TECHNICAL SPECIFICATION

ISO/TS 22559-2

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Safety requirements for lifts (elevators) —

Part 2:
Safety parameters meeting the global essential safety requirements (GESRs)

Exigences de sécurité des ascenseurs —

Partie 2: Paramètres de securité repondant aux exigences essentielles de sécurité globale des ascenseurs

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 22559-2 was prepared by Technical Committee ISO/TC 178, *Lifts, escalators and moving walks.*

ISO/TS 22559 consists of the following parts, under the general title *Safety requirements for lifts (elevators)*:

— *Part 1: Global essential safety requirements (GESRs)*

— *Part 2: Safety parameters meeting the global essential safety requirements (GESRs)*

The following parts are under preparation:

— *Part 3: Global conformity assessment procedures (GCAP) — General requirements*

— *Part 4: Global conformity assessment procedures (GCAP) — Certification and accreditation requirements*

Introduction

This part of ISO/TS 22559 was prepared in response to the need to set global safety parameters for lifts (elevators).

The objective of ISO/TS 22559 (all parts) is to:

a) define a common global level of safety for all people using, or associated with, lifts (elevators);

b) facilitate innovation of lifts (elevators) not designed according to existing local, national or regional safety standards, while maintaining equivalent levels of safety. If such innovations become state of the art, they can be integrated into the detailed local safety standard at a later date;

c) help remove trade barriers.

ISO/TS 22559-1 establishes global essential safety requirements (GESRs) for lifts (elevators) by addressing hazards and risks that can be encountered on a lift (elevator). The GESRs, however, state only the safety objectives of a lift (elevator).

This part of ISO/TS 22559 provides guidance and criteria for achieving conformance with safety requirements of GESRs by specifying global safety parameters (GSPs) for use and implemention, where applicable, in a lift (elevator) to eliminate hazards or mitigate safety risks addressed in the GESRs. However, GSPs are not mandatory.

Clause 4 describes the approach and methodology used in the development of this part of ISO/TS 22559. Clause 5 gives instructions for the use and implementation of GSPs. The GSPs are presented in Clause 6 in the sequence of GESRs in ISO/TS 22559-1.

This part of ISO/TS 22559 is a product safety standard in accordance with ISO/IEC Guide 51.

Safety requirements for lifts (elevators) —

Part 2:
Safety parameters meeting the global essential safety requirements (GESRs)

1 Scope

1.1 This part of ISO/TS 22559:

a) specifies global safety parameters (GSPs) for lifts (elevators), their components and their functions;

b) complements the system and methods specified in ISO/TS 22559-1 for mitigating safety risks that can arise in the course of the operation and use of, or work on, lifts (elevators).

NOTE Hereinafter, the term “lift” is used instead of the term “elevator”.

1.2 This part of ISO/TS 22559 is applicable to lifts that can

a) be located in any permanent and fixed structure within or attached to a building, except lifts located in

1) private residences (single family units), or

2) means of transport, e.g. ships,

b) have any

3) rated load, size of load-carrying unit (LCU) and speed, and

4) travel distance and number of landings,

c) be affected by fire in the load-carrying unit, earthquakes, weather or floods,

d) be foreseeably misused (e.g. overloaded), but not vandalized.

1.3 This part of ISO/TS 22559 does not specifically cover

a) all the needs of users with disabilities[1], or

b) risks arising from

1) work on lifts under construction, during testing, or during alterations and dismantling,

2) use of lifts for firefighting and emergency evacuation,

3) vandalism,

4) fire outside the LCU,

5) explosive atmosphere,

6) transportation of dangerous goods.

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1) Although the GESRs mentioned in this part of ISO/TS 22559 have been identified and evaluated by risk assessment, not all disabilities or combinations of disabilities of users have necessarily been addressed.

2 Normative references

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

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

ISO 14119, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

ISO 14120:2002, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 14122-2:2001, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 14122-3:2001, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

ISO 14122-4, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*

ISO 14798:2009, *Lifts (elevators), escalators and moving walks — Risk assessment and reduction methodology*

ISO 15534-1, *Ergonomic design for the safety of machinery — Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery*

ISO 15534-2, *Ergonomic design for the safety of machinery — Part 2: Principles for determining the dimensions required for access openings*

ISO 15534-3, *Ergonomic design for the safety of machinery — Part 3: Anthropometric data*

ISO 22199, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Emission*

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

ISO/TS 22559-1:2004, *Safety requirements for lifts (elevators) — Part 1: Global essential safety requirements (GESRs)*

3 Terms and definitions

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

3.1
authorized person
person with authorization to access restricted lift areas [e.g. machinery spaces, lift well (hoistway), pit and LCU top] and to work therein, for the purpose of inspecting, testing, repairing, and maintaining the lift or for rescuing users from a stalled load-carrying unit (LCU)

[ISO/TS 22559-1:2004, definition 3.1]

3.2
cause
circumstance, condition, event, or action that in a hazardous situation contributes to the production of an effect

[ISO 14798:2009, definition 2.1]

3.3
counterweight
mass that contributes traction in the case of a traction lift, or mass that saves energy by balancing all or part of the mass of the LCU (car) and the rated load

[ISO/TS 22559-1:2004, definition 3.5]

3.4
door
landing or LCU mechanical device (including devices that partially or fully enclose the opening) used to secure an LCU or landing entrance

3.5
effect
result of a cause in the presence of a hazardous situation

[ISO 14798:2009, definition 2.2]

3.6
electromagnetic compatibility
EMC
degree of immunity to incident electromagnetic radiation and level of emitted electromagnetic radiation of electrical apparatuses

3.7
essential safety requirement
ESR
requirement intended to eliminate or sufficiently mitigate the risk of harm to users, non-users and authorized persons using, or associated with, lifts

3.8
fully loaded load-carrying unit
fully loaded LCU
LCU (car) with its rated load

3.9
global essential safety requirement
GESR
globally agreed upon essential safety requirement

See 3.7.

3.10
global safety parameter
GSP
globally agreed upon safety parameter

See 3.33.

3.11
harm
physical injury or damage to the health of people, or damage to property or the environment

[ISO/IEC Guide 51:1999, definition 3.3] [ISO 14798:2009, definition 2.3]

3.12
harmful event
occurrence in which a hazardous situation results in harm

[ISO/IEC Guide 51:1999, definition 3.4] [ISO 14798:2009, definition 2.4]

3.13
hazard
potential source of harm

[ISO/IEC Guide 51:1999, definition 3.5] [ISO 14798:2009, definition 2.5]

3.14
hazardous situation
circumstance in which people, property or the environment are exposed to one or more hazards

[ISO/IEC Guide 51:1999, definition 3.6] [ISO 14798:2009, definition 2.6]

3.15
well (GB)
hoistway (US)
travel path(s) of the LCU and related equipment, plus the spaces below the lowest landing and above the highest landing

3.16
hoistway enclosure (US)
well enclosure (GB)
fixed structural elements that isolate the well (hoistway) from all other areas or spaces

3.17
landing
floor, balcony or platform used to receive and discharge persons or goods (freight) from the LCU

3.18
life cycle
period of usage of a component or a lift system

[ISO 14798:2009, definition 2.7]

3.19
lift (GB)
elevator (US)
lifting appliance intended to transport persons with or without goods or freight by means of a power-operated load-carrying unit that is guided by a fixed guiding system from one landing to another, at an angle of more than 75° to the horizontal

NOTE 1 This term does not include mobile or other working platforms or baskets, or lifting appliances used in the course of construction of buildings or structures.

