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Metroloogilised nõuded mitteautomaatkaaludele

Metrological aspects of non-automatic weighing instruments

EESTI STANDARDIKESKUS
ESTONIAN CENTRE FOR STANDARDISATION

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 45501:2004 sisaldab Euroopa standardi EN 45501:1992 + AC:1993 ingliskeelset teksti.	This Estonian standard EVS-EN 45501:2004 consists of the English text of the European standard EN 45501:1992 + AC:1993.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 45501:1992

October 1992

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Descriptors: Metrology, measuring instruments, weighing machines, indicating instruments, tare weight devices, definitions, metrological inspection, specifications, characteristics, traceability, fidelity, errors, instrument sensitivity, tests, name plate, marking, certification

English version

Metrological aspects of non-automatic weighing instruments

Aspects métrologiques des instruments de pesage à fonctionnement non automatique

Metrologische Aspekte der nichtselbsttätigen Waagen

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CONTENTS

Introduction

T Terminology
T.1 General definitions
T.2 Construction of an instrument
T.3 Metrological characteristics of an instrument
T.4 Metrological properties of an instrument
T.5 Indications and errors
T.6 Influences and reference conditions
T.7 Performance test
Alphabetical list of the terms which are defined in the Terminology

1 Scope

2 Principles of the European Standard
2.1 Units of measurement
2.2 Principles of the metrological requirements
2.3 Principles of the technical requirements
2.4 Application of requirements

3 Metrological regulation
3.1 Principles of classification
3.2 Classification of instruments
3.3 Additional requirements for a multi-interval instrument
3.4 Auxiliary indicating devices
3.5 Maximum permissible errors
3.6 Permissible differences between results
3.7 Verification standards
3.8 Discrimination
3.9 Variations due to influence quantities and time
3.10 Type examination tests

4 Technical requirements for a self- or semi-self-indicating instrument
4.1 General requirements of construction
4.2 Indication of weighing results
4.3 Analogue indicating device
4.4 Digital indicating and printing devices
4.5 Zero-setting and zero-tracking devices
4.6 Tare device
4.7 Preset tare device
4.8 Locking positions
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-load transmitting devices and various load measuring devices
4.12 Requirements for load cells
4.13 "Plus" and "minus" comparator instrument
4.14 Instrument for direct sales to the public

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4.15 Additional requirements for an instrument for direct sales to the public with price indication
4.16 Instrument similar to one normally used for direct sales to the public
4.17 Price-labelling instrument

5 Requirements for electronic instruments
5.1 General requirements
5.2 Acting upon significant faults
5.3 Functional requirements
5.4 Performance and span stability tests

6 Technical requirements for a non-self-indicating instrument
6.1 Minimum sensitivity
6.2 Acceptable solutions for indicating devices
6.3 Conditions of construction
6.4 Simple equal arm beam
6.5 Simple 1/10 ratio beam
6.6 Simple sliding poise instrument (steelyard)
6.7 Roberval and Beranger instruments
6.8 Instrument with ratio platforms
6.9 Instrument with a load-measuring device with accessible sliding poises (of the steelyard type)

7 Marking of an instrument
7.1 Descriptive markings
7.2 Verification marks
7.3 Additional inscriptions

8 Certification procedure
8.1 Type examination
8.2 Verification of conformity to type

Annex A (normative) Testing procedures for non-automatic weighing instruments

A.1 Administrative examination
A.2 Compare construction with documentation
A.3 Initial examination
A.4 Performance tests
A.5 Influence factors
A.6 Endurance test

Annex B (normative) Additional tests for electronic instruments

B.1 General requirements for electronic instruments under test (EUT)
B.2 Performance tests for influence factors
B.3 Performance tests for disturbances
B.4 Span stability test

Annex C (normative) Test procedure for immunity to radiated radio-frequency electromagnetic fields

Bibliography

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Foreword

This European Standard has been prepared by a Joint CEN/CENELEC Working Group on Non-automatique weighing instruments.

A Reference Document on "Metrological aspects of non-automatique weighing instruments", prepared by the Bureau International de Métrologie Légale (BIML) on basis of the Recommendation OIML R 76, edition 1988, was submitted to the common CEN/CENELEC PQ procedure from 1989-01-20 to 1989-04-20.

