

Glossary of

Terms for procedures for setting out, measurement and surveying in building construction (including guidance notes)

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Committees responsible for this British Standard

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- Association of County Councils
- British Standards Society
- Building Employers Confederation
- Chartered Institution of Building Services Engineers
- Concrete Society
- Department of Education and Science
- Department of the Environment (Building Research Establishment)
- Department of the Environment (Property Services Agency)
- Incorporated Association of Architects and Surveyors
- Institute of Building Control
- Institute of Clerks of Works of Great Britain Inc.
- Institution of Civil Engineers
- Institution of Structural Engineers
- Institution of Water and Environmental Management (IWEM)
- National Council of Building Materials Producers
- Royal Institute of British Architects
- Royal Institution of Chartered Surveyors

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National foreword

This British Standard has been prepared under the direction of the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Committee. It is identical with the English text of ISO 7078:1985 “*Building construction — Procedures for setting out, measurement and surveying — Vocabulary and guidance notes*”, prepared by Technical Committee 59, Building construction, of the International Organization for Standardization (ISO).

The terms defined in this standard primarily relate to BS 5964: *Building setting out and measurement — Part 1: Methods of measuring, planning and organization and acceptance criteria — Part 2: Measuring stations and targets — Part 3: Check-lists for the procurement of surveys and measurement services*; BS 7307: *Building tolerances — Measurement of buildings and building products — Part 1: Methods and instruments*; and — *Part 2: Position of measuring points*. They also relate to the BS 7334 series of standards “*Measuring instruments for building construction. Methods for determining accuracy*”.

Wherever the words “International Standard” appear in the text, referring to this standard, they should read as “British Standard”. Reference in the “Scope and field of application” to the French text and equivalent German terms, can be ignored.

Cross-references

International Standard	Corresponding British Standard
	BS ISO 3534 <i>Statistics, vocabulary and symbols</i>
ISO 3534-1:1993	BS ISO 3534-1:1993 <i>Probability and general statistical terms</i> (Identical)
ISO 3534-3:1985	BS ISO 3534-3:1985 <i>Glossary of terms relating to the design of experiments</i> (Identical)
	BS 5964 <i>Building setting out and measurement</i>
ISO 4463-1:1989	Part 1:1990 <i>Methods of measuring, planning and organization and acceptance criteria</i> (Identical)
ISO 4463-2:1995	Part 2:1966 <i>Measuring stations and targets</i> (Identical)
ISO 4463-3:1995	Part 3:1996 <i>Check-lists for the procurement of surveys and measurement services</i> (Identical)

The Technical Committee has reviewed the provisions of ISO 1803-1 and ISO 1803-2 to which reference is made in the text and has decided that they are acceptable for use in conjunction with this standard. A related standard to ISO 1803 is BS 6100 “*Glossary of building and civil engineering terms*”, Sub-section 1.5.1:1984 “*Co-ordination of dimensions, tolerance and accuracy*”.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 32, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Introduction

This International Standard is one of a series dealing with methods of measurement in building construction. It gives explanations of the terms and concepts used in measuring procedures in the building industry and used in International Standards dealing with this subject.

The practical realization of dimensional accuracy in the building industry involves not only land surveyors and measuring technicians, but also building professionals engaged in the different stages of the construction process. This implies the necessity for smooth communication between these different professions and consequently, in order to promote such communication, the need for agreement on terms and concepts used in setting out, measurement and surveying. The purpose of this International Standard is, therefore, to provide a consistent language for use by the various professions involved in measurement in the building industry.

Scope and field of application

This International Standard defines terms, in English and French, that are commonly used in procedures for setting out, measurement and surveying in building construction. It also gives equivalent German terms in the annex.

