BRITISH STANDARD

BS 6501-2: 1991

Flexible metallic hose assemblies —

Part 2: Specification for strip wound hoses and hose assemblies

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Piping Systems Components Standards Policy Committee (PSE/-) to Technical Committee PSE/12, upon which the following bodies were represented:

British Compressed Gases Association
British Gas plc
British Rubber Manufacturers' Association
Electricity Supply Industry in United Kingdom
Energy Industries Council
Engineering Equipment and Materials Users' Association
Liquefied Petroleum Gas Industry Technical Association (UK)
Ministry of Defence
Petrol Pump Manufacturers' Association
United Kingdom Petroleum Industry Association Ltd.

This British Standard, having been prepared under the direction of the Piping Systems Components Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on
20 December 1991

First published February 1988
Second edition 20 December 1991

The following BSI reference relates to the work on this standard:
Committee reference PSE/12

ISBN 0 580 19984 3

Amendments issued since publication

Amd. No.	Date	Comments

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Foreword

This Part of BS 6501 having been prepared under the direction of the Piping Systems Components Standards Policy Committee supersedes BS 6501-2:1988 which is withdrawn. This edition introduces technical changes but it does not reflect a full review or revision of the standard, which will be undertaken in due course. In this revision, a new nominal pressure of hose assembly of PN 0.25 has been added.

BS 6501-1 covers the requirements for corrugated flexible metallic hose assemblies. This Part covers the requirements for strip-wound flexible metallic hoses and hose assemblies. BS 669-1 contains details of construction of leak-proof strip-wound hose assemblies for use with gas appliances.

Strip-wound metallic hose assemblies, as a part of pipework systems, are used to convey non-searching liquids, powders and gases under various pressure and temperature conditions in applications where, because of the need to accept displacement during operation, the use of conventional rigid piping is precluded. Strip-wound assemblies may also be used as temporary pipelines for connecting fixed and movable installations during loading/discharge operations.

Strip-wound hose, compared with other types of hose, is extremely robust and it can accept both lateral and axial displacements. It is well suited for manhandling, powder transfer, engine exhaust and armouring applications. It also has intrinsic electrical conductivity. It is not suitable for highly penetrating liquids and extremes of temperature or pressure.

Since the flexibility of strip-wound hose is achieved by sliding, fatigue is of lesser importance than with corrugated hose.

Asbestos has been specified for certain of the hose constructions covered by this Part of BS 6501 as the only packing material that can meet the duty required although alternative materials are being investigated.

The manufacture of all asbestos based products is covered by the requirements of the Control of Asbestos at Work Regulations 1987, introduced on 1 March 1988. These set out comprehensive provisions covering work activities involving exposure to asbestos. Advice on how to comply with these regulations can be obtained from the manufacturers of the material, from the Asbestos Information Centre, St Andrew's House, 22-28 High Street, Epsom, Surrey KT19 8AH, from the local area office of the Health and Safety Executive or from the Environmental Health Department of the Local Authority.

Particular note has to be taken of the Asbestos Products (Safety) Regulations 1985, made under the Consumer Safety Act 1978 and of the Asbestos (Prohibitions) Regulations 1985 made under the Health and Safety at Work etc. Act 1974, which prohibit the supply of products containing amosite or crocidolite and set out requirements for the labelling of all products containing asbestos.

All the above legislation implements European Directives.

It is considered highly desirable that manufacturers of strip-wound hose assemblies employ quality assurance systems complying with BS 5750-2.

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 10, 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.

1 Scope

This Part of BS 6501 specifies the requirements for design, manufacture and testing of flexible metallic hoses and hose assemblies of strip-wound construction.

A number of flexible metallic hose types are included ranging from unpacked simple overlap construction intended for non-pressure applications to packed double overlap construction intended for pressure applications. Nominal sizes DN 4 to DN 400 are specified and, for pressure hoses, six nominal pressures are defined. Manufacturing materials are specified.

NOTE 1 Information to be supplied by the purchaser is given in Appendix A.
NOTE 2 Guidance on selection and application is given in Appendix B.
NOTE 3 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 6501 the following definitions apply.