The above mentioned working group has prepared a draft European Standard in view of the results of the PQ procedures, which has been available to CEN/CENELEC for formal vote and has been accepted.

According to the CEN/CENELEC Rules, the following countries are bound to implement this European Standard: Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Iceland, Italy, Luxembourg, the Netherlands, Norway, Austria, Portugal, Sweden, Switzerland, Spain and United Kingdom.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1993, and conflicting national standards shall be withdrawn at the latest by April 1995.

INTRODUCTION

This draft European Standard has been adapted from the

OIML-Recommendation R76-1, Edition 1992,
NON-AUTOMATIC WEIGHING INSTRUMENTS
Part 1: Metrological and technical requirements - Tests

by a Joint Working Group from CEN and CENELEC. It was elaborated following a standardization request from the Commission of the European Communities (CEC) and the Secretariat of the European Free Trade Association (EFTA) to CEN and CENELEC, to establish European Standard(s) related to Council Directive 90/384/EEC on Non-Automatic Weighing Instruments.

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TERMINOLOGY

The vocabulary used in this European Standard conforms to the

"International Vocabulary
of Basic and General Terms
in Metrology"
(1984 edition)

published in the name of

BIPM	International Bureau of Weights and Measures
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
OIML	International Organization for Legal Metrology

and to the

"Vocabulary of Legal Metrology"
(1978 edition, as amended in 1987)

published by OIML.

Where these vocabularies do not adequately define terms specific to weighing instruments and where additional terms are required, the following definitions apply.

Wherever these terms appear in the text of this European Standard, they are identified by capital letters to draw attention to the definitions. An alphabetic list - see end of Terminology - helps to find the definitions.

T.1 General definitions

T.1.1 Weighing instrument

Measuring instrument that serves to determine the mass of a body by using the action of gravity on this body.

The instrument may also be used to determine other quantities, magnitudes, parameters or characteristics related to mass.

According to its method of operation, a weighing instrument is classified as an automatic or non-automatic instrument.

T.1.2 Non-automatic weighing instrument

Instrument that requires the intervention of an operator during the weighing process, for example to deposit on or remove from the receptor the load to be measured and also to obtain the result.

The instrument permits direct observation of the weighing results, either displayed or printed; both possibilities are covered by the word "indication".

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Note 1: Terms such as "indicate", "indicating component" and their derivatives, do not include printing.

A non-automatic weighing instrument may be:

- graduated or non-graduated,

- self-indicating, semi-self-indicating or non-self-indicating.

Note 2: In this European Standard a non-automatic weighing instrument is called an "instrument".

T.1.2.1 Graduated instrument

Instrument allowing the direct reading of the complete or partial weighing result.

T.1.2.2 Non-graduated instrument

Instrument not fitted with a scale numbered in units of mass.

T.1.2.3 Self-indicating instrument

Instrument in which the position of equilibrium is obtained without the intervention of an operator.

T.1.2.4 Semi-self-indicating instrument

Instrument with a self-indication weighing range, in which the operator intervenes to alter the limits of this range.

T.1.2.5 Non-self-indicating instrument

Instrument in which the position of equilibrium is obtained entirely by the operator.

T.1.2.6 Electronic instrument

Instrument equipped with electronic devices.

T.1.2.7 Instrument with price scales

Instrument that indicates the price to pay by means of price charts or scales related to a range of unit prices.

T.1.2.8 Price-computing instrument

Instrument that calculates the price to pay on the basis of the indicated mass and the unit price.

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T.1.2.9 Price-labelling instrument

Price-computing instrument that prints the weight value, unit price and price to pay for prepackages.

T.1.2.10 Self-service instrument

Instrument that is intended to be operated by the customer

T.1.3 Indications provided by an instrument

T.1.3.1 Primary indications

Indications, signals and symbols that are subject to requirements of this European Standard.

T.1.3.2 Secondary indications

Indications, signals and symbols that are not primary indications.

T.2 Construction of an instrument

In this European Standard the term "device" is used for any means by which a specific function is performed, irrespective of the physical realization, e.g. by a mechanism or a key initiating an operation; the device may be a small part or a major portion of an instrument.

T.2.1 Main devices

T.2.1.1 Load receptor

Part of the instrument intended to receive the load.