References

ISO 1803-1, *Tolerances for building — Vocabulary — Part 1: General terms.*

ISO 1803-2, *Tolerances for building — Vocabulary — Part 2: Derived terms.*

ISO 3534, *Statistics — Vocabulary and symbols.*

ISO 4463, *Measurement methods for building — Setting out and measurement — Permissible measuring deviations.*

Terms and definitions

1 General terms

NOTE Alternative terms given in brackets are deprecated; use of *italics* indicates a term which is defined elsewhere in this vocabulary.

1.1

measurement

set of operations having the object of determining the value of a quantity

NOTE In general, a measurement may include preparation, calculation, and presentation of the results of the measurement.

1.2

setting out (US: layout)

establishment of marks and lines to define the position and *level* of the elements for the construction work so that work may proceed with reference to them

NOTE This process may be contrasted with the purpose of surveying, which is to determine by measurement the position of existing features.

1.3

metrology

field of knowledge concerned with *measurement*

NOTE 1 Metrology includes all aspects, both theoretical and practical, concerning *measurements*, whatever their accuracy, and in whatever fields of science or technology they occur.

NOTE 2 The term **legal metrology** is used in those activities involving verification, etc., governed by law or some other legal statute.

1.4

geodesy

science of **measurement** on or in the vicinity of the ground to determine form, dimensions and the distribution of mass and fields of gravity on the earth or parts of it

NOTE 1 **Surveying** is the science of *measurements* necessary to determine the locations of points (features) on or beneath the surface of the earth.

NOTE 2 Where *measurements* cover such a large part of the earth's surface that the curvature cannot be ignored, then the operations are termed geodetic surveying or measuring.

1.5 photogrammetry

technique of *measurement* using photographs, for example aerial photographs, to determine, primarily, geometrical properties such as size, location and form of objects

NOTE Photogrammetric *measurement* is often used for mapping and also has some engineering applications.

1.6 geometric measurement

measurement of shape and dimensions, i.e. length, area, volume and angle

NOTE Geometric *measurement* covers, in addition to surveying, *measurement* with other instruments or measuring tools.

1.7 measuring instrument

device intended to make a *measurement*, alone or in conjunction with other equipment

NOTE The term **measuring tool** often refers to simple measuring devices, for example *folding rules*, tape measures, *squares*.

1.8 measuring equipment

equipment which includes the basic *measuring instrument* and its necessary supplementary items required to carry out a specified measuring task

NOTE Examples of such measuring equipment are

- a) *theodolite* and tripod;
- b) *EDM instrument*, tripod, reflector and batteries;
- c) centring devices;
- d) thermometers, etc., for the determination of influencing quantities.

1.9 ancillary equipment

equipment additional to the actual *measuring equipment* used when carrying out *measurements*

NOTE Examples of such ancillary equipment are pegs, sighting *targets* and chalk marking lines.

1.10 testing of measuring instruments

procedures designed to determine whether a *measuring instrument* satisfies requirements in respect of one or more specified properties under specified conditions

1.11 calibration

in land surveying and building construction *measurement*, a set of operations carried out to determine the values of relevant parameters of a *measuring instrument*

NOTE Examples of such parameters are additive constants and scale factors within a *measuring instrument* or measuring tool.

1.12 gauging

operation of fixing the positions of the *gauge marks* or *scale marks* of a *measuring instrument* (in some cases of certain principal marks only), in relation to the corresponding values of the measured quantity

1.13 calibration temperature

temperature specified for the *calibration* and *gauging* of a *measuring instrument*

NOTE In some countries, the concept **normal temperature** is used. This is the temperature for which the length of a length-measuring device has its **nominal value**. The normal temperature, which varies from one device to another, is calculated according to certain formulae in which the calibration temperature has been taken into account.

1.14 measurement standard

measuring instrument or system intended to define, realize, conserve or reproduce a unit or one or more known values of a quantity in order to transmit them to other *measuring instruments* by comparison

NOTE 1 Primary measurement standards are maintained by national authorities.

NOTE 2 The term standard must be qualified by a word such as length, for example *length standard*. The word standard is also used to indicate that certain procedures, dimensions, performances, etc., are agreed upon, for example a standard length used for *gauges*.

