INTERNATIONAL STANDARD

ISO 18738-1

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Measurement of ride quality —

Part 1:
Lifts (elevators)

Mesure de la qualité de déplacement —

Partie 1: Ascenseurs

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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.

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 18738-1 was prepared by Technical Committee ISO/TC 178, *Lifts, escalators, passenger conveyors*.

ISO 18738 consists of the following parts, under the general title *Measurement of ride quality*:

— *Part 1: Lifts (elevators)*

— *Part 2: Escalators and moving walks*

Introduction

The objective of this part of ISO 18738 is to encourage industry-wide uniformity in the definition, measurement, processing and expression of vibration and noise signals that comprise lift ride quality.

The aim of such uniformity is to benefit lift industry clients by reducing variability in the results of lift ride quality measurements caused by differences in the methods of acquiring and quantifying the signals.

This part of ISO 18738 is intended to be referred to by those parties interested in

a) developing manufacturing specifications and calibration methods for instrumentation,

b) defining the scope of the specifications for lift ride quality in contracts, and

c) measuring lift ride quality in accordance with an International Standard.

It is intended to produce lift ride quality measurements which

a) are simple to understand without specialized knowledge of noise and vibration analysis,

b) correlate well with human response to ensure plausibility, and

c) are accountable via calibration procedures which are traceable to national standards.

This part of ISO 18738 refers to ISO 8041 and IEC 61672 and has drawn significantly on the considerable body of research implicit in these standards. However, several special challenges drawing on additional research and development were also recognized.

Experience in the lift industry indicates that evaluation of vibration in terms of peak-to-peak levels is of particular relevance to passenger comfort. It was considered necessary for this part of ISO 18738 to provide a dual form of expression, quantifying both the maximum peak-to-peak and A95 peak-to-peak vibration levels.

To minimize the adverse effects of external influences unique to the lift industry, it was considered necessary to prescribe the prerequisites and method of the measurement process as well as the relevant boundaries (start and end points) over which each signal is quantified.

It was also considered necessary to analyse vertical vibration and vertical motion control separately in order to correlate with human response.

Finally, through the inclusion of algorithms amenable to digital programming, this part of ISO 18738 reflects the commercial need in the lift industry for instrumentation capable of rapid automatic computation of the required signal quantities. Analog systems may be used provided that the requirements of this part of ISO 18738 are met.

Measurement of ride quality —

Part 1:
Lifts (elevators)

1 Scope

This part of ISO 18738 specifies requirements and methodology for the measurement and reporting of lift ride quality during lift motion. It does not specify acceptable or unacceptable ride quality.

NOTE Lift performance parameters are often referenced in conjunction with lift ride quality. Parameters relevant to lift performance include jerk and acceleration. This part of ISO 18738 defines and uses performance parameters where they are integral to the evaluation of ride quality.

2 Normative references

The following referenced documents are indispensable for the application 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 2041:2009, *Vibration and shock — Vocabulary*

ISO 5805:1997, *Mechanical vibration and shock — Human exposure — Vocabulary*

ISO 8041:2005, *Human response to vibration — Measuring instrumentation*

IEC 61672-1:2002, *Electroacoustics — Sound level meters — Part 1: Specifications*

IEC 61672-2:2003, Electroacoustics — Sound level meters — Part 2: Pattern Evaluation Tests

ISO 80000-8:2007, *Quantities and units — Part 8: Acoustics*

ISO/IEC Guide 98:1993, Guide to the expression of uncertainty in measurement (GUM)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041, ISO 5805, IEC 61672, and ISO 80000-8 and the following apply.

3.1
acceleration
rate of change of z-axis velocity, attributed to lift motion control

NOTE It is expressed in metres per second squared (m/s^2).

3.2
vibration
variation with time of the magnitude of acceleration, when the magnitude is alternately greater and smaller than the average acceleration of the lift when no lift motion is present

NOTE 1 It is expressed in metres per second squared (m/s^2).

NOTE 2 The deprecated unit Gal (Galileo) is sometimes used: 1 Gal = 0,01 m/s^2.

3.3
A95
value of acceleration or vibration, within defined boundaries or limits, which 95 % of found values are equal to or less than

NOTE 1 This value is used statistically to estimate typical levels.

NOTE 2 See 5.2.3, 5.4.1 and 5.4.3.

3.4
velocity
rate of change of *z*-axis displacement, attributed to lift motion control

NOTE Velocity is reported as speed and direction of travel. It is given in metres per second (m/s).

