Document: Technical Construction File

File No：TCF22041513MD

Revision:V1

Date: 2022.04.15

Boring machine

Models:TK、TH、FA、T、TPX、CKE、CLS、DL、DT、VT、C、CK、VTC、AK、SM、SC、SX、VDL、VDLS、HDAL 、MDV、TD 、VDF、VDM 、VMC 、MDH、X 、XD-A 、VC5A、VDU、VDW、VC、CMV、XKW

According to

Machinery Directive 2006/42/EC

presented by

General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.
No.100,Liaohe East Road,Dalian Economic and Technological Development Zone-East Zone 1

Content

Part I：General

1.1 General description

The product is Boring machine.

In order to prevent the main risks mentioned above, the protection guarding system are provided, and all the detail safety provision are constructed in accordance with the requirement of EN ISO 12100:2010 and EN13128:2001+A2:2009/AC:2010.

As for the compliance of low voltage risk, the inspection and test report carried out according to the European standards of EN 60204-1:2018.

In order to ensure the conformity for CE marking for these machines, some main European and/or International standards have been used to made assessment of conformity, they are:
－EN ISO 12100:2010 and EN13128:2001+A2:2009/AC:2010 for checking of mechanical structures and carrying out risk assessment;
－EN 60204-1:2018 for checking of electrical equipment;

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

1.2 Variations of the series products

Regarding the whole family of the series, they can be divided into various different groups according to their main features, they are:

TK、TH、FA、T、TPX、CKE、CLS、DL、DT、VT、C、CK、VTC、AK、SM、SC、SX、VDL、VDLS、HDAL 、MDV、TD 、VDF、VDM 、VMC 、MDH、X 、XD-A 、VC5A、VDU、VDW、VC、CMV、XKW

All models are with the same machine structure but with some small differences as described as the following:

1. The power is different.
2. The Spindle travel is different.
3. The weight is different.

To present the conformity of this series machine with Machinery Directive, we discuss the conformity systematically with the relative Directive and standards for XD-A as a basic evaluation in clause.

1.3 List of applicable regulations and standards

Regulations

- Machinery Directive: 2006/42/EC

Standards

- EN ISO 12100: 2010

Safety of machinery — General principles for design — Risk assessment and risk reduction.

- EN 60204-1:2018

Safety of machinery - Electrical equipment of machines Part 1: General requirements

- EN 14120:2010

Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards

- EN ISO 13850:2008

Safety of machinery — Emergency stop —Principles for design

- EN 13128:2001+A2:2009/AC:2010

Safety of machine tools — Milling machines (including boring machines)

1.4 Quality control system

In order to ensure the conformity of the series production, the **General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.** has taken the related procedures mentioned below：

（1）Apply for the consultant form the qualified body in Italy.

The General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd. has applied for the consultant from Technical Inspection Certification.

The complete technical construction file（TCF）have been established before applying for the CE marking certificate.

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

Before the assemblies of the series production, the QC engineers of General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd. has to check and inspect the technical specifications and intended functions of parts and components to ensure the correct use of them according to the contents of TCF and principle described in the related technical information.

（3）Carry out the inspection ＆ testing for the products before packing

Before packing the products, the QC engineers of General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd. have to do the necessary inspection and testing to ensure the conformity of related requirements. In particular, they should do the testing and inspection of electrical characteristics and outer feature.

（4）Carry out the inspection for the package.

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

（5）Provision for the change of design

Any change of the products described in this TCF must be checked in detail and written down again in the TCF by the designer of General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd. if the change may effects the related electrical or mechanical characteristics.

（6）Provision for the Quality Assurance

For the provisions of internal control measures to ensure the conformity of series production of the machines, General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd. has built an internal quality control system in accordance with the international standard of ISO 9001.

Part II：Assessment of conformity

2. Essential health and safety requirements checklist

ASSESSMENT REPORT
per
Council Directive 2006/42/EC, Annex I

ESSENTIAL HEALTH AND SAFETY REQUIREMENTS

TCF
Reference No. ..... : No: TCF22041513MD
Tested by(+ signature).....:Jim Song
Reviewed by(+ signature).....:Jack Ma
Date of issue ..... : 2022-04-15
Number of pages (Report) ..... : 8

Applicant
Name .....: General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.
Address ..... :No.100,Liaohe East Road,Dalian Economic and Technological Development Zone-East Zone 1

Test specification
Standard ..... : Council Directive 2006/42/EC Annex I
Test procedure ..... : CE-MD
Non-standard test method ..... : N.A.

Test item description：
Manufacturer..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.
Factory..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.
Trademark ..... : NA
Model/Type reference ..... : XD-A
Rating(s) ..... : 380V 50Hz

General product information:
The product is Boring machine.

Council Directive 2006/42/EC, Annex I			
Clause	Requirement-Test	Result-Remark	Verdict
1	**Essential health and safety requirements**		-
1.1	**General remarks**		-
1.1.1	Definitions		P
1.1.2	Principles of safety integration	Considered for the machine professionally. See the drawings and instruction.	P
1.1.3	Materials and products	The materials and products is safe, no hazards.	P
1.1.4	Lighting		N
1.1.5	Design of machinery to facilitate its handling	The machine is well designed to facilitate its handling.	P
1.1.6	Ergonomics	Comply with requirement	P
1.1.7	Operating positions	No hazards in the operating positions	P
1.1.8	Seating	No seat.	N
1.2	**Controls**		-
1.2.1	Safety and reliability of control systems	Reliable design, certificated control components provided, no dangerous.	P
1.2.2	Control devices	Identification clear, durable. The movement of the control is consistent with its effect. Locations are adequate to operate.	P
1.2.3	Starting	Start button provided. Not restart after stop.	P
1.2.4	Stopping	See below.	P
1.2.4.1	Normal stopping	Mains power switch provided. It cut off the power.	P
1.2.4.2	Operational stop	Stop button and soft stop button of touch screen used	P
1.2.4.3	Emergency stop		P
1.2.4.4	Assembly of machinery		N
1.2.5	Selection of control or operating modes	Manual and auto mode	P
1.2.6	Failure of the power supply	AC power supply used. all the movement of the machine stopped immediately once failure of the power supply presented, don't lead dangerous situation.	P
1.3	**Protection against mechanical hazards**	See below	P
1.3.1	Risk of loss of stability	The machine is stable enough.	P
1.3.2	Risk of break-up during operation	Fixed guard provided	P
1.3.3	Risked due to falling or ejected objects	Guard to prevent the ejected objects.	P
1.3.4	Risks due to surfaces, edges or angles	Smooth surface and edges	P
1.3.5	Risks related to combined machinery		N
1.3.6	Risks related to variations in operating conditions	No such hazards	P
1.3.7	Prevention of risks related to moving parts	The moving parts are separated by interlock guard and fixed guards. Some parts are added warning signs.	P
1.3.8	Choice of protection against risk arising from	Guards are used to protect	P

Council Directive 2006/42/EC, Annex I			
Clause	Requirement-Test	Result-Remark	Verdict
	moving parts	against risk.	
1.3.8.1	Moving transmission parts	Fixed guards provided, and all of the moving parts are separated by guard.	P
1.3.8.2	Moving parts involved in the process	Fixed guards provided.	P
1.3.9	Risks of uncontrolled movements	No such risk.	N
1.4	Required characteristics of guards and protection devices	See below	P
1.4.1	General requirement	Comply with the requirement	P
1.4.2	Special requirements for guards		P
1.4.2.1	Fixed guards	Cannot be apart without tools	P
	Fixed guards must be fixed by systems that can be opened or removed only with tools.	Can be opened only with tools	P
	Their fixing systems must remain attached to the guards or to the machinery when the guards are removed.	The bolts remain attached to the guards.	P
1.4.4.2	Interlocking movable guards		N
1.4.2.3	Adjustable guards restricting access	Not provided	N
1.4.3	Special requirements for protection devices	No such special requirements.	N
1.5	**Protection against other hazards**	See below	P
1.5.1	Electricity supply	AC power supply provided and protection is enough, see the report for EN 60204-1.	P
1.5.2	Static electricity	Comply with the requirement. PE system.	P
1.5.3	Energy supply other than electricity		P
1.5.4	Error of fitting	The machine should be well fitted and installed by Manufacturer. See the drawings and instruction.	P
1.5.5	Extreme temperatures		P
1.5.6	Fire	The machine was well designed and manufactured to avoid fire.	P
1.5.7	Explosion	The machine can’t used in potencial explosion environment, and the machine was well designed and manufactured to avoid explosion.	P
1.5.8	Noise	The noise that emitted by the machine is at a level <85dB(A), the operator worked around the control station.	P
1.5.9	Vibration		N
1.5.10	Radiation	Not within the assessment scope	N
1.5.11	External radiation	Not within the assessment scope	N
1.5.12	Laser equipment		N
1.5.13	Emissions of hazardous materials and	During the operation, using	P

Council Directive 2006/42/EC, Annex I			
Clause	Requirement-Test	Result-Remark	Verdict
	substances	the exhaust system	
1.5.14	Risk of being trapped in a machine	No such hazards	P
1.5.15	Risk of slipping, tripping or falling	Using personal fall protection equipment	P
1.5.16	Lightning		P
1.6	**Maintenance**	See below	P
1.6.1	Machinery maintenance	Professional maintainer required,see user manual. outside danger zones.	P
1.6.2	Access to operating position and servicing points	Comply with the requirement. access in safety to all areas	P
1.6.3	Isolation of energy sources	See report of EN 60204-1.	P
1.6.4	Operator intervention	Professional maintainer required	P
1.6.5	Cleaning of internal parts	Easy to access and clean.	P
1.7	**Indicators**	See below	P
1.7.1	Information and warnings on machinery	Comply with the requirement	P
1.7.1.1	Information and information devices	See the labels on the machine.	P
1.7.1.2	Warning devices	warning device and warning signs are provided	P
1.7.2	Warning of residual risks	Comply with requirements. See the copy of marking label .	P
1.7.3	Marking of machinery	See the marking on the machine.	P
1.7.4	Instruction		P
1.7.4.1	General principles for the drafting of instructions	See the instruction	P
1.7.4.2	Contents of the instructions	See the instruction	P
1.7.4.3	Sales literature	The same as instruction	P
2	**SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS FOR CERTAIN CATEGORIES OF MACHINERY**	Not such machine	N
2.1.	**FOODSTUFFS MACHINERY AND MACHINERY FOR COSMETICS OR PHARMACEUTICAL PRODUCTS**		N
2.2	**PORTABLE HAND-HELD AND/OR HAND-GUIDED MACHINERY**		N
2.3	**MACHINERY FOR WORKING WOOD AND MATERIAL WITH SIMILAR PHYSICAL CHARACTERISTICS**		N
3	**Essential health and safety requirement to offset the particular hazards due to the mobility machinery**	Not mobility machine	N
3.1	**General**		N
3.1.1	Definition		N
3.2	**Work positions**		N
3.2.1	Driving position		N
3.2.2	Seating		N
3.2.3	Positions for other persons		N
3.3	**Controls**		N

Council Directive 2006/42/EC, Annex I			
Clause	Requirement-Test	Result-Remark	Verdict
3.3.1	Control devices		N
3.3.2	Starting/moving		N
3.3.3	Travelling function		N
3.3.4	Movement of pedestrian-controlled machinery		N
3.3.5	Control circuit failure		N
3.4	**Protection against mechanical hazards**		N
3.4.1	Uncontrolled moverments		N
3.4.2	Moving transmission parts		N
3.4.3	Roll-over and tip-over		N
3.4.4	Falling objects		N
3.4.5	Means of access		N
3.4.6	Towing devices		N
3.4.7	Transmission of power between self-propelled machinery (or tractor) and recipient machinery		N
3.5	**Protection against other hazards**		N
3.5.1	Batteries		N
3.5.2	Fire		N
3.5.3	Emissions of hazardous substances		N
3.6	**Indications**		N
3.6.1	Signs, signals and warnings		N
3.6.2	Marking		N
3.6.3	Instruction handbook		N
3.6.3.1	Vibrations		N
3.6.3.2	Multiple uses		N
4	**Essential health and safety requirement to offset the particular hazards due to a lifting operation**		N
4.1	**General**		N
4.1.1	Definition		N
4.1.2	Protection against mechanical hazards		N
4.1.2.1	Risk due to lack of stability		N
4.1.2.2	Machinery running on guide rails and rail tracks		N
4.1.2.3	Mechanical strength		N
4.1.2.4	Pulleys, drums, wheels, chains or ropes		N
4.1.2.5	Lifting accessories and their components		N
4.1.2.6	Control of movements		N
4.1.2.7	Movements of loads during handling		N
4.1.2.8	Machinery serving fixed landings		N
4.1.2.8.1	Movements of the carrier		N
4.1.2.8.2	Access to the carrier		N
4.1.2.8.3	Risks due to contact with the moving carrier		N
4.1.2.8.4	Risk due to the load falling off the carrier		N
4.1.2.8.5	Landings		N
4.1.3	Fitness for purpose		N
4.2	**Requirements for machinery whose power source is other than manual effort**		N
4.2.1	Control of movements		N

Council Directive 2006/42/EC, Annex I			
Clause	Requirement-Test	Result-Remark	Verdict
4.2.2	Loading control		N
4.2.3	Installation guided by cables		N
4.3	**Information and markings**		N
4.3.1	Chains, ropes and webbing		N
4.3.2	Lifting accessories		N
4.3.3	Lifting machinery		N
4.4	**Instructions**		N
4.4.1	Lifting accessories		N
4.4.2	Lifting machinery		N
5	**Essential health and safety requirement for machinery intended for underground work**	Not such machine	N
5.1	**Risks due to lack of stability**		N
5.2	**Movement**		N
5.3	**Control devices**		N
5.4	**Stopping**		N
5.5	**Fire**		N
5.6	**Exhaust emissions**		N
6	**Essential health and safety requirement to offset the particular hazards due to the lifting or moving of persons**		N
6.1	**General**		N
6.1.1	Mechanical strength		N
6.1.2	Loading control for machinery moved by power other than human strength		N
6.2	**Control devices**		N
6.3	**Risk to persons in or on the carrier**		N
6.3.1	Risks due to movements of the carrier		N
6.3.2	Risk of persons falling from the carrier		N
6.3.3	Risk due to objects falling on the carrier		N
6.4	**Machinery serving fixed landings**		N
6.4.1	Risks to persons in or on the carrier		N
6.4.2	Controls at landings		N
6.4.3	Access to the carrier		N
6.5	**Markings**		N

Notice

1. This test report shall be invalidation without the cachet of the testing laboratory.
2. This copied report shall be invalidation without sealed the cachet of the testing laboratory.
3. This report shall be invalidation without tester signature, reviewer signature and approver signature.
4. This altered report shall be invalidation.
5. Client shall put forward demurrer within 15days after received report. The testing laboratory shall refuse disposal if exceeded the time limit.
6. The test results presented in this report relate only to the object tested.

Part III：Assessment report

3.1 EN ISO 12100:2010 Assessment report and Risk assessment

ASSESSMENT REPORT

per

EN ISO 12100:2010

Safety of machinery — General principles for design —

Risk assessment and risk reduction

TCF

Reference No. ..... : No: TCF22041513MD

Tested by(+ signature).....:Jim Song

Reviewed by(+ signature).....:Jack Ma

Date of issue ..... : 2022-04-15

Number of pages (Report) ..... : 45

Applicant

Name .....: General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Address ..... :No.100,Liaohe East Road,Dalian Economic and Technological Development Zone-East Zone 1

Test specification

Standard ..... : EN ISO 12100:2010

Test procedure ..... : CE-MD

Non-standard test method ..... : N.A.

Test item description:

Manufacturer..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Factory..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Trademark ..... : NA

Model/Type reference ..... : XD-A

Rating(s) ..... : 380V 50Hz

General product information:

The product is Boring machine.

1. Risk assessment

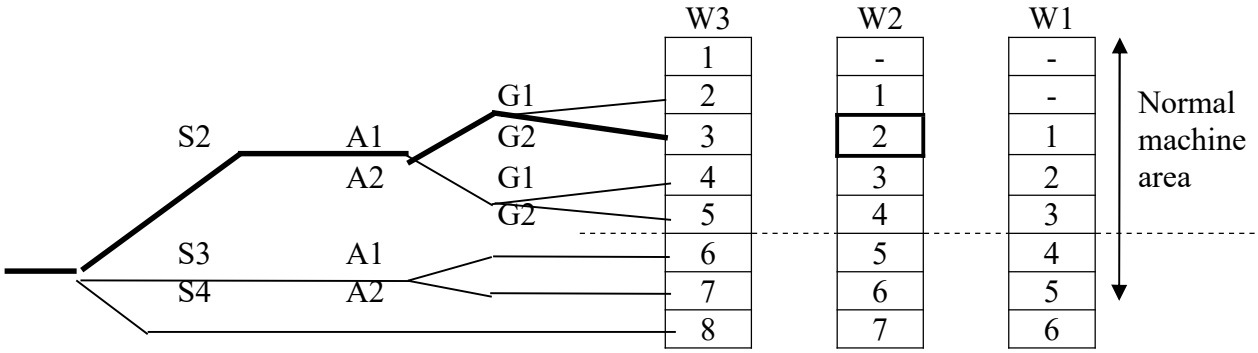
This risk assessment report is based on the methods in the EN ISO 12100:2010 and EN ISO 14121-2 standards, and the 4 factors S-A-G-W have been used for evaluating the level of risks.

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	***2***	***1***	***1***	***2***	***1***
1.2	Shearing	***2***	***1***	***1***	***2***	***1***
1.3	Cutting or severing	***2***	***1***	***1***	***2***	***1***
1.4	Entanglement	***2***	***1***	***1***	***2***	***1***
1.5	Drawing-in or trapping	***2***	***1***	***1***	***2***	***1***
1.6	Impact	***2***	***1***	***1***	***2***	***1***

1.7	Stabbing or puncture	***2***	***1***	***1***	***2***	***1***
1.8	Friction or abrasion					
1.9	High pressure fluid injection or ejection					
Electrical hazards						
2.1	Contact with live parts	***2***	***1***	***1***	***2***	***1***
2.2	Contact with parts which have become live under faulty conditions	***2***	***1***	***1***	***2***	***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	***1***	***1***	***1***	***1***	**-**
4.2	Interference with speech communication, acoustic signals, etc.	***1***	***1***	***1***	***1***	**-**
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	***1***	***1***	***1***	***1***	**-**
7.2	Fire and explosion hazard					
7.3	Biological and micro-biological (viral or bacterial) hazards	***1***	***1***	***1***	***1***	**-**
Hazards generated by neglecting ergonomic principles in machine design						
8.1	Unhealthy postures or excessive effort	***2***	***1***	***1***	***2***	***1***
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	***2***	***1***	***1***	***2***	***1***
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	***2***	***1***	***1***	***2***	***1***
8.7	Inadequate design, location or identification of manual controls	***2***	***1***	***1***	***2***	***1***
8.8	Inadequate design, location or identification of manual controls	***2***	***1***	***1***	***2***	***1***
Combination of hazards						

9	Combination of hazards					
Unexpected start-up, unexpected overrun/over-speed						
10.1	Failure/disorder of the control system	***1***	***1***	***1***	***1***	**-**
10.2	Restoration of energy on supply after an interruption	***1***	***1***	***1***	***1***	**-**
10.3	External influences on electrical equipment	***1***	***1***	***1***	***1***	**-**
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	***1***	***1***	***1***	***1***	**-**
Failure of the control circuit						
14	Failure of the control circuit	***1***	***1***	***1***	***1***	**-**
Errors of fitting						
15	Errors of fitting	***1***	***1***	***1***	***1***	**-**
Break-up during operation						
16	Break-up during operation					
Falling or ejected objects or fluids						
17	Falling or ejected objects or fluids	***1***	***1***	***1***	***1***	**-**
Loss of stability / overturning of machinery						
18	Loss of stability / overturning of machinery	***1***	***1***	***1***	***1***	**-**
Slip, trip and fall of persons (related to machinery)						
19	Slip, trip and fall of persons(related to machinery)	***1***	***1***	***1***	***1***	**-**
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					
21.10	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	***1***	***1***	***1***	***1***	**-**
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	***1***	***1***	***1***	***1***	**-**
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**
1.1	Crushing	***2***	***1***	***1***	***2***	***1***
Where	*Between fixed and moving elements of the machine*					
When	*Moving axes, workpiece and tool clamping setting, loading/unloading, maintenance*					
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.* *4. Check and inspection according to the specified durations of the instruction manual.* *5. Using the guards*		***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
1.2	Shearing	***2***	***1***	***1***	***2***	***1***
Where	*Between tool/ spindle and table/ workpiece*					
When	*Moving axes, machine operation*					
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.* *4. Check and inspection according to the specified durations of the instruction manual.* *5. Using the guards*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
1.3	Cutting or severing	***2***	***1***	***1***	***2***	***1***
Where	*At spindle or tool*					
When	*Spindle running*					
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.* *4. Check and inspection according to the specified durations of the instruction manual.* *5. Using the guards*	***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
1.4	Entanglement	***2***	***1***	***1***	***2***	***1***
Where	*At spindle or tool*					
When	*Rotating spindle or tool removal of swarf/chips, Workpiece load/unload, positional adjustment,manual swarf/chip removal, cutting fluid application*					
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.* *4. Check and inspection according to the specified durations of the instruction manual.* *5. Using the guards.*	***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
1.5	Drawing in or trapping	***2***	***1***	***1***	***2***	***1***
Where	*Envelope of movement of workpiece on table axes; envelope of movement of tool in spindle head*					
When	*Rapid travel of table or spindle head, power–operated motion of workpiece on table or tool in spindle*					
Improvement result						

Method	**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Connection of protective earthing indeed.* *4.Excellent electrical shielded housing.* *5.Periodic maintenance.*	***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
1.6	Impact	***2***	***1***	***1***	***2***	***1***
Where	*At spindle or tool*					
When	*Moving/rotating tool, spindle running*					
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.* *4. Check and inspection according to the specified durations of the instruction manual.* *5. Using the guards*	***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
1.7	Stabbing or puncture	***2***	***1***	***1***	***2***	***1***

Where	*At tool in spindle, at sharp cutter faces, at workpiece, table, and swarf /chip collecting and discharge zones*					
When	*Process control, during manual tool change, during loading/unloading and cleaning*					
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.* *4. Check and inspection according to the specified durations of the instruction manual.* *5. Using the guards*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
2.1	Contact with live parts	***2***	***1***	***1***	***2***	***1***
Where	*Electrical cabinet, terminal boxes, control panels at machine*					
When	*Contact with live parts or connections during commissioning, maintenance, trouble shooting*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. *Only operation by training/authorized persons.* *2. Operation of the machine shall conform to the instructions of the instruction manual.* *3. Check and inspection according to the specified durations of the instruction manual.* *4. Using safety components in accordance with those relevant international standards.* *5.Use of warning label.*		***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
2.2	Contact with parts which have become live under faulty conditions	***2***	***1***	***1***	***2***	***1***
Where	*At machine or faulty part*					
When	*Contact with live parts or connections during operation, inspection and maintenance of machine*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. *Only operation by training/authorized persons.* *2. Operation of the machine shall conform to the instructions of the instruction manual.* *3. Check and inspection according to the specified durations of the instruction manual.* *4. Using safety components in accordance with those relevant international standards.* *5.Use of warning label.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
4.1	Hearing loss (deafness), other physiological disorders	***1***	***1***	***1***	***1***	**-**
Where	*Near machine*					

When	*Motion of power transmission elements, cutting processes and fluid power systems during operating cycle of machine*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Noise reduction at source by design *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
4.2	Interference with speech communication, acoustic signals, etc.	***1***	***1***	***1***	***1***	**-**
Where	*Near machine*					
When	*Air blast used for cleaning of tool or pallet locations during operating cycle of machine*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Noise reduction at source by design *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
7.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	***1***	***1***	***1***	***1***	**-**
Where	*At or near machine*					
When	*Conditions near machine caused by ejection of particles of work material, fluid droplets or mist from metal working fluids during operating cycle of the machine*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.* *4.Periodic maintenance.* *5.Use safety guard.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
7.3	Biological and micro-biological (viral or bacterial) hazards	***1***	***1***	***1***	***1***	**-**
Where	*At or near machine*					
When	*contact with hydraulic or metal working fluid as liquid or mist containing detritus and bacteria during operation, process control, and maintenance*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.* *4.Periodic maintenance.* *5.Use safety guard.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
8.1	Unhealthy postures or excessive effort	***2***	***1***	***1***	***2***	***1***
Where	*At load/unload and tool mounting positions, maintenance action points*					

When	*Lifting and reaching while handling workpiece, tools, and machine parts during loading/unloading, process control, and maintenance*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Training before using this machine.* *3.Make reference to the instruction manual before using this machine.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	***2***	***1***	***1***	***2***	***1***
Where	*At load/unload and tool mounting positions, maintenance action points*					
When	*Inappropriate location of controls during loading/unloading, process control, and maintenance*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Training before using this machine.* *3.Make reference to the instruction manual before using this machine.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
8.6	Human error, human behavior	***2***	***1***	***1***	***2***	***1***
Where	*At load/unload, tool mounting positions* at load/unload,					
When	*Reasonably foreseeable misuse, inadvertent operation of controls, incorrect work material and cutter handling and setting during loading/unloading, process control, tool handling*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Training before using this machine.* *3.Make reference to the instruction manual before using this machine.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
8.7	Inadequate design, location or identification of manual controls	***2***	***1***	***1***	***2***	***1***
Where	*At or near machine*					
When	*Inadvertent operation of controls during setting, operating cycle*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Training before using this machine.* *3.Make reference to the instruction manual before using this machine.*		***1***	***1***	***1***	***1***	**-**
NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
8.8	Inadequate design, location or identification of manual controls	***2***	***1***	***1***	***2***	***1***
Where	*At or near machine*					
When	*Misinterpretation of displayed information during setting, operating cycle*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1.Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.* *4.Periodic maintenance.*		***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	S	A	G	W	Level
10.1	Failure/disorder of the control system	*1*	*1*	*1*	*1*	-
Where	*At machine*					
When	*mechanical hazards associated with selected machine movement during setting, cleaning*					
Improvement result						
Method		S	A	G	W	Level
1.Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.* *4.Periodic maintenance.*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	S	A	G	W	Level
10.2	Restoration of energy on supply after an interruption	*1*	*1*	*1*	*1*	-
Where	*At or near machine*					
When	*Unexpected movements of machine during setting, cleaning or maintenance*					
Improvement result						
Method		S	A	G	W	Level
1.Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Connection of protective earthing indeed.* *4.Excellent electrical shielded housing.* *5.Periodic maintenance.*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	S	A	G	W	Level
10.3	External influences on electrical equipment	*1*	*1*	*1*	*1*	-
Where	*At or near machine*					
When	*Unpredictable behavior of electronic controls due to electromagnetic interference during setting, cleaning or maintenance.*					
Improvement result						
Method		S	A	G	W	Level
1. All electrical equipments have been submitted to carry out the EMC testing according to relevant EN standards and get the CE E-mark. *2. Connection of protective earthing indeed.* *3. Excellent electrical shielded housing.*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	S	A	G	W	Level
13	Failure of the power supply	*1*	*1*	*1*	*1*	-
Where	*At machine where machine elements retained in a safe condition by the application of power .*					
When	*Malfunctions of the control with consequent misapplication of stored energy or power. Power work holding fails, motor overspeed. Part breakage causes machine elements to move under residual forces causing external elements to move unexpectedly during operation, process control, maintenance.*					
Improvement result						
Method		S	A	G	W	Level
1. Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.* *4. Periodic maintenance.*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	S	A	G	W	Level

14	Failure of the control circuit	*1*	*1*	*1*	*1*	-
Where	*At or near machine*					
When	*Unexpected movements of machine during setting, cleaning or maintenance*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Checking before operation. *2. Make reference to the instruction manual before operate this machine.* 3. *Daily/periodic inspection and maintenance.*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
15	Errors of fitting	*1*	*1*	*1*	*1*	-
Where	*At machine*					
When	*Machine elements fail or swing unexpectedly during process control, tool mounting, maintenance*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Only authorized person can use the machine. *2.Make reference to the instruction manual before using this machine.* *3.Check before operation.* *4. Periodic maintenance.*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
17	Falling or ejected objects or fluids	*1*	*1*	*1*	*1*	-
Where	*At or near machine*					
When	*Ejection of machine parts, workpiece or tools caused by clamping device, control system failures or collision due to data errors during the operating cycle of the machine*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Only authorized person can use the machine. *2. Make reference to the instruction manual before using this machine.* *3. Check before operation.* *4. Periodic maintenance*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
18	Loss of stability / overturning of machinery	*1*	*1*	*1*	*1*	-
Where	*At machine*					
When	*Unrestrained machine or machine part falls or overturns during loading/unloading and process control, at heavy/unwieldy workpieces during maintenance*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Only authorized person can use the machine. *2. Make reference to the instruction manual before using this machine.* *3. Check before operation.* *4. Periodic maintenance*		*1*	*1*	*1*	*1*	-

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
19	Slip, trip and fall of persons(related to machinery)	*1*	*1*	*1*	*1*	-
Where	*Machine table, floor area around machine and workpiece permanent means of access to the machine*					

