Technical Construction File

(File No. J55-HXF-21985)
Version: 01
According to

Machinery Directive	2006/42/EC
Electromagnetic Compatibility	2014/30/EU
Standard	EN ISO 11553-1:2020+A11:2020 EN ISO 12100:2010 EN ISO 13849-1:2015 EN ISO 13849-2:2012 EN 60204-1:2018 EN IEC 61000-6-2:2019 EN IEC 61000-6-4:2019
Product:	**Laser welding machine**
Model(s)	AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W
Issued Date:	May 21, 2024

Applicant

Company:	Hefei XFH Electromechanical Technology Co., Ltd
Address:	C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China

Manufacturer

Company:	Hefei XFH Electromechanical Technology Co., Ltd
Address:	C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China
Brand:	
Tel:	
Fax:	
Contact person:	

Same a

/

Prepared by:

Mandy Long	Wendy
Quality Engineer	Project Manager

GUANGZHOU DEXIN TESTING SERVICES CO.,LTD Technical Construction File

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Technical Contruction File (TCF)

EN ISO 11553-1

Safety of machinery - Laser processing machines

Part 1: General safety requirements

Report Reference No.....:	J55-HXF-21985
Date of issue.....:	May 21, 2024
Test Labortory :	Hefei XFH Electromechanical Technology Co., Ltd
Address :	C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China
Testing procedure.....:	Commission Test
Applicant's name.....:	Hefei XFH Electromechanical Technology Co., Ltd
Address .....:	C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China
Manufacturer's name .....:	Same as applicant
Address .....:	
Factory's name .....:	Same as applicant
Address .....:	
Test specification:	
Standard .....:	☒ EN ISO 11553-1:2020+A11:2020
Test procedure .....:	Commission Test
Non-standard test method……..:	N/A
Test Report Form No. .....:	EN ISO 11553-1
TRF Originator.....:	SBD
Master TRF.....:	Dated 2022-05
Test item description.....:	Laser welding machine
Trade Mark .....:	Brand: No Brand
Model/Type reference.....:	AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W
Ratings .....:	380-415V 3 ~ 50Hz 6500W Classification of Laser: Class 4

Copy of marking plate:	
Laser welding machine Model: xxx Band: No Brand 380-415V 3 ~ 50Hz 6500W Classification of Laser: Class 4 Hefei XFH Electromechanical Technology Co., Ltd C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China Made in China	xxx= AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W

Summary of testing:

This test sample complies with all clause from EN ISO 11553-1

Test Report Content

This test report consists of:

Main report

Annex I: Photo Documentation, 1 page(s).

Test item particulars:	
Degree of protection against access to hazardous parts and against harmful ingress of solid foreign objects .....:	IP2X
Degree of protection against harmful ingress of water .....:	IPX0
Test case verdicts:	
Test case does not apply to the test object ...:	N/A
Test object does meet the requirement .....:	Pass (P)
Test object does not meet the requirement ..:	Fail (F)
Testing:	
Date of receipt of test item .....:	April 01, 2023
Date(s) of performance of test .....:	April 01, 2023 to May 21, 2024

General remarks:

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

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

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

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

"(see appended table)" refers to a table in the Test Report.

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

Description of product:

Laser welding machine

Model: AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W

230V ~ 50Hz 6500W Classification of Laser: Class 4

Model DH-1325C is selected for full test.

Remarks:

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
5	**Safety requirements and measures**		-
5.1	**General requirements**		-
	The extent to which hazards are covered is indicated in the Scope.		-
	Machinery shall comply as appropriate with ISO 12100-1 and ISO 12100-2 for hazards which are not covered by this part of ISO 11553.		P
	Manufacturers shall ensure the safety of laser processing machines by		P
	– hazard identification and analysis,		P
	– implementation of safety measures,		P
	– certification and verification of the safety measures, and		P
	– provision of appropriate information for the user.		P
	Based on the hazard identification (see 5.2), appropriate safety measures shall be incorporated into the laser processing machine by design and manufacture.		P
	The following requirements shall be satisfied:		P
	– each manufacturer shall comply with the safety requirements and measures stipulated in this clause;		P
	– the manufacturer of an installed machine shall be responsible for the compliance of the whole machine, including subassemblies.		P
	NOTE These requirements apply even if the manufacturer and the customer/user are the same legal entity.		P
	These measures shall take into account each hazard listed in Clause 4, and the results of the hazard analysis, and should take into account information in Annexes A and B.		P
5.2	**Risk assessment**		-
	A risk assessment shall be performed		P
	– for all phases of machine “life” (as applicable); for examples see ISO 12100-1;		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	– after each modification of the machine by the person or organization responsible for the modification.		P
	A risk assessment includes but is not limited to		-
	a) hazards listed in 4.2 and 4.3;		P
	b) danger zones, particularly those associated with		P
	– the laser system,		P
	– the laser beam path/beam delivery system, and		P
	– the process zone;		P
	c) "interferences" listed in 4.3.		-
	The results of the risk assessment shall be duly documented. Concerning principles for risk assessment, see also EN 1050.		P
5.3	**Implementation of corrective measures**		-
5.3.1	**General**		-
	Safety measures shall be incorporated in the machine by design and manufacture as specified in 5.3.2 to 5.3.4.		P
5.3.2	**Protection against laser radiation hazards**		P
5.3.2.1	**General**		-
5.3.2.1.1	For laser processing machines operating in locations with unrestricted and uncontrolled access, the possibility that people be exposed to levels of laser radiation exceeding the accessible emission limit (AEL) for Class 4 shall be eliminated during production.		P
	Access to radiation in excess of the AEL for which direct viewing is not permitted shall be eliminated for maintenance.		P
	To satisfy these requirements, the following conditions shall be met.		P
	Unauthorized human access to a danger zone shall be prevented by engineering measures as stipulated in IEC 60825-1 and ISO 12100-1 and ISO 12100-2.		P
5.3.2.1.2	For laser processing machines operating in		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	locations with restricted or controlled access, the possibility that people be exposed to levels of laser radiation exceeding the maximum permissible exposure (MPE) at the ocular exposure limits for 3 x10^4 seconds exposure shall be eliminated during production (normal or otherwise).		
	To satisfy this requirement, the following conditions shall be met.		P
	A Risk Assessment shall be performed.		P
	Unauthorized human access to a danger zone should be prevented by engineering measures as specified in IEC 60825-1 and ISO 12100-1 and ISO 12100-2.		P
	If access cannot be prevented, exposure above the ocular MPE shall be eliminated by use of engineering or administrative controls, including Personal Protective Equipment (PPE).		P
5.3.2.1.3	For all laser processing machines, without regard to restricted or controlled access, the following shall apply.		P
	If human presence in a danger zone is unavoidable while the machine is functioning (e.g. during service), the machine shall be equipped with means for direct control of machine motion, beam direction and beam stop (see 5.3.3.5).		P
	The design of protective devices, such as shutters, guards, beam dissipation devices and deterring/impeding devices, shall meet the requirements specified in IEC 60825-1 and ISO 12100-1 and ISO 12100-2.		P
	A single protective device may be used to provide simultaneous protection against more than one hazard.		P
	– Laser guards shall comply with requirements specified in IEC 60825-4.		P
5.3.2.2	**Protection during production**		P
	The principal danger zone is usually the process zone but the danger zone shall be defined as a		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	result of the risk assessment.		
	The hazard analysis shall indicate which type of guarding (local protection or peripheral protection) is to be used.		P
	Local protection is a method of guarding to reduce laser radiation and associated optical radiation to a safe level based on a risk assessment (e.g. by means of a nozzle or a small guard fitted close to the beam focus at the workpiece) without totally enclosing the workpiece, the workpiece support and/or machine motion system.		P
	Peripheral protection is a method of guarding to reduce laser radiation and associated optical radiation to a safe level based on a risk assessment by means of one or more distant guards (e.g. a protective enclosure) that enclose the workpiece, workpiece support and, usually, most of the machine motion system.		P
	The sort of protection will depend on several factors, for instance:		P
	– the direction (fixed or variable) of beam propagation with regard to the workpiece;		P
	– the type of machining operation to be realized (cutting, welding, etc.);		P
	– the material and shape of the workpiece to be processed;		P
	– the workpiece support;		P
	– the visibility of the process zone.		P
5.3.2.3	**Protection during service**		-
	During service procedures, human access to laser radiation exceeding the AEL for Class 4 is sometimes unavoidable.		P
	Machines shall therefore be designed, and appropriate safety measures provided, with respect to the following four situations (listed in order of preference):		P
	a) servicing takes place outside danger zones;		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	b) servicing takes place in danger zones to which access is controlled in the same manner as during production;		P
	c) servicing takes place in a danger zone (e.g. with open guards that are normally closed during production) but accessible laser radiation does not exceed the AEL for Class 4;		P
	d) servicing takes place in danger zones, for example because opening of guards (normally closed during production) is necessary.		P
	In this case accessible laser radiation exceeds the AEL for Class 4.		P
	The manufacturer shall indicate the class of accessible laser radiation and recommended safety procedures for each of these situations.		P
5.3.2.4	**Protection during teaching, programming and programme verification**		P
	During teaching, path programming and programme verification, human access to laser radiation exceeding the AEL for Class 4 should be prevented. If this condition cannot be met, the same requirements as for servicing shall apply.		P
5.3.3	**Control means and circuits**		-
	Control means and circuits shall comply with IEC 60204-1. The design of control systems shall comply with ISO 13849-1.		P
	NOTE Typically, this would result in Safety Category 3.		P
5.3.3.1	**Start/stop controls**		-
	The machine stop control shall stop the machine (i.e. switch off actuators) and either isolate the laser beam or deactivate laser beam generation.		P
	The laser stop control shall deactivate beam generation.		P
	Separate control devices may be provided for the laser system and the rest of the machine.		P
5.3.3.2	**Emergency stop control**		P
	The emergency stop control shall comply with IEC		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	60204-1.		
	The emergency stop control shall		P
	deactivate laser beam generation and automatically position the laser beam stop,		P
	deactivate the machine (i.e. actuator power off), and		P
	switch off the laser power supply and discharge all stored energy.		P
	If a laser device is used for several machines which work separately from one another, the emergency stop control located on one of the machines shall work as above, or		N
	deactivate the relevant machine (i.e. actuator power off), and isolate the laser beam optical path leading to the relevant machine.		P
	Unexpected start-up shall be prevented by compliance with ISO 14118 and, for the emergency stop equipment, ISO 13849-1 shall apply.		P
5.3.3.3	**Interlocks and guard control**		-
	When guards (per ISO 12100-1 and ISO 12100-2) are opened or displaced, or safety interlocks are defeated, automatic operation of the machine shall be impossible.		P
	If the design of the machine requires occasional procedures to be carried out with one or more guards open (normally closed during production) and with power supplied to the machine actuators, then an operating mode shall be provided to make overriding of the guard(s) possible.		P
	The selection of this operating mode shall		P
	be by means of a lockable mode selector,		P
	automatically isolate the laser beam or deactivate the laser, and		P
	prevent automatic operation of the machine (see ISO 14118).		P
	A key-operated switch may be used as the mode		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	selector.		
	Discrete, deliberate, interlock override mechanisms on removable access panels with safety interlocks (defeatable safety interlocks) shall meet the requirements of IEC 60825-1 for such override mechanisms.		P
	The operation mode selected shall be clearly signalled. After this operation mode has been selected, it shall be possible to override the beam isolation (i.e. “open” the beam stop) for service procedures.		P
	Interlocking systems shall comply with ISO 14119.		P
5.3.3.4	**Provisions for isolation of the laser beam**		-
	Isolation of the laser beam shall be achieved by blocking and/or deflecting the laser beam to prevent it from entering the beam delivery system.		P
	Beam isolation shall be accomplished using a fail-safe laser beam stop (shutter) located inside or immediately outside the laser.		P
	A position indicator shall show when the beam stop is in the closed position (i.e. preventing the beam from proceeding).		P
	Suitable easily accessible means shall be provided for locking the laser beam stop in the closed position.		P
	A key-control shall be permitted for this purpose.		P
	Additional beam stops may be provided by the machine manufacturer, for example in the following situations:		P
	a) when there are maintenance/cleaning areas present along the beam path (beam delivery system);		P
	b) when one laser device supplies more than one beam path, and there is a need for human intervention in one path while the beam is following one of the other paths.		P
5.3.3.5	**Device for protection when people are inside a danger zone**		-

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	As stated in ISO 12100-2:2003, 5.2.4, for situations (except production) when human presence in a danger zone is necessary, the machine shall be provided with a device for control of machine motion and laser beam emission, to be operated by the person inside the danger zone.		P
	The following requirements shall apply to this device:		-
	a) the device shall be provided with a hold-to-run control which, when released, prevents access to radiation in excess of AEL for which direct viewing with the unaided eye is not permitted or other means of control as provided in IEC 60204-1;		P
	b) when placed under the control of this device, all machine motions and laser beam emission shall be controllable only from this device;		P
	c) if it is possible to enter the danger zone through a door, then it shall be possible to start laser emission using this device only after closing such doors.		P
	This clause fulfils the requirements of ISO 12100-2:2003, 5.2.4.		P
5.3.4	**Protection against hazards generated by materials and substances**		-
	The manufacturer shall inform the customer/user of the materials that are intended to be processed with the machine.		P
	This applies also for materials and substances unintentionally deteriorated by the laser radiation.		P
	The manufacturer shall supply suitable means for capturing the fumes and airborne particles from these materials.		P
	The manufacturer shall provide information on the threshold limit values for the fumes and particulate matter generated by machining these materials.		P
	NOTE The safe removal and disposal of fumes and particulate matter from the machine according to local, national or regional Threshold Limit Values are the		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	responsibility of the customer/user.		
	Due regard shall be given to the hazards from associated gases (e.g. oxygen) used to assist laser/workpiece interactions and from any fumes that are produced. Related hazards include explosion, fire, toxic effects, oxygen excess and oxygen depletion.		p
	Additional information is given in Annex A.		-
6	**Verification of safety requirements and measures**		-
	General conformance with the requirements of this part of ISO 11553, particularly those relating to the presence and positioning of guards and control devices, shall be confirmed by visual inspection.		P
	Correct functioning of control devices shall be verified according to functional tests specified by the manufacturer.		P
	Verification procedures relating to laser radiation levels shall conform to IEC 60825-1.		P
7	**Information for user**		-
	In addition to the requirements of IEC 60204-1, IEC 60825-1, ISO 11252 and ISO 12100-2, the following requirements shall be satisfied.		P
	a) The manufacturer shall supply pertinent safety-related documentation and data, including correct maintenance and servicing procedures to the customer/user.		P
	b) The manufacturer shall inform the user as to the responsibilities of the user relating to the removal and/or disposal of fumes and particulate material from the machine.		P
	c) The manufacturer shall provide information on the limit values for the materials intended to be processed and for the fumes and particulate matter generated by machining these materials.		P
	The manufacturer shall also provide general information about equipment for removal of fumes and particulate matter.		p

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	d) The manufacturer shall make available suitable safety-related training to the user.		P
	e) The manufacturer shall advise users of known potential hazards by providing a prominently placed warning statement in the user instructions and/or operator's manual.		P
	The following items should be considered for inclusion in the user's instructions and/or operator's manual.		-
	IEC 60825-1 specifies protective measures for the primary laser radiation.		P
	The minimum requirement, in the case of potential exposure by a class 3B and class 4 product, is to wear protective eyewear rated for the laser power and wavelength.		P
	Some operations (e.g. welding) may produce intense UV and visible radiation.		P
	The minimum requirement, in the case of potential exposure to this kind of radiation, is to wear appropriate protective eyewear (e.g. a welding mask).		P
	Most material processing applications produce fumes and particles. When processing metals, heavy metal vapours may be produced.		P
	These can harm body tissues and organs. When processing plastics, hazardous (e.g. allergic, toxic, carcinogenic) by-products can be produced.		P
	Suitable protective measures such as guards or filtered breathing masks may be necessary.		P
	The minimum requirements, before starting the process, are		P
	a) to be familiar with the material to be processed, know what by-products may result, assess their risk to health and determine what precautions are necessary;		p
	b) to employ appropriate measures to prevent or control the risk; such measures will normally require positive exhaust of fumes from the process		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	zone and adequate purification before exhaust gases are returned to the atmosphere away from personnel;		
	c) to inform, instruct and train operators about the risks, and the precautions to be taken;		P
	d) where necessary, to monitor the exposure of operators and carry out an appropriate form of surveillance of their health in compliance with local regulations;		N
	e) to consult a pertinent authority to find out what national, state and/or local regulations must be satisfied before exhaust gases are returned into the atmosphere.		P
	Dangerous voltage/current is used to power the laser and its associated equipment.		P
	Power supplies can contain capacitor banks which may remain charged for some time after switching the equipment off.		P
	The minimum requirements in the case of repair is to follow the rules for electrical safety practices.		P
8	**Labelling**		-
	Local or regional laws for labelling shall be adhered to.		P
	The machine shall be labelled to indicate		P
	– the name and address of the laser processing machine manufacturer,		P
	– the manufacturing date, and		P
	- the series or type of machine (if appropriate) and serial number (if any).		P
	The labels shall satisfy the following requirements:		P
	colours, sizes and print styles of laser radiation warning labels shall be as described in IEC 60825-1;		P
	in addition to the labelling required by IEC 60825-1, the laser processing machine shall, after installation, carry other pertinent cautionary and warning labels (e.g. “TOXIC FUMES/PARTICLES		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	MAY BE GENERATED BY THIS MACHINE").		
	The size and location of the labels shall be such as to make the appropriate labels legible from outside the danger zones without exposing anyone to any of the hazards listed in Clause 4.		P
	The colour, size and print style of the labels shall comply with the requirements of ISO 3864.		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict

2	Continuity of protective bonding circuit		P
	Test Current (A) ..... :	10	
	Ambient (°C) ..... :	34	

Test locations	Conductor Diameter (mm^2)	Resistance(Ω)
PE-motors	2.5	0.07/0.08
PE-meter	2.5	0.06
PE- body and cover	2.5	0.07

On site test and the power supply is offered by the client.

3	Insulation resistance			P
	Test Voltage (V) ..... :		500V d.c.	
	Ambient (°C) ..... :		34	

Test	locations	Insulation Resistance (MΩ)	
Mian circuit	PE- L	>100	
	PE- N	>100	

4	Voltage test			P
	Test Voltage (V) ..... :		1000V a.c.	
	Test Duration (s) ..... :		1 sec.	

Test	locations	Observation
Mian circuit	PE- L	☒ Puncture ☒ Flash-over
	PE- N	☒ Puncture ☒ Flash-over ☒ No Break down

5	Functional test		P
Test requirements	The function of electrical equipment shall be tested, particularly those related to safety and safeguarding.		
1.Function of button	Function is verified accordance with the requirements		OK

6	Resistance of nozzle to earth		P

EN ISO 11553-1			
Clause	Requirement – Test	Result	Verdict
	Test Current (A) ..... :	10	-
	Ambient (°C) ..... :	34	-

Test locations	Conductor Diameter (mm^2)	Requirements(Ω)	Resistance(Ω)
PE- Operating Parts	/	<1MΩ	0.22-0.26

- End of Test Report -

TEST REPORT

EN ISO 12100

Safety of machinery – General principles for design, risk assessment and risk reduction

IEC 60204-1 / EN60204-1

Safety of machinery - Electrical equipment of machines

Part 1: General requirements

EN ISO13849-1

Safety-related parts of control systems -Part 1: General principles for design

EN ISO13849-2

Safety-related parts of control systems - Part 2:Validation

Report Reference No. ..... :	J55-HXF-21985
Date of issue ..... :	May 21, 2024
Testing laboratory..... :	Hefei XFH Electromechanical Technology Co., Ltd
Address ..... :	C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China
Applicant's name ..... :	Hefei XFH Electromechanical Technology Co., Ltd
Address ..... :	C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China
Manufacturer's name..... :	Hefei XFH Electromechanical Technology Co., Ltd
Address ..... :	C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China
Factory's name..... :	Same as applicant
Address ..... :	
Test specification:	
Standard ..... :	☒ EN ISO 12100:2010 ☒ EN 60204-1:2018 ☒ EN ISO13849-1:2015 ☒ EN ISO13849-2:2012
Test procedure ..... :	Commission Test
Non-standard test method……..:	N/A
Test Report Form No. ..... :	
TRF Originator ..... :	SBD
Master TRF ..... :	Dated 2023-01
Test item description ..... :	Laser welding machine
Trade Mark ..... :	/
Model/Type reference ..... :	AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W
Ratings ..... :	380-415V 3 ~ 50/60Hz 1,12 kW

Summary of testing:	
Tests performed (name of test and test clause): **All of test are performed at:** Manuacturer’s address	**Testing location:** Manuacturer’s address
Summary of compliance with National Differences: European Group Differences and National Differences have been taken into consideration. Annex I in Directive 2006/42/EC Machinery Essential Health and Safety Requirements	

Test case verdicts:	
Test case does not apply to the test object ..:	N/A
Test object does meet the requirement .....:	Pass (P)
Test object does not meet the requirement .:	Fail (F)
Testing:	
Date of receipt of test item .....:	May 06, 2024
Date(s) of performance of test .....:	May 06, 2024 to May 21, 2024

General remarks:
The test results presented in this report relate only to the item(s) tested.
This report shall not be reproduced, except in full, without the written approval of the testing laboratory.
"(see remark #)" refers to a remark appended to the report.
"(see Annex #)" refers to an annex appended to the report.
"(see appended table)" refers to a table in the Test Report.
Throughout this report a comma (point) is used as the decimal separator.

Copy of marking plate	
Laser welding machine Model xxx 380-415V 3 ~ 50/60Hz 1,12 kW Hefei XFH Electromechanical Technology Co., Ltd C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China Made in China	xxx= AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W
Remark on the marking plate: 1. The height of graphical symbols is not less than 5 mm; 2. The height of letters and numerals are not less than 2 mm	

EN ISO 12100 / EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6	**Risk reduction**		-
6.1	**General**		-
	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).	This requirement is complied with.	P
6.2	**Inherently safe design measures**		-
6.2.1	**General**		-
	Inherently safe design measures are the first and most important step in the risk reduction process 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**		

EN ISO 12100 / EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.2.2.1	Geometrical factors		-
	Such factors include the following.		-
	a) The form of machinery is designed to maximize direct visibility of the working areas and hazard zones from the control position - reducing blind spots, for example - and choosing and locating means of indirect vision where necessary (mirrors, etc.) so as to take into account the characteristics of human vision, particularly when safe operation requires permanent direct control by the operator, for example: - the travelling and working area of mobile machines; - the zone of movement of lifted loads or of the carrier of machinery for lifting persons; - the area of contact of the tool of a hand-held or hand-guided machine with the material being worked. The design of the machine shall be such that, from the main control position, the operator is able to ensure that there are no exposed persons in the danger zones.	Appropriate machine design has been performed by the manufacturer.	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).	Appropriate machine design has been performed by the manufacturer.	P
	c) Avoiding sharp edges and corners, protruding parts: in so far as their purpose allows, accessible	Appropriate machine design has been performed by the manufacturer.	P

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	parts of the machinery shall have no sharp edges, no sharp angles, no rough surfaces, no protruding parts likely to cause injury, and no openings which can “trap” parts of the body or clothing. In particular, sheet metal edges shall be deburred, flanged or trimmed, and open ends of tubes which can cause a “trap” shall be capped.		
	d) The form of the machine is designed so as to achieve a suitable working position and provide accessible manual controls (actuators).	Appropriate machine design has been performed by the manufacturer.	P
6.2.2.2	Physical aspects		-
	Such aspects include the following:		-
	a) limiting the actuating force to a sufficiently low value so that the actuated part does not generate a mechanical hazard;	The actuating force has been limited to be a sufficiently low value so that the actuated part does not generate a mechanical hazard.	P
	b) limiting the mass and/or velocity of the movable elements, and hence their kinetic energy;	The mass and/or velocity of the movable elements, and hence their kinetic energy have been limited.	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,	The emissions by acting on the characteristics of the source have been limited.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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)]		
6.2.3	**Taking into account general technical knowledge of machine design**		
	This general technical knowledge can be derived from technical specifications for design (standards, design codes, calculation rules, etc.), which should be used to cover		
	a) mechanical stresses such as		
	- stress limitation by implementation of correct calculation, construction and fastening methods as regards, for example, bolted assemblies and welded assemblies,	The appropriate technical knowledge of mechanical has been taken into account.	P
	- stress limitation by overload prevention (bursting disk, pressure-limiting valves, breakage points, torque-limiting devices, etc.),	The appropriate technical knowledge of mechanical has been taken into account.	P
	- avoiding fatigue in elements under variable stresses (notably cyclic stresses),	The appropriate technical knowledge of mechanical has been taken into account.	P
	- static and dynamic balancing of rotating	The appropriate technical	P

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	elements,	knowledge of mechanical has been taken into account.	
	b) materials and their properties such as		-
	- resistance to corrosion, ageing, abrasion and wear,	The materials have been treated by appropriate methods.	P
	- hardness, ductility, brittleness,	The materials have been treated by appropriate methods.	P
	- homogeneity,	The materials have been treated by appropriate methods.	P
	- toxicity,	The materials have been treated by appropriate methods.	P
	- flammability	The materials have been treated by appropriate methods.	P
	c) emission values for		
	- noise,	No noise will result in hazard in this machine.	P
	- vibration,	No vibration will result in hazard in this machine.	P
	- hazardous substances,	No hazardous substances will result in hazard in this machine.	P
	- radiation	No radiation will result in hazard in this machine.	P
	When the reliability of particular components or assemblies is critical for safety (for example, ropes, chains, lifting accessories for lifting loads or persons), stress limits shall be multiplied by appropriate working coefficients.	Appropriate working coefficients have been taken into account during design and calculation.	P
6.2.4	**Choice of appropriate technology**		-

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	One or more hazards can be eliminated or risks reduced by the choice of the technology to be used in certain applications such as the following:		
	a) on machines intended for use in explosive atmospheres, using - appropriately selected pneumatic or hydraulic control system and machine actuators, - intrinsically safe electrical equipment (see IEC 60079-11);	Not applicable.	N/A
	b) for particular products to be processed (for example, by a solvent), by using equipment that ensures the temperature will remain far below the flash point;	Not applicable.	N/A
	c) the use of alternative equipment to avoid high noise levels, such as - electrical instead of pneumatic equipment, - in certain conditions, water-cutting instead of mechanical equipment.	The appropriate technology has been chosen.	P
6.2.5	**Applying principle of positive mechanical action**		-
	Positive mechanical action is achieved when a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements. An example of this is positive opening operation of switching devices in an electrical circuit (see IEC 60947-5-1 and ISO 14119).	The principle of the positive mechanical action of a component on another component has been applied.	P
6.2.6	**Provisions for stability**		
	Machines shall be designed so that they have sufficient stability to allow them to be used safely in their specified conditions of use.	These machines have been designed to have sufficient stability to allow them to be used safely in their specified conditions of use.	P
	Factors to be taken into account include		
	- the geometry of the base,	The factor has been taken into account during design.	P

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	- the weight distribution, including loading,	The factor has been taken into account during design.	P
	- the dynamic forces due to movements of parts of the machine, of the machine itself or of elements held by the machine which can result in an overturning moment,	The factor has been taken into account during design.	P
	- vibration	The factor has been taken into account during design.	P
	- oscillations of the centre of gravity,	Not applicable.	N/A
	- characteristics of the supporting surface in case of travelling or installation on different sites (ground conditions, slope, etc.),	The factor has been taken into account during design.	P
	- external forces, such as wind pressure and manual forces.	The factor has been taken into account during design.	P
	Stability shall be considered in all phases of the life cycle of the machine, including handling, travelling, installation, use, dismantling, disabling and scrapping.	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	**Provisions for maintainability**		
	When designing a machine, the following maintainability factors shall be taken into account to enable maintenance of the machine:		
	- accessibility, taking into account the environment and the human body measurements, including the dimensions of the working clothes and tools used;	The factor has been taken into account during design.	P
	- 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**		
	Ergonomic principles shall be taken into account in designing machinery so as to reduce the mental or physical stress of, and strain on,	Appropriate ergonomic principles have been taken into account in designing machinery to reduce mental or physical stress and strain	P

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	the operator.	of the operator.	
	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, signalling or data display elements, shall be designed to be easily understood so that clear and unambiguous interaction between the operator and the machine is possible. See EN 614-1, EN 13861 and IEC 61310-1.	All arrangement and design of manual controls have been checked in compliance with.	P
	The designer's attention is particularly drawn to following ergonomic aspects of machine design.		-
	a) Avoid the necessity for stressful postures and movements during the use of the machine (for example, providing facilities to adjust the machine to suit the various operators).	Stressful postures and movements during use of the machine have been avoided.	P
	b) Design machines, especially hand-held and mobile machines, so as to enable them to be operated easily, taking into account human effort, actuation of controls and hand, arm and leg anatomy.	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.		P
	e) Provide local lighting on or in the machine for the illumination of the working area and of adjusting, setting-up and frequent maintenance zones when the design features of the machine	All these factors have been taken into account during design.	P

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	and/or its guards render the ambient lighting inadequate. Flicker, dazzling, shadows and stroboscopic effects shall be avoided if they can cause a risk. If the position or the lighting source has to be adjusted, its location shall be such that it does not cause any risk to persons making the adjustment.		
	f) Select, locate and identify manual controls (actuators) so that		-
	- they are clearly visible and identifiable, and appropriately marked where necessary (see 6.4.4),	All design and arrangement of the control logic have been checked in compliance with this requirement.	P
	- they can be safely operated without hesitation or loss of time and without ambiguity (for example, a standard layout of controls reduces the possibility of error when an operator changes from a machine to another one of similar type having the same pattern of operation),	All design and arrangement of the control logic have been checked in compliance with this requirement.	P
	- their location (for push-buttons) and their movement (for levers and hand wheels) are consistent with their effect (see IEC 61310-3),	All the function has been checked in compliance with this requirement.	P
	- their operation cannot cause additional risk.		P
	Where a control is designed and constructed to perform several different actions - namely, where there is no one-to-one correspondence (for example, keyboards) - the action to be performed shall be clearly displayed and subject to confirmation where necessary.		N/A
	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.	All the arrangement of the control logic have been checked in compliance with this requirement.	P

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	Constraints due to the necessary or foreseeable use of personal protective equipment (such as footwear, gloves) shall be taken into account.		
	g) Select, design and locate indicators, dials and visual display units so that		
	- they fit within the parameters and characteristics of human perception,		P
	- information displayed can be detected, identified and interpreted conveniently, i.e. long-lasting, distinct, unambiguous and understandable with respect to the operator's requirements and the intended use,		P
	- the operator is able to perceive them from the control position.		P
6.2.9	**Electrical hazards**		
	For the design of the electrical equipment of machines, IEC 60204-1 gives general provisions about disconnection and switching of electrical circuits and for protection against electric shock.	Please also make reference to EN 60204-1 test report.	P
	For requirements related to specific machines, see corresponding IEC standards (for example, IEC 61029, IEC 60745 or IEC 60335).		N/A
6.2.10	**Pneumatic and hydraulic hazards**		-
	Pneumatic and hydraulic equipment of machinery shall be designed so that		
	- the maximum rated pressure cannot be exceeded in the circuits (using, for example, pressure-limiting devices),	This requirement is complied with.	P
	- no hazard results from pressure fluctuations or increases, or from loss of pressure or vacuum,	This requirement is complied with.	P
	- no hazardous fluid jet or sudden hazardous movement of the hose (whiplash) results from leakage or component failures,	This requirement is complied with.	P

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	- air receivers, air reservoirs or similar vessels (such as in gas-loaded accumulators) comply with the applicable design standard codes or regulations for these elements,	This requirement is complied with.	P
	- all elements of the equipment, especially pipes and hoses, are protected against harmful external effects,	This requirement is complied with.	P
	- as far as possible, reservoirs and similar vessels (for example, gas-loaded accumulators) are automatically depressurized when isolating the machine from its power supply (see 6.3.5.4) and, if not possible, means are provided for their isolation, local depressurizing and pressure indication (see also ISO 14118:2000, Clause 5),	This requirement is complied with.	P
	- all elements which remain under pressure after isolation of the machine from its power supply are provided with clearly identified exhaust devices, and there is a warning label drawing attention to the necessity of depressurizing those elements before any setting or maintenance activity on the machine.	This requirement is complied with.	P
6.2.11	**Applying inherently safe design measures to control systems**		-
6.2.11.1	General		-
	The design measures of the control system shall be chosen so that their safety-related performance provides a sufficient amount of risk reduction (see ISO 13849-1 or IEC 62061).	Inherently safe design measures to control system have applied.	P
	The correct design of machine control systems can avoid unforeseen and potentially hazardous machine behaviour.		P
	Typical causes of hazardous machine behaviour are		
	- an unsuitable design or modification (accidental or deliberate) of the control system	No this kind of hazard in this machine	P

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	logic,		
	- a temporary or permanent defect or failure of one or several components of the control system,	No this kind of hazard in this machine	P
	- a variation or a failure in the power supply of the control system,	No this kind of hazard in this machine	P
	- inappropriate selection, design and location of the control devices.	No this kind of hazard in this machine	P
	Typical examples of hazardous machine behaviour are		
	- unexpected start-up (see ISO 14118),	No this kind of hazard in this machine	P
	- uncontrolled speed change,	No this kind of hazard in this machine	P
	- failure to stop moving parts,	No this kind of hazard in this machine	P
	- dropping or ejection of part of the machine or of a workpiece clamped by the machine,	No this kind of hazard in this machine	P
	- machine action resulting from inhibition (defeating or failure) of protective devices.	No this kind of hazard in this machine	P
		The design of control systems comply with the related principles and methods	P
	In order to prevent hazardous machine behaviour and to achieve safety functions, the design of control systems shall comply with the principles and methods presented in this subclause (6.2.11) and in 6.2.12. These principles and methods shall be applied singly or in combination as appropriate to the circumstances (see ISO 13849-1, IEC 60204-1 and IEC 62061).		
	Control systems shall be designed to enable the operator to interact with the machine safely and easily.		
	- systematic analysis of start and stop	Systematic analysis have been applied.	P

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	conditions;		
	- provision for specific operating modes (for example, start-up after normal stop, restart after cycle interruption or after emergency stop, removal of the workpieces contained in the machine, operation of a part of the machine in case of a failure of a machine element);	Enough provisions have been provided.	P
	- clear display of the faults;		P
	- measures to prevent accidental generation of unexpected start commands (for example, shrouded start device) likely to cause dangerous machine behaviour (see ISO 14118:2000, Figure 1);	Main switch with lock and related devices are provided.	P
	- maintained stop commands (for example, 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/A
	The different zones shall be clearly defined and it shall be obvious which parts of the machine belong to which zone.		N/A
	Likewise, it shall be obvious which control devices (for example, emergency stop devices, supply disconnecting devices) and/or protective devices belong to which zone.		N/A
	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/A
	Control systems shall be designed to limit the movements of parts of the machinery, the machine itself, or work pieces and/or loads held	This requirement is complied with.	P

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	by the machinery, to the safe design parameters (for example, range, speed, acceleration, deceleration, load capacity). Allowance shall be made for dynamic effects (swinging of loads, etc.).		
6.2.11.2	**Starting of an internal power source/switching on an external power supply**		
	The starting of an internal power source or switching-on of an external power supply shall not result in a hazardous situation.	Please also make reference to EN 60204-1 test report.	P
6.2.11.3	**Starting/stopping of a mechanism**		
	The primary action for starting or accelerating the movement of a mechanism should be performed by the application or an increase of voltage or fluid pressure, or — if binary logic elements are considered — by passage from state 0 to state 1 (where state 1 represents the highest energy state).	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		P
	— if binary logic elements are considered — by passage from state 1 to state 0 (where state 1 represents the highest energy state)		
	In certain applications, such as high-voltage switchgear, this principle cannot be followed, in which case other measures should be applied to achieve the same level of confidence for the stopping or slowing down.		N/A
	When, in order for the operator to maintain permanent control of deceleration, this principle is not observed (for example, a hydraulic		P

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	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.		
6.2.11.4	**Restart after power interruption**		
	If a hazard could be generated, the spontaneous restart of a machine when it is re-energized after power interruption shall be prevented (for example, by use of a self-maintained relay, contactor or valve).		P
6.2.11.5	**Interruption of power supply**		
	Machinery shall be designed to prevent hazardous situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met:	The hazardous situations resulting from interruption or excessive fluctuation of the power supply has been prevented.	P
	- the stopping function of the machinery shall remain;		P
	- all devices whose permanent operation is required for safety shall operate in an effective way to maintain safety (for example, locking, clamping devices, cooling or heating devices, power-assisted steering of self-propelled mobile machinery);		P
	- parts of machinery or workpieces and/or loads held by machinery which are liable to move as a result of potential energy shall be retained for the time necessary to allow them to be safely lowered.		P
6.2.11.6	**Use of automatic monitoring**		
	Automatic monitoring is intended to ensure that a safety function or functions implemented by a protective measure do not fail to be performed if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed such that	Appropriate automatic monitoring has been used.	P

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	hazards are generated.		
	Automatic monitoring either detects a fault immediately or carries out periodic checks so that a fault is detected before the next demand upon the safety function. In either case, the protective measure can be initiated immediately or delayed until a specific event occurs (for example, the beginning of the machine cycle).	Appropriate automatic monitoring has been used.	P
	The protective measure may be, for example,		-
	- the stopping of the hazardous process,		P
	- preventing the restart 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**		-
6.2.11.7.1	General		-
	A control system that includes programmable electronic equipment (for example, programmable controllers) can, where appropriate, be used to implement safety functions at machinery.		N/A
	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.		N/A
	The design of the programmable electronic control system shall be such that the probability of random hardware failures and the likelihood of systematic failures that can adversely affect the performance of the safety-related control function(s) is sufficiently low.		P
	Where a programmable electronic control system performs a monitoring function, the		P

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	system behaviour on detection of a fault shall be considered (see also the IEC 61508 series for further guidance).		
	The programmable electronic control system should be installed and validated to ensure that the specified performance [for example, safety integrity level (SIL) in IEC 61508] for each safety function has been achieved.		N/A
	Validation comprises testing and analysis (for example, static, dynamic or failure analysis) to show that all parts interact correctly to perform the safety function and that unintended functions do not occur.		N/A
6.2.11.7.2	Hardware aspects		-
	The hardware (including, for example, sensors, actuators and logic solvers) shall be selected, and/or designed and installed, to meet both the functional and performance requirements of the safety function(s) to be performed, in particular, by means of		N/A
	- architectural constraints (the configuration of the system, its ability to tolerate faults, its behaviour on detection of a fault, etc.),		N/A
	- selection, and/or design, of equipment and devices with an appropriate probability of dangerous random hardware failure, and		N/A
	- the incorporation of measures and techniques within the hardware so as to avoid systematic failures and control systematic faults.		N/A
6.2.11.7.3	Software aspects		-
	The software, including internal operating software (or system software) and application software, shall be designed so as to satisfy the		N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	performance specification for the safety functions (see also IEC 61508-3). Application software should not be reprogrammable by the user. This may be achieved by use of embedded software in a non-reprogrammable memory [for example, micro-controller, application-specific integrated circuit (ASIC)]. When the application requires reprogramming by the user, the access to the software dealing with safety functions should be restricted (for example, by locks or Pwords for the authorized persons).		
6.2.11.8	Principles relating to manual control		
	a) Manual control devices shall be designed and located according to the relevant ergonomic principles given in 6.2.8, item f).	This requirement has been taken into account during design.	P
	b) A stop control device shall be placed near each start control device. Where the start/stop function is performed by means of a hold-to-run control, a separate stop control device shall be provided when a risk can result from the hold-to-run control device failing to deliver a stop command when released.	A stop control device has been placed near each start control device.	P
	c) Manual controls shall be located out of reach of the danger zones (see IEC 61310-3), except for certain controls where, of necessity, they are located within a danger zone, such as emergency stop or teach pendant.	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.		P
	e) If it is possible to start the same hazardous	Not applicable.	N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	element by means of several controls, the control circuit shall be so arranged that only one control is effective at a given time. This applies especially to machines which can be manually controlled by means of, among others, a portable control unit (such as a teach pendant), with which the operator can enter danger zones.		
	f) Control actuators shall be designed or guarded so that their effect, where a risk is involved, cannot occur without intentional operation (see ISO 9355-1, ISO 9355-3 and ISO 447).		P
	g) For machine functions whose safe operation depends on permanent, direct control by the operator, measures shall be implemented to ensure the presence of the operator at the control position (for example, by the design and location of control devices).		P
	h) For cableless control, an automatic stop shall be performed when correct control signals are not received, including loss of communication (see IEC 60204-1).	Not applicable.	N/A
6.2.11.9	Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance		
	Where, for setting, teaching, process changeover, fault-finding, cleaning or maintenance of machinery, a guard has to be displaced or removed and/or a protective device has to be disabled, and where it is necessary for the purpose of these operations for the machinery or part of the machinery to be put into operation, the safety of the operator shall be achieved using a specific control mode	Not applicable.	N/A

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	which simultaneously		
	a) disables all other control modes,	Not applicable.	N/A
	b) permits operation of the hazardous elements only by continuous actuation of an enabling device, a two-hand control device or a hold-to-run control device,	Not applicable.	N/A
	c) permits operation of the hazardous elements only in reduced risk conditions (for example, reduced speed, reduced power/force, step-by-step, for example, with a limited movement control device),	Not applicable.	N/A
	d) prevents any operation of hazardous functions by voluntary or involuntary action on the machine's sensors.	Not applicable.	N/A
6.2.11.10	Selection of control and operating modes		
	If machinery has been designed and built to allow for its use in several control or operating modes requiring different protective measures and/or work procedures (for example, to allow for adjustment, setting, maintenance, inspection), it shall be fitted with a mode selector which can be locked in each position. Each position of the selector shall be clearly identifiable and shall exclusively allow one control or operating mode.	This requirement is complied with.	P
	The selector may be replaced by another selection means which restricts the use of certain functions of the machinery to certain categories of operators (for example, access codes for certain numerically controlled functions).	This requirement is complied with.	P
6.2.11.11	Applying measures to achieve electromagnetic compatibility (EMC)		
	For guidance on electromagnetic compatibility, see IEC 60204-1 and IEC 61000-6.		N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.2.11.12	Provision of diagnostic systems to aid fault-finding		
	Diagnostic systems to aid fault-finding should be included in the control system so that there is no need to disable any protective measure.		P
6.2.12	**Minimizing probability of failure of safety functions**		-
6.2.12.1	General		-
	Safety of machinery is not only dependent on the reliability of the control systems but also on the reliability of all parts of the machine. The continued operation of the safety functions is essential for the safe use of the machine. This can be achieved by the measures given in 6.2.12.2 to 6.2.12.4.		P
6.2.12.2	Use of reliable components		
	Reliable components” means components which are capable of withstanding all disturbances and stresses associated with the usage of the equipment in the conditions of intended use (including the environmental conditions), for the period of time or the number of operations fixed for the use, with a low probability of failures generating a hazardous malfunctioning of the machine. Components shall be selected taking into account all factors mentioned above (see also 6.2.13).	Reliable components have been used.	P
6.2.12.3	Use of “oriented failure mode” components		
	“Oriented failure mode” components or systems are those in which the predominant failure mode is known in advance and which can be used so that the effect of such a failure on the machine function can be predicted.		N/A
6.2.12.4	Duplication (or redundancy) of components or		