3.5
V95
value of velocity, within defined boundaries or limits, which 95 % of found values are equal to or less than

NOTE 1 This value is used statistically to estimate typical levels.

NOTE 2 See 5.5.3.

3.6
axes of measurement
orthogonal reference axes for the measurements, where for lifts of conventional configuration, *x* is the perpendicular to the plane of the car front door (i.e. back to front); *y* is the perpendicular to *x* and *z* (i.e. side to side); *z* is the perpendicular to the car floor (i.e. vertical)

NOTE For lifts of unconventional configuration, the axes should be defined for directions of basicentric coordinate systems for mechanical vibrations influencing human subjects, for a standing person facing the front car door, in accordance with ISO 2631-1.

3.7
lift ride quality
sound levels in the car, and vibration of the car floor, relevant to passenger perception, associated with lift motion

3.8
jerk
rate of change of *z*-axis acceleration, attributed to lift motion control

NOTE 1 The passenger perception of vertical ride quality during jerk is represented by the assessment of vertical vibration during non-constant acceleration. See 5.3 and 5.4.3.

NOTE 2 Jerk is expressed in metres per second cubed (m/s^3).

3.9
peak-to-peak vibration levels
sum of the magnitudes of two peaks of opposite sign separated by a single zero crossing

3.10
sound pressure level
$L_{p,A}$
sound pressure level using frequency weighting A as defined in IEC 61672-1:$L_{p,A} = 10 \lg (p_A{}^2/p_0{}^2)$ dB(A)

NOTE 1 The reference sound pressure level, p_0, is 20 µPa (2×10^{-5} Pa).

NOTE 2 The measured sound pressure, p_A, in Pascals (Pa), using frequency weighting A.

3.11
equivalent sound pressure level
L_{Aeq}
average sound pressure level, using frequency weighting A and time weighting “fast”, determined within defined boundaries

4 Measuring instrumentation

4.1 General

The measuring instrumentation shall consist of the following:

a) transducers to measure acceleration in each of the three orthogonal axes;

b) a transducer to measure the sound pressure level;

c) data acquisition system;

d) data storage system;

e) data processing system.

4.2 Characteristics

The characteristics of the measuring instrumentation shall be as described in Table 1.

Table 1 — Characteristics of measuring instrumentation

Characteristic	Vibration	Acceleration	Sound
Frequency weighting	Whole body *x*, *y*, *z* (see ISO 8041)	N/A	A-weighted (see IEC 61672-1)
Band limiting	See ISO 8041	10 Hz low-pass filter, (2-pole Butterworth)	N/A
Accuracy[a]	Type 1 (see ISO 8041)	Type 1 (see ISO 8041)[b]	Class 2 (see IEC 61672-1)
Time weighting	N/A	N/A	Fast (see IEC 61672-1)
Environmental	See ISO 8041	See ISO 8041	See IEC 61672-1
Resolution	0,005 m/s^2	0,01 m/s^2	1 dB
Measurement range	20 % above max. instantaneous acceleration to 20 % below min. instantaneous acceleration[c]	20 % above max. acceleration to 20 % below min. acceleration[d]	2 dB below min. to 5 dB above max.[e]

N/A = not applicable

[a] The signals shall be filtered to exclude aliasing.

[b] Accuracy in the range from 0 Hz to 1 Hz shall be equal to the accuracy specified for 1 Hz in ISO 8041.

[c] A range of –1,5 m/s^2 to +1,5 m/s^2 should meet the above requirement.

[d] A range of 7 m/s^2 to 13 m/s^2 should meet the above requirement.

[e] A range from 30 dB to 90 dB (A-weighted) should meet the above requirement.

4.3 Processing of vibration data

Vibration data shall be weighted in accordance with ISO 8041 to simulate the human body’s response to vibration.

The vibration signals shall be frequency weighted with the whole body *x*, *y* and *z* weighting factors and band limiting as defined in ISO 8041.

For digital sampling systems, uncompressed data shall be used.

4.4 Environmental effects

The instrumentation shall comply with the criteria for mechanical vibration, temperature range and humidity range specified in ISO 8041.

4.5 Sound measurement requirements

The sound measuring system shall comply with the requirements for Class 2 sound level meters as specified in IEC 61672-1:2002.

