

Calibration of rubber and plastics test equipment

Part 3. Calibration schedules

**Section 3.4 Mechanical properties
of rubber**

ICS 83.200

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Foreword

This Section of BS 7825 has been prepared by Technical Committee PRI/20.

In commercial practice it is necessary for the parties concerned in the manufacture or supply of materials or products to operate or agree upon specified performance requirements. Those performance requirements are verified by standardized methods of test. Test result variability is influenced by both test variability and product variability. As it is product variability which needs to be identified, test variability has to be kept to a minimum. An important element in the achievement of this reduced variability is the calibration of test instrumentation, to traceable standards, at acceptable intervals.

The use of this British Standard will encourage proper calibration and make it possible for all users and calibration laboratories to work to common procedures.

BS 7825 comprises the following three separate Parts:

Part 1	<i>Specification for principles and general requirements</i>
Part 2	<i>Calibration procedures</i>
Part 3	<i>Calibration schedules</i>

Part 3 will comprise 13 Sections, each of which will provide calibration schedules for specific areas of rubber or plastics testing, as follows:

Section 3.1	<i>Thermal properties</i>
Section 3.2	<i>Electrical properties</i>
Section 3.3	<i>Mechanical properties of plastics</i>
Section 3.4	<i>Mechanical properties of rubber</i>
Section 3.5	<i>Optical and weathering properties</i>
Section 3.6	<i>Dimensional properties</i>
Section 3.7	<i>Rheological properties</i>
Section 3.8	<i>Degradation and environmental properties</i>
Section 3.9	<i>Flammability characteristics</i>
Section 3.10	<i>Conditioning, sample and test piece preparation</i>
Section 3.11	<i>Rubber polymer identification and chemical properties</i>
Section 3.12	<i>Chemical properties of plastics</i>
Section 3.13	<i>Chemical properties of resins</i>

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.

1 Scope

This Section of BS 7825 provides schedules for the calibration of a range of methods of test used for the evaluation of the mechanical properties of rubber.

2 References

2.1 Normative references

This Section of BS 7825 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 32. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the publications apply to this Section of BS 7825 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Section of BS 7825 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Section of BS 7825 the definitions, where relevant, given in BS EN 30012-1, BS 5233, PD 6461 : Part 1, BS 4778 and ISO Guide 30 apply.

4 Inspection

Before any calibration is undertaken, the condition of the items to be calibrated shall be ascertained by inspection and recorded on any calibration report or certificate. It shall be reported whether calibration is made in the 'as-received' condition or after rectification of any abnormality or fault.

It shall be ascertained that the apparatus is generally fit for the intended purpose, including any requirements specified as approximate and hence not formally calibrated. If such parameters could change, then the need for periodic checks shall be written into the detailed calibration procedures.

5 Schedules

The calibration schedules given in this Section of BS 7825 have been compiled by listing all of the parameters specified in the relevant test method cited, together with the specified requirement. A parameter and requirement may relate to the main test apparatus, part of that apparatus or to an ancillary apparatus necessary for the test. In some cases tolerances not given in the test method standard have been added.

For each parameter a calibration procedure is indicated by reference to Part 2 of BS 7825, to another publication or to a procedure particular to that test method which is detailed.

The verification frequency for each parameter is given by a code letter. The code letters used in the schedules are:

Procedure:	P	Particular procedure
	R	Use of certified reference material
	C	Requirement to be confirmed but no measurement
Requirement: *		Tolerance not specified in the test method standard
Verification:	N	Initial verification only
	S	Standard interval as given in Part 1 of BS 7825
	P	Particular interval given in the standard
	U	In use

In use checks additional to the schedule are listed separately.

A list is given of reference materials either required by the calibration schedule or otherwise required by the test method.

Reagents, including cleaning materials, are listed. In some cases a reagent may be considered as a particular type of reference material.

In addition to the items listed, some standards assume the use of 'normal' laboratory apparatus, e.g. timers, beakers etc. These may need calibrating in accordance with the appropriate procedure given in Part 2 of BS 7825. Also, there may be items specified in the relevant cited standard which have a dimension, for example a 250 ml flask. Where the size has no particular significance, other than convenience of use, these items will not require to be calibrated.

