**94/9/EC**
Directive 94/9/EC of the European Parliament and the Council of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. →ATEX 95 Directive

**98/37/EC**
Directive 98/37/EC of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery. This directive was replaced by directive →2006/42/EC on 29 December 2009. →Machinery Directive

**A/D converter**
→analog-digital converter

**abbreviations**
Weighing terms established by national and international regulations, standards, and agreements. Examples: →verification scale interval *e*, →number of scale intervals *d*, →maximum capacity *Max*, →minimum load *Min*, →accuracy class (I), (II), (III), (IIII) or →number of verification scale intervals *n*.

**ability of being verified**
A measuring device or instrument (→balance, →weight piece) can be verified if it is generally approved for national verification or for →EC verification, if it satisfies the applicable verification requirements or if its design is approved for verification by the competent authorities. →admission to verification

**Above-Medium Accuracy Weights Directive**
Above-Medium Accuracy Directive →74/148/EEC

**absolute weighing**
Determination of the →mass or →conventional mass and indication of its measurement value in integrals, fractions, and multiples of the mass of the →International Prototype of the Kilogram. If greater accuracy is required when weighing in air, an →air buoyancy correction is necessary.

**absorption**
1. Process in which a solid body takes up another substance, a gas or a liquid, into itself. →weighing error (compare: →adsorption, →desorption)
2. Attenuation of electromagnetic radiation (radiation absorption) by transformation into heat. →physical weighing principle 3.1

**acceleration due to gravity**
If the surface that supports a body is removed, the body can fall freely. The →weight force that acts on the body causes it to accelerate. Since the inertial and gravitational →mass of a body are identical (→equivalence principle), the acceleration is equal to the →gravity and is given by

$$a = g \approx 9.81 \text{ m/s}^2.$$

The variation of →local gravity is primarily a function of the geographical latitude and elevation of the →place of installation.

**acceptable amount, smallest**
→smallest acceptable amount

**accreditation**
Formal recognition of the technical and organizational competence of a calibration, testing, inspection, or certification laboratory to perform a specific service within the scope of the accreditation according to internationally governing standards. In many cases, accreditation is according to ISO 17025 "General requirements for the competence of testing and calibration laboratories".

**accuracy**
1. Closeness of agreement between a measured quantity value and a true quantity value of a measurand ([VIM:2008] 2.13).
2. Qualitative designation for the closeness of the approximation of determined results to the reference value. The reference value may be defined or agreed to be the true value or the expected value [DIN 55350-13]. →error limits
3. The closeness of agreement between a test result and the accepted reference value ([ISO 5725] 3.6). Example: Ability of a measuring instrument to deliver output quantities that are close to the true value ([VIM:1993] 5.18). For repeated measurements, accuracy requires →trueness (absence of →systematic errors) and →precision. For a single measurement, this need not necessarily be the case (Fig. 1).
4. The property of the stated values of weight pieces to correspond to their true value (→accuracy classes of weight pieces).
5. The property of the →measurement value of a weighing instrument to correspond to the value of the load on the instrument (→accuracy classes of weighing instruments).

**accuracy class, higher**
→higher accuracy class

**accuracy classes**
Classification of various types of →weighing instruments, or →weight pieces, into classes of the same accuracy. →weight classes, →accuracy classes of weighing instruments, →accuracy classes of weight pieces

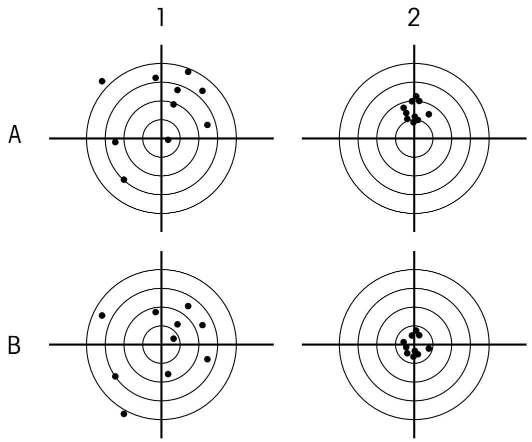


Fig. 1:
Explanation of the relationship between accuracy, precision, and trueness
Row A shows measuring points with systematic error (lack of trueness); row B measuring points with no systematic error (correct).
Column 1 shows scattered measurement points (lack of precision); column 2 shows measuring points with virtually no scatter (precise).
For repeated measurements, accuracy requires correct and precise measuring points; thus, in general, only the measuring points in field B2 are accurate.