4.6 Calibration requirements

4.6.1 General

All instrumentation calibrations shall be traceable to national standards. The measurement system shall be calibrated before first use, and following any major repairs or modifications likely to affect the calibration.

4.6.2 Vibration measuring system

Calibration shall include determination of the reading error for sinusoidal input at 8 Hz and at five or more other frequencies approximately equally spaced between 0,1 Hz and 80 Hz, with acceleration amplitudes not less than 0,1 m/s^2.

Calibration shall be in accordance with ISO 8041.

4.6.3 Acceleration measuring system

Calibration shall be at 8 Hz and at 0 Hz, as follows.

a) At 8 Hz, the reading error shall be determined for at least five equally spaced acceleration amplitudes between 0,01 m/s^2 and 2,0 m/s^2. Calibration shall be in accordance with ISO 8041.

b) At 0 Hz, an accuracy check shall be performed. The system accuracy from 0 Hz to 1 Hz shall be equivalent to the accuracy specified in ISO 8041 for 1 Hz.

4.6.4 Sound measuring system

Calibration of the sound measuring system shall be carried out with Class 2 sound level meters as specified in IEC 61672-2:2003.

5 Evaluation of ride quality

5.1 Boundaries of calculation

The following boundaries shall be used to define the regions over which signal quantities are calculated (see Figure 1).

Boundary 0 at least 0,5 s before commencement of door closing at the departure terminal floor.

Boundary 1 500 mm after commencement of lift motion from the departure terminal floor.

Boundary 2 500 mm before cessation of lift motion at the arrival terminal floor.

Boundary 3 at least 0,5 s after completion of door opening, or cessation of lift motion, at the arrival terminal floor, whichever occurs last.

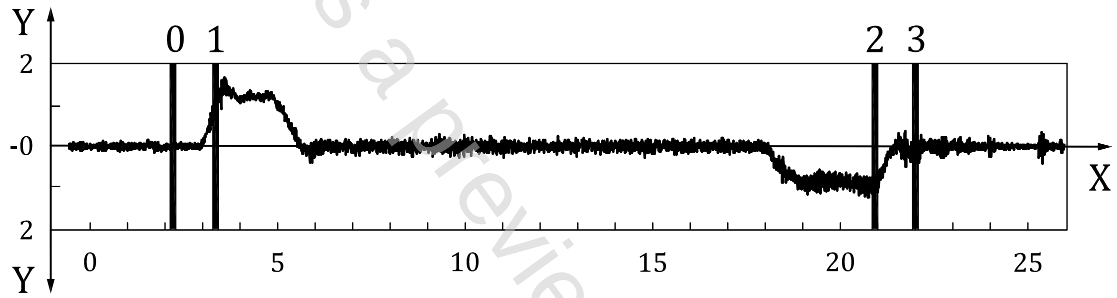
NOTE 1 Boundaries 1 and 2 have been empirically derived to allow the signals resulting from lift motion to be evaluated separately from the signals resulting from door operation. In rare cases however, boundaries 1 or 2 can include a dominant door operation effect, or can exclude a dominant region of a signal resulting from lift motion. In such cases, subject to agreement by the parties involved, it is permitted to adjust either boundary sufficiently to prevent this, when quantifying a signal resulting from lift motion.

Boundary 1 or 2 should be

a) increased to more than 500 mm if the vibration or sound of door operation dominates a signal resulting from lift motion 500 mm from a terminal (e.g. if the vibration or sound of door close operation decays abnormally slowly), and

b) decreased to less than 500 mm if there is dominant vibration or sound in the signal resulting from lift motion which would otherwise be excluded from the calculations (e.g. vibration of a problematic hydraulic lift during leveling into the floor).

NOTE 2 Boundaries 0 and 3 have been defined to include the commencement and cessation of lift motion. This ensures accuracy of the velocity calculation described in 5.5.1. Boundaries 1 and 2 have been defined based on a distance to exclude door operation and simplify signal processing.



Key

0 boundary 0

1 boundary 1

2 boundary 2

3 boundary 3

Y acceleration, m/s^2

X time, s

Figure 1 — Boundaries of calculation shown on a typical *z*-axis acceleration signal

5.2 Acceleration and deceleration

5.2.1 General

The values of acceleration and deceleration shall be calculated by applying a 10 Hz low-pass filter to the unweighted *z*-axis signal, as shown in Figure 2. The 10 Hz low-pass filter shall be a 2-pole Butterworth filter as described in Table 1.