Most standards for the testing of materials require the test piece to be conditioned. This implies the use of a thermometer and possibly a hygrometer, both of which will require calibration. Conditioning and test temperatures and humidities cited in the relevant standard have not been repeated.

Test piece dimensions are usually specified. This implies the use of dimensional measuring instruments which will require calibration. Test piece dimensions cited in the relevant standard have not been repeated.

6 Calibration schedules for individual test methods

The calibration schedules relating to this Section of BS 7825 are listed below in the numerical order of the international standard to which they relate:

BS 903 :	<i>Physical testing of rubber</i>
BS 903 : Part A3 : 1995	<i>Method for determination of tear strength (trouser, angle and crescent test pieces)</i> (Identical with ISO 34-1 : 1994)
BS 903 : Part A12 : 1995	<i>Method for determination of the adhesion strength to textile fabric</i> (Identical with ISO 36 : 1993)
BS 903 : Part A2 : 1995	<i>Method for determination of tensile stress-strain properties</i> (Identical with ISO 37 : 1994)
BS 903 : Part A26 : 1995	<i>Method for determination of hardness (hardness between 10 IRHD and 100 IRHD)</i> (Identical with ISO 48 : 1994)
BS 903 : Part A10 : 1984	<i>Determination of flex cracking (De Mattia)</i> (Identical with ISO 132 : 1983)
BS 903 : Part A11 : 1985	<i>Determination of crack growth (De Mattia)</i> (Identical with ISO 133 : 1983)
BS 903 : Part A21 :	<i>Determination of rubber to metal bond strength</i>
BS 903 : Section A21.1 : 1997	<i>Adhesion to rigid substrates — 90° peel method</i> (Identical with ISO 813 : 1997)
BS 903 : Section A21.2 : 1997	<i>Two plate method</i> (Identical with ISO 814 : 1996)
BS 903 : Part A6 : 1992	<i>Method for determination of compression set at ambient, elevated or low temperatures</i> (Identical with ISO 815 : 1991)
BS 903 : Part A3 :	<i>Determination of tear strength</i>
BS 903 : Section A3.2 : 1997	<i>Small (Delft) pieces</i> (Identical with ISO 34-2 : 1996)
BS 903 : Part A42 : 1992	<i>Method for determination of stress relaxation in compression at ambient and at elevated temperatures</i> (Identical with ISO 3384 : 1991)
BS 903 : Part A14 : 1992	<i>Method for determination of modulus in shear or adhesion to rigid plates. Quadruple shear method</i> (Identical with ISO 1827 : 1991)
BS 903 : Part A5 : 1997	<i>Determination of tension set at normal and high temperatures</i> (Identical with ISO 2285 : 1997)
BS 903 : Part A63 : 1995	<i>Method for determination of crystallization effects by hardness measurements</i> (Identical with ISO 3387 : 1994)
ISO 4074-5 : 1996	<i>Rubber condoms — Part 5: Testing for holes — Water leak test</i>
BS 903 : Part A27 : 1986	<i>Determination of rubber to fabric adhesion: direct tension method</i> (Identical with ISO 4637 : 1979)
BS 903 : Part A48 : 1984	<i>Determination of static adhesion to textile cord (H-pull test)</i> (Identical with ISO 4647 : 1982)
ISO 4649 : 1985	<i>Rubber — Determination of abrasion resistance using a rotating cylindrical drum device</i>
ISO 4662 : 1986	<i>Rubber — Determination of rebound resilience of vulcanizates</i>
ISO 4663 : 1986	<i>Rubber — Determination of dynamic behaviour of vulcanizates at low frequencies — Torsion pendulum method</i>

