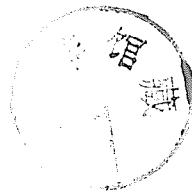
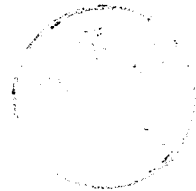


2004年6月3日

Physical testing of rubber —

Part 0: General



ICS 83 060



050920015915

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

5月7日 6日

BSi
British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PRI/22, Physical testing of rubber, upon which the following bodies were represented:

- British Rubber Manufacturers Association Ltd.
- RAPRA Technology Ltd.
- Royal Society of Chemistry
- Satra Technology Centre
- Tun Abdul Razak Research Centre

Licensed Copy: Wang Bin, ISO/Exchange China Standards Information Centre, 15 September 2003, Uncontrolled Copy, (c) BSI

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 12 June 2003

© BSI 12 June 2003

First published June 1990

The following BSI references relate to the work on this British Standard:
Committee reference PRI/22
Draft for comment 00/121348 DC

ISBN 0 580 41688 7

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
<hr/>	
1 Scope	1
2 Terms and definitions	1
3 Normative reference	1
4 Reproducibility	1
5 Test method categories and properties	1
6 Usage	5
7 Statistical analysis	6
8 Analysis of graphical traces	6
9 Electrical properties	6
<hr/>	
Annex A (informative) List of British Standard test methods for the physical properties of rubber	7
Annex B (informative) List of international methods	12
Annex C (informative) Recommendations for the rounding-off of test results	17
<hr/>	
Bibliography	19
<hr/>	
Table A.1 — Methods of testing rubber: relationship between British Standards and international standards	7
Table B.1 — International standards for methods of testing rubber	12
Table C.1 — Recommendations for the rounding-off of test results for the physical properties of rubber	17
<hr/>	

Foreword

This British Standard has been prepared by Technical Committee PRI/22. It supersedes BS 903-0:1990 which is withdrawn.

BS 903 is the best-known British Standard for rubber and was first published as a compilation of test methods in 1940. It quickly developed an international reputation, especially in the Commonwealth and parts of Europe, and many of its methods were subsequently adopted as international (ISO) standards.

BS 903 is split into two series. Series A comprises the general methods of test A1–A65. Series C comprises the methods of test C1–C5, used to determine the electrical properties of vulcanized rubber.

The work of Subcommittee ISO/TC 45/SC2, Rubber and rubber products — Testing and analyses, continues in reviewing and revising international standards and in developing new test methods and guides to keep abreast of changes and developments in technology, and in this the UK plays a leading and active role. As a consequence, the status of methods is continually changing, as new editions are published and new methods appear. It is therefore never possible for this Part of BS 903 to be completely up-to-date and this present edition is therefore only a snapshot in time.

The purpose of this part is to provide a general introduction to the range of British and international Standard test methods used to determine the physical properties of rubber. (The methods embrace raw, unvulcanized, vulcanized and thermoplastic rubbers.)

A detailed and comprehensive cross-reference is given in Annex A of corresponding international standards; Annex B gives a list of those international standards issued by ISO/TC 45/SC2; and Annex C provides recommendations for the rounding-off of test results.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its 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 19 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

1 Scope

This part of this British Standard provides a general introduction to BS 903 and to BS ISO standards in the BS 903 series. It describes a range of laboratory-scale methods for the physical testing of rubber in raw, unvulcanized, vulcanized and thermoplastic forms. A list of closely-related British Standards is also provided.

NOTE The status of methods referenced here should be verified with the relevant standards body; they are continually changing as new editions are issued and new methods appear, in line with developments in technology.

2 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 3558 apply.

3 Normative reference

BS 3558 (all parts), *Glossary of rubber terms*.

4 Reproducibility

A number of the test methods include a statement on test precision as determined by an interlaboratory test programme and ISO/TC 45 intends that this should eventually be extended to all methods. Attention is drawn to ISO/TR 9272 and ISO/TR 11753.

5 Test method categories and properties

5.1 General

The individual test methods published in the A series of BS 903 and as BS ISO standards are listed in Annex A. Most of the BS 903 A series test methods are identical with those standardized by Technical Committee ISO/TC 45, Rubber and rubber products, of the International Organization for Standardization (ISO) and, where this is so, the methods have been published as dual-numbered British Standards, although current practice is now to adopt ISO standards as BS ISO standards with the same ISO numbers. In all cases the ISO equivalents are also listed. Additional methods are in preparation.

Annex B gives a full list of those international standards issued by ISO/TC 45/SC2.

The methods fall into seven main categories:

- a) tests for unvulcanized rubber;
- b) preparative procedures;
- c) mechanical tests;
- d) viscoelastic tests;
- e) degradation and environmental tests;
- f) tests on effect of fluids;
- g) adhesion and contact property tests.

In terms of these categories the existing parts of BS 903 and BS ISO standards can be grouped as in 5.2 to 5.8, although there will be some overlap.

NOTE The prefix BS 903 applies to the referenced standards unless otherwise indicated.