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	subsystems		
	In the design of safety-related parts of the machine, duplication (or redundancy) of components may be used so that, if one component fails, another component or components continue to perform the respective function(s), thereby ensuring that the safety function remains available.	Not applicable.	N/A
	In order to allow the proper action to be initiated, component failure shall be detected by automatic monitoring (see 6.2.11.6) or in some circumstances by regular inspection, provided that the inspection interval is shorter than the expected lifetime of the components.	Not applicable.	N/A
	Diversity of design and/or technology can be used to avoid common cause failures (for example, from electromagnetic disturbance) or common mode failures.	Not applicable.	N/A
6.2.13	**Limiting exposure to hazards through reliability of equipment**		
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring intervention, thereby reducing exposure to hazards.	This requirement is complied with.	P
	This applies to power systems (operative part, see Annex A) as well as to control systems, and to safety functions as well as to other functions of machinery.	This requirement is complied with.	P
	Safety-related components (for example, certain sensors) of known reliability shall be used.	This requirement is complied with.	P
	The elements of guards and of protective devices shall be especially reliable, as their failure can expose persons to hazards, and also because poor reliability would encourage	This requirement is complied with.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	attempts to defeat them.		
6.2.14	**Limiting exposure to hazards through mechanization or automation of loading (feeding)/ unloading (removal) operations**		
	Mechanization and automation of machine loading/unloading operations and, more generally, of handling operations - of workpieces, materials or substances - limits the risk generated by these operations by reducing the exposure of persons to hazards at the operating points.	This requirement is complied with.	P
	Automation can be achieved by, for example, robots, handling devices, transfer mechanisms and air-blast equipment. Mechanization can be achieved by, for example, feeding slides, push-rods and hand-operated indexing tables.	This requirement has been complied with by design.	P
	While automatic feeding and removal devices have much to offer in preventing accidents to machine operators, they can create danger when any faults are being corrected. Care shall be taken to ensure that the use of these devices does not introduce further hazards, such as trapping or crushing, between the devices and parts of the machine or workpieces/materials being processed. Suitable safeguards (see 6.3) shall be provided if this cannot be ensured.	This requirement has been complied with by design.	P
	Automatic feeding and removal devices with their own control systems and the control system of the associated machine shall be interconnected after thorough study of how all safety functions are performed in all the control and operation modes of the entire equipment.	This requirement has been complied with by design.	P
6.2.15	**Limiting exposure to hazards through location of setting and maintenance points**		

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	outside danger zones		
	The need for access to danger zones shall be minimized by locating maintenance, lubrication and setting points outside these zones.		P
6.3	**Safeguarding and complementary protective measures**		
6.3.1	**General**		
	Guards and protective devices shall be used to protect persons whenever an inherently safe design measure does not reasonably make it possible either to remove hazards or to sufficiently reduce risks. Complementary protective measures involving additional equipment (for example, emergency stop equipment) may have to be implemented. NOTE The different kinds of guards and protective devices are defined in 3.27 and 3.28.		P
6.3.2	**Selection and implementation of guards and protective devices**		
6.3.2.1	General		
	This subclause gives guidelines for the selection and the implementation of guards and protective devices the primary purpose of which is to protect persons against hazards generated by moving parts, according to the nature of those parts (see Figure 4) and to the need for access to the danger zone(s).		P
	The exact choice of a safeguard for a particular machine shall be made on the basis of the risk assessment for that machine.		P
	In selecting an appropriate safeguard for a particular type of machinery or hazard zone, it shall be borne in mind that a fixed guard is simple and shall be used where the access of an operator into a danger zone is not required		P

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	during the normal operation (operation without malfunction) of the machinery.		
	As the need for frequency of access increases, this inevitably leads to the fixed guard not being replaced.	Movable interlocking guard is used.	P
	This requires the use of an alternative protective measure (movable interlocking guard, sensitive protective equipment).		N/A
	A combination of safeguards can sometimes be required. For example, where, in conjunction with a fixed guard, a mechanical loading (feeding) device is used to feed a workpiece into a machine, thereby removing the need for access to the primary hazard zone, a trip device can be required to protect against the secondary drawing-in or shearing hazard between the mechanical loading (feeding) device, when reachable, and the fixed guard.		N/A
	Consideration shall be given to the enclosure of control positions or intervention zones to provide combined protection against several hazards including	This requirement has been taken in to consideration.	P
	a) hazards from falling or ejected objects, using, for example, protection in the form of a falling object protection structure (FOPS),	No such hazards exist in this machine.	P
	b) emission hazards (protection against noise, vibration, radiation, substances hazardous to health, etc.),	No such hazards exist in this machine.	P
	c) hazards due to the environment (protection against heat, cold, foul weather, etc.),	No such hazards exist in this machine.	P
	d) hazards due to tipping over or rolling over of machinery, using, for example, protection in the form of roll-over or tip-over protection structures (ROPS and TOPS).	No such hazards exist in this machine.	P
	The design of enclosed work stations, such as	Ergonomic principles have	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	cabs and cabins, shall take into account ergonomic principles concerning visibility, lighting, atmospheric conditions, access, posture.	been taken into account during design.	
6.3.2.2	Where access to the hazard zone is not required during normal operation		
	Where access to the hazard zone is not required during normal operation of the machinery, safeguards should be selected from the following:		
	a) fixed guards (see also ISO 14120);	Fixed guards are provided.	P
	b) interlocking guards with or without guard locking (see also 6.3.3.2.3, ISO 14119 and ISO 14120);	Not applicable.	N/A
	c) self-closing guards (see ISO 14120:2002, 3.3.2);	Not applicable.	N/A
	d) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496) or pressure-sensitive protective devices (see ISO 13856).	Not applicable.	N/A
6.3.2.3	Where access to the hazard zone is required during normal operation		
	Where access to the hazard zone is required during normal operation of the machinery, safeguards should be selected from the following:		
	a) interlocking guards with or without guard locking (see also ISO 14119, ISO 14120 and 6.3.3.2.3 of this document); b) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496); c) adjustable guards; d) self-closing guards (see ISO 14120:2002, 3.3.2);	Not applicable.	N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	e) two-hand control devices (see ISO 13851); f) interlocking guards with a start function (control guard) (see 6.3.3.2.5).		
6.3.2.4	Where access to the hazard zone is required for machine setting, teaching, process changeover, fault-finding, cleaning or maintenance		
	As far as possible, machines shall be designed so that the safeguards provided for the protection of the production operator also ensure the protection of personnel carrying out setting, teaching, process changeover, fault-finding, cleaning or maintenance, without hindering them in the performance of their task. Such tasks shall be identified and considered in the risk assessment as parts of the use of the machine (see 5.2).	Not applicable.	N/A
6.3.2.5	Selection and implementation of sensitive protective equipment1)		
6.3.2.5.1	Selection		
	Due to the great diversity of the technologies on which their detection function is based, all types of sensitive protective equipment are far from being equally suitable for safety applications. The following provisions are intended to provide the designer with criteria for selecting, for each application, the most suitable device(s).	Not applicable.	N/A
	Types of sensitive protective equipment include - light curtains, - scanning devices, for example, laser scanners, - pressure-sensitive mats, and - trip bars, trip wires.	Not applicable.	N/A
	Sensitive protective equipment can be used	Not applicable.	N/A
	- for tripping purposes,		
	- for presence sensing,		

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	- for both tripping and presence sensing, or		
	- to re-initiate machine operation		
	- a practice subject to stringent conditions.		
	The following characteristics of the machinery, among others, can preclude the sole use of sensitive protective equipment: - tendency for the machinery to eject materials or component parts; - necessity to guard against emissions (noise, radiation, dust, etc.); - erratic or excessive machine stopping time; - inability of a machine to stop part-way through a cycle.	Not applicable.	N/A
6.3.2.5.2	Implementation		
	Consideration should be given to a) the size, characteristics and positioning of the detection zone (see ISO 13855, which deals with the positioning of some types of sensitive protective equipment), b) the reaction of the device to fault conditions (see IEC 61496 for electrosensitive protective equipment), c) the possibility of circumvention, and d) detection capability and its variation over the course of time (as a result, for example, of its susceptibility to different environmental conditions such as the presence of reflecting surfaces, other artificial light sources and sunlight or impurities in the air).	Not applicable.	N/A
	Sensitive protective equipment shall be integrated in the operative part and associated with the control system of the machine so that - a command is given as soon as a person or part of a person is detected, - the withdrawal of the person or part of a	Not applicable.	N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	person detected does not, by itself, restart the hazardous machine function(s), and therefore the command given by the sensitive protective equipment is maintained by the control system until a new command is given, - restarting the hazardous machine function(s) results from the voluntary actuation by the operator of a control device placed outside the hazard zone, where this zone can be observed by the operator, - the machine cannot operate during interruption of the detection function of the sensitive protective equipment, except during muting phases, and - the position and the shape of the detection field prevents, possibly together with fixed guards, a person or part of a person from entering or being present in the hazard zone without being detected.		
6.3.2.5.3	Additional requirements for sensitive protective equipment when used for cycle initiation		
	In this exceptional application, the starting of the machine cycle is initiated by the withdrawal of a person or of the detected part of a person from the sensing field of the sensitive protective equipment, without any additional start command, hence deviating from the general requirement given in the second point of the dashed list in 6.3.2.5.2, above. After switching on the power supply, or when the machine has been stopped by the tripping function of the sensitive protective equipment, the machine cycle shall be initiated only by voluntary actuation of a start control.	Not applicable.	N/A
	Cycle initiation by sensitive protective	Not applicable.	N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	equipment shall be subject to the following conditions:		
	a) only active optoelectronic protective devices (AOPDs) complying with IEC 61496 series shall be used;	Not applicable.	N/A
	b) the requirements for an AOPD used as a tripping and presence-sensing device (see IEC 61496) are satisfied - in particular, location, minimum distance (see ISO 13855), detection capability, reliability and monitoring of control and braking systems;	Not applicable.	N/A
	c) the cycle time of the machine is short and the facility to re-initiate the machine upon clearing of the sensing field is limited to a period commensurate with a single normal cycle;	Not applicable.	N/A
	d) entering the sensing field of the AOPD(s) or opening interlocking guards is the only way to enter the hazard zone;	Not applicable.	N/A
	e) if there is more than one AOPD safeguarding the machine, only one of the AOPDs is capable of cycle re-initiation;	Not applicable.	N/A
	f) with regard to the higher risk resulting from automatic cycle initiation, the AOPD and the associated control system comply with a higher safety-related performance than under normal conditions.	Not applicable.	N/A
6.3.2.6	Protective measures for stability		
	If stability cannot be achieved by inherently safe design measures such as weight distribution (see 6.2.6), it shall be maintained by the use of protective measures such as		
	- anchorage bolts,		P
	- locking devices,		P
	- movement limiters or mechanical stops,		P
	- acceleration or deceleration limiters,		N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- load limiters,		P
	- alarms warning of the approach to stability or tipping limits.		N/A
6.3.2.7	Other protective devices		
	When a machine requires continuous control by the operator (for example, mobile machines, cranes) and an error of the operator can generate a hazardous situation, this machine shall be equipped with the necessary devices to enable the operation to remain within specified limits, in particular	Not applicable.	N/A
	- when the operator has insufficient visibility of the hazard zone,	Not applicable.	N/A
	- when the operator lacks knowledge of the actual value of a safety-related parameter (distance, speed, mass, angle, etc.),	Not applicable.	N/A
	- when hazards can result from operations other than those controlled by the operator.	Not applicable.	N/A
	The necessary devices include		
	a) devices for limiting parameters of movement (distance, angle, velocity, acceleration), b) overloading and moment limiting devices, c) devices to prevent collisions or interference with other machines, d) devices for preventing hazards to pedestrian operators of mobile machinery or other pedestrians, e) torque limiting devices, and breakage points to prevent excessive stress of components and assemblies, f) devices for limiting pressure or temperature, g) devices for monitoring emissions, h) devices to prevent operation in the absence of the operator at the control position, i) devices to prevent lifting operations unless	Not applicable.	N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	stabilizers are in place, j) devices to limit inclination of the machine on a slope, and k) devices to ensure that components are in a safe position before travelling.		
	Automatic protective measures triggered by such devices that take operation of the machinery out of the control of the operator (for example, automatic stop of hazardous movement) should be preceded or accompanied by a warning signal to enable the operator to take appropriate action (see 6.4.3).	Not applicable.	N/A
6.3.3	**Requirements for design of guards and protective devices**		
6.3.3.1	General requirements		
	Guards and protective devices shall be designed to be suitable for the intended use, taking into account mechanical and other hazards involved. Guards and protective devices shall be compatible with the working environment of the machine and designed so that they cannot be easily defeated.	Guards and protective devices have been appropriately designed.	P
	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 shall		
	a) be of robust construction,	This requirement has been taken into account during design.	P
	b) not give rise to any additional hazard,	This requirement has been taken into account during design.	P
	c) not be easy to bypass or render non-operational,	This requirement has been taken into account during design.	P
	d) be located at an adequate distance from the	This requirement has been taken into account during	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	danger zone (see ISO 13855 and ISO 13857),	design.	
	e) cause minimum obstruction to the view of the production process,	This requirement has been taken into account during design.	P
	f) enable essential work to be carried out for the installation and/or replacement of tools and for maintenance by allowing access only to the area where the work has to be carried out - if possible, without the guard having to be removed or protective device having to be disabled.	This requirement has been taken into account during design.	P
6.3.3.2	Requirements for guards		
6.3.3.2.1	Functions of guards		
	The functions that guards can achieve are		
	- prevention of access to the space enclosed by the guard, and/or - containment/capture of materials, workpieces, chips, liquids which can be ejected or dropped by the machine, and reduction of emissions (noise, radiation, hazardous substances such as dust, fumes, gases) that can be generated by the machine.	These functions are achieved by fixed guards	P
	Additionally, they could need to have particular properties relating to electricity, temperature, fire, explosion, vibration, visibility (see ISO 14120) and operator position ergonomics (for example, usability, operator's movements, postures, repetitive movements).	These functions are achieved by fixed guards	P
6.3.3.2.2	Requirements for fixed guards		
	Fixed guards shall be securely held in place either - permanently (for example by welding), or - by means of fasteners (screws, nuts) making removal/opening impossible without using tools; they should not remain closed without their fasteners (see ISO 14120).	All the fixed guards are securely held in place by appropriate fasteners.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.3.3.2.3	Requirements for movable guards		
	Movable guards which provide protection against hazards generated by moving transmission parts shall	Not applicable.	N/A
	a) as far as possible when open remain fixed to the machinery or other structure (generally by means of hinges or guides), and		
	b) be interlocking (with guard locking when necessary) (see ISO 14119). See Figure 4.		
	Movable guards against hazards generated by non-transmission moving parts shall be designed and associated with the machine control system so that		
	- moving parts cannot start up while they are within the operator's reach and the operator cannot reach moving parts once they have started up, with this able to be achieved by interlocking guards, with guard locking when necessary,		
	- they can be adjusted only by an intentional action, such as the use of a tool or a key, and		
	- the absence or failure of one of their components either prevents starting of the moving parts or stops them, with this able to be achieved by automatic monitoring (see 6.2.11.6).		
6.3.3.2.4	Requirements for adjustable guards		
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed. Manually adjustable guards shall be - designed so that the adjustment remains fixed during a given operation, and - readily adjustable without the use of tools.	Not applicable.	N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.3.3.2.5	Requirements for interlocking guards with a start function (control guards)		
	An interlocking guard with a start function may only be used provided that a) all requirements for interlocking guards are satisfied (see ISO 14119), b) the cycle time of the machine is short, c) the maximum opening time of the guard is preset to a low value (for example, equal to the cycle time) and, when this time is exceeded, the hazardous function(s) cannot be initiated by the closing of the interlocking guard with a start function and resetting is necessary before restarting the machine, d) the dimensions or shape of the machine do not allow a person, or part of a person, to stay in the hazard zone or between the hazard zone and the guard while the guard is closed (see ISO 14120), e) all other guards, whether fixed (removable type) or movable, are interlocking guards, f) the interlocking device associated with the interlocking guard with a start function is designed such that - for example, by duplication of position detectors and use of automatic monitoring (see 6.2.11.6) - its failure cannot lead to an unintended/unexpected start-up, and g) the guard is securely held open (for example, by a spring or counterweight) such that it cannot initiate a start while falling by its own weight.	Not applicable.	N/A
6.3.3.2.6	Hazards from guards		
	Care shall be taken to prevent hazards which could be generated by	No such hazards exist in this machine.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- the guard construction (sharp edges or corners, material, noise emission, etc.), - the movements of the guards (shearing or crushing zones generated by power-operated guards and by heavy guards which are liable to fall).		
6.3.3.3	Technical characteristics of protective devices		
	Protective devices shall be selected or designed and connected to the control system such that correct implementation of their safety function(s) is ensured.	This requirement has been taken into account during design.	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.	This requirement has been taken into account during design.	P
	Protective devices shall be installed and connected to the control system so that they cannot be easily defeated.	This requirement has been taken into account during design.	P
6.3.3.4	Provisions for alternative types of safeguards		
	Provisions should be made to facilitate the fitting of alternative types of safeguards on machinery where it is known that it will be necessary to change the safeguards because of the range of work to be carried out.	Not applicable.	N/A
6.3.4	Safeguarding to reduce emissions		
6.3.4.1	General		
	If the measures for the reduction of emissions at source specified in 6.2.2.2 are not adequate, the machine shall be provided with additional protective measures (see 6.3.4.2 to 6.3.4.5).		P
6.3.4.2	Noise		
	Additional protective measures against noise	No such hazards exist in	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	include - enclosures (see ISO 15667), - screens fitted to the machine, and - silencers (see ISO 14163).	this machine.	
6.3.4.3	Vibration		
	Additional protective measures against vibration include - vibration isolators, such as damping devices placed between the source and the exposed person, - resilient mounting, and - suspended seats. For measures for vibration isolation of stationary industrial machinery see EN 1299.	No such hazards exist in this machine.	P
6.3.4.4	Hazardous substances		
	Additional protective measures against hazardous substances include - encapsulation of the machine (enclosure with negative pressure), - local exhaust ventilation with filtration, - wetting with liquids, and – special ventilation in the area of the machine (air curtains, cabins for operators).	No such hazards exist in this machine.	P
6.3.4.5	Radiation		
	Additional protective measures against radiation include - use of filtering and absorption, and - use of attenuating screens or guards.	No such hazards exist in this machine.	P
6.3.5	**Complementary protective measures**		
6.3.5.1	General		
	Protective measures which are neither inherently safe design measures, nor safeguarding (implementation of guards and/or protective devices), nor information for use, could have to be implemented as required by		P

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	the intended use and the reasonably foreseeable misuse of the machine. Such measures include, but are not limited to, those dealt with in 6.3.5.2 to 6.3.5.6.		
6.3.5.2	Components and elements to achieve emergency stop function		
	If, following a risk assessment, a machine needs to be fitted with components and elements to achieve an emergency stop function for enabling actual or impending emergency situations to be averted, the following requirements apply:		
	- the actuators shall be clearly identifiable, clearly visible and readily accessible;	The actuators can be clearly identifiable, clearly visible and readily accessible	P
	- the hazardous process shall be stopped as quickly as possible without creating additional hazards, but if this is not possible or the risk cannot be reduced, it should be questioned whether implementation of an emergency stop function is the best solution;	The hazardous process can be stopped as quickly as possible without creating additional hazards	P
	- the emergency stop control shall trigger or permit the triggering of certain safeguard movements where necessary.	No this situation exists.	P
	Once active operation of the emergency stop device has ceased following an emergency stop command, the effect of this command shall be sustained until it is reset.	Reset is necessary before re-start.	P
	This reset shall be possible only at the location where the emergency stop command has been initiated. The reset of the device shall not restart the machinery, but shall only permit restarting.	This requirement is complied with by appropriate design of the emergency stop.	
	More details for the design and selection of electrical components and elements to achieve the emergency stop function are provided in	Please see the related clauses.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	IEC 60204.		
6.3.5.3	Measures for the escape and rescue of trapped persons		
	Measures for the escape and rescue of trapped persons may consist, among others, of - escape routes and shelters in installations generating operator-trapping hazards, - arrangements for moving some elements by hand, after an emergency stop, - arrangements for reversing the movement of some elements, - anchorage points for descender devices, - means of communication to enable trapped operators to call for help.	Not applicable.	N/A
6.3.5.4	Measures for isolation and energy dissipation		
	Machines shall be equipped with the technical means to achieve isolation from power supply(ies) and dissipation of stored energy by means of the following actions:		
	a) isolating (disconnecting, separating) the machine (or defined parts of the machine) from all power supplies;	A main switch with lock is provided	P
	b) locking (or otherwise securing) all the isolating units in the isolating position;	Please see the report for EN60204	P
	c) dissipating or, if this is not possible or practicable, restraining (containing) any stored energy which can give rise to a hazard;	Please see the report for EN60204	P
	d) verifying, by means of safe working procedures, that the actions taken according to a), b) and c) above have produced the desired effect.	Please see the report for EN60204	P
6.3.5.5	Provisions for easy and safe handling of machines and their heavy component parts		
	Machines and their component parts which cannot be moved or transported by hand shall	Appropriate attachments are provided.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	be provided or be capable of being provided with suitable attachment devices for transport by means of lifting gear.		
	These attachments may be, among others,		
	- standardized lifting appliances with slings, hooks, eyebolts, or tapped holes for appliance fixing,	Such devices are used	P
	- appliances for automatic grabbing with a lifting hook when attachment is not possible from the ground,		N/A
	- fork locating devices for machines to be transported by a lift truck,	Such devices are used	P
	- lifting and stowing gear and appliances integrated into the machine.		N/A
	Parts of machinery which can be removed manually in operation shall be provided with means for their safe removal and replacement.		P
6.3.5.6	Measures for safe access to machinery		
	Machinery shall be so designed as to enable operation and all routine tasks relating to setting and/or maintenance to be carried out as far as possible by a person remaining at ground level.		P
	Where this is not possible, machines shall have built-in platforms, stairs or other facilities to provide safe access for those tasks; however, care should be taken to ensure that such platforms or stairs do not give access to danger zones of machinery.	Not applicable.	N/A
	The walking areas shall be made from materials which remain as slip resistant as practicable under working conditions and, depending on the height from the ground, shall be provided with suitable guard-rails (see ISO 14122-3).		N/A
	In large automated installations, particular attention shall be given to safe means of		N/A

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	access, such as walkways, conveyor bridges or crossover points.		
	Means of access to parts of machinery located at height shall be provided with collective means of protection against falls (for example, guard-rails for stairways, stepladders and platforms and/or safety cages for ladders).		N/A
	As necessary, anchorage points for personal protective equipment against falls from height shall also be provided (for example, in carriers of machinery for lifting persons or with elevating control stations).		N/A
	Openings shall, whenever possible, open towards a safe position.		N/A
	They shall be designed to prevent hazards due to unintended opening. The necessary aids for access shall be provided (steps, handholds, etc.).		N/A
	Control devices shall be designed and located to prevent their being used as aids for access.		N/A
	When machinery for lifting goods and/or persons includes landings at fixed levels, these shall be equipped with interlocking guards for preventing falls when the platform is not present at a level. Movement of the lifting platform shall be prevented while the guards are open.		N/A
6.4	**Information for use**		-
6.4.1	**General requirements**		-
6.4.1.1	Drafting information for use is an integral part of the design of a machine (see Figure 2). Information for use consists of communication links, such as texts, words, signs, signals, symbols or diagrams, used separately or in combination to convey information to the user.	All the information is stated in the appropriate place.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Information for use is intended for professional and/or non-professional users.		
6.4.1.2	Information shall be provided to the user about the intended use of the machine, taking into account, notably, all its operating modes.		
	The information shall contain all directions required to ensure safe and correct use of the machine. With this in view, it shall inform and warn the user about residual risk.	All the information is stated in the instruction manual.	P
	The information shall indicate, as appropriate,		
	- the need for training, - the need for personal protective equipment, and - the possible need for additional guards or protective devices (see Figure 2, Footnote d).	All the information is stated in the instruction manual.	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.	All the information is stated in the appropriate place.	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.	All the information is stated in the instruction manual.	P
6.4.2	**Location and nature of information for use**		
	Depending on the risk, the time when the information is needed by the user and the machine design, it shall be decided whether the		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	information — or parts thereof — are to be given		
	a) in/on the machine itself (see 6.4.3 and 6.4.4),	Adequate information is stated in the instruction manual.	P
	b) in accompanying documents (in particular instruction handbook, see 6.4.5),	Adequate information is stated in the instruction manual.	P
	c) on the packaging,	Adequate information is stated in the instruction manual.	P
	d) by other means such as signals and warnings outside the machine.	Adequate information is stated in the instruction manual.	P
	Standardized phrases shall be considered where important messages such as warnings are given (see also IEC 62079).		P
6.4.3	**Signals and warning devices**		
	Visual signals, such as flashing lights and audible signals such as sirens may be used to warn of an impending hazardous event such as machine start-up or overspeed. Such signals may also be used to warn the operator before the triggering of automatic protective measures (see 6.3.2.7).	Signals and warning devices are provided.	P
	It is essential that these signals		
	a) be emitted before the occurrence of the hazardous event, b) be unambiguous, c) be clearly perceived and differentiated from all other signals used, and d) be clearly recognized by the operator and other persons.	This requirement is taken into account during design and selection of the warning devices.	P
	The warning devices shall be designed and		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	located such that checking is easy. The information for use shall prescribe regular checking of warning devices.		
	The attention of designers is drawn to the possibility of “sensorial saturation”, which can result from too many visual and/or acoustic signals and which can also lead to defeating the warning devices.		P
6.4.4	**Markings, signs (pictograms) and written warnings**		
	Machinery shall bear all markings which are necessary		
	a) for its unambiguous identification, including at least		
	1) the name and address of the manufacturer, 2) the designation of series or type, and 3) the serial number, if any,	Adequate information is provided.	P
	b) in order to indicate its compliance with mandatory requirements, comprising		
	1) marking, and 2) written indications, such as the authorized representative of the manufacturer, designation of the machinery, year of construction, and intended use in potentially explosive atmospheres),	Adequate information is provided.	P
	c) for its safe use, for example,		
	1) maximum speed of rotating parts,	Adequate information is provided.	P
	2) maximum diameter of tools,		
	3) mass (in kilograms) of the machine itself and/or of removable parts,		
	4) maximum working load,		
	5) necessity of wearing personal protective equipment,		

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	6) guard adjustment data, and		
	7) frequency of inspection.		
	Information printed directly on the machine should be permanent and remain legible throughout the expected life of the machine.	This requirement is complied with.	P
	Signs or written warnings indicating only “Danger” shall not be used.	This requirement is complied with.	P
	Markings, signs and written warnings shall be readily understandable and unambiguous, especially as regards the part of the function(s) of the machine to which they are related. Readily understandable signs (pictograms) should be used in preference to written warnings.	This requirement is complied with.	P
	Signs and pictograms should only be used if they are understood in the culture in which the machinery is to be used.	This requirement is complied with.	P
	Markings shall comply with recognized standards (for example, ISO 2972 or ISO 7000, for pictograms, symbols and colours in particular).	All the markings are standard.	P
6.4.5	**Accompanying documents (in particular - instruction handbook)**		
6.4.5.1	Contents		
	The instruction handbook or other written instructions (for example, on the packaging) shall contain, among others, the following:	All the related information is stated in the instruction handbook	P
	a) information relating to transport, handling and storage of the machine, such as		
	1) storage conditions for the machine, 2) dimensions, mass value(s), position of the centre(s) of gravity, and 3) indications for handling (for example, drawings indicating application points for lifting equipment); b) information relating to installation and	All the related information is stated in the instruction handbook	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	commissioning of the machine, such as		
	1) fixing/anchoring and dampening of noise and vibration requirements, 2) assembly and mounting conditions, 3) space needed for use and maintenance, 4) permissible environmental conditions (for example, temperature, moisture, vibration, electromagnetic radiation), 5) instructions for connecting the machine to power supply (particularly on protection against electrical overloading), 6) advice on waste removal/disposal, and 7) if necessary, recommendations related to protective measures which have to be implemented by the user — for example, additional safeguards (see Figure 2, Footnote d), safety distances, safety signs and signals;	All the related information is stated in the instruction handbook	P
	c) information relating to the machine itself, such as 1) detailed description of the machine, its fittings, guards and/or protective devices, 2) the comprehensive range of applications for which the machine is intended, including prohibited usages, if any, taking into account variations of the original machine if appropriate, 3) diagrams (especially schematic representation of safety functions), 4) data on noise and vibration generated by the machine, and on radiation, gases, vapours and dust emitted by it, with reference to the measuring methods (including measurement uncertainties) used, 5) technical documentation of electrical equipment (see IEC 60204), and 6) documents attesting that the machine complies with mandatory requirements;	All the related information is stated in the instruction handbook	P
	d) information relating to the use of the machine, such as that related to or describing		
	1) intended use,	All the related information is	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	2) manual controls (actuators), 3) setting and adjustment, 4) modes and means for stopping (especially emergency stop), 5) risks which could not be eliminated by the protective measures implemented by the designer, 6) particular risks which can be generated by certain applications, by the use of certain fittings, and about specific safeguards necessary for such applications, 7) reasonably foreseeable misuse and prohibited applications, 8) fault identification and location, for repair and for restarting after an intervention, and 9) personal protective equipment needed to be used and the training that is required; e) information for maintenance, such as 1) the nature and frequency of inspections for safety functions, 2) specification of the spare parts to be used when these can affect the health and safety of operators,	stated in the instruction handbook All the related information is stated in the instruction handbook	P
	3) instructions relating to maintenance operations which require a definite technical knowledge or particular skills and hence need to be carried out exclusively by skilled persons (for example, maintenance staff, specialists), 4) instructions relating to maintenance actions (replacement of parts, etc.) which do not require specific skills and hence may be carried out by users (for example, operators), and 5) drawings and diagrams enabling maintenance personnel to carry out their task rationally (especially fault-finding tasks);		

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	f) information relating to dismantling, disabling and scrapping;	All the related information is stated in the instruction handbook	P
	g) information for emergency situations, such as 1) the operating method to be followed in the event of accident or breakdown, 2) the type of fire-fighting equipment to be used, and 3) a warning of possible emission or leakage of hazardous substance(s) and, if possible, an indication of means for fighting their effects;	All the related information is stated in the instruction handbook	P
	h) maintenance instructions provided for skilled persons [item e) 3) above] and maintenance instructions provided for unskilled persons [item e) 4) above], that need to appear clearly separated from each other.	All the related information is stated in the instruction handbook	P
6.4.5.2	Production of instruction handbook		
	The following applies to the production and presentation of the instruction handbook.		
	a) The type fount and size of print shall ensure the best possible legibility. Safety warnings and/or cautions should be emphasized by the use of colours, symbols and/or large print. b) The information for use shall be given in the language(s) of the country in which the machine will be used for the first time and in the original version. If more than one language is to be used, each should be readily distinguished from another, and efforts should be made to keep the translated text and relevant illustration together.. NOTE In some countries the use of specific language(s) is covered by legal requirements	All the related information is stated in the instruction handbook	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	c) Whenever helpful to the understanding, text should be supported by illustrations. These illustrations should be supplemented with written details enabling, for example, manual controls (actuators) to be located and identified. They should not be separated from the accompanying text and should follow sequential operations. d) Consideration should be given to presenting information in tabular form where this will aid understanding. Tables should be adjacent to the relevant text. e) The use of colours should be considered, particularly in relation to components requiring quick identification. f) When information for use is lengthy, a table of contents and/or an index should be provided. g) Safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator.		
6.4.5.3	Drafting and editing information for use		
	The following applies to the drafting and editing of information for use.		
	a) Relationship to model: the information shall clearly relate to the specific model of machine and, if necessary, other appropriate identification (for example, by serial number). b) Communication principles: when information for use is being prepared, the communication process “see – think – use” should be followed in order to achieve the maximum effect and should follow sequential operations. The questions, “How?” and “Why?” should be anticipated and the answers provided.	All the related information is stated in the instruction handbook	P
	c) Information for use shall be as simple and as		

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	brief as possible, and should be expressed in consistent terms and units with a clear explanation of unusual technical terms. d) When it is foreseen that a machine will be put to non-professional use, the instructions should be written in a form that is readily understood by the non-professional user. If personal protective equipment is required for the safe use of the machine, clear advice should be given, for example, on the packaging as well as on the machine, so that this information is prominently displayed at the point of sale. e) Durability and availability of the documents: documents giving instructions for use should be produced in durable form (i.e. they should be able to survive frequent handling by the user). It can be useful to mark them “keep for future reference”. Where information for use is kept in electronic form (CD, DVD, tape, hard disk, etc.), information on safety-related issues that need immediate action shall always be backed up with a hard copy that is readily available.		
7	**Documentation of risk assessment and risk reduction**		
	The documentation shall demonstrate the procedure that has been followed and the results that have been achieved. This includes, when relevant, documentation of		
	a) the machinery for which the risk assessment has been made (for example, specifications, limits, intended use); b) any relevant assumptions that have been made (loads, strengths, safety factors, etc.); c) the hazards and hazardous situations	Please see the risk assessment report in detail.	P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	identified and the hazardous events considered in the risk assessment; d) the information on which risk assessment was based (see 5.2): 1) the data used and the sources (accident histories, experience gained from risk reduction applied to similar machinery, etc.); 2) the uncertainty associated with the data used and its impact on the risk assessment; e) the risk reduction objectives to be achieved by protective measures; f) the protective measures implemented to eliminate identified hazards or to reduce risk; g) residual risks associated with the machinery; h) the result of the risk assessment (see Figure 1); i) any forms completed during the risk assessment. Standards or other specifications used to select protective measures referred to in f) above should be referenced.		

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
1	Essential health and safety requirements		-
1.1	General remarks		-
1.1.1	Definitions		-
1.1.2	Principles of safety integration		-
a)	Machinery must be designed and constructed so that it is fitted for its function, and can be operated, adjusted and maintained without putting persons at risk when these operations are carried out under the conditions foreseen but also taking into account any reasonably foreseeable misuse thereof.	All the machines are fitted for the function. Enough protection is provided.	P
	The aim of measures taken must be to eliminate any risk throughout the foreseeable lifetime of the machinery including the phases of transport, assembly, dismantling, disabling and scrapping.	These requirements have been complied with.	P
b)	In selecting the most appropriate methods, the manufacturer or his authorized representative must apply the following principles, in the order given:	-	
	- eliminate or reduce risks as far as possible (inherently safe machinery design and construction)	Manufacturer has provided enough safety devices to eliminate or reduce risks.	Pass
	- take the necessary protective measures in relation to risks that cannot be eliminated.	Safety guards and other devices are used.	P
	- inform users of the residual risks due to any shortcomings of the protective measures adopted, indicate whether any particular training is required and specify any need to provide personal protective equipment.	Enough warnings are provided in the appropriate spot	P
c)	When designing and constructing machinery, and when drafting the instruction, the manufacturer must envisage not the normal use of the machinery but also uses which could reasonably be expected	All the conditions are considered by the manufacturer, and the related information also has been provided within the instruction manual	P
	The machinery must be designed to prevent abnormal use if such use would engender a risk In	These requirements have been complied with, and the related information also has been provided within the	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	other cases the instructions must draw the user's attention to ways which experience has shown might occur-in which the machinery should not be used	instruction manual.	
d)	Machinery must be designed and constructed to take account of the constraints to which the operator is subject as a result of the necessary or foreseeable use of personal protective equipment.	These requirements have been taken into account during the design of this machine	P
e)	Machinery must be supplied with all the special equipment and accessories essential to enable it to be adjusted, maintained and used safely.	These requirements have been taken into account during the design of this machine	P
1.1.3	Materials and products	-	
	The materials used to construct machinery or products used or created during its use must not endanger persons' safety or health. In particular, where fluids are used, machinery must be designed and constructed to prevent risks due to filling, use, recovery or draining.	They cannot endanger exposed person's safety or health	P
1.1.4	Lighting		-
	Machinery must be supplied with integral lighting suitable for the operations concerned where the absence thereof is likely to cause a risk despite ambient lighting of normal intensity	No integral lighting has been used.	N/A
	Machinery must be designed and constructed so that there is no area of shadow likely to cause nuisance, that there is no irritating dazzle and that there are no dangerous stroboscopic effects on moving parts due to the lighting.	No integral lighting has been used.	N/A
	Internal parts requiring frequent inspection, and adjustment and maintenance areas, must be provided with appropriate lighting	No integral lighting has been used.	
1.1.5	Design of machinery to facilitate its handling		-
	Machinery or each component part thereof must:		-
	- be capable of being handled and transported	Enough measures have been taken to ensure the safe of	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	safely.	the handling.	
	- be packaged or designed so that it can be stored safely and without damage	The machine can be stored in wood box safely and without damage.	P
	During the transportation of the machinery and/or its component parts, there must be no possibility of sudden movements or of hazards due to instability as long as the machinery and/or its component parts are handled in accordance with the instructions.		
	Where the weight, size or shape of machinery or its various component parts prevents them from being moved by hand, the machinery or each components must:	-	-
	- either be fitted with attachments for lifting gear, or	Not applicable	N/A
	- be designed so that it can be fitted with such attachments, or	Not applicable	N/A
	be shaped in such a way that standard lifting gear can easily be attached	Not applicable	N/A
	Where machinery or one of its component parts is to be moved by hand, it must:	-	-
	either be easily movable, or	Not applicable	N/A
	be equipped for picking up and moving in complete safety.	Not applicable	N/A
	Special arrangement must be made for the handling of tools and/or machinery parts, even if lightweight, which could be dangerous	Not applicable	N/A
1.1.6	Ergonomics	-	-
	Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as:	-	-
	allowing for the variability of the operator's physical dimensions, strength and stamina		Pass

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	providing enough space for movements of the parts of the operator's body		Pass
	avoiding a machine-determined work rate		Pass
	avoiding monitoring that requires lengthy concentration,		Pass
	adapting the man/machinery interface to the foreseeable characteristics of the operators.		Pass
1.1.7	Operating positions		-
	The operating position must be designed and constructed in such a way as to avoid any risk due to exhaust gases and/or lack of oxygen	Not applicable	N/A
	If the machinery is intended to be used in a hazardous environment presenting risks to the health and safety of the operator or if the machinery itself gives rise to a hazardous environment, adequate means must be provided to ensure that the operator has good working conditions and is protected against any foreseeable hazards.	This machinery is not to be used in a hazardous environment	N/A
	Where appropriate, the operating position must be fitted with an adequate cabin designed, constructed and/or equipped to fulfil the above requirements. The exit must allow rapid evacuation. Moreover, when applicable, an emergency exit must be provided in a direction which is different from the usual exit.	Not applicable	N/A
1.1.8	Seating	-	-
	Where appropriate and where the working conditions so permit, work stations constituting an integral part of the machinery must be designed for the installation of seats.	Not applicable	N/A
	If the operator is intended to sit during operation and the operating position is an integral part of the machinery, the seat must be provided with the machinery.	Not applicable	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	The operator's seat must enable him to maintain a stable position. Furthermore, the seat and its distance from the control devices must be capable of being adapted to the operator.	Not applicable	N/A
	If the machinery is subject to vibrations, the seat must be designed and constructed in such a way as to reduce the vibrations transmitted to the operator to the lowest level that is reasonably possible. The seat mountings must withstand all stresses to which they can be subjected. Where there is no floor beneath the feet of the operator, footrests covered with a slip-resistant material must be provided.	Not applicable	N/A
1.2	Control Systems	-	-
1.2.1	Safety and reliability of control systems	-	-
	Control systems must be designed and constructed in such a way as to prevent hazardous situations from arising.	The control system for this machine is safe and reliable by appropriate designing	P
	Above all they must be designed and constructed:	-	
	they can withstand the intended operating stresses and external influences,	The control system can withstand related effects during normal operation.	P
	a fault in the hardware or the software of the control system does not lead to hazardous situations	Any error in logic doesn’t lead to dangerous situations.	P
	errors in the control system logic do not lead to hazardous situations		P
	reasonably foreseeable human error during operation does not lead to hazardous situations		P
	Particular attention must be given to the following points:	-	-
	the machinery must not start unexpectedly		P
	the parameters of the machinery must not change in an uncontrolled way, where such change may lead to hazardous situations		P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	the machinery must not be prevented from stopping if the stop command has already been given		P
	no moving part of the machinery or piece held by the machinery must fall or be ejected		P
	automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded		P
	the protective devices must remain fully effective or give a stop command		P
	the safety-related parts of the control system must apply in a coherent way to the whole of an assembly of machinery and/or partly completed machinery		P
	For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss of communication.		P
1.2.2	Control devices	-	-
	Control devices must be:	-	-
	clearly visible and identifiable, using pictograms where appropriate	Appropriate lables and markings are provided This requirement has been complied with.	P
	positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity	Appropriate positions have been taken into account during design.	P
	designed in such a way that the movement of the control device is consistent with its effect	Movement of the control is consistent with its effect	P
	located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant	All control devices have been located outside the danger zones.	P
	positioned in such a way that their operation cannot cause additional risk	All operation of control devices ’tcause additional risk.	P
	designed or protected in such a way that the desired effect, where a hazard is involved, can only be achieved by a deliberate action	appropriate safety devices have been used to comply with this requirement.	P
	made in such a way as to withstand foreseeable	All of them can withstand foreseeable	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces.	strain.	
	Where a control is designed and constructed to perform several different actions, namely where there is no one-to-one correspondence, the action to be performed must be clearly displayed and subject to confirmation where necessary	Not applicable.	N/A
	Controls must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles	These requirements have been taken into account during design.	P
	Constraints due to the necessary foreseeable use of personal protection equipment must be taken into account	Not applicable.	
	Machinery must be fitted with indicators as required for safe operation	The indicators have been provided.	P
	The operator must be able to read them from the control position	The indicators are clearly visible in the control position.	P
	From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone.	The danger zones are visible for the operator in the main control position.	P
	If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up.	Not applicable.	
	If necessary, means must be provided to ensure that the machinery can be controlled only from control positions located in one or more predetermined zones or locations.	Emergency stop, main switch and other related devices have been provided for the exposed person.	P
	Where there is more than one control position, the	Not applicable.	

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops.		
	When machinery has two or more operating positions, each position must be provided with all the required control devices without the operators hindering or putting each other into a hazardous situation.	Not applicable.	
1.2.3	Starting		-
	It must be possible to start machinery only by voluntary actuation of a control provided for the purpose	Devices preventing unintended strating have been provided.	P
	The same requirement applies:	-	-
	when restarting the machinery after stoppage, whatever the cause	Reset is necessary before restaring.	P
	when effecting a significant change in the operating conditions	These requirements have been complied with.	P
	However, the restarting of the machinery or a change in operating conditions may be effected by voluntary actuation of a device other than the control device provided for the purpose, on condition that this does not lead to a hazardous situation.	-	N/A
	For machinery functioning in automatic mode, the starting of the machinery, restarting after a stoppage, or a change in operating conditions may be possible without intervention, provided this does not lead to a hazardous situation.	Not applicable.	N/A
	Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to	Not applicable.	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.		
1.2.4	Stopping device	-	-
1.2.4.1	Normal stopping	-	-
	Machinery must be fitted with a control device whereby the machinery can be brought safely to a complete stop.	A normal stop control has been provided.	P
	Each workstation must be fitted with a control to stop some or all of the moving parts of the machinery, depending on the type of hazard, so that the machinery is rendered safe.	A normal stop control has been provided.	P
	The machinery's stop control must have priority over the start controls	It has priority over the start control.	P
	Once the machinery or its dangerous parts have stopped, the energy supply to the actuators concerned must be cut off.	The stops belong to the category 0, or category 1 stops.	P
1.2.4.2	Operational stop	-	
	Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained.	Not applicable.	
1.2.4.3	Emergency stop	-	
	Machinery must be fitted with one or more emergency stop devices to enable actual or impending danger to be averted.	These machines are fitted with one emergency stop devices.	P
	The following exceptions apply:	-	
	machinery in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken,	Not applicable.	
	portable hand-held and/or hand-guided	Not applicable.	

