# Gas Industry Standard

**GIS/LC14:2009**

Specification for

## Annular gap sealants

nationalgrid

Northern Gas Networks

Scotia Gas Networks plc

WALES&WEST UTILITIES

# Contents

## Contents *(continued)*

## 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

| | |
|---|---|
| First Issued as: GBE/LC14 | November 1993 |
| Revised as: T/SP/LC14 | October 1998 |
| Editorial update to reflect demerger November 2000 | June 2001 |
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| Reviewed on behalf of the Gas Distribution Networks' Technical Standard Forum by BSI | November 2014 |

## 1 Scope

This Gas Industry Standard specifies the physical, chemical and mechanical performance requirements of sealant materials used to prevent the passage of gas along the annulus formed between an inserted plastic pipe and an existing metallic pipe over its lifetime, at an operating temperature range of between –5 °C and 30 °C operating at pressures of up to and including 75 mbar.

## 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.

**Gas Industry Standards**

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 fitting.*

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

**National Grid standards**

T/PR/DIS/5.5.1, *Work procedure — Pressure testing — Hydrostatic and advanced (acoustic) pressure testing of medium and intermediate pressure gas mains and services, and pressure testing service risers supplying more than two emergency control valves operating low pressure.*

T/PR/DIS/5.10.1, *Work procedure for service entries for multi-storey premises.*

**Government standards**

*New Roads and Street Works Act 1991: Specification for the reinstatement of openings in highways* [1]

## 3 Terms and definitions

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

**3.1**
**service head adapter**
class B metal bodied fitting used within premises to join a steel encased polyethylene service to a steel pipe conforming to GIS/PL3

**3.2**
**“fill and drain” process**
process to internally seal the pipe threads of service risers by completely filling the pipe with a sealant and allowing the excess to drain

**3.3**
**primary seal**
permanent seal of the annular space between the polyethylene pipe and the steel carrier pipe

**3.4**
**interim seal**
mechanism for preventing the passage of gas between the polyethylene pipe and steel carrier pipe during insertion and to act as a retaining seal for the annular gap sealant, e.g. a nose cone

**3.5**
**system**
method of inserting a polyethylene pipe into a carrier pipe and permanently sealing the annular space between the polyethylene pipe and the carrier pipe

**3.6**
**liquid B**
standard simulated fuel mixture consisting of 70 % vol. 2,2,4-trimethylpentane (iso-octane) and 30 % vol. toluene

**3.7**
**live service insertion**
insertion under live gas conditions where the sealant is exposed to live gas during its working life

**3.8**
**dead service insertion**
insertion under no gas conditions where the sealant is not normally exposed to live gas during its working life

## 4 Basic properties of annular gap sealants

### 4.1 General

**4.1.1** The annular gap sealant shall meet the full specification at the end of the specified shelf life.

**4.1.2** The annular gap sealant shall be non-biodegradable.

**4.1.3** The risks from using the components and reacted sealants shall be as low as reasonably practicable under all site operating conditions.

NOTE Acceptance of products can only be granted following appropriate risk and COSHH assessments being undertaken.

**4.1.4** There shall be no adverse chemical effects (e.g. dissolution or softening) by the reacted annular gap sealant or by un-reacted components on the inserted polyethylene pipe. The test for stress corrosion cracking shall be performed in accordance with Annex A.

### 4.2 Size of inserted pipe

The preferred sizes of plastic pipe inserted into an existing service pipe or metallic pipe are given in Tables 1 and 2 respectively.

### 4.3 Uncured sealant

Using a standard sealant kit, the annular gap sealant shall be capable of filling the annular space at a distance of at least 4 m for the pipe sizes given in Tables 1 and 2.

### 4.4 Fully cured product

Assuming no external interference, the annular gap sealant shall perform successfully in accordance with the accelerated ageing tests as detailed in Annex C for services up to 2 in diameter. In the case of mains insertion, the relevant life test is detailed in Annex V. Successful completion of these tests indicates a projected lifetime of greater than or equal to 50 years.

**Table 1 — Preferred diameters of plastic pipe inserted into metallic services**

| **Diameter of existing steel pipe** in | **Preferred diameter of service insertion pipe** mm |
|---|---|
| ¾ | 16 |
| 1 | 20 (standard polyethylene or corrugated pipe) |
| 1¼ | 25 |
| 1½ | 32 and 25 |
| 2 | 23 and 40 |

**Table 2 — Preferred diameters of plastic pipe inserted into metallic mains**

| **Diameter of existing steel pipe** in | **Preferred diameter of service insertion pipe** mm |
|---|---|
| 3 | 63 |
| 4 | 63 and 75 |
| 5 | 90 |
| 6 | 125 |
| 7 | 125 |
| 8 | 180 |
| 9 | 180 |
| 10 | 180 |
| 12 | 250 |
| 15 | 355 |
| 18 | 400 |
| 24 | 500 |

## 5 Service insertion systems up to 2 in in diameter

### 5.1 Service head adapter

The service head adapters shall meet the requirements of GIS/PL3 and be installed in accordance with the manufacturer’s instructions to ensure that the annular gap sealant does not exude from the fitting during injection.

## 5.2 Dead service insertion

### 5.2.1 *Pressure*

The effectiveness of the annular gap sealant shall be determined by an initial short term pressure test and a subsequent 6 month test, performed in accordance with Annex B. The pressure drop shall not exceed 1 mbar at a pressure of 100 mbar for each of the three samples when tested after a 6 month period.

### 5.2.2 *Lifetime*

The lifetime of the annular gap sealant shall be determined by the test detailed in Annex C. Successful completion of this test indicates a predicted service life of at least 50 years.

### 5.2.3 *Annular gap sealant flow*

An annular gap sealant flow test shall be carried out in accordance with Annex D to ensure that within a specified temperature range, the annular gap sealant can successfully fill the annulus when corrosion holes are present.

Failure is deemed to have occurred if the sealant cannot bridge the 2 mm and 10 mm holes. Failure is also deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at a pressure of 100 mbar for a period of 5 min.

### 5.2.4 *Slump*

A slump test shall be carried out in accordance with Annex E to ensure that the annular gap sealant can successfully fill the annulus when large volumes of material are required.

Failure is deemed to have occurred if the sealant has not completely filled the annular space between the polyethylene and the steel carrier pipe when both of the two 300 mm lengths of the assembly are visually examined. Failure is also deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer.

### 5.2.5 *Thermal cycling*

A thermal cycling test shall be carried out in accordance with Annex F to ensure that there is no detrimental effect on the annular gap sealant properties.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer after 400 cycles.

### 5.2.6 *Contamination*

A test shall be carried out in accordance with Annex G to ensure that the contaminants commonly found in gas distribution systems do not affect the performance of the annular gap sealant.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar over a 5 min period after 24 h of sealant cure and a further 1 month after sealant cure.

## 5.3 Live service insertion

### 5.3.1 *Systems inserted from the garden*

#### **5.3.1.1** *General*

Systems shall meet the requirements of Clause **4**, **5.2.2**, **5.2.3**, **5.2.4**, **5.2.5**,**5.2.6**, **5.3.1.2** and **5.3.3**.

The manufacturer shall state, in general terms, the method of operation of their annular gap sealant. The compatibility of all components intended for use within a particular system shall be proven for that system. The annular gap sealant shall be clearly marked as compatible with the

particular system(s). The manufacturer shall also specify a maximum fill length for their annular gap sealant for each pipe diameter.

**5.3.1.2** *Full system application*

Systems submitted for live insertion from the garden shall be demonstrated on a simulated live main and service (see Annex H) under a pressure of 75 mbar, the service connected to the main by a top tee. The primary seal shall be achieved within 100 mm of the connection to the main. Annular gap sealant shall not pass the interim seal.

Allow the annular gap sealant to cure for the minimum time as specified by the manufacturer. The garden fitting shall be removed and a 100 mbar pressure decay test shall be applied to the primary seal only. Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer over 5 min. This shall be demonstrated on one service of 20 mm polyethylene inserted in 1 in steel and one service of 32 mm polyethylene inserted in 2 in steel. The primary seal shall then be subjected to a further applied pressure of 100 mbar after 6 months. Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer over 5 min.

**5.3.2** ***Systems inserted from inside the property***

**5.3.2.1** *General*

Systems shall meet the requirements of Clause **4**, **5.1**, **5.2.2**, **5.2.3**, **5.2.4**, **5.2.5**, **5.2.6**, **5.3.2.2** and **5.3.4**.

The manufacturer shall state, in general terms, the method of operation of their annular gap sealant. The compatibility of all components intended for use within a particular system shall be proven for that system. The annular gap sealant shall be clearly marked as compatible with the particular system(s). The manufacturer shall also specify a maximum fill length for their annular gap sealant for each pipe diameter.

**5.3.2.2** *Full system application test*

Systems submitted for live insertion from inside the property shall be demonstrated on a simulated live main and service (Annex J) under a pressure of 75 mbar, the service connected to the main by a top tee. The primary seal shall be achieved within 100 mm of the connection to the main. Sealant shall not pass the interim seal. Allow the sealant to cure for the minimum time as specified by the manufacturer. The service head adapter shall be removed and a 100 mbar pressure decay test shall be applied to the annular gap sealant only. Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer over 5 min. This shall be demonstrated on one service of 20 mm polyethylene inserted into 1 in steel and one service of 32 mm polyethylene inserted into 2 in steel. The primary seal shall then be subjected to a further applied pressure of 100 mbar after 6 months. Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer over 5 min.

**5.3.3** ***Field application test for systems inserted from the garden***

**5.3.3.1** The field application test shall require a minimum of 60 live service insertions to be undertaken. The range of service pipe diameters and insertion lengths shall be representative of the size of service insertion to be proved by the trial.

**5.3.3.2** Live insertion shall be carried out in accordance with T/PR/DIS/5.10.1 and the manufacturer's/supplier's installation instructions. The instructions shall include all additional items and equipment that are required to carry out the installation.

**5.3.3.3** Information relating to each installation shall be recorded in accordance with Annex J. Monitoring before and after installation shall be in accordance with Annex K.

**5.3.3.4** A sample of 30 installations shall be extracted for on-site testing in accordance with Annex L. Assessment of the extracted samples shall be in accordance with Annex M.

All services are required to be subjected to pass the following tests:

— 100 mbar pressure drop test of annular space for 5 min, with a maximum of 1 mbar pressure drop allowed;

— a 95 % fill of the annular space along the length of service pipes which are over 5 m in length. For service pipes less than 5 m in length, a 100 % fill of the annular space is required;

— there shall be no evidence of voids within the 0.5 m section removed from the service pipe;

If there are more than four services that fail any of the criteria in the list above then the material will be deemed to have failed to meet the requirements of this document.

**5.3.3.5** A minimum of 29 samples (only one failure permitted) shall be required to pass the criteria detailed in Annex M. In the event of two or more failures occurring, then the sample size will need to be increased in line with figures given in Table M.1 and **M.2.6**.

All services are required to be subjected to pass the following tests:

— 100 mbar pressure drop test of annular space for 5 min, with a maximum of 1 mbar pressure drop allowed. If the pressure drop is greater than 1 mbar, then the leakage flow rate shall be less than 0.8 l/min;

— a 95 % fill of the annular space along the length of service pipes which are over 5 m in length. For service pipes less than 5 m in length, a 100 % fill of the annular space is required;

— there shall be no evidence of voids within the 0.5 m section removed from the service pipe.

If there are more than three services that fail any of the criteria in the list above then the material will be deemed to have failed to meet the requirements of this document.

**5.3.4** ***Field application test for systems inserted from inside the property***

**5.3.4.1** The field application test shall require a minimum of 225 live service insertions to be undertaken. The range of service pipe diameters and insertion lengths shall be representative of the size of service insertion to be proved by the trial.

**5.3.4.2** Live insertion shall be carried out in accordance with T/PR/DIS/5.10.1 and the manufacturer's/supplier's installation instructions. The instructions shall include all additional items and equipment that are required to carry out the installation.

**5.3.4.3** Information relating to each installation shall be recorded in accordance with Annex J. Monitoring before and after installation shall be in accordance with Annex K.

**5.3.4.4** A minimum sample of 200 installations shall be extracted for on-site testing in accordance with Annex L. Assessment of the extracted samples shall be in accordance with Annex N.

**5.3.4.5** Out of a minimum of 200 tests only a maximum of one service insertion failure shall be permitted. Note that in the event of a single failure, the flow rate shall not exceed 1.77 $ft^3$/h. All remaining services shall be required to pass the criteria detailed in Annex N.

**5.3.4.6** In the event of two or more failures occurring, then the sample size will need to be increased in line with figures given in Table N.1 and **N.2.6**. Note that the leakage associated with any acceptable failure shall not exceed 1.77 $ft^3$/h.

## 6 Service insertion above 2 in in diameter

### 6.1 Dead insertion

#### 6.1.1 *General*

The annular gap sealant shall meet the requirements of Clause **4**, **5.2.1**, **5.2.2**, **5.2.3**, **5.2.5**, **5.2.6** and **6.1.2**.

#### 6.1.2 *Slump*

A slump test shall be carried out in accordance with Annex O to ensure that the annular gap sealant material can successfully fill the annulus when large volumes of sealant are used. The maximum temperature rise during the curing of the sealant shall not exceed 70 °C.

Failure is deemed to have occurred if the sealant has not completely filled the annular space between the polyethylene and the steel carrier pipe when both of the two lengths of the assembly are visually examined. Failure is also deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at a pressure of 100 mbar 24 h after sealant cure and 1 month after sealant cure.

### 6.2 Dead insertion into high rise buildings

#### 6.2.1 *General*

The annular gap sealant shall meet the requirements of **6.1** and **6.2.2**.

#### 6.2.2 *Adhesion to "fill and drain" materials*

To demonstrate that the annular gap sealant performs effectively when pipes have been subjected to the "fill and drain" process, a test shall be carried out in accordance with Annex P.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar at a source pressure of 100 mbar over a 5 min period is indicated by a standard water manometer 24 h after sealant cure and 1 month after sealant cure.

### 6.3 Live insertion

#### 6.3.1 *Systems inserted from the garden*

The annular gap sealant shall meet the requirements of Clause **4**, **5.2.2**, **5.2.3**, **5.2.5**, **5.2.6**, **5.3.1.2**, **5.3.3** and **6.1**.

#### 6.3.2 *Systems inserted from inside the property*

The annular gap sealant shall meet the requirements of Clause **4**, **5.1**, **5.2.2**, **5.2.3**, **5.2.5**, **5.2.6**, **5.3.2.2**, **5.3.4** and **6.1**.

## 7 Mains insertion

### 7.1 Dead mains insertion

#### 7.1.1 *General*

The manufacturer shall specify a maximum fill length obtained for their annular gap sealant for each pipe diameter at 5 °C and 25 °C. The annular gap sealant shall meet the requirements of Clause **4**, and **5.2.2** plus the requirements given in **7.1.2** to **7.1.4**.

#### 7.1.2 *Slump*

A slump test shall be carried out in accordance with Annex Q to ensure that the annular gap sealant material can successfully fill the annulus when large volumes of annular gap sealant are used. The maximum temperature rise during the curing of the sealant shall not exceed 70 °C.

Failure is deemed to have occurred if the sealant has not completely filled the annular space between the polyethylene and the steel carrier pipe when both of the two lengths of the assembly are visually examined. Failure is also deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer over 5 min at a pressure of 100 mbar, 24 h and 6 months after sealant cure.

#### 7.1.3*Contamination*

A test shall be carried out in accordance with Annex R to ensure that the contaminants commonly found in gas distribution systems do not affect the performance of the annular gap sealant.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h and 1 month after sealant cure.

#### 7.1.4 *Sealant flow test*

A test shall be carried out in accordance with Annex S to ensure that the annular gap sealant can successfully fill the annulus if corrosion damage is present in the host main.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h and 1 month after sealant cure.

### 7.2 Live mains insertion

#### 7.2.1 *General*

The manufacturer shall specify the maximum fill length for their annular gap sealant for each pipe diameter at temperatures of 5 °C and 25 °C.

#### 7.2.2 *Service transfer material*

For the service transfer material, the annular gap sealant shall be tested in accordance with Annex T.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 1 hour and 24 hours after sealant cure.

#### 7.2.3 *End seals*

For the end seal material, the annular gap sealant shall be tested in accordance with Annex U.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 1 h and 6 months after sealant cure.

### 7.3 Live mains transfer

#### 7.3.1 *General*

The manufacturer shall specify the maximum fill length for their annular gap sealant for each pipe diameter at temperatures of 5 °C and 25 °C.

NOTE The range of mains that can be transferred by this method is shown in Table 3.

**Table 3 — Range of mains suitable for live mains transfer**

| **Diameter of existing metallic pipe**<br>in | **Diameter of inserted polyethylene pipe**<br>mm |
|---|---|
| 3 | 55 |
| 4 | 75 |
| 6 | 125 |

### 7.3.2 *Pressure*

The effectiveness of the annular gap sealant shall be determined by an initial short-term pressure test and a subsequent 6 month test, performed in accordance with Annex V.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h and 6 months after sealant cure.

### 7.3.3 *Lifetime test*

The lifetime of the annular gap sealant shall be determined by the test detailed in Annex W. Successful completion of this test indicates a predicted service life of at least 50 years. When the lower edge of the failure band is extrapolated to 50 years, the corresponding pressure shall not be less than 1.5 times the maximum working pressure (see Figure W.2).

### 7.3.4 *Annular gap sealant flow*

An annular gap sealant flow test shall be carried out in accordance with Annex X to ensure that within a specified temperature range, the annular gap sealant can successfully fill the annulus when corrosion holes are present.

The sealant shall bridge the simulated corrosion hole in the pipe.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h and 1 month after sealant cure.

### 7.3.5 *Slump test*

A slump test shall be carried out in accordance with Annex Y to ensure that annular gap sealant material can successfully fill the annulus when large volumes of sealant are used. The maximum temperature rise during the curing of the sealant shall not exceed 70 °C.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h and 6 months after sealant cure.

### 7.3.6 *Thermal cycling test*

A thermal cycling test shall be carried out in accordance with Annex Z to ensure that there is no detrimental effect on the annular gap sealant properties.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h after sealant cure. Failure is also deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h after 200 thermal cycles.

### 7.3.7 *Contamination test*

A test shall be carried out in accordance with Annex AA to ensure that the contaminants commonly found in gas distribution systems do not affect the performance of the annular gap sealant.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period 24 h and 6 months after sealant cure.

### 7.3.8 *Full system application test*

A full system test shall be carried out in accordance with Annex BB.

Annular sealant shall not have flowed passed the front face of the nose cone by more than 20 mm and also shall not encroach into the bore of the nose cone.

Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer at 100 mbar over 5 min period after removal of the nose cone.

### 7.3.9 *Field application test*

A field application test shall be carried out in accordance with Annex CC.

The field application test will be deemed to have failed if annular sealant does not meet the following requirements.

- It shall be possible to insert the polyethylene pipe and nose cone into the parent main to the desired location under live gas conditions.
- The minimum fill length of cured annular sealant shall be 3 m.
- Annular sealant shall not leak past the front of the nose cone and into the parent main by more than 20 mm and shall not encroach into the bore of the nose cone.

## Annex A (normative)
## Environmental stress cracking of polyethylene pipe

### A.1 Principle

This test determines the ability of an annular gap sealant to promote environmental stress cracking in polyethylene pipe. For multi-part annular gap sealants, each part is tested separately.

### A.2 Apparatus

**A.2.1** *Airtight glass container*, 250 ml.

**A.2.2** *Polyethylene pipe*, 25 mm diameter (SDR11 polyethylene conforming to GIS/PL2-1).

**A.2.3** *Nylon cable ties*.

**A.2.4** *Razor blades*.

### A.3 Test samples

Four test pieces of 25 mm diameter SDR11 polyethylene pipe by 12.7 mm wide.

