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Title: BS EN 12929-1 Draft Safety requirements for cableway installations designed to carry persons. General requirements. Part 1: Requirements for all installations.

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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.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

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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

Safety requirements for cableway installations designed to
carry persons - General requirements - Part 1:
Requirements for all installations

Prescriptions de sécurité pour les installations à câbles
destinées au transport des personnes - Dispositions
générales - Partie 1 : Prescriptions applicables à toutes
les installations

Sicherheitsanforderungen an Seilbahnen für die
Personenbeförderung - Allgemeine Bestimmungen -
Teil 1: Anforderungen an alle Anlagen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 242.

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.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 12929-1:2025) has been prepared by Technical Committee CEN/TC 242 "Safety requirements for cableway installations designed to carry persons", the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN -Enquiry.

This document supersedes EN 12929-1:2015+A1:2022.

EN 12929-1:2025 contains the following major technical changes compared to EN 12929-1:2015+A1:2022:

- the term "longitudinal sway" has been replaced by "longitudinal deflection" throughout the standard text;
- the term "transverse sway" has been replaced by "transverse deflection" throughout the standard text;
- terms and abbreviations have been included in Section 3;
- in 4.5.1, 4.5.2, 7.1.6, 11.1.1, 11.1.3, 11.1.5, 11.1.7, 11.1.8, 11.1.11 and 14.10.1, changes/additions were included with regard to protection of workers in line with the findings of the work carried out by WG 15;
- in 6.2, the last paragraph was aligned with the German reference version (only in the French version);
- in 6.3.2 and 7.4, the term "dynamic pressure" was replaced by "wind velocity pressure";
- in 6.3.2, 6.3.4, 6.3.5, 6.3.7, 7.4, 12.2.3, 12.2.4 and 14.4 changes/additions were made to take better account of the effects of wind;
- the provisions on guides in 6.3.4 were moved to 6.3.7;
- subclauses 6.3.8 and Annexes D, E and F have been inserted to take better account of the effects of wind;
- in 7.4, the second paragraph was inserted to align with the German reference version (only in the French version);
- in Section 15, the structure has been corrected;
- Annex ZA has been updated.

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

For relationship with EU Directives, see informative Annex ZA, which is an integral part of this document.

EN 12929 consists of the following parts, with the main title "Safety requirements for cableway installations designed to carry persons — General requirements":

- Part 1: Requirements for all installations;
- Part 2: Additional requirements for bi-cable ropeways without carrier truck brakes.

Part 1 deals with the general requirements that apply to all cableway installations designed to carry persons. Part 2 deals with additional requirements that apply to bi-cable ropeways without carrier truck brakes.

This European Standard is part of a European series of standards on safety requirements for cableway installations designed to carry persons. This series of standards consists of the following parts:

- EN 1907 Terminology
- EN 12929 General requirements
- EN 12930 Calculations
- EN 12927 Ropes
- EN 1908 Tensioning devices
- EN 13223 Drive systems and other mechanical equipment
- EN 13796 (all parts) Carriers
- EN 13243 Electrical equipment other than for drive systems
- EN 13107 Civil engineering works
- EN 1709 Precommissioning inspection and instructions for maintenance and operational inspection and checks
- EN 1909 Recovery and evacuation
- EN 12397 Operation
- EN 12408 Quality control
- EN 17064 Prevention and fight against fire

All these standards form a whole for the planning, manufacture, installation, maintenance and operation of cableway installations designed to carry persons.

For the ski tows, the work of the International Organization for Transportation by Rope (OITAF) has been taken into account in the drafting of this document.

It is noted that some elements of this document may affect patent rights. CEN is not responsible for identifying any or all patent rights in this respect.

1 Scope

This document establishes the general requirements regarding the safety requirements for cableway installations designed to carry persons. Additional safety requirements for bi-cable ropeways without carrier truck brakes are defined in EN 12929-2.

General technical features, principles for planning and the general safety requirements are established in this part of EN 12929.

Operation and maintenance details, calculations and detailed requirements for the design of components are not established in this part of EN 12929.

This part of EN 12929 defines requirements for the prevention of accidents and protection of workers, without prejudice to the application of national regulations.

National regulations of a construction or regulatory character or which serve to protect special groups of persons, remain unaffected.

