BS ISO 22201-2:2013

BSI Standards Publication

Lifts (elevators), escalators and moving walks — Programmable electronic systems in safety related applications

Part 2: Escalators and moving walks (PESSRAE)

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National foreword

This British Standard is the UK implementation of ISO 22201-2:2013.

The UK participation in its preparation was entrusted to Technical Committee MHE/4, Lifts, hoists and escalators.

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

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INTERNATIONAL STANDARD

ISO 22201-2

First edition
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Lifts (elevators), escalators and moving walks — Programmable electronic systems in safety related applications —

Part 2: Escalators and moving walks (PESSRAE)

Ascenseurs, escaliers mécaniques et trottoirs roulants — Systèmes électroniques programmables dans les applications liées à la sécurité —

Partie 2: Escaliers mécaniques et trottoirs roulants

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 178, *Lifts, escalators and moving walks*.

ISO 22201 consists of the following parts, under the general title *Lifts (elevators), escalators and moving walks — Programmable electronic systems in safety-related applications*:

— *Part 2: Escalators and moving walks (PESSRAE)*

— *Part 3: Life cycle guideline for Programmable Electronic Systems related to PESSRAL and PESSRAE* [Technical Report]

When revised, ISO 22201:2009, *Lifts (elevators) — Design and development of programmable electronic systems in safety-related applications for lifts (PESSRAL)*, will become Part 1.

Introduction

Systems comprised of electrical and/or electronic components have been used for many years to perform safety functions in most application sectors. Computer-based systems, generically referred to as programmable electronic systems (PES), are being used in many application sectors to perform non-safety functions and, increasingly, to perform safety functions. If computer system technology is to be effectively and safely exploited, it is essential that those responsible for making decisions have sufficient guidance on the safety aspects on which to make these decisions. In most situations, safety is achieved by a number of protective systems that rely on many technologies (for example mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic). Any safety strategy must therefore consider not only all the elements within an individual system (for example sensors, controlling devices and actuators) but also all the safety-related sub-systems making up the total combination of safety-related systems.

This International Standard is based upon the guidelines provided in the generic International Electrotechnical Commission (IEC) Standard IEC 62061 and Comité Européen de Normalisation (CEN) Standard EN 115-1:2008.

The requirements given in this International Standard recognize the fact that the product family covers a total range of passenger and goods/passenger escalators and moving walks used in residential buildings, offices, hospitals, hotels, industrial plants, etc. This International Standard is the product family standard for escalators and moving walks and takes precedence over all aspects of the generic standard.

This International Standard sets out the product specific requirements for systems comprised of programmable electronic components and programmable electronic systems (PES) that are used to perform safety functions in escalators and moving walks. This International Standard has been developed in order that consistent technical and performance requirements and rational be specified for Programmable Electronic System in Safety-Related Application for Escalators and moving walks (PESSRAE).

Risk analysis, terminology, and technical solutions have been considered taking into account the methods of the IEC 61508 series of standards. The risk analysis of each safety function specified in Table 1 resulted in the classification of electric safety functions applied to PESSRAE. Tables 1 and 2 give the safety integrity level and functional requirements, respectively, for each electric safety function.

The safety integrity levels (SIL) specified in this International Standard may also be applied to other technologies used to satisfy the safety functions specified in this International Standard.

Harmonization with national escalator and moving walk norms:

Application of this International Standard:

The application of this International Standard is intended to be by reference within a national escalator and moving walk norm such as escalator and moving walk codes, standards, or laws. There are three reasons for this.

— To allow selective reference by national norms to specific escalator and moving walk safety functions described in this International Standard. Not all escalator and moving walk safety functions identified in this International Standard are called out in every national norm.

— To allow for future harmonization of national norms with escalator and moving walk safety functions identified in this International Standard. Because there exist some differences in the requirements for fulfilment of the safety objective of national escalator and moving walk norms and in national practice of escalator and moving walk use and maintenance, there are instances where the requirements for escalator and moving walk safety functions described in this International Standard are based on the consensus work and agreement by the ISO committee responsible for this International Standard. National bodies may choose to selectively harmonize with those escalator and moving walk safety functions that differ in the requirements called for by the existing national norm in future norm revisions.

— To allow for the application of this International Standard where escalator and moving walk safety functions are new or deviate from those specified in this International Standard. More and more,

national escalator and moving walk legislations are moving to performance based requirements. For this reason the development of new or different escalator and moving walk safety functions can be foreseen in product specific applications. For those who require escalator and moving walk safety functions that are new or different from those specified in this International Standard, this International Standard provides a verifiable method to establish the necessary level of safety integrity for those functions.

INTERNATIONAL STANDARD ISO 22201-2:2013(E)

Lifts (elevators), escalators and moving walks — Programmable electronic systems in safety related applications —

Part 2: Escalators and moving walks (PESSRAE)

1 Scope

1.1 This International Standard is applicable to the product family of escalators and moving walks used in residential buildings, offices, hospitals, hotels, industrial plants, etc. This International Standard covers those aspects that need to be addressed when programmable electronic systems are used to carry out electric safety functions for escalators and moving walks (PESSRAE). This International Standard is applicable for escalator and moving walk safety functions that are identified in escalator and moving walk codes, standards, or laws that reference this International Standard for PESSRAE application. The safety integrity levels (SILs) specified in this International Standard are understood to be valid for PESSRAE application in the context of the referenced escalator and moving walk codes, standards, and laws in Annex B.

1.2 This International Standard is also applicable for the application of PESSRAE that are new or deviate from those described in this International Standard.

1.3 The requirements of this International Standard regarding electrical safety/protective devices are such that the possibility of a failure of an electric safety/protective device complying with all the requirements of the standard needs not to be taken into consideration.