### A.4 Procedure

Cut four test pieces 12.7 mm wide from the 25 mm diameter pipe (see Figure A.1).

With reference to Figure A.1, cut a notch 19 mm long · 0.64 mm deep in each ring using the razor blade. Place the notch in the centre of the ring and parallel to the edge.

Compress the rings until the inner section of the middle areas touch. Secure this compression using a nylon cable tie. During compression, place the notched area parallel to the direction of compression, i.e. on the short radius (see Figure A.1).

Immediately immerse three of the rings (the fourth ring being the control sample) into 125 ml of the un-reacted liquid component in a 250 ml capacity sealed glass container, maintained at a temperature of 23 °C ±2 °C.

Examine samples for crack initiation in the notched area after 1 week, 1 month and 4 months. Use a low magnification (·10) glass with an illumination lamp. Compare with control sample.

### A.5 Expression of results

Record if is there is any dissolution or softening of the test pieces after 1 week, 1 month and 4 months.

### A.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

All dimensions in millimetres

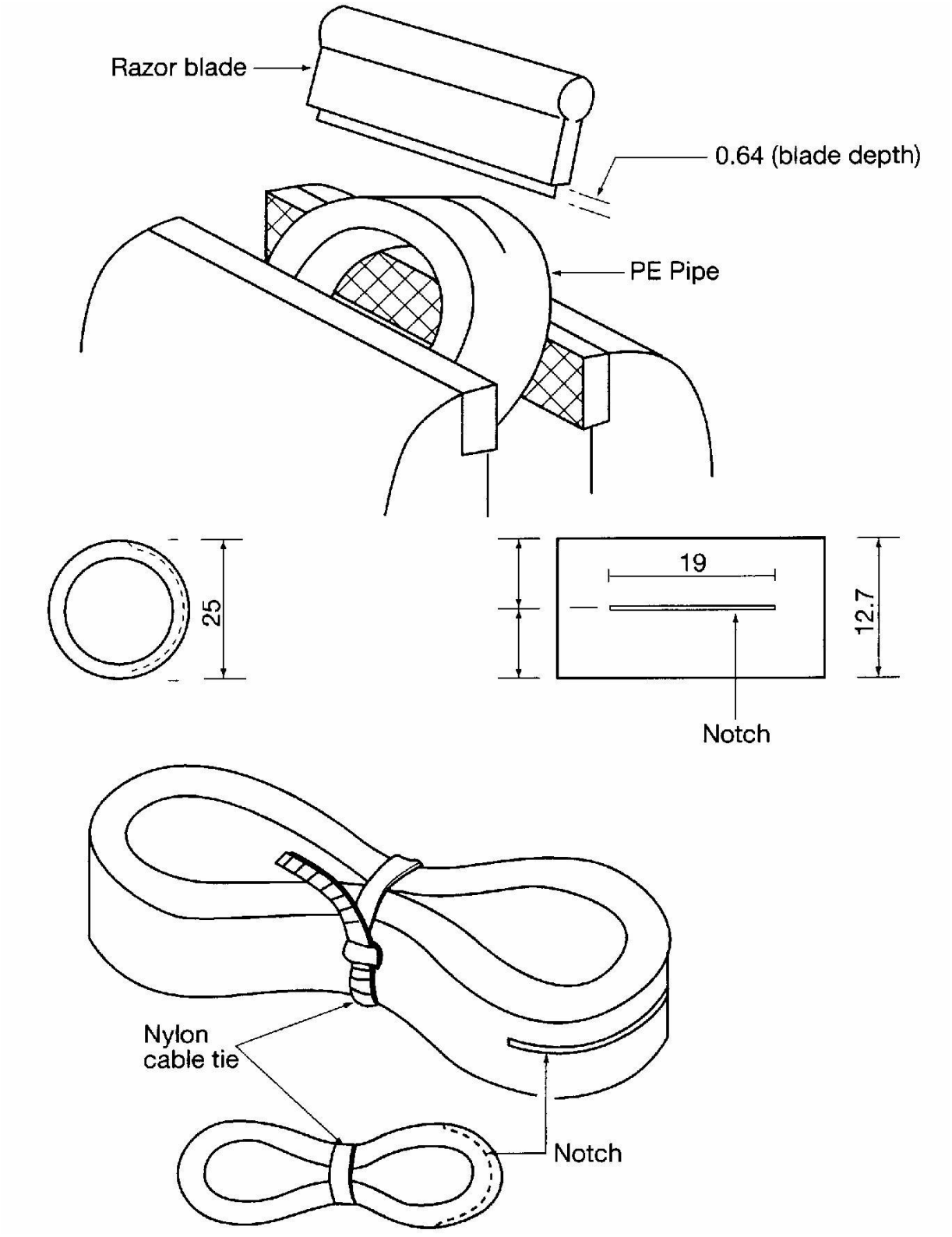


**Figure A.1 — Test pieces for environmental stress cracking test**

## Annex B (normative)
## Pressure test

### B.1 Principle

This test determines the ability of short lengths of annular sealant in an inserted pipe to resist operating pressures over a 6 month period.

NOTE 1 For services below 2 in diameter, use 1 in diameter steel service pipe and 20 mm diameter polyethylene pipe.

NOTE 2 For services above 2 in diameter, use 3 in diameter steel service pipe and 63 mm diameter polyethylene pipe

### B.2 Apparatus

**B.2.1** *Service head adaptor*.

**B.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**B.2.3** *Water manometer*.

**B.2.4** *Steel pipe*, either 1 in or 3 in.

### B.3 Test sample

One test sample as shown in Figure B.1.

### B.4 Procedure

Degrease the sections and threads of the steel service pipe. Assemble the service as shown in Figure B.1.

Ensure all screwed joints are leak proof, i.e. use an approved jointing paste.

Insert the polyethylene pipe and fit the service head adapter.

Carry out annular gap filling by following the annular gap sealant manufacturer’s instructions. Ensure the volume of annular gap sealant kit used is sufficient to fill the annulus to excess.

Allow a maximum of 24 h cure time and remove the service head adapter. Subject the assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min. If a pressure drop of more than 1 mbar is indicated by a standard water manometer then proceed to the 6 month pressure test.

Then section the assembly such that three 1 m lengths of straight pipe are available. Then subject each section to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it. Record the pressure drop over a 5 min period. Maintain the pressure for 6 months and repeat the pressure drop test at 100 mbar over a 5 min period.

### B.5 Expression of results

The pressure drop in millibars over a 5 min period for the whole of the assembly.

The pressure drop in millibars over a 5 min period for the three 1 m lengths, and after a 6 month period.

### B.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

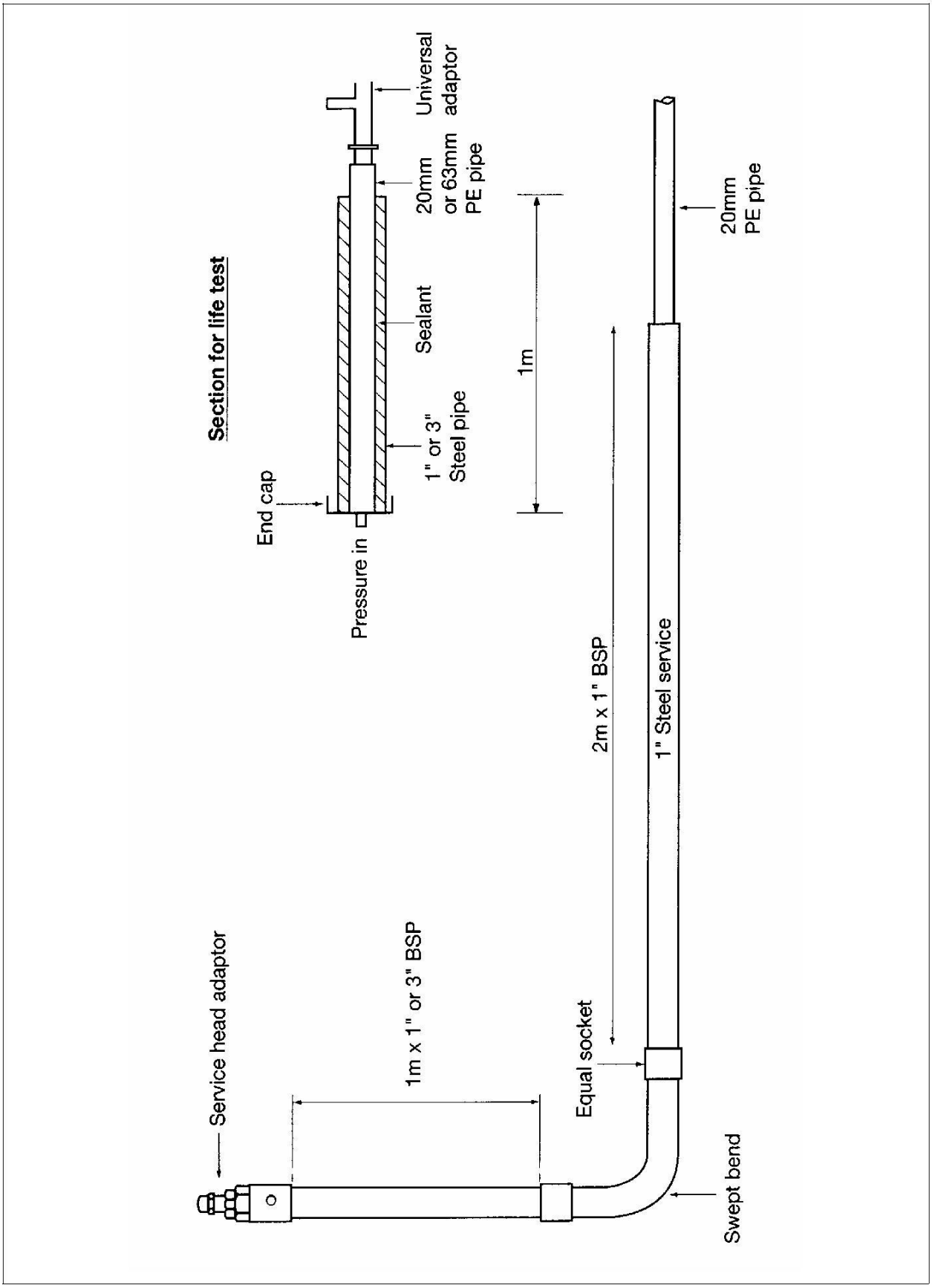


**Figure B.1 — Assembly for pressure test**

## Annex C (normative)
## Lifetime prediction

### C.1 Principle

This test determines the predicted life of the annular sealant.

NOTE Chemical degradation generally follows an Arrhenius relationship and it is assumed as a general rule that for every 10 °C rise in temperature the reaction rate of the sealant doubles.

### C.2 Apparatus

**C.2.1** *Pressure source*, capable of supplying pressure at 120 mbar.

**C.2.2** *Water manometer*.

**C.2.3** *Oven*, capable of being maintained 100 °C.

### C.3 Test samples

Three 1 m lengths of 1 in diameter steel.

Three 1.2 m lengths of 20 mm polyethylene pipe and six polyethylene electro-fusion end caps.

### C.4 Procedure

Prepare three 1 m lengths of 1 in diameter steel service pipe. Fill each pipe with liquid B. Empty and allow to drain for 5 min. Repeat with GMO 60 and again with MEG.

Insert the 20 mm polyethylene pipe and fit end caps.

Carry out annular gap filling by following the sealant manufacturer's instructions. Ensure the volume of annular gap sealant kit used is sufficient to fill the annulus to excess.

Allow a maximum of 24 h cure time. Subject the assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar (40 in wg) applied to it for 5 min. At this stage if the pressure drop is more than 1 mbar in 5 min then the lifetime test has not been passed, it is permissible to prepare a further three samples at this stage in accordance with **C.1** to **C.3** and repeat the initial pressure drop test at 100 mbar. If a pressure drop of more than 1 mbar in 5 min is recorded, carry out no further testing.

Place the three samples in an oven at temperature $T_1$, where $T_1$ is either 100 ℃ or 15 ℃ above the maximum possible continuous operating temperature of the sealant, whichever is the lower.

After 3 days, perform a pressure test so that only the annular gap has a pressure of 100 mbar applied to it for 5 min. Failure is deemed to have occurred if a pressure drop of more than 5 mbar is indicated by a standard water manometer on any of the three samples over the 5 min period. Record the pressure drop and the time exposed at $T_1$.

If all the three samples pass the pressure test then repeat the above testing procedure after a further 4 days and then once each week. If leakage greater than 5 mbar in 5 min is recorded, then record the time to failure.

If no failure is recorded then continue testing until the time $t_{max}$ is reached. $t_{max}$ (in hours) is given by the following equation:

$$t_{max} = 438\,000 / 2^{(T_1 - 10)/10}$$

where 438 000 is the approximate number of hours in 50 years.

If no failure has occurred by $t_{max}$ then no further testing is required.

If a time to failure is recorded at $T_1$ then prepare three further samples as described above. Repeat the testing at $T_2$ ($T_2 = T_1 - 10$ ℃) until one or more of the samples fail the test or $t_{max}$ is

reached. (The value of $t_{max}$ is calculated using the above equation but $T_1$ is replaced with $T_2$.) If no failure is recorded by $t_{max}$ then no further testing is required.

If a time to failure is recorded at $T_2$ then prepare three further samples as described above. Repeat the testing at $T_3$ ($T_2$ = –10 °C) until one or more of the samples fail the test or $t_{max}$ is reached. (The value of $t_{max}$ is calculated using the above equation but $T_2$ is replaced with $T_3$.)

If no failure has occurred by $t_{max}$ then no further work is required.

If failure has occurred before time $t_{max}$ then plot log time to failure on the y-axis against 1/absolute temperature (in Kelvin) on the x-axis. Interpolate from the three results to obtain the time to failure at a temperature of 10 °C.

### C.5 Expression of results

Record the pressure drop over a 5 min period at a test period of 100 mbar after the initial 24 h sealant cure period.

Record temperature $T_1$, the associated value of $t_{max}$ and the pressure drop over a 5 min period at a test period of 100 mbar.

If the pressure drop at temperature $T_1$ is greater than 1 mbar over 5 min then record temperature $T_2$, the associated value of $t_{max}$ and the pressure drop over a 5 min period at a test period of 100 mbar.

If the pressure drop at temperature $T_2$ is greater than 1 mbar over 5 min then record temperature $T_3$, the associated value of $t_{max}$ and the pressure drop over a 5 min period at a test period of 100 mbar.

If the pressure drop at temperature $T_3$ is greater than 1 mbar over 5 min then plot log time to failure on the y-axis against 1/absolute temperature (in Kelvin) on the x-axis. Interpolate from the three results at $T_1$, $T_2$ and $T_3$ to obtain the time to failure at a temperature of 10 °C.

### C.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

## Annex D (normative)
## Service sealant flow test

### D.1 Principle

This test determines the ability of the sealant to flow within an annular gap and bridge simulated corrosion holes in the test pipe.

### D.2 Apparatus

**D.2.1** *Service head adaptor*.

**D.2.2** *Steel pipe*.

**D.2.3** *Polyethylene pipe*.

**D.2.4** *Pressure source*, capable of supplying pressure at 120 mbar.

**D.2.5** *Water manometer*, capable of reading up to 120 mbar.

**D.2.6** *Environmental chamber*, capable of being maintained at –5 °C.

**D.2.7** *Environmental chamber*, capable of being maintained at 30 °C.

**D.2.8** *Drill*.

**D.2.9** *Drill bits*, 2 mm and 10 mm in diameter.

NOTE 1 For services below 2 in diameter, use 1 in diameter steel service pipe and 20 mm diameter polyethylene pipe.

NOTE 2 For services above 2 in diameter, use 3 in diameter steel service pipe and 63 mm diameter polyethylene pipe.

### D.3 Test samples

Two test samples as shown in Figure D.1

### D.4 Procedure

Degrease the sections and threads of the steel service pipe. Assemble the service as shown in Figure D.1 and drill three holes 2 mm in diameter in the swept bend. Two assemblies are required, one maintained at a temperature of –5 ℃ and the other at a temperature of 30 ℃.

Ensure that all screwed joints are leak proof, i.e. use an approved jointing paste.

Insert the polyethylene pipe and fit the service head adapter.

Carry out two tests, one using sealant material which has been stored at a temperature of 5 ℃ and the other at a temperature of 2 ℃, both for a minimum period of 12 h before the test.

Carry out annular gap filling via the service head adapter by following the sealant manufacturer’s instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess.

Use the sealant stored at a temperature of 5 ℃ in the assembly maintained at a temperature of –5 ℃ and the sealant stored at a temperature of 25 ℃ in the assembly maintained at a temperature of 30 ℃.

Observe the extent that the sealant cannot bridge the drilled holes in the swept bend and successfully fill the annular gap of the assembly.

Allow a maximum of 24 h cure time and remove the service head adapter. Subject the assembly to a pneumatic pressure test so that the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

The above procedure shall be repeated on assemblies where a 10mm diameter hole is drilled in the swept bend. The pipework shall be supported with an uncompacted 50/50 mixture (by volume) of 10mm gravel and dry sand contained in a box 30cm square and 45cm deep. The bend shall be central in the box and covered to a depth of 30cm.

### D.5 Expression of results

Record the temperatures of the samples and the sealant for each test.

Record whether the annular sealant is capable of bridging the 2 mm diameter holes.

Record whether the annular sealant is capable of bridging the 10 mm diameter hole.

After 24 h cure time, record the pressure, the time for holding the pressure and any pressure drop on the sample.

### D.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

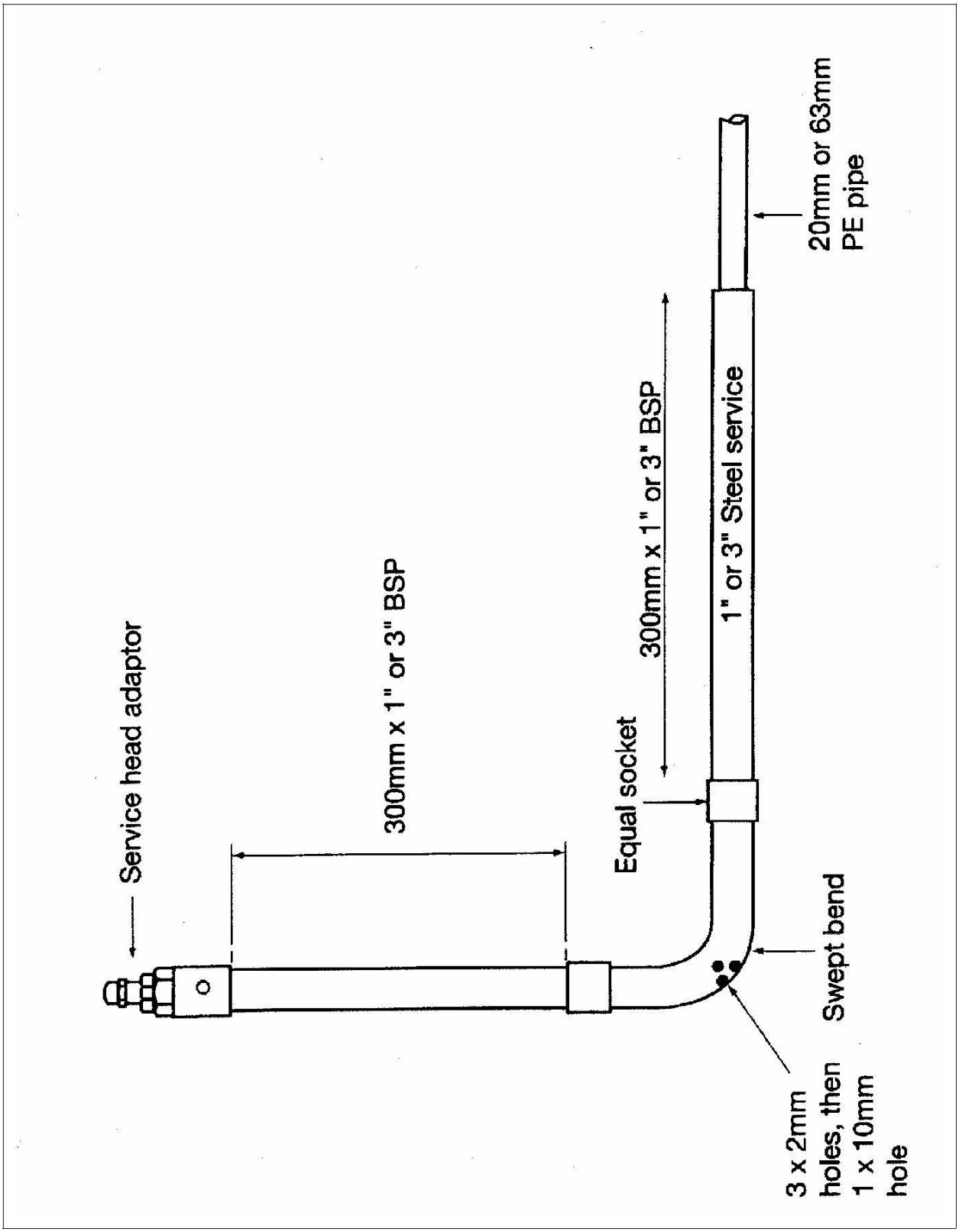


**Figure D.1 — Assembly for service sealant flow test**

## Annex E (normative)
## Service sealant slump test

### E.1 Principle

This test determines the ability of the sealant to be able to fill the annular gap without slumping.

