BRITISH STANDARD

BS 6364:1984

Incorporating Amendments Nos. 1, 2 and 3

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Specification for

Valves for cryogenic service

ICS 23.060.01

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Mechanical Engineering Standards Committee (MEE/-) to Technical Committee MEE/191 upon which the following bodies were represented:

Amalgamated Union of Engineering Workers
Associated Offices Technical Committee
Association of Bronze and Brass Founders
Association of Hydraulic Equipment Manufacturers
British Chemical Engineering Contractors Association
British Compressed Gases Association
British Gas Corporation
British Ship Research Association
British Shipbuilders
British Valve Manufacturers Association Ltd.
Copper Development Association
Copper Tube Fittings Manufacturers' Association
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Institution of Gas Engineers
Institution of Mechanical Engineers
Institution of Water Engineers and Scientists
National Coal Board
Society of British Gas Industries
Steel Casting Research and Trade Association
Water Companies Association
Coopted members

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Contents

Foreword

This British Standard has been prepared under the direction of the Mechanical Engineering Standards Committee.

It is the first national standard for valves for cryogenic service but it is intended that it can only be used in conjunction with the appropriate valve product standard since the requirements and tests specified are additional to those specified in the valve product standards.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This British Standard specifies the requirements for the design, manufacture and testing of valves for cryogenic service. It is a requirement of this standard that the valves comply with the appropriate valve product British Standards, i.e.:

steel wedge gate valves: BS 1414;

steel check valves: BS 1868;

steel globe and globe stop and check valves: BS 1873;

steel ball valves: BS 5351;

steel wedge gate, globe and check valves DN 50 and smaller: BS 5352;

copper alloy globe, globe stop and check, check and gate valves: BS 5154;

testing of valves: BS 6755;

butterfly valves for general purposes: BS 5155.

The size range covered by this standard is DN 15 to a maximum nominal size appropriate to the above product standards, in the temperature range – 50 °C to – 196 °C, yet capable of operation at ambient conditions to allow for start-up and run-down.

NOTE 1 For marine applications where design temperatures are below – 165 °C attention is drawn to the need to check requirements with the relevant Statutory Authority.

Appendix C lists the information to be supplied by the purchaser.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1
nominal size (DN)

a numerical designation of size which is common to all components in a piping system other than components designated by outside diameters or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions

NOTE 1 It is designated by DN followed by a number.
NOTE 2 This definition is in accordance with ISO 6708.

2.2
nominal pressure (PN)

a numerical designation relating to pressure that is a convenient round number for reference purposes

it is intended that all equipment of the same nominal size (DN) designated by the same PN number shall have the same mating dimensions appropriate to the type of end connections

the permissible working pressure depends upon materials, design and working temperature and has to be selected from the pressure/temperature rating tables in corresponding standards

NOTE 1 It is designated by PN followed by a number.
NOTE 2 This definition is in accordance with ISO 7268.

3 General requirements

Valves shall comply with the appropriate standards listed in clause **1** in addition to clauses **4** to **9** of this standard.

Section 2. Design

4 Requirements

4.1 Valves shall be supplied with extended bonnets/glands (see Figure 1). The length of the extension shall be sufficient to maintain the stem packing at a temperature high enough to permit operation within the normal temperature range of the packing material.

4.2 Valves on gas service shall be capable of operation with the valve stem at or above the horizontal position.

4.3 Valves in liquid service other than cold box applications shall be capable of operation with the valve stem at or above 45° above the horizontal position.

4.4 For cold box applications, valves shall be suitable for use with the valve stem at or above 15° above the horizontal position and in addition the minimum gland extension length as shown in Figure 1 shall be as given in Table 1.

NOTE If any special length of gland extension is required by the purchaser he should state this (see Appendix C).

4.5 For applications other than cold box applications the minimum gland extension length shall be 250 mm (see Figure 1).

4.6 Valves shall be designed to relieve pressures above normal working pressure that may build up in trapped cavities due to thermal expansion or evaporation of liquid.

NOTE For ball and gate valves this requirement can be met by the provision of a pressure relief hole or passage or other means, e.g. pressure relieving seats, to relieve pressure in the bonnet and body cavities to the upstream side of the valve. The means adopted will be determined by the manufacturer unless the purchaser exercises his option in accordance with Appendix C.

