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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Entertainment technology - Part 1: Machinery for stages and other production areas - Safety requirements and inspections

Technologies du spectacle - Partie 1: Machinerie pour
scènes et autres zones de production - Exigences et
inspections relatives à la sécurité

Veranstaltungstechnik - Teil 1: Maschinen für Bühnen
und andere Produktionsbereiche -
Sicherheitstechnische Anforderungen und Prüfungen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 433.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.



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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 17206-1:2025) has been prepared by Technical Committee CEN/TC 433 “Entertainment Technology – Machinery, equipment and installations”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 17206:2020 and EN 17206:2020/AC:2021.

CEN/TC 433/WG1 has reviewed EN 17206:2020 to adapt the standard to the technical progress, new requirements and changes in the standard referenced. The main changes are:

- Terminology related to axis definition has been removed and replaced with shared loads, group of machines, individual machines, and multiple machines, according to context.
- The definitions of shared and non-shared loads, control system, normal operation, positive load holding device, and friction load holding device have been added.
- Exceptional load and related failure conditions have been adopted, replacing the concept of Load at Failure, which is no longer referenced.
- Load assumptions for lower machinery and horizontal machinery have been revised.
- The drive system chapter has been restructured.
- Requirements for Direct Acting Capacity Limiters settings have been revised to align with EN 14492-2 specifications.
- Traction sheaves specifications, following design requirements as per EN 81-50:2020, have been adopted.
- Clarifications concerning dynamic forces to be considered for UC1 and UC2 machinery have been added.
- Manual performer flying system requirements related to fibre ropes, operator lines, travel ropes, pulleys, block systems, sheaves, drums, track systems, and trolleys have been added.
- Requirements and specifications for machinery horizontal movements have been added.
- Load test of lifting equipment specifications has been revised.
- Specifications and description of protection against position deviation have been added.
- Upper machinery and Lower machinery Use Case requirements have been revised, with the addition of Use Cases for Upper machinery horizontal movements.
- Standard references to Eurocodes have been corrected.
- An informative Annex H for the calculation of exceptional loads has been added to the document.
- An informative Annex I for the definition of the partial safety factors and design risk factors has been added to the document.

EN 17206, *Machinery for stages and other production areas* consists of the following parts:

- *Part 1: Safety requirements and inspections* [the present document]
- *Part 2: Safety requirements for stands and truss lifts of stands*

Introduction

The purpose of this document is to produce European safety specifications for the design, manufacture and installation of lifting and load bearing equipment within the entertainment industry. Apart from the Machinery Directive, the Council Directive 2009/104/EC of 16 September 2009 concerning the minimum safety and health requirements for the use of work equipment by workers at work states in Annex II:

“3.1.3

Measures must be taken to ensure that workers are not present under suspended loads, unless such presence is required for the effective operation of the work

Loads may not be moved above unprotected workplaces usually occupied by workers.

Where that is the case, if work cannot be carried out properly any other way, appropriate procedures must be laid down and applied.”

This document considers situations that give rise to danger, such as moving or holding scenery or equipment:

- a) over persons and/or unprotected areas;
- b) in areas with low light conditions, limited visibility, for example while using stage fog and other masking effects.

These situations apply not only during performances, but also during rehearsals, technical set-up, preparations, installations and other situations. This document covers these hazards and suggests appropriate procedures to maintain safety.

Machinery installations are all technical installations and equipment used for operations in stage and production facilities in the entertainment industry. Such installations are used to lift, lower, suspend and carry loads (e.g. scenery, traverse systems, or lighting, film/video and sound equipment). They can also be used to move persons, and persons can stand under such equipment while the loads are at rest or in motion.

“Stages” are, for example, staging facilities and production areas in theatres, multipurpose halls, studios, production facilities for film, television or radio, concert halls, congress centres, schools, exhibition centres, trade-fair centres, museums, discotheques, amusement parks, sports facilities and open-air-theatres.

“Events” are, for example, concerts, shows, congresses, exhibitions, presentations, demonstrations, film or television recordings, etc.

This document considers permanently and temporarily installed lifting and movement equipment for stages and production areas within the entertainment industry.

This document does not consider the design or control of fire curtains.

Typical applications of this document include but are not limited to the following:

- acoustic doors;
- auditorium elevators;
- compensating elevators;
- cycloramas;
- fly bar systems (manually powered and motor driven);

- lighting bars;
- movable lighting towers;
- movable proscenium arches;
- orchestra elevators;
- performer flying systems;
- point hoists;
- revolving stages and turntables;
- rotators;
- scenery storage elevators;
- side stage and rear stage shutters;
- stage elevators;
- stage wagons;
- tiltable stage floors;
- track guided systems;
- trap elevators.

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

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

1 Scope

This document applies to machinery, machinery installations and machinery control systems used in places of assembly and in staging and production facilities for events and theatrical productions (stage machinery, for short). Such facilities include theatres, multi-purpose halls, exhibition halls; film, television and radio studios; concert halls, schools, bars, discotheques, open-air stages and other rooms for shows and events.

The document applies to machinery installations with guided or unguided loads.

This document covers machinery used in the entertainment industry including machinery that is excluded from the Machinery Directive (2006/42/EC) specifically Article 1, 2(j) which excludes “*machinery intended to move performers during artistic performances*”.

This machinery includes controls, electrical and electronic control systems, electrical and electronic equipment, hydraulic and pneumatic power supplies.

The principles in this document also apply to machinery installations based on new technologies or specially designed installations which are not expressly mentioned here but which nevertheless operate in a similar manner or are meant for similar purposes to the equipment listed above.

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

EN 818-1, *Short link chain for lifting purposes — Safety — Part 1: General conditions of acceptance*

EN 818-7, *Short link chain for lifting purposes — Safety — Part 7: Fine tolerance hoist chain, Grade T (Types T, DAT and DT)*

EN 1090-2, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

EN 1090-3, *Execution of steel structures and aluminium structures — Part 3: Technical requirements for aluminium structures*

EN 1993-1, *Eurocode 3: Design of steel structures*

EN 1999-1, *Eurocode 9: Design of aluminium structures*

EN 10204, *Metallic products — Types of inspection documents*

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

EN 13411 (all parts), *Terminations for steel wire ropes — Safety*

EN 13480-3, *Metallic industrial piping — Part 3: Design and calculation*

EN 14492-1, *Cranes — Power driven winches and hoists — Part 1: Power driven winches*

EN 14492-2, *Cranes — Power driven winches and hoists — Part 2: Power driven hoists*

EN 60034-1, *Rotating electrical machines — Part 1: Rating and performance (IEC 60034-1)*

EN 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

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

EN IEC 60947-4-1, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4-1)*

EN 60947-5-1, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices (IEC 60947-5-1)*

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

EN IEC 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4)*

EN 61326-3-1, *Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) — General industrial applications*

EN IEC 61439-1, *Low-voltage switchgear and controlgear assemblies — Part 1: General rules (IEC 61439-1)*

EN 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508)*

EN 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

EN 81346-1, *Industrial systems, installations and equipment and industrial products — Structuring principles and reference designations — Part 1: Basic rules (IEC 81346-1)*

EN IEC/IEEE 82079-1, *Preparation of information for use (instructions for use) of products — Part 1: Principles and general requirements (IEC/IEEE 82079-1)*

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

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

EN ISO 13849-2, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

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

EN ISO 13854, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body (ISO 13854)*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp/>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 General terms

3.1.1

competent person

person with sufficient practical and theoretical knowledge and experience to carry out the person's duties, and who is aware of the limits of the person's competency, expertise and knowledge

3.1.2

drive system

part of a load bearing machine that executes movement and holding of the load and which converts energy into movement

Note 1 to entry: See Figure 2 c), Figure 3 c) and Figure 4 c).

