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Specification for

Flexible steel conduit and adaptors for the protection of electric cable

UDC 621.315.67:669.14 – 462

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:—

Admiralty	Institute of Marine Engineers
Air Ministry	Institute of Petroleum
Associated Offices' Technical Committee	Institution of Civil Engineers
Association of Consulting Engineers, Incorporated	Institution of Gas Engineers*
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British Electrical and Allied Manufacturers' Association	Institution of Mechanical Engineers (Automobile Division)
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British Engineers' Association	Locomotive Manufacturers' Association
British Internal Combustion Engine Manufacturers' Association	Machine Tool Trades' Association*
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Engineering Equipment Users' Association	Ministry of Works
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The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following industrial organizations, were directly represented on the committee entrusted with the preparation of this standard:

Association of Supervising Electrical Engineers	Society of Motor Manufacturers and Traders
Cable Makers' Association	Individual manufacturers of conduit and adaptors
Electrical Contractors' Association	
Federation of British Rubber Manufacturers' Associations	

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Foreword

This standard makes reference to the following British Standards:—

BS 31, *Steel conduits and fittings for electrical wiring*.

BS 309, *Whiteheart malleable iron castings*.

BS 310, *Blackheart malleable iron castings*.

BS 1400, *Copper alloy ingots and castings*.

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

This British Standard forms part of the revision of BS 731, “*Flexible steel conduit for cable protection and flexible steel tubing to enclose flexible drives*”, which was issued in 1937. In the course of revision it was decided to separate those parts of the standard dealing with flexible steel conduit for cable protection and flexible steel tubing to enclose flexible drives. Part 2 of this revised standard, covering flexible steel tubing to enclose flexible drives, will be published in the near future.

This revised standard provides for three types of flexible steel conduit suitable for insulated cables and for two types of adaptors. In addition to standardizing dimensions, the standard specifies mechanical requirements and tests for the finished conduit, and prescribes suitable qualities of materials for use in the manufacture of flexible steel conduit and adaptors for cable protection.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, 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 British Standard specifies requirements for flexible steel conduit of the types given at a) below, and for adaptors of the types given at b) below.

a) Conduit.

Type A. Flexible steel conduit — unpacked.

Suitable for use as a mechanical protection to insulated electric cables exposed to normal atmospheric conditions.

Type B. Flexible steel conduit — asbestos

packed. Suitable for use as a mechanical protection to insulated electric cables likely to be exposed to damp conditions or where the temperature precludes the use of rubber.

Type C. Flexible steel conduit — rubber

packed. Suitable for use as a mechanical protection to insulated electric cables likely to be exposed to gas or water or dust-laden atmospheres.

b) Adaptors.

i) Clamp type.

ii) Solid type.

Section 1. Conduit

2 Construction

Type A. Flexible steel conduit — unpacked. This shall be of the square-locked type made by helically coiling a formed steel strip. (See Figure 1.)

Type B. Flexible steel conduit — asbestos packed. This shall be of the square-locked type made by helically coiling a formed steel strip, and shall be provided with a continuous packing of asbestos yarn inserted between the coils. (See Figure 1.)

Type C. Flexible steel conduit — rubber packed. This shall be of the square-locked type made by helically coiling a formed steel strip, and shall be provided with a continuous rubber thread inserted between the coils. (See Figure 1.)

3 Material

a) **Steel strip.** The strip used in the manufacture of the conduit shall be of mild steel, bright, cold rolled and annealed, at least equivalent in quality to Grade En.2 as specified in BS 1449, "*Steel plate, sheet and strip*". The strip shall be electro-galvanized, electro-tinned or otherwise provided with an equally effective protective coating before being formed into tubing, the thickness of the coating being not less than 0.00010 in.

NOTE 1 The electro-deposition is neither designed nor intended to be other than a protection to the material during manufacture, handling, storage and transport. The onus of protecting the tube in service is on the user, who should adopt methods suited to the particular conditions prevailing.

