British Standard

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14 March 2003

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BRITISH STANDARD

BS EN 10002-4:1995

Tensile testing of metallic materials —

Part 4: Verification of extensometers used in uniaxial testing

The European Standard EN 10002-4:1994 has the status of a British Standard

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee ISE/NFE/4, Mechanical testing of metals, upon which the following bodies were represented:

AEA Technology
Aluminium Federation
British Non-Ferrous Metals Federation
British Railways Board
British Steel Industry
Copper Development Association
Department of Trade and Industry (National Measurement Accreditation Service)
Department of Trade and Industry (National Physical Laboratory)
ERA Technology Ltd.
Electricity Association
GAMBICA (BEAMA Ltd.)
The Institute of Materials
Light Metal Founders' Association
Ministry of Defence
Society of British Aerospace Companies Limited
University College London
TWI

The following bodies were also represented in the drafting of the standard, through sub-committees and panels:

Association of Consulting Scientists
British Society for Strain Measurements
British Welded Steel Tube Association
Institute of Physics
Institute of Sheet Metal Engineering
Lloyd's Register of Shipping
Process Plant Association

This British Standard, having been prepared under the direction of the Health and Environment Sector Board, was published under the authority of the Standards Board and comes into effect on 15 December 1995

The following BSI references relate to the work on this standard:
Committee reference ISE/NFE/4
Draft for comment 90/43830 DC

ISBN 0 580 24998 0

Amendments issued since publication

Amd. No.	Date	Comments

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National foreword

This British Standard has been prepared by Technical Committee ISE/NFE/4 and is the English language version of EN 10002-4:1994 *Metallic materials — Tensile test — Part 4: Verification of extensometers used in uniaxial testing* published by the European Committee for Standardization (CEN). It supersedes BS 3846:1970 which is withdrawn.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 8 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.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10002-4

November 1994

ICS 17.040.30; 77.040.10

Descriptors: Metallurgical products, dilatometers, verification, classifications

English version

Metallic materials — Tensile test — Part 4: Verification of extensometers used in uniaxial testing

Matériaux métalliques — Essai de traction — Partie 4: Vérification des extensomètres utilisés lors d'essais uniaxiaux

Metallische Werkstoffe — Zugversuch — Teil 4: Prüfung von Längenänderungs-Meßeinrichtungen für die Prüfung mit einachsiger Beanspruchung

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 10002-4:1994 E

Foreword

This European Standard was prepared by the Technical Committee ECISS/TC 1A, Mechanical and physical tests, of which the Secretariat is held by AFNOR.

The text incorporates ISO 9513 prepared by ISO/TC 164/SC 1, *Metallic materials — uniaxial testing*, with some amendments, the main one of which is the addition of a class 0,2.

ECISS/TC 1A decided to submit the final draft for formal vote by its resolution 183/1993. The result was positive.

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 May 1995, and conflicting national standards shall be withdrawn at the latest by May 1995.

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

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0 Introduction

The Standard EN 10002 is valid for metallic materials and comprises the following parts:

— *Part 1: Metallic materials — Tensile test — Method of test (at ambient temperature);*

— *Part 2: Metallic materials — Tensile test — Verification of the force measuring system of the tensile testing machine;*

— *Part 3: Metallic materials — Tensile test — Calibration of proving devices used for the verification of uniaxial testing machines;*

— *Part 4: Metallic materials — Tensile test — Verification of extensometers used in uniaxial testing;*

— *Part 5: Metallic materials — Tensile test — Method of test at elevated temperatures.*

1 Scope

This European Standard specifies a method for the static verification of extensometers used in uniaxial testing.

The term extensometer is understood to mean the displacement measuring device and the system for indicating or recording this displacement.

2 Symbols and designations

(See Table 1).

Table 1 — Symbols and designations

Symbol	Designation	Unit
L_e	Nominal value of gauge length of extensometer	mm
L'_e	Measured value of gauge length of extensometer	mm
E_{max}	Maximum limit of verification range	mm
E_{min}	Minimum limit of verification range	mm
l_i	Displacement indicated by extensometer	μm
l_t	True displacement given by calibration apparatus	μm
q_{Le}	Relative gauge length error	%
q	Relative bias error of extensometer	%
r	Resolution of extensometer	μm

3 Principle

The verification of an extensometer involves a comparison of the readings given by the extensometer with known variations in length provided by a calibration apparatus.