5.2 Tests for unvulcanized rubber**5.2.1 Mooney viscometer tests**

Mooney viscosity	A58:1990 (incorporating Amendments No. 1:1991 and No. 2:2001) (≠ ISO 289-1:1994 and ISO 289-2:1994) (partially replaced by A58.1:2001)
Delta Mooney (for non-pigmented, oil-extended, emulsion-polymerized SBR)	A58.1:2001 (≡ ISO 289-3:1999)
Prevulcanization characteristics	A58:1990 (incorporating Amendments No. 1:1991 and No. 2:2001) (≠ ISO 289-1:1994 and ISO 289-2:1994) (partially replaced by A58.1:2001)

5.2.2 Plastimeter tests

Rapid plasticity number	A59.1:1997 (≡ ISO 2007:1991)
Plasticity retention index	A59.2:1997 (≡ ISO 2930:1995)

5.2.3 Curemeter tests

Curemetering — Guide to the use of curemeters	A60.1:2000 (incorporating Amendment No. 1:2000) (≡ ISO 6502:1999)
Vulcanization characteristics using oscillating disc curemeter	A60.2:1992 (≡ ISO 3417:1991)

5.2.4 Other tests

Green strength of raw or unvulcanized rubber	A62:1993 (≡ ISO 9026:1991)
Assessment of carbon black dispersion	A65:1998 (≡ ISO 11345:1997)

NOTE BS 903-A65 is also applicable to vulcanized rubber.

5.3 Preparative procedures**5.3.1 General**

For raw rubber, attention is also drawn to BS ISO 1795.

5.3.2 Test compounds

preparation, mixing and vulcanization	A64:1995 (≡ ISO 2393:1994)
---------------------------------------	----------------------------

5.3.3 Test pieces

preparation of samples and test pieces	A36:1995 (≡ ISO 4661-1:1993)
measurement of dimensions	A38:1991 (≡ ISO 4648:1991)

5.3.4 Test conditions

standard laboratory atmospheres	A35:1995 (≡ ISO 471:1995)
general directions for achieving elevated or subnormal temperatures	A32:1988 (≡ ISO 3383:1985)

5.4 Mechanical tests**5.4.1 Density**

A1:1996 (≡ ISO 2781:1988 incorporating Corrigendum No. 1:1996)

5.4.2 Stress-strain properties

in tension	A2:1995 (≡ ISO 37:1994)
in compression	A4:1990 (incorporating Amendment No. 1:1991) (≡ ISO 7743:1989 incorporating Corrigendum No. 1:1990)
in shear	A14:1992 (≡ ISO 1827:1991)
dynamic	BS ISO 4664:1998 (≡ ISO 4664:1998) and A31:1976 (incorporating Amendment No. 1:1986) (≠ ISO 4663:1986)

5.4.3 Hardness

IRHD	A26:1995 (incorporating Amendment No. 1:2001) (≡ ISO 48:1994 incorporating Amendment No. 1:1999)
by pocket hardness meters	A57:1997 (≡ ISO 7619:1997)

5.4.4 Strength properties

tensile	A2:1995 (≡ ISO 37:1994)
tear	A3:1995 (≡ ISO 34-1:1994) A3.2:1997 (≡ ISO 34-2:1996)
fatigue (by crack growth)	A10:1999 (≡ ISO 132:1999) A51:1986 (≡ ISO 6943:1984)

5.5 Viscoelastic tests**5.5.1 Set and recovery**

in tension	BS ISO 2285:2001 (≡ ISO 2285:2001)
in compression	A6:1992 (incorporating Amendment No. 1:1994) (≡ ISO 815:1991 incorporating Corrigendum No. 1:1993)

5.5.2 Creep

A15:1990 (≡ ISO 8013:1988)

5.5.3 Stress relaxation

A42:1999 (incorporating Amendment No. 1:2001) (≡ ISO 3384:1999 incorporating Amendment No. 1:2001)

5.5.4 Frictional properties

A61:2000 (incorporating Amendment No. 1:2001) (≡ ISO 15113:1999 incorporating Corrigendum No. 1:2001)

5.5.5 Crystallization effects

A63:1995 (≡ ISO 3387:1994 incorporating Corrigendum No. 1:2000)

5.5.6 Dynamic testing

BS ISO 4664:1998 (≡ ISO 4664:1998)

A31:1976 (incorporating Amendment No. 1:1986) (≠ ISO 4663:1986)

5.5.7 Resilience

A8:1990 (≠ ISO 4662:1986)

5.5.8 Heat build-up

A49:1984 (≡ ISO 4666-1:1982)

A50:1984 (≡ ISO 4666-3:1982)

NOTE BS 903-A49 and -A50 may also be used to determine resistance to fatigue, creep and set caused by thermal degradation during flexure.

5.6 Degradation and environmental tests**5.6.1 Thermal and thermal-oxidative ageing**

accelerated ageing and heat resistance	A19:1998 (≡ ISO 188:1998)
by stress relaxation	A52:1986 (≡ ISO 6914:1985)
Estimation of life time and maximum temperature of use	BS ISO 11346 ¹⁾ (≡ ISO 11346 ²⁾)

NOTE BS 903-A6, -A15, -A42, -A49 and -A50 may also be used to measure the time-dependent thermal stability of vulcanized rubber under specified conditions.