In particular, this International Standard:

a) uses safety integrity levels (SIL) for specifying the target failure rate for the safety functions to be implemented by the PESSRAE;

b) specifies the requirements for achieving safety integrity for a function but does not specify who is responsible for implementing and maintaining the requirements (for example, designers, suppliers, owner/operating company, contractor); this responsibility is assigned to different parties according to safety planning and national regulations;

c) applies to PES used in escalator and moving walk applications that meet the minimum requirements of a recognized escalator and moving walk standards such as EN 115, ASME A17.1/CSA B44, or escalator and moving walk laws such as The Japan Building Standard Law Enforcement Order For Elevator and Escalator;

d) defines the relationship between this International Standard and IEC 61508 and defines the relationship between this International Standard and the EMC Standard for Escalators and moving walks on immunity, ISO 22200;

e) outlines the relationship between escalator and moving walk safety functions and their safe-state conditions;

f) applies to phases and activities that are specific to design of hardware and software but not those phases and activities which occur post design, for example sourcing and manufacturing;

g) requires the manufacturer of the PESSRAE to provide instructions that specify what is necessary to maintain the integrity of the PESSRAE (instruction manual) for organization carrying out the assembly, connections, adjustment and maintenance of the escalators and moving walks;

h) provides requirements relating to the hardware and software safety validation;

i) establishes the safety integrity levels for specific escalator and moving walk safety functions;

j) specifies techniques/measures required for achieving the specified safety integrity levels;

k) defines a maximum level of performance (SIL 3) which can be achieved for a PESSRAE according to this International Standard and defines a minimum level of performance (SIL 1).

1.4 This International Standard does not cover:

a) hazards arising from the PES equipment itself such as electric shock etc.;

b) the concept of fail-safe that may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail-safe was considered inappropriate because of the full range of complexity of PESSRAE that are within the scope of this International Standard;

c) other relevant requirements necessary for the complete application of a PESSRAE in a escalator and moving walk safety function such as system integration specifications, temperature and humidity, the mechanical construction, mounting and labelling of switches, actuators, or sensors that contain PESSRAE. These requirements are to be carried out in accordance with the national escalator and moving walk norm that references this International Standard.

2 Conformance

To conform to this International Standard, it shall be shown that each of the requirements outlined in Clause 6 has been satisfied to the defined criteria and therefore the clause objective(s) has(have) been met.

3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 1: General Requirements*

IEC 61508-2, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 2: Requirements for electrical/electronic/programmable/electronic safety-related systems*

IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 3: Software requirements*

IEC 61508-4, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 4: Definitions and abbreviations*

IEC 61508-5, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 5: Example of methods for the determination of Safety Integrity Levels*

ISO 22200, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Immunity*

IEC 61249-2-1, *Materials for printed boards and other interconnecting structures - Part 2-1: Reinforced base materials, clad and unclad - Phenolic cellulose paper reinforced laminated sheets, economic grade, copper clad*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61508-4 apply, except that the definitions in this International Standard take precedence over those in the generic standard.

4.1
manually operated stopping device
stopping device which is intentionally, by human intervention, actuated and de-actuated

EXAMPLE toggle switch, mushroom type, hand operated switches

4.2
non-manually operated stopping device
stopping device which is automatically actuated or de-actuated due to human intervention or detection

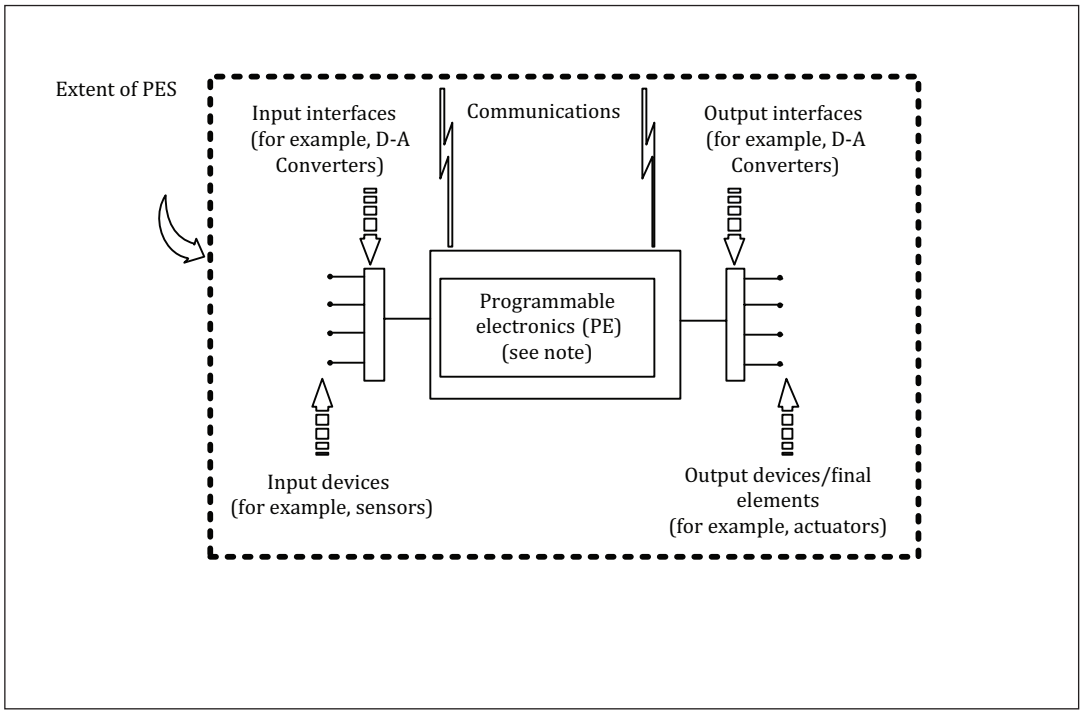
4.3
non-SIL relevant safe-state requirement
required response to the actuation of a SIL rated safety function where the function performing this response is not required to be SIL rated

Note 1 to entry: See Figure 4 and Table 2.

4.4
programmable electronic system
PES
system for control, protection or monitoring based on one or more programmable electronic devices, including all elements of the system such as power supplies, sensors and other input devices, data highways and other communication paths, and actuators and other output devices

Note 1 to entry: See Figure 1.

Note 2 to entry: A PES may perform functions that fulfil requirements for SIL rated and non-SIL rated function(s). The SIL rating of a function is only required to consider that portion of PES that perform the SIL relevant functional requirements.



NOTE The programmable electronics are shown centrally located but could exist at several places in the PES.

Figure 1 — Basic PES structure

4.5
Programmable Electronic Systems in Safety-Related Applications for Escalators and moving walks
PESSRAE
application of a software-based PES in a safety-related system for escalators and moving walks

4.6
proof test
periodic test performed to detect failures in a safety-related system

Note 1 to entry: For example, where separate channels are used; these tests are done for each channel separately.

