Technical Construction File

Related to CE Directive: 2006/42/EC (Machinery)
TCF Number: VM(23)042301MR
Date: Apr. 23, 2023

Applicant: Anhui Vmax Heavy Industry Co., Ltd.

Address: No.18 South Shengli Road, Centralized Demonstration Area, Lu'an City Of Anhui Province, China.

Product: Electric Pallet Stacker

Brand name/Trade mark: VMAX

Models: CDD05,CDD06, CDD07, CDD08, CDD09, CDD10, CDD12, CDD15, CDD16, CDD18, CDD20, CDD25, CDD30, CDD35, CDD40, CDD45, CDD50, CDD55, CDD60, CDD65, CDD70, CDD75, CDD80, CDD85, CDD90, CDD95, CDD100, CDD110, CDD120, CDD130, CDD140, CDDB05, CDDB06, CDDB07, CDDB08, CDDB09, CDDB10, CDDB11, CDDB12, CDDB13, CDDB14, CDDB15, CDDB16, CDDB17, CDDB18, CDDB19, CDDB20, CDDB25, CDDB30, CDDB35, CDDB40, CDDB50, CDDP05, CDDP06, CDDP07, CDDP08, CDDP09, CDDP10, CDDP11, CDDP12, CDDP13, CDDP14, CDDP15, CDDP16, CDDP17, CDDP18, CDDP19, CDDP20, CDDP25, CDDP30, CDDP35, CDDP40, CDDP45, CDDP50, CDDP60

According to: EN ISO 12100:2010, EN 60204-1:2018, EN 1175:2020, EN ISO 3691-1:2015+AC:2016+A1:2020, EN 16307-1:2020

REPORT FOR COMPLIANCE WITH

EN ISO 12100:2010, EN 60204-1:2018, EN 1175:2020,
EN ISO 3691-1:2015+AC:2016+A1:2020, EN 16307-1:2020

Manufacturer	Anhui Vmax Heavy Industry Co., Ltd.	
Address	No.18 South Shengli Road, Centralized Demonstration Area, Lu'an City Of Anhui Province, China.	
Trade mark :	VMAX	
Product Name	Electric Pallet Stacker	
Main Model	CDD20	
Series Model(s)	CDD05,CDD06, CDD07, CDD08, CDD09, CDD10, CDD12, CDD15, CDD16, CDD18, CDD20, CDD25, CDD30, CDD35, CDD40, CDD45, CDD50, CDD55, CDD60, CDD65, CDD70, CDD75, CDD80, CDD85, CDD90, CDD95, CDD100, CDD110, CDD120, CDD130, CDD140, CDDB05, CDDB06, CDDB07, CDDB08, CDDB09, CDDB10, CDDB11, CDDB12, CDDB13, CDDB14, CDDB15, CDDB16, CDDB17, CDDB18, CDDB19, CDDB20, CDDB25, CDDB30, CDDB35, CDDB40, CDDB50, CDDP05, CDDP06, CDDP07, CDDP08, CDDP09, CDDP10, CDDP11, CDDP12, CDDP13, CDDP14, CDDP15, CDDP16, CDDP17, CDDP18, CDDP19, CDDP20, CDDP25, CDDP30, CDDP35, CDDP40, CDDP45, CDDP50, CDDP60	
File No.	VM(23)042301MR	
Directive	2006/42/EC Machinery Directive	
Standards Compliance	EN ISO 12100:2010, EN 60204-1:2018, EN 1175:2020, EN ISO 3691-1:2015+AC:2016+A1:2020, EN 16307-1:2020	
Date of issue	Apr.23, 2023	
Date of Testing	Apr.18, 2023- Apr.23, 2023	
Testing Laboratory	Shenzhen ZCT Technology Co., Ltd. 3F, 5th Building, Hongsheng Industrial Zone, No.4336 Bao'an Road, Bao'an District, Shenzhen, China.	
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SHENZHEN ZCT TECHNOLOGY CO.,LTD. APPROVED

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Industrial trucks – Safety requirement and verification Part 1: Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks
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Part I : General

1.1 General description

In order to ensure the conformity for CE marking for these machines, some main European and/or International standards have been used to made assessment of conformity, they are

-EN ISO 12100:2010

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

-EN 60204-1:2018Safety of machinery - Electrical equipment of machines - Part 1: General requirements

- EN 1175:2020 Safety of industrial trucks - Electrical/electronic requirements.
- EN ISO 3691-1:2015+AC:2016+A1:2020

Industrial trucks – Safety requirement and verification Part 1: Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks

-EN 16307-1:2020

Industrial trucks - Safety requirements and verification - Part 1: Supplementary requirements for self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks

These applicable standards in detail have been included in the relevant sub-clauses of this technical construction file.

1.2 Variations of the series products

Regarding the whole family of the series, they can be divided into different models according to their main features. They are CDD05,CDD06, CDD07, CDD08, CDD09, CDD10, CDD12, CDD15, CDD16, CDD18, CDD20, CDD25, CDD30, CDD35, CDD40, CDD45, CDD50, CDD55, CDD60, CDD65, CDD70, CDD75, CDD80, CDD85, CDD90, CDD95, CDD100, CDD110, CDD120, CDD130, CDD140, CDDB05, CDDB06, CDDB07, CDDB08, CDDB09, CDDB10, CDDB11, CDDB12, CDDB13, CDDB14, CDDB15, CDDB16, CDDB17, CDDB18, CDDB19, CDDB20, CDDB25, CDDB30, CDDB35, CDDB40, CDDB50, CDDP05, CDDP06, CDDP07, CDDP08, CDDP09, CDDP10, CDDP11, CDDP12, CDDP13, CDDP14, CDDP15, CDDP16, CDDP17, CDDP18, CDDP19, CDDP20, CDDP25, CDDP30, CDDP35, CDDP40, CDDP45, CDDP50, CDDP60

To present the conformity of this series machine with Machinery Directive, we discuss the conformity systematically with the relative Directive and standards for CDD20 as a basic evaluation in clause.

1.3 Quality control system

In order to ensure the conformity of the series production, the Anhui Vmax Heavy Industry Co., Ltd. has taken the related procedures mentioned below：

（1） Anhui Vmax Heavy Industry Co., Ltd. has applied for the certification in UDEM.

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

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

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

Before packing the products, the QC engineers of Anhui Vmax Heavy Industry Co., Ltd. have to do the necessary inspection and testing to ensure the conformity of related requirements, in particularly, 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 Anhui Vmax Heavy Industry Co., Ltd. if the change may effects the related electrical or mechanical characteristics.

（6） Provision for the Quality Assurance

For the provisions of internal control measures to ensure the conformity of series production of the machines, Anhui Vmax Heavy Industry Co., Ltd. has built an internal quality control system in accordance with the international standards.

1.4 Declaration of conformity

EC DECLARATION OF CONFORMITY

CE

According to the following EC Directives

2006/42/EC Machinery Directive
2014/30/EU Electromagnetic Compatibility Directive

Manufacturer: Anhui Vmax Heavy Industry Co., Ltd.
No.18 South Shengli Road, Centralized Demonstration Area,
Lu'an City Of Anhui Province, China.

Manufacturer declares that the machine described hereafter:

Product name: Electric Pallet Stacker

Models: CDD05,CDD06, CDD07, CDD08, CDD09, CDD10, CDD12, CDD15, CDD16, CDD18, CDD20, CDD25, CDD30, CDD35, CDD40, CDD45, CDD50, CDD55, CDD60, CDD65, CDD70, CDD75, CDD80, CDD85, CDD90, CDD95, CDD100, CDD110, CDD120, CDD130, CDD140, CDDB05, CDDB06, CDDB07, CDDB08, CDDB09, CDDB10, CDDB11, CDDB12, CDDB13, CDDB14, CDDB15, CDDB16, CDDB17, CDDB18, CDDB19, CDDB20, CDDB25, CDDB30, CDDB35, CDDB40, CDDB50, CDDP05, CDDP06, CDDP07, CDDP08, CDDP09, CDDP10, CDDP11, CDDP12, CDDP13, CDDP14, CDDP15, CDDP16, CDDP17, CDDP18, CDDP19, CDDP20, CDDP25, CDDP30, CDDP35, CDDP40, CDDP45, CDDP50, CDDP60

Fulfills all the relevant provisions of the directives:

2006/42/EC Machinery Directive
2014/30/EU Electromagnetic Compatibility Directive

EN ISO 12100:2010,
EN 60204-1:2018,
EN 1175:2020,
EN ISO 3691-1:2015+AC:2016+A1:2020,
EN 16307-1:2020,
EN 12895:2015+A1:2019

Signature: _____ (Manager)

Date: 2023.4.26

Part II：Assessment of conformity

2.1 Essential health and safety requirements

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
1	Essential health and safety requirements		-
1.1	General remarks		-
1.1.1	Definitions		-
1.1.2	Principles of safety integration		-
a)	Machinery must be designed and constructed so that it is fitted for its function, and can be operated, adjusted and maintained without putting persons at risk when these operations are carried out under the conditions foreseen but also taking into account any reasonably foreseeable misuse thereof.		P
	The aim of measures taken must be to eliminate any risk throughout the foreseeable lifetime of the machinery including the phases of transport, assembly, dismantling, disabling and scrapping.		P
b)	In selecting the most appropriate methods, the manufacturer or his authorized representative must apply the following principles, in the order given:		-
	- eliminate or reduce risks as far as possible		P
	- take the necessary protection measure in relation to risks that can’t be eliminated		P
	- inform users of the residual risks due to any shortcomings of the protection measures adopted, indicate whether any particular training is required and specify any need to provide personal protection equipment		P
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		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		P
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.		P
e)	Machinery must be supplied with all the special equipment and accessories essential to enable it to be adjusted, maintained and used safely.		P.
1.1.3	Materials and products		-
	The materials used to construct machinery or products used or created during its use must not endanger persons' safety or health.		P
	In particular, where fluids are used, machinery must be designed and constructed to prevent risks due to filling, use, recovery or draining.		P
1.1.4	Lighting		-
	Machinery must be supplied with integral lighting suitable for the operations concerned where the absence thereof is likely to cause a risk despite ambient lighting of normal intensity.		P
	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.		P
	Internal parts requiring frequent inspection, and adjustment and maintenance areas, must be provided with appropriate		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	lighting		
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,		P
	- be packaged or designed so that it can be stored safely and without damage.		P
	Where the weight, size or shape of machinery or its various component parts prevents them from being moved by hand, the machinery or each components part must:		-
	- either be fitted with attachments for lifting gear		P
	- be designed so that it can be fitted with such attachments, or		P
	- be shaped in such a way that standard lifting gear can easily be attached		P
	Where machinery or one of its component parts is to be moved by hand, it must:		-
	- either be easily movable, or		P
	- be equipped for picking up and moving in complete safety		P
	Special arrangement must be made for the handling of tools and/or machinery parts, even if lightweight, which could be dangerous		P
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 principle ssuch as:		P
	– allowing for the variability of the operator’s physical dimensions, strength and stamina,		P
	– providing enough space for movements of the parts of the operator’s body,		P
	– avoiding a machine-determined work rate,		P
	– avoiding monitoring that requires lengthy concentration,		P
	– adapting the man/machinery interface to the foreseeable		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	characteristics of the operators.		
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.		P
	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.		P
	Where appropriate, the operating position must be fitted with an adequate cabin designed, constructed and/or equipped to fulfill the above requirements.		P
	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.		P
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.		N
	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		N
	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.		N
	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		N

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	no floor beneath the feet of the operator, footrests covered with a slip-resistant material must be provided.		
1.2	CONTROL SYSTEMS		-
1.2.1	Safety and reliability of control systems		-
	Control systems must be designed and constructed in such a way as to prevent hazardous situations from arising.		P
	Above all, they must be designed and constructed in such a way that:		-
	- they can withstand the intended operating stresses and external influences,		P
	-a fault in the hardware or the software of the control system does not lead to hazardous situations,		P
	- errors in logic don’t lead to dangerous situations		P
	-reasonably foreseeable human error during operation does not lead to hazardous situations.		P
	Particular attention must be given to the following points:		-
	– the machinery must not start unexpectedly		P
	– the parameters of the machinery must not change in an uncontrolled way, where such change may lead to hazardous situations,		P
	– the machinery must not be prevented from stopping if the stop command has already been given,		P
	– no moving part of the machinery or piece held by the machinery must fall or be ejected,		P
	– automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded,		P
	– the protective devices must remain fully effective or give a stop command,		P
	– the safety-related parts of the control system must apply in a coherent way to the whole of an assembly of machinery and/or partly completed machinery.		P
	For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	of communication.		
1.2.2	Control devices		-
	Control devices must be:		-
	- clearly visible and identifiable, using pictograms where appropriate,		P.
	- positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity,		P
	- designed in such a way that the movement of the control device is consistent with its effect,		P.
	- located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant,		P
	- positioned in such a way that their operation cannot cause additional risk,		P
	- designed or protected in such a way that the desired effect, where a hazard is involved, can only be achieved by a deliberate action,		P
	- made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be		P
	Where a control device is designed and constructed to perform several different actions, namely where there is no one-toone correspondence, the action to be performed must be clearly displayed and subject to confirmation, where necessary.		N
	their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.		P
	Machinery must be fitted with indicators as required for safe operation. The operator must be able to read them from the control position.		P
	The operator must be able to read them from the control position		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone.		P
	If neither of these possibilities is applicable, before the machinery starts,		P
	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.		P
	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.		P
	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.		P
1.2.3	Starting		-
	It must be possible to start machinery only by voluntary actuation of a control provided for the purpose		P
	The same requirement applies:		-
	- when restarting the machinery after stoppage, whatever the cause		P
	- when effecting a significant change in the operating conditions		P
	However, the restarting of the machinery or a change in operating conditions may be effected by voluntary actuation of a device other than the control device provided for the purpose, on condition that this does not lead to a hazardous situation.		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		P
	Where machinery has several starting controls and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks		P
	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		P
1.2.4	Stopping		-
1.2.4.1	Normal stopping		-
	Machinery must be fitted with a control device whereby the machinery can be brought safely to a complete stop.		P
	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.		P
	The machinery’s stop control must have priority over the start controls		P
	Once the machinery or its hazardous functions have stopped, the energy supply to the actuators concerned must be cut off.		P
1.2.4.2	Operational stop		-
	Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained.		P
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		P
	The following exceptions apply:		-
	machinery in which an emergency stop device would not lessen the risk, either because it would not reduce the		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	stopping time or because it would not enable the special measures required to deal with the risk to be taken,		
	– portable hand-held and/ handguided machinery.		-
	The device must:		-
	– have clearly identifiable, clearly visible and quickly accessible control devices,		P
	– stop the hazardous process as quickly as possible, without creating additional risks,		P
	- where necessary, trigger or permit the triggering of certain safeguard movements		P
	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		P
	It must be possible to disengage the device only by an appropriate operation, and disengaging the device must not restart the machinery but only permit restarting		P
	The emergency stop function must be available and operational at all times, regardless of the operating mode.		P
	Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.		P
1.2.4.4	Assembly of machinery		-
	In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.		N
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.		N
	If machinery has been designed and Constructed to allow its		N

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		N
	The selector may be replaced by another selection method which restricts the use of certain functions of the machinery or certain categories of operator		N
	If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled,		N
	the control or operating mode selector must simultaneously:		-
	- disable all other control or operating modes,		N
	- permit operation of hazardous functions only by control devices requiring sustained action,		N
	– permit the operation of hazardous functions only in reduced risk conditions		N
	while preventing hazards from linked sequences,		N
	– prevent any operation of hazardous functions by voluntary or involuntary action on the machine’s sensors.		N
	If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone.		N
	In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.		N
1.2.6	Failure of the power supply		-
	The interruption, re-establishment after an interruption or fluctuation in whatever manner of the power supply to the machinery must not lead to a dangerous situation		P
	Particular attention must be given to the following points:		-
	- the machinery must not start unexpectedly		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	– the parameters of the machinery must not change in an uncontrolled way when such change can lead to hazardous situations,		P
	- the machinery must not be prevented from stopping if the command has already been given		P
	- no moving part of the machinery or piece held by the machinery must fall or be ejected		P
	- automatic or manual stopping of the moving parts whatever they may be must be unimpeded		P
	– the protective devices must remain fully effective or give a stop command.		P
1.3	Protection against mechanical hazards		-
1.3.1	Risk of loss of stability		-
	Machinery and its components and fittings must be stable enough to avoid overturning, falling or uncontrolled movements during transportation, assembly, dismantling, and any other action involving the machinery.		P
	If the shape of the machinery itself or its intended installation doesn't offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions		P
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.		P
	The durability of the materials used must be adequate for the nature of the working environment foreseen by the manufacturer or his authorised representative, in particular as regards the phenomena of fatigue, ageing, corrosion and abrasion.		P
	The instructions must indicate the type and frequency of inspections and maintenance required for safety reasons.		P
	They must, where appropriate, indicate the parts subject to		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		P
	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.		P
	Where the material to be processed is fed to the tool automatically, the following conditions must be fulfilled to avoid risks to persons:		P
	- when the work piece comes into contact with the tool the later must have attained its normal working conditions		P
	- when the tool starts and/or stops the feed movement and the tool movement must be coordinated		P
1.3.3	Risked due to falling or ejected objects		-
	Precautions must be taken to prevent risks from falling or ejected objects.		P
1.3.4	Risks due to surfaces, edges or angles		-
	In so far as their purpose allows, accessible parts of the machinery must have no sharp edges, no sharp angles, and no rough surfaces likely to cause injury		P
1.3.5	Risks related to combined machinery		-
	Where the machinery is intended to carry out several different operations with manual removal of the piece between each operation (combined machinery), it must be designed and constructed in such a way as to enable each element to be used separately without the other elements constituting a risk for exposed persons.		N
	For this purpose, it must be possible to start and stop separately and elements that are not protected		N

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
1.3.6	Risks related to variations in operating conditions		-
	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.		P
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.		P
	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.		P
	The instructions and, where possible, a sign on the machinery shall identify these specific protective devices and how they are to be used.		P
1.3.8	Choice of protection against risks arising from 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.		P
1.3.8.1	. Moving transmission parts		-
	Guards designed to protect persons against the hazards generated by moving transmission parts must be:		P
	– either fixed guards as referred to in section 1.4.2.1, or		P
	— interlocking movable guards as referred to in section 1.4.2.2.		P
	Interlocking movable guards should be used where frequent		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	access is envisaged.		
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		P
	– interlocking movable guards as referred to in section 1.4.2.2, or		P
	– protective devices as referred to in section 1.4.3, or		P
	– a combination of the above.		P
	However, when certain moving parts directly involved in the process cannot be made completely inaccessible during operation owing to operations requiring operator intervention		P
	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		P
	– adjustable guards as referred to in section 1.4.2.3 restricting access to those sections of the moving parts where access is necessary.		N
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.		N
1.4	Required characteristics of guards and protection devices		-
1.4.1	General requirement		-
	Guards and protection devices must:		-
	- be of robust construction		P
	– be securely held in place,		P
	- not give rise to any additional hazard,		P
	- not be easy to bypass or render non-operational		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	- be located at an adequate distance from the danger zone		P
	- cause minimum obstruction to the view id the production process		P
	– enable essential work to be carried out on the installation and/or replacement of tools and for maintenance purposes by restricting access exclusively to the area where the work has to be done, if possible without the guard having to be removed or the protective device having to be disabled.		P
	In addition, guards must, where possible,protect against the ejection or falling of materials or objects and against emissions generated by the machinery.		P
1.4.2	Special requirements for guards		-
1.4.2.1	Fixed guards		-
	Fixed guards must be fixed by systems that can be opened or removed only with tools		P
	Their fixing systems must remain attached to the guards or to the machinery when the guards are removed.		P
	Where possible, guards must be incapable to remain in place without their fixings		P
1.4.4.2	Interlocking movable guards must:		-
	– as far as possible remain attached to the machinery when open,		P
	-– be designed and constructed in such a way that they can be adjusted only by means of an intentional action. [See 3rd hyphen of old 1.4.2.2		P
	Interlocking movable guards must be associated with an interlocking device that:		-
	– prevents the start of hazardous machinery functions until they are closed, and		P
	– gives a stop command whenever they are no longer closed.		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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:		P
	– prevents the start of hazardous machinery functions until the guard is closed and locked, and		P
	-– keeps the guard closed and locked until the risk of injury from the hazardous machinery functions has ceased.		P
	Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery functions		P
1.4.2.3	Adjustable guards restricting access		-
	Adjustable guards restricting access to those areas of the moving parts strictly necessary for the work must:		-
	- be adjustable manually or automatically according to the type of work involved		P
	- be readily adjustable without the use of tools		P.
1.4.3	Special requirements for protective 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,		P
	– persons cannot reach moving parts while the parts are moving, and		P
	– the absence or failure of one of their components prevents starting or stops the moving parts.		P.
	Protective devices must be adjustable only by means of an intentional action.[See 3rd hyphen of old 1.4.3]		P
1.5	RISKS DUE TO OTHER HAZARDS		-
1.5.1.	Electricity supply		-

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	Where machinery has an electricity supply it must be designed, constructed and equipped so that all hazards of an electrical nature are or can be prevented		N
	The safety objectives set out in Directive 73/23/EEC shall apply to machinery. However, the obligations concerning conformity assessment and the placing on the market and/or putting into service of machinery with regard to electrical hazardsare governed solely by this Directive.		N
1.5.2	Static electricity		-
	Machinery must be so designed and constructed as to prevent or limit the build-up of potentially dangerous electrostatic changes and/or be fitted with a discharging system		P
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.		N
1.5.4	Error 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.		P
	Where necessary, the instructions must give further information on these risks.		P
	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.		N

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
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.		P
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.		P
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.		N
	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.		N
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.		P
1.5.9	Vibration		-
	Machinery must be designed and constructed in such a way		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		N
	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.		N
	Any functional non-ionising radiation emissions during setting, operation and cleaning must be limited to levels that do not have adverse effects on persons.		N
1.5.11	External radiation		-
	Machinery must be designed and constructed in such a way that external radiation does not interfere with its operation.		N
1.5.12	Laser equipment		-
	Where laser equipment is used, the following provisions should be taken into account;		N
	– laser equipment on machinery must be designed and constructed in such a way as to prevent any accidental radiation,		N
	– 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,		N
	– optical equipment for the observation or adjustment of laser		N

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		P
	Where a hazard cannot be eliminated,the machinery must be so equipped that hazardous materials and substances can be contained, evacuated, precipitated by water spraying, filtered or treated by another equally effective method.		P
	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.		P
1.5.14	Risk of being trapped in a machine		-
	Machinery must be designed, constructed or fitted with a means of preventing a person from being enclosed within it or, if that is impossible, with a means of summoning help.		P
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.		P
	Where appropriate, these parts must be fitted with handholds that are fixed relative to the user and that enable them to maintain their stability.		P
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		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	the resultant electrical charge to earth.		
1.6	Maintenance		-
1.6.1	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.		P
	If one or more of the above conditions cannot be satisfied for technical reasons, measures must be taken to ensure that these operations can be carried out safely (see section 1.2.5).		P
	In the case of automated machinery and, where necessary, other machinery, a connecting device for mounting diagnostic fault-finding equipment must be provided.		P
	Automated machinery components which have to be changed frequently		P
	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.		P
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.		P
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.		N
	Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has		N

