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Comparison of worldwide lift safety standards —

Part 1: Electric lifts (elevators)

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British Standards

National foreword

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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.

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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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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	300 N (8.3.2.1)	330 N (2.14.1.3)	300 N (8.3.2.1)	330 N (23.18)	No spec
Force over area	5 cm^2	No spec	5 cm^2	5 cm^2	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 1*g* (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.

3.10.2 Assumption 8 as applied in current standards

See Table 3.

Table 3 — Assumption 8 as applied in current standards

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

Assumption	EN 81-1:1998	A17.1-2000/ B44-00	AS1735-1:2001	AS1735-2:2001	Japan
Average retardation [a f]					
Safety gear for downwards direction	0,2*g* to 1*g* [g] (9.8.4) [b]	1*g* [h] (2.17.8.2) [b]	0,2*g* to 1*g* [g] (9.8.4) [b]	1*g* [h]	1*g* & 0,5*g* [d e] (BSL-EO Art 129.10 item 1 para. 1)
Buffers	1*g* [c] (10.4.3.3)	1*g* [c] (2.22.4.2)	1*g* [c] (10.4.3.3)	1*g*	1*g* & 0,5*g* [d] (BSL-EO Art 129.10 item 1 para. 1)
Device for "up" overspeed protection	⩽ 1*g* (9.10.3)	⩽ 1*g* [2.19.3.2 e)]	⩽ 1*g* (9.10.3)	No spec	No spec
Maximum retardation					
Safety gear	No spec	No spec	No spec	2,5*g* for 0,04 s	No spec
Device for "up" overspeed protection	No spec (9.10.3)	No spec	No spec (9.10.3)	No spec	No spec
Buffer duration	> 2,5*g* ⩽ 0,04 s (10.4.3.3)	> 2,5*g* ⩽ 0,04 s (2.22.4.2)	> 2,5*g* ⩽ 0,04 s (10.4.3.3)	> 2,5*g* ⩽ 0,04 s (9.6.3)	> 2,5*g* ⩽ 0,04 s (JEAS 517)

[a] Average retardation levels exceeding 1*g* can occur with a lightly loaded car during safety or buffer application.
[b] For progressive safety gears only (applicable to CEN).
[c] At 115 % of nominal speed (applicable to CEN).
[d] 1*g* in vertical direction, over 0,5*g* in horizontal direction. No spec for instantaneous gear or spring buffer (applicable to Japan).
[e] Stopping distance for gradual-type safety is stipulated in JIS A 4302. The value is calculated based on the stopping distance and the speed of actuation of the safety gear (applicable to Japan).
[f] 1*g* = 9,81 m/s^2.
[g] Retardation in free-fall situation.
[h] Retardation with counterweight attached.

4 Spaces and clearances

NOTE Section 4.1 has been updated as per current standards listed in the Scope. References in this section are to the standards instead of to the standards organizations.

4.1 Historical background

4.1.1 The comparison of requirements in the current standards (see Scope) for spaces and clearances is in Annex A, Table A.1. The following are comments on the discrepancies between the requirements.

4.1.2 Guided travel of car. While EN 81-1:1998 quantifies the length of “guided travel of car” (see Table A.1, item 1.1), other standards use performance language to specify that the car shoes shall not leave their guides.

4.1.3 Free height above car roof. Requirements for the free height above the car roof are expressed differently in each standard, but the end results are similar. The A17.1-2000 and B44-00 codes use the phrase “maximum upward travel” which includes the counterweight on its fully compressed buffer, plus any additional movement to take into account the jump of the car upon counterweight buffer engagement. EN 81-1:1998 defines the distance from the position of the car with the counterweight on its fully compressed buffer, plus $0{,}035V^2$. After these distances are taken into account, A17.1-2000 and B44-00 codes require now an additional 1,10 m and EN 81-1:1998 requires 1 m. All of these requirements apply only to a specific area of the car roof intended to be used by persons performing maintenance or inspection.

Requirements for clearances from the equipment located on the tops of cars vary significantly between the standards (see Table A.1, item 1.3).

The top car clearances, according to EN 81-1:1998, are measured from the position of the car when the counterweight is on its fully compressed buffer, while in A17.1-2000 and B44-00 the clearances are measured with the car at the top car landing.

4.1.4 Jump of car. Both EN 81-1:1998 and A17.1-2000/B44-00 allow a reduction in the top of car clearance where means are provided to limit the jump of the car upon counterweight buffer engagement [see Table A.1, item 1.5 b)]. EN 81-1:1998, however, requires that the clearance be increased by a value equal to the possible travel of the compensating sheave (tensioning pulley) plus 1/500 of the car travel (or at least 0,2 m) to take rope-stretch into account. A17.1-2000 and B44-00 do not include this provision. The other standards do not cover this situation.

4.1.5 Refuge space. There are major differences in the requirements for the size and location of the refuge space on the car top (see Table A.1, item 3). While A17.1-2000 and B44-00 require that one face of the rectangular block be located on the car roof, EN 81-1:1998 appears to permit the location of this imaginary block anywhere above the car top equipment. An EN 81-1:1998 interpretation indicates that the projection of the block on the car roof must include the working surface specified in EN 81-1:1998 paragraph 8.13.2.

4.1.6 Bottom runby. There is no requirement for a bottom runby (Table A.1, item 4) in EN 81-1:1998*, while the maximum car and counterweight runbys are specified in A17.1-2000 and B44-00, JAPAN and AS1735 Standards. Bottom car runby is defined in A17.1/B44 as “the distance between the car buffer striker plate and the striking surface of the car buffer when the car floor is level with the bottom terminal landing”. Bottom counterweight runby is defined in A17.1/B44 as “the distance between the counterweight buffer striker plate and the striking surface of the counterweight buffer when the car floor is level with the top terminal landing”.

*NOTE EN 81-1:1998 requires the distance between the terminal landing and the buffer plate to be sufficient to allow the final limit switch to operate.

4.1.7 Pit clearance. The minimum pit clearance (see Table A.1, item 5.1) varies from 0,5 m (EN 81-1:1998) to 0,6 m (A17.1-2000/B44-00 and AS1735-1 and -2:2001).

4.1.8 Well-to-entrance side clearances. For well-to-entrance car-side clearances (see Table A.1, item 6), there are no major discrepancies between the standards, although there are minor differences. Some standards permit cars without doors, and there are also minor differences in the requirements here.

NOTE EN 81-1:1998 no longer permits cars without doors.

4.1.9 Horizontal well clearances. Most standards specify various minimum horizontal well clearances (see Table A.1, item 7) between the car counterweight, and well enclosure, recognizing the risk for passengers and equipment if the running clearances are not maintained. EN 81-1:1998 has omitted most of the requirements except for the car-to-counterweight (item 7.2) and the car-to-car (item 7.6) clearances.

NOTE EN 81-1:1998 now provides requirements depending on the distance between two cars or between counterweights or balancing weights in the same well.

4.1.10 Machine room clearances. There are differences in the requirements for the machine room clearances. Within each standard, the clearances also vary depending on the type of equipment that is located in specific parts of the machine room.

4.2 Observations and suggestions by individual experts

4.2.1 The requirements for spaces and clearances in the standards are significantly different in respect to the concept and the quantity. This is an obvious result of the lack of basic assumptions in respect to the acceptable clearances or spaces that should be based on specified minimum safety level for passengers (clearances around the car entrance), lift mechanics (car top, well, pit, and machine room), or equipment and indirectly passengers (e.g. well-roof-to-car-guide-shoe clearances).

4.2.2 The need for various horizontal well clearances (see Table A.1, item 7) should be re-examined. The requirements could be replaced with a simple performance requirement that the movement of the car or counterweight shall not be obstructed considering their relative displacement caused by wear, tear, deflection expected by elevator use, or by the design of their guiding means.

4.2.3 One expert noted that all of the standards require enough space on the car top to safely accommodate only one person. This assumption, however, is not stated.

4.2.4 While there are differences in hoistway running clearances, refuge spaces, etc., between the various standards, there is no evidence to support any contention that these are deficient in providing safety. Further, there would be no sound reason to propose a reduction to present numerical values without inviting resistance by field employees and possible government intervention.

4.3 Point agreed upon

4.3.1 If reduction in the car top clearances is permitted on lifts with tie-down compensation, the possibility of the compensating pulley (sheave) movement and the rope stretch should be taken into account.

4.3.2 For consistency with car top refuge space requirements, all standards should specify requirements for pit refuge spaces (see Table A.1, item 5.3), that is presently covered only in CEN.

NOTE In addition to EN 81-1:1998, the standards A17.1-2000/B44-00 and AS1735-1 and -2:2001 now also require a pit refuge space.

4.3.3 Regardless of clearances specified, prudent designers must also consider construction tolerances, effects of loading, and wear to assure that the movement of the car and counterweight are not affected.

4.3.4 Refuge spaces are intended to provide adequate space on top of or beneath the elevator car for a person when the car is at the extreme limit of travel.

5 Door systems and interlocks

NOTE This section did not need any updating. Only a few notes have been added pointing to changes in ASME/CSA standards.

5.1 Historical background

5.1.1 General. Every safety standard recognizes that proper closing and locking of landing lift entrances is of paramount importance for the safety of lift users.

Rules are given for door locking devices, for door panels, and for the door-panel interconnecting means.

Comparison of requirements in present standards for horizontally sliding doors is in Annex A, Table A.2.

5.1.2 Door panels. Discrepancies in the requirements for the strength of door panels and their fastenings are significant, ranging from 300 N (CEN) to 5 000 N (CSA/ASME) forces perpendicular to door panels.

The CSA requirements were introduced after a number of persons were fatally injured by falling into the hoistway from a landing where the door panel was dislodged when typically two persons smashed into the door while horse playing in the hallway. Following a series of tests with a soft body of 200 kg impacting in the center of a typical elevator door panel at a speed of 10 km/h, reactions were recorded. The corresponding static force of 5 000 N in the door center was established as design criteria. A safety factor of 1,5 to 2 is assured with that force.

Since a person would not normally exert a force perpendicular to the door panel, but rather at an angle, one component of the force would tend to push the door inwards and the other to lift the door. For that reason, an additional design criterion was added in CSA (Table A.2, item 3).

NOTE The CSA and ASME codes now both have requirements identical to those in the CSA B44 Supplement 1:1989 code.

5.1.3 Locks and contacts. Electrical requirements are similar. Major differences: Some standards do not specify the minimum engagement of the locking pins (Table A.2, item 8) and the minimum strength of the locking member, with a force applied in the direction of door opening (item 10). Electrical checking of closing unlocked panels is required only in CEN.

5.1.4 Testing. Major differences are in the number of test cycles[1)] (Table A.2, items 20 and 21). Also, not all standards require testing of door assemblies including means used for interconnecting locked and non-locked panels.

A survey carried out by an elevator company estimates the number of car stops per year at 100-200 thousand in residential buildings, 300-400 thousand in office buildings and 600 000 in hotels. If the car stops at the main floor landing once in every 3 to 6 stops, the locking device at the main floor would be operated 17 000 to 33 000 times a year in a low-traffic apartment building, up to 100 000 to 200 000 cycles a year in a hotel.

5.2 Observations and suggestions by individual experts

5.2.1 The door assemblies strength requirements in present standards should be re-examined. At least Assumption 7 (see 3.9) should be taken into consideration.

5.2.2 The door lock should never be considered apart from the door even in the case of a single panel, because the lock attachments to the door are important for the locking function. The “linkage” between a door and its lock, as well as between two door components should be specified in greater details. All linkages should be considered as parts of locking systems.

5.2.3 Standards should specify minimum engagement of the lock pin before the electrical contact is closed. Further, the standards should prohibit wear of locking pins during operation (rubbing between moving and stationary locking components).

5.2.4 Locking systems should be tested for endurance through at least 1 million cycles.

NOTE For values in current standards, see Table A.2, items 20 to 23.

5.2.5 The number of cycles in the type test should vary based on the application, type of door system, and frequency of inspection.

5.3 Points agreed upon

5.3.1 The door assemblies strength requirements in most present standards should be re-examined. At least Assumption 7 (see 3.9) should be taken into consideration.

5.3.2 The door lock should never be considered apart from the door even in the case of a single panel, because the lock attachments to the door are important for the locking function. The performance of a lock should be specified in more detail, however, it is not proposed that every possible combination of components be type-tested.

1) Differences have been minimized with changes in the ASME/CSA codes.

5.3.3 Standards should specify minimum engagement of the lock pin before the electrical contact is closed. Further, even if wear occurs, the locking function should not be diminished.

5.3.4 It is agreed that the quality of interlocks must be verified through type testing, however there is no agreement in regard to the number of cycles which should be required. The experience of countries which use 100 000 cycles does not justify an increase to 1 000 000 cycles.

NOTE For values in current standards, see Table A.2, items 20 to 23.

6 Kinetic energy

NOTE No revisions have been made to this section, except that a note concerning instantaneous kinetic energy has been added to 6.3.4.

6.1 Historical background

6.1.1 In preparation for the post-World-War-II major revision to the A17.1 Code which was published in 1955, a Technical Subcommittee on Power Door Operation was formed in 1952 to study the subject of power door closing and to revise the code requirements as necessary. This Subcommittee carried out their study, considering the following points:

a) the industry trend following World War II was toward “operatorless” elevators;

b) passenger reaction and behaviour really sets the human factor limits;

c) the impact of the moving door system is proportional to the kinetic energy of the moving masses;

d) the industry accident experience was relevant;

e) present practice should be considered;

f) instantaneous kinetic energy values as high as 25 ft-lb were common on elevators having attendants;

g) there should be a reduced value of the kinetic energy where there is no door;

h) consideration should be given to the development of rules to regulate the minimum door closing times;

i) the velocity-time curves for the door motion profile should be as flat as possible;

j) from an enforcement perspective, it was desirable to use verifiable criteria which could be checked in the field;

k) marking plates which should specify the maximum door closing speed and kinetic energy should be considered;

l) during the course of the A17 study, a survey was made of subway train doors in the NYC Transit system during which it was found that the subway doors had a 40 lb stall force;

m) future development should not be impeded by unrealistic and/or unnecessary Code limits.

6.1.2 The results of the three-year study by the A17 Technical Subcommittee on Power Door Operation reaffirmed that two engineering parameters should continue to be used: kinetic energy, which addresses the impact of the moving masses; and the stall force, which addresses the potential for crushing a passenger between doors closing from opposite directions or between doors and the door jambs.

6.1.3 The numerical values of these parameters have been in the A17.1 Code since the 1955 edition. These values have also served as the basis for regulating door systems within the US building industry on power-operated doors unrelated to elevators, such as sliding or swinging glass doors.

6.1.4 Table 4 summarizes the A17.1 Code requirements covering the power door closing operation of passenger elevators predating the period when limits were first set and continuing up to the present day.

Prior to the 1931 version of the A17.1 Code, there were no requirements relating to power door closing of passenger elevator doors. However, the 1931 Code did specify limits for the door stall force and kinetic energy, recognizing that it was quite common to have power-closed car doors used in conjunction with manual hoistway doors.

A 30 lb stall force limit was specified for the car doors, and a kinetic energy of 5 ft-lb was allowed for the car door, however, if the car and hoistway doors were coupled, the allowable kinetic energy was increased 40 % to 7 ft-lb. In determining the kinetic energy, an average door closing speed (v_{avg}) across the entire door opening width was taken.

Table 4

NOTE This table has not been revised. For instantaneous KE, see note to 6.3.4.

A17.1 Code	Stall force (lb)		Kinetic energy (ft-lb)			v_{avg}
	C	C & H	C	H	C & H	Basis
Pre-1931	—	—	—	—	—	—
1931	30,0	—	5,0	—	5,0	Full opening
1955 to present	30,0	—	7 (reduced to 2,5 when no reopening device)			Code zone
Notation: C = Car door only. H = Hoistway door only. C & H = Car and hoistway doors.						

6.1.5 With the inclusion of the 1955 requirements in the A17.1 Code, the focus shifted to the hoistway doors, or to both the car and hoistway doors if they were coupled. There is an additional subtlety involving the basis for determining the average closing speed of the doors. Prior to the 1955 Code, it was based on the entire door opening width. In 1955, the average closing speed became based upon the “code zone distance,” which is slightly less than the entire door opening. The A17.1 Technical Subcommittee on Power Door Operation decided during their 1953 study that it was best to discount the slow door travel at the start of the acceleration phase and at the end of the retardation phase. The Subcommittee further concluded that having 2 discrete points which could be marked on the sill would facilitate taking stopwatch readings.

