ERRATUM:

OIML R 60

Edition 2000 (E)

INTERNATIONAL RECOMMENDATION

Metrological regulation for load cells

THIS ERRATUM ONLY CONCERNS THE ENGLISH VERSION OF R 60 (2000)

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

NOTE: Since the publication of OIML R 60(E) Edition 2000, a number of points have been corrected. These are listed below and should be taken into account when using OIML R 60.

Page in R 60 (2000)	*Clause or section*	*Correction to be applied*
40	C.2.4.3	*Replace the existing text by:* Divide C_M by $(T_2 – T_1)$ and multiply the result by 5 for classes B, C, and D, or by 2 for class A. This gives the change in v per 5 °C for classes B, C, and D, or in v per 2 °C for class A.
40	C.2.4.4	*Replace the existing text by:* Multiply the preceding result by $[(D_{max} – D_{min})/n] / v_{min}$ to give the final result in units of v_{min} per 5 °C for classes B, C, and D, or units of v_{min} per 2 °C for class A; this final result must not exceed p_{LC}.
44	C.4.3	*Replace the symbol "<" by the symbol "≤":* $n = n_{max} – 500$ and $n = n_{max} – 1\,000$ (provided that $n \ge 500$)
44	C.4.4	*Replace the symbol "<" by the symbol "≤" (twice):* $v_{min} \le v$ $v_{min} \le (D_{max} – D_{min}) / n_{max}$
47	Annex D	*Under the section* "Information concerning the pattern", "Power voltage", *second line, insert a colon (:) after* "V"*:* or V: ___________ V
50	Summary of the test	*Change the reference between the two tables from* "C.3" *to* "C.4"*:*
50	Summary of the test	*Change the second table as below:*

Paragraph No.	Description	n_{max}		$n_{max} – 500$		$n_{max} – 1\,000$	
		Pass	Fail	Pass	Fail	Pass	Fail
C.4.2, C.4.3, C.4.5	Check all calculations using values of n at n_{max} and at lower than n_{max}						
C.4.4	Check that $v_{min} \le \dfrac{D_{max} – D_{min}}{n_{max}}$						

Worst case figure for minimum dead load output return error (in mass units) = DR = ____________ see *Note 3*

56	Table D.5	*Left column: Change the reference in the bottom line of the* "Exercise cells" *paragraph from* "Figure A.2" *to* "Figure A.1".
56	Pass/Fail section	*In the Pass/Fail box section underneath Table D.5, third line, change* "DR < 0.5 V" *to* "DR ≤ 0.5 V".
56	Pass/Fail section	*In the Pass/Fail box section underneath Table D.5, fourth line, change* "MDLOR within DR requirements:" *to* "DR within manufacturer specified DR requirements:".
57	Note 1	*Delete* "/kPa" *from the first line of Note 1.*

INTERNATIONAL
RECOMMENDATION

OIML R 60

Edition 2000 (E)

Metrological regulation for load cells

Réglementation métrologique des cellules de pesée

OIML

ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

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Foreword

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

The two main categories of OIML publications are:

- **International Recommendations (OIML R)**, which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity; the OIML Member States shall implement these Recommendations to the greatest possible extent;
- **International Documents (OIML D)**, which are informative in nature and intended to improve the work of the metrological services.

OIML Draft Recommendations and Documents are developed by technical committees or subcommittees which are formed by the Member States. Certain international and regional institutions also participate on a consultation basis.

Cooperative agreements are established between OIML and certain institutions, such as ISO and IEC, with the objective of avoiding contradictory requirements; consequently, manufacturers and users of measuring instruments, test laboratories, etc. may apply simultaneously OIML publications and those of other institutions.

International Recommendations and International Documents are published in French (F) and English (E) and are subject to periodic revision.

This publication - reference OIML R 60, edition 2000 - was developed by the Technical Committee TC 9 *Instruments for measuring mass and density*. It was approved for final publication by the International Committee of Legal Metrology in 1999 and will be submitted to the International Conference of Legal Metrology in 2000 for formal sanction. It supersedes the previous edition dated 1991 (including Annex A, published in 1993).

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Metrological regulation for load cells

1 Scope

1.1 This Recommendation prescribes the principal metrological static characteristics and static evaluation procedures for load cells used in the measurement of mass. It is intended to provide authorities with uniform means for determining the metrological characteristics of load cells used in measuring instruments that are subjected to metrological controls.

1.2 This Recommendation utilizes the principle that several load cell errors shall be considered together when applying load cell performance characteristics to the permitted error envelope. Thus, it is not considered appropriate to specify individual errors for given characteristics (non-linearity, hysteresis, etc.), but rather to consider the total error envelope allowed for a load cell as the limiting factor. The use of an error envelope allows the balancing of the individual contributions to the total error of measurement while still achieving the intended final result.

Note: The error envelope may be defined as the curves that provide the boundary of the maximum permissible errors (see Table 5) as a function of the applied load (mass) over the measuring range. The combined errors determined may be positive or negative and include the effects of non-linearity, hysteresis and temperature.

1.3 Instruments which are associated with load cells and which give an indication of mass, are the subjects of separate Recommendations.

2 Terminology (Terms and definitions)

The terms most frequently used in the load cell field and their definitions are given below (see 2.6 for an illustration of certain definitions). The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology*, second edition (1993) and the *Vocabulary of Legal Metrology* (1978 edition). In addition, for the purposes of this Recommendation, the following definitions apply.

An index of all the terms defined below is published as a separate sheet at the end of this Recommendation, to assist in finding the corresponding definitions.

2.1 General terms

2.1.1 Application of load

2.1.1.1 Compression loading

Compressive force applied to a load cell.

2.1.1.2 Tension loading

Tension force applied to a load cell.

2.1.2 Load cell

Force transducer which, after taking into account the effects of the acceleration of gravity and air buoyancy at the location of its use, measures mass by converting the measured quantity (mass) into another measured quantity (output).

2.1.3 Load cell equipped with electronics

Load cell employing an assembly of electronic components having a recognizable function of its own.

Examples of electronics: p-n junction, amplifier, encoder, A/D converter, CPU, I/O interface, etc. (not including strain gauge bridge circuits).

2.1.3.1 Electronic component

The smallest physical entity that uses electron or hole conduction in semiconductors, gases or in a vacuum.

2.1.4 Performance test

Test to verify whether the load cell under test is capable of performing its intended functions.

2.2 Metrological characteristics of a load cell

2.2.1 Accuracy class

Class of load cells that are subject to the same conditions of accuracy. [Adapted from VIM 5.19]

2.2.2 Humidity symbol

Symbol assigned to a load cell that indicates the conditions of humidity under which the load cell has been tested.

2.2.3 Load cell family

For the purposes of type evaluation/pattern approval, a load cell family consists of load cells that are of:

- the same material or combination of materials (for example, mild steel, stainless steel or aluminum);
- the same design of the measurement technique (for example, strain gauges bonded to metal);
- the same method of construction (for example, shape, sealing of strain gauges, mounting method, manufacturing method);
- the same set of specifications (for example, output rating, input impedance, supply voltage, cable details); and
- one or more load cell groups.

Note: The examples provided are not intended to be limiting.

2.2.3.1 Load cell group

All load cells within a family possessing identical metrological characteristics (for example, class, n_{max}, temperature rating, etc.).

Note: The examples provided are not intended to be limiting.

2.3 Range, capacity and output terms

2.3.1 Load cell interval

Part of the load cell measuring range into which that range is divided.

2.3.2 Load cell measuring range

Range of values of the measured quantity (mass) for which the result of measurement should not be affected by an error exceeding the maximum permissible error (mpe) (see 2.4.9).

2.3.3 Load cell output

Measurable quantity into which a load cell converts the measured quantity (mass).

2.3.4 Load cell verification interval (v)

Load cell interval, expressed in units of mass, used in the test of the load cell for accuracy classification.

2.3.5 Maximum capacity (E_{max})

Largest value of a quantity (mass) which may be applied to a load cell without exceeding the mpe (see 2.4.9).

2.3.6 Maximum load of the measuring range (D_{max})

Largest value of a quantity (mass) which is applied to a load cell during test or use. This value shall not be greater than E_{max} (see 2.3.5). For the limits on D_{max} during testing, see A.3.2.4.

2.3.7 Maximum number of load cell verification intervals (n_{max})

Maximum number of load cell verification intervals into which the load cell measuring range may be divided for which the result of measurement shall not be affected by an error exceeding the mpe (see 2.4.9).

2.3.8 Minimum dead load (E_{min})

Smallest value of a quantity (mass) which may be applied to a load cell without exceeding the mpe (see 2.4.9).

2.3.9 Minimum dead load output return (DR)

Difference in load cell output at minimum dead load, measured before and after load application.

2.3.10 Minimum load cell verification interval (v_{min})

Smallest load cell verification interval (mass) into which the load cell measuring range can be divided.

2.3.11 Minimum load of the measuring range (D_{min})

Smallest value of a quantity (mass) which is applied to a load cell during test or use. This value shall not be less than E_{min} (see 2.3.8). For the limits on D_{min} during testing, see A.3.2.4.

2.3.12 Number of load cell verification intervals (n)

Number of load cell verification intervals into which the load cell measuring range is divided.

2.3.13 Relative DR *or* Z

Ratio of the maximum capacity, E_{max}, to two times the minimum dead load output return, DR. This ratio is used to describe multi-interval instruments.

2.3.14 Relative v_{min} *or* Y

Ratio of the maximum capacity, E_{max}, to the minimum load cell verification interval, v_{min}. This ratio describes the resolution of the load cell independent from the load cell capacity.

2.3.15 Safe load limit (E_{lim})

Maximum load that can be applied without producing a permanent shift in the performance characteristics beyond those specified.

2.3.16 Warm-up time

Time between the moment power is applied to a load cell and the moment at which the load cell is capable of complying with the requirements.

2.4 Measurement and error terms

2.4.1 Creep

Change in load cell output occurring with time while under constant load and with all environmental conditions and other variables also remaining constant.

2.4.2 Apportionment factor (p_{LC})

The value of a dimensionless fraction expressed as a decimal (for example, 0.7) used in determining mpe (see 2.4.9). It represents that apportionment of a whole error (as may apply to a weighing instrument) which has been assigned to the load cell alone.

2.4.3 Expanded uncertainty

Quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand. [*Guide to the Expression of Uncertainty in Measurement*, BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1993]

2.4.4 Fault

Difference between the load cell error and the load cell intrinsic error (see 2.4.8).

2.4.5 Fault detection output

Electrical representation issued by the load cell indicating that a fault condition exists.

2.4.6 Hysteresis error

Difference between load cell output readings for the same applied load, one reading obtained by increasing the load from minimum load, D_{min}, and the other by decreasing the load from maximum load, D_{max}.

2.4.7 Load cell error

Difference between the load cell measurement result and the true value of the measurand (the applied force expressed in mass). [Adapted from VIM 5.20]

2.4.8 Load cell intrinsic error

Error of a load cell, determined under reference conditions (see 2.5.3). [Adapted from VIM 5.24]

2.4.9 Maximum permissible error (mpe)

Extreme values of an error permitted by this Recommendation (refer to clause 5) for a load cell. [Adapted from VIM 5.21]

2.4.10 Non-linearity

Deviation of the increasing load cell signal output curve from a straight line.

2.4.11 Repeatability

Ability of a load cell to provide successive results that are in agreement when the same load is applied several times and applied in the same manner on the load cell under constant test conditions. [Adapted from VIM 5.27]

2.4.12 Repeatability error

Difference between load cell output readings taken from consecutive tests under the same loading and environmental conditions of measurement. [Adapted from VIM 5.27]

2.4.13 Sensitivity

Ratio of a change in response (output) of a load cell to a corresponding change in the stimulus (load applied).

2.4.14 Significant fault

Fault greater than the load cell verification interval, v.

The following are not considered significant faults, even when they exceed the load cell verification interval, v:

- faults arising from simultaneous and mutually independent causes;
- faults implying the impossibility to perform any measurements;
- faults being so serious that they are bound to be noticed by all interested in the result of measurement; and
- transitory faults being momentary variations in the load cell output which cannot be interpreted, memorized or transmitted as a measurement result.

2.4.15 Span stability

Capability of a load cell to maintain the difference between the load cell output at maximum load, D_{max}, and the load cell output at minimum load, D_{min}, over a period of use within specified limits.

2.4.16 Temperature effect on minimum dead load output

Change in minimum dead load output due to a change in ambient temperature.

2.4.17 Temperature effect on sensitivity

Change in sensitivity due to a change in ambient temperature.

2.5 Influences and reference conditions

2.5.1 Influence quantity

Quantity that is not the measurand but that affects the result of the measurement. [VIM 2.7] (For example, temperature or humidity level at the instant the measurements on the load cell are being observed or recorded.)

2.5.1.1 Disturbance

Influence quantity having a value within the limits specified in this Recommendation, but outside the specified rated operating conditions of the load cell.

2.5.1.2 Influence factor

Influence quantity having a value within the specified rated operating conditions of the load cell. (For example, a specific temperature or a specific power voltage in which the load cell can be tested).

2.5.2 Rated operating conditions

Conditions of use, for which the metrological characteristics of the load cell are intended to lie within the specified mpe (see 2.4.9).

Note: The rated operating conditions generally specify ranges or rated values of the measurand and of the influence quantities. [Adapted from VIM 5.5]

2.5.3 Reference conditions

Conditions of use prescribed for testing the performance of a load cell or for the intercomparison of results of measurements.

Note: The reference conditions generally include reference values or reference ranges for the influence quantities affecting the load cell. [Adapted from VIM 5.7]

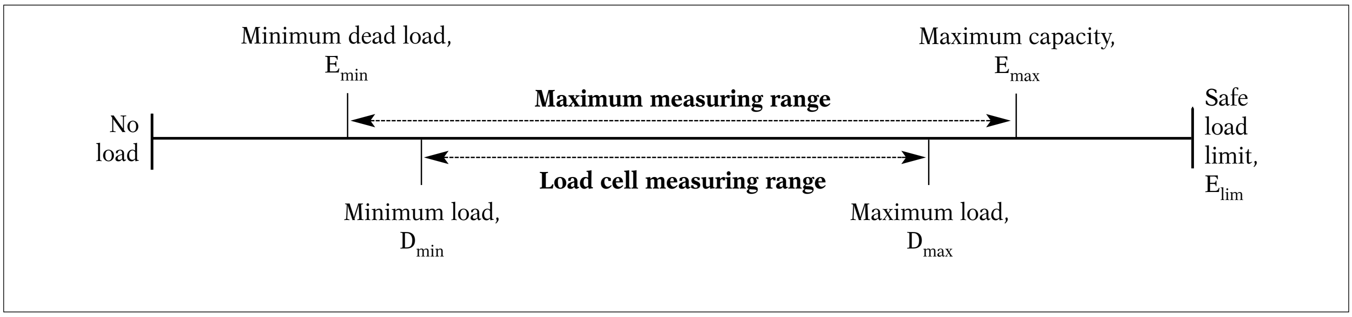

Figure 1 Illustration of certain definitions

2.6 Illustration of certain definitions

The terms that appear above the central horizontal line in Figure 1 below are parameters that are fixed by the design of the load cell. The terms that appear below that line are parameters that are variable, dependent on the conditions of use or in the test of a load cell (in particular, those load cells used in weighing instruments).

3 Units of measurement

The units of measurement of mass are the gram (g), kilogram (kg) or tonne (t).

4 Metrological requirements

4.1 Principle of load cell classification

The classification of load cells into specific accuracy classes is provided to facilitate their application to various mass measuring systems. In the application of this Recommendation, it should be recognized that the effective performance of a particular load cell may be improved by compensation within the measuring system with which it is applied. Therefore, it is not the intent of this Recommendation to require that a load cell be of the same accuracy class as the measuring system in which it may be used. Nor does it require that a measuring instrument, giving indications of mass, use a load cell which has been separately approved.