5.6.2 Ozone and weathering resistance

static strain ozone exposure	A43:1990 (≡ ISO 1431-1:1989)
dynamic strain ozone exposure	A44:1995 (≡ ISO 1431-2:1994)
ozone concentration	A45:2000 (≡ ISO 1431-3:2000)
outdoor exposure	BS ISO 4665:1998 (≡ ISO 4665:1998)
artificial light exposure	BS ISO 4665:1998 (≡ ISO 4665:1998)
assessment of properties after weathering	BS ISO 4665:1998 (≡ ISO 4665:1998)

5.6.3 Low temperature properties

torsion modulus	A13:1990 (≡ ISO 1432:1988)
impact brittleness	A25:1992 (≡ ISO 812:1991)
temperature retraction	A29:1997 (≡ ISO 2921:1997)
compression set	A6:1992 (incorporating Amendment No. 1:1994) (≡ ISO 815:1991 incorporating Corrigendum No. 1:1993)
crystallization by hardness measurements	A63:1995 (≡ ISO 3387:1994 incorporating Corrigendum No. 1:2000)

5.7 Tests on effects of fluids

NOTE Attention is also drawn to BS ISO 13226.

resistance to liquids	A16:1999 (≡ ISO 1817:1999)
water vapour absorption	A18:1973 (no corresponding ISO)
gas permeability	A30:1996 (≡ ISO 2782:1995)
vapour transmission rate of volatile liquids (for rubber sheets and coated fabrics)	BS EN ISO 6179:2001 (incorporating Amendment No. 1:2001) (≡ ISO 6179:1998)

5.8 Adhesion and contact property tests**5.8.1 Adhesion strength****5.8.1.1 To fabrics:**

peel test	A12:1999 (≡ ISO 36:1999)
direct tension	A27:1986 (≡ ISO 4637:1979)

¹⁾ To be published; ISO 11346 not yet implemented by BSI.

²⁾ Published, see Bibliography.

5.8.1.2 To textile cord:

A48:1984 (≡ ISO 4647:1982)

5.8.1.3 To wire cord:

A56:1989 (≡ ISO 5603:1986)

5.8.1.4 To rigid materials:

peel test	A21.1:1997 (≡ ISO 813:1997)
two-plate method	A21.2:1997 (≡ ISO 814:1996)
in quadruple shear	A14:1992 (≡ ISO 1827:1991)
using conical test pieces	A40:1988 (≡ ISO 5600:1986)

NOTE Includes metals and plastics materials. BS 903-A21 is intended primarily for rubber to metal adhesion but can be applied to other rigid substrates.

5.8.2 Contact properties

staining of organic materials	A33:1998 (≡ ISO 3865:1997)
adhesion to and corrosion of metals	A37:1997 (≡ ISO 6505:1997)
friction	A61:2000 (incorporating Amendment No. 1:2001) (≡ ISO 15113:1999 incorporating Corrigendum No. 1:2001)
abrasion	A9:1988 (partially replaced by BS ISO 4649:2002) BS ISO 4649:2002 (≡ ISO 4649:2002)

6 Usage**6.1 Application**

For the testing of rubber the use of BS 903 and BS ISO test methods from the BS 903 series should always be considered before resorting to other methods or procedures. These methods are intended for use with small, laboratory test pieces taken either from specially prepared samples or test sheets or from finished rubber products. In most instances these test pieces will be cut by dies or knives from a representative sample and here, attention is drawn to the procedures specified in BS 903-A36, since the method of preparation can affect test performance, especially where strength measurements are involved. For some tests, directly moulded test pieces are necessary or most appropriate.

The BS 903 series test methods, including the BS ISO methods listed in this part of BS 903, are applicable to unvulcanized and vulcanized rubber prepared from dry rubber or latex. Most, although not all, of the test methods described for vulcanized rubber are suitable for use with thermoplastic rubbers and their products. The scopes of many of the test methods have already been extended to include thermoplastic rubbers.

The BS 903 series test methods, including the BS ISO methods listed in this part of BS 903, are not intended for use with cellular rubber or with rubber-coated fabrics except where specified, although several standards can be applied to some cellular rubber materials and products. Dedicated test methods for flexible cellular materials are given in BS 4443, whilst dedicated methods for coated fabrics are given in BS 3424.

6.2 Selection of test method

Detailed guidance on the selection and use of laboratory-scale tests is given in BS 903-1.

Many of the methods give options for test piece size and shape, test procedure, test environment and, where appropriate, test duration. For example, heat ageing tests conducted in accordance with BS 903-A19 may be carried out at one or more of several standard or recommended test temperatures and times. Such options should be selected to suit the particular application and in all cases the conditions used should be specified and reported. Considerations will include the size of sample or product, the overall test time, the anticipated service environment and for example whether or not the test is for quality control or type approval purposes.

Attention is drawn to BS 903-3 and BS 903-4 on the acquisition and presentation of comparable test data. These standards specify test procedures, test pieces and conditions from the options given in test methods in order to assist a meaningful comparison of materials and reduce unnecessary testing. BS 903-3 addresses single-point data, whilst BS 903-4 is concerned with multi-point data, for example the results of accelerated ageing for several test times.

The following references also prove helpful when selecting test methods and choosing test conditions:

- BS 6716;
- Physical Testing of Rubber* [1];
- Handbook of Polymer Testing: Physical Methods* [2].

6.3 Expression of test results

At present few of the test methods specify the number of significant figures to which the test results should be expressed. For comparative purposes it is desirable that the precision should be the same irrespective of the means by which the individual results of the appropriate measure of central tendency is calculated. Thus results need to be rounded off to an accuracy representative of the test method and the number of test pieces specified. Attention is therefore drawn to the recommendations given in Annex C, produced in support of BS 903-1 to BS 903-4.

6.4 Calibration of test equipment

It is important that the test equipment specified in test methods is suitably calibrated for consistent and reproducible test results. Attention is therefore drawn to the specification, procedures and schedules for the calibration of rubber and plastic test equipment described in BS 7825.