6.1.6 The basis for determining the value of 7 ft-lb for the kinetic energy centered on a typical industry standard entrance measuring 42 in wide and 84 in high. The surface area of the door panel including the overlap at the door jambs was approximately 25,0 ft^2. Based upon conventional door panel construction, i.e. sheet with internal stiffeners, car door panels were assumed to weigh 5,0 lb/ft^2; hoistway doors assumed to weigh 7,0 lb/ft^2. Car door hangers and hoistway door hangers were taken as 25,0 lb per set of doors.

The summary of weights were as follows:

125,0 lb Car door

175,0 lb Hoistway door

50,0 lb Hangers & Rollers

(Car & Hoistway)

10,0 lb Vanes & Hardware

360,0 lb Total

An average door closing speed of 1,0 ft/sec (12,0 in/sec) was used since this was a typical door closing speed used in practice. Using the conventional kinetic energy equation:

$$\text{KE} = \frac{1}{2} MV^2 = \frac{1}{2} \times \frac{(360)(1{,}0)^2}{32{,}2} = 5{,}6 \text{ ft-lb}$$

Recognizing that the kinetic energy of the entire door system is affected by the rotational kinetic energy of the operator motor and transmission (pulley, chains, gearing, arms, etc.), an additional 25 % was added. Therefore, the permissible amount of kinetic energy was established for the case where the doors were provided with a reopening device. In setting the reduced value of the kinetic energy where no reopening device is provided, a 40 % reduction to the average speed which resulted in 7,0 ft-lb kinetic energy would result in the lower value of 2,5 ft-lb.

6.1.7 While the values for door stall force and kinetic energy based upon the average closing speed can be related to the most common size doors used at the time, there is no documentation available that shows any correlation to acceptable levels of impact to the human body. The major problem in trying to establish an impact standard is that there is no such thing as a standard body. The human body contains approximately 200 bones. The stability and strength of the human body to resist impact is dependent upon the relative position of the muscular-skeletal structure at any given time and the inherent elasticity of the bones. Thresholds of discomfort or pain attributable to door impact vary between different parts of the body and from person to person.

6.1.8 The force and kinetic energy design criteria in the other standards appear to have originated in the ASME A17.1 standard. Minor variations between values in Annex A, Table A.3, are attributed to the rounding of values when converting between Imperial and metric dimensional units.

6.1.9 Questions about the correctness of the current values in the codes for kinetic energy and door stall force may be attributable more to the absence of bio-engineering data used to document these values than to the accident experience in the US industry and the public expectations. The A17.1 Code values appear to have withstood the test of time over their 35-year history.

6.1.10 The comparison of the kinetic energy and force limitations imposed in the major worldwide codes is summarized in Annex A, Table A.3.

6.1.11 Limits for forces necessary to prevent closing of horizontally sliding doors are almost identical. The portion of door travel where the forces are measured is different.

6.1.12 Limits for kinetic energy of automatic horizontally sliding doors are similar too. This is based on average closing speed. Each standard gives two limits, the first if a reopening device is provided, the second if no reopening device is provided (see Table A.3, item 2).

6.1.13 When CEN was developed, in order to equip field lift experts with a usable measuring tool, the kinetic energy was converted into the accumulated energy of a spring with the force of the spring $F = C \times S$ (N), where C = 25,000 N/m spring rate, and S (m) the stroke of the spring. The spring rate was established by measuring the elasticity of the forearm of two persons. The measuring was done at 140 N - 8 mm, corresponding to kinetic energy of 0,4 J. The maximum kinetic energy of 10 J corresponds to a maximum spring force of 707 N.

6.2 Observations and suggestions by individual experts

One expert serving in Working Group 4 studied the subject and indicated, amongst other things, the following:

a) The increasing importance of floor-to-floor time and its influence on lift capacity may lead to the decrease in door time and the increase in kinetic energy, creating unsafe conditions for lift users. Every second used for the door closing usually means decrease in lift capacity of 5 %. This might be an incentive for compromising safety. Even more, door operators could formally comply with requirements in present standards (based on average speed) but still create extremely high kinetic energy peaks.

b) With respect to 6.1.13, it must be noted that calculated kinetic energy often gives considerably greater values than measured kinetic energy, because of the elasticity of door hangers and couplers. Therefore, reliance on calculated rather than measured (by spring) values of kinetic energy often results in safer doors.

c) “High-quality” doors require as rigid as possible links between the door operator, car and landing doors, that means as little elasticity as possible, which in turn will cause the increase in the door force.

d) Even with controlled door force and kinetic energy, the risk of injuries still exists. The risk results from the limited elasticity of the parts of human bodies. Based on variations in the strength of various human bones (as reported in literature), it is possible to prove that the tolerances of kinetic energy without injuries can vary for the arm or the finger of an old person from nearly 0 J to 10 J, but for a young adult from 0,7 J to 100 J. Furthermore, while the skull of an adult can resist 45 J to 100 J, an energy of only 4,5 J may cause the skull of a child to crack.

e) A recent laboratory experiment established the following pain thresholds: 0,2 J (finger), 0,8 J (hand), 1 J (head), 3 J (arm).

f) In light of these values, one may question the correctness of limitations in present lift safety standards.

g) Reopening devices should be such that the door changes its direction before it meets an obstacle.

6.3 Points agreed upon

6.3.1 When the car and landing doors are coupled and closing together, and are in close proximity (see Table A.1, item 6.2.3 for maximum distances), the use of reopening devices on only one set of doors is considered adequate and safe.

6.3.2 Providing reopening device does not guarantee that a person will not be struck by a door. The approaching speed and direction of the person are also factors.

6.3.3 The kinetic energy requirements are based on average closing speeds. It is possible for instantaneous kinetic energy values to be 2,5 times the average.

6.3.4 Safety standards should consider limiting the maximum instantaneous kinetic energy on the basis that a person walking through the entrance could be impacted by the door system at a specific location where the energy of the closing door system is at its maximum. Setting limitations of instantaneous kinetic energy at specific points of the door's travel should also be considered, especially at a point where the doors approach their closed positions.

NOTE A17.1-2000/B44-00, Rule 2.13.4.2.1 b)(1) now limits the instantaneous kinetic energy at any point to 23 J, while the average remains 10 J.

6.3.5 Consideration should be given in the standards to requiring the availability of data related to the kinetic energy of the door system which will provide verifiable information to the enforcing authority. As an example, such data could include the minimum door closing time with the given door masses and door operator identification.

7 Traction calculations

NOTE This section has been updated as noted. See ISO/TR 11071-2 for a complete comparison of requirements for suspension ropes.

7.1 Historical background

7.1.1 The comparison of requirements in lift safety standards as related to traction is in Annex A, Table A.4.

7.1.2 All standards require traction to withstand the static force resulting from 125 % of rated load in the car.

NOTE This point has been editorially updated.

7.1.3 Requirements related to traction under dynamic conditions are less clearly defined. However, explicitly or implicitly, all standards require positive traction (or traction with controlled slip) for 110 % or 125 % of rated load from any speed up to the speed at which overspeed switch is set.

7.1.4 Only CEN limits the specific pressure of ropes in grooves (see also 7.2.7).

NOTE EN 81-1:1998 no longer limits the specific pressure of ropes in grooves. Those requirements have been superseded by the equation in Appendix N of EN 81-1:1998 for calculation of a safety factor, which is based on:

a) the number of bends obtained by calculating an "equivalent number of sheaves/pulleys";

b) the materials traditionally used in the design of the rope drives for elements such as steel/cast iron traction sheaves;

c) the use of steel wire ropes in accordance with European standards; and

d) a sufficient lifetime of the ropes, assuming regular maintenance and inspection.

7.1.5 Minimum drive-sheave to rope ratio is the same in all standards.

7.1.6 Ratio of car versus counterweight masses is not limited in any standard.

7.2 Observations and suggestions by individual experts

7.2.1 One expert believes that standards should be as specific in requirements for traction as they are in the case of brakes, because a good braking system is of no use if traction fails.

7.2.2 Checking of limits of traction at acceptance or any follow-up tests are not reliable, since the traction can deteriorate because of wear during lift operation. For that reason, the standards should specify limits and require calculations of traction, as is the case with CEN.

Another expert, however, suggests that available traction could be established by measuring frequency of oscillation of the car and/or counterweight masses. For that purpose, one mass must be locked in place (e.g. counterweight), the drive sheave rotated in one and then in opposite direction, while the frequency of the oscillations of another mass (the car in this example) is measured.

7.2.3 CEN formulae, in the opinion of one expert, are not satisfactory in all cases, because they are based on the mathematical approach which ignores: (i) the impact of variations in rope diameter and (ii) variations in the traction factor when the rope is slipping. Another expert suggests that the acceleration factors (C_1) used in CEN formulae are based on accelerations which are below those recorded in practice. Further, the formulae cover only one lift design: 1:1 roping with the machine above the hoistway.

NOTE A new calculation method in EN 81-1:1998 covers other roping arrangements.

7.2.4 Variations in the rope diameter are tolerated by rope standards such as ISO 4344. In addition, rope stretches during the first few months of operation (approximately 0,75 % of its length). Using an empirical formula, the expert states that the rope diameter may be reduced by up to 4,35 % because of rope stretch. Change in rope diameter must be considered when the groove diameter is designed. The change in diameter would affect the traction more in the case of half-round grooves than in the case of V-grooves.

7.2.5 A 10 % reduction in rope diameter is the industry standard rope replacement criteria in most of North American and in some European jurisdictions.

7.2.6 CEN assumes a constant friction factor of 0,09. If the traction is properly calculated for 125 % of rated, there will be no risk of rope slippage in normal operation. That is not the case for emergency stops.

For that reason, an expert proposed an empirical formula for friction as a function of speed. Another expert considered that variation in friction factors are minimal if the differential in speeds (of ropes and grooves) is taken into consideration. The sliding speed is not equal to the running speed unless the traction is lost and the sheave stops instantly.

NOTE EN 81-1:1998 no longer uses a fixed value for the friction factor, but a speed-related value. The traction calculation in EN 81-1:1998 now considers:

a) car loading and emergency braking conditions;

b) car stalled conditions (counterweight resting on the buffers and the machine rotating in the “up” direction); and

c) friction factors that depend on the groove type, the groove hardening process and the rope speed.

7.2.7 Commenting on CEN limitations on the specific pressure of the ropes in the grooves, one expert believes that it is not a safety issue since the pressure is indirectly limited through other requirements in safety standards, such as high factors of safety and rope-to-sheave diameter ratio.

NOTE See note to 7.1.4.

7.2.8 One expert suggests these criteria for grooves:

a) they shall accommodate 5 % oversized ropes without pinching;

b) V and undercut grooves shall allow ropes to sink the equivalent of 75 % of the rope diameter before reaching the groove bottom;

c) the sheave shall be re-grooved or replaced and new ropes installed if a rope sinks the equivalent of 50 % of the rope diameter or 1 mm in relation to other ropes;

d) re-grooving shall not reduce the sheave strength below an acceptable limit.

Another expert agrees that reduction in sheave strength by re-grooving is a serious problem and suggests that at least on new lifts the sheaves should be marked to show the amount of re-grooving allowed.

NOTE This is required by A17.1-2000/B44-00, Rule 2.25.2.4.

7.3 Points agreed upon

7.3.1 There are certain inherent limitations in the formulae in the CEN code.

NOTE See note to 7.2.6.

7.3.2 Sheaves should be marked in order to show the maximum permissible amount of re-grooving.

8 Safety gear

8.1 Historical background

8.1.1 All existing lift safety standards require each electric lift to be provided with a device ("safety gear" in combination with "overspeed governor") that has to perform the following two functions:

a) to stop a free-falling car or reduce its speed to the speed for which the buffers are designed, should its suspension means fail (in most codes required implicitly); and

b) to stop a car descending at a speed exceeding a specified speed, with suspension means intact, and counterweight attached.

In addition, a component of this device (overspeed governor, except that CEN permits provision of another device) must detect overspeeding in any direction and initiate car stopping through stopping means, e.g. machine brake (see also section 9).

The comparison of present requirements for safety gears are shown in Annex A, Table A.5.

8.2 Observations and suggestions by individual experts

8.2.1 Dual functions, imposed by the standards, on a single mechanical device, may be impractical.

8.2.2 Safety gear, if set in accordance with requirements stipulated in some standards, may, under certain conditions, not be able to stop a free-falling car.

8.2.3 A standard that requires type testing to prove functioning of the safety gear in free fall does not however necessarily require sufficient number of tests under all possible conditions to prove the reliability and durability of the device.

8.2.4 Other experts suggest that the protection against free fall need not be provided, considering the reliability of modern wire rope, high safety factors and redundancy (multiple ropes) required in all standards.

8.2.5 No standard presently requires protection against the risk of car movement:

a) at uncontrolled overspeed upwards, in the case of a mechanical failure listed in 3.5 b 2) of this report or the failure in the car speed control system; or

b) at any speed in any direction, in the case of any similar mechanical or control failure, with the landing and car doors open.

NOTE A17.1-2000/B44-00 and EN 81-1:1998 now require protection against the risk in a). In addition, A17.1-2000/B44-00 also requires protection against the risk in b).

8.2.6 Present rules for safeties and governors are written in the form of design specifications, rather than in performance language. This obstructs the possibility of implementation of new technologies, for example, achieving the free fall and overspeed protection by separate devices.

8.2.7 The 1990 edition of the CSA standard will require protection against all risks mentioned in 8.2.5 except that CSA assumes that the uncontrolled movement of the car with the doors open may be caused by the brake or control failure only and not by the failure of any other machine components. ASME is also studying the issue.

NOTE See note to 8.2.5 for updated information.

8.2.8 The new rules in the CSA standard, written in performance language, will also allow the possibility of separating the free fall and overspeed protection, while still allowing the use of car/counterweight safeties and governors.

8.3 Points agreed upon

8.3.1 Protection should be provided to protect a car in case of free fall, however, it is not necessary to stop the car - only retard its speed so that the buffer can safely absorb the energy.

8.3.2 Protection should be provided for car overspeeding in both the up and down directions. (Refer to 3.5.1.2 for the rationale.)

8.3.3 Safety standards requirements should be performance oriented.

8.3.4 Standard should allow the possibility of separating free-fall and overspeed protection.

9 Overspeed governors

9.1 Historical background

9.1.1 The comparison of requirements in the safety standards as related to overspeed governors is in Annex A, Table A.6.

9.1.2 Each overspeed governor has to detect overspeed condition in the down direction and trigger the safety gear at a specified speed (see item 1 in Table A.6) and for that reason it must generate a minimum force in the governor rope (see item 7 in Table A.6). The requirements are similar in all standards.

9.1.3 In addition, the governor (or another device in the case of CEN) must detect a predetermined overspeed in both directions and trigger the lift braking system. There are exceptions in ASME and CSA for provision of this feature (see item 2.1 in Table A.6).

NOTE All exceptions have been deleted in the 2000 edition of A17.1/B44.

9.1.4 Type testing of governors is required in CEN only (see Table A.6, item 10).

9.2 Observations and suggestions by individual experts

9.2.1 Since the overspeed switch triggers the braking system, which can stop the car only if traction and suspension means are available, there is no justification for location of the overspeed detecting means on the governor only.

It may be more desirable to locate the detecting means directly at the machine, in particular if the means check the speed continuously. This is not the case with most present governors where the switch can be triggered only intermittently and therefore the car speed may reach a dangerous level (in the case of high accelerations) before the switch is triggered.

9.2.2 Furthermore, a device for the continuous speed monitoring could be used for checking the levelling and inspection speeds.

9.2.3 As in the case of the switch, triggering of the safety gear may take place at speeds higher than it is designed for, because most governors can be triggered only at given points of the circumference of the governor sheave, e.g. every 60 degrees or 90 degrees or even 180 degrees. This is especially critical in the case of free fall. Example: a governor with the sheave 200 mm in diameter and triggering possibility every 90 degrees, and which is set to trigger at 0,8 m/s. If during free fall one triggering point was just missed, the car speed will reach 2,02 m/s by the time the governor is triggered. This corresponds to car travel (free fall) of 157 mm. According to the CEN standard, only 113 mm is assumed. This problem is less significant for high speed lifts.