ISO 4664 : 1987	<i>Rubber — Determination of dynamic properties of vulcanizates for classification purposes (by forced sinusoidal shear strain)</i>
BS 903 : Part A49 : 1984	<i>Determination of temperature rise and resistance to fatigue in flexometer testing (basic principles)</i> (Identical with ISO 4666-1 : 1982)
BS 903 : Part A49 : 1984	<i>Determination of temperature rise and resistance to fatigue in flexometer testing (basic principles)</i> (Identical with ISO 4666-1 : 1982)
ISO 4666-2 : 1982	<i>Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing — Part 2: Rotary flexometer</i>
BS 903 : Part A50 : 1984	<i>Determination of temperature rise and resistance to fatigue in flexometer testing (compression flexometer)</i> (Identical with ISO 4666-3 : 1982)
BS 903 : Part A40 : 1988	<i>Determination of adhesion to rigid materials using conical shaped parts</i> (Identical with ISO 5600 : 1986)
BS 903 : Part A56 : 1989	<i>Determination of adhesion to wire cord</i> (Identical with ISO 5603 : 1986)
BS 5214 :	<i>Specification for testing machines for rubbers and plastics</i>
BS 5214 : Part 1 : 1995	<i>Tensile, flexural and compression types (constant rate of traverse)</i> (Identical with ISO 5893 : 1993)
ISO 6471 : 1994	<i>Rubber, vulcanized — Determination of crystallization effects under compression</i>
BS 903 : Part A37 : 1997	<i>Determination of tendency to adhere to and to corrode metals</i> (Identical with ISO 6505 : 1997)
BS 903 : Part A51 : 1986	<i>Determination of resistance to tension fatigue</i> (Identical with ISO 6943 : 1984)
BS 903 : Part A57 : 1997	<i>Determination of indentation hardness by means of pocket hardness meters</i> (Identical with ISO 7619 : 1997)
BS 903 : Part A4 : 1990	<i>Determination of compression stress-strain properties</i> (Identical with ISO 7743 : 1989)
BS 903 : Part A15 : 1990	<i>Method for determination of creep in compression or shear</i> (Identical with ISO 8013 : 1988)
BS 903 : Part A62 : 1993	<i>Method for determination of green strength of raw rubber of unvulcanized compounds</i> (Identical with ISO 9026 : 1991)

Table 1. BS 903 : Part A3 : 1995 (identical with ISO 34-1 : 1994)				
Parameter	Requirement	Procedure	Verification frequency	Notes
Dies	As in figures 1, 2 and 3; sharp and no ragged edges	3.2 3.3 3.9	— S S	—
Testing machine	As in BS 5214 : Part 1 (ISO 5893)	10.1	S	BS 5214 : Part 1 (ISO 5893) states: 'according to national standards'
Force measurement	Grade B	—	—	—
Traverse (trouser test)	(100 ± 10) mm/min	12.4	S	Low inertia machine with autographic recording
Traverse (other tests)	(500 ± 50) mm/min	12.4	S	—
Grips	Uniform pressure	C	N	E.g. air actuated
Test pieces	Inserted symmetrically	C	U	See also figure 4
Axial alignment	Direction of pull	C	U	—

Table 2. BS 903 : Part A12 : 1995 (identical with ISO 36 : 1993)				
Parameter	Requirement	Procedure	Verification frequency	Notes
Test machine	As in BS 5214 : Part 1 (ISO 5893)	—	—	—
Force measurement	Grade B	10.1	S	—
Rate of traverse	(50 ± 5) mm/min	12.4	S	—
Grips	No slipping	C	U	—
Chart recorder	Large scale	2.6	S	To permit easy interpretation

Table 3. BS 903 : Part A2 : 1995 (identical with ISO 37 : 1994)				
Parameter	Requirement	Procedure	Verification frequency	Notes
Tensile test machine with grip separation	(500 ± 50) mm/min or (100 ± 10) mm/min	12.4	S	—
Micrometer gauge	—	3.1	S	—
Foot pressure	20 kPa ⁺⁵ ₀ kPa*	10.3	S	—
Rotatable pulleys	Dia. 25 mm ± 0.1 mm* Dia. 4.5 mm ± 0.1 mm*	C	U	One automatically rotating
Rotational frequency	10 per minute to 50 per minute	C	U	—
Grips	Tighten automatically	C	U	—
Force measurement	As in BS 5214 : Part 1* (ISO 5893*)	—	—	—
Elongation	As in BS 5214 : Part 1* (ISO 5893*)	—	—	—

Table 4. BS 903 : Part A26 : 1995 (identical with ISO 48 : 1994)