When	*Ejection or spillage of metal working fluids and lubricants during workpiece load/unload, setting, process control and maintenance work at heights work to replenish fluids (e.g. lubricants)*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Only authorized person can use the machine. *2. Make reference to the instruction manual before using this machine.* *3. Check before operation.* *4. Periodic maintenance*		***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
25.1	Unauthorized start-up/use	***1***	***1***	***1***	***1***	**-**
Where	Control system					
When	*Operation, adjustment or maintenance of the machine*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Always starting the machine by training/authorized persons. *2. During adjustment or maintenance, put a warning nameplate near the working area.* 3. *Lock the power switch of the machine.*		***1***	***1***	***1***	***1***	**-**

NO.	Hazards source	**S**	**A**	**G**	**W**	**Level**
26	Insufficient instructions for the driver/operator	***1***	***1***	***1***	***1***	**-**
Where	Whole machine					
When	*Installation, assembly/disassembly, operation, adjustment or maintenance of the machine*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Edit the instruction manual in conformity with those requirement of Machinery Directive and EN ISO 12100：2010 standard. 2. *Each machine accompanied with a complete instruction manual.*		***1***	***1***	***1***	***1***	**-**

2. EN ISO 12100:2010 part 6-7

EN ISO 12100:2010			
Clause	Requirement-Test	Result-Remark	Verdict
6	**Risk reduction**		**P**
6.1	General		P
	The objective of risk reduction can be achieved by the elimination of hazards, or by separately or simultaneously reducing each of the two elements that determine the associated risk: -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).	Appropriate machine design has been performed by the manufacturer	P
6.2	Inherently safe design measures		P

EN ISO 12100:2010			
Clause	Requirement-Test	Result-Remark	Verdict
6.2.1	General		P
	Inherently safe design measures are the first and most important step in the risk reduction process because protective measures inherent to the characteristics of the machine are likely to remain effective, whereas experience has shown that even well-designed safeguarding may fail or be violated and information for use may not be followed.	Appropriate machine design has been performed by the manufacturer.	P
	Inherently safe design measures are achieved by avoiding hazards or reducing risks by a suitable choice of design features of the machine itself and/or interaction between the exposed persons and the machine. NOTE See 6.3 for safeguarding and complementary measures that can be used to achieve the risk reduction objectives in the case where inherently safe design measures are not sufficient (see 6.1 for the three-step method).	Appropriate machine design has been performed by the manufacturer.	P
6.2.2	Consideration of geometrical factors and physical aspects		P
6.2.2.1	Geometrical factors		P
	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 traveling 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.	Reducing blind spots	P
	b) The form and the relative location of the mechanical components parts: for instance, crushing and shearing hazards are avoided by increasing the minimum gap between the moving parts, such that the part of the body under consideration can enter the gap safely, or by reducing the gap so that no part of the body can enter it (see ISO 13854 and ISO 13857).	By increasing the minimum gap between the moving parts or by reducing the gap.	P

EN ISO 12100:2010			
Clause	Requirement-Test	Result-Remark	Verdict
	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.	No sharp edges, no sharp angles, no rough surfaces, no protruding parts.	P
	d) The form of the machine is designed so as to achieve a suitable working position and provide accessible manual controls (actuators).	Suitable working position,accessible manual controls.	P
6.2.2.2	Physical aspects		P
	Such aspects include the following:		-
	a) limiting the actuating force to a sufficiently low value so that the actuated part does not generate a mechanical hazard;	The actuating force has been limited to be a sufficiently low value.	P
	b)limiting the mass and/or velocity of the movable elements, and hence their kinetic energy;		P
	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 the general technical knowledge regarding machine design		P
	This general technical knowledge can be derived from technical specifications for design (e.g. standards, design codes, calculation rules).These should be used to cover :		-

EN ISO 12100:2010			
Clause	Requirement-Test	Result-Remark	Verdict
	a) mechanical stresses such as - stress limitation by implementation of correct calculation, construction and fastening methods as regards, e.g. bolted assemblies, welded assemblies - stress limitation by overload prevention, (e.g. “fusible” plugs, pressure-limiting valve, breakage points, torque-limiting devices); - avoiding fatigue in elements under variable stresses (notably cyclic stresses); - static and dynamic balancing of rotating elements;	The appropriate technical knowledge of mechanical has been taken into account.	P
	b) materials and their properties such as - resistance to corrosion, aging, abrasion and wear; - hardness, ductility, brittleness; - homogeneity; - toxicity; - flammability.	The materials have been treated by appropriate methods.	P
	c) emission values for : - noise; - vibration; - hazardous substances; - radiation.		P
	When the reliability of particular components or assemblies is critical for safety (e.g. ropes, chains, lifting accessories for lifting loads or persons), stress values shall be multiplied by appropriate working coefficients.	Appropriate working coefficients have been taken into account during design and calculation.	P
6.2.4	Choice of an appropriate technology		N
	One or more hazards can be eliminated or risks reduced by the choice of the technology to be used in certain applications, e.g. :		-
	a) on machines intended for use in explosive atmospheres: - fully pneumatic or hydraulic control system and machine actuators; - “intrinsically safe” electrical equipment (see IEC 60079-11)		N
	b) for particular products to be processed such as a solvent: equipment assuring that the temperature will remain far below the flash point.		N
	c) alternative equipment to avoid high noise level, e.g.: - electrical instead of pneumatic equipment - in certain conditions, water cutting instead of		N

EN ISO 12100:2010			
Clause	Requirement-Test	Result-Remark	Verdict
	mechanical equipment.		
6.2.5	Applying the principle of the positive mechanical action		N
	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).		N
6.2.6	Provisions for stability		P
	Machines shall be designed to have sufficient stability to allow them to be used safely in their specified conditions of use.	These machines have been designed to have sufficient stability .	P
	Factors to be taken into account include		-
	- geometry of the base;	The factor has been taken into account during design.	P
	- weight distribution, including loading;	The factor has been taken into account during design.	P
	- dynamic forces due to movements of parts of the machine, of the machine itself, or of elements held by the machine which may result in an overturning moment;	The factor has been taken into account during design.	P
	- vibration	The factor has been taken into account during design.	P
	- oscillations of the center of gravity;		N
	- characteristics of the supporting surface in case of traveling or installation on different sites (e.g. ground conditions, slope);	The factor has been taken into account during design.	P
	- external forces (e.g. wind pressure, manual forces)	The factor has been taken into account during design.	P
	Stability shall be considered in all phases of the life of the machine, including handling, traveling, installation, use, decommissioning and dismantling.	The factor has been taken into account during design.	P
	Other protective measures for stability relevant to safeguarding are given in 6.3.2.6	Please see the related clause.	P
6.2.7	Provision for maintainability		P
	When designing a machine, the following maintainability factors shall be taken into account:		-
	- accessibility, taking into account the environment and the human body measurements, including the dimensions of the working clothes and tools used;	These factors have been taken into account during	P

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		design.	
	- ease of handling, taking into account human capabilities;	The factor has been taken into account during design.	P
	- limitation of the number of special tools and equipment;	The factor has been taken into account during design.	P
6.2.8	Observing ergonomic principles		P
	Ergonomic principles shall be taken into account in designing machinery to reduce mental or physical stress and strain of the operator.	Appropriate ergonomic principles have been taken into account in designing machinery.	P
	These principles shall be considered when allocating functions to operator and machine (degree of automation) in the basic design.	These principles have been taken into account during allocating functions to operator and machine.	P
	Account shall be taken of body sizes likely to be found in the intended user population, strengths and postures, movement amplitudes, frequency of cyclic actions (see ISO 10075 and ISO 10075-2)	All these factors have been taken into account during design.	P
	All elements of the “operator-machine” interface such as controls, signaling or data display elements, shall be designed to be easily understood so that clear and unambiguous interaction between the operator and the machine is possible.(see EN 614-1, ISO 6385, EN 13861 and IEC 61310-1)	All arrangement and design of manual controls have been checked in compliance with.	P
	Designer’s attention is especially drawn to following ergonomic aspects of machine design		-
	a) Avoiding stressful postures and movements during use of the machine (e.g. by providing facilities to adjust the machine to suit the various operators).	Stressful postures and movements during use of the machine have been avoided.	P
	b) Designing machines, and more especially hand-held and mobile machines to enable them to be operated easily taking into account human effort, actuation of controls and hand, arm and leg anatomy.	This machine has been adjusted to the human strength and convenient movement.	P
	c) Limit as far as possible noise, vibration and thermal effects such as extreme temperatures.	This machine has been designed with low noise, vibration.	P
	d) Avoid linking the operator's working rhythm to an automatic succession of cycles.	This situation has been avoided.	P

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	e) Providing local lighting on or in the machine for the illumination of the working area and of adjusting, setting-up, and frequent maintenance zones when the design features of the machine and /or its guards render the ambient lighting inadequate. Flicker, dazzling, shadows and stroboscopic effects shall be avoided if they can cause a risk. If the position of the lighting source has to be adjusted, its location shall be such that it does not cause any risk to persons making the adjustment.		N
	f) Select, locate and identify manual controls (actuators) so that		-
	- they are clearly visible and identifiable and appropriately marked where necessary (see6.4.4)	Clearly visible and appropriately marked	P
	- they can be safely operated without hesitation or loss of time and without ambiguity (e.g. a standard layout of controls reduces the possibility of error when an operator changes from a machine to another one of similar type having the same pattern of operation)	Standard layout of controls. See the photos.	P
	- their location(for push-buttons) and their movement (for levers and handwheels) are consistent with their effect (see IEC 61310-3)	Push-buttons are consistent with their effect.	P
	- their operation cannot cause additional risk		P
	Where a control is designed and constructed to perform several different actions, namely where there is no one-to-one correspondence (e.g. keyboards), the action to be performed shall be clearly displayed and subject to confirmation where necessary.	one-to-one correspondence	N
	Controls shall be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	Taking account of ergonomic principles	P
	Constraints due to the necessary or foreseeable use of personal protective equipment(such as footwear, gloves)shall be taken into account.	safety glove, safety footwear	P
	g) Select, design and locate indicators, dials and visual display units so that		-
	- they fit within the parameters and characteristics of human perception		P
	- information displayed can be detected, identified and interpreted conveniently, i.e. long lasting, distinct, unambiguous and understandable with respect to the	All the information displayed comply with this requirement.	P

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	operator's requirements and the intended use;		
	- the operator is able to perceive them form the control position		P
6.2.9	Preventing electrical hazard		P
	For the design of the electrical equipment of machines EN 60204-1 gives general provisions, especially in clause 6 for protection against electric shock.	See the test report of EN 60204-1	P
	For requirements related to specific machines, see corresponding IEC standards (e.g. series of IEC 61029, IEC 60745, IEC 60335).		N
6.2.10	Pneumatic and hydraulic hazards		P
	Pneumatic and hydraulic equipment of machinery shall be designed so that :		-
	- the maximum rated pressure cannot be exceeded in the circuits (e.g. by means of pressure limiting devices)		P
	- no hazard results from pressure surges or rises, pressure losses or drops or losses of vacuum;		P
	- no hazardous fluid jet or sudden hazardous movement of the hose (whiplash)results from leakage or component failures;		P
	- air receivers, air reservoirs or similar vessels (e.g. in gas loaded accumulators) comply with the design rules for these elements;		P
	- air elements of the equipment, and especially pipes and hoses, be protected against harmful external effects;		P
	- as far as possible, reservoirs and similar vessels (e.g. in gas loaded accumulators)are automatically depressurized when isolating the machine from its power supply (see 6.3.5.4) and, if it is not possible, means are provided for their isolation, local depressurizing and pressure indication (see also ISO 14118:2000, clause 5)		P
	- all elements which remain under pressure after isolation of the machine from its power supply be provided with clearly identified exhaust devices, and a warning label drawing attention to the necessity of depressurizing those elements before any setting or maintenance activity on the machine. See also ISO 4413 and ISO4414		P
6.2.11	Applying inherently safe design measures to control system		P
6.2.11.1	General		P
	The design measures of the control system shall be	Inherently safe design	P

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	chosen so that their safety-related performance provides a sufficient amount of risk reduction (see ISO 13849-1 or IEC 62061)	measures to control system have applied.	
	The correct design of machine control systems can avoid unforeseen and potentially hazardous machine behaviour.	Inherently safe design measures to control system have applied.	P
	Typical causes of hazardous machine behavior are :		-
	- an unsuitable design or modification (accidental or deliberate) of the control system logic;	No this kind of hazard in this machine	N
	- a temporary or permanent defect or a failure of one or several components of the control system;		N
	- a variation or a failure in the power supply of the control system;	No this kind of hazard in this machine	N
	- inappropriate selection, design and location of the control devices;	No this kind of hazard in this machine	N
	Typical examples of hazardous machine behaviour are :		-
	- unintended/unexpected start-up(see ISO 14118)	No this kind of hazard in this machine	P
	- uncontrolled speed change;		P
	- failure to stop moving parts;		P
	- dropping or ejection of a mobile part of the machine or of a workpiece clamped by the machine;		P
	- machine action resulting from inhibition (defeating or failure) of protective devices	No this kind of hazard in this machine	N
	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.	See the related clause	P
	These principles and methods shall be applied singly or in combination as appropriate to the circumstances (see ISO 13849-1 and EN 60204-1and IEC 62061).	See the test report of EN 60204-1	P
	Control systems shall be designed to enable the operator to interact with the machine safely and easily; this requires one or several of the following solutions;	The operator interact with the machine safely and easily.	P
	- systematic analysis of start and stop conditions;	Systematic analysis have been applied.	P
	- provision for specific operating modes (e.g. start-up after normal stop, restart after cycle interruption or after emergency stop, removal of the workpieces contained in	Enough provisions have been provided.	P

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	the machine, operation of a part of the machine in case of a failure of a machine element)		
	- clear display of the faults;		N
	- measures to prevent accidental generation of unexpected start commands (e.g. shrouded start device) likely to cause dangerous machine behaviour (see ISO 14118:2000, figure 1)	Main switch devices are provided.	P
	- maintained stop commands(e.g. interlock) to prevent restarting that could result in dangerous machine behaviour (see ISO 14118:2000, figure 1)	This requirement is complied with.	P
	An assembly of machines may be divided into several zones for emergency stopping, for stopping as a result of protective devices and/or for isolation and energy dissipation.		N
	The different zones shall be clearly defined and it shall be obvious which parts of the machine belong to which zone.		N
	Likewise it shall be obvious which control devices (e.g. emergency stop devices, supply disconnecting devices)and/or protective devices belong to which zone.		N
	The interfaces between zones shall be designed such that no function in one zone creates hazards in another zone which has been stopped for an intervention.		N
	Control systems shall be designed to limit the movements of parts of the machinery, the machine itself, or workpieces and/or loads held by the machinery, to the safe design parameters(e.g. range, speed, acceleration, deceleration, load capacity). Allowance shall be made for dynamic effects (e.g. the swinging of loads).		N
	For example:		-
	- the traveling speed of mobile pedestrian controlled machinery other than remote-controlled shall be compatible with walking speed.		N
	- the range, speed, acceleration and deceleration of movements of the person-carrier and carrying vehicle for lifting persons shall be limited to non-hazardous values, taking into account the total reaction time of the operator and the machine.		N
	- the range of movements of parts of machinery for lifting loads shall be kept within specified limits.		N
	When machinery is designed to use synchronously different elements which can also be used independently the control system shall be designed to prevent risks due		N

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	to lack of synchronization.		
6.2.11.2	Starting of internal power source/switching on an external power supply		P
	The starting of an internal power source or switching-on of an external power supply shall not result in a hazardous situation. For example: -starting the internal combustion engine shall not lead to movement of a mobile machine; -connection to mains electricity supply shall not result in the starting of working parts of a machine. See EN 60204-1:2006, 7.5 (see also Annexes A and B).	Not result in the starting of working parts of a machine	P
6.2.11.3	Starting/stopping of a mechanism		P
	The primary action for starting or accelerating the movement of a mechanism should be performed by application or increase of voltage or fluid pressure, or, if binary logic elements are considered, by passage from state 0 to state 1(if state 1 represents the highest energy state)	This requirement has been taken into account during design.	P
	The primary action for stopping or slowing down should be performed by removal or reduction of voltage or fluid pressure, or, if binary logic elements are considered, by passage from state 1 to state 0 (if state 1 represents the highest energy state).	The type of stopping of this machine belongs to state 1 and state 0.	P
	When, in order for the operator to maintain permanent control of deceleration, this principle is not observed (e.g. 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	No such situation exist.	N
6.2.11.4	Restart after power interruption		P
	If it may generate a hazard, the spontaneous restart of a machine when it is re-energized after power interruption shall be prevented (e.g. by use of a self-maintained relay, contactor or valve).		P
6.2.11.5	Interruption of power supply		P
	Machinery shall be designed to prevent hazardous situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met:		P
	- the stopping function of the machinery shall remain;		P
	- all devices whose permanent operation is required for safety shall operation an effective way to maintain safety (e.g. locking, clamping devices, cooling or heating devices, power-assisted steering of self-propelled mobile		P

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	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		P
	Automatic monitoring is intended to ensure that a safety function(s) implemented by a protective measure do(es) not fail to be performed if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed in such a way that hazards are generated.		P
	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.		P
	In either case, the protective measure can be initiated immediately or delayed until a specific event occurs (e.g. the beginning of the machine cycle.) The protective measures may be , e.g.:		P
	- the stopping of the hazardous process;		P
	- preventing the re-start of this process after the first stop following the failure;		P
	- the triggering of an alarm		P
6.2.11.7	Safety functions implemented by programmable electronic control systems		P
6.2.11.7.1	General		P
	A control system including programmable electronic equipment (e.g. programmable controllers) can be used to implement safety functions t machinery.		P
	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.		P
	The design of the programmable electronic control system shall be such that the probability of random hardware failures and the likelihood of systematic failures that can adversely affect the performance of the safety-related control function(s) are sufficiently low.		P
	Where a programmable electronic control system performs a monitoring function, the system behaviour on detection of a fault shall be considered (see also IEC 61508 series for further guidance)		P
	The programmable electronic control system should be installed and validated to ensure that the specified		P

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	performance (e.g. safety integrity level (SIL) in IEC 61508 series) for each safety function has been achieved.		
	Validation comprises testing an analysis (e.g. static, dynamic or failure analysis) to show that all parts interact correctly to perform the safety function and that unintended functions do not occur.		P
6.2.11.7.2	Hardware aspects		P
	The hardware (including e.g. sensors, actuators, logic solvers) shall be selected (and/or designed) and installed to meet both the functional and performance requirements of the safety function(s) to be performed, in particular, by means of :		P
	- architectural constraints (e.g. the configuration of the system, its ability to tolerate faults, its behaviour on detection of a fault);		P
	- selecting (and/or designing) equipment and devices with an appropriate probability of dangerous random hardware failure;		P
	-Incorporating measures and techniques within the hardware to avoid systematic failures and control systematic faults.		P
6.2.11.7.3	Software aspects		P
	The software (including internal operating software (or system software) and application software) shall be designed so as to satisfy the performance specification for the safety functions (see also IEC 61508-3)		P
	Application software		P
	Application software should not be re-programmable by the user.		P
	This may be achieved by use of embedded software in a non re-programmable memory (e.g. micro-controller, application specific integrated circuit (ASIC)		P
	When the application requires reprogramming by the user, the access o the software dealing with safety functions should be restricted e.g. by : - locks; - passwords for the authorized persons		P
6.2.11.8	Principles relating to manual control		P
	a) Manual control devices shall be designed and located according to the relevant ergonomic principles given in 6.2.8	See the photo.	P
	b) A stop control device shall be placed near each start control device. Where the start/stop function is performed by means of a hold-to-run control, a separate stop control device shall be provided when a risk can result from the hold-to-run control device failing to		P

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	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.	Manual controls have been located out of reach of the danger zones.	P
	d) Whenever possible, control devices and control positions shall be located so that the operator is able to observe the working area or hazard zone.	The operator is able to observe the working area or hazard zone.	P
	The driver of a ride-on mobile machine shall be able to actuate all control devices required to operate the machine from the driving position, except for functions which can be controlled more safely from other positions.	Not a ride-on mobile machine	N
	On machinery intended for lifting persons, controls for lifting and lowering and, if appropriate, for moving the carrier, shall generally be located in the carrier. If safe operation requires controls to be situated outside the carrier, the operator in the carrier shall be provided with the means of preventing hazardous movements.		P
	e) if it is possible to start the same hazardous element by means of several controls, the control circuit shall be so arranged that only one control is effective at a given time. This applies especially to machines which can be manually controlled by means among others of a portable control unit (teach pendant, for instance), with which the operator may enter danger zones.		P
	f) Control actuators shall be designed or guarded so that their effect, where a risk is involved, cannot occur without intentional operation (see ISO 9355-1 and ISO 447)		P
	g) For machine functions whose safe operation depends on permanent, direct control by the operator, measures shall be taken to ensure the presence of the operator at the control position , e.g. by the design and location of control devices.		N
	h) For cableless control an automatic stop shall be performed when correct control signals are not received, including loss of communication (see EN 60204-1)	No cableless control	N
6.2.11.9	Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance		P
	Where, for setting, teaching, process changeover, fault-finding, cleaning or maintenance of machinery, a guard has to displaced or removed and/or a protective device has to be disabled, and where it is necessary for the purpose of these operations for the machinery or part of the machinery to be put in operation, safety of the operator shall be achieved using a specific control mode		P

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	which simultaneously:		
	- disables all other control modes;		P
	- permits operation of the hazardous elements only by continuous actuation of an enabling device, a hold-to-run control device or a two-hand control device;		P
	- permits operation of the hazardous elements only in reduced risk conditions (e.g. reduced speed, reduced power/force, step-by-step operation, e.g. with a limited movement control device)		P
	prevents any operation of hazardous functions by voluntary or involuntary action on the machine's sensors.		P
	This control mode shall be associated with one or more of following measures:		P
	- restriction of access to the danger zone as far as possible.		P
	- emergency stop control within immediate reach of the operator;		P
	- portable control unit (teach pendant) and/or local controls allowing sight of the controlled elements.(see EN 60204-1:2006, 9.2.4)		P
6.2.11.10	Selection of control and operating modes		P
	If machinery has been designed and built to allow for its use in several control or operating modes requiring different protective measures and/or work procedures (e.g. to allow for adjustment , setting, maintenance, inspection), it shall be fitted with a mode selector which can be locked in each position.		P
	Each position of the selector shall be clearly identifiable and shall exclusively allow one control or operating mode.		P
	The selector may be replaced by another selection means which restricts the use of certain functions of the machinery to certain categories of operators (e.g. access codes for certain numerically controlled functions).		P
6.2.11.11	Applying measures achieve electromagnetic compatibility (EMC)		N
	For guidance on electromagnetic compatibility, see EN 60204-1, and IEC 61000-6 series.		N
6.2.11.12	Provision of diagnostic systems to aid fault-finding		P
	Diagnostic systems to aid fault finding should be included in the control system so that there is no need to disable any protective measures.		P
6.2.12	Minimizing the probability of failure of safety functions		P
6.2.12.1	General		P
	Safety of machinery is not only dependent on the reliability of the control systems but also on the reliability of all parts of the machine.The continued		P

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	operation of the safety functions is essential for the safe use of the machine. This can be achieved by :		
6.2.12.2	Use of reliable components		P
	“Reliable components” means components which are capable of withstanding all disturbances and stresses associated with the usage of the equipment in the conditions of intended use (including the environmental conditions), for the period of time or the number of operations fixed for the use, with a low probability of failures generating a hazardous malfunctioning of the machine. Components shall be selected taking into account all factors mentioned above(see also 6.213)	Reliable components have been used.	P
6.2.12.3	Use of “oriented failure mode” components		P
	“Oriented failure mode” components or systems are those in which the predominant failure mode is known in advance and which can be used so that such a failure leads to a non-hazardous alteration of the machine function.		P
	The use of such components should always be considered, particularly in cases where redundancy is (see 6.2.12.4) not employed.		P
6.2.12.4	Duplication (or redundancy) of components or subsystems		P
	In the design of safety-related parts of the machine, duplication (or redundancy) of components may be used so that, if one component fails, another component (or other components) continue(s) to perform its (their) function, thereby ensuring that the safety function remains available.	No duplication (or redundancy) of components	N
	In order to allow the proper action to be initiated, component failure shall be preferably detected by automatic monitoring (see 6.2.11.6) or in some circumstances by regular inspection,	Be preferably detected by automatic monitoring	P
	provided that the inspection interval is shorter than the expected lifetime of the components.		P
	Diversity of design and/or technology can be used to avoid common cause failures (e.g. from electromagnetic disturbance) or common mode failures.		P
6.2.13	Limiting exposure to hazards through reliability of equipment		P
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring rectification, thereby reducing exposure to hazards.	This requirement is complied with.	P
	This applies to power systems (operative part) as well as to control systems, to safety functions as well as to other functions of machinery.	This requirement is complied with.	P
	Safety-critical components (as e.g. certain sensors) with a known reliability shall be used.	Safety-critical components are used .	P

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	The elements of guards and of protective services shall be particularly reliable, as their failure can expose persons to hazards, and also as poor reliability would encourage attempts to defeat them.		P
6.2.14	Limiting exposure to hazards through mechanization or automation of loading(feeding) /unloading (removal) operations		N
	Mechanization and automation of machine loading/unloading operations and more generally of handling operations (of workpieces, materials, substances) limit the risk generated by these operations by reducing the exposure of persons to hazards at the operating points.		N
	Automation can be achieved e.g. by robots, handling devices, transfer mechanisms, air blast equipment.		N
	Mechanization can be achieved, e.g. by feeding slides, push rods, hand-operated indexing tables.		N
	While automatic feeding and removal devices have much to offer in preventing accidents to machine operators, they can create danger when any faults are being rectified.		N
	Care shall be taken to ensure that the use of these devices does not introduce further hazards (e.g. trapping, crushing) between the devices and parts of the machine or workpieces/materials being processed.		N
	Suitable safeguards (see 6.3) shall be provided if this cannot be ensured.		N
	Automatic feeding and removal devices with their own control systems and the control systems of the associated machine shall be interconnected after thoroughly studying how all safety functions are performed in all control and operation modes of the whole equipment.		N
6.2.15	Limiting exposure to hazards through location of the setting and maintenance points outside of danger zones.		P
	The need for access to danger zones shall be minimized by locating maintenance, lubrication and setting points outside these zones.		P
6.3	Safeguarding and complementary protective measures		P
6.3.1	General		P
	Guards and protective devices shall be used to protect persons whenever inherently safe design does not reasonably make it possible either to remove hazards or to sufficiently reduce risks. Complementary protective measures involving additional equipment (e.g. emergency stop equipment) may have to be implemented.	Appropriate guards and protective devices have been used to protect persons	P
	Certain safeguards may be used to avoid exposure to more than one hazard (e.g. a fixed guard preventing	fixed guard is used.	P

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	access to a zone where a mechanical hazard is present being used to reduce noise level and collect toxic emissions)		
6.3.2	Selection and implementation of guards and protective devices		P
6.3.2.1	General		P
	This subclause gives guidelines for the selection and the implementation of guards and protective devices the primary purpose of which is to protect persons against hazard generated by moving parts, according to the nature of those parts (see figure 4) and to the need for access to the danger zone(s).	Fixed guard	P
	The exact choice of a safeguard for a particular machine shall be made on the basis of the risk assessment for that machine.		P
	In selecting an appropriate safeguard for a particular type of machinery or hazard zone, it shall be borne in mind that a fixed guard is simple and shall be used where access of an operator to the danger zone is not required during normal operation (operation without any malfunction) of the machinery.		P
	As the need for frequency of access increase this inevitably leads to the fixed guard not being replaced.		N
	This requires the use of an alternative protective measure (movable interlocking guard, sensitive protective equipment.)		N
	A combination of safeguards may sometimes be required. For example , where, in conjunction with a fixed guard, a mechanical loading (feeding) device is used to feed a workpiece into a machine, thereby removing the need for access to the primary hazard zone, a trip device may be required to protect against the secondary drawing-in or shearing hazard between the mechanical loading (feeding) device, when reachable, and the fixed guard.		N
	Consideration shall be given to the enclosure of control positions or intervention zones to provide combined protection against several hazards which may include:	This requirement has been taken in to consideration.	P
	- hazards from falling or ejected objects (e.g. falling object protection structure)		P
	- emission hazards (e.g. protection against noise, vibration, radiation , harmful substances)		P
	- hazards due to the environment (e.g. protection against heat, cold, foul weather)		P
	- hazards due to tipping over or rolling over of machinery (e.g. roll-over or tip-over protection structure)	No such hazards exist in this machine.	N
	The design of such enclosed work stations (e.g. cabs and cabins) shall take into account ergonomic principles	No enclosed work stations.	N

