

Gas Industry Standard

GIS/F2:2013

Specification for

**Main sealing plugs and service connection fittings for
use at pressures not greater than 2 bar**



Contents

	Page
Mandatory and non-mandatory requirements	iii
Disclaimer	iii
Brief history	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Materials	3
4.1 Metal-bodied fittings	3
4.2 Plastic-bodied fittings	3
4.3 Elastomeric components	3
5 Design	4
5.1 General	4
5.2 Service connection fittings	4
5.3 Inlet and outlet sizes	4
5.4 Overall dimensions	5
5.5 Installation requirements	9
6 Performance of service connection fittings and mains sealing plugs	10
6.1 Inlet connections	10
6.2 Outlet connection on service connection fittings	10
6.3 Internal sealing plug on service connection fittings	10
6.4 Joints between components on the service connection fitting apart from inlet and outlet	11
7 Type approval tests	13
7.1 General	13
7.2 Documentation	13
8 Marking	13
Annex A (normative) Service connection fitting: pressure drop test	14
Annex B (normative) Plastic-bodied mains sealing plug or service connection fitting: impact test	19
Annex C (normative) Pneumatic pressure tests on mains sealing plugs and service connection fittings	19
Annex D (normative) Service connection fitting: resistance to pull-out tests	25
Annex E (normative) Short-term strength test for plastic-threaded service connection fittings or mains sealing plugs	27
Annex F (normative) Long-term strength test for plastic-threaded service connection fittings or mains sealing plugs	29

Contents (continued)

	Page
Figure 1 — Typical mains sealing plug with limiting dimensions	6
Figure 2 — Limiting dimensions for BS 21 thread size $\frac{3}{4}$ in and 1 in inlet service connection fittings	7
Figure 3 — Limiting dimensions for BS 21 thread size $1\frac{1}{4}$ in inlet service connection fittings	8
Figure 4 — Limiting dimensions for BS 21 thread size $1\frac{1}{2}$ and 2 inlet mains sealing plugs	9
Figure A.1 — Layout of test rig for service connection pressure drop test	16
Figure B.1 — Typical impact test assembly	18
Figure C.1 — Inlet seal test pieces	24
Table 1 — Inlet and outlet sizes for service connection fittings and mains sealing plugs	4
Table 2 — Fittings inlet and parent pipe sizes	5
Table 3 — Special parallel external threads for gas appliances where pressure-tight seals are made on machined faces (adapted from BS 21:1985)	12
Table A.1 — Gas flow rates for testing pressure drop	14
Table C.1 — Required test pipe combinations for mains sealing plug or service connection fitting inlet sizes	19
Table C.2 — Test pressures and durations for different service pipe specimen materials	22
Table D.1 — End load requirements for pull-out test	26

Foreword

Gas Industry Standards (GIS) are revised, when necessary, by the issue of new editions. Users should ensure that they are in possession of the latest edition. Contractors and other users external to Gas Transporters should direct their requests for copies of a GIS to the department or group responsible for the initial issue of their contract documentation.

Comments and queries regarding the technical content of this document should be directed in the first instance to the contract department of the Gas Transporter responsible for the initial issue of their contract documentation.

This standard calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Compliance with this engineering document does not confer immunity from prosecution for breach of statutory or other legal obligations.

Mandatory and non-mandatory requirements

For the purposes of a GIS the following auxiliary verbs have the meanings indicated:

- can** indicates a physical possibility;
- may** indicates an option that is not mandatory;
- shall** indicates a GIS requirement;
- should** indicates best practice and is the preferred option. If an alternative method is used then a suitable and sufficient risk assessment needs to be completed to show that the alternative method delivers the same, or better, level of protection.

Disclaimer

This engineering document is provided for use by Gas Transporters and such of their contractors as are obliged by the terms of their contracts to comply with this engineering document. Where this engineering document is used by any other party, it is the responsibility of that party to ensure that the engineering document is correctly applied.

Brief history

<p>First published as BGC/PS/F2 Amendment No.1 published Amended version published as BGES/F2 Editorial update to reflect demerger November 2000 Editorial update to comply with GRM Edited by BSI in accordance with BS 0-3:1997 Reviewed on behalf of the Gas Distribution Networks' Technical Standard Forum by BSI Reviewed by TSF Reviewed by TSF</p>	<p>November 1974 July 1976 July 1994 June 2001 August 2004 August 2006 September 2013 June 2018 April 2023</p>
---	--

© Energy Networks Association on behalf of Cadent Gas Limited, Northern Gas Networks, SGN and Wales & West Utilities Ltd.

This Gas Industry Standard is copyright and must not be reproduced in whole or in part by any means without the approval in writing of Energy Networks Association.

1 Scope

This Gas Industry Standard (GIS) specifies the requirements for metallic or plastic-bodied main sealing plugs and service connection fittings for connecting steel or polyethylene (PE 80) service pipe to steel, grey cast iron and ductile iron pipes at pressures not greater than 2 bar. It applies to PE 80 (MDPE) polyethylene pipe only.

This Gas Industry Specification covers only mains sealing plugs and service connection fittings normally fitted under pressure using a combined drilling, tapping and service fitting insertion machine meeting the requirements of GIS/E1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Formal standards

BS 21:1985, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions)*.

BS 1211, *Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage (current, obsolescent) (partially replaced by BS EN 969)*.

BS EN 10255, *Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions*

BS 4622, *Specification for grey iron pipes and fittings (current, obsolescent)*.

BS EN 682, *Elastomeric seals — Materials requirements for seals used in pipes and fittings carrying gas and hydrocarbon fluids*.

BS EN 969, *Specification for ductile iron pipes, fittings, accessories and their joints for gas pipelines. Requirements and test methods*.

BS EN 1562, *Founding — Malleable cast irons*.

BS EN 1563, *Founding — Spheroidal graphite cast iron*.

BS EN 1982, *Copper and copper alloys — Ingots and castings*.

BS EN 10226-1, *Pipe threads where pressure tight joints are made on the threads — Taper external threads and parallel internal threads — Dimensions, tolerances and designation*.

BS EN 10250-1, *Open steel die forgings for general engineering purposes — General requirements*.

BS EN 10250-4, *Open steel die forgings for general engineering purposes — Stainless steels*.

BS EN ISO 14713, *Protection against corrosion of iron and steel in structures — Zinc and aluminium coatings — Guidelines*.

Gas Industry Standards

GIS/E1, *Specification for combined drilling, tapping and service fitting insertion machines for use up to 2 bar*.

GIS/L2, *Specification for steel pipe 21.3 mm to 1 219 mm outside diameters for operating pressures up to 7 bar*.

GIS PL2-1, *Specification for polyethylene pipes and fittings for natural gas and suitable manufactured gas — Part 1: General and polyethylene compounds for use in polyethylene pipes and fittings*.

GIS/PL2-2, *Specification for polyethylene pipes and fittings for natural gas and suitable manufactured gas — Part 2: Pipes for use at pressures up to 5.5 bar.*

GIS/PL2-4, *Specification for polyethylene pipes and fittings for natural gas and suitable manufactured gas — Part 4: Fusion fittings with integral heating elements(s).*

GIS/PL2-8, *Specification for polyethylene pipes and fittings for natural gas and suitable manufactured gas — Part 8: Pipes for use at pressures up to 7 bar.*

GIS/PL3, *Specification for self anchoring mechanical fittings for polyethylene pipe for natural gas and suitable manufactured gas.*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

mains sealing plug

plastic sealing plug, solid metallic plug or emid-type metallic plug

NOTE Metallic plugs have a metallic profiled backing ring and threaded locknut with profiled rubber seal. Plastic plugs have either a plastic shoulder with profiled rubber seal or plastic threaded nut and backing ring with profiled rubber seal. Where the threaded locknut is used, the locknut is tightened down onto rubber seal to make a leak-tight joint. Where the plastic shoulder is used, the plug body tightens down the shoulder onto the rubber seal making a leak tight joint.

3.2

PE 80

material grade of polyethylene pipe (for description of material grade see GIS/PL2-1)

NOTE Also referred to as MDPE or medium density polyethylene.

3.3

protection cap

cap with a female thread that provides protection to the internal sealing plug of the service connection fitting against ingress of materials, liquids and leak sealing of fitting

NOTE 1 Removing the protection cap provides access to the internal plug for commission and decommission of the service outlet pipe.

NOTE 2 A protection plug is an alternative measure that performs the same function.

3.4

protection plug

plug with a male thread that provides protection to the internal sealing plug of the service connection fitting against ingress of materials, liquids and leak sealing of fitting

NOTE 1 Removing the protection cap provides access to the internal plug for commission and decommission of the service outlet pipe.

NOTE 2 A protection cap is an alternative measure that performs the same function.

3.5

service connection fitting

fitting for making a connection in a threaded hole in a metallic inlet pipe to provide an outlet to a gas service pipe

NOTE Also referred to as service tees, service fittings. An example is a service top tee fitting.