4.7
safety circuit
total combination of safety devices that fulfil all or a group of escalator and moving walk safety functions

Note 1 to entry: See Figure 2.

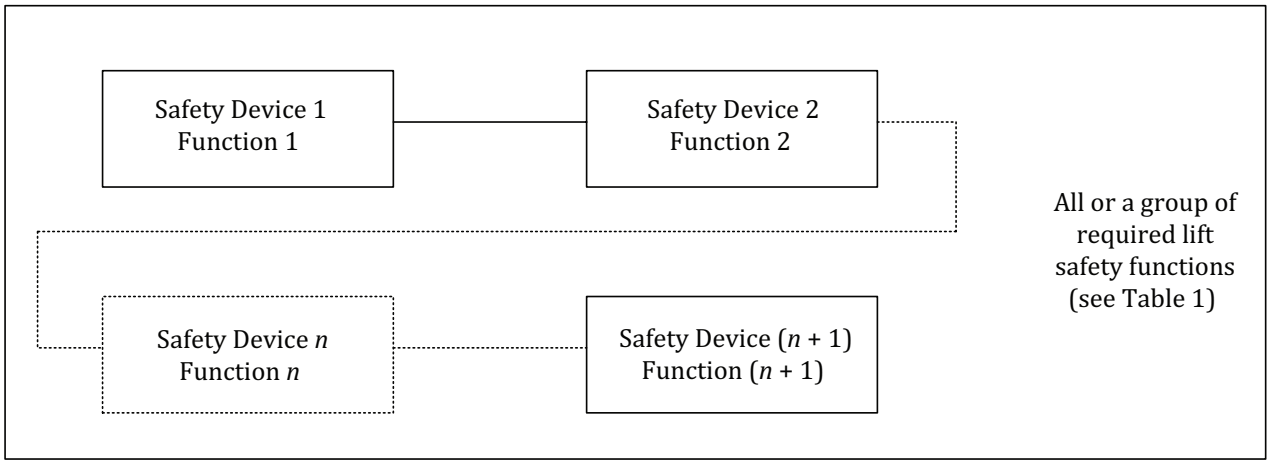


Figure 2 — Safety chain

4.8
safety device
part of the safety-related system, including necessary control circuits, that has been designated to achieve, in its own right, an escalator and moving walk safety function and may consist of PES elements and non-PES elements

Note 1 to entry: See Figure 3 and Table 1.

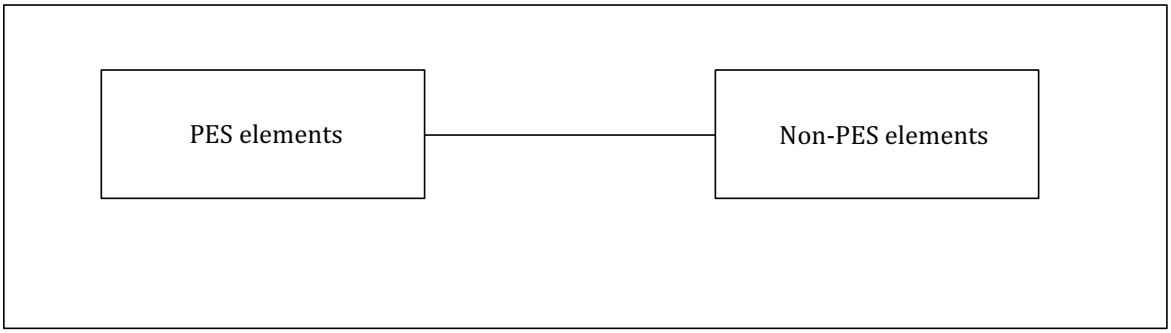


Figure 3 — Safety Device

4.9
safety function
function to be implemented by a safety-related system, which is intended to achieve or maintain a safe-state of the escalator and moving walk, with respect to a specific hazardous event

Note 1 to entry: See Table 1.

Note 2 to entry: A safety function may include non-SIL relevant requirements, see Table 2.

4.10
safety-related system
consists of one or more safety devices performing one or more safety functions that may be based on programmable electronic systems (PES), electrical, electronic and/or mechanical elements of the escalator and moving walk

Note 1 to entry: The term includes all the hardware, software and supporting services (for example, power supplies) necessary to carry out the specified safety function (sensors, other input devices, final elements (actuators) and other output devices are therefore included in the safety-related system).

4.11
safety integrity level
SIL
discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the programmable electronic safety-related system, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest. The SIL is indicative of a failure rate that includes all causes of failures (both random hardware failures and systematic failures), which lead to an unsafe state, for example hardware failures, software induced failures and failures due to electrical interference

Note 1 to entry: In the context of this International Standard, SIL 3 is the highest safety integrity level that is applied to escalators and moving walks.

4.12
SIL Relevant Safe-State Requirement
part of the safety-related system where the specified SIL of the function is required to be met

Note 1 to entry: See Figure 4 and Table 2.

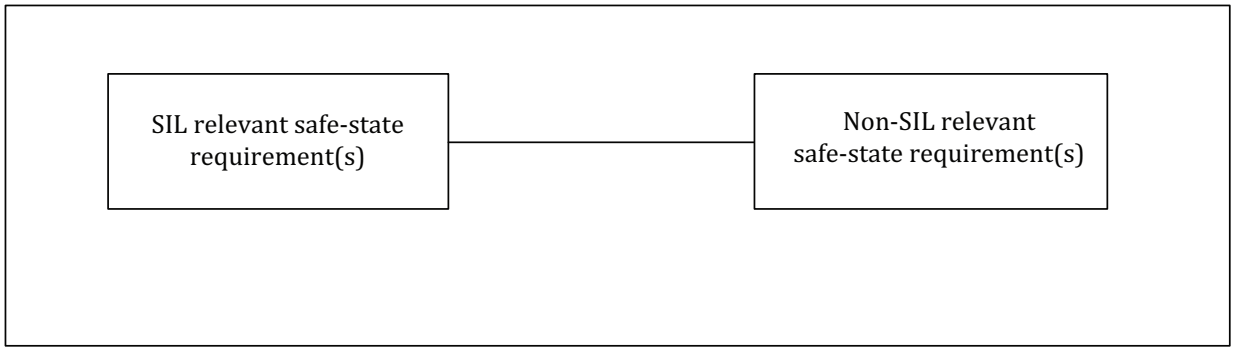


Figure 4 — Escalator and moving walk safety function

4.13
system reaction time
sum of the following two values:

a) the time period between the occurrence of a fault in the PESSRAE and the initiation of the corresponding action on the escalator and moving walk;

b) the time period for the escalator and moving walk to respond to the action, maintaining a safe state.