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	machinery.		
	The device must:	-	
	have clearly identifiable, clearly visible and quickly accessible control devices,	The emergency sop has red button, yellow background and maked with “emergency stop”	P
	stop the hazardous process as quickly as possible, without creating additional risks,	The emergency stop will stop the machine as soon as it is pressed and it will not create any additional hazards.	P
	where necessary, trigger or permit the triggering of certain safeguard movements.	Not applicable.	
	Once active operation of the emergency stop device has ceased following a stop command, that command must be sustained by engagement of the emergency stop device until that engagement is specifically overridden;	After the action of the emergency stop,machine can not be restarted until reset the emergency stop.	P
	it must not be possible to engage the device without triggering a stop command;	Operator should turn the emergency stop to disengage the device.	P
	it must be possible to disengage the device only by an appropriate operation, and disengaging the device must not restart the machinery but only permit restarting.	These specified requirements have been complied with.	P
	The emergency stop function must be available and operational at all times, regardless of the operating mode.		P
	Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.		P
1.2.4.4	Assembly of machinery	-	
	In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.	Not applicable.	

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
1.2.5	Mode selection	-	
	The control mode selected must override all other control systems with the exception of the emergency stop	The emergency stop is effective regardless of operating modes.	P
	If machinery has been designed and built to allow for its use in several control or operating modes presenting different safety levels, it must be fitted with a mode selector which can be locked in each position	Not applicable. No this kind of mode selectionhas been found.	
	Each position of the selector must correspond to a single operating or control mode	No this kind of mode selection has been found	N/A
	The selector may be replaced by another selection method which restricts the use of certain functions of the machinery or certain categories of operator	No this kind of mode selection has been found.	N/A
	If, for certain operations, the machinery must be able to operate with its protection devices neutralized, the mode selector must simultaneously:	No this kind of mode selection has been found.	N/A
	disable the automatic control mode	Not applicable.	N/A
	permit movements only by controls requiring sustained action	Not applicable.	N/A
	permit the operation of dangerous moving parts only in enhanced safety conditions while preventing hazards from linked sequences	Not applicable.	N/A
	prevent any movement liable to pose a danger by acting voluntarily or involuntarily on the machine’s internal sensors	Not applicable.	N/A
	If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone.	Not applicable.	N/A
	In addition, the operator must be able to control operation of the parts he is working on at the	No this kind of mode selectionhas been found.	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	adjustment point		
1.2.6	Failure of the power supply	-	
	The interruption, re-establishment after an interruption or fluctuation in whatever manner of the power supply to the machinery must not lead to a dangerous situations	No any dangerous situation has been found.	P
	Particular attention must be given to the following points:	-	-
	the machinery must not start unexpectedly	Reset is necessary before restarting the site control system in which the machine located.	P
	the parameters of the machinery must not change in an uncontrolled way when such change can lead to hazardous situations,		P
	the machinery must not be prevented from stopping if the command has already been given	The stop command has the priorityover all other devices	P
	no moving part of the machinery or piece held by the machinery must fall or be ejected	No such part is found.	P
	automatic or manual stopping of the moving parts whatever they may be must be unimpeded	Stopping of the moving partsis always effective.	P
	the protective devices must remain fully effective or give a stop command.	The protection devices remain effective after the failure of the power supply.	P
1.3	Protection against mechanical hazards	-	
1.3.1	Risk of Loss of Stability	-	
	Machinery and its components and fittings must be stable enough to avoid overturning, falling or uncontrolled movements during transportation, assembly, dismantling and any other action involving the machinery.	These requirements have been taken into account design	P
	If the shape of the machinery itself or its intended installation doesn’t offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions	The sufficient stability has been offered for this machine.	N/A
1.3.2	Risk of Break-up During Operation	-	

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	The various parts of machinery and their linkages must be able to withstand the stresses to which they are subject when used.	All parts of the machine can withstand related stress when they are used.	P
	The durability of the materials used must be adequate for the nature of the working environment foreseen by the manufacturer or his authorised representative, in particular as regards the phenomena of fatigue, ageing, corrosion and abrasion.	All materials used for this machine areappropriate for their intended useand have adequate life.	P
	The instructions must indicate the type and frequency of inspections and maintenance required for safety reasons.	The related information has been provided within the instruction manual.	P
	They must, where appropriate, indicate the parts subject to wear and the criteria for replacement.		P
	Where a risk of rupture or disintegration remains despite the measures taken, the parts concerned must be mounted, positioned and/or guarded in such a way that any fragments will be contained, preventing hazardous situations.	No such risk is possible.	N/A
	Both rigid and flexible pipes carrying fluids, particularly those under high pressure, must be able to withstand the foreseen internal and external stresses and must be firmly attached and/or protected to ensure that no risk is posed by a rupture.	Not applicable.	N/A
	Where the material to be processed is fed to the tool automatically, the following conditions must be fulfilled to avoid risks to the persons exposed:	-	-
	when the work piece comes into contact with the tool the later must have attained its normal working conditions,		P
	when the tool starts and/or stops (intentionally or accidentally), the feed movement and the tool movement must be coordinated.		P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
1.3.3	Risked due to falling or ejected objects	-	-
	Precautions must be taken to prevent risks from falling or ejected object	All the conditions has been considered.	P
1.3.4	Risks due to surfaces, edges or angles	-	
	In so far as their purpose allows, accessible parts of the machinery must have no sharp edges, no sharp angles, and no rough surfaces likely to cause injury	No this kind injury has been found.	P
1.3.5	Risks related to combined machinery	-	-
	Where the machinery is intended to carry out several different operations with manual removal of the piece between each operation (combined machinery), it must be designed and constructed in such a way as to enable each element to be used separately without the other elements constituting a risk for exposed persons.	No this kind of combined machinery.	N/A
	For this purpose, it must be possible to start and stop separately and elements that are not protected	No this kind of combined machinery.	N/A
1.3.6	Risks relating to variations in the rotation speeds of tools	-	-
	When the machine is designed to perform operations under different conditions of use, it must be designed and constructed in such a way that selection and adjustment of these conditions can be carried out safely and reliably	Not applicable.	N/A
1.3.7	Risks related to moving parts	-	
	The moving parts of machinery must be designed and constructed in such a way as to prevent risks of contact which could lead to accidents or must, where risks persist, be fitted with guards or protective devices.	This kind of hazards have been prevented by appropriate guards.	P
	All necessary steps must be taken to prevent accidental blockage of moving parts involved in	All necessary steps have been taken.	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	the work		
	In cases where, despite the precaution taken, a blockage is likely to occur, specific protection devices or tools, the instruction handbook and possibly a sign on the machinery should be provided by the manufacturer to enable the equipment to be safely unblocked	No this kind of need.	N/A
	The instructions and, where possible, a sign on the machinery shall identify these specific protective devices and how they are to be used.	Not applicable.	N/A
1.3.8	Choice of protection against risks arising from moving parts	-	-
	Guards or protection devices used to protect against the risks related to moving parts mustbe selected on the basis of the type of risk	It is in accordance with the risk assessment.	P
	The following guidelines must be used to help make the choice	-	-
1.3.8.1	Moving transmission parts	-	-
	Guards designed to protect exposed persons against the risks associated with moving transmission parts must be:	-	-
	either fixed guards as referred to in section 1.4.2.1, or	See the related clauses.	P
	interlocking movable guards as referred to in section 1.4.2.2.	See the related clauses.	P
	Interlocking movable guards should be used where frequent access is envisaged		P
1.3.8.2	Moving parts involved in the process	-	-
	Guards or protective devices designed to protect persons against the hazards generated by moving parts involved in the process must be:	-	-
	either fixed guards as referred to in section 1.4.2.1, or	See the related clauses.	P
	interlocking movable guards as referred to in	No this kind of situation.	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	section 1.4.2.2, or		
	protective devices as referred to in section 1.4.3, or	No this kind of situation.	N/A
	a combination of the above.		N/A
	However, when certain moving parts directly involved in the process cannot be made completely inaccessible during operation owing to operations requiring operator intervention, such parts must be fitted with:	-	-
	fixed guards or interlocking movable guards preventing access to those sections of the parts that are not used in the work, and	See the related clauses.	P
	adjustable guards as referred to in section 1.4.2.3 restricting access to those sections of the moving parts where access is necessary.	See the related clauses.	P
1.3.9	Risks of uncontrolled movements	-	-
	When a part of the machinery has been stopped, any drift away from the stopping position, for whatever reason other than action on the control devices, must be prevented or must be such that it does not present a hazard.		P
1.4	Required characteristics of guards and protection devices	-	-
1.4.1	General requirements	-	-
	Guards and protection devices must:	-	-
	be of robust construction	All the guards have enough strength.	P
	be securely held in place,	No additional risk is found.	P
	not give rise to any additional hazard,	All the guards can’t be bypassed orrendered non-operational by design.	P
	not be easy to by-pass or render non-operational	All the guards comply with the safety distances.	P
	be located at an adequate distance from the danger zone		P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	cause minimum obstruction to the view of the production process, and	Transparentmaterials are used to make guards.	P
	enable essential work to be carried out on the installation and/or replacement of tools and for maintenance purposes by restricting access exclusively to the area where the work has to be done, if possible without the guard having to be removed or the protective device having to be disabled	These requirements have been taken into account during design.	P
	In addition, guards must, where possible, protect against the ejection or falling of materials or objects and against emissions generated by the machinery.		P
1.4.2	Special requirements for guards	-	
1.4.2.1	Fixed guards	-	
	Fixed guards must be fixed by systems that can be opened or removed only with tools.	They all 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	Not applicable.	
	Where possible, guards must be unable to remain in place without their fixings	Not applicable.	
1.4.2.2	Interlocking Movable Guards	-	
	Interlocking movable guards must:	-	
	as far as possible remain fixed to the machinery when open	They remain fixed to the machine when open..	P
	be designed and constructed in such a way that they can be adjusted only by means of an intentional action.	The locking device has been used.	P
	Interlocking movable guards must be associated with an interlocking device that:	-	
	prevents the start of hazardous machinery functions until they are closed and	Interlocking switch is provided.	P
	gives a stop command whenever they are no		P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	longer closed.		
	Where it is possible for an operator to reach the danger zone before the risk due to the hazardous machinery functions has ceased, movable guards must be associated with a guard locking device.		P
	In addition to an interlocking device that:	-	
	prevents the start of hazardous machinery functions until the guard is closed and locked, and	This kind of situation doesn't exist.	P
	keeps the guard closed and locked until the risk of injury from the hazardous machinery functions has ceased.	This kind of situation doesn't exist.	P
	Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery functions.	This kind of situation doesn't exist.	P
1.4.2.3	Adjustable guards restricting access	-	-
	Adjustable guards restricting access to those areas of the moving parts strictly necessary for the work must be:	-	-
	adjustable manually or automatically depend on the type of work involved, and	Not applicable.	N/A
	readily adjustable without the use of tools	Not applicable.	N/A
1.4.3	Special requirements for protective devices	-	-
	Protection devices must be designed and incorporated into the control system in such a way that:	-	-
	moving parts can't start up while they are within the operator's reach	Not applicable.	N/A
	persons cannot reach moving parts while the parts are moving, and	Not applicable.	N/A
	the absence or failure of one of their components prevents starting or stops the moving parts.	Not applicable..	N/A
	Protective devices must be adjustable only by means of an intentional action	Not applicable.	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
1.5	Risks Due to other hazards	-	-
1.5.1	Electricity supply	-	-
	Where machinery has an electricity supply it must be designed, constructed and equipped so that all hazards of an electrical nature are or can be prevented	See the EN 60204-1 test report in detail.	P
	The safety objectives set out in Directive 73/23/EEC shall apply to machinery. However, the obligations concerning conformity assessment and the placing on the market and/or putting into service of machinery with regard to electrical hazards are governed solely by this Directive	See the EN 60204-1 test report in detail.	P
1.5.2	Static electricity		-
	Machinery must be so designed and constructed as to prevent or limit the build-up of potentially dangerous electrostatic changes and/or be fitted with a discharging system	See the EN 60204-1 test report in detail.	P
1.5.3	Energy supply other than electricity	-	-
	Where machinery is powered by an energy other than electricity, it must be so designed, constructed and equipped as to avoid all potential hazards associated with these types of energy	Not applicable.	N/A
1.5.4	Errors of fitting	-	
	Errors likely to be made when fitting or refitting certain parts which could be a source of risk must be made impossible by the design of such parts or, failing this, by information on moving parts and/or their housing where the direction of movement must be known to avoid a risk	These requirements have been taken into account during design.	P
	Where necessary, the instructions must give further information on these risks.	The related information has been provided within the instruction manual.	P
	Where a faulty connection can be the source of risk, incorrect connections must be made impossible by design or, failing this, by information	All related information have been provided within the instruction manual.Necessary lables and markings have been provided.	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	given on the elements to be connected and, where appropriate, on the means of connection.		
1.5.5	Extreme temperatures	-	
	Step must be taken to eliminate any risk of injury caused by contact with or proximity to machinery parts or materials at high or very low temperatures	No this kind of risk exists.	N/A
	The necessary steps must also be taken to avoid or protect against the risk of hot or very cold material being ejected.	No this kind of risk exists.	N/A
1.5.6	Fire	-	
	Machinery must be designed and constructed to avoid all risk of fire or overheating posed by the machinery itself or by gases, liquids, dusts, vapors or the other substances produced or used by the machinery	Not applicable.	N/A
1.5.7	Explosion	-	-
	Machinery must be designed and constructed in such a way as to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.	No such risk is exist	N/A
	Machinery must comply, as far as the risk of explosion due to its use in a potentially explosive atmosphere is concerned, with the provisions of the specific Community Directives.	No such risk is exist	N/A
1.5.8	Noise	-	
	Machinery must be so designed and constructed that risks resulting from the emission of airborne noise are reduced to the lowest level taking accounting of technical progress and the availability of means of reducing noise, in particular at source	The design and construction of this machine are in conformity with this requirements. Noise of this machine is not more than 72 db.	P
	The level of noise emission may be assessed with		P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	reference to comparative emission data for similar machinery.		
1.5.9	Vibrations	-	
	Machinery must be so designed and constructed that risks resulting from the vibrations produced by the machinery are reduced to the lowest level, taking account of technical progress and the availability of means of reducing vibration, in particular at source	The design and construction of this machine are in conformity with this requirements. Vibrationsof this machine will not creat any risk.	P
	The level of vibration emission may be assessed with reference to comparative emission data for similar machinery		P
1.5.10	Radiation	-	-
	Undesirable radiation emissions from the machinery must be eliminated or be reduced to levels that do not have adverse effects on persons.	Not applicable. No harmful emission of radiation has been found.	N/A
	Any functional ionising radiation emissions must be limited to the lowest level which is sufficient for the proper functioning of the machinery during setting, operation and cleaning. Where a risk exists, the necessary protective measures must be taken.	Not applicable.	N/A
	Any functional non-ionising radiation emissions during setting, operation and cleaning must be limited to levels that do not have adverse effects on persons	Not applicable.	N/A
1.5.11	External radiation	-	
	Machinery must be so designed and constructed that external radiation doesn’t interfere with its operation	The machine can withstand the external radiation by appropriate design and construction.	P
1.5.12	Laser Radiation	-	
	Where laser equipment is used, the following provisions should be taken into account;	No laser equipment has been used.	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	laser equipment on machinery must be designed and constructed so as to prevent any accidental radiation	Not applicable.	N/A
	laser equipment on machinery must be protected so that effective radiation, radiation produced by reflection or diffusion and secondary radiation don't damage health	Not applicable.	N/A
	optical equipment for the observation or adjustment of laser equipment on machinery must be such that no health risk is created by the laser rays	Not applicable.	N/A
1.5.13	Emissions of hazardous materials and substances	-	
	Machinery must be designed and constructed in such a way that risks of inhalation, ingestion, contact with the skin, eyes and mucous membranes and penetration through the skin of hazardous materials and substances which it produces can be avoided.	Adequate design and construction have been taken.	P
	Where a hazard cannot be eliminated, the machinery must be so equipped that hazardous materials and substances can be contained, evacuated, precipitated by water spraying, filtered or treated by another equally effective method.	Not applicable	N/A
	Where the process is not totally enclosed during normal operation of the machinery, the devices for containment and/or evacuation must be situated in such a way as to have the maximum effect.	All the conditions has been considered.	P
1.5.14	Risk of being trapped in a machine	-	
	Machinery must be designed, constructed or fitted with a means of preventing a person from being enclosed within it or, if that is impossible, with a means of summoning help.	Not applicable	
1.5.15	Risk of slipping, tripping or falling	-	

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	Parts of the machinery where persons are liable to move about or stand must be designed and constructed in such a way as to prevent persons slipping, tripping or falling on or off these parts.	Not applicable	
	Where appropriate, these parts must be fitted with handholds that are fixed relative to the user and that enable them to maintain their stability.	Not applicable	
1.5.16	Lightning	-	
	Machinery in need of protection against the effects of lightning while being used must be fitted with a system for conducting the resultant electrical charge to earth.	Not applicable	
1.6	Maintenance	-	-
1.6.1	Machinery maintenance	-	-
	Adjustment and maintenance points must be located outside danger zones.	The design and construction of this machine are in conformity with this requirement.	P
	It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill.	Maintenance, repair, cleaning and servicing, operations can only be implemented while machinery is at a standstill	P
	If one or more of the above conditions cannot be satisfied for technical reasons, measures must be taken to ensure that these operations can be carried out safely (see section 1.2.5).	No this kind of situation.	N/A
	In the case of automated machinery and, where necessary, other machinery, a connecting device for mounting diagnostic fault-finding equipment must be provided.	Some adequate provisions have been taken.	P
	Automated machinery components which have to be changed frequently must be capable of being removed and replaced easily and safely.	The related parts can be removed and replaced easily and in safety.	P
	Access to the components must enable these tasks to be carried out with the necessary technical means in accordance with a specified operating method.	All operation methods have been specified by the manufacturer.	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
1.6.2	Access to operating position and servicing points	-	
	Machinery must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during operation, adjustment and maintenance of the machinery.	Appropriate guards and safety control devices have been used.	P
1.6.3	Isolation of energy sources	-	
	Machinery must be fitted with means to isolate it from all energy sources.	The power switch has been used.	P
	Such isolators must be clearly identified	They are identified clearly.	P
	They must be capable of being locked if reconnection could endanger exposed persons	No this component used in the machine.	P
	The isolator must be capable of being locked also where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off	The isolator can be locked in the off position.	P
	In the case of machinery capable of being plugged into an electricity supply, removal of the plug is sufficient, provided that the operator can check from any of the points to which he has access that the plug remains removed.	Not applicable.	
	After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons.	All the parts will not be live after after the energy is cut off.	P
	As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.	No this kind of situation.	N/A
1.6.4	Operator intervention	-	-
	Machinery must be so designed, constructed and	The design and construction of this machine are in	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	equipped that the need for operator intervention is limited.	conformity with these requirements.	
	If operator intervention can't be avoided, it must be possible to carry it out easily and in safety	No this kind of situation.	N/A
1.6.5	Cleaning of internal parts		-
	The machinery must be designed and constructed in such a way that it is possible to clean internal parts which have contained dangerous substances or preparations without entering them; any necessary unblocking must also be possible from the outside.	The design of this machine is allowed to carried out this work.	P
	If it is impossible to avoid entering the machinery, it must be designed and constructed in such a way as to allow cleaning to take place safely.	No this kind of situation.	N/A
1.7	Information		-
1.7.1	Information and warnings on the machinery		-
	Information and warnings on the machinery should preferably be provided in the form of readily understandable symbols or pictograms.	The information is identified clearly and can be easily under understood.	P
	Any written or verbal information and warnings must be expressed in an official Community language or languages, which may be determined in accordance with the Treaty by the Member State in which the machinery is placed on the market and/or put into service and may be accompanied, on request, by versions in any other official Community language or languages understood by the operators.	The clause has been met.	P
1.7.1.1	Information and information devices	-	
	The information needed to control machinery must be provided in a form that is unambiguous and easily understood.	The clause has been met.	P
	It must not be excessive to the extent of overloading the operator.	The clause has been met.	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	Visual display units or any other interactive means of communication between the operator and the machine must be easily understood and easy to use.	The clause has been met.	P
1.7.1.2	Warning devices	-	
	Where the health and safety of persons may be endangered by a fault in the operation of unsupervised machinery, the machinery must be equipped in such a way as to give an appropriate acoustic or light signal as a warning.	Not applicable.	
	Where machinery is equipped with warning devices, these must be unambiguous and easily perceived	The warning devices comply with ergonomic principles.	P
	The operator must have facilities to check the operation of such warning devices at all times	Such facilities are provided.	P
	The requirements of the specific directives concerning colors and safety signals must be complied with	These requirements are complied with.	P
1.7.2	Warning of residual risks	-	
	Where risks remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted, the necessary warnings, including warning devices, must be provided.	No any residual risk has been found.	N/A
1.7.3	Marking of machinery		-
	All machinery must be marked legibly and indelibly with the following minimum particular		-
	the business name and full address of the manufacturer and, where applicable, his authorized representative	Name and address of the manufacturer as been marked in the nameplate.	P
	designation of the machinery		P
	the CE Marking (see Annex III)		P
	designation of series or type	Designation of series or type has been marked in the nameplate.	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	serial number, if any	Serial number has been marked in the nameplate.	P
	the year of construction, that is the year in which the manufacturing process is completed.		P
	It is prohibited to pre-date or post-date the machinery when affixing the CE marking.	Pre-date and post-date is excluded by internal check	Pass
	Furthermore, machinery designed and constructed for use in a potentially explosive atmosphere must be marked accordingly.	This machine is not intended to be used in a potentially explosive atmosphere.	N/A
	Machinery must also bear full information relevant to its type and essential for safe use. Such information is subject to the requirements set out in section 1.7.1.		P
	Where a machine part must be handled during use with lifting equipment, its mass must be indicated legible, indelibly and unambiguously	Not applicable.	
1.7.4	Instructions	-	
	All machinery must be accompanied by instructions in the official Community language or languages of the Member State in which it is placed on the market and/or put into service.	Chinese and English versions of the instruction manual is provided.	P
	The instructions accompanying the machinery must be either ‘Original instructions’ or a ‘Translation of the original instructions’, in which case the translation must be accompanied by the original instructions.		P
	By way of exception, the maintenance instructions intended for use by specialised personnel mandated by the manufacturer or his authorised representative may be supplied in only one Community language which the specialised personnel understand.		P
	The instructions must be drafted in accordance with the principles set out below:	-	

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
1.7.4.1	General principles for the drafting of instructions	-	
	The instructions must be drafted in one or more official Community languages. The words 'Original instructions' must appear on the language version(s) verified by the manufacturer or his authorized representative.	English	P
	Where no 'Original instructions' exist in the official language(s) of the country where the machinery is to be used, a translation into that/those language(s) must be provided by the manufacturer or his authorized representative or by the person bringing the machinery into the language area in question. The translations must bear the words 'Translation of the original instructions'.		P
	The contents of the instructions must cover not only the intended use of the machinery but also take into account any reasonably foreseeable misuse thereof.		P
	In the case of machinery intended for use by non-professional operators, the wording and layout of the instructions for use must take into account the level of general education and acumen that can reasonably be expected from such operators.		P
1.7.4.2	Contents of the instructions	-	
	Each instruction manual must contain, where applicable, at least the following information:	-	
	the business name and full address of the manufacturer and of his authorized representative;	All related information have been provided within the instruction manual	P
	the designation of the machinery as marked on the machinery itself, except for the serial number (see section 1.7.3);	All related information have been provided within the instruction manual.	P
	the EC declaration of conformity, or a document	All related information have been provided within the	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	setting out the contents of the EC declaration of conformity, showing the particulars of the machinery, not necessarily including the serial number and the signature;	instruction manual.	
	a general description of the machinery;	All related information have been provided within the instruction manual.	P
	the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning;	All related information have been provided within the instruction manual.	P
	a description of the workstation(s) likely to be occupied by operators;	All related information hasbeen provided within the instruction manual.	P
	a description of the intended use of the machinery;	All related information hasbeen provided within the instruction manual.	P
	warnings concerning ways in which the machinery must not be used that experience has shown might occur;		P
	assembly, installation and connection instructions, including drawings, diagrams and the means of attachment and the designation of the chassis or installation on which the machinery is to be mounted;		P
	instructions relating to installation and assembly for reducing noise or vibration;		P
	instructions for the putting into service and use of the machinery and, if necessary, instructions for the training of operators;		P
	information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted;		P
	instructions on the protective measures to be taken by the user, including, where appropriate, the personal protective equipment to be provided;	All related information has een provided within the instruction manual.	P

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	the essential characteristics of tools which may be fitted to the machinery;	English version of the instruction manual is provided.	P
	the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns;	An English version of the instruction manual is provided.	P
	instructions with a view to ensuring that transport, handling and storage operations can be made safely, giving the mass of the machinery and of its various parts where these are regularly to be transported separately;	The translation is done by the manufacture	P
	the operating method to be followed in the event of accident or breakdown; if a blockage is likely to occur, the operating method to be followed so as to enable the equipment to be safely unblocked;		P
	the description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed;	All related information has been provided within the instruction manual.	P
	instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;	No such situation exists.	P
	the specifications of the spare parts to be used, when these affect the health and safety of operators;	All related information hasbeen provided within the technical documentation.	P
	the following information on airborne noise emissions:	-	
	the A-weighted emission sound pressure level at workstations, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact must be indicated,	The noise pressure level is 72dB.	P
	the peak C-weighted instantaneous sound pressure value at workstations, where this	Not applicable.	N/A

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	exceeds 63 Pa (130 dB in relation to 20μPa),		
	the A-weighted sound power level emitted by the machinery, where the A-weighted emission sound pressure level at workstations exceeds 80 dB(A).	Not applicable.	N/A
	In the case of very large machinery, instead of the A-weighted sound power level, the A-weighted emission sound pressure levels at specified positions around the machinery may be indicated.	This machine is not a very large machinery.	N/A
	Where the harmonised standards are not applied, sound levels must be measured using the most appropriate method for the machinery.	Appropriate standards are applied to determine the sound level.	P
	Whenever sound emission values are indicated the uncertainties surrounding these values must be specified.	Not applicable.	
	The manufacturer must indicate the operating conditions of the machinery during measurement and what methods have been used for the measurement	All related information has been provided within the technical documentation.	P
	Where the workstation(s) are undefined or cannot be defined, A-weighted sound pressure levels must be measured at a distance of 1 metre from the surface of the machinery and at a height of 1.6 metres from the floor or access platform.	The workstation has been defined.	N/A
	The position and value of the maximum sound pressure must be indicated	It has been indicated in the appropriate position of the machine.	P
	Where specific Community Directives lay down other requirements for the measurement of sound pressure levels or sound power levels, those Directives must be applied and the corresponding provisions of this section shall not apply;	Not applicable.	
	where machinery is likely to emit non-ionising radiation which may cause harm to persons, in particular persons with active or non-active implantable medical devices, information	Not applicable.	

Essential Health and Safety Requirements			
Clause	Requirement – Test (Annex I in Directive 2006/42/EC Machinery)	Result - Remark	Verdict
	concerning the radiation emitted for the operator and exposed persons.		
1.7.4.3	Sales literature	-	
	Sales literature describing the machinery must not contradict the instructions as regards health and safety aspects.	All these requirements have been taken into account.	P
	Sales literature describing the performance characteristics of machinery must contain the same information on emissions as is contained in the instructions.	This information has been provided.	P
2	Essential health and safely requirements for certain categories of machinery		-
2.1	Foodstuffs machinery and machinery for cosmetics or pharmaceutical products		-
2.2	Portable hand-help and/or hand-guided machinery		-
2.3	Machinery for working wood and material with similar physical characteristics		
3	Essential health and safety requirement to offset the particular hazards due to the mobility machinery		-
4	Essential health and safety requirement to offset the particular hazards due to a lifting operation		-
5	Essential health and safety requirement for machinery intended for underground work		-
6	Essential health and safety requirement to offset the particular hazards due to the lifting or moving of persons		-

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Clause	Requirement - Test	Result - Remark	Verdict
4	**GENERAL REQUIREMENTS**		-
4.1	General		-
	Hazards relevant to the electrical equipment are assessed as part of the overall risk assessment of the machine.		P
4.2	Selection of equipment		P
4.2.1	Electrical components/devices suitable for their intended use and applied in accordance with supplier's instructions.		P
4.2.2	Where possible electrical equipment in compliance with the IEC 60439 series.		P
4.3	Electrical supply		P
4.3.1	Electrical equipment to be designed for correct operation within the conditions of mains power supply - as stated below (cl. 4.3.2 or 4.3.3)		P
	or as stated by the user (record specs in this TR)		N
	or as stated by the supplier[1]		P
4.3.2	AC supplies		P
	Supply Voltage: Steady state voltage: 0,9 ... 1,1 of nominal voltage	230V ~ 50Hz	P
	Frequency: 0,99 ... 1,01 of nominal frequency continuously; 0,98 ... 1,02 short time.		P
	Harmonics: not exceeding 10 % of the total r.m.s. etc.		P
	Voltage unbalance: not exceeding 2% deviation.		P
	Voltage interruption: interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1 s between successive interruptions.		P
	Voltage dips not exceeding 20 % of the peak voltage of the supply for more than one cycle with more than 1 s between successive dips.		P
4.3.3	DC supplies Supply Voltage: - other:0,85 to 1,15 of nominal voltage; - battery-operated vehicles: 0,7 to 1,2 of nom. volt. - from converting equipment: 0,9 to 1,1 of nom.		N N

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Clause	Requirement - Test	Result - Remark	Verdict
	volt.		
	Voltage interruption: - other: not exceeding 5 ms - converting equipment: not exceeding 20 ms Ripple (peak-to-peak): not exceed. 0,15 of nom. volt.		N N
4.3.4	Special supply systems; e.g. on board generators limits acc. 4.3.2 /.3 exceeded, but equipment designed acc. exceeded limits.		N
4.4	Physical environment and operating conditions		P
4.4.1	Electrical equipment suitable for the physical environment and operating conditions of its intended use.		P
4.4.2	Electromagnetic compatibility (EMC): Equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended operating environment and shall have a level of immunity to electromagnetic disturbances so that it can function in its intended environment (IEC 61000-6-1 or IEC 61000-6-2 and CISPR 61000-6-3 or IEC 61000-6-4 give general EMC emission and immunity limits.)		P
	Are there sufficient measures to limit the generation of electromagnetic disturbances, i.e. conducted and radiated provided? (E.g. power supply filtering; cable shielding; enclosures designed to minimize RF radiation; RF suppression techniques; design of functional bonding system, using conductors with low RF impedance and as short as practicable.		P
4.4.3	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. (Minimum requirement: air temperatures of +5 °C and +40 °C)		P
4.4.4	Electrical equipment shall be capable of operating correctly when the relative humidity is up to 50 % at a maximum temperature of +40 °C		P
4.4.5	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.		P
4.4.6	Electrical equipment shall be adequately		P

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Clause	Requirement - Test	Result - Remark	Verdict
	protected against the ingress of solids and liquids (see 11.3)		
4.4.7	Electrical equipment shall withstand ionizing and non-ionizing radiation.		P
4.4.8	Electrical equipment shall withstand vibration, shock and bump.		P
4.5	Electrical equipment designed to withstand the effects of transportation and storage within a temperature range of - 25 to + 55 °C.		P
4.6	Heavy or bulky electrical equipment of the machine provided with suitable means for handling.		P
4.7	Electrical equipment is installed and operated in accordance with the supplier’s instruction.		P
5	**INCOMING SUPPLY CONDUCTOR TERMINATIONS AND DEVICES FOR DISCONNECTING AND SWITCHING OFF**		-
5.1	Incoming supply conductor terminal		P
5.1	Electrical equipment of a machine connected to one single power supply (For large complex machinery comprising a number of widely-spaced machines working together in a coordinated manner, there can be a need for more than one incoming supply depending upon the site supply arrangements)		P
	Power supply conductors terminated to main disconnecting device of electrical equipment (unless a plug is provided for disconnection)		P
	Neutral conductor clearly indicated in technical documentation with “N” (see cl. 16.1)		P
	No connection between neutral conductor and protective bonding circuit nor combined PEN-terminals. Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the power supply to the machine for TN-C systems.		P
	All terminals of incoming supply clearly marked in ac. with cl. 16.1 (symbols acc. to EN 60445)		P
5.2	Terminal for connection to external protective earthing system		P
	For each incoming supply, a terminal shall be provided in the vicinity of the associated phase		P

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Clause	Requirement - Test	Result - Remark	Verdict
	conductor terminals for connection of the machine to the external protective earthing system or to the external protective conductor, depending upon the supply distribution system.		
	Cross section of incoming PE conductor acc. to cl. 5.2, table 1. (Where an external protective conductor of a material other than copper is used, the terminal size shall be selected accordingly. See also 8.2.2).	1,5 mm^2	P
	Protective earth identified either by graphic symbol, letters “PE”, or bicolour combination GREEN / YELLOW		P
5.3	Supply disconnecting device		-
5.3.1	A supply disconnecting device shall be provided: – for each incoming source of supply to a machine – for each on-board power supply.		P
5.3.2	Type of power supply disconnecting device:		-
	a) Switch-disconnector, acc. to EN 60947-3 for appliance category AC-23 B or DC-23 B		P
	b) Disconnector with or without fuses, with aux. contact (acc. to EN 60947-3		P
	c) Power circuit breaker suitable for isolation (acc. to EN 60947-2)		P
	d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1as well as a utilization category		P
	e) Plug/socket combination for electrical load (requirements see cl. 5.3.3)	No such construction	N
5.3.3	Disconnection device has to fulfil all of the following requirements		-
	- isolate the electrical equipment from the supply and have only one OFF (isolated) and only one ON position marked with "O" and "I"		P
	- visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating function have been satisfied		P
	- have an external operating means e.g.a handle (except power operated CB’s)		P

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Clause	Requirement - Test	Result - Remark	Verdict
	- coloured black or grey recommended (If used as an emergency stop, red/yellow combination selected)		P
	- be provided with a means permitting it to be locked in the OFF position (padlocks). When so locked, remote as well as local closing shall be prevented		P
	- disconnect all live conductors of its power supply circuit (For TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory.)		p
	Requirements for plug/socket combination as a disconnection device: - Breaking capacity of the plug/socket combination: sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. - further see. cl. 13.4.5 a) to f)		N
5.3.4	The operating means are easily accessible and located between 0,6 m and 1,9 m above the servicing level.	1,25m	P
5.3.5	Only the following circuits need not be disconnected by the supply disconnecting device: - lighting circuits for lighting needed during maintenance or repair; – plug and socket outlets for the exclusive connection of repair or maintenance tools and equipment;		N
	– under voltage protection circuits that are only provided for automatic tripping in the event of supply failure;		
	– circuits supplying equipment that should normally remain energized for correct operation		
	– control circuits for interlocking		
	Such circuits are provided with their own disconnecting device.		
	Circuits not disconnected by the supply disconnecting device have: - permanent warning labels in accordance with cl. 16.1		N

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Clause	Requirement - Test	Result - Remark	Verdict
	- a statement is included in the maintenance manual		N
	- additionally one or more of the following is applied; - a permanent warning label in accordance with 16.1 is affixed in proximity to each excepted circuit, or - the circuit is separated from other circuits, or - the conductors are identified by colour taking into account the recommendation of Cl.13.2.4.		N
5.4	Disconnecting devices to prevent of unexpected start-up:		-
	- Devices for the prevention of unexpected start-up are provided These devices are appropriate and convenient for the intended use, are suitably placed, and readily identifiable as to their function and purpose (for example by a durable marking in accordance with cl. 16.1).		P
	- Means are provided to prevent inadvertent and/or mistaken closure of these devices either at the controller or from other locations		P
	- Devices that do not fulfil the isolation function (e.g. a contactor switched off by a control circuit) are only used for situations that include: – inspections; – adjustments; – no hazardous work on the electrical equipment (for example replacement of plug-in devices without disturbing existing wiring)		P
5.5	Devices for disconnecting electrical equipment		-
	- Requirements to devices for disconnecting electrical equipment to enable work to be carried out when it is de-energised and isolated: – appropriate and convenient for the intended use; – suitably placed; – readily identifiable as to which part or circuit of the equipment is served (for example by durable marking in accordance with 16.1 where necessary). - Additional means are provided to prevent of		P

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Clause	Requirement - Test	Result - Remark	Verdict
	inadvertent and/or mistaken closure of these devices either at the controller or from other locations		
	- Where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of a number of machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device is provided for each part, or for each machine, requiring separate isolation. In addition to the mentioned supply disconnecting device, the following devices that fulfil the isolation function may be provided for this purpose: – devices described in 5.3.2; – disconnectors, withdrawable fuse links and withdrawable links only if located in an electrical operating area (see 3.15) and relevant information is provided with the electrical equipment (see 17.2 b)9) and b)12)).		P
5.6	Protection against unauthorized, inadvertent and/or mistaken connection		-
	For devices acc. to cl. 5.4(disconnecting electrical equipment) and 5.5 (prevention of unexpected start-up) locking means in OFF position are provided and no remote reconnection is possible.		P
	Where a non-lockable disconnecting device is provided (for example withdrawable fuse-links, withdrawable links), other means of protection against unintended energising are used.		P
	Where plug/socket combinations according to 5.3.2 e) are used for the purpose of prevention of unexpected start-up the are so positioned that they can be kept under the immediate supervision of the person carrying out the work.		P
6	**PROTECTION AGAINST ELECTRIC SHOCK**		-
6.2.2	Protection against direct contact		-
	Live parts that are located inside enclosures have to bee conform to the relevant requirements of Clauses 4, 11, and 14 and have to have a protection against direct contact of at least IP2X or IPXXB.	IP20	P

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Clause	Requirement - Test	Result - Remark	Verdict
	Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against direct contact provided by the top surfaces shall be IP4X or IPXXD.	IP54	P
6.2.2 a	Opening an enclosure (i.e. opening doors, lids, covers, and the like) is possible only when: a) Either the use of a key or tool is necessary for access and: - all live parts, that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected are protected against direct contact to at least IP2X or IPXXB - live parts on the inside of doors are protected against direct contact to at least IP1X or IPXXA.		P
6.2.2 b	b) Or the opening of an enclosure (i.e. opening doors, lids, covers, and the like) is possible only if disconnection is provided for all live parts inside the enclosure before it can be opened. Exception: If a special device or tool (intended for use only by skilled or instructed persons) as prescribed by the supplier is provided that can be used to defeat the interlock and that intends that: - it is possible at all times while the interlock is defeated to open the disconnecting device and lock the disconnecting device in the OFF position or otherwise prevent unauthorised closure of the disconnecting device; - upon closing the door, the interlock is automatically restored - all live parts, that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected are protected against direct contact to at least IP2X or IPXXB - live parts on the inside of doors shall be protected against direct contact to at least IP1X or IPXXA - relevant information is provided with the electrical equipment like instructions on the procedures for securing the machine for safe maintenance and information on the residual risks. - means are provided to restrict access to live		P

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Clause	Requirement - Test	Result - Remark	Verdict
	parts behind doors not directly interlocked with the disconnecting means to skilled or instructed persons. - parts still alive after switching off are protected at least IP 2X or IP XXB and marked with a warning sign in accordance with 16.2.1  Excepted from this marking are: - parts that can be live only because of connection to interlocking circuits and that are distinguished by colour as potentially live in accordance with 13.2.4 - the supply terminals of the supply disconnecting device when the latter is mounted alone in a separate enclosure.		
6.2.2 c	c) Or the opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against direct contact to at least IP2X or IPXXB. Where barriers provide this protection, either they shall require a tool for their removal or all live parts protected by them shall be automatically disconnected when the barrier is removed.		P
6.2.3	Protection by insulation of live parts:		-
	Live parts are completely covered with insulation that can only be removed by destruction and that is capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions.		
	Paint, varnish lacquer etc. not used as the unique insulation layer.		P
6.2.4	Protection against residual voltages		-
	Live parts with residual voltage greater than 60 V after a time period of 5 s after disconnection of the supply shall be discharged until this interferes with the proper functioning of the equipment.		P
	Except are components with charges of ≤ 60 µC (- equivalent to capacitor with less then 1µF @ 60V).		P
	Where pins of plugs or similar devices after withdrawal are exposed, discharge time is ≤ 1s. Otherwise such conductors are protected against	No such construction	N

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Clause	Requirement - Test	Result - Remark	Verdict
	direct contact to at least IP2X or IPXXB.		
	If above requirements cannot be achieved, additional disconnecting devices or appropriate warning devices shall be applied (e.g. warning acc. cl. 16.1).		P
6.2.5	For protection by barriers, 412.2 of IEC 60364-4-41 is applied.		N
6.2.6	For protection by placing out of reach, 412.4 of IEC 60364-4-41 shall apply. For protection by obstacles, 412.3 of IEC 60364-4-41 is applied.		P
6.3	Protection against indirect contact		-
6.3.2	Prevention of the occurrence of a touch voltage		-
6.3.2.2	Protection by provision of:		P
	- class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140) or - switchgear and control gear assemblies having total insulation in accordance with IEC 60439-1or - supplementary or reinforced insulation in accordance with 413.2 of IEC 60364-4-41.		
6.3.2.3	Protection by electrical separation. For this type of protection, the requirements of 413.5 of IEC 60364-4-41 apply.		P
6.3.3	Protection by automatic disconnection of supply.		
6.3.3 a)	Use of overcurrent protective device for automatic cut-off in the event of an insulation failure in a TN-System. Where disconnection within the time specified in Clause A.1 cannot be assured, supplementary bonding is provided as necessary to meet the requirements of Clause A.3.		P
6.3.3 b)	Use of residual current protective devices (RCD) for automatic cut-off in the event of an insulation failure in a TN - or TT -System.		P
6.3.3 c)	Use of earth fault detection device to initiate automatic disconnection in a IT-System.		P
6.4	Protection by the use of PELV		P
6.4.1 a)	PELV circuits shall satisfy all of the following conditions: -the nominal voltage does not exceed:		P

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Clause	Requirement - Test	Result - Remark	Verdict
	• 25 V a.c. r.m.s. or 60 V ripple-free d.c. when the equipment is normally used in dry locations and when large area contact of live parts with the human body is not expected; or • 6 V a.c. r.m.s. or 15 V ripple-free d.c. in all other cases;		
6.4.1 b)	one side of the circuit or one point of the source of the supply of that circuit is connected to the protective bonding circuit;		P
6.4.1 c)	live parts of PELV circuits is electrically separated from other live circuits		P
6.4.1 d)	Conductors of each PELV circuit are physically separated from those of any other circuit. If this requirement is impracticable, the insulation provisions of 13.1.3 are fulfilled;		P
6.4.1 e)	plugs and socket-outlets for a PELV circuit are conform to the following: 1) plugs do not to enter socket-outlets of other voltage systems; 2) socket-outlets do not admit plugs of other voltage systems.	No PELV plug and socket provided	N
6.4.2	Sources for PELV		-
	The source for PELV shall be one of the following: - safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6 or - a source of current with a degree of safety equi-valent to that of the safety isolating transformer or - an source independent of circuit with higher voltage - electronic power supply conforming to appropriate standards		P
6.1	Other measures from IEC 60364-4-41 are used. (Description!)		P
7.	**PROTECTION OF EQUIPMENT**		-
7.2.	Overcurrent protection Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the overcurrent protective device for the supply conductors to the electrical equipment (see Annex B).		P
7.2.2.	On the installation diagram data necessary for selecting the overcurrent protective device are		P