3.6

internal sealing plug

threaded plug inside service connection fitting that can be raised (to commission) or lowered (to decommission) the gas service pipe. It seals in the lower position to allow testing of the gas service pipe before commissioning. It is present in both metal-bodied and plastic-bodied service connection fittings

4 Materials

NOTE Illustration of any particular components or design features does not indicate that they are preferred.

4.1 Metal-bodied fittings

4.1.1 Components shall be made from either:

- a) ductile iron conforming to BS EN 1563 and following the requirements in BS EN 969;
- b) blackheart malleable iron conforming to BS EN 1562 grade B290/6;
- c) whiteheart malleable iron conforming to BS EN 1562 grade W340/3;
- d) gun metal conforming to BS EN 1982 grade LG2 or LG4;
- e) stainless steel in the softened condition conforming to BS EN 10250-1 and BS EN 10250-4 grade 320 or S17.

4.1.2 The internal sealing plug inside service connection fittings referred to in 3.6 and 6.3 shall be made from unfilled Nylon 6.

4.2 Plastic-bodied fittings

4.2.1 Where fused outlets are used on service connection fittings, the outlet shall be made of polyethylene of PE 80 or MDPE material grade meeting the requirements of GIS/PL2-1 to facilitate fusion to polyethylene service pipe.

4.2.2 Compression outlets may be used instead of fused outlets on service connection fittings.

4.2.3 The section of the plastic-bodied service connection fitting or mains sealing plug to be screwed into the pipe shall be moulded from a material that passes the short- and long-term strength tests given in Annexes E and F and conforms to GIS/PL3.

NOTE An example of such a material is an acetal resin such as Delrin ® 107.

4.2.4 Plastic-bodied single-piece service connection fittings may be formed of one moulding or a number of different mouldings

4.3 Elastomeric components

Elastomeric components shall be made from butadiene/acril or nitrile rubber that conforms to BS EN 682.

5 Design

NOTE Illustration of any particular components or design features does not indicate that they are preferred.

5.1 General

All main sealing plugs and service connection fittings, whether metal-bodied or plastic-bodied, shall have:

- a) dimensions that allow them to be fitted and withdrawn using machines that conform to GIS/E1;
- b) features that facilitate their fitting into, and withdrawal from, the inlet pipe using machines that conform to GIS/E1;
- c) threads to meet the requirements of BS 21 and BS EN 10226-1;
- d) the ability to seal onto the outside diameter of the pipe with a profiled rubber seal that conforms to BS EN 682. This may be compressed by a shoulder forming an integral part of the body or by a loose back-nut and backing ring.

5.2 Service connection fittings

The service connection fittings shall:

- a) have features that facilitate pressure testing of the service after their installation as well as a threaded internal sealing plug to allow commissioning and decommissioning of the gas service pipe as well as a protection cap/plug at access point to the internal sealing plug;
- b) be sufficiently protected against corrosion to give at least 50 years' useful life (as tested in accordance with Annex F) in the working environment in which the fitting is proposed to be used, conforming to BS EN ISO 14713.

5.3 Inlet and outlet sizes

The inlet and outlet sizes of fittings shall be as given in Table 1.

Table 1 — Inlet and outlet sizes for service connection fittings and mains sealing plugs

Inlet (BS 21 nominal thread size)	Steel outlet (nominal) mm	Plastic outlet mm
$\frac{3}{4}$	20, 25	20, 25, 32
1	25	20, 25, 32
$1\frac{1}{4}$ ^{a)}	Not applicable	Not applicable
$1\frac{1}{2}$	40, 50	63
2	50	63
2	50	63
^{a)} The 1 in to $1\frac{1}{4}$ in size only applies to mains sealing plugs as it is an obsolete size for service connection fittings.		

An elastomeric seal that forms a gas tight joint on the outside of the inlet pipe shall be incorporated. This sealing arrangement may be used on flat surfaces and on the combinations of inlet diameters and parent pipe sizes given in Table 2.

Table 2 — Fittings inlet and parent pipe sizes

Inlet (BS 21 thread size designation nominal)	Parent pipe sizes	
	Metric conforming to */SP/C4 mm	Imperial to BS 1211 or BS 4622 in
$\frac{3}{4}$	100 to 600	3 to 36
1	100 to 600	4 to 36
$1\frac{1}{4}$	150 to 600	5 to 36
$1\frac{1}{2}$	150 to 600	6 to 36
2	200 to 600	8 to 36

5.4 Overall dimensions

5.4.1 Service connection fittings and mains sealing plugs, whether metal-bodied or plastic-bodied, shall incorporate a section of the body suitably shaped for tightening/ loosening with a spanner or adjustable wrench to allow fitting and withdrawal using machines that meet the requirements of GIS/E1 (see Figures 1, 2, 3 and 4). Mains sealing plug inlet connections shall follow relevant parts of Figure 2 for $\frac{3}{4}$ in and 1 in and Figure 4 for $1\frac{1}{2}$ in and 2 in. Service connection fitting inlets shall follow Figure 2 for $\frac{3}{4}$ in and 1 in and Figure 4 for $1\frac{1}{2}$ in and 2 in.

5.4.2 Service connection fittings, whether metal-bodied or plastic-bodied, with the inlet seal components and internal sealing plugs in place but without the outlet seal components, shall conform to the limiting dimensions shown in Figures 2 and 3.

5.4.3 PE 80 outlet plastic-bodied service connection fittings shall be suitable for use with electrofusion socket fittings that conform to GIS/PL2-4.

