

# INSTALLATION, OPERATION AND MAINTENANCE MANUAL

FORGED STEEL VALVES

ISO 9001 : 2015 CERTIFICATE

THIRD ISSUED DATE : DEC. 01, 2020

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## 1. Instruction

"It is my great pleasure to introduce SWI Valve Co., Ltd(SWI). And forged steel valves. SWI product forged steel valves since SWI foundation in 1987. SWI valves are only progressed through highly automated machining by skilful specialists. Our products are continually judged for compliance with EN 97/23/EC, API, ASME, MSS and other quality standards, the sophisticated specifications and codes. We thank you for your support and look forward to work as partners as we step into the next century."

## 2. Purpose

This manual covers important directive of installation, operation, maintenance and storage of SWI's forged steel valves. We hope that this manual will help our partners to familiarize with our forged steel valves and make it more convenient to specify and use our products.

## 3. Relevant specification

### 3.1 En Standards

1. EN 12516-1 Valves-Shell design strength-Part 1: Tabulation method for steel valve shells
2. EN 12516-2 Valves-Shell design strength-Part 2: Calculation method for steel valve shells
3. EN 12516-3 Valves-Shell design strength-Part 3: Experimental method
4. EN 1984 Industrial Valves-Steel gate valves
5. EN 13709 Industrial Valves-Steel globe and globe stop and check valves
6. EN 1983 Industrial Steel Ball Valves
7. EN 736-1 Valves-Terminology-Part 1: Definition of types of valves
8. EN 736-2 Valves-Terminology-Part 2: Definition of components of valves
9. EN 736-3 Valves-Terminology-Part 1 : Definition of Terms of valves
10. EN 1092 Flange and their joints, circular flanges for pipes, valves, fittings and accessories PN-designated
11. EN 13445-3 Unfired pressure vessels – Part 3: Design
12. EN 1591-1 Flange and their joints. Design rules for gasket circular flange connection
13. EN 10222-1 Steel forgings for pressure purposes ; Part 1: General Requirements
14. EN 10222-2 Steel forgings for pressure purpose; Part 2: Ferritic and martensitic steels with specified elevated properties.

15. EN 10222-3 Steel forgings for pressure purposes; Part 3: Nickel steels with specified low temperatures.
16. EN 10222-4 Steel forgings for pressure purposes; Part 4: Fine grain steels with high proof stress.
17. EN 10222-5 Steel forgings for pressure purposes; Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.
18. ISO 261 – ISO general purpose metric screw threads-General Plan.

### 3.2 Other national standards

1. API 602 Compact Steel Gate Valves
2. API 598 Valve inspection and Testing
3. ASME B16.5 Pipe flanges and flanged fittings
4. ASME B16.10 Face to Face and End to End dimensions of ferrous valves
5. ASME B16.11 Forged Fittings, Socket-Welding and Threaded
6. ASME B16.34 Valves-Flanged, threaded and welding end
7. ASME Section VIII - Appendix 2 Division 1
8. ASME A105, A182, A276, A350, B462, B164, B408 etc.
9. ASTM A193 or A320

## 4. Safety information



**Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.**



**Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.**



**Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.**

## 5. Types of Valves

### 5.1 Gate Valves

The gate valve is the type of valve most often used in industrial piping. The significant feature of the gate valve is less obstruction to flow with less turbulence within the valve and very little pressure drop. When the valve is wide open, the wedge is lifted entirely out of the waterway, providing a straightway flow area through the valve. The gate valve should be specified when pressure drop is to be avoided. Also, gate valve should never be used for throttling purposes; only in the fully open or closed positions. If kept in an intermediate or partially open position, the bottom of the wedge and seat will become badly eroded in a short time. Also, the wedge will tend to chatter and noise in the line.



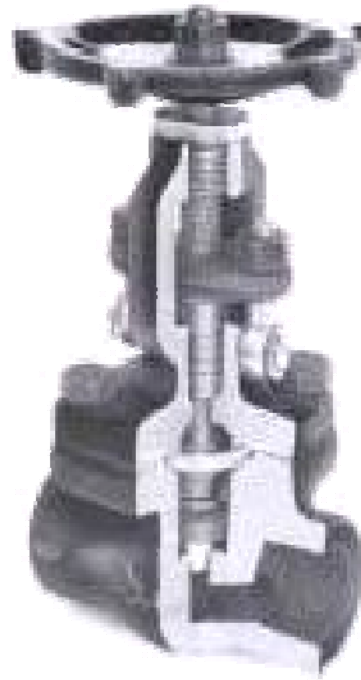
**Figure 1. Gate valve**



**Gate valve shall be used either in the fully open or fully closed position.  
Gate valve shall not be used for flux control and viscosity fluid.**

## 5.2 Globe Valves

The globe valve is used principally in throttling service to control the flow to any desired degree. Advantages of the globe valves are efficient throttling, with minimum wire drawing or disc and seat erosion. As the valve seat is parallel to the line of flow, globe valves are not recommended where resistance to flow and pressure drop are unwanted because the design of the valve body changes the direction of flow and cause turbulence and pressure drop within the valve. The shorter disc travel and the fewer turns to open and close this valve saves time and wear on the valve stem and bonnet. In most globe valves seat and disc can be repaired without removing the valve from the line.



**Figure 2. Globe valve**



**Globe valve shall not be used for very small flux control.**  
**Globe valve shall not be used for on-off.**

### 5.3 Lift check valves

The lift check valve is automatic valve that prevent return or reverse flow on process. The lift check, companion for the globe valve, works automatically by line pressure. These valves should be installed in the horizontal position only and the pressure must be under the disc for the valve to operate. The vertical lift check is designed for working automatically on upward flow only. This valve must be installed with the pressure under the disc and the inlet end of the valve down.



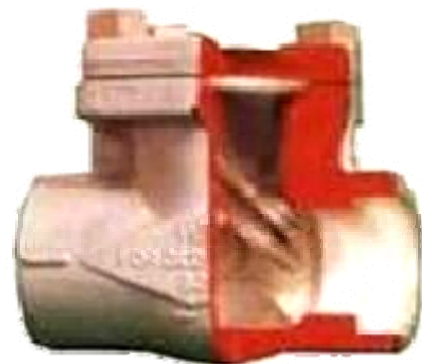
**Figure 3. Lift check valve**



**Lift check valve shall be used in the horizontal position and should not be used in the vertical position except spring lift check valve.**

### 5.4 Swing check valves

The swing check, companion for the gate valve, works automatically. When the disc is wide open, a straightway flow area with the least amount of obstruction is provided. Turbulence and pressure drop within the valve are very low. Pressure must be under the disc for the valve to function properly. When the flow reverses, the reversal pressure and weight of the disc closes the against the seat stopping all backflow. These valves may be regarded as safety or precautionary equipment.



**Figure 4. Swing check valve**



**Swing check valve shall be used in the horizontal position and should not be used in the vertical position.**

### 5.5 Ball valves

The ball valve is used in many of the processing industries. These valves are quick opening and closing. They also provided a very tight closure on hard to hold fluids. Ball valves are non-sticking and pressure drop through the valve is reduced to a minimum due to the full pipe size opening the ball.



**Figure 5. Ball valve**



**Ball valve with soft seats shall not be used at high temperature. (above 180°C)**



**5.6 Bellows valves**

The bellows valve shows how the escape to atmosphere of gas or fluid is completely prevented. The conventional stem packing is replaced by a flexible metallic membrane and all possible leakage paths via the stem or body/bonnet joints are welded. The bellows used in these valves are lift-cycle tested. They satisfy and far exceed the life, temperature and pressure requirements of BS5352. As the back seat is fully protected from the line fluid by the bellows and atmospheric pollution by the stem baffle, it is permanently maintained in a new condition, thereby providing a consistently high standard of sealing in an emergency. The bellows gate valves should be used in the main for low and medium pressure steam, steam tracing lines and for services such as heat transfer etc. The bellows globe valves should be used for medium and high pressure steam where safety is involved in the isolation of vessels. They should also be used for handling toxic or explosive media and in every case where there is any question of flow regulation.



**Figure 6. Bellows gate valve**

**Figure 7. Bellows globe valve**



**Bellows valve has to be used with condition as per C.W.P of name plate.  
C.W.P : Cold Working Pressure**

## **6. Precaution of valves before installation**

**6.1** When valves are to be stored before installation, keep them wrapped and protected as shipped from the manufacturer. If they are unprotected and left exposed, sand or other gritty matter may get into the working parts and if not thoroughly cleaned out, it will cause trouble later on. Also, store valves so that they should not fall or where other heavy material should not fall upon them. Great care should always be exercised in handling valves.

**6.2** The valve shall be checked the pressure and temperature of name plate (Appendix II) and closed tightly before it is installed. Before installation, the inside of valves should be blown out with compressed air or flushed with water to remove all dirt and grit. Piping should be cleaned out in the same manner, or it should be swabbed to remove dirt or metal chips from operations or welding on the pipe.

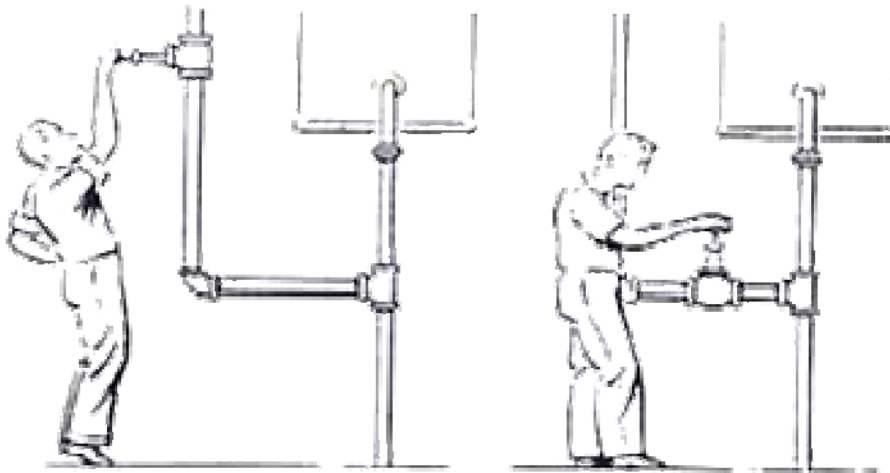


**“Appendix VII Corrosion Tables” shall be used for selection of valve’s material.**

## 7. Installation

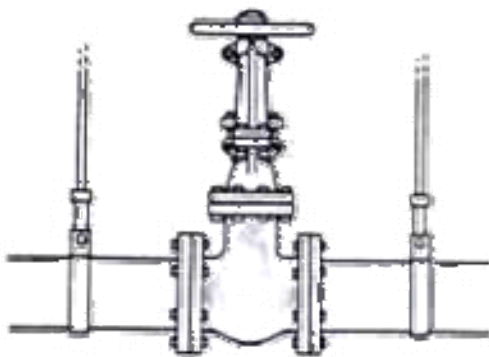
### 7.1 Install location

When should be conveniently located in the line so they can be easily and safely reached, and so the operator can exert just the right amount of force open or close them properly. Keep pipe strains off valves don't let the valves carry the weight in the line.

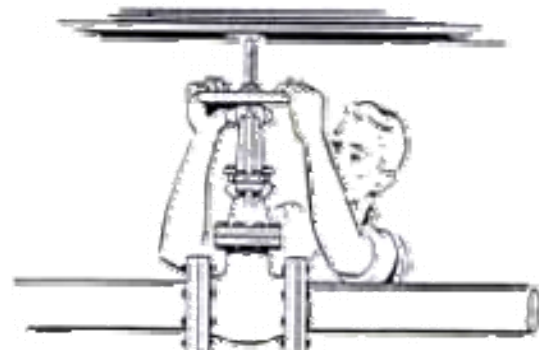


**Figure 8. Locate valves so they can be easily reached.**

Piping should be suspended from hangers placed on each side of the valve to take up the weight, and large heavy valves should be independently suspended. When you installing rising stem valves be sure to allow sufficient clearance to remove stem and bonnet if necessary. Insufficient clearance prevent valves from being fully opened.



