

Flexible metallic hose assemblies —

Part 1: Specification for corrugated hose assemblies

Committees responsible for this British Standard

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- British Compressed Gases Association
- British Rubber Manufacturers' Association
- Electricity Supply Industry in the 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.

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Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Definitions	1
3 Information to be supplied by the purchaser and the manufacturer	2
4 Materials	2
5 Nominal sizes and measurement of nominal length	2
6 Bend radii	4
7 Design	4
8 Construction	6
9 Methods of assembly	7
10 Welding and brazing	8
11 Additional protection	8
12 End fittings	8
13 Product quality	8
14 Type testing	8
15 Production tests for all types of hose assembly	10
16 Marking	11
17 Cleaning and packaging	11
18 Test certificate	11
Appendix A Selection and installation of corrugated metallic hose assemblies	12
Appendix B Hose assembly lengths and installation configurations	25
Appendix C Flame test	27
Figure 1 — Details of butt-welded and edge-welded hose joints	6
Figure 2 — Welding of end fitting, ferrule and braid to hose	7
Figure 3 — Bend test for type A hose assembly	9
Figure 4 — Fatigue test for types B and C hose assemblies	9
Figure 5 — Vertical loop (maximum vertical travel about fixed point)	26
Figure 6 — Vertical loop (short horizontal travel)	26
Figure 7 — Horizontal loop (maximum horizontal travel about fixed point)	26
Figure 8 — Correct installation of hose assemblies	27
Figure 9 — Butane gas torch for standard flame test	28
Figure 10 — Typical flame test rig	29
Table 1 — Materials	3
Table 2 — Nominal pressures and nominal sizes	4
Table 3 — Minimum bend radii of hose assemblies	4
Table 4 — Temperature de-rating factors for hose assemblies	5
Table 5 — Numbers of hose assemblies required for testing	8
Table 6 — Fatigue test for types B and C hose assemblies	10
Table 7 — Guidance on the corrosion resistance of materials	13
Publication(s) referred to	Inside back cover

Foreword

This Part of BS 6501 has been prepared under the direction of the Piping System Components Standards Policy Committee. It replaces BS 6501-1:1984 which is withdrawn. This edition introduces technical changes to bring the standard up-to-date but it does not reflect a full review of the standard, which will be undertaken in due course.

In this revision:

- a) the pressure class of hoses has been replaced by nominal pressure (PN);
- b) hoses of 0.25 nominal pressure (PN) and nominal size 12 (DN) have been added;
- c) the welding and brazing requirements have been updated and related to the end fitting materials;
- d) the series of pressure-temperature rating charts have been replaced by a simple table and a maximum temperature limit of 400 °C for carbon steel has been added;
- e) the requirements for end nuts have been deleted;
- f) the requirements for braid, hose length measurement and the static bend test have been made clearer;
- g) the standards referred to in the text have also been reviewed and updated.

BS 6501-2 covers strip-wound hose assemblies.

Corrugated metallic hoses assemblies, as part of pipework systems, are used to convey liquids and gases under various pressure and temperature conditions in applications where, because of the need to accept displacement during operation, the use of standard piping materials is precluded. Corrugated hose assemblies may be used also as pipelines for connecting fixed and movable installations during loading/discharge operations.

On account of the materials of its construction, a corrugated hose is electrically conductive and is more suitable for certain duties than a non-metallic hose, particularly where resistance to extremes of temperature, crushing or fire and flame is involved. Corrugated hose assemblies are suitable also for applications involving vacuum or high pressure.

The piping services in which corrugated metallic hose assemblies may be used include those for hazardous applications such as high pressure steam, chemicals and gases as well as non-hazardous applications.

It is considered highly desirable that manufacturers of corrugated metallic 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 30, 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 corrugated metallic hose assemblies.

This Part of this British Standard specifies nominal sizes from DN 6 to DN 300, ten nominal pressure values and three flexibility types of hose assembly. These variable parameters permit the selection of a corrugated hose assembly to suit any particular application.