T.2.1.2 Load-transmitting device

Part of the instrument for transmitting the force produced by the load acting on the load receptor, to the load-measuring device.

T.2.1.3 Load-measuring device

Part of the instrument for measuring the mass of the load by means of an equilibrium device for balancing the force coming from the load-transmitting device, and an indicating or printing device.

T.2.2 Module

Part of an instrument which performs a specific function, can be examined separately and is subject to specified partial error limits.

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T.2.3 Electronic parts

T.2.3.1 Electronic device

A device employing electronic sub-assemblies and performing a specific function. An electronic device is usually manufactured as a separate unit and can be independently tested.

Note: An electronic device, as defined above, may be a complete instrument (e.g., instrument for direct sales to the public) or part of an instrument (e.g., printer, indicator ...).

T.2.3.2 Electronic sub-assembly

A part of an electronic device, employing electronic components and having a recognizable function of its own.

Examples: A/D converter, display matrix,...

T.2.3.3 Electronic component

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

T.2.4 Indicating device (of a weighing instrument)

Part of the load-measuring device on which the direct reading of the result is obtained.

T.2.4.1 Indicating component

Component indicating the equilibrium and/or the result.

On an instrument with one position of equilibrium it indicates only the equilibrium (so-called zero).

On an instrument with several positions of equilibrium it indicates both the equilibrium and the result. On an electronic instrument, this is the display.

T.2.4.2 Scale mark

A line or other mark on an indicating component corresponding to a specified value of mass.

T.2.4.3 Scale base

An imaginary line through the centres of all the shortest scale marks.

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T.2.5 Auxiliary indicating devices

T.2.5.1 Rider

Detachable poise of small mass that may be placed and moved either on a graduated bar integral with the beam or on the beam itself.

T.2.5.2 Device for interpolation of reading (vernier or nonius)

Device connected to the indicating element and sub-dividing the scale of an instrument, without special adjustment.

T.2.5.3 Complementary indicating device

Adjustable device by means of which it is possible to estimate, in units of mass, the value corresponding to the distance between a scale mark and the indicating component.

T.2.5.4 Indicating device with a differentiated scale division

Digital indicating device of which the last figure after the decimal marker is clearly differentiated from other figures.

T.2.6 Extended indicating device

A device temporarily changing the actual scale interval (d) to a value less than the verification scale interval (e) following a manual command.

T.2.7 Supplementary devices

T.2.7.1 Levelling device

Device for setting an instrument to its reference position.

T.2.7.2 Zero-setting device

Device for setting the indication to zero when there is no load on the load receptor.

T.2.7.2.1 Non-automatic zero-setting device

Device for setting the indication to zero by an operator.

T.2.7.2.2 Semi-automatic zero-setting device

Device for setting the indication to zero automatically following a manual command.

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T.2.7.2.3 Automatic zero-setting device

Device for setting the indication to zero automatically without the intervention of an operator.

T.2.7.2.4 Initial zero-setting device

Device for setting the indication to zero automatically at the time the instrument is switched on and before it is ready for use.

T.2.7.3 Zero-tracking device

Device for maintaining the zero indication within certain limits automatically.

T.2.7.4 Tare device

Device for setting the indication to zero when a load is on the load receptor:

- without altering the weighing range for net loads (additive tare device) or
- reducing the weighing range for net loads (substractive tare device).

It may function as:

- a non-automatic device (load balanced by an operator),
- a semi-automatic device (load balanced automatically following a single manual command),
- an automatic device (load balanced automatically without the intervention of an operator).

T.2.7.4.1 Tare-balancing device

Tare device without indication of the tare value when the instrument is loaded.

T.2.7.4.2 Tare-weighing device

Tare device that stores the tare value and is capable of indicating or printing it whether or not the instrument is loaded.

T.2.7.5 Preset tare device

Device for subtracting a preset tare value from a gross or net weight value and indicating the result of the calculation. The weighing range for net loads is reduced accordingly.

T.2.7.6 Locking device

Device for immobilizing all or part of the mechanism of an instrument.

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T.2.7.7 Auxiliary verification device

Device permitting separate verification of one or more main devices of an instrument.

T.2.7.8 Selection device for load receptors and load-measuring devices

Device for attaching one or more load receptors to one or more load-measuring devices, whatever intermediate load-transmitting devices are used.