Table 1 Maximum number of load cell verification intervals (n_{max}) according to accuracy class

	Class A	Class B	Class C	Class D
Lower limit	50 000	5 000	500	100
Upper limit	Unlimited	100 000	10 000	1 000

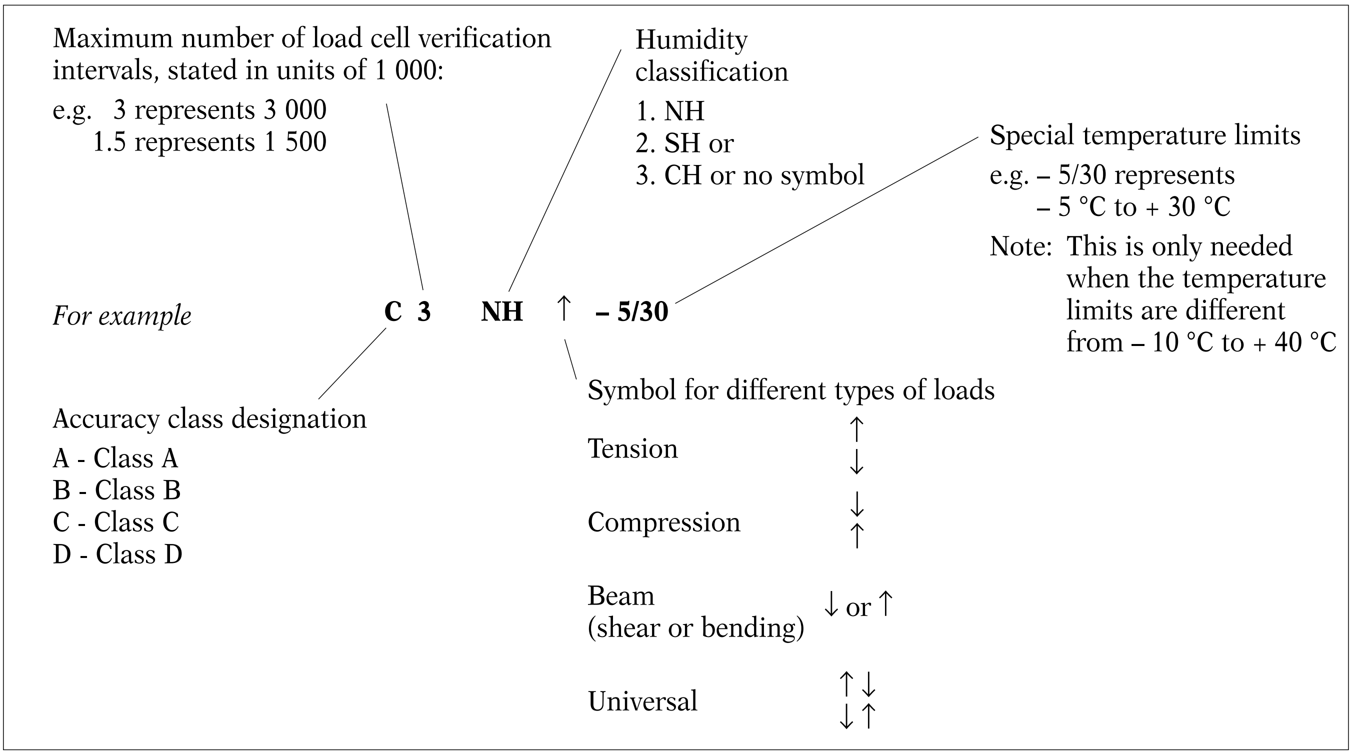

Figure 2 Illustration of standard classification symbols

4.2 Accuracy classes

Load cells shall be ranked, according to their overall performance capabilities, into four accuracy classes whose designations are as follows:

Class A;
Class B;
Class C;
Class D.

4.3 Maximum number of load cell verification intervals

The maximum number of load cell verification intervals, n_{max}, into which the load cell measuring range can be divided in a measuring system shall be within the limits fixed in Table 1.

4.4 Minimum load cell verification interval

The minimum load cell verification interval, v_{min}, shall be specified.

4.5 Supplementary classifications

Load cells shall also be classified by the type of load applied to the load cell, i.e. compression loading or tension loading. A load cell may bear different classifications for different types of load applied to the load cell. The type of load for which the classification(s) applies(y) shall be specified. For multiple capacity load cells, each capacity shall be classified separately.

4.6 Complete load cell classification

The load cell shall be classified according to six parts:

(1) accuracy class designation (see 4.2 and 4.6.1);
(2) maximum number of load cell verification intervals (see 4.3 and 4.6.2);
(3) type of load, if necessary (see 4.5 and 4.6.3);
(4) special limits of working temperature, if necessary (see 4.6.4);
(5) humidity symbol, if necessary (see 4.6.5); and
(6) additional characterization information, as listed below.

An example illustrating the six parts of the load cell classification is shown in Figure 2.

4.6.1 Accuracy class designation

Class A load cells shall be designated by the character “A”, class B by “B”, class C by “C” and class D by the character “D”.

4.6.2 Maximum number of load cell verification intervals

The maximum number of load cell verification intervals for which the accuracy class applies shall be designated in actual units (e.g. 3 000) or, when combined with the accuracy class designation (see 4.6.1 above) to produce a classification symbol (see 4.6.7), it shall be designated in units of 1 000.

4.6.3 Designation of the type of load applied to the load cell

The designation of the type of load applied to the load cell shall be specified when it is not clearly apparent from the load cell construction, using the symbols shown in Table 2.

Table 2 Symbols for different types of loads

Tension	↑ ↓
Compression	↓ ↑
Beam (shear or bending)	↑ or ↓
Universal	↑↓ ↓↑

4.6.4 Working temperature designation

The special limits of working temperature, as referred to in 5.5.1.2, shall be specified when the load cell cannot perform within the limits of error in 5.1 to 5.5 over the temperature range specified in 5.5.1.1. In such cases, the limits of temperature shall be designated in degrees Celsius (°C).

4.6.5 Humidity symbol

4.6.5.1 When a load cell is neither to be subjected to the humidity test as specified in A.4.5 nor the humidity test as specified in A.4.6, it shall be marked by the symbol NH.

4.6.5.2 When a load cell is to be subjected to the humidity test as specified in A.4.5, it may be marked with the symbol CH or have no humidity classification symbol.

4.6.5.3 When a load cell is to be subjected to the humidity test as specified in A.4.6, it shall be marked with the symbol SH.

4.6.6 Additional information

4.6.6.1 Mandatory additional information

In addition to the information required in 4.6.1 to 4.6.5, the following information shall be specified:

a) name or trademark of manufacturer;
b) manufacturer's designation or load cell model;
c) serial number and year of manufacture;
d) minimum dead load, E_{min}, maximum capacity, E_{max}, safe load limit, E_{lim} (all in units of g, kg or t, as applicable);
e) minimum load cell verification interval, v_{min};
f) other pertinent conditions that must be observed to obtain the specified performance (for example, electrical characteristics of the load cell such as output rating, input impedance, supply voltage, cable details, etc.); and
g) the value of the apportionment factor, p_{LC}, if not equal to 0.7.

4.6.6.2 Non-mandatory additional information

In addition to the information required in 4.6.1 to 4.6.6.1, the following information may optionally be specified:

a) for a weighing instrument (for example a multiple range instrument according to OIML R 76), the relative v_{min}, Y, where $Y = E_{max} / v_{min}$ (see 2.3.14);
b) for a weighing instrument (for example a multi-interval instrument according to OIML R 76), the relative DR, Z, where $Z = E_{max} / (2 \times DR)$ (see 2.3.13) and the value of DR (see 2.3.9) is set at the maximum permissible minimum dead load output return according to 5.3.2.

4.6.7 Standard classification

Standard classifications shall be used; examples are shown in Table 3.

Table 3 Examples of load cell classification

Classification symbol	Description
C2	Class C, 2 000 intervals
C3 5/35	Class C, 3 000 intervals, compression, + 5 °C to + 35 °C
C2 NH	Class C, 2 000 intervals, not to be subjected to humidity test

4.6.8 Multiple classifications

Load cells that have complete classifications for different types of load shall be designated using separate information for each classification. Examples are shown in Table 4.

An illustration of the standard classification symbols using an example is shown in Figure 2.

4.7 Presentation of information

4.7.1 Minimum load cell markings

The following minimum amount of information, required in 4.6, shall be marked on each load cell:

a) name or trademark of manufacturer;
b) manufacturer's designation or load cell model;
c) serial number;
d) maximum capacity, E_{max}.

Table 4 Examples of multiple classifications

Classification symbol	Description
C2 ↑ C1.5 ↓	Class C, 2 000 intervals, shear beam Class C, 1 500 intervals, bending beam
C1 ↓↑ – 5/30 C3 ↑↓ – 5/30	Class C, 1 000 intervals, compression, – 5 °C to + 30 °C Class C, 3 000 intervals, tension, – 5 °C to + 30 °C

Table 5 Maximum permissible errors (mpe) on pattern evaluation

mpe	Load, m			
	Class A	Class B	Class C	Class D
$p_{LC} \times 0.5$ v	$0 \leq m \leq$ 50 000 v	$0 \leq m \leq$ 5 000 v	$0 \leq m \leq$ 500 v	$0 \leq m \leq$ 50 v
$p_{LC} \times 1.0$ v	50 000 v < m ≤ 200 000 v	5 000 v < m ≤ 20 000 v	500 v < m ≤ 2 000 v	50 v < m ≤ 200 v
$p_{LC} \times 1.5$ v	200 000 v < m	20 000 v < m ≤ 100 000 v	2 000 v < m ≤ 10 000 v	200 v < m ≤ 1 000 v

4.7.2 Required information not marked on load cell

If the information required in 4.6 is not marked on the load cell then it shall be provided in an accompanying document provided by the manufacturer. Where such a document is provided, the information required in 4.7.1 shall also be given therein.

4.8 OIML certificate

4.8.1 Preparation of certificate

The OIML certificate shall be prepared according to the rules contained within the OIML Publication *OIML Certificate System for Measuring Instruments*. The format of the certificate shall be as specified in Annex E, *OIML Certificate of conformity for load cells*.

4.8.2 Reference of values on certificate

Regardless of the evaluation result of any load cell in a load cell family, the certificate to be issued should not provide for any characteristics or values which are beyond those that the manufacturer has requested and for which the manufacturer intends to guarantee, for example, by expressing the relevant characteristics and values in its data sheet.

5 Maximum permissible load cell errors

5.1 Maximum permissible errors for each accuracy class

The maximum permissible load cell errors for each accuracy class (the indicated load cell output having been adjusted to zero at minimum dead load, E_{min}) are related to the maximum number of load cell verification intervals specified for the load cell (see 4.3) and to the actual value of the load cell verification interval, v.

5.1.1 Pattern evaluation

The mpe (see 2.4.9) on pattern evaluation shall be the values derived using the expressions contained in the left column of Table 5. The apportionment factor, p_{LC}, shall be chosen and declared (if other than 0.7) by the manufacturer and shall be in the range of 0.3 to 0.8 ($0.3 \leq p_{LC} \leq 0.8$)[1].

The value of the apportionment factor, p_{LC} shall appear on the OIML certificate, if the value is not equal to 0.7. If the apportionment factor, p_{LC} is not specified on the certificate then the value 0.7 shall be assumed.

The maximum permissible load cell errors may be positive or negative and are applicable to both increasing and decreasing loads.

The above limits of error include errors due to nonlinearity, hysteresis and temperature effect on sensitivity over certain temperature ranges, specified in 5.5.1.1 and 5.5.1.2. Further errors, not included in the above limits of error, are treated separately.

5.2 Rules concerning the determination of errors

5.2.1 Conditions

The above limits of error shall apply to all load cell measuring ranges complying with the following conditions:

$$n \leq n_{max}$$

$$v \geq v_{min}$$

[1] Associated with apportionment of error provisions contained within OIML R 76-1, 3.5.4; R 50-1, 2.2.3; R 51-1, 5.2.3.4; R 61-1, 5.2.3.3; R 106-1, 2.10.1, 3.3.4, 5.1.3.2; or R 107-1, 5.1.3.2, 5.2.1.1, when load cell is applied to such instruments.

5.2.2 Limits of error

The above limits of error shall refer to the error envelope defined in 1.2 and 5.1 which is referenced to the straight line that passes through the minimum load output and the load cell output for a load of 75 % of the measuring range taken on ascending load at 20 °C. This is based upon the initial 20 °C load test. See C.2.2.

5.2.3 Initial readings

During the conduct of the tests, the initial reading shall be taken at a time interval after the initiation of loading or unloading, whichever is applicable, as specified in Table 6.

Table 6 Combined loading and stabilization times to be achieved prior to reading

Change in load		Time
Greater than	Up to and including	
0 kg	10 kg	10 seconds
10 kg	100 kg	20 seconds
100 kg	1 000 kg	30 seconds
1 000 kg	10 000 kg	40 seconds
10 000 kg	100 000 kg	50 seconds
100 000 kg		60 seconds

5.2.3.1 Loading/unloading times

The loading or unloading times shall be approximately half the time specified. The remaining time shall be utilized for stabilization. The tests shall be conducted under constant conditions. Time shall be recorded in the test report in absolute, not relative, units.

5.2.3.2 Loading/unloading times impracticable

When the specified loading or unloading times cannot be achieved, the following shall apply:

a) in the case of the minimum dead load output return test, the time may be increased from 100 % to a limit of 150 % of the specified time provided that the permissible variation of the result is proportionally reduced from 100 % to 50 % of the allowable difference between the initial reading of the minimum load output upon unloading and the reading before loading; and

b) in other cases, the actual times shall be recorded in the Test Report.

5.3 Permissible variation of results

5.3.1 Creep

With a constant maximum load, D_{max}, between 90 % and 100 % of E_{max}, applied to the load cell, the difference between the initial reading and any reading obtained during the next 30 minutes shall not exceed 0.7 times the absolute value of the mpe (see 5.3.1.1) for the applied load. The difference between the reading obtained at 20 minutes and the reading obtained at 30 minutes shall not exceed 0.15 times the absolute value of the mpe (see 5.3.1.1).

5.3.1.1 Maximum permissible error for creep

Regardless of the value declared by the manufacturer for the apportionment factor, p_{LC}, the mpe for creep shall be determined from Table 5 using the apportionment factor, $p_{LC} = 0.7$.

5.3.2 Minimum dead load output return

The difference between the initial reading of the minimum load output and the reading after returning to minimum load, D_{min}, subsequent to the maximum load, D_{max}, between 90 % and 100 % of E_{max}, having been applied for 30 minutes, shall not exceed half the value of the load cell verification interval (0.5 v).

5.4 Repeatability error

The maximum difference between the results of five identical load applications for classes A and B and of three identical load applications for classes C and D, shall not be greater than the absolute value of the mpe for that load.

5.5 Influence quantities

5.5.1 Temperature

5.5.1.1 Temperature limits

Excluding temperature effects on minimum dead load output, the load cell shall perform within the limits of error in 5.1.1 over the temperature range of – 10 °C to + 40 °C, unless otherwise specified as in 5.5.1.2 below.

5.5.1.2 Special limits

Load cells for which particular limits of working temperature are specified shall satisfy, within those ranges, the conditions defined in 5.1.1.

These ranges shall be at least:

5 °C for load cells of class A;

15 °C for load cells of class B;

30 °C for load cells of classes C and D.

5.5.1.3 Temperature effect on minimum dead load output

The minimum dead load output of the load cell over the temperature range, as specified in 5.5.1.1 or 5.5.1.2, shall not vary by an amount greater than the apportionment factor, p_{LC}, times the minimum load cell verification interval, v_{min}, for any change in ambient temperature of:

2 °C for load cells of class A;

5 °C for load cells of classes B, C and D.

The minimum load output shall be taken after the load cell has thermally stabilized at ambient temperature.

5.5.2 Barometric pressure

The output of the load cell shall not vary by an amount greater than the minimum load cell verification interval, v_{min}, for a change in barometric pressure of 1 kPa over the range from 95 kPa to 105 kPa.

5.5.3 Humidity

When a load cell is marked with the symbol NH, it shall not be subjected to the humidity test, as specified in A.4.5 or A.4.6.

When a load cell is marked with the symbol CH or is not marked with a humidity symbol, it shall be subjected to the humidity test, as specified in A.4.5.

When a load cell is marked with the symbol SH, it shall be subjected to the humidity test, as specified in A.4.6.

5.5.3.1 Humidity error (applicable to load cells marked CH or with no humidity symbol marking and not applicable to load cells marked NH or SH)

The difference between the average of the readings of the minimum load output before the conduct of the humidity test and the average of the readings for the same load obtained after the conduct of the humidity test according to A.4.5, shall not be greater than 4 % of the difference between the output at the maximum capacity, E_{max}, and that at the minimum dead load, E_{min}.

The difference between the average of the three output values at the maximum load, D_{max}, for load cells of accuracy classes C and D, or five output values for load cells of accuracy classes A and B, (corrected for the minimum load output) obtained before the conduct of the humidity test according to A.4.5, and the average of the three output values for load cells of accuracy classes C and D, or five output values for load cells of accuracy classes A and B obtained for the same maximum load, D_{max}, (corrected for the minimum load output) after the conduct of the humidity test, shall not be greater than the value of the load cell verification interval, v.

5.5.3.2 Humidity error (applicable to load cells marked SH and not applicable to load cells marked CH or NH or with no humidity symbol marking)

A load cell shall meet the applicable mpe during the conduct of the humidity test, according to A.4.6.

5.6 Measurement standards

The expanded uncertainty, *U* (for coverage factor k = 2), for the combination of the force-generating system and the indicating instrument (used to observe the load cell output) shall be less than 1/3 times the mpe of the load cell under test. [*Guide to the Expression of Uncertainty in Measurement*, 1993]

6 Requirements for load cells equipped with electronics

6.1 General requirements

In addition to the other requirements of this Recommendation, a load cell equipped with electronics shall comply with the following requirements. The mpe shall be determined using an apportionment factor, p_{LC}, equal to 1.0 (p_{LC} = 1.0) substituted for the apportionment factor, p_{LC}, that is declared by the manufacturer and applied to the other requirements.

If a load cell is configured with substantially all the electronic functions of an electronic weighing instrument then it may be required to undergo additional evaluation against other requirements contained in the OIML Recommendation for the weighing instrument. Such evaluation is outside the scope of this Recommendation.

6.1.1 Faults

A load cell equipped with electronics shall be designed and manufactured such that when it is exposed to electrical disturbances either:

a) significant faults do not occur; or
b) significant faults are detected and acted upon.

Messages of significant faults should not be confused with other messages presented.

Note: A fault equal to or smaller than the load cell verification interval, v, is allowed irrespective of the value of the error in output.

6.1.2 Durability

The load cell shall be suitably durable so that the requirements of this Recommendation may be met in accordance with the intended use of the load cell.