Specifications for testing machines for rubber and plastics are given in BS 5214.

7 Statistical analysis

Attention is drawn to BS 903-2, which provides examples of statistical techniques, applied to particular rubber testing situations.

8 Analysis of graphical traces

Graphical traces of test results can be interpreted automatically by software packages that sometimes do not use the same basis of analysis, leading inevitably to differences in interpretation and in test results. BS ISO 6133 provides one means of avoiding this pitfall.

9 Electrical properties

For the determination of the electrical properties of rubber, use should be made of the test methods described in the C series of BS 903. The methods refer to vulcanized rubber but are also suitable for thermoplastic rubbers. The following parts are available:

- C1 Determination of surface resistivity
- C2 Determination of volume resistivity
- C5 Determination of insulation resistance

Other relevant test methods are BS 7663 which replaced BS 903-C3 for the determination of permittivity and BS EN 60243-2 which replaced ultimately BS 903-C4 for the determination of electric strength.

Annex A (informative)**List of British Standard test methods for the physical properties of rubber**

Table A.1 cross-references British Standards and international test methods for rubber. It also includes the BS 903 C series of electrical tests for rubber.

NOTE BS 903-A5, -A7, -A11, -A17, -A20, -A22 to -A24, -A28, -A34, -A39, -A41, -A46, -A47, -A53 to -A55, -C3 and -C4 no longer exist, and their test methods have been superseded by other parts or by BS ISO standards.

Table A.1 — Methods of testing rubber: relationship between British Standards and international standards

BS No.	Title	Corresponding international standard	Relationship
Associated methods			
BS 903-1:1995	Guide to the selection and use of methods of test for rubber	No corresponding ISO	—
BS 903-2:1997	Guide to the application of statistics to rubber testing	No corresponding ISO	—
BS 903-3:2003	Acquisition and presentation of comparable single-point data	No corresponding ISO	—
BS 903-4:2003	Acquisition and presentation of comparable multi-point data	No corresponding ISO	—
Methods of testing rubber			
903-A1:1996	Determination of density	ISO 2781:1988 (incorporating Corrigendum No. 1:1996)	Identical
903-A2:1995	Method for determination of tensile stress-strain properties	ISO 37:1994	Identical
903-A3:1995	Method for determination of tear strength (trouser, angle and crescent test pieces)	ISO 34-1:1994	Identical
903-A3.2:1997	Determination of tear strength — Small (Delft) test pieces	ISO 34-2:1996	Identical
903-A4:1990 (incorporating Amendment No. 1:1991)	Determination of compression stress-strain properties	ISO 7743:1989 (incorporating Corrigendum No. 1:1990)	Identical
BS ISO 2285:2001 (supersedes BS 903-A5:1997)	Rubber, vulcanized or thermoplastic — Determination of tension set under constant elongation, and of tension set, elongation and creep under constant tensile load	ISO 2285:2001	Identical
903-A6:1992 (incorporating Amendment No. 1:1994)	Method for determination of compression set at ambient, elevated or low temperatures	ISO 815:1991 (incorporating Corrigendum No. 1:1993)	Identical
903-A8:1990	Method for determination of rebound resilience	ISO 4662:1986	Related
903-A9:1988 (partially replaced by BS ISO 4649:2002)	Determination of abrasion resistance	ISO 4649:2002 ISO 5470:1980	Related Related
BS ISO 4649:2002 (partially supersedes BS 903-A9:1988)	Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device	ISO 4649:2002	Identical

Table A.1 — Methods of testing rubber: relationship between British Standards and international standards (continued)

BS No.	Title	Corresponding international standard	Relationship
<i>Methods of testing rubber (continued)</i>			
903-A10:1999 (also numbered as BS ISO 132:1999)	Determination of flex cracking and crack growth (De Mattia)	ISO 132:1999	Identical
903-A12:1999 (also numbered as BS ISO 36:1999)	Determination of adhesion to textile fabric	ISO 36:1999	Identical
903-A13:1990	Method for determination of stiffness at low temperature (Gehman test)	ISO 1432:1988	Identical
903-A14:1992	Method for determination of modulus in shear or adhesion to rigid plates — Quadruple shear method	ISO 1827:1991	Identical
903-A15:1990	Method for determination of creep in compression or shear	ISO 8013:1988	Identical
903-A16:1999 (also numbered as BS ISO 1817:1999)	Determination of the effect of liquids	ISO 1817:1999	Identical
903-A18:1973	Determination of equilibrium water vapour absorption	No corresponding ISO	—
903-A19:1998 (also numbered as BS ISO 188:1998)	Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests	ISO 188:1998	Identical
903-A21.1:1997	Determination of rubber to metal bond strength — Adhesion to rigid substrates — 90° peel method	ISO 813:1997	Identical
903-A21.2:1997	Determination of rubber to metal bond strength — Two plate method	ISO 814:1996	Identical
BS ISO 4664:1998 (supersedes BS 903-A24:1992)	Rubber — Guide to the determination of dynamic properties	ISO 4664:1998	Identical
903-A25:1992	Determination of low-temperature brittleness	ISO 812:1991	Identical
903-A26:1995 (incorporating Amendment No. 1:2001)	Method for determination of hardness (hardness between 10 IRHD and 100 IRHD)	ISO 48:1994 (incorporating Amendment No. 1:1999)	Identical
903-A27:1986	Determination of rubber to fabric adhesion: direct tension method	ISO 4637:1979	Identical
903-A29:1997	Determination of low temperature characteristics — Temperature-retraction procedure (TR test)	ISO 2921:1997	Identical
903-A30:1996	Determination of permeability to gases	ISO 2782:1995	Identical
903-A31:1976 (incorporating Amendment No. 1:1986)	Determination of the low-frequency dynamic properties of rubbers by means of a torsion pendulum	ISO 4663:1986	Related

