BS EN 528:2021+A1:2022

BSI Standards Publication

Rail dependent storage and retrieval equipment — Safety requirements for S/R machines

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National foreword

This British Standard is the UK implementation of EN 528:2021+A1:2022. It supersedes BS EN 528:2021, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by [A1⟩ ⟨A1].

The UK participation in its preparation was entrusted to Technical Committee MHE/14, Rail dependent storage and retrieval equipment - Safety.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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For the Great Britain market (England, Scotland and Wales), if UK Government has designated this publication for conformity with UKCA marking (or similar) legislation, it may contain an additional National Annex. Where such a National Annex exists, it shows the correlation between this publication and the relevant UK legislation. If there is no National Annex of this kind, the relevant Annex ZA or ZZ in the body of the European text will indicate the relationship to UK regulation applicable in Great Britain. References to EU legislation may need to be read in accordance with the UK designation and the applicable UK law. Further information on designated standards can be found at www.bsigroup.com/standardsandregulation.

For the Northern Ireland market, UK law will continue to implement relevant EU law subject to periodic confirmation. Therefore Annex ZA/ZZ in the European text, and references to EU legislation, are still valid for this market.

UK Government is responsible for legislation. For information on legislation and policies relating to that legislation, consult the relevant pages of www.gov.uk.

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NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 528:2021+A1

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Regalbediengeräte - Sicherheitsanforderungen

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European foreword

This document (EN 528:2021+A1:2022) has been prepared by Technical Committee CEN/TC 149 “Power-operated warehouse equipment”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2023, and conflicting national standards shall be withdrawn at the latest by January 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive(s) / Regulation(s).

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

This document includes Amendment 1 approved by CEN on 4 May 2022.

This document supersedes ▌A1⟩ EN 528:2021 ⟨A1▌.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ▌A1⟩ ⟨A1▌.

The main changes compared to the previous edition EN 528:2008 are as follows:

— clearer / more understandable Annex C dealing with preventing access to dangerous movements across the load entry/exit points;

— Annex ZA has been updated by introducing the generic template for Annex ZA amended in accordance with decision of EU commission;

— revision and adaption of Annex B Performance level according to EN ISO 13849-1:2015;

— the scope has been stated more precisely;

— more readable and clearer text in standard due to avoidness of separate chapters for automatic and manual machines;

— amendment or rather change of the following definitions (3):

  — on-board control position (3.4), permanent on-board control position (3.5), load entry / exit points (3.7), working place (3.8), pick and deposit station (3.9), restricted area (3.11), danger area (3.12), satellite vehicle (3.15), powered access cabin (3.20), climb assistance system (3.21), rated speed (3.22), normal operation (3.25), deleted definition 3.22 and renamed following definitions;

— speed limitation (4.9.4) has been updated and been stated more precisely;

— where a powered access cabin is provided, it shall comply with the requirements for control positions (4.9.7.2);

— Detachable ladders may be used up to a maximum height of 3 m (4.9.7);

— safety gear required for lifting carriages, that are designed to carry person(s) (4.4.4.1);

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— the ratio of the minimum breaking force to the maximum static force for all types of suspension elements to the lifting of persons has been reduced from 10 to 8 (4.4.5.1);

— requirements for additional person(s) on the lifting carriage has been stated more precisely (4.9.2.2);

— ladder along the mast shall be fitted with a guided type of a fall arresters according with EN 353-1:2014+A1:2017 and anchor points at the transition points (4.9.3);

— prevention against load falling into adjacent automatically operated aisles: Safety level (PLr) is not more depending on the frequency of access to the aisle (4.10.7.3);

— physical safety backstops shall be dimensioned according to the loads that occur (4.10.7);

— information on the planned dismantling of the installation is required in information for use (6.8).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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Introduction

This document is a type C standard as stated in EN ISO 12100:2010.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulars, accident prevention organizations, market surveillance etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e.g. for maintenance (small, medium and large enterprises).

The above-mentioned stakeholder groups have been given possibility to participate at the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the Scope of this standard.

When requirements of this type-C standard are different from those which are stated in type-A or type-B standards, the requirements of this type-C standard take precedence over the requirements of the other standards, for machines that have been designed and built according to the requirements of this type-C standard.

While producing this standard, it was assumed that:

a) only competent persons operate the machine;

b) components without specific requirements are:

   1) designed in accordance with the usual engineering practice and calculation codes, including all failure modes;

   2) of suitable mechanical and electrical construction;

   3) made of materials with adequate strength and of suitable quality;

c) harmful materials, such as asbestos are not used as part of the machine;

d) components are kept in good repair and working order, so that the required characteristics remain despite wear;

e) by design of the load bearing elements, safe operation of the machine is ensured for loading ranging from zero to 100 % of the rated possibilities;

f) discussions have taken place between the user and the supplier concerning particular conditions for the use and places of use of the machinery;

g) working area is adequately lit;

h) places of installation allow a safe use of the machine.

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1 Scope

This document is applicable to all types of Storage and Retrieval (S/R) machines, restricted to the rails on which they travel within and outside the aisles for the storage and retrieval of unit loads and/or long goods such as bar materials and/or for order picking or similar duties. These machines embody lifting means along a mast and may include lateral handling facilities. Also included is the transfer equipment used to change between aisles. Control of machines may range from manual to fully automatic.

S/R-machine-related satellite vehicles according to definition 3.15 are included as a load-handling-device (LHD).

References in this standard to racking, buildings and systems only apply where it is necessary to assess the hazards and risks at their interfaces with S/R machines.

This document deals with all significant hazards relevant to rail dependent storage and retrieval equipment, when they are used under the conditions intended by the manufacturer including reasonably foreseeable misuse (see Annex F "List of significant hazards").

This document is applicable to machines and equipment that are manufactured after the date of issue of this document. A transition period of 12 months is proposed.

Figures of examples of machines and transfer equipment to which this standard applies are shown in Annex A.