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		P
	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.		P
	As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.		P
1.6.4	Operator intervention		-
	Machinery must be so designed, constructed and equipped that the need for operator intervention is limited		P
	If operator intervention can’t be avoided, it must be possible to carry it out easily and in safety		P
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		P
	If it is impossible to avoid entering the machinery, it must be designed and constructed in such a way as to allow cleaning to take place safely.		P
1.7	INFORMATION		-
1.7.1	Information and warnings on the machinery		-
	Information and warnings on the machinery should preferably be provided in the form of readily understandable symbols or pictograms. Any written or verbal information and warnings must be expressed in an official Community language or		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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. [Compare with 1.7.2 of the old directive]		
1.7.1.1	. Information and information devices		
	The information needed to control machinery must be provided in a form that is unambiguous and easily understood. It must not be excessive to the extent of overloading the operator.		P
	Visual display units or any other interactive means of communication between the operator and the machine must be easily understood and easy to use.		P
1.7.1.2.	Warning devices Where the health and safety of persons may be endangered by a fault in the operation of unsupervised machinery, the machinery must be equipped in such a way as to give an appropriate acoustic or light signal as a warning.		P
	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.		P
	The requirements of the specific Community Directives concerning colours and safety signals must be complied with.		P.
1.7.2	Warning of residual risks		-
	Where risks remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted, the necessary warnings, including warning devices, must be provided.		P
1.7.3	Marking of machinery		-

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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,		P
	– designation of the machinery,		P
	– the CE Marking (see Annex III),		P
	– designation of series or type		P
	– serial number, if any,		P
	– the year of construction, that is the year in which the manufacturing process is completed.		P
	It is prohibited to pre-date or post-date the machinery when affixing the CE marking.		P
	Furthermore, machinery designed and constructed for use in a potentially explosive atmosphere must be marked accordingly.		P
	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.		P
1.7.5	Instruction		-
	All machinery must be accompanied by instructions in the official Community languageor languages of the Member State in which it is placed on the market and/or put into service.		P
	The instructions accompanying the machinery must be either ‘Original instructions’ or a ‘Translation of the original instructions’, in which case the translation must be accompanied by the original instructions.		P
	By way of exception, the maintenance instructions intended for use by specialized personnel mandated by the manufacturer or his authorised representative may be		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	supplied in only one Community language which the specialised personnel understand.[Compare with old 1.7.4 b]		
	The instructions must be drafted in accordance with the principles set out below.		P
1.7.5.1	. General principles for the drafting of instructions		P
	(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 authorized representative.		P
	(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’.		P
	(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.		P
	(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.		P
1.7.5.2	. Contents of the instructions		P
	-Each instruction manual must contain, where applicable, at least the following information:		P
	(a) the business name and full address of the manufacturer and of his authorized representative;		P
	(b) the designation of the machinery as marked on the machinery itself, except for the serial number (see section1.7.3);		P
	(c) the EC declaration of conformity, or a document setting		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	out the contents of the 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;		P
	(e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning;		P
	(f) a description of the workstation(s) likely to be occupied by operators;		P
	g) a description of the intended use of the machinery;		P
	(h) warnings concerning ways in which the machinery must not be used that experience has shown might occur;		P
	(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;		P
	(j) instructions relating to installation and assembly for reducing noise or vibration;		P
	(k) instructions for the putting into service and use of the machinery and, if necessary, instructions for the training of operators;		P
	(l) information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted;		N
	(m) instructions on the protective measures to be taken by the user, including, where appropriate, the personal protective equipment to be provided;		P
	(n) the essential characteristics of tools which may be fitted to the machinery;		P
	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

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	(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; [Comparewith the 10th hyphen of old 1.7.4. (a)]		P
	(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;		P
	(r) the description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that shouldbe observed;		P
	(s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;		P
	(t) the specifications of the spare parts to be used, when these affect the health and safety of operators;		P
	(u) the following information on airborne noise emissions:		P
	– 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,		P
	– the peak C-weighted instantaneous sound pressure value at workstations, where this exceeds 63 Pa (130 dB in relation to 20 μPa),		P
	– the A-weighted sound power level emitted by the machinery, where the A-weighted emission sound pressure level at workstations exceeds 80 dB(A).		P
	These values must be either those actually measured for the machinery in question or those established on the basis of		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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		P
	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.		P
	The operating conditions of the machinery during measurement and the measuring methods used must be described.		P
	Where the workstation(s) are undefined or cannot be defined, A-weighted sound pressure levels must be measured at a distance of 1 metre from the surface of the machinery and at a height of 1,6 metre from the floor or access platform. The position and value of the maximum sound pressure must be indicated.		P
	Where specific Community Directives lay down other requirements for the measurement of sound pressure levels or sound power levels, those Directives must be applied and the corresponding provisions of this section shall not apply;		P
	(v) where machinery is likely to emit nonionising 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.		P
1.7.5.3	. Sales literature		
	Sales literature describing the machinery must not contradict		P

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	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.		
2	SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS FOR CERTAIN CATEGORIES OF MACHINERY		-
2.1	FOODSTUFFS MACHINERY AND MACHINERY FOR COSMETICS OR PHARMACEUTICAL PRODUCTS		-
2．1．1	General		-
	Machinery intended for use with foodstuffs or with cosmetics or pharmaceutical products must be designed and constructed in such a way as to avoid any risk of infection, sickness or contagion. The following requirements must be observed:		-
	(a) materials in contact with, or intended to come into contact with, foodstuffs or cosmetics or pharmaceutical products must satisfy the conditions set down in the relevant Directives. The machinery must be designed and constructed in such a way that these materials can be cleaned before each use. Where this is not possible disposable parts must be used;		P
	(b) all surfaces in contact with foodstuffs or cosmetics or pharmaceutical products, other than surfaces of disposable parts,must:		-
	– be smooth and have neither ridges nor crevices which could harbour organic materials. The same applies to their joinings,		P
	– be designed and constructed in such a way as to reduce the projections, edges and recesses of assemblies to a minimum,		P
	– be easily cleaned and disinfected, where necessary after removing easily dismantled parts; the inside surfaces must		P

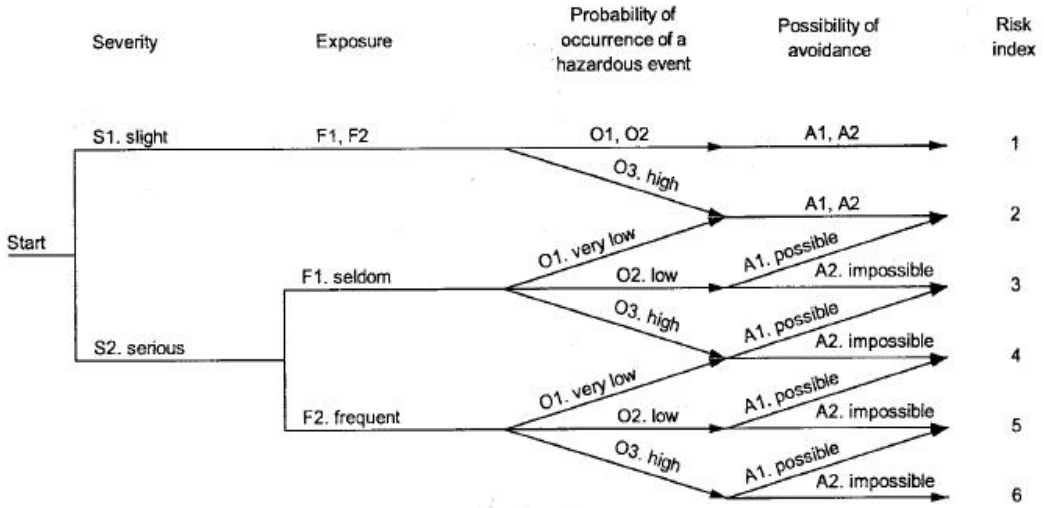
Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
	have curves with a radius sufficient to allow thorough cleaning;		
	(c) it must be possible for liquids, gases and aerosols deriving from foodstuffs, cosmetics or pharmaceutical products as well as from cleaning, disinfecting and rinsing fluids to be completely discharged from the machinery (if possible, in a ‘cleaning’ position);		P
	(d) machinery must be designed and constructed in such a way as to prevent any substances or living creatures, in particular insects, from entering, or any organic matter from accumulating in areas that cannot be cleaned;		P
	(e) machinery must be designed and constructed in such a way that no ancillary substances hazardous to health, including the lubricants used, can come into contact with foodstuffs, cosmetics or pharmaceutical products. Where necessary, machinery must be designed and constructed in such a way that continuing compliance with this requirement can be checked		P
2.1.2.	Instructions		-
	The instructions for foodstuffs machinery and machinery for use with cosmetics or pharmaceutical products must indicate recommended products and methods for cleaning, disinfecting and rinsing, not only for easily accessible areas but also for areas to which access is impossible or inadvisable.		P
2.2	PORTABLE HAND-HELD AND/OR HAND-GUIDED MACHINERY		N
2.3	MACHINERY FOR WORKING WOOD AND MATERIAL WITH SIMILAR PHYSICAL CHARACTERISTICS		N.
3	SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS TO OFFSET HAZARDS DUE TO THE MOBILITY OF MACHINER		-

Annex Ⅰ in Directive 2006/42/EC Machinery			
Items	Requirements	Result-Remark	Verdict
4	SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS TO OFFSET HAZARDS DUE TO LIFTING OPERATIONS		-
5	SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS FOR MACHINERY INTENDED FOR UNDERGROUND WORK		-
6	SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS FOR MACHINERY PRESENTING PARTICULAR HAZARDS DUE TO THE LIFTING OF PERSONS		-

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

2.1 Risk Estimation Method

For risk estimation, the risk graph method of ISO / TR 14121-2, figure A.3, was used as the following.



Despite the rough estimation of the risk index, if after application of well-tried protective measure it is considered that the risk is adequately reduced, no further actions will be required. Otherwise, a specific risk estimation method should be used.

2.2 Risk Assessment Methodology

The risk assessment is based on a method recommended in ISO / TR 14121-2: 2007, in which the factors Se-CI (Fr + Pr + Av) and diagram are used to evaluate the level of risk. The meaning of those is described in the following:

(1) Se, severity of the possible harm:

1. Scratched, bruises that are cured by first aid or similar.

2. More severe scratches, bruises, stabbing which require medical attention from professionals.

3. Normally irreversible injury; it will be slightly difficult to continue work after healing, if possible at all.

4. Irreversible injury in such a way that it will very difficult to continue work after healing, if possible at all.

(2) Fr, average interval between frequency of the exposure and its duration;

1. Interval between exposures is more than a year.

2. Interval between exposures is more than two weeks but less than or equal to a year.

3. Interval between exposures is more than a day but less than or equal to two days.

4. Interval between exposure is more than an hour but less than or equal to a day. Where the duration is short than 10 minutes, the above values may

be decreased to the next level.

5. Interval less than or equal to an hour. This value is not to be decreased at any time.

(3) Pr, possibility of occurrence of a hazardous event:

1. Negligible

2. Rarely

3. Possible

4. Likely

5. Very high

(4) Av, possibility of avoiding or limiting harm:

1. Likely

2. Possible

3. Impossible

The risk is evaluated by using matrix as below:

Severity S	Class Cl (Fr + Pr + Av)				
	3-4	5-7	8-10	11-13	14-15
4					
3					
2					
1					

Where the severity, Se, cross the class, Cl:

In the black area, protective measures have to be implemented to reduce risk;

In the gray area, protective measures are recommended to be implemented to further reduce risk;

In the remaining area, the risk is already adequately reduced.

2.3 Acceptance Criteria

A form is filled in with the result of this risk assessment; each hazardous situation is allocated a risk index. In this example, the estimation of each hazardous situation is made with consideration given to the following:

- a risk of 1 or 2 corresponds to the lowest priority of action (priority 3);
- a risk index of 3 or 4 corresponds to the medium priority of action (priority 2);
- and a risk index of 5 or 6 corresponds to the highest priority of action (priority 1).

Possible means of reducing risk are considered and the risk is then estimated for the final design using the same risk graph in the same manner as for the initial design. In this specific case, a risk index of 2 or less have been evaluated as representing the level at which no further risk reduction is required.

1. Mechanical	
Sub-clause of EN 12100:2010	–6.2.2.1; –6.2.2.2; –6.2.3 a); –6.2.3 b); –6.2.6; –6.2.10; –6.3.1; –6.3.2; – 6.3.3; – 6.3.5.2; – 6.3.5.4; – 6.3.5.5; – 6.3.5.6; –6.4.1; – 6.4.3; – 6.4.4; – 6.4.5
Origin	– acceleration, deceleration;– angular parts;– approach of a moving element to a fixed part;– cutting parts;– elastic elements;– falling objects;– high pressure;– instability; – moving elements;– rotating elements;– rough, slippery surface;– sharp edges;

No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
1.1	Being run over	When the machine is running	Se 3, Fr 1, Pr 2, Av 1, Cl 4	1.Designed to comply with the standards 2. Read the instructions before using the machine
1.2	Being thrown	When the machine is running	Se 3, Fr 1, Pr 2, Av 1, Cl 4	1.Designed to comply with the standards 2. Read the instructions before using the machine
1.3	Crushing	When the machine is running	Se 3, Fr 3, Pr 2, Av 1, Cl 6	1.Designed to comply with the standards 2. Read the instructions before using the machine
1.4	Cutting or severing	Not applicable		

1.5	Drawing in or trapping	When the machine is running	Se 3, Fr 1, Pr 2, Av 1, Cl 4	1. warning signs was used 2. appropriate brake system was provided 3. Read the instructions before using the machine 4． appropriate safety guard was provided
1.6	Entanglement	When maintaining the machine	Se 3, Fr 1, Pr 2, Av 1, Cl 4	1.Designed to comply with the standards 2. Read the instructions before using the machine
1.7	Friction or abrasion	When maintaining the machine or the machine is running	Se 2, Fr 4, Pr 1 Av 1, Cl 6	1. warning signs was used 2. appropriate brake system was provided 3. Read the instructions before using the machine
1.8	Impact	When maintaining the machine or the machine is running	Se 2, Fr 4, Pr 1 Av 1, Cl 6	1. warning signs was used 2. appropriate brake system was provided 3. Read the instructions before using the machine
1.9	Injection	Not applicable		
1.10	Shearing	When maintaining the machine or the machine is running	Se 2, Fr 2, Pr 1 Av 1, Cl 6	1. warning signs was used 2. appropriate brake system was provided 3. Read the instructions before using the machine

1.11	Slip, trip and fall of person	When maintaining the machine or the machine is running	Se 2, Fr 4, Pr 1 Av 1, Cl 6	1. warning signs was used 2. appropriate safety guard was provided 3. Read the instructions before using the machine
1.12	Stabbing or puncture	When maintaining the machine or the machine is running	Se 2, Fr 4, Pr 1 Av 1, Cl 6	1.Designed to comply with the standards 2. Read the instructions before using the machine
1.13	Suffocation	Not applicable		

2. Electrical				
Sub-clause of EN 12100:2010	–6.2.9; –6.3.2; –6.3.3.2; –6.3.5.4; –6.4.4; –6.4.5			
Origin	– electromagnetic phenomena; – live parts; – not enough distance to live parts under high voltage; – overload; — short-circuit			
No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
2.1	Burn	1. The main power's input	Se 2 ,Fr 1, Pr 1, Av 1, Cl 3	1. warning signs was used 2. Read the instructions before using the machine
2.2	Electrocution	When the machine is running	Se 3, Fr 1, Pr 2, Av 1, Cl 4	-1.Designed to comply with the standards 2. Read the instructions before using the machine
2.3	Falling, being thrown	Not applicable	-	-
2.4	Fire	Not applicable		

2.5	Shock	1. The main power's input	-Se 1, -Fr2 -Pr 2, -Av 1 -Cl 5	1.Affixing the flash sign in the entrance. 2. The cabinet's door should be open by key or tools. 3. warning signs was used 4. Read the instructions before using the machine

3. Thermal	
Sub-clause of EN 12100:2010	– 6.2.4 b); – 6.2.8 c); – 6.3.2.7; – 6.3.3.2.1; – 6.3.4.5;
Origin	– explosion; – flame; – objects or materials with a high or low temperature;.

No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
3.1	Burn	Not applicable		
3.2	Dehydration;	Not applicable	-	-
3.3	Discomfort;	Not applicable	-	-

4. Noise	
Sub-clause of EN 12100:2010	－6.2.2.2; －6.2.3 c); －6.2.4 c); －6.2.8 c); －6.3.1; －6.3.2.1 b); －6.3.2.5.1; －6.3.3.2.1; －6.3.4.2; －6.4.3; －6.4.5.1 b) and c);
Origin	－ cavitation phenomena;－ exhausting system;－ gas leaking at high speed; － manufacturing process (stamping, cutting, etc.);－ moving parts; － scraping surfaces;－ unbalanced rotating parts;－ whistling pneumatics; － worn parts.

No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
4.1	Discomfort	1. when machine is running	Se 3, Fr 1, Pr 2, Av 1, Cl 4-	1.Designed to comply with the standards
4.2	Loss of awareness	Not applicable	-	-
4.3	Loss of balance	Not applicable	-	-
4.4	Permanent hear loss	Not applicable		
4.5	Stress	Not applicable		
4.6	Tinnitus	Not applicable		
4.7	Tiredness	Not applicable		

	Any other (for example, mechanical, electrical) as a consequence of an interference with speech	Not applicable		

5. Vibration				
Sub-clause of EN 12100:2010	– 6.2.2.2; – 6.2.3 c); – 6.2.8 c); – 6.3.3.2.1; – 6.3.4.3; – 6.4.5.1 c);			
Origin	– cavitation phenomena; – misalignment of moving parts; – mobile equipment; – scraping surfaces; – unbalanced rotating parts; – vibrating equipment; – worn parts.			
No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
5.1	Discomfort	1. when machine is running	Se 3, Fr 1, Pr 2, Av 1, Cl 4-	1.Designed to comply with the standards
5.2	Low-back morbidity	Not applicable		
5.3	Neurological disorder	Not applicable		
5.4	Osteo-articular disorder	Not applicable		
5.5	Trauma of the spine	Not applicable		
5.6	Vascular disorder	Not applicable		

6. Radiation				
Sub-clause of EN 12100:2010	– 6.2.2.2;– 6.2.3 c);– 6.3.3.2.1;– 6.3.4.5;– 6.4.5.1 c);			
Origin	– ionizing radiation source;– low frequency electromagnetic radiation; – optical radiation (infrared, visible and ultraviolet), including laser; – radio frequency electromagnetic radiation.			
No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
6.1	Burn	Not applicable		
6.2	Damage to eyes and skin	Not applicable		
6.3	Effects on reproductive capability	Not applicable		
6.4	Genetic mutation	Not applicable		
6.5	Headache, insomnia,	Not applicable		

7.Material/ substance hazards	
Sub-clause of EN 12100:2010	– 6.2.2.2;– 6.2.3 b);– 6.2.3 c);– 6.2.4 a);– 6.2.4 b);– 6.3.1; – 6.3.3.2.1;– 6.3.4.4;– 6.4.5.1 c);– 6.4.5.1 g);
Origin	– aerosol; – biological and microbiological (viral or bacterial) agent; – combustible; – dust; – explosive; – fibre; – flammable; – fluid; – fume; – oxidizer.

No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
7.1	Breathing difficulties, suffocation	Not applicable		
7.2	Cancer	Not applicable		
7.3	Corrosion	Not applicable		
7.4	Effects on reproductive capability	Not applicable		
7.5	Explosion	Not applicable		
7.6	Fire	Not applicable		
7.7	Infection	Not applicable		

7.8	Mutation	Not applicable		
7.9	Poisoning	Not applicable		
7.10	Sensitization	Not applicable		

8. Ergonomic hazards	
Sub-clause of EN 12100:2010	－6.2.2.1;－6.2.7;－6.2.8;－6.2.11.8;－6.3.2.1;－6.3.3.2.1;
Origin	－ access;－ design or location of indicators and visual displays units; － design, location or identification of control devices; － effort; － flicker, dazzling, shadow, stroboscopic effect; － local lighting; － mental overload/underload;－ posture;－ repetitive activity;－ visibility － oxidizer.

