FUKUI

PSL-MP Series

Contents

- Features 1
- Certification 1
- Configuration of Pilot-Operated Pressure Relief Valve 2
- Structure of Main Valve 2
- Structure of PMP Pilot Valve 5
- Operating Principle of PMP Pilot Valve 6
- Structure of P70L Pilot Valve 8
- Operating Principle of P70L Pilot Valve 9
- Piping System Diagram 11
- Accessories 13
- Type code 17
- Cross-sectional View of Main Valve 18
- Standard Material of Main Valve 19
- Cross-sectional View of Pilot Valve 20
- Standard Material of Pilot Valve 22
- Actual Area 24

- Pressure–Temperature Rating 25
- Dimensions and Weight 26

Features

The PSL-MP series is a pilot-operated pressure relief valve developed for liquefied gas storage tanks (LPG etc.). The main valve adopts a piston structure. We have also obtained type approval certificates for vessels from various classification societies.

- Large throat area
  The valve has the largest possible throat area relative to the inlet diameter, making it possible to minimize the pressure relief valve size.

- High seat airtightness performance
  This pilot-operated type offers high nozzle airtightness performance even in environments such as gas carrying vessels where vibration is expected.

- Multi-set capability
  In the case of gas carrying vessels etc. , the required set pressure varies depending on the cargo. Installing an auxiliary setter will make it possible to change the set pressure easily.

Certification

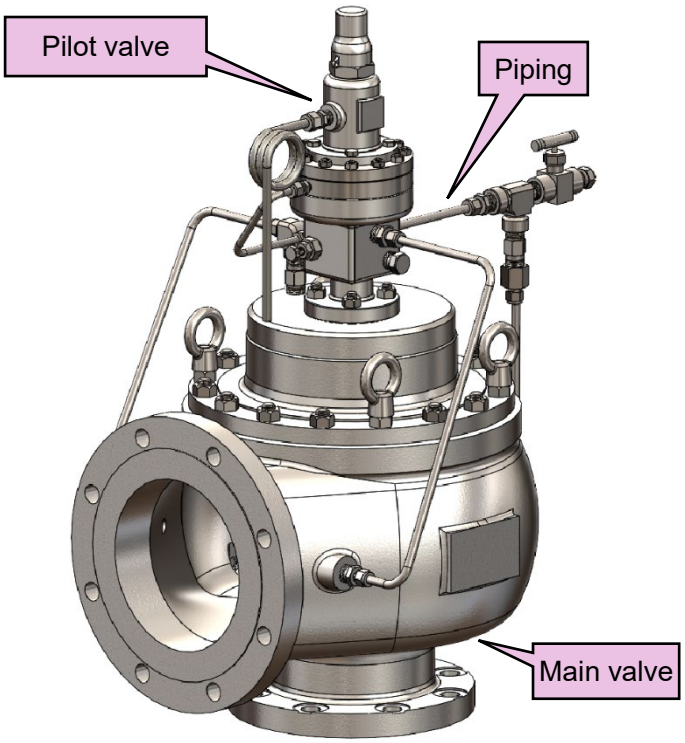
Classification society	Size	Pressure (MPa)	Temperature (°C)
NK	2*3, 3*4, 4*6, 6*8, 8*10	0.025–2.0 2.0–2.5	-253–125 -196–125
LRS	2*3, 3*4, 4*6, 6*8, 8*10 3*4	0.1–2.5 0.1–2.5	-196–125 -253–125
BV	2*3, 3*4, 4*6, 6*8, 8*10	0.1–2.5	-196–125
DNV	2*3, 3*4, 4*6, 6*8, 8*10	–2.5	-196–125
KR	2*3, 3*4, 4*6, 6*8, 8*10	0.025–1.96	-196–204
ABS	2*3, 3*4, 4*6, 6*8, 8*10	–2.5	-196–204
CCS	2*3, 3*4, 4*6, 6*8, 8*10	0.1–2.5	-196–125
RINA	2*3, 3*4, 4*6, 6*8, 8*10	0.025–2.0	-162–204

* Certifications are updated as needed. The latest certification range may differ.
* We have also obtained certification from ASME BPVC Section VIII Division 1.
* There are cases where products exceeding this pressure–temperature ratings can also be manufactured.

Configuration of Pilot-Operated Pressure Relief Valve

The PSL-MP series is a pilot-operated pressure relief valve. The pilot-operated pressure relief valves offer more advantages than the spring-loaded pressure relief valve.

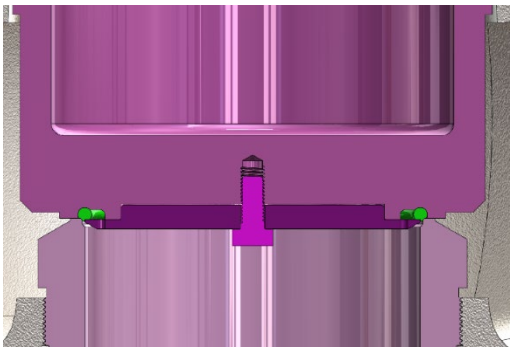
The pilot-operated pressure relief valve consists of the main valve, pilot valve, and piping. It is possible to install options corresponding to other specification requirements. The pilot valve actuates the main valve by controlling the dome pressure of the main valve. The main valve discharges the required discharge amount.



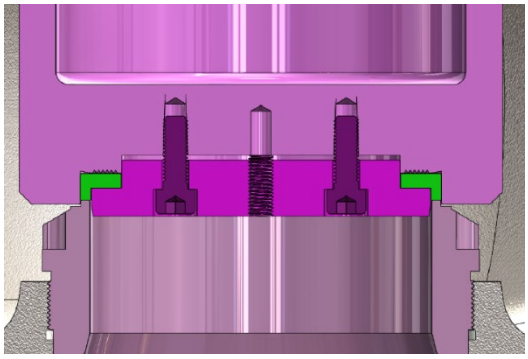
Structure of Main Valve

The main valve structure adopts two types of soft seats: the O-ring seat or PTFE seat. The standard type is the O-ring seat.
The Teflon seat is used when lower temperatures or corrosion resistance which cannot be accommodated by the O-ring seat is required.

- O-ring seat
  This type ensures airtightness with an O-ring. Suitable elastomers can be selected as the O-ring material depending on the service. The minimum operating temperature varies depending on the elastomer: operation at as low as -50°C can be accommodated.



O-ring seat

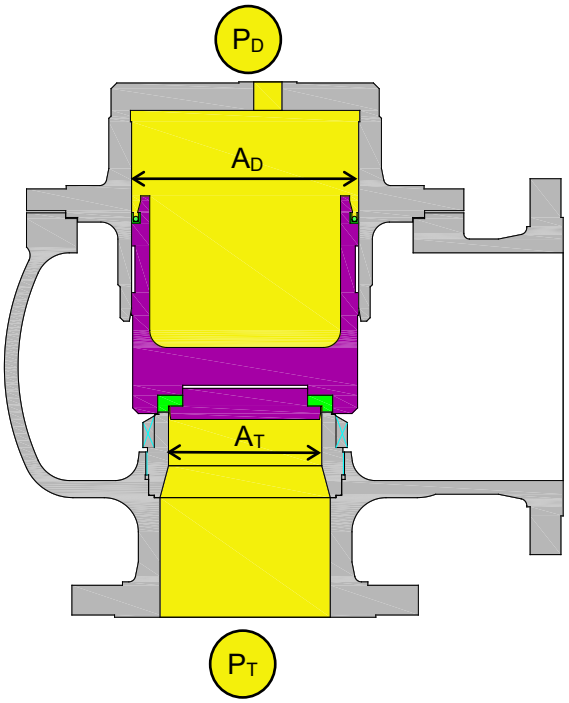


PTFE seat

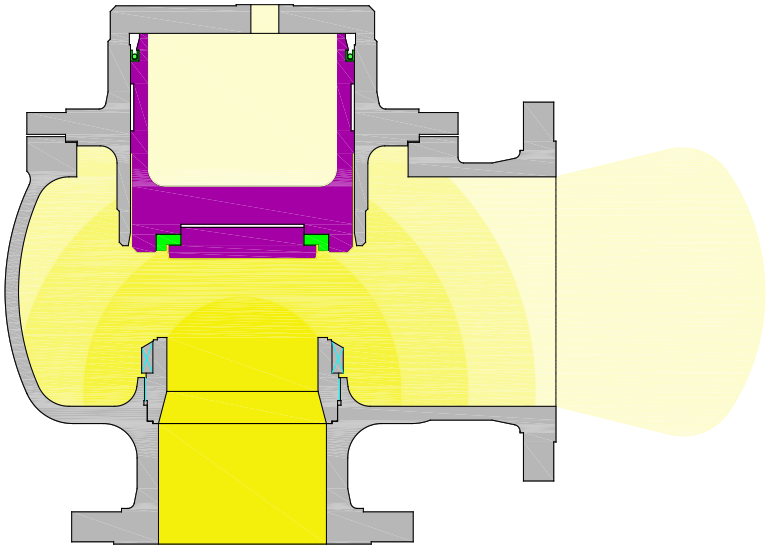
- PTFE seat
  This type is mainly used for low-temperature services which cannot be accommodated by the O-ring seat. PTFE is used as the seat material.

Operating Principle of Main Valve

The dome area (A_D) is designed to be larger than the seat area (A_T). The dome pressure (P_D) and the seat pressure (P_T) are equal until the valve operates. Since the downward load applied on the disc ($A_D \times P_D$) is greater than the upward load applied on the disc ($A_T \times P_T$), the disc is firmly seated on the seat to close the valve.



Closed valve condition



Open valve condition

When the seat pressure rises and reaches the set pressure, the gas or vapor in the dome is discharged through the pilot valve, causing the dome pressure (P_D) to drop. As a result of this pressure drop, the upward load applied on the disc ($A_T \times P_T$) becomes greater than the downward load applied on the disc ($A_D \times P_D$), causing the disc to move away from the seat to operate the main valve.

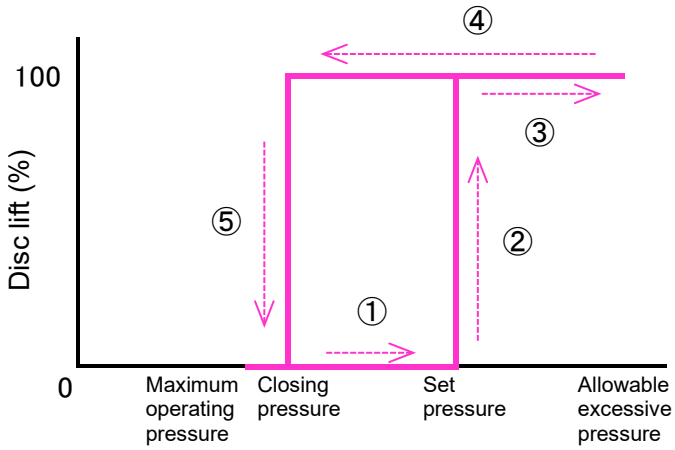
Types of Pilot Valves

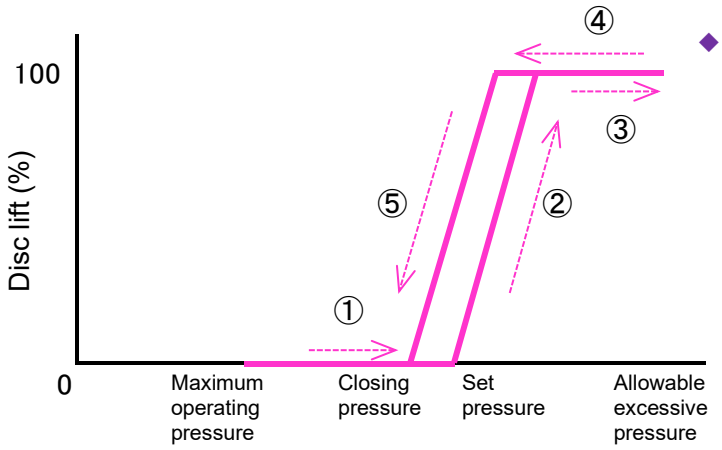
◆ Operating characteristics of pilot valve

The pilot valve has two different operating characteristics: pop action and modulating action. In addition, two types are available: the flowing type which continuously discharges gas from the pilot valve during main valve operation, and the non-flowing type which discharges only the gas amount necessary for main valve operation.