**It's good practice to support the line on each side of the valve.**

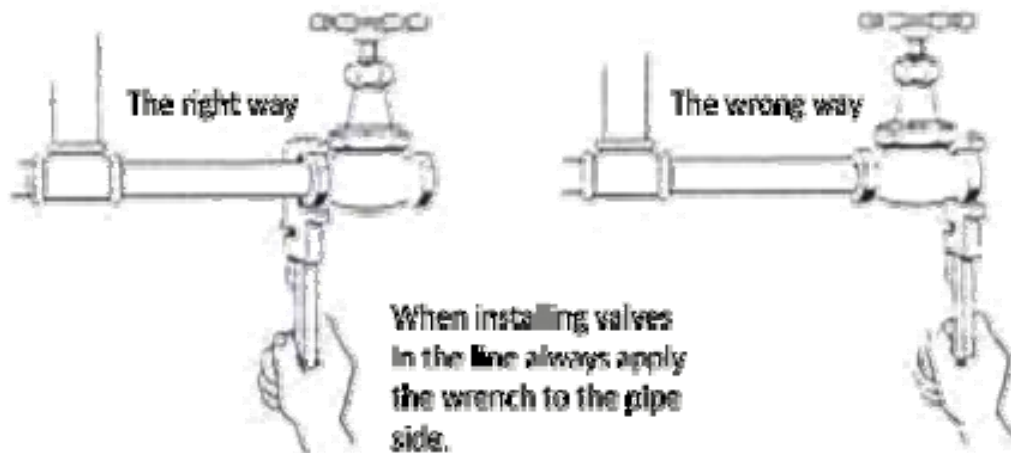


**Plenty of clearance must be provided so rising stem valves can be fully opened.**

**Figure 9. Install Location**

### 7.2 Threads type of valves installation

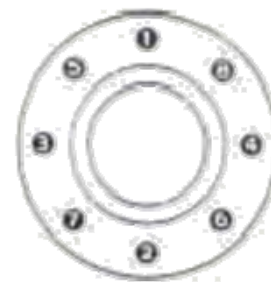
When installing threaded end valves always use the proper size wrenches with flat jaws. All pipe threads in valve bodies are gauged to standard tolerances.



**Figure 10. Threads type of valves installation.**

### 7.3 Flange type of valves installation

On flanged valves and fittings the flange bolts should be tightened by pulling down the nuts diametrically opposite each other and in the order as numbered as following Figure 11.



**Figure 11. Flange**

#### 7.4 Socket welded type of valves installation

All welding end of valves must be carefully checked for proper condition and the disc and seat must be properly protected from the spatters when welding the backing ring. It is important that the valve is kept partially open during the welding and the PWHT, but the valve must be fully closed again after completion.

PWHT should be in accordance with the accepted standard procedures for the particular involved however the local PWHT for welded areas should be made in order to avoid the rise in temperature of the valve elements.

#### 7.5 Socket welded type of ball valves installation

1. Provide the ample clearance for valves maintain and remove valve internal parts.
2. Spot weld the valve into the piping.
3. Remove the 3ea connector bolt and the other 1ea bolt remain but lose.
4. Swing out the centre section(body) with the valve in open position.
5. Secure the seat rings against falling out (e.g. with tape).
6. After completion of welding operation, swing back the centre section (body), tighten the 4ea bolts with equally distributed load.



WARNING

- \* **The installer and welder is authorized by personnel qualification procedure.**
- \* **The weld rod should be the same to material of valve body and stored proper condition.**
- \* **The installer must be put on personal protective devise.**  
(Ex. Safety helmet, protection glasses, safety clothes, safety shoes, gloves etc.)



CAUTION

- \* **Cryogenic valve shall be installed with the stem oriented from 45° to 90° above the horizontal plane.**

## 8. Operation

**8.1** Before the valve is put into operation, the drain valve must be fully opened for complete draining because the condensed fluid deposited in the valve body while warming up the piping line can be a cause for leakage resulted from irregular of seating elements. It is preferable, therefore, to provide a drain-trap or other arrangement where collection of condensation may be expected.

**8.2** Always operate the valve properly and make sure to close the valve tightly.



- \* **The operator is authorized by personnel qualification procedure.**
- \* **Open-Close symbol of hand wheel should be checked.**
- \* **The operator must be put on personal protective devise.**  
(Ex. Safety helmet, protection glasses, safety clothes, safety shoes, gloves etc.)



- \* **For cryogenic valve, valve surface temperature may become extremely cold due to operation condition. Prevent any type of direct contact with the valve that may harm the workers.**

## 9. Maintenance

Construction of the valve have to reference APPENDIX I.

### 9.1 Inspect periodically all critical parts

1. Stem thread
2. Packing and gland
3. Body-Bonnet(Cap) and Body-Connector joint
4. Body-Bonnet(Cap) and Body-Connector surfaces
5. End connection

**9.2** If leakages on stuffing box occur, tighten the gland bolt being careful to maintain perpendicular between stem and gland. Even so, leakage occurs. It is necessary to repacking. The repacking operation shall be performed as per paragraph 10.1.

**9.3** If leakage on Body-Bonnet (cap) and Body-Connector joint. It is necessary to re-gasket. The re-gasket operation shall be performed as per paragraph 10.2

**9.4** Except paragraph 9.2, 9.3, the leakage and non-operation valve have to change.

**9.5** The repacking of Ball valve shall be performed as per paragraph 10.3

**9.6** The re-gasket and reseal of ball valve shall be performed as per paragraph 10.4

**9.7** If leakage on seat of valve occur, The valve shall be replaced.



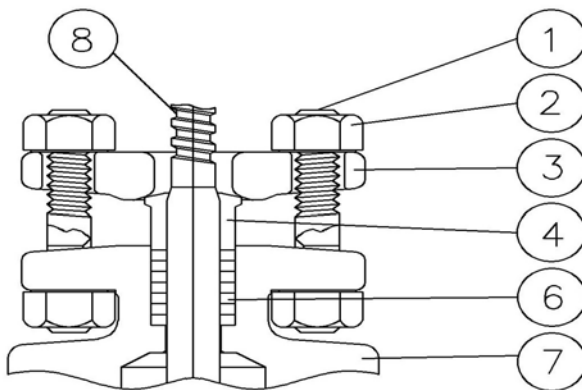
WARNING

- \* The repair operator trained personnel and use proper tools.
  - \* For repair operation. Remove the pressure and fluid of piping, the valve remove from the piping.
  - \* The repair space shall be clean and lighted area.
  - \* Before reinstallation, the repaired valve is tested as per APPENDIX III.
  - \* The repair operator must be put on personal protective devise.
- (Ex. Safety helmet, protection glasses, safety clothes, safety shoes, gloves etc.)

## 10. Repair

For repair operation, construction of the valve have to reference APPENDIX I. Repair parts shall be prepared as per APPENDIX V and VI.

### 10.1 Repacking of gate and globe valves

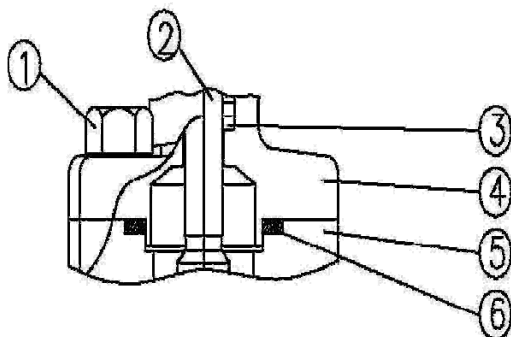


- a) Remove the gland nut(②).
- b) Lift the gland flange(③) and gland(④).
- c) Remove the old gland packing (⑥) with proper tools. (Care shall be taken to avoid scratching the stem or stuffing box surfaces.)
- d) Insert new ⑥ gland packing, one at a time. Stagger should be each joint 90° to 120° (90° is acceptable/ 120° is optimal) with valve.

e) Install the gland(④) and gland flange(③). Install the gland bolt(①) and nut(②). Tighten the gland nut(②) with torque wrench to specified torque (See Appendix V Bolting Torque Table For Gland )

**Figure 12. Packing Area**

### 10.2 Re-gasket of gate, globe and check valves



- a) Open the valves properly.
- b) Remove the bonnet/cap bolt(②) with proper tools.
- c) Lift the bonnet/cap(④).
- d) Remove the old gasket(⑥).
- e) Insert the new gasket(⑥).

f) Reassembly the bonnet/cap(④) and bonnet/cap bolt(②) with torque wrench to specified torque (See Appendix VI Bolting Torque Table For Bonnet).

**Figure 13. Gasket Area**



### 10.3 Seat of gate, globe and check valves

Seat of valves cannot be replaced.

**\*\* Bolting Torque Table for Gland & Bonnet shall be attached on Appendix V & VI**

### 10.4 Repacking of ball valves

**Reference APPENDIX I-Figure 27 & 28**

- a) Remove the pressure in the piping
- b) Remove stem nut, nameplate, lever, stop plate and gland with proper tools.
- c) Remove old packing.
- d) Insert new packing.
- e) Reassembly gland, stem nut, stop plate, lever and name plate with proper tools.

### 10.5 Reseat ring, gasket and ball of ball valves

**Reference APPENDIX I-Figure 27 & 28**

- a) Remove the pressure in the piping
- b) Remove connector bolt 3ea and remain connector bolt 1ea but lose
- c) Turn connector remove old packing.
- d) Remove old seat ring, gasket and ball.
- e) Insert new seat ring, gasket and ball
- f) Reassembly body, connector and connector bolt with proper tools.

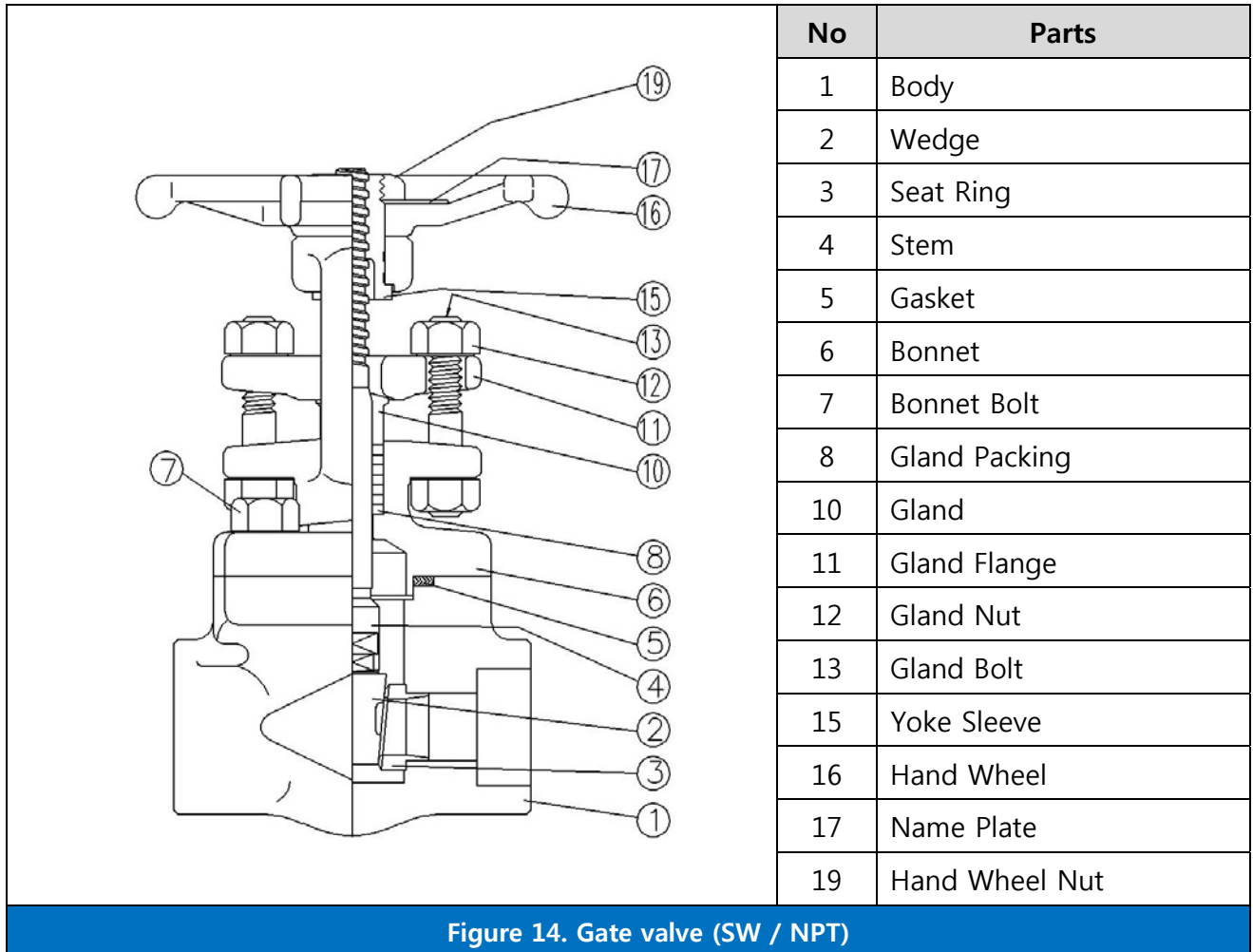


- \* **The repair operator trained personnel and use proper tools.**
- \* **For repair operation. Remove the pressure and fluid of piping, the valve remove from the piping.**
- \* **The repair space shall be clean and lighted area.**
- \* **Lubricate stem and bolt thread with proper grease.**  
**Stem: EX. Shell Darina R2, Mobil Grease 1 Synthetic Grease**  
**Bolt: EX. Never-Seez, Mobil Grease 1 Synthetic Grease**
- \* **Before reinstallation, the repaired valve is tested as per APPENDIX III.**
- \* **The repair operator must be put on personal protective devise.**  
**(Ex. Safety helmet, protection glasses, safety clothes, safety shoes, gloves etc.)**

## 11. Storage on site

Store should be always clean and dry. Only permitted worker should be allowed to enter the site. Check up the storage conditions often. The valve should be protected from wild animals like a mouse etc. All valves should be prevented from the chemical materials such as food, drink and salt as well as from the hazard chemicals, paint, solvent etc. If stored outside, the valves should be covered with a waterproof. It is necessary make the drainage equipment furnished in order to keep the site dry. It is good for the valves to be tagged with mark for the distinction.

