

Safety rules for the construction and installation of escalators and passenger conveyors

The European Standard EN 115 : 1995 has the status of a
British Standard

UDC 621.876.32 . 625 36 001 4 : 003 62 . 614 8

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The preparation of this British Standard was entrusted to Technical Committee MHE/4, Lifts, hoists and escalators, upon which the following bodies were represented:

Associated Offices Technical Committee
 Association of District Councils
 British Broadcasting Corporation
 British Lift Association
 British Retail Consortium
 British Telecommunications plc
 Chartered Institution of Building Services Engineers
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 Post Office
 Royal Association for Disability and Rehabilitation

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on
 15 October 1995

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First published as BS 5656,
 October 1983
 Second edition October 1995

The following BSI references relate to the work on this standard:
 Committee reference MHE/4
 Draft for comment 92/75489 DC

ISBN 0 580 24707 4

Amendments issued since publication

Amd. No.	Date	Text affected

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National foreword

This British Standard has been prepared by Technical Committee MHE/4 and is the English language version of EN 115 : 1995 *Safety rules for the construction and installation of escalators and passenger conveyors*, published by the European Committee for Standardization (CEN). EN 115 was produced as a result of international discussion in which the United Kingdom took an active part.

BS EN 115 : 1995 supersedes BS 5656 : 1983 (EN 115 : 1983), which is withdrawn.

Cross-references

Publication referred to	Corresponding British Standard
	BS EN 292 <i>Safety of machinery. Basic concepts, general principles for design</i>
EN 292-1 : 1991	Part 1 : 1991 <i>Basic terminology, methodology</i>
EN 292-2 : 1991	Part 2 : 1991 <i>Technical principles and specifications</i>
EN 294 : 1992	BS EN 294 : 1992 <i>Safety of machinery. Safety distances to prevent danger zones being reached by the upper limbs</i>
EN 60068-2-6 : 1995	BS EN 60068-2-6 : 1995 <i>Environmental testing</i> Part 2 <i>Tests</i> <i>Test Fc. Vibration (sinusoidal)</i>
EN 60068-2-27 : 1993	BS EN 60068-2-27 : 1993 <i>Environmental testing</i> Part 2 <i>Tests</i> <i>Test Ea and guidance. Shock</i>
EN 60269-1 : 1989	BS 88 <i>Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c.</i> Part 1 : 1988 <i>Specification of general requirements</i>
EN 60439-1 : 1994	BS EN 60439 <i>Specification for low-voltage switchgear and controlgear assemblies</i> Part 1 : 1994 <i>Specification for type-tested and partially type-tested assemblies</i>
EN 60529 : 1991	BS EN 60529 : 1992 <i>Specification for degrees of protection provided by enclosures (IP code)</i>
EN 60742 : 1989	BS 3535 <i>Isolating transformers and safety isolating transformers</i> Part 1 : 1990 <i>General requirements</i>
	BS EN 60947 <i>Specification for low-voltage switchgear and controlgear</i>
EN 60947-4-1 : 1992	Part 4 <i>Contactors and motor-starters</i> Section 1 : 1992 <i>Electromechanical contactors and motor-starters</i>
EN 60947-5-1	Part 5 <i>Control circuit devices and switching elements</i> Section 1 : 1992 <i>Electromechanical control circuit devices</i>
IEC 249-2	BS EN 60249 <i>Base materials for printed circuits</i> Part 2 <i>Specifications</i>
IEC 326-1 : 1994	BS 6221 <i>Printed wiring boards</i> Part 1 : 1990 <i>Guide for the specification writer</i>
IEC 747-5 : 1992	BS 6493 <i>Semiconductor devices</i> Part 1 <i>Discrete devices</i> Section 1.5 : 1992 <i>Recommendations for optoelectronic devices</i>

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EUROPEAN STANDARD
 NORME EUROPÉENNE
 EUROPÄISCHE NORM

EN 115

January 1995

ICS 91.140.90

Supersedes EN 115 : 1983

Descriptors: escalators, passenger conveyors, safety requirements, accident prevention, equipment specifications, lighting, machine rooms, ports: openings, safety devices, stopper devices, handrails, steps (stairs), braking, brakes electrical, installation, overspeed protection, tests, maintenance, inspection

English version

Safety rules for the construction and installation of escalators and passenger conveyors

Règles de sécurité pour la construction et
 l'installation des escaliers mécaniques et
 trottoirs roulants

Sicherheitsregeln für die Konstruktion und
 den Einbau von Fahrtreppen und Fahrsteigen

This European Standard was approved by CEN on 1995-01-03. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

European Committee for Standardization
 Comité Européen de Normalisation
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Ref. No. EN 115 : 1995 E

Foreword

This European Standard has been prepared by WG 2, Escalators and passenger conveyors, of the Technical Committee CEN/TC 10, Passenger, goods and service lifts, and supersedes EN 115 : 1983. The secretariat is held by AFNOR.

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

Considering that EN 115 : 1983 had given rise to requests for interpretation and that the Directive on machinery safety (89/392/EEC) had been adopted, CEN/TC 10 asked its working group WG 2 to amend EN 115 : 1983

- to take into account these requests for interpretation;
- to cancel the national deviations;
- to cover the Directive 89/392/EEC.

This task was completed by CEN/TC 10/WG 2 in 1991 after nine working meetings. The major changes are:

- reactivation for automatic restart;
- balustrades with central handrails (according to 5.1.5.8 EXCEPTION);
- interruption of electricity supply to the brake by at least two independent electrical devices;
- revision of the requirements for safety circuits;
- amendment in the article 'introduction' concerning the transportation of trolleys, etc. (see 0.5.3)

Although this draft did not fully comply with EN 414 *Safety of machinery – Rules for the drafting and presentation of safety standards*, it was agreed by the interested parties to submit it to the CEN enquiry with the aim to have as soon as possible a harmonized standard on escalators and passenger conveyors to provide one means of conforming with the Essential Safety Requirements of the Machinery Directive and associated EFTA Regulations. Those hazards which have been identified and taken into account are listed in annex C (normative).

EN 414 will be taken into account during the next revision of EN 115.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 1995, and conflicting national standards shall be withdrawn at the latest by July 1995.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

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0 Introduction

The purpose of this standard is to define safety rules for escalators and passenger conveyors in order to safeguard people and objects against risks of accidents during maintenance and inspection work.

0.1 It is necessary that all components:

0.1.1 are properly dimensioned, of sound mechanical and electrical construction and made of material with adequate strength and of suitable quality and free from defects; the use of materials with asbestos is not permitted;

0.1.2 are kept in good repair and working order. In particular, care shall be taken that the dimensions indicated are maintained despite wear; if necessary, the worn parts shall be replaced.

0.2 Where, for elucidation of the text, an example is given, this shall not be considered as the only possible design. Any other solution leading to the same result is permissible if it is guaranteed that with an equivalent function the same safety level exists.

0.3 It is not the purpose of this standard to preclude new developments of escalators and passenger conveyors. A new design shall meet at least the safety requirements of this standard.

0.4 Certain escalators and passenger conveyors are subject to special operational conditions. For these cases some additional requirements are defined, marked in this standard with the note 'For Public Service Escalators and Public Service Passenger Conveyors'. Additional recommendations for that kind of escalator and passenger conveyor are given in annex D (informative).

During the planning stage it should be specified if it will be a public service escalator or public service passenger conveyor (for criteria and definition see 3.9).

0.5 Special indications

0.5.1 Fire protection and building requirements differ from country to country and so far neither have been harmonized, either on the international level or in Europe.

Therefore, this standard cannot include specific requirements for fire protection and building requirements. However, it is recommended that as far as possible, escalators and passenger conveyors are made of materials that are not easy to ignite¹⁾.

0.5.2 If escalators or passenger conveyors have 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 shall be used that satisfy the particular conditions.

In addition, it is recommended that for escalators and passenger conveyors which otherwise would be exposed to weather conditions, the customer provides a roof and enclosure.

0.5.3 If, exceptionally, means of transportation, e.g. push chairs, luggage trolleys or baggage carts, shall be carried on escalators or passenger conveyors, special measures shall be agreed between the manufacturer of the escalator/passenger conveyor, the manufacturer of the means of transportation and the customer. Within those measures, care has to be taken that the conditions defined in 8.2.1 for the steps, pallets and the belt are observed when selecting the means of transportation. The measures to be taken are governed by very different conditions, which make a standardization within the scope of EN 115 impossible.

0.6 Requirements related to the life of the escalators and passenger conveyors are not included in this standard as they depend on the place of installation and customers' special specifications.

0.7 This standard has been drawn up taking into account in certain cases the imprudent act of the user. However, this standard takes into consideration proper use and not abuse.

0.8 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.

¹⁾ 'not easy to ignite' equals 'schwer entflammbar' in German and 'difficilement inflammable' in French.

1 Scope

1.1 This standard is applicable for all new escalators and passenger conveyors (pallet or belt type).

1.2 Existing escalators and passenger conveyors are not subject to this standard. It is, however, recommended that they be adapted to this standard.

1.3 If some dimensions of this standard cannot be kept due to structural conditions in existing buildings, it has to be defined in the individual case which alternative requirements are necessary.

NOTE. In addition, see 0.5 and 0.6.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

		EN 60068-2-27	<i>Basic environmental testing procedures — Part 2: Tests; Test Ea and guidance: Shock</i>
		EN 60269-1	<i>Low-voltage fuses — Part 1: General requirements</i>
		EN 60439-1	<i>Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies</i>
		EN 60529	<i>Degrees of protection provided by enclosures (IP code)</i>
		EN 60742	<i>Specifications for safety isolating transformers</i>
		EN 60947-4-1	<i>Low-voltage switchgear and controlgear — Part 4: Contactors and motor starters Section One — Electromechanical contactors and motor starters</i>
EN 292-1	<i>Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology</i>	EN 60947-5-1	<i>Low-voltage switchgear and controlgear — Part 5: Control circuit devices and switching elements Section One — Electromechanical control circuit devices</i>
EN 292-2	<i>Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications</i>	IEC 249-2	<i>Metal-clad base materials for printed circuits — Part 2: Specifications</i>
EN 294	<i>Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs</i>	IEC 249-3	<i>Metal-clad base materials for printed circuits — Part 3: Special materials</i>
prEN 1037	<i>Safety of machinery — Prevention of unexpected start-up</i>	IEC 326-1	<i>Printed boards — Part 1: General information for the specification writer</i>
prEN 60068-2-6	<i>Basic environmental testing procedures — Part 2: Tests; Test Fc and guidance: Vibration (sinusoidal)</i>	IEC 664-1	<i>Insulation co-ordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests</i>

IEC 665	<i>A.C. electric ventilating fans and regulations for household and similar purposes</i>
IEC 747-5	<i>Semi-conductor devices — discrete devices and integrated circuits — Part 5: Opto-electronic devices</i>
CENELEC HD 21	<i>Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 1: General requirements Part 3: Single-core non-sheathed cables for fixed wiring Part 4: Sheathed cables for fixed wiring Part 5: Flexible cables(cords)</i>
HD 22.4	<i>Rubber-insulated cables of rated voltages up to and including 450/750 V — Part 4: Cords and flexible cables</i>
HD 323.2.39	<i>Basic environmental testing procedures — Part 2: Tests; Test Z/AMD: Combined sequential cold, low air pressure, and damp heat test</i>
HD 384	<i>Electrical installations of buildings — Part 4: Protection for safety — Chapter 41: Protection against electric shock Part 5: Selection and erection of electrical equipment — Chapter 54: Earthing arrangements and protective conductors</i>

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1 escalator

Power-driven installation with endless moving stairway for the conveyance of passengers in the upward or downward direction (see also 0.5.3).

3.2 passenger conveyor

Power-driven installation with endless moving walkway (e.g. pallets, belt) for the conveyance of passengers, either on the same or between different traffic levels (see also 0.5.3).

3.3 handrail

Moving part intended to serve as a handhold for the passengers.

3.4 comb

Parts which, at both landings, mesh with the steps, pallets or the belt in order to facilitate the transition of passengers.

3.5 deflector device

An additional device to minimize the risk of trapping between the step and the skirting.

3.6 rated speed

Speed in the direction of the moving steps, pallets or the belt, when operating the equipment under no load condition, stated by the manufacturer as that for which the escalator or passenger conveyor has been designed and at which it should operate.

3.7 angle of inclination

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

3.8 theoretical capacity

Number of persons that can be carried theoretically by the escalator or passenger conveyor in 1 h.

For the determination of the theoretical capacity, it is assumed that on one step with an average depth of 0,4 m, and per 0,4 m visible length of a pallet or belt, there are carried:

1 person at a nominal width $z_1 = 0,6$ m

1,5 persons at a nominal width $z_1 = 0,8$ m

2 persons at a nominal width $z_1 = 1,0$ m

The theoretical capacity calculation is then:

$$c_t = v \times 3600 \times k/0,4$$

where

c_t theoretical capacity (persons/h);

v rated speed (m/s);

k factor.

For the most common widths there will be:

$k = 1$	for $z_1 = 0,6$ m;
$k = 1,5$	for $z_1 = 0,8$ m;
$k = 2$	for $z_1 = 1,0$ m.

With this formula, the theoretical capacity is as given in table 1.

Nominal width m	Theoretical capacity persons/h		
	Rated speed m/s		
	0,5	0,65	0,75
0,6	4500	5850	6750
0,8	6750	8775	10 125
1,0	9000	11 700	13 500

3.9 public service escalator/passenger conveyor

Escalator/passenger conveyor to which the following conditions apply:

- it is part of a public traffic system including entrance and exit points;
- it is suitable for regularly operating for approximately 140 h/week with a load reaching 100 % of the brake load (12.4.4.1 and 12.4.4.3) during periods lasting for at least 0,5 h during any time interval of 3 h.

4 Symbols for quantities

The units used are chosen from the International System of units (SI). See table 2.

5 Enclosure, surrounds, supporting structure and lighting

5.1 Enclosure of the escalator and passenger conveyor

5.1.1 General

5.1.1.1 All mechanically moved parts of the escalator or passenger conveyor 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.

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

5.1.1.3 Accumulation of materials (e.g. grease, oil, dust, paper) represents a fire risk. Therefore it should be possible to clean the underside enclosure, if any, of dirt. If such cleaning is not possible, other precautions (e.g. sprinkler-system or other fire abatement system) shall be taken to avoid the related fire hazard arising.

5.1.2 The enclosure shall have adequate mechanical strength and rigidity.

5.1.3 Inspection doors and trap doors

5.1.3.1 Inspection doors and trap doors shall be provided only where necessary for the inspection and maintenance of the equipment.

5.1.3.2 It shall be possible to open inspection doors and trap doors by means only of a key or a tool specially suited for that purpose, which shall be in the hands of authorized persons only.

If rooms behind inspection or trap doors can be entered, it shall be possible to open the inspection or trap doors from the inside without a key even when locked.

5.1.3.3 Inspection doors or trap doors which open on to adjacent escalator or passenger conveyor treadways shall be provided with safety contacts, according to 14.1.2, which prevent adjacent escalators or passenger conveyors from being operated when these doors are opened.

5.1.3.4 Inspection doors and trap doors shall be imperforate and conform to the same conditions as required for the enclosure material (see 5.1.2).

5.1.4 Apertures for ventilation

It shall not be possible to touch any moving part through a ventilation aperture (see 5.4 of EN 294 : 1992).

5.1.5 Balustrades (see figure 2)

5.1.5.1 Balustrades shall be installed on each side of the escalator or passenger conveyor. The balustrade consists of components for which the following terms are usual:

5.1.5.1.1 skirting - A

Portion of the enclosure adjacent to the outer edges of the steps, pallets or belt (see figure 2 and 5.1.5.6).

5.1.5.1.2 interior profile - B

This profile connects the skirting with the balustrade interior panelling.

5.1.5.1.3 balustrade interior panelling - C

Interior panels between the skirting or the interior profile and the balustrade decking underneath the handrail.

