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T-03

VALVES FOR ALTERNATIVE FUEL

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Foreword

China Classification Society (hereinafter referred to as CCS) Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed service@ccs.org.cn .

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Main change:

Add the requirements for exemption from fire tests to align with the rules..

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VALVES FOR ALTERNATIVE FUEL

1 Application

1.1 The Guidelines are applicable to valves for marine LNG, methanol and ammonia as well as valves with working temperature lower than -55℃.

1.2 The Guidelines are not applicable to safety valves which shall meet the requirements of CCS P-05 *Safety Valve Guideline*, CCS *Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk* and relevant applicable standards.

1.3 Other generally-recognized standards may be accepted by CCS for the technical requirements and test methods mentioned in the Guidelines.

2 Normative references

2.1 The basis for approval and inspection used in the Guidelines are as follows:

(1) Chapter 2, Part 3 of CCS *Rules for Classification of Sea-going Steel Ships*

(2) Chapter 5, Part 3 of CCS *Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*

(3) Chapter 13 of CCS *Rules for Natural Gas Fuel Used in Ships*

(4) CCS *Guideline P-02 Valves of Piping Systems*

(5) Chapter 3 of CCS *Guidelines for Ships Using Methanol/Ethanol Fuel*

(6) Chapter 3 of CCS *Guidelines for Ships Using Ammonia Fuel*

(7) IMO *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*

(8) IMO *International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels*

(9) Chapter 4 of the Ship Technical Regulations of the People's Republic of China - Interim Rules for Technology and Survey of Alcohol Fuel-powered Ships

(10) IACS UR G3 Liquefied Gas Cargo and Process Piping

(11) SIGTTO Selection and Testing of Valves for LNG Applications

(12) BS 6755-2 Testing of Valves - Part 2: Specification for Fire Type-Testing Requirements

(13) GB/T 30832 Valves - Test Method of Flow Coefficient and Flow Resistance Coefficient

(14) ISO 10497 Testing of Valves - Fire Type-testing Requirements

3 Terms and definitions

3.1 The relevant definitions in CCS *Rules for Classification of Sea-going Steel Ships* and CCS *Guideline P-02 Valves of Piping Systems* are applicable to the Guidelines.

3.2 Relevant definitions in the Guidelines are as follows:

Extended bonnet: i.e., the extended neck of the bonnet, refers to the portion of the bonnet supporting from the uppermost end to the bottom of the stuffing box of the bonnet.

4 Drawings and documents

4.1 During product drawing approval, the following drawings and data shall be submitted to CCS for approval:

(1) List of product main performance specifications (including the design pressure, design temperature, applicable medium, performance and use of the whole series of products to be approved. If valves are supplied in complete sets with hydraulic, electronic, pneumatic control devices, etc., the model and parameters of supporting devices shall also be included). Valves with one-way sealing shall be clearly indicated in the technical documents;

(2) General assembly drawing;

(3) Drawings of main parts and components: valve body and connecting flange, extended bonnet, valve disc and stem, valve seat, spring (if any), server (if any);

(4) List of physical and chemical properties of main parts and materials.

4.2 During product drawing approval, the following drawings and data shall be submitted for information:

(1) Product instructions, nameplate and factory certificate (sample);

(2) Document describing the compatibility between valve material and medium.

4.3 During type approval, the following drawings and data shall be submitted for approval:

(1) Factory overview: factory name, address, production history, production capacity, technical and inspection personnel, main products, affiliation, product trademarks, etc.;

(2) Details of the product to be approved;

(3) List of main production equipment;

(4) List of main testing equipment;

(5) Brief production process, main process documents, cryogenic process, welding procedure and heat treatment, surfacing of sealing surface and spray welding procedure (if applicable) of the product to be approved;

(6) Quality management documents or quality system certificates;

(7) Enterprise registration certificate;

(8) Qualification certificate and/or production license, if applicable;

(9) Product quality certificate or sample of certificate;

(10) Quality control plan, if applicable;

(11) List of qualified suppliers, if applicable;

(12) Type test program.

5 Technical requirements

5.1 Material requirements

5.1.1 The materials selected for main parts and components of cryogenic valves shall be suitable for the type, temperature, pressure and other conditions of the conveyed medium. Valve materials should meet the following requirements: They shall resist low-temperature brittle failure at working temperature and shall be resistant to corrosion from the media and shall maintain a stable organizational structure. For valve internals, the materials selected shall be able to minimize the risk of jamming, seizure, and scratches during frequent operations, and they shall provide electrochemical corrosion resistance that is at least equivalent to that of the valve body.