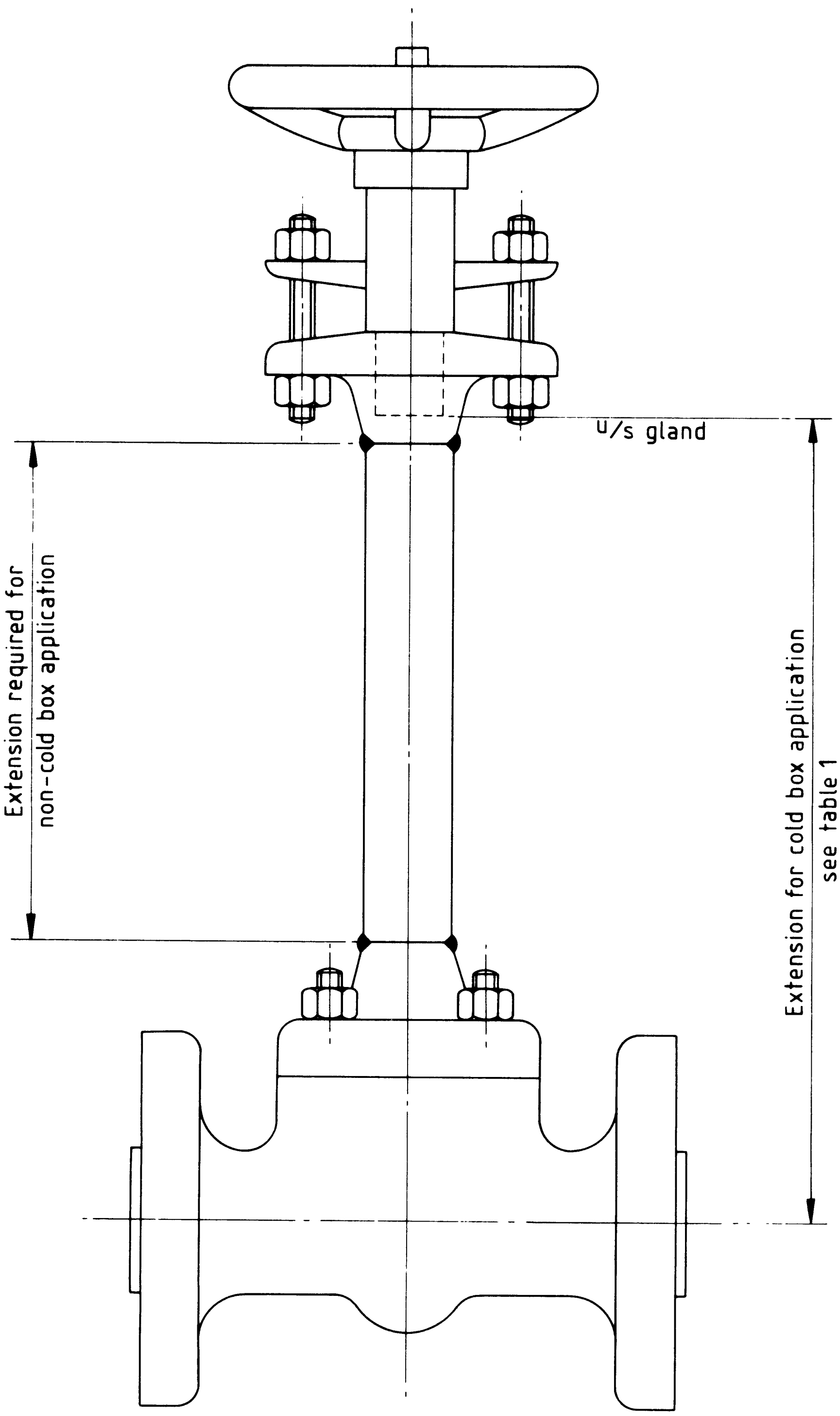


Figure 1 — Valve with extended bonnet/gland

Table 1 — Minimum gland extension length for cold box applications

Type	Gland extension length (min.) for nominal size DN:														
	15	20	25	38	50	80	100	150	200	250	300	350	400	450	500
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Globe	500	500	500	600	600	700	700	700	750	850	850	—	—	—	—
Gate	500	500	500	600	600	700	700	750	900	1 000	1 100	1 200	1 300	1 400	1 500
Ball	500	500	500	600	600	700	700	—	—	—	—	—	—	—	—
Butterfly	—	—	—	—	—	—	700	700	700	750	800	850	850	900	950