3.1.3

emergency stop

emergency stop function

E-stop

function which is intended to

- avert arising or reduce existing hazards to persons, damage to machinery or to work in progress, and
- be initiated by a single human action

Note 1 to entry: ISO 13850 gives detailed provisions.

[SOURCE: EN ISO 12100:2010, 3.40, modified — Term “E-Stop” added]

3.1.4

failure

termination of the ability of an item to perform a required function

Note 1 to entry: After failure the item has a fault.

Note 2 to entry: “Failure” is an event, as distinguished from “fault”, which is a state.

Note 3 to entry: This concept as defined does not apply to items consisting of software only.

Note 4 to entry: In practice the terms “failure” and “fault” are often used synonymously.

[SOURCE: IEC 192-03-01]

3.1.5**fault**

state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

Note 1 to entry: A fault is often the result of a failure of the item itself, but can exist without prior failure.

Note 2 to entry: In the field of machinery, the English term “fault” is commonly used in accordance with the definition in IEV 192-04-01, whereas the French term “défaut” and the German term “Fehler” are used rather than the terms “Panne” and “Fehlzustand” that appear in the IEV with this definition.

Note 3 to entry: In practice, the terms “fault” and “failure” are often used synonymously.

[SOURCE: EN ISO 12100:2010, 3.33]

3.1.6**fly bar**

fly bar (e.g. bar or truss) having several load bearing lines for lifting, lowering, and suspending loads, with the load being either uniformly distributed or concentrated (point load)

Note 1 to entry: A distinction is made between manually powered flying systems (e.g. manual counterweight systems) and motor-driven systems (e.g. with electric or hydraulic drive).

3.1.7**hazard**

potential source of harm

Note 1 to entry: The term “hazard” can be qualified in order to define its origin (for example, mechanical hazard, electrical hazard) or the nature of the potential harm (for example, electric shock hazard, cutting hazard, toxic hazard, fire hazard).

Note 2 to entry: The hazard envisaged by this definition either

- is permanently present during the intended use of the machine (for example, motion of hazardous moving elements, electric arc during a welding phase, unhealthy posture, noise emission, high temperature), or
- can appear unexpectedly (for example, explosion, crushing hazard as a consequence of an unintended/unexpected start-up, ejection as a consequence of a breakage, fall as a consequence of acceleration/deceleration).

Note 3 to entry: The French term “*phénomène dangereux*” should not be confused with the term “*risque*”, which was sometimes used instead in the past.

[SOURCE: EN ISO 12100:2010, 3.6]

3.1.8**hazard zone**

danger zone

space within and/or around machinery in which a person can be exposed to a hazard

3.1.9**lifting accessory**

component or equipment, allowing the load to be held, which is placed between the lifting machinery and the load or on the load itself, or which is intended to constitute an integral part of the load and which is independently placed on the market

3.1.10

load bearing element

parts of a machine between the load and the machinery anchor point

3.1.11

load bearing equipment

assembly of load bearing elements, including the drive mechanism

Note 1 to entry: See Figure 2 b), Figure 3 b) and Figure 4 b).

3.1.12

load carrying device

part of stage machinery which directly carries the intended load

EXAMPLES Fly bar of a bar hoist, platform of an elevator, truss, hook of a point hoist.

Note 1 to entry: For trusses refer to EN 17115.

Note 2 to entry: See Figure 2 d), Figure 3 d) and Figure 4 d).

3.1.13

load securing device

mechanical device that can bring a load to a defined stop and prevents unintentional movement

EXAMPLES A brake, self-braking worm gear, shut-off valve.

3.1.14

load holding device

device that prevents unintentional movement of an already stationary load

EXAMPLES Rope lock, locking pin, brake.

3.1.15

machinery installation

all elements between the load and the machinery anchor point

Note 1 to entry: See Figure 2 a); Figure 3 a); Figure 4 a).

3.1.16

manual counterweight system

manually powered fly bar moved by means of an operating rope, where the load is fully or partially balanced by counterweights carried in a guided frame connected to the flying bar

3.1.17

rated speed

maximum speed at which the machine is designed to operate

3.1.18

point hoist

lifting equipment having one load bearing line for lifting, lowering, and suspending loads

3.1.19

protective measure

measure intended to achieve risk reduction

3.1.20

risk

combination of the probability of occurrence of harm and the severity of that harm

3.1.21

safeguard

guard or protective device

[SOURCE: EN ISO 12100:2010, 3.26]

3.1.22

stage elevator

part of a horizontal or inclined (tilted) stage, performance area, studio or auditorium floor which can be moved vertically up and/or down, including all necessary drive elements

EXAMPLE 1 Elevator which is a permanent part of the stage, performance area, studio or auditorium floor (e.g. orchestra elevator, single- or double-deck stage elevator, stage compensating elevator, scenery storage elevator or auditorium elevator).

EXAMPLE 2 Elevator which is not a permanent part of the stage, performance area, studio or auditorium floor, which is used primarily for scenic purposes and which normally rests below stage (e.g. stage trap elevator).

Note 1 to entry: A stage elevator at rest can be part of the stage.

3.1.23

stage elevator platform

part of a stage elevator which supports the load

3.1.24

normal operation

intended use according to the manufacturers' specification and defined in the instructions, excluding the use of muting and maintenance functions

3.1.25

positive load holding device

load holding device that forms a fixed connection to prevent unintentional movement (e.g. locking pin)

3.1.26

friction load holding device

load holding device that relies on friction force to prevent unintentional movement (e.g. piston clamping device, rope lock, brake)

3.1.27

traction sheave

frictionally engaged drive element for ropes

3.1.28

traction winch

winch with a traction sheave driving the rope

3.2 Loads, forces and pressures

Table 1 — Loads and forces

Loads and forces in normal operation	
	ENTERTAINMENT LOAD LIMIT (ELL)
+	WEIGHT OF LOAD CARRYING DEVICE
=	SYSTEM LOAD
+	DYNAMIC FORCES
=	CHARACTERISTIC LOAD
x 2	= DESIGN LOAD

Exceptional loads and forces	
	ENTERTAINMENT LOAD LIMIT (ELL)
+	WEIGHT OF LOAD CARRYING DEVICE
=	SYSTEM LOAD
+	DYNAMIC FORCES DURING EXCEPTIONAL CONDITIONS
=	EXCEPTIONAL LOAD
x 1	= DESIGN LOAD

3.2.1

characteristic load

[entertainment]

characteristic load is the sum of the system load and the dynamic forces occurring during normal operation

Note 1 to entry: Normal operation also includes holding of loads at rest.