2.1
strip

metal sheet suitable for cold forming into metallic hose

2.2
packing

copper wire or rubber or gauged rope of cotton or gauged rope of asbestos[1)] used to ensure the tightness of the hose

2.3
strip-wound hose

a hose manufactured from helically wound preformed strip, generally with right-hand lead, whose turns, which may be with or without packing, are connected together by simple or double overlapping. Flexibility is obtained by adjacent turns sliding on each other

2.4
leak-proof hose

a hose that may be used under pressure or vacuum

2.5
hose with limited tightness

a hose that may be used under low pressure, with admissible leakage

2.6
hose without tightness

a hose to be used without pressure

2.7
hose assembly

a hose with end fittings attached, with or without a covering or lining, ready for service

2.8
nominal size (DN)

a numerical designation of size that is common to all components in a piping system other than components designated by outside diameter or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions

2.9
design pressure

the maximum pressure at which a hose assembly is designed to be serviceable

NOTE Where several pressure/temperature combinations are specified the design pressure is the most onerous of the specified pressure/specified temperature combinations.

2.10
design temperature range

the highest and lowest temperatures to which the hose will be subjected

NOTE The design temperature range includes adequate margins to cover uncertainties in service conditions, e.g. sudden reductions in line pressure may cause temperature drops. It also takes into account the materials used in the hose or hose assembly and the attachment method.

2.11
burst pressure

the pressure at which any part of the hose assembly fails.

2.12
temperature de-rating factor

the ratio of burst pressure at maximum design temperature to burst pressure at 20 °C, which is equal to the ratio of the design pressure at the maximum design temperature to the design pressure at 20 °C

NOTE See Table 2 and Figure 1.

2.13
nominal pressure (PN)

A numerical designation which is a convenient number for reference purposes.

NOTE See Table 2.

2.14
minimum bend radius

the minimum radius of a bend measured to the centre line of the hose at which the hose can be used, associated with adjacent turns touching

[1)] See foreword and warning note to Table 1.

2.15
profile

the geometrical form shown by a turn after a longitudinal section of the hose has been made along its axis

2.16
liner

a flexible internal lining, usually metallic, that protects the internal surface of the hose against erosion

2.17
packed fitting

a leak-proof end fitting that is screwed on to the tube, packed and locked by means of a back nut

2.18
mechanical fitting

a screwed or swaged fitting without tightness

2.19 manufactured length

2.19.1

for hoses without tightness, the length measured in a taut rectilinear position with contact between each turn, i.e. the hose in the extended position

2.19.2

for hoses with limited tightness or leak-proof, the length measured in a rectilinear position after the hose has been rolled and then unrolled, i.e. the hose in mid-position

3 Materials

The strip used in the manufacture of the hose, the packing material (if required) and the material used for the manufacture of the end fittings shall be selected from the materials given in Table 1.

Table 1 — Construction and materials

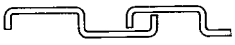
Type of construction	Hose		End fitting material	End fitting attachment	
	Strip material	Packing material		Method	Material
 Simple overlap (lay-on or square lock) unpacked or packed	Carbon steel to BS 1449-1, grade CS4 subsequently electro-galvanized	None	Carbon steel to BS 970-1, 070M20 or brass to BS 2874, designation CZ 121 or CZ 131	Mechanical	—
		Cotton		Solder	Soft solder to BS 219, grade G
		Rubber			
 Double overlap (lock) unpacked	Carbon steel to BS 1449-1, grade CS4 subsequently electro-galvanized	None	Carbon steel to BS 970-1, 070M20	Mechanical	—
				filler rod to BS 1453, type C2	Filler rod to BS 2901-1, type A15
				Weld	
	Stainless steel to BS 1449-2 grade 304S15	None	Carbon steel to BS 970-1, 070M20	Mechanical	—
				Silver braze	Silver braze rod having a silver content not less than 23 %
				Weld	Filler rod to BS 2901-2, type 316S96