4.7 Where valves, by design, are unidirectional in operation, the flow direction shall be clearly indicated either on and integral with the body of the valve or on a plate securely attached to the body of the valve.

In the design of such valves, measures shall be taken to prevent incorrect assembly.

4.8 Valve bonnets shall be bolted, welded or union type. Union type bonnets shall only be used on valves DN 50 and below, or for marine applications DN 40 and below, and the union nut shall be locked to the body. The use of screwed bonnets shall not be permitted.

NOTE Gasket materials for bolted bonnets are outside the scope of this standard (see Appendix C).

4.9 For steel valves, fabricated gland extensions shall be constructed from a single length of seamless tube butt-welded to the bonnet and gland housing.

4.10 For high pressure bronze or copper alloy valves of PN 100 rating or greater, the extension tube shall be screwed into the bonnet prior to silver soldering.

4.11 The clearance between the valve stem and gland extension bore shall be designed to minimize convection heat losses. The wall thickness of the extension shall be minimized, compatible with the rating of the valve and mechanical strength requirements in order to reduce conduction heat losses.

4.12 Valve stems shall be of one-piece construction except for end entry ball valves, in which case the valve design shall be such that the valve stem cannot be blown out of the body in the event of the gland being removed while the valve is under pressure. Rising stem valves with renewable gland packing that incorporate a back seat shall have the back seat located in the region of the gland.

Gland designs incorporating lantern rings and screwed plugs in the gland body shall not be used.

4.13 Globe valves shall have tapered or conical discs. The use of flat seated discs shall not be permitted.

4.14 The maximum force required to operate the valves manually under service conditions, when applied at the rim of the handwheel or lever, shall not exceed 350 N, except for valve seating and unseating only, when it shall be permissible for this value to be increased to 500 N. Where reduction gearing is provided, it shall be suitable for operation at ambient temperature.

4.15 Valves for flammable service shall be designed to ensure electrical continuity to prevent build-up of static electricity.

5 Materials

NOTE The specification of materials and gland packing is outside the scope of this standard owing to the variety of materials for the temperature range of operation, but Appendix B gives the preferred austenitic steels and non-ferrous materials that may be used.

5.1 Bolting materials shall be selected from those listed in BS 4882.

NOTE Note that on first cooling below ambient temperature and down to – 196 °C, some austenitic steels increase slightly in size owing to a permanent metallurgical change. This may result, for example, in bolts relaxing their pre-load the first time they are cooled. The manufacturer/user should take account of this in selecting the steels used.

5.2 Valves shall have metal/metal or soft seats (see Appendix C). Soft seats shall be backed by a secondary metal seat. Virgin PTFE shall be supported in such a way as to prevent cold flow.

5.3 The valve trim materials selected shall be such as to avoid the effects of galling (seizure or binding) caused by frequent operation at cryogenic temperatures.

6 Non-destructive testing

6.1 Examination of welds. Butt welded joints on fabricated sections of valves shall be fully radiographed and shall comply with **5.7** of BS 5500:1988.

6.2 Examination of castings

6.2.1 If weld ends are to be radiographed they shall meet a minimum radiographic standard for a distance of 25 mm from the machined weld preparations, and shall be as specified for class 1 in BS 5998.

NOTE Further non-destructive examination of castings in relation to quality, if required, should be in accordance with BS 5998.

6.2.2 The method of radiographic examination of castings shall be in accordance with BS 4080. Radiographic records shall be retained for a period of at least 5 years by the manufacturer.

7 Repair of castings

Weld repair of castings shall be to the standards of acceptability in accordance with the quality level specified in BS 5998.