6.1.3 Compliance with requirements

A load cell equipped with electronics is presumed to comply with the requirements in 6.1.1 and 6.1.2, if it passes the examinations specified in 6.3 and 6.4.

6.1.4 Application of the requirements in 6.1.1

The requirements in 6.1.1 may be applied separately to each individual cause or significant fault. The choice of whether 6.1.1 a) or 6.1.1 b) is applied is left to the manufacturer.

6.2 Acting upon significant faults

When a significant fault has been detected, either the load cell shall be made inoperative automatically or a fault detection output shall be issued automatically. This fault detection output shall continue until the user acts on the fault or the fault disappears.

6.3 Functional requirements

6.3.1 Special procedure for load cell with indicator

When a load cell equipped with electronics includes an indicator, a special procedure shall be performed upon application of power. This procedure shall show all relevant signs of the indicator in their active and non-active states sufficiently long to be checked by the user.

6.3.2 Warm-up time

During the design warm-up time of a load cell equipped with electronics there shall be no transmission of measurement results.

6.3.3 Mains power supply (AC)

A load cell equipped with electronics that operates from a mains power supply shall be designed to comply with the metrological requirements if the mains power supply varies:

a) in voltage from – 15 % to + 10 % of the supply voltage specified by the manufacturer; and
b) in frequency from – 2 % to + 2 % of the frequency specified by the manufacturer, if AC is used.

6.3.4 Battery power supply (DC)

A load cell equipped with electronics that operates from a battery power supply shall either continue to function correctly or not provide a measurement result whenever the voltage is below the value specified by the manufacturer.

6.3.5 Disturbances

When a load cell equipped with electronics is subjected to the disturbances specified in 6.4.1, the difference between the load cell output due to a disturbance and the load cell output without disturbance (load cell intrinsic error) shall not exceed the load cell verification interval, v, or the load cell shall detect and react to a significant fault.

6.3.6 Span stability requirements (not applicable to class A load cells)

A load cell equipped with electronics shall be subjected to the span stability test specified in 6.4.1 and A.4.7.8. The variation in load cell span shall not exceed half the load cell verification interval (0.5 v) or half the absolute value of the mpe (0.5 mpe), whichever is the greater, for the test load applied. The aim of this test is not to measure the influence on the metrological performances of mounting or dismounting the load cell on or from the force-generating system, so the installation of the load cell in the force-generating system shall be carried out with particular care.

6.4 Additional tests

6.4.1 Performance and stability tests

A load cell equipped with electronics shall pass the performance and stability tests according to A.4.7 for the tests given in Table 7.

Table 7 Performance and stability tests for a load cell equipped with electronics

Test	Annex A test procedure	p_{LC}	Characteristic under test
Warm-up time	A.4.7.2	1.0	Influence factor
Power voltage variations	A.4.7.3	1.0	Influence factor
Short-time power reductions	A.4.7.4	1.0	Disturbance
Bursts (electrical fast transients)	A.4.7.5	1.0	Disturbance
Electrostatic discharge	A.4.7.6	1.0	Disturbance
Electromagnetic susceptibility	A.4.7.7	1.0	Disturbance
Span stability	A.4.7.8	1.0	Influence factor

Generally, the tests are carried out on fully operational equipment in its normal state or in a status as similar as possible thereto. If the load cell is equipped with an interface that permits it to be coupled to external equipment, all functions that are performed or initiated via an interface shall operate correctly.

7 Metrological controls

7.1 Liability to legal metrological controls

7.1.1 Imposition of controls

This Recommendation prescribes performance requirements for load cells used in the measurement of mass. National legislation may impose metrological controls that verify compliance with this Recommendation. Such controls, when imposed, may include pattern evaluation.

7.2 Test requirements

Test procedures for the pattern evaluation of load cells are provided in Annex A and the Test Report Format is provided in Annexes C and D. Initial and subsequent verification of load cells independent of the measuring system in which they are used is normally considered inappropriate if the complete system performance is verified by other means.

7.3 Selection of load cells within a family

Where a family composed of one or more groups of load cells of various capacities and characteristics is presented for pattern evaluation, the following provisions shall apply.

7.3.1 Number of load cells to be tested

The selection of load cells to be tested shall be such that the number of load cells to be tested is minimized (see practical example in Annex B).

7.3.2 Load cells of the same capacity belonging to different groups

Where load cells of the same capacity belong to different groups, approval of the load cell with the best metrological characteristics implies approval of the load cells with the lesser characteristics. Therefore, when a choice exists, the load cells with the best metrological characteristics shall be selected for test.

7.3.3 Load cells with a capacity in between the capacities tested

Load cells with a capacity in between the capacities tested, as well as those above the largest capacity tested, but not over 5 times above the largest capacity tested, are deemed to be approved.

7.3.4 Smallest capacity load cell from the group

For any family, the smallest capacity load cell from the group with the best characteristics shall be selected for testing. For any group, the smallest capacity load cell in the group shall always be selected for test unless that capacity falls within the range of allowed capacities of selected load cells having better metrological characteristics according to the requirements of 7.3.2 and 7.3.3.

7.3.5 Ratio of largest capacity to the nearest smaller capacity

When the ratio of the largest capacity load cell in each group to the nearest smaller capacity having been selected for test is greater than 5, then another load cell shall be selected. The selected load cell shall have a capacity between 5 and 10 times that of the nearest smaller capacity load cell which has been selected. When no capacity meets this criterion, the selected load cell shall be that having the smallest capacity exceeding 10 times that of the nearest smaller capacity load cell which has been selected.

7.3.6 Humidity test

If more than one load cell of a family has been submitted for testing, only one cell shall be tested for humidity when applicable, and only one cell shall be subjected to the additional tests for load cells equipped with electronics when applicable, that being the load cell with the most severe characteristics (for example, the greatest value of n_{max} or the lowest value of v_{min}).

Annex A
(Mandatory)
Test procedures for pattern evaluation

A.1 Scope

This Annex provides test procedures for pattern evaluation testing of load cells used in the measurement of mass.

A.1.1 Wherever possible test procedures have been established to apply as broadly as possible to all load cells within the scope of OIML R 60.

A.1.2 The procedures apply to the testing of load cells only. No attempt has been made to cover testing of complete systems that include load cells.

A.2 Purpose

The following test procedures for quantitative determination of load cell performance characteristics are established to ensure uniform pattern evaluation.

A.3 Test conditions

A.3.1 Test equipment

The basic equipment for pattern evaluation tests consists of a force-generating system and a suitable linear instrument, which measures the output of the load cell (see 5.6).

A.3.2 General considerations for environmental and test conditions

Before adequate testing and evaluation of a load cell can be performed, careful attention shall be paid to the environmental and test conditions under which such evaluations are to be made. Significant discrepancies are frequently a result of insufficient recognition of such details. The following shall be thoroughly considered prior to any pattern evaluation testing program.

A.3.2.1 Acceleration of gravity

The mass standards used in testing shall be corrected, if necessary, for the site of testing and the value of the gravity constant, g, at the test site shall be recorded with the test results. The value of the mass standards used to generate the force shall be traceable to the national standard of mass.

A.3.2.2 Environmental conditions

Tests shall be performed under stable environmental conditions. The ambient temperature is deemed to be stable when the difference between extreme temperatures noted during the test does not exceed one fifth of the temperature range of the load cell under test, without being greater than 2 °C.

A.3.2.3 Loading conditions

Particular attention shall be paid to loading conditions to prevent the introduction of errors not inherent to the load cell. Factors such as surface roughness, flatness, corrosion, scratches, eccentricity, etc., should be taken into consideration. Loading conditions shall be in accordance with the requirements of the load cell manufacturer. The loads shall be applied and removed along the sensitive axis of the load cell without introducing shock to the load cell.

A.3.2.4 Measuring range limits

The minimum load, D_{min}, (hereafter referred to as “minimum test load”) shall be as near as possible to but not less than the minimum dead load, E_{min}, as permitted by the force-generating system. The maximum load, D_{max}, (hereafter referred to as “maximum test load”) shall be not less than 90 % of E_{max}, nor shall it be greater than E_{max} (refer to Fig. 1).

A.3.2.5 Reference standards

Periodic (depending on use) verification of standards shall be made.

A.3.2.6 Stabilization period

A stabilization period for the load cell under test and the indicating instrument shall be provided, as recommended by the manufacturers of the equipment used.

A.3.2.7 Temperature conditions

It is important to allow sufficient time for temperature stabilization of the load cell to be achieved. Particular attention shall be devoted to this requirement for large load cells. The loading system shall be of a design which will not introduce significant thermal gradients within the load cell. The load cell and its connecting means (cables, tubes, etc.) which are integral or contiguous shall be at the same test temperature. The indicating instrument shall be maintained at room temperature. The temperature effect on auxiliary connecting means shall be considered in determining results.

A.3.2.8 Barometric pressure effects

Where changes in barometric pressure may significantly affect the load cell output, such changes shall be considered.

A.3.2.9 Stability of loading means

An indicating instrument and a loading means shall be used which will provide sufficient stability to permit readings within the limits specified in 5.6.

A.3.2.10 Indicating instrument checking

Some indicating instruments are provided with a convenient means for checking the indicating instrument itself. When such features are provided, they shall be utilized frequently to ensure that the indicating instrument is within the accuracy required by the test being performed. Periodic verification of the indicating instrument calibration shall also be performed.

A.3.2.11 Other conditions

Other conditions specified by the manufacturer such as input/output voltage, electrical sensitivity, etc. shall be taken into consideration during the test.

A.3.2.12 Time and date data

All time and date points shall be recorded such that the data can later be presented in test reports in absolute, not relative, units of local time and date. The date shall be recorded in the ISO 8601 format of ccyy-mm-dd.

Note: "cc" may be omitted in cases where there is no possible confusion as to the century.

A.3.2.13 Span stability

The installation of the load cell in the force-generating system shall be done with particular care, since the aim of this test is not to measure the influence on the metrological performances of mounting/dismounting the load cell on/from the force-generating system.

A.4 Test procedures

Each of the tests below is presented as a "stand alone" individual test. However, for the efficient conduct of the load cell tests, it is acceptable that the increasing and decreasing load, creep, and minimum dead load output return tests be conducted at the given test temperature before changing to the next test temperature (see A.5, Figures A.1 and A.2). The barometric pressure and the humidity tests are conducted individually following completion of the above tests.

A.4.1 Determination of load cell error, repeatability error and temperature effect on minimum dead load output

A.4.1.1 Check test conditions

Refer to the test conditions in A.3 to ensure that proper consideration has been given to those conditions, prior to performing the following tests.

A.4.1.2 Insert load cell

Insert the load cell into the force-generating system, load to the minimum test load, D_{min}, and stabilize at 20 °C.

A.4.1.3 Exercise load cell

Exercise the load cell by applying the maximum test load, D_{max}, three times, returning to the minimum test load, D_{min}, after each load application. Wait 5 minutes.

A.4.1.4 Check indicating instrument

Check the indicating instrument according to A.3.2.10.

A.4.1.5 Monitor load cell

Monitor the minimum test load output until stable.

A.4.1.6 Record indication

Record the indicating instrument indication at the minimum test load, D_{min}.

A.4.1.7 Test load points

All test load points in a loading and unloading sequence shall be spaced at approximately equal time intervals. The readings shall be taken at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.1.8 Apply loads

Apply increasing loads up to the maximum test load, D_{max}. There shall be at least five increasing load points, which shall include loads approximating to the highest values in the applicable steps of maximum permissible load cell errors, as listed in Table 5 in 5.1.1.

A.4.1.9 Record indications

Record the indicating instrument indications at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.1.10 Decrease test loads

Decrease the test loads to the minimum test load, D_{min}, using the same load points as described in A.4.1.8.

A.4.1.11 Record indications

Record the indicating instrument indications at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.1.12 Repeat procedures for different accuracy classes

Repeat the operations described in A.4.1.7 to A.4.1.11 four more times for accuracy classes A and B or two more times for accuracy classes C and D.

A.4.1.13 Repeat procedures for different temperatures

Repeat the operations described in A.4.1.3 to A.4.1.12, first at the higher temperature, then at the lower temperature, including the approximate temperature range limits for the accuracy class intended; then perform the operations in A.4.1.3 to A.4.1.12 at 20 °C.

A.4.1.14 Determine magnitude of load cell error

The magnitude of the load cell error shall be determined based on the average of the results of the tests conducted at each temperature level and compared with the maximum permissible load cell errors in 5.1.1.

A.4.1.15 Determine repeatability error

From the resulting data, the repeatability error may be determined and compared with the limits specified in 5.4.

A.4.1.16 Determine temperature effect on minimum dead load output

From the resulting data, the temperature effect on minimum dead load output may be determined and compared with the limits specified in 5.5.1.3.

A.4.2 Determination of creep error

A.4.2.1 Check test conditions

Refer to the test conditions in A.3 to ensure that proper consideration has been given to those conditions prior to performing the following tests.

A.4.2.2 Insert load cell

Insert the load cell into the force-generating system, load to the minimum test load, D_{min}, and stabilize at 20 °C.

A.4.2.3 Exercise load cell

Exercise the load cell by applying the maximum test load, D_{max}, three times, returning to the minimum test load, D_{min}, after each load application. Wait one hour.

A.4.2.4 Check indicating instrument

Check the indicating instrument according to A.3.2.10.

A.4.2.5 Monitor load cell

Monitor the minimum test load output until stable.

A.4.2.6 Record indication

Record the indicating instrument indication at the minimum test load, D_{min}.

A.4.2.7 Apply load

Apply a constant maximum test load, D_{max}.

A.4.2.8 Record indications

Record the initial indicating instrument indication at the time intervals specified in Table 6 in 5.2.3. Continue to record periodically thereafter, at recorded time intervals over a 30-minute period, ensuring that a reading is taken at 20 minutes.

A.4.2.9 Repeat procedures for different temperatures

Repeat the operations described in A.4.2.3 to A.4.2.8, first at the higher temperature, then at the lower temperature, including the approximate temperature range limits for the accuracy class intended.

A.4.2.10 Determine creep error

With the resulting data, and taking into account the effect of barometric pressure changes according to A.3.2.8, the magnitude of the creep error can be determined and compared with the permissible variation specified in 5.3.1.

A.4.3 Determination of minimum dead load output return (DR)

A.4.3.1 Check test conditions

Refer to the test conditions in A.3 to ensure that proper consideration has been given to those conditions prior to performing the following test.

A.4.3.2 Insert load cell

Insert the load cell into the force-generating system, load to the minimum test load, D_{min}, and stabilize at 20 °C.

A.4.3.3 Exercise load cell

Exercise the load cell by applying the maximum test load, D_{max}, three times, returning to the minimum test load, D_{min}, after each load application. Wait one hour.

A.4.3.4 Check indicating instrument

Check the indicating instrument according to A.3.2.10.

A.4.3.5 Monitor load cell

Monitor the minimum test load output until stable.

A.4.3.6 Record indication

Record the indicating instrument indication at the minimum test load, D_{min}.

A.4.3.7 Apply load

Apply a constant maximum test load, D_{max}.

A.4.3.8 Record indications

Record the initial indicating instrument indication at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded. Record the time at which the load is fully applied and maintain the load for a 30-minute period.

A.4.3.9 Record data

Record the time of initiation of unloading and return to the minimum test load, D_{min}.

A.4.3.10 Record indication

Record the indicating instrument indication at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.3.11 Repeat procedures for different temperatures

Repeat the operations described in A.4.3.3 to A.4.3.10, first at the higher temperature, then at the lower temperature, including the approximate temperature range limits for the accuracy class intended.

A.4.3.12 Determine minimum dead load output return (DR)

With the resulting data, the magnitude of the minimum dead load output return (DR) can be determined and compared with the permissible variation specified in 5.3.2.

A.4.4 Determination of barometric pressure effects

This test shall be conducted unless there is sufficient design justification to show that the load cell performance is not affected by changes in barometric pressure.

A.4.4.1 Check test conditions

Refer to the test conditions in A.3 to ensure that proper consideration has been given to those conditions prior to performing the following test.

A.4.4.2 Insert load cell

At room temperature, insert the unloaded load cell into the pressure chamber at atmospheric pressure.

A.4.4.3 Check indicating instrument

Check the indicating instrument according to A.3.2.10.

A.4.4.4 Monitor load cell

Monitor the output until stable.

A.4.4.5 Record indication

Record the indicating instrument indication.

A.4.4.6 Change barometric pressure

Change the barometric pressure to a value of approximately 1 kPa lower or higher than atmospheric pressure and record the indicating instrument indication.

A.4.4.7 Determine barometric pressure error

With the resulting data, the magnitude of the barometric pressure influence can be determined and compared with the limits specified in 5.5.2.

A.4.5 Determination of humidity effects for load cells marked CH or not marked

A.4.5.1 Check test conditions

Refer to the test conditions in A.3 to ensure that proper consideration has been given to those conditions prior to performing the following test.

A.4.5.2 Insert load cell

Insert the load cell into the force-generating system, load to the minimum test load, D_{min}, and stabilize at 20 °C.

A.4.5.3 Exercise load cell

Exercise the load cell by applying the maximum test load, D_{max}, three times, returning to the minimum test load, D_{min}, after each application.

A.4.5.4 Check indicating instrument

Check the indicating instrument according to A.3.2.10.

A.4.5.5 Monitor load cell

Monitor the minimum test load output until stable.