4 Calibration apparatus

The calibration apparatus which allows a known displacement l_t, to be applied to the extensometer, may consist of a rigid frame with suitable coaxial spindles or other fixtures to which the extensometer can be attached. The calibration apparatus shall comprise a mechanism for moving at least one of the axial spindles and a device for measuring accurately the change in length produced. The variations in length can be measured, for example, using an interferometer or gauge blocks and a comparator or a screw micrometer. The gauge blocks, comparator, micrometer or interferometer used shall be calibrated by a method which is traceable to the international unit (SI) of length and their accuracy shall be known. The error of the calibration apparatus shall not be greater than one-third of the permissible error of the extensometer (see Table 2).

The resolution of the calibration apparatus shall be in accordance with Table 2.

5 Procedure

5.1 Position of the extensometer

The extensometer shall be placed in the calibration apparatus in the same position and orientation in which it is used during uniaxial testing so as to avoid errors due to loss of equilibrium or deformation of any part of the extensometer.

The extensometer shall be attached in the same way as during uniaxial testing.

5.2 Temperature at which the verification is made

In general, the verification of the extensometer shall be carried out at a temperature stable to within ± 2 °C; this temperature shall be within the range between 18 °C and 28 °C.

For extensometers used for uniaxial testing at temperatures inside the range 10 °C to 35 °C, it is recommended that the verification be carried out at or near the test temperature, if facilities exist.

The extensometer shall be placed near the calibration apparatus or mounted on it for a sufficient length of time, prior to its verification, so that the parts of the extensometer and of the calibration apparatus which are in contact shall attain the verification temperature.

5.3 Accuracy of gauge length of the extensometer

The gauge length of the extensometer can be measured directly or indirectly. The following indirect method is given as an example.

The extensometer is placed on a soft metal test piece in such a way that the blades or points of the extensometer leave their marks. Once the extensometer is removed, the distance between the marks on the test piece is measured.

The relative error on the gauge length, q_{Le}, calculated from the following formula shall not exceed the values given in Table 2:

$$q_{Le} = \frac{L'_e - L_e}{L_e} \times 100 \qquad (1)$$

In the case of an extensometer having several gauge lengths, the verification shall be carried out for each of the gauge lengths required by the user.

For extensometers where gauge length is defined by the test piece then the gauge length of this test piece shall be measured to an accuracy consistent with the class of extensometer to be used.

5.4 Range of verification

The verification range shall be defined by the user to cover the measuring range required to determine a given material property. The maximum and minimum limits E_{max} and E_{min} of the verification range shall be such that:

$$5 \leq \frac{E_{max}}{E_{min}} \leq 10 \qquad (2)$$

If several ranges are specified by the user, each one shall be verified. An example of verification ranges is given in Annex A. The ranges of verification shall be noted in the verification report.

5.5 Verification procedure

5.5.1 When the temperature has stabilized, it is recommended that, before verification, the extensometer be exercised at least twice by the verification apparatus over the verification range of the extensometer. If possible, the displacement is taken to a slightly negative value and returned to zero. Where appropriate, the extensometer is reset to zero.

5.5.2 The verification consists first of one series of at least 10 measurements, l_i, distributed approximately evenly throughout the verification range of the extensometer. The extensometer is removed and then placed back on the calibration apparatus. A second series of measurements is then made in the same manner as the first. Depending on the expected use of the extensometer, the two series of measurements are made for increases in length or for decreases in length or for both.

For each measurement point, the relative bias error is calculated (see **5.6.2**).

5.6 Determination of the characteristics of the extensometer

5.6.1 *Resolution*

The resolution, r, is the smallest quantity which can be read on the instrument. The values of the resolution of the extensometer shall be in accordance with the values given in Table 2.