Table 2. List of symbols for quantities			
Clause	Explanation (in the order it appears in the document)	Symbol for quantity	Unit
3	Theoretical capacity	c_t	persons/h
3	Rated speed	v	m/s
3	Factor for different step width	k	—
5.1.5.6	Vertical distance between top edge of skirting or bottom edge of cover joints and the tread surface of the steps, pallets or belt	h_2	mm
5.1.5.7	Angle of inclination between the interior profile and the balustrade interior panelling	γ	° (degree)
5.1.5.7.1	Horizontal part of the interior profile that directly joins the balustrade interior panelling	b_4	mm
5.1.5.9	Newel, including the handrail in longitudinal direction measured from the combs	l_2	m
5.2.2	Root of the comb teeth	L_1	—
5.2.3	Free height above the steps, pallets or belt	h_4	m
5.2.4	Vertical obstruction	h_5	m
5.2.4	Distance between the centreline of the handrail and an obstacle	b_9	m
5.3 and 8.1.3	Nominal width for the load carrying area (step, pallet or belt)	z_1	m
5.3	Distance between supports	l_1	m
7.2	Horizontal portion of the handrail in the direction of landing measured from the root of the comb teeth	l_3	m
7.3.1	Distance between the handrail profile and guide or cover profiles	b_6'	mm
		b_6''	mm
7.3.1	Horizontal distance between the outer edge of the handrail and walls or other obstacles	b_{10}	mm
7.3.2	Width of the handrail	b_2	mm
7.3.3	Distance between the handrail and the edge of the balustrade	b_5	mm
7.4	Distance between the handrail centrelines	b_1	m
7.4	Distance between skirting	z_2	m
7.5.1	Distance between the entry of handrail into the newel and the floor	h_3	m
7.5.2	Horizontal distance between the furthest point reached by the handrail and the point of entry into the newel	l_4	m
7.6	Vertical distance between the handrail and step nose or pallet surface or belt surface	h_1	m
8.1.1	Step height	x_1	m
8.1.2	Step depth	y_1	m
8.2.3.2 and 8.2.4.2	Width of the grooves	b_7	mm
8.2.3.3 and 8.2.4.3	Depth of the grooves	h_7	mm

Clause	Explanation (in the order it appears in the document)	Symbol for quantity	Unit
8.2.3.4 and 8.2.4.4	Web width	b_8	mm
8.2.4.6.1.1	Transverse distance between the supporting rollers	z_3	mm
8.3.2.3	Design angle of the teeth of the comb	β	° (degree)
10.1.1	Angle of inclination of the escalator or passenger conveyor	α	° (degree)
11.3.1 and 11.4.1	Mesh depth of the comb into the grooves of the tread	h_8	mm
11.3.2 and 11.4.2	Clearance between the upper edge of the tread surface and the root of the comb teeth	h_6	mm
14.2.1.1	Comb intersection line	L_2	—

5.1.5.1.4 balustrade decking – E

This decking is situated underneath the handrail and forms the top cover of the balustrade panelling.

5.1.5.1.5 balustrade exterior panelling – D

Exterior panelling which from the balustrade deckings encloses the escalator or passenger conveyor.

5.1.5.1.6 newel

End of the balustrade on the landings, where the handrails change their direction of movement.

5.1.5.2 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.

Normally, climbing on the outside of the balustrade is possible only at the lower landings, because at the upper landings, railings or parapets prevent access to the balustrade. Climbing on the balustrade within the area of the lower landings is prevented, for instance, by the smooth outer balustrade decking, by railings arranged parallel to the balustrade, or by additional parts arranged at right angles to the balustrade.

5.1.5.3 With a vertical force of 900 N distributed over the surface of the handrail for a length of 0,5 m, there shall be no permanent deformation, no breakage or displacement of any balustrade parts.

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

Cover joints in the direction of travel (in particular between the skirting and the balustrade interior panelling) shall be arranged and formed in such a manner that the risk of trapping is reduced to a minimum.

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

The balustrade interior panelling shall have adequate mechanical strength and rigidity. When a force of 500 N is applied to the balustrade interior panelling 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 (setting tolerances are permitted).

The use of glass for the balustrade interior panelling is permitted provided it is splinter-free one-layer safety glass (tempered glass) and has sufficient mechanical strength and rigidity. The thickness of the glass shall be not less than 6 mm.

5.1.5.5 Protrusions and indentations shall not present sharp edges.

5.1.5.6 The skirting shall be vertical. The vertical distance h_2 between the top edge of the skirting or the bottom edge of projecting cover joints or the rigid part of deflector devices (for definition see 3.5) where installed, and the tread surface of the steps, pallets or belt shall be not less than 25 mm (see figure 2).

5.1.5.6.1 The skirting shall be extremely rigid, plane, and butt-jointed. However, special arrangements instead of butt-jointing will possibly be necessary for long passenger conveyors at the points where they pass over building expansion joints.

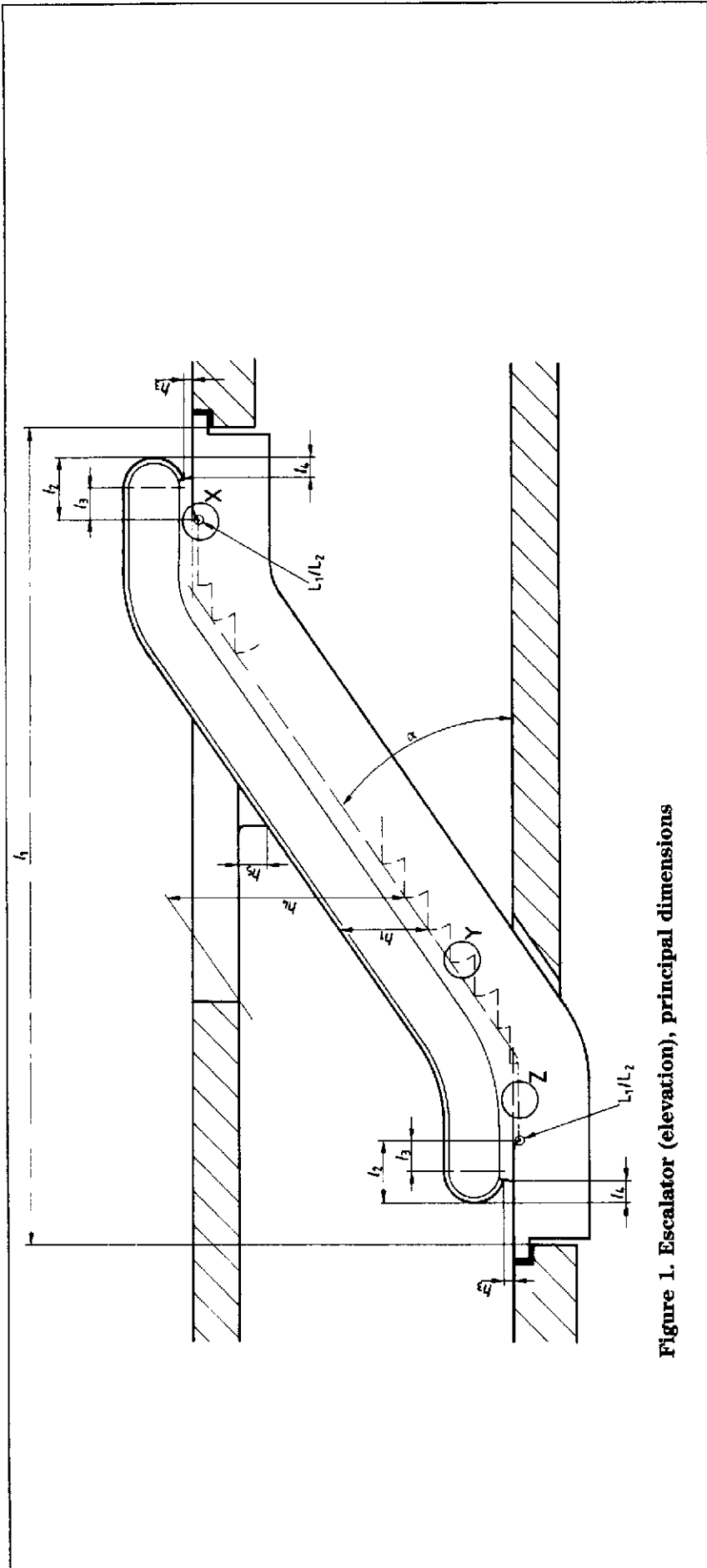


Figure 1. Escalator (elevation), principal dimensions

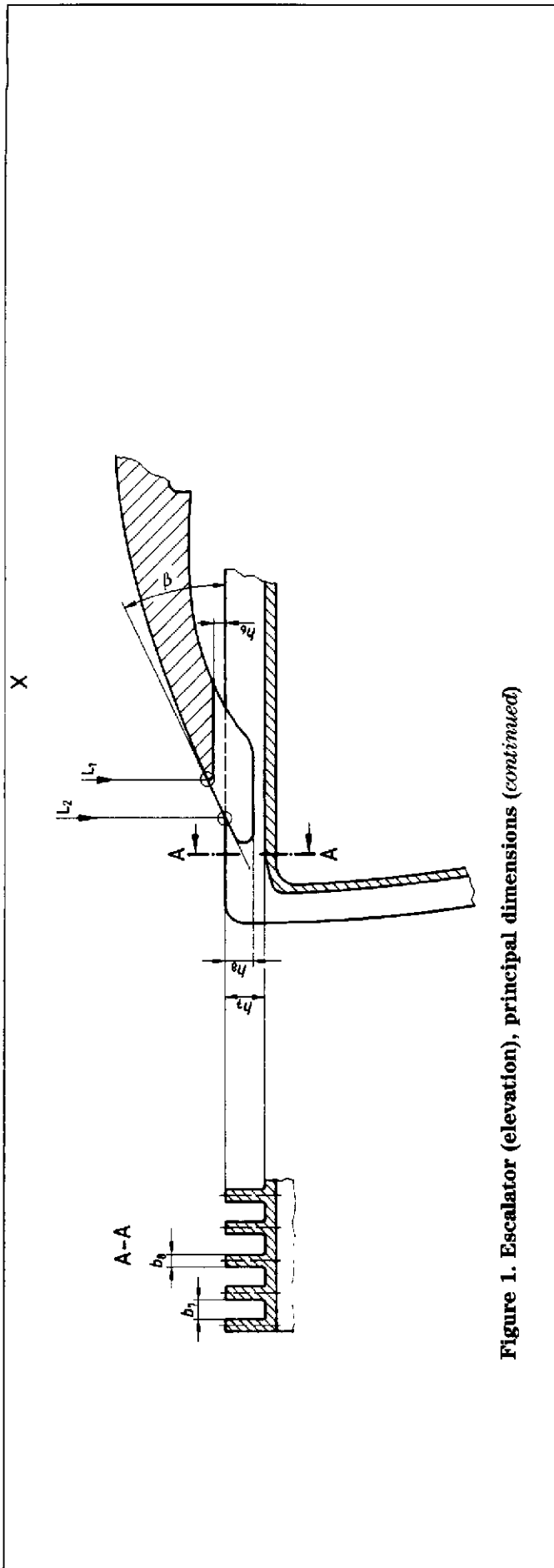


Figure 1. Escalator (elevation), principal dimensions (continued)

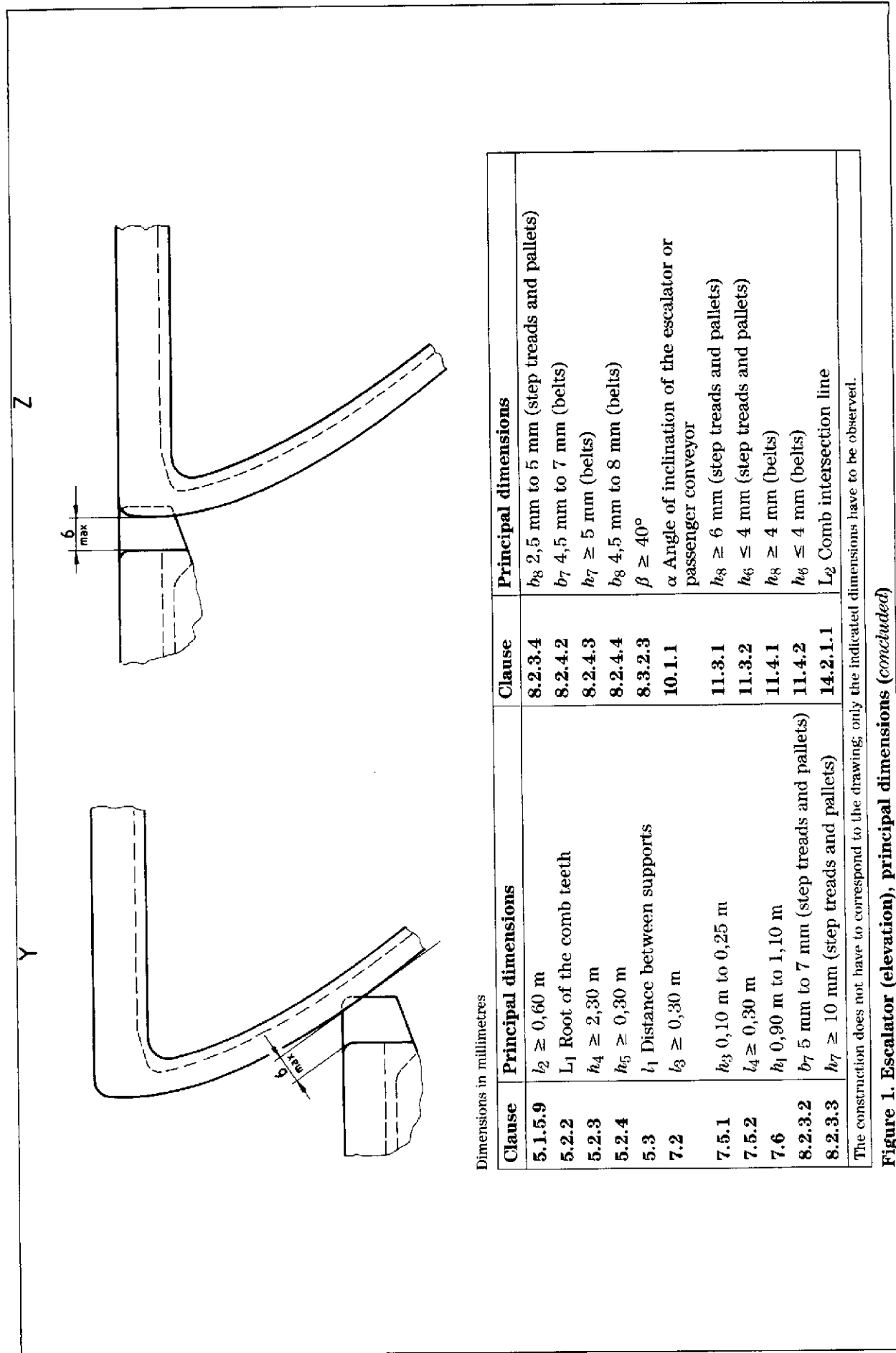


Figure 1. Escalator (elevation), principal dimensions (concluded)

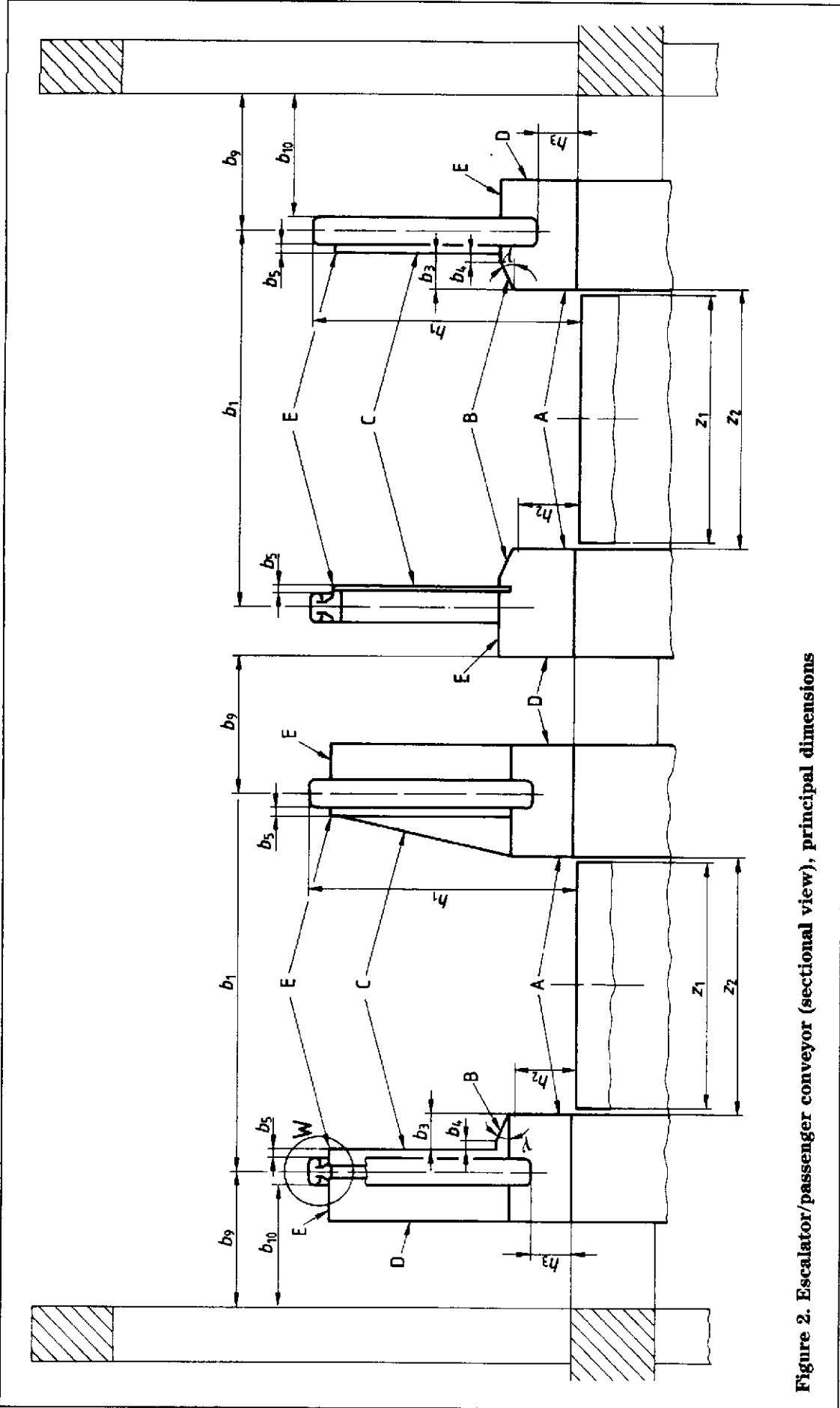
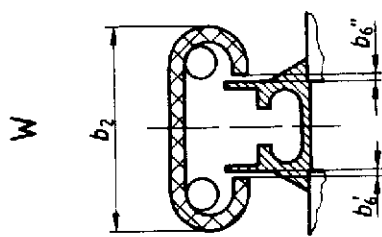