No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
8.1	Breathing difficulties, suffocation	Not applicable		
8.2	Cancer	Not applicable		
8.3	Corrosion	Not applicable		
8.4	Effects on reproductive capability	Not applicable		
8.5	Explosion	Not applicable		

9. Associated with Environment in which the Machine is Used				
Sub-clause of EN 12100:2010	—6.2.6;—6.2.11.11;—6.3.2.1;—6.4.5.1 b);			
Origin	— dust and fog;— electromagnetic disturbance;— lightning;— moisture; — snow;— temperature;— water;— wind;— lack of oxygen.			
No.	Potential Consequences	Hazardous Situation	Risk Estimation	Risk Reduction and Protective Measures
9.1	Burn	Not applicable		
9.2	Slight disease	Not applicable		
9.3	Slipping, falling	Not applicable		
9.4	Suffocation	Not applicable		

2.3 EN 60204-1:2018Safety of machinery - Electrical equipment of machines - Part 1: General requirements

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
4	General requirements		-
4.1	General		-
	This standard specifies requirements for the electrical equipment of machines. 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:		-
	– identify the need for risk reduction; and – determine and adequate risk reductions; – determine the necessary protective measures for persons who can be exposed to those hazards, while still maintaining an appropriate performance of the machine and its equipment.		P
	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, arc, or 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 can result in a failure of a safety function, for example those that depend on sliding or rolling contacts; – electrical disturbances for example, electromagnetic, electrostatic either from outside the electrical equipment or internally generated, resulting in the malfunctioning of the machine;		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	– release of stored energy (either electrical or mechanical) resulting in, for example, electric shock, unexpected movement that can cause injury; – acoustic noise and mechanical vibration at levels that cause health problems to persons; – surface temperatures that can cause injury.		
	The design and development process shall identify hazards and the risks arising from them. 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.		P
4.2	Selection of equipment		-
4.2.1	General		-
	Electrical components and devices shall:		-
	– be suitable for their intended use; and		P
	– conform to relevant IEC standards where such exist; and		P
	– be applied in accordance with the supplier’s instructions		P
4.2.2	Switchgear		-
	In addition to the requirements of IEC 60204-1, depending upon the machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the machine that are in compliance with relevant parts of the IEC 61439 series (see also Annex F).		P
4.3	Electrical supply		-
4.3.1	General		-
	The electrical equipment shall be designed to operate		-

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	correctly with the conditions of the supply:		
	– as specified in 4.3.2 or 4.3.3, or		P
	as otherwise specified by the user, or		N
	– as specified by the supplier of a special source of supply (see 4.3.4)		N
4.3.2	AC supplies		-
	Voltage: Steady state voltage: 0,9 to 1,1 of nominal voltage. Frequency: 0,99 to 1,01 of nominal frequency continuously; 0,98 to 1,02 short time. Harmonics: Harmonic distortion not exceeding 12 % of the total r.m.s. voltage between live conductors for the sum of the 2nd through to the 30th harmonic. 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 rms voltage of the supply for more than one cycle with more than 1 s between successive dips.		P
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.		N
	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.		N

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
4.3.4	Special supply systems		-
	For special supply systems (e.g. on-board generators, DC bus, etc.) the limits given in 4.3.2and 4.3.3 may be exceeded provided that the equipment is designed to operate correctly with those conditions.		N
4.4	Physical environment and operating conditions		-
4.4.1	General		-
	The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use. The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of machines covered by this part of		P
4.4.2	Electromagnetic compatibility (EMC)		-
	The electrical equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended operating environment. In addition, the electrical equipment shall have a sufficient level of immunity to electromagnetic disturbances so that it can function in its intended environment.		P
4.4.3	Ambient air temperature		-
	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. The minimum requirement for all electrical equipment is correct operation in ambient air temperatures outside of enclosures (cabinet or box) between +5 °C and +40 °C.		P
4.4.4	Humidity		-
	The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities are permitted at lower temperatures (for example 90 % at 20 °C).		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	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..		P
4.4.6	Contaminants		-
	Electrical equipment shall be adequately protected against the ingress of solids and liquids (see 11.3).		P
	The electrical equipment shall be adequately protected against contaminants (for example dust, acids, corrosive gases, salts) that can be present in the physical environment in which the electrical equipment is to be installed.		P
4.4.7	Ionizing and non-ionizing radiation		-
	When equipment is subject to radiation (for example microwave, ultraviolet, lasers, X-rays), additional measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation.		P
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.		P
4.5	Transportation and storage		-
	Electrical equipment shall be designed to withstand, or suitable precautions shall be taken to protect against, the effects of transportation and storage temperatures within a range of –25 °C to +55 °C and for short periods not exceeding 24 h at up to +70 °C. Suitable means shall be provided to		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	prevent damage from humidity, vibration, and shock.		
4.6	Provisions for handling		-
	Heavy and bulky electrical equipment that has to be removed from the machine for transport, or that is independent of the machine, shall be provided with suitable means for handling, including where necessary means for handling by cranes or similar equipment.		P
5	Incoming supply conductor terminations and devices for disconnecting and switching off		-
5.1	Incoming supply conductor terminations		-
	It is recommended that, where practicable, the electrical equipment of a machine is connected to a single incoming supply. Where another supply is necessary for certain parts of the equipment (for example, electronic equipment that operates at a different voltage), that supply should be derived, as far as is practicable, from devices (for example, transformers, converters) forming part of the electrical equipment of the machine. For large complex machinery 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).		P
	Unless a plug is provided with the machine for the connection to the supply (see 5.3.2 e)), it is recommended that the supply conductors are terminated at the supply disconnecting device. Where a neutral conductor is used it shall be clearly indicated in the technical documentation of the machine, such as in the installation diagram and in the circuit diagram, and a separate insulated terminal, labelled N in accordance with 16.1, shall be provided for the neutral conductor. The neutral terminal may be provided as part of the supply disconnecting device. There shall be no connection between the neutral conductor and the protective bonding circuit inside the		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	electrical equipment.		
5.2	Terminal for connection of the external protective conductor		-
	For each incoming supply, a terminal shall be provided in the same compartment as the associated line conductor terminals for connection of the machine to the external protective conductor.		P
5.3	Supply disconnecting (isolating) device		-
5.3.1	General		-
	A supply disconnecting device shall be provided:		-
	– for each incoming supply to (a) machine(s);		P
	– for each on-board power supply.		N
	The supply disconnecting device shall disconnect (isolate) the electrical equipment of the machine from the supply when required (for example for work on the machine, including the electrical equipment).		P
	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.		N
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;		N
	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;		N
	c) a circuit-breaker suitable for isolation in accordance with IEC 60947-2;		N
	d) any other switching device in accordance with an IEC product standard for that device and which meets the		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	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.		N
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 (2002-10) and IEC 60417-5007 (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 operating means (see 5.3.4); – 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 other loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. Where motor(s) are supplied by converter(s) or similar devices, the calculation should take into account the possible effect on the required		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	breaking capacity.		
	Where the supply disconnecting device is a plug/socket combination, it shall comply with the requirements of 13.4.5 and shall have the breaking capacity, or be interlocked with a switching device that has a breaking capacity, sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and other loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. Where the interlocked switching device is electrically operated (for example a contactor) it shall have an appropriate utilisation category. Where motor(s) are supplied by converter(s) or similar devices, the calculation should take into account the possible effect on the required breaking capacity.		N
	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.		N
5.3.4	Operating means of the supply disconnecting device		-
	The operating means (for example, a handle) of the supply disconnecting device shall be external to the enclosure of the electrical equipment.		P
	Exception: power-operated switchgear need not be provided with a handle outside the enclosure where other means (e.g. pushbuttons) are provided to open the supply disconnecting device from outside the enclosure.		N
	The operating means of the supply disconnecting device shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level. An upper limit of 1,7 m is recommended.		P
	Where the external operating means is not intended for		-

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	emergency operations:		
	it is recommended that it be coloured BLACK or GREY (see 10.2) – supplementary cover or door that can be readily opened without the use of a key or tool may be provided, for example for protection against environmental conditions or mechanical damage. Such a cover/door shall clearly show that it provides access to the operating means. This can be achieved, for example, by use of the relevant symbol IEC 60417-6169-1 (2012-08) (Figure 2) or IEC 60417-6169-2 (2012-08), (Figure 3).		P
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; socket outlets for the exclusive connection of repair or maintenance tools and equipment (for example hand drills, test equipment) (see 15.1); – 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, heaters, program storage devices).		N
	Control circuits supplied via another supply disconnecting device, regardless of whether that disconnecting device is located in the electrical equipment or in another machine or other electrical equipment, need not be disconnected by the supply disconnecting device of the electrical equipment.		N
	Where excepted circuits are not disconnected by the supply disconnecting device:		N
	– permanent warning label(s) shall be appropriately placed in proximity to the operating means of the supply disconnecting		N

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	device to draw attention to the hazard;		
	a corresponding statement shall be included in the maintenance manual, and one or more of the following shall apply: • the conductors are identified by colour taking into account the recommendation of 13.2.4; • excepted circuits are separated from other circuits; • excepted circuits are identified by permanent warning label(s).		N
5.4	Devices for removal of power for prevention of unexpected start-up		-
	Devices for removal of power for the prevention of unexpected start-up shall be provided where a start-up of the machine or part of the machine can create a hazard (for example during maintenance). Such devices shall be appropriate and convenient for the intended use, be suitably placed, and readily identifiable as to their function and purpose. Where their function and purpose is not otherwise obvious (e.g. by their location) these devices shall be marked to indicate the extent of removal of power.		P
	The supply disconnecting device or other devices in accordance with 5.3.2 may be used for prevention of unexpected start-up.		P
	Disconnectors, withdrawable fuse links and withdrawable links may be used for protection of unexpected start-up only if they are located in an enclosed electrical operating area (see 3.1.23).		P
	Devices that do not fulfil the isolation function (for example a contactor switched off by a control circuit, or Power Drive System (PDS) with a Safe Torque Off (STO) function in accordance with IEC 61800-5-2) may only be used for prevention of unexpected start-up during tasks such as:		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	– 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). The selection of a device will be dependent on the risk assessment, taking into account the intended use of the device, and the persons who are intended to operate them.		
5.5	Devices for isolating electrical equipment		-
	Devices shall be provided for isolating (disconnecting) the electrical equipment or part(s) of the electrical equipment to enable work to be carried out when it is de-energised and isolated. Such devices shall be:		P
	– appropriate and convenient for the intended use;		P
	– suitably placed;		P
	–readily identifiable as to which part(s) or circuit(s) of the equipment is served. Where their function and purpose is not otherwise obvious (e.g. by their location) these devices shall be marked to indicate the extent of the equipment that they isolate.		P
	The supply disconnecting device (see 5.3) may, in some cases, fulfil that function. However, where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of the machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device shall be provided for each part, or for each machine, requiring separate isolation.		P
	In addition to the supply disconnecting device, the following devices that fulfil the isolation function may be provided for		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	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 3.1.23) and relevant information is provided with the electrical equipment (see Clause 17).		
5.6	Protection against unauthorized, inadvertent and/or mistaken connection		-
	Where the devices described in 5.4 and 5.5 are located outside an enclosed electrical operating area they shall be equipped with means to secure them in the OFF position (disconnected state), (for example by provisions for padlocking, trapped key interlocking). When so secured, remote as well as local reconnection shall be prevented. Where the devices described in 5.4 and 5.5 are located inside an enclosed electrical operating area other means of protection against reconnection (for example warning labels) can be sufficient. 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.		P
6	Protection against electric shock		-
6.1	General		-
	The electrical equipment shall provide protection of persons against electric shock by: – basic protection (see 6.2 and 6.4), and; – fault protection (see 6.3 and 6.4). The measures for protection given in 6.2, 6.3, and, for PELV, in 6.4, are a selection from IEC 60364-4-41. Where those measures are not practicable, for example due to the physical		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
	or operational conditions, other measures from IEC 60364-4-41 may be used (e.g. SELV).		
6.2	Basic protection		-
6.2.1	General		-
	For each circuit or part of the electrical equipment, the measures of either 6.2.2 or 6.2.3 and, where applicable, 6.2.4 shall be applied.		P
	Where the equipment is located in places open to all persons, which can include children, measures of either 6.2.2 with a minimum degree of protection against contact with live parts corresponding to IP4X or IPXXD (see IEC 60529), or 6.2.3 shall be applied.		N
6.2.2	Protection by enclosures		-
	Live parts shall be located inside enclosures that provide protection against contact with live parts of at least IP2X or IPXXB (see IEC 60529).		P
	Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against contact with live parts provided by the top surfaces shall be IP4X or IPXXD.		P
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.		P
6.2.4	Protection against residual voltages		-
	Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge		P

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	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 that contains the live parts.		
	In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.		N
6.2.5	Protection by barriers		-
	For protection by barriers, the requirements of IEC 60364-4-41 shall apply.		P
6.2.6	Protection by placing out of reach or protection by obstacles		-
	For protection by placing out of reach, the requirements of IEC 60364-4-41 shall apply. For protection by obstacles, the requirements of IEC 60364-4-41 shall apply. For conductor wire systems or conductor bar systems with a degree of protection less than IP2X or IPXXB, see 12.7.1.		P

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Clause	Requirements	Result-Remark	Verdict
6.3	Fault protection		-
6.3.1	General		-
	Fault protection (3.31) is intended to prevent hazardous situations due to an insulation fault between live parts and exposed conductive parts.		-
	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		P
	–automatic disconnection of the supply before the time of contact with a touch voltage can become hazardous (6.3.3).		N
6.3.2	Prevention of the occurrence of a touch voltage		-
6.3.2.1	General Measures to prevent the occurrence of a touch voltage include the following: – provision of class II equipment or by equivalent insulation; – electrical separation		P
6.3.2.2	Protection by provision of class II equipment or by equivalent insulation		-
	This measure is intended to prevent the occurrence of touch voltages on the accessible parts through a fault in the basic insulation. 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 control gear assemblies having total insulation in accordance with IEC 61439-1; – supplementary or reinforced insulation in accordance with IEC 60364-4-41.		P
6.3.2.3	Protection by electrical separation		-

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Clause	Requirements	Result-Remark	Verdict
	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.		P
6.3.3	Protection by automatic disconnection of supply		
	Automatic disconnection of the supply of any circuit affected by an insulation fault is intended to prevent a hazardous situation resulting from a touch voltage. This measure consists of the interruption of one or more of the line conductors by the automatic operation of a protective device in case of a fault. This interruption shall occur within a sufficiently short time to limit the duration of a touch voltage to a time within the limits specified in Annex A for TN and TT systems		P
	This measure necessitates co-ordination between:		-
	– the type of supply system, the supply source impedance and the earthing system; – the impedance values of the different elements of the line and of the associated fault current paths through the protective bonding circuit; – the characteristics of the protective devices that detect insulation fault(s).		P
6.4	Protection by the use of PELV		-
6.4.1	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 8.2.1).		P
6.4.2	Sources for PELV		-
	The source for PELV shall be one of the following:		-
	– a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6;		P
	– a source of current providing a degree of safety equivalent		N

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Clause	Requirements	Result-Remark	Verdict
	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);		N
	– an electronic power supply conforming to appropriate standards specifying measures to be –taken to ensure that, even in the case of an internal fault, the voltage at the outgoing terminals cannot exceed the values specified in 6.4.1.		N
7	Protection of equipment		-
7.1	General		-
	This Clause 7 details the measures to be taken to protect equipment against the effects of: – overcurrent arising from a short-circuit; – 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.		P
7.2	Overcurrent protection		-
7.2.1	General		-
	Overcurrent protection shall be provided where the current in any circuit can exceed either the rating of any component or the current carrying capacity of the conductors, whichever is the lesser value. The ratings or settings to be selected are detailed in 7.2.10.		P
7.2.2	Supply conductors		-
	Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the		P

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Clause	Requirements	Result-Remark	Verdict
	supply conductors and the overcurrent protective device for the supply conductors to the electrical equipment. The supplier of the electrical equipment shall state in the installation documents the data necessary for conductor dimensioning (including the maximum cross-sectional area of the supply conductor that can be connected to the terminals of the electrical equipment) and for selecting the overcurrent protective device (see 7.2.10 and 17).		
7.2.3	Power circuits		-
	Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10, shall be applied to each live conductor including circuits supplying control circuit transformers.		P
	The following conductors, as applicable, shall not be disconnected without disconnecting all associated live conductors: – the neutral conductor of AC power circuits; – the earthed conductor of DC power circuits; – DC power conductors bonded to exposed conductive parts of mobile machines.		P
	Where the cross-sectional area of the neutral conductor is at least equal to or equivalent to that of the line conductors, it is not necessary to provide overcurrent detection for the neutral conductor nor a disconnecting device for that conductor. For a neutral conductor with a cross sectional area smaller than that of the associated line conductors, the measures detailed in 524 of IEC 60364-5-52:2009 shall apply.		P
	In IT systems, it is recommended that the neutral conductor is not used. However, where a neutral conductor is used, the measures detailed in 431.2.2 of IEC 60364-4-43:2008 shall apply.		P
7.2.4	Control circuits		-
	Conductors of control circuits directly connected to the supply		P

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Clause	Requirements	Result-Remark	Verdict
	voltage shall be protected against overcurrent in accordance with 7.2.3.		
	Conductors of control circuits supplied by a transformer or DC supply shall be protected against overcurrent (see also 9.4.3.1.1): – 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 all control circuits of the equipment have the same current carrying capacity, by inserting an overcurrent protective device into the switched conductor, or; • where different control circuits of the equipment have different current carrying capacity, by inserting an overcurrent protective device into both switched and common conductors of each control circuit.		P
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. See also 15.1.		P
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.		P
7.2.7	Transformers		-
	Transformers shall be protected by an overcurrent protective		P

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Clause	Requirements	Result-Remark	Verdict
	device having a type and setting in accordance with the transformer 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.		
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(s) between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is no longer than 3 m; – the conductors are installed in such a manner as to reduce the possibility of a shortcircuit, for example, protected by an enclosure or duct.		P
7.2.9	Overcurrent protective devices		-
	The rated short-circuit breaking capacity shall be at least equal to the prospective fault current at the point of installation. Where the short-circuit current to an overcurrent protective device can include additional currents other than from the supply (for example from motors, from power factor correction capacitors), those currents shall be taken into consideration.		P
7.2.10	Rating and setting of overcurrent protective devices		-
	The rated current of fuses or the setting current of other		P

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Clause	Requirements	Result-Remark	Verdict
	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		
	The rated current or setting of an overcurrent protective device for conductors is determined by the current carrying capacity of the conductors to be protected in accordance with 12.4, Clause D.3 and the maximum allowable interrupting time *t* in accordance with Clause D.4, taking into account the needs of co-ordination with other electrical devices in the protected circuit.		P
7.3	Protection of motors against overheating		-
7.3.1	General		-
	Protection of motors against overheating shall be provided for each motor rated at more than 0,5 kW. Exception: In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps), the means of detection shall give a warning signal to which the operator can respond.		P
	Protection of motors against overheating can be achieved by: – overload protection (7.3.2), – over-temperature protection (7.3.3), or – current-limiting protection.		P
	Automatic restarting of any motor after the operation of protection against overheating shall be prevented where this can cause a hazardous situation or damage to the machine or to the work in progress.		P
7.3.2	Overload protection		-
	Where overload protection is provided, detection of overload(s) shall be provided in each live conductor except		P

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Clause	Requirements	Result-Remark	Verdict
	for the neutral conductor.		
	However, where the motor overload detection is not used for cable overload protection (see also Clause D.2), detection of overload may be omitted in one of the live conductors. For motors having single-phase or DC power supplies, detection in only one unearthed live conductor is permitted.		P
	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.		P
	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.		P
	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.		P
7.3.3	Over-temperature protection		-
	The provision of motors with over-temperature protection in accordance with IEC 60034-11 is recommended in situations where the cooling can be impaired (for example dusty environments). Depending upon the type of motor, protection under stalled rotor or loss of phase conditions is not always ensured by over-temperature protection, and additional protection should then be provided. Over-temperature protection is also recommended for motors that cannot be overloaded (for example torque motors, motion drives that are either protected by mechanical		P

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Clause	Requirements	Result-Remark	Verdict
	overload protection devices or are adequately dimensioned), where the possibility of over-temperature exists (for example due to reduced cooling).		
7.4	Protection against abnormal temperature		-
	Equipment shall be protected against abnormal temperatures that can result in a hazardous situation.		P
7.5	Protection against 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.		P
	Where the operation of the machine can allow for an interruption or a reduction of the voltage for a short time period, delayed undervoltage protection may be provided. The operation of the undervoltage device shall not impair the operation of any stopping control of the machine.		P
	Upon restoration of the voltage or upon switching on the incoming supply, automatic or unexpected restarting of the machine shall be prevented where such a restart can cause a hazardous situation.		P
	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.		P
7.6	Motor overspeed protection		-
	Overspeed protection shall be provided where overspeeding can occur and could possibly cause a hazardous situation taking into account measures in accordance with 9.3.2. Overspeed protection shall initiate appropriate control		P

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Clause	Requirements	Result-Remark	Verdict
	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		
7.7	Additional earth fault/residual current protection		-
	I 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. If fault currents with DC components are possible, an RCD of type B in accordance with IEC TR 60755 can be required.		P
7.8	Phase sequence protection		-
	Where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine, protection shall be provided.		P
7.9	Protection against overvoltages due to lightning and to switching surges		-
	Surge protective devices (SPDs) can be provided to protect against the effects of overvoltages due to lightning or to switching surges		P
7.10	Short-circuit current rating		-
	The short-circuit current rating of the electrical equipment shall be determined. This can be done by the application of design rules or by calculation or by test.		P
8	Equipotential bonding		-
8.1	General		-
	This Clause 8 provides requirements for protective bonding and functional bonding. Figure 4 illustrates those concepts.		P

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Clause	Requirements	Result-Remark	Verdict
	Protective bonding is a basic provision for fault protection to enable protection of persons against electric shock (see 6.3.3 and 8.2).		
8.2	Protective bonding circuit		-
8.2.1	General		-
	The protective bonding circuit consists of the interconnection of: • PE terminal(s) (see 5.2); • the protective conductors (see 3.1.51) in the equipment of the machine including sliding contacts where they are part of the circuit; • the conductive structural parts and exposed conductive parts of the electrical equipment; Exception: see 8.2.5. • conductive structural parts of the machine.		P
8.2.2	Protective conductors		-
	Protective conductors shall be identified in accordance with 13.2.2. Copper conductors are preferred. Where a conductor material other than copper is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm2 in cross-sectional area for reasons of mechanical durability.		P
8.2.3	Continuity of the protective bonding circuit		-
	Where a part is removed for any reason (for example routine maintenance), the protective bonding circuit for the remaining parts shall not be interrupted.		P
	Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and conductors of aluminium or aluminium alloys are used, particular consideration should be given to the possibility of		P

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Clause	Requirements	Result-Remark	Verdict
	electrolytic corrosion		
	Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured and a protective conductor (see 8.2.2) is recommended. Where a protective conductor is not provided, fastenings, hinges or sliding contacts designed to have a low resistance shall be used (see 18.2.2, Test 1). The continuity of conductors in cables that are exposed to damage (for example flexible trailing cables) shall be ensured by appropriate measures (for example monitoring).		P
	For requirements for the continuity of conductors using conductor wires, conductor bars and slip-ring assemblies, see 12.7.2.		P
	The protective bonding circuit shall not incorporate a switching device, an overcurrent protective device (for example switch, fuse), or other means of interruption.		P
	Exception: links that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area may be provided for test or measurement purposes.		P
	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).		P
8.2.4	Protective conductor connecting points		-
	All protective conductors shall be terminated in accordance with 13.1.1. The protective conductor connecting points are not intended, for example, to attach appliances or parts		P
	Each protective conductor connecting point shall be marked or labelled as such using the symbol IEC 60417-5019:2006-08 as illustrated in Figure 5, or with the letters PE, the graphical symbol being preferred,		P

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	or by use of the bicolour combination GREEN-AND-YELLOW, or by any combination of these.		
8.2.5	Mobile machines		-
	On mobile machines with on-board power supplies, the protective conductors, the conductive structural parts of the electrical equipment, and those extraneous-conductive-parts which form the structure of the machine shall all be connected to a protective bonding terminal to provide protection against electric shock. Where a mobile machine is also capable of being connected to an external incoming power supply, this protective bonding terminal shall be the connection point for the external protective conductor.		N
8.2.6	Additional requirements for electrical equipment having earth leakage currents higher than 10 mA		N
	Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:		N
	a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage; b) the protective conductor has a cross-sectional area of at least 10 mm2 Cu or 16 mm2 Al; c) where the protective conductor has a cross-sectional area of less than 10 mm2 Cu or 16 mm2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm2 Cu or 16 mm2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.		N

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	d) the supply is automatically disconnected in case of loss of continuity of the protective conductor; e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm2 as part of a multi-conductor power cable is provided.		
	A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.		N
8.3	Measures to restrict the effects of high leakage current		N
	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 8.2.6.		N
8.4	Functional bonding		-
	Protection against maloperation as a result of insulation failures can be achieved by connecting to a common conductor in accordance with 9.4.3.1.1. For recommendations regarding functional bonding to avoid maloperation due to electromagnetic disturbances, see 4.4.2 and Annex H. Functional bonding connecting points should be marked or labelled as such using the symbol IEC 60417-5020:2002-10 (see Figure 6).		P
9	Control circuits and control functions		-
9.1	Control circuits		-