Not all special groups of people (e.g. persons with limited mobility) will always be able to be carried on all types of cableway installations. However, it is the aim to enable carrying by cableway installation for as large a group of people as possible.

This standard does not apply to cableway installations for the carriage of goods or to lifts.

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 1709:2019, *Safety requirements for cableway installations designed to carry persons — Precommissioning inspection and instructions for maintenance and operational inspection and checks*

EN 1907:2017, *Safety requirements for cableway installations designed to carry persons — Terminology*

EN 1908:2015, *Safety requirements for cableway installations designed to carry persons — Tensioning devices*

EN 1909:2017, *Safety requirements for cableway installations designed to carry persons — Recovery and evacuation*

EN 12385-8:2002, *Steel wire ropes — Safety — Part 8: Stranded hauling and carrying-hauling ropes for cableway installations designed to carry persons*

EN 12385-9:2002, *Steel wire ropes — Safety — Part 9: Locked coil carrying ropes for cableway installations designed to carry persons*

EN 12397:2017, *Safety requirements for cableway installations designed to carry persons — Operation*

EN 12464-1:2021, *Light and lighting — Lighting of workplaces — Part 1: Indoor workplaces*

EN 12927:2019, *Safety requirements for cableway installations designed to carry persons — Ropes*

EN 12929-2:2015+A1:2022, *Safety requirements for cableway installations designed to carry persons — General requirements — Part 2: Additional requirements for bi-cable ropeways without carrier truck brakes*

EN 12930:2015, *Safety requirements for cableway installations designed to carry persons — Calculations*

EN 13107:2015,¹ *Safety requirements for cableway installations designed to carry persons — Civil engineering works*

EN 13223:2015+A1:2022, *Safety requirements for cableway installations designed to carry persons — Drive systems and mechanical equipment*

EN 13243:2015, *Safety requirements for cableway installations designed to carry persons — Electrical equipment other than for drive systems*

EN 13796-1:2017, *Safety requirements for cableway installations designed to carry persons — Carriers — Part 1: Grips, carrier trucks, on-board brakes, cabins, chairs, carriages, maintenance carriers, tow hangers*

EN 13796-2:2017+A1:2022, *Safety requirements for cableway installations designed to carry persons — Carriers — Part 2: Slipping resistance tests for grips*

EN 13796-3:2017+A1:2022, *Safety requirements for cableway installations designed to carry persons — Carriers — Part 3: Fatigue tests*

EN 17064:2018, *Safety recommendations for cableway installations designed to carry persons — Prevention and fight against fire*

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

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

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

3 Terms, abbreviations and equivalent designations

For the purposes of this document, the terms and definitions given in EN 1907 and the following apply.

ISO and IEC maintain terminological databases for use in standardisation 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

v_r

maximale Fahrgeschwindigkeit/vitesse de marche/maximum speed

maximum travel speed intended for the cableway installation at the position under consideration

3.2

ρ_A

Auslegungsluftdichte/masse volumique de l'air de conception/design air density

Air density used to calculate wind velocity pressures on a cableway installation in operation (see also Annex E)

¹ In the version as amended by EN 13107:2015/AC:2016.

3.3 v_w **Windgeschwindigkeit (in m/s)/vitesse du vent naturel/wind velocity**

Natural wind velocity (without taking travel speed into account)

3.4 v_m **mittlere Windgeschwindigkeit/vitesse moyenne du vent/mean wind velocity**

Wind velocity over an averaging time of 10 min

3.5 v_p **Spitzenwindgeschwindigkeit/vitesse de vent de pointe/peak wind velocity**

Wind velocity over a maximum averaging time of 1 s

3.6 GA **Böen-Amplitude/amplitude de rafale/gust amplitude**

Difference between the peak wind velocity and the mean wind velocity

3.7 N **Nominalzustand in Betrieb/état nominal en exploitation/nominal state in operation**

Conditions for the cableway installation when in service, up to which it can be assumed that the hazards caused by wind are within an acceptable range without special precautions being required

3.8 v_N **Nominal-Windgeschwindigkeit/vitesse nominal du vent naturel/nominal wind velocity**

Wind velocity under nominal state in operation N

3.9 q_N **Nominal-Wind-Geschwindigkeitsdruck/pression dynamique nominale du vent naturel/nominal wind velocity pressure**