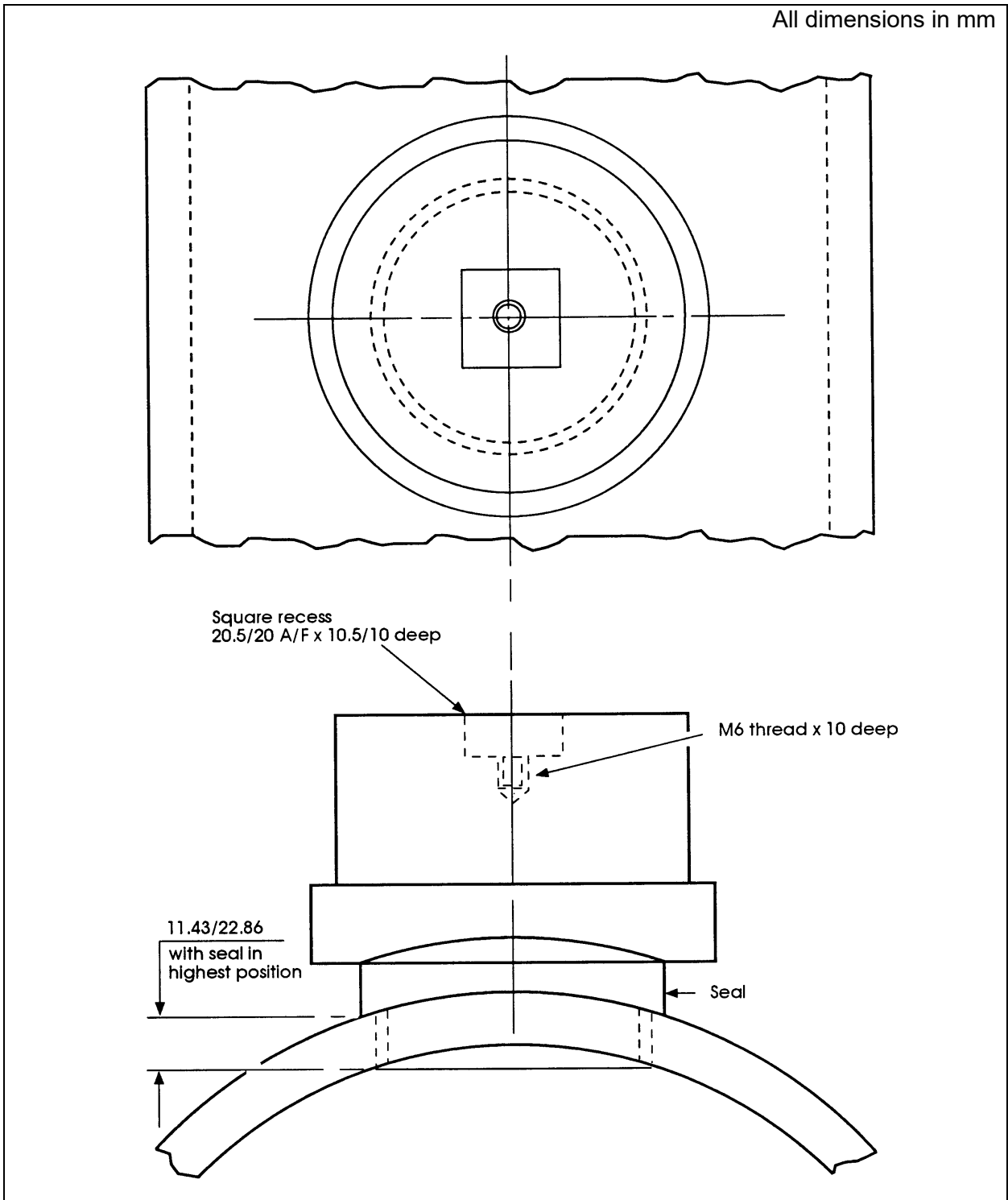


Figure 1 — Typical mains sealing plug with limiting dimensions

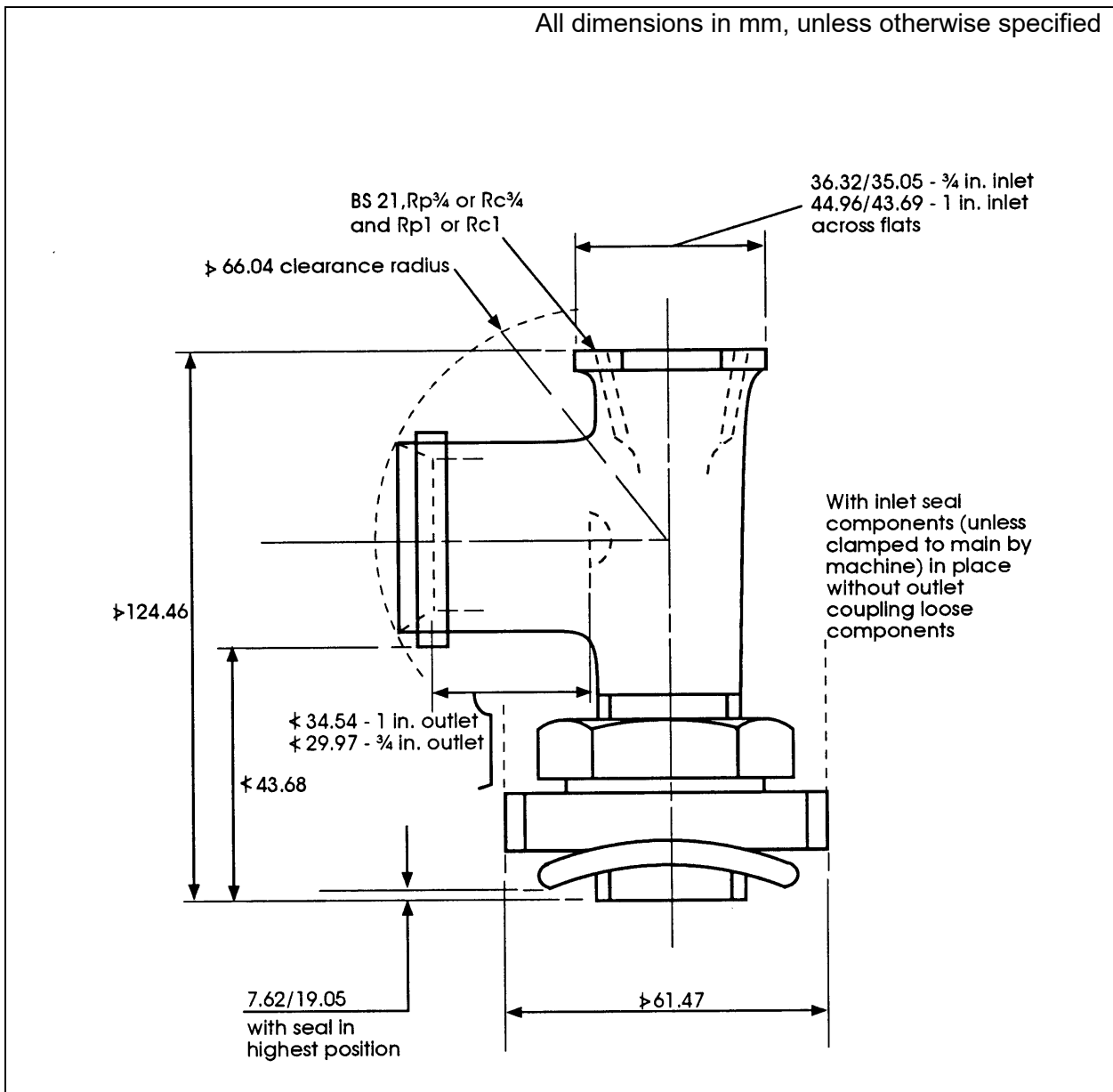


Figure 2 — Limiting dimensions for BS 21 thread size $\frac{3}{4}$ in and 1 in inlet service connection fittings

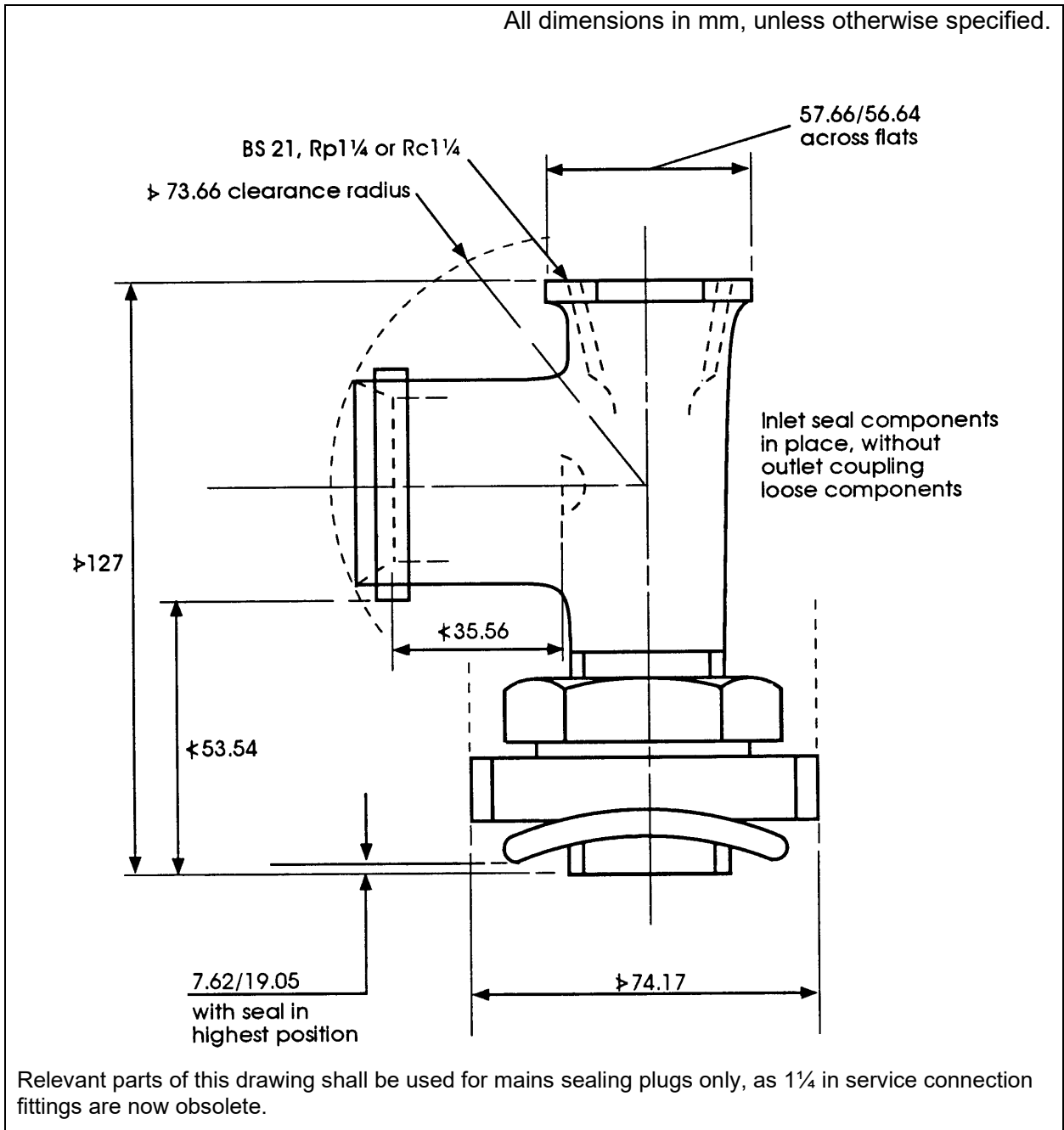


Figure 3 — Limiting dimensions for BS 21 thread size 1 1/4 in inlet service connection fittings