3.2.2

characteristic load pressure

in a hydraulic system, the pressure generated by the characteristic load

3.2.3**design load**

load to be used for calculation/validation of a specific component according to the standards and the technical literature applicable for the specific component

Note 1 to entry: For machinery, design load is obtained by doubling the characteristic load (or one time the exceptional load, depending on the specific condition being considered) of the component. See 5.1.

3.2.4**entertainment load limit****ELL**

maximum load that an item of lifting equipment is designed to raise, lower or sustain in an entertainment industry application

3.2.5**entertainment load limit at rest****ELL/R**

maximum load that an item of lifting equipment is designed to sustain at rest in an entertainment industry application

Note 1 to entry: Due to additional measures (such as locking pins in elevators), the Entertainment Load Limit at Rest could be higher than the entertainment load limit that the machine is capable of moving.

3.2.6**exceptional load**

loads occurring infrequently, usually neglected in fatigue assessment, determining an exceptional loading condition

Note 1 to entry: It is the sum of the system load and the dynamic forces occurring due to exceptional conditions.

Note 2 to entry: Exceptional conditions may include but are not limited to the following:

- a) failure in electric power supply;
- b) pressure failure in hydraulic system;
- c) activation of a safety device;
- d) stalling of the motor due to snagging of the load/load carrying device;
- e) sudden lifting of a load started with no tension on the load bearing elements;
- f) test loads;
- g) loads due to buffer forces or mechanical stops;
- h) loads due to tilting forces;
- j) loads due to unintentional loss of load;
- k) loads caused by failure of mechanism or components;
- l) loads caused during assembly and dismantling;

Note 2 to entry: In EN 17206:2020 previously referred to as "Load at Failure".

3.2.7

nominal pressure

pressure stated by the manufacturer of the component

3.2.8

no shared loads

single machine that performs by itself the movement of a single load

3.2.9

operating pressure

pressure generated by the system

3.2.10

shared loads

two or more machines that may be operated independently and are installed into an assembly of machinery to perform the movement of a single shared load

3.2.11

system load

sum of entertainment load limit and the weight of the load carrying device

3.2.12

system pressure

operating pressure limited by a pressure device

3.2.13

test load

load used when testing a lifting device, load bearing equipment, or load carrying or securing devices

Note 1 to entry: See 9.3.2.3 for further details.

3.3 Electrical equipment and control systems

3.3.1

control circuit

circuit used for the operational control of stage machinery and for protection of the power circuits

3.3.2

control device

device for the activation of a movement, e.g. lever, push button, wheel

3.3.3

controlled stop

stopping of machine motion with power to the machine actuators maintained during the stopping process

[SOURCE: EN 60204-1:2018, 3.1.14]

3.3.4

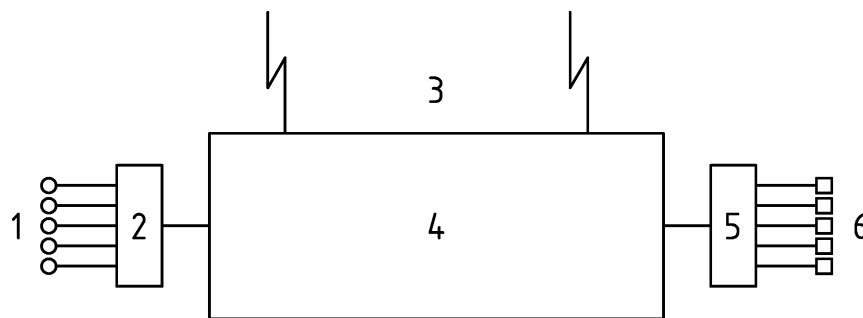
electrical/electronic/programmable electronic system E/E/PE system

system for control, protection or monitoring based on one or more electrical/electronic programmable electronic (E/E/PE) devices, including all elements of the system such as power supplies, sensors and other input devices, data highways and other communication paths, and actuators and other output devices

Note 1 to entry: For structure and terminology, see Figure 1.

EXAMPLE Electrical/electronic/programmable electronic devices include:

- a) electro-mechanical devices (electrical);
- b) solid-state non-programmable electronic devices (electronic); and
- c) electronic devices based on computer technology (programmable electronic).



Key

- | | |
|--|---|
| 1 input devices (e.g. sensors, switches) | 4 E/E/PE device |
| 2 input interfaces A-D-converters | 5 output interfaces D-A-converters |
| 3 communications | 6 output devices, final elements (e.g. actuators) |

NOTE The E/E/PE device is shown centrally located but such device(s) could exist at several places in the E/E/PE system.

Figure 1 — Electrical/electronic programmable electronic system (E/E/PE system) – Structure and terminology

3.3.5

equipotential bonding

provision of electric connections between conductive parts, intended to achieve equipotentiality

[SOURCE: IEC 195-1-10]

3.3.6

load profile monitoring

programming of a specific load condition followed by monitoring of the load with an automatic stop of the machine once the measured load deviates from the programmed load

3.3.7

muting

temporary suspension of a safety function by the SRP/CS

3.3.8

overload condition

condition in which the load has gone above a preset value

3.3.9

performance level

PL

discrete level used to specify the ability of safety related parts of control systems to perform a safety function under foreseeable conditions

[SOURCE: EN ISO 13849-1:2023, 3.1.23, modified — Note 1 removed.]

3.3.10

power source failure

change in the electrical or fluid (liquid or gas) power supply that could adversely affect the performance of a machine

Note 1 to entry: This might include under-voltage, over-voltage, phase loss, incorrect phase sequence and fluid over-pressure or fluid under-pressure.

3.3.11

protective bonding circuit

protective conductors and conductive parts connected together to provide protection against electric shock in the event of an insulation failure

[SOURCE: EN 60204-1:2018, 3.1.50]

3.3.12

protective conductor

PE

conductor required by some measures for protection against electric shock for electrically connecting any of the following parts:

- a) exposed conductive parts;
- b) extraneous conductive parts;
- c) main earthing terminal;
- d) earth electrode; and
- e) earthed point of the source or artificial neutral

[SOURCE: EN 61984:2009, 3.35]

3.3.13

redundancy

application of more than one device or system, or part of a device or system, with the objective of ensuring that in the event of one failing to perform its function another is available to perform that function

[SOURCE: EN 60204-32:2008, 3.57]

3.3.14**safety function**

function that is intended to achieve or maintain a safe state for the machine in respect of a specific hazardous event

3.3.15**safety integrity level****SIL**

discrete level (one out of a possible three) for specifying the safety integrity requirements of the safety-related control functions to be allocated to the SRECS, where safety integrity level three has the highest level of safety integrity and safety integrity level one has the lowest

Note 1 to entry: See EN 61508-4:2010, 3.5.8.