5.1.2 The methanol valves shall be selected with consideration given to the corrosivity and swelling property of the medium. Materials sensitive to methanol shall not be used, such as metallic aluminum alloy, galvanized steel, lead alloy, non-metallic nitrile rubber, butyl rubber.

5.1.3 The ammonia valves shall be selected with consideration given to the corrosivity of the medium. Materials susceptible to ammonia corrosion shall not be used, such as cast iron, copper, copper-containing alloy, zinc, zinc-containing alloy, cadmium-containing and mercury-containing materials. Gaskets and seals shall be made of metal, rubber, polymer and other materials compatible with ammonia, such as spiral wound gasket and PTFE. The corrosivity of ammonia to materials in different phases should be considered separately.

Nickel steel containing more than 5% nickel and carbon-manganese steel not meeting the requirements in 3.3.1.4 and 3.3.1.5 of CCS *Guidelines for Ships Using Ammonia Fuel* shall not be used for ammonia containers and pipeline systems. If the fuel temperature meets the requirements in 3.3.1.4(3) of CCS *Guidelines for Ships*

Using Ammonia Fuel, nickel steels containing not more than 5% nickel may be used, such as nickel alloy steel with steel grades of 1.5Ni and 2.25Ni.

5.2 Cryogenic valves should be provided with extended bonnets, and the extended length shall be sufficient to keep the temperature of valve stem packing within the nominal temperature range of packing. The wall thickness of the extended part should be the minimum thickness to ensure compatibility with the valve medium pressure and operating force, so as to facilitate heat conduction.

The extended part may be cast or forged integral with the bonnet, or butt-welded to the bonnet and stuffing box by using a seamless steel pipe. If welding is used, a welding procedure qualification is necessary.

5.3 The pressure in the valve chamber will rise due to thermal expansion or liquid evaporation. If it may be higher than the design pressure, measures shall be taken for cryogenic valves to prevent overpressure in the valve chamber. A middle chamber relief valve seat is acceptable for the LNG valve. Nevertheless, it shall be designed according to API 6D or other applicable standards and undergo corresponding tests to avoid rupture of the valve body under excessive pressure.

5.4 For cryogenic valves designed for one-way operation, the flow direction of medium shall be marked on the valve body or on a label firmly fixed to the valve body. Valves that do not meet two-way sealing requirements, e.g., those with pressure relief holes, must be clearly identified in technical documents. This ensures they are not used in situations requiring reverse pressure bearing.

5.5 Cryogenic valves should be designed with metal-to-metal seals or soft seals. The soft seals shall be supported by secondary metal seals to avoid cold flow of pure PTFE seat.

5.6 Valves with non-metallic seats shall have an anti-static structure. The design shall ensure that the valve body, opening and closing members and stem are electrically conductive. The maximum resistance of the discharge path should not exceed 10Ω.

5.7 Flammable and explosive fuel valves with threaded connection can only be used for minor pipelines and instrument pipelines with an outer diameter less than or equal to 25 mm.

5.8 The valve welding procedure, including the surfacing process of the sealing surface, must undergo welding procedure qualification.

6 Materials and components

6.1 Raw materials, parts and components mainly include: valve body, valve bonnet, extended bonnet, valve disc, valve plate, valve stem, valve seat, valve element, spring (if any), server (if any) and other parts and components.

6.2 The raw materials, parts and components of products shall be controlled in accordance with the relevant requirements of the current CCS rules.

6.3 If the purchased pressure-bearing parts and components such as valve bodies and bonnets are castings or forgings, they shall be purchased from factories approved by CCS.

7 Type test

7.1 Selection of typical samples:

(1) Initial approval or additional approval:

Type tests are mandatory for each type and each size of LNG valves, valves with a working temperature lower than -55℃ and ammonia valves with a working temperature lower than -29℃.

For methanol valves and other ammonia valves, the products with maximum design pressure and maximum design diameter shall be selected as typical samples according to the characteristics of structure, purpose, design pressure and design temperature of valves made of different materials based on each series of products to be approved.

(2) For certificate renewal approval, it is allowed to select only one model/specification that is the most representative or has the highest market demand as the typical sample for the series of approved products.

7.2 Type test items

Type test items are detailed in Table 7.2.