The hose assemblies specified in this standard are not suitable for applications involving axial compression or extension.

NOTE 1 Guidance on the selection and application of metallic hose assemblies is given in Appendix A and Appendix B.

NOTE 2 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 tube

a plain cylindrical uncorrugated material which may be processed during manufacture to become hose

2.2 hose

the flexible leak-tight metal element of an assembly without fittings or covering

2.3 braid

a layer (or layers) of cylindrically woven wires covering the hose and attached to the hose ends and fittings, serving the functions of:

- a) restraining the hose against elongation; and
- b) damping vibration of the hose.

2.4 hose assembly

a hose with end fittings attached, complete with braid and/or other covering, if required, ready for service

2.5 nominal size (DN)

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

2.6 design pressure

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

2.7 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.

2.8 nominal pressure (PN)

a numerical designation which is a convenient rounded number for reference purposes

2.9 burst pressure

the pressure at which any part of the hose assembly fails

2.10 cyclic life

the minimum number of complete cycles which, at the test conditions, the hose is designed to withstand without failure

2.11 bend radius

the radius of a bend measured to the hose centre line

2.12 dynamic bend radius

the minimum radius to which the hose can be bent on one side of the centre line when movement takes place

2.13 static bend radius

the minimum radius to which the hose can be bent when no movement takes place

2.14 flexibility type

the type of hose determined from the cyclic life

NOTE See 7.3.

2.15 fitting

a pressure fitting attached to the braided or unbraided hose by means of welding or brazing

2.16 ferrule

a metal sleeve used to restrict the bending of the corrugations affected by heat during the attachment of end fittings

2.17**external sleeve/protective coil**

a device used to provide protection to the external surface of the hose against mechanical damage and/or against corrosion from the external environment

2.18**temperature de-rating factor**

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

NOTE See 7.2.

3 Information to be supplied by the purchaser and the manufacturer

3.1 Information to be supplied by the purchaser

It is essential that the purchaser states the following in all enquiries and orders:

- a) intended service (see Appendix A);
- b) nominal size and hose assembly length (see 5.2);
- c) movement required (see Appendix B);
- d) design pressure (see 7.1);
- e) temperature range (see 7.2);
- f) cyclic life (see 7.3);
- g) type of end fitting required and, where applicable, specification of thread (see clause 12);
- h) product to be conveyed (see Appendix A);
- i) product velocity;
- j) any special information concerning choice of material (see clause 4);
- k) whether heat treatment is required (see 8.2);
- l) whether a pneumatic pressure test is required, and if so, if it is in addition to or as an alternative to the hydraulic test (see 15.2 and 15.3);
- m) whether additional protection is required (see 11.1);
- n) any special requirements for hydraulic test fluid (see 15.2);
- o) any additional requirements for cleaning and post-test treatment (see 17.1);
- p) requirements for test certificates (see clause 18);
- q) if a coloured cover or other identification marking is required (see clause 16);
- r) any special requirements for packaging (see 17.2).

3.2 Information to be supplied by the manufacturer

The manufacturer shall supply the following information to the purchaser:

- a) material specifications for hose, braid and end fittings;
- b) material of outer cover, if fitted, and any restriction in bend radius that such a cover may cause;
- c) details of end connections;
- d) whether hose is welded or seamless;
- e) whether the hose will include hose joints;
- f) manufacturer's test pressure.

4 Materials

4.1 Materials for the manufacture of corrugated metallic hose assemblies shall be selected on the basis of their suitability for fabrication, e.g. cold forming, welding, as appropriate, and according to the conditions under which they will operate.

Because of the wide variety that exists in such conditions and the choice of materials available, this standard does not make the choice of materials the subject of compliance by specifying a comprehensive list of materials.

Table 1, however, lists those materials that are preferred and except under the provisions stated in 4.2, all materials shall be in accordance with Table 1.

The materials specified for end fittings shall apply to those parts welded or silver brazed to the hose.