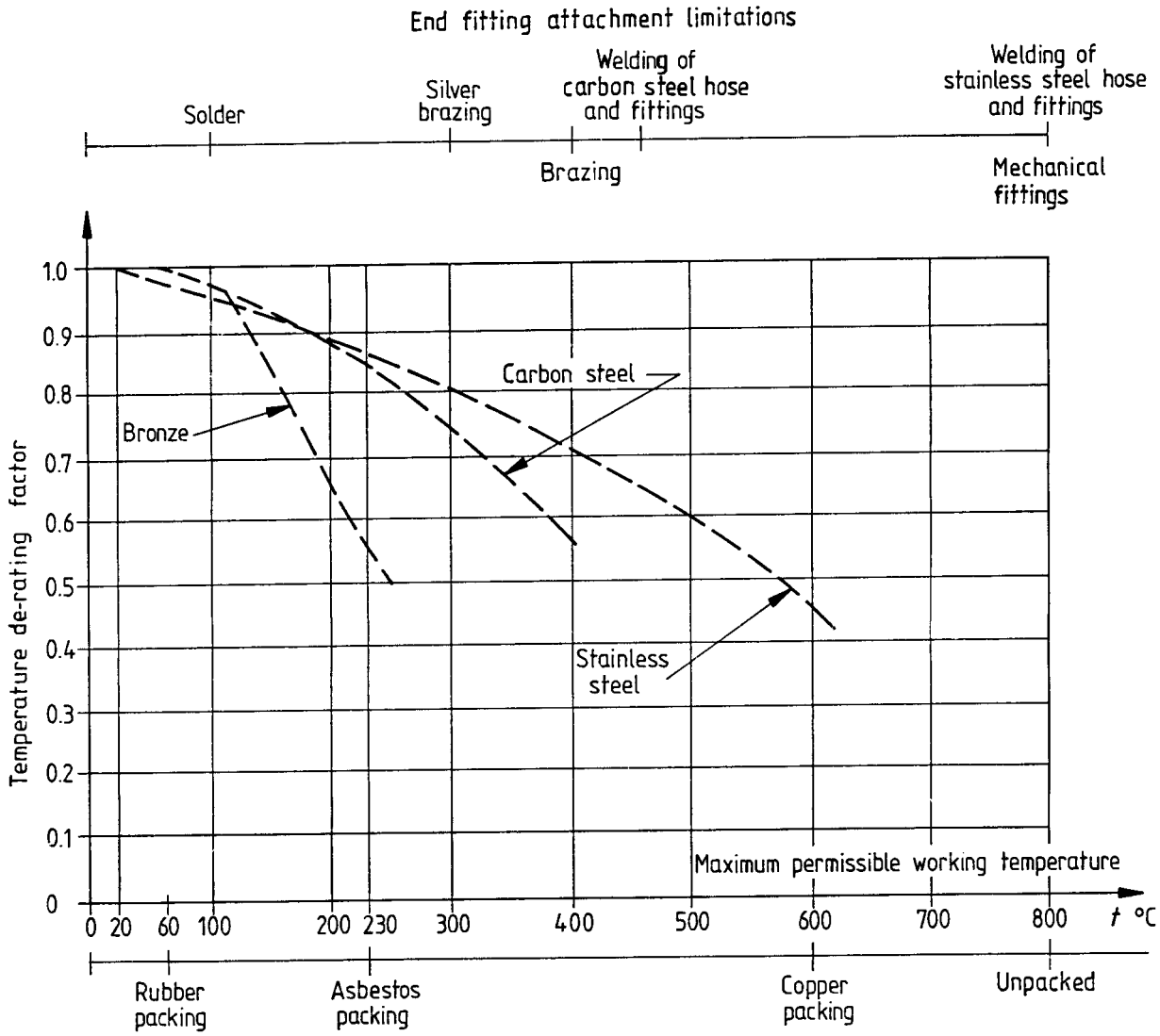
Table 1 — Construction and materials

Type of construction	Hose		End fitting material	End fitting attachment	
	Strip material	Packing material		Method	Material
 Double overlap (interlock) packed	Carbon steel to BS 1449-1, grade CS4 subsequently electro-galvanized	Asbestos[ab]	Carbon steel to BS 970-1, 070M20 or gunmetal to BS 1400, designation G1 or LG4	Solder	Soft solder to BS 219, grade G[a]
				Packed	Asbestos[ab]
		Copper wire to BS 4109	Carbon steel to BS 970-1, 070M20	Mechanical	—
				Solder	Soft solder to BS 219, grade G
				Braze	Filler rod to BS 1453, type C2
				Weld	Filler rod to BS 2901-1, type A15
	Phosphor bronze containing a min. of 95 % copper and a min. of 1 % tin	Asbestos[ab]	Gunmetal to BS 1400, designation G1 or LG4	Solder	Soft solder to BS 219, grade G[a]
				Packed	Asbestos[ab]
	Stainless steel to BS 1449-2, grade 304S15 or 316S11	Asbestos[ab]	Carbon steel to BS 970-1, 070M20 or stainless steel to BS 1449-2, grade 304S15 or gunmetal to BS 1400, designation G1 or LG4	Packed	Asbestos[ab]
		Copper wire to BS 4109	Carbon steel to BS 970-1, 070M20 or stainless steel to BS 1449-2, grade 304S15	Mechanical	—
				Silver braze	Silver braze rod having a silver content not less than 23 %
				Weld	Filler rod to BS 2901-2, type 16S96