Figure 2. Escalator/passenger conveyor (sectional view), principal dimensions

Clause	Principal dimensions	Clause	Principal dimensions
5.1.5.1.1	A Skirting	7.3.1	$b_6' \leq 8 \text{ mm}$
5.1.5.1.2	B Interior profile	7.3.1	$b_6'' \leq 8 \text{ mm}$
5.1.5.1.3	C Balustrade interior panelling	7.3.1	$b_{10} \geq 80 \text{ mm}$
5.1.5.1.4	E Balustrade decking	7.3.2	b_2 70 mm to 100 mm
5.1.5.1.5	D Balustrade exterior panelling	7.3.3	$b_5 \leq 50 \text{ mm}$
5.1.5.6	$h_2 \geq 25 \text{ mm}$	7.4	$b_1 \leq z_2 + 0,45 \text{ m}$
5.1.5.7	$\gamma \geq 25^\circ$	7.4	$z_2 = z_1 + 7 \text{ mm}$ (see 11.2.1); distance between skirting
5.1.5.7.1	$b_4 < 30 \text{ mm}$	7.5.1	h_3 0,10 m to 0,25 m
5.1.5.7.2	$b_3 < 0,12 \text{ m}$ (if γ less than 45°)	7.6	h_1 0,90 m to 1,10 m
5.2.4	$b_9 \geq 0,50 \text{ m}$		
5.3	z_1 Nominal width		



The construction of the escalator or passenger conveyor does not have to correspond to the drawing; only the indicated dimensions have to be observed.

Figure 2. Escalator/passenger conveyor (sectional view), principal dimensions (concluded)

5.1.5.6.2 The skirting defined in 5.1.5.6 shall yield not more than 4 mm under a single force of 1500 N acting at the most unfavourable point at right angles to the surface over an area of 25 cm². No permanent deformation shall result from this.

5.1.5.6.3 On escalators, the possibility of trapping between skirting and steps shall be reduced.

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

- sufficient rigidity of the skirting according to 5.1.5.6.2;
- clearances to be in accordance with 11.2.1;
- reduction of the coefficient of friction by the use of suitable materials or a suitable type of lining for the skirting.

In addition, suitable deflector devices or yellow markings may be provided on the sides of the step tread surface.

5.1.5.7 The interior profile and the balustrade interior panelling shall have an angle of inclination γ of at least 25° to the horizontal (see figure 2).

5.1.5.7.1 This requirement does not apply to the horizontal part of the interior profile that directly joins the balustrade interior panelling (see b_4 in figure 2).

This horizontal part b_4 up to the balustrade interior panelling shall be less than 30 mm.

5.1.5.7.2 The width b_3 , measured horizontally, of each interior profile inclined at an angle of less than 45° to the horizontal shall be less than 0,12 m (see figure 2).

5.1.5.8 The horizontal distance (measured at right angles to the direction of travel) between the balustrade interior panelling at lower points shall be equal to or less than the horizontal distance measured at points higher up. The maximum distance between the balustrade interior panelling at any point shall be smaller than the distance between handrails.

EXCEPTION. If the horizontal distance between the handrails is smaller than the distance between the balustrade panelling underneath the handrails (exempt from this is the area of skirting) the following additional requirements apply.

- a) The rated speed shall not exceed 0,5 m/s; the nominal width of the steps, pallets or the belt z_1 shall be at least 800 mm.
- b) the distance l_2 between projection of the comb intersection line and the point at the newel where the handrails change their direction of movement shall, contrary to 5.1.5.9, be at least 1,20 m.

5.1.5.9 The newel including the handrails shall project beyond the root of the comb teeth by at least 0,6 m in longitudinal direction (see L_1 and l_2 in figure 1 and detail X).

5.2 Surrounds of the escalator and passenger conveyor

5.2.1 At the landings of the escalator and passenger conveyor, a sufficient unrestricted area shall be available to accommodate passengers. The width of the unrestricted area shall at least correspond to the distance between the handrail centrelines (see b_1 in figure 2). The depth shall be at least 2,50 m, measured from the end of the balustrade. It is permissible to reduce it to 2,00 m if the width of the unrestricted area is increased to at least double the distance between the handrail centrelines. Attention is drawn to the fact that this free area has to be considered as part of the whole traffic function and, thus, needs sometimes to be increased.

In the case of successive escalators and passenger conveyors without intermediate exits, they shall have the same theoretical capacity (see 14.2.2.4.1j).

5.2.2 The landing area of escalators and passenger conveyors shall have a surface that provides a secure foothold²⁾ for a minimum distance of 0,85 m measured from the root of the comb teeth (see L_1 in figure 1 and detail X). Exempt from this are the combs mentioned in 8.3.

5.2.3 The clear height above the steps of the escalator or pallets or belt of the passenger conveyor at all points shall be not less than 2,30 m (see h_4 in figure 1).

5.2.4 Where building obstacles can cause injuries, appropriate preventive measures shall be taken; see 7.3.1.

In particular, at floor intersections and on criss-cross escalators or passenger conveyors, a vertical obstruction of not less than 0,30 m in height, not presenting any sharp cutting edges shall be placed above the balustrade decking, e.g. as an imperforate triangle (see h_5 in figure 1). It is not necessary to comply with these requirements when the distance b_9 between the centreline of the handrail and any obstacle is equal to or greater than 0,50 m (see figure 2).

5.3 Supporting structure of the escalator or passenger conveyor

The supporting structure shall be designed in such a way that it can support the dead weight of the escalator or passenger conveyor plus a passenger weight of 5000 N/m² [load carrying area = nominal width z_1 (see figure 2) of the escalator or passenger conveyor \times distance between supports l_1 (see figure 1)]. An impact factor shall not be added to the passenger load.

²⁾ 'secure foothold' equals 'trittsicher' in German and 'surface de foulée antidérapante' in French.

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

For public service escalators and public service passenger conveyors

Based on passenger load, the maximum calculated or measured deflection shall not exceed $1/1000$ of the distance between supports l_1 .

5.4 Lighting

5.4.1 The escalator or passenger conveyor and its surrounds shall be sufficiently and adequately illuminated, especially in the vicinity of the combs.

5.4.2 It is permissible to arrange the lighting in the surrounding space or at the installation itself. The intensity of illumination at the landings including the combs, shall be related to the intensity of illumination of the general lighting in the area. On indoor escalators or passenger conveyors the intensity of illumination shall be not less than 50 lx at the landings; on outdoor escalators or passenger conveyors it shall be not less than 15 lx at the landings, measured at floor level.

5.5 Transportation

Completely assembled escalators/passenger conveyors or components of escalators/passenger conveyors which cannot be handled by hand shall:

- a) either be equipped with fittings for movement by a lifting device or transportation means; or
- b) be designed so that such fittings can be attached (e.g. threaded holes); or
- c) be shaped so that the lifting device or transportation means can be attached easily.

6 Machinery Spaces

6.1 General

Driving and return stations, machinery spaces inside the truss, as well as separate machinery spaces, shall not be accessible to unauthorized persons.

These rooms shall be used only for accommodating the equipment necessary for the operation of the escalator or passenger conveyor.

Fire alarm systems, equipment for direct fire abatement and sprinkler heads, provided they are sufficiently protected against incidental damage, are permitted in these rooms. Lift driving equipment is also permitted in these rooms.

NOTE. See clause 16 for instructions for use, covering maintenance requirements and inspection activities.

6.2 Accessibility

6.2.1 Ways and access routes to machinery spaces shall be easy and safe.

The clear height of the access shall be at least 1,80 m.

6.2.2 It is preferable that authorized personnel obtain access to inspection doors and trap doors, separate machinery spaces, separate driving and return stations by means of stairs only. Where stairs are difficult to install, it is permitted to use ladders that satisfy the following conditions.

- a) They shall be not liable to slip or to turn over.
- b) They shall, when in position of use, form an angle of 65° to 75° to the horizontal, unless they are fixed and their height is less than 1,50 m.
- c) On vertical ladders up to a maximum height of 1,5 m, the distance between the rungs and the wall behind shall be at least 0,15 m.
- d) They shall be exclusively used for this purpose and be kept always available in the vicinity; the necessary provisions shall be made for that purpose.
- e) At the upper part of the ladder there shall be one or more handhold(s) within easy reach.
- f) When the ladders are not fastened, fixed attachment points shall be provided.

6.3 Construction and equipment of machinery spaces, driving and return stations

6.3.1 General

6.3.1.1 In machinery spaces and return stations, space with a sufficiently large standing area shall be kept free from fixed parts of any kind. The size of the standing area shall be at least $0,30 \text{ m}^2$ and the smaller side shall be at least 0,50 m long.

6.3.1.2 Where the main drive or brake is arranged between the passenger side of the step, pallet or belt and the return line, a suitable approximately horizontal standing area in the working zone of not less than $0,12 \text{ m}^2$ shall be provided. The minimum dimension shall be not less than 0,30 m.

This part is permitted to be fixed or removable. In the latter case, it shall always be available in the vicinity. Necessary provisions shall be made for this purpose.

6.3.1.3 The size of separate machinery spaces, separate driving and return stations, and the space in front of fixed control panels shall be sufficient to permit easy and safe access for maintenance personnel to all the equipment, especially to the electrical connections.

In particular there shall be provided:

- a) a free space above an area of the full width of the control panels or cabinets (but not less than 0,50 m) and 0,80 m in depth, to give access to the equipment they support or contain;
- b) a free space above an area of at least $0,50 \text{ m} \times 0,60 \text{ m}$ for maintenance and inspection of moving parts at points where this is necessary;
- c) access routes, having a width of at least 0,50 m, to these free spaces.

SPECIFIC CASE. It is permitted to reduce the width of 0,50 m to 0,40 m in areas where there are no moving parts.

6.3.1.4 In separate machinery spaces, and separate driving and return stations, and in front of fixed control panels, the clear height shall under no circumstances be less than 2,0 m.

6.3.2 Lighting

Electric lighting installation in separate machinery spaces, or separate driving and return stations, shall be permanent and fixed. Electric lighting installation in driving and return stations and machine rooms inside the truss shall be by means of a portable lamp permanently available in one of these places. One or more socket outlets shall be provided in each of these places.

The electric lighting installation and the socket outlets shall be independent of the power supply to the machine, being fed either by a separate cable or a branch cable which is connected before the main switch of the escalator or passenger conveyor (see 13.4.1 and 13.6).

6.3.3 Stop switch

It shall be possible to switch off the escalator and passenger conveyor in the driving and return station.

Escalators and passenger conveyors with the driving unit arranged between the passenger side of the step, pallet or belt and the return line, or outside the return stations, shall have additional stop switches in the area of the driving unit.

The operation of these stop switches shall cause the disconnection of the power supply from the driving machine and allow the operational brake to become effective to stop the escalator or passenger conveyor.

The stop switches shall:

- be of a manually opened and closed type;
- have the switching positions marked unambiguously and permanently;
- be safety contacts satisfying 14.1.2.2.

SPECIFIC CASE. A stop switch need not be provided in a machinery space if a main switch according to 13.4 is located therein.

7 Handrail (see figures 1 and 2)

7.1 General

On the top of each balustrade there shall be provided a handrail moving in the same direction and at a speed tolerance of 0 % to 2 % of the speed of the steps, pallets or belt.

7.2 Continuation of the handrail beyond the comb

The horizontal portion of the handrail shall continue longitudinally at the landings for a distance l_3 (see figure 1) of at least 0,30 m past the root of the comb teeth (see L_1 in figure 1 and detail X).

In the case of inclined passenger conveyors without a horizontal section at the landings, the continuation of the handrail parallel to the angle of inclination is permitted.

7.3 Profile and position

7.3.1 The handrail profiles and their guides on the balustrades shall be formed or enclosed in such a way that the possibility of pinching or trapping of fingers or hands is reduced.

The distance between the handrail profile and guide or cover profiles shall under no circumstances be wider than 8 mm (see b_6' and b_6'' in figure 2, detail W).

To prevent collision, the horizontal distance b_{10} (see figure 2) between the outer edge of the handrail and walls or other obstacles shall under no circumstances be less than 80 mm. This distance shall be maintained to a height of at least 2,10 m above the steps of the escalator and above the pallets or the belt of the passenger conveyor. This height is permitted to be smaller if by appropriate measures the risk of injury is avoided.

For escalators arranged adjacent to one another either parallel or criss-cross, the distance between the edges of the handrails shall be not less than 120 mm.

7.3.2 The width b_2 of the handrail shall be between 70 mm and 100 mm (see figure 2, detail W).

7.3.3 The distance b_5 between the handrail and the edge of the balustrade shall not exceed 50 mm (see figure 2).

7.4 Distance between the handrail centrelines

The distance b_1 between the centreline of the handrails shall not exceed the distance between the skirting by more than 0,45 m (see b_1 and z_2 in figure 2).

7.5 Protection at the point of entry into the balustrade

7.5.1 The lowest point of entry of the handrail into the newel shall be at a distance h_3 from the floor which shall be not less than 0,10 m and not exceed 0,25 m (see figures 1 and 2).

7.5.2 The horizontal distance l_4 between the furthest point reached by the handrail and the point of entry into the newel shall be at least 0,30 m (see figure 1).

7.5.3 At the point of entry of the handrail into the newel a guard shall be installed to prevent the pinching of fingers and hands.

A switch according to 14.2.2.4.1k shall be provided.

7.6 Height above the steps, pallets and the belt

The vertical distance h_1 between the handrail and step nose or pallet surface or belt surface shall be not less than 0,90 m and not exceed 1,10 m (see figures 1 and 2).

7.7 Guiding

The handrail shall be guided and tensioned in such a way that it will not leave its guides during normal use.

7.8 For public service escalators and public service passenger conveyors. Control device for handrail breakage

If the handrail is not certified by its manufacturer for a breaking load of at least 25 kN, a device shall cause the escalator or passenger conveyor to stop if the handrail breaks (see 14.2.2.4.1m).

8 Steps, pallets, belt and combs

8.1 Dimensions (see figure 3)

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

If escalators are permitted to be used as an emergency exit when out of service, the step height shall not exceed 0,21 m.

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

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

For passenger conveyors with an angle of inclination up to 6° , larger widths are permitted.

8.2 Construction of the steps, pallets and the belt

(see figure 1, detail X and figure 3)

8.2.1 The steps, pallets and the belt shall match the operational conditions. They shall be able to support continuously an equally distributed load corresponding to 6000 N/m^2 without such deformation that would prejudice the proper functioning of the escalator or passenger conveyor.

To establish the dimensions of the belt, an area of effective width $\times 1,0 \text{ m}$ length shall be taken as a basis for this specific load (in addition, the requirements of 8.2.4.6.1 shall be complied with).