Speed pressure at nominal wind velocity

3.10 E **Grenzzustand in Betrieb/état limite en exploitation/limit state in operation**

Conditions for the cableway installation when in service, above which it shall be assumed that the hazards caused by wind are no longer within an acceptable range, even if specific precautions are taken

3.11 v_D **Grenz-Windgeschwindigkeit in Betrieb/vitesse limite du vent naturel en exploitation/limit wind velocity in operation**

Wind velocity at the limit state in operation D

3.12 q_D **Grenz-Wind-Geschwindigkeitsdruck in Betrieb/pression dynamique limite du vent naturel en exploitation/limit wind velocity pressure in operation**

Speed pressure at limit wind velocity in operation D

3.13

u

Grenzzustand außer Betrieb/état limite hors exploitation/limit state out of operation

Conditions defined by the design of the cableway installation with the characteristic loads when out of service

3.14

q_u

Grenz-Wind-Geschwindigkeitsdruck außer Betrieb/preSSION dynamique limite du vent naturel hors exploitation/limit wind velocity pressure out of operation

Speed pressure of the wind for the design of the cableway when out of service

NOTE 1 with regard to the term: For q_u , the gust speed pressure from EN 1991-1-4, an existing national appendix, if any, or from an installation-specific wind report shall be used.

3.15

Windwarnung/avertissement de vent/wind warning

Visual and acoustic message for operating personnel when a wind velocity v_{warn} (wind warning value) is exceeded, indicating that specific precautions are now required due to wind

3.16

Indices:

as indices for influences on the cableway installation (such as forces caused by wind) and their effects (such as deflections), the following are defined in accordance with the vehicle standard EN 13796-1:2017:

x along the track axis and

y perpendicular to the track axis

e.g. β_x Deflection of a carrier due to wind in the track axis

4 Principles of cableway installation safety

4.1 General principles

4.1.1 High safety requirements are the top priority for the planning, manufacture, assembly, maintenance and operation of cableway installations.

Only those companies and specialists that have the necessary knowledge and experience and ensure careful execution and proper operational management may be entrusted with the planning, manufacture, assembly, maintenance and operation of cableway installations.

All components shall be precisely calculated, mechanically and electrically well designed and manufactured using sound, resistant materials with the required properties.

4.1.2 All components shall be kept functional and in good condition. Please refer to the European Standards EN 1709:2019 and EN 12397:2017.

4.1.3 In addition to the cableway installation-specific European Standards, the available European specifications shall be applied in the planning, manufacture, assembly, maintenance and operation of cableway installations.

4.1.4 In certain cases, this document takes into account carelessness on the part of the persons being carried. In this case, intended use and not misuse is assumed.

4.2 Exceptions

4.2.1 Exceptions to the requirements of standards EN 1709:2019, EN 1908:2015, EN 1909:2017, EN 12385-8:2002, EN 12385-9:2002, EN 12397:2017, EN 12927:2019, EN 12929-1:2015+A1:2022, EN 12929-2:2015+A1:2022, EN 12930:2015, EN 13107:2015, EN 13107:2015/AC:2016, EN 13223:2015+A1:2022, EN 13243:2015, EN 13796-1:2017, EN 13796-2:2017+A1:2022, EN 13796-3:2017+A1:2022, EN 17064:2018 are possible, in particular in the case of innovations. These exceptions are to be justified by means of a safety analysis and at least an equivalent level of safety shall be achieved.

4.2.2 Exceptions to the requirements of these standards are also possible when replacing components in already existing installations.

4.3 General safety requirements for installations and their components

4.3.1 General safety principles

The following principles shall be considered in the specified order for planning, construction and operation of cableway installations designed to carry persons:

- a) Hazards shall be avoided or at least limited by suitable precautions during planning and construction.
- b) The potential protective measures shall be taken in order to prevent hazards that cannot be avoided by means of design and structural measures.
- c) To minimise hazards that cannot be fully prevented using the above precautions and protective measures, precautionary measures shall be set out and identified.