A.4.5.6 Record indication

Record the indicating instrument indication at the minimum test load, D_{min}.

A.4.5.7 Apply load

Apply a maximum test load, D_{max}.

A.4.5.8 Record indications

Record the initial indicating instrument indication at time intervals as near as possible to those specified in

Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.5.9 Remove load

Remove the test load to the minimum test load, D_{min}.

A.4.5.10 Record indication

Record the indicating instrument indication at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.5.11 Repeat procedures for different accuracy classes

Repeat the operations described in A.4.5.7 to A.4.5.10 four more times for accuracy classes A and B or two more times for accuracy classes C and D.

A.4.5.12 Conduct damp heat, cyclic test

Conduct a damp heat, cyclic test in accordance with IEC 60068-2-30 (1980-01) Environmental testing - Part 2: Tests. Test Db and guidance: Damp heat cyclic (12 + 12-hour cycle) as amended by IEC 60068-2-30-am1 (1985-01). Background information concerning damp heat, cyclic tests is given in IEC 60068-2-28 (1990-03) Environmental testing - Part 2: Tests. Guidance for damp heat tests.

Test procedure in brief:

This test consists of exposure to 12 temperature cycles of 24-hour duration each. The relative humidity is between 80 % and 96 % and the temperature is varied from 25 °C to 40 °C, in accordance with the specified cycle.

Test severity:

40 °C, 12 cycles.

Initial measurements:

According to A.4.5.1 to A.4.5.11 above.

State of load cell during conditioning:

Load cell placed in the chamber with the output connection external to the chamber, and switched off. Use variant 2 of IEC 60068-2-30 (1980-01) as amended by IEC 60068-2-30-am1 (1985-01) when lowering the temperature.

Recovery conditions and final measurements:

According to A.4.5.13 below.

A.4.5.13 Remove load cell from chamber

Remove the load cell from the humidity chamber, carefully remove surface moisture, and maintain the load cell at standard atmospheric conditions for a period sufficient to attain temperature stability (normally 1 to 2 hours).

Repeat A.4.5.1 to A.4.5.11 ensuring that the minimum test load, D_{min}, and the maximum test load, D_{max}, applied are the same as previously used.

A.4.5.14 Determine the magnitude of humidity-induced variations

With the resulting data, the magnitude of humidity-induced variations can be determined and compared with the limits specified in 5.5.3.1.

A.4.6 Determination of humidity effects for load cells marked SH

A.4.6.1 Check test conditions

Refer to the test conditions in A.3 to ensure that proper consideration has been given to those conditions prior to performing the following tests.

A.4.6.2 Insert load cell

Insert the load cell into the force-generating system, load to the minimum test load, D_{min}, and stabilize at 20 °C.

A.4.6.3 Exercise load cell

Exercise the load cell by applying the maximum test load, D_{max}, three times, returning to the minimum test load, D_{min}, after each load application.

A.4.6.4 Check indicating instrument

Check the indicating instrument according to A.3.2.10.

A.4.6.5 Monitor load cell

Monitor the minimum test load output until stable.

A.4.6.6 Record indication

Record the indicating instrument indication at the minimum test load, D_{min}.

A.4.6.7 Test load points

All test load points in a loading and unloading sequence shall be spaced at approximately equal time intervals. The readings shall be taken at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.6.8 Apply loads

Apply increasing loads up to the maximum test load, D_{max}. There shall be at least five increasing load points which shall include loads approximating to the highest values in the applicable steps of maximum permissible load cell errors, as listed in Table 5 in 5.1.1.

A.4.6.9 Record indications

Record the indicating instrument indications at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.6.10 Decrease load

Decrease the test load to the minimum test load, D_{min}, using the same load points as described in A.4.6.8.

A.4.6.11 Conduct damp heat, steady state test

Conduct a damp heat, steady state test in accordance with IEC 60068-2-3 (1969-01) Environmental testing - Part 2: Tests. Test Ca: Damp heat, steady state, IEC 60068-2-56 (1988-12) Environmental testing - Part 2: Tests. Test Cb: Damp heat, steady state, primarily for equipment and IEC 60068-2-28 (1990-03) Environmental testing - Part 2: Tests. Guidance for damp heat tests.

Test procedure in brief:

This test involves exposure of the load cell to a constant temperature and a constant relative humidity. The load cell shall be tested as specified in A.4.6.1 to A.4.6.10:

a) at a reference temperature (20 °C or the mean value of the temperature range whenever 20 °C is outside this range) and a relative humidity of 50 % following conditioning;

b) at the high temperature of the range specified in 5.5.1 for the load cell and a relative humidity of 85 %, two days following temperature and humidity stabilization; and

c) at the reference temperature and relative humidity of 50 %.

State of load cell during conditioning:

Place the load cell in the chamber with the output connection external to the chamber, and switched on. Use IEC 60068-2-3 (1969-01) and IEC 60068-2-56 (1988-12) when lowering the temperature.

A.4.6.12 Recording indications

Record the indicating instrument indications at time intervals as near as possible to those specified in Table 6 in 5.2.3. These two time intervals shall be recorded.

A.4.6.13 Determine the magnitude of humidity-induced variations

With the resulting data, the magnitude of humidity-induced variations can be determined and compared with the limits specified in 5.5.3.2.

A.4.7 Additional tests for load cells equipped with electronics

A.4.7.1 Evaluation of error for load cells with digital output interval

For load cells possessing a digital output interval greater than 0.20 v, the changeover points are to be used in the evaluation of errors, prior to rounding as follows.

At a certain load, L, the digital output value, I, is noted. Additional loads, for example 0.1 v, are successively added until the output of the load cell is increased unambiguously by one digital output increment (I + v). The additional amount of load, ΔL, added to the load cell gives the digital output value prior to rounding, P, by using the following formula:

$$P = I + 1/2\ v - \Delta L$$

where:

I = the indication or digital output value;
v = the load cell verification interval; and
ΔL = additional load added to the load cell.

The error, E, prior to rounding is:

$$E = P - L = I + 1/2\ v - \Delta L - L$$

and the corrected error, E_c, prior to rounding is:

$$E_c = E - E_o \leq mpe$$

where E_o is the error calculated at the minimum test load, D_{min}.

A.4.7.2 Warm-up time (see 6.3.2)

Test procedure in brief:

Stabilize the load cell at 20 °C and disconnect from any electrical supply for a period of at least 8 hours prior to the test.

Insert the load cell into the force-generating system.

Exercise the load cell by applying a maximum test load, D_{max}, three times, returning to the minimum test load, D_{min}, after each load application.

Allow the load cell to rest for 5 minutes.

Connect the load cell to the power supply and switch on.

Record data:

As soon as a measurement result can be obtained, record the minimum test load output and the maximum test load, D_{max}, applied.

Loading and unloading:

The maximum test load output shall be determined at time intervals as close as possible to those specified in Table 6 in 5.2.3 and recorded and the load should be returned to the minimum test load, D_{min}. These measurements shall be repeated after 5, 15 and 30 minutes.

Maximum allowable variations:

The absolute value of the difference between the indication at the maximum test load, D_{max}, and that at the minimum test load, D_{min}, taken immediately prior to the application of the maximum test load, D_{max}, in the case of any of the individual measurements shall not exceed the absolute value of the mpe for the maximum test load, D_{max}, applied.

For load cells of class A, the provisions of the operating manual for the time following connection to electrical supply shall be observed.

A.4.7.3 Power voltage variations (see 6.3.3 and 6.3.4)

Test procedure in brief:

This test consists of subjecting the load cell to variations of power voltage.

A load test is performed in accordance with A.4.1.1 to A.4.1.12 at 20 °C, with the load cell powered at reference voltage. The test is repeated with the load cell powered at the upper limit and at the lower limit of power voltage.

Before any test:

Stabilize the load cell under constant environmental conditions.

Test severity:

Mains power voltage variations:

a) upper voltage limit (V + 10 %);
b) lower voltage limit (V – 15 %).

Battery power voltage variations:

a) upper voltage limit (not applicable);
b) lower voltage limit (specified by the manufacturer, below V).

The voltage, V, is the value specified by the manufacturer. If a range of reference mains power voltage (V_{min}, V_{max}) is specified, then the test shall be performed at an upper voltage limit of V_{max} and a lower voltage limit of V_{min}.

Maximum allowable variations:

All functions shall operate as designed.

All measurement results shall be within maximum permissible errors.

Note: Where a load cell is powered by a three-phase supply, the voltage variations shall apply to each phase successively and all phases simultaneously.

Reference to IEC Publication:

IEC Publication 61000-4-11 (1994-06) Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests. Section 5.2 (Test levels – voltage variation), Section 8.2.2 (Execution of the test – voltage variation).

A.4.7.4 Short-time power reductions (see 6.3.5)

Test procedure in brief:

This test consists of exposing the load cell to specified short-time power reductions.

A test generator capable of reducing the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage shall be used. The test generator shall be adjusted before connecting to the load cell. The mains voltage reductions shall be repeated ten times at intervals of at least 10 seconds.

Test load:

During the test, the effect of any automatic zero-setting or zero-tracking features shall be switched off or suppressed, for example by applying a small test load. The test load need not be greater than necessary to accomplish this suppression.

Before any test:

Stabilize the load cell under constant environmental conditions.

Test severity:

Reduction:	100 %	50 %
Number of half cycles:	1	2

Maximum allowable variations:

The difference between the measurement result due to the disturbance and the measurement result without the disturbance shall not exceed one minimum load cell verification interval, v_{min}, or the load cell shall detect and react to a significant fault.

Reference to IEC Publication:

IEC Publication 61000-4-11 (1994-06) Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests. Section 5.1 (Test levels – voltage dips and short interruptions), Section 8.2.1 (Execution of the test – voltage dips and short interruptions).

A.4.7.5 Bursts (electrical fast transients) (see 6.3.5)

Test procedure in brief:

This test consists of exposing the load cell to specified bursts of voltage spikes.

Test instrumentation:

In accordance with IEC 61000-4-4 (1995-01), No. 6.

Test set-up:

In accordance with IEC 61000-4-4 (1995-01), No. 7.

Test procedure:

In accordance with IEC 61000-4-4 (1995-01), No. 8.

Before any test:

Stabilize the load cell under constant environmental conditions.

The test shall be applied separately to:

a) power supply lines;

b) I/O circuits and communication lines, if any.

Test load:

During the test, the effect of any automatic zero-setting or zero-tracking features shall be switched off or suppressed, for example by applying a small test load. The test load need not be greater than necessary to accomplish this suppression.

Test severity:

Level 2 (in accordance with IEC 61000-4-4 (1995-01), No. 5).

Open circuit output test voltage for:

- power supply lines: 1 kV;
- I/O signal, data, and control lines: 0.5 kV.

Maximum allowable variations:

The difference between the measurement result due to the disturbance and the measurement result without the disturbance shall not exceed one minimum load cell verification interval, v_{min}, or the load cell shall detect and react to a significant fault.

Reference to IEC Publication:

IEC Publication 61000-4-4 (1995-01) Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test. Basic EMC publication.

A.4.7.6 Electrostatic discharge (see 6.3.5)

Test procedure in brief:

This test consists of exposing the load cell to specified direct and indirect electrostatic discharges.

Test generator:

In accordance with IEC 61000-4-2 (1999-05) Ed 1.1 Consolidated edition, No. 6.

Test set-up:

In accordance with IEC 61000-4-2 (1999-05) Ed 1.1 Consolidated edition, No. 7.

Test procedure:

In accordance with IEC 61000-4-2 (1999-05) Ed 1.1 Consolidated edition, No. 8.

Discharge methods:

1. This test includes the paint penetration method, if appropriate;
2. For direct discharges, the air discharge shall be used where the contact discharge method cannot be applied.

Before any test:

Stabilize the load cell under constant environmental conditions.

Discharge type:

At least 10 direct discharges and 10 indirect discharges shall be applied.

Time interval:

The time interval between successive discharges shall be at least 10 seconds.

Test load:

During the test, the effect of any automatic zero-setting or zero-tracking features shall be switched off or suppressed, for example by applying a small test load. The test load need not be greater than necessary to accomplish this suppression.

Test severity:

Level 3 (in accordance with IEC 61000-4-2 (1999-05) Ed 1.1 Consolidated edition, No. 5). DC voltage up to and including 6 kV for contact discharges and 8 kV for air discharges.

Maximum allowable variations:

The difference between the measurement result due to the disturbance and the measurement result without the disturbance shall not exceed one minimum load cell verification interval, v_{min}, or the load cell shall detect and react to a significant fault.

Reference to IEC Publication:

IEC Publication 61000-4-2 (1999-05) Ed 1.1 Consolidated edition, Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test.

A.4.7.7 Electromagnetic susceptibility (see 6.3.5)

Test procedure in brief:

This test consists of exposing the load cell to specified electromagnetic fields.

Test generator:

In accordance with IEC 61000-4-3 (1998-11) Ed 1.1 Consolidated edition, No. 6.

Test set-up:

In accordance with IEC 61000-4-3 (1998-11) Ed 1.1 Consolidated edition, No. 7.

Test procedure:

In accordance with IEC 61000-4-3 (1998-11) Ed 1.1 Consolidated edition, No. 8.

Before any test:

Stabilize the load cell under constant environmental conditions.

Electromagnetic field strength:

The load cell shall be exposed to electromagnetic fields of the strength and character as specified by the severity level.

Test load:

During the test, the effect of any automatic zero-setting or zero-tracking features shall be switched off or suppressed, for example by applying a small test load. The test load need not be greater than necessary to accomplish this suppression.

Test severity:

Level 2 (in accordance with IEC 61000-4-3 (1998-11) Ed 1.1 Consolidated edition, No. 6)

Frequency range:	26 MHz to 1 000 MHz;
Field strength:	3 V/m;
Modulation:	80 % AM, 1 kHz sine wave.

Maximum allowable variations:

The difference between the measurement result due to the disturbance and the measurement result without the disturbance shall not exceed one minimum load cell verification interval, v_{min}, or the load cell shall detect and react to a significant fault.

Reference to IEC Publication:

IEC Publication 61000-4-3 (1998-11) Ed 1.1 Consolidated edition, Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.

A.4.7.8 Span stability (see 6.3.6)
(not applicable to class A load cells)

Test procedure in brief:

This test consists of observing the variations of the load cell under sufficiently constant ambient conditions (i.e. ± 2 °C) before, at various intervals during, and after the load cell is subjected to any of the applicable tests contained in this Annex.

The load cell shall be disconnected from the mains power supply, or battery supply where fitted, two times for at least 8 hours during the period of test. The number of disconnections may be increased if the manufacturer specifies so or at the discretion of the approval authority in the absence of any such consideration.

For the conduct of this test, the manufacturer's operating instructions shall be considered.

The load cell shall be stabilized at sufficiently constant ambient conditions after switch-on for at least 5 hours, but at least 16 hours after any temperature or humidity tests have been performed.

Test duration:

The time necessary to carry out all the required tests in this Annex but not to exceed 28 days, whichever is shorter.

Time between measurements:

Between 1/2 day (12 hours) and 10 days (240 hours), with an even distribution of the measurements over the total duration of the test.

Test loads:

A minimum test load, D_{min}; the same test load shall be used throughout the test.

A maximum test load, D_{max}; the same test load shall be used throughout the test.

Number of measurements: At least 8.

Test sequence:

Identical test equipment and test loads shall be used throughout the test.

Stabilize all factors at sufficiently constant ambient conditions.

Each set of measurements shall consist of the following:

a) exercise the load cell by applying the maximum test load, D_{max}, three times, returning to the minimum test load, D_{min}, after each load application;

b) stabilize the load cell at the minimum test load, D_{min};

c) read the minimum test load output and apply the maximum test load, D_{max}. Read the maximum test load output at time intervals as near as possible to those specified in Table 6 in 5.2.3, and return to the minimum test load, D_{min}. Repeat this four more times for accuracy class B or two more times for accuracy classes C and D;

d) determine the span measurement result, which is the difference in output between the mean maximum test load outputs and the mean minimum test load outputs. Compare subsequent results with the initial span measurement result and determine the error.

Record the following data:

a) date and time (absolute, not relative);
b) temperature;
c) barometric pressure;
d) relative humidity;
e) test load values;
f) load cell outputs;
g) errors.

Apply all necessary corrections resulting from variations in temperature, pressure, etc. between the various measurements.

Allow full recovery of the load cell before any other tests are performed.

Maximum allowable variations:

The variation in the load cell span measurement results shall not exceed half the load cell verification interval or half the absolute value of the mpe for the test load applied, whichever is the greater on any of the measurements.

Where differences of results indicate a trend of more than half the allowable variation specified above, the test shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

A.5 Recommended test sequence

A.5.1 Test sequence

The recommended test sequence for each test temperature when all tests are carried out in the same force-generating system is shown in Figure A.1 (see page 30).

A.5.2 Test sequence for minimum dead load output return

The recommended test sequence for each test temperature for the minimum dead load output return (DR) and creep tests when carried out in a force-generating system different to that used for the load tests is shown in Figure A.2 (see page 30).