4.2 NOTE If materials other than those listed in Table 1 are used, it is essential that this selection be made by agreement between the purchaser and the manufacturer.

The materials selected shall comply with a widely recognized, authoritative specification, e.g. API, ASTM, which is at least as comprehensive in its requirements as those listed in Table 1 for the nearest equivalent material.

For ferritic steels used for end fittings, the sulphur and phosphorus content shall not exceed 0.05 % each in the ladle analysis.

5 Nominal sizes and measurement of nominal length

5.1 Nominal sizes

The nominal sizes (DN) of hose assemblies for each nominal pressure value (designated by PN numbers, see 2.8) shall be within the size range given in Table 2.

Table 1 — Materials

Type of assembly	Tube and ferrule	Braid	End fitting	Joining method
Stainless steel assemblies	Austenitic stainless steel to BS 1449-2 316S11, 321S31 or BS 304S11	Fully annealed austenitic stainless steel wire to BS 1554 316S19, 321S31 or 304S31 (0.045 % C maximum)	Ferrous: Flanges: steels specified by BS 1560-3.1 or BS 4504-3.1 as appropriate Tubes: steels to the requirements of BS 3601 ERW or S, BS 3602-1, BS 3603 LT50 or BS 3605 304S14 or S22, 316S14 or S22, or 321S18, S22 or S59 Other: Carbon steel to BS 970-1 070M20 Austenitic steels to BS 970-1 316S11, 321S31 or 304S11 See 7.2 and A.3.6.3.1	Welding, using rod to BS 2901-2 308S92 or 309S94 for carbon steel end fittings Welding, using rod to BS 2901-2 316S96 or 316S92 for austenitic steel end fittings
			Copper based alloys: if formed, deep drawing quality required; for flanges see BS 4504-3.3	Silver brazing using rod having a silver content of not less than 23 %
Copper based alloy assemblies	Deep drawing quality Phosphor bronze containing a minimum of 95 % copper and a minimum of 1 % tin	Phosphor bronze wire containing a minimum of 95 % copper and a minimum of 1 % tin	Copper based alloys: if formed, deep drawing quality required; for flanges see BS 4504-3.3	Silver brazing using rod having a silver content of not less than 2 %
Nickel based alloy assemblies	BS 3073 NA 16, NA 15 or NA 14	Fully annealed austenitic stainless steel wire to BS 1554 316S19, 321S31 or 304S31 (0.045 % C maximum) Wire to BS 3075 NA13	Austenitic steel tube to BS 3605 304S14 or S22, 316S14 or S22, or 321S18, S22 or S59 Austenitic steel bar to BS 970-1 316S11, 321S31 or 304S11 Austenitic steel flanges to BS 1560-3.1 Tube to BS 3074 NA13 or bar to BS 3076 NA13	Welding using rod of Inconel 65 or Inconel 182 Welding using rod of Monel 60
	Inconel 625 or BS 3073 NA13			

Table 2 — Nominal pressures and nominal sizes

Nominal pressure (PN)	Design pressure at 20 °C	Nominal size (DN) range
	bar ^a	
0.25	0.25	6 to 300
2.5	2.5	6 to 300
10	10.0	6 to 300
20	20.0	6 to 250
25	25.0	6 to 200
50	50.0	6 to 80
65	65.0	6 to 65
100	100.0	6 to 40
150	150.0	6 to 25
200	200.0	6 to 20

^a 1 bar = 10⁵ N/m² = 100 kPa.

5.2 Measurement of nominal length

The method of measurement of the length of the hose assembly shall be in accordance with BS 5173-101.2.

6 Bend radii

The minimum dynamic and static bend radii of hose assemblies shall be as given in Table 3.