Note 2 to entry: SIL 4 is not considered in this document, as it is not relevant to the risk reduction requirements normally associated with machinery. For requirements applicable to SIL 4, see EN 61508-1 and EN 61508-2.

3.3.16**slack condition**

condition in which a wire or load bearing device is no longer supporting its attached load

Note 1 to entry: Commonly referred to as a slack wire condition.

3.3.17**safety-related part of a control system****SRP/CS**

part of a control system that responds to safety-related input signals and generates safety-related output signals

Note 1 to entry: The combined safety-related parts of a control system start at the point where the safety-related input signals are initiated (including, for example, the actuating cam and the roller of the position switch) and end at the output of the power control elements (including, for example, the main contacts of a contactor).

Note 2 to entry: If monitoring systems are used for diagnostics, they are also considered as SRP/CS.

[SOURCE: EN ISO 13849-1:2023, 3.1.1]

3.3.18**uncontrolled stop**

stopping of machine movement by loss of or removal of power to the machine

3.3.19**underload condition**

condition in which the load has gone below a preset value

3.3.20**control system**

system which responds to an input from, for example, the process, other machine elements, an operator, external control equipment, and generates an output(s) causing the machine to behave in the intended manner

[SOURCE: EN 62061:2005+A2:2015, modified — The original term was “machine control system”.]

3.4 Tolerances relating to movement

3.4.1

group synchronization tolerance

permissible deviation in the position in relation to another machine within a group

3.4.2

group synchronization tolerance in the event of failure

permissible deviation in the position in relation to another of the machine within a group during (moving) and after (stationary) an event of failure.

4 Hazards

4.1 General

When designing and using lifting and load bearing equipment as in this document, all foreseeable hazards shall be identified.

Only competent persons shall be responsible for:

- a) describing the intended use;
- b) risk assessment.

After risk assessment has been carried out, the appropriate measures to be taken shall be established for specific hazards. The risk assessment can be carried out on the basis of EN ISO 12100 or according to the example hazards listed in Annex A, Table A.1. Suitable facilities and provisions to enable the recovery of performers and other persons shall be provided in the event of any of the identified hazards occurring.

The following steps shall be taken when selecting protective measures:

- c) specify the limits of the machinery (intended use, reasonably foreseeable misuse, space limits, the foreseeable life limit, and wear factors);
- d) identify hazards and estimate risks (see Annex E and Annex F for examples of risk estimation and Annex G for hazard application examples);
- e) avoid hazards by means of inherently safe design measures and reduce risks as much as possible;
- f) inform users of any residual risks (information for use).

4.2 List of significant hazards

Table 2 shows a list of significant hazards, hazardous situations and hazardous events that could result in risks to persons during normal use and foreseeable misuse. It also contains the relevant clauses in this document that are necessary to reduce or eliminate the risks associated with those hazards.

Table 2 — List of significant hazards

	Hazards	Relevant clause(s) in this document
	<i>The significant hazards below are based upon EN 12100:2010</i>	
1	Mechanical hazards due to:	
1.1	Acceleration, deceleration	5.1; 5.3; 6.3; 6.4; 6.5
1.2	Angular parts	5.1; 6.3
1.3	Approach of moving element to a fixed part	5.1; 6.3
1.5	Elastic elements	5.1; 6.3
1.6	Falling objects	5.1; 5.3; 5.4; 5.6
1.7	Gravity	5.1; 5.3; 5.6
1.8	Height from the ground	5.1; 5.3;
1.9	High pressure	5.6.5
1.10	Instability	5.1; 5.3; 5.6
1.11	Kinetic energy	5.1; 5.3; 6.3
1.12	Machinery mobility	5.1; 6.3; 7.3.4.14; 7.3.4.15
1.13	Rotating elements	5.1; 6.3
1.14	Rough, slippery surface	—
1.15	Sharp edges	5.1; 6.3
1.16	Stored energy	5.6.5
2	Electrical hazards due to:	
2.1	Electromagnetic phenomena	7.1; 7.1.3.1
2.2	Electrostatic phenomena	7.1; 7.2.1; 7.2.3
2.3	Live parts	7.1; 7.2.2; 7.2.3
2.4	Overload	7.1; 7.2.2; 7.2.3
2.5	Part which have become live under fault conditions	7.1; 7.2.2; 7.2.3
2.6	Short-circuit	7.1; 7.2.2; 7.2.3
2.7	Thermal radiation	7.1; 7.2.2; 7.2.3
3	Thermal hazards due to:	
3.1	Explosion	—
3.2	Flame	—
3.3	Objects or materials with high or low temperature	5.6
3.4	Radiation from heat sources	—
4	Noise hazards due to:	

	Hazards	Relevant clause(s) in this document
4.1	Cavitation phenomena	—
4.2	Exhausting system	—
4.3	Gas leaking at high speed	5.6.5
4.4	Manufacturing process (stamping, cutting, etc.)	—
4.5	Moving parts	5.6
4.6	Scraping surfaces	—
4.7	Unbalanced rotating parts	5.6
4.8	Whistling pneumatics	—
4.9	Worn parts	—
5	Vibration hazards due to:	
5.1	Cavitation phenomena	—
5.2	Misalignment of moving parts	5.4.1
5.3	Mobile equipment	6.3
5.4	Scraping surfaces	—
5.5	Unbalanced rotating parts	5.6
5.6	Vibrating equipment	5.4.1; 5.6
5.7	Worn parts	—
6	Radiation hazards	
6.1	Low frequency, radio frequency radiation	7.1.3.1; 7.2.4.4
6.2	Infrared, visible and ultraviolet lights	7.2.4.4
6.3	Lasers	7.3.1; 7.3.4.2; 7.3.4.14; 7.3.4.16; 7.5.1
7	Material and substances hazards	
7.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dust	5.6.3; 7.3.4.10
7.2	Fire or explosion hazards	5.6.5
8	Ergonomic hazards	
8.1	Access	6.1; 6.2; 6.3; 6.4; 6.5; 7.5.1
8.2	Design or Location of indicators and visual display units	7.2.4.2; 7.8.1;
8.3	Design, location or identification of control devices	7.2.4.2; 7.8.1
8.4	Effort	5.6.7; 5.6.8; 6.5; 7.8
8.5	Human error, human behaviour	7.2.4.2
8.6	Local lighting	7.8.1

