



Lifts, escalators and moving walks

Part 5: Escalators and moving walks

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 - Australian Industry Group
 - Australian Institute of Building Surveyors
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 - Engineers Australia
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-

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Australian Standard[®]

Lifts, escalators and moving walks

Part 5: Escalators and moving walks

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PREFACE

This Standard was prepared by the Standards Australia Committee ME-004, Lift Installations, to supersede AS 1735.5—2003, *Lifts, escalators and moving walks, Part 5: Escalators and moving walks (BS EN 115:1995, MOD)*.

The objective of this Standard is to deal with significant hazards and risks associated with the installation, operation, maintenance and inspection relevant to escalator and moving walk designs.

This Standard is identical with, and has been reproduced from EN 115-1:2008, *Safety of escalators and moving walks, Part 1: Construction and installation*, and its Amendment 1:2010, which has been incorporated into the source text.

As this Standard is reproduced from an International Standard, the following applies:

- (a) In the source text ‘this Standard’ should read ‘this Australian Standard’.
- (b) A full point substitutes for a comma when referring to a decimal marker.

None of the normative references in the source document have been adopted as Australian or Australian/New Zealand Standards.

For wiring of escalators or moving walks see AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annex to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

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INTRODUCTION

This standard is a Type C standard as stated in EN ISO 12100-1.

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

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

The purpose of this standard is to define safety requirements for escalators and moving walks in order to safeguard people and objects against risks of accidents during installation, operation, maintenance and inspection work.

The contents of this standard are based on the assumption that persons using escalators and moving walks are able to do so unaided. However, physical and sensory abilities in a population can vary over a wide range, escalators and moving walks are also likely to be used by persons with a range of other disabilities.

Some individuals, in particular older people, might have more than one impairment. Some individuals are not able to use an escalator or moving walk independently and rely on assistance/support being provided by a companion. Furthermore some individuals can be encumbered by objects or be responsible for other persons, which can affect their mobility. The extent to which an individual is incapacitated by impairments and encumbrances often depends on the usability of products, facilities and the environment.

The use of wheelchairs on escalators and moving walks can lead to dangerous situations which cannot be mitigated by machine designs and therefore should not be permitted.

The use of lifts is the preferred method of vertical travel for most people with disabilities and in particular wheelchair users and persons with guide dogs.

Additional signs should be provided to indicate the location of other facilities, these facilities should be in close proximity to the escalators and moving walks and easy to find.

It is assumed that negotiations have been made for each contract between the customer and the supplier/installer (see also Annex A) about:

- a) intended use of the escalator or moving walk;
- b) environmental conditions;
- c) civil engineering problems;
- d) other aspects related to the place of installation.

If escalators or moving walks are intended to be operated under special conditions, such as directly exposed to the weather or explosive atmosphere, or in exceptional cases serve as emergency exits, appropriate design criteria, components, materials and instructions for use should be used that satisfy the particular conditions.

An Interpretation Committee has been established to clarify, if necessary, the spirit in which the clauses of the standard have been drafted and to specify the requirements appropriate to particular cases. Interpretation Requests can be sent to the National Standard Bodies which will contact the responsible Technical Committee CEN/TC 10. The formats of an interpretation request and the interpretation are given in Annex L.

AUSTRALIAN STANDARD

Lifts, escalators and moving walks**Part 5:****Escalators and moving walks****1 Scope**

1.1 This standard is applicable for new escalators and moving walks (pallet or belt type) as defined in Clause 3.

This standard deals with all significant hazards, hazardous situations and events relevant to escalators and moving walks when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

1.2 This standard does not deal with hazards arising from seismic activities.

1.3 This document is not applicable to escalators and moving walks which were manufactured before the date of its publication as EN. It is, however, recommended that existing installations be adapted to this standard.

2 Normative references

The following referenced documents are indispensable for the application 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.

 deleted text 

EN 1929-2, *Basket trolleys — Part 2: Requirements, tests and inspection for basket trolleys with or without a child carrying facility, intended to be used on passenger conveyors*

EN 1929-4, *Basket trolleys — Part 4: Requirements and tests for basket trolleys with additional goods carrying facility(ies), with or without a child carrying facility, intended to be used on passenger conveyors*

EN 1993-1-1, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 10025-1, *Hot rolled products of structural steels — Part 1: General technical delivery conditions*

EN 10025-2, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3, *Hot rolled products of structural steels — Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10025-4, *Hot rolled products of structural steels — Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels*

EN 10025-5, *Hot rolled products of structural steels — Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*

EN 10025-6, *Hot rolled products of structural steels — Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

EN 10083-1, *Steels for quenching and tempering — Part 1: General technical delivery conditions*

EN 10083-2, *Steels for quenching and tempering — Part 2: Technical delivery conditions for non alloy steels*

EN 10083-3, *Steels for quenching and tempering — Part 3: Technical delivery conditions for alloy steels*

EN 12015, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Emission*

EN 12016, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Immunity*

EN 13015:2001, *Maintenance for lifts and escalators — Rules for maintenance instructions*

EN 13501-1:2007, *Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests*

EN 60068-2-6:1995, *Environmental testing — Part 2: Tests — Tests Fc: Vibration (sinusoidal) (IEC 60068-2-6:1995 + Corrigendum 1995)*

EN 60068-2-14, *Environmental testing — Part 2: Tests — Test N: Change of temperature (IEC 60068-2-14:1984 + A1:1986)*

EN 60068-2-27:1993, *Basic environmental testing procedures — Part 2: Tests — Test Ea and guidance: Shock (IEC 60068-2-27:1987)*

EN 60068-2-29, *Basic environmental testing procedures — Part 2: Tests; Test Eb and guidance: Bump (IEC 60068-2-29:1987)*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60269-1, *Low-voltage fuses - Part 1: General requirements (IEC 60269-1:2006)*

EN 60439-1:1999, *Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies (IEC 60439 1:1999)*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 60664-1:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests (IEC 60664-1:2007)*

EN 60947-4-1, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters; Electromechanical contactors and motor-starters (IEC 60947-4-1:2000)*

EN 60947-5-1, *Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices (IEC 60947-5-1:2003)*

EN 61249 series, *Materials for printed boards and other interconnecting structures (IEC 61249 series)*

EN 61558-1:2005, *Safety of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests (IEC 61558-1:2005)*

Ⓐ EN 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005)* Ⓐ

EN 62326-1, *Printed boards — Part 1: Generic specification (IEC 62326-1:2002)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles (ISO 12100-2:2003)*