NOTE 2 See ISO/TR 11071-1:2004, Clause 2, for use of the term “lift” versus the term “elevator” in current national standards for lifts.

[ISO/TS 22559-1:2004, definition 3.19]

3.20
load-carrying unit
LCU
car
part of a lift designed to carry persons and/or other goods for the purpose of transportation

[ISO/TS 22559-1:2004, definition 3.20]

3.21
machinery space
space inside or outside the well (hoistway), which contains the lift's mechanical equipment, and can also contain electrical equipment used directly in connection with the lift

NOTE This space can also contain the electric driving machine, the hydraulic machine or means for emergency operation.

3.22
maintenance
process of examination, lubrication, cleaning, adjustment and routine replacement of lift parts to ensure the safe and intended functioning of the lift and its components after completion of the installation and throughout its life cycle

3.23
non-user
person in the vicinity of a lift, but not intending to access or use the lift

3.24
overload
overloaded
load in the LCU that exceeds the rated load of the lift

3.25
platform
part of the LCU that accommodates persons and load for the purpose of transportation

3.26
protective measures
means used to reduce risk

NOTE Protective measures include risk reduction by inherently safe design, protective devices, personal protective equipment, information for use and installation and training.

[ISO/IEC Guide 51:1999, definition 3.8] [ISO 14798:2009, definition 2.8]

3.27
rated load
load that the lift is designed and installed to transport

3.28
relative movement
situation where a lift component moves in the vicinity of another lift component that is stationary or that moves at a different speed or in a different direction

NOTE This can also occur in a situation where a lift component moves in the vicinity of a structure where persons can be present.

EXAMPLE Building floor surrounding the lift well (hoistway).

3.29
risk
combination of the probability of occurrence of harm and the severity of that harm

[ISO/IEC Guide 51:1999, definition 3.2] [ISO 14798:2009, definition 2.10]

3.30
risk analysis
systematic use of available information to identify hazards and to estimate the risk

[ISO/IEC Guide 51:1999, definition 3.10] [ISO 14798:2009, definition 2.11]

3.31
risk assessment
overall process comprising a risk analysis and a risk evaluation

[ISO/IEC Guide 51:1999, definition 3.12] [ISO 14798:2009, definition 2.12]

3.32
risk evaluation
consideration of the risk analysis results to determine if the risk reduction is required

[ISO 14798:2009, definition 2.13]

3.33
safety parameter
SP
quantitative unit, the value of which, in the form of numerical values or references to International Standards or other standards, provides a level of safety consistent with that provided by relevant standards in current use in the lift industry and good engineering practices

3.34
scenario
sequence of a hazardous situation, cause and effect

[ISO 14798:2009, definition 2.14]

3.35
severity
level of potential harm

[ISO 14798:2009, definition 2.15]

3.36
transportation
process in the course of which persons enter, or goods are moved into, an LCU, which is then lifted or lowered to another landing, where the person exits, or goods are removed from, the LCU

3.37
travel path
path and related space between the lift terminal landings within which an LCU travels

NOTE For "space" above and below terminal landings, see 3.15.

3.38
uncontrolled movement
situation where

— the LCU moves when, according to the design of the lift, it was to remain stationary, or

— the LCU travels at a speed that is beyond the control of the means designed and intended to control the LCU speed during the lift operation

EXAMPLE 1 The LCU starts to move away from a landing while the users are entering or leaving the LCU due to failure or breakdown of lift components, such as the speed control or brake system.

EXAMPLE 2 The LCU speed exceeds its designed speed or does not decelerate or stop as intended due to failure or breakdown of lift components, such as the speed control or brake system.

3.39
user
person using the lift for the purpose of normal transportation, without any help or supervision, including a person carrying goods and a person using a specially dedicated operating system to transport goods or loads

NOTE An example of use of a specially dedicated operating system is "independent service" for transport of hospital patients, whereby the operation of the lift is under the sole control of the patient's attendant.

3.40
vandalism
deliberate destruction of, or damage to, property for no obvious gain or reason

3.41
working area
working space
area or space defined for use by authorized persons to perform maintenance, repair, inspection or testing of the lift

4 Development of global safety parameters (GSPs)

4.1 Purpose of GSPs

4.1.1 To enable verification that the lift and its selected components and functions have achieved safety objectives of applicable GESRs, GSPs, such as strength, clearances, acceleration or retardation values, are provided in this part of ISO/TS 22559 in the form of numerical values or references to International Standards or other standards.

4.1.2 According to ISO/TS 22559-1:2004, 5.1.5, “a GESR states only the safety objective, or 'what' shall be done or accomplished but not 'how' to accomplish the objective. Therefore, in order to achieve the safety objective of a GESR, appropriate designs of lift components and functions shall be selected and their compliance with the GESR shall be verified.”. ISO 14798 describes a risk assessment process that can help to establish that the GESRs have been fulfilled with a specific design or lift configuration. In order to mitigate specific risks identified in the risk assessment process, specific components, functions or GSPs may be used.

4.1.3 ISO/TS 22559-1 and this part of ISO/TS 22559 do not mandate the use of specific designs of components and functions (such as specific designs of “safety gear”, “door interlocks” or “spring buffers”) as they are commonly specified and required in prescriptive lift standards. Such components and functions are not mandated in this part of ISO/TS 22559 as that would inhibit design innovations.

4.1.4 All applicable GESRs shall be fulfilled, in accordance with ISO/TS 22559-1, irrespective of whether or not there is a GSP specified in this part of ISO/TS 22559.

4.2 Approach

4.2.1 As was the case with development of ISO/TS 22559-1, the development of this part of ISO/TS 22559 also involved experts from various parts of the world working in three regional study groups (North American, European and Asia-Pacific). Specialized task groups carried out research in areas, such as anthropometric, ergonomic, spatial and environmental influences by review of relevant International Standards and other standards.

4.2.2 Individual experts and task groups derived safety parameters from independent research of existing standards, anthropometric data, clearances, forces, etc. and a comparison of major codes. GSPs that were determined to provide sufficient mitigation of risks related to relevant GESRs are included in this part of ISO/TS 22559.

5 Understanding and implementing GSPs

5.1 Overall objective

5.1.1 Consistent with the purpose described in 4.1, global safety parameters in relation to individual GESRs are specified in Clause 6.

5.1.2 The objective of the global safety parameters in Clause 6 is to

a) introduce parameters that provide universal means to demonstrate compliance with GESRs, and

b) stimulate the harmonization of safety parameters in existing national and regional standards.

5.1.3 To accomplish the safety objective of a GESR, a GSP, although not mandatory, may be an adequate means of achieving compliance. The list of GSPs in Table 2 is not exhaustive.

Table 2 specifies fixed minimum or maximum values. Where the GSP gives a possible range of values in the referenced International Standards, dependent on the circumstance in which it is used, justification that the correct value has been chosen can be required to suit the particular hazardous situation(s).

5.1.4 Listed GSPs should not be interpreted as the only measure of conformity with a GESR. Conformance with a GESR may be achieved by deviating from the listed GSPs, provided that the risk is mitigated using other equally effective protective measures. Parameters consistent with good engineering practices or selected from applicable codes or standards may be used. In such cases, it shall be demonstrated that the type of parameters chosen

a) sufficiently mitigate the risk addressed in the GESR, and

b) ensure that any new risks created by implementation of the parameter(s) are sufficiently mitigated.

NOTE See ISO 14798 (e.g. ISO 14798:2009, 4.4.1.3).