	Hazards	Relevant clause(s) in this document
8.7	Mental overload/underload	—
8.8	Posture	6.1; 6.2; 6.3; 6.4; 6.5
8.9	Repetitive activity	6.1; 6.2; 6.3; 6.4; 6.5
8.10	Visibility	6.1
9	Hazards associated with the environment in which the machine is used	
9.1	Dust and fog	—
9.2	Electromagnetic disturbance	7.1.3.1; 7.2.3.1
9.3	Lightning	7.2.3.1
9.4	Moisture	7.1.3.2
9.5	Pollution	—
9.6	Snow	—
9.7	Temperature	7.1.3.2; 7.2.3.1
9.8	Water	7.1.3.2
9.9	Wind	—
9.10	Lack of oxygen	6.4.1
10	Combination of hazards	
	<i>Additional hazards and hazardous events due to lifting procedures, load or machinery collisions due to:</i>	
11	Unintentional movements hazards	
11.1	Failure/malfunctioning of the control system	7.3.4; 7.4
11.2	Software errors	7.6; 7.7; 7.8
11.3	Uncontrolled movements	5.6
11.4	Unintentional movement due to mechanical failure	5.1; 5.3; 5.4; 5.5; 5.6
12	Improper use hazards	
12.1	Unauthorized start-up	7.1.1; 7.2.4.2; 7.3.1
12.2	Unauthorized use	7.1.1; 7.2.4.2
12.3	Improper operation	8
12.4	Insufficient instructions for the operator	8
	<i>Additional hazards, hazardous situations and hazardous events due to lifting</i>	

	Hazards	Relevant clause(s) in this document
13	Mechanical hazards and hazardous events	
13.1	Lack of stability	5.1; 5.3; 5.4; 5.5; 5.6
13.2	Uncontrolled loading – overloading – overturning moments exceeded	7.3.4.3; 7.3.4.4; 7.3.4.11
13.3	Unexpected/unintended movement of loads	5.6.1
13.4	Inadequate holding devices/accessories	5.4
13.5	Collision of more than one machine	7.3.4.14
13.6	From insufficient mechanical strength of parts	5.1; 5.3; 5.4; 5.5; 5.6
13.7	From inadequate design of pulleys, drums	5.5
13.8	From unsuitable selection of chains, ropes, lifting and accessories and their inadequate integration into the machine	5.4
13.9	From abnormal conditions of assembly/testing/use/maintenance	8
13.10	From the effect of load on persons (impact by load or counterweight)	6.1; 6.2; 6.3; 6.4; 6.5
13.11	Incorrect arrangement of machinery parts	5.1; 5.6
13.12	Incorrect installation, testing, use and maintenance	5.6; 8
	<i>Additional hazards, hazardous situations and hazardous events due to the lifting or moving of persons</i>	
14	Mechanical and unintentional movement hazards	
14.1	Inadequate mechanical strength – inadequate working coefficients	5.1; 5.6
14.2	Failure/malfunctioning of the control system	7.3.1; 7.3.2; 7.3.3; 7.3.4
14.3	Software errors	7.6
14.4	Uncontrolled movements	5.1; 5.6

5 Design requirements

5.1 General

The basic safety concept laid down in this document is based on the principles of intrinsic safety or single fault safety design. This is achieved either through doubling the characteristic load in calculations or through redundancy.

Load bearing elements shall be designed such that the design load is twice the characteristic load.

In addition, safety factors from calculation methods should be applied.

In the design of machinery intended for lifting operation at speeds up to 0,2 m/s, without people in the hazard zone, dynamic forces may be omitted from the characteristic load calculation.

To account for failure or exceptional conditions, load bearing elements shall be designed such that the design load is 1 times the exceptional load.

Guidelines on how to calculate the “dynamic forces at exceptional load” can be found in EN 13001-2:2021. See especially EN 13001-2:2021, 4.2.2.5 “Loads caused by acceleration of drives”.

If the failure of load bearing elements does not lead to any hazardous situation, then it is acceptable that the design load is equal to the characteristic load.

Load bearing elements shall be designed according to appropriate standards, for example EN 1993-1 (Eurocode 3) for steel constructions and EN 1999-1 (Eurocode 9) for aluminium constructions.

All welding of fabrications shall be constructed and manufactured according to EN 1090-2 and EN 1090-3.

Natural frequency and lateral torsional buckling and lateral buckling of the structures shall be considered.

Inflammable elements are permitted only where design measures ensure that their destruction does not lead to the load carrying device and its load falling.

Stage machinery load bearing elements are for example:

- a) load bearing equipment, see 5.4;
- b) drive systems; see 5.6;
- c) load carrying devices, see 5.7.

Examples of these are given in 5.2.

5.2 Examples of machine installations showing the groups

Examples of machine installations are given in Figure 2 to Figure 4.