### E.2 Apparatus

**E.2.1** *Service head adaptor*.

**E.2.2** *Steel pipe*, 2 in.

**E.2.3** *Polyethylene pipe*, 32 mm.

**E.2.4** *Pressure source*, capable of supplying pressure at 120 mbar.

**E.2.5** *Water manometer*, capable of reading up to 120 mbar.

**E.2.6** *Environmental chamber*, capable of being maintained at –5 °C.

**E.2.7** *Environmental chamber*, capable of being maintained at 30 °C.

### E.3 Test samples

Two samples of polyethylene pipe inserted into steel pipe.

### E.4 Procedure

Degrease the sections and threads of the 2 in diameter steel service pipe. Assemble as shown in Figure E.1. Two assemblies are required, one maintained at a temperature of –5 ℃ and the other at a temperature of 30 ℃.

Ensure all screwed joints are leak proof, i.e. use an approved jointing paste.

Insert the 32 mm diameter polyethylene pipe and fit the service head adapter.

Carry out two tests: one test using the sealant material that has been stored at a temperature of 5 ℃ and the other at a temperature of 25 ℃, both for a minimum period of 12 h before the test.

Carry out annular gap filling via the service head adapter by following the sealant manufacturer’s instructions. Ensure the volume of sealant kit used fills the annulus to excess. Use the sealant stored at a temperature of 5 ℃ in the assembly maintained at a temperature of –5 ℃ and the sealant stored at a temperature of 25 ℃ in the assembly maintained at a temperature of 3 ℃.

Allow a maximum of 24 h cure time and remove the service head adapter. Then cut the assembly into two 300 mm lengths. Check the degree of annular fill.

Subject the two 300 mm lengths to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

Allow a minimum time period of 1 month to elapse before subjecting the sealed annular gap to a further pneumatic pressure test of 100 mbar for 5 min.

### E.5 Expression of results

Record the degree of annular fill after 24 h cure period on the two 300 mm long samples.

Record the pressure and pressure drop over a 5 min period on the two 300 mm long samples.

Record the pressure and pressure drop over a 5 min period on the two 300 mm long samples after a period of 1 month.

**E.6 Test report**

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

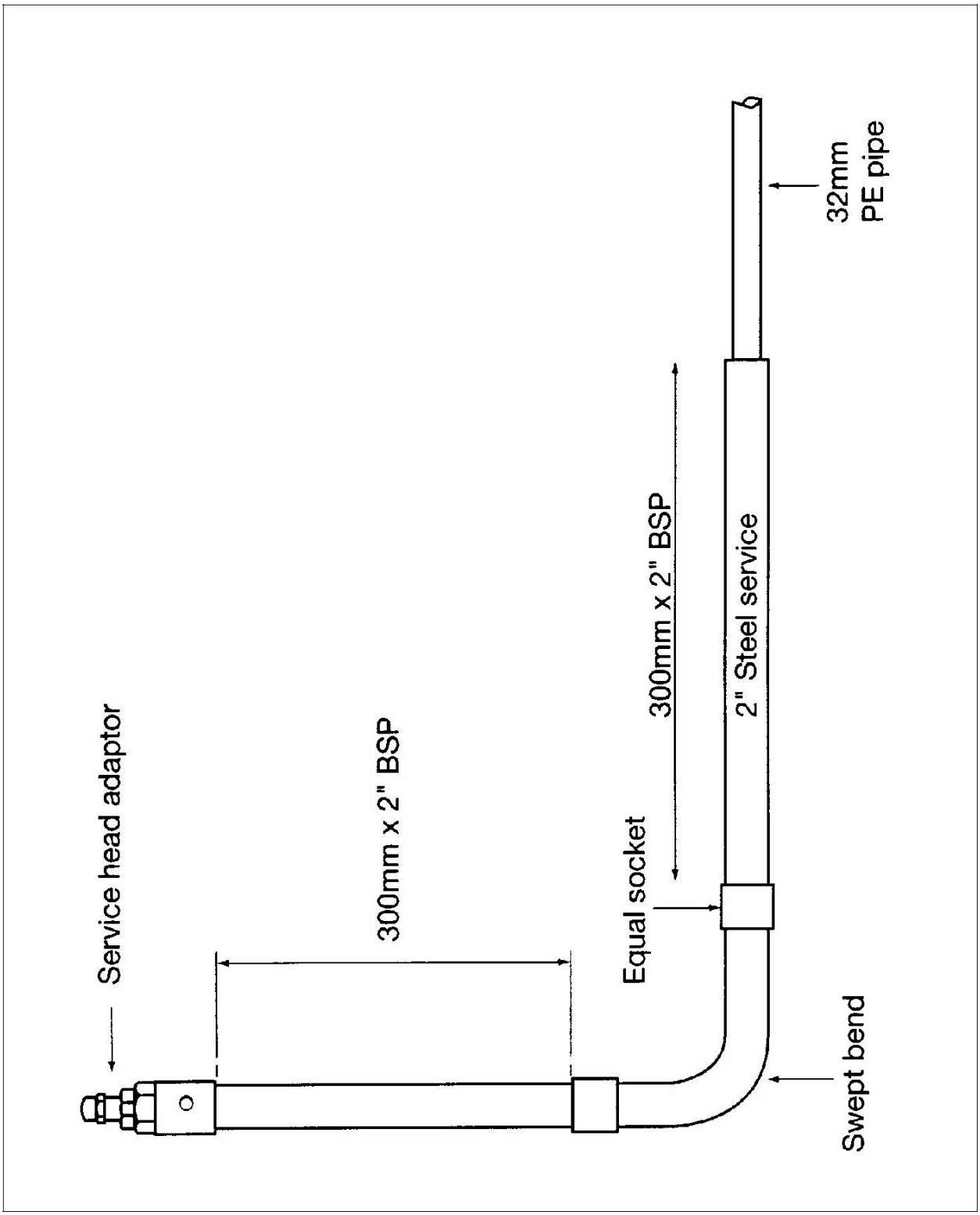


**Figure E.1 — Assembly for service slump test**

## Annex F (normative)
## Thermal cycling test

### F.1 Principle

This test determines the ability of the annular sealant to withstand temperature cycling.

### F.2 Apparatus

**F.2.1** *Service head adaptors*.

**F.2.2** *Steel pipe*.

**F.2.3** *Polyethylene pipe*.

**F.2.4** *Water trough*.

**F.2.5** *Environmental chamber*, capable of holding temperatures between –10 °C and 40 °C.

**F.2.6** *Thermocouple and temperature measuring equipment*.

**F.2.7** *Manometer*.

NOTE 1 For services below 2 in diameter, use 1 in diameter steel service pipe and 20 mm diameter polyethylene pipe.

NOTE 2 For services above 2 in diameter, use 3 in diameter steel service pipe and 63 mm diameter polyethylene pipe.

### F.3 Test sample

One test sample in accordance with Figure F.1.

### F.4 Procedure

Degrease the sections and threads of the steel service pipe and assemble as shown in Figure F.1.

Ensure all screwed joints are leak proof, i.e. use an approved jointing paste.

Insert the polyethylene pipe and fit the service head adapter.

Carry out annular gap filling via the service head adapter in accordance with the manufacturer's instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess.

Allow the sealant to cure for a maximum of 24 h and then remove the service head adapter. Apply a pneumatic pressure test at 100 mbar to the sealed annular gap for a period of 5 min. Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer.

Place the assembly in the water trough as shown in Figure F.1. Subject the whole assembly to continuous freeze/thaw cycles where the change from –5 °C to 30 °C is over a 6 h period and the change from 30 °C to –5 °C is also 6 h. This represents one cycle. Ensure 400 cycles are completed.

On completion of the thermal cycling test, remove the assembly and, at room temperature, apply a final pneumatic pressure test at 100 mbar to the sealed annular gap for a period of 5 min.

### F.5 Expression of results

Record the pressure drop at 100 mbar over 5 min period, 24 h after cure of sealant.
Record the pressure drop at 100 mbar over 5 min period, after 400 thermal cycles

### F.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

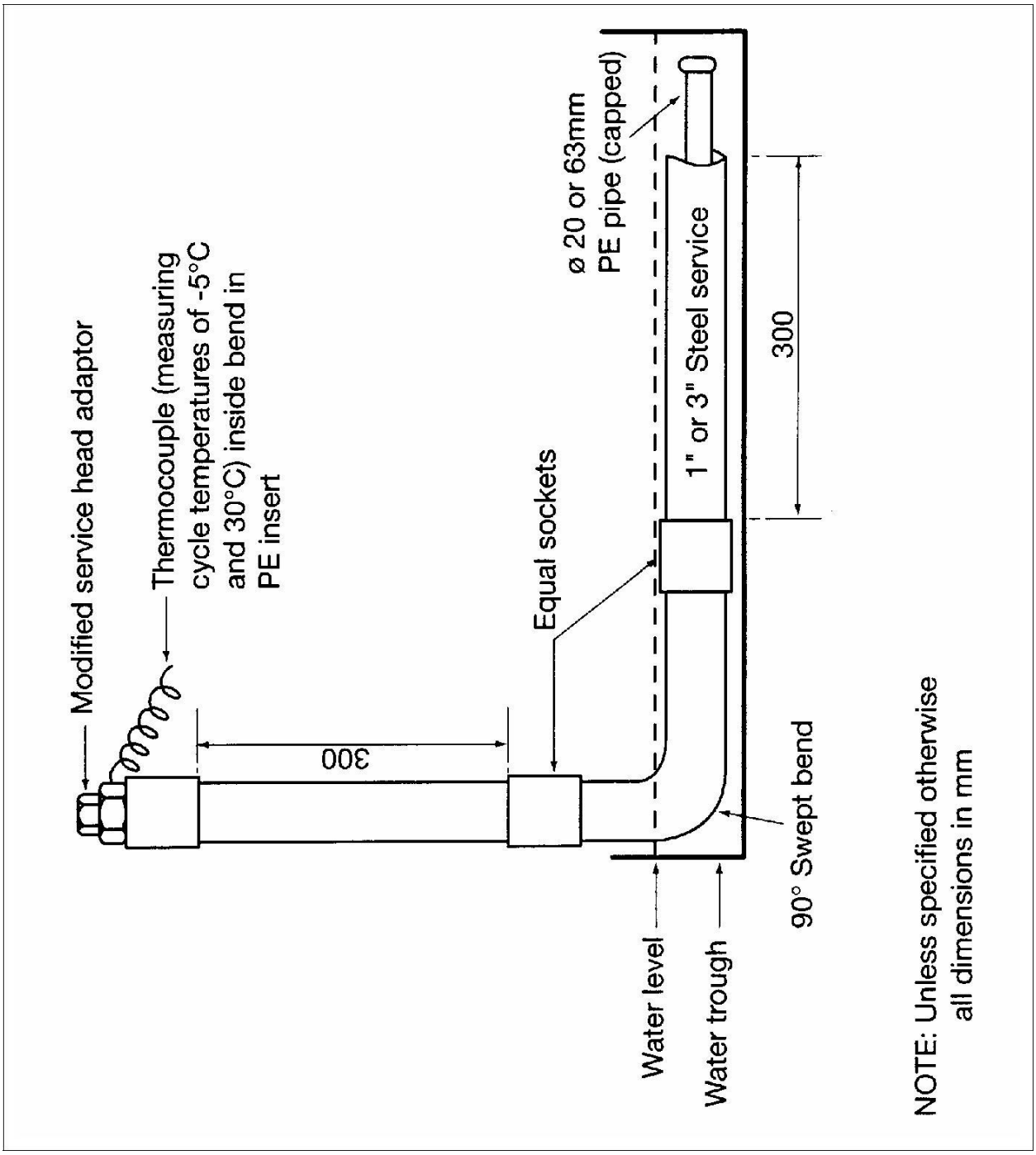


**Figure F.1 — Assembly for thermal cycling test**

## Annex G (informative)
## Service contamination test

### G.1 Principle

This test determines the ability of the annular sealant to be unaffected by contaminants that could be found in a gas service pipe.

### G.2 Apparatus

**G.2.1** *Service head adaptors*, (four required).

**G.2.2** *Steel pipe*.

**G.2.3** *Polyethylene pipe*.

**G.2.4** *MEG*.

**G.2.5** *Distillate*.

**G.2.6** *Water*.

**G.2.7** *GMO oil*.

NOTE 1 For services below 2 in diameter, use 1 in diameter steel service pipe and 20 mm diameter polyethylene pipe.

NOTE 2 For services above 2 in diameter, use 3 in diameter steel service pipe and 63 mm diameter polyethylene pipe.

### G.3 Test samples

Four test samples in accordance with Figure G.1.

### G.4 Procedure

**G.4.1** Assemble four steel pipes as shown in Figure G.1. Use one assembly in each of the following conditions:

- new, degreased pipe immersed in water and allowed to drain for 5 min;
- new, degreased pipe immersed in MEG and allowed to drain for 5 min;
- new, degreased pipe immersed in distillate and allowed to drain for 5 min;
- new, degreased pipe immersed in GMO 60 oil and allowed to drain for 5 min.

**G.4.2** Insert 20 mm diameter polyethylene as shown in Figure G.1 and fit the service head adapter.

**G.4.3** Carry out annular gap filling via the service head adapter in accordance with the manufacturer's instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess.

**G.4.4** Allow a maximum of 24 h cure time and remove the service head adapter. Then subject the assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min. If the pressure drop is less than 1 mbar then proceed to **G.4.5**.

**G.4.5** Allow a minimum period of 1 month to elapse before subjecting the sealed annular gap to a further pneumatic pressure test of 100 mbar for 5 min.

### G.5 Expression of results

Record the pressure drop over 5 min period at a pressure of 100 mbar 24 h after cure time. Record the pressure drop over 5 min period at a pressure of 100 mbar 1 month after cure time.

