0	’18.03.14	FOR CONSTRUCTION	HOL	YHDK	KMK	
A	’18.01.31	FOR APPROVAL	HOL	YHDK	KMK	
REV. NO.	DATE	DESCRIPTION	DGN	CHK	APP	CL.APP

한국조선해양기자재연구원
Korea Marine Equipment Research Institute

LNG 연료추진 기자재 안정성/성능 시험평가 설비 상세설계

PURCHASING SPECIFICATION FOR CRYOGENIC CHECK VALVE

SCALE	JOB NO.	PHASE	DOCUMENT NO.	REV.
NONE			LTB-P-REQ-1006	0

한국가스기술공사
KOREA GAS TECHNOLOGY CORPORATION

CONTENTS

1. SCOPE
2. CODES AND STANDARDS
3. TECHNICAL SPECIFICATION
4. TEST AND INSPECTION
5. MARKING
6. PACKING
7. OTHERS

1. SCOPE

This specification covers the manufacture, test and inspection, and other related matters of cryogenic check valve.

2. COEDS AND STANDARDS

The following laws, codes, and standards referred to in this specification shall be their latest editions. Any item inconsistent with this specification shall be approved by the purchaser prior to manufacturing those valves.

American Petroleum Institute (API)

API 594	Water Check Valves
API 598	Valve Inspection and Testing
API 600	Steel Gate Valve, Flanged and Butt-welding End
API 6D	Specification for Pipeline Valves
API 6FA	Specification for Fire Test for Valves
API 607	Fire Test for Soft Seated Quarter-Turn Valves

American Society of Mechanical Engineers (ASME)

ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.25	Butt Welding Ends
ASME B16.34	Valves-Flanged, Threads, and Welding End

Contractors Standardization Society of The Valve and Fitting Industry (MSS)

MSS-SP-6	Standard Finishes for Contract Face of Pipe Flange and Connecting-end Flanges of Valves and Fittings
MSS-SP-25	Standard Marking System for Valves, Fittings Flanges and unions
MSS-SP-55	Quality Standard for steel Castings for Valves, Flanges and Fittings and other Piping Components (Visual Method)

American Society for Testing and Materials (ASTM)

A351/A351M	Casting, Austenitic, Austenitic-Ferritic (Duplex), for Pressure -Containing Parts
A370	Mechanical Testing of Steel Products
A703	Steel Casting, General Requirements, for Pressure Containing Parts
E186/280/446	Standard reference Radiographs for Steel Castings

American Society of Mechanical Engineers (ASME, Boiler and Pressure Vessel Code)

Sec. IX	Welding and Brazing Qualifications
Sec. V	Nondestructive Examination
Sec. Ⅷ	Pressure Vessels

British Standard (BS)

BS 6364	Valves for Cryogenic Service

Korean Gas-Related Laws

High-Pressure Gas Safety Control Act

Urban Gas Business Act

Safety Control and Business Regulation of Liquefied Petroleum Gas Act

3. TECHNICAL SPECIFICATION

3.1 General

3.1.1 Fluid

Classification	Temperature (at atmospheric pressure.	Density (Fluid.
LNG	-183℃ to -88℃	434 to 478㎏/㎥
NG	-160℃ to 65℃	(0.7 to 0.89㎏/㎥)
LN_2	-196℃	804㎏/㎥
N_2	-196℃ to 65℃	(1.184㎏/㎥)

3.1.2 Working pressure and design temperature

Pressure Rating of valves	Maximum Working Pressure MPa(PSI)	Remarks
Class 150	2.0(290)	On the basis of normal temperature
Class 300	5.2(750)	
Class 600	10.3(1500)	
Class 900	15.5 (2250)	
Class 2500	32.0 (4640)	

a. The pressure rating and the maximum working pressure shall conform to ASME B16.34.
b. The maximum working pressure over Class 2500 shall conform to Class 2500.
c. The working pressure of the valves shall conform to the line list provided by the purchaser
d. The design temperature shall be in -196℃ to +65℃.