Parameter	Requirement	Procedure	Verification frequency	Notes
Standard method (hardness between 30 IRHD and 85 IRHD)				
Ball diameter	2.5 mm $\pm$ 0.01 mm	3.2/3.3	S	—
Foot diameter	20 mm $\pm$ 1 mm	3.2	S	—
Hole diameter	6 mm $\pm$ 1 mm	3.2	S	—
Contacting force	0.3 N $\pm$ 0.02 N	10.3	S	—
Indenting force	5.4 N $\pm$ 0.01 N	10.3	S	—
Total force	5.7 N $\pm$ 0.03 N	10.3	S	—
Force on foot	8.3 N $\pm$ 1.5 N	10.3	S	—
Pressure on foot	30 kPa $\pm$ 5 kPa	10.3	S	—
Friction	Negligible	C	S	—
Indenter clearance	Initially above foot	C	S	—
Dial calibration	According to table 3	3.1	S	—
Interval timer	(5 s or 30 s) $^{+1}_0$ s	12.1	S	Calibrate to ± 0.1 s
In-use checks	On each occasion of use check for absence of appreciable friction and looseness of the foot. It is recommended that correct operation is checked at least once during each day (*) and that the apparatus is in use using certified standard hardness blocks	—	—	—
Micro method (hardness between 30 IRHD and 85 IRHD)				
Ball diameter	0.395 mm $\pm$ 0.005 mm	3.2/3.3	S	—
Foot diameter	3.35 mm $\pm$ 0.15 mm	3.2	S	—
Hole diameter	1.0 mm $\pm$ 0.15 mm	3.2	S	—
Contact force	8.3 mN $\pm$ 0.5 mN	10.3	S	—
Indenting force	145 mN $\pm$ 0.5 mN	10.3	S	—
Total force	153 mN $\pm$ 1 mN	10.3	S	—
Force on foot alternatively:	235 mN $\pm$ 30 mN 380 mN $\pm$ 30 mN	10.3 10.3	S S	See note 1 of table 1 of BS 903 : Part A26 (ISO 48)
Friction	Negligible	C	S	—
Indenter clearance	Initially above foot	C	S	—
Dial calibration	According to table 3	3.1	S	—
Interval timer	(5 s or 30 s) $^{+1}_0$ s	12.1	S	—
In-use checks	On each occasion of use check for absence of appreciable friction and looseness of the foot. It is recommended that correct operation is checked at least once during each day (*) and that the apparatus is in use using certified standard hardness blocks	—	—	—

Table 5. BS 903 : Part A10 : 1984 (identical with ISO 132 : 1983)				
Parameter	Requirement	Procedure	Verification frequency	Notes
De Mattia type machine	Motor shall not generate ozone. No. of cycles recorded	12.3	S	—
Travel	57 mm $+0.5_0$ mm	3.2	S	See figure 1
Maximum distance	75 mm $+1_0$ mm	3.2	S	See figure 1
Motion	Straight	C	N	—
Planes of gripping surface	Parallel throughout	C	N	—
Direction	Common centre line of each pair of grips	C	N	—
Frequency	5.00 Hz $\pm$ 0.17 Hz	12.3	S	—
Power to flex	Six to 12 test pieces at one test	C	N	—
Grips	One fixed, one moving. Grips hold firmly, no undue compression. Adjustment possible	C	U	—
Temperature control	± 2 °C	6	S	—
NOTE. Results of the test are dependent on the thickness of each test piece. For comparison, thicknesses should be kept within the tolerance allowed.				

Table 6. BS 903 : Part A11 : 1985 (identical with ISO 133 : 1983)				
Parameter	Requirement	Procedure	Verification frequency	Notes
De Mattia type machine	Motor shall not generate ozone. No. of cycles recorded	C 12.3	N S	—
Grips	One fixed, one moving. Grips hold firmly, no undue compression. Adjustment possible	C	U	—
Travel	57 mm $+0.5_0$ mm	3.2	S	See figure 1
Maximum distance	75 mm $+1_0$ mm	3.2	S	See figure 1
Motion	Straight	C	N	—
Direction	Common centre line of each pair of grips	C	N	—
Planes of gripping surface	Parallel throughout	C	N	—
Frequency	5.00 Hz $\pm$ 0.17 Hz	12.3	S	—
Temperature control	± 2 °C	6	S	—
Different test temperature	3 h at test temperature (see ISO 3383)	6	S	—
Piercing tool	Normal to surface and as in figure 3	3.2	S	Test piece on a flat solid support
Hole for piercing tool	To allow penetration of 2.5 mm to 3 mm	C	N	—
Grip separation for measurement	65 mm	3.2	U	—
Intervals	E.g. 1 kHz; 3 kHz; 5 kHz	12.3	S	To locate (L + 2), (L + 6) and (L + 10)
NOTE. Results of the test are dependent on the thickness of each test piece. For comparison, thickness must be within tolerances allowed.				