5.2 Properties and use of GSPs

5.2.1 GSPs

5.2.1.1 The GSPs are listed in Table 2.

NOTE 1 International Standards and other standards have been used wherever applicable for developing GSPs as they represent long-standing history in lift safety or scientifically developed data which has been applied for some time in safety-related applications. The other standards include lift safety codes, electrical codes, anthropometric standards and various materials standards. In all cases, the use of the relevant standard is to assist the user of this part of ISO/TS 22559.

NOTE 2 This part of ISO/TS 22559 recognizes that slightly different or non-identical values for safety-related criteria have been used around the world in order to ensure the safe operation of lifts. Examples of these are safety factors, space sizes to prevent body part entry, space sizes to allow body part entry, forces, deceleration levels and illumination levels. In many cases, the values vary only slightly (e.g. as a result of conversions of imperial to SI units of measurement or due to different origins of the units). Nevertheless, these slightly differing values have proven to result in safe lift operation over many years.

5.2.1.2 Safety factors should be considered relative to the material being used and its application, based on good engineering practice.

5.2.1.3 It is recognized that electronic safety devices and programmable electronic systems in safety-related applications (i.e. PESSRAL) are being extensively used in many industries. Where used in lift safety applications, guidance on safety integrity levels (SILs) is provided in ISO 22201.

For devices using electro-mechanical or non-programmable electronic devices, methods such as Failure Modes and Effects Analysis (FMEA) should be considered to establish the safety level.

5.2.1.4 The values in Table 2 are globally harmonized values based upon current applicable national or regional standards, with the recognition that some of the values are not absolute in nature.

5.2.1.5 When existing national, regional or international lift safety standards are revised, these GSPs, (i.e. these values and generic International Standards) should be considered.

5.2.2 Process of implementing GSPs

In evaluating a lift system or component for compliance with a particular GESR, the following risk assessment and risk reduction process, in accordance with ISO 14798, shall be applied:

a) the risk scenario, which includes the hazardous situation addressed in a GESR and the harmful event, shall be formulated;

b) risk shall be estimated, evaluated and assessed;

c) if the risk level requires mitigation, protective measures are proposed. The protective measures should eliminate the hazard or reduce the risk. Reducing the risk may include implementing GSPs;

d) after applying the protective measures, the risk shall be re-assessed. Step c) shall be repeated until the risk has been sufficiently mitigated;

e) if a new hazard is created as a result of mitigating a given risk, the risk resulting from this new hazard shall be fully mitigated using the above-mentioned process.

5.2.3 Ways of using GESRs and GSPs

5.2.3.1 With respect to a specific task affecting lift safety, such as designing a lift or its components, GESRs and related GSPs may be used in two ways, namely

a) one can begin with the risk assessment of scenarios related to the task in order to identify the applicable GESRs and related GSPs, as in 5.2.3.2, or

b) one can begin with a review of all GESRs in order to identify those that can be applicable to the task, as in 5.2.3.3.

NOTE In addition to designing, tasks can include installing or servicing, or writing design-prescriptive safety standards for lifts or their components.

5.2.3.2 When designing a lift or its components, a review of the intended use, foreseeable misuse (see ISO 14798:2009, 4.5.5.4) and design should be made, in which all possible risk scenarios are formulated and risk assessment is performed in order to find out which, if any, GESRs and relevant GSPs are applicable to the design. All risk scenarios that could occur during operation and use should be considered, as well as during the maintenance, repair or inspection of the lift.

The risk scenarios shall include specifications of all hazardous situations, combined with all harmful events (i.e. causes, effects and possible levels of harm). The risk analysis of a scenario shall be followed by the process of risk estimation and evaluation in accordance with the methodology specified in ISO 14798. As long as a risk is assessed as not sufficiently mitigated, the proposed design has to be continually improved until the applicable GESRs have been fulfilled.

EXAMPLE By following this process, risk scenarios similar to those in Case 1.1 or 1.2 of Table 1 can be formulated and it can be concluded that there is a possibility of injury to persons exposed to shearing, crushing or abrasion hazards. The assessment of the risk indicates that the risk needs further mitigation, which should be achieved by changing the design. If this is not feasible, further mitigation should be achieved by implementing other protective measures in order to comply with GESR 6.1.5 and the corresponding GSP specified in Table 2.

NOTE 1 For the practical use of GESRs, see ISO/TS 22559-1:2004, 5.2.

NOTE 2 Rationales for the GESRs, given in notes following each GESR in Table 2, are intended to provide further understanding of the intent and use of GESRs.

5.2.3.3 The process may start with the review of GESRs. In this case, one considers the design or actual installation of the lift or its components, with the intent of identifying those GESRs that could be applicable to the design, installation of the lift or its components. Compliance with each identified GESR shall be assessed. If the compliance is not self-evident, risk assessment shall be completed to demonstrate compliance.

EXAMPLE In the case of the GESR 6.1.5 in Case 1.1 or 1.2 of Table 1, one would observe the lift design or installation to find out whether any person travelling in the LCU, entering or exiting the LCU, or being around the lift travel path or well (hoistway), or in a similar situation, can be exposed to shearing, crushing, abrasion or a similar hazard that can cause harm.

5.2.4 Applicability of GESRs and GSPs

When analysing the safety of a lift design or component, or when writing a design-prescriptive requirement or standard, the applicability of all GESRs should be determined. Only systematic descriptions of all risk scenarios combined with the risk assessment of all scenarios (see ISO 14798) determine applicability of individual GESRs and relevant GSPs.

Table 2 addresses safety hazards in specific GESR. The relevant GSP(s) given for a GESR does/do not necessarily mitigate all risks relevant to a specific lift system, component or function. However, such risks would be addressed by another GESR and associated relevant GSP(s).

5.2.5 Safety objectives of GSPs

5.2.5.1 When designing a lift, appropriate components and functions should be selected in terms of specific GSPs (see Table 2). Examples are size, dimensions, strength, force, energy, material and acceleration. Reliability of performance of safety-related parts, as applicable, and their ability to eliminate or sufficiently mitigate the risks to achieve compliance with the objective specified in the GESR should be established.

5.2.5.2 Table 1 contains examples that illustrate the methods described in 5.2.3.1 a) and b). The examples are consistent with the corresponding examples in ISO/TS 22559-1:2004, Table 1.

a) Cases 1.1, 1.2, 2.1 and 2.2 illustrate the method described in 5.2.3.1 a), where a GESR and corresponding GSP are used to mitigate a risk.

b) Cases 3 and 4 illustrate the method described in 5.2.3.1 b), where applicable GESRs are identified, and a risk assessment is carried out on a specific scenario. A GSP is used to mitigate the risk.

c) The examples are not comprehensive, in that other risks pertaining to the scenarios are not addressed. A comprehensive risk assessment would address all risks.

5.2.5.3 In Case 1.1 or 1.2 of Table 1, in order to eliminate or mitigate the risks to persons inside the LCU, in the lift entrance area and in the area around the LCU travel path, the following shall be determined:

a) the minimum height of the guards or walls on the sides of the LCU platform to avoid the shearing, crushing and abrasion hazard;

b) the maximum perforation (openings) in the LCU guards or walls, if any;

c) the maximum permissible impact, force, speed, kinetic energy, if any, of the door when closing on the person;

d) the minimum height of the guards or wall separating the LCU travel path and other moving components from the lift landing and floor area around the lift;

e) the maximum perforation (openings) in the guards or walls around the travel path, if any.

