British Standard

A single copy of this British Standard is licensed to

Sheffield University

14 March 2003

BRITISH STANDARD

BS EN 10002-3:1995

Tensile testing of metallic materials —

Part 3: Calibration of force proving instruments used for the verification of uniaxial testing machines

The European Standard EN 10002-3:1994 has the status of a British Standard

UDC 669:620.172:53.089.6:620.1.05

Cooperating organizations

The European Committee for Standardization (CEN), under whose supervision this European Standard was prepared, comprises the national standards organizations of the following countries:

Austria	Oesterreichisches Normungsinstitut
Belgium	Institut belge de normalisation
Denmark	Dansk Standard
Finland	Suomen Standardisoimisliito, r.y.
France	Association française de normalisation
Germany	Deutsches Institut für Normung e.V.
Greece	Hellenic Organization for Standardization
Iceland	Technological Institute of Iceland
Ireland	National Standards Authority of Ireland
Italy	Ente Nazionale Italiano di Unificazione
Luxembourg	Inspection du Travail et des Mines
Netherlands	Nederlands Normalisatie-instituut
Norway	Norges Standardiseringsforbund
Portugal	Instituto Portuguès da Qualidade
Spain	Asociación Española de Normalización y Certificación
Sweden	Standardiseringskommissionen i Sverige
Switzerland	Association suisse de normalisation
United Kingdom	British Standards Institution

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

The following BSI references relate to the work on this standard:
Committee reference ISE/NFE/4
Special announcement in *BSI News* April 1994

ISBN 0 580 23129 1

Amendments issued since publication

Amd. No.	Date	Comments

Contents

National foreword

This British Standard has been prepared under the direction of the Iron and Steel, and the Non-ferrous Metals Standards Policy Committees and is the English language version of EN 10002-3:1994 *Metallic materials — Tensile test — Part 3: Calibration of force proving instruments used for the verification of uniaxial testing machines,* published by the European Committee for Standardization (CEN).

It supersedes BS 1610-2:1985 which is withdrawn.

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, the EN title page, pages 2 to 16, 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.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10002-3

May 1994

UDC 669:620.172:53.089.6:620.1.05

Descriptors: Metal products, test equipment, verification, strain measurements, force, measuring instruments, dynanometers, calibration, classifications, utilization

English version

Metallic materials — Tensile test — Part 3: Calibration of force proving instruments used for the verification of uniaxial testing machines

Matériaux métalliques — Essai de traction — Partie 3: Etalonnage des instruments de mesure de force utilisés pour la vérification des machines d'essais uniaxiaux

Metallische Werkstoffe — Zugversuch — Teil 3: Kalibrierung der Kraftmeßgeräte für die Prüfung von Prüfmaschinen mit einachsiger Beanspruchung

This European Standard was approved by CEN on 1994-05-18. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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 10002-3:1994 E

Foreword

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

It was submitted to the formal vote according to a decision of the Committee of Coordination (COCOR) of the European Committee for Iron and Steel Standardization.

It was approved and ratified by CEN as a European Standard.

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 November 1994, and conflicting national standards shall be withdrawn at the latest by November 1994.

In accordance with 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 and United Kingdom.

Contents

0 Introduction

The European 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 tensile testing machines*;

— *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 covers the calibration of force proving instruments used for the static verification of uniaxial testing machines (e.g. tensile testing machines) and describes a procedure for classifying these instruments. The force proving instrument is defined as being the whole assembly from the force transducer through to and including the indicator. This European Standard generally applies to force proving instruments in which the force is determined by measuring the elastic deformation of a loaded member or a quantity which is proportional to it.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 10002-2, *Metallic materials — Tensile test — Verification of the force measuring system of the tensile testing machines.*

3 Principle

Calibration consists in applying forces to the loaded member which are precisely known and recording the data from the deflection-measuring system, which is considered as an integral part of the force proving instrument.

When an electrical measurement is made, the indicator may be replaced by an indicator that can be shown to have at least an equal uncertainty of measurement.

4 Characteristics of force proving instruments

4.1 Identification of the force proving instrument

All the elements of the force proving instrument (including the cables for electrical connection) shall be individually and uniquely identified, for example, by the name of the manufacturer, the model and the serial number. For the force transducer, the maximum working force shall be indicated.

4.2 Application of force

The force transducer and its loading parts shall be designed so as to ensure axial application of force, whether in tension or compression.

Examples of loading fittings are given in Annex A.

4.3 Measurement of deflection

Measurement of the deflection of the loaded member of the force transducer may be carried out by mechanical, electrical, optical or other means with an adequate accuracy and stability.

The type and the quality of the deflection-measuring system determine whether the force proving instrument is classified only for specific calibration forces or for interpolation (see clause **7**).

Generally, the use of force proving instruments with dial gauges as a means of measuring the deflection is limited to the forces for which the instruments have been calibrated. In fact, the dial gauge if used over a long travel may contain large localized periodic errors which produce an uncertainty too great to permit interpolation between calibration forces. Nevertheless, it may be used for interpolation if the characteristics of the dial gauge have been determined previously, and if its periodic error has a negligible influence on the interpolation error of the force proving instrument.