T.2.7.9 Indication stabilizing device

Device for maintaining a stable indication under given conditions.

T.3 Metrological characteristics of an instrument

T.3.1 Weighing capacity

T.3.1.1 Maximum capacity (Max)

Maximum weighing capacity, not taking into account the additive tare capacity.

T.3.1.2 Minimum capacity (Min)

Value of the load below which the weighing results may be subject to an excessive relative error.

T.3.1.3 Self-indication capacity

Weighing capacity within which equilibrium is obtained without the intervention of an operator.

T.3.1.4 Weighing range

Range between the minimum and maximum capacities.

T.3.1.5 Extension interval of self-indication

Value by which it is possible to extend the range of self-indication within the weighing range.

T.3.1.6 Maximum tare effect (T+, T-)

Maximum capacity of the additive tare device or the substractive tare device.

T.3.1.7 Maximum safe load (Lim)

Maximum static load that can be carried by the instrument without permanently altering its metrological qualities.

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T.3.2 Scale divisions

T.3.2.1 Scale spacing (instrument with analogue indication)

Distance between any two consecutive scale marks, measured along the scale base.

T.3.2.2 Actual scale interval (d)

Value expressed in units of mass of:

- the difference between the values corresponding to two consecutive scale marks, for analogue indication, or
- the difference between two consecutive indicated values, for digital indication.

T.3.2.3 Verification scale interval (e)

Value, expressed in units of mass, used for the classification and verification of an instrument.

T.3.2.4 Scale interval of numbering

Value of the difference between two consecutive numbered scale marks.

T.3.2.5 Number of verification scale intervals (single-interval instrument)

Quotient of the MAXIMUM CAPACITY and the VERIFICATION SCALE INTERVAL:

$$n = Max/e$$

T.3.2.6 Multi-interval instrument

Instrument having one weighing range which is divided into partial weighing ranges each with different scale intervals, with the weighing range determined automatically according to the load applied, both on increasing and decreasing load.

T.3.2.7 Multiple range instrument

Instrument having two or more weighing ranges with different maximum capacities and different scale intervals for the same load receptor, each range extending from zero to its maximum capacity.

T.3.3 Reduction ratio R

The reduction ratio of a load-transmitting device is

$$R = FM/FL$$

FM: force acting on the load-measuring device
FL: force acting on the load receptor

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T.4 Metrological properties of an instrument

T.4.1 Sensitivity

For a given value of the measured mass, the quotient of the change of the observed variable I and the corresponding change of the measured mass M:

$$k = \Delta I / \Delta M$$

T.4.2 Discrimination

Ability of an instrument to react to small variations of load.

The discrimination threshold, for a given load, is the value of the smallest additional load that, when gently deposited on or removed from the load receptor, causes a perceptible change in the indication.

T.4.3 Repeatability

Ability of an instrument to provide results that agree one with the other when the same load is deposited several times and in a practically identical way on the load receptor under reasonably constant test conditions.

T.4.4 Durability

The capability of an instrument to maintain its performance characteristics over a period of use.

T.4.5 Warm-up time

The time between the moment power is applied to an instrument and the moment at which the instrument is capable of complying with the requirements.

T.5 Indications and errors

T.5.1 Methods of indication

T.5.1.1 Balancing by weights

Value of metrologically controlled weights that balance the load (taking into account the reduction ratio of the load).

T.5.1.2 Analogue indication

Indication enabling the evaluation of the equilibrium position to a fraction of the scale interval.

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T.5.1.3 Digital indication

Indication in which the scale marks are composed of a sequence of aligned figures that do not permit interpolation to fractions of the scale interval.

T.5.2 Weighing results

Note: The following definitions apply only when the indication has been zero before the load has been applied to the instrument.

T.5.2.1 Gross value (G or B)

Indication of the weight of a load on an instrument, with no tare or preset tare device in operation.

T.5.2.2 Net value (N)

Indication of the weight of a load placed on an instrument after operation of a tare device.

T.5.2.3 Tare value (T)

The weight value of a load, determined by a tare weighing device.

T.5.3 Other weight values

T.5.3.1 Preset tare value (PT)

Numerical value, representing a weight, that is introduced into the instrument.

"Introduced" includes procedures such as: keying in, recalling from a data storage, or inserting via an interface.

