CE

Technical Construction File

File No： SHENGTIAN-2016-A2

According to

2006/42/EC Machinery Directive

related to the

Strap Type Cutter

MODEL： DCQ-700; DCQ-700B; DCQ-900; DCQ-900B; DCQ-1200; DCQ-1200B; DCQ-1200-1.

its variants and modifications,

presented by

Zhejiang Shengtian Machinery Co., Ltd

Changdian Zone, Yanjiang Town, Linhai City, Taizhou State, Zhejiang Province, China

Applicant:	**Zhejiang Shengtian Machinery Co., Ltd**
	Changdian Zone, Yanjiang Town, Linhai City, Taizhou State, Zhejiang Province, China
Manufacturer:	**Zhejiang Shengtian Machinery Co., Ltd**
	Changdian Zone, Yanjiang Town, Linhai City, Taizhou State, Zhejiang Province, China
Product:	**Strap Type Cutter**
Model:	**DCQ-700; DCQ-700B; DCQ-900; DCQ-900B; DCQ-1200; DCQ-1200B; DCQ-1200-1**
Prepared By:	**Shanghai Dutong Testing & Certification Co., Ltd.**
	30, No. 666, East Beijing Road, Huangpu District, Shanghai, China
Directive:	**2006/42/EC Machinery Directive**
Standards:	**EN ISO 12100:2010; EN 60204-1: 2006+A1:2009**
Report No.:	**SHENGTIAN-2016-A2**
Test Date:	**2016.12.23**
Test result:	**Pass**

This device described above has been tested by HOU, the test result is in compliance with the 2006/42/EC requirements. Test result is applicable only to the tested sample identified in this report.

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Contents

Part I：General

1.1 General description

The strap type cutter is a large efficient cutting machine for cloth and various material.Use of the rapid ribbon cutting knife, stacked to the thickness of the 150~200mm for cutting into pieces. Apply to large and medium-sized garment manufacturers cut cotton cloth, woollen, linen, silk, synthetic leather cutting and cutting, and also applies to small knitwear and clothing material cut.

In order to ensure the conformity for CE marking for these machines, some main European and/or International standards have been used to made assessment of conformity, they are:
- EN ISO 12100 for mechanical safety and risk assessment;
- EN 60204-1 for assessing electrical safety.

The main risk of this kind of diesel generating set could be:
- The risk of access to the power transmission elements.
- The risk of access to the electrical hazard.

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

1.2 Product specification

See file No. 3
To present the conformity of this series machine with Machinery Directive, we discuss the conformity systematically with the relative Directive and standards for DCQ-1200-1 in clause.

1.3 Quality control system

In order to ensure the conformity of the series production, the Zhejiang Shengtian Machinery Co., Ltd has taken the related procedures mentioned below：

（1） Apply for the consultant form the qualified body in China

The Shengtian has applied for the consultant form Shanghai HOU Technology Co., Ltd. who is a competent institute for the CE marking consultant and certification in China.
The complete technical construction file (TCF) has been established before applying for the CE marking certificate under the consultant of HOUCERT.

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

Before the assemblies of the series production, the QC engineers of Shengtian has to check and inspect the technical specifications and intended functions of parts and components to ensure the correct use of them according to the contents of TCF and principle described in the related technical information.

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

Before packing the products, the QC engineers of Shengtian have to do the necessary inspection and testing to ensure the conformity of related requirements, in particular the testing and inspection of electrical characteristics and outer feature.

（4） Carry out the inspection for the packing

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

（5） Provision for the change of design

Any change of the products described in this TCF must be checked in detail and written down again in the TCF by the designer of Shengtian if the change may effects the related electrical or mechanical characteristics.

（6） Provision for the Quality Assurance

For the provisions of internal control measures to ensure the conformity of series production of the machines, Shengtian has built an internal quality control system in accordance with the international standard of ISO-9001.

1.4 Declaration of conformity

EC DECLARATION OF CONFORMITY

(Machinery Directive 2006/42/EC, Annex II.A)

Manufacturer:

Name & address: Zhejiang Shengtian Machinery Co., Ltd

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Address: l.M.C 4 Blok No. 4203 FATIH / UNKAPANI - ISTANBUL

Herewith we declare that:

Product: Strap Type Cutter

Models: DCQ-700; DCQ-700B; DCQ-900; DCQ-900B; DCQ-1200; DCQ-1200B; DCQ-1200-1.

Serials No.: All serials covered

are in conformity with the EU Directive:

2006/42/EC Machinery Directive

Furthermore, the following harmonized standards have been used:

- EN ISO 12100:2010 Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)
- EN 60204-1: 2006/A1:2009 Safety of machinery - Electrical equipment of machines -Part 1: General requirements. Industrial electrical device.

CE

Place and date of issue: Linhai, China, 2016-12-08

Manager: _____

Signature: _____

1.5 List of applicable regulations and standards

Regulations

Machinery Directive: 2006/42/EC

Standards

EN 60204-1: 2006/A1:2009 Safety of machinery - Electrical equipment of machines -Part 1: General requirements. Industrial electrical device.

EN ISO 12100:2010 Safety of machinery - General principles for design – Risk assessment and risk reduction

Part II：Assessment of conformity

2.1 Essential health and safety requirements

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
1	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.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. (b) In selecting the most appropriate methods, the manufacturer or his authorised representative must apply the following principles, in the order given: — eliminate or reduce risks as far as possible (inherently safe machinery design and construction), — take the necessary protective measures in relation to risks that cannot be eliminated, — 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. (c) When designing and constructing machinery and when drafting the instructions, the manufacturer or his authorised representative must envisage not only the intended use of the machinery but also any reasonably foreseeable misuse thereof. The machinery must be designed and constructed in such a way as to prevent abnormal use if such use would engender a risk. Where appropriate, the instructions must draw the user's attention to ways —which experience has shown might occur — in which the machinery should not be used. (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. (e) Machinery must be supplied with all the special equipment and accessories essential to enable it to be adjusted, maintained and used safely.	☑			a-Pass. b- Relevant protective measures are taken, information is given in user manual and warning signs are affixed on machine for residual risks. c- There is no any accident occurs. Abnormal conditions are considered during risk assessment d-operator must wear safety wire gloves when using this machine e- Relevant equipment and document is supplied with machine.
	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.	☑			The materials used to constructed machinery can't endanger person's safety or health.

	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. 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. Internal parts requiring frequent inspection and adjustment, and maintenance areas must be provided with appropriate lighting.	☑			The workshop for the machine working is with enough light.
	1.1.5	*Design of machinery to facilitate its handling* Machinery, or each component part thereof, must: — be capable of being handled and transported safely, — be packaged or designed so that it can be stored safely and without damage.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 component part must: — either be fitted with attachments for lifting gear, or — be designed so that it can be fitted with such attachments, or — be shaped in such a way that standard lifting gear can easily be attached. Where machinery or one of its component parts is to be moved by hand, it must: — either be easily moveable, or — be equipped for picking up and moving safely. Special arrangements must be made for the handling of tools and/or machinery parts which, even if lightweight, could be hazardous.	☑			Lifting points are provided Please see instruction manual for detail information Lift truck is used
	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, — providing enough space for movements of the parts of the operator's body, — avoiding a machine-determined work rate, — avoiding monitoring that requires lengthy concentration, — adapting the man/machinery interface to the foreseeable characteristics of the operators.	☑			Ergonomical principles are considered during design No need to manual interfernce during operation

	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. 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. 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.	☑			The machine is not used in a hazardous environment
	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. 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. 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. 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.			☑	-----
	1.2 1.2.1	**Control Systems** *Safety and reliability of control systems* Control systems must be designed and constructed in such a way as to prevent hazardous situations from arising. Above all, they must be designed and constructed in such a way that: — they can withstand the intended operating stresses and external influences, — a fault in the hardware or the software of the control system does not lead to hazardous situations, — errors in the control system logic do not lead to hazardous situations, — reasonably foreseeable human error during operation does not lead to hazardous situations. Particular attention must be given to the following points:	☑			This machine’s control is simple Only start/stop button is used

		— the machinery must not start unexpectedly, — the parameters of the machinery must not change in an uncontrolled way, where such change may lead to hazardous situations, — the machinery must not be prevented from stopping if the stop command has already been given, — no moving part of the machinery or piece held by the machinery must fall or be ejected, — automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, — the protective devices must remain fully effective or give a stop command, — 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. For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss of communication.				
	1.2.2	<u>*Control devices*</u> Control devices must be: — clearly visible and identifiable, using pictograms where appropriate, — positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, — designed in such a way that the movement of the control device is consistent with its effect, — located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, — positioned in such a way that their operation cannot cause additional risk, — designed or protected in such a way that the desired effect, where a hazard is involved, can only be achieved by a deliberate action, — made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. Where a control device 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. Control devices 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. Machinery must be fitted with indicators as required for safe operation. The operator must be able to read them from the control position. From each control position, the operator must be able to ensure that no-one is in	☑			This machine's control is simple Only start/stop button is used

		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. 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. 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. Where there is more than one control position, the 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.				
	1.2.3	*Starting* It must be possible to start machinery only by voluntary actuation of a control device provided for the purpose. The same requirement applies: — when restarting the machinery after a stoppage, whatever the cause, — when effecting a significant change in the operating conditions. 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. 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. Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to 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.	☑			This machine's control is simple Only start/stop button is used

	1.2.4.1	*Stopping* Normal stopping Machinery must be fitted with a control device whereby the machinery can be brought safely to a complete stop. Each workstation must be fitted with a control device to stop some or all of the functions of the machinery, depending on the existing hazards, so that the machinery is rendered safe. The machinery's stop control must have priority over the start controls. Once the machinery or its hazardous functions have stopped, the energy supply to the actuators concerned must be cut off.	☑			This machine's control is simple Only start/stop button is used
	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.			☑	-----
	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. 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, — portable hand-held and/or hand-guided machinery. The device must: — have clearly identifiable, clearly visible and quickly accessible control devices, — stop the hazardous process as quickly as possible, without creating additional risks, — where necessary, trigger or permit the triggering of certain safeguard movements. 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; it must not be possible to engage the device without triggering a stop command; 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. The emergency stop function must be available and operational at all times, regardless of the operating mode. Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.			☑	

	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.			☑	
	1.2.5	***Selection of control or operating modes*** The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop. If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode. The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator. If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled, the control or operating mode selector must simultaneously: — disable all other control or operating modes, — permit operation of hazardous functions only by control devices requiring sustained action, — permit the operation of hazardous functions only in reduced risk conditions while preventing hazards from linked sequences, — prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. 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. In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.			☑	
	1.2.6	*Failure of the power supply* The interruption, the re-establishment after an interruption or the fluctuation in whatever manner of the power supply to the machinery must not lead to dangerous situations.Particular attention must be given to the following points: — the machinery must not start unexpectedly, — the parameters of the machinery must not change in an uncontrolled way when such change can lead to hazardous situations, — the machinery must not be prevented from stopping if the command has	☑			Only operator push the start button can restart the machine This machine’s control is simple Only start/stop button is used

		already been given, — no moving part of the machinery or piece held by the machinery must fall or be ejected, — automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, — the protective devices must remain fully effective or give a stop command.				
	1.3 1.3.1	PROTECTION AGAINST MECHANICAL HAZARDS 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. If the shape of the machinery itself or its intended installation does not offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions.	☑			Machine is fixed on the floor, it is stable enough.
	1.3.2	*Risk of break-up during operation* The various parts of machinery and their linkages must be able to withstand the stresses to which they are subject when used. 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. The instructions must indicate the type and frequency of inspections and maintenance required for safety reasons. They must, where appropriate, indicate the parts subject to wear and the criteria for replacement. 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. 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. Where the material to be processed is fed to the tool automatically, the following conditions must be fulfilled to avoid risks to persons: — when the workpiece comes into contact with the tool, the latter must have attained its normal working condition, — when the tool starts and/or stops (intentionally or accidentally), the feed movement and the tool movement must be coordinated.	☑			All parts of the machine can withstand related stress when they are used.

	1.3.3	*Risks due to falling or ejected objects* Precautions must be taken to prevent risks from falling or ejected objects			☑	
	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.	☑			
	1.3.5	*Risks related to combined machinery* Where the machinery is intended to carry out several different operations with the 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 danger or risk for the exposed person. For this purpose, it must be possible to start and stop separately any elements that are not protected.			☑	
	1.3.6	Risks Related To Variations İn Operating Conditionsxd Where the machinery performs 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.			☑	
	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. All necessary steps must be taken to prevent accidental blockage of moving parts involved in the work. In cases where, despite the precautions taken, a blockage is likely to occur, the necessary specific protective devices and tools must, when appropriate, be provided to enable the equipment to be safely unblocked. The instructions and, where possible, a sign on the machinery shall identify these specific protective devices and how they are to be used.	☑			Cutting hazard exists when using the machine operator must wear safety wire gloves to use the machine
	1.3.8	*Choice of protection against risks related to moving parts* Guards or protective devices designed to protect against risks arising from moving parts must be selected on the basis of the type of risk. The following guidelines must be used to help to make the choice.	☑			operator must wear safety wire gloves to use the machine
	1.3.8.1	Moving Transmission Parts Guards designed to protect persons against the hazards generated by moving transmission parts must be: — either fixed guards as referred to in section 1.4.2.1, or — interlocking movable guards as referred to in section 1.4.2.2. Interlocking movable guards should be used where frequent access is envisaged.	☑			Guard is used

	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 — interlocking movable guards as referred to in section 1.4.2.2, or — protective devices as referred to in section 1.4.3, or — a combination of the above. 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 — adjustable guards as referred to in section 1.4.2.3 restricting access to those sections of the moving parts where access is necessary.			☑	
	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.			☑	
	1.4 1.4.1	*Required characteristics of guards and protection devices* *General requirements* Guards and protective devices must: — be of robust construction, — be securely held in place, — not give rise to any additional hazard, — not be easy to by-pass or render non-operational, — be located at an adequate distance from the danger zone, — cause minimum obstruction to the view of the production process, and — 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. In addition, guards must, where possible, protect against the ejection or falling of materials or objects and against emissions generated by the machinery.	☑			
	1.4.2 1.4.2.1	*Special requirements for guards* *Fixed guards* Fixed guards must be fixed by systems that can be opened or removed only with	☑			Fixed guards are fixed by systems that can be opened or removed only with tools.

		tools.Their fixing systems must remain attached to the guards or to the machinery when the guards are removed.Where possible, guards must be incapable of remaining in place without their fixings.				
	1.4.2 1.4.2.2	Interlocking Movable Guards Interlocking movable guards must: — as far as possible remain attached to the machinery when open, — be designed and constructed in such a way that they can be adjusted only by means of an intentional action.Interlocking movable guards must be associated with an interlocking device that: — prevents the start of hazardous machinery functions until they are closed and — gives a stop command whenever they are no 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 in addition to an interlocking device that: — prevents the start of hazardous machinery functions until the guard is closed and locked, and — keeps the guard closed and locked until the risk of injury from the hazardous machinery functions has ceased. Interlocking movable guards must be designed in such a way that the absence			☑	
	1.4.2 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, depending on the type of work involved, and — readily adjustable without the use of tools.			☑	---
	1.4.3	*Special requirements for protection devices* Protective devices must be designed and incorporated into the control system in such a way that: — moving parts cannot start up while they are within the operator's reach, — persons cannot reach moving parts while the parts are moving, and — the absence or failure of one of their components prevents starting or stops the moving parts.Protective devices must be adjustable only by means of an intentional action.			☑	

	1.5 1.5.1	RISKS DUE TO OTHER HAZARDS *Electricity supply* Where machinery has an electricity supply, it must be designed, constructed and equipped in such a way that all hazards of an electrical nature are or can be prevented.The safety objectives set out in Directive LVD 2006/95/EC 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.	☑			
	1.5.2	*Static electricity* Machinery must be designed and constructed to prevent or limit the build-up of potentially dangerous electrostatic charges and/or be fitted with a discharging system.	☑			---
	1.5.3	*Energy supply other than electricity* Where machinery is powered by source of energy other than electricity, it must be so designed, constructed and equipped as to avoid all potential risks associated with such sources of energy.			☑	
	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 and construction of such parts or, failing this, by information given on the parts themselves and/or their housings. The same information must be given on moving parts and/or their housings where the direction of movement needs to be known in order to avoid a risk. Where necessary, the instructions must give further information on these risks. Where a faulty connection can be the source of risk, incorrect connections must be made impossible by design or, failing this, by information given on the elements to be connected and, where appropriate, on the means of connection.	☑			Only authorized staff can make operation and maintenance.Detailed information is given in user manual for spare part, trouble-shooting and contact information.
	1.5.5	*Extreme temperatures* Steps must be taken to eliminate any risk of injury arising from contact with or proximity to machinery parts or materials at high or very low temperatures. The necessary steps must also be taken to avoid or protect against the risk of hot or very cold material being ejected.			☑	
	1.5.6	*Fire* Machinery must be designed and constructed in such a way as to avoid any risk of fire or overheating posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.			☑	---
	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.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.(ATEX)				
	1.5.8	*Noise* Machinery must be designed and constructed in such a way that risks resulting from the emission of airborne noise are reduced to the lowest level, taking account of technical progress and the availability of means of reducing noise, in particular at source. The level of noise emission may be assessed with reference to comparative emission data for similar machinery.	☑			Noise emission value is low, less than 70dB
	1.5.9	*Vibrations* Machinery must be designed and constructed in such a way that risks resulting from 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 level of vibration emission may be assessed with reference to comparative emission data for similar machinery.			☑	---
	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. 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. Any functional non-ionising radiation emissions during setting, operation and cleaning must be limited to levels that do not have adverse effects on persons.	☑			CE Marked electrical components are used. See component list.
	1.5.11	*External radiation* Machinery must be so designed and constructed that external radiation does not interfere with its operation.	☑			CE Marked electrical components are used. See component list.
	1.5.12	*Laser radiation* Where laser equipment is used, the following should be taken into account: — laser equipment on machinery must be designed and constructed in such a way as to prevent any accidental radiation, — laser equipment on machinery must be protected in such a way that effective radiation, radiation produced by reflection or diffusion and secondary radiation do not damage health, — optical equipment for the observation or adjustment of laser equipment on machinery must be such that no health risk is created by laser radiation.			☑	---

	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. 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.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.			☑	---
	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.			☑	---
	1.5.15	*Risk of slipping, tripping or falling* 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. Where appropriate, these parts must be fitted with handholds that are fixed relative to the user and that enable them to maintain their stability.			☑	---
	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.	☑			
	1.6 1.6.1	*Maintenance* *Machinery maintenance* Adjustment and maintenance points must be located outside danger zones. It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill. 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).In the case of automated machinery and, where necessary, other machinery, a connecting device for mounting diagnostic fault-finding equipment must be provided. Automated machinery components which have to be changed frequently must be capable of being removed and replaced easily and safely. Access to the components must enable these tasks to be carried out with the necessary technical means in accordance with a specified operating method.	☑			Please see instruction manual

	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.	☑			It is supplied by manufacturer.
	1.6.3	*Isolation of energy sources* Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified.They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. 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. 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. 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.	☑			
	1.6.4	*Operator intervention* Machinery must be so designed, constructed and equipped that the need for operator intervention is limited. If operator intervention cannot be avoided, it must be possible to carry it out easily and safely.	☑			Operator could intervent to main switch and energy supplying,
	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. 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.			☑	
	1.7 1.7.1	INFORMATION 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. Any written or verbal information and warnings must be expressed in an official Community language or	☑			The dimensions and the colours of the warning signs are complied with the relevant references

		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.				
	1.7.1.1	Information And İnformation Devices The information needed to control machinery must be provided in a form that is unambiguous and easily understood. It must not be excessive to the extent of overloading the operator. Visual display units or any other interactive means of communication between the operator and the machine must be easily understood and easy to use.	☑			---
	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. Where machinery is equipped with warning devices these must be unambiguous and easily perceived. The operator must have facilities to check the operation of such warning devices at all times. The requirements of the specific Community Directives concerning colours and safety signals must be complied with.	☑			
	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.	☑			Warning signs are affixed on machine frame and necessary information is given in user manual
	1.7.3	*Marking of machinery* All machinery must be marked visibly, legibly and indelibly with the following minimum particulars: — the business name and full address of the manufacturer and, where applicable, his authorised representative, — designation of the machinery, — the CE Marking (see Annex III), — designation of series or type, — serial number, if any, — the year of construction, that is the year in which the manufacturing process is completed.It is prohibited to pre-date or post-date the machinery when affixing the CE marking. Furthermore, machinery designed and constructed for use in a potentially explosive atmosphere must be marked accordingly.	☑			See name plate

		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. Where a machine part must be handled during use with lifting equipment, its mass must be indicated legibly,indelibly and unambiguously.				
	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.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.9.6.2006 EN Official Journal of the European Union L 157/47 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.The instructions must be drafted in accordance with the principles set out below.	☑			A detailed user manual is prepared and send to customer with machine.According to client request user manual is translated to different languages
	1.7.4.1	General Principles For The Drafting Of İnstructions (a) 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 authorised representative. (b) 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 authorised 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'. (c) 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. (d) 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.	☑			Chinese and English General safety instructions and warning signs are affixed on the machine and explained in user manual.
	1.7.4.2	**Contents of the instructions** Each instruction manual must contain, where applicable, at least the following information: (a) the business name and full address of the manufacturer and of his authorised representative; (b) the designation of the machinery as marked on the machinery itself, except for the serial number (see section 1.7.3); (c) the EC declaration of conformity, or a document setting out the contents of the	☑			See User Manual. A detailed user manual is prepared.