Section 3. Testing

8 Pressure testing

8.1 Shell strength test

8.1.1 The valve body and bonnet shall be subjected to a hydrostatic or pneumatic test. Hydrostatic testing shall be carried out as described in the appropriate standard(s) given in clause **1**. For stainless steel valves, the chloride content of the water for hydrostatic tests shall not exceed 30 p.p.m. Pneumatic tests shall be at the full test pressure specified in the appropriate valve product standard.

WARNING. Attention is drawn to the hazardous nature of pneumatic testing.

8.1.2 For shell tests, discs and wedges, if fitted, shall be in the open position and ball valves shall be in the half-open position.

8.1.3 After hydrostatic shell testing, the component parts of the valve shall be thoroughly cleaned and degreased.

8.2 Shell leak test. After the hydrostatic or pneumatic strength test, body and bonnet joints and glands of valves shall be soap or immersion-under-water tested using dry oil-free air or nitrogen at the full seat rating of the valve.

The stem shall be free to turn at this pressure. During the test duration specified in Appendix B of BS 6755-1:1986, there shall be no visible leakage.

8.3 Seat leak test

8.3.1 Valve seats shall be tested with dry oil-free air or inert gas at the full seat rating or for ball valves at 6.9 bar[1)] Valve shut-off shall be achieved by the normal methods of operation and duration of tests shall be in accordance with BS 6755-1.

8.3.2 For valves having metal-to-metal seats, the maximum permitted leakage rate shall be 0.3 mm^3/s ° DN.

8.3.3 For valves having soft seats there shall be no visible leakage for the duration of the test.

8.4 Cryogenic prototype testing. When tested as described in Appendix A, valves shall satisfy all the requirements of the test as given in that appendix.

Valves intended for marine applications shall be subjected to the tests described in Appendix A.

NOTE For all other applications, cryogenic testing is normally carried out only when requested by the purchaser and it is essential, therefore, for the purchaser to state he requires this testing to be done end also, whether he wishes to be present (see Appendix C).

9 Marking[2)]

In order to comply with clause **4**, each valve will be marked in accordance with the requirements of the appropriate base standard to which it is produced and in addition, each valve shall be marked with the number of this British Standard together with the minimum temperature for which it is suitable.

e.g. BS 6364:1984 – 196 °C

[1)] 1 bar = 10^5 N/m^2 = 100 kPa.

[2)] Marking BS 6364:1984 on or in relation to a product is a claim by the manufacturer that the product has been manufactured to the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the appropriate certification body.

Appendix A Cryogenic test

A.1 Temperature. The cryogenic test temperature shall be – 196 °C.

A.2 Prior to testing

A.2.1 Degrease the valve components, dry them and assemble the valve in a clean and dust- and grease-free environment.

A.2.2 Tighten bolts to a pre-determined torque or tension and record the value.

A.2.3 Make suitable thermocouple connections to the valve to enable valve body and bonnet temperature to be monitored throughout the test.

A.3 Testing

A.3.1 Handwheel operated valves: gate, globe, ball and butterfly valves

A.3.1.1 A suitable test apparatus is shown diagrammatically in Figure 2. Set up the valve as shown in Figure 2 in the test tank and make all connections. Take care to ensure that the valve gland is positioned clear of the cold boil-off gas in the top of the tank.

A.3.1.2 Make an initial system proving test at the maximum seat test pressure [see **A.3.1.4** d)] at ambient temperature using helium gas to ensure that the valve is in a suitable condition for the test to proceed.

A.3.1.3 Cool down the valve by immersing it in liquid nitrogen to a depth such that the level of the liquid covers at least the top of the valve body/bonnet joint. Maintain a purge of helium gas throughout the cooling operation.

A.3.1.4 When the valve body and bonnet are at a temperature of – 196 °C carry out the following operations a) to e).

a) **Soak the valve at the test temperature for at least 1 h until all temperatures have stabilized. Take temperature measurements by means of the thermocouples to ensure uniform temperature of the valve.**

b) Repeat the initial proving test described in **A.3.1.2** at the test temperature.

c) **Open the valve and close it 20 times. Measure the open and close forces for at least the first and last operation.**

d) Subject the valve to a seat pressure test in the normal flow direction for the valve. For valves which are capable of sealing in both directions, test each seat separately. Raise the pressure in increments, as given in the tabulated data below, up to the maximum permissible working pressure at 20 °C as specified in the appropriate product standard. (See **1 Scope** for list of product standards.)