Safety requirements and/or measures in this standard apply to equipment used under indoor conditions. However, additional risk assessments and safety measures need to be considered for uses in severe conditions, e.g. extremely high temperatures, loads, the nature of which could lead to a dangerous situation (e.g. especially brittle loads, explosives), earthquake effects and also contact with foodstuff.

This document also deals with the technical requirements for electromagnetic compatibility (EMC).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 81-50:2020, *Safety rules for the construction and installation of lifts — Examinations and tests — Part 50: Design rules, calculations, examinations and tests of lift components*

EN 341:2011, *Personal fall protection equipment — Descender devices for rescue*

EN 353-1:2014+A1:2017, *Personal fall protection equipment — Guided type fall arresters including an anchor line — Part 1: Guided type fall arresters including a rigid anchor line*

EN 358:2018, *Personal protective equipment for work positioning and prevention of falls from a height — Belts and lanyards for work positioning or restraint*

EN 361:2002, *Personal protective equipment against falls from a height — Full body harnesses*

EN 363:2018, *Personal fall protection equipment — Personal fall protection systems*

EN 614-1:2006+A1:2009, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

EN 795:2012, *Personal fall protection equipment — Anchor devices*

EN 894-1:1997+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 1: General principles for human interactions with displays and control actuators*

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EN 894-2:1997+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

EN 894-3:2000+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

EN 12385-4:2002+A1:2008, *Steel wire ropes — Safety — Part 4: Stranded ropes for general lifting applications*

EN 13501-1:2018, *Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests*

A1 EN 14449:2005, *Glass in building — Laminated glass and laminated safety glass — Product standard* A1

EN 60204-32:2008, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines (IEC 60204-32:2008)*

EN IEC 61000-6-2:2019, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments (IEC 61000-6-2:2016)*

EN 61496-1:2013, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests*

EN ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components (ISO 4413:2010)*

EN ISO 4871:2009, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

EN ISO 7731:2008, *Ergonomics — Danger signals for public and work areas — Auditory danger signals (ISO 7731:2003)*

EN ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections (ISO 11201:2010)*

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design (ISO 13850:2015)*

EN ISO 13851:2019, *Safety of machinery — Two-hand control devices — Principles for design and selection (ISO 13851:2019)*

EN ISO 13855:2010, *Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body (ISO 13855:2010)*

EN ISO 13856-1:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors (ISO 13856-1:2013)*

EN ISO 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2019)*

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EN ISO 14119:2013, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection (ISO 14119:2013)*

EN ISO 14120:2015, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards (ISO 14120:2015)*

EN ISO 14122-1:2016, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means and general requirements of access (ISO 14122-1:2016)*

EN ISO 14122-2:2016, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways (ISO 14122-2:2016)*

EN ISO 14122-3:2016, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails (ISO 14122-3:2016)*

EN ISO 14122-4:2016, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders (ISO 14122-4:2016)*

ISO 16625:2013, *Cranes and hoists — Selection of wire ropes, drums and sheaves*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
control position
every place, from where the machine can be controlled, including external control position (3.2), emergency control position (3.3) and on-board control position (3.4)

3.2
external control position
control position placed outside of the operational area of the S/R machine, from where the movements of the machine can be controlled

3.3
emergency control position
position on the machine or inside the danger area of the machine, from where the machine can be controlled in case of fault clearing (emergency) or maintenance works

3.4
on-board control position
protected position on the machine, from where the movements of the machine can be controlled (includes permanent on-board-control position as defined in 3.5)

3.5
permanent on-board control position
protected position on the machine, from where the movements of the machine can be controlled, intended to be used by an on-board operator in the normal operation

Note 1 to entry: Permanent on-board control is fitted e.g. for on-board picking.

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3.6
maintenance position
position on or off the S/R machine intended for maintenance and repair

3.7
load entry / exit points
points where loads were transferred into or out of the restricted area or danger area

3.8
working place
place where persons carry out their duties

3.9
pick and deposit station
location where a load can be picked up from or deposited to the conveyor by the S/R-machine

Note1 to entry: Within the document "pick and deposit" is abbreviated as "P&D"

3.10
traffic area
area, which is accessible to or reachable without opening a guard, activating a trip device or using additional means

3.11
restricted area
enclosed area where only authorized operators who are especially skilled to do maintenance, trouble shooting and repairing work have access to

Note 1 to entry: See also Annex D.

3.12
danger area
area where persons can be exposed to danger during operation of the machine

3.13
load handling device
part of the S/R machine for carrying the specified loads (including one or more satellite vehicles, related to the S/R machine)

Note1 to entry: Within the document "load handling device" is abbreviated as "LHD".

3.14
transfer device
device for transferring a S/R machine from one aisle to another and which is not integral with the S/R machine

3.15
satellite vehicle
vehicle intended for transferring loads into or out of the rack structure by leaving the S/R machine

Note 1 to entry: There may be one or more satellite-vehicles per S/R machine.

3.16
lifting carriage
part of the machine moving vertically along the mast and carrying both load handling device and load; it may also carry (depending on type of machine) an on-board control position or an emergency control position

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3.17
rated load
maximum load which the machine has been designed to carry, excluding the mass of operator(s) and any part of the machine

3.18
test load
rated load plus additional load for test purposes

3.19
specified load
load with specified characteristics (mass, dimensions, pallet or container, packaging, etc.) which the machine has been designed to carry

3.20
powered access cabin
enclosed cabin moving independently from the lifting carriage along the mast in order to provide access to and egress from the lifting carriage and/or maintenance platforms

Note 1 to entry: The on-board control position may be installed within this powered access cabin.

3.21
climb assistance system
powered device used in conjunction with a full body harness in order to ease climbing by providing a defined lifting force (below person`s weight) along the access ladder

3.22
rated speed
maximum speed of the machine for which it has been designed and for which normal operation is guaranteed by the manufacturer

3.23
safety gear
mechanical device for stopping and maintaining stationary the lifting carriage in case of overspeed in the downward direction

3.24
key
opening or switching device that can be mechanical, electrical, magnetic or similar with unique characteristics

3.25
normal operation
operating condition where the S/R machine is operating in accordance with the manufacturer's instructions primarily for the storage, retrieval and reorganisation of specified loads

3.26
system axes
directions, in which the S/R machine can move

Note 1 to entry: x = aisle length direction; y = aisle vertical direction; z = aisle lateral direction.