5 Symbols and designations

(see Table 1)

Table 1 — Symbols and designation

Symbol	Unit	Designation
F_n	N	Maximum capacity of the measuring range
F_f	N	Maximum capacity of the transducer
i	—	Reading[a] on the indicator with increasing test force
i'	—	Reading[a] on the indicator with decreasing test force
i_o	—	Reading[a] on the indicator before application of force
i_f	—	Reading[a] on the indicator after removal of force
X	—	Deflection with increasing test force
X'	—	Deflection with decreasing test force
$\bar{X}_r$	—	Average value of the deflections with rotation
$\bar{X}_{wr}$	—	Average value of deflections without rotation
X_{max}		Maximum deflection
X_{min}		Minimum deflection
X_a	—	Computed value of deflection
X_N	—	Deflection corresponding to the maximum capacity
b	%	Relative repeatability error with rotation
b'	%	Relative repeatability without rotation
f_o	%	Relative zero error
f_c	%	Relative interpolation error
r	—	Resolution of the indicator
u	%	Relative reversibility error of the force proving instrument

[a] Reading value corresponding to the deflection.

6 Verification of the force proving instrument

6.1 General

Before undertaking the calibration of the force proving instrument, ensure that this instrument is able to be calibrated. This can be done by means of preliminary tests such as those defined below and given as examples.

6.1.1 ***Overloading test***

This optional test is described in clause **B.1**.

6.1.2 ***Verification relating to application of forces***

Ensure

— that the attachment system of the force proving instrument allows axial application of the load where the instrument is used for tensile testing;

— that there is no interaction between the force transducer and its support on the calibration machine when the instrument is used for compression testing.

Clause **B.2** gives an example of a method which can be used.

6.1.3 ***Variable voltage test***

This test is left to the discretion of the calibration service. For force proving instruments requiring an electrical supply, verify that a variation of ± 10 % of the line voltage has no significant effect. This verification can be carried out by means of a force transducer simulator or by another appropriate method.

6.2 Resolution of the indicator

6.2.1 ***Analog scale***

The thickness of the graduation marks on the scale shall be uniform and the width of the pointer shall be approximately equal to the width of a graduation mark.

The resolution r of the indicator shall be obtained from the ratios between the width of the pointer and the centre-to-centre distance between two adjacent scale graduation marks (scale interval), the recommended ratios being 1/2, 1/5 or 1/10: a spacing of 1,25 mm or greater being required for the estimation of a tenth of the division on the scale.

6.2.2 ***Digital scale***

The resolution is considered to be one increment of the last active number on the numerical indicator, provided that the indication does not fluctuate by more than one increment when the instrument is unloaded.

6.2.3 ***Variation of readings***

If the readings fluctuate by more than the value previously calculated for the resolution (with the instrument unloaded), the resolution shall be deemed to be equal to half the range of fluctuation.

6.2.4 ***Units***

The resolution shall be converted to units of force.

6.3 Minimum force

Taking into consideration the accuracy with which the deflection of the instrument may be read during calibration or during its subsequent use for verifying machines, the minimum force applied to a force proving instrument shall comply with the two following conditions.

a) the minimum force shall be greater than or equal to:

4 000 × r for the class 00

2 000 × r for the class 0.5

1 000 × r for the class 1

500 × r for the class 2

b) the minimum force shall be greater than or equal to 0,02F_f.

6.4 Test procedure

6.4.1 ***Preloading***

Before the calibration forces are applied, in a given mode (tension or compression), the maximum force shall be applied to the instrument three times. The duration of the application of each preload shall be between 1 and 1,5 minutes.

6.4.2 ***Procedure***

The calibration shall be carried out by applying two series of calibration forces to the proving device with increasing values only, without disturbing the device.

Then apply at least two further series with both increasing and decreasing values. Between each of the further series of forces, the proving device shall be rotated symmetrically on its axis to positions uniformly distributed over 360° (i.e. 0°, 120°, 240°). When this is not possible, it is permissible to adopt the following three positions: 0°, 180° and 360° (see Figure 1).

For the determination of the interpolation curve, the number of forces shall be not less than 8, and these forces shall be distributed as uniformly as possible over the calibration range.

NOTE If a periodic error is suspected, it is recommended that intervals between the forces which correspond to the periodicity of this error should be avoided.

The force proving instrument shall be pre-loaded three times to the maximum force in the direction in which the subsequent forces are to be applied and, in the same way, when the direction of loading is changed, the maximum force shall be applied three times in the new direction.

Between loadings, the readings corresponding to no load after waiting at least 30 s for the return to zero shall be noted.

At least once during calibration, the instrument shall be dismantled as for packaging and transport. In general, this dimantling shall be carried out between the second and third series of calibration forces, the force proving instrument shall be subjected three times to the maximum force before the next series of calibration forces is applied.

Before starting the calibration of an electrical force proving instrument, the zero signal may be noted (see clause **B.3**).

6.4.3 ***Loading conditions***

The time interval between two successive loadings shall be as uniform as possible, and no reading shall be taken less than 30 s after the start of the force change. The calibration shall be performed at a temperature stable to ± 1 °C, this temperature shall be within the range 18 to 28 °C and shall be recorded. Sufficient time shall be allowed for the force proving instrument to attain a stable temperature.