		EC declaration of conformity, showing the particulars of the machinery, not necessarily including the serial number and the signature; (d) a general description of the machinery; (e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning; (f) a description of the workstation(s) likely to be occupied by operators; (g) a description of the intended use of the machinery; (h) warnings concerning ways in which the machinery must not be used that experience has shown might occur; (i) 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; (j) instructions relating to installation and assembly for reducing noise or vibration; (k) instructions for the putting into service and use of the machinery and, if necessary, instructions for the training of operators; (l) information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted; (m) instructions on the protective measures to be taken by the user, including, where appropriate, the personal protective equipment to be provided; (n) the essential characteristics of tools which may be fitted to the machinery; (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns; (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; (q) 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; (r) 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; (s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations; (t) the specifications of the spare parts to be used, when these affect the health and safety of operators; (u) 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 peak C-weighted instantaneous sound pressure value at workstations, where this exceeds 63 Pa (130 dB in relation to 20 µPa), — the A-weighted sound power level emitted by the machinery, where the A-weighted emission sound pressure level at workstations exceeds 80 dB(A). These values must be either those actually measured for the machinery in question or those established on the basis of measurements taken for technically comparable machinery which is representative of the machinery to be produced. 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.Where the harmonised standards are not applied, sound levels must be measured using the most appropriate method for the machinery. Whenever sound emission values are indicated the uncertainties surrounding these values must be specified. The operating conditions of the machinery during measurement and the measuring methods used must be described.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 position and value of the maximum sound pressure must be indicated. 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; (v) 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 concerning the radiation emitted for the operator and exposed persons.				
	1.7.4.3	<u>Sales Literature</u> Sales literature describing the machinery must not contradict the instructions as regards health and safety aspects. Sales literature describing the performance characteristics of machinery must contain the same information on emissions as is contained in the instructions.	☑			Sales literature are not have any conflicts between user manual and directives

Internal Production Control						
Technical construction file shall be retained and kept available for the competent national authorities for at least 10 years following the date of manufacture of the machinery or of the last unit produced.			☑			TCF would be saved 10 years after last product would manufactured.
Safety measures for fulfilling the product conformity requirements - Critical components shall be checked for every purchasing order if it is comply with the critical component list and relevant conformance and requirements are considered during incoming inspection. - Production flow chart and quality control plans - Regulatory compliance records for the released machinery. (Availability and compliance) ¤ Relevant warning signs ¤ CE Conformity mark ¤ User manual ¤ Relevant circuit diagrams ¤ Relevant accessories, tools and apparatus ¤ Functional tests ¤ Mechanical tests ¤ Electrical safety tests			☑			See records and reports See ISO 9001 certificate

2.2 Risk assessment

Risk Assessment Strategy

To implement risk assessment and risk reduction the designer shall take the following actions, in the order given (see Figure 1):

a) determine the limits of the machinery, which include the intended use and any reasonably foreseeable misuse thereof;
b) identify the hazards and associated hazardous situations;
c) estimate the risk for each identified hazard and hazardous situation;
d) evaluate the risk and take decisions about the need for risk reduction;

The final step is related to risk reduction.

e) eliminate the hazard or reduce the risk associated with the hazard by means of protective measures.

Follow the above steps to analyse the risks associated with machinery.

Risk assessment is always followed where possible risk reduction and iteration of the process can be required to eliminate hazards as far as practicable and to implement protective measures to reduce risks.

Protective Measures

Protective measures are the measures implemented by the designer and the user, protective measures designed into the product are generally more effective and tend to be cheaper to implement.

The objective is to achieve the most practicable risk reduction taking into account the following:

a) Safety of the machine in all the phases of the life cycle
b) Ability of the machine to perform its function
c) The usability of the machine
d) The manufacturing, operational and dismantling cost of the machine

Risk reduction

Following a risk assessment risk reduction may be required. This can be achieved by the elimination of the hazard or by separately or simultaneously reducing each of the elements that determine the associated risk.

a) Severity of harm from the hazard,
b) Probability of the occurrence of that harm.

All protective measures that are intended to meet this objective shall be applied using the 'Three Step Method'.

Step 1: Inherently safe design measures

Inherently safe design measures eliminate hazards or reduce the associated risks by a suitable choice of design features of the machine itself and/or interaction between the exposed persons and the machine.

NOTE 1: This stage is the only one at which hazards can be eliminated, thus avoiding the need for additional protective measures such as safeguarding or complementary protective measures.

Step 2: Safeguarding and/or complementary protective measures

Taking into account the intended use and the reasonably foreseeable misuse, appropriately selected safeguarding and complementary protective measures can be used to reduce risk when it is not practicable to eliminate a hazard, or reduce its associated risk sufficiently, using inherently safe design measures.

Step 3: Information for use

Where risks remain despite inherently safe design measures, safeguarding and the adoption of complementary protective measures, the residual risks shall be identified in the information for use. The information for use shall include, but not be limited to, the following:

Operating procedures for the use of the machinery consistent with the expected ability of personnel who use the machinery or other persons who can be exposed to the hazards associated with the machinery.

The recommended safe working practices for the use of the machinery and the related training requirements adequately described.

Sufficient information, including warning of residual risks for the different phases of the life of the machinery.

The description of any recommended personal protective equipment, including detail as to its need as well as to training needed for its use.

Information for use shall not be a substitute for the correct application of inherently safe design measures, safeguarding or complementary protective measures.

NOTE 2: Adequate protective measures associated with each of the operating modes and intervention procedures reduce the possibility of operators being induced to use hazardous intervention techniques in case of technical difficulties.

Prior to beginning work the first time, the operators are expected to have read and understood the safety section of the instructions that accompany the machinery, and to be familiar with the location and operation of each control, and to have received appropriate training / competence assessment.

Risk Estimation

Hazards should be assessed at all phases of the machine life i.e. construction, transportation, assembly, installation, commissioning, use, maintenance, dismantling & disposal.

Risk is a function of the combination of the **severity of harm** and the **probability of occurrence** of that harm. Information taken from the determined limits of the machinery will allow the risk assessor to correctly estimate the risks.

The severity of harm is estimated by considering the *severity of injury* or damage to health and the *extent of the harm*. The probability of occurrence is itself a function of the *exposure of person* (s) to the hazard, the *occurrence of a hazardous event* and the *possibility to avoid* or limit the harm.

Severity of Harm

When completing risk assessments, the risk from the most likely severity of harm that is likely to occur from each identified hazard shall be considered and the highest foreseeable severity shall also be taken into account, even if the probability is low.

The **severity of harm** can be distinguished in better detail by considering the **severity of injury** and the **extent of that harm**.

Probability of Occurrence of that harm

This is a combination of factors that can be split into the **Frequency of Exposure** and **Possibility of Avoidance**. The frequency of exposure takes into account the *frequency of access, the nature of access, the number of persons* requiring access to the hazard zone and the *time spend within the hazard zone*. Also there are other element to identification of possibility of avoidance which considers the machines history (reliability / known problems) and the type of machine by using comparison of risks to similar machines.

The possibility of avoidance considers the skill of the operators / persons exposed to the harm, how quickly the hazardous situation develops and how easy it is for the operator / persons exposed to the harm to identify a risk. The risk score is calculated by multiplying: severity of injury x extent of harm, frequency of exposure x possibility of avoidance using the following scoring system:

	Rating	Description	Score
Severity of Injury *SOI*	High	irreversible e.g. loss of limb, or fatality	3
	Medium	recoverable e.g. broken bone or deep cuts	2
	Low	reversible, minor cuts and bruises	1
Extent of Harm *EOH*	Several	Multiple persons exposed to hazard	2
	One	Single person exposed to hazardous situation	1
Frequency of Exposure *FOE*	High	frequent e.g. more than once every 10 minutes	3
	Medium	regularly e.g. once per hour	2
	Low	infrequent e.g. once per week	1
Possibility of Avoidance *POA*	High	obvious and slow moving	1
	Medium	can get out of the way with normal reactions	2
	Low	hazard not obvious and moving fast	3

Note: The scoring for Possibility of Avoidance is reversed from the other 2 categories.

For each hazard the objective is to get to a risk score of 4 or less.

Once the risk has been assessed, appropriate elimination and reduction measures should be taken and the risk rating recalculated.
Risk reduction can be done by separately or simultaneously reducing each of the elements which determine the risk, SOI, EOH, FOE and POA. The measures taken should be reevaluated to check if they have introduced any new hazards.

The risk assessment process should be repeated until an acceptable risk level is achieved.
This called an “iterative” process.

Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re - estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
1			**Mechanical**													
1.1	1.3.7	6.2.2.1 6.2.2.2	Crushing													
1.2	1.3.4	6.2.2.1 6.2.2.2	Cutting or severing	Operator's finger is cut by saw blade	3	2	2	1	12	Only trained person can operate/maintenance machine Warning label is affixed Operator must wear safety wire gloves when using this machine	2	2	1	1	4	
1.3	1.3.7	6.2.2.1 6.2.2.2	Drawing-in or trapping	Transmission parts	2	2	1	2	8	Fixed guards are used to protect the moving parts	1	1	1	1	1	
1.4	1.3.7	6.2.2.1 6.2.2.2	Entanglement													
1.5	1.3.4	6.2.2.1 6.2.2.2	Friction or abrasion													
1.6	1.3.3	6.2.2.1 6.2.2.2	Impact													
1.7	1.3.2	6.2.10	Injection (e.g. high pressure fluids)													
1.8	1.3.7	6.2.2.1	Shearing													

1.10	1.5.15	6.3.5.6	Slipping, tripping and falling													
1.11	1.3.4	6.2.2.1	Stabbing or puncture													
1.12	1.1.7 1.1.13	6.2.3	Suffocation													
1.13	1.3.3	6.2.3 6.3.1	Falling or ejected objects													
1.14	1.3.1	6.2.6 6.3.2.6	Stability													
1.15	1.3.2	6.2.3	Break up of machine													
1.16	1.1.5	6.2.2.1	Run over (e.g. transportation)													
2			**Electrical**													
2.1	1.5.1	6.2.9	Contact electrocution	contact whole power when operating and maintenance	3	1	2	1	6	good grounding;	1	1	1	1	1	warning label is used
										electrical parts is ensured that finger can't be approached						
2.2	1.5.2	6.2.9	Indirect contact - electrocution	contact whole power when operating and maintenance	3	1	2	1	6	good grounding;	1	1	1	1	1	warning label is used
2.3.	1.5.1	6.2.9	Approach to	contact the electrical	3	1	2	1	6	electrical parts is	1	1	1	1	1	

			electrical parts	parts when maintenance and setting						ensured that finger can't be approached							
2.4	1.5.5	6.2.9	Electrical burns														
2.5	1.5.2	6.2.9	Electrostatic phenomena														
2.6	1.5.10	6.2.3	Effects on medical implants														
2.7	1.5.6	6.3.5.4	Fire														
2.8	1.3.3	6.2.3 6.3.1	Projection of molten particles														
2.9	1.1.6	6.2.8	Shock (e.g. after incident)														
2.10	1.5.15	6.3.5.6	Falling / being thrown (e.g. during electrocution)														
3			**Thermal**														
3.1	1.5.5	6.2.3	Burn														
3.2	1.1.6	6.2.8	Dehydration														
3.3	1.1.6	6.2.8	Discomfort														

3.4	1.5.5	6.2.9	Frostbite													
3.5	1.5.5	6.2.3	Injuries by the radiation of heat sources													
3.6	1.5.5	6.2.3	Scald													
4			**Noise**													
4.1	1.5.8	6.2.2.2	Permanent hearing loss													
4.2	1.5.8	6.2.2.2	Tinnitus													
4.3	1.5.8	6.2.2.2 6.2.8	Interference of speech													
4.4	1.1.6	6.2.8	Loss of awareness													
4.5	1.1.6	6.2.8	Loss of balance													
4.6	1.1.6	6.2.8	Discomfort													
4.7	1.1.6	6.2.8	Stress													
5			**Vibration**													
5.1	1.5.9	6.2.3 6.3.4.3	Handheld													

5.2	1.5.9	6.2.3 6.3.4.3	Whole body													
5.3	1.5.9	6.2.3 6.3.4.3	Discomfort													
5.4	1.5.9	6.2.3 6.3.4.3	Low-back morbidity													
5.5	1.5.9	6.2.3 6.3.4.3	Neurological disorder													
5.6	1.5.9	6.2.3 6.3.4.3	Osteo-articular disorder													
5.7	1.5.9	6.2.3 6.3.4.3	Trauma of the spine													
5.8	1.5.9	6.2.3 6.3.4.3	Vascular disorder													
6			**Radiation**													
6.1	1.5.10	6.2.2.2 6.2.3	Lonising													
6.2	1.5.11	6.3.4.5	Low frequency electromagnetic													
6.3	1.5.10	6.2.3 6.3.4.5	Optical (e.g. infrared, ultraviolet)													
6.4	1.5.12	6.2.3 6.3.4.5	Laser													
6.5	1.5.10	6.2.3 6.3.4.5	Radio frequency													

		6.3.5.1	electromagnetic													
7			**Material**													
7.1	1.1.3 1.5.13	6.2.2.2 6.2.3 6.2.4	Breathing / suffocation (aerosols, dust, fibres, fluids, gas)													
7.2	1.1.3 1.5.13	6.2.2.2 6.2.3	Cancer (biological / microbiological agents)													
7.3	1.1.3	6.2.2.2 6.2.3	Corrosion													
7.4	1.1.3	6.2.2.2 6.2.3	Effects of reproduction capability													
7.5	1.1.3	6.2.2.2 6.2.4 6.3.1	Explosion													
7.6	1.1.3	6.2.2.2 6.2.3 6.2.4	Fire													
7.7	1.1.3	6.2.2.2 6.2.3	Infection / sensitization / mutation													
7.8	1.1.3 1.5.13	6.2.2.2 6.2.3	Poisoning													
8			**Ergonomic**													
8.1	1.1.6	6.2.8	Discomfort - unhealthy postures	installation,commissioning	1	1	3	1	3	ergonomics principles are considered	1	1	1	1	1	
				maintenance												
8.2	1.1.6	6.2.8	Musculoskelet	installation,commissi	1	1	3	1	3	ergonomics	1	1	1	1	1	

			al disorder - inadequate consideration of anatomy	oning						principles are considered							
				maintenance													
8.3	1.1.6 1.2.2	6.2.8	Fatigue														
8.4	1.1.6	6.2.8	Stress														
8.5	1.1.6	6.3.2.1	Mental overload / underload														
8.6	1.1.4	6.2.7	Inadequate local lighting														
8.7	1.2.2	6.2.11.8 6.3.2.1	Human error														
8.8	1.1.6 1.2.2	6.2.11.8	Inadequate manual controls														
9			**Environmental**														
9.1	1.5.6 1.5.7	6.3.2.1 6.4.5.1	Dust / fog														
9.2	1.5.16	6.2.11.11	Lightning														
9.3	1.3.2	6.2.3 6.3.4.5	Water / moisture														
9.4	1.3.2	6.2.3 6.3.4.5	Pollution														
9.5	1.5.5	6.4.5.1	Temperature														

9.6	1.3.2	6.3.2.1	Snow / ice													
9.7	1.3.1	6.2.6	Wind													
9.8	1.1.7	6.4.5.1 6.3.5.3	Lack of oxygen													
10			**Combination**													
10.1			Repetitive activity + effort + high enviornmental temperature													