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Clause	Requirement - Test	Result - Remark	Verdict
	stated for each incoming feeder. (see 7.2.10 and 17.4)		
7.2.3	Power circuits:		-
	Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10, are applied to each live conductor.		P
	And, none of the following conductors, as applicable, is disconnected without disconnecting all associated live conductors:		
	– the neutral conductor of a.c. power circuits;		
	– the earthed conductor of d.c. power circuits;		
	– d.c. power conductors bonded to exposed conductive parts of mobile machines.		
	Cross section area of neutral conductor is at least equal to the phase conductor. No overcurrent protective/ disconnecting device is required. (For a neutral conductor with a cross sectional area smaller than that of the associated phase conductors, the measures detailed in 524 of IEC 60364-5-52 shall apply.)		P
	IT-Systems:, no neutral conductor is used. Or, when it is used, the measures detailed in 431.2.2 of IEC 60364-4-43 are applied.		P
7.2.4	Control circuits		-
	Conductors of control circuits directly connected to the supply voltage and of circuits supplying control circuit transformers are protected against overcurrent in accordance with 7.2.3.		P
	Conductors of control circuits supplied by a control circuit transformer or d.c. supply: see 9.4.3.1		-
7.2.5	Socket outlets and their associated conductors		-
	Overcurrent protection is provided for the circuits feeding the general purpose socket.		P
7.2.6	Lighting circuits		-
	Lighting circuits are protected separate from other circuits.		P
7.2.7	Transformers		-
	Transformers are protected in accordance with the manufacturer’s instructions and includes: - avoiding tripping due to transformer magnetizing		P

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Clause	Requirement - Test	Result - Remark	Verdict
	inrush currents - avoiding a winding temperature rise in excess of the permitted value for the insulation class when there is a short circuit at the secondary terminals. - type and setting of the overcurrent protective device in accordance with the recommendations of the transformer supplier.		
7.2.8	Location of overcurrent protective devices:		-
	- located at the point where a reduction in the cross sectional area of the conductors or another change reduces the current-carrying capacity of the conductors.		P
	Exceptions: - current carrying capacity of the conductors is at least equal to that of the load and - conductors between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is ≤ 3 m and - the conductor is protected e.g. by an enclosure or duct.		P
7.2.9	Selection of overcurrent protective devices		-
	The rated short-circuit breaking capacity Icn is at least equal to the prospective fault current at the point of installation. Additional currents other than from the supply (e.g. from motors, from power factor correction capacitors) shall be taken into consideration.		P
	Reduced breaking capacity is permitted, where another protective device is installed at supply side with the necessary breaking capacity. (In that case, the characteristics of the two devices shall be co-ordinated so that the let-through energy (I^2t) of the two devices in series does not exceed that which can be withstood without damage to the overcurrent protective device on the load side and to the conductors protected by that device. See Annex A of IEC 60947-2).		N
	Where fuses are provided as overcurrent protective devices, a type readily available in the country of use shall be selected, or arrangements shall be made for the supply of spare parts.		P

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Clause	Requirement - Test	Result - Remark	Verdict
7.2.10	Rating and setting of overcurrent protective devices:		-
	Rated current of fuses or overcurrent setting of other protective devices selected as low as possible, but adequate for anticipated overcurrents.		P
	The rated current of overcurrent protective device is determined by the current carrying capacity of the conductors to be protected in accordance with Cl. 12.4, D.2 and the maximum allowable interrupting time *t* in accordance with Clause D.3, taking into account the needs of coordination with other electrical devices in the protected circuit.		P
7.3	Protection of motors against overheating		P
7.3.1	Overload protection for all motors provided for ratings of > 0.5 kW in continuous operation.		P
	Protective device may be omitted for motors, which cannot be overloaded.		P
	Exceptions: In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps), the means of detection shall give a warning signal to which the operator can respond.		P
7.3.2	Protection achieved by overload protection device: - detection in each live conductor - switching off of all live conductors (not necessary to switch of neutral conductor)		P
	For special duty motors, appropriate protective devices are recommended		P
7.3.3	Protection achieved by over-temperature protection device: Is recommended in situations where the cooling can be impaired (for example dusty environments)		P
7.3.4	Protection achieved by current limiting protection: Where protection against the effects of overheating in three phase motors is achieved by current limitation, the number of current limitation devices may be reduced from 3 to 2.		P
7.4	Abnormal temperature protection: Resistance heating or other circuits that are capable of attaining or causing abnormal		P

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Clause	Requirement - Test	Result - Remark	Verdict
	temperatures and can cause a hazardous situation are provided with suitable detection to initiate an appropriate control response.		
7.5	Protection against supply interruption or voltage reduction and subsequent restoration: Where a supply interruption or a voltage reduction can cause a hazardous situation, damage to the machine, or to the work in progress, undervoltage protection is provided.		P
	Upon restoration of supply voltage, automatic or unexpected restarting of machine prevented.		P
	Undervoltage protection does initiate appropriate control responses to ensure necessary coordination of groups of machines working together		P
7.6	Motor overspeed protection: Overspeed protection is provided where overspeeding can occur and could possibly cause a hazardous situation.		P
7.8	Phase sequence protection: Where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine, protection shall be provided.		P
7.9	Protection against overvoltage due to lightning and to switching surges: - Devices are connected to the incoming terminals of the supply disconnecting device.		P
8	**EQUIPOTENTIAL BONDING**		-
8.2	Protective bonding circuit		P
8.2.1	Where the conductance of structural parts of the electrical equipment or of the machine is less than that of the smallest protective conductor connected to the exposed conductive parts, a supplementary bonding conductor is provided.		P
	In IT distribution systems, the machine structure is part of the protective bonding circuit and insulation monitoring is provided.		P
	Exposed conductive parts of equipment in accordance with 6.3.2.3 (Protection by electrical separation) are not connected to the protective bonding circuit. (For this type of protection, the requirements of		P

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Clause	Requirement - Test	Result - Remark	Verdict
	413.5 of IEC 60364-4-41 apply.)		
8.2.2	Protective conductors		-
	Protective conductors shall be identified in accordance with 13.2.2.		P
	Copper conductors are preferred.		P
	Where other material is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm^2 in cross-sectional area.	No other material used for conductor	N
	The cross-sectional area of protective conductors shall be determined in accordance with the requirements of: – 543 of IEC 60364-5-54; or – 7.4.3.1.7 of IEC 60439-1, as appropriate. This requirement is met in most cases if it is in accordance with Table 1 of this standard (see 5.2).		P
8.2.3	Continuity of the protective bonding circuit		P
	All exposed conductive parts are connected to the protective bonding circuit in accordance with 8.2.1. Parts that are mounted so that they do not constitute a hazard because cannot be touched on large surfaces or grasped with the hand and they are small in size (less than approximately 50 mm × 50 mm) or they are located so that either contact with live parts, or an insulation failure is unlikely need not be connected to the protective bonding circuit		
	Where a part is removed the protective bonding circuit for the remaining parts isn't interrupted.		P
	Current-carrying capacity of connection and bonding points cannot impaired by mechanical, chemical, or electrochemical influences (e.g. electrolytic corrosion on aluminium parts)		P
	Metal ducts of flexible or rigid construction and metallic cable sheaths are not used as protective conductors. Nevertheless they are connected to the protective bonding circuit.		P
	Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the		P

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Clause	Requirement - Test	Result - Remark	Verdict
	protective bonding circuit shall be ensured. The use of a protective conductor (see 8.2.2) is recommended.		
	For cables that are exposed to damage (for example flexible trailing cables) the continuity of the protective conductors are ensured by appropriate measures (for example monitoring).		P
8.2.4	No means of interruption of the protective bonding conductor are provided. Exception: links for test or measurement purposes that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area.		P
	As well the protective bonding circuit does not incorporate a switching device or an over current protective device (for example switch, fuse).		P
	Removable current collectors, plug/socket combinations or withdrawable plug-in units: The protective bonding circuit is interrupted by a first make last break contact. (see also 13.4.5)		P
8.2.6	Protective conductor connecting points: have no other function and are not intended to attach or connect appliances or parts.		P
	Each protective conductor connecting point is marked or labelled as such using the symbol IEC 60417-5019 or the letters PE or by use of bicolour GREEN / YELLOW		P
8.2.7	Mobile machines with on-board power supplies: The protective bonding system is connected to a single protective bonding terminal. This protective bonding terminal is the connection point for a possible additional external incoming power supply.		N
8.2.8	Electrical equipment having earth leakage currents higher than 10 mA a.c. or d.c.: Additional protective bonding requirements: - Cross section of protective conductor ≥ 10 mm^2 CU or 16 mm^2 AL - OR Second protective conductor of at least the same cross sectional area if above cross section is impracticable - OR monitoring of continuity of protective conductor with automatic disconnection function.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Additionally a warning label is provided adjacent to the PE terminal.		P
9	**CONTROL CIRCUITS AND CONTROL FUNCTIONS**		-
9.1.	Control circuit		P
9.1.1	Control circuit supply: Control transformers mandatory only when more then one motor starter or two control devices are used.		P
	Control transformers with separate windings are used for supplying the control circuits.		P
	Where several transformers are used, the secondary voltages are in phase.		P
	Separate windings on transformer for DC supplies connected to PE.		P
	Switch-mode units fitted with transformers in accordance with IEC 61558-2-17		P
9.1.2	The nominal voltage of control supply does not exceed 277 V when supplied from a transformer.		P
9.1.3	Control circuits are provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		P
9.2.	Control functions		P
	Safety related control functions in accordance with ISO 13849-1 (2006), ISO 13849-2 (2003) and /or IEC 62061 (see 9.4.1)		-
9.2.1	Start functions operating by energizing the relevant circuit (see 9.2.5.2).		P
9.2.3	Operating modes		-
	Suitable means are prevented for unauthorized or inadvertent mode selection if hazardous situations can result.		P
	Mode selection by itself does not initiate machine operation. A separate actuation of the start control has to be stated by the operator.		P
	Indication of the selected operating mode is provided (e.g. the position of a mode selector, the provision of an indicating light, a visual display indication).		P
9.2.4	Where it is necessary to suspend safety functions and/or protective measures (for example for setting or maintenance purposes), protection is ensured.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.2.5	Operation		-
	Prevention of movement of the machine in an unintended or unexpected manner is taken after any stopping of the machine. (e.g. due to locked-off condition, power supply fault, battery replacement, lost signal condition with cableless control)		P
	When a machine has more than one control station, measures are provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.		P
9.2.5.2	Start of an operation is possible only when all of the relevant safety functions and/or protective measures are in place and are operational.		P
	Where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations are by hold-to-run controls, together with enabling devices, as appropriate.		P
	In the case of machines requiring the use of more than one control station to initiate a start, each of these control stations shall have a separate manually actuated start control device. The conditions to initiate a start are: - all required conditions for machine operation are met - and all start control devices are in the released (off) position - then all start control devices have to be actuated concurrently (see 3.6).		P
9.2.5.3	Stop category 0 and/or stop category 1 and/or stop category 2 stop functions are provided as indicated by the risk assessment and the functional requirements of the machine (see 4.1).		P
	Stop functions override related start functions		P
	Facilities to connect protective devices and interlocks are provided, where required. If such a protective device or interlock causes a stop of the machine, it may be necessary for that condition to be signalled to the logic of the control system. The reset of the stop function does not initiate any hazardous situation.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Where more than one control station is provided, stop commands from any control station is effective when required by the risk assessment of the machine.		P
9.2.5.4	Emergency operations (emergency stop, emergency switching off)		-
	Emergency stop or emergency switching off commands are sustained until it is reset.		P
	This reset is possible only by a manual action at that location where the command has been initiated.		P
	The reset of the command does not restart the machinery but only permit restarting.		P
	It is not be possible to restart the machinery until all emergency stop commands are reset.		P
	It is not be possible to reenergize the machinery until all emergency switching off commands are reset.		P
9.2.5.4.2	The emergency stop does function either as a stop category 0 or as a stop category 1.		P
	- it overrides all other functions and operations in all modes;		P
9.2.5.4.3	Emergency switching off is provided where: -Protection against direct contact is achieved only by placing out of reach or by obstacles (see 6.2.6) - or there is the possibility of other hazards or damage caused by electricity.		P
	Emergency switching off is accomplished by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply.		P
9.2.5.5	Movement or action that can result in a hazardous situation are monitored by providing, for example, overtravel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices.		P
9.2.6	Other control functions		-
9.2.6.2	No type 1 two-hand control device is used for the initiation of hazardous operation. It need type 2 or type 3 two-hand control devices for such operations.		P
9.2.6.3	Enabling control: Enabling control are arranged in the way to		P

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Clause	Requirement - Test	Result - Remark	Verdict
	minimize the possibility of defeating, e. g. by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It is not possible to defeat the enabling function by simple means.		
9.2.6.4	Combined start and stop controls: Push-buttons etc. that alternately initiate and stop motion are provided only for functions, which cannot result in a hazardous situation.		P
9.2.7	Cableless control station		N
9.2.7.1	Means shall be provided to readily remove or disconnect the power supply of the operator control station (see also 9.2.7.3).		N
	Means (for example key operated switch, access code) are provided, as necessary, to prevent unauthorized use of the operator control station.		N
	Each operator control station carries an unambiguous indication of which machine(s) is (are) intended to be controlled by that operator control station.		N
9.2.7.2	Measures shall be taken to ensure that control commands: – affect only the intended machine; – affect only the intended functions.		N
	Measures are taken to prevent the machine from responding to signals other than those from the intended operator control station(s).		N
	Where necessary, means are provided so that the machine can only be controlled from operator control stations in one or more predetermined zones or locations.		N
9.2.7.3	Operator control stations include a separate and clearly identifiable means to initiate the stop function of the machine or of all the operations that can cause a hazardous situation. The actuating means to initiate this stop function are not marked or labelled as an emergency stop device, even though the stop function initiated on the machine can fulfil an emergency stop function.		N
	Stopping of the machine and preventing a potentially hazardous operation is automatically initiated in the following situations:		N

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Clause	Requirement - Test	Result - Remark	Verdict
	– when a stop signal is received; – when a fault is detected in the cableless control system; – when a valid signal (which includes a signal that communication is established and maintained) has not been detected within a specified period of time (see Annex B), except when a machine is executing a pre-programmed task taking it outside the range of the cableless control where no hazardous situation can occur.		
9.2.7.4	Machines having more than one operator control station, including one or more cableless control stations, have measures provided to ensure that only one of the control stations can be enabled at a given time.		N
	An indication of which operator control station is in control of the machine is provided at suitable locations as determined by the risk assessment of the machine. Exception: a stop command from any one of the control stations are effective when required by the risk assessment of the machine.		N
9.2.7.5	Battery-powered cableless operator control stations: A variation in the battery voltage does not cause a hazardous situation.		N
	A clear warning is given to the operator when a variation in battery voltage exceeds specified limits.		N
	Under those circumstances, the cableless operator control station remains functional long enough for the operator to put the machine into a non- hazardous situation.		N
9.3	Protective interlocks		P
9.3.1	The reclosing or resetting of an interlocking safeguard does not initiate hazardous machine operation.		P
9.3.2	Where overtraveling an operating limit (for example speed, pressure, position) can lead to a hazardous situation, means are provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action.		P
9.3.3	The correct operation of auxiliary functions is		P

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Clause	Requirement - Test	Result - Remark	Verdict
	checked by appropriate devices.		
	Appropriate interlocking is provided, when non-operation of an auxiliary function (for example lubrication, supply of coolant, swarf removal) can cause a hazardous situation, or cause damage to the machine or to the work in progress.		P
9.3.4	Interlocks between different operations and for contrary motions are provided if this operations lead to hazardous situations.		P
9.3.5	Reverse current braking: Where braking of a motor is accomplished by current reversal, measures prevent the motor starting in the opposite direction at the end of braking where that reversal can cause a hazardous situation or damage to the machine or to the work in progress.		P
	For this purpose, a device operating exclusively as a function of time is not permitted.		P
	Control circuits are arranged that rotation of a motor shaft, for example manually, does not result in a hazardous situation.		P
9.4	Control functions in the event of failure		P
9.4.1	The safety related electrical control circuits have an appropriate level of safety performance that has been determined from the risk assessment at the machine. The requirements of IEC 62061 and/or ISO 13849-1, ISO 13849-2 are met.		P
	Where memory retention is achieved for example, by battery power, measures are taken to prevent hazardous situations arising from failure or removal of the battery.		P
	Means are provided to prevent unauthorized or inadvertent memory alteration by, e.g. requiring the use of a key, access code or tool.		P
9.4.2	Measures are taken to minimize risk in the event of failure:		-
9.4.2.1	- Use of proven circuit techniques and components		P
9.4.2.2	- Provisions of partial or complete redundancy		P
9.4.2.3	- Provision of diversity		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.4.2.4	- Provision for functional tests		P
9.4.3	Protection against mal-operation due to earth faults, voltage interruptions and loss of circuit continuity		-
9.4.3.1	Earth faults on any control circuit don't cause unintentional starting, potentially hazardous motions, or prevent stopping of the machine. Methods to meet these requirements include but are not limited to the following:		-
	a) 1) Control circuits, fed by control transformers and connected to the protective bonding circuit at the point of supply. (PELV) (see Figure 3 of this standard)		P
	a) 2) Control circuits, fed by control transformers without connection to the protective bonding circuit at the point of supply in the arrangement according to figure 3 and having a device that interrupts the circuit automatically in the event of an earth fault		P
	b) Control circuits fed by a control transformer with a centre-tapped winding, this centre tap connected to the protective bonding circuit, arranged as shown in Figure 4 of this standard with the overcurrent protective device having switching elements in all control circuit supply conductors.		P
	c) Where the control circuit is not fed from a control transformer and is either: 1) directly connected between the phase conductors of an earthed supply, or; 2) directly connected between the phase conductors or between a phase conductor and a neutral conductor of a supply that is not earthed or is earthed through a high impedance, multpole switch that switch all live conductors are used for those functions that can cause hazardous situations or damage to the machine.		P
	Or in case of c) 2), a device is provided that interrupts the circuit automatically in the event of an earth fault.		P
9.4.3.2	For control systems using a memory device(s), proper functioning in the event of power failure is ensured (e.g. by using a non-volatile memory) to		P

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Clause	Requirement - Test	Result - Remark	Verdict
	prevent any loss of memory that can result in a hazardous situation.		
9.4.3.3	Upon sliding contacts the loss of continuity of safety-related control circuits depending on, can result in a hazardous situation. Appropriate measures are taken (for example by duplication of the sliding contacts).		P
10	**OPERATOR INTERFACE AND MACHINE-MOUNTED CONTROL DEVICES**		-
10.1.1	As far as is practicable, those devices are selected, mounted, and identified or coded in accordance with relevant parts of IEC 61310.		P
10.1.2	As far as is practicable, machine-mounted control devices are: – readily accessible for service and maintenance;		P
	– mounted in such a manner as to minimize the possibility of damage from activities such as material handling.		P
	The actuators of hand-operated control devices are selected and installed so that: – they are not less than 0,6 m above the servicing level and		P
	– 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.		P
	The actuators of foot-operated control devices are selected and installed so that: – they are within easy reach of the normal working position of the operator;		P
	– the operator is not placed in a hazardous situation when operating them.		P
10.1.3	The degree of protection (see IEC 60529) together with other appropriate measures does afford protection against:		P
	– the effects of aggressive liquids, vapours, or gases found in the physical environment or used on the machine;		P
	– the ingress of contaminants (for example swarf, dust, particulate matter).		P
	The operator interface control devices has a minimum degree of protection against direct contact of IPXXD (see IEC 60529).		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.1.4	Position sensors (for example position switches, proximity switches) are so arranged that they will not be damaged in the event of overtravel.		P
	Position sensors in circuits with safety-related control functions shall have direct opening action (see IEC 60947-5-1) or shall provide similar reliability (see 9.4.2).		P
10.1.5	Portable and pendant operator control stations and their control devices are so selected and arranged as to minimize the possibility of inadvertent machine operations caused by shocks and vibrations		P
10.2	Push-buttons		P
10.2.1	Mandatory: The colour RED is used only for emergency stop and emergency switching off actuators.		P
	The recommend colours of push-buttons are as shown in table 2 of this standard.		P
10.2.2	The recommend markings on push-buttons are as shown in table 3 of this standard.		P
10.3	Indicator lights and displays		-
10.3.1	Indicator lights and displays are selected and installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310-1).		P
	Indicator light circuits used for warning lights are fitted with facilities to check the operability of these lights.		P
	The recommend colours on Indicator light are as shown in table 4 of this standard.		P
	Indicating towers on machines have the applicable colours in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.		P
	Where flashing lights or displays are used to provide higher priority information, audible warning devices should also be provided.		P
10.4	illuminated push-button actuators are colour-coded in accordance with Tables 2 and 4. Where there is difficulty in assigning an appropriate colour, WHITE is used.		P
	The colour RED for the emergency stop actuator shall not depend on the illumination of its light.		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.5	Devices having a rotational member, such as potentiometers and selector switches, have means of prevention of rotation of the stationary member. Friction alone isn't considered sufficient.		P
10.6	Actuators used to initiate a start function or the movement of machine elements (for example slides, spindles, carriers) are constructed and mounted so as to minimize inadvertent operation.		P
	However, mushroom-type actuators are used for two-hand control only. (see also ISO 13851).		P
10.7	Emergency stop devices		-
10.7.1	Devices for emergency stop are readily accessible.		P
	They are located at each operator control station and at other locations where the initiation of an emergency stop can be required (exception: see 9.2.7.3).		P
	In circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station, means (for example, information for use) are provided to minimise confusion.		P
10.7.2	Allowed types of device for emergency stop: – a push-button operated switch with a palm or mushroom head type; – a pull-cord operated switch; – a pedal-operated switch without mechanical guard. The devices are direct opening operation (see IEC 60947-5-1, Annex K).		P P
10.7.3	Actuators are coloured RED. If a background exists immediately around the actuator, then this background is coloured YELLOW. See also ISO 13850.		P
10.7.4	The supply disconnecting device may be locally operated to serve the function of emergency stop when: – it is readily accessible to the operator; and – it is of the type described in 5.3.2 a), b), c), or d). When also intended for this use, the supply disconnecting device meets the colours		P

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Clause	Requirement - Test	Result - Remark	Verdict
	RED/YELLOW.		
10.8	Emergency switing off device		P
10.8.1	Means are provided, where necessary, to avoid confusion between these devices.		P
10.8.2	The types of device for emergency switching off include: – a push-button operated switch with a palm or mushroom head type of actuator; – a pull-cord operated switch. The devices are direct opening action (see IEC 60947-5-1, Annex K). The push-button operated switch may be in a break-glass enclosure.		P
10.8.3	Actuators are coloured RED. If a background exists immediately around the actuator, then this background is coloured YELLOW. See also ISO 13850.		P
10.8.4	Where the supply disconnecting device is to be locally operated for emergency switching off, it is be readily accessible and meets the colours RED/YELLOW.		P
10.9	Enabling control device		P
	An enabling control device as a part of a system, does allow operation when actuated in one position only. In any other position, operation is stopped or prevented.		P
	Functions of two-position types: position 1: off-function of the switch (actuator is not operated); position 2: enabling function (actuator is operated)		P
	Functions of three-position types: position 1: off-function of the switch (actuator is not operated); position 2: enabling function (actuator is operated in its mid position); position 3: off-function (actuator is operated past its mid position); when returning from position 3 to position 2, the enabling function is not activated.		P
11	**CONTROLGEAR: LOCATION, MOUNTING AND ENCLOSURES**		

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Clause	Requirement - Test	Result - Remark	Verdict
11.2.1	All items of controlgear (inclusively terminals that are not part of controlgear components or devices) are placed and oriented so that they can be identified without moving them or the wiring.		P
	For items that require checking for correct operation or that are liable to need replacement, those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers, barriers or obstacles).		P
	All controlgear are mounted so as to facilitate its operation and maintenance from the front.		P
	Necessary tools to adjust, maintain, or remove a device are supplied.		P
	Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0,4 m and 2,0 m above the servicing level.		P
	Terminals are least 0,2 m above the servicing level and so placed that conductors and cables can be easily connected to them.		P
	Only operating, indicating, measuring, and cooling devices are mounted on doors or on normally removable access covers of enclosures.		P
	Plug-in arrangements of control devices and plug-in-devices:		-
	The connection is clearly identified by shape, marking or reference designation, singly or in combination.		P
	When they have to bee handled during normal operation means are provided with non-interchangeable features where the lack of such a facility can result in malfunctioning.		P
	Plug/socket combinations that are handled during normal operation are unobstructedly accessible.		P
	Test points for connection of test equipment are: – unobstructedly accessible; – clearly identified to correspond with the documentation; – adequately insulated; – sufficiently spaced.		P
11.2.2	Non-electrical parts and devices, not directly associated with the electrical equipment, are not		P

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Clause	Requirement - Test	Result - Remark	Verdict
	located within enclosures containing controlgear.		
	Devices such as solenoid valves are separated from the other electrical equipment (for example in a separate compartment).		P
	Control devices mounted in the same location and connected to the supply voltage, or to both supply and control voltages, are grouped separately from those connected only to the control voltages.		P
	Terminals shall be separated into groups for: – power circuits; – associated control circuits; – other control circuits, fed from external sources (for example for interlocking).		P
	The clearances and creepage distances specified by the supplier are maintained, taking into account the external influences or conditions of the physical environment.		P
11.2.3	Heat generating components (for example heat sinks, power resistors) are located so, that the temperature of each component in the vicinity remains within the permitted limit. Controlgears are sufficiently protected against: - ingress of solid foreign objects - liquids - dust, coolants, and swarf, taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental conditions).		P P
	Enclosures of controlgear provide a degree of protection of at least IP22 (see IEC 60529). Exceptions: a) specific electrical operating area b) When with removable collectors on conductor wire or conductor bar systems do not achieve IP22 measures of 6.2.5 are applied.		P
11.4	Enclosures, doors and openings		P
	Enclosures (inclusively screens of windows (windows: toughened glass or polycarbonate sheet of not less than 3 mm thickness), joints, gaskets of doors and lids) do withstand the foreseeable mechanical, electrical and thermal		P

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Clause	Requirement - Test	Result - Remark	Verdict
	stresses and other environmental factors and of the aggressive liquids, vapours, or gases used on the machine.		
	Fasteners used to secure doors and covers are of the captive type.		P
	Enclosure doors are not wider than 0,9 m and have vertical hinges, with an angle of opening > 95°.		P
	Openings in enclosures (for example, for cable access), including those towards the floor or foundation or to other parts of the machine are equipped with means to ensure the degree of protection specified for the equipment. A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away.		P
	Openings for cable entries shall be easily re-opened on site.		P
	No openings between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate.		P
	Holes in an enclosure for mounting do not impair the required protection.		P
	Equipment that, in normal or abnormal operation, can attain a surface temperature sufficient to cause a risk of fire or harmful effect to an enclosure material is: – located within an enclosure that will withstand, such temperatures; and – is located at a sufficient distance from adjacent equipment allowing safe dissipation of heat (see also 11.2.3); or – is otherwise screened by material that can withstand to the harmful effect.		P
11.5	Access to control gear		N
	Doors in gangways for access to electrical operating areas: – are at least 0,7 m wide and 2,1 m high; – do open outwards; – have a means (for example panic bolts) to allow opening from the inside without the use of a key		N

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Clause	Requirement - Test	Result - Remark	Verdict
	or tool.		
	Enclosures which readily allow a person to fully enter are be provided with means to allow escape, e.g. panic bolts on the inside of doors.		N
	Enclosures intended for such access, for example for resetting, adjusting, maintenance, shall have a clear width of at least 0,7 m and a clear height of at least 2,1 m When equipment is likely to be live during access with > 1,0m and when on both side with > 1.5m.		N
12	**CONDUCTORS AND CABLES**		P
	IMPORTANT: The following requirements do not apply to the integral wiring of assemblies, subassemblies, and devices that are manufactured and tested in accordance with their relevant IEC standard (for example IEC 60439-1).		-
12.2	In general, conductors are of copper. Where aluminium conductors are used, the cross-sectional area is at least 16 mm^2.		P
	The cross-sectional areas of conductors are according to Table 5 and its notes.		P
	All conductors that are often in movement (> one movement per hour of machine operation) have flexible stranding of class 5 or class 6.		P
	Where the insulation of conductors and cables (for example PVC) can constitute hazards due to the propagation of a fire or the emission of toxic or corrosive fumes adequate means are provided. Special attention is given to the integrity of a circuit having a safety-related function		P
	Minimum insulation test voltages for used cables are: – ≥ 2 000 V a.c. for a duration of 5 min for operation at voltages higher than 50 V a.c. or 120 V d.c., or – ≥ 500 V a.c. for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment).		P
	Insulation strong enough to withstand damage due to operation or during laying, especially for cables pulled into ducts.		P
12.4	Current-carrying capacity in normal service in accordance with table 6.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Or in accordance with suppliers recommendation.		
12.6	Flexible cables		P
12.6.1	All flexible cables have Class 5 or Class 6 conductors. Cables under severe duties are adequately protected against: - abrasion due to mechanical handling and dragging across rough surfaces; - 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	The tensile stress applied to copper conductors does not exceed 15 N/mm2 of cross-sectional area. Or special measures are taken to withstand the applied stress. For material other than copper the applied stress is within the cable manufacturer's specification.		P
12.6.3	For cables installed on drums, the maximum current-carrying capacity in free air is derated in accordance with Table 7.		P
12.7	Conductor wires, conductor bars and slip-ring assemblies		P
12.7.1	During normal access to the machine, protection against direct contact to conductor wires, conductor bars and slip-ring assemblies is achieved by the application of one of the following protective measures: – protection by partial insulation of live parts, or where this is not practicable; – protection by enclosures or barriers of at least IP2X.		P
	Horizontal top surfaces of barriers or enclosures that are readily accessible provide a degree of protection of at least 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 9.2.5.4.3 is applied.		P
	Conductor wires and conductor bars are so placed / protected as to:		P

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Clause	Requirement - Test	Result - Remark	Verdict
	– prevent contact with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains; – prevent damage from a swinging load.		
12.7.2	Protective conductor circuit (PE) and the neutral conductor (N) each use a separate conductor wire, conductor bar or slip-ring.		P
	The continuity of the protective conductor circuit using sliding contacts is ensured by taking appropriate measures (for example, duplication of the current collector, continuity monitoring)		P
12.7.3	Protective conductor current collectors have a shape or construction so that they are not interchangeable with the other current collectors. Such current collectors shall be of the sliding contact type.		P
12.7.4	Removable current collectors (e.g. swivelingable) with disconnector function: The protective conductor circuit interrupts after and reconnects before any live conductor.		P
12.7.5	Clearances in air between conductors and adjacent systems are suitable at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1 (For example 4 kV for 230/400 V systems → clearances 3mm)		P
12.7.6	Creepage distances between conductors and adjacent systems are suitable suitable for operation in the intended environment, e.g. open air (IEC 60664-1), inside buildings, protected by enclosures. In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply: – unprotected conductor etc.: minimum creepage dist. of 60 mm – enclosed conductor etc.: minimum creepage distance of 30 mm		P
12.7.7	Conductor system divided into isolated sections: suitable design measures are employed to prevent the energization of adjacent sections by the current collectors themselves.		P
12.7.8	Construction of conductor wires etc.:		P

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Clause	Requirement - Test	Result - Remark	Verdict
	- power circuits are grouped separately from those in control circuits. - do withstand the foreseeable mechanical forces and thermal effects of short-circuit current. - covers can not be opened without the use of a tool - all conductive parts of accompanying enclosures are connected to the protective bonding circuit - underground and underfloor conductor bar ducts have drainage facilities		
13	**WIRING PRACTICES**		P
13.1	Connections and routing		P
13.1.1	All connections are secured against accidental loosening.		P
	The means of connection are suitable for the cross-sectional areas and nature of the conductors being terminated.		P
	No connection of two or more conductors to one terminal, unless the terminal is designed for it.		P
	No soldered connections to terminals unless they are suitable for it.		P
	Terminals on terminal blocks are plainly marked or labelled corresponding with the diagrams.		P
	Installations of flexible conduits and cables are such that liquids drain away from the fittings.		P
	Retaining means for conductor strand and shields provided (no soldering for that purpose)		P
	Indentification tags legible, permanent, and appropriate for the physical environment.		P
	Terminal blocks mounted and wired so that the internal and external wiring does not cross over the terminals (see IEC 60947-7-1).		P
13.1.2	Conductors and cables run from terminal to terminal without splices or joints. Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be joints for the purpose of this subclause.		P
	Terminations of cables are adequately supported to prevent mechanical stresses at the terminations of the conductors.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Protective conductor placed close to the associated live conductors in order to decrease the impedance of the loop.		P
13.1.3	Conductors for circuits that operate at different voltages are separated by suitable barriers, or are insulated for the highest voltage that occurs within the same duct.		P
13.1	Connections and routing		P
13.2.1	Each conductor is identifiable at each termination in accordance with the technical documentation.		P
13.2.2	The protective conductor has the bicolour combination GREEN-AND-YELLOW Where the protective conductor can be easily identified colour coding throughout its length is not necessary, but the ends or accessible locations are clearly identified by the graphical symbol or by the bicolour combination GREEN-AND-YELLOW.		P
13.2.3	Neutral conductors are identified by the colour LIGHT BLUE. That colour is not used for identifying any other conductor where confusion is possible.		P
	Bare conductors used as neutral conductors have at minimum a stripe in LIGHT BLUE 15 mm to 100 mm wide in each compartment or unit and at each accessible location.		P
	Identification by colour for other conductors: Colours GREEN or YELLOW are not used. (Details to colour coding see this norm Cl. 13.2.3)		P
13.3	Wiring inside enclosures		P
	Conductors inside enclosures are supported where necessary. Conductors and cables that do not run in ducts are adequately supported.		P
	Non-metallic supports are made with a flame-retardant insulating material (see IEC 60332 series)		P
	Connections to devices mounted on doors or to other movable parts are using flexible conductors in accordance with 12.2 and 12.6.		P
13.4	Wiring outside enclosures		P
13.4.2	Conductors and their connections external to the electrical equipment are placed in suitable ducts		P

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	(see cl.13.5). Exceptions: - Cables with special suitable protection. - Position switches or proximity switches supplied with a dedicated cable which is sufficiently short.		
13.4.3	Connection to moving elements of the machine		N
	Connections to moving elements of the machine are made of flexible cable in accordance with 12.2 and 12.6.		N
	Bending radius of the cable are of at least 10 times the diameter of the cable		N
	Cables close to moving parts, maintain a space of at least 25 mm between the moving parts and the cables or barriers are provided.		N
	Cable handling systems: Lateral cable angles do not exceeding 5°, at being wound on and off cable drums or approaching and leaving cable guidance devices. The bending radius is in accordance with table 8.		N
	Flexible conduit: - is not used for connections to rapidly or frequently moving parts, except when specifically designed for that purpose. - is supported when adjacent to moving parts		N
13.4.4	Interconnection of devices on the machine is made through adequate terminals.		P
13.4.5	Requirements to plug/socket combinations outside of enclosures: Exceptions: components connected to a bus system by a plug/socket combination a) Prevention for unintentional contact with live parts at any time. At least IPXXB. (PELV circuits are excepted from this requirement.) b) First make last break protective bonding contact if used in TN- or TT-systems. c) Sufficient load-breaking capacity, when intended to be disconnected under running conditions. When rated at ≥ 30 A interlocked with a switching device d) When rated at ≥ 16 A having a retaining means	No such construction	N

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	to prevent unintended or accidental disconnection. e) when unintended or accidental disconnection +can cause a hazardous situation, having a retaining means. f) Component remaining live after disconnection having at least IP2X or IPXXB, taking into account the required clearance and creepage distances.(PELV circuits are excepted from this requirement.) g) Metallic housings of plug/socket combinations being connected to the protective bonding circuit. (PELV circuits are excepted from this requirement.) h) Having retaining means to prevent unintended or accidental disconnection and being marked that they are not intended to be disconnected under load. i) Clearly identifiable if more then one plug / socket per device. It is recommended that mechanical coding being used. j) When used in control circuits fulfilling the applicable requirements of IEC 61984. Exception: see item k). k) No plug/socket combinations intended for household and similar general purposes used for control circuits. In plug/socket combinations in accordance with IEC 60309-1, only those contacts shall be used for control circuits which are intended for those purposes. Exception: The requirements of item k) do not apply to control functions using high frequency signals on the power supply.		
13.4.6	Protection of Plug / socket from the physical environment during transportation and storage.		P
13.5	Ducts, connection boxes and other boxes		P
	Provided with a degree of protection suitable for the application.		P
	No sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come into contact.		P
	Where human passage is required, least 2 m above the working surface.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Not used as connection for protective bonding circuit.		P
	Where cable trays are a.s.o. are only partially covered, the cables used are of a suitable type.		P
13.5.2	Filling the percentage of ducts adapted to the straightness and length of the duct and the flexibility of the conductors.		P
13.5.3	Rigid metal conduit and fittings shall galvanized steel or of a corrosion-resistant material		P
	Fittings compatible with the conduit.		P
	Conduit bends properly made		P
13.5.4	Flexible metal tubing or woven wire armour suitable for the expected physical environment.		P
13.5.5	Flexible non-metallic conduit resistant to kinking and suitable for the expected physical environment.		P
13.5.6	Requirements to cable trunking systems: - Rigidly supported and clear of all moving or contaminating portions of the machine - Covers overlapping the sides and attached.		P
13.5.7	The compartments of machine used as cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed, and the conductors are secured.		P
13.5.8	Connection boxes and other boxes used for wiring: - Are accessible for maintenance. - Provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate (see 11.3). - Do not have unused knockouts etc.		P
13.5.9	Motor connection boxes: Encloses only connections to the motor and motor-mounted devices (e.g brakes, temperature sensors)		P
14	**ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT**		P
14.1	Electric motors are conform to the relevant parts of IEC 60034 series.		P
	There protection is conform to the requirements given in 7.2 for overcurrent protection, in 7.3 for		P

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	overload protection, and in 7.6 for overspeed protection.		
	Motor control equipment is located and mounted in accordance with Clause 11.		P
14.2	Minimal IP23 protection for all motors. More stringent requirements depending on the application and the physical environment.		P
14.4	Motors incorporated as an integral part of the machine are adequately protected from mechanical damage.		P
	motors and its associated parts (inclusively motor connection box) are easily accessible for inspection and maintenance etc		P
	Cooling is ensured and the temperature rise remains within the limits of the insulation class (see IEC 60034-1)		P
	No opening between the motor compartment and any other compartment that does not meet the motor compartment requirements.		P
14.5	The characteristics of motors and associated equipment are selected in accordance with the anticipated service and physical environmental conditions (see 4.4). Detailed criteria see 14.5 of this norm.		P
14.6	Overload and overcurrent protective devices for mechanical brake actuators initiate simultaneously the deenergization (release) of the associated motors.		P
15	**ACCESSORIES AND LIGHTING**		P
15.1	Requirements for socket-outlets for accessory equipment:		P
	– conform to IEC 60309-1 (Where that is not practicable, they are clearly marked with voltage and current ratings);		P
	–continuity of the protective bonding circuit to the socket-outlet is ensured, except where protected by PELV;		P
	– unearthed conductors connected to the socket-outlet are overcurrent- and if required overload-protected		P
	– protection is separately from other circuits;		P
	– power supply to the socket-outlet is not		P

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Clause	Requirement - Test	Result - Remark	Verdict
	disconnected by the supply disconnecting device for the machine or the section of the machine, the requirements of 5.3.5 apply.		
15.2.1	Requirements for local lighting of the machine and equipment: - protective bonding circuit in accordance with 8.2.2. - ON/OFF switch incorporated in the lamp-holder or in the flexible connecting cords. - Stroboscopic effects avoided. - Where fixed lighting electromagnetic compatibility is taken into account.		P
15.2.2	Requirements to the power supply for local lighting:		P
	– Nominal voltage not exceeding 250 V between conductors – isolating transformer connected to the load side of the supply with overcurrent protection in the secondary circuit; or – isolating transformer connected to the line side of the supply disconnecting device with overcurrent protection in the secondary circuit. That source is permitted for maintenance lighting circuits in control enclosures only; or – from a machine circuit with dedicated overcurrent protection; or – from an isolating transformer connected to the line side of the supply disconnecting device, provided with a dedicated primary disconnecting means and secondary overcurrent protection, and mounted within the control enclosure adjacent to the supply disconnecting device; or – from an externally supplied lighting circuit (for example factory lighting supply). This shall be permitted in control enclosures only, and for the machine work light(s) where their total power rating is not more than 3 kW. Exception: Where fixed lighting is out of reach of operators during normal operations, the provisions of this subclause do not apply.		
15.2.3	All unearthed conductors of circuits supplying lighting have their own overcurrent protecting devices.		P

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
15.2.4	Requirements to the fittings for local lighting: – Adjustable lighting fittings are suitable for the physical environment. – lamp holders are in accordance with the relevant IEC standard; – lamp holders are constructed with an insulating material protecting the lamp cap – Reflectors are supported by a bracket and not by the lamp holder. Exception: where fixed lighting is out of reach of operators during normal operation, the provisions of this subclause do not apply.		P
16	**MARKING, WARNING SIGNS AND REFERENCE DESIGNATIONS**		
16.1	Warning signs, nameplates, markings, and identification plates are of sufficient durability to withstand the physical environment.		P
16.2.1	Enclosures that do not clearly show that they contain electrical equipment that has a risk of electric shock are marked with the graphical symbol  plainly visible on the enclosure door or cover. Exception: – enclosure equipped with a supply disconnecting device; – operator-machine interface or control station; – a single device with its own enclosure (for example position sensor).		P
16.2.2	Hazardous hot surfaces of the electrical equipment, are equipped with the graphical warning symbol 	No such construction	N
16.2.3	Control devices, visual indicators, and displays are clearly and durably marked to their functions.		P
16.2.4	Equipment (e.g. controlgear assemblies) is legibly and durably marked. A nameplate is attached to the enclosure adjacent to each incoming supply with: – name or trade mark of supplier; – certification mark, when required; – serial number, where applicable; – rated voltage, number of phases and frequency		P

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	(if a.c.), – full-load current for each supply; – short-circuit rating of the equipment; – main document number (see IEC 62023).		
16.2.5	All enclosures, assemblies, control devices, and components are plainly identified with the same reference designation as shown in the technical documentation.		P
17	**TECHNICAL DOCUMENTATION**		-
17.1	Documentation in agreed language provided.	Documentation in English	P
17.2	Information provided with the electrical equipment include: a) A main document (parts list or list of documents); b) Complementary documents including: 1) a clear, comprehensive description of the equipment, installation and mounting, and the connection to the electrical supply(ies); 2) electrical supply(ies) requirements; 3) information on the physical environment (for example lighting, vibration, noise levels, atmospheric contaminants) where appropriate; 4) overview (block) diagram(s) where appropriate; 5) circuit diagram(s); 6) information (as applicable) on: - programming, as necessary for use of the equipment; - sequence of operation(s); - frequency of inspection; - frequency and method of functional testing; - guidance on the adjustment, maintenance, and repair, particularly of the protective devices and circuits; -recommended spare parts list; - list of tools supplied. 7) a description (including interconnection diagrams) of the safeguards, interlocking functions, and interlocking of guards against hazards, particularly for machines operating in a		P

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	co-ordinated manner; 8) a description of the safeguarding and of the means provided where it is necessary to suspend the safeguarding (for example for setting or maintenance), (see 9.2.4); 9) instructions on the procedures for securing the machine for safe maintenance; (see also 17.8); 10) information on handling, transportation and storage; 11) information regarding load currents, peak starting currents and permitted voltage drops, as applicable; 12) information on the residual risks due to the protection measures adopted, indication of whether any particular training is required and specification of any necessary personal protective equipment.		
17.3	Unless otherwise agreed between manufacturer and user: – the documentation is in accordance with relevant parts of IEC 61082; – reference designations are in accordance with relevant parts of IEC 61346; - instructions / manuals are in accordance with IEC 62079. - parts lists where provided are in accordance with IEC 62027, class B.		P
17.4	Installation documents giving all information necessary for the preliminary work of setting up the machine (including commissioning) are provided. (In complex cases, it may be necessary to refer to the assembly drawings for details.)		P
	The recommended position, type, and cross-sectional areas of the supply cables to be installed on are clearly indicated.		P
	Data necessary for choosing the type, characteristics, rated currents, and setting of the overcurrent protective device for the supply conductors to the electrical equipment of the machine is stated (see 7.2.2).		P
	The size, purpose, and location of any ducts in the foundation that are to be provided by the user		P

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	are detailed (see Annex B).		
	The size, type, and purpose of ducts, cable trays, or cable supports between the machine and the associated equipment that are to be provided by the user are detailed (see Annex B).		P
	A diagram indicates where space is required for the removal or servicing of the electrical equipment.		P
	An interconnection diagram or table is provided, where it is appropriate. They give full information about all external connections.		P
	Where the electrical equipment is intended to be operated from more than one source of electrical supply, the interconnection diagram or table does indicate the modifications or interconnections required for the use of each supply.		P
17.5	Where it is necessary to facilitate the understanding of the principles of operation, an overview diagram is provided.		P
17.6	The circuit diagram shows the electrical circuits on the machine and its associated electrical equipment.		P
	Any graphical symbol not shown in IEC 60617-DB:2001 are separately described on the diagrams or supporting documents.		P
	The symbols and identification of components and devices are consistent throughout all documents and on the machine.		P
	Switch symbols on the electromechanical diagrams are shown with all supplies turned off (for example electricity, air, water, lubricant) and with the machine and its electrical equipment ready for a normal start.		P
	Conductors are identified in accordance with 13.2.		P
	Characteristics relating to the function of the control devices and components which are not evident from their symbolic representation are included on the diagrams adjacent to the symbol or referenced to a footnote.		P
17.7	An operating manual detailing proper procedures for set-up and use of the electrical equipment is provided.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Particular attention is given to the safety measures.		P
	Where the operation of the equipment can be programmed, detailed information on methods of programming, equipment required, program verification, and additional safety procedures (where required) is given.		P
17.8	A maintenance manual detailing proper procedures for adjustment, servicing and preventive inspection, and repair is provided. Recommendations on maintenance/service intervals and records are part of that manual. Where methods for the verification of proper operation are provided (for example software testing programs), the use of those methods is detailed		P
17.9	The parts list, where provided, comprises, as a minimum, information necessary for ordering spare or replacement parts (for example components, devices, software, test equipment, technical documentation) required for preventive or corrective maintenance including those that are recommended to be carried in stock by the user of the equipment.		P
18	**VERFICATION**		P
18.1	The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b) and f) and may include one or more of the items c) to e):		-
	a) verification that the electrical equipment complies with its technical documentation; b) in case of protection against indirect contact by automatic disconnection, conditions for protection by automatic disconnection shall be verified according to 18.2; c) insulation resistance test (see 18.3); d) voltage test (see 18.4); e) protection against residual voltage (see 18.5); f) functional tests (see 18.6).		
18.2	Verification of conditions for protection by		

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	automatic disconnection of supply		
18.2.2	Test 1: Verification of the continuity of the protective bonding circuit		-
	The resistance of each protective bonding circuit between the PE terminal and relevant points that are part of each protective bonding circuit is measured with a current between at least 0,2 A. And the resistance measured is in the expected range according to the length, the cross sectional area and the material of the related protective bonding conductor.		P
	Test 2: Fault loop impedance verification and suitability of the associated overcurrent protective device.		P
	The connections of the power supply and of the incoming external protective conductor to the PE terminal of the machine are verified by inspection.		P
	The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A a verified by both: 1) A verification of the fault loop impedance by calculation, or - measurement in accordance with A.4, and		P
	2) A confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A or table 10		P
18.3	Insulation resistance tests (facultative) The insulation resistance measured at 500 V d.c. between the power circuit conductors and the protective bonding circuit are not less than 1 MΩ.		P
18.4	Voltage test (facultative) Testing voltage; twice the rated supply voltage of the equipment or 1 000 V whichever is the greater With test voltage applied between the power circuit conductors and the protective bonding circuit for a period of approximately 1 s. there is no disruptive discharge occurred.		P
18.5	Protection against residual voltages (facultative) Compliance with 6.2.4. is ensured		P
18.6	Functional tests The function of circuits for electrical safety (for		P

IEC 60204-1			
Clause	Requirement - Test	Result - Remark	Verdict
	example earth fault detection) is insured.		