Table 7. BS 903 : Section A21.1 : 1997 (identical with ISO 813 : 1997)

Parameter	Requirement	Procedure	Verification frequency	Notes
Tensile testing machine	As in BS 5214 : Part 1 (ISO 5893)	—	—	—
Force accuracy	Grade B	10.1	S	Inertia-less dynamometer preferred
Rate of traverse	(50 ± 5) mm/min	12.4	S	—
Direction of pull	Near perpendicular to plane of rubber/metal bond	C	U	E.g fixture in figure 1
Grip	No slip or rupture of rubber	C	U	—
Determine dimensions	As in ISO 4648	—	—	—
Metal strip	(1.5 ± 0.1) mm thick	3.2	U	—
	(25 ± 0.1) mm wide	3.2	U	—
	(60 ± 1) mm long	3.2	U	—
Bonded area	$(25 \text{ mm} \times 25 \text{ mm}) \pm 0.1 \text{ mm}$	3.2	U	—
Reagents	Solvent as recommended Bonding system	—	—	—

Table 8. BS 903 : Part A21 : Section A21.2 : 1997 (identical with ISO 814 : 1996)

Parameter	Requirement	Procedure	Verification frequency	Notes
Tensile testing machine	As in BS 5214 : Part 1 (ISO 5893)	—	—	—
Force measurement	Grade B of BS 5214 : Part 1 (ISO 5893)	10.1	S	—
Rate of traverse	$50 \text{ mm} \pm 5 \text{ mm/min}$	12.4	S	—
Fixtures(grips)	Accurate centring	C	N	See figure 1
Circular metal parts	Rolled carbon steel	3.2/3.9	S	Or other metal
Projection of rubber	Approximately 0.04 mm	C	U	Prior to vulcanization
Tension during testing	Uniformly distributed	C	U	—

Table 9. BS 903 : Part A6 : 1992 (identical with ISO 815 : 1991)				
Parameter	Requirement	Procedure	Verification frequency	Notes
Compression plates	Parallel, flat, highly polished	—	—	—
Finish	Not worse than 0.4 μm R_a to ISO 468	3.5	S	—
Bending	Not more than 0.01 mm	3.2	N	Under load
Size	To contain whole test piece when compressed	C	U	—
Suggested sizes	Diameter about 115 mm Thickness about 6.5 mm and 12.5 mm	—	—	See figure 1
Low temperature measurement	± 0.5 °C	6	S	—
Spacers	No contact with test piece	C	U	—
Spacers to give compression strain	25 % $\pm$ 1 % of thickness	—	—	See note 3 for details
Hardness 80 IRHD to 89 IRHD				
Compression strain	15 %	—	—	—
Spacers type A type B	10.6 mm < h_s < 10.7 mm	—	—	—
	5.3 mm < h_s < 5.4 mm	—	—	—
Hardness above 90 IRHD				
Spacers type A type B	11.25 mm < h_s < 11.30 mm	3.2	U	—
	5.65 mm < h_s < 5.70 mm	3.2	U	—
Compression strain	10 %	—	—	—
Clamping device				
Standard or high temperatures	Screw satisfactory	C	N	—
Low temperature	Quick-release	C	N	—
Temperature cabinet	As in ISO 3383	C	N	—
Temperature	± 0.5 °C	6	S	—
Micrometer dial gauge	Suitable for temperature	3.1	S	Calibrated at temperature
Foot diameter	4 mm to 10 mm	3.2	S	—
Flat sold base	ISO 4648 Method A	—	—	—
Pressure	22 kPa $\pm$ 5 kPa	4.6	S	—
Timing device	± 0.1 s or ± 1 %	12.1	S	—
Reagent	Lubricant, e.g. silicone or fluorosilicone having a kinematic viscosity of 0.01 m^2/s at standard temperature	—	—	—