NOTE 1 There are additional GESRs applicable to the guards on LCU sides (see also GSP for GESR 6.4.4 in Table 2) and LCU travel path or well (hoistway) sides (see 6.2.1 in Case 2.1 or 2.2 of Table 1 and GSP for GESR 6.2.1 in Table 2). They are related to the risk of persons falling into the travel path from the LCU and from the floors around the travel path.

NOTE 2 All GESR headings from ISO/TS 22559-1:2004 are listed in Table 2 and aligned with their relevant GSPs.

Table 1 — Anthropometric and design data — Examples of risk scenarios related to GESRs and GSPs using method described in 5.2.3.1 a)

Case no.	Scenario			Estimation of risk elements		Protective measures (risk reduction measures)	After protective measures		Residual risk
	Hazardous situation	Harmful event		S	P		S	P	
		Cause	Effect						
1.1	Users are on a moving LCU that has low or perforated guards on its sides.	User extends a hand or protrudes a foot beyond the LCU perimeters; the hand or foot engages with external lift objects.	User's hand or foot is sheared, crushed or cut.	2	B	Remark: This hazard is addressed by GESR 6.1.5. Conform to GSP 6.1.5 [p1] Where a full imperforate enclosure is not provided, see ISO 13857. [p2] Where an enclosure is provided on all sides, but is perforated, see ISO 13857:2008, Tables 5 and 6, and 4.2.2 and 4.2.3. [p3] Where an enclosure is not provided on all sides, see ISO 13857:2008, Table 2, for the distances a, b and c, Figures 1 and 2, and 4.2.2 and 4.2.3.	4	E	None
1.2	Users are in the lift entrance area and enter the LCU when the entrance door is closing.	The doors contact the users who are entering the LCU.	Persons are crushed or sheared or they are destabilized, possibly resulting in an injury due to a fall.	2	A	Remark: This hazard is address by GESR 6.1.5 and 6.3.1. Conform to GSPs 6.1.5 and 6.3.1.	3	E	None

Comments:

1. The level of severity of harm in Case 1.1 is reduced from 2 to 4 as the hazard is effectively eliminated by design changes consistent with relevant International Standards. The level of probability of occurrence of harm has been reduced from B to E.

2. The level of severity of harm in Case 1.2 is reduced from 2 to 3 as the force and kinetic energy has been reduced, but not eliminated. The level of probability of occurrence of harm has been reduced from A to E.

3. This example is not comprehensive in that other risks (e.g. falling from the LCU) are not addressed. A comprehensive risk assessment would address all risks.

Table 1 (*continued*)

Case no.	Scenario			Estimation of risk elements		Protective measures (risk reduction measures)	After protective measures		Residual risk
	Hazardous situation	Harmful event		S	P		S	P	
		Cause	Effect						
2.1	There are no guards between the LCU travel path and the floors surrounding the travel path, high above the bottom of the well (hoistway). A person is standing close to the well (hoistway).	A person leans over the floor edge or the entrance opening sill.	The person falls down the well (hoistway).	1	A	Remark: This hazard is addressed by GESR 6.2.1. Conform to GSP 6.2.1 [p1] Landing doors to resist impact with 100 kg mass moving at 3 m/s velocity (this results in an impact energy value of 450 J and allows permanent deformation with structural integrity).	1	F	None
2.2	Guards in Case 1.1 are provided, but do not have adequate strength. Users in LCU.	A person leans against the guard.	The person breaks through the guard and falls down into the well (hoistway).	1	C	[p2] Well wall(s) of sufficient height and strength should be provided in accordance with local regulations. NOTE See also remarks in GSP 6.2.1 relating to static and dynamic forces in Table 2. Remark: This hazard is addressed by GESR 6.1.5 and 6.3.1. Conform to GSPs 6.1.5 and 6.3.1.	1	F	None

Comment:

After the guards or enclosures around the LCU and the well (hoistway) have been put in place, the level of severity of harm remains the same as the height between the landing and the well (hoistway) floor is the same (i.e. falling hazard remains), but the level of probability of occurrence of harm has been reduced to F.

Table 1 (*continued*)

Case no.	Scenario			Estimation of risk elements		Protective measures (risk reduction measures)	After protective measures		Residual risk
	Hazardous situation	Harmful event		S	P		S	P	
		Cause	Effect						
3	Users or non-users have access to lift machinery and the equipment installed to move or control the LCU.	A person inadvertently or deliberately comes into contact with moving or rotating machinery or electrical equipment.	This contact results in death or serious injury if the person is drawn into or comes into contact with the machinery; or the person is electrocuted if he comes into contact with exposed electrical equipment.	1	C	Conform to GSP 6.1.3 [p1] Where a full imperforate enclosure is not provided, see ISO 13857. [p2] Where equipment is covered on all sides, but the guards are perforated, see ISO 13857:2008, Tables 5 and 6, for mechanical protection. [p3] Where equipment is not covered on all sides, see ISO 13857:2008, Table 2, for the distances a, b and c, and Figures 1 and 2. [p4] For electrical protection, see GESR 6.1.9. Conform to GSP 6.1.9	1	E	Hazardous spaces can be left open and unlocked, and non-authorized persons can enter, thus becoming exposed to hazards.
Comment: The risk level 2E falls into Risk Group II (see ISO 14798:2009, Table D.3), but the review of the residual risk concluded that no further protective measures are needed.									

Table 1 (*continued*)

Case no.	Scenario			Estimation of risk elements		Protective measures (risk reduction measures)	After protective measures		Residual risk
	Hazardous situation	Harmful event							
		Cause	Effect	S	P		S	P	
4	An authorized person is working on top of the LCU or in some other working space.	The working space does not have sufficient strength to support the authorized person and tools. The working surface collapses.	The authorized person falls into the LCU or into the well (hoistway) sustaining serious injuries.	2	B	Conform to GSPs 6.5.4 [p1] Working platforms shall be provided in accordance with ISO 14122-2. [p2] Ladders shall be provided in accordance with ISO 14122-3 or ISO 14122-4.	2	F	None

Comment:

After the strength and size of the working area is properly designed, the level of probability of occurrence of harm is reduced from B to F.

A Highly probable B – Probable C – Occasional D – Remote E – Improbable F – Highly improbable

P Level of probability of occurrence of harm[a].

S Levels of severity of the harm[a]:

1 High 2 Medium 3 Low 4 Negligible

[a] See ISO 14798:2009, 4.5.3.1 and 4.5.4.1.

5.3 Use of ISO/TS 22559-1 and this part of ISO/TS 22559

5.3.1 Users

This part of ISO/TS 22559 shall supplement ISO/TS 22559-1 in providing a uniform process for assessing the safety of lifts. The GESRs and GSPs are intended for use by

a) writers of safety or safety-related standards for lifts,

b) lift designers, manufacturers and installers, and maintenance and service organizations,

c) independent [third-party] conformity assessment bodies, and

d) inspection and testing bodies and similar organizations.

NOTE For details on the procedures followed by these types of users, see ISO/TS 22559-1:2004, 5.3.2 to 5.3.5. For an overview of GESRs, in relation to lift subsystems, see ISO/TS 22559-1:2004, Annex A.

6 Global safety parameters

GSPs listed in Table 2 shall be applied as described in Clause 5.