◆ Pop action

The pop action pressure relief valve performs full lift without excessive pressure. The standard pilot valve of the PSL-MP adopts this type.





◆ Modulating action

In the case of the modulating action, the disc of the main valve lifts in proportion to the increase in pressure. This makes it possible to reduce the gas or vapor to be discharged and noise. The modulating action allows the outlet piping of the pressure relief valve to be designed economically, because the outlet piping can be designed based on the backpressure corresponding to the required discharge rate. This pilot is mainly used to prevent carbon dioxide etc. from sublimating and becoming dry ice during operation.

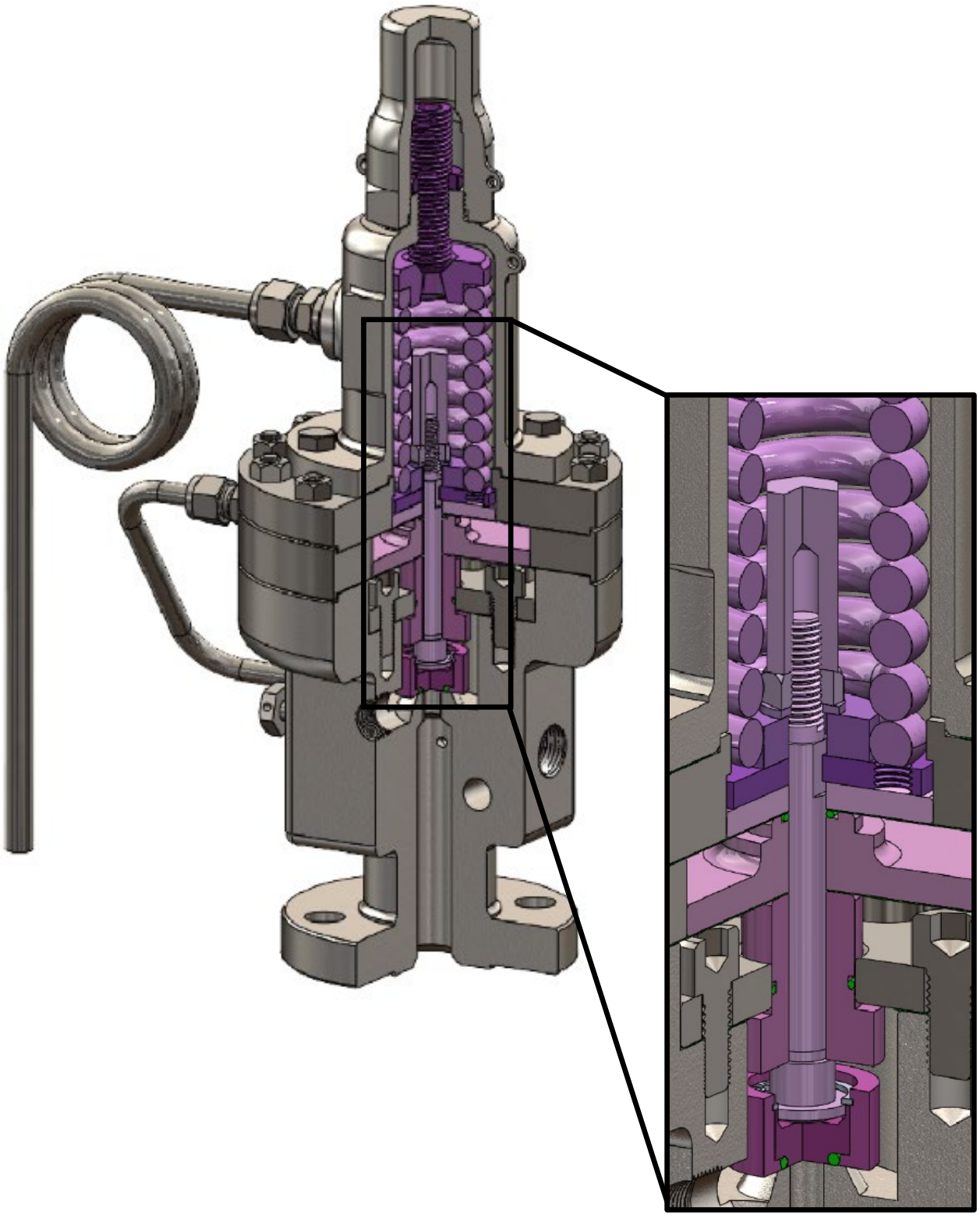
◆ List of pilot valve characteristics

The following two types of pilot valves are in the lineup.

Pilot valve	Operating characteristics	Discharge type	Main applicable gas or vapor
PMP	Pop action	Flowing	Other than carbon dioxide
P70L	Modulating action	Non-flowing	Carbon dioxide

Structure of PMP Pilot Valve

The PMP pilot valve is a pilot valve characterized by a flowing-type pop action.



Operating Principle of PMP Pilot Valve

The system is connected to the sense chamber through the adjusting needle N, and to the dome chamber through the fixed orifice O.

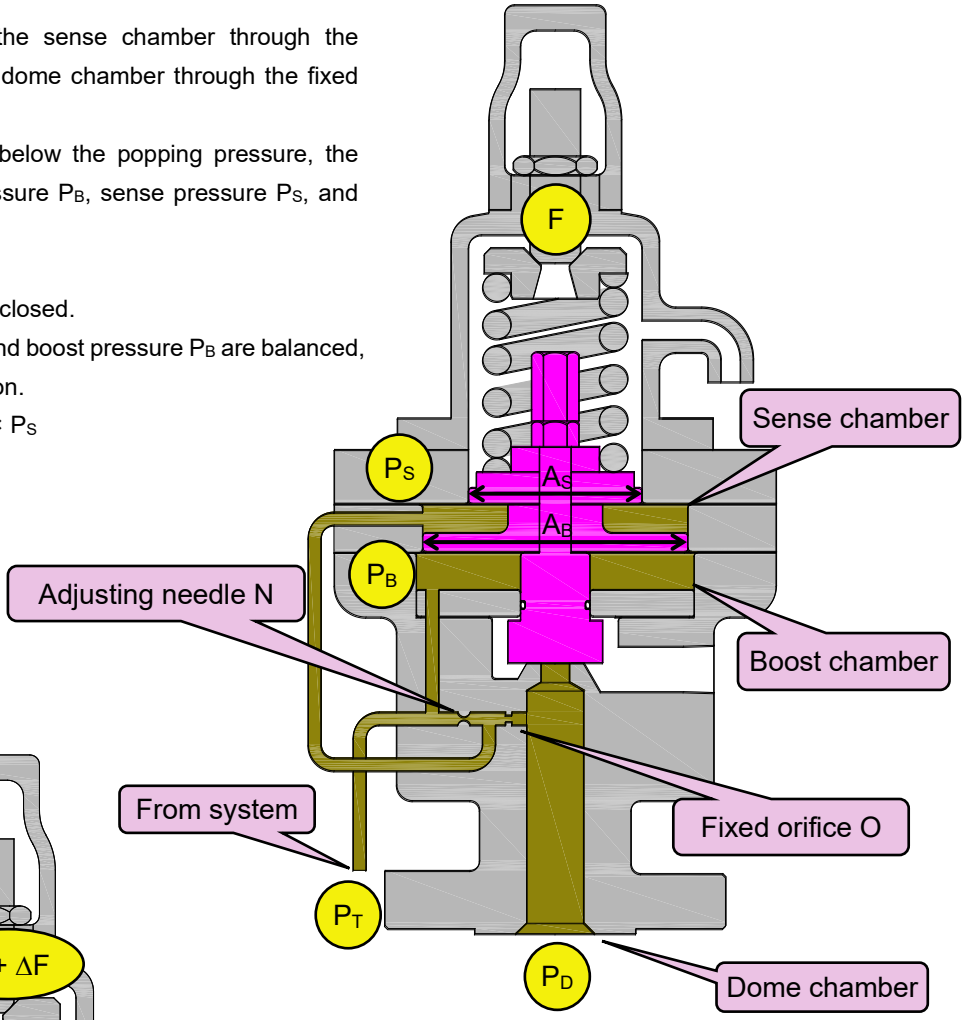
When the system pressure is below the popping pressure, the system pressure P_T, boost pressure P_B, sense pressure P_S, and dome pressure P_D are all equal.

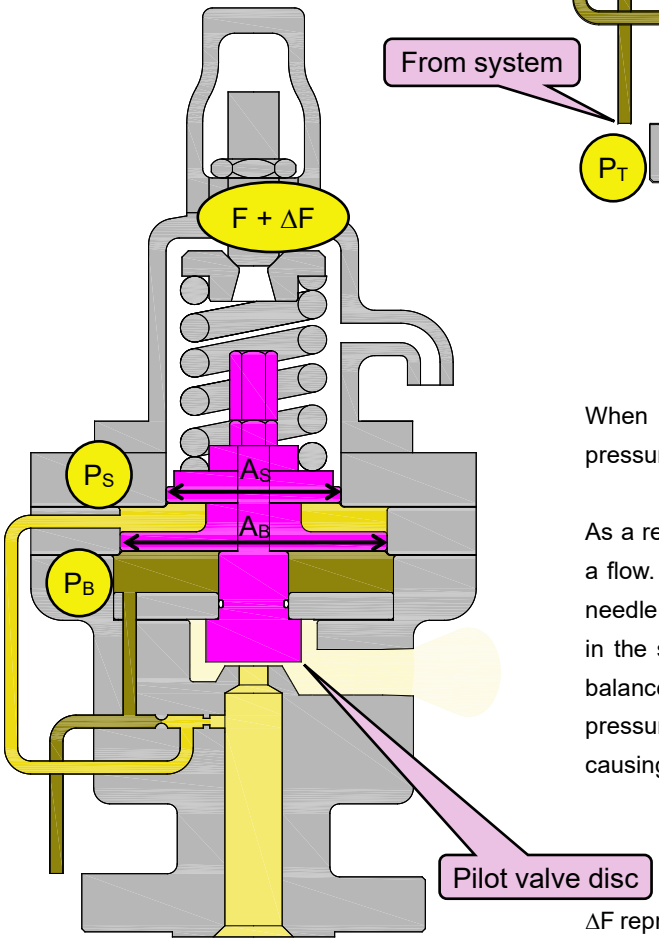
$$P_T = P_B = P_S = P_D$$

As a result, the main valve gets closed.