5 Symbols and abbreviated terms

PCB Printed Circuit Board

6 Requirements

6.1 General

6.1.1 Table 1 defines the safety function names, the associated escalator and moving walk functional description, applicable escalator and moving walk type and required SIL for the SIL relevant part of the safety function.

NOTE Safety functions refer to those escalator and moving walk functions that are identified in codes, standards and laws that reference this International Standard for PESSRAE application. (See B.1).

6.1.2 Table 2 defines the safe-state requirements when the safety functions in Table 1 are actuated. If a safety function actuates, the safety function shall cause the escalator and moving walk system to revert to the safe-state conditions specified by the requirements of Table 2.

6.1.3 PESSRAE shall consider the reaction time of the escalator and moving walk to respond to the safety function and internal fault detection in the necessary time to achieve the safe-state condition without hazard. Methods that fulfil internal fault detection must consider the necessary system reaction time required by the SIL.

NOTE For example, if an internal fault is detected by comparison of data in a 2-channel system within the time necessary to meet the system reaction time, then a variable memory range test need not be completed within the system reaction time because safety integrity is verified by the 2-channel design.

6.2 Extended application of this International Standard

The following requirements are provided to verify SILs and safe-state conditions for escalator and moving walk safety functions that are new or deviate from the requirements provided in 6.3 and 6.4, or are referenced by codes and standards not harmonized with the requirements of codes, standards, or laws referenced in B.1.

6.2.1 Risk assessment

Where alternatives to the requirements of 6.3 and/or 6.4 are sought, methods for the determination of the required safety integrity level shall be performed according to IEC 61508-5 or IEC/EN 62061. The same methods shall be used to establish rationale for a new PESSRAE function and corresponding SIL or a revised PESSRAE function and/or SIL that deviate from the requirements of 6.3 and 6.4. The mean target failure frequency for the worst-case severity of any single potential consequence hazard scenario shall not exceed a frequency of 5×10^{-7} per year. See also Annex C.

6.2.2 Limits for specifying SIL for PESSRAE

Target failure measures required for specifying a PES in a escalator and moving walk safety-related function shall be no less than a SIL 1 and no greater than SIL 3. If a target failure measure requires higher than SIL 3, consideration should be made to redesign the system such that the required target failure measure shall be satisfied with SIL 3 or less. If a SIL lower than SIL 1 is required, a non-SIL rated PES may be used but shall not be classified as a PESSRAE. No PESSRAE shall have a SIL of less than SIL 1 even if it is applied to a safety function requiring less than SIL 1.

Applications that require the use of a single safety function of safety integrity level 4 are not typically required in the escalator and moving walk industry. Such applications shall be avoided because of the difficulty of achieving and maintaining such high levels of performance throughout the life cycle of the safety device. If the analysis results in a safety integrity level of 4 or higher being assigned to an escalator and moving walk safety function, consideration shall be given to changing the process design in such a way that it becomes more inherently safe or by adding additional layers of protection. These enhancements could perhaps then reduce safety integrity level requirements for the escalator and moving walk safety function. If the safety integrity level cannot be reduced, the target failure measure for the safety function shall be distributed across multiple PESSRAE of SIL 3 or less that are sufficiently independent, and certified in the application.

6.2.3 Safe-state requirements

For escalator and moving walk safety functions that are new or differ from those specified in 6.3 and 6.4, the designer shall identify the safe-state requirements in a manner similar to how they are described in Table 2.

6.3 Safety function SIL requirements

Table 1 provides the required SIL for each escalator and moving walk safety function. For further information, see Table B.1.

Table 1 — Safety function SIL requirements

Id. No.	Escalator and moving walk safety function	Functional description	SIL
1	Check for excessive speed	Detect overspeed of the escalator or moving walk and remove power from machine motor and brake before the speed exceeds 20 % of rated speed.	2
2	Check for unintentional reversal of the direction of travel	Detect for unintended reversal of travel when operated in the ascending direction	2
3	Check for the closing of the auxiliary brake	Detect that the auxiliary brake has actuated	1
4	Check Broken Step-Chain Device	Detect the step chain is broke	1
5	Check Extension or reduction of the distance between the driving and return devices	Detect extension or reduction of the distance between the driving and return devices	1
6	Check Comb-Step Impact Devices	Detect displacement of comb	1
7	Check for Egress Restriction Device	Detect obstruction or barrier at the egress	2
8	Check for objects entrapped in the handrail entry	Detect objects or body parts entering the handrail entry	1
9	Check for the sagging of step or pallet	Detect a downward displacement of step or pallet at the transitions and before entering the comb	2
10	Check for a missing step or pallet	Detect a step or pallet is missing prior to exiting the comb	2
11	Check for non-lifting of the operational braking system	Detect the machine brake has not lifted	1
12	Check for hand rail speed deviation	Detect a speed deviation of more than 15 % between the handrail and the steps or pallet	1
13	Check for opened inspection cover and open floor plate	Detect access cover and floor plates to inspection area are open	1
14	Check manual hand winding means	Detect prior to or when a winding means to move the rack will be used on the machine	1
15	Check actuation of Stopping switch for emergency situations	Detect the actuation of the emergency stopping device	1
16	Check Broken Drive-Chain Device	Detect a broken drive chain	1
17	Check Escalator Skirt Obstruction Device	Detect an obstruction between skirt and step	1
18	Check Maintenance and repair stop switch	Detect actuation of stop switch in the maintenance area	2
19	Check Step Up thrust Device	Detect an upward force on the step in the lower transition	1
20	Check Disconnected Motor Safety Device	Detect the motor is disconnected from the gearbox	1
21	Check Step Lateral Displacement Device	Detect excessive lateral displacement of steps	2
22	Check Stop switch in inspection controls	Detect actuation of the stopping device on the inspection control panel	2

Table 1 *(continued)*

Id. No.	Escalator and moving walk safety function	Functional description	SIL
23	Check Dynamic Skirt Panel Obstruction Device	Detect an entrapment between the dynamic skirt panel and the dynamic skirt panel cover	1
24	Check Dynamic Skirt Panel in place	Detect missing dynamic skirt panel	1
25	Check inspection control actuation	Detect actuation of inspection control	2
26	Control and operating circuits		No less than the highest safety function applied in the safety circuit

6.4 SIL relevant and non-SIL relevant safe state requirements

Table 2 provides the required response of the escalator and moving walk to the escalator and moving walk safety functions of Table 1 and the SIL and non-SIL relevant requirements for each response from actuation of that function. An "X" indicates the response is required for the safe-state condition when the safety function actuates or, where the PESSRAE detects an internal fault condition. See corresponding notes where a numerical note reference value is used in place of an "X" for further clarification of the required response.