NOTE When it is known that the force proving instrument is not temperature compensated, care should be taken to ensure that temperature variations do not affect the calibration.

Strain gauge transducers shall be energized for not less than 30 minutes before calibration.

6.4.4 ***Determination of deflection***

A deflection is defined as the difference between a reading under force and a reading without force.

NOTE This definition of deflection applies to output readings in electrical units as well as to output at readings in length units.

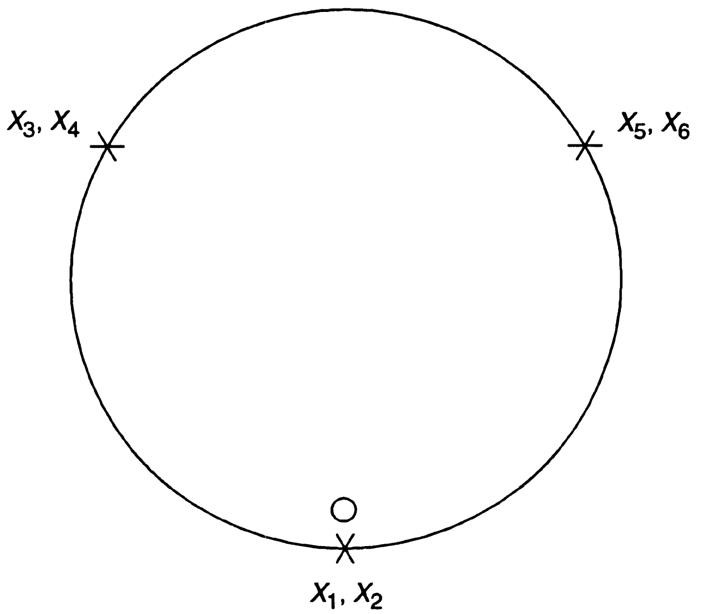

Figure 1 — Positions of the proving device

6.5 Assessment of the force proving instrument

6.5.1 *Relative repeatability error, b and b′*

This is calculated for each calibration force and in the two cases : with the rotation of the proving instrument (b) and without rotation (b′), using the following equations:

$$b = \frac{X_{max} - X_{min}}{X_r} \times 100$$

where

$$\bar{X}_r = \frac{X_1 + X_3 + X_5}{3}$$

$$b' = \frac{|X_2 - X_1|}{\bar{X}_{wr}}$$

where

$$\bar{X}_{wr} = \frac{X_1 + X_2}{2}$$

6.5.2 *Relative interpolation error, f_c*

This error is determined using a first-, second-, or third-degree equation giving the deflection as a function of the calibration force. The equation used shall be indicated in the calibration report:

$$f_c = \frac{\bar{X}_r - X_a}{X_a} \times 100$$

6.5.3 *Relative zero error, f_0*

The zero shall be adjusted before and recorded after each series of tests. The zero reading shall be taken approximately 30 s after the force has been completely removed.

The relative zero error is calculated from the equation:

$$f_0 = \frac{i_f - i_0}{X_N} \times 100$$

6.5.4 *Relative reversibility error, u*

The relative reversibility error is determined at each calibration, by carrying out a verification with increasing forces and then with decreasing forces.

The difference between the values obtained with increasing force and with decreasing force enables the relative reversibility error to be calculated using the equation.

$$u = \frac{i' - i}{i} \times 100$$

7 Classification of the force proving instrument

7.1 Principle of classification

The range for which the force proving instrument is classified is determined by considering each calibration force one after the other starting with the maximum force and decreasing from this to the lowest calibration force. The classification range ceases at the last force for which the classification requirements are satisfied.

The force proving instrument can be classified:

— either for specific forces;

— or for interpolation.

7.2 Classification criteria

The range of classification of a force proving instrument shall at least cover the range 50 % to 100 % of F_N.

7.2.1 For instruments classified only for specific forces, the criteria which shall be taken into consideration are:

— the relative repeatability error;

— the relative zero error;

— the relative reversibility error.

7.2.2 For instruments classified for interpolation, the following criteria shall be taken into consideration:

— the relative repeatability error;

— the relative interpolation error;

— the relative zero error;

— the relative reversibility error.

Table 2 gives the values of these different parameters in accordance with the class of the force proving instrument as with the uncertainity of the calibration forces.

7.3 Calibration certificate and duration of validity

7.3.1 If a force proving instrument has satisfied the requirements of this European Standard at the time of calibration, the calibration authority shall draw up a certificate stating the following information.

a) identity of all elements of the force proving instrument and loading fittings and of the calibration machine;

b) the mode of force application (tension-compression);

c) that the instrument is in accordance with the requirements of preliminary tests;

d) the class and the range (or forces) of validity;

e) the results of the calibration and, when required, the calibration curve;

f) the temperature at which the calibration was performed.

7.3.2 For the purposes of this European Standard, the maximum period of validity of the certificate shall not exceed 26 months.