Table A.1 — Methods of testing rubber: relationship between British Standards and international standards (continued)

BS No.	Title	Corresponding international standard	Relationship
<i>Methods of testing rubber (continued)</i>			
903-A32:1988	General directions for achieving elevated or subnormal temperatures for test purposes	ISO 3383:1985	Identical
903-A33:1998 (also numbered as BS ISO 3865:1997)	Methods of test for staining in contact with organic material	ISO 3865:1997	Identical
903-A35:1995	Temperatures, humidities and times for conditioning and testing of test pieces	ISO 471:1995	Identical
903-A36:1995	Method for preparation of samples and test pieces	ISO 4661-1:1993	Identical
903-A37:1997	Determination of tendency to adhere to and to corrode metals	ISO 6505:1997	Identical
903-A38:1991	Methods for the determination of dimensions of test pieces and products for test purposes	ISO 4648:1991	Identical
903-A40:1988	Determination of adhesion to rigid materials using conical shaped parts	ISO 5600:1986	Identical
903-A42:1999 (incorporating Amendment No. 1:2001) (also listed as BS ISO 3384:1999)	Rubber, vulcanized or thermoplastic — Determination of stress relaxation in compression at ambient and at elevated temperatures	ISO 3384:1999 (incorporating Amendment No. 1:2001)	Identical
903-A43:1990	Method for determination of resistance to ozone cracking (static strain test)	ISO 1431-1:1989	Identical
903-A44:1995	Method of determination of resistance to ozone cracking (dynamic strain test)	ISO 1431-2:1994	Identical
903-A45:2000 (also numbered as BS ISO 1431-3:2000)	Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Reference and alternative methods for determining the ozone concentration in laboratory test chambers	ISO 1431-3:2000	Identical
BS EN ISO 6179:2001 (incorporating Amendment No. 1:2001) (supersedes BS 903-A46:1998)	Rubber, vulcanized or thermoplastic — Rubber sheets and rubber-coated fabric — Determination of transmission rate of volatile liquids (gravimetric technique)	ISO 6179:1998	Identical
BS ISO 6133:1998 (supersedes BS 903-A47:1982)	Rubber and plastics — Analysis of multi-peak traces obtained in determinations of tear strength and adhesion strength	ISO 6133:1998	Identical

Table A.1 — Methods of testing rubber: relationship between British Standards and international standards (continued)

BS No.	Title	Corresponding international standard	Relationship
<i>Methods of testing rubber (continued)</i>			
903-A48:1984	Methods of testing vulcanized rubber — Determination of static adhesion to textile cord (H-pull test)	ISO 4647:1982	Identical
903-A49:1984	Determination of temperature rise and resistance to fatigue in flexometer testing (basic principles)	ISO 4666-1:1982	Identical
903-A50:1984	Methods of testing vulcanized rubber — Determination of temperature rise and resistance to fatigue in flexometer testing (compression flexometer)	ISO 4666-3:1982	Identical
903-A51:1986	Methods of testing vulcanized rubber — Determination of resistance to tension fatigue	ISO 6943:1984	Identical
903-A52:1986	Determination of ageing characteristics by measurement of stress at a given elongation	ISO 6914:1985	Identical
BS ISO 4665:1998 (supersedes BS 903-A53:1989, -A54:1989 and -A55:1989)	Rubber, vulcanized or thermoplastic — Resistance to weathering	ISO 4665:1998	Identical
903-A56:1989	Determination of adhesion to wire cord	ISO 5603:1986	Identical
903-A57:1997	Determination of indentation hardness by means of pocket hardness meters	ISO 7619:1997	Identical
903-A58:1990 (incorporating Amendment No. 1:1991 and Amendment No. 2:2001) (partially replaced by 903-A58.1:2001)	Methods using the Mooney viscometer	ISO 289-1:1994 ISO 289-2:1994	Related Related
903-A58.1:2001 (partially replaces BS 903-A58:1990)	Methods using the Mooney viscometer — Determination of the Delta Mooney value for non-pigmented, oil-extended, emulsion-polymerized SBR	ISO 289-3:1999	Identical
903-A59.1:1997	Methods using plastimeters — Determination of the rapid plasticity number	ISO 2007:1991	Identical
903-A59.2:1997	Methods using plastimeters — Determination of the plasticity retention index (PRI) of raw natural rubber	ISO 2930:1995	Identical
903-A60.1:2000 (incorporating Amendment No. 1:2000) (also listed as BS ISO 6502:1999)	Curemetering — Guide to the use of curemeters	ISO 6502:1999	Identical

Table A.1 — Methods of testing rubber: relationship between British Standards and international standards (continued)