Ⓐ deleted text Ⓐ

EN ISO 13850, *Safety of machinery — Emergency stop — Principles for design (ISO 13850:2006)*

EN ISO 13857:2006, *Safety of machinery — Safety distances to prevent hazard zones being reached by the upper and lower limbs (ISO 13857:2008)*

ISO 3864-1, *Graphical symbols — Safety colours and safety signs - Part 1: Design principles for safety signs in workplaces and public areas (Note: Corrected and reprinted in 2003-12)*

ISO 3864-3, *Graphical symbols — Safety colours and safety signs — Part 3: Design principles for graphical symbols for use in safety signs*

HD 21.3 S3, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 3: Non-sheathed cables for fixed wiring (IEC 60227-3:1993, modified)*

HD 21.4 S2, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 4: Sheathed cables for fixed wiring*

HD 21.5 S3, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 5: Flexible cables (cords) (IEC 60227-5:1979, modified)*

HD 22.4 S4, *Cables of rated voltages up to and including 450/750 V and having crosslinked insulation — Part 4: Cords and flexible cables*

HD 60364-4-41, *Low-voltage electrical installations — Part 4-41: Protection for safety — Protection against electric shock (IEC 60364- 4-41:2005, modified)*

IEC 60747-5-5, *Semiconductor devices — Discrete devices — Part 5-5: Optoelectronic devices — Photocouplers (NOTE: This standard is intended to be published unmodified as an EN 60747-5-5.)*

3 Terms and definitions - Symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100-1:2003 and the following apply.

3.1.1

angle of inclination

maximum angle to the horizontal in which the steps, the pallets or the belt move

3.1.2

balustrade

part of the escalator/moving walk which ensures the user's safety by providing stability, protecting from moving parts and supporting the handrail

3.1.3

balustrade decking

transverse member of the balustrade which meets the handrail guidance profile and which forms the top cover of the balustrade

3.1.4

brake load

load on the step/pallet/belt which the brake system is designed to stop the escalator/moving walk

3.1.5 a

comb

pronged section at each landing that meshes with the grooves

3.1.5 b**comb plate**

platform at each landing to which the combs are attached

3.1.6**electrical safety system**

safety related part of the electrical control system as an arrangement of safety circuits and monitoring devices

3.1.7**electrical safety devices**

part of a safety circuit consisting of safety switches and/or fail safe circuits

3.1.8**escalator**

power-driven, inclined, continuous moving stairway used for raising or lowering persons in which the user carrying surface (e.g. steps) remains horizontal

NOTE Escalators are machines - even when they are out of operation - and cannot be considered as fixed staircases.

3.1.9**exterior panel**

part of the exterior side of the enclosure of an escalator or moving walk

3.1.10**fail safe circuit**

safety related electrical and/or electronic system with defined failure mode behaviour

3.1.11**handrail**

power-driven moving rail for persons to grip while using the escalator or moving walk

3.1.12**interior panel**

panel located between the skirting or lower inner decking and the handrail guidance profile or balustrade decking

3.1.13 a**lower inner decking**

profile that connects the skirting with the interior panel when they do not meet at a common point

3.1.13 b**lower outer decking**

profile that connects the exterior panels with the interior panel

3.1.14**machinery**

escalator or moving walk machine(s) mechanisms and associated equipment

3.1.15**machinery spaces**

space(s) inside or outside of the truss where the machinery as a whole or in parts is placed

3.1.16**maximum capacity**

maximum flow of persons that can be achieved under operational conditions

3.1.17**moving walk**

power-driven installation for the conveyance of persons in which the user carrying surface remains parallel to its direction of motion and is uninterrupted (e.g. pallets, belt)

NOTE Moving walks are machines - even when they are out of operation – and should not be used as a fixed access.

3.1.18**newel**

end of the balustrade

3.1.19**nominal speed**

speed in the direction of the moving steps, pallets or the belt, when operating the equipment under no load condition (i.e. without persons), stated by the manufacturer as that for which the escalator or moving walk has been designed

NOTE Rated speed is the speed the escalator/moving walk moves under rated load conditions.

A1 3.1.20**programmable electronic system in safety related applications for escalators and moving walks (PESSRAE)**

system for control, protection or monitoring based on one or more programmable electronic 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, used in safety related applications as listed in Table 6 **A1**

3.1.21**rated load**

load which the equipment is designed to move

NOTE For maximum capacity, see Annex H.

3.1.22**rise**

vertical distance between the upper and lower finished floor levels

3.1.23**safety circuit**

part of the electric safety system consisting of electrical safety devices

A1 3.1.24**safety integrity level (SIL)**

discrete level for specifying the safety integrity requirements of the safety functions to be allocated to the PESSRAE

NOTE In this European Standard SIL 1 is representing the lowest level and SIL 3 the highest, even when it does not make use of SIL 3. **A1**

3.1.25**skirting**

vertical part of the balustrade interfacing with the steps, pallets or belt

3.1.26**skirt deflector**

device to minimise the risk of trapping between the step and the skirting

3.1.27**stand-by operation**

mode in which an escalator/moving walk can be stopped or operated under no load condition with any speed below the nominal speed

▣^{A1} 3.1.28**system reaction time**

sum of the following two values:

- a) time period between the occurrence of a fault in the PESSRAE and the initiation of the corresponding action on the escalator/moving walk;
- b) time period for the escalator/moving walk to respond to the action, maintaining a safe state ▣^{A1}

3.2 Symbols and abbreviations

The following symbols and corresponding units of measurement of the following Table 1 are used in this standard.

Table 1 — Symbols and corresponding units of measurement used in this standard

Symbol	Designation	Unit	Figure
b_1	Distance between the handrail centre lines	m	3
b_2	Width of the handrail	mm	3
b_3	Horizontal distance between skirting and interior panel	mm	3
b_4	Width of the horizontal part of the lower inner decking that directly joins the interior panel	mm	3
b_5	Horizontal distance between the inner edge of the handrail and the top edge of the interior panel	mm	3
b_6', b_6''	Horizontal distance between the handrail profile and guide or cover profiles	mm	3
b_7	Width of the grooves	mm	2
b_8	Web width	mm	2
b_9	Horizontal distance between the outer edge of the handrail and a non-continuous obstruction, e.g. roof intersection, column	mm	A.1
b_{10}	Horizontal distance between the outer edge of the handrail and a continuous obstruction, e.g. wall	mm	A.1
b_{11}	Horizontal distance between the handrails of adjacent escalators/moving walks	mm	A.1
b_{12}	Vertical distance between the lower edge of the handrail and the balustrade decking	mm	3
b_{13}	Width of the lower outer decking	mm	4
b_{14}	Horizontal distance between the outer edges of interior panels on adjacent escalators or moving walks	mm	4
b_{15}	Horizontal distance between the building structure (wall) and the centreline of the handrail	mm	4
b_{16}	Horizontal distance between the centrelines of the handrails of adjacent escalators/moving walks	mm	4
b_{17}	Horizontal distance of the anti-slide device to the outer edge of the handrail	mm	4
h_1	Vertical distance between the top of the handrail and step nose or pallet surface or belt surface	m	2, 3
h_2	Vertical distance between top edge of skirting or bottom edge of cover joints and the line of the step nose or the tread surface of the pallets or belt	mm	3
h_3	Distance between the entry of handrail into the newel and the floor	m	2,3
h_4	Free height above any point of step surfaces, pallets or belt over the area between both outer edges of the handrails	m	2, A.1
h_5	Height of the deflector	m	2,4