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	concerning visibility, lighting, atmospheric conditions, access, posture.		
6.3.2.2	Where access to the hazard zone is not required during normal operation		P
	Where access to the hazard zone is not required during normal operation of the machinery, safeguard should be selected from the following:		-
	a) fixed guard (see also ISO 14120)	Fixed guards are provided.	P
	b) interlocking guard with or without guard locking (see also 6.3.3.2.3, ISO 14119, ISO 14120);		N
	c) self-closing guard (see ISO 14120:2002, 3.3.2)		P
	d) sensitive protective equipment, e.g. electro-sensitive protective equipment (see IEC 61496) or pressure sensitive mat (see ISO 13856)		N
6.3.2.3	Where access to the hazard zone is required during normal operation		N
	Where access to the hazard zone is required during normal operation of the machinery , safeguards should be selected from the following:		-
	a) interlocking guard with or without guard locking (see also ISO 14119, ISO 14120 and 6.3.3.2.3 of this standard);		N
	b) sensitive protective equipment, e.g electro-sensitive protective equipment (see IEC 61496)		N
	c) adjustable guard;		N
	d) self-closing guard (see ISO 14120:2002, 3.3.2)		N
	e) two-hand control device (see ISO 13851)		N
	f) interlocking guard with a start function (control guard) (see 6.3.3.2.5 of this standard)		N
6.3.2.4	Where access to the hazard zone is required for machine setting, teaching, process changeover, fault finding, cleaning or maintenance.		N
	As far as possible, machines shall be designed so that the safeguards provided for the protection of the production operator may ensure also the protection of personnel in charge of setting, teaching, process changeover, fault finding, cleaning or maintenance without hindering them in performing their task.		N
	Such tasks shall be identified and considered in the risk assessment as parts of the use of the machine (see 5.2)		N
6.3.2.5	Selection and implementation of sensitive protective equipment		N
6.3.2.5.1	Selection		N
	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		N

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	for safety applications.		
	The following provisions are intended to provide the designer with criteria for selecting , for each application , the most suitable device(s).		N
	Types of sensitive protective equipment include, e.g.:		-
	- light curtains;		N
	- scanning devices as, e.g. laser scanners;		N
	- pressure sensitive mats;		N
	- trip bars, trip wires.		N
	Sensitive protective equipment can be used:		-
	- for tripping purposes;		N
	- for presence sensing;		N
	- for both tripping and presence sensing		N
	- to re-initiate machine operation, a practice which is subject to stringent conditions.		N
	The following characteristics of the machinery, among others, can preclude the sole use of sensitive protective equipment:		N
	- tendency for the machinery to eject materials or component parts;		N
	- necessity to guard against emissions (noise, radiation, dust, etc.)		N
	- erratic or excessive machine stopping time;		N
	- inability of a machine to stop part-way through a cycle.		N
6.3.2.5.2	Implementation		N
	consideration should be given to :		-
	a) - size, characteristics and positioning of the detection zone (see ISO 13855, which deals with the positioning of some types of sensitive protective equipment)		N
	b) - reaction of the device to fault conditions (see IEC 61496for electro-sensitive protective equipment)		N
	c)- possibility of circumvention		N
	d)- detection capability and its variation over the course of time (e.g. as a result of its susceptibility to different environmental conditions such as the presence of reflecting surfaces, other artificial light sources, sunlight or impurities in the air.		N
	sensitive protective equipment shall be integrated in the operative part and associated with the control system of the machine so that:		-
	- a command is given as soon as a person or part of a person is detected;		N
	- the withdrawal of the person or part of a person detected does not, by itself, restart the hazardous machine function (s); therefore, the command given by		N

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	the sensitive protective equipment shall be 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;		N
	- he machine cannot operate during interruption of the detection function of the sensitive protective equipment, except during muting phases;		N
	- the position and the shape of detection field prevents, ,possibly together with fixed guards, a person or part of a person from entering the hazard zone, or being present in it, without being detected.		N
6.3.2.5.3	Additional requirements for sensitive protective equipment when used for cycle initiation.		N
	In this exceptional application, starting of the machine cycle is initiated by the withdrawal of a person or of the detected part of a person from the sensing field of the sensitive protective equipment, without any additional start command, hence deviating from the general requirement given in the second point of the dashed list in 6.3.2.5.2, above. After switching on the power supply, or when the machine has been stopped by the tripping function of the sensitive protective equipment, the machine cycle shall be initiated only by voluntary actuation of a start control.		N
	Cycle initiation by sensitive protective equipment shall be subject to the following conditions:		-
	a) only active optoelectronic protective devices (AOPDs) complying with IEC 61496 series shall be used;		N
	b) the requirements for an AOPD used as a tripping and presence-sensing device (see IEC 61496) are satisfied — in particular, location, minimum distance (see ISO 13855), detection capability, reliability and monitoring of control and braking systems;		N
	c) the cycle time of the machine is short and the facility to re-initiate the machine upon clearing of the sensing field is limited to a period commensurate with a single normal cycle;		N
	d) entering the sensing field of the AOPD(s) or opening interlocking guards is the only way to enter the hazard zone;		N
	e) if there is more than one AOPD safeguarding the machine, only one of the AOPD（s） is capable of cycle re-initiation;		N
	f) with regard to the higher risk resulting from automatic cycle initiation, the AOPD and the associated control		N

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Clause	Requirement-Test	Result-Remark	Verdict
	system comply with a higher safety-related performance than under normal conditions.		
6.3.2.6	Protective measures for stability		P
	If stability cannot be achieved by inherently safe design measures such as weight distribution (see 4.6), it will be necessary to maintain it by protective measures such as the use of :		P
	- anchorage bolts;		P
	- locking devices;		N
	- movement limiters or mechanical stops;		N
	- acceleration or deceleration limiters;		N
	- load limiters;		N
	- alarms warning of the approach to stability or tipping limits;		N
6.3.2.7	Other protective devices		N
	When a machine requires continuous control by the operator(e.g. mobile machines, cranes) and an error of the operator can generate a hazardous situation, this machine shall be equipped with the necessary devices to enable the operation to remain within specified limits , in particular:		N
	- when the operator has insufficient visibility of the hazard zone;		N
	- when the operator lacks knowledge of the actual value of a safety –related parameter (e.g. .a distance, a speed, the mass of a load, the angle of a slope)		N
	- when hazards may result from operations other than those controlled by the operator;		N
	The necessary devices include:		-
	- devices for limiting parameters of movement (distance, angle, velocity , acceleration)		N
	- overloading and moment limiting devices:		N
	- devices to prevent collisions or interference with other machines;		N
	-device for preventing hazards to pedestrian operators of mobile machinery or other pedestrians;		N
	- torque limiting devices, breakage points to prevent excessive stress of components and assemblies;		N
	- devices for limiting pressure, temperature;		N
	- devices for monitoring emissions;		N
	- devices prevent operation in the absence of the operator at the control position;		N
	- device to prevent lifting operations unless stabilizers are in place;		N
	- devices to limit inclination of the machine on a slope;		N

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Clause	Requirement-Test	Result-Remark	Verdict
	- devices to ensure that components are in a safe position before traveling;		N
	Automatic protective measures triggered by such devices which take operation of the machinery out of the control of the operator (e.g. automatic stop of hazardous movement) should be preceded or accompanied by a warning signal to enable the operator to take appropriate action (see 6.4.3)		N
6.3.3	Requirements for the design of guards and protective devices		P
6.3.3.1	General requirements		P
	Guards and protective devices shall be designed to be suitable for the intended use, taking into account mechanical and other hazards involved. Guards and protective devices shall be compatible with the working environment of the machine and designed so that they cannot be easily defeated. They shall provide the minimum possible interference with activities during operation and other phases of machine life, in order to reduce any incentive to defeat them.	Guards and protective devices have been appropriately designed.	P
	Guards and protective devices shall :		-
	- be of robust construction.	Steel	P
	- not give rise to any additional hazard;	No additional hazard	P
	- not be easy to by-pass or render non-operational;	Not be easy to by-pass	P
	- be located at an adequate distance from the danger zone (see ISO 13857 and ISO 13855).	an adequate distance from the danger zone	P
	- cause minimum obstruction to the view of the production process;		P
	- enable essential work to be carried out on installation and/or replacement of tools and also for maintenance by allowing access only to the area where the work has to be done, if possible without the guard or protective device having to be moved;		P
	For openings in the guards see ISO 13857		P
6.3.3.2	Requirements for fixed guards		P
6.3.3.2.1	Functions of guards		P
	The functions that guards can achieve are:		P
	- prevention of access to the space enclosed by guard and/or - containment/capture of materials, workpieces, chips, liquids which may be ejected or dropped by the machine and reduction of emissions(noise, radiation, hazardous substances such as dust, fumes, gases) which may be generated by the machine.		P

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Clause	Requirement-Test	Result-Remark	Verdict
	Additionally, they may need to have particular propertied relating to electricity, temperature, fire, explosion, vibration, visibility(see ISO 14120) and operator position ergonomics(e.g. usability, operator's movements, posture, repetitive movements).		P
6.3.3.2.2	Requirements for fixed guards		P
	Fixed guards shall be securely held in place:		-
	- either permanently (e.g. by welding) - or by means of fasteners (screws, nuts) making removal/opening impossible without using tools; they should not remain closed without their fasteners (see ISO 14120)	All the fixed guards are securely held in place by appropriate fasteners.	P
6.3.3.2.3	Requirements for movable guards		P
	a) movable guards which provide protection against hazards generated by moving transmission parts shall :		-
	- as far as possible remain fixed to the machinery or other structure (generally by means of hinges or guides) when open;		P
	- be interlocking guards (with guard locking when necessary) (see ISO 14119)		N
	b) movable guards against hazards generated by non-transmission moving parts shall be designed and associated with the machine control system so that:		-
	- moving parts cannot start up while they are within the operator's reach and the operator cannot reach moving parts once they have started up ; this can be achieved by interlocking guards, with guard locking when necessary.		N
	- they can be adjusted only by an intentional action , such as the use of a tool or a key;		N
	- the absence or failure of one of their components prevents starting of the moving parts or stops them; this can be achieved by automatic monitoring (see 4.11.6)		N
6.3.3.2.4	Requirements for adjustable guards	No adjustable guards	N
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed;		N
	They shall :		-
	- be designed so that the adjustment remains fixed during a given operation;		N
	- be readily adjustable without the use of tools;		N
6.3.3.2.5	Requirements for interlocking guards with a start function (control guards)		N
	An interlocking guard with a start function may be used provided that		-
	- all requirements for interlocking guards are satisfied (see ISO 14119)		N

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Clause	Requirement-Test	Result-Remark	Verdict
	- the cycle time of the machine is short		N
	- the maximum opening time of the guard is present to a low value (e.g. equal to the cycle time). When this time is exceeded, the hazardous function(s) cannot be initiated by the closing of the interlocking guard with a start function and resetting is necessary before restarting the machine.		N
	- the dimensions or shape of the machine do not allow a person, or part of a person, to stay in the hazard zone or between the hazard zone and the guard while the guard is closed (see ISO 14120)		N
	- all other guards whether fixed (removable type) or movable are interlocking guards;		N
	- the interlocking device associated with the interlocking guard with a start function is designed in such a way – e.g. by duplication of position detectors and use of automatic monitoring (see 4.11.6)- that its failure cannot lead to an unintended/unexpected start-up;		N
	- the guard is securely held open (e.g. by a spring or counterweight)such that it cannot initiate a start while falling by its own weight;		N
6.3.3.2.6	Hazards from guards		P
	Care shall be taken to prevent hazards which might be generated by :		-
	- the guard construction (e.g. sharp edges or corners, material);	No harp edges and corners.	P
	- 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		P
	Protective devices shall be selected or designed and connected to the control system so as to ensure correct implementation of their safety function (s) is ensured.		P
	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
	Protective devices shall be installed and connected to the control system so that they cannot be easily defeated.		P
6.3.3.4	Provisions for alternative types of safeguards.		N
	Provisions should be made to facilitate the fitting of alternative types of safeguards on machinery where it s known that this fitting will be necessary because the work to be done on it will vary.		N
6.3.4	Safeguarding for reducing emissions		P

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Clause	Requirement-Test	Result-Remark	Verdict
6.3.4.1	General		
	If the measures for the reduction of emissions at source mentioned in 6.2.2.2 are not adequate, the machine shall be provided with additional protective measures (see 6.3.4.2 to 6.3.4.5).		P
6.3.4.2	Noise		P
	Additional protective measures include, for example: - enclosures (see ISO 15667) - screens fitted to the machine; - silencers (see ISO 14163)	Enclosures	P
6.3.4.3	Vibration		N
	Additional protective measures include, for example, damping devices for vibration isolation between the source and the exposed person such as resilient mounting or suspended seats.		N
	For measures for vibration isolation of stationary industrial machinery see EN 1299		N
6.3.4.4	Hazardous substances		N
	Additional protective measures include, for example:		-
	- encapsulation of the machine (enclosure with negative pressure);		N
	- local exhaust ventilation with filtration.		N
	- wetting with liquids;		N
	- special ventilation in the area of the machine (air curtains , cabins for operators)		N
6.3.4.5	Radiation		N
	Additional protective measures include, for example:		-
	- use of filtering and absorption;		N
	- use of attenuating screens or guards		N
6.3.5	Complementary protective measures		N
6.3.5.1	General		N
	Protective measures which are neither inherently safe design measures, nor safeguarding (implementation of guards and/or protective devices), nor information for use may have to be implemented as required by the intended use and the reasonably foreseeable misuse of the machine.Such measures include, but are not limited to , the ones dealt with in 6.3.5.2 to 6.3.5.6		N
6.3.5.2	Components and elements to achieve the emergency stop function		N
	If following a risk assessment, a machine needs to be fitted with components and elements to achieve an emergency stop function to enable actual or impending emergency situations to be averted, the following requirements apply:		-

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Clause	Requirement-Test	Result-Remark	Verdict
	- the actuators shall be clearly identifiable, clearly visible and readily accessible		N
	- the hazardous process shall be stopped as quickly as possible without creating additional hazards . 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;		N
	- the emergency stop control shall trigger or permit the triggering of certain safeguard movements where necessary.		N
	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.		N
	This reset shall be possible only at that location where the emergency stop command has been initiated.The reset of the device shall not restart the machinery , but only permit restarting.		N
	More details for the design and selection of electrical components and elements to achieve the emergency stop function are provided in EN 60204 series.		N
6.3.5.3	Measures for the escape and rescue of trapped persons		P
	Measures for the escape and rescue of trapped persons may consist e.g. of :		-
	- escape routes and shelters in installations generating operator-trapping hazards		P
	- arrangements for moving some elements by hand, after an emergency stop		N
	- arrangements for reversing the movement of some elements		N
	- anchorage points for descender devices;		P
	- means of communication to enable trapped operators to call for help		P
6.3.5.4	Measures for isolation and energy dissipation		P
	Especially with regard to their maintenance and repair , machines shall be equipped with the technical means to achieve the isolation from power supply(ies) and dissipation of stored energy as a result of following actions:		P
	a) isolating (disconnecting, separating) the machine (or defined parts of the machine) from all power supplies;		P
	b) locking (or otherwise securing) all the isolating units in the isolating position;		P
	c) dissipating or , if this is not possible or practicable, restraining (containing) any stored energy which may give rise to a hazard;		N
	d) verifying, by means of a safe working procedure, that		P

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Clause	Requirement-Test	Result-Remark	Verdict
	the actions taken according to a), b) and c) above have produced the desired effect.		
	See ISO 14118:2000, clause 5 and EN 60204-1:2006, 5.5 and 5.6	See the test report of EN 60204-1.	P
6.3.5.5	Provisions for easy and safe handling of machines and their heavy component parts		P
	Machines and their component parts which cannot be moved or transported by hand shall be provided or capable of being provided with suitable attachment devices for transport by means of lifting gear.		P
	These attachments may be, among others,		-
	- standardized lifting appliances with slings, hooks, eyebolts, or tapped holes for appliance fixing;		P
	- appliances for automatic grabbing with a lifting hook when attachment is not possible from the ground.		N
	- guiding grooves for machines to be transported by a fork truck;		N
	- lifting gear and appliances integrated into the machine.		N
	Parts of machinery which can be removed manually in operation shall be provided with means for their safe removal and replacement; See also 6.4.4c)（ item 3).		P
6.3.5.6	Measures for safe access to machinery		P
	Machinery shall be so designed as to enable operation and all routine tasks relating to setting and/or maintenance, to be carried out, as far as possible, by a person remaining at ground level.		P
	Where this is not possible, machines shall have built-in platforms, stairs or other facilities to provide safe access for those tasks, but care should be taken to ensure that such platforms or stairs do not give access to danger zones of machinery.		N
	The walking areas shall be made from materials which remain as slip resistant as practicable under working conditions and, depending on the height from the ground, suitable guard-rails (see ISO 14122-3) shall be provided.		N
	In large automated installations, particular attention shall be given to safe means of access such as walkways, conveyor bridges or crossover points.		N
	Means of access to parts of machinery located at a height shall be provided with collective means of protection against falls (e.g. guard-rails for stairways, stepladders and platforms and/or safety cages for ladders)		N
	As necessary , anchorage points for personal protective equipment against falls from a height shall also be provided (e.g. in carriers of machinery for lifting persons or with elevating control stations)		N

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Clause	Requirement-Test	Result-Remark	Verdict
	Openings shall whenever possible open towards a safe position. They shall be designed to prevent hazards due to unintended opening.		P
	The necessary aids for access shall be provided (e.g. steps, handholds). Control devices shall be designed and located to prevent their being used as aids for access.		N
	When machinery for lifting goods and/or persons includes landings at fixed levels, these shall be equipped with interlocking guards preventing falls when the platform is not present at the level.	Not lifting machinery	N
	Movement of the lifting platform shall be prevented while the guards are open.	Not lifting platform	N
	For detailed provisions see ISO 14122.		P
6.4	Information for use		P
6.4.1	General requirements		P
6.4.1.1	Drafting information for use is an integral part of the design of a machine (see figure 2).		P
	Information of use consists of communication links, such as texts, words, signs, signals, symbols or diagrams, used separately or in combination to convey information to the user. It is directed to professional and/or non-professional users.		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.	See the instruction	P
	The information shall contain all directions required to ensure safe and correct use of the machine. With this in view, it shall inform and warn the user about residual risk.	See the instruction	P
	The information shall indicate, as appropriate,		-
	- the need for training,	See the instruction	P
	- the need for personal protective equipment,	safety glove, safety footwear, glasses	P
	- the possible need for additional guards or protective devices (see Figure 2, Footnote d).	See the instruction	P
	It shall not exclude uses of the machine that can reasonably be expected from its designation and description and shall also warn about the risk which would result from using the machine in other ways than the ones described in the information, especially considering its reasonably foreseeable misuse.	See the instruction	P
6.4.1.3	Information for use shall cover, separately or in combination, transport, assembly and installation, commissioning, use of the machine (setting, teaching/programming or process changeover, operation, cleaning, fault-finding and maintenance) and, if necessary, dismantling, disabling and scrapping.	See the instruction	P

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Clause	Requirement-Test	Result-Remark	Verdict
6.4.2	Location and nature of the information for use		P
	Depending on the risk , the time when the information is needed by the user and the machine design , it shall be decided whether the information – or parts thereof – are to be given:		P
	- in /on the machine itself (see 6.3 and 6.4.4)	Adequate information is stated in the machine itself.	P
	- in accompanying documents (in particular instruction handbook , see 6.4.5)	See the instruction	P
	- on the packaging	Adequate information is stated on the packaging	P
	- by other means such as signals and warnings outside the machine.	Signals and warnings outside the machine.	P
	Standardized phrases shall be considered where important messages such as warnings need to be given (see also IEC 62079)		P
6.4.3	Signals and warning devices		P
	Visual signals (e.g. flashing lights) and audible signals (e.g. sirens) may be used to warn of an impending hazardous event such as machine start-up or overspeed.	Signals and warning devices are provided.	P
	Such signals may also be used to warn the operator before the triggering of automatic protective measures (see last paragraph of 5.2.7)	Please the related clause.	P
	It is essential that these signals:		-
	- be emitted before the occurrence of the hazardous event; - be unambiguous; - be clearly perceived and differentiated from all other signals used; - be clearly recognized by the operator and other persons.	Unambiguous, clearly perceived, clearly recognized	P
	The warning devices shall be designed and located such that checking is easy.		N
	The information for use shall prescribe regular checking of warning devices.		P
	The attention of designers is drawn to the risks from “sensorial saturation” which results from too many visual and/or acoustic signals, which may also lead to defeating the warning devices.		P
6.4.4	Markings, signs (pictograms), written warnings		P
	Machinery shall bear all markings which are necessary:		-
	a) for its unambiguous identification, at least :		-

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Clause	Requirement-Test	Result-Remark	Verdict
	- name and address of the manufacturer; - designation of series or type; - serial number, if any.	General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd. XD-A	P
	b) in order to indicate its compliance with mandatory requirements; - marking; - written indications (e.g. for machines intended for use in potentially explosive atmosphere)		P
	c) for its safe use, e.g. :		-
	- maximum speed of rotating parts;		P
	- maximum diameter of tools;		P
	- mass (expressed in kilograms) of the machine itself and/or of removable parts		P
	- maximum working load;		N
	-necessity of wearing personal protective equipment;	safety glove, safety footwear, glasses	P
	- guard adjustment data;		N
	- frequency of inspection.	See the instruction	P
	Information printed directly on the machine should be permanent and remain legible throughout the expected life of the machine.	Permanent and remain legible	P
	Signs or written warnings only saying “danger” shall not be used.		P
	Markings, signs and written warnings shall be readily understandable and unambiguous, especially as regards the part of the function(s) of the machine which they are related to.		P
	Readily understandable signs (pictograms) should be used in preference to written warnings.		P
	Signs and pictograms should only be used if they are understood in the culture in which the machinery is to be used.		P
	Markings shall comply with recognized standards (see ISO 2972, ISO 7000, particularly for pictograms, symbols , colours) See EN 60204 series as regards marking of electrical equipment.	All the markings are standard.	P
6.4.5	Accompanying documents (in particular, instruction handbook)		P
6.4.5.1	Contents		P
	The instruction handbook or other written instructions (e.g. on the packaging) shall contain among others:		-

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Clause	Requirement-Test	Result-Remark	Verdict
	a) information relating to transport, handling and storage of the machine e.g. : - storage conditions for the machine; - dimensions , mass value(s), position of the centre (s) of gravity; - indications for handling (e.g. drawings indicating application points for lifting equipment)	All the related information is stated in the instruction handbook	P
	b) information relating to installation and commissioning of the machine, e.g. - fixing/anchoring and vibration dampening requirements; - assembly and mounting conditions; - space needed for use and maintenance; - permissible environmental conditions (e.g. temperature, moisture, vibration, electromagnetic radiation); - instructions for connecting the machine to power supply (particularly about protection against electrical overloading); - advice about waste removal /disposal; - if necessary, recommendations about protective measures which have to be taken by the user; e.g. additional safeguards, safety distances, safety signs and signals.	All the related information is stated in the instruction handbook	P
	c) information relating to the machine itself, e.g. : - detailed description of the machine, its fittings, its guards and/or protective devices; - 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. - diagrams (especially schematic representation of safety functions); - data about noise and vibration generated by the machine, about radiation , gases, vapours, dust emitted by it, with reference to the measuring methods used. - technical documentation about electrical equipment (see EN 60204 series) - documents attesting that the machine complies with mandatory requirements;	All the related information is stated in the instruction handbook	P

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Clause	Requirement-Test	Result-Remark	Verdict
	d) information relating to the use of the machine, e.g. about: - intended use; - description of manual controls (actuators); - setting and adjustment; - modes and means for stopping (especially emergency stop) - risks which could not be eliminated by the protective measures taken by the designer; - particular risks which may be generated by certain applications, by the use of certain fittings, and about specific safeguards which are necessary for such applications.	All the related information is stated in the instruction handbook	P
	- reasonably foreseeable misuse and prohibited usages; - fault identification and location , repair, and re-starting after an intervention; - personal protective equipment which need to be used and training required.		
	e) information for maintenance e.g. - nature and frequency of inspections for safety functions; - instructions relating to maintenance operations which require a definite technical knowledge or particular skills and hence should be carried out exclusively by skilled persons (e.g. maintenance staff, specialists) - instructions relating to maintenance actions (e.g. replacement of parts) which do not require specific skills and hence may be carried out by users (e.g. operators) - drawings and diagrams enabling maintenance personnel to carry out their task rationally (especially fault-finding tasks)	All the related information is stated in the instruction handbook	P
	f) information relating to de-commissioning , dismantling and disposal;	See the instruction handbook	P
	g) information for emergency situations , e.g. : - type of fire-fighting equipment to be used. - warning about possible emission or leakage of harmful substance(s), and if possible, indication of means to fight their effects.		N
	h) maintenance instructions provided for skilled persons (second dash in e))and maintenance instructions provided for unskilled persons (third dash in e)), that should appear clearly separated from each other.	All the related information is stated in the instruction handbook	P
6.4.5.2	Production of the instruction handbook		P

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Clause	Requirement-Test	Result-Remark	Verdict
	a) type and size of print shall ensure the best possible legibility. Safety warnings and/or cautions should be emphasized the use of colours, symbols and/or large print.	Legibility.	P
	b) information for use shall be given in the language(s) of the country in which the machine will be used for the first time and in the original version. If more than one language are to be used, each language should be readily distinguished from the other(s), and efforts should be made to keep the translated text and the relevant illustration together.	English	P
	c) whenever helpful to the understanding, text should be supplemented with written details enabling , for instance, manual controls (actuators) to be located and identified; they should not be separated from the accompanying text and should follow sequential operations.	See the Instruction handbook.	P
	d) consideration should be given to presenting information in tabular form where this will aid understanding. Tables should be adjacent to the relevant text.	See the Instruction handbook.	P
	e) the use of colours should be considered, particularly in relation to components requiring quick identification.		N
	f) when information for use is lengthy, a table of contents and/or an index should be given.		P
	g) safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator.		P
6.4.5.3	Drafting and editing information for use		P
	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).	See the difference between the models	P
	b) communicate principles : when information for use is being prepared, the communication process “see-think-use” should be followed in order to achieve the maximum effect and should follow sequential operations. The questions “how ?” and “why ?” should be anticipated and the answers provided.		P
	c) information for use shall be as simple and as brief as possible, and should be expressed in consistent terms and units with a clear explanation of unusual technical terms.		P

EN ISO 12100:2010			
Clause	Requirement-Test	Result-Remark	Verdict
	d) when it is foreseen that a machine will be put to non-professional use, the instructions should be written in a form that is readily understood by the non-professional users. If personal protective equipment is required for the safe use of the machine, clear advice should be given, e.g. on the packaging as well as on the machine, so that this information is prominently displayed at the point of sale.	Not for non-professional use	N
	e) durability and availability of the documents : documents giving instructions for use should be produced in durable form (i.e. they should be able to survive frequent handling by the user). It may be useful to mark them “keep for future reference”. Where information for use is kept in electronic form (e.g. CD, DVD, tape) information on safety-related issues that need immediate action shall always be backed up with a hand copy that is readily available.	Kept in electronic form	P
7	Documentation of risk assessment and risk reduction		P
	The documentation shall demonstrate the procedure that has been followed and the results that have been achieved. This includes, when relevant, documentation of		-
	a) the machinery for which the risk assessment has been made (for example, specifications, limits, intended use);		P
	b) any relevant assumptions that have been made (loads, strengths, safety factors, etc.);		P
	c) the hazards and hazardous situations identified and the hazardous events considered in the risk assessment;		P
	d) the information on which risk assessment was based (see 5.2):		-
	1) the data used and the sources (accident histories, experience gained from risk reduction applied to similar machinery, etc.);		P
	2) the uncertainty associated with the data used and its impact on the risk assessment;		P
	e) the risk reduction objectives to be achieved by protective measures;		P
	f) the protective measures implemented to eliminate identified hazards or to reduce risk;	Warning sign and wear PPE	P
	g) residual risks associated with the machinery;		P
	h) the result of the risk assessment (see Figure 1);		P
	i) any forms completed during the risk assessment.		P
	Standards or other specifications used to select protective measures referred to in f) above should be referenced.		P

Notice

1. This test report shall be invalidation without the cachet of the testing laboratory.
2. This copied report shall be invalidation without sealed the cachet of the testing laboratory.
3. This report shall be invalidation without tester signature, reviewer signature and approver signature.
4. This altered report shall be invalidation.
5. Client shall put forward demurrer within 15days after received report. The testing laboratory shall refuse disposal if exceeded the time limit.
6. The test results presented in this report relate only to the object tested.

3.2 EN13128:2001+A2:2009/AC:2010 Assessment report

ASSESSMENT REPORT

per

EN13128:2001+A2:2009/AC:2010

Safety of machine tools — Milling machines (including boring machines)

TCF

Reference No. ..... : No: TCF22041513MD

Tested by(+ signature).....:Jim Song

Reviewed by(+ signature).....:Jack Ma

Date of issue ..... : 2022-04-15

Number of pages (Report) ..... : 15

Applicant

Name .....: General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Address ..... :No.100,Liaohe East Road,Dalian Economic and Technological Development Zone-East Zone 1

Test specification

Standard ..... : EN13128:2001+A2:2009/AC:2010

Test procedure ..... : CE-MD

Non-standard test method ..... : N.A.

Test item description:

Manufacturer..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Factory..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Trademark ..... : NA

Model/Type reference ..... : XD-A

Rating(s) ..... : 380V 50Hz

General product information:

The machine tool belongs to Boring machine.

