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Ships and marine technology — Ball valves for use in low temperature applications — Design and testing requirements

Navires et technologie maritime — Robinets à boisseau sphérique destinés aux applications à basse température — Exigences de conception et d'essai

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ships and marine technology — Ball valves for use in low temperature applications — Design and testing requirements

1 Scope

This document specifies requirements for design, manufacture and test methods of cryogenic ball valves in order to have an excellent quality leakage stability in a very low temperature service (–196 °C to 80 °C).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 5208, *Industrial valves — Pressure testing of metallic valves*

ISO 5209, *General purpose industrial valves — Marking*

ISO 5211, *Industrial valves — Part-turn actuator attachments*

ISO 28921-1, *Industrial valves — Isolating valves for low-temperature applications — Part 1: Design, manufacturing and production testing*

API 6D, *Specification for Pipeline Valves/ Petroleum and natural gas industries — Pipeline transportation systems — Pipeline*

API 6FA, *Specification for Fire Test for Valves*

ASME B16.5 *Pipe Flanges and Flanged Fittings*

ASME B16.10, *Face-to-Face and End-to-End Dimensions of Valves*

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*

ASME B16.25, *Butt welding Ends*

ASME B16.34:2007, *Valves — Flanged, Threaded, and Welding End*

Sec ASME VIII, *Pressure vessels*

ASTM A182/A182M, *Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings and Valves and Parts for High-temperature Service*

ASTM A193/A193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A194/A194M, *Carbon and Alloy Steel Nuts and Bolts for High-Pressure and High-Temperature Service*

ASTM A276, *Standard Specification for Stainless Steel Bars and Shapes*

ASTM A312/A312M,*Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*

ASTM A320/A320M, *Alloys-Steel Bolting material for Low-Temperature service*

ASTM A351/A351M, *Casting, Austenitic, Austenitic-Ferritic(Duplex), for Pressure-Containing Parts*

ASTM E186, *Reference Radiographs for Heavy-Walled(2 to 4 1/2-in) Steel Castings*

ASTM E 446, *Reference Radiographs for Steel Castings up to 2in. in Thickness*

MSS-SP-44. Steel pipeline flanges

MSS-SP-55. Quality Standard for steel Castings for Valves, Flanges and Fittings and other Piping Components (Visual Method)

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
nominal diameter
DN
alphanumeric designation of size for components of a pipe-work system, used for reference purposes, comprising the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections

Note 1 to entry: The number following the letters DN does not represent a measure value and shall not be used for calculation purposes except where specified in the relevant standard.

Note 2 to entry: In those standards which use the DN designation system, any relationship between DN and component dimensions shall be given, e.g. DN/OD or DN/ID.

3.2
nominal pressure
PN
numerical designation relating to pressure that is a convenient round number for reference purposes

Note 1 to entry: 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.

3.3
nominal pipe size
NPS
alphanumeric designation of size that is common for components used in a piping system, used for reference purposes, comprising the letters NPS followed by a dimensionless number having an indirect correspondence to the physical size of the bore or outside diameter of the component end connections

Note 1 to entry: The dimensionless number may be used as a size identifier without the prefix NPS. The dimensionless number does not represent a measurable value and is not used for calculation purposes.

Note 2 to entry: Prefix NPS usage is applicable to components bearing Class designations according to ISO 7268.

3.4
class
alphanumeric designation, used for reference purposes, related to a combination of mechanical and dimensional characteristics of a component of a pipe-work system, comprising the word "class" followed by a dimensionless whole number

4 Pressure-temperature rating

4.1 The types of typical fluid are shown in Table 1.

Table 1 — Types of typical fluid

Type of fluid	Temperature (in atmospheric pressure)	Liquid density (density)
LNG (Liquefied natural gas)	−163 °C to −88 °C	(434 to 478) kg/m^3
NG (Natural gas)	−160 °C to −65 °C	(0,7 to 0,89) kg/m^3
LN2 (Liquefied nitrogen)	−196 °C	804 kg/m^3
N2 (Nitrogen)	−196 °C to −65 °C	1,184 kg/m^3

4.2 The valve shall be designed to operate without failure or leakage at the extreme temperature and pressure ranges expected in service. The maximum working pressure in ambient temperature are shown in Table 2.

Table 2 — Maximum working pressure

PN	Class	Maximum working pressure MPa(psi)	Note
20	150	2,0(290)	in ambient temperature
50	300	5,2(750)	
64	400	6,62(960)	
100	600	10,3(1 500)	

NOTE The piping design condition including, but not limited to, working pressure, service temperature and fluid is provided by the purchasers.