8.2.2 The steps and pallets shall satisfy the following tests and requirements.

8.2.2.1 Static test

8.2.2.1.1 Steps

The step shall be tested for deflection with a single force of 3000 N (including the weight of the plate) applied perpendicular to the tread surface on a steel plate $0,20 \text{ m} \times 0,30 \text{ m}$ in size and at least 25 mm thick, in the centre of the tread surface. The edge of the plate which is 0,20 m long shall be arranged parallel to the front edge of the step, the edge of the plate which is 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 (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.

8.2.2.1.2 Pallets

The pallet shall be tested for deflection with a single force which, for a pallet area of 1 m^2 , shall be 7500 N (including the weight of the plate). The force shall be applied perpendicular to the tread surface on a steel plate $0,30 \text{ m} \times 0,45 \text{ m}$ in size and at least 25 mm thick, in the centre of the tread surface, and the edge of the plate which is 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 3000 N (including the weight of the plate), the size of the plate be not smaller than $0,20 \text{ m} \times 0,30 \text{ m}$ and its thickness be not less than 25 mm.

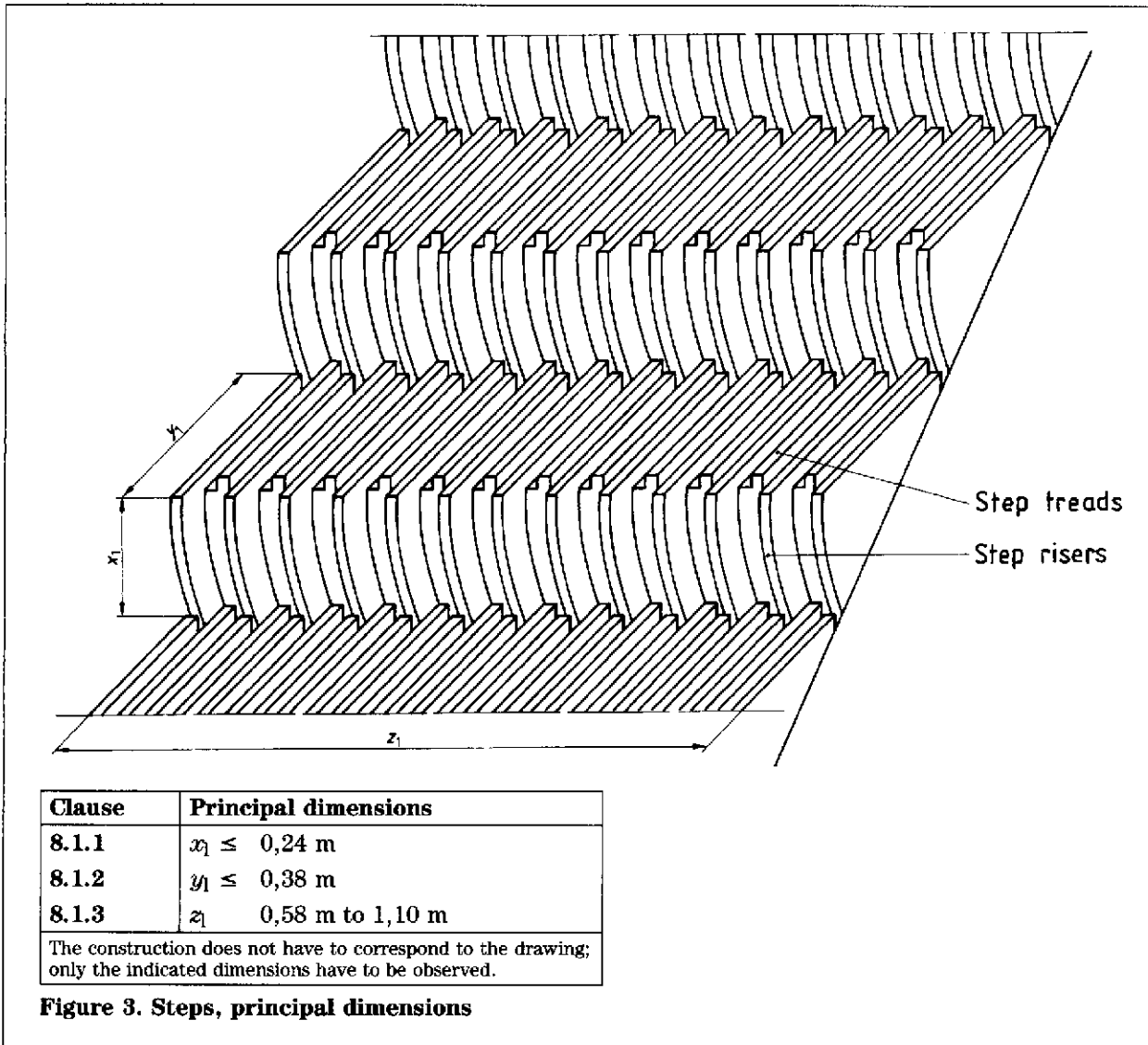
During this test, the deflection measured at the tread surface shall be not more than 4 mm. There shall be no permanent deformation (setting tolerances are permitted).

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 passenger conveyor, is not required.

8.2.2.2 Dynamic test

8.2.2.2.1 Steps

The step shall be tested at the maximum inclination (inclined support) for which the step 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 3000 N at a frequency between approximately 5 Hz and 20 Hz for at least 5×10^6 cycles, whereby an undisturbed harmonic force flow shall be achieved. The load shall be applied perpendicular to the tread surface on a steel plate $0,20 \text{ m} \times 0,30 \text{ m}$ in size and at least 25 mm thick, arranged as specified in 8.2.2.1.1, in the centre of the tread surface.



After the test, the step shall show neither fracture nor permanent deformation greater than 4 mm, measured at the tread surface.

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

8.2.2.2.2 Pallets

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 3000 N at a frequency between approximately 5 Hz and 20 Hz for at least 5×10^6 cycles, whereby an undisturbed harmonic force flow shall be achieved. The load shall be applied perpendicular to the tread surface on a steel plate 0,20 m \times 0,30 m in size and at least 25 mm thick, in the centre of the tread surface.

After the test, the pallet shall show neither fracture nor permanent deformation greater than 4 mm, measured at the tread surface.

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

8.2.3 Step treads and pallets

(see figure 1, detail X)

8.2.3.1 The surface of the step treads and pallets shall have grooves in the direction of movement, with which the teeth of the combs mesh. The step treads of the escalator shall be approximately horizontal in the usable area of the escalator.

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

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

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

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

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

8.2.4 Belts (see figure 1, detail X)

8.2.4.1 The belts shall have grooves in the direction of movement, with which the teeth of the comb mesh.

8.2.4.2 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.

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

8.2.4.4 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.

8.2.4.5 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.

8.2.4.6 Belt passenger conveyors with edge supported belt

8.2.4.6.1 Where the treadway belt is transversely rigid and is supported by rollers along its edges only, the following requirements shall apply.

8.2.4.6.1.1 With the belt tensioned to suit operational conditions, a single force of 750 N (including the weight of the plate) shall be applied on a steel plate 0,15 m × 0,25 m × 0,02 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 $0,01z_3$, where z_3 is the transverse distance between the supporting rollers (see z_3 in figure 5).

8.2.4.6.1.2 Additional treadway supports shall be provided at intervals not exceeding 2 m along the centreline 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 **8.2.4.6.1.1**.

8.2.5 Step risers

The step risers shall be sufficiently rigid and breakage-resistant.

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

8.3 Combs

8.3.1 General

Combs shall be fitted at both landings to facilitate the transition of passengers.

8.3.2 Construction

8.3.2.1 The teeth of the combs shall mesh with the grooves of the steps, pallets or belt (see **11.3** and **11.4**). The width of the comb teeth shall be not less than 2,5 mm, measured at the tread surface.

8.3.2.2 The ends of the combs shall be rounded off and so shaped as to minimize the risk of trapping between combs and steps, pallets or belt. The radius of the teeth end shall be not greater than 2 mm.

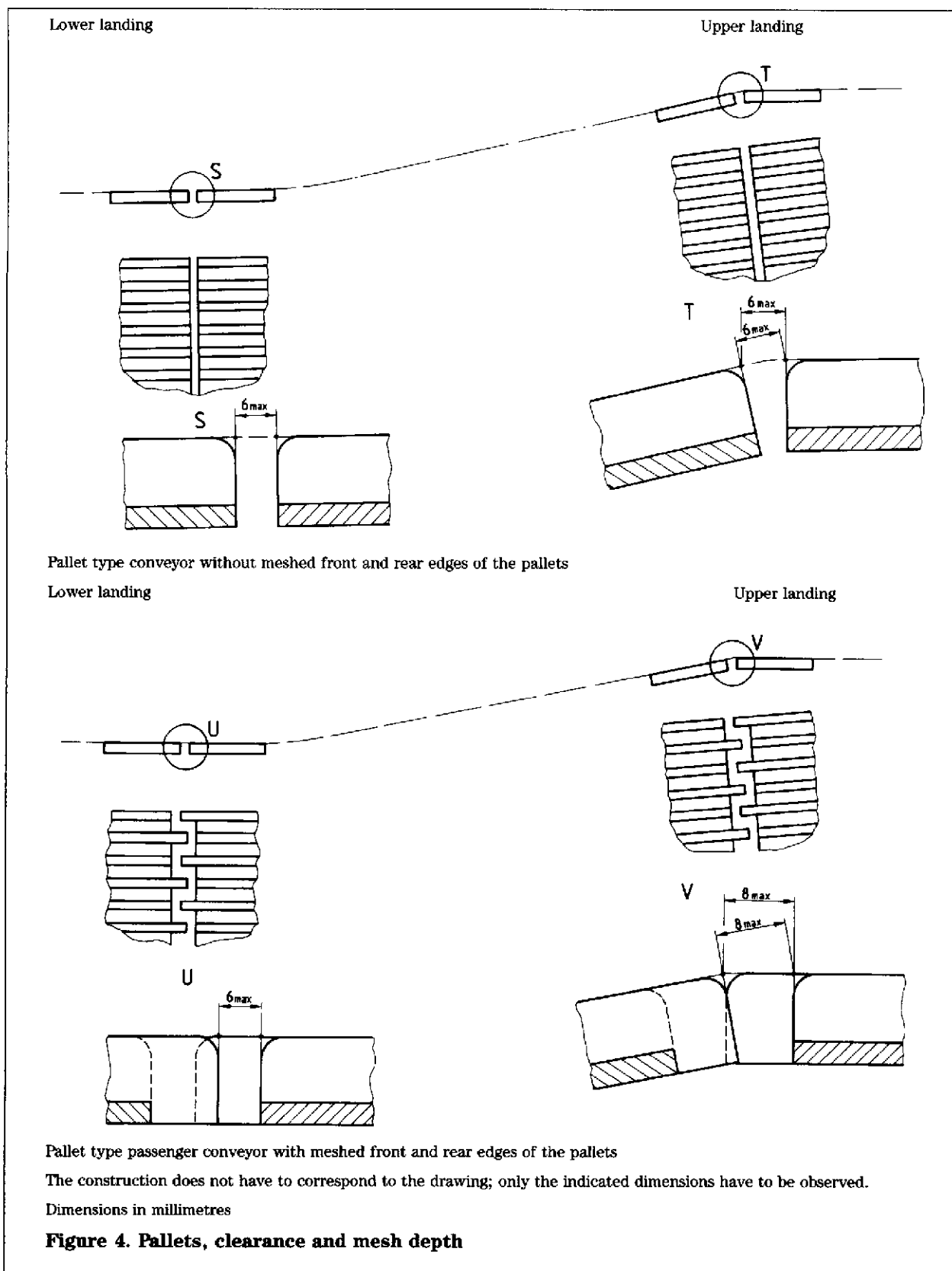
8.3.2.3 The teeth of the comb shall have a form and inclination so that the feet of passengers, leaving the escalator or passenger conveyor, will not stub against them. The design angle β shown in figure 1, detail X, shall not exceed 40° .

8.3.2.4 The combs or their supporting structure shall be readjustable, to ensure correct meshing. The combs shall be easily replaceable.

8.3.2.5 On escalators and pallet passenger conveyors, the combs shall be rigid and have such a design that upon trapping of foreign bodies either their teeth deflect and remain in mesh with the grooves of the steps or pallets, or they break.

On belt passenger conveyors, the combs shall be rigid. Upon trapping of foreign bodies the belt webs are permitted to deflect; however, the comb teeth shall remain in mesh with the grooves.

8.3.2.6 In the case of objects being trapped which are not dealt with by the means described in **8.3.2.5** and that give rise to a risk of damaging the steps, pallets, belt or comb-supporting structure, the escalator or passenger conveyor shall be stopped (see **14.2.2.4.1i**).



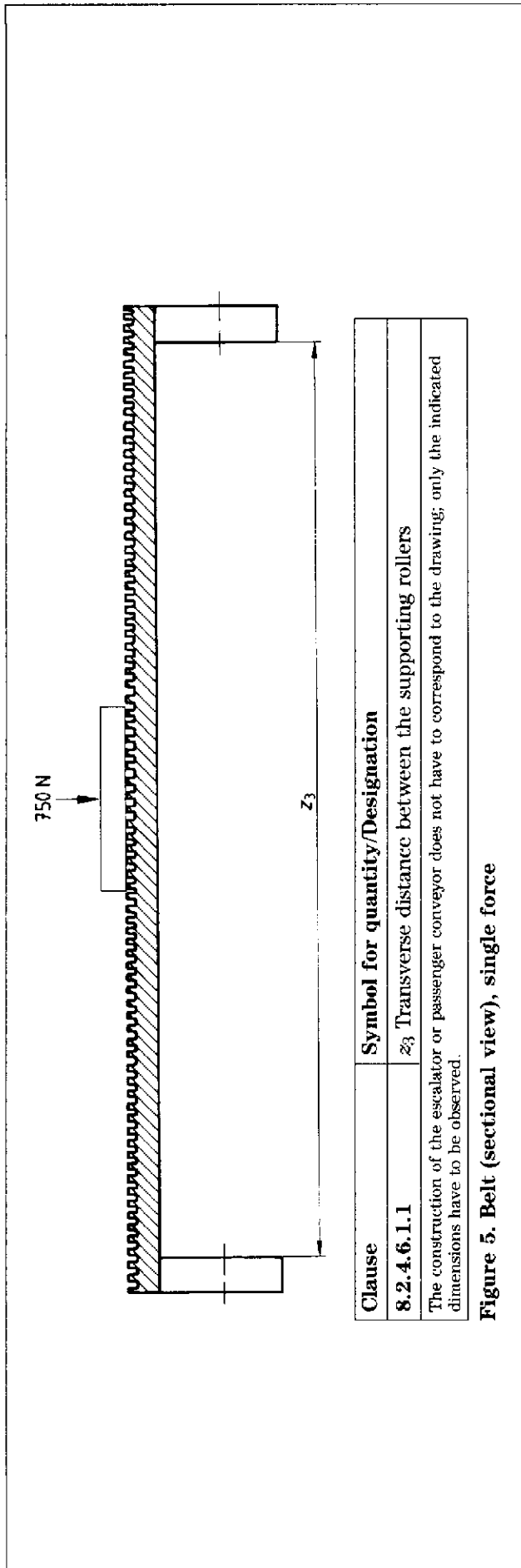


Figure 5. Belt (sectional view), single force

9 Drive for steps, pallets or belt

9.1 Chain drive for the steps and pallets

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

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

9.1.2 The factor of safety of each chain shall be at least 5.

This factor is determined as the ratio between the breaking strength of the chain and the static force to which the chain is subjected when the escalator or passenger conveyor carries the passenger weight according to 5.3 together with the tension force of the tensioning device.

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

9.1.3 The chains shall be tensioned continuously and automatically. Tension springs as a tensioning device are not permitted. When weights are used for tensioning they shall be safely caught should their suspension break.

9.2 Drum drive for the belt

9.2.1 The factor of safety of the belt, including splicing, shall be at least 5.

This factor is determined as the ratio between the breaking strength of the belt and the static force to which the belt is subjected when the passenger conveyor carries the passenger weight according to 5.3 together with the tension force of the tensioning device.

9.2.2 The belt shall be driven by drums and be tensioned continuously and automatically. Tension springs as a tensioning device are not permitted. When weights are used for tensioning they shall be safely caught should their suspension break.

9.3 Other methods of driving steps, pallets or belt

Other methods of driving are permitted if safety and operation are at least equal to those required in 9.1 and 9.2.