Table 1 (continued)

Symbol	Designation	Unit	Figure
h_6	Clearance between the upper edge of the tread surface and the root of the comb teeth	mm	2
h_7	Depth of the grooves	mm	2
h_8	Mesh depth of the comb into the grooves of the tread	mm	2
h_9	Vertical distance between floor and lower end of the anti-climbing device	mm	4
h_{10}	Vertical distance between lower edge of the handrail and upper end of the access restriction device	mm	4
h_{11}	Height of the anti-slide device	mm	4
h_{12}	Height of the upper edge of the free space outside the handrail	mm	A.1
h_{13}	Vertical distance between the upper and lower finished floor levels	m	2
L_1	Root of the comb teeth	-	2
l_1	Horizontal distance between supports	m	2
L_2	Comb intersection line	-	2
l_2	Distance between the furthest point reached by the handrail and the comb intersection line measured parallel to the tread surface	m	2
l_3	Length of the straight portion of the handrail in the direction of landing measured from the comb intersection line	m	2
l_4	Distance between the furthest point reached by the handrail and the point of entry into the newel measured parallel to the tread surface	m	2
l_5	Length of anti-climbing device on the lower outer decking	mm	4
v	Nominal speed	m/s	-
x_1	Step height	m	5
y_1	Step depth	m	5
z_1	Nominal width for the load carrying area (step, pallet or belt)	m	3, 5
z_2	Horizontal distance between skirting	m	3
z_3	Transverse distance between the supporting rollers	mm	8
α	Angle of inclination of the escalator or moving walk	°(degree)	2
β	Design angle of the teeth of the comb	°(degree)	2
γ	Cross-sectional angle of inclination of the lower inner decking	°(degree)	3
μ	Friction coefficient	-	-

4 List of significant hazards

4.1 General

This clause contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this standard, identified by risk assessment as significant for escalators and moving walks and which require action to eliminate or reduce the risk. These significant hazards are based upon EN ISO 14121-1 [2].

4.2 Mechanical hazards

Mechanical hazards on escalators and moving walks and in their immediate vicinity can occur because of the design of the machine or access to it.

These include:

- contact with moving machinery parts (e.g. driving unit, handrail drive) normally not accessible to the public (see 5.2.1.1, 5.2.1.2, 5.2.1.3, 5.2.1.5, 5.2.1.6, 5.2.3, 5.2.4, 5.8.1, 5.8.4, 5.12.2.5, A.3.2, A.3.3);
- crushing and shearing of fingers between handrail and balustrade and between balustrades (see 5.5.2.5, 5.6.2);
- cutting hazard caused by adjacent cover profile parts (see 5.5.2.4);
- impact on bodies caused by collision with building structures (wall, roof, criss-cross arrangement), or with persons on adjacent escalators/moving walks (see A.2.1, A.2.2, A.2.3, A.2.4);
- drawing-in at handrail entry into the balustrade (see 5.6.4.3, 5.6.5);
- trapping between skirting and steps, between comb and step/pallet (see 5.3.4, 5.3.5, 5.4.2.1, 5.4.2.2, 5.5.3, 5.5.5, 5.7.2.5, 5.7.3, Fig. G.2);
- trapping between the floor and the handrail (see 5.6.4.1, 5.6.4.2);
- trapping between step and step or pallet and pallet (see 5.3.2).

4.3 Electric hazards

Electric hazardous situations can occur due to:

- contact of persons with live parts (see 5.8.3.3, 5.11.1.3);
- indirect contact (see 5.11.1.4, A.4);
- inadequate emergency stops (see 5.12.2.2.3);
- wrong assembly of electric components (see 5.11.5.4);
- electrostatic phenomena (see 5.11.7);
- external influences on electric equipment (see 5.12.1.2.1.4, 5.12.1.2.1.5, 5.12.1.2.2.3).

4.4 Radiation hazards

4.4.1 Electromagnetic radiation generated by the machine

Electromagnetic radiation can be emitted by the escalator or moving walk during normal operation (see 5.11.1.2.3, 5.12.1.2.1.5).

4.4.2 Electromagnetic radiation received from outside

Immission of low frequency radiation, radio frequency radiation, and microwaves can occur (see 5.11.1.2.3, 5.12.1.2.1.5).

4.5 Fire hazard

Fire hazards can be generated by accumulation of combustible material inside the truss, by the insulation material for cables and overloading of drives (see 5.2.1.4, 5.9).

4.6 Hazards generated by neglecting ergonomic principles in machinery design

Hazardous situation can occur because of:

- neglecting ergonomic dimensions for the users (e.g. height of balustrade, width of handrail) (see 5.5.2.1, 5.6.2, 5.6.3);
- inadequate lighting in the working places and access to them (see 5.8.3.1, 5.8.3.2, A.3.4, A.3.5);
- insufficient space in working places (see 5.8.2.1, 5.8.2.2, 5.8.2.3, A.3.6, A.3.7, A.3.8);
- missing lifting equipment for heavy loads (see 5.8.2.2, 5.10).

4.7 Hazard generated by failure of control circuit

Hazardous situation can occur because of:

- no stopping in case of dangerous situations (see 5.11.2, 5.12.1);
- short circuit of electric wiring (see 5.11.1.4, 5.11.6);
- overload of electric wiring (see 5.11.3, 5.11.5, 5.4.1.5, 5.12.1, 5.12.2);
- unexpected start of machine after an interruption (see 5.4.1.5, 5.12.2);
- unexpected reversal of drive (see 5.4.2.3, 5.12.1);
- excessive speed (see 5.4.2.3, 5.12.1);
- excessive deceleration during stopping (see 5.12.1).

