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LNG 벙커링기자재 시험평가 설비 기본 상세설계

PURCHASING SPECIFICATION FOR CRYOGENIC GLOBE VALVE

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한국가스기술공사
KOREA GAS TECHNOLOGY CORPORATION

CONTENTS

1. SCOPE

This specification applies to the manufacture, test, inspection, and other related matters of cryogenic globe valves.

2. CODES 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 6D	Specification for Pipeline Valves
API 598	Valve inspection and Testing
API 6FA	Specification for Fire Test for Valves
API 600	Steel Gate Valves, Flanged and Butt-Welding Ends

American Society of Mechanical Engineers (ASME)

ASME B1.5	ASME Screw Threads
ASME B1.8	Stub ASME Screw Threads
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	Buttwelding Ends
ASME B16.34	Valves-Flanged, Threads, and Welding End
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ASME B16.47	Series "A" Large Diameter Steel Flange (NPS 26 through 60)

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

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)

A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

A105/105M	Forgings, Carbon Steel, for Piping Components
A106	Seamless Carbon Steel Pipe for High-Temperature Service
A182/A182M	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings and Valves and Parts for High-temperature Service
A194/A194M	Carbon and Alloy Steel Nuts and Bolts for Fusion Welding for High-Temperature Service
A216/216M	Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service
A320/320M	Alloys-Steel Bolting Material for Low-Temperature Service
A350/350M	Forgings, Carbon and Low-Alloy Steel, Requiring Notch Toughness Testing for Piping Components
A351/351M	Casting, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts
A370	Test Methods and Definition for Mechanical Testing of Steel Products
A694/694M	Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission service
E186	Reference Radiographs for Heavy-Walled (2 to 41/2-in) Steel Castings
446	Reference Radiograph for Steel Castings up to 2in. in Thickness

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

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

British Standard (BS)

BS 6364	Valves for Cryogenic Service

ISO(International Organization for Standardization)

ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness- Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 8504-1	Preparation of steel substrates before application of paints and

related products - Surface preparation methods - Part 1 : General principles

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 (Liquid)
LNG	-183℃ to -88℃	434 to 478kg/㎥
NG	-160℃ to 65℃	(0.7 to 0.89kg/㎥)
LN2	-196℃	804kg/㎥
N2	-196℃ to 65℃	(1.184kg/㎥)

3.1.2 Working pressure and design temperature

Pressure Rating of Valve	Maximum Working Pressure of Valve, Bar	Remarks
Class 150	19.8	On the basis of ambient temperature
Class 300	51.7	
Class 600	103.4	
Class 900	155.1	
Class 2500	490.9	

* The pressure rating and the maximum working pressure shall conform to ASME B16.34.
* The maximum working pressure over class 2500 shall conform to class 2500.
* The normal working pressure of the valve shall conform to the line list supplied by the purchaser.
* Design temperature shall be -196℃ to +65℃

3.2 Valve Specification

The valve construction shall be of an OS&Y (outside screw and yoke), BB (bolted bonnet), solid plug, extended bonnet type, and a rising stem and non-rising hand wheel type to open the valve. The construction, function, and specification of the valve shall satisfy the following requirements. Any deviation from this specification shall be reported in the "deviation sheet" to the purchaser and shall be approved by the purchaser.

3.2.1 Type and material of body

a. Type

The valve shall be of a top entry type (one piece bolted type)

b. 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	Material	
		Flanged Type Valve	Welded Type Valve
3 and	Casting	ASTM A351 CF8, CF8M	ASTM A351 CF3, CF3M
2 and under	Forging	ASTM A182 F304, F316	ASTM A182 F304L, F316L

* Forging materials for NPS 3 and over may be the same as those for NPS 2 and under.

c. Manufacture

The following shall be applied, unless otherwise specified

1) The face-to-face distanced shall conform to ASME B16.10
2) The minimum wall thickness of the valve body shall be equal to or over the minimum thickness specified in ASME B16.34, Table 3.4.
3) The end connections of valve bodies shall be either a welded type or a flanged type and shall be fabricated as follows:
   (a) Welded end type
      (1) Under NPS 2 : 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.

(2) NPS 2 and over : Butt welding

- In case the wall thickness of connected piping is Sch.40S in accordance with ASME B16.25.
- In case the wall thickness of connected piping is over Sch.40S, the valve ends shall be trimmed to the pipe wall thickness in accordance with ASME B16.25.
- The wall thickness of connected piping shall conform to the line schedules supplied by the purchaser.