10 Angle of inclination of the escalator and passenger conveyor and guiding of the steps, pallets and belt

10.1 Angle of inclination and position of the steps

10.1.1 The angle of inclination α of the escalator shall not exceed 30° , but for rises not exceeding 6 m and a rated speed not exceeding 0,50 m/s the angle of inclination is permitted to be increased up to 35° (see α in figure 1).

The angle of inclination of passenger conveyors shall not exceed 12° .

10.1.2 The step treads shall be approximately horizontal in the usable area of the escalator.

10.1.3 At the landings, the steps of the escalator shall be guided in such a way that the front edges of the steps leaving the comb and the rear edges of the steps entering the comb are moving horizontally for a length of at least 0,80 m measured from point L_1 (see figure 1 and detail X).

A vertical difference in level between two consecutive steps of 4 mm maximum is permitted.

At rated speeds above 0,50 m/s or rises above 6 m, this length shall be at least 1,20 m, measured from point L_1 (see figure 1 and detail X).

NOTE. Additional recommendations to 10.1.3 for public service escalators are given in annex D (informative).

10.1.4 For escalators, the radius of curvature in the upper transition from incline to horizontal shall be:

- at least 1,00 m for rated speeds $v \leq 0,5$ m/s;
- at least 1,50 m for rated speeds $v > 0,5$ m/s.

The radius of curvature in the lower transition from incline to horizontal of the escalator shall be at least 1,00 m, irrespective of the rated speed.

NOTE. Additional recommendations to 10.1.4 for public service escalators are given in annex D (informative).

10.1.5 For belt passenger conveyors, the radius of curvature in the transition from incline to horizontal shall be at least 0,40 m.

For pallet passenger conveyors, it is not necessary to determine the radius of curvature because, on account of the maximum permissible distance between two consecutive pallets (see 11.1), it will always be sufficiently large.

10.1.6 At the upper landings of passenger conveyors with an inclination of more than 6° , the pallets or belt shall move for a length of at least 0,40 m at a maximum angle of 6° before entering or leaving the comb.

Analogous to **10.1.3**, for pallet passenger conveyors the movement is specified as follows.

The front edge of the pallet leaving the comb and the rear edge of the pallet entering the comb shall move, without changing the degree of angle, over at least 0,40 m.

10.2 Guiding of steps, pallets and belt

10.2.1 Provisions shall be made to limit the displacement of the steps or pallets out of their guiding system should a driving device (according to clause 9) become defective, and to prevent the belt from leaving its guideway should the belt break.

This requirement applies only to the usable area of the escalator or passenger conveyor.

10.2.2 Provisions shall be made in the area of the combs to ensure the correct meshing of the comb teeth with the grooves of the tread surface.

The belt shall be supported in this area in a suitable manner, e.g. by drums, rollers, sliding plates.

11 Clearance between steps or pallets and between steps, pallets or belt and skirting

11.1 Clearance between steps or pallets

The clearance between two consecutive steps (see also **8.2.5**) or pallets in any usable position, measured at the tread surface, shall not exceed 6 mm (see figure 1, details Y, Z, and figure 4 except detail V).

In the area of the transition curves of passenger conveyors with meshed front edges and rear edges of the pallets, this clearance is permitted to be increased to 8 mm (see figure 4, detail V).

11.2 Clearance between steps, pallets or belt and skirting

11.2.1 Where the skirting of escalators or passenger conveyors is placed beside the steps and pallets or the belt, the horizontal clearance shall not exceed 4 mm at either side, and 7 mm for the sum of clearances measured at both sides at two directly opposite points.

11.2.2 Where the skirting of passenger conveyors finishes above the pallets or the belt, the clearance shall not exceed 4 mm measured vertically from the tread surface. Oscillating motion of the pallets or the belt in a lateral direction shall not cause a gap between the sides of the pallets or the belt and the vertical projection of the skirting.

11.3 Mesh depth of the combs into the grooves of the step or pallet tread

11.3.1 The mesh depth h_8 of the combs into the grooves of the tread (see figure 1, detail X) shall be at least 6 mm.

11.3.2 The clearance h_8 (see figure 1, detail X) shall not exceed 4 mm.

11.4 Mesh depth of the combs into the grooves of the belt

11.4.1 The mesh depth h_8 of the combs into the grooves of the belt (see figure 1, detail X) shall be at least 4 mm.

11.4.2 The clearance h_8 (see figure 1, detail X) shall not exceed 4 mm.

12 Driving machine

12.1 General

Each escalator and each passenger conveyor shall be driven by at least one machine of its own.

12.2 Speed

12.2.1 The rated 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° .

12.2.2 The rated speed of passenger conveyors shall not exceed 0,75 m/s.

12.2.2.1 Contrary to **12.2.2**, passenger conveyors are permitted to have a maximum rated speed of 0,90 m/s provided that the width of the pallets or the belt does not exceed 1,10 m, and that, contrary to **10.1.6**, at the landings, the pallets or the belt move horizontally for a length of at least 1,60 m before entering the combs.

12.2.2.2 **12.2.2** and **12.2.2.1** do not apply to passenger conveyors with acceleration paths or passenger conveyor systems with direct transition to passenger conveyors travelling at different speeds.

12.2.3 At rated frequency and at rated voltage, the speed, measured under no load in the direction of movement of the steps and pallets or the belt, is permitted to deviate from the rated speed by a maximum of $\pm 5\%$.

12.3 Link between operational brake and step, pallet or belt drive according to clause 9

12.3.1 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 such as trapezoidal belts are used (flat belts are not permitted), an auxiliary brake in accordance with 12.6 shall be used.

12.3.2 All driving elements shall be sufficiently dimensioned. In accordance with 9.1.2 and 9.2.1, the factor of safety for chains, belts and trapezoidal belts shall be at least 5, whereby in the case of trapezoidal belts at least 3 belts shall be applied.

12.4 Braking system

12.4.1 Escalators and passenger conveyors shall have a braking system by means of which they can be brought to rest with a largely uniform deceleration and maintained stationary (operational braking); see also 14.1.2.1.6 and 14.1.2.4. There shall be no intentional delay in the application of the braking system.

12.4.1.1 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.

12.4.1.2 Operational braking is permitted to 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 12.6 shall be provided.

12.4.2 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) or by weight(s). Self-excitation of the brake releasing device shall be impossible.

The interruption of the electricity supply shall be effected by at least two independent electrical devices. They can be those which break the supply to the machine. If, after the stopping of the escalator or passenger conveyor, one of these electrical devices has not opened, restarting shall be impossible.

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

12.4.4 Brake load and stopping distances for operational brake

12.4.4.1 Determination of brake load for escalators

Per step and at a nominal width z_1 of

up to 0,6 m	60 kg
more than 0,6 m up to 0,8 m	90 kg
more than 0,8 m up to 1,1 m	120 kg

shall be applied.

The number of steps to be considered is determined by 'rise divided by maximal visible height of the step riser' (see x_1 in figure 3).

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.

12.4.4.2 Stopping distances of the escalator

The stopping distances for unloaded and downward moving loaded escalators (see 12.4.4.1) shall be between the following values.

Rated speed m/s	Stopping distance between m	
	Minimum	Maximum
0,50	0,20	1,00
0,65	0,30	1,30
0,75	0,35	1,50

For intermediate speeds, the stopping distances are to be interpolated.

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

12.4.4.3 Determination of the brake load for designing the brake for passenger conveyors

Per 0,4 m length and at a nominal width z_1 of the pallets or the belt of

up to 0,6 m	50 kg
more than 0,6 m up to 0,8 m	75 kg
more than 0,8 m up to 1,1 m	100 kg

shall be applied.

In the case where passenger conveyors with an angle of inclination of up to 6° have nominal widths larger than 1,1 m, another 25 kg per 0,4 m length shall be applied for each additional 0,3 m width.

To determine the brake load for passenger conveyors which in their length overcome several inclinations (differences in level), only those horizontal and inclined sections which taken together give the most unfavourable load, shall be considered.

12.4.4.4 Stopping distances for passenger conveyors

The stopping distances for unloaded and horizontally or downward moving loaded passenger conveyors (see 12.4.4.3) shall be between the following values.

Rated speed m/s	Stopping distance between m	
	Minimum	Maximum
0,50	0,20	1,00
0,65	0,30	1,30
0,75	0,35	1,50
0,90	0,40	1,70

For intermediate speeds, the stopping distances are to be interpolated.

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

For passenger conveyors, a brake test under no load will be sufficient.

For loaded passenger conveyors, the manufacturer shall prove the stopping distances by calculation (see 16.2.1.1.c).

12.5 Protection against risks of overspeed and unintentional reversal of the direction of travel

12.5.1 Escalators and passenger conveyors shall be equipped in such a way that they stop automatically before the speed exceeds a value of 1,2 times the rated speed (see 14.2.2.4.1e).

Where speed control devices are used for this purpose they shall have switched off the escalator or passenger conveyor before the speed exceeds a value of 1,2 times the rated speed.

It is permissible to disregard this requirement in the case of a.c. motors which have a non-friction connection with the drive for the steps, pallets or the belt, and which have a slip not exceeding 10 %, if thereby overspeed is prevented.

12.5.2 Escalators and inclined passenger conveyors shall be equipped in such a way that they stop automatically by the time the steps and pallets or the belt change from the preset direction of travel (see 14.2.2.4.1e).

12.6 Auxiliary brake for the non-friction part of the driving system for steps and pallets or the belt

12.6.1 Escalators and inclined passenger conveyors shall be equipped with auxiliary brake(s) acting immediately on the non-friction part of the driving system for the steps, pallets or the belt (one single chain is not considered to be a non-friction part), if:

- a) the coupling of the operational brake (see 12.4) and the driving wheels of the steps, pallets or the belt is not accomplished by shafts, gear wheels, multiplex chains, or two or more single chains; or
- b) the operational brake is not an electro-mechanical brake according to 12.4.2; or
- c) the rise exceeds 6 m.

NOTE. Additional recommendations to 12.6.1 for public service escalators and public service passenger conveyors are given in annex D (informative).

12.6.2 The auxiliary brake shall be dimensioned in such a way that escalators and passenger conveyors travelling with brake load downward are brought to rest by effective retardation and maintained stationary.

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

12.6.4 The auxiliary brake shall become effective in either of the following conditions:

- a) before the speed exceeds a value of 1,4 times the rated 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. It is not necessary that this device is operated electrically such as is the operational brake mentioned in 12.4.2.

12.6.5 Auxiliary brakes 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 distances according to 12.4.4.2 and 12.4.4.4 are kept; otherwise a simultaneous operation of the two brakes is only permitted under the conditions of 12.6.4.

12.6.6 Upon operation of the auxiliary brake it is not necessary to keep the stopping distances defined for the operational brake (see 12.4.4).

12.7 Hand winding device

If a hand winding device is provided it shall be easily accessible and safe to operate (see 15.1.3).

If the hand winding device is placed outside machinery spaces, driving and return stations, it shall not be accessible to unauthorized persons.

Crank handles or perforate hand wheels are not permitted.

12.8 Stopping the machine and checking its stopped position

Stopping the escalator or passenger conveyor by means of the electrical safety devices according to 14.1.2 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 passenger conveyor is stopped, one of the main contacts of one of the contactors has not opened, restarting shall be impossible.

12.9 Protection in driving stations and/or return stations

According to clause 4 of EN 292-2 : 1991, effective protection shall be provided for rotating parts if they are accessible and dangerous, in particular for:

- a) keys and screws in shafts;
- b) tapes, chains, belts;
- c) gears, gear wheels, sprockets;
- d) projecting motor shafts;
- e) speed governors not enclosed;
- f) step and pallet reversal in driving stations and/or return stations if these must be entered for maintenance purposes.

SPECIFIC CASES. Handwheels, brake drums and similar smooth round parts. Such parts shall be painted yellow, at least in part.

13 Electrical installations and appliances

13.1 General

The electrical installation of escalators or passenger conveyors shall be so designed and manufactured as to ensure protection against hazards arising from the electrical equipment or which may be caused by external influences on it, provided that the equipment is used in applications for which it was made and is adequately maintained.

Therefore, the electrical equipment shall:

- a) comply with the requirements stated in the CENELEC harmonized standards;
- b) where no harmonized standards as referred to in a) exist, comply with the requirements of the International Electrotechnical Commission (IEC), which are stated in the CENELEC harmonized documents;

c) where no documents as referred to in a) and b) exist, comply with the requirements of the national rules of the producer's country, comparable to those of the country where it is installed;

d) where no documents as referred to in a) to c) exist, comply with the requirements of the national rules of the country where it is installed.

13.1.1 Limits of application

13.1.1.1 The requirements of this standard relating to the installation and to the constituent components of the electrical equipment apply:

- a) to the main switch of the power circuit of the escalator or passenger conveyor and dependent circuits;
- b) to the switch for the lighting circuit of the escalator or passenger conveyor and dependent circuits.

The escalator or passenger conveyor shall be considered as a whole, in the same way as a machine with its incorporated apparatus.

13.1.1.2 The electricity supply to the input terminals of the switches referred to in 13.1.1.1 and the electricity supply to the lighting of the machinery spaces, driving and return stations are not laid down by this standard.

13.1.2 In separate machinery spaces and separate driving and return stations (according to 6.3.1.3), protection against direct contact by means of enclosures providing a degree of protection of at least IP 2X is necessary.

13.1.3 The resistance of the insulation between conductors, and between conductors and earth, shall be greater than 1000 Ω/V with a minimum of ³⁾:

- a) 500 000 Ω for power circuits and electrical safety device circuits;
- b) 250 000 Ω for other circuits (controls, lighting, signalling, etc.).

13.1.4 For control and safety circuits, the mean value in direct current, or the r.m.s. value in alternating current, between conductors or between conductors and earth, shall not exceed 250 V.

13.1.5 The neutral conductor and the earth-continuity conductor shall be in accordance with CENELEC HD 384.

³⁾ These values are provisional and will be aligned later with those accepted by CENELEC/TC 64.

13.2 Contactors, relay contactors, components of electrical safety circuits**13.2.1 Contactors and relay contactors**

13.2.1.1 To stop the machine (see 14.1.2.4), the main contactors shall belong to the following categories as defined in EN 60947-4-1 : 1992:

- a) AC-3 for contactors of alternating-current motors;
- b) DC-3 for contactors of direct-current machines.

13.2.1.2 Relay contactors (see 14.1.2.4) shall belong to the following categories as defined in EN 60947-5-1 : 1991:

- a) AC-15 for contactors in alternating-current control circuits;
- b) DC-13 for contactors in direct-current control circuits.

13.2.1.3 For both the main contactors (see 13.2.1.1) and the relay contactors (see 13.2.1.2), it is permissible to assume, in the measures taken to comply with 14.1.1.1, that:

- a) if one of the break contacts (normally closed) is closed, all the make contacts are open;
- b) if one of the make contacts (normally open) is closed, all the break contacts are open.

13.2.2 Components of electrical safety circuits

13.2.2.1 When devices according to 13.2.1.2 are used as relays in a safety circuit, the assumptions of 13.2.1.3 also apply.

13.2.2.2 If the relays used, are such that the break and make contacts are never closed simultaneously for any position of the armature, the possibility of partial attraction of the armature is permitted to be disregarded (see 14.1.1.1f).

13.2.2.3 Devices connected after electrical safety devices shall meet the requirements of 14.1.2.2.2 with regard to the creep distances and air gaps (not with regard to the separation distances).

This requirement does not apply to the devices mentioned in 13.2.1.1, 13.2.1.2 and 13.2.1.3.

13.3 Protection of motors

13.3.1 Motors directly connected to the mains shall be protected against short-circuiting.

13.3.2 Motors directly connected to the mains shall be protected against overload by means of automatic circuit breakers with manual reset (except as provided for in 13.3.3) which shall cut off the supply to the motor in all live conductors (see EN 60947-4-1).

13.3.3 When the detection of overload operates on the basis of temperature increase in the windings of the motor, the circuit breaker is permitted to close automatically after sufficient cooling down has taken place; however, it shall only be possible to restart the escalator or passenger conveyor under the conditions of 14.2.1.

13.3.4 The provisions of 13.3.2 and 13.3.3 apply to each winding if the motor has windings supplied by different circuits.

13.3.5 When the escalator or passenger conveyor driving motors are supplied by d.c. generators driven by motors, the generator driving motors shall also be protected against overload.

13.4 Main switches

13.4.1 In the vicinity of the machine or in the return stations, or in the vicinity of the control devices, there shall be a main switch capable of breaking the supply to the motor, to the brake releasing device and to the control circuit in the live conductors.

This switch shall not cut the supply to the socket outlets or to the lighting circuits necessary for inspection and maintenance.