Part III ： Test report
3.1 EN 60204-1 test report

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
1		**Scope**				
2		**Normative references**				
3		**Terms and definitions**				
4		**General requirements**				
	4.1	**General** This part of IEC 60204 is intended to apply to electrical equipment used with a wide variety of machines and with a group of machines working together in a co-ordinated manner. The risks associated with the hazards relevant to the electrical equipment shall be assessed as part of the overall requirements for risk assessment of the machine. This will determine the adequate risk reduction, and the necessary protective measures for persons who can be exposed to those hazards, while still maintaining an acceptable level of performance of the machine and its equipment. Hazardous situations can result from, but are not limited to, the following causes: – failures or faults in the electrical equipment resulting in the possibility of electric shock or electrical fire; – failures or faults in control circuits (or components and devices associated with those circuits) resulting in the malfunctioning of the machine; – disturbances or disruptions in power sources as well as failures or faults in the power circuits resulting in the malfunctioning of the machine; – loss of continuity of circuits that depend upon sliding or rolling contacts, resulting in a failure of a safety function; – electrical disturbances for example, electromagnetic, electrostatic either from outside the electrical equipment or internally generated, resulting in the malfunctioning of the machine; – release of stored energy (either electrical or mechanical) resulting in, for example, electric shock, unexpected movement that can cause injury; – *Text deleted* – surface temperatures that can cause injury. Safety measures are a combination of the measures incorporated at the design stage and those measures required to be implemented by the user. The design and development process shall identify hazards and the risks arising from them.	☑			Risk assessment has been done. Relevant protective measures are taken, information is given in user manual and warning signs are affixed on machine for residual risks.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Where the hazards cannot be removed and/or the risks cannot be sufficiently reduced by inherently safe design measures, protective measures (for example safeguarding,) shall be provided to reduce the risk. Additional means (for example, awareness means) shall be provided where further risk reduction is necessary. In addition, working procedures that reduce risk can be necessary. The use of the enquiry form as shown in Annex B of this part of IEC 60204 is recommended in order to facilitate an appropriate agreement between the user and the supplier(s) on basic conditions and additional user specifications related to the electrical equipment. Those additional specifications are to: – provide additional features that are dependent on the type of machine (or group of machines) and the application; – facilitate maintenance and repair; and – improve the reliability and ease of operation.				
	4.2 **4.2.1**	**Selection of equipment** **General** Electrical components and devices shall: – be suitable for their intended use; and – conform to relevant IEC standards where such exist; and – be applied in accordance with the supplier's instructions.	☑			Electrical components and devices meet this requirement.
	4.2.2	**Electrical equipment in compliance with the EN 60439 series** The electrical equipment of the machine shall satisfy the safety requirements identified by the risk assessment of the machine. 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).	☑			The electrical equipment of the machine satisfy the safety requirements of EN 60439 series.
	4.3 **4.3.1**	**Electrical supply** **General** The electrical equipment shall be designed to operate correctly with the conditions of the supply: – as specified in 4.3.2 or 4.3.3, or – as otherwise specified by the user (see Annex B), or – as specified by the supplier in the case of a special source of supply such as an on-board generator.	☑			The electrical equipment is designed to operate correctly with the conditions of the supply.
	4.3.2	**AC supplies** **Voltage** Steady state voltage: 0,9 to 1,1 of nominal voltage. **Frequency** 0,99 to 1,01 of nominal frequency continuously;	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		0,98 to 1,02 short time. **Harmonics** Harmonic distortion not exceeding 10 % of the total r.m.s. voltage between live conductors for the sum of the 2nd through to the 5th harmonic. An additional 2 % of the total r.m.s. voltage between live conductors for the sum of the 6th through to the 30th harmonic is permissible. **Voltage unbalance** Neither the voltage of the negative sequence component nor the voltage of the zero sequence component in three-phase supplies exceeding 2 % of the positive sequence component. **Voltage interruption** Supply interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1 s between successive interruptions. **Voltage dips** 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.				
	4.3.3	**DC supplies** From batteries: **Voltage** 0,85 to 1,15 of nominal voltage; 0,7 to 1,2 of nominal voltage in the case of battery-operated vehicles. **Voltage interruption** Not exceeding 5 ms. From converting equipment: **Voltage** 0,9 to 1,1 of nominal voltage. **Voltage interruption** Not exceeding 20 ms with more than 1 s between successive interruptions. NOTE This is a variation to IEC Guide 106 to ensure proper operation of electronic equipment. **Ripple (peak-to-peak)** Not exceeding 0,15 of nominal voltage.	☑			
	4.3.4	**Special supply systems** For special supply systems such as on-board generators, the limits given in 4.3.2 and 4.3.3 may be exceeded provided that the equipment is designed to operate correctly with those conditions.			☑	
	4.4 **4.4.1**	**Physical environment and operating conditions** **General** The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use. The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of machines covered by this part of EN 60204. When special conditions apply or the limits specified are exceeded, an agreement between user and supplier (see 4.1) is recommended (see	☑			The electrical equipment is suitable for the physical environment and operating conditions of its intended use.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Annex B).				
	4.4.2	**Electromagnetic compatibility (EMC)** The equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended operating environment. In addition, the equipment shall have a level of immunity to electromagnetic disturbances so that it can function in its intended environment. NOTE 1 The generic EMC standards 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. NOTE 2 IEC 61000-5-2 gives guidelines for earthing and cabling of electrical and electronic systems aimed at ensuring EMC. If specific product standards exist (for example, IEC 61496-1, IEC 61800-3, IEC 60947-5-2) they take precedence over generic standards. Measures to limit the generation of electromagnetic disturbances, i.e. conducted and radiated emissions include: – power supply filtering; – cable shielding; – enclosures designed to minimize RF radiation; – RF suppression techniques. Measures to enhance the immunity of the equipment against conducted and radiated RF disturbance include: – design of functional bonding system taking into account the following; - connection of sensitive electrical circuits to the chassis. Such terminations should be marked or labelled with the symbol IEC 60417-5020 (DB:2002-10):  - connection of the chassis to earth (PE) using a conductor with low RF impedance and as short as practicable; – connection of sensitive electrical equipment or circuits directly to the PE circuit or to a functional earthing conductor (FE) (see Figure 2), to minimize common mode disturbance. This latter terminal should be marked or labelled by the symbol IEC 60417-5018 (DB:2002-10):	☑			The key elcetrical equipments have CE certificates.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		 – separation of sensitive circuits from disturbance sources; – enclosures designed to minimize RF transmission; – EMC wiring practices: - using twisted conductors to reduce the effect of differential mode disturbances, - keeping sufficient distance between conductors emitting disturbances and conductors of sensitive circuits, - using cable orientation as close to 90 as possible when cables cross, - running the conductors as close as possible to the ground plane, - using electrostatic screens and/or electromagnetic shields with a low RF impedance termination.				
	4.4.3	**Ambient air temperature** Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. The minimum requirement for all electrical equipment is correct operation 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).	☑			
	4.4.4	**Humidity** The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities are permitted at lower temperatures (for example 90 % at 20 °C). Harmful effects of occasional condensation shall be avoided by design of the equipment or, where necessary, by additional measures (for example built-in heaters, air conditioners, drain holes).	☑			
	4.4.5	**Altitude** Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.	☑			
	4.4.6	**Contaminants** Electrical equipment shall be adequately protected against the ingress of solids and liquids (see 11.3). The electrical equipment shall be adequately protected against contaminants (for example dust, acids, corrosive gases, salts) that can be present in the physical environment in which the electrical equipment is to be installed (see Annex B)	☑			The IP-code of electrical equipment is at least IP 54.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	4.4.7	**Ionizing and non-ionizing radiation** When equipment is subject to radiation (for example microwave, ultraviolet, lasers, X-rays), additional measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation. A special agreement is recommended between the supplier and the user (see Annex B).			☑	
	4.4.8	**Vibration, shock, and bump** Undesirable effects of vibration, shock and bump (including those generated by the machine and its associated equipment and those created by the physical environment) shall be avoided by the selection of suitable equipment, by mounting it away from the machine, or by provision of anti-vibration mountings. A special agreement is recommended between the supplier and the user (see Annex B).			☑	
	4.5	**Transportation and storage** Electrical equipment shall be designed to withstand, or suitable precautions shall be taken to protect against, the effects of transportation and storage temperatures within a range of –25 °C to +55 °C and for short periods not exceeding 24 h at up to +70 °C. Suitable means shall be provided to prevent damage from humidity, vibration, and shock. A special agreement can be necessary between the supplier and the user (see Annex B). NOTE Electrical equipment susceptible to damage at low temperatures includes PVC insulated cables.	☑			The design of the electrical equipment is considered this requirement.
	4.6	**Provisions for handling** Heavy and bulky electrical equipment that has to be removed from the machine for transport, or that is independent of the machine, shall be provided with suitable means for handling by cranes or similar equipment.	☑			This information is provided in user's manual.
	4.7	**Installation** Electrical equipment shall be installed in accordance with the electrical equipment supplier's instructions.	☑			This information is provided in user's manual.
5		**Incoming supply conductor terminations and devices for disconnecting and switching off**				
	5.1	**Incoming supply conductor terminations** It is recommended that, where practicable, the electrical equipment of a machine is connected to a single incoming supply. Where another supply is necessary for certain parts of the equipment (for example, electronic equipment that operates at a different voltage), that supply should be derived, as far as is practicable, from devices (for example, transformers, converters) forming part of the electrical equipment of	☑			A single incoming supply. No neutral conductor is used.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		the machine. 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 (see 5.3.1). Unless a plug is provided with the machine for the connection to the supply (see 5.3.2 e), it is recommended that the supply conductors are terminated at the supply disconnecting device. Where a neutral conductor is used it shall be clearly indicated in the technical documentation of the machine, such as in the installation diagram and in the circuit diagram, and a separate insulated terminal, labelled **N** in accordance with 16.1, shall be provided for the neutral conductor (see also Annex B). There shall be no connection between the neutral conductor and the protective bonding circuit inside the electrical equipment nor shall a combined PEN terminal be provided. **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. All terminals for the incoming supply connection shall be clearly identified in accordance with IEC 60445 and 16.1. For the identification of the external protective conductor terminal, see 5.2. See 17.8 for the provision of instructions for maintenance.				
	5.2	**Terminal for connection to the external protective earthing system** For each incoming supply, a terminal shall be provided in the vicinity of the associated phase 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. The terminal shall be of such a size as to enable the connection of an external protective copper conductor with a cross-sectional area in accordance with 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). At each incoming supply point, the terminal for connection of the external protective earthing system or the external protective conductor shall be marked or labelled with the letters **PE** (see IEC 60445).	☑			The letters PE are labeled.
	5.3 **5.3.1**	**Supply disconnecting (isolating) device** **General** A supply disconnecting device shall be provided: – for each incoming source of supply to a machine(s);	☑			Start/stop button is used

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		NOTE The incoming supply can be connected directly to the machine or via a feeder system. Feeder systems of machines can include conductor wires, conductor bars, slip-ring assemblies, flexible cable systems (reeled, festooned) or inductive power supply systems. – for each on-board power supply The supply disconnecting device shall disconnect (isolate) the electrical equipment of the machine from the supply when required (for example for work on the machine, including the electrical equipment). When two or more supply disconnecting devices are provided, protective interlocks for their correct operation shall also be provided in order to prevent a hazardous situation, including damage to the machine or to the work in progress.				
	5.3.2	**Type** The supply disconnecting device shall be one of the following types: a) switch-disconnector, with or without fuses, in accordance with IEC 60947-3, utilization category AC-23B or DC-23B; b) disconnector, with or without fuses, in accordance with IEC 60947-3, that has an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector; c) a circuit-breaker suitable for isolation in accordance with IEC 60947-2; d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1 as well as a utilization category defined in the product standard as appropriate for on-load switching of motors or other inductive loads; e) a plug/socket combination for a flexible cable supply.	☑			c) circuit breaker
	5.3.3	**Requirements** When the supply disconnecting device is one of the types specified in 5.3.2 a) to d) it shall fulfil all of the following requirements: – isolate the electrical equipment from the supply and have one OFF (isolated) and one ON position marked with "O" and "I" (symbols IEC 60417-5008 (DB:2002-10) and IEC 60417-5007 (DB:2002-10), see 10.2.2); – have a visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating function have been satisfied; – have an external operating means (for example handle), (**exception:** power-operated switchgear need not be operable from outside the enclosure where there are other means to open it). Where the external operating means is not	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		intended for emergency operations, it is recommended that it be coloured BLACK or GREY (see 10.7.4 and 10.8.4); – be provided with a means permitting it to be locked in the OFF (isolated) position (for example by padlocks). When so locked, remote as well as local closing shall be prevented; – disconnect all live conductors of its power supply circuit. However, for TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory; – have a breaking capacity sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. When the supply disconnecting device is a plug/socket combination, it shall fulfil the following requirements: – have the switching capability, or be interlocked with a switching device that has a breaking capacity, sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. When the interlocked switching device is electrically operated (for example a contactor) it shall have an appropriate utilisation category. – a) to f) of 13.4.5. NOTE A suitably rated plug and socket-outlet, cable coupler, or appliance coupler, in accordance with IEC 60309-1 can fulfil these requirements. Where the supply disconnecting device is a plug/socket combination, a switching device with an appropriate utilisation category shall be provided for switching the machine on and off. This can be achieved by the use of the interlocked switching device described above.				
	5.3.4	**Operating means** The operating means (for example, a handle) of the supply disconnecting device shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level. An upper limit of 1,7 m is recommended. NOTE The direction of operation is given in IEC 61310-3.	☑			Operating means meets this requirement

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	5.3.5	**Excepted circuits** The following circuits need not be disconnected by the supply disconnecting device: – lighting circuits for lighting needed during maintenance or repair; – plug and socket outlets for the exclusive connection of repair or maintenance tools and equipment (for example hand drills, test equipment); – undervoltage protection circuits that are only provided for automatic tripping in the event of supply failure; – circuits supplying equipment that should normally remain energized for correct operation (for example temperature controlled measuring devices, product (work in progress) heaters, program storage devices); – control circuits for interlocking. It is recommended, however, that such circuits be provided with their own disconnecting device. Where such a circuit is not disconnected by the supply disconnecting device: – permanent warning label(s) in accordance with 16.1 shall be appropriately placed in proximity to the supply disconnecting device; – a corresponding statement shall be included in the maintenance manual, and one or more of the following shall apply; - a permanent warning label in accordance with 16.1 is affixed in proximity to each excepted circuit, or - the excepted circuit is separated from other circuits, or - the conductors are identified by colour taking into account the recommendation of 13.2.4.			☑	
	5.4	**Devices for switching off for prevention of unexpected start-up** Devices for switching off for the prevention of unexpected start-up shall be provided (for example where, during maintenance, a start-up of the machine or part of the machine can create a hazard). Such devices shall be appropriate and convenient for the intended use, shall be suitably placed, and readily identifiable as to their function and purpose (for example by a durable marking in accordance with 16.1 where necessary). NOTE 1 This part of IEC 60204 does not address all provisions for prevention of unexpected start up. See ISO 14118 (EN 1037). 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. Means shall be provided to prevent inadvertent and/or mistaken closure of these devices either at the controller or from other locations (see also 5.6).			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		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 enclosed electrical operating area (see 3.19). Devices that do not fulfil the isolation function (for example a contactor switched off by a control circuit) may only be provided where intended to be used for situations that include: – inspections; – adjustments; – work on the electrical equipment where: - there is no hazard arising from electric shock (see Clause 6) and burn; - the switching off means remains effective throughout the work; - the work is of a minor nature (for example replacement of plug-in devices without disturbing existing wiring). 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 or withdrawable links located in enclosed electrical operating areas can be inappropriate for use by cleaners (see 17.2 b)12)).				
	5.5	**Devices for disconnecting electrical equipment** Devices shall be provided for disconnecting (isolating) electrical equipment to enable work to be carried out when it is de-energised and isolated. Such devices shall be: – appropriate and convenient for the intended use; – suitably placed; – readily identifiable as to which part(s) or circuit(s) of the equipment is served (for example by durable marking in accordance with 16.1 where necessary). Means shall be provided to prevent inadvertent and/or mistaken closure of these devices either at the controller or from other locations (see also 5.6). The supply disconnecting device (see 5.3) may, in some cases, fulfil that function. However,where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of a number of machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device shall be provided for each part, or for each machine, requiring separate isolation. In addition to the supply disconnecting device, the following devices that fulfil the	☑			Only start/stop button is used

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		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)). NOTE Where protection against electric shock is provided in accordance with 6.2.2 c), withdrawable fuse links or withdrawable links for this purpose are intended for use by skilled or instructed persons.				
	5.6	**Protection against unauthorized, inadvertent and/or mistaken connection** The devices described in 5.4 and 5.5 that are located outside an enclosed electrical operating area shall be equipped with means to secure them in the OFF position (disconnected state), (for example by provisions for padlocking, trapped key interlocking). When so secured, remote as well as local reconnection shall be prevented. Where a non-lockable disconnecting device (for example withdrawable fuse-links, withdrawable links) other means of protection against reconnection (for example warning labels in accordance with 16.1) may be provided. However, when a plug/socket combination according to 5.3.2 e) is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for securing in the disconnected state need not be provided.			☑	
6	**6.1**	**Protection against electric shock** **General** The electrical equipment shall provide protection of persons against electric shock from: – direct contact (see 6.2 and 6.4); – indirect contact (see 6.3 and 6.4). The measures for this protection given in 6.2, 6.3, and, for PELV, in 6.4, are a recommended selection from IEC 60364-4-41. Where those recommended measures are not practicable, for example due to the physical or operational conditions, other measures from IEC 60364-4-41 may be used.	☑			The measures for this protection are given.
	6.2 **6.2.1**	**Protection against direct contact** **General** For each circuit or part of the electrical equipment, the measures of either 6.2.2 or 6.2.3 and, where applicable, 6.2.4 shall be applied. **Exception:** where those measures are not appropriate, other measures for protection against direct contact (for example by using barriers, by placing out of	☑			The protection measures are applied.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		reach, using obstacles, using construction or installation techniques that prevent access) as defined in IEC 60364-4-41 may be applied (see 6.2.5 and 6.2.6). When the equipment is located in places open to all persons, which can include children, measures of either 6.2.2 with a minimum degree of protection against direct contact corresponding to IP4X or IPXXD (see IEC 60529), or 6.2.3 shall be applied.				
	6.2.2	**Protection by enclosures** Live parts shall be located inside enclosures that conform to the relevant requirements of Clauses 4, 11, and 14 and that provide protection against direct contact of at least IP2X or IPXXB (see IEC 60529). 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. Opening an enclosure (i.e. opening doors, lids, covers, and the like) shall be possible only under one of the following conditions: a) The use of a key or tool is necessary for access. For enclosed electrical operating areas, see IEC 60364-4-41, or IEC 60439-1 as appropriate. NOTE 1 The use of a key or tool is intended to restrict access to skilled or instructed persons (see 17.2 b)12)). All live parts, that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected, shall be protected against direct contact to at least IP2X or IPXXB. Other live parts on the inside of doors shall be protected against direct contact to at least IP1X or IPXXA. b) The disconnection of live parts inside the enclosure before the enclosure can be opened. This may be accomplished by interlocking the door with a disconnecting device (for example, the supply disconnecting device) so that the door can only be opened when the disconnecting device is open and so that the disconnecting device can only be closed when the door is closed. **Exception:** a special device or tool as prescribed by the supplier can be used to defeat the interlock provided 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 (isolated) position or otherwise prevent unauthorised closure of the disconnecting device; – upon closing the door, the interlock is automatically restored;	☑			Live parts located inside enclosures conform to the relevant requirements. a) a key or tool (screwdriver)is used for opening doors or covers

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		– 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 and other live parts on the inside of doors are protected against direct contact to at least IP1X or IPXXA; – relevant information is provided with the electrical equipment (see 17.2 b)9) and b)12)). NOTE 2 The special device or tool is intended for use only by skilled or instructed persons (see 17.2 b)12)) Means shall be provided to restrict access to live parts behind doors not directly interlocked with the disconnecting means to skilled or instructed persons. (See 17.2 b)12)). All parts that are still live after switching off the disconnecting device(s) (see 5.3.5) shall be protected against direct contact to at least IP2X or IPXXB (see IEC 60529). Such parts shall be marked with a warning sign in accordance with 16.2.1 (see also 13.2.4 for identification of conductors by colour). Excepted from this requirement for 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. c) Opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against direct contact to at least IP2X or IPXXB (see IEC 60529). Where barriers provide this protection, either they shall require a tool for their removal or all live parts protected by them shall be automatically disconnected when the barrier is removed. NOTE 3 Where protection against direct contact is achieved in accordance with 6.2.2 c), and a hazard can be caused by manual actuation of devices (for example manual closing of contactors or relays), such actuation should be prevented by barriers or obstacles that require a tool for their removal.				
	6.2.3	**Protection by insulation of live parts** Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction. Such insulation shall be capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions. NOTE Paints, varnishes, lacquers, and similar products alone are generally considered to be inadequate for protection against electric shock under normal	☑			The electrical enclousure is painted and cables are wrapped with isolated materials