Nominal pressure PN	Increment bar
20	3.5
50	7.5
64	10.0
100	20.0

Where the valve seat rating has been downrated by the manufacturer, use this value as the seat test pressure.

Measure and record leakage rate at each pressure stage.

The leakage rate measured at the flowmeter shall not exceed 100 $mm^3/s \times°$ DN.

e) With the valve in the open position, close the needle valve (see Figure 2) on the outlet side of the valve and pressurize the valve body to the seat test pressure. Maintain this pressure for a period of 15 min and check the valve gland and body/bonnet joint for leak tightness. There shall be no visible leakages.

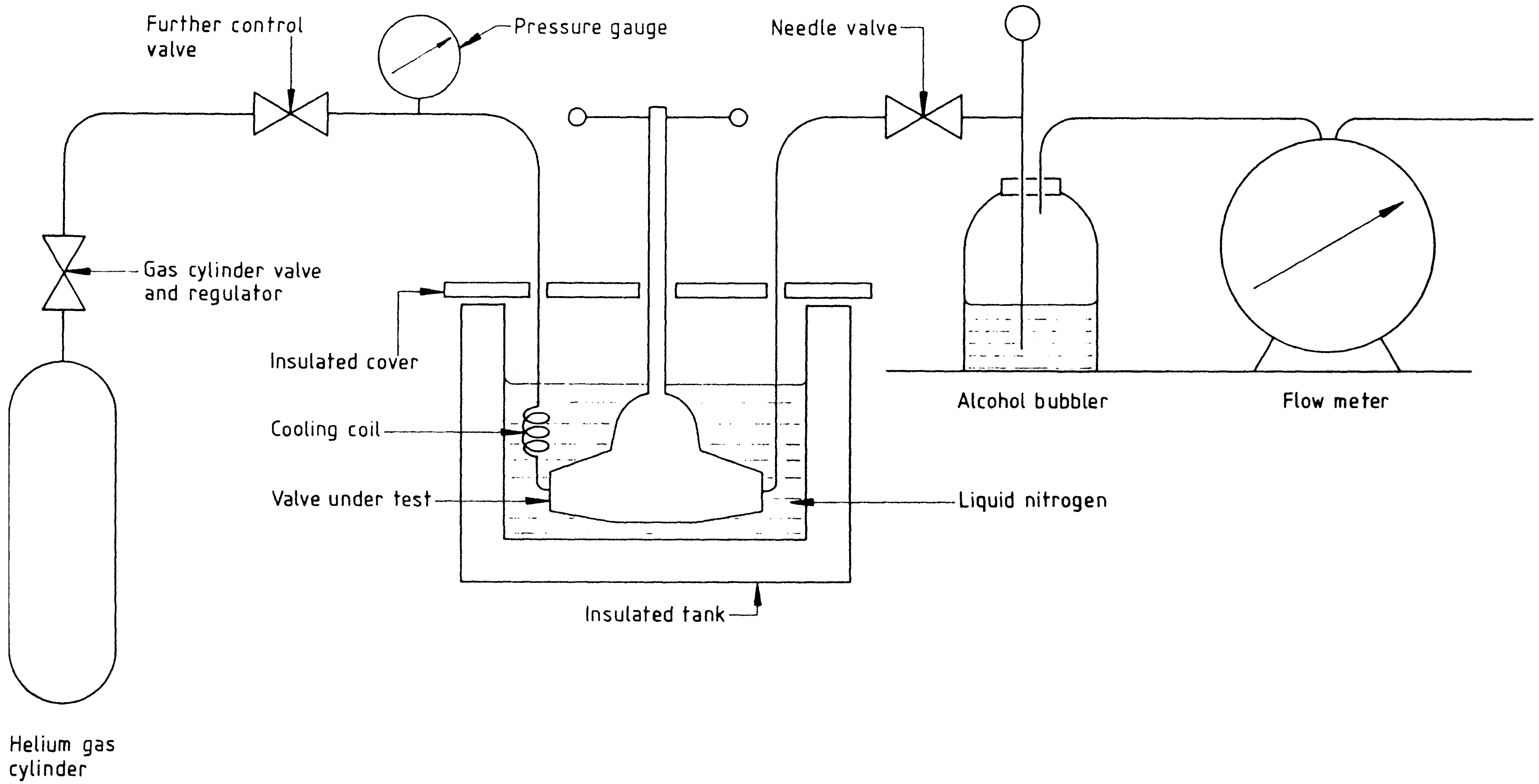
A.3.2 ***Check valve***

A.3.2.1 A suitable test apparatus is shown diagrammatically in Figure 2 and the test apparatus shall be capable of interchanging the gas supply and the measuring system. Set up the valve in the normal flow direction as shown in Figure 2 in the test tank and make all connections.

A.3.2.2 Make an initial system proving test at ambient temperature using helium gas at the maximum seat test pressure [see **A.3.1.4** d)]. Interchange the test apparatus and subject the valve to a seat pressure in the reverse flow direction [see **A.3.1.4** d)] to ensure the valve is in a suitable condition for the test to proceed.

A.3.2.3 Carry out requirements described in **A.3.1.3**, the purge of helium gas to be in the normal direction of flow.

During cool-down monitor the temperature of the valve body and bonnet by means of suitably placed thermocouples.



NOTE 1 Value spindle gland positioned above the tank top level.
NOTE 2 Check valves — the test apparatus shall be capable of interchanging the gas supply system and the flow measuring system.

Figure 2 — Typical arrangement of low temperature type test rig

A.3.2.4 When the valve body and bonnet are at a temperature of – 196 °C carry out the following operations a) to e).

a) Soak the valve at the test temperature for at least 1 h until all temperatures have stabilized. Take temperature measurements by means of the thermocouples to ensure uniform temperature of the valve.

b) Repeat the initial proving test described in **A.3.2.2** at the test temperature.