NOTE 3 A primary standard is a standard of a particular quantity which has the highest metrological qualities in a given field. A secondary standard is a standard whose value is fixed by direct or indirect comparison with a primary standard.

1.15

comparator

measuring equipment used in addition to a standard for *calibration* of instruments, for example for comparing a *measuring tape* or an *EDM instrument* with a bar standard or for the determination of the accuracy of an angular scale in a *theodolite*. In *photogrammetry*, comparators, for example stereocomparators, are used to determine co-ordinates on photographs

1.16

gauge (length standard)

bar of steel or other suitable material of standard length, accurately made, for the purpose of checking or verification of length-measuring devices

1.17

co-ordinate system

two- or three-dimensional reference system for defining the location points on a surface or in space by means of distances (rectangular/Cartesian co-ordinates) or angles (angles co-ordinates) or both (polar co-ordinates), with relation to designated angles or planes

NOTE In land surveying, the *x*-axis may be in the direction of astronomic (true) north, magnetic north or an assumed north, for example grid north, with the *y*-axis towards east. The *z*-axis points approximately upwards (towards the zenith). In some countries, the *x*- and *y*-axes are reversed whilst in others *E*, *N* and *H* are used to refer to “East”, “North” and “Height”. In building surveying, a local orthogonal system is often set up with the reference axes parallel to the building axes or chosen at the convenience of the surveyor.

1.18

geodetic co-ordinates

spherical rectangular co-ordinates to define a point on the earth with respect to the ellipsoid and with reference to a selected meridian and to a point on this meridian

1.19

geographic co-ordinates

angular co-ordinates (angular distances) expressed as latitude and longitude to define a point on the surface of the earth with reference to the equator and the meridian of Greenwich

1.20

level (US: elevation)

the vertical distance of a point above or below a defined reference datum, usually mean sea level
see also 5.2

NOTE Datum is a numerical or geometrical quantity which may serve as a reference for similar quantities.

1.21

height

vertical distance between two points, for instance on a structure or the distance of a feature above the ground, for example the height of a building

1.22

observation

measurement operations performed by an operator to obtain observed values of a quantity

1.23

error

result of a *measurement* minus the *true value* of the measured quantity

in land surveying and building construction *measurement*, this means the difference between the observed or calculated value of a quantity and the *true value* or the value of that quantity accepted as true

NOTE 1 *Errors* can generally be divided into *random errors* (accidental errors) and *systematic errors*. See terms 2.9 to 2.12. A **blunder** or **gross error** is a mistake, such as *reading* a scale incorrectly.

NOTE 2 The true value is usually unknown, so that the error can only be estimated.

NOTE 3 For an example of calculated value, see 2.12, *closing error*.

1.24

reading

part of an *observation* which only involves the operator's notations of values on a *scale* or other methods of recording values

2 Quality of measurement

2.1

actual measured value

value obtained for a quantity after *correction* of the *measurement* for known measurement errors

2.2

true value

value which characterizes a quantity perfectly defined in the conditions which exist when that quantity is observed

NOTE 1 The mean of a sufficiently large sample of *observations* of the same object is, after elimination of *systematic errors*, generally considered to be the best estimate of the *true value*.

NOTE 2 For certain purposes, given reference values are considered as being true values.

2.3

influence quantity

quantity which is not the subject of the *measurement* but which influences the value to be measured or the indication of the measuring instrument, for example *tape* temperature when measuring distances

2.4

accuracy of measurement

closeness of agreement between the result of a *measurement* (actual measured value) and the true value, or a value of the measured quantity accepted as true

NOTE The terms "precision" and "accuracy" should be used in their correct sense and not be interchanged indiscriminately.

2.5

precision of measurement

closeness of agreement between measured values obtained by applying the measuring procedure several times under prescribed conditions

NOTE The *standard deviation* is applicable as a measure of precision. The smaller the *random errors*, the more precise is the procedure. The term precision is often incorrectly used to indicate a high quality of a *measuring instrument* or a method, for example precise tape. Precision is not to be confused with accuracy (see 2.4).