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		operating conditions.				
	6.2.4	**Protection against residual voltages** Live parts having a residual voltage greater than 60 V after the supply has been disconnected shall be discharged to 60 V or less within a time period of 5 s after disconnection of the supply voltage provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 µC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure containing the capacitances. In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time shall not exceed 1 s, otherwise such conductors shall be protected against direct contact to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning device (for example a warning notice in accordance with 16.1) shall be applied.	☑			Electrical equipment can fulfil residual voltage
	6.2.5	**Protection by barriers** For protection by barriers, 412.2 of IEC 60364-4-41 shall apply.			☑	
	6.2.6	**Protection by placing out of reach or protection by obstacles** For protection by placing out of reach, 412.4 of IEC 60364-4-41 shall apply. For protection by obstacles, 412.3 of IEC 60364-4-41 shall apply. For conductor wire systems or conductor bar systems with a degree of protection less than IP2X, see 12.7.1.			☑	
	6.3 **6.3.1**	**Protection against indirect contact** **General** Protection against indirect contact (3.29) is intended to prevent hazardous situations due to an insulation fault between live parts and exposed conductive parts. For each circuit or part of the electrical equipment, at least one of the measures in accordance with 6.3.2 to 6.3.3 shall be applied: – measures to prevent the occurrence of a touch voltage (6.3.2); or – automatic disconnection of the supply before the time of contact with a touch	☑			Protection against indirect contact is provided.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		voltage can become hazardous (6.3.3). NOTE 1 The risk of harmful physiological effects from a touch voltage depends on the value of the touch voltage and the duration of possible exposure. NOTE 2 For classes of equipment and protective provisions, see IEC 61140.				
	6.3.2 **6.3.2.1**	**Prevention of the occurrence of a touch voltage** **General** Measures to prevent the occurrence of a touch voltage include the following: – provision of class II equipment or by equivalent insulation; – electrical separation.	☑			Class II equipment electrical separation is used.
	6.3.2.2	**Protection by provision of class II equipment or by equivalent insulation** This measure is intended to prevent the occurrence of touch voltages on the accessible parts through a fault in the basic insulation. This protection is provided by one or more of the following: – class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140); – switchgear and controlgear assemblies having total insulation in accordance with IEC 60439-1; – supplementary or reinforced insulation in accordance with 413.2 of IEC 60364-4-41.	☑			See above
	6.3.2.3	**Protection by electrical separation** Electrical separation of an individual circuit is intended to prevent a touch voltage through contact with exposed conductive parts that can be energized by a fault in the basic insulation of the live parts of that circuit. For this type of protection, the requirements of 413.5 of IEC 60364-4-41 apply.			☑	
	6.3.3	**Protection by automatic disconnection of supply** This measure consists of the interruption of one or more of the line conductors by the automatic operation of a protective device in case of a fault. This interruption shall occur within a sufficiently short time to limit the duration of a touch voltage to a time within which the touch voltage is not hazardous. Interruption times are given in Annex A. This measure necessitates co-ordination between: – the type of supply and earthing system; – the impedance values of the different elements of the protective bonding system; – the characteristics of the protective devices that detect insulation fault(s). Automatic disconnection of the supply of any circuit affected by an insulation fault is	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		intended to prevent a hazardous situation resulting from a touch voltage. This protective measure comprises both: – protective bonding of exposed conductive parts (see 8.2.3), – and either: a) overcurrent protective devices for the automatic disconnection of the supply on detection of an insulation fault in TN systems, or b) residual current protective devices to initiate the automatic disconnection of the supply on detection of an insulation fault from a live part to exposed conductive parts or to earth in TT systems, or c) insulation monitoring or residual current protective devices to initiate automatic disconnection of IT systems. Except where a protective device is provided to interrupt the supply in the case of the first earth fault, an insulation monitoring device shall be provided to indicate the occurrence of a first fault from a live part to exposed conductive parts or to earth. This insulation monitoring device shall initiate an audible and/or visual signal which shall continue as long as the fault persists. NOTE In large machines, the provision of an earth fault location system can facilitate maintenance. Where automatic disconnection is provided in accordance with a), and disconnection within the time specified in Clause A.1 cannot be assured, supplementary bonding shall be provided as necessary to meet the requirements of Clause A.3.				
	6.4 **6.4.1**	**Protection by the use of PELV** **General requirements** The use of PELV (Protective Extra-Low Voltage) is to protect persons against electric shock from indirect contact and limited area direct contact (see 8.2.5). PELV circuits shall satisfy all of the following conditions: a) the nominal voltage shall not exceed: 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; NOTE *Ripple-free* is conventionally defined for a sinusoidal ripple voltage as a ripple content of not more than 10 % r.m.s. b) one side of the circuit or one point of the source of the supply of that circuit shall be connected to the protective bonding circuit; c) live parts of PELV circuits shall be electrically separated from other live circuits. Electrical separation shall be not less than that required between the primary and			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		secondary circuits of a safety isolating transformer (see IEC 61558-1 and IEC 61558-2-6); d) conductors of each PELV circuit shall be physically separated from those of any other circuit. When this requirement is impracticable, the insulation provisions of 13.1.3 shall apply; e) plugs and socket-outlets for a PELV circuit shall conform to the following: 1) plugs shall not be able to enter socket-outlets of other voltage systems; 2) socket-outlets shall not admit plugs of other voltage systems.				
	6.4.2	**Sources for PELV** The source for PELV shall be one of the following: – a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6; – a source of current providing a degree of safety equivalent to that of the safety isolating transformer (for example a motor generator with winding providing equivalent isolation); – an electrochemical source (for example a battery) or another source independent of a higher voltage circuit (for example a diesel-driven generator); – an electronic power supply conforming to appropriate standards specifying measures to be taken to ensure that, even in the case of an internal fault, the voltage at the outgoing terminals cannot exceed the values specified in 6.4.1			☑	
7		**Protection of equipment**				
	7.1	**General** This Clause details the measures to be taken to protect equipment against the effects of: – overcurrent arising from a short circuit; – overload and/or loss of cooling of motors; – abnormal temperature; – loss of or reduction in the supply voltage; – overspeed of machines/machine elements; – earth fault/residual current; – incorrect phase sequence; – overvoltage due to lightning and switching surges.	☑			Relevant protective measures are taken.
	7.2 **7.2.1**	**Overcurrent protection** **General** Overcurrent protection shall be provided where the current in a machine circuit can	☑			Overcurrent protection is provided

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		exceed either the rating of any component or the current carrying capacity of the conductors, whichever is the lesser value. The ratings or settings to be selected are detailed in 7.2.10.				
	7.2.2	**Supply conductors** 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). The supplier of the electrical equipment shall state on the installation diagram the data necessary for selecting the overcurrent protective device (see 7.2.10 and 17.4).	☑			Electrical diagram is given in TCF
	7.2.3	**Power circuits** Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10, shall be applied to each live conductor. The following conductors, as applicable, shall not be 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. Where the cross-sectional area of the neutral conductor is at least equal to or equivalent to that of the phase conductors, it is not necessary to provide overcurrent detection for the neutral conductor nor a disconnecting device for that conductor. For a neutral conductor with a cross-sectional area smaller than that of the a sociated phase conductors, the measures detailed in 524 of IEC 60364-5-52 shall apply. In IT systems, it is recommended that the neutral conductor is not used. However, where a neutral conductor is used, the measures detailed in 431.2.2 of IEC 60364-4-43 shall apply.	☑			Circuit breaker is provided
	7.2.4	**Control circuits** Conductors of control circuits directly connected to the supply voltage and of circuits supplying control circuit transformers shall be protected against overcurrent in accordance with 7.2.3. Conductors of control circuits supplied by a control circuit transformer or d.c. supply shall be protected against overcurrent (see also 9.4.3.1): – in control circuits connected to the protective bonding circuit, by inserting an overcurrent protective device into the switched conductor; – in control circuits not connected to the protective bonding circuit; - where the same cross sectional area conductors are used in all control circuits, by			☑	Only power circuit is used

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		inserting an overcurrent protective device into the switched conductor, and; - where different cross sectional areas conductors are used in different sub-circuits, by inserting an overcurrent protective device into both switched and common conductors of each sub-circuit.				
	7.2.5	**Socket outlets and their associated conductors** Overcurrent protection shall be provided for the circuits feeding the general purpose socket outlets intended primarily for supplying power to maintenance equipment. Overcurrent protective devices shall be provided in the unearthed live conductors of each circuit feeding such socket outlets.			☑	
	7.2.6	**Lighting circuits** All unearthed conductors of circuits supplying lighting shall be protected against the effects of short circuits by the provision of overcurrent devices separate from those protecting other circuits.	☑			
	7.2.7	**Transformers** Transformers shall be protected against overcurrent in accordance with the manufacturer's instructions. Such protection shall (see also 7.2.10): – avoid nuisance tripping due to transformer magnetizing inrush currents; – avoid a winding temperature rise in excess of the permitted value for the insulation class of transformer when it is subjected to the effects of a short circuit at its secondary terminals. The type and setting of the overcurrent protective device should be in accordance with the recommendations of the transformer supplier.			☑	
	7.2.8	**Location of overcurrent protective devices** An overcurrent protective device shall be located at the point where a reduction in the crosssectional area of the conductors or another change reduces the current-carrying capacity of the conductors, except where all the following conditions are satisfied: – the current carrying capacity of the conductors is at least equal to that of the load; – the part of the conductor between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is no longer than 3 m; – the conductor is installed in such a manner as to reduce the possibility of a short-circuit, for example, protected by an enclosure or duct.	☑			
	7.2.9	**Overcurrent protective devices** The rated short-circuit breaking capacity shall be at least equal to the prospective fault current at the point of installation. Where the short-circuit current to an	☑			Circuit breaker is used

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		overcurrent protective device can include additional currents other than from the supply (for example from motors, from power factor correction capacitors), those currents shall be taken into consideration. A lower breaking capacity is permitted where another protective device (for example the overcurrent protective device for the supply conductors (see 7.2.2) having the necessary breaking capacity is installed on the supply side. In that case, the characteristics of the two devices shall be co-ordinated so that the let-through energy (*I*2*t*) 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). NOTE The use of such a co-ordinated arrangement of overcurrent protective devices can result in the operation of both overcurrent protective devices. 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.				
	7.2.10	**Rating and setting of overcurrent protective devices** The rated current of fuses or the setting current of other overcurrent protective devices shall be selected as low as possible but adequate for the anticipated overcurrents (for example during starting of motors or energizing of transformers). When selecting those protective devices, consideration shall be given to the protection of switching devices against damage due to overcurrents (for example welding of the switching device contacts). The rated current or setting of an overcurrent protective device is determined by the current carrying capacity of the conductors to be protected in accordance with 12.4, D.2 and the maximum allowable interrupting time *t* in accordance with Clause D.3, taking into account the needs of co-ordination with other electrical devices in the protected circuit.	☑			
	7.3 **7.3.1**	**Protection of motors against overheating** **General** Protection of motors against overheating shall be provided for each motor rated at more than 0,5 kW. **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.	☑			Protection of motors against overheating is provided.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Protection of motors against overheating can be achieved by: – overload protection (7.3.2), NOTE 1 Overload protective devices detect the time and current relationships (*I* 2*t*) in a circuit that are in excess of the rated full load of the circuit and initiate appropriate control responses. – over-temperature protection (7.3.3), or NOTE 2 Temperature detection devices sense over-temperature and initiate appropriate control responses. – current-limiting protection (7.3.4). Automatic restarting of any motor after the operation of protection against overheating shall be prevented where this can cause a hazardous situation or damage to the machine or to the work in progress.				
	7.3.2	**Overload protection** Where overload protection is provided, detection of overload(s) shall be provided in each live conductor except for the neutral conductor. However, where the motor overload detection is not used for cable overload protection (see also Clause D.2), the number of overload detection devices may be reduced at the request of the user (see also Annex B). For motors having single-phase or d.c. power supplies, detection in only one unearthed live conductor is permitted. Where overload protection is achieved by switching off, the switching device shall switch off all live conductors. The switching of the neutral conductor is not necessary for overload protection. Where motors with special duty ratings are required to start or to brake frequently (for example, motors for rapid traverse, locking, rapid reversal, sensitive drilling) it can be difficult to provide overload protection with a time constant comparable with that of the winding to be protected. Appropriate protective devices designed to accommodate special duty motors or over-temperature protection (see 7.3.3) can be necessary. For motors that cannot be overloaded (for example torque motors, motion drives that either are protected by mechanical overload protection devices or are adequately dimensioned), overload protection is not required.	☑			Overload protection is provided
	7.3.3	**Over-temperature protection** The provision of motors with over-temperature protection (see IEC 60034-11) is recommended in situations where the cooling can be impaired (for example dusty environments). Depending upon the type of motor, protection under stalled rotor or loss of phase conditions is not always ensured by over-temperature protection, and			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		additional protection should then be provided. Over-temperature protection is also recommended for motors that cannot be overloaded (for example torque motors, motion drives that are either protected by mechanical overload protection devices or are adequately dimensioned), where the possibility of over-temperature exists (for example due to reduced cooling).				
	7.3.4	**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 (see 7.3.2). For motors having single phase a.c or d.c. power supplies, current limitation in only one unearthed live conductor is permitted.			☑	
	7.4	**Abnormal temperature protection** Resistance heating or other circuits that are capable of attaining or causing abnormal temperatures (for example, due to short-time rating or loss of cooling medium) and therefore can cause a hazardous situation shall be 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 shall be provided by, for example, switching off the machine at a predetermined voltage level. Where the operation of the machine can allow for an interruption or a reduction of the voltage for a short time period, delayed undervoltage protection may be provided. The operation of the undervoltage device shall not impair the operation of any stopping control of the machine. Upon restoration of the voltage or upon switching on the incoming supply, automatic or unexpected restarting of the machine shall be prevented where such a restart can cause a hazardous situation. Where only a part of the machine or of the group of machines working together in a coordinated manner is affected by the voltage reduction or supply interruption, the undervoltage protection shall initiate appropriate control responses to ensure co-ordination.	☑			
	7.6	**Motor overspeed protection** Overspeed protection shall be provided where overspeeding can occur and could possibly cause a hazardous situation taking into account measures in accordance with 9.3.2.			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Overspeed protection shall initiate appropriate control responses and shall prevent automatic restarting. The overspeed protection should operate in such a manner that the mechanical speed limit of the motor or its load is not exceeded. NOTE This protection can consist, for example, of a centrifugal switch or speed limit monitor.				
	7.7	**Earth fault/residual current protection** In addition to providing overcurrent protection for automatic disconnection as described in 6.3, earth fault/residual current protection can be provided to reduce damage to equipment due to earth fault currents less than the detection level of the overcurrent protection. The setting of the devices shall be as low as possible consistent with correct operation of the equipment.	☑			
	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. NOTE Conditions of use that can lead to an incorrect phase sequence include: – a machine transferred from one supply to another; – a mobile machine with a facility for connection to an external power supply.			☑	
	7.9	**Protection against overvoltages due to lightning and to switching surges** Protective devices can be provided to protect against the effects of overvoltages due to lightning or to switching surges. Where provided: – devices for the suppression of overvoltages due to lightning shall be connected to the incoming terminals of the supply disconnecting device. – devices for the suppression of overvoltages due to switching surges shall be connected across the terminals of all equipment requiring such protection.	☑			
8		**Equipotential bonding**	☑			
	8.1	**General** This Clause provides requirements for both protective bonding and functional bonding. Figure 2 illustrates those concepts. Protective bonding is a basic provision for fault protection to enable protection of persons against electric shock from indirect contact (see 6.3.3 and 8.2). The objective of functional bonding (see 8.3) is to minimize:	☑			These requirements are complied with.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		– the consequence of an insulation failure which could affect the operation of the machine; – the consequences of electrical disturbances to sensitive electrical equipment which could affect the operation of the machine. Normally functional bonding is achieved by connection to the protective bonding circuit, but where the level of electrical disturbances on the protective bonding circuit is not sufficiently low for proper functioning of electrical equipment, it may be necessary to connect the functional bonding circuit to a separate functional earthing conductor (see Figure 2).				
	8.2 **8.2.1**	**Protective bonding circuit** **General** The protective bonding circuit consists of: – PE terminal(s) (see 5.2); – the protective conductors in the equipment of the machine including sliding contacts where they are part of the circuit; – the exposed conductive parts and conductive structural parts of the electrical equipment; – those extraneous conductive parts which form the structure of the machine. All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses that can be caused by earth-fault currents that could flow in that part of the protective bonding circuit. 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 shall be provided. This supplementary bonding conductor shall have a cross-sectional area not less than half that of the corresponding protective conductor. If an IT distribution system is used, the machine structure shall be part of the protective bonding circuit and insulation monitoring shall be provided. See 6.3.3 c). Conductive structural parts of equipment in accordance with 6.3.2.2 need not be connected to the protective bonding circuit. Extraneous conductive parts which form the structure of the machine need not be connected to the protective bonding circuit where all the equipment provided is in accordance with 6.3.2.2. Exposed conductive parts of equipment in accordance with 6.3.2.3 shall not be connected to the protective bonding circuit.	☑			The protective bonding circuit is provided.
	8.2.2	**Protective conductors** Protective conductors shall be identified in accordance with 13.2.2.	☑			Copper