In addition, sense pressure P_S and boost pressure P_B are balanced, resulting in the following condition.

$$F \text{ (spring load)} > A_S \times P_S$$





When the system pressure rises to the popping pressure, the following condition results:

$$F \approx A_S \times P_S$$

As a result, the pilot valve disc opens slightly to create a flow. This flow causes pressure loss at the adjusting needle N and fixed orifice O, resulting in a pressure drop in the sense chamber. Due to this pressure drop, the balance between the sense pressure and boost pressure is disrupted and an upward load is generated, causing the pilot valve to perform a pop action.

$$A_B > A_S$$

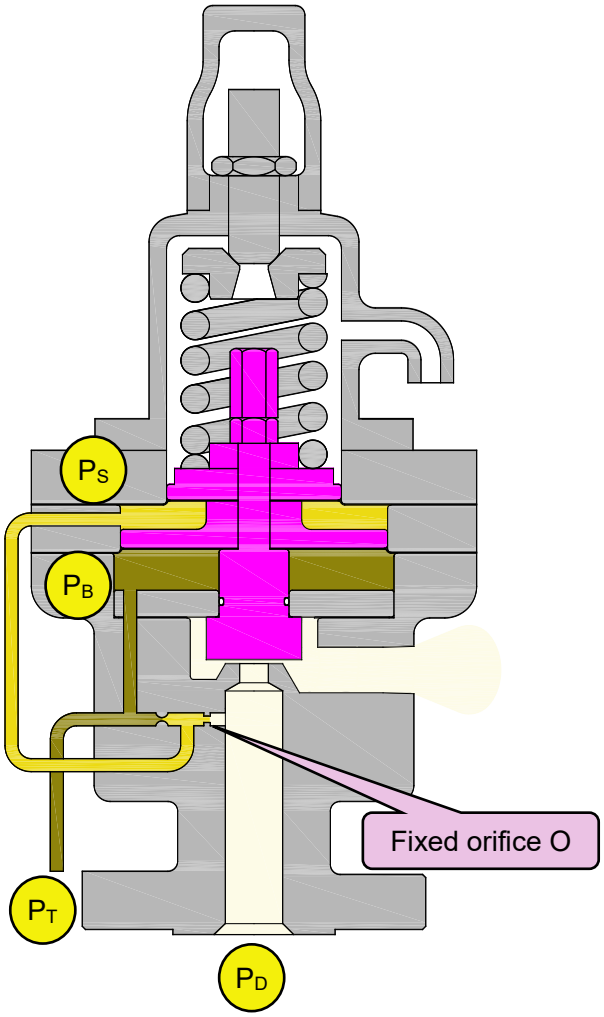
$$F + \Delta F < A_S \times P_S + A_B (P_B - P_S)$$

ΔF represents the increase in the spring load associated with the pilot valve lifting.

Since the pop action of the pilot valve makes the discharge volume from the pilot valve larger than the inflow volume to the dome chamber through the fixed orifice O, the dome chamber pressure drops nearly to the atmospheric pressure. Due to this dome chamber pressure drop, the main valve disc is pushed up by system pressure, performing full lift at the specified pressure.

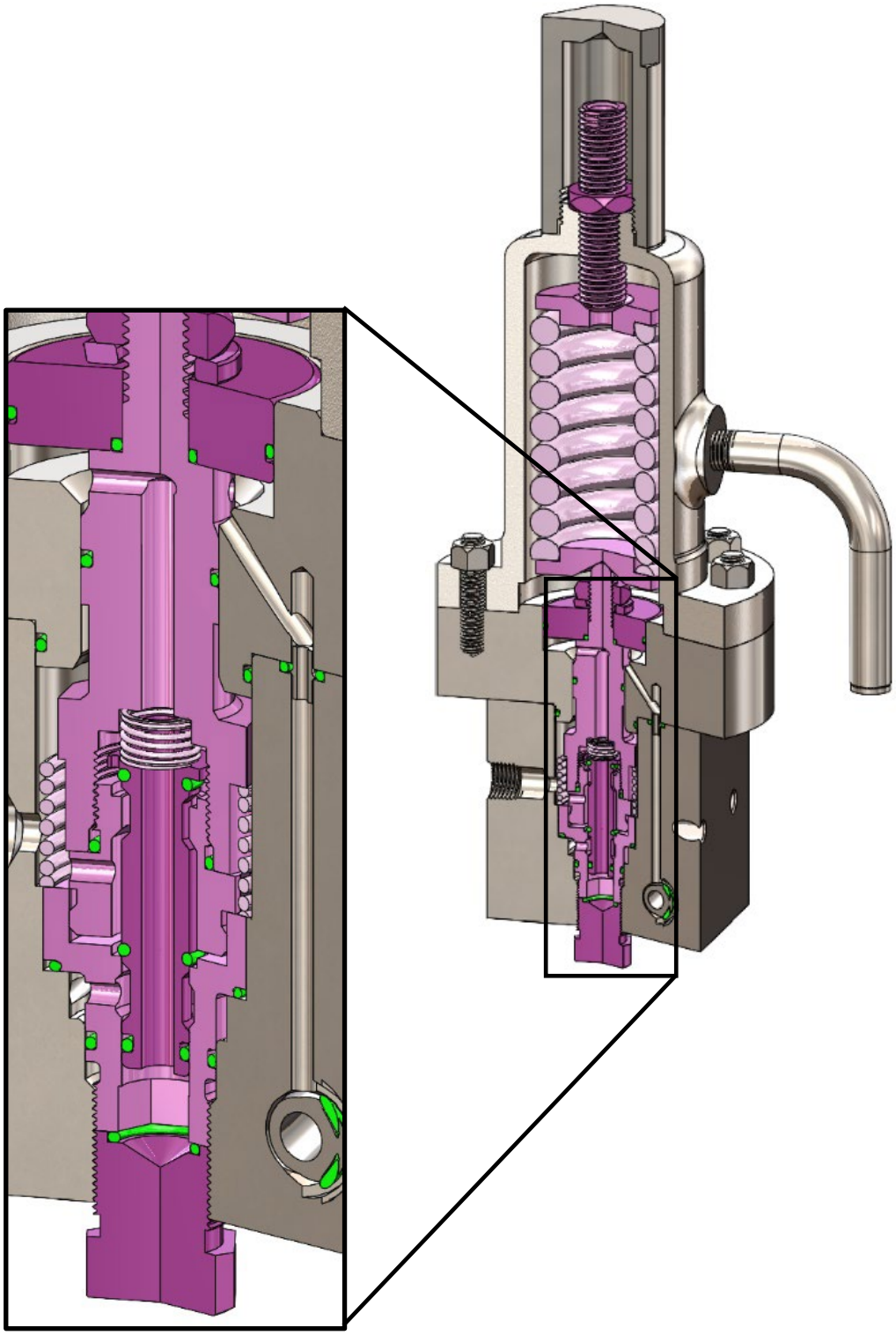
$$P_T = P_B > P_S > P_D \approx o$$

When the main valve operates and the system pressure drops to the closing pressure, the lifting force of the pilot valve becomes smaller than the spring load, causing the pilot valve to close. As the pilot valve closes, the main valve dome chamber pressure is restored, causing the main valve disc to close.



Structure of P70L Pilot Valve

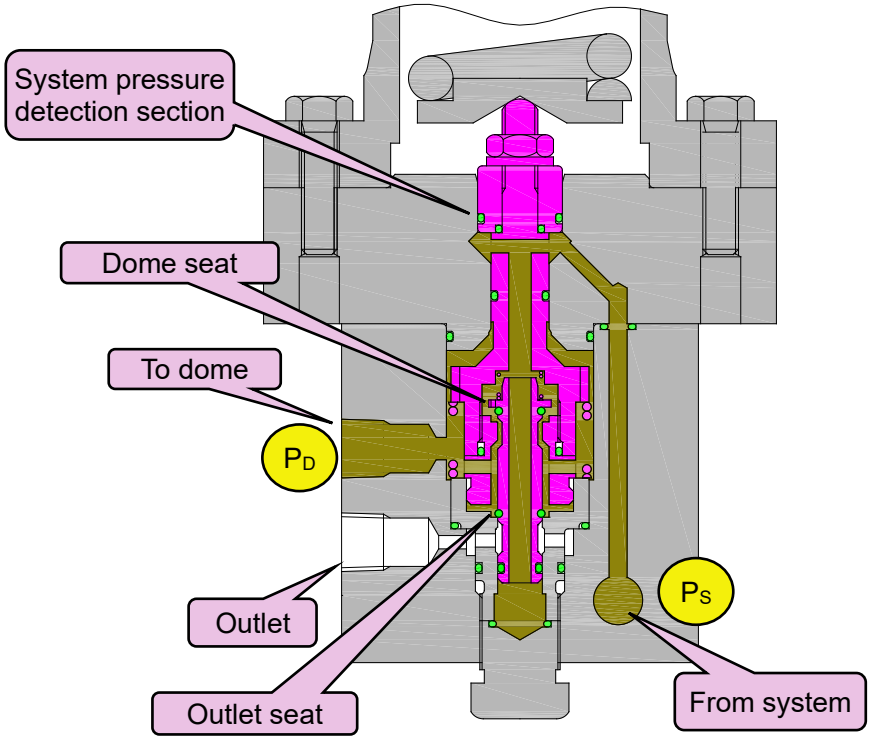
The P70L pilot valve is a pilot valve characterized by a non-flowing modulating type.

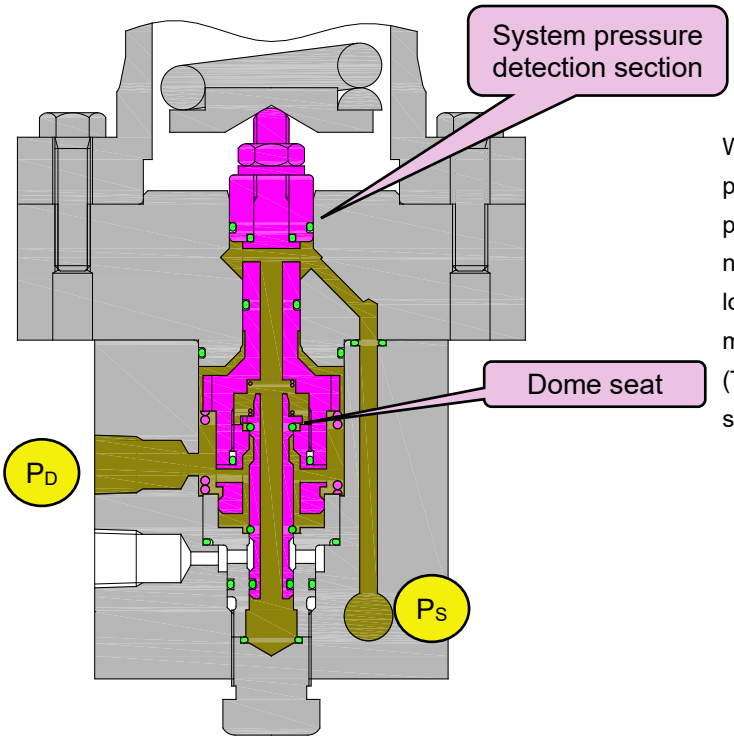


Operating Principle of P70L Pilot Valve

Up to the popping pressure, gas or vapor flows from the system through the dome seat to the dome, making the dome pressure P_D equal to the system pressure P_S.