WARNING. Materials containing asbestos are subject to legislation that requires precautions to be taken when handling them to ensure that they do not constitute a hazard to health (see foreword).

[a] Leak-proof assembly.

[b] Alternatives to asbestos are permitted provided that they provide a leak-proof assembly and that the temperature limitation for asbestos as given in Figure 1 is also met.



NOTE 1 The curve for galvanized steel is the same as one for unalloyed steel (carbon steel). The temperature limit is 230 °C and corresponds to that of the oxidation of the protection.

NOTE 2 Typical limitations of packing and fitting attachment methods are shown in the figure.

Figure 1 — Temperature de-rating factors and upper temperature limitations for materials and end fitting attachment methods

4 Nominal sizes

The nominal size range, designated by DN numbers (see **2.8**), for each nominal pressure of hose assembly shall be as given in Table 2 [see **A.1** c)]. Hoses with limited tightness and hoses without tightness shall be manufactured in the nominal size range DN 4 to DN 400.

Table 2 — Nominal pressures and nominal sizes

Nominal pressure	Design pressure at 20 °C	Nominal size
PN	bar[a]	DN
0.25	0.25	6 to 300
2.5	2.5	20 to 400
10	10	20 to 350
20	20	20 to 125
25	25	20 to 75
50	50	20 to 25

[a] 1 bar = 10^5 N/m^2 = 100 kPa.

5 Design requirements

5.1 Pressure

Leak-proof hose assemblies, as indicated in Table 1, shall be in accordance with one of the nominal pressures specified in Table 2 [see **A.1** d)].

The design pressure shall be not less than the maximum service pressure including surge pressure.

NOTE For specialized applications where additional statutory requirements are specified, the factor of safety should be agreed between the manufacturer and the purchaser.

5.2 Elevated temperature

Hose assemblies for use at elevated temperature shall be of a design that is in accordance with the temperature limits given in Figure 1 for the relevant hose materials, packing and end attachment methods [see **A.1** e)].

The temperature de-rating factors for leak-proof hose assemblies operating at elevated temperatures shall be as given by Figure 1.

6 Construction

6.1 Hose manufacturing method

Hoses shall be wound from fully annealed profile strip and shall incorporate either a simple or a double overlap.

NOTE Hoses are supplied in either round or polygonal form.

6.2 End reinforcement and protection

If the hose ends are reinforced, this shall be done using short lengths of a larger size of strip-wound hose.

NOTE 1 The purchaser should state in the enquiry or order if the hose ends are to be reinforced [see **A.2** a)].

NOTE 2 Hose assemblies may require additional protection, i.e. an outer cover to prevent mechanical damage, or a jacket to provide insulation, or an inner liner generally for protection against erosion. The purchaser should state in the enquiry or order if the hose assemblies are to have an outer cover and/or an inner liner see [**A.2** b)].

NOTE 3 The fitting of an outer cover and/or inner liner may increase the minimum bend radius of the hose.

7 Methods of assembly

The attachment of end fittings shall be in accordance with Table 1, which specifies fitting methods together with filler materials, where appropriate.

With leak-proof assemblies, only end fitting attachment methods which do not burn the packing shall be used, i.e. soft soldering or packed fittings. For leak-proof stainless steel hose assemblies, only packed fittings shall be used (see Table 1).

NOTE It should be appreciated that the hose is constructed from relatively thin strip and any undue heat applied during assembly could harm the product.

8 End fittings

8.1 General

The lesser value of the nominal pressure of the end fitting and the nominal pressure of the hose shall be taken as the nominal pressure of the hose assembly.