4.8 Hazards generated by break-up during operation

Even if the design of an escalator or moving walks follows the requirements of EN 115-1, there are specific hazards which can occur due to

- greater than specified user and structural loads on the truss (see 5.2.5);
- loads greater than specified onto the balustrade (see 5.5.2.3, 5.5.2.4);
- loads greater than specified on the steps/pallets by unforeseeable misuse (see 5.3.3);
- loads greater than specified on the drive unit (see 5.4.1.3, 5.4.3, 5.4.4).

4.9 Slipping, tripping and falling hazards

Most of the dangerous situations on escalators and moving walks are caused by the slipping and falling of persons.

These include:

- slipping on steps/pallets/belt, on the comb plate and floor plate (see 5.3.1, 5.5.4, 5.7.1);
- falling caused by handrail speed deviation (incl. standstill) (see 5.6.1, Fig. G.1, Fig. G.3);
- falling caused by change of the direction of movement (see 5.4.2.3);

- falling caused by increased acceleration/deceleration (see 5.2.2, 5.4.1.1, 5.4.1.2, 5.4.2.1, 5.7.2.1, 5.7.2.2, 5.7.2.3, 5.7.2.4);
- falling caused by unexpected start or over-speed of the machine (see 5.4.1.5);
- falling caused by inadequate lighting at the landings (see A.2.8, A.2.9).

4.10 Hazards specific for this type of machine

Many hazards are specific for that type of machine. These include:

- missing steps or pallets (see 5.3.6);
- trapping by hand winding device (see 5.4.1.4);
- misuse by transporting others items than persons (e.g. shopping or luggage trolleys, push chairs) (see 7.4.1 d), Fig. G.4, Annex I);
- climbing on the outside of the balustrade (see 5.5.2.2);
- sliding between balustrades (see 5.5.2.2);
- climbing over the balustrade (see 5.5.2.6);
- surfing on the handrail (see 5.5.2.2);
- storage of merchandise adjacent to the balustrade (see 7.4.1 d));
- creation of traffic jam at blocked landings or intermediate exits of consecutive escalators or moving walks (see A.2.5, A.2.6);
- disturbance of the person flow in connected escalators/moving walks (see A.2.5, A.2.6);
- lifting by the handrail at the newel ends and falling over adjacent fixed barrier or the balustrade of the escalator/moving walk (see A.2.7).

NOTE For the actual type of machinery, noise is not considered as a significant nor relevant hazard.

5 Safety requirements and/or protective measures

5.1 General

Escalators and moving walks shall comply with the safety requirements and/or protective measures of this clause. In addition, escalators and moving walks shall be designed according to the principles of EN ISO 12100-2 for relevant but not significant hazards, which are not dealt with by this standard.

Certain escalators and moving walks are subject to special operational and environmental conditions. For these cases some additional recommendations are defined (see H.2).

5.2 Supporting structure (truss) and enclosure

5.2.1 General

5.2.1.1 All mechanically moving parts of the escalator or moving walk shall be completely enclosed within imperforate panels or walls. Exempt from this are the accessible steps, the accessible pallets, the accessible

belt and that part of the handrail available for the user. Apertures for ventilation are permitted (see also 5.2.1.5).

5.2.1.2 The exterior panels shall withstand a force of 250 N at any point at right angles on an area of 25 cm² without breakage or deflection resulting in any gap. The fixing shall be designed in that way to carry at least twice the dead load of the enclosure.

5.2.1.3 It is permissible to omit an enclosure of the mechanically moved parts if other measures (such as rooms with locked doors accessible to authorised personnel only) make a hazard to the public impossible.

5.2.1.4 Accumulation of materials (e.g. grease, oil, dust, paper) represents a fire risk. Therefore it shall be possible to clean the inner part of the escalator/moving walk.

5.2.1.5 Ventilation apertures shall be built or arranged in such a way to comply with EN ISO 13857:2006, Table 5. However it shall not be possible to pass a straight rigid rod 10 mm in diameter through the enclosure and to touch any moving part through a ventilation aperture.

5.2.1.6 Any exterior panels which are designed to be opened (e.g. for cleaning purposes) shall be provided with an electric safety device according to Table 6 n).

5.2.2 Angle of inclination

The angle of inclination α of the escalator shall not exceed 30°, but for rises h_{13} not exceeding 6 m and a nominal speed not exceeding 0,50 m/s the angle of inclination is permitted to be increased up to 35° (see α in Figure 2).

The angle of inclination of moving walks shall not exceed 12°.

5.2.3 Access to the interior

Machinery spaces inside the truss shall only be accessible to authorised persons (e.g. by key, access control).

5.2.4 Inspection covers and floor plates

Inspection covers and floor plates shall be provided with a control device according to Table 6 n).

It shall only be possible to open inspection covers and floor plates by a key or a tool suited for that purpose.

If rooms behind inspection covers and floor plates can be entered, it shall be possible to open them from the inside without a key or a tool even when locked.

Inspection covers and floor plates shall be imperforate. Inspection covers shall conform to the same conditions as required for the location where they are installed.

5.2.5 Structural design

The supporting structure shall be designed in a way that it can support the dead weight of the escalator or moving walk plus a rated load of 5 000 N/m². It shall be calculated in accordance with EN 1993-1-1.

NOTE Load carrying area = (nominal width z_1 (see Figure 3) of the escalator or moving walk) x (distance l_1 between the supports) (see Figure 2).

Based on the rated load, the maximum calculated or measured deflection shall not exceed 1/750 of the distance l_1 between the supports.

5.3 Steps, pallets, belt

5.3.1 General

In the user carrying area of the escalator, the step treads shall be horizontal with a tolerance of $\pm 1^\circ$ in the direction of travel.

NOTE 1 The maximum permissible height between two consecutive steps at the landings is defined in 5.3.4 and 5.7.2.1.

Tread surfaces for escalators and moving walks shall provide a secure foothold.

NOTE 2 For definition of materials and test methods, see Annex J.

5.3.2 Dimensions

5.3.2.1 General

For escalators and moving walks the nominal width z_1 shall be not less than 0,58 m and not exceed 1,10 m.

For moving walks with an angle of inclination up to 6° widths up to 1,65 m are permitted.

5.3.2.2 Step treads and pallets (see Figure 2, detail X and Figure 5)

5.3.2.2.1 The step height x_1 shall not exceed 0,24 m.

5.3.2.2.2 The step depth y_1 shall be not less than 0,38 m.

5.3.2.2.3 The surface of the step treads and pallets shall have grooves in the direction of movement with which the teeth of the combs mesh.