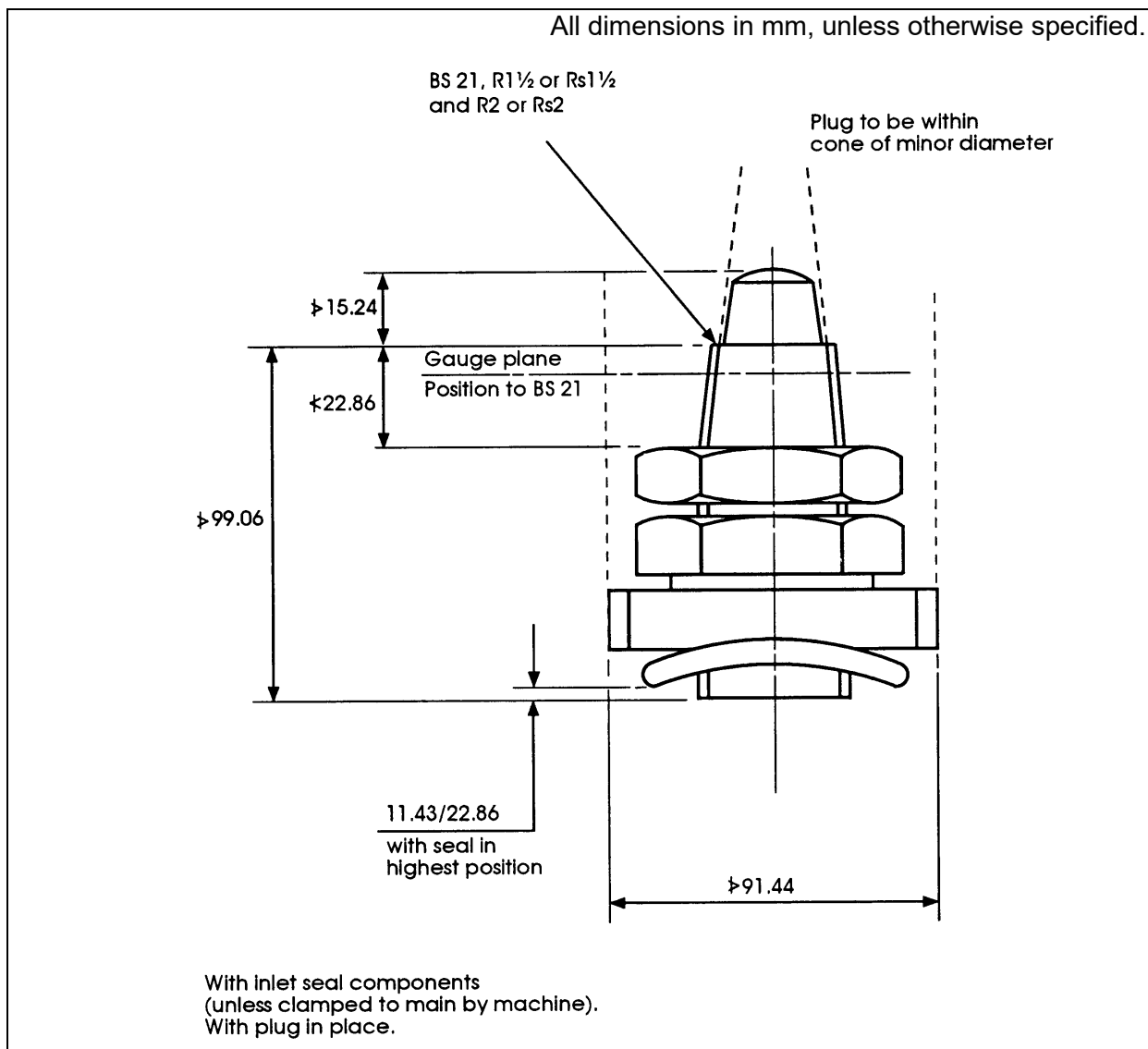


Figure 4 — Limiting dimensions for BS 21 thread size 1½ and 2 inlet mains sealing plugs

5.5 Installation requirements

5.5.1 Metal-bodied or plastic-bodied service connection fittings may be designed as either:

- a) a single-piece fitting;
- b) a two-piece fitting consisting of a plugged nipple, which is fitted to the pipe first and an upper body, fitted to the pipe afterwards (two piece fittings shall not be used on ¾ in and 1 in sizes).

5.5.2 Plastic-bodied fittings shall conform to GIS/PL2-4, except for requirements relating to the method of attachment to the pipe or drilling the pipe.

5.5.3 One-piece service connection fittings shall have rubber inlet seals (conforming to BS EN 682) incorporating a loose back-nut (or a shoulder forming an integral part of the moulding in the case of plastic-bodied fittings), which enable the seal compression to be achieved. Plugged nipples need not have a loose back-nut if the service connection fitting outlet orientation can be set by adjusting the joint between the plugged nipple and the upper body of the service connection fitting. Plugged nipples shall be capable of being inserted into

the inlet pipe using machines meeting the requirements of GIS/E1. The thread on loose backnut, plugged nipple or service connection fitting shall meet the requirements of BS 21 and BS EN 10226-1.

5.5.4 For both designs of the service connection fitting (one-piece and two-piece), the contractor shall provide fitting instructions at the time of initial type approval testing.

5.5.5 The fitting instructions shall include a maximum recommended torque for:

- a) tightening the sealing plug or service connection fitting on the inlet pipe;
- b) tightening the internal plug in the service connection fitting;
- c) tightening the protection cap/plug of the service connection fitting;
- d) tightening the outlet connection of the service connection fitting.

The recommended torque for a) and d) only shall be within the range 30 N·m to 136 N·m inclusive.

6 Performance of service connection fittings and mains sealing plugs

6.1 Inlet connections

Service connection fittings and mains sealing plugs shall incorporate a parallel thread on the inlet connection that conforms to Table 2 for screwing to grey or ductile iron pipes or steel pipes through a saddle using machines that conform to GIS/E1.

6.2 Outlet connection on service connection fittings

6.2.1 Steel service pipe outlets

6.2.1.1 Outlet connections of service connection fittings shall conform to BS 1387 (heavy) pipe and GIS/L2 pipe requirements.

6.2.1.2 The sealing gasket on the outlet gland connection shall be of material that conforms to BS EN 682 (see 4.1.1 for material types). The contractor shall recommend a tightening torque for the outlet gland nut in the range 30 N·m to 136 N·m inclusive.

6.2.1.3 Service connection fittings shall have outlet connections capable of accommodating a 2.5° misalignment between the steel pipe and fitting outlet centre line before becoming metal-bound.

6.2.2 Polyethylene service pipe outlet connections

6.2.2.1 Outlet connections of service connection fittings shall conform to GIS/PL2-2 (metric series, SDR 11).

6.2.2.2 Outlets of service connection fittings shall meet the pull-out test requirements given in Annex D.

6.3 Internal sealing plug on service connection fittings

6.3.1 In the raised position, the internal sealing plug shall be retained securely in the service connection upper body above the outlet branch, but need not provide a perfect seal, as a leak tight protection cap or protection plug shall be added.

6.3.2 Provision shall be made for the threaded internal sealing plug to be lowered or raised without gas leakage through the plug thread, either through the design of plug and fitting or by

use of a special plug lifting/capping tool that allows no-gas operation. It shall be the responsibility of the manufacturer to ensure the availability of a plug-lifting tool to suit the design of service fitting.

6.3.3 A protection cap/plug shall be fitted above the internal sealing plug. The cap or plug may have parallel threads and a separate gasket or taper threads sealed with a thread-sealing compound.

6.3.4 Where a nipple and separate upper body fitting are used the following shall apply.

- a) The internal sealing plug shall be retained securely in the raised position in the upper body above the outlet branch.

NOTE The plug need not provide a perfect seal as a leak-tight protection cap or protection plug is used above it.

- b) It shall be possible to lower or raise the internal sealing plug without gas leakage through the thread, either through the design of the internal sealing plug and upper body fitting or by using a plug lifting and capping tool that makes a no-gas operation possible.
- c) The manufacturer shall ensure the availability of a tool, which is compatible with their type of service connection fitting design, to raise and lower the internal sealing plug and tighten and remove the leak-tight cap or plug.
- d) The internal sealing plug in the nipple and the upper body fitting shall both fasten securely into the nipple.

6.4 Joints between components on the service connection fitting apart from inlet and outlet

Where taper/taper or taper/parallel threads with a thread sealant are used, the threads shall conform to BS 21 and BS EN 10226-1.

**Table 3 — Special parallel external threads for gas appliances where pressure-tight seals are made on machined faces
(adapted from BS 21:1985)**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Thread size designation	No. of threads in 25.4 mm	Pitch mm	Thread depth mm	Major diameter (gauge diameter) mm				Pitch diameter mm				Minor diameter mm		
				Basic	Tolerance	Max.	Min.	Basic	Tolerance	Max.	Min.	Basic	Tolerance	Max.
1¼	11	2.309	1.479	41.910	-0.211 to -0.541	41.699	41.369	40.431	-0.211 to -0.391	40.221	40.040	38.952	-0.211 and over	38.741
1½	11	2.309	1.479	47.803	-0.211 to -0.541	47.592	47.262	46.324	-0.211 to -0.391	46.113	45.933	44.845	-0.211 and over	44.634
2	11	2.309	1.479	59.614	-0.211 to -0.541	59.403	59.073	58.135	-0.211 to -0.391	57.924	57.744	56.656	-0.211 and over	56.445

7 Type approval tests

7.1 General

Type approval tests shall be carried out on each size of each design of service connection fittings or mains sealing plugs that the contractor offers and they shall meet the requirements of the following tests:

- a) metallic bodied mains sealing plugs conforming to Annex C (inlet sealing pneumatic pressure test only);
- b) plastic bodied sealing plugs conforming to Annex B (impact test), Annex C (inlet sealing pneumatic pressure test only), Annex E (short term strength test) and Annex F (long term strength test);
- c) metallic bodied service connection fittings conforming to Annex A (pressure drop test), Annex C (pneumatic pressure test) and Annex D (resistance to pull-out test);
- d) plastic bodied service connection fittings conforming to Annex A (pressure drop test), Annex B (impact test), Annex C (pneumatic pressure test), Annex D but only if not an electrofusion connection (resistance to pull-out test), Annex E (short term strength test) and Annex F (long term strength test).