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Clause	Requirements	Result-Remark	Verdict
9.1.1	Control circuit supply		-
	Where control circuits are supplied from an AC source, transformers having separate windings shall be used to separate the power supply from the control supply.		P
	Exception: Transformers or switch mode power supply units fitted with transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices (for example, interlock device, start/stop control station).		P
	Where DC control circuits derived from an AC supply are connected to the protective bonding circuit (see 8.2.1), they shall be supplied from a separate winding of the AC control circuit transformer or by another control circuit transformer.		P
9.1.2	Control circuit voltages		-
	The nominal value of the control voltage shall be consistent with the correct operation of the control circuit.		-
	– 230 V for circuits with 50 Hz nominal frequency,		P
	– 277 V for circuits with 60 Hz nominal frequency		P
	The nominal voltage of DC control circuits should preferably not exceed 220 V.		P
9.1.3	Protection		-
	Control circuits shall be provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		P
9.2	Control functions		-
9.2.2	Categories of stop functions		-
	There are three categories of stop functions as follows: – stop category 0: stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop – see 3.1.64); – stop category 1: a controlled stop (see 3.1.14) with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved;		P

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	– stop category 2: a controlled stop with power remaining available to the machine actuators.		
9.2.3	Operation		
9.2.3.1	General		P
	Safety functions and/or protective measures (for example interlocks (see 9.3)) shall be provided where required to reduce the possibility of hazardous situations.		P
	Where a machine has more than one control station, measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.		P
9.2.3.2	Start		-
	Start functions shall operate by energizing the relevant circuit		P
	The start of an operation shall be possible only when all relevant safety functions and/or protective measures are in place and are operational, except for conditions as described in 9.3.6.		P
	For those machines (for example mobile machines) where safety functions and/or protective measures cannot be applied for certain operations, starting of such operations shall be by hold-to-run controls, together with enabling devices, as appropriate.		P
	The provision of acoustic and/or visual warning signals before the starting of hazardous machine operation shall be considered during the risk assessment. Where the risk assessment determines that either or both are required the emission level of noise/light shall be suitable for the intended environment		P
	Suitable interlocks shall be provided where necessary for correct sequential starting.		P
	In the case of machines requiring the use of more than one		P

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	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:		
	• 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 3.1.7).		P
9.2.3.3	Stop		-
	Stop category 0 and/or stop category 1 and/or stop category 2 stop functions shall be provided as indicated by the risk assessment and the functional requirements of the machine (see 4.1).		P
	Stop functions shall override related start functions.		P
	Where more than one control station is provided, stop commands from any control station shall be effective when required by the risk assessment of the machine		P
9.2.3.4	Emergency operations (emergency stop, emergency switching off)		P
9.2.3.4.1	General		P
	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).		P
	This part of IEC 60204 specifies the requirements for the emergency stop and the emergency switching off functions of the emergency operations listed in Annex E, both of which are intended to be initiated by a single human action		P
	Once active operation of an emergency stop (see 10.7) or		P

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Clause	Requirements	Result-Remark	Verdict
	emergency switching off (see 10.8) actuator has ceased following a stop or switching off command, the effect of this command shall be sustained until it is reset. This reset shall be possible only by a manual action at the device where the command has been initiated. The reset of the command shall not restart the machinery but only permit restarting.		
	It shall not be possible to restart the machinery until all emergency stop commands have been reset. It shall not be possible to reenergize the machinery until all emergency switching off commands have been reset.		P
9.2.3.4.2	Emergency stop		-
	Requirements for functional aspects of emergency stop equipment are given in ISO 13850.		P
	The emergency stop shall function either as a stop category 0 or as a stop category 1. The choice of the stop category of the emergency stop depends on the results of a risk assessment of the machine		P
	Exception: In some cases, to avoid creating additional risks, it can be necessary to perform a controlled stop and maintain the power to machine actuators even after stopping is achieved. The stopped condition shall be monitored and upon detection of failure of the stopped condition, power shall be removed without creating a hazardous situation.		P
	In addition to the requirements for stop given in 9.2.3.3, the emergency stop function has the following requirements:		P
	• it shall override all other functions and operations in all modes; • it shall stop the hazardous motion as quickly as practicable without creating other hazards; • reset shall not initiate a restart.		P
9.2.3.4.	Emergency switching off		-

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3			
	The functional aspects of emergency switching off are given in 536.4 of IEC 60364-5-53:2001.		P
	Emergency switching off should be provided where:		-
	• basic protection (for example for conductor wires, conductor bars, slip-ring 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.		P
	Emergency switching off is accomplished by switching off the relevant supply by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply. When a machine cannot tolerate this category 0 stop, it may be necessary to provide other measures, for example basic protection, so that emergency switching off is not necessary.		P
9.2.3.5	Operating modes		-
	Each machine can have one or more operating modes (for example manual mode, automatic mode, setting mode, maintenance mode) determined by the type of machine and its application.		P
	Where machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and having a different impact on safety, it shall be fitted with a mode selector which can be locked in each position (for example key operated switch). Each position of the selector shall be clearly identifiable and shall correspond to a single operating or control mode.		P
	The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator (for example access code).		P

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Clause	Requirements	Result-Remark	Verdict
	Mode selection by itself shall not initiate machine operation. A separate actuation of the start control shall be required		P
	For each specific operating mode, the relevant safety functions and/or protective measures shall be implemented.		P
	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).		P
9.2.3.6	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		P
9.2.3.7	Hold-to-run controls		-
	Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation.		N
9.2.3.8	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:		N
	Type I: this type requires: • the provision of two control devices and their concurrent actuation by both hands; • continuous concurrent actuation during the hazardous situation; • machine operation shall cease upon the release 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.		N
	Type II: a Type I control requiring the release of both control devices before machine operation can be reinitiated.		N

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Clause	Requirements	Result-Remark	Verdict
	Type III: a Type II control requiring concurrent actuation of the control devices as follows: • it shall be necessary to actuate the control devices within a certain time limit of each other, not exceeding 0,5 s; • where this time limit is exceeded, both control devices shall be released before machine operation can be initiated		N
9.2.3.9	Enabling control		N
	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, and • prevents initiation of machine operation. Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated		N
9.2.3.10	Combined start and stop controls		N
	Push-buttons and similar control devices that, when operated, alternately initiate and stop motion shall only be provided for functions which cannot result in a hazardous situation.		N
9.2.4	Cableless control system (CCS)		N
9.2.4.1	General requirements		N
	Subclause 9.2.4 deals with the functional requirements of control systems employing cableless (for example radio, infra-red) techniques for transmitting control signals and data between operator control station(s) and other parts of the control system(s).		N
	The CCS shall have functionality and a response time suitable for the application based on the risk assessment		N
9.2.4.2	Monitoring the ability of a cableless control system to control		N

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Clause	Requirements	Result-Remark	Verdict
	a machine		
	The ability of a cableless control system (CCS) to control a machine shall be automatically monitored, either continuously or at suitable intervals. The status of this ability shall be clearly indicated (for example, by an indicating light, a visual display indication, etc.)		N
	If the communication signal is degraded in a manner that might lead to the loss of the ability of a CCS to control a machine (e.g., reduced signal level, low battery power) a warning to the operator shall be provided before the ability of the CCS to control a machine is lost.		N
	When the ability of a CCS to control a machine has been lost for a time that is determined from a risk assessment of the application, an automatic stop of the machine shall be initiated.		N
	Restoration of the ability of a CCS to control a machine shall not restart the machine. Restart shall require a deliberate action, for example manual actuation of a start button.		N
9.2.4.3	Control limitation		N
	Measures shall be taken (e.g. coded transmission) to prevent the machine from responding to signals other than those from the intended cableless operator control station(s).		N
	Cableless operator control station(s) shall only control the intended machine(s) and shall affect only the intended machine functions.		N
9.2.4.4	Use of multiple cableless operator control stations		N
	When more than one cableless operator control station is used to control a machine, then: • only one cableless operator control station shall be enabled at a time except as necessary for the operation of the machine; • transfer of control from one cableless operator control		N

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Clause	Requirements	Result-Remark	Verdict
	station to another shall require a deliberate manual action at the control station that has control; • during machine operation, transfer of control shall only be possible when both cableless operator control stations are set to the same mode of machine operation and/or function(s) of the machine; • transfer of control shall not change the selected mode of machine operation and/or function(s) of the machine; • each cableless operator control station that has control of the machine shall be provided with an indication that it has control (by for example, the provision of an indicating light, a visual display indication).		
9.2.4.5	Portable cableless operator control stations		N
	Portable cableless operator control stations shall be provided with means (for example key operated switch, access code) to prevent unauthorized use.		N
	Each machine under cableless control should have an indication when it is under cableless control.		N
	When a portable cableless operator control station can be connected to one or more of several machines, means shall be provided on the portable cableless operator control station to select which machine(s) is to be connected. Selecting a machine to be connected shall not initiate control commands.		N
9.2.4.6	Deliberate disabling of cableless operator control stations		N
	Where a cableless operator control station is disabled when under control, the associated machine shall meet the requirements for loss of ability of a CCS to control a machine in 9.2.4.2.		N
	Where it is necessary to disable a cableless operator control station without interrupting machine operation, means shall be provided (for example on the cableless operator control station) to transfer control to another fixed or portable control station.		N

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Clause	Requirements	Result-Remark	Verdict
9.2.4.7	Emergency stop devices on portable cableless operator control stations		N
	Emergency stop devices on portable cableless operator control stations shall not be the sole means of initiating the emergency stop function of a machine.		N
	Confusion between active and inactive emergency stop devices shall be avoided by appropriate design and information for use. See also ISO 13850		N
9.2.4.8	Emergency stop reset		N
	Restarting of cableless control after power loss, disabling and re-enabling, loss of communication, or failure of parts of the CCS shall not result in a reset of an emergency stop condition		N
	The instructions for use shall state that the reset of an emergency stop condition initiated by a portable cableless operator control station shall only be performed when it can be seen that the reason for initiation has been cleared.		N
9.3	Protective interlocks		-
9.3.1	Reclosing or resetting of an interlocking safeguard		-
	The reclosing or resetting of an interlocking safeguard shall not initiate hazardous machine operation		P
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.		P
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		P

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Clause	Requirements	Result-Remark	Verdict
	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.		P
	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.		P
	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.		P
	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		P
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.		N
	Control circuits shall be so arranged that rotation of a motor		N

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Clause	Requirements	Result-Remark	Verdict
	shaft, for example by applying a manual force or any other force causing the shaft to rotate after it has stopped, shall not result in a hazardous situation.		
9.3.6	Suspension of safety functions and/or protective measures		-
	Where it is necessary to suspend safety functions and/or protective measures (for example for setting or maintenance purposes), the control or operating mode selector shall simultaneously:		N
	• disable all other operating (control) modes; • permit operation only by the use of a hold-to-run device or by a similar control device positioned so as to permit sight of the hazardous elements; • permit operation of the hazardous elements only in reduced risk conditions (e.g. reduced speed, reduced power / force, step-by-step operation, e.g. with a limited movement control device); • prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors.		N
	• disable all other operating (control) modes; • permit operation only by the use of a hold-to-run device or by a similar control device positioned so as to permit sight of the hazardous elements; • permit operation of the hazardous elements only in reduced risk conditions (e.g. reduced speed, reduced power / force, step-by-step operation, e.g. with a limited movement control device); • prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors.		N
9.4	Control functions in the event of failure		-
9.4.1	General requirements		-
	Where failures or disturbances in the electrical equipment can cause a hazardous situation or damage to the machine or to the work in progress, appropriate measures shall be taken to		P

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Clause	Requirements	Result-Remark	Verdict
	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).		
	Examples of such measures that can be appropriate include but are not limited to: • protective interlocking of the electrical circuit; • use of proven circuit techniques and components (see 9.4.2.2); • provision of partial or complete redundancy (see 9.4.2.3) or diversity (see 9.4.2.4); • provision for functional tests (see 9.4.2.5).		P
	The electrical control system(s) shall have an appropriate performance that has been determined from the risk assessment of the machine.		P
	The requirements for safety-related control functions of IEC 62061 and/or ISO 13849-1, ISO 13849-2 shall apply.		P
	Where functions performed by the electrical control system(s) have safety implications but application of IEC 62061 leads to a required safety integrity less than that required by SIL 1, compliance with the requirements of this part of IEC 60204 can lead to an adequate performance of the electrical control system(s).		P
	Where memory retention is achieved for example, by battery power, measures shall be taken to prevent hazardous situations arising from failure, undervoltage or removal of the battery.		P
	Means shall be provided to prevent unauthorized or inadvertent memory alteration by, for example, requiring the use of a key, access code or tool.		P
9.4.2	Measures to minimize risk in the event of failure		-
9.4.2.1	General		-

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Clause	Requirements	Result-Remark	Verdict
	Measures to minimize risk in the event of failure include but are not limited to: • use of proven circuit techniques and components; • provisions of partial or complete redundancy; • provision of diversity; • provision for functional tests.		P
9.4.2.2	Use of proven circuit techniques and components		-
	These measures include but are not limited to: • bonding of control circuits to the protective bonding circuit for functional purposes (see 9.4.3.1.1 and Figure 4); • connection of control devices in accordance with 9.4.3.1.1; • stopping by de-energizing; • the switching of all control circuit conductors (for example both sides of a coil) of the device being controlled; • switching devices having direct opening action (see IEC 60947-5-1); • monitoring by: – use of mechanically linked contacts (see IEC 60947-5-1); – use of mirror contacts (see IEC 60947-4-1); • circuit design to reduce the possibility of failures causing undesirable operations.		P
9.4.2.3	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.		P
	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		P
9.4.2.4	Provision of diversity		-

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Clause	Requirements	Result-Remark	Verdict
	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 use of a combination of normally open and normally closed contacts; – the use of different types of control devices in the circuit(s); – the combination of electromechanical and electronic equipment in redundant configurations		P
	The combination of electrical and non-electrical systems (for example mechanical, hydraulic, pneumatic) may perform the redundant function and provide the diversity.		P
9.4.2.5	Provision for functional tests		-
	Functional tests may be carried out automatically by the control system, or manually by inspection or tests at start-up and at predetermined intervals, or a combination as appropriate (see also 17.2 and 18.6).		P
9.4.3	Protection against malfunction of control circuits		-
9.4.3.1	Insulation faults		-
9.4.3.1.1	General		-
	Measures shall be provided to reduce the probability that insulation faults on any control circuit can cause malfunction such as unintentional starting, potentially hazardous motions, or prevent stopping of the machine		P
	The measures to meet the requirements include but are not limited to the following methods: – method a) Earthed control circuits fed by transformers; – method b) Non-earthed control circuits fed by transformers; – method c) Control circuits fed by transformer with an earthed centre-tap winding; – method d) Control circuits not fed by a transformer		P

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Clause	Requirements	Result-Remark	Verdict
9.4.3.2	Voltage interruptions		-
	See also 7.5. 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.		P
9.4.3.3	Loss of circuit continuity		-
	Where the loss of continuity of control circuits depending upon sliding contacts can result in a hazardous situation, appropriate measures shall be taken (for example by duplication of the sliding contacts).		P
10	Operator interface and machine-mounted control devices		-
10.1	General		-
10.1.1	General requirements		-
	Control devices for operator interface shall, as far as is practicable, be selected, mounted, and identified or coded in accordance with IEC 61310 series. 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, and of sensors (for example position sensors) that can initiate machine operation. Further information can be found in IEC 60447.Ergonomic principles shall be taken into account in the location of operator interface devices		P
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		P

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Clause	Requirements	Result-Remark	Verdict
	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.		P
	The actuators of foot-operated control devices shall be selected and installed so that: • they are within easy reach of the normal working position of the operator; • the operator is not placed in a hazardous situation when operating them.		P
10.1.3	Protection		-
	The degree of protection (IP rating in accordance with IEC 60529) together with other appropriate measures shall provide protection against: • the effects of 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 contact with live parts of IPXXD in accordance with IEC 60529.		P
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.		N

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Clause	Requirements	Result-Remark	Verdict
	Position sensors in circuits with safety-related control functions (for example, to maintain the safe condition of the machine or prevent hazardous situations arising at the machine) shall have direct opening action (see IEC 60947-5-1) or shall provide similar reliability (see 9.4.2).		N
10.1.5	Portable and pendant control stations		-
	Portable and pendant operator control stations and their control devices shall be so selected and arranged as to minimize the possibility of machine operations caused by inadvertent actuation, shocks and vibrations (for example if the operator control station is dropped or strikes an obstruction) (see also 4.4.8).		N
10.2	Actuators		-
10.2.1	Colours		-
	Actuators (see 3.1.1) shall be colour-coded as follows.		-
	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 (including supply disconnecting devices where it is foreseen that they are for use in an emergency). If a background exists immediately around the actuator, then this background shall be coloured YELLOW. The combination of a RED actuator with a YELLOW background shall only be used for emergency operation devices. 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		P

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

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Clause	Requirements	Result-Remark	Verdict
	confirm the termination of a change or transition period. The colours BLUE and WHITE are normally used in this mode and GREEN may be used in some case		
	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). Circuits used for visual or audible devices used to warn persons of an impending hazardous event shall be fitted with facilities to check the operability of these devices.		P
10.3.2	Colours		-
	Indicator lights should be colour-coded with respect to the condition (status) of the machine in accordance with Table 4.		P
	Indicating towers on machines should have the applicable colours in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE		P
10.3.3	Flashing lights and displays		-
	For further distinction or information and especially to give additional emphasis, flashing lights and displays can be provided for the following purposes: – 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 flashing frequencies are 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, additional acoustic warnings should be considered.		P
10.4	Illuminated push-buttons		-
	Illuminated push-button actuators shall be colour-coded in accordance with 10.2.1. Where there is difficulty in assigning		P

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Clause	Requirements	Result-Remark	Verdict
	an appropriate colour, WHITE shall be used. The colour of active emergency stop actuators shall remain RED regardless of the state of the illumination		
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.		P
10.6	Start devices		-
	Actuators used to initiate a start function or the movement of machine elements (for example slides, spindles, carriers) shall be constructed and mounted so as to minimize inadvertent operation.		P
10.7	Emergency stop devices		-
10.7.1	Location of emergency stop devices		-
	Devices for emergency stop shall be readily accessible		P
	Emergency stop devices shall be provided at each location where the initiation of an emergency stop can be required.		P
	There can be circumstances where confusion can occur between active and inactive emergency stop devices caused by, for example, unplugging or otherwise disabling an operator control station. In such cases, means (for example, design and information for use) shall be provided to minimise confusion.		P
10.7.2	Types of emergency stop device		-
	The types of device for emergency stop include, but are not limited to: • a push-button device for actuation by the palm or the fist (e.g. mushroom head type); • a pull-cord operated switch; • a pedal-operated switch without a mechanical guard. The devices shall be in accordance with IEC 60947-5-5.		P

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Clause	Requirements	Result-Remark	Verdict
10.7.3	Operation of the supply disconnecting device to effect emergency stop		-
	Where a stop category 0 is suitable, the supply disconnecting device may serve the function of emergency stop where: • it is readily accessible to the operator; and • it is of the type described in 5.3.2 a), b), c), or d). Where intended for emergency use, the supply disconnecting device shall meet the colour requirements of 10.2.1.		P
10.8	Emergency switching off devices		-
10.8.1	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 confusion can occur between emergency stop and emergency switching off devices, means shall be provided to minimise confusion.		P
10.8.2	Types of emergency switching off device		-
	The types of device for initiation of emergency switching off include: • a push-button operated switch with a palm or mushroom head type of actuator; • a pull-cord operated switch. The devices shall have direct opening action (see Annex K of IEC 60947-5-1:2003 and IEC 60947-5-1:2003/AMD1:2009		P
10.8.3	Local operation of the supply disconnecting device to effect emergency switching off		-
	Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and shall meet the colour requirements of 10.2.1.		P
10.9	Enabling control device		-
	The enabling control function is described in 9.2.3.9.		P

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Clause	Requirements	Result-Remark	Verdict
	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); • position 3: off-function (actuator is operated past its mid position); • when returning from position 3 to position 2, the enabling function is not activated.		P
11	Controlgear: location, mounting, and enclosures		-
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		P
11.2	Location and mounting		-
11.2.1	Accessibility and maintenance		-
	All items of controlgear shall be placed and oriented so that they can be identified without moving them or the wiring. For items that require checking for correct operation or that are liable to need replacement, those actions should be possible		P

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Clause	Requirements	Result-Remark	Verdict
	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. Where a special tool is necessary to adjust, maintain, or remove a device, such a tool shall be supplied. Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0,4 m and 2,0 m above the servicing level. It is recommended that terminals be at least 0,2 m above the servicing level and be so placed that conductors and cables can be easily connected to them.		P
	No devices except devices for operating, indicating, measuring, and cooling shall be mounted on doors or on access covers of enclosures that are expected to be removed.		P
	Where control devices are connected through plug-in arrangements, their association shall be made clear by type (shape), marking or reference designation, singly or in combination (see 13.4.5).		P
	Plug/socket combinations that are handled during normal operation shall be located and mounted so as to provide unobstructed access.		P
	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; – adequately insulated; – sufficiently spaced.		P
11.2.2	Physical separation or grouping		-
	Non-electrical parts and devices, not directly associated with the electrical equipment, shall not be located within		P

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Clause	Requirements	Result-Remark	Verdict
	enclosures containing controlgear. Devices such as solenoid valvesshould be separated from the other electrical equipment (for example in a separate compartment).		
	Control devices mounted in the same location and connected to the power circuits, or to both power and control circuits, should be grouped separately from those connected only to the control circuits.		P
	Terminals shall be separated into groups for: – power circuits; – control circuits of the machine; – other control circuits, fed from external sources (for example for interlocking).		P
	The groups may be mounted adjacently, provided that each group can be readily identified (for example by markings, by use of different sizes, by use of barriers or by colours).		P
	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.		P
11.2.3	Heating effects		-
	The temperature rise inside electrical equipment enclosures shall not exceed the ambient temperature specified by the component manufacturers.		P
	Heat generating components (for example heat sinks, power resistors) shall be so located that the temperature of each component in the vicinity remains within the permitted limit.		P
11.3	Degrees of protection		-
	The protection of controlgear against ingress of solid foreign objects and of liquids shall be adequate taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental		P

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Clause	Requirements	Result-Remark	Verdict
	conditions) and shall be sufficient against dust, coolants, lubricants and swarf. Enclosures of controlgear shall provide a degree of protection of at least IP22 (see IEC 60529).		
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.		P
	Fasteners used to secure doors and covers should be of the captive type.		P
	Windows of enclosures shall be of a material suitable to withstand expected mechanical stress and chemical attack.		P
	It is recommended that enclosure doors having vertical hinges be not wider than 0,9 m, with an angle of opening of at least 95°.		P
	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.		P
	Where openings in enclosures are provided (for example, for cable access), including those towards the floor or foundation or to other parts of the machine, means shall be provided to ensure the degree of protection specified for the equipment. Openings for cable entries shall be easy to re-open on site. A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can		P

