TECHNICAL REPORT

ISO/TR 11071-2

Second edition
2006-04-15

Comparison of worldwide lift safety standards —

Part 2: Hydraulic lifts (elevators)

Comparaison des normes mondiales de sécurité des ascenseurs —

Partie 2: Ascenseurs hydrauliques

Reference number
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Foreword

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

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

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

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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

ISO/TR 11071-2 was prepared by Technical Committee ISO/TC 178, *Lifts, escalators and moving walks*.

This second edition cancels and replaces the first edition (ISO/TR 11071-2:1996), and amendment 1 (ISO/TR 11071-2:1996/Amd. 1:1999), which have been technically revised.

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

Introduction to 1996 edition

At the 1981 plenary meeting of ISO/TC 178, work was started on a comparison of CEN standard EN 81/1 with the American, Canadian, and USSR lift safety standards. In 1983, Working Group 4 was officially formed to carry out the task of preparing 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 a gradual convergence of the technical requirements. In 1984, the study was expanded to include the Council for Mutual Economic Assistance (CMEA) safety standard. That report, ISO/TR 11071-1, *Comparison of worldwide lift safety standards — Part 1: Electric lifts (elevators),* was published 1990-12-01.

In 1989, the charge to WG 4 was expanded to include hydraulic lifts. Since there was no standard for hydraulic lifts in the Russian Federation, and the CMEA standard was being phased out of use, this Part 2 of the comparison is generally limited to the ASME, CEN, and CSA standards. The Japan Elevator Association was invited to add their standards to this comparison, however, no response to this request was received.

This report is intended to aid standards writers in developing their safety requirements, and to help standard 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

After the original publication (1996) of this technical report, including American, Canadian and European data and thereto Supplement 1 (1999-08-01), which added Australian and Japanese data, has been revised or amended. The recommendations in the form of “agreed upon points” stated in the first edition have also affected the revisions of the national standards.

The original report and amendment have been widely used by lift industry and standards writing organizations, including the ISO Technical Committee 178. Users have expressed need for an updated and consolidated version of the document, in particular the comparison tabulations. With the Resolution 208/2002, the ISO/TC 178 requested WG4 to consolidate original publications, including Supplements and “to update comparison tables in ISO/TR 11071 with data from the most recently 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 assumptions, historical backgrounds, observations and suggestions as well as the points agreed upon were the result of extensive work of the 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 reference. Extensive work on complete re-write of the narrative sections was 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. However, because of recent (2000) harmonization of ASME and CSA Codes, it was necessary to replace the quoted rule numbers with those in the current Codes In most sentences the ASME and CSA. I some other cases quoted references are updated in a NOTE following the narrative section or sentence.

All quoted requirement referenced in all tables (CEN, ASME/CSA, Japan and SA) are up to date.

Comparison of worldwide lift safety standards —

Part 2:
Hydraulic 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 81-2:1998, *Safety rules for the construction and installation of lifts — Part 2: Hydraulic lifts*;

b) ASME A17.1:2004, Safety Code for Elevators and Escalators and CSA B44:2004, Safety Code for Elevators;

c) Japan - Building Standard Law of Japan (BSLJ);

d) Standards Australia:

— AS 1735-1:2003, *Lifts, Escalators and Moving Walks — Part 1: General Requirements*;

— AS 1735-3:2002, *Lifts, Escalators and Moving Walks — Part 3: Passenger and Goods Lifts — Electro-hydraulic*.

This Technical Report applies to hydraulic lifts only, both of the direct and indirect acting type.

It should be noted that, in addition to the above listed standards, lifts must conform to the requirements of other standards (for example, standards covering mechanical, structural, and electrical equipment; building codes, and environmental regulations). Some of the standards will be referred to in this Technical Report.

2 Terminology

2.1 Lifts and elevators

2.1.1 The CEN term *lift* corresponds to the ASME and CSA term *elevator*. These terms are used inter-changeably in this report.

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 other Standards:

Term used in this report	**Correspond to terms used in the following standards***	
	CEN	ASME and CSA
Passenger lift	Lift except goods passenger lift	Passenger elevator & freight elevator permitted to carry passengers
Freight lift	Goods passenger lift**	Freight elevator

* See the definitions in the applicable Standards.

** This term is used only to enable comparisons to be made later in this report. It does not indicate recognition of the term “freight lift” by CEN.

2.2 Hydraulic terminology

2.2.1 Difference

There are some notable differences in the standards respecting hydraulic lift terminology as shown in the Table 1, Column A and B.

2.2.2 Agreed-upon points, re: hydraulic terminology

The differences should be eliminated or minimized through proposed changes to ASME and CSA Standards, as shown in Table 1, Column D.

If approved by ASME and CSA Committees, the proposed changes would eliminate major differences between CEN and North American Standards.

Column C gives the description of the equipment that a term (listed in Column A, B, or D) embraces.

In addition to “hydraulic machine”, ASME and CSA propose to introduce the term “hydraulic driving machines” hydraulic driving machines”. The terms are needed to differentiate between “electric” and “hydraulic” driving machines all covered in one ASME and CSA Standard. This is not necessarily applicable to CEN, as the electric and hydraulic lifts are covered by two separate standards.