GSPs are grouped in Table 2 in the same order as GESRs are grouped in ISO/TS 22559-1, which is based on locations where a person can be exposed to a hazard, such as spaces adjacent to a lift, lift entrance and egress, space inside the LCU and working areas. Users of this part of ISO/TS 22559, who prefer the regrouped GESRs and related GSPs based on the lift subsystems, should use ISO/TS 22559-1:2004, Table A.1.

Table 2 — Global safety parameters (GSPs) for specific GESRs

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
6.1 Common GESRs and GSPs related to persons at different locations (ISO/TS 22559-1:2004, 6.1)		
1. Supports for lift equipment (ISO/TS 22559-1:2004, 6.1.1)	[p1] The relevant parameters for this GESR are illustrated under other GESRs (e.g. for foreseeable overload), see 6.4.1 [p3].	Regarding safety factors: these should take account of — material properties, — intended use and loading conditions, including foreseeable overloads, — life cycle, — dynamic conditions (e.g. counterweight jump), and — building regulations, national codes and standards. Regarding building interface: interfaces between the lift equipment and the building should be taken into consideration, including any supporting beams, brackets and attachments of guides to walls.

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
2. Lift maintenance and repair (ISO/TS 22559-1:2004, 6.1.2)	No parameter required.	Remarks on "appropriate instructions": The maintenance instructions shall contain appropriate information such as: a) a schedule of maintenance operations; b) the need to address any relevant local regulations, other requirements, and their implications on the lift maintenance; c) the need for maintenance to be carried out by a qualified maintenance organization employing competent personnel.
3. Equipment inaccessible to users and non-users (ISO/TS 22559-1:2004, 6.1.3)	[p1] Where a full imperforate enclosure is not provided, see ISO 13857. [p2] Where equipment is covered on all sides, but is perforated, see ISO 13857:2008, Tables 5 and 6, for mechanical protection. [p3] Where equipment is not covered on all sides, see ISO 13857:2008, Table 2, for the distances a, b and c, and Figures 1 and 2. [p4] For protection against electrical hazards, see GESR 6.1.9.	
4. Floors of the LCU and working areas (ISO/TS 22559-1:2004, 6.1.4)	[p1] No ledges or non-uniform projections > 6 mm. [p2] For guidance on slipping, see ISO 14122-2:2001, Annex A. [p3] Slope of LCU floors ⩽ 1 % (during normal operation). [p4] Slope of working areas ⩽ 5 %.	Comments on [p1]: Many floor finishes for both public and industrial applications require the use of patterned floor surfaces to enhance resistance to slip by providing greater traction between the floor surface and the user's footwear or to produce harder-wearing surfaces. Many such floor coverings achieve this by having uniform projections and recesses that are not considered tripping hazards. [p1] Does not apply to equipment projections in the vicinity of working areas.

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
5. Hazards due to relative movement (ISO/TS 22559-1:2004, 6.1.5)	[p1] Where a full imperforate enclosure is not provided, see ISO 13857. [p2] Where enclosure is provided on all sides, but is perforated, see ISO 13857:2008, Tables 5 and 6, and 4.2.2 and 4.2.3. [p3] Where enclosure is not provided on all sides, see ISO 13857:2008, Table 2, for the distances a, b and c, and Figures 1 and 2, and 4.2.3 and 4.2.3.	Comment on [p2]: An imperforate enclosure is preferred. However, where an enclosure with perforations is provided, care should be taken where objects can pass through and cause injury. See also 6.3.1.
6. Locking landing doors and closing LCU door (ISO/TS 22559-1:2004, 6.1.6)	[p1] Well (hoistway) or LCU door is not closed if gap $>$ 10 mm. [p2] When locked, locking device to resist an opening force $\geqslant$ 1 000 N.	Comments on [p1]: For side-opening doors, 10 mm shall be measured from jam to door edge. For centre-opening doors, 10 mm shall be measured from door edge to door edge. Any powered movement of LCU with open doors is unacceptable, except those mentioned in NOTE 2 of the GESR. Comments on [p2]: Parameter [p2] is intended to be applied to horizontally sliding doors. For other types of doors, different parameters can need to be considered. The well (hoistway) door can still be locked, even if it is open up to $<$ 10 mm.
7. Evacuation (ISO/TS 22559-1:2004, 6.1.7)	[p1] For guidance on openings for access and egress, see Annex A (anthropometric data) and ISO 15534-1.	Remark: See also GSP 6.3.4.

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
8. Sharp edges (ISO/TS 22559-1:2004, 6.1.8)	See remarks.	Remarks: Sharp edges present a cutting, shearing or scraping hazard if exposure to body parts occurs. Removal of sharp edges should be considered as the first course of action. The radius of an edge which sufficiently mitigates the risk of injury and satisfies the GESR depends on the following: — material properties of the edge; — surface finish of the edge; — relative velocity of body part to the edge at the time of contact; — level of protection (if any) of the body part, e.g. clothing. Moreover, the probability of contact influences the risk. The risk can also be mitigated by shielding the user from the sharp edge. Good engineering practice, considering all the variables, should be used in reaching a safe conclusion.
9. Hazards arising from the risk of electrical shock (ISO/TS 22559-1:2004, 6.1.9)	[p1] For guidance, see — IEC 60204-1, — IEC 60364-4-41, — IEC 60529, — IEC 61140, and — IEC/TS 61201. NOTE Local regulations and standards can apply.	Points to be considered a) Protection with regard to direct contact: — enclosure barrier; — insulation of live parts; — limited energy; — protective impedance; — voltage limitation; — protective separation between circuits. b) Additional protection by residual current-operated protective device (RCD) c) Protection with regard to indirect contact: — double reinforced insulation; — basic insulation and protective bonding; — additional protection by RCD.

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
10. Electromagnetic compatibility (ISO/TS 22559-1:2004, 6.1.10)	[p1] Immunity in accordance with ISO 22200 [p2] Emissions in accordance with ISO 22199 or local regulations	
11. Illumination of LCU and landings (ISO/TS 22559-1:2004, 6.1.11)	[p1] For illumination on landings: ⩾ 50 lux. [p2] For illumination in the LCU: ⩾ 50 lux at floor level and on control devices. [p3] For emergency illumination in the LCU: ⩾ 2 lux on lift control and emergency devices, including instructions, if any, for ⩾ 1 h.	Comment related to [p1]: The provision of illumination on the landing is normally included in the building lighting system. Comments related to [p1], [p2] and [p3]: Manufacturers should design their products to achieve a level of illumination as indicated in the parameters, on the floor and on the control device. However, the practical consideration of different LCU finishes and degradation of the light source over time leads to small changes in the actual level of light under site conditions. The parameters are intended to safeguard against tripping hazards and to provide guidance in locating control devices in both normal and emergency operations. This can be achieved if the lighting levels are within a small variance of the figures given in ISO/TS 22559-1.
12. Effects of earthquake (ISO/TS 22559-1:2004, 6.1.12)	[p1] For guidance, see ISO/TR 25741. NOTE Local regulations or standards apply.	
13. Hazardous materials (ISO/TS 22559-1:2004, 6.1.13)	NOTE Local standards and regulations apply.	
14. Environmental influences (ISO/TS 22559-1:2004, 6.1.14)	NOTE Local standards and regulations apply.	