T.5.3.2 Calculated net value

Value of the difference between a gross or net weight value and a preset tare value.

T.5.3.3 Calculated total weight value

Calculated sum of more than one weight value and/or calculated net value.

T.5.4 Reading

T.5.4.1 Reading by simple juxtaposition

Reading of the weighing result by simple juxtaposition of consecutive figures giving the weighing result, without the need of calculation.

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T.5.4.2 Overall inaccuracy of reading

The overall inaccuracy of reading of an instrument with analogue indication is equal to the standard deviation of the same indication, the reading of which is carried out under normal conditions of use by several observers.

It is customary to make at least ten readings of the result.

T.5.4.3 Rounding error of digital indication

Difference between the indication and the result the instrument would give with analogue indication.

T.5.4.4 Minimum reading distance

The shortest distance that an observer is able freely to approach the indicating device to take a reading under normal conditions of use.

This approach is considered to be free for the observer if there is a clear space of at least 0,8 m in front of the indicating device (see Figure 1).

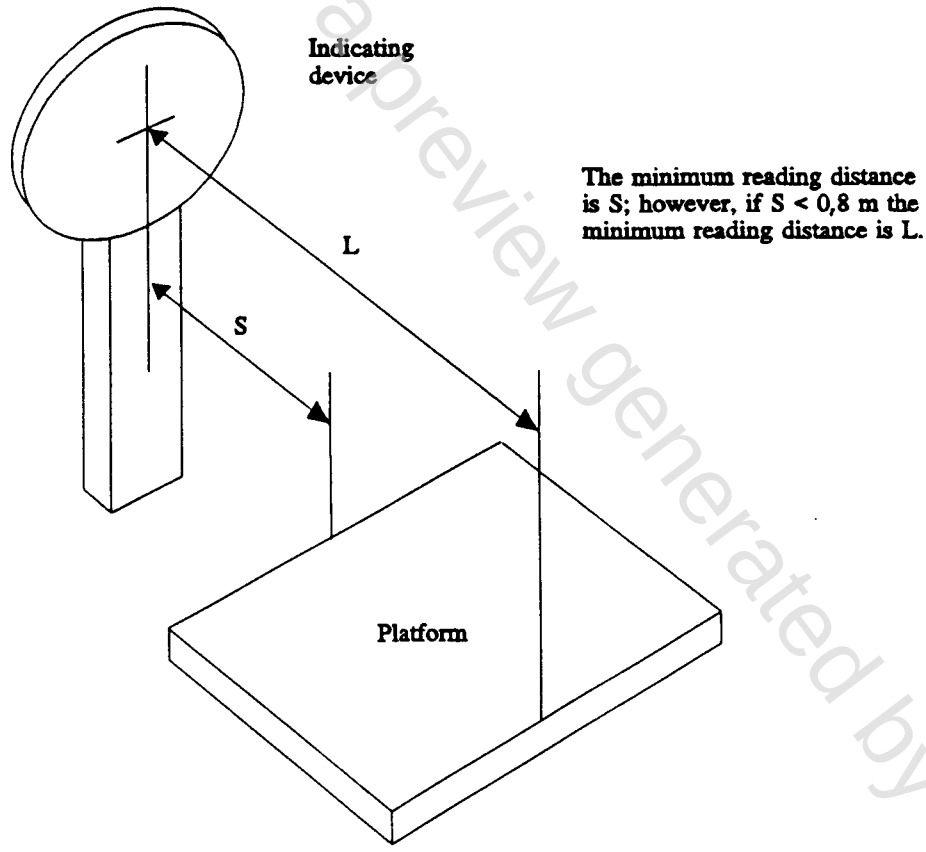

Figure 1

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T.5.5 Errors

(See Figure 2 for illustration of certain terms used)

T.5.5.1 Error (of indication)

The indication of an instrument minus the (conventional) true value of the mass.

T.5.5.2 Intrinsic error

The error of an instrument under reference conditions.

T.5.5.3 Initial intrinsic error

The intrinsic error of an instrument as determined prior to the performance and span stability tests.