When separate supplies are provided for auxiliary equipment such as heating, balustrade lighting and comb lighting, it shall be possible to switch them off independently. The corresponding switches shall be located close to the main switch and be marked unambiguously.

13.4.2 The main switches as defined in 13.4.1 shall be capable of being locked or otherwise secured in the 'isolated' position, with the use of a padlock or equivalent, to ensure no inadvertent operation by others (see 5.2 of prEN 1037 : 1994). The control mechanism of the main switch shall be easily and rapidly accessible after opening of the doors or trap doors.

13.4.3 Main switches shall be capable of interrupting the highest current involved in normal operating conditions of the escalator or passenger conveyor. They shall have a breaking capacity corresponding to category AC-3 as defined in EN 60947-4-1 : 1992.

13.4.4 When main switches for several escalators or passenger conveyors are arranged in one machinery space, it shall be possible to identify easily to which escalator or passenger conveyor they refer.

13.5 Electrical wiring

13.5.1 Cables shall be selected from those standardized by CENELEC and be of a quality at least equivalent to that defined by CENELEC HD 21 and HD 22.

13.5.1.1 Conductors such as those in conformity with CENELEC HD 21.3 S2, Part 2 (HO7V-U and HO7V-R), Part 3 (HO7V-K), Part 4 (HO5V-U) and Part 5 (HO5V-K) are permitted only in conduits, ducting, or similar fittings ensuring equivalent protection. When deviating from CENELEC HD 21.3 S2, the nominal cross-sectional area of the conductors shall be not less than 0,75 mm².

NOTE. These requirements replace those in the guide to use appearing in annex 1 of CENELEC HD 21.1 S2.

13.5.1.2 Rigid cables, such as those in conformity with Part 2 of CENELEC HD 21.4 S2, are permitted only in visible mountings fixed to the walls, or in conduits, ducting or similar fittings.

13.5.1.3 Ordinary flexible cables, such as those in conformity with Part 3 (HO5RR-F) of CENELEC HD 22.4 S2 and Part 5 (HO5VV-F) of CENELEC HD 21.5 S2, are permitted only in conduits, ducting or similar fittings ensuring equivalent protection.

Flexible cables with a thick sheath, such as those in conformity with Part 5 of CENELEC HD 22.4 S2, are permitted to be installed rigidly in the conditions defined in 13.5.1.2 and for connection to a movable appliance, or if they are subject to vibrations.

13.5.1.4 The requirements of 13.5.1.1, 13.5.1.2 and 13.5.1.3 need not apply to the wiring of control or distribution devices in control cabinets or on control panels, either:

- a) between different pieces of electrical equipment; or
- b) between these pieces of equipment and the connection terminals.

In these instances the requirements in 7.8 of EN 60439-1 : 1994 apply.

13.5.2 Cross-sectional area of conductors

The nominal cross-sectional area of the conductors of electrical safety circuits shall be not less than 0,75 mm².

13.5.3 Method of installation

13.5.3.1 The electrical installation shall be provided with the indications necessary to make it easy to understand.

13.5.3.2 Connections, connection terminals and connectors, except those defined in 13.1.2, shall be located in control cabinets, control boxes or on panels provided for this purpose.

13.5.3.3 If, after the opening of the main switch or switches of the escalator or passenger conveyor, some connection terminals remain live, they shall be clearly separated from terminals which are not live; if the voltage exceeds 50 V, they shall be suitably marked.

13.5.3.4 In order to ensure continuity of mechanical protection, the protective enclosures of cables shall enter the casings of switches and appliances, or shall have proper glands at their ends.

13.5.3.5 If the same conduit or cable contains conductors the circuits of which have different voltages, all cables shall have the insulation specified for the highest voltage.

13.5.4 Connectors

Connectors and devices of the plug-in type which are placed in safety circuits and which can be extracted without the use of a tool, shall be designed in such a way that it is impossible to re-insert them incorrectly.

13.6 Socket outlets

13.6.1 The supply to the socket outlets shall be independent of the supply to the machine, and it shall be possible to break the supply of all phases by means of a separate switch.

13.6.2 Socket outlets shall be either:

- a) of type 2 P+T (2 poles + earth conductor), 250 V, directly supplied by the mains; or
- b) of a type that is supplied at a safety extra-low voltage in accordance with CENELEC HD 384.4.41 S1, subclause 411.

13.7 Connecting terminals

Connection terminals, accidental interconnection of which could lead to a dangerous malfunction of the escalator or passenger conveyor, shall be clearly separated.

14 Protection against electrical faults — controls

14.1 Protection against electrical faults

14.1.1 General

Any one of the faults envisaged in 14.1.1.1 in the electrical equipment of the escalator or passenger conveyor; if it cannot be excluded under conditions described in 14.1.1.2 and/or annex A (normative), shall not on its own be the cause of a dangerous malfunction of the escalator or passenger conveyor.

14.1.1.1 Faults envisaged:

- a) absence of voltage;
- b) voltage drop;
- c) loss of continuity of a conductor;
- d) fault to earth of a circuit;
- e) short circuit or open circuit, change of value or function in an electrical component such as a resistor, capacitor, transistor, lamp;
- f) non-attraction or incomplete attraction of the moving armature of a contactor or relay;
- g) non-separation of the moving armature of a contactor or relay;
- h) non-opening of a contact;
- i) non-closing of a contact.

14.1.1.2 The non-opening of a contact need not be considered in the case of safety contacts conforming to 14.1.2.2.

14.1.1.3 The fault to earth of a circuit⁴⁾ in which there is an electrical safety device shall cause the immediate stopping of the driving machine. The return to service shall not be possible except by an authorized person.

14.1.2 Electrical safety devices

14.1.2.1 General requirements

14.1.2.1.1 The operation of an electrical safety device for any of the events 14.2.2.4.1b to 14.2.2.4.1m shall prevent the driving machine from starting or cause the immediate stopping of the driving machine according to 14.1.2.4.

The electrical safety devices shall consist of either:

- a) one or more safety contacts satisfying 14.1.2.2, directly disconnecting the supply to the contactors or their relay contactors; or
- b) safety circuits satisfying 14.1.2.3, consisting of either:
 - 1) one or more safety contacts satisfying 14.1.2.2, not directly disconnecting the supply to the contactors or their relay contactors; or
 - 2) contacts not satisfying the requirements of 14.1.2.2; or
 - 3) other components in accordance with the requirements of annex A (normative).

14.1.2.1.2 No electrical equipment shall be connected in parallel to electrical safety devices.

14.1.2.1.3 The effects of internal or external inductance or capacitance shall not cause failures of electrical safety circuits.

14.1.2.1.4 An output signal emanating from an electrical safety circuit shall not be altered by an extraneous signal emanating from another electrical device placed further down the same circuit, which would cause a dangerous condition.

14.1.2.1.5 In safety circuits comprising two or more parallel channels, all information other than that required for the functioning of the safety circuit shall be taken from one channel only.

14.1.2.1.6 Circuits which record or delay calls shall not, even in event of fault, prevent or intentionally delay the stopping of the driving machine through the functioning of an electrical safety device.

14.1.2.1.7 The construction and arrangement of the internal power supply units shall be such as to prevent the appearance of false signals at the outputs of electrical safety devices due to the effects of switching. In particular, voltage peaks arising from the operation of the escalator or passenger conveyor or other equipment on the network shall not create inadmissible disturbances in electronic components (noise immunity).

14.1.2.2 Safety contacts

14.1.2.2.1 The operation of a safety contact shall be by positive mechanical separation of the circuit breaking devices. This positive mechanical separation shall occur even if the contacts are welded together.

Positive mechanical separation is achieved when all the contact-breaking elements are brought to their open position in such a way that for a significant part of the travel there are no resilient elements (e.g. springs) between the moving contacts and the part of the actuator to which the actuating force is applied.

The design shall be such as to minimize the risk of a short circuit resulting from a faulty component.

14.1.2.2.2 The safety contacts shall be provided for a rated insulation voltage of 250 V if the enclosure provides a degree of protection of at least IP 4X (in accordance with EN 60529 : 1991), or 500 V if the degree of protection of the enclosure is less than IP 4X.

Safety contacts shall belong to the following categories as defined in EN 60947-5-1 : 1991:

- a) AC-15 for safety contacts in alternating-current circuits;
- b) DC-13 for safety contacts in direct-current circuits.

⁴⁾ 'fault to earth of a circuit' equals 'Masse- oder Erdschluß in einem Schaltkreis' in German and 'défaut d'isolement par rapport à la masse ou à la terre dans un circuit' in French.

14.1.2.2.3 If the protective enclosure is not at least of type IP 4X, the air gaps shall be at least 3 mm and creep distances at least 4 mm. The distances for breaking contacts shall be at least 4 mm after separation.

14.1.2.2.4 In the case of multiple breaks, the individual distances for breaking contacts shall be at least 2 mm after separation.

14.1.2.2.5 Debris from the conductive material shall not lead to short-circuiting of contacts.

14.1.2.3 Safety circuits

14.1.2.3.1 Any one of the faults envisaged in 14.1.1. shall not on its own be the cause of a dangerous situation.

14.1.2.3.2 Furthermore, the following conditions apply for the faults envisaged in 14.1.1:

If one fault combined with a second fault can lead to a dangerous situation, the escalator or passenger conveyor shall be stopped by the time the next operating sequence takes place in which the faulty element should participate.

The possibility of the second fault leading to a dangerous situation before the escalator or passenger conveyor has been stopped by the sequence mentioned, is not considered.

If the malfunction of the component which has caused the first fault cannot be detected by a change of state, appropriate measures shall ensure that the fault is detected and movement prevented at the latest when the escalator or passenger conveyor is restarted according to 14.2.4.

The MTBF (mean time between failures) of the safety circuit shall be at least 2,5 years. This time was determined under the assumption that within a period of 3 months each escalator or each passenger conveyor is restarted according to 14.2.4 at least once and, thus, is subject to a change of state.

14.1.2.3.3 If two faults combined with a third fault can lead to a dangerous situation, the escalator or passenger conveyor shall be stopped by the time the next operating sequence takes place in which one of the faulty elements should participate.

The possibility of the third fault leading to a dangerous situation before the escalator or passenger conveyor has been stopped by the sequence mentioned, is not considered.

If the malfunction of the components which have caused the two faults cannot be detected by a change of state, appropriate measures shall ensure that the faults are detected and movement is prevented at the latest when the escalator or passenger conveyor is restarted according to 14.2.4.

The MTBF (mean time between failures) of the safety circuit shall be at least 2,5 years. This time was determined under the assumption that within a period of 3 months each escalator or each passenger conveyor is restarted according to 14.2.4 at least once and, thus, is subject to a change of state.

14.1.2.3.4 A combination of more than three faults can be disregarded if:

- a) the safety circuit is built-up of at least two channels, and their equal status is monitored by a control circuit. The control circuit shall be checked prior to a restart of the escalator or passenger conveyor according to 14.2.4 (see also annex B (normative)); or
- b) the safety circuit is built-up of at least three channels, and their equal status is monitored by a control circuit.

If the requirements of a) or b) are not fulfilled, it is not permitted to interrupt the failure analysis, which shall be continued analogous to 14.1.2.3.3.

14.1.2.4 Operation of electrical safety devices

When operated, an electrical safety device shall prevent the setting in motion of the driving machine, or immediately initiate its stopping. The operational brake shall be applied.

Electrical safety devices shall act directly on the equipment controlling the supply to the driving machine.

If, because of the power to be transmitted, relay contactors are used to control the driving machine, these shall be considered as equipment directly controlling the supply to the driving machine for starting and stopping.

14.1.2.5 Control of electrical safety devices

The components controlling the electrical safety devices shall be selected and assembled so that they are able to function properly even under the mechanical stresses resulting from continuous operation.

In the case of redundancy-type safety circuits, it shall be ensured by mechanical or geometric arrangements of the transmitter elements that a mechanical fault cannot cause unnoticed loss of redundancy.

Transmitter elements of safety circuits shall withstand the requirements of:

A.6.1 of prEN 60068-2-6 : 1994:

Endurance by sweeping: table C.2:

- 20 sweep cycles in each axis;
- at amplitude 0,35 mm or $5g_n$; and
- in the frequency range 10 Hz to 55 Hz;

and also of:

4.1 of EN 60068-2-27 : 1993:

Acceleration and duration of pulse: table 1: the combination of:

- peak acceleration 294 m/s^2 or $30g_n$;
- corresponding duration of pulse 11 ms; and
- corresponding velocity change 2,1 m/s half-sine.

NOTE. Where shock absorbers are used for the transmitter elements, they shall be considered as part of the transmitter elements.

14.2 Controls

14.2.1 Starting and making available for use the escalator or passenger conveyor

Starting of the escalator or passenger conveyor (or making it available for use when starting is automatic by a user passing a certain point) shall be effected by one or more switches available to authorized persons only (e.g. key-operated switches, switches with detachable lever, lockable protective caps for switches). Such switches shall not function concurrently as main switches described in 13.4. The person who operates the switch shall either be able to see the entire escalator or entire passenger conveyor or shall have means of ensuring that nobody is using the escalator or passenger conveyor before making this operation. The direction of travel shall be distinctly recognizable from the indication on the switch.

14.2.1.1 Escalators or passenger conveyors which start automatically by the passing of a user shall start to move before the person walking reaches the comb intersection line.

This is, for instance, accomplished by:

- a) lightrays, if they are arranged at least 1,30 m before the comb intersection line (see L_2 in figure 1, detail X);
- b) contact mats, if the outer edge of the contact mat is arranged at least 1,80 m before the comb intersection line. The length of the contact mat

in the direction of travel shall be at least 0,85 m. Contact mats reacting to weight shall respond before the load reaches 150 N, applied to a surface of 25 cm^2 at any point.

Constructional measures shall discourage circumvention of the control elements.

14.2.1.2 On escalators or passenger conveyors which start automatically by the passing of a user, the direction of travel shall be predetermined, clearly visible and marked distinctly (see 15.2).

In such cases, where escalators or passenger conveyors which start automatically by the passing of a user can be entered in the direction opposite to their predetermined direction of travel, they shall start in the predetermined direction and conform to the requirements of 14.2.1.1. The running time shall be not less than 10 s.

14.2.2 Stopping

All stopping devices shall act by interrupting current and not by the completion of a circuit of a relay.

14.2.2.1 Stopping, not automatically operated

Before stopping, the person who operates the switch shall have means of ensuring that nobody is using the escalator or passenger conveyor, before making this operation.

14.2.2.2 Stopping, automatically operated

It is permitted to design the control in such a way that the escalator or passenger conveyor is stopped automatically after a sufficient time (at least the anticipated passenger transfer time plus 10 s) after the passenger has actuated a control element described in 14.2.1.1.

14.2.2.3 Emergency stopping, not automatically operated

14.2.2.3.1 Emergency stop devices shall be placed in conspicuous and easily accessible positions at or near to the landings of the escalator or passenger conveyor (see 15.1.2.2).

For escalators with rises above 12 m, additional emergency stop devices shall be provided.

For passenger conveyors with a length of the treadway of more than 40 m, additional emergency stop devices shall be provided.

The distances to and between the additional emergency stop devices shall not exceed:

- 15 m on escalators;
- 40 m on passenger conveyors.

14.2.2.3.2 The emergency stop devices shall be safety contacts according to 14.1.2.2.

14.2.2.4 *Emergency stopping, automatically operated*

14.2.2.4.1 The escalator or passenger conveyor shall stop automatically in case of:

- a) absence of control voltage;
- b) fault to earth of a circuit (according to 14.1.1.3);
- c) overload (according to 13.3.2);
- d) overload (according to 13.3.3);
- e) operation of the control devices at overspeed and unintentional reversal of the direction of travel (according to 12.5);
- f) operation of the auxiliary brake (according to 12.6.4);
- g) breakage or undue elongation of parts immediately driving the steps, pallets or the belt, e.g. chains or racks;
- h) (unintended) reduction of the distance between the driving and return devices;
- i) foreign bodies being trapped at the point where the steps, pallets or the belt enter the comb (according to 8.3.2.6);
- j) stopping of a succeeding escalator or passenger conveyor where an intermediate exit does not exist (see 5.2.1);
- k) operation of the handrail entry guard (see 7.5.3);
- l) any part of the step or pallet is sagging so that meshing of the combs is no longer ensured at the point at which the steps or pallets enter the landing (see 8.3.1). Switching off shall be operated at a sufficient distance before the comb intersection line to ensure that the step or pallet which has sagged does not reach the comb intersection line (see stopping distances defined in 12.4.4.2 and 12.4.4.4). The control device can be applied at any point of the steps or pallets.