4.3 The manufacturers and purchasers may reach an agreement when Class exceeds 600.

4.4 Design temperature should be between −196 °C and 80 °C.

5 Structure

5.1 General

5.1.1 Structure

The ball valve is top-entry with bolted bonnet, extended bonnet type. The end connection of the body is ‘welding ends’ type or ‘flange ends’ type. A wheel or lever is used to apply the turning torque or thrust to open or close the valve. The ball valve may be either soft-seated or metal-seated. The sealing force can be produced by “medium piston effect” or stem pushing. If fluid trapping is possible, then the valve is to be provided with automatic cavity-pressure relief. Configuration and functions of the ball valve are shown in this document. If there are some differences from this document, the manufacturers can make a decision after reaching an agreement with the purchasers. General examples of the structure of the valve are shown in Annex A.

5.1.2 Materials

Throughout this document, materials are specified for each of the various parts of the valve. In lieu of the materials specified, other materials may be used provided they are manufactured by the same process as the materials specified, such as forging, casting, bar, or seamless pipe. In addition, the material shall be suitable for the operating temperatures and pressure of the valve and the metal materials shall have

mechanical properties, including low temperature impact resistance, and resistance to corrosion equal to or better than the material specified for the specific valve part.

5.2 Design and materials of the body

5.2.1 Design

The ball valve shall be supplied with minimum internal bore as per API 6D.

5.2.2 Materials

Materials are shown in Table 3. Materials for 'welding ends' type valves may be used for 'Flanged ends' type material.

Table 3 — Materials by manufacturing method

Manufacturing method	Materials		
	Flanged ends type		Welding ends type
Forging	ASTM A182	F316	ASTM A182 F316L
Casting	ASTM A351	CF8M	ASTM A351CF3M

5.2.3 Manufacturing

The valve shall be manufactured according to the following requirements except when there are purchaser's special orders.

a) Face-to-face and end-to-end dimensions of the body shall satisfy ASME B16.10.

b) The minimum wall thickness shall be equal to or thicker than the values shown in ASME B16.34:2007 6.1.

c) The end connection of the body shall be manufactured as specified below:

   1) socket welding ends:

      — PN20(Class 150), PN50(Class 300), PN64(Class 400): to satisfy Class 3000 in ASME B16.11; and

      — PN100(Class 600): to satisfy Class 6000 in ASME B16.11;

   2) butt welding ends:

      — according to the wall thickness of connected pipes which is given by the purchasers, manufactured according to ASME B16.25; and

      — the butt welding ends may add a short stub if specified in the order. The wall thickness shall conform to the requirement of the purchasers;

   3) flange ends type:

      — NPS 24(DN600) and under, except NPS22(DN550): to be manufactured in accordance with ASME B16.5; and

      — NPS22(DN550): to be manufactured in accordance with MSS SP-44.

5.3 Design and materials of the extended bonnet

5.3.1 Design

The extended bonnet shall meet the following:

a) the minimum wall thickness shall conform to ASME B16.34:2007, 6.1, and the operation torque produced by actuators shall be considered when determining the neck thickness;

b) the minimum bonnet extension length shall satisfy ISO 28921-1 or 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;

c) drip pan may be installed by welding or clamping; the welding procedure of the drip pan is beyond the requirements of 5.11;

d) lifting points are optional; the manufacturer shall ensure the necessity of lifting points and verify the suitability.

5.3.2 Materials

Materials are shown in Table 3 for the valve body.

If short pipe is used for the extended bonnet, it shall be seamless and made of ASTM A312 or 316L.

5.4 Design and materials of ball

5.4.1 Design

The ball shall be integral forging, casting or formed of pieces, such as 2 spherical caps and one wedge. The top and under part shall be provided with a pivot fixing device where the ball is of a fixed type.

5.4.2 Materials

The materials of the ball shall be forging as per ASTM A182 F316. The surface of the ball or sealing part shall be adhered with hard alloy. If overlay hard surface is selected, its thickness should be at least 1,6 mm.

5.5 Design and materials of the stem

5.5.1 Design

The stem shall be as follows.

a) It shall be of an extended type.

b) The top and under parts shall be provided with a pivot fixing device where the ball is of a fixed type.

c) The critical section of the stem shall be out of the valve pressure interface and designed with 1,5 times of the calculated operating torque.

d) The ball valve shall have an anti-static device if specified by the order.

e) The ball valve shall be designed to ensure that the stem does not eject under any internal pressure conditions or if the packing gland components and/or valve operator mounting components are removed.

5.5.2 Materials

Materials shall be forging or bars of ASTM A182 F316 and ASTM A276 316.