2.2.3 Terminology in this report

In this report, the CEN terminology will be used, with the ASME and CSA terms in brackets if different.

Table 1 — Hydraulic Terminology

Column A	Column B	Column C	Column D
CEN	ASME & CSA Current	Description	Agreed upon points: ASME & CSA proposed changes
Direct acting lift	Direct plunger hydraulic elevator	—	Direct acting hydraulic elevator [a]
Indirect acting lift	Roped hydraulic Elevator	—	No change
Machine	—	Pump, motor, valves	Hydraulic Machine [b]
Jack	Driving machine	Cylinder and ram	Hydraulic jack [c]
Ram	Plunger or piston	—	Plunger (ram) or piston
Base	Head/bottom (Includes plunger end cap as well)	Cylinder end cap	No change
Valves:			
Non-return	Check	—	No change
Pressure relief	Pump relief	—	No change
Direction	Control	—	No change
Rupture	ASME-Safety CSA-Rupture	—	No change

NOTE ASME and CSA adopted terms:

[a] "direct-acting".

[b] "hydraulic machine".

[c] "hydraulic jack".

2.3 Working pressure vs full load pressure

ASME and CSA use *working pressure* (WP), which is defined as the pressure at the hydraulic driving machine when lifting the car and its rated load at rated speed, or with class C2 loading, when leveling up with maximum static load.

CEN defines *full load pressure* (FLP) as the static pressure exerted at the piping directly connected to the jack, the car with the rated load being at rest at the highest landing level.

CEN Annex K, clause K.1.1 recognizes that friction losses as a result of fluid flow are on the order of 15 %; thus a factor of 1,15 is included in their factor of safety determination.

NOTE CEN reference to “Clause 12, NOTE 1” in this clause and through the 1996 edition of this document has been replaced with reference to “Annex K, Clause K1.1” in this edition.

Thus, ASME WP = 1,15 x (CEN FLP).

2.4 Other terms

Additional terminology, where there is a difference between the CEN and the ASME and CSA standards, is shown in Table 2:

NOTE Since ASME and CSA are now harmonized they will be shown through this edition in a column under title “ASME and CSA” or “ASME/CSA”.

Table 2 — Terminology

CEN	ASME and CSA
Docking operation	Truck zone operation
Electric safety device	Electrical protective device
Fixings	Fastenings
Landing door	Hoistway door
Mains	Main power supply
Reeving ratio	Roping ratio
Instantaneous safety gear	Type A safeties (instantaneous safeties)
Progressive safety gear	Type B safeties (progressive safeties)
Pulley	Sheave
Safety gear	Safeties
Well	Hoistway

2.5 Abbreviations

The following abbreviations are used in this report:

FOS = Factor of safety or safety factor.

YP = Yield point.

WP = Working pressure.

UTS = Ultimate tensile strength.

FLP = Full load pressure.

NOTE See also list of abbreviations in item 4.1.2.

3 Basis for lift safety standards development (basic assumptions)

3.1 Historical background

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/WG1 N99 (see Annex C) the assumptions that, in the opinion of the committee, were used in the CEN standard.

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/WG1 N99;

b) some assumptions used in other standards differ from those in CEN/TC10/WG1 N99.

3.1.4 Using CEN/TC10/WG1 N99 as a model, the following list of assumptions (see 3.3 through 3.9 in this report) has been developed, which could be used as a basis for future work on safety standards.

The CEN assumptions 5 (related to car speed) and 7 (related to restrictors) as listed in Annex C have not been considered for adoption in this report, since they are deemed to be design parameters.

Further, CEN assumption 2 is adopted in this report as assumption 1 and CEN assumption 6 as assumption 3(c) in order to be consistent with Part 1 of this report.

In summary, CEN assumptions 1, 3, 4, 8, 9, and 10 correspond to assumptions 1, 2, 3, 4, 5, and 6 in this report. Assumption 7 is not covered in the CEN document.

3.2 General

3.2.1 Listed in 3.3 through 3.9 (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 behaviour 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 behaviour.

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.

3.3.1.2 In the case of *freight lifts*, 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 Currently CEN does not specifically require a 25 % overload safety margin; however, the design requirements provide for that level of safety.

ASME and CSA requirements 3.16 and 2.16.8 specifically require that safety be assured on *passenger lifts* in the case of 25 % overload.

3.3.2.2 With exceptions given in 3.3.2.5, the ratio of the rated load to the car platform area for passenger lifts is equal (± 5 %) in all standards for the range of 320 to 4 000 kg, and in that respect, universality of the assumption #1 is achieved.

However, the assumed average weight of a passenger differs: 75 kg (CEN) and 72,5 kg (ASME and CSA).

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

CEN (non-commercial vehicle with instructed users)	200 kg/m^2
ASME/CSA (general freight Class A)	244/240 kg/m^2
(motor vehicle Class B)	146/145 kg/m^2
(industrial truck Class C)	244/240 kg/m^2

3.3.2.4 The CEN standard contains two tables showing the ratio between the rated load and the maximum available car area (for *passenger lifts*), see Table 3.