Type Test Items **Table 7.2**

S/N	Test Items	LNG Valves and Valves with a Working Temperature Lower Than -55 ℃	Ammonia Valves with a Working Temperature Lower Than -29 ℃	Methanol Valves	Other Ammonia Valves
1	Physical and chemical property test of raw materials for main parts and components	X	X	X	X
2	Dimension and visual inspection	X	X	X	X
3	Strength test of pressure parts	X	X	X	X
4	Shell sealing test, seal test and back seal test (if applicable)	X	X	X	X
5	Physical property test of non-metallic valve seat (if applicable)	X	X	X	X
6	Flow test	X			
7	Fire test (if applicable)	X			
8	Cryogenic test	X	X		
9	Functional test (for valves with actuators)	X	X	X	X
10	NDT (if applicable)	X	X	X	X
11	Special tests (if applicable)	X	X	X	X

Note: The test item marked with "X" means "applicable".

7.3 For test requirements and test methods, please refer to the following requirements:

(1) Physical and chemical property test of raw materials for main parts and components

The chemical composition and mechanical properties of raw materials for main parts and components shall meet the requirements in drawings approved by CCS.

(2) Dimension and visual inspection

The structural length tolerance of valves, along with the dimensions and minimum wall thickness of parts shall meet the requirements of approved drawings.

Pores and other scars are not allowed on the grinding sealing surface of the valve;

The fluid channel shall be carefully cleaned and processed, and no molding sand or sundries are allowed;

The coating on the valve outer surface shall be smooth and intact, without holidays, flow marks or depositions;

The assembled valve shall meet the following requirements: It shall allow flexible opening and closing without jamming.

(3) Strength test of pressure parts

Pressure parts such as valve body, bonnet and extended bonnet shall undergo the hydrostatic test or air pressure test. The test pressure shall be 1.5 times the design pressure. For the test duration, please refer to Table 7.3:

Test Duration **Table 7.3**

Nominal Diameter (mm)	Minimum Pressure Holding Time During Test (s)
＜250	120
≥250	180

During the test, the pressure shall not drop, and the outer surface of the pressure part shall be free from visible leakage.

(4) Shell sealing test, seal test and back seal test (if applicable)

For the shell sealing test, air pressure test shall be carried out. The test pressure should be 1.1 times of the design pressure and maintained for 15 minutes. Soapy water can be applied at the joint of valve body and bonnet and at the packing for leakage test. There shall be no visible leakage during the test.

For the seal test or back seal test, air pressure test shall be carried out. The test pressure should be 1.1 times of the design pressure and maintained for 5 minutes. For valves with two-way sealing, the sealing test shall be carried out in each direction separately. During the test, check the sealing pair of valve disc and valve seat (seal test) or the sealing pair of valve stem and bonnet (back seal test) with soapy water. The maximum allowable leakage shall meet the requirements of applicable standards. For soft seal valves, there shall be no visible leakage in the sealing test.

For the test methods of various valves, please refer to CCS *Guideline P-02 Valves of Piping Systems*.

(5) Physical property test of non-metallic valve seat (if applicable)

The physical properties of non-metallic valve seats shall meet the requirements of drawings approved by CCS.

(6) Flow test

For each type and size of valves, the flow test shall be carried out in accordance with recognized standards.

The manufacturer shall carry out tests to verify the flow characteristics of valves according to recognized standards. For the test methods, please refer to GB/T 30832 or other recognized standards.

For valves with a nominal diameter of 200mm or greater, the flow test can be verified by a small-scale model.

For valves approved by series, the flow coefficient or resistance can be calculated through flow simulation for each specification. On this basis, samples representing large, medium, and small specifications and comprising at least 10% of the total should be selected to verify the flow coefficient. The deviation between test results and simulation calculation results shall not exceed 5%.

(7) Fire test (if applicable)

For emergency stop valves with a melting point below 925 ℃, fire tests shall be performed in accordance with recognized standards.

For the test methods, please refer to BS 6755-2 or ISO 10497, or other recognized standards.

If components on the valve are made of materials with a melting point below 925 ℃, but this does not affect the body or seat sealing of the valve, such valves may be exempt from fire test.

(8) Cryogenic test: Cryogenic sealing test and cryogenic operation test

For each type and size of valves, a valve seat tightness test shall be carried out in both flow directions at intervals across the full range of working pressure and temperature not exceeding the design pressure of the valve. The allowable leakage rate shall meet the requirements of applicable standards. During the test, the valve should be verified to have good working performance.

The back seal test at low temperature can be carried out in accordance with the requirements of applicable standards.