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
6.2 GESRs and GSPs related to persons adjacent to the lift (ISO/TS 22559-1:2004, 6.2)		
15. Falling into the well (hoistway) (ISO/TS 22559-1:2004, 6.2.1)	[p1] Landing doors and well (hoistway) wall(s), where accessible, to resist impact with 100 kg mass moving at 3 m/s velocity. NOTE 1 This results in an impact energy value of 450 J and allows permanent deformation with structural integrity. NOTE 2 Local regulations for well (hoistway) walls can also be considered.	Remark: See also GSP 6.1.6 for door locking strength. a) Dynamic forces The typical case is represented by the impact against the landing door of an individual moving at walking speed. More rarely, but not improbably, the impact speed can be that of a person running. Forces resulting from the energy of dynamic impact on doors and walls are difficult to estimate, since their values are related to the percentage of energy transmitted (coefficient of restitution), and also to the design of the landing door. It is very unlikely, for normal lift applications, that the LCU walls would be subject to high-energy impacts. Typically, the body impact takes place at shoulder or hip level. The design of lift landing doors, frames and attachments should integrate the shock of a heavy human body (i.e. 100 kg) moving at 3 m/s. b) Static forces Equivalent static forces that can be imposed on the doors and walls are less than those produced by the dynamic force requirements covered in [p1].
6.3 GESRs and GSPs related to persons at the entrances (ISO/TS 22559-1:2004, 6.3)		
16. Access and egress (ISO/TS 22559-1:2004, 6.3.1)	[p1] Height of door: ⩾ 2 000 mm. [p2] Door clear opening: ⩾ 800 mm. [p3] LCU out of level tolerance: ⩽ 20 mm. [p4] Door kinetic energy: ⩽ 10 J at average closing speed; ⩽ 4 J at reduced closing speed (nudging). NOTE The average closing speed is calculated not including the final 50 mm for side-closing doors or 25 mm for centre-opening doors at each end. [p5] Door closing force: ⩽ 150 N, applied after the first one third of its travel.	Comment on [p1]: There is a trend for younger generations of people to be taller. Nevertheless, a 2 000 mm clear height for lift doors is sufficient for a safe access and egress for the vast majority of the world's population. Some countries where the trend of population height increase is more acute (Netherlands, Scandinavia) might have other local requirements (e.g. 2 100 mm). Comment on [p2]: A door clear opening of 800 mm permits the access of most of the wheelchairs designed to International Standards.

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
		More significant openings may be justified by the intended use of the lift. Comment on [p3]: The parameter is intended to reduce the risk of tripping associated with the difference in level of the LCU sill position with the sill of the landing under stopping, loading, levelling and re-levelling conditions. While the intent for the designer is clearly to produce a product where such misalignment is reduced to the minimum, technology used in the control of lift movement inevitably leads to some change in levels under different operating conditions, e.g. rope stretch and hydraulic fluid compression. Comment on [p4]: The normal operation of typical lift doors develops a kinetic energy which has an order of magnitude of 10 J, in average, which is generally indicated in the lift safety codes as the maximum accepted value for door impacts. Comment on [p5]: The normal operation of typical lift doors requires a pulling/pushing force on the door panels of 120 N to 150 N, a value which is generally indicated in the lift safety codes as the maximum accepted value for door closing force. This order of magnitude of the closing force alone is not harmful for typical lift use.
17. Horizontal sill-to-sill gap (ISO/TS 22559-1:2004, 6.3.2)	[p1] Gap $\leqslant$ 35 mm. NOTE See also GSP for 6.3.3.	Comment on [p1]: The intent of this parameter is to prevent the risk of tripping at the entrance threshold due to persons' footwear entering the gap or becoming trapped in it.
18. Alignment of the LCU and landing (ISO/TS 22559-1:2004, 6.3.3)	[p1] LCU out of level tolerance: $\leqslant$ 20 mm. NOTE See also GSP for 6.3.2.	Remark: The state of the art today states that acceptable stopping accuracy is around 10 mm to 13 mm. The parameter of 20 mm includes movement of the LCU due to loading and unloading.

Table 2 (*continued*)

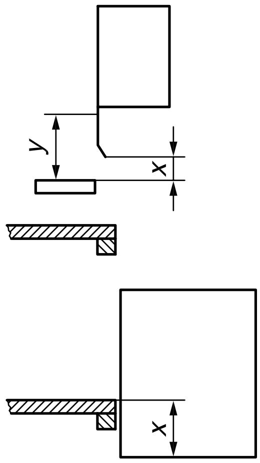
GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
19. Self-evacuation from an LCU (ISO/TS 22559-1:2004, 6.3.4)	[p1] The landing doors cannot be unlocked and opened from inside the LCU when it is outside the unlocking zone which is the maximum distance: $y \leqslant 500$ mm. [p2] Vertical opening between bottom of LCU (e.g. apron) and landing: $x \leqslant 100$ mm	Rationale for [p1]: Falls from a height of up to 500 mm are covered in ISO 14122-3:2001, 7.1.2. Rationale for [p2]: 110 mm is the dimension of a child's chest depth as shown in item 28 of Annex A. For simplicity, 100 mm is used in [p2].  x max. vertical opening y max. distance
20. Gap between the landing doors and LCU doors (ISO/TS 22559-1:2004, 6.3.5)	[p1] Space between coupled sliding doors: $\leqslant$ 140 mm. [p2] Space between LCU flexible door and hinged landing door: $\leqslant$ 100 mm.	Comment on [p1]: 140 mm is the typical value based on the most commonly used horizontally sliding LCU and landing door arrangements. Other door arrangements should be subject to appropriate considerations. Comment on [p2]: For swinging and folding doors, the space is considered to be any space between the doors, when the doors are fully closed. NOTE See also 6.1.3.
21. Means to reopen doors when the LCU is at landing (ISO/TS 22559-1:2004, 6.3.6)	GESR is self-explanatory.	Comment: This GESR is not intended to eliminate the “nudging” (i.e. closing doors at reduced speed) function.

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
6.4 GESRs and GSPs related to persons in the LCU		
22. Strength and size (ISO/TS 22559-1:2004, 6.4.1)	[p1] For guidance on LCU dimensions and rated loads, see ISO 4190-1. [p2] Take into account the overload ⩾ 125 % of the rated load. NOTE In some specific cases, where the rated load is lower than is typical, the rated load can be significantly exceeded and, in this event, the overload shall be adjusted accordingly to take this into account. [p3] Clear height of LCU: ⩾ 2 000 mm.	Remark: See also GESRs 6.4.3.and 6.4.6. Comments on “overload” in [p2] Comment 1 There are two concepts of overload: a) Starting overload: the overload at which the lift is permitted to start and operate. This is addressed in comment to GESR 6.4.3. (based on AFNOR comment on 6.4.3) b) static overload the overload that the LCU can physically accommodate and which should be taken into account as a design parameter, e.g. traction calculation. This is addressed in GESRs 6.4.1 and 6.4.2 Comment 2 Experiments have shown that overloads of 25 % of rated loads can be reached by people squeezing into the LCU. This value is widely used in lift standards, and adopted [p2].
23. LCU support/suspension (ISO/TS 22559-1:2004, 6.4.2)	[p1] Take into account the static overload of 125 % of a rated load. [p2] For guidance on factors of safety, see 5.2.1.2. [p3] For guidance on hydraulic components, see ISO/TR 11071-2:2006, Clause 4.	Remark: See comments in 6.4.1.
24. Overloaded LCU (ISO/TS 22559-1:2004, 6.4.3)	GESR is self-explanatory.	Comment: The intent of this GESR is to prevent the LCU from starting when the load is above the rated load. However, there are factors influencing the design, where a reasonable overload can be accommodated to allow the lift to start and operate as indicated in GESR 6.4.1, comment 1 a).

