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Lifts for the transport of persons and goods —

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

Élévateurs pour le transport de personnes et d'objets — Partie 2: Règles de conception, calculs, examens et essais des composants pour élévateurs

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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 documents 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 178, *Lifts, escalators, passenger conveyors*.

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.

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

Introduction

The content of this document was already published in EN 81-50:2014. This document contains only editorial changes and update of references.

The object of this document is to define safety rules related to lifts with a view to safeguarding persons and objects against the risk of accidents associated with the use, maintenance and emergency operations of lifts.

Reference is made to the respective introductions of the standards (e.g. ISO 8100-1:2019) calling for the use of this document with regard to persons and objects to be safeguarded, assumptions, principles, etc.

Lifts for the transport of persons and goods —

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

1 Scope

This document specifies the design rules, calculations, examinations and tests of lift components which are referred to by other standards used for the design of passenger lifts, goods passenger lifts, goods only lifts, and other similar types of lifting appliances.

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 4344, *Steel wire ropes for lifts — Minimum requirements*

ISO 8100-1:2019, *Safety rules for the construction and installation of lifts — Lifts for the transport of persons and goods — Passenger and goods passenger lifts*

ISO/TS 8100-3, *Requirements from Other Standards (ASME A17.1/CSA B44 and JIS A 4307-1/ JIS A 4307-2) not included in ISO 8100-1 or ISO 8100-2*

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

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

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*

IEC 60947-4-1, *Low-voltage switchgear and control gear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters*

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

EN 10025 (all parts), *Hot rolled products of non-alloy structural steels — Technical delivery conditions*

EN 12385-5, *Steel wire ropes — Safety — Part 5: Stranded ropes for lifts*

3 Terms and definitions

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

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

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

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

3.1
approved body
organization or manufacturer, operating an approved full quality assurance system to undertake testing of *safety components* (3.2)

3.2
safety component
component provided to fulfil a safety function when in use

3.3
type examination certificate
document issued by an *approved body* (3.1) carrying out a type-examination in which it certifies that the product example under consideration complies with the provisions applicable to it

4 List of significant hazards

This clause contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this document, identified by risk assessment as significant for this type of machinery, and they require action to eliminate or reduce the risk (see Table 1).

Table 1 — List of significant hazards

No.	Hazards as listed in ISO 12100:2010, Annex B	Relevant clauses
1	**Mechanical hazards** due to:	
	Acceleration, deceleration (kinetic energy)	5.3; 5.4; 5.5; 5.7; 5.8; 5.9
	Approach of a moving element to a fixed part	5.2
	Elastic elements	5.10; 5.11; 5.12; 5.13
	Falling objects	5.3; 5.4; 5.5; 5.9
	Gravity (stored energy)	5.3; 5.4; 5.5; 5.9
	Height from the ground	5.3; 5.4; 5.5; 5.9
	High pressure	5.13
	Moving elements	5.2; 5.3; 5.4; 5.5; 5.6; 5.7; 5.8; 5.9; 5.10; 5.11; 5.12; 5.13; 5.14; 5.15; 5.16
	Rotating elements	5.4; 5.11; 5.12
	Stability	5.10; 5.11; 5.12; 5.13; 5.14
	Strength	5.10; 5.11; 5.12; 5.13; 5.14
2	**Electrical hazards**	
	Arc	5,2; 5.4; 5.6; 5.7; 5.8; 5.15; 5.16
	Electrostatic phenomena	5,2; 5.4; 5.6; 5.7; 5.8; 5.15; 5.16
	Live parts	5,2; 5.4; 5.6; 5.7; 5.8; 5.15; 5.16
	Not enough distance to live parts under high voltage	5,2; 5.4; 5.6; 5.7; 5.8; 5.15; 5.16
	Overload	5,2; 5.4; 5.6; 5.7; 5.8; 5.15; 5.16
	Parts which have become live under faulty conditions	5,2; 5.4; 5.6; 5.7; 5.8; 5.15; 5.16
	Short-circuit	5,2; 5.4; 5.6; 5.7; 5.8; 5.15; 5.16