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4 Safety requirements and/or protective/risk reduction measures

4.1 General

Machinery shall comply with the safety requirements and/or protective/risk reduction measures of this clause.

In addition, the machine 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.

Means of access shall comply with EN ISO 14122:2016 parts 1 to 4 except as otherwise specified in this document.

In the design of machines and sub-assemblies provisions for lifting shall be considered. Safety distances shall comply with EN ISO 13857:2019 apart from the deviations stated in this standard.

Guards shall comply with EN ISO 14120:2015 and interlocking devices shall comply with EN ISO 14119:2013 apart from the deviations stated in this standard.

4.2 Control position

4.2.1 General

Depending on the intended use of the machine the following control position are required:

— S/R machines with one or more on-board operators shall have a permanent on-board control position as described in 3.5;

— in the case of fully automatically controlled machines an on-board control position is not required, but an emergency control position as described in 3.3 shall be provided for each machine.

4.2.2 Access to and egress from the permanent on-board control position

Means of access shall be provided to enter and leave a permanent on-board control position in the normal parking position, in accordance with EN ISO 14122:2016 parts 1 to 4.

Leaving in an emergency shall be possible from all positions by using a ladder as described in 4.9.7 or a descending device for rescue in accordance with EN 341:2011.

4.2.3 Floor of the on-board control position

The floor of the on-board control position shall be within 5° of the horizontal and slip resistant.

The floor shall be designed in accordance with EN ISO 14122-2:2016, 4.2.5.

If glazing is provided for the floor, it shall comply with ⟦A1⟩ EN 14449:2005 ⟦A1⟧.

Where grated flooring is provided, the holes or openings shall not allow a 30 mm diameter sphere to pass through. The area of each opening shall in no case exceed 900 mm^2.

4.2.4 Design and dimensioning of permanent on-board control position

4.2.4.1 Ergonomic principles

Ergonomic principles shall be incorporated where practicable within the confines of the S/R machine design, in accordance with EN 614-1:2006+A1:2009, EN 894-1:1997+A1:2008, EN 894-2:1997+A1:2008 and EN 894-3:2000+A1:2008.

The permanent on-board control position shall be arranged and designed so that the operator has a clear view of his/her immediate working area. If glass is fitted it shall be of the laminated safety glass type.

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4.2.4.2 Safeguard operator against falling risks

The permanent on-board control position shall be fitted with means to prevent persons from falling.

These means include guard-rails, guards and structural parts of the S/R machine and shall:

— comply with EN ISO 14122-3:2016, Clause 7;

— be fixed to the permanent on-board control position.

Guards and guard-rails are not necessary at the sides of the permanent on-board control position if all three of the following conditions are met:

— the rack structure at sides of the aisles in which the S/R machine operates will prevent the fall of persons from the permanent on-board control position

— the S/R machine can only leave the protected area when the floor of the permanent on-board control position is less than 1 m above the floor level, and

— the gap between the on-board control position platform and rack does not exceed 75 mm

Doors and gates designed as a means to prevent persons falling shall not open outwards and sliding doors shall not open downwards.

They shall be designed as interlocked movable guards complying with EN ISO 14120:2015 and EN ISO 14119:2013 and shall prevent any movement of the S/R machine when they are not fully closed.

For S/R machines designed for picking from the permanent on-board control position, the height of the fall protection means may be reduced to a minimum of 0,9 m in deviation to EN ISO 14122-3:2016 in the lateral direction to facilitate picking and may be reduced to a minimum of 0,9 m in the aisle direction where picking tables with minimum depth of 0,2 m are provided.

The S/R machine shall be designed to allow emergency access without tools to the permanent on-board control position for rescue purposes

4.2.4.3 Overhead protection

Overhead protection shall be provided for the operator in the permanent on-board control position. It shall protect the operator at all times during the travelling and hoisting movements of the machine.

This protection shall be of a solid plate type and capable of withstanding a mass of 100 kg distributed over an area of 0,16 m^2 at any part of its surface without causing any permanent deformation.

4.2.4.4 Structure

Structural parts of the permanent on-board control position shall be non-combustible according to EN 13501-1:2018, class A1, and any furnishings shall be difficult to ignite according to EN 13501-1:2018, class C1.

4.2.5 Emergency call device on permanent on-board control positions

The permanent on-board control position shall be fitted with an emergency call device to attract attention in an emergency situation (e.g. an auditory danger signal in accordance with EN ISO 7731:2008).

4.2.6 Lighting on permanent on-board control position

The permanent on-board control position and the adjacent pick-faces shall be illuminated with minimum 200 lx.

Emergency lighting shall be provided at the permanent on-board control position.

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4.3 Control equipment

4.3.1 General

The text of 4.3 and its subclauses fully replaces and deviates from the text in EN 60204-32:2008, 9.4 and its sub clauses.

Safety related parts and safety related functions are listed in Table B.1. Performance levels shall be in accordance with the performance levels required in these tables.

Adjustable safety related parts (e.g. electronic control circuitry, software, safety devices) shall be protected against access by unauthorised persons (e.g. by the use of access codes, seals, enclosures, tools).

Safety related parts shall be designed, located or protected to withstand foreseeable strain or damage.

4.3.2 Safeguard of the operator on a permanent on-board control position

Means shall be provided to safeguard the operator(s) against injuries due to contact with objects outside of the permanent on-board control position during movement of the machine.

For this purpose, the permanent on-board control position shall be either:

a) fully enclosed with guards whilst the machine is moving within the aisle; or,

b) be equipped with two-hand-control of type IIIA according to EN ISO 13851:2019 and/or means giving equivalent safety provided that no part of the body is endangered when the operator is in the correct posture within his range of movement in his driving position.