9.2.4 To facilitate matching governors from one source and safety gears from another, necessary markings should be required on both components.

9.2.5 Governors should be type tested as required in CEN. In addition, the tests should be made with an adequate mass in free fall. The certificate should specify any possible “dead travel” and the minimum and maximum forces exerted by the governor.

9.2.6 One expert believes that the following three functions should be treated separately, because they are not necessarily easy to combine in a single component: electrical checking of overspeed; application of safety gear in the event of overspeed; and application of safety gear in the event of free fall.

9.2.7 One expert believes that, in addition to tests required in CEN, governors should be certified for a specific number of applications without adjustments.

9.3 Points agreed upon

9.3.1 Rules for overspeed protection should be written in performance rather than design language.

9.3.2 Electrical overspeed detection should not be required on lifts with certain types of machines (see Assumption 6 in 3.8) since no dangerous overspeeding can take place. Only CSA rules are written with this in mind.

NOTE With changes in B44-00, the statement related to CSA is no longer correct.

9.3.3 The overspeed device which activates the braking system (i.e. removes power from the driving machine motor and brake) should not necessarily be required to be located on the governor. Other locations could be permitted as long as the speed is measured by the direct movement of the car and the accuracy of the speed measurement does not rely on the maintenance of traction between the suspension ropes and the drive sheave.

9.3.4 The response time of the overspeed governor before tripping should be sufficiently short so as not to permit a dangerous speed to be reached before the moment of safety gear operation.

9.3.5 The compatibility of the governor, governor rope, safety, and releasing carrier, if used, should be verifiable.

NOTE A17.1-2000/B44-00 now requires data plates on safety gear and governors to facilitate checking of compatibility.

10 Buffers

10.1 Historical background

NOTE EN 81-1:1998 specifies the requirements and test conditions for non-linear buffers of the energy accumulation type.

10.1.1 A comparison of requirements in the present standards is in Annex A, Table A.7 for spring buffers and Table A.8 for hydraulic buffers.

10.1.2 In the case of spring buffers, the requirements relating to the stroke and forces vary.

10.1.3 For hydraulic buffers, the requirements relating to the stroke and retardation are the same. The requirements relating to load rating are similar.

10.2 Observations and suggestions by individual experts

10.2.1 One expert noted that the assumptions on which the rules for buffers are based are not clear in most standards. Some rules seem to assume free fall (e.g. rules for type tests), others assume overspeed with the counterweight attached. He suggests that:

a) when rating buffers, free fall of the car or counterweight should not be considered;

b) buffers should be expected to safely stop a car with 125 % of its rated load from the speed at which the overspeed switch is set to operate (see Annex A, Table A.6, item 3).

10.2.2 Another expert believes that 25 % overload need not be considered for performance rating, but 20 % overload should be the basis for a strength test.

10.2.3 With respect to spring buffers, one expert recommends that all standards should require:

a) stroke at least 2,4 times gravity stopping distance from 115 % of the rated speed;

b) spring force between 2 and 3 times the mass (with counterweight attached).

In addition, since all standards imply that the spring characteristic is linear, that should be clearly stated in the standards. For non-linear springs, a proper justification should be required.

10.2.4 One expert suggested that the standards should introduce two limits for average deceleration, both based on time:

a) maximum — above 1g;

b) minimum — a reasonable fraction of gravity.

Another expert believes that it does not make sense to limit maximum retardation since very short duration "spikes" always occur when an impact takes place. Concerning the accuracy of instruments, the level of filtration would have to be regulated by standards if the maximum is to be limited. It does not make sense to limit the minimum, since it is always zero when the energy dissipation is complete.

10.2.5 Several experts suggest that all present standards are deficient in not taking into account the increased loads on buffers which result from tie-down compensation.

One expert proposes that the maximum load rating for a buffer where tie-down compensation is used should be reduced as follows:

$$\text{Actual load rating} \times \frac{a_{\text{np}}}{a_{\text{tp}}}$$

where

a_{np} = maximum peak retardation produced by a given oil buffer when tie-down compensation is <u>not</u> used;

a_{tp} = maximum peak retardation produced when struck by the same masses but with tie-down compensation.

10.2.6 One expert suggests that type testing of buffers might not be needed if acceptance tests include tests with no load, rated load, and overload, and if no excessive slack rope is experienced during the tests.

10.2.7 One expert noted that data in Table A.7 is applicable to “steel” springs. CEN, however, does not prohibit springs made of other materials, but admits that different criteria should apply for polyurethane, etc.

NOTE EN 81-1:1998 specifies the requirements and test conditions for non-linear buffers of the energy accumulation type.

10.3 Points agreed upon

Standards should take into account the increased loads on buffers which result from tie-down compensation.

11 Braking systems

NOTE This section has been revised as indicated in the notes.

11.1 Historical background

11.1.1 All existing electric lift safety standards require an electromechanical brake and permit explicitly or implicitly that the brake may be assisted by other braking means (e.g. electric).

11.1.2 The standards, however, significantly differ in specifications of the capacity of the electromechanical brakes alone (unassisted by other means), requiring sufficient capacity (see Table A.9):

a) to stop and hold 125 % of rated load (CEN and Japan) at rated speed;

b) to stop and hold an empty car at governor tripping speed in the up direction only (A17.1-2000/B44-00);

c) to hold (not to stop) 125 % of rated load (ASME and CSA);

d) to stop from 5 %–10 % of rated speed (AS1735-2:2001).

NOTE Points a) through d) have been updated in this edition of this Technical Report.

11.1.3 Only CEN presently assumes that mechanical components of the brake can fail and requires stand-by redundancy in the form of two sets of components, with each set having sufficient braking effort to slow down the car with rated load.

NOTE ASME/CSA also assumes failure of any component of the electromechanical brake and requires a stand-by emergency brake. CEN and SA require similar emergency brakes, but do not refer specifically to electromechanical failure. (See items 14 to 26 in Table A.9.)

11.1.4 Other differences are shown in Annex A, Table A.9.

11.2 Observations and suggestions by individual experts

11.2.1 The braking system (as a whole) should be required to perform safe slow down and stopping, that is:

a) initiated by any normal operating means, of any load up to 125 % of rated load from any speed up to rated speed; and

b) initiated by any “electrical safety device”, of any load up to 125 % of rated load for any speed up to the speed at which the governor (or any other) overspeed switch is set to initiate stopping, provided that the braking system is designed in accordance with requirements for “electrical safety devices" (see also 11.2.3).

11.2.2 The electromechanical brake alone should be required to stop 125 % of rated load from rated speed:

a) in the case of power failure; and

b) in the case of any other emergency operation if the braking system cannot be classified an "electrical safety device" (see also 11.2.3).

11.2.3 If assumption 3 b) 2) is adopted by safety standards (see section 3.5), and if a stand-by device is provided to safely stop the car in case of the failure of the electromechanical brake or braking system, or any other failure listed in assumption 3 b) (see also section 8), in that case:

a) contrary to 11.2.1 b), the braking system need not be designed as an "electrical safety device"; and

b) contrary to 11.2.2, the electromechanical brake alone should be designed only to hold a stationary car loaded with 125 % of the rated load.

11.2.4 Deceleration should be limited (e.g. up to 1 m/s as specified in section 9 NOTE 1 of CEN), at least in the case of normal operation, in order to ensure comfort for passengers and eliminate continuous slippage.

11.2.5 The CSA requirement [see 11.1.2 b)] is based on the rationale that the failure of the braking system, with a descending fully loaded car, is backed up by the car safeties.

NOTE The same now applies to A17.1-2000.

11.3 Points agreed upon

11.3.1 Standards should clearly define the role of "braking systems" (incorporating an electromechanical brake and other braking means, e.g. electric) and the role of the "electromechanical brake alone".

11.3.2 It is recognized that, even though the machine has been stopped, the required normal traction may not be maintained, which may permit continued movement of the car.

11.3.3 The brake alone should have sufficient capacity to prevent the car with 125 % of rated load from striking the buffer above the design rating from the speed at which the governor overspeed switch is set.

12 Electrical devices

12.1 Historical background

12.1.1 Electrical safety and protective devices

Where malfunctioning of an elevator component may create a serious hazard for lift users (e.g. door non-closing), the operation of such components is checked by an "electrical safety device". An electrical safety device may be necessary to ensure safety of lift mechanics (e.g. stop switch on car top). Furthermore, where a lesser hazard (e.g. door closing kinetic energy exceeding a limit) may be created, a "protective device" is required.

The comparison of requirements in existing safety standards for provision of electrical safety devices and protective devices is shown in items 1 to 31 of Table A.10 in Annex A.

12.1.2 Other electrical requirements

The comparison of requirements regarding electric socket outlets, lighting, signals and emergency alarm devices is shown in items 32 to 35 of Table A.10.

As indicated in item 36, most standards refer to other national standards for design and installation of electrical components and features (such as insulation, voltage, over-current protection, etc.), which are not covered by this comparison.

12.1.3 Design of electrical safety devices

12.1.3.1 Contacts with positive separation. Most standards assume that only a contact opened by positive separation of its circuit-breaking devices (CEN) or a contact positively opened mechanically (CSA and ASME) may be sufficiently reliable to be used as an electric safety device. CEN (14.1.2.2.1) requires such contacts on all electric safety switches. ASME [209.3 a) and 210.2 e), g), h), i), j), k) and v)] and CSA (3.12.4.3) require such contacts only on certain switches.

NOTE ASME and CSA references in this paragraph have not been updated in this Second Edition. For current ASME/CSA data, see Table A.10.

12.1.3.2 Redundancy-type circuits. Most standards take into consideration the possibility of a failure of a contactor or relay to release [CEN in 14.1.1.1 g); ASME in 210.9 c), 210.9 d), and 210.9 e); and CSA in 3.12.9 c), e) and f)], and imply that redundancy-type circuits are required wherever contactors or relays are used. CEN [14.1.2.3.3 a)] requires redundancy in every safety circuit.

NOTE EN 81-1:1998 includes safety circuits with electronic components, but not safety circuits using software. ISO/TC 178 Resolution 174/1999 proposed that a new standard be developed on programmable electronic systems in safety-related applications for lifts.

With a 1987 revision, ASME 210.9 c) introduced redundancy requirements for every circuit incorporating an electrical safety device.

CSA is about to introduce a similar revision. Presently CSA requires redundancy only in circuits incorporating terminal limits and door interlocks and contacts.

NOTE For current ASME/CSA data, see Table A.10.

12.1.3.3 Checking of redundancy. Only CEN assumes that a redundancy type circuit can fail by subsequent failure of one component after another and therefore CEN requires continuous or cyclical checking of redundancy [14.1.2.3.3 a)]. CEN does not consider the possibility of the second failure occurring after the first and before the lift has been stopped by cyclical checking [14.1.2.3.3 a), 2nd paragraph], but CEN does consider the possibility of two failures occurring in more than one circuit arising from a single cause and for that reason requires measures to minimize such risk [14.1.2.3.3 d)].

Contrary to CEN, the ASME and CSA standards assume (by omission of corresponding requirements) that there is no possibility for the second failure occurring before the first is visually detected and manually corrected (by service mechanics) and also that there is no risk of two simultaneous failures. Exceptions are ASME Rules 210.9 d) 6) and 210.9 e) 6) and CSA Rules 3.12.9 e) vi) and 3.12.9 f) vi) where checking of redundancy is required.

NOTE The above statements regarding CSA and ASME are no longer true. See Table A.10 for current ASME/CSA data.

12.2 Observations and suggestions by individual experts

12.2.1 Standards should be specific in defining the role and performance of electrical safety versus protective devices, including criteria for their design to achieve expected operational reliability (see Table A.10, item 24).

12.2.2 One expert suggested that the “normal terminal stopping device” (required in ASME and CSA but not in CEN) is required for reasons of convenience rather than safety, noting that it is the function of final limits to stop the car safely, though away from terminal landings.

Another expert, however, suggested that stopping beyond the landing is unsafe for passengers and suggests that “normal terminal limits” should be required and designed as an electrical safety device (see Table A.10, item 31.2).

12.2.3 One expert suggests that safety standards should neither request nor permit switches for overriding landing door interlocks. Another expert suggests that the switch is a safer tool provided for use by mechanics than a jumper on interlock contacts (see Table A.10, item 8).

12.2.4 One expert suggested that ASME and CSA should require a safety device to check extension of all hydraulic buffers as in CEN.

Another expert, however, suggested that every buffer, after engagement, has to be checked by a qualified mechanic including its proper extension, and therefore electrical checking is redundant (see Table A.10, item 19).

12.2.5 The limits of both the levelling zone and the levelling speed should be checked by an electrical safety device, regardless of the type of drive (see Table A.10, item 26).

12.2.6 With the recent revision of ASME and the pending revision of CSA, the differences in requirements for provision of redundancy type circuits are being reduced. However, the differences in rules for checking of all redundancies are yet to be resolved.

NOTE See Table A.10 for current ASME/CSA data in 2000 editions.

12.2.7 One expert suggested that all safety standards were deficient in not addressing the failure of a door reopening device since it is not considered an electrical safety device.

Another expert expressed concern on whether a door protective device can be made “fail safe” to satisfy criteria for a safety device. Reopening cannot be “fail safe” because it requires closing of a circuit and “closing” is not considered “fail safe”.

12.2.8 One expert suggested that safety standards must require type testing and certification of electrical circuits designed to incorporate electrical safety devices, where conformance with applicable standards (in particular redundancy requirements) cannot be easily verified either through the review of schematic diagrams or during a field inspection.

12.2.9 In addition to requiring hoistway door interlocks, the safety standards should require a means to detect the presence of hoistway door panels in the closed position. The purpose of this is to ensure that the elevator cannot run if a hoistway door panel is missing.

12.3 Points agreed upon

12.3.1 Electrical safety and protective devices should be mentioned twice in every lift safety standard: first, in the rule dealing with the lift component or feature which needs checking by a safety or protective device; and then again in the sections dealing with electrical safety and protective devices.

12.3.2 Safety standards should require car door interlocks where the lift well is not fully enclosed (e.g. observation lifts) and where car-entrance-to-hoistway-wall clearances exceed a prescribed limit (see item 2 in Table A.10).

12.3.3 Where an unlocked door panel is connected to a locked panel only by rope, chain, or similar means, the closed position of the unlocked panel should be checked electrically (see Table A.10, item 6).

12.3.4 Where redundancy is required in an electrical circuit, the standards should require that the redundant nature of the circuit be automatically verified either continuously or on a regular basis.

12.3.5 Detecting the failure of a door reopening device, with the intent of preventing doors from closing in an unsafe manner, should be addressed by all lift safety standards.

Annex A
(normative)

Tabulations

NOTE 1 All data in this annex have been updated as per current standards (see Scope).

NOTE 2 For the title and edition of the standards compared, refer to section 1 of this report.

NOTE 3 Rules on which entries in the tabulations are based are indicated in parentheses.

Key:

No spec There is no rule covering the specific subject

> Greater than

< Less than

\+ When attached to the clause reference (e.g. 5.7.3.3 +) in the AS1735-1:2001 column, it indicates that there may be differences in details when compared with EN 81-1:1998. AS1735-1:2001 allows use of EN 81-1:1998 with some modifications to suit Australian conditions, which are made in Appendix A of AS1735-1:2001. Part 1 of AS1735 is an alternative to AS1735-2:2001, that is the latest version of the original Australian Code. Electric lifts installed in full compliance with either code are acceptable in Australia.

