TECHNICAL REPORT

ISO/TR 11071-1

Second edition
2004-07-15

Comparison of worldwide lift safety standards —

Part 1:
Electric lifts (elevators)

Comparaison des normes mondiales de sécurité des ascenseurs —

Partie 1: Ascenseurs électriques

Reference number
ISO/TR 11071-1:2004(E)

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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.

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 exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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/TR 11071-1 was prepared by Technical Committee ISO/TC 178, *Lifts, escalators and moving walks*.

This second edition cancels and replaces the first edition (ISO/TR 11071-1:1990), which has been updated. It also incorporates the Amendments ISO/TR 11071-1:1990/Amd.1:1999, *References to Japanese standards*, and ISO/TR 11071-1:1990/Amd.2:2001, *References to Australian standards*.

ISO/TR 11071 consists of the following parts, under the general title *Comparison of worldwide lift safety standards*:

— *Part 1: Electric lifts (elevators)*

— *Part 2: Hydraulic lifts (elevators)*

Introduction to the first edition (1990)

At the 1981 plenary meeting of ISO/TC 178, work began on a comparison of CEN standard EN 81-1 with the American, Canadian, and USSR safety codes. In 1983, Working Group 4 was officially formed to carry out the task of preparing a cross reference between the relevant sections of these standards and to analyze the differences on selected subjects. The goal at that time was to prepare a technical report which would provide reference information to assist national committees when reviewing and revising individual standards which may initiate gradual convergence of the technical requirements. In 1984, the study was expanded to include the CMEA safety standard.

The content of this report is based on the information provided by the WG 4 members. The information which could not be obtained on the CMEA standard at the time of publication is noted in the report by a "?" in some of the tables.

This report is intended to aid standards writers in developing their safety requirements, and to help standards users understand the basis for the requirements as they are applied throughout the world.

This report is not intended to replace existing safety standards. Conclusions are arrived at in some cases, but only where there is unanimity amongst the various experts. In other cases, the reasons for the divergent views are expressed.

This report must be read in conjunction with the various safety standards, as it was often necessary to summarize the requirements for the sake of clarifying the comparisons. Further, the information contained in this report does not necessarily represent the opinions of the standards writing organizations responsible for the development of the safety standards which are being compared, and they should be consulted regarding interpretations of their requirements (see Annex B).

Introduction to this edition

Since the original publication of this Technical Report in 1990, each standard compared therein has been revised or amended. The recommendations in the form of "agreed upon points" stated in the original report have also affected the revisions of the national standards.

Furthermore, since 1990 two amendments to the original report have been published:

— Amendment 1: References to Japanese standards (1999-04-15); and

— Amendment 2: References to Australian standards (2001-07-15).

The original report and amendments have been widely used by the lift industry and standards writing organizations, including ISO/TC 178. Users have expressed the need for an updated and consolidated version of the document, in particular the comparison tabulations. In response, with Resolution 208/2002, ISO/TC 178 requested WG4 "to update comparison tables in ISO/TR 11071 with data from the most recent published standards for lifts, and to republish both documents, Part 1 and Part 2, with updated tables and with minimum changes to the narrative sections".

The narrative sections of the original publication, in particular the assumptions, historical background, observations and suggestions as well as the points agreed upon, were the result of extensive work by ISO/TC 178 Working group 4. ISO/TC 178 is currently working on a new series of ISO documents under the general title "*Safety requirements for lifts (elevators)*". In that process, the updated comparison tables are being used as a reference. Extensive work on a complete re-write of the narrative sections is not deemed necessary. However, republication of the text with only minor editorial changes would help readers to understand the background to the safety concerns being addressed in the current national standards for lifts. To clarify the scope of the revisions to the narrative sections or clauses, and to minimize inconsistencies between the data in the tables and in the narrative parts, "NOTES" have been inserted.

