ANNEX A

Testing procedures for non-automatic weighing instruments

A.1 Administrative examination (8.2.1)

Review the documentation that is submitted, including necessary photographs, drawings, relevant technical specifications of main components, etc., to determine if it is adequate and correct. Consider the operating manual or equivalent user documentation.

Note: An "operating manual" may be a draft.

A.2 Compare construction with documentation (8.2.2)

Examine the various devices of the instrument to ensure compliance with the documentation. Consider also 3.10.

A.3 Initial examination

A.3.1 Metrological characteristics

Note the metrological characteristics according to the Test Report Format

A.3.2 Descriptive markings (7.1)

Check the descriptive markings according to the checklist given in the Test Report Format.

A.3.3 Stamping and securing (4.1.2.4 and 7.2)

Check the arrangements for stamping and securing according to the checklist given in the Test Report Format.

A.4 Performance tests

A.4.1 General conditions

A.4.1.l Normal test conditions (3.5.3.1)

Errors shall be determined under normal test conditions. When the effect of one factor is being evaluated, all other factors are to be held relatively constant, at a value close to normal.

For instruments of class I all necessary corrections in respect to influence factors due to the test load shall be applied, i.e. influence of air buoyancy.

A.4.1.2 Temperature

The tests shall be performed at a steady ambient temperature, usually normal room temperature unless otherwise specified.

The temperature is deemed to be steady when the difference between the extreme temperatures noted during the test does not exceed one-fifth of the temperature range of the given instrument without being greater than 5 °C (2 °C in the case of a creep test), and the rate of change does not exceed 5 °C per hour.

A.4.1.3 Power supply

Instruments using electric power shall normally be connected to the mains power or power supply device and switched on throughout the tests.

A.4.1.4 Reference position before tests

For an instrument liable to be tilted, the instrument shall be leveled at its reference position.

A.4.1.5 Automatic zero-setting and zero-tracking

During the tests, the effect of the automatic zero-setting device or the zero-tracking device may be switched off or suppressed by starting the test with a load equal to say 10 *e*.

In certain tests where the automatic zero-setting or zero-tracking must be in operation (or not), specific mention of this is made in those test descriptions.

A.4.1.6 Indication with a scale interval smaller than *e*

If an instrument with digital indication has a device for displaying the indication with a smaller scale interval (not greater than 1/5 *e*), this device may be used to determine the error. If a device is used it should be noted in the Test Report.

A.4.1.7 Using a simulator to test modules (3.10.2 and 3.7.1)

If a simulator is used to test a module, the repeatability and stability of the simulator should make it possible to determine the performance of the module with at least the same accuracy as when a complete instrument is tested with weights, the mpe to be considered being those applicable to the module. If a simulator is used, this shall be noted in the Test Report Format and its traceability referenced.

A.4.1.8 Adjustment (4.1.2.5)

A semi-automatic span adjustment device shall be initiated only once before the first test.

An instrument of class I shall, if applicable, be adjusted prior to each test following the instructions in the operating manual.

Note: The temperature test A.5.3.1 is considered as one test.

A.4.1.9 Recovery

After each test the instrument should be allowed to recover sufficiently before the following test.

A.4.1.10 Preloading

Before each weighing test the instrument shall be pre-loaded once to Max or to Lim if this is defined, except for the tests in A.5.2 and A.5.3.2.

Where load cells are tested separately the pre-loading shall be as follows:
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.4.1.11 Multiple range instruments

In principle, each range should be tested as a separate instrument. For instruments with automatic change over, however, combined tests can be possible.

A.4.2 Checking of zero

A.4.2.1 Range of zero-setting (4.5.1)

A.4.2.1.1 Initial zero-setting

With the load receptor empty, set the instrument to zero. Place a test load on the load receptor and switch the instrument off and then back on. Continue this process until, after placing a load on the load receptor and switching the instrument off and on, it does not re-zero. The maximum load that can be re-zeroed is the positive portion of the initial zero-setting range.

Remove any load from the load receptor and set the instrument to zero. Then remove the load receptor (platform) from the instrument. If, at this point, the instrument can be reset to zero by switching it off and back on, the mass of the load receptor is used as the negative portion of the initial zero-setting range.

If the instrument cannot be reset to zero with the load receptor removed, add weights to any live part of the scale (e.g. on the parts where the load receptor rests) until the instrument indicates zero again.

Then remove weights and, after each weight is removed, switch the instrument off and back on. The maximum load that can be removed while the instrument can still be reset to zero by switching it off and on is the negative portion of the initial zero-setting range.

The initial zero-setting range is the sum of the positive and negative portions. If the load receptor cannot readily be removed, only the positive part of the initial zero-setting range need be considered.

A.4.2.1.2 Non-automatic and semi-automatic zero-setting

This test is performed in the same manner as described in A.4.2.1.1, except that the zero-setting means is used rather than switching the instrument off and on.

A.4.2.1.3 Automatic zero-setting

Remove the load receptor as described in A.4.2.1.1 and place weights on the instrument until it indicates zero.

Remove weights in small amounts and after each weight is removed allow time for the automatic zero-setting device to function so as to see if the instrument is reset to zero automatically. Repeat this procedure until the instrument will not reset to zero automatically.

The maximum load that can be removed so that the instrument can still be reset to zero is the zero-setting range.

If the load receptor cannot readily be removed, a practical approach can be to add weights to the instrument and use another zero-setting device, if provided, to set the instrument to zero. Then remove weights and check whether the automatic zero-setting still sets the instrument to zero. The maximum load that can be removed so that the instrument can still be reset to zero is the zero-setting range.

A.4.2.2 Zero indicating device (4.5.5)

For instruments fitted with a zero indicating device and digital indication, adjust the instrument to about one scale interval below zero; then by adding weights equivalent, for example, to 1/10 of the scale interval, determine the range over which the zero indicating device indicates the deviation from zero.

A.4.2.3 Accuracy of zero-setting (4.5.2)

The test may be combined with A.4.4.1.

A.4.2.3.1 Non-automatic and semi-automatic zero-setting

The accuracy of the zero-setting device is tested by first loading the instrument to an indication as close as possible to a changeover point, and then by initiating the zero-setting device and determining the additional load at which the indication changes from zero to one scale interval above zero. The error at zero is calculated according to the description in A.4.4.3.

A.4.2.3.2 Automatic zero-setting or zero-tracking

The indication is brought out of the automatic range (e.g. by loading with 10 e). Then the additional load at which the indication changes from one scale interval to the next above is determined and the error is calculated according to the description in A.4.4.3. It is assumed that the error at zero load would be equal to the error at the load in question.

A.4.3 Setting to zero before loading

For instruments with digital indication, the adjustment to zero, or the determination of the zero point is carried out as follows:

a) For instruments with non-automatic zero-setting, weights equivalent to half a scale interval are placed on the load receptor, and the instrument is adjusted until the indication alternates between zero and one scale interval. Then weights equivalent to half a scale interval are removed from the load receptor to attain a centre of zero reference position.

b) For instruments with semi-automatic or automatic zero-setting or zero-tracking, the deviation from zero is determined as described in A.4.2.3.

A.4.4 Determination of weighing performance

A.4.4.1 Weighing test

Apply test loads from zero up to and including Max, and similarly remove the test loads back to zero. When determining the initial intrinsic error, at least 10 different test loads shall be selected, and for other weighing tests at least 5 shall be selected. The test loads selected shall include Max and Min (Min only if Min ≥ 100 mg) and values at or near those at which the maximum permissible error (mpe) changes.

During type examination it should be noted that when loading or unloading weights the load shall be progressively increased or progressively decreased. It is recommended to apply the same procedure as far as possible during initial verification (8.3) and subsequent metrological control (8.4).

If the instrument is provided with an automatic zero-setting or zero-tracking device, it may be in operation during the tests, except for the temperature test. The error at zero point is then determined according to A.4.2.3.2.

A.4.4.2 Supplementary weighing test (4.5.1)

For instruments with an initial zero-setting device with a range greater than 20 % of Max, a supplementary weighing test shall be performed using the upper limit of the range as zero point.

A.4.4.3 Evaluation of error (A.4.1.6)

For instruments with digital indication and without a device for displaying the indication with a smaller scale interval (not greater than 1/5 e), the changeover points are to be used to determine the indication of the instrument, prior to rounding, as follows.

At a certain load, L, the indicated value, I, is noted. Additional weights of say 1/10 e are successively added until the indication of the instrument is increased unambiguously by one scale interval ($I + e$). The additional load ΔL added to the load receptor gives the indication P, prior to rounding by using the following formula:

$$P = I + \tfrac{1}{2} e - \Delta L$$

The error prior to rounding is:

$$E = P - L = I + \tfrac{1}{2} e - \Delta L - L$$

The corrected error prior to rounding is:

$$E_c = E - E_0 \leq \text{mpe}$$

where E_0 is the error calculated at zero or at a load close to zero (e.g. 10 e).

Example: An instrument with a verification scale interval, e, of 5 g is loaded with 1 kg and thereby indicates 1 000 g. After adding successive weights of 0.5 g, the indication changes from 1 000 g to 1 005 g at an additional load of 1.5 g. Inserted in the above formula these observations give:

$$P = (1\,000 + 2.5 - 1.5)\text{ g} = 1\,001\text{ g}$$

Thus the true indication prior to rounding is 1 001 g, and the error is:

$$E = (1\,001 - 1\,000)\text{ g} = +1\text{ g}$$

If the changeover point at zero as calculated above was $E_0 = +0.5$ g, the corrected error is:

$$E_c = +1 - (+0.5) = +0.5\text{ g}$$

In the tests A.4.2.3 and A.4.11.1, the error shall be determined with a sufficient accuracy in view of the tolerance in question.

Note: The above description and formulae are also valid for multi-interval instruments. Where the load, L, and the indication, I, are in different partial weighing ranges:

- the additional weights ΔL are to be in steps of 1/10 e_i,
- in the equation "$E = P - L = ...$" above, the term "½ e" is to be ½ e_i or ½ $e_i + 1$ according to the partial weighing range in which the indication ($I + e$) appears.

A.4.4.4 Testing of modules

When testing modules separately, it shall be possible to determine the errors with a sufficiently small uncertainty considering the chosen fractions of the mpe either by using a device for displaying the indication with a scale interval smaller than (1/5) $p_i \times e$ or by evaluating the changeover point of the indication with an uncertainty better than (1/5) $p_i \times e$.

A.4.4.5 Weighing test using substitution material (3.7.3)

The test shall be carried out only during verification and at the place of use taking A.4.4.1 into account.

Determine the allowed number of substitutions according to 3.7.3.

Check the repeatability error at a load of about the value where the substitution is made, by placing it three times on the load receptor. The results of the repeatability test (A.4.10) may be used if the test loads have a comparable mass.

Apply test loads from zero up to and including the maximum quantity of standard weights.

Determine the error (A.4.4.3) and then remove the weights so that the no-load indication, or, in the case of an instrument with a zero-tracking device, the indication of say 10 e, is reached.

Substitute the previous weights with substitution material until the same changeover point, as used for the determination of the error, is reached. Repeat the above procedure until Max of the instrument is reached.

Unload in reverse order to zero, i.e. unload the weights and determine the changeover point. Place the weights back and remove the substitution material until the same changeover point is reached. Repeat this procedure until no-load indication.

Similar equivalent procedures may be applied.

A.4.5 Instruments with more than one indicating device (3.6.3)

If the instrument has more than one indicating device, the indications of the various devices shall be compared during the tests described in A.4.4.

A.4.6 Tare

A.4.6.1 Weighing test (3.5.3.3)

Weighing tests (loading and unloading according to A.4.4.1) shall be performed with different tare values. At least 5 load steps shall be selected. The steps shall include values close to Min (Min only if Min ≥ 100 mg), values at or near those at which the maximum permissible error (mpe) changes and the value close to the maximum possible net load.

The weighing tests should be performed on instruments with:

- subtractive tare: with one tare value between 1/3 and 2/3 of maximum tare;
- additive tare: with two tare values of about 1/3 and 3/3 of maximum tare effect.

For 8.3 and 8.4, the practical test may be replaced by other appropriate procedures, e.g. by numerical or graphical considerations; simulation of a tare-balancing operation by displacement (shifting) of the error limits (mpe) to any points of the error curve (curve of weighing test results); or checking if the error curve and hysteresis are inside the mpe at every point.

If the instrument is provided with automatic zero-setting or zero-tracking device it may be in operation during the test, in which case the error at zero point shall be determined according to A.4.2.3.2.

A.4.6.2 Accuracy of tare setting (4.6.3)

The test may be combined with A.4.6.1.

The accuracy of the tare device shall be established in a manner similar to the test described in A.4.2.3 with the indication set to zero using the tare device.

A.4.6.3 Tare weighing device (3.5.3.4 and 3.6.3)

If the instrument has a tare weighing device, the results obtained for the same load (tare), by the tare weighing device and the indicating device, shall be compared.

A.4.7 Eccentricity tests (3.6.2)

Large weights should be used in preference to several small weights. Smaller weights shall be placed on top of larger weights, but unnecessary stacking should be avoided within the segment to be tested. The load shall be applied centrally in the segment if a single weight is used, but applied uniformly over the segment, if several small weights are used. It is sufficient to apply the load only to the eccentric segments, not to the centre of the load receptor.

Note: If an instrument is designed in such a way that loads may be applied in different manners, it may be appropriate to apply more than one of the tests described in A.4.7.1-A.4.7.5.

The location of the load shall be marked on a sketch in the Test Report.

The error at each measurement is determined according to A.4.4.3. The zero error E_0 used for the correction is the value determined prior to each measurement. Normally it is sufficient to determine the zero error only at the beginning of the measurement, but on special instruments (accuracy class I, high capacity, etc.) it is recommended that the zero error be determined prior to each eccentricity loading. However, if the mpe is exceeded, the test with zero error prior to each loading is necessary.

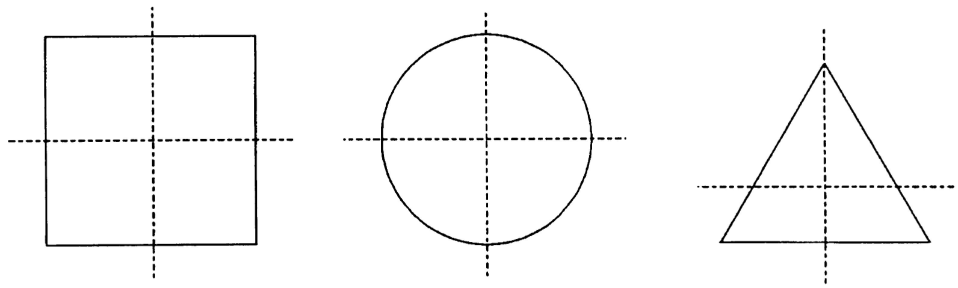
If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation during the following tests.

Note: If operating conditions are such that no eccentricity can occur, eccentricity tests need not be performed.

A.4.7.1 Instruments with a load receptor having not more than four points of support

The four quarter segments roughly equal to ¼ of the surface of the load receptor (as shown in the sketches in Figure 9 or similar sketches) shall be loaded in turn.

Figure 9



Examples: A load receptor which transmits the force from the load:

- directly into 1 single point load cell has 1 point of support;
- directly into 3 load cells has 3 points of support; and
- with 4 mechanical connection elements into a lever works has 4 points of support.

A.4.7.2 Instruments with a load receptor having more than four points of support

The load shall be applied over each support on an area of the same order of magnitude as the fraction $1/n$ of the surface area of the load receptor, where n is the number of points of support.

Where two points of support are too close together for the above-mentioned test load to be distributed as indicated above, the load shall be doubled and distributed over twice the area on both sides of the axis connecting the two points of support.

A.4.7.3 Instruments with special load receptors (tank, hopper, etc.)

The load shall be applied to each point of support.

A.4.7.4 Instruments used for weighing rolling loads (3.6.2.4)

A load shall be applied at different positions on the load receptor. These positions shall be at the beginning, the middle and at the end of the load receptor in the normal driving direction. The positions shall then be repeated in the reverse direction, if the application in both directions is possible. Before changing direction zero has to be determined again. If the load receptor consists of several sections, the test shall be applied to each section.

A.4.7.5 Eccentricity tests for mobile instruments

A.4.7 and A.4.7.1 to A.4.7.4 should be applied as far as these points are applicable. If not, the positions of the test loads during this test have to be defined according to the operational conditions of use.

A.4.8 Discrimination test (3.8)

The following tests shall be performed with three different loads, e.g. Min, ½ Max and Max.

A.4.8.1 Non-self-indication and analog indication

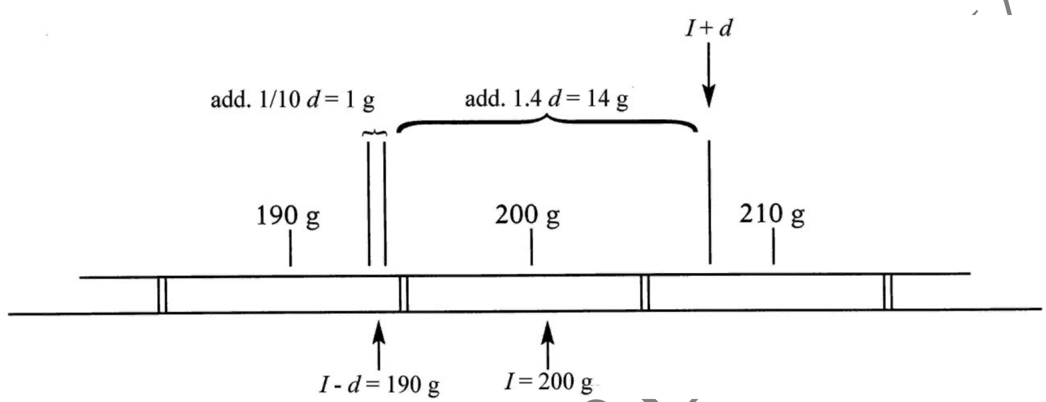
An extra load, but not less than 1 mg, shall be placed gently on or removed from the load receptor while the instrument is at equilibrium. For certain extra load the equilibrium mechanism shall assume a different position of equilibrium, as specified.

A.4.8.2 Digital indication

This test applies only to type examination and to instruments with $d \geq 5$ mg.

A load plus sufficient additional weights (say 10 times 1/10 *d*) shall be placed on the load receptor. The additional weights shall then be removed successively until the indication, *I*, is decreased unambiguously by one actual scale interval, $I - d$. One of the additional weights shall be placed back on the load receptor and a load equal to 1.4 *d* shall then be gently placed on the load receptor and give a result increased by one actual scale interval above the initial indication, $I + d$. See example in Figure 10.

Figure 10 – Instrument with $d = 10$ g



The indication at the start is $I = 200$ g.

Remove additional weights until the indication changes to $I - d = 190$ g.

Add 1/10 $d = 1$ g and thereafter 1.4 $d = 14$ g.

The indication shall then be $I + d = 210$ g.

A.4.9 Sensitivity of a non-self-indicating instrument (6.1)

During this test the instrument shall oscillate normally, and an extra load equal to the value of the mpe for the applied load, but not less than 1 mg, shall be placed on the instrument while the load receptor is still oscillating. For damped instruments the extra load shall be applied with a slight impact. The linear distance between the middle points of this reading and the reading without the extra load shall be taken as the permanent displacement of the indication. The test shall be performed with a minimum of two different loads (e.g. zero and Max).

A.4.10 Repeatability test (3.6.1)

For type approval two series of weighings shall be performed, one with a load of about 50 % and one with a load close to 100 % of Max. For instruments with Max less than 1 000 kg each series shall consist of 10 weighings. In other cases each series shall consist of at least 3 weighings. Readings shall be taken when the instrument is loaded, and when the unloaded instrument has come to rest between weighings. In the case of a zero deviation between the weighings, the instrument shall be reset to zero, without determining the error at zero. The true zero position need not be determined between the weighings.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall be in operation during the test.

For verification one series of weighings with about 0.8 Max is sufficient. Three weighings on classes III and IIII or six weighings on classes I and II are necessary.

A.4.11 Variation of indication with time (for instruments of classes II, III or IIII only)

A.4.11.1 Creep test (3.9.4.1)

Load the instrument close to Max. Take one reading as soon as the indication has stabilized and then note the indication while the load remains on the instrument for a period of four hours. During this test the temperature should not vary more than 2 °C.

The test may be terminated after 30 minutes if the indication differs less than 0.5 *e* during the first 30 minutes and the difference between 15 and 30 minutes is less than 0.2 *e*.

A.4.11.2 Zero return test (3.9.4.2)

The deviation in the zero indication before and after a period of loading with a load close to Max for half an hour, shall be determined. The reading shall be taken as soon as the indication has stabilized.

For multiple range instruments, continue to read the zero indication during the following 5 minutes after the indication has stabilized.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

A.4.12 Test for the stability of equilibrium (4.4.2)

Check the documentation of the manufacturer, whether the following stable equilibrium functions are described in detail and sufficiently:

- the basic principle, the function and the criteria for stable equilibrium;
- all adjustable and not adjustable parameters of the stable equilibrium function (time interval, number of measuring cycles, etc.);
- securing of these parameters; and
- definition of the most critical adjustment of the stable equilibrium (worst case). This shall cover all variants of a type.

Test the stable equilibrium with the most critical adjustment (worst case) and check that printing (or storing) is not possible when stable equilibrium is not yet reached.

Check that, under continuous disturbance of the equilibrium, no functions can be performed which require stable equilibrium, e.g. printing, storing, zero or tare operations.

Load the instrument up to 50 % of Max or up to a load included in the range of operation of the relevant function. Manually disturb the equilibrium by one single action and initiate the command for printing, data storage, or other function, as soon as possible. In the case of printing or data storage, read the indicated value over a period of 5 seconds following print-out. Stable equilibrium is considered to be achieved when no more than two adjacent values are indicated, one of which being the printed value. For instruments with differentiated scale divisions, this paragraph applies to *e* rather than to *d*.

In the case of zero-setting or tare balancing, check the accuracy according to A.4.2.3/A.4.6.2. Perform the test 5 times.

In case of vehicle-mounted, vehicle-incorporated or mobile instruments, tests have to be performed with a known operational test load, the instrument being in motion to ensure either that the stability criteria inhibit any weighing operation or that the stable equilibrium criteria of 4.4.2 are met. In case the instrument can be used to weigh liquid products in a vehicle, tests should be performed in conditions where the vehicle is stopped just before testing so that either the stability criteria inhibit any weighing operation or that the stable equilibrium criteria of 4.4.2 are met.

A.4.13 Additional tests for portable weighbridges (4.19)

Note: Portable instruments have very different constructions for a large number of very different applications so that it is principally not possible to define uniform test procedures. Different requirements, conditions and specifications could be necessary depending on the construction and application and, of course, on the metrological demands (e.g. accuracy class). These should be mentioned and described in the respective Test Report. A.4.13 therefore only provides some general means for properly testing a portable instrument.

To be performed during type approval:

- At a site agreed with the manufacturer:
  - examine the evenness of the reference area (all points of support of the bridge being at the same level) and then perform an accuracy test and an eccentricity test; and
  - realize several reference areas with some different faults in the evenness (the values of these faults are to be equal to the limits given by the manufacturer) and then perform an eccentricity test for each configuration.
- At a site where the instrument is used:
  - examine the conformity to the requirements for the mounting surface; and
  - examine the installation and perform tests to establish conformity with the metrological requirements.

A.5 Influence factors

A.5.1 Tilting (only class II, III and IIII instruments) (3.9.1.1)

The instrument shall be tilted both forwards and backwards longitudinally, and from side to side, transversely.

In practice the tests (no-load and loaded) described in A.5.1.1.1 and A.5.1.1.2 can be combined as follows.

After zero-setting in the reference position, the indication (prior to rounding) is determined at no-load and at the two test loads. The instrument is then unloaded and tilted (without a new zero-setting), after which the indications at no load and at the two test loads are determined. This procedure is repeated for each of the tilting directions.

In order to determine the influence of tilting on the loaded instrument, the indication obtained at each tilt shall be corrected for the deviation from zero which the instrument had prior to loading.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

A.5.1.1 Tilting of instruments with a level indicator or automatic tilt sensor (3.9.1.1a and b)

A.5.1.1.1 Tilting at no-load

The instrument shall be set to zero in its reference position (not tilted). The instrument shall then be tilted longitudinally up to the limiting value of tilting. The zero indication is noted. The test shall be repeated with transverse tilting.

A.5.1.1.2 Tilting when loaded

The instrument shall be set to zero in its reference position and two weighings shall be carried out at a load close to the lowest load where the maximum permissible error changes, and at a load close to Max. The instrument is then unloaded and tilted longitudinally and set to zero. The tilting shall be equal to the limiting value of tilting. Weighing tests as described above shall be performed. The test shall be repeated with transverse tilting.

A.5.1.2 Other instruments (3.9.1.1 c)

For instruments liable to be tilted and neither fitted with a level indicator nor with an automatic tilt sensor the tests in A.5.1.1 shall be performed with a tilting of 50/1000 or, in case of an instrument with automatic tilt sensor, with a tilting equal to the limiting value of tilting as defined by the manufacturer.

A.5.1.3 Tilt test for mobile instruments used outside in open locations (3.9.1.1d and 4.18.1)

Appropriate load receptors for applying the test loads are to be provided by the applicant.

The tilt test shall be performed with the limiting value of tilting.

The instrument shall be tilted both forwards and backwards longitudinally, and from side to side, transversely.

Functional tests shall be performed to ensure that, if applicable, tilt sensors or inclination switches function properly especially when generating the signal that the maximum permissible tilt is reached or exceeded (e.g. display switch-off, error signal, lamp), and inhibiting transmission and printing of weighing results.

The test shall be performed near the switching-off point (in the case of an automatic tilt sensor) or near the tilt where the load receptor comes into contact with the surrounding frame construction (in the case of a cardanic suspension). This is the limiting value of tilting.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

The instrument shall be tested according to A.5.1 and A.5.1.1 or A.5.1.2.

A.5.2 Warm-up time test (5.3.5)

An instrument using electric power shall be disconnected from the supply for a period of at least 8 hours prior to the test. The instrument shall then be connected and switched on and as soon as the indication has stabilized, the instrument shall be set to zero and the error at zero shall be determined. Calculation of the error shall be made according to A.4.4.3. The instrument shall be loaded with a load close to Max. These observations shall be repeated after 5, 15 and 30 minutes. Every individual measurement performed after 5, 15, and 30 minutes, shall be corrected for the zero error at that time.

For instruments of class I, the provisions of the operating manual for the time following connection to the mains shall be observed.

A.5.3 Temperature tests

Note: See Figure 11 for a practical approach to performing the temperature tests.

A.5.3.1 Static temperatures (3.9.2.1 and 3.9.2.2)

The test consists of exposure of the equipment under test (EUT) to constant (see A.4.1.2) temperatures within the range stated in 3.9.2, under free air conditions, for a 2 hour period after the EUT has reached temperature stability.

The weighing tests (loading and unloading) shall be carried out according to A.4.4.l:

- at a reference temperature (normally 20 °C but for class I instruments the mean value of the specified temperature limits);
- at the specified high temperature;
- at the specified low temperature;
- at a temperature of 5 °C, if the specified low temperature is ≤ 0 °C; and
- at the reference temperature.

The change of temperature shall not exceed 1 °C/min during heating and cooling down.

For class I instruments, changes in barometric pressure shall be taken into account.

For weighing tests at the specified high temperature the relative humidity shall not exceed 20 g/m^3.

Note: An absolute humidity of 20 g/m^3 corresponds to a relative humidity of 39 % at 40 °C, of 50 % at 35 °C and of 66 % at 30 °C. These values are valid for an air pressure of 1 013.25 hPa [4].

A.5.3.2 Temperature effect on the no-load indication (3.9.2.3)

The instrument shall be set to zero and then changed to the prescribed highest and lowest temperatures as well as at 5 °C if applicable. After stabilization the error of the zero indication shall be determined. The change in zero indication per 1 °C (class I instruments) or per 5 °C (other instruments) shall be calculated. The changes of these errors per 1 °C (class I instruments) or per 5 °C (other instruments) shall be calculated for any two consecutive temperatures of this test.

This test may be performed together with the temperature test (A 5.3.1). The errors at zero shall then be additionally determined immediately before changing to the next temperature and after the 2 hour period after the instrument has reached stability at this temperature.

Note: Preloading is not allowed before these measurements.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

A.5.4 Voltage variations (3.9.3)

Stabilize the EUT under constant environmental conditions.

The test consists of subjecting the EUT to voltage variations according to A.5.4.1, A.5.4.2, A.5.4.3 or A.5.4.4.

The test shall be performed with test loads of 10 *e* and a load between ½ Max and Max.

If the instrument is provided with an automatic zero-setting device or a zero-tracking device, it may be in operation during the test, in which case the error at zero point shall be determined according to A.4.2.3.2.

In the following U_{nom} designates the nominal value marked on the instrument. In case a range is specified U_{min} relates to the lowest value and U_{max} to the highest value of the range.

Reference: [4], [17]

A.5.4.1 Variations of AC mains voltage

Test severity:	Voltage variations:	lower limit 0.85 U_{nom} or 0.85 U_{min} upper limit 1.10 U_{nom} or 1.10 U_{max}
Maximum allowable variations:	All functions shall operate as designed. All indications shall be within the maximum permissible errors.	

Note: Where an instrument is powered by a three phase supply, the voltage variations shall apply for each phase successively.

A.5.4.2 Variations of external or plug-in power supply device (AC or DC), including rechargeable battery power supply if (re)charge of batteries during the operation of the instrument is possible

Test severity:	Voltage variations:	lower limit minimum operating voltage (see 3.9.3) upper limit: 1.20 U_{nom} or 1.20 U_{max}
Maximum allowable variations:	All functions shall operate as designed or the indication shall switch off. All indications shall be within the maximum permissible errors.	

A.5.4.3 Variations of non-rechargeable battery power supply, including rechargeable battery power supply if (re)charge of batteries during the operation of the instrument is not possible

Test severity:	Voltage variations:	lower limit: minimum operating voltage (see 3.9.3) upper limit: U_{nom} or U_{max}
Maximum allowable variations:	All functions shall operate as designed or the indication shall switch off. All indications shall be within the maximum permissible errors.	

A.5.4.4 Voltage variations of a 12 V or 24 V road vehicle battery

For specifications of the power supply used during the test to simulate the battery, refer to [21].

Test severity:	Voltage variations:	lower limit: minimum operating voltage (see 3.9.3) upper limit 12 V battery: 16 V upper limit 24 V battery: 32 V
Maximum allowable variations:	All functions shall operate as designed or the indication shall switch off. All indications shall be within the maximum permissible errors.	

A.6 Endurance test (3.9.4.3)

Note: Applicable only to instruments of classes II, III and IIII with Max ≤ 100 kg.

The endurance test shall be performed after all other tests.

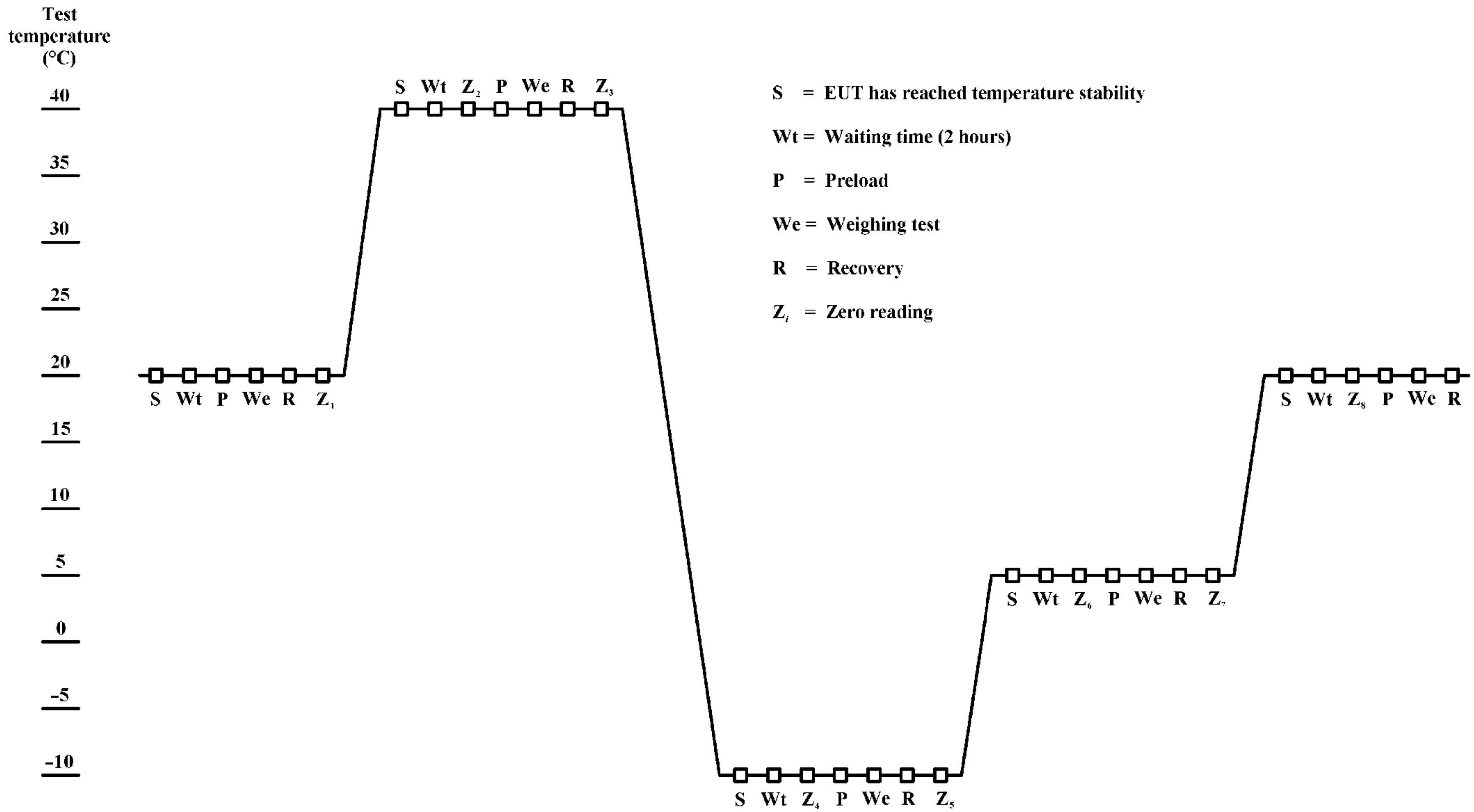
Under normal conditions of use, the instrument shall be subjected to the repetitive loading and unloading of a load approximately equal to 50 % of Max. The load shall be applied 100 000 times. The frequency and speed of application shall be such that the instrument attains an equilibrium when loaded and when unloaded. The force of the load applied shall not exceed the force attained in a normal loading operation.

A weighing test in accordance with the procedure in A.4.4.1 shall be performed before the endurance test is started to obtain the intrinsic error. A weighing test shall be performed after the completion of the loadings to determine the durability error due to wear and tear.

If the instrument is provided with an automatic zero-setting or zero-tracking device, it may be in operation during the test, in which case the error at zero point shall be determined according to A.4.2.3.2.

Figure 11

Proposed test sequence for test A.5.3.1 combined with A.5.3.2
(temperature test where the temperature limits are + 40 °C / – 10 °C



ANNEX B
Additional tests for electronic instruments

Preliminary note 1: The tests which are specific to electronic instruments, as described in this Annex, have been taken as far as possible from the work of the International Electrotechnical Commission (IEC) also taking into consideration the latest edition of the OIML International Document D 11 [4].

Preliminary note 2: Although references to current versions of IEC publications have been made, all EMC and other additional tests for electronic instruments should be conducted on the basis of most recent versions valid at the time of testing. This should be mentioned in the Test Report. The objective is to keep pace with future technical developments.

B.1 General requirements for electronic instruments under test

Energize the equipment under test (EUT) for a time period equal to or greater than the warm-up time specified by the manufacturer and maintain the EUT energized for the duration of the test.

Adjust the EUT as closely as practicable to zero prior to each test, and do not readjust it at any time during the test, except to reset it if a significant fault has been indicated. The deviation of the no-load indication due to any test condition shall be recorded, and any load indication shall be corrected accordingly to obtain the weighing result.

The handling of the instrument shall be such that no condensation of water occurs on the instrument.

B.2 Damp heat, steady state

Note: Not applicable to class I instruments or class II instruments where *e* is less than 1 g.

Test procedure in brief: The test consists of exposure of the EUT to a constant temperature (see A.4.1.2) and a constant relative humidity The EUT shall be tested with at least five different test loads (or simulated loads):

- at the 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;
- at the high temperature of the range specified in 3.9.2 and a relative humidity of 85 %, two days following temperature and humidity stabilization; and
- at the reference temperature and relative humidity of 50 %.

Maximum allowable variations: All functions shall operate as designed.

All indications shall be within maximum permissible errors.

Reference: [8], [10]

B.3 Performance tests for disturbances

Prior to any test, the rounding error shall be set as chose as possible to zero.

If there are interfaces on the instrument, an appropriate peripheral device shall be connected to each different type of interface during the tests.

For all tests note the environmental conditions at which they were realized.

Energize the EUT for a time period equal to or greater than the warm-up time specified by the manufacturer and maintain the EUT energized for the duration of the test.

Adjust the EUT as closely as practicable to zero prior to each test, and do not readjust it at any time during the test, except to reset it if a significant fault has been indicated. The deviation of the no-load indication due to any test condition shall be recorded, and any load indication shall be corrected accordingly to obtain the weighing result.

The handling of the instrument shall be such that no condensation of water occurs on the instrument.

Necessary additional or alternative disturbance tests for non-automatic weighing instruments powered from the vehicle battery shall be conducted according to [20], [21], [22] (see also B.3.7).

B.3.1 AC mains voltage dips and short interruptions

Test procedure in brief: Stabilize the EUT under constant environmental conditions.

A test generator suitable to reduce for a defined period of time 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 the EUT. The mains voltage reductions shall be repeated 10 times with an interval of at least 10 seconds.

The test shall be performed with one small test load.

Test severity:

Test	Reduction of amplitude to	Duration/ number of
Voltage dips: Test a	0 %	0.5
Voltage dips: Test b	0 %	1
Voltage dips: Test c	40 %	10
Voltage dips: Test d	70 %	25
Voltage dips: Test e	80 %	250
Short interruption	0 %	250

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed *e* or the instrument shall detect and react to a significant fault.

Reference: [4]

B.3.2 Bursts

The test consists in exposing the EUT to specified bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on a 50 Ω and a 1 000 Ω load are defined in the referenced standard. The characteristics of the generator shall be adjusted before connecting the EUT.

Before any test stabilize the EUT under constant environmental conditions.

The test shall be applied separately to:

- power supply lines; and
- I/O circuits and communication lines, if any.

The test shall be performed with one small test load.

Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than one minute for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy from being dissipated in the mains. For the coupling of the bursts into the input/output and communication lines, a capacitive coupling clamp as defined in the standard shall be used.

Test severity:	Level 2
Amplitude (peak value)	Power supply lines: 1 kV, I/O signal, data and control lines: 0.5 kV.
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed *e* or the instrument shall detect and react to a significant fault.
Reference:	[14]

B.3.3 Surge

This test is only applicable in those cases where, based on typical situations of installation, the risk of a significant influence of surges can be expected. This is especially relevant in cases of outdoor installations and/or indoor installations connected to long signal lines (lines longer than 30 m or those lines partially or fully installed outside the buildings regardless of their length).

The test is applicable to power lines, communication lines (internet, dial up modem, etc.), and other lines for control, data or signal mentioned above (lines to temperature sensors, gas or liquid flow sensors, etc.).

It is also applicable to DC powered instruments if the power supply comes from DC mains.

The test consists of exposing the EUT to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referenced standard. The characteristics of the generator shall be adjusted before connecting the EUT.

Before any test stabilize the EUT under constant environmental conditions.

The test shall be applied to power supply lines.

On AC mains supply lines at least 3 positive and 3 negative surges shall be applied synchronously with AC supply voltage in angles 0°, 90°, 180° and 270°. On any other kind of power supply, at least three positive and three negative surges shall be applied.

The test shall be performed with one small test load.

Both positive and negative polarity of the surges shall be applied. The duration of the test shall not be less than one minute for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the surge energy being dissipated in the mains.

Test severity:	Level 2
Amplitude (peak value)	Power supply lines: 0.5 kV (line to line) and 1 kV (line to earth)
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed *e* or the instrument shall detect and react to a significant fault.
Reference:	[15]

B.3.4 Electrostatic discharge

The test consists in exposing the EUT to specified direct and indirect electrostatic discharges.

An electrostatic discharge generator shall be used which has a performance as defined in the referenced standard. Before starting the tests, the performance of the generator shall be adjusted.

This test includes the paint penetration method, if appropriate.

For direct discharges the air discharge shall be used where the contact discharge method cannot be applied.

Before any test stabilize the EUT under constant environmental conditions.

At least 10 discharges shall be applied. The time interval between successive discharges shall be at least 10 seconds. The test shall be performed with one small test load.

For an EUT not equipped with a ground terminal, the EUT shall be fully discharged between discharges.

Contact discharges shall be applied on conductive surfaces; air discharges shall be applied on non-conductive surfaces.

Direct application:	In the contact discharges mode the electrode shall be in contact with the EUT. In the air discharge mode the electrode is approached to the EUT and the discharge occurs by spark.
Indirect application:	The discharges are applied in the contact mode to coupling planes mounted in the vicinity of the EUT.
Test severity:	Level 3 (see IEC 61000-4-2 [12]) DC voltage up to and including 6 kV for contact discharges and 8 kV for air discharges.
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed *e* or the instrument shall detect and react to a significant fault.
Reference:	[12]

B.3.5 Immunity to radiated electromagnetic fields

The test consists of exposing the EUT to specified electromagnetic fields.

Test equipment:	See IEC 61000-4-3 [13]
Test set-up:	See IEC 61000-4-3 [13]
Test procedure:	See IEC 61000-4-3 [13]

Before any test, stabilize the EUT under constant environmental conditions.

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

The test shall be performed with one small test load only.

Test severity:	Frequency range:	80 MHz-2 000 MHz
	Note: For instruments having no mains or other I/O ports available so that the test according to B.3.6 cannot be applied, the lower limit of the radiation test is 26 MHz.	
	Field strength:	10 V/m
	Modulation:	80 % AM, 1 kHz, sine wave

Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed *e* or the instrument shall detect and react to a significant fault.
Reference:	[13]

B.3.6 Immunity to conducted radio-frequency fields

The test consists in exposing the EUT to disturbances induced by conducted radio-frequency fields.

Test equipment:	See IEC 61000-4-6 [16]
Test set-up:	See IEC 61000-4-6 [16]
Test procedure:	See IEC 61000-4-6 [16]

Before any test, stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

The test shall be performed with one small test load only.

Test severity:	Frequency range:	0.15 MHz-80 MHz
	RF amplitude (50 Ω):	10 V (emf)
	Modulation:	80 % AM, 1 kHz, sine wave

Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed *e* or the instrument shall detect and react to a significant fault.
Reference:	[16]

B.3.7 Special EMC requirements for instruments powered from a road vehicle power supply

B.3.7.1 Electrical transient conduction along the supply line of external 12 V and 24 V batteries

The test consists in exposing the EUT to conducted transient disturbances along supply lines.

Test equipment:	See ISO 7637-2 (2004) [21]
Test set-up:	See ISO 7637-2 (2004) [21]
Test procedure:	See ISO 7637-2 (2004) [21]
Applicable standard:	ISO 7637-2 (2004) [21]

Before any test, stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

The test shall be performed with one small test load only.

Test pulses: Test pulses 2a+2b, 3a+3b, 4

Objective of the test: To verify compliance with the provisions mentioned under "maximum allowable variations" under the following conditions:

- transients due to a sudden interruption of current in a device connected in parallel with the device under test due to the inductance of the wiring harness (pulse 2a);

- transients from DC motors acting as generators after the ignition is switched off (pulse 2b);
- transients on the supply lines, which occur as a result of the switching processes (pulses 3a and 3b);
- voltage reductions caused by energizing the starter-motor circuits of internal combustion engines (pulse 4).

Test severity: Level IV of ISO 7637-2 (2004) [21]:

Battery voltage	Test pulse	Conducted voltage
12 V	2a	+ 50 V
	2b	+ 10 V
	3a	– 150 V
	3b	+ 100 V
	4	– 7 V
24 V	2a	+ 50 V
	2b	+ 20 V
	3a	– 200 V
	3b	+ 200 V
	4	– 16 V

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed *e* or the instrument shall detect and react to a significant fault.

Reference: [21]

B.3.7.2 Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines

The test consists in exposing the EUT to conducted disturbances along lines other than supply lines.

Test equipment: See ISO 7637-3 [22]

Test set-up: See ISO 7637-3 [22]

Test procedure: See ISO 7637-3 [22]

Applicable standard: ISO 7637-3 [22]

Before any test, stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

The test shall be performed with one small test load only.

Test severity: According to ISO 7637-3 [22]

Test pulses: Test pulses a and b

Objective of the test: To verify compliance with the provisions mentioned under "maximum allowable variations" under conditions of transients which occur on other lines as a result of the switching processes (pulses a and b)

Test severity: Level IV of ISO 7637-3 [22]

Battery voltage	Test pulse	Conducted voltage
12 V	a	– 60 V
	b	+ 40 V
24 V	a	– 80 V
	b	+ 80 V

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed *e* or the instrument shall detect and react to a significant fault.

Reference: [22]

B.4 Span stability test

Note: Not applicable to class I instruments.

Test procedure in brief: The test consists in observing the variations of the error of the EUT under sufficiently constant ambient conditions (reasonably constant conditions in a normal laboratory environment) at various intervals before, during and after the EUT has been subjected to performance tests. For instruments with an incorporated automatic span adjustment device the device shall be activated during this test before each measurement in order to prove its stability and its intended use.

The performance tests shall include the temperature test and, if applicable, the damp heat test; they shall not include any endurance test; other performance tests in Annexes A and B may be performed.

The EUT shall be disconnected from the mains power (also battery) or power supply device, two times for at least 8 hours during the period of the 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 specification.

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

The EUT shall be stabilized at sufficiently constant ambient conditions after switch-on for at least 5 hours, but at least 16 hours after the temperature and damp heat tests have been performed.

Test duration: 28 days or the period necessary for the performance tests to be carried out, whichever is shorter.

Time between measurements:	Between ½ day and 10 days, with a fairly even distribution of the measurements over the total duration of the test.
Test load:	Near Max. The same test weights shall be used throughout this test.
Number of measurements:	At least 8.
Test sequence:	Stabilize all factors at sufficiently constant ambient conditions. Adjust the EUT as close to zero as possible. Automatic zero-tracking shall be made inoperative and automatic built-in span adjustment device shall be made operative. Apply the test weight(s) and determine the error. At the first measurement immediately repeat zeroing and loading four times to determine the average value of the error. For the next measurements perform only one, unless either the result is outside the specified tolerance or the range of the five readings of the initial measurement is more than 0.1 *e*. Record the following data: a) date and time, b) temperature, c) barometric pressure, d) relative humidity, e) test load, f) indication, g) errors, h) changes in test location, and apply all necessary corrections resulting from variations of temperature, pressure, and other influence factors due to the test load between the various measurements. Allow full recovery of the EUT before any other tests are performed.
Maximum allowable variations:	The variation in the errors of indication shall not exceed half the verification scale interval or half the absolute value of the maximum permissible error on initial verification for the test load applied, whichever is greater, on any of the *n* measurements. Where the differences of the results indicate a trend 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.

ANNEX C

Testing and certification of indicators and analog data processing devices as modules of non-automatic weighing instruments

C.1 Applicable requirements

The use of the term "indicator" in the following, includes any analog data processing devices.

Families of indicators are possible if the requirements under 3.10.4 are observed.

The following requirements apply to indicators:

3.1.1	Accuracy classes
3.1.2	Verification scale interval
3.2	Classification of instruments
3.3	Additional requirements for multi-interval instruments
3.4	Auxiliary indicating devices
3.5	Maximum permissible errors
3.9.2	Temperature
3.9.3	Power supply
3.10	Type evaluation tests and examinations
4.1	General construction requirements
4.1.1	Suitability
4.1.2	Security
4.2	Indication of weighing results
4.3	Analog indicating device
4.4	Digital indicating devices
4.5	Zero-setting and zero-tracking devices
4.6	Tare devices
4.7	Preset tare devices
4.9	Auxiliary verification devices (removable or fixed)
4.10	Selection of weighing ranges on a multiple range instrument
4.11	Devices for selection (or switching) between various load receptors and/or load transmitting devices and various load measuring devices
4.12	"Plus and minus" comparator instruments
4.13	Instruments for direct sales to public
4.14	Additional requirements for price-computing instruments for direct sales to the public
4.16	Price-labeling instruments
5.1	General requirements
5.2	Acting upon significant faults
5.3	Functional requirements
5.4	Performance and span stability tests
5.5	Additional requirements for software-controlled electronic devices

Note: Especially for PCs, the category and necessary tests according to Table 11 should be observed.

C.1.1 Accuracy class

The indicator shall have the same accuracy class as the weighing instrument it is intended to be used with. An indicator of class III can also be used in a weighing instrument of class IIII taking into account the requirements of class IIII.

C.1.2 Number of verification scale intervals

The indicator shall have the same or a higher number of verification scale intervals as the weighing instrument with which it is intended to be used.

C.1.3 Temperature range

The indicator shall have the same or a larger temperature range as the weighing instrument with which it is intended to be used.

C.1.4 Range of input signal

The range of the analog output signal of the load cell(s) connected shall be within the range of the input signal for which the indicator is specified.

C.1.5 Minimum input signal per verification scale interval

The minimum input signal per verification scale interval (μV) the indicator is specified for shall be equal or smaller than the analog output signal of the load cell(s) connected divided by the number of scale intervals of the weighing instrument.

C.1.6 Range of load cell impedance

The resulting impedance of the load cell(s) connected to the indicator shall be within the range specified for the indicator.

C.1.7 Maximum cable length

Only indicators employing six-wire technology with remote sensing (of the load cell excitation voltage) shall be used if the load cell cable has to be lengthened or if several load cells are connected by means of a separate load cell junction box. However, the length of the (additional) cable between the load cell or the load cell junction box and the indicator shall not exceed the maximum length the indicator is specified for. The maximum cable length depends on the material and the cross section of the single wire, and thus can also be expressed as the maximum wire resistance, given in units of impedance.

C.2 General principles of testing

A number of tests can be performed with either a load cell or a simulator but both have to fulfill the requirements of A.4.1.7. However the disturbance tests should be performed with a load cell or a weighing platform with load cell being the most realistic case.

Note: For the testing of a family of indicators, in principle, the provisions described in 3.10.4 apply. Special attention has to be paid to the possibly different EMC and temperature behavior of different variants of indicators.

C.2.1 Worst case conditions

In order to limit the number of tests the indicator shall, as far as possible, be tested under conditions which cover the maximum range of applications. This means that most tests shall be performed under worst case conditions.

C.2.1.1 Minimum input signal per verification scale interval, *e*

The indicator shall be tested at minimum input signal (normally minimum input voltage) per verification scale interval, *e*, specified by the manufacturer. This is assumed to be the worst case for the performance tests (intrinsic noise covering the load cell output signal) and for the disturbance tests (unfavorable ratio of signal and e.g. high frequency voltage level).

C.2.1.2 Minimum simulated dead load

The simulated dead load shall be the minimum value the manufacturer has specified. A low input signal of the indicator covers the maximum range of problems with regard to linearity and other significant properties. The possibility of a larger zero drift with a larger dead load is regarded as a less significant problem. However, possible problems with the maximum value of the dead load (e.g. saturation of the input amplifier) have to be considered.

C.2.2 Testing at high or low simulated load cell impedance

The disturbance tests (see 5.4.3) shall be performed with a load cell instead of a simulator and with the highest practical value of the impedance (at least 1/3 of the specified highest impedance) for the load cell(s) to be connected as specified by the manufacturer. For the “Immunity to radiated electromagnetic fields” test, the load cell(s) should be placed within the uniform area (IEC 61000-4-3 [13]) inside the anechoic chamber. The load cell cable shall not be decoupled because the load cell is supposed to be an essential part of the weighing instrument and not a peripheral (see also Figure 6 in IEC 61000-4-3 [13] which shows a test set-up for a modular EUT).

The influence tests (see 5.4.3) may either be performed using a load cell or a simulator. However the load cell / simulator shall not be exposed to the influence during the tests (i.e. the simulator is outside the climate chamber). The influence tests shall be performed at the lowest impedance of the load cell(s) to be connected as specified by the applicant.

Table 12 indicates which test has to be performed with the lowest impedance (low) and which with the highest practical value of the impedance (high).

Table 12

EN 45501 clause	Article concerning	Fraction, p_i	Impedance	µV/*e*
A.4.4	Weighing performance	0.3 .. 0.8	low	min
A.4.5	Multiple indicating device			
	Analog	1	low	min
	Digital	0	low	min
A.4.6.1	Weighing accuracy with tare		low	min
A.4.10	Repeatability		low	min/max**
A.5.2	Warm-up time test	0.3 .. 0.8	low	min/max**
A.5.3.1	Temperature (effect on amplification)	0.3 .. 0.8	low	min/max**
A.5.3.2	Temperature (effect on no-load)	0.3 .. 0.8	low	min
A.5.4	Voltage variations	1	low	min
3.9.5	Other influences			
B.2.2	Damp heat steady state	0.3 .. 0.8	low	min/max**
B.3.1	AC mains voltage dips and short interruptions	1	high*	min
B.3.2	Bursts	1	high*	min
B.3.3	Surge (if applicable)	1	high*	min
B.3.4	Electrostatic discharge	1	high*	min
B.3.5	Immunity to radiated electromagnetic fields	1	high*	min
B.3.6	Immunity to conducted radio-frequency fields	1	high*	min
B.3.7	Special EMC requirements for instruments powered from road vehicle power supply	1	high*	min
B.4	Span stability	1	low	min

* Test has to be performed with load cell.

** See C.3.1.1.

The impedance of the load cell referred to in this Annex is the input impedance of the load cell which is the impedance that is connected between the excitation lines.

C.2.3 Peripheral equipment

Peripheral equipment shall be supplied by the applicant to demonstrate correct functioning of the system or sub-system and the non-corruption of weighing results.

When performing disturbance tests, peripheral equipment may be connected to all different interfaces. However, if not all optional peripheral equipment is available or cannot be placed on the test site (especially when having to place them in the uniform area during radiated fields tests), then at least cables shall be connected to the interfaces. Cable types and lengths shall be as specified in the manufacturer's authorized manual. If cable lengths longer than 3 m are specified, testing with lengths of 3 m is regarded as being sufficient.

C.2.4 Adjustment and performance tests

The adjustment (calibration) shall be performed as described by the manufacturer. Weighing tests shall be performed with at least five different (simulated) loads from zero to the maximum number of verification scale intervals, *e*, with the minimum input voltage per *e* (for high sensitive indicators possibly also with the maximum input voltage per *e*, see C.2.1.1). It is preferable to choose points close to the changeover points of the error limits.

C.2.5 Indication with a scale interval smaller than *e*

If an indicator has a device for displaying the weight value with a smaller scale interval (not greater than $1/5 \times p_i \times e$, high resolution mode), this device may be used to determine the error. It may also be tested in service mode where the "raw values" (counts) of the analog-to-digital converter are given. If either device is used it should be noted in the Test Report.

Prior to the tests it shall be verified that this indicating mode is suitable for establishing the measuring errors. If the high resolution mode does not fulfill this demand, a load cell, weights and small additional weights shall be used to determine the changeover points with an uncertainty better than $1/5 \times p_i \times e$ (see A.4.4.4).

C.2.6 Load cell simulator

The simulator shall be suitable for the indicator. The simulator shall be calibrated for the used excitation voltage of the indicator (AC excitation voltage also means AC calibration).

C.2.7 Fractions, p_i

The standard fraction is $p_i = 0.5$ of the maximum permissible error of the complete instrument, however, it may vary between 0.3 and 0.8.

The manufacturer shall state the fraction p_i which is then used as a basis for the tests for which a range of p_i is assigned (see Table under C.2.2).

No value for the fraction p_i is given with respect to repeatability. Insufficient repeatability is a typical problem of mechanical instruments with leverworks, knives and pans and other mechanical structures that may cause e.g. a certain friction. It is expected that the indicator will normally not cause a lack in repeatability. In the rare cases it does, this is not a lack of repeatability within the meaning of R 76-1, however, special attention shall be paid to the reasons and the consequences.

C.3 Tests

C.3.1 Temperature and performance tests

In principle, the temperature effect on the amplification is tested according to the following procedure:

- Carry out the prescribed adjustment procedure at 20 °C.
- Change the temperature and verify that the measuring points are within the error limits after correction of a zero shift.

This procedure shall be carried out at the highest amplification and the lowest impedance to which the indicator can be adjusted. However, those conditions shall ensure that the measurement can be performed with such an accuracy that it is sufficiently certain that non-linearities found in the error curve are not caused by the test equipment used.

In case this accuracy cannot be reached (e.g. with high sensitive indicators) the procedure has to be carried out twice (C.2.1.1). The first measurement has to be carried out with the lowest amplification, using at least five measuring points. The second measurement is carried out with the highest amplification, using two measuring points, one at the low end and one at the high end of the measuring range. The change in amplification due to temperature is acceptable if a line of the same form found at the first measurement, drawn between the two points and corrected for a zero-shift, is inside the relevant error limits (error envelope).

The temperature effect on no load indication is the influence of temperature variation on the zero expressed in changes of the input signal in µV. The zero drift is calculated with the help of a straight line through the indications at two adjacent temperatures. The zero drift should be less than $p_i \times e$ / 5 K.

C.3.1.1 Tests with high and low amplification

If the minimum input voltage per verification scale interval is very low, i.e. less than or equal to 1 µV/*e*, it may be difficult to find a suitable simulator or load cell to determine the linearity. If the value of the fraction p_i is 0.5 for an indicator with 1 µV/*e* then the maximum permissible error for simulated loads smaller than 500 *e* is ± 0.25 µV/*e*. The error of the simulator shall not cause an effect exceeding 0.05 µV/*e* or at least the repeatability should be equal to or better than 0.05 µV/*e*.

In any case, the following has to be taken into account:

a) The linearity of the indicator is tested over the complete input range. Example: A typical indicator with a load cell excitation power supply of 12 V has a measuring range of 24 mV. If the indicator is specified for 6000 *e* the linearity can be tested with 24 mV/6000 *e* = 4 µV/*e*.

b) With the same setup, the temperature effect on the amplification shall be measured, during the static temperature test and during the damp heat steady state test.

c) After that the indicator is set up with the minimum dead load specified and with the minimum input voltage per verification scale interval, *e*. Suppose this value is 1 µV/*e*, which means that only 25 % of the input range is used.

d) The indicator shall now be tested with an input voltage close to 0 mV and close to 6 mV. The indication at both input voltages is registered at 20 °C, 40 °C, – 10 °C, 5 °C and 20 °C. The differences between the indication at 6 mV (corrected for the indication at 0 mV) at 20 °C and the corrected indications at the other temperatures are plotted on a graph. The points found are connected to the zero point by means of curves of the same shape form as those found in (a) and (b). The curves drawn shall be within the error envelope for 6 000 *e*.

e) During this test the temperature effect on no load indication can also be measured to see if the effect is less than $p_i \times e$/5 K.

f) If the indicator fulfils the above-mentioned requirements it also complies with 3.9.2.1, 3.9.2.2, 3.9.2.3 and it complies with the requirements for the static temperature test and damp heat steady state test.

C.3.2 Tare

The influence of tare on the weighing performance depends exclusively on the linearity of the error curve. The linearity will be determined when the normal weighing performance tests are carried out. If the error curve shows a significant nonlinearity, the error envelope shall be shifted along the curve, to see if the indicator meets the demands for the tare value corresponding with the steepest part of the error curve.

C.3.3 Testing the sense function (with six wire load cell connection only)

C.3.3.1 Scope

Indicators intended for connection of strain gauge load cells employ the 4-wire or the 6-wire principle of the load cell connection. When 4-wire technology is used, lengthening the load cell cable or using a separate load cell junction box with an extra cable is not allowed at all. Indicators using 6-wire technology have a sense input enabling the indicator to compensate variations in load cell excitation voltage due to lengthened cables or changes of cable resistance due to temperature. However, in contrast to the theoretical principle of function, the compensation of variations in load cell excitation voltage is limited due to a limited input resistance of the sense input. This may lead to an influence by variation of cable resistance due to temperature variation and result in a significant shift of the span.

C.3.3.2 Test

The sense function shall be tested under worst case conditions, i.e.:

- the maximum value of the load cell excitation voltage;
- the maximum number of load cells that may be connected (can be simulated); and
- the maximum cable length (can be simulated).

C.3.3.2.1 Simulated maximum number of load cells

The maximum number of load cells can be simulated by putting an extra ohmic shunt resistor on the excitation lines, connected in parallel with the load cell simulator or the load cell respectively.

C.3.3.2.2 Simulated maximum cable length

The maximum cable length can be simulated by putting variable ohmic resistors in all six lines. The resistors shall be set to the maximum cable resistance and thus the maximum cable length (depending on the intended material, e.g. copper or others, and the cross section). However, in most cases it is sufficient to place the resistors only in the excitation lines and the sense lines, since the input impedance of the signal input is extremely high in comparison to that of the sense input. Therefore the signal input current is nearly zero or at least extremely small in comparison to the current on the excitation and sense lines. The input current being near to zero, no significant effect can be expected, since the voltage drop is negligible.

C.3.3.2.3 Readjustment of the indicator

The indicator shall be readjusted after having set the cable simulation resistors.

C.3.3.2.4 Determining the span variation

The span between zero and maximum (simulated) load shall be measured. It is assumed that under worst case conditions a change of resistance due to a temperature change corresponding to the whole temperature range of the instrument may occur. Therefore a variation of the resistance, ΔR_{Temp}, corresponding to the difference between minimum and maximum operating temperatures shall be simulated. The expected variation of resistance shall be determined according to the following formula:

$$\Delta R_{\text{Temp}} = R_{\text{cable}} \times \alpha \times (T_{\max} - T_{\min})$$

where: R_{cable} = resistance of a single wire, calculated according to the following formula:

$$R_{cable} = (\rho \times l) / A$$

where: ρ = specific resistance of the material (e.g. copper: ρ_{copper} = 0.017 5 Ω mm² / m)

l = length of the cable (in m)

A = cross section of the single wire (in mm²)

α = temperature coefficient of the cable material in 1/K (e.g. for copper, α_{copper} = 0.003 9 1/K)

After having set the variable ohmic resistors to the new value the span between zero and maximum load shall be determined again. Since the variation can be positive or negative both directions shall be tested, e.g. for a class III instrument the variation of simulated cable resistance shall correspond to a variation of temperature by 50 K in both directions, increasing and decreasing temperature (the temperature range being – 10 °C to + 40 °C).

C.3.3.2.5 Limits of span variation

For determining the limits of span variation due to temperature influence on the cable, the results of the temperature tests on the indicator shall be considered. The difference between the maximum span error of the indicator due to temperature and the error limit may be assigned to the effect on the span due to limited compensation by the sense device. However, this effect shall not cause an error of more than one third of the absolute value of the maximum permissible error multiplied by p_i.

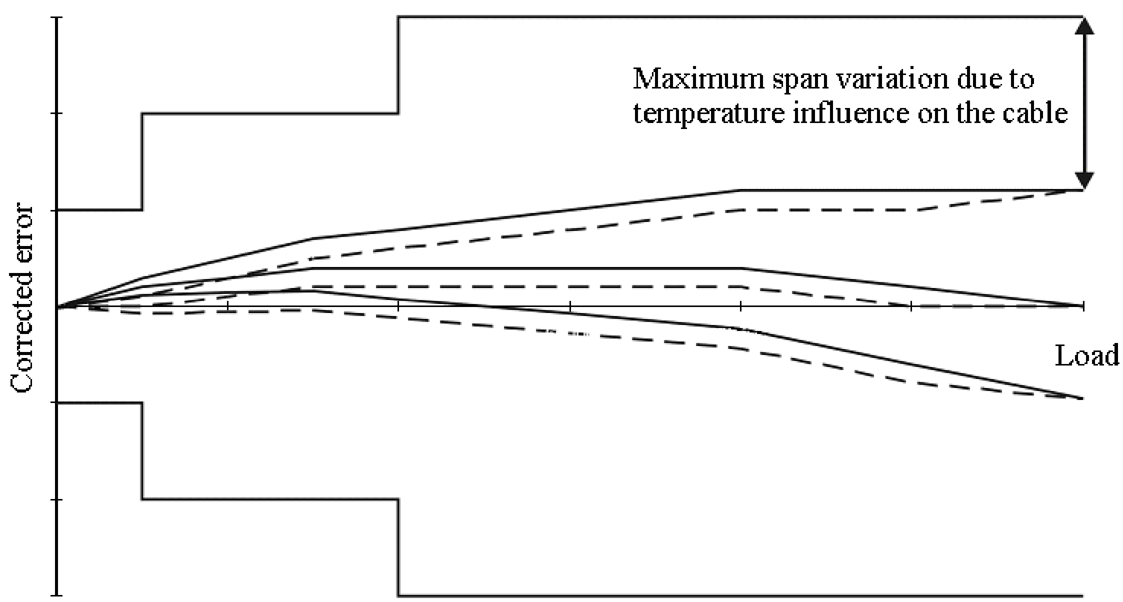
$$\Delta \text{span}(\Delta T) \leq p_i \times \text{mpe} - E_{max}(\Delta T)$$

where: $\Delta \text{span}(\Delta T) \leq {}^{1}/_{3}\, p_i \times \text{mpe}_{abs}$

If the indicator is not able to meet these conditions, the maximum cable resistance and thus the maximum cable length has to be reduced or a larger cross section has to be chosen.

The specific cable length may be given in the form m/mm² (depending on the material of the cable, e.g. copper, aluminium).

Figure 12



C.3.4 Other influences

Other influences and restraints should be taken into consideration for the complete instrument and not for the modules.

C.4 Type Approval Certificates Certificates

C.4.1 General

The Certificate shall contain common information and data about the Issuing Authority, the manufacturer and the indicator.

The following important information about the indicator shall be given as “Identification of the certified module”:

- type, accuracy class;
- value of the fractional error, p_i;
- temperature range;
- maximum number of verification scale intervals;
- minimum input voltage per verification scale interval;
- measuring range; and
- minimum load cell impedance.

C.4.2 Test Report Format

The Test Report Format shall contain detailed information about the indicator. These are technical data, description of the functions, characteristics and features 2. The relevant information is as follows:

Report number:	zzzzz
Type examination of:	Indicator as a module of a non-automatic electromechanical weighing instrument
Issuing authority:	Name, address, person responsible
Manufacturer:	Name, address
Type of module:	....
Test requirements:	EN 45501: XXXX
Summary of the examination:	Separately tested module, p_i = 0.5, connected load cell or load cell simulator, connected peripherals, special information if some tests were performed by the manufacturer and why they were accepted, results of the test in brief.
Evaluator:	Name, date, signature

Table of contents:

This report belongs to Test Certificate no xxxxxx

1 General information concerning the module:

Description of the housing, display, keyboard, plugs and connectors, etc. shall be briefly described and supported by corresponding figures or photos of the indicator.

2 Functions, facilities and devices of the module:

Zero-setting devices, tare devices, weighing ranges, modes of operation, etc. (see clause 4), and facilities of electronic instruments as mentioned in clause 5 shall be listed.

3 Technical data:

In order to check the compatibility of modules when using the modular approach (see 3.10.2 and Annex F) a certain set of data is necessary. This part contains the data of the indicator in the same presentation and units that is needed to check the requirements of Annex F easily.

3.1 Metrological data with regard to the weighing instrument

- Accuracy class
- Maximum number of verification scale intervals, n
- Operating temperature range (°C)
- Value of the fractional error, p_i

3.2 Electrical data

- Power supply voltage (V AC or DC)
- Form (and frequency (Hz)) of the power supply
- Load cell excitation voltage (V AC or DC)
- Minimum signal voltage for dead load (mV)
- Maximum signal voltage for dead load (mV)
- Minimum input voltage per verification scale interval, *e* (µV)
- Measuring range minimum voltage (mV)
- Measuring range maximum voltage (mV)
- Minimum load cell impedance (Ω)
- Maximum load cell impedance (Ω)

3.3 Sense system

Existing or not existing

3.4 Signal cable

Additional cable between the indicator and the load cell or the load cell junction box respectively (only allowed with indicators using six wire system, i.e. sense system) shall be specified as follows:

- material (copper, aluminium, etc.);
- length (m)
- cross section (mm^2); or
- specific length (m/mm^2) when the material (copper, aluminium etc.) is specified; or
- maximum ohmic resistance per single wire.

4 Documents:

List of documents.

5 Interfaces:

Interface types and numbers for peripheral devices and for other devices.
All interfaces are protective in the sense of 5.3.6.1 in R 76-1.

6 Connectable devices:

Printer, display, etc. For applications not subject to mandatory verification, any peripheral devices may be connected. Examples: D/A converters, PC, etc.

7 Descriptive markings and control marks:

The means to apply the descriptive markings shall be described considering 7.1.4 and 7.1.5 as far as applicable. In addition to the complete instrument the module itself must be clearly identifiable. The places for the descriptive plate and the verification marks shall be described. If applicable the means for sealing and securing the indicator shall be described and shown in figures or photos.

8 Test equipment:

Information concerning the test equipment used for type evaluation of this module and information about calibration of the test equipment. Examples: load cell simulator, temperature chambers, voltmeters, transformers, disturbance test equipment, etc.

9 Remarks on the tests:

Example: In the R 76-2 checklist, the parts related to the complete weighing instrument ("descriptive markings", "verification marks and sealing" and partially "indicating device") are not filled in. During the disturbance tests a load cell of the type .... and a printer of the type .... was connected.

10 Measuring results:

11 Technical requirements:

ANNEX D

Testing and certification of digital data processing devices, terminals and digital displays as modules of non-automatic weighing instruments

D.1 Applicable requirements

D.1.1 Requirements for digital data processing devices, terminals and digital displays

The following requirements apply to these modules as far as applicable:

3.3	Additional requirements for multi-interval instruments
3.9.3	Power supply
3.9.5	Other influence quantities and restraints
3.10	Type evaluation tests and examinations
4.1	General construction requirements
4.2	Indication of weighing results *(not for digital data processing devices)*
4.4	Digital indicating devices *(not for digital data processing devices)*
4.5	Zero-setting and zero-tracking devices
4.6	Tare devices
4.7	Preset-tare devices
4.10	Selection of weighing ranges on a multiple range instrument
4.11	Devices for selection (or switching) between various load receptors and/or load transmitting devices and various load measuring devices
4.13	Instruments for direct sales to the public
4.14	Additional requirements for price computing instruments for direct sales to the public
4.16	Price-labeling instruments
5.1	General requirements
5.2	Acting upon significant faults
5.3	Functional requirements
5.4	Performance and span stability tests
5.5	Additional requirements for software-controlled electronic devices
8.2.1.2	Descriptive documents

D.1.2 Supplementary requirements

D.1.2.1 Fraction of error limits

Digital data processing devices, terminals and digital displays are purely digital modules. For these modules, the fraction is p_i = 0.0 of the maximum permissible error of the complete instrument it is intended to be used with.

D.1.2.2 Accuracy class

Digital data processing devices, terminals and digital displays are purely digital modules. Therefore they can be used in weighing instruments of all accuracy classes. The relevant requirements of the class of weighing instrument they are intended to be used with shall be taken into account.

D.2 General principles of testing

D.2.1 General

Digital data processing devices, terminals and digital displays are purely digital modules. Therefore the:

- design and construction according to the documentation (8.2.1.2);
- functions and indications according to the requirements mentioned in E.1.1; and
- disturbances according to E.3

shall be tested.

However, all indicated values and all functions which are transmitted and/or released via an interface shall be tested to ensure that they are correct and in compliance with this Recommendation.

D.2.2 Simulating devices

For testing these modules a suitable simulating device (e.g. ADC for testing a digital data processing device; weighing module or digital data processing device for testing a terminal or digital display) shall be connected to the input interface of the module so that all functions can be operated and tested.

D.2.3 Displaying devices

For testing a digital data processing device a suitable digital display or terminal shall be connected to display the respective weighing results and to operate all functions of the digital data processing device.

D.2.4 Interface

The requirements of 5.3.6 are applicable to all interfaces.

D.2.5 Peripheral devices

Peripheral devices shall be supplied by the applicant to demonstrate correct functioning of the module and that weighing results cannot inadmissibly be influenced by peripheral devices.

When performing disturbance tests peripheral devices shall be connected to every different interface.

D.3 Tests

For these modules the following tests (according to Annex A and Annex B) shall be performed:

Voltage variations*	A.5.4
AC mains voltage dips and short interruptions**	B.3.1
Bursts**	B.3.2
Surge (if applicable)**	B.3.3
Electrostatic discharge**	B.3.4
Immunity to radiated electromagnetic fields**	B.3.5
Immunity to conducted radio-frequency fields**	B.3.6
Special EMC requirements for instruments powered from road vehicle power supply**	B.3.7

* For the voltage variations test only the legally relevant functions and the easy and unambiguous reading of the primary indications shall be observed.

** Purely digital modules need not be tested for disturbances (B.3) if conformity to the relevant IEC Standards is otherwise established to at least the same level as required in this Recommendation.

D.4 Test Certificates

D.4.1 General

The Certificate shall contain common information and data about the Issuing Authority, the manufacturer and the module (digital data processing device, terminal or digital display).

D.4.2 Test Report Format

The Test Report shall contain detailed information about the module (digital data processing device, terminal or digital display). These are technical data, description of the functions, characteristics,and features. The relevant information is as follows:

Report number:	zzzzz
Type examination of a:	Module (digital data processing device, terminal or digital display) for a non-automatic electromechanical weighing instrument.
Issuing authority:	Name, address, person responsible.
Manufacturer:	Name, address.
Type of module:	....
Test requirements:	EN 45501 xxxx
Summary of the examination:	Separately tested module, $p_i = 0.0$, connected devices for simulating the input signal, for displaying the weighing results and to operate the module, connected peripherals, special information as if some tests were performed by the manufacturer and why they were accepted, results of the test in brief.
Evaluator:	Name, date, signature.

Table of contents:

1 General information concerning the type of module:

Short description of the module, interfaces.

2 Functions, facilities and devices of the module:

Zero-setting devices, tare devices, multi-interval function, different weighing ranges, modes of operation, etc.

3 Technical data:

Tare ranges, etc.

4 Documents:

List of documents.

5 Interfaces:

Interface types and numbers, for peripheral devices and for other devices.

All interfaces are protective

6 Connectable devices:

Terminal, printer, digital display, etc.. For applications not subject to mandatory verification, any peripheral devices may be connected (examples: D/A converters, PC, etc.).

7 Control marks:

If securing (sealing) is required for the weighing instrument the adjustment elements of this module can be protected by a control mark (adhesive mark or seal).

8 Test equipment:

Information concerning the test equipment used for type evaluation of this module. Information about calibration of the equipment. Examples: voltmeters, transformers, disturbance test equipment, etc.

9 Remarks on the tests:

During the disturbance tests a printer of the type ... was connected.

10 Measuring results:

.

11 Technical requirements:

ANNEX E

Testing and certification of weighing modules as modules of non-automatic weighing instruments

E.1 Applicable requirements

E.1.1 Requirements for weighing modules

The following requirements apply to weighing modules:

3.1	Principles of classification
3.2.	Classification of instruments
3.3	Additional requirements for multi-interval instruments
3.5	Maximum permissible errors
3.6	Permissible differences between results
3.8	Discrimination
3.9	Variations due to influence quantities and time
3.10	Type evaluation tests and examinations
4.1	General construction requirements
4.2	Indication of weighing results
4.4	Digital indicating devices
4.5	Zero-setting and zero-tracking devices
4.6	Tare devices
4.7	Preset-tare devices
4.10	Selection of weighing ranges on a multiple range instrument
4.11	Devices for selection (or switching) between various load receptors and/or load transmitting devices and various load measuring devices
4.13	Instruments for direct sales to the public
4.14	Additional requirements for price computing instruments for direct sales to the public
4.16	Price-labeling instruments
5.1	General requirements
5.2	Acting upon significant faults
5.3	Functional requirements
5.4	Performance and span stability tests
5.5	Additional requirements for software-controlled electronic devices

E.1.2 Supplementary requirements

E.1.2.1 Fraction of error limits

For a weighing module, the fraction is p_i = 1.0 of the maximum permissible error of the complete instrument.

E.1.2.2 Accuracy class

The weighing module shall have the same accuracy class as the weighing instrument it is intended to be used with. A weighing module of class III can also be used in a weighing instrument of class IIII taking into account the requirements of class IIII.

E.1.2.3 Number of verification scale intervals

The weighing module shall have at least the same number of verification scale intervals as the weighing instrument it is intended to be used with.

E.1.2.4 Temperature range

The weighing module shall have the same or a wider temperature range as the weighing instrument it is intended to be used with.

E.2 General principles of testing

E.2.1 General

A weighing module shall be tested in the same way as a complete weighing instrument, with the exception of testing the design and construction of the indicating device and control elements. However, all indicated values and all functions which are transmitted and/or released via the interface shall be tested to ensure that they are correct and in compliance with this Recommendation.

E.2.2 Indicating devices

For this test a suitable indicating device or terminal shall be connected to indicate the respective weighing results and to operate all functions of the weighing module.

If the weighing results of the weighing module have a differentiated scale division according to 3.4.1 the indicating device shall indicate this digit.

The indicating device should preferably allow indication to a higher resolution to determine the error, e.g. in a special service mode. If a higher resolution is used it should be noted in the Test Report.

E.2.3 Interface

The requirements of 5.3.6 are applicable to all interfaces.

E.2.4 Peripheral equipment

Peripheral equipment shall be supplied by the applicant to demonstrate correct operation of the system or sub-system and the non-corruption of weighing results.

When performing disturbance tests, peripheral equipment shall be connected to every different interface.

E.3 Tests

The complete testing procedure for non-automatic weighing instruments (according to Annex A and Annex B) shall be performed.

E.4 OIML Certificates

E.4.1 General

The Certificate shall contain common information and data about the Issuing Authority, the manufacturer and the weighing module.

E.4.2 Test Report Format

The Report shall contain detailed information about the weighing module. These are technical data, description of the functions, characteristics, features and the checklist of R 76-2. The relevant information is as follows:

Report number:	zzzzz
Type examination of a:	Weighing module for a non-automatic electromechanical weighing instrument.

Issuing authority:	Name, address, person responsible.
Manufacturer:	Name, address.
Type of module:	....
Test requirements:	EN 45501 xxxx.
Summary of the examination:	Separately tested module, $p_i = 1.0$, connected device for indicating the weighing results and to operate the module, connected peripherals, special information as if some tests were performed by the manufacturer and why they were accepted, results of the test in brief.
Evaluator:	Name, date, signature.

Table of contents:

This report belongs to Certificate no.

1 General information concerning the type of module:

Description of mechanical structures, load cell, analog data processing device, interfaces.

2 Functions, facilities and devices of the module:

Zero-setting devices, tare devices, multi-interval weighing module, different weighing ranges, modes of operation, etc.

3 Technical data:

Table with accuracy class, $p_i = 1.0$, Max, Min, n, n_i, tare and temperature ranges, etc.

4 Documents:

List of documents.

5 Interfaces:

Interface types and numbers for the indicating and operating device (terminal), for peripheral devices and for other devices.

All interfaces are protective

6 Connectable devices:

Indicating and operating device (terminal) with $p_i = 0.0$, printer, display, etc. For applications not subject to mandatory verification, any peripheral devices may be connected. Examples: D/A converters, PC, etc.

7 Control marks:

If securing (sealing) is required for the weighing instrument, components and adjustment elements of this module can be protected by a control mark (adhesive mark or seal) over the housing screw under the plate of the load receptor. An additional securing is not necessary.

8 Test equipment:

Information concerning the test equipment used for type evaluation of this module. Information about calibration. Examples: standard weights (class), load cell simulator, temperature chambers, voltmeters, transformers, disturbance test equipment, etc.

9 Remarks on the tests:

During the disturbance tests a printer of the type ... was connected.

10 Measuring results:

11 Technical requirements:

ANNEX F
(Mandatory for separately tested modules)

Compatibility checking of modules of non-automatic weighing instruments

Notes: **F.1 to F.4:**
Only for analog load cells in conformity with R 60 or having a test certificate issued by a Notified Body in combination with indicators in conformity with Annex C.

F.5:
Only for digital load cells in combination with indicators, analog or digital data processing units or terminals.

F.6:
Examples of compatibility checks.

When using the modular approach, the compatibility check of the weighing instrument and the modules needs certain sets of data. The first three clauses of this Annex describe the data of the weighing instrument, the load cell(s) and the indicator that are needed to check the compatibility requirements.

F.1 Weighing instruments

The following metrological and technical data of the weighing instrument are necessary for the compatibility check:

Accuracy class of the weighing instrument.

Max	(g, kg, t)	Maximum capacity of weighing instrument according to T.3.1.1 (Max_1, Max_2, …, Max in the case of a multi-interval weighing instrument and Max_1, Max_2, …, Max_r in the case of a multiple range weighing instrument).
e	(g, kg)	Verification scale interval according to T.3.2.3. (e_1, e_2, e_3) (in the case of a multi-interval or multiple range weighing instrument, where $e_1 = e_{min}$).
n		Number of verification scale intervals according to T.3.2.5: n = Max / e (n_1, n_2, n_3) (in the case of a multi-interval or multiple range weighing instrument, where $n_i = Max_i / e_i$).
R		Reduction ratio, e.g. of a lever work according to T.3.3, is the ratio (Force on the load cell) / (Force on the load receptor).
N		Number of load cells
IZSR	(g, kg)	Initial zero setting range, according to T.2.7.2.4: the indication is automatically set to zero when the weighing instrument is switched on, before any weighing.
NUD	(g, kg)	Correction for non-uniform distributed load**.
DL	(g, kg)	Dead load of load receptor: mass of the load receptor itself resting upon the load cells and any additional construction mounted on the load receptor.
T^+	(g, kg, t)	Additive tare.
T_{min}	(°C)	Lower limit of temperature range.
T_{max}	(°C)	Upper limit of temperature range.

CH, NH, SH — Symbol of humidity test performed.

Connecting system, 6-wire-system:

L (m) — Length of connecting cable.

A (mm²) — Cross section of wire.

Q — Correction factor.
The correction factor, $Q > 1$ considers the possible effects of eccentric loading (non uniform distribution of the load), dead load of the load receptor, initial zero setting range and additive tare in the following form:

$$Q = (\text{Max} + \text{DL} + \text{IZSR} + \text{NUD} + \text{T}^{+}) / \text{Max}$$

** The values for the non uniform distribution of the load generally might be assumed for typical constructions of weighing instruments when no other estimations are presented.

- Weighing instruments (WIs) with lever work and one load cell, or WIs with load receptors which allow only minimal eccentric load application, or WIs with one single point load cell: 0 % of Max
  e.g. hopper or funnel hopper with a symmetric arrangement of the load cells, but without shaker for material flow on the load receptor
- Other conventional WIs: 20 % of Max
- Fork lift scales, over head track scales and weighbridges: 50 % of Max
- Multi-platform weighing machine:
  fixed combination: 50 % of $\text{Max}_{\text{total}}$
  variable selection or combined: 50 % of $\text{Max}_{\text{single bridge}}$

F.2 Separately tested load cells

Load cells that have been tested separately may be used without repeated testing if a respective OIML or Test Certificate exists and the requirements in 3.10.2.1, 3.10.2.2, and 3.10.2.3 are met. Only SH and CH tested load cells are allowed under the modular approach (not NH load cells).

F.2.1 Accuracy classes

The accuracy classes including temperature ranges and the evaluation of stability against humidity and creep of load cell(s) (LC) must meet the requirements for the weighing instrument (WI).

Table 13 – Corresponding accuracy classes

	Accuracy				**Reference**
WI	I	II	III	IIII	OIML R 76
LC	A	A*, B	B*, C	C, D	OIML R 60

* if the temperature ranges are sufficient and the evaluation of stability against humidity and creep correspond to the requirement in the lower class.

F.2.2 Fraction of the maximum permissible error

If no value for the load cell is indicated in the OIML or Test Certificate, then $p_{\text{LC}} = 0.7$. The fraction may be $0.3 \leq p_{\text{LC}} \leq 0.8$, in accordance with 3.10.2.1.

F.2.3 Temperature limits

If no value for the load cell is indicated in the OIML or test Certificate, then $T_{\min} = -10$ °C and $T_{\max} =$ 40 °C. The temperature range may be limited, in accordance with 3.9.2.2.

F.2.4 Maximum capacity of the load cell

The maximum capacity of the load cell shall satisfy the condition:

$$E_{max} \geq Q \times \text{Max} \times R / N$$

F.2.5 Minimum dead load of the load cell

The minimum load caused by the load receptor must equal or exceed the minimum dead load of a load cell (a lot of load cells have $E_{min} = 0$):

$$E_{min} \leq \text{DL} \times R / N$$

F.2.6 Maximum number of load cell intervals

For each load cell the maximum number of load cell intervals, n_{LC}**,** (see OIML R 60) shall not be less than the number of verification scale intervals, n, of the instrument:

$$n_{LC} \geq n$$

On a multiple range or multi-interval instrument, this applies to any individual weighing range or partial weighing range:

$$\text{n}_{LC} \geq n_i$$

On a **multi-interval** instrument, the minimum dead load output return, DR (see OIML R 60), shall satisfy the condition:

$$\text{DR} \times E / E_{max} \leq 0.5 \times e_1 \times R / N, \quad \text{or} \quad \text{DR} / E_{max} \leq 0.5 \times e_1 / \text{Max}$$

Where: $E = \text{Max} \times R / N$ is the partial loading of the load cell when loading the weighing instrument with Max.

Acceptable solution:

Where DR is not known, the condition $n_{LC} \geq \text{Max} / e_1$ is satisfied.

Furthermore on a **multiple range** instrument where the same load cell(s) is (are) used for more than one range, the minimum dead load output return, DR, of the load cell (see OIML R 60) shall satisfy the condition:

$$DR \times E / E_{max} \leq e_1 \cdot \times R / N, \quad \text{or} \quad DR / E_{max} \leq e_1 / \text{Max}$$

Acceptable solution:

Where DR is not known, the condition $n_{LC} \geq 0.4 \times \text{Max}_r / e_1$ is satisfied.

F.2.7 Minimum load cell verification interval

The minimum load verification interval, v_{min}, (see OIML R 60) shall not be greater than the verification scale interval, e, multiplied by the reduction ratio, R, of the load transmitting device and divided by the square root of the number, N, of load cells, as applicable:

$$v_{min} \leq e_1 \times \cdot R / \sqrt{N}$$

Note: v_{min} is measured in mass units. The formula applies to both analog and digital load cells.

On a multiple range instrument where the same load cell(s) is (are) used for more than one range, or a multi-interval instrument, e is to be replaced by e_1.

F.2.8 Input resistance of a load cell

The input resistance of a load cell, R_{LC}, is limited by the indicator:

R_{LC} / N has to be within the range for the indicator R_{Lmin} to R_{Lmax}

F.3 Separately tested indicators and analog data processing devices

Indicators and analog data processing devices that have been tested separately according to Annex C may be used without repeated testing if a respective OIML Certificate exists and the requirements in 3.10.2.1, 3.10.2.2, and 3.10.2.3 are met.

F.3.1 Accuracy class

The accuracy classes including temperature ranges and the evaluation of stability against humidity must meet the requirements for the weighing instrument (WI).

Table 14 – Corresponding accuracy classes

	Accuracy				Reference
WI	I	II	III	IIII	
IND	I	I*, II	II*, III	III, IIII	

* if the temperature ranges are sufficient and the evaluation of stability against humidity correspond to the requirement in the lower class.

F.3.2 Fraction of the maximum permissible error

If no value for the indicator is indicated in the OIML or Test Certificate, then $p_{ind} = 0.5$. The fraction may be $0.3 \le p_{ind} \le 0.8$ in accordance with 3.10.2.1.

F.3.3 Temperature limits

If no value for the load cell is indicated in the OIML or Test Certificate, then $T_{min} = -10$ °C and $T_{max} = 40$ °C. The temperature range may be limited in accordance with 3.9.2.2.

F.3.4 Maximum number of verification intervals

For each indicator the maximum number of verification intervals, n_{ind}, shall not be less than the number of verification scale intervals, n, of the weighing instrument:

$$n_{ind} \ge n$$

On a multiple range or multi-interval instrument, this applies to any individual weighing range or partial weighing range:

$$n_{ind} \ge n_i$$

In case of multi-interval or multiple range applications, these functions must be included in the certified indicator.

F.3.5 Electrical data with regard to the weighing instrument

U_{exc} (V) Load cell excitation voltage

U_{min} (mV) General minimum input voltage for indicator

Δu_{min} (µV) Minimum input voltage per verification scale interval for the indicator

The signal per verification scale interval, Δu, is calculated as follows:

$$\Delta u = \frac{C}{E_{max}} \times U_{exc} \times \frac{R}{N} \times e$$

For multiple range or multi-interval WIs, $e = e_1$

U_{MRmin} (mV) Measuring range minimum voltage

U_{MRmax} (mV) Measuring range maximum voltage

R_{Lmin} (Ω) Minimum load cell impedance

R_{Lmax} (Ω) Maximum load cell impedance

Note: R_{Lmin} and R_{Lmax} are the limits of the allowed impedance range for the electronic indicator for the actual applied load cell input impedance(s).

F.3.5.1 Connection cable

Additional cable between the indicator and the load cell or the load cell junction box respectively (only allowed with indicators using six wire system, i.e. **sense system**) must have been specified in the Test Certificate for the indicator.

The most simple procedure is to specify a value for the ratio of the cable length to the cross section of one wire (m/mm²) for a given material (copper, aluminium, etc.) in the indicator Certificate.

In other cases it must be calculated from length (m), cross section (mm^2), the conductor material data and the maximum ohmic resistance (Ω) per single wire.

Note: For cable with different wire cross sections, the connection for the sense-wire is of interest. When using lightning barriers or barriers for explosion-proof applications, the excitation voltage at the load cells must be checked, to prove conditions are met for the minimum input voltage per verification scale interval of the indicator.

F.4 Compatibility checks for modules with analog output

The relevant quantities and characteristics identified which together establish compatibility have been included in the following form. If all conditions are met, the compatibility requirements are met. The Tables in which data may be entered allow decisions to be taken easily as to whether or not the conditions are satisfied.

The manufacturer of the weighing instrument can check and prove this compatibility by filling in the form on the following page.

Clause F.6 provides typical examples of filled-in forms for compatibility checks.

Form: Compatibility check

(1) Accuracy class of load cell (LC), indicator (IND) and weighing instrument (WI)

LC	&	IND	equal or better	WI	pass	fail
	&		equal or better		☐	☐

(2) Temp. limits of the weighing instr.(WI) compared with the temp. limits of the load cell (LC) and the indicator (IND) in °C

	LC		IND		WI	pass	fail
T_{min}		&		≤		☐	☐
T_{max}		&		≥		☐	☐

(3) Sum of the squares of the fractions p_i of the max. permissible errors of connecting elements, indicator and load cells

p_{con}^2	+	p_{ind}^2	+	p_{LC}^2	≤ 1	pass	fail
	+		+		≤ 1	☐	☐

(4) Maximum number of verification scale intervals of the indicator and number of scale intervals of the weighing instrument

		n_{ind}	≥	$n_i = \text{Max}_i / e_i$	pass	fail
Single range weighing instrument			≥		☐	☐
Multi-interval, or Multiple range WI	$i = 1$		≥		☐	☐
	$i = 2$		≥		☐	☐
	$i = 3$		≥		☐	☐

(5) Maximum capacity of load cells must be compatible with Max of the weighing instrument

Factor, Q: $Q = (\text{Max} + \text{DL} + \text{IZSR} + \text{NUD} + \text{T}^+) / \text{Max} =$ .....

$Q \times \text{Max} \times R/N$	≤	E_{max}	pass	fail
	≤		☐	☐

(6a) Maximum number of verification scale intervals of the load cell and number of scale intervals of the weighing instrument

		n_{LC}	≥	$n_i = \text{Max}_i / e_i$	pass	fail
Single range weighing instrument			≥		☐	☐
Multi-interval, or Multiple range WI	$i = 1$		≥		☐	☐
	$i = 2$		≥		☐	☐
	$i = 3$		≥		☐	☐

(6b) Minimum dead load output return of the load cell and smallest verification scale interval, e_1, of a multi-interval WI

n_{LC} or $Z = E_{max} / (2 \times \text{DR})$	≥	Max_r / e_1	pass	fail
	≥		☐	☐

(6c) Minimum dead load output return of the load cell and smallest verification scale interval, e_1, of a multiple range WI

n_{LC} or $Z = E_{max} / (2 \times \text{DR})$	≥	$0.4 \times \text{Max}_r / e_1$	pass	fail
	≥		☐	☐

(6d) Actual dead load of the load receptor to the minimum dead load of the load cells in kg

$\text{DL} \times R/N$	≥	E_{min}	pass	fail
	≥		☐	☐

(7) Verification scale interval of the weighing instrument and minimum load cell scale interval (in kg) must be compatible

$e \times R / \sqrt{N}$	≥	$v_{min} = E_{max} / Y$	pass	fail
	≥		☐	☐

(8) Minimum input voltage in general for the electronic indicator and minimum input voltage per verification scale interval and actual output of the load cells

				pass	fail
Minimum input voltage in general for electr. ind. (unloaded WI)	$U = C \times U_{exc} \times R \times \text{DL} / (E_{max} \times N)$	≥	U_{min}	pass	fail
		≥		☐	☐
Minimum input voltage per verification scale interval	$\Delta u = C \times U_{exc} \times R \times e / (E_{max} \times N)$	≥	Δu_{min}	pass	fail
		≥		☐	☐

(9) Allowed impedance range for the electronic indicator and actual load cell impedance in Ω

R_{Lmin}	≤	R_{LC} / N	≤	R_{Lmax}	pass	fail
	≤		≤		☐	☐

(10) Length of extension cable between the load cell(s) and indicator per wire cross section of this cable in m/mm^2

(L/A)	≤	$(L/A)_{max}$	pass	fail
	≤		☐	☐

F.5 Compatibility checks for modules with digital output

For weighing modules and other digital modules or devices (see Figure 1), no special compatibility checks are necessary; testing of the correct operation of one complete instrument is sufficient. If there is no correct data transmission between the modules (and probably between other components/devices) the instrument will not work at all or some functions will fail, e.g. zero-setting or tare.

For digital load cells, the same compatibility check as in F.4 applies, with the exception of conditions (8), (9) and (10) in the form.

F.6 Examples of compatibility checks for modules with analog output

F.6.1 Road vehicle weigher with one measuring range (Example no. 1)

Weighing instrument:

accuracy class	III
maximum capacity	Max = 60 t
verification scale interval	e = 20 kg
number of load cells	N = 4
without leverwork	R = 1
dead load of load receptor	DL = 12 t
initial zero-setting range	IZSR = 10 t
correction for non uniform distributed load	NUD = 30 t
additive tare	$T^+ = 0$
temperature range	– 10 °C to + 40 °C
cable length	L = 100 m
cross section of wire	$A = 0.75\ \text{mm}^2$

Indicator:

accuracy class	III
max. number of verification scale intervals	n_{ind} = 3 000
load cell excitation voltage	U_{exc} = 12 V
minimum input voltage	U_{min} = 1 mV
min. input voltage per verification scale interval	Δu_{min} = 1 µV
min./max. load cell impedance	30 Ω to 1 000 Ω
temperature range	– 10 °C to + 40 °C
fraction of mpe	p_{ind} = 0.5
cable connection	6 wires
max. value of cable length per wire cross section	$(L/A)_{max} = 150\ \text{m/mm}^2$

Load cell(s):

accuracy class	C
maximum capacity	E_{max} = 30 t
minimum dead load	E_{min} = 2 t
rated output[1]	C = 2 mV/V
max. number of verification scale intervals	n_{LC} = 3 000
ratio E_{max} / v_{min}	Y = 6 000
ratio E_{max} / (2 × DR)	Z = 3 000
input resistance of one load cell	R_{LC} = 350 Ω

[1] Change of output signal of the load cell related to input voltage after loading with E_{max}, normally in mV/V.

Note: For a more moderate calculation the following relative values are used in R 60:

$$Y = E_{max} / v_{min}$$

$$Z = E_{max} / (2 \times \text{DR})$$

temperature range	– 10 °C to + 40 °C
fraction of mpe	$p_{LC} = 0.7$

Connecting elements:

fraction of mpe	$p_{con} = 0.5$

Compatibility check (Example no. 1)

(1) Accuracy class of load cell (LC), indicator (IND) and weighing instrument (WI)

LC	&	IND	equal or better	WI	pass	fail
C	&	III	equal or better	III	☒	☐

(2) Temp. limits of the weighing inst. (WI) compared with the temp. limits of the load cell (LC) and the indicator (IND) in °C

	LC		IND		WI	pass	fail
T_{min}	– 10 °C	&	– 10 °C	≤	– 10 °C	☒	☐
T_{max}	40 °C	&	40 °C	≥	40 °C	☒	☐

(3) Sum of the squares of the fractions p_i of the max. permissible errors of connecting elements, indicator and load cells

p_{con}^2	+	p_{ind}^2	+	p_{LC}^2	≤ 1	pass	fail
0.25	+	0.25	+	0.49	≤ 1	☒	☐

(4) Maximum number of verification scale intervals of the indicator and number of scale intervals of the weighing instrument

		n_{ind}	≥	$n_i = \text{Max}_i / e_i$	pass	fail
Single range weighing instrument		3 000	≥	3 000	☒	☐
Multi-interval, or Multiple range WI	$i = 1$	-	≥	-	☐	☐
	$i = 2$	-	≥	-	☐	☐
	$i = 3$	-	≥	-	☐	☐

(5) Maximum capacity of load cells must be compatible to Max of the weighing instrument

Factor Q: $Q = (\text{Max} + \text{DL} + \text{IZSR} + \text{NUD} + \text{T}^+) / \text{Max} =$ *1.867*

$Q \times \text{Max} \times R/N$	≤	E_{max}	pass	fail
28000 kg	≤	30000 kg	☒	☐

(6a) Maximum number of verification scale intervals of the load cell and number of scale intervals of the weighing instrument

		n_{LC}	≥	$n_i = \text{Max}_i / e_i$	pass	fail
Single range weighing instrument		3 000	≥	3 000	☒	☐
Multi-interval, or Multiple range WI	$i = 1$	-	≥	-	☐	☐
	$i = 2$	-	≥	-	☐	☐
	$i = 3$	-	≥	-	☐	☐

(6b) Minimum dead load output return of the load cell and smallest verification scale interval, e_1, of a multi-interval WI

n_{LC} or $Z = E_{max} / (2 \times DR)$	≥	Max_r / e_1	pass	fail
-	≥	-	☐	☐

(6c) Minimum dead load output return of the load cell and smallest verification scale interval, e_1, of a multiple range WI

n_{LC} or $Z = E_{max} / (2 \times DR)$	≥	$0.4 \times \text{Max}_r / e_1$	pass	fail
-	≥	-	☐	☐

(6d) Actual dead load of the load receptor to the minimum dead load of the load cells in kg

$\text{DL} \times R / N$	≥	E_{min}	pass	fail
3 000 kg	≥	2 000 kg	☒	☐

(7) Verification scale interval of the weighing instrument and minimum load cell scale interval (in kg) must be compatible

$e \times R / \sqrt{N}$	≥	$v_{min} = E_{max} / Y$	pass	fail
10.00 kg	≥	5.00 kg	☒	☐

(8) Minimum input voltage in general for the electronic indicator and minimum input voltage per verification scale interval and actual output of the load cells

				pass	fail
Minimum input voltage in general for electr. ind. (unloaded WI)	$U = C \times U_{exc} \times R \times \text{DL} / (E_{max} \times N)$	≥	U_{min}	pass	fail
	2.40 mV	≥	1 mV	☒	☐
minimum input voltage per verification scale interval	$\square u = C \times U_{exc} \times R \times e / (E_{max} \times N)$	≥	Δu_{min}	pass	fail
	4.00 µV	≥	1.0 µV	☒	☐

(9) Allowed impedance range for the electronic indicator and actual load cell impedance in Ω

R_{Lmin}	≤	R_{LC} / N	≤	R_{Lmax}	pass	fail
30	≤	87.5	≤	1 000	☒	☐

(10) Length of extension cable between the load cell(s) and indicator per wire cross section of this cable in m/mm²

(L/A)	≤	$(L/A)_{max}$	pass	fail
133.3	≤	150	☒	☐

F.6.2 Industrial scale with three measuring ranges (Example no. 2)

Weighing instrument

accuracy class	III
maximum capacity	Max = 5 000 kg
	Max_2 = 2 000 kg
	Max_1 = 1 000 kg
verification scale interval	e_3 = 2 kg
	e_2 = 1 kg
	e_1 = 0.5 kg
number of load cells	N = 4
without leverwork	R = 1
dead load of load receptor	DL = 250 kg
initial zero setting range	IZSR = 500 kg
correction for non uniform distributed load	NUD = 1 000 kg
additive tare	$T^+ = 0$
temperature range	– 10 °C to + 40 °C
cable length	L = 20 m
cross section of wire	A = 0.75 mm^2

Indicator:

accuracy class	III
max. number of verification scale intervals	n_{ind} = 3 000
load cell excitation voltage	U_{exc} = 10 V
minimum input voltage	U_{min} = 0.5 mV
min. input voltage per verification scale interval	Δu_{min} = 1 µV
min./max. load cell impedance	30 Ω to 1 000 Ω
temperature range	– 10 °C to + 40 °C
fraction of mpe	p_{ind} = 0.5
cable connection	6 wires
max. value of cable length per wire cross section	$(L/A)_{max}$ = 150 m/mm^2

Load cell(s):

accuracy class	C
maximum capacity	E_{max} = 2 000 kg
minimum dead load	E_{min} = 0 t
rated output[2]	C = 2 mV/V
max. number of verification scale intervals	n_{LC} = 3000
minimum verification scale interval	v_{min} = 0.2 kg
ratio E_{max} / (2 × DR)	Z = 5 000
input resistance of one load cell	R_{LC} = 350 Ω
temperature range	– 10 °C to + 40 °C
fraction of mpe	p_{LC} = 0.7

Connecting elements:

fraction of mpe	p_{con} = 0.5

[2] Change of output signal of the load cell related to input voltage after loading with E_{max}, normally in mV/V.

Note: For a more moderate calculation the following relative values are used in R 60:

$$Y = E_{max} / v_{min}$$

$$Z = E_{max} / (2 \times DR)$$

Compatibility check (Example no. 2)

(1) Accuracy class of load cell (LC), indicator (IND) and weighing instrument (WI)

LC	&	IND	equal or better	WI	pass	fail
C	&	III	equal or better	III	☒	☐

(2) Temp. limits of the weighing inst. (WI) compared with the temp. limits of the load cell (LC) and the indicator (IND) in °C

	LC		IND		WI	pass	fail
T_{min}	– 10 °C	&	– 10 °C	≤	– 10 °C	☒	☐
T_{max}	40 °C	&	40 °C	≥	40 °C	☒	☐

(3) Sum of the squares of the fractions, p_i, of the max. permissible errors of connecting elements, indicator and load cells

p_{con}^2	+	p_{ind}^2	+	p_{LC}^2	≤ 1	pass	fail
0.25	+	0.25	+	0.49	≤ 1	☒	☐

(4) Maximum number of verification scale intervals of the indicator and number of scale intervals of the weighing instrument

		n_{ind}	≥	$n_i = \text{Max}_i / e_i$	pass	fail
Single range weighing instrument		-	≥	-	☐	☐
Multi-interval, or Multiple range WI	$i = 1$	3 000	≥	2 000	☒	☐
	$i = 2$	3 000	≥	2 000	☒	☐
	$i = 3$	3 000	≥	2 500	☒	☐

(5) Maximum capacity of load cells must be compatible to Max of the weighing instrument

Factor Q: $Q = (\text{Max} + \text{DL} + \text{IZSR} + \text{NUD} + \text{T}^+) / \text{Max} =$ *1.35*

$Q \times \text{Max} \times R / N$	≤	E_{max}	pass	fail
1 687.5 kg	≤	2 000 kg	☒	☐

(6a) Maximum number of verification scale intervals of the load cell and number of scale intervals of the weighing instrument

		n_{LC}	≥	$n_i = \text{Max}_i / e_i$	pass	fail
Single range weighing instrument		-	≥	-	☐	☐
Multi-interval or Multiple range WI	$i = 1$	3 000	≥	2 000	☒	☐
	$i = 2$	3 000	≥	2 000	☒	☐
	$i = 3$	3 000	≥	2 500	☒	☐

(6b) Minimum dead load output return of the load cell and smallest verification scale interval, e_1, of a multi-interval WI

n_{LC} or $Z = E_{max} / (2 \times DR)$	≥	Max_r / e_1	pass	fail
-	≥	-	☐	☐

(6c) Minimum dead load output return of the load cell and smallest verification scale interval, e_1, of a multiple range WI

n_{LC} or $Z = E_{max} / (2 \times DR)$	≥	$0.4 \times \text{Max}_r / e_1$	pass	fail
5 000	≥	4 000	☒	☐

(6d) Actual dead load of the load receptor to the minimum dead load of the load cells in kg

$\text{DL} \times R / N$	≥	E_{min}	pass	fail
62.5 kg	≥	0 kg	☒	☐

(7) Verification scale interval of the weighing instrument and minimum load cell scale interval (in kg) must be compatible

$e \times R / \sqrt{N}$	≥	$v_{min} = E_{max} / Y$	pass	fail
0.25 kg	≥	0.2 kg	☒	☐

(8) Minimum input voltage in general for the electronic indicator and minimum input voltage per verification scale interval and actual output of the load cells

				pass	fail
Minimum input voltage in general for electr. ind. (unloaded WI)	$U = C \times U_{exc} \times R \times \text{DL} / (E_{max} \times N)$	≥	U_{min}	pass	fail
	0.625 mV	≥	0.5 mV	☒	☐
Minimum input voltage per verification scale interval	□$u = C \times U_{exc} \times R \times e / (E_{max} \times N)$	≥	Δu_{min}	pass	fail
	1.25 µV	≥	1 µV	☒	☐

(9) Allowed impedance range for the electronic indicator and actual load cell impedance in Ω

R_{Lmin}	≤	R_{LC} / N	≤	R_{Lmax}	pass	fail
30	≤	87.5	≤	1 000	☒	☐

(10) Length of extension cable between the load cell(s) and indicator per wire cross section of this cable in m/mm²

(L/A)	≤	$(L/A)_{max}$	pass	fail
26.67	≤	150.0	☒	☐

ANNEX G

Additional examinations and tests for software-controlled digital devices and instruments

.

G.1 Devices and instruments with embedded software (5.5.1)

Review the descriptive documents according to 8.2.1.2 and check whether the manufacturer has described or declared that the software is embedded, i.e. that it is used in a fixed hardware and software environment and cannot be modified or uploaded via any interface or by other means after securing or sealing.

Check whether the securing means are described and provide evidence of an intervention.

Check whether there is a software identification that is clearly assigned to the legally relevant software and the legally relevant functions it performs as described in the documentation submitted by the manufacturer.

Check whether the software identification is easily provided by the instrument.

G.2 Personal computers and other devices with programmable or loadable software (5.5.2)

G.2.1 Software documentation

Check that the manufacturer has supplied software documentation according to 5.5.2.2 (d) containing all relevant information to examine the legally relevant software.

G.2.2 Software protection

G.2.2.1 Software with closed shell (no access to the operating system and/or programs possible for the user):

- Check whether there is a complete set of commands (e.g. function keys or commands via external interfaces) supplied and accompanied by short descriptions.
- Check whether the manufacturer has submitted a written declaration of the completeness of the set of commands.

G.2.2.2 Operating system and / or program(s) accessible for the user:

- Check whether a checksum or equivalent signature is generated over the machine code of the legally relevant software (program module(s) subject to legal control and type-specific parameters).
- Check whether the legally relevant software cannot be started if the code is falsified using a text editor.

G.2.2.3 In addition to the cases in G.2.2.1 or G.2.2.2:

- Check whether all device-specific parameters are sufficiently protected, e.g. by a checksum.
- Check whether there is an audit trail for the protection of the device-specific parameters and a description of the audit trail.
- Perform some practical spot checks to test whether the documented protections and functions work as described.

G.2.3 Software interface(s)

- Check whether the program modules of the legally relevant software are defined and separated from the modules of the associated software by a defined protective software interface.
- Check whether the protective software interface itself is part of the legally relevant software.
- Check whether the functions of the legally relevant software that can be released via the protective software interface are defined and described.
- Check whether the parameters that may be exchanged via the protective software interface are defined and described.
- Check whether the description of the functions and parameters are conclusive and complete.
- Check whether each documented function and parameter does not contradict the requirements of this Recommendation.
- Check whether there are appropriate instructions for the application programmer (e.g. in the software documentation) concerning the protectiveness of the software interface.

G.2.4 Software identification

- Check whether there is an appropriate software identification generated over the program module(s) of the legally relevant software and the type-specific parameters at runtime of the instrument.
- Check whether the software identification is indicated on manual command and can be compared with the reference identification fixed at type approval.
- Check whether all relevant program module(s) and type-specific parameters of the legally relevant software are included in the software identification.
- Check also by some practical spot checks whether the checksums (or other signatures) are generated and work as documented.
- Check whether an effective audit trail exists.

G.3 Data storage devices (5.5.3)

Review the documentation submitted and check whether the manufacturer has foreseen a device - whether incorporated in the instrument or connected externally - that is intended to be used for long-term storage of legally relevant data. If so:

G.3.1 Check whether the software used for data storage is realized on a device with embedded software (G.1) or with programmable/ loadable software (G.2). Apply either G.1 or G.2 to examine the software used for data storage.

G.3.2 Check whether the data are stored and retrieved correctly.

Check whether the storage capacity and the measures to prevent inadmissible data loss are described by the manufacturer and are sufficient.

G.3.3 Check whether the data stored contain all relevant information necessary to reconstruct an earlier weighing (relevant information is: gross or net values and tare values (if applicable, together with a distinction of tare and preset tare), the decimal signs, the units (e.g. kg may be encoded), the identification of the data set, the identification number of the instrument or load receptor if several instruments or load receptors are connected to the data storage device, and a checksum or other signature of the data set stored.

G.3.4 Check whether the data stored are adequately protected against accidental or intentional changes.

Check whether the data are protected at least with a parity check during transmission to the storage device.

Check whether the data are protected at least with a parity check in the case of a storage device with embedded software (5.5.1).

Check whether the data are protected by an adequate checksum or signature (at least 2 bytes, e.g. a CRC-16 checksum with hidden polynomial) in the case of a storage device with programmable or loadable software (5.5.2).

G.3.5 Check whether the data stored are capable of being identified and displayed, that the identification number(s) is stored for later use and recorded on the official transaction medium, i.e. it is printed, for instance, on the print-out.

G.3.6 Check whether the data used for a transaction are stored automatically, i.e. not depending on the decision of the operating person.

G.3.7 Check whether stored data sets which are to be verified by means of the identification are displayed or printed on a device subject to legal control.

G.4 Test Report Format

The Test Report shall contain all relevant information about the hardware and software configuration of the PC examined and the test results.

BIBLIOGRAPHY

Ref.	Standards and reference documents	Description
[1]	International Vocabulary of Basic and General Terms in Metrology (VIM) (1993)	Vocabulary, prepared by a joint working group consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML
[2]	International Vocabulary of Terms in Legal Metrology, BIML, Paris (2000)	Vocabulary including only the concepts used in the field of legal metrology. These concepts concern the activities of the legal metrology service, the relevant documents as well as other problems linked with this activity. Also included in this Vocabulary are certain concepts of a general character which have been drawn from the VIM.
[3]	OIML B 3 (2003) OIML Certificate System for Measuring Instruments (formerly OIML P 1)	Gives rules for issuing, registering and using OIML Certificates of conformity
[4]	OIML D 11 (2004) General requirements for electronic measuring instruments	Contains general requirements for electronic measuring instruments
[5]	IEC 60068-1 (1988-6), Appendix B (including Amendment 1, 1992-4) Environmental testing. Part 1: General and guidance	Enumerates a series of environmental tests and appropriate severities, and prescribes various atmospheric conditions for measurements for the ability of specimens to perform under normal conditions of transportation, storage and operational use
[6]	IEC 60068-2-1 (1990-05) with amendments 1 (1993-02) and 2 (1994-06) Environmental testing, Part 2: Tests, Test A: Cold	Concerns cold tests on both non heat dissipating and heat dissipating specimens
[7]	IEC 60068-2-2 (1974-01) with amendments 1 (1993-02) and 2 (1994-05) Environmental testing Part 2: Tests, Test B: Dry heat	Contains test Ba : dry heat for non heat dissipating specimen with sudden change of temperature; test Bb dry heat for non heat dissipating specimen with gradual change of temperature; tests Bc : dry heat for heat dissipating specimen with sudden change of temperature; test Bd dry heat for heat dissipating specimen with gradual change of temperature. The 1987 reprint includes IEC No. 62-2-2A

Ref.	Standards and reference documents	Description
[8]	IEC 60068-2-78 (2001-08) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state *(IEC 60068-2-78 replaces the following withdrawn standards:* *IEC 60068-2-3, test Ca and* *IEC 60068-2-56, test Cb)*	Provides a test method for determining the suitability of electrotechnical products, components or equipment for transportation, storage and use under conditions of high humidity. The test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation on the specimen over a prescribed period. This test provides a number of preferred severities of high temperature, high humidity and test duration. The test can be applied to both heat-dissipating and non-heat dissipating specimens. The test is applicable to small equipment or components as well as large equipment having complex interconnections with test equipment external to the chamber, requiring a set-up time which prevents the use of preheating and the maintenance of specified conditions during the installation period.
[9]	IEC 60068-3-1 (1974-01) + Supplement A (1978-01): Environmental testing Part 3 Background information, Section 1: Cold and dry heat tests	Gives background information for Tests A: Cold (IEC 68-2-1), and Tests B: Dry heat (IEC 68-2-2). Includes appendices on the effect of: chamber size on the surface temperature of a specimen when no forced air circulation is used; airflow on chamber conditions; on surface temperatures of test specimens; wire termination dimensions and material on surface temperature of a component; measurements of temperature, air velocity and emission coefficient. Supplement A gives additional information for cases where temperature stability is not achieved during the test.
[10]	IEC 60068-3-4 (2001-08) Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	Provides the necessary information to assist in preparing relevant specifications, such as standards for components or equipment, in order to select appropriate tests and test severities for specific products and, in some cases, specific types of application. The object of damp heat tests is to determine the ability of products to withstand the stresses occurring in a high relative humidity environment, with or without condensation, and with special regard to variations of electrical and mechanical characteristics. Damp heat tests may also be utilized to check the resistance of a specimen to some forms of corrosion attack.
[11]	IEC 61000-4-1 (2000-04) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 1: Overview of IEC 61000-4 series	Gives applicability assistance to the users and manufacturers of electrical and electronic equipment on EMC standards within the IEC 61000-4 series on testing and measurement techniques. Provides general recommendations concerning the choice of relevant tests.

Ref.	Standards and reference documents	Description
[12]	IEC 61000-4-2 (1995-01) with amendment 1 (1998-01) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 2: Electrostatic discharge immunity test. Consolidated Edition: IEC 61000-4-2 (2001-04) Ed. 1.2 This publication is based on IEC 60801-2 (second edition: 1991).	Relates to the immunity requirements and test methods for electrical and electronic equipment subjected to static electricity discharges, from operators directly, and to adjacent objects. Additionally defines ranges of test levels which relate to different environmental and installation conditions and establishes test procedures. The object of this standard is to establish a common and reproducible basis for evaluating the performance of electrical and electronic equipment when subjected to electrostatic discharges. In addition, it includes electrostatic discharges which may occur from personnel to objects near vital equipment.
[13]	IEC 61000-4-3 consolidated Edition 2.1 (2002-09) with amendment 1 (2002-08) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 3: Radiated, radio-frequency, electromagnetic field immunity test	Applies to the immunity of electrical and electronic equipment to radiated electromagnetic energy. Establishes test levels and the required test procedures. Establishes a common reference for evaluating the performance of electrical and electronic equipment when subjected to radio-frequency electromagnetic fields.
[14]	IEC 61000-4-4 (2004-07) Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Establishes a common and reproducible reference for evaluating the immunity of electrical and electronic equipment when subjected to electrical fast transient/burst on supply, signal, control and earth ports. The test method documented in this part of IEC 61000-4 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon. The standard defines: – test voltage waveform; – range of test levels; – test equipment; – verification procedures of test equipment; – test set-up; and – test procedure. The standard gives specifications for laboratory and post installation tests.
[15]	IEC 61000-4-5 (2001-04) consolidated edition 1.1 (Including Amendment 1 and Correction 1) Electromagnetic compatibility (EMC) Part 4-5: Testing and measurement techniques - Surge immunity test	Relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by overvoltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment. Establishes a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and inter-connection lines.

Ref.	Standards and reference documents	Description
[16]	IEC 61000-4-6 (2003-05) with amendment 1 (2004-10) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 6: Immunity to conducted disturbances, induced by radio-frequency fields	Relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz - 80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection), which can couple the equipment to the disturbing RF fields is excluded. This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the test and the severity level to be applied to their equipment.
[17]	IEC 61000-4-11 (2004-03) Electromagnetic compatibility (EMC) Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations immunity tests	Defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations. This standard applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase, for connection to 50 Hz or 60 Hz AC networks. It does not apply to electrical and electronic equipment for connection to 400 Hz AC networks. Tests for these networks will be covered by future IEC standards. The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to voltage dips, short interruptions and voltage variations. It has the status of a Basic EMC Publication in accordance with IEC Guide 107.
[18]	IEC 61000-6-1 (1997-07) Electromagnetic compatibility (EMC) Part 6: Generic standards - Section 1: Immunity for residential, commercial and light-industrial environments	Defines the immunity test requirements in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges, for electrical and electronic apparatus intended for use in residential, commercial and light-industrial environment, and for which no dedicated product or product-family standard exists. Immunity requirements in the frequency range 0 kHz - 400 GHz are covered and are specified for each port considered. This standard applies to apparatus intended to be directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the apparatus and the low-voltage public mains network.

Ref.	Standards and reference documents	Description
[19]	IEC 61000-6-2 (1999-01) Electromagnetic compatibility (EMC) Part 6: Generic standards Section 2: Immunity for industrial environments	Applies to electrical and electronic apparatus intended for use in industrial environments, for which no dedicated product or product-family immunity standard exists. Immunity requirements in the frequency range 0 Hz - 400 GHz are covered, in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges. Test requirements are specified for each port considered. Apparatus intended to be used in industrial locations are characterized by the existence of one or more of the following: - a power network powered by a high or medium voltage power transformer dedicated to the supply of an installation feeding manufacturing or similar plant; - industrial, scientific and medical (ISM) apparatus; - heavy inductive or capacitive loads that are frequently switched; - currents and associated magnetic fields that are high.
[20]	ISO 7637-1 (2002) Road vehicles - Electrical disturbance from conducting and coupling Part 1: Definitions and general considerations	Defines basic terms used in the various parts for electrical disturbance by conduction and coupling. Also gives general information relating to the whole International Standard and common to all parts.
[21]	ISO 7637-2 (2004) Road vehicles - electrical disturbance from conducting and coupling Part 2: Electrical transient conduction along supply lines only	Specifies bench tests for testing the compatibility to conducted electrical transients of equipment installed on passenger cars and light commercial vehicles fitted with a 12 V electrical system or commercial vehicles fitted with a 24 V electrical system. Failure mode severity classification for immunity to transients is also given. It is applicable to these types of road vehicle, independent of the propulsion system (e.g. spark ignition or diesel engine, or electric motor).
[22]	ISO 7637-3 (1995) with correction 1 (1995) Road vehicles - Electrical disturbance by conducting and coupling Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines	Establishes a common basis for the evaluation of the EMC of electronic instruments, devices and equipment in vehicles against transient transmission by coupling via lines other than supply lines. The test intention is the demonstration of the immunity of the instrument, device or equipment when subjected to coupled fast transient disturbances, such as those caused by switching (switching of inductive loads, relay contact bounce, etc.)
[23]	OIML B 10 (2004) + Amendment 1 (2006) Framework for a Mutual Acceptance Arrangement on OIML Type Evaluations (MAA)	Establishes the rules for a voluntary framework whereby Participants within OIML Member States and Associates within Corresponding Members accept and utilize Test Reports (when validated with an OIML Certificate) for type approval or recognition in their national/regional metrological control programs, and/or for issuing subsequent OIML Certificates.