3.2 Valve Specification

In principle, check valves shall be of a swing, dual plate wafer, or lift type. The construction, function, and specification of a valve shall satisfy the followings. Any deviation from this specification shall be reported in the "deviation sheet" and be approved by the purchaser.

3.2.1 Body material

a. Material

The material of valve bodies shall be as follows or equivalent. The materials of welded type valves may be used also for flanged type valves.

NPS	Manufacturing Method	Materials	
		Flanged Type Valve	Welded Type Valve
3 & Over	Casting	ASTM A351 CF8, CF8M	ASTM A351 CF3, CF3M
2 & Under	Forging	ASTM A182 F304, F316	ASTM A182 F304L, F316L

* In case forged valves are used for NPS 3 and over, the materials may be the same as those for NPS 2 and under.

b. Manufacture

The manufacture shall conform to the followings, unless otherwise specified

1) Face-to-face distance

- Swing type : ASME B16.10
- Dual plate type : API 594
- Lift type : Contractor's specification

2) The minimum wall thickness of the body wall shall be equal to or over the minimum wall thickness specified in ASME B16.34. Table 3,4.

3) The end connections of valve bodies shall be either a welded end type or a flanged end type, and be fabricated as follows:

(a) Welded end type

- Under NPS: Socket welding except for class 25R1J
  - Class 150 and Class 300 : To conform to Class 3000 specified in ASME B 16.11
  - Class 600 : To conform to Class 6000 specified in ASME B16.11
  - Class 800 to 1500 : To conform to Class 9000 specified in ASME B16.11.
- NPS 2 and over or class 25R1J : Butt welding
  - In case the wall thickness of connected piping is Sch.40S and under, the valve ends shall be trimmed to Sch.40S in accordance with ASME B16.25
  - In case the wall thickness of connected piping exceeds Sch.40S, the valve ends shall be trimmed to the pipe thickness in accordance with ASME B16.25.
  - The wall thickness of connected piping shall be in accordance with the line schedule provided by the purchaser.

(b) Flange type

- NPS 24 and under : To conform to ASME B16.5.
  - Class 150, Class 300 : Raised face(RF) type flange
  - Class 600 and over : Large groove face (LGF) type flange or RF type flange or RTJ type flange
- NPS 26 and over : To conform to ASME B16.47.
  - Class 150, class 300 : RF type flange
  - Class 600 and over : LGF type flange or RF type flange
- Flange faces shall be machined in accordance with ASME B16.5 and ASME B16.47 for each flange type, and shall be measured in accordance with ASME B16.1.
  - RF type flange: 3.2 ~ 6.3㎛ Ra (125-250 μ in)
  - LGF type flange: 3.2 ㎛ Ra (125 μ in) and under

- RTJ type flange: 3.2 ㎛ Ra (125 μ in) and under

3.2.2 Type and material of bonnet

a. Type

In the case of a bonnet type welded to the body, the body and bonnet shall be connected by screw connection at first and then by welding.

b. Material

The material shall be ASTM A182 Gr.F316 or ASTM A351 Gr.CF8M or equivalent.

3.2.3 Type and material of trim

a. Type

The type of the disk and the valve body shell shall be of a type which can minimize the wear of the seat ring when the valve is being operated.

b. Material

The material shall be ASTM A182 F316 or ASTM A351 CF8M or equivalent, and the surface part in contact with the body seat ring shall be hardened by surface treatment with high-hardness stellite grade 6 to improve wear resistance, and the surface treatment thickness shall be at least 1.6㎜ after machining.

3.2.4 Type and material of gasket

The gaskets shall be made of metal usable in the temperature range of -196℃ and +65℃.

3.2.5 Type and material of seat ring

a. Type

The valve body seat ring shall of a single seated type, of which port part cuts off the fluid flow in contact with the disk.

b. Material

The material shall be ASTM A182 F316 or equivalent, and the surface part in contact with the body seat ring shall be hardened by surface treatment with high-hardness stellite grade 6 to improve wear resistance, and the surface treatment thickness shall be at least 1.6㎜ after machining.