$$P_S = P_D$$



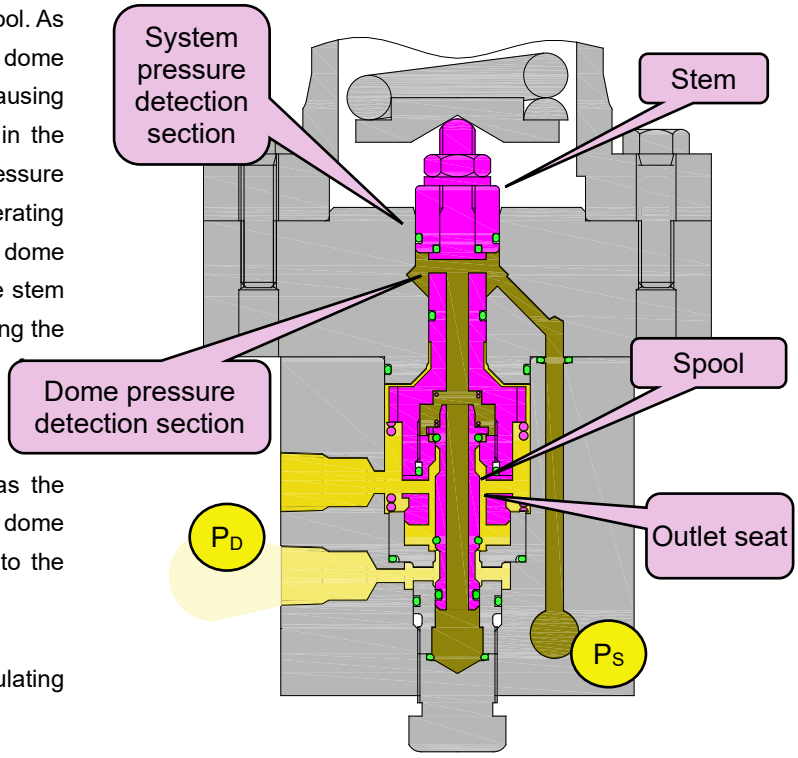


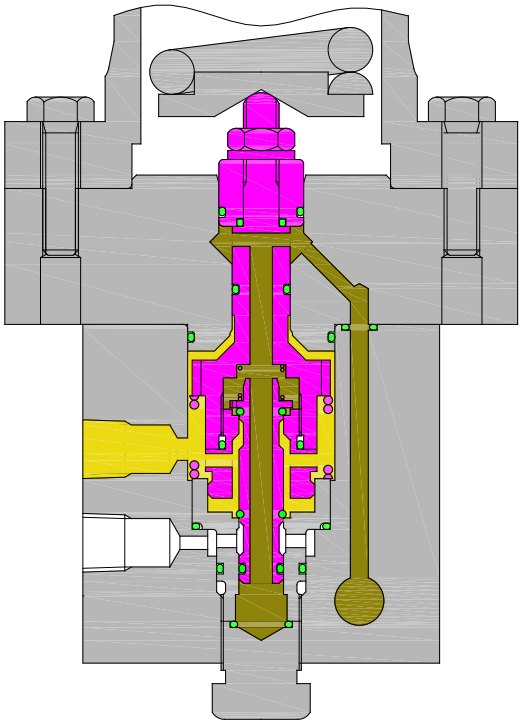
When the load generated by the system pressure detection section area and system pressure P_S (valve opening load) becomes nearly equal to the spring load (valve closing load), the stem moves upward. This movement causes the dome seat to close. (The inflow from the system pressure is stopped, resulting in a non-flowing state.)

When the system pressure P_S rises further, the stem slightly moves up together with the spool. As a result of this upward movement, the dome pressure is released through the outlet, causing the dome pressure P_D to drop. This drop in the dome pressure P_D generates a pressure difference with the system pressure P_S, generating a load that pushes down the stem at the dome pressure detection section. This causes the stem to move down together with the spool, seating the outlet seat to stop the dome pressure dropping.

The above-mentioned action is repeated as the system pressure P_S rises, causing the dome pressure P_D to drop in inverse proportion to the rise in the system pressure P_S.

This makes the main valve perform a modulating action.



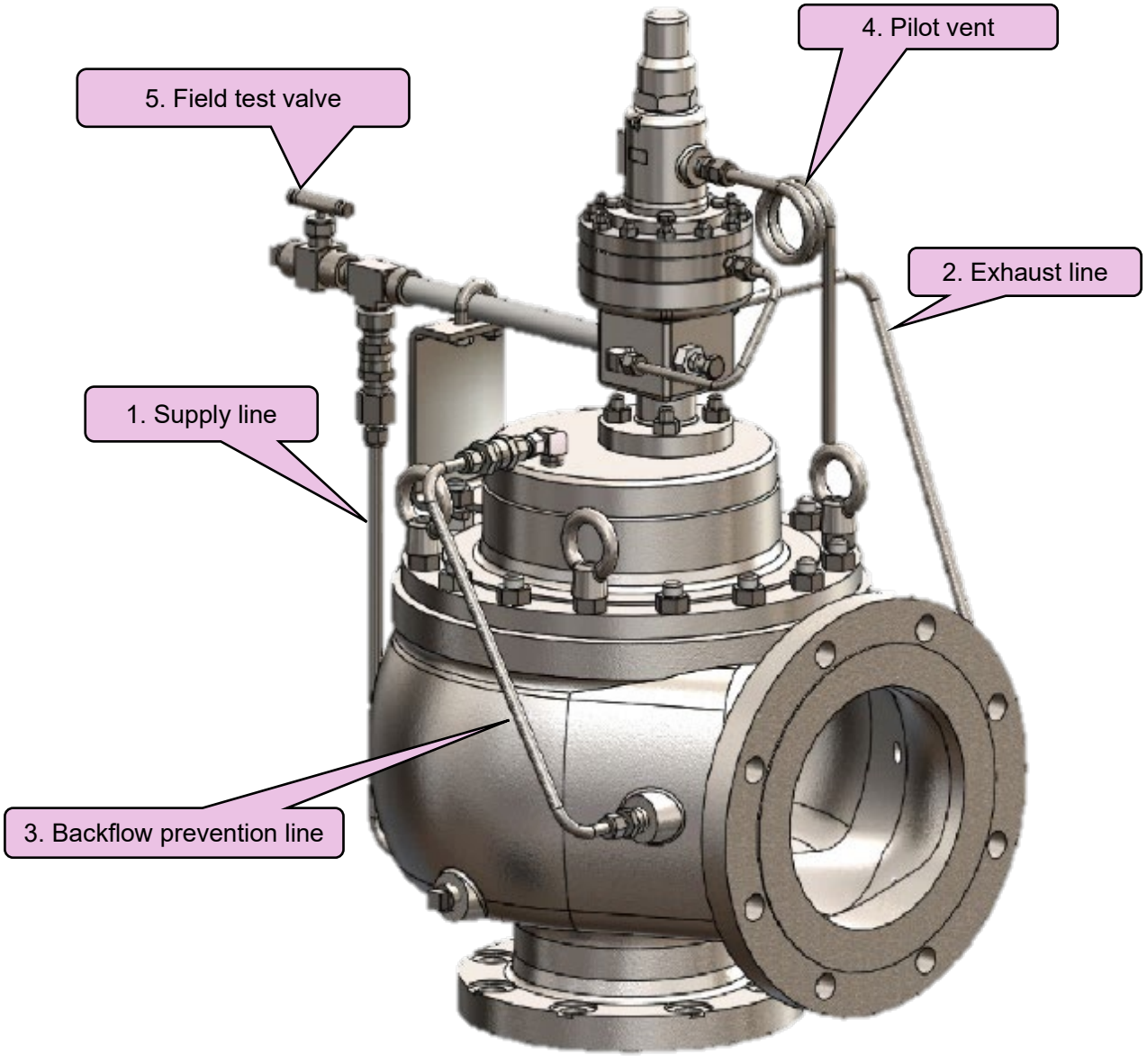


As the system pressure P_S drops, the reverse action occurs repeatedly, causing the dome pressure P_D to rise in inverse proportion to the drop in the system pressure P_S. As a result, the dome pressure P_D is restored to close the main valve.

Piping System Diagram

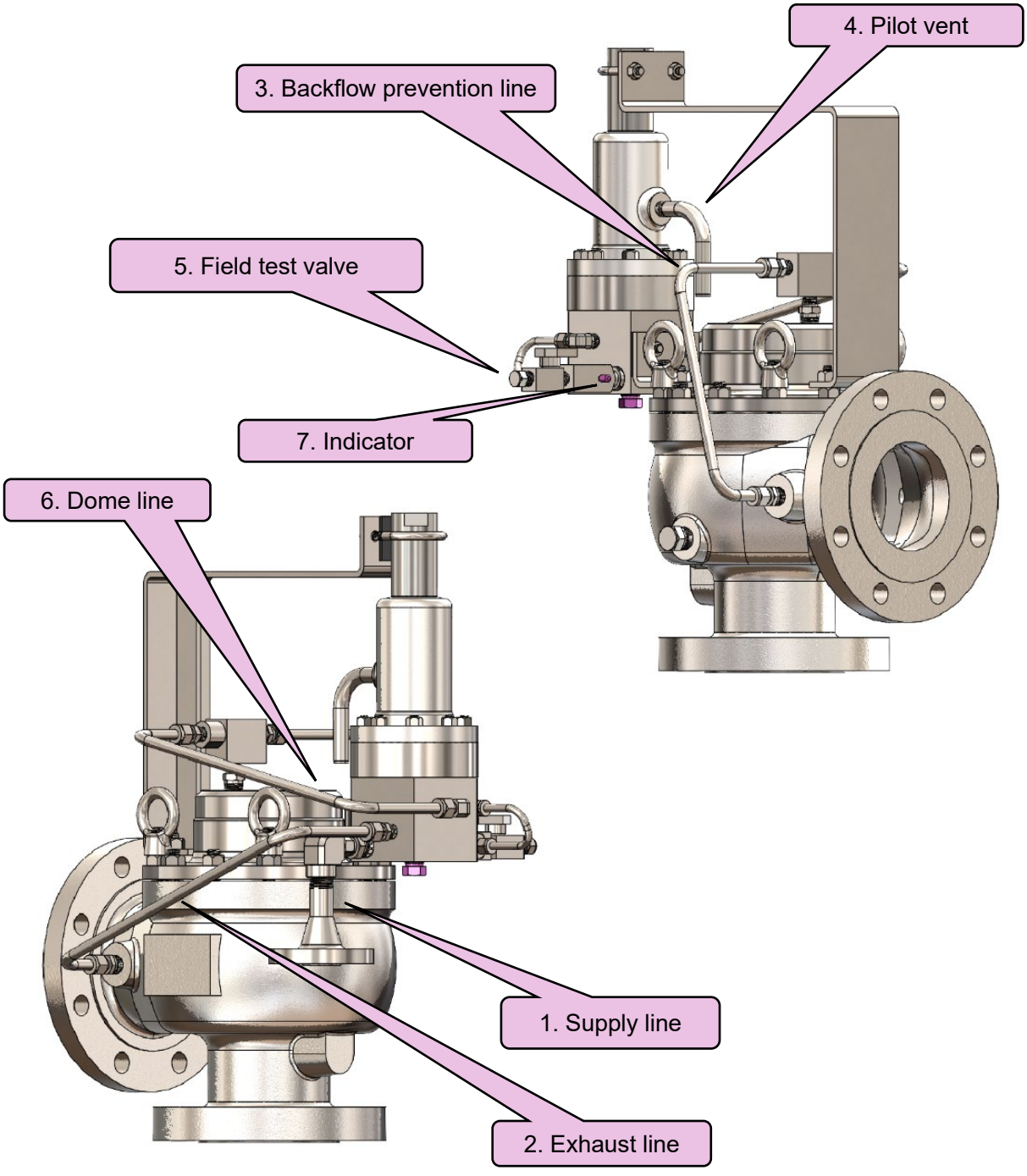
A typical piping diagram of the PMP pilot valve is shown below. This piping varies depending on the accessories.