Table 2 — Safe state requirements

(References in matrix (R#) appended to this table)		Remove motor and operational brake power	Remove power from Main Drive Shaft Brake	Block All Other Starting	Block Other Inspection Control Devices	Manual reset to start (see R6)	Bypass Safety Functions	Block normal operation starting	Remove motor and operational brake power	Remove power from Main Drive Shaft Brake	Audible Signal				
Id	**Escalator and moving walk safety function**	**SIL relevant**							**Non-SIL relevant**						
1	Check for excessive speed or unintentional reversal of the direction of travel	R1				X				X					
2	Check for unintentional reversal of the direction of travel	X				X				X					
3	Check for the closing of the auxiliary brake								X						
4	Broken Step-Chain Device	X				X									
5	Extension or reduction of the distance between the driving and return devices	X													
6	Comb-Step Impact Devices	R2													
7	Escalator Egress Restriction Device	X													
8	Check for foreign bodies being trapped in the handrail entry	X													
9	Check for the sagging of step or pallet	X				X									
10	Check for a missing step, pallet, or dynamic skirt	X				X									
11	Check for non-lifting of the operational braking system	X				X									
12	Check for hand rail speed deviation	R3									X				

Table 2 *(continued)*

(References in matrix (R#) appended to this table)		Remove motor and operational brake power	Remove power from Main Drive Shaft Brake	Block All Other Starting	Block Other Inspection Control Devices	Manual reset to start (see R6)	Bypass Safety Functions	Block normal operation starting	Remove motor and operational brake power	Remove power from Main Drive Shaft Brake	Audible Signal				
13	Check for opened inspection cover	X													
14	Check manual hand winding means	X													
15	Stopping switch for emergency situations	X													
16	Drive-Chain Device	X	X			X									
17	Escalator Skirt Obstruction Device	X													
18	Maintenance and repair stop switch	X													
19	Step Up thrust Device	X													
20	Disconnected Motor Safety Device	X				X									
21	Step Lateral Displacement Device	X				X									
22	Stop switch in inspection controls	X													
23	Dynamic Skirt Panel Obstruction Device	X				X									
24	Check Dynamic Skirt Panel in place	X				X									
25	Inspection station actuation			R4			R5								
R1	Actuate before speed exceeds 120% of nominal speed (no load speed). Note this is more stringent than at rated speed, rated load.														
R2	Detects impact (no displacement required)														
R3	Detects whenever the speed of either handrail deviates from the step speed by 15% or more for more than 15 s														
R4	All other starting includes all other inspection operating devices														

Table 2 *(continued)*

(References in matrix (R#) appended to this table)	Remove motor and operational brake power	Remove power from Main Drive Shaft Brake	Block All Other Starting	Block Other Inspection Control Devices	Manual reset to start (see R6)	Bypass Safety Functions	Block normal operation starting	Remove motor and operational brake power	Remove power from Main Drive Shaft Brake	Audible Signal			
R5	When enabled, the following means shall be permitted to be rendered ineffective: 1) Tandem and egress protection 2) Step Levelling Device 3) Missing step pallet 4) Non-lifting of braking system 5) Hand Rail Speed 6) Open the inspection cover and floor plates												
R6	Manual reset (of Failure Lock) to enable start: Requires restricted human intervention to reset the safety function in order to start or restart the escalator or moving walk. The escalator or moving walk start key does not perform a restricted reset. (Note: the requirement for manual reset is not a function of the SIL, it is a function of possible hazardous situations after an event.)												

6.5 Implementation and demonstration requirements for verification of SIL compliance

6.5.1 General

The Safety Integrity Level of a PESSRAE shall be verified in conformance with the requirements of this clause.

6.5.2 Required techniques and measures to implement and demonstrate PES compliance with specified safety integrity levels in this International Standard.

6.5.2.1 Techniques and measures necessary to implement and demonstrate compliance with SIL 1 to SIL 3 shall be satisfied by the techniques and measures of Annex A.

6.5.2.2 Where two or more safety functions are implemented with a common safety circuit, the SIL of this common circuit shall be at least as high as the highest SIL rating of the escalators and moving walk safety functions included in that circuit (see definition of safety circuit).

6.5.3 Loss of power after a PESSRAE device has actuated

6.5.3.1 Where a manual reset is not required for the function, a PESSRAE shall be permitted to revert to a normal operating mode after a power recovery condition and the device output state shall be determined by input conditions that exist after the power recovery.

6.5.3.2 Where a manual reset is required (see Table 2), the PESSRAE output shall revert to its output state just prior to the power loss.

Annex A
(normative)

Techniques and measures to implement, verify, and maintain SIL compliance

A.1 General

This Annex addresses the requirements for the implementation, verification, and maintenance of PESSRAE SIL compliance.

A.1.1 Techniques and measures that shall be used to satisfy the SIL requirements of this International Standard

Techniques and measures necessary to implement and demonstrate PESSRAE SIL compliance shall be satisfied by the techniques and measures provided in A.2 using IEC 61508-2 and IEC 61508-3.

A.1.2 Instruction manual

The manufacturer shall provide an instruction manual.

Where the functional verification of the PESSRAE is not possible during normal operation of the escalators and moving walks, information shall be provided in the instruction manual to enable functional verification to be carried out. The instruction manual shall also inform about the following so that they can be carried out effectively and without danger:

— assembly;

— connection;

— adjustment;

— maintenance and repair;

— identification, marking, labelling, certification and listing;

— frequency of functional verification.

