

Gas Industry Standard

GIS/F13:2007

Specification for

**Ductile iron and fabricated steel cap ends for use on
cast iron, ductile iron and steel gas mains up to 2 bar
maximum operating pressure**

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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

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1 Scope

This Gas Industry Standard specifies requirements for the design and performance of bolted cap ends for sealing the open ends of cast iron, ductile iron and steel gas mains up to 2 bar maximum operating pressure.

Normative references

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

Formal standards

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

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

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

BS EN 10216-1, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties.*

BS EN 10217-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties.*

BS EN 12329, *Corrosion protection of metals — Electrodeposited coatings of zinc with supplementary treatment on iron or steel.*

BS EN 12330, *Corrosion protection of metals — Electrodeposited coatings of cadmium on iron or steel.*

Gas Industry Standards

GIS/C6, *Specification for distribution pipe fittings cast in ductile iron for use up to 7 bar maximum operating pressures.*

GIS/LC8-4, *Specification for methods of repairing leaking ferrous gas mains — Part 4: Pipe repair clamps, split collars and under-pressure branch connections.*

2 Construction and materials

2.1 Elastomeric materials

Elastomeric materials shall conform to BS EN 682 for the appropriate hardness class.

2.2 Body castings

Ductile iron body castings shall conform to GIS/C6. Coatings shall conform to **4.2**.

3 Design

3.1 General

Cap ends shall be designed to seal off the open ends of cast iron, ductile iron and steel pipes for at least 50 years, without requiring further attention, in the internal and external environments present in and around gas mains. The design shall be capable of tolerating the effects of corrosive ground conditions through the coatings applied (see **4.2** below) or the materials that the cap end assemblies are made from, e.g. stainless steel.

Cap ends shall be capable of accommodating specified pipe movements (axial pull in accordance with Table 1 in **5.1.5** and Annex A) and resisting specified loads without failure (vibration in accordance with Table 1 in **5.1.5** and Annex B). Seals shall be of one-piece construction for sizes up to and including 300 mm.

Cap ends above 20 kg shall have the facility to allow lifting aids to be used.

NOTE Above this size vulcanization can be used to join the seal ends.

3.2 Coatings

Cap ends and fasteners shall have a factory applied corrosion resistant coating conforming to BS EN 12329 and BS EN 12330.

3.3 Maximum working pressure.

The cap end shall be designed for a maximum operating pressure of 2 bar.

3.4 Temperature ranges

Cap ends shall be designed for the temperature range of $-10\text{ }^{\circ}\text{C}$ to $40\text{ }^{\circ}\text{C}$.

3.5 Pipe diameters

Cap ends shall seal on the minimum and maximum outside pipe diameter tolerance range shown in the table in Annex F and be suitable for use on:

- a) vertically-cast iron pipe with nominal diameters of (75 mm) 3 in to 1200 mm (48 in) and shall be in accordance with BS EN 969;
- b) grey spun iron pipe with nominal diameters of (75 mm) 3 in to 1200 mm (48 in) and shall be in accordance with BS EN 969;
- c) ductile iron pipe with nominal diameters of 80 mm to 600 mm and shall be in accordance with BS EN 969; and
- d) steel pipe with nominal diameters of (75 mm) 3 in to (600 mm) 24 in and shall be in accordance with BS EN 10216-1 and BS EN 10217-1.

Cap ends for nominal pipe diameters of 80 mm to 300 mm shall be made from cast ductile material and shall be universal to fit across pipes of all materials (cast iron, ductile iron (spheroidal graphite cast iron) and steel pipes).

NOTE Cap ends for nominal pipe diameters of 350 mm to 1200 mm can be made from cast ductile material or fabricated from steel and will not be universal but can be manufactured to fit a particular type of pipe.

3.6 Bolt head and nut clearances

Cap ends shall be designed to provide appropriate clearance for ring spanners, socket spanners and torque wrenches to be used for assembly of the particular diameter and type of cap end.

3.7 Excavation

The cap end assembly overall length and outside dimensions shall be designed to minimize the size of the excavation consistent with safety.

3.8 Installation instructions

The contractor shall supply detailed instructions for the installation of the cap end within the delivery package.

3.9 Pipe surface preparation

The contractor shall specify a standard of preparation for the pipe surface, which can be achieved by normal hand cleaning methods prior to installation of the cap end. The preparation shall have no detrimental effect on the integrity of the pipe wall or the leak-tight sealing of the cap end on the main.

This shall be stated in the cap end instructions.