**Appendix I Construction of valves**



**Figure 14. Gate valve (SW / NPT)**

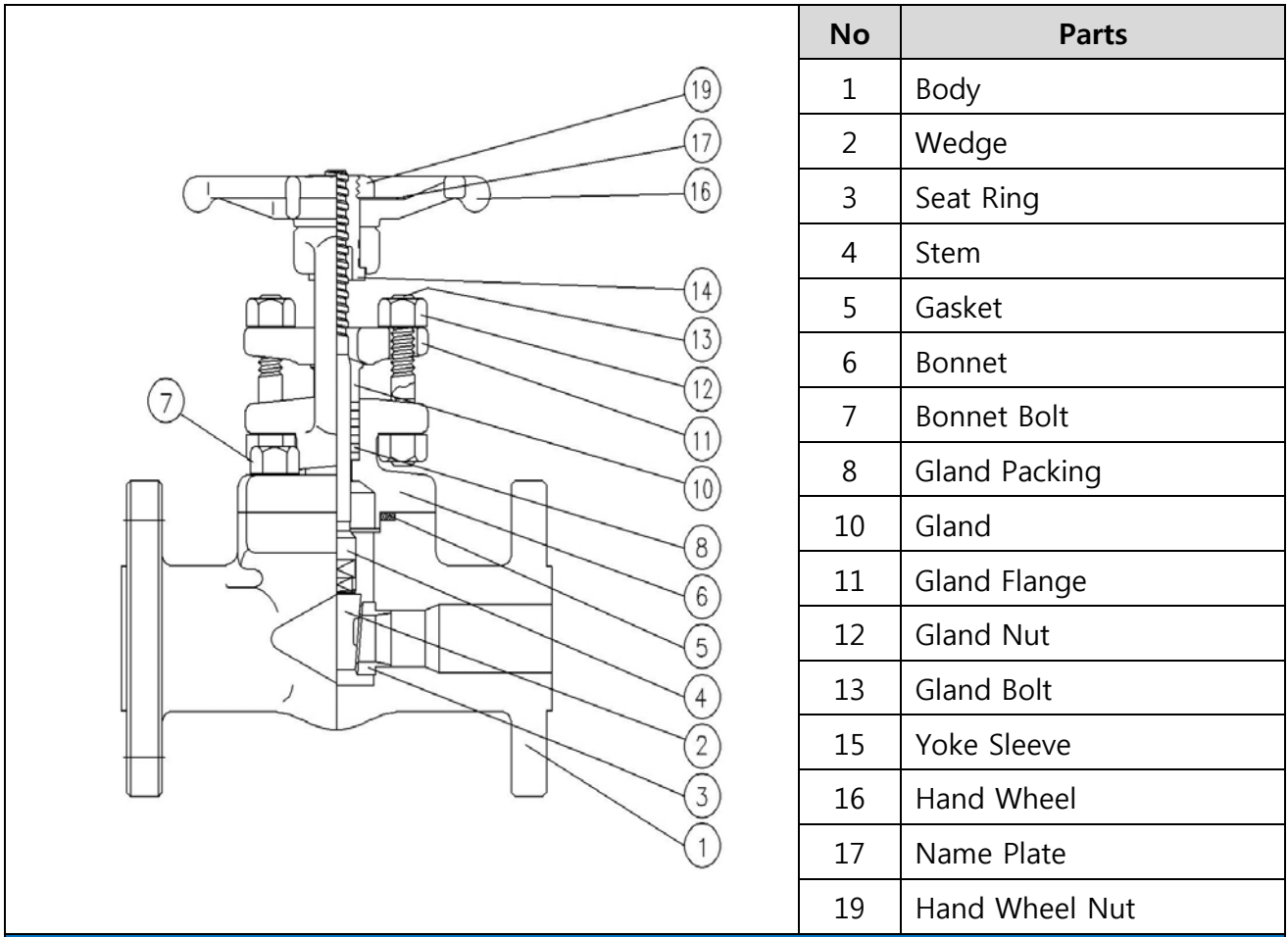
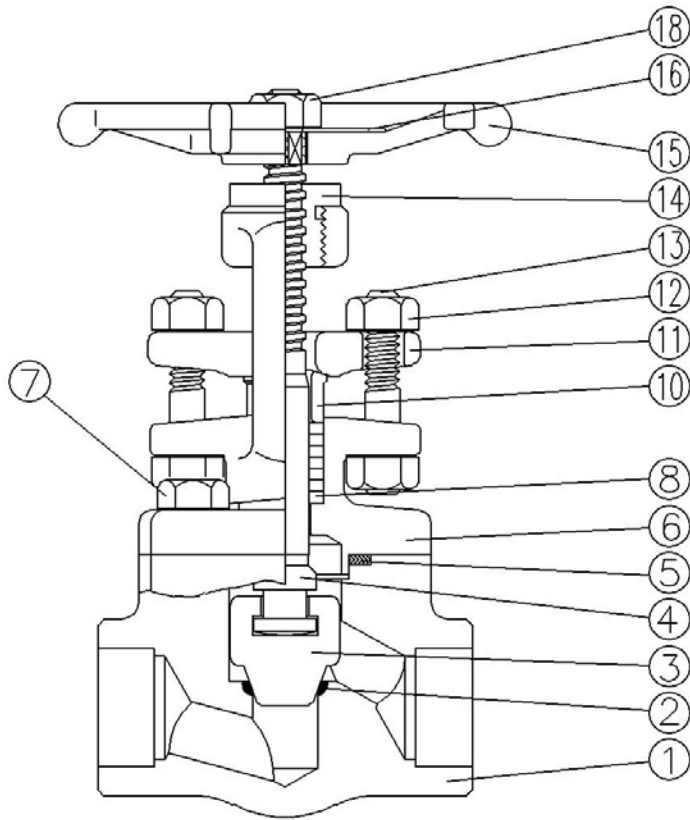
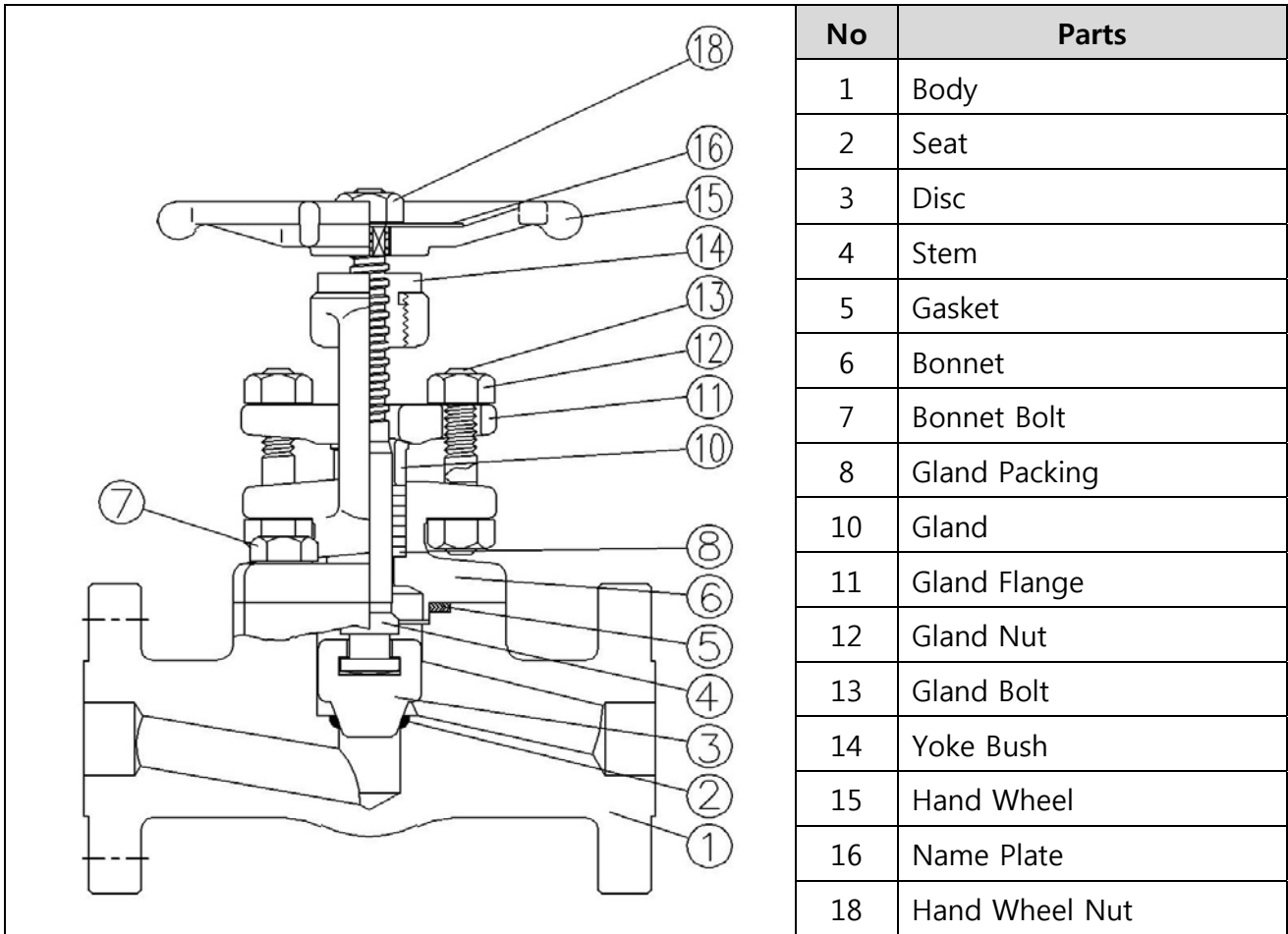


Figure 15. Gate valve (RF / FF / RTJ)

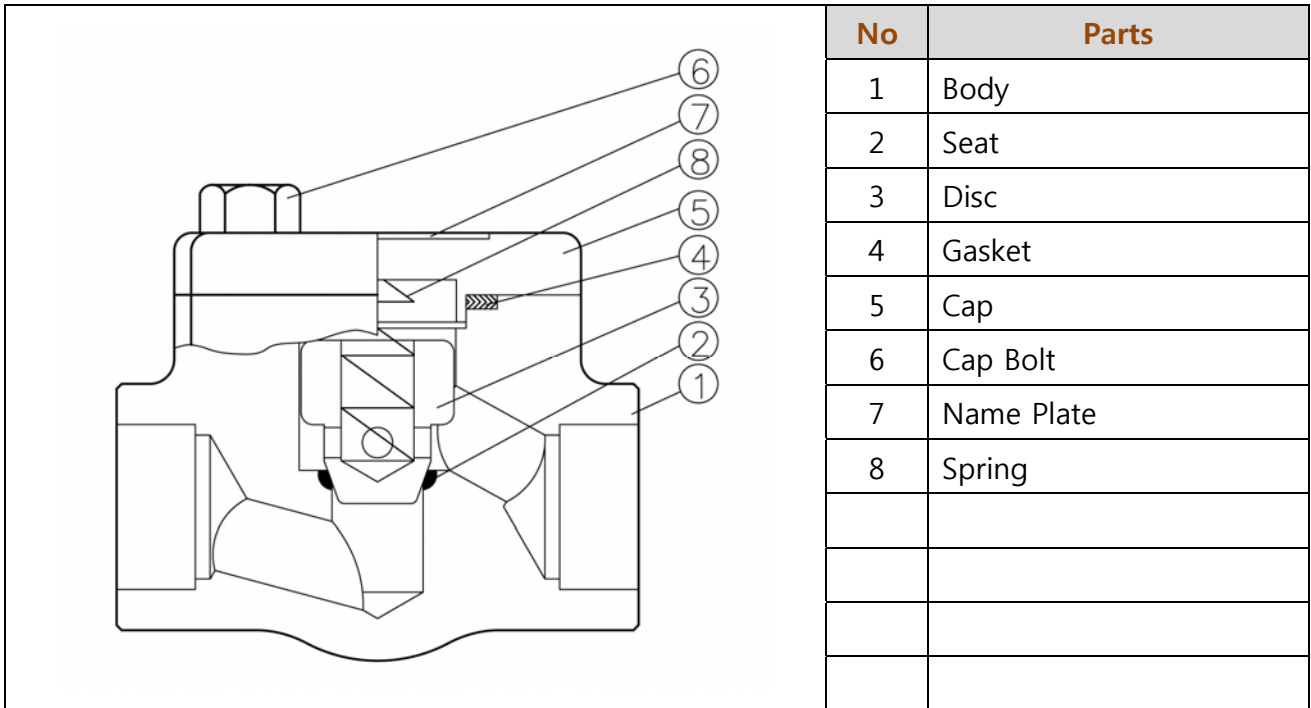


No	Parts
1	Body
2	Seat
3	Disc
4	Stem
5	Gasket
6	Bonnet
7	Bonnet Bolt
8	Gland Packing
10	Gland
11	Gland Flange
12	Gland Nut
13	Gland Bolt
14	Yoke Bush
15	Hand Wheel
16	Name Plate
18	Hand Wheel Nut