Especially it shall not be attractive to reach dangerous places until the S/R machine comes to a complete stop (e.g. to pick during positioning). This shall be achieved by the following means:

— the two-hand-control-levers shall be both equipped with presence-contacts;

— those presence-contacts have to remain engaged until complete standstill of the machine;

— if the operator let those contacts go before complete standstill the machine shall stop with maximum deceleration and at the restart of the machine a penalty time of at least 30 s is applied by the control-system.

Any additional person on board the machine shall be similarly protected including the training of an operator.

4.3.3 Prevention of unauthorised operation (equipment switch)

A key operated switch shall be fitted to the onboard-control panel of each machine to prevent unauthorised operation. With the key switch in the position related to automatic operation, all manual movements of the machine shall be prevented. It shall only be possible to remove the key from this switch in the position related to automatic operation.

For manual S/R machines, this key allows the operator to take control of the machine. In the case of automatic machines this key, in conjunction with the key in 4.3.4, allow operation of the machine for commissioning, fault finding or any other work where the machine needs to be operated by manual control.

4.3.4 Changing mode of operation (mode switch)

To prevent danger due to a change from manual to automatic control, or vice versa, one or more key operated mode switches, shall be provided for each automated machine. The mode switches are associated with the safety concept of limited access described in 4.10.4 (see also Figure A.3). When a mode switch is actuated, powered motion shall cease. The machinery shall then remain in a stationary condition. Separate start devices at the external control position, located if possible in a position that

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allows direct sight of the machine and on the machine (on-board control position), shall be provided to be actuated and thus restart the machine.

It shall only be possible to remove the key from the mode switch on the machine in the “automatic” position and from the mode switch at a control position outside the machine operating area in the “manual” or “off” position.

4.3.5 Key dependence

For manual machines the door key (see 4.10.4.2 b)) shall be the same key as specified in 4.3.3, or permanently attached to it. For automatic machines the door key shall be the same key as specified in 4.3.4, or permanently attached to it.

Equivalent key dependent systems, e.g. key transfer systems as described in ISO/TS 19837:2018, may be provided.

Where one machine is dedicated to one enclosed aisle, then each key shall be unique to a machine and the access door associated with the machine operating area.

Where machines are not dedicated to one aisle (e.g. machines with transfer devices, curve going machines) the key shall be unique for each dedicated aisle entrance door. The key for the machines may all be the same but permanently attached to the entrance door key.

If additional keys or master keys are foreseen for emergency rescue access such keys shall only be kept in secure locations. The use of such a key shall not allow the restart of the S/R machine (see 4.10.4.4).

NOTE E.g. such keys can be stored in a clearly labelled break glass box at each aisle entrance close to the key mode switch.

4.3.6 Control devices for powered movements

Control devices for all movements shall be designed and arranged so that the possibility of unintended actuation is avoided.

For machines with fully enclosed on-board control position (see 4.3.2) the stop category may be 2 (see 4.3.8.1). If a stop command is given, powered motion shall cease, and the equipment shall then remain in a stationary condition until the start control device has subsequently been actuated.

4.3.7 Control device identification

Each control device shall be identifiable and clearly marked with the resultant direction of movement in the language of the country of use or by pictograms where appropriate. The way in which the control devices are actuated shall, as far as possible, correspond to the particular movement.

The application of EN 61310-3:2008 is recommended.

4.3.8 Stop function

4.3.8.1 Stop categories

The stop function shall comply with EN 60204-32:2008, 9.2.5.3 and EN ISO 13849-1:2015, 5.2. It shall be:

— category “0” or “1” stop, or

— category “2” stop,

as required by the design (see EN 60204-32:2008, 9.2.2).

4.3.8.2 Initiation of the stop-function

After a stop-function has been initiated powered motion shall cease. If a stop control does not cut off the energy supply (category “2” stop) the stop condition shall be monitored and maintained. The equipment shall then remain in a stationary condition until a start device has subsequently been actuated.

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4.3.9 Emergency stop function

4.3.9.1 General

The emergency stop function shall comply with EN ISO 13850:2015. The stop category 0 or 1 shall be chosen according to the design of the drives and in compliance with EN 60204-32:2008, 9.2.5.4.2.

4.3.9.2 Location of actuators

In addition to the requirements of EN 60204-32:2008, 10.7.1.1 the actuators for the emergency stop function shall be located in all control positions as a minimum.

If an emergency stop device is actuated, the emergency stop function shall be initiated automatically and powered motion shall cease. The equipment shall then remain in a stationary condition until the emergency stop device has been reset and the start device has subsequently been actuated.

4.3.9.3 Electronic devices

Programmable electronic equipment or electronic devices (including electronic sub-assemblies) may be provided for emergency stop functions if the devices and equipment are at least in accordance with the requirements of Annex B.

4.3.10 Safety requirements related to EMC

NOTE This clause is related to the Machinery Directive.

The machine shall have immunity to electromagnetic disturbances enabling it to operate as safely as intended and shall not fail to danger, when exposed to the levels and types of disturbance as specified in EN IEC 61000-6-2:2019. The manufacturer of the machine shall design, install and wire the equipment and sub-assemblies, taking into account the recommendations of the supplier(s) of the sub-assemblies, to ensure that the effects of electromagnetic disturbances generated shall not lead to unsafe operation and/or failure to danger.

There shall be no loss of performance or degradation of performance that could lead to danger. In particular, the following losses of performance or degradations of performance shall not occur:

— unexpected start-up (see EN 60204-32:2008);

— blocking of an emergency stop command, or resetting of the emergency stop function (see EN ISO 13850:2015 and EN 60204-32:2008);

— inhibition of the operation of any safety related circuit including safety related fault detection capabilities.

Information on measures to reduce the effects of electromagnetic disturbances on the machine is given in EN 60204-32:2008, 4.4.2.

4.4 Hoist unit

4.4.1 Hoist unit brake

4.4.1.1 General

All hoist units shall be equipped with brakes capable of stopping the movements of the hoist unit with its test load at its rated speed and maintaining it in its stopped position.