Table 3 — Minimum bend radii of hose assemblies

Nominal size (DN)	Static bend radius		Dynamic bend radius, types B and C hose assemblies only
	Unbraided type A hose only	Braided type A hose assemblies and all types B and C hose assemblies	
	mm	mm	mm
6	12	25	100
10	20	40	150
12	25	50	200
15	25	50	200
20	30	70	200
25	45	90	200
32	60	110	250
40	95	130	250
50	125	175	350
65	—	200	410
80	—	205	450
100	—	230	560
125	—	280	660
150	—	320	815
200	—	435	1 015
250	—	560	1 220
300	—	660	1 420

7 Design

7.1 Pressure

Hose assemblies shall be designed to be in accordance with one of the nominal pressure values (designated by PN numbers, see 2.8) given in Table 2.

The lesser value of the nominal pressure of the end fitting or the hose shall be the nominal pressure of the hose assembly.

The design pressure shall be as given in either a) or b) as follows:

- not less than the pressure which will exist at the hose when the pressure relieving device starts to relieve or the set pressure of the pressure relieving device, whichever is the higher;
- the maximum pressure which can be obtained in service where this pressure is not limited by a relieving device.

Table 4 — Temperatures de-rating factors for hose assemblies

Material	Temperature range														
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
	> – 200	> – 20	> 50	> 100	> 150	> 200	> 250	> 300	> 350	> 400	> 450	> 500	> 550	> 600	> 650
	≤ – 20	≤ 50	≤ 100	≤ 150	≤ 200	≤ 250	≤ 300	≤ 350	≤ 400	≤ 450	≤ 500	≤ 550	≤ 600	≤ 650	≤ 700
Temperature de-rating factors															
321S31	1	1	0.96	0.92	0.88	0.84	0.80	0.76	0.72	0.66	0.60	0.54	0.44	0.36	—
316S11 304S11	1	1	0.94	0.90	0.86	0.82	0.78	0.74	0.70	0.66 ^a	0.60 ^a	—	—	—	—
Copper alloys	1	1	0.88	0.78	0.64	—	—	—	—	—	—	—	—	—	—
Nickel alloys	1	1	0.98	0.96	0.94	0.91	0.88	0.86	0.80	0.72	0.63	0.50	0.38	0.20	0.09
Carbon steel	—	1	0.91	0.83	0.74	0.66	0.59	0.54	0.52	—	—	—	—	—	—
^a For applications in the temperature range, advice should be sought from the manufacturer on creep life.															

NOTE 1 It is essential that the maximum pressure, including surge pressure, to which the hose assembly is subjected in service does not exceed the design pressure specified.

NOTE 2 For specialized applications additional statutory requirements may specify a factor of safety between the burst pressure and the design pressure higher than that specified in 14.5.

7.2 Operating temperature

Hose, braid and end fittings manufactured from materials listed in Table 1 shall be de-rated by the appropriate temperature de-rating factor given in Table 4.

7.3 Cyclic life

7.3.1 General

Hose assemblies shall comply with the appropriate flexibility type described in 7.3.2, 7.3.3, or 7.3.4.

NOTE 1 The fatigue testing of test hose assemblies does not imply that the minimum or average cyclic life expectancy can be achieved in circumstances other than under the specific test procedure. In any applications where fatigue life is a significant design criterion it is essential that the manufacturer be consulted when establishing the design requirements, which should take account of a mutually acceptable factor of safety.

NOTE 2 Appendix A gives guidance on the selection of flexibility types of hose assembly.

7.3.2 Type A hose assemblies

Type A hose assemblies shall have a cyclic life of not less than 30 bends when tested in accordance with 14.2.

7.3.3 Type B hose assemblies

Type B hose assemblies up to DN 80 shall have a mean life of 5 000 cycles when tested in accordance with 14.4.

NOTE No requirements are specified for hoses of larger size. In these cases the cyclic life should be as agreed between the purchaser and the manufacturer [see 3.1 f)].

7.3.4 Type C hose assemblies

Type C hose assemblies up to DN 80 shall have a mean life of 50 000 cycles when tested in accordance with 14.4.

NOTE No requirements are specified for hoses of larger size. In these cases the cyclic life should be as agreed between the purchaser and the manufacturer [see 3.1 f)].