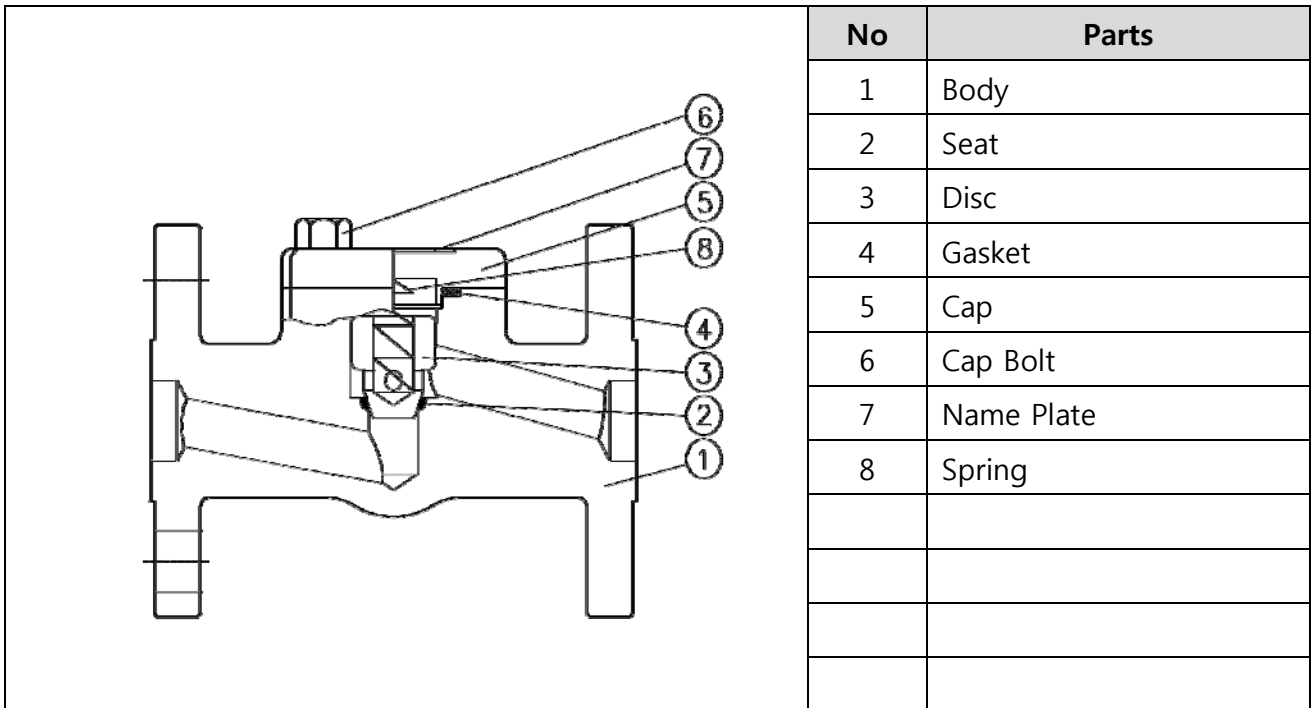
**Figure 16. Globe valve (SW / NPT)**



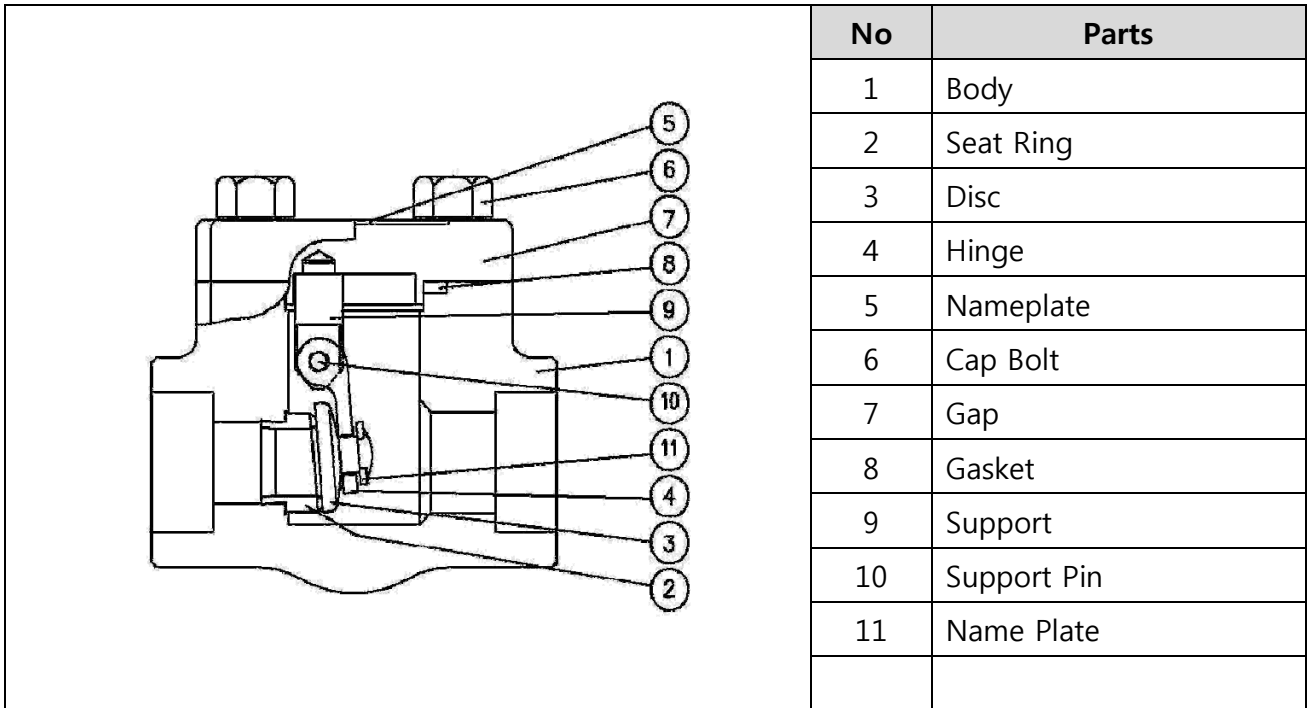
**Figure 17. Globe valve (RF / FF / RTJ)**



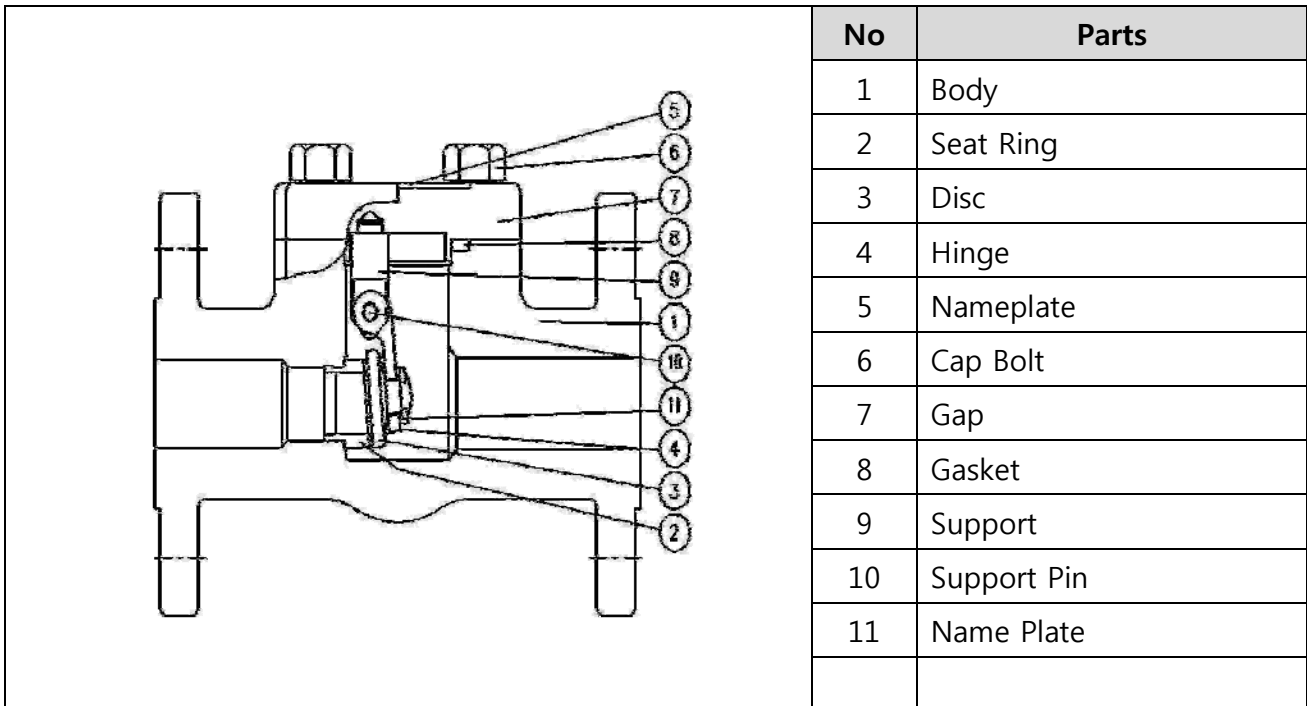
**Figure 18. Lift check valve (SW / NPT)**



**Figure 19. Lift check valve (RF / FF / RTJ)**

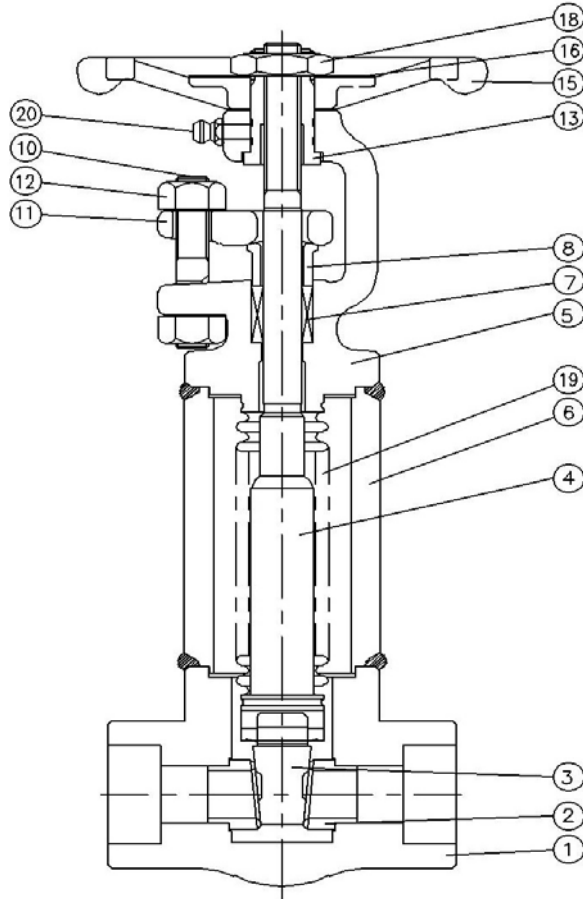


**Figure 20. Swing check valve (SW / NPT)**



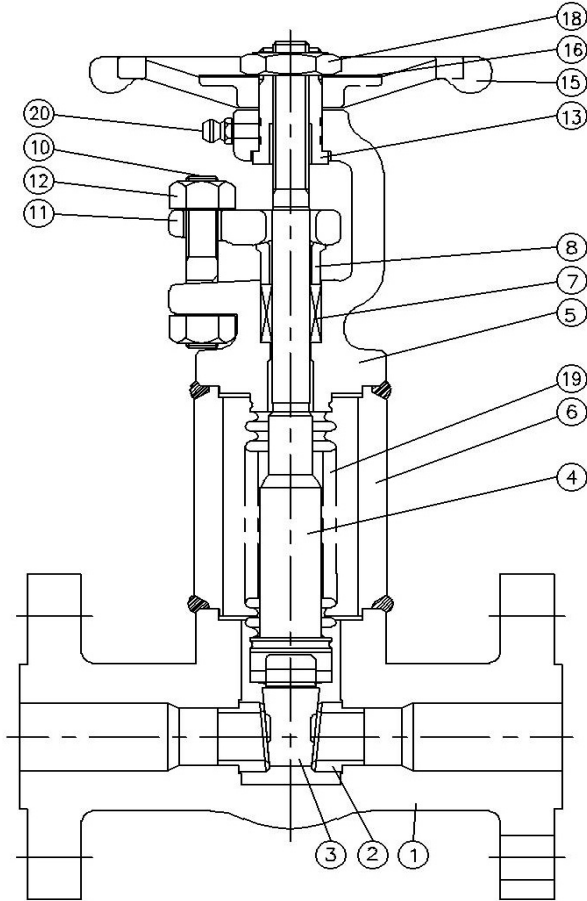
**Figure 21. Swing check valve (RF / FF / RTJ)**