**accuracy classes of weighing instruments**

Separation of →weighing instruments into different accuracy classes and assignment of different instrument types to classes of identical accuracy. The international recommendation [OIML R 76-1] and EC directives divide weighing instruments into the following accuracy classes (by decreasing accuracy): →Weighing instrument of special accuracy Ⓘ, →weighing instrument of high accuracy Ⓘⓘ, →weighing instrument of medium accuracy ⓘⓘⓘ, and →weighing instrument of ordinary accuracy ⓘⓘⓘⓘ ([OIML R 76-1] 3.1.1).
The →verification scale interval, →number of verification scale intervals and the →minimum capacity, in relation to the accuracy class of an instrument, are given in Tab. 1 and Fig. 2.

Tab. 1
Requirements for accuracy classes of weighing instruments according to OIML Recommendation R 76-1, 3.2. For instruments of class I with d < 0.1 mg, $n$ may be less than 50000 (OIML R 76-1, 3.4.4).

| Accuracy class | Verification scale interval $e$ | Number of verification scale intervals $n = Max/e$ | | Minimum load[1] |
|---|---|---|---|---|
| | | Minimum | Maximum | |
| I | 0.001 g ≤ $e$ | 50000 | – | 100 $e$ |
| II | 0.001 g ≤ $e$ ≤ 0.05 g<br>0.1 g ≤ $e$ | 100<br>5000 | 100 000<br>100 000 | 20 $e$<br>50 $e$ |
| III | 0.1 g ≤ $e$ ≤ 2 g<br>5 g ≤ $e$ | 100<br>500 | 10 000<br>10 000 | 20 $e$<br>20 $e$ |
| IIII | 5 g ≤ $e$ | 100 | 1000 | 10 $e$ |

[1] With instruments of classes Ⓘ and Ⓘⓘ, where the →scale interval $d$ may be smaller than the →verification scale interval $e$, in the column "Minimum load" the verification scale interval $e$ is replaced by the →scale interval $d$ ([OIML R 76-1] 3.4.3).

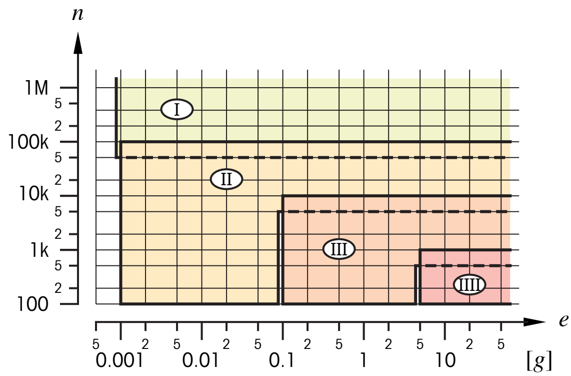


Fig. 2
Number of verification scale intervals *n* versus verification scale interval *e* by accuracy class according to OIML R 76-1

**accuracy classes of weight pieces**

Classes containing error limits for weights that are in systematic steps to fulfill different requirements. In most cases the error limits proceed from class to class in logarithmic steps, i.e. for each step the relative error limit increases (or decreases) by the same factor. Examples of the assignment of weight pieces to →accuracy classes are:

1. →OIML weight classes (international)
2. →ASTM weight classes (USA)
3. Medium accuracy weights (→Directive on Medium Accuracy Weights, →71/317/EEC)
4. Weights of above-medium accuracy (→Directive on Above-Medium Accuracy Weights, →74/148/EEC)

**accuracy, medium**

→medium accuracy

**actual scale interval**

Value expressed in →units of mass

1. for analog indication or analog printout: difference between the values corresponding to two consecutive scale marks (→scale division); scale interval $d$.
2. for digital indication or digital printout: difference between two consecutive indicated values (→numerical interval); digital scale interval $d$.
   ([OIML R 76-1] T.3.2.2)
3. A fixed value (→conventional scale interval $d$) used to classify weighing instruments that are not equipped with an indicator device.
   →readability

**adaptive filter**

→Signal filter with variable characteristics, usually implemented as a →digital filter. Adaptive filters modify their characteristics automatically according to the weighing signal to attain an optimum between interference suppression and →settling time.

**additive tare device**

A device used to weigh or compensate a →tare load without utilizing any part of the weighing range of the balance. →tare weighing device, →tare compensation device (compare: →subtractive tare device)

**adjust, to**

1. Set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured ([VIM:2008] 3.11).
2. Adjusting is the action of setting a measuring instrument or standard so that the measured value is correct, or deviates as little as possible from the correct value, or the deviation remains within acceptable limits of error. This is obtained
   a) in the case of a weighing instrument, through adjusting the manual fine setting of its →indication by trained specialist personnel, or semi-automatically by the user, by placing on the instrument a →reference weight that is kept either externally or inside the instrument, or automatically if the instrument has an adjusting mechanism with reference weight (→self-adjustment).
   b) in the case of a weight piece, through correcting its mass to the corresponding nominal value, e.g. by filing, or by adding or removing correction material in an →adjusting cavity.

   (compare: →calibration)

**adjusting cavity**

Sealable cavity, a.k.a. adjustment cavity.