(b) Flange type

(1) 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

(2) 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

(3) 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 B46.1.

- RF type flange : 3.2 ~ 6.3㎛ Ra (125-250㎛ in)
- LGF type flange : 3.2㎛ Ra (125㎛in) and under

3.2.2 Type and material of extended bonnet

a. Type

1) The minimum wall thickness of the bonnet shall be equal to or heavier than the minimum wall thickness specified in ASME B16.34 Table 3, and 4. However, the thickness of the valve neck above the back seat shall conform to ASME B16.34 Sec. 6.1.3.
2) The flange connection of the bonnet connected to the body shall conform to API 600 Sec. 5.5.
3) The location of Extended Bonnets and the location, diameter, thickness of heat sink shall be referred to the followings for Stem Packing to maintain the ambient temperature.
However, the contractor shall submit to the purchaser for approval about the actual manufacturing length based on test and calculations.

NPS	1/2 to 1	1 1/2 to 3	4 to 6	8 and Over
Length of Extension, mm (in)	254 910)	304.8 (12)	356.6 (14)	457.2 (18)

4) Insulation collars or drip plates shall be provided in the proper locations of the extended bonnet that is not insulated. However, the contractor shall submit to the purchaser for approval the proper material, size and location of Insulation collar or drip Plate based on test and calculations.

5) Valve driving mechanism such as a gearbox shall be constructed so that it will not be frozen even in extremely cold seasons and the areas to be insulated shall be marked in the manufacturing drawing.

6) Back seats and rings shall be provided in the extended bonnet so that the packing for stem sealing can be replaced without LNG leakage during valve operation.

b. Material

The bonnet shall be fabricated either by casting it in whole or casting (or forging) the bonnet part only and welding transition pieces to it.

1) In case the bonnet is cast in whole, the material shall be same as that of the body or equivalent.

2) In case the cast (or forged) part and transition pieces are welded, the casting material shall be ASTM 351 CF3, CF3M, the forging material ASTM A182 F304L, F316L, and transition pieces ASTM A312 or A358, 304L, 316L or equivalent. However, no circumferential weld is permitted on the transition pieces, which shall be fabricated on the transition pieces, which shall be fabricated with seamless or one longitudinal seam pipes

3.2.3 Type and material of plug

a. Type

1) Plugs shall be of one piece and the port part that shuts off the fluid shall be of a single-seated type.

2) A plug guide shall be provided between the plug and the valve body shell to minimize the wear of the seat ring during valve operation and to align the plug and the stem in a straight line.

b. Material

The material of the plug shall be ASTM A182, F316, ASTM A351, CF8M or equivalent, and the part in contact with the seat ring shall be hard-faced by surface treatment with high hardening stellite grade 6 to improve

wear-resistance. Surface-treated thickness shall be a minimum of 1.6 ㎜ after machining the surface.

3.2.4 Type and material of the stem

a. Type

1) In principle, the stem shall be of an extended stem type. unless otherwise specified.

2) The minimum diameter of the stem shall not be smaller than the minimum diameter specified in API 600, Table 6.

3) The minimum diameter of the stem shall not be constructed not to be displaced from the plug during operation, and be sufficiently strong.

4) The outer surface of the stem shall be in precise contact with the packing to maintain tightness, and shall be machined precisely not damage the packing (surface roughness: under 6㎛).

5) The stem part to be in contact with the back seat when the valve is full open shall be constructed in a conical or spherical shape to be in perfectly tight contact with the back seat.

6) The stem shall be threaded by the methods specified in ASME B1.5 or B1.8.

b. Materials

The material of the stem shall be ASTM A182, F316 or equivalent.

3.2.5 Stem sealing

a. The stem shall be sealed in a double or multiple construction (stem packing or lantern ring) to prevent any leakage at the stem.

b. The stem sealing packing shall be sufficiently tight and strong enough to withstand the impact of long-period use and repeated open-close operations.

c. The materials for stem sealing packing shall be graphite, PTFE (diagonal braid of PTFE fibers impregnated with PTFE), carbon fiber impregnated with graphite and PTFE, or equivalent. They shall be approved by the purchaser, and shall not cause any chemical or physical reaction with the fluid components to form any adhesive material which sticks to the stem and hinders smooth valve operation.

d. The stem sealing packing shall be constructed for easy replacement.

3.2.6 Type and material of seat ring

a. Type

The construction of the seat ring inside the valve body shall be of a single-seated type in the port that shuts off the fluid in contact with the

plug.

b. Material

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.

