International Standard

# ISO 8100-2

# Lifts for the transport of persons and goods —

## Part 2:
## Design rules, calculations, verifications and tests of lift components

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# Foreword

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

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This document was prepared by Technical Committee ISO/TC 178, *Lifts, escalators and moving walks,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 10, *Lifts, escalators and moving walks,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).



This second edition cancels and replaces the first edition (ISO 8100-2:2019), which has been technically revised.

The main changes are as follows:

— mechanical tests and temperature tests of safety circuits and SIL-rated circuits have been updated;

— errors in the formulae for traction calculation have been corrected;

— verification methods for suspension and compensation means other than steel wire ropes have been added;

— discard criteria for suspension means and sheaves have been added;

— requirements for SIL-rated circuits (previously called PESSRAL) have been revised;

— the document structure has been revised as per the ISO/IEC Directives, Part 2.

ISO/TS 8100-3:2019 provides information on the differences between this document and local standards (ASME A17.1/CSA B44 and JIS A 4307 1/JIS A 4307 2) not included in this document.

This document is intended to be used in conjunction with documents calling for the use of this document (e.g. ISO 8100-1:2026).

A list of all parts in the ISO 8100 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

# Introduction

This document is a type-C standard as stated in ISO 12100:2010.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organizations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e.g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate in the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or type-B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

# Lifts for the transport of persons and goods —

# Part 2:
# Design rules, calculations, verifications and tests of lift components

## 1 Scope

This document specifies for passenger lifts and goods passenger lifts:

— the verification of door locking devices;

— the verification of safety gears;

— the verification of overspeed governors;

— the verification of buffers;

— the verification of safety circuits and SIL-rated circuits;

— the verification of ascending car overspeed protection means;

— the verification of unintended car movement protection means;

— the verification of rupture valves and one-way restrictors;

— the verification of suspension and compensation means;

— the discard criteria for suspension means and sheaves;

— the calculation of guide rails;

— the calculation of rams, cylinders, rigid pipes and fittings;

— the evaluation of the traction;

— the evaluation of the safety factor on suspension means;

— the pendulum shock tests;

— the fault exclusion for electric and electronic components;

— the design rules for SIL-rated circuits.

This document is not applicable to passenger lifts, goods passenger lifts or lift components, which are installed or manufactured before the date of its publication.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148-1:2016, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 3108:2017, *Steel wire ropes — Test method — Determination of measured breaking force*

ISO 4344:2022, *Steel wire ropes for lifts — Minimum requirements*

ISO 7500-1:2018, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 8100-1:2026, *Lifts for the transport of persons and goods — Part 1: Safety rules for the construction and installation of passenger and goods passenger lifts*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 17638:2016, *Non-destructive testing of welds — Magnetic particle testing*

ISO 23277:2015, *Non-destructive testing of welds — Penetrant testing — Acceptance levels*

ISO 29584:2015, *Glass in building — Pendulum impact testing and classification of safety glass*

IEC 60068-2-6:2007, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14:2023, *Environmental testing — Part 2-14: Tests — Test N: Change of temperature*

IEC 60068-2-27:2008, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

IEC 60947-5-1:2024, *Low-voltage switchgear and control gear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*

IEC 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 1: General requirements*



IEC 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 3: Software requirements*



IEC 61709:2017, *Electric components — Reliability — Reference conditions for failure rates and stress models for conversion*

EN 10025-2:2019, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010 and ISO 8100-1:2026 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

## 4 Design rules, calculations, verifications and tests

### 4.1 General

Passenger and goods passenger lifts shall be in accordance with the safety requirements and/or protective measures of the following clauses. In addition, the passenger and goods passenger lifts shall be designed in accordance with the principles of ISO 12100:2010 for hazards relevant but not significant that are not dealt with by this document.

The precision of the instruments shall allow measurements to be made within the following accuracy:

a) ±1 % for masses, forces, distances, speeds;

b) ±2 % for accelerations, retardations;

c) ±5 % for voltages, currents;

d) ±5 °C for temperatures;

e) ±2,5 % for flow rate;

f) ±1 % for pressure, $p$, below 200 kPa;

g) ±5 % for pressure, $p$, above 200 kPa.

Recording equipment shall be capable of detecting signals, which vary in time of 0,01 s.

## 4.2 Verification of landing and car door locking devices

### 4.2.1 Verifications and tests

#### 4.2.1.1 Verification of operation

It shall be verified that the electric safety device is not activated unless the locking element is engaged as specified by the standard calling for the use of this document (e.g. 7 mm as per ISO 8100-1:2026, 4.3.9.1.2).