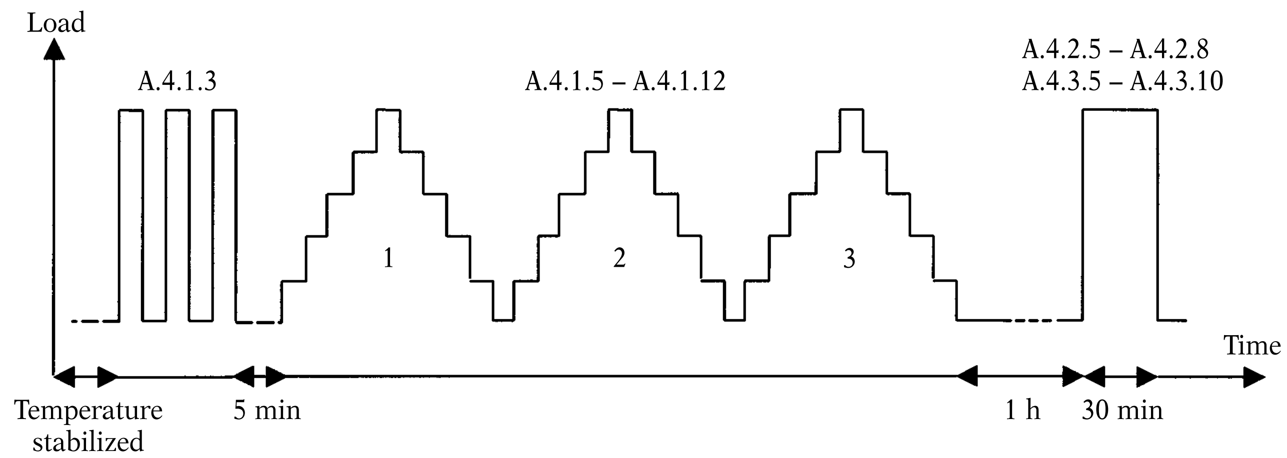

Figure A.1 Recommended test sequence for each test temperature when all tests are carried out in the same machine

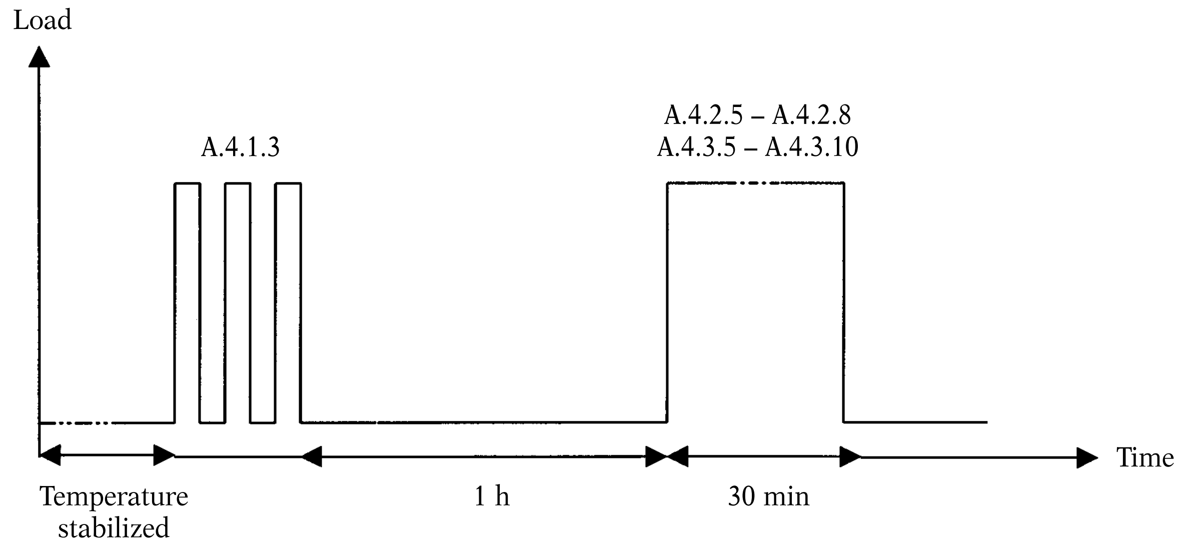

Figure A.2 Recommended test sequence for each test temperature for the minimum dead load output return (DR) and creep tests when carried out in a machine different from that used for the load tests

Annex B
(Informative)
Selection of load cell(s) for testing - a practical example

B.1 This Annex describes a practical example showing the complete procedure for the selection of test samples out of a load cell family.

B.2 Assume a family consisting of three groups of load cells, differing in class, maximum number of load cell verification intervals, n_{max}, and maximum capacities, E_{max}. The capacities, E_{max}, overlap between the groups according to the following example:

Group 1: Class C, n_{max} = 6 000, Y = 18 000, Z = 6 000
E_{max}: 50 kg, 100 kg, 300 kg and 500 kg

Group 2: Class C, n_{max} = 3 000, Y = 12 000, Z = 4 000
E_{max}: 100 kg, 300 kg, 500 kg, 5 000 kg, 10 t, 30 t and 50 t

Group 3: Class B, n_{max} = 10 000,Y = 25 000, Z = 10 000
E_{max}: 500 kg, 1 000 kg and 4 000 kg

B.2.1 Summarize and sort the load cells with respect to E_{max} and accuracy as follows:

Class n_{max} Group	Y Z	<--- lowest			E_{max}, kg v_{min}, kg			---> highest			
C3 3 000 2	12 000 4 000		100 0.0083	300 0.025	500 0.042			5 000 0.42	10 000 0.83	30 000 2.5	50 000 4.17
C6 6 000 1	18 000 6 000	50 0.0028	100 0.0055	300 0.0167	500 0.028						
B10 10 000 3	25 000 10 000				500 0.020	1 000 0.040	4 000 0.16				

B.2.2 Identify the smallest capacity load cells in each group to be tested, according to 7.3.4:

Class n_{max} Group	Y Z	<--- lowest E_{max}, kg ---> highest v_{min}, kg									
C3 3 000 2	12 000 4 000		100 0.0083	300 0.025	500 0.042			5 000 0.42	10 000 0.83	30 000 2.5	50 000 4.17
C6 6 000 1	18 000 6 000	50 0.0028	100 0.0055	300 0.0167	500 0.028						
B10 10 000 3	25 000 10 000				500 0.020	1 000 0.040	4 000 0.16				

In this example, select and identify:

C6 - 50 kg (full evaluation test required)

B10 - 500 kg (full evaluation test required)

Although load cell C3 - 100 kg is the smallest capacity in its group, its capacity falls within the range of other selected load cells having better metrological characteristics. Therefore, it is not selected.

B.2.3 **Begin with the group with the best metrological characteristics** (in this example, B10) and in accordance with 7.3.5, select the next largest capacity between 5 and 10 times that of the nearest smaller capacity load cell which has been selected. When no capacity meets this criterion, the selected load cell shall be that having the smallest capacity exceeding 10 times that of the nearest smaller capacity load cell which has been selected. Continue this process until all load cell capacities in the group have been considered.

Class n_{max} Group	Y Z	<--- lowest E_{max}, kg ---> highest v_{min}, kg									
C3 3 000 2	12 000 4 000		100 0.0083	300 0.025	500 0.042			5 000 0.42	10 000 0.83	30 000 2.5	50 000 4.17
C6 6 000 1	18 000 6 000	50 0.0028	100 0.0055	300 0.0167	500 0.028						
B10 10 000 3	25 000 10 000				500 0.020	1 000 0.040	4 000 0.16				

In this example, select and identify:

B10 - 4 000 kg (full evaluation test required)

B.2.4 **Move to the group with the next best characteristics** (in this example, C6) and, in accordance with 7.3.5, select the next largest capacity between 5 and 10 times that of the nearest smaller capacity load cell which has been selected. When no capacity meets this criterion, the selected load cell shall be that having the smallest capacity exceeding 10 times that of the nearest smaller capacity load cell which has been selected. Continue this process until all load cell capacities in the group have been considered.

Class n_{max} Group	Y Z	<--- lowest E_{max}, kg ---> highest v_{min}, kg									
C3 3 000 2	12 000 4 000		100 0.0083	300 0.025	500 0.042			5 000 0.42	10 000 0.83	30 000 2.5	50 000 4.17
C6 6 000 1	18 000 6 000	50 0.0028	100 0.0055	300 0.0167	500 0.028						
B10 10 000 3	25 000 10 000				500 0.020	1 000 0.040	4 000 0.16				

In this example, **there is no change** to the load cells selected. The capacities of the load cells C6 - 300 kg and C6 - 500 kg exceed the capacity of the load cell C6 - 50 kg by greater than 5 times but not greater than 10 times. However, a 500 kg load cell of better metrological characteristics (from group B10) has already been selected. Therefore, in order to minimize the number of load cells to be tested according to 7.3.1, neither cell is selected.

B.2.5 **Again, and repeating this process until all groups have been considered, move to the group with the next best characteristics** (in this example, C3) and in accordance with 7.3.5, select the next largest capacity between 5 and 10 times that of the nearest smaller capacity load cell which has been selected. When no capacity meets this criterion, the selected load cell shall be that having the smallest capacity exceeding 10 times that of the nearest smaller capacity load cell which has been selected. Continue this process until all load cell capacities in the group and all groups have been considered.

Class n_{max} Group	Y Z	<--- lowest			E_{max}, kg v_{min}, kg			---> highest			
C3 3 000 2	12 000 4 000		100 0.0083	300 0.025	500 0.042			5 000 0.42	10 000 0.83	30 000 2.5	50 000 4.17
C6 6 000 1	18 000 6 000	50 0.0028	100 0.0055	300 0.0167	500 0.028						
B10 10 000 3	25 000 10 000				500 0.020	1 000 0.040	4 000 0.16				

In this example, select and identify:

C3 - 30 000 kg (full evaluation test required)

Proceeding from smallest to largest capacity, the only capacity of load cell which is greater than 5 times the capacity of an already selected load cell but less than 10 times that capacity is the C3 - 30 000 kg load cell.

Since the capacity of the C3 - 50 000 kg load cell does not exceed 5 times the capacity of the next smaller selected load cell, which is C3 - 30 000 kg, according to 7.3.3 it is deemed to be approved.

B.2.6 After completing steps B.2.2 to B.2.5 and identifying the load cells, compare load cells of the same capacity from different groups. Identify the load cells with the highest accuracy class and highest n_{max} in each group (see shaded portion of table below). For those load cells of the same capacity but from different groups, identify only the one with the highest accuracy class and n_{max} and lowest v_{min}.

Class n_{max} Group	Y Z	<--- lowest			E_{max}, kg v_{min}, kg			---> highest			
C3 3 000 2	12 000 4 000		100 0.0083	300 0.025	500 0.042			5 000 0.42	10 000 0.83	30 000 2.5	50 000 4.17
C6 6 000 1	18 000 6 000	50 0.0028	100 0.0055	300 0.0167	500 0.028						
B10 10 000 3	25 000 10 000				500 0.020	1 000 0.040	4 000 0.16				

Inspect the values of v_{min}, Y, and Z for all cells of the same capacity.

If any load cell of the same capacity has a lower v_{min} or higher Y than the identified load cell, that load cell (or load cells) is also liable for partial evaluation testing, specifically the conduct of additional temperature effect on minimum dead load, E_{min} and barometric pressure effect tests.

If any load cell of the same capacity has a higher Y than the selected load cell, that load cell (or load cells) is also liable for partial evaluation testing, specifically the conduct of additional creep and DR tests.

In this example, **the load cells identified above also have the best characteristics of lowest v_{min}, highest Y and highest Z.** This is normally the case, but not always.

B.2.7 If applicable, select the load cell for humidity testing in accordance with 7.3.6, that being the load cell with the most severe characteristics, for example the greatest value of n_{max} or the lowest value of v_{min}.

In this example, the load cell with the greatest value of n_{max} or the lowest value of v_{min} is the same load cell, therefore select:

B10 - 500 kg (humidity test required)

Note: The other B10 load cells also possess the same qualifications and are possible choices. The 500 kg load cell was chosen because it is the smallest of the applicable B10 capacities. Although the C6 - 50 kg load cell has the lowest v_{min} of 0.0028, the B10 load cells have the highest n_{max}, highest accuracy class, and the highest Y and Z.

B.2.8 If applicable, select the load cell for the additional tests to be performed on load cells equipped with electronics in accordance with 7.3.6, that being the load cell with the most severe characteristics, for example the greatest value of n_{max} or the lowest value of v_{min}.

In this example, no load cell in the family is equipped with electronics.

B.2.9 Summarizing, the load cells selected for test are:

Summary	*Selected cells*
Load cells requiring full evaluation test	C6 - 50 kg B10 - 500 kg B10 - 4 000 kg C3 - 30 000 kg
Load cells requiring partial evaluation test	None
Load cell to be tested for humidity	B10 - 500 kg
Load cells equipped with electronics for additional tests	None

Annex C
(Mandatory)
Test report format - General

C.1 Introduction

C.1.1 The objective of the *Test Report Format* is to provide a standard format for the presentation of test results obtained when evaluating a load cell for conformity with the test procedures described in OIML R 60.

C.1.2 In the framework of the *OIML Certificate System for Measuring Instruments*, applicable to load cells in conformity with R 60 (2000 edition), use of this test report format is mandatory, in French and/or in English, with translation into the national languages of the countries issuing such certificates, if appropriate.

C.1.3 Some of the tests may have to be repeated several times and reported using several identical sheets; therefore, report pages must be numbered in the space provided at the top of each page, completed by the indication of the total number of pages.

C.2 Calculation procedures

C.2.1 In order to facilitate a comparison of the reports established in English and in French, the same abbreviations (those of the English language) are used in both versions; the meanings of these abbreviations is given whenever appropriate.

In testing and evaluating load cells for pattern evaluation, it is recognized that the test apparatus and practices used by the various laboratories will be different. OIML R 60 allows for these variations and still provides a method for testing, recording and calculating results that are readily understandable by other knowledgeable parties reviewing the data.

In order to achieve this ease of comparability it is necessary that those persons conducting the tests use a common system for recording data and calculating results.

Thus, it is essential that the calculation procedures below be reviewed and followed closely in the completion of this test report.

C.2.2 Load cell errors (E_L = Error Load test)

C.2.2.1 Complete a Table D.1 (3 runs) for each test temperature, calculate the averages and record in the right hand column. When five runs are necessary, use Table D.1 (5 runs).

C.2.2.2 Determine the conversion factor, f, which is the number of indicated units per load cell verification interval, v, and is used to convert all “indicated units” to “v”. It is determined from the test data averages of the increasing load tests at the initial 20 °C nominal test temperature.

C.2.2.3 If a test load corresponding to 75 % of the measuring range for the load cell under test (i.e., 2 250 divisions for a 3 000 division cell, which is D_{min} plus 75 % of the difference between D_{max} and D_{min}) is not included in the test loads used in Table D.1, interpolate between the adjacent upper and lower values of the averages of all three test runs and record in Table D.2 (see 5.2.2).

C.2.2.4 Calculate the difference between the average indication on the increasing load test runs at 75 % of the difference between D_{max} and D_{min} and the indication at D_{min}. Divide the result (to five significant figures) by the number of verification intervals (75 % n) for that load to obtain the conversion factor, f, and record in the tables that follow.

$$f = [\text{indication at 75 \% of } (D_{max} - D_{min}) - \text{indication at } D_{min}] / (0.75 \times n)$$

C.2.2.5 Enter the average test indications of the tests at the temperatures following the initial test at a nominal 20 °C in Table D.2. In recording this data, indicate a "no test load" indication as "0". This may require subtracting the "no load indication" from the "test load indication" so that the first entry in the column is "0". These "0's" have been preprinted on the form to clarify that a dead load condition is recorded as "0".

C.2.2.6 Calculate the reference indication, R_i, by converting the net test load, in mass units, to "v" units, by multiplying by the conversion factor, f, for each test load and recording in the 2nd column in Table D.2.

$$R_i = [(\text{test load} - D_{min}) / (D_{max} - D_{min})] \times n \times f$$

where f = indicated units/v

C.2.2.7 In Table D.2 calculate the difference between the average test indication and the reference indication for each test load at each test temperature and divide by f to obtain the error, E_L, for each test load in terms of v.

$$E_L = (\text{average test indication} - \text{reference indication}) / f$$

C.2.2.8 Compare E_L with the corresponding mpe for each test load.

C.2.3 Repeatability error (E_R = Error Repeatability)

C.2.3.1 Enter data in Table D.3.

C.2.3.2 Calculate the maximum difference between the test indications on Form D.1 and divide by f to obtain the repeatability error, E_R, in terms of v.

$$E_R = (\text{maximum indication} - \text{minimum indication}) / f$$

C.2.3.3 Compare E_R with the absolute value of the corresponding mpe for each test load.

C.2.4 Temperature effects on minimum dead load output (MDLO) (C_M = Change MDLO)

C.2.4.1 Enter in Table D.4 the average indication for the initial minimum test load, D_{min}, for each test temperature from Table D.1.

C.2.4.2 Calculate the difference between the average test indications for each temperature in sequence and divide by f to obtain the change in terms of v.

$$C_M = (\text{indication at } T_2 - \text{indication at } T_1) / f$$

C.2.4.3 Divide C_M by $(T_2 - T_1)$ and multiply the result by 5 to determine the change in v per 5 °C.