5.6.2 *Relative bias error*

The relative bias error, q, for a given displacement l_t, is calculated from the formula:

$$q = \frac{l_i - l_t}{l_t} \times 100 \qquad (3)$$

Table 2 — Classification of extensometers

Class of extensometer	Extensometer (maximum values)					Calibration apparatus (maximum values)			
	Relative error on the gauge length	Resolution[a]		Bias[a]		Resolution[a]		Bias error[a]	
	q_{Le}	Percentage of readings r/l_i	Absolute value r	Relative error q	Absolute error $l_i - l_t$	Relative value	Absolute value	Relative error	Absolute value
	%	%	µm	%	µm	%	µm	%	µm
0,2	± 0,2	0,1	0,2	± 0,2	± 0,6	0,05	0,1	± 0,06	± 0,2
0,5	± 0,5	0,25	0,5	± 0,5	± 1,5	0,12	0,25	± 0,15	± 0,5
1	± 1,0	0,50	1,0	± 1,0	± 3,0	0,25	0,50	± 0,3	± 1,0
2	± 2,0	1,0	2,0	± 2,0	± 6,0	0,5	1,0	± 0,6	± 2,0

[a] Whichever value is the greater.

6 Classification of the extensometer

Table 2 gives the maximum permissible values for the relative gauge length error, the resolution and the relative bias error.

7 Frequency of verification

The time between two verifications depends on the type of extensometer, the maintenance standard and the number of times the extensometer has been used. Under normal conditions, it is recommended that verification be carried out at intervals of approximately 12 months. This interval shall not exceed 18 months unless the test is expected to last more than 18 months, in this case the extensometer shall be verified before and after the test.

The extensometer shall be verified after each repair or adjustment of its constituent elements which affects the accuracy of measurements.

8 Verification report

The verification report shall contain at least the following information:

a) General information:

1) reference to this European Standard;

2) identification of the extensometer (type, make, serial number and mounting position);

3) type and reference number of calibration apparatus;

4) temperarature at which the verification was carried out;

5) nature of variations of length for which the verification was carried out, i.e. either for increases and/or for decreases in length;

6) date of verification;

7) name or mark of the organisation which carried out the verification;

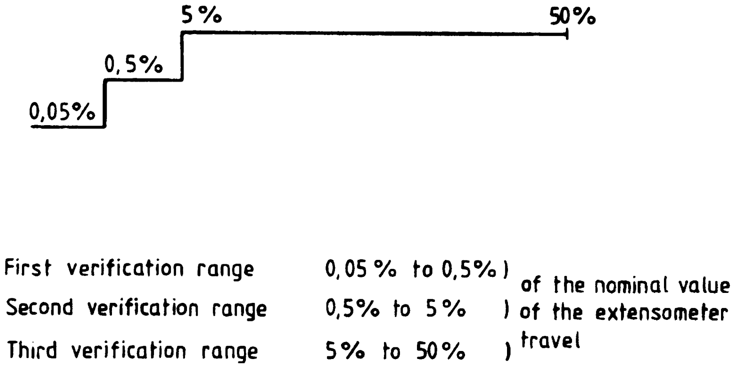
8) date of expiry of the verification report.

b) Results of the verification:

1) class of each range of the extensometer;

2) the individual values of the bias errors, if requested.

Annex A (informative)



Example of verification ranges of an extensometer

Annex B (informative) Parameters for classification of an extensometer

In order to clarify the definition of the parameters used for the classification of an extensometer in accordance with clause **6**.

a) Table B.1 gives three examples of calculations of these parameters.

b) The diagrams in Figure B.1 and Figure B.2 illustrate clearly, for class 1 extensometers, how to decide which of the two limits, relative or absolute, should be chosen.