#### 4.2.1.2 Mechanical tests



##### 4.2.1.2.1 General

The mechanical tests shall be performed in the following sequence:



a) endurance test as per 4.2.1.2.2;

b) static test as per 4.2.1.2.3;

c) dynamic test as per 4.2.1.2.4.

The static test and the dynamic test shall be carried out with the same test sample used in the endurance test.

##### 4.2.1.2.2 Endurance test

The locking device shall be submitted to 1 000 000 (±1 %) complete cycles; one cycle comprises one forward and return movement over the full travel possible in both directions.

During the endurance test, the electrical safety device of the lock shall close a resistive circuit under the rated voltage and at a current value double that of the rated current of the locking device.

If the locking device is provided with a mechanical checking device for the locking pin or the position of the locking element, this mechanical checking device shall additionally be submitted to an endurance test of 100 000 (±1 %) cycles with the counterpart (means allowing the positive operation of the means used to prove the position of a locking element) not in place and the mechanical locking and the safety contact being not made.

The driving of the device shall be at a rate of 60 (±10 %) cycles per minute.

The number of operations of the locking element and the mechanical checking device shall be recorded by mechanical or electrical counters.

#### 4.2.1.2.3 Static test

The test shall be made consisting of the application of a force, applied at the level of the lock, increasing to the value laid down in the standard calling for the use of this document [e.g. ISO 8100-1:2026, 4.3.9.1.6 a)] between 30 s to 60 s. The force shall be applied for a period of 300 s.

#### 4.2.1.2.4 Dynamic test

The test shall be made consisting of the shock laid down in the standard calling for the use of this document [e.g. ISO 8100-1:2026, 4.3.9.1.6 b)] at the height of the locking device.

### 4.2.1.3 Criteria for the mechanical tests

After the endurance test (see 4.2.1.2.2), the static test (see 4.2.1.2.3) and the dynamic test (see 4.2.1.2.4), carried out on the locking device, there shall not be:

— wear reducing the minimum engagement of the locking element(s) as specified in the standard calling for the use of this document (e.g. ISO 8100-1:2026, 4.3.9.1.2); or

— permanent deformation; or

— breakage of parts of the locking device or of the mechanical linkage.

### 4.2.1.4 Electrical test

#### 4.2.1.4.1 Endurance test of safety contacts

This test is included in the endurance test laid down in 4.2.1.2.2.



#### 4.2.1.4.2 Test of ability to break circuit



**4.2.1.4.2.1** This test shall be carried out after the endurance test to check the ability to break a live circuit. This test shall be made in accordance with the procedure in IEC 60947-5-1:2024. The values of current and rated voltage serving as a basis for the tests shall be those specified for the locking device.

The capacity to break circuit shall be verified for both AC and DC conditions.

The tests shall be carried out with the locking device in all assembly positions specified in the instructions (see 4.2.3).

The sample tested shall be provided with covers and electric wiring.

**4.2.1.4.2.2** Locking devices for AC current shall open and close an electric circuit under a voltage equal to 110 % of the specified rated voltage of the safety contact 50 times at intervals of 5 s to 10 s. The contact shall remain closed for at least 0,5 s.

The testing circuit shall comprise of an inductor and a resistor in series. Its power factor shall be 0,7 ± 0,05 and the test current shall be 11 times the specified rated current of the locking device.

**4.2.1.4.2.3** Locking devices for DC current shall open and close an electric circuit under a voltage equal to 110 % of the specified rated voltage of the safety contact 20 times at intervals of 5 s to 10 s. The contact shall remain closed for at least 0,5 s.

The testing circuit shall comprise of an inductor and a resistor in series, having values such that the current reaches 95 % of the steady-state value of the test current in 300 ms.

The test current shall be 110 % of the specified rated current of the locking device.

**4.2.1.4.2.4** The tests are considered satisfactory if the safety contact has the ability to break a live circuit.

#### 4.2.1.4.3 Verification of clearances and creepage distances

The clearances in air and creepage distances shall be in accordance with the requirements laid down in the standards calling for the use of this document (e.g. ISO 8100-1:2026, 4.11.2.2.4).

#### 4.2.1.4.4 Verification of the protection against direct contact

In case of access to hazardous voltage this verification shall be made taking into account the mounting position, the orientation and the layout of the locking device (e.g. ISO 8100-1:2026, 4.10.1.2).

### 4.2.2 Test particular to certain types of locking devices

#### 4.2.2.1 Locking device for horizontally or vertically sliding doors with several panels

Devices providing direct mechanical linkage between panels shall be included in the tests mentioned in 4.2.1.2.2.