Comparison of worldwide lift safety standards —

Part 1: Electric lifts (elevators)

1 Scope

This Technical Report consists of a comparison of the requirements of selected topics as covered by the following worldwide safety standards (excluding regional or national deviations):

a) CEN — European Standard EN 81-1:1998, *Safety rules for the construction and installation of lifts — Part 1: Electric lifts*;

b) ASME A17.1-2000 and CSA B44-00, *Safety Code for elevators and escalators*;

c) Building Standard Law of Japan — Enforcement order — Section 2, Elevator equipment, Articles 129-3 to 129-13, as well as year 2000 Ministry of Construction notices:

— Nos. 1413 up to and including 1418;

— Nos. 1423, 1424, 1428 and 1429;

— No. 1597;

d) AS1735.1-2001, *Lifts, escalators and moving walks — Part 1: General requirements*, and AS1735.2-2001, *Lifts, escalators and moving walks — Part 2: Passenger and goods lifts — Electric.*

NOTE 1 The following standards were compared in the original (1990) publication:

— CEN EN 81 – Part 1:1985;

— ASME/ANSI A17.1 (1987 edition plus the A17.a-1988 and A17.1b-1989 addenda);

— CSA/CAN3-B44 (1985 edition plus Supplement 1 – 1987);

— USSR Elevator design and safe operation code (Edition NEDRA, 1971);

— CMEA – Elevator Safety Regulations of the Council for Mutual Economic Assistance.

NOTE 2 Since the 1990 edition:

— the ASME and CSA standards have been harmonized with insignificant deviations, therefore shown in a single tabulation column;

— the USSR and CMEA standards have been withdrawn following the political change to the former Soviet Union and East Block;

— in Russia, the PUBEL document has been issued, which is currently undergoing major revisions;

— therefore, all related references to USSR and CEMA have been removed in this edition and no new data for the Russian Federation have been introduced.

This report applies to electric traction lifts only, although some sections may also be applicable to positive drive lifts suspended by rope or chain.

It should be noted that, in addition to the standards listed above, lifts must conform to the requirements of other standards covering mechanical, structural and electrical equipment.

2 Terminology

NOTE In this section and throughout the document, except the Annexes, the acronyms listed below have the meaning given:

— CEN – EN 81-1:1998;

— ASME – A17.1b–1989;

— CSA – B44 Supplement 1 – 1997;

— AS – AS1735 – Part 1 & Part 2;

— JAPAN – One of standards listed in 1c).

2.1 Lifts and elevators

2.1.1 The term lift as used in the CEN standard is referred to as elevator in ASME and CSA standards. These terms are used interchangeably in this report.

NOTE The term lift is also used in the Australian Standards (AS).

2.1.2 For the purposes of this report, unless otherwise specified, the terms passenger lift and freight lift correspond to the following terms used in CEN standard:

Terms used in this document	Correspond to terms used in the following standards [a c]	
	CEN	**ASME/CSA**
Passenger lift	Lift except non-commercial vehicle lift [b c]	Passenger elevator and freight elevator permitted to carry passengers
Freight lift [b c]	Non-commercial vehicle lift with instructed users [b c]	Freight elevator

[a] See definitions in the applicable standards.

[b] This term is used only to enable comparisons in this report. It does not indicate recognition of the term “freight lift” by CEN.

[c] NOTE: This table has not been updated with EN 81-1:1998 edition. EN 81-1 does not distinguish any more between “passenger lift” and “non-commercial vehicle lift”.

2.2 Electrical safety devices and electrical protective devices

Terms used in this report	Correspond to terms used in the following standards:	
	CEN	**ASME/CSA**
Electrical safety device	Electrical safety device	Electrical protective device

2.3 Safety gear and safeties

The term safety gear as used in the CEN standard is referred to as safeties in ASME and CSA standards. They are used interchangeably in this report.