Brakes shall be applied automatically when the power supply of the brake is interrupted.

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4.4.1.2 Acceleration and deceleration at permanent on-board control position

Under normal operating conditions (including emergency stop to category 1 according to EN 60204-32:2008, 9.2.2) maximum permitted acceleration and deceleration shall be less than 2,5 m/s^2 in the vertical direction.

4.4.1.3 Arrangement

The hoist unit shall be arranged so that the connection between the brake and the drum or sprocket cannot be disengaged without tools.

4.4.1.4 Manual brake release lever

When a manual brake release lever is provided, the brake shall be operational when the lever is released.

4.4.2 Limitation of the lifting and lowering movement

In order that lifting and lowering movements are stopped without undue shock, upper and lower limit stops shall be fitted to define the extent of the vertical travel.

NOTE 1 Regarding the equivalent function see 4.5.2 together with an additional (redundant) braking system.

All of the following shall be provided:

a) preliminary devices for initiating a controlled stop towards the upper and lower hoist limits when variable or multi-step drives are fitted;

b) control devices (e.g. limit switch or proximity device) which prohibit incorrect hoist direction at the hoist travel limits;

c) a secondary ultimate limit device. If an ultimate limit device is actuated, an emergency stop function in accordance with 4.3.9 shall be initiated automatically. If switches are provided as an ultimate limit device, actuators shall be independent of the other drive system components.

   Machines with slack rope, chain or belt protection do not require ultimate limit devices for the bottom limit except for continuous rope, chain or belt drives;

d) S/R machines with liftable on-board control position according to 3.4 or 3.5 shall be equipped with buffers or other devices with equivalent function. The maximum deceleration of the lowering movement affecting persons on the liftable on-board control position shall not exceed 3 g under worst conditions as identified in the specific design.

NOTE 2 If a safety gear with a tripping speed of not more than 1 m/s is installed, practicable values for deceleration will not exceed 3g.

4.4.3 Overload and slack condition protection

4.4.3.1 Overload protection

Machines shall be equipped with an overload protection system when the rated load is greater than or equal to 1 000 kg.

Where the rated load is less than 1 000 kg, an overload protection system shall be provided:

1) for machines that are designed to lift (a) person(s);

2) where there is a risk to persons e.g. due to rack collapse by the machine or breakage of suspension elements.

If an overload condition is detected, a stop function in accordance with 4.3.8 shall be automatically initiated.

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The setting of the overload protection shall be defined design specific and shall not exceed 110 % of the stress defined by the gross weight (i.e. dead weight of lifting carriage + rated load + weight of the operator) under rated hoist acceleration.

The setting shall be practically verified by

— either increased load under static conditions

— or increased stress under dynamic conditions (by variation of parameters load and/or acceleration).

All settings and test conditions shall be recorded.

4.4.3.2 Slack condition protection

Hoist units using suspension elements shall be equipped with a device to identify a slack condition that, when actuated, stops all operational movements except lifting at the slowest hoisting speed of the machine. If endless chains or belts are fitted, this protection is not necessary.

Provisions shall be made to prevent the restarting of the machine until the fault has been cleared by an authorized person.

4.4.4 Safety gear and overspeed governor

4.4.4.1 General

All S/R machines:

— with a lifting carriage, that are designed to carry person(s) and that can be raised more than 1,5 m, other than those using self-sustaining lead-screw drives or direct acting hydraulic drives,

— where there is a risk for persons at a lower floor level if the ceiling floor breaks due to the falling of the lifting carriage or counterweight;

shall be equipped with an independent working safety gear and overspeed governor.

If lifting carriages without safety gear are intended to be entered when stationary, they shall be fitted with direct acting mechanical devices so that the lifting carriage can be secured. This device shall be deployable at any height of the lifting carriage.

4.4.4.2 Operation of the safety gear

The safety gear shall engage by means of an overspeed governor at a tripping speed not higher than 1,4 times the rated speed. For rated speeds below 0,5 m/s the governor tripping speed can be set to 0,7 m/s.

Operation of the safety gear at a tripping speed of more than 1 m/s shall not result in an average design retardation of more than 3 g taking into account the mass of the relevant machine parts, the rated load and the operator(s).

The force to activate the safety gear shall be at least the greater of the following two values:

a) either 300 N; or

b) twice that necessary to engage the safety gear.

The breaking load of the rope shall be at least 8 times the tensile force produced in the rope of the overspeed governor when tripped.

Operation of the safety gear shall automatically initiate an emergency stop function in accordance with 4.3.9.

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4.4.4.3 Function of several safety gears

When there is more than one safety gear, their actuators shall be connected (e.g. by mechanical means) to ensure they operate simultaneously.

4.4.4.4 Breakage of or slackness in the overspeed governor rope or chain

Breakage of or slackness in the overspeed governor rope or chain shall be detected by a safety device. If the device is actuated, it shall automatically initiate an emergency stop function in accordance with 4.3.9.

4.4.4.5 Lead-screw drives or direct acting hydraulic drives

Safety gear is not required for hoist units using self-sustaining lead-screw drives or direct acting hydraulic drives, but safety means as in 4.4.6.4 and 4.4.7.3 shall be provided.

4.4.5 Suspension elements

4.4.5.1 General

The ratio between the minimum breaking force and the maximum static tensile force for all types of suspension elements shall be at least 8 for hoist units intended to lift a person(s) and at least 5 for other hoist units. It is permitted to use a single suspension element.

The static tensile force results from the sum of the rated load and the lifting carriage including possible person(s) divided by the number of suspension elements.

$$F = \frac{(m_c + m_L) \times g}{n}$$

$$m_c = Mass\ lifting\ cage$$

$$m_L = Mass\ load$$

$$n = Number\ of\ carryingbelts$$

4.4.5.2 Steel wire rope

4.4.5.2.1 General

Wire rope, drum and pulley diameters shall be calculated according to ISO 16625:2013.

4.4.5.2.2 Size, strength and construction of wire ropes

All wire ropes of one lifting unit shall be of the same size, strength and construction. If they are intended to carry person(s), ropes shall be in accordance with EN 12385-4:2002+A1:2008.