2.6

accuracy class:

- 1) Classification of *measurement* results into groups, the members of which exhibit a similar accuracy within specified limits of *errors*.
- 2) Classification of specified demands on accuracy for a *measuring instrument* or a measuring method.

2.7

repeatability of measurement

closeness of the agreement between the results of successive *measurements* of the same quantity carried out subject to all of the following conditions:

- the same *method of measurement*;
- the same observer;
- the same *measuring instrument*;
- the same location;
- the same conditions of use;
- repetition over a short period of time.

2.8

reproducibility

closeness of agreement between the results of *measurements* of the same quantity where the individual measurements are carried out changing conditions such as:

- *method of measurement*;
- observer;
- *measuring instrument*;
- location;
- conditions of use;
- time.

2.9

systematic error

component of the *error of measurement* which, in the course of a number of *measurements* of the same quantity, remains constant or varies in a predictable way when the conditions change

NOTE 1 The causes of *systematic errors* may be known or unknown.

NOTE 2 Some *systematic errors* can be identified and isolated, and their effect can be eliminated by using prescribed measuring procedures, by calculation or by *calibration*. They cannot, as a rule, be determined by for example, repeated *measurement*.

2.10

random error (accidental error)

component of the *error of measurement* which, in the course of a number of *measurements* of the same quantity varies in an unpredictable way under effectively identical conditions

NOTE 1 Random errors are produced by irregular causes often governed by a general law, for example the law of normal distribution. Characteristics of these *errors* are, for example:

- small *errors* occur more frequently than large *errors*;
- there are approximately as many negative *errors* as there are positive *errors*;
- the common theories of *errors*, for example the method of least squares, can be applied to *random errors*.

NOTE 2 It is not possible to take account of *random errors* by application of a correction.

2.11

total measuring error

whole *error of a measurement* which consists of a combination of the *random error* and the *systematic error*

NOTE The total measuring error can be expressed as an **absolute error** or a **relative error** where

- a) an *absolute error* is the *error of measurement* expressed in units of the measured quantity, i.e. the result of the measurement minus the *true value*;
- b) a *relative error* is the *error of measurement* expressed as a ratio, i.e. the *absolute error* divided by the *true value*.

2.12

closing error; error of closure

amount by which the value of one or more quantities obtained by surveying operations fails to agree with a fixed or theoretical value of the same quantities

NOTE In *traversing*, this can, for example, be the amounts by which the computed, but not adjusted, co-ordinates of the end *station* of a traverse fail to agree with the given co-ordinates of that *station*.

2.13

discrepancy:

- 1) Difference between results of duplicate or comparable measures of a quantity.
- 2) Difference in computed values of a quantity obtained by different processes using data from the same survey.

NOTE In ISO 4463, the discrepancy is expressed as “the difference between the measured and calculated values of points with given co-ordinates”.

2.14

adjustment calculation; adjustment

calculation process designed to distribute *discrepancies* obtained due to the existence of redundant *observations* over the measuring results carried out according to certain rules, for example the method of least squares

NOTE In this context, a redundant *observation* is any *observation* which exceeds the number of *observations* which are necessary for an unambiguous determination of the value of a quantity.

The concept adjustment is also used when correcting an instrument (see 6.32).

2.15

residual

difference between the adjusted and the *measured value* of a quantity

2.16

correction

value to be added algebraically to an observed or calculated value in order to eliminate the known *systematic errors*, caused by for example temperature, slope and sag in distance *measurement*

2.17

arithmetic mean

sum of *measured values* divided by their number:

$$\bar{x} = \frac{\sum x_i}{n}$$

where

$\bar{x}$ is the arithmetic mean;

x_i are the *measured values*;

n is the number of *measured values*;

$$\sum x_i = x_1 + x_2 + \dots + x_n$$

2.18

weight of a measurement

number which expresses the degree of confidence in the result of a *measurement* of a quantity in comparison with the results of another *measurement* of the same quantity, for example when using different types of instruments, or the ratio of the reliability of various quantities in *adjustment* procedures, when determining co-ordinates in *triangulation* nets

NOTE The higher the number, the greater the confidence.