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Copper conductors are preferred. Where a conductor material other than copper is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm2 in cross-sectional area. 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 where the relationship between the cross-sectional area of the phase conductors associated with that part of the equipment and the crosssectional area of the associated protective conductor is in accordance with Table 1 (see 5.2). See also 8.2.8				
	8.2.3	**Continuity of the protective bonding circuit** All exposed conductive parts shall be connected to the protective bonding circuit in accordance with 8.2.1. **Exception**: see 8.2.5. Where a part is removed for any reason (for example routine maintenance), the protective bonding circuit for the remaining parts shall not be interrupted. Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and conductors of aluminium or aluminium alloys are used, particular consideration should be given to the possibility of electrolytic corrosion. Metal ducts of flexible or rigid construction and metallic cable sheaths shall not be used as protective conductors. Nevertheless, such metal ducts and the metal sheathing of all connecting cables (for example cable armouring, lead sheath) shall be connected to the protective bonding circuit. Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured and a protective conductor (see 8.2.2) is recommended. Otherwise fastenings, hinges or sliding contacts designed to have a low resistance shall be used (see 18.2.2, Test 1). The continuity of the protective conductor in cables that are exposed to damage (for example flexible trailing cables) shall be ensured by appropriate measures (for example monitoring). For requirements for the continuity of the protective conductor using conductor wires, conductor bars and slip-ring assemblies, see 12.7.2.	☑			Continuity of the protective bonding circuit is tested.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	8.2.4	**Exclusion of switching devices from the protective bonding circuit** The protective bonding circuit shall not incorporate a switching device or an overcurrent protective device (for example switch, fuse). No means of interruption of the protective bonding conductor shall be 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. Where the continuity of the protective bonding circuit can be interrupted by means of removable current collectors or plug/socket combinations, the protective bonding circuit shall be interrupted by a first make last break contact. This also applies to removable or withdrawable plug-in units (see also 13.4.5).	☑			The protective bonding circuit does not incorporate a switching device or an overcurrent protective device
	8.2.5	**Parts that need not be connected to the protective bonding circuit** It is not necessary to connect exposed conductive parts to the protective bonding circuit where those parts are mounted so that they do not constitute a hazard because: – they 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. This applies to small parts such as screws, rivets, and nameplates and to parts inside an enclosure, irrespective of their size (for example electromagnets of contactors or relays and mechanical parts of devices) (see also 410.3.3.5 of IEC 60364-4-41).	☑			No large live parts are exposed to operators
	8.2.6	**Protective conductor connecting points** All protective conductors shall be terminated in accordance with 13.1.1. The protective conductor connecting points shall have no other function and are not intended, for example, to attach or connect appliances or parts. Each protective conductor connecting point shall be marked or labelled as such using the symbol IEC 60417-5019 (DB:2002-10):  or with the letters **PE**, the graphical symbol being preferred, or by use of the bicolour combination GREEN-AND-YELLOW, or by any combination of these.	☑			 **or PE** GREEN-AND-YELLOW
	8.2.7	**Mobile machines** On mobile machines with on-board power supplies, the protective conductors, the conductive structural parts of the electrical equipment, and those extraneous			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		conductive parts which form the structure of the machine shall all be connected to a protective bonding terminal to provide protection against electric shock. Where a mobile machine is also capable of being connected to an external incoming power supply, this protective bonding terminal shall be the connection point for the external protective conductor. NOTE When the supply of electrical energy is self-contained within stationary, mobile, or movable items of equipment, and when there is no external supply connected (for example when an on-board battery charger is not connected), there is no need to connect such equipment to an external protective conductor.				
	8.2.8	**Additional protective bonding requirements for electrical equipment having earth leakage currents higher than 10 mA a.c. or d.c.** NOTE 1 Earth leakage current is defined as “current flowing from the live parts of an installation to earth, in the absence of an insulation fault” (IEV 442-01-24). This current may have a capacitive component including that resulting from the deliberate use of capacitors. NOTE 2 Most adjustable speed electrical power drive systems that comply with relevant parts of IEC 61800 will have an earth leakage current greater than 3,5 mA a.c. A touch current measurement method is specified as a type test in IEC 61800-5-1 to determine the earth leakage current of an adjustable speed electrical power drive system. Where electrical equipment has an earth leakage current (for example adjustable speed electrical power drive systems and information technology equipment) that is greater than 10 mA a.c. or d.c. in any incoming supply, one or more of the following conditions for the associated protective bonding circuit shall be satisfied: a) the protective conductor shall have a cross-sectional area of at least 10 mm2 Cu or 16 mm2 Al, through its total run; b) where the protective conductor has a cross-sectional area of less than 10 mm2 Cu or 16 mm2 Al, a second protective conductor of at least the same cross-sectional area shall be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm2 Cu or 16 mm2 Al. NOTE 3 This can require that the electrical equipment has a separate terminal for a second protective conductor. c) automatic disconnection of the supply in case of loss of continuity of the protective conductor. To prevent difficulties associated with electromagnetic disturbances, the requirements of 4.4.2 also apply to the installation of duplicate protective			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		conductors. In addition, a warning label shall be provided adjacent to the PE terminal, and where necessary on the nameplate of the electrical equipment. The information provided under 17.2 b)1) shall include information about the leakage current and the minimum crosssectional area of the external protective conductor.				
	8.3	**Functional bonding** Protection against maloperation as a result of insulation failures can be achieved by connecting to a common conductor in accordance with 9.4.3.1. For recommendations regarding functional bonding to avoid maloperation due to electromagnetic disturbances, see 4.4.2.	☑			
	8.4	**Measures to limit the effects of high leakage current** The effects of high leakage current can be restricted to the equipment having high leakage current by connection of that equipment to a dedicated supply transformer having separate windings. The protective bonding circuit shall be connected to exposed conductive parts of the equipment and, in addition, to the secondary winding of the transformer. The protective conductor(s) between the equipment and the secondary winding of the transformer shall comply with one or more of the arrangements described in 8.2.8.			☑	
9		**Control circuits and control functions**	☑			
	9.1 **9.1.1**	**Control circuits** **Control circuit supply** Where control circuits are supplied from an a.c. source, control transformers shall be used for supplying the control circuits. Such transformers shall have separate windings. Where several transformers are used, it is recommended that the windings of those transformers be connected in such a manner that the secondary voltages are in phase. Where d.c. control circuits derived from an a.c. supply are connected to the protective bonding circuit (see 8.2.1), they shall be supplied from a separate winding of the a.c. control circuit transformer or by another control circuit transformer. NOTE Switch-mode units fitted with transformers having separate windings in accordance with IEC 61558-2-17 meet this requirement. Transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices (for example interlock device, start/stop control station).			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	9.1.2	**Control circuit voltages** The nominal value of the control voltage shall be consistent with the correct operation of the control circuit. The nominal voltage shall not exceed 277 V when supplied from a transformer.			☑	
	9.1.3	**Protection** Control circuits shall be provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.			☑	
	9.2 **9.2.1**	**Control functions** NOTE 1 Information on the safety-related aspects of control functions is given in ISO 13849-1, ISO 13849-2, and IEC 62061. NOTE 2 This subclause does not specify requirements for the equipment used to implement control functions. Examples of such requirements are given in Clause 10. **Start functions** Start functions shall operate by energizing the relevant circuit (see 9.2.5.2)	☑			
	9.2.2	**Stop functions** There are three categories of stop functions as follows: – stop category 0: stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop – see 3.56); – stop category 1: a controlled stop (see 3.11) with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved; – stop category 2: a controlled stop with power left available to the machine actuators.	☑			stop category 0
	9.2.3	**Operating modes** Each machine can have one or more operating modes determined by the type of machine and its application. When a hazardous situation can result from a mode selection, unauthorised and/or inadvertent selection shall be prevented by suitable means (for example key operated switch, access code). Mode selection by itself shall not initiate machine operation. A separate actuation of the start control shall be required. For each specific operating mode, the relevant safety functions and/or protective measures shall be implemented. Indication of the selected operating mode shall be provided (for example the position of a mode selector, the provision of an indicating light, a visual display indication).	☑			
	9.2.4	**Suspension of safety functions and/or protective measures** Where it is necessary to suspend safety functions and/or protective measures (for	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		example for setting or maintenance purposes), protection shall be ensured by: – disabling all other operating (control) modes; and – other relevant means (see 4.11.9 of ISO 12100-2:2003), that can include, for example, one or more of the following: - initiation of operation by a hold-to-run device or by a similar control device; - a portable control station with an emergency stop device and, where appropriate, an enabling device. Where a portable control station is in use, initiation of motion shall only be possible from that control station; - a cableless control station with a device to initiate stop functions in accordance with 9.2.7.3 and, where appropriate, an enabling device. Where a cableless control station is in use, initiation of motion shall only be possible from that control station; - limitation of the speed or the power of motion; - limitation of the range of motion.				
	9.2.5 **9.2.5.1**	**Operation** **General** The necessary safety functions and/or protective measures (for example interlocks (see 9.3)) shall be provided for safe operation. Measures shall be taken to prevent movement of the machine in an unintended or unexpected manner after any stopping of the machine (for example due to locked-off condition, power supply fault, battery replacement, lost signal condition with cableless control). Where a machine has more than one control station, measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.	☑			Only one control station
	9.2.5.2	**Start** The start of an operation shall be possible only when all of the relevant safety functions and/or protective measures are in place and are operational except for conditions as described in 9.2.4. On those machines (for example mobile machines) where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations shall be by hold-to-run controls, together with enabling devices, as appropriate. Suitable interlocks shall be provided to secure correct sequential starting. In the case of machines requiring the use of more than one control station to initiate a start, each of these control stations shall have a separate manually actuated start control device. The conditions to initiate a start shall be:	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		– all required conditions for machine operation shall be met, and – all start control devices shall be in the released (off) position, then – all start control devices shall be actuated concurrently (see 3.6).				
	9.2.5.3	**Stop** Stop category 0 and/or stop category 1 and/or stop category 2 stop functions shall be rovided as indicated by the risk assessment and the functional requirements of the machine (see 4.1). NOTE The supply disconnecting device (see 5.3) when operated achieves a stop category 0. Stop functions shall override related start functions (see 9.2.5.2 Where required, facilities to connect protective devices and interlocks shall be provided. 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 shall not initiate any hazardous situation. Where more than one control station is provided, stop commands from any control station shall be effective when required by the risk assessment of the machine.	☑			Stop category 0
	9.2.5.4 **9.2.5.4.1**	**Emergency operations (emergency stop, emergency switching off)** **General** This part of IEC 60204 specifies the requirements for the emergency stop and the emergency switching off functions of the emergency operations listed in Annex E, both of which are, in this part of IEC 60204, initiated by a single human action. Once active operation of an emergency stop (see 10.7) or emergency switching off (see 10.8) actuator has ceased following a command, the effect of this command shall be sustained until it is reset. This reset shall be possible only by a manual action at that location where the command has been initiated. The reset of the command shall not restart the machinery but only permit restarting. It shall not be possible to restart the machinery until all emergency stop commands have been reset. It shall not be possible to reenergize the machinery until all emergency switching off commands have been reset. NOTE Emergency stop and emergency switching off are complementary protective measures that are not primary means of risk reduction for hazards (for example trapping, entanglement, electric shock or burn) at a machine (see ISO 12100 (all parts)).			☑	
	9.2.5.4.2	**Emergency stop** Principles for the design of emergency stop equipment, including functional aspects,			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		are given in ISO 13850. The emergency stop shall function either as a stop category 0 or as a stop category 1 (see 9.2.2). The choice of the stop category of the emergency stop depends on the results of a risk assessment of the machine. In addition to the requirements for stop (see 9.2.5.3), the emergency stop function has the following requirements: – it shall override all other functions and operations in all modes; – power to the machine actuators that can cause a hazardous situation(s) shall be either removed immediately (stop category 0) or shall be controlled in such a way to stop the hazardous motion as quickly as possible (stop category 1) without creating other hazards; – reset shall not initiate a restart.				
	9.2.5.4.3	**Emergency switching off** The functional aspects of emergency switching off are given in 536.4 of IEC 60364-5-53. Emergency switching off should be provided where: – protection against direct contact (for example with conductor wires, conductor bars, slipring assemblies, controlgear in electrical operating areas) is achieved only by placing out of reach or by obstacles (see 6.2.6); or – there is the possibility of other hazards or damage caused by electricity. Emergency switching off is accomplished by switching off the relevant incoming supply by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply. When a machine cannot tolerate this stop category 0 stop, it may be necessary to provide other measures, for example protection against direct contact, so that emergency switching off is not necessary.			☑	
	9.2.5.5	**Monitoring of command actions** Movement or action of a machine or part of a machine that can result in a hazardous situation shall be monitored by providing, for example, overtravel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices. NOTE On some manually controlled machines, operators provide monitoring.			☑	
	9.2.6 **9.2.6.1**	**Other control functions** **Hold-to-run controls** Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation. NOTE Hold-to-run control can be accomplished by two-hand control devices.			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	9.2.6.2	**Two-hand control** Three types of two-hand control are defined in ISO 13851, the selection of which is determined by the risk assessment. These shall have the following features: **Type I**: this type requires: – the provision of two control devices and their concurrent actuation by both hands; – continuous concurrent actuation during the hazardous situation; – machine operation shall cease upon the release of either one or both of the control devices when hazardous situations are still present. A Type I two-hand control device is not considered to be suitable for the initiation of hazardous operation. **Type II**: a type I control requiring the release of both control devices before machine operation can be reinitiated. **Type III**: a type II control requiring concurrent actuation of the control devices as follows: – it shall be necessary to actuate the control devices within a certain time limit of each other, not exceeding 0,5 s; – where this time limit is exceeded, both control devices shall be released before machine operation can be initiated.			☑	
	9.2.6.3	**Enabling control** 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, and b) when de-activated – initiates a stop function in accordance with 9.2.5.3, and – prevents initiation of machine operation.			☑	
	9.2.6.4	**Combined start and stop controls** Push-buttons and similar control devices that, when operated, alternately initiate and stop motion shall only be provided for functions which cannot result in a hazardous situation.			☑	
	9.2.7 **9.2.7.1**	**Cableless control** **General** This subclause deals with the functional requirements of control systems employing cableless (for example radio, infra-red) techniques for transmitting commands and signals between a machine control system and operator control station(s). NOTE Some of these application and system considerations can also be applicable to			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		control functions employing serial data communication techniques where the communications link uses a cable (for example coaxial, twisted-pair, optical fibre). Means shall be provided to readily remove or disconnect the power supply of the operator control station (see also 9.2.7.3). Means (for example key operated switch, access code) shall be provided, as necessary, to prevent unauthorized use of the operator control station. Each operator control station shall carry an unambiguous indication of which machine(s) is (are) intended to be controlled by that operator control station.				
	9.2.7.2	**Control limitation** Measures shall be taken to ensure that control commands: – affect only the intended machine; – affect only the intended functions. Measures shall be taken to prevent the machine from responding to signals other than those from the intended operator control station(s). Where necessary, means shall be provided so that the machine can only be controlled from operator control stations in one or more predetermined zones or locations.			☑	
	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. The actuating means to initiate this stop function shall not be marked or labelled as an emergency stop device (see10.7). A machine which is equipped with cableless control shall have a means of automatically initiating the stopping of the machine and of preventing a potentially hazardous operation, in the following situations: – 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	**Use of more than one operator control station** Where a machine has more than one operator control station, including one or more cableless control stations, measures shall be provided to ensure that only one of the control stations can be enabled at a given time. An indication of which operator			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		control station is in control of the machine shall be provided at suitable locations as determined by the risk assessment of the machine. **Exception:** a stop command from any one of the control stations shall be effective when required by the risk assessment of the machine.				
	9.2.7.5	**Battery-powered operator control stations** A variation in the battery voltage shall not cause a hazardous situation. If one or more potentially hazardous motions are controlled using a battery-powered cableless operator control station, a clear warning shall be given to the operator when a variation in battery voltage exceeds specified limits. Under those circumstances, the cableless operator control station shall remain functional long enough for the operator to put the machine into a nonhazardous situation.			☑	
	9.3 **9.3.1**	**Protective interlocks** **Reclosing or resetting of an interlocking safeguard** The reclosing or resetting of an interlocking safeguard shall not initiate hazardous machine operation. NOTE Requirements for interlocking guards with a start function (control guards) are given in 5.3.2.5 of ISO 12100-2.			☑	
	9.3.2	**Exceeding operating limits** Where an operating limit (for example speed, pressure, position) can be exceeded leading to a hazardous situation, means shall be provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action.			☑	
	9.3.3	**Operation of auxiliary functions** The correct operation of auxiliary functions shall be checked by appropriate devices (for example pressure sensors). Where the non-operation of a motor or device for an auxiliary function (for example lubrication, supply of coolant, swarf removal) can cause a hazardous situation, or cause damage to the machine or to the work in progress, appropriate interlocking shall be provided.			☑	
	9.3.4	**Interlocks between different operations and for contrary motions** All contactors, relays, and other control devices that control elements of the machine and that can cause a hazardous situation when actuated at the same time (for example those which initiate contrary motion), shall be interlocked against incorrect operation. Reversing contactors (for example those controlling the direction of rotation of a motor) shall be interlocked in such a way that in normal service no short circuit can occur when switching.			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Where, for safety or for continuous operation, certain functions on the machine are required to be interrelated, proper co-ordination shall be ensured by suitable interlocks. For a group of machines working together in a co-ordinated manner and having more than one controller, provision shall be made to co-ordinate the operations of the controllers as necessary. Where a failure of a mechanical brake actuator can result in the brake being applied when the associated machine actuator is energized and a hazardous situation can result, interlocks shall be provided to switch off the machine actuator.				
	9.3.5	**Reverse current braking** Where braking of a motor is accomplished by current reversal, measures shall be provided to prevent the motor starting in the opposite direction at the end of braking where that reversal can cause a hazardous situation or damage to the machine or to the work in progress. For this purpose, a device operating exclusively as a function of time is not permitted. Control circuits shall be so arranged that rotation of a motor shaft, for example manually, shall not result in a hazardous situation.			☑	
	9.4 **9.4.1**	**Control functions in the event of failure** **General requirements** Where failures or disturbances in the electrical equipment can cause a hazardous situation or damage to the machine or to the work in progress, appropriate measures shall be taken to minimize the probability of the occurrence of such failures or disturbances. The required measures and the extent to which they are implemented, either individually or in combination, depend on the level of risk associated with the respective application (see 4.1). The electrical control circuits shall 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 shall apply. Measures to reduce those risks include but are not limited to: – protective devices on the machine (for example interlocking guards, trip devices); – protective interlocking of the electrical circuit; – use of proven circuit techniques and components (see 9.4.2.1); – provision of partial or complete redundancy (see 9.4.2.2) or diversity (see 9.4.2.3); – provision for functional tests (see 9.4.2.4). Where memory retention is achieved for example, by battery power, measures shall	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		be taken to prevent hazardous situations arising from failure or removal of the battery. Means shall be provided to prevent unauthorized or inadvertent memory alteration by, for example, requiring the use of a key, access code or tool.				
	9.4.2 **9.4.2.1**	**Measures to minimize risk in the event of failure** **Use of proven circuit techniques and components** These measures include but are not limited to: – bonding of control circuits to the protective bonding circuit for functional purposes (see 9.4.3.1 and Figure 2); – connection of control devices in accordance with 9.4.3.1; – stopping by de-energizing (see 9.2.2); – the switching of all control circuit conductors to the device being controlled (see 9.4.3.1); – switching devices having direct opening action (see IEC 60947-5-1); – circuit design to reduce the possibility of failures causing undesirable operations.			☑	
	9.4.2.2	**Provisions of partial or complete redundancy** By providing partial or complete redundancy, it is possible to minimize the probability that one single failure in the electrical circuit can result in a hazardous situation. Redundancy can be effective in normal operation (on-line redundancy) or designed as special circuits that take over the protective function (off-line redundancy) only where the operating function fails. Where off-line redundancy which is not active during normal operation is provided, suitable measures shall be taken to ensure that those control circuits are available when required.			☑	
	9.4.2.3	**Provision of diversity** The use of control circuits having different principles of operation, or using different types of components or devices can reduce the probability of hazards resulting from faults and/or failures. Examples include: – the combination of normally open and normally closed contacts operated by interlocking guards; – the use of different types of control circuit components in the circuit; – the combination of electromechanical and electronic equipment in redundant configurations. The combination of electrical and non-electrical systems (for example mechanical, hydraulic, pneumatic) may perform the redundant function and provide the diversity.			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	9.4.2.4	**Provision for functional tests** Functional tests may be carried out automatically by the control system, or manually by inspection or tests at start-up and at predetermined intervals, or a combination as appropriate (see also 17.2 and 18.6).			☑	
	9.4.3 **9.4.3.1**	**Protection against maloperation due to earth faults, voltage interruptions and loss of circuit continuity** **Earth faults** Earth faults on any control circuit shall not 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: **Method a)** Control circuits, fed by control transformers: 1) In case of earthed control circuit supplies, the common conductor is connected to the protective bonding circuit at the point of supply. All contacts, solid state elements etc., which are intended to operate an electromagnetic or other device (for example, a relay, indicator light) are inserted between one side, the switched conductor of the control circuit supply and one terminal of the coil or device. The other terminal of the coil or device (preferably always having the same marking) is connected directly to the common conductor of the control circuit supply without any switching elements (see Figure 3). **Exception**: Contacts of protective devices may be connected between the common conductor and the coils, provided that: – the circuit is interrupted automatically in the event of an earth fault, or – the connection is very short (for example in the same enclosure) so that an earth fault is unlikely (for example overload relays). 2) Control circuits fed from a control transformer and not connected to the protective bonding circuit, having the same arrangement as shown in Figure 3 and provided with a device that interrupts the circuit automatically in the event of an earth fault (see also 7.2.4). **Method b)** Control circuits fed from a control transformer with a centre-tapped winding, this centre tap connected to the protective bonding circuit, arranged as shown in Figure 4 with the overcurrent protective device having switching elements in all control circuit supply conductors. NOTE 1 On a centre-tapped earthed control circuit, the presence of one earth fault can leave 50 % voltage on a relay coil. In this condition, a relay can hold on, resulting	☑			Methods to meet these requirements are used.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		in inability to stop a machine. NOTE 2 Coils or devices may be switched on either or both sides. **Method 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, Multi-pole control switches that switch all live conductors are used for START or STOP of those machine functions that can cause a hazardous situation or damage to the machine in the event of unintentional starting or failure to stop, or in the case of c) 2), a device shall be provided that interrupts the circuit automatically in the event of an earth fault.				
	9.4.3.2	**Voltage interruptions** The requirements detailed in 7.5 shall apply. Where the control system uses a memory device(s), proper functioning in the event of power failure shall be ensured (for example by using a non-volatile memory) to prevent any loss of memory that can result in a hazardous situation.	☑			
	9.4.3.3	**Loss of circuit continuity** Where the loss of continuity of safety-related control circuits depending upon sliding contacts can result in a hazardous situation, appropriate measures shall be taken (for example by duplication of the sliding contacts).	☑			
10		**Operator interface and machine-mounted control devices**				
	10.1 **10.1.1**	**General** **General device requirements** This Clause contains requirements for devices mounted outside or partially outside control enclosures. As far as is practicable, those devices shall be selected, mounted, and identified or coded in accordance with relevant parts of IEC 61310. The possibility of inadvertent operation shall be minimized by, for example, positioning of devices, suitable design, provision of additional protective measures. Particular consideration shall be given to the selection, arrangement, programming and use of operator input devices such as touchscreens, keypads and keyboards, for the control of hazardous machine operations. See IEC 60447.	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	10.1.2	**Location and mounting** As far as is practicable, machine-mounted control devices shall be: – readily accessible for service and maintenance; – mounted in such a manner as to minimize the possibility of damage from activities such as material handling. The actuators of hand-operated control devices shall be selected and installed so that: – they are not less than 0,6 m above the servicing level and are within easy reach of the normal working position of the operator; – the operator is not placed in a hazardous situation when operating them. The actuators of foot-operated control devices shall be selected and installed so that: – they are within easy reach of the normal working position of the operator; – the operator is not placed in a hazardous situation when operating them.	☑			Ergonomic principles are considered
	10.1.3	**Protection** The degree of protection (see IEC 60529) together with other appropriate measures shall afford protection against: – the effects of aggressive liquids, vapours, or gases found in the physical environment or used on the machine; – the ingress of contaminants (for example swarf, dust, particulate matter). In addition, the operator interface control devices shall have a minimum degree of protection against direct contact of IPXXD (see IEC 60529).	☑			IP 54
	10.1.4	**Position sensors** Position sensors (for example position switches, proximity switches) shall be so arranged that they will not be damaged in the event of overtravel. 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). NOTE A safety-related control function is intended to maintain the safe condition of the machine or prevent hazardous situations arising at the machine.			☑	
	10.1.5	**Portable and pendant control stations** Portable and pendant operator control stations and their control devices shall be so selected and arranged as to minimize the possibility of inadvertent machine operations caused by shocks and vibrations (for example if the operator control station is dropped or strikes an obstruction) (see also 4.4.8)			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	10.2 **10.2.1**	**Push-buttons** **Colours** Push-button actuators shall be colour-coded in accordance with Table 2 (see also 9.2 and Annex B). The colours for START/ON actuators should be WHITE, GREY, BLACK or GREEN with a preference for WHITE. RED shall not be used. The colour RED shall be used for emergency stop and emergency switching off actuators. The colours for STOP/OFF actuators should be BLACK, GREY, or WHITE with a preference for BLACK. GREEN shall not be used. RED is permitted, but it is recommended that RED is not used near an emergency operation device. WHITE, GREY, or BLACK are the preferred colours for push-button actuators that alternately act as START/ON and STOP/OFF push-buttons. The colours RED, YELLOW, or GREEN shall not be used (see also 9.2.6). WHITE, GREY, or BLACK are the preferred colours for push-button actuators that cause operation while they are actuated and cease the operation when they are released (for example hold-to-run). The colours RED, YELLOW, or GREEN shall not be used. Reset push-buttons shall be BLUE, WHITE, GREY, or BLACK. Where they also act as a STOP/OFF button, the colours WHITE, GREY, or BLACK are preferred with the main preference being for BLACK. GREEN shall not be used. Where the same colour WHITE, GREY, or BLACK is used for various functions (for example WHITE for START/ON and for STOP/OFF actuators) a supplementary means of coding (for example shape, position, symbol) shall be used for the identification of push-button actuators.	☑			Push-button actuators are colour-coded in accordance with Table 2.
	10.2.2	**Markings** In addition to the functional identification as described in 16.3, it is recommended that pushbuttons be marked, near to or preferably directly on the actuators, with the symbols given in Table 3.	☑			Symbols comply with table 3
	10.3 **10.3.1**	**Indicator lights and displays** **General** Indicator lights and displays serve to give the following types of information: – indication: to attract the operator's attention or to indicate that a certain task should be performed. The colours RED, YELLOW, BLUE, and GREEN are normally used in this mode; for flashing indicator lights and displays, see 10.3.3. – confirmation: to confirm a command, or a condition, or to confirm the termination	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		of a change or transition period. The colours BLUE and WHITE are normally used in this mode and GREEN may be used in some cases. Indicator lights and displays shall be selected and installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310-1). Indicator light circuits used for warning lights shall be fitted with facilities to check the operability of these lights.				
	10.3.2	**Colours** Unless otherwise agreed between the supplier and the user (see Annex B), indicator lights shall be colour-coded with respect to the condition (status) of the machine in accordance with Table 4. Indicating towers on machines should have the applicable colours in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.	☑			
	10.3.3	**Flashing lights and displays** For further distinction or information and especially to give additional emphasis, flashing lights and displays can be provided for the following purposes: – to attract attention; – to request immediate action; – to indicate a discrepancy between the command and actual state; – to indicate a change in process (flashing during transition). It is recommended that higher frequency flashing lights or display be used for higher priority information (see IEC 60073 for recommended flashing rates and pulse/pause ratios). Where flashing lights or displays are used to provide higher priority information, audible warning devices should also be provided.			☑	
	10.4	**Illuminated push-buttons** Illuminated push-button actuators shall be colour-coded in accordance with Tables 2 and 4. Where there is difficulty in assigning an appropriate colour, WHITE shall be used. The colour RED for the emergency stop actuator shall not depend on the illumination of its light.	☑			
	10.5	**Rotary control devices** Devices having a rotational member, such as potentiometers and selector switches, shall have means of prevention of rotation of the stationary member. Friction alone shall not be considered sufficient.			☑	
	10.6	**Start devices** Actuators used to initiate a start function or the movement of machine elements (for	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		example slides, spindles, carriers) shall be constructed and mounted so as to minimize inadvertent operation. However, mushroom-type actuators may be used for two-hand control (see also ISO 13851).				
	10.7 **10.7.1**	**Emergency stop devices** **Location of emergency stop devices** Devices for emergency stop shall be readily accessible. Emergency stop devices shall be 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). There can be circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station. In such cases,means (for example, information for use) shall be provided to minimise confusion.			☑	
	10.7.2	**Types of emergency stop device** The types of device for emergency stop include: – a push-button operated switch with a palm or mushroom head type; – a pull-cord operated switch; – a pedal-operated switch without a mechanical guard. The devices shall have direct opening operation (see IEC 60947-5-1, Annex K).			☑	
	10.7.3	**Colour of actuators** Actuators of emergency stop devices shall be coloured RED. If a background exists immediately around the actuator, then this background shall be coloured YELLOW. See also ISO 13850.			☑	
	10.7.4	**Local operation of the supply disconnecting device to effect emergency stop** 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 such use, the supply disconnecting device shall meet the colour requirements of 10.7.3.			☑	
	10.8 **10.8.1**	**Emergency switching off devices** **Location of emergency switching off devices** Emergency switching off devices shall be located as necessary for the given application. Normally, those devices will be located separate from operator control stations. Where it is necessary to provide a control station with an emergency stop device and			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		an emergency switching off device, means shall be provided to avoid confusion between these devices. NOTE This can be achieved by, for example, the provision of a break-glass enclosure for the emergency switching off device.				
	10.8.2	**Types of emergency switching off device** 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 shall have direct opening action (see IEC 60947-5-1, Annex K). The push-button operated switch may be in a break-glass enclosure.			☑	
	10.8.3	**Colour of actuators** Actuators of emergency switching off devices shall be coloured RED. If a background exists immediately around the actuator, then this background shall be coloured YELLOW. Where confusion can occur between emergency stop and emergency switching off devices, means shall be provided to minimise confusion.			☑	
	10.8.4	**Local operation of the supply disconnecting device to effect emergency switching off** Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and should meet the colour requirements of 10.8.3.			☑	
	10.9	**Enabling control device** When an enabling control device is provided as a part of a system, it shall signal the enabling control to allow operation when actuated in one position only. In any other position, operation shall be stopped or prevented. Enabling control devices shall be selected and arranged so as to minimize the possibility of defeating. Enabling control devices shall be selected that have the following features: – designed in accordance with ergonomic principles; – for a two-position type: - position 1: off-function of the switch (actuator is not operated); - position 2: enabling function (actuator is operated). – for a three-position type: - position 1: off-function of the switch (actuator is not operated); - position 2: enabling function (actuator is operated in its mid position);			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		- 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. NOTE The enabling control function is described in 9.2.6.3.				
11		**Controlgear: location, mounting, and enclosures**				
	11.1	**General requirements** All controlgear shall be located and mounted so as to facilitate: – its accessibility and maintenance; – its protection against the external influences or conditions under which it is intended to operate; – operation and maintenance of the machine and its associated equipment.	☑			
	11.2 **11.2.1**	**Location and mounting** **Accessibility and maintenance** All items of controlgear shall be placed and oriented so that they can be identified without moving them or the wiring. For items that require checking for correct operation or that are liable to need replacement, those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers, barriers or obstacles). Terminals not part of controlgear components or devices shall also conform to these requirements. All controlgear shall be mounted so as to facilitate its operation and maintenance from the front. Where a special tool is necessary to adjust, maintain, or remove a device, such a tool shall be supplied. Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0,4 m and 2,0 m above the servicing level. It is recommended that terminals be at least 0,2 m above the servicing level and be so placed that conductors and cables can be easily connected to them. No devices except devices for operating, indicating, measuring, and cooling shall be mounted on doors or on normally removable access covers of enclosures. Where control devices are connected through plug-in arrangements, their association shall be made clear by type (shape), marking or reference designation, singly or in combination (see 13.4.5). Plug-in devices that are handled during normal operation shall be provided with noninterchangeable features where the lack of such a facility can result in malfunctioning. Plug/socket combinations that are handled during normal operation shall be located and mounted so as to provide unobstructed access.	☑			Relevant devices are located between 0.4m to 2.0m Ergonomic principles are considered