Table 1 *(continued)*

No.	Hazards as listed in ISO 12100:2010, Annex B	Relevant clauses
6	**Hazards generated by radiation**	
	Low frequency electromagnetic radiation	5.6; 5.15; 5.16
	Radio frequency electromagnetic radiation	5.6; 5.15; 5.16
9	**Hazards associated with the environment in which the machine is used**	5.2; 5.3; 5.4; 5.5; 5.6; 5.7; 5.8; 5.9; 5.10; 5.11; 5.12; 5.13; 5.14; 5.15; 5.16

5 Design rules, calculations, examinations and tests

5.1 General provisions for type examinations of safety components

5.1.1 Object and extent of the tests

The safety component/device is submitted to a test procedure to verify that insofar as construction and operation are concerned, it conforms to the requirements imposed by this document. It shall be checked, in particular, that the mechanical, electrical and electronic components of the device are properly rated and that, in the course of time, the device does not lose its effectiveness, particularly through wear or aging. If the safety component is needed to satisfy particular requirements (waterproof, dust proof or explosion proof construction), supplementary examinations and/or tests under appropriate criteria shall be made.

5.1.2 General provisions

5.1.2.1 For the purposes of this document, it is assumed that the laboratory undertakes both the testing and the certification as an approved body. An approved body may be that of a manufacturer operating an approved full quality assurance system. In certain cases, the test laboratory and the body approved for the issue of type examination certificates may be separate. In these cases, the administrative procedures can differ from those described in this document.

5.1.2.2 The application for type examination shall be made by the manufacturer of the component, or their authorized representative, and shall be addressed to an approved test laboratory.

5.1.2.3 The dispatch of samples for examination shall be made by agreement between the laboratory and the applicant.

5.1.2.4 The applicant may attend the tests.

5.1.2.5 If the laboratory entrusted with the complete examination of one of the components requiring the supply of a type examination certificate has no appropriate means available for certain tests or examinations, it may, under its responsibility, have these made by other laboratories with the agreement of the applicant.

5.1.2.6 Unless specified otherwise, 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) recording equipment shall be capable of detecting signals, which vary in time of 0,01 s;

f) ±2,5 % for flow rate;

g) ±1 % for pressure, *P*, below 200 kPa;

h) ±5 % for pressure, *P*, above 200 kPa.

5.2 Type examination of landing and car door locking devices

5.2.1 General provisions

5.2.1.1 Field of application

These procedures are applicable to locking devices for landing and car doors. It is understood that each component taking part in the locking of doors and in the checking of the locking forms part of the locking device.

5.2.1.2 Documents to be submitted

5.2.1.2.1 Schematic arrangement drawing with description of operation

This drawing shall clearly show all the details relating to the operation and the safety of the locking device, including:

a) the operation of the device in normal service, showing the effective engagement of the locking elements and the point at which the electrical safety device operates;

b) the operation of the device for mechanical checking of the locking position if this device exists;

c) the control and operation of the emergency unlocking device;

d) the type (A.C. and/or D.C.), rated voltage and rated current.

5.2.1.2.2 Assembly drawing with key

This drawing shall show all parts important to the operation of the locking device, in particular those required to conform to the requirements of this document. A key shall indicate the list of the principal parts, the type of materials used, and the characteristics of the fixing elements.

5.2.1.3 Test samples

One door-locking device shall be submitted to the laboratory.

If the test is carried out on a prototype, it shall be repeated later on a production model.

If the test of the locking device is only possible when the device is mounted in the corresponding door, the device shall be mounted on a complete door in working order. However, the door dimensions may be reduced by comparison with a production model, on the condition that it does not falsify the test results.

5.2.2 Examination and tests

5.2.2.1 Examination of operation

This examination aims to verify that:

— the mechanical and electrical components of the locking device are operating correctly with respect to safety, and in conformity with:

  — the requirements of this document;

  — the standard calling for this locking device; and

— the device is in conformity with the particulars provided in the application.