A.1.2.1 General requirements on maintenance and repair for the instruction manual

As required by the manufacturer, the instruction manual shall provide the following concerning maintenance and repair of a PESSRAE:

— unique requirements and/or precautions for training of maintenance personnel to sustain full functional performance of the PESSRAE to its SIL;

— proof-test, preventive and breakdown maintenance activities;

— the unique measures and techniques to be used for maintenance;

— verification and documentation requirements of adherence to maintenance activities;

— when maintenance activities shall take place;

— ensuring that test equipment used during normal maintenance activities is properly calibrated and maintained;

— the maintenance and repair activities to be followed when faults or failures occur in the PESSRAE including:

  — activities for fault diagnostics and repair;

  — activities for revalidation;

  — maintenance and failure reporting requirements.

A.1.3 Maintenance or maintainability design requirements

The design of a PESSRAE shall allow for testing either end-to-end or in parts. Where the expected interval between scheduled testing is greater than the proof-test interval used to determine the SIL rating of the PESSRAE, then appropriate provisions for testing are required.

NOTE The term end-to-end means from sensor end to safe-state actuation. When automatic proof testing is required, provisions for testing shall be an integral part of the SIL rated design to test for undetected failures.

A.1.4 EMC immunity

A PESSRAE shall fulfil the "safety circuit" test levels specified in ISO 22200 for the SIL relevant safe-state requirements. Non-SIL relevant safe-state requirements shall fulfil "general function circuits" and "all circuits" test levels in ISO 22200. Local radio telecommunications regulations apply where radio frequency is intentionally used for PESSRAE.

A.2 Techniques and measures to implement and demonstrate SIL compliance using IEC 61508-2 and IEC 61508-3

A.2.1 General Requirements

This clause provides the requirements for the application of IEC 61508 where it is used for the implementation and demonstration of PESSRAE SIL compliance

A.2.1.1 For the purpose of this International Standard, the SIL represents the requirement for a device operating in the low demand mode and the probability of failure to perform its safety function on demand (refer to IEC 61508-1, Table 2). However, where a PESSRAE is used for continuous control to maintain functional safety, the SIL shall represent the requirement for a PESSRAE considered operating in the high demand mode and the dangerous failure rate shall be used (refer to IEC 61508-1, Table 3).

NOTE When there is a possibility that some combination of output states of a subsystem can directly cause a hazardous event, then it should be necessary to regard the detection of dangerous faults in the subsystem as a safety function operating in the continuous mode.

A.2.1.2 Device(s) and software used to perform non-SIL rated requirements shall not be used to implement a SIL relevant requirement of a PESSRAE unless these device(s) and software have also been included in the rating of the SIL for the safety-related function.

A.2.1.3 The detection of a dangerous fault (by diagnostic tests, proof tests or by any other means) in any PESSRAE subsystem that can tolerate a single fault shall result in the specified safe-state of Table 2. If necessary, to maintain the integrity of the PESSRAE and maintain the safe-state condition prior to a second fault in the same subsystem that could lead to a dangerous condition, a manual reset shall be required to remove the PESSRAE from the safe-state condition.

Where the above actions depend on an operator or remote sub-system taking specific actions in response to an alarm of a dangerous fault, then the alarm shall be considered part of the SIL relevant function of the PESSRAE.

A.2.2 Implementation and SIL compliance

Implementation of SIL compliance for a PESSRAE shall be in accordance with the guidelines and measures of IEC 61508-2 for hardware and IEC 61508-3 for software.

NOTE It is possible to use several lower safety integrity level systems to satisfy the need for a higher safety integrity level function provided that adequate levels of independence are achieved, and certified in the application.

A.2.3 Verification of conformity

For the purposes of this International Standard, it is assumed that the laboratory undertakes both the testing and the certification as an approved body.

NOTE An approved body is a third party accredited by a national authority for the scope of escalators and moving walks and corresponding safety devices.

The application for type examination shall be made by the manufacturer of the component or his authorized representative and shall be addressed to an approved test laboratory.

Annex B
(informative)

Applicable escalator and moving walk codes, standards, and laws

Safety functions refer to those escalator and moving walk functions that are identified in other norms, i.e. codes, standards, and laws that reference this ISO standard for PESSRAE application. For the purpose of record and cross reference, Table B.1 indicates the relationship between the following edition of escalator and moving walk codes, standards and laws and the safety functions set forth in Table 1:

— ASME A17.1-2004, with Addenda A-2005 and Supplement S-2005, *Safety Code for Elevators and Escalators* (ASME)

— European Standard EN 115-1:2008+A1:2010, *Safety of escalators and moving walks: Part 1: Construction and installation* (CEN)

— The Building Standard Law of Japan, enforcement order (for elevator and escalator): 2002 (JBL)

Table B.1 — A cross reference to applicable escalator and moving walk codes, standards, and laws

Table 1		CEN Cross Reference		ASME Cross Reference		JBL Cross Reference BSLJ-EO:Building Standard Law Enforcement Order / MOC-N:Notification of Ministry of Construction	
Id. No.	**Escalator and moving walk safety function**	**CEN clause**	**CEN Text**	**ASME clause**	**ASME Text**	**JBL**	**JBL Implementation**
1	Check for excessive speed	5.4.2.3.1	Check for excessive speed and actuate the machine, machine brake and aux brake which shall not be more than 20% above the nominal speed. (nominal speed is at no load) Requires manual reset	6.1.6.3.2	Speed Governor. A speed governor shall be provided, except as specified in 6.1.6.3.2(b). (a) The operation of the governor shall cause the electric power to be removed from the driving machine motor and brake should the speed of the steps exceed a predetermined value, which shall not be more than 40% above the rated speed. (d) The device shall be of the manual-reset type. Rated speed is at rated load.	N/A	N/A
2	Check for unintentional reversal of the direction of travel	5.4.2.3.2	Check for unintentional reversal of the direction of travel Manual reset required	6.1.6.3.8	Means shall be provided to cause the electric power to be removed from the driving-machine motor and brake in case of reversal of travel while the escalator is operating in the ascending direction. The device shall be of the manual-reset type.	N/A	N/A
3	Check for the closing of the auxiliary brake	5.4.2.2.4	Check for the closing of the auxiliary brake.	N/A	N/A	N/A	N/A