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, 2.8.

b. Material

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.

3.2.8 Requirements of driving mode and operating mechanism

a. The driving modes of valves are classified as follows according to valve classes and may be changed (to a chain wheel, pneumatic, hydraulic, or motor-driven type) according to design conditions. Valves shall be able to be easily operated without using a special tool or applying excessive power.

NPS	Valve Class	Driving Mode
All bores	class 150, class 300 class 600, class 800	direct hand wheel
Under 4	class 900	
Under 2	class 1500 and over	
4 and over	class 900	gear
2 and over	class 1,500 and over	

b. The manual operation of valves shall be performed with hand wheels and the applied force at the end tip of manually-operating mechanism shall not exceed maximum 245 N (25㎏f) at the differential pressure condition of the normal operating pressure of the valve. And the diameter of a hand wheel shall not exceed 760 ㎜.

c. The materials of manually operating valve mechanisms (gearboxes and hand wheels) shall be as follows or equivalent, and shall be galvanized for rust prevention. The mechanism shall be designed and fabricated to withstand the stress caused by the valve operation at the differential pressure condition of

the normal operating pressure of the valve.

1) Gearbox
   (a) Forging steel : ASTM A105, A350 LF2, A694 F52
   (b) Cast steel : ASTM A216 WCC
2) Hand wheel
   (a) Pearlitic ductile cast iron with the yielding strength of 372.7㎫ (38㎏/㎟) and over.
   (b) Carbon steel : ASTM A53, A106

d. The explosion - proof class of an automatic valve operating mechanism, especially an explosion - proof type electrical equipment, shall conform to the hazardous area classification of the area where such a valve is to be located.
e. The valve shall be provided with a position indicator so that the valve opening can checked at distance.
f. In the case of an automatic-operating mechanism, the valve shall be provided also with a position indicator so that the valve opening can be checked at a distance and a limit switch so that excessive strength can not be applied to the stem and the seat ring. The contractor shall submit the manufacturing standards to the purchaser for his approval.
g. Gearboxes shall be of a waterproof construction to prevent any ingress of water.
h. The direction and location of the hand-wheel shall be approved by the purchaser.
I. The opening direction of the valve shall be counter-clockwise.
j. The stem protector shall be fabricated with transparent acrylate and shall be of a construction preventing water ingress.
k. In case the actuator is very heavy, the contractor shall design and fabricate a self-supporting structure for it so that the stem will not be damaged such as being deflected.

3.2.9 Painting

The operating systems of valves (Hand lever, Hand wheel. Gear box and Actuator) shall be surface-treated and painted as follows

a. Surface treatment

The surfaces shall be removed of foreign materials such as oil, grease, rust and blasted with steel shots, steel grits or other equivalent abrasives to secure necessary roughness. The treated surface condition shall conform to

SA 2½ or over of ISO-8501-1.

b. External painting

The internal and external valve surfaces shall be completely cleaned of abrasives and dust. Exposed above-ground valves shall be painted with primer, epoxy and urethane paint to the dry thickness of 250㎛ (color : Munsell No.7.5 Gr-5.5/1 green grey).

c. The contractor shall submit detailed painting specifications of all painting works for the purchaser's approval prior to the painting and shall keep ready at hand a painting thickness gauge.

d. Others shall conform to the manufacture's specification.

3.3 Surface Treatment

After fabrication and testing, all valves shall be treated with pickling and passivation to form 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) which have been 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, repair of cracked defects shall not be accepted.

c. Nondestructive tests on the repair welds shall be performed by the test method of the related location.

d. The contractor shall prepare a list of defects in major parts such as the 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 performed in accordance with heat treatment specification 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, related standards and specifications, the latest test and inspection procedures approved by the purchaser, and manufacturing drawings.
The test and inspection may be performed by the purchaser or an authorized third party inspector appointed by the purchaser.

4.1 Material Tests

4.1.1 Mill certificates and cryogenic impact teat 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, Paragraphs UHA 51 and UG 84, and the test values of 3 test pieces shall be 0.381㎜ (15 mils) or over for each piece in lateral expansion

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

4.2 Nondestructive Test (RT)

The test procedure shall be approved by the purchaser prior to such nondestructive tests. Radiographs and nondestructive test reports shall be kept and managed at least for the guaranty and warranty period and immediately be submitted to the purchaser upon his request.