Reference can also be made to the following test requirements and methods:

Test requirements:

① The cryogenic test shall be carried out after the valve under test passes the normal temperature test;

② The test and cooling mediums shall comply with applicable standards. The test medium shall be helium with a specific purity recommended by relevant standards. For LNG valves, the test temperature shall be -196 ℃. Generally, liquid nitrogen is selected as the cooling medium. For other valves, the cooling medium not higher than the valve design temperature shall be selected.

③ The deviation between the test temperature and the minimum design temperature shall be ±5% or ±5 ℃, whichever is smaller;

④ Temperature measuring thermocouples shall be provided inside the valve body, at the flange and stuffing box (except for non-return valves) in the valve body. If the nominal size of the valve under test is small, only one thermocouple can be placed at the flange part in the valve body and inside the valve body respectively. Throughout the test, the temperature inside the valve must be continuously monitored.

⑤ In high-pressure gas tests, it is crucial to note the potential dangers and ensure that the increment value of the test pressure complies with relevant standards.

Test methods:

① In the normal temperature test, use nitrogen or air for an initial test of the valve to ensure that the valve is further tested only after it is proved qualified in such an initial test.

② See Figure 7.3(1) for typical test devices of cryogenic valves. Install the valve in the test container and connect all joints, and ensure that the valve packing gland is located above the thermal insulation box cover;

③ Before the valve starts to cool, continuously purge the valve chamber with helium to replace the air in the valve chamber;

④ Immerse the valve in the cooling medium which shall cover the upper end of the connection part between the valve body and the bonnet, so as to cool the valve to the corresponding cryogenic test temperature. Throughout the cooling process, keep inflation. The test temperature shall be consistent with the minimum design temperature of the valve, and the valve shall be soaked until the temperature at each part is stable. When the valve is cooled to the test temperature, turn off the inflated test medium and measure the temperature with a thermocouple to ensure that the temperature is the same in all parts of the valve.

⑤ The procedures of cryogenic sealing test and cryogenic operation test are as follows:

Cryogenic operation test: At the cryogenic test temperature, pressurize to 0.2MPa and open and close the valve for 5 times. For valves equipped with actuators, conduct operational cycle tests according to the above requirements. During these tests, the valves shall be able to operate flexibly without jamming or creeping. This test is not applicable to non-return valves.

Cryogenic sealing test: Conduct the valve sealing test following the marked flow direction indicated on the valve. For valves with two-way sealing, test the seals on each side independently. At the cryogenic test temperature, gradually pressurize to the design pressure of the valve, maintain the pressure for 5 minutes, and measure and record the leakage rate of the valve. The leakage rate at each pressure stage can be measured during pressurization. The allowable leakage rate shall meet the requirements of applicable standards.

For non-return valves, the cryogenic test device shall be capable of reversing the air source and measuring system. The steps are as follows: Install the non-return valve in the test vessel according to the opening direction and connect all joints. Perform initial system verification test in the indicated flow direction of the non-return valve. After the temperature reaches that for the cryogenic test, gradually pressurize the non-return valve in the closing direction to

its design pressure, and conduct the sealing test according to the above requirements.

⑥ For the back seal test at low temperature, refer to the following test procedures:

With the valve in the open position, close the needle valve on the outlet side of the valve and pressurize the valve body to the design pressure of the valve. Maintain this pressure for 15 minutes, check the tightness of the packing bushing and valve body/bonnet connection of the valve. The allowable leakage rate shall meet the requirements of applicable standards.