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Test points for connection of test equipment, where provided, shall be: – mounted so as to provide unobstructed access; – clearly identified to correspond with the documentation (see 17.3); – adequately insulated; – sufficiently spaced.				
	11.2.2	**Physical separation or grouping** Non-electrical parts and devices, not directly associated with the electrical equipment, shall not be located within enclosures containing controlgear. Devices such as solenoid valves should be separated from the other electrical equipment (for example in a separate compartment). Control devices mounted in the same location and connected to the supply voltage, or to both supply and control voltages, shall be grouped separately from those connected only to the control voltages. Terminals shall be separated into groups for: – power circuits; – associated control circuits; – other control circuits, fed from external sources (for example for interlocking). The groups may be mounted adjacently, provided that each group can be readily identified (for example by markings, by use of different sizes, by use of barriers or by colours). When arranging the location of devices (including interconnections), the clearances and creepage distances specified for them by the supplier shall be maintained, taking into account the external influences or conditions of the physical environment.			☑	Only power circuit is used
	11.2.3	**Heating effects** Heat generating components (for example heat sinks, power resistors) shall be so located that the temperature of each component in the vicinity remains within the permitted limit.			☑	
	11.3	**Degrees of protection** The protection of controlgear against ingress of solid foreign objects and of liquids shall be adequate taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental conditions) and shall be sufficient against dust, coolants, and swarf. NOTE 1 Requirements for protection against electric shock are given in Clause 6. NOTE 2 The degrees of protection against ingress of water are covered by IEC 60529. Additional protective measures can be necessary against other liquids. Enclosures of controlgear shall provide a degree of protection of at least IP22 (see	☑			The protection of controlgear conforms to the requirements. Enclosure :IP54