4.2.1 Radiography test (RT)

a. Test scope

1) In accordance with ASME B16.34 Chapter 8, all welds on cast valves (butt welds of fabricated extended bonnet, and longitudinal welds on the fabricated extended bonnet) and critical areas shall be tested hundred percent with radiography. However, the body ends shall be tested prior to beveling.

2) In the cast valves, radiography test shall be performed on 5% of the cast quantity for each class (bore size and pressure)(a minimum of 1 valve) a

hundred percent with radiography. In case any defect is discovered, 10% of related classes shall additionally be sampled and tested. In case any defect is found again among them, the whole cast quantity of the related valve class shall be rejected.

b. Test procedure and acceptance standards

1) The tests shall be performed in accordance with ASME Sec. V and ASME B16.34, Mandatory Appendix 1.

2) In the case of casting, radiograph reading shall be performed in comparison with the reference radiograph in ASTM E446 [wall thickness under 50.8㎜ (2")] and ASTM E186 [wall thickness 50.8㎜ (2") and over, to but not including 114.3㎜ (4.5")].

3) The acceptance standards shall be as follows for cast products:

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	CD1	CC2
		type 4	CD1	CD2
D	Crack	None	None	
E	Hot tear	None	None	
F	Insert	None	None	
G	Mottling	None	None	

* Critical areas are seats, end parts and upper ends of valve bodies, and the bonnet neck to be tested a hundred percent with radiography. (Refer to ASME B16.34 Fig 6, 10.)
* 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 scope

1) All outer surfaces of the valve body and bonnet, their inner surfaces accessible for the test, beveled end parts of the body, and sockets and fillet welds (lifting lugs and support legs) which can not be radiography-tested shall be penetrant-tested a hundred percent in accordance with ASME B16.34, Chapter 8.
2) Defective cast parts gouged for removal of such defects shall be tested a hundred percent.
3) Bolts over 25.4㎜ (1") In diameter shall be tested a hundred percent.
4) The plug and the body seat ring shall be tested a hundred percent. Hard-

faced parts on the plug and the body seat ring by surface treatment with high-hardening stellite grade shall be tested a hundred percent after machining the surfaces.

5) All sealing welds shall be tested a hundred percent.

b. The test procedure shall conform to ASME Sec.V and ASME B16.34, Mandatory Appendix III, and the cast surfaces shall be prepared to 400-500 ㎛ inch in roughness to secure reliable test results and welds shall be cleaned out with proper solvent after testing.

c. Acceptance standards

1) Cast 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 scope

1) The bodies and bonnets of forged valves shall be tested a hundred percent in accordance with ASME B16.34, Chapter 8.

2) The stems of all valves shall be tested a hundred percent.

b. Test procedure shall conform to ASME Sec.V and ASME B 16.34, Mandatory Appendix Ⅳ.

c. Acceptance standards shall conform to ASME B 16.34, Mandatory Appendix Ⅳ

4.2.4 Retest

Parts rejected dafter testing shall be repaired and each related part shall be tested again in accordance with the corresponding test method and procedure.

4.2.5 Submittal of test results The contractor shall submit to the purchaser the test results in the test and inspection report (together with accompanying drawings with sketched test areas.)

4.3 Dimensional Check

All manufactured valves shall be checked and the major dimensions shall be checked against the related specifications and manufacturing drawings.

4.4 Visual Inspection

All valves shall be checked if there is any harmful scratch, crack, crease, shrinkage, protrusion, surface discontinuity, casting sand, or rust in accordance with MSS-SP-55 and shall be checked if there is any scratch, undercut, or 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

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

4.6 Operation test

The operation test of manufactured valves shall be performed 15 times or more. The first 5 tests shall be performed without any pressure and the remaining 10 tests shall be performed at normal working pressure to confirm the normal operation. And the operation test shall be performed again at the normal differential pressure for 1 time or more and the applied force shall not exceed a maximum of 245 N (25㎏f)

4.7 Pressure and pneumatic tests

All manufactured valves shall be tested to check the strength and tightness of valves in accordance with API 598 as follows 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 prepared to prevent applying any pressure to the valve bodies during the process of shutting off valve inlets and outlets for the pressure and pneumatic tests.