Table A.1 — Spaces and clearances

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	Top car clearances for traction elevators (With counterweight on fully compressed buffers in all except JAPAN columns) NOTE 1 $0{,}035V^2$ represents ½ gravity stop distance with 115 % of rated speed. This may be reduced. NOTE 2 For Japan column, TCC means: The distance between car crosshead beam and overhead floor or beams when car stops at top landing (in the Notice). The distance between car ceiling and overhead floor or beams when car stops at top landing for car without crosshead (explanation of the Notice). The distance between top of landing entrance and overhead floor or beams when car stops at top landing for car without ceiling (car lift) (explanation of the Notice).	(5.7.1) (See NOTE 1)	(2.4.6 & 2.4.12) (See NOTE 1)	2000 MOC Notice No. 1423 item 1 (See NOTE 2)	(5.7.1) (See NOTE 1)	(21.10)
1.1	Guided travel of car …………………….min.	0,1 m + $0{,}035V^2$	"Up to extreme car travel limit" (see 2.23.8)	No spec	0,1 m + $0{,}035V^2$	600 mm above highest point of travel of car and CWT including jump with compressed buffers
1.2	Free height above a specific area of the car roof ……………………………………..min.	1 m + $0{,}035V^2$	1,10 m + possible car jump	No spec	1 m + $0{,}035V^2$	(8.3.2) Car platform level at top landing B = m+d+Y+1000 for traction machines M = max allowable CWT bufffer clearance d = CWT buffer stroke Y = car jump

Continued on next page

Table A.1 (*continued*)

<table>
<tr><th></th><th>Requirements</th><th>EN 81-1:1998</th><th>A17.1-2000/B44-00</th><th>Japan</th><th>AS1735-1:2001</th><th>AS1735-2:2001</th></tr>
<tr><td>1.3</td><td>Well roof to car cross-head……………..min.
NOTE 3 The second possibility in Japan is to calculate TCC as follows:
• Spring buffer
TCC $= S + R + \frac{V^2}{720} + C$ (cm)
• Oil buffer
TCC $= S + R + \frac{V^2}{1068} + C$ (cm)
S: buffer stroke (cm);
R: counter weight runby (cm);
V: rated speed (m/s.)
C: 60 cm (can be reduced to 2,5 cm, if the device to secure the minimum distance of 1,2 m between the top of the car and overhead floor is supplied).</td><td>0,3 m + 0,035V^2</td><td>0,60 m + 0,035V^2</td><td>2000 MOC Notice No. 1423 item 1
The following two methods to decide TCC are stipulated.
The specific value according rated speed as per the table below (see also NOTE 3):
<table><tr><th>Rated speed (m/s)</th><th>TCC (m)</th></tr><tr><td>$V \le 0,75$</td><td>1,2</td></tr><tr><td>$0,75 < V \le 1,0$</td><td>1,4</td></tr><tr><td>$1,0 < V \le 1,5$</td><td>1,6</td></tr><tr><td>$1,5 < V \le 2,0$</td><td>1,8</td></tr><tr><td>$2,0 < V \le 2,5$</td><td>2,0</td></tr><tr><td>$2,5 < V \le 3,0$</td><td>2,3</td></tr><tr><td>$3,0 < V \le 3,5$</td><td>2,7</td></tr><tr><td>$3,5 < V \le 4,0$</td><td>3,3</td></tr><tr><td>$4,0 < V$</td><td>4,0</td></tr></table></td><td>0,3 m + 0,035V^2</td><td>(8.3.2)
Car platform level at top landing
B = m+d+Y+600 for traction machines
m = max allowable CWT buffer clearance
d = CWT buffer stroke
Y = car jump</td></tr>
<tr><td>1.4</td><td>Well roof to equipment on car top (except 1.5)…………….…………………….……..min.</td><td>0,3 m + 0,035V^2</td><td>0,15 m + 0,035V^2</td><td>No spec</td><td>0,3 m + 0,035V^2</td><td>(8.3.1)
Car platform level at top landing
B = m+d+Y+300 for traction machines
m = max allowable CWT buffer clearance
d = CWT buffer stroke
Y = car jump</td></tr>
<tr><td>1.5</td><td>Well roof to guide shoes, rope attachments, door header of vert. sliding doors……....min.</td><td>0,1 m+0,035V^2</td><td>$>$ 0 + 0,035V^2</td><td>No spec</td><td>0,1 m + 0,035V^2</td><td></td></tr>
<tr><td></td><td>a) If slow-down control is used, 0,035V^2 may be as follows:</td><td>If $V \le 4$ m/s, multiply by ½ , but min. 0,25 m
If $V > 4$ m/s, multiply by 1/3, but min. 0,28 m
(5.7.1.3)</td><td>multiply by ½
[2.4.6.2 d) 1)]</td><td>No spec</td><td>If $V \le 4$ m/s, multiply by ½ , but min. 0,25 m
If $V > 4$ m/s, multiply by 1/3, but min. 0,28 m
(5.7.1.3)</td><td>[9.6.2 b)]
Buffer can be reduced by max. 1/3 stroke required, but minimum stroke is 0,422 m</td></tr>
</table>

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Table A.1 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
	b) If comp. rope tie-down, $0{,}035V^2$ may be reduced to:	Stroke of tie-down + 1/500 of travel height, minimum 0,2 m (see 5.7.1.4)	< 0,0 m [see 2.4.6.2 e)]	No spec	Stroke of tie-down + 1/500 of travel height, Minimum 0,2 m (see 5.7.1.4)	No spec
2.	Top counterweight clearance (with car on compressed buffers)	(5.7.1.2)	(2.4.9)	No spec	(5.7.1.2)	(8.5) With car floor level with bottom landing
2.1	Guided travel of counterweight…………min.	$0{,}1\ m + 0{,}035V^2$	“Up to extreme car travel limit” (see 2.23.8)	No spec	$0{,}1\ m + 0{,}035V^2$	(21.10) 600 mm above highest point of travel of car and CWT including jump with compressed buffers
2.2	Well roof to counterweight………………min.	No spec	$0{,}15\ m + 0{,}035V^2$	No spec	No spec	(8.5) With car floor level with bottom landing $f = h+i+j+Y_1$ h = car buffer clearance i = stroke of car buffer j = 150 mm for traction machine Y_1 = CWT jump
3.	Refuge space on car top	[5.7.1.1 d)]	(2.4.12)	Stipulated (Explanation of BSLJ-EO 129-10)	[5.7.1.1 d)]	Not specified as refuge area but states min. working area and minimum height
3.1	Minimum area	Rectangular block	$0{,}5\ m^2$	No spec	Rectangular block	(23.13.3.2) $0{,}12\ m^2$, one side at least 300 mm
3.2	Minimum height	(0,5 x 0,6 x 0,8) m	1,10 m + possible car jump	1,2 m	(0,5 x 0,6 x 0,8) m	(8.3.2) See 1.2 above.

Continued on next page

Table A.1 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
4	Bottom runby	No spec	(2.4.2 & 2.4.4)	JIS A 4302 (4.2.4)	No spec	Buffer clearance
4.1	Minimum car & CWT runby	Sufficient to allow operation of the limit switch	0 to 0,3 m, depends on type of buffer & motor control	Rated speed (m/s) / AC elev. / DC elev.: Spring buffer: $V \le 0,125$ / 75 / 150 $0,125V \le 0,25$ / 150 $0,25V \le 0,5$ / 225 $0,5V$ / 300 Not stipulated	Sufficient to allow operation of limit switch 10.5.1	150 mm oil car (8.2) 150 mm CWT (8.4)
4.2	Maximum car runby	No spec	600 mm	600 mm	No spec	600 mm (8.2)
4.3	Maximum CWT runby	No spec	900 mm	900 mm	No spec	No spec
5.	Pit clearances[a] a) with car on fully compressed buffers in EN 81-1:1998 and ASME columns; b) in JAPAN column, the pit depth is defined as the vertical distance between lowest floor level and bottom of hoistway; c) in JAPAN column, a smaller pit depth which has enough space to install correct buffer specified in 2000 MOC Notice 1423 item 2 paragraph 6 may be used instead of the depth indicated in the table.	(5.7.3.3)	(2.4.1)	2000 MOC Notice No.1423 item 1 Rated speed (m/s) / Pit depth[b c]: $V \le 0,75$ / 1,2 $0,75 < V \le 1,0$ / 1,5 $1,0 < V \le 1,5$ / 1,8 $1,5 < V \le 2,0$ / 2.1 $2,0 < V \le 2,5$ / 2,4 $2,5 < V \le 3,0$ / 2,7 $3,0 < V \le 3,5$ / 3.2 $3,5 < V \le 4,0$ / 3,8 $4,0 < V$ / 4,0	(5.7.3.3 +)	[8.1 b)]
5.1	Pit floor and the lowest portion of car structure (except 5.2)……………………min.	0,5 m	0,6 m		0,6 m	0,6 m
5.2	Pit floor to guide shoes, roller, safety gear blocks, toe guards, car door……………min.	0,1 m	> 0 m	See 5.1	0,1 m	0,05 m
5.3	Sufficient space for a rectangular block	(0,5 x 0,6 x 1,0) m	(0,6 x 1,2 x 0,6) m or (0,45 x 0,9 x 1,07) m	See 5.1	0,6 m high x 0,5 m x 1,0 m	Rectangular box 1,37 m x 0,6 m high x 0,45 m
5.4	Highest parts fixed in the pit and lowest parts of the car	0,3 m	(2.4.1.2) 0,6 m, except in restricted area > 0 m	No spec	[5.7.3.3 c)] 0,3 m	[8.1 a)] 0,05 m on fully compressed buffer

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Table A.1 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
6.	Well-to-entrance car-side clearances					
6.1	Car without car doors	Not permitted	Not permitted (2.14.4.1)	2000 MOC Notice No.1413 item 1 para. 6. Permitted only in car lifts.	Not permitted	Not permitted
6.2	Car with car doors	(5.4.3 & 11.2)	(2.4.4.5 & 2.5.1.4/5)	(4.1.14 & Table 1)	No spec	(24.1)
6.2.1	Car sill to landing sill.............................min. ....max.	No spec 35 mm	13 mm (20 mm*) 32 mm *Corner car guides	No spec 40 mm BSLJ-EO 129-6.(4)	No spec 35 mm	13 mm/20 mm corner car guides 40 mm
6.2.2	Car sill to inner well face					
	a) limited to ....max.	150 mm	125 mm	No spec	150 mm	150 mm
	b) except for vertical sliding doors ....max.	200 mm	190 mm	No spec	150 mm	150 mm
	c) except if car door lock provided...max.	Not limited	Not limited	No spec	Not limited	40 mm within levelling zone.
	d) specific cases.............................max.	200 mm through height max. 500 mm	No spec	No spec	No spec	No spec
6.2.3	Car door panel to landing door panel...max.	(11.2.3) 120 mm	(2.14.4.5) 140 mm	No spec	(11.2.3) 120 mm	(15.1.5) 150 mm
	– swinging landing door + car gate......max.	No spec	100 mm	No spec	No spec	No spec
	– swinging landing door on freight elevator......................................max.	No spec	165 mm	No spec	No spec	No spec
6.2.4	– swinging landing door + folding car door ....max.	150 mm ϕ ball	165 mm	No spec	150 mm ϕ ball (11.2.4)	No spec

Continued on next page

Table A.1 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
7.	Other horizontal well clearances	(11.4 & 5.6.2)	(2.5.1)			[15.2 a)]
7.1	Car to well enclosure……………………min. (except sides covered in 6) ………………………………………………max.	No spec No spec	20 mm No spec	No spec No spec	No spec No spec But where distance exceeds 300 mm, fall protection has to be provided on top of car (8.13.3)	20 mm No spec But where distance exceeds 300 mm, fall protection has to be provided on top of car (23.13.3.3)
7.2	Car to counterweight…………………min. …………………………………………max.	50 mm No spec	25 mm No spec	No spec No spec	50 mm (11.3) No spec	25 mm [25.2 b)] No spec
7.3	Counterweight to well enclosure………min.	No spec	20 mm	No spec	No spec	20 mm [15.2 c)]
7.4	Counterweight to CWT guard..............min.	No spec	20 mm	No spec	No spec	25 mm [15.2 c)]
7.5	Car to CWT guard……………………min.	No spec	20 mm	No spec	No spec	20 mm [15.2 a)]
7.6	Car to car in common wells……………min.	No spec If ≥ 500 mm, then partition up to 2,5 m above lowest landing; if < 500 mm, then full-height partition	50 mm	No spec	No spec If ≥ 500 mm, then partition up to 2,5 m above lowest landing; if < 500 mm, then full-height partition	100 mm [15.2 d)]
8.	Clearances in machine room (MR) & machinery spaces (MS) NOTE Except for JAPAN, machineroomless lifts are not covered.	(6.3.2 & 6.4.2.2)	(2.8.1, 2.7.2.2 & 2.7.4)	BSLJ-EO129-9 & 2000 MOC Notice No.1413 item 1 para. 4 for machineroomless elevators	(6.3.2 & 6.4.2.2)	(5.7.2)
8.1	Clearances around panel or cabinet A*: means ASME (U.S.A.) C*: means CSA (Canada)	No spec	A*: NFPA 70 C*: CSA C21.1 C	No spec	No spec	No spec
8.1.1	In front					
a)	Depth……………………………………min.	0,7 m	A*: 0,9 m (0–150V) A*: 1,1 m (51–600V) C*: 0,75 m	50 cm (No spec for machineroomless elevators)	0,7 m (Height 2,1 m)	600 mm (26.14.2.2)

Continued on next page

Table A.1 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
b)	Width………………………………….....min.	Width of control panel or min. 0,5 m	**A*: 0,762 m** C*: No spec	No spec	Width of control panel or min. 0,5 m	No spec
8.1.2	At rear if openable...……………………....min.	No spec	**A: same as front** **C*: 0,6 m**	50 cm	No spec	600 mm (26.14.1)
8.2	Clearance near parts requiring maintenance & inspection except panel or cabinet (8.1):					
a)	Clearance...........................……….....min.	(0,5 x 0,6) m	0,45 m (2.7.2.2)	50 cm	(0,5 x 0,6) m	0,45 m [5.7.2 2)]
b)	Accessway to those areas....……………min.	0,5 m	0,45 m	50 cm (No spec for machineroomless elevators)	0,5 m (Height 2,1 m)	0,45 m (5.7.2)
c)	Accessway if no moving parts…………min.	0,4 m	0,45 m	50 cm (No spec for machineroomless elevators)	0,4 m	0,45 m (5.7.2)
8.3	Clear headroom in MR & MS………….min. Exceptions:	2 m	2,13 m	(BSLJ-EO 129-9 item 1 para. 2) **Rated speed (m/s)** – **Headroom** $V \leq 1{,}0$ – 2,0 $1{,}0 < V \leq 2{,}5$ – 2,2 $2{,}5 < V \leq 3{,}5$ – 2,5 $3{,}5 < V$ – 2,8	2,1 m	2.1 m (5.6)
a)	Space for sheaves only.........…………....min.	1,5 m	1,07 m	1,5 m (explanation of BSLJ129-9)	1,5 m	2,0 m where equipment installed 1,5 m under beams 1,7 m without speed governor (6.6)
b)	Space for governor & selector………...min.	1,5 m	1,35 m	1,5 m (explanation of BSLJ129-9)	2,1 m	2,0 m
c)	Clear height for movement ...…………...min.	1,8 m	2,13 m	Same as 8.3	2,1 m	2,0 m
8.4	Clear vertical distance above rotating parts...................................……….......min.	0,3 m	No spec	No spec	(6.3.2.3) 0,3 m	No spec
8.5	If difference in MR floor levels exceeds this height, stairs or ladders and guard rails must be provided	(6.3.2.4) 0,5 m	(2.1.3.6) 0,4 m	(BSLJ-EO129-9 item 1 para. 5) 0,23 m 1,0 m guard rail	(6.3.2.4) 0,5 m	(5.11) 0,6 m

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Table A.1 (*concluded*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
8.6	Machine room door – width……………...min. – height……………min.	0,6 m 1,8 m	0,75 m 2,03 m	70 cm 180 cm (BSLJ-EO129-9 item 1 para. 4)	0,6 m 1,98 m	0,6 m 1,98 m
8.7	Machine room access trap door………...min.	(0,8 x 0,8) m (6.3.3.2)	Prohibited	Prohibited	No spec	(5.9.2) Permitted size based on equipment
8.8	Pulley room access trap door…………...min.	(6.3.3.2) (0,8 x 0,8) m	[2.7.3.4.1 a)] (750 x 750) mm	Allowed but no spec	No spec	(5.9.2) Permitted size based on equipment
8.9	Machine room area	No spec	No spec	In principle, 2 times cross section of hoistway (BSLJ-EO129-9 item 1 para. 4)	No spec	No spec