Table B.1 — Examples of calculation of parameters for the classification of extensometers

Gauge length of extensometer L_e mm	True value		Measured value		Absolute bias error		Relative bias error q % [1)]	
	Displacement l_t μm	Strain $l_t/L_e = \epsilon_t$	Displacement l_i μm	Strain $l_i/L_e = \epsilon_i$	Displacement $l_i - l_t$ μm	Strain $\epsilon_i - \epsilon_t$	Displacement $\frac{l_i - l_t}{l_t} \times 100$	Strain $\frac{\varepsilon_i - \varepsilon_t}{\varepsilon_t} \times 100$
50	100	2×10^{-3}	101	$2{,}02 \times 10^{-3}$	1	$0{,}02 \times 10^{-3}$	1	1
100	100	1×10^{-3}	101	$1{,}01 \times 10^{-3}$	1	$0{,}01 \times 10^{-3}$	1	1
100	200	2×10^{-3}	201	$2{,}01 \times 10^{-3}$	1	$0{,}01 \times 10^{-3}$	0,5	0,5

[1)] For a given displacement error, the relative error, q, is independent of the gauge length of the extensometer, L_e, but is dependent on the displacement value, l_t.

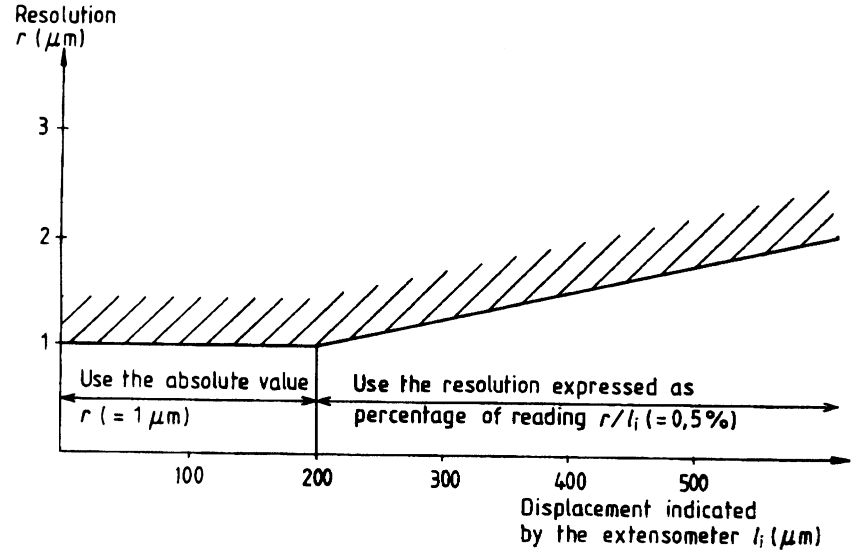


Figure B.1 — Resolution of a class 1 extensometer

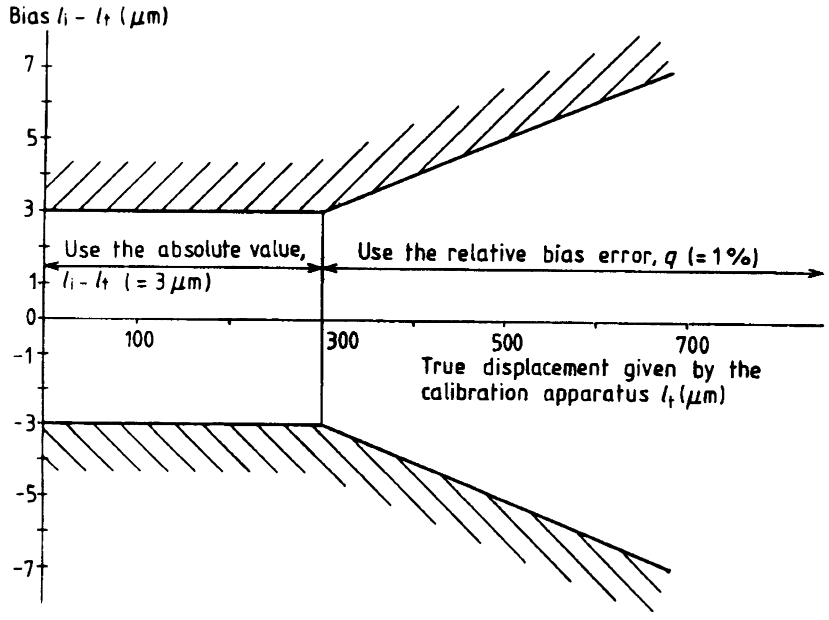


Figure B.2 — Limits of bias error of a class 1 extensometer

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