### G.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

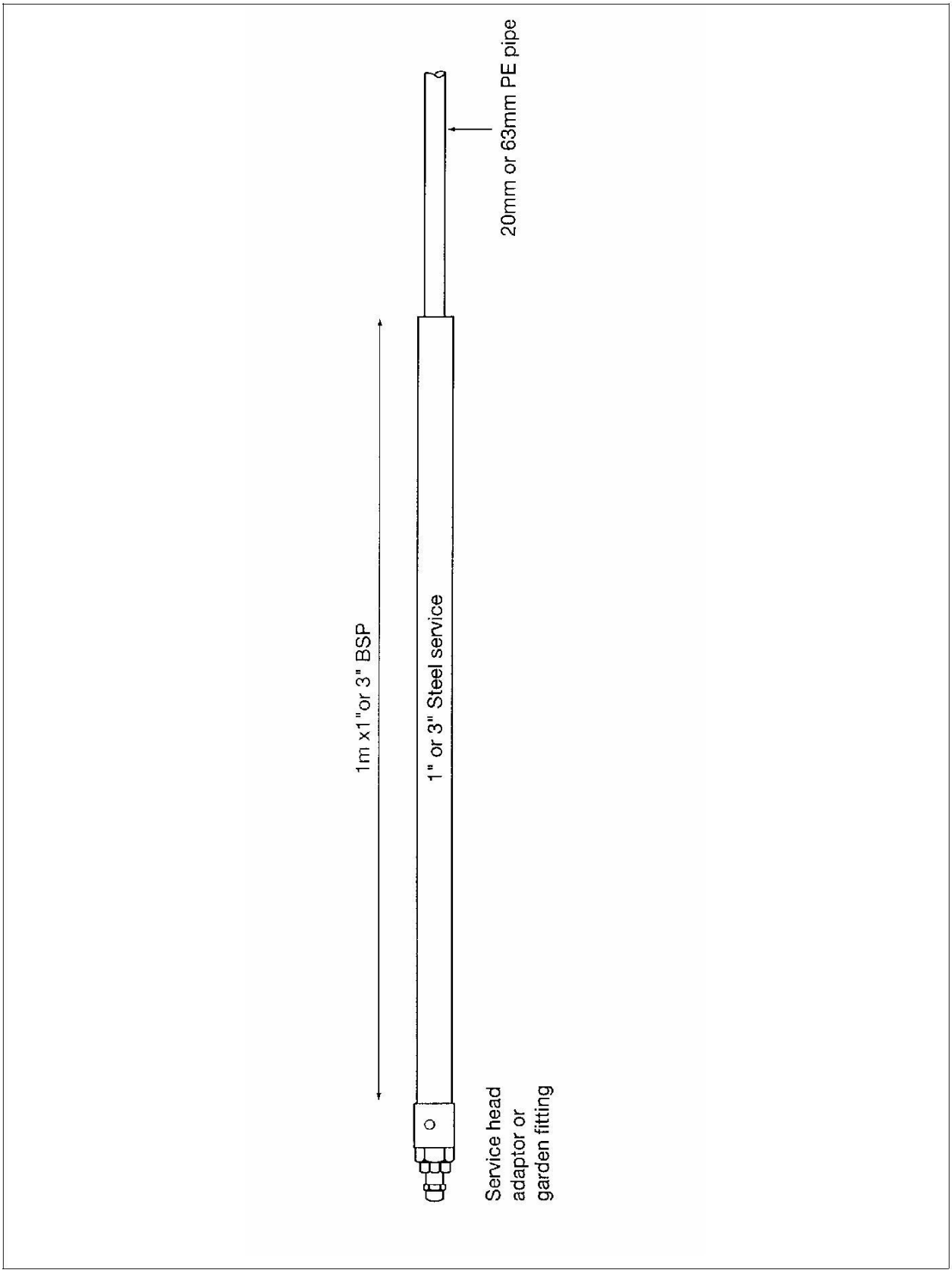


**Figure G.1 — Assembly for service contamination test**

**Annex H (normative)**
**Full system application (garden method)**

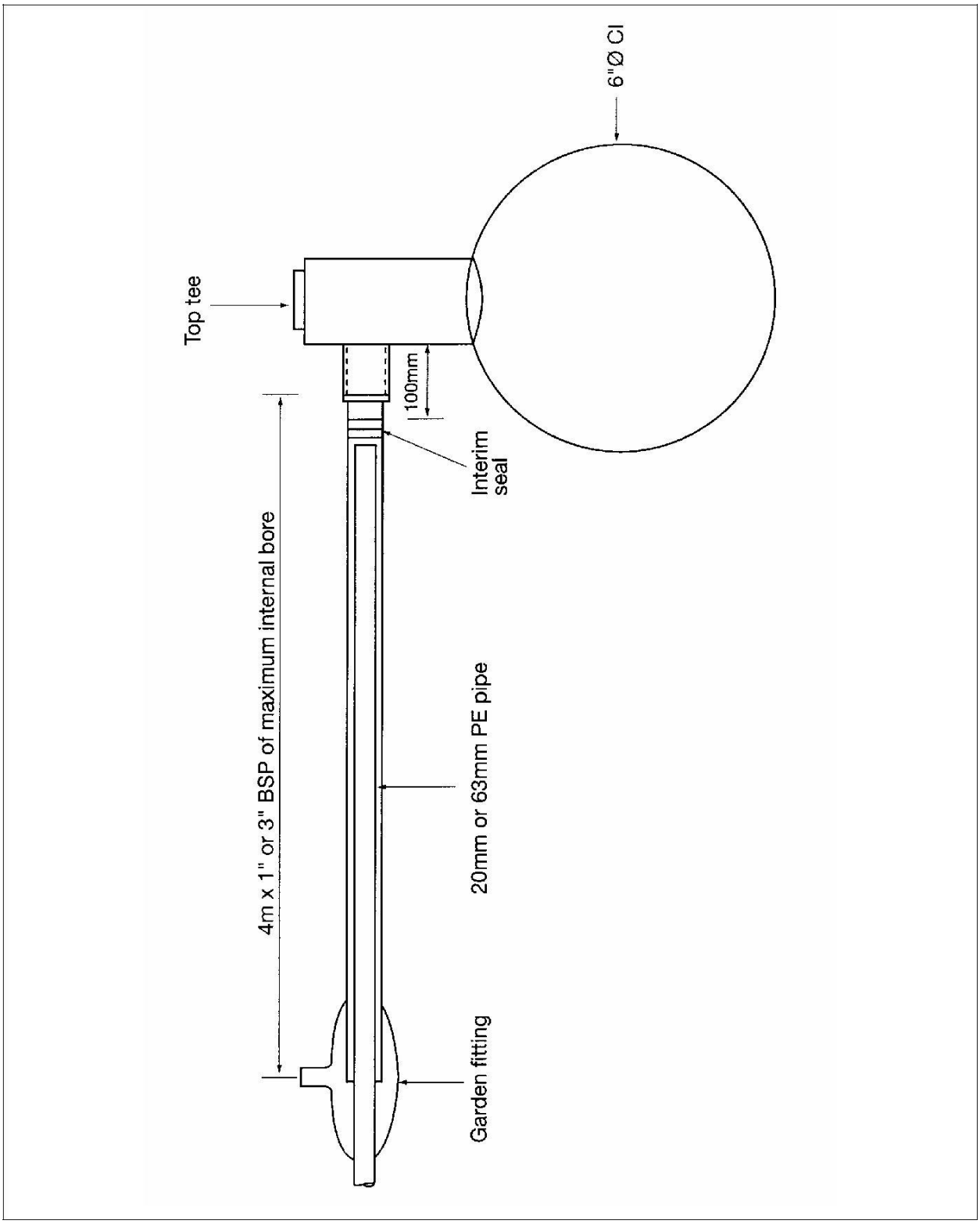


**Figure H.1 — Full system application (garden method)**

**Annex I (informative)**
**Full system application (insertion from the house)**

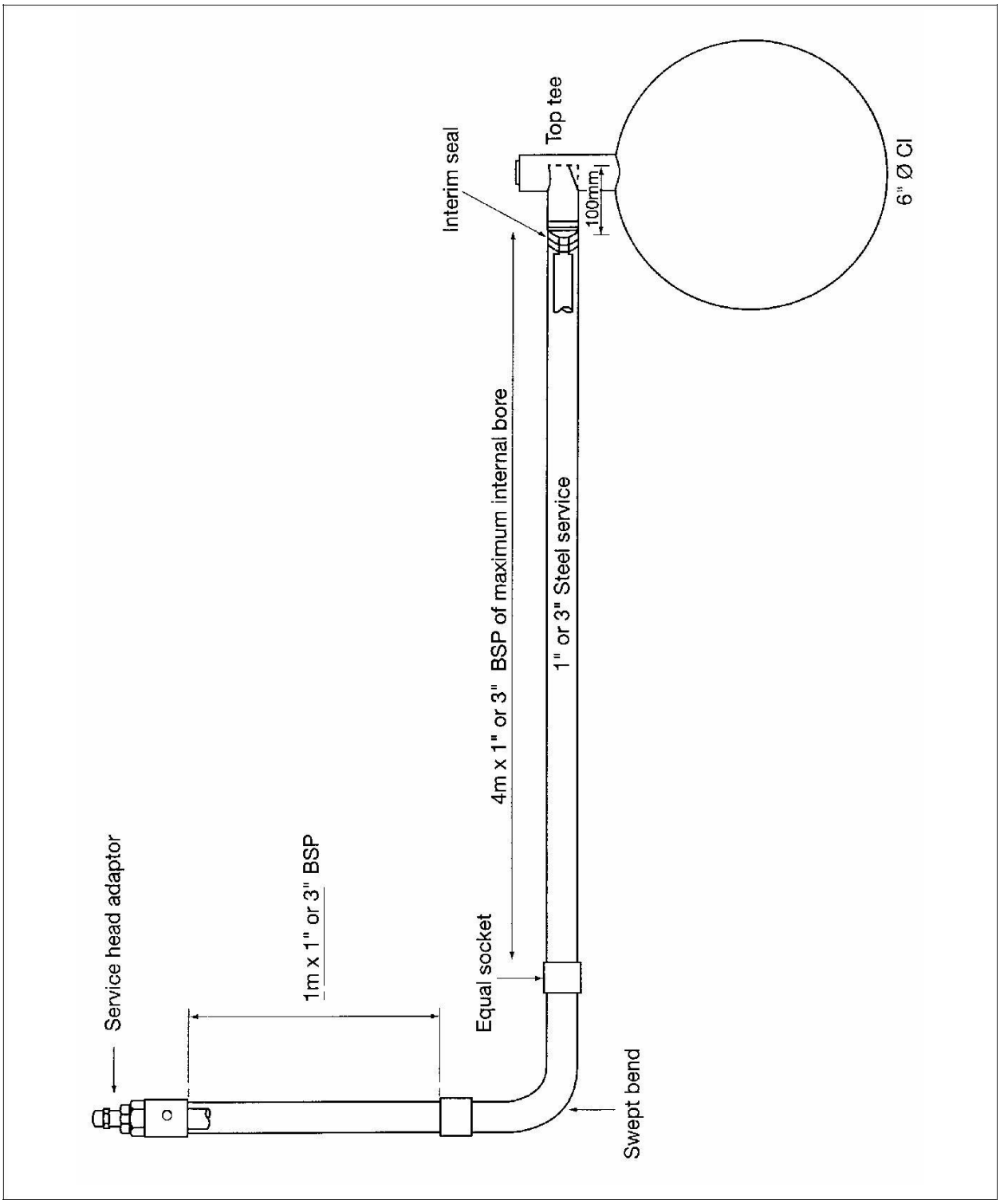


**Figure I.1 — Full system application (insertion from the house)**

**Annex J (normative)**
**Field application test: LSI installation record sheet**

Date of installation
Address

Work record number

Length of inserted service

Total length of service

Steel service pipe diameter

Steel service pipe material type if known (black/yellow wrapped steel)
Material temperature

Gas readings along the line of service before installation, e.g.

ppm Gas readings along the line of service after installation, e.g.

ppm Meter position

Size of annular sealant packs and no. used.

Service suitable for removal? YES/NO

Comments

Team leader

## Annex K (normative)
## Monitoring procedure: field application test of LSI system

### K.1 Monitoring procedure

**K.1.1** Each installation shall be rechecked along the line of the service pipe using a flame ionization machine (FIM). This shall be carried out by a technically competent engineer and the results recorded in the format as below. Alternatively, a PRED recheck form can be used.

**K.1.2** Carry out a FIM/PPM survey along the line of each renewed service at the following times:

- before and after insertion;
- 1 week after insertion;
- 1 month after insertion.

### K.2 Survey record

| **Address location:** | | | | | |
|---|---|---|---|---|---|
| | **Before insertion** | **After insertion** | **1 week after insertion** | **1 month after insertion** | **Comments** (include actions taken in the event that a leak is discovered) |
| **Date** | | | | | |
| **Reading along service line** | | | | | |
| **Surveyed by** | | | | | |

## Annex L (informative)
## Field application test procedure for LSI system

### L.1 Principle

This test determines the ability of the sealant to be used for live service insertion (LSI) in a practical field test.

### L.2 Apparatus

**L.2.1** *Water manometer*.

**L.2.2** *FIM leak detection equipment*.

### L.3 Test samples

60 services shall be installed.

NOTE A minimum of 30 services shall be excavated and assessed in accordance with Annex M.

### L.4 Recording information

The installation sheet shall be completed as part of the installation procedure and provides information relating to address location, service pipe diameter, service length and nose cone position (see Annex J).

A record card shall be completed by the operative following the test procedure and shall be attached securely to each test piece after removal. This should take the following format:

| |
|---|
| Address location: |
| Pressure test of polyethylene, 5 min @ 100 mbar: PASS/FAIL [a)] |
| Pressure test of annulus, 5 min @ 100 mbar: PASS/FAIL |
| Distance of nose cone from top tee (in metres): |
| Distance of annular gap sealant from nose cone (in metres): |
| Date of test: |
| Tested by: |

[a)] If there is a pressure drop of more than 1 mbar over 5 min on an LSI installation carried out from the house, then it will be necessary to measure the flow rate associated with the leak, and record the information on this sheet.

### L.5 Leakage survey

Carry out FIM survey from the main to the property over the length of the service.

Record the results of survey on the record sheet and include nil readings (see Annex K).

### L.6 Test method

Turn off the emergency control valve inside/outside the property and install a cap end.

Identify the point of insertion (always at a point adjacent to the house) and use the polyethylene service length (from the installation sheet) to locate position of the nose cone.

Excavate a hole large enough to expose a section of pipe, which contains the nose cone. Ensure the size of excavation is adequate to provide a suitable point of disconnection of the

service from the main and comfortably allows the removal of a 0.5 m section of service pipe, which contains the nose cone.

Disconnect the service pipe at a point as near to the main as possible at the same time ensuring the nose cone is not dissected and remains intact.

Cut out a 0.5 m section of pipe, which contains the nose cone, again ensuring that the nose cone remains intact. Label this section appropriately and return to gas transporter coordinator.

Measure the distance between the end of the annular sealant to the nose cone and record this distance.

Ensure that the service cap is sound and apply a 100 mbar pressure test to the polyethylene pipe from the main end. Record result of pressure test.

NOTE 1 If this pressure test does not hold, action should then be taken to identify the location of leakage and repair as appropriate. This action and repair method should be recorded.

Once the polyethylene is confirmed as sound, apply a 100 mbar pressure test to the annular space from the main end to the steel service pipe. Record result of pressure test on the record card.

NOTE 2 If this pressure test does not hold, action should then be taken to identify the location of leakage and repair as appropriate. This action and repair method should be recorded

### L.7 Transfer of service

Transfer the service to a position on the main and commission in accordance with the gas transporter's procedures.

Commission the supply in accordance with the gas transporter's procedures.

Complete reinstatement in accordance with *New Roads and Street Works Act 1991: Specification for the reinstatement of openings in highways* [1].

### L.8 Expression of results

Results of the installation shall be recorded in accordance with Annex J.

Results of the FIM survey shall be recorded in accordance with Annex K.

### L.9 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

## Annex M (normative)
## Assessment criteria for field trial of LSI system from garden insertion

### M.1 Principle

This test determines the probability that a LSI system is acceptable.

### M.2 Apparatus

**M.2.1** *Water manometer*.

### M.3 Test sample

60 services shall be installed in accordance with Annex L.

NOTE A minimum of 30 services should be excavated and assessed.

### M.4 Procedure for assessment

All services are required to be subjected to pass the following tests:

- 100 mbar pressure drop test of annular space for 5 min;
- test to determine the fill of the annular space along the length of service pipe;
- test to determine if there is evidence of any voids within the 0.5 m section removed from the service pipe.

NOTE 1 Failure of more than one service will result in the need to carry out more tests. Table M.1 gives details of the maximum number of failures that can be tolerated within a particular number of tests and still maintain the same level of confidence in the overall failure rate in the total population of insertions.

**Table M.1 — Maximum permitted failures for insertion from the garden**

| Max. no. of failures | Min. no. of tests required |
|---|---|
| 1 | 30 |
| 2 | 39 |
| 3 | 48 |
| 4 | 56 |

NOTE 2 If the failure exceeds four, then the material will be deemed to have failed to meet the requirements of this document.

### M.5 Expression of results

For each service assessed record:

- pressure drop test at 100 mbar for 5 min period;
- length of annular fill;
- evidence of voids within 0.5 m of the 0.5 m section removed from the service pipe.

### M.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

## Annex N (normative)
## Assessment criteria for field trial of LSI system from house insertion

### N.1 Sample size

A minimum of 225 services shall be installed and a minimum of 200 shall be tested as described in Annex K.

### N.2 Assessment criteria

**N.2.1** All services are required to pass the following tests given in **N.2.2** to **N.2.7**.

**N.2.2** A 100 mbar pressure drop test of annular space for 5 min, with a maximum of 1 mbar pressure drop allowed.

**N.2.3** A 95 % fill of the annular space along the length of service pipes which are over 5 m in length. For service pipes less than 5 m in length, a 100 % fill of the annular space is required.

**N.2.4** There shall be no evidence of voids within the 0.5 m section removed from the service pipe.

**N.2.5** Failure of more than one service will result in the need to carry out more tests. If a single failure of more than 1 mbar in 5 min is found, then it shall be demonstrated that the flow rate is less than 1.77 $ft^3$/h. If the flow rate is above this limit then the field trial is to be abandoned and the material will have been shown not to be acceptable for LSI from house insertion.

**N.2.6** Table N.1 gives details of the maximum number of failures that can be tolerated within a particular number of tests and still maintain the same level of confidence in the overall failure rate in the total population of insertions. In the case of two or more failures, additional installations would be required in order to be able to carry out the minimum number of tests. Again, if flow rate of any of the failures is above 1.77 $ft^3$/h then the field trial is to be abandoned and the material will have been shown not to be acceptable for LSI from house insertion.

**Table N.1 — Maximum permitted failures for insertion from the house**

| Max. no. of failures | Min. no. of tests required |
|---|---|
| 1 | 200 |
| 2 | 260 |
| 3 | 310 |

**N.2.7** If the number of failures exceeds three then the material will be deemed to have failed to meet the gas transporter's requirements. It would be possible to increase the size of the field trial and conduct further tests in an attempt to recover the situation. However, further work would be required to determine the number of tests required for a given failure rate. Note that in all cases the flow rate associated with any leakage shall not exceed 1.77 $ft^3$/h.

## Annex O (normative)
## Slump test

### O.1 Principle

This test determines the ability of the annular sealant not to slump when injected.

### O.2 Apparatus

**O.2.1** *Environmental chamber*, capable of being controlled at –5 °C and at 30 °C.

**O.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**O.2.3** *Water manometer*, capable of reading up to 120 mbar.

**O.2.4** *Sealant injection point*.

**O.2.5** *Steel pipe*, 3 in diameter.

**O.2.6** *Polyethylene pipe*, 32 mm diameter.

### O.3 Test sample

Two test assemblies in accordance with Figure O.1.

### O.4 Procedure

Degrease the sections and threads of the 3 in diameter steel pipe. Assemble as shown in Figure O.1. Two assemblies are required, one maintained at a temperature of –5 °C and the other at 30 °C.

Ensure all screwed joints are leak proof, i.e. use an approved jointing paste.

Insert the 32 mm diameter polyethylene pipe and fit the sealant injection point.

Carry out two tests, one test using sealant material which has been stored at a temperature of 5 °C and the other at a temperature of 25 °C, both for a minimum period of 12 h before the test.

Carry out annular gap filling via the sealant injection point following the sealant manufacturer's instructions. Ensure the volume of sealant kit used fills the annulus to excess. Use the sealant stored at a temperature of 5 °C in the assembly maintained at a temperature of –5 °C and the sealant stored at a temperature of 25 °C in the assembly maintained at a temperature of 30 °C.

Allow a maximum of 24 h cure time and remove the material injection point removed. Then cut the assembly into one 1 m length and one 2 m length. Inspect for the presence and degree of fill of the sealant.

Then subject the two lengths to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

Subject the assembly to a further pneumatic pressure test 1 month after injection. Apply a pneumatic pressure of 100 mbar to the sealed annular gap for 5 min.

### O.5 Expression of results

Record the following:

- the temperature of installation;
- the degree of annular fill;
- the pressure drop at 100 mbar over 5 min period 24 h after sealant cure;
- the pressure drop at 100 mbar over 5 min period 1 month after sealant cure.

**O.6 Test report**

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

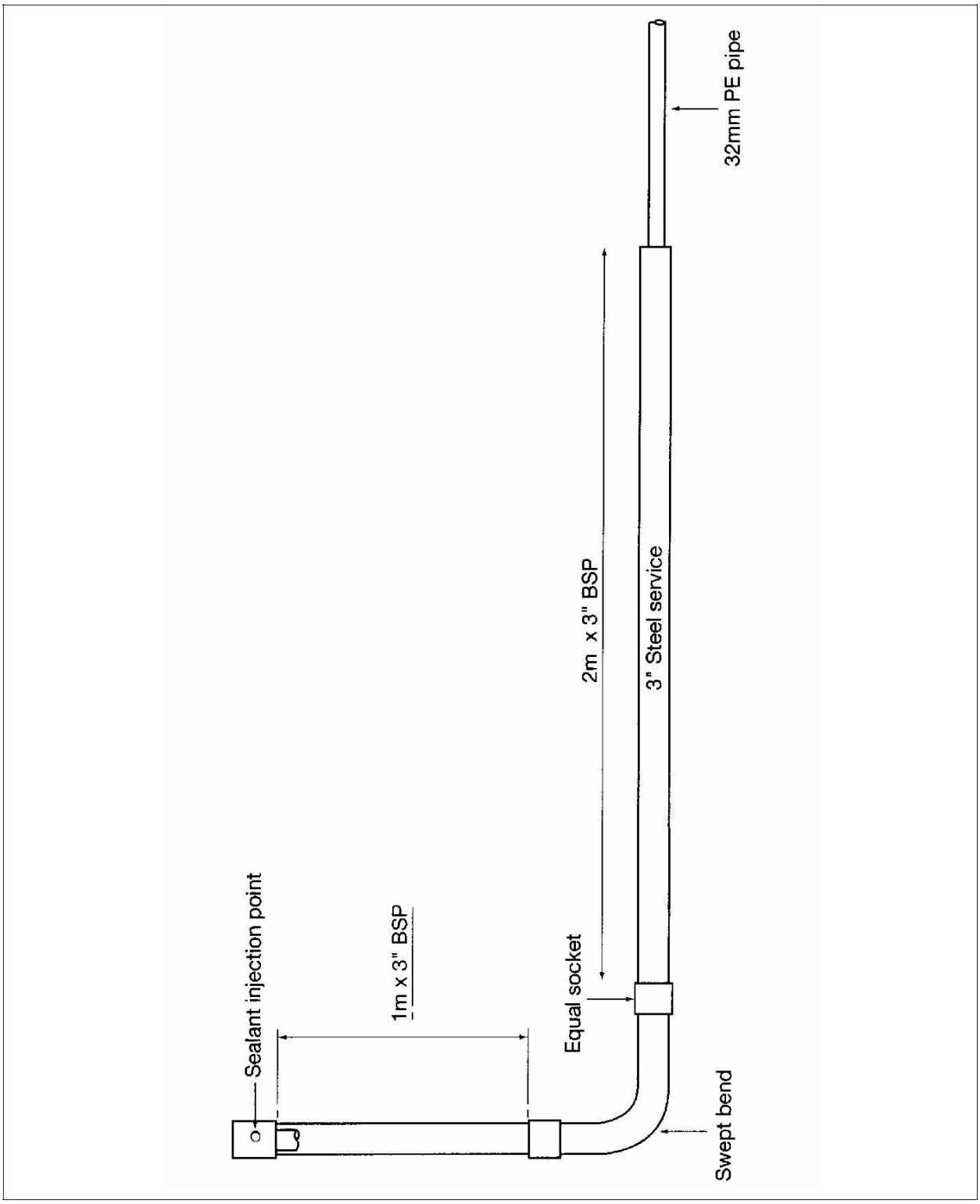


**Figure O.1 — Assembly for slump test**

## Annex P (normative)
## Adhesion/contamination test

### P.1 Principle

This test determines the ability of the sealant to adhere to, and not be adversely contaminated by, bitumen based material.