Table B.1 *(continued)*

Table 1		CEN Cross Reference		ASME Cross Reference		JBL Cross Reference BSLJ-EO:Building Standard Law Enforcement Order / MOC-N:Notification of Ministry of Construction	
Id. No.	**Escalator and moving walk safety function**	**CEN clause**	**CEN Text**	**ASME clause**	**ASME Text**	**JBL**	**JBL Implementation**
4	Broken Step-Chain Device	Table 6, e)	Breakage or undue elongation of parts immediately driving the steps, pallets or the belt, e.g. chains or racks. Manual reset required	6.1.6.3.3	Broken Step-Chain Device (a) A broken step-chain device shall be provided, which shall cause the electric power to be removed from the driving-machine motor and brake (1) if a step chain breaks, (2) where no automatic chain tension device is provided, if excessive sag occurs in either step chain. (b) The device shall be of the manual-reset type.	MOC-N 1424.2.1	Check for abnormal elongation of the step (&, pallet) chains
5	Extension or reduction of the distance between the driving and return devices	Table 6, f)	Breakage or undue elongation of parts immediately driving the steps, pallets or the belt, e.g. chains or racks. Manual reset required	N/A	N/A	N/A	N/A
6	Comb-Step Impact Devices.	5.7.3.2.6	Check for foreign bodies being trapped at the point where the steps, pallets or the belt enter the comb	6.1.6.3.13	Comb-Step Impact Devices. Devices shall be provided that will cause the opening of the power circuit to the escalator driving-machine motor and brake.	N/A	N/A
7	Escalator Egress Restriction Device.	Table 6-h	Stopping of a succeeding escalator or moving walk where an intermediate exit does not exist (see A.2.7) or the exit of the escalator or moving walk by structural measures is blocked (e.g. shutters, fire protection gates)	6.1.6.3.7 6.1.6.6	Escalator Egress Restriction Device. Egress restrictors that would prevent the free and continuous exiting of passengers, if used, shall provide a signal to a device on the escalator that shall cause the electric power to be removed from the escalator driving machine motor and brake when the exit restrictors begin to close. Tandem Operation. Tandem operation escalators shall be electrically interlocked where traffic flow is such that bunching will occur if the escalator carrying passengers away from the intermediate landing stops. The electrical interlocks shall stop the escalator carrying passengers into the common intermediate landing if the escalator carrying passengers away from the landing stops. These escalators shall also be electrically interlocked to assure that they run in the same direction.	MOC-N 1424.2.3	Stopping of escalator or moving walk when a shutter provided around landings starting to close.

Table B.1 *(continued)*

Table 1		CEN Cross Reference		ASME Cross Reference		JBL Cross Reference BSLJ-EO:Building Standard Law Enforcement Order / MOC-N:Notification of Ministry of Construction	
Id. No.	**Escalator and moving walk safety function**	**CEN clause**	**CEN Text**	**ASME clause**	**ASME Text**	**JBL**	**JBL Implementation**
8	Check for foreign bodies being trapped in the handrail entry	5.6.4.3	Check for foreign bodies being trapped in the handrail entry	6.1.6.3.12	Handrail Entry Device. A handrail entry device shall be provided at each newel. It shall be operative in the newels in which the handrail enters the balustrade. It shall be of the manually reset type and shall cause the escalator to stop by removing power from the driving-machine motor and brake.	MOC-N 1424.2.5	Check for foreign bodies being trapped in the handrail entry
9	Check for the sagging of step or pallet	5.7.2.5	Check for the sagging of step or pallet Manual reset required	6.1.6.3.11	Step Level Device. Step level devices shall be located at the top and bottom of the escalator. These devices shall detect downward displacement of 3 mm (0.125 in.) or greater at the riser end at either side of the step. When activated, the device shall cause the escalator to stop before the step enters the comb plate. The device shall cause power to be removed from the driving-machine motor and brake. Devices shall be of the manual-reset type.	N/A	N/A
10	Check for a missing step or pallet	5.3.6	Check for a missing step or pallet	6.1.6.5	6.1.6.5 Missing Step and Missing Dynamic Skirt Devices a) A device shall be provided to detect a missing step and bring the escalator to a stop, before the gap resulting from the missing step emerges from the comb. The device shall cause power to be removed from the driving-machine motor and brake. The device shall be of the manual-reset type. (b) For escalators with dynamic skirts, a device shall be provided to detect a missing dynamic skirt panel and bring the escalator to a stop, before the gap resulting from the missing dynamic skirt panel emerges from the balustrade. The device shall cause power to be removed from the driving-machine motor and brake. The device shall be of the manual-reset type.	N/A	N/A
11	Check for non-lifting of the braking system	5.4.2.1.1	Check for non-lifting of the braking system after starting the escalator or moving walk	N/A	N/A	N/A	N/A

Table B.1 *(continued)*

Table 1		CEN Cross Reference		ASME Cross Reference		JBL Cross Reference BSLJ-EO:Building Standard Law Enforcement Order / MOC-N:Notification of Ministry of Construction	
Id. No.	**Escalator and moving walk safety function**	**CEN clause**	**CEN Text**	**ASME clause**	**ASME Text**	**JBL**	**JBL Implementation**
12	Check for hand rail speed deviation	5.6.1	Check for hand rail speed deviation of more than –15 % to the actual speed for more than 15 s	6.1.6.4	Handrail Speed Monitoring Device. A handrail speed monitoring device shall be provided that will cause the activation of the alarm required by 6.1.6.3.1(b) without any intentional delay, whenever the speed of either handrail deviates from the step speed by 15% or more. The device shall also cause electric power to be removed from the driving-machine motor and brake when the speed deviation of 15% or more is continuous within a 2 s to 6 s range. The device shall be of the manual-reset type.	BSLJ-EO 129.12.1.3 Reference for design	It is recommended to provide a device to stop escalators/moving walks when stopping of a handrail is detected or speed of handrails delayed abnormally from the steps.
13	Check for opened inspection cover	5.2.4	Check for opened inspection cover in the area of the truss	N/A	N/A	N/A	N/A
14	Check manual hand winding means	5.4.1.5	Check manual hand winding means	N/A	N/A	N/A	N/A
15	Stopping switch for emergency situations	5.12.2.2.3	Stopping switch for emergency situations	6.1.6.3.1	Stopping switch for emergency situations	BSLJ-EO 129.12.4	A device to stop escalators shall be located at the landings.
16	Drive-Chain Device.	5.4.1.3.2	Safety factor for driving elements.	6.1.6.3.4	Drive-Chain Device. When the driving machine is connected to the main drive shaft by a chain, a device shall be provided that will cause the application of the brake on the main drive shaft, and will also cause the electric power to be removed from the driving machine motor and brake if the drive chain between the machine and the main drive shaft becomes disengaged from the sprockets. The device shall be of the manual reset type.	MOC-N 1424.2.1 Note for design	Check for breakage of driving chain.