#### 4.2.2.2 Flap type locking device for hinged door

For the flap type locking device the following shall be verified:

— the specified minimum overlap-dimensions as required by the standard calling for this device [e.g. ISO 8100-1:2026, 4.3.9.1.12 b) and 4.3.9.1.12 c)];

— the locking device cannot engage when the landing door is not fully in the closed position as required by the standard calling for this device [e.g. ISO 8100-1:2026, 4.3.9.1.12 d)];

— the locking force limiter as in the standard calling for the use of this document [e.g. ISO 8100-1:2026, 4.3.9.1.12 f)] shall be tested on an operationally constructed door by pushing open the door panels with a steadily increasing force until the locking force limiter releases the flap. The force shall be applied as required by the standard calling for this device [e.g. ISO 8100-1:2026, 4.3.9.1.12 f)]. The flap shall not release before the force exceeds the force required by the standard calling for this device [e.g. ISO 8100-1:2026, 4.3.9.1.12 f)].

  The test shall be carried out on a door with the largest width.

  In the case of elements to limit the load on the flap that are triggered via a predetermined breaking point, the locked door shall be force-opened three times, each time with renewed trigger elements. In the case of non-destructive release elements, a limited endurance test with 50 force openings is required.

  There shall be no permanent deformation or breakage on the locking device after the test.

### 4.2.3 Instructions

In addition to the information for assembly, connection, adjustment and maintenance, the instructions of the locking device shall contain the following information based on the verification:

a) type and application of locking device;

b) type (AC and/or DC) and values of the rated voltage and rated current of the locking device safety contact;

c) in the case of flap type door locking devices: the necessary force to actuate the locking force limiter.

## 4.3 Verification of safety gear

### 4.3.1 General provisions

Safety gears shall be verified as described in 4.3.2, 4.3.3 and 4.3.4.

### 4.3.2 Instantaneous safety gear

#### 4.3.2.1 Test samples

Two gripping assemblies with wedges or clamps and two lengths of guide rail shall be provided.

The arrangement and the fixing details for the samples shall be determined in accordance with the equipment that it uses.

If the same gripping assemblies can be used with different types of guide rails, a new test shall not be required if the thickness of the guide rails, the width of the grip needed for the safety gear, and the surface state (drawn, milled, ground) are the same.

#### 4.3.2.2 Testing

##### 4.3.2.2.1 Method of test

The test shall be made using a press or similar device, which moves continuously. Measurements shall be made of:

a) the distance travelled as a function of the force;

b) the deformation of the safety gear block as a function of the force or as a function of the distance travelled.

##### 4.3.2.2.2 Test procedure



The guide rail shall be moved through the safety gear until the minimum required force is reached or rupture has occured.

##### 4.3.2.2.3 Documents



**4.3.2.2.3.1** Two charts shall be drawn up as follows:

a) the first one shall show the distance travelled as a function of the force;

b) the second one shall show the deformation of the block. It shall be done in such a way that it can be related to the first chart.

**4.3.2.2.3.2** The capacity of the safety gears shall be established by integration of the area of the distance-force chart.

The area of the chart to be taken into consideration shall be:

a) the total area, if there is no permanent deformation;

b) if permanent deformation or rupture has occurred, either:

   1) the area up to the value at which the elastic limit has been reached; or

   2) the area up to the value corresponding to the maximum force.

#### 4.3.2.3 Determination of the permissible mass

##### 4.3.2.3.1 Energy absorbed by the safety gear

The distance of free fall in metres, $h$, shall be taken as Formula (1):

$$h = \left( \frac{v_1^2}{2 \cdot g_n} \right) + 0,1 + 0,03 \quad (1)$$

where

| | |
|---|---|
| $g_n$ | is the standard acceleration of free fall in metres per square second; |
| $v_1$ | is the maximum tripping speed of the safety gear expressed in metres per second; |
| 0,1 | corresponds to the distance travelled during the response time, in metres; |
| 0,03 | corresponds to the travel during take-up of clearance between the gripping elements and the guide rails, in metres. |

The total energy the safety gear is capable of absorbing is calculated with Formulae (2) and (3):

$$2 \cdot K = (P + Q)_1 \cdot g_n \cdot h \quad (2)$$

$$\text{from which: } (P + Q)_1 = \frac{2 \cdot K}{g_n \cdot h} \quad (3)$$

where

| | |
|---|---|
| $K$ | is the energy absorbed by one safety gear block, in joules (calculated in accordance with the chart); |
| $P$ | are the masses of the empty car and components supported by the car, i.e. part of the travelling cable, compensation means (if any), etc., in kilograms; |
| $Q$ | is the rated load, in kilograms; |
| $(P + Q)_1$ | is the permissible mass, in kilograms. |