C.2.4.4 Multiply the result by the number of v_{min} per v in terms of mass (as stated by the manufacturer); this result must not exceed p_{LC}.

$$p_{LC} \leq [(D_{max} - D_{min}) / n] / v_{min}$$

C.2.5 Creep and minimum dead load output return (DR)

(C_C = Creep, expressed in terms of the load cell verification interval, v)

(C_{DR} = DR, expressed in terms of the load cell verification interval, v)

C.2.5.1 From the test indications recorded in Table D.5, calculate the greatest difference between the initial indication obtained at the test load after the stabilization period and any indication obtained over the 30-minute test period and divide by f (f must be recalculated if D_{max} or D_{min} for this test differ from those in the load test using the "load cell errors" procedure, C.2.2) to obtain the creep error, C_C, in terms of v.

$$C_C = (\text{indication} - \text{initial indication}) / f$$

C.2.5.2 C_C must not exceed 0.7 times the absolute value of the mpe for the test load.

C.2.5.3 Calculate the difference between the test indications obtained at 20 minutes and 30 minutes after the initial load application and divide by f to obtain the creep error, C_C (30 – 20), in terms of v.

$$C_C\ (30 - 20) = (\text{test indication at 30 minutes} - \text{test indication at 20 minutes}) / f$$

C.2.5.4 C_C (30 – 20) must not exceed 0.15 times the absolute value of the mpe for the test load.

C.2.5.5 Calculate the difference between the test indication at the minimum test load, D_{min}, before and after the creep test and divide by f to obtain the minimum dead load output return, C_{DR}, error in terms of v.

$$C_{DR} = (\text{minimum test load indication}_2 - \text{minimum test load indication}_1) / f$$

C.2.5.6 If the time intervals specified in Table 6 have been met, C_{DR} must not exceed 0.5 v.

If the actual time is between 100 % and 150 % of the specified time, then C_{DR} must not exceed:

$$0.5\ (1 - (x - 1)) \text{ in units of v, where } x = \text{actual time/specified time}$$

C.2.5.7 OIML R 76 requires calculations involving the minimum dead output return, DR, value to be carried out. Whereas C_{DR} expresses the minimum dead load output return in terms of v, the value of DR is expressed in units of mass (g, kg or t).

C.2.5.8 Calculate the minimum dead load output return, DR, value as follows:

$$DR = (E_{max} \times C_{DR}) / n_{max}$$

C.2.5.9 The value of DR must not exceed 0.5 v, expressed in units of mass.

C.2.5.10 Regardless of the value declared by the manufacturer for the apportionment factor, p_{LC}, the mpe for creep shall be determined from Table 5 using the apportionment factor, p_{LC} = 0.7 (see 5.3.1.1).

C.2.6 Barometric pressure effects[1] (C_P = Change Barometric Pressure)

C.2.6.1 From the test indications recorded in Table D.6, calculate the difference between the indications for each pressure and divide by f to obtain the change, C_P, in terms of v.

$$C_P = (\text{indication at } P_2 - \text{indication at } P_1) / f$$

C.2.6.2 Divide by $(P_2 - P_1)$ to determine the change in v per kilopascal (kPa).

C.2.6.3 Multiply the result by $[(D_{max} - D_{min}) / n] / v_{min}$ in terms of mass (as stated by the manufacturer) to obtain the result in terms of v_{min} / kPa.

C.2.6.4 The result must not exceed 1.

C.2.7 Humidity effects[2] **(CH or no mark)** (C_{Hmin} = Change Humidity effect min; C_{Hmax} = Change Humidity effect max)

C.2.7.1 From the test indications recorded in Table D.7, calculate the difference between the initial indications for the minimum test load, D_{min}, before and after the damp heat test and divide by f (f must be recalculated if for this test D_{max} or D_{min} differ from those in the "load cell errors" procedure, C.2.2) to obtain the change, C_{Hmin}, in terms of v.

$$C_{Hmin} = [(\text{indication at } D_{min})_{after} - (\text{indication at } D_{min})_{before}] / f$$

C.2.7.2 C_{Hmin} must not exceed 0.04 n_{max}.

C.2.7.3 Calculate the average indications at D_{min} and D_{max} (see 5.5.3.1 and A.4.5) for the required number of test indications, before and after the damp heat test. Subtract the average D_{min} indication from the average D_{max} indication for each test and then calculate the difference between the results before and after the damp heat test. Divide the difference by f to obtain the change, C_{Hmax}, in terms of v.

$$C_{Hmax} = [(\text{indication at } D_{max} - \text{indication at } D_{min})_{after} - (\text{indication at } D_{max} - \text{indication at } D_{min})_{before}] / f$$

---

[1] This test may not be necessary depending on the design of the load cell.

[2] This test is not necessary if the load cell is marked NH or SH.

C.2.7.4 C_{Hmax} must not exceed 1 v.

C.2.8 Humidity effects[3] (SH)

Report load test errors at different temperatures and humidity conditions using Forms D.1, then indicate the results in Table D.8 utilizing the procedure contained within "load cell errors" procedure, C.2.2, in a manner similar to that used for the preparation of Table D.2.

C.3 Additional tests for load cells equipped with electronics

C.3.1 Warm-up time

C.3.1.1 Enter data on Form D.11.

C.3.1.2 Span is the result of subtraction of the indication at the minimum test load, D_{min}, from the indication at the maximum test load, D_{max}.

C.3.1.3 Change is the difference between the span and the initial run span.

C.3.2 Power voltage variations

C.3.2.1 Enter data on Form D.12.

C.3.2.2 Perform load tests and record results utilizing Form D.12.

C.3.2.3 Calculate reference indications in accordance with the "load cell errors" procedure, C.2.2.

C.3.2.4 Indicate results on Form D.12.

C.3.3 Short-time power reductions

C.3.3.1 Enter data on Form D.13.

C.3.3.2 Calculate the difference, which is:

(indication with disturbance, in units – indication without disturbance, in units) / conversion factor, f .

C.3.3.3 Indicate results on Form D 13.

---

[3] This test is not necessary if the load cell is marked NH or CH or has no humidity marking.

C.3.4 Bursts (electrical fast transients)

C.3.4.1 Enter data on Forms D.14.1 and D.14.2.

C.3.4.2 Calculate the difference, which is:

(indication with disturbance, in units – indication without disturbance, in units) / conversion factor, f.

C.3.4.3 Indicate results on Forms D.14.1 and D.14.2.

C.3.5 Electrostatic discharge

C.3.5.1 Enter data on Forms D.15.1 and D.15.2.

C.3.5.2 Calculate the difference, which is:

(indication with disturbance, in units – indication without disturbance, in units) / conversion factor, f.

C.3.5.3 Indicate results on Forms D.15.1 and D.15.2.

C.3.5.4 Provide test point information on Form D.15.3.

C.3.6 Electromagnetic susceptibility

C.3.6.1 Enter data on Form D.16.1.

C.3.6.2 Calculate the difference, which is:

(indication with disturbance, in units – indication without disturbance, in units) / conversion factor, f.

C.3.6.3 Indicate results on Form D.16.1.

C.3.6.4 Provide test set-up information on Form D.16.2.

C.3.7 Span stability

C.3.7.1 Enter data on Forms D.17.1.1 (3 runs) to D.17.1.1 (5 runs).

C.3.7.2 Calculate averages and record on Forms D.17.1.1 (3 runs) to 17.1.1 (5 runs).

C.3.7.3 Indicate results on Form D.17.2.

C.4 General notes

C.4.1 Absolute (not relative) time shall be recorded.

C.4.2 The calculations made do not include the application of 5.2.1. To ensure that these requirements are met, the calculations should be carried out using lower n values than the n_{max} specified.

C.4.3 It should be sufficient to carry out the calculations with:

$$n = n_{max} - 500 \text{ and } n = n_{max} - 1\,000 \text{ (provided } 500 < n).$$

C.4.4 Check to make certain that: $v_{min} < v$

$$v_{min} < (D_{max} - D_{min}) / n_{max}$$

C.4.5 Check calculations not only at n_{max} but at (applying 5.2.1):

$$n_{max} - 500$$

$$n_{max} - 1\,000$$

C.4.6 Indicate the result in the "Summary of test" portion of the test report.

C.4.7 The testing laboratory may submit any graphs or plots depicting the test results on the following pages of this report.

Note: For example, Figure C.1 gives a sample plot depicting the combined errors versus applied load.

C.4.8 When reporting values for individual test data, the data should be truncated to two significant digits to the right of the decimal place and reported in load cell verification intervals, v.

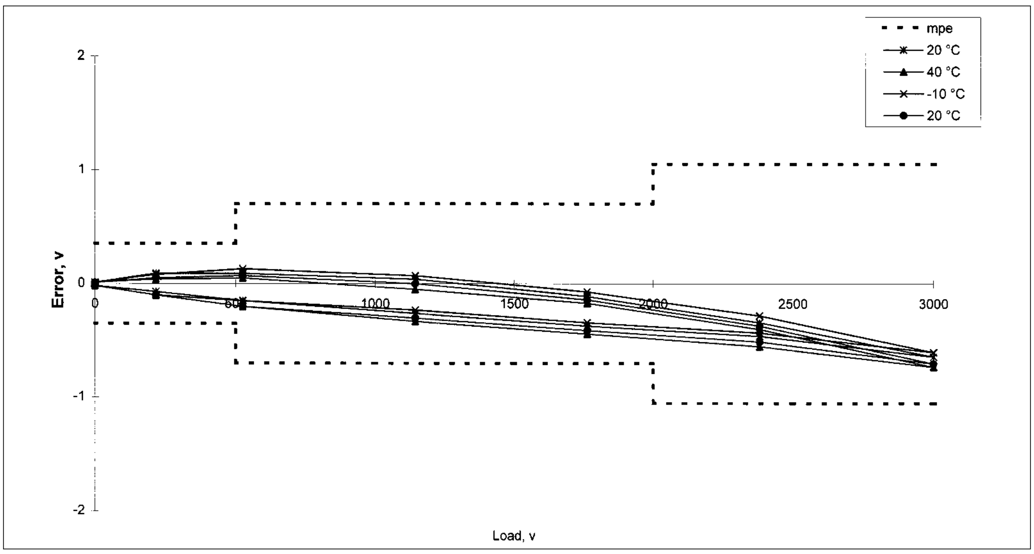

Figure C.1 Example of an error envelope

Table C.1 List of symbols

Symbol	*Description*	*Reference*
0	no test load indication	C.2.2.5
C_C	creep magnitude, expressed in terms of v	C.2.5
$C_C(30 – 20)$	difference between output at 30 and at 20 minutes during creep test	C.2.5
C_{DR}	minimum dead load output return, expressed in terms of v	C.2.5
C_{Hmax}	humidity effect on maximum test load output, expressed in terms of v	C.2.7
C_{Hmin}	humidity effect on minimum test load output, expressed in terms of v	C.2.7
C_M	temperature effect on minimum dead load output, expressed in terms of v	C.2.4
C_P	barometric pressure effect, expressed in terms of v	C.2.6
D_{max}	maximum load of the measuring range (maximum test load)	2.3.6
D_{min}	minimum load of the measuring range (minimum test load)	2.3.11
DR	minimum dead load output return, expressed in mass units	2.3.9
E_L	load cell error, expressed in terms of v	C.2.2
E_{max}	maximum capacity	2.3.5
E_{min}	minimum dead load	2.3.8
E_R	repeatability error, expressed in terms of v	C.2.3
f	conversion factor, number of indicated units per verification interval, v	C.2.2.2
mpe	maximum permissible error	2.4.9
n	number of load cell verification intervals	2.3.12
n_{max}	maximum number of load cell verification intervals	2.3.7
p_{LC}	apportionment factor	2.4.2
R_i	reference indication (net test load), expressed in indication units	C.2.2.6
T_1, T_2	$temperature_1$, $temperature_2$	C.2.4.2
v	load cell verification interval	2.3.4
v_{min}	minimum load cell verification interval	2.3.10
Y	relative v_{min}, $Y = E_{max} / v_{min}$	2.3.14, 4.6.6.2
Z	relative DR, $Z = E_{max} / (2 \times DR)$	2.3.13, 4.6.6.2

Table C.2 Summary of formulae contained within calculation procedures

Symbol	*Formula*
C_C	C_C = (indication – initial indication) / f
$C_C(30 – 20)$	$C_C(30 – 20)$ = (test indication at 30 minutes – test indication at 20 minutes) / f
C_{DR}	C_{DR} = (minimum test load $indication_2$ – minimum test load $indication_1$) / f
C_{Hmin}	C_{Hmin} = [(indication at $D_{min})_{after}$ – (indication at $D_{min})_{before}$] / f
C_{Hmax}	C_{Hmax} = [(indication at D_{max} – indication at $D_{min})_{after}$ – (indication at D_{max} – indication $D_{min})_{before}$] / f
C_M	C_M = (indication at T_2 – indication at T_1) / f
C_P	C_P = (indication at P_2 – indication at P_1) / f
DR	$DR = E_{max} \times C_{DR} / n_{max}$
E_L	E_L = (average test indication – reference indication) / f
E_R	E_R = (maximum indication – minimum indication) / f
f	f = [indication at 75 % of ($D_{max} – D_{min}$) – indication at D_{min})] / (0.75 × n) [see *Note 2*]
R_i	$R_i = [(\text{test load} – D_{min}) / (D_{max} – D_{min})] \times n \times f$

Notes: *1* Observe extreme caution by referring to calculation procedure for correct application of these formulae.

2 Use with initial 20 °C ascending load run only. Refer to 5.2.2.

Annex D
(Mandatory)
Test report format - Forms

Testing authority

Name: ______________________

Address: ______________________

Contact information: ______________________

Applicant/Manufacturer information

Application no.: ______________________
Application date: ______________________
Model designation: ______________________

Manufacturer: ______________________
Address: ______________________

Applicant: ______________________
Address: ______________________

Representative: ______________________
(name, telephone) ______________________

Instrument category: Load cell: ______________ Documentation no.: ______________

Information concerning the pattern

Accuracy class: ☐ A ☐ B ☐ C ☐ D

Maximum number of load cell verification intervals (n_{max}): ______________

Direction of loading: (for load cell characterization, see 4.6.3)

☐ Tension ☐ Beam (shear) ☐ Compression
☐ Universal ☐ Beam (bending)

Safe load limit (Lim): ______________ Apportionment factor, p_{LC} (see *Note*): ______________

Limits of working temperature: (only if other than – 10 °C to + 40 °C, see 5.5.1.1)

Upper: __________ °C Lower: __________ °C

Power voltage: V_{min}: __________ V V_{max}: __________ V

or V __________ V ☐ AC ☐ DC Recommended: ☐ AC ☐ DC

Humidity evaluation symbol: NH ☐ Yes ☐ No
SH ☐ Yes ☐ No
CH or no markings ☐ Yes ☐ No

Electronic load cell: ☐ Yes ☐ No

Note: This value of p_{LC} is assumed to be 0.7 unless otherwise declared by the manufacturer.

Information concerning the pattern (continued)

Application no.: ____

Specify other conditions that must be observed to obtain the specified performance (for example, electrical characteristics of the load cell):

Various designs within model range:

Maximum capacity E_{max} (g, kg or t)	Minimum load cell verification interval v_{min} (g, kg or t)	Minimum dead load E_{min} (g, kg or t)	Maximum number of load cell intervals n_{max}	Minimum dead load output return DR (g, kg or t)

All values in this table are taken from documentation pages ______________________________________.

DR information required only when applicable.

Load cell(s) submitted:

Model designation	Serial number	E_{max}

Secondary equipment (specify load adapters, etc.):

Remarks:

General information concerning test conditions

Ref.: A.3

Application no.: ____________________

Load cell model: ____________ Serial no.: ____________ E_{max}: ____________

n_{max}: ____________ v_{min}: ____________ DR (if applicable): ____________

Force-generating system - description: ____________________
(see *Note)*

Minimum test load ____________________

Indicating instrument - description: ____________________

Environmental equipment - description: ____________________

Temperature: ____________ °C

Relative humidity: ____________ %

Barometric pressure: ____________ kPa

Test location: ____________________

Acceleration of gravity at test location: ____________ m/sec^2

Evaluator: ____________________

Note: Include information concerning accuracy (for example, accredited laboratory).

Summary of the test

Application no.: ____________________

Load cell model: ____________________

Serial no.: ____________________

E_{max}: ____________________ n_{max}: ____________________

v_{min}: ____________________ DR: ____________________

Force-generating system: ____________________ p_{LC}: ____________________

Indicating instrument: ____________________

Evaluator: ____________________

No.	Test description	Passed	Failed	Report page	Remarks
D.2	Load cell errors (E_L)				
D.3	Repeatability errors (E_R)				
D.4	Temperature effects on MDLO (C_M)				
D.5	Creep (C_C)				
D.5	DR (C_{DR})				(see *Note 2*) DR =
D.6	Barometric pressure effects (C_P)				
D.7	Humidity effects (CH or no mark) (C_{Hmin})				
D.7	Humidity effects (CH or no mark) (C_{Hmax})				
D.8	Humidity effects (SH)				
D.9	Marking requirements				
D.10	Load cells equipped with electronics				
D.11	Warm-up time				
D.12	Power voltage variations				
D.13	Short time power reductions				
D.14	Bursts (electrical fast transients)				
D.15	Electrostatic discharge				
D.16	Electromagnetic susceptibility				
D.17	Span stability				

The following table checks the required calculations as per the *General notes* provisions of C.3:

No.	Test description	n_{max} (g, kg or t)		n_{max} – 500 (g, kg or t)		n_{max} – 1 000 (g, kg or t)	
		+	–	+	–	+	–
D.2	Check that $v_{min} \leq \frac{D_{max} - D_{min}}{n_{max}}$						

Worst case figure for minimum dead load output return error (in mass units) = DR = ____________ see *Note 3*

Notes:
1 Enter "NA" for "the test is not applicable".
2 Record error to accommodate OIML R 76.
3 This DR value is used in association with OIML R 76.