4.4.5.2.3 Rope drums

Rope drums shall be provided with a single continuous spiral groove for each rope. The rope shall only be wound on in one layer, unless a special guidance system is fitted that prevents damage to the rope.

In lowest position of the lifting carriage there shall remain a minimum of 2 turns of rope before the end-fixings on the drum (lifting carriage in the position of fully compressed buffers).

The rope has to be fixed on the drum in a way that the connection withstands to a force 2,5 times higher than the force acting when carrying the nominal static load, calculated according to the numbers of turns remaining on the drum. The coefficient of friction has to be calculated with μ = 0,1.

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4.4.5.2.4 Ratio of the diameter of pulleys and drums

The ratio of the diameter, of pulleys and drums measured at the centreline of the rope, to the nominal diameter of the rope shall be at least 22 to 1.

4.4.5.2.5 Equalization of the tension

Means shall be provided to equalize the tension of the wire ropes, where more than one element is fixed to one point, and its position shall be monitored. If a hazardous condition is detected, an emergency stop function (see 4.3.9) shall be initiated automatically.

4.4.5.2.6 Visual examination

Visual examination of wire ropes and wire rope terminations shall be possible without having to remove the wire ropes or having to disassemble the structural components of the machine.

4.4.5.2.7 Rope terminations

Rope terminations other than on the drum shall have a minimum breaking load of at least 80 % of the minimum breaking load of the rope.

One of the following means shall be employed:

— aluminium pressed ferrules (according to EN 13411-3:2004+A1:2008);

— flemish eyes (according to EN 13411-3:2004+A1:2008);

— asymmetric wedge socket clevises (according to EN 13411-6:2004+A1:2008);

— socketing (according to EN 13411-4:2011);

— swage terminals (according to EN 13411-8:2011).

4.4.5.2.8 Prevention of unintentional displacement

Means shall be provided to prevent unintentional displacement of the rope from the rope pulleys, even under slack rope conditions.

4.4.5.2.9 Protection against falling objects

Where there is a risk of a foreign object falling between a rope and a pulley, a protection shall be installed to minimize this risk.

4.4.5.3 Chain

4.4.5.3.1 General

Chains shall be leaf or roller type only. Round link chains shall not be employed.

4.4.5.3.2 Size, strength and construction

All lifting chains of one lifting unit shall be of the same size, strength and construction.

4.4.5.3.3 Equalization of the tension of several chains

Means shall be provided to equalize the tension of the chains, where more than one element is fixed to one point, and its position shall be monitored. If a hazardous condition is detected, an emergency stop function (see 4.3.9) shall be initiated automatically.

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4.4.5.3.4 Connection between the chain and chain fixing

The connection between the chain and chain fixing shall have a minimum breaking load of at least 80 % of the minimum breaking load of the chain.

4.4.5.3.5 Visual examination

Visual examination of the chain and the termination shall be possible without removing the chain or having to disassemble the structural components of the machine.

4.4.5.3.6 Prevention of unintentional displacement

Means shall be provided to prevent unintentional displacement of the chain from the chain wheels or pulleys, even under slack chain conditions.

4.4.5.3.7 Protection against falling objects

Where there is a risk of a foreign object falling between a chain and sprocket or pulley, a form of protection shall be installed to minimize this risk.

4.4.5.4 Belt

4.4.5.4.1 General

Belts shall be suitable for the environment in which they are intended to operate and shall have steel wire reinforcement. Particularly the effects of temperature, humidity and contaminants should be considered.

4.4.5.4.2 Size, strength and construction

All belts of one lifting unit shall be of the same size, strength and construction.

4.4.5.4.3 Equalization of the tension of several belts

Means shall be provided to equalize the tension of the belts, where more than one element is fixed to one point, and its position shall be monitored. If a hazardous condition is detected, an emergency stop function (see 4.3.9) shall be initiated automatically.

4.4.5.4.4 End fixings

Open-ended belts shall be secured to the structure or equipment, using clamping devices. This device shall have a breaking load of 100 % of the minimum braking load of the belt.

4.4.5.4.5 Pre-tensioning, axial alignment, pulleys and end fixings

The pre-tensioning and axial alignment of each belt, the design (e.g. diameters, width, shape and material) of the drive and idler pulleys, e.g. ISO 13050:2014, and the design of the end fixings shall be in accordance with belt supplier's recommendations.

4.4.5.4.6 Visual examination

Visual examination of the belt and the termination shall be possible without removing the belt or having to disassemble the structural components of the machine.

4.4.5.4.7 Prevention of unintentional displacement

Means shall be provided to prevent unintentional displacement of the belt from the pulleys, even under slack belt conditions.

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4.4.5.4.8 Protection against falling objects

Where there is a risk of a foreign object falling between a belt and a pulley, a protection shall be installed to minimize this risk.

4.4.6 Hydraulic drives

4.4.6.1 General

Hydraulic installation shall comply with EN ISO 4413:2010.

4.4.6.2 Hoses

Hoses shall be able to withstand 4 times the setting value of the related pressure relief valve.

4.4.6.3 Pressure relief valve

A pressure relief valve shall be installed between the pump and the non-return valve and shall operate at no more than 20 % above the operating pressure.

4.4.6.4 Prevention of lowering of the on-board control position

A valve shall be connected directly to the lifting cylinder to prevent lowering of the lifting carriage in case of pipe or hose failure if they are intended to carry people.

The lowering control valve shall be tested according to 5.1.5.

4.4.6.5 Parts of the lifting units which enter racks

Where a part of the lifting unit enters a rack, the system shall be so designed that unintentional lowering of the lift unit shall not occur even in the event of a failure of the hydraulic system. This does not apply for leakage at the cylinder (see EN ISO 4413:2010).

4.4.6.6 Auxiliary hoist units

For auxiliary hoist units operated by cylinders directly connected to the lifting carriage or load handling devices, valves shall be fitted to the cylinder to prevent uncontrolled lowering in case of pipe or hose failure.