8 Construction

8.1 Hose manufacturing method

The hose shall be of single ply construction and shall be manufactured from either a) or b) as follows:

- a) seamless tube;
- b) single longitudinally butt-welded tube.

Transverse joining of strip or circumferential jointing of tube prior to corrugating shall not be permitted.

The corrugations shall be annular and of uniform height and pitch and continuous along the length of the hose. After forming the corrugated hose, the surface shall be free from any defects, e.g. scores, dents or cuts which might cause premature failure.

Where a manufacturer uses hose joints prior to braiding, such joints shall be either butt-welded or edge-welded as shown in Figure 1 and all the appropriate tests described in clauses 14 and 15 shall be carried out on hose incorporating such a joint.

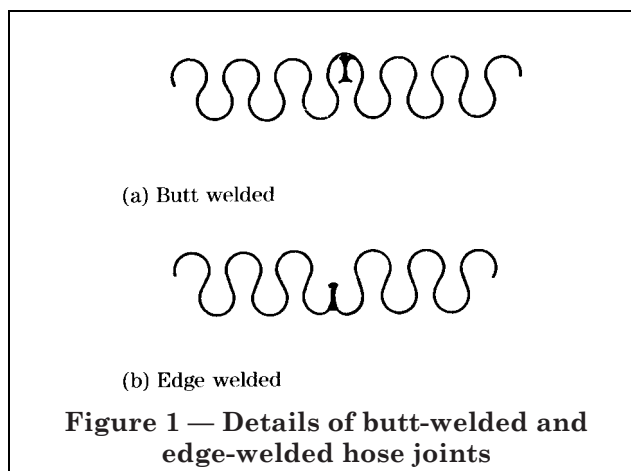


Figure 1 — Details of butt-welded and edge-welded hose joints

8.2 Heat treatment

NOTE Where the purchaser requires heat treatment of the hose assembly it is essential that he states his requirements, including the process and procedure to be employed [see 3.1 k)].

Where the hose is subject to heat treatment all the appropriate tests specified in this standard shall be carried out on the hose assembly in the finally heat treated condition.

8.3 Braid

8.3.1 Where braided, the hose shall be closely covered by wire either machine woven around the hose or fitted by hand as a stocking.

8.3.2 Braided hose assemblies shall be of such a length that there is at least one complete revolution of braid along the length of the hose.

8.3.3 Braid wires shall be continuous. Joints in braid wires shall only be made in individual wires and shall be welded or brazed. The jointing operation shall not give sharp edges or projections.

8.4 Ferrules

8.4.1 Ferrules shall be fitted to support the heat affected zone of all types B and C hose assemblies.

8.4.2 The minimum ferrule length shall be equal to the hose nominal size for hose assemblies up to DN 40 and shall be equal to 40 mm or the length of three corrugations, whichever is the greater, for larger hose assemblies.