7.2 Documentation

Following completion of the type approval tests, the contractor shall compile a data folder including details of all test results and a set of drawings showing all critical information (i.e. dimensions, materials finishes, heat treatment, manufacturing and assembly techniques, operating, inspection, safety and maintenance instructions).

8 Marking

8.1 Products conforming to GIS/F2 shall be permanently marked with the following information:

- a) the name or trademark of the manufacturer or their appointed agent;
- b) where authorized, the product conformity mark of a third party certification body, e.g. BSI Kitemark.

NOTE Attention is drawn to the advantages of using third party certification of conformance to a standard.

8.2 The following information shall be permanently marked on the product packaging or fitting instructions:

- a) the number and date of this standard, i.e. GIS/F2:2013 ¹⁾;
- b) the manufacturer's contact details.

8.3 Where different seal components are required to suit the various pipe sizes, the components shall be clearly marked with the diameters for which they are suitable.

¹⁾ Marking GIS/F2:2013 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.

Annex A (normative)

Service connection fitting: pressure drop test

A.1 Principle

This test is to ensure that the pressure drop across the service connection fitting does not exceed four velocity heads, at a working pressure of 25 mbar for the appropriate natural gas flow given in Table A.1.

NOTE This will ensure that there is no adverse effect on gas flow through the service connection fitting from the inlet to outlet pipe.

Table A.1 — Gas flow rates for testing pressure drop

Outlet		
Plastic outlet nominal outside diameter	Steel outlet nominal bore diameter	Flow rate
mm	mm	m ³ /h
20	—	3
25	20	3
32	25	4.3
—	40	18
63	50	18

A.2 Apparatus

A.2.1 *Specimen service fitting*, configured as shown in Figure A.1.

A.2.2 *Pressure controller*, capable of giving a steady output of 25 mbar.

A.2.3 *Flow meter*, of the positive displacement or turbine meter type, accurate to $\pm 5\%$, installed in accordance with the requirements of the device selected.

A.2.4 *Inclined manometer* (for pipe pressure).

A.2.5 *Inclined manometer* (for differential pressure).

A.2.6 *Outlet valve*.

A.3 Procedure

A.3.1 Set up the apparatus as shown in Figure A.1.

A.3.2 Connect the inclined manometer across the service fitting and partially open the outlet valve (E).

A.3.3 Open the inlet valve so that gas starts to flow and check that gas flows from the outlet valve only.

A.3.4 By means of pressure controller (A), regulate the pipe pressure (C) to 25 mbar and measure and record the gas flow rate (Q) on flow meter (B) and the pressure drop (ΔP) on the manometer (D).

A.3.5 Open the outlet valve (E) sufficiently to reduce the pipe pressure (C) by approximately 5 mbar.

A.3.6 Increase the flow rate until the pipe pressure (C) returns to 25 mbar and measure and record the gas flow rate (Q) and the pressure drop (ΔP).

A.3.7 Repeat the operations detailed in **A.3.3** and **A.3.4** until the outlet valve (E) is fully open.

A.3.8 Determining the pressure drop

The procedure specified in **A.3** gives a number of pressure drop values and the corresponding flow rate for each. From the relationship:

$$\Delta P = FQ^2 \quad (\text{A.1})$$

where:

ΔP is the pressure drop, in mbar

Q is the gas flow rate, in m³/h

F is a factor.

Calculate the factor *F* for each set of readings and the average value determined.

Using the average value, determine the pressure drop (ΔP) for a gas flow rate (Q) appropriate to the size of service fitting (see Table A.1).

NOTE If air or nitrogen is used for this test, the flow rates should be corrected using the following relationship:

$$Q_{\text{nat}} = Q_{\text{med}} \sqrt{\rho_{\text{med}} / \rho_{\text{nat}}} \quad (\text{A.2})$$

where:

Q_{nat} is the flow rate using natural gas

Q_{med} is the flow rate using other gas

ρ_{med} is the density of other gas.

ρ_{nat} is the density of natural gas

Calculate the number of velocity heads lost across the fitting from:

$$K = \left(\frac{\Delta P}{\rho} \right) \frac{200}{V_2^2} + \left(\frac{V_1^2}{V_2^2} - 1 \right) \quad (\text{A.3})$$

where:

K is the velocity head lost in the fitting based on the velocity in the service pipe

ΔP is the measured pressure drop, in mbar

ρ is the density of natural gas (0.71 kg/m³)

V_1 is the velocity in pipe ($Q_{nat} / A_1 = m / s$)

where:

A_1 is the bore area of the pipe

V_2 is the velocity in service pipe ($Q_{nat} / A_2 = m / s$)

where:

A_2 is the bore area of service pipe under test.

NOTE The equation assumes the density effects due to velocity are negligible.

A.4 Results

The number of velocity heads across the fitting shall be less than or equal to four.

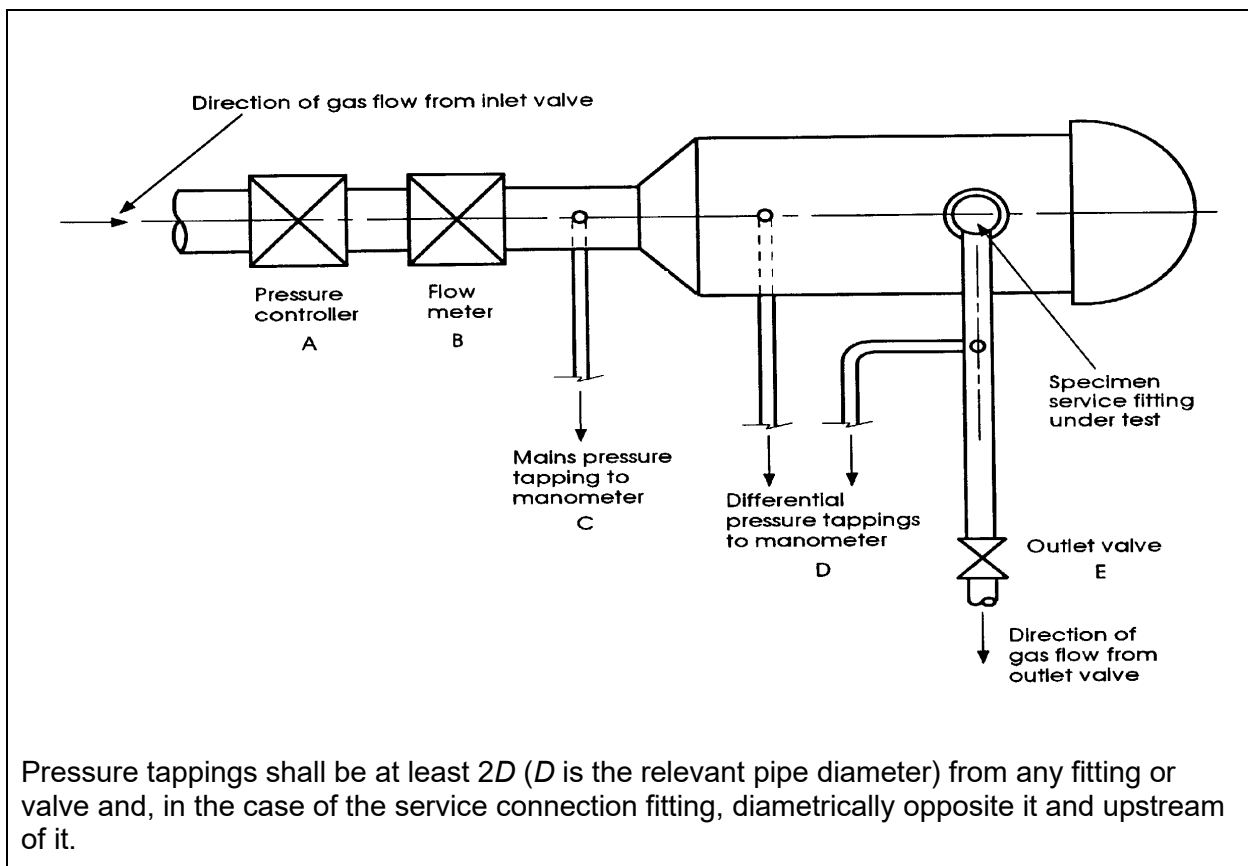


Figure A.1 — Layout of test rig for service connection pressure drop test

Annex B (normative)**Plastic-bodied mains sealing plug or service connection fitting: impact test****B.1 Principle**

This test is to establish whether the assembly can withstand an impact energy of 100 J without failure when applied perpendicular to the fitting.