3.2.6 Type and material of hinge

a. Type

The hinge shall be of a construction which is solid and can be installed inside the body.

b. Material

The material shall be ASTM A182 Gr.F316 or ASTM A351 Gr.CF8M or equivalent.

3.2.7 Type and materials of bolts and nuts

a. Type

Bolts and nuts for the bonnet flange, yoke, and gland flange shall be manufactured in accordance with API 600 Para. 2.8.

b. Materials

1) The material of bolts shall be ASTM A320 Gr. B8, Class 2 or equivalent.

2) The material of nuts shall be ASTM A194 Gr.8MA or equivalent/

c. Vendor shall also supply one set of stud bolts and heavy hex nuts for each wafer type check valve, based on counter flange, ASME B16.5 for NPS 24 & smaller and MSS SP 44 for NPS 26 & larger.

3.3 Surface Treatment

After their fabrication and testing, all valves shall be treated with picking and passivation to form a passive coating.

3.4 Welding and Heat Treatment

3.4.1 Welding

a. Welding works shall be performed in accordance with the welding procedure specification (WPS) and the procedure qualification record (PQR) approved in accordance with ASME Sec. IX.

b. Repair welding shall be performed in accordance with the repair welding procedure prepared by the contractor and approved by the purchaser. However, any repair of cracked defects shall not be accepted.

c. Nondestructive tests on repaired welds shall be performed by the test methods suitable for the related test parts.

d. The contractor shall prepare a list of defects in major parts such as a valve body prior to the repair works and submit it to the inspector during the inspection.

3.4.2 Heat treatment

Heat treatment shall be conducted in accordance with the heat treatment procedure for each material and each size approved by the purchaser.

4. TEST AND INSPECTION

All tests and inspections shall be performed in accordance with this specification and related specifications, the latest test and inspection procedures approved by the purchaser, and manufacturing drawings.

This cope of service may be performed either by the purchaser or by a third party inspection agency appointed by the purchaser.

4.1 Material Tests

4.1.1 Mill certificates and cryogenic impact test results of major parts (such as a body, a ball, a stem, transition pieces, a seat ring, an extended bonnet, bolts, and nuts) specified with chemical analyses and mechanical test results shall be submitted to the purchaser for his approval, and the test results shall satisfy the requirements of related standards.

4.1.2 The cryogenic impact tests shall be performed at a temperature of -196℃ in accordance with ASME Sec.Ⅷ Div.1, Para. UHA 51 and UG 84, and the test valves of 3 test pieces shall be 0.381㎜ (15 mils) or for each piece in lateral expansion.

4.1.3 The δ-ferrite valve of the valve body shall be 5 to 10%

4.2 Nondestructive test

The nondestructive test procedures shall be approved by the purchaser prior to such nondestructive tests. The contractor shall keep and mange radiographs and nondestructive test reports for at least the period of warrantee period and immediately submit them to the purchaser upon his request.

4.2.1 Radiography Test (RT)

a. Test range

1) Radiography tests shall be performed in accordance with ASME B16.34, Chapter 8, and the bodies, bonnets, welds (butt welds of fabricated extended bonnets and longitudinal welds of fabricated extended bonnets), and other critical areas shall be tested a hundred percent with radiography. However, the body ends shall be tested prior to their beveling.

2) In the case of cast valves, full radiography test shall be performed over

the whole valve on 5% of the cast quantity of each valve group (bore size and pressure rating. In the related valve group shall be additionally sampled and tested. In case any defect is discovered again among those tested valves, the whole cast quantity in the related valve group shall be rejected.

b. Test procedure and acceptance standards

1) Tests shall be performed in accordance with ASME Sec. V and ASME B16.34 Mandatory Appendix I.

2) In the case of cast valves, radiographs shall be read out by comparing them with the reference radiographs in ASTM E446 [for the wall thickness under 50.8㎜ (2")], and ASTM E186 [for the wall thickness 50.8㎜ (2") and over to but not including 114.3㎜(4.5")].