c) Subject the valve to flow in the normal flow direction to unseat the valve and then flow in the reverse flow direction to close the valve. Repeat three times.

d) Subject the valve to a seat pressure test in the reverse flow direction for the valve. Raise the pressure in increments, as given in the tabulated data below, up to the maximum permissible working pressure at 20 °C as specified in the appropriate product standard (see **1 Scope** for list of products).

Nominal pressure PN bar	Increment
20	3.5
50	7.5
64	10.0
100	20.0

Where the valve seat rating has been down rated by the manufacturer, use this value as the rated seat test pressure.

Measure and record leakage rate at each pressure stage.

The leakage rate measured at the flow meter shall not exceed 200 mm^3/s ° DN.

e) With the valve in the normal flow direction, close the needle valve (see Figure 2) on the outlet side of the valve and pressurize the valve body to the maximum seat test pressure. Maintain this pressure for a period of 15 min and check the valve gland and body/bonnet joint for leak tightness. There shall be no visible leakage.

A.3.3 Return the valve to ambient temperature, then repeat the helium gas proving test detailed in **A.3.2.2**. Measure any leakage through the valve and record it and compare the result with the reading taken under **A.3.2.4**.

A.3.4 After completion of the test, dismantle the valve and in a clean, dust-free environment. Check for ease of dismantling and examine all component parts for wear and damage.

A.4 Test report. The test report shall include the following information:

a) conditions of valve parts after the test (see **A.3.4**);

b) torque applied to valve body, bonnet and gland bolts (see **A.2.2**);

c) leakage rates;

d) results of proving tests at ambient temperature (see **A.3.1.2** or **A.3.2.2**) and at test temperature (see **A.3.1.4** b) or **A.3.2.4** b)].

e) record of valve body temperature measurements [see **A.3.1.4** a) or **A.3.2.4** a);

f) record that the valve unseated and seated [see **A.3.2.4** c)].

g) record any other measurements or observations made during the course of the test.

Appendix B Preferred materials

Table 2 and Table 3 list the preferred materials for construction of valves for cryogenic service.