No.	Name	Description
1	Supply line	This is the pressure detection (supply) piping of the pilot valve.
2	Exhaust line	This is the exhaust line of the pilot valve. It is normally connected to the main valve outlet.
3	Backflow prevention line	This is the line connecting the backflow prevention device to the main valve outlet.
4	Pilot vent	This is the line for the pilot valve to detect atmospheric pressure. No gas or vapor is discharged from this line.
5	Field test valve	Pressure is applied through this valve during a field test.



A typical piping diagram of the P70L pilot valve is shown below. This piping varies depending on the accessories.

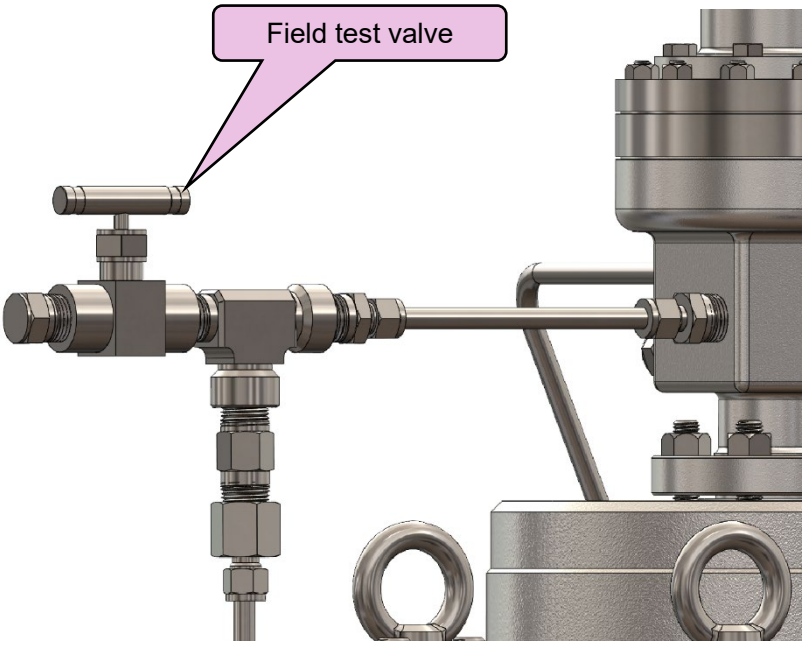
No.	Name	Description
1	Supply line	This is the pressure detection (supply) piping of the pilot valve.
2	Exhaust line	This is the exhaust line of the pilot valve. It is normally connected to the main valve outlet.
3	Backflow prevention line	This is the line connecting the backflow prevention device to the main valve outlet.
4	Pilot vent	This is the line for the pilot valve to detect atmospheric pressure. No gas or vapor is discharged from this line.
5	Field test valve	Pressure is applied through this valve during a field test.
6	Dome line	This is the line connecting the pilot valve to the main valve dome.
7	Indicator	This is used to check the operational status of the pilot valve during a field test.



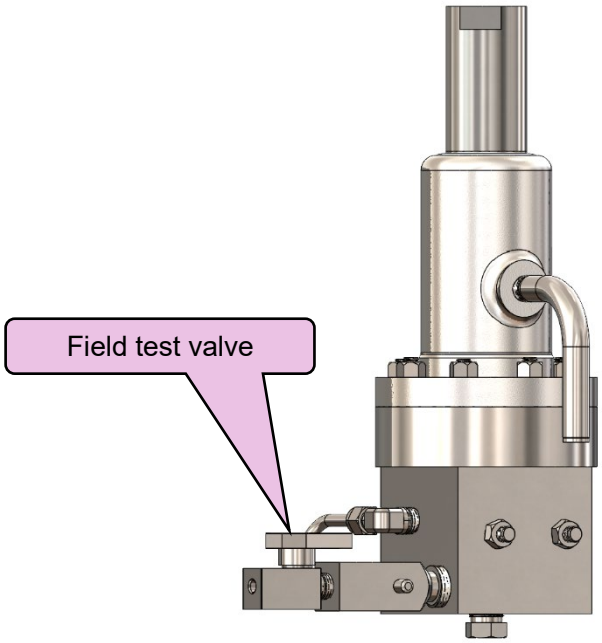
Accessories

- Field test valve

  This valve is intended to check the set pressure with the pressure relief valve installed. In this field test, a nitrogen cylinder is usually used as the pressure supply source, an appropriate regulator etc. is used to reduce the pressure, and then pressure is gradually increased. Normally, this test is conducted with no pressure applied to the main valve. For the operation confirmation method etc., refer to the instruction manual.



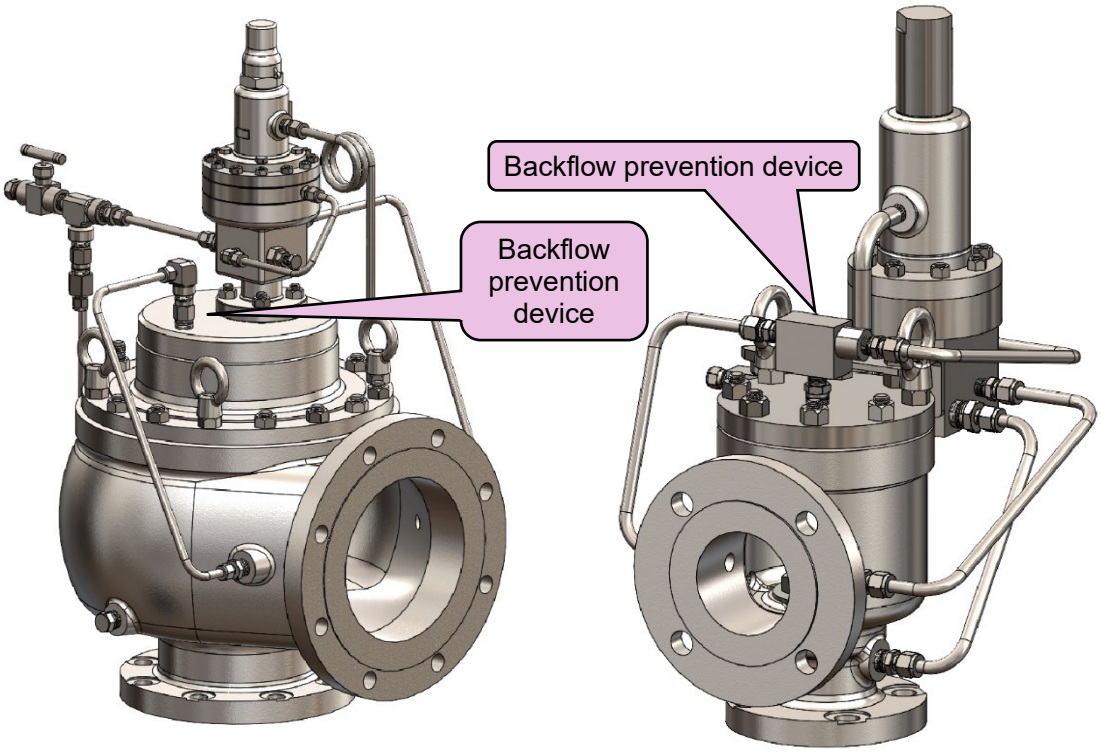
PMP pilot



P70L pilot

◆ Backflow prevention device

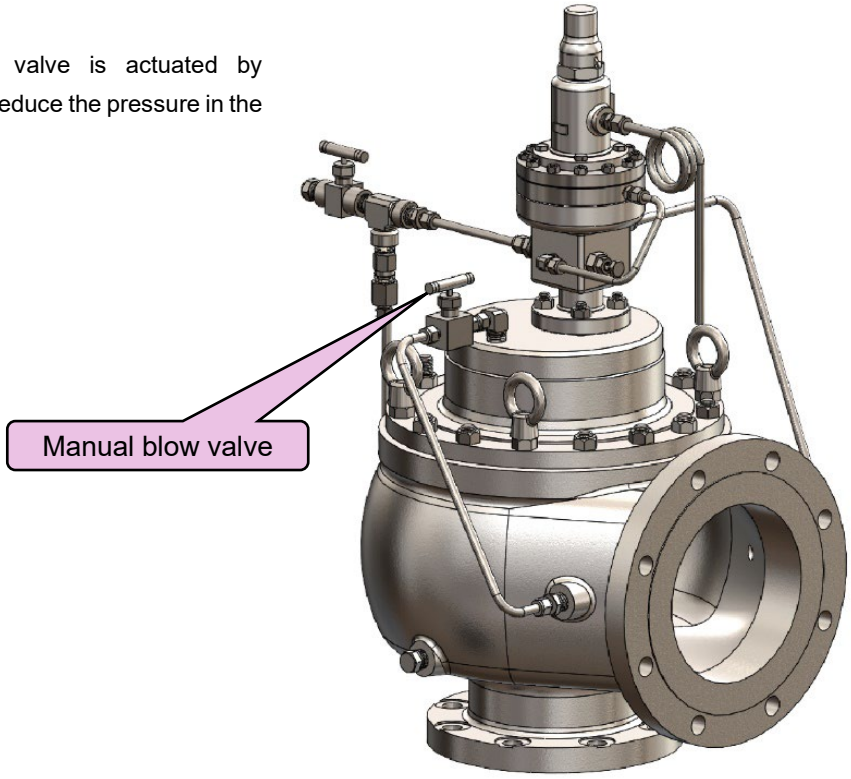
The backflow prevention device is required when pressure exceeding the inlet pressure is generated on the outlet side of the pressure relief valve. This is because when the outlet pressure becomes higher, a valve opening force acts on the main valve piston to cause backflow.



PMP pilot　　P70L pilot

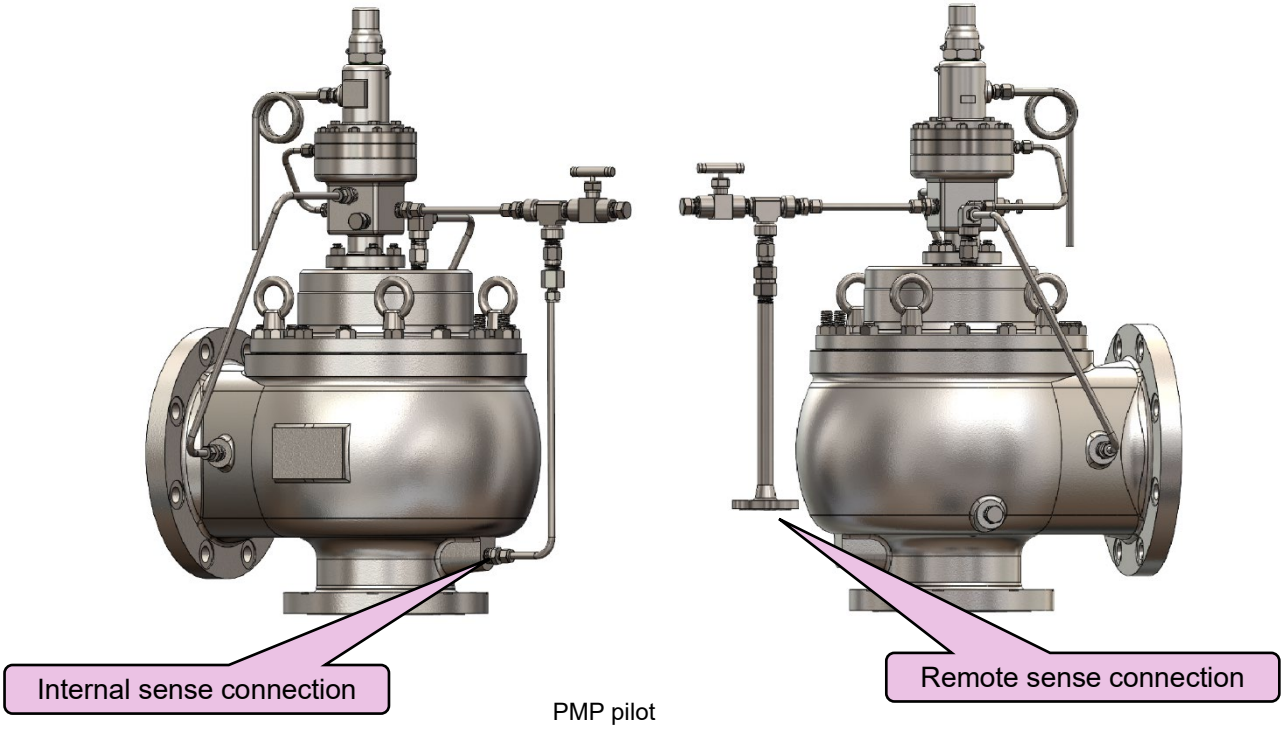
◆ Manual blow valve

The pressure relief valve is actuated by opening this valve to reduce the pressure in the main valve dome.