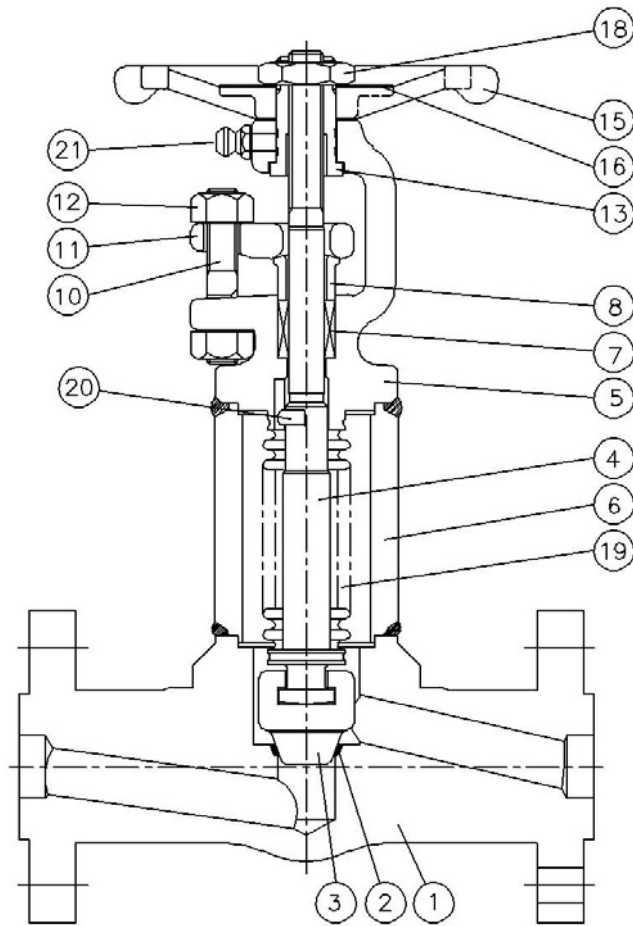
No	Parts
1	Body
2	Seat Ring
3	Wedge
4	Stem
5	Bonnet
6	Connector
7	Gland Packing
8	Gland
10	Gland Bolt
11	Gland Flange
12	Gland Nut
13	Yoke Sleeve
15	Hand Wheel
16	Name Plate
18	Hand Wheel Nut
19	Bellows
20	Grease Nipple

**Figure 22. Bellows gate valve (SW / NPT)**



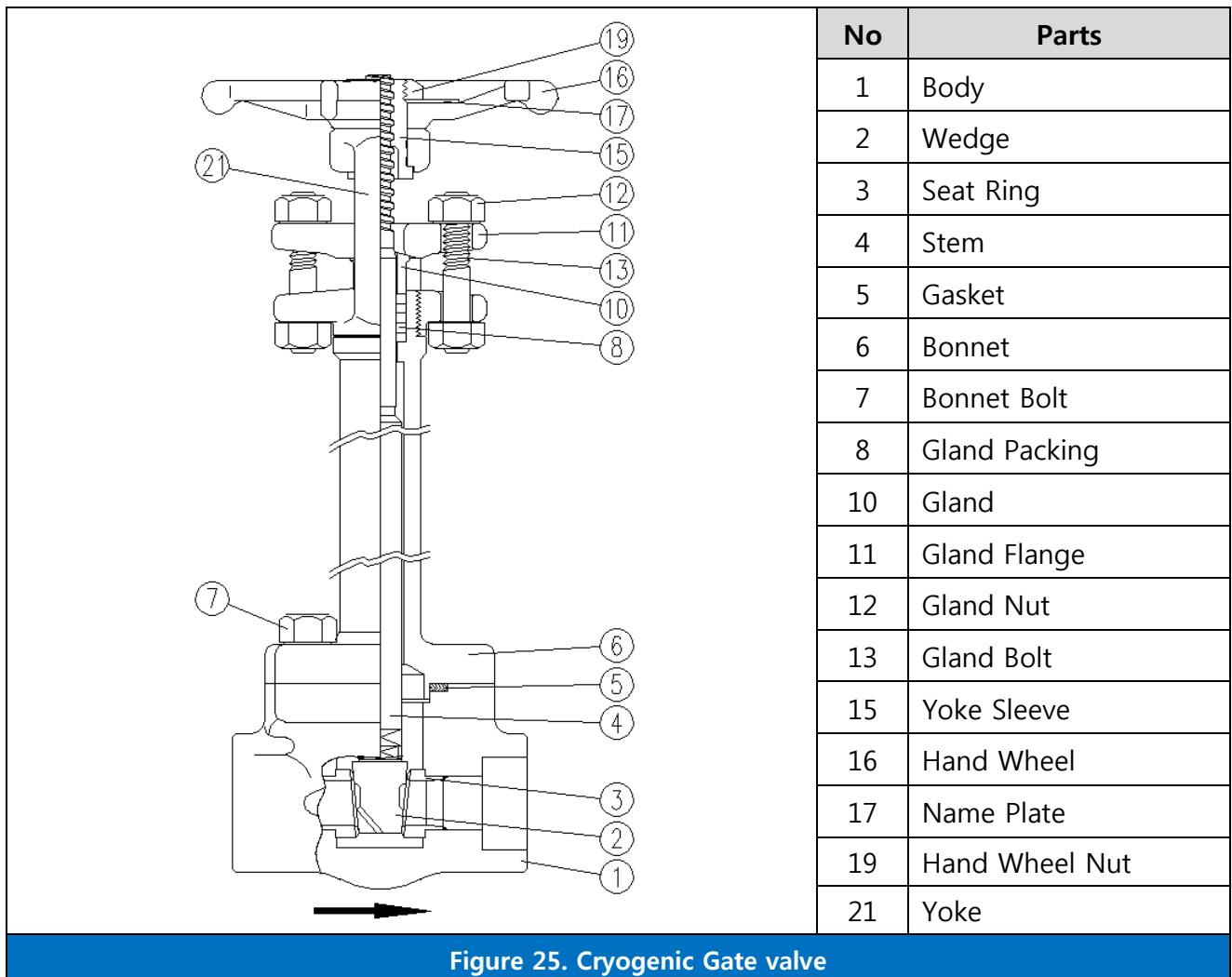
No	Parts
1	Body
2	Seat Ring
3	Wedge
4	Stem
5	Bonnet
6	Connector
7	Gland Packing
8	Gland
10	Gland Bolt
11	Gland Flange
12	Gland Nut
13	Yoke Sleeve
15	Hand Wheel
16	Name Plate
18	Hand Wheel Nut
19	Bellows
20	Grease Nipple

**Figure 23. Bellows gate valve (RF / FF/ RJT)**



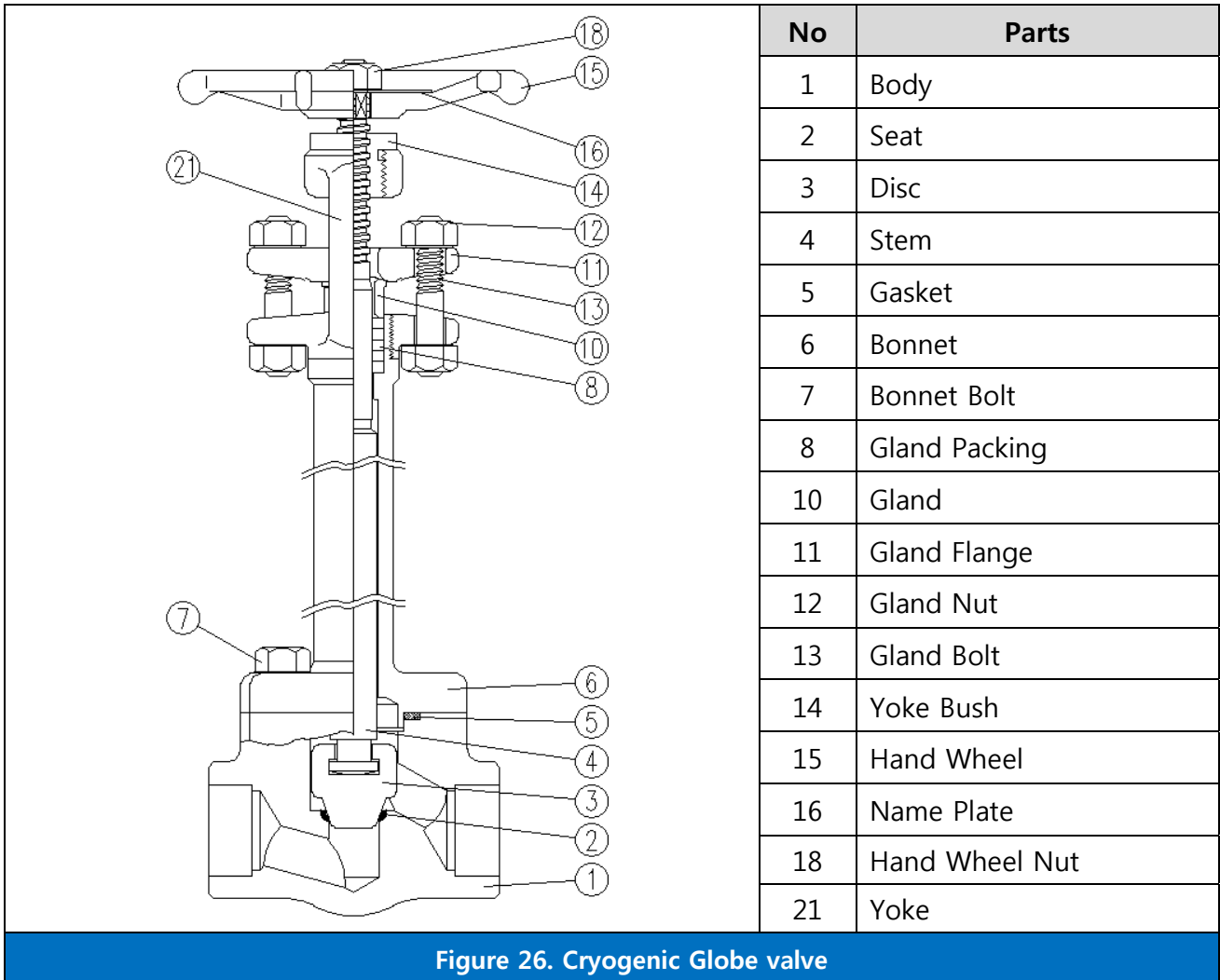
No	Parts
1	Body
2	Seat
3	Disc
4	Stem
5	Bonnet
6	Connector
7	Gland Packing
8	Gland
10	Gland Bolt
11	Gland Flange
12	Gland Nut
13	Yoke Sleeve
15	Hand Wheel
16	Name Plate
18	Hand Wheel Nut
19	Bellows
20	Guide Pin
21	Grease Nipple