4.7.1 Pressure test

Item	Shell Pressure Test	Low Pressure Closure Test	High Pressure Closure Test
Test Media	Test media approved as volatile fluid such as kerosene, methanol, alcohol, etc.	dry air or nitrogen	Test media approved as volatile fluid such as kerosene, methanol alcohol, etc.
Test Pressure	1.5 times the maximum working pressure at 38℃ (100℃F) specified in ASME B16.34, Table2-2.1B, 2.2B (special class) (valve slightly open)	0.7 ㎫ (7 bar) (valve closed)	1.1 times the maximum working pressure at 38℃ (100°F) specified in ASME B16.34, Table 2-2.1B, 2.2B (special class) (valve closed)
Test Time	5 minutes minimum	5 minutes minimum (bubble test)	5 minutes minimum
Test Method	Completely tighten the packing gland	Completely tighten the packing gland	Completely tighten the packing gland.
Acceptance Standard	No external leak	No visible leak	No visible leak

* Closure tests shall be performed by applying pressure upstream of the flow direction and by checking downstream if there is any leak.
* Standard class ratings of ASME B16.34 shall be used for flanged end type valves only. (For control valve only)

4.7.2 Back seat test

Item	High Pressure Back Seat Test	Low Pressure Back Seat Test
Test Media	Approved as volatile fluid such as kerosene, methanol, alcohol etc.	Dry air or nitrogen
Test Pressure	1.1 times the maximum working pressure at 38℃ (100°F) specified in ASME B16.34, Table 2-2.1B and 2.2B (special class) (full open)	0.7 ㎫ (7 bar) (full open)
Test Method	Loosen the packing gland.	Loosen the packing gland.
Test Time	5 minutes minimum	5 minutes minimum
Acceptance Standards	No leak through the packing gland.	No leak through the packing gland.

* Standard class ratings of ASME B16.34 shall be used for flanged end type valves only. (For control valve only)

4.7.3 High-pressure pneumatic shell test

This test shall be performed after completing the shell pressure test. The test media shall be either nitrogen or dry air. The test shall be performed with the valve slightly open at 1.1 times the normal working pressure of the valve for a minimum of 5 minutes and there shall be no leakage at the valve exterior.

4.8 Fire Safe Test

This test may be replaced by the submittal of the certificates issued in accordance with API 6FA.

4.9 Cryogenic Test

Cryogenic tests shall be performed as follows. Any items not covered herein shall be in accordance with BS 6364, Appendix A.

4.9.1 Test scope

a. Five (5%) of all valves for each valve class (bore size and pressure) shall be sampled and cryogenic-tested (a minimum of 1 valve). [However, all the valves for emergency shut down (ESD) shall be tested a hundred percent.]

b. In case the test result fails to satisfy the requirements, 10% of the related class shall additionally be sampled and tested. In case the test results fails again to satisfy the requirements, the whole lot of the related valve class shall be rejected. (Satisfaction of cryogenic test requirements means that the test results of initial proving test, cryogenic performance test, ambient temperature restoration test, and disassembly test satisfy their corresponding standards.)

4.9.2 Test procedure

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

a. Initial proving test

This is a test to confirm the tightness of valves at ambient temperature and shall be performed with valves closed as follows

1) Test temperature : Ambient temperature
2) Test medium : Helium gas
3) Test pressure : 1.1 times the normal working pressure of the valve
4) Test time : 5 minutes
5) Allowable leakage : No visible leaks

6) Pressurization in steps shall be performed as follows

Valve Pressure Class	Pressurization at Each Step, MPa (bar)	Holding Time for Each Step (minutes)	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 (10.0)	10	
Class 800 and over	2.0 (20.0)	10	

b. Cryogenic performance test

1) Test preparation

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

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

(c) Cool down the valve by submerging the valve body, bonnet, and upper end of connection part in the liquefied nitrogen container. Purge the valve inside with helium gas during cool-down process and check the temperatures of the inside and outside of the valve body, bonnet, and gland housing.

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

2) Kind and methods of tests

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

(a) Cryogenic pressure test

The test medium shall be helium gas. The valve shall be tested with the plug slightly opened at 1.1 times the normal pressure of the valve for 15minutes. There shall be no leakage on the valve outside surface (packing gland, valve body, bonnet connection parts).

(b) Cryogenic operation test

The valve shall be opened and closed 1 time or more at the differential pressure condition of the normal working pressure at the cryogenic temperature of -196℃, and the applied forces at the end tip of operating

device shall be measured and recorded. [Acceptance standard: 245㎫ (25 ㎏f) and under].