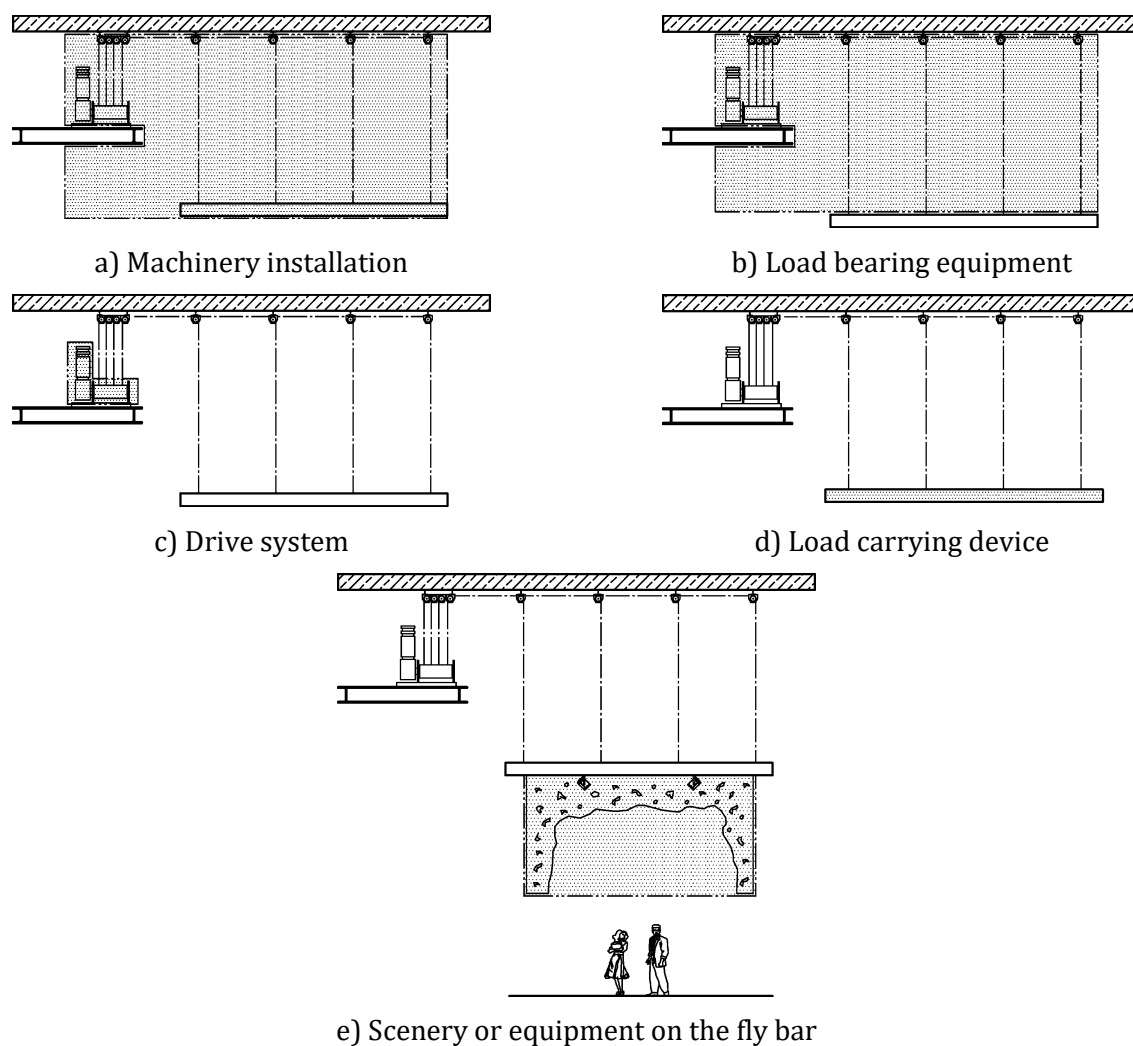


Figure 2 — Schematic representation of a bar hoist winch system

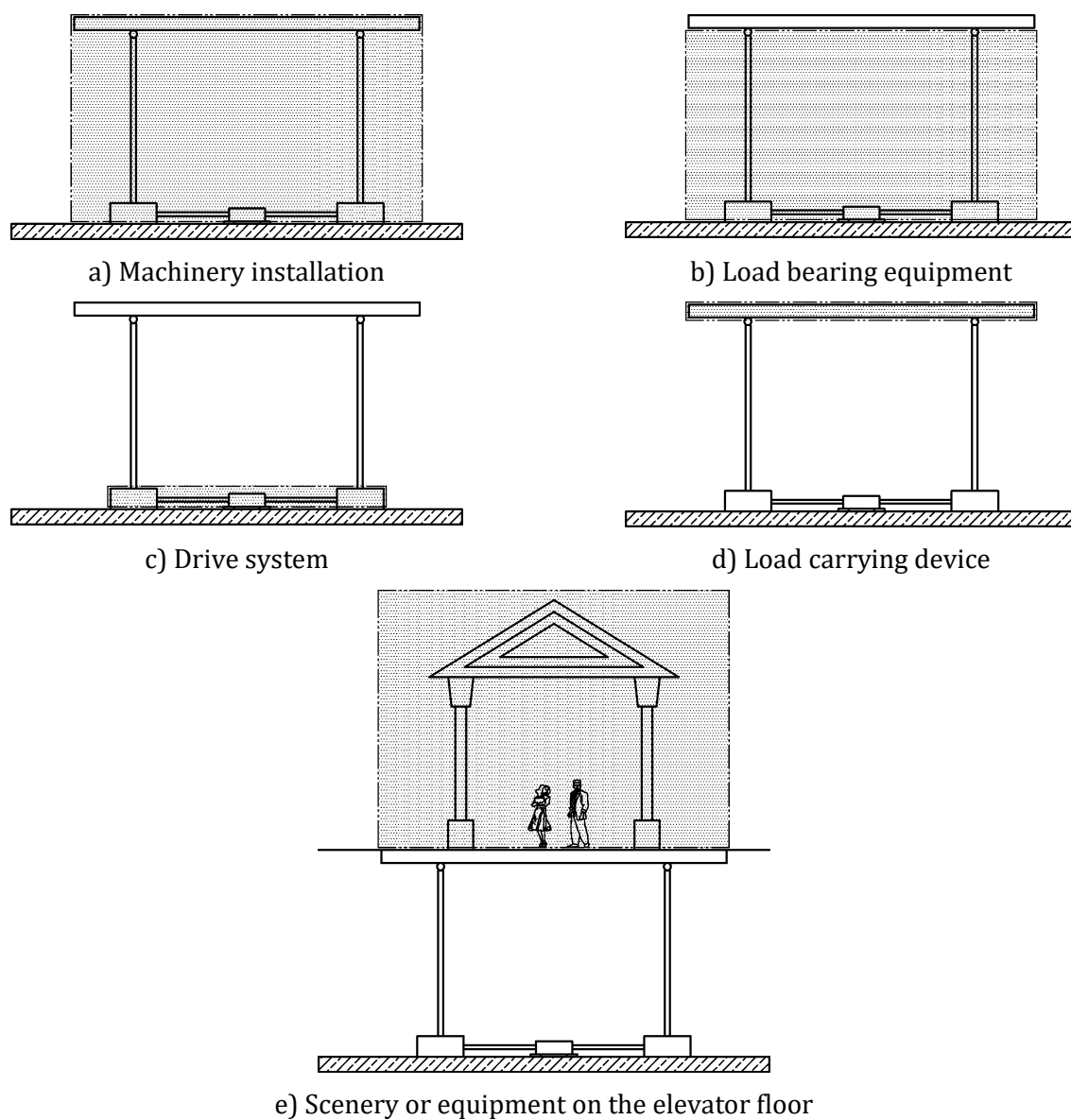


Figure 3 — Schematic representation of a stage elevator

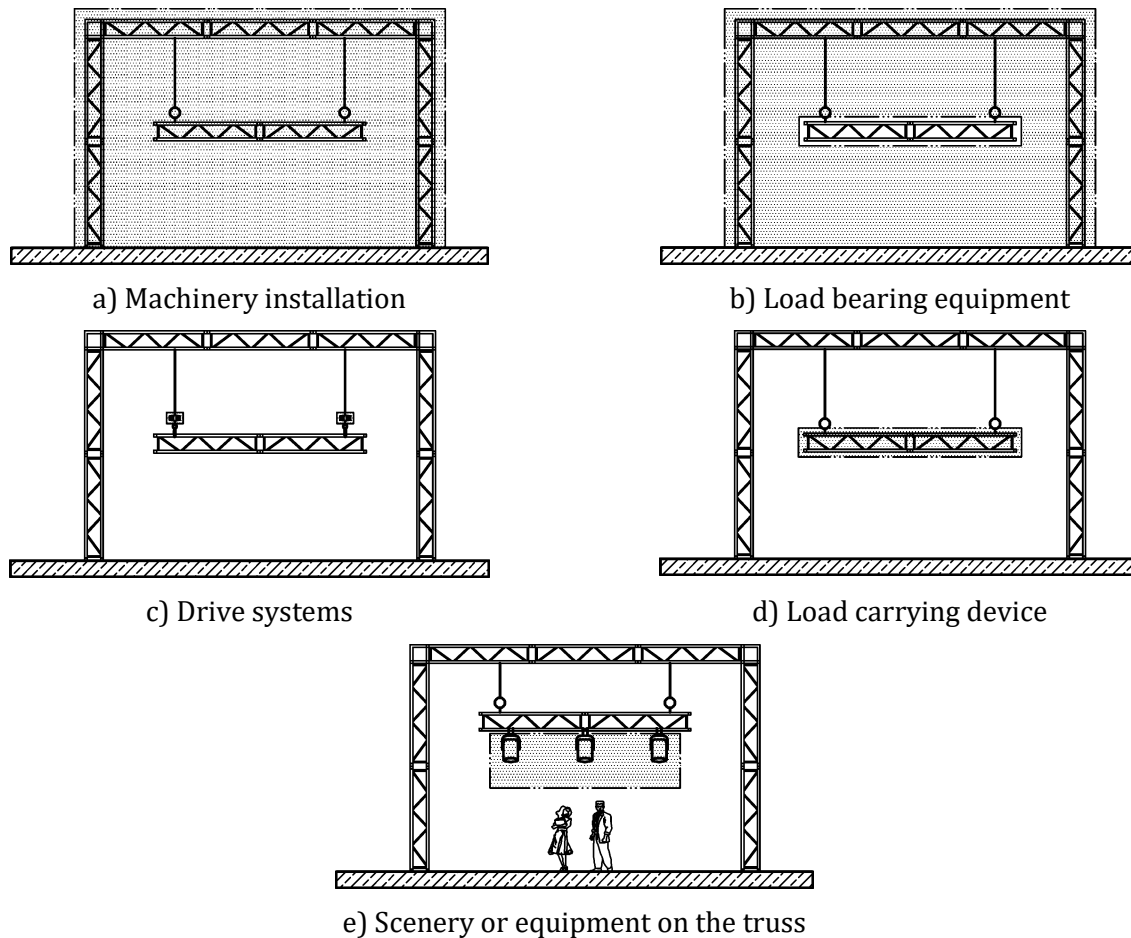


Figure 4 — Schematic representation of a system using multiple hoists

5.3 Additional load assumptions

5.3.1 Load assumptions for stage elevators

The following loads shall be specified:

- a) ELL;
- b) ELL/R;
- c) distributed load;
- d) point loads.

The distributed load with the stage elevator at rest as permanent part of the stage floor shall be at least the same as the surrounding stage floor; when the stage elevator is used solely for artistic purposes and not as a permanent part of the stage floor construction, it may have a different or lower distributed load.

To obtain sufficient longitudinal and lateral rigidity the elevator should be capable of withstanding a horizontal force of at least 5 % of the ELL when in motion, and 5 % of the ELL/R when at rest.

5.3.2 Load assumptions for stage wagons and turntables

The following loads shall be specified:

- a) ELL;
- b) ELL/R;
- c) distributed load;
- d) point loads.

The distributed load with the stage wagon or turntable at rest as permanent part of the stage floor shall be at least the same as the surrounding stage floor; when the stage wagon or turntable is used solely for artistic purposes and not as a permanent part of the stage floor construction, it may have a different or lower distributed load.

5.4 Load bearing equipment

5.4.1 General

It is possible to use a single load bearing line.

All elements shall be secured against unintentional loosening.

For example, when quick links are used, the direction of the link shall be with the nut screwing downwards when the link is closed.

All structural elements of load bearing equipment shall be made of non-flammable materials.

Synthetic or natural fibre ropes may be only used if the risk assessments indicate it is safe to do so.

5.4.2 Load bearing lines

5.4.2.1 Wire ropes

Wire rope which complies with EN 12385-1, EN 12385-2, EN 12385-4, and EN 12385-5 may be used as load bearing lines.