##### 4.3.2.3.2 Permissible mass

a) If the elastic limit has not been exceeded, the permissible mass in kilograms, $(P + Q)_1$, is calculated with Formula (4):

$$(P + Q)_1 = \frac{2 \cdot K}{2 \cdot g_n \cdot h} \quad (4)$$

where

| | |
|---|---|
| $K$ | is calculated by the integration of the area defined in 4.3.2.2.3.2 a); |
| 2 | is taken as the dividing safety coefficient; |
| $h$ | is the distance of free fall, in metres. |

b) If the elastic limit has been exceeded, Formulae (5) and (6) shall be used and the higher permissible mass may be selected.

$$(P + Q)_1 = \frac{2 \cdot K_1}{2 \cdot g_n \cdot h} \quad (5)$$

where

| | |
|---|---|
| $K_1$ | is calculated by the integration of the area defined in 4.3.2.2.3.2 b) 1); |
| 2 | is taken as the dividing safety coefficient; |
| $h$ | is the distance of free fall, in metres. |

$$(P+Q)_1 = \frac{2 \cdot K_2}{3{,}5 \cdot g_n \cdot h} \quad (6)$$

where

| | |
|---|---|
| $K_2$ | is calculated by the integration of the area defined in 4.3.2.2.3.2 b) 2); |
| 3,5 | is taken as the dividing safety coefficient; |
| $h$ | is the distance of free fall, in metres. |

### 4.3.3 Progressive safety gear

#### 4.3.3.1 Testing

##### 4.3.3.1.1 Method of test

**4.3.3.1.1.1** The test shall be carried out in free fall. Direct or indirect measurements shall be made of:

a) the total height of the fall;

b) the braking distance on the guide rails;

c) the sliding distance of the overspeed governor rope, or that of the device used in its place;

d) the total travel of the elements forming the spring.

Measurements a) and b) shall be recorded as a function of the time.



**4.3.3.1.1.2** The following shall be determined:

a) the average braking force;



b) the greatest instantaneous braking force;

c) the smallest instantaneous braking force.

##### 4.3.3.1.2 Test procedure

**4.3.3.1.2.1 Safety gear for a single mass**

Four tests with the mass $(P + Q)_1$ shall be carried out. Between each test, the friction parts shall be allowed to return to the ambient temperature.

If during the tests, the friction parts are replaced, each set shall be capable of:

a) three tests, if the rated speed does not exceed 4 m/s;

b) two tests, if the rated speed exceeds 4 m/s.

The height of free fall shall be calculated to correspond to the maximum tripping speed of the safety gear.

The engagements of the safety gear shall be achieved by a means allowing the tripping speed to be fixed precisely.

**4.3.3.1.2.2 Safety gear for different masses**

Where adjustment is in stages or continuous, two series of tests in accordance with 4.3.3.1.2.1 shall be carried out for:

a) the maximum; and

b) the minimum values applied for.

A formula or a chart shall be provided showing the variation of the braking force as a function of a given parameter.

The validity of the supplied formula or chart shall be verified by one series of tests for a linear chart or two series of tests for a nonlinear chart.

The series of tests shall be performed with an intermediate value adjustment.

#### 4.3.3.1.3 Determination of the braking force of the safety gear

##### 4.3.3.1.3.1 Safety gear for a single mass

The braking force that the safety gear is capable of for the given adjustment and the type of guide rail, is taken as equal to the average of the average braking forces determined during the tests. Each test shall be made on an unused section of guide rail.

A check shall be made that the average values determined during the tests lie within a range of ±25 % in relation to the value of the braking force defined above.

NOTE Tests have shown that the coefficient of friction can be considerably reduced if several successive tests are carried out on the same area of a machined guide rail. This is attributed to a modification in the surface condition during successive safety gear operations.

##### 4.3.3.1.3.2 Safety gear for different masses

Adjustment in stages or continuous adjustment.



The braking force that the safety gear is capable of, shall be calculated as laid down in 4.3.3.1.3.1 for the maximum and minimum values applied for.

#### 4.3.3.1.4 Checking after the tests



After the test, the safety gear shall be operational.

### 4.3.3.2 Calculation of the permissible mass

#### 4.3.3.2.1 Safety gear for a single mass

The permissible mass shall be calculated using Formula (7):

$$(P+Q)_1 = \frac{F_B}{16} \tag{7}$$

where

| | |
|---|---|
| $F_B$ | is the braking force in newtons, determined in accordance with 4.3.3.1.3; |
| $P$ | is the masses of the empty car and components supported by the car, i.e. part of the travelling cable, compensation means (if any), etc., in kilograms; |
| $Q$ | is the rated load, in kilograms; |
| $(P + Q)_1$ | is the permissible mass, in kilograms. |

If the calculated permissible mass is larger than the tested mass, the tested mass may be taken as permissible mass, provided that the average retardation of each test did not exceed 1,0 $g_n$.