B.2 Apparatus

B.2.1 *Section of base pipe*, with threaded hole for the item being impact tested, sized to fit in the test assembly as shown in Figure B.1, plugged off at both ends and held securely in the assembly to prevent rotation during impact testing.

B.2.2 *Typical impact test assembly* (see Figure B.1).

B.2.3 *Length of metallic pipe*, three times longer than the normal outside diameter of the base pipe.

B.2.4 *Rigid base plate*.

B.2.5 *Hardened steel weight*, massing (5 ± 0.5) kg, with a hemispherical striking face of 25 mm diameter.

B.3 Procedure

B.3.1 Carry out the test not less than 24 h after fitting and testing the service fittings assembly.

B.3.2 Place the assembly in a conditioning chamber for at least 1 h before testing, at a temperature of $-5\text{ °C} \pm 2\text{ °C}$.

B.3.3 Within 5 min of removing the assembly from the chamber, carry out the testing, at a temperature of $23\text{ °C} \pm 2\text{ °C}$.

B.3.4 Fix the assembly to the rigid base plate. Ensure that the end plugs offer no support to the saddle.

B.3.5 Release the weight onto the assembly from a height of 2 m:

- a) ensure that the weight strikes the assembly 25 mm below its highest point, with an impact direction parallel to the pipe axis to give an impact energy of 100 J.
- b) ensure that the falling weight strikes the assembly perpendicular to the surface.

B.3.6 Turn the assembly upside-down and repeat the test on the opposite face.

B.4 Result

The assembly shall withstand an impact energy of 100 J without failure. This shall be established by subjecting the assembly to a minimum 3 bar pneumatic pressure test for a period of 1 h, after which it shall display no leakage.

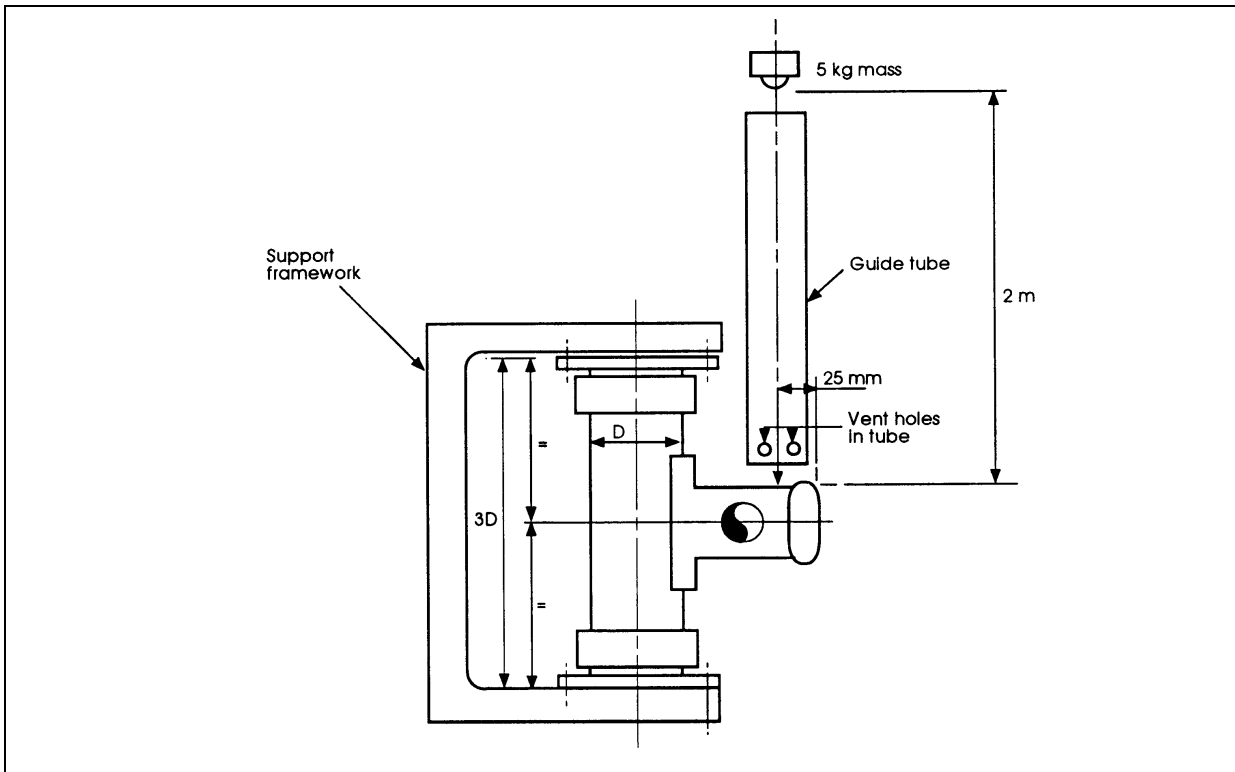


Figure B.1 — Typical impact test assembly

Annex C (normative)

Pneumatic pressure tests on mains sealing plugs and service connection fittings

C.1 Principle

These tests are to ensure that the sealing ability of the fitting's inlet (pipe tapping) and outlet (service connection), the internal sealing plug in the lower or closed position, and the protection cap/plug is adequate.

C.2 Inlet connection seal test

C.2.1 Apparatus

C.2.1.1 Test pipes, in the size combinations for metric and imperial relative to the inlet sizes as given in Table C.1. The test pipes shall have surface corrosion but not deep pitting or loose fragmentation.

C.2.1.2 Three inlet seal test pieces, prepared as shown in Figure C.1 for each inlet and combination given in Table C.1.

C.2.1.3 Pressure gauges, 15 mbar to 3 bar.

C.2.1.4 Test medium, e.g. air.

Table C.1 — Required test pipe combinations for mains sealing plug or service connection fitting inlet sizes

Inlet size	Test pipe materials and diameters	
(BS 21 thread size designation nominal)	Steel pipe conforming to GIS/L2 or ductile pipe conforming to BS EN 969 and *SP/C4	Grey cast iron pipe conforming to BS 4622 or spun iron pipe conforming to BS 1211
	mm	in
$\frac{3}{4}$	150, 450	3, 4, 12, 24
1	150, 450	4, 12, 24
$1\frac{1}{4}$	200, 450	5, 12, 24
$1\frac{1}{2}$	200, 450	6, 12, 24
2	200, 450	8, 12, 24

C.2.1.5 Leak detector solution and applicator brush.

C.2.1.6 Leakage flow meter, or method of calculating the leakage rate (see **C.2.2.4**).

C.2.1.7 Pressure source, capable of being connected to the test specimen and holding the specified test pressure.

C.2.2 Procedure

C.2.2.1 Ensure adequate precautions are in place to provide protection to personnel should a specimen fail under test. In the interests of safety, the test section volume may be reduced by use of a filler rod or suitable solid material.

C.2.2.2 Assemble three fittings with seals on test pipes in each combination given in Table C.1

at 50 % of the recommended torque (see **5.5.5a**). Fill the test assembly with the test medium ensuring it is pressurized to at least 50 mbar and leave to condition for 1 h at temperature of between 20 °C and 26 °C. Attach the specimen to the pressure source and apply the appropriate test pressure for the durations shown in Table C.2. Keep the seals at this torque for a minimum of 24 h. Check for visible leakage on assembly with application of leak detector solution and use of pressure gauge.

C.2.2.3 Further tighten the test seals to twice the manufacturer's recommended torque (see **5.5.5a**). Check for visible leakage on assembly with application of leak detector solution and use of pressure gauge.

C.2.2.4 Partially screw in the threaded part of fitting, ensuring the elastomeric seal does not make any sealing with the test fitting surface. Check for visible leakage on assembly with application of leak detector solution, use of pressure gauge and measure/calculate leakage rate.

C.2.3 Results

C.2.3.1 Under the test conditions in **C.2.2.2**, no visible signs of leakage shall occur at any pressure from 15 mbar to 3 bar inclusive, either initially or at any of the required test pressures or durations shown in Table C.2.

C.2.3.2 Under any of the test conditions, no detrimental mechanical failure, tearing, or extrusion of the elastomeric seal shall take place.

C.2.3.3 The leakage rate under the test conditions in **C.2.2.4** shall not exceed $56 \times 10^{-3} \text{ m}^3/\text{min}$ for the fittings inlet and parent pipe sizes given in Table 3.

C.3 Outlet connection and fitting body seal test

C.3.1 Apparatus

C.3.1.1 *Three inlet seal test pieces*, prepared as for **C.2.1.2**.

C.3.1.2 *Three outlet pieces*, prepared for attachment to outlets of service connection fittings fitting into the relevant test pieces to enable a pneumatic pressure test.