In the case of installations and components complying with EN 1709:2019, EN 1908:2015, EN 1909:2017, EN 12385-8:2002, EN 12385-9:2002, EN 12397:2017, EN 12927:2019, EN 12929-1:2015+A1:2022, EN 12929-2:2015+A1:2022, EN 12930:2015, EN 13107:2015, EN 13107:2015/AC:2016, EN 13223:2015+A1:2022, EN 13243:2015, EN 13796-1:2017, EN 13796-2:2017+A1:2022, EN 13796-3:2017+A1:2022 and EN 17064:2018 it can be assumed that these safety principles are observed.

4.3.2 Possible personal injuries

The hazards that can cause the following harm to persons in particular shall be taken into account:

- a) Fall injuries (including injuries from falling carriers);
- b) Bruises, contusions and pinching injuries (other than fall injuries);
- c) Harm to health that is caused by persons being held up for a longer period of time in unfavourable weather conditions;
- d) Other types of damage to health, for example from electricity, burns, noise, air pollution, breathing in poisonous gases.

4.3.3 Hazard scenarios

The following events may result in hazardous situations which are reduced or avoided by the safety requirements of this document:

- a) Failure of a component in an installation (breakage, malfunction or breakdown);
- b) Malfunctions in the interaction of the components of an installation with each other or with the environment;

- c) Foreseeable misconduct by persons (persons being carried, operating personnel or third parties) as well as foreseeable misuse by them;
- d) Foreseeable external influences, for example caused by wind, avalanches, landslides, rock falls, lightning strikes, snowgrooming vehicles, aircraft.

The following events shall be investigated in particular:

- Failure or defects in the load-bearing supports of the structures;
- Defects at the boarding and alighting areas;
- Failure of cable tensioning systems and cable end attachments;
- Failure of cable support and guide elements;
- Failure of carrier components;
- Defects or failure of drive and braking equipment;
- Defects or failure of steering and control equipment as well as safety and signalling equipment;
- Misconduct of persons being carried, operating personnel or third parties.

Chain reactions which can happen as a result of an event shall be taken into account. On the other hand, simultaneous occurrence of two or more independent hazardous situations may be disregarded.

4.4 Safety requirements for installations

4.4.1 General

In this document, general requirements are set out in order to keep the hazards listed in 4.3 to a minimum and to prevent the hazardous situations.

4.4.2 Protective measures

In particular, the hazardous situations listed below require safety devices as protective measures in order to recognise and eliminate them. Table 1 below indicates those standards that deal with the hazardous situations.

Table 1 — List of hazardous situations

System of the installation	Hazardous situation	Referenced standard
All installations, except ski tows	Impermissible deviation of the basic tensioning force in moving cables (except for tension weights)	EN 1908 EN 13243
	Reaching the end positions of tensioning devices	EN 1908 EN 13223
	Impermissible exceeding of the speed	EN 13223
	Unintentional reversal	EN 13223
	Sudden periodic change in the drive torque beyond those values that are characteristic for the installation	EN 13223 EN 13243

System of the installation	Hazardous situation	Referenced standard
	Failure of the door lock on closed carriers before exiting the station	EN 13223 EN 13243
	Unintentional starting	EN 13243
Funicular railways and bi-cable ropeways	Misalignment of the haul rope in relation to its supports or to the track rope (e.g. haul rope overturn, haul rope derailment)	EN 12929-1 EN 13223 EN 13243
	Impermissible lowering of the tension force in the haul rope (except for bi-cable gondolas)	EN 12929-1 EN 13223 EN 13243
Funicular railways	Impermissible exceeding of the speed and/or unintentional reversal of the carriers	EN 13223
Monocables	Deropement of the carrying-hauling rope on supports and on such rollers in stations that have a similar functions to line rollers	EN 12929-1 EN 13223 EN 13243
Funicular railways, cable cars and pulsating gondolas	Fault when reducing the travel speed when approaching stations or other line points	EN 13223
	Overrunning the normal stopping point at the end of the line	EN 13223 EN 13243
Cableway installations with detachable carriers	Fault in the attachment or detachment process	EN 13796-1 EN 13223
	Impermissible deviation of the carrier distances	EN 13796-1 EN 13223
	Fault in the movement of carriers in the stations	EN 13796-1 EN 13223
Chairlifts	Overrunning the alighting areas with occupied carriers (except in the case of intermediate stations)	EN 12929-1 EN 13223