A force proving instrument shall be recalibrated when it sustains an overload higher than the test overload (see clause **B.1**) or after repair.

Table 2 — Characteristics of force proving instruments

Class	Relative error of the force proving instrument, %					Calibration force
	of repeatability b	of repeatability b'	of interpolation f_c	of zero f_0	of reversibility u	Uncertainty[a] %
00	0.05	0.025	± 0.025	± 0.012	0.07	± 0.01
0.5	0.10	0.05	± 0.05	± 0.025	0.15	± 0.02
1	0.20	0.10	± 0.10	± 0.050	0.30	± 0.05
2	0.40	0.20	± 0.20	± 0.10	0.50	± 0.10

[a] The uncertainty of the calibration force is obtained by combining the random and systematic errors of the force calibration machine.

8 Use of calibrated force proving instruments

Force proving instruments shall be loaded in accordance with the conditions under which they were calibrated. Precautions shall be taken to prevent the instrument from being subjected to forces greater than the maximum calibration force.

Instruments classified only for specific forces shall be used only for these forces.

Instruments classified for interpolation may be used for any force in the interpolation range.

If a force proving instrument is used at a temperature other than the calibration temperature, the deflection of the instrument shall be, if necessary, corrected for any temperature variation (see clause **B.5**).

Annex A (informative) Recommended dimensions of force transducers and corresponding loading fittings

In order to calibrate force transducers in force standard machines and to enable easy axial installation in materials testing machines to be verified the following design specifications and dimensions should be considered.

A.1 Tensile Force Transducers

1) To aid assembly, it is recommended that the clamping heads on the face be machined down to the core diameter over a length of about two threads.

2) The centring bores used in the manufacture of the force transducer should be retained.

A.2 Compressive Force Transducers

To allow for the restricted mounting height in materials testing machines, compressive force transducers should not exceed the overall heights given in Table A.2.

The overall height comprises the height of the force transducer and the associated loading fittings.

A.3 Loading fittings

Loading fittings should be designed in such a way that the line of force application is not distorted. As a rule, tensile force transducers should be fitted with two ball nuts, two ball cups and, if necessary, with two intermediate rings, while compressive force transducers should be fitted with one or two compression pads.

The dimensions recommended in **A.3.1** to **A.3.4** require the use of material with a yield strength of at least 350 N/mm^2.

A.3.1 *Ball nuts and ball cups*

Figure A.1 shows the shape of ball nuts and ball cups required for tensile force transducers. Their dimensions should be in accordance with Table A.3.

Large ball cups and ball nuts for maximum (nominal) forces of 4 MN and greater should be provided with blind holes distributed around the periphery as an aid to transportation and assembly. In the case of ball cups, two pairs of opposite bores are sufficient, one of which shall be made in the centre plane and the other in the upper third of the top ball cup and in the lower third of the bottom ball cup (see Figure A.1).

In ball nuts, two opposite blind holes offset by 60° should be made in an upper plane, a mid plane and a lower plane.

Table A.1 — Dimensions of tensile force transducers for nominal forces of not less than 10 kN

Maximum (nominal) force of force proving device[a]	Maximum overall length[b]	Size of external thread of heads[c]	Maximum length of thread	Maximum width or diameter
From 10 kN to 20 kN	500	M20 × 1,5[d]	16	110
40 kN and 60 kN	500	M20 × 1,5[d]	16	125
100 kN	500	M24 × 2	20	150
200 kN	500	M30 × 2	25	—
400 kN	600	M42 × 3	40	—
600 kN	650	M56 × 4	40	—
1 MN	750	M64 × 4	60	—
2 MN	950	M90 × 4	80	—
4 MN	1 300	M125 × 4	120	—
6 MN	1 500	M160 × 6	150	—
10 MN	1 700	M200 × 6	180	—
15 MN	2 000	M250 × 6	225	—
25 MN	2 500	M330 × 6	320	—

[a] Dimensions of tensile force transducers for nominal forces of less than 10 kN are not standardized.
[b] Length of tensile force transducer including any necessary thread adapters.
[c] Of the tensile force transducer or of the thread adapters.
[d] Pitch of 2 mm also permissible.

Table A.2 — Overall height of compressive force transducers

Dimensions in millimetres

Maximum (nominal) force of force proving device	Maximum overall height[a] of devices for the verification of materials testing machines of	
	Class 1[b]	Classes 2[b] and 3[b]
Up to 40 kN	145	115
60 kN	170	145
100 kN	220	145
200 kN	220	190
400 kN	290	205
600 kN	310	205
1 MN	310	205
2 MN	310	205
3 MN	330	205
4 MN	410	205
5 MN	450	350
6 MN	450	400
10 MN	550	400
15 MN	670	—

[a] The use of transducers having a greater overall height is permissile if the actual mounting clearances of the materials testing machines make this possible.
[b] According to EN 10002-2.

A.3.2 ***Intermediate rings***

Wherever necessary, type A or type B intermediate rings as shown in Figure A.2 and Figure A.3 respectively and specified in Table A.4, should be used for the verification of multi-range materials testing machines.

Intermediate rings should have a suitable holding fixture (e.g. threaded pins) for securing other mounting parts.