8.2 Stub connections

Where stub connections are provided for butt welding, the plain stub length shall be of adequate length to prevent any harm to hose assembly due to heat transfer or weld spatter.

8.3 Packed fittings

Packed fittings shall be of such a design that they can be screwed and locked on to the hose without the application of torque to the hose.

9 Product quality

The preformed strip in a manufactured hose shall be free from any local thinning or thickening.

Hoses shall be free from damage such as scores, dents, weld spatter and arc strikes.

Attachment welds shall be free from globular deposits, discontinuities, porosity and undercutting and shall have a regular surface.

10 Type testing

10.1 Bend test

This test shall apply only to hoses without an outer cover and/or liner.

The hose shall be bent until adjacent turns of the hose are in contact. In this position the bend radius of the hose shall not be greater than the appropriate minimum bend radius given in Table 3.

10.2 Hydraulic pressure tests for leak-proof assemblies

A straight sample of hose, unrestrained torsionally and axially, and having a length of at least 600 mm excluding end fittings shall be subjected to the following hydraulic pressure tests at ambient temperature.

a) A pressure of 1.6 times the stated design pressure shall be applied for 5 min and released. After the release of pressure there shall be no permanent change of shape of the strip section.

NOTE To detect any change in the outer profile caused by change in the shape of the strip section of the hose, the use of a straight edge is recommended.

b) A pressure of 3 times the stated design pressure shall be applied for 10 min, during which time interval the hose shall remain pressure tight.

11 Production tests for leak-proof hoses and hose assemblies

11.1 Hydraulic pressure test

After manufacture every length of hose and hose assembly intended for pressure service shall be subjected to a hydraulic pressure test at ambient temperature during which there shall be no sign of leakage or of any other mode of failure.

The test pressure shall be not less than 1.5 times the design pressure (see Table 2). The test pressure shall be applied hydraulically and maintained for a sufficient period of time to permit a visual examination of all surfaces and joints and shall be not less than 1 min for hoses up to and including DN 50, 2 rain for hoses over DN 50 and up to and including DN 100, and 3 min for hoses over DN 100.

Unless the product to be conveyed [see **A.1** b)] does not permit their use, the test medium shall be water for stainless steel and bronze hoses, and oil for carbon steel hoses.

NOTE 1 Attention is drawn to the need to control the chloride content of water used for testing austenitic stainless steel assemblies, to below 30 mg/L.

NOTE 2 Where liquids other than water are used, additional precautions may be necessary.

11.2 Pneumatic test

If the hose assembly is to be tested pneumatically, the manufacturer shall carry out a pneumatic test in accordance with the following procedure at ambient temperature.

The test pressure shall be not less than 1.05 times the design pressure (see Table 2). The test pressure shall be applied pneumatically and maintained for a sufficient period of time to permit a visual examination of all surfaces and joints and shall be not less than 1 min for hoses up to and including DN 50, 2 min for hoses over DN 50 and up to and including DN 100, and 3 min for hoses over DN 100.

NOTE 1 It is not common practice for strip-wound hoses to be pneumatically tested.

NOTE 2 Pneumatic testing is potentially a much more dangerous operation than hydraulic testing in that, irrespective of size, any failure during test is likely to be of an explosive nature. Attention is drawn to the Health and Safety Notice GS4 "Safety in Pressure Testing".

NOTE 3 The purchaser should state in the enquiry or order if the hose assembly is to be tested pneumatically and the leakage criterion agreed [see **A.2** c)].

12 Cleaning and packaging

12.1 Cleaning

Immediately after the completion of production tests, each hose assembly shall be cleaned and shall be maintained in a clean and dry condition until packaged for dispatch.

NOTE Where special cleaning is required after testing, the requirements should be stated on the order [see **A.2** d)].

12.2 Packaging

Each completed hose assembly shall, before dispatch, have sealing caps fitted at each end to prevent the ingress of foreign matter. Each hose assembly shall be protected in order to avoid damage, taking into account the method of transport. Carbon and alloy steel fittings shall be protected with an easily removable coating in order to given an adequate storage life.

NOTE Any special packaging requirements should be stated in the enquiry or order [see **A.2** e)].