Table A.2 — Landing door systems and interlocks

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	DOOR PANELS Elastic deformation allowed for panels (deflection/force)	(7.2.3.1) 15 mm/300 N	No spec	No spec	(7.2.3.1) 15 mm/300 N	(12.4.1) 1,2 kN
2.	– max horizontal force without permanent deformation	300 N	(2.11.11.5.7) 2 500 N	No spec	300 N	(12.4.1) 1,2 kN
	– applied at	Either side, any place	Landing side	No spec	Either side	Centre of panel
	– area of application of testing	5cm^2 (7.2.3.1)	100 cm^2	No spec	5 cm^2 (7.2.3.1)	0,1 m^2 (12.4.1)
3.	Maximum horizontal force without – displacement exceeding 20 mm	No spec	5 000 N (2.11.11.8)	No spec	No spec	No spec
	– area of application of the force	No spec	900 cm^2	No spec	No spec	No spec
	– maximum upwards force of 1 000 N and simultaneous horizontal force of 1 000 N from landing side	No	Yes (2.11.11.8)	No spec	No	No
4.	Minimum vertical force on door hanger tracks	No spec	4 times panel weight, applied up plus down (2.11.11.2)	No spec	No spec	4 times load up plus down (12.16.4)
5.	Maximum force to prevent closing	150 N (7.5.2.1.1.1)	135 N (2.13.4.2.3)	147 N for residential elevator (JEAS 511A) (No spec for elevators other than residential elevators)	150 N (7.5.2.1.1.1)	150 N (25.5)
	Measured at	1/3 to 3/3 of travel	1/3 to 2/3 of travel	Center of travel	1/3 to 3/3 of travel	From rest

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Table A.2 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
6.	LOCKS/CONTACTS/LINKAGE/UNLOCKING Locking device required? Unlocking zone	Yes (7.7.1) +/– 200 mm in general case but +/– 350 mm if mech. operated car and landing doors operating simultaneously (7.7.1)	Yes (2.12.1) +/– 250 mm if manual levelling +/– 450 mm if auto levelling +/– 76 mm if solid state control (2.26.1.6)	Yes (BSLJ-EO 129-10 item 3 para. 1 & 2) +/– 200 mm	Yes (7.7.1 +) +/– 200 mm in general case but +/– 350 mm if mech. operated car and landing doors operating simultaneously (7.7.1 +)	Yes (13.1) +/– 450 mm auto levelling & power doors (13.2.1) +/– 230 mm w/out levelling
7.	Type of contact for (6) NOTE Opening of contacts is not dependent solely on springs.	Safety contact (7.7.3.1)	Positive opening (2.12.2.4.1)	No spec (generally, positive opening contacts are used)	2 safety contacts [7.7.3.1 g) +]	2 safety contacts (13.1.2 vii)
8.	Minimum engagement for locking pin	7 mm (7.7.3.1.1)	7 mm (2.12.2.4.3)	No spec	No spec	No spec
9.	Is metal required for locking elements ?	Yes (7.7.3.1.4)	No spec	No spec	No spec	No spec
10.	Force applied to lock in open direction…………………min.	1 000 N (7.7.3.1.6) 3 000 N for hinged doors	1 000 N (8.3.3.4.8) 3 000 N for hinged doors	No spec	500 N (7.7.3.1 +)	500 N
10 a)	Locking action by: gravity?	Yes (7.7.3.1.7)	Yes (2.12.2.4.2)	No spec	Yes	Yes [14.2 b)]
	Permanent magnet	Yes	No	No spec	No	No [14.2 b)]
	Compression spring	Yes	Yes	No spec	Yes	Yes [14.2 b)]
	Positive linkage	No	Yes	No spec	No	No
10 b)	Self-closing of landing doors required with car out of landing zone?	Yes (7.7.3.2)	Yes (2.11.3.1)	No spec	Yes (7.7.3.2)	Yes, for passenger lifts only. (12.27)
11.	Is emergency unlocking ………………..……...required?	Yes — each door (7.7.3.2)	Yes — each door (2.12.6.1)	No spec	Yes — each door (7.7.3.2 +)	Yes - each door (12.21)
	……………………………………….………...permitted?	N/A	N/A	N/A	N/A	N/A
12.	Hoistway access switch to move car with open landing doors, required or forbidden?	No spec In practice, not permitted	Required for Vr > 0,75 m/s or if top landing to car-top height exceeds 900 mm (2.12.7.1)	No spec	No spec	No spec
13.	Parking device required?	No	No	No spec	No spec	No spec

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Table A.2 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
14.	Neutralization by single action prohibited?	Yes (7.7.5.1)	No – see location (2.12.2.3.1, 2.12.2.6, 2.12.3.5)	No spec	Yes (7.7.5.1)	Yes (13.1.2)
15.	Specs for linkage of multipanels	Vague (7.7.6.2)	Yes — safety factors (2.11.11.7)	No spec	Yes (7.7.6.2)	Yes (12.16.5)
16.	Door contact required on trailing panels?	Yes (7.7.6.2)	No (2.12.2.4.4)	No spec	Yes (7.7.6.2)	No (if 12.16.5 is applied)
17.	Opening of landing doors:					
	…………………………… in landing zone from inside car	Required (8.11.1)	Required (2.12.5.3)	No spec	Required (8.11.1)	Yes
	……………………………………….. out of landing zone	Permitted, except prohibited if 11.2.1 c) is applicable	Prohibited	No spec	Permitted, but prohibited if 11.2.1 c) is applicable	No spec
	…………………………………………………….max force	300 N (8.11.2)	330 N (2.14.5.7)	No spec	300 N (8.11.2)	No spec
	TESTING					
18.	Type test required?	Yes (7.7.3.1.6)	Yes (2.12.4.1)	No spec	No spec	Yes (14.3)
19.	To be carried out on complete doors?	Yes if multipanels; the test is only possible in the mounted position (F.1.1.1.4)	No	No spec	No spec	No (AS1735-10)
20.	No. of cycles with lubrication during test	1 000 000 (F.1.2.2.1.1)	960 000 (8.3.3.4.1)	No spec	No spec	No spec
21.	No. of cycles with original lubricant	No spec	960 000 (8.3.3.4.1)	No spec	No spec	100 000 AS1735-10 (4.7)
22.	No. of cycles without lubricant	No spec	25 000 (8.3.3.4.3)	No spec	No spec	100 000 AS1735-10 (4.7)
23.	No. of cycles in moisture atmosphere	No spec	30 + 15 000	No spec	No spec	15 000 AS1735-10 (4.9)
24.	Electrical current during endurance test?	Yes (F.1.2.2.1.1)	Yes (8.3.3.4.2)	No spec	No spec	Yes
	(with no "break") Voltage……………………	Rated	110 % of rated	No spec		115 V DC
	Current……………………..	2 x rated	11 x rated	No spec		0,5 A
25.	Static test (force) – see 10 above	1 000 N (F.1.2.2.2) 3 000 N for hinged	1 000 N (8.3.3.4.8)	No spec	No spec	500 N
25 a)	Forces & retiring cam movement test	No spec	Yes (8.3.3.4.7)	No spec	No spec	Yes (AS1735-10)

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Table A.2 (*concluded*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
26.	Dynamic test (weight/fall)	4 kg/0,5 m rigid mass (F.1.2.2.3)	No spec	No spec	No spec	No spec
27.	Misalignment test	No spec	Yes (8.3.3.4.5)	No spec	No spec	Yes AS1735-10 (4.11)
28.	Electrical checks: "break AC"	Yes (F.1.2.4.2.1)	Yes [8.3.3.4.2 a)]	No spec	No spec	No spec
	………………….number	50 times	50 times	No spec	No spec	No spec
	………………….voltage	110 % of rated	110 % of rated	No spec	No spec	No spec
	……………………amps	1 100 % of rated	1 100 % of rated	No spec	No spec	No spec
	……………power factor	0,7	0,7	No spec	No spec	No spec
29.	Electrical checks: "break DC"	Yes (F.1.2.4.2.2)	Yes [8.3.3.4.2 b)]	No spec	No spec	No spec
	………………….number	20 times	20 times	No spec	No spec	No spec
	………………….voltage	110 % of rated	110 % of rated	No spec	No spec	No spec
	……………………amps	110 % of rated	110 % of rated	No spec	No spec	No spec
30.	Minimum contact opening	4 mm (14.1.2.2.3) 2 mm (14.1.2.2.4)	No spec	No spec	No spec	No spec
31.	Minimum creep distance	4 mm if…IP4X, 3 mm if > IP4X (14.1.2.2.3)	No spec	No spec	No spec	No spec
32.	Minimum air gaps	3 mm (14.1.2.2.3)	No spec	No spec	No spec	No spec
33.	Insulation tests NOTE JAPAN column indicates the insulation resistance which should be measured in commissioning inspection and annual inspection. It is not the voltage that the insulation must withstand during an insulation test.	In accordance with IEC	$\sqrt{(2 \times \text{rated } V)} + 1000V$ (8.3.3.4.6)	JIS A 4302 4.2.1 (2) Insulation resistance (see NOTE) ≤150 V DC — > 0,1 MΩ >150 V DC but < 300 V DC — > 0,2 MΩ	No spec	$\sqrt{(2 \times \text{rated } V)} + 1000V$ 40/60 Hz AS1735-10 (4.12)
34.	All lock tests to include linkage of panels	Yes (F.1.3.1)	No spec	No spec	No spec	No spec

Table A.3 — Kinetic energy

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
	POWER-OPERATED HORIZONTALLY SLIDING DOORS	(7.5.2.1.1)	(2.13.4 & 2.13.5)	JEAS 511	(7.5.2.1.1 +)	(25)
1.	FORCE:					
1.1	To prevent door closing…………………………….....max. NOTE In Japan, 147 N specified only for residential elevators (JEAS 511A)	150 N	133 N (30 lbf)	No spec (see NOTE)	150 N	150 N [25.5 b)]
1.2	Measured in which portion of travel?	1/3 to 3/3* *Fully closed	1/3 to 2/3	Center of door travel	1/3 to 3/3* *Fully closed	From rest
2.	KINETIC ENERGY OF AUTOMATIC DOORS:					
2.1	If re-opening is provided…………………..…max. average	10 J	10 J (7,37 ft-lbf)	No spec	10 J	10 J [25.5 a)]
	If re-opening is provided………………max. instantaneous	No spec	23 J (17 ft-lbf)	No spec	No spec	No spec
2.2	If re-opening device is not provided…………………..max.	4 J	3,5 J (2,5 ft-lbf)	No spec	3,4 J (for nudging)	3,4 J (for nudging) (25.6.2 & 25.6.3)
2.3	Energy calculated or measured?	Both	Calculated	No spec	Both	No spec
2.4	Energy calculated/measured at average closing speed over door's travel, less at each end of travel:					
	— if centrally closing door	25 m	25 mm (1 in)	No spec	25 mm	25 mm
	— if side-closing door	50 mm	50 mm (2 in)	No spec	50 mm	50 mm
2.5	Measuring device specified?	Yes	No	No spec	Yes	No
3.	KINETIC ENERGY OF CONTINUOUS-PRESSURE BUTTON					
	Operated doors may exceed that in 2.1?	Yes	Yes	No spec	(7.5.2.1.2) Yes	No spec
	— if the average closing speed is limited to…………max.	0,3 m/s	Not limited	No spec	0,3 m/s	No spec
	— if certain requirements related to CPB operation and location fulfilled	Not mentioned	Yes (2.13.3.2)	No spec	Not mentioned	No spec

Table A.4 — Traction

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.1	MAXIMUM TRACTION Machine shall not raise:					
	– empty car with counterweight on buffers	Yes [9.3 c)]	Yes [2.24.2.3.2 a)]	No spec	Yes [9.3 c)]	Yes [7.14 b)]
	– counterweight, with car on buffers	No spec	Yes [2.24.2.3.2 a)]	No spec	No spec	Yes [7.14 b)]
1.2	Alternative to 1.1 – or machine shall stall	No spec	Yes [2.24.2.3.2 b)]	No spec	No spec	No spec
2.	MINIMUM STATIC TRACTION					
	Car with the percentage of rated load indicated in the relevant column			2000 MOC Notice No. 1 429 item 1 para. 1(2)		
	……………………………………... passenger lift	125 % [9.3 a)]	125 % (2.24.2.3)	125 %	125 % [9.3 a)]	No spec
	………………………………………… freight lift [a]	125 % [9.3 a)]	100 %	125 % & 150 % for C2 loading	125 % [9.3 a)]	No spec
	shall not break traction when stationary at the lowest landing [a] For term “freight lift”, see 2.1.2 in this document.	Yes	Yes	Yes	Yes	No spec
3.	MINIMUM DYNAMIC TRACTION					
	Car with this percentage of rated load shall not break traction out of control (shall not accelerate) in the following cases:	100 % [9.3 b)] 0 % [9.3 b)] (min. retardation of 0,5/0,8 m/s^2)	125 % (8.11.2.3.4)	125 % for passenger elevators	100 % [9.3 b)] 0 % [9.3 b)] (min. retardation of 0,5/0,8 m/s^2)	125 % [7.14 a)]
	– When making downwards emergency stops	Yes [9.3 b)]	Yes (8.11.2.3.10)	Yes	Yes [9.3 b)]	No spec
	– When making normal stops	No spec	Yes (8.11.2.3.4)	Yes	No spec	Yes
4.	MAXIMUM SPECIFIC PRESSURE of ropes in grooves limited?	No (but life time considered in Annex N)	No spec	No spec	No (but life time considered in Annex N)	No spec

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Table A.4 (*concluded*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
5.	MINIMUM DRIVE-SHEAVE-TO-ROPE diameter ratio	40 (9.2.1)	40 (2.24.2.2)	2000 MOC Notice No. 1414 item 2 para. 3(3) 40 except in following cases: — 36 for arc of contact less than 90° and elevators with rated speed of less than 0,75 m/s, rated load of less than 3 100 N and rise of up to 13 m. — 30 for elevators with rated speed of less than 0,5 m/s, rated load of less than 2 000 N and rise of up to 10 m.	40 (9.2.1)	40 (19.2)
6.	Car/counterweight mass ratio					
	– limited in standard?	No	No	No spec	No	40 %-50 % (20.1.1.2)
	– design data verified at inspection?	Yes (D.2 h 3)	No	No spec	Yes (D.2 h 3)	Yes but not specified

Table A.5.1 — Safeties (passenger car instantaneous type)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	Car direction for setting	Down only (9.8.1.1)	No spec	Down only (2000 MOC Notice No. 1423 item 2 para. 4)	Down only (9.8.1.1)	Down only (33.6)
2.	Ability to operate in free fall?	Yes	Yes (2.17.8.1)	Yes (JEAS 517 4.2)	Yes	Yes (4.7.1)
3.	Acceptable load in car	100 % of nominal	125 % of nominal (12.17.3)	100 % of nominal (JEAS 517 4.2)	100 % of nominal	100 % of nominal (33.4.1)
4.	Upper speed limit for plain instantaneous	0,63 m/s (9.8.2) 1 m/s for CWT (9.8.2.3)	0,75 m/s (2.17.8)	0,75 m/s (2000 MOC Notice No.1423 item 2 para. 4)	0,63 m/s (9.8.2)	0,65 m/s (33.8.1)
5.	Upper speed limit if buffered effect (Type C)	1 m/s	2,50 m/s	No spec	1 m/s	2,5 m/s (33.8.1)
6.	Oil buffer required for (5)?	No (9.8.6.2)	Yes	No spec	No (9.8.6.2)	Yes
7.	Tripping by overspeed?	Yes (9.8.3.1)	Yes (2.17.7)	Yes (2000 MOC Notice No.1423 item 2 para. 4)	Yes (9.8.3.1)	Yes (33.8)
8.	Tripping by inertia or equivalent?	No Up to 1 m/s for CWT by rupture of suspension	Yes	No spec	No	Yes (33.8)
9.	Release by lifting the car only?	Yes (9.8.5.1.2)	Optional (2.17.9.3)	No spec	Yes (9.8.5.1.2)	Yes (33.9.3)
10.	Deceleration limit specified?	No	No	No spec	No	No
11.	Type test required NOTE The type test conditions are such that the safety must be able to absorb 2 times the kinetic energy of the falling mass.	Yes (F.3.2) (see NOTE)	No	Yes (JEAS 517 4.2)	Yes (F.3.2) (see NOTE)	Yes (AS1735-10)
12.	Test required at lift acceptance?	Yes (D.2 j)	Yes [8.10.2.2.2(bb)(2)]	Yes [JIS A 4302 4.2.1(6)]	Yes (D.2 j)	Yes
13.	Load in car for (12)	100 % of nominal	100 % of nominal	638 N (65 kg)	100 % of nominal	100 %
14.	Speed of car for (12)	100 % of nominal	100 % of nominal	Slow speed [JIS A 4302 4.2 (6)]	100 % of nominal	Governor trip speed AS1735-10 (5.4)