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Clause	Requirement - Test	Result - Remark	Verdict

(ATTACHMENT TO TEST REPORT IEC 60204-1,
European Group Differences and National Differences **)**

ATTACHMENT TO TEST REPORT IEC 60204-1 EUROPEAN GROUP DIFFERENCES AND NATIONAL DIFFERENCES **Safety of machinery - Electrical equipment of machines** **Part 1: General requirements**
Differences according to .....: EN 60204-1:2018
Attachment Form No.....: EU_GD_IEC60204_1A **Attachment Originator .....**: Electrosuisse **Master Attachment**.....: 2019-11

	CENELEC COMMON MODIFICATIONS (EN)		
1.	Scope		-
	– are sewing machines, units, and systems; NOTE 7 For sewing machines, see EN 60204-31. – are hoisting machines. NOTE 8 For hoisting machines, see EN 60204-32.		-
3.	Terms and definitions		-
3.56	Uncontrolled stop NOTE This definition does not imply any particular state of other (for example, non-electrical) stopping devices, for example, mechanical or hydraulic brakes that are outside the scope of this standard.		-
4.2	Section of equipment		P
4.2.2	The electrical equipment of the machine shall satisfy the safety requirements identified by the risk assessment of the machine.		P
	Depending upon the machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the machine that are in compliance with EN 60439-1 and, as necessary, other relevant parts of the EN 60439 series (see also Annex F).		P
4.4	Physical environment and operating conditions		P
4.4.1	The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use.		P
	The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of machines covered by this part of EN 60204.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	When special conditions apply or the limits specified are exceeded, an agreement between user and supplier (see 4.1) is recommended (see Annex B).		P
4.4.3	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature.		P
	The minimum requirement for all electrical equipment is correct operation between air temperatures of +5 °C and +40 °C. For very hot environments (for example hot climates, steel mills, paper mills) and for cold environments, additional measures are recommended (see Annex B).		P
4.4.7	When equipment is subject to radiation (for example microwave, ultraviolet, lasers, X-rays), additional measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation.	No radiation subjected.	N
	A special agreement is recommended between the supplier and the user (see Annex B).		P
4.4.8	Undesirable effects of vibration, shock and bump (including those generated by the machine and its associated equipment and those created by the physical environment) shall be avoided by the selection of suitable equipment, by mounting it away from the machine, or by provision of anti-vibration mountings.		P
	A special agreement is recommended between the supplier and the user (see Annex B).		P
5.	Incoming supply conductor terminations and devices for disconnecting and switching off		P
5.1	Add: See 17.8 for the provision of instructions for maintenance.		-
5.4	NOTE 2 Further information on the location and actuation of devices such as those used for the prevention of unexpected start-up is provided in EN 60447.		-
	After the fifth paragraph, replace note 2 with: NOTE 3 The selection of a device should take into account, for example, information derived from the risk assessment, intended use and foreseeable misuse of the device. For example, the use of disconnectors, withdrawable fuse links		P
9.	Control circuits and control functions		P
9.2.6.3	Enabling control (see also 10.9) is a manually activated control function interlock that:		-
	a) when activated allows a machine operation to be initiated by a separate start control		N
	b) when de-activated – initiates a stop function in accordance with		N

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Clause	Requirement - Test	Result - Remark	Verdict
	9.2.5.3, and – prevents initiation of machine operation.		
	Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It should not be possible to defeat the enabling function by simple means.		N
9.2.7.3	Stop:		-
	Cableless control stations shall include a separate and clearly identifiable means to initiate the stop function of the machine or of all the operations that can cause a hazardous situation.		P
	The actuating means to initiate this stop function shall not be marked or labelled as an emergency stop device (see10.7).		P
10.	Operator interface and machine-mounted control devices		P
	Replace table 2 with **Table 2 – Colour coding for push-button actuators and their meanings** Colour / Meaning / Explanation / Examples of application RED / Emergency / Actuate in the event of a hazardous situation or emergency / Emergency stop; Initiation of emergency function (see also 10.2.1) YELLOW / Abnormal / Actuate in the event of an abnormal condition / Intervention to suppress abnormal condition; Intervention to restart an interrupted automatic cycle BLUE / Mandatory / Actuate for a condition requiring mandatory action / Reset function GREEN / Normal / Actuate to initiate normal conditions / (See 10.2.1) WHITE / No specific meaning assigned / For general initiation of functions except for emergency stop / START/ON (preferred) STOP/OFF GREY / No specific meaning assigned / For general initiation of functions except for emergency stop / START/ON STOP/OFF BLACK / No specific meaning assigned / For general initiation of functions except for emergency stop / START/ON STOP/OFF (preferred)		P
12.	Conductors and cables		P
12.7.8	Construction and installation of conductor wire, conductor bar systems and slip-ring assemblies		-
	The protective bonding circuit shall include the covers or cover plates of metal enclosures or underfloor ducts.		P
	Where metal hinges form a part of the bonding circuit, their continuity shall be verified (see Clause 18).		P
17.	Technical documentation		P
17.2	Information to be provided 3) information on the physical environment (for example lighting, vibration, atmospheric contaminants) where appropriate;		P
18.	Verification		P
18.1	General (5th paragraph) For tests in accordance with 18.2 and 18.3, measuring equipment in accordance with the EN 61557 series is applicable.		P
	NOTE For other tests as required by this standard measuring equipment in accordance with relevant IEC or European Standards should		P

IEC60204_1A - ATTACHMENT			
Clause	Requirement - Test	Result - Remark	Verdict
	be used.		
ZA	**ANNEX ZA, Normative references to IEC standards (normative)**		P
	Normative references to international publications with their corresponding European publications		-
	The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.	-	
	NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.		-
ZZ	**ANNEX ZZ, Essential requirements EC directives (informative)**		**P**
	Coverage of Essential Requirements of EC Directives		-
	This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers only the following essential requirements out of those given in Annex I of the EC Directive 98/37/EC:		-
	– 1.1.2 – 1.2 – 1.5.1 – 1.5.4 – 1.6.3 (for isolation of electrical supplies of machinery) – 1.6.4 (for access to electrical equipment) – 1.7.0 – 1.7.1 – 1.7.2 (for residual risks of an electrical nature) – 1.7.4(c)		-
	Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.		-
	WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.		-

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Clause	Requirement - Test	Result - Remark	Verdict

1. Continuity of the protective bonding circuit

Test Points	Test Result	Requirment	Test Current(A)	Voltage Drop(V)	Verdict
PE-Control Panel	54 mΩ	< 100 mΩ	100	0,68	P
PE-Electrical Box	67 mΩ	< 100 mΩ	100	0,58	P
PE-Accessible metal	58 mΩ	< 100 mΩ	100	0,58	P

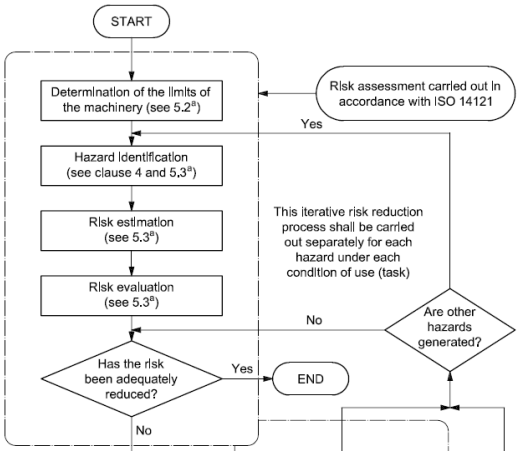
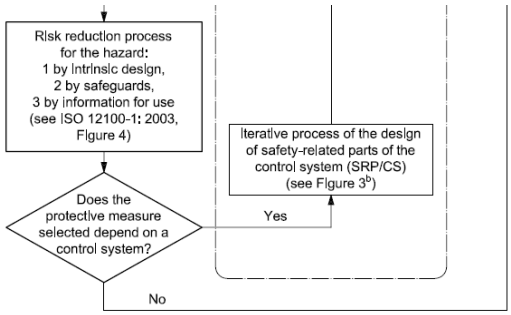
2. Insulation Resistance

Test Points	Requirement	Test Result(MΩ)	Verdict
L-Control Panel	Min 4 MΩ	250	P
L-Electrical Box	Min 4 MΩ	220	P

Test voltage: 500V DC

3. Withstanding Voltage

Test Points	Test voltage	Breakdown	Verdict
L-Control Panel	1460V 60s 5mA	No	P
L-Electrical Box	1460V 60s 5mA	No	P

EN ISO13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
4	**Design considerations**		-
4.1	**Safety objectives in design**		-
	The SRP/CS shall be designed and constructed so that the principles of ISO 12100 and ISO 14121 are fully taken into account (see Figures 1 and 3).		P
	All intended use and reasonable foreseeable misuse shall be considered.		P
			-
			-
	a Refers to ISO 12100-1:2003.		-
	b Refers to this part of ISO 13849.		-
	Figure 1 - Overview of risk assessment/risk reduction		-
4.2	**Strategy for risk reduction**		-
4.2.1	**General**		-
	The strategy for risk reduction at the machine is given in ISO 12100-1:2003, Clause 5, and further guidance is given in ISO 12100-2:2003, Clauses 4 (inherent design measures) and 5 (safeguarding and complementary protective measures).		P
	This strategy covers the whole life cycle of the		P

EN ISO13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	machine.		
	The hazard analysis and risk reduction process for a machine requires that hazards are eliminated or reduced through a hierarchy of measures:		P
	- hazard elimination or risk reduction by design (see ISO 12100-2:2003, Clause 4);		P
	- risk reduction by safeguarding and possibly complementary protective measures (see ISO 12100-2:2003, Clause 5);		P
	- risk reduction by the provision of information for use about the residual risk (see ISO 12100-2:2003, Clause 6).		P
4.2.2	**Contribution to the risk reduction by the control system**		-
	The purpose in following the overall design procedure for the machine is to achieve the safety objectives (see 4.1).		P
	The design of the SRP/CS to provide the required risk reduction is an integral subset of the overall design procedure for the machine.		P
	The SRP/CS provides safety function(s) at a PL which achieves the required risk reduction. In providing safety function(s), either as an inherently safe part of the design or as a control for a safeguard or protective device, the design of the SRP/CS is a part of the strategy for risk reduction.		P
	This is an iterative process and is illustrated in Figures 1 and 3.		P
	For each safety function, the characteristics (see Clause 5) and the required performance level shall be specified and documented in the safety requirements specification.		P
	In this part of ISO 13849 the performance levels are defined in terms of probability of dangerous failure per hour.		P
	Five performance levels (a to e) are set out, with defined ranges of probability of a dangerous failure per hour (see Table 3).		P

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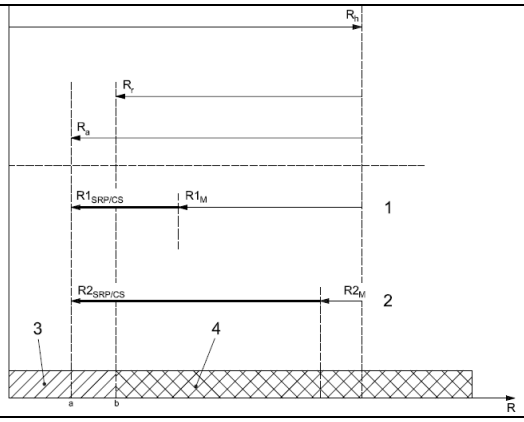
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

Table 3 - Performance levels (PL)

PL	Average probability of dangerous failure per hour 1/h
a	>=10^{-5} to < 10-4
b	>=3 x 10^{-6} to < 10^{-5}
c	>=10^{-6} to < 3 x 10^{-6}
d	>=10^{-7} to < 10^{-6}
e	>=$10^{-8}$to < 10^{-7}

NOTE Besides the average probabilily of dangerous failure per hour other measures are also necessary 10 achieve the PL

	From the risk assessment (see ISO 14121) at the machine, the designer shall decide the contribution to the reduction of risk which needs to be provided by each relevant safety function which is carried out by the SRP/CS(s).		P
	This contribution does not cover the overall risk of the machinery under control, e.g. not the overall risk of a mechanical press, or washing machine is considered, but that part of risk reduced by the application of particular safety functions.		P
	Examples of such functions are the stopping function initiated by using an electro-sensitive protective device on a press or the door-locking function of a washing machine.		P
	Risk reduction can be achieved by applying various protective measures (both SRP/CS and non SRP/CS) with the end result of achieving a safe condition (see Figure 2).		P
			P
	Key		P
	Rh for a specific hazardous situation, the risk before protective measures are applied		P
	Rr risk reduction required from protective		P

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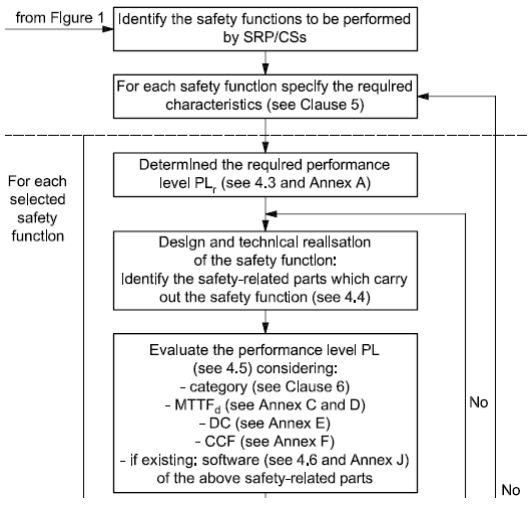
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	measures		
	Ra actual risk reduction achieved with protective measures		P
	1 solution 1 - important part of risk reduction due to protective measures other than SRP/CS (e.g. mechanical measures), small part of risk reduction due to SRP/CS		P
	2 solution 2 - important part of risk reduction due to the SRP/CS (e.g. light curtain), small part of risk reduction due to protective measures other than SRP/CS (e.g. mechanical measures)		P
	3 adequately reduced risk		P
	4 inadequately reduced risk		P
	R risk		P
	a residual risk obtained by solutions 1 and 2		P
	b adequately reduced risk		P
	R1SRP/CS R2SRP/CS risk reduction from the safety function carried out by the SRP/CS		P
	R1M, R2M risk reduction from protective measures other than SRP/CS (e.g. mechanical measures)		P
	NOTE See ISO 12100 for further information on risk reduction.		-
	Figure 2 - Overview of the risk reduction process for each hazardous situation		-
			P

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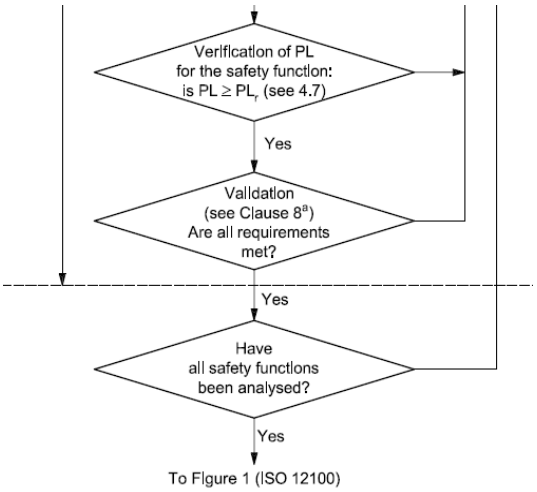
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
			
	a ISO 13849-2 provides additional help for the validation.		P
	Figure 3 - Iterative process for design of safety-related parts of control systems (SRP/CS)		-
4.3	**Determination of required performance level (PLr)**		-
	For each selected safety function to be carried out by a SRP/CS, a required performance level (PLr) shall be determined and documented (see Annex A for guidance on determining PLr).		P
	The determination of the required performance level is the result of the risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system (see Figure 2).		P
	The greater the amount of risk reduction required to be provided by the SRP/CS, the higher the PLr shall be.		P
4.4	**Design of SRP/CS**		-
	Part of the risk reduction process is to determine the safety functions of the machine. This will include the safety functions of the control system, e.g. prevention of unexpected start-up.		P
	A safety function may be implemented by one or more SRP/CS, and several safety functions may		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	share one or more SRP/CS [e.g. a logic unit, power control element(s)].		
	It is also possible that one SRP/CS implements safety functions *and* standard control functions.		P
	The designer may use any of the technologies available, singly or in combination. SRP/CS may also provide an operational function (e.g. an AOPD as a means of cycle initiation).		P
	A typical safety function diagrammatic presentation is given in Figure 4 showing a combination of safetyrelated parts of control systems (SRP/CS) for		P
	- input (SRP/CSa),		P
	- logic/processing (SRP/CSb),		P
	- output/power control elements (SRP/CSc), and		P
	- interconnecting means (*i*ab, *i*bc) (e.g. electrical, optical).		P
	NOTE 1 Within the same machinery it is important to distinguish between different safety functions and their related SRP/CS carrying out a certain safety function.		P
	Having identified the safety functions of the control system, the designer shall identify the SRP/CS (see Figures 1 and 3) and, where necessary, shall assign them to input, logic and output and, in the case of redundancy, the individual channels, and then evaluate the performance level PL (see Figure 3).		P
	NOTE 2 Designated architectures are given in Clause 6.		P
	NOTE 3 All interconnecting means are included in the safety-related parts.		P

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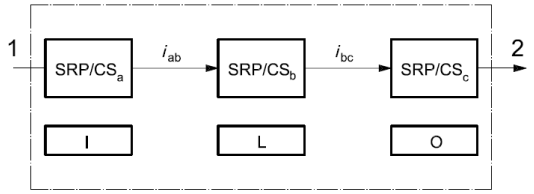
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
			P
	Key		P
	I input		P
	L logic		P
	O output		P
	1 initiation event (e.g. manual actuation of a push button, opening of guard, interruption of beam of AOPD)		P
	2 machine actuator (e.g. motor brakes)		P
	Figure 4 - Diagrammatic presentation of combination of safety-related parts of control systems for processing typical safety function		P
4.5	**Evaluation of the achieved performance level PL and relationship with SIL**		-
4.5.1	**Performance level PL**		-
	For the purposes of this part of ISO 13849, the ability of safety-related parts to perform a safety function is expressed through the determination of the performance level.		P
	For each selected SRP/CS and/or for the combination of SRP/CS that performs a safety function the estimation of PL shall be done.		P
	The PL of the SRP/CS shall be determined by the estimation of the following aspects:		P
	- the MTTFd value for single components (see Annexes C and D);		P
	- the DC (see Annex E);		P
	- the CCF (see Annex F);		P
	- the structure (see Clause 6);		P
	- the behaviour of the safety function under fault condition(s) (see Clause 6);		P
	- safety-related software (see 4.6 and Annex J);		P
	- systematic failure (see Annex G);		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- the ability to perform a safety function under expected environmental conditions.		P
	NOTE 1 Other parameters, e.g. operational aspects, demand rate, test rate, can have certain influence.		P
	These aspects can be grouped under two approaches in relation to the evaluation process:		P
	a) quantifiable aspects (MTTFd value for single components, DC, CCF, structure);		P
	b) non-quantifiable, qualitative aspects which affect the behaviour of the SRP/CS (behaviour of the safety function under fault conditions, safety-related software, systematic failure and environmental conditions).		P
	Among the quantifiable aspects, the contribution of reliability (e.g. MTTFd, structure) can vary with the technology used.		P
	For example, it is possible (within certain limits) for a single channel of safety-related parts of high reliability in one technology to provide the same or higher PL as a fault-tolerant structure of lower reliability in another technology.		P
	There are several methods for estimating the quantifiable aspects of the PL for any type of system (e.g. a complex structure), for example, Markov modelling, generalized stochastic petri nets (GSPN), reliability block diagrams [see, e.g. IEC 61508].		P
	To make the assessment of the quantifiable aspects of the PL easier, this part of ISO 13849 provides a simplified method based on the definition of five designated architectures that fulfil specific design criteria and behaviour under a fault condition (see 4.5.4).		P
	For a SRP/CS or combination of SRP/CS designed according to the requirements given in Clause 6, the average probability of a dangerous		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	failure could be estimated by means of Figure 5 and the procedure given in Annexes A to H, J and K.		
	For a SRP/CS which deviates from the designated architectures, a detailed calculation shall be provided to demonstrate the achievement of the required performance level (PLr).		P
	In applications where the SRP/CS can be considered simple, and the required performance level is a to c, a qualitative estimation of the PL may be justified in the design rationale.		P
	NOTE 2 For the design of complex control systems, such as PES designed to perform safety functions, the application of other standards can be appropriate (e.g. IEC 61508, IEC 62061 or IEC 61496).		P
	The achievement of qualitative aspects of the PL can be demonstrated by the application of the recommended measures given in 4.6 and Annex G.		P
	In standards in accordance with IEC 61508, the ability of safety-related control systems to perform a safety function is given through a SIL. Table 4 displays the relationship between the two concepts (PLs and SILs).		P
	PL a has no correspondence on the SIL scale and is mainly used to reduce the risk of slight, normally reversible, injury.		P
	Since SIL 4 is dedicated to catastrophic events possible in the process industry, this range is not relevant for risks at machines.		P
	Thus PL e corresponding to SIL 3 is defined as the highest level.		P

Table 4 - Relationship between performance level (PL) and safety integrity level (SIL)

PL	**SIL** (IEC 61508, for information) high/continuous mode of operation
a	No correspondence
b	1
c	1
d	2

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
e	3		
	Therefore, protective measures to reduce the risk shall be applied, principally the following.		P
	- Reduce the probability of faults at the component level. The aim is to reduce the probability of faults or failures which affect the safety function.		P
	This can be done by increasing the reliability of components, e.g. by selection of well-tried components and/or applying well-tried safety principles, in order to minimize or exclude critical faults or failures (see ISO 13849-2).		P
	- Improve the structure of the SRP/CS. The aim is to avoid the dangerous effect of a fault. Some faults may be detected and a redundant and/or monitored structure could be needed.		P
	Both measures can be applied separately or in combination.		P
	With some technologies, risk reduction can be achieved by selecting reliable components and by fault exclusions; but with other technologies, risk reduction could require a redundant and/or monitored system.		P
	In addition, common cause failures (CCF) shall be taken into account (see Figure 3).		P
	For architectural constraints, see Clause 6.		P
4.5.2	**Mean time to dangerous failure of each channel ($MTTF_d$)**		-
	The value of the $MTTF_d$ of each channel is given in three levels (see Table 5) and shall be taken into account for each channel (e.g. single channel, each channel of a redundant system) individually.		P
	According to $MTTF_d$, a maximum value of 100 years can be taken into account.		P

Table 5 - Mean time to dangerous failure of each channel ($MTTF_d$)

$MTTF_d$	
Denotation of each channel	Range of each channel

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

Low	3 years <= MTTFd < 10 years
Medium	10 years <= MTTFd < 30 years
High	30 years <= MTTFd <=100 years

Note 1 The choice of Ihe MTTFd ranges of each channel is based on failure rales found in the field as state-of-the-art, forming a kind loganthmlc scale fitung to the |oga lthmlC PL scale An MaTbToFudt value of each charnneless than thee yeamls not expected to be found real SRP/CS since this would mean Ihalafter one year about 30 % of all syslems on the market will fail and will need 10 be replaced An MTTF d value of each of each channel greater than 100 years is not acceptable because SRP/CS for hight risks should not depend on the liabilily of componenls alone. To reinforce the SRP/CS against systemalic and random failure addilional means such as redundancy d lesling should be required. To be praclicable the number of ranges was reslricled 10 Ihree. The limilalion of MTTFd of each channel use 10 a maximum of 100 years refers 10 the single channel of Ihe SRP/CS which carries oulIhe safely function. Higher MTTF d uses can be used for single components (see Table 0.1)
Note The indicaled borders of Ihis lable are assumed wilhin an accuracy of 5 %

	For the estimation of $MTTF_d$ of a component, the hierarchical procedure for finding data shall be, in the order given:		P
	a) use manufacturer's data;		P
	b) use methods in Annexes C and D;		P
	c) choose ten years.		P
4.5.3	**Diagnostic coverage (DC)**		-
	The value of the DC is given in four levels (see Table 6).		P
	For the estimation of DC, in most cases, failure mode and effects analysis (FMEA, see IEC 60812) or similar methods can be used.		P
	In this case, all relevant faults and/or failure modes should be considered and the PL of the combination of the SRP/CS which carry out the safety function should be checked against the required performance level (PL_r).		P
	For a simplified approach to estimating DC, see Annex E.		P

Table 6 - Diagnostic coverage (DC)

DC	
Denotation	Range
None	DC < 60 %
Low	60% <= DC < 90 %
Medium	90% <= DC < 99 %

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

High	99 % <= DC

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

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

4.5.4	**Simplified procedure for estimating PL**		-
	The PL may be estimated by taking into account all relevant parameters and the appropriate methods for calculation (see 4.5.1).		P
	This clause describes a simplified procedure for estimating the PL of a SRP/CS based on designated architectures.		P
	Some other architectures with similar structure may be transformed to these designated architectures in order to obtain an estimation of the PL.		P
	The designated architectures are represented as block diagrams, and are listed in the context of each category in 6.2. Information about the block method and the safety-related block diagrams are given in 6.2 and Annex B.		P
	The designated architectures show a logical representation of the system structure for each category.		P
	The technical realization or, for example, the functional circuit diagram, may look completely different.		P
	The designated architectures are drawn for the combined SRP/CS, starting at the points where the safetyrelated signals are initiated and ending at the output of the power control elements (see also ISO 12100-1:2003, Annex A).		P
	The designated architectures can also be used to describe a part or subpart of a control system that responds to input signals and generates safety-related output signals.		P
	Thus the “input” element can represent, for example, a light curtain (AOPD) as well as input circuits of control logic elements or input switches.		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	“Output” can also represent, for example, an output signal switching device (OSSD) or outputs of laser-scanners.		P
	For the designated architectures, the following typical assumptions are made:		P
	- mission time, 20 years (see Clause 10);		P
	- constant failure rates within the mission time;		P
	- for category 2, demand rate u 1/100 test rate;		P
	- for category 2, $MTTF_{d,TE}$ larger than half of $MTTF_{d,L}$.		P
	NOTE When blocks of each channel cannot be separated, the following can be applied: $MTTF_d$ of the summarized test channel (TE, OTE) larger then half $MTTF_d$ of the summarized functional channel (I, L, O).		P
	The methodology considers the categories as architectures with defined DC_{avg}. T		P
	he PL of each SRP/CS depends on the architecture, the mean time to dangerous failure ($MTTF_d$) in each channel and the DC_{avg}.		P
	Common cause failures (CCF) should also be taken into account (for guidance, see Annex F).		P
	For SRP/CS with software, the requirements of 4.6 apply.		P
	If quantitative data is not available or not used (e.g. low complexity systems), the worst case of all relevant parameters should be chosen.		P
	A combination of SRP/CS or a single SRP/CS may have a PL.		P
	The combination of several SRP/CS with different PL is considered in 6.3.		P
	In the case of applications with PL_r a to c, measures to avoid faults can be sufficient; for higher risk applications, PL_r d to e, the structure of the SRP/CS can provide measures for avoiding, detecting or tolerating faults. Practical measures include redundancy, diversity, monitoring (see also ISO 12100-2:2003, Clause 3 and IEC 60204-1:2000).		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Figure 5 shows the procedure for the selection of categories in combination with the $MTTF_d$ of each channel and DC_{avg} to achieve the required PL of the safety function.		P
	For the estimation of the PL, Figure 5 gives the different possible combinations of category with Dc_{avg} (horizontal axis) and the $MTTF_d$ of each channel (bars). The bars in the diagram represent the three $MTTF_d$ ranges of each channel (low, medium and high) which can be selected to achieve the required PL.		P
	Before using this simplified approach with Figure 5 (which represents results of different Markov models based on designated architectures of Clause 6), the category of the SRP/CS as well as DC_{avg} and the $MTTF_d$ of each channel shall be determined (see Clause 6 and Annexes C to E).		P
	For categories 2, 3 and 4, sufficient measures against common cause failure shall be carried out (for guidance, see Annex F).		P
	Taking these parameters into account, Figure 5 provides a graphical method for determining the PL, achieved by the SRP/CS.		P
	The combination of category (including common cause failure) and Dc_{avg} determines which column of Figure 5 is to be chosen.		P
	According to the $MTTF_d$ of each channel, one of the three different shaded areas of the relevant column shall be chosen.		P
	The vertical position of this area determines the achieved PL which can be read off the vertical axis. If the area covers two or three possible PLs, the PL achieved is given in Table 7.		P
	For a more precise numerical selection of PL depending on the precise value of $MTTF_d$ of each channel, see Annex K.		P

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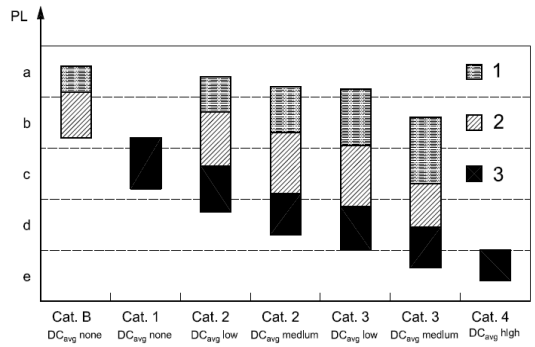
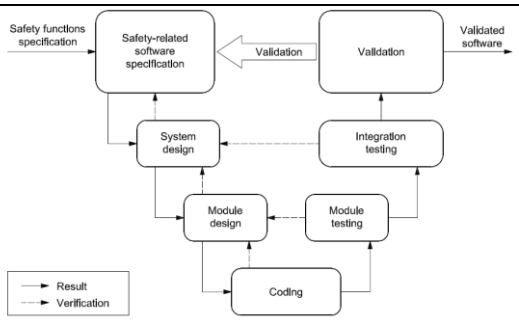
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
			-
	Key		-
	PL performance level		-
	1 MTTFd of each channel low		-
	2 MTTFd of each channel medium		-
	3 MTTFd of each channel high		-
	Figure 5 - Relationship between categories, DC_{avg}, $MTTF_d$ of each channel and PL		-

Table 7 - Simplified procedure for evaluating PL achieved by SRP/CS

Caegory	B	1	2	2	3	3	4
DC avg	none	none	low	medium	low	medium	high
MTTFd of each channel							
Low	a	Not covered	a	b	b	C	Not covered
Medium	b	Not covered	b	C	C	d	Not covered
High	Not covered	C	C	d	d	d	e

4.6	**Software safety requirements**		-
4.6.1	**General**		-
	All lifecycle activities of safety-related embedded or application software shall primarily consider the avoidance of faults introduced during the software lifecycle (see Figure 6).		P
	The main objective of the following requirements is to have readable, understandable, testable and maintainable software.		P
			P
	NOTE Annex J gives more detailed		-

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	recommendations for lifecycle activities.		
	Figure 6 - Simplified V-model of software safety lifecycle		-
4.6.2	**Safety-related embedded software (SRESW)**		-
	For SRESW for components with PLr a to d, the following basic measures shall be applied:		P
	- software safety lifecycle with verification and validation activities, see Figure 6;		P
	- documentation of specification and design;		P
	- modular and structured design and coding;		P
	- control of systematic failures (see G.2);		P
	- where using software-based measures for control of random hardware failures, verification of correct implementation;		P
	- functional testing, e.g. black box testing;		P
	- appropriate software safety lifecycle activities after modifications.		P
	For SRESW for components with PLr c or d, the following additional measures shall be applied:		P
	- project management and quality management system comparable to, e.g. IEC 61508 or ISO 9001;		P
	- documentation of all relevant activities during software safety lifecycle;		P
	- configuration management to identify all configuration items and documents related to a SRESW release;		P
	- structured specification with safety requirements and design;		P
	- use of suitable programming languages and computer-based tools with confidence from use;		P
	- modular and structured programming, separation in non-safety-related software, limited module sizes with fully defined interfaces, use of design and coding standards;		P
	- coding verification by walk-through/review with		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	control flow analysis;		
	- extended functional testing, e.g. grey box testing, performance testing or simulation;		P
	- impact analysis and appropriate software safety lifecycle activities after modifications.		P
	SRESW for components with PLr =e shall comply with IEC 61508-3:1998, Clause 7, appropriate for SIL 3.		P
	When using diversity in specification, design and coding, for the two channels used in SRP/CS with category 3 or 4, PLr =e can be achieved with the above-mentioned measures for PLr of c or d.		P
	NOTE 1 For a detailed description of such measures, see, e.g. IEC 61508-7:2000.		P
	NOTE 2 For SRESW with diversity in design and coding, for components used in SRP/CS with category 3 or 4, the effort involved in taking measures to avoid systematic failures can be reduced by, for example, reviewing parts of the software only by considering structural aspects instead of checking each line of code.		P
4.6.3	**Safety-related application software (SRASW)**		-
	The software safety lifecycle (see Figure 6) applies also to SRASW (see Annex J).		P
	SRASW written in LVL and complying with the following requirements can achieve a PL a to e. If SRASW is written in FVL, the requirements for SRESW shall apply and PL a to e is achievable.		P
	If a part of the SRASW within one component has any impact (e.g. due to its modification) on several safety functions with different PL, then the requirements related to the highest PL shall apply.		P
	For SRASW for components with PLr from a to e, the following basic measures shall be applied:		P
	- development lifecycle with verification and validation activities, see Figure 6;		P
	- documentation of specification and design;		P
	- modular and structured programming;		P
	- functional testing;		P
	- appropriate development activities after modifications.		P
	For SRASW for components with PLr from c to e, the following additional measures with increasing efficiency (lower effectiveness for PLr of c,		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	medium effectiveness for PLr of d, higher effectiveness for PLr of e) are required or recommended.		
	a) The safety-related software specification shall be reviewed (see also Annex J), made available to every person involved in the lifecycle and shall contain the description of:		P
	1) safety functions with required PL and associated operating modes,		P
	2) performance criteria, e.g. reaction times,		P
	3) hardware architecture with external signal interfaces, and		P
	4) detection and control of external failure.		P
	b) Selection of tools, libraries, languages:		P
	1) Suitable tools with confidence from use: for PL =e achieved with one component and its tool, the tool shall comply with the appropriate safety standard; if two diverse components with diverse tools are used, confidence from use may be sufficient.		P
	Technical features which detect conditions that could cause systematic error (such as data type mismatch, ambiguous dynamic memory allocation, incomplete called interfaces, recursion, pointer arithmetic) shall be used.		P
	Checks should mainly be carried out during compile time and not only at runtime.		P
	Tools should enforce language subsets and coding guidelines or at least supervise or guide the developer using them.		P
	2) Whenever reasonable and practicable, validated function block (FB) libraries should be used - either safety-related FB libraries provided by the tool manufacturer (highly recommended for PL =e) or validated application specific FB libraries and in conformity with this part of ISO 13849.		P

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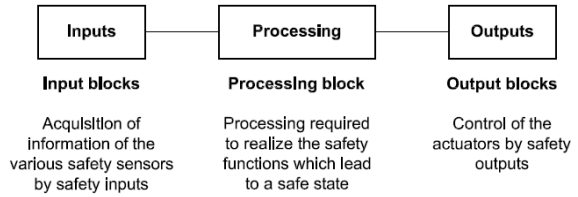
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	3) A justified LVL-subset suitable for a modular approach should be used, e.g. accepted subset of IEC 61131-3 languages. Graphical languages (e.g. function block diagram, ladder diagram) are highly recommended.		P
	c) Software design shall feature:		P
	1) semi-formal methods to describe data and control flow, e.g. state diagram or program flow chart,		P
	2) modular and structured programming predominantly realized by function blocks deriving from safetyrelated validated function block libraries,		P
	3) function blocks of limited size of coding,		P
	4) code execution inside function block which should have one entry and one exit point,		P
	5) architecture model of three stages, Inputs ⇒ Processing ⇒ Outputs (see Figure 7 and Annex J),		P
	6) assignment of a safety output at only one program location, and		P
	7) use of techniques for detection of external failure and for defensive programming within input, processing and output blocks which lead to safe state.		P
			P
	Figure 7 - General architecture model of software		-
	d) Where SRASW and non-SRASW are combined in one component:		P
	1) SRASW and non-SRASW shall be coded in different function blocks with well-defined data links;		P
	2) there shall be no logical combination of		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	non-safety-related and safety-related data which could lead to downgrading of the integrity of safety-related signals, for example, combining safety-related and non-safety-related signals by a logical “OR” where the result controls safety-related signals.		
	e) Software implementation/coding:		P
	1) code shall be readable, understandable and testable and, because of this symbolic variables (instead of explicit hardware addresses) should be used;		P
	2) justified or accepted coding guidelines shall be used (see also Annex J);		P
	3) data integrity and plausibility checks (e.g. range checks.) available on application layer (defensive programming) should be used;		P
	4) code should be tested by simulation;		P
	5) verification should be by control and data flow analysis for PL = d or e.		P
	f) Testing:		P
	1) the appropriate validation method is black-box testing of functional behaviour and performance criteria (e.g. timing performance);		P
	2) for PL d or e, test case execution from boundary value analysis is recommended;		P
	3) test planning is recommended and should include test cases with completion criteria and required tools;		P
	4) I/O testing shall ensure that safety-related signals are correctly used within SRASW.		P
	g) Documentation:		P
	1) all lifecycle and modification activities shall be documented;		P
	2) documentation shall be complete, available, readable and understandable;		P
	3) code documentation within source text shall		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	contain module headers with legal entity, functional and I/O description, version and version of used library function blocks, and sufficient comments of networks/statement and declaration lines.		
	h) Verification2)		P
	EXAMPLE Review, inspection, walkthrough or other appropriate activities.		P
	i) Configuration management		P
	It is highly recommended that procedures and data backup be established to identify and archive documents, software modules, verification/validation results and tool configuration related to a specific SRASW version.		P
	j) Modifications		P
	After modifications of SRASW, impact analysis shall be performed to ensure specification.		P
	Appropriate lifecycle activities shall be performed after modifications. Access rights to modifications shall be controlled and modification history shall be documented.		P
	NOTE Modification does not affect systems already in use.		P
4.6.4	**Software-based parameterization**		-
	Software-based parameterization of safety-related parameters shall be considered as a safety-related aspect of SRP/CS design to be described in the software safety requirements specification.		P
	Parameterization shall be carried out using a dedicated software tool provided by the supplier of the SRP/CS.		P
	This tool shall have its own identification (name, version, etc.) and shall prevent unauthorized modification, for example, by use of a password.		P
	The integrity of all data used for parameterization shall be maintained.		P
	This shall be achieved by applying measures to		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- control the range of valid inputs,		P
	- control data corruption before transmission,		P
	- control the effects of errors from the parameter transmission process,		P
	- control the effects of incomplete parameter transmission, and		P
	- control the effects of faults and failures of hardware and software of the tool used for parameterization.		P
	The parameterization tool shall fulfil all requirements for SRP/CS according to this part of ISO 13849.		P
	Alternatively, a special procedure shall be used for setting the safety-related parameters.		P
	This procedure shall include confirmation of input parameters to the SRP/CS by either		P
	- retransmission of the modified parameters to the parameterization tool, or		P
	- other suitable means of confirming the integrity of the parameters, as well as subsequent confirmation, e.g. by a suitably skilled person and by means of an automatic check by a parameterization tool.		P
	NOTE 1 This is of particular importance where parameterization is carried out using a device not specifically intended for the purpose (e.g. personal computer or equivalent).		P
	The software modules used for encoding/decoding within the transmission/retransmission process and software modules used for visualization of the safety-related parameters to the user shall, as a minimum, use diversity in function(s) to avoid systematic failures.		P
	Documentation of software-based parameterization shall indicate data used (e.g. pre-defined parameter sets) and information		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	necessary to identify the parameters associated with the SRP/CS, the person(s) carrying out the parameterization together with other relevant information such as date of parameterization.		
	The following verification activities shall be applied for software based parameterization:		P
	- verification of the correct setting for each safety-related parameter (minimum, maximum and representative values);		P
	- verification that the safety-related parameters are checked for plausibility, for example by use of invalid values, etc.;		P
	- verification that unauthorized modification of safety-related parameters is prevented;		P
	- verification that the data/signals for parameterization are generated and processed in such a way that faults can not lead to a loss of the safety function.		P
	NOTE 2 This is of particular importance where the parameterization is carried out using a device not specifically intended for this purpose (e.g. personal computer or equivalent).		P
4.7	**Verification that achieved PL meets PLr**		-
	For each individual safety function the PL of the related SRP/CS shall match the required performance level (PLr) determined according to 4.3 (see Figure 3). If this is not the case, an iteration in the process described in Figure 3 is necessary.		P
	The PL of the different SRP/CS which are part of a safety function shall be greater than or equal to the required performance level (PLr) of this safety function.		P
4.8	**Ergonomic aspects of design**		-
	The interface between operators and the SRP/CS shall be designed and realized such that no		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	person is endangered during all intended use and reasonable foreseeable misuse of the machine [see also ISO 12100, EN 614-1, ISO 9355-1, ISO 9355-2, ISO 9355-3, EN 1005-3, IEC 60204-1:2000, Clause 10, IEC 60447 and IEC 61310].		
	Ergonomic principles shall be used so that the machine and the control system, including the safety-related parts, are easy to use, and so that the operator is not tempted to act in a hazardous manner.		P
	The safety requirements for observing ergonomic principles given in ISO 12100-2:2003, 4.8, apply.		P
5	**Safety functions**		-
5.1	**Specification of safety functions**		-
	This clause provides a list and details of safety functions which can be provided by the SRP/CS.		P
	The designer (or type-C standard maker) shall include those necessary to achieve the measures of safety required of the control system for the specific application.		P
	EXAMPLE Safety-related stop function, prevention of unexpected start-up, manual reset function, muting function, hold-to-run function.		P
	NOTE Machinery control systems provide operational and/or safety functions.		P
	Operational functions (e.g. starting, normal stopping) can also be safety functions, but this can be ascertained only after a complete risk assessment on the machinery has been carried out.		P
	Tables 8 and 9 list some typical safety functions and, respectively, certain of their characteristics and safetyrelated parameters, while making reference to other International Standards whose requirements relate to the safety function,		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	characteristic or parameter.		
	The designer (or type-C standard maker) shall ensure that all applicable requirements are satisfied for the relevant safety functions listed in the tables.		P
	Additional requirements are set out in this clause for certain of the safety function characteristics .		P
	Where necessary, the requirements for characteristics and safety functions shall be adapted for use with different energy sources.		P
	As most of the references in Tables 8 and 9 relate to electrical standards, the applicable requirements will need to be adapted in the case of other technologies (e.g. hydraulic, pneumatic).		P

Table 8 - Some International Standards applicable to typical machine safety functions and certain of their characteristics

Safty function / Characteristic	Requirement(s)			For additional information, see:
	This part of ISO 13849	ISO 12100-1:2003	ISO 12100-2:2003	
Safety-related stop function initiated by safetyguard a	5.2.1	3.26.8	4.11.3	IEC 60204-1, 9.2.5.3, 9.2.5.5
Manual reset function	5.2.2	-	-	IEC 60204-1, 9.2.5.3, .2.5.4
Sart / restart function	5.2.3	-	4.11.34.11.4	IEC 60204-1, 9.2.1 9.2.5.19.2.5.29.2.6
Local control function	5.2.4	-	4.11.84.11.10	IEC 60204-1,10.1.5
Muting function	5.2.5	-	-	-
Hold-to-run function		-	4.11.8 b)	IEC 60204-1,9.2.6.1
Enabling device ction		-	-	IEC 60204-1, 9.2.6.3, 10.9
Prevention of expected start-up	-	-	4.11.4	ISO 14118, IEC 60204-1:2005 5.4
Escape and rescue of pped persons	-	-	5.5.3	-
Isolation and energy sipation function	-	-	5.5.4	ISO 14118, IEC 60204-1, 5.36.3.1
Control modes and de selection	-	-	4.11.84.11.10	IEC 60204-1, 9.2.3, 9.2.4
Interaction between ferent safety-related rts of control sytems	-	-	4.11.1 (last sentence)	IEC 60204-1, 9.3.4
Monitoring of rameterization of fety-related input lues	4.6.4	-	-	
Emergency stop function b	-	-	5.5.2	ISO /IEC 13850 I EC 60204-1, 9.2.5.4

a Including interlocked guards and limiting devices (e.g. overspeed, overtemperature, overpressure).

b Complementary protective measure, see ISO 12100.