NOTE 2 In view of the deleterious effect of copper on rubber, it is recommended that the strip used for Type C conduit should not be copper-plated either before or after the forming process.

b) **Asbestos packing.** The packing shall consist of a commercial grade asbestos yarn of the chrysotile variety. The yarn shall have an organic content not exceeding 15 per cent, and shall be of a suitable count and of a size sufficient to ensure reasonable and satisfactory tightness.

c) Rubber thread.

i) *Composition.* The thread, which shall be square or round in section, shall be made from first grade natural rubber suitably compounded and vulcanized, and shall have a specific gravity not exceeding 1.02.

Accelerators and antioxidants shall be allowed but the mix shall not contain any waste, reclaim, or rubber substitute (vulcanized oils). The use of a suitable type of synthetic rubber shall be permitted as an alternative for all or part of the natural rubber.

ii) *Elongation test.* The thread shall be tested as described in Appendix A and the full extended length of the test piece shall be not less than 18 in. and not more than 32 in.

iii) *Accelerated ageing test.* The thread shall pass satisfactorily the accelerated ageing tests described in Appendix B.

4 Dimensions

The dimensions and pitch of the conduit shall be in accordance with Table 1. The conduit shall be supplied in such lengths as may be specified by the purchaser or his representative.

5 Workmanship

The interior of flexible steel conduit shall be free from burrs or sharp edges that might cause abrasion to the insulation on the cable, and free from obstructions that might interfere with the easy introduction of the maximum size of cable for which the conduit is normally intended.

The conduit shall be reasonably uniform in diameter.

When the conduit is cut to length, the ends shall be cut square and free from burrs or sharp edges that would interfere with the assembly of the conduit with the parts with which it is used.

All conduit shall be so formed in manufacturing that it will not unravel when cut, and shall be free from any other defects that would affect its serviceability.

6 Electrical resistance

The flexible conduit and adaptors or other anchorings shall be electrically continuous. (See Appendix C.)

Section 2. Adaptors

7 Construction

Adaptors shall comply, in general, with the requirements for one of the following types:—

- a) **Clamp type.** This type shall have either an internal box thread or internally projecting fins, in order to engage and hold secure the flexible steel conduit. It shall be fitted with an external earthing lug with a hole to accommodate not less than 7/029 in. earthing wire. The lug shall be integral with the solid portion of the adaptor and shall be tapped and fitted with a clamping screw with a head. Alternatively, an earthing screw with a head and washer shall be fitted to the solid portion. A typical example is shown in Figure 2.
- b) **Solid type.** This type shall have either an internal box thread or internally projecting fins, and shall be fitted either with an external earthing lug as for the clamp type in Clause 7 a) above, or with an earthing screw with a head and washer. A typical example is shown in Figure 3.
- c) **Other types.** The dimensions shall be in accordance with those specified in Table 1. They shall be made either with or without provision for an earth wire.

Installations employing flexible steel conduit shall comply with the appropriate I.E.E. Regulation which is set out in Appendix C. The onus of ensuring that this Regulation is complied with rests with the installing engineer.

8 Materials

Adaptors and other anchorings shall be made of brass complying with BS 1400, "*Copper alloy ingots and castings*," or of malleable iron complying with either BS 309, "*Whiteheart malleable iron castings*" or BS 310, "*Blackheart malleable iron castings*." Alternatively, by agreement between purchaser and manufacturer, they may be made from other suitable metals or alloys.

9 Threads

Box threads or fins shall be of the pitch specified in Table 1.

10 Depth of engagement with flexible conduit

The depth of engagement of the flexible conduit in the adaptors or anchorings shall be not less than that shown in Table 1.

11 Engagement with rigid conduit or fittings

The specification, and depth of engagement, of male and female threads shall be in accordance with BS 31, "*Steel conduits and fittings for electrical wiring*," and BS 4568, "*Steel conduit and fittings with metric threads of ISO form for electrical installations*", Part 1: "*Steel conduit, bends and couplers*".