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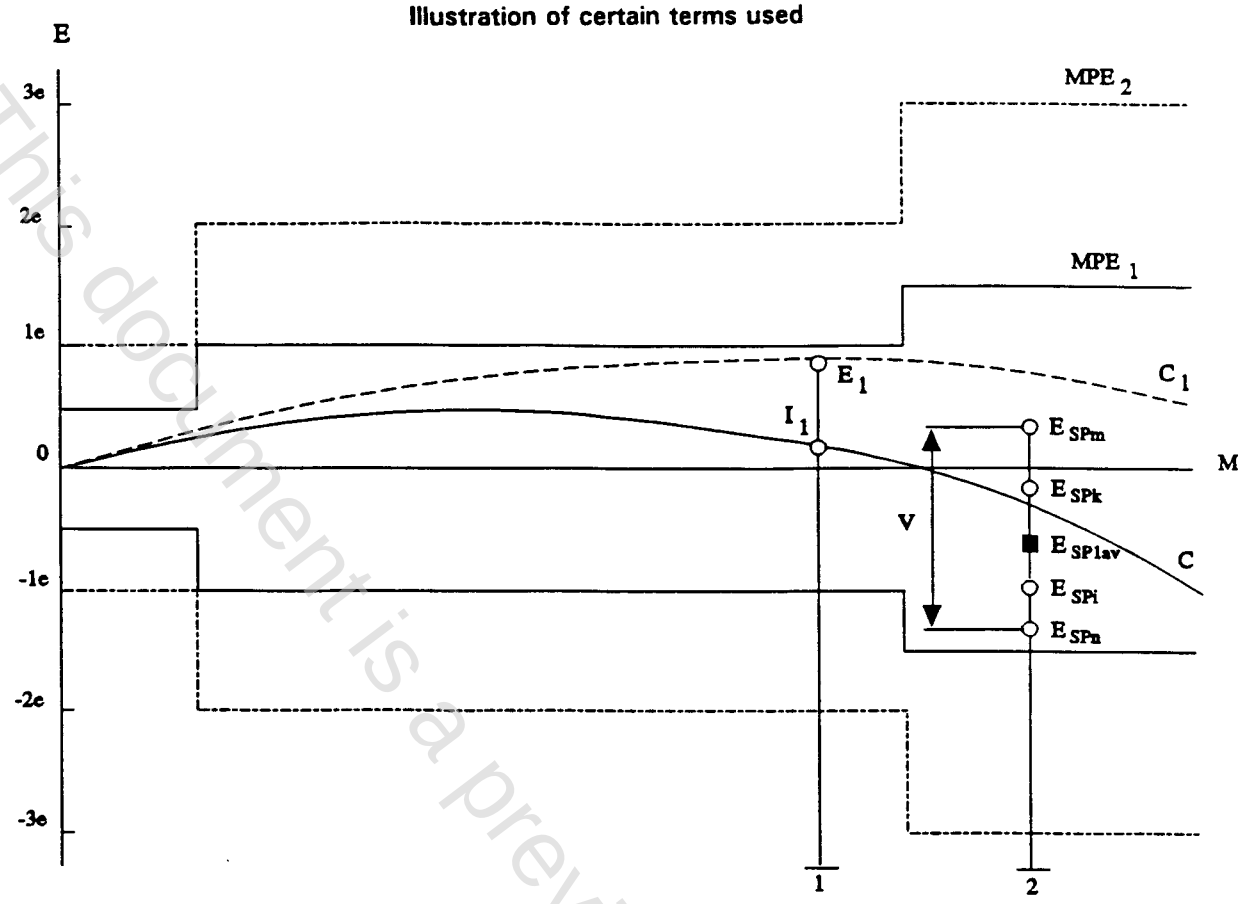
Figure 2
Illustration of certain terms used



M = mass to be measured
E = error of indication (T.5.5.1)
MPE_1 = maximum permissible error on initial verification
MPE_2 = maximum permissible error in service
C = characteristic under reference conditions
C_1 = characteristic due to influence factor or disturbance[1)]
E_{SP} = error of indication evaluated during span stability test
I = intrinsic error (T.5.5.2)
V = variation in the errors of indication during span stability test

Situation 1 - shows the error E_1 of an instrument due to an influence factor or a disturbance. I_1 is the intrinsic error. The fault (T.5.5.5) due to the influence factor or disturbance applied equals E_1 minus I_1.