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

Table 9 - Some International Standards giving requirements for certain safety functions and safety-related parameters

Safety functionl /	Requirement		For additional information, see
safety-related parameter	This part of ISO13849	ISO 12100	ISO 13855, 3.2A.3A.4
response time	5.2.6	-	-
safety-related parameter ch as speedtemperature pressure	5.2.7	4.11.8e)	IEC 60204-1, 7.19.3.29.3.4
Fluctuationsloss and toration of power sources	5.2.8	4.11.8e)	IEC 60204-1:20054.37.17.5
indications and alarms		4.8	ISO 7731 ISO 11428 ISO 11429 IEC 61310 IEC 60204-1, 10.3, 10.4 IEC61131 IEC 62061

	When identifying and specifying the safety function(s), the following shall at least be considered:		P
	a) results of the risk assessment for each specific hazard or hazardous situation;		P
	b) machine operating characteristics, including		P
	- intended use of the machine (including reasonable foreseeable misuse),		P
	- modes of operation (e.g. local mode, automatic mode, modes related to a zone or part of the machine),		P
	- cycle time, and		P
	- response time;		P
	c) emergency operation;		P
	d) description of the interaction of different working processes and manual activities (repairing, setting, cleaning, trouble shooting, etc.);		P
	e) the behaviour of the machine that a safety function is intended to achieve or to prevent;		P
	f) condition(s) (e.g. operating mode) of the machine in which it is to be active or disabled;		P
	g) the frequency of operation;		P
	h) priority of those functions that can be		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	simultaneously active and that can cause conflicting action.		
5.2	**Details of safety functions**		-
5.2.1	**Safety-related stop function**		-
	The following applies in addition to the requirements of Table 8.		P
	A safety-related stop function (e.g. initiated by a safeguard) shall, as soon as necessary after actuation, put the machine in a safe state. Such a stop shall have priority over a stop for operational reasons.		P
	When a group of machines are working together in a coordinated manner, provision shall be made for signalling the supervisory control and/or the other machines that such a stop condition exists.		P
	NOTE A safety-related stop function can cause operational problems and a difficult restart, e.g. in an arc welding application.		P
	To reduce the temptation to defeat this stop function, it can be preceded with a stop for operational reasons to finalize the actual operation and prepare for an easy and quick restart from the stop position (e.g. without any damage of the production).		P
	One solution is the use of interlocking device with guard locking where the guard locking is released when the cycle has reached a defined position where the easy restart is possible.		P
5.2.2	**Manual reset function**		-
	The following applies in addition to the requirements of Table 8.		P
	After a stop command has been initiated by a safeguard, the stop condition shall be maintained until safe conditions for restarting exist.		P
	The re-establishment of the safety function by resetting of the safeguard cancels the stop command.		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	If indicated by the risk assessment, this cancellation of the stop command shall be confirmed by a manual, separate and deliberate action (manual reset).		P
	The manual reset function shall		P
	- be provided through a separate and manually operated device within the SRP/CS,		P
	- only be achieved if all safety functions and safeguards are operative,		P
	- not initiate motion or a hazardous situation by itself,		P
	- be by deliberate action,		P
	- enable the control system for accepting a separate start command,		P
	- only be accepted by disengaging the actuator from its energized (on) position.		P
	The performance level of safety-related parts providing the manual reset function shall be selected so that the inclusion of the manual reset function does not diminish the safety required of the relevant safety function.		P
	The reset actuator shall be situated outside the danger zone and in a safe position from which there is good visibility for checking that no person is within the danger zone.		P
	Where the visibility of the danger zone is not complete, a special reset procedure is required.		P
	NOTE One solution is the use of a second reset actuator. The reset function is initiated within the danger zone by the first actuator in combination with a second reset actuator located outside the danger zone (near the safeguard). This reset procedure needs to be realized within a limited time before the control system accepts a separate start command.		P
5.2.3	**Start/restart function**		-
	The following applies in addition to the		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	requirements of Table 8.		
	A restart shall take place automatically only if a hazardous situation cannot exist. In particular, for interlocking guards with a start function, ISO 12100-2:2003, 5.3.2.5, applies.		P
	These requirements for start and restart shall also apply to machines which can be controlled remotely.		P
	NOTE A sensor feedback signal to the control system can initiate an automatic restart.		P
	EXAMPLE In automatic machine operations, sensor feedback signals to the control system are often used to control the process flow. If a work piece has come out of position, the process flow is stopped.		P
	If the monitoring of the interlocked safeguard is not superior to the automatic process control, there could be a danger of restarting the machine while the operator readjusts the work piece.		P
	Therefore the remotely controlled restart ought not to be allowed until the safeguard is closed again and the maintainer has left the hazardous area.		P
	The contribution of prevention of unexpected start-up provided by the control system is dependant on the result of the risk assessment.		P
5.2.4	**Local control function**		-
	The following applies in addition to the requirements of Table 8.		P
	When a machine is controlled locally, e.g. by a portable control device or pendant, the following requirements shall apply:		P
	- the means for selecting local control shall be situated outside the danger zone;		P
	- it shall only be possible to initiate hazardous conditions by a local control in a zone defined by the risk assessment;		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- switching between local and main control shall not create a hazardous situation.		P
5.2.5	**Muting function**		-
	The following applies in addition to the requirements of Table 8.		P
	Muting shall not result in any person being exposed to hazardous situations. During muting, safe conditions shall be provided by other means.		P
	At the end of muting, all safety functions of the SRP/CS shall be reinstated.		P
	The performance level of safety-related parts providing the muting function shall be selected so that the inclusion of the muting function does not diminish the safety required of the relevant safety function.		P
	NOTE In some applications, an indication signal of muting is necessary.		P
5.2.6	**Response time**		-
	The following applies in addition to the requirements of Table 9.		P
	The response time of the SRP/CS shall be determined when the risk assessment of the SRP/CS indicates that this is necessary (see also Clause 11).		P
	NOTE The response time of the control system is part of the overall response time of the machine. The required overall response time of the machine can influence the design of the safety-related part, e.g. the need to provide a braking system.		P
5.2.7	**Safety–related parameters**		-
	The following applies in addition to the requirements of Table 9.		P
	When safety-related parameters, e.g. position, speed, temperature or pressure, deviate from present limits the control system shall initiate appropriate measures (e.g. actuation of stopping,		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	warning signal, alarm).		
	If errors in manual inputting of safety-related data in programmable electronic systems can lead to a hazardous situation, then a data checking system within the safety-related control system shall be provided, e.g. check of limits, format and/or logic input values.		P
5.2.8	**Fluctuations, loss and restoration of power sources**		-
	The following applies in addition to the requirements of Table 9.		P
	When fluctuations in energy levels outside the design operating range occur, including loss of energy supply, the SRP/CS shall continue to provide or initiate output signal(s) which will enable other parts of the machine system to maintain a safe state.		P
6	**Categories and their relation to MTTFd of each channel, DCavg and CCF**		-
6.1	**General**		-
	The SRP/CS shall be in accordance with the requirements of one or more of the five categories specified in 6.2.		P
	Categories are the basic parameters used to achieve a specific PL.		P
	They state the required behaviour of the SRP/CS in respect of its resistance to faults based on the design considerations described in Clause 4.		P
	Category B is the basic category. The occurrence of a fault can lead to the loss of the safety function.		P
	In category 1 improved resistance to faults is achieved predominantly by selection and application of components.		P
	In categories 2, 3 and 4, improved performance in respect of a specified safety function is achieved predominantly by improving the structure of the		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	SRP/CS.		
	In category 2 this is provided by periodically checking that the specified safety function is being performed.		P
	In categories 3 and 4 this is provided by ensuring that the single fault will not lead to the loss of the safety function.		P
	In category 4, and whenever reasonably practicable in category 3, such faults will be detected.		P
	In category 4 the resistance to the accumulation of faults will be specified.		P
	Table 10 gives an overview of categories of the SRP/CS, the requirements and the system behaviour in case of faults.		P
	When considering the causes of failures in some components it is possible to exclude certain faults (see Clause 7).		P
	The selection of a category for a particular SRP/CS depends mainly upon		P
	- the reduction in risk to be achieved by the safety function to which the part contributes,		P
	- the required performance level (PL_r),		P
	- the technologies used,		P
	- the risk arising in the case of a fault(s) in that part,		P
	- the possibilities of avoiding a fault(s) in that part (systematic faults),		P
	- the probability of occurrence of a fault(s) in that part and relevant parameters,		P
	- the mean time to dangerous failure ($MTTF_d$),		P
	- the diagnostic coverage (DC), and		P
	- the common cause failure (CCF) in the case of categories 2, 3 and 4.		P
6.2	**Specifications of categories**		-
6.2.1	**General**		-

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Each SRP/CS shall comply with the requirements of the relevant category, see 6.2.3 to 6.2.7.		P
	The following architectures typically meet the requirements of the respective category.		P
	The following figures show not examples but general architectures.		P
	A deviation from these architectures is always possible, but any deviation shall be justified, by means of appropriate analytical tools (e.g. Markov modelling, fault tree analysis), such that the system meets the required performance level (PL_r).		P
	The designated architectures cannot be considered only as circuit diagrams but also as logical diagrams.		P
	For categories 3 and 4, this means that not all parts are necessarily physically redundant but that there are redundant means of assuring that a fault cannot lead to the loss of the safety function.		P
	The lines and arrows in Figures 8 to 12 represent logical interconnecting means and logical possible diagnostic means.		P
6.2.2	**Designated architectures**		-
	The structure of a SRP/CS is a key characteristic having great influence on the PL. Even if the variety of possible structures is high, the basic concepts are often similar.		P
	Thus, most structures which are present in the machinery field can be mapped to one of the categories.		P
	For each category, a typical representation as a safety-related block diagram can be made.		P
	These typical realizations are called designated architectures and are listed in the context of each of the following categories.		P
	It is important that the PL shown in Figure 5, depending on the category, $MTTF_d$ of each channel and DC_{avg}, is based on the designated architectures.		P
	If Figure 5 is used to estimate the PL the architecture of the SRP/CS should be demonstrated to be equivalent to the designated		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	architecture of the claimed category. Designs		
	fulfilling the characteristics of the respective category in general are equivalent to the respective designated architecture of the category.		P
	NOTE In some cases arising from a specific technical solution or determined by a type-C standard, the safety-related performance of the SRP/CS can be required only by a category without additional PL_r. For such specific cases, safety is provided particularly by the architecture, and the requirements for MTTF, DC and CCF do not apply.		P
6.2.3	**Category B**		-
	The SRP/CS shall, as a minimum, be designed, constructed, selected, assembled and combined in accordance with the relevant standards and using basic safety principles for the specific application to withstand		P
	- the expected operating stresses, e.g. the reliability with respect to breaking capacity and frequency,		P
	- the influence of the processed material, e.g. detergents in a washing machine, and		P
	- other relevant external influences, e.g. mechanical vibration, electromagnetic interference, power supply interruptions or disturbances.		P
	There is no diagnostic coverage (DC_{avg} none) within category B systems and the $MTTF_d$ of each channel can be low to medium. In such structures (normally single-channel systems), the consideration of CCF is not relevant.		P
	The maximum PL achievable with category B is PL =b.		P
	NOTE When a fault occurs it can lead to the loss of the safety function.		P
	Specific requirements for electromagnetic		P

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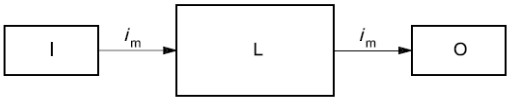
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	compatibility are found in the relevant product standards, e.g. IEC 61800-3 for power drive systems. F		
	or functional safety of SRP/CS in particular, the immunity requirements are relevant. If no product standard exists, at least the immunity requirements of IEC 61000-6-2 should be followed.		P
			-
	Key		-
	i_m interconnecting means		-
	I input device, e.g. sensor		-
	L logic		-
	O output device, e.g. main contactor		-
	Figure 8 - Designated architecture for category B		-
6.2.4	**Category 1**		-
	For category 1, the same requirements as those according to 6.2.3 for category B shall apply. In addition, the following applies.		P
	SRP/CS of category 1 shall be designed and constructed using well-tried components and well-tried safety principles (see ISO 13849-2).		P
	A “well-tried component” for a safety-related application is a component which has been either		P
	a) widely used in the past with successful results in similar applications, or		P
	b) made and verified using principles which demonstrate its suitability and reliability for safety-related applications.		P
	Newly developed components and safety principles may be considered as equivalent to “well-tried” if they fulfil the conditions of b).		P
	The decision to accept a particular component as		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	being “well-tried” depends on the application.		
	NOTE 1 Complex electronic components (e.g. PLC, microprocessor, application-specific integrated circuit) cannot be considered as equivalent to “well tried”.		P
	The $MTTF_d$ of each channel shall be high.		P
	The maximum PL achievable with category 1 is PL =c.		P
	NOTE 2 There is no diagnostic coverage (DC_{avg} = none) within category 1 systems. In such structures (single-channel systems) the consideration of CCF is not relevant.		P
	NOTE 3 When a fault occurs it can lead to the loss of the safety function. However, the $MTTF_d$ of each channel in category 1 is higher than in category B. Consequently, the loss of the safety function is less likely.		P
	It is important that a clear distinction between “well-tried component” and “fault exclusion” (see Clause 7) be made.		P
	The qualification of a component as being well-tried depends on its application.		P
	For example, a position switch with positive opening contacts could be considered as being well-tried for a machine tool, while at the same time as being inappropriate for application in a food industry - in the milk industry, for instance, this switch would be destroyed by the milk acid after a few months.		P
	A fault exclusion can lead to a very high PL, but the appropriate measures to allow this fault exclusion should be applied during the whole lifetime of the device.		P
	In order to ensure this, additional measures outside the control system may be necessary.		P
	In the case of a position switch, some examples of these kinds of measures are		P
	- means to secure the fixing of the switch after its adjustment,		P

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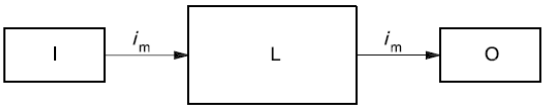
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- means to secure the fixing of the cam,		P
	- means to ensure the transverse stability of the cam,		P
	- means to avoid overtravel of the position switch, e.g. adequate mounting strength of the shock absorber and any alignment devices, and		P
	- means to protect it against damage from outside.		P
			-
	Key		-
	i_m interconnecting means		-
	I input device, e.g. sensor		-
	L logic		-
	O output device, e.g. main contactor		-
	Figure 9 - Designated architecture for category 1		-
6.2.5	**Category 2**		-
	For category 2, the same requirements as those according to 6.2.3 for category B shall apply.		P
	“Well–tried safety principles” according to 6.2.4 shall also be followed. In addition, the following applies.		P
	SRP/CS of category 2 shall be designed so that their function(s) are checked at suitable intervals by the machine control system.		P
	The check of the safety function(s) shall be performed		P
	- at the machine start-up, and		P
	- prior to the initiation of any hazardous situation, e.g. start of a new cycle, start of other movements, and/or periodically during operation if the risk assessment and the kind of operation shows that it is necessary.		P
	The initiation of this check may be automatic. Any check of the safety function(s) shall either - allow		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	operation if no faults have been detected, or		
	- generate an output which initiates appropriate control action, if a fault is detected.		P
	Whenever possible this output shall initiate a safe state.		P
	This safe state shall be maintained until the fault is cleared. When it is not possible to initiate a safe state (e.g. welding of the contact in the final switching device) the output shall provide a warning of the hazard.		P
	For the designated architecture of category 2, as shown in Figure 10, the calculation of $MTTF_d$ and DC_{avg} should take into account only the blocks of the functional channel (i.e. I, L and O in Figure 10) and not the blocks of the testing channel (i.e. TE and OTE in Figure 10).		P
	The diagnostic coverage (DC_{avg}) of the total SRP/CS including fault-detection shall be low.		P
	The $MTTF_d$ of each channel shall be low-to-high, depending on the required performance level (PL_r).		P
	Measures against CCF shall be applied (see Annex F).		P
	The check itself shall not lead to a hazardous situation (e.g. due to an increase in response time).		P
	The checking equipment may be integral with, or separate from, the safety-related part(s) providing the safety function.		P
	The maximum PL achievable with category 2 is PL d.		P
	NOTE 1 In some cases category 2 is not applicable because the checking of the safety function cannot be applied to all components.		P
	NOTE 2 Category 2 system behaviour allows that		P
	- the occurrence of a fault can lead to the loss of the		P

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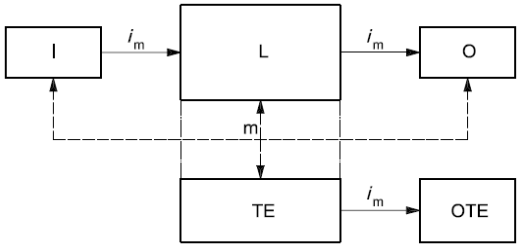
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	safety function between checks,		
	- the loss of safety function is detected by the check.		P
	NOTE 3 The principle that supports the validity of a category 2 function is that the adopted technical provisions, and, for example, the choice of checking frequency can decrease the probability of occurrence of a dangerous situation.		P
			-
	Dashed lines represent reasonably practicable fault detection.		-
	Key		-
	i_m interconnecting means		-
	I input device, e.g. sensor		-
	L logic		-
	m monitoring		-
	O output device, e.g. main contactor		-
	TE test equipment		-
	OTE output of TE		-
	Figure 10 - Designated architecture for category 2		-
6.2.6	**Category 3**		-
	For category 3, the same requirements as those according to 6.2.3 for category B shall apply. “Well-tried safety principles” according to 6.2.4 shall also be followed. In addition, the following applies.		P
	SRP/CS of category 3 shall be designed so that a single fault in any of these parts does not lead to the loss of the safety function.		P
	Whenever reasonably practicable, the single fault shall be detected at or before the next demand		P

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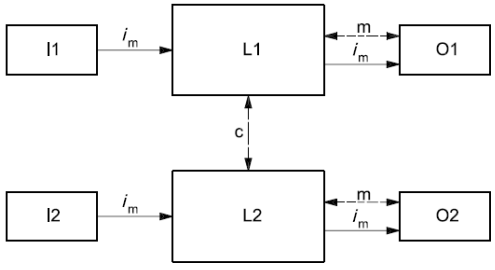
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	upon the safety function.		
	The diagnostic coverage (DC_{avg}) of the total SRP/CS including fault-detection shall be low.		P
	The $MTTF_d$ of each of the redundant channels shall be low-to-high, depending on the PL_r.		P
	Measures against CCF shall be applied (see Annex F).		P
	NOTE 1 The requirement of single-fault detection does not mean that all faults will be detected. Consequently, the accumulation of undetected faults can lead to an unintended output and a hazardous situation at the machine. Typical examples of practicable measures for fault detection are use of the feedback of mechanically guided relay contacts and monitoring of redundant electrical outputs.		P
	NOTE 2 If necessary because of technology and application, type-C standard makers need to give further details on the detection of faults.		P
	NOTE 3 Category 3 system behaviour allows that		P
	- when the single fault occurs the safety function is always performed,		P
	- some but not all faults will be detected,		P
	- accumulation of undetected faults can lead to the loss of the safety function.		P
	NOTE 4 The technology used will influence the possibilities for the implementation of fault detection.		P
			P

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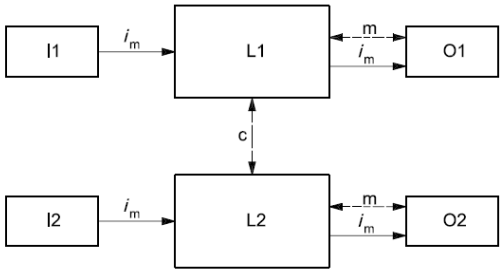
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
			P
	Dashed lines represent reasonably practicable fault detection.		-
	Key		-
	i_m interconnecting means		-
	c cross monitoring		-
	I1, I2 input device, e.g. sensor		-
	L1, L2 logic		-
	m monitoring		-
	O1, O2 output device, e.g. main contactor		-
	Figure 11 - Designated architecture for category 3		-
6.2.7	**Category 4**		-
	For category 4, the same requirements as those according to 6.2.3 for category B shall apply.		P
	“Well-tried safety principles” according to 6.2.4 shall also be followed. In addition, the following applies.		P
	SRP/CS of category 4 shall be designed such that		P
	- a single fault in any of these safety-related parts does not lead to a loss of the safety function, and		P
	- the single fault is detected at or before the next demand upon the safety functions, e.g. immediately, at switch on, or at end of a machine operating cycle, but if this detection is not possible, then an accumulation of undetected faults shall not lead to the loss of the safety function.		P
	The diagnostic coverage (DCavg) of the total SRP/CS shall be high, including the accumulation of faults.		P
	The MTTFd of each of the redundant channels		P

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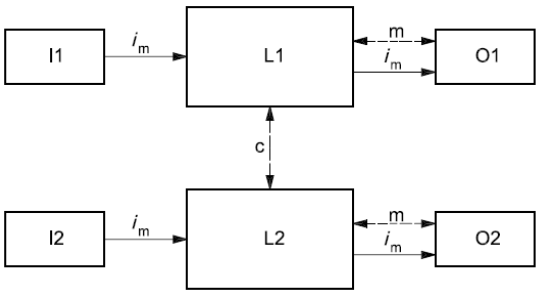
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	shall be high. Measures against CCF shall be applied (see Annex F)		
	NOTE 1 Category 4 system behaviour allows that		-
	- when a single fault occurs the safety function is always performed,		P
	- the faults will be detected in time to prevent the loss of the safety function,		P
	- accumulation of undetected faults is taken into account.		P
	NOTE 2 The difference between category 3 and category 4 is a higher DCavg in category 4 and a required MTTFd of each channel of “high” only.		P
	In practice, the consideration of a fault combination of two faults may be sufficient.		P
			P
	Solid lines for monitoring represent diagnostic coverage that is higher than in the designated architecture for category 3.		P
	Key		P
	*i*m interconnecting means		P
	c cross monitoring		P
	I1, I2 input device, e.g. sensor		P
	L1, L2 logic		P
	m monitoring		P
	O1, O2 output device, e.g. main contactor		P
	Figure 12 - Designated architecture for category 4		P
6.3	**Combination of SRP/CS to achieve overall PL**		-
	A safety function can be realized by a combination of several SRP/CS: input system, signal processing unit, output system.		P

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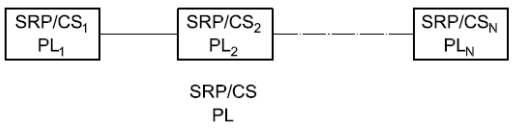
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	These SRP/CS may be assigned to one and/or different categories.		P
	For each SRP/CS used, a category according to 6.2 shall be selected.		P
	For the overall combination of these SRP/CS, an overall PL may be identified using Table 11.		P
	In this case, the validation of the combination of SRP/CS is required (see Figure 3).		P
	According to 6.2, the combined safety-related parts of a control system start at the points where the safety-related signals are initiated and end at the output of the power control elements.		P
	But the combined SRP/CS could consist of several parts connected in a linear (series alignment) or redundant (parallel alignment) way.		P
	To avoid a new complex estimation of the performance level (PL) achieved by the combined SRP/CS where the separate PLs of all parts are already calculated, the following estimations are presented for a series alignment of SRP/CS.		P
	Assumed are *N* separate SRP/CSi in a series alignment, as a whole performing a safety function.		P
	For each SRP/CSi, a PLi has already been evaluated.		P
	This situation is illustrated in Figure 13 (see also Figure 4 and Figure H.2).		P
			P
	Figure 13 - Combination of SRP/CS to achieve overall PL		P
	The following method allows the calculation of the PL of the whole combined SRP/CS performing the safety function:		P
	a) Identify the lowest PLi: this is PLlow.		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	b) Identify the number N_{low} <=N of SRP/CSi, with PL_i =PLlow.		P
	c) Look-up PL in Table 11.		P

Table 11 - Calculation of PL for series alignment of SRP/CS

PL low	N low	=>	PL
a	>3	=>	Nonenot allowed
	<=3	=>	a
b	>2	=>	a
	<=2	=>	b
c	>2	=>	b
	<=2	=>	C
d	>3	=>	C
	<=3	=>	d
e	> 3	=>	d
	<=3	=>	e

	NOTE The values calculated for this look-up table are based on reliability values at the midpoint for each PL.		P
7	**Fault consideration, fault exclusion**		-
7.1	**General**		-
	In accordance with the category selected, safety-related parts shall be designed to achieve the required performance level (PLr).		P
	The ability to resist faults shall be assessed.		P
7.2	**Fault consideration**		-
	ISO 13849-2 lists the important faults and failures for the various technologies.		P
	The lists of faults are not exclusive and, if necessary, additional faults shall be considered and listed.		P
	In such cases, the method of evaluation should also be clearly elaborated.		P
	For new components not mentioned in ISO 13849-2, a failure mode and effects analysis (FMEA, see IEC 60812) shall be carried out to		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	establish the faults that are to be considered for those components.		
	In general, the following fault criteria shall be taken into account: CCF);		P
	- if, as a consequence of a fault, further components fail, the first fault together with all following faults shall be considered as a single fault;		P
	- two or more separate faults having a common cause shall be considered as a single fault (known as a		P
	- the simultaneous occurrence of two or more faults having separate causes is considered highly unlikely and therefore need not be considered.		P
7.3	**Fault exclusion**		-
	It is not always possible to evaluate SRP/CS without assuming that certain faults can be excluded.		P
	For detailed information on fault exclusions, see ISO 13849-2.		P
	Fault exclusion is a compromise between technical safety requirements and the theoretical possibility of occurrence of a fault.		P
	Fault exclusion can be based on		P
	- the technical improbability of occurrence of some faults,		P
	- generally accepted technical experience, independent of the considered application, and		P
	- technical requirements related to the application and the specific hazard.		P
	If faults are excluded, a detailed justification shall be given in the technical documentation.		P
8	**Validation**		-
	The design of the SRP/CS shall be validated (see Figure 3).		-
	The validation shall demonstrate that the		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	combination of SRP/CS providing each safety function meets all relevant requirements of this part of ISO 13849.		
	For details of validation, see ISO 13849-2.		P
9	**Maintenance**		-
	Preventive or corrective maintenance can be necessary to maintain the specified performance of the safety-related parts. Deviations with time from the specified performance can lead to a deterioration in safety or even to a hazardous situation.		P
	The information for use of the SRP/CS shall include instructions for the maintenance (including periodic inspection) of the SRP/CS.		P
	The provisions for the maintainability of the safety-related part(s) of a control system shall follow the principles given in ISO 12100-2:2003, 4.7.		P
	All information for maintenance shall comply with ISO 12100-2:2003, 6.5.1 e).		P
10	**Technical documentation**		-
	When designing a SRP/CS, its designer shall document at least the following information relevant to the safety-related part:		P
	- safety function(s) provided by the SRP/CS;		P
	- the characteristics of each safety function;		P
	- the exact points at which the safety-related part(s) start and end;		P
	- environmental conditions;		P
	- the performance level (PL);		P
	- the category or categories selected;		P
	- the parameters relevant to the reliability (MTTFd, DC, CCF and mission time);		P
	- measures against systematic failure;		P
	- the technology or technologies used;		P
	- all safety-relevant faults considered;		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- justification for fault exclusions (see ISO 13849-2);		P
	- the design rationale (e.g. faults considered, faults excluded);		P
	- software documentation;		P
	- measures against reasonably foreseeable misuse.		P
	NOTE In general, this documentation is foreseen as being for the manufacturer’s internal purposes and will not be distributed to the machine user.		P
11	**Information for use**		-
	The principles of ISO 12100-2:2003, 6.5.2, and the applicable sections of other relevant documents (e.g. IEC 60204-1:2005, Clause 17), shall be applied. In particular, that information which is important for the safe use of the SRP/CS shall be given to the user.		P
	This shall include, but is not limited to the following:		P
	- the limits of the safety-related parts to the category(ies) selected and any fault exclusions;		P
	- the limits of the SRP/CS and any fault exclusions (see 7.3), for which, when essential for maintaining the selected category or categories and safety performance, appropriate information (e.g. for modification, maintenance and repair) shall be given to ensure the continued justification of the fault exclusion(s);		P
	- the effects of deviations from the specified performance on the safety function(s);		P
	- clear descriptions of the interfaces to the SRP/CS and protective devices;		P
	- response time;		P
	- operating limits (including environmental conditions);		P
	- indications and alarms;		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- muting and suspension of safety functions;		P
	- control modes;		P
	- maintenance (see Clause 9);		P
	- maintenance check lists;		P
	- ease of accessibility and replacing of internal parts;		P
	- means for easy and safe trouble shooting;		P
	- information explaining the applications for use relevant to the category to which reference is made;		P
	- checking test intervals where relevant.		P
	Specific information shall be provided on the category or categories and performance level of the SRP/CS, as follows:		P
	- dated reference to this part of ISO 13849 (i.e. “ISO 13849-1:2006”);		P
	- the Category, B, 1, 2, 3, or 4;		P
	- the performance level, a, b, c, d, or e.		P
	EXAMPLE An SRP/CS in accordance with this edition of ISO 13849-1, of Category B and performance level a, would be referred to as follows:		P
	ISO 13849-1 Category B PL a		-

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
4	**Validation process**		-
4.1	**Validation principles**		-
	The purpose of the validation process is to confirm that the design of the SRP/CS supports the overall safety requirements specification for the machinery.		P
	The validation shall demonstrate that each SRP/CS meets the requirements of ISO 13849-1 and, in particular, the following:		P
	a) the specified safety characteristics of the safety functions provided by that part, as set out in the design rationale;		P
	b) the requirements of the specified performance level (see ISO 13849-1:2006, 4.5):		P
	1) the requirements of the specified category (see ISO 13849-1:2006, 6.2),		P
	2) the measures for control and avoidance of systematic failures (see ISO 13849-1:2006, Annex G),		P
	3) if applicable, the requirements of the software (see ISO 13849-1:2006, 4.6), and		P
	4) the ability to perform a safety function under expected environmental conditions;		P
	c) the ergonomic design of the operator interface, e.g. so that the operator is not tempted to act in a hazardous manner, such as defeating the SRP/CS (see ISO 13849-1:2006, 4.8).		P
	Validation should be carried out by persons who are independent of the design of the SRP/CS.		P
	NOTE “Independent person” does not necessarily mean that a third-party test is required.		P
	Validation consists of applying analysis (see Clause 5) and executing functional tests (see Clause 6) under foreseeable conditions in accordance with the validation plan. Figure 1 gives an overview of the validation process.		P
	The balance between the analysis and testing depends on the technology used for the safety-related parts and the required performance level. For Categories 2, 3 and 4 the validation of		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	the safety function shall also include testing under fault conditions.		
	The analysis should be started as early as possible in, and in parallel with, the design process.		P
	Problems can then be corrected early while they are still relatively easy to correct, i.e. during steps “design and technical realization of the safety function” and “evaluate the performance level PL” [the fourth and fifth boxes down in in ISO 13849-1:2006, Figure 3].		P
	It can be necessary for some parts of the analysis to be delayed until the design is well developed.		P
	Where necessary due to the system’s size, complexity or the effects of integrating it with the control system (of the machinery), special arrangements should be made for		P
	- validation of the SRP/CS separately before integration, including simulation of the appropriate input and output signals, and		P
	- validation of the effects of integrating safety-related parts into the remainder of the control system within the context of its use in the machine.		P
	“Modification of the design” in Figure 1 refers to the design process. If the validation cannot be successfully completed, changes in the design are necessary.		P
	The validation of the modified safetyrelated parts should then be repeated.		P
	This process should be iterated until all safety-related parts of the safety functions are successfully validated.		P
4.2	**Validation plan**		-
	The validation plan shall identify and describe the requirements for carrying out the validation process for the specified safety functions, their categories and performance levels.		P
	The validation plan shall also identify the means to		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	be employed to validate the specified safety functions, categories and performance levels. It shall set out, where appropriate		
	a) the identity of the specification documents,		P
	b) the operational and environmental conditions during testing,		P
	c) the analyses and tests to be applied,		P
	d) the reference to test standards to be applied, and		P
	e) the persons or parties responsible for each step in the validation process.		P
	Safety-related parts which have previously been validated to the same specification need only a reference to that previous validation.		P
4.3	**Generic fault lists**		-
	The validation process involves consideration of the behaviour of the SRP/CS for all faults to be considered.		P
	A basis for fault consideration is given in the tables of fault lists in Annexes A to D, which are based on experience and which contain		P
	- the components/elements to be included, e.g. conductors/cables (see Annex D),		P
	- the faults to be taken into account, e.g. short circuits between conductors,		P
	- the permitted fault exclusions, taking into account environmental, operating and application aspects, and		P
	- a remarks section giving the reasons for the fault exclusions.		P
	Only permanent faults are taken into account in the fault lists.		P
4.4	**Specific fault lists**		P
	If necessary, a specific product-related fault list shall be generated as a reference document for the validation process of the safety-related part(s).		P
	The list can be based on the appropriate generic list(s) found in the annexes.		P
	Where the specific product-related fault list is		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	based on the generic list(s) it shall state		
	a) the faults taken from the generic list(s) to be included,		P
	b) any other relevant faults to be included but not given in the generic list (e.g. common-cause failures),		P
	c) the faults taken from the generic list(s) which may be excluded on the basis that the criteria given in the generic list(s) (see ISO 13849-1:2006, 7.3) are satisfied, and exceptionally		P
	d) any other faults for which the generic list(s) do not permit an exclusion, but for which justification and rationale for an exclusion is presented (see ISO 13849-1:2006, 7.3).		P
	Where this list is not based on the generic list(s), the designer shall give the rationale for fault exclusions.		P
4.5	**Information for validation**		-
	The information required for validation will vary with the technology used, the category or categories and performance level(s) to be demonstrated, the design rationale of the system, and the contribution of the SRP/CS to the reduction of the risk.		P
	Documents containing sufficient information from the following list shall be included in the validation process to demonstrate that the safety-related parts perform the specified safety functions to the required performance level or levels and category or categories:		P
	a) specification of the required characteristics of each safety function, and its required category and performance level;		P
	b) drawings and specifications, e.g. for mechanical, hydraulic and pneumatic parts, printed circuit boards, assembled boards, internal wiring, enclosure, materials, mounting;		P
	c) block diagram(s) with a functional description of the blocks;		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	d) circuit diagram(s), including interfaces/connections;		P
	e) functional description of the circuit diagram(s);		P
	f) time sequence diagram(s) for switching components, signals relevant for safety;		P
	g) description of the relevant characteristics of components previously validated;		P
	h) for safety-related parts other than those listed in g), component lists with item designations, rated values, tolerances, relevant operating stresses, type designation, failure-rate data and component manufacturer, and any other data relevant to safety;		P
	i) analysis of all relevant faults (see also 4.3 and 4.4), such as those listed in the tables of Annexes A to D, including the justification of any excluded faults;		P
	j) an analysis of the influence of processed materials;		P
	k) information for use, e.g. installation and operation manual/instruction handbook.		P
	Where software is relevant to the safety function(s), the software documentation shall include		P
	- a specification which is clear and unambiguous and which states the safety performance the software is required to achieve,		P
	- evidence that the software is designed to achieve the required performance level (see 9.5), and		P
	- details o f t ests (in p articular t est r eports) c arried o ut t o p rove t hat t he r equired s afety performance is achieved.		P
	NOTE See ISO 13849-1:2006, 4.6.2 and 4.6.3, for requirements.		P
	Information is required on how the performance level and average probability of a dangerous failure per hour is determined.		P
	The documentation of the quantifiable aspects shall include		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- the safety-related block diagram (see ISO 13849-1:2006, Annex B) or designated architecture (see ISO 13849-1:2006, 6.2),		P
	- the determination of MTTFd, DCavg and CCF, and		P
	- the determination of the category (see Table 2).		P
	Information is required for documentation on systematic aspects of the SRP/CS.		P
	Information is required as to how the combination of several SRP/CS achieves a performance level in accordance with the performance level required.		P

Table 2 - Documentation requirements for categories in respect of performance levels

Documentation requirement	Category for which documentation is required				
	B	**1**	**2**	**3**	**4**
Basic safety principles	X	X	X	X	X
Expected operating stresses	X	X	X	X	X
Influences of processed material	X	X	X	X	X
Performance during other relevant external influences	X	X	X	X	X
Well-tried components	-	X	-	-	-
Well-tried safety principles	-	X	X	X	X
Mean time to dangerous failure ($MTTF_d$) of each channel	X	X	X	X	X
The check procedure of the safety function(s)	-	-	X	-	-
Diagnostic measures performed, including fault reaction	-	-	X	X	X
Checking intervals, when specified	-	-	X	X	X
Diagnostic coverage (DC_{avg})	-	-	X	X	X
Foreseeable single faults considered in the design and the detection method used	-	-	X	X	X
Common-cause failures (CCF) identified and how to prevent them	-	-	X	X	X
Foreseeable single faults excluded	-	-	-	X	X
Faults to be detected	-	-	X	X	X
How the safety function is maintained in the case of each of the faults	-	-	-	X	X
How the safety function is maintained for each of the combinations of faults	-	-	-	-	X

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

Measures against systematic faults	X	X	X	X	X
Measures against software faults	X	-	X	X	X

X documentation required

\- documentation not required

NOTE The categories are those given in ISO 13849-1:2006.