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Clause	Requirements	Result-Remark	Verdict
	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.		P
	Where there are holes in an enclosure for mounting purposes, means may be necessary to ensure that after mounting, the holes do not impair the required protection		P
	Equipment that, in normal or abnormal operation, can attain a surface temperature sufficient to cause a risk of fire or detrimental 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.		P
11.5	Access to electrical equipment		-
	Doors in gangways and for access to electrical operating areas shall: – be at least 0,7 m wide and 2,0 m high; – open outwards; – have a means (for example panic bolts) to allow opening from the inside without the use of a key or tool.		P
12	Conductors and cables		-
12.1	General requirements		-

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Clause	Requirements	Result-Remark	Verdict
	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		P
	These requirements do not apply to the integral wiring of assemblies, subassemblies, and devices that are manufactured and tested in accordance with their relevant IEC standard (for example IEC 61800 series).		P
12.2	Conductors		-
	Conductors should be of copper. Where aluminium conductors are used, the cross-sectional area shall be at least 16 mm2.		P
	To ensure adequate mechanical strength, the cross-sectional area of conductors should not be less than as shown in Table 5. However, conductors with smaller cross-sectional areas or other constructions than shown in Table 5 may be used in equipment provided adequate mechanical strength is achieved by other means and proper functioning is not impaired.		P
12.3	Insulation		-
	Where the insulation of conductors and cables can constitute hazards due for example to the propagation of a fire or the emission of toxic or corrosive fumes, guidance from the cable supplier sh be sought. It is important to give special attention to the integrity of a circuit having a safety-related function		P
	The insulation of cables and conductors used, shall be suitable for a test voltage:		-
	– not less than 2 000 V AC for a duration of 5 min for operation at voltages higher than 50 V AC or 120 V DC, or		P

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Clause	Requirements	Result-Remark	Verdict
	– not less than 500 V AC for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment).		N
	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.		P
12.4	Current-carrying capacity in normal service		-
	The current-carrying capacity depends on several factors, for example insulation material, number of conductors in a cable, design (sheath), methods of installation, grouping and ambient temperature.		P
	One typical example of the current-carrying capacities for PVC insulated wiring between enclosures and individual items of equipment under steady-state conditions is given in Table 6.		P
12.5	Conductor and cable voltage drop		-
	The voltage drop from the point of supply to the load in any power circuit cable shall not exceed 5 % of the nominal voltage under normal operating conditions. In order to conform to this requirement, it can be necessary to use conductors having a larger cross-sectional area than that derived from Table 6.		P
	In control circuits, the voltage drop shall not reduce the voltage at any device below the manufacturer’s specification for that device, taking into account inrush currents. See also 4.3. The voltage drop in components, for example overcurrent protective devices and switching devices, should be considered		P
12.6	Flexible cables		-
12.6.1	General		-
	Flexible cables shall have Class 5 or Class 6 conductors.		P
	Cables that are subjected to severe duties shall be of adequate construction to protect against:		P

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Clause	Requirements	Result-Remark	Verdict
	– 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.		
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.		P
	The maximum stress applied to the conductors of flexible cables with material other than copper shall be within the cable manufacturer's specification.		P
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.		
12.7	Conductor wires, conductor bars and slip-ring assemblies		-
12.7.1	Basic protection		-
	Conductor wires, conductor bars and slip-ring assemblies shall be installed or enclosed in such a way that, during normal access to the machine, basic protection is achieved by the application of one of the following protective measures: – protection by partial insulation of live parts, or where this is not practicable;		P

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Clause	Requirements	Result-Remark	Verdict
	– protection by enclosures or barriers of at least IP2X or IPXXB		
	Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X or IPXXD.		P
	Where the required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching off in accordance with 9.2.3.4.3 shall be applied.		P
	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.		P
12.7.2	Protective conductors		-
	Where conductor wires, conductor bars and slip-ring assemblies are installed as part of the protective bonding circuit, they shall not carry current in normal operation. Therefore, the protective conductor (PE) and the neutral conductor (N) shall each use a separate conductor wire, conductor bar or slip-ring.		P
	The continuity of protective conductors using sliding contacts shall be ensured by taking appropriate measures (for example, duplication of the current collector, continuity monitoring).		P
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.		P

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Clause	Requirements	Result-Remark	Verdict
12.7.4	Removable current collectors with a disconnector function		-
	Removable current collectors having a disconnector function shall be so designed that the protective conductor circuit is interrupted only after the live conductors have been disconnected, and the continuity of the protective conductor circuit is re-established before any live conductor is reconnected (see also 8.2.3).		P
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.		P
12.7.6	Creepage distances		-
	Creepage distances between the respective conductors, between adjacent systems of conductor wires, conductor bars and slip-ring assemblies, and their current collectors shall be suitable for operation in the intended environment, for example open air, inside buildings, protected by enclosures.		P
	In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply: – unprotected conductor wires, conductor bars, and slip-ring assemblies shall be equipped with insulators with a minimum creepage distance of 60 mm; – enclosed conductor wires, insulated multipole conductor bars and insulated individual conductor bars shall have a minimum creepage distance of 30 mm.		P
	The manufacturer's recommendations shall be followed regarding special measures to prevent a gradual reduction in the insulation values due to unfavourable ambient conditions (for example deposits of conductive dust, chemical attack).		P
12.7.7	Conductor system sectioning		-

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Clause	Requirements	Result-Remark	Verdict
	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.		P
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.		P
	Conductor wires, conductor bars and slip-ring assemblies, including their current collectors, shall be capable of withstanding, without damage, the mechanical forces and thermal effects of short-circuit currents		P
	Removable covers for conductor wire and conductor bar systems laid underground or underfloor shall be so designed that they cannot be opened by one person without the aid of a tool.		P
	Where conductor bars are installed in a common metal enclosure, the individual sections of the enclosure shall be bonded together and connected to the protective bonding circuit. Metal covers of conductor bars laid underground or underfloor shall also be bonded together and connected to the protective bonding circuit.		P
	The protective bonding circuit shall include the covers or cover plates of metal enclosures or underfloor ducts. Where metal hinges form a part of the protective bonding circuit, their continuity shall be verified (see Clause 18).		P
	Conductor bar ducts that can be subject to accumulation of liquid such as oil or water shall have drainage facilities		P
13	Wiring practices		-
13.1	Connections and routing		-
	All connections, especially those of the protective bonding		P

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Clause	Requirements	Result-Remark	Verdict
	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.		P
	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.		P
	Soldered connections shall only be permitted where terminals are provided that are suitable for soldering.		P
	Terminals on terminal blocks shall be plainly marked or labelled to correspond with the identification used in the diagrams		P
	Where an incorrect electrical connection (for example, arising from replacement of devices) is identified as a source of risk that needs to be reduced and it is not practicable to reduce the possibility of incorrect connection by design measures, the conductors and/or terminations shall be identified.		P
	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.		P
	Shielded conductors shall be so terminated as to prevent fraying of strands and to permit easy disconnection.		P
	Identification tags shall be legible, permanent, and appropriate for the physical environment.		P
	Terminal blocks shall be mounted and wired so that the wiring does not cross over the terminals.		P
13.1.2	Conductor and cable runs		-
	Conductors and cables shall be run from terminal to terminal		P

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Clause	Requirements	Result-Remark	Verdict
	without splices or joints. Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be splices or joints for the purpose of 13.1.2.		
	Where it is necessary to connect and disconnect cables and cable assemblies, sufficient extra length shall be provided for that purpose.		P
	The terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors.		P
	Wherever practicable, the protective conductor shall be placed close to the associated live conductors in order to decrease the impedance of the loop.		P
13.1.3	Conductors of different circuits		
	Conductors of different circuits may be laid side by side, may occupy the same duct (for example conduit, cable trunking system), or may be in the same multiconductor cable or in the same plug/socket combination provided that the arrangement does not impair the proper functioning of the respective circuits and: • where those circuits operate at different voltages, the conductors are separated by suitable barriers or; • the conductors are insulated for the highest voltage to which any of the conductors can be subjected, for example line to line voltage for unearthed systems and phase to earth voltage for earthed systems.		P
13.1.4	AC circuits – Electromagnetic effects (prevention of eddy currents)		-
	Conductors of AC circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit, including the protective conductor of each circuit, are contained in the same enclosure. Where such conductors enter a ferrous enclosure, they shall be arranged		P

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Clause	Requirements	Result-Remark	Verdict
	such that the conductors are not individually surrounded by ferromagnetic material. Single-core cables armoured with steel wire or steel tape should not be used for AC circuits.		
13.1.5	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 shall be:– as short as practicable; – adequately protected against mechanical damage.		P
13.2	Identification of conductors		-
13.2.1	General requirements		-
	Each conductor shall be identifiable at each termination in accordance with the technical documentation.		P
	It is recommended (for example to facilitate maintenance) that conductors be identified by number, alphanumeric, colour (either solid or with one or more stripes), or a combination of colour and numbers or alphanumeric. When numbers are used, they shall be Arabic; letters shall be Roman (either upper or lower case).		P
13.2.2	Identification of the protective conductor / protective bonding conductor		-
	The protective conductor / protective bonding conductor shall be readily distinguishable from other conductors by shape, location, marking, or colour. When identification is by colour alone, the bicolour combination GREEN-AND-YELLOW shall be used throughout the length of the conductor. This colour identification is strictly reserved for protective conductors/protective bonding conductors. 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(s) can be easily identified by		P

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Clause	Requirements	Result-Remark	Verdict
	its shape, position, or construction (for example a braided conductor, uninsulated stranded conductor), or where the insulated conductor is not readily accessible or is part of a multicore cable, colour coding throughout its length is not necessary. However, where the conductor is not clearly visible throughout its length, the ends or accessible locations shall be clearly identified by the graphical symbol IEC 60417-5019:2006-08 (see Figure 16) or with the letters PE or by the bicolour combination GREEN-AND-YELLOW.		
13.2.3	Identification of the neutral conductor		-
	Where a circuit includes a neutral conductor that is identified by colour alone, the colour used for this conductor shall be BLUE. In order to avoid confusion with other colours, it is recommended that an unsaturated blue be used, called here “light blue” (see 6.2.2 of IEC 60445:2010). Where the selected colour is the sole identification of the neutral conductor, that colour shall not be used for identifying any other conductor where confusion is possible.		P
	Where identification by colour is used, bare conductors used as neutral conductors shall be either coloured by a stripe, 15 mm to 100 mm wide in each compartment or unit and at each accessible location, or coloured throughout their length.		P
13.2.4	Identification by colour		-
	Where colour-coding is used for identification of conductors (other than the protective conductor (see 13.2.2) and the neutral conductor (see 13.2.3)), the following colours may be used: BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE		P
	It is recommended that, where colour is used for identification, the colour be used throughout the length of the conductor either by the colour of the insulation or by colour		P

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Clause	Requirements	Result-Remark	Verdict
	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).		P
	Colour identification using combinations of those colours listed above may be used provided there can be no confusion and that GREEN or YELLOW is not used except in the bicolour combination GREEN-AND-YELLOW		P
	Where colour-coding is used for identification of conductors, it is recommended that they be colour-coded as follows: – BLACK: AC and DC power circuits; – RED: AC control circuits; – BLUE: DC control circuits; – ORANGE: excepted circuits in accordance with 5.3.5.		P
	Exceptions to the above are permitted where insulation is not available in the colours recommended (for example in multiconductor cables).		P
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).		P
	It is recommended that electrical equipment mounted inside enclosures be designed and constructed in such a way as to permit modification of the wiring from the front of the enclosure (see also 11.2.1). Where that is not practicable and control devices are connected from the rear of the enclosure, access doors or swingout panels shall be provided.		P
	Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors in		P

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Clause	Requirements	Result-Remark	Verdict
	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.		P
	Terminal blocks or plug/socket combinations shall be used for control wiring that extends beyond the enclosure. For plug/socket combinations, see also 13.4.5 and 13.4.6.		P
	Power cables and cables of measuring circuits may be directly connected to the terminals of the devices for which the connections were intended.		P
13.4	Wiring outside enclosures		-
13.4.1	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). Conductors of a circuit shall not be distributed over different multi-core cables, conduits, cable ducting systems or cable trunking systems. This is not required where a number of multi-core cables, forming one circuit, are installed in parallel. Where multi-core cables are installed in parallel, each cable shall contain one conductor of each phase and the neutral if any.		P
13.4.2	External ducts		-
	Conductors and their connections external to the electrical equipment enclosure(s) shall be enclosed in suitable ducts (i.e. conduit or cable trunking systems) as described in 13.5 except for suitably protected cables that may be installed without ducts and with or without the use of cable trays or cable support means. Where devices such as position switches or proximity switches are supplied with a dedicated cable, their cable need not be enclosed in a duct when		P

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Clause	Requirements	Result-Remark	Verdict
	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 cables shall be suitable for the physical environment		P
	Flexible conduit or flexible multiconductor cable shall be used where it is necessary to employ flexible connections to pendant push-button stations. The weight of the pendant stations shall be supported by means other than the flexible conduit or the flexible multiconductor cable, except where the conduit or cable is specifically designed for that purpose.		P
13.4.3	Connection to moving elements of the machine		-
	The design of connections to moving parts shall take into account the foreseeable frequency of movement and shall be made using conductors in accordance with 12.2 and 12.6. Flexible cable and flexible conduit shall be so installed as to avoid excessive flexing and straining, particularly at the fittings.		P
	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 as specified by the cable manufacturer or if no such specification is given, at least 10 times the diameter of the cable.		P
	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;		P

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Clause	Requirements	Result-Remark	Verdict
	– 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).		P
	Where cables subject to movement are close to moving parts, precautions shall be taken to maintain a space of at least 25 mm between the moving parts and the cables. Where that distance is not practicable, fixed barriers shall be provided between the cables and the moving parts		P
	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		P
	Measures shall be taken to ensure that at least two turns of flexible cables always remain on a drum.		P
	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.		P
	The straight section between two bends shall be at least 20 times the diameter of the cable		P
	Where flexible conduit is adjacent to moving parts, the construction and supporting means shall prevent damage to the flexible conduit under all conditions of operation. Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically		P

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Clause	Requirements	Result-Remark	Verdict
	designed for that purpose		
13.4.4	Interconnection of devices on the machine		-
	Where several machine-mounted devices (for example position sensors, push-buttons) are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points. Such terminals shall be conveniently placed, adequately protected, and shown on the relevant diagrams.		P
13.4.5	Plug/socket combinations		-
	Components or devices inside an enclosure, terminated by fixed plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination, are not considered to be plug/socket combinations for the purpose of this 13.4.5.		N
	After installation in accordance with item a) below, plug/socket combinations shall be of such a type as to prevent unintentional contact with live parts at any time, including during insertion or removal of the connectors. The degree of protection shall be at least IP2X or IPXXB. PELV circuits are excepted from this requirement		N
	Where the plug/socket contains a contact for the protective bonding circuit, it shall have a first make last break contact (see also 8.2.4).		N
	Plug/socket combinations intended to be connected or disconnected during load conditions shall have sufficient load-breaking capacity. Where the plug/socket combination is rated at 30 A, or greater, it shall be interlocked with a switching device so that the connection and disconnection is possible only when the switching device is in the OFF position.		N
	Plug/socket combinations that are rated at more than 16 A shall have a retaining means to prevent unintended or		N

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Clause	Requirements	Result-Remark	Verdict
	accidental disconnection		
	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: a) The component which remains live after disconnection shall have a degree of protection of at least IP2X or IPXXB, taking into account the required clearance and creepage distances. PELV circuits are excepted from this requirement. b) Metallic housings of plug/socket combinations shall be connected to the protective bonding circuit. c) Plug/socket combinations intended to carry power loads but not to be disconnected during load conditions shall have a retaining means to prevent unintended or accidental disconnection and shall be clearly marked that they are not intended to be disconnected under load. d) Where more than one plug/socket combination is provided in the same electrical equipment, the associated combinations shall be clearly identifiable. It is recommended that mechanical coding be used to prevent incorrect insertion. e) Plug/socket combinations used in control circuits shall fulfil the applicable requirements of IEC 61984.		N
13.4.6	Dismantling for shipment		-
	Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points. Such terminals shall be suitably enclosed and plug/socket combinations shall be protected from the physical environment during transportation and storage.		P
13.4.7	Additional conductors		-
	Consideration should be given to providing additional conductors for maintenance or repair.		P

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

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Clause	Requirements	Result-Remark	Verdict
	and cables.		
13.5.2	Rigid metal conduit and fittings		-
	Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material suitable for the conditions.		P
	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 should 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.		P
13.5.3	Flexible metal conduit and fittings		-
	A flexible metal conduit shall consist of a flexible metal tubing or woven wire armour. It shall be suitable for the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application		P
13.5.4	Flexible non-metallic conduit and fittings		-
	Flexible non-metallic conduit shall be resistant to kinking and shall have physical characteristics similar to those of the sheath of multiconductor cables. The conduit shall be suitable for use in the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.		P
13.5.5	Cable trunking systems		-
	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving parts of the machine and of sources of contamination.		P
	Covers shall be shaped to overlap the sides; gaskets shall be permitted. Covers shall be attached to cable trunking systems		P

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Clause	Requirements	Result-Remark	Verdict
	by suitable means. On horizontal cable trunking systems, the cover shall not be on the bottom unless specifically designed for such installation.		
	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		P
13.5.6	Machine compartments and cable trunking systems		-
	The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided the compartments or cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed. Conductors run in enclosed compartments and cable trunking systems shall be so secured and arranged that they are not subject to damage.		P
13.5.7	Connection boxes and other boxes		-
	Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance. Those boxes shall provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate (see 11.3).		P
	Those boxes shall not have opened but unused knockouts nor any other openings and shall be so constructed as to exclude materials such as dust, flyings, oil, and coolant.		P
13.5.8	Motor connection boxes		-
	Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (for example brakes, temperature sensors, plugging switches, tachometer generators).		P
14	Electric motors and associated equipment		P
15	Socket-outlets and lighting		P

EN 60204-1:2018			
Clause	Requirements	Result-Remark	Verdict
16	Marking, warning signs and reference designations		P
17	Technical documentation		P
18	Verification		P

2.4 EN 1175:2020 Safety of industrial trucks – Electrical/electronic requirements.

EN 1175:2020			
Items	Requirements	Result-Remark	Verdict
4	Requirements		-
4.1	Introduction		-
	Trucks shall comply with the safety requirements and/or protective measures of this clause. In addition, the truck shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.		-
4.2	Validation of safety functions		-
	The design of safety functions shall be validated in accordance with EN ISO 13849-1:2015,		P

EN 1175:2020			
Items	Requirements	Result-Remark	Verdict
	Clause 8.		
4.3	General requirements		-
4.3.1	Low voltage/high voltage		-
	Safety shall not be compromised at any voltage level that can occur. Electrical systems of trucks powered by lead-acid batteries shall be designed so that all functions operate in the voltage range from 70 % up to 120 % of the nominal battery voltage. These limits shall be adapted to other energy sources technologies by the manufacturer		P
4.3.2	Frame fault		-
	The electric circuits shall be so designed or protected, that frame faults shall not cause hazardous inadvertent movements that cannot be corrected or compensated by the operator. Compliance shall be verified by means of the type test of 4.10.4.		P
4.3.3	Protection from ingress of water and dust		-
	The electrical installation of the trucks in operating condition shall be designed and constructed such that the protection from harmful ingress of water and dust is in accordance with the environmental conditions in which the truck is designed to operate, including reasonably foreseeable misuses, as defined in the instruction handbook (see EN ISO 3691-1:2015, 6.2.2).		P
4.3.4	Protection against electric shock		-
	Non-insulated live parts of trucks in the operating condition shall be protected to a degree of IPXXB preventing direct contact. For top surfaces, the minimum degree shall be IPXXD in accordance with EN 60529:1991.		P

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Items	Requirements	Result-Remark	Verdict
	Access to an electrical enclosure containing uninsulated live parts in excess of nominal voltage 60 V DC or 25 V AC shall be possible only using a tool. Indirect contact with live parts shall be avoided by electric separation of the protection devices in accordance with EN 60204-1:2006, 6.3.2.3. It shall be possible to electrically disconnect the energy sources for maintenance and replacement operations. An easily accessible switch, connector or disconnectable battery terminals meets the intent of this requirement, For energy sources with nominal voltage greater than 60 V DC or 25 V AC live parts shall be protected against direct contact.		
4.3.5	Connection to the frame		-
4.3.5.1	Battery powered trucks		-
	There shall be no electrical connection to the truck frame, except for:		-
	a) frame fault detection system; b) electric/electronic circuits with a nominal voltage not greater than 60 V DC which are galvanically separated from the energy source; c) connection to the earthing terminal of on-board chargers; d) suppression capacitors. If the nominal battery voltage exceeds 60 V DC, minimum requirement for the capacitor shall be Class Y in accordance with EN 60384-14; e) the screen of shielded cables and components. This condition shall meet the requirements of the insulation resistance testing in 4.10.2; f) suppression resistor for ESD reduction, the system shall meet the requirements of 4.10.2.		P
4.3.5.2	IC trucks		-

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Items	Requirements	Result-Remark	Verdict
	a) Electrical system with nominal voltage not greater than 48 V (starter battery): — one pole of the electrical system may be connected to the truck frame; — all conductors not connected to the truck frame shall be effectively insulated and where necessary protected against thermal and mechanical damage; — there shall be means to disconnect both poles of the starter battery from the truck for service purposes; b) electrical system with nominal voltage greater than 48 V (hybrid drive system): — electrical systems with nominal voltage greater than 48 V shall be electrically insulated and galvanically separated from frame, with the exceptions listed in 4.3.5.1 a), b), d), e) and f); — control and auxiliary circuits shall have a maximum voltage not greater than 120 V DC or 50 V AC. Where the energy source maximum voltage is greater, control and auxiliary circuits shall be electrically and galvanically separated from the energy source; — for maximum voltages greater than 120 V DC and 50 V AC, equipotential bonding shall be provided between the frame of the vehicle and conductive enclosures, e.g. motor frames.		P
4.3.6	Protection from residual voltages		-
	After disconnecting energy sources, the voltage of the capacitors in power circuits shall be less than 60 V DC after 10 s. If the above condition is not technically achievable or		P