12 Workmanship

Adaptors shall be free from burrs or sharp edges and the threads or fins shall be well formed.

Section 3. Mechanical tests

13 Mechanical tests

- a) **Flexibility test.** The conduit shall be capable of being easily formed completely round a former with a diameter equal to twice the bending radius specified in Table 1, Columns 5 or 6, and returned to the straight without damage.
- b) **Linear breaking test.** A piece of conduit 12 in. long shall be placed in the jaws of a tensile testing machine, 4 in. of each end being held by the jaws, leaving 4 in. between the jaws. A mandrel of the proper diameter and 4 in. long shall be inserted in each end of the conduit to prevent distortion. The conduit shall show no indication of yielding under a load less than that specified in Table 1, maintained for a period of three minutes.
- c) **Bend-fracture test.** A piece of conduit shall be bent to a U-shape between the flat heads of a compression testing machine. The conduit shall be held in the machine in such a position that as the load is applied the radius of the bend shall be decreased until the yield point is reached. The breaking load thus found shall be not less than that specified in Table 1.
- d) **Crushing test.** A 2 in. length of conduit shall be compressed between flat steel plates and a load of 250 lb. per linear inch shall be applied across the diameter, when no permanent distortion shall be produced.

e) **Soundness test.** (*Type C flexible steel conduit — rubber packed.*) After the completion of the test specified in Clause 13 a) the conduit shall be pressure tested with air. The conduit shall show no sign of leakage when one end is sealed and the entire length immersed in water and subjected to an internal air pressure of 20 in. of water.

14 Test certificate

Manufacturers shall, if so requested, provide a certificate to the effect that their products comply with this British Standard. Such certificate shall be based on periodic tests carried out in accordance with Clause 13, either in the manufacturer's works or by a recognized authority.

Table 1 — Requirements for flexible steel conduit (unpacked or asbestos or rubber packed) and adaptors

1 Nominal internal dia.	2 External dia. in normal position (maximum)	3 Thickness of strip (minimum)	4 Pitch in normal position (approx.)	5 Bending radius ^a (minimum)		7 Depth of engagement between conduit and adaptor (minimum)	8 Linear breaking load ^b (minimum)	9 Bending fracture load (minimum)
				Unpacked	Packed			
				in.	in.			
$\frac{3}{16}$	0.275	0.0100	96	1	$2\frac{1}{2}$	$\frac{7}{16}$	50	15
$\frac{1}{4}$	0.345	0.0100	96	$1\frac{1}{8}$	3	$\frac{7}{16}$	75	25
$\frac{5}{16}$	0.410	0.0124	96	$1\frac{1}{8}$	$3\frac{1}{2}$	$\frac{7}{16}$	100	30
$\frac{3}{8}$	0.490	0.0124	72	$1\frac{1}{4}$	4	$\frac{9}{16}$	130	40
$\frac{1}{2}$	0.640	0.0148	60	$1\frac{1}{2}$	$4\frac{1}{2}$	$\frac{9}{16}$	180	50
$\frac{5}{8}$	0.775	0.0148	60	$1\frac{3}{4}$	5	$\frac{5}{8}$	240	75
$\frac{3}{4}$	0.925	0.0164	48	$2\frac{1}{2}$	5	$\frac{3}{4}$	320	100
$\frac{7}{8}$	1.047	0.0164	48	$2\frac{1}{2}$	5	$\frac{15}{16}$	400	100
1	1.220	0.0200	48	3	6	$\frac{15}{16}$	460	100
$1\frac{1}{4}$	1.460	0.0200	48	$3\frac{1}{2}$	8	1	580	125
$1\frac{1}{2}$	1.750	0.0200	30	$4\frac{1}{2}$	9	1	730	150
$1\frac{3}{4}$	2.010	0.0200	30	$4\frac{3}{4}$	$9\frac{1}{2}$	$1\frac{3}{16}$	800	200
2	2.260	0.0200	30	5	10	$1\frac{3}{16}$	900	230
$2\frac{1}{2}$	2.780	0.0200	30	7	12	$1\frac{3}{8}$	950	280
3	3.260	0.0200	30	$7\frac{1}{2}$	14	$1\frac{1}{2}$	1 000	325

^a Inner radius of bend without straining conduit.