Wire ropes excluding terminations used as load bearing lines shall meet the requirements for a safety factor of at least 10 at characteristic load, and for a safety factor of at least 2 at exceptional load, where the safety factor is the quotient of the minimum breaking load and the partial tensile force acting at characteristic load or at exceptional load respectively.

When wire-ropes are used to push-pull tracking systems or guided wagons and the failure of a wire rope does not lead to the load carrying device and its load failing, then it is acceptable that a safety factor of at least 5 at characteristic load.

When wire-ropes do not travel over pulleys or drums, a lesser safety-factor may be used following a risk assessment.

Wire ropes shall be provided with a type 2.2 inspection document as in EN 10204 confirming testing as in EN 12385-4.

If a cover (plastic or textile) is used it shall be possible to inspect the entire length of the wire rope.

Jacketed wire ropes shall not be used as part of the machinery installation.

5.4.2.2 Chains

If short link steel chains are used in machinery installations, these are to be calibrated and tested as in EN 818-7. Short link steel chains used to carry loads shall meet the requirements for a safety factor of at least 8 at characteristic loading, in relation to the breaking force as specified in EN 818-7. Exceptional load shall not give rise to permanent deformation.

Chains shall be provided with a type 2.2 inspection document as in EN 10204 confirming testing as in EN 818-7. Other types of chain (e.g. roller chains) shall meet the above requirements by analogy. Type-specific characteristics are to be taken into consideration.

5.4.3 Load bearing lines terminations

5.4.3.1 Wire rope terminations

The choice of wire rope termination shall take into account the type of wire rope used.

Terminations shall be such that at least 80 % of the rope's minimum breaking force is maintained.

The rope end connection shall be designed so that its condition can be checked by inspection. End connections shall meet the requirements of EN 13411.

Use of grips as in EN 13411-5 is not allowed as a means to terminate load bearing lines.

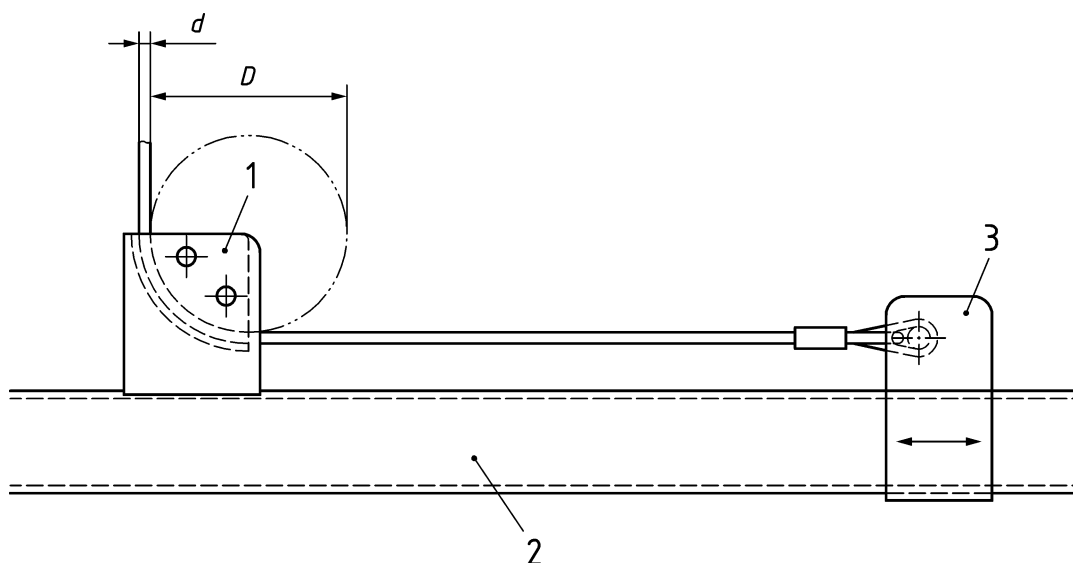
5.4.3.2 Detachable wire rope terminations