A.3.3 ***Adapters (extensions, reducers pieces, etc.)***

If, owing to the design of the materials testing machine, adapters are required for mounting the force transducer, they shall be designed so as to ensure the central loading of the force transducer.

A.3.4 ***Loading pads***

Loading pads are to be used as the force introduction components of compressive force transducers. If a loading pad has two flat surfaces for force transmission, they shall be ground plane parallel.

In the verification of force proving devices used in a force calibration machine or a force standard machine, the surface pressure on the compression platens of the machine should not be greater than 100 N/mm^2; if necessary, additional intermediate plates should be selected and installed (see Figure A.4) with a diameter d_9, large enough to ensure that this condition is met.

Figure A.4a) shows, by way of example, the shape of a loading pad for compressive force transducers having a convex area of force introduction; its height h_7 should be equal to or greater than $\frac{d_9}{2}$.

Height h_8 and diameter d_{10} of all loading pads should, however, be adapted to the force introduction components in such a way that the loading pad can be located both centrally and without lateral contact to the force introduction component. Diameter d_{10} should therefore be 0,1 mm to 0,2 mm greater than the diameter of the forces introduction component.

Figure A.4b) shows, by way of example, the shape of a loading pad for compressive force transducers having a flat area of force introduction. Diameter d_{11} should be greater or equal to the diameter of the force introduction component.

Table A.3 — Dimensions of ball nuts and ball cups for tensile force transducers with a maximum force of not less than 10 kN

Maximum (nominal) force of force proving device	d_1	d_2 (c11)	d_3	h_1	h_2	r
From 10 kN to 40 kN	32	$35^{-0,120}_{-0,280}$	22	16	12	30
60 kN	43	$45^{-0,130}_{-0,290}$	27	18	15	30
100 kN	47	$50^{-0,130}_{-0,290}$	32	20	15	50
200 kN	60	$64^{-0,140}_{-0,330}$	44	25	15	50
400 kN and 600 kN	86	$90^{-0,170}_{-0,390}$	60	40	18	80
1 MN	115	$120^{-0,180}_{-0,400}$	74	60	25	100
2 MN	160	$165^{-0,230}_{-0,480}$	100	90	30	150
4 MN	225	$235^{-0,280}_{-0,570}$	150	120	40	250
6 MN	260	$270^{-0,300}_{-0,620}$	170	150	45	250
10 MN	335	$345^{-0,360}_{-0,720}$	220	180	55	300
15 MN	410	$420^{-0,440}_{-0,840}$	265	225	65	350
25 MN	550	$580^{-0,5}_{-1,0}$	345	310	85	500