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		IEC 60529). **Exceptions:** a) Where an electrical operating area is used as a protective enclosure for an appropriate degree of protection against the ingress of solid bodies and liquids. b) Where removable collectors on conductor wire or conductor bar systems are used and IP22 is not achieved, but the measures of 6.2.5 are applied. NOTE 3 Some examples of applications, along with the degree of protection typically provided by their enclosures, are listed below: – ventilated enclosure, containing only motor starter resistor and other large size equipment IP10 – ventilated enclosure, containing other equipment IP32 – enclosure used in general industry IP32, IP43 and IP54 – enclosure used in locations that are cleaned with low-pressure water jets (hosing) IP55 – enclosure providing protection against fine dust IP65 – enclosure containing slip-ring assemblies IP2X Depending upon the conditions where installed, another degree of protection can be appropriate.				
	11.4	**Enclosures, doors and openings** Enclosures shall be constructed using materials capable of withstanding the mechanical, electrical and thermal stresses as well as the effects of humidity and other environmental factors that are likely to be encountered in normal service. Fasteners used to secure doors and covers should be of the captive type. Windows provided for viewing internally mounted indicating devices shall be of a material suitable to withstand mechanical stress and chemical attack (for example toughened glass or polycarbonate sheet of not less than 3 mm thickness). It is recommended that enclosure doors be not wider than 0,9 m and have vertical hinges, with an angle of opening of at least 95°. The joints or gaskets of doors, lids, covers and enclosures shall withstand the chemical effects of the aggressive liquids, vapours, or gases used on the machine. The means provided to maintain the degree of protection of an enclosure on doors, lids and covers that require opening or removal for operation or maintenance shall: – be securely attached to either the door/cover or the enclosure; – not deteriorate due to removal or replacement of the door or the cover, and so impair the degree of protection.	☑			Enclosures, doors and openings are cheked in compliance with these requirements.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Where openings in enclosures are provided (for example, for cable access), including those towards the floor or foundation or to other parts of the machine, means shall be provided to ensure the degree of protection specified for the equipment. Openings for cable entries shall be easily re-opened on site. A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away. There shall be no opening between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate. This requirement does not apply to electrical devices specifically designed to operate in oil (for example electromagnetic clutches) nor to electrical equipment in which coolants are used. Where there are holes in an enclosure for mounting purposes, means may be necessary to ensure that after mounting, the holes do not impair the required protection. Equipment that, in normal or abnormal operation, can attain a surface temperature sufficient to cause a risk of fire or harmful effect to an enclosure material shall: – be located within an enclosure that will withstand, without risk of fire or harmful effect, such temperatures as can be generated; and – be mounted and located at a sufficient distance from adjacent equipment so as to allow safe dissipation of heat (see also 11.2.3); or – be otherwise screened by material that can withstand, without risk of fire or harmful effect, the heat emitted by the equipment. NOTE A warning label in accordance with 16.2.2 may be necessary.				
	11.5	**Access to controlgear** Doors in gangways and for access to electrical operating areas shall: – be at least 0,7 m wide and 2,1 m high; – open outwards; – have a means (for example panic bolts) to allow opening from the inside without the use of a key or tool. Enclosures which readily allow a person to fully enter shall be provided with means to allow escape, for example panic bolts on the inside of doors. Enclosures intended for such access, AQ1`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. In cases where:			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		– equipment is likely to be live during access; and – conducting parts are exposed, the clear width shall be at least 1,0 m. In cases where such parts are present on both sides of the access way, the clear width shall be at least 1,5 m. NOTE These dimensions are derived from ISO 14122 series				
12		**Conductors and cables**				
	12.1	**General requirements** Conductors and cables shall be selected so as to be suitable for the operating conditions (for example voltage, current, protection against electric shock, grouping of cables) and external influences (for example ambient temperature, presence of water or corrosive substances, mechanical stresses (including stresses during installation), fire hazards) that can exist. NOTE Further information is given in CENELEC HD 516 S2. These requirements do not apply to the integral wiring of assemblies, subassemblies, and devices that are manufactured and tested in accordance with their relevant IEC standard (for example IEC 60439-1).	☑			Conductors and cables selected meet this requirement.
	12.2	**Conductors** In general, conductors shall be of copper. Where aluminium conductors are used, the crosssectionalarea shall be at least 16 mm2. To ensure adequate mechanical strength, the cross-sectional area of conductors should not be less than as shown in Table 5. However, conductors with smaller cross-sectional areas or other constructions than shown in Table 5 may be used in equipment provided adequate mechanical strength is achieved by other means and proper functioning is not impaired. NOTE Classification of conductors is given in Table D.4. Class 1 and class 2 conductors are primarily intended for use between rigid, non-moving parts. All conductors that are subject to frequent movement (for example one movement per hour of machine operation) shall have flexible stranding of class 5 or class 6.	☑			Conductors are copper.
	12.3	**Insulation** The types of insulation include (but are not limited to): – polyvinyl chloride (PVC); – rubber, natural and synthetic; – silicone rubber (SiR); – mineral;	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		– cross-linked polyethylene (XLPE); – ethylene propylene compound (EPR). 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, guidance from the cable supplier should be sought. It is important to give special attention to the integrity of a circuit having a safety-related function. The insulation of cables and conductors used, shall be suitable for a test voltage: – not less than 2 000 V a.c. for a duration of 5 min for operation at voltages higher than 50 V a.c. or 120 V d.c., or – not less than 500 V a.c. for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment). The mechanical strength and thickness of the insulation shall be such that the insulation cannot be damaged in operation or during laying, especially for cables pulled into ducts.				
	12.4	**Current-carrying capacity in normal service** The current-carrying capacity depends on several factors, for example insulation material, number of conductors in a cable, design (sheath), methods of installation, grouping and ambient temperature. NOTE 1 Detailed information and further guidance can be found in IEC 60364-5-52, in some national standards or given by the manufacturer. One typical example of the current-carrying capacities for PVC insulated wiring between enclosures and individual items of equipment under steady-state conditions is given inTable 6. NOTE 2 For specific applications where the correct cable dimensioning can depend on the relationship between the period of the duty cycle and the thermal time constant of the cable (for example starting against high-inertia load, intermittent duty), the cable manufacturer should be consulted.	☑			
	12.5	**Conductor and cable voltage drop** The voltage drop from the point of supply to the load shall not exceed 5 % of the nominal voltage under normal operating conditions. In order to conform to this requirement, it can be necessary to use conductors having a larger cross-sectional area than that derived from Table 6.			☑	
	12.6 **12.6.1**	**Flexible cables** **General**	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Flexible cables shall have Class 5 or Class 6 conductors. NOTE 1 Class 6 conductors have smaller diameter strands and are more flexible than Class 5 conductors (see Table D.4). Cables that are subjected to severe duties shall be of adequate construction to protect against: – abrasion due to mechanical handling and dragging across rough surfaces; – kinking due to operation without guides; – stress resulting from guide rollers and forced guiding, being wound and re-wound on cable drums. NOTE 2 Cables for such conditions are specified in relevant national standards. NOTE 3 The operational life of the cable will be reduced where unfavourable operating conditions such as high tensile stress, small radii, bending into another plane and/or where frequent duty cycles coincide.				
	12.6.2	**Mechanical rating** The cable handling system of the machine shall be so designed to keep the tensile stress of the conductors as low as is practicable during machine operations. Where copper conductors are used, the tensile stress applied to the conductors shall not exceed 15 N/mm2 of the copper cross-sectional area. Where the demands of the application exceed the tensile stress limit of 15 N/mm2, cables with special construction features should be used and the allowed maximal tensile stress should be agreed with the cable manufacturer. The maximum stress applied to the conductors of flexible cables with material other than copper shall be within the cable manufacturer's specification. NOTE The following conditions affect the tensile stress on the conductors: – acceleration forces; – speed of motion; – dead (hanging) weight of the cables; – method of guiding; – design of cable drum system.	☑			
	12.6.3	**Current-carrying capacity of cables wound on drums** Cables to be wound on drums shall be selected with conductors having a cross-sectional area such that, when fully wound on the drum and carrying the normal service load, the maximum allowable conductor temperature is not exceeded. For cables of circular cross-sectional area installed on drums, the maximum current-carrying capacity in free air should be derated in accordance with Table 7			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		(see also Clause 44 of IEC 60621-3). NOTE The current-carrying capacity of cables in free air can be found in manufacturers' specifications or in relevant national standards.				
	12.7 **12.7.1**	**Conductor wires, conductor bars and slip-ring assemblies** **Protection against direct contact** Conductor wires, conductor bars and slip-ring assemblies shall be installed or enclosed in such a way that, during normal access to the machine, protection against direct contact 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 (see 412.2 of IEC 60364-4-41). Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X (see 412.2.2 of IEC 60364-4-41). Where the required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching off in accordance with 9.2.5.4.3 shall be applied. Conductor wires and conductor bars shall be so placed and/or protected as to: – prevent contact, especially for unprotected conductor wires and conductor bars, with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains; – prevent damage from a swinging load.			☑	
	12.7.2	**Protective conductor circuit** Where conductor wires, conductor bars and slip-ring assemblies are installed as part of the protective bonding circuit, they shall not carry current in normal operation. Therefore, the protective conductor (PE) and the neutral conductor (N) shall each use a separate conductor wire, conductor bar or slip-ring. The continuity of the protective conductor circuit using sliding contacts shall be ensured by taking appropriate measures (for example, duplication of the current collector, continuity monitoring).			☑	
	12.7.3	**Protective conductor current collectors** Protective conductor current collectors shall have a shape or construction so that they are not interchangeable with the other current collectors. Such current collectors shall be of the sliding contact type.			☑	
	12.7.4	**Removable current collectors with a disconnector function** Removable current collectors having a disconnector function shall be so designed			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		that the protective conductor circuit is interrupted only after the live conductors have been disconnected, and the continuity of the protective conductor circuit is re-established before any live conductor is reconnected (see also 8.2.4).				
	12.7.5	**Clearances in air** Clearances between the respective conductors, and between adjacent systems, of conductor wires, conductor bars, slip-ring assemblies and their current collectors shall be suitable for at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1.			☑	
	12.7.6	**Creepage distances** Creepage distances between the respective conductors, between adjacent systems of conductor wires, conductor bars and slip-ring assemblies, and their current collectors shall be suitable for operation in the intended environment, for example open air (IEC 60664-1), inside buildings, protected by enclosures. In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply: – unprotected conductor wires, conductor bars, and slip-ring assemblies shall be equipped with insulators with a minimum creepage distance of 60 mm; – enclosed conductor wires, insulated multipole conductor bars and insulated individual conductor bars shall have a minimum creepage distance of 30 mm. The manufacturer's recommendations shall be followed regarding special measures to prevent a gradual reduction in the insulation values due to unfavourable ambient conditions (for example deposits of conductive dust, chemical attack).			☑	
	12.7.7	**Conductor system sectioning** Where conductor wires or conductor bars are arranged so that they can be divided into isolated sections, suitable design measures shall be employed to prevent the energization of adjacent sections by the current collectors themselves.			☑	
	12.7.8	**Construction and installation of conductor wire, conductor bar systems and slip-ring assemblies** Conductor wires, conductor bars and slip-ring assemblies in power circuits shall be grouped separately from those in control circuits. Conductor wires, conductor bars and slip-ring assemblies shall be capable of withstanding, without damage, the mechanical forces and thermal effects of short-circuit currents Removable covers for conductor wire and conductor bar systems laid underground or underfloor shall be so designed that they cannot be opened by one person without the aid of a tool.			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Where conductor bars are installed in a common metal enclosure, the individual sections of the enclosure shall be bonded together and connected to a protective bonding conductor at several points depending upon their length. Metal covers of conductor bars laid underground or underfloor shall also be bonded together and connected to a protective bonding conductor. The protective bonding circuit shall include the covers or cover plates of metal enclosures or underfloor ducts. Where metal hinges form a part of the bonding circuit, their continuity shall be verified (see Clause 18). Underground and underfloor conductor bar ducts shall have drainage facilities.				
13		**Wiring practices**				
	13.1 **13.1.1**	**Connections and routing** **General requirements** All connections, especially those of the protective bonding circuit, shall be secured against accidental loosening. The means of connection shall be suitable for the cross-sectional areas and nature of the conductors being terminated. The connection of two or more conductors to one terminal is permitted only in those cases where the terminal is designed for that purpose. However, only one protective conductor shall be connected to one terminal connecting point. Soldered connections shall only be permitted where terminals are provided that are suitable for soldering. Terminals on terminal blocks shall be plainly marked or labelled to correspond with markings on the diagrams. Where an incorrect electrical connection (for example, arising from replacement of devices) can be a source of risk and it is not practicable to reduce the possibility of incorrect connection by design measures, the conductors and/or terminations shall be identified in accordance with 13.2.1. The installation of flexible conduits and cables shall be such that liquids shall drain away from the fittings. Means of retaining conductor strands shall be provided when terminating conductors at devices or terminals that are not equipped with this facility. Solder shall not be used for that purpose. Shielded conductors shall be so terminated as to prevent fraying of strands and to permit easy disconnection.	☑			Wiring conforms to these requirements.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		Identification tags shall be legible, permanent, and appropriate for the physical environment. Terminal blocks shall be mounted and wired so that the internal and external wiring does not cross over the terminals (see IEC 60947-7-1).				
	13.1.2	**Conductor and cable runs** Conductors and cables shall be run from terminal to terminal without splices or joints. Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be joints for the purpose of this Subclause. **Exception:** Where it is impracticable to provide terminals in a junction box (for example on mobile machines, on machines having long flexible cables; cable connections exceeding a length which is not practical to be supplied by the cable manufacturer on one cable drum; repair of cable due to mechanical stresses during installation and operation), splices or joints may be used. Where it is necessary to connect and disconnect cables and cable assemblies, a sufficient extra length shall be provided for that purpose. The terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors. Wherever practicable, the protective conductor shall be placed close to the associated live conductors in order to decrease the impedance of the loop.	☑			
	13.1.3	**Conductors of different circuits** Conductors of different circuits may be laid side by side, may occupy the same duct (for example conduit, cable trunking system), or may be in the same multiconductor cable provided that the arrangement does not impair the proper functioning of the respective circuits. Where those circuits operate at different voltages, the conductors shall be separated by suitable barriers or shall be insulated for the highest voltage to which any conductor within the same duct can be subjected, for example line to line voltage for unearthed systems and phase to earth voltage for earthed systems.	☑			
	13.1.4	**Connection between pick-up and pick-up converter of an inductive power supply system** The cable between the pick-up and the pick-up converter as specified by the manufacturer of the inductive power supply shall be: – as short as practicable; – adequately protected against mechanical damage. NOTE The output of the pick-up can be a current source, therefore damage to the			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		cable can result in a high voltage hazard.				
	13.2 **13.2.1**	**Identification of conductors** **General requirements** Each conductor shall be identifiable at each termination in accordance with the technical documentation (see Clause 17). It is recommended (for example to facilitate maintenance) that conductors be identified by number, alphanumeric, colour (either solid or with one or more stripes), or a combination of colour and numbers or alphanumeric. When numbers are used, they shall be Arabic; letters shall be Roman (either upper or lower case). NOTE Annex B can be used for agreement between supplier and user regarding a preferred method of identification.	☑			Conductors are labelled with specific signs.
	13.2.2	**Identification of the protective conductor** The protective conductor shall be readily distinguishable by shape, location, marking, or colour. When identification is by colour alone, the bicolour combination GREEN-AND-YELLOW shall be used throughout the length of the conductor. This colour identification is strictly reserved for the protective conductor. For insulated conductors, the bicolour combination GREEN-AND-YELLOW shall be such that on any 15 mm length, one of the colours covers at least 30 % and not more than 70 % of the surface of the conductor, the other colour covering the remainder of the surface. Where the protective conductor can be easily identified by its shape, position, or construction (for example a braided conductor, uninsulated stranded conductor), or where the insulated conductor is not readily accessible, colour coding throughout its length is not necessary but the ends or accessible locations shall be clearly identified by the graphical symbol IEC 60417-5019 (DB:2002-10) or by the bicolour combination GREEN-AND-YELLOW.	☑			GREEN-AND-YELLOW
	13.2.3	**Identification of the neutral conductor** Where a circuit includes a neutral conductor that is identified by colour alone, the colour used for this conductor shall be BLUE. In order to avoid confusion with other colours, it is recommended that an unsaturated blue be used, called here “light blue” (see 3.2.2 of IEC 60446). Where the selected colour is the sole identification of the neutral conductor, that colour shall not be used for identifying any other conductor where confusion is possible. Where identification by colour is used, bare conductors used as neutral conductors			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		shall be either coloured by a stripe, 15 mm to 100 mm wide in each compartment or unit and at each accessible location, or coloured throughout their length.				
	13.2.4	**Identification by colour** Where colour-coding is used for identification of conductors (other than the protective conductor (see 13.2.2) and the neutral conductor (see 13.2.3)), the following colours may be used: BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE. NOTE This list of colours is derived from IEC 60757. It is recommended that, where colour is used for identification, the colour be used throughout the length of the conductor either by the colour of the insulation or by colour markers at regular intervals and at the ends or accessible location. For safety reasons, the colour GREEN or the colour YELLOW should not be used where there is a possibility of confusion with the bicolour combination GREEN-AND-YELLOW (see 13.2.2). Colour identification using combinations of those colours listed above may be used provided there can be no confusion and that GREEN or YELLOW is not used except in the bicolour combination GREEN-AND-YELLOW. Where colour-coding is used for identification of conductors, it is recommended that they be colour-coded as follows: – BLACK: a.c. and d.c. power circuits; – RED: a.c. control circuits; – BLUE: d.c. control circuits; – ORANGE: excepted circuits in accordance with 5.3.5. **Exceptions:** to the above are permitted where: – insulation is used that is not available in the colours recommended; or – multiconductor cable is used, but not the bicolour combination GREEN-AND-YELLOW.	☑			The recommended color-coded is used.
	13.3	**Wiring inside enclosures** Conductors inside enclosures shall be supported where necessary to keep them in place. Non-metallic ducts shall be permitted only when they are made with a flame-retardant insulating material (see the IEC 60332 series). It is recommended that electrical equipment mounted inside enclosures be designed and constructed in such a way as to permit modification of the wiring from the front of the enclosure (see also 11.2.1). Where that is not practicable and control devices	☑			Wiring inside enclosures meets these requirments.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		are connected from the rear of the enclosure, access doors or swingout panels shall be provided. Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors in accordance with 12.2 and 12.6 to allow for the frequent movement of the part. The conductors shall be anchored to the fixed part and to the movable part independently of the electrical connection (see also 8.2.3 and 11.2.1). Conductors and cables that do not run in ducts shall be adequately supported. Terminal blocks or plug/socket combinations shall be used for control wiring that extends beyond the enclosure. For plug/socket combinations, see also 13.4.5 and 13.4.6. Power cables and cables of measuring circuits may be directly connected to the terminals of the devices for which the connections were intended.				
	13.4 **13.4.1**	**Wiring outside enclosures** **General requirements** The means of introduction of cables or ducts with their individual glands, bushings, etc., into an enclosure shall ensure that the degree of protection is not reduced (see 11.3).	☑			
	13.4.2	**External ducts** Conductors and their connections external to the electrical equipment enclosure(s) shall be enclosed in suitable ducts (i.e. conduit or cable trunking systems) as described in 13.5 except for suitably protected cables that may be installed without ducts and with or without the use of open cable trays or cable support means. Where devices such as position switches or proximity switches are supplied with a dedicated cable, their cable need not be enclosed in a duct when the cable is suitable for the purpose, sufficiently short, and so located or protected, that the risk of damage is minimized. Fittings used with ducts or multiconductor cable shall be suitable for the physical environment. Flexible conduit or flexible multiconductor cable shall be used where it is necessary to employ flexible connections to pendant push-button stations. The weight of the pendant stations shall be supported by means other than the flexible conduit or the flexible multiconductor cable, except where the conduit or cable is specifically designed for that purpose.	☑			
	13.4.3	**Connection to moving elements of the machine** Connections to frequently moving parts shall be made using conductors in accordance with 12.2 and 12.6. Flexible cable and flexible conduit shall be so			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		installed as to avoid excessive flexing and straining, particularly at the fittings. Cables subject to movement shall be supported in such a way that there is no mechanical strain on the connection points nor any sharp flexing. When this is achieved by the provision of a loop, it shall have sufficient length to provide for a bending radius of the cable of at least 10 times the diameter of the cable. Flexible cables of machines shall be so installed or protected as to minimize the possibility of external damage due to factors that include the following cable use or potential abuse: – being run over by the machine itself; – being run over by vehicles or other machines; – coming into contact with the machine structure during movements; – running in and out of cable baskets, or on or off cable drums; – acceleration forces and wind forces on festoon systems or suspended cables; – excessive rubbing by cable collector; – exposure to excessive radiated heat. The cable sheath shall be resistant to the normal wear that can be expected from movement and to the effects of environmental contaminants (for example oil, water, coolants, dust). Where cables subject to movement are close to moving parts, precautions shall be taken to maintain a space of at least 25 mm between the moving parts and the cables. Where that distance is not practicable, fixed barriers shall be provided between the cables and the moving parts. The cable handling system shall be so designed that lateral cable angles do not exceed 5 , avoiding torsion in the cable when: – being wound on and off cable drums; and – approaching and leaving cable guidance devices. Measures shall be taken to ensure that at least two turns of flexible cables always remain on a drum. Devices serving to guide and carry a flexible cable shall be so designed that the inner bending radius at all points where the cable is bent is not less than the values given in Table 8, unless otherwise agreed with the cable manufacturer, taking into account the permissible tension and the expected fatigue life. The straight section between two bends shall be at least 20 times the diameter of the cable. Where flexible conduit is adjacent to moving parts, the construction and supporting				

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		means shall prevent damage to the flexible conduit under all conditions of operation. Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically designed for that purpose.				
	13.4.4	**Interconnection of devices on the machine** Where several machine-mounted switching devices (for example position sensors, pushbuttons) are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points. Such terminals shall be conveniently placed, adequately protected, and shown on the relevant diagram s.	☑			
	13.4.5	**Plug/socket combinations** Where plug/socket combinations are provided, they shall fulfil one or more of the following requirements as applicable: **Exception:** The following requirements do not apply to components or devices inside an enclosure, terminated by fixed plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination. a) When installed correctly in accordance with f), plug/socket combinations shall be of such a type as to prevent unintentional contact with live parts at any time, including during insertion or removal of the connectors. The degree of protection shall be at least IPXXB. PELV circuits are excepted from this requirement. b) Have a first make last break protective bonding contact (earthing contact) (see also 6.3, 8.2.4) if used in TN- or TT-systems. c) Plug/socket combinations intended to be connected or disconnected during load conditions shall have sufficient load-breaking capacity. Where the plug/socket combination is rated at 30 A, or greater, it shall be interlocked with a switching device so that the connection and disconnection is possible only when the switching device is in the OFF position. d) Plug/socket combinations that are rated at more than 16 A shall have a retaining means to prevent unintended or accidental disconnection. e) Where an unintended or accidental disconnection of plug/socket combinations can cause a hazardous situation, they shall have a retaining means. The installation of plug/socket combinations shall fulfil the following requirements as applicable: f) The component which remains live after disconnection shall have a degree of protection of at least IP2X or IPXXB, taking into account the required clearance and			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		creepage distances. PELV circuits are excepted from this requirement. g) Metallic housings of plug/socket combinations shall be connected to the protective bonding circuit. PELV circuits are excepted from this requirement. h) Plug/socket combinations intended to carry power loads but not to be disconnected during load conditions shall have a retaining means to prevent unintended or accidental disconnection and shall be clearly marked that they are not intended to be disconnected under load. i) Where more than one plug/socket combination is provided in the same electrical equipment, the associated combinations shall be clearly identifiable. It is recommended that mechanical coding be used to prevent incorrect insertion. j) Plug/socket combinations used in control circuits shall fulfil the applicable requirements of IEC 61984. **Exception:** see item k). k) Plug/socket combinations intended for household and similar general purposes shall not be 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	**Dismantling for shipment** Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points. Such terminals shall be suitably enclosed and plug/socket combinations shall be protected from the physical environment during transportation and storage.	☑			
	13.4.7	**Additional conductors** Consideration should be given to providing additional conductors for maintenance or repair. When spare conductors are provided, they shall be connected to spare terminals or isolated in such a manner as to prevent contact with live parts.	☑			
	13.5 **13.5.1**	**Ducts, connection boxes and other boxes** **General requirements** Ducts shall provide a degree of protection suitable for the application (see IEC 60529). All sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come in contact shall be removed from ducts and fittings. Where necessary, additional protection consisting of a flame-retardant, oil-resistant	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		insulating material shall be provided to protect conductor insulation. Drain holes of 6 mm diameter are permitted in cable trunking systems, connection boxes, and other boxes used for wiring purposes that can be subject to accumulations of oil or moisture. In order to prevent confusion of conduits with oil, air, or water piping, it is recommended that the conduits be either physically separated or suitably identified. Ducts and cable trays shall be rigidly supported and positioned at a sufficient distance from moving parts and in such a manner so as to minimize the possibility of damage or wear. In areas where human passage is required, the ducts and cable trays shall be mounted at least 2 m above the working surface. Ducts shall be provided only for mechanical protection (see 8.2.3 for requirements for connection to the protective bonding circuit). Cable trays that are partially covered should not be considered to be ducts or cable trunking systems (see 13.5.6), and the cables used shall be of a type suitable for installation with or without the use of open cable trays or cable support means.				
	13.5.2	**Percentage fill of ducts** Consideration of the percentage fill of ducts should be based on the straightness and length of the duct and the flexibility of the conductors. It is recommended that the dimensions and arrangement of the ducts be such as to facilitate the insertion of the conductors and cables.	☑			
	13.5.3	**Rigid metal conduit and fittings** Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material suitable for the conditions. The use of dissimilar metals in contact that can cause galvanic action should be avoided. Conduits shall be securely held in place and supported at each end. Fittings shall be compatible with the conduit and appropriate for the application. Fittings shall be threaded unless structural difficulties prevent assembly. Where threadless fittings are used, the conduit shall be securely fastened to the equipment. Conduit bends shall be made in such a manner that the conduit shall not be damaged and the internal diameter of the conduit shall not be effectively reduced.			☑	
	13.5.4	**Flexible metal conduit and fittings** A flexible metal conduit shall consist of a flexible metal tubing or woven wire armour. It shall be suitable for the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.			☑	