The CEN Table “1.1” corresponding to the requirements for electric lifts is based on the rationale explained in 3.3.1.1 and was taken into consideration when formulating the statement in 3.3.2.2.

3.3.2.5 The CEN Table “1.1 A”, acceptable for Goods passengers lifts, is based on the rationale that where there is a low probability of the car being overloaded with persons, the available area of a hydraulic lift may be increased up to therein specified maximum, provided that additional safety measures are taken to ensure the safe interruption in the lift operation. Such measures include:

a) a pressure switch to prevent a start for a normal journey when the pressure exceeds the full load pressure by more than 20 %;

b) the design of the car, car sling, car-ram connection, suspension means, car safety gear, rupture valve, clamping or pawl device, guide rails, and buffers must be based on a load resulting from CEN Table “1.1”;

c) the design pressure of the jack and the piping shall not be exceeded by more than 1,4.

Starting point for CEN Table “1.1A” was the comparison of safety factors of driving systems on electric traction lifts versus hydraulic lifts. On hydraulic lifts the safety factor for the car suspension means and supporting structure is at least 3 times higher than that of the traction driving systems, when friction between the suspension ropes and the grooves of the drive sheave is taken into account. Consequently, the safety risk of unintended car movement downwards due to the overloading on hydraulic lifts is significantly lower than on electric traction lifts.

Furthermore, assuming that the car weight is equal to the rated load, in that case an overload of x % on the electric traction lift would correspond to only x/2 % overload for the hydraulic system.

NOTE This is true for machine power only; not for e.g. safety gear operation, guide rails dimensioning, etc.

For car areas up to 5 m^2, the required rated load in CEN Table “1.1 A” for a hydraulic lift may be 1,6 times less than the rated load according to CEN Table 1.1.

NOTE 1.6 is an ISO-standard number R5. This is important in view of the rated loads according to ISO 4190-1 1999, *Lift (US: Elevator) installation — art 1: Class I, II, III and VI lifts,* e.g. a Goods passengers lift with 5 m^2 available car area requires 2 500 kg rated load in the case of an electric lift, and 1 600 kg in the case of a hydraulic lift. For car areas bigger than 5 m^2 there is no mathematical background.

See Table 3 for an abbreviated comparison of the CEN Tables.

Table 3 — CEN Tables

Rated Load	Maximum Car Area		Increase in Car Area "1.1 A" over "1.1"
	CEN Table 1.1	CEN Table 1.1 A for Goods passengers lifts	
kg	m^2	m^2	%
400	1,17	1,68	44
800	2,00	2,96	48
1 200	2,80	4,08	46
1 600	3,56	5,04	42
over 1 600, add	N/A	0,40/100 kg	N/A
2 000	4,20	6,64	58
2 500	5,00	8,84	73
over 2 500, add	0,16/100 kg	0,4/100 kg	250

3.3.2.6 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.

NOTE 3.3.2.6 CEN Assumption 2 (see Annex C) is not a new assumption, but rather one of the methods as to how Assumption 1 is applied in the CEN standard.

3.4 Assumption 2 - failure of electric safety devices

The possibility of a failure of an electric 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 electric safety devices are similar in present standards. There are, however, differences and inconsistencies, as detailed in section 11.

Section 11.1.3 deals in particular with discrepancies in assumptions implied in requirements for design of electric 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, such as safety factors. See sections 4.1.3 and 4.2.1 of this report;

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

1) rupture of car suspension means;

2) 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;

NOTE Since 2000, overspeed valve is required by ASME and CSA when flexible hoses are used and when elevator is located in seismic risk zones 2 or greater;

3) small leakage in the hydraulic system (jack included);

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.

NOTE 1 The Working Group could not agree upon adopting the CEN Assumption 4.3 (see Annex C) requiring that “the possibility of rupture in the hydraulic system (jack excluded) shall be taken into consideration”;

NOTE 2 Presently, this assumption is implemented only in CEN by requiring a rupture valve or similar devices, while CSA assumes the rupture of flexible hoses only and in that case only, the rupture valve is required. In ASME, the overspeed valve (safety valve) is only required in seismic risk zones 2 or greater.

NOTE 3 The CEN rupture valve protects only in the case of rupture of piping, not the cylinder. The USA's experience indicates that most problems arise from the rupture of cylinders rather than piping;

NOTE 4 Refer to section 10 and table 12 in this Report for detailed comparison of requirements for free fall and excessive speed protection.

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 and chains, exists.

3.5.1.2 With the assumption in 3.5 (b)(2) 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 (9.5.1) clearly assumes failure of suspension means, while ASME and CSA requirement 3.17 imply that safety gear must be able tostop, or at least slow down, a free falling car.

3.5.2.2 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 and CSA requirement 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 (9.10.2.10.3) assumes the possibility of governor rope failure.

3.5.2.3 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.

3.5.2.4 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.

3.5.2.5 All standards require an anti-creep system based on assumption 3.5 (b)(3).

3.6 Assumption 4 - imprudent act 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 a safety circuit failure).

3.6.1 Assumption 4 as applied in current standards

All three standards 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

3.7.2.1 All three standards are based on this assumption.