BS No.	Title	Corresponding international standard	Relationship
<i>Methods of testing rubber (continued)</i>			
903-A60.2:1992	Curemetering — Method for the determination of vulcanization characteristics using an oscillating disc curemeter	ISO 3417:1991	Identical
903-A61:2000 (incorporating Amendment No. 1:2001) (also listed as BS ISO 15113:1999)	Rubber — Determination of frictional properties	ISO 15113:1999 (incorporating Corrigendum No. 1:2001)	Identical
903-A62:1993	Method for determination of green strength of raw rubber of unvulcanized compounds	ISO 9026:1991	Identical
903-A63:1995	Method for determination of crystallization effects by hardness measurements	ISO 3387:1994 (incorporating Corrigendum No. 1:2000)	Identical
903-A64:1995	Method for the preparation, mixing and vulcanization of rubber test mixes	ISO 2393:1994	Identical
903-A65:1998 (also numbered as BS ISO 11345:1997)	Rubber — Assessment of carbon black dispersion — Rapid comparative methods	ISO 11345:1997	Identical
<i>Determination of electrical properties of vulcanized rubber</i>			
903-C1:1991 (also numbered as BS 2782-2: Method 231A:1991)	Determination of surface resistivity	No corresponding ISO	—
903-C2:1982 (also numbered as BS 2782-2: Method 230A:1982)	Determination of volume resistivity	IEC 60093:1980	Related
903-C5:1992 (also numbered as BS 2782-2: Method 232:1992)	Determination of insulation resistance	IEC 60167:1964	Identical

Annex B (informative)

List of international methods

Table B.1 cross-references international standards for methods of test with corresponding British Standards.

Table B.1 — International standards for methods of testing rubber

ISO No.	Title	Corresponding BS	Relationship
34-1:1994	Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces	903-A3:1995	Identical
34-2:1996	Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 2: Small (Delft) test pieces	903-A3:Section 3.2:1997	Identical
36:1999	Rubber, vulcanized or thermoplastic — Determination of adhesion to textile fabric	903-A12:1999 (also numbered as BS ISO 36:1999)	Identical
37:1994	Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties	903-A2:1995	Identical
48:1994 (incorporating Amendment No. 1:1999)	Rubber, vulcanized or thermoplastic — Determination of hardness (Hardness between 10 IRHD and 100 IRHD)	903-A26:1995 (incorporating Amendment No. 1:2001)	Identical
132:1999	Rubber, vulcanized or thermoplastic — Determination of flex cracking and crack growth (De Mattia)	903-A10:1999 (also numbered as BS ISO 132:1999)	Identical
188:1998	Rubber, vulcanized or thermoplastic — Accelerated ageing and heat-resistance tests	903-A19:1998 (also numbered as BS ISO 188:1998)	Identical
289 289-1:1994 289-2:1994	Rubber, unvulcanized — Determinations using a shearing-disc viscometer Part 1: Determination of Mooney viscosity Part 2: Determination of pre-vulcanization characteristics	903-A58:1990 (incorporating Amendment No. 1:1991 and Amendment No. 2:2001)	Related
289-3:1999	Rubber, unvulcanized — Determinations using a shearing-disc viscometer — Part 3: Determination of the Delta Mooney value for non-pigmented, oil-extended emulsion-polymerized SBR	903-A58.1:2001 (partially replaces BS 903-A58:1990)	Identical
471:1995	Rubber — Temperatures, humidities and times for conditioning and testing	903-A35:1995	Identical
812:1991	Rubber, vulcanized — Determination of low temperature brittleness	903-A25:1992	Identical

Table B.1 — International standards for methods of testing rubber (continued)

ISO No.	Title	Corresponding BS	Relationship
813:1997	Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate — 90 degree peel method	903-A21.1:1997	Identical
814:1996	Rubber, vulcanized — Determination of adhesion to metal — Two-plate method	903-A21.2:1997	Identical
815:1991 (incorporating Corrigendum No. 1:1993)	Rubber, vulcanized or thermoplastic — Determination of compression set at ambient, elevated or low temperatures	903-A6:1992 (incorporating Amendment No. 1:1994)	Identical
1431-1:1989 (under revision)	Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static strain test	903-A43:1990	Identical
1431-2:1994	Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 2: Dynamic strain test	903-A44:1995	Identical
1431-3:2000	Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 3: Reference and alternative methods for determining the ozone concentration in laboratory test chambers	903-A45:2000 (also numbered as BS ISO 1431-3:2000)	Identical
1432:1988	Rubber, vulcanized or thermoplastic — Determination of low temperature stiffening (Gehman test)	903-A13:1990	Identical
1817:1999	Rubber, vulcanized — Determination of the effect of liquids	903-A16:1999 (also numbered as BS ISO 1817:1999)	Identical
1827:1991	Rubber, vulcanized or thermoplastic — Determination of modulus in shear or adhesion to rigid plates — Quadruple shear method	903-A14:1992	Identical
2007:1991	Rubber, unvulcanized — Determination of plasticity — Rapid plastimeter method	903-A59.1:1997	Identical
2285:2001	Rubber, vulcanized or thermoplastic — Determination of tension set under constant elongation, and of tension set, elongation and creep under constant tensile load	BS ISO 2285:2001 (supersedes BS 903-A5:1997)	Identical
2393:1994	Rubber test mixes — Preparation, mixing and vulcanization — Equipment and procedures	903-A64:1995	Identical
2781:1988 (incorporating Corrigendum No. 1:1996)	Rubber, vulcanized — Determination of density	903-A1:1996	Identical

Table B.1 — International standards for methods of testing rubber (continued)