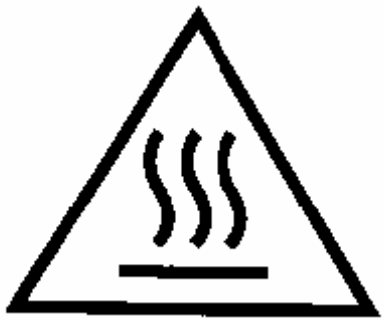
Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	13.5.5	**Flexible non-metallic conduit and fittings** Flexible non-metallic conduit shall be resistant to kinking and shall have physical characteristics similar to those of the sheath of multiconductor cables. The conduit shall be suitable for use in the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.	☑			
	13.5.6	**Cable trunking systems** Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving or contaminating portions of the machine. Covers shall be shaped to overlap the sides; gaskets shall be permitted. Covers shall be attached to cable trunking systems by suitable means. On horizontal cable trunking systems, the cover shall not be on the bottom unless specifically designed for such installation. NOTE Requirements for cable trunking and ducting systems for electrical installations are given in the IEC 61084 series. Where the cable trunking system is furnished in sections, the joints between sections shall fit tightly but need not be gasketed. The only openings permitted shall be those required for wiring or for drainage. Cable trunking systems shall not have opened but unused knockouts.			☑	
	13.5.7	**Machine compartments and cable trunking systems** The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided the compartments or cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed. Conductors run in enclosed compartments and cable trunking systems shall be so secured and arranged that they are not subject to damage.	☑			
	13.5.8	**Connection boxes and other boxes** Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance. Those boxes shall provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate (see 11.3). Those boxes shall not have opened but unused knockouts nor any other openings and shall be so constructed as to exclude materials such as dust, flyings, oil, and coolant.	☑			
	13.5.9	**Motor connection boxes** Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (for example brakes, temperature sensors, plugging switches, tachometer generators).	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
14		**Electric motors and associated equipment**				
	14.1	**General requirements** Electric motors should conform to the relevant parts of IEC 60034 series. The protection requirements for motors and associated equipment are given in 7.2 for overcurrent protection, in 7.3 for overload protection, and in 7.6 for overspeed protection. As many controllers do not switch off the supply to a motor when it is at rest, care shall be taken to ensure compliance with the requirements of 5.3, 5.4, 5.5, 7.5, 7.6 and 9.4. Motor control equipment shall be located and mounted in accordance with Clause 11.	☑			
	14.2	**Motor enclosures** It is recommended that motor enclosures be chosen from those included in IEC 60034-5. The degree of protection shall be at least IP23 (see IEC 60529) for all motors. More stringent requirements can be needed depending on the application and the physical environment (see 4.4). Motors incorporated as an integral part of the machine shall be so mounted that they are adequately protected from mechanical damage.	☑			
	14.3	**Motor dimensions** As far as is practicable, the dimensions of motors shall conform to those given in the IEC 60072 series.	☑			
	14.4	**Motor mounting and compartments** Each motor and its associated couplings, belts, pulleys, or chains, shall be so mounted that they are adequately protected and are easily accessible for inspection, maintenance, adjustment and alignment, lubrication, and replacement. The motor mounting arrangement shall be such that all motor hold-down means can be removed and all terminal boxes are accessible. Motors shall be so mounted that proper cooling is ensured and the temperature rise remains within the limits of the insulation class (see IEC 60034-1). Where practicable, motor compartments should be clean and dry, and when required, shall be ventilated directly to the exterior of the machine. The vents shall be such that ingress of swarf, dust, or water spray is at an acceptable level. There shall be no opening between the motor compartment and any other compartment that does not meet the motor compartment requirements. Where a conduit or pipe is run into the motor compartment from another compartment not	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		meeting the motor compartment requirements, any clearance around the conduit or pipe shall be sealed.				
	14.5	**Criteria for motor selection** The characteristics of motors and associated equipment shall be selected in accordance with the anticipated service and physical environmental conditions (see 4.4). In this respect, the points that shall be considered include: – type of motor; – type of duty cycle (see IEC 60034-1); – fixed speed or variable speed operation, (and the consequent variable influence of the ventilation); – mechanical vibration; – type of motor control; – influence of the harmonic spectrum of the voltage and/or current feeding the motor (particularly when it is supplied from a static convertor) on the temperature rise; – method of starting and the possible influence of the inrush current on the operation of other users of the same power supply, taking also into account possible special considerations stipulated by the supply authority; – variation of counter-torque load with time and speed; – influence of loads with large inertia; – influence of constant torque or constant power operation; – possible need of inductive reactors between motor and converter.	☑			
	14.6	**Protective devices for mechanical brakes** Operation of the overload and overcurrent protective devices for mechanical brake actuators shall initiate the simultaneous de-energization (release) of the associated machine actuators. NOTE Associated machine actuators are those associated with the same motion, for example cable drums and long-travel drives.	☑			
15		**Accessories and lighting**				
	15.1	**Accessories** Where the machine or its associated equipment is provided with socket-outlets that are intended to be used for accessory equipment (for example hand-held power tools, test equipment), the following apply: – the socket-outlets should conform to IEC 60309-1. Where that is not practicable,			☑	

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		they should be clearly marked with the voltage and current ratings; – the continuity of the protective bonding circuit to the socket-outlet shall be ensured except where protection is provided by PELV; – all unearthed conductors connected to the socket-outlet shall be protected against overcurrent and, when required, against overload in accordance with 7.2 and 7.3 separately from the protection of other circuits; – where the power supply to the socket-outlet is not disconnected by the supply disconnecting device for the machine or the section of the machine, the requirements of 5.3.5 apply. NOTE 1 See also Annex B. NOTE 2 Circuits for socket-outlets can be provided with residual current protective devices (RCDs).				
	15.2 **15.2.1**	**Local lighting of the machine and equipment** **General** Connections to the protective bonding circuit shall be in accordance with 8.2.2. The ON/OFF switch shall not be incorporated in the lampholder or in the flexible connecting cords. Stroboscopic effects from lights shall be avoided by the selection of appropriate luminaires. Where fixed lighting is provided in an enclosure, electromagnetic compatibility should be taken into account using the principles outlined in 4.4.2.	☑			
	15.2.2	**Supply** The nominal voltage of the local lighting circuit shall not exceed 250 V between conductors. A voltage not exceeding 50 V between conductors is recommended. Lighting circuits shall be supplied from one of the following sources (see also 7.2.6): – a dedicated isolating transformer connected to the load side of the supply disconnecting device. Overcurrent protection shall be provided in the secondary circuit; – a dedicated isolating transformer connected to the line side of the supply disconnecting device. That source shall be permitted for maintenance lighting circuits in control enclosures only. Overcurrent protection shall be provided in the secondary circuit (see also 5.3.5 and 13.1.3); – a machine circuit with dedicated overcurrent protection; – an isolating transformer connected to the line side of the supply disconnecting device, provided with a dedicated primary disconnecting means (see 5.3.5) and secondary	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		overcurrent protection, and mounted within the control enclosure adjacent to the supply disconnecting device (see also 13.1.3); – 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	**Protection** Local lighting circuits shall be protected in accordance with 7.2.6.	☑			
	15.2.4	**Fittings** Adjustable lighting fittings shall be suitable for the physical environment. The lampholders shall be: – in accordance with the relevant IEC standard; – constructed with an insulating material protecting the lamp cap so as to prevent unintentional contact. Reflectors shall be supported by a bracket and not by the lampholder. **Exception:** where fixed lighting is out of reach of operators during normal operation, the provisions of this Subclause do not apply.			☑	
16		**Marking, warning signs and reference designations**				
	16.1	**General** Warning signs, nameplates, markings, and identification plates shall be of sufficient durability to withstand the physical environment involved.	☑			
	16.2 **16.2.1**	**Warning signs** **Electric shock hazard** Enclosures that do not otherwise clearly show that they contain electrical equipment that can give rise to a risk of electric shock shall be marked with the graphical symbol IEC 60417-5036 (DB:2002-10).  The warning sign shall be plainly visible on the enclosure door or cover.	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		The warning sign may be omitted (see also 6.2.2 b)) for: – an enclosure equipped with a supply disconnecting device; – an operator-machine interface or control station; – a single device with its own enclosure (for example position sensor).				
	16.2.2	**Hot surfaces hazard** Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures of the electrical equipment, the graphical symbol IEC 60417-5041 (DB:2002-10) shall be used. 	☑			
	16.3	**Functional identification** Control devices, visual indicators, and displays (particularly those related to safety) shall be clearly and durably marked with regard to their functions either on or adjacent to the item. Such markings may be as agreed between the user and the supplier of the equipment (see Annex B). Preference should be given to the use of standard symbols given in IEC 60417- DB:2002 and ISO 7000.	☑			
	16.4	**Marking of equipment** Equipment (for example controlgear assemblies) shall be legibly and durably marked in a way that is plainly visible after the equipment is installed. A nameplate giving the following information shall be attached to the enclosure adjacent to each incoming supply: – name or trade mark of supplier; – certification mark, when required; – serial number, where applicable; – rated voltage, number of phases and frequency (if a.c.), and full-load current for each supply;	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		– short-circuit rating of the equipment; – main document number (see IEC 62023). The full-load current shown on the nameplate shall be not less than the running currents for all motors and other equipment that can be in operation at the same time under normal conditions. Where only a single motor controller is used, that information may instead be provided on the machine nameplate where it is plainly visible.				
	16.5	**Reference designations** All enclosures, assemblies, control devices, and components shall be plainly identified with the same reference designation as shown in the technical documentation.	☑			
17		**Technical documentation**				
	17.1	**General** The information necessary for installation, operation, and maintenance of the electrical equipment of a machine shall be supplied in the appropriate forms, for example, drawings, diagrams, charts, tables, instructions. The information shall be in an agreed language (see also Annex B). The information provided may vary with the complexity of the electrical equipment. For very simple equipment, the relevant information may be contained in one document, provided that the document shows all the devices of the electrical equipment and enables the connections to the supply network to be made. NOTE 1 The technical documentation provided with items of electrical equipment can form part of the documentation of the electrical equipment of the machine. NOTE 2 In some countries, the requirement to use specific language(s) is covered by legal requirements.	☑			The information necessary is supplied in the appropriate forms in english.
	17.2	**Information to be provided** The information provided with the electrical equipment shall 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,atmospheric contaminants) where appropriate; 4) overview (block) diagram(s) where appropriate;	☑			Circuit diagram; user's manual and so on.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		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; and 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 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	**Requirements applicable to all documentation** Unless otherwise agreed between manufacturer and user: – the documentation shall be in accordance with relevant parts of IEC 61082; – reference designations shall be in accordance with relevant parts of IEC 61346; – instructions/manuals shall be in accordance with IEC 62079. – parts lists where provided shall be in accordance with IEC 62027, class B. NOTE See item 13 of Annex B. For referencing of the different documents, the supplier shall select one of the following methods: – where the documentation consists of a small number of documents (for example less than 5) each of the documents shall carry as a cross-reference the document numbers of all other documents belonging to the electrical equipment; or	☑			Documentation meets these requirements.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		– for single level main documents only (see IEC 62023), all documents shall be listed with document numbers and titles in a drawing or document list; or – all documents of a certain level (see IEC 62023) of the document structure shall be listed, with document numbers and titles, in a parts list belonging to the same level.				
	17.4	**Installation documents** The installation documents shall give all information necessary for the preliminary work of setting up the machine (including commissioning). In complex cases, it may be necessary to refer to the assembly drawings for details. The recommended position, type, and cross-sectional areas of the supply cables to be installed on site shall be clearly indicated. The data necessary for choosing the type, characteristics, rated currents, and setting of the overcurrent protective device(s) for the supply conductors to the electrical equipment of the machine shall be stated (see 7.2.2). Where necessary, the size, purpose, and location of any ducts in the foundation that are to be provided by the user shall be 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 shall be detailed (see Annex B). Where necessary, the diagram shall indicate where space is required for the removal or servicing of the electrical equipment. NOTE 1 Examples of installation diagrams can be found in IEC 61082-4. In addition, where it is appropriate, an interconnection diagram or table shall be provided. That diagram or table shall give full information about all external connections. Where the electrical equipment is intended to be operated from more than one source of electrical supply, the interconnection diagram or table shall indicate the modifications or interconnections required for the use of each supply. NOTE 2 Examples of interconnection diagrams/tables can be found in IEC 61082-3	☑			
	17.5	**Overview diagrams and function diagrams** Where it is necessary to facilitate the understanding of the principles of operation, an overview diagram shall be provided. An overview diagram symbolically represents the electrical equipment together with its functional interrelationships without necessarily showing all of the interconnections. NOTE 1 Examples of overview diagrams can be found in IEC 61082 series. Function diagrams may be provided as either part of, or in addition to, the overview diagram.	☑			

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		NOTE 2 Examples of function diagrams can be found in IEC 61082-2.				
	17.6	**Circuit diagrams** A circuit diagram(s) shall be provided. This diagram(s) shall show the electrical circuits on the machine and its associated electrical equipment. Any graphical symbol not shown in IEC 60617-DB:2001 shall be separately shown and described on the diagrams or supporting documents. The symbols and identification of components and devices shall be consistent throughout all documents and on the machine. Where appropriate, a diagram showing the terminals for interface connections shall be provided. That diagram may be used in conjunction with the circuit diagram(s) for simplification. The diagram should contain a reference to the detailed circuit diagram of each unit shown. Switch symbols shall be shown on the electromechanical diagrams with all supplies turned off (for example electricity, air, water, lubricant) and with the machine and its electrical equipment ready for a normal start. Conductors shall be identified in accordance with 13.2. Circuits shall be shown in such a way as to facilitate the understanding of their function as well as maintenance and fault location. Characteristics relating to the function of the control devices and components which are not evident from their symbolic representation shall be included on the diagrams adjacent to the symbol or referenced to a footnote.	☑			
	17.7	**Operating manual** The technical documentation shall contain an operating manual detailing proper procedures for set-up and use of the electrical equipment. Particular attention should be given to the safety measures provided. 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) shall be provided.	☑			Operating manual meets this requirement.
	17.8	**Maintenance manual** The technical documentation shall contain a maintenance manual detailing proper procedures for adjustment, servicing and preventive inspection, and repair. Recommendations on maintenance/service intervals and records should be part of that manual. Where methods for the verification of proper operation are provided (for example software testing programs), the	☑			Maintenance manual is provided.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		use of those methods shall be detailed.				
	17.9	**Parts list** The parts list, where provided, shall comprise, 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.	☑			The parts lists conform to this requirement.
18		**Verification**				
	18.1	**General** This part of IEC 60204 gives general requirements for the electrical equipment of machines. 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). When these tests are performed, it is recommended that they follow the sequence listed above. When the electrical equipment is modified, the requirements stated in 18.7 shall apply. For tests in accordance with 18.2 and 18.3, measuring equipment in accordance with the EN 61557 series is applicable. NOTE For other tests as required by this standard measuring equipment in accordance with relevant IEC or European Standards should be used. The results of the verification shall be documented.	☑			Verification is done.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
	18.2 **18.2.1**	**Verification of conditions for protection by automatic disconnection of supply** **General** The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests. For TN-systems, those test methods are described in 18.2.2; their application for different conditions of supply are specified in 18.2.3. For TT and IT systems, see IEC 60364-6-61.	☑			TN-system
	18.2.2	**Test methods in TN-systems** Test 1 verifies the continuity of the protective bonding circuit. Test 2 verifies the conditions for protection by automatic disconnection of the supply. **Test 1 – Verification of the continuity of the protective bonding circuit** The resistance of each protective bonding circuit between the PE terminal (see 5.2 and Figure 2) and relevant points that are part of each protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 413.1 of IEC 60364-4-41) having a maximum no-load voltage of 24 V a.c. or d.c.. It is recommended not to use a PELV supply since such supplies can produce misleading results in this test. The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective bonding conductor(s). NOTE 1 Larger currents used for the continuity test increases the accuracy of the test result, especially with low resistance values, i.e. larger cross sectional areas and/or lower conductor length. **Test 2 – Fault loop impedance verification and suitability of the associated overcurrent protective device** The connections of the power supply and of the incoming external protective conductor to the PE terminal of the machine, shall be verified by inspection. The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A shall be verified by both: 1) verification of the fault loop impedance by: – calculation, or – measurement in accordance with A.4, and 2) confirmation that the setting and characteristics of the associated overcurrent protectivedevice are in accordance with the requirements of Annex A. NOTE 2 A fault loop impedance measurement can be carried out for circuits where the conditions of protection by automatic disconnection requires a current *I*a up to	☑			Test 1 is done.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		about 1 kA (*I*a is the current causing the automatic operation of the disconnecting device within the time specified in Annex A).				
	18.2.3	**Application of the test methods for TN-systems** Test 1 of 18.2.2 shall be carried out on each protective bonding circuit of a machine. When Test 2 of 18.2.2 is carried out by measurement, it shall always be preceded by Test 1. NOTE A discontinuity of the protective bonding circuit can cause a hazardous situation for the tester or other persons, or damage to the electrical equipment during the loop impedance test. The tests that are necessary for machines of different status are specified in Table 9. Table 10 can be used to enable determination of the machine status.	☑			Testing method is carried out according to the Procedure A in Table 9.
	18.3	**Insulation resistance tests** When insulation resistance tests are performed, the insulation resistance measured at 500 V d.c. between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation. **Exception:** for certain parts of electrical equipment, incorporating for example busbars, conductor wire or conductor bar systems or slip-ring assemblies, a lower minimum value is permitted, but that value shall not be less than 50 kΩ. If the electrical equipment of the machine contains surge protection devices which are likely to operate during the test, it is permitted to either: – disconnect these devices, or – reduce the test voltage to a value lower than the voltage protection level of the surge protection devices, but not lower than the peak value of the upper limit of the supply (phase to neutral) voltage.	☑			Insulation resistance tests are performed.
	18.4	**Voltage tests** When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used. The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz. The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for a period of approximately 1 s. The requirements are satisfied if no disruptive discharge occurs. Components and devices that are not rated to withstand the test voltage shall be	☑			Voltage tests are performed.

Article	Sub-article	Requirement	Fullfilment			Remark
			Y	N	N/A	
		disconnected during testing. Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.				
	18.5	**Protection against residual voltages** Where appropriate, tests shall be performed to ensure compliance with 6.2.4			☑	
	18.6	**Functional tests** The functions of electrical equipment shall be tested. The function of circuits for electrical safety (for example earth fault detection) shall be tested.	☑			
	18.7	**Retesting** Where a portion of the machine and its associated equipment is changed or modified, that portion shall be reverified and retested, as appropriate (see 18.1). Particular attention should be given to the possible adverse effects that retesting can have on the equipment (for example overstressing of insulation, disconnection/reconnection of devices).			☑	

3.2 Earthing continuity test report

Manufacturer：Zhejiang Shengtian Machinery Co., Ltd

EUT：Strap Type Cutter

Test model：DCQ-1200-1

Ratings：380V；50/60Hz

Test Equipment：Aino Electronics

Model：AN9640

Test conditions：10A

Date：2016-12-15

Test Point	Test Result-Voltage Drop (V)
Electrical cabinet	0.25
Motor 1	0.2
Motor 2	0.2

3.3 Insulation resistance test report

Manufacturer：Zhejiang Shengtian Machinery Co., Ltd

EUT：Strap Type Cutter

Test model：DCQ-1200-1

Ratings：380V；50/60Hz

Test Equipment：Aino Electronics

Model：AN9640

Test conditions：500VDC

Date：2016-12-15

Test Point	Test Result (MΩ)
M1	≥ 500
M2	≥ 500

3.4 Airborne noise test report

Applicable standards

1. EN ISO 3746：Acoustics-Determination of sound power levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane.
2. EN ISO 11202：Acoustics - Noise emitted by machinery and equipment - Measurement of emission sound pressure levels at the work station and at other specified positions - Survey method in situ.
3. ISO/TR 11688-1：Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 1 ：Planning.

I. Test instrument

The sound level meter used in the noise measurement is TES1350A manufactured by TES Electrical Electronic Corp. with the following features：

- Portable with light weight ＆ easy operation.
- Measurement range from 35 to 130 dB（A）.
- Type 1 precision.
- With “F” ＆ ”S” detect mode in accordance with IEC 651 type 1.
- Built in A-weighting network.
- Equipped with a high prepolarized condenser microphone.
- With automatic ＆ manual display.
- DC output for level recorder.

II. Measurement method

The measurements of this test have been carried out by a hand-held sound level meter, and readings are taken by A-frequency weighting at each measuring position.
For operator positions in process of measurement, the measuring instrument is to be set at a distance of 1 m from the machine and 1.5 m above the floor.

III. Test environment

The test was carried out in the location of machine inside the factory, and the background noise has been ensured that its measuring value is lower than that of machine.

IV. Test result

Background

Reading value: 50dB(A)

Test position / Reading value	1
Reading value 1 (dB (A))	60.3
Reading value 2 (dB (A))	59.7
Reading value 3 (dB (A))	59.5

Annex：Technical Information

A.1 Company profile
A.2 Product information
A.3 Specification
A.4 DoC
A.5 Overall drawing
A.6 Electrical circuit diagram and parts list
A.7 Instruction manual
A.8 Warning label and nameplate
A.9 CE Certificates of key components