3.10 Anchorage

The design shall incorporate a facility to install, between the cap end and surrounding ground, a restraining strut against end loading caused by internal gas pressure.

NOTE This should normally be a flat end surface for struts or to a design agreed with the gas transporter.

3.11 Bolt torque

The contractor shall specify bolt torque and bolt tightening sequence within the cap end instructions or this information shall be available upon request.

3.12 Backfill time

The design of the cap end shall be such that an excavation can be safely backfilled and the normal gas mains operating pressure applied immediately after installation.

3.13 Dimensions

Dimensions and general design of the cap end shall be sufficient to allow easy connection to the ends of the pipe and allow enough pipe penetration length to avoid pull-off of the cap end in service. This penetration length shall allow for any cut methods that may not leave the pipe with square ends such as on large diameter pipes. The tolerance range for sealing on the minimum and maximum outside pipe diameters is shown in the table in Annex F.

4 Type approval tests

4.1 General

4.1.1 Test pipes

The test pipes shall be manufactured from steel pipe of adequate wall thickness to incorporate the surface defects as shown in Fig.1 and withstand all forces and pressures applied during testing.

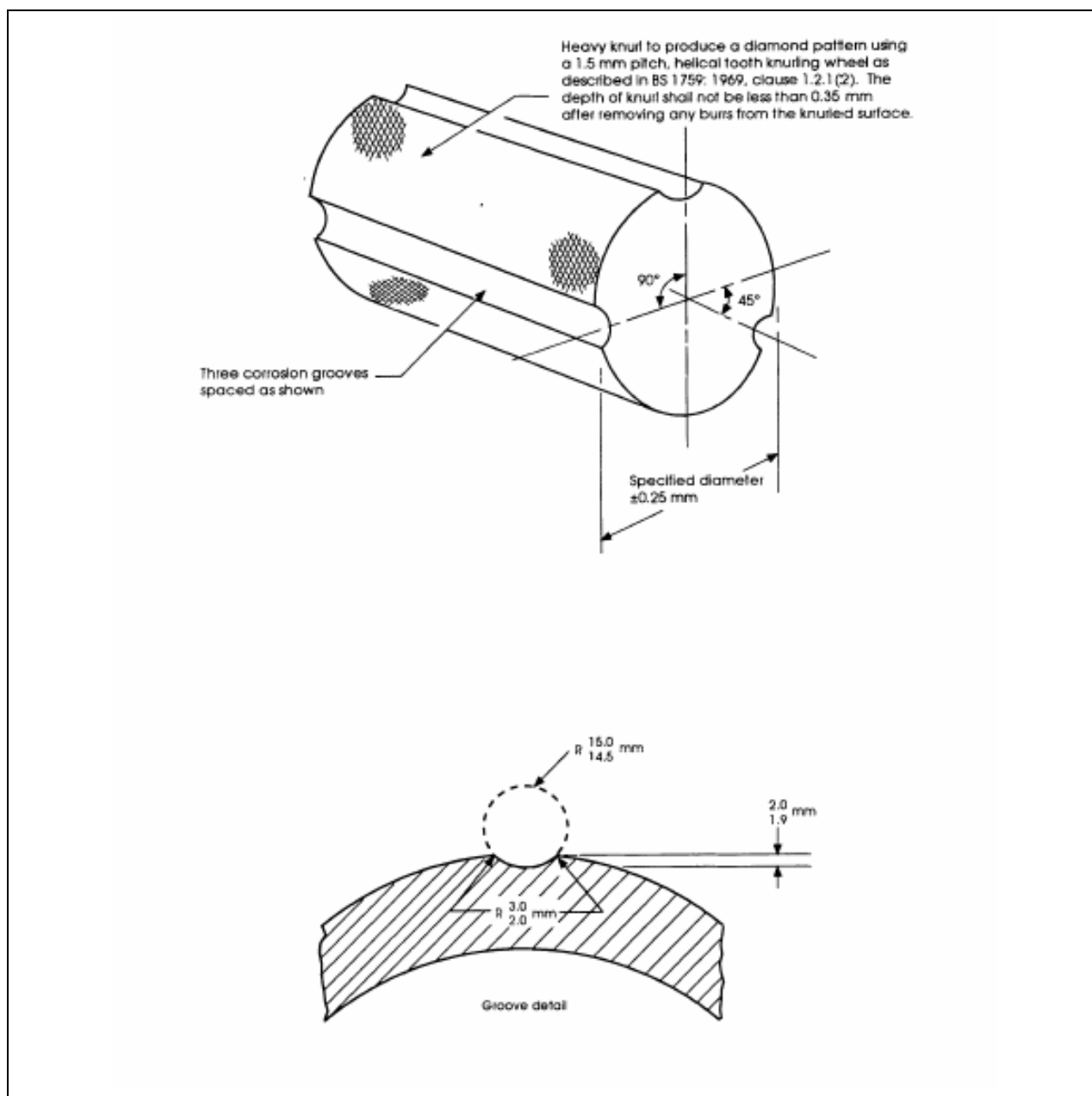


Figure 1 — Surface defects of test piece

4.1.2 Test batch

Each of the specified tests shall be carried out on three cap ends assembled on maximum diameter test pipes and three cap ends assembled on minimum diameter test pipes, with the exception of the optional pressure life test, where the number of cap ends is specified in the appropriate clause. The tolerance range for minimum and maximum outside pipe diameters is shown in the table in Annex F.

4.1.3 Test pipe sizes

All tests shall be carried out using 150 mm (6 in) nominal size test pipes for the sizes up to 300 mm diameter for the cast product, provided that the gas transporter is satisfied that the design is suitable for the whole range of sizes 80 mm to 300 mm offered by the contractor.

Application tests shall be carried out on other sizes of cap ends specified by the gas transporter and this will normally be a 450 mm mandrill or alternative arrangement as agreed with the gas transporter. Satisfactory performance shall then qualify the other sizes of cap ends in the particular range.

All tests shall be conducted with equipment which simulates actual working recommendations such as thrust blocks and restraining struts.

4.1.4 Number of cap ends and test time-scale

The number of cap ends and the time-scale for each test shall be in accordance with Table 1.

4.1.5 Assembly of cap ends

For each test, the cap end shall be assembled in accordance with the contractor's installation instructions on test pipes.

Table 1 — Summary of type approval tests

Test method	Parameter tested	Number of cap ends	Conditioning time	Approximate test duration
Annex C	Application	6	—	1 day
Annex D	Strength and distortion	6	—	1 day
Annex A	Axial pull	6	4 weeks	1 week
Annex B	Vibration	6	4 weeks	3 weeks
Annex E	Pressure/ life	24	—	6 months
NOTE 1 5.1 and 5.2.				
NOTE 2 The total test time is the sum of the test duration and the conditioning time, where applicable.				
NOTE 3 The times above apply to each test specimen. The total time will depend on the number of cap ends under test concurrently.				

4.2 Safety precautions

4.2.1 Responsibility

The contractor shall ensure that the specified system performance tests can be carried out with safety.

NOTE This standard calls for the use of substances and/or 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.

4.2.2 Hydrostatic pressure test

Before commencing the system performance tests, the pressure testing of all cap ends and test equipment to be used at 1.5 times the test pressure shall be conducted if agreed between the supplier and purchaser.

NOTE If necessary, the seal components of cap ends may be replaced after the pressure test.

4.2.3 Test precautions

Care shall be exercised when an assembly for a performance test is pressurized and during the inspection of the pressurized assembly.

5 Production testing

5.1 Cap ends shall be pneumatically or hydraulically tested to at least 1.5 times the designed maximum operating pressure (MOP) for at least 2 mins. This test shall be restricted to confirming that all pressure retaining components are fit for purpose and are free from blow holes, inclusions, etc. This shall be carried out for the minimum and maximum outside pipe diameters shown in the table in Annex F to ensure sealing across the tolerance range to cover cast iron, ductile and steel pipe sizes of that diameter.

5.2 Cap ends shall be subject to a strength and distortion test in accordance with Annex D.

6 Marking

Products conforming to GIS/F13 shall also be permanently marked with the following information:

- a) the number and date of this standard, i.e. GIS/F13:2006 ¹⁾;
- b) the name or trademark of the manufacturer or their appointed agent (on end cap);
- c) the manufacturer's contact details;
- d) production date;
- e) production batch identification number (on end cap);
- f) model and serial number;
- g) where authorized, the product conformity mark of a third party certification body, e.g. BSI Kitemark.

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

- h) pressure rating (on end cap);
- i) use by date;
- j) summary instructions for use and any hazard notification;
- k) weight of fitting;
- l) cap end instructions; (on packaging/ cap end instructions);
- m) nominal size; (on end cap);
- n) all sizes and materials of compatible pipes; (on packaging/ cap end instructions);
- o) "ductile", "duct" or "S.G." (on end cap).

7 Packaging

Packaging of cap ends shall be provided to prevent damage by normal handling and storage.

¹⁾ Marking GIS/F13:2006 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim.

Annex A (normative)

Axial pull test

A.1 Principle

Ensure fitting can resist any axial pull that may be encountered in service by simulation methods of axial extension and pipe displacement.

A.2 Apparatus

A.2.1 Test pipes, manufactured from steel pipe of adequate wall thickness to incorporate the surface defects as shown in Fig.1 and withstand all forces and pressures applied during testing and in test pipe sizes for diameters specified in 3.5 and Annex F.

A.2.2 Three cap ends, assembled on maximum diameter test pipes and three cap ends assembled on minimum diameter test pipes.

A.3 Procedure

A.3.1 The standard test temperature for system conditioning and performance testing shall be $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The standard test pressure shall be 1.5 times maximum operating pressure (MOP).

A.3.2 Assemble each cap end on a test pipe section and condition for four weeks at the standard test pressure. Pressurize with air or nitrogen through test pipe.

A.3.3 Axially extend the test pipe and cap end, at atmospheric pressure, at a rate of $1\text{ mm/min} \pm 0.1\text{ mm/min}$ until the displacement reaches 6.5 mm.

A.3.4 Apply the standard test pressure and maintain the pressure and displacement for a period of seven days.

A.3.5 Leakage shall be determined by checking with leak detection fluid or by immersion of the assembly in clear water.

A.4 Test results

No visible leakage shall be detected or any visible detrimental effect on the cap end assembly shall occur when the standard test pressure, axial pull and pipe displacement are maintained for a period of seven days.

Annex B (normative)

Vibration test

B.1 Principle

The ability of the cap end fitting to withstand vibration without any leakage or detrimental effect to actual cap end or it's installation method is determined.

B.2 Apparatus

B.2.1 *Test pipes*, manufactured from steel pipe of adequate wall thickness to incorporate the surface defects as shown in Fig.1 and withstand all forces and pressures applied during testing and in test pipe sizes for diameters specified in 3.5 and Annex F.

B.2.2 Three cap ends, assembled on maximum diameter test pipes and three cap ends assembled on minimum diameter test pipes.

B.3 Procedure

B.3.1 The standard test temperature for performance testing shall be $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The standard test pressure shall be 1.5 times maximum operating pressure (MOP).

B.3.2 Assemble each cap end on a test pipe section and condition for four weeks at the standard test pressure. Pressurize with air or nitrogen through test pipe. Maintain the standard test pressure throughout the periods of vibration.

B.3.3 Continuously vibrate the test pipes at a frequency of $1\text{ Hz} \pm 0.1\text{ Hz}$ and peak to peak amplitude of $0.25^{\circ} \pm 0.025^{\circ}$ between limits of 3° and 3.24° to the axis.

B.3.4 With the cap end anchored, continuously vibrate the test pipes at a frequency of $0.5\text{ Hz} \pm 0.05\text{ Hz}$ and peak to peak amplitude of $0.75^{\circ} \pm 0.075^{\circ}$, between limits of 3° and 3.75° to the axis.

B.3.5 Maintain the standard test pressure after the period of vibration for a period of three weeks.

B.3.6 Leakage shall be determined by checking with leak detection fluid or by immersion of the assembly in clear water.

B.4 Test results

The cap end assembly shall withstand 40×10^3 cycles and no visible leakage shall be detected, or any visible detrimental effect on the cap end assembly shall occur, during these vibration tests.

Annex C (normative)

Application test

C.1 Principle

The leaktightness of the cap end at the required maximum or minimum operational pressures is verified. Also, the installation instructions for assembly and installation can be checked.

C.2 Apparatus

C.2.1 *Test pipes*, manufactured from steel pipe of adequate wall thickness to incorporate the surface defects as shown in Fig.1 and withstand all forces and pressures applied during testing and in test pipe sizes for diameters specified in 3.5 and Annex F

C.2.2 Three cap ends, assembled on maximum diameter test pipes and three cap ends assembled on minimum diameter test pipes.

C.3 Procedure

C.3.1 The standard test temperature for performance testing shall be $20\text{ °C} \pm 5\text{ °C}$. The standard test pressure shall be 1.5 times maximum operating pressure (MOP) and for low pressure application test a special test pressure of 20 mbar shall be used.

C.3.2 Assemble each cap end, in accordance with the installation instructions, onto the test pipe.

C.3.3 Pressurize with air or nitrogen through test pipe. Test each cap end using the standard test pressure for at least 24 h. During this test, assess the general practicability of the cap ends for site use.

C.3.4 Test each cap end using the special test pressure of 20 mbar for the minimum operational pressure application test.

C.3.5 Leakage shall be determined by checking with leak detection fluid or by immersion of the assembly in clear water.

C.4 Test results

C.4.1 Each fitting shall pass both the standard test pressure and low minimum operational pressure test with no leakage detectable or any visible detrimental affect on any of the cap end assembly being tested.

C.4.2 The fitting shall be deemed practicable for site use (see **C.3.3**).

Annex D (normative) **Strength and distortion test**

D.1 Principle

The ability of the cap end to cope with the MOP and applied torques without leakage, distortion or other damage is determined.

D.2 Apparatus

D.2.1 *Test pipes*, manufactured from steel pipe of adequate wall thickness to incorporate the surface defects as shown in Fig.1 and withstand all forces and pressures applied during testing and in test pipe sizes for diameters specified in 3.5 and Annex F

D.2.2 *Three cap ends*, assembled on maximum diameter test pipes and three cap ends assembled on minimum diameter test pipes.

D.3 Procedure

D.3.1 The standard test temperature for system conditioning and performance testing shall be $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

D.3.2 Assemble each cap end on the pipe test section and tighten the bolt to a torque of 150 Nm. If the use of torque limiting devices is specified, the bolts shall be tightened to 1.5 times the contractor's recommended torque values.

D.3.3 Pressurize with air or nitrogen through test pipe. Apply the standard test pressure of 1.5 times maximum operating pressure (MOP) and maintain for a period of 24 h.

D.3.4 Leakage shall be determined by checking with leak detection fluid or by immersion of the assembly in clear water.

D.4 Test results

D.4.1 No component of the fitting shall break, show evidence of any damage or have severe distortion.

D.4.2 Each fitting shall pass both the torque test and standard pressure test with no detectable leakage and no visible detrimental effect on the cap end assembly being tested.

Annex E (normative) Pressure-life test

E.1 Principle

The useful working life of a cap end is determined by conducting the pressure-life test.

E.2 Apparatus

E.2.1 *Test pipes*, manufactured from steel pipe of adequate wall thickness to incorporate the surface defects as shown in Fig.1 and withstand all forces and pressures applied during testing and in test pipe sizes for diameters specified in 3.5 and Annex F.

E.2.2 Cap ends, twelve assembled on maximum diameter test pipes and twelve assembled on minimum diameter test pipes.

E.3 Procedure

E.3.1 The standard test temperature for performance testing shall be $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The standard test pressure shall be 1.5 times maximum operating pressure (MOP).

E.3.2 The test shall be carried out on twelve cap ends assembled on maximum diameter straight test pipes and twelve cap ends assembled on minimum diameter straight test pipes.

NOTE All 24 cap ends need not necessarily be under test simultaneously.

E.3.3 Apply the test procedure specified in **E.3.4** to **E.3.8** inclusive to each set of twelve cap ends.

E.3.4 Subject three cap ends to a pressure which will ensure failure within 1 h. Pressurize with air or nitrogen through test pipe. 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 E.1.

E.3.5 Pressurize three cap ends and hold at a pressure P_1 , a second set of three cap ends at a pressure P_2 and a third set of three cap ends at a pressure P_3 .

E.3.6 Establish pressure 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_1 shall be the pressure corresponding to six months on the time axis.

E.3.7 Pressures P_2 and P_3 shall be determined to give points equidistant on a logarithmic scale between P_1 and P .

E.3.8 The duration of the tests shall be either six months or until failure occurs, whichever is the shorter period. Leakage shall be determined by checking with leak detection fluid or by immersion of the assembly in clear water.

E.4 Expression of results

The results obtained shall be plotted on the graph to show the failure band.

E.5 Test results

When the lower edge of the failure band is extrapolated to 50 years on the results graphs (see **E.3.4**), the corresponding pressure read off the graph shall not be less than 1.5 times the designed maximum recommended working pressure for the cap end assembly.