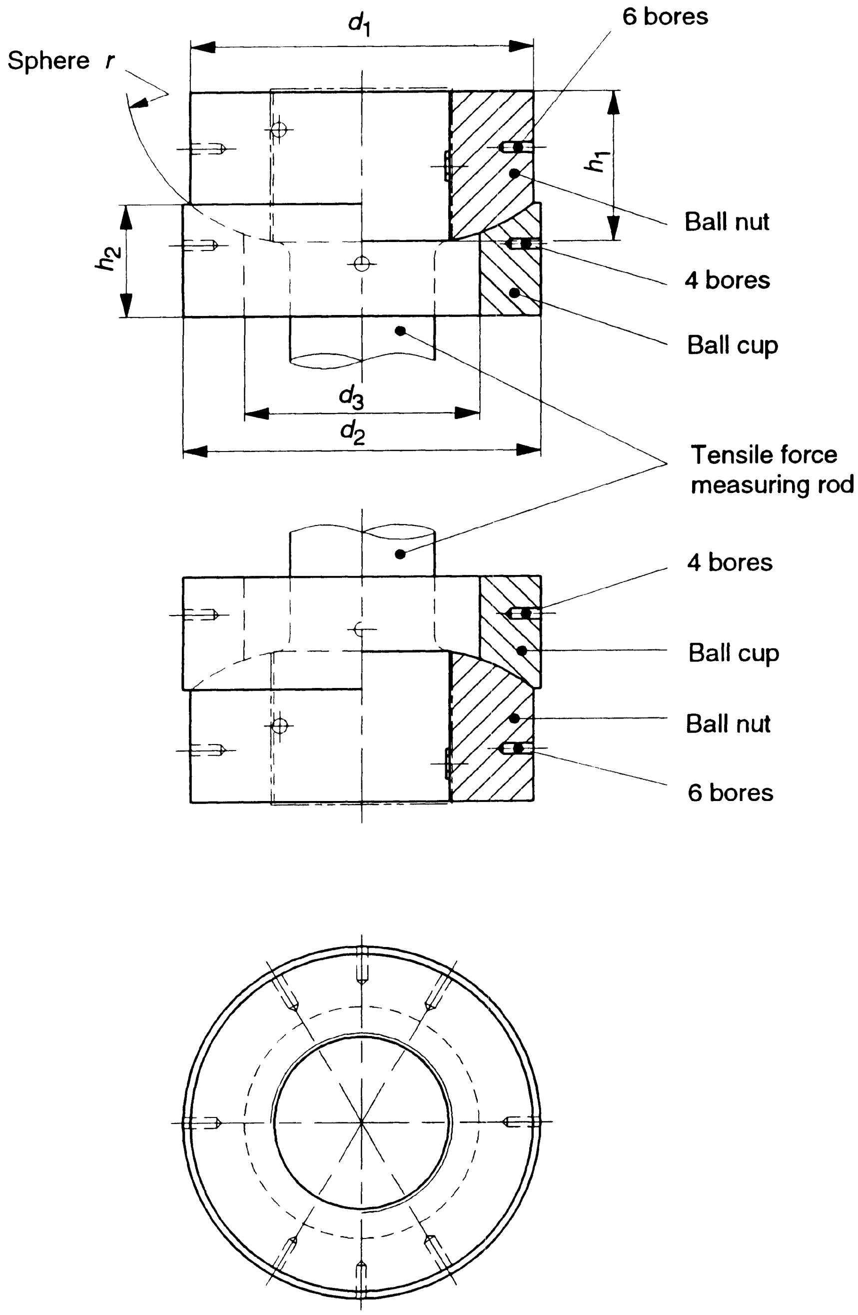

Figure A.1 — Ball nut, ball cup and tensile force measuring rod

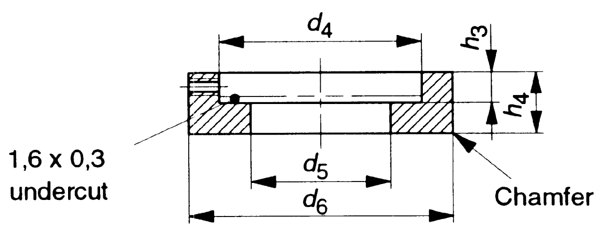

Figure A.2 — Type A intermediate ring

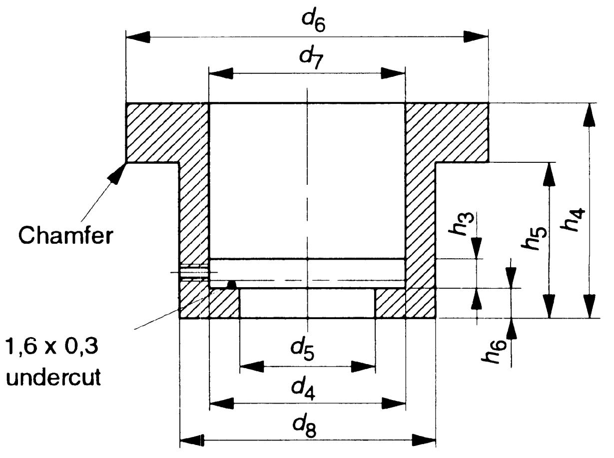

Figure A.3 — Type B intermediate ring

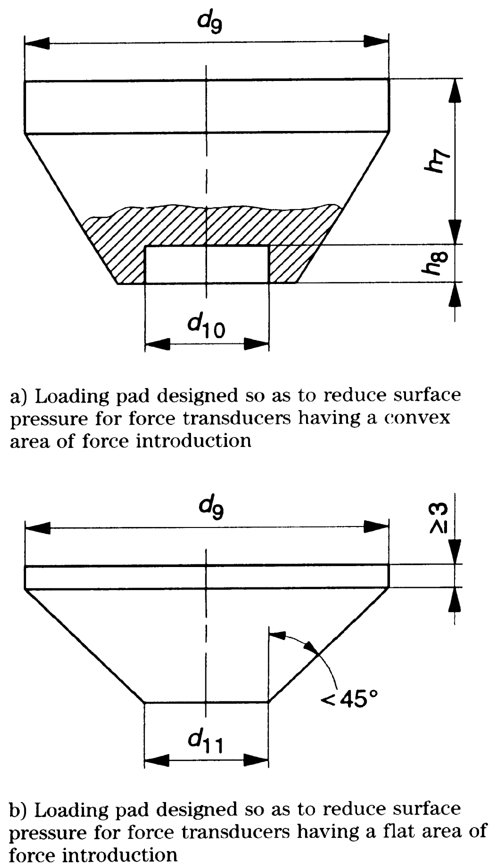

Figure A.4 — Loading pads

Table A.4 — Dimensions of intermediate rings

Dimensions in millimetres

Maximum force of materials testing machine[a]	Maximum force of force proving device	Type of intermediate ring	d_4 H7	d_5	d_6 C11	d_7	d_8	h_3	h_4	h_5	h_6
60 kN	40 kN	A	$35^{+0,025}_{0}$	24	$45^{-0,130}_{-0,290}$	—	—	5	10	—	—
100 kN	40 kN	A	$35^{+0,025}_{0}$	24	$50^{-0,130}_{-0,290}$	—	—	7	15	—	—
	60 kN	A	$45^{+0,025}_{0}$	29		—	—	7	15	—	—
200 kN	40 kN	B	$35^{+0,025}_{0}$	24	$64^{-0,140}_{-0,330}$	36	46	5	34	22	12
	60 kN	A	$45^{+0,025}_{0}$	29		—	—	7	15	—	—
	100 kN	A	$50^{+0,025}_{0}$	34		—	—	7	15	—	—
400 kN and 600 kN	40 kN	B	$35^{+0,025}_{0}$	24	$90^{-0,170}_{-0,390}$	36	61	5	57	42	12
	60 kN	B	$45^{+0,025}_{0}$	29		46	61	7	57	42	12
	100 kN	B	$50^{+0,025}_{0}$	34		51	61	7	57	42	15
	200 kN	A	$64^{+0,030}_{0}$	47		—	—	12	20	—	—
1 MN	60 kN	B	$45^{+0,025}_{0}$	29	$120^{-0,180}_{-0,400}$	46	77	7	60	45	15
	100 kN	B	$50^{+0,025}_{0}$	34		51	77	7	60	45	15
	200 kN	B	$64^{+0,030}_{0}$	47		65	77	12	60	45	15
	400 kN and 600 kN	A	$90^{+0,035}_{0}$	65		—	—	18	32	—	—
2 MN	200 kN	B	$64^{+0,030}_{0}$	47	$165^{-0,230}_{-0,480}$	67	103	12	87	60	15
	400 kN and 600 kN	A	$90^{+0,035}_{0}$	65		—	—	18	48	—	—
	1MN	A	$120^{+0,035}_{0}$	78		—	—	25	50	—	—
4 MN	400 kN and 600 kN	B	$90^{+0,035}_{0}$	65	$235^{-0,280}_{-0,570}$	92	158	18	130	95	35
	1 MN	B	$120^{+0,035}_{0}$	78		122	158	25	130	95	45
	2 MN	A	$165^{+0,040}_{0}$	105		—	—	27	62	—	—
6 MN	400 kN and 600 kN	B	$90^{+0,035}_{0}$	65	$270^{-0,300}_{-0,620}$	92	173	18	155	115	35
	1 MN	B	$120^{+0,035}_{0}$	78		122	173	25	155	115	45
	2 MN	A	$165^{+0,040}_{0}$	105		—	—	27	77	—	—
	4 MN	A	$235^{+0,046}_{0}$	160		—	—	35	60	—	—
10 MN	1 MN	B	$120^{+0,035}_{0}$	78	$345^{-0,360}_{-0,720}$	122	223	25	200	150	40
	2 MN	B	$165^{+0,040}_{0}$	105		167	223	27	200	150	60
	4 MN	A	$235^{+0,046}_{0}$	160		—	—	35	90	—	—
	6 MN	A	$270^{+0,052}_{0}$	185		—	—	40	75	—	—

[a] Tensile testing machines for nominal forces greater than 10 MN are special versions for which any necessary intermediate rings shall be made by arrangement.

Annex B (informative) Additional information

B.1 Overloading test

The force proving instrument is subjected 4 times in succession to an overload which should exceed the maximum force by a minimum of 8 % and a maximum of 12 %. Overloadings is maintained for a period of 1 to 1½ min.

B.2 Example of a method of verifying that there is no interaction between the force transducer of an instrument used in compression and its support on the calibration machine