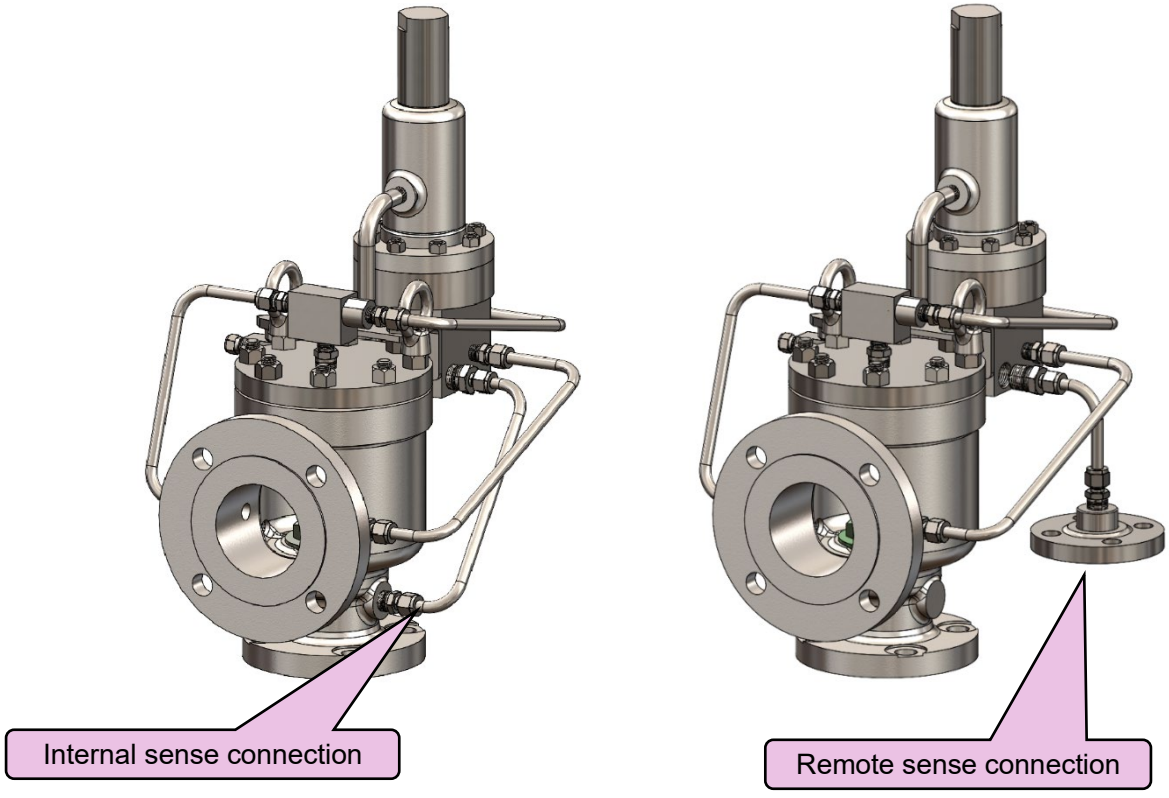


◆ Sense Pressure connection of pilot valve

There are two types of pressure connection of the pilot valve: the internal sense connection and remote pressure sense connection. When the pressure relief valve operates, a pressure loss occurs in the inlet piping. If this pressure loss exceeds 3%, using the remote pressure sense connection, which senses pressure from a point where no pressure loss occurs during pressure relief valve operation, can reduce the risk of unstable operation of the pressure relief valve.



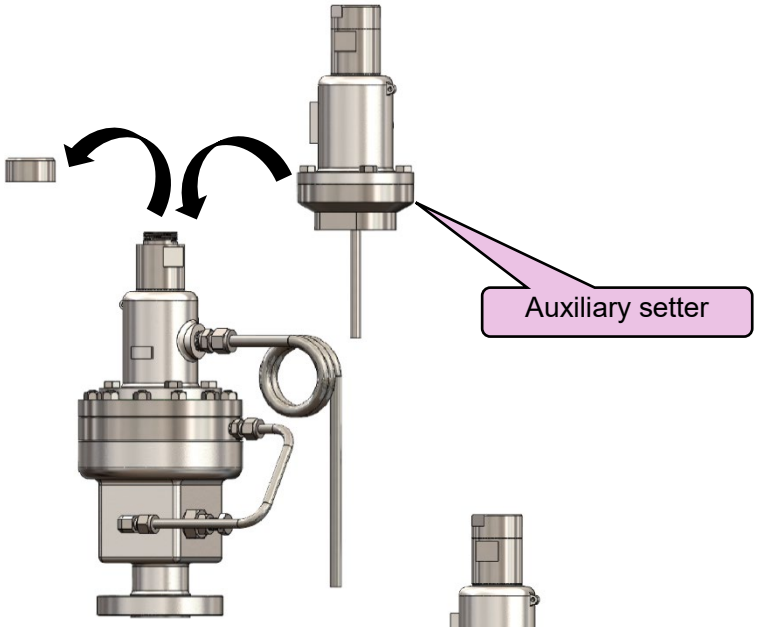
PMP pilot



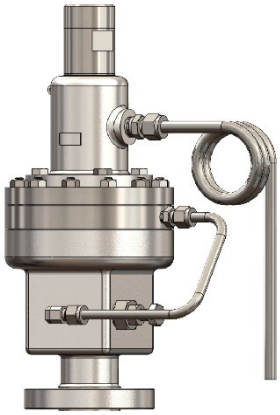
P70L pilot

◆ Auxiliary setter

In the case of marine cargo tank services, this setter is used to change the set pressure easily without breaking the pressure relief valve seal, for example, when changing the cargo.



Set pressure changing method



First set pressure

Second set pressure

Type code

PSL-MP11-	1	6	1-	E	S1		(A)

Cap code

(A)	Sealed screwed
(B)	Sealed bolted

Additional code

Blank	Standard pilot	-P70	Modulation pilot

Material code (See the table below.)

Blank	A216-WCB (SCPH2)	E	SA105M
C5	A352-LCB (SCPL1)	E5	LF2
S	A351-CF8 (SCS13A)	G	SUSF304
S1	A351-CF8M (SCS14A)	G1	SUSF316
S2	A351-CF3 (SCS19A)	G2	SUSF304L
S3	A351-CF3M (SCS16A)	G3	SUSF316L

Supplementary symbol

E	PTFE sheet & Standard orifice	G	O-ring sheet & Standard orifice
T	PTFE sheet & Enlarged orifice	R	O-ring sheet & Enlarged orifice

Connection code

1-	ASME Flange	4-	JIS Flange	9-	JIS B 8210 (1986) Flange
2-	JPI Flange	5-	Special	0-	JIS B 8210 (1994) Flange

Temperature class code (determined by discharge temperature) Unit: °C (°F)

3	-196 (-320) ≤ T< -101(-150)	5	-101(-150) ≤ T< -29(-20)	6	-29(-20) ≤ T< 128(262)

Pressure class code

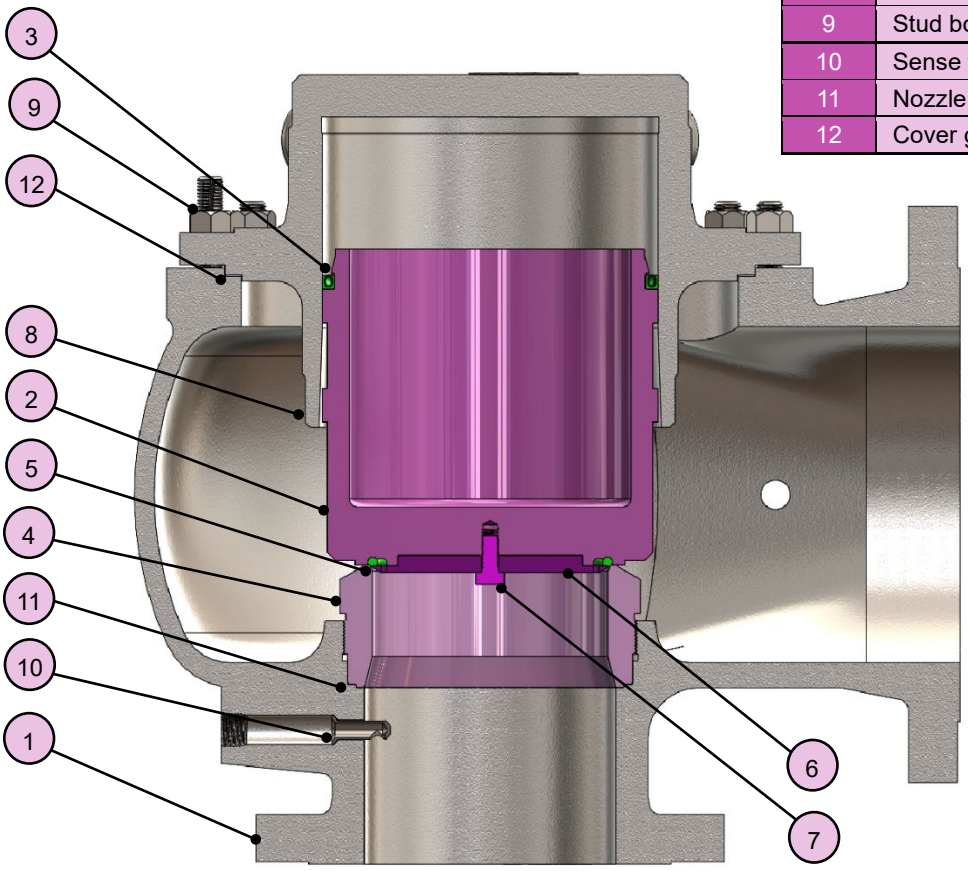
1	Class 150 or JIS 10K	2	Class 300 or JIS 20K	3	Class 300 or JIS 30K

Type code [1] + [2] + [3]

[1]	[2]		[3]	
PSL-MP	1	Single pilot & Single set	1	Piston type
	2	Single pilot & Multi set		
	3	Dual pilot & Single set		
	4	Dual pilot & Multi set		

Cross-sectional View of Main Valve

No.	Part name
1	Body
2	Disk
3	Disk seal
4	Nozzle
5	Seat
6	Seat retainer
7	Retainer bolt
8	Cover
9	Stud bolt, nut
10	Sense tube
11	Nozzle gasket
12	Cover gasket



* This shows a general structure. The structure varies depending on the seat type or size.