### P.2 Apparatus

**P.2.1** *Steel pipe*, 3 in diameter.

**P.2.2** *Polyethylene pipe*, 32 mm diameter.

**P.2.3** *Sealant injection port*.

**P.2.4** *Water manometer*.

**P.2.5** *Pressure source*, capable of supplying pressure at 120 mbar.

**P.2.6** *Metallic end cap*.

**P.2.7** *Polyethylene end cap*.

**P.2.8** *Bitumen base material*.

### P.3 Test sample

One test sample.

### P.4 Procedure

Assemble 3 in diameter steel pipes as shown in Figure P.1. Fill one assembly with proprietary bitumen based fill and drain the material. After draining the excess sealant, allow the remainder to dry for a period of 24 h.

Insert 32 mm diameter polyethylene pipe as shown in Figure P.1 and fit the sealant injection point.

Carry out annular gap filling via the sealant injection point in accordance with the manufacturer's instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess.

Allow a maximum of 24 h cure time. Then subject the assembly to a pneumatic pressure test such that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min. Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer.

Subject the assembly to a further pneumatic pressure test 1 month after injection. Subject the sealed annular gap to a pressure of 100 mbar for 5 min. Failure is deemed to have occurred if a pressure drop of more than 1 mbar is indicated by a standard water manometer.

### P.5 Expression of results

Record the pressure drop at 100 mbar over a 5 min period 24 h after sealant cure.

Record the pressure drop at 100 mbar over a 5 min period 1 month after sealant cure.

**P.6 Test report**

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

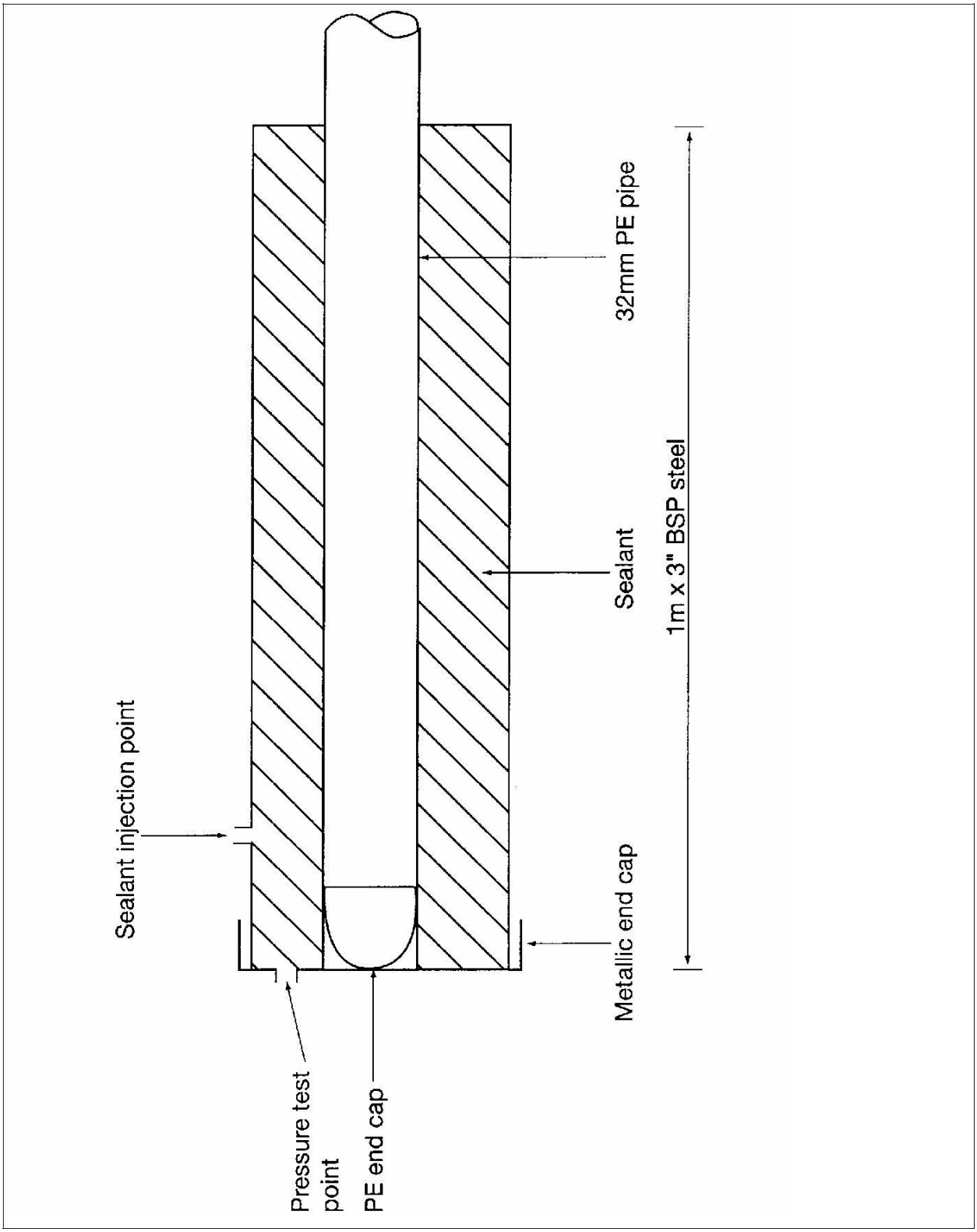


**Figure P.1 — Assembly for contamination test**

## Annex Q (normative)
## Mains slump test

### Q.1 Principle

This test determines the ability of the annular sealant not to slump when injected.

### Q.2 Apparatus

**Q.2.1** *Environmental chamber*, capable of being controlled at –5 °C and at 30 °C.

**Q.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**Q.2.3** *Water manometer*, capable of reading up to 120 mbar.

**Q.2.4** *Metallic pipe*, 8 in diameter.

**Q.2.5** *Polyethylene pipe*, 125 mm diameter.

**Q.2.6** *Polyethylene end cap*.

### Q.3 Test sample

Two test samples.

### Q.4 Procedure

Assemble the 8 in ductile iron (DI) pipe as shown in Figure Q.1. Two assemblies are required, one maintained at a temperature of –5 °C and the other at a temperature of 30 °C.

Insert the 125 mm diameter polyethylene pipe and fit an end cap as shown in Figure Q.1 such that the material can be injected into the annulus and a pressure test can be applied to the annulus after the sealant has cured.

Carry out two tests, one test using the sealant material which has been stored at a temperature of 5 °C and the other at a test temperature of 25 °C, both for a minimum period of 12 h before the test.

Carry out annular gap filling via the injection point by following the sealant manufacturer's instructions. Ensure the volume of sealant kit fills the annulus to excess. Use the sealant stored at a temperature of 5 °C in the assembly maintained at a temperature of –5 °C and use the sealant stored at a temperature of 25 °C in the assembly maintained at a temperature of 30 °C.

Allow a maximum of 24 h cure time and subject the assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min

Section the assembly such that two 1 m lengths of straight pipe are available and inspect for presence of voids and incomplete annular fill.

Subject each section to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 6 months.

### Q.5 Expression of results

Record the following information:

- the temperature during each installation;
- the degree of annular fill;
- the pressure drop over 5 min at 100 mbar 24 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 6 months after sealant cure.

**Q.6 Test report**

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

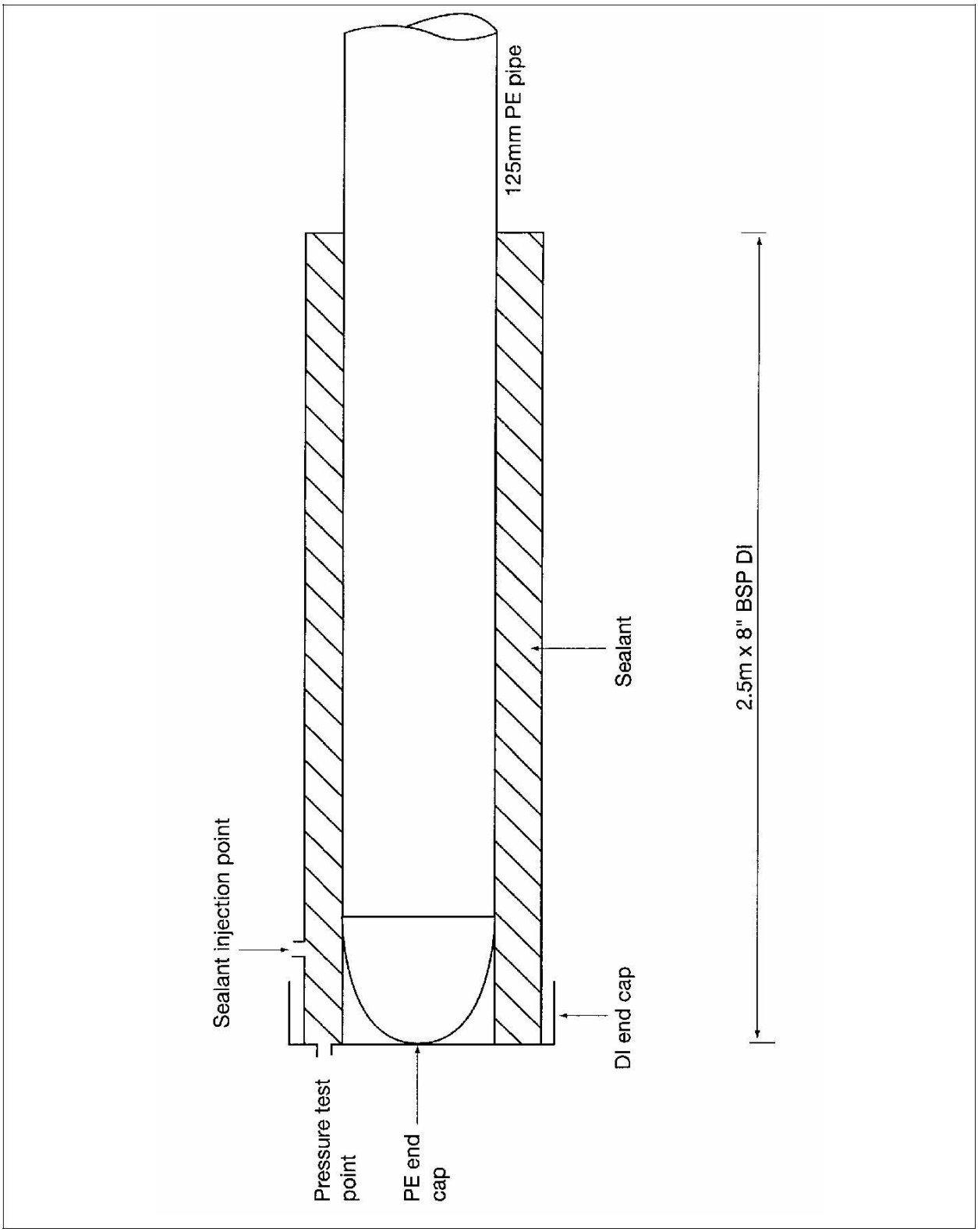


**Figure Q.1 — Assembly for slump test and pressure test**

## Annex R (normative)
## Contamination test

### R.1 Principle

This test determines the ability of the annular sealant to be unaffected by contaminants that could be found in a gas main.

### R.2 Apparatus

**R.2.1** *DI pipe*, 8 in diameter.

**R.2.2** *Polyethylene pipe*, 125 mm diameter.

**R.2.3** *Polyethylene end cap*.

**R.2.4** *Distillate*.

**R.2.5** *GMO 60*.

**R.2.6** *MEG*.

### R.3 Test sample

Four test samples, 8 in diameter, 1 m in length.

### R.4 Procedure

Assemble the 8 in diameter ductile iron (DI) pipe as shown in Figure R.1. Ensure one is in each of the following conditions:

- pipe immersed in water and allowed to drain for 5 min;
- pipe immersed in distillate and allowed to drain for 5 min;
- pipe immersed in GMO 60 oil and allowed to drain for 5 min;
- pipe immersed in MEG and allowed to drain for 5 min.

Insert l25 mm diameter polyethylene as shown in Figure R.1 and fit an end cap such that the annular gap can be filled.

Carry out annular gap filling in accordance with the manufacturer’s instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess.

Allow a maximum of 24 h cure time and then subject the assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

Allow a minimum time period of 1 month to elapse before subjecting the sealed annular gap to a further pneumatic pressure test of 100 mbar for 5 min.

### R.5 Expression of results

Record the following information:

- contaminants used;
- pressure drop 24 h after sealant cure;
- pressure drop 1 month after sealant cure.

**R.6 Test report**

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

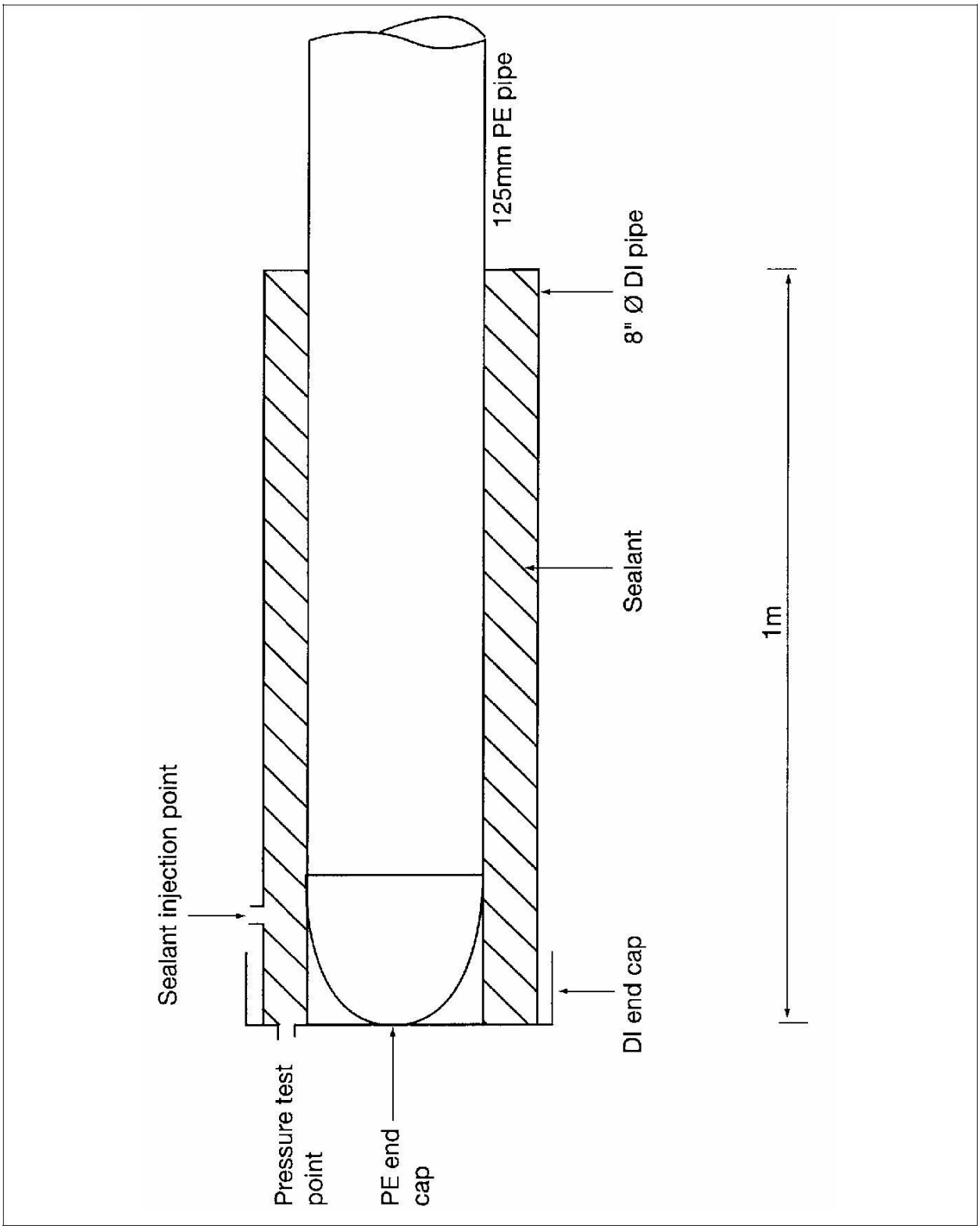


**Figure R.1 — Assembly for contamination test**

## Annex S (normative)
## Sealant flow test

### S.1 Principle

This test determines the ability of the sealant to bridge a simulated corrosion hole in a metallic main.

### S.2 Apparatus

**S.2.1** *Environmental chamber*, capable of being controlled at –5 °C and at 30 °C.

**S.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**S.2.3** *Water manometer*, capable of reading up to 120 mbar.

**S.2.4** *Metallic pipe*, 8 in diameter.

**S.2.5** *Polyethylene pipe*, 125 mm diameter.

**S.2.6** *Polyethylene end cap*.

**S.2.7** *Drill*.

**S.2.8** *Drill bit*, 10 mm.

**S.2.9** *Gravel*.

**S.2.10** *Compaction box*.

### S.3 Test sample

Two test samples, 8 in diameter pipe, 2 m in length.

### S.4 Procedure

Assemble the 8 in diameter ductile iron (DI) pipe with a 10 mm diameter drilled hole with the 125 mm diameter polyethylene inserted as shown in Figure R.1. Support the pipework containing the drilled hole with an un-compacted 50/50 mixture (by volume) of 10 mm gravel and dry sand contained in a box 38 cm square and 60 cm deep. Ensure the pipe is central in the box and covered to a depth of 30 cm. Two assemblies are required, one maintained at a temperature of –5 °C and the other at 30°C.

Carry out two tests, one test using sealant material which has been stored at a temperature of 5°C and the other at a temperature of 25 °C, both for a minimum period of 12 h before the test.

Carry out sealing via the sealant injection point following the sealant manufacturer's instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess. Use the sealant stored at a temperature of 5 °C in the assembly maintained at a temperature of –5 °C and the sealant stored at a temperature of 25 °C in the assembly maintained at a temperature of 30 °C.

Allow a maximum of 24 h cure time and then subject the assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

Allow a minimum time period of 1 month to elapse before subjecting the sealed annular gap to a further pneumatic pressure test of 100 mbar for 5 min.

### S.5 Expression of results

Record the following information:

- the temperature during each installation;
- the pressure drop over 5 min at 100 mbar 24 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 1 month after sealant cure.