System of the installation	Hazardous situation	Referenced standard
Ski tows	Impermissible deviation of the basic tensioning force in the carrying-hauling rope (except for tension weights)	EN 1908 EN 13223
	Unintentional starting	EN 13243
	Overrunning the arrival area by a skier	EN 13223
	Sudden periodic change in the drive torque beyond those values that are characteristic for normal operating conditions	EN 13223 EN 13243
	Incomplete retraction of a tow hanger	EN 13223
	Deropement of the carrying-hauling rope on supports and on such rollers in stations that have a similar functions to line rollers	EN 12929-1 EN 13223 EN 13243

4.5 General requirements for protection of workers

4.5.1 Cableway installations shall be planned and designed in such a way that the operation and performance of maintenance work is possible without endangering the operating personnel if they behave as intended.

The protection of workers in cable car installations is largely based on the standard machine safety provisions. However, the purpose of a cableway installation differs from that of a machine, as the transport of persons requires the availability of the installations even under exceptional conditions. The hazards for passengers, for example in the event of an abrupt stop or prolonged standstill of the cableway installation, shall be taken into account here. It may therefore be necessary to work on components whose protective devices have been removed or opened. Certain other safety principles apply to cableway installations, taking into account the size of individual components, the freedom of movement of carriers, the need for certain adjustments or checks during operation of the installation. It is assumed that the safety of personnel is ensured by the presence of certain additional technical devices, suitable instruction manuals and operating instructions, as well as relevant information and training.

Cableway installations shall be planned and designed in such a way that required maintenance work is kept to a minimum. Access to components that are to be regularly maintained shall be provided (see EN 13107:2015 and EN 13107:2015/AC:2016 for requirements for such access).

NOTE Limiting the maintenance work is carried out, for example with regard to lubricating installation parts, if the technical design largely avoids manual lubrication (e.g. installation of permanently lubricated roller bearings, power-driven central lubrication).

In order to protect the safety and health of employees, a risk analysis shall be carried out by the manufacturer in order to:

- determine the work required, the duration and the frequency thereof, to ensure supervision, recovery and maintenance;
- identify the workplaces for carrying out this work (e.g. stations, towers, maintenance carrier);
- identify the hazards involved in carrying out such work;

- determine and provide evidence of the design measures implemented to take account of the listed hazards.

When planning the installation and its components, it shall be taken into account that maintenance work may only be carried out if the installation or parts of the installation are switched off and secured against being switched back on.

However, some work such as adjustments and checks may also be carried out while the installation or parts thereof are in operation, provided that suitable measures such as protective devices, control and/or communication elements are provided.

In this case, access to the affected work areas shall be restricted to personnel familiar with the particular risks.

All equipment and special tools required to safely adjust, maintain and operate the installation shall be taken into account when planning the installation.

Where it is necessary, in particular due to the weight, lifting devices shall be provided for the devices which are likely to have to be moved several times during the service life of the installation.

To assess the above-mentioned hazards, the risks from 4.3.2 and the following risks shall be considered:

- | | |
|--------------|--|
| - slipping | - electric shock |
| - falling | - burns |
| - crashing | - heat |
| - retracting | - noise |
| - bumping | - suffocation |
| - crushing | - freezing |
| - shearing | - radiation (UV, electromagnetic fields, etc.) |
| - pinching | - manual handling of loads |
| - splashing | |

On the basis of this assessment, the manufacturer shall set out the operating and maintenance instructions with regard to the protection of workers.

In particular, these instructions shall enable the operator to determine the instructions for his personnel and the necessary qualifications.

4.5.2 Hazardous points on machinery and vehicles in the working and traffic areas as well as in high-lying maintenance areas shall be avoided by taking suitable precautions during design and construction.

If the hazardous points cannot be avoided in this way, they shall be secured according to the principles of EN ISO 12100:2010. With regard to the requirements for the design and arrangement of protective constructions, EN ISO 14120:2015 and EN ISO 13857:2019 shall be complied with.

NOTE Hazardous points include pinch points, shear points, entry points or trapping points. For example, compliance with minimum gaps to avoid crushing parts of the human body according to EN ISO 13854 avoids pinch points.