2.19

weighted mean

sum of the products of each *measured value* and its weight, divided by the sum of the weights:

$$\bar{x}_w = \frac{\sum p_i x_i}{\sum p_i}$$

where

$\bar{x}_w$ is the weighted mean;

x_i are the *measured values*;

p_i is the weight of the *measured value* x_i ;

$$\sum p_i x_i = p_1 x_1 + p_2 x_2 + \dots + p_n x_n$$

2.20

dispersion

scatter of the *measured values* obtained in a set of *measurements* of a quantity

2.21

range (of variation)

measure of the *dispersion* defined as the difference between the greatest and the smallest of the *measured values* of a quantity

2.22**variance**

measure of the *dispersion* based on the mean square deviation from the *arithmetic mean*:

$$s^2 = \frac{\sum (x_i - \bar{x})^2}{n - 1}$$

where

s^2 is the variance;

x_i are the *measured values*;

$\bar{x}$ is the *arithmetic mean*;

n is the number of measured values;

$$\sum (x_i - \bar{x})^2 = (x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \dots + (x_n - \bar{x})^2$$

NOTE The value $n - 1$ expresses the number of redundant measurements.

2.23**standard deviation**

positive square root of the *variance*, defined as

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}}$$

where

s is the standard deviation;

x_i are the *measured values*;

$\bar{x}$ is the *arithmetic mean*;

n is the number of *measurements*.

NOTE 1 The value $n - 1$ expresses the number of redundant *measurements*.

Any new series of *measurements* will, in general, not have exactly the same distribution and, consequently, will not produce a histogram of exactly the same shape as a previous or a succeeding one. However, in measuring techniques it is often assumed that those histograms of different shapes will fit a certain pattern, namely the normal distribution.

The normal distribution has two parameters, the expectation (m) and the *standard deviation* (σ). In practice, these two parameters are generally not known and have to be estimated from the available *measured values* x_i . This means that the formula given above has to be replaced by