^b Linear breaking load = load at which coils pull off adjacent beading.

Appendix A Method for the determination of elongation of rubber threads under constant load

Two 10 in. lengths of the thread shall be used for this test. Before elongation, these pieces shall be allowed to remain at rest, shielded from light, for 24 hours at a temperature of 20 ± 2 °C. Each length shall be suspended from a suitable grip and a weight corresponding to 225 lb. per square inch of the cross-section of the thread shall be attached so that a 6 in. length is tested. The weight shall then be lowered at the rate of $1\frac{1}{2}$ in. per second to the fullest extension of the thread and the full extended length measured immediately after the application of the full load.

The average extension of the two specimens shall be not less than 12 in. and not more than 26 in. but the test results shall be expressed as the full extended length (i.e. from 18 in. to 32 in.). The temperature throughout the test shall be 20 ± 2 °C.

Appendix B Method for the determination of the resistance to accelerated ageing of rubber threads

Four lengths of thread shall be selected, as follows:—

2 lengths each 10 in. long

2 lengths each 4 in. long

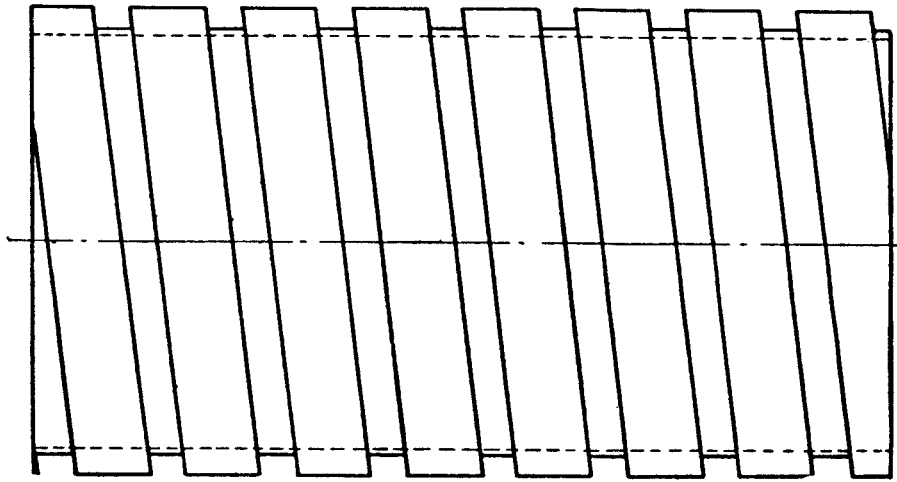
1) The two 10 in. lengths shall be placed in a thermostatically controlled air oven kept continuously at a temperature of 70 ± 1 °C. They shall be so suspended or otherwise supported as to be free from stress, freely exposed to air and not touching each other or any part of the oven. Provision shall be made for a continuous slow change of air in the oven during this treatment.

Both lengths shall be withdrawn after a period of 288 hours in the oven. Immediately after removal from the oven, the lengths shall be kept for 24 hours at a temperature of 20 ± 2 °C., throughout which period they shall be shielded from light. They shall then be subjected to the test described in Appendix A, when their length shall not be found to depart from the original figures by more than ± 20 per cent.