C.3.1.3 *Service connection fittings for steel service pipe*, with minimum insertion length as shown in either Figure 2 or Figure 3, as appropriate for diameter size.

C.3.1.4 *One or more joints*, formed by the outlet assembly, in accordance with the approved instructions from the manufacturer, of at least one fitting and one or more pieces of either:

- a) polyethylene pipe conforming to GIS/PL2-2 (Class B fittings) and GIS/PL2-8 (Class C fittings); or
- b) steel pipe conforming to either BS 1387 (heavy) or GIS/L2 that is degreased and rust-free.

C.3.1.5 *Gland nut on outlet connection*.

C.3.1.6 *Length of pipe between fittings*, four times the outside diameter for pipes of diameter 16 mm to 63 mm inclusive and three times the outside diameter for pipes of diameter 75 mm to 630 mm inclusive.

C.3.1.7 *Test medium*, e.g. air.

C.3.1.8 *Pressure source*, capable of being connected to the test specimen and holding the specified test pressure.

C.3.1.9 *Pressure gauges*, 15 mbar to 3 bar.

C.3.1.10 *Leak detector solution and application brush*.

C.3.1.11 *Leakage flow meter or other method of calculating the leakage rate*.

C.3.1.12 *Bath of clean water*, large enough to be able to immerse the test specimen to a depth of not more than 250 mm.

C.3.2 Procedure

C.3.2.1 Tighten the gland nut to twice the recommended torque (see **5.5.5d**). For fittings that produce a gas seal (either elastomeric or O ring) on the external surface of the polyethylene pipe, notch the polyethylene pipe in accordance with GIS/PL3:2006, **6.3.3.1** and **6.3.3.2**, and Figure A1.

C.3.2.2 Fill the test assembly with the test medium, ensuring it is pressurized to at least 50 mbar, and leave to condition for at least 1 h at a temperature of between 20 °C and 26 °C. In the interests of safety, the volume may be reduced by use of a filler rod or suitable solid material. Check for visible leakage on assembly with application of leak detector solution and pressure gauge.

C.3.2.3 Attach the specimen to the pressure source and apply the appropriate test pressure (see Table C.2). Check for visible leakage on assembly with application of leak detector solution and pressure gauge.

C.3.2.4 Subject Class C fittings to a further 24 h at 1.5 times the fitting's stated maximum operating pressure (see Table C.2). Check for visible leakage on assembly with application of leak detector solution and pressure gauge.

C.3.2.5 Immerse the pressurized specimen in a bath of clean water, at a depth not greater than 250 mm and check for visible leakage in form of bubbles.

Table C.2 — Test pressures and durations for different service pipe specimen materials

Service pipe material (fitting outlet pipe)	Test pressure bar	Duration for Class A and B fittings h	Duration for Class C fittings h
Corrugated polyethylene	1.3	1	Not applicable
Plain polyethylene SDR 11	7	1	24 at 7 bar followed by 24 at 1.5 × MOP
Plain polyethylene SDR 17.6	4.5	1	24 at 4.5 bar followed by 24 at 1.5 × MOP
Plain polyethylene SDR 21	3	1	24 at 3 bar followed by 24 at 3 bar
Plain polyethylene SDR 26	3	1	24 at 3 bar followed by 24 at 3 bar
Steel pipe	1.5 × MOP (maximum operating pressure)	1	24 at 3 bar followed by 24 at 3 bar

C.3.2.6 Service connection fittings with a threaded internal sealing plug and protection cap/plug shall be additionally tested as follows.

- a) Use the internal sealing plug, in its lower position by tightening to the manufacturer's recommended torque [see 5.5.5b)]. Ensure the plug seals the service fitting against 3 bar pneumatic pressure for 24 h and positively holds in the lower (closed) position during pneumatic pressure testing (friction is not sufficient, that is ensure the plug is threaded and not loose/sliding fit). Check for visible leakage on assembly with application of leak detector solution and pressure gauge.
- b) Where the fitting has a protection cap/plug fitted above the internal sealing plug:
 - 1) parallel thread with a separate seal:
 - i) seal three samples of each size at 50 % of the manufacturer's recommended torque [see 5.5.5c)] for 24 h against a pneumatic pressure of 3 bar. Check for visible leakage on assembly with application of leak detector solution and pressure gauge;
 - ii) tighten the protection cap/plug to twice the manufacturer's recommended torque [see 5.5.5c)]. Check for visible leakage on assembly with application of leak detector solution and pressure gauge.
 - 2) taper thread with applied thread jointing compound used to obtain leak-tightness:
 - i) seal three samples of each size at 50 % of the manufacturer's recommended torque [see 5.5.5c)], using the manufacturer's recommended thread jointing compound, for 24 h against a pneumatic pressure of 3 bar. Check for visible leakage on assembly with application of leak detector solution and pressure gauge;

- ii) tighten the protection cap/plug to twice the manufacturer's recommended torque [see 5.5.5c)]. Check for visible leakage on assembly with application of leak detector solution and pressure gauge.

C.3.3 Results

C.3.3.1 No detrimental mechanical failure, tearing or gross extrusion of the elastomeric seal shall take place.

C.3.3.2 Service fittings for steel pipe shall have outlet connections capable of passing the tightness test as shown in C.2.2.

C.3.3.3 For the extra testing on one-piece service fittings with an internal plug:

- a) the internal sealing plug shall stay in position during fitting and pneumatic pressure testing. Friction is not sufficient;
- b) all three samples shall seal initially with no visible leakage, and after a period of 24 h, with no visible damage or leakage.

C.3.3.4 The tested assembly shall not leak at or below the pressures and durations specified for these tests.

C.3.3.5 No visible leakage shall occur whether detected through pressure gauge, underwater immersion or applied leak detector solution.

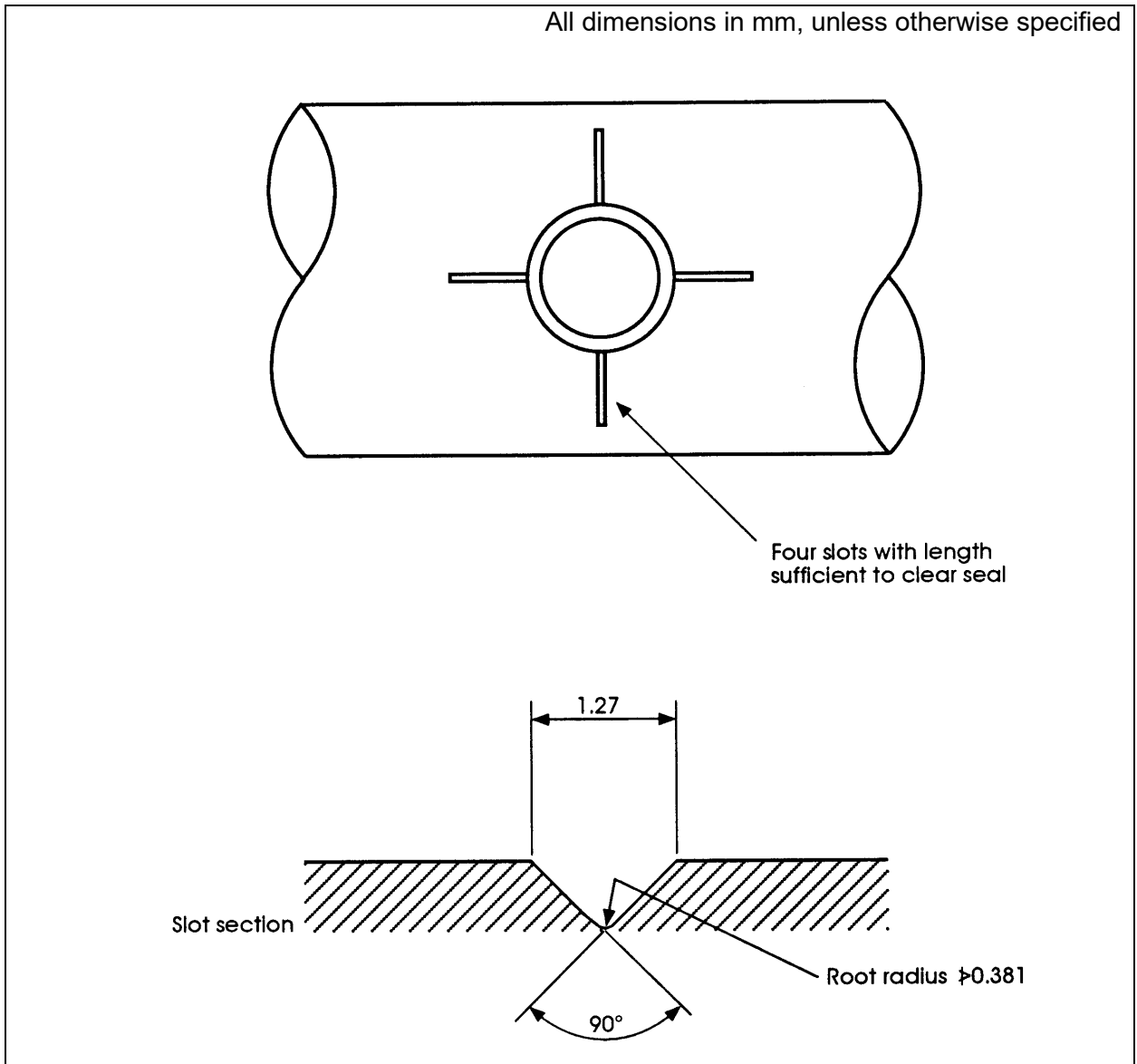


Figure C.1 — Inlet seal test pieces

Annex D (normative)**Service connection fitting: resistance to pull-out tests****D.1 Principle (plain polyethylene pipe)**

This test is to ensure that the plain polyethylene pipe does not pull out of the fitting outlet connection when subjected to a tensile load (not required for electrofused outlet connections).