3) The acceptance standard for cast valves shall be as follows

Category	Discontinuity Type		Acceptable Severity Level	
			Critical Areas	Non critical areas
A	Gas Porosity		A1	A2
B	Sand & Slag Inclusion		B1	B3
C	Shrinkage	type 1	CA1	CA2
		type 2	CB1	CB2
		type 3	CC1	CC2
		type 4	CD1	CD2
D	Crack	None	None	None
E	Hot Tear	None	None	None
F	Insert	None	None	None
G	Mottling	None	None	None

- Critical areas are those areas subject to 100% radiography test and include the valve seat, both ends of the body, upper part of body, and the neck of the bonnet (Refer to ASME B16.34 Fig 10 and 11.)
- According to the results of nondestructive tests performed by Korea Gas Safety Corporation on the welds of valve ends installed at the site, any defect shall be repaired by the valve manufacturer under his responsibility.

4) Welds shall be tested in accordance with ASME Sec.Ⅷ Div.1 UW-51 and Appendix 4.

4.2.2 Penetrant test (PT)

a. Test range

1) All valve bodies, the outside surface of the bonnets, and their inside surface accessible for test, beveled end parts of the body, socket welds and fillet welds (for lifting lugs and supporting legs) which cannot be tested with radiography shall be tested with penetrant in accordance with ASME B16.34, Chapter 8.

2) Cast parts gouged to remove casting defects shall be tested.

3) Bolts over 25.4㎜ (1") in diameter shall be tested.

4) Plugs and body seat rings shall be tested. Those plugs and body seat rings hardened by surface treatment with high-hardening stellite grade 6 shall be tested after surface machining.

5) All seal welds shall be tested.

b. The test procedure shall conform to ASME Sec. V and ASME B16.34 Mandatory Appendix III, and the cast surfaces shall be finished to the roughness of 400 ~ 500μ inch and welds shall be ground if necessary to secure reliable test results. Chlorides and halogen compounds in the penetrant harmful to test objects shall not exceed 1% by weight, and all contaminants shall be removed after test by means of proper solvent.

c. Acceptance standards

1) Cast parts and forged parts shall conform to ASME B16.34 Mandatory Appendix III.

2) Welds shall conform to ASME Sec.Ⅷ Div.1 Appendix 8.

4.2.3 Ultrasonic test (UT)

a. Test range

Forged valve bodies and bonnets shall be tested in accordance with ASME B16.34, Chapter 8.

b. The test procedure shall conform to ASME Sec.V and ASME B16.34 Mandatory Appendix IV.

c. Acceptance standards shall conform to ASME B16.34 Mandatory Appendix IV.

4.2.4 Retest

Parts rejected by a test shall be retested after repairing them in accordance with the test method and test procedure suitable for the related ones.

4.2.5 Submittal of test results

The contractor shall submit to the purchaser the test results in the test and inspection report (including drawings with test part sketches).

4.3 Dimensional Check

All manufactured valves shall undergo dimensional check, and their major dimensions shall be checked if they conform to the specification and the manufacturing drawings.

4.4 Visual Inspection

All valves shall be checked in accordance with MSS-SP-55 if there is any harmful scratch, crack, crease, shrinkage, protrusion, surface discontinuity, casting sand, or rust, and be ensured that there is no damage to machined surface and the seat ring. Welds shall be free of any scratch, undercut, and arc strike harmful to use, and the height of weld bead shall not be lower than the base metal surface.

4.5 Inspection of Heat Treatment

The inspection of heat treatment shall be performed in accordance with the heat treatment specification approved by the purchaser, and the specification shall include heating temperature, heating method, holding time, cooling rate, and cooling method. The furnace shall be recorded during the heat treatment by an automatic temperature recorder and the record charts shall be submitted to the purchaser.

4.6 Pressure test and pneumatic test

All manufactured valves shall be tested to check their strength and tightness as follows in accordance with API 598, and the test results shall be submitted to the purchaser in the form of record charts recorded by an automatic pressure recorder. Proper test equipment shall be provided to avoid applying any undue stress to the valve body during the process of shutting off the inlet and outlet of the valve for pressure test and pneumatic test.