The force proving instrument is loaded by means of intermediate bearing pads having a cylindrical shape and plane, convex and concave surfaces and which are in contact with the base of the device.

The concave and convex surfaces are considered as representing the limits of the absence of flatness and of variations in hardness of the bearing pads on which the instrument may be used when in operation.

The intermediate bearing pads are made of steel having a hardness between 400 and 650 HV 30. The convexity and concavity of the surfaces are 1,0 ± 0,1 in 1 000 of the radius [(0,1 ± 0,01) % of the radius)].

If a force proving instrument is submitted for calibration with associated loading pads which will subsequently always be used with the force proving instrument, the test device is considered to be a combination of the force proving instrument plus the associated loading pads. This combination is loaded in turn through the plane and conical bearing pads.

Two test forces are applied to the force proving instrument, the first being the maximum force of the instrument and the second, the minimum calibration force for which deflection of the instrument is sufficient from the point of view of repeatability.

The tests are repeated so as to have three force applications for each of the three types of intermediate bearing pad. For each force, the difference between the mean deflection using concave and plane bearing pads should not exceed the following limits, in relation with the class of the force proving instrument.

Table B.1

Class	Maximum permissible difference, %	
	At maximum force	At minimum force
00	0.05	0.1
0.5	0.1	0.2
1	0.2	0.4
2	0.4	0.8

If the force proving instrument satisfies the requirements relating to the maximum force but does not fulfil that for the minimum force, the smallest force for which the instrument fulfils the condition should be determined.

The smallest increase in the force used to determine the smallest force satisfying the condition is left to the discretion of the authority qualified to carry out the calibration. Generally, there is no need to repeat these tests with intermediate bearing pads each time the instrument is calibrated but only after an overhaul of the force proving instrument.

B.3 Comments on the record of the zero signal of unloaded force transducer

A change of zero of the unloaded force transducer indicates plastic deformations due to overloading of the force transducer. A permanent long time drifting indicates the moisture influence of the strain gauges base or a bonding defect of the strain gauges.

B.4 Example of calibration procedure for dial gauges (see 4.3)

The calibration procedure described concerns dial gauges used for interpolation.