4.6	Validation record		-
	Validation by analysis and testing shall be recorded.		P
	The record shall demonstrate the validation process for each of the safety requirements.		P
	Cross-reference may be made to previous validation records, provided they are properly identified.		P
	For any safety-related part which has failed an element of the validation process, the validation record shall describe which elements in the validation analysis/testing have been failed. It shall be ensured that all safety-related parts are successfully re-validated after modification.		P
5	Validation by analysis		-
5.1	General		-
	Validation of the SRP/CS shall be carried out by analysis. Inputs to the analysis include the following:		P
	- the safety function(s), their characteristics and the required performance level(s) identified during the risk analysis (see ISO 13849-1:2006, Figures 1 and 3);		P
	- the quantifiable aspects (MTTFd, DCavg and CCF);		P
	- the system structure (e.g. designated architectures) (see ISO 13849-1:2006, Clause 6);		P
	- the non-quantifiable, qualitative aspects which affect system behaviour (if applicable, software aspects);		P
	- deterministic arguments.		P
	Validation of the safety functions by analysis rather		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	than testing requires the formulation of deterministic arguments.		
	NOTE 1 A deterministic argument is an argument based on qualitative aspects (e.g. quality of manufacture, experience of use). This consideration depends on the application, which, together with other factors, can affect the deterministic arguments.		P
	NOTE 2 Deterministic arguments differ from other evidence in that they show that the required properties of the system follow logically from a model of the system. Such arguments can be constructed on the basis of simple, well-understood concepts.		P
5.2	Analysis techniques		-
	The s election o f a n a nalysis t echnique d epends u pon t he p articular o bject. Two b asic t echniques exist, as follows.		P
	a) Top-down (deductive) techniques are suitable for determining the initiating events that can lead to identified top events, and calculating the probability of top events from the probability of the initiating events. They can also be used to investigate the consequences of identified multiple faults.		P
	EXAMPLE Fault tree analysis (FTA, see IEC 61025), event tree analysis (ETA).		P
	b) Bottom-up (inductive) techniques are suitable for investigating the consequence of identified single faults.		P
	EXAMPLE Failure modes and effects analysis (FMEA, see IEC 60812) and failure modes, effects and criticality analysis (FMECA).		P
6	Validation by testing		-
6.1	General		-
	When validation by analysis is not conclusive, testing shall be carried out to complete the validation.		P
	Testing is always complementary to analysis and		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	is often necessary.		
	Validation tests shall be planned and implemented in a logical manner. In particular:		P
	a) a test plan shall be produced before testing begins that shall include		P
	1) the test specifications,		P
	2) the required outcome of the tests for compliance, and		P
	3) the chronology of the tests;		P
	b) test records shall be produced that include		P
	1) the name of the person carrying out the test,		P
	2) the environmental conditions (see Clause 10),		P
	3) the test procedures and equipment used,		P
	4) the date of the test, and		P
	5) the results of the test;		P
	c) the test records shall be compared with the test plan to ensure that the specified functional and performance targets are achieved.		P
	The test sample shall be operated as near as possible to its final operating configuration, i.e. with all peripheral devices and covers attached.		P
	This testing may be applied manually or automatically, e.g. by computer.		P
	Where applied, validation of the safety functions by testing shall be carried out by applying input signals, in various combinations, to the SRP/CS.		P
	The resultant response at the outputs shall be compared to the appropriate specified outputs.		P
	It is recommended that the combination of these input signals be applied systematically to the control system and the machine.		P
	An example of this logic is power-on, start-up, operation, directional changes, restart-up. Where necessary, an expanded range of input data shall be applied to take into account anomalous or unusual situations, in order to see how the SRP/CS responds.		P
	Such combinations of input data shall take into account foreseeable incorrect operation(s).		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The objectives of the test will determine the environmental condition for that test, which can be one or another of the following:		P
	- the environmental conditions of intended use;		P
	- the conditions at a particular rating;		P
	- a given range of conditions if drift is expected.		P
	The range of conditions which is considered stable and over which the tests are valid should be agreed between the designer and the person(s) responsible for carrying out the tests and should be recorded.		P
6.2	Measurement accuracy		-
	The accuracy of measurements during the validation by testing shall be appropriate for the test carried out.		P
	In general, these measurement accuracies shall be within 5 K for temperature measurements and 5 % for the following:		P
	a) time measurements;		P
	b) pressure measurements;		P
	c) force measurements;		P
	d) electrical measurements;		P
	e) relative humidity measurements;		P
	f) linear measurements.		P
	Deviations from these measurement accuracies shall be justified.		P
6.3	More stringent requirements		P
	If, according to its accompanying documentation, the requirements for the SRP/CS exceed those within this part of ISO 13849, the more stringent requirements shall apply.		P
	NOTE More stringent requirements can apply if the control system has to withstand particularly adverse service conditions, e.g. rough handling, humidity effects, hydrolysation, ambient temperature variations, effects of chemical agents, corrosion, high strength of electromagnetic fields		P
	- for example, due to close proximity of transmitters.		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.4	Number of test samples		-
	Unless otherwise specified, the tests shall be made on a single production sample of the safety-related part being tested.		P
	Safety-related part(s) under test shall not be modified during the course of the tests.		P
	Certain tests can permanently change the performance of some components.		P
	Where a permanent change in a component causes the safety-related part to be incapable of meeting the requirements of further tests, a new sample or samples shall be used for subsequent tests.		P
	Where a particular test is destructive and equivalent results can be obtained by testing part of the SRP/CS in isolation, a sample of that safety-related part may be used instead of the whole safety-related part(s) for the purpose of obtaining the results of the test.		P
	This approach shall only be applied where it has been shown by analysis that testing of a safety-related part(s) is sufficient to demonstrate the safety performance of the whole safety-related part that performs the safety function.		P
7	Validation of safety requirements specification for safety functions		-
	Prior to the validation of the design of the SRP/CS, or the combination of SRP/CS providing the safety function, the requirements specification for the safety function shall be verified to ensure consistency and completeness for its intended use.		P
	The safety requirements specification should be analysed before starting the design, since every other activity is based on these requirements.		P
	It shall be ensured that requirements for all safety functions of the machine control system are documented.		P
	In order to validate the specification, appropriate		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	measures to detect systematic faults (errors, omissions or inconsistencies) shall be applied.		
	Validation may be performed by reviews and inspections of the SRP/CS safety requirements and design specification(s), in particular to prove that all aspects of		P
	- the intended application requirements and safety needs, and		P
	- the operational and environmental conditions and possible human errors (e.g. misuse) have been considered.		P
	Where a product standard specifies the safety requirements for the design of a SRP/CS (e.g. ISO 11161 for integrated manufacturing systems or ISO 13851 for two-hand control devices), these shall be taken into account.		P
8	Validation of safety functions		-
	The validation of safety functions shall demonstrate that the SRP/CS, or combination of SRP/CSs, provides the safety function(s) in accordance with their specified characteristics.		P
	NOTE 1 A loss of the safety function in the absence of a hardware fault is due to a systematic fault, which can be caused by errors made during the design and integration stages (a misinterpretation of the safety function characteristics, an error in the logic design, an error in hardware assembly, an error in typing the code of software, etc.).		P
	Some of these systematic faults will be revealed during the design process, while others will be revealed during the validation process or will remain unnoticed. In addition, it is also possible for an error to be made (e.g. failure to check a characteristic) during the validation process.		P
	Validation of the specified characteristics of the safety functions shall be achieved by the application of appropriate measures from the following list.		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- Functional analysis of schematics, reviews of the software (see 9.5).		P
	NOTE 2 Where a machine has complex or a large number of safety functions, an analysis can reduce the number of functional tests required.		P
	- Simulation.		P
	- Check of the hardware components installed in the machine and details of the associated software to confirm their correspondence with the documentation (e.g. manufacture, type, version).		P
	- Functional testing of the safety functions in all operating modes of the machine, to establish whether they meet the specified characteristics (see ISO 13849-1:2006, Clause 5, for specifications of some typical safety functions).		P
	The functional tests shall ensure that all safety-related outputs are realized over their complete ranges and respond to safety-related input signals in accordance with the specification.		P
	The test cases are normally derived from the specifications but could also include some cases derived from analysis of the schematics or software.		P
	- Extended functional testing to check foreseeable abnormal signals or combinations of signals from any input source, including power interruption and restoration, and incorrect operations.		P
	- Check of the operator–SRP/CS i nterface f or t he m eeting o f e rgonomic p rinciples (see ISO 13849-1:2006, 4.8).		P
	NOTE 3 Other measures against systematic failures mentioned in 9.4 (e.g. diversity, failure detection by automatic tests) can also contribute in the detection of functional faults.		P
9	Validation of performance levels and categories		-
9.1	Analysis and testing		-
	For the SRP/CS or combination of SRP/CSs that provides the safety function(s), validation shall demonstrate that the required performance levels		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	(PLr) and categories in the safety requirements specification are fulfilled.		
	Principally, this will require failure analysis using circuit diagrams (see Clause 5) and, where the failure analysis is inconclusive:		P
	- fault injection tests on the actual circuit and fault initiation on actual components, particularly in parts of the system where there is doubt regarding the results obtained from failure analysis (see Clause 6);		P
	- a simulation of control system behaviour in the event of a fault, e.g. by means of hardware and/or software models.		P
	In some applications it may be necessary to divide the connected safety-related parts into several functional groups and to subject these groups and their interfaces to fault simulation tests.		P
	When validating by testing, the tests should include, as appropriate,		P
	- fault injection tests into a production sample,		P
	- fault injection tests into a hardware model,		P
	- software simulation of faults, and		P
	- subsystem failure, e.g. power supplies.		P
	The precise instant at which a fault is injected into a system can be critical.		P
	The worst-case effect of a fault injection shall be determined by analysis and by injecting the fault at this appropriate critical time.		P
9.2	Validation of category specifications		-
9.2.1	Category B		-
	SRP/CSs to Category B shall be validated in accordance with basic safety principles (see Tables A.1, B.1, C.1 and D.1) by demonstrating that the specification, design, construction and choice of components are in accordance with ISO 13849-1:2006, 6.2.3.		P
	The MTTFd of t he channel shall be demonstrated to be at least 3 years.		P
	This shall be achieved by checking that the		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	SRP/CS is in accordance with its specification as provided in the documents for validation (see 4.5).		
	For the validation of environmental conditions, see 6.1.		P
	NOTE In particular cases, higher values of MTTFd can be required - for example, when PLr = b.		P
9.2.2	Category 1		-
	SRP/CSs to Category 1 shall be validated by demonstrating the following:		P
	a) they meet the requirements of Category B;		P
	b) components are well-tried (see Tables A.3 and D.3), meeting at least one of the following conditions:		P
	1) they have been widely used in the past with successful results in similar applications;		P
	2) they have been made and verified usi ng principles which demonstrate their suitability and reliability for safety-related applications;		P
	c) well-tried safety principles (where applicable, see Tables A.2, B.2, C.2 and D.2) have been implemented correctly, and, where newly developed principles have been used, validation has been made of		P
	1) how the expected modes of failure have been avoided, and		P
	2) how faults have been avoided or their probability reduced to a suitable level.		P
	Relevant component standards may be used to demonstrate compliance with this subclause (see Tables A.3 and D.3).		P
	The MTTFd of the channel shall be demonstrated to be at least 30 years.		P
9.2.3	Category 2		-
	SRP/CSs to Category 2 shall be validated by demonstrating the following:		P
	a) they meet the requirements of Category B;		P
	b) the well-tried safety principles used (if applicable) are in accordance with 9.2.2 c);		P
	c) the checking equipment detects all relevant		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	faults applied, one at a time, during the checking process and generates an appropriate control action which		
	1) initiates a safe state or, when this is not possible,		P
	2) provides a warning of the hazard;		P
	d) the check(s) provided by the checking equipment do not introduce an unsafe state;		P
	e) the initiation of the check is carried out		P
	1) at the machine start-up and prior to the initiation of a hazardous situation, and		P
	2) periodically, during operation in accordance with the design specification and if the risk assessment and kind of operations show that it is necessary;		P
	NOTE 1 The need for, and extent of, checks during operation are determined by the designer's risk assessment and the kind of operation necessary.		P
	f) the MTTFd of the functional channel (MTTFd,L) is at least 3 years;		P
	g) the MTTFd,TE is larger than half of MTTFd,L;		P
	h) the test rate ≥ 100 × expected demand rate;		P
	i) the DCavg is at least 60 %;		P
	j) common-cause failures are sufficiently reduced (see ISO 13849-1:2006, Annex F).		P
	NOTE 2 In particular cases, higher values of MTTFd and/or DCavg can be required		P
	- for example, owing to high PLr.		P
9.2.4	Category 3		-
	SRP/CSs to Category 3 shall be validated by demonstrating the following:		P
	a) they meet the requirements of Category B;		P
	b) the well-tried safety principles (if applicable) meet the requirements of 9.2.2 c);		P
	c) a single fault does not lead to the loss of the safety function;		P
	d) single faults (including common cause faults) are detected in accordance with the design rationale and the technology applied;		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	e) the MTTFd of each channel is at least 3 years;		P
	f) the DCavg is at least 60 %;		P
	g) common-cause failures are sufficiently reduced (see ISO 13849-1:2006, Annex F).		P
	NOTE In particular cases, higher values of MTTFd and/or DCavg can be required - for example, due to high PLr.		P
9.2.5	Category 4		-
	SRP/CSs to Category 4 shall be validated by demonstrating the following:		P
	a) they meet the requirements of Category B;		P
	b) the well-tried safety principles (if applicable) are in accordance with 9.2.2 c);		P
	c) a single fault (including common-mode faults) does not lead to the loss of the safety function;		P
	d) single faults are detected at or before the next demand on the safety function, this being achieved with a DCavg of at least 99 %;		P
	e) if a single fault is not detected with a DCavg of at least 99 %, an accumulation of faults does not lead to the loss of the safety function(s), and the extent of the accumulation of faults considered is in accordance with the design rationale;		P
	f) the MTTFd of each channel is at least 30 years;		P
	g) common-cause failures are sufficiently reduced (see ISO 13849-1:2006, Annex F).		P
9.3	Validation of MTTFd, DCavg and CCF		-
	The validation of MTTFd, DCavg and CCF is typically performed by analysis and visual inspection.		P
	The MTTFd values for components (including B10d, T10d and nop values) shall be checked for plausibility (e.g. against ISO 13849-1:2006, Annex C).		P
	For example, the value given on the supplier datasheet is to be compared with ISO 13849-1:2006, Annex C.		P
	Where fault exclusion claims mean that particular components do not contribute to the channel		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	MTTFd, the plausibility of the fault exclusion shall be checked.		
	NOTE 1 A fault exclusion implies infinite MTTFd; therefore, the component will not contribute to the calculation of channel MTTFd.		P
	NOTE 2 For the determination of the B10d value, see e.g. IEC 60947-4-1:2010, Annex K.		P
	The MTTFd of each channel of the SRP/CS, including application of the symmetrisation formula (see ISO 13849-1:2006,		P
	Annex D) to dissimilar redundant channels, shall be checked for correct calculation. It shall be ensured that the MTTFd of individual channels has been restricted to no greater than 100 years before the symmetrisation formula is applied.		P
	The DC values for components and/or logic blocks shall be checked for plausibility (e.g. against measures in ISO 13849-1:2006, Annex E).		P
	The correct implementation (hardware and software) of checks and diagnostics, including appropriate fault reaction, shall be validated by testing under typical environmental conditions in use.		P
	The DCavg of the SRP/CS shall be checked for correct calculation.		P
	The correct implementation of sufficient measures against common-cause failures shall be validated (e.g. against ISO 13849-1:2006, Annex F).		P
	Typical validation measures are static hardware analysis and functional testing under environmental conditions.		P
	NOTE 3 For the calculation of the MTTFd values of electronic components, an ambient temperature of +40 °C is taken as a basis.		P
	During validation, it is important to ensure that, for MTTFd values, the environmental and functional conditions (in particular temperature) taken as basis are met.		P
	Where a device, or component, is operated		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	significantly above (e.g. more than 15 °C) the specified temperature of +40 °C, it will be necessary to use MTTFd values for the increased ambient temperature.		
9.4	Validation of measures against systematic failures related to performance level and category of SRP/CS		-
	The validation of measures against systematic failures (defined in ISO 13849-1:2006, 3.1.7) related to performance levels and categories of each SRP/CS can typically be provided by		P
	a) inspections of design documents which confirm the application of		P
	1) basic and well-tried safety principles (see Anexes A to D),		P
	2) further measures for avoidance of systematic failures (see ISO 13849-1:2006, G.3), and 3) further measures for the control of systematic failures such as hardware diversity (see ISO 13849-1:2006, Annex G), modification protection or failure assertion programming;		P
	b) failure analysis (e.g. FMEA);		P
	c) fault injection tests/fault initiation;		P
	d) inspection and testing of data communication, where used;		P
	e) checking that a quality management system avoids the causes of systematic failures in the manufacturing process.		P
9.5	Validation of safety-related software		-
	The validation of both safety-related embedded software (SRESW) and safety-related application software (SRASW) shall include		P
	- the specified functional behaviour and performance criteria (e.g. timing performance) of the software when executed on the target hardware,		P
	- verification that the software measures are sufficient for the specified PLr of the safety function, and - measures and activities taken		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	during software development to avoid systematic software faults.		
	As a first step, check that there is documentation for the specification and design of the safetyrelated software.		P
	This documentation shall be reviewed for completeness and absence of erroneous interpretations, omissions or inconsistencies.		P
	NOTE In the case of small programs, an analysis of the program by means of reviews or walk-through of control flow, procedures, etc. using the software documentation (control flow chart, source code of modules or blocks, I/O and variable allocation lists, cross-reference lists) can be sufficient.		P
	In general, software can be considered a “black box” or “grey box” (see ISO 13849-1:2006, 4.6.2), and validated by the black- or grey-box test, respectively.		P
	Depending on the PLr [ISO 13849-1:2006, 4.6.2 (for SRESW) and 4.6.3 (for SRASW)], the tests should include		P
	- black-box testing of functional behaviour and performance (e.g. timing performance),		P
	- additional extended test cases based upon limit value analyses, recommended for PL d or e,		P
	- I/O tests to ensure that the safety-related input and output signals are used properly, and		P
	- test cases which simulate faults determined analytically beforehand, together with the expected response, in order to evaluate the adequacy of the software-based measures for control of failures.		P
	Individual software functions which have already been validated do not need to be validated again.		P
	Where a number of such safety function blocks are combined for a specific project, however, the resulting total safety function shall be validated.		P
	Software documentation shall be checked to		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	confirm that sufficient measures and activities have been implemented against systematic software faults in accordance with the simplified V-model (ISO 13849-1:2006, Figure 6).		
	The measures for software implementation according to ISO 13849-1:2006, 4.6.2 (for SRESW) and 4.6.3 (for SRASW), which depend on the PL to be attained, shall be examined with regard to their proper implementation.		P
	Should the safety-related software be subsequently modified, it shall be revalidated on an appropriate scale.		P
9.6	Validation and verification of performance level		-
	For the simplified procedure for estimating PL of the SRP/CS according t o ISO 13849-1:2006, 4.5.4, and ISO 13849-1:2006, Annexes B t o F a nd A nnex K , t he following verification a nd v alidation s teps shall be performed:		P
	- checking for correct evaluation of PL based on the category, DCavg a nd M TTFd (according to ISO 13849-1:2006, 4.5.4 and Annex K);		P
	- verification that the PL achieved by the SRP/CS satisfies the required performance level PLr in the safety requirements specification for the machinery: PL ≥ PLr.		P
	Where other methods are used to evaluate the achieved PL, based on the estimated average probability of a dangerous failure per hour, validation shall consider		P
	- the MTTFd value for each component,		P
	- the DC,		P
	- the CCF,		P
	- the structure, and		P
	- the documentation, application and calculation, which shall be checked for correctness.		P
9.7	Validation of combination of safety-related parts		-
	Where the safety function is implemented by two or more safety-related parts, validation of the combination		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- by analysis and, if necessary, by testing		P
	- shall be undertaken to establish that the combination achieves the performance level specified in the design.		P
	Existing recorded validation results of safety-related parts can be taken into account. The following validation steps shall be performed:		P
	- inspection of design documents describing the overall safety function(s);		P
	- a check that the overall PL of the SRP/CS combination has been correctly evaluated, based on the PL of each individual safety-related part (according to ISO 13849-1:2006, 6.3);		P
	NOTE A summation of the average probability of dangerous failures per hour of all combined SRP/CS can be used as an alternative to ISO 13849-1:2006, Table 11. It is important to check the non-quantifiable restrictions of systematic, architectural and CCF aspects which can limit the overall performance level to lower values.		P
	- consideration of the characteristics of the interfaces, e.g. voltage, current, pressure, data format of information, signal level;		P
	- failure analysis relating to combination / integration, e.g. by FMEA;		P
	- for redundant systems, fault injection tests relating to combination/integration.		P
10	Validation of environmental requirements		-
	The performance specified in the design of the SRP/CS shall be validated with respect to the environmental conditions specified for the control system.		P
	Validation shall be carried out by analysis and, if necessary, by testing.		P
	The extent of the analysis and of the testing will depend upon the safety-related parts, the system in which they are installed, the technology used, and the environmental condition(s) being validated.		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The use of operational reliability data on the system or its components, or the confirmation of compliance to appropriate environmental standards (e.g. for waterproofing, vibration protection) can assist this validation process.		P
	Where applicable, validation shall address		P
	- expected mechanical stresses from shock, vibration, ingress of contaminants,		P
	- mechanical durability,		P
	- electrical ratings and power supplies,		P
	- climatic conditions (temperature and humidity), and		P
	- electromagnetic compatibility (immunity).		P
	When testing is needed to determine compliance with the environmental requirements, the procedures outlined in the relevant standards shall be followed as far as required for the application.		P
	After the completion of validation by testing, the safety functions shall continue to be in accordance with the specifications for the safety requirements, or the SRP/CS shall provide output(s) for a safe state.		P
11	Validation of maintenance requirements		-
	The validation process shall demonstrate that the provisions for maintenance requirements specified in ISO 13849-1:2006, Clause 9, Paragraph 2, have been implemented.		P
	Validation of maintenance requirements shall include the following, as applicable:		P
	a) a review of the information for use confirming that		P
	1) maintenance instructions are complete [including procedures, required tools, frequency of inspections, time interval for changing components subjected to wear (T10d) etc.] and understandable,		P
	2) if appropriate, there are provisions for the maintenance to be performed only by skilled maintenance personnel;		P

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Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	b) a check that measures for ease of maintainability (e.g. provision of diagnostic tools to aid faultfinding and repair) have been applied.		P
	In addition, the following measures shall be included when applied:		P
	- measures against mistakes during maintenance (e.g. detection of wrong input data via plausibility checks);		P
	- measures against modification (e.g. password protection to prevent access to the program by unauthorized persons).		P
12	Validation of technical documentation and information for use		-
	The validation process shall demonstrate that the requirements for technical documentation specified in ISO 13849-1:2006, Clause 10, and for information for use specified in ISO 13849-1:2006, Clause 11, have been implemented.		P

List of test equipment used:

Clause	ID of test equipment	Measurement / testing	Testing / measuring equipment / material used	Range used	Calibration date	Next calibration date
4.4	PT-2	Psychrometer-Thermograph	-10~50°C, 5 % ~ 98 % R.H	10~50°C, 5 % ~98 % R.H	2024-03-02	2025-03-01
4.3	JO-1	Oscilloscope	0~20KVac/ 0~16KVdc, 0 ~ 200MHz,0~200MS	0-500V	2024-03-02	2025-03-01
7.4, 11.2.3	JT-4	Chart Recorder	0~1000°C	0-200°C	2024-03-02	2025-03-01
17	TM-1	Tape-Measure	0~35 m	0-35m	2024-03-02	2025-03-01
12.7.6	XS-1	Digital Caliper	0~200 mm	0-200mm	2024-03-02	2025-03-01
18.4	DH-3	Withstanding Voltage Tester	0~5KV 0.3-100mA 50/60Hz	2000V ac	2024-03-02	2025-03-01
8.2	DA-3	Leakage Current Meter	0-10mA, 0-150V / 0-500V	0-500V ac	2024-03-02	2025-03-01
18.4	SW-2	Stop watch	0-99 h	0-99h	2024-03-02	2025-03-01
18.3	INSU-01	Insulation resistance meter	0-500 M ohm	0-500 Mohm	2024-03-02	2025-03-01
8.2	GRD-01	Earthening continuity meter	0-10 ohm	0-2 ohm	2024-03-02	2025-03-01
7.4, 11.2.3	TH-1	Thermocouple	0-1000°C, type K	0-200°C	2024-03-02	2025-03-01

- End of Test Report -

1. Cover Page

EMC TEST REPORT

Application No.:	J55-HXF-21985
Applicant:	Hefei XFH Electromechanical Technology Co., Ltd C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China
Manufacturer:	Same as applicant
Factory:	Same as applicant
Trade mark:	-

Equipment Under Test (EUT):

EUT Name:	Laser welding machine
Item No.:	AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W
Electrical ratings:	380-415V 3 ~ 50/60Hz 1,12 kW
Serial No.:	N/A
Standards:	☒ EN IEC 61000-6-2:2019 ☒ EN IEC 61000-6-4:2019
Date of Receipt:	May 06, 2024
Date of Test:	May 06, 2024 to May 21, 2024
Date of Issue:	May 21, 2024

Test Result :	**PASS***

2 Version

	Revision	Record		
Version	Chapter	Date	Modifier	Remark
00		May 21, 2024		Original

3 Test Summary

Test	Test Requirement	Test Method	Class / Severity	Result
Conducted Emission on AC, 150kHz to 30MHz	EN61000-6-4	EN 61000-6-4	Table 1 Columns 2 & 3	PASS
Radiated Power, 30MHz to 300MHz	EN61000-6-4	EN 61000-6-4	Table 2 Columns 2 & 3	PASS
Harmonic Emission on AC, 100Hz to 2kHz	EN61000-6-4	N/A	Class 7 of EN 61000-3-2	PASS
Flicker Emission on AC	EN61000-6-4	EN 61000-3-3	N/A	PASS
Immunity	EN 61000-6-2	N/A	Clause 4.1 of EN IEC 55014-2	PASS

The tests were performed according to following standards:

EN 61000-6-1

Electro-magnetic compatibility (EMC) Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments

EN 61000-6-3

Electro-magnetic compatibility (EMC) Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments

EN IEC 55014-1

Electromagnetic compatibility- Requirement for household appliances, electric tools and similar apparatus

Part 1: Emission

EN 61547: 2009

Electromagnetic compatibility-Requirements for lighting device

Part 2: Immunity-Product family standard

EN 55013

Sound and television broadcast receivers and associated equipment-Radio disturbance characteristics-Limits and method of measurement

EN 55015

Limits and method of measurement of radio disturbance of electrical lighting and similar equipment

EN 55020

Sound and television broadcast receivers and associated equipment- Immunity characteristics- Limits and methods of measurement

EN 55022

Information technology equipment- Radio disturbance characteristics- Limits and methods of measurement

EN 55024

Information technology equipment- Immunity characteristics- Limits and methods of measurement

EN IEC 61000-3-2

Electromagnetic compatibility(EMC) Part 3-2:Limits Limits for harmonic current emissions(equipment input current up to and including 16A per phase)

EN 61000-3-3

Electromagnetic compatibility(EMC) Part 3-3: Limits- Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current<= 16A per phase and not subject to conditional connection

EN 61000-3-11

Electromagnetic compatibility(EMC) Part 3-11: Limits- Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current<= 75A per phase and subject to conditional connection

Abbreviations

AC	Alternating Current
AMN	Artificial Mains Network
DC	Direct Current
EM	ElectroMagnetic
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
IF	Intermediate Frequency
RF	Radio Frequency
Rms	root mean square
EMI	Electromagnetic Interference
EMS	Electromagnetic Susceptibility

Performance Criterion

Criterion A: The equipment shall continue to operate as intended without operator intervention. No degradation of performance of loss of function is allowed below a performance level specified by the manufacturer when the equipment is used as intended.

Criterion B: After the test, the equipment shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed, after the application of the phenomena below a performance level specified by the manufacturer, when the equipment is used as intended.

Criterion C: Loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions.

Remark: *

In the configuration tested, the EUT detailed in this report complied with the standards specified above. Please refer to section 2 of this report for further details.

4 General Information

4.1 General Description of E.U.T.

EUT Name:	Laser welding machine
Item No.:	AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W
Serial No.:	Not supplied by client

4.2 Details of E.U.T.

Laser welding machine , models AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W electrical ratings as the following:

380-415V 3 ~ 50/60Hz 1,12 kW

4.3 Description of Support Units

The EUT has been tested as an independent unit.

4.4 Standards Applicable for Testing

The customer requested EMC tests for a Pressure Transmitters.

The standards used were EN IEC 55014-1, EN 61000-3-2, EN 61000-3-11 & EN IEC 55014-2.

Table 1 : Tests Carried Out Under EN 61000-6-4

Standard		Status
EN 61000-6-4	Radiated Emissions	×
EN 61000-6-4	Conducted Emissions on AC	√
EN 61000-6-4	Radiated Power	√
EN 61000-6-4	Discontinuous Emissions on AC	×

× Indicates that the test is not applicable.

√ Indicates that the test is applicable.

Note:

The EUT is powered by transformer and incorporating no electronic circuits and contains no thermostator or relay to make discontinuous turbance. Hence the EUT falls in Category D of EN IEC 55014-1, CE & RP test are applicable.

Table 2: Tests Carried Out Under EN 61000-3-2		
Standard		**Status**
EN 61000-3-2	Harmonic Emissions on AC	√
EN 61000-3-3	Flicker Emissions on AC	√

× Indicates that the test is not applicable.

√ Indicates that the test is applicable.

Table 3 : Tests Carried Out Under EN IEC 55014-2					
TEST		**Cat I**	**Cat II**	**Cat III**	**Cat IV**
EN 61000-4-2	ESD		o	o	o
EN 61000-4-4	Fast transients		o	o	o
EN 61000-4-6	Injection currents up to 230 MHz		o	o	
EN 61000-4-5	Surge		o		o
EN 61000-4-11	Voltage dips		o		o
EN 61000-4-6	Injection currents up to 80 MHz				o
EN 61000-4-3	Radio frequency EM fields				o
EN 61000-6-2	None	√			

o Indicates the testing requirements for each category of equipment

× Indicates that the test is not applicable

√ Indicates that the test is applicable

Note: The EUT does not contain any electronics as defined in EN IEC 55014-2 and falls within category I of EN IEC 55014-2, hence immunity tests are not required.

4.6 Test Location

All tests were performed at: -

Hefei XFH Electromechanical Technology Co., Ltd

C1 Gongtou Industrial Park at the Intersection of Fanhua Avenue and Wenshan Road, Feixi Economic Development Zone, Hefei City, Anhui, China

No tests were sub-contracted.

4.7 Test Environment

Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 degree

Humidity: 30-60 % RH

Atmospheric pressure: 86-106 kPa

Definitions of symbols used in this test report

- The black square indicates that the listed condition, standard or equipment is applicable for this report.

O - The empty circle indicates that the listed condition, standard or equipment is not applicable for this report.

Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4:Specification for radio disturbance and immunity measuring apparatus and methods Part 4: Uncertainty in EMC Measurements and is documented in the quality system acc. to EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device

4.8 Test Facility

All of the test facility is calibrated.

4.9 Deviation from Standards

None

4.10 Abnormalities from Standard Conditions

None.

4.11 Monitoring of EUT for All Immunity Test

None.

5 Equipment Used during Test

Conducted Emission

No	Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Due Date (yyyy-mm-dd)	Calibration Interval
1	LISN	Schaffner Chase	MNZ050D11	3041	03-20-2025	1Y
2	Coaxial Cable	GTS	N/A	2235	03-20-2025	1Y
3	Variac	Debao Factory	TS/DGC2-5	EMC0101	Check Before Use	-
4	EMI Test Receiver	Rohde & Schwarz	ESCS30	22354	03-20-2025	1Y
5	EMI Test Software	Rohde & Schwarz	ES-K1	235115	N/A	N/A
6	Temperature, Humidity & Barometer	Oregon Scientific	BA-888	HM-01	03-20-2025	1Y
7	Shielding Room	Frankonia	12 x 4 x 4 m3	SR-01	N/A	N/A

Radiated Power

No	Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Due Date (yyyy-mm-dd)	Calibration Interval
1	Shielding Room	Frankonia	12 x 4 x 4 m3	SR-01	N/A	N/A
2	Absorbing Clamp	Schwarzbeck	MDS 20	AC-02	03-20-2025	1Y
3	Coaxial Cable (7m)	GTS	N/A	CC-03	03-20-2025	1Y
4	Slide Bar	HD-GmbH	KMS560	SB-02	N/A	N/A
5	Slide Bar Controller	HD-GmbH	HD50	SB-05	N/A	N/A
6	Variac	Debao Factory	TS/DGC2-5	N/A	Check Before Use	-

Hamornics & Flicker

No	Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Due Date (yyyy-mm-dd)	Calibration Interval
1	Variac	Debao Factory	TS/DGC2-5	N/A	Check before use	-
2	Harmonics 1000	EMC Partner	HAR1H01B	HA0602	03-20-2025	1Y

Common Used Equipment

No	Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Due Date (yyyy-mm-dd)	Calibration Interval
1	DMM	FLUKE	73	DMM006	03-20-2025	1Y
2	Temperature, Humidity & Barometer	Oregon Scientific	BA-888	HM-01	03-20-2025	1Y

6 Emission Test Results

6.1 Conducted Emissions Mains Terminals, 150kHz to 30MHz

Test Requirement:	EN 61000-6-4
Test Method:	Based on EN IEC 55014-1
Test Date:	May 21, 2024
Frequency Range:	150kHz to 30MHz
Class / Severity:	Table 1, Columns 2 & 3 (AC Terminals)
Detector:	Peak for pre-scan (9kHz Resolution Bandwidth)
	Quasi-Peak & Average if maximised peak within 6dB of limit

6.1.1 E.U.T. Operation

Operating Environment:

Temperature: 24.0 °C Humidity: 61% RH Atmospheric Pressure: 1012 mbar

EUT Operation:
Perform a pre-test on the EUT in On Mode varying voltages +/- 10% in order to find the worse case. Test the EUT in On Mode for each samples at **380-415V 3 ~ 50Hz** for the compliance test as no worse case was found.

TEST PROCEDURES

Procedure of Preliminary Test

□ The EUT and Support equipment, if needed, was set up as per the test configuration to simulate typical usage per the user's manual. When the EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per EN 55022 (see Test Facility for the dimensions of the ground plane used). When the EUT is a floor standing equipment, it is placed on the ground plane, which has a 3-12 mm non-conductive covering to insulate the EUT from the ground plane.

□ All I/O cables were positioned to simulate typical actual usage as per EN 55022.

□ The test equipment EUT installed received AC main power, through a Line Impedance Stabilization Network (LISN), which supplied power source and was grounded to the ground plane.

□ All support equipment power received from a second LISN.

□ The EUT test program was started. Emissions were measured on each current carrying line of the EUT using an EMI Test Receiver connected to the LISN powering the EUT.

□ The Receiver scanned from 150kHz to 30MHz for emissions in each of the test modes.

□ During the above scans, the emissions were maximized by cable manipulation.

□ The test mode(s) described in Item 4.1 were scanned during the preliminary test.

□ After the preliminary scan, we found the test mode described in Item 4.1 producing the highest emission level.

□ The EUT configuration and cable configuration of the above highest emission levels were recorded for reference of the final test.

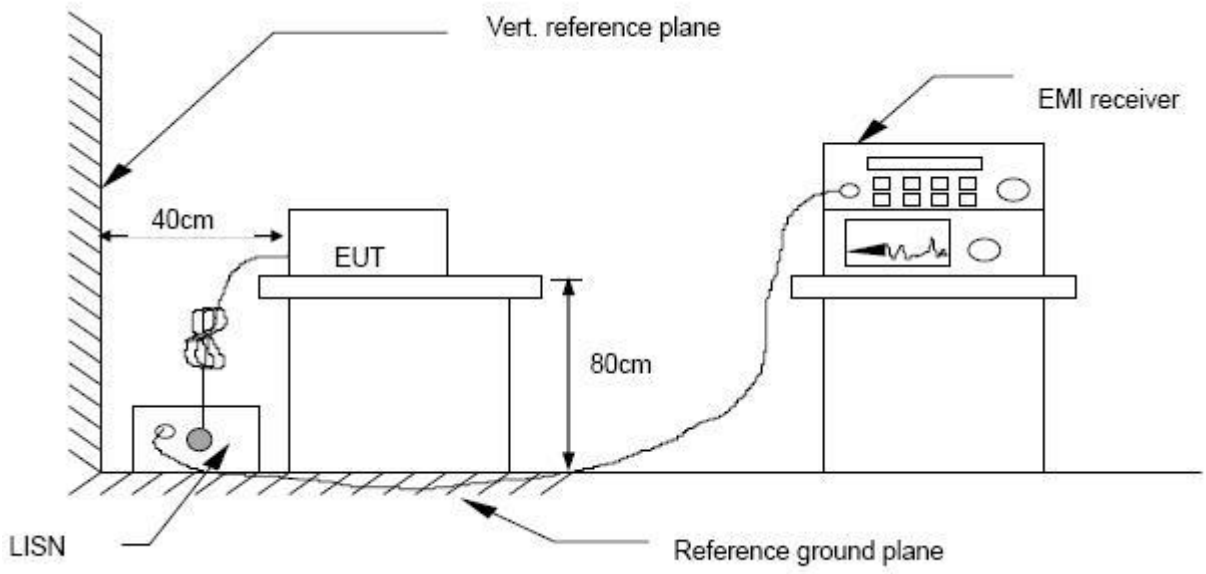
Procedure of Final Test

□ EUT and support equipment were set up on the test bench as per the configuration with highest emission level in the preliminary test.

□ A scan was taken on both power lines, Line 1 and Line 2, recording at least the six highest emissions. Emission frequency and amplitude were recorded into a computer in which correction factors were used to calculate the emission level and compare reading to the applicable limit.

□ The test data of the worst-case condition(s) was recorded.

TEST SETUP



6.1.2 Measurement Data

An initial pre-scan was performed on the live and neutral lines in On Mode at 24V.

No further Quasi-peak & average measurements were performed since no peak emissions were detected within 6dB of the average limit line.

Please see the attached peak measurement data for reference.

The following peak measurements were performed on the EUT on May 21, 2024

Data Sample:

Freq. (MHz)	Q.P. Raw (dBuV)	Average Raw (dBuV)	Q.P. Limit (dBuV)	Average Limit (dBuV)	Q.P. Margin (dB)	Average Margin (dB)	Note
x.xx	34.44	27.28	60.00	50.00	-25.56	-22.72	L1

Freq. = Emission frequency in MHz

Raw dBuV = Uncorrected Analyzer/Receiver reading + Insertion loss of LISN, if it > 0.5 dB

Limit dBuV = Limit stated in standard

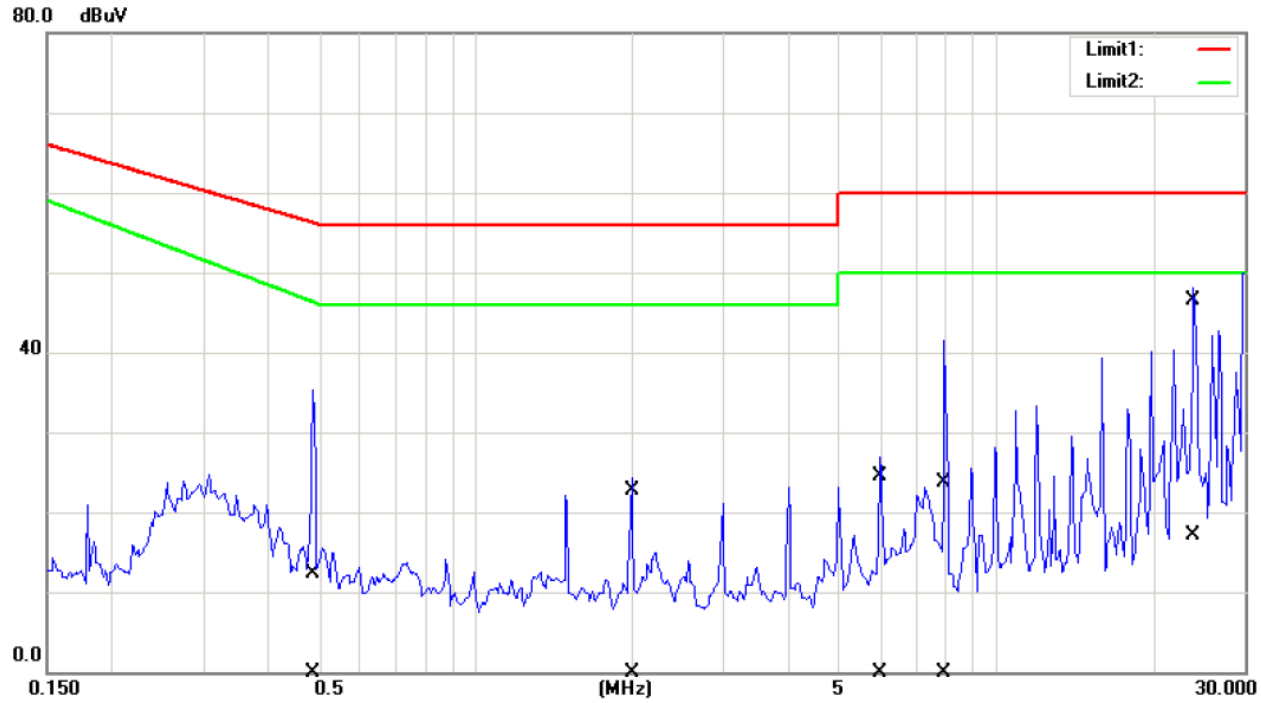
Margin dB = RAW (dBuV) – Limit (dBuV)

Note = Current carrying line of reading

Q.P.: =Quasi-Peak

Live Line--QP

148,5kHz-30MHz:

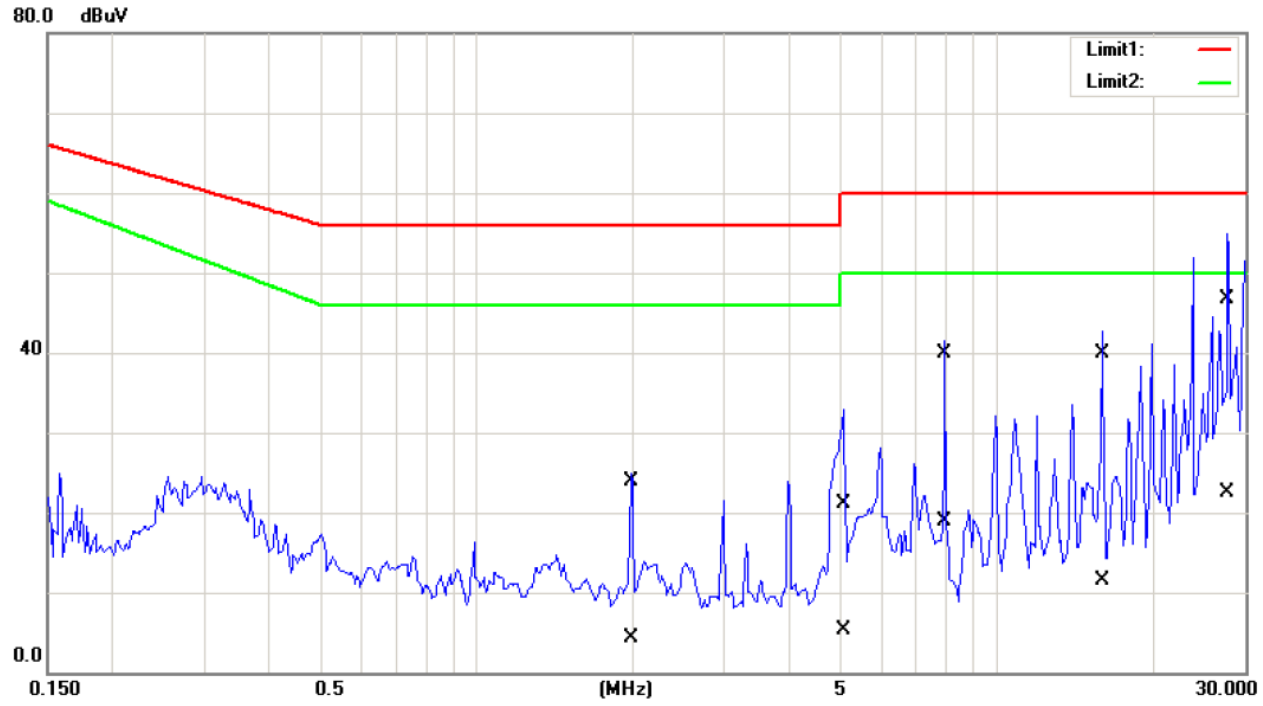


Quasi-peak and Average measurement:

No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	Factor(dB)	(dBuV)	(dBuV)	(dB)	
1	0.4879	12.26	0.00	12.26	56.20	-43.94	QP
2	0.4879	-15.31	0.00	-15.31	46.26	-61.57	AVG
3	1.9909	22.62	0.16	22.78	56.00	-33.22	QP
4	1.9909	-2.74	0.16	-2.58	46.00	-48.58	AVG
5	5.9777	24.22	0.20	24.42	60.00	-35.58	QP
6	5.9777	-1.91	0.20	-1.71	50.00	-51.71	AVG
7	7.9557	23.50	0.20	23.70	60.00	-36.30	QP
8	7.9557	-4.52	0.20	-4.32	50.00	-54.32	AVG
9	23.9590	46.12	0.33	46.45	60.00	-13.55	QP
10	23.9590	16.84	0.33	17.17	50.00	-32.83	AVG

Netural Line-QP

148,5kHz-30MHz:



Quasi-peak and Average measurement:

No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	Factor(dB)	(dBuV)	(dBuV)	(dB)	
1	1.9889	23.76	0.16	23.92	56.00	-32.08	QP
2	1.9889	4.09	0.16	4.25	46.00	-41.75	AVG
3	5.0689	20.86	0.20	21.06	60.00	-38.94	QP
4	5.0689	5.04	0.20	5.24	50.00	-44.76	AVG
5	7.9557	39.74	0.20	39.94	60.00	-20.06	QP
6	7.9557	18.80	0.20	19.00	50.00	-31.00	AVG
7	15.8878	39.70	0.30	40.00	60.00	-20.00	QP
8	15.8878	11.19	0.30	11.49	50.00	-38.51	AVG
9	27.8343	46.20	0.43	46.63	60.00	-13.37	QP
10	27.8343	22.10	0.43	22.53	50.00	-27.47	AVG

6.2 Radiated Power: 30MHz to 300MHz

Test Requirement:	EN 61000-6-4
Test Method:	Based on EN IEC 55014-1
Test Date:	May 21, 2024
Frequency Range:	30MHz to 300MHz
Class / Severity:	Table 2, Columns 2 & 3
Detector:	Peak for pre-scan (9kHz Resolution Bandwidth)
	Quasi-Peak & Average if pre-scan peak within 15dB of average limit.