4.6.1 Pressure test

Item	Shell Pressure Test	High Pressure Closure Test
Test Media	Fluids approved as volatile fluids such as kerosene, methanol, alcohol	Fluids approved as volatile fluids such as kerosene, methanol, alcohol
Test	1.5 times the maximum working pressure at 38℃(100°F) specified in ASME B16.34 Table 2-2.1B, 2.2B (special class) (To pressurize the value at the upstream side)	1.1 times the maximum working pressure at 38℃(100°F) specified in ASME B16.34 Table 2-2.1B, 2.2B (special class) (To pressurize the valve at the downstream side.
Test Time	5 minutes minimum	5 minutes minimum
Acceptance Standard	No external leakage	3cc/(min·inch)

- For closure test, valves shall be pressurized at the downstream side and leakage is checked at the upstream side.
- Standard class ratings of ASME B16.34 shall be used for flanged end type & water type valves only.

4.6.2 High-pressure pneumatic shell test

This test shall be performed after the shell pressure test. Nitrogen or dry air shall be used as the test medium, and the test pressure of 1.1 times the normal valve working pressure shall be applied at the upstream side of the valve and held for a minimum of 5 minutes to ensure that there is no leakage from the valve.

4.7 Fire Safe Test

This test may be replaced by submitting the certificate of API 6FA.

4.8 Cryogenic Test

The cryogenic test shall be performed as follows. Any matter not covered herein shall conform to BS 6364, Appendix A.

4.8.1 Test range

a. Five percent (5%, a minimum of 1 valve) of the number of all valves in each valve group (bore size and pressure rating) shall be sampled and tested.

b. In case the test results fail to satisfy the requirements, 10% of the related valve group shall be additionally sampled and tested. In case the test results fails again to satisfy the requirements, all the valves in the related valve group

shall be rejected. (The satisfaction of cryogenic test requirements means that each test result of initial proving test, cryogenic performance test, ambient temperature test, disassembly test satisfies its acceptance standard.)

4.8.2 Test procedure

The cryogenic tests shall proceed in the order of initial proving test, cryogenic performance test, ambient temperature restoration test, disassembly test, and the method and procedure of each test shall be as follows

a. Initial proving test

This test is performed prior to cryogenic tests to check if valves leak at the ambient temperature, and shall be performed as follows with closed valves:

1) Test temperature : Ambient temperature
2) Test medium : Helium gas
3) Test pressure : 1.1 times normal valve working pressure and pressurized at the downstream side of valves.
4) Test time : 5 minutes
5) Allowable leakage is 0, 0, and 40 cc/(min·inch. respectively for lift type, swing type and wafer type.
6) Pressurization to the test pressure shall be performed in the following steps

Valve Pressure Class	Pressurization at Each Step [㎫(bar)]	Holding Time at Each Step (Min.)	Remarks
Class 150	0.35(3.5)	10	Measure and record the leakage at each pressurization step.
Class 300	0.75(7.5)	10	
Class 600	1.0(1.0)	10	
Class 800 & Over	2.0(20.0)	10	

b. Cryogenic performance Test

1) Test preparation

(a) Measure and record the bolting torques of the valve body and bonnet.

(b) Prepare the test equipment suitable for cryogenic tests in accordance with BS 6364, Appendix A, and install thermocouples in proper locations on the valve body and bonnet to measure the cryogenic test temperatures.

(c) Cool down the valve by submerging it in a liquefied nitrogen container

up to the connection part of its body and bonnet. Purge the valve inside with helium gas during cooling down and check the temperatures of the inside and outside of the body and bonnet.

(d) Keep the valve in the liquefied nitrogen container for at least one hour until the temperatures of the body and bonnet are stabilized.

2) Kinds and methods of tests

When the cryogenic test temperature of -196℃ is constantly maintained, the tests shall be performed as follows

(a) Cryogenic pressure test

Helium gas shall be used as the test medium. The valve shall be pressurized to 1.1 times the valve working pressure at the upstream side and checked for 15 minutes to ensure that there is no leakage to its outside (the connection part of its body and bonnet).