Table 2 — Austenitic steels

Type of valve body	ASTM Standard and grade	British Standard and grade
Castings		
a) Flanged valves only	ASTM A351, CF8	BS 1504, 304C15 BS 3100, 304C15
	ASTM A351, CF8M	BS 1504, 316C16 BS 3100, 316C16
b) Flanged or weld end valves	ASTM A351, CF3	BS 1504, 304C12 BS 3100, 304C12
	ASTM A351, CF3M	BS 1504, 316C12 BS 3100, 316C12
	ASTM A351, CF8C	BS 1504, 347C17 BS 3100, 347C17
Forgings		
a) Flanged valves only	ASTM A182, F304	BS 970, 304S15 BS 1503, 304S31
	ASTM A182, F316	BS 970, 316S16 BS 1503, 316S31
b) Flanged or weld end valves	ASTM A182, F304L	BS 970, 304S12 BS 1503, 304S11
	ASTM A182, F316L	BS 970, 316S12 BS 1503, 316S11 BS 1503, 316S13
	ASTM A182, F321	BS 970, 321S12 BS 1503, 321S31
	ASTM A182, F347	BS 970, 347S17 BS 1503, 347S31

NOTE When specified in the order, cast steels should be Charpy V-notch impact tested in accordance with BS 131-2. British Standard cast steels should have the impact properties specified in BS 1504 and BS 3100. Steels to ASTM A351 should have impact properties equal to the equivalent British Standard grades.

Table 3 — Non-ferrous materials

Type of valve body	British Standard and grade
Castings (aluminium alloy)	BS 1490
Castings (copper alloy)	BS 1400, LG4
Bar stock	BS 2874, CZ114 BS 2872, CZ114

Appendix C Information to be supplied by purchaser

a) Number of relevant valve product standard.

b) Nominal size (DN).

c) Nominal pressure (PN).

d) Whether valves are for cold-box application (see **4.4**).

e) Any special lengths of gland extension (see **4.4**).

f) Any particular method of pressure relief (see **4.6**).

g) Any special requirements for bolted bonnet gasket material (see **4.8**).

h) Whether valves are required for flammable service (see **4.15**).

i) Any special requirements for gland packing (see clause **5**).

j) Type of valve seat (see **5.2**).

k) Whether weld ends are to be radiographed (see **6.2**).

l) Any special requirements for the degreasing medium (see **8.1.3**).

m) Whether cryogenic tests are required (see **8.4**).

n) Whether Charpy V-notch impact testing is required on cast steels (see Table 2).

Publications referred to

BS 131, *Methods for notched bar tests.*

BS 131-2, *The Charpy V-notch impact test on metals.*

BS 970, *Specification for wrought steels for mechanical and allied engineering purposes.*

BS 1400, *Specification for copper alloy ingots and copper alloy and high conductivity copper castings.*

BS 1414, *Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.*

BS 1503, *Specification for steel forgings (including semi-finished products) for pressure purposes.*

BS 1504, *Specification for steel castings for pressure purposes.*

BS 1868, *Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.*

BS 1873, *Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.*

BS 2872, *Specification for copper and copper alloys. Forging stock and forgings.*

BS 2874, *Specification for copper and copper alloy rods and sections (other than forging stock).*

BS 3100, *Specification for steel castings for general engineering purposes.*

BS 4080, *Methods for non-destructive testing of steel castings.*

BS 4882, *Specification for bolting for flanges and pressure containing purposes.*

BS 5154, *Specification for copper alloy globe, globe stop and check, check, and gate valves.*

BS 5155, *Specification for butterfly valves.*

BS 5351, *Specification for steel ball valves for the petroleum, petrochemical and allied industries.*

BS 5352, *Specification for steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.*

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

BS 5998, *Specification for quality levels for steel valve castings.*

BS 6755, *Testing of valves.*

BS 6755-1, *Specification for production pressure testing requirements.*

ISO 6708, *Pipe components — Definition of nominal size.*

ISO 7268, *Pipe components — Definition of nominal pressure.*

ASTM A182, *Forged or rolled alloy steel pipe flanges, forged fittings and valves and parts for high temperature service.*

ASTM A351, *Ferritic and austenitic steel castings for high temperature service.*

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