### S.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

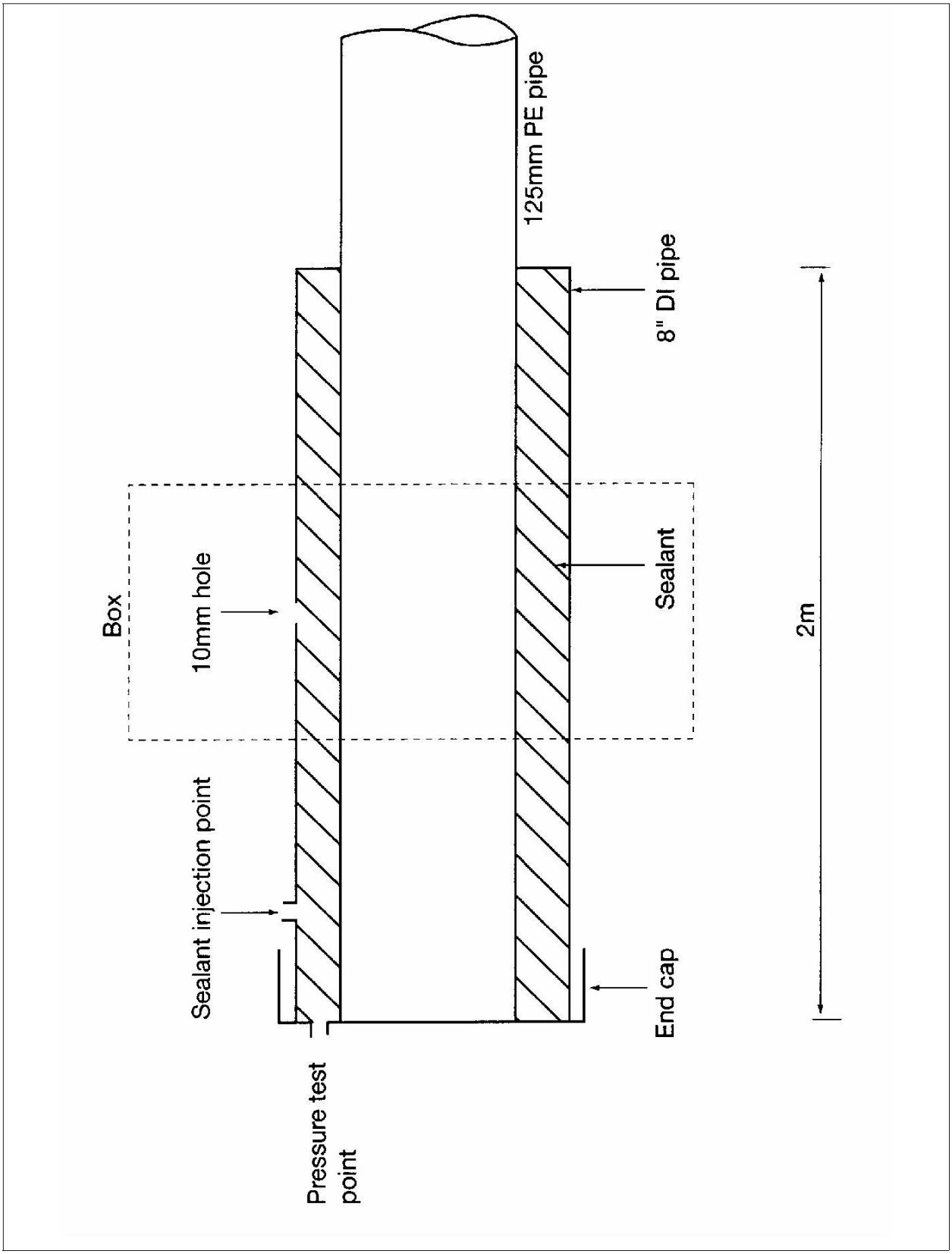


**Figure S.1 — Assembly for sealant flow test**

**Annex T (normative)**
**Service transfer test**

## T.1 Principle

This test determines the short term ability of the sealant to resist gas pressure.

## T.2 Apparatus

**T.2.1** *Environmental chamber*, capable of being controlled at –5 °C and at 30 °C.

**T.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**T.2.3** *Water manometer*, capable of reading up to 120 mbar.

**T.2.4** *Metallic pipe*, in accordance with Table T.1.

**T.2.5** Polyethylene pipe, in accordance with Table T.1.

**T.2.6** *Polyethylene end caps*, in accordance with Table T.1.

**Table T.1 — Range of polyethylene and mains to be tested**

| **Diameter of main** in | **Diameter of polyethylene pipe** mm | **Comment** |
|---|---|---|
| 4 | 63 | 125 mm polyethylene in 8 in steel pipe shall cover this range |
| 6 | 90 | |
| 8 | 125 | |
| 10 | 180 | 250 mm polyethylene in 12 in steel pipe shall cover this range |
| 12 | 250 | |
| 15 | 355 | 500 mm polyethylene in 24 in steel pipe shall cover this range |
| 18 | 400 | |
| 24 | 500 | |

## T.3 Test samples

Two samples for each combination of pipe shall be tested in accordance with Table T.1

It shall be required to test a representative combination of mains pipe inserted with polyethylene pipe to cover the range insertions to be carried out in the field. It shall be acceptable to use steel pipe to replicate the main. For combinations, see Table T.1.

## T.4 Procedure

Assemble the steel pipe with the polyethylene pipe inserted as shown in Figure T.1 (a typical arrangement for 125 mm polyethylene in 8 in pipe is shown). Two assemblies are required, one maintained at a temperature of –5 °C and the other at 30 °C.

Carry out two tests, one using sealant material which has been stored at a temperature of 5 °C and the other at a temperature of 25 °C, both for a minimum period of 12 h before the test.

Carry out sealing via the sealant injection point following the sealant manufacturer’s instructions. Use the sealant stored at a temperature of 5 °C in the assembly maintained at a

temperature of –5 °C and the sealant stored at a temperature of 25 °C in the assembly maintained at a temperature of 30 °C.

Allow a maximum of 1 h cure time before subjecting the assembly to a pneumatic pressure test where only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

After a period of 24 h, carry out the above pneumatic pressure test to ensure that the sealant is still capable of retaining pressure.

### T.5 Expression of results

Record the following information:

- the temperature during each installation;
- the pressure drop over 5 min at 100 mbar 1 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 24 h after sealant cure.

### T.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

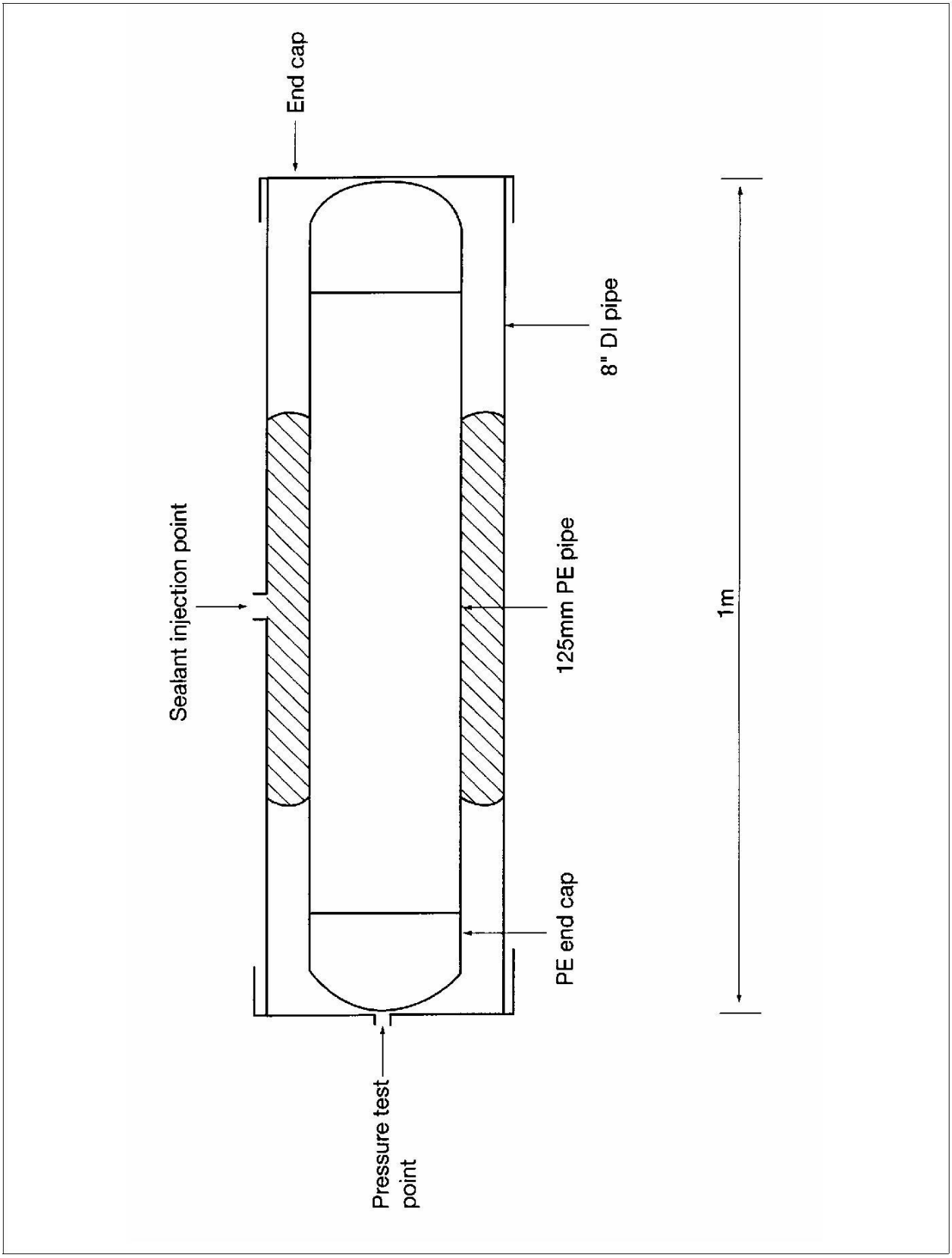


**Figure T.1 — Assembly for testing of service transfer sealant**

## Annex U (normative)
## End seal test

### U.1 Principle

This test determines the ability of the end seal to resist gas pressure during its working life.

### U.2 Apparatus

**U.2.1** *Environmental chamber*, capable of being controlled at –5 °C and at 30 °C.

**U.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**U.2.3** *Water manometer*, capable of reading up to 120 mbar.

**U.2.4** *Metallic pipe*, in accordance with Table U.1.

**U.2.5** *Polyethylene pipe*, in accordance with Table U.1.

**U.2.6** *Polyethylene end caps*, in accordance with Table U.1.

**Table U.1 — Range of end seals to be tested**

| **Diameter of main** in | **Diameter of polyethylene pipe** mm | **Comment** |
|---|---|---|
| 4 | 63 | 125 mm polyethylene in 8 in steel pipe shall cover this range. Use an 8 in end seal |
| 6 | 90 | |
| 8 | 125 | |
| 10 | 180 | 250 mm polyethylene in 12 in steel pipe shall cover this range. Use a 12 in end seal |
| 12 | 250 | |
| 15 | 355 | 500 mm polyethylene in 24 in steel pipe shall cover this range. Use a 24 in end seal |
| 18 | 400 | |
| 24 | 500 | |

### U.3 Test samples

Two samples for each combination of pipe shall be tested in accordance with Table U.1.

It shall be required to test a representative combination of mains pipe inserted with polyethylene pipe to cover the range of end seals to be tested. It shall be acceptable to use steel pipe to replicate the main. For combinations see Table U.1.

### U.4 Procedure

Assemble the steel pipe with the polyethylene pipe inserted as shown in Figure U.1 (a typical arrangement for 125 mm polyethylene in 8 in steel pipe is shown). Two assemblies are required, one maintained at a temperature of –5 °C and the other at 30 °C.

Carry out two tests, one using sealant material which has been stored at a temperature of 5 °C and the other at a temperature of 25 °C, both for a minimum period of 12 h before the test.

Fit the end seal according to the sealant manufacturer's instructions. Use the sealant stored at a temperature of 5 °C in the assembly maintained at a temperature of –5 °C and the sealant at a temperature of 25 °C in the assembly maintained at a temperature of 30 °C.

Allow a maximum of 1 h cure time before the assembly is subjected to a pneumatic pressure test where only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

After a period of 6 months, carry out the above pneumatic pressure test to ensure that the sealant is still capable of retaining pressure during its anticipated life.

### U.5 Expression of results

Record the following information:

- the temperature during each installation;
- the pressure drop over 5 min at 100 mbar 1 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 6 months after sealant cure.

### U.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

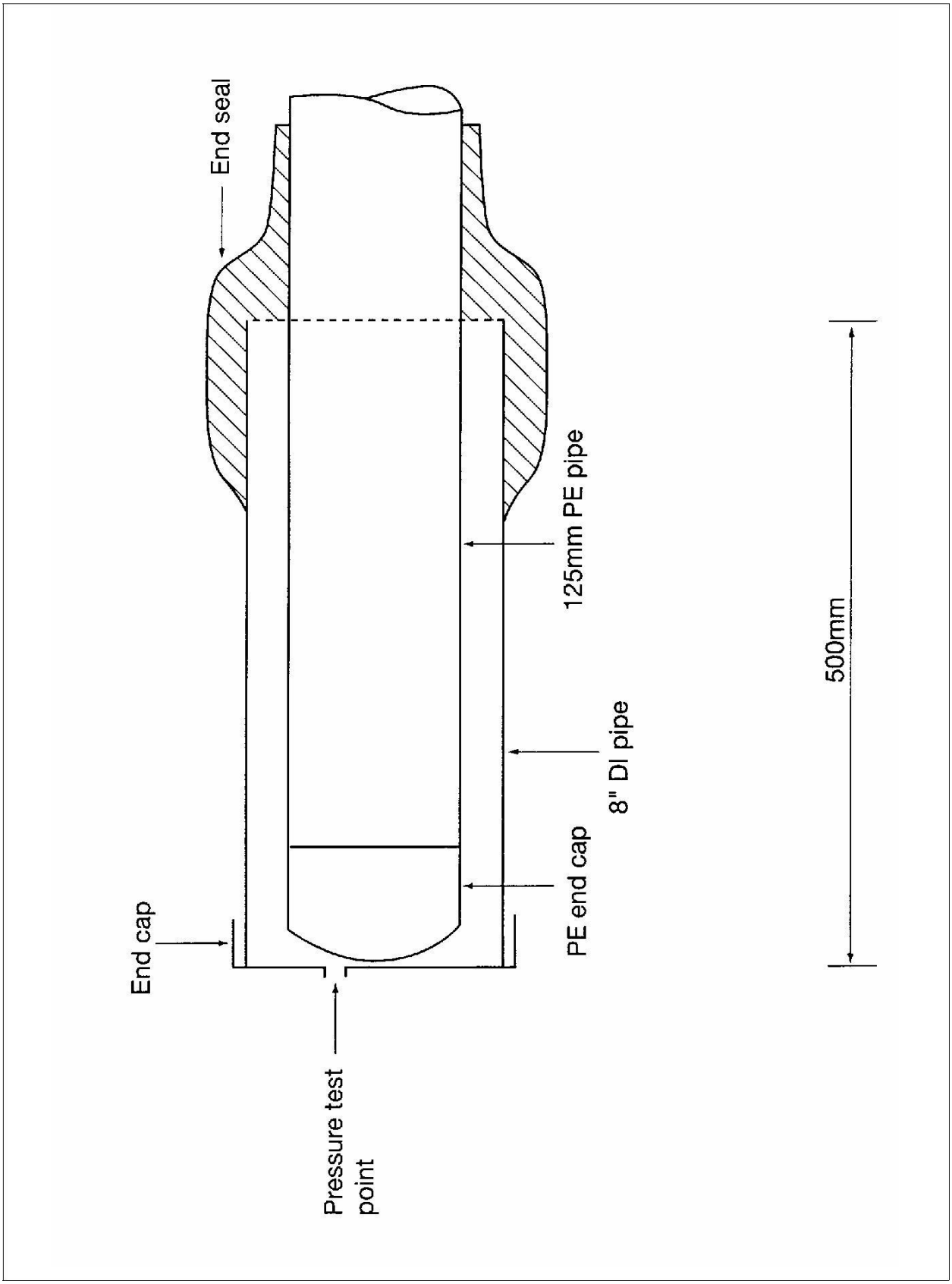


**Figure U.1 — Assembly for testing of end seals**

## Annex V (normative)
## Live mains transfer pressure test

### V.1 Principle

This test determines the ability of the sealant to withstand gas mains pressure.

### V.2 Apparatus

**V.2.1** *Pressure source*, capable of supplying pressure at 120 mbar.

**V.2.2** *Water manometer*, capable of reading up to 120 mbar.

**V.2.3** *Three steel pipes*, 1.5 m long.

**V.2.4** *Three nose cones*.

**V.2.5** *Three Polyethylene pipes*, 2 m long.

NOTE 1 For mains up to 4 in diameter, use 75 mm polyethylene pipe inserted into 4 in diameter steel pipe.

NOTE 2 For mains up to 6 in diameter, use 125 mm polyethylene pipe inserted into 6 in diameter steel pipe.

### V.3 Test samples

Three samples are required for each size to be tested.

### V.4 Procedure

For each size to be tested, degrease three sections of steel pipe 1.5 m long, and prepare three sections of polyethylene pipe 2 m long.

Attach the nose cone to the polyethylene pipe together with the sealant delivery equipment and insert into the steel pipe.

Inject the annular gap sealant in accordance with the manufacturer's instructions. Ensure the volume of annular gap sealant kit used is sufficient to fill the annulus to excess.

Allow a minimum of 24 h cure time before removing the nose cone section and fitting an electro-fusion end cap to the protruding section of polyethylene pipe.

Ensure the final sample test lengths are 0.9 m and the test arrangement is as shown in Figure V.1.

Subject the assemblies to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

Then subject each assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for a 6 month period.

### V.5 Expression of results

Record the following information:

- the temperature during each installation;
- the pressure drop over 5 min at 100 mbar 24 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 6 months after sealant cure.

**V.6 Test report**

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

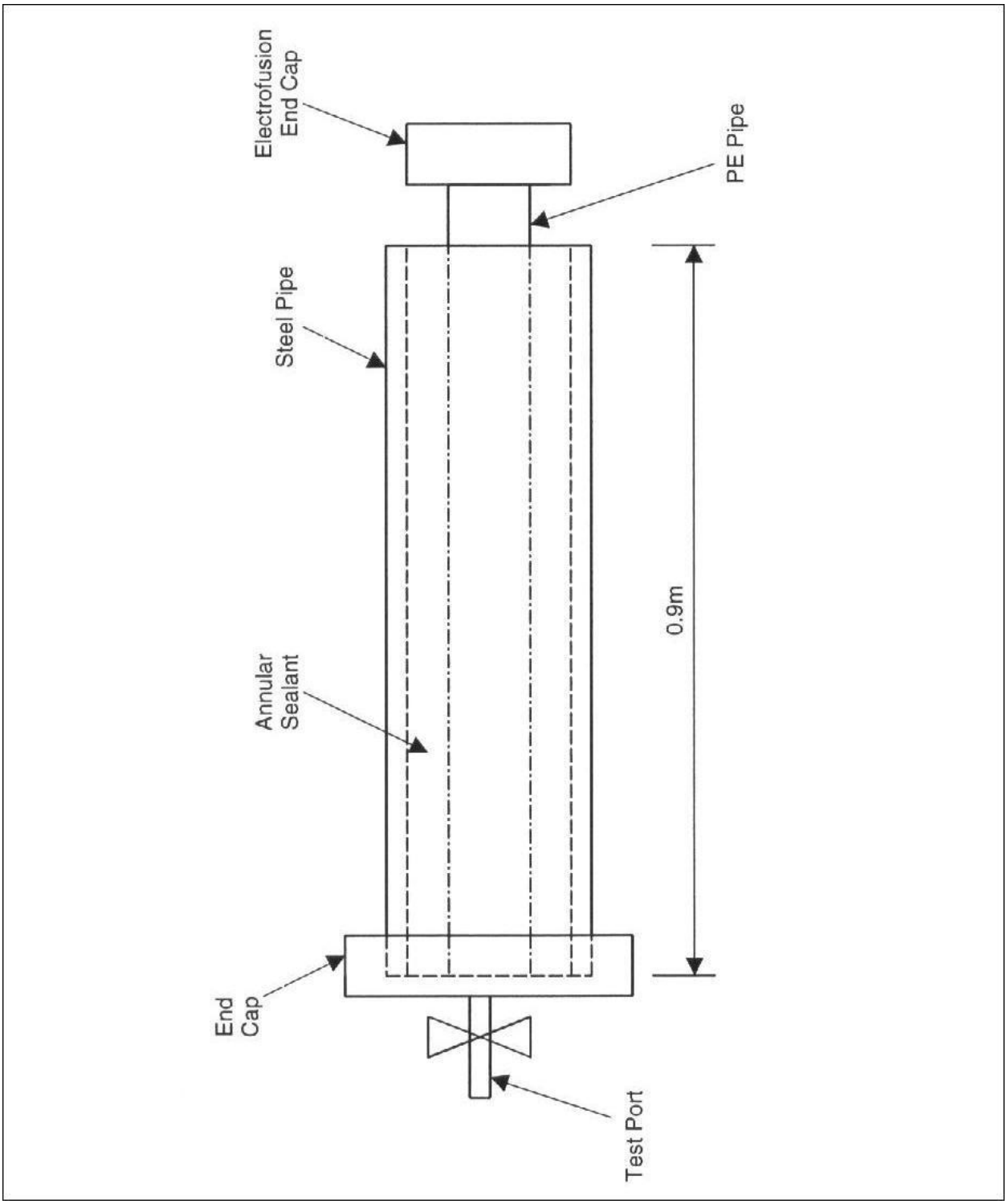


**Figure V.1 — Pressure test**

## Annex W (normative)
## Live mains transfer pressure/life test

### W.1 Principle

This test determines the ability of the sealant to resist gas pressure in the long term.