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
1	Scope	Boring machine	P
2	Normative references		-
3	Terms and definitions		-
4	List of significant hazards	See the risk assessment.	P
5	Safety requirements and/or protective measures		P
5.1	General requirements		P
	Machines covered by the scope of this standard shall comply with the safety requirements and/or protective measures of this clause.		P
	In addition, the machine shall be designed according to the principles of EN 292 for hazards relevant but not significant which are not dealt with by this standard.		P
5.2	Specific requirements		P
	Each machine type shall be designed and safeguarded in accordance with the specific requirements and/or protective measures listed in tables 2, 3 or 4 and the relevant requirements and/or protective measures of table 5.	Manual and automatic machines	P
	Table 2 Manual machines with continuous powered axis feedrates not exceeding 2 m/min and/or a hold–to–run controlled rapid traverse axis speed not exceeding 5 m/min Table 3 Manual machines with continuous powered axis speeds in excess of 2 m/min or hold–to–run controlled rapid traverse axis speed in excess of 5 m/min Table 4 Automatic machines (mechanical hazards) Table 5 Manual and automatic machines (hazards other than those listed in tables 2, 3, and 4)	Manual and automatic machines	P
Table 2	1.1 Work zone Adjustable cutter guard(s) or adjustable guards mounted to the machine table shall be provided to inhibit access to the cutting tool (see figures C.8 and C.9). Guards shall be in accordance with EN 953:1997.	Comply with the requirements.	P
Table 2	1.2 Provision for interlocked guards Since some applications require the user to fit an interlocked movable guard, all machines shall be provided with an electrical interface to connect a guard interlock..	No interlocked guards.	N
Table 3	1.1 Work zone 1.1.1 Guarding Work zone shall be guarded with fixed and/or interlocked	Fixed guard used.	P

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	movable guard(s) (see figure C.9). Guards shall be in accordance with EN 953:1997.		
Table 3	1.1.2 Interlocking Machine movements shall only be possible when the interlocked movable guard(s) are closed. Interlocking devices shall be in accordance with EN 1088:1995. Opening of an interlocked movable guard shall cause the hazardous movements to cease and be inhibited. The stop category shall be 0 in accordance with 9.2.5.3 of EN 60204-1:1997 except for mechanisms requiring a sequenced shutdown where a category 1 stop shall be implemented. Guard locking (see EN 1088:1995, 7.4) shall be provided when opening of the interlocked movable guard provides access to these hazards during deceleration (i.e. run-down).	No interlocked guards.	N
Table 3	1.1.3 Provisions for setting When powered machine movements are required with the movable guard open (e.g. for setting purposes), these movements shall only be permitted under the following conditions: a) axis movements limited to 2m/min initiated with a hold－to－run control device b) spindle rotation shall be initiated and maintained by one of the following means: － a hold－to－run control device; － a spindle start device together with an enabling device. The spindle speed shall be limited to that capable of being stopped within two (2) spindle revolutions (no load condition). This reduced speed function shall be in accordance with table 5, 14. c) swarf/chip conveyor if provided, under hold－to－run control or other suitable protective devices.	Comply with the requirements.	P
Table 3	1.2 Protection against impact Fixed and/or interlocked movable guard(s) shall be provided to prevent access to moving machine elements with linear speeds greater than 15 m/min; for safety distances, see EN 294, EN 811.	Comply with the requirements.	P
Table 4	1.1 Work zone 1.1.1 Primary safeguards The work zones of automatic machines shall be safeguarded. The guarding arrangements shall be designed		P

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	to prevent access to hazardous situations. For the purposes of this clause, 1) all protective equipment shall be in accordance with the following:in accordance with EN 61496-1:1997 (ESPE), in accordance with prEN 61496-2:1997, category 4 (AOPD), in accordance with EN 61496-1:1997 (PSPD). 2) Guards shall be in accordance with EN 953:1997, and interlocking devices shall be in accordance with EN 1088:1995.		
Table 4	1.1.2 Guarding strategies 1.1.2.1 General The work zone shall be enclosed where possible by fixed and/or interlocked movable guards during machining operations. Where enclosure is not reasonably practicable (e.g. due to the size of the workpiece, its geometry, other special characteristics of the machine or its application), operators and other exposed persons shall be safeguarded by a combination of other means (e.g. protected operator position (cabin), perimeter guarding, other protective devices).		P
Table 4	1.1.2.2 Enclosure Where reasonably practicable, work zone guarding shall be fixed to the structure of the machine (see 3.2.1 of EN 953:1997) (see also guard characteristics below and figures C.10 (a), (b), (c)).		N
Table 4	1.1.2.3 Alternatives to enclosures Access to the work zone, by the operator, from the normal (fixed) operating position shall be prevented by local guarding (typically forming a cabin - see figure C.10(d)). Access to the cabin shall not require entry into the hazard zone enclosed by perimeter fencing or other protectivedevices. Where this is not possible because of the machine configuration or other operating constraints, the access route to the operating position shall not require approach to hazardous situations. Where the machine operator requires access to the work zone from the protected (fixed) operating position (cabin) e.g. for setting purposes orprocess control, the cabin shall be designed so that access is via an interlocked movable guard from within the cabin. Alternatively themovement of a pendant control from the cabin position shall have the same effect as the interlocked guard above. Operation of		N

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	the machine in mode 1 (automatic cycle) shall only be possible when the pendant control (above) is relocated in the cabin. Any other powered movement of machine elements shall only be achieved by selection of the appropriate operating mode (see operating modes below).		
Table 4	Access to the work zone by persons other than the machine operator shall be prevented by perimeter fencing and/or other means (e.g. electrosensitive protective equipment (ESPE), active-opto electronic protective devices (AOPDs), pressure sensitive protective devices (PSPDs). Where access points (e.g. gates), are provided they shall be interlocked. Where interlocking is not possible because of the particular machine configuration and application, any non interlocked access points shall be within the visual field of the operator(s) from the normal working position. Where it is foreseen that the machine will be operated unattended, for some or all of the operating cycle, other means of access control (e.g. key pad operated locks), shall be provided to prevent unauthorised access.		N
Table 4	1.1.3 Multiple work zones Where more than one work zone is provided on a single machine, safeguards(e.g. fixed or movable interlocked guards, AOPD, ESPE) shall protect the operator(s) from adjacent active work zone hazards (e.g. when loading or unloading workpieces in a non-active work zone, cleaning). Unauthorised movement of the machine into an adjacent non-active work zone shall be prevented using a limiting device. (e.g. Mechanical stops, range limit switches, light beams, AOPDs).	Only on work zone	N
Table 4	1.1.4 Guard Characteristics 1.1.4.1 Height and Position Where guards are floor mounted (e.g. perimeter fencing), they shall be securely fixed and have a minimum height of 1,4 m at a distance in accordance with table 2 of EN 294:1992 from the hazard zone. Any opening between the bottom of the guard and the floor shall not exceed 300 mm.	Not floor mounted.	N
Table 4	1.1.4.2 Containment Guards shall be designed to contain and/or prevent exposure to swarf/chips, fluids and parts that can be		P

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	discharged or ejected (see also 7.1.4 mist and vapour, 17.1 fluids mists and 17.2 ejection, 19.2 contamination of floors etc., in table 5).		
Table 4	1.1.4.3 Observation Where routine observation of the machine operation is required, means (e.g. windows) shall be provided so that this can be achieved without the need to open, remove or suspend any work zone guard or other protective device(s) (see also 8.4 lighting, in table 5).		P
Table 4	1.1.5 Interlocking 1.1.5.1 All movable guards through which frequent access to the work zone is required (i.e. more than once per shift) shall be interlocked. Opening of a guard or actuation of a protective device in mode 1 (automatic cycle - see below) shall cause hazardous movements to stop and further movement to be inhibited (see EN 1037). Measures to minimise the possible defeat of interlocking device(s) shall be taken (see clauses 5 and 7 of EN 1088:1995).		N
Table 4	1.1.5.2 If opening of an interlocking movable guard exposes operators to hazards listed from 1.1 to 1.7 of table 1, guard locking shall be provided (see EN 1088 and also 7.2.m) of clause 7).		N
Table 4	1.1.6 Modes of operation		P
Table 4	1.1.6.1 General Each machine shall have at least two modes of operation (i.e. modes 1 and 2) with the option of a third mode (i.e. mode 3). The selection of a mode of operation shall be either by key switch, access code or equally secure means and shall only be permitted from outside the work zone. Selection of a mode shall not initiate hazardous situations.	Automatic mode and setting mode	P
Table 4	1.1.6.2 Mode 1 - Automatic cycle [automatic production] The guards shall be closed and/or the protective devices be active to permit execution of programmed sequential machine operation under numerical control.		P
Table 4	1.1.6.3 Mode 2 – Setting Setting mode is a mode of operation in which adjustments for the subsequent machining process are performed by the operator. When any interlocked movable guard is open or a protective device is suspended, powered machine movements shall only be permitted under the following	Not open	P

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	conditions:		
Table 4	a) Axis movements at a maximum rate of 2 m/min or a maximum increment of 10 mm. These movements shall be selected one axis at a time and may be initiated and maintained by one of the following means: – a hold-to-run control device; – an electronic handwheel; – manual data input (MDI) followed by cycle start together with an enabling device.		P
Table 4	b) Spindle speed shall be limited by its stopping performance which shall not exceed 2 revolutions. Spindle rotation shall only be initiated and maintained by one of the following means: – a hold-to-run control device – a spindle start control device together with an enabling device. Release of an enabling device shall initiate a category 1 stop in accordance with 9.2.2 of EN 60204-1:1997.		P
Table 4	c) The limits of speed or incremental distance [defined in a) and b) above] shall be monitored and if exceeded, the power to the drives shall be removed by a controlled stop (Category 1 - see 9.2.2 of EN 60204-1:1997).		N
Table 4	d) Means shall be provided to prevent hazardous movement of vertical or slant axes under gravity.		N
Table 4	e) Automatic workpiece changing mechanisms shall remain inhibited. Initiation of their automatic movement shall only be possible by reselection of mode 1.		N
Table 4	f) Unguarded swarf/chip conveyor movements shall only be initiated and maintained by a hold-to-run control device.		N
Table 4	g) Where multiple hold-to-run control device locations are provided (e.g. main control station, hand-held pendant), only one shall be functional at a time.		N
Table 4	1.1.6.4 Mode 3 - Optional mode for manual intervention under restricted operating conditions	No such mode	N
Table 4	1.1.7 Release of trapped persons Means shall be provided for the movement of machine axes for emergency purposes (e.g. release of trapped persons). These meansare for example: a) With power off: - manually operated relief valves to depressurise systems		N

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	under pressure; - manual release of power-actuated brakes provided that weight-balancing exists; b) With power on: - manual control facilities of power-piloted valves/drives; - control facilities to start counter motions.		
Table 5	1.1 Workpiece transfer devices (e.g. pallet changing devices, automatic workpiece changing devices)	No such device	N
	1.2 Swarf /chip collection and removal	Swarf /chip collection	P
	1.2.1 Access to hazardous moving parts of swarf/chip collection and removal systems shall be prevented by means of fixed guards. Where operators have a need to access more frequently than once per shift, interlocked movable guards shall be provided. Guards shall be in accordance with EN 953.	Fixed guard.	P
	1.2.2 Opening an interlocked movable guard, which provides access to the hazardous moving parts of a swarf/chip system shall cause the movement to cease and remain inhibited (see also 14.1.1 of this table and 1.1.5 of table 4).	No interlocked guard.	N
	1.2.3 If movement of a swarf/chip system with an interlocked guard open is essential (e.g. for cleaning purposes) the movement shall only be permitted under the control of a hold – to – run device with an adjacent emergency stop device. A warning sign shall indicate the hazardous area of the swarf/chip system discharge (see also 7.2 f) of clause 7).		N
	1.3 Power transmission mechanisms (e.g. driveshafts, belts, pulleys, gears)		P
	1.3.1 Access to hazardous power transmission parts (e g belts, chains, gears. pulleys, shafts) shall be prevented by means of fixed guards but interlocked movable guards shall be provided where operators have a need to access more frequently than once per shift. Guard shall be in accordance with EN 953.	Fixed guard	P
	1.3.2 Opening an interlocked movable guard, which exposes moving power transmission parts, shall cause their movement to cease and remain inhibited. Interlocking provisions shall conform to EN 1088 and as a minimum to category 1 of EN 954 – 1:1996.		N
	1.3.3 Where the hazardous moving parts can be reached		N

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	before they come to rest. guard locking shall be applied to prevent opening of the guard until the hazardous movement has ceased. Delayed unlocking shall be achieved by means of a motion detector or timer control. (see 7.2 and 7.3 of EN 1088:1995 and EN 999).		
	1.4 Pits		N
	1.5 Operating platforms		N
	2.1 Direct contact To minimise the hazards of malfunction, shock or burn, all electrical equipment shall be designed and applied in accordance with EN 60204-1. Means shall be provided to isolate the machine from sources of electrical energy (see 6.2 of EN 60 204-1:1997). In particular: Means of isolation shall be located at the main electrical enclosure in accordance with 6.2.2 (b). All other enclosures shall be in accordance with 6.2.2(a). All live parts shall be protected against direct contact to at least IP2X in accordance with 6.2.2(c).	See the EN 60204-1.	P
	2.2 Indirect contact The requirements of 6.3 of EN 60204-1:1997 shall be followed.	See the EN 60204-1.	P
	2.3 Protection of control gear Enclosures of control gear shall provide a degree of protection of at least IP22, see EN 60529:1991, except IP55 shall be provided for control gear enclosures within the work zone.	IP54	P
	4.1 Noise reduction methods		P
	4.1.1 Control of noise at source When designing milling machines, the information and technical measures to control noise at source given in EN ISO 11688-1 and ISO/TR 11688-2 shall be followed. The design shall take into account noise from each source. Appropriate technical measures for reducing noise at the main sound sources of the milling machines are listed below: a) transmission noise gearbox damping b) pneumatic exhaust silencers c) power generation source damping or absorber d) noise under cutting process e) workpiece change	the work zone enclosing guard	P
	4.1.2 Control of transmission paths		N

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	Where noise levels must be reduced beyond those achievable by design at source the machine shall be provided with protective measures (e.g.; noise enclosures, screens fitted to the machinery, silencers). The above list is not exhaustive. Alternative technical measures for noise reduction with identical or greater efficiency can be used.		
	6.5 Lasers Built – in laser feedback systems shall be designed to prevent exposure to beam paths or specular reflections, see EN 60825-1:1994.	No laser	N
	7.1 Fluids, mists, fumes, and dust Because the materials which may be processed depend on specific applications, it is not possible to provide detailed recommendations for the reduction of the risks in this standard.		P
	7.2 Fire or explosion Because of the diverse nature of workpiece materials which may be processed, and metalworking fluids which may be used, it is not possible to provide detailed requirements in this standard for the reduction of fire and explosion risks. Guidance may be found in prEN 13478:1999, Fire Prevention and Protection, and EN 1127-1:1997.		P
	7.3 Minimising biological and microbiological hazards in metalworking fluids		N
	8 Neglect of ergonomic principles inmachinery design		P
	8.1 Unhealthy posture or excessive efforts (repetitive strain)		P
	8.2 Inadequate consideration of hand-arm or foot-leg anatomy		P
	8.4 Inadequate local lighting		P
	8.6 Human error, human behaviour		P
	8.7 Inadequate design location or identification of manual controls Input devices (e.g. key boards, key pads, push buttons) shall be in accordance with EN 894 – 1, – 3.		P
	8.8 Inadequate design or location of visual display units		P
	10.1 Failure / disorder of the control system Control systems shall be designed in accordance with EN 60 204-1, EN 982, and EN 983. Unexpected machine movements (e.g. spindle rotation,	See the EN 60204-1	P

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	axis movement, tool release from the spindle) shall be prevented (see EN 1037).		
	10.2 Restoration of energy supply after an interruption Control system design shall ensure that automatic restart is prevented and re-actuation of the start control is always required to initiate powered movement following, for example, any change of mode, selection of optional function, system re-set, guard interlock interruption, restoration of adequate pressure or voltage, or correction of a system failure (see EN 1037).		P
	10.3 External influences on the electrical equipment Electromagnetic compatibility Immunity:Electronic control systems shall be designed and installed so as to be protected from electromagnetic interference and stable when exposed to electrical system operation or failure in accordance with EN 61000-6-2 Emission:Electrical/electronic design shall apply technical information and physical measures to limit electromagnetic emissions in accordance with EN 50081-2.		N
	13.1 Energy supply failures 13.1.1 Systems shall be designed such that a line rupture in any circuit (e.g. broken wire, pipe or hose) will not result in the loss of a safety function (see EN 60204-1, EN 982, EN 983).	not result in the loss of a safety function	P
	13.1.2 Interruption or failure of any energy supply shall not result in a hazard. Inadequate pressure or voltage shall be detected and the machine cycle shall be interrupted or inhibited.	not result in a hazard	P
	13.1.3 Means shall be provided for the isolation of power supplies (see 5.1.6 of EN 982:1996, 5.1.6 of EN 983:1996 and 5.3 of EN 60204-1:1997) and dissipation of stored energy, see 5.3 of EN 1037:1995.	See the EN 60204-1	P
	14.1 Safety functions of control systems		P
	15 Errors of fitting Means shall be embodied in the design of machine parts to prevent errors of fitting (e.g. use of male/female connections, asymmetrical location features) and/or the machine parts shall be marked with instructions for fitting.	marked with instructions for fitting	P
	17.1 Containment of processed materials and fluids Guards shall be provided to retain or contain the foreseeable ejection of processed material and	By fixed guard	P

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	metalworking fluid. Such guards shall be designed in accordance with clause 8 of EN 953:1997. These may take the form of a deflecting adjustable guard fixed to the spindle head to direct processed material/metalworking fluid towards their collecting area or by a fixed guard covering the whole area of ejection (see 7.2 f) of clause 7).		
	17.2 Ejection of parts - Guard strength		N
	17.3 Tool retention For power operated spindle drawbars, the drawbar shall be designed to avoid risks from tool ejection if the power supply fails. The drawbar mechanism shall be monitored so that a failure to achieve correct registration or clamping of the retention knob on the tool shall inhibit the spindle start control in all operating modes. Unclamping of the tool by releasing of the drawbar shall be inhibited during spindle rotation.		N
	18 Loss of stability/overturning of machinery Machines shall be designed and constructed so that they are stable under foreseeable operating conditions, and without risks of overturning, falling or unexpected movement. When the use of foundation bolting is one of the measures used to help prevent overturning, manufacturers shall specify the bolts and foundation requirements necessary (see also 7.2 b) of clause 7).	Stable.	P
	19 Slip, trip and fall of persons		N
6	Verification of safety requirements and/or measures		P
7	Information for use		P
7.1	General		P
	Machine warning devices (e.g. audible and visual signals), markings (e.g. signs, symbols), and instructional material (e.g. manuals for operation, maintenance) shall be in accordance with clause 5 of EN 292–2:1991and EN 457.		P
7.2	Instruction handbook		P
	In addition to the requirements of 7.1, each machine shall be accompanied by a handbook containing: a) the name and address of the manufacturer/supplier; b) any necessary information for safe installation of the machine and its guarding system (e.g. Floor conditions, services, anti-vibration mountings, guarding fitting); c) instructions for how the initial test and examination of the machine and its guarding system are to be carried out before first use and being placed into production;	See the instruction handbook.	P

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	d) instructions for periodic maintenance, test and examination of the machine, guards, protective devices and other safety critical parts (e.g. spindle braking elements); e) instructions for any test or examination necessary after change of component parts or addition of optional equipment (both hardware and software) to the machine which can affect the safety functions; f) instructions for safe operation, setting and maintenance including safe working practices and the training necessary to achieve the required skill level of operators; g) the intended application of the machine when mode 3 (see table 4, 1.1.6.4) is provided; h) instructions on control systems including circuit diagrams for electrical, hydraulic, and pneumatic systems; i) the noise levels determined by methods specified in 7.3; j) descriptions of possible failure modes and advice on detection and prevention by periodic maintenance and correction; k) the specification for any fluid to be used in lubrication, braking, or transmission system: l) guidance on correct selection, preparation, application, and maintenance of metal working fluids and/or lubricants; m) provide guidance on the means for the release of persons trapped in the machine; n) information describing residual risks (e.g. conditions where noise levels are likely to exceed 80 dB (A), hazards arising from sharp or hot tools/components) o) recommendations on additional protective measures (e.g. personal protective equipment); p) information defining the limits for the maximum mass, moment of inertia, tilting moment, and spatial envelope of tools; q) information defining the limits for the spatial envelope, maximum mass, position of the centre of gravity of the workpiece and work holding fixture; r) procedures to avoid errors of fitting during maintenance of the machine; s) warning of the hazards arising from sharp tools/components and of the need to wear appropriate personal protective equipment;		

EN 13128:2001+A2:2009/AC:2010			
Clause	**Requirement**	**Result-Remark**	**Verdict**
	t) In particular for manually operated machines (i.e. manual feed and workpiece load/unload), instructions and guidance shall be provided concerning the safe methods of workpiece holding. This information shall make reference to correct use of suitable clamping devices and the use of suitable milling fixtures.		
7.3	Noise declaration		P
7.4	Marking		P
	Each machine shall be marked in a distinct and permanent manner with: a) name and address of the manufacturer and, where applicable, business name and full address of the authorised representative; b) mass of machine; c) supply data for electrical and where applicable. hydraulic, and pneumatic systems (e.g. minimum pneumatic pressure); d) lifting points for transportation and installation purposes where applicable; e) speed range where applicable; f) the designation of machinery and the designation of series or type.	a) General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd. c) 380VAC. f) XD-A	P

Notice

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6. The test results presented in this report relate only to the object tested.

3.3 EN 60204-1:2018 Assessment report

ASSESSMENT REPORT

per

EN 60204-1:2018

Safety of machinery — Electrical equipment of machines — Part 1: General requirements

TCF

Reference No. ..... : No: TCF22041513MD

Tested by(+ signature).....:Jim Song

Reviewed by(+ signature).....:Jack Ma

Date of issue ..... : 2022-04-15

Number of pages (Report) ..... : 69

Applicant

Name .....: General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Address ..... :No.100,Liaohe East Road,Dalian Economic and Technological Development Zone-East Zone 1

Test specification

Standard ..... : EN 60204-1:2018

Test procedure ..... : CE-MD

Non-standard test method ..... : N.A.

Test item description:

Manufacturer..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Factory..... :General Technology Group Dalian Machine Tool Imp.&Exp. Co.,Ltd.

Trademark ..... : NA

Model/Type reference ..... : XD-A

Rating(s) ..... : 380V 50Hz

General product information:

The product is Boring machine.

EN 60204-1:2018			
Clause	Requirement-Test	Result-Remark	Verdict
1	Scope		-
	This part of IEC 60204 applies to electrical, electronic and programmable electronic equipment and systems to machines not portable by hand while working, including a group of machines working together in a co-ordinated manner.	This machine is within this scope.	P
	This part of IEC 60204 is applicable to the electrical equipment or parts of the electrical equipment that operate with nominal supply voltages not exceeding 1 000 V for alternating current (AC) and not exceeding 1 500 V for direct current (DC), and with nominal supply frequencies not exceeding 200 Hz.	AC 380V 50Hz.	P
2	Normative references		-
3	Terms,definitions and abbreviated terms		-
4	General requirements		-
4.1	General		-
	This standard specifies requirements for the electrical equipment of machines.		P
	The risks associated with the hazards relevant to the electrical equipment shall be assessed as part of the overall requirements for risk assessment of the machine.	See the risk assessment report in detail.	P
4.2	Selection of equipment		-
4.2.1	General		-
	Electrical components and devices shall:		-
	— be suitable for their intended use; and		P
	— conform to relevant IEC standards where such exist; and		P
	— be applied in accordance with the supplier’s instructions.		P
4.2.2	Switchgear		-
	In addition to the requirements of IEC 60204-1, depending upon the machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the machine that are in compliance with relevant parts of the IEC 61439 series (see also Annex F).	See the component certificate.	P
4.3	Electrical supply		-
4.3.1	General		-
	The electrical equipment shall be designed to operate correctly with the conditions of the supply:		P

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Clause	Requirement-Test	Result-Remark	Verdict
	— as specified in 4.3.2 or 4.3.3, or		P
	— as otherwise specified by the user, or		N
	— as specified by the supplier of a special source of supply (see 4.3.4)		N
4.3.2	AC supplies		-
	Voltage Steady state voltage: 0,9 to 1,1 of nominal voltage.	380V3~, comply with ±10% rated voltage	P
	Frequency 0,99 to 1,01 of nominal frequency continuously; 0,98 to 1,02 short time.	50Hz, comply with ±2% rated frequency	P
	Harmonics Harmonic distortion not exceeding 12 % of the total r.m.s. voltage between live conductors for the sum of the 2nd through to the 30th harmonic.	<10% of the total r.m.s voltage	P
	Voltage unbalance Neither the voltage of the negative sequence component nor the voltage of the zero sequence component in three-phase supplies exceeding 2 % of the positive sequence component.	<2% positive sequence	P
	Voltage interruption Supply interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1 s between successive interruptions.	Comply with requirement	P
	Voltage dips Voltage dips not exceeding 20 % of the rms voltage of the supply for more than one cycle with more than 1 s between successive dips.	Comply with requirement	P
4.3.3	DC supplies	AC power supply	N
	From batteries:		N
	Voltage 0,85 to 1,15 of nominal voltage; 0,7 to 1,2 of nominal voltage in the case of battery-operated vehicles.		N
	Voltage interruption Not exceeding 5 ms. From converting equipment:		N
	From converting equipment:		N
	Voltage 0,9 to 1,1 of nominal voltage.		N

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Clause	Requirement-Test	Result-Remark	Verdict
	Voltage interruption Not exceeding 20 ms with more than 1 s between successive interruptions.		N
	Ripple (peak-to-peak) Not exceeding 0,15 of nominal voltage.		N
4.3.4	Special supply systems		N
	For special supply systems (e.g. on-board generators, DC bus, etc.) the limits given in 4.3.2 and 4.3.3 may be exceeded provided that the equipment is designed to operate correctly with those conditions.	Not onboard power supply	N
4.4	Physical environment and operating conditions		-
4.4.1	General		-
	The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use. The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of machines covered by this part of IEC 60204. When special conditions apply or the limits specified are exceeded, an exchange of information between user and supplier (see 4.1) can be necessary.		P
4.4.2	Electromagnetic compatibility (EMC)		-
	The electrical equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended operating environment. In addition, the electrical equipment shall have a sufficient level of immunity to electromagnetic disturbances so that it can function in its intended environment.		N
	Immunity and/or emission tests are required on the electrical equipment unless the following conditions are fulfilled:		-
	• the incorporated devices and components comply with the EMC requirements for the intended EMC environment specified in the relevant product standard (or generic standard where no product standard exists), and;		N
	• the electrical installation and wiring are consistent with the instructions provided by the supplier of the devices and components with regard to mutual influences, (cabling, screening, earthing etc.) or with informative Annex H if such instructions are not available from the supplier.		N

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Clause	Requirement-Test	Result-Remark	Verdict
4.4.3	Ambient air temperature		-
	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. The minimum requirement for all electrical equipment is correct operation in ambient air temperatures outside of enclosures (cabinet or box) between +5 °C and +40 °C.	17℃~25℃	P
4.4.4	Humidity		-
	The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities are permitted at lower temperatures (for example 90 % at 20 °C).	<75%, for a short time, maximum 95%	P
	Harmful effects of occasional condensation shall be avoided by design of the equipment or, where necessary, by additional measures (for example built-in heaters, air conditioners, drain holes).	air conditioners used.	P
4.4.5	Altitude		-
	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.	<1000m	P
	For equipment to be used at higher altitudes, it is necessary to take into account the reduction of:		-
	— the dielectric strength, and;		N
	— the switching capability of the devices, and;		N
	— the cooling effect of the air.		N
	It is recommended that the manufacturer is consulted regarding the correction factors to be used where the factors are not specified in product data.		N
4.4.6	Contaminants		-
	Electrical equipment shall be adequately protected against the ingress of solids and liquids (see 11.3).		P
	The electrical equipment shall be adequately protected against contaminants (for example dust, acids, corrosive gases, salts) that can be present in the physical environment in which the electrical equipment is to be installed.	IP54	P
4.4.7	Ionizing and non-ionizing radiation		-
	When equipment is subject to radiation (for example microwave, ultraviolet, lasers, X-rays), additional measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation.	The electrical equipment of the machine is not subject	N

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Clause	Requirement-Test	Result-Remark	Verdict
		to ionizing and non-ionizing radiation.	
4.4.8	Vibration, shock, and bump		-
	Undesirable effects of vibration, shock and bump (including those generated by the machine and its associated equipment and those created by the physical environment) shall be avoided by the selection of suitable equipment, by mounting it away from the machine, or by provision of anti-vibration mountings.	The machine equips with cushion reduced vibration	P
4.5	Transportation and storage		-
	Electrical equipment shall be designed to withstand, or suitable precautions shall be taken to protect against, the effects of transportation and storage temperatures within a range of -25 °C to +55 °C and for short periods not exceeding 24 h at up to +70 °C. Suitable means shall be provided to prevent damage from humidity, vibration, and shock.	Comply with the requirements	P
4.6	Provisions for handling		-
	Heavy and bulky electrical equipment that has to be removed from the machine for transport, or that is independent of the machine, shall be provided with suitable means for handling, including where necessary means for handling by cranes or similar equipment.		P
5	Incoming supply conductor terminations and devices for disconnecting and switching off		-
5.1	Incoming supply conductor terminations		-
	It is recommended that, where practicable, the electrical equipment of a machine is connected to a single incoming supply. Where another supply is necessary for certain parts of the equipment (for example, electronic equipment that operates at a different voltage), that supply should be derived, as far as is practicable, from devices (for example, transformers, converters) forming part of the electrical equipment of the machine. For large complex machinery there can be a need for more than one incoming supply depending upon the site supply arrangements (see 5.3.1).	Single power supply.	P
	Unless a plug is provided with the machine for the connection to the supply (see 5.3.2 e)), it is recommended that the supply conductors are terminated at the supply		N