5.3.2.2.4 The step risers shall be cleated and the surface of the cleat shall be smooth. The ends of the step tread shall mesh with the cleating of the next step riser.

5.3.2.2.5 The width b_7 of the grooves shall be at least 5 mm and not exceed 7 mm.

5.3.2.2.6 The depth h_7 of the grooves shall be not less than 10 mm.

5.3.2.2.7 The web width b_8 shall be at least 2,5 mm and not exceed 5 mm.

5.3.2.2.8 The step treads and step risers or pallets shall not finish with a groove at their side edges.

5.3.2.2.9 The edge between the surface of the step tread and the riser shall have any sharpness relieved.

5.3.2.3 Belts (see Figure 2, detail X)

5.3.2.3.1 The belts shall have grooves in the direction of travel with which the teeth of the comb mesh.

5.3.2.3.2 The width b_7 of the grooves shall be at least 4,5 mm and not exceed 7 mm, and shall be measured at the tread surface of the belt.

5.3.2.3.3 The depth h_7 of the grooves shall be not less than 5 mm.

5.3.2.3.4 The web width b_8 shall be at least 4,5 mm and not exceed 8 mm and shall be measured at the tread surface of the belt.

5.3.2.3.5 The belt shall not finish with a groove at the side edge of the belt.

Splicing of the treadway belt shall be such as to provide a continuous unbroken treadway surface.

5.3.3 Structural design

5.3.3.1 General

The materials shall retain their strength characteristics during their specified life cycle taking into account the environmental conditions, e.g. temperature, ultra violet radiation, humidity, corrosion.

The steps, pallets and the belt shall be designed to withstand all possible loading and distortion effects, which may be imposed by the tracking, guiding and driving system during normal operation and shall be designed to support an equally distributed load corresponding to 6 000 N/m².

NOTE 6 000 N/m² is derived from a static load of 5 000 N/m² (see 5.2.5) plus an impact factor of 1,2.

To establish the dimensions of the belt and its supporting system, an area of effective width x 1,0 m length shall be taken as a basis for this corresponding load (in addition the requirements of 5.3.3.2.4 shall be complied with).

Assembled steps and pallets shall be designed such that all component parts e.g. inserts or fixings are securely attached and do not become loose during their life cycle. The inserts and fixings shall withstand the reaction force of operating the comb/comb plate electric safety device (Table 6 g)).

5.3.3.2 Static test

5.3.3.2.1 Steps

The step shall be tested for deflection with a single force of 3 000 N (including weight of the plate) applied perpendicular to the tread surface on a steel plate 0,20 m x 0,30 m in size and at least 25 mm thick, in the centre of the tread surface. The edge of the plate being 0,20 m long shall be arranged parallel to the front edge of the step, the edge of the plate being 0,30 m long at right angles to the front edge of the step.

During this test, the deflection measured at the tread surface shall be not more than 4 mm. There shall be no permanent deformation (initial setting tolerances are permitted).

The step shall be tested as a whole together with rollers (not rotating), axles or stub shafts (if existing) in a horizontal position (horizontal support) and at the maximum inclination (inclined support) for which the step is to be applied.

For all inclinations smaller than the maximum inclination permitted, a new test is not required. A test of the installed step, i.e. together with the guide rails and the supporting structure of the escalator, is also not necessary.

5.3.3.2.2 Step riser

The riser shall not deflect by more than 4 mm, when subjected to a single load of 1 500 N applied normal to the surface, on an area of 25 cm², using a square or round steel plate, minimum thickness 25 mm, shaped to fit the risers curvature. This load shall be applied in three positions across the width of the riser, on the centre line, in the middle and at both ends. There shall be no permanent deformation.

5.3.3.2.3 Pallets

The pallet shall be tested for deflection with a single force which, for a pallet area of 1 m², shall be 7 500 N (including weight of the plate). The force shall be applied perpendicular to the tread surface on a steel plate 0,30 m x 0,45 m in size and at least 25 mm thick, in the centre of the tread surface, and the edge of the plate being 0,45 m long shall be arranged parallel to the lateral edge of the pallet.

For pallets with smaller or larger areas, the force and the loading area shall be changed proportionally, whereby for the loading area the ratio of edge length shall be 1:1,5; however, the force shall be not below 3 000 N (including weight of the plate), the size of the plate be not smaller than 0,20 m x 0,30 m and its thickness be not less than 25 mm.

For pallets with a depth smaller than 0,30 m the plate width shall be 0,20 m and the length of the plate shall be the depth of the pallet.

During this test the deflection measured at the tread surface shall be not more than 4 mm. There shall be no permanent deformation (initial setting tolerances are permitted).

The pallet shall be tested as a whole together with rollers (not rotating), axles or stub shafts (if existing) in a horizontal position. A test of the installed pallet, i.e. together with the guide rails and the supporting structure of the moving walk, is not required.

5.3.3.2.4 Belts

With the belt tensioned to suit operational conditions, a single force of 750 N (including weight of the plate) shall be applied on a steel plate 0,15 m x 0,25 m x 0,025 m in size. The plate shall be placed centrally between the edge supporting rollers in such a way that its longitudinal axis is parallel to the longitudinal axis of the belt. The deflection at the centre shall not exceed 0,01 z_3 where z_3 is the transverse distance between the supporting rollers (see z_3 in Figure 8).

5.3.3.3 Dynamic tests

5.3.3.3.1 Steps

5.3.3.3.1.1 Load test

The step shall be tested at the maximum inclination (inclined support) for which it is to be applied, together with rollers (not rotating), axles or stub shafts (if existing). It shall be subjected to a load pulsating between 500 N and 3 000 N at one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved. The load shall be applied perpendicular to the tread surface on a steel plate 0,20 m x 0,30 m in size and at least 25 mm thick, arranged as specified in 5.3.3.2.1, in the centre of the tread surface.

After the test the step shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Steps or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

If rollers are damaged during the test, it is permissible to replace them.

5.3.3.3.1.2 Torsional test

The step design shall be such that the structure can accommodate torsional loading equivalent to a ± 2 mm displacement of the trailer wheel centre, moving in an arc whose centre is the chain wheel centre. The ± 2 mm displacement is a relative to a trailer wheel to chain wheel centre distance of 400 mm. This ratio shall be maintained, when the 400 mm dimension is varied (see Annex F for test examples).

The dynamic test shall be adjustable to ensure that the specified deflections above are achieved throughout the test. It shall be applied with one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved.