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Items	Requirements	Result-Remark	Verdict
	practicable a warning/safety label shall be provided. This warning label shall be permanent and indelible and shall be affixed on, or in close proximity to, the enclosure containing the capacitors.		
4.3.7	Overcurrent protection		-
	Power, control and auxiliary circuits shall be provided with overcurrent protection that is sized to prevent overheating of the smallest size conductor. Overcurrent protective devices shall be capable of interrupting the maximum fault current without creating a fire hazard. Overcurrent protective devices in the control and power circuits shall be as close as practicable to the energy source. Non-resettable overcurrent protective devices shall be identified according to the replacement rating of the device. If the overcurrent protection is realized by electronic systems, e.g. by inverters or DC/DC converters, this function shall be in accordance with PLr as defined in Table 6. Overcurrent protective devices shall be identified, and rating of these devices shall be indicated on the electrical diagram. Replaceable overcurrent protective devices shall be provided with rating which shall be located on the truck, adjacent or close to the device itself.		P
4.3.8	Fire and heat hazards (installation of arcing and sparking parts)		-
	Any arcing part in a power circuit shall be enclosed or installed to adequately reduce the possibility of flame or molten material causing a risk of fire.Relevant parts shall be accessible for servicing and inspection		P

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Items	Requirements	Result-Remark	Verdict
4.3.9	Sparking or heat dissipating electrical components		-
	Sparking components and components which can reach a temperature of 300 °C or more under normal operating conditions, shall not be located where potentially explosive gas/air mixtures can be present. Battery connectors shall be accepted as non-sparking components if they are not used as an emergency switching-off device.		P
4.3.10	Electromagnetic radiation		P
4.4	Energy sources		-
4.4.1	General		-
	Energy sources shall conform to Annex C.		P
	Connectors used for connecting energy sources to industrial trucks and to the charging equipment shall conform to the requirements of Annex A.		P
4.4.2	Connection to the mains		-
4.4.2.1	Battery charging		-
	When external charging supply cables are connected to the truck, truck movement shall be prevented. This safety function shall be in accordance with PLr as defined in Table 6. This does not apply to trucks designed only for permanent charging during operation. The requirement is not intended for starter batteries.		P
4.4.2.2	On board charger and/or additional components		-
	When trucks are fitted with on-board chargers or other devices connected to the mains, e.g. heaters, the requirements of EN 60204-1:2006, 6.3, 7.2.1 and Clause 8 up to and including 8.2 shall apply. Enclosures containing equipment connected to the mains supply shall be in accordance with IPXXB of EN 60529:1991. However, for top surfaces		P

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Items	Requirements	Result-Remark	Verdict
	the degree of protection shall be in accordance with at least IPXXD. When the mains supply cables are connected to the truck it shall not be possible to induce any truck movement. This safety function shall be in accordance with PLr as defined in Table 6. NOTE 1 Where a main external power supply socket could be switched off this requirement can be met by an interlock when the charger plug is in the home stowed position. A position shall be provided on the truck to safely and properly store the cable, where permanently attached.		
4.4.3	Electrical energy sources for IC trucks (hybrid systems		-
	warning signs for residual voltage. Energy sources based on battery technology shall be equipped with a switching off device in accordance with 4.9.1.3. They shall be manually disconnectable and shall be automatically disconnected in case of an electrical fault related to the power system. They shall be provided with warning signs referring to high stored energy at high voltage. The warning signs shall be permanent and indelible.		P
4.4.4	Connectors		-
	Connectors for energy sources shall conform to Annex A. Connectors not fitted with locking devices as defined in A.3.9 shall be arranged so that dead weight and environmental effects e.g. vibration or acceleration do not lead to an unintended disconnection of the connector		P

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Items	Requirements	Result-Remark	Verdict
4.4.5	Direct current contactors		-
	Contactors shall be designed and manufactured to withstand the stresses occurring during installation and normal use. For additional information see the relevant part of EN 60947. Electromagnetic contactors used for performing safety functions shall conform to Annex B. Truck manufacturers shall select and install contactors, and provide information for maintenance with the instruction handbook, in accordance with the specifications and instructions of the contactor manufacturer.		P
4.4.6	Electric drive system		-
	Motors, converters, generators and energy sources shall conform to Annex D.		P
4.4.7	Electrical Components		-
	Conductors and cables shall conform to Annex G.		P
4.5	Travel and brake control systems		-
4.5.1	General		P
	For the drive system the following are considered as safe and can be used to achieve a safe state e.g. in case of a failure in the drive system:		-
	a) no driving torque, on the condition that the truck has an additional braking system which can be activated by the operator; b) automatic braking by the drive system and/or by the braking system till and during standstill; c) automatic speed reduction to a specific limit based on type, application and condition of the truck so long as the operator has full control and release of the speed control leads to the stopping of powered movement. Failures of the electrical system leading to behaviour		P

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Items	Requirements	Result-Remark	Verdict
	as mentioned in a), b) or c) or any combination thereof may be treated as a non-safety relevant failures.		
4.5.2	Travel control system		-
	The travel control system shall be so arranged that on level ground the truck will start from standstill only when the control(s) for speed and direction are activated. For IC trucks, after engaging direction control, low speed is allowed without activation of the speed control.		P
	Means shall be provided to avoid any truck movement when:		-
	— switching on the travel control system; — starting the engine of an IC truck.		P
	Any initial activation of the drive system shall only be possible from the neutral position of the speed and/or directional control(s). These safety functions shall be in accordance with the PLr as defined in Table 2.		P
4.5.3	Monitoring of operating position		-
	On sit-on rider-controlled trucks a separate device (OPC), independent of the speed control (accelerator), shall automatically bring an active drive system to a safe state, as defined in 4.5.1 a) or b) when the operator leaves the normal operating position. On stand-on rider-controlled trucks a separate device (OPC), independent of the speed control (accelerator), shall automatically bring an active drive system to a safe state, as defined in 4.5.1 b) when the operator leaves the normal operating position.Nuisance deactivation of the OPC due to operating conditions, such as rough ground, shall be		P

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Items	Requirements	Result-Remark	Verdict
	prevented. The safe state shall be initiated not later than 2,0 s after deactivation of the OPC. This time delay shall be reduced to maximum 0,2 s when the speed control device is released. In addition to the deceleration provided by the OPC, the braking system shall be available to the operator. Powered travel movement from standstill after the operator returns to the normal operating position shall occur only when the traction control device is activated from the neutral position. During deceleration following release of the OPC while travelling, powered travel movement can be restored automatically provided that the speed control is active. Restoring the powered travel movement shall not cause hazardous accelerations which cannot be controlled by the operator. Where separate travel controls other than those at the normal operating position are provided according to EN ISO 3691-1:2015, 4.4.2.6 the OPC can be overridden when this system is used. It shall not be possible to override the OPC when operation is from the normal operation position (e.g. interlock). It shall be ensured that the resulting hazards when an additional control remote from the driving position is used are sufficiently reduced by additional measures, e.g. safe speed/acceleration limitation and/or personal detection means, where trucks are designed for travel controlled from outside and the detection device of operator position overridden. These safety functions shall be in accordance with the PLr as defined in Table 2.		

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Items	Requirements	Result-Remark	Verdict
4.5.4	Tiller controlled trucks		-
4.5.4.1	Tiller brake function for pedestrian controlled trucks		-
	If the tiller brake function with tiller in upper or lower end position according to EN ISO 3691-1:2015, 4.4.2.4 b/c is realized using an electrical/electronic system, the safety function shall be in accordance with the PLr as defined in Table 2. If the tiller brake function can be overridden by a travel control device, additional measures shall be applied for travelling at the upper end position of the tiller, for example speed limitation or sustained action. These additional safety functions shall be in accordance with the PLr as defined for the tiller brake function.		P
4.5.4.2	Tiller head safety device		-
	4.4.2.4, d. The tiller head safety device may be disabled when the truck is travelling away from the operator. Activation and deactivation shall be automatic and not accessible to the operator to ensure that the tiller head safety device is not disabled while the truck is travelling towards the operator. For trucks designed to operate with the tiller in its upper and/or lower rest position, the braking function shall be initiated by activating the tiller head safety device. This safety function shall be in accordance with the PLr as defined in Table 2.		P
4.5.4.3	Tiller head safety device on platform trucks		-
	On trucks with foldable operator platform the tiller head safety device may be automatically deactivated when the platform is folded down. Means can be provided to allow the operator to		P

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Items	Requirements	Result-Remark	Verdict
	deactivate the tiller head safety device when the platform is folded down if the function is restored automatically to active mode by the operator presence system as well as by switching on the truck. Permanent activation and deactivation shall not be accessible to the operator. The mode of the tiller head safety device (active or inactive) shall be indicated to the operator if it can be deactivated in accordance with the requirements of the first paragraph of this subclause. If such indication is realized by electric/electronic means, this safety function shall be in accordance with the PLr as defined in Table 2.		
4.5.5	Automatic restoration of drive system		-
	The automatic release of the drive system from a limited mode shall not cause an unsafe movement. If the truck speed near or equal to zero is caused by a speed limitation and the limitation is exceeding a time specified by the manufacturer, a release of the speed limitation shall be possible only after return to neutral position of the speed control. Speed and time duration can depend on truck type and acceleration rate. The return to neutral is not required if the operator activates a function that cancels the limiting condition, e.g. release of the speed limitation by lowering the load below a specific lift height. This safety function shall be in accordance with the PLr as defined in Table 2.		P
4.5.6	Deviation from setpoint		-
4.5.6.1	General		-
	The drive system shall be so designed that any deviation from operator setpoint caused by an		P

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Items	Requirements	Result-Remark	Verdict
	electrical fault which could result in hazardous truck movement that cannot be controlled by the operator in the normal operating position is prevented.		
4.5.6.2	Uncontrolled acceleration from standstill on level ground		-
	The drive system shall be so designed that uncontrolled hazardous acceleration from standstill on level ground is prevented. This safety function shall be in accordance with the PLr as defined in Table 2. Any uncontrolled acceleration caused by an electrical failure is treated as hazardous when the criteria defined in Table 1 are exceeded. Movement from rest in the wrong direction shall be considered hazardous.		P
4.5.6.3	Unintended truck behaviour while truck is moving		-
4.5.7	Unintended deceleration		-
	Under normal operating conditions as defined in EN ISO 3691-1:2015, 4.1.3, unintended deceleration caused by an electric/electronic failure of the electronic controlled service brake, parking brake or the drive system shall not lead to tip-over. Inherently safe design of electronic controlled service brake shall be considered as satisfying this requirement. This safety function shall be in accordance with the PLr as defined in Table 2.		P
4.5.8	Electrically/electronic controlled service brake		-
	Electrical and electronic control systems of the service brake shall be designed to ensure the required brake function operates correctly or fail safe. The design shall ensure that an electrical failure will		P

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Items	Requirements	Result-Remark	Verdict
	not increase the risk of brake failure e.g. because of friction caused by a permanently partly released brake. This safety function shall be in accordance with the PLr as defined in Table 2.		
4.5.9	Parking brake systems		-
4.5.9.1	Trucks with automatic parking brake		-
	a) Automatic operation of parking brakes shall not result in hazardous situations. The control system of the parking brake shall be designed to prevent the automatic release of the parking brake not intended by the operator. Where activating the travel control device can result in automatic release of the parking brake, it shall not result in hazardous truck movements which cannot be controlled by the operator. These safety functions shall be in accordance with the PLr as defined in Table 2.		P
	b) With the truck at standstill, the parking brake shall be applied if the operator is not in the normal operating position This safety function shall be in accordance with the PLr as defined in Table 2.		P
	c) When the truck is designed to hold the truck on a ramp stationary or at low speed by the drive system and the travel control is released, the parking brake shall be activated automatically before the drive system loses the ability to hold the truck. This safety function shall be in accordance with the PLr as defined in Table 2.		P
	d) Failure of the control system of an automatically applied parking brake shall be indicated to the operator (see EN ISO 3691-1:2015, 4.2.2.1). The safety function of failure detection shall be in		P

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Items	Requirements	Result-Remark	Verdict
	accordance with PLr as defined in Table 2		
4.5.9.2	Trucks without automatically applied parking brake		-
	If the movement of a truck without an automatically applied parking brake is actively controlled or minimized by the drive system, measures shall be taken so that the operator becomes aware of this situation, e.g. creeping of the truck on a ramp at low speed. Measures shall be taken to warn the operator before leaving the truck (see EN ISO 3691-1:2015, 4.2.2.1) without applying the brake as long as the power supply of the truck is not switched off by the operator. If the required warning is realized by an electric/electronic system, it shall be in accordance with the PLr as defined in Table 2.		P
4.5.9.3	Indication of parking brake state		-
	Automatically or manually applied parking brake state shall be indicated to the operator when engaged. The exceptions to this requirement are brake systems fitted to stand-on and pedestrian controlled trucks equipped with a brake system that will automatically engage upon release of the brake actuating control in accordance with EN ISO 3691-1:2015, 4.3.3. An electrical indication of the parking brake state is not required when power supply of the truck has been switched off (see EN ISO 3691-1:2015, 4.2.2.1). This safety function shall be in accordance with the PLr as defined in Table 2.		P
4.5.10	Speed limitation		-
	The electrical system limiting truck speed shall be so designed that the admissible maximum		P

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Items	Requirements	Result-Remark	Verdict
	speed on level ground is not exceeded. In the event of an electrical fault the transition to the safe state, as defined in 4.5.1 a) and c) shall be initiated.		
	The following speed limitation functions shall be in accordance with the PLr as defined in Table 2:		-
	a) lateral- and front-stacking trucks in accordance with EN ISO 3691-3:2016, 4.4.1; b) travel speed limitation to comply with braking and stability requirements, e.g. trucks specifically designed to travel with elevated loads; c) reach trucks with elevated mast in accordance with EN ISO 3691-1:2015, 4.2.3.3; d) speed limit of counterbalance trucks to ensure dynamic stability in accordance with EN 16307-1:2013+A1:2015, 4.11; e) pedestrian controlled trucks in accordance with EN 16307-1:2013+A1:2015, 4.3; f) if triggered by platform and/or side guards' position in accordance with EN ISO 3691-1:2015, 4.7.3.3; g) operating from outside the truck in accordance with EN ISO 3691-1:2015, 4.4.2.6; h) trucks with attachments for freight containers in accordance with EN ISO 3691-1:2015, 4.6.5.5; i) stand-on and foldable platform trucks in accordance with EN 16307-1:2013+A1:2015, 4.3.		P
4.5.11	Interface for speed limitation		-
	If trucks are provided with interfaces for external speed limitation, changes of speed caused by the external system shall be limited by the truck logic to a level that can be controlled by the operator (for instance see 4.5.5, 4.5.7).		P

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Items	Requirements	Result-Remark	Verdict
	The external speed limitation shall not exceed the limit set by the truck controller.		
4.6	Electrical load handling system		-
4.6.1	General		-
	A stationary LHS is considered as a safe state		P
4.6.2	Movement from standstill		-
	Movement of a function of the LHS from standstill shall be possible only by operating the dedicated control for an LHS function, e.g. joysticks.		P
	Means shall be provided to avoid any movement of a function of the LHS: — while switching on the system; — while starting the engine of an IC truck. After switching on the LHS control system and/or after starting the engine, initial activation of the LHS shall only be possible from the neutral position of the controls intended for LHS		P
4.6.3	Monitoring of operating position		-
	On sit-on and stand-on trucks a separate device (OPC) independent of the LHS controls shall automatically bring an active LHS to a safe state, as defined in 4.6.1, if the operator leaves the normal operating position. Nuisance deactivation of the OPC due to operating conditions, such as rough ground, shall be prevented. The safe state shall be initiated not later than 2,0 s after deactivation of the OPC. If the LHS function is electric/electronic controlled this time delay shall be reduced to maximum 0,2 s when the LHS control device is released. Powered LHS movement after the operator returns to the normal operating position shall occur only when the LHS control device is activated from		P

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Items	Requirements	Result-Remark	Verdict
	the neutral position. This safety function shall be in accordance with the PLr as defined in Table 3. Where separate LHS controls remote from the normal operating position are provided, separate device for detecting the normal operating position can be overridden when the remote controls are selected.		
4.6.4	Deviation from setpoint		-
	The LHS shall be so designed that deviation from operator setpoint, caused by an electrical fault, which could result in hazardous truck movement is prevented. The following behaviour is considered as hazardous:		P
	a) movement from standstill, longer than a time of 0,2 s, without activating LHS controls; b) unintended hazardous deviation from setpoint of an active LHS function. The level of deviation depends on the LHS function. Hazardous deviations are those deviations from setpoint that the operator is not able to control, and which lead to loss of load or stability. For specific applications a time less than 0,2 s can be required, e.g. electric/electronic controlled load clamp devices. These safety functions shall be in accordance with the PLr as defined in Table 3.		P
4.6.5	Load clamp devices		-
	Trucks equipped with attachments which hold the load by power (for instance, paper clamps) shall feature controls with a secondary action to prevent unintentional release of the load in accordance with EN ISO 3691-1:2015, 4.4.4.1.		P

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Items	Requirements	Result-Remark	Verdict
	If the prevention of unintentional release is realized by an electric/electronic system this safety function shall be in accordance with the PLr as defined in Table 3.		
4.6.6	Limitation of load movement functions		-
	Electrical/electronic speed - and/or position - control and limitation systems shall be in accordance with the PLr shown in Table 3. For limitation of load movement as operator assistance see Annex E. An LHS limiting function shall be considered a safety function if it is required for passing the truck stability type tests, e.g. tilting angle limitation, maximum reach of the mast, limitation of the side shift displacement		P
4.7	Steering		-
4.7.1	General		-
	The hazards resulting from failures of electric or electric assisted steering systems are dependent on the type of the steering system. The following safety functions shall be applied to the corresponding steering system		P
4.7.2	Electrical/electronic steering		-
4.7.2.1	General		-
	Electrical/electronic steering control systems shall be designed to avoid hazardous deviations not controllable by the operator		P
4.7.2.2	Unintended steering movements		-
	A single electrical/electronic fault shall not lead to a risk of an unintended operation caused by the steering system.		P
	Within 0,1 s from the start of an unintended steering movement:		-

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Items	Requirements	Result-Remark	Verdict
	a) on trucks not provided with backup steering, the fault shall be detected, the stop of the unintended steering operation and a controlled stop shall be initiated; b) on trucks provided with backup steering, the fault shall be detected, the stop of the unintended steering operation shall be initiated, the backup steering system shall be activated automatically.		P
4.7.2.3	Supervision of steering system		-
	An electrical/electronic fault potentially leading to loss of steering functions (for instance breakdown of steering controller or output stage, loss of power supply) shall on trucks:		P
	a) without a backup steering system initiate a controlled stop; or b) with backup (secondary) system initiate an automatic activation of the backup (secondary) system		P
4.7.2.4	Backup steering warning		-
	A single electrical/electronic fault as described in 4.7.2.2 and 4.7.2.3 on trucks provided with backup steering shall activate a warning to the operator.		P
4.7.2.5	Deviation from setpoint		-
	The steering control system shall detect potentially hazardous deviations between setpoint and actpoint. Hazardous deviations are those deviations from setpoint that the operator is not able to control. In case of hazardous deviations, one of the conditions defined in 4.5.1 shall be initiated within 0,1 s.		P

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Items	Requirements	Result-Remark	Verdict
	This safety function shall be in accordance with PLr as defined in Table 4.		
4.7.3	Electric powered assisted steering systems		-
	Any failure of the electrical part of an electric powered assisted steering system shall not prevent the truck from maintaining the path being steered. A failure of the electric powered assisted steering system shall be signalled to the operator. This safety function shall be in accordance with the PLr as defined in Table 4.		P
4.8	Software design		P
4.9	Other protective measures		P
4.10	Electrical verifications		P

2.5 EN ISO 3691-1:2015+AC:2016+A1:2020

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EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
4	Safety requirements and/or protective measures		-
4.1	General		-
4.1.1	Overall requirements		P
4.1.2	Normal climatic conditions		P
4.1.3	Normal operating conditions		P
4.1.4	Electrical requirements		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
4.1.5	Edges or angles		P
4.1.6	Stored energy components		P
4.2	Starting/Moving		-
4.2.1	Unintended starting		P
4.2.2	Unintentional movement and inadvertent activation		P
4.2.2.1	Parking brake		P
4.2.2.2	Internal-combustion-engine powered trucks		N
4.2.2.3	Travel controls		P
4.2.2.4	Powered travel movement		P
4.2.2.5	Manual gearbox and manually operated clutch pedal		P
4.2.3	Travel speed		-
4.2.3.1	Pedestrian- controlled trucks		N
4.2.3.2	Stand-on trucks and Pedestrian- controlled trucks with foldable platform		N
4.2.3.3	Travel with mast raised		N
4.3	Brakes		-
4.3.1	All trucks shall be designed with service and parking brakes complying with ISO 6292		P
4.3.2	Failure of energy supply to service brake		P
4.3.3	Stand-on and pedestrian-controlled trucks		N
	Stand-on and pedestrian-controlled trucks shall be equipped with a brake system that will automatically engage upon release of the brake actuating control by the operator. This system may serve as the service and parking brake.		N
4.4	Manual control actuators		-
4.4.1	General		-
4.4.1.1	Consistency with the truck motions		P
4.4.1.2	Multiple operators		N
4.4.1.3	Multiple operating positions		N
4.4.2	Travel and braking controls		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
4.4.2.1	General The motion of the speed operating control shall be so designed that an increase in the movement of the control increases the travel speed. When the control is released, it shall return to the neutral position of the control actuator.		P
4.4.2.2	Sit-on trucks Trucks with pedal-operated travel and braking controls shall comply with ISO 21281.		P
4.4.2.3	Stand-on trucks		N
	The requirements for travel and braking controls for a stand-on truck are as follows. a) Travel control functions		N
	--- Where a tiller is used, it shall be fitted with control devices for travel direction and speed. --- Where a steering wheel or similar control is used, the controls for travel direction and speed shall be positioned in close proximity to the steering control. The service brake function shall be engaged --- automatically when the tiller is released, if operated by the tiller, --- automatically when the travel-control is released, if operated by the travel-control, --- automatically when releasing the pedal, if the brake function is foot-operated, --- when activating the hand actuator, if the brake function is hand-operated.		N
	b) Trucks with elevating operator platform up to 1 200 mm		
4.4.2	Means shall be provided to prevent travel while the platform is elevated more than 500 mm, unless the controls are elevated with the platform.		
4.4.2.4	Pedestrian-controlled trucks		N

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Items	Requirements	Result-Remark	Verdict
	The requirements for pedestrian-controlled trucks are as follows. a) The tiller shall be fitted with control devices for		N
	travel direction and speed. b) When the tiller is released, it shall automatically return to its upper rest position, cut off traction power in the travel direction and engage the brake. c) When the tiller is in its lowered position, the traction power in the travel direction shall be cut off and the brake shall be engaged. d) The tiller shall be fitted with a device to energize the direction of travel away from the operator until pressure on the device is relieved, or that stops the truck by applying the brakes, if the head of the tiller in its operating position comes into contact with a solid body (e.g. the operator's body).		N
4.4.2.5	Differential locking		P
	It shall be possible to unlock the differential when the truck is moving. For trucks fitted with a pedal-operated differential lock, depression of the pedal shall lock the differential and shall be released when releasing the pedal.Differential locking comply the requirement		P
4.4.2.6	Additional operation from outside the truck		N
4.4.2.7	Additional operation from alongside pedestriancontrolled and stand-on trucks (coasting)		N
4.4.3	Steering controls		P
4.4.3.1	Steering direction		P
	a) For stand-on or sit-on trucks, when travelling in the forward direction, clockwise rotation of the		P