**Figure 24. Bellows globe valve (RF / FF/ RJT)**

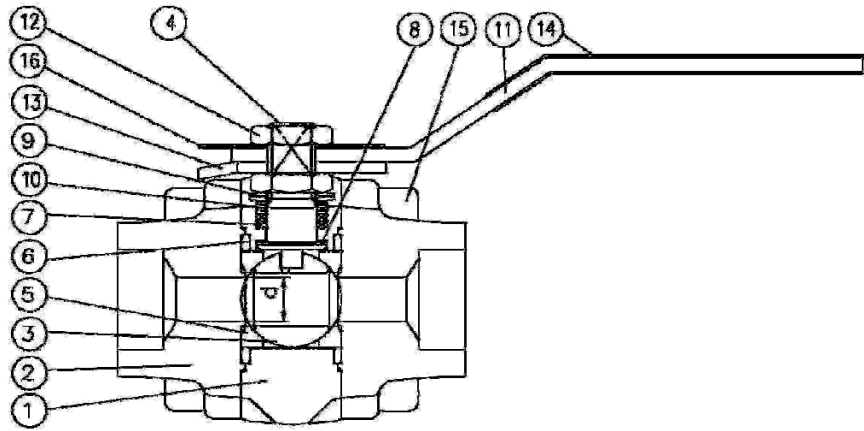


\* Note

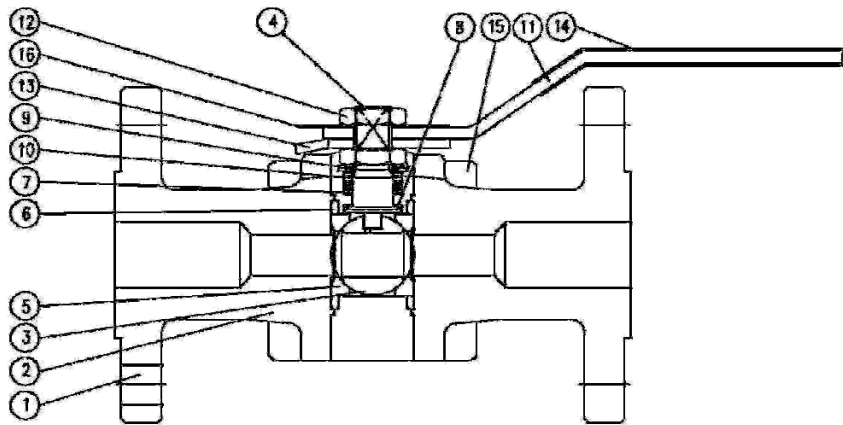
- Uni-Directional
- Cavity relief hole to be provided to upstream



**Figure 26. Cryogenic Globe valve**



**Figure 27. Ball valve (SW / NPT)**



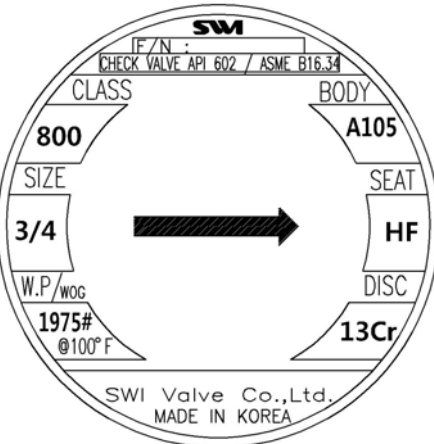



**Figure 28. Ball valve (RF / FF / RTJ)**

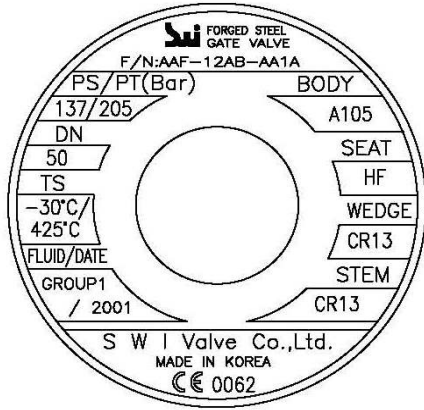
No.	Parts	No.	Parts
1	Body	9	Disc Spring
2	Connector	10	Gland
3	Ball	11	Lever
4	Stem	12	Stem Nut
5	Seat Ring	13	Stop Plate
6	Gasket	14	Lever Sleeve
7	Gland Packing	15	Connector Bolt
8	Thrust Seal	16	Name Plate

**Appendix II Name Plate**

- Standard Nameplate

 <p>A circular nameplate for a Gate Valve or Globe Valve. It features a central circular cutout. The text is arranged in segments around the cutout: 'SWI' at the top; 'F/N : [ ]' and 'GATE VALVE API 602 / ASME B16.34' below it; 'CLASS' and 'BODY' on the left and right respectively; '800' and 'A105' in the next row; 'SIZE' and 'SEAT' in the next row; '3/4' and 'HF' in the next row; 'W.P./WOG' and 'WEDGE' in the next row; '1975#' and '13Cr' in the next row; and '@100°F' and 'STEM' in the bottom row. At the very bottom, it says 'SWI Valve Co., Ltd. MADE IN KOREA'.</p>	 <p>A circular nameplate for a Bellows Valve. It features a central circular cutout. The text is arranged in segments: 'SWI' at the top; 'F/N : [ ]' and 'BELLOWS SEAL PER MSS SP-117/API 602/ASME B16.34' below it; 'TYPE' and 'BODY' on the left and right; 'GATE' and 'A105' in the next row; 'CLASS' and 'SEAT' in the next row; '800' and 'HF' in the next row; 'SIZE' and 'WEDGE' in the next row; '3/4' and '13Cr' in the next row; 'W.P./WOG' and 'STEM' in the next row; '1975#' and '13Cr' in the next row; and '@100°F' and 'BELLOWS' in the bottom row. At the very bottom, it says 'SWI Valve Co., Ltd. MADE IN KOREA'.</p>
<p><b>Gate valve / Globe valve</b></p>	<p><b>Bellows Valve</b></p>
 <p>A circular nameplate for a Check Valve. It features a central rectangular cutout with a thick black arrow pointing to the right. The text is arranged in segments: 'SWI' at the top; 'F/N : [ ]' and 'CHECK VALVE API 602 / ASME B16.34' below it; 'CLASS' and 'BODY' on the left and right; '800' and 'A105' in the next row; 'SIZE' and 'SEAT' in the next row; '3/4' and 'HF' in the next row; 'W.P./WOG' and 'DISC' in the next row; and '1975#' and '13Cr' in the bottom row. At the very bottom, it says 'SWI Valve Co., Ltd. MADE IN KOREA'.</p>	 <p>A circular nameplate for a Ball Valve. It features a central rectangular cutout. The text is arranged in segments: 'SWI' at the top; 'F/N : [ ]' and 'FIN APH-E11AN-AA1A' below it; 'BODY' and 'STEM' on the left and right; 'A105N' and '316' in the next row; 'SIZE' and 'BALL' in the next row; '1' and '316' in the next row; 'CLASS' and 'SEATS' in the next row; '150' and 'R1FE' in the next row; and 'OPEN' and 'SHUT' in the bottom row. At the very bottom, it says 'MADE IN KOREA SWI VALVE CO., LTD. SWI'.</p>
<p><b>Check Valve</b></p>	<p><b>Ball valve</b></p>

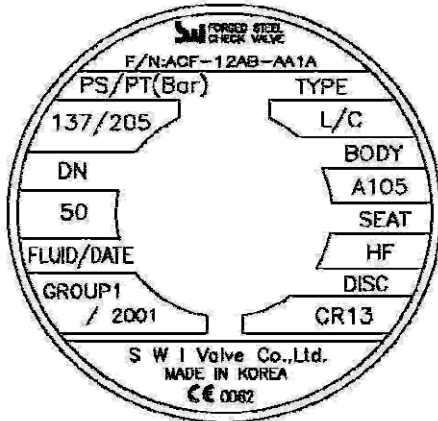
- CE Nameplate



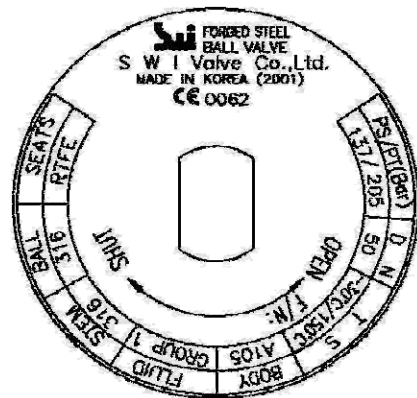
Gate valve / Bellows gate valve



Globe valve / Bellows globe valve



Lift check valve / Swing check valve



Ball valve



## Appendix III Pressure Table

Class	150LB		300LB		600LB		800LB		1500LB	
	Shell	Seat	Shell	Seat	Shell	Seat	Shell	Seat	Shell	Seat
Material	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>	kg/cm <sup>2</sup>
A105N, A350-LF2	32.0	23.0	79.5	58.5	156.5	116.5	209.5	153.0	392.0	288.5
A182-F5, F9, F11, F22	32.0	23.0	79.5	58.5	158.5	116.5	211.0	155.0	395.5	290.5
A182-F304, F316, 321, 347	30.0	23.0	77.5	56.5	153.0	112.5	204.0	149.5	380.0	279.5
A182-F304L, F316L	25.0	19.5	63.5	47.5	127.0	93.5	169.0	125.0	316.5	232.5

Class	150LB		300LB		600LB		800LB		1500LB	
	Shell	Seat	Shell	Seat	Shell	Seat	Shell	Seat	Shell	Seat
Material	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar
A105N, A350-LF2	31.4	22.6	76.0	57.4	153.4	114.2	205.4	150.0	384.2	282.8
A182-F5, F9, F11, F22	31.4	22.6	78.0	57.4	155.4	114.2	206.8	152.0	387.6	284.7
A182-F304, F316, 321, 347	29.4	22.6	76.0	55.4	150.0	110.3	200.0	146.6	372.4	274.0
A182-F304L, F316L	24.5	19.2	62.3	46.6	124.5	91.7	165.7	122.5	310.2	227.9

Note 1 Gate valve air seat test pressure : minimum 6.0 kg/cm<sup>2</sup>(5.9 Bar)

Note 2 Ball valve air seat test pressure : minimum 7.0 kg/cm<sup>2</sup>(6.9 Bar)

## Appendix IV Standard Material Specification

### Standard Material Specification - Gate Valve

No	ASTM Designation	A105N	A350		A182				A182			
	Parts		LF2	LF3	F5	F9	F11	F22	F304	F304L	F316	F316L
1	Body	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
2	Wedge	A217-CA15		A351-CF8M+STL	A217-CA15				A351-CF8M+STL			
3	Seat Ring	A276-410+STL		A276-316+STL	A276-410+STL				A276-316+STL			
4	Stem	A276-410		A276-304	A276-410				A276-304		A276-316	
5	Gasket	304Hoop+Graphite								304L Hoop+ Graphite	316 Hoop+ Graphite	316L Hoop+ Graphite
6	Bonnet	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
7	Bonnet Bolt	A193-B7	A320-L7	A193-B8	A193-B16				A193-B8			
8	Gland Packing	Graphite + Carbon Fiber										
10	Gland	A276-316										
11	Gland Flange	A105		A182-F304	A105				A182-F304			
12	Gland Nut	A194-2H	A194-7						A194-8			
13	Gland Bolt	A193-B7	A320-L7	A193-B8	A193-B16				A193-B8			
14	Yoke Sleeve	A276-410										
15	Handwheel	A47										
16	Nameplate	Aluminium							A240-304			
17	Handwheel Nut	A563A										

## Standard Material Specification - Globe Valve

No	ASTM Designation	A105N	A350		A182				A182			
	Parts		LF2	LF3	F5	F9	F11	F22	F304	F304L	F316	F316L
1	Body	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
2	Seat	Stellite Hardfacing on Body										
3	Disc	A217-CA15	A351-CF8M+STL	A217-CA15				A351-CF8M+STL				
4	Stem	A276-410	A276-304	A276-410				A276-304		A276-316		
5	Gasket	304Hoop+Graphite								304L Hoop+ Graphite	316 Hoop+ Graphite	316L Hoop+ Graphite
6	Bonnet	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
7	Bonnet Bolt	A193-B7	A320-L7	A193-B8	A193-B16				A193-B8			
8	Gland Packing	Graphite + Carbon Fiber										
10	Gland	A276-316										
11	Gland Flange	A105		A182-F304	A105				A182-F304			
12	Gland Nut	A194-2H	A194-7						A194-8			
13	Gland Bolt	A193-B7	A320-L7	A193-B8	A193-B16				A193-B8			
14	Yoke Bush	A276-410										
15	Handwheel	A47										
16	Nameplate	Aluminium							A240-304			
17	Handwheel Nut	A194-2H										

## Standard Material Specification - Lift Check Valve

No	ASTM Designation	A105N	A350		A182				A182			
	Parts		LF2	LF3	F5	F9	F11	F22	F304	F304L	F316	F316L
1	Body	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
2	Seat	Stellite Hardfacing on Body										
3	Disc	A276-410	A276-316+STL	A276-410				A276-316+STL				
	Ball	A276-304								A276-316		
4	Gasket	304Hoop+Graphite							304L Hoop+Graphite	316 Hoop+Graphite	316L Hoop+Graphite	
5	Cap	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
6	Bolt	A193-B7	A320-L7	A193-B8	A193-B16				A193-B8			
7	Nameplate	Aluminium							A240-304			