13 Marking

Leak-proof hose assemblies shall carry the following information:

a) the number and date of this British Standard, i.e. BS 6501-2:1991[2)];

b) the manufacturer's name or trade mark;

c) the hose assembly serial number;

d) the month and year of manufacture (e.g. 6/1991);

e) the nominal size (DN);

f) the nominal pressure (PN) at 20 °C (e.g. PN25/20 °C).

14 Test certificate

If for a completed leak-proof hose assembly or batch of assemblies the manufacturer supplies a production test certificate, it shall state:

a) compliance with this standard;

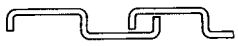
b) the production test pressure;

c) the unique marking reference.

NOTE The purchaser should state in the enquiry or order whether he wishes to receive a test certificate [see **A.2** f)] and if the marking reference should enable the complete hose assembly or batch of assemblies and its manufacturing history to be traced [see **A.2** g)].

[2)] Marking BS 6501-2:1991 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Table 3 — Minimum bend radii

Nominal size	Type of construction			
	Simple overlap (lay on or square lock) 		Double overlap (lock) 	Double overlap (interlock) 
	Minimum radius for unpacked hose	Minimum radius for packed hose	Minimum radius for unpacked hose	Minimum radius for packed hose
DN	mm	mm	mm	mm
4	—	—	57	—
5	—	—	65	—
6	27	75	65	—
8	32	80	80	—
10	37	90	90	—
12	—	100	100	—
15	—	110	125	—
20	60	125	150	210
25	71	150	175	240
32	91	200	225	290
40	112	225	250	350
45	—	—	275	—
50	138	250	300	420
65	175	—	330	550
75	210	275	400	650
90	—	—	450	—
100	260	320	500	820
125	320	380	675	1 050
150	390	440	800	1 250
200	500	700	1 100	1 600
225	—	820	1 200	—
250	620	1 100	1 250	2 000
300	740	1 700	1 400	2 400
350	850	—	—	2 800
375	—	—	—	—
400	960	—	—	3 200

Appendix A Information to be supplied by the purchaser

A.1 The purchaser should specify the following information in his enquiry or order:

a) the number and date of this British Standard, i.e. BS 6501-2:1991;

b) the intended service;

1) the product to be conveyed;

2) the rate of flow of the product;

3) the movement required;

4) the external environment;

c) the nominal size and overall length (see clause **4**);

d) the maximum service pressure including surge pressure (see **5.1**);

e) the temperature range (see **5.2**);

f) the type of end fitting (see **8.1**).

A.2 The purchaser may wish to specify that:

a) end reinforcements are required (see **6.2**);

b) additional protection is required (see **6.2**);

c) a pneumatic test is required (see **11.2**);

d) special cleaning is required after testing (see **12.1**);

e) special packaging requirements (see **12.2**);

f) a test certificate is required (see clause **14**);

g) the marking reference should relate to the record of manufacturing history (see clause **14**).

A.3 In the event that the purchaser does not specify his requirements then:

a) end reinforcements will not be fitted;

b) additional protection will not be fitted;

c) a pneumatic test will not be carried out;

d) no special cleaning will be carried out;

e) no special packaging will be provided;

f) a test certificate will not be supplied;

g) the marking reference will not be linked to the record of manufacturing history.

Appendix B Selection and application of strip-wound metallic hose assemblies

B.1 General

This appendix is provided in order to assist the purchaser in the selection of a hose assembly for a specific application.

B.2 Viscosity of fluid conveyed

The packing of strip-wound hose assemblies can be penetrated by fluids of very low viscosity. Strip-wound hose assemblies are not recommended for conveying fluids with a kinematic viscosity lower than $48 \times 10^{-6} m^2/s$ (200 s. Redwood no. 1).

B.3 Minimum bend radius

Strip-wound hoses should not be bent to radii less than those given in Table 3 in order to avoid sustaining permanent deformation and damage.

B.4 Allowable axial and lateral movement

Strip-wound hoses accommodate axial, lateral and bending movements by the sliding of adjacent turns.

The maximum allowable axial movement for hoses, Y (in mm), (either shortening or lengthening) is given approximately by equation (1).

$$Y = \pm \frac{DL}{3R} \qquad (1)$$

where

D is the mean diameter (in mm) of the hose (half the sum of the bore and outside diameter);

L is the hose length, with the hose in mid-position (in mm);

R is the minimum bend radius to the hose centre line (in mm).