4.4.6.7 Cushion cylinder

The switches in 4.4.2 are not necessary if a cushion cylinder is fitted to prevent excessive stress.

4.4.7 Lead-screw drive

4.4.7.1 General

The ratio of the ultimate tensile stress of the material specified to the design stress of the threads for lead-screws and nuts at maximum payload and additional loads for all kinds of lead-screws shall not be less than 6.

A lower safety factor, but not less than 3, may be applied on a machine without an elevating control position unless there is a danger to persons.

4.4.7.2 Lead-screw mechanism

The lead-screw mechanism shall be designed to prevent its separation from the lifting carriage during normal operation.

4.4.7.3 Safety nut

A safety nut shall be fitted if the lifting carriage is intended to carry person(s).

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The safety nut shall be of the same material and size as the load bearing nut and shall only be loaded if the load bearing nut fails. It shall not be possible to raise the lifting carriage when the safety nut is under load. The lead-screw shall have higher wear resistance than the nuts.

4.4.7.4 Inspection of the load bearing nut

It shall be possible to inspect the condition of the load bearing nut without major disassembly, for instance by measuring the clearance between the load bearing nut and the safety nut.

4.4.7.5 Lead-screw devices

Lead-screws shall be fitted with devices at both ends to prevent the load bearing and safety nuts from leaving the lead-screw.

4.4.8 Rack and pinion drives

4.4.8.1 General

The ratio of the ultimate tensile stress of the material specified to the design stress of racks and pinions at maximum payload and additional loads for all kinds of rack and pinions shall not be less than 6. A lower safety factor may be applied on a machine without an elevating control position unless there is a danger to persons.

4.4.8.2 Driving pinion

In addition to the normal mechanisms of the machines, positively acting devices shall also be provided that prevent the driving pinion and the pinion that operates the safety gear from becoming disengaged from the rack. These devices shall ensure that the axial movement of the pinion is limited so that at least 2/3 of the tooth width remains engaged. They shall also restrict the radial movement of the pinion out of its normal combing position to a maximum of 1/3 of the tooth height.

4.4.8.3 Visual examination of the pinions

Visual examination of the pinions shall be possible without the removal of the pinions or major disassembly of structural components.

4.5 Travel unit of the S/R machine

4.5.1 Travel unit braking system

4.5.1.1 General

The machine shall be capable of being decelerated and stopped from the rated speed with the rated load plus operator(s) during normal operation and in the case of an emergency by the following means:

a) electrical or mechanical braking system for normal operation;

b) mechanical braking system to operate automatically in the event of the power supply being interrupted in any way;

c) where machines have an on-board control position and an indirect rope, belt or chain drive travel unit, the braking system shall be effective also in the event of failure of the rope, belt or chain, or associated components; this brake can be combined with the brake described in 4.5.1.1 b).

4.5.1.2 Acceleration and deceleration at permanent on-board control position

Under normal operating conditions (including emergency stop to category 1 according to EN 60204-32:2008, 9.2.2) maximum permitted acceleration and deceleration shall be less than 1,5 m/s^2 in the horizontal direction.

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Means shall be provided to prevent the operator from losing his balance due to acceleration or deceleration (e.g. handholds or seats).

4.5.1.3 Additional braking system

An additional braking system is required to operate automatically in the event of failure of the normal operational braking system in the following cases when:

a) curves have to be negotiated at limited speed;

b) end stops (e.g. buffers) are designed for a speed less than 70 % of the rated speed (in this case 4.5.2 b) also applies);

c) there is a danger of collision with other machines (e.g. more than one machine is operating on the same rail) and no other means (e.g. on-board bumpers) are fitted.

The additional braking system shall be able to operate even in the event of component failure in the travel unit.

4.5.1.4 Machines with front and rear drive units

For S/R machines fitted with front and rear drive units each with a separate electrical and mechanical braking system, the additional braking system in 4.5.1.3 may be dispensed with if each braking system is independently capable of meeting the requirements in 4.5.1.1. It shall be possible to test each braking system individually.

4.5.1.5 Self-acting parking brake

All machines shall be equipped with a self-acting parking brake to prevent unintentional movement of the machine (e.g. during maintenance work). This brake can be combined with the brake described in 4.5.1.1 b) and 4.5.1.1 c).

4.5.2 Speed reducing system

Automatic speed reduction shall be provided in addition to that in 4.5.1.1 when a lower speed is required for safety reasons, for example in the following cases when:

a) curves have to be negotiated at limited speed;

b) end stops are not capable of stopping the machine travelling at rated speed;

c) there is a danger of collision with other machines (e.g. more than one machine is operating on the same rail) and no other means (e.g. on-board buffers) are fitted.

The function of this system shall be automatically monitored. In case of failure, the machine shall be stopped automatically (see Annex B No.10).

4.5.3 Limitation of travel

The following means shall be provided to stop the machine safely at the limit of travel:

a) devices (e.g. buffers) to absorb the energy of the travel movement. This device shall be such that the maximum deceleration for a person(s) on the S/R machine shall not exceed 10 m/s^2;

b) operational device/function in the control circuit to stop the machine before the machine contacts the buffers. This device/function is not required if the buffer is designed for continual use and automatically monitored ensuring it returns to its initial position; after the S/R machine has left the buffer any travel in the direction of this buffer shall only be possible when the buffer is in its initial position;

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c) a safe ultimate limit system. If a safe ultimate limit system is triggered, an emergency stop function in accordance with 4.3.9 shall be initiated automatically (see Annex B No. 6);

d) means to prevent collisions which may result in injury to personnel or damage to machines when there is a danger of collision with other machines (e.g. more than one machine is operating on the same rail).

4.5.4 Anti-derailment devices

4.5.4.1 General

A device to prevent derailment, e.g. profile plate around the head of the rail, shall be fitted on the machine. This shall be effective even in the case of failure of travel wheels or guide rollers.

4.5.4.2 Rail junctions

Rail junctions shall include interlocking devices to prevent derailment.