## Standard Material Specification - Swing Check Valve

No	ASTM Designation	A105N	A350		A182				A182			
	Parts		LF2	LF3	F5	F9	F11	F22	F304	F304L	F316	F316L
1	Body	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
2	Seat Ring	A276-410+ STL		A276-316 +STL	A276-410+ STL				A276-316+STL			
3	Disc	A276-316+STL										
4	Hinge	A351+CF8M										
5	Nameplate	Aluminium							A240-304			
6	Bolt	A193-B7	A320-L7		A193-B16				A193-B8			
7	Cap	A105N	A350-LF2	A350-LF3	A182-F5	A182-F9	A182-F11	A182-F22	A182-F304	A182-F304L	A182-F316	A182-F316L
8	Gasket	304 Hoop+ Graphite							304L Hoop+ Graphite	316 Hoop+ Graphite	316L Hoop+ Graphite	
9	Support	A276-316										
10	Support Pin	A276-316										
11	Retaining Washer	A276-316										

## Standard Material Specification - Cryogenic Gate Valve

No	ASTM Designation	A182			
	Parts	F304	F304L	F316	F316L
1	Body	A182-F304	A182-F304L	A182-F316	A182-F316L
2	Wedge	A351-CF8M+STL			
3	Seat Ring	A276-316+STL			
4	Stem	A276-304		A276-316	
5	Gasket	304 Hoop + Graphite	304L Hoop + Graphite	316 Hoop + Graphite	316L Hoop + Graphite
6	Bonnet	A182-F304	A182-F304L	A182-F316	A182-F316L
7	Bonnet Bolt	A193-B8			
8	Gland Packing	Graphite + Carbon Fiber			
10	Gland	A276-316			
11	Gland Flange	A182-F304			
12	Gland Nut	A194-8			
13	Gland Bolt	A193-B8			
14	Yoke Sleeve	13Cr Stainless Steel			
15	Handwheel	A47			
16	Nameplate	A240-304			
17	Handwheel Nut	A583A			
18	Yoke	A182-F304			

## Standard Material Specification - Cryogenic Globe Valve

No	ASTM Designation	A182			
	Parts	F304	F304L	F316	F316L
1	Body	A182-F304	A182-F304L	A182-F316	A182-F316L
2	Seat	Stellite Hardfacing on Body			
3	Disc	A351-CF8+STL	A351-CF8M+STL		
4	Stem	A276-304	A276-316		
5	Gasket	304 Hoop + Graphite	304L Hoop + Graphite	316 Hoop + Graphite	316L Hoop + Graphite
6	Bonnet	A182-F304	A182-F304L	A182-F316	A182-F316L
7	Bonnet Bolt	A193-B8			
8	Gland Packing	Graphite + Carbon Fiber			
10	Gland	A276-316			
11	Gland Flange	A182-F304			
12	Gland Nut	A194-8			
13	Gland Bolt	A193-B8			
14	Yoke Bush	13Cr Stainless Steel			
15	Handwheel	A47			
16	Nameplate	A240-304			
17	Handwheel Nut	A583A			
18	Yoke	A182-F304			

## Standard Material Specification - Ball Valve

No	ASTM Designation	A105	A182			A350	
	Parts		F304	F316	F316L	LF2	LF3
1	Body	A105	A182-F304	A182-F316	A182-F316L	A350-LF2	A350-LF3
2	Connector	A105	A182-F304	A182-F316	A182-F316L	A350-LF2	A350-LF3
3	Ball	A276-316/A351-CF8M					
4	Stem	A376-316					
5	Seat Ring	Teflon / 15% or 25% Glass Fiber Filled					
6	Gasket	Teflon					
7	Gland Packing	Teflon / Graphite					
8	Thrust Seal	Teflon / 35% Carbon Filled					
9	Disk Spring	Carbon Steel, Galvanized					
10	Gland	A276-316					
11	Lever	A283D (Carbon Steel / Galvanized)					
12	Stem Nut	A563A (Carbon Steel / Galvanized)					
13	Stop Plate	A283D (Carbon Steel / Galvanized)					
14	Lever Sleeve	Vinyl Plastic					
15	Connector Bolt	A193-B7	A193-B8				
16	Name Plate	A240-304					
17	Stop Pin	A276-304					



## Appendix V Bolting Torque Table For Packing

### API VALVE

1. Perform the API 598 shell test after reassembling. After finishing the shell test, loosen the packing to zero load on backseat position. Perform the API 598 backseat test. Tighten the gland nut to final torque load. Perform the API 598 seat test. Verify the final Torque.
2. Within 2weeks of installing the Valve, a facility must check that the packing gland nut torque should be verified per the above table.

-Standard Packing (Non - API 622)

Unit : N-m

Size	Gate		Globe	
	Up to 800#	1500#	Up to 800#	1500#
1/2"	2.7~3.2	4.3~4.9	2.7~3.2	4.2~4.8
3/4"	2.7~3.2	4.3~4.9	3.6~4.2	4.8~5.4
1"	3.6~4.2	10. 0~11.4	4.1~4.8	10.9~12.5
1-1/2"	8.6~10.1	11.0~12.5	9.4~10.9	12.4~14.2
2"	9.4~10.9	11.4~13.1	10.6~12.4	12.4~14.2

-Low Emission Packing (Certified API 622)

Unit : N-m

Size	Gate				Globe			
	Up to 800#		1500#		Up to 800#		1500#	
	Pre-Load	Final Load	Pre-Load	Final Load	Pre-Load	Final Load	Pre-Load	Final Load
1/2"	7.1	5.5	7.1	5.5	7.1	5.5	7.1	5.5
3/4"	7.1	5.5	7.1	5.5	7.1	5.5	8.9	6.8
1"	7.1	5.5	19.0	14.6	8.9	6.8	20.6	15.9
1-1/2"	19.0	14.6	20.6	15.9	20.6	15.9	23.8	18.4
2"	20.6	15.9	21.7	16.7	23.8	18.4	23.8	18.4

**ANSI VALVE**

Unit : N-m

Size	Gate		Globe	
	1500#	2500#	1500#	2500#
1/2"	15.4-17.3	36.3-40.4	15.4-17.3	36.3-40.4
3/4"	22.0-24.4	54.1-60.2	22.0-24.4	54.1-60.2
1"	32.7-36.4	54.1-60.2	32.7-36.4	54.1-60.2
1-1/2"	32.7-36.4	59.9-66.5	32.7-36.4	59.9-66.5
2"	36.2-40.2	91.1-101.1	36.2-40.2	91.1-101.1

## Appendix VI Bolting Torque Table For Bonnet

### 1) Forged Gate / Globe / Check Valve

#### Class 800 & Below

Unit : N-m

Valve Size	R.B	1/2"	3/4"	1"	1.1/2"	2"
	F.B		1/2"	3/4"	1"	1.1/2"
Bolt Size		3/8	3/8	3/8	1/2	5/8
B7/B16/L7		29-34	29-34	29-34	71-85	141-169
B7M/L7M		22-26	22-26	22-26	54-64	107-129
B8(M)-CL.1		8-10	8-10	8-10	20-24	40-48
B8-CL.2		27-32	27-32	27-32	67-81	134-161
B8M-CL.2		26-31	26-31	26-31	64-77	127-153

#### Class 1500

Unit : N-m

Valve Size	R.B	1/2"	3/4"	1"	1.1/2"	2"
	F.B		1/2"	3/4"	1"	1.1/2"
Bolt Size		7/16	7/16	9/16	3/4	7/8
B7/B16/L7		46-55	46-55	102-122	289-347	469-563
B7M/L7M		35-42	35-42	78-93	220-264	357-429
B8(M)-CL.1		13-16	13-16	29-35	82-99	134-161
B8-CL.2		44-53	44-53	97-117	276-331	357-429
B8M-CL.2		42-50	42-50	92-111	262-314	357-429

## 2) Forged Ball Valve

### Class 800 & Below

Unit : N-m

Valve Size	R.B	1/2"	3/4"	1"	1.1/2"	2"
	F.B		1/2"	3/4"	1"	1.1/2"
Bolt Size		3/8	3/8	3/8	7/16	5/8
B7/B16/L7		29-34	29-34	29-34	46-55	141-169
B7M/L7M		22-26	22-26	22-26	35-42	107-129
B8(M)-CL.1		8-10	8-10	8-10	13-16	40-48
B8-CL.2		27-32	27-32	27-32	44-53	134-161
B8M-CL.2		26-31	26-31	26-31	42-50	127-153

### Class 1500

Unit : N-m

Valve Size	R.B	1/2"	3/4"	1"	1.1/2"	2"
	F.B		1/2"	3/4"	1"	1.1/2"
Bolt Size		7/16	7/16	9/16	3/4	7/8
B7/B16/L7		46-55	46-55	102-122	289-347	469-563
B7M/L7M		35-42	35-42	78-93	220-264	357-429
B8(M)-CL.1		13-16	13-16	29-35	82-99	134-161
B8-CL.2		44-53	44-53	97-117	276-331	357-429
B8M-CL.2		42-50	42-50	92-111	262-314	357-429

**Appendix VII Corrosion Tables**

CODE:										CODE:							
E — Excellent										E — Excellent							
F — Fair										F — Fair							
G — Good										G — Good							
O — Not recommended										O — Not recommended							
Blank — No data										Blank — No data							
CORROSIVE MEDIA	CARBON STEEL	BRONZE	AISI 304	AISI 316, 347, 321	ALLOY 20	HASTELLOY	MONEL- INCONEL	TRIM ONLY ARMCO 17-4, 17-7	CORROSIVE MEDIA	CARBON STEEL	BRONZE	AISI 304	AISI 316, 347, 321	ALLOY 20	HASTELLOY	MONEL- INCONEL	TRIM ONLY ARMCO 17-4, 17-7
acetaldehyde	O	O	E	E	E	E	E	E	borac acid	O	G	G	G				
acetic acid aerated	O	O	E	E	E	E	E	E	bromine (dry)	O	O	O	O				
acetic acid (air free)	O	O	E	E	E	E	E	E	bromine (wet)	O	O	O	O	O			
acetic anhydride	O	F	G	G	E	E	E	E	butadiene	F	O	G	O				
acetone	E	E	E	E	E	E	E	E	butane	G	E	G	G	G			
acetylene	E	E	G	E	E	E	E	E	buttermilk	O	O	E	G				
air	E	E	E	E	E	E	E	E	butyric acid	O	O	G	G	E			
alcohols	G	G	E	E	E	E	E	E	calcium bisulfite	O	G	F	G	E			
aluminium acetate	O	O	E	E	E	E	E	E	<b>calcium carbonate</b>	O	F	E	E	E	E	G	E
aluminium chloride 10%	O	O	O	O	E	O	E	O	calcium chloride	F	G	F	G	G	E	G	F
aluminium chloride 10%	O	O	O	O	E	O	E	O	calcium hydroxide	F	O	E	E	E	E	E	E
aluminium fluoride	O	O	G	G	E	G	E	G	calcium hypochlorite	O	O	F	F	F	E		F
aluminium hydroxide	O	O	E	E	E	G	E	E	calcium sulfate	O	E	E	E	E	G	G	E
aluminium oxalate	O	O							carbolic acid	O	G	G	G	E	E	G	G
aluminium potassium sulphate	O	O	E	E	E	G	G	E	<b>carbon bisulfide</b>	G	F	G	G	E	E	G	G
aluminium sulfate (alums)	O	F	F	G	E	E	F	F	carbon tetrachloride (dry)	F	F	G	E	E	E	G	G
amines	G	O	E	E	E	E	F	E	carbonated water	O	G	E	E	E	E	G	E
ammonia (aqueous)	E	E	E	E	E	G	E	E	carbonic acid	O	O	G	G	E	E	E	G
ammonia (anhydrous liquid)	G	O	G	G	G	G	E	G	castor oil	G	E	E	E	E	E	E	E
ammonium bicarbonate	F	O	G	G	G			G	china wood oil (tung)	F	F	E	E				
ammonium carbonate	G	O	G	G	G	G		G	chlorinated solvents	G	F	E	E				
ammonium chloride	O	O	F	F	E	G	G	F	chlorine gas (dry)	F	F	G	G	E	E	G	G
ammonium hydroxide (28%)	O	O	G	G	E	E		G	chloroacetic acid	O	O	O	O	O	E	G	O
ammonium hydroxide (conc)	O	O	G	G	E	E		G	chlorobenzene (dry)	F	F	E	E	F		F	E
ammonium monophosphate	O	O	G	G	E	E		G	chloroform (dry)	O	G	E	E	E	E	E	E
ammonium nitrate	O	O	G	G	E	E		G	chromic acid	O	O	E	E	E	E	E	E
ammonium phosphate	O	O	G	G	E	E		G	citrus juices	O	O	E	E	E	E	G	E
ammonium sulfate	F	G	G	G	E	G	G	G	coca-cola syrup (pure)	O	O	E	E				
amyl acetate	F	G	G	G	E	G	G	G	coconut oil	O	O	G	G	G		G	G
aniline	F	F	G	G	G	G	G	G	copper chloride	O	F	O	O	E	E	G	O
aniline dyes	F	O	E	E	E	E		E	cooking oil	O	G	E	E	E	E	E	E
antimony trichloride	O	O	O	O	O	E	G	O	copper nitrate	O	O	E	E	E	E	O	E
apple juice	O	O	G	O	O			G	copper sulfate	O	O	G	G	E	G	E	G
arsenic acid	O	O	G	G	G			G	corn oil	F		G	G	G	G	E	G
asphalt emulsion	G	G	E	E	E			E	cottonseed oil	F		G	G	G	G	E	G
asphalt liquid	G	G	E	E	E			E	creosote oil	G	G	G	G	G	E	E	G
barium carbonate	G	G	E	E	E			E	creylic acid	F	F	G	G	G	G	E	G
<b>barium chloride</b>	F	G	G	G	F	E	G	G	cupric chloride	O	O	O	O	O	O	E	O
barium hydroxide	F	O	G	G	E	E		G	diesel fuels	E	E	E	E				
barium sulfate	F	F	E	E	E		G	F	dowtherm	G		E	E				
barium sulfide	F	F	G	G	G		F	G	drying oil			G	G	G		G	G
beer	O	E	E	E	G	E		E	epsom salt	F	G	G	G	G		G	G
beet sugar liquors	G	E	E	E	G	E		E	ethers	G	G	E	E	E	G	E	E
benzene (benzol)	G	G	E	E	E	G	G	E	ethyl acetate	G	F	G	G	G	E	G	G
benzoid acid	O	O	E	E	E	E	G	E	ethyl alcohol	G	G	G	G	G	G	G	G
borax liquors	F	O	E	E	E	E	G	E	ethyl chloride (dry)	G	G	E	E	E	G	G	E