The calibration procedure is made only in the increasing direction and in the utilization range (for example 3,000 to 8,000 mm).

The, calibration points are closer at the beginning of the range of use.

According to the range of use, the calibration can be made as follows:

a) move the plunger until the totalization needle (small dial) indicates 3,000 mm and rotate the bezel so that the zero coincides with the indicating needle in the vertical position;

b) over the range 3,000 mm to 3,400 mm (corresponding to the range not used by the force proving instrument), no readings are taken;

c) over the range 3,400 mm to 4,500 mm, one reading per 0,05 mm is taken;

d) over the range 4,500 mm to 8,000 mm, one reading per 0,1 mm is taken.

B.5 Use of calibrated force proving instruments

The correction of the deflection of the instrument for any temperature variation is calculated according to the following equation

$D_t = D_e [1 + K(t - te)]$.

Where

D_t is the deflection at the temperature t °C;

D_e is the deflection at the calibration temperature t_e °C;

D is the temperature coefficient of the instrument, in reciprocal degrees Celsius.

For instruments other than those having a force transducer with electrical outputs made of steel containing not more than 7 % of alloy elements, the value K = 0,00027/°C may be used.

For instruments made of material other than steel or which include force transducers with electrical outputs, the value K shall be determined experimentally and shall be provided by the manufacturer. The value used shall be stated on the calibration certificate of the instrument.

Table B.2 gives the deflection corrections for instruments of the first type. These corrections were obtained with K = 0,00027/°C.

NOTE When the instrument is made of steel and the deflection is measured in units of length, the temperature correction is equal to approximately 0,001 for each variation of 4 °C.

Most force transducers with electrical outputs are thermally compensated.

Generally, it is sufficient to measure the temperature of the device to 1 °C (see note in **6.4.3**).

If a deflection has been measured with a force proving instrument at a temperature greater than the calibration temperature and it is desired to obtain the deflection of the instrument for the calibration temperature, the deflection correction given in the Table B.2 shall be deducted from the deflection measured.

When the measurement is carried out with a force proving instrument at a temperature lower than the calibration temperature, the correction shall be added.

EXAMPLE: temperature of the force proving instrument: 22 °C

deflection observed : 729,6 divisions

calibration temperature: 20 °C

temperature variation: 22 – 20 = + 2 °C

In the column corresponding to the variation of + 2 °C, the nearest deflection which exceeds 729,6 divisions is 833 divisions. For this value of deflection, Table B.2 gives a correction of 0,4 divisions.

The corrected deflection is 729,6 – 0,4 = 729,2 divisions.

Table B.2 — Deflection correction for temperature variations of a steel force proving instrument (not including force transducer with electrical outputs)

Deflection corrections in scale division	Maximum deflection to which correction is applied (in scale divisions) for temperature variation in relation to the calibration temperature							
	1 °C	2 °C	3 °C	4 °C	5 °C	6 °C	7 °C	8 °C
0.0	185	92	61	46	37	30	26	23
0.1	555	277	185	138	111	92	79	69
0.2	925	462	308	231	185	154	132	115
0.3	1 296	648	432	324	259	216	185	162
0.4	1 666	833	555	416	333	277	238	208
0.5	2 037	1 018	679	509	407	339	291	234
0.6		1 203	802	601	481	401	343	300
0.7		1 388	925	694	555	462	396	347
0.8		1 574	1 049	787	629	524	449	393
0.9		1 759	1 172	879	703	586	502	439
1.0		1 944	1 296	972	777	648	555	486
1.1		2 129	1 419	1 064	851	709	608	532
1.2			1 543	1 157	925	771	661	578
1.3			1 666	1 250	999	833	714	625
1.4			1 790	1 342	1 074	895	767	671
1.5			1 913	1 435	1 148	956	820	717
1.6			2 037	1 527	1 222	1 018	873	763
1.7			2 160	1 620	1 296	1 080	925	810
1.8				1 712	1 370	1 141	978	865
1.9				1 805	1 444	1 203	1 031	902
2.0				1 898	1 518	1 265	1 084	949
2.1				1 990	1 592	1 327	1 137	995
2.2				2 083	1 666	1 388	1 190	1 041
2.3					1 740	1 450	1 243	1 087
2.4					1 814	1 512	1 296	1 134
2.5					1 888	1 574	1 349	1 180

National annex NA (informative)
Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the Engineering Sector Board to Technical Committee ISE/NFE/4, 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 Physical Laboratory)
Department of Trade and Industry (National Measurement Accreditation Service)
ERA Technology Ltd.
GAMBICA (BEAMA Ltd.)
Institute of Materials
Light Metal Founders' Association
Ministry of Defence
Society of British Aerospace Companies Limited
University College London
Welding Institute

The following body was also represented in the drafting of the standard, through subcommittees and panels:

Department of Trade and Industry (National Engineering Laboratory)

National annex NB (informative)
Cross-reference

Publication referred to	Corresponding British Standard
	BS EN 10002 *Tensile testing of metallic materials*
EN 10002-2	Part 2:1992 *Verification of the force measuring system on the tensile testing machine*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL