

# Gas Industry Standard

GIS/E13.1:2019

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Specification for

**Gas filters (80 mm nominal size and above) suitable  
for use in the pressure range above 75 mbar and not  
exceeding 7 bar**

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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 (GIS) specifies the requirements for gas filters of nominal sizes 80 mm and above suitable for use at ambient temperatures in the range  $-20\text{ }^{\circ}\text{C}$  to  $60\text{ }^{\circ}\text{C}$  and in the nominal pressure range:

- a) above 75 mbar and not exceeding 2 bar;
- b) above 2 bar and not exceeding 7 bar.

It is for use by manufacturers and suppliers of gas filters.

## 2 Normative references

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

### Formal standards

BS EN 10226, Pipe threads where pressure tight joints are made on the threads.

BS 4518, *Specification for metric dimensions of toroidal sealing rings ('O'-rings) and their housings.*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories.*

BS EN 485 Series, *Aluminium and aluminium alloys — Sheet strip and plate.*

BS EN 515, *Aluminium and aluminium alloys — Wrought products — Temper designations.*

BS EN 573-1 *Aluminium and aluminium alloys — Chemical composition and form of wrought products. Numerical designation system*

BS EN 573-2 *Aluminium and aluminium alloys — Chemical composition and form of wrought products. Chemical symbol based designation system*

BS EN 573-3, *Aluminium and aluminium alloys — Chemical composition and form of wrought products. Chemical composition and form of products*

BS EN 573-5, *Aluminium and aluminium alloys — Chemical composition and form of wrought products. Codification of standardized wrought products*

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

BS EN 754-1, *Aluminium and aluminium alloys — Cold drawn rod/bar and tube — Part 1: Conditions for inspection and delivery.*

BS EN 754-2, *Aluminium and aluminium alloys — Cold drawn rod/bar and tube — Part 2: Mechanical properties.*

BS EN 754-7, *Aluminium and aluminium alloys — Cold drawn rod/bar and tube — Part 7: Seamless tubes, tolerances on dimensions and form.*

BS EN 755 Series, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles.*

BS EN 1092-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges.*

BS EN 1092-2, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges.*

BS EN 1092-4, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 4: Aluminium alloy flanges.*

- BS EN 1559-1, *Founding — Technical conditions of delivery — Part 1: General.*
- BS EN 1559-4, *Founding — Technical conditions of delivery — Part 4: Additional requirements for aluminium alloy castings.*
- BS EN 1562, *Founding — Malleable cast irons.*
- BS EN 1563, *Founding — Spheroidal graphite cast iron.*
- BS EN 1676, *Aluminium and aluminium alloys — Alloyed ingots for re-melting — Specifications.*
- BS EN 1706, *Aluminium and aluminium alloys — Castings — Chemical composition and mechanical properties.*
- BS EN 1759-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, class-designated — Part 1: Steel flanges, NPS 1/2 to 24.*
- BS EN 1982, *Copper and copper alloys — Ingots and castings.*
- BS EN 10028, *Specification for flat products made of steels for pressure purposes.*
- BS EN 10029, *Specification for tolerances on dimensions, shape and mass for hot rolled steel plates 3 mm thick or above.*
- BS EN 10088-2, *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes.*
- BS EN 10088-3, *Stainless steels — Part 2: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes.*
- BS EN 10213 + A1, *Steel castings for pressure purposes.*
- 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 10216-4, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 4: Non-alloy and alloy steel tubes with specified low 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 10217-4, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 4: Electric welded non-alloy steel tubes with specified low temperature properties.*
- BS EN 10222-1, *Steel forgings for pressure purposes — Part 1: General requirements for open die forgings.*
- BS EN 10222-2, *Steel forgings for pressure purposes — Part 2: Ferritic and martensitic steels with specified elevated temperatures properties.*
- BS EN 10222-3, *Steel forgings for pressure purposes — Part 3: Nickel steels with specified low temperature properties.*
- BS EN 10222-4, *Steel forgings for pressure purposes — Part 4: Weldable fine-grain steels with high proof strength.*
- BS EN 10222-5, *Steel forgings for pressure purposes — Part 4: Martensitic, austenitic and austenitic-ferritic stainless steels.*
- BS EN 10272, *Stainless steel bars for pressure purposes.*
- BS EN 10273, *Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties.*
- BS EN 12020-2, *Aluminium and aluminium alloys extruded precision profiles in alloys EN AW-6060 and EN AW-6063 — Part 2: Tolerances on dimensions and form.*
- BS EN 12266-1, *Industrial valves — Testing of valves — Part 1: Pressure tests, test*



*procedures and acceptance criteria — Mandatory requirements.*

BS EN 12266-2, *Industrial valves — Testing of valves — Part 2: Pressure tests, test procedures and acceptance criteria — Supplementary requirements.*

BS EN 13445 (all parts), *Unfired pressure vessels.*

BS EN ISO 3183, *Petroleum and natural gas industries. Steel pipe for pipeline transportation systems*

PD 5500, *Specification for unfired fusion welded pressure vessels.*

API 5L, *Specification for line pipe.*

ASME Code Section VIII, Division 1, *Pressure vessels. Rules for construction of pressure vessels.*

ASTM A106/A106M-04b, *Standard specification for seamless carbon steel pipe for high-temperature service.*

ASTM A333, *Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness*

### **Individual Gas Distribution Network Standards**

*\* /SP/PA/10, Specification for new and maintenance painting at works and site for above ground pipeline and plant installations.*

\* = Denotes each gas distribution network reference

## **3 Terms and definitions**

For the purposes of this GIS the following definitions apply:

### **3.1**

#### **allowable leakage**

amount of test gas so small that no bubbles are observed breaking loose from the filter when fully immersed in water during the test specified

NOTE See also BS EN 12266-1.

### **3.2**

#### **element**

removable filter component preventing contaminants greater than the specified level of filtration passing downstream of the filter body

NOTE The element can consist of a single layer or multiple layers of materials, some or none of which might be replaceable.

### **3.3**

#### **ladle analysis**

composition of the casting material in its molten state

### **3.4**

#### **maximum working pressure (MWP)**

maximum pressure to which a filter body and its components may be subjected in normal operation

## **4 Materials**

**4.1** All materials used for the components of the filters shall be suitable for use with natural gas.

**4.2** No materials used shall be adversely affected by any gas constituents or gas additives.

**4.3** Components used under pressurized conditions shall be manufactured to the appropriate standard given in Table 1.

**Table 1 — Materials**

<b>Product</b>	<b>Material Type</b>	<b>Standard</b>	<b>Grade</b>
Castings	Spheroidal graphite cast iron	BS EN 1563	EN-GJS-350-22-LT, EN-GJS-400-18-LT
Castings	Malleable cast iron	BS EN 1562	EN-GJMW-360-12, EN-GJMB-350-10
Castings	Carbon & C-Mn steel	BS EN 10213	G17Mn5, G20Mn5
Castings	Copper-base alloys	BS EN 1982	CC491K, CC492K, CC331G, CC333G
Castings	Aluminium alloys	BS EN 1559-1 BS EN 1559-4 BS EN 1676 BS EN 1706	EN AC-45200, EN AC 42100 EN AC44200, EN AC46600
Forgings	Carbon & C-Mn steel	BS EN 10222-1 BS EN 10222-2 BS EN 10222-3	13MnNi6-3, 15NiMn6, 12Ni14
Plates	Carbon & C-Mn steel	BS EN 10028 BS EN 10029	P275NL1
Plate, sheet, strip	Aluminium alloys	BS EN 485 (all parts) BS EN 515 BS EN 573 (all parts)	EN AW-5251, EN AW-5454, EN AW-5154A, EN AW-508
Pipe/tubes	Carbon & C-Mn steel	BS EN 10216-1 BS EN 10217-1	P235TR2, P265TR2
Pipe/tubes	Carbon & C-Mn steel	BS EN 10216-4 BS EN 10217-4	P265NL
Pipe/tubes	Carbon & C-Mn steel	API 5L BS EN ISO 3183	GR B PSL 1 or PSL 2 (seamless or straight seam submerged arc welded)
Pipe/tubes	Carbon & C-Mn steel	ASTM A106 ASTM A333	GR B Grade 6
Pipe/tubes	Aluminium alloys	BS EN 515 BS EN 754-1 BS EN 754-2 BS EN 754-7 BS EN 573	EN AW-5251, EN AW-5154A, EN AW-5083
Bars and sections	Aluminium alloys	BS EN 12020-2 BS EN 515 BS EN 573 BS EN 755 (all parts)	EN AW-5251, EN AW-5154A, EN AW-5083
Bars and sections	Steel	BS EN 10272 BS EN 10273	
The magnesium content of aluminium alloys and welding filler metals shall not exceed 6 %.			

**4.4** Material grades shall be selected to meet any impact test requirements of the design code.

**4.5** For steel compositions of welding grades (including weld repaired steel castings), the ladle analysis shall be checked to ensure that the carbon equivalent (CE) does not exceed 0.45, based on the formula:

$$CE = \%C + \frac{\%Mn}{6} + \frac{(\%Cr + \%Mo + \%V)}{5} + \frac{(\%Cu + \%Ni)}{15}$$

**4.6** Austenitic stainless steel components shall conform to BS EN 10088 grades 1.4401 (X5CrNiMo17-12-2), 1.4436 (X3CrNiMo17-13-3) or 1.4571 (X6CrNiMoTi17-12-2).

**4.7** The designation (suffix) of the specific variant of the steel grade for a product form (casting, plate, etc.) and its related British Standard shall be specified by the supplier on the delivery / certification documentation.

**4.8** Elastomeric components of filters (e.g. seals) shall comply with the requirements of either BS 4518 or BS EN 682.

## 5 Design requirements

### 5.1 Filter

**5.1.1** Filters shall be designed in conformance to one of the following pressure vessel standards: ASME VIII, PD 5500 or the BS EN 13445 series.

**5.1.2** The design shall be proved by calculation in accordance a design standard as specified in Only when this is not possible shall the design be proof tested in accordance with the type test given in **B.3**.

**5.1.3** Filters shall be designed for at ambient temperatures from -20 °C to 60 °C. The actual design temperature shall be suitable for the filter operating conditions, taking account of the pressure temperature .

**5.1.4** The direction of flow shall be cast or similarly permanently marked on the filter body.

**5.1.5** Manufacturing tolerances shall be such that replacement parts are interchangeable.

**5.1.6** All critical fastenings shall be locked to prevent vibrational loosening and be re-lockable if unlocked during maintenance and before commissioning. Any free moving or loose components shall remain so during service and shall not be capable of being inadvertently locked.

**5.1.7** External impulse connections shall be internally threaded in conformance to BS 10226. Alternatively flanges to BS EN 1092 or BS EN 1759 may be specified. Two connections  $R_C$  1/4 or  $R_P$ 1/4 as a minimum shall be provided for differential pressure purposes and two further connections, one on the inlet and one on the outlet minimum  $R_C$ 1/2 or  $R_P$ 1/2, shall be provided for venting/diagnostic purposes. Where the handing or construction of the filter requires a drain, either one of the venting/diagnostic connections shall be used or a separate drain tapping shall be provided.

**5.1.8** Filter bodies, other than those integral with another device, shall have flanged ends that meet the requirements of BS EN 1092, unless BS EN 1759-1 is specified by the gas transporter.

**5.1.9** Filters with one or more flanges of 200 mm diameter nominal size and above shall

incorporate lifting lugs appropriate to both the horizontal and vertical positions. Each lug shall be capable of taking the full weight of the filter. Tapped holes and eyebolts shall not be used.

**5.1.10** Filters for use in the pressure range above 75 mbar and not exceeding 2 bar shall have a filtration cut off not greater than 200  $\mu\text{m}$ . Filters for use in the pressure range above 2 bar and not exceeding 7 bar shall have a filtration cut off not greater than 50  $\mu\text{m}$ .

**5.1.11** Means shall be provided to ensure that the element is positively and correctly located within the body of the filter prior-to and after the cover is fitted.

## **5.2 Element**

**5.2.1** The element should be designed so that when removed from the filter body, any dust or debris retained by the element is removed with it.

**5.2.2** The element shall be suitable for reverse flow conditions.

**5.2.3** For pressures above 75 mbar and not exceeding 2 bar, the element shall be capable of withstanding a minimum differential pressure of 350 mbar.

**5.2.4** For pressures above 2 bar and not exceeding 7 bar, the element shall be capable of withstanding a minimum differential pressure of 1 bar.

## **5.3 Bypass**

**5.3.1** Where the gas transporter specifies that the element is to be bypassed, an external indication should be incorporated to identify that the bypass has operated. This shall be independent of the differential pressure gauge.

**5.3.2** When the bypass is in operation the accumulated dust and other debris generated shall not be discharged downstream of the element.

## **5.4 Filter cover**

**5.4.1** The filter cover shall be of a quick release type.

**5.4.2** A venting arrangement shall be provided that is interlocked with the cover so that the cover is restrained until the pressure in the filter body has been released. A suitable procedure shall be agreed between the supplier and the gas transporter to demonstrate that the cover cannot be removed whilst there is still pressure within the body. The written procedure shall be included in the filter delivery documentation.

**5.4.3** The locking mechanism shall be designed so that failure of any one element of the mechanism cannot result in the failure of any other element or the unsecured release of the cover.

**5.4.4** It shall not be possible to over-compress the seal between cover and body.

**5.4.5** Consideration should be given to providing means of mechanical assistance for handling large or heavy filter covers.

## **6 Type approval testing**

### **6.1 General**

**6.1.1** Implementation of the tests in this GIS shall be the responsibility of the contractor.

**6.1.2** A type approval test shall be carried out on each design and size of filter as specified in the schedule in Annex A.

**6.1.3** The testing may be carried out by the contractor and witnessed by the gas transporter, or by carried out by an independent laboratory accredited to BS EN ISO/IEC 17025 acting on the contractor's behalf.

## 7 Production testing

### 7.1 General

Each production filter shall be tested by the contractor in accordance with the tests specified in 7.2 and 7.3. Filters which fail to meet the requirements of any of the tests shall be rejected

### 7.2 Tests prior to assembly

#### 7.2.1 General

The completed pressure-containing components shall be tested for leakage and strength prior to the application of any paint or synthetic protection coating.

#### 7.2.2 Strength

The strength test shall be carried out at the multiple of the MWP, for the times specified according to their material type, as given in Tables 2 and 3 respectively. The test pressure shall be limited to 90% of the SMYS of the material.

**Table 2 — Standard production strength test**

Material		Test pressure (multiple of MWP)
Cast iron	Ductile	2.0
Cast iron	Malleable	2.5
Steel	Cast	1.5
Steel	Fabricated	1.5
Copper	Cast	1.5
Copper	Forged	1.5
Copper	Fabricated	1.5
Aluminium alloys	Cast	1.5
Aluminium alloys	Forged	1.5
Aluminium alloys	Fabricated	1.5

**Table 3 — Duration of strength test**

Inlet flange size		Duration of test
mm	in	minutes
80	3	4
$> 80 \leq 150$	$> 3 \leq 6$	6
$> 150 \leq 250$	$> 6 \leq 10$	10
$> 250 \leq 450$	$> 10 \leq 18$	14
$> 450$	$> 18$	16

Where the test duration shown in this table conflicts with the requirements of the chosen design code (ASME V111, PD 5500 or BS EN 13445) the requirements of the design code shall take precedence.

### 7.2.3 Leakage

The leakage test applied to the body, cover and other pressure-containing parts shall be carried out at a pressure of either 0.5 times the MWP or 3.5 bar, whichever is the lesser, for not less than 60 s, during which time allowable leakage shall not be exceeded.

### 7.3 Test after assembly

**7.3.1** A pneumatic pressure test, as given in **7.3.2**, shall be carried out on the assembled filter to check for external leakage.

**7.3.2** The filter shall first be tested at an air pressure of 20 mbar for 30 seconds and then at the MWP for 30 seconds, during which allowable leakage shall not be exceeded.

**7.3.3** These tests shall be carried out on fully assembled filters prior to packaging.

**7.3.4** Paints and synthetic protective coatings may be applied prior to these tests.

## 8 Repair of castings

### 8.1 General

Castings shall not be repaired unless the repairs are permitted in the relevant standard for the casting material (BS EN 1562 for malleable cast iron, BS EN 1563 for spheroidal graphite cast iron or BS EN 10213 for cast steel). Such repairs shall be carried out to a procedure previously agreed between the contractor and the gas transporter.

### 8.2 Ductile iron

**8.2.1** The following forms of defect are the only ones acceptable for repair.

- a) Superficial surface cavities may be cosmetically repaired with a suitable iron cement compound, provided that the remaining wall thickness does not fall below the specified design minimum thickness.
- b) Cosmetic repairs by welding shall be allowed if weld procedures have been agreed with the gas transporter.
- c) Micro-porosity may be repaired by impregnation if the leak path does not reduce the mechanical/structural strength of the casting. Resin based fillers shall be used for all impregnation repairs.

**8.2.2** Repair of leaks by impregnation is not permitted on flange surfaces.

### **8.3 Steel**

Repair by welding may be allowed if weld procedures have been agreed with the gas transporter.

### **8.4 Other cast materials**

Other cast materials may be repaired to a procedure previously agreed between the contractor and the gas transporter.

### **8.5 Pressure test**

All repaired castings except those specified in **8.6** shall be pressure tested in accordance with Clause **7** after completion of the repairs.

### **8.6 Metal filler**

Metal fillers, used to enhance the appearance of castings, shall only be used after completion of all pressure testing.

## **9 Painting**

**9.1** External surfaces of the filter shall be painted in accordance with the requirements of \*/SP/PA10, Specific Painting Application (SPA) 1 unless the gas transporter specifies the application of a holding primer for storage protection compatible with \*/SP/PA10.

## **10 Performance data**

Charts for pressure drops across the filter, obtained from the results of the type approval tests in Clause **6** shall be made readily available to the gas transporter by the contractor. The format and requirements of the charts are specified in **B.5.2**.

## **11 Marking**

**11.1** Filters conforming to this GIS shall be permanently marked in a way that does not detract from the mechanical strength or service requirements of the filter. The marking shall include the following information:

- a) the number and date of this standard, i.e. GIS/E13.1:2019 <sup>1)</sup>;
- b) the name or trademark of the manufacturer or their appointed agent;
- c) the manufacturer's contact details;
- d) 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.

- e) the contractor's name or trademark;
- f) the batch number and serial number of the individual filter;
- g) the filter type;

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<sup>1)</sup> Marking GIS/E13.1:2019 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

h) the size of the filter;

i) date of manufacture;

NOTE A code may be used for this item.

j) maximum inlet pressure;

k) hydrostatic test pressure.

**11.2** Markings shall be stamped or raised and shall remain legible under normal handling, storage and installation procedures.

**11.3** For filters contained within the same combined regulator module as other equipment, markings that appear elsewhere on the unit need not be repeated on the filter.

## **12 Packing and shipping**

**12.1** All external openings shall be protected with a non-metallic material immediately after the production tests in Clauses **7** and **8** have been completed and the filters are free of water and cleaned. Such protection shall prevent ingress of dirt or moisture. End protection on flanged filters should allow them to stand upright.

**12.2** Shipping containers shall be such that each filter is protected against damage.



**Annex A (normative)**  
**Test schedule for type testing**

**A.1** The schedule of tests is specified in Table A.1.

**A.2** Failure of any filter shall constitute a failure of the type tests.

**A.3** Details of the tests are specified in Annex B.

**Table A.1 — Schedule of tests**

<b>Subclause</b>	<b>Test title</b>
<b>B.3</b>	Proof test <sup>a)</sup>
<b>B.4</b>	Integrity of locking mechanism
<b>B.5</b>	Pressure loss
<b>B.6</b>	Bypass test (where fitted)
<b>B.7</b>	Element strength
<b>B.8</b>	Reverse flow
<b>B.9</b>	Endurance
<b>B.10</b>	Inspection
<sup>a)</sup> Where the proof test is not required because the design has been validated by calculation, the production test specified in <b>7.2.2</b> shall be carried out before tests <b>B.4</b> to <b>B.10</b> inclusive.	
NOTE Certain components and features may be common and identical to various filters and would only require type testing once.	

## **Annex B (normative)**

### **Tests**

#### **B.1 General**

This Annex details the requirements of the tests referred to in the schedule in Annex A. All pressures are gauge unless specified otherwise.

#### **B.2 Instrumentation accuracy requirements**

The instrumentation used in the following tests shall be accurate to the following tolerances:

- a) Inlet pressure:  $P_1 \pm 0.5\%$  nominal value.
- b) Differential pressure:  $(P_1 - P_2) \pm 1$  mbar nominal value.
- c) Flowrate:  $\pm 2.5\%$  nominal value.
- d) Temperature:  $\pm 2$  °C nominal value.

#### **B.3 Proof test**

##### **B.3.1 Principle**

The proof test is to confirm the MWP.

The test is based on the bursting test procedure specified in ASME VIII Division I (UG 101). The procedure is for use only when the thickness of all parts of the pressure vessel cannot be calculated satisfactorily by means of the code design rules or other acceptable design formulae. In such circumstances cast materials shall be subjected to a proof test at the appropriate ratio in addition to any design by calculation. A seal, suitable for test pressures, shall be used between the cover and body.

The proof test pressure will vary according to the type of material involved and reference shall be made to ASME VIII for materials not given in Table B.1.

##### **B.3.2 Apparatus**

**B.3.2.1** *The filter body or filter parts*, which have not previously been subjected to a pressure greater than that given in Table B.1.

**B.3.2.2** *Suitable instrumentation, such as dial test indicators or approved strain gauges*, suitably located on the filter.

##### **B.3.3 Procedure**

**B.3.3.1** Increase the pressure in the filter body gradually until a pressure of  $0.5 \times$  MWP is reached.

**B.3.3.2** Hold this pressure for 10 min.

**B.3.3.3** Release the pressure to zero to permit determination of any permanent strain or displacement.

NOTE This will be evident if gauges do not return to zero.

**B.3.3.4** Increase the pressure by approximately 1 bar increments, repeating **B.3.2.2** and **B.3.2.3** on every occasion until a pressure equal to that given in Table B.1 is reached.

**B.3.3.5** Record all gauge readings and plot them on a graph of gauge extension versus pressure.

**B.3.3.6** After the final pressure is reached, held and recorded, the pressure shall be released to zero.

### **B.3.4 Results**

The filter body or filter parts shall be deemed acceptable when:

- a) for test pressures given in Table 2, there shall be no permanent strain or distortion on completion of the test; and
- b) the pressure given in Table B.1 is achieved and the test completed without failure of any component.

## **B.4 Integrity of locking mechanism**

### **B.4.1 Procedure**

**B.4.1.1** Ensure the filter has one failed locking element or component in the locking mechanism.

**B.4.1.2** Increase the hydrostatic pressure in the filter body gradually until a pressure of  $0.5 \times \text{MWP}$  is reached.

**B.4.1.3** Release the pressure to zero to permit determination of any permanent strain or displacement.

**B.4.1.4** Increase the hydrostatic pressure shall be increased by 1 bar increments, repeating **B.4.1.3** on each occasion. Terminate the testing when pressure has reached the multiple of MWP given in Table 2.

**B.4.1.5** Repeat the tests **B.4.1.1** to **B.4.1.4** for each of the other locking elements in the failed position, unless the locking elements are identical and symmetrically positioned.

### **B.4.2 Requirements**

Failure of any one locking element or component in the locking mechanism shall not result in the failure of any other locking element / or the release of the cover.

**Table B.1 — Proof test pressures**

Material		Proof test pressure
Cast iron	Ductile	$6.25 \times R \times MWP$
Cast iron	Malleable	$6.67 \times R \times MWP$
Steel	Cast	$5.00 \times R \times MWP$
Steel	Fabricated	$5.00 \times R \times MWP$
Copper	Cast	$5.00 \times R \times MWP$
Copper	Forged	$5.00 \times R \times MWP$
Copper	Fabricated	$5.00 \times R \times MWP$
Aluminium alloys	Cast	$5.00 \times R \times MWP$
Aluminium alloys	Forged	$5.00 \times R \times MWP$
Aluminium alloys	Fabricated	$5.00 \times R \times MWP$
NOTE 1 The proof test pressure is that pressure to be achieved in order to validate the desired MWP.		
NOTE 2 The proof test pressure shall be as specified in <b>C.3.2</b> .		
NOTE 3 Definition of R = $\frac{\text{Average tensile strength of test specimens}}{\text{Listed minimum tensile strength}} \times \frac{t}{t - c}$		
where:		
t = nominal thickness at weakest point		
c = corrosion allowance (minimum 1.5mm)		

## B.5 Pressure loss

### B.5.1 Procedure

**B.5.1.1** Install the filter, together with clean element, in the configuration shown in Figure B.1.

**B.5.1.2** With the inlet pressure maintained at a suitable pressure level, record the pressures  $P_1$  and  $(P_1 - P_2)$  at equal increments of flow to allow the pressure loss coefficient to be determined.

**B.5.1.3** Repeat the testing **B.5.1.1** and **B.5.1.2** elements of different design/filtration levels.

### B.5.2 Results

**B.5.2.1** The results of the pressure loss tests shall be presented as a series of curves and the pressure loss used for plotting these curves shall be  $(P_1 - P_2)$  obtained from **B.5.1.2**.

**B.5.2.2** Charts shall be available for each design, size and filtration level with curves at various inlet pressures.

**B.5.2.3** As a minimum, the curves for 350 mbar inlet pressure (for 2 bar filters) and 2.5 bar inlet pressure (for 7 bar filters) shall be included on the chart.

**B.5.2.4** The flow axis (horizontal) shall be in m<sup>3</sup>/h, the pressure loss axis (vertical) and the inlet pressure annotated on each curve shall be in mbar or bar, as appropriate.

**B.5.2.5** Each family of curves shall be produced from the pressure loss coefficient determined in **B.5.1.2** for flow and pressure conditions not tested.

## **B.6 Bypass test (where fitted)**

### **B.6.1 Procedure**

**B.6.1.1** Completely block the inlet side of the filter element for example by use of a spray-on coating of a non-porous flexible substance, such as a polyurethane varnish.

**B.6.1.2** Fit the filter element in the filter body and install it in the configuration shown in Figure C.1 with the demand valve opened.

**B.6.1.3** Test the filter element by increasing the inlet pressure gradually up to either 2 bar or 7 bar, depending on the operating regime of the equipment, until either the bypass opens or the filter element fails.

**B.6.1.4** Record the differential pressure at which the bypass operates.

### **B.6.2 Results**

The bypass shall operate prior to the filter element failing and it shall operate at the manufacturers claimed setting  $\pm 5\%$ .

## **B.7 Element strength**

### **B.7.1 Procedure**

**B.7.1.1** Completely block the inlet side of the filter element, for example, by use of a spray-on coating of a non-porous flexible substance, such as a polyurethane varnish. If a bypass is fitted, lock it in the closed position.

**B.7.1.2** Fit the filter element in the filter body and install it in the configuration shown in Figure C.1 with the demand valve opened.

**B.7.1.3** Test the filter element by increasing the inlet pressure gradually until the pressure  $P_1$  is either 2 bar or 7 bar, according to the nominal pressure range of the body or until the element fails, whichever is the lesser.

**B.7.1.4** Repeat **B.7.1.1** to **B.7.1.3** for elements of different design/filtration levels.

### **B.7.2 Results**

**B.7.2.1** For pressures above 75 mbar and not exceeding 2 bar, the filter element shall be capable of withstanding a minimum differential pressure of 450 mbar.

**B.7.2.2** For pressures above 2 bar and not exceeding 7 bar, the filter element shall be capable of withstanding a minimum differential pressure of 1.25 bar.

## **B.8 Reverse flow**

### **B.8.1 Procedure**

**B.8.1.1** Install the filter, together with a clean element, in the apparatus as shown in Figure C. 1 but with the air supply and demand valve interchanged.

**B.8.1.2** With the demand valve dosed, apply a pressure of 0.1 bar to the filter.

**B.8.1.3** Close the air supply entrapping the 0.1 bar pressure and the pipework on the inlet to the air supply valve removed. Quickly move the air supply valve to the fully opened position to evacuate the trapped volume of air.

### **B.8.2 Results**

The element shall sustain no visible damage and retain its integrity and remain in place.

## **B.9 Endurance**

### **B.9.1 Procedure**

**B.9.1.1** Subject the locking mechanisms and cover to 50 cycles of fastening, opening up and refastening.

NOTE A cycle consists of fastening, opening, element removal, element replacement and complete refastening of the locking mechanism.

**B.9.1.2** Subject the body to a pressure of  $0.5 \times \text{MWP}$  and check for leakage.

**B.9.1.3** Repeat the procedure in **B.9.1.1** and **B.9.1.2** a further four times.

### **B.9.2 Results**

**B.9.2.1** There shall be no external leakage.

**B.9.2.2** It shall be possible to operate the locking mechanism or remove the cover.

## **B.10 Inspection**

### **B.10.1 Procedure**

**B.10.1.1** Dismantle the filter and examine all moving parts for damage, wear, binding, evidence of corrosion and other defects.

**B.10.1.2** At each stage of dismantling, record any binding of moving parts and other difficulties encountered in dismantling the filter.

### **B.10.2 Results**

Any evidence of undue wear, binding, corrosion damage or other defects which can affect the long term performance of the filter shall be a cause for failure of the test schedule.

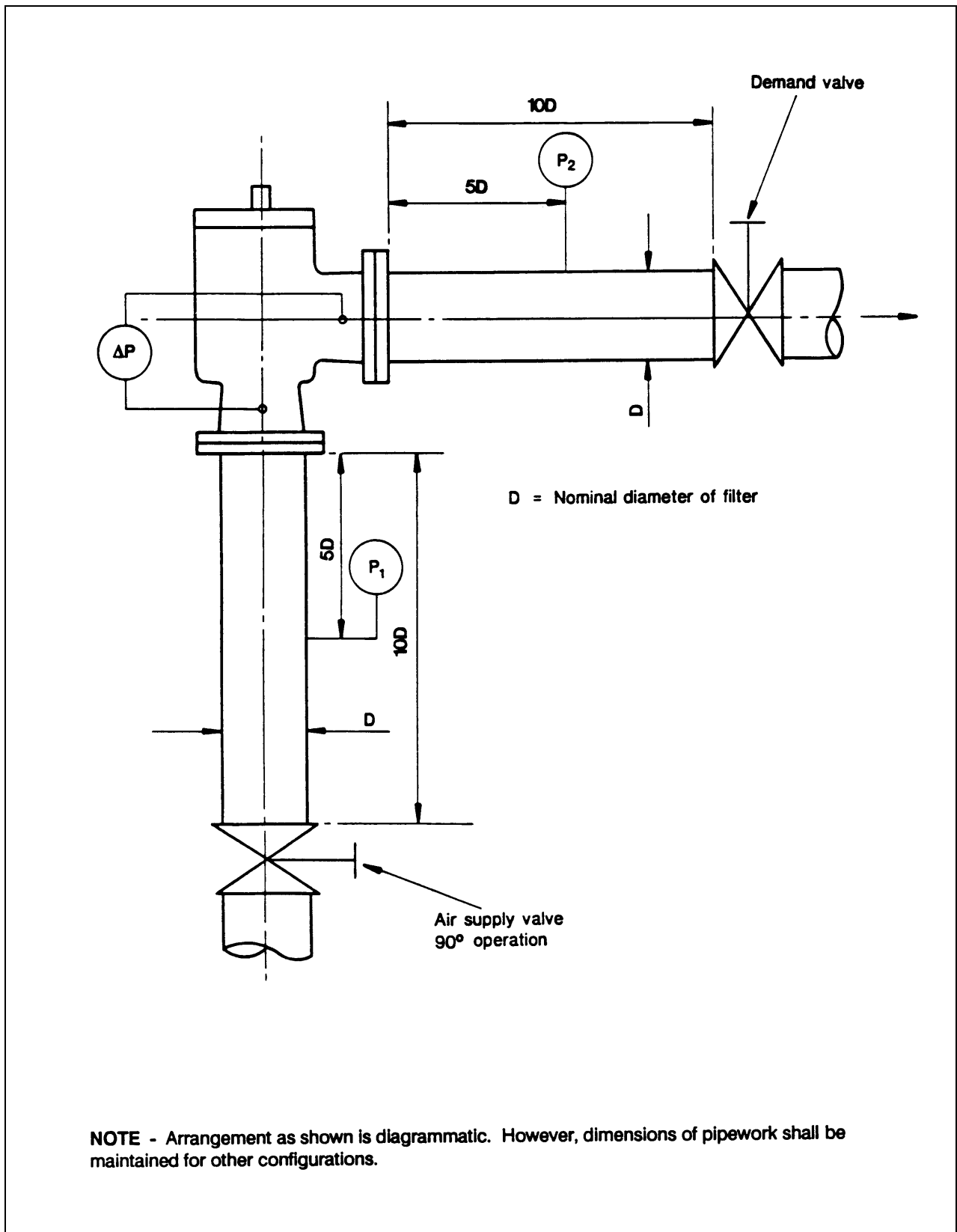


Figure B.1 — Flow test configuration