After the test the step shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Steps or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

5.3.3.3.2 Pallets

5.3.3.3.2.1 Load test

The pallet, irrespective of its size, shall be tested in a horizontal position together with rollers (not rotating), axles or stub shafts (if existing). It shall be subjected to a load pulsating between 500 N and 3 000 N at one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved. It shall be applied perpendicular to the tread surface on a steel plate 0,20 m x 0,30 m in size and at least 25 mm thick, in the centre of the tread surface.

For pallets with a smaller length than 0,30 m the plate width shall be 0,20 m and the length of the plate shall be the length of the pallet.

After the test, the pallet shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Pallets or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

If rollers are damaged during the test, it is permissible to replace them.

5.3.3.3.2.2 Torsional test

A torsional test is only required if the pallets are fitted with trailer rollers.

The pallet design shall be such that the structure can accommodate torsional loading equivalent to a ± 2 mm displacement of the trailer wheel centre, moving in an arc whose centre is the chain wheel centre. The ± 2 mm displacement is related to a trailer wheel to chain wheel centre distance of 400 mm. This ratio shall be maintained, when the 400 mm dimension is varied (see Annex F for test examples).

The dynamic load shall be adjusted to achieve a deflection with a tolerance of - 5% during the test. It shall be applied with one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved.

For pallets with a smaller length than 0,30 m, the plate width shall be 0,20 m and the length of the plate shall be the length of the pallet.

After the test, the pallet shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Pallets or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

5.3.4 Guiding of steps, pallets and belt

The lateral displacement of the steps or pallets out of their guiding system shall not exceed 4 mm at either side and 7 mm for the sum of clearances measured at both sides and the vertical displacement shall not exceed 4 mm for steps and pallets and 6 mm for belts.

This requirement applies only to the usable area of the steps, pallets or belt.

Treadway supports for belts shall be provided at intervals not exceeding 2 m along the centre line of the treadway. These supports shall be located at a level not more than 50 mm below the underside of the treadway when it is loaded under the conditions required by 5.3.3.2.4.

5.3.5 Clearance between steps or pallets

The clearance between two consecutive steps or pallets in any usable position measured at the tread surface shall not exceed 6 mm (see Figure 2, details Y, Z, Figure 6, detail S and Figure 7, detail U).

Demarcation (e.g. groove in the step tread) shall be provided to highlight at the landings the rear edge of the steps.

In the area of the transition curves of moving walks with meshed front edges and rear edges of the pallets, this clearance is permitted to be increased to 8 mm (see Figure 7, detail V).

5.3.6 Missing step or pallet device

A missing step/pallet (see Table 6 k)) shall be detected and the escalator/moving walk stopped before the gap (resulting from the missing step/pallet) emerges from the comb. This shall be ensured by a device provided at each driving and return station.

5.4 Drive unit

5.4.1 Driving machine

5.4.1.1 General

A drive unit shall not operate more than one escalator or moving walk.

5.4.1.2 Speed

5.4.1.2.1 The nominal speed shall not deviate by more than $\pm 5\%$ at nominal frequency and nominal voltage.

5.4.1.2.2 The nominal speed of the escalator shall not exceed:

- 0,75 m/s for an escalator with an angle of inclination α up to 30° ;
- 0,50 m/s for an escalator with an angle of inclination α of more than 30° up to 35° .

5.4.1.2.3 The nominal speed of moving walks shall be not higher than 0,75 m/s.

Deviating from the above a nominal speed up to 0,90 m/s is permitted provided the width of the pallets or the belt does not exceed 1,10 m, and at the landings, the pallets or the belt move horizontally for a length of at least 1,60 m before entering the combs.

The before mentioned requirements do not apply to moving walks with acceleration paths or moving walk systems with direct transition to moving walks travelling at different speeds.

5.4.1.3 Link between operational brake and step, pallet or belt drive

5.4.1.3.1 For the link between the operational brake and the step, pallet or belt drive, preferably non-friction driving elements should be used such as shafts, gear wheels, multiplex chains, two or more single chains. Where friction elements are used such as trapezoidal belts (flat belts are not permitted) an auxiliary brake in accordance with 5.4.2.2 shall be used.

5.4.1.3.2 Safety factors of all driving elements shall be at least 5 for static calculations. In the case of trapezoidal belts, at least 3 belts shall be applied.

This safety factor is determined as the ratio between the breaking force of the driving element and the static force to which the driving element is subjected when the escalator or inclined moving walk carries the rated load (person weight) according to 5.2.5 together with the tension force of the tensioning device.

For horizontal moving walks the dynamic forces according to 5.4.2.1.3.3 respectfully 5.4.2.1.3.4 together with the tension force of the tensioning device shall be used to determine the safety factor.

5.4.1.4 Hand winding device

If a hand winding device is provided it shall be easily accessible and safe to operate (see 7.2.1.3 and 7.4.1 g) for instructions).

If the hand winding device is removable an electric safety device (see Table 6 q)) in conformity with 5.12.1.2.2 shall be actuated when or before the hand winding device is put on the machine.

Crank handles or perforate hand wheels are not permitted.

5.4.1.5 Stopping the machine and checking its stopped position

Stopping the escalator or moving walk by means of the electric safety devices according to 5.12.1.2 shall be effected as follows:

The supply shall be interrupted by two independent contactors, the contacts of which shall be in series in the supply circuit. If, when the escalator or moving walk is stopped, one of the main contacts of one of the contactors has not opened, restarting shall be impossible.

5.4.2 Braking system

5.4.2.1 Operational brake

5.4.2.1.1 General

5.4.2.1.1.1 Escalators and moving walks shall have a braking system by means of which they can be brought to rest with a uniform deceleration and maintained stationary (operational braking); see also 5.12.1.2.4. There shall be no intentional delay in the application of the braking system.

If the stopping distance exceeds the maximum values of 5.4.2.1.3.2 and 5.4.2.1.3.4 by more than 20 %, a restart shall be possible only after the failure lock has been reset (see Table 6 o)). Before manual reset the brake system has to be investigated and corrective action has to be taken, if necessary (see also 7.4.1 e)).

A device shall be provided to monitor the lifting of the braking system after starting the escalator/moving walk (see also Table 6 l)).

5.4.2.1.1.2 The braking system shall operate automatically:

- a) in the event of loss of the voltage supply;
- b) in the event of loss of the voltage supply to the control circuits.

5.4.2.1.1.3 Operational braking shall be effected by an electro-mechanical brake or by other means.

Where no electro-mechanical operational brake is used, an auxiliary brake in accordance with 5.4.2.2 shall be provided.

5.4.2.1.1.4 Brakes that can be released by hand shall require continuous application of manual pressure to keep them open.