### W.2 Apparatus

**W.2.1** *Pressure source*, capable of supplying pressure at 5 bar.

**W.2.2** *Pressure gauge*, capable of measuring up to 5 bar.

**W.2.3** *Twelve steel pipes*, 6 in diameter × 1.5 m long.

**W.2.4** *Twelve polyethylene pipes*, 125 mm diameter × 2 m long.

**W.2.5** *Twelve nose cones*.

**W.2.6** *Twelve polyethylene end caps*.

NOTE For mains up to 6 in diameter, use 125 mm polyethylene pipe inserted into 6 in diameter steel pipe.

### W.3 Test samples

Twelve samples, 6 in diameter steel × 1.5 m long inserted with 125 mm diameter polyethylene pipe × 2 m long.

### W.4 Procedure

Degrease 12 sections of steel pipe 1.5 m long, and prepare 12 sections of polyethylene pipe 2 m long.

Attach the nose cone to the polyethylene pipe together with the sealant delivery equipment and insert into the metal pipe.

Inject the annular gap sealant in accordance with the manufacturer's instructions. Ensure the volume of annular gap sealant kit used is sufficient to fill the annulus to excess.

Allow a maximum of 24 h cure time before removing the nose cone section and fitting an electro-fusion end cap to the protruding section of polyethylene pipe.

Ensure the final sample test lengths are 0.9 m and the test arrangement is as shown in Figure W.1.

Subject three samples to a pressure which will ensure failure between 1 h and 3 h. Note the pressure at which failure occurs, $P$, and the time to failure $T_p$. Plot the results on a log/log plot of pressure against time in minutes of the type shown in Figure W.2.

Pressurize three samples and hold at a pressure $P_1$, a second set of three samples at a pressure of $P_2$ and a third set of samples at a pressure of $P_3$.

Establish $P_1$ by drawing a straight line joining the initial point ($T_p$ $P$) to the 50 year/1.5 times specified maximum working pressure point ($P_{mw}$). $P_1$ is the pressure corresponding to 6 months on the time axis.

Determine $P_2$ and $P_3$ to give points equidistant on a logarithmic scale between $P_1$ and $P$.

Ensure the duration of the tests is either 6 months or until a failure occurs, whichever is the shorter period.

Plot the results obtained on the graph to show the failure band. When the lower edge of the failure band is extrapolated to 50 years, the corresponding pressure shall not be less than 1.5 times the maximum working pressure.

### W.5 Expression of results

Record the following information:

- for three samples, the pressure at which annular sealant leaks between 1 h and 3 h after curing;
- the values of $P_1$, $P_2$ and $P_3$;
- a plot of log pressure versus log time to failure (see Figure W.2).

### W.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

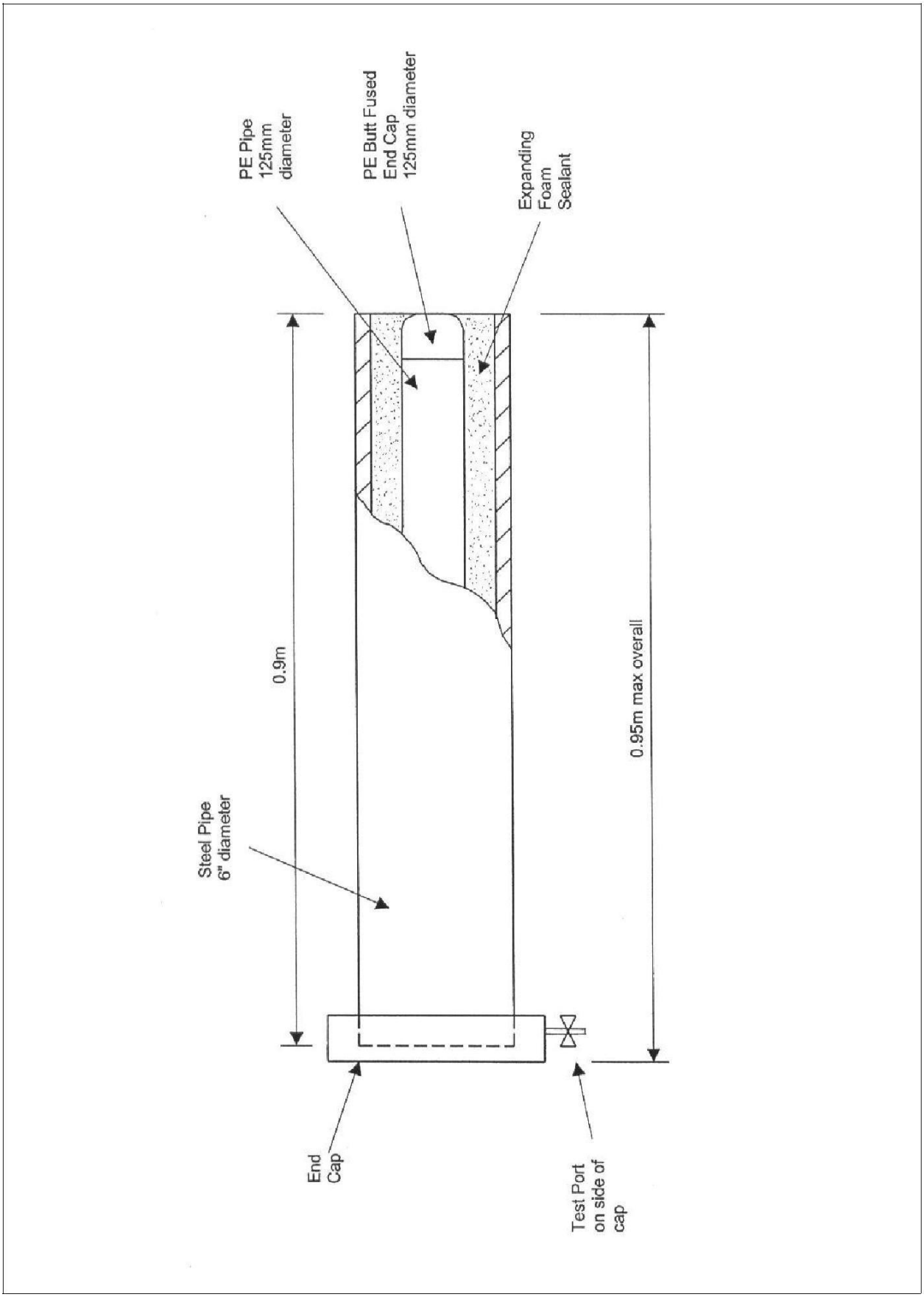


**Figure W.1 — Sample for pressure/life test**

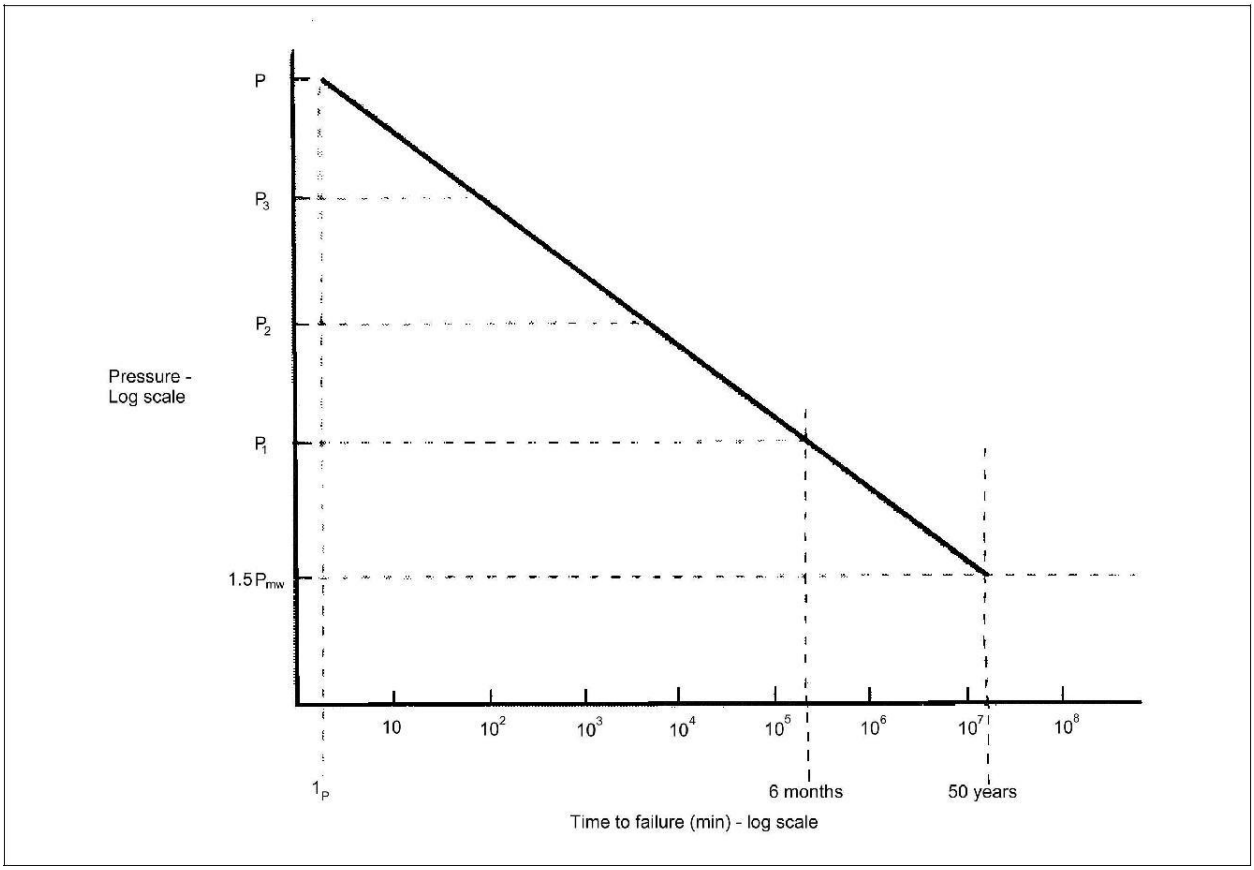


**Figure W.2 — Pressure/life testing**

## Annex X (normative)
## Live mains transfer sealant flow test

### X.1 Principle

This test determines the ability of the sealant to bridge a simulated corrosion hole in a metallic main.

### X.2 Apparatus

**X.2.1** *Environmental chamber*, capable of being controlled at –5 °C and at 30 °C.

**X.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**X.2.3** *Water manometer*, capable of reading up to 120 mbar.

**X.2.4** *Metallic pipe*, 6 in diameter × 1.5 m long.

**X.2.5** *Polyethylene pipe*, 125 mm diameter × 2 m long.

**X.2.6** *Polyethylene end cap*, 125 mm diameter.

**X.2.7** *Drill*.

**X.2.8** *Drill bit*, 10 mm.

**X.2.9** *Gravel*.

**X.2.10** *Compaction box*.

### X.3 Test samples

Two test samples consisting of 6 in diameter steel × 1.5 m long inserted with 125 mm diameter polyethylene pipe × 2 m long.

### X.4 Procedure

Degrease two sections of 6 in diameter steel pipe 1.5 m long, and prepare two sections of 125 mm polyethylene pipe 2 m long. Drill a 10 mm hole through the wall of the steel pipe 0.75 m from one end.

Support the pipework containing the drilled hole with an un-compacted 50/50 mixture (by volume) of 10 mm gravel and dry sand contained in a box 38 cm square and 60 cm deep. Ensure the pipe is central in the box and covered to a depth of 30 cm. Insert the assembly with a nose cone attached to the polyethylene pipe and set up ready for injection of annular sealant. Two assemblies are required, one maintained at a temperature of –5 °C and the other at 30 °C.

Carry out two tests, one using sealant material which has been stored at a temperature of 5 °C and the other at a temperature of 25 °C, both for a minimum period of 12 h before the test.

Inject the annular sealant in accordance with the manufacturer’s instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess.

Use the sealant stored at a temperature of 5 °C in the assembly maintained at a temperature of –5 °C and the sealant stored at a temperature of 25 °C in the assembly maintained at a temperature of 30 °C.

Allow a minimum of 24 h cure time and then prepare the assembly for a pneumatic test as shown in Figure X.1. Ensure the finished length of sample is 0.9 m. Subject the assembly to a

pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

Allow a minimum time period of 1 month to elapse before subjecting the sealed annular gap to a further pneumatic pressure test of 100 mbar for 5 min.

### X.5 Expression of results

Record the following information:

- the temperature during each installation;
- the extent to which the 10 mm hole is bridged by the sealant;
- the pressure drop over 5 min at 100 mbar 24 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 1 month after sealant cure.

### X.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

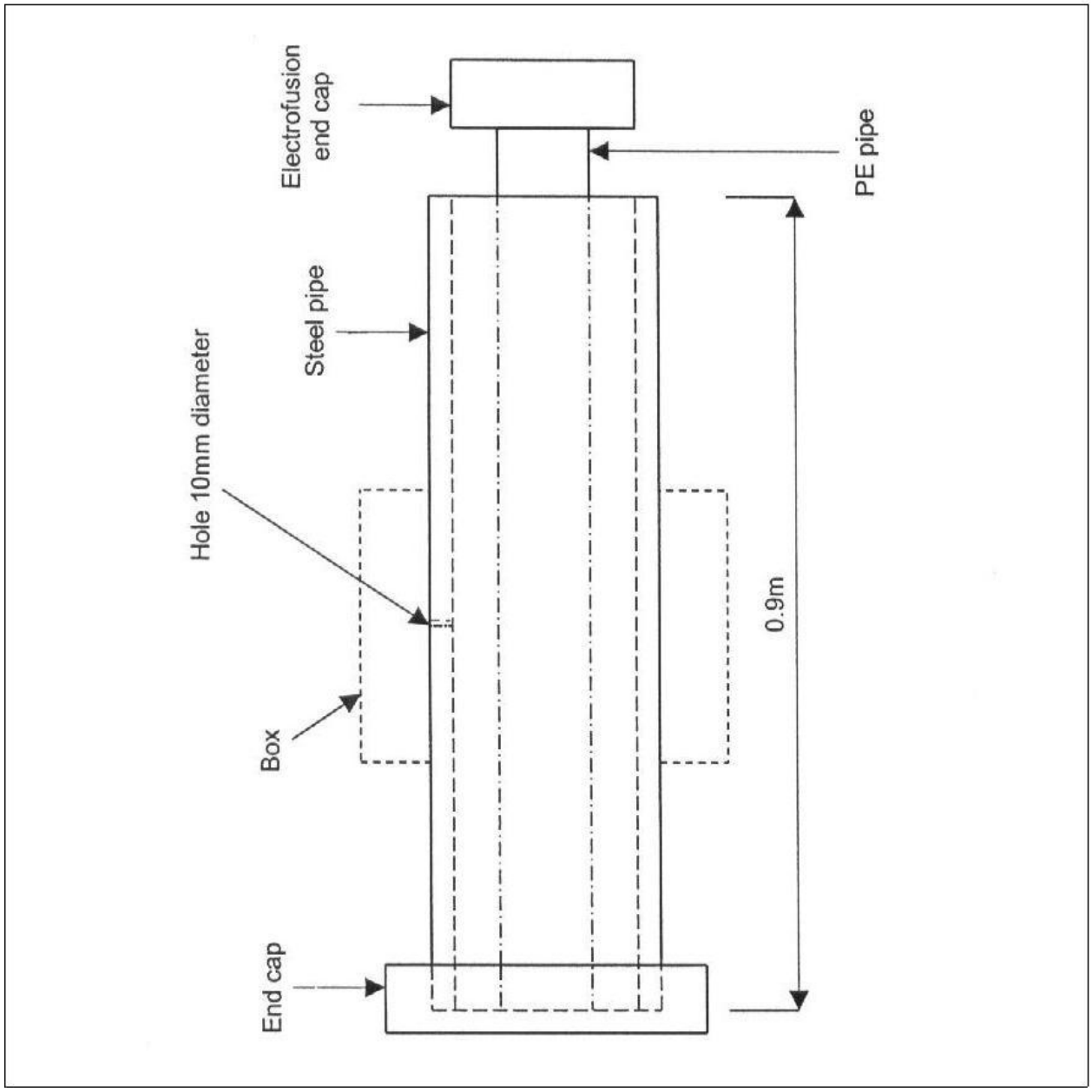


**Figure X.1 — Sealant flow test**

## Annex Y (normative)
## Live mains transfer slump test

### Y.1 Principle

This test determines the ability of the annular gap sealant material to successfully fill the annulus when large volumes of annular gap sealant are used.

### Y.2 Apparatus

**Y.2.1** *Environmental chamber*, capable of being controlled at –5 °C and at 30 °C.

**Y.2.2** *Pressure source*, capable of supplying pressure at 120 mbar.

**Y.2.3** *Water manometer*, capable of reading up to 120 mbar.

**Y.2.4** *Steel pipe*, 6 in diameter × 3 m long,

**Y.2.5** *Polyethylene pipe*, 125 mm diameter × 3.5 m long

**Y.2.6** *Two polyethylene end caps*.

### Y.3 Test samples

Two test samples of 6 in diameter steel pipe × 3 m long inserted with 125 mm diameter polyethylene pipe × 3.5 m long.

### Y.4 Procedure

Degrease two sections of 6 in diameter steel pipe 3 m long, and prepare two sections of 125 mm polyethylene pipe 3.5 m long.

Attach a nose cone to the polyethylene pipe together with the sealant delivery equipment and insert into both of the steel pipes.

Two assemblies are required, one maintained at a temperature of –5 °C and the other at a temperature of 30 °C

Condition annular sealant at 25 °C for a period of 12 h and then inject it into the assembly at 30 °C in accordance with the manufacturer’s instructions. Ensure the volume of annular gap sealant kit used is sufficient to fill the annulus to excess.

Condition annular sealant at 5 °C for a period of 12 h and then inject it into the assembly at – 5 °C in accordance with the manufacturer’s instructions. Ensure the volume of annular gap sealant kit used is sufficient to fill the annulus to excess.

After a minimum 24 h cure time, section the assemblies to give a final length of 0.9 m long as shown in Figure Y.1 with an end cap butt fused onto the exposed section of polyethylene pipe.

Then subject each section to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for a 5 min period.

Finally, subject each section to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 6 months.