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
25. Falling from an LCU (ISO/TS 22559-1:2004, 6.4.4)	[p1] Gap between LCU platform and well (hoistway) guard: ⩽ 100 mm. [p2] Where the gap is > 100 mm, at a minimum a permanently fixed guard-rail in accordance with ISO 14122-3:2001, 7.1, is to be fitted. [p3] Height of barrier: ⩾ 1,1 m. [p4] Strength of barrier. Barrier to resist force ⩽ 300 N static force with deflection ⩽ 30 mm in accordance with ISO 14122-3:2001, 7.3. Barrier to resist impact: 100 kg at 1,5 m/s. [p5] For maximum barrier apertures, see ISO 13857.	The term "barrier" It is used to mean guards, barriers or wall around the perimeter of the LCU platform. Comment on [p1] to [p5]: These parameters are limited to mitigate falling hazard and not shearing, crushing and other hazards. Comment on [p1]: 100 mm is based on a child's chest depth of 110 mm. See Annex A, item 28. Comment on [p2]: Enclosed LCU barriers are preferable. Comment on [p3]: This parameter only addresses normal operation and not panic situations, entrapments or foreseeable misuse. Comment on [p4]: See commentary on GSP 6.2.1 [p1].
26. LCU travel path limits (ISO/TS 22559-1:2004, 6.4.5)	[p1] For values of deceleration, see 6.4.9. [p2] For guidance on electrical slowdown devices, see 5.2.1.3.	Remark: For refuge spaces beyond travel limits, see 6.5.9.
27. Uncontrolled movement of an LCU (ISO/TS 22559-1:2004, 6.4.6)	[p1] While travelling with all doors closed, any hazardous overspeed of the LCU shall be detected and LCU slowed down with a deceleration ⩽ 1 g. NOTE See GESR 6.4.9 for more on deceleration. [p2] Unintended movement of LCU from landing to address crushing hazard; the movement shall be detected and the LCU stopped within a distance of ⩽ 1 200 mm. Vertical opening between bottom of LCU (e.g. apron) and landing: ⩽ 100 mm.	Comments and rationale: [p1] Hazardous overspeed is considered to be a speed in excess of that for which safety devices are designed. If the LCU exceeds a speed for which the safety devices are rated, the devices can fail or not operate appropriately. Therefore, the overspeed should be detected before such speeds are reached and deceleration of the LCU is initiated. [p2] Unintended movement of car from landings with open doors should be interrupted in consideration of the following: a) Stop the movement before a crushing hazard would become significant. Limiting the movement to 1 200 mm seems appropriate, since this would leave 800 mm clear (with doors of 2 000 mm).

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
		b) Stop the movement in the upward direction before space under the car would allow falling into well (see 6.3.4). Vertical opening between bottom of LCU and landing: $x \leqslant 100$ mm). c) Stop the movement, with deceleration not exceeding 1 g.
28. LCU collision with objects in or beyond the travel path (ISO/TS 22559-1:2004, 6.4.7)	GESR is self-explanatory.	Remark: See 5.2.1.3.
29. LCU horizontal and rotational motion (ISO/TS 22559-1:2004, 6.4.8)	[p1] Average horizontal acceleration: $\leqslant$ 0,1 g. [p2] No peak horizontal acceleration: $>$ 0,1 g for durations $>$ 0,125 s.	Comments on [p1] and [p2]: Stability of standing people subject to accelerations in the horizontal plane, as a result of back and forth, transverse or rotational velocity changes, is affected by the resultant acceleration magnitude, direction and time of exposure. Stability criteria established in North America for inclined lifts indicate that an average resultant horizontal acceleration of $\leqslant$ 0,1 g is appropriate, provided no peak value in excess of 0,1 g is present for $>$ 0,125 s. These parameters are more than sufficient for the normal use of lifts as defined in this part of ISO/TS 22559.
30. Change of speed or acceleration (ISO/TS 22559-1:2004, 6.4.9)	[p1] Average deceleration rate: $\leqslant$ 1 g. [p2] No peak retardations: $>$ 2,5 g for durations $>$ 0,04 s.	Remark: Study of risks involving emergency stopping has not been completed; therefore, traditional values are proposed for this edition.
31. Objects falling on the LCU (ISO/TS 22559-1:2004, 6.4.10)	GESR is self-explanatory.	Remark: Location of equipment and machinery inside the well should be given special consideration to address this hazard.
32. LCU ventilation (ISO/TS 22559-1:2004, 6.4.11)	GESR is self-explanatory.	Remark: Local weather conditions should be considered.
33. Fire/smoke in LCU (ISO/TS 22559-1:2004, 6.4.12)	GESR self-explanatory.	Remark: Local standards apply.
34. LCU in flooded areas (ISO/TS 22559-1:2004, 6.4.13)	GESR self-explanatory.	Remark: Local standards apply.
35. Stopping means inside the LCU (ISO/TS 22559-1:2004, 6.4.14)	GESR self-explanatory.	

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
36. Landing indication (ISO/TS 22559-1:2004, 6.4.15)	[p1] For guidance, see ISO 4190-5.	Remarks: When providing indication, factors, such as size, illumination and location of letters, numerals and symbols should be taken into consideration. Other issues, such as audible indication and tactile characteristics, may also be considered. Local accessibility requirements may also be considered.
6.5 GESRs and GSPs related to persons in working areas (ISO/TS 22559-1:2004, 6.5)		
37. Working space (ISO/TS 22559-1:2004, 6.5.1)	[p1] Minimum dimensions to stand or move: — apply ISO 15534-1, ISO 15534-2 and ISO 15534-3, using 99th percentile values. [p2] Minimum distance to danger zones shall be protected with — guard/cover in accordance with ISO 13857:2008, 4.2.1 and 4.2.2, and Table 1, or — guard/cover in accordance with ISO 14119 and ISO 14120. [p3] Openings in protective structure or guard/cover shall be in accordance with — ISO 13857. [p4] Electric shock — see 6.5.11	Remark: Also comply with applicable local requirements defined by local regulations. Equipment that is maintained should be readily accessible.
38. Accessible equipment (ISO/TS 22559-1:2004, 6.5.2)	[p1] For guidance, see ISO 13854, ISO 13857 and ISO 14122 (all parts). NOTE See also 6.5.1, 6.5.4 and 6.5.9.	
39. Access to and egress from working spaces in the well (hoistway) (ISO/TS 22559-1:2004, 6.5.3)	[p1] Vertical distance between access point and workspace — The vertical distance is ⩽ 0,5 m, in accordance with ISO 14122-3:2001, 7.1.2. — If the distance is more than 0,5 m, a ladder in accordance with ISO 14122-4 shall be used. [p2] Escape openings — Crawling height: ⩾ 365 mm	Comments: [p1] Provides guidance for normal access and egress. [p2] For guidance, the lift movement should be inhibited or limited to a position which leaves an opening for egress, when a person is at a working place. The minimum crawling height dimension of 365 mm is derived from an adult body thickness of 342 mm (see Annex A, item 20) plus a work clothing allowance of 20 mm (see Annex A, item 4), plus rounding.