Standard Material of Main Valve

Standard material by temperature

No.	Application temperature range (°C)	-196 – -46	-46 – -29	-29 – 125
	Material code	S	C5	Blank
1	Body	A315-CF8 or SCS13A	A352-LCB or SCPL1	A216-WCB or SCPH2
2	Disk	SUS304		
3	Disk seal	PTFE	ELASTOMER	
4	Nozzle	SUS304		
5	Seat	PTFE	ELASTOMER	
6	Seat retainer	SUS304		
7	Retainer bolt	SUS304		
8	Cover	SCS13A		
9	Stud bolt, nut	SUS304		
10	Sense tube	SUS304		
11	Nozzle gasket	PFA		
12	Cover gasket	V7020		

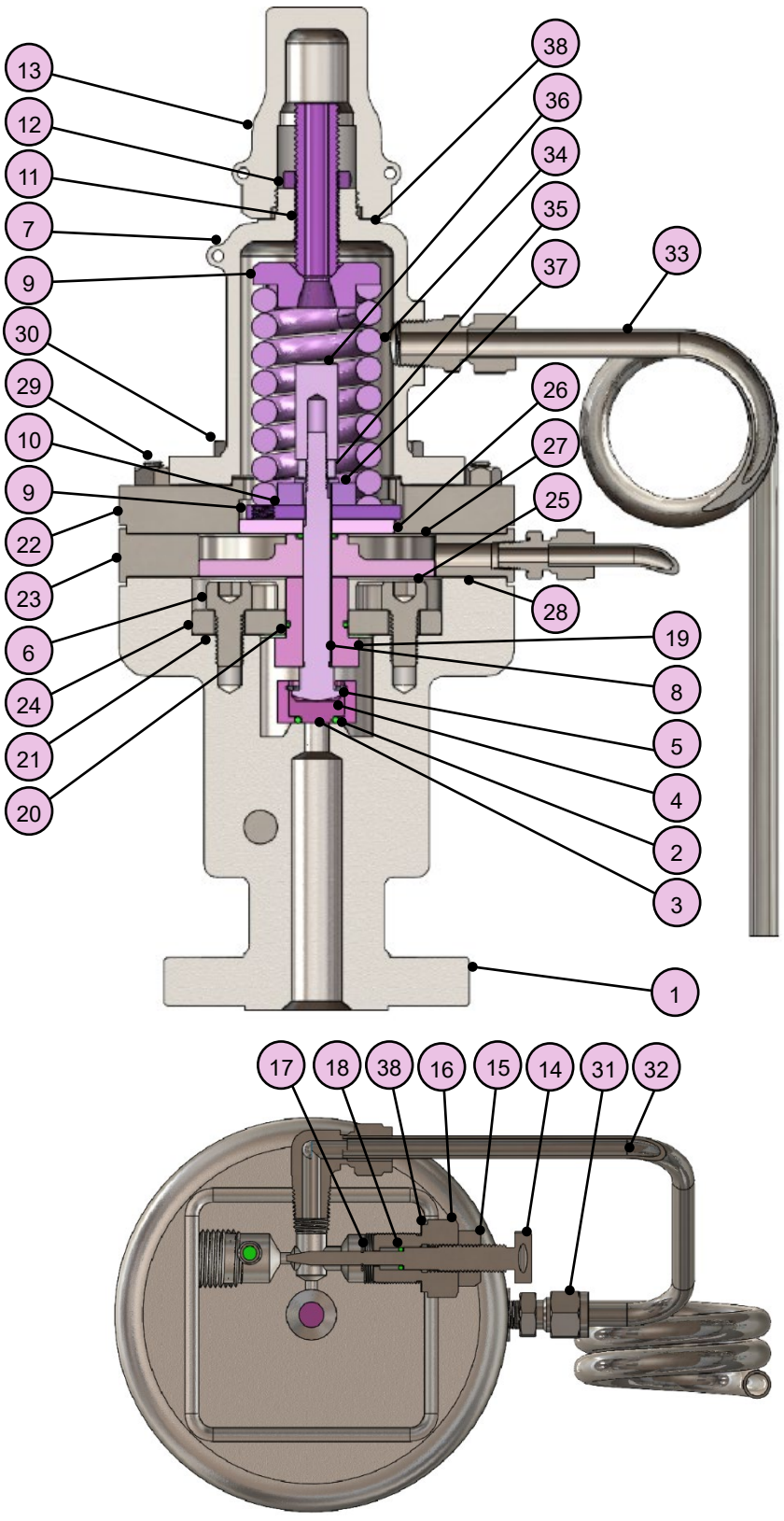
* The minimum operating temperature of SCPH2 varies depending on the applicable regulations.

Standard material (main valve) by material code

	Material code	S1	S2	S3
1	Body	A351-CF8M or SCS14A	A351-CF3 or SCS19A	A351-CF3M or SCS16A
2	Disk	SUS316	SUS304L	SUS316L
3	Disk seal	PTFE or ELASTOMER		
4	Nozzle	SUS316	SUS304L	SUS316L
5	Seat	PTFE or ELASTOMER		
6	Seat retainer	SUS316	SUS304L	SUS316L
7	Retainer bolt	SUS316	SUS304L	SUS316L
8	Cover	SCS14A	SCS13A	SCS16A
9	Stud bolt, nut	SUS316	SUS304	SUS316
10	Sense tube	SUS316	SUS304L	SUS316L
11	Nozzle gasket	PFA		
12	Cover gasket	V7020		

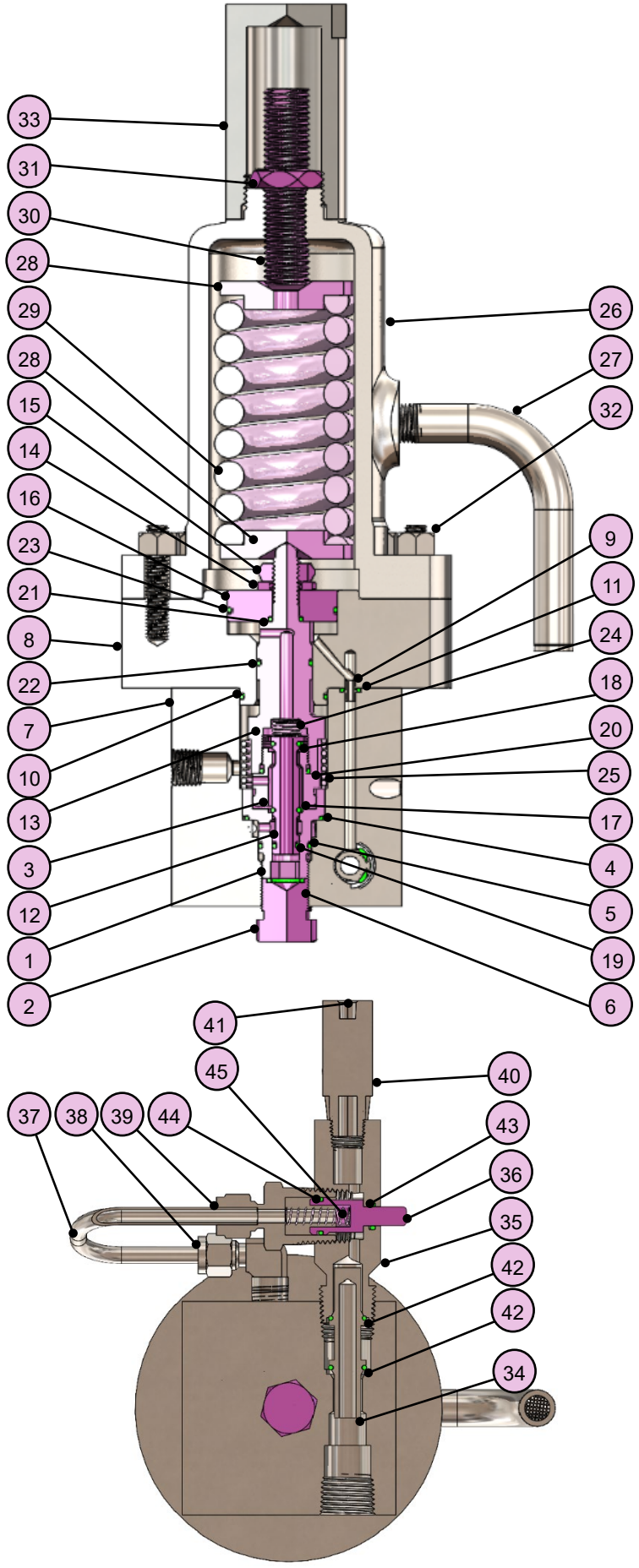
Cross-sectional View of Pilot Valve

PMP pilot



No	Part name
1	Body
2	Seat
3	Seat base
4	Seat retainer
5	Retainer ring
6	Spindle bolt
7	Bonnet
8	Spindle
9	Spring washer
10	Spring spacer
11	Adjust screw
12	Adjust screw lock nut
13	Cap
14	Adjust needle
15	Needle lock nut
16	Needle bush
17	Retaining ring
18	Needle seal
19	Set plate
20	Set plate seal
21	Spindle seal
22	Upper case
23	Diaphragm retainer
24	Spindle diaphragm retainer
25	Diaphragm set plate 1
26	Diaphragm set plate 2
27	Sense diaphragm
28	Boost diaphragm
29	Stud bolt nut
30	Bonnet bolt
31	Tube connector
32	Sense pipe
33	Vent tube
34	Spring
35	Spindle nut
36	Spindle nut lock nut
37	Washer
38	Gasket

70L pilot



No.	Part name
1	Nozzle
2	Nozzle bush
3	Dome nozzle
4	Nozzle seal (upper)
5	Nozzle seal (lower)
6	Nozzle bush seal
7	Body
8	Piston case
9	Positioning pin
10	Piston case seal
11	Positioning pin seal
12	Spool
13	Stem
14	Stem washer
15	Stem nut
16	Sensing piston
17	Outlet seat
18	Dome seat
19	Spool seal
20	Dome nozzle seal
21	Stem seal (upper)
22	Stem seal (lower)
23	Piston seal
24	Inner spring
25	Outer spring
26	Bonnet
27	Vent elbow
28	Spring retainer
29	Spring
30	Adjusting screw
31	Adjusting screw lock nut
32	Stud bolt
33	Cap
34	Shuttle check piston
35	Indicator body
36	Indicator
37	Indicator tube
38	Indicator fitting 1
39	Indicator fitting 2
40	Field test valve
41	Plug
42	Shuttle check seat
43	Indicator seal 1
44	Indicator seal 2
45	Indicator spring

* This shows a general structure. The structure may vary depending on the specifications.