Table A.5.2 Safeties (passenger car progressive type)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	Car direction for setting of safety gear	Down (9.8.1.1) A safety gear operation in upward direction may be used in accordance with 9.10 (see NOTE 1)	No spec (see NOTE 2)	Down only (2000 MOC Notice No. 1423 item 2 para. 4)	Down (9.8.1.1) A safety gear operation in upward direction may be used in accordance with 9.10 (see NOTE 1) +	Car: No spec (33.1 & 35.1) CWT: Down only (33.6)
2.	Ability to operate in free fall?	Yes	Yes (See NOTE 3)	Yes (JEAS 517 4.2)	Yes	Yes (33.4.1)
3.	Acceptable load in car	100 % of nominal	125 % of nominal (2.17.3)	100 % of nominal (JEAS 517 4.3)	100 % of nominal	100 % of stopping distance [see Table 33.4.3(B)]
4.	Upper speed limit	No limit	No limit	No limit (2000 MOC Notice No.1423 item 2 para. 4)	No limit	No limit
5.	Tripping by overspeed governor only?	Yes	Yes (2.17.7)	Yes [BSLJ-EO 129-9.(7)]	Yes	Yes
6.	Tripping by inertia or equivalent?	No (See NOTE 5)	No	No spec	No	No spec
7.	Release by lifting the car only?	Yes (9.8.5.2)	Permitted (2.17.9.3)	No spec	Yes (9.8.5.2)	Yes (33.9.3)
8.	Deceleration limit specified?	Yes	Yes (8.2.6) (See NOTE 4)	Average 1g [BSLJ-EO129-10 item 2 para. 1, JIS A 4302 4.2.1(5)] (See NOTE 6)	Yes	Yes [Table 33.4.3 (B)]
9.	Type test required?	Yes (F.3.3)	No	Yes [JIS A 4302 4.2.1(5)]	Yes (F3.3)	Yes [AS1735-10 (2)]
10.	Test required at lift acceptance?	Yes (D.2 j 2) (See NOTE 3)	Yes [8.10.2.2.2 (bb)(4)]	Yes [JIS A 4302 4.2.1(5)]	Yes [D2 AS1735-10(5.4 +)]	Yes [AS1735-10 (5.4)]
11.	Load in car for (10)	125 % of nominal	100 % of nominal	100 % of nominal [JIS A 4302 4.2.1(5)]	100 % of nominal	100 % of nominal
12.	Speed of car for (10)	Rated speed or lower	Governor trip speed	Slow speed [JIS A 4302 4.2.1(5)]	Governor trip speed	Governor trip speed

NOTE 1 EN 81-1:1998, Subclause 9.10, covers ascending car overspeed protection.

NOTE 2 In 2000 edition, A17.1 deleted the "down only" restriction in the previous editions.

NOTE 3 In EN 81-1:1998, the capacity of the safety gear is determined by the type test and corresponds to a car with 100 % of rated load.

NOTE 4 See ASME A17 Interpretation Book No. 11, Inquiry 86-2, where the ability of Type B safeties to operate in free fall was confirmed as required in the A17.1 Code, which applies to the 2000 editions of A17.1 and B44 Codes.

NOTE 5 Up to 1 m/s for CWT by rupture of suspension.

NOTE 6 JIS A 4302 4.2.1(5) stipulates the stopping distance; the "average 1g" deceleration indicated in this table was calculated from the stopping distance and the actuation speed of the safety gear.

Table A.6 — Overspeed governors

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	GOVERNOR TRIPPING SPEED — CAR MOVING DOWNWARDS					
1.1	Maximum	See Figure A.1	See Figure A.1	1,13 m/s for rated speeds up to 0,75 m/s. 140 % of rated speed for other than above (2000 MOC Notice No. 1423 item 2 para. 4)	See Figure A.1	See Table (34.2)
1.2	Minimum percentage of rated speed	115 % (9.9.1)	115 % (2.18.2.1)	No spec	115 % (9.9.1)	115 % (34.2.1)
2.	OVERSPEED SWITCH					
2.1	Required?	Yes (9.9.11.1)	Yes (2.18.4.1)	Yes (2000 MOC Notice No.1423 item2 para. 4)	Yes (9.9.11.1)	Yes (34.3)
2.2	As necessary part of governor?	No (9.9.11.1)	Yes	Yes (2000 MOC Notice No.1423 item 2 para. 4)	No (9.9.11.1)	Yes: > 0,65 m/s with static power or Vee-belt drives
3.	MAXIMUM TRIPPING SPEED FOR GOVERNOR OVERSPEED SWITCH, as percentage of governor trip speed (GTS) (see 1 above) or rated speed (RS)	Any direction – below GTS: 100 % of GTS if RS ≤ 1 m/s (9.9.11.1)	In down direction: 90 % of GTS if RS = 0,75 to 2,5 m/s 95 % of GTS if RS > 2,5 m/s 90 % if static control 100 % with speed-reducing switch In up direction: 100 % (2.18.4.2.4)	1.05 m/s for rated speeds of up to 0,75 m/s 130 % of RS for other than above (2 000 MOC Notice No. 1423 item 2 para. 4)	Any direction – below GTS: 100 % of GTS if RS ≤ 1 m/s (9.9.11.1)	N/A Static control: 90 % of GTS for RS ≤ 2,5 m/s 95 % of GTS for RS > 2,5 m/s Other controls: 90 % of GTS (34.3.3)
4.	INERTIA OPERATION FOR INSTANTANEOUS SAFETY REQUIRED?	No	Yes (2.17.8.1)	No	No	Yes (33.8.1)
5.	AUTOMATIC RESETTING REQUIRED?	No	No	No	No	No spec

Continued on next page

Table A.6 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
6.	SWITCH FOR NON-AUTO RESETTING REQUIRED?	Yes (9.9.11.2)	Yes (2.18.4.4)	No	Yes (9.9.11.2)	NOTE 2, (34.3.2)
7.	MINIMUM FORCE GENERATED					
7.1	Times (x) force required by safety gear	2 x (9.9.4)	1,67 x (2.18.6.1)	No spec	2 x (9.9.4)	2 x (33.14)
7.2	Absolute minimum	300 N	No spec	No spec	300 N	No spec
8.	GOVERNOR ROPE					
8.1	Minimum diameter (mm)	6 (9.9.6.3)	9,5 (2.18.5.1)	No spec	6 (9.9.6.3)*	6 if speed ≤1,75 m/s and no rope grip jaws, othewise 8 mm (34.5.2)
8.2	Safety factor	8 (9.9.6.2)	5 (2.18.5.1)	No spec	8 (9.9.6.2)	8 for ropes < 8 mm dia and 5 for all others (34.5.3)
8.3	Sheave to rope ratio (minimum)	30 (9.9.6.4)	32 to 42 (2.18.7.4)	No spec	30 (9.9.6.4)	25 to 37 (Table 34.7)
8.4	Slack rope contact required?	Yes (9.9.11.3)	Jawed: No Jawless: Yes	No	Yes (9.9.11.3).	Yes (34.10)
8.5	Jaw grip required?	No	No	No	No	Yes for speeds > 1,75 m/s (34.6)
9.	COUNTERWEIGHT GOVERNOR					
9.1	Not required if speed is equal or less than........	1,0 m/s (9.8.3.1)	0,75 m/s (2.17.7.1)	No spec for rated speed, but required when there are habitable spaces below the pit (explanation of BSLJ-EO129-7)	No spec	No spec
9.2	Max. tripping speed – % of 1.1	110 % (9.9.3)	110 % (2.18.2.2)	110 % (explanation of 2000 MOC Notice No.1423 item 2 para. 4(a)	Higher than car tripping speed but not by more than 10 % higher (9.9.3)	Higher than car tripping speed but not > 110 % of max. allowable setting of car governor (34.2.2)
10.	TYPE TEST REQUIRED?	Yes (F.4)	No	Yes (Guideline 8.3)	Yes (F.4)	No

Continued on next page

Table A.6 (*concluded*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
11.	ACCEPTANCE TEST REQUIRED?	Yes (D.2 i)	Yes [8.10.2.2.2 (aa)]	Yes [JIS A 4302 4.2.1(6)]	Yes (D.2 i)	Yes
12.	PERIODIC TEST REQUIRED?	Yes (E.1)* *ANNEX E is only an informative part of EN 81-1:1998	Yes (8.11.2.2.3)	Yes, once a year [BSLJ Art.12 item 2)]	Yes (E.1)	Yes (AS1735-10)

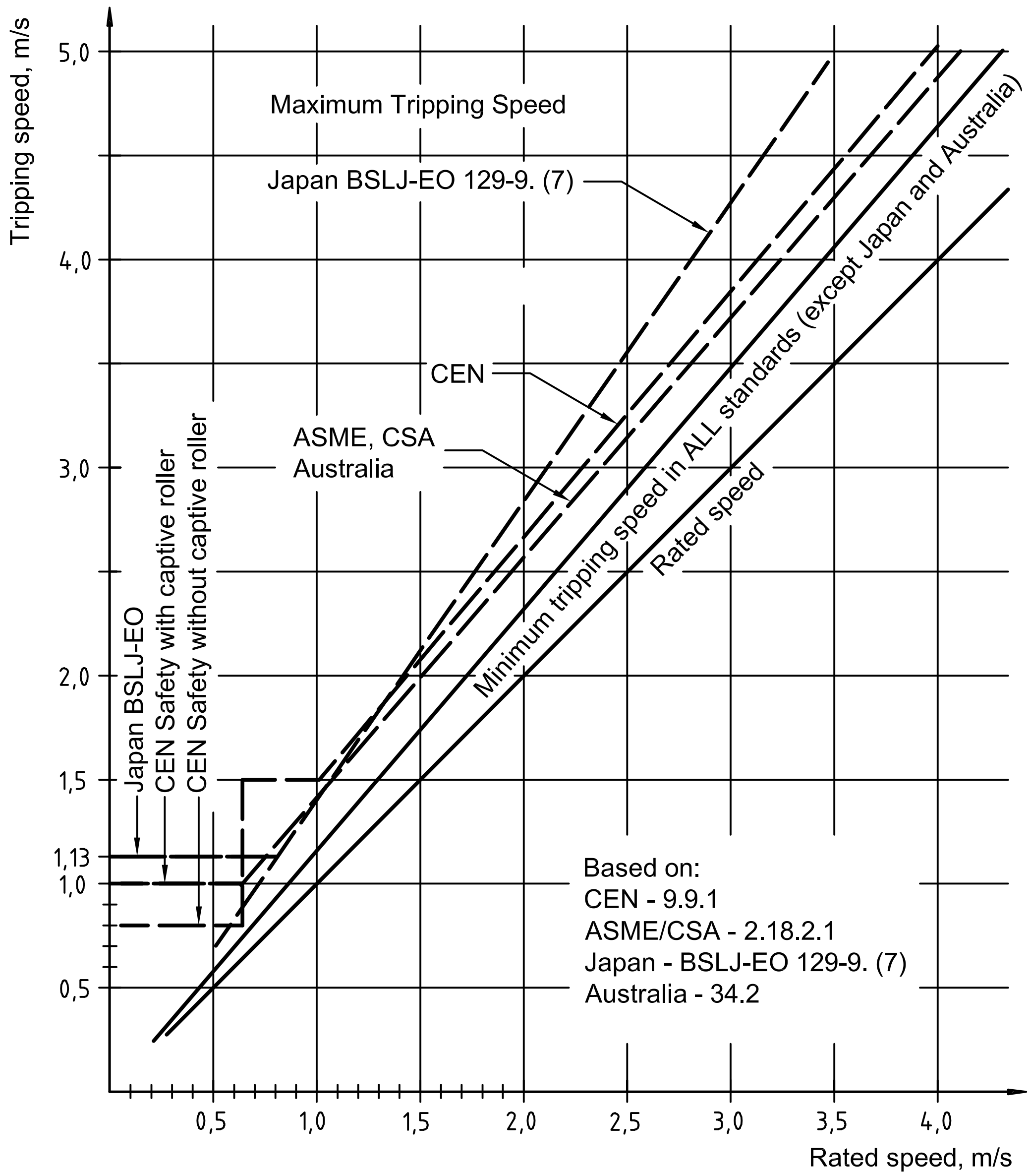

Figure A.1 — Overspeed governors

Table A.7 — Spring buffers

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	**BUMPERS** Maximum rated speed	Non-linear buffers 1 m/s (10.4.1.2)	Not permitted	0,5 m/s only if furnished with a device to stop the descending car before the descending speed exceeds 1,4 x RS	Non-linear buffers: 1 m/s (10.4.1.2)	0,4 m/s (9.1)
2.	**SPRING BUFFERS** Maximum rated speed	1 m/s (10.3.3)	1 m/s (2.22.1.1.1)	1 m/s (2000 MOC Notice No.1423 item 2 para. 6)	1 m/s (10.3.3)	1,0 m/s (9.1)
3.	Stroke	See Figure A.2	See Figure A.2	**Rated speed (m/s)** — **Stroke (cm)** $V \leq 0,5$ — 3,8 $0,5 < V \leq 0,75$ — 6,6 $0,75 < V$ — 10,0	See Figure A.2 CEN line applies	See Table 9.5.2 in AS1735-2:2001 See also Figure A.2 in this document
4.	Minimum stroke	0,065 m (Annex L)	0,038 m (2.22.3.1)	3,8 cm (2000 MOC Notice No.1423 item 2 para. 6)	0,065 m (Annex L)	0,038 mm (Table 9.5.2 in AS1735-2:2001)
5.	Car rated load to be considered	100 % (10.4.1.1.2)	100 % (2.22.3.2)	100 % (explanation of 2000 MOC Notice No.1423 item 2 para. 6)	100 % (10.4.1.1.2)	100 %
6	Force at full compression, expressed in terms of maximum suspended load, R	$2,5 \leq R \leq 4$ (10.4.1.1.2)	$2 \leq R \leq 3$ (2.22.3.2.1 and 2.22.3.2.2)	No spec	$2,5 \leq R \leq 4$ (10.4.1.1.2)	$2 \leq R \leq 3$ (9.5.1)
7.	Type test?	No (but required for non-linear buffers)	No	No	No (but required for non-linear buffers)	No spec
8.	Data required at lift acceptance	Spring curve	Marking plate	None	Spring curve	Spring curve
9.	Stroke and load rating to be marked on buffer?	No	Yes (2.22.3.3)	No	No	Yes (9.5.3)
10.	Test at life acceptance	Static D.2(1)	No [8.10.2.2.5(c)]	No	Yes D.2(1)	Dynamic: AS1723-10 (6.2A)