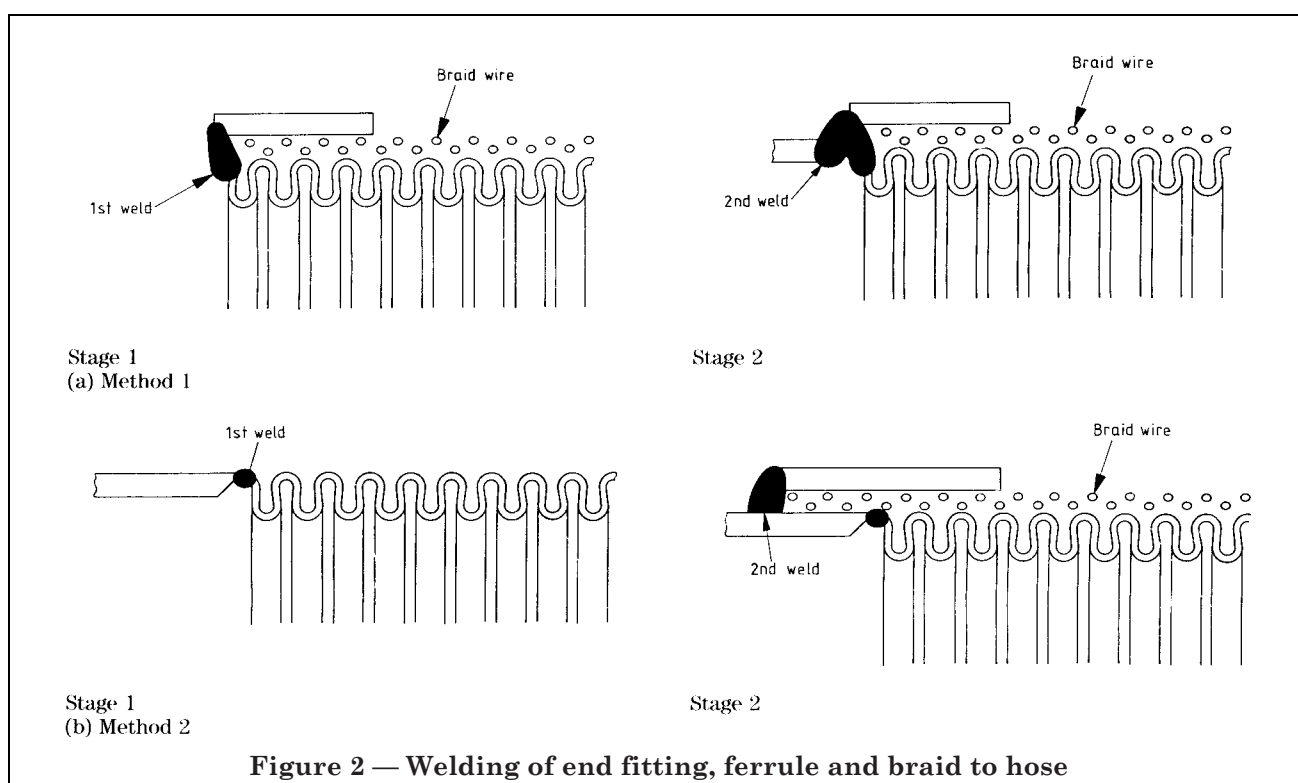


Figure 2 — Welding of end fitting, ferrule and braid to hose

9 Methods of assembly

9.1 General

All end fittings, hoses and, where used, braid shall be welded or brazed in accordance with 9.2 to 9.4 and clause 10.

9.2 Braided assemblies

9.2.1 Welded construction

Construction shall comply with the method given in either a) or b) as follows.

a) The braid shall be passed through a ferrule and shall be welded to the end of the corrugated hose and to the ferrule so that the braid wires are bonded securely. The end fitting shall then be introduced and welded to the hose by a second weld. Surface oxidation of the first weld shall be removed prior to commencement of the second weld [see Figure 2(a)].

b) The end fitting shall be welded to the end of the corrugated hose and the braid added to this assembly. A ferrule shall then be placed around the braid at the end fitting. The braid and ferrule shall then be welded to the end fitting, this second weld being spaced at a distance from the first weld, so that the braid wires are bonded securely [see Figure 2(b)].

In no case shall the end fitting, hose, braid and ferrule be welded using a single weld.

9.2.2 Silver brazed construction

The braids shall be passed through a ferrule and shall be brazed to the end of the hose, ferrule and end fitting. The method of brazing shall be such that the braid wires are bonded securely.

Care shall be taken to remove all flux deposits.

9.3 Unbraided type A assemblies

9.3.1 Welded construction

The hose and end fitting shall be welded with a single pass weld.

9.3.2 Brazed construction

The hose and end fitting shall be brazed with a single pass braze.

9.4 Unbraided types B and C assemblies

9.4.1 Welded construction

A ferrule shall be placed around and near to the end of the hose. The ferrule and hose shall then be welded to the end fitting.

9.4.2 Brazed construction

A ferrule shall be placed around and near to the end of the hose. The ferrule and hose shall then be brazed to the end fitting.