Standard Material of Pilot Valve

Material of PMP pilot

No	Part name	Standard	S1
1	Body	SCS13A	SCS14A
2	Seat	Elastomer	
3	Seat base	B637-N07750	
4	Seat retainer	SUS304	SUS316
5	Retainer ring	SUS304	SUS316
6	Spindle bolt	SUS304	SUS316
7	Bonnet	SCS13A	SCS14A
8	Spindle	B637-N07750	
9	Spring washer	SUS304	SUS316
10	Spring spacer	SUS304	SUS316
11	Adjust screw	SUS304	SUS316
12	Adjust screw lock nut	SUS304	SUS316
13	Cap	SCS13A	SCS14A
14	Adjust needle	SUS304	SUS316
15	Needle lock nut	SUS304	SUS316
16	Needle bush	SUS304	SUS316
17	Retaining ring	SUS304	
18	Needle seal	PFA	
19	Set plate	SUS304	SUS316
20	Set plate seal	Elastomer	
21	Spindle seal	PFA	
22	Upper case	SUS304	SUS316
23	Diaphragm retainer	SUS304	SUS316
24	Spindle diaphragm retainer	SUS304	SUS316
25	Diaphragm set plate 1	SUS304	SUS316
26	Diaphragm set plate 2	SUS304	SUS316
27	Sense diaphragm	PFA	
28	Boost diaphragm	PFA	
29	Stud bolt nut	SUS304	SUS316
30	Bonnet bolt	SUS304	SUS316
31	Tube connector	SUS316	
32	Sense pipe	SUS304-TP	SUS316-TP
33	Vent tube	SUS304-TP	SUS316-TP
34	Spring	SUS304	SUS316
35	Spindle nut	SUS304	SUS316
36	Spindle nut lock nut	SUS304	SUS316
37	Washer	SUS304	SUS316
38	Gasket	PFA	

Standard material of P70L pilot

No.	Part name	Standard	S3
1	Nozzle	SUS316	SUS316L
2	Nozzle bush	SUS316	SUS316L
3	Dome nozzle	SUS316	SUS316L
4	Nozzle seal (upper)	Elastomer	
5	Nozzle seal (lower)	Elastomer	
6	Nozzle bush seal	Elastomer	
7	Body	SUSF316	SUSF316L
8	Piston case	SUS316	SUS316L
9	Positioning pin	SUS316	SUS316L
10	Piston case seal	Elastomer	
11	Positioning pin seal	Elastomer	
12	Spool	SUS316	SUS316L
13	Stem	SUS316	SUS316L
14	Stem washer	SUS316	SUS316L
15	Stem nut	SUS316	SUS316L
16	Sensing piston	SUS316	SUS316L
17	Outlet seat	Elastomer	
18	Dome seat	Elastomer	
19	Spool seal	Elastomer	
20	Dome nozzle seal	Elastomer	
21	Stem seal (upper)	Elastomer	
22	Stem seal (lower)	Elastomer	
23	Piston seal	Elastomer	
24	Inner spring	SUS316	
25	Outer spring	SUS316	
26	Bonnet	SCS14A	
27	Vent elbow	SUS316-TP	SUS316L-TP
28	Spring retainer	SUS316	SUS316L
29	Spring	SUS316	SUS316L
30	Adjusting screw	SUS316	SUS316L
31	Adjusting screw lock nut	SUS316	SUS316L
32	Stud bolt	SUS316	SUS316L
33	Cap	SUS316	SUS316L
34	Shuttle check piston	SUS316	SUS316L
35	Indicator body	SUS316	SUS316L
36	Indicator	SUS316	SUS316L
37	Indicator tube	SUS316-TP	SUS316L-TP
38	Indicator fitting 1	SA182-F316	
39	Indicator fitting 2	SA182-F316	
40	Field test valve	SA479-316	
41	Plug	SUS316	SUS316L
42	Shuttle check seat	Elastomer	
43	Indicator seal 1	Elastomer	
44	Indicator seal 2	Elastomer	
45	Indicator spring	SUS316	

Actual Area

The orifice is Fukui's original product for securing a large discharge area.

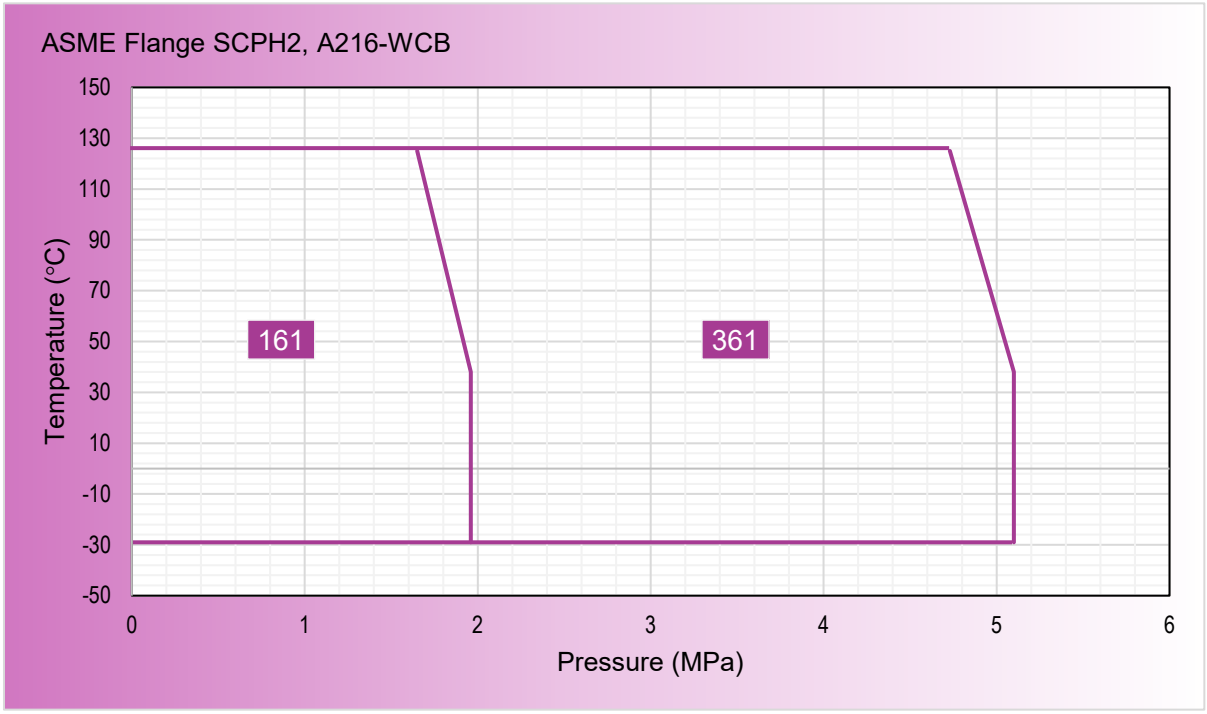
Size	FUKUI					
	Throat diameter		Nominal lift		Throat area	
	mm	in	mm	in	mm^2	in^2
2*3	50.0	1.9685	27.5	1.0826	1963.4	3.04327
3*4	71.0	2.7952	39.1	1.5393	3959.1	6.13661
	75.0	2.9527	41.3	1.6259	4417.8	6.84760
4*6	92.0	3.6220	50.6	1.9921	6647.6	10.3038
	95.5	3.7598	52.6	2.0708	7163.0	11.1026
6*8	135	5.3149	74.3	2.9251	14313.8	22.1864
	140	5.5118	77.0	3.0314	15393.8	23.8604
8*10	180	7.0866	99.0	3.8976	25446.9	39.4427

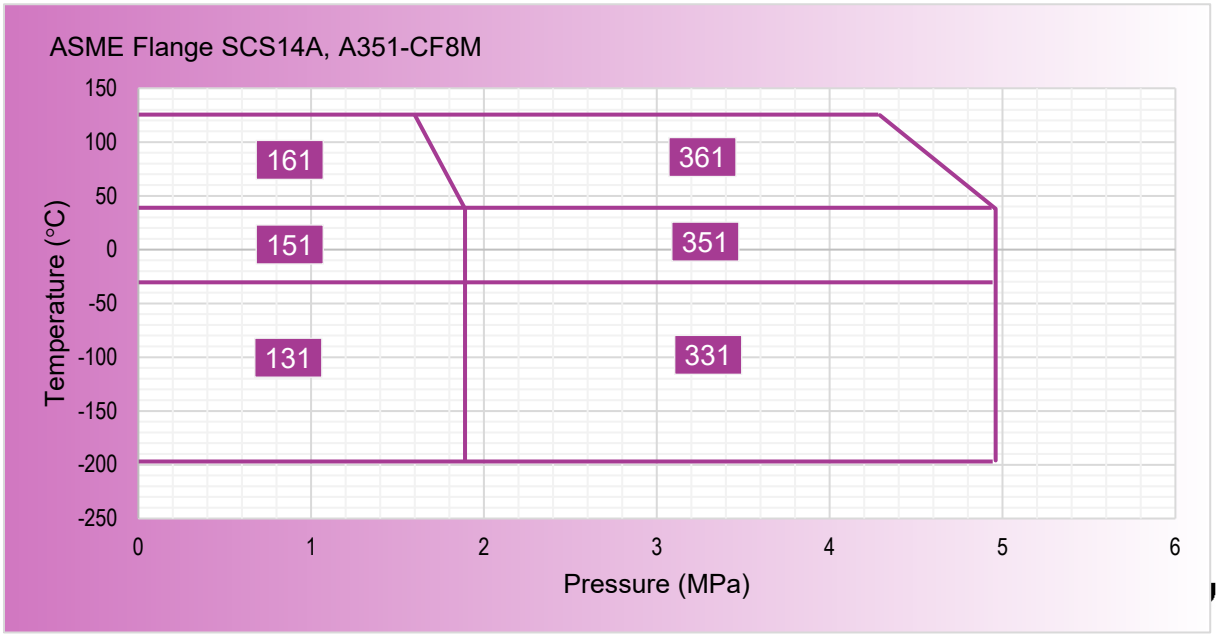
Sizes of 10*12 or larger are also manufactured.

Pressure–Temperature Rating

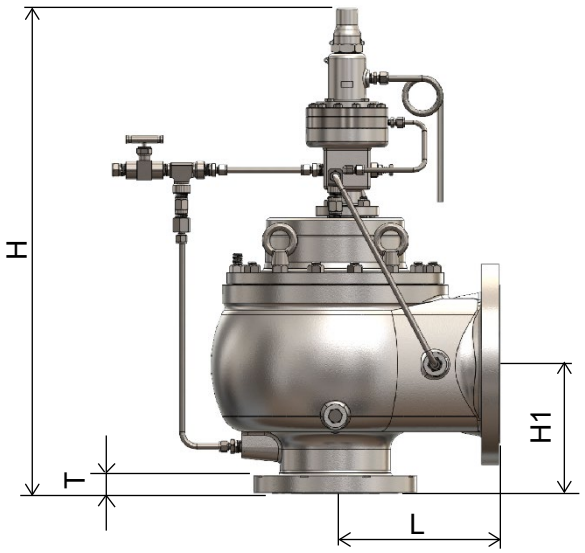
Pressure–Temperature Rating ASME B16.5 Flange						
Material Body Bonnet	Flange class		Maximum pressure limit (Mpa)			
	Inlet	Outlet	Temperature T (°C)	-196 ≤ T < -101	-101 ≤ T < -29	-29 ≤ T < 125
			*1 *2	3	5	6
SCPH2 A216-WCB	150	150	1	-	-	1.96
	300		3	-	-	5.1
SCS14A A351- CF8M	150	150	1	1.89	1.89	1.89
	300		3	4.96	4.96	4.96

*1 Indicates the pressure class code. *2 Indicates the temperature code.





Dimensions and Weight



ASME Flange Dimensions and Weight Units: mm, kg

Size	Pressure class code	Flange class		Center-to-face dimension		Inlet flange dimension T	Overall length H	Approximate weight
		Inlet	Outlet	H1	L			
2*3	1	150	150	125	135	23	610	50
	3	300						
3*4	1	150	150	160	175	29	680	70
	3	300						
4*6	1	150	150	175	200	24	720	110
	3	300		183		32	728	115
6*8	1	150	150	220	280	28	830	170
	3	300		229		37	839	180
8*10	1	150	150	260	82	28	900	250
	3	300		272		42	914	265

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