1. In weight pieces to hold the material used to adjust the weights to their nominal value (Fig. 182b). Weight pieces of OIML →accuracy class E1 and E2, and ASTM class 0 (→accuracy classes of weight pieces) are not permitted to have adjusting cavities.
2. On the load receptor of a mechanical weighing instrument to set the unloaded instrument to read zero.

**adjustment**

1. Result of the action of adjusting (→to adjust) an instrument.

2. Non-technical simplified term for →sensitivity adjustment.

**adjustment weight**
→reference weight

**admission to verification**
Requirements specified in the →Weights and Measures Acts for the verification of measuring instruments. A type may either be generally approved, or approved after testing by the →Notified Body. →types of approval

**adsorption**
Process in which a liquid or gaseous substance is retained on the surface of a solid body. →weighing error (compare: →desorption, →absorption)

**AGME**
Abbreviation for →'Arbeitsgemeinschaft Mess- und Eichwesen'.


Fig. 3
Air baggage scale

**air baggage scale**
→Scale to determine the weight of passengers' baggage with readout possibilities on two sides and a load surface that allows easy handover of the baggage (Fig. 3).

**air buoyancy**
Buoyancy force that counteracts the →weight force of a body that is surrounded by air. The magnitude of the →buoyancy force is given by

$$F_a = m_a g = \rho_a V g = \frac{\rho_a}{\rho} mg$$

where

$m$ mass of the body
$\rho$ density of the body
$\rho_a$ density of the air (→air density)
$V$ volume of the body
$m_a$ mass of the air displaced by the body
$g$ →local gravity.

Since the buoyancy force of a body that is involved in a weighment cannot be separately detected by the weighing instrument, the instrument does not indicate the value of the →mass, but the →weighing value. Air buoyancy is usually the main cause of →systematic error when weighing in air, particularly in →high-resolution weighing.
→deviation

**air buoyancy correction**

A →weighment performed in air is subject to →air buoyancy. Normally, the →weighing value does not contain a correction for air buoyancy. Unless stated otherwise, →weighing instruments and →weight pieces are always adjusted to the conventionally defined reference density of $\rho_c$ = 8000 kg/m$^3$ (→conventional mass).

1. If the purpose of the weighment is to determine the →mass $m$ of the weighed object, the →weighing value $W$ (the sum of the weight pieces, the value read from, or indicated by, the weighing instrument) must be multiplied by the factor $B_W$, i.e.

   $$m = B_W\, W$$

   where

   $$B_W = \frac{1 - \dfrac{\rho_a}{\rho_c}}{1 - \dfrac{\rho_a}{\rho}}$$

   In this formula are

   $\rho_a$ density of the air (at the time of weighing) (→air density)

   $\rho_c$ conventional object density 8000 kg/m$^3$

   $\rho$ density of the weighed object.

   The correction for air buoyancy can be obtained from Fig. 4.

2. If the purpose of the weighment is to determine the →conventional mass $m_c$ of the weighed object, the weighing value $W$ (the sum of the weight pieces, the value read from, or indicated by, the weighing instrument) must be corrected as follows:

   $$m_c = \frac{1 - \dfrac{\rho_a^*}{\rho_r}}{1 - \dfrac{\rho_a}{\rho}} \; \frac{1 - \dfrac{(\rho_a)_c}{\rho}}{1 - \dfrac{(\rho_a)_c}{\rho_r}} \; W$$

   In this formula

   $\rho_a$ density of the air at the time of weighing (→air density)

   $\rho_a^*$ 1. for weighing instruments that function by mass comparison (→physical weighing principle 1): density of the air at the time of weighing: $\rho_a^* = \rho_a$
   2. for weighing instruments that function by force comparison (→physical weighing principle 2): density of the air at the time of the →sensitivity adjustment: $\rho_a^* = (\rho_a)_r$

   $\rho_r$ density of the reference weights (if not known, use $\rho_c$ = 8000 kg/m$^3$)

   $(\rho_a)_c$ conventional density of air 1.2 kg/m$^3$

   $\rho$ density of the weighed object.

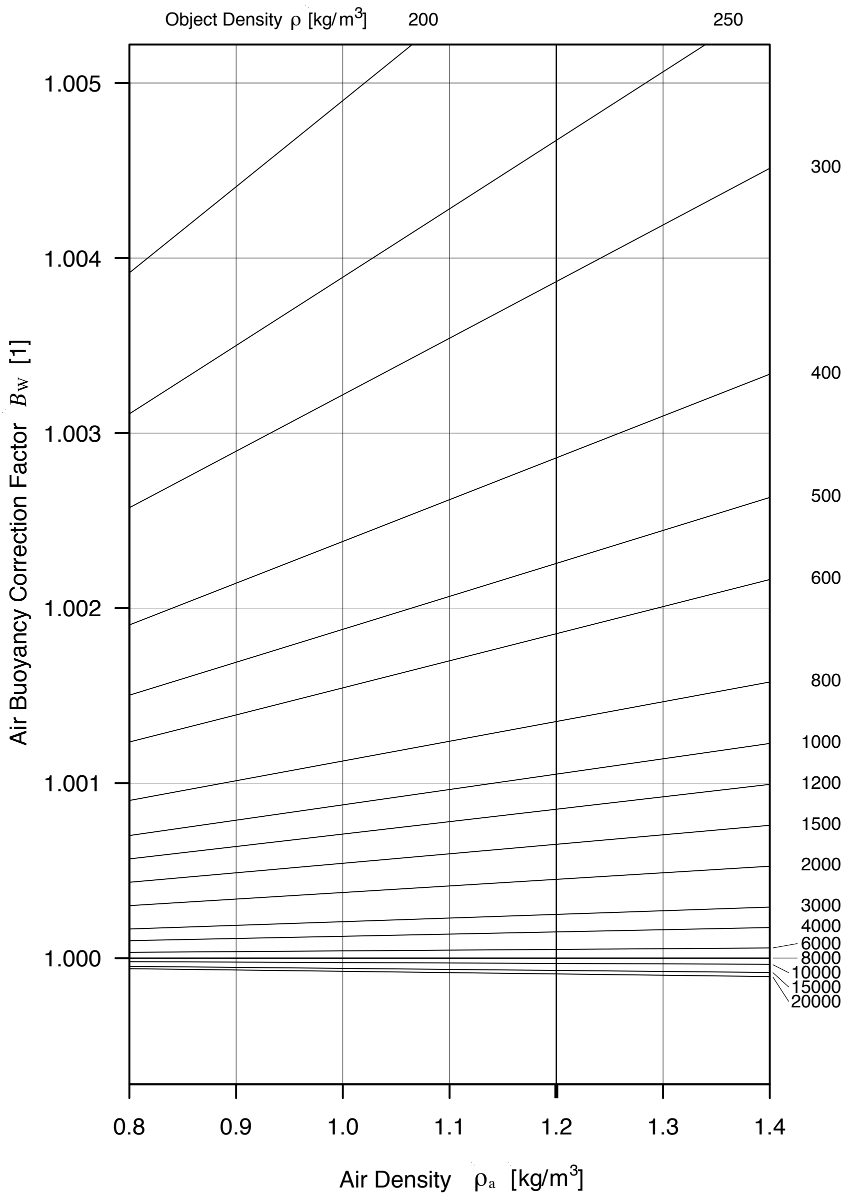


Fig. 4
Correction for air buoyancy: To obtain the mass of the weighed object, the value read from the weighing instrument must be multiplied by the appropriate factor.

$\rho_a$: air density
$\rho$: density of the weighed object
$B_W$: air density correction factor

**air damping**

→damping systems

**air density**

The →density $\rho_a$ of dry air is proportional to the →air pressure and inversely proportional to the absolute temperature, according to

$$\rho_a = \frac{1}{R_a}\frac{p}{T}$$

$R_a$ gas constant of dry air: ~ 287 J/(kg·K)

$p$ air pressure [2]

$T$ absolute air temperature [K].

Under normal conditions at sea level (20 °C, 1013 hPa), the density of dry air is therefore

$$(\rho_a)_0 = \frac{1}{287\ \frac{\text{J}}{\text{kg·K}}}\ \frac{1013\ \text{hPa}}{(20 + 273.15)\text{K}} = 1.20\ \frac{\text{kg}}{\text{m}^3}$$

If the density of air needs to be determined more accurately, its humidity must also be taken into account

$$\rho_a = \frac{0.348444\ p - (0.00252\ t - 0.020582)\ h}{273.15 + t} \quad (1)$$ [3]

$\rho_a$ air density [kg/m$^3$]

$p$ air pressure [2] [hPa]

$h$ relative air humidity [%]

$t$ air temperature [°C].

In the range of (1.2 kg/m$^3$) ±10%, the air density determined with formula (1) has a typical relative uncertainty of $4\times10^{-4}$.

**air humidity**

The amount of water vapor in the air. Relative humidity $h$ is the ratio between the actual vapor pressure of water and its saturated vapor pressure.

**air pressure**

The static →pressure prevailing in the mixture of gases that forms the Earth's atmosphere. Mean air pressure at sea level is 1013 hPa (normal pressure) and decreases continuously with increasing height. It also fluctuates constantly with changing weather conditions. The standard deviation of these fluctuations from the local mean value over a period of two or more weeks at temperate latitudes is of the order of 7 hPa, or approximately 0.7% of normal pressure.

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[2] Station pressure STP (→air pressure)

[3] Simplified version of CIPM-formula, standard version ([CG-18], Appendix A, Formula A1.2-1)

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