D.2 Apparatus (plain polyethylene pipe)

D.2.1 Apparatus, used to apply and measure the tensile axial load, agreed with the gas transporter.

D.2.2 Fitting, assembled in accordance with the contractor's approved installation instructions, including:

- a) a polyethylene pipe that conforms to GIS/PL2-2 (for Class B fittings) or GIS/PL2-8 (for Class C fittings) with a free length of at least:
 - 1) four times the nominal pipe diameter of the fitting under test (for pipe sizes not greater than 63 mm); or
 - 2) three times the nominal pipe diameter of the fitting under test (for pipe sizes 75 mm to 630 mm inclusive);
- b) one screwed outlet for each type and diameter of service connection fitting being tested connected to suitable adaptors, used to apply the tensile loads;
- c) no loading grips applied directly to the fitting.

D.2.3 Loading grips.

D.2.4 Service connection fitting assembly, 20 mm.

D.3 Procedure (plain polyethylene pipe)

D.3.1 Clamp the assembly in a jointed assembly with the loading grips not directly applied to the pipe.

D.3.2 Apply a tensile axial load to a 20 mm service connection fitting assembly, as given in Table D.1, between the pipe and the service connection fitting at a cross-head speed of 25×10 mm/min, until necking of the pipe sample of the polyethylene pipe is observed.

D.3.3 Record test temperature and tensile axial load results for 20 mm service connection fitting, pipe necking test.

NOTE Necking is where the PE pipe wall yields due to stretching and its diameter reduces (called necking or waisting) around the stressed area.

D.3.4 Conduct a pneumatic pressure leak test, in accordance with Annex C, to the pipe and 20 mm service connection fitting jointed assembly to check that necking has not affected the leak-tightness of the pipe and no visual signs of pipe damage such as kinking or splitting.

D.3.5 Apply a tensile axial load, in accordance with Table D.1, between the polyethylene pipe and the other range (apart from 20 mm necking test) of service connection fittings under test at a cross-head speed of 25×10 mm/min.

D.3.6 Record the test temperature and tensile axial load results for rest of range under test.

Table D.1 — End load requirements for pull-out test

	End load (min.) kN				
	Class B fittings – PE 80 pipe				Class C fittings
mm	SDR 11	SDR 17.6	SDR 21	SDR 26	SDR 11
16	1.7	—	—	—	—
20	2.2	—	—	—	—
25	2.8	—	—	—	—
32	4.6	—	—	—	—
50	11.0	—	—	—	—
55	13.4	—	—	—	—
63	17.3	—	—	—	23.1
75	24.1	16.2	—	—	32.2
90	35.0	23.4	—	—	46.7
125	67.2	44.1	—	—	89.6
140	78.1	55.0	—	—	111.6
162	—	—	—	51.1	—
180	129.5	91.3	—	63.3	185.0
213	—	—	—	88.4	—
250	248.3	162.8	—	120.7	354.7
268	—	—	—	139	—
315	393.9	257.1	—	189.1	562.8
355	501.4	327.7	276.6	225.7	716.3
400	636.2	415.4	350.1	286.4	908.9
450	803.2	524.9	444.4	362.0	1 147.5
500	993/1	647.2	547.9	446.4	1 418.9
560	1 243.3	812.5	688.3	561.3	1 776.4
630	1 575.5	1 025.9	869.0	705.9	2 251.0

D.4 Results (steel pipe)

D.4.1 The pipe shall not show any visible signs of damage or movement within the jointed assembly of the service connection fitting.

D.4.2 The jointed assembly shall withstand the pneumatic pressure leak test in Annex C and shall not show any visible signs of leakage using pressure gauge and leak detector solution whilst achieving the pull-out requirements listed in Table D.2.

D.4.3 The resistance to pull out of de-greased, rust-free service pipe shall exceed the values given in Table D.2 when the gland nut is tightened to twice the recommended torque.

Annex E (normative)**Short-term strength test for plastic-threaded service connection fittings or mains sealing plugs****E.1 Principle**

This test is to ensure that the level of torque experienced in operational service would be at most 50 % of the torque required to strip the threads from plastic-threaded fittings.

E.2 Apparatus

E.2.1 *Three plastic threaded service connection fittings or mains sealing plugs into the pipe.*

E.2.2 *Steel or cast iron pipes, machined with grooves as shown in Figure C.1 to simulate corrosion, with wall thickness of 5 mm or greater and diameters as shown in Table C.2.*

E.2.3 *Leak detector solution and applicator brush.*

E.2.4 *Torque wrench, calibrated and certified.*

E.2.5 *Pressure gauges, 15 mbar to 3 bar.*

E.2.6 *Test medium, e.g. air.*

E.3 Procedure for determination of torque (T_s)

E.3.1 Test three plastic-threaded service connection fittings or mains sealing plugs, using a new seal each time and averaging the results.

E.3.2 Assemble three service connection fittings or mains sealing plugs into the test piece pipes of relevant sizes, as given in Table 4.

E.3.3 Fit the service connection fittings or mains sealing plugs loosely by hand and pressurize the pipe to 3 bar.

E.3.4 Apply torque to the fittings, or to the back-nut if fitted, in increments of 5 N·m, testing for leakage with leak detector solution at each stage.

E.3.5 When no leakage is observed, leave the assembly under pressure for 24 h, then make a further leakage check.

E.3.6 If leakage is present, repeat the test with a new seal and use a higher torque, until the torque which gives no leakage after a period of 24 h is determined (designated T_s).

E.4 Procedure for plastic-threaded service connection fittings or mains sealing plugs with loose backnut or plug

E.4.1 Apply the torque to the fittings in increments of 5 N·m until the minimum required mechanical strength is reached, e.g. $4 \times T_s$, recording results at each increment.

E.4.2 Test for leakage with leak detector solution at each stage.

E.4.3 Continue in 5 N·m increments until mechanical failure is achieved. Record results and damage description.

E.5 Procedure for fittings without loose backnut or plug

E.5.1 Apply torque to the fittings in increments of 5 N·m until a torque of $2 \times T_s$ is achieved.

E.5.2 Where single-piece fittings comprise separate upper and lower body moulds permanently and securely jointed during manufacture, apply the torque to the upper body and hence across the joint between the body sections.

E.5.3 Tighten the fitting a full turn and record the torque.

E.5.4 If the torque is less than $4 \times T_s$, gradually increase in 5 N·m increments up to $4 \times T_s$, recording results at each increment.

E.5.5 Test for leakage with leak detector solution at each stage.

E.5.6 Continue in 5 N·m increments until mechanical failure is achieved. Record results and damage description.

E.6 Results

E.6.1 The mechanical strength shall be at least $4 \times T_s$.

E.6.2 There shall be no failures of the three fittings tested.

E.6.3 The level of torque required to strip the threads into the pipe or on the backnut shall be at least 100 % greater than the torque normally experienced in service.

Annex F (normative)**Long-term strength test for plastic-threaded service connection fittings or mains sealing plugs****F.1 Principle**

This test is to demonstrate a minimum of a 50-year service life for plastic-threaded fittings.

F.2 Apparatus

F.2.1 *Three plastic-threaded service connection fittings or mains sealing plugs.* .

F.2.2 *Steel or cast iron pipes*, machined with grooves as shown in Figure C.1 to simulate corrosion with wall thickness of 5 mm or greater and diameters as shown in Table C.2.

F.2.3 *Leak detector solution and applicator brush.*

F.2.4 *Torque wrench*, calibrated and certified.

F.2.5 *Socket*, calibrated or certified for design range of fittings to be tested.

F.2.6 *Oven*, capable of providing an air-enriched environment of temperature between 78 °C and 82 °C for a period of at least 168 h.

F.3 Procedure

F.3.1 Assemble three plastic-threaded service connection fittings or mains sealing plugs into pipes of relevant sizes given in Table C.2 and tighten them to the torque (T_s) given in Annex E.

F.3.2 Heat the plastic-threaded service connection fittings or mains sealing plugs in the oven at a temperature between 78 °C and 82 °C, after which examine the plastic components.

F.4 Results

No failures or any damage shall occur to any of the components whether mechanical damage or visible leakage.