Situation 2 - shows the average value E_{SP1av} of the errors at the first measurement of the span stability test, some other errors E_{SPi} and E_{SPk}, and the extreme values of the errors, E_{SPm} and E_{SPn}, all these errors being evaluated at different moments during the span stability test. The variation V in the errors of indication during the span stability test equals $E_{SPm} - E_{SPn}$.

1) For the purposes of this illustration it is supposed that the influence factor or the disturbance has an influence on the characteristic which is not erratic.

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T.5.5.4 Maximum permissible error

Maximum difference, positive or negative, allowed by regulation between the indication of an instrument and the corresponding true value, as determined by reference standard masses, with the instrument being at zero at no-load, in the reference position.

T.5.5.5 Fault

The difference between the error of indication and the intrinsic error of an instrument.

Note: Principally, a fault is the result of an undesired change of data contained in or flowing through an electronic instrument.

T.5.5.6 Significant fault

A fault greater than e.

Note: For a multi-interval instrument, the value of e is that appropriate to the partial weighing range.

The following are not considered to be significant faults, even when they exceed e:

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

T.5.5.7 Durability error

The difference between the intrinsic error over a period of use and the initial intrinsic error of an instrument.

T.5.5.8 Significant durability error

A durability error greater than e.

Notes: 1- A durability error can be due to mechanical wear and tear or due to drift and ageing of electronic parts. The concept of significant durability error applies only to electronic parts.

2- For a multi-interval instrument, the value of e is that appropriate to the partial weighing range.

The following are not considered to be significant durability errors, even when they exceed e:

errors occuring after a period of instrument use that are clearly the result of a failure of a device/component, or of a disturbance and for which the indication:

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- cannot be interpreted, memorized, or transmitted as a measurement result, or

- implies the impossibility to perform any measurement, or

- is so obviously wrong that it is bound to be noticed by all those interested in the result of measurement.

T.5.5.9 Span stability

The capability of an instrument to maintain the difference between the indication of weight at maximum capacity and the indication at zero over a period of use within specified limits.

T.6 Influences and reference conditions

T.6.1 Influence quantity

A quantity that is not the subject of the measurement but which influences the values of the measurand or the indication of the instrument.

T.6.1.1 Influence factor

An influence quantity having a value within the specified rated operating conditions of the instrument.

T.6.1.2 Disturbance

An influence quantity having a value within the limits specified in this European Standard, but outside the specified rated operating conditions of the instrument.

T.6.2 Rated operating conditions

Conditions of use, giving the range of values of influence quantities for which the metrological characteristics are intended to lie within the specified maximum permissible errors.

T.6.3 Reference conditions

A set of specified values of influence factors fixed to ensure valid intercomparison of the results of measurements.

T.6.4 Reference position

Position of the instrument at which its operation is adjusted.

T.7 Performance test

A test to verify whether the equipment under test (EUT) is capable of performing its intended functions.

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ALPHABETICAL LIST OF THE TERMS WHICH ARE DEFINED IN THE TERMINOLOGY

Actual scale interval (d)	T.3.2.2
Analogue indication	T.5.1.2
Automatic zero-setting device	T.2.7.2.3
Auxiliary indicating device	T.2.5
Auxiliary verification device	T.2.7.7
Balancing by weights	T.5.1.1
Calculated net value	T.5.3.2
Calculated total weight value	T.5.3.3
Complementary indicating device	T.2.5.3
Device for interpolation of reading (vernier or nonius)	T.2.5.2
Digital indication	T.5.1.3
Discrimination	T.4.2
Disturbance	T.6.1.2
Durability	T.4.4
Durability error	T.5.5.7
Electronic component	T.2.3.3
Electronic device	T.2.3.1
Electronic instrument	T.1.2.6
Electronic sub-assembly	T.2.3.2
Error (of indication)	T.5.5.1
Extended indicating device	T.2.6
Extension interval of self-indication	T.3.1.5
Fault	T.5.5.5
Graduated instrument	T.1.2.1
Gross value (G or B)	T.5.2.1
Indicating component	T.2.4.1
Indicating device (of a weighing instrument)	T.2.4
Indicating device with a differentiated scale division	T.2.5.4
Indication stabilizing device	T.2.7.9
Influence factor	T.6.1.1
Influence quantity	T.6.1
Initial intrinsic error	T.5.5.3
Initial zero-setting device	T.2.7.2.4
Instrument with price scales	T.1.2.7
Intrinsic error	T.5.5.2
Levelling device	T.2.7.1
Load-measuring device	T.2.1.3
Load receptor	T.2.1.1
Load-transmitting device	T.2.1.2
Locking device	T.2.7.6
Maximum capacity (Max)	T.3.1.1
Maximum permissible error	T.5.5.4
Maximum safe load (Lim)	T.3.1.7
Maximum tare effect (T+, T-)	T.3.1.6
Minimum capacity (Min)	T.3.1.2
Minimum reading distance	T.5.4.4
Module	T.2.2
Multi-interval instrument	T.3.2.6
Multiple range instrument	T.3.2.7