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Clause	Requirement-Test	Result-Remark	Verdict
	disconnecting device.		
	Where a neutral conductor is used it shall be clearly indicated in the technical documentation of the machine, such as in the installation diagram and in the circuit diagram, and a separate insulated terminal, labelled N in accordance with 16.1, shall be provided for the neutral conductor. The neutral terminal may be provided as part of the supply disconnecting device.		P
	There shall be no connection between the neutral conductor and the protective bonding circuit inside the electrical equipment.		P
	Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the electrical equipment to a TN-C supply system.		P
	For machines supplied from parallel sources, the requirements of IEC 60364-1 for multiple source systems apply.	Single power supply.	N
	Terminals for the incoming supply connection shall be clearly identified in accordance with IEC 60445. The terminal for the external protective conductor shall be identified in accordance with 5.2.	L1. L2, L3,N.PE marking.	P
5.2	Terminal for connection of the external protective conductor		-
	For each incoming supply, a terminal shall be provided in the same compartment as the associated line conductor terminals for connection of the machine to the external protective conductor.		P
	The terminal shall be of such a size as to enable the connection of an external protective copper conductor with a cross-sectional area determined in relation to the size of the associated line conductors in accordance with Table 1.	Meet the requirements	P
	Where an external protective conductor of a material other than copper is used, the terminal size and type shall be selected accordingly.	Copper	P
	At each incoming supply point, the terminal for connection of external protective conductor shall be marked or labelled with the letters PE (see IEC 60445).	‘PE’ is marked.	P
5.3	Supply disconnecting (isolating) device		-

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Clause	Requirement-Test	Result-Remark	Verdict
5.3.1	General		-
	A supply disconnecting device shall be provided:		-
	— for each incoming supply to (a) machine(s);		P
	— for each on-board power supply.		N
	The supply disconnecting device shall disconnect (isolate) the electrical equipment of the machine from the supply when required (for example for work on the machine, including the electrical equipment).	Mains switch and used circuit breaker	P
	Where two or more supply disconnecting devices are provided, protective interlocks for their correct operation shall also be provided in order to prevent a hazardous situation, including damage to the machine or to the work in progress.		P
5.3.2	Type		-
	The supply disconnecting device shall be one of the following types:		-
	a) switch-disconnector, with or without fuses, in accordance with IEC 60947-3, utilization category AC-23B or DC-23B; b) control and protective switching device suitable for isolation, in accordance with IEC 60947-6-2; c) a circuit-breaker suitable for isolation in accordance with IEC 60947-2; d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements and the appropriate utilization category and/or specified endurance requirements defined in the product standard; e) a plug/socket combination for a flexible cable supply.	c).	P
5.3.3	Requirements		-
	Where the supply disconnecting device is one of the types specified in 5.3.2 a) to d) it shall fulfil all of the following requirements:		-
	— isolate the electrical equipment from the supply and have one OFF (isolated) and one ON position marked with "O" and "I" (symbols IEC 60417-5008 (2002-10) and IEC 60417-5007 (2002-10), see 10.2.2);	On and off position	P
	— have a visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating	marked with ”0” and ”I”	P

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Clause	Requirement-Test	Result-Remark	Verdict
	function have been satisfied;		
	— have an operating means (see 5.3.4);		P
	— be provided with a means permitting it to be locked in the OFF (isolated) position (for example by padlocks). When so locked, remote as well as local closing shall be prevented;	Meet the requirements	P
	— disconnect all live conductors of its power supply circuit. However, for TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory;		N
	— have a breaking capacity sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and other loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. Where motor(s) are supplied by converter(s) or similar devices, the calculation should take into account the possible effect on the required breaking capacity.	Meet the requirements	P
	Where the supply disconnecting device is a plug/socket combination, it shall comply with the requirements of 13.4.5 and shall have the breaking capacity, or be interlocked with a switching device that has a breaking capacity, sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and other loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. Where the interlocked switching device is electrically operated (for example a contactor) it shall have an appropriate utilisation category. Where motor(s) are supplied by converter(s) or similar devices, the calculation should take into account the possible effect on the required breaking capacity.	Meet the requirements	P
	Where the supply disconnecting device is a plug/socket combination, a switching device with an appropriate utilisation category shall be provided for switching the machine on and off. This can be achieved by the use of the interlocked switching device described above.	Meet the requirements	P
5.3.4	Operating means of the supply disconnecting device		-
	The operating means (for example, a handle) of the	Handle and push button	P

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Clause	Requirement-Test	Result-Remark	Verdict
	supply disconnecting device shall be external to the enclosure of the electrical equipment.	used.	
	The operating means of the supply disconnecting device shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level. An upper limit of 1,7 m is recommended.	1.5m	P
	Where the external operating means is intended for emergency operation, see 10.7.3 or 10.8.3.		P
	Where the external operating means is not intended for emergency operations:		-
	— it is recommended that it be coloured BLACK or GREY (see 10.2)	Black and Grey	P
	— a supplementary cover or door that can be readily opened without the use of a key or tool may be provided, for example for protection against environmental conditions or mechanical damage. Such a cover/door shall clearly show that it provides access to the operating means. This can be achieved, for example, by use of the relevant symbol IEC 60417-6169-1 (2012-08) (Figure 2) or IEC 60417-6169-2 (2012-08), (Figure 3).	No such cover and door.	N
5.3.5	Excepted circuits		-
	The following circuits need not be disconnected by the supply disconnecting device:		-
	— lighting circuits for lighting needed during maintenance or repair;		N
	— socket outlets for the exclusive connection of repair or maintenance tools and equipment (for example hand drills, test equipment) (see 15.1);		N
	— undervoltage protection circuits that are only provided for automatic tripping in the event of supply failure;		N
	— circuits supplying equipment that should normally remain energized for correct operation (for example temperature controlled measuring devices, heaters, program storage devices).		N
	It is recommended, however, that such circuits be provided with their own disconnecting device.		N
	Control circuits supplied via another supply disconnecting device, regardless of whether that disconnecting device is located in the electrical		N

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Clause	Requirement-Test	Result-Remark	Verdict
	equipment or in another machine or other electrical equipment, need not be disconnected by the supply disconnecting device of the electrical equipment.		
	Where excepted circuits are not disconnected by the supply disconnecting device:		-
	— permanent warning label(s) shall be appropriately placed in proximity to the operating means of the supply disconnecting device to draw attention to the hazard;		N
	— a corresponding statement shall be included in the maintenance manual, and one or more of the following shall apply:		N
	• the conductors are identified by colour taking into account the recommendation of 13.2.4;		N
	• excepted circuits are separated from other circuits;		N
	• excepted circuits are identified by permanent warning label(s).		N
5.4	Devices for removal of power for prevention of unexpected start-up		-
	Devices for removal of power for the prevention of unexpected start-up shall be provided where a start-up of the machine or part of the machine can create a hazard (for example during maintenance). Such devices shall be appropriate and convenient for the intended use, be suitably placed, and readily identifiable as to their function and purpose. Where their function and purpose is not otherwise obvious (e.g. by their location) these devices shall be marked to indicate the extent of removal of power.		P
	The supply disconnecting device or other devices in accordance with 5.3.2 may be used for prevention of unexpected start-up.	Main switch	P
	Disconnectors, withdrawable fuse links and withdrawable links may be used for protection of unexpected start-up only if they are located in an enclosed electrical operating area (see 3.1.23).		P
	Devices that do not fulfil the isolation function (for example a contactor switched off by a control circuit, or Power Drive System (PDS) with a Safe Torque Off (STO) function in accordance with IEC 61800-5-2) may only be used for prevention of unexpected start-up during tasks		N

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Clause	Requirement-Test	Result-Remark	Verdict
	such as:		
	— inspections;		N
	— adjustments;		N
	— work on the electrical equipment where:		N
	• there is no hazard arising from electric shock (see Clause 6) and burn;		P
	• the switching off means remains effective throughout the work;		P
	• the work is of a minor nature (for example, replacement of plug-in devices without disturbing existing wiring).		P
	The selection of a device will be dependent on the risk assessment, taking into account the intended use of the device, and the persons who are intended to operate them.		P
5.5	Devices for isolating electrical equipment		-
	Devices shall be provided for isolating (disconnecting) the electrical equipment or part(s) of the electrical equipment to enable work to be carried out when it is de-energised and isolated. Such devices shall be:	Circuit breaker used	P
	— appropriate and convenient for the intended use;		P
	— suitably placed;		P
	— readily identifiable as to which part(s) or circuit(s) of the equipment is served. Where their function and purpose is not otherwise obvious (e.g. by their location) these devices shall be marked to indicate the extent of the equipment that they isolate.	Circuit breaker used for each branch circuits	P
	The supply disconnecting device (see 5.3) may, in some cases, fulfil that function. However, where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of the machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device shall be provided for each part, or for each machine, requiring separate isolation.	Circuit breaker used	P
	In addition to the supply disconnecting device, the following devices that fulfil the isolation function may be provided for this purpose:		-
	— devices described in 5.3.2;		P
	— disconnectors, withdrawable fuse links and withdrawable links only if located in an enclosed electrical operating area (see 3.1.23) and relevant		P

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Clause	Requirement-Test	Result-Remark	Verdict
	information is provided with the electrical equipment (see Clause 17).		
5.6	Protection against unauthorized, inadvertent and/or mistaken connection		-
	Where the devices described in 5.4 and 5.5 are located outside an enclosed electrical operating area they shall be equipped with means to secure them in the OFF position (disconnected state), (for example by provisions for padlocking, trapped key interlocking). When so secured, remote as well as local reconnection shall be prevented.	Circuit breaker is inside the metal enclosure which is opened using key by skilled person	P
	Where the devices described in 5.4 and 5.5 are located inside an enclosed electrical operating area other means of protection against reconnection (for example warning labels) can be sufficient.	Warning message used.	P
	However, when a plug/socket combination according to 5.3.2 e) is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for securing in the disconnected state need not be provided.	No plug/ socket outlet combinations.	N
6	Protection against electric shock		-
6.1	General		-
	The electrical equipment shall provide protection of persons against electric shock by:		-
	— basic protection (see 6.2 and 6.4), and;	See the relevant clauses.	P
	— fault protection (see 6.3 and 6.4).	See the relevant clauses.	P
	The measures for protection given in 6.2, 6.3, and, for PELV, in 6.4, are a selection from IEC 60364-4-41. Where those measures are not practicable, for example due to the physical or operational conditions, other measures from IEC 60364-4-41 may be used (e.g. SELV).	See the relevant clauses.	P
6.2	Basic protection		-
6.2.1	General		-
	For each circuit or part of the electrical equipment, the measures of either 6.2.2 or 6.2.3 and, where applicable, 6.2.4 shall be applied.	See the relevant clauses.	P
	Where the equipment is located in places open to all persons, which can include children, measures of either 6.2.2 with a minimum degree of protection against	This machine shall be located in the factory, and be operated by the	N

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Clause	Requirement-Test	Result-Remark	Verdict
	contact with live parts corresponding to IP4X or IPXXD (see IEC 60529), or 6.2.3 shall be applied.	authorized persons.	
6.2.2	Protection by enclosures		-
	Live parts shall be located inside enclosures that provide protection against contact with live parts of at least IP2X or IPXXB (see IEC 60529).	IP54	P
	Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against contact with live parts provided by the top surfaces shall be IP4X or IPXXD.	IP54	P
	Opening an enclosure (i.e. opening doors, lids, covers, and the like) shall be possible only under one of the following conditions:		
	a) The use of a key or tool is necessary for access.	Use tool	P
	All live parts, (including those on the inside of doors) that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected, shall be protected against contact to at least IP2X or IPXXB. Other live parts on the inside of doors shall be protected against unintentional direct contact to at least IP1X or IPXXA.	IP54	P
	b) The disconnection of live parts inside the enclosure before the enclosure can be opened.	No such disconnection.	N
	This may be accomplished by interlocking the door with a disconnecting device (for example, the supply disconnecting device) so that the door can only be opened when the disconnecting device is open and so that the disconnecting device can only be closed when the door is closed.		N
	Exception: a key or tool as prescribed by the supplier can be used to defeat the interlock provided that the following conditions are met:		N
	— it is possible at all times while the interlock is defeated to open the disconnecting device and lock the disconnecting device in the OFF (isolated) position or otherwise prevent unauthorised closure of the disconnecting device;		N
	— upon closing the door, the interlock is automatically restored;		N
	— all live parts, (including those on the inside of doors)		N

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Clause	Requirement-Test	Result-Remark	Verdict
	that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected, are protected against unintentional contact with live parts to at least IP2X or IPXXB and other live parts on the inside of doors are protected against unintentional contact to at least IP1X or IPXXA;		
	— relevant information about the procedures for the defeat of the interlock is provided with the instructions for use of the electrical equipment (see Clause 17).		N
	— means are provided to restrict access to live parts behind doors that are not directly interlocked with the disconnecting means to skilled or instructed persons. (See 17.2 b)).		N
	All parts that are still live after switching off the disconnecting device(s) (see 5.3.5) shall be protected against direct contact to at least IP2X or IPXXB (see IEC 60529). Such parts shall be marked with a warning sign in accordance with 16.2.1 (see also 13.2.4 for identification of conductors by colour), except for:		N
	— parts that can be live only because of connection to interlocking circuits and that are distinguished by colour as potentially live in accordance with 13.2.4;		N
	— the supply terminals of the supply disconnecting device when the latter is mounted alone in a separate enclosure.		N
	c) Opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against contact to at least IP2X or IPXXB (see IEC 60529). Where barriers provide this protection, either they shall require a tool for their removal or all live parts protected by them shall be automatically disconnected when the barrier is removed. Where protection against contact is achieved in accordance with 6.2.2 c), and a hazard can be caused by manual actuation of devices (for example manual closing of contactors or relays), such actuation should be prevented by barriers or obstacles that require a tool for their removal.	Use tool.	N
6.2.3	Protection by insulation of live parts		-
	Live parts protected by insulation shall be completely	Removed by	P

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

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Clause	Requirement-Test	Result-Remark	Verdict
	For protection by placing out of reach, the requirements of IEC 60364-4-41 shall apply. For protection by obstacles, the requirements of IEC 60364-4-41 shall apply.	Meet the requirements	P
	For conductor wire systems or conductor bar systems with a degree of protection less than IP2X or IPXXB, see 12.7.1.	IP2X	P
6.3	Fault protection		-
6.3.1	General		-
	Fault protection (3.31) is intended to prevent hazardous situations due to an insulation fault between live parts and exposed conductive parts.		P
	For each circuit or part of the electrical equipment, at least one of the measures in accordance with 6.3.2 to 6.3.3 shall be applied:	See the following descriptions.	P
	— measures to prevent the occurrence of a touch voltage (6.3.2); or	See the following descriptions.	P
	— automatic disconnection of the supply before the time of contact with a touch voltage can become hazardous (6.3.3).	See the following descriptions.	P
6.3.2	Prevention of the occurrence of a touch voltage		-
6.3.2.1	General		-
	Measures to prevent the occurrence of a touch voltage include the following:		-
	— provision of class II equipment or by equivalent insulation;	Not class equipment	N
	— electrical separation.		P
6.3.2.2	Protection by provision of class II equipment or by equivalent insulation		-
	This measure is intended to prevent the occurrence of touch voltages on the accessible parts through a fault in the basic insulation.		N
	This protection is provided by one or more of the following:		-
	— class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140);		N
	— switchgear and controlgear assemblies having total insulation in accordance with IEC 61439-1;		N
	— supplementary or reinforced insulation in accordance		N

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Clause	Requirement-Test	Result-Remark	Verdict
	with IEC 60364-4-41.		
6.3.2.3	Protection by electrical separation		-
	Electrical separation of an individual circuit is intended to prevent a touch voltage through contact with exposed conductive parts that can be energized by a fault in the basic insulation of the live parts of that circuit.	Electrical clearance and creepage distance comply relevant requirements	P
	For this type of protection, the requirements of IEC 60364-4-41 apply.		P
6.3.3	Protection by automatic disconnection of supply		-
	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.	Breaker used.	P
	This measure consists of the interruption of one or more of the line conductors by the automatic operation of a protective device in case of a fault. This interruption shall occur within a sufficiently short time to limit the duration of a touch voltage to a time within the limits specified in Annex A for TN and TT systems.		P
	This measure necessitates co-ordination between:		-
	— the type of supply system, the supply source impedance and the earthing system;		P
	— the impedance values of the different elements of the line and of the associated fault current paths through the protective bonding circuit;		P
	— the characteristics of the protective devices that detect insulation fault(s).		P
	This protective measure comprises both:		-
	— protective bonding of exposed conductive parts (see 8.2.3),		P
	— and one of the following:		-
	a) In TN systems, the following protective devices may be used:		-
	• overcurrent protective devices;	Breaker uses	P
	• residual current protective devices (RCDs) and associated overcurrent protective device(s).		N
	b) in TT systems, either:	TN system	-
	• RCDs and associated overcurrent protective device(s) to initiate the automatic disconnection of the supply on detection of an insulation fault from a live part		N

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	to exposed conductive parts or to earth, or		
	• overcurrent protective devices may be used for fault protection provided a suitably low value of the fault loop impedance Zs (see A.2.2.3) is permanently and reliably assured;		N
	c) In IT systems the relevant requirements of IEC 60364-4-41 shall be fulfilled. During an insulation fault, an acoustic and optical signal shall be sustained. After annunciation, the acoustic signal may then be manually muted. This can require an agreement between the supplier and user regarding the provision of insulation monitoring devices and/or insulation fault location system(s).		N
	Where automatic disconnection is provided in accordance with a), and disconnection within the time specified in A.1.1 cannot be assured, supplementary protective bonding shall be provided as necessary to meet the requirements of A.1.3.		P
	Where a power drive system (PDS) is provided, fault protection shall be provided for those circuits of the power drive system that are supplied by the converter. Where this protection is not provided within the converter, the necessary protection measures shall be in accordance with the converter manufacturer's instructions.	Meet the requirements	P
6.4	Protection by the use of PELV		P
6.4.1	General requirements		P
	The use of PELV (Protective Extra-Low Voltage) is to protect persons against electric shock from indirect contact and limited area direct contact (see 8.2.1).		P
	PELV circuits shall satisfy all of the following conditions:		-
	a) the nominal voltage shall not exceed:		-
	• 25 V AC r.m.s. or 60 V ripple-free DC when the equipment is normally used in dry locations and when large area contact of live parts with the human body is not expected; or	24V	P
	• 6 V AC r.m.s. or 15 V ripple-free DC in all other cases;		N
	b) one side of the circuit or one point of the source of the supply of that circuit shall be connected to the		N

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	protective bonding circuit;		
	c) live parts of PELV circuits shall be electrically separated from other live circuits. Electrical separation shall be not less than that required between the primary and secondary circuits of a safety isolating transformer (see IEC 61558-1 and IEC 61558-2-6);		N
	d) conductors of each PELV circuit shall be physically separated from those of any other circuit. When this requirement is impracticable, the insulation provisions of 13.1.3 shall apply;		N
	e) plugs and socket-outlets for a PELV circuit shall conform to the following:		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
6.4.2	Sources for PELV		-
	The source for PELV shall be one of the following:		-
	— a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6;		P
	— 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
	— an electronic power supply conforming to appropriate standards specifying measures to be taken to ensure that, even in the case of an internal fault, the voltage at the outgoing terminals cannot exceed the values specified in 6.4.1.		N
7	Protection of equipment		-
7.1	General		-
	This Clause 7 details the measures to be taken to protect equipment against the effects of:		-
	— overcurrent arising from a short-circuit;		P
	— overload and/or loss of cooling of motors;		P
	— abnormal temperature;		N
	— loss of or reduction in the supply voltage;		P

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	— overspeed of machines/machine elements;		N
	— earth fault/residual current;		N
	— incorrect phase sequence;		P
	— overvoltage due to lightning and switching surges.		P
7.2	Overcurrent protection		-
7.2.1	General		P
	Overcurrent protection shall be provided where the current in any circuit can exceed either the rating of any component or the current carrying capacity of the conductors, whichever is the lesser value. The ratings or settings to be selected are detailed in 7.2.10.	Circuit breaker and fuse have overcurrent protection function	P
7.2.2	Supply conductors		-
	Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the supply conductors and the overcurrent protective device for the supply conductors to the electrical equipment.	Circuit breaker and fuse have overcurrent protection function	P
	The supplier of the electrical equipment shall state in the installation documents the data necessary for conductor dimensioning (including the maximum cross-sectional area of the supply conductor that can be connected to the terminals of the electrical equipment) and for selecting the overcurrent protective device (see 7.2.10 and 17).		P
7.2.3	Power circuits		-
	Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10, shall be applied to each live conductor including circuits supplying control circuit transformers.	Circuit breaker and fuse have overcurrent protection function	P
	The following conductors, as applicable, shall not be disconnected without disconnecting all associated live conductors:		-
	— the neutral conductor of AC power circuits;	No such circuit	N
	— the earthed conductor of DC power circuits;	No such circuit	N
	— DC power conductors bonded to exposed conductive parts of mobile machines.	No such circuit	N
	Where the cross-sectional area of the neutral conductor is at least equal to or equivalent to that of the line conductors, it is not necessary to provide overcurrent detection for the neutral conductor nor a disconnecting device for that conductor. For a neutral conductor with a cross- sectional area smaller than that of the associated	No neutral conductor	N

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	line conductors, the measures detailed in 524 of IEC 60364-5-52:2009 shall apply.		
	In IT systems, it is recommended that the neutral conductor is not used. However, where a neutral conductor is used, the measures detailed in 431.2.2 of IEC 60364-4-43:2008 shall apply.	Not IT system.	N
7.2.4	Control circuits		-
	Conductors of control circuits directly connected to the supply voltage shall be protected against overcurrent in accordance with 7.2.3.		P
	Conductors of control circuits supplied by a transformer or DC supply shall be protected against overcurrent (see also 9.4.3.1.1):	Breaker used.	P
	— in control circuits connected to the protective bonding circuit, by inserting an overcurrent protective device into the switched conductor;		P
	— in control circuits not connected to the protective bonding circuit;		P
	• where all control circuits of the equipment have the same current carrying capacity, by inserting an overcurrent protective device into the switched conductor, or;		N
	• where different control circuits of the equipment have different current carrying capacity, by inserting an overcurrent protective device into both switched and common conductors of each control circuit.		P
	Exception: Where the supply unit provides current limiting below the current carrying capacity of the conductors in a circuit and below the current rating of connected components, no separate overcurrent protective device is required.		N
7.2.5	Socket outlets and their associated conductors	No such device.	N
	Overcurrent protection shall be provided for the circuits feeding the general purpose socket outlets intended primarily for supplying power to maintenance equipment. Overcurrent protective devices shall be provided in the unearthed live conductors of each circuit feeding such socket outlets. See also 15.1.		N
7.2.6	Lighting circuits		-
	All unearthed conductors of circuits supplying lighting		N

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Clause	Requirement-Test	Result-Remark	Verdict
	shall be protected against the effects of short-circuits by the provision of overcurrent devices separate from those protecting other circuits.		
7.2.7	Transformers		-
	Transformers shall be protected by an overcurrent protective device having a type and setting in accordance with the transformer manufacturer's instructions. Such protection shall (see also 7.2.10):		P
	— avoid nuisance tripping due to transformer magnetizing inrush currents;		P
	— 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.		P
7.2.8	Location of overcurrent protective devices		P
	An overcurrent protective device shall be located at the point where a reduction in the cross- sectional area of the conductors or another change reduces the current-carrying capacity of the conductors, except where all the following conditions are satisfied:	located at point where conductor is connected to the supply	P
	— the current carrying capacity of the conductors is at least equal to that of the load;	Comply with requirement	P
	— the part of the conductor(s) between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is no longer than 3 m;	2m max.	P
	— the conductors are installed in such a manner as to reduce the possibility of a short- circuit, for example, protected by an enclosure or duct.	By enclosure	P
7.2.9	Overcurrent protective devices		-
	The rated short-circuit breaking capacity shall be at least equal to the prospective fault current at the point of installation. Where the short-circuit current to an overcurrent protective device can include additional currents other than from the supply (for example from motors, from power factor correction capacitors), those currents shall be taken into consideration.	Comply with requirement	P
	Where fuses are provided as overcurrent protective devices, a type readily available in the country of use shall be selected, or arrangements shall be made for the	Comply with requirement	P

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	supply of spare parts.		
7.2.10	Rating and setting of overcurrent protective devices		-
	The rated current of fuses or the setting current of other overcurrent protective devices shall be selected as low as possible but adequate for the anticipated overcurrents (for example during starting of motors or energizing of transformers). When selecting those protective devices, consideration shall be given to the protection of switching devices against damage due to overcurrents.	Meet the requirements	P
	The rated current or setting of an overcurrent protective device for conductors is determined by the current carrying capacity of the conductors to be protected in accordance with 12.4, Clause D.3 and the maximum allowable interrupting time t in accordance with Clause D.4, taking into account the needs of co-ordination with other electrical devices in the protected circuit.	Meet the requirements	P
7.3	Protection of motors against overheating		-
7.3.1	General		-
	Protection of motors against overheating shall be provided for each motor rated at more than 0,5 kW.		P
	Protection of motors against overheating can be achieved by:		-
	— overload protection (7.3.2),		P
	— over-temperature protection (7.3.3), or		P
	— current-limiting protection.		P
	Automatic restarting of any motor after the operation of protection against overheating shall be prevented where this can cause a hazardous situation or damage to the machine or to the work in progress.		N
7.3.2	Overload protection		
	Where overload protection is provided, detection of overload(s) shall be provided in each live conductor except for the neutral conductor.		P
	However, where the motor overload detection is not used for cable overload protection (see also Clause D.2), detection of overload may be omitted in one of the live conductors. For motors having single-phase or DC power supplies, detection in only one unearthed live conductor is permitted.		N
	Where overload protection is achieved by switching off,		N

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Clause	Requirement-Test	Result-Remark	Verdict
	the switching device shall switch off all live conductors. The switching of the neutral conductor is not necessary for overload protection.		
	Where motors with special duty ratings are required to start or to brake frequently (for example, motors for rapid traverse, locking, rapid reversal, sensitive drilling) it can be difficult to provide overload protection with a time constant comparable with that of the winding to be protected. Appropriate protective devices designed to accommodate special duty motors or over-temperature protection (see 7.3.3) can be necessary.		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
7.3.3	Over-temperature protection		-
	The provision of motors with over-temperature protection in accordance with IEC 60034-11 is recommended in situations where the cooling can be impaired (for example dusty environments). Depending upon the type of motor, protection under stalled rotor or loss of phase conditions is not always ensured by over-temperature protection, and additional protection should then be provided.		P
	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).		P
7.4	Protection against abnormal temperature		-
	Equipment shall be protected against abnormal temperatures that can result in a hazardous situation.		P
7.5	Protection against the effects of supply interruption or voltage reduction and subsequent restoration		-
	Where a supply interruption or a voltage reduction can cause a hazardous situation, damage to the machine, or to the work in progress, undervoltage protection shall be provided by, for example, switching off the machine at a predetermined voltage level.	Under voltage protection provided.	P

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Clause	Requirement-Test	Result-Remark	Verdict
	Where the operation of the machine can allow for an interruption or a reduction of the voltage for a short time period, delayed undervoltage protection may be provided. The operation of the undervoltage device shall not impair the operation of any stopping control of the machine.		P
	Upon restoration of the voltage or upon switching on the incoming supply, automatic or unexpected restarting of the machine shall be prevented where such a restart can cause a hazardous situation.		N
	Where only a part of the machine or of the group of machines working together in a co- ordinated manner is affected by the voltage reduction or supply interruption, the undervoltage protection shall initiate appropriate control commands to ensure co-ordination.		N
7.6	Motor overspeed protection		-
	Overspeed protection shall be provided where overspeeding can occur and could possibly cause a hazardous situation taking into account measures in accordance with 9.3.2. Overspeed protection shall initiate appropriate control responses and shall prevent automatic restarting.		N
	The overspeed protection should operate in such a manner that the mechanical speed limit of the motor or its load is not exceeded.		N
7.7	Additional earth fault/residual current protection	No such protection	N
	In addition to providing overcurrent protection for automatic disconnection as described in 6.3, earth fault/residual current protection can be provided to reduce damage to equipment due to earth fault currents less than the detection level of the overcurrent protection.		N
	The setting of the devices shall be as low as possible consistent with correct operation of the equipment.		N
	If fault currents with DC components are possible, an RCD of type B in accordance with IEC TR 60755 can be required.		N
7.8	Phase sequence protection	No such protection	N
	Where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine, protection shall be provided.		N
7.9	Protection against overvoltages due to lightning and to		-