Paragraph l) does not apply for belt passenger conveyors (see 10.2.2);

- m) for public service escalators and public service passenger conveyors:

operation of the device mentioned in 7.8, caused by a broken handrail.

14.2.2.4.2 All switching-off operations in the cases 14.2.2.4.1e to 14.2.2.4.1m shall be performed by safety contacts or safety circuits.

14.2.3 *Reversal of direction of travel*

An intended reversal of the direction of travel shall be possible only if the escalator or passenger conveyor stands still and 14.2.1, 14.2.1.1, 14.2.1.2 and 14.2.2.2 are complied with.

14.2.4 *Restarting*

14.2.4.1 *Restarting by switch*

After each stop (14.2.2.1, 14.2.2.3, 14.2.2.4), except the one mentioned in 14.2.2.2, restarting shall be possible only by means of the switches mentioned in 14.2.1 or by means of the inspection control described in 14.2.5. It shall be observed that where stopping is effected in the cases 14.2.2.4.1e, f, g and l, restarting shall be possible only after the stop device has been checked and reset to working order.

14.2.4.2 *Reactivation for automatic restart*

Where stopping is effected by an emergency stopping device according to 14.2.2.3, reactivation of the escalator or passenger conveyor for automatic restart without the switches mentioned in 14.2.1 is permitted under the following conditions.

- a) The steps, pallets or the belt shall be supervised between the comb intersection lines and additional 0,30 m beyond each comb so that reactivation for automatic restart is effected only when there is no person or object within this zone.

For the test, an opaque upright standing cylinder with a diameter of 0,30 m and a height of 0,30 m is used, which at any place within this zone shall be detected by the control device. As control devices, for instance, transmitters can be applied, placed at a distance of not more than 0,30 m in the inclined section and horizontal section and of not more than 0,20 m in the curved section.

- b) The escalator or passenger conveyor shall be started by the passing of a user according to 14.2.1.1.

Starting shall be effected only if, for a period of at least 10 s, the control device has not detected any persons or objects within the defined zone.

- c) The reactivation control for automatic restart shall be an electrical safety device according to 14.1.2. Self-controlling transmitter elements are permitted in single-channel design.

14.2.5 *Inspection control*

14.2.5.1 Escalators or passenger conveyors shall be equipped with inspection controls to permit operation during maintenance or repair or inspection by means of portable and manually operated control devices.

14.2.5.2 For this purpose, one inspection outlet for the connection of the flexible cable of the portable control device shall be provided at least at each landing, e.g. in the driving station and the return station in the truss. The length of the cable shall be at least 3,0 m. Inspection outlets shall be located in such a way that any point of the escalator or passenger conveyor can be reached with the cable.

14.2.5.3 The operating elements of this control device shall be protected against accidental operation. The escalator or passenger conveyor is permitted to run only as long as the operating elements are switched on by permanent application of manual pressure. Each control device shall have a stop switch (according to 14.1.2.2) which once having been operated shall remain in the open position. The direction of travel shall be distinctly recognizable from the indication on the switch.

14.2.5.4 When this control device is used, all other starting switches shall be rendered inoperative.

All inspection outlets shall be arranged in such a way that when more than one control device is connected, they either become inoperative or all need to be actuated at the same time to be operative. The safety switches and safety circuits (according to 14.2.2.4) shall remain effective.

15 Signs, notices for use and signals

15.1 Plates, inscriptions and notices for use

15.1.1 All signs, inscriptions and notices for use shall be of durable material, placed in a conspicuous position and written in clearly legible characters in the language of the country where the escalator or passenger conveyor is in operation, and/or pictographs shall be used (see figures 6, 7, 8).

15.1.2 Notices near the entrances of escalators or passenger conveyors

15.1.2.1 The following notices for the user shall be fixed in the vicinity:

- 'Small children must be held firmly';
- 'Dogs must be carried';
- 'Stand facing the direction of travel, keep feet away from sides';
- 'Hold the handrail'.

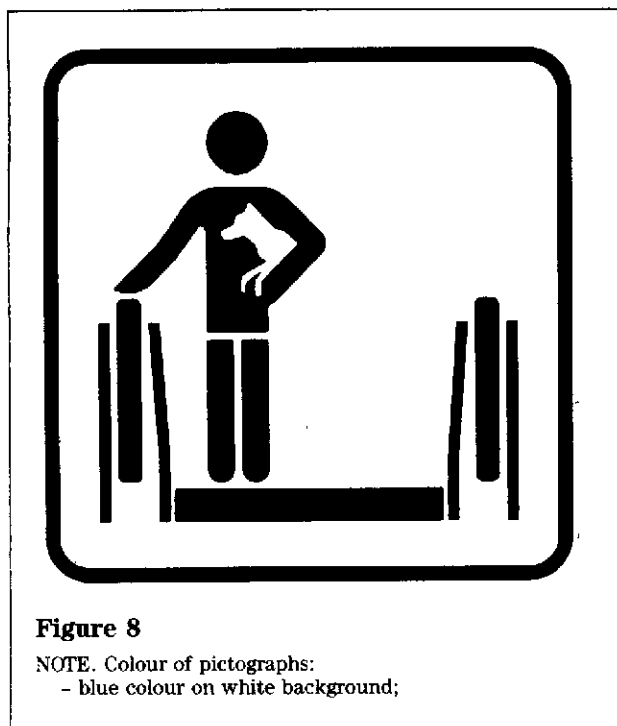


Figure 6



Figure 7

NOTE. Colour of pictographs:
- blue colour on white background;
- in figure 7, indication sign (X) in red colour.



Additional notices will possibly be necessary when required by local conditions, e.g. 'Use permitted only with footwear', 'Transportation of bulky and heavy loads not permitted', 'Transportation of pushchairs not permitted'.

Whenever possible, these notices shall be given in the form of pictographs. The minimum dimensions of the pictographs shall be 80 mm × 80 mm. Pictographs used shall be as defined in this standard.

15.1.2.2 Emergency stop devices referred to in 14.2.2.3 shall be coloured red and, either on the device itself or in its immediate vicinity, be marked with the inscription 'STOP'.

15.1.2.3 During maintenance, repair, inspection or similar work, the access to the escalator or passenger conveyor shall be barred to the user by suitable devices which shall bear the notice:

'No Access';

or the valid road traffic sign:

'No Entry';

and be available in the vicinity.

15.1.3 Instructions for hand winding devices

If a hand winding device is provided, corresponding instructions for use shall be available in the vicinity, and the direction of travel of the escalator or passenger conveyor shall be indicated clearly.

15.1.4 Notices on the access doors to machinery spaces, driving and return stations

On access doors to machinery spaces, driving and return stations, a notice shall be fixed with the inscription:

'Machinery space — danger, access prohibited to unauthorized persons'.

15.1.5 Marking of escalators and passenger conveyors

At least at one landing:

- the name and address of the manufacturer;
- the year of construction;
- the designation of series or type;
- the serial number, if any;

shall be indicated, visible from the outside.

15.2 Special notices for escalators and passenger conveyors starting automatically

In the case of escalators or passenger conveyors starting automatically, a clearly visible signal system, e.g. road traffic signals, shall be provided indicating to the user whether the escalator or passenger conveyor is available for use, and its direction of travel.

16 Instructions for use (inspection and test; register; putting into operation, maintenance and repair)

The instruction handbook drawn up by the manufacturer or his authorized representative established in the Community, should especially stress the following measures.

16.1 General

During maintenance or repair or inspection and test, precautions should be taken so that escalators and passenger conveyors cannot be set in motion without the knowledge and the consent of the person performing such work.

16.2 Inspection and test

Escalators and passenger conveyors should be inspected before their first use, after major modifications and at regular intervals.

Such inspections and tests should be made by a competent person or a representative of an organization which is accredited by the public authority.

16.2.1 First inspection and test

16.2.1.1 Preliminary check

For checking compliance with the requirements of this standard, the following documentation will be sufficient:

16.2.1.1.1 Calculation data:

- a) static stress analysis of the supporting structure of the escalator or passenger conveyor, or equivalent certificate by a static stress analyst;
- b) proof by calculation of sufficient breakage resistance of the parts immediately driving the steps, pallets or the belt, e.g. step chains, racks;
- c) calculation of the stopping distances for loaded passenger conveyors (see 12.4.4.4), together with adjustment data;
- d) proof of steps or pallets;
- e) proof of the breaking strength of the belt;
- f) for public service escalators and public service passenger conveyors:
certificate of the handrail breaking strength.

16.2.1.1.2 Layout drawings, description of the equipment and wiring diagrams (current flow chart with legend or explanations, and a terminal connection chart) which permit a check of compliance with the safety requirements specified in this standard.

16.2.1.2 *Constructional inspection and acceptance inspection and test*

The constructional inspection and acceptance inspection and test should be carried out at the jobsite on completion of the escalator or passenger conveyor.

For the constructional inspection and acceptance inspection and test, the data specified in 16.2.1.1 should be available.

The constructional inspection comprises the examination of the completed installation for conformity with the required data, and with regard to proper workmanship as specified in this standard.

The acceptance inspection and test comprises:

- a) overall visual inspection;
- b) functional test;
- c) test of safety devices with regard to their effective operation;
- d) test of the brake(s) of the escalator or passenger conveyor under no load, for compliance with the prescribed stopping distances (see 12.4.4.2 and 12.4.4.4). An examination of the brake adjustment according to the calculation required in 16.2.1.1.c is also necessary.

Additionally, for escalators, a test of the stopping distances under brake load (see 12.4.4.1) is required, unless the stopping distances can be checked by other methods;

- e) measurement of the insulation resistance of the different circuits between conductors and earth (see 13.1.3). For this measurement, the electronic components shall be disconnected;
- test of the electrical continuity of the connection between the earth terminal(s) in the driving station and the different parts of the escalator or passenger conveyor liable to be live accidentally.

16.2.2 *Inspection and test after major modifications*

A major modification is a change of the speed, of the safety devices, of the braking system, of the drive, of the control, of the step band. Wherever applicable, the principles set forth for the constructional inspection and acceptance inspection and test (16.2.1.2) should apply.

The replacement of parts by parts of the same design is not considered to be a major modification.

16.2.3 *Periodic inspection and test*

The periodic inspection and test should ascertain whether the escalator or passenger conveyor is safe in operation, and should bear on:

- a) safety devices, with regard to their effective operation;
- b) brake(s) according to 16.2.1.2d;
- c) driving elements for visible signs of wear and tear, and for insufficient tension of belts and chains;
- d) steps, pallets or the belt, for defects, true run and guidance;
- e) dimensions and tolerances specified in this standard (see 0.1.2);
- f) combs, for proper condition and adjustment;
- g) balustrade interior panelling and the skirting;
- h) handrails;
- i) test of the electrical continuity of the connection between the earth terminal(s) in the driving station and the different parts of the escalator or passenger conveyor liable to be live accidentally.

16.3 Register

16.3.1 The technical data of the escalator(s) or passenger conveyor(s) should be recorded in a register or file, drawn up by the time the escalator(s) or passenger conveyor(s) is (are) put into service. This register or file should be kept up-to-date and comprise:

- a) a technical section indicating the date the escalator(s) or passenger conveyor(s) was (were) put into service, the characteristics of the escalator(s) or passenger conveyor(s), modifications or alterations. Layout drawings and wiring diagrams shall be attached;
- b) a section where dated reports of the inspections and tests, with observations as well as records of any accidents, are kept.

16.3.2 This register or file should be available to those in charge of maintenance and to the person or organization performing the periodic inspections (the national authority can indicate, with reference to their regulations, who is responsible for the register).

16.4 Putting into operation, maintenance and repair

The manufacturer should provide instructions for putting into service, and for maintenance and repair.

Escalators and passenger conveyors should be regularly maintained by competent personnel.

NOTE. Detailed advice for maintenance and repair operations is given in a standard currently being prepared by CEN/TC 10/WG 5 when issuing this standard.

Annex A (normative)**Safety circuits — components, design and testing****A.1 Scope**

14.1 envisages a number of faults of the electric equipment of the escalator/passenger conveyor.

During the failure analysis, some faults can be excluded under certain conditions.

This annex describes these conditions and gives the requirements for fulfilling them.

A.2 Failure exclusions: conditions

Table A.1 shows:

- a list of the major and most usual components used in present electronic technology. The components have been grouped by 'families':

- passive components	1
- semiconductors	2
- miscellaneous	3
- assembled printed circuits	4
- a number of identified failures:

- interruption	I
- short circuit	II
- change value to higher value	III
- change value to lower value	IV
- change of function	V
- the possibility and conditions of failure exclusion:

'The first condition for failure exclusion is that components must always be used within their own 'worst case' limits, even in the 'worst case' conditions specified by the standards, in the field of temperature, humidity, voltage and vibrations'.
- some remarks.

A.3 Design guideline

Recommendations to avoid dangerous situations, in the case when information is collected from the safety chain for control purposes, for remote control, alarm control, etc.:

The danger comes from the possibility of bridging one or several safety contacts by local interruption of a common lead (earth), combined with one or several other failures.

- Design the board and circuits with distances in accordance with specifications 3.1 and 3.6 of table A.1.

- Organize the common lead so that the common lead for the control of the escalators/passenger conveyor comes behind the electronic components. Any rupture will cause a non-operation of the control (danger exists that changes in wiring occur during the life of the escalator/passenger conveyor).

- Always make calculations about the 'worst case' condition (what happens if ...?; is the current resulting from all combinations of possible failures high enough to keep the contactors on ...?).

- Always use outside (out of element) resistors as protective devices of input elements; the internal resistor of the device should not be considered as safe.

- Use only components according to listed specifications.

- Backwards voltage coming from electronics must be considered. Using galvanically separated circuits can solve the problems in some cases.

- Electrical installations should be in accordance with CENELEC HD 384.5.54 S1.

- The 'worst case' calculation cannot be avoided, whatever the design. If modifications or add-ons are made after the installation of the escalator/passenger conveyor, the 'worst case' calculation, involving new and existing equipment must be carried out again.

- Some failure exclusions can be accepted, according to table A.1.

- Failures outside the environment of the escalator/passenger conveyor need not be taken into consideration.

- 'An interruption of the earth from the main supply of the building to the controller collection earth bar (rail) can be excluded, providing the installation is made in accordance with CENELEC HD 384.5.54 S1'.

Component	Excluded failure					Condition(s) for failure exclusion — Remarks
	I	II	III	IV	V	
1 Passive components						
1.1 Resistor fixed	No	(1)	No	(1)	—	(1) Only for film resistors with varnished or sealed resistance film and axial connection according to applicable IEC standards, and only for wire-wound resistors of they are made by a single layer winding protected by enamel or sealed.
1.2 Resistor, variable	No	No	No	No	—	
1.3 Resistor, non-linear						
1.3.1 NTC	No	No	No	No	—	
1.3.2 PTC	No	No	No	No	—	
1.3.3 VDR	No	No	No	No	—	
1.3.4 IDR	No	No	No	No	—	
1.4 Capacitor	No	No	No	No	—	
1.5 Inductive components:	No	No	—	No	—	
— coil						
— choke						
2 Semi-conductors						
2.1 Diode LED	No	No	—	—	No	Change of function refers to a change in reverse current value.
2.2 Zener diode	No	No	—	No	No	Change of value to lower refers to change in Zener voltage. Change of function refers to change in reverse current value.
2.3 Thyristor, triac, GTO	No	No	—	—	No	Change of function refers to self-triggering or latching of components.
2.4 Optocoupler	No	(1)	—	—	No	'T' means interruption of one of the two basic components (LED and photo-transistor), but 'II' means short circuit <i>between them</i> . Can be excluded under condition that they are in line with IEC 747-5, and the isolation voltage is at least according to the table below, taken from IEC 664-1 : 1992, table 1.