Table 2 (*continued*)

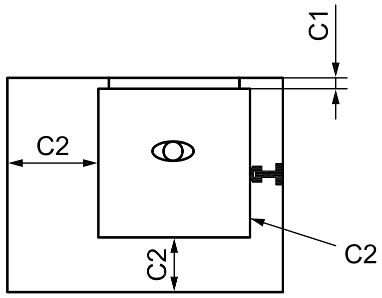
GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
40. Strength of working areas (ISO/TS 22559-1:2004, 6.5.4)	[p1] Working platforms shall be provided in accordance with ISO 14122-2.	[p1] For guidance on design loading, see ISO 14122-2:2001, 4.2.5.
41. Restrictions on equipment in lift spaces (ISO/TS 22559-1:2004, 6.5.5)	GESR is self-explanatory.	Remark: Local regulations pertaining to sprinklers, lighting, ventilation, etc. in lift spaces can apply.
42. Falling from working areas (ISO/TS 22559-1:2004, 6.5.6)	[p1] If falling height is > 500 mm, falling hazard is to be mitigated by limiting gap (see C1 and C2) ⩽ 300 mm. [p2] If gap (see C1 and C2) > 300 mm, a barrier should be fitted around working area in accordance with ISO 14122-3:2001, 7.1 and 7.3.	
43. LCU movement under control of an authorized person (ISO/TS 22559-1:2004, 6.5.7)	[p1] While movement is under the control of the authorized person, the LCU travel speed is ⩽ 0,75 m/s.	Remark: The intent of the GESR is generally accomplished by instruction and training of authorized persons and appropriate tools and equipment. It is common practice during maintenance for the speed of the LCU to be low (see [p1]), since stopping is normally provided by the brake. Furthermore, many other factors should be considered when designing this type of control system, e.g. constant pressure buttons, disconnecting landing calls.
44. Uncontrolled, unintended equipment movement inside the well (hoistway) (ISO/TS 22559-1:2004, 6.5.8)	[p1] For guidance on deceleration values, see 6.4.9. [p2] For guidance on speed values, see 6.5.7.	
45. Means of protection from various hazards (ISO/TS 22559-1:2004, 6.5.9)	[p1] For guidance on shearing and crushing protection, see ISO 13857 and ISO 13854.	Remark 1: See also 6.4.5. For guidance on temperatures of touchable surfaces, see local requirements. Remark 2: For guidance on entrapment, see 6.1.7.
46. Falling objects in the well (hoistway) (ISO/TS 22559-1:2004, 6.5.10)	GESR is self-explanatory.	Remark: Location of equipment and machinery inside the well should be given special consideration to address this hazard.

Table 2 (*continued*)

GESR	GSPs referenced in this part of ISO/TS 22559[a]	Remark/illustration/comment
47. Electric shock in working spaces (ISO/TS 22559-1:2004, 6.5.11)	[p1] For guidance, see 6.1.9.	
48. Illumination of working spaces (ISO/TS 22559-1:2004, 6.5.12)	[p1] Well illumination ⩾ 50 lux at 1 m above work places. [p2] Machinery spaces illumination (see definition) ⩾ 200 lux at work places.	

[a] Before using any GSPs from Table 2, 5.1.3, 5.1.4 and 5.2.2 shall be conformed to, in order to ensure that all hazards are sufficiently addressed.

Annex A
(informative)

Anthropometric and design data summary

The dimensions shown in Table A.1 have been taken from many sources, as shown. The dimensions given are the result of studies of persons and should be taken as guidance when establishing design criteria.

Values given are based on the 95th percentile, which is adequate to avoid crushing. However, to avoid parts of the body passing through a particular gap, the 5th percentile should be used.

Unless stated at a minimum, dimensions given in this annex accommodate 95 % of the population (e.g. item 6, "foot length: 285 mm" indicates that 95 % of the population would have a foot length of 285 mm or less).

It is advisable, when using the dimensions given in this annex, to consult with the sources for explanations and diagrams of the parameters and dimensions.

Table A.1 — Anthropometric and design data

Item	Parameter	Dimension mm	Source
Anthropometric data			
1	Standing height with arm in extension – Adult (over head fingertip reach)	2 393	U.S. Army
2	Body reaching side-to-side – Adult (span tip-to-tip)	1 960	U.S. Army
3	Grip reach (forward reach) – Adult	820	ISO 15534-3
4	Spaces allowing “free” movements Allowance for work clothing	100 20	ISO 15534-2
5	Foot width – Adult	113	ISO 15534-3
6	Foot length – Adult	285	ISO 15534-3
7	Foot thickness – Adult	96	ISO 15534-2
8	Shoe length – Adult	320	ISO 3411
9	Shoe width – Adult	115	ISO 3411
10	Arm length – Adult	782	Humanscale
11	Arm diameter – Adult	120	ISO 15534-3
12	Hand breadth (width) – Adult	97	ISO 15534-3
13	Hand depth (thickness) – Adult	30	ISO 15534-3
14	Hand length – Adult	205	ISO 3411
16	Finger diameter[a] – Adult	32	Humanscale
17	Finger length – Adult	88	ISO 15534-2
18	Body height – Adult	1 881	ISO 15534-3
19	Body shoulder width – Adult	495	Humanscale
20	Body thickness – Adult	342	ISO 15534-3
21	Body weight[b] (kg) – Adult	98,3	U.S. Army

Table A.1 (*continued*)

Item	Parameter	Dimension mm	Source
22	Crouching dimensions height – Adult	1 220	ISO 15534-2
23	Crouching dimensions depth – Adult	790	Humanscale
24	Crouching dimensions width (shoulder) – Adult	495	Humanscale
25	Head width – Adult	161	U.S. Army
26	Head length (to nose) – Adult (tip of nose to back of head)	240	ISO 15534-3
27	Head height – Adult (chin to top of head)	247	U.S. Army
28	Chest depth – Child	110	Anthrokids
29	Chest width – Adult	367	U.S. Army
30	Step height – Adult	152 to 191	Humanscale
31	Climbing height – Distance between ladder rungs	Min. 180 Max. 300	Humanscale
32	Step length (span)	284	Humanscale
33	Hips width – Adult	378	Humanscale
34	Elbow-to-elbow breadth – Adult	545	ISO15534-3
Design criteria developed from anthropometric data			
35	Minimum gap to avoid crushing – Adult – Body	500	ISO 13854
36	Minimum gap to avoid crushing – Adult – Head	300	ISO 13854
37	Minimum gap to avoid crushing – Adult – Leg	180	ISO 13854
38	Minimum gap to avoid crushing – Adult – Foot	120	ISO 13854
39	Minimum gap to avoid crushing – Adult – Toes	50	ISO 13854
40	Minimum gap to avoid crushing – Adult – Arm	120	ISO 13854
41	Minimum gap to avoid crushing – Adult – Hand/wrist/fist	100	ISO 13854
42	Minimum gap to avoid crushing – Adult – Finger	25	ISO 13854
43	Minimum gap to avoid crushing – Child – Body (laterally across shoulders)	300	Anthrokids
44	Minimum gap to avoid crushing – Child – Head	200	Anthrokids
45	Minimum gap to avoid crushing – Child – Leg	110	Anthrokids
46	Minimum gap to avoid crushing – Child – Foot	60	Anthrokids
47	Minimum gap to avoid crushing – Child – Toes	25	Assume 1/2 Adult Dimension
48	Minimum gap to avoid crushing – Child – Arm	60	Anthrokids
49	Minimum gap to avoid crushing – Child – Hand/wrist/fist	70	Anthrokids
50	Minimum gap to avoid crushing – Child – Finger	12	Anthrokids

NOTE Anthrokids 95th percentile is M/F – 4,5 to 5,5 years old.

[a] Value to allow access.

[b] Based on 95th percentile of body weight. Applicable to strength, impact and other related criteria. This is not to be used for determining the handling or transportation capacity of lifts.

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