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Clause	Requirement-Test	Result-Remark	Verdict
	switching surges		
	Surge protective devices (SPDs) can be provided to protect against the effects of overvoltages due to lightning or to switching surges.	Circuit breaker used	P
	Where provided:		
	— SPDs for the suppression of overvoltages due to lightning shall be connected to the incoming terminals of the supply disconnecting device.	Circuit breaker used	P
	— SPDs for the suppression of overvoltages due to switching surges shall be connected as necessary for equipment requiring such protection.	Circuit breaker used	P
7.10	Short-circuit current rating		-
	The short-circuit current rating of the electrical equipment shall be determined. This can be done by the application of design rules or by calculation or by test.	Circuit breaker used	P
8	Equipotential bonding		-
8.1	General		-
	This Clause 8 provides requirements for protective bonding and functional bonding. Figure 4 illustrates those concepts.		P
	Protective bonding is a basic provision for fault protection to enable protection of persons against electric shock (see 6.3.3 and 8.2).	Meet the requirements	P
	The objective of functional bonding (see 8.4) is to reduce:		-
	— the consequence of an insulation failure which could affect the operation of the machine;		P
	— electrical disturbances to sensitive electrical equipment which could affect the operation of the machine;		P
	— induced currents from lightning which could damage the electric equipment.		P
	Functional bonding is achieved by connection to the protective bonding circuit, but where the level of electrical disturbances on the protective bonding circuit is not sufficiently low for proper functioning of electrical equipment, it can be necessary to use separate conductors for protective and functional bonding.	Meet the requirements	P
8.2	Protective bonding circuit		-
8.2.1	General		-

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	The protective bonding circuit consists of the interconnection of:		-
	• PE terminal(s) (see 5.2);		P
	• the protective conductors (see 3.1.51) in the equipment of the machine including sliding contacts where they are part of the circuit;		N
	• the conductive structural parts and exposed conductive parts of the electrical equipment; Exception: see 8.2.5.		N
	• conductive structural parts of the machine.		P
	All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses that can be caused by earth-fault currents that could flow in that part of the protective bonding circuit.		P
	The cross-sectional area of every protective conductor which does not form part of a cable or which is not in a common enclosure with the line conductor shall be not less than		P
	— 2,5 mm2 Cu or 16 mm2 Al if protection against mechanical damage is provided,		P
	— 4 mm2 Cu or 16 mm2 Al if protection against mechanical damage is not provided.		N
	A protective conductor not forming part of a cable is considered to be mechanically protected if it is installed in a conduit, trunking or protected in a similar way. Conductive structural parts of equipment in accordance with 6.3.2.2 need not be connected to the protective bonding circuit. Conductive structural parts of the machine need not be connected to the protective bonding circuit where all the equipment provided is in accordance with 6.3.2.2.		P
	Exposed conductive parts of equipment in accordance with 6.3.2.3 shall not be connected to the protective bonding circuit.		P
	It is not necessary to connect exposed conductive parts to the protective bonding circuit where those parts are mounted so that they do not constitute a hazard because:		N
	— they cannot be touched on large surfaces or grasped with the hand and they are small in size (less than		N

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	approximately 50 mm 50 mm); or		
	— they are located so that either contact with live parts, or an insulation failure, is unlikely.		N
	This applies to small parts such as screws, rivets, and nameplates and to parts inside an enclosure, irrespective of their size (for example electromagnets of contactors or relays and mechanical parts of devices).		N
8.2.2	Protective conductors		-
	Protective conductors shall be identified in accordance with 13.2.2.	See clause 14.2.2 in detail.	P
	Copper conductors are preferred. Where a conductor material other than copper is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm2 in cross-sectional area for reasons of mechanical durability.	Copper used	P
	Metal enclosures or frames or mounting plates of electrical equipment, connected to the protective bonding circuit, may be used as protective conductors if they satisfy the following three requirements:	Meet the requirements	P
	• their electrical continuity shall be assured by construction or by suitable connection so as to ensure protection against mechanical, chemical or electrochemical deterioration;	Meet the requirements	P
	• they comply with the requirements of 543.1 of IEC 60364-5-54:2011;	Meet the requirements	P
	• they shall permit the connection of other protective conductors at every predetermined tap-off point.	Meet the requirements	P
	The cross-sectional area of protective conductors shall either be calculated in accordance with 543.1.2 of IEC 60364-5-54:2011, or selected in accordance with Table 1 (see 5.2). See also 8.2.6. and 17.2 (d) of this document.		P
	Each protective conductor shall:		N
	• be part of a multicore cable, or;		N
	• be in a common enclosure with the line conductor, or;		N
	• have a cross-sectional area of at least;		N
	• 2,5 mm2 Cu or 16 mm2 Al if protection against mechanical damage is provided;		P
	• 4 mm2 Cu or 16 mm2 Al if protection against		N

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	mechanical damage is not provided.		
	A protective conductor not forming part of a cable is considered to be mechanically protected if it is installed in a conduit, trunking or protected in a similar way.		P
	The following parts of the machine and its electrical equipment shall be connected to the protective bonding circuit but shall not be used as protective conductors:		P
	• conductive structural parts of the machine;		P
	• metal ducts of flexible or rigid construction;		N
	• metallic cable sheaths or armouring;		N
	• metallic pipes containing flammable materials such as gases, liquids, powder.		N
	• flexible or pliable metal conduits;		N
	• constructional parts subject to mechanical stress in normal service;		N
	• flexible metal parts; support wires; cable trays and cable ladders.		N
8.2.3	Continuity of the protective bonding circuit		P
	Where a part is removed for any reason (for example routine maintenance), the protective bonding circuit for the remaining parts shall not be interrupted.	If one part removed, protective continuity not interrupted	P
	Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and conductors of aluminium or aluminium alloys are used, particular consideration should be given to the possibility of electrolytic corrosion.	Connect to protective bonding circuits	P
	Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured and a protective conductor (see 8.2.2) is recommended. Where a protective conductor is not provided, fastenings, hinges or sliding contacts designed to have a low resistance shall be used (see 18.2.2, Test 1).		P
	The continuity of conductors in cables that are exposed to damage (for example flexible trailing cables) shall be ensured by appropriate measures (for example monitoring).		P

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	For requirements for the continuity of conductors using conductor wires, conductor bars and slip-ring assemblies, see 12.7.2.		P
	The protective bonding circuit shall not incorporate a switching device, an overcurrent protective device (for example switch, fuse), or other means of interruption.	Meet the requirements	P
	Exception: links that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area may be provided for test or measurement purposes.		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. This also applies to removable or withdrawable plug-in units (see also 13.4.5).	No switching devices or any other current protective devices	P
8.2.4	Protective conductor connecting points		-
	All protective conductors shall be terminated in accordance with 13.1.1. The protective conductor connecting points are not intended, for example, to attach appliances or parts.		P
	Each protective conductor connecting point shall be marked or labelled as such using the symbol IEC 60417-5019:2006-08 as illustrated in Figure 5:	Earthing symbol is used.	P
	or with the letters PE, the graphical symbol being preferred, or by use of the bicolour combination GREEN-AND-YELLOW, or by any combination of these.	GREEN-AND-YELLOW	P
8.2.5	Mobile machines	Not mobile machine	-
	On mobile machines with on-board power supplies, the protective conductors, the conductive structural parts of the electrical equipment, and those extraneous-conductive-parts which form the structure of the machine shall all be connected to a protective bonding terminal to provide protection against electric shock. Where a mobile machine is also capable of being connected to an external incoming power supply, this protective bonding terminal shall be the connection point for the external protective conductor.		N
8.2.6	Additional requirements for electrical equipment having	<10mA	N

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	earth leakage currents higher than 10 mA		
	Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:		N
	a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;		N
	b) the protective conductor has a cross-sectional area of at least 10 mm2 Cu or 16 mm2 Al;		N
	c) 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 is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm2 Cu or 16 mm2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.		N
	d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;		N
	e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm2 as part of a multi-conductor power cable is provided.		N
	A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.		N
8.3	Measures to restrict 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. The protective bonding circuit shall be connected to exposed conductive parts of the equipment and, in addition, to the secondary winding of the transformer. The protective conductor(s) between the equipment and the secondary winding of the transformer		P

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Clause	Requirement-Test	Result-Remark	Verdict
	shall comply with one or more of the arrangements described in 8.2.6.		
8.4	Functional bonding		-
	Protection against maloperation as a result of insulation failures can be achieved by connecting to a common conductor in accordance with 9.4.3.1.1.	Meet the requirements	P
	For recommendations regarding functional bonding to avoid maloperation due to electromagnetic disturbances, see 4.4.2 and Annex H.	Meet the requirements	P
	Functional bonding connecting points should be marked or labelled as such using the symbol IEC 60417-5020:2002-10 (see Figure 6).	Meet the requirements	P
9	Control circuits and control functions		-
9.1	Control circuits		-
9.1.1	Control circuit supply		-
	Where control circuits are supplied from an AC source, transformers having separate windings shall be used to separate the power supply from the control supply.	Supplied by isolating transformer	P
	Examples include:		-
	• control transformers having separate windings in accordance with IEC 61558-2-2,		N
	• switch mode power supply units in accordance with IEC 61558-2-16 fitted with transformers having separate windings,		P
	• low voltage power supplies in accordance with IEC 61204-7 fitted with transformers having separate windings.		N
	Where several transformers are used, it is recommended that the windings of those transformers be connected in such a manner that the secondary voltages are in phase.		N
	Exception: Transformers or switch mode power supply units fitted with transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices (for example, interlock device, start/stop control station).		N
	Where DC control circuits derived from an AC supply are connected to the protective bonding circuit (see 8.2.1), they shall be supplied from a separate winding of the AC control circuit transformer or by another control circuit transformer.	Switching Power Supply	P

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9.1.2	Control circuit voltages		-
	The nominal value of the control voltage shall be consistent with the correct operation of the control circuit.		P
	The nominal voltage of AC control circuits should preferably not exceed		-
	— 230 V for circuits with 50 Hz nominal frequency,	220V	P
	— 277 V for circuits with 60 Hz nominal frequency.		N
	The nominal voltage of DC control circuits should preferably not exceed 220 V.	24V	P
9.1.3	Protection		-
	Control circuits shall be provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		P
9.2	Control functions		-
9.2.1	General		-
9.2.2	Categories of stop functions		-
	There are three categories of stop functions as follows:		-
	— stop category 0: stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop – see 3.1.64);	Power circuit breaker	P
	— stop category 1: a controlled stop (see 3.1.14) with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved;	“STOP“ button	P
	— stop category 2: a controlled stop with power remaining available to the machine actuators.		N
9.2.3	Operation		-
9.2.3.1	General		-
	Safety functions and/or protective measures (for example interlocks (see 9.3)) shall be provided where required to reduce the possibility of hazardous situations.	Meet the requirements	P
	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.		P
9.2.3.2	Start		-
	Start functions shall operate by energizing the relevant circuit.		P
	The start of an operation shall be possible only when all relevant safety functions and/or protective measures are	Meet the requirements	P

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	in place and are operational, except for conditions as described in 9.3.6.		
	For those machines (for example mobile machines) where safety functions and/or protective measures cannot be applied for certain operations, starting of such operations shall be by hold-to-run controls, together with enabling devices, as appropriate.		N
	The provision of acoustic and/or visual warning signals before the starting of hazardous machine operation should be considered.	Meet the requirements	P
	Suitable interlocks shall be provided where necessary for correct sequential starting.	Meet the requirements	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 shall be:	Only one control device	N
	• all required conditions for machine operation shall be met, and		N
	• all start control devices shall be in the released (off) position, then		N
	• all start control devices shall be actuated concurrently (see 3.1.7).		N
9.2.3.3	Stop		-
	Stop category 0 and/or stop category 1 and/or stop category 2 stop functions shall be provided as indicated by the risk assessment and the functional requirements of the machine (see 4.1).	Meet the requirements	P
	Stop functions shall override related start functions.		P
	Where more than one control station is provided, stop commands from any control station shall be effective when required by the risk assessment of the machine.	Only one control device	N
9.2.3.4	Emergency operations (emergency stop, emergency switching off)		-
9.2.3.4.1	General		-
	Emergency stop and emergency switching off are complementary protective measures that are not primary means of risk reduction for hazards (for example trapping, entanglement, electric shock or burn) at a machine (see ISO 12110).		P

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	This part of IEC 60204 specifies the requirements for the emergency stop and the emergency switching off functions of the emergency operations listed in Annex E, both of which are intended to be initiated by a single human action.		P
	Once active operation of an emergency stop (see 10.7) or emergency switching off (see 10.8) actuator has ceased following a stop or switching off command, the effect of this command shall be sustained until it is reset. This reset shall be possible only by a manual action at the device where the command has been initiated. The reset of the command shall not restart the machinery but only permit restarting.		P
	It shall not be possible to restart the machinery until all emergency stop commands have been reset. It shall not be possible to reenergize the machinery until all emergency switching off commands have been reset.		P
9.2.3.4.2	Emergency stop		-
	Requirements for functional aspects of emergency stop equipment are given in ISO 13850.		P
	The emergency stop shall function either as a stop category 0 or as a stop category 1. The choice of the stop category of the emergency stop depends on the results of a risk assessment of the machine.		P
	In addition to the requirements for stop given in 9.2.3.3, the emergency stop function has the following requirements:		-
	• it shall override all other functions and operations in all modes;		P
	• it shall stop the hazardous motion as quickly as practicable without creating other hazards;		P
	• reset shall not initiate a restart.		P
9.2.3.4.3	Emergency switching off		-
	The functional aspects of emergency switching off are given in 536.4 of IEC 60364-5-53:2001.		-
	Emergency switching off should be provided where:		-
	• basic protection (for example for conductor wires, conductor bars, slip-ring assemblies, controlgear in		N

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Clause	Requirement-Test	Result-Remark	Verdict
	electrical operating areas) is achieved only by placing out of reach or by obstacles (see 6.2.6); or		
	• there is the possibility of other hazards or damage caused by electricity.		N
	Emergency switching off is accomplished by switching off the relevant supply by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply. When a machine cannot tolerate this category 0 stop, it may be necessary to provide other measures, for example basic protection, so that emergency switching off is not necessary.		N
9.2.3.5	Operating modes		-
	Each machine can have one or more operating modes (for example manual mode, automatic mode, setting mode, maintenance mode) determined by the type of machine and its application.		N
	Where machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and having a different impact on safety, it shall be fitted with a mode selector which can be locked in each position (for example key operated switch). Each position of the selector shall be clearly identifiable and shall correspond to a single operating or control mode.		N
	The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator (for example access code).		N
	Mode selection by itself shall not initiate machine operation. A separate actuation of the start control shall be required.		N
	For each specific operating mode, the relevant safety functions and/or protective measures shall be implemented.		N
	Indication of the selected operating mode shall be provided (for example the position of a mode selector, the provision of an indicating light, a visual display indication).		N
9.2.3.6	Monitoring of command actions		-
	Movement or action of a machine or part of a machine		N

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Clause	Requirement-Test	Result-Remark	Verdict
	that can result in a hazardous situation shall be monitored by providing, for example, overtravel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices.		
9.2.3.7	Hold-to-run controls		N
	Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation.		N
9.2.3.8	Two-hand control	No such control	N
	Three types of two-hand control are defined in ISO 13851, the selection of which is determined by the risk assessment. These shall have the following features:		N
	Type I: this type requires:		N
	• the provision of two control devices and their concurrent actuation by both hands;		N
	• continuous concurrent actuation during the hazardous situation;		N
	• machine operation shall cease upon the release of either one or both of the control devices when hazardous situations are still present.		N
	A Type I two-hand control device is not considered to be suitable for the initiation of hazardous operation.		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:		N
	• it shall be necessary to actuate the control devices within a certain time limit of each other, not exceeding 0,5 s;		N
	• where this time limit is exceeded, both control devices shall be released before machine operation can be initiated.		N
9.2.3.9	Enabling control	No such control	N
	Enabling control (see also 10.9) is a manually activated control function interlock that:		N
	a) when activated allows a machine operation to be initiated by a separate start control, and		N
	b) when de-activated		N
	• initiates a stop function, and		N
	• prevents initiation of machine operation.		N

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Clause	Requirement-Test	Result-Remark	Verdict
	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
9.2.3.10	Combined start and stop controls		N
	Push-buttons and similar control devices that, when operated, alternately initiate and stop motion shall only be provided for functions which cannot result in a hazardous situation.		N
9.2.4	Cableless control system (CCS)	No such system	N
9.2.4.1	General requirements		-
	Subclause 9.2.4 deals with the functional requirements of control systems employing cableless (for example radio, infra-red) techniques for transmitting control signals and data between operator control station(s) and other parts of the control system(s).		N
	Transmission reliability requirements can be necessary for safety functions of a CCS that rely on data transmission (for example, safety-related active stop, motion commands).		N
	The CCS shall have functionality and a response time suitable for the application based on the risk assessment.		N
9.2.4.2	Monitoring the ability of a cableless control system to control a machine		-
	The ability of a cableless control system (CCS) to control a machine shall be automatically monitored, either continuously or at suitable intervals. The status of this ability shall be clearly indicated (for example, by an indicating light, a visual display indication, etc.)		N
	If the communication signal is degraded in a manner that might lead to the loss of the ability of a CCS to control a machine (e.g., reduced signal level, low battery power) a warning to the operator shall be provided before the ability of the CCS to control a machine is lost.		N
	When the ability of a CCS to control a machine has been lost for a time that is determined from a risk assessment of the application, an automatic stop of the machine shall be initiated.		N
	Restoration of the ability of a CCS to control a machine		N

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	shall not restart the machine. Restart shall require a deliberate action, for example manual actuation of a start button.		
9.2.4.3	Control limitation		-
	Measures shall be taken (e.g. coded transmission) to prevent the machine from responding to signals other than those from the intended cableless operator control station(s).		N
	Cableless operator control station(s) shall only control the intended machine(s) and shall affect only the intended machine functions.		N
9.2.4.4	Use of multiple cableless operator control stations		-
	When more than one cableless operator control station is used to control a machine, then:		N
	• only one cableless operator control station shall be enabled at a time except as necessary for the operation of the machine;		N
	• transfer of control from one cableless operator control station to another shall require a deliberate manual action at the control station that has control;		N
	• during machine operation, transfer of control shall only be possible when both cableless operator control stations are set to the same mode of machine operation and/or function(s) of the machine;		N
	• transfer of control shall not change the selected mode of machine operation and/or function(s) of the machine;		N
	• each cableless operator control station that has control of the machine shall be provided with an indication that it has control (by for example, the provision of an indicating light, a visual display indication).		N
9.2.4.5	Portable cableless operator control stations		-
	Portable cableless operator control stations shall be provided with means (for example key operated switch, access code) to prevent unauthorized use.		N
	Each machine under cableless control should have an indication when it is under cableless control.		N
	When a portable cableless operator control station can be connected to one or more of several machines, means shall be provided on the portable cableless operator		N

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Clause	Requirement-Test	Result-Remark	Verdict
	control station to select which machine(s) is to be connected. Selecting a machine to be connected shall not initiate control commands.		
9.2.4.6	Deliberate disabling of cableless operator control stations		-
	Where a cableless operator control station is disabled when under control, the associated machine shall meet the requirements for loss of ability of a CCS to control a machine in 9.2.4.2.		N
	Where it is necessary to disable a cableless operator control station without interrupting machine operation, means shall be provided (for example on the cableless operator control station) to transfer control to another fixed or portable control station.		N
9.2.4.7	Emergency stop devices on portable cableless operator control stations		-
	Emergency stop devices on portable cableless operator control stations shall not be the sole means of initiating the emergency stop function of a machine.		N
	Confusion between active and inactive emergency stop devices shall be avoided by appropriate design and information for use. See also ISO 13850.		N
9.2.4.8	Emergency stop reset		-
	Restarting of cableless control after power loss, disabling and re-enabling, loss of communication, or failure of parts of the CCS shall not result in a reset of an emergency stop condition.		N
	The instructions for use shall state that the reset of an emergency stop condition initiated by a portable cableless operator control station shall only be performed when it can be seen that the reason for initiation has been cleared.		N
	Depending on the risk assessment, in addition to the resetting of the emergency stop actuator on the portable cableless operator control station, one or more supplementary fixed reset devices should be provided.		N
9.3	Protective interlocks		-
9.3.1	Reclosing or resetting of an interlocking safeguard		-
	The reclosing or resetting of an interlocking safeguard shall not initiate hazardous machine operation.		N
9.3.2	Exceeding operating limits		-
	Where an operating limit (for example speed, pressure,		N

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Clause	Requirement-Test	Result-Remark	Verdict
	position) can be exceeded leading to a hazardous situation, means shall be provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action.		
9.3.3	Operation of auxiliary functions		-
	The correct operation of auxiliary functions shall be checked by appropriate devices (for example pressure sensors).		N
	Where the non-operation of a motor or device for an auxiliary function (for example lubrication, supply of coolant, swarf removal) can cause a hazardous situation, or cause damage to the machine or to the work in progress, appropriate interlocking shall be provided.		N
9.3.4	Interlocks between different operations and for contrary motions		-
	All contactors, relays, and other control devices that control elements of the machine and that can cause a hazardous situation when actuated at the same time (for example those which initiate contrary motion), shall be interlocked against incorrect operation.		N
	Reversing contactors (for example those controlling the direction of rotation of a motor) shall be interlocked in such a way that in normal service no short-circuit can occur when switching.		N
	Where, for safety or for continuous operation, certain functions on the machine are required to be interrelated, proper co-ordination shall be ensured by suitable interlocks. For a group of machines working together in a co-ordinated manner and having more than one controller, provision shall be made to co-ordinate the operations of the controllers as necessary.		N
	Where a failure of a mechanical brake actuator can result in the brake being applied when the associated machine actuator is energized and a hazardous situation can result, interlocks shall be provided to switch off the machine actuator.		N
9.3.5	Reverse current braking		-
	Where braking of a motor is accomplished by current reversal, measures shall be provided to prevent the motor starting in the opposite direction at the end of braking		N

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Clause	Requirement-Test	Result-Remark	Verdict
	where that reversal can cause a hazardous situation or damage to the machine or to the work in progress. For this purpose, a device operating exclusively as a function of time is not permitted.		
	Control circuits shall be so arranged that rotation of a motor shaft, for example by applying a manual force or any other force causing the shaft to rotate after it has stopped, shall not result in a hazardous situation.		N
9.3.6	Suspension of safety functions and/or protective measures		-
	Where it is necessary to suspend safety functions and/or protective measures (for example for setting or maintenance purposes), the control or operating mode selector shall simultaneously:		-
	• disable all other operating (control) modes;		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
	• permit operation of the hazardous elements only in reduced risk conditions (e.g. reduced speed, reduced power / force, step-by-step operation, e.g. with a limited movement control device);		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 simultaneously, the control or operating mode selector shall activate other protective measures designed and constructed to ensure a safe intervention zone. In addition, the operator shall be able to control operation of the parts he is working on from the adjustment point.		N
9.4	Control functions in the event of failure		-
9.4.1	General requirements		-
	Where failures or disturbances in the electrical equipment can cause a hazardous situation or damage to the machine or to the work in progress, appropriate measures shall be taken to minimize the probability of the occurrence of such failures or disturbances. The required measures and the extent to which they are implemented, either individually or in combination, depend on the level of risk associated with the respective application (see 4.1).	Meet the requirements	P

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Clause	Requirement-Test	Result-Remark	Verdict
	Examples of such measures that can be appropriate include but are not limited to:		-
	• protective interlocking of the electrical circuit;	Not used	N
	• use of proven circuit techniques and components (see 9.4.2.2);	Conform to relevant IEC standards	P
	• provision of partial or complete redundancy (see 9.4.2.3) or diversity (see 9.4.2.4);		N
	• provision for functional tests (see 9.4.2.5).	Comply with clause 18.6	P
	The electrical control system(s) shall have an appropriate performance that has been determined from the risk assessment of the machine.		P
	The requirements for safety-related control functions of IEC 62061 and/or ISO 13849-1, ISO 13849-2 shall apply.	Meet the requirements.	P
	Where functions performed by the electrical control system(s) have safety implications but application of IEC 62061 leads to a required safety integrity less than that required by SIL 1, compliance with the requirements of this part of IEC 60204 can lead to an adequate performance of the electrical control system(s).		N
	Where memory retention is achieved for example, by battery power, measures shall be taken to prevent hazardous situations arising from failure, undervoltage or removal of the battery.	No memory retention is achieved.	N
	Means shall be provided to prevent unauthorized or inadvertent memory alteration by, for example, requiring the use of a key, access code or tool.	No memory retention is achieved.	N
9.4.2	Measures to minimize risk in the event of failure		-
9.4.2.1	General		-
	Measures to minimize risk in the event of failure include but are not limited to:		-
	• use of proven circuit techniques and components;		P
	• provisions of partial or complete redundancy;		N
	• provision of diversity;		N
	• provision for functional tests.		P
9.4.2.2	Use of proven circuit techniques and components		-
	These measures include but are not limited to:		-
	• bonding of control circuits to the protective bonding		P

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Clause	Requirement-Test	Result-Remark	Verdict
	circuit for functional purposes (see 9.4.3.1.1 and Figure 4);		
	• connection of control devices in accordance with 9.4.3.1.1;		P
	• stopping by de-energizing;		P
	• the switching of all control circuit conductors (for example both sides of a coil) of the device being controlled;		P
	• switching devices having direct opening action (see IEC 60947-5-1);		P
	• monitoring by:		-
	— use of mechanically linked contacts (see IEC 60947-5-1);		N
	— use of mirror contacts (see IEC 60947-4-1);		P
	• circuit design to reduce the possibility of failures causing undesirable operations.		P
9.4.2.3	Provisions of partial or complete redundancy		N
	By providing partial or complete redundancy, it is possible to minimize the probability that one single failure in the electrical circuit can result in a hazardous situation. Redundancy can be effective in normal operation (on-line redundancy) or designed as special circuits that take over the protective function (off-line redundancy) only where the operating function fails.		N
	Where off-line redundancy which is not active during normal operation is provided, suitable measures shall be taken to ensure that those control circuits are available when required.		N
9.4.2.4	Provision of diversity		N
	The use of control circuits having different principles of operation, or using different types of components or devices can reduce the probability of hazards resulting from faults and/or failures. Examples include:		N
	— the use of a combination of normally open and normally closed contacts;		N
	— the use of different types of control devices in the circuit(s);		N
	— the combination of electromechanical and electronic equipment in redundant configurations.		N
	The combination of electrical and non-electrical systems		N

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Clause	Requirement-Test	Result-Remark	Verdict
	(for example mechanical, hydraulic, pneumatic) may perform the redundant function and provide the diversity.		
9.4.2.5	Provision for functional tests		-
	Functional tests may be carried out automatically by the control system, or manually by inspection or tests at start-up and at predetermined intervals, or a combination as appropriate (see also 17.2 and 18.6).	Comply with clause 18.6	P
9.4.3	Protection against malfunction of control circuits		-
9.4.3.1	Insulation faults		-
9.4.3.1.1	General		-
	Measures shall be provided to reduce the probability that insulation faults on any control circuit can cause malfunction such as unintentional starting, potentially hazardous motions, or prevent stopping of the machine.	Meet the requirements	P
	The measures to meet the requirements include but are not limited to the following methods:		-
	— method a) Earthed control circuits fed by transformers;		N
	— method b) Non-earthed control circuits fed by transformers;		N
	— method c) Control circuits fed by transformer with an earthed centre-tap winding;		N
	— method d) Control circuits not fed by a transformer.		P
9.4.3.1.2	Method a) – Earthed control circuits fed by transformers		-
	The common conductor shall be connected to the protective bonding circuit at the point of supply. All contacts, solid state elements, etc., which are intended to operate an electromagnetic or other device (for example, a relay, indicator light) are to be inserted between the switched conductor of the control circuit supply and one terminal of the coil or device. The other terminal of the coil or device is connected directly to the common conductor of the control circuit supply without any switching elements (see Figure 7).		N
	Exception: Contacts of protective devices may be connected between the common conductor and the coils, provided that the connection is very short (for example in the same enclosure) so that an earth fault is unlikely (for		N

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Clause	Requirement-Test	Result-Remark	Verdict
	example overload relays directly fitted to contactors).		
9.4.3.1.3	Method b) – Non-earthed control circuits fed by transformers		N
	Control circuits fed from a control transformer that is not connected to the protective bonding circuit shall either:		-
	1) have 2-pole control switches that operate on both conductors, see Figure 8; or		N
	2) be provided with a device, for example an insulation monitoring device, that interrupts the circuit automatically in the event of an earth fault, see Figure 9; or		N
	3) where an interruption as per item 2 above would increase the risk, for example when continued operation is required during the first fault to earth, it can be sufficient to provide an insulation monitoring device (e.g. in accordance with IEC 61557-8) that will initiate an acoustic and optical signal at the machine, see Figure 10. Requirements for the procedure to be performed by the machine user in response to this alarm shall be described in the information for use.		N
9.4.3.1.4	Method c) – Control circuits fed by transformer with an earthed centre-tap winding		N
	Control circuits fed from a control transformer with its centre-tap winding connected to the protective bonding circuit shall have overcurrent protective devices that break both the conductors.		N
	The control switches shall be 2-pole types that operate on both conductors.		N
9.4.3.1.5	Method d) – Control circuits not fed by a transformer		N
	Control circuits that are not fed by a control transformer or switch mode power supply units fitted with transformers having separate windings in accordance with IEC 61558-2-16 are only allowed for machines with a maximum of one motor starter and/or maximum of two control devices, in accordance with 9.1.1.		N
	Depending on the earthing of the supply system the possible cases are:		-
	1) directly connected to an earthed supply system (TN- or TT-system) and:		N