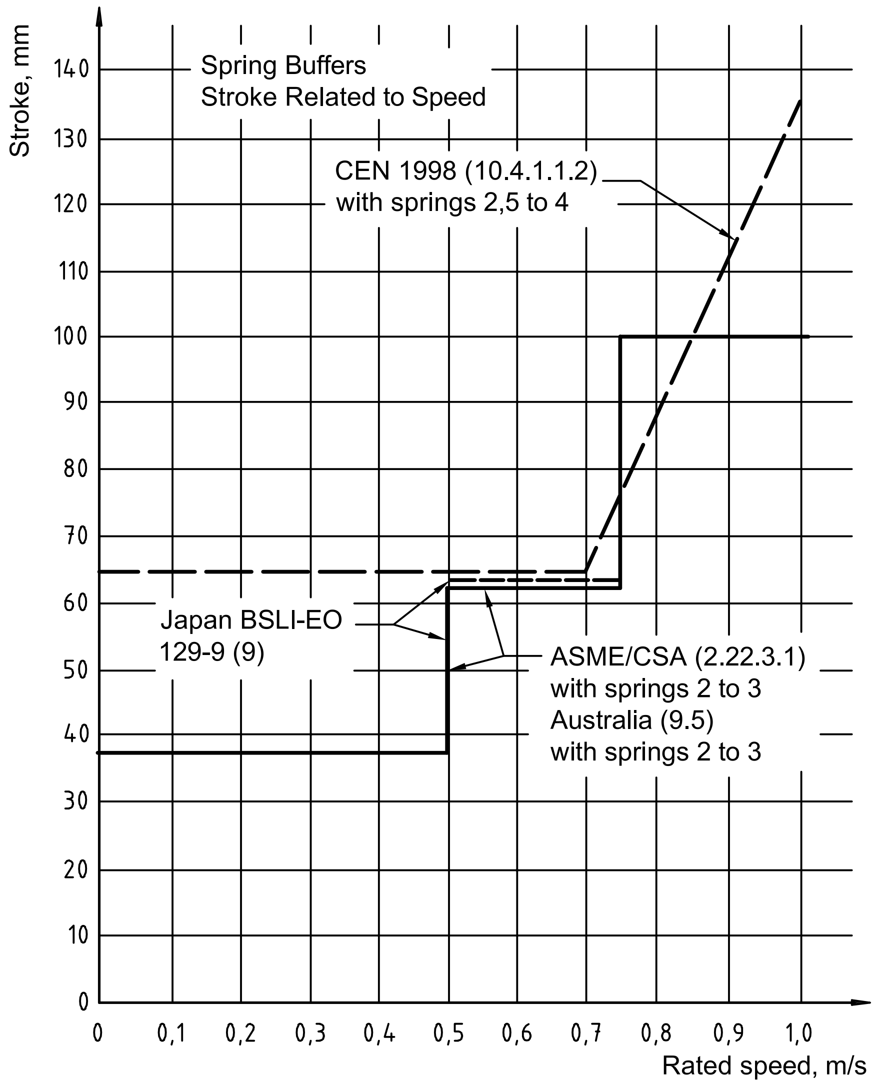

Figure A.2 — Spring buffers

Table A.8 — Hydraulic buffers

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	Limits of application	None	None	None (2000 MOC Notice No.1423 item 2 para. 6)	None	None
2.	Minimum stroke in relation to speed (V = rated speed in m/s, g = 9,81 m/s^2)	$(1,15V)^2/(2g)$	$(1,15V)^2/(2g)$ (8.2.4)	$(1,15V)^2/(2g)$	$(1,15V)^2/(2g)$	$(1,15V)^2/(2g)$
3.	Absolute minimum stroke	None	None	No (explanation of 2000 MOC Notice No.1423 item 2 para. 6)	No spec	No spec
4.	Max. mean deceleration (see NOTE)	1g (10.4.3.3)	1g (2.22.4.2)	9,8 m/s^2 in vertical direction and 5 m/s^2 in horizontal direction (BSLJ-EO129-10 item 2 para. 1)	1g [10.4.3.3)]	1g [9.6.2 a)]
5.	Not to exceed 2,5g for more than 0,04 s?	Yes	Yes	Yes (JEAS 517)	Yes	Yes
6.	Rated load of car to be considered for (4) + (5)	100 %	70 kg to 100 % (full range)	Yes (100 %) (explanation of 2000 MOC Notice No.1423 item 2 para. 6 & JEAS 517)	100 %	100 % (9.6.3)
7.	Reduced-stroke buffers permitted?	Yes (10.4.3.2)	Yes (2.22.4.1.2)	Yes (explanation of 2000 MOC Notice No.1423 item1 para. 1)	Yes (10.4.3.2)	Yes [9.6.2 b)]
8.	Minimum reduced stroke of buffers for speeds ≤ 4 m/s	50 % of (2) if 2,5 m/s < RS ≤ 4 m/s	50 % of (2) if 2,5 m/s < RS ≤ 4 m/s	50 % of (2) [BSLJ-EO129-9(5)]	50 % of (2) if 2,5 m/s < RS ≤ 4 m/s	Cannot be less than 33,3 % of required stroke for speeds > 2,5 m/s (Table 9.6.2)
9.	But with min. stroke for (8) – See item 15	0,42 m	No spec	No spec	0,42 m	0,42 m
10.	If rated speed > 4 m/s, min. stroke	33,3 % of (2)	33,3 % of (2)	33,3 % of (2) (explanation of 2000 MOC Notice No.1423 item 1 para. 1)	33,3 % of (2)	33,3 % (9.6.2)
11.	But with min. stroke for (10) – See also item 15	0,54 m	0,46 m	0,46 m (explanation of 2000 MOC Notice No.1423 item 1 para. 1)	0,54 m	0,42 m
12.	Switch for checking full extension?	Yes (10.4.3.4)	Yes, but only if gas return [2.22.4.5 c)]	No	Yes (10.4.3.4)	Yes (9.6.6)

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Table A.8 (*concluded*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
13.	Type test required?	Yes (F.5)	Yes (2.22.4.7)	Yes	Yes (F.5)	Yes (9.6.10)
14.	Acceptance test required?	Yes [D.2 e)]	Yes [8.10.2.2.5 c)]	Yes	Yes [D.2 e)]	Yes
15.	Minimum stroke in (9) and (11) translates into the speed below which reduced-stroke buffers in (8) and (10) are not permitted	50 %....2,5 m/s 33,3 %....4 m/s	50 %....No spec 33,3 %....2,6 m/s	No spec	50 %....2,5 m/s 33,3 %....2,5 m/s	50 %....No spec 33,3 %....2,5 m/s

GENERAL NOTE

None of the codes specifies if the average must be based on time or on distance. Calculations already made in ASME and CSA, as well as the minimum given by the EN 81-1:1998 formula, indicate that the mean deceleration considered is based on distance.

Table A.9 — Braking systems and emergency brakes
(For footnotes, see end of table)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
	MACHINE BRAKING SYSTEM Items 1 to 13					
1.	Electromechanical brake alone Must be able to handle specific loads from specific speeds, as follows:					
1.1	In DOWN direction: this % of rated load..................	125 % (12.4.2.1)	125 %[a] (2.24.8.3)	125 % (150 % for freight elevators with C_2 loading) (2000 MOC Notice No.1429 item 1 para. 2)	125 % (12.4.2.1)	[7.10 h)] 125 % with dynamic braking 105 % each shoe/brake when no dynamic braking
	from this % of rated speed	100 %	0 % [2.24.8.3 a)] Holding only	100 % (0 % for freight elevator with C_2 loading)	100 %	5 % to 10 % with dynamic braking 100 % when no dynamic braking
1.2	In UP direction: this load..................................	No spec	Empty car [2.24.8.3 c)]	Same as 1.1	No spec	No spec
	from this speed........................	No spec	Governor trip	Same as 1.1	No spec	No spec
2.	BRAKING SYSTEM which includes (1) and other braking means (e.g. electric), must be able to handle the following loads from specific speeds:					
2.1	this % of rated load.................	125 % [D.2 d)]	125 %[a] (2.24.8.2)	No spec	125 %	125 %
2.2	from this % of rated speed.......	100 %	Gov trip	No spec	100 %	100 %
2.3	with maximum deceleration of..	No spec	1*g*	No spec	No spec	No spec
3.	The brake shall be held off:	(12.4.2.3) By continuous flow of current	(2.24.8.2) Electrically, electro-mechanically, electro-hydraulically	(2000 MOC Notice No.1423 item 2 para. 3) Electrically	(12.4.2.3) By continuous flow of current	[7.10 a)] Electrically

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Table A.9 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
4.	Electric power to brake must be controlled by at least this number of devices (contactors)	2 (12.4.2.3.1)	2 (2.26.8.1)	No spec	2 (12.4.2.3.1)	2 [7.10 c)]
5.	Checking of contactors at every stop required?	Yes[b] (12.4.2.3.1)	Yes (2.26.9.4)	No spec	Yes[b] (12.4.2.3.1)	Static control [29.11 g)]
6.	Delay in brake application in emergency?	Not permitted (12.4.2.3.3)	Not permitted (2.26.8)	Not permitted (2000 MOC Notice No. 1423 item 2 para. 6)	Not permitted (12.4.2.3.3)	No spec
7.	Brake application by	Springs/weights (12.4.2.5)	Springs/gravity (2.24.8.3)	No spec	Springs/weights (12.4.2.5 +)	Springs/weights (7.10)
8	Mechanical brake components in two sets with one set able to slow down rated load?	Yes (12.4.2.1)	No Yes, if used as emergency brake	No spec	Yes (12.4.2.1)	Yes (7.10)
9.	Retardation limited?	Yes (12.4.2.1)	No Yes, if used as emergency brake	9,8 m/s^2 in vertical direction 5 m/s^2 in horizontal direction (BSLJ-EO 129-10 item 2 para. 1)	Yes (12.4.2.1)	Stop and hold 105 % of rated load
10.	Electrical checking of brake?	No	No	No spec	No	No spec
11.	Permanent label for brake setting required?	No	Yes (2.24.8.5)	No spec	No	No spec
12.	Acceptance test with load/speed %	125 %/100 % (D.2d)	125 %[a]/100 %[a] [8.10.2.2.2 o)]	No spec	125 %/100 % (D.2 d)	105 %/100 % on one shoe (7.10 h)
13.	Periodic test	Visual (E.1)	Visual [8.11.2.1.2 o)] 5-yearly (8.11.2.3.4)	Yes, once a year (BSL Art.12 item 2)	Visual (E.1)	Yes (AS1735-10)
	EMERGENCY BRAKE – Items 14 to 26					
14.	Ascending car overspeed protection required?	Yes (9.10)	Yes (2.19.1)	No spec	Yes (9.10 +)	Yes (35)

Continued on next page

Table A.9 (*concluded*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
15.	Possibility of failure considered in: – machine motor, brake, coupling, shaft, gearing? – control system? – any component defining car speed? – suspension failure excepted?	No spec	(2.19.1.1) Yes Yes Yes Yes	No spec	No spec	No spec
16.	Minimum detection speed Maximum detection speed	115 % of RS Same as tripping speed of speed governor	No spec 110 % of governor tripping speed	No spec	115 % of RS Same as tripping speed of speed governor	No spec Not more than 10 % above governor tripping speed (35.1)
17.	Means (emergency brake) to stop or reduce car speed to CWT buffer rating?	Yes	Means to decelerate car	No spec	Yes	Yes (35.1)
18.	Maximum deceleration	1g	1g	No spec	1g (9.10.3)	1g [35.2 b)]
19.	Means (emergency brake) may act on – car? – counterweight? – rope system? – traction sheave or its shaft?	 Yes Yes Yes Yes	 Yes Yes Yes Yes	No spec	 Yes Yes Yes Yes	 Yes Yes Yes Yes
20.	Type-testing (laboratory) required?	Yes	No	No spec	Yes	No
21.	Protection required against unintended car movement away from a landing?	No	Yes (2.19.2)	No spec	No	No
22.	In case of failure, in which components?	N/A	(2.19.1.1)	No spec	N/A	N/A
23.	Protection to detect car movement and stop car within this maximum distance from landing.............	N/A	1 220 mm [2.19.2.2 b)]	No spec	N/A	N/A
24.	Maximum deceleration	N/A	1g	No spec	N/A	N/A
25.	Means (emergency brake) may act on	N/A	Same as 19	No spec	N/A	N/A
26	Type-testing required?	N/A	No	No spec	N/A	N/A

a Where ASME/CSA column indicates 125 % of rated load, it should read 100 % for freight lifts.

b In EN 81-1:1998, at least at the next change in the direction of motion.

Table A.A.10 — Electrical devices

Symbols used in this table:

A Electric safety device in a form of safety contacts (switches) (see 2.2 in this document).

B Electric safety device in a form of a safety circuit (see 2.2 in this document).

D Protective device – term as used in EN 81-1:1998.

NOTE 1 Entry A means that the device must be of that type. Entry A or B means that the device may be of either type.

NOTE 2 For EN 81-1:1998, the entries are based on EN 81-1:1998, Appendix A. For other codes, they are based on rules.

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
1.	Check on well closed position of:					
	– well auxiliary doors or traps?	Yes: A or B (5.2.2.2.)	Yes [2.11.1.2 e)]	Yes [BSLJ-EO 129-9.(1)]	Yes (5.2.2.2.2 +)	Yes (12.24)
	– pit access doors?	Yes (5.7.3.2), but not always required (see 5.2.2.2.2)	Yes [2.2.4.4 b1)]	Yes	Yes (5.7.3.2.3)	Yes (12.21.3)
	– access opening to clean glass in observation elevators?	No spec	Yes (2.11.1.4)	No spec	No spec	No spec
2.	Check on locking of car doors in cases specified in rule?	Yes: A or B [11.2.1 c)]	Yes (2.14.4.2.3)	No spec	Yes [11.2.1 c) +]	Yes (15.1.3.5)
3.	Automatic landing/car door reopening device (D) for following door types:					
	– horizontal sliding, always required?	Yes (7.5.2.1.1.3)	No	No spec	Yes (7.5.2.1.1.3+)	Yes (25.6.1)
	– if kinetic energy above a set limit?	N/A (8.7.2.1.1.3)	Yes (2.13.5)	No spec	N/A (8.7.2.1.1.3+)	No spec
	– vertically sliding landing and car doors if automatic or actuated by momentary pressure?	Not permitted (7.5.2.2 & 8.7.2.2)	Yes (2.13.3.4.3)	No spec	Not permitted (7.5.2.2 & 8.7.2.2)	No spec
4.	Check on locking of landing doors?	Yes: A or B (7.7.3.1)	Yes (2.12.2.1)	Yes (BSLJ-EO ART 129-10 Note 3, para. 1)	Yes (7.7.3.1 +)	Yes (13.2.1)
5.	Check whether landing doors closed (as part of 4 or separately)?	Yes: A or B (7.7.4)	Yes	Yes (BSLJ-EO ART 129-10 Note 3, para. 1)	Yes (7.7.4)	Yes (13.2.1)
6.	Check on closed position of landing door panels which are not locked:					
	– if panels directly linked mechanically?	No (7.7.6.2)	No (2.12.2.4.4)	Yes (BSLJ-EO ART 129-10 Note 3, para. 1)	No (7.7.6.2)	No (12.16.5)
	– if panels linked only indirectly by ropes, chains, etc.?	Yes: A or B (7.7.6.2)	No (2.12.2.4.4)	Yes (BSLJ-EO ART 129-10 Note 3, para. 1)	Yes (7.7.6.2)	Yes (12.16.5)
8.	Hoistway access switch, overriding 4 to 6 (A)?	Not permitted	Yes (2,12,7.3)	No spec	Not permitted	No spec

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Table A.10 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
9.	Check on retracted position of hinged or moveable car sills (A)?	No spec	Yes (2.26.2.20)	No spec	No spec	No spec
10.	Photocells (D) for doorless cars permitted?	Not permitted	Not permitted	Permitted for car lifts (2000 MOC Notice No.1413 item 1 para. 6)	Not permitted	Not permitted
11.	Check on closed position of car door?	Yes: A or B (8.9.2)	Yes (2.14.4.2)	Yes (BSLJ-EO Art 129-10 item 3 parag.1)	Yes: A or B (8.9.2)	Yes (24.3)
12.	Check on locking or closing of:					
	– car top emergency traps?	Locking: A or B (8.12.4.2)	Closing (2.14.1.5.2f)	Yes (BSL-EO Art 129-10 item 3 para. 1)	Locking: A or B (8.12.4.2)	Locking (23.14 f)
	– car side emergency doors?	Locking: A or B (8.12.4.2)	Closing (2.26.2.17)	Yes (BSL-EO Art 129-10 item 3 para. 1)	Locking: A or B (8.12.4.2)	Not permitted
	– panels on observation elevators?	No spec	Locking (2.26.2.31)	No spec	No spec	No spec
13.	Check on extension of 2 suspension ropes or clearances, if permitted?	Yes: A or B (9.5.3)	Not permitted (2.20.4)	No spec	Yes: A or B (9.5.3)	Yes (30.7) (chain not permitted)
14.	Check on compensation ropes:					
	– tension or lower sheave limit?	Yes: A or B (9.6.1e)	Both (2.26.2.3)	No spec	Yes: A or B (9.6.1e)	Yes (30.8)
	– rebound or upper sheave limit?	Yes: A or B (9.6.2)		No spec	Yes: A or B (9.5.2)	No spec
15.	Check on operation of car safety gear?	Yes: A or B (9.8.8)	Yes (2.17.7.3)	No spec	Yes: A or B (9.8.8)	Yes (33.7.1)
16.	Check on car overspeed by:					
	– a device on governor or other device	Either A or B (9.9.11.1)	Governor (2.18.4.1)	Mechanical governor (2000 MOC Notice No.1423 item 2 para. 2)	Either A or B (9.9.11.1)	Governor (34.3.1)
	– device of Type A or B	Either A or B	A only	Electrical governor is permitted for elevators with slack rope safety (explanation of 2000 MOC Notice No.1423 item 2 para. 2)	Either A or B	Either A or B
17.	Check on non-automatic resetting of governor?	Yes: A or B (9.9.11.2)	No[a] (2.18.4.2.5)	Yes (explanation of 2000 MOC Notice No.1423 item 2 para. 2)	Yes: A or B (9.9.11.2)	Yes (34.3.2a)

[a] Electrical device not necessary in ASME/CSA because governor switch (No. 16) and car safety gear switch (No. 15) must be a manually reset type.