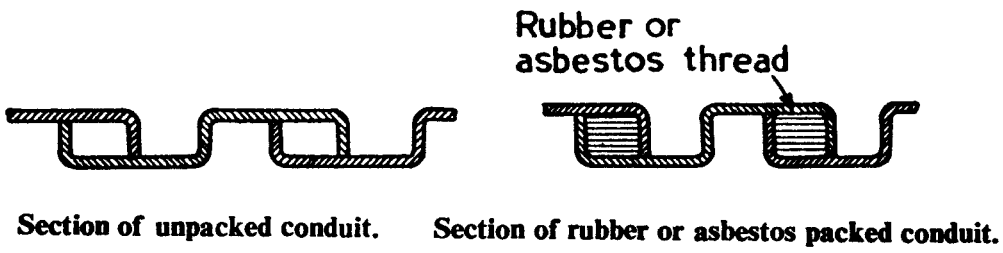
2) The two 4 in. lengths shall be stretched on a suitable frame, so that a 2 in. test length is elongated to 6 in., and shall then be placed in an oven kept at a temperature of 70 ± 1 °C as described in Paragraph 1 above. After 288 hours' heating the sample shall be removed from the oven, immediately taken off the frame and kept at a temperature of 20 ± 2 °C for 24 hours, throughout which period it shall be shielded from light. Each sample, having been marked with reference marks 1 in. apart, shall be shown to be capable of being extended without breaking so that the distance between the reference lines is 4 in.

Appendix C Extract from twelfth edition (1950) of "regulations for electrical equipment of buildings" published by the institution of electrical engineers

Section 10: Regulation 1003, Earth continuity conductor, Clause (E). Flexible metallic tubing shall not be used as an earth continuity conductor. Where such tubing forms part of an earthed metal-conduit system, a separate earth-continuity conductor having a cross-sectional area not less than that required by Clause (B) [This reads: "Not less than 0.0045 sq. in. (7/029 in.)"] shall be installed with the tubing and connected to it at each end and, in the case of long runs, at suitable intervals throughout the run.