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Clause	Requirement-Test	Result-Remark	Verdict
	a) being powered between a line conductor and the neutral conductor, see Figure 12; or		N
	b) being powered between two line conductors, see Figure 13; or		N
	2) directly connected to a supply system that is not earthed or is earthed through a high impedance (IT-system) and:		N
	a) being powered between a line conductor and the neutral conductor, see Figure 14; or		N
	b) being powered between two line conductors, see Figure 15.		N
	Method d1b) requires multi-pole control switches that switch all live conductors in order to avoid an unintentional start in case of an earth fault in the control circuit.		N
	Method d2) requires that a device shall be provided that interrupts the circuit automatically in the event of an earth fault.		N
9.4.3.2	Voltage interruptions		-
	Where the control system uses a memory device(s), proper functioning in the event of power failure shall be ensured (for example by using a non-volatile memory) to prevent any loss of memory that can result in a hazardous situation. See also 7.5.	Any loss of memory can't result in a hazardous condition.	P
9.4.3.3	Loss of circuit continuity		-
	Where the loss of continuity of control circuits depending upon sliding contacts can result in a hazardous situation, appropriate measures shall be taken (for example by duplication of the sliding contacts).		N
10	Operator interface and machine-mounted control devices		-
10.1	General		-
10.1.1	General requirements		-
	Control devices for operator interface shall, as far as is practicable, be selected, mounted, and identified or coded in accordance with IEC 61310 series.	Comply with requirements	P
	The possibility of inadvertent operation shall be minimized by, for example, positioning of devices, suitable design, provision of additional protective	Comply with requirements	P

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Clause	Requirement-Test	Result-Remark	Verdict
	measures. Particular consideration shall be given to the selection, arrangement, programming and use of operator input devices such as touchscreens, keypads and keyboards for the control of hazardous machine operations, and of sensors (for example position sensors) that can initiate machine operation. Further information can be found in IEC 60447.		
	Ergonomic principles shall be taken into account in the location of operator interface devices.	Comply with requirements	P
10.1.2	Location and mounting		-
	As far as is practicable, machine-mounted control devices shall be:		-
	• readily accessible for service and maintenance;		P
	• mounted in such a manner as to minimize the possibility of damage from activities such as material handling.	Comply with requirements	P
	The actuators of hand-operated control devices shall be selected and installed so that:		-
	• they are not less than 0,6 m above the servicing level and are within easy reach of the normal working position of the operator;		P
	• the operator is not placed in a hazardous situation when operating them.	Comply with requirements	P
	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;	Comply with requirements	P
	• the operator is not placed in a hazardous situation when operating them.	Comply with requirements	P
10.1.3	Protection		-
	The degree of protection (IP rating in accordance with IEC 60529) together with other appropriate measures shall provide protection against:	IP54	P
	• the effects of liquids, vapours, or gases found in the physical environment or used on the machine;		P
	• the ingress of contaminants (for example swarf, dust, particulate matter).		P
	In addition, the operator interface control devices shall have a minimum degree of protection against contact with live parts of IPXXD in accordance with IEC 60529.	IP54	P

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Clause	Requirement-Test	Result-Remark	Verdict
10.1.4	Position sensors		-
	Position sensors (for example position switches, proximity switches) shall be so arranged that they will not be damaged in the event of overtravel.		P
	Position sensors in circuits with safety-related control functions (for example, to maintain the safe condition of the machine or prevent hazardous situations arising at the machine) shall have direct opening action (see IEC 60947-5-1) or shall provide similar reliability (see 9.4.2).		P
10.1.5	Portable and pendant control stations		-
	Portable and pendant operator control stations and their control devices shall be so selected and arranged as to minimize the possibility of machine operations caused by inadvertent actuation, shocks and vibrations (for example if the operator control station is dropped or strikes an obstruction) (see also 4.4.8).		N
10.2	Actuators		-
10.2.1	Colours		-
	Actuators (see 3.1.1) shall be colour-coded as follows.		P
	The colours for START/ON actuators should be WHITE, GREY, BLACK or GREEN with a preference for WHITE. RED shall not be used.	Comply with requirements	P
	The colour RED shall be used for emergency stop and emergency switching off actuators (including supply disconnecting devices where it is foreseen that they are for use in an emergency). If a background exists immediately around the actuator, then this background shall be coloured YELLOW. The combination of a RED actuator with a YELLOW background shall only be used for emergency operation devices.		N
	The colours for STOP/OFF actuators should be BLACK, GREY, or WHITE with a preference for BLACK. GREEN shall not be used. RED is permitted, but it is recommended that RED is not used near an emergency operation device.	Comply with requirements	P
	WHITE, GREY, or BLACK are the preferred colours for actuators that alternately act as START/ON and STOP/OFF actuators. The colours RED, YELLOW, or GREEN shall not be used.	Comply with requirements	P

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Clause	Requirement-Test	Result-Remark	Verdict
	WHITE, GREY, or BLACK are the preferred colours for actuators that cause operation while they are actuated and cease the operation when they are released (for example hold-to-run). The colours RED, YELLOW, or GREEN shall not be used.		N
	Reset actuators shall be BLUE, WHITE, GREY, or BLACK. Where they also act as a STOP/OFF actuator, the colours WHITE, GREY, or BLACK are preferred with the main preference being for BLACK. GREEN shall not be used.		N
	The colour YELLOW is reserved for use in abnormal conditions, for example, in the event of an abnormal condition of the process, or to interrupt an automatic cycle.		N
	Where the same colour WHITE, GREY, or BLACK is used for various functions (for example WHITE for START/ON and for STOP/OFF actuators) a supplementary means of coding (for example shape, position, symbol) shall be used for the identification of actuators.		N
10.2.2	Markings		-
	In addition to the functional identification as described in 16.3, recommended symbols to be placed near to or preferably directly on certain actuators are given in Table 2 or 3.	Comply with requirements	P
10.3	Indicator lights and displays		-
10.3.1	General		-
	Indicator lights and displays serve to give the following types of information:		-
	— indication: to attract the operator's attention or to indicate that a certain task should be performed. The colours RED, YELLOW, BLUE, and GREEN are normally used in this mode; for flashing indicator lights and displays, see 10.3.3.		P
	— confirmation: to confirm a command, or a condition, or to confirm the termination of a change or transition period. The colours BLUE and WHITE are normally used in this mode and GREEN may be used in some cases.		P
	Indicator lights and displays shall be selected and	Comply with	P

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	installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310-1).	requirements	
	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.	Comply with requirements	P
10.3.2	Colours		-
	Indicator lights should be colour-coded with respect to the condition (status) of the machine in accordance with Table 4.	Comply with requirements	P
	Indicating towers on machines should have the applicable colours in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.		P
10.3.3	Flashing lights and displays		-
	For further distinction or information and especially to give additional emphasis, flashing lights and displays can be provided for the following purposes:		N
	— to attract attention;		N
	— to request immediate action;		N
	— to indicate a discrepancy between the command and actual state;		N
	— to indicate a change in process (flashing during transition).		N
	It is recommended that higher flashing frequencies are used for higher priority information (see IEC 60073 for recommended flashing rates and pulse/pause ratios).		N
	Where flashing lights or displays are used to provide higher priority information, additional acoustic warnings should be considered.		N
10.4	Illuminated push-buttons		-
	Illuminated push-button actuators shall be colour-coded in accordance with 10.2.1. Where there is difficulty in assigning an appropriate colour, WHITE shall be used.		N
	The colour of active emergency stop actuators shall remain RED regardless of the state of the illumination.	Red	N
10.5	Rotary control devices		N
	Devices having a rotational member, such as potentiometers and selector switches, shall have means of prevention of rotation of the stationary member. Friction		N

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	alone shall not be considered sufficient.		
10.6	Start devices		P
	Actuators used to initiate a start function or the movement of machine elements (for example slides, spindles, carriers) shall be constructed and mounted so as to minimize inadvertent operation.		N
10.7	Emergency stop devices		-
10.7.1	Location of emergency stop devices		-
	Devices for emergency stop shall be readily accessible.		P
	Emergency stop devices shall be provided at each location where the initiation of an emergency stop can be required.		P
	There can be circumstances where confusion can occur between active and inactive emergency stop devices caused by, for example, unplugging or otherwise disabling an operator control station. In such cases, means (for example, design and information for use) shall be provided to minimise confusion.		P
10.7.2	Types of emergency stop device		-
	The types of device for emergency stop include, but are not limited to:		-
	• a push-button device for actuation by the palm or the fist (e.g. mushroom head type);		P
	• a pull-cord operated switch;		N
	• a pedal-operated switch without a mechanical guard. The devices shall be in accordance with IEC 60947-5-5.		N
10.7.3	Operation of the supply disconnecting device to effect emergency stop		-
	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		P
	• 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.		P
10.8	Emergency switching off devices	No such device	-

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10.8.1	Location of emergency switching off devices		N
	Emergency switching off devices shall be located as necessary for the given application. Normally, those devices will be located separate from operator control stations. Where confusion can occur between emergency stop and emergency switching off devices, means shall be provided to minimise confusion.		N
10.8.2	Types of emergency switching off device		-
	The types of device for initiation of emergency switching off include:		-
	• a push-button operated switch with a palm or mushroom head type of actuator;		N
	• a pull-cord operated switch.		N
	The devices shall have direct opening action (see Annex K of IEC 60947-5-1:2003 and IEC 60947-5-1:2003/AMD1:2009).		N
10.8.3	Local operation of the supply disconnecting device to effect emergency switching off		-
	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
10.9	Enabling control device	No such device	-
	The enabling control function is described in 9.2.3.9.		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 accordance with ergonomic principles;		N
	— for a two-position type:		N
	• position 1: off-function of the switch (actuator is not operated);		N
	• position 2: enabling function (actuator is operated).		N
	— for a three-position type:		N
	• position 1: off-function of the switch (actuator is not operated);		N
	• position 2: enabling function (actuator is operated in its mid position);		N

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	• position 3: off-function (actuator is operated past its mid position);		N
	• when returning from position 3 to position 2, the enabling function is not activated.		N
11	Controlgear: location, mounting, and enclosures		-
11.1	General requirements		-
	All controlgear shall be located and mounted so as to facilitate:		-
	— its accessibility and maintenance;	Accessibility and maintain ability	P
	— its protection against the external influences or conditions under which it is intended to operate;		P
	— operation and maintenance of the machine and its associated equipment.	Easy access for operation and maintenance	P
11.2	Location and mounting		-
11.2.1	Accessibility and maintenance		-
	All items of controlgear shall be placed and oriented so that they can be identified without moving them or the wiring. For items that require checking for correct operation or that are liable to need replacement, those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers, barriers or obstacles). Terminals not part of controlgear components or devices shall also conform to these requirements.	Meet the requirements Part list provided	P
	All controlgear shall be mounted so as to facilitate its operation and maintenance. Where a special tool is necessary to adjust, maintain, or remove a device, such a tool shall be supplied. Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0,4 m and 2,0 m above the servicing level. It is recommended that terminals be at least 0,2 m above the servicing level and be so placed that conductors and cables can be easily connected to them.		P
	No devices except devices for operating, indicating, measuring, and cooling shall be mounted on doors or on access covers of enclosures that are expected to be removed.		P
	Where control devices are connected through plug-in		P

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	arrangements, their association shall be made clear by type (shape), marking or reference designation, singly or in combination (see 13.4.5).		
	Plug-in devices that are handled during normal operation shall be provided with non- interchangeable features where the lack of such a facility can result in malfunctioning.		P
	Plug/socket combinations that are handled during normal operation shall be located and mounted so as to provide unobstructed access.		N
	Test points for connection of test equipment, where provided, shall be:		-
	— mounted so as to provide unobstructed access;		P
	— clearly identified to correspond with the documentation;		P
	— adequately insulated;		P
	— sufficiently spaced.		P
11.2.2	Physical separation or grouping		-
	Non-electrical parts and devices, not directly associated with the electrical equipment, shall not be located within enclosures containing controlgear. Devices such as solenoid valves should be separated from the other electrical equipment (for example in a separate compartment).	separated from the other electrical equipment	P
	Control devices mounted in the same location and connected to the power circuits, or to both power and control circuits, should be grouped separately from those connected only to the control circuits.	be grouped separately	P
	Terminals shall be separated into groups for:		-
	— power circuits;		P
	— control circuits of the machine;		P
	— other control circuits, fed from external sources (for example for interlocking).		P
	The groups may be mounted adjacently, provided that each group can be readily identified (for example by markings, by use of different sizes, by use of barriers or by colours).	Markings	P
	When arranging the location of devices (including interconnections), the clearances and creepage distances specified for them by the supplier shall be maintained,	Meet the requirements	P

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	taking into account the external influences or conditions of the physical environment.		
11.2.3	Heating effects		-
	The temperature rise inside electrical equipment enclosures shall not exceed the ambient temperature specified by the component manufacturers.	Air condition are used.	P
	Heat generating components (for example heat sinks, power resistors) shall be so located that the temperature of each component in the vicinity remains within the permitted limit.		P
11.3	Degrees of protection		-
	The protection of controlgear against ingress of solid foreign objects and of liquids shall be adequate taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental conditions) and shall be sufficient against dust, coolants, lubricants and swarf.	Meet the requirements	P
	Enclosures of controlgear shall provide a degree of protection of at least IP22 (see IEC 60529).		P
	Exception: an enclosure providing a minimum degree of protection IP22 is not required where:	IP54	P
	a) an electrical operating area provides an appropriate degree of protection against ingress of solids and liquids, or:	Meet the requirements	P
	b) removable collectors on conductor wire or conductor bar systems are used and the measures of 12.7.1 are applied.	Meet the requirements	P
11.4	Enclosures, doors and openings		-
	Enclosures shall be constructed using materials capable of withstanding the mechanical, electrical and thermal stresses as well as the effects of humidity and other environmental factors that are likely to be encountered in normal service.	Meet the requirements	P
	Fasteners used to secure doors and covers should be of the captive type.	Meet the requirements	P
	Windows of enclosures shall be of a material suitable to withstand expected mechanical stress and chemical attack.		N
	It is recommended that enclosure doors having vertical hinges be not wider than 0,9 m, with an angle of opening		N

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	of at least 95°.		
	The joints or gaskets of doors, lids, covers and enclosures shall withstand the chemical effects of the aggressive liquids, vapours, or gases used on the machine. The means provided to maintain the degree of protection of an enclosure on doors, lids and covers that require opening or removal for operation or maintenance shall:	Meet the requirements	P
	• be securely attached to either the door/cover or the enclosure;	Meet the requirements	P
	• not deteriorate due to removal or replacement of the door or the cover, and so impair the degree of protection.	Meet the requirements	P
	Where openings in enclosures are provided (for example, for cable access), including those towards the floor or foundation or to other parts of the machine, means shall be provided to ensure the degree of protection specified for the equipment. Openings for cable entries shall be easy to re-open on site. A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away.	Meet the requirements Rubber pad used.	P
	There shall be no opening between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate. This requirement does not apply to electrical devices specifically designed to operate in oil (for example electromagnetic clutches) nor to electrical equipment in which coolants are used.	Meet the requirements	P
	Where there are holes in an enclosure for mounting purposes, means may be necessary to ensure that after mounting, the holes do not impair the required protection.	Rubber pad used.	P
	Equipment that, in normal or abnormal operation, can attain a surface temperature sufficient to cause a risk of fire or harmful effect to an enclosure material shall:		-
	— be located within an enclosure that will withstand, without risk of fire or harmful effect, such temperatures as can be generated; and	Meet the requirements	P
	— be mounted and located at a sufficient distance from adjacent equipment so as to allow safe dissipation of heat (see also 11.2.3); or	Meet the requirements	P
	— be otherwise screened by material that can withstand,	Meet the requirements	P

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	without risk of fire or harmful effect, the heat emitted by the equipment.		
11.5	Access to electrical equipment		-
	Doors in gangways and for access to electrical operating areas shall:		-
	— be at least 0,7 m wide and 2,0 m high;		N
	— open outwards;		N
	— have a means (for example panic bolts) to allow opening from the inside without the use of a key or tool.		N
12	Conductors and cables		-
12.1	General requirements		-
	Conductors and cables shall be selected so as to be suitable for the operating conditions (for example voltage, current, protection against electric shock, grouping of cables) and external influences (for example ambient temperature, presence of water or corrosive substances, mechanical stresses (including stresses during installation), fire hazards) that can exist.	Input cables and outer ground bonding conductors are supplied by user according to instructions	P
	These requirements do not apply to the integral wiring of assemblies, subassemblies, and devices that are manufactured and tested in accordance with their relevant IEC standard (for example IEC 61800 series).	Conform to relevant IEC standards	P
12.2	Conductors		-
	Conductors should be of copper. Where aluminium conductors are used, the cross-sectional area shall be at least 16 mm2.	Copper	P
	To ensure adequate mechanical strength, the cross-sectional area of conductors should not be less than as shown in Table 5. However, conductors with smaller cross-sectional areas or other constructions than shown in Table 5 may be used in equipment provided adequate mechanical strength is achieved by other means and proper functioning is not impaired.	Only copper conductors are used.	P
	Class 1 and class 2 conductors are primarily intended for use between rigid, non-moving parts where vibration is not considered to be likely to cause damage.	Only copper conductors are used.	P
	All conductors that are subject to frequent movement (for example one movement per hour of machine operation)	Comply with requirement	P

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	should have flexible stranding of class 5 or class 6.		
12.3	Insulation		-
	Where the insulation of conductors and cables can constitute hazards due for example to the propagation of a fire or the emission of toxic or corrosive fumes, guidance from the cable supplier should be sought. It is important to give special attention to the integrity of a circuit having a safety-related function.	Meet the requirements	P
	The insulation of cables and conductors used, shall be suitable for a test voltage:		-
	— not less than 2 000 V AC for a duration of 5 min for operation at voltages higher than 50 V AC or 120 V DC, or	2000V, no breakdown	P
	— not less than 500 V AC for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment).		P
	The mechanical strength and thickness of the insulation shall be such that the insulation cannot be damaged in operation or during laying, especially for cables pulled into ducts.	Not be damaged during cable laying or in operation	P
12.4	Current-carrying capacity in normal service		-
	The current-carrying capacity depends on several factors, for example insulation material, number of conductors in a cable, design (sheath), methods of installation, grouping and ambient temperature.	Meet the requirements	P
	One typical example of the current-carrying capacities for PVC insulated wiring between enclosures and individual items of equipment under steady-state conditions is given in Table 6.	Meet the requirements	P
12.5	Conductor and cable voltage drop		-
	The voltage drop from the point of supply to the load in any power circuit cable shall not exceed 5 % of the nominal voltage under normal operating conditions. In order to conform to this requirement, it can be necessary to use conductors having a larger cross-sectional area than that derived from Table 6.	Not exceed 5%.	P
	In control circuits, the voltage drop shall not reduce the voltage at any device below the manufacturer’s	Meet the requirements	P

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	specification for that device, taking into account inrush currents. See also 4.3.		
	The voltage drop in components, for example overcurrent protective devices and switching devices, should be considered.	Meet the requirements	P
12.6	Flexible cables		-
12.6.1	General		-
	Flexible cables shall have Class 5 or Class 6 conductors.		P
	Cables that are subjected to severe duties shall be of adequate construction to protect against:		P
	— abrasion due to mechanical handling and dragging across rough surfaces;		P
	— kinking due to operation without guides;		P
	— stress resulting from guide rollers and forced guiding, being wound and re-wound on cable drums.		P
12.6.2	Mechanical rating		-
	The cable handling system of the machine shall be so designed to keep the tensile stress of the conductors as low as is practicable during machine operations. Where copper conductors are used, the tensile stress applied to the conductors shall not exceed 15 N/mm2 of the copper cross-sectional area. Where the demands of the application exceed the tensile stress limit of 15 N/mm2, cables with special construction features should be used and the allowed maximal tensile stress should be agreed with the cable manufacturer.	<15 N/mm^2 of copper cross section area	P
	The maximum stress applied to the conductors of flexible cables with material other than copper shall be within the cable manufacturer’s specification.	Copper used.	N
12.6.3	Current-carrying capacity of cables wound on drums		-
	Cables to be wound on drums shall be selected with conductors having a cross-sectional area such that, when fully wound on the drum and carrying the normal service load, the maximum allowable conductor temperature is not exceeded.	Not be wound on drums	N
	For cables of circular cross-sectional area installed on drums, the maximum current-carrying capacity in free air should be derated in accordance with Table 7		N

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12.7	Conductor wires, conductor bars and slip-ring assemblies		-
12.7.1	Basic protection		-
	Conductor wires, conductor bars and slip-ring assemblies shall be installed or enclosed in such a way that, during normal access to the machine, basic protection is achieved by the application of one of the following protective measures:	Meet the requirements	P
	— protection by partial insulation of live parts, or where this is not practicable;		P
	— protection by enclosures or barriers of at least IP2X or IPXXB.	IP2X	P
	Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X or IPXXD.	IP4X	P
	Where the required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching off in accordance with 9.2.3.4.3 shall be applied.		N
	Conductor wires and conductor bars shall be so placed and/or protected as to:		-
	— prevent contact, especially for unprotected conductor wires and conductor bars, with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains;	Meet the requirements	P
	— prevent damage from a swinging load. See also 6.2.6.		P
12.7.2	Protective conductors		-
	Where conductor wires, conductor bars and slip-ring assemblies are installed as part of the protective bonding circuit, they shall not carry current in normal operation. Therefore, the protective conductor (PE) and the neutral conductor (N) shall each use a separate conductor wire, conductor bar or slip-ring.	Meet the requirements	P
	The continuity of protective conductors using sliding contacts shall be ensured by taking appropriate measures (for example, duplication of the current collector, continuity monitoring).	Not use sliding contacts	N
12.7.3	Protective conductor current collectors		-
	Protective conductor current collectors shall have a shape or construction so that they are not interchangeable with	No such collector	N

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	the other current collectors. Such current collectors shall be of the sliding contact type.		
12.7.4	Removable current collectors with a disconnector function		-
	Removable current collectors having a disconnector function shall be so designed that the protective conductor circuit is interrupted only after the live conductors have been disconnected, and the continuity of the protective conductor circuit is re-established before any live conductor is reconnected (see also 8.2.3).	No such collector	N
12.7.5	Clearances in air		-
	Clearances between the respective conductors, and between adjacent systems, of conductor wires, conductor bars, slip-ring assemblies and their current collectors shall be suitable for at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1.	Meet the requirements	P
12.7.6	Creepage distances		-
	Creepage distances between the respective conductors, between adjacent systems of conductor wires, conductor bars and slip-ring assemblies, and their current collectors shall be suitable for operation in the intended environment, for example open air, inside buildings, protected by enclosures.	Meet the requirements	P
	In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply:		-
	— unprotected conductor wires, conductor bars, and slip-ring assemblies shall be equipped with insulators with a minimum creepage distance of 60 mm;	Meet the requirements	P
	— enclosed conductor wires, insulated multipole conductor bars and insulated individual conductor bars shall have a minimum creepage distance of 30 mm.	Meet the requirements	P
	The manufacturer's recommendations shall be followed regarding special measures to prevent a gradual reduction in the insulation values due to unfavourable ambient conditions (for example deposits of conductive dust, chemical attack).	Meet the requirements	P
12.7.7	Conductor system sectioning		-
	Where conductor wires or conductor bars are arranged so that they can be divided into isolated sections, suitable design measures shall be employed to prevent the	Meet the requirements	P

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	energization of adjacent sections by the current collectors themselves.		
12.7.8	Construction and installation of conductor wire, conductor bar systems and slip-ring assemblies		-
	Conductor wires, conductor bars and slip-ring assemblies in power circuits shall be grouped separately from those in control circuits.	Meet the requirements	P
	Conductor wires, conductor bars and slip-ring assemblies, including their current collectors, shall be capable of withstanding, without damage, the mechanical forces and thermal effects of short-circuit currents.	Meet the requirements	P
	Removable covers for conductor wire and conductor bar systems laid underground or underfloor shall be so designed that they cannot be opened by one person without the aid of a tool.		N
	Where conductor bars are installed in a common metal enclosure, the individual sections of the enclosure shall be bonded together and connected to the protective bonding circuit. Metal covers of conductor bars laid underground or underfloor shall also be bonded together and connected to the protective bonding circuit.	Meet the requirements	P
	The protective bonding circuit shall include the covers or cover plates of metal enclosures or underfloor ducts. Where metal hinges form a part of the protective bonding circuit, their continuity shall be verified (see Clause 18).	Meet the requirements	P
	Conductor bar ducts that can be subject to accumulation of liquid such as oil or water shall have drainage facilities.		P
13	Wiring practices		-
13.1	Connections and routing		-
13.1.1	General requirements		-
	All connections, especially those of the protective bonding circuit, shall be secured against accidental loosening.	Fixed by screws	P
	The means of connection shall be suitable for the cross-sectional areas and nature of the conductors being terminated.	Fixed by screws	P
	The connection of two or more conductors to one terminal is permitted only in those cases where the	No terminal has been connected with three or	P

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	terminal is designed for that purpose. However, only one protective conductor shall be connected to one terminal connecting point.	more conductors.	
	Soldered connections shall only be permitted where terminals are provided that are suitable for soldering.	No soldered connection has been used.	N
	Terminals on terminal blocks shall be plainly marked or labelled to correspond with the identification used in the diagrams.	Marked letters and numbers	P
	Where an incorrect electrical connection (for example, arising from replacement of devices) is identified as a source of risk that needs to be reduced and it is not practicable to reduce the possibility of incorrect connection by design measures, the conductors and/or terminations shall be identified.	Meet the requirements	P
	The installation of flexible conduits and cables shall be such that liquids shall drain away from the fittings.	No liquids	N
	Means of retaining conductor strands shall be provided when terminating conductors at devices or terminals that are not equipped with this facility. Solder shall not be used for that purpose.	No solder used	N
	Shielded conductors shall be so terminated as to prevent fraying of strands and to permit easy disconnection.		N
	Identification tags shall be legible, permanent, and appropriate for the physical environment.	The tags are legible, permanent, and appropriate for the physical environment.	P
	Terminal blocks shall be mounted and wired so that the wiring does not cross over the terminals.	No conductor cross over the terminals.	P
13.1.2	Conductor and cable runs		-
	Conductors and cables shall be run from terminal to terminal without splices or joints. Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be splices or joints for the purpose of 13.1.2.	All of them are run from terminal to terminal without splices or joints.	P
	Exception: Where it is impracticable to provide terminals in a junction box (for example on mobile machines, on machines having long flexible cables; cable connections exceeding a length which is not practical to be supplied by the cable manufacturer on one cable drum), splices or joints may be used.		N

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Clause	Requirement-Test	Result-Remark	Verdict
	Where it is necessary to connect and disconnect cables and cable assemblies, sufficient extra length shall be provided for that purpose.	sufficient extra length	P
	The terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors.	Adequate support measure has been taken.	P
	Wherever practicable, the protective conductor shall be placed close to the associated live conductors in order to decrease the impedance of the loop.		P
13.1.3	Conductors of different circuits		-
	Conductors of different circuits may be laid side by side, may occupy the same duct (for example conduit, cable trunking system), or may be in the same multiconductor cable or in the same plug/socket combination provided that the arrangement does not impair the proper functioning of the respective circuits and:	Conductor for different circuits laid side by side or occupy the same duct	P
	• where those circuits operate at different voltages, the conductors are separated by suitable barriers or;	Enough insulation provided	P
	• the conductors are insulated for the highest voltage to which any of the conductors can be subjected, for example line to line voltage for unearthed systems and phase to earth voltage for earthed systems.	Enough insulation provided	P
13.1.4	AC circuits – Electromagnetic effects (prevention of eddy currents)		-
	Conductors of AC circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit, including the protective conductor of each circuit, are contained in the same enclosure. Where such conductors enter a ferrous enclosure, they shall be arranged such that the conductors are not individually surrounded by ferromagnetic material.	Meet the requirements	P
	Single-core cables armoured with steel wire or steel tape should not be used for AC circuits.		P
13.1.5	Connection between pick-up and pick-up converter of an inductive power supply system	No such system	-
	The cable between the pick-up and the pick-up converter shall be:		N
	— as short as practicable;		N
	— adequately protected against mechanical damage.		N

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13.2	Identification of conductors		-
13.2.1	General requirements		-
	Each conductor shall be identifiable at each termination in accordance with the technical documentation.	Identification at each termination	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. When numbers are used, they shall be Arabic; letters shall be Roman (either upper or lower case).	A combination of colour and numbers or alphanumeric. Arabic and Roman	P
13.2.2	Identification of the protective conductor / protective bonding conductor		-
	The protective conductor / protective bonding conductor shall be readily distinguishable from other conductors by shape, location, marking, or colour. When identification is by colour alone, the bicolour combination GREEN-AND-YELLOW shall be used throughout the length of the conductor. This colour identification is strictly reserved for protective conductors/protective bonding conductors.	By marking and color. GREEN-AND-YELLOW.	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.	By GREEN-AND-YELLOW.	P
	Where the protective conductor(s) can be easily identified by its shape, position, or construction (for example a braided conductor, uninsulated stranded conductor), or where the insulated conductor is not readily accessible or is part of a multicore cable, colour coding throughout its length is not necessary. However, where the conductor is not clearly visible throughout its length, the ends or accessible locations shall be clearly identified by the graphical symbol IEC 60417-5019:2006-08 (see Figure 16) or with the letters PE or by the bicolour combination GREEN-AND-YELLOW.	PE	P
	Exception: Protective bonding conductors may be marked with the letters PB and/or the symbol IEC 60417-5021 (2002-10) (see Figure 17).		N