If, in the case of detachable installations, the circulation area of the carriers needs to be crossed in order to reach the machine area:

- provision shall be made for crossing in the slow-moving area;
- the traffic routes to stairs or fixed ladders shall be marked in such a way as to guide personnel.

There is no need for protective devices at rope run-up points in high-lying maintenance areas.

In terms of the present document, the following applies:

- Working and traffic areas are workplaces at ground level and traffic routes for the operating personnel. The workplaces at floor level include, for example, boarding and alighting areas for passengers and control points;
- High-lying maintenance places are places that cannot be reached directly from the ground level, and from which maintenance work can be carried out on mechanical and electrical components as well as on carriers.

Components of the installation can be reached directly if tools such as fixed ladders are not required.

Workplaces, including for maintenance, and traffic shall be designed in such a way that the risk of slipping is reduced as much as possible (non-slip structures and surfaces).

Floor escape hatches are usually in the closed position without the need for locking. They shall be equipped with a device to support the opening process and remain in a stable position after opening.

There shall be warning signs indicating the presence of an open hatch.

A device such as a barrier shall be fitted to prevent access to the open hatch.

4.5.3 Maintenance switches according to EN 13243:2015 shall be available to operating personnel.

4.5.4 Emergency stop buttons according to EN 13243:2015 shall be available to the operating personnel and, if necessary, also to the persons being carried.

5 Route and route layout

5.1 Choice of route

The route of funicular railways, aerial ropeways and ski tows shall be chosen in such a way that no hazards are to be expected for the safety of the persons being carried, the operating personnel and third parties in service or out of service.

When choosing the cableway installation system, the following shall be taken into account:

- The characteristics of the terrain being travelled over, in particular with regard to the possibilities for recovery;
- The geological and hydrogeological nature of the subsoil;
- The hazards from the environment (e.g. avalanches, rock falls, meteorological influences, intersections with traffic routes).

If required, protective measures shall be provided.

5.2 Route for funicular railways

5.2.1 When determining the route of funicular railways, the following shall be taken into account in particular:

- The lateral acceleration acting on the persons being carried;
- Safe rope storage on the rollers;
- The safe tracking of the carriages including with regards to possible wheel relief;
- The required braking force and safe functioning of the rail brakes;

— The characteristics of the carriers.

5.2.2 The free lateral acceleration shall generally be less than 0.65 m/s^2 . It can be raised to up to 1.0 m/s^2 if the jerk is limited to a maximum of 0.8 m/s^3 by means of a transition curve.

Track superelevation can be carried out in the course of the track to limit the free lateral acceleration.

Both this measure and also the selected curve radii shall not impair the safety of the track guidance and the effectiveness of the rail brake.

5.2.3 For reasons of safety and travel comfort, the slope of the route is to be chosen so that the actual longitudinal slope of the carrier floor in relation to the horizontal is no more than ± 0.20 rad.

5.2.4 The length of a passing place is to be determined in such a way that a collision between the carriers cannot occur if the rail brake is applied as a result of a torn haul rope or if the cable end attachment fails.

If the rail brake is triggered when the carrier is going downhill, the following shall be taken into account:

- Most unfavourable carrier positions;
- Response time of the on-board brake when the carrier is going downhill with the subsequent braking distance;
- Stopping distance of the drive, discharge of carrier travelling uphill;
- Downhill slope of the counter rope.

If the rail brake is triggered when the carrier is going uphill, the following shall be taken into account:

- Most unfavourable carrier positions;
- Position of the carrier going uphill after self-deceleration and emergency braking after reversing the direction of travel;
- Position of the carrier going downhill after triggering the on-board brake as a consequence of overspeed with subsequent stopping distance;
- Downhill slope of the counter rope.

5.3 Route for aerial ropeways

5.3.1 In general, the axle of aerial ropeways runs in a straight line between the stations and in general the ropes are run with a consistent track width.

5.3.2 In the case of horizontal rope deflections to achieve a deflection of the axle or a change in track width, the following conditions shall be observed:

- a) for all aerial ropeways: The horizontal force caused by the deflection and the rope tension force shall not exceed 10% of the resulting tracking force of the rope in any load case;
- b) for bi-cable ropeways: The lateral ramp angle of track ropes on the rope saddle shall not exceed 0.005 rad;
- c) for monocables: The lateral ramp angle of carrying-hauling ropes on roller batteries shall not exceed 0.005 rad.