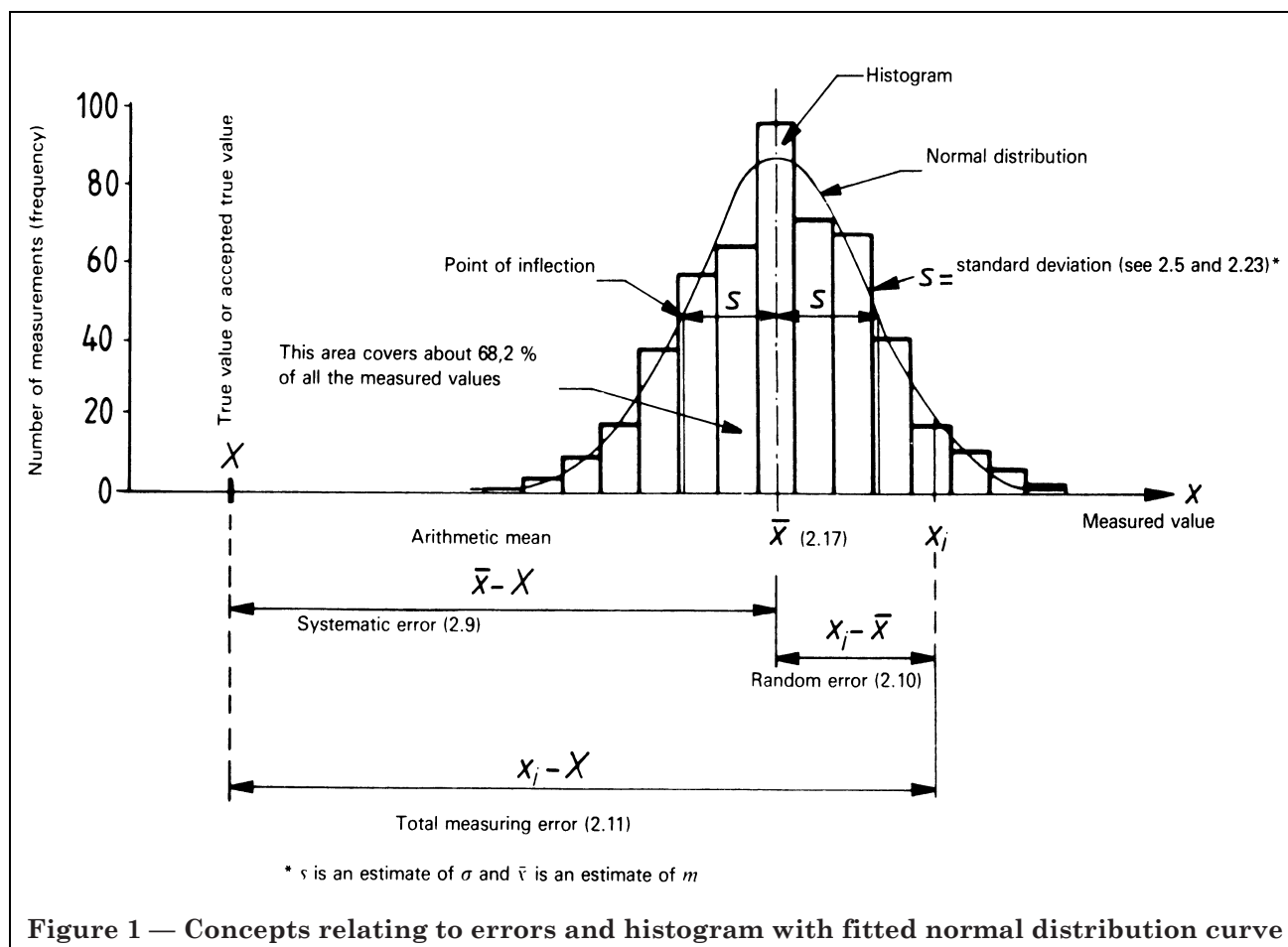
$$f(x) = \frac{1}{s\sqrt{2\pi}} \exp \left[-\frac{1}{2} \left(\frac{x - \bar{x}}{s} \right)^2 \right]$$

where

$\bar{x}$ is the *arithmetic mean*;

s is the (experimental) *standard deviation*.

In the theory of *errors*, the normal distribution is often used for the analysis of a *measurement*, for example if a set of *measurements* does not exhibit a normal distribution or has a normal distribution with parameters which differ significantly from those specified, there may be cause to investigate the measuring procedure used.



NOTE 2 In *geodesy* and *land surveying* literature, the term standard deviation is frequently replaced by the term **mean square error** or **root mean square error (RMS)**, especially after an *adjustment procedure*. This term is also used in *calibration* processes where *measured values* are compared with given (*true*) values. The result of this *calibration* can be represented by the *accuracy* concept

$$\hat{s} = \sqrt{\frac{\sum \varepsilon^2}{n}}$$

where

ε is the *measured value* minus the given value;

n is the number of *measurements*.

In *engineering surveys* with known negligible *systematic errors*, it is usually sufficient to use the formula in the definition, which in this case gives both the *precision* and the *accuracy*.

NOTE 3 An increasing number of *measurements* normally results in a reduced standard deviation of the mean $\bar{x}$, expressed as

$$s_{\bar{x}} = \frac{s}{\sqrt{n}}$$

See also the note to 2.5.

NOTE 4 The formula is also used in quality control, for example for the *compliance measurement* of components.

2.24 standard error of position

square root of the sum of the squared errors of the co-ordinates (x and y or East and North) of a point

NOTE This error is normally calculated after adjustment.