ISO No.	Title	Corresponding BS	Relationship
2782:1995	Rubber, vulcanized or thermoplastic — Determination of permeability to gases	903-A30:1996	Identical
2921:1997	Rubber, vulcanized — Determination of low-temperature characteristics — Temperature-retraction procedure (TR test)	903-A29:1997	Identical
2930:1995	Rubber, raw natural — Determination of plasticity retention index (PRI)	903-59.2:1997	Identical
3383:1985	Rubber — General directions for achieving elevated or subnormal temperatures for test purposes	903-A32:1988	Identical
3384:1999 (incorporating Amendment No. 1:2001)	Rubber, vulcanized or thermoplastic — Determination of stress relaxation in compression at ambient and at elevated temperatures	903-A42:1999 (incorporating Amendment No. 1:2001) (also listed as BS ISO 3384:1999)	Identical
3387:1994 (incorporating Corrigendum No. 1:2000)	Rubber — Determination of crystallization effects by hardness measurements	903-A63:1995	Identical
3417:1991	Rubber — Measurement of vulcanization characteristics with the oscillating disc curemeter	903-A60.2:1992	Identical
3865:1997	Rubber, vulcanized or thermoplastic — Methods of test for staining in contact with organic material	903-A33:1998 (also numbered as BS ISO 3865:1997)	Identical
4637:1979	Rubber-coated fabrics — Determination of rubber-to-fabric adhesion — Direct tension method	903-A27:1986	Identical
4647:1982	Rubber, vulcanized — Determination of static adhesion to textile cord — H-pull test	903-A48:1984	Identical
4648:1991	Rubber, vulcanized or thermoplastic — Determination of dimensions of test pieces and products for test purposes	903-A38:1991	Identical
4649:2002	Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device	BS ISO 4649:2002 (partially supersedes BS 903-A9:1988)	Identical
4661-1:1993	Rubber, vulcanized or thermoplastic — Preparation of samples and test pieces — Part 1: Physical tests	903-A36:1995	Identical
4662:1986	Rubber — Determination of rebound resilience of vulcanizates	903-A8:1990	Related
4663:1986	Rubber — Determination of dynamic behaviour of vulcanizates at low frequencies — Torsion pendulum method	903-A31:1976 (incorporating Amendment No. 1:1986)	Related

Table B.1 — International standards for methods of testing rubber (continued)

ISO No.	Title	Corresponding BS	Relationship
4664:1998	Rubber — Guide to the determination of dynamic properties	BS ISO 4664:1998 (supersedes BS 903-A24:1992)	Identical
4665:1998	Rubber, vulcanized and thermoplastic — Resistance to weathering	BS ISO 4665:1998 (supersedes BS 903-A53:1989, -A54:1989 and -A55:1989)	Identical
4666-1:1982	Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing — Part 1: Basic principles	903-A49:1984	Identical
4666-2:1982	Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing — Part 2: Rotary flexometer	No corresponding BS	—
4666-3:1982	Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing — Part 3: Compression flexometer	903-A50:1984	Identical
5600:1986	Rubber — Determination of adhesion to rigid materials using conical shaped parts	903-A40:1988	Identical
5603:1986	Rubber, vulcanized — Determination of adhesion to wire cord	903-A56:1989	Identical
6133:1998	Rubber and plastics — Analysis of multi-peak traces obtained in determinations of tear strength and adhesion strength	BS ISO 6133:1998 (supersedes BS 903-A47:1982)	Identical
6179:1998	Rubber, vulcanized or thermoplastic — Rubber sheets and rubber-coated fabrics — Determination of transmission rate of volatile liquids (gravimetric technique)	BS EN ISO 6179:2001 (supersedes BS 903-A46:1998)	Identical
6471:1994	Rubber, vulcanized — Determination of crystallization effects under compression	No corresponding BS	—
6505:1997 (under revision)	Rubber, vulcanized or thermoplastic — Determination of adhesion to, and corrosion of, metals	903-A37:1997	Identical
6914:1985	Rubber, vulcanized — Determination of ageing characteristics by measurement of stress at a given elongation	903-A52:1986	Identical
6943:1984	Rubber, vulcanized — Determination of tension fatigue	903-A51:1986	Identical

Table B.1 — International standards for methods of testing rubber (continued)

ISO No.	Title	Corresponding BS	Relationship
7323:1985	Rubber, raw and unvulcanized compounded — Determination of plasticity number and recovery number — Parallel plate method	No corresponding BS	—
7619:1997 (under revision)	Rubber — Determination of indentation hardness by means of pocket hardness meters	903-A57:1997	Identical
7743:1989 (incorporating Corrigendum No. 1:1990 (under revision)	Rubber, vulcanized or thermoplastic — Determination of compression stress-strain properties	903-A4:1990 (incorporating Amendment No. 1:1991)	Identical
8013:1988	Rubber, vulcanized — Determination of creep in compression or shear	903-A15:1990	Identical
9026:1991	Raw rubber or unvulcanized compounds — Determination of green strength	903-A62:1993	Identical
11345:1997	Rubber — Assessment of carbon black dispersion — Rapid comparative methods	903-A65:1998 (also numbered as BS ISO 11345:1997)	Identical
11346:1997 (under revision)	Rubber, vulcanized or thermoplastic — Estimation of life-time and maximum temperature of use from an Arrhenius plot	(Revision of 1997 edition, ISO/DIS 11346:2001, will be implemented as BS ISO 11346)	—
15113:1999 (incorporating Corrigendum No. 1:2001)	Rubber — Determination of frictional properties	903-A61:2000 (incorporating Amendment No. 1:2001) (also numbered as BS ISO 15113:1999)	Identical

Annex C (informative)

Recommendations for the rounding-off of test results

The following apply to mean or median results determined by standard test procedures using the minimum specified number of test pieces. Any further decimal places added to these test result data would be meaningless unless justified for statistical analysis. The examples given below are not to be interpreted as a measure of the repeatability or reproducibility of the relevant tests.