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Net value (N)	T.5.2.2
Non-automatic weighing instrument	T.1.2
Non-automatic zero-setting device	T.2.7.2.1
Non-graduated instrument	T.1.2.2
Non-self-indicating instrument	T.1.2.5
Number of verification scale intervals (single-interval instrument)	T.3.2.5
Overall inaccuracy of reading	T.5.4.2
Performance test	T.7
Preset tare device	T.2.7.5
Preset tare value (PT)	T.5.3.1
Price-computing instrument	T.1.2.8
Price-labelling instrument	T.1.32.9
Primary indications	T.1.3.1
Rated operating conditions	T.6.2
Reading by simple juxtaposition	T.5.4.1
Reduction ratio R	T.3.3
Reference conditions	T.6.3
Reference position	T.6.4
Repeatability	T.4.3
Rider	T.2.5.1
Rounding error of digital indication	T.5.4.3
Scale base	T.2.4.3
Scale interval of numbering	T.3.2.4
Scale mark	T.2.4.2
Scale spacing (instrument with analogue indication)	T.3.2.1
Secondary indications	T.1.3.2
Selection device for load receptors and load-measuring devices	T.2.7.8
Self-indicating instrument	T.1.2.3
Self-indication capacity	T.3.1.3
Self-service instrument	T.1.2.10
Semi-automatic zero-setting device	T.2.7.2.2
Semi-self-indicating instrument	T.1.2.4
Sensitivity	T.4.1
Significant durability error	T.5.5.8
Significant fault	T.5.5.6
Span stability	T.5.5.9
Tare-balancing device	T.2.7.4.1
Tare device	T.2.7.4
Tare value (T)	T.5.2.3
Tare-weighing device	T.2.7.4.2
Verification scale interval (e)	T.3.2.3
Warm-up time	T.4.5
Weighing instrument	T.1.1
Weighing range	T.3.1.4
Weighing results	T.5.2
Zero-setting device	T.2.7.2
Zero-tracking device	T.2.7.3

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METROLOGICAL ASPECTS
of
NON-AUTOMATIC WEIGHING INSTRUMENTS

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1 Scope

This European Standard specifies the metrological and technical requirements for NON-AUTOMATIC WEIGHING INSTRUMENTS.

It is intended to provide standardized requirements and testing procedures to evaluate the metrological and technical characteristics in a uniform and traceable way.

2 Principles of the European Standard

2.1 Units of measurement

The units of mass to be used on an instrument shall be the legal units in the country where an instrument is intended to be taken into service.

Subject to compliance with this condition, the following units are permitted:

- SI units:	kilogramme (symbol kg), microgramme (μg), milligramme (mg), gramme (g), tonne (t).
- Imperial units:	pound (lb), ounce (oz), Troy ounce (oz tr)
- Other non-SI units:	metric carat (ct), if weighing precious stones.

For instruments that make use of the Imperial units of mass referred to above, specified requirements shall be converted to the corresponding Imperial units using simple interpolation.

2.2 Principles of the metrological requirements

The requirements apply to all instruments irrespective of their principles of measurement.

Instruments are classified according to:

- the VERIFICATION SCALE INTERVAL, representing absolute accuracy, and

- the NUMBER OF VERIFICATION SCALE INTERVALS, representing relative accuracy.

The MAXIMUM PERMISSIBLE ERRORS are in the order of magnitude of the VERIFICATION SCALE INTERVAL.

A MINIMUM CAPACITY (Min) is specified to indicate that use of the instrument with light loads is likely to give rise to excessive relative errors.