Form D.1 (3 runs) Load test data (E_L)

Ref.: A.4.1.1 to A.4.1.11. Complete one sheet for each test temperature, one for each humidity (SH) test in A.4.6, and when applicable, one for each electronics power voltage in A.4.7.3.

Application no.: ______________________

Load cell model: ______________________

Serial no.: ______________________

E_{max}: ______________________

n_{max}: ______________________

v_{min}: ______________________

p_{LC}: __________ DR: __________

Force-generating system: ______________________

Indicating instrument: ______________________

Evaluator: ______________________

	At start	At end	
Date:			
Temperature:			°C
Relative humidity:			%
Barometric pressure:			kPa
Indicator temperature:			°C

Electronics power voltage (when applicable): __________ V

Table D.1 (3 runs)

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )	Repeatability error ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time		
0								
0								
0								
0								
0							*	

Notes: *1* * = Average initial minimum test load indication.
2 Absolute (not relative) time shall be recorded.

Form D.1 (5 runs) Load test data (E_L)

Ref.: A.4.1.1 to A.4.1.11. Complete one sheet for each test temperature, one for each humidity (SH) test in A.4.6, and when applicable, one for each electronics power voltage in A.4.7.3.

Application no.: ______________________

Load cell model: ______________________

Serial no.: ______________________

E_{max}: ______________________

n_{max}: ______________________

v_{min}: ______________________

p_{LC}: ____________ DR: ____________

Evaluator: ______________________

	At start	At end	
Test temperature:			°C
Relative humidity:			%
Barometric pressure:			kPa
Indicator temperature:			°C

Electronics power voltage (when applicable): ____________ V

Force-generating system: ______________________ Indicating instrument: ____________

Table D.1 (5 runs)

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )	Repeatability error ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time		
0												
0												
0												
0												
0											*	

Notes: *1* * = Average initial minimum test load indication.

2 Absolute (not relative) time shall be recorded.

Form D.2 Load cell errors (E_L) calculation

Ref.: 5.1.1; A.4.1.12 to A.4.1.14; C.2.2.

Application no.: ____________________

Load cell model: ____________________

Serial no.: ____________________

E_{max}: ____________________

n_{max}: ____________________

v_{min}: ____________________

p_{LC}: __________ DR: __________

Force-generating system: ____________________

Indicating instrument: ____________________

Evaluator: ____________________

	At start	At end	
Date:			
Temperature:			°C
Relative humidity:			%
Barometric pressure:			kPa
Indicator temperature:			°C

Conversion factor, f: ____________________

75 % test load (g, kg or t): ____________________

Reference indication at 75 % test load: ____________________

Table D.2

Test load (g, kg or t)	Reference indication ( )	. . . . °C (20 °C)		. . . . °C (40 °C)		. . . . °C (– 10 °C)		. . . . °C (20 °C)		mpe (v)
		Indication ( )	Error (E_L) (v)	Indication ( )	Error (E_L) (v)	Indication ( )	Error (E_L) (v)	Indication ( )	Error (E_L) (v)	
0	0	0		0		0		0		

Minimum test load, D_{min}: ____________________ PASS: ☐ FAIL: ☐

Notes:

1 Load/reference indications: if a 75 % load point was not obtained, a straight line interpolation between the adjacent higher and lower load point indications is used (see 5.2.2 and calculation procedures in C.2.2).

2 Error, E_L: the difference between the test indication and the reference indication divided by the conversion factor, f.

3 Test load values are values above minimum test load, D_{min}.

Form D.3 Repeatability error (E_R) calculation

Ref.: 5.4; A.4.1.13; C.2.3.

Application no.: ____________________

Load cell model: ____________________

Serial no.: ____________________

E_{max}: ____________________

n_{max}: ____________________

v_{min}: ____________________

p_{LC}: __________ DR: __________

Force-generating system: ____________________ Conversion factor, f: ____________________

Indicating instrument: ____________________

Evaluator: ____________________

Table D.3

Test load (g, kg or t)	. . . . °C (20 °C)		. . . . °C (40 °C)		. . . . °C (– 10 °C)		. . . . °C (20 °C)		mpe (v)
	Repeatability error ( )	Repeatability error (v)	Repeatability error ( )	Repeatability error (v)	Repeatability error ( )	Repeatability error (v)	Repeatability error ( )	Repeatability error (v)	

PASS: ☐ FAIL: ☐

Note: Error, E_R: the maximum difference between the three test indications divided by the conversion factor, f (classes C and D) or the maximum difference between the five test indications divided by the conversion factor, f (classes A and B).

Form D.4 Temperature effects on MDLO (C_M) calculation

Ref.: 5.5.1.3; A.4.1.14; C.2.4.

Application no.: ______________________

Load cell model: ______________________

Serial no.: ______________________

E_{max}: ______________________

n_{max}: ______________________

v_{min}: ______________________

p_{LC}: __________ DR: __________

Force-generating system: ______________________ Conversion factor, f: ______________________

Indicating instrument: ______________________

Evaluator: ______________________

Table D.4

Temperature °C	Indication ( )	Change (C_M) (v)	Change (v_{min} / . . . . °C)	mpc (v_{min} / . . . . °C)
				p_{LC}
				p_{LC}
				p_{LC}

PASS: ☐ FAIL: ☐

Notes: *1* MDLO: minimum dead load output.

2 Indication: the average initial minimum test load indication obtained from Table D.1.

3 The maximum permissible change (mpc) allowed is: (v_{min} / 5 °C) for classes B, C, and D; (v_{min} / 2 °C) for class A.

4 Change, C_M (v): the difference between the observed indications, and the indications at the prior temperature, divided by the conversion factor, f.

Form D.5 Creep (C_C) and DR (C_{DR})

Ref.: 5.3.1, 5.3.2; A.4.2, A.4.3. Complete one sheet for each test temperature.

Application no.: ____________________

Load cell model: ____________________

Serial no.: ____________________

E_{max}: ____________________

n_{max}: ____________________

v_{min}: ____________________

p_{LC}: __________ DR: __________

Force-generating system: ____________________

Indicating instrument: ____________________

Evaluator: ____________________

	At start	At end	
Date:			
Temperature:			°C
Relative humidity:			%
Barometric pressure:			kPa
Indicator temperature:			°C

Conversion factor, f: ____________________

Table D.5

	Test load (g, kg or t)	Indication ( )	Barometric pressure	Time	Change (v)	mpc (v)	
Exercise cells	0						
These rows may							
be omitted for a	0						
load sequence as							
shown in	0						
Figure A.2							
	0						
(*) ®	0						← initial “no load” indication
Fill in time ®	Record time of initial loading →						
(**) ®							← initial “load” indication
Constant							
maximum							
test load,							
D_{max}							
Fill in time ®	Record time of initial unloading →						
(***) ®	0						← initial indication
These rows	0						
are for	0						
reference	0						
purposes only	0						
	0						
	30 – 20 minute creep difference in units:						

DR (v):		30 minute creep:	PASS:		FAIL:	
actual time (s):		30 – 20 minute creep difference:	PASS:		FAIL:	
specified time (s):		DR < 0.5 v:	PASS:		FAIL:	
mpc for DR (v):		MDLOR within DR requirements:	PASS:		FAIL:	

Notes:

1 Change (v) for creep: the observed indication minus the initial "load" indication (**) divided by the conversion factor, f.

2 Determine the difference between the reading obtained at 20 minutes and the reading obtained at 30 minutes (see 5.3.1).

3 Change (v) for DR: the initial indication (***) minus the initial "no load" indication (*) divided by the conversion factor, f.

4 Absolute (not relative) time shall be recorded.

Form D.6 Barometric pressure effects (C_P)

Ref.: 5.5.2; A.4.4.

Application no.: ______________________

Load cell model: ______________________

Serial no.: ______________________

E_{max}: ______________________

n_{max}: ______________________

v_{min}: ______________________

p_{LC}: __________ DR: __________

Force-generating system: ______________________

Indicating instrument: ______________________

Evaluator: ______________________

	At start	At end	
Date:			
Temperature:			°C
Relative humidity:			%
Barometric pressure:			kPa
Indicator temperature:			°C

Conversion factor, f: ______________________

Table D.6

Pressure (kPa)	Indication ( )	Time	Change (v)	Change (v_{min} / kPa)	mpc (v_{min} / kPa)
			0	0	0
					1
					1
					1
					1

PASS: ☐ FAIL: ☐

Remarks:

Notes: *1* Change (v_{min} / kPa): the difference between the observed indication and the initial indication divided by the conversion factor, f.

2 Although A.4.4 specifies a change of only 1 kPa for this test, additional measurements may be taken.

3 Absolute (not relative) time shall be recorded.

Form D.7 Humidity effects (CH or no mark)

Ref.: 5.5.3.1; A.4.5.

Application no.:			At start	At end	
Load cell model:		Date:			
Serial no.:		Temperature:			°C
E_{max}:		Relative humidity:			%
n_{max}:		Barometric pressure:			kPa
v_{min}:		Indicator temperature:			°C
p_{LC}:	DR:	Conversion factor, f:			
Force-generating system:		Conditions during damp heat, cyclic test:			
Indicating instrument:		Chamber temp. (high): ______ °C	Relative humidity: ______ %		
Evaluator:		Chamber temp. (low): ______ °C	Relative humidity: ______ %		

Table D.7

	Test load (g, kg or t)	Before humidity test		After humidity test		Change (v)	mpc (v)
		Indication ( )	Time	Indication ( )	Time		
	0						
	0						
	0						
	0						
¤	0						
‡							
¤	0						
‡							
¤	0						
‡							
¤	0						
‡							
¤	0						
‡							
¤	0						
	Average (¤)						⇦ ≤ 4 % n_{max}
	Average (‡)						
	Averages difference (*)						1.0 v

(¤) Indications at minimum test load — Change (¤), C_{Hmin}: PASS: ☐ FAIL: ☐

(‡) Indications at maximum test load (see *Note 3*) — Change (*), C_{Hmax}: PASS: ☐ FAIL: ☐

(*) Average, see 5.5.3.1 and C.2.7

Notes:
1 This test is not necessary if the load cell is marked NH or SH.
2 Change (v): the difference between the after indication and the before indication divided by the conversion factor, f.
3 Use five test runs for classes A and B; use three test runs for classes C and D.
4 Absolute (not relative) time shall be recorded.

Form D.8 Humidity effects (SH)

Ref.: 5.5.3.2; A.4.6.

Application no.:	____________		At start / At end
Load cell model:	____________	Date:	
Serial no.:	____________	Conditioning period:	
E_{max}:	____________	Reference temperature:	°C
n_{max}:	____________	High temperature:	°C
v_{min}:	____________	Reference relative humidity:	%
p_{LC}:	______ DR: ______	High relative humidity:	%
Force-generating system:	____________	Conversion factor, f:	____________
Indicating instrument:	____________	Page of load test before humidity test:	______
Evaluator:	____________	Page of load test during humidity test:	______
		Page of load test after humidity test:	______

Summary of load test errors: use Form D.1 (3 runs) or D.1 (5 runs), as appropriate, to record individual test results.

Table D.8

Test load (g, kg or t)	Reference indication ( )	. . . . °C (20 °C) . . . . % RH (50 % RH)		. . . . °C (High) . . . . % RH (85 % RH)		. . . . °C (20 °C) . . . . % RH (50 % RH)		mpe (v)
		Indication ( )	Error (E_L) (v)	Indication ( )	Error (E_L) (v)	Indication ( )	Error (E_L) (v)	
0	0	0		0		0		

PASS: ☐ FAIL: ☐

Notes: *1* Load/reference indications: if a 75 % load point was not obtained, a straight line interpolation between the adjacent higher and lower load point indications is used, (see 5.2.2 and calculation procedures in C.2.2).
2 Error, E_L: the difference between the test indication and the reference indication divided by the conversion factor, f.
3 Test load values are values above minimum test load, D_{min}.
4 Conditioning period: the time period for exercising the load cell.

Form D.9 Marking requirements

Ref.: 4.6, 4.7.

Application no.: ______________________

Load cell model: ______________________

Serial no.: ______________________

E_{max}: ______________________

n_{max}: ______________________

v_{min}: ______________________

p_{LC}: __________ DR: __________

Force-generating system: ______________________

Indicating instrument: ______________________

Evaluator: ______________________

Table D.9.1

R 60 reference	Mandatory information	On load cell	In document
4.6.1	Accuracy class designation		
4.6.2	Maximum number of load cell verification intervals, n_{max}		
4.6.3	Loading designation (if necessary)		
4.6.4	Working temperature designation		
4.6.5.1	Humidity symbol "NH"		
4.6.5.3	Humidity symbol "SH"		
4.6.6.1, 4.7.1	Name or trademark of manufacturer (see *Note 1*)		
4.6.6.1,4.7.1	Manufacturer's own designation or load cell model (see *Note 1*)		
4.6.6.1, 4.7.1	Serial number (see *Note 1*)		
4.6.6.1	Year of manufacture		
4.6.6.1	Minimum dead load, E_{min}		
4.6.6.1, 4.7.1	Maximum capacity, E_{max} (see *Note 1*)		
4.6.6.1	Safe load limit, E_{lim}		
4.6.6.1	Minimum load cell verification interval (v_{min})		
4.6.6.1	Other pertinent conditions		
4.6.6.1	Apportionment factor, p_{LC} (if not equal to 0.7)		
4.6.7	Standard classification		
4.6.8	Multiple classifications		

Table D.9.2

R 60 reference	Non-mandatory additional information	On load cell	In document
4.6.5.2	Humidity symbol "CH"		
4.6.6.2	Relative v_{min}, Y		
4.6.6.2	Relative DR, Z		

Include references to the following:

Documents supplied with load cells: ____

Diagrams showing markings on load cells: ____

Notes: *1* Required both on load cell and in document.
2 Indicate that the marking is present with a "+"
3 Indicate that the marking is not present with a "–"
4 Indicate that the marking is not applicable with a "/"

Form D.10 Summary of results - Load cells equipped with electronics

Ref.: Clause 6.

Application no.: ______________________

Load cell model: ______________________

Serial no.: ______________________

E_{max}: ______________________

n_{max}: ______________________

v_{min}: ______________________

p_{LC}: __________ DR: __________

Force-generating system: ______________________

Indicating instrument: ______________________

Evaluator: ______________________

Table D.10 Summary of results

Test description	Test procedure	Test report form no.	Passed	Failed	Remarks
Warm-up time	A.4.7.2	D.11			
Power voltage variations	A.4.7.3	D.12			
Short time power reductions	A.4.7.4	D.13			
Bursts (electrical fast transients)	A.4.7.5	D.14.1, D.14.2			
Electrostatic discharge	A.4.7.6	D.15.1, D.15.2, D.15.3			
Electromagnetic susceptibility	A.4.7.7	D.16.1, D.16.2			
Span stability test	A.4.7.8	D.17.1.1, D.17.2			

Additional remarks:

Form D.11 Warm-up time

Ref.: 6.3.2; A.4.7.2.

Application no.: ______________________

Load cell model: ______________________

Serial no.: ______________________

E_{max}: ______________________

n_{max}: ______________________

v_{min}: ______________________

p_{LC}: __________ DR: __________

Force-generating system: ______________________

Indicating instrument: ______________________

Evaluator: ______________________

	At start	At end	
Date:			
Time:			
Temperature:			°C
Relative humidity:			%
Barometric pressure:			kPa

Conversion factor, f: ______________

Minimum test load, D_{min}: ______________

Maximum test load, D_{max}: ______________

Duration of disconnection before test: ______________

Table D.11

	Initial run		After 5 min.		After 15 min.		After 30 min.		mpc
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	(v)
Minimum test load									
Maximum test load									
Span ( )									
Span (v)									
Change (v)	0								

PASS: ☐ FAIL: ☐

Notes:

1 Absolute (not relative) time shall be recorded.

2 Span: the result of subtracting the indication at minimum test load from the indication at maximum test load. All span errors (error at maximum test load minus the error at minimum test load) shall be within the maximum permissible error during the 30 minute test.

3 Change: the difference between the span and the initial run span.

4 Maximum permissible change, mpc: the absolute value of the maximum permissible error for the maximum test load applied.

Report no.: ....

Report page no.: .... of ....

Report date: ....

Form D.12 Power voltage variations

Ref.: 6.3.3, 6.3.4; A.4.7.3.

Application no.: ____________ Date: [ ]

Load cell model: ____________ Time: [ ]

Serial no.: ____________ Temperature: [ ] °C

E_{max}: ____________ Relative humidity: [ ] %

n_{max}: ____________ Barometric pressure: [ ] kPa

v_{min}: ____________

p_{LC}: ________ DR: ________

Force-generating system: ____________ Conversion factor, f: ____________

Indicating instrument: ____________ Minimum test load, D_{min}: ____________

Evaluator: ____________ Maximum test load, D_{max}: ____________

Power voltage (A.4.7.3): Mains: [ ] Battery: [ ] Reference voltage or range (see *Note 5*): ________ V

Upper limit: ________ V

Lower limit: ________ V

Table D.12

Test load (g, kg or t)	Reference indication ( )	Upper limit		Lower limit		mpe (v)
		Indication ( )	Error (v)	Indication ( )	Error (v)	

PASS: [ ] FAIL: [ ]

Equipment used (supply sketch if necessary):

Notes:
1 Upper limit not applicable to battery powered load cells.
2 At lower limit, battery powered load cells shall function and be within mpe, or cease to function.
3 Reference indications: if a 75 % load point was not obtained, a straight line interpolation between the adjacent higher and lower load point indications is used (see 5.2.2 and calculation procedures in C.2.2).
4 Error: the difference between the test indication and the reference indication divided by the conversion factor, f.
5 When a voltage range is marked, use the average value as the reference value and determine the upper and lower values of applied voltage according to A.4.7.3.