Detachable wire rope terminations may be:

- a) asymmetric wedge socket as in EN 13411-6;
- b) symmetric wedge socket in EN 13411-7.

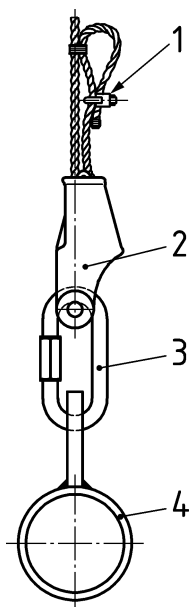
Detachable terminations shall be secured against self-detachment, for instance by using grips as in EN 13411-5, which shall be attached according to the wedge socket manufacturer's instructions (see Figure 5 and Figure 6 for examples).

The connection to the fly bar shall allow free movement in all horizontal directions (see Figure 5).

**Key**

- 1 wire rope deflection
D : d ratio shall maintain 100 % of the wire rope integrity according to the manufacturer's specification, or, where the manufacturer's specification is not available, the rope deflection D : d ratio shall not be less than 7
- D diameter of deflection
- d diameter of rope
- 2 fly bar
- 3 sliding clip

Figure 5 — Sliding pipe clip as an example of a device for compensating the length of a wire rope

**Key**

- 1 grip as in EN 13411-5
- 2 asymmetric wedge socket
- 3 quick link with screw caps
- 4 fly bar with welded lug

Figure 6 — Example of a means of suspending a fly bar

5.4.3.3 Fixed or Non-detachable wire rope terminations

Examples of non-detachable terminations for wire rope are:

- a) splices as in EN 13411-2;
- b) ferrules as in EN 13411-3;
- c) swage terminals as in EN 13411-8.

5.4.3.4 Load Hooks

Hooks shall be designed in accordance with the state of the art, e.g. in accordance with EN 14492-1 and EN 14492-2.

Hooks shall be such that the unintentional detachment of the load is prevented. This can be achieved by:

- a) a safety device; or
- b) the shape of the hook.

Hooks equipped with a safety-latch fulfil these requirements.

5.4.3.5 End connections for steel chains

Chain end terminations shall be designed and manufactured in such a way that they shall withstand 100 % of the chain's minimum breaking force before failure occurs. Roller chain terminations shall be designed and calculated with clear indications of the limits of bending in the unfavourable plane. The manufacturer shall take these limits into account when installing roller chains in entertainment lifting machinery. A pivoting or hinging attachment shall prevent unintended side loading.

Threaded connections shall be locked to prevent self-loosening. The condition of the fastening shall be verifiable.

5.5 Winding devices and diverter pulleys

5.5.1 Winding devices for wire ropes

Where round ropes are used, a wire rope drum with a helical groove shall be used to take up the rope. Other lifting devices that do not use a drum are possible.

It is preferable that round wire rope may only be wound in one layer. When using pile wind drums, each rope shall have its own winding chamber and it shall be ensured that the rope is layered in such a manner that the rope centres line up.

In order to preserve the wire rope integrity wire rope crossovers and improper winding shall be prevented or detected. This applies to both single and multiple layer drums.

The attachment of the rope to the drum shall be designed to take 80 % of the calculated required minimum breaking force either by friction by the remaining turns on the drum or by end termination or a combination of both.

When clamps are used to attach the rope, a single failure shall not lead to the attachment becoming ineffective.

Design measures shall ensure that the fleet angle of the rope from the groove of the drum or pulley when it is being pulled up or down, even when it is under loaded or slack shall never exceed 4° on either side, but it is preferred that the maximum should not be more than 1,5°.

The rope drum diameter, measured from the rope centreline to centreline, shall not be less than 18 times the rope diameter.

5.5.2 Diverter pulleys for round wire ropes

The diverter pulley diameter, measured from the rope centreline to centreline, shall be equal to at least 20 times the rope diameter.

Diverter pulleys shall be designed in such a manner as to prevent the rope from coming out of the groove of the sheave.

The bottom of the rope groove shall be a circular arc.

The radius of the rope groove should be between $0,52 d$ and $0,56 d$ where d is the nominal diameter of the rope.

The radius shall be greater than $0,52 d$ and shall not exceed the nominal wire rope diameter.

The opening angle of the rope pulley shall be symmetrical and between 30° and 60° . The depth of the grooves shall not be less than $1,4 \times$ nominal rope diameter.

See also EN 14492-1.

5.5.3 Drive and idler sprockets for steel chains

Calculations for chain drives with short steel link chains shall be made in accordance with EN 818-1 and with EN 818-7.

Chain drives shall be provided with a device which ensures that the chain runs properly over chain drive sprockets and chain guide wheels and which prevents the chain from jumping out, twisting and jamming.

5.5.4 Traction sheaves

The traction sheave shall be designed in such a way that it does not slip under double the characteristic load or $1,0 \times$ the exceptional load, whichever is greater.

For any application where traction slippage could represent a source of hazard, design requirements as per EN 81-50:2020, 5.11 shall be followed. The traction sheave shall have a higher hardness than the tensile strength of the rope material.

The risk assessment may demonstrate that a load securing device could not be required.

If the rope is not endless then a mechanical stop on the rope shall be provided.

Means shall be provided to prevent the ropes from running off the sides of the traction sheave.

The machinery design should aim for a zero-fleet angle into the traction sheave.

5.6 Drive systems

5.6.1 General

Drive systems shall be designed so as to preclude unintentional hazardous movements.

Between the load carrying and the load securing device, all components of drive systems shall be designed such that twice the characteristic load shall not give rise to permanent deformation or failure of the component. The selection of gearboxes or components of the transmission drive train should take a minimum of 400 h at rated speed at twice the characteristic load as the basis for calculations, unless a longer time is appropriate.

NOTE The figure of 400 h or any other time used above is purely a basis for calculations and does not necessarily correspond to the operating time at $1 \times$ characteristic load. The operating time can be determined by the manufacturer.