Table C.1 — Recommendations for the rounding-off of test results for the physical properties of rubber

Test	Recommendation	Example
Density	nearest 0.01 Mg/m ^{3a}	1.22
Hardness	nearest one IRHD ^b	58
Tensile strength	nearest 0.1 MPa	19.7
Tensile stress at a given elongation (modulus)	nearest 0.1 MPa	3.4
Elongation at break	nearest 10 %	380
Tear strength	nearest kN/m ^c	21
Compression set	nearest 0.5 %	17.5
Tension set	nearest 0.5 %	9.5
Creep, stress relaxation	nearest 0.1 %	10.3
Fatigue cracking	nearest kc	76
Abrasion resistance index	nearest 1	121
Rebound resilience	nearest 1 %	63
Shear modulus	nearest 0.01 MPa	1.91
Phase angle	nearest 0.01 rad or 0.1°	0.08 rad or 4.6°
Loss factor, tan Δ	nearest 0.01	0.18
Volume swelling < 10 %	nearest 0.1 %	5.9
Volume swelling > 10 %	nearest 1 %	83
Property change after ageing, as percentage	nearest 1 %	32
Temperature	nearest 1 °C ^d	83
Mooney viscosity	nearest 0.5 unit	51.5
(Wallace) rapid plasticity number	nearest 1 unit	22

^a As specified for method A in BS 903-A1:1996.
^b As specified in BS 903-A26:1995.
^c As specified in BS 903-A3:1995, irrespective of method or test piece.
^d As temperature applies to heat build-up, impact brittleness, temperature retraction, etc.

Bibliography

Standards publications

- BS 903 (all parts), *Physical testing of rubber*.
- BS 3424 (all parts), *Testing coated fabrics*.
- BS 4443 (all parts), *Methods of test for flexible cellular materials*.
- BS 5214 (all parts), *Specification for testing machines for rubbers and plastics*.
- BS 6716, *Guide to properties and types of rubber*.
- BS 7663, *Methods of test for determination of permittivity and dissipation factor of electrical insulating material in sheet or tubular form*.
- BS 7825 (all parts), *Calibration of rubber and plastics test equipment*.
- BS EN 60243-2, *Methods of test for electric strength of solid insulating materials — Additional requirements for tests using direct voltage*. (IEC 60243-2)
- BS EN ISO 6179, *Rubber, vulcanized or thermoplastic — Rubber sheets and rubber-coated fabrics — Determination of transmission rate of volatile liquids (gravimetric technique)*.
- BS ISO 1795, *Rubber, raw natural and raw synthetic — Sampling and further preparative procedures*.
- BS ISO 2285, *Rubber, vulcanized or thermoplastic — Determination of tension set under constant elongation, and of tension set, elongation and creep under constant tensile load*.
- BS ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device*.
- BS ISO 4665, *Rubber, vulcanized and thermoplastic — Resistance to weathering*.
- BS ISO 6133, *Rubber and plastics — Analysis of multi-peak traces obtained in determinations of tear strength and adhesion strength*.
- BS ISO 13226, *Rubber — Standard reference elastomers (SRE's) for characterizing the effect of liquids on vulcanized rubbers*.
- IEC 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*.
- ISO 289, *Rubber, unvulcanized — Determinations using a shearing-disc viscometer — Part 1: Determination of Mooney viscosity*.
- ISO 3383, *Rubber — General directions for achieving elevated or subnormal temperatures for test purposes*.
- ISO 4662, *Rubber — Determination of rebound resilience of vulcanizates*.
- ISO 4663, *Rubber — Determination of dynamic behaviour of vulcanizates at low frequencies — Torsion pendulum method*.
- ISO 5470, *Rubber or plastics coated fabrics — Determination of abrasion resistance*.
- ISO 11346, *Rubber, vulcanized or thermoplastic — Estimation of life-time and maximum temperature of use from an Arrhenius plot*.
- ISO/TR 9272, *Rubber and rubber products — Determination of precision for test method standards*.
- ISO/TR 11753, *Rubber and rubber products — Confidence intervals for repeatability and reproducibility values determined by inter-laboratory tests*.

Other publications

- [1] Brown, R. P., *Physical Testing of Rubber*, Chapman and Hall, London 1996.
- [2] Brown, R. P. (ed.), *Handbook of Polymer Testing, Physical Methods*, Marcel Dekker Inc., New York, Basel 1999.

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: +44 (0)20 8996 9000. Fax: +44 (0)20 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: +44 (0)20 8996 9001.
Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at <http://www.bsi-global.com>.

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: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

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: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001.
Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at <http://www.bsi-global.com/bsonline>.

Further information about BSI is available on the BSI website at <http://www.bsi-global.com>.

Copyright

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI.

This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

Details and advice can be obtained from the Copyright & Licensing Manager.
Tel: +44 (0)20 8996 7070. Fax: +44 (0)20 8996 7553.
Email: copyright@bsi-global.com.

BSI
389 Chiswick High Road
London
W4 4AL