(c) Cryogenic pneumatic test

Right after the cryogenic operation test, the test shall be performed in accordance with the initial proving test procedure in above 4.9.2 a. at the temperature of −196℃, and the allowable leakage shall be 5 normal ㎤/(min·inch) for the nominal diameter of the valve.

c. Ambient temperature restoration test

After completion of cryogenic tests and when the valve temperature is returned to the ambient temperature, the following tests shall be performed

1) Pneumatic test at ambient temperature

Valve leakage shall be checked by the same method of the initial proving test in 4.9.2 a. The maximum allowable leakage for each valve size shall conform to API 598 Table 5.

2) Operation test

The valve shall be opened and closed 1 time or more at the differential pressure condition of normal working pressure. And the applied forces at the end tip of operating device shall be measured and recorded at the time of open/close operation [acceptance standard : 245 N (25㎏f) and under] and 5 times more at the normal operating pressure without the differential pressure.

d. Disassembly test

After the completion of the ambient temperature restoration test, the valve shall be disassembled in a clean place and checked for easiness of disassembly, and any damage and wear of its parts.

e. Final pneumatic test and back seat test

After the completion of the disassembly test, the valve shall be reassembled and final pneumatic test and back seat test shall be performed in accordance with the low pressure closure test and high pressure closure test in 4.7.1 and the back seat test in 4.7.2.

4.9.3 Submittal of test results

After the cryogenic test, the test report including following contents shall be submitted to the purchaser:

a. Result of initial proving test at ambient temperature [4.9.2 a.]

b. Bolting torque of the valve body, the bonnet, and the gland [4.9.2 b. 1) (a)]

c. Temperature measurement result at cryogenic temperature [4.9.2 b. 1) (c)]

d. Pressure test result at cryogenic temperature [4.9.2 b. 2) (a)]
e. Operation(open/close) test result at cryogenic temperature [4.9.2 b. 2) (b)]
f. Pneumatic test result at cryogenic temperature at each step of pressure [4.9.2 b. 2) (c)]
g. Pneumatic test result after restoration to ambient temperature [4.9.2 c. 1)]
h. Operation(open/close) test result after restoration to ambient temperature [4.9.2 c. 2)]
i. Conditions of valve parts after the cryogenic tests [4.9.2.d.]

5. MARKING

5.1 Markings on the valve body shall conform to API 6D Sec.6 and the flow direction shall be marked also.
"LT" shall be marked in the upper or lower place of the flow direction marking (at the center of body).

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

5.3 The open/close directions of the valve shall be marked.

6. PACKING

6.1 Valves shall be packed in their closed position to prevent any damage.

6.2 Welded valves shall be covered at their end openings with solid covers (caps of wood, plastic, or metal) to prevent any damage and the ingress of foreign materials and to protect the valve ends during transportation and storage.

6.3 Flange valves shall be covered with flange covers to prevent any damage to flange faces and valve interior.

6.4 All valve shall be packed with polyethylene sheets with moisture absorbent inside to prevent any ingress of moisture and contaminants. (However, ocean-freighted valves shall be packed in sealed condition to prevent corrosion.)

6.5 Valves shall be delivered in plastic or wooden packing to prevent any damage during transportation and storage. Tag numbers shall be attached so that the contents can be identified in detail from the outside.

6.6 Valves shall be supported in a proper way to keep them fixed safe 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 All valves shall be inspected and stamped by Korea Gas Safety Corporation.

7.2 The contractor shall submit to the purchaser the drawings specified with materials and dimensions and get hit his approval prior to manufacturing the valves.

7.3 Items to be witness-tested shall be approved by the purchaser after reviewing the inspection items submitted by the contractor.

7.4 All valve weighing 40㎏ and more shall be provided with lifting lugs, for easy transportation and handling, and may be provided with supporting legs, if necessary. Lifting legs and supporting legs shall be fabricated after the manufacturing drawing specified with dimensions and manufacturing method approved by the purchaser.

7.5 Valves shall be of an anti-static design at between the plug and the stem, and between the stem and the body to prevent static electricity generation between the plug and the stem and from external impacts.

7.6 In case the valve specification is to be modified because of the contractor's specific characteristics, the contractor's specification may be adopted if improved quality is guaranteed.

7.7 All costs and expenses for the test and inspection of valves (including retest and re-inspection) shall be borne by the valve contractor.

7.8 The purchaser shall be entitled to select the kind and submittal schedule of all documents to be submitted in connection with 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 upgrade versions. And all certificates and inspection records to be submitted shall be scanned and converted to ***.jpeg files and submitted in the form of diskettes or CD ROMs during the approval stage of manufacturing drawings and documents.