In particular, it shall be verified that:

a) there is at least 7 mm engagement of the locking elements before the electric safety device operates;

b) it is not possible to operate the lift from positions normally accessible to persons with a door open or unlocked, after one single action not forming part of the normal operation.

5.2.2.2 Mechanical tests

5.2.2.2.1 General

These tests have the purpose of verifying the strength of the mechanical locking components and the electrical components.

The sample of the locking device in its normal operating position is controlled by the devices normally used to operate it.

The sample shall be lubricated in accordance with the requirements of the manufacturer of the locking device.

When there are several possible means of control and positions of operation, the endurance test shall be made in the arrangement which is regarded as the most unfavourable from the point of view of the forces on the components.

The number of complete cycles of operation and the travel of the locking components shall be registered by mechanical or electrical counters.

5.2.2.2.2 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.

The driving of the device shall be smooth, without shocks, and at a rate of 60 (±10 %) cycles per minute.

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

If the locking device is provided with a mechanical checking device for the locking pin or the position of the locking element, this device shall be submitted to an endurance test of 100 000 (±1 %) cycles.

The driving of the device shall be smooth, without shocks, and at a rate of 60 (±10 %) cycles per minute.

5.2.2.2.3 Static test

For locking devices intended for hinged doors, a test shall be made consisting of the application over a total period of 300 s of a static force, increasing progressively to a value of 3 000 N.

This force shall be applied in the opening direction of the door and in a position corresponding as far as possible to that which can be applied when a user attempts to open the door. The force applied shall be 1 000 N in the case of a locking device intended for sliding doors.

5.2.2.2.4 Dynamic test

The locking device, in the locked position, shall be submitted to a shock test in the opening direction of the door.

The shock shall correspond to the impact of a rigid mass of 4 kg falling in free fall from a height of 0,50 m.

5.2.2.3 Criteria for the mechanical tests

After the endurance test (5.2.2.2.2), the static test (5.2.2.2.3) and the dynamic test (5.2.2.2.4), there shall not be any wear, deformation or breakage, which could adversely affect safety.

5.2.2.4 Electrical test

5.2.2.4.1 Endurance test of contacts

This test is included in the endurance test laid down in 5.2.2.2.2.

5.2.2.4.2 Test of ability to break circuit

5.2.2.4.2.1 General

This test shall be carried out after the endurance test. It shall check that the ability to break a live circuit is sufficient. This test shall be made in accordance with the procedure in IEC 60947-4-1 and IEC 60947-5-1. The values of current and rated voltage serving as a basis for the tests shall be those indicated by the manufacturer of the device.

If nothing is specified, the rated values shall be as follows:

a) alternating current: 230 V, 2 A;

b) direct current: 200 V, 2 A.

Unless indicated otherwise, the capacity to break circuit shall be examined for both A.C. and D.C. conditions.

The tests shall be carried out with the locking device in the working position. If several positions are possible, the test shall be made in the most unfavourable position.

The sample tested shall be provided with covers and electric wiring as used in normal service.

5.2.2.4.2.2 A.C. locking devices shall open and close an electric circuit under a voltage equal to 110 % of the rated voltage 50 times, at normal speed and at intervals of 5 s to 10 s. The contact shall remain closed for at least 0,5 s.

The circuit shall comprise a choke and a resistance in series. Its power factor shall be 0,7 ± 0,05 and the test current shall be 11 times the rated current indicated by the manufacturer of the device.

5.2.2.4.2.3 D.C. locking devices shall open and close an electric circuit under a voltage equal to 110 % of the rated voltage 20 times, at normal speed and at intervals of 5 s to 10 s. The contact shall remain closed for at least 0,5 s.

The circuit shall comprise a choke and a resistance 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 rated current indicated by the manufacturer of the device.

5.2.2.4.2.4 The tests are considered satisfactory if no tracking or arcing is produced and if no deterioration occurs which can adversely affect safety.

5.2.2.4.3 Test for resistance to leakage currents

This test shall be made in accordance with the procedure in IEC 60112. The electrodes shall be connected to a source providing an A.C. voltage which is sinusoidal at 175 V, 50 Hz.