The maximum allowable lateral movement, X (in mm), for hoses with a length to minimum bend radius ratio of up to 5 : 1 is given approximately by the smaller of the two values obtained from equations (2) and (3).

$$X = \pm 3R\left(1 - \cos\frac{L}{3R}\right) \qquad (2)$$

$$X = \pm \frac{5DL}{3R} \qquad (3)$$

where

D, L and R are as defined for equation (1).

Equations (2) and (3) underestimate the allowable lateral movement for hoses with a length to minimum bend radius ratio exceeding 5 : 1; in such cases reference should be made to the manufacturer.

Figure 2 illustrates the movement envelope obtainable with the hose assembly ends parallel.

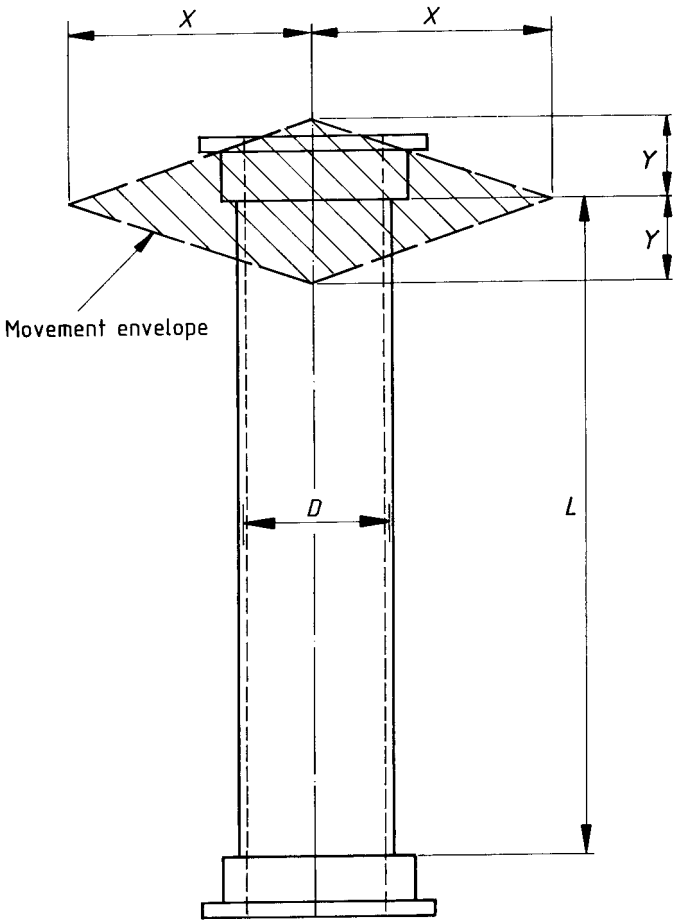


Figure 2 — Allowable axial and lateral movements of strip-wound metallic hose assemblies with ends parallel

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Publication(s) referred to

BS 219, *Specification for soft solders.*

BS 669, *Flexible hoses, end fittings and sockets for gas burning appliances*[3)].

BS 669-1, *Specification for strip-wound metallic flexible hoses, covers, end fittings and sockets for domestic appliances burning 1st and 2nd family gases.*

BS 970, *Specification for wrought steels for mechanical and allied engineering purposes.*

BS 970-1, *General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels.*

BS 1400, *Specification for copper alloy ingots and copper alloy and high conductivity copper castings.*

BS 1449, *Steel plate, sheet and strip.*

BS 1449-1, *Specification for carbon and carbon-manganese plate, sheet and strip.*

BS 1449-2, *Specification for stainless and heat-resisting steel plate, sheet and strip.*

BS 1453, *Specification for filler materials for gas welding.*

BS 2874, *Specification for copper and copper alloy rods and sections (other than forging stock)* .

BS 2901, *Filler rods and wires for gas-shielded arc welding.*

BS 2901-1, *Ferritic steels.*

BS 2901-2, *Specification for stainless steels.*

BS 4109, *Specification for copper for electrical purposes. Wire for general electrical purposes and for insulated cables and flexible cords.*

BS 5750, *Quality systems*[3)].

BS 5750-2, *Specification for production and installation.*

BS 6501, *Flexible metallic hose assemblies*[3)].

BS 6501-1, *Specification for corrugated hose assemblies.*

[3)] Referred to in the foreword only.

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