Form D.13 Short time power reductions

Ref.: 6.3.5; A.4.7.4.

Application no.: ____________

Load cell model: ____________

Serial no.: ____________

E_{max}: ____________

n_{max}: ____________

v_{min}: ____________

p_{LC}: ________ DR: ________

Force-generating system: ____________

Indicating instrument: ____________

Evaluator: ____________

Date: ____________

Time: ____________

Temperature: ____________ °C

Relative humidity: ____________ %

Barometric pressure: ____________ kPa

Conversion factor, f: ____________

Minimum test load, D_{min}: ____________

Reference voltage range: ____________ V

Table D.13

Test load (g, kg or t)	Disturbance				Result			
	Amplitude (%)	Duration (cycles)	Number of disturbances	Repetition interval (s)	Indication ( )	Difference (v)	Significant fault > v_{min}	
							No	Yes (remarks)
	without disturbance							
	0	0.5	10					
	50	1	10					

Equipment used (supply sketch if necessary):

PASS: ☐ FAIL: ☐

Remarks:

Note: In the case of a voltage range, use the average value as the reference value.

Form D.14.1 Bursts (electrical fast transients) - power supply lines

Ref.: 6.3.5; A.4.7.5.

Application no.:		Date:		
Load cell model:		Time:		
Serial no.:		Temperature:		°C
E_{max}:		Relative humidity:		%
n_{max}:		Barometric pressure:		kPa
v_{min}:				
p_{LC}:	DR:			
Force-generating system:		Conversion factor, f:		
Indicating instrument:		Minimum test load, D_{min}:		
Evaluator:				

Table D.14.1

Power supply lines: test voltage = 1 kV; duration of the test = 1 minute at each polarity.

Test load (g, kg or t)	Connection			Polarity	Result			
	L to ground	N to ground	PE to ground		Indication ( )	Difference (v)	Significant fault > v_{min}	
							No	Yes (remarks)
	without disturbance							
	X			pos				
				neg				
	without disturbance							
		X		pos				
				neg				
	without disturbance							
			X	pos				
				neg				

PASS: ☐ FAIL: ☐

L = phase, N = neutral, PE = protective earth

Equipment used (supply sketch if necessary):

Remarks:

Form D.14.2 Bursts (electrical fast transients) - I/O circuits and communications lines

Ref.: 6.3.5; A.4.7.5.

Application no.:			Date:	
Load cell model:			Time:	
Serial no.:			Temperature:	°C
E_{max}:			Relative humidity:	%
n_{max}:			Barometric pressure:	kPa
v_{min}:				
p_{LC}:	DR:			
Force-generating system:			Conversion factor, f:	
Indicating instrument:			Minimum test load, D_{min}:	
Evaluator:				

Table D.14.2

I/O signals, data and control lines: test voltage = 0.5 kV; duration of the test = 1 minute at each polarity.

Test load (g, kg or t)	Cable interface	Polarity	Result			
			Indication ( )	Difference (v)	Significant fault > v_{min}	
					No	Yes (remarks)
	without disturbance					
		pos				
		neg				
	without disturbance					
		pos				
		neg				
	without disturbance					
		pos				
		neg				
	without disturbance					
		pos				
		neg				
	without disturbance					
		pos				
		neg				
	without disturbance					
		pos				
		neg				

Equipment used (supply sketch if necessary): PASS: ☐ FAIL: ☐

Remarks:

Note: Explain or make a sketch indicating where the clamp is located on the cable; if necessary, use additional page(s).

Form D.15.1 Electrostatic discharge - direct application

Ref.: 6.3.5; A.4.7.6.

Application no.: ______________________
Load cell model: ______________________
Serial no.: ______________________
E_{max}: ______________________
n_{max}: ______________________
v_{min}: ______________________
p_{LC}: __________ DR: __________
Force-generating system: ______________________
Indicating instrument: ______________________
Evaluator: ______________________

Date: ☐
Time: ☐
Temperature: ☐ °C
Relative humidity: ☐ %
Barometric pressure: ☐ kPa

Conversion factor, f: ______________
Minimum test load, D_{min}: ______________

☐ Contact discharges
☐ Paint penetration
☐ Air discharges

Polarity (see *Note 2*):
☐ Positive
☐ Negative

Table D.15.1

Test load (g, kg or t)	Discharges			Result			
	Test voltage (kV)	No. of discharges ≥ 10	Repetition interval (s)	Indication ( )	Difference (v)	Significant fault > v_{min}	
						No	Yes (remarks)
	without disturbance						
	2						
	4						
	6						
	8 (air discharges)						

PASS: ☐ FAIL: ☐

Remarks:

Notes: *1* If the load cell fails, the test point at which this occurs shall be recorded.
2 IEC Publication 61000-4-2 (1999-05) Ed 1.1 Consolidated edition specifies that the test be conducted with the most sensitive polarity.

Form D.15.2 Electrostatic discharge - indirect application

Ref.: 6.3.5; A.4.7.6.

Application no.:		Date:	
Load cell model:		Time:	
Serial no.:		Temperature:	°C
E_{max}:		Relative humidity:	%
n_{max}:		Barometric pressure:	kPa
v_{min}:			
p_{LC}:	DR:		
Force-generating system:		Conversion factor, f:	
Indicating instrument:		Minimum test load, D_{min}:	
Evaluator:			

Polarity (see *Note 2*): ☐ Positive ☐ Negative

Table D.15.2.1 - Horizontal coupling plane

Test load (g, kg or t)	Discharges			Result			
	Test voltage (kV)	No. of discharges ≥ 10	Repetition interval (s)	Indication ( )	Difference (v)	Significant fault > v_{min}	
						No	Yes (remarks)
	without disturbance						
	2						
	4						
	6						

Table D.15.2.2 - Vertical coupling plane

Test load (g, kg or t)	Discharges			Result			
	Test voltage (kV)	No. of discharges ≥ 10	Repetition interval (s)	Indication ( )	Difference (v)	Significant fault > v_{min}	
						No	Yes (remarks)
	without disturbance						
	2						
	4						
	6						

PASS: ☐ FAIL: ☐

Remarks:

Notes: *1* If the load cell fails, the test point at which this occurs shall be recorded.

2 IEC Publication 61000-4-2 (1999-05) Ed 1.1 Consolidated edition specifies that the test be conducted with the most sensitive polarity.

Form D.15.3 Electronic discharge (continued) - specification of test points

Ref.: D.15.1 and D.15.2.

Specify test points utilized on load cell and test equipment used, e.g. by photos or sketches.

a) Direct application

Contact discharges:

Air discharges:

b) Indirect application

Form D.16.1 Electromagnetic susceptibility

Ref.: 6.3.5; A.4.7.7.

Application no.: ____________ Date: [ ]

Load cell model: ____________ Time: [ ]

Serial no.: ____________ Temperature: [ ] °C

E_{max}: ____________ Relative humidity: [ ] %

n_{max}: ____________ Barometric pressure: [ ] kPa

v_{min}: ____________

p_{LC}: ________ DR: ________

Force-generating system: ____________ Conversion factor, f: ____________

Indicating instrument: ____________ Minimum test load, D_{min}: ____________

Evaluator: ____________

Rate of sweep: [ ]

Test load: [ ] Test load material: [ ]

Table D.16.1

Disturbance				Result			
Antenna	Frequency range (MHz)	Polarization	Facing load cell	Indication ( )	Difference (v)	Significant fault > v_{min}	
						No	Yes (remarks)
without disturbance							
		Vertical	Front				
			Right				
			Left				
			Rear				
		Horizontal	Front				
			Right				
			Left				
			Rear				

PASS: [ ] FAIL: [ ]

Frequency range: 26 – 1 000 MHz
Field strength: 3 V/m
Modulation: 80 % AM, 1 kHz sine wave

Remarks:

Note: If the load cell fails, the test point at which this occurs shall be recorded.

Form D.16.2 Electromagnetic susceptibility (continued) - description of the test set-up

Ref.: D.16.1.

Describe the set-up of the test and equipment, e.g. by photos or sketches:

Form D.17.1.1 (3 runs) Span stability - measurement data for classes C and D

Ref.: 6.3.6; A.4.7.8.

Application no.: ____________ Force-generating system: ____________

Load cell model: ____________ Indicating instrument: ____________

Serial no.: ____________ p_{LC}: ________ DR: ________

E_{max}: ____________ Conversion factor, f: ____________

n_{max}: ____________ Minimum test load, D_{min}: ____________

v_{min}: ____________ Maximum test load, D_{max}: ____________

Notes: 1 Span is the result of subtracting the average indication at minimum test load from the average indication at maximum test load.

2 Absolute (not relative) time shall be recorded.

Table D.17.1.1 (3 runs)

Measurement no. 1:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________ Remarks:

Measurement no. 2:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________ Remarks:

Form D.17.1.1 (3 runs) Span stability - measurement data for classes C and D (continued)

Measurement no. 3:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Measurement no. 4:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Measurement no. 5:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Report no.: ....

Report page no.: .... of ....

Report date: ....

Form D.17.1.1 (3 runs) Span stability - measurement data for classes C and D (continued)

Measurement no. 6:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Measurement no. 7:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Measurement no. 8:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
						Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Form D.17.1.1 (5 runs) Span stability - measurement data for class B

Ref.: 6.3.6; A.4.7.8.

Application no.: ____________ Force-generating system: ____________

Load cell model: ____________ Indicating instrument: ____________

Serial no.: ____________ p_{LC}: ________ DR: ________

E_{max}: ____________ Conversion factor, f: ____________

n_{max}: ____________ Minimum test load, D_{min}: ____________

v_{min}: ____________ Maximum test load, D_{max}: ____________

Notes: 1. Span is the result of subtracting the average indication at minimum test load from the average indication at maximum test load.

2. Absolute (not relative) time shall be recorded.

Table D.17.1.1 (5 runs)

Measurement no. 1:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________ Remarks:

Measurement no. 2:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________ Remarks:

Report no.: ....

Report page no.: .... of ....

Report date: ....

Form D.17.1.1 (5 runs) Span stability - measurement data for class B (continued)

Measurement no. 3:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Measurement no. 4:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Measurement no. 5:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:		
Time:		
Temperature:		°C
Relative humidity:		%
Barometric pressure:		kPa

Evaluator: ____________________ Remarks:

Form D.17.1.1 (5 runs) Span stability - measurement data for class B (continued)

Measurement no. 6:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:
Time:
Temperature: °C
Relative humidity: %
Barometric pressure: kPa

Evaluator: ______________________ Remarks:

Measurement no. 7:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:
Time:
Temperature: °C
Relative humidity: %
Barometric pressure: kPa

Evaluator: ______________________ Remarks:

Measurement no. 8:

Test load (g, kg or t)	Run no. 1		Run no. 2		Run no. 3		Run no. 4		Run no. 5		Average indication ( )
	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	Indication ( )	Time	
										Span	

Date:
Time:
Temperature: °C
Relative humidity: %
Barometric pressure: kPa

Evaluator: ______________________ Remarks:

Form D.17.2 Span stability - summary of test results

Ref.: 6.3.2; A.4.7.8; D.17.1.1 (3 runs) or D.17.1.1 (5 runs).

Application no.: ____________

Load cell model: ____________

Serial no.: ____________

E_{max}: ____________

n_{max}: ____________

v_{min}: ____________

p_{LC}: ______ DR: ______

Force-generating system: ____________

Indicating instrument: ____________

Evaluator: ____________

Table D.17.2

Measurement no. (see *Note 3*)	Span		Variation (v)	Maximum allowable variation (v)
	( )	(v)		
1				
2				
3				
4				
5				
6				
7				
8				

PASS: ☐ FAIL: ☐

Remarks:

Notes:
1 Variation: the difference in the span value from the span value of run no. 1.
2 Maximum allowable variation: half the load cell verification interval or half the absolute value of the maximum permissible error for the maximum test load applied.
3 Use the results from measurements nos. 1 - 8 on Form D.17.1.1 (3 runs) or Form D.17.1.1 (5 runs).

Annex E
(Mandatory)
OIML Certificate of conformity for load cells

E.1 Format of certificate

Member State | **OIML CERTIFICATE OF CONFORMITY** | OIML certificate no.

____________________ ____________________

Issuing Authority

Name: ....

Address: ....

Person responsible: ....

Applicant

Name: ....

Address: ....

Manufacturer of the certified pattern (if the manufacturer is not the applicant) ....

Identification of the certified pattern: Load cell (construction principle, for example, strain gauge, compression, etc.)

....

Model designation				
Maximum capacity, E_{max}				
Accuracy class				
Maximum number of load cell verification intervals, n_{max}				
Minimum verification interval, v_{min}				
Apportionment factor, p_{LC}				

(Additional characteristics and identification, as applicable according to R 60, 2.2.3 and 4.6, continued overleaf or on addendum if necessary)

This certificate attests the conformity of the above-mentioned pattern (represented by the samples identified in the associated test report(s) with the requirements of the following Recommendation of the International Organization of Legal Metrology - OIML):

R 60 *Metrological regulation for load cells* Edition .... for accuracy class ....

This certificate relates only to the metrological and technical characteristics of the pattern of instrument concerned, as covered by the relevant OIML International Recommendation.

This certificate does not bestow any form of legal international approval.

The conformity was established by tests described in the associated test report no. ……, which includes ……. pages.

Identification(s) and signature(s) or stamp(s), of (as applicable):

Issuing Authority: **CIML Member:**

Date: .... Date: ....

OIML certificate no.

____

*

* *

Additional characteristics[1] and identification, as applicable to R 60, 2.2.3 and 4.6 *(continued)*

Model designation				
(Additional characteristics, per 2.2.3 and 4.6)				

Special conditions: ....

....

....

....

....

....

....

....

....

....

Important note: Apart from the mention of the certificate's reference number and the name of the OIML Member State in which the certificate was issued, partial quotation of the certificate or the associated test report is not permitted, though they may be reproduced in full.

[1] The table with the essential technical data may, upon request by the manufacturer, be placed on the certificate or on an addendum.

E.2 Contents of addendum to test certificate (Informative)

Addendum to test certificate no. ....

(Name and type of the load cell) ....

E.2.1 Technical data

The essential technical data for the test certificates are listed on the certificate (at the request of the manufacturer) alternatively, in the case of limited space on the certificate the following information may be provided:

Table E.1 Technical data

Model designation	*Designation*	*Example*				*Units*
Classification		C4				
Additional markings		–				
Maximum number of load cell verification intervals		4 000				
Maximum capacity	E_{max}	30 000				kg
Minimum dead load, relative	E_{min} / E_{max}	0				%
Relative v_{min} (ratio to minimum load cell verification interval)	$Y = E_{max} / v_{min}$	24 000				
Relative DR (ratio to minimum dead load output return)	$Z = E_{max} / (2 \times DR)$	7 500				
Rated output*		2.5				mV/V*
Maximum excitation voltage		30				V
Input impedance (for strain gauge load cells)	R_{LC}	4 000				Ω
Temperature rating		– 10/+ 40				°C
Safe overload, relative	E_{lim} / E_{max}	150				%
Cable length		3				m
Additional characteristics per 2.2.3 and 4.6**		–				

* *Note:* For load cells with digital output this refers to the number of counts for E_{max}

** *Note:* For load cells with digital output this is not required

E.2.2 Tests

The tests listed in Table E.2 have been carried out in accordance with OIML R 60:

- at the laboratory .... *(insert laboratory name)*
- as documented in the test report no. .... *(insert test report number)*

Table E.2 Tests performed with load cell:

Serial no.: ....

Class: ....

E_{max}: ....

n_{max}: ....

Y: ....

Z: ....

Test	*R 60 Ref.*	*Approved*	*Institute*
Temperature test and repeatability at 20 °C, 40 °C, – 10 °C, 20 °C	5.1.1, 5.4; A.4.1		
Temperature effect on minimum dead load output at 20 °C, 40 °C, – 10 °C, 20 °C	5.5.1.3; A.4.1		
Creep at 20 °C, 40 °C, – 10 °C	5.3.1; A.4.2		
Minimum dead load output return at 20 °C, 40 °C, – 10 °C	5.3.2; A.4.3		
Barometric pressure effects at room temperature	5.5.2; A.4.4		
Damp heat, cyclic: marked CH (or not marked)	5.5.3.1; A.4.5		
Damp heat, steady state: marked SH	5.5.3.2; A.4.6		
Additional tests for load cells equipped with electronics	6; A.4.7		
Warm-up time	6.3.2; A.4.7.2		
Power voltage variations	6.3.3, 6.3.4; A.4.7.3		
Short time power reductions	6.3.5; A.4.7.4		
Bursts (electrical fast transients)	6.3.5; A.4.7.5		
Electrostatic discharge	6.3.5; A.4.7.6		
Electromagnetic susceptibility	6.3.5; A.4.7.7		
Span stability	6.3.6; A.4.7.8		

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