2.4 Other terms

The following is a list of additional terminology where there is a difference between the English version of the CEN standard and the ASME/CSA standards:

CEN	ASME/CSA
Anti-rebound device	Compensating rope tie down
Docking operation	Truck zone operation
Fixings	Fastenings
Mains	Main power supply
Well	Hoistway
Progressive safety gear	Type B safeties

3 Basis for lift safety standards development (basic assumptions)

3.1 Historical background

NOTE This section has been updated as indicated in notes following a title or subclause.

3.1.1 All lift safety standards assume certain things as being true, without proving them as such, and stipulate safety rules that are based on these assumptions.

3.1.2 No standard, however, clearly spells out the assumptions used. The CEN committee analyzed its standard and summarized in the document CEN/TC10/GT1 N144E (see Annex C) the assumptions that, in the opinion of the CEN committee, were used in the CEN standard.

NOTE EN 81-1:1998 includes some of the assumptions in its Introduction, point 0.3.

3.1.3 The CEN assumptions were compared with assumptions implicitly built into other safety standards. It has been indicated that:

a) some assumptions apparently used in the CEN standard were not listed in the document referred to in CEN/TC10/GT1 N144E;

b) some assumptions used in other standards differ from those in CEN/TC10/GT1 N144E; and

c) some things assumed in all standards as being true have been proven as being false, such as the possibility of overspeeding in the up direction as a result of failures not presently anticipated in existing standards.

NOTE ASME, CSA and CEN standards now recognize the possibility of uncontrolled upward movement.

3.1.4 Using CEN/TC10/GT1 N144E as a model, the following list of assumptions has been developed which could be used as a basis for future work on safety standards.

3.2 General

3.2.1 Listed in 3.3 through 3.10 (except as noted) are those things specific to lifts that are assumed as true, although not yet proven or demonstrated as such, including:

a) functioning and reliability of lift components;

b) human behaviours and endurance; and

c) acceptable level of safety and safety margins.

3.2.2 Where the probability of an occurrence is considered highly unlikely, it is considered as not happening.

3.2.3 Where an occurrence proves that an assumption is false, it does not necessarily prove that all other assumptions are false.

3.2.4 The assumptions should be subject to periodic review by standards writing organizations to ensure their continuing validity - considering accident statistics, as well as such things as changes in technologies, public expectations (e.g. product liability), and human behavior.

3.3 Assumption 1 – safe operation assured to 125 % of rated load

Safe operation of lifts is assured for loads ranging from 0 % to 100 % of the rated load. In addition, in the case of passenger lifts (see 2.1.2), safe operation is also assured for an overload of 25 %, however, it is not necessary to be able to raise this overload nor to achieve normal operation (rated load performance).

3.3.1 Rationale for Assumption 1

3.3.1.1 All safety standards limit the car area in relation to its rated capacity (load and/or number of persons) in order to minimize the probability of inadvertent overloading. However, it is recognized that the possibility of an overloading of up to 25 % still exists on passenger lifts. To eliminate any hazard for passengers, safe operation must be assured, but not necessarily normal operation.

NOTE When a car loaded with 125 % of its rated load is stopped or moving, the passengers' safety must not be affected. However, the lift need not function as when operating with its rated load, e.g. does not have to achieve its rated speed.

3.3.1.2 In the case of freight lifts (see 2.1.2), no overloading is anticipated. It is assumed that designated attendants and freight handlers will adhere to instructions posted in cars and will not overload them.

3.3.2 Assumption 1 as applied in current standards

3.3.2.1 The ratio of the rated load to the car platform areas for passenger lifts is approximately same (within ± 5 %) in all standards for the range of 320 kg to 4 000 kg, and in that respect, universality of the assumption is achieved.

NOTE This statement is based on data in CEN and ASME/CSA standards, not on the current standards listed in the Scope.

However, the assumed average weight of a passenger differs: 75 kg (CEN) and 72,5 kg (CSA), while in ASME it is not specified. Prior to A17.1a-1985 edition, the assumed weight in ASME for purposes of computing the maximum number of passengers which could be safely transported in an emergency was 68 kg.