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Items	Requirements	Result-Remark	Verdict
	steering wheel, or equivalent movement of the steering control, shall steer the truck to the right.		
	b) For trucks with an operator control position rotatable by more than 90°, or having duplicated control positions, in order to facilitate the operator facing in the opposite direction, clockwise rotation of the steering wheel, or equivalent movement of the steering control, shall steer the truck to the right as viewed from the new position — i.e. the steering control sense is reversed beyond 90° to facilitate the operator facing in the opposite direction.		N
	c) Trucks with continuous 360° steering — i.e. the steering/drive wheel can move through 360° to propel the truck in the direction selected by the steering control — shall operate in the same sense as a), above, when travelling in the forward direction. d) For pedestrian-operated trucks fitted with a tiller, when travelling in the forward direction, clockwise movement of the tiller shall steer the truck to the right.		N
	e) Exceptionally, when requested by the user, end-control trucks may be equipped with “reverse steering” — i.e. clockwise rotation of the steering control will steer the truck to the left. Such trucks should be clearly identified.		N
4.4.3.2	Failure of power supply		P
4.4.4	Load handling controls		P
4.4.4.1	Controls shall return to the neutral position when released and stop the corresponding load movement. When single levers are used to control a		P

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Items	Requirements	Result-Remark	Verdict
	function on trucks other than reach trucks with retractable mast or forks, the lever closest to the operator shall control lifting and lowering, the second closest lever should control the tilt function, the third closest lever should control the side shift and the fourth closest lever should be for auxiliary functions.		
	When single levers are used to control a function on reach trucks with a retractable mast or forks, the lever closest to the operator shall control lifting and lowering, the second closest lever should control the displacement of the mast or forks, the third closest lever should control the tilt function, the fourth closest lever should control side shift and the fifth closest lever should be for auxiliary functions. Trucks equipped with attachments which hold the load by power (e.g. paper clamp) shall feature control(s) with a secondary action to prevent unintentional release of the load.		N
4.4.4.2	The hand power forces and the layout of controls of manually operated lifting systems shall comply with ISO 3691-5		N
4.4.5	Multi-function controls		P
4.4.6	Controls for automated functions		N
4.4.7	Marking		P
4.5	Power systems and accessories		-
4.5.1	Exhaust and cooling system		
4.5.1.1	The exhaust system shall be designed in accordance with 4.7.6 and such that engine exhaust is directed away from the operator position. Materials used in the vicinity of exhaust systems shall be non-flammable and shall be chosen and protected such that they are not		N

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Items	Requirements	Result-Remark	Verdict
	adversely affected by heat from the exhaust system.		
4.5.1.2	The air flow through the cooling system shall be arranged so as to avoid discomfort to the operator		N
4.5.2	Fuel tank		N
4.5.2.1	If a fuel tank is within or adjacent to the engine compartment and excessively high temperatures can occur, the tank and/or filling arrangement shall be isolated from the electrical and exhaust systems by suitable protection, e.g. a separate enclosure or baffles. The tank location and facilities for filling shall be such that spillage or leakage will not drain into the engine or operator's compartment or onto electrical or exhaust system parts.		N
4.5.2.2	Fuel spillage shall not be possible under normal operating conditions.		N
4.5.3	Access to engine and other compartment		N
4.5.3.1	Engine covers Warning labels provided and fan was guarded.		N
4.5.3.2	The access covers shall be provided preventing unintentional closure		N
4.5.4	Liquefied petroleum gas (LPG)-powered trucks		N
4.5.4.1	Container		N
	a)Permanently fixed on the truck or removable		N
	b) Removable containers shall be secured on the truck		N
	c) Pipe fittings and accessories on containers		N
	d) Containers shall be equipped with a device to prevent unintentional emission		N
	e) The fuel take-off on the container shall be equipped with a manually operated valve.		N
	f) The fuel take-off shall be in a liquid form unless		N

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Items	Requirements	Result-Remark	Verdict
	the container and engine are specially equipped for a direct vapour withdrawal.		
	g) Containers to be filled by the user, shall fitted: -A safety pressure relief valve -A fixed maximum level indicating device -Maximum level indicating devices which rely on bleeding to atmosphere -Maximum liquid level devices		N
	h)Ventilation openings at the bottom of compartments		N
	i)Fastenings of removable containers		N
	j) Removable containers which incorporate a safety pressure relief valve		N
	k)Additional container		N
	l)The position of containers		N
	m)Containers shall be fitted to prevent abrasion or shock orcorrosive action of the product		N
	n)There are no projections outside the plan view outline of the truck		N
4.5.4.2	LPG piping		N
	a)Connecting piping and all associated parts		N
	b)Requirements of the support on pressure flexible hoses and rigid pipes		N
	c)The pressure that hoses,pipes shall withstand pressure		N
	d)Excessive pressure shall be avoided		N
	e)Aluminium piping shall not be used in LPG lines		N
	f)Hose lengths shall be as short as practical.		N
	g) Pressure unions and joints above 1 bar		N
4.5.4.3	Equipment		N
	a)The supply of gas shall be automatically cut off when the engine stopsb)Requirements for multi-fuel		N

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Items	Requirements	Result-Remark	Verdict
	applications		
	c)The truck is equipped with two or more containers to supply fuel		N
	d)Installation of safety pressure relief valves or liquid level indicators		N
	e)Corrosion resistant protective coating		N
	f)All fuel system components shall be firmly secured to the truck		N
	g)Pressure reducing valves		N
	h) The engine compartment shall be designed in accordance with 4.5.4.1 g), in order to avoid any LPG accumulation		N
4.5.4.4	LPG-powered trucks are subject to regional requirements, additional to the requirements of this part of ISO 3691. See ISO/TS 3691-8.		
4.6	Systems for lifting and tilting		-
4.6.1	Lift chains		P
4.6.2	Mechanical lifting system		N
4.6.2.1	Comply with the requirements of 5.6.3.3		N
4.6.2.2	Failure of the mechanism or its parts		N
4.6.2.3	The lowering speed		N
4.6.3	Hydraulic lifting and tilting system		P
4.6.3.1	Hydraulic lifting system		P
4.6.3.2	Lowering speed limitation		P
4.6.3.3	Limitation of stroke		P
4.6.3.4	Hydraulic tilting system		
4.6.3.5	Mast tilt and carriage isolation		
4.6.4	Hydraulic system		P
	4.6.4.1 Hydraulic circuit		P
	4.6.4.2 Pressure control		P
4.6.4.3	Failure of energy supply to hydraulic circuit		P
4.6.4.4	Fluid purification		P
4.6.5	Load-handling and -stacking attachments		P

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Items	Requirements	Result-Remark	Verdict
4.6.5.1	Unintentional displacement or detachment		P
4.6.5.2	Malfunction in the power supply system		N
4.6.5.3	Hydraulic system for attachment		N
4.6.5.4	Combined hydraulic systems		N
4.6.5.5	Attachments for lifting freight containers		N
4.6.5.6	Fork arms		P
4.6.5.6.1	Solid-section fork arms shall be manufactured and tested in accordance with ISO 2330, except with respect to safety factors. The safety factors are subject to regional requirements, additional to the requirements of this part of ISO 3691. See ISO/TS 3691-8		P
4.6.5.6.2	The total capacity of all fork arms fitted to a truck shall not be less than the actual capacity of the truck.		P
4.6.5.6.3	Means to prevent unintentional lateral displacement of the fork arms		P
4.6.5.6.4	Fork-arm extensions shall be designed to prevent accidental disengagement from the fork arms, and shall be in accordance with ISO 13284.		P
4.6.5.7	Fork carriers		N
4.7	Operator position		-
4.7.1	Dimensions		P
	4.7.2 Operator access and egress		P
	4.7.2.1 General		-
	Trucks shall be designed to permit safe and easy access and egress and to minimize the risk of slipping, falling and tripping. Steps, running boards and hand holds (grab handles, fixed parts of the truck structure, etc.) shall be provided above a step height of 350 mm to give three-point contact at all heights (i.e. one hand and two feet or two hands and one foot). Step width, instep		P

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Items	Requirements	Result-Remark	Verdict
	clearance and toe clearance shall comply with ISO 2867.		
4.7.2.2	Steps		P
	Steps shall have slip-resistant surfaces or covering (e.g. expanded metal, abrasive coating). The first step shall be not more than 550 mm from the ground and succeeding steps shall be 250 mm to 350 mm, preferably at equal intervals		P
4.7.2.3	Compartment floors		P
	The compartment floor frequented by the operator, steps and walkways shall be free of obstacles and shall have a slip-resistant surface, e.g. ribbed mats, abrasive coating, expanded metal.		P
4.7.2.4	Walkways		N
	Walkways more than 2 000 mm from the ground shall have guard rails. The guard rails shall have a height of 900 mm to 1 100 mm and shall be capable of withstanding, without permanent deformation, a force of 900 N applied in a horizontal direction from the inside to the outside.		N
4.7.2.5	Hand holds		P
	For access to, and egress from, the normal operating position with a floor height above 300 mm, hand hold(s) shall be provided; these may be part of the truck structure. The clearance dimension for a hand hold shall be at least of 45 mm width, 130 mm length and diameter of 15 mm (see Figure 3).		
4.7.3	Platform		N
4.7.3.1	General		N
	Operator stand-on platforms on pedestriancontrolled and stand-on end-controlled trucks shall be dimensioned in accordance with 4.7.1		N

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Items	Requirements	Result-Remark	Verdict
	and shall be capable of withstanding a compression force corresponding to 2,5 times the mass of the laden truck applied along the longitudinal axis of the truck with the outermost projection of the platform against a flat vertical surface. For the purpose of this requirement, the operator platform includes any surrounding reinforcement or parts of the truck which provide resistance to crushing of the platform, except for pedestrian-controlled stand-on trucks employing a tiller.		
4.7.3.2	Platforms overhanging the truck chassis		N
	Platforms overhanging the truck chassis on tilleroperated stand-on trucks, capable of travelling more than 6 km/h, shall, in addition to 4.7.3.1, be provided with a guard at either the sides or the front of the platform. The guards shall be capable of withstanding a horizontal force of 900 N acting from inside to outside applied in line with the centre of the operator's standing position without permanent deflection. The side guards shall be at a minimum height of 700 mm above the platform in its protective position.		N
4.7.3.3	Pedestrian-controlled trucks with foldable platforms		N
	Operator stand-on platforms that are fitted to pedestrian-controlled trucks and overhang the truck's chassis may be capable of being folded or pivoted to an upright position when the operator leaves the platform; this may be done automatically. For platforms which do not act automatically, devices shall be provided to prevent the truck manoeuvring or travelling unless the operator is standing on the platform or the platform is in its		N

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Items	Requirements	Result-Remark	Verdict
	upper rest position. Travelling of more than 6 km/h shall only be possible when the platform is pivoted down and guards are in their protective position.		
4.7.3.4	Stand-on platforms		N
	Operator stand-on platforms which are built within the plan view outline of pedestrian-controlled trucks, where the operator stands to the side of the motor housing, shall be equipped with an additional grab rail for operator stability when riding. This grab rail shall be capable of withstanding a horizontal force of 900 N applied in line with the operator's standing position, without permanent deformation. The requirements of 4.7.3.2 do not apply for this configuration of pedestrian-controlled truck.		N
4.7.3.5	Trucks with foldable platforms and foldable side guards		N
	On trucks with side guards and platforms of the folding or pivoting type as described in 4.7.3.2 and 4.7.3.3, travelling movement shall only be possible when the side guard or platform is in a protective position or an inactive rest position. No travelling movement is allowed with the platform or side guard in an intermediate position.		N
4.7.4	Operatror’s seat		P
	a)The seat has a facility allowing fore and aft adjustment without using tools		P
	b)The weight adjustable seat		N
	c)The seat has facility allowing it to swivel about a vertical axis		N
	d)The seat mounting		P
	e)Additional operator’s seats		N
	f)Auxiliary seat on a stand-on industrial truck		N

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Items	Requirements	Result-Remark	Verdict
	g) The seat anchorage to the battery cover or engine cover of sit-on counterbalanced trucks, as well as the latching method of the cover to the truck chassis, shall have sufficient strength in the event of a backwards tip-over of the truck from a loading dock. The seat anchorage shall be able to withstand a force of 2 250 N at a 45°± 5° angle, as shown in Figure 4.		P
4.7.5	Protection from road wheels an objects trrown up		P
4.7.5.1	Ride-on trucks		P
4.7.5.2	Pedestrian controlled trucks		N
4.7.6	Protection from burning		P
4.7.7	Protection against crushing,sheating and tranpping points		P
4.7.7.1	General		P
4.7.7.2	Minimum distances		P
	Parts which move relative to one another which are within the reach of the operator in the normal operating position shall be adequately guarded or be separated by the following minimum distance: - Places where the operators fingers can be trapped: min 25 mm - Places where the operators hands or feet can be trapped: min 50 mm - Places where the operators arms and legs can be trapped: min 100 mm Relative moving parts that need to contact or move in close proximity to one another shall be guarded to prevent access when the distance between those parts is more than 8 mm. If residual hazards exist, those shall be identified on the truck in accordance with 6.3.3.4.		P
4.7.7.3	Attachments		P

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Items	Requirements	Result-Remark	Verdict
	Crushing and shearing hazards to the operator in the normal operating position associated with attachments, except at the load supporting points, shall also meet the relevant requirements of 4.7.7.1. If such hazards still exist, they shall be identified according to 6.2 and on the attachment by a warning sign in accordance with 6.3.3.4.		P
4.7.7.4	Foot protection		N
	Trucks with side-facing seating or standing shall be so built that when traveling, the operator cannot unintentionally keep his foot outside the confines of the truck or the truck shall be equipped with a traction cut out or signalling device which informs the operator if his foot is not in the safeguarded position.		N
4.7.8	Operator restrain		P
4.7.9	Additional operator positions		N
4.8	Stability		-
4.8.1	In order to reduce the hazards of longitudinal and lateral tip-over in the operating conditions foreseen by the manufacturer, the trucks specified below shall comply with the stability requirements given in the applicable part of ISO 22915, without permanent deformation of the structure (see 5.2): ---basic test criteria and requirements for all applicable truck types, ISO 22915-1; ---counterbalanced trucks with mast, ISO 22915-2; ---reach and straddle trucks, ISO 22915-3; ---pallet stackers, double stackers and orderpicking trucks with operator position elevating up to and including 1 200 mm lift height, ISO 22915-4; ---bidirectional and multidirectional trucks, ISO		P

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Items	Requirements	Result-Remark	Verdict
	22915-7; ---industrial variable-reach trucks, ISO 22915-11; ---order-picking trucks with operator position elevating above 1 200 mm, ISO 22915-21.		
4.8.2	Specific operating conditions		N
	For specific operating conditions foreseen by the manufacturer, additional stability tests shall be carried out in accordance with the following parts of ISO 22915, as applicable: --- trucks operating in the special condition of stacking with mast tilted forward and load elevated, ISO 22915-8; --- trucks operating in the special condition of stacking with load laterally displaced by powered devices, ISO 22915-10; --- trucks operating in the special condition of offset load, offset by utilization, ISO 22915-20.		N
4.8.3	Levelling indicator for rough-terrain trucks		N
4.9	Protective devices		-
4.9.1	Operators overhead guard		P
4.9.1.1	Ride-on trucks with a maximum lift height of more than 1 800 mm above the floor shall be fitted with an overhead guard complying with ISO 6055 to protect the operator from falling objects. Trucks with an elevating operator position up to and including 1 200 mm that feature a lift height of the load of more than 1 800 mm above the operator platform shall be fitted with an overhead guard complying with ISO 6055 to protect the operator from falling objects.		P
4.9.1.2	Additional fitting against falling small objects		P
	The overhead guard specified in 4.9.1.1 shall, when handling a load above 1 800 mm lift height,		P

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Items	Requirements	Result-Remark	Verdict
	be constructed in such a manner that it can be provided with an additional fitting making it possible in those special cases to increase the protection of the operator against falling small objects		
4.9.1.3	Pedestrian-controlled trucks with foldable platform		N
	Pedestrian-controlled trucks with a foldable platform as specified in 4.7.3.3 shall be provided with means to prevent lifting over 1 800 mm from the floor when the side guards are in their protective position. This does not apply if an overhead guard as specified in 4.9.1.1 is fitted on the truck.		N
4.9.2	Load backrest extension		P
4.9.2.1	Provision for load backrest extension		P
	Trucks fitted with fork arms with a lift height of more than 1 800 mm shall be designed so that they can be fitted with a load backrest extension.		P
4.9.2.2	Size of openings		P
	Load backrest extensions, if provided, shall have height, width, and size openings sufficient to minimize the possibility of the load falling toward the mast when the mast is in a position of maximum rearward tilt. The size of openings in the load backrest extension, if provided, shall not exceed 150 mm in one of the two dimensions.		P
4.9.3	Warning device		P
	Trucks shall be equipped with an operatorcontrolled audible warning device.		P
4.9.4	Wheels with split wheel rims for inflatable tyres		P
	When split wheel rims are used with pneumatic tyres, the truck shall be provided with means to prevent the user from separating the halves of the		P

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Items	Requirements	Result-Remark	Verdict
	wheel before removing it from the axle. Information on the proper means of removing the tyre from the wheel shall be provided in the instruction handbook (see 6.2).		
4.9.5	Traction battery compartment		P
4.9.5.1	Unauthorized access		P
	On trucks with a nominal battery voltage exceeding 120 V d.c., if a lockable cover is not present on the battery enclosure, facilities shall be provided to enable the battery compartment to be secured so as to prevent unauthorized access to the battery.		N
4.9.5.2	Metal cover		P
	A metal cover for a battery compartment or battery enclosure shall have either a) sufficient strength and rigidity, in conjunction with an air spacing of at least 30 mm provided between it and the battery terminals, so that the battery terminals are not short-circuited when a 980 N force is applied to any area 300 mm -300 mm of the cover, or b) an air space reduced to a minimum of 10 mm, provided covers or live parts of the battery are insulated in such a way that disintegration and/or displacement of the insulation is prevented.		P
4.9.5.3	Non-metallic cover		N
	For non-metallic covers of battery compartments, the following applies. a) The cover shall have a burn rating of V0 or V1 in accordance with IEC 60695-11-10. b) The cover shall comply with an impact test of 136 J, the impact being produced by dropping a steel sphere having a diameter of 100 mm and		N

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Items	Requirements	Result-Remark	Verdict
	mass of 4,11 kg from a height of 3,3 m. If the battery is located under an overhead guard, the impact may be reduced to 68 J, produced by dropping a steel sphere having a diameter of 100 mm and mass of 4,11 kg from a height of 1,65 m. There shall be no live parts exposed or impact that causes physical damage to the battery. c) If metallic parts project into the battery compartment, then 4.9.5.2 applies.		
4.9.5.4	Ventilation		P
4.9.5.5	Resistance to electrolyte		P
4.9.6	Battery-restraint devices		P
4.9.7	Starter battery requirements		P
4.10	Visibility/Lighting		-
4.10.1	Requirements for all-round visibility from unladen trucks up to and including 10 000 kg rated capacity shall be in accordance with ISO 13564-1. For visibility with load, see 6.2.2, considering that, if direct visibility is limited by the load, aids can be used. Visibility requirements are subject to regional requirements, additional to the requirements of this part of ISO 3691. See ISO/TS 3691-7:2011.		P
4.10.2	Ride-on trucks shall be so designed that it is possible, referring to the manufacturer's instructions, to equip them with travel lights, working lights and signal lights.		P
4.11	Environmental conditions		-
4.11.1	Operator’s cab		P
4.11.1.1	Cab is fitted in lieu of an overhead guard on an industrial truck,it shall comply with 4.9.1		P
4.11.1.2	The material of the cab and fixing devices		P
4.11.1.3	Efficient ventilation and encironmental conditions		N

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Items	Requirements	Result-Remark	Verdict
	for use		
4.11.1.5	Wipers on the windscreen or rear window and safety glass		N
4.11.1.6	Emergency exit		P
4.11.1.7	The storage of the instruction handbook		P
4.11.1.8	Positions for additional operators		N
4.11.2	Noise emission		P
4.11.3	Vibration		P
4.11.4	Electromagnetic compatibility (EMC)		N
4.11.5	Transport		P
4.11.5.1 4.11.5.2	If the manufacturer specifies in the instruction handbook that a truck may be lifted without disassembling, locations for slinging points shall be provided		P
	Lifting points for the removal and transportation of individual assemblies of the truck, if required, shall be indicated on the assembly, or in the operating instructions.		P
4.11.5.3	Locations for slinging of removable attachments shall be provided as stated in the instruction handbook		P
4.11.6	Operation in potentially explosive atmospheres		N
	4.12 Devices for towing		P
5	VERIFICATION OF SAFETY REQUIREMENTS AND/IR MEASURES		-
5.1	General		-
5.2	Structural test		-
	These tests are to be performed on a sample that is representative of series production. The structural components of the truck and its attachments shall carry static loads of 1,33 Q1 and 1,33 Q2 for 15 min each, where Q1 is the rated capacity at the standard lift height and standard load centre distance in accordance		P

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Items	Requirements	Result-Remark	Verdict
	with the information on the capacity plate; Q2 is the actual capacity at maximum lift height in accordance with the information on the capacity plate. The truck shall be on substantially level ground with the mast in the substantially vertical position and may be anchored to prevent tip-over. The loads may be applied at the corresponding height by means independent of the truck. The test shall not result in any visual permanent deformation or damage.		
5.3	Functional verification		-
	Functional verification shall be carried out on each truck to verify that it is able to perform the tasks for which it was designed. These tests shall be done according to the manufacturer's instructions. They shall be performed by trained persons either operating and testing the truck according to the manufacturer's instructions or simulating thes tests by any method giving an equivalent effect and producing substantially the same result. Each truck shall be inspected to ensure that the travelling, braking, steering, load-handling controls and combined functions, if any, are appropriately identified and operate correctly. The correct operation of warning devices, safety devices and lighting, if any, shall also be checked.		
6	INFORMATION FOR USE		-
6.1	General		-
	Each truck and removable attachment shall be supplied to the user with an instruction handbook(s), covering operating and regular servicing and addressing all identified hazards, printed in the language(s) of the country in which the truck is to be used, where required by national law. See also ISO 12100:2010, 6.4.5.		P

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Items	Requirements	Result-Remark	Verdict
	There is no need for the workshop and parts handbooks intended for use by specialized personnel employed by the manufacturer or his authorized representative to be supplied with each truck, and these can be printed in the language of the country where the truck is to be used, as required by national law. In other cases, the instructions shall be in a language agreed between the truck supplier and purchaser.		
6.2 I	nstruction handbook		-
	These manuals shall include if applicable at least the following information:		-
6.2.1	Concerning the truck/attachment		P
	- Name and address of the manufacturer or the authorized representative. - Designation of type. - Description of the truck and its accessories. - Attachments which are fitted to the truck and their assembly precautions. - Details of use of the load backrest. - Details for the installation of a fire extinguisher, if required by the application of the truck. - Admissible wheel rims and tyres with inflation pressures for pneumatic tyres. - Description of the safety devices and warning labels. - Details of the noise and vibration generated by the truck. (The noise declaration shall be made in accordance with prEN 12053) - Overall dimensions, load capacity and performance details of the truck. - Visibility conditions when using remote controlled devices for the truck.		P