Table A.1 (continued)

Component	Excluded failure					Condition(s) for failure exclusion — Remarks														
	I	II	III	IV	V															
						<table border="1"> <tr> <td>Voltage phase-to-earth derived from rated system voltage up to and including V r.m.s and d.c</td> <td>Preferred series of impulse withstand voltages in volts for installation (category III)</td> </tr> <tr> <td>50</td> <td>800</td> </tr> <tr> <td>100</td> <td>1500</td> </tr> <tr> <td>150</td> <td>2500</td> </tr> <tr> <td>300</td> <td>4000</td> </tr> <tr> <td>600</td> <td>6000</td> </tr> <tr> <td>1000</td> <td>8000</td> </tr> </table>	Voltage phase-to-earth derived from rated system voltage up to and including V r.m.s and d.c	Preferred series of impulse withstand voltages in volts for installation (category III)	50	800	100	1500	150	2500	300	4000	600	6000	1000	8000
Voltage phase-to-earth derived from rated system voltage up to and including V r.m.s and d.c	Preferred series of impulse withstand voltages in volts for installation (category III)																			
50	800																			
100	1500																			
150	2500																			
300	4000																			
600	6000																			
1000	8000																			
2.5. Hybrid circuits	No	No	No	No	No	Change in function to oscillation 'and' gates becoming 'or' gates, etc.														
2.6 Integrated circuits	No	No	No	No	No															
3 Various																				
3.1 Connectors Terminals Plugs	No	(1)	-	-	-	<p>(1) If the protection of the connector is not better than IP 4X, the short circuits of connectors can be excluded if the minimum values are at least:</p> <ul style="list-style-type: none"> - 4 mm for creepage distances; - 3 mm for clearances. <p>These are absolute minimum values which can be found on the connected unit, not pitch dimension or theoretical values.</p> <p>If the protection of the connector is better than IP 4X (in accordance with EN 60529 : 1991), the creepage distance can be reduced to 3 mm.</p>														
3.2 Neon bulb	No	No	-	-	-	<p>(1) Short circuits include short circuits of primary or secondary windings, or between primary and secondary coils.</p> <p>(2) Change in value refers to change of ratio by partial short circuit in a winding.</p> <p>(1) (2) Can be excluded under the condition that the isolation voltage between windings and core is in line with EN 60742 : 1989, 17.2 and 17.3. The working voltage is the highest possible voltage of table 6 between live to earth.</p>														
3.3 Transformer	No	(1)	(2)	(2)	-															

Component	Excluded failure					Condition(s) for failure exclusion — Remarks
	I	II	III	IV	V	
3.4 Fuse	-	(1)	-	-	-	(1) Can be excluded if the fuse is correctly rated, and constructed according to EN 60269-1. 'II' means short circuit of the blown fuse.
3.5 Relay	No	(1) (2)				(1) Short circuits between contacts, and between contacts and coil, can be excluded if the relay fulfils the requirements of 13.2.2.3 (14.1.2.2.2). (2) Welding of contacts <i>cannot</i> be excluded. However, if the relay is constructed to have mechanically forced interlocked contacts, and made according to EN 60947-5-1, the assumptions of 13.2.1.3 apply.
3.6 Printed circuit board	No	(1)	-	-	-	The general specifications of the PCB are in accordance with IEC 326-1. The base material must be according to the specifications of IEC 249-2 and/or IEC 249-3. (1) If the PCB is constructed according to the above requirements, and the protection is not better than IP 4X, the short circuit can be excluded, if the minimum values are at least: - 4 mm for creepage distances; - 3 mm for clearances. These are absolute minimum values, which can be found on the connected unit, not pitch dimension or theoretical values. If the protection of the PCB is better than IP 4X, or the material involved is of higher quality, the creepage distances can be reduced to 3 mm.
4 Assembly of components on PCB	No	(1)	-	-	-	(1) Short circuit can be excluded under circumstances where the component itself can be excluded, and is mounted in a way that the creepage distances and clearances are not reduced below the minimum acceptable values as listed in 3.1 and 3.6, not by the mounting technique, nor by the PCB itself.
I Interruption/II Short circuit/III Change value to higher value/IV Change value to lower value/V Change of function						

A.4 Testing

For printed circuit boards, laboratory tests are necessary because practical checks on site, by inspectors, are very difficult.

A.4.1 Mechanical tests

During the tests, the tested object (printed circuit) is kept under operation. During and after the tests, no unsafe operation or condition shall appear within the safety circuit.

A.4.1.1 Vibrations

Vibration tests are carried out according to the requirements of 14.1.2.5.

After tests, clearances and creepage distances shall not become smaller than the minimum accepted.

A.4.1.2 Bumping (see EN 60068-2-27)

It is the purpose of bumping tests to simulate the cases when printed circuits fall, introducing the risk of rupture of components and an unsafe situation.

Tests are divided into the partial shock test, and continuous shock tests. During the tests, the operation of the circuit is not required.

Shock test:

The test object shall satisfy the following minimum requirements:

- | | |
|------------------------------|-----------|
| 1) Shock pulse shapes | half-sine |
| 2) Amplitude of acceleration | 15g |
| 3) Duration of shock | 11 ms |

Continuous shock test:

The test object shall satisfy the following minimum requirements:

- | | |
|------------------------------|-----------|
| 1) Amplitude of acceleration | 10g |
| 2) Duration of shock | 16 ms |
| 3) a) Number of shocks | 1000 ± 10 |
| b) Shock frequency | 2/s |

A.4.2 Climatic stress testing

A.4.2.1 Temperature tests

Operating ambient limits: 0 °C, + 65 °C (the ambient temperature is of the safety device).

Test conditions:

- The device must be in the operational position.
- The device must be supplied with the normal nominal voltage.
- The safety device must operate during and after the test. If the printed circuit board includes components other than safety circuits, they also must operate during the test (their failure is not considered).
- Tests will be carried out for minimum and maximum temperature (0 °C, + 65 °C); tests will last a minimum of 4 h.
- If the device is designed to operate within wider temperature limits, it must be tested for these values.

A.4.2.2 Humidity tests

Humidity tests are not necessary for safety circuits as the pollution degree for escalators/passenger conveyors is supposed to be IEC 665 : 1980, class 3, and the relative creepage distances and clearances are specified in this standard.

A.4.3 Electromagnetic disturbances

Detailed testing conditions will be issued later, based on the conclusions of CENELEC/TC 110 work.

Annex B (normative)

Drafting and assessing safety circuits

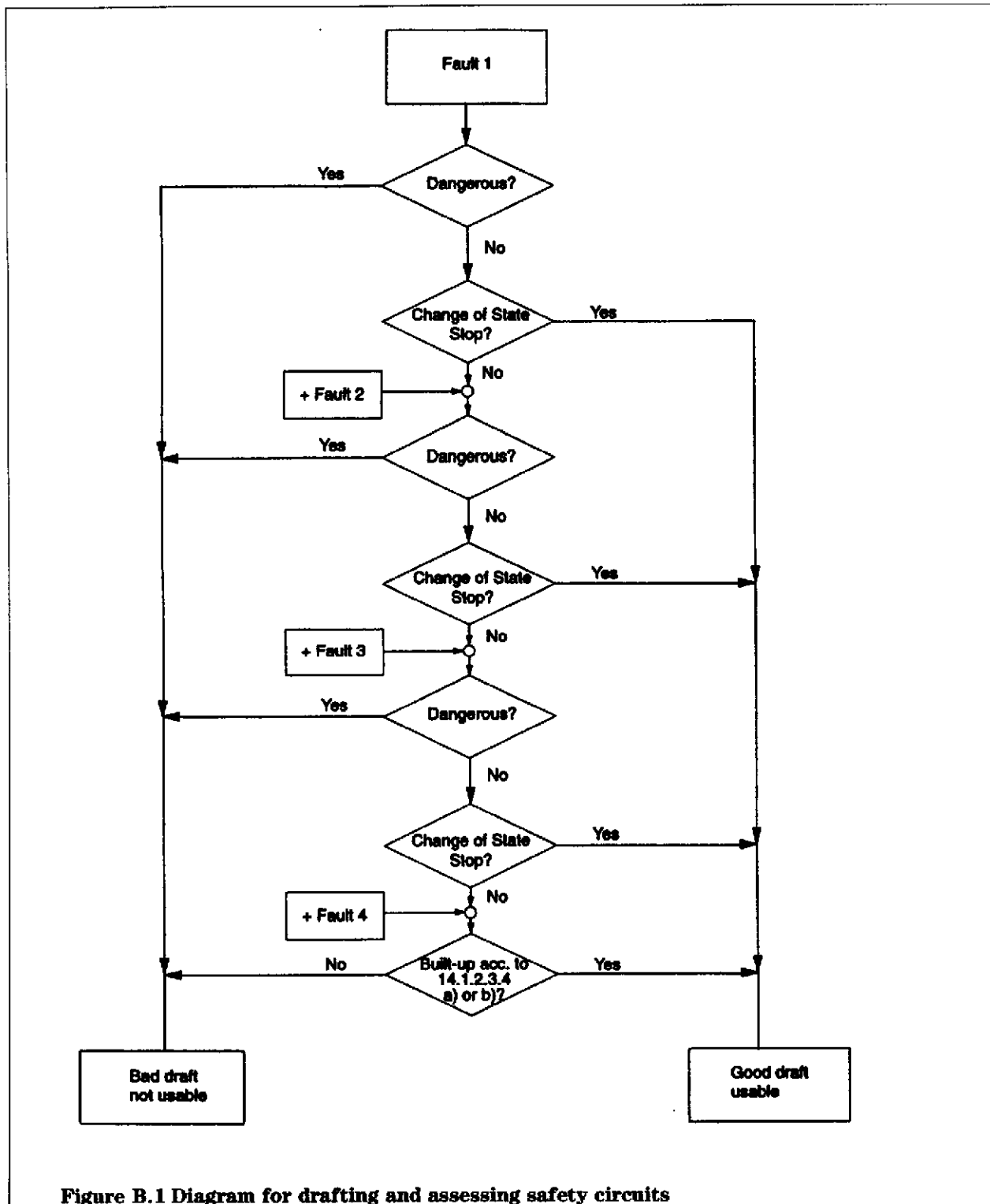


Figure B.1 Diagram for drafting and assessing safety circuits

Annex C (normative)

List of hazards

The hazards that can influence the safety of

- passengers during operation or maintenance,
- personnel during maintenance,
- inspectors during inspection,

have been identified by the risk assessment procedure and the corresponding requirements have been formulated.

Table C.1 shows the hazards which have been identified and where the corresponding requirements have been formulated in this standard. A hazard which is not applicable or is not significant and for which, therefore, no requirements are formulated, is shown as NA (not applicable).

Table C.1 List of hazards		
Hazards		Relevant clauses in this standard
1	Mechanical hazards	-
1.1	crushing hazard	5.1.1, 5.1.2, 5.1.3, 5.1.4, 5.1.5.4, 5.1.5.6, 6.1, 6.3.1.1, 7.3.1, 7.5, 8.2.3, 8.2.5, 8.3.2, 10, 11, 12.9
1.2	shearing hazard	5.1.1, 5.1.2, 5.1.3, 5.1.4, 5.1.5.4, 5.1.5.6, 5.2.4, 6.1, 6.3.1.1, 12.9
1.3	cutting or severing hazard	5.1.5.5, 10, 12.9
1.4	entanglement hazard	5.1.1, 5.1.2, 5.1.3, 5.1.5.4, 5.1.5.6, 6.1, 6.3.1.1, 12.7, 12.9
1.5	drawing-in or trapping hazard	5.1.1, 5.1.2, 5.1.3, 5.1.5.4, 5.1.5.6, 6.1, 6.3.1.1, 7.5, 8.2.3, 8.2.5, 8.3.2, 10, 11, 12.9
1.6	impact hazard	5.2.4, 6.2.1, 6.3.1.4, 7.3.1
1.7	stabbing or puncture hazard	NA
1.8	friction or/abrasion hazard	0.1.1, 6.1, 16.4
1.9	high-pressure fluid injection hazard	NA
1.10	ejection of parts	5.1.1
1.11	loss of stability (of machinery and machine parts)	0.1.1, 0.1.2, 5.1.2, 5.3, 7.8, 8.2, 9, 12.3.2
1.12	slip, trip and fall hazards	5.1.5.9, 6.2, 7.1, 7.2, 7.4, 7.6, 7.7, 8.3, 10, 12.2, 12.4.1, 14.2.1.1
2	Electrical hazards, caused for example by:	13.1, 13.2, 13.3, 13.5, 13.6, 13.7
2.1	electrical contact (direct or indirect)	0.1.1, 13.1.2, 13.1.3, 13.1.4, 13.1.5
2.2	electrostatic phenomena	0.1.1, 13.1
2.3	thermal radiation	NA
2.4	external influences on electrical equipment	13.1, 14.1.2.2.2, 14.1.2.2.5, 14.1.2.5
3	Thermal hazards, for example resulting in:	-
3.1	burns and scalds, by a possible contact of persons, by flames or explosions and also by radiation from heat sources	NA
3.2	health-damaging effects of a hot or cold work environment	NA
4	Hazards generated by noise, resulting for example in:	-
4.1	hearing losses (deafness), other physiological disorders (e.g. loss of balance, loss of awareness etc.)	NA
4.2	interference with speech communication, acoustic signals etc.	NA

Table C.1 List of hazards		
Hazards		Relevant clauses in this standard
5	Hazards generated by vibration (resulting in a variety of neurological and vascular disorders)	NA
6	Hazards generated by radiation, especially by:	—
6.1	electrical arcs	NA
6.2	lasers	NA
6.3	ionizing radiation sources	NA
6.4	machine making use of high frequency electromagnetic fields	NA
7	Hazards generated by materials and substances processed, used or emitted by machinery for example:	—
7.1	hazards resulting from contact with or inhalation of harmful fluids, gases, mists, dusts and fumes	0.1.1
7.2	fire or explosion hazard	0.5.1, 0.5.2, 5.1.1.3, 6.1
7.3	biological and microbiological (viral or bacterial) hazards	NA
8	Hazards generated by neglecting ergonomic principles in machine design (mismatch of machinery with human characteristics and abilities), caused for example by:	7.3.2, 7.3.3, 7.4
8.1	unhealthy postures or excessive efforts	6.2.2, 6.3.1
8.2	inadequate consideration of human hand-arm or foot-leg anatomy	NA
8.3	neglected use of personal protection equipment	NA
8.4	inadequate area lighting	5.4, 6.3.2
8.5	mental overload or underload, stress, etc.	NA
8.6	human error	0.5.3, 0.7, 5.1.5.2, 5.1.5.7, 13.4.2, 13.7, 14.2.2.3.1, 14.2.5.3
9	Hazard combinations	NA
10	Hazards caused by failure of energy supply, breaking down of machinery parts, and other functional disorders, for example:	—
10.1	failure of energy supply (of energy and/or control circuits)	12.6.5
10.2	unexpected ejection of machine parts or fluids	5.1.1
10.3	failure/malfunction of control system (unexpected start up, unexpected overrun)	12.4.2, 12.5, 12.8, 14.2.1, 14.2.2.4.1e
10.4	errors of fitting	13.5.3, 13.5.4, 13.7
10.5	overturn, unexpected loss of machine stability	7.8, 9.1.3, 9.2.2, 10.2.1, 14.2.2.4.1
11	Hazards caused by (temporarily) missing and/or incorrectly positioned safety-related measures/means, for example:	—
11.1	all kinds of guard	5.1, 7.5, 12.9, 15.1.2.3
11.2	all kinds of safety-related (protection) devices	6.1, 14, 15.1.4

Table C.1 List of hazards		
Hazards		Relevant clauses in this standard
11.3	starting and stopping devices	12, 14.2
11.4	safety signs and signals	6.3.3b, 15.1.4
11.5	all kinds of information or warning devices	13.4.4, 14.2.1.2, 15
11.6	energy supply disconnecting devices	6.3.3, 7.8, 12.4.2, 12.6.4, 12.8, 13.4, 13.6, 14.1.2.4, 14.2.2.3, 14.2.2.4
11.7	emergency devices	7.8, 8.1.1, 12.5, 14.2.2.3, 14.2.2.4, 14.2.4
11.8	means of feeding/removing workpieces	NA
11.9	essential equipment and accessories for safe adjusting and/or maintaining	5.1.3, 5.5, 6, 8.3.2.4, 12.9, 13.1.2, 13.4, 13.5.3, 13.5.4, 13.6, 14.2.5, 15.1.3, 16.2.1.1.2, 16.2.3i, 16.3
11.10	equipment for evacuating gases, etc.	NA

Annex D (informative)

Additional recommendations for public service escalators and public service passenger conveyors

- D.1** to 10.1.3: At rated speeds above 0,65 m/s, it is recommended for public service escalators to guide the steps of the escalator at the landings in such a way that the front edges of the steps leaving the comb and the rear edges of the steps entering the comb are moving horizontally for a length of at least 1,60 m, measured from point L₁ (see figure 1 and detail X).
- D.2** to 10.1.4: At rated speeds above 0,65 m/s, it is recommended for public service escalators to increase the minimum radius of curvature in the upper transition from incline to horizontal of the escalator to 2,60 m, and in the lower transition from incline to horizontal of the escalator, to 2,00 m.
- D.3** to 12.6.1: It is recommended for public service escalators and public service passenger conveyors to install auxiliary brakes also for rises below 6 m.

List of references

See national foreword.

BS EN
115 : 1995

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