5.2.2.4.4 Examination 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 8100-1:2019, 5.11.2.2.4).

5.2.2.4.5 Examination of the requirements appropriate to safety contacts and their accessibility

This examination shall be made taking account of the mounting position and the layout of the locking device, as appropriate.

5.2.3 Test particular to certain types of locking devices

5.2.3.1 Locking device for horizontally or vertically sliding doors with several panels

According to the requirements laid down in the standards calling for the use of this document, the devices providing direct mechanical linkage between panels (e.g. ISO 8100-1:2019, 5.3.14.1) or indirect mechanical linkage (e.g. ISO 8100-1:2019, 5.3.14.2) are considered forming part of the locking device.

These devices shall be submitted to the tests mentioned in 5.2.2. The number of cycles per minute in such endurance tests shall be suited to the dimensions of the construction.

5.2.3.2 Flap type locking device for hinged door

If this device is provided with an electric safety device required to check the possible deformation of the flap, and if, after the static test envisaged in 5.2.2.2.3, there are any doubts on the strength of the device, the load shall be increased progressively until the safety device begins to open. No component of the locking device or of the door shall be damaged or permanently deformed by the load applied.

If, after the static test, the dimensions and construction leave no doubt as to its strength, it is not necessary to proceed to the endurance test on the flap.

5.2.4 Type examination certificate

The certificate shall indicate the following:

a) information according to Annex A;

b) type and application of locking device;

c) type (A.C. and/or D.C.) and values of the rated voltage and rated current;

d) in the case of flap type door locking devices: the necessary force to actuate the electric safety device for checking the elastic deformation of the flap.

5.3 Type examination of safety gear

5.3.1 General provisions

The applicant shall state the range of use provided, i.e.:

— minimum and maximum masses;

— maximum rated speed and maximum tripping speed.

Detailed information shall be provided on the materials used, the type of guide rails and their surface condition (drawn, milled, ground).

The following documents shall be attached to the application:

a) detailed and assembly drawings showing the construction, operation, materials used, dimensions and tolerances of the construction components;

b) in the case of progressive safety gear, also a load diagram relating to elastic parts.

5.3.2 Instantaneous safety gear

5.3.2.1 Test samples

Two gripping assemblies with wedges or clamps and two lengths of guide rail shall be submitted to the laboratory.

The arrangement and the fixing details for the samples shall be determined by the laboratory 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.

5.3.2.2 Test

5.3.2.2.1 Method of test

The test shall be made using a press or similar device, which moves without abrupt speed change. 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.

5.3.2.2.2 Test procedure

The guide rail shall be moved through the safety gear.

Reference marks shall be traced onto the blocks in order to be able to measure their deformation.

The distance travelled shall be recorded as a function of the force.

After the test:

a) the hardness of the block and the gripping element shall be compared with the original values quoted by the applicant. Other analyses may be carried out in special cases;

b) if there is no fracture, deformations and other changes shall be examined (for example, cracks, deformations or wear of the gripping elements, appearance of the rubbed surfaces);

c) if necessary, photographs shall be taken of the block, the gripping elements and the guide rail for evidence of deformations or fractures.

5.3.2.2.3 Documents

5.3.2.2.3.1 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 other shall show the deformation of the block. It shall be done in such a way that it can be related to the first chart.

5.3.2.2.3.2 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.

5.3.2.3 Determination of the permissible mass

5.3.2.3.1 Energy absorbed by the safety gear

A distance of free fall, calculated with reference to the maximum tripping speed of the overspeed governor fixed in the requirements laid down in the standards calling for the use of this document (e.g. ISO 8100-1:2019, 5.6.2.2.1.2), shall be adopted.

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

$$h = \frac{{v_1}^2}{2 \cdot g_n} + 0{,}1 + 0{,}03 \tag{1}$$

where

g_n is the standard acceleration of free fall in metres per square second;

v_1 is the tripping speed of overspeed governor 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):

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

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

where