Wind effects and dynamic influences do not have to be taken into account.

5.3.3 For larger deflections that no longer comply with the requirements of 5.3.2, suitable devices or suitable structures along the line shall be provided.

5.4 Span lengths for aerial ropeways

5.4.1 In the case of aerial ropeways, the span lengths and their arrangement relative to one another are to be selected in such a way that the dynamic behaviour of the moving cables is not adversely affected.

5.4.2 If no other devices are installed on gondolas with attachable clamps to prevent an insufficiently coupled carrier from leaving the station, the length and slope of the rope spans adjoining the stations shall be selected in such a way that this type of carrier cannot slide down the rope on the line.

The distance between the last exit monitoring system and the start of the downhill route (e.g. start of the roller assembly at the nearest tower) shall be selected according to the stopping distance after the exit monitoring system has responded. Two cases are to be differentiated from each other here:

- a) Response of the safety device and response of the first braking system, whereby a 20% addition to the calculated value of the stopping distance is to be taken into account;
- b) Response of the safety device, failure of the first braking system and response of the braking deceleration monitoring, whereby no addition has to be taken into account for the calculated value of the stopping distance, which corresponds to the triggered second braking system.

In the case of monocables, the chord of such rope spans shall be laid out approximately horizontally (gradient at most 0.01 rad). In the case of bi-cable ropeways, the chord of such spans shall rise towards the line and allow the carriers to stop safely due to their self-deceleration.

5.4.3 If there are no devices at the station exits of monocables to prevent an insufficiently coupled carrier from leaving the station, structural precautions shall be taken to prevent such a carrier from falling after leaving the station.

This requirement can then be disregarded if only unoccupied carriers leave the station and third parties (e.g. on a path being crossed below) are not endangered by a crash.

5.4.4 If design measures are taken to prevent an insufficiently coupled carrier from leaving the station, their effects on the entire installation shall be taken into account, in particular when determining the greatest possible longitudinal deflection according to 6.3.5.

5.4.5 The requirements given in 5.4.2 to 5.4.4 do not apply if slipping and falling by an insufficiently coupled carrier is prevented, for example through a redundant arrangement of clamps and coupling devices (e.g. in the case of double monocables).

5.5 Route for ski tows

5.5.1 In the event of a longer standstill of the installation or if a person being carried falls on the towing lane, each user of the installation is required to be able to leave the towing lane safely and immediately and reach a safe area.

5.5.2 For ski tows with low rope guides, the towing lane is to be accessible from the monitoring points.

5.5.3 The longitudinal slope in the course of the towing lane shall not exceed the following values:

- a) for ski tows with low rope guides:
 - 1) when holding on to the carrying-hauling rope: 25%;

- 2) with tow hangers: 40%;
- b) for ski tows with high rope guides:
 - 1) with tow hangers for 2 persons: 50%;
 - 2) with tow hangers for 1 person: 60%.

For a length of no more than two hanger distances, the longitudinal slope can be raised to 60% for ski tows with high rope guides that are equipped with tow hangers for two persons. Such towing lane areas shall be preceded by flatter sections with a maximum slope of 40% and at least the same length.

5.5.4 Reverse slopes in the course of the towing lane may be constructed with an average slope, based on the shortest distance between two tow hangers, as follows:

- a) with tow hangers for 2 persons: to a maximum of 3%;
- b) with tow hangers for 1 person: to a maximum of 5%.

5.5.5 The transverse gradient of the towing lane shall be close to 0%, with the following deviations being permissible:

- a) with tow hangers for 2 persons: up to $\pm 5\%$; in exceptional cases in short areas (e.g. in curves or in areas with an increased longitudinal slope according to 5.5.3) up to $\pm 10\%$;
- b) with tow hangers for 1 person: up to $\pm 10\%$.

There shall not be a transverse incline to a tower.

6 Limit profile

6.1 General

The limit profile of cableway installations is the space requirement of the cables, carriers or tow hangers and if necessary the arm's reach, ski or foot reaches as well as the property transported.

The limit profile shall be tested for the "in service" and "out of service" cases.