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

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Clause	Requirement-Test	Result-Remark	Verdict
	— BLACK: AC and DC power circuits;		P
	— RED: AC control circuits;		P
	— BLUE: DC control circuits;		P
	— ORANGE: excepted circuits in accordance with 5.3.5.		P
	Exceptions to the above are permitted where insulation is not available in the colours recommended (for example in multiconductor cables).		N
13.3	Wiring inside enclosures		-
	Conductors inside enclosures shall be supported where necessary to keep them in place. Non-metallic ducts shall be permitted only when they are made with a flame-retardant insulating material (see the IEC 60332 series).	Fixed by screws	P
	It is recommended that electrical equipment mounted inside enclosures be designed and constructed in such a way as to permit modification of the wiring from the front of the enclosure (see also 11.2.1). Where that is not practicable and control devices are connected from the rear of the enclosure, access doors or swingout panels shall be provided.		P
	Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors in accordance with 12.2 and 12.6 to allow for the frequent movement of the part. The conductors shall be anchored to the fixed part and to the movable part independently of the electrical connection (see also 8.2.3 and 11.2.1).	Meet the requirements	P
	Conductors and cables that do not run in ducts shall be adequately supported.		P
	Terminal blocks or plug/socket combinations shall be used for control wiring that extends beyond the enclosure. For plug/socket combinations, see also 13.4.5 and 13.4.6.		P
	Power cables and cables of measuring circuits may be directly connected to the terminals of the devices for which the connections were intended.	Meet the requirements	P
13.4	Wiring outside enclosures		-
13.4.1	General requirements		-
	The means of introduction of cables or ducts with their	The protection degree	P

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Clause	Requirement-Test	Result-Remark	Verdict
	individual glands, bushings, etc., into an enclosure shall ensure that the degree of protection is not reduced (see 11.3).	can be secured.	
	Conductors of a circuit shall not be distributed over different multi-core cables, conduits, cable ducting systems or cable trunking systems. This is not required where a number of multi-core cables, forming one circuit, are installed in parallel. Where multi-core cables are installed in parallel, each cable shall contain one conductor of each phase and the neutral if any.		P
13.4.2	External ducts		-
	Conductors and their connections external to the electrical equipment enclosure(s) shall be enclosed in suitable ducts (i.e. conduit or cable trunking systems) as described in 13.5 except for suitably protected cables that may be installed without ducts and with or without the use of cable trays or cable support means. Where devices such as position switches or proximity switches are supplied with a dedicated cable, their cable need not be enclosed in a duct when the cable is suitable for the purpose, sufficiently short, and so located or protected, that the risk of damage is minimized.	Used the conduit and cable trunking systems	P
	Fittings used with ducts or cables shall be suitable for the physical environment.	Plastic cable ties used	P
	Flexible conduit or flexible multiconductor cable shall be used where it is necessary to employ flexible connections to pendant push-button stations. The weight of the pendant stations shall be supported by means other than the flexible conduit or the flexible multiconductor cable, except where the conduit or cable is specifically designed for that purpose.	Flexible conduit Used.	P
13.4.3	Connection to moving elements of the machine		-
	The design of connections to moving parts shall take into account the foreseeable frequency of movement and shall be made using conductors in accordance with 12.2 and 12.6. Flexible cable and flexible conduit shall be so installed as to avoid excessive flexing and straining, particularly at the fittings.	Flexible cable and flexible conduit used.	P
	Cables subject to movement shall be supported in such a way that there is no mechanical strain on the connection	Meet the requirements.	P

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Clause	Requirement-Test	Result-Remark	Verdict
	points nor any sharp flexing. When this is achieved by the provision of a loop, it shall have sufficient length to provide for a bending radius of the cable as specified by the cable manufacturer or if no such specification is given, at least 10 times the diameter of the cable.		
	Flexible cables of machines shall be so installed or protected as to minimize the possibility of external damage due to factors that include the following cable use or potential abuse:		
	— being run over by the machine itself;		P
	— being run over by vehicles or other machines;		N
	— coming into contact with the machine structure during movements;		P
	— running in and out of cable baskets, or on or off cable drums;		P
	— acceleration forces and wind forces on festoon systems or suspended cables;		P
	— excessive rubbing by cable collector;		N
	— exposure to excessive radiated heat.		N
	The cable sheath shall be resistant to the normal wear that can be expected from movement and to the effects of environmental contaminants (for example oil, water, coolants, dust).	Rubber and PVC	P
	Where cables subject to movement are close to moving parts, precautions shall be taken to maintain a space of at least 25 mm between the moving parts and the cables. Where that distance is not practicable, fixed barriers shall be provided between the cables and the moving parts.	Meet the requirements.	P
	The cable handling system shall be so designed that lateral cable angles do not exceed 5°, avoiding torsion in the cable when:		P
	— being wound on and off cable drums; and		N
	— approaching and leaving cable guidance devices.		P
	Measures shall be taken to ensure that at least two turns of flexible cables always remain on a drum.	No drum.	N
	Devices serving to guide and carry a flexible cable shall be so designed that the inner bending radius at all points where the cable is bent is not less than the values given in Table 8, unless otherwise agreed with the cable manufacturer, taking into account the permissible tension	Meet the requirements.	P

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Clause	Requirement-Test	Result-Remark	Verdict
	and the expected fatigue life.		
	The straight section between two bends shall be at least 20 times the diameter of the cable.	Meet the requirements.	P
	Where flexible conduit is adjacent to moving parts, the construction and supporting means shall prevent damage to the flexible conduit under all conditions of operation.	Meet the requirements.	P
	Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically designed for that purpose.	Meet the requirements.	P
13.4.4	Interconnection of devices on the machine		P
	Where several machine-mounted devices (for example position sensors, push-buttons) are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points. Such terminals shall be conveniently placed, adequately protected, and shown on the relevant diagrams.	Meet the requirements.	P
13.4.5	Plug/socket combinations	No plug/socket combination.	-
	Components or devices inside an enclosure, terminated by fixed plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination, are not considered to be plug/socket combinations for the purpose of this 13.4.5.		N
	After installation in accordance with item a) below, plug/socket combinations shall be of such a type as to prevent unintentional contact with live parts at any time, including during insertion or removal of the connectors. The degree of protection shall be at least IP2X or IPXXB. PELV circuits are excepted from this requirement.		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. Where the plug/socket combination is rated at 30 A, or greater, it shall be interlocked with a switching device so that the connection and disconnection is possible only when the switching device is in the OFF position.		N

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Clause	Requirement-Test	Result-Remark	Verdict
	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, taking into account the required clearance and creepage distances. PELV circuits are excepted from this requirement.		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 that they are not intended to be disconnected under load.		N
	d) Where more than one plug/socket combination is provided in the same electrical equipment, the associated combinations shall be clearly identifiable. It is recommended that mechanical coding be used to prevent incorrect insertion.		N
	e) Plug/socket combinations used in control circuits shall fulfil the applicable requirements of IEC 61984.		N
	Exception: In plug/socket combinations in accordance with IEC 60309-1, only those contacts shall be used for control circuits which are intended for those purposes. This exception does not apply to control circuits using high frequency signals superimposed on the power circuits.		N
13.4.6	Dismantling for shipment		-
	Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points. Such terminals shall be suitably enclosed and plug/socket combinations shall be protected from the physical environment during transportation and storage.	Internal wiring is located fully for shipment, and input terminal for power cords provided	P

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Clause	Requirement-Test	Result-Remark	Verdict
13.4.7	Additional conductors		-
	Consideration should be given to providing additional conductors for maintenance or repair. When spare conductors are provided, they shall be connected to spare terminals or isolated in such a manner as to prevent contact with live parts.	Providing additional conductors for maintenance and repair.	P
13.5	Ducts, connection boxes and other boxes		-
13.5.1	General requirements		-
	Ducts shall provide a degree of protection (see IEC 60529) suitable for the application.	IP54	P
	All sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come in contact shall be removed from ducts and fittings. Where necessary, additional protection consisting of a flame-retardant, oil-resistant insulating material shall be provided to protect conductor insulation.	Edges smooth	P
	Drain holes of 6 mm diameter are permitted in cable trunking systems, connection boxes, and other boxes used for wiring purposes that can be subject to accumulations of oil or moisture.		P
	In order to prevent confusion of conduits with oil, air, or water piping, it is recommended that the conduits be either physically separated or suitably identified.	Physically separated	P
	Ducts and cable trays shall be rigidly supported and positioned at a sufficient distance from moving parts and in such a manner so as to minimize the possibility of damage or wear. In areas where human passage is required, the ducts and cable trays shall be mounted at least 2 m above the working surface.	Meet the requirements	P
	Cable trays that are partially covered should not be considered to be ducts or cable trunking systems (see 13.5.6), and the cables used shall be of a type suitable for installation on open cable trays.	Meet the requirements	P
	It is recommended that the dimensions and arrangement of ducts be such as to facilitate the insertion of the conductors and cables.	Meet the requirements	P
13.5.2	Rigid metal conduit and fittings		-
	Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material suitable for the		N

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Clause	Requirement-Test	Result-Remark	Verdict
	conditions. The use of dissimilar metals in contact that can cause galvanic action should be avoided.		
	Conduits shall be securely held in place and supported at each end.		N
	Fittings shall be compatible with the conduit and appropriate for the application. Fittings should be threaded unless structural difficulties prevent assembly. Where threadless fittings are used, the conduit shall be securely fastened to the equipment.		N
	Conduit bends shall be made in such a manner that the conduit shall not be damaged and the internal diameter of the conduit shall not be effectively reduced.		N
13.5.3	Flexible metal conduit and fittings		-
	A flexible metal conduit shall consist of a flexible metal tubing or woven wire armour. It shall be suitable for the expected physical environment.	Not used flexible metallic conduits	N
	Fittings shall be compatible with the conduit and appropriate for the application.	Not used flexible metallic conduits	N
13.5.4	Flexible non-metallic conduit and fittings		-
	Flexible non-metallic conduit shall be resistant to kinking and shall have physical characteristics similar to those of the sheath of multiconductor cables.	Meet the requirements	P
	The conduit shall be suitable for use in the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.	Fixed by metal loop on machine	P
13.5.5	Cable trunking systems		-
	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving parts of the machine and of sources of contamination.		N
	Covers shall be shaped to overlap the sides; gaskets shall be permitted. Covers shall be attached to cable trunking systems by suitable means. On horizontal cable trunking systems, the cover shall not be on the bottom unless specifically designed for such installation.		N
	Where the cable trunking system is furnished in sections, the joints between sections shall fit tightly but need not be gasketed.		N
	The only openings permitted shall be those required for wiring or for drainage. Cable trunking systems shall not		P

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Clause	Requirement-Test	Result-Remark	Verdict
	have opened but unused knockouts.		
13.5.6	Machine compartments and cable trunking systems		-
	The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided the compartments or cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed. Conductors run in enclosed compartments and cable trunking systems shall be so secured and arranged that they are not subject to damage.		N
13.5.7	Connection boxes and other boxes		-
	Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance. Those boxes shall provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate (see 11.3).	Readily accessible for maintenance IP54	P
	Those boxes shall not have opened but unused knockouts nor any other openings and shall be so constructed as to exclude materials such as dust, flyings, oil, and coolant.		P
13.5.8	Motor connection boxes		-
	Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (for example brakes, temperature sensors, plugging switches, tachometer generators).		P
14	Electric motors and associated equipment		-
14.1	General requirements		-
	Electric motors should conform to the relevant parts of IEC 60034 series.		P
	The protection requirements for motors and associated equipment are given in 7.2 for overcurrent protection, in 7.3 for protection of motors against overheating, and in 7.6 for overspeed protection.		P
	As many controllers do not switch off the supply to a motor when it is at rest, care shall be taken to ensure compliance with the requirements of 5.3, 5.4, 5.5, 7.5, 7.6 and 9.4. Motor control equipment shall be located and mounted in accordance with Clause 11.		P
14.2	Motor enclosures		-

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Clause	Requirement-Test	Result-Remark	Verdict
	Enclosures for motors should be in accordance with IEC 60034-5.		P
	The degree of protection shall be dependent on the application and the physical environment (see 4.4). All motors shall be adequately protected from mechanical damage.		P
14.3	Motor dimensions		-
	As far as is practicable, the dimensions of motors shall conform to those given in the IEC 60072 series.		P
14.4	Motor mounting and compartments		-
	Each motor and its associated couplings, belts, pulleys, or chains, shall be so mounted that they are adequately protected and are easily accessible for inspection, maintenance, adjustment and alignment, lubrication, and replacement. The motor mounting arrangement shall be such that all motor mounting means can be removed and all terminal boxes are accessible.		P
	Motors shall be so mounted that proper cooling is ensured and the temperature rise remains within the limits of the insulation class (see IEC 60034-1).		P
	Where practicable, motor compartments should be clean and dry, and when required, shall be ventilated directly to the exterior of the machine. The vents shall be such that ingress of swarf, dust, or water spray is at an acceptable level.		P
	There shall be no opening between the motor compartment and any other compartment that does not meet the motor compartment requirements. Where a conduit or pipe is run into the motor compartment from another compartment not meeting the motor compartment requirements, any clearance around the conduit or pipe shall be sealed.		P
14.5	Criteria for motor selection		-
	The characteristics of motors and associated equipment shall be selected in accordance with the anticipated service and physical environmental conditions (see 4.4).		P

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Clause	Requirement-Test	Result-Remark	Verdict
	In this respect, the points that shall be considered include:		
	— type of motor;		P
	— type of duty cycle (see IEC 60034-1);		P
	— fixed speed or variable speed operation, (and the consequent variable influence of the ventilation);		P
	— mechanical vibration;		P
	— type of motor control;		P
	— temperature rise and other effects of the frequency spectrum of the voltage and/or current feeding the motor (particularly when it is supplied from a converter);		P
	— method of starting and the possible influence of the inrush current on the operation of other users of the same power supply, taking also into account possible special considerations stipulated by the supply authority;		P
	— variation of counter-torque load with time and speed;		P
	— influence of loads with large inertia;		P
	— influence of constant torque or constant power operation;		P
	— possible need of inductive reactors between motor and converter.		P
14.6	Protective devices for mechanical brakes		-
	Operation of the overload and overcurrent protective devices for mechanical brake actuators shall initiate the simultaneous de-energization (release) of the associated machine actuators.		P
15	Socket-outlets and lighting		-
15.1	Socket-outlets for accessories	No socket-outlets.	-
	Where the machine or its associated equipment is provided with socket-outlets that are intended to be used for accessory equipment (for example hand-held power tools, test equipment), the following apply:		N
	— the socket-outlets should conform to IEC 60309-1. Where that is not practicable, they should be clearly marked with the voltage and current ratings;		N
	— the continuity of the protective bonding circuit to the socket-outlet shall be ensured;		N
	— all unearthed conductors connected to the		N

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	socket-outlet shall be protected against overcurrent and, when required, against overload in accordance with 7.2 and 7.3 separately from the protection of other circuits;		
	— where the power supply to the socket-outlet is not disconnected by the supply discon- necting device for the machine or the section of the machine, the requirements of 5.3.5 apply;		N
	— where fault protection is provided by automatic disconnection of supply, the disconnection time shall be in accordance with Table A.1 for TN systems or Table A.2 for TT systems;		N
	— circuits supplying socket-outlets with a current rating not exceeding 20 A shall be provided with residual current protection (RCDs) with a rated operating current not exceeding 30 mA.		N
15.2	Local lighting of the machine and of the equipment		-
15.2.1	General		-
	The ON/OFF switch shall not be incorporated in the lampholder or in the flexible connecting cord.		N
	Stroboscopic effects from lights shall be avoided by the selection of appropriate luminaires.		N
	Where fixed lighting is provided in an enclosure, electromagnetic compatibility should be taken into account using the principles outlined in 4.4.2.		N
15.2.2	Supply		-
	The nominal voltage of the local lighting circuit shall not exceed 250 V between conductors. A voltage not exceeding 50 V between conductors is recommended.		N
	Lighting circuits shall be supplied from one of the following sources (see also 7.2.6):		N
	— a dedicated isolating transformer connected to the load side of the supply disconnecting device. Overcurrent protection shall be provided in the secondary circuit;		N
	— a dedicated isolating transformer connected to the line side of the supply disconnecting device. That source shall be permitted for maintenance lighting circuits in control enclosures only. Overcurrent protection shall be provided in the secondary circuit (see also 5.3.5);		N
	— a circuit of the electrical equipment of the machine		N

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Clause	Requirement-Test	Result-Remark	Verdict
	for lighting, with dedicated overcurrent protection;		
	— an isolating transformer connected to the line side of the supply disconnecting device, provided with a dedicated primary disconnecting means (see 5.3.5) and secondary overcurrent protection, and mounted within the control enclosure adjacent to the supply disconnecting device;		N
	— an externally supplied lighting circuit (for example factory lighting supply). This shall be permitted in control enclosures only, and for the machine work light(s) where their total power rating is not more than 3 kW;		N
	— power supply units, for DC supply to LED light sources, fitted with isolating transformers (for example, in accordance with IEC 61558-2-6).		N
	Exception: where fixed lighting is out of reach of operators during normal operations, the provisions of 15.2.2 do not apply.		N
15.2.3	Protection		-
	Local lighting circuits shall be protected in accordance with 7.2.6.		N
15.2.4	Fittings		-
	Adjustable lighting fittings shall be suitable for the physical environment.		N
	The lampholders shall be:		-
	— in accordance with the relevant IEC standard;		N
	— constructed with an insulating material protecting the lamp cap so as to prevent unintentional contact.		N
	Reflectors shall be supported by a bracket and not by the lampholder.		N
	Exception: where fixed lighting is out of reach of operators during normal operation, the provisions of 15.2.4 do not apply.		N
16	Marking, warning signs and reference designations		-
16.1	General		-
	Warning signs, nameplates, markings, labels and identification plates shall be of sufficient durability to withstand the physical environment involved.	Comply with requirement	P
16.2	Warning signs		-

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16.2.1	Electric shock hazard		-
	Enclosures that do not otherwise clearly show that they contain electrical equipment that can give rise to a risk of electric shock shall be marked with the graphical symbol ISO 7010-W012 (see Figure 18).	Marked 	P
	The warning sign shall be plainly visible on the enclosure door or cover. The warning sign may be omitted (see also 6.2.2 b)) for:	It is plainly visible on the enclosure door.	P
	— an enclosure equipped with a supply disconnecting device;		P
	— an operator-machine interface or control station;		P
	— a single device with its own enclosure (for example position sensor).		N
16.2.2	Hot surfaces hazard		-
	Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures of the electrical equipment, the graphical symbol ISO 7010-W017 shall be used (see Figure 19).		P
16.3	Functional identification		-
	Control devices and visual indicators shall be clearly and durably marked with regard to their functions either on or adjacent to the item. It is recommended that such markings are made in accordance with IEC 60417 and ISO 7000.	Marking clear and durable	P
16.4	Marking of enclosures of electrical equipment		-
	The following information shall be legibly and durably marked in a way that is plainly visible after the equipment is installed on enclosures that receive incoming power supplies:	They have been marked legibly and durably.	P
	• name or trade mark of supplier;	See the nameplate	P
	• certification mark or other marking that can be required by local or regional legislation, when required;	See the nameplate	P
	• type designation or model, where applicable;		P
	• serial number where applicable;	See the nameplate	P
	• main document number (see IEC 62023) where applicable;	See the nameplate	P
	• rated voltage, number of phases and frequency (if AC), and full-load current for each incoming supply.		P

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Clause	Requirement-Test	Result-Remark	Verdict
	It is recommended that this information is provided adjacent to the main incoming supply(ies).	See the nameplate	P
16.5	Reference designations		-
	All enclosures, assemblies, control devices, and components shall be plainly identified with the same reference designation as shown in the technical documentation.	See circuit diagram	P
17	Technical documentation		-
17.1	General		-
	The information necessary for identification, transport, installation, use, maintenance, decommissioning and disposal of the electrical equipment shall be supplied.	All the information have been provided by many forms in the instruction.	P
	Annex I should be considered as guidance for the preparation of information and documents.		P
17.2	Information related to the electrical equipment		-
	The following shall be supplied:		-
	a) where more than one document is provided, a main document for the electrical equipment as a whole, listing the complementary documents associated with the electrical equipment;		P
	b) identification of the electrical equipment (see 16.4);	See the nameplate	P
	c) information on installation and mounting including:		-
	• a description of the electrical equipment's installation and mounting, and its connection to the electrical supplies and where relevant other supplies;	See instruction	P
	• short-circuit current rating of the electrical equipment for each incoming power supply;	See instruction	P
	• rated voltage, number of phases and frequency (if AC.), type of distribution system (TT, TN, IT) and full-load current for each incoming supply;	See instruction	P
	• any additional electrical supply(ies) requirements (for example maximum supply source impedance, leakage current) for each incoming supply;	See instruction	P
	• space required for the removal or servicing of the electrical equipment;	See instruction	P

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	• installation requirements where needed to ensure that the arrangements for cooling are not impaired;	See instruction	P
	• environmental limitations (for example lighting, vibration, EMC environment, atmospheric contaminants) where appropriate;	See instruction	P
	• functional limitations (for example peak starting currents and permitted voltage drop(s)) as applicable;	See instruction	P
	• precautions to be taken for the installation of the electrical equipment relevant to the electromagnetic compatibility;	See instruction	P
	d) an instruction for the connection of simultaneously accessible extraneous-conductive- parts in the vicinity of the machine (for example, within 2,5 metres) such as the following to the protective bonding circuit:	See instruction	P
	• metallic pipes;		P
	• fences;		P
	• ladders;		P
	• handrails.		P
	e) information on the functioning and operation, including as applicable:		-
	• an overview of the structure of the electrical equipment (for example by structure diagram or overview diagram);	See instruction	P
	• procedures for programming or configuring, as necessary for the intended use;	See instruction	P
	• procedures for restarting after an unexpected stop;	See instruction	P
	• a sequence of operation;	See instruction	P
	f) information on maintenance of the electrical equipment, as appropriate, including:		-
	• frequency and method of functional testing;	See instruction	P
	• instructions on the procedures for safe maintenance and where it is necessary to suspend a safety function and/or protective measure (see 9.3.6);	See instruction	P
	• guidance on the adjustment, repair, and frequency and method of preventive maintenance;	See instruction	P
	• details of the interconnections of the electrical components subject to replacement (for example by circuit diagrams and/or connection tables);	See instruction	P

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Clause	Requirement-Test	Result-Remark	Verdict
	• information on required special devices or tools;	See instruction	P
	• information on spare parts;	See instruction	P
	• information on possible residual risks, indication of whether any particular training is required and specification of any necessary personal protective equipment;	See instruction	P
	• where applicable, instructions to restrict availability of key(s) or tool(s) to skilled or instructed persons only;	See instruction	P
	• settings (DIP-switches, programmable parameter values, etc);	See instruction	P
	• information for validation of safety related control functions after repair or modification, and for periodic testing where necessary;	See instruction	P
	g) information on handling, transportation and storage as appropriate (for example dimensions, weight, environmental conditions, possible ageing constraints);		-
	h) information for proper disassembly and handling of components (for example for recycling or disposal).	See instruction	P
18	Verification		-
18.1	General		-
	The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):		-
	a) verification that the electrical equipment complies with its technical documentation;		P
	b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);		P
	c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;		P
	d) insulation resistance test (see 18.3);		P
	e) voltage test (see 18.4);		P
	f) protection against residual voltage (see 18.5);		P
	g) verification that the relevant requirements of 8.2.6 are met;		P
	h) functional tests (see 18.6).		P

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Clause	Requirement-Test	Result-Remark	Verdict
	When these tests are performed, it is recommended that they follow the sequence listed above.		P
	When the electrical equipment is modified, the requirements stated in 18.7 shall apply.		N
	For verifications that include measurement, measuring equipment in accordance with the IEC 61557 series is recommended.		P
	The results of the verification shall be documented.		P
18.2	Verification of conditions for protection by automatic disconnection of supply		-
18.2.1	General		-
	The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests. Test 1 verifies the continuity of the protective bonding circuit.		P
	Test 2 verifies the conditions for protection by automatic disconnection of the supply in TN systems.		P
	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.	Not TN-system	N
	For TT systems, see Clause A.2. For IT systems, see IEC 60364-6.		N
	Where RCDs are used in the electrical equipment, their function shall be verified in accordance with the manufacturer’s instructions. The test procedure and test interval shall be specified in the maintenance instructions.		N
18.2.2	Test 1 – Verification of the continuity of the protective bonding circuit		-
	The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.	(See appended table 18.2) 10A	P
	The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).		P
	Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.		P

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Clause	Requirement-Test	Result-Remark	Verdict
18.2.3	Test 2 – Fault loop impedance verification and suitability of the associated overcurrent protective device		N
	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.		N
	The conditions for the protection by automatic disconnection of supply in accordance with		-
	6.3.3 and Annex A shall be verified by both:		N
	a) verification of the fault loop impedance by:		N
	— calculation, or		N
	— measurement in accordance with A.1.4, and		N
	b) confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A, and where a power drive system (PDS) is used, confirmation that the setting and characteristics of the protective device(s) associated with a PDS are in accordance with the converter manufacturer's and protective device manufacturer's instructions.		N
18.2.4	Application of the test methods for TN-systems		-
	When Test 2 of 18.2.3 is carried out by measurement, it shall always be preceded by Test 1 of 18.2.2.		P
	The tests that are necessary for machines of different status are specified in Table 9.		P
18.3	Insulation resistance tests		-
	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 M . The test may be made on individual sections of the complete electrical installation.	(See appended table 18.3) 500V DC	P
	Exception: for certain parts of electrical equipment, incorporating for example busbars, conductor wire or conductor bar systems or slip-ring assemblies, a lower minimum value is permitted, but that value shall not be less than 50 k .		P
	If the electrical equipment of the machine contains surge protection devices which are likely to operate during the		N

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Clause	Requirement-Test	Result-Remark	Verdict
	test, it is permitted to either:		
	— disconnect these devices, or		N
	— reduce the test voltage to a value lower than the voltage protection level of the surge protection devices, but not lower than the peak value of the upper limit of the supply (phase to neutral) voltage.		N
18.4	Voltage tests		-
	When voltage tests are performed, test equipment in accordance with IEC 61180—2 should be used.		P
	The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.	50HZ	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. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.	(See appended table 18.4) 1000V	P
	Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.		P
	Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.		P
18.5	Protection against residual voltages		-
	Where appropriate, tests shall be performed to ensure compliance with 6.2.4.	(See appended table 18.5)	P
18.6	Functional tests		-
	The functions of electrical equipment shall be tested.	(See appended table 18.6)	P
18.7	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

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Clause	Requirement-Test	Result-Remark	Verdict
	Particular attention should be given to the possible adverse effects that retesting can have on the equipment (for example overstressing of insulation, disconnection/reconnection of devices).		

18.5	TABLE 1: Residual Voltages Measurements	**P**

Test point	Measured time (s)	<60V DC(42V AC) Pass/Fail
L-N	<1s	Pass

18.2	TABLE 3 : Continuity of the protective bonding circuit	**N**

Location	Current (A)	Measured Resistance (Ω)	Measured voltage(V)	<1V Pass/Fail
PE to enclosure	10.8	0.019	0.205	Pass
PE to motor	10.7	0.016	0.171	Pass
PE to bolt	10.9	0.016	0.174	Pass
PE to transformer	10.8	0.026	0.273	Pass
PE to control panel	10.1	0.019	0.208	Pass

18.3	TABLE 4: Insulation resistance tests	**P**

Location		Test Voltage (V)d.c	Duration(s)	Measured insulation resistance(MΩ)	>10MΩ Pass/Fail
Motor	L1-PE	534	10	>999.9	Pass
Motor	L2-PE	533	10	>999.9	Pass
Motor	L3-PE	533	10	>999.9	Pass

18.4	TABLE 5 : Voltage tests	**P**

Test point	Test voltage (V) a.c. / d.c.	Duration (s)	Leakage current(mA)	Breakdown Yes / No
Motor L1-PE	1033 a.c.	60	0.0	No
Motor L2-PE	1032 a.c.	60	0.0	No
Motor L3-PE	1030 a.c.	60	0.0	No

18.6	TABLE 6: Function tests	**P**

S/N	Function	requirement	Result
1	Transmission parts checking	Suitable for intended use, no abnormal noise	OK
2	Completed product		OK
3	Emergency stop switch	When press the botton, the machine stop	OK

Annex I

Test instrument list

Item	Equipment	Manufacturer	Model No.	Last Cal.	Cal. Interval
1.	Multitester	Metrel	MI2094	Jun. 01, 21	1 Year
2.	thermometer			Jun. 01, 21	1 Year
3	multimeter	Uni-t	UT890D	Oct. 13,21	1 Year

Temperature：28℃
Humidity： 72%

Notice

1. This test report shall be invalidation without the cachet of the testing laboratory.
2. This copied report shall be invalidation without sealed the cachet of the testing laboratory.
3. This report shall be invalidation without tester signature, reviewer signature and approver signature.
4. This altered report shall be invalidation.
5. Client shall put forward demurrer within 15days after received report. The testing laboratory shall refuse disposal if exceeded the time limit.
6. The test results presented in this report relate only to the object tested.

Annex：Technical Information

A.1 Photo

Fig.1