(b) Cryogenic pneumatic test

The cryogenic pneumatic test shall be performed in accordance with the above 4.8.2 b. and the test temperature shall be -196℃. The allowable leakage shall be 50, 20, 300 normal ㎤/(min·inch) for lift type, swing type, and wafer type respectively.

c. Ambient temperature restoration test

After completion of cryogenic tests, the valve temperature shall be restored to the ambient temperature and the following test shall be performed

1) Pneumatic test at ambient temperature

Valve leakage shall be checked by the same method as that of the initial proving test in 4.8.2 a. The maximum allowable leakage rate for each valve size shall conform to API 598 Table 5.

d. Disassembly test

After completion of the ambient temperature restoration test, valves shall be disassembled in a clean place and checked if they can be easily disassembled and if their parts are damaged or worn out.

e. Final pneumatic test

After completion of disassembly test, valves shall be reassembled and undergo the final pneumatic test in accordance with the standard for high pressure closure test in 4.6.1.

4.8.3 Submittal of test results

After cryogenic tests, the test report including the followings shall be submitted to the client

a. Results of initial proving test at ambient temperature [4.8.2 a.]
b. Bolting torques of valve body and bonnet [4.8.2 b. 1) (a)]
c. Results of Temperature measurement at cryogenic temperature [4.8.2 b. 1) (c)]
d. Results of pressure test at cryogenic temperature [4.8.2 b. 2) (a)]
e. Results of Pneumatic test at cryogenic temperature in each pressurization step [4.8.2 b. 2) (b)]
f. Results of pneumatic test after restoration to ambient temperature [4.8.2 c. 1)]
g. Conditions of valve parts after cryogenic tests [4.8.2 d.]
h. Results of final pneumatic test after restoration to ambient temperature [4.8.2 e.]

5. MARKING

5.1 Marking on the valve body shall conform to API 6D Sec. 6 and flow direction shall be marked also. In addition, "LT" shall be marked on the upper part or the lower part (at the center of the body) of the flow direction.

5.2 The description on the nameplate shall conform to API 60 Sec. 6, and the tag number, purchaser, and inspector of the valve shall be included. he dimension, material, marking method, and attachment location of the nameplate shall be approved by the purchaser prior to its manufacture.

6. PACKING

6.1 Valves shall be fixed in their closed condition and packed.

6.2 Welded valves shall be covered at their end openings with solid covers (wood, plastic, or metal covers) in order to prevent any damage to their flange faces and insides.

6.3 All valves shall be packed with polyethylene sheets with enclosed moisture absorbent to prevent any ingress of moisture and foreign materials. (However, ocean-freighted valves shall be sealed and packed to prevent them form being corroded.)

6.5 Valves shall be delivered in plastic or wooden packing to prevent their damage during transportation or storage, and tag numbers shall be attached to identify

their contents in detail.

6.6 Valves shall be supported in a proper way to keep them fixed during transportation.

6.7 Quarantine requirements for wood packing materials

All wood packing materials for all imported consignments shall be subject to quarantine requirements of National Plant Quarantine Service, under the sole responsibility of seller.

7. OTHERS

7.1 The contractor shall submit to the purchaser drawings specified with materials and dimensions and get the purchaser's approval of them prior to the valve manufacture.

7.2 Items to be witness-tested shall be submitted to and reviewed and approved by the purchaser.

7.3 Valves weighing 40㎏ and over shall be provided with lifting lugs for easy transportation and handling, and may be provided with supporting legs, if necessary. Lifting lugs and supporting legs shall be fabricated by the method and in accordance with the drawings specified with dimensions approved by the purchaser.

7.4 In case valve specification has to be changed due to the contractor's characteristics, the contractor's specification may be adopted when better quality is guaranteed.

7.5 All cost and expenses for test and inspection (including retests and re-inspections) of valves shall be borne by the valve contractor.

7.6 The purchaser is entitled to select the kind and submittal schedule of documents related to the valves and to request them. The language may be either English or Korean. All manuals shall be prepared in computer files by means of MS Word 2007 or its upgraded version.

Certificates and inspection records for submittal shall be scanned and converted to computer files and submitted in the form of diskettes or CD ROMs during the approval stage of manufacturing drawings and documents.