Furthermore, the rated load to car platform area ratio is different for freight lifts.

3.3.2.2 Lift components that are normally designed to withstand, without permanent damage, overloads greater than 25 % (such as ropes, guides, sheaves, buffers, disconnect switches) are not considered in this comparison.

3.3.2.3 Table 1 shows some of the safety rules for lift components or features (as applicable to passenger lifts) which do not always take into account the case of car overload of 25 %.

Table 1 — Comparison of Components' Ratings (Percentage of Rated Load)

NOTE All data in this Table have been updated as per current standards listed in the Scope of this Second Edition.

Component	EN 81-1:1998	A17.1-2000/ B44-00	AS1735-1:2001	AS1735-2:2001	Japan
Rope traction					
Dynamic	100 % (9.3)	125 % (2.24.2.3.1)	100 % (9.3)	125 % (2.14)	125 % * [BSLJ-EO-129.8 2000 MOC Notice No. 1429(1)(2)]
Static	125 % (9.3)	125 % (2.24.2.3.1)	125 % (9.3)	No spec	125 % * (BSLJ-EO-129.8 2000 MOC Notices No. 1429 & No. 2000)
Mechanical brake alone					
(1) from rated speed	125 % (12.4.2.1)	No load	125 % (12.4.2.1)	125 % (7.10 h)	125 % (BSLJ-EO-129.8 2000 MOC Notices No. 1429 & No. 2000)
(2) at rest	125 %	125 % [2.24.8.3 a)]	125 %	No spec	125 %
(3) from governor trip speed in up direction	No spec	No load	No spec	No spec	No spec
Safety gear **	100 % *** (9.8.1.1)	125 % (2.17.3)	100 % *** (9.8.1.1)	100 % (33.4.1)	100 % [JIS A 4302 4.2.1(6)]

* A 125 % loaded car shall not descend more than 75 mm below floor level due to brake slip, rope slip or rope stretch or any other causes.

** According to CEN, the safety gear is type-tested in free fall. According to ASME and CSA, it is tested on each new installation at governor tripping speed with 100 % of rated load.

*** For progressive safety gear test, 125 % is required in EN 81-1:1998 (see D.2.j.2 i) at rated speed or lower speed.

3.4 Assumption 2 – failure of electrical safety devices

The possibility of a failure of an electrical safety device complying with the requirement(s) of a lift safety standard is not taken into consideration.

Since national safety rules for lifts may be based on different assumptions (some are listed below), universality of Assumption 2 may be questioned.

3.4.1 Rationale for Assumption 2

Reliability and safety performance of lift components designated as electric safety devices is assured if designed in accordance with rules contained in a given lift safety standard. However, the design rules may be based on different assumptions.

3.4.2 Assumption 2 as applied in current standards

Most methods of assuring performance reliability of electrical safety devices are similar in present standards. There are, however, differences and inconsistencies, as detailed in section 12. Section 12.1.3 deals in particular with discrepancies in assumptions implied in requirements for design of electrical safety devices.

3.5 Assumption 3 – failure of mechanical devices

a) With the exception of items listed below, a mechanical device built and maintained according to good practice and the requirements of a standard comprising safety rules for lifts, is assumed not to deteriorate to the point of creating hazards before the failure is detected.

NOTE National practices and safety rules may be different, e.g. as regards safety factors.

b) The possibility of the following mechanical failures shall be taken into consideration:

   1) rupture of car suspension means;

   2) uncontrolled motion of the lift due to:

      — loss of traction while the car, loaded in accordance with Assumption 1, is descending, or stationary;

      — brake failure with car descending, ascending, or stationary;

      — failure of machine components such as shafts, gearing and bearings with the car descending, ascending, or stationary;

   3) rupture and slackening of any connecting means such as safety related auxiliary ropes, chains and belts where the safety of normal lift operation or the operation of a safety related standby component is dependent on such connections.

c) The possibility of a car or counterweight striking a buffer at a speed higher than the buffer's rating is not taken into consideration.

d) The possibility of a simultaneous failure of a mechanical device listed above and another mechanical device provided to ensure safe operation of a lift, should the first failure occur, is not taken into consideration.