6.2 Limit profile for funicular railways

The following shall be taken into account for the limit profile:

- Overhang of the carrier in horizontal and vertical track curves;
- The lateral carrier play;
- The possible deflection of the carrier in all directions;
- The track play at the nominal track width of the track;
- Possible dimensional tolerances (e.g. of the carrier, the track position);
- A kinematic space requirement of at least 0.05 m on both sides, unless the installation conditions require a more detailed examination of the kinematic space requirement;
- The arm's reach.

The arm's reach is 1.00 m with the possibility of reaching through all window openings and on open carriers.

Providing the bottom hung windows can be opened by a maximum of 0.20 m, the arm's reach is:

- 0.20 m, if the bottom edge of the open window is more than 1.80 m above the carrier floor;
- 0.50 m, if the bottom edge of the open window is 1.50 m to 1.80 m above the carrier floor.

6.3 Limit profile for aerial ropeways

6.3.1 General

The following shall be taken into account for the limit profile:

- Displacements of the ropes in a lateral direction (6.3.2);
- Displacements of the ropes in a vertical direction (6.3.3);
- Transverse deflections of the carriers (6.3.4);
- Longitudinal deflections of the carriers (6.3.5);
- Arm's reach, foot and ski reaches (6.3.6).

The overlap of transverse and longitudinal deflection may be disregarded – except for guides according to 6.3.7.

Out of service, carriers shall then be taken into account if they remain on the line; they shall then be presumed to be unoccupied.

At crossing points or when approaching two clearance profiles, the limit profile of the cableway installation shall also take into account a deropement of a rope in the rope catcher or in the rope catching arm on a tower.

6.3.2 Lateral displacement of the ropes

The lateral displacement of the ropes as a result of wind action may be determined with a reduced wind velocity pressure q' :

$$q' = q \times (l^{*'} / l^*)^2 \quad (1)$$

whereby

q Minimum wind velocity pressure

— in service:

For track width verification:

$$q = \max (q_{N,Y}, 200 \text{ N/m}^2)$$

For other evidence of freedom of movement:

$$q = \max (0.8 \cdot q_{D,Y}, 200 \text{ N/m}^2)$$

— out of service:

$$q = \max (q_U, 1200 \text{ N/m}^2)$$

l^* Sloped span length;

$l^{*'}$ Notional field length.

Wind velocity pressure q' acts as a uniformly distributed load on the entire sloped span length l^* .

Notional field length $l^{*'} is determined based on the sloped field length l^* in accordance with the following formula:$

$$l^{*' = l^* \times \delta \quad (2)$$

Where δ is the reduction coefficient and is:

- 1.00 at $l^* \leq 200$ m;
- 0.65 at $l^* = 900$ m;
- 0.50 at $l^* \geq 2000$ m.

For a sloped field length l^* between 200 m and 900 m or between 900 m and 2000 m, δ shall be determined by linear interpolation.

When determining the lateral displacement, the increase of the lateral wind-exposed areas of the ropes as a result of an ice curtain shall be taken into account. Provided that an expert opinion does not set out any other values, an ice coat with an ice thickness of

- 20 mm for ropes with a rope nominal diameter ≤ 10 mm;
- 25 mm for ropes with a rope nominal diameter ≥ 100 mm;

shall be assumed.

For a rope nominal diameter between 10 mm and 100 mm the ice thickness shall be determined through linear interpolation.

If the climatic conditions at the installation site require it, greater ice thicknesses shall be assumed. For favourable climatic conditions, smaller values can also be used.

The following cases shall be assumed for determining lateral displacement of the ropes:

a) in service:

- 1) 100% of the wind velocity pressure without ice coat;
- 2) 100% of the wind velocity pressure at 40% of the ice thickness;
- 3) 80% of the wind velocity pressure at 100% of the ice coat;

b) out of service:

- 1) 100% of the wind velocity pressure without ice coat;
- 2) 65% of the wind velocity pressure at 40% of the ice thickness;
- 3) 40% of the wind velocity pressure at 100% of the ice coat.

In the case of ropes that are moved or travelled on in service, the simultaneous effects of wind and ice in service do not have to be taken into account.

When determining the lateral displacement of the ropes, no dynamic effects have to be taken into account. The working range of regulated tensioning devices shall be taken into account.