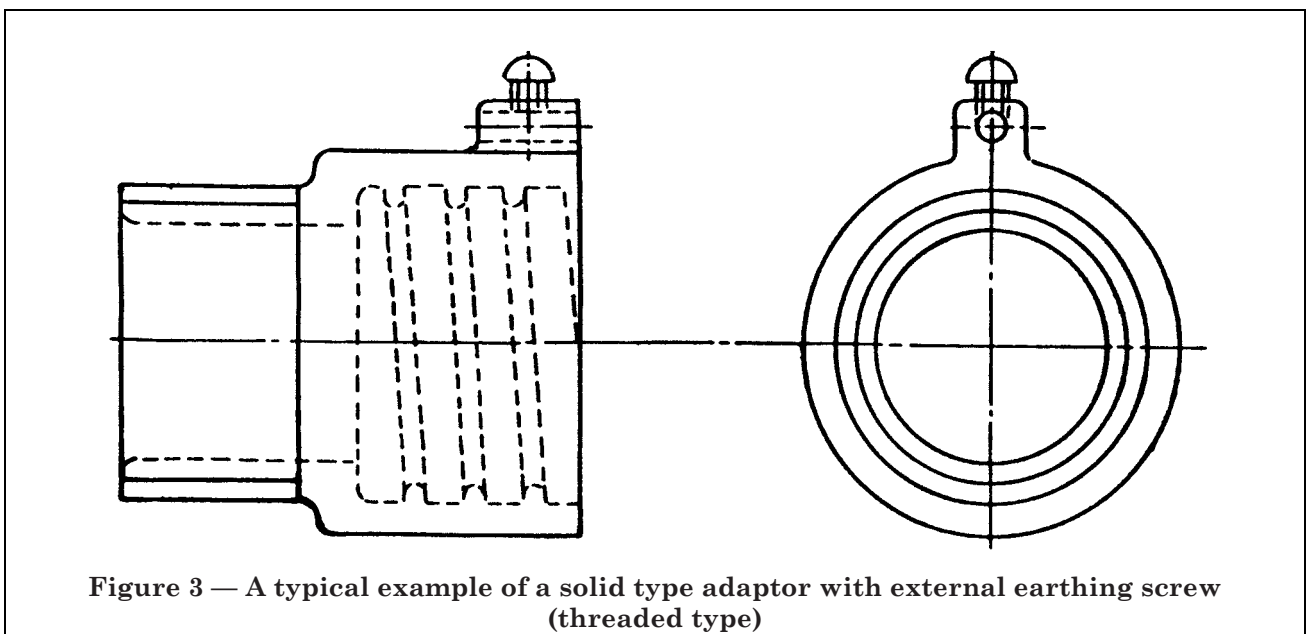
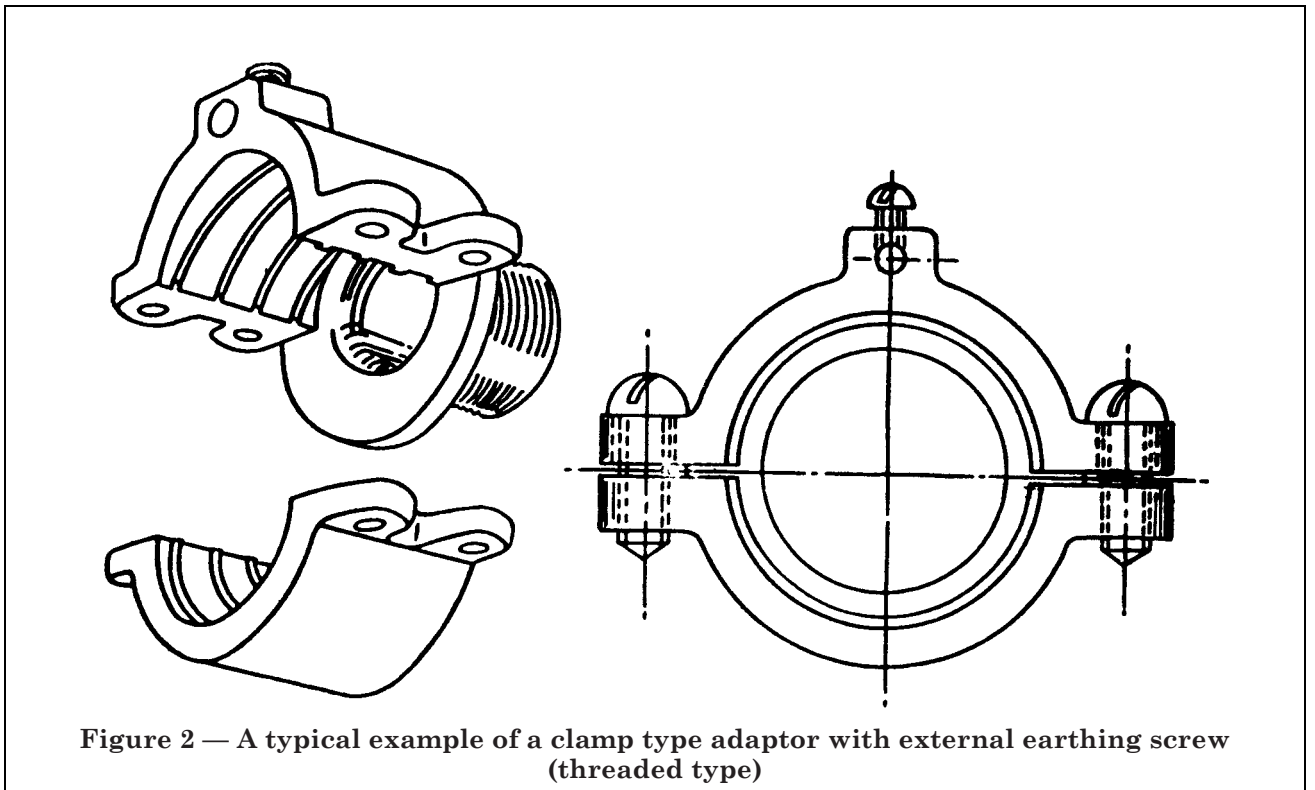
General view of unpacked and asbestos or rubber packed conduit.



Section of unpacked conduit.

Section of rubber or asbestos packed conduit.

Figure 1



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