3.5.1 Rationale for Assumption 3

3.5.1.1 Although recent accident records do not support the assumption in 3.5 b) 1), most safety standards (including those studied in the preparation of this report) still assume that the risk of suspension means failure, in particular wire ropes, exists.

3.5.1.2 The list of possible mechanical failures in 3.5 b) 2) is compiled on the basis of records of recent accidents, which indicate that the assumptions related to the reliability of certain mechanical components need continual review and revision where necessary. In addition, the list intends to resolve inconsistencies in assumptions used in existing standards.

3.5.1.3 With the assumption in 3.5 b) 3) it is recognized that the listed components could deteriorate to the point of creating a direct or potential hazard (by making a safety related standby component inoperative) before the deterioration is detected.

3.5.2 Assumption 3 as applied in current standards

3.5.2.1 CEN (9.8.1.1) clearly assumes failure of suspension means, while ASME and CSA rules imply that safety gear must be able to stop, or at least slow down, a free falling car.

3.5.2.2 All standards imply that protection in the case of loss of traction of a stationary or descending car must be provided. CEN requires the safety gear to be rated for 100 % of rated load, while traction and the brake are to be rated for 125 %.

3.5.2.3 No standard addresses a loss of traction while the car is ascending.

3.5.2.4 No standard assumes a failure of the brake while the car is ascending. ASME/CSA alone assumes failure of mechanical components of a brake and requires redundancy for such components only (see also 11.1.3).

3.5.2.5 No standard assumes a failure of any of the listed machine components while the car is ascending.

NOTE EN 81-1:1998, ASME A17.1-2000, CSA B44-00 and AS1735:1-2001 and AS1735:2-2001 now recognize the possibility of uncontrolled upward movement of the car.

3.5.2.6 Standards differ significantly in regard to the rupture or slackening of connecting means. Only CEN seems to be consistent in adopting this assumption. Some standards are inconsistent, e.g. ASME/CSA (2.25.2.3.2)* anticipate failure of tapes, chains or ropes operating normal terminal stopping devices but they do not anticipate failure of an overspeed governor rope. Only CEN (9.9.11.3) assumes the possibility of governor rope failure.

*NOTE This reference has been updated as per ASME A17.1-2000 and CSA B44-00.

3.5.2.7 All standards have adopted the assumption that the possibility of a car or counterweight striking buffers at a speed higher than the buffer's rating is not taken into consideration.

3.5.2.8 All standards have adopted the assumption that the possibility of a simultaneous failure of a mechanical device mentioned in Assumption 3 and another mechanical device provided to ensure safe operation of a lift, should the first failure occur, is not taken into consideration.

3.6 Assumption 4 – imprudent acts by users

A user may in certain cases make one imprudent act, intentionally made to circumvent the safety function of a lift component without using special tools. However, it is assumed that:

a) two imprudent acts by users will not take place simultaneously; and

b) an imprudent user's act and the failure of the backup component designed to prevent the safety hazard resulting from such imprudent acts will not take place simultaneously (e.g. a user manipulating an interlock and safety circuit failure).

3.6.1 Assumption 4 as applied in current standards

It would appear that most existing codes are based on this assumption.

3.7 Assumption 5 – neutralization of safety devices during servicing

If a safety device, inaccessible to users, is deliberately neutralized in the course of servicing work, the safe operation of the lift is no longer assured.

3.7.1 Rationale for Assumption 5

If a mechanic, while servicing a lift, neutralizes or circumvents a safety device (e.g. bypassing door interlocks using a jumper cable or readjusting overspeed governor), safe lift operation cannot be assured.