CORROSIVE MEDIA	CODE:							CORROSIVE MEDIA	CODE:								
	CARBON STEEL	BRONZE	AISI 304	AISI 316, 347, 321	ALLOY 20	HASTELLOY	MONEL- INCONEL		TRIM ONLY ARMCO 17-4, 17-7	CARBON STEEL	BRONZE	AISI 304	AISI 316, 347, 321	ALLOY 20	HASTELLOY	MONEL- INCONEL	TRIM ONLY ARMCO 17-4, 17-7
ethylene glycol	G	G	G	G	G	G	G	G	lacquers (and solvents)	F	F	F	F	F	F	F	F
ethylene oxide	G	G	G	G	G	G	G	G	lactic acid	O	G	F	F	F	G	F	F
fatty acids	O	O	G	F	F	G	G	G	large oil	F	F	G	G	G	F	F	F
ferric chloride	O	O	O	O	O	O	F	O	lead acetate	O	O	F	F	F	G	F	F
ferric nitrate	O	O	G	G	G	O	F	G	linseed oil	O	G	F	F	F	F	F	F
ferric sulfate	O	O	G	G	G	O	F	G	lubricating oil	F	F	F	F	F	F	F	F
ferrous chloride	O	G	O	O	O	O	F	O	magnesium chloride	G	G	F	F	F	G	F	F
ferrous sulfate	O	G	F	F	F	G	F	O	magnesium hydroxide	G	G	F	F	F	G	F	F
fish oils				G				G	magnesium sulfate	G	G	F	F	F	G	F	F
fluorine								G	maleic acid	G	G	G	F	F	F	G	F
formaldehyde	O	F	D	F	F	F	F	F	malic acid			F	F	F	G	F	F
formic acid	O	G	F	G	G	G	F	F	mayonnaise			F	F	F	G	F	F
fruit juices		G	F	F	F	F	F	F	mercury	F	O	F	F	F	G	F	F
fuel oil		G	F	F	F	F	F	F	methyl alcohol	G	G	G	G	G	G	F	G
furfural	G	F	G	F	F	F	F	G	methyl chloride	G	G	G	F	F	G	G	G
gallic acid	O	F	F	F	F	F	F	F	methyl ethyl ketone	F	F	F	F	F	F	F	F
gas-manufactured	G	G	F	F	F	F	F	F	milk	O	F	F	F	F	G	F	F
gas-natural	G	G	F	F	F	F	F	F	mine waters (acid)	F	G	G	F	F	O	F	G
gasoline (leaded)	F	F	F	F	F	F	F	F	mineral oil			F	F	F	F	F	F
gasoline (unleaded)	F	F	F	F	F	F	F	F	molasses, edible	F	F	F	F	F	G	F	F
gelatin			F	F	F	F	F	F	molasses, crude	F	F	F	F	F	F	F	F
glucose		F	F	F	F	F	F	F	mustard	O	O	F	F	F	G	F	F
glue	F	G	G	G	G	G	G	G	mercuric chloride					F	F	F	F
glycerin	F	G	F	F	F	F	F	F	naphtha	G	G	F	F	F	F	F	F
heptane	O	O	O	O	F	G	O	O	naphthalene	F	G	G	G	G	F	F	G
hydrochloric acid (air free)	O	O	O	O	O	F	G	O	nickel chloride	O		G	G	G	G	F	G
*hydrogen chloride									nickel nitrate			G	G	G	G	G	G
**hydrochloric acid	O	O	O	O	O	O	F	O	nickel sulfate	O		G	G	G	G	G	G
hydrofluoric acid	O	O	O	O	O	G	G	O	nitric acid (10%)	O	O	F	F	F	O	G	F
hydrogen fluoride	O	O	O	F	F	F	F	O	nitric acid (30%)	O	O	F	F	F	O	G	F
hydrogen		F	F	F	F	F	F	F	nitric acid (100%)	O	O	F	F	F	O	G	F
hydroxide	O	O	F	F	F	G	F	F	nitrobenzene	G		G	G	F	G	F	G
hydrogen peroxide	O	G	G	F	F	G	F	G	nitrous acid (10%)	O	O	G	G	G	O	G	F
hydrogen sulfite (dry)	G	F	F	F	F	G	F	F	nitrous oxide	G		G	G	G	O	G	F
hydrogen sulfide (wet)	F	F	F	F	F	F	F	F	oleic acid	F	G	G	F	F	G	G	G
hypo (sodium thiosulfate)	O	F	F	F	F	G	F	F	oleum	G		G	G	G	G	G	G
hypochlorites—sodium		O	F	F	F	G	F	F	olive oil			F	F	F	F	F	F
ink		G	F	F	F	G	F	F	oxalate	O	O			F	G	F	F
iodine (wet)		O	O	O	O	F	F	O	oxalic acid	O	G	F	F	F	G	G	F
iodoform	G	O	F	F	F	F	F	O	palmitic acid		G	G	G	G	G	F	G
isopropyl alcohol		G	G	G	G	G	G	G	palm oil			G	G				G
JP-4		F	F	F	F	F	F	F	paraffin	G	F	F	F	F	F	F	F
JP-5 fuel		F	F	F	F	F	F	F	paraformaldehyde	G	G	G	G	G	G	G	G
kerosene	G	F	F	F	F	G	F	F	penicillin	O	O	O	G	O	F	O	O
ketchup	O	O	F	F	F	G	F	F	pentane	G	F	F	F	G	G	G	F
									petrolatum			G	G	G			G

Also consult pressure temperature tables.



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	CARBON STEEL	BRONZE	AISI 304	AISI 316, 347, 321	ALLOY 20	HASTELLOY	MONEL-INCONEL		TRIM ONLY ARMCO 17-4, 17-7	CARBON STEEL	BRONZE	AISI 304	AISI 316, 347, 321	ALLOY 20	HASTELLOY	MONEL-INCONEL
phenol	O	E	E	E	E	E	E	E	F	F	G	G	G	G	G	G
phosphoric acid (10%)	O	E	G	G	E	E	E	G	G	G	G	G	G	G	G	G
phosphoric acid (25%)	O	E	G	G	E	E	E	G	G	G	G	G	G	G	G	G
phthalic acid			G	G	G	G	E	G								
picric acid	O	E	E	E	E	E	E	E								
pine oil	G	E	E	E	E	E	E	E								
pineapple juice			E	E	E	E	E	E								
potassium bisulfite	O	E	G	G	G	O	G	G								
potassium bromide	O	E	E	E	E	E	E	E								
potassium carbonate	G	G	G	G	G	G	G	G								
potassium chlorate	G	E	G	G	G	G	G	G								
potassium chloride	F	G	F	F	F	G	G	F								
potassium cyanide	G	O	G	G	G	G	G	G								
potassium dichromate	F	O	G	G	G	E	G	G								
potassium diphosphate			E	E	E	E	E	E								
potassium ferricyanide	F	O	G	G	G	G	G	G								
potassium ferrocyanide	F	G	G	G	G	G	G	G								
potassium hydroxide	F	G	G	G	G	E	E	G								
potassium iodide	F	E	G	G	G	G	G	G								
potassium nitrate	E	E	G	G	G	G	G	G								
potassium permanganate	G	E	G	G	G	E	G	G								
potassium sulfite	G	G	G	G	G	G	G	G								
propane	G	E	G	G	G	G	G	G								
pyrogalllic acid	G	E	E	E	E	E	E	E								
rosin emulsion	F	G	G	G	G	E	G	G								
salad oil	F	G	G	G	G	G	G	G								
salicylic acid	O	G	G	G	G	G	G	G								
sea water	O	F	E	E	E	E	E	E								
silver nitrate	O	O	G	G	G	O	G	G								
sodium acetate	F	E	G	G	G	F	G	G								
sodium aluminate			G	G	G	G	G	G								
sodium bicarbonate	F	G	G	G	E	G	G	G								
sodium bisulfate (10%)	O	G	E	E	E	E	G	G								
sodium bisulfite	O	G	E	E	E	E	G	G								
sodium borate			G	G	G	G	G	G								
sodium bromide (10%)	G	E	F	G	G	G	G	F								
sodium carbonate	G	G	G	G	G	G	G	G								
sodium chlorate			G	G	G	G	G	G								
sodium chloride	F	G	G	G	G	G	G	G								
sodium chromate	G	F	E	E	E	E	E	E								
sodium cyanide	G	O	G	G	G	G	G	G								
sodium fluoride	O	F	G	E	E	E	F	G								
sodium hydroxide	F	G	G	G	G	E	E	G								
sodium hypochlorite	O	O	O	G	E	O	E	O								
sodium nitrate	G	G	G	G	G	G	G	G								
sodium perborate	G	E	G	G	G	G	G	G								
sodium peroxide	F	O	G	G	G	G	G	G								
sodium phosphate																
sodium silicate	G	G	G	G	G	G	E	G								
sodium sulfate	G	G	G	G	E	E	E	E								
sodium sulfide	G	O	G	G	G	G	E	G								
sodium thiosulfate			E	E	E	E	E	E								
soybean oil	F	E	E	E	E	E	E	E								
stannic chloride	O	O	O	E	E	E	F	G								
stannous chloride	O	O	O	E	E	E	F	G								
starch																
steam (212°F)	E	E	E	E	E	E	E	E								
stearic acid			F	E	E	E	E	E								
sugar liquids	O	O	E	E	E	E	E	E								
sulfate — black liquor			F	G	G	G	G	E								
sulfate — green liquor				G	G	G	G	E								
sulfate — white liquor				G	G	G	F	E								
sulfur dioxide (dry)	G	F	G	G	G	G	E	G								
sulfur trioxide (dry)	G	G	G	G	G	G	E	G								
sulfuric acid (20%)	O	G	O	O	E	E	E	O								
sulfuric acid (50%)	O	G	O	O	E	E	E	I								
sulfuric acid (100%)	F	E	O	G	E	O	E	O								
sulfurous acid	O	F	F	O	E	O	G	F								
tail oil																
tannic acid	F	G	E	E	E	E	G	G								
tartaric acid	O	E	E	E	E	E	G	E								
tetraethyl lead																
toluene	E	E	E	E	E	E	E	E								
tomato juice			F	E	E	E	G	E								
trichloroethylene	G	G	G	G	G	E	E	G								
tung oil																
turpentine	G	G	G	G	G	G	G	G								
titanium "E"																
urea																
varnish	O	O	E	E	E	E	G	E								
vegetable oil, edible			E	E	E	E	E	E								
vegetable oil, non-edible			E	E	E	E	E	E								
vinegar	O	E	E	E	E	E	E	E								
vitamins	O	O	O	G	O	E	E	O								
water — distilled (aerated)	O	E	E	E	E	E	E	E								
water — fresh			F	E	E	E	E	E								
water — sea	O	F	E	E	E	E	E	E								
whiskey	O	E	E	E	E	E	E	E								
wine	O	E	E	E	E	E	E	E								
xylene (dry)	G	E	E	E	E	E	E	E								
zinc chloride	O	O	O	O	G	G	G	O								
zinc hydrosulfite	E	E	E	E	E	E	E	E								
zinc sulfate	O	G	G	G	G	G	G	G								