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Items	Requirements	Result-Remark	Verdict
6.2.2	Operation of truck		-
	a) intended uses of the truck and attachments, and examples of hazardous misuse; b) training requirements for the operator; c) function of operating controls and displays; d) pre-shift checks before the truck is put into operation; e) instructions for adjustment of the operator's seat; f) instructions for operation with/without cab, with/without doors; g) instructions for access and egress; h) instructions for safe handling by the operator, e.g. when changing attachments or moving fork arms; i) requirements of the ground/floor where the truck is to be used; j) instructions for starting, driving and stopping the truck; k) instructions for handling loads, warning about the hazards due to the action of wind forces; l) instructions when operating on a gradient; m) instructions for towing the truck; n) instructions for parking the truck; o) warning of risks during the use of the truck and its attachments, including crushing and shearing hazards; p) climatic conditions in which the truck is designed to operate; q) information about the direction of turning of the truck in relation to rotation of the steering wheel for end-controlled trucks;		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	r) information about operating the truck with loads causing insufficient visibility; s) information on the use of any visual aid that may be provided; t) information and conditions for the use of the drawbar; u) instructions when operating a rear touch device; v) information or instructions on action to be taken in the event of a malfunction; w) information for operation of the truck by a remote control device, e.g. visibility; x) the normal operating conditions as defined by the manufacturer, i.e. those for which the truck has been designed and the manner in which the truck will be used; y) instructions on the use of the operator-restraint device, system or enclosure, and guidance on the operator's behaviour in the event of a tip-over; z) information about lighting of the working area; aa) the procedure for movement of inoperative trucks; bb) instructions against operating truck with guarding removed; cc) lift height for travelling; dd) crushing and shearing hazards for the operator of pedestrian-controlled trucks featuring foldable platforms and reach trucks, between parts of the environment and the truck during travelling forward; ee) instructions to the operator of a stand-on endcontrol		

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	truck to step off and away from the truck in the event of a tip-ove or off-dock accident; ff) information and instructions for using attachments, e.g. load bearing clamp.		
6.2.3	Details for battery powered trucks		-
	a) specification of approved batteries and onboard battery chargers; b) procedure for safe handling of batteries, including installation, removal and secure mounting on the truck; c) warning of risks of accumulation of hydrogen under covers; d) battery charging procedures and instructions; e) service mass of battery and ballast when required.		P
6.2.4	Details for internal-combustion-engine powered trucks		N
	a) approved fuels; b) procedure for safe handling of fuels; c) procedure for refuelling; d) warning of the effect of exhaust emissions in confined spaces; e) warning of the effect of exhaust emissions for the operator.		N
6.2.5	Service and maintenance		-
	a) training and qualifications needed for service and maintenance staff; b) safe procedure for the identification, detection and correction of faults; c) instructions for changing tyres or wheels; d) instructions for verification that markings, e.g. decals, are in place and legible;		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	e) instructions for de-energizing of stored energy components; f) access to maintenance while working at height; g) servicing operations for which no specific skills are required; h) use of approved spare parts; i) drawings and diagrams necessary for truck service and maintenance; j) instructions for disposing of waste material (e.g. oils and battery); k) type and frequency of inspections and maintenance operations, with particular attention to the replacement and durability of wear and serviceable parts, emissions, and to the user's logbook (e.g. filter, brakes, chains, hydraulic hoses); l) instructions for removing and reattaching guarding; m) instructions for regular verification of seat belt related to 1) cut or frayed straps, 2) worn or damaged hardware, including anchor points, 3) buckle or retractor malfunction, 4) loose stitching.		
6.2.6	Transportation, commissioning and storage		-
	dismantled parts for transport, commissioning and storage; b) procedures for transporting, including loading and unloading; c) procedure for truck reassembly and mounting of attachments;		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	d) functional tests on completion of commissioning; e) procedure for movement of inoperative trucks; f) procedure for prolonged shut down and storage of trucks.		
6.2.7	Truck modification		P
6.2.7.1	Unauthorized truck modification is not permitted. The text of 6.2.7.3 shall be included in the instruction handbook and the workshop handbook.		P
6.2.7.2	Except where provided in 6.2.7.3, no modifications or alterations to a powered industrial truck, which could affect, for example, capacity, stability or safety requirements of the truck, shall be made without the prior written approval of the original truck manufacturer, its authorized representative, or a successor thereof. This includes changes affecting, for example, braking, steering, visibility and the addition of removable attachments. When the manufacturer or his successor approves a modification or alteration, the manufacturer or successor shall also make and approve appropriate changes to the capacity plate, decals, tags and operation and maintenance handbooks.		P
6.2.7.3	Only in the event that the truck manufacturer is no longer in business and there is no successor in the interest to the business, may the user arrange for a modification or alteration to a powered industrial truck, provided, however, that the user		P
	a) arranges for the modification or alteration to be designed, tested and implemented by an engineer(s) expert in industrial trucks and their		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	safety, b) maintains a permanent record of the design, test(s) and implementation of the modification or alteration, c) approves and makes appropriate changes to the capacity plate(s), decals, tags and instruction handbook, and d) affixes a permanent and readily visible label to the truck stating the manner in which the truck has been modified or altered, together with the date of the modification or alteration and the name and address of the organization that accomplished those tasks.		
6.3	Marking		-
6.3.1	Information plates		P
6.3.1.1	Trucks		P
	Trucks shall be marked legibly and indelibly (e.g. weather-proofed, profiled letters) with at least the following details: a) name and address of the manufacturer or his authorized representative; b) designation of series or type and compliance with the requirements of this part of ISO 3691; c) serial number and year of manufacture; d) unladen mass of the truck in working order and without removable attachments, and without battery in the case of battery-powered trucks, but with fork arms or integral attachments, the actual mass being permitted to vary from the stated mass by up to 5 % or 1 000 kg, whichever is the lower of the two; e) actual capacity at maximum lift height with load		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	centre distance; where a secondary lift is fitted to a truck, the capacity at maximum lift shall be determined with the secondary mast fully elevated; f) actual capacities at other lift heights and load centre distances, if applicable; g) actual capacity with each removable attachment fitted at the manufacturer's authorized lift height(s) and load centre(s), these actual capacities being easily readable by the operator in the normal operating position; h) on battery-powered trucks, the authorized maximum and minimum battery mass and the system voltage; i) if fitted, the maximum supporting force on the towing point connection, in newtons; j) if fitted, the drawbar pull on the towing point connection, in newtons; k) the nominal power in kilowatts, e.g. marked on the engine or electric motor.		
6.3.1.2	Removable attachment		N
	Removable attachments shall be marked legibly and indelibly (e.g. weather-proofed, profiled letters) with at least the following details: a) name and address of the attachment manufacturer or his authorized representative; b) model or type; c) serial number and year of manufacture; d) mass of attachment, which may vary from the stated figure by up to 5 % or 200 kg, whichever is the lower of the two; e) distance of the centre of gravity of the attachment from its mounting face on the truck;		N

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	f) rated capacity; g) in the case of hydraulically or pneumatically operated attachments, the maximum operating pressure recommended by the attachment manufacturer; h) load centre, if applicable; i) lost load centre distance; j) the instruction “The capacity of the truck and attachment combination shall be complied with”.		
6.3.1.3	Tractors		N
	Tractors shall be marked legibly and indelibly (e.g. weather-proofed, profiled letters) with at least the following details: a) name and address of the manufacturer or the authorized representative; b) designation of series or type; c) unladen mass of the tractor in working order without battery for battery-powered tractors; the mass may vary from the figure shown by up to 5 % or 1 000 kg, whichever is the lower; d) serial number and year of manufacture; e) on battery-powered tractors, the authorized minimum and maximum battery mass and the system of voltage; f) the nominal power in kilowatts, e.g. marked on the engine or electric motor; g) the maximum supporting force on the tow-hook, in newtons; h) the drawbar pull, in newtons, and the period of time during which this pull can be exerted		N
6.3.1.4	Marking of controls		P
	Controls shall be legibly and indelibly marked (e.g. weather-proofed, profiled letters) with graphic		P

EN ISO 3691-1:2015+AC:2016+A1:2020			
Items	Requirements	Result-Remark	Verdict
	symbols indicating the function(s), except where these are obvious, e.g. accelerator pedal. Each symbol shall be affixed on, or in close proximity to, the control to which it applies. Control symbols shall comply with ISO 3287, for existing symbols.		
6.3.2	Information plate for trucks operating in special conditions		N
	If a truck is designed to operate in special conditions (see 4.1.1. and 4.8.2), the manufacturer shall provide, where appropriate, and in addition to the information provided in the instruction handbook, an information plate on the truck identifying those special conditions of use, including capacity if different from the capacity during normal operation (see 4.1.2).		N
6.3.3	Other information		-
6.3.3.1	Marking for slinging of trucks		P
6.3.3.2	Pneumatic tyre inflation pressure		P
6.3.3.3	Filling points		P
6.3.3.4	Warning signs		P
6.3.4	Languages English		P
6.3.5	Operator restraint		P
ANNEX A	Determination of driving direction and rated capacity		P
ANNEX B	List of significant hazards		P

2.6 EN 16307-1:2020 Industrial trucks - Safety requirements and verification - Part 1: Supplementary requirements for self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
4	Safety requirements and/or protective measures		-
4.1	General		-
	Machinery shall comply with the safety requirements and/or protective measures of 4.2 to 4.16. In addition, the machine shall be designed according to		P

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
	the principles of EN ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document. The following applies to the self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks, dealt with in EN ISO 3691-1:2015. These are additional to the requirements of EN ISO 3691-1:2015 and, in certain instances, replace them		
4.2	Electrical requirements		-
	Electrical systems and equipment shall be in accordance with the relevant part(s) of EN 1175:1998+A1:2010.		P
4.3	Travel speed		-
	The requirements of EN ISO 3691-1:2015, 4.2.3 shall apply, except the reference to ISO/TS 3691-8, with the following addition:		-
	The travel speed of variable-speed pedestrian-controlled trucks operating on level ground shall not exceed 6 km/h.		P
	The maximum speed on level ground of stand-on trucks and pedestrian-controlled trucks fitted with a foldable platform when the operator is on the platform shall not exceed 16 km/h		P
4.4	Brakes		-
	The requirements of EN ISO 3691-1:2015, 4.3.1 shall apply, except the reference to ISO/TS 3691-8, with the following addition:		-
	The parking and service brakes of trucks that can travel with an elevated operator position and/or elevated load above 500 mm, and up to and including 1 200 mm, are subject to the following requirements:		-
	— for travel speeds up to and including 9 km/h, parking		P

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
	brakes shall be in accordance with ISO 6292:2020, 6.2.2 a), and service brakes shall comply with the specifications of ISO 6292:2020, Table 2, Group C;		
	— for travel speeds above 9 km/h, parking brakes shall be in accordance with ISO 6292:2020, 6.2.2 b) and service brakes shall comply with the specifications of ISO 6292:2020, Table 2, Group A1.		P
4.5	Travel and braking controls - additional operation from alongside pedestriancontrolled and stand-on trucks		-
	The requirements of EN ISO 3691-1:2015, 4.4.2.7 shall apply, except the reference to ISO/TS 3691-8, with the following addition:		-
	Low-lift order-picking trucks provided with a system that allows operating while walking alongside the truck are subject to the following requirements:		-
	— activation of the travel control device from outside of the truck shall only be possible when the truck is stationary;		P
	— the travel control shall be a hold-to-run control and the speed shall not exceed 4 km/h while operating the travel control from outside of the truck		P
	— braking function shall be automatically applied when travel control device is released.		P
4.6	Lift chains		-
	The requirements of EN ISO 3691-1:2015, 4.6.1 shall apply, except the reference to ISO/TS 3691-8, with the following addition:		-
	The minimum safety factor of the lifting mechanism, $K1$, shall be as follows:		-
	— for trucks ≤ 10 000 kg rated capacity: $K1 \geq 5$ — for trucks > 10 000 kg rated capacity: $K1 \geq 5 - 0{,}2(Q' - 10)$, but not less than 4 where Q' is the rated capacity of the truck, in tonnes.		P

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
4.7	Mast tilt and carriage isolation		-
	The requirements of EN ISO 3691-1:2015, 4.6.3.5 shall apply, with the following addition: For ride-on trucks, the movement of powered attachments shall not be possible through operation of the control when the operator is not in the normal operating position.		P
4.8	Operator's seat		-
	The requirements of EN ISO 3691-1:2015, 4.7.4 shall apply with the following addition: The operator's seat shall be specified and marked in accordance with EN 13490:2001+A1:2008		P
4.9	Protection against crushing, shearing and trapping		-
4.9.1	General		-
	The requirements of EN ISO 3691-1:2015, 4.7.7.1 shall apply with the following addition: Where fixed and/or removable guard systems are needed, the requirements of EN ISO 14120:2015 shall be met. When a fixed guard is removed, its fixing system shall remain on the guard or on the truck. This requirement applies to any fixed guards that are liable to be removed by the user with a risk of loss of the fixings, e.g. fixed guards that are liable to be removed during routine maintenance or setting operations carried out at the place of use.		P
4.9.2	Pedestrian and stand-on end-controlled trucks with mast		-
	The mast shall be guarded at the side facing the operating controls, e.g. by a transparent cover. The guard shall, as a minimum, cover the whole width of the hazardous zone and the full length of the nonelevated mast, or up to 2,2 m from the ground, whichever is less.		P
4.10	Loading control		-

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
	The manufacturer shall give information regarding the residual risk of overloading and overturning in the instruction handbook, see 6.1.1.		P
4.11	Lateral stability		P
	The requirements of EN ISO 3691-1:2015, 4.8.1 shall apply. In addition, counterbalanced lift trucks other than rough terrain counterbalanced trucks, that have a centre control, sit down, non-elevating operator, with a rated capacity up to and including 5 000 kg shall comply with EN 16203:2014.		P
4.12	Visibility		-
	The requirements of EN ISO 3691-1:2015, 4.10.1 shall apply except the reference to ISO 13564-1 and with the following modification		P
	The requirements of EN 16842 shall apply. EN 16842-1:2018 defining the basic test criteria and requirements for all applicable truck types shall be applied in conjunction with the truck type specific part of EN 16842:		-
	— sit-on counterbalance trucks and rough terrain masted trucks up to and including 10 000 kg capacity: EN 16842-2:2018; — reach trucks up to and including 10 000 kg: EN 16842-3:2018; — sit-on counterbalance trucks and rough terrain masted trucks greater than 10 000 kg capacity: EN 16842-6:2018; — masted container trucks handling freight containers of 6 m (20 ft) length and longer: EN 16842-7:2018.		P
4.13	Reduction of noise by design		-
4.13.1	General		-
	Industrial trucks shall be designed and constructed		P

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
	such that risks resulting from the emission of airborne noise are reduced according the state of the art. When noise is a significant hazard, there is need for a low-noise design. In this case, the methodology for low-noise design given in EN ISO 11688-1:2009 shall be considered.		
4.13.2	Main source of noise		-
	On industrial trucks, the main sources of noise are components, such as the following, in a high-speed operation mode:		-
	— combustion engines, including air intake, cooling fan and exhaust system; — hydraulic pumps/motors.		P
4.13.3	Measures to reduce noise at the operator's position		-
	Typical measures to reduce noise include:		-
	— selection of low-noise components; — use of elastic mountings that prevent the transmission of structure born noise from the components to the structures; — the use of improved noise insulation in the cabin, if fitted. These and other measures of identical or better efficiency may be used.		P
4.13.4	Determination of noise emission values		-
	The value of noise emission shall be measured using the test method given in EN 12053:2001+A1:2008.		P
4.14	Vibration		-
	Whole body vibration shall be measured using the test method given in EN 13059:2002+A1:2008.		P
4.15	Electromagnetic radiation		
4.15.	Non-ionising radiation		-

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
1			
	Where trucks are fitted with functional related non-ionising radiation devices, the radiation shall be minimised with consideration to the influence to persons, in particular with active or non-active implantable medical devices. Electromagnetic emission of trucks shall comply with EN 12895:2015+A1:2019, 4.1, 5.1 and 5.2.		P
4.15.2	External radiation		-
	Electromagnetic immunity of trucks shall comply with EN 12895:2015+A1:2019, 4.2, 5.1 and 5.3.		P
4.16	Operator restraint system		-
	Whenever the truck is switched-on and in drive mode, a visual warning shall indicate to the operator that the restraint system as required in EN ISO 3691-1:2015, 4.7.8, is not engaged (e.g. seat belt not buckled, door bar or cabin door not closed).		P
	When the restraint device is engaged, the visual warning shall be switched-off.		P
	When the restraint device is not engaged, and the truck speed is greater than 4 km/h an audible warning shall be given to the operator. If it is not possible to determine the speed of the truck, an audible warning shall be given after a reasonable time after switch-on of the truck, latest 30 s after switch-on of the truck or detection of the operator by the operator control (e. g. seat switch) when the restraint device is not engaged.		P
	When the truck is equipped with more than one operator restraint, it is sufficient if one of these devices is engaged.		P
	When the truck is equipped with a driving system that is not able to accelerate the truck to a speed of		P

EN 16307-1:2020			
Items	Requirements	Result-Remark	Verdict
	more than 4 km/h if the restraint system is not engaged, an audible warning is not required.		
5	Verification of safety requirements and/or protective measures		P
6	Information for use		P

Annex：Technical Information

A.1 Specifications table

A.2 Overall drawing

A.3 Electrical circuit diagram

A.4 Hydraulischematic diagram

A.5 Design And Count Book

A.6 Electrical parts list

A.7 Technical parameter

A.8 Instruction manual

A.9 The photo of the machine

Annex：Technical Information

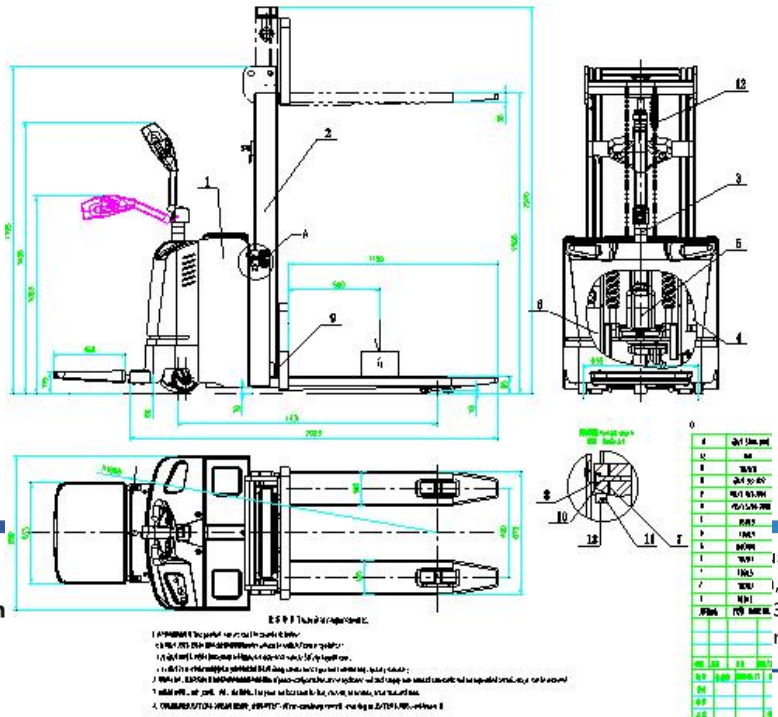
A.1 Specifications table

VMAX ANHUI VMAX HEAVY INDUSTRY CO.,LTD

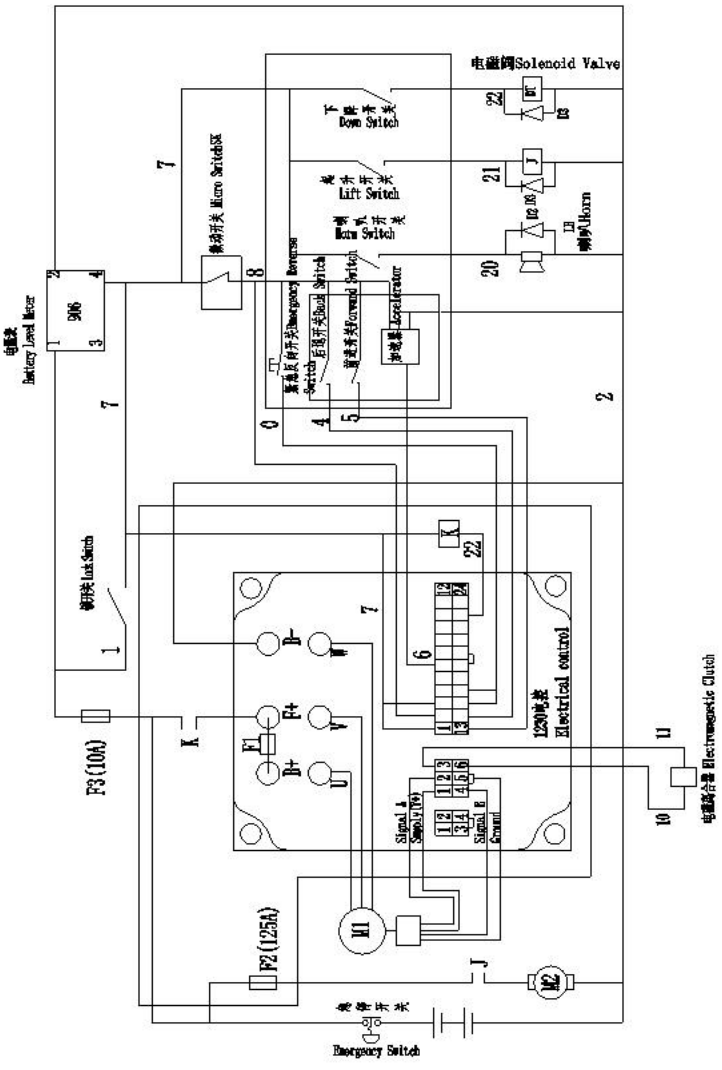
Product name	ELECTRIC PALLET STACKER		
Model	CDD15-50	Load center	500 mm
Load capacity	1500 kg	Battery voltage	24V/210AH V
Max. lift height	500 mm	Serial No.	220823269B15F
Service weight	1470 kg	Chassis No.	202208051
Manuf. license No.	TS2510589-2025	Production date	2022.08

Add: No.18 Shengli Road, Jin'an Development Area, Lu'an City, Anhui Province, China

A.2 Overall drawing



A.3 Electrical circuit diagram



A.9 The photo of the machine

Attachment - EUT Photos

CDD20

======End======