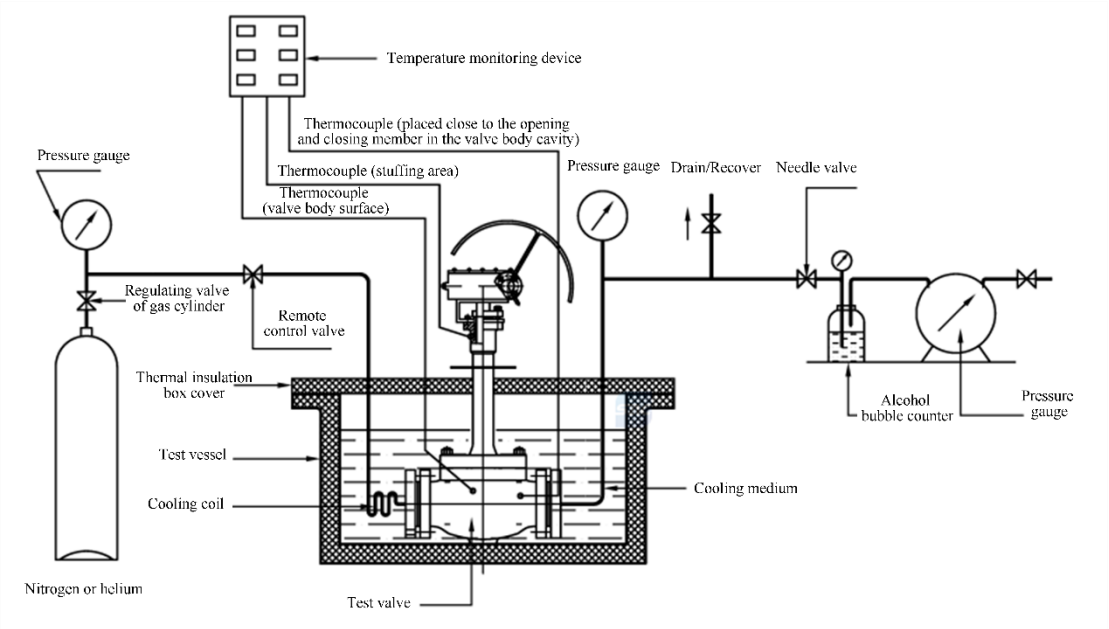

Figure 7.3 (1) Typical Test Devices of Cryogenic Valves

(9) Functional test (for valves with electric, pneumatic or hydraulic actuators)

Valves with electric, pneumatic or hydraulic actuators must be verified to ensure that their functions meet the requirements of product approval drawings and product technical parameters.

(10) NDT (if applicable)

For valves with butt welding of shell and nozzle, the NDT shall be carried out according to CCS *Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*.

(11) Special tests (if applicable)

① The LNG valve with a middle chamber relief valve seat shall be designed according to API 6D or other applicable standards and undergo corresponding tests to avoid rupture of the valve body under excessive pressure.

② Anti-static test:

Valves with non-metallic seats must undergo a minimum of five opening and closing operation cycles, and the resistance value shall be measured using a DC voltage not exceeding 12V. The measurement results shall meet the requirements in 5.6.

Note:

For the test duration of the above tests, the factory can refer to the requirements of applicable standards.

8 Unit/batch inspection

8.1 The manufacturer can apply for a survey of marine products only after successfully completing and passing the specified delivery inspection/test.

8.2 The test items to be witnessed by the surveyor are as follows:

All LNG valves, valves with a working temperature lower than -55℃ and ammonia valves with a working temperature lower than -29℃ to be surveyed shall be tested one by one. The test items include: visual inspection (dimension, flow direction mark, valve operation, etc.), strength test of pressure parts, shell sealing test, seal test, back seal test (if applicable) and functional test (if applicable). For each type and size of cryogenic valves, at least 10% of them (at least one in any case) shall be randomly selected for cryogenic sealing test and cryogenic operation test.

For methanol valves and other ammonia valves, at least 3% (at least one in any case) shall be randomly selected from each batch/each structural type of them for tests. The test items include: visual inspection (dimension, flow direction mark, valve operation, etc.), strength test of pressure parts, shell sealing test, seal test, back seal test (if applicable) and functional test (if applicable).

For instrument isolating valves on pipelines with a diameter of 25mm or less, it is not necessary for a surveyor to witness the product test. However, the test record must be available for inspection.

8.3 The test items for which the test reports should be submitted to CCS for review are as follows:

Quality certificate for raw materials of main parts and components; castings and forgings of valve body and bonnet (if purchased) shall have the factory approval certificates and quality certificates issued by CCS;

For all valves to be surveyed, the reports of tests carried out as required in 8.2 above;

NDT report (if applicable);

Verification certificate or verification list of test instruments and meters.

8.4 If the manufacturer requests to replace the tests specified in 8.2 for LNG valves, valves with a working temperature below -55 ℃ and ammonia valves with a working temperature below -29 ℃, the certification survey for these valves can proceed according to the following requirements:

(1) The valve has been subject to type approval test in accordance with the requirements of the Guidelines;

(2) The manufacturer has the approved quality system which is certified and periodically audited by CCS;

(3) The quality control plan includes: All valves are subject to the visual inspection, strength test of pressure parts, shell sealing test, seal test and back seal test (if applicable) one by one as required. The manufacturer shall keep the test records;

(4) For each type and size of valves, at least 10% of them (at least one in any case) shall be selected for the cryogenic sealing test and cryogenic operation test under the witness of the surveyor.