### Y.5 Expression of results

Record the following information:

- the temperature during each installation;
- the extent to which the 10 mm hole is bridged by the sealant;
- the pressure drop over 5 min at 100 mbar 24 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 6 months after sealant cure.

### Y.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

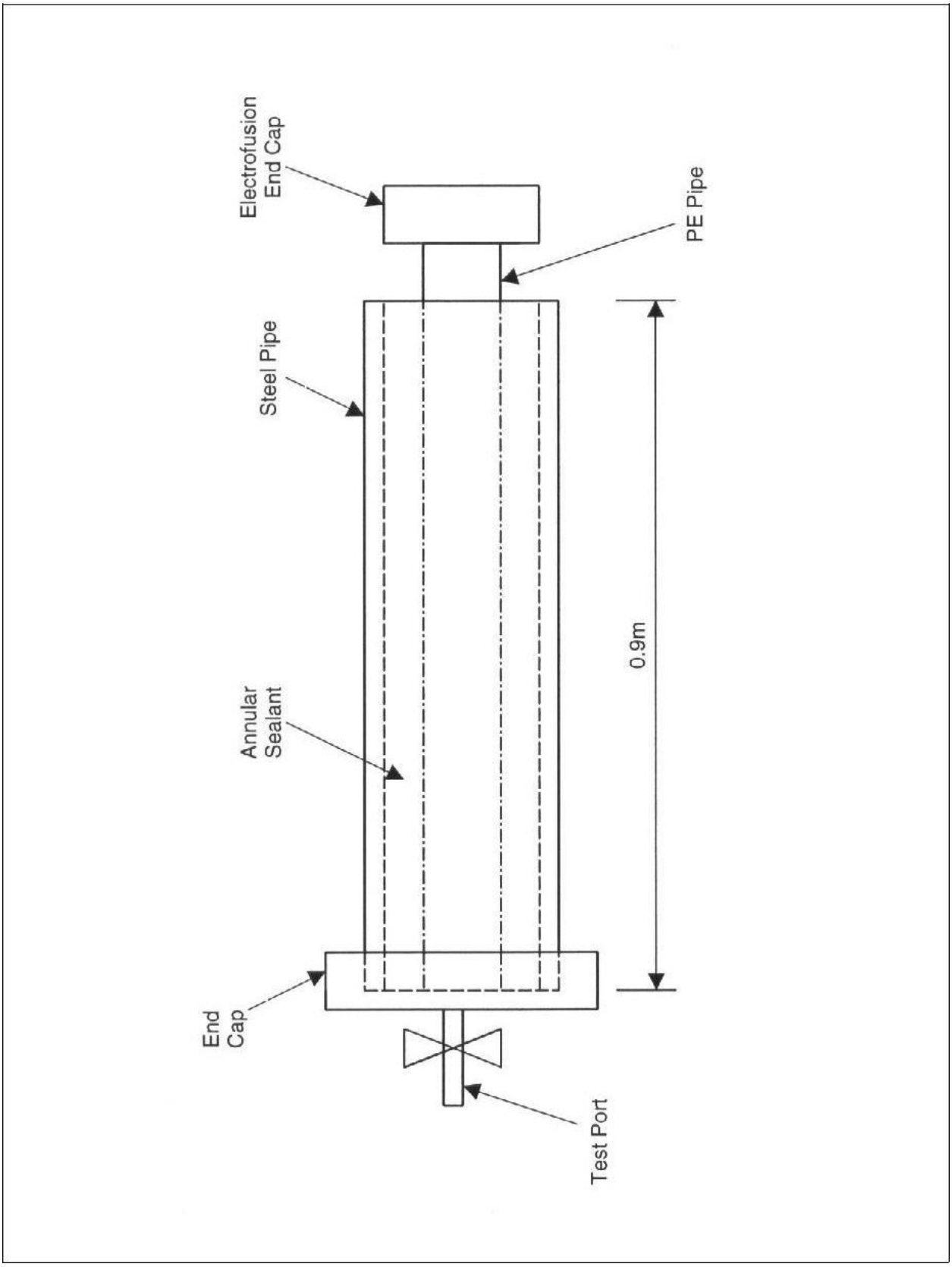


**Figure Y.1 — Slump pressure test**

## Annex Z (normative)
## Live mains transfer thermal cycling test

### Z.1 Principle

This test determines the ability of the sealant to withstand thermal cycling.

### Z.2 Apparatus

**Z.2.1** *Pressure source*, capable of supplying pressure at 120 mbar.

**Z.2.2** *Water manometer*, capable of reading up to 120 mbar.

**Z.2.3** *Steel pipe*, 6 in diameter × 1.5 m long,

**Z.2.4** *Polyethylene pipe*, 125 mm diameter × 2 m long

**Z.2.5** *Two polyethylene end caps*.

### Z.3 Test sample

One test sample of 6 in diameter steel pipe × 1.5 m long inserted with 125 mm diameter polyethylene pipe × 2 m long.

### Z.4 Procedure

Degrease one section of 6 in diameter steel pipe 1.5 m long, and prepare one section of 125 mm polyethylene pipe 2 m long. Blank off one end of the 125 mm polyethylene pipe with a butt-fused end cap.

Condition the pipe and annular sealant at a temperature of 25 °C.

Carry out annular gap filling by following the annular gap sealant manufacturer's instructions. Ensure the volume of annular gap sealant kit used is sufficient to fill the annulus to excess.

After a minimum cure time of 24 h, section the assembly to give a final length of 0.9 m long as shown in Figure Z.1. Apply a pneumatic pressure test at 100 mbar to the sealed annular gap for a period of 5 min.

Subject the whole assembly to continuous temperature cycle where the change from 2 °C to 20 °C is over a 12 h period and the change from 20 °C to 2 °C is also over 12 h. This represents one cycle. Ensure that 200 cycles are completed.

On completion of the thermal cycling test, remove the assembly and, at room temperature, apply a final pneumatic pressure test at 100 mbar to the sealed annular gap for a period of 5 min.

### Z.5 Expression of results

Record the following information:

- the pressure drop over 5 min at 100 mbar 24 h after sealant cure;
- the maximum and minimum temperatures during thermal cycling;
- the number of cycles completed;
- the pressure drop over 5 min at 100 mbar after 200 thermal cycles.

### Z.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

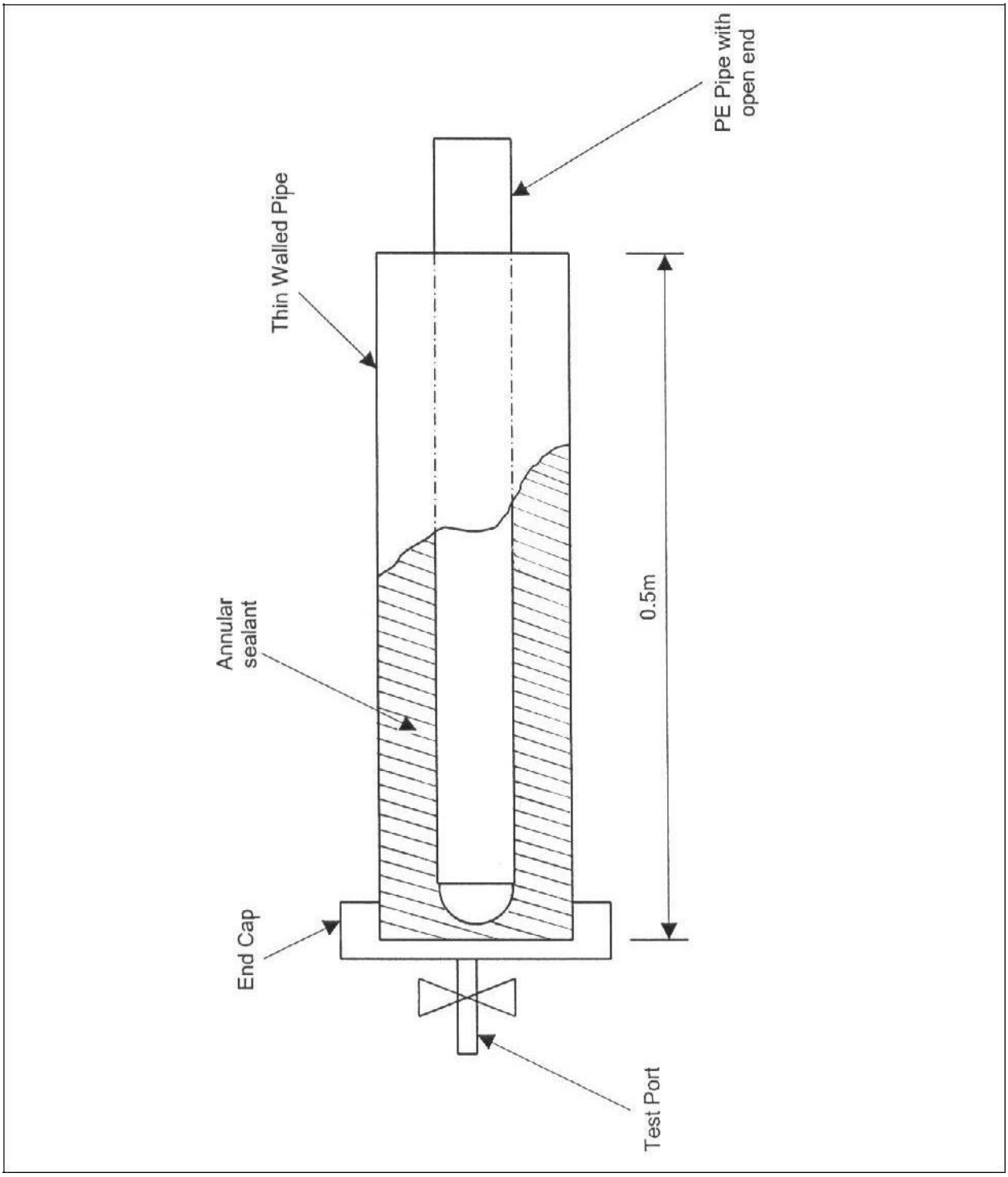


**Figure Z.1 — Thermal cycling test**

## Annex AA (normative)
## Live mains transfer contamination test

### AA.1 Principle

This test determines the ability of the annular sealant to be unaffected by contaminants that could be found in a gas main.

### AA.2 Apparatus

**AA.2.1** *Steel pipe*, 6 in diameter × 1.5 m long.

**AA.2.2** *Polyethylene pipe*, 125 mm diameter × 2 m long.

**AA.2.3** *Polyethylene end cap*.

**AA.2.4** *Distillate*.

**AA.2.5** *GMO 60*.

**AA.2.6** *MEG*.

**AA.2.7** *Water manometer*.

**AA.2.8** *Pressure source*, capable of supplying pressure at 125 mbar.

### AA.3 Test samples

One test sample of 6 in diameter steel pipe × 1.5 m long inserted with 125 mm diameter polyethylene pipe × 2 m long.

### AA.4 Procedure

Degrease one section of 6 in diameter steel pipe 1.5 m long, and prepare one section of 125 mm diameter polyethylene pipe 2 m long.

Subject the 6 in diameter steel pipe to the following contaminants:

- pipe swabbed in water and allowed to drain for 5 min;
- pipe swabbed in distillate and allowed to drain for 5 min;
- pipe swabbed in GMO 60 oil and allowed to drain for 5 min;
- pipe swabbed in MEG and allowed to drain for 5 min.

Attach the nose cone to the 125 mm diameter polyethylene pipe together with the sealant delivery equipment and insert into the metal pipe.

Inject the annular sealant in accordance with the manufacturer’s instructions. Ensure the volume of sealant kit used is sufficient to fill the annulus to excess.

Allow a minimum of 24 h cure time before removing the nose cone section and fitting an electro-fusion end cap to the protruding section of polyethylene pipe.

Ensure the final sample test length is 0.9 m and the test arrangement is as shown in Figure AA.1.

Subject the assembly to a pneumatic pressure test so that only the sealed annular gap has a pressure of 100 mbar applied to it for 5 min.

Allow a minimum time period of 6 months to elapse before subjecting the sealed annular gap to a further pneumatic pressure test of 100 mbar for 5 min

### AA.5 Expression of results

Record the following information:

- the contaminants used;
- the pressure drop over 5 min at 100 mbar 24 h after sealant cure;
- the pressure drop over 5 min at 100 mbar 6 months after sealant cure.

### AA.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

c) any additional factors which may have affected the results of the test.

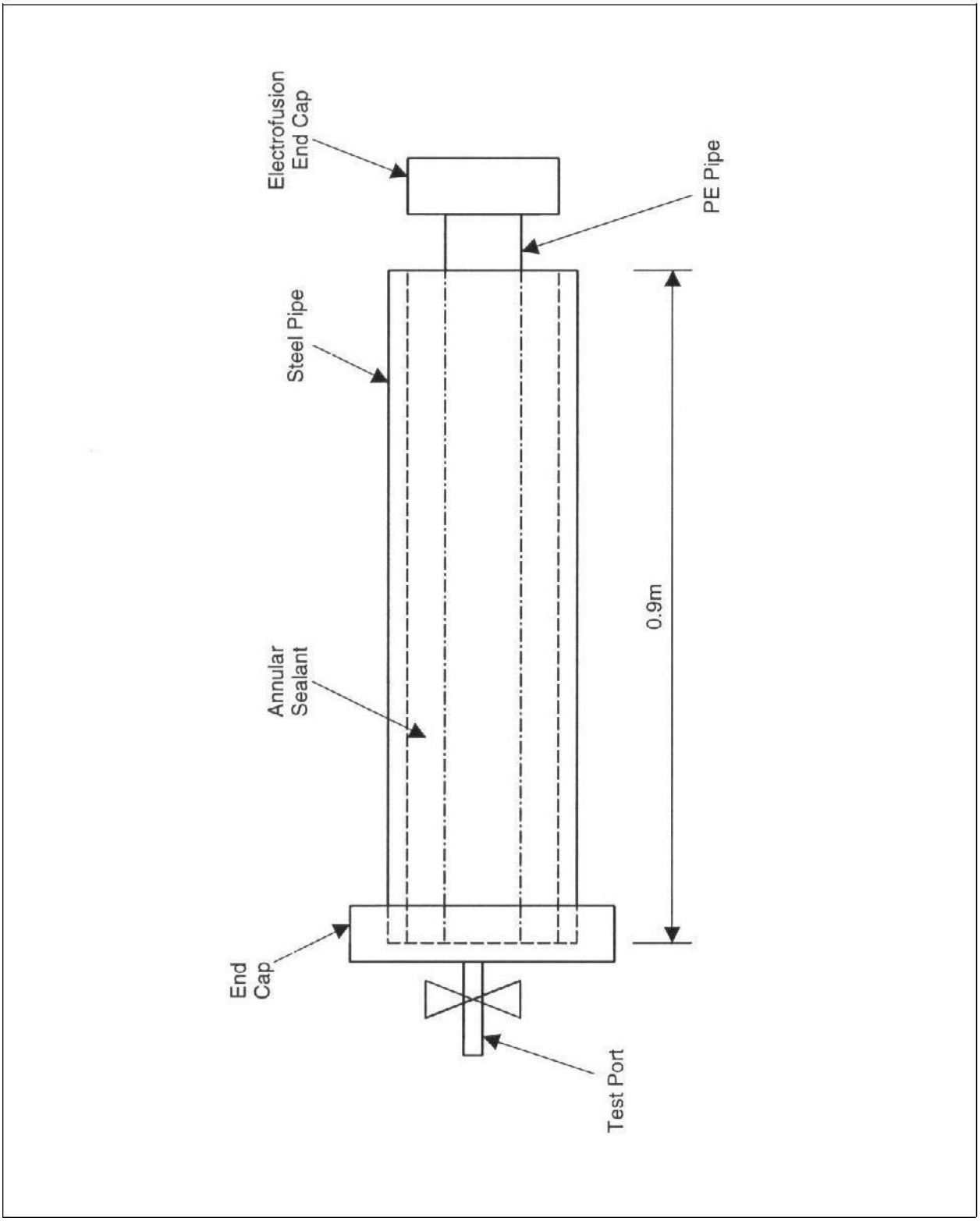


**Figure AA.1 — Contamination tests**

## Annex BB (normative)
## Live mains transfer system test

### BB.1 Principle

This test determines the ability of the system to effectively be used for live gas transfer.

### BB.2 Apparatus

**BB.2.1** *Pressure source*, capable of supplying pressure at 120 mbar.

**BB.2.2** *Water manometer*.

**BB.2.3** *Metallic pipe*, 13 m in length in accordance with Table 3.

**BB.2.4** *Polyethylene pipe*, 15 m in length in accordance with Table 3.

### BB.3 Test sample

One sample is required for each size of pipe to be qualified (for sizes see Table 3).

### BB.4 Procedure

Prepare the lengths of polyethylene from coiled pipe for size range 55 mm and 75 mm or from sticks of 125 mm diameter. Perform an integrity test on any polyethylene pipe joints in accordance with the gas transporter's procedures.

Set up a section of main to be inserted. Ensure the length of the main is sufficient to accommodate a 13 m insertion. For each main diameter to be qualified, it will be necessary to test each size of nose cone and corresponding size of polyethylene.

Attach the launch equipment to the flow-stopped main and close the gate valve and pressurize the main to 112.5 mbar using regulated compressed air.

Insert the polyethylene pipe through the launch assembly and polyethylene gland cartridge arrangement and then attach the nose cone and sealant delivery tube. Pressure test the nose cone arrangement and polyethylene bore to 100 mbar over a 5 min period.

Open the gate valve and insert the nose cone and polyethylene pipe for a length of 13 m. Ensure the insertion is in accordance with the manufacturer's instructions.

Connect the sealant delivery system and inject sealant. Ensure the quantity of sealant is in accordance with the manufacturer's instructions.

When the sealant has cured sufficiently in accordance with the manufacturer's instructions, remove the launch assembly, then retrieve the nose cone core and squeeze off the polyethylene pipe.

After 24 h of sealant curing, depressurize the system and check the length annular fill. Ensure the length of annular fill is at least 3 m long.

Remove the nose cone section from the main and conduct a pressure drop test on annular fill of the inserted main. Pressure test the arrangement and polyethylene bore to 100 mbar over a 5 min period.

Inspect the front face of the nose cone for the presence of annular sealant.

### BB.5 Expression of results

Record the following information:

- the diameter of pipe tested;
- the extent of any annular sealant on the front face of the nose cone;
- the pressure drop over 5 min at 100 mbar after removal of the nose cone.

### BB.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;
b) the results of the determination;
c) any additional factors which may have affected the results of the test.

**Annex CC (normative)**
**Live mains transfer field application test**

### CC.1 Principle

This test determines the ability of the system to be successfully deployed on an operational gas site. It is necessary to test each size of nose cone to be qualified. The field application test consists of a minimum of three live mains transfers for each size of nose cone.

### CC.2 Apparatus

**CC.2.1** *Live field trial site*.

**CC.2.2** *Means of extracting nose cone or camera*.

### CC.3 Test sample

Three test samples are required for each size of pipe to be tested.

### CC.4 Procedure

Carry out the live mains transfer in accordance with the gas transporter's procedures and the manufacturer's instructions.

On one of the field trials, excavate the section of main containing the nose cone to enable the presence of annular sealant beyond the front face of the nose cone to be determined. Alternatively, perform a camera inspection of the main to detect the presence of annular sealant beyond the front face of the nose cone. Ensure that either operation does not take place less 24 h after the curing of the sealant.

### CC.5 Expression of results

Record the following information:

- location of main to be inserted and date of insertion;
- diameter and type of gas main;
- length of insertion;
- the length of annular fill;
- any presence of annular sealant beyond the front face of the nose cone.

### CC.6 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/LC14;

b) the results of the determination;

any additional factors which may have affected the results of the test.

## Bibliography

[1] GREAT BRITAIN. *New Roads and Street Works Act 1991: Specification for the reinstatement of openings in highways.* Second edition, London: TSO.