5.4.2.1.2 Electro-mechanical brake

The normal lifting of the electro-mechanical brake shall be by a continuous flow of electric current. The braking operation shall be effective immediately after the electric brake circuit is opened.

The brake force shall be generated by guided compression spring(s). Electrically generated self-excitation of the brake releasing device shall be impossible.

The interruption of the electricity supply shall be effected by at least two independent electric devices. They can be those which break the supply to the machine. If after the stop of the escalator or moving walk one of these electric devices has not opened, restarting shall be prevented (see also 5.4.1.5).

5.4.2.1.3 Brake load and stopping distances for operational brake

5.4.2.1.3.1 Determination of the brake load for escalators

Table 2 shall be applied for the determination of the brake load for escalators.

Table 2 — Determination of brake load for escalators

Nominal width z_1	Brake load per step
up to 0,60 m	60 kg
more than 0,60 m up to 0,80 m	90 kg
more than 0,80 m up to 1,10 m	120 kg

The number of steps to be considered is determined by "rise h_{13} divided by maximum visible height of the step riser" (see x_1 in Figure 5).

For the purpose of a test, the total brake load is permitted to be distributed over two-thirds of the number of steps thus obtained.

5.4.2.1.3.2 Stopping distances for the escalator

The stopping distances for unloaded and downward moving loaded escalators (see 5.4.2.1.3.1) shall be as given in Table 3.

Table 3 — Stopping distances for escalators

Nominal speed v	Stopping distance between
0,50 m/s	0,20 m and 1,00 m
0,65 m/s	0,30 m and 1,30 m
0,75 m/s	0,40 m and 1,50 m

For intermediate speeds the stopping distances shall be interpolated.

The stopping distances shall be measured from the time the electric stopping device is actuated.

The deceleration, measured on a downward moving escalator, in the direction of travel shall not exceed 1 m/s^2 during the operation of the braking system. The raw deceleration signal shall be band-limited using a 4,0 Hz two-pole Butterworth filter.

NOTE It is recommended to achieve the shortest possible stopping distance within the given deceleration limit.

5.4.2.1.3.3 Determination of the brake load for moving walks

Table 4 shall be applied for the determination of the brake load for moving walks.

Table 4 — Determination of brake load for moving walks

Nominal width z_1	Brake load per 0,4 m length
up to 0,60 m	50 kg
more than 0,60 m up to 0,80 m	75 kg
more than 0,80 m up to 1,10 m	100 kg
more than 1,10 m up to 1,40 m	125 kg
more than 1,40 m up to 1,65 m	150 kg

To determine the brake load for moving walks which in their length overcome several inclinations (differences in level), only the downward running sections shall be considered.

5.4.2.1.3.4 Stopping distances for moving walks

The stopping distances for unloaded and horizontally or downward moving loaded moving walks (see 5.4.2.1.3.3) shall be as given in Table 5.

Table 5 — Stopping distances for moving walks

Nominal speed v	Stopping distance between
0,50 m/s	0,20 m and 1,00 m
0,65 m/s	0,30 m and 1,30 m
0,75 m/s	0,40 m and 1,50 m
0,90 m/s	0,55 m and 1,70 m

For intermediate speeds the stopping distances shall be interpolated.

The stopping distances shall be measured from the time the electric device for stopping is actuated.

The deceleration, measured on a downward moving or horizontal moving walk, in the direction of travel shall not exceed 1 m/s^2 during the operation of the braking system. The raw deceleration signal shall be band-limited using a 4,0 Hz two-pole Butterworth filter.

NOTE It is recommended to achieve the shortest possible stopping distance within the given deceleration limit. For moving walks a brake test under no load will be sufficient.

For loaded moving walks, the manufacturer shall prove the stopping distances by calculation (see 6.2.c)).

5.4.2.2 Auxiliary brake

5.4.2.2.1 Escalators and inclined moving walks shall be equipped with auxiliary brake(s) if:

- the connection between the operational brake (see 5.4.2.1) and the driving sprockets of the steps/pallets or the drum of the belt is not accomplished by shafts, gear wheels, multiplex chains, or more than one single chain, or
- the operational brake is not an electro-mechanical brake according to 5.4.2.1.2, or
- the rise h_{13} exceeds 6 m (see also H.2).

The connection between the auxiliary brake and the driving sprockets of the steps/ pallets or the drum of the belt shall be accomplished by shafts, gear wheels, multiplex chains or more than one single chain. It is not permissible for the connection to comprise friction drives, i.e. clutches.

5.4.2.2.2 The auxiliary braking system shall be dimensioned in such a way that escalators and moving walks travelling with brake load downward are brought to rest by effective retardation and maintained stationary. The deceleration of 1 m/s² shall not be exceeded.

Upon operation of auxiliary brakes it is not necessary to keep the stopping distances defined for the operational brake (see 5.4.2.1.3.1).

5.4.2.2.3 Auxiliary brakes shall be of the mechanical (friction) type.

5.4.2.2.4 Auxiliary brakes shall become effective in either of the following conditions:

- a) before the speed exceeds a value of 1,4 times the nominal speed;
- b) by the time the steps and pallets or the belt change from the present direction of motion.

Its operation shall positively open the control circuit.

5.4.2.2.5 Auxiliary brake(s) are permitted to operate together with the operational brake when in case of power failure or of an interruption of a safety circuit the stopping conditions according to 5.4.2.1.3.2 and 5.4.2.1.3.4 are kept; otherwise a simultaneous operation of the auxiliary and the operational braking system is only permitted under the conditions of 5.4.2.2.4.

5.4.2.3 Protection against risks of excessive speed and unintentional reversal of the direction of travel

5.4.2.3.1 Escalators and moving walks shall be equipped in such a way that they stop automatically before the speed exceeds a value of 1,2 times the nominal speed (see Table 6.c)). Where speed control devices are used for this purpose they shall have switched off the escalator or moving walk before the speed exceeds a value of 1,2 times the nominal speed.

It is permissible to disregard this requirement if the design prevents excessive speed.

5.4.2.3.2 Escalators and inclined ($\alpha \geq 6^\circ$) moving walks shall be equipped in such a way that they stop automatically by the time the steps and pallets or the belt change from the pre-set direction of travel (see Table 6 c)).

5.4.3 Steps and pallets drive

5.4.3.1 The steps of escalators shall be driven by at least two chains of which at least one shall be located on each side of the step.

The pallets of moving walks are permitted to be driven by only one chain if the parallel movement of the pallets in the usable area is ensured by other mechanical measures.