6.2.1 E.U.T. Operation

Operating Environment:

Temperature: 24.0°C Humidity: 61% RH Atmospheric Pressure: 1012 Mbar

EUT Operation:

Perform a pre-test on the EUT in On Mode varying voltages +/- 10% in order to find the worse case.

Test the EUT in On Mode for both models at 250V AC for the compliance test as no worse case was found.

If any maximised peak emissions are detected within 15dB of the average limit line, then:

Perform Quasi-Peak and Average (if Quasi-Peak is within 15dB of Average Limit) measurement with the clamp next to the EUT (i.e. zero position). If both Quasi-Peak and Average measurement are greater than 15dB below the respective limit, then the test is terminated.

If either the Quasi-Peak and Average measurement are within 15dB of the respective limit, then extend the lead to 6m length.

Maximised all Quasi-Peak and Average measurement by moving clamp along cable.

6.2.2 Measurement Data

Peak Scan was performed on the AC mains cable, no further Quasi-peak & average measurements were performed for the EUT since no peak emissions were detected within 15dB of the average limit line

No further Quasi-peak & average measurements were performed since no peak emissions were detected within 6 dB of the average limit line.

Please see the attached peak measurement data for reference.

Procedure of Preliminary Test

□ The equipment was set up as per the test configuration to simulate typical usage per the user's manual. When the EUT is a tabletop system, a wooden turntable with a height of 0.8 meters is used which is placed on the ground plane. When the EUT is a floor standing equipment, it is placed on the ground plane which has a 3-12 mm

non-conductive covering to insulate the EUT from the ground plane.

□ Support equipment, if needed, was placed as per EN 55022.

□ All I/O cables were positioned to simulate typical usage as per EN 55022.

□ The EUT received AC power source from the outlet socket under the turntable. All support equipment power received from another socket under the turntable.

□ Mains cables, telephone lines or other connections to auxiliary equipment located outside the test are shall drape to the floor, be fitted with ferrite clamps or ferrite tubes placed on the floor at the point where the cable reaches the floor and then routed to the place where they leave the turntable. No extension cords shall be used to mains receptacle.

□ The antenna was placed at 10 meter away from the EUT as stated in EN 55022. The antenna connected to the Spectrum Analyzer via a cable and at times a pre-amplifier would be used.

□ The Analyzer / Receiver quickly scanned from 30MHz to 1000MHz. The EUT test program was started. Emissions were scanned and measured rotating the EUT to 360 degrees and positioning the antenna 1 to 4 meters above the ground plane, in both the vertical and the horizontal polarization, to maximize the emission reading level.

□ The test mode(s) described in Item 4.1 were scanned during the preliminary test:

□ After the preliminary scan, we found the test mode described in Item 4.1 producing the highest emission level.

□ The EUT and cable configuration, antenna position, polarization and turntable position of the above highest emission level were recorded for the final test.

Procedure of Final Test

□ EUT and support equipment were set up on the turntable as per the configuration with highest emission level in the preliminary test.

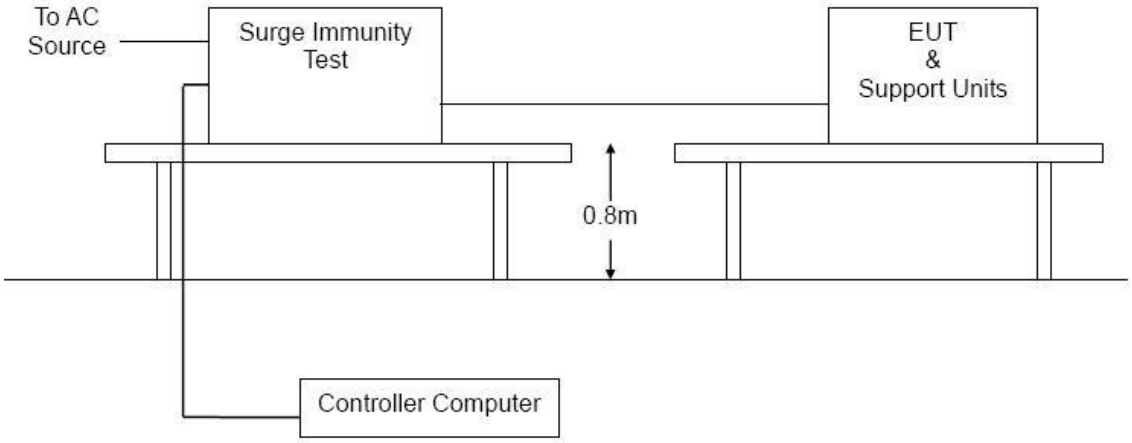
□ The Analyzer / Receiver scanned from 30MHz to 1000MHz. Emissions were scanned and measured rotating the EUT to 360 degrees, varying cable placement and positioning the antenna 1 to 4 meters above the ground plane, in both the vertical and the horizontal polarization, to maximize the emission reading level.

□ Recorded at least the six highest emissions. Emission frequency, amplitude, antenna position, polarization and turntable position were recorded into a computer in which correction factors were used to calculate the emission level and compare reading to the applicable limit and only Q.P. reading is presented.

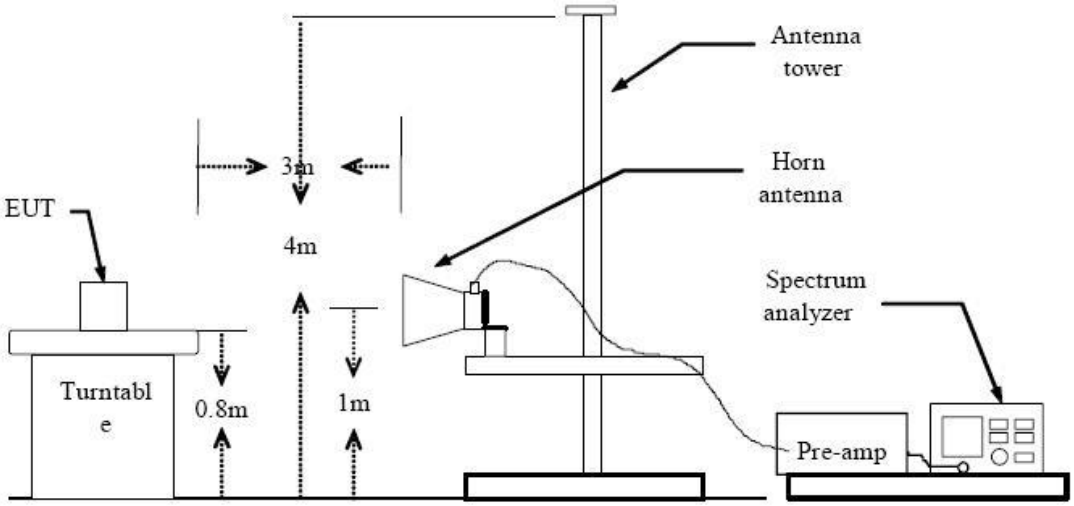
□ The test data of the worst-case condition(s) was recorded.

Test setup

Below 1 GHz

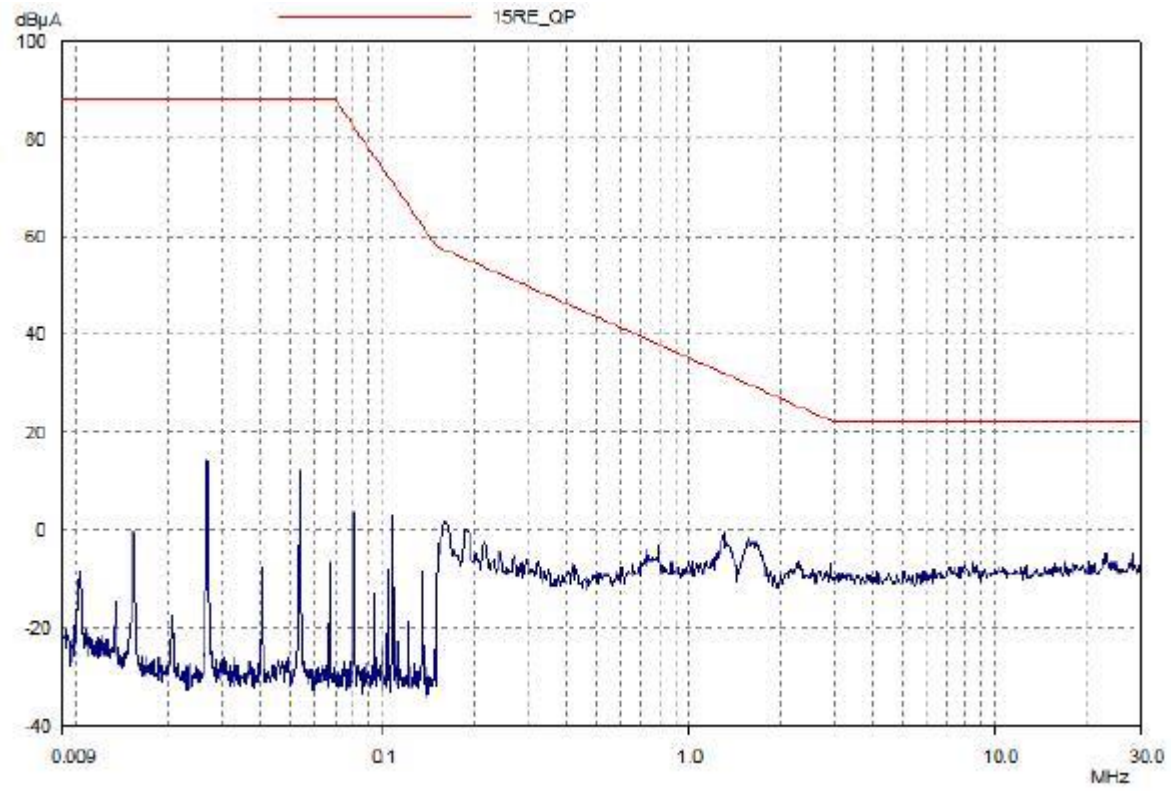


Above 1 GHz



30MHz-300Hz

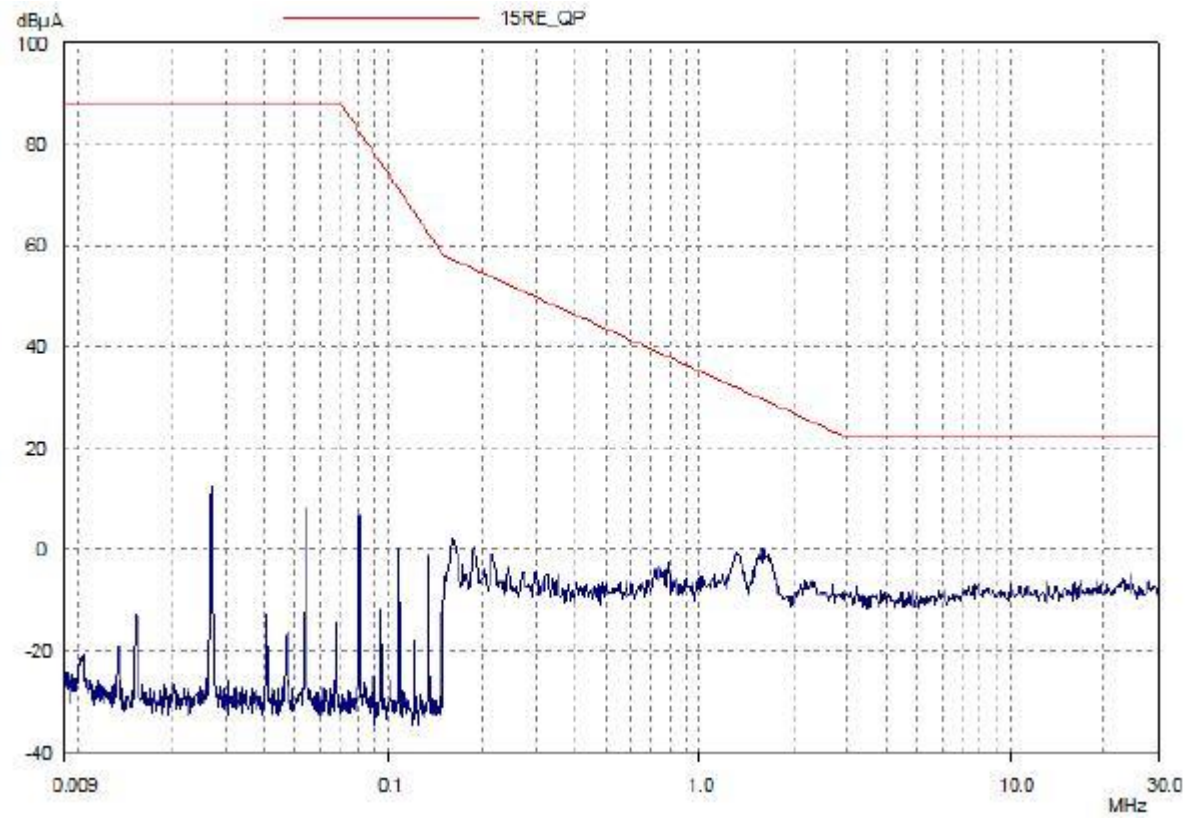
X Direction



Frequency /MHz	X direction	Quasi-peak (dBμA) Disturbance level Y direction	Z direction	Permitted limit
0.009	*	*	*	88.00
0.05	*	*	*	88.00
0.1	*	*	*	73.96
0.24	*	*	*	52.40
0.55	*	*	*	42.52
1.0	*	*	*	35.39
1.4	*	*	*	31.39
2.0	*	*	*	27.14
3.5	*	*	*	22.00
6.0	*	*	*	22.00
10.0	*	*	*	22.00
17.579	*	*	*	22.00
30.0	*	*	*	22.00

Notes: * means the disturbance level is 6dB lower than the relevant limit.

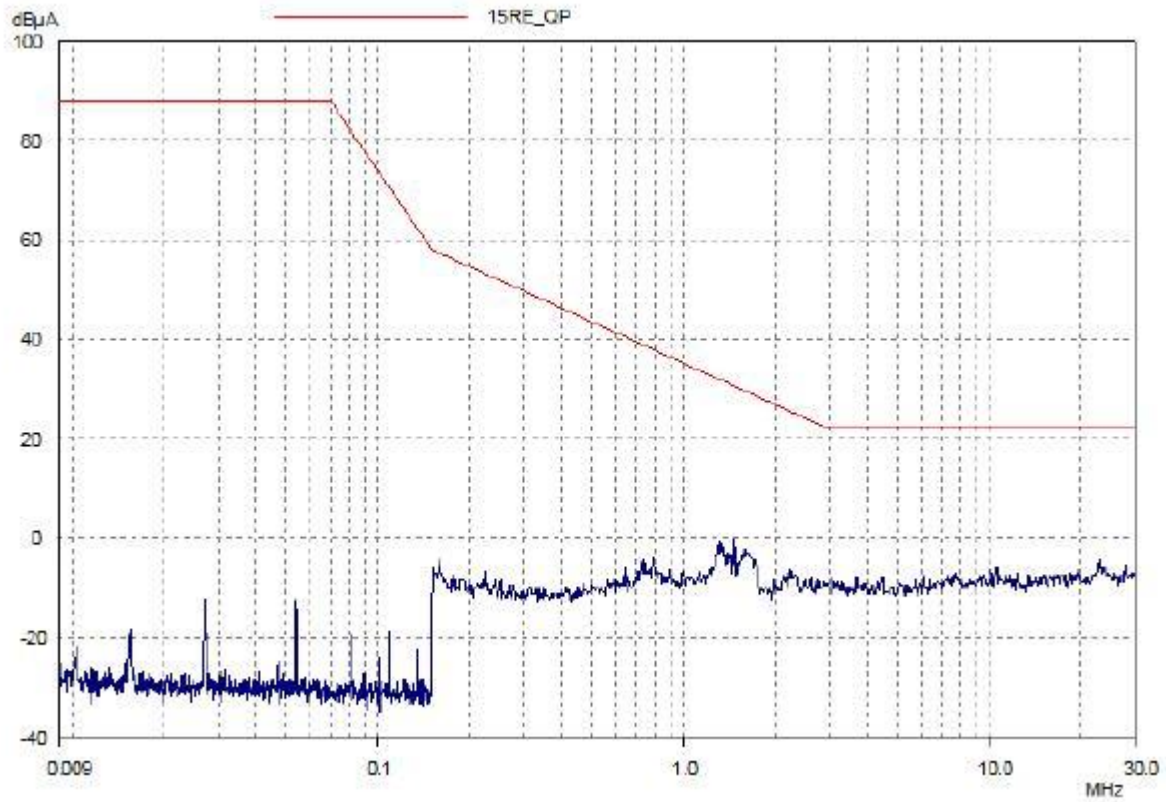
Y Direction



Frequency /MHz	X direction	Quasi-peak (dB µA) Disturbance level Y direction	Z direction	Permitted limit
0.009	*	*	*	88.00
0.05	*	*	*	88.00
0.1	*	*	*	73.96
0.24	*	*	*	52.40
0.55	*	*	*	42.52
1.0	*	*	*	35.39
1.4	*	*	*	31.39
2.0	*	*	*	27.14
3.5	*	*	*	22.00
6.0	*	*	*	22.00
10.0	*	*	*	22.00
17.579	*	*	*	22.00
30.0	*	*	*	22.00

Notes: * means the disturbance level is 6dB lower than the relevant limit.

Z Direction



Frequency /MHz	X direction	Quasi-peak (dB µA) Disturbance level Y direction	Z direction	Permitted limit
0.009	*	*	*	88.00
0.05	*	*	*	88.00
0.1	*	*	*	73.96
0.24	*	*	*	52.40
0.55	*	*	*	42.52
1.0	*	*	*	35.39
1.4	*	*	*	31.39
2.0	*	*	*	27.14
3.5	*	*	*	22.00
6.0	*	*	*	22.00
10.0	*	*	*	22.00
17.579	*	*	*	22.00
30.0	*	*	*	22.00

Notes: * means the disturbance level is 6dB lower than the relevant limit.

6.3 Harmonics Test Results

Test Requirement:	EN 61000-6-4
Test Method:	EN 61000-3-2
Test Date:	May 21, 2024
Frequency Range:	100Hz to 2kHz
Measurement Time:	3 mins
Class/Severity:	Class A
Detector:	As per EN61000-3-2

6.3.1 E.U.T. Operation

Operating Environment:

Temperature:	24.0°C	Humidity:	61% RH	Atmospheric Pressure:	1012 Mbar

EUT Operation:

Test the EUT in on mode for both models with the maximum. power at 220V ~ 50/60Hz

Test procedure

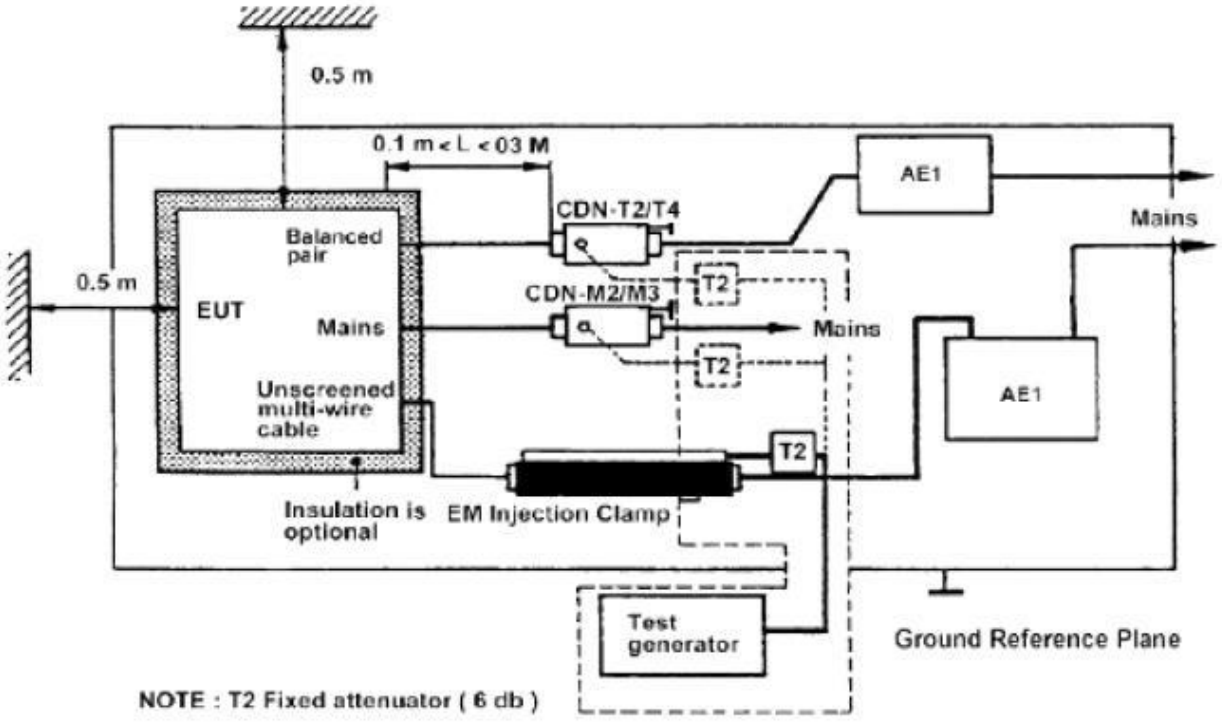
The EUT shall be tested within its intended operating and climatic conditions.

The test shell performed with the test generator connected to each of the coupling and decoupling devices in turn, while the other non-excited RF input ports of the coupling devices are terminated by a 50-ohm load resistor.

The frequency range was swept from 150 kHz to 80 MHz, using the signal level established during the setting process and with a disturbance signal of 80 % amplitude. The signal was modulated with a 1 kHz sine wave, pausing to adjust the RF signal level or the switch coupling devices as necessary. The sweep rate was 1.5 x 10-3 decades/s. Where the frequency range is swept incrementally, the step size was 1 % of preceding frequency value from 150 kHz to 80 MHz.

The dwell time at each frequency was less than the time necessary for the EUT to be exercised, and able to respond. Sensitive frequencies such as clock frequency(ies) and harmonics or frequencies of dominant interest, was analyzed separately.

Attempts was made to fully exercise the EUT during testing, and to fully interrogate all exercise modes selected for susceptibility.



Test procedure

□ The EUT was placed on the top of a wooden table 0.8 meters above the ground and operated to produce the maximum harmonic components under normal operating conditions for each successive harmonic component in turn.

□ The classification of EUT is according to section 5 of EN 61000-3-2.

□ The EUT is classified as follows:

Class A: Balanced three-phase equipment, Household appliances excluding equipment as Class D, Tools excluding portable tools, Dimmers for incandescent lamps, audio equipment, equipment not specified in one of the three other classes.

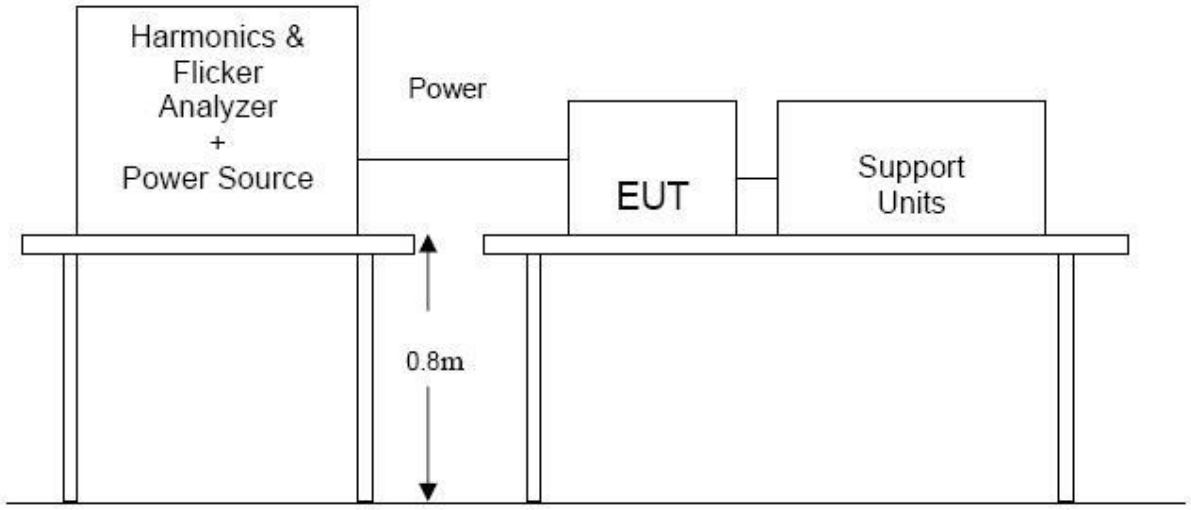
Class B: Portable tools; Arc welding equipment which is not professional equipment.

Class C: Lighting equipment.

Class D: Equipment having a specified power less than or equal to 600 W of the following types: Personal computers and personal computer monitors and television receivers.

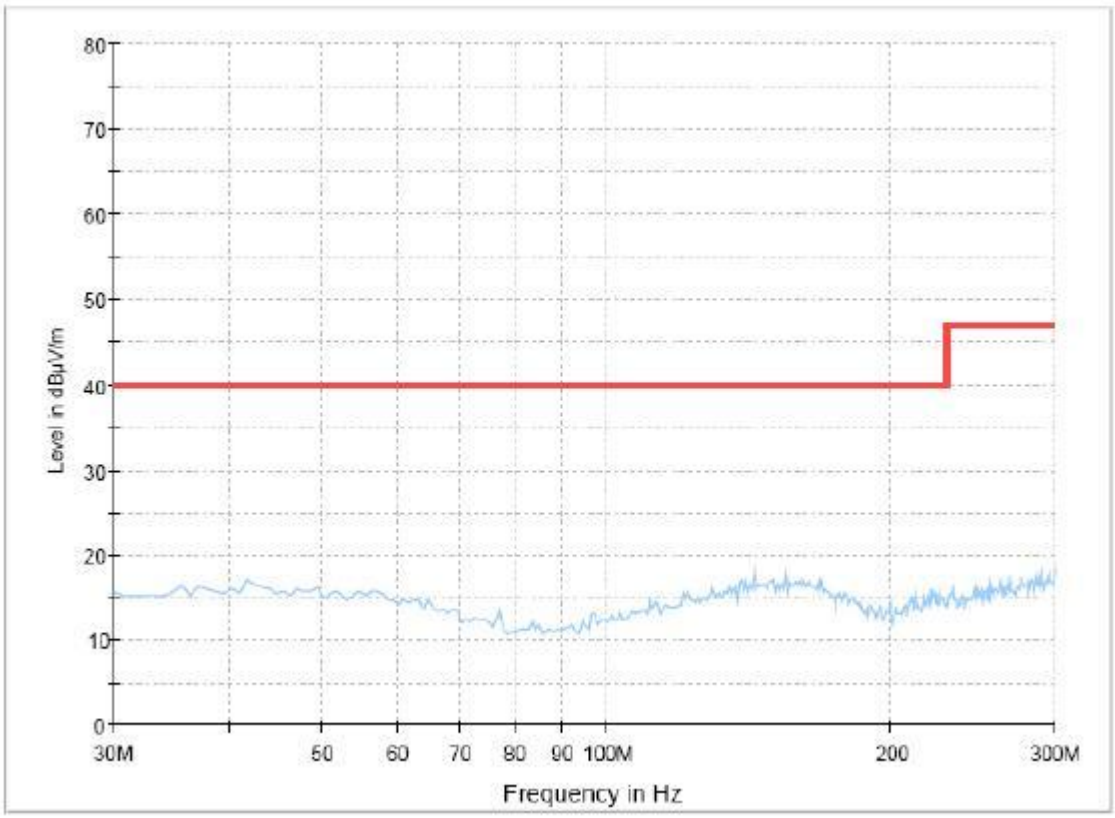
□ The correspondent test program of test instrument to measure the current harmonics emanated from EUT is chosen. The measure time shall be not less than the time necessary for the EUT to be exercised.

TEST SETUP


Harmonics &
Flicker
Analyzer
+
Power Source
Power
EUT
Support
Units
0.8m

6.3.2 Measurement Data

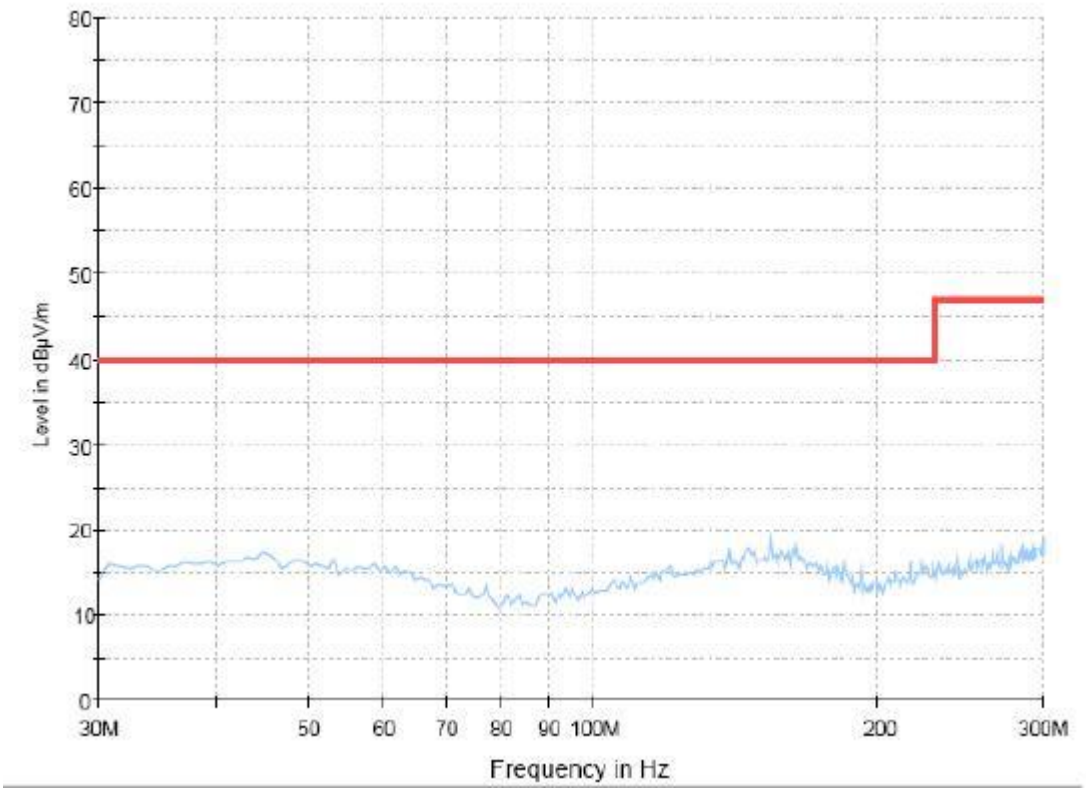
Horizontal:



Frequency	Receiver QP Level	Limit	Margin
(MHz)	(dBuV/m)	(dBuV/m)	(dB)
30.00	*	40.00	*
40.00	*	40.00	*
50.00	*	40.00	*
100.00	*	40.00	*
150.00	*	40.00	*
200.00	*	40.00	*
250.00	*	47.00	*
300.00	*	47.00	*

“*” means the emission level is 6dB lower than the relevant limit.

Vertical



Frequency (MHz)	Receiver QP Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
30.00	*	40.00	*
40.00	*	40.00	*
50.00	*	40.00	*
100.00	*	40.00	*
150.00	*	40.00	*
200.00	*	40.00	*
250.00	*	47.00	*
300.00	*	47.00	*

“*” means the emission level is 6dB lower than the relevant limit .

6.4 Flicker Test Result

Test Requirement:	EN 61000-3-2
Test Method:	EN 61000-3-2
Test Date:	May 21, 2024
Measurement Time:	10 mins
Class / Severity:	Clause 6 of EN 61000-3-2

6.4.1 E.U.T. Operation

Operating Environment:

Temperature:	24.0°C	Humidity:	61% RH	Atmospheric Pressure:	1012 Mbar

EUT Operation:

Test the EUT in Operation Mode with once stop/run operation.

6.4.2 Measurement Data

No test required.

Remark: only require to evaluate dmax, dc, dt. The Pst and Plt shall not be evaluated.

Since the EUT does not meet the limits of the standard EN 61000-3-3 when tested or evaluated with reference Zref, the another standard EN 61000-3-2 is applicable to this EUT which is, therefore, subject to conditional connection

According to EN 61000-3-2

The limits for motor (air compressor) : Pst=1.0; Plt=0.65; d(t)=500ms; dc=3.3%; dmax=7%

For testing using Zref

Ra=0.24 ohm Xa=j0.15 ohm at 50Hz; Rn=0.16 ohm Xn= j0.10 ohm at 50Hz

The Zref = 0.472 ohm

Result: : the max. data Dmax=6.330%, Dc=0.900%,Dt=120ms

According to EN6100-3-11 clause 6.2.2 to calculation of the maximum permissible system impedance:

The maximum permissible system impedance **Zmax= 0.520 ohm**

According to sub-clause 4 of the standard EN 61000-3-2, the applicant, therefore, may choose to declare that the EUT complies the standard EN 61000-3-2 provided that the EUT is connected only to a supply of impedance equal to or less than the Zmax calculated above. The Zmax values shall be declared in the equipment instruction manual, which shall also instruct to determine in consultation with the supply authority if necessary

7 Immunity Test Results

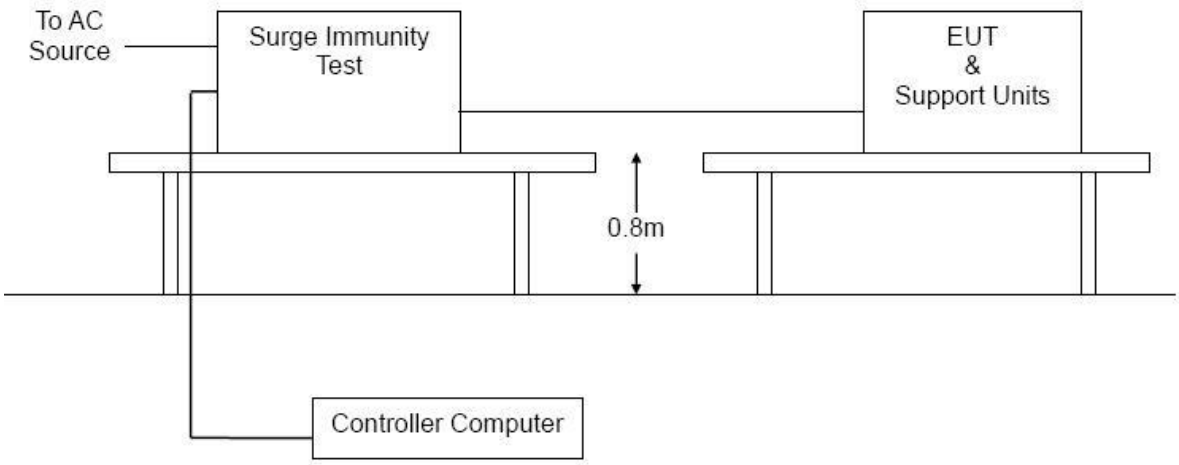
7.1 Performance Criteria Description in Clause 6 of EN 61000-6-2

Criterion A: The apparatus shall continue to operate as intended during the test. No degradation of performance or loss of function is allowed below a performance level (or permissible loss of performance) specified by the manufacturer, when the apparatus is used as intended. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and from what the user may reasonably expect from the apparatus if used as intended.

Criterion B: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level (or permissible loss of performance) specified by the manufacturer, when the apparatus is used as intended. During the test, degradation of performance is allowed, however. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation and from what the user may reasonably expect from the apparatus if used as intended.

Criterion C: Temporary loss of function is allowed, provided the function is self recoverable or can be restored by the operation of the controls, or by any operation specified in the instructions for use.

TEST SETUP



7.2 ESD

Performance Criterion:	C	
Discharge Impedance:	330 W / 150 pF	
Discharge Voltage:	Air Discharge:	8 kV
	Contact Discharge:	4 kV
	VCP/HCP:	4 kV
Polarity:	Positive & Negative	
Number of Discharge:	Minimum 10 times at each test point	
Discharge Mode:	Single Discharge	
Discharge Period:	1 second minimum	

7.2.1 Test Results

Direct Application Test Results

Observations: Test Point:

1. All insulated enclosure and seams.

2. All accessible metal parts of the enclosure.

Direct Application			Test	Results
Discharge Level (kV)	Polarity (+/-)	Test Point	Contact Discharge	Air Discharge
8	+/-	1	N/A	A
4	+/-	2	A	N/A

Indirect Application Test Results

Observations: Test Point: 1. All sides.

Test points:

Indirect Application			Test	Results
Discharge Level (kV)	Polarity (+/-)	Test Point	Horizontal Coupling	Vertical Coupling
4	+/-	1	N/A	A

Results: A: No degradation in the performance of the EUT was observed. N/A: Not applicable (floor mounted EUT or not requested by Standard)

- End of Test Report -

Type of equipment, model: Laser welding machine, AH-700W, AH-1200W, AH-1500W, WH-1000W, WH-1500W, WH-2000W, WH-3000W

Details of: Model AH-700W

View:

[X] general

[ ] front

[ ] rear

[ ] right

[ ] left

[ ] top

[ ] bottom

Details of: Model AH-1200W

View:

[X] general

[ ] front

[ ] rear

[ ] right

[ ] left

[ ] top

[ ] bottom

Details of: Model WH-1000W

View:

[X] general

[ ] front

[ ] rear

[ ] right

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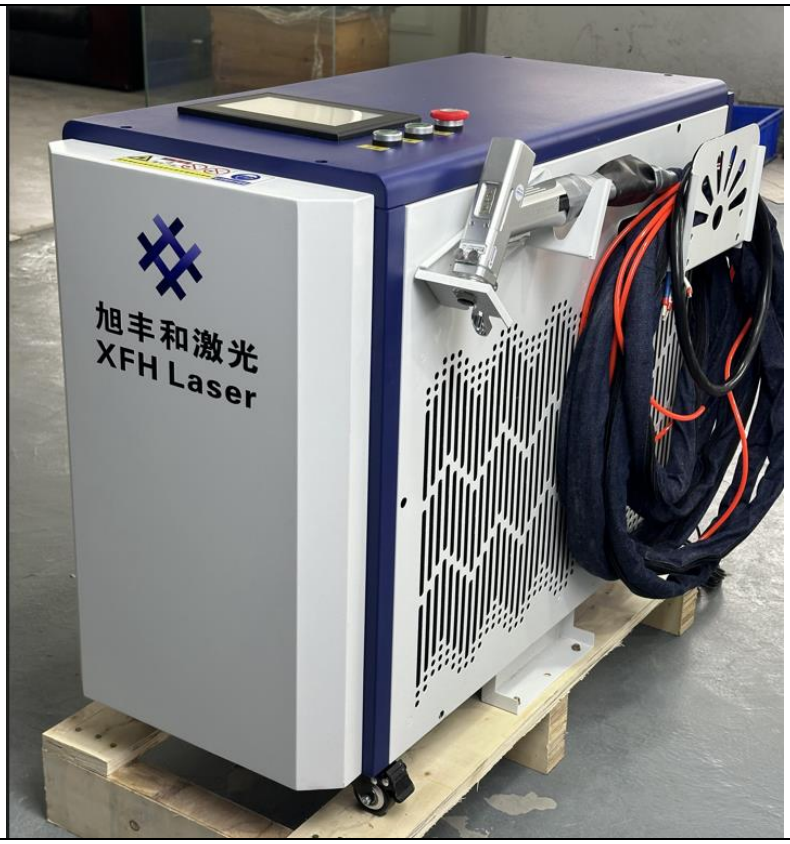
[ ] top

[ ] bottom



Details of: Model WH-1000W

View:

[X] general

[ ] front

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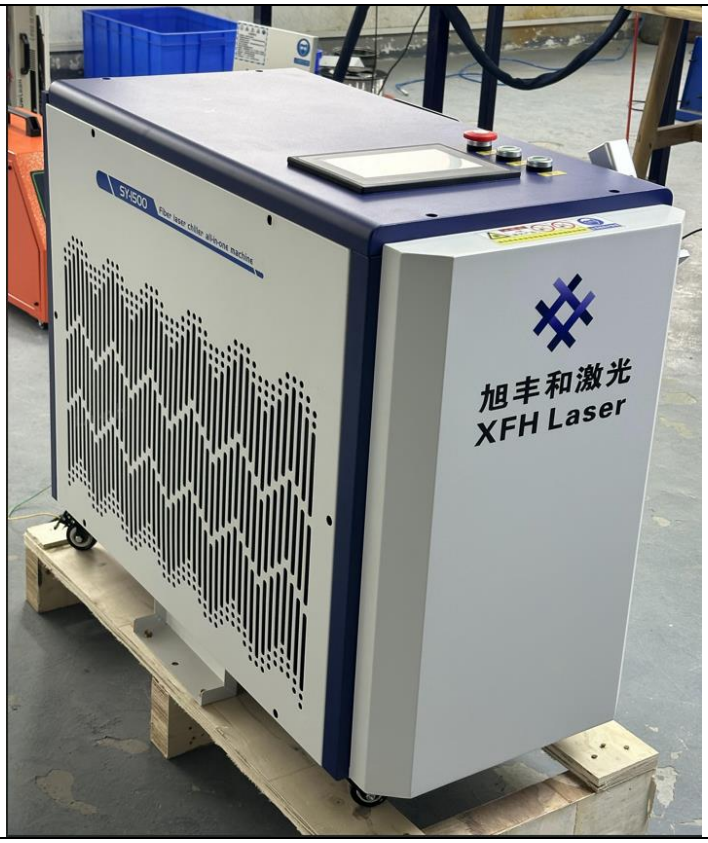

- End of Annex I -