Continued on next page

Table A.10 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
18.	Check of tension in governor rope?	Yes: A or B (9.9.11.3)	Yes (2.18.7.2) (jawless only)	No spec	Yes (9.9.11.3)	Yes (34.10)
19.	Check on buffer return to normal position:					
	– with pit buffers?	Yes: A or B (10.4.3.4)	If gas return [2.22.4.5 b)]	No spec	Yes: A or B (10.4.3.4)	Yes (9.6.6)
	– with Type C safety buffers? [b] For energy dissipation type buffers (10.4.3).	Yes (9.8.6.2)[b]	Yes (2.17.8.2.7)	No spec	Yes [9.8.6.2)]	Yes [33.8.2 g)] (D Type)
20.	Check for slack rope or chain on drum machines?	Yes: A or B (12.9)	Yes (2.26.2.1)	Yes (2000 MOC Notice No.1423 item 2 para. 7)	Yes: A or B (12.9 +) Chains not permitted	Yes Rope (30.9) Chains not permitted
21.	Electrical check of traction (D)?	Yes (12.10)	No	No spec	Yes (12.10)	No spec
22.	Stopping of the machine and checking stopped condition (B)?	Yes (12.7)	Yes: static only (2.26.9.5/6)	No spec	Yes (12.7)	Yes: static only (29.11f)
23.	Control of main switch in specific cases:					
	– by means of a Type A device?	Yes (13.4.2)	No spec	No spec	Yes (13.4.2)	No spec
	– by means of secondary switches?	Yes (13.4.3)	Yes (2.26.4.1)	No spec	Yes (13.4.3)	No spec
24.	Requirements for electrical safety devices of Type A and Type B?	Yes (14.1.2) (12.7)	Yes (2.26.4.3) (2.26.9) (2.26.2)	No spec	Yes (14.1.2) (12.7)	Yes (29.11)
25.	Requirements for Type D devices?	Yes (14.2.1.1)	Yes (2.26.1.1)	No spec	Yes (14.1.2) (12.7)	Yes (29.1)
26.	Leveling and re-leveling with door open:	(14.2.1.2)	(2.26.1.6)	No spec	(14.2.1.2)	No spec
	– check on leveling and re-leveling with a Type A or Type B device?	A or B (14.2.1.2a2)	A	No spec	A or B [14.2.1.2a)2)]	Yes (29.1)
	– check on tension in the device for transmission of the car position by a Type A device?	Yes (14.2.1.2a)3)	No	No spec	Yes [14.2.1.2a)3)]	Yes (29.3)
27.	Inspection operation required? [c] In Japan, for elevators with top clearance and pit depth of less than 1,2 m, switch is required to ensure the safety distance in pit and overhead during maintenance or inspection operations.	Yes (14.2.1.3)	Yes (2.26.1.4.1)	Yes[c]	Yes (14.2.1.3 +)	Yes (29.3)

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Table A.10 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
	– check on proper switching to inspection operation by a Type A device?	Yes (14.2.1.3)	Yes [2.26.1.4 b)]	Yes (BSL-EO Art 129-10 item 2 para. 2 & 2000 MOC Notice No.1413, item 1 para. 4)	Yes (14.2.1.3 +)	Yes (29.3)
28.	Emergency electrical operation switch (A) (from machine room)?	Yes (14.2.1.4)	No	Yes, for elevators without emergency exit on car ceiling (2000 MOC Notice No.1413 item 1 para. 1)	Yes (12.5 +)	Yes [23.14 c)]
29.	Docking/truck zone operation:	(14.2.1.5)	(2.26.1.6)	No spec	Not permitted	Not permitted
	– check on travel limits (A or B) and key-operated safety contact (A)?	A (14.2.1.5 b/g3) A or B	(2.26.1.6)	No spec	No spec	No spec
30.	Stop switch (A) conforming to these rules, in the following locations:	(14.2.2)	(2.26.2.5)	See below	(14.2.2)	
	– pit?	Yes (5.7.3.4)	Yes (2.26.2.7)	Yes (explanation of BSL-EO Art 129-7 item 1 para. 1)	Yes (5.7.3.4 +)	Yes (10.6)
	– pulley room/secondary level?	Yes (6.4.5)	No	No spec	Yes (6.4.5)	Yes (5.12)
	– car top?	Yes [8.15 b)]	Yes (2.26.2.8)	Yes (2000 MOC Notice No.1429 item 1 para. 1)	Yes [8.15 b)]	Yes (26.10)
	Inside car:					
	– if imperforate (solid) door?	Prohibited (14.2.2.3)[c]	Key-operated only (2.26.2.21)	Yes (2000 MOC Notice No.1429 item 1 para. 1)	Yes (Not accessible to public) (14.2.2.3 +)	Yes (Not accessible to public) (30.1)
	– if perforated doors or enclosure?	N/A	Yes (2.26.2.5)	Yes (2000 MOC Notice No.1429 item 1 para. 1)	Yes (Not accessible to public) (14.2.2.3 +)	Yes (Not accessible to public) (30.1)
	– if no car doors? c Required for docking operations (14.2.1.5)	N/A	N/A	Yes (2000 MOC Notice No.1429 item 1 para. 1)	N/A	N/A
31.	**TERMINAL LANDING FOR TRACTION LIFTS**					
31.1	– final terminal limits switches of Type A?	Yes [10.5.3.1 b)]	Yes (2.25.3)	Yes (2000 MOC Notice No.1423 item 2 para. 5)	Yes [10.5.3.1 b)]	Yes (31.3.3)

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Table A.10 (*continued*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
	– operated directly by car or indirectly by a device linked to car, with linkage being controlled by a Type A safety device?	Both (10.5.2.3)	Car only (2.25.3.3.1)	No spec	Both (10.5.2.3)	Car only [31.3.3 a)]
31.2	Normal terminal stopping device must:					
	– use a control device separate from final limit switches?	Yes (10.5.2.1)	Yes (2.25.2.1.2)	No spec	Yes (10.5.2.1)	Yes (31.3.3)
	– be operated directly by car or through a linkage, in which case the linkage must be checked (A)?	No	Yes (2.25.2.2.1 & 2.25.2.3.3)	No spec	No	Yes (31.2.4)
	– emergency terminal stopping device for static control required?	No	Yes (2.25.4.2)	No spec	No	> 1 m/s (31.4)
31.3	Terminal slow-down device when reduced-stroke buffers are used:					
	– may be of Type A or B?	Either (12.8.5)	Either (2.25.4.1)	No spec	Either (12.8.5)	A (31.4)
	– are operated directly by car or indirectly, but are not dependent on traction, and connecting means must be checked by a Type A device?	Yes (12.8.4)	Yes (2.25.4.1.9) [2.25.4.1.8 b)]	No spec	Yes (12.8.4)	Yes [31.4 d)]
	– are independent of normal terminal stopping devices?	No spec	Yes, must be (2.25.4.1.1)	No spec	N/A	No spec
32.	Electric socket outlet:		Electrical standards in USA: NFPA 70 Canada: CSA C21.1			
	– in pit?	Yes (5.7.3.4)	Yes (2.2.5)	No spec	Yes (5.7.3.4)	Yes (10.11)
	– in machine room?	Yes (6.3.6)	Yes (2.7.5)	Yes (explanation of BSL-EO Art 129-7)	Yes (6.3.6)	Yes (5.16)
	– in pulley room/secondary level?	Yes (6.4.7)	Yes (2.7.5)	No spec	Yes (6.4.7)	No spec
	– on car top?	Yes [8.15 c)]	Yes (2.14.7.1.4)	No spec	Yes [8.15 c)]	Yes (26.11)
33.	Lighting					
	– in pit (minimum "lux" if specified)?	50 lux (5.9)	100 lux (2.2.5.1)	No spec	Yes (5.9 +), 36 W fluoro	Yes (5.9 +), 36 W fluoro
	– along WELL walls or on car TOP?	Yes (5.9) (WELL)	Yes (2.14.7.1.4) (TOP)	No spec	Yes (5.9 +), 6 m apart	Yes (11.3), 6 m apart

Continued on next page

Table A.10 (*concluded*)

	Requirements	EN 81-1:1998	A17.1-2000/B44-00	Japan	AS1735-1:2001	AS1735-2:2001
	– minimum lux	50 lux/1 m above car top	No spec	No spec	No spec	No spec
	– in machine room (lux if specified)?	200 lux (6.3.6)	200 lux (2.7.5.1)	Yes (but lux is not specified) (explanation of BSL-EO Art 129-7)	200 lux (6.3.6)	200 lux (5.13)
	– pulley room/secondary level (lux if specified)?	Yes, 200 lux (6.4.7)	200 lux (2.7.5.1)	No spec	Yes (6.4.7)	Yes (6.4)
	– at landing, minimum (lux if specified)	50 lux (7.6.1)	100 lux (2.11.10.2)	No spec	40 lux (7.6.1+)	No spec
	– in car, minimum (lux) Passenger lifts	50 lux (8.17.1)	50 lux (2.14.7.1.2)	No spec	50 lux (8.17.1)	50 lux (23.25.2.1)
	Freight lifts	Same	25 lux (2.14.7.1.2)	No spec	Same	30 lux (23.25.2.1)
	Emergency	1W/60 min (8.17.4)	2 lux (2.14.7.1.3)	1 lux for passenger elevator and hospital elevator) (BSL-EO Art 129-10 item 3 para. 4)	20 lux/120 min (8.17.4)	20 lux (23.25.2.9)
34.	Audible and light signals					
	– light: "car here" if manual doors without vision panel?	Yes (7.6.2)	No	No spec	Yes (7.6.2)	No spec
	– light: direction of next car movement if collective control?	Yes (14.2.4.3)	No	No spec	Yes (14.2.4)	No spec
	– audible: car arriving?	Yes, recommended (14.2.4.3, NOTE)	No	Yes (JEAS 515B)	Yes, recommended (14.2.4.3, Note)	No spec
35.	Emergency alarm device required?	Yes (14.2.3)	Yes (211.1)	Yes (BSL-EO 129-10 item3 para. 3)	Yes (14.2.3 +)	Yes (32.4.4)
36.	Electrical installation and components					
	– general (standard, insulation, voltage limitations, wiring, lighting, socket outlets, motor protection)	13.1, 13.3, 13.5 and 13.6	2.8.1, 2.26.4	ELEC. This prescribes detailed rules in the Electric Utility Industry Law. For example, it specifies the usage of traveling cables for elevators in Article 215.	AS3000 (26)	AS3000 (26)
	– contacts, relays, components of safety circuits	13.2	2.26.7 to 2.26.9		13.2	REF. (26, 29)
	– main power switches	13.4	2.26.4		13.4 +	(26.2)
	– phase reversal (Type D)	[14.1.1.1 j)]	2.26.6		[14.1.1.1 j)]	Yes (30.20)

Annex B
(informative)

References

This annex includes information on obtaining copies of the safety standards covered in this Technical Report. It also includes information regarding correspondence with the standards writing committees.

European Standard EN 81-1, *Safety rules for the construction and installation of lifts — Part 1: Electric lifts*	
EN 81-1:1998 is available from **CEN National Members**, who are responsible for selling European Standards. Go straight to the catalogue search page of individual Members via the following link: http://www.cenorm.be/catweb/cwen.htm	All enquiries regarding this European standard, including requests for interpretation, should be addressed to: CEN/TC 10 Secretariat AFNOR 11 Avenue Francis de Pressensé 93571 Saint Denis La Plaine Cedex France http://www.afnor.fr/portail.asp Tel. : +33 (0)1 41 62 80 00 Fax : +33 (0)1 49 17 90 00 E-mail: nicole.michelet@afnor.fr

ASME A17.1, *Safety Code for Elevators and Escalators*	
The Code can be purchased from: ASME Order Department Box 2300 22 Law Drive Fairfield, NJ 07007-2300 USA www.asme.org/catalog Tel (973) 882-1167 Fax (973) 882-1717	For technical information on A17.1, contact: Secretary, A17 Committee The American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017 USA E-mail: burdeshawg@asme.org

B44-00 Safety Code for Elevators	
This Code can be purchased from: Canadian Standards Association 5060 Spectrum Way, Ste. 100 Mississauga, ON L4W 5N6 Canada Tel: 1-800-463-6727 Web: www.csa.ca	All enquiries regarding this code, including requests for interpretation, should be addressed to Jeet Tulshi at the above address or e-mail at: totaram.tulshi@csa.ca

AS1735-1 and AS1735-2, *Lifts, Escalators and Moving Walks*	
These Standards can be purchased from: Standards Australia 286 Sussex Street, Sydney, NSW 2000 GPO Box 5420, Sydney, NSW 2001 Telephone: +61 2 8206 6000 E-mail: mail@standards.com.au Website: http://www.standards.org.au	For technical information on these standards, contact John Inglis at: Tel: + 612-9-498-2275 Fax: + 612-9-498-5918 E-mail: amron@bigpond.net.au

Japan Industrial Standards A 4301 and A 4302	
These Standards can be purchased from: JSA 4-1-24 Akasaka Minato-ku,Tokyo 107-8440, Japan Tel: +81-3-3583-8005 Fax: +81-3-3586-2014 Website: http://www.jsa.or.jp/	For technical information on these standards, contact Teichii Ishii at: Tel: 03-3407-6471 Fax: 03-3407-2259 E-mail: donishii@coral.ocn.ne.jp

Annex C
(informative)

CEN/TC 10/WG 1 Document N144E
BASIC ASSUMPTIONS IN EN 81 1, 1985 EDITION

Spelling out these assumptions does not mean that in case of a failure or an accident the fact that one of these assumptions is not verified will nullify all the other assumptions.

1) Safe operation of the lift shall be assured for loads ranging from zero to 100 % of rated load.

2) The possibility of a failure of an electric safety device complying with all the requirements of the standard is not taken into consideration.

3) With the exception of the items listed below, a mechanical device built according to good practice and the requirements of the standard is assumed not to deteriorate to the point of creating hazard before the failure is detected. The possibility of the following mechanical failures shall be taken into consideration:

— rupture of the suspension;

— uncontrolled slipping of the ropes on the traction sheave;

— rupture and slackening of all linking by auxiliary ropes, chains and belts;

— failure of one of the mechanical components of the electro-mechanical brake which take part in the application of the braking action on the drum or disk.

NOTE For the time being, the possibility of this failure is not taken into consideration by all CEN-Member Committees.

The possibility of the car (or counterweight) striking the buffer(s) in free fall before tripping the safety gear is not taken into consideration.

4) A user may in certain cases make one imprudent act. The possibility of two simultaneous acts of imprudence and/or the abuse of instructions for use will not be considered.

5) If in the course of servicing work a safety device normally not accessible to the users is deliberately neutralized, safe operation of the lift is no longer assured.

6) When the speed of the car is linked to the frequency of the mains up to the moment of the application of the mechanical brake, the speed is assumed not to exceed 115 % of the rated speed or a corresponding fractional speed.

7) The following horizontal forces a person can exert shall be taken into consideration:

a) steady force: 300 N;

b) force resulting from impact: 1 000 N.

NOTE EN 81-1:1998 includes these assumptions in Section 0.3.

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