4.5.4.3 Prevention from dropping

Means shall be provided to prevent the machine from dropping more than 10 mm if a travel wheel or axle fails.

4.5.5 Stability

The machine and the rails shall be designed and built in such a way that the machine will not overturn even during operation of the safety devices.

The stability factor (υ_s) is calculated as follows:

$$\upsilon_s = \frac{\sum stabilisingmoments}{\sum overturningmoments} \tag{1}$$

Stabilizing effects resulting from the rated load plus persons and horizontal forces due to the masses associated with the machine may only be taken into account when these actually exist under the defined load combinations. If the stability is ensured by additional equipment, this equipment shall be designed for the task. In the case of anti-tipping devices which engage rail heads, the rails, their fixings, the guides and associated parts shall be able to withstand the forces developed.

Horizontal forces due to the mass of the rated load plus persons on the machine and all parts of the machine above the lower carriage shall be multiplied by a factor to take into account the effect of oscillation. This factor shall not be applied in the case of buffer impact.

Under normal working conditions, the stability factor shall be $\upsilon_s \geq 1{,}5$. This shall take into account the least favourable tipping axis, the moments due to the machine itself and the rated load plus persons, the horizontal forces due to the mass, and where applicable wind loading, for each load condition under the least favourable loading combinations.

In the event of mechanical braking resulting from emergency situations arising from the operation of an emergency stop or the loss of power, υ_s may be lower but shall be ≥ 1,1, assuming that no effect from any anti-tipping devices is taken into account.

The factor of oscillation has to be chosen and applied according to the electrical and mechanical drive system (acceleration and deceleration). This factor is to be calculated from the greatest dynamic stress which results from the sudden change of acceleration to deceleration and vice versa and additionally the worst amplitude of the mast.

If machines without anti-tipping devices, with or without load, hit the buffers, the wheel loading shall remain positive.

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4.6 Load handling devices

4.6.1 Load stability

The load handling device (e.g. forks, platforms or satellites) shall be constructed in such a way that every part of the specified load will remain in a stable position during normal operation.

4.6.2 Determination of possible impacts on the rack

The racking supplier shall be advised of the maximum envisaged kinetic energy of the load and load handling device (including the related input-parameters: load mass and speed and masses and speeds of the moving parts of the LHD) and the maximum envisaged drive forces at the point of impact of the load handling device including the effect of any force limiting device (mechanical or electronical) to be able to calculate the resulting quasi-static forces.

NOTE One possible calculation method for transferring those given values into static rack reaction forces is defined in FEM 9.842, [Rail dependent storage and retrieval systems – Consideration of accidental kinetic energy action in compliance with EN 528].

4.6.3 Rotating devices

To restrain the load handling device when stationary, the drive unit for a rotating load handling device shall be fitted with a braking system or a gear that is self-sustaining in all modes of operation (e.g. an appropriate worm gear).

4.6.4 Interlocking functions

Interlocking functions shall be provided that only allow lateral movement of the load handling device (with exception of lateral movements of load handling device or load within the confines of the lifting carriage or lateral movements of satellites completely within the racking) when the machine has stopped.

Interlocking functions shall be provided to prevent accidental contact of the load or load handling device with racks or other objects, in particular:

a) machine out of position horizontally and/or vertically (during load transfer);

NOTE 1 Wrong horizontal positioning can damage the rack column resulting in a total rack collapse.

b) load contour outside of limit in z-direction (except during load transfer);

c) LHD not central (except during load transfer);

d) aperture occupied (during load transfer).

With the load handling device extended or the satellite transferring into or out of the racking, travelling movements shall only be possible at a maximum speed of 0,05 m/s and over a maximum distance ± 40 mm.

In manual operation safety functions a), b) and d) are not mandatory.

NOTE 2 Aperture occupied is not a safety function as specified in Table B.1.

4.6.5 Auxiliary handling equipment

Auxiliary lifting and pulling devices shall be built in such a way that the load cannot be moved into or over the on-board control position, and in such a way that the operator is protected against falling parts of the load.

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4.6.6 Load position monitoring

For automatic machines the load shall be checked for correct positioning on the load handling device before lift or travel movements take place.

4.6.7 Satellites

The satellite shall be capable of being decelerated and stopped from the rated speed with the rated load without undue shock during normal operation and in the case of an emergency by the following means:

— electrical or mechanical braking system for normal operation;

— mechanical braking system to operate automatically in the event of the power supply being interrupted in any way.

4.7 Electrical equipment

4.7.1 General

The electrical equipment for the machines shall be provided in accordance with the applicable clauses of EN 60204-32:2008 together with the particular requirements below. Deviations are stated in the respective clauses.

NOTE Electrical equipment includes materials, fittings, devices, appliances, fixtures, apparatus and the like, fitted as part of, or in connection with, the electrical installation of the machine. This includes electronic equipment, the means of disconnection from the supply and all wiring on and from the machinery to the means of disconnection from the supply.

4.7.2 Electrical supply conditions

If the equipment is intended for use in electrical supply conditions outside the range of EN 60204-32:2008, 4.3 (e.g. supply voltage outside the tolerances), then the manufacturer shall design the equipment to ensure the same level of safety as for the use specified in EN 60204-32:2008.

4.7.3 Environment

The electrical equipment shall be selected and installed to suit the intended working environment. If the equipment is intended for use in conditions outside the range in EN 60204-32:2008, 4.4 (e.g. ambient temperature, humidity, altitude, corrosive atmosphere) the environmental design parameters shall be stated in the information for use.

4.7.4 Supply disconnecting (isolating) device

4.7.4.1 General

In deviation from EN 60204-32:2008, 5.3.1 the functions of disconnection and/or switching the energy supply will be made by:

a) main switch: a supply disconnecting device for each S/R machine, which also switches the fixed supply (e.g. bus-bars, festoon cables);

b) on-board switch: an additional disconnecting device on each machine having on-board control (e.g. motor starters, inverters).

4.7.4.2 Type

Main switch: The main switch shall be either type a), type c) or type d) according to EN 60204-32:2008, 5.3.2.

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