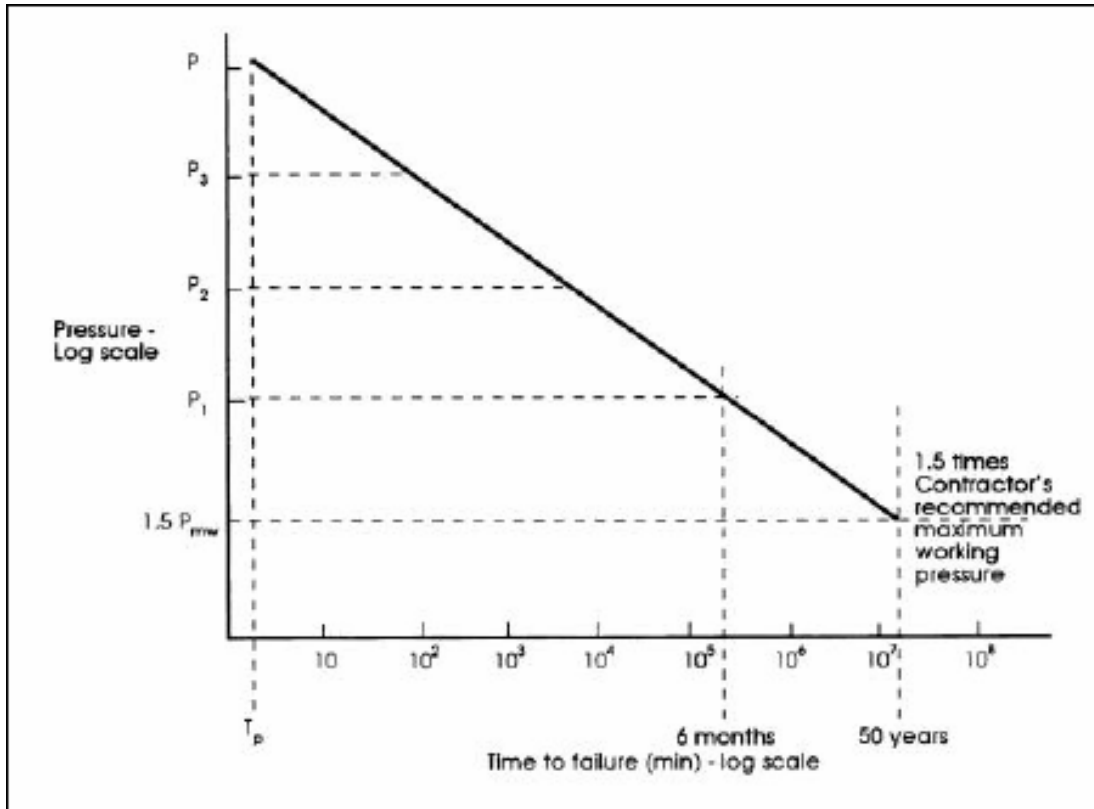


Figure E.1 — Pressure-life testing

Annex F (normative)

Table of Minimum and Maximum Pipe Diameters

(Covering cast iron, ductile iron and steel pipes in all known diameters and wall thicknesses).

In using the table below the following manufacturing tolerances shall be taken into account:-

Maximum pipe type is Cast iron with a manufacturing tolerance of Nominal dia + or – 2mm.

Minimum pipe type is steel with a manufacturing tolerance of + or – 1%.

Sealing Range on universal cast fittings up to 12in should ideally accommodate these manufacturing tolerances. Sealing range on fabricated fittings above 12in will be more restricted and will have dedicated sealing range to suit a callipered main size.

Pipe Nominal Diameter	Minimum Pipe Diameter	Maximum Pipe Diameter		Pipe Nominal Diameter	Minimum Pipe Diameter	Maximum Pipe Diameter
80mm (3in)	88.9mm	98.0mm		500mm (20in)	508.0mm	560.3mm
100mm (4in)	114.3mm	122.0mm		525mm (21in)	571.5mm	587.2mm
125mm (5in)	139.7mm	149.9mm		550mm (22in)	559.0mm	613.7mm
150mm (6in)	168.3mm	177.3mm		600mm (24in)	610.0mm	667.0mm
175mm (7in)	193.7mm	204.7mm		700mm (27in)	711.0mm	746.8mm
200mm (8in)	219.1mm	232.2mm		800mm (30in)	813.0mm	826.0mm
225mm (9in)	244.5mm	259.1mm		900mm (36in)	914.0mm	984.5mm
250mm (10in)	273.0mm	286.0mm		1000mm (40in)	1016.0mm	1090.2mm
300mm (12in)	323.9mm	345.4mm		1200mm (48in)	1219.0mm	1300.5mm
350mm (14in)	355.6mm	399.3mm				
375mm (15in)	413.0mm	426.2mm				
400mm (16in)	406.4mm	453.1mm				
450mm (18in)	457.0mm	507.0mm				

Bibliography

BS 1759:1969, *Specification for knurling wheels.*