While it is assumed that lifts will be designed to facilitate ease of servicing work and that service mechanics will be equipped with adequate instructions, tools and expertise to safely service lifts, it is recognized that "fail-safe" service work can never be assured solely by the design of a lift.

3.7.2 Assumption 5 as applied in existing standards

Most standards are based on this assumption.

3.8 Assumption 6 – car speed linked to frequency of mains

An alternating current lift motor, connected directly to its mains having constant voltage and frequency, will not allow the lift to reach a speed in excess of 115 % of its rated speed while the motor's connections with the power supply are maintained.

3.8.1 Rationale for Assumption 6

This assumption is based on the inherent feature of an AC squirrel cage motor whose speed is determined by the number of poles of its winding and frequency of its supply. The rotating speed of the motor may vary up to ± 15 % from its synchronous speed, while it is operating as a motor or generator.

3.8.2 Assumption 6 as applied in current standards

CEN uses this assumption (9.9.11.1)*, permitting governor overspeed switches to operate at the same speed at which the governor itself trips. CSA also uses this assumption (3.8.4.1.1)**, permitting governors without an overspeed switch on lifts powered by a squirrel cage motor. Other codes, however, do not consider this assumption to be false.

*NOTE 1 This CEN rule applies to any type of drive but only for rated speeds up to 1 m/s.

**NOTE 2 CSA B44-00 has deleted this permissive rule.

3.9 Assumption 7 – horizontal forces exerted by a person

One person can exert either of the following horizontal forces at a surface perpendicular to the plane at which the person stands:

a) static force – 300 N;

b) force resulting from impact – 1 000 N.

Static forces of short time duration may be exerted by the simultaneous deliberate acts of several people located immediately adjacent to each other at every 300 mm interval along the width of a surface.

3.9.1 Rationale for Assumption 7

It is assumed that a person leaning against a vertical surface will exert these forces at that surface. It is further assumed that more than one person can exert this force on a surface simultaneously. Only by relating force to the width of a surface on which it can be exerted, can a realistic design requirement be obtained.

3.9.2 Assumption 7 as applied in current standards

See Table 2.

Table 2 — Assumption 7 as applied in standards

NOTE All data in this table have been updated as per current standards listed in the Scope.

Component	EN 81-1:1998	A17.1-2000/ B44-00	AS1735-1:2001	AS1735-2:2001	Japan
Static force					
Landing doors	300 N (7.2.3)	2 500 N (2.11.11.5.7)	300 N (7.2.3)	1 200 N (12.4.1)	No spec
Force over area	5 cm^2 at any point on the panel	100 mm x 100 mm	5 cm^2 at any point on the panel	0,1 m^2	No spec
Force per unit area	0,6 N/mm^2	0,25 N/mm^2	0,6 N/mm^2	0,012 N/mm^2	No spec
Car enclosure Force over area	300 N (8.3.2.1) 5 cm^2	330 N (2.14.1.3) No spec	300 N (8.3.2.1) 5 cm^2	330 N (23.18) 5 cm^2	No spec No spec
Impact force					
Impact on landing doors	Pendulum* shock test only when glass is used (7.2.3.3)	5 000 N on landing doors only (2.11)	Pendulum* shock test only when glass is used (7.2.3.3)	No spec	No spec
Impact on car enclosure	Pendulum* shock test only when glass is used (8.3.2.2)	No spec	Pendulum* shock test only when glass is used (8.3.2.2)	No spec	No spec

* The pendulum shock tests – hard and soft – required are described in Annex J of EN 81-1:1998.

3.10 Assumption 8 – retardation

A person is capable of withstanding an average vertical retardation of 1g (9,81 m/s^2), and higher transient retardations.

3.10.1 Rationale for Assumption 8

The retardation which can be withstood without injury varies from person to person. Historically, the values used in the standards (see Table 3) have not been shown to be unsafe for a vast majority of people.