Table B.1 *(continued)*

Table 1		CEN Cross Reference		ASME Cross Reference		JBL Cross Reference BSLJ-EO:Building Standard Law Enforcement Order / MOC-N:Notification of Ministry of Construction	
Id. No.	**Escalator and moving walk safety function**	**CEN clause**	**CEN Text**	**ASME clause**	**ASME Text**	**JBL**	**JBL Implementation**
17	Escalator Skirt Obstruction Device.	N/A	N/A	6.1.6.3.6	Escalator Skirt Obstruction Device. Means shall be provided to cause the electric power to be removed from the escalator driving-machine motor and brake if an object becomes caught between the step and the skirt as the step approaches the upper or lower comb plate. The device shall be located at a point at which the step assumes a flat step position (see 6.1.3.6.5). The escalator shall stop before that object reaches the comb plate with any load up to full brake rated load with escalator running [see 6.1.3.9.3(a)(2) and (b)(2)].	MOC-N 1424.2.4	Passenger or an object becomes caught between the step and the skirt near the landings.
18	Maintenance and repair stop switch	5.8.4	Maintenance and repair stop switch	6.1.6.3.5	Stop Switch in Machinery Spaces.	N/A	N/A
19	Step Up thrust Device.	N/A	N/A	6.1.6.3.9	Step Up thrust Device. Means shall be provided in the passenger-carrying line of the track system to detect a step forced upward in the lower transition curve at or prior to the point of tangency of the horizontal and curved track. The means shall actuate when the riser end of the step is displaced upward more than 5 mm (0.20 in.) at the lower landing. Actuation of the means shall cause power to be removed from the driving- machine motor and brake. The escalator shall stop, before the detected step reaches the comb plate with any load up to brake rated load with escalator running [see 6.1.3.9.3(a)(2) and (b)(2)].	N/A	N/A
20	Disconnected Motor Safety Device.	N/A	N/A	6.1.6.3.10	Disconnected Motor Safety Device. If the drive motor is attached to a gear reducer by means other than a continuous shaft, mechanical coupling, or toothed gearing, a device shall be provided that will cause the electric power to be removed from the driving-machine motor and brake (see 6.1.5.3.1), if the motor becomes disconnected from the gear reducer. The device shall be of the manual-reset type.	N/A	N/A

Table B.1 *(continued)*

Table 1		CEN Cross Reference		ASME Cross Reference		JBL Cross Reference BSLJ-EO:Building Standard Law Enforcement Order / MOC-N:Notification of Ministry of Construction	
Id. No.	**Escalator and moving walk safety function**	**CEN clause**	**CEN Text**	**ASME clause**	**ASME Text**	**JBL**	**JBL Implementation**
21	Step Lateral Displacement Device	N/A	N/A	6.1.6.3.14	Step Lateral Displacement Device. A device shall be provided on curved escalators to cause the opening of the power circuit to the escalator driving machine motor and brake, should a step be excessively displaced horizontally due to a failure in the lateral support system. The device shall be of the manual reset type.	N/A	N/A
22	Stop switch in inspection controls	5.12.2.5.3	Stop switch in inspection controls	6.1.6.3.15	6.1.6.3.15 Stop Switch in Inspection Controls.	N/A	N/A
23	Dynamic Skirt Panel Obstruction Device.			6.1.6.3.16	Dynamic Skirt Panel Obstruction Device. Means shall be provided to cause the electric power to be removed from the escalator driving-machine motor and brake if an object becomes caught between the dynamic skirt panel and the dynamic skirt panel cover in the upper or lower transition zone. The device shall be of the manual-reset type.	N/A	N/A
24	Check Dynamic Skirt Panel in place	5.3.6					
25	Check inspection station actuation	5.12.2.5.4					

Annex C
(informative)

Example of risk reduction decision table

An example of a risk-reduction decision table for the application of PESSRAL is given as Table C.1 and the associated corrective action is summarized in Table C.2. The definition of the consequences is as follows:

a) catastrophic: total loss of the safety objective within the scope of the standard;

b) critical: permanent partial loss of the safety objective within the scope of the standard;

c) marginal: temporary loss of the safety objective within the scope of the standard;

d) negligible: negligible or no loss of the safety objective within the scope of the standard.

Table C.1 — Risk reduction decision table

Frequency			Severity			
Potential frequency for effect *F*	**Mean value per year per unit escalator or moving walk**	**Mean value for total (2 000) population per year**	**1 High**	**2 Medium**	**3 Low**	**4 Negligible**
$F \geq 0{,}01$	0,01	20	IA	IIA	IIIA	IVA
$0{,}001 \geq F < 0{,}01$	0,005	10	IB	IIB	IIIB	IVB
$0{,}000\ 1 \geq F < 0{,}001$	0,000 5	1	IC	IIC	IIIC	IVC
$0{,}000\ 01 \geq F < 0{,}000\ 1$	0,000 05	0,1	ID	IID	IIID	IVD
$0{,}000\ 001 \geq F < 0{,}000\ 01$	0,000 005	0,01	IE	IIE	IIIE	IVE
$F < 0{,}000\ 001$	$4{,}166\ 67 \times 10^{-7}$	0,000 833 333	IF	IIF	IIIF	IVF

Table C.2 — Corrective action - Risk reduction requirements

IA, IB, IC, ID, IE, IIA, IIB, IIC, IIIA, IIIB	Corrective action required to mitigate the effect and if practicable, eliminate it
IID, IIE, IIIC, IIID, IVA, IVB	Review and determine if any further mitigation is technically practicable
IF, IIF, IIIE, IIIF, IVC, IVD, IVE, IVF	No action required

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