5.4.3.2 The step chain design shall be of nominally infinite fatigue life.

The safety factor against breaking of each chain shall be at least 5 (see 5.4.1.3.2) with respect to structural steel according to EN 10025-1 in combination with EN 10025-2, EN 10025-3, EN 10025-4, EN 10025-5 and EN 10025-6 and with respect to quenched and tempered steel according to EN 10083-1 in combination with EN 10083-2 and EN 10083-3. The step chain shall be subject to a tensile test.

When more than one chain is used it is assumed that the load is equally distributed over the chains.

5.4.3.3 The chains shall be tensioned continuously. The escalator/moving walk shall be stopped automatically before the tensioning device moves in excess of ± 20 mm (see Table 6 e) and f)). Springs working in tension are not permitted for the tensioning device. When weights are used for tensioning they shall be safely retained should their suspension break.

5.4.4 Belt drive

5.4.4.1 The factor of safety of the belt including splicing shall be at least 5 (see 5.4.1.3.2) for the dynamic forces according to 5.4.2.1.3.3 respectively 5.4.2.1.3.4. The calculation shall be carried out for the worst case.

5.4.4.2 The belt shall be driven by drums and be tensioned continuously and automatically. Springs working in tension are not permitted for the tensioning device. When weights are used for tensioning they shall be safely retained should their suspension break.

5.5 Balustrade

5.5.1 General

Balustrades shall be installed on each side of the escalator or moving walk.

5.5.2 Dimensions of balustrade

5.5.2.1 In the inclined section the vertical height h_1 from step nose or pallet surface or belt surface to top of the handrail shall be not less than 0,90 m and not exceed 1,10 m (see Figures 2 and 3).

5.5.2.2 The balustrades shall have no parts on which a person would normally stand.

Appropriate measures shall be taken to discourage people from climbing on the outsides of the balustrade if there is a danger of people falling from them.

To ensure this, on escalators and moving walks devices (see 1 in Figure 4) shall be provided on the lower outer decking at a point $(1\ 000 \pm 50)$ mm above the floor level (see h_9 in Figure 4) where the bottom of the device intersects with the balustrade decking and shall extend to a length l_5 of at least 1 000 mm parallel with the balustrade decking where no stepping is possible. The device shall extend to at least a height in line with the top of the handrail not conflicting with the requirements of b_{10} and b_{12} .

Where escalators or moving walks are located adjacent to walls, devices (see 2 in Figure 4) to restrict access to the balustrade decking shall be provided at the top and bottom ends of these walls when the lower outer decking width b_{13} exceeds 125 mm. On adjacent parallel arrangements, this protection shall be provided when the combined balustrade decking width b_{14} exceeds 125 mm. The device shall extend to the height h_{10} .

All exposed fastener heads for the devices shall be of the vandal resistant type.

Where handrail level balustrade decking are provided between escalators/inclined moving walks and adjacent walls, anti-slide devices (see 3 in Figure 4) shall be provided on the balustrade decking when the distance b_{15} between the structure of the building (wall) and the centreline of the handrail is greater than 300 mm. These devices shall consist of objects fastened to the balustrade decking, no closer than 100 mm to the handrail (see b_{17}) and spaced no greater than 1 800 mm apart. The height h_{11} shall be not less than 20 mm. The devices shall have no sharp corners or edges.

The above mentioned also applies to adjacent escalators/inclined moving walks when the distance b_{16} between the centrelines of the handrails is greater than 400 mm.

5.5.2.3 Balustrades shall be designed to resist the simultaneous application of a static lateral force of 600 N and a vertical force of 730 N, both equally distributed over a length of 1 m and acting on the top of the handrail guiding system in the same place.

5.5.2.4 The parts of the balustrade facing the steps, pallets or belt shall be smooth and flush. Covers not in the direction of travel shall not project more than 3 mm. They shall be rigid and have rounded or bevelled edges. Covers of such nature are not permitted at the skirting.

Cover joints in the direction of travel (in particular between the skirting and the interior panel) shall be arranged and formed in such a manner as to eliminate any risk of harm caused by trapping.

Gaps between the interior panels of the balustrade shall be not wider than 4 mm. The edges shall be rounded off or bevelled.

When a force of 500 N is applied to the interior panel at any point of the panelling at right angles on an area of 25 cm², there shall be no gap greater than 4 mm and no permanent deformation.

If glass is used for the interior panel it shall be toughened glass. The minimum thickness of 6 mm shall apply to single layer balustrades. When multi-layer glass balustrades are used, they shall be laminated toughened glass, the thickness of at least one layer shall also be not less than 6 mm.

5.5.2.5 The horizontal distance (measured at right angles to the direction of travel) between the interior panel at lower points shall be equal to or less than the horizontal distance measured at points higher up.

5.5.2.6 The lower inner decking and the interior panel shall have an angle of inclination γ of at least 25° to the horizontal (see Figure 3). This does not apply to the horizontal part of the lower inner decking that directly joins the interior panel (see b_4 in Figure 3).

5.5.2.6.1 The horizontal part b_4 up to the interior panel shall be less than 30 mm.

5.5.2.6.2 The width b_3 , measured horizontally, of each lower inner decking inclined at an angle of less than 45° to the horizontal shall be less than 0,12 m (see Figure 3).

5.5.3 Skirting

5.5.3.1 The skirting shall be vertical, plain and butt-jointed.

NOTE However, special arrangements instead of butt-jointing (e.g. sliding joints) will possibly be necessary for long moving walks at the points where they pass over building expansion joints.

5.5.3.2 The perpendicular distance h_2 between top edge of skirting or bottom edge of projecting cover joints or the lower edge of the rigid part of skirt deflectors (for definition, see [A1](#) 3.1.26 [A1](#)) and the line of the step nose or the tread surface of the pallets or belt shall be not less than 25 mm (see Figure 3).

5.5.3.3 The skirting shall yield not more than 4 mm under a single force of 1 500 N acting at the most unfavourable point at right angles to the surface over an area of 2 500 mm² using a square or round area. No permanent deformation shall result from this.

5.5.3.4 On escalators, the possibility of trapping between skirting and steps shall be minimised.

For this purpose, the following four conditions shall be fulfilled:

- a) sufficient rigidity of the skirting according to 5.5.3.3;
- b) clearances to be in accordance with 5.5.5.1;
- c) installation of skirt deflectors which fulfil the following requirements:
 - They shall consist of a rigid and a flexible part (e.g. brushes, rubber profiles).
 - They shall have a minimum projection of 33 mm and a maximum of 50 mm from the vertical face of the skirt panels.