

SF-15, 15L, 16, 16L Type Safety Valve (Full Bore Type)

for (Pressure Vessels), (Steam Boiler), etc. (1.0MPa)



SF-15 Type



SF-16 Type

■ PRESSURE DIVISION

(MPa)

Code No.	Pressure division
1	0.1
2	Over 0.1~0.12
3	Over 0.12~0.15
4	Over 0.15~0.18
5	Over 0.18~0.21
6	Over 0.21~0.25
7	Over 0.25~0.3
8	Over 0.3~0.36
9	Over 0.36~0.43
A	Over 0.43~0.5
B	Over 0.5~0.65
C	Over 0.65~0.8
D	Over 0.8~1.0

■ SPECIFICATIONS

Model name	SF-15	SF-15L	SF-16	SF-16L
Code name	SF15-C □	SF15L-C □	SF16-C □	SF16L-C □
	※ Code No. of pressure division is required in □.			
Cap type	With lever		Without lever	
Applicable fluid	Air	Steam	Air, gases & liquids	Steam
Size	40~150(1½"~6")			
Fluid temperature	-5~235°C			
Set pressure range	0.1~1.0MPa			
End connection	Inlet: Flanged JIS 10KRF (Thickness is based on table of DIMENSIONS)* ¹ . Outlet: Flanged JIS 10KFF* ² .			
Materials	Body (Cast steel)* ³ , Disc & Seat ring (Stainless steel)* ⁴			
Valve body pressure test	Hydraulic 2.0MPa			

*1. Flange codes JIS B8210 10K (Inlet) × JIS B2220 10K (Outlet) and ASME (ANSI) Class 150 × 150 are also available upon your request.

*2. RF flange for outlet side is also available upon your request.

*3. Stainless steel body is available. (Applicable pressure is different for each size)

*4. The valve for steam has split valve disc.

*5. For size 15~25mm, please see Page 82.

■ DIMENSIONS

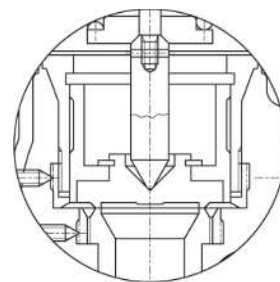
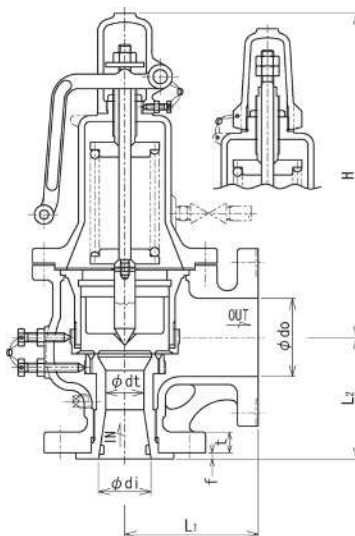
(mm)

Size Inlet×Throat dia.×Outlet	Seat opening dia. D	Throat dia. dt	Throat area a(mm ²)	Lift ℓ	Face to Face L ₁ L ₂		Height H SF-15 SF-15L Type SF-16 SF-16L Type		Thickness of flange t f		Mass(kg) SF-15 SF-15L Type SF-16 SF-16L Type	
di×dt×do												
40(1½")×25/30×65(2½")	35	25 30	490.6 706.5	6.5 7.5	127	125	290	291	24	6	21	21
50(2")×34/38×80(3")	45	34 38	907.4 1133.5	8.5 9.5	136	135	341	342	26	6	27	26
65(2½")×43/49×100(4")	58	43 49	1451.4 1884.7	11.0 12.5	156	160	396	397	28	8	45	44
80(3")×55/61×125(5")	71	55 61	2374.6 2920.9	14.0 15.5	176	180	480	481	30	8	63	61
100(4")×69/76×150(6")	88	69 76	3737.3 4534.1	17.5 19.0	206	205	553	554	32	10	97	95
125(5")×86/95×200(8")	111	86 95	5805.8 7084.6	21.5 24.0	225	240	686	687	34	10	160	158
150(6")×105/115×200(8")	134	105 115	8654.6 10381.6	26.5 29.0	255	250	813	815	36	12	242	236

Flange code inlet JIS 10KRF
Outlet JIS 10K

■ CONSTRUCTION

● CONSTRUCTION OF SF-15L, 16L VALVE PART



Depending on nominal diameter, the structure of the valve may be different from what is shown in the drawing.

Extract from JIS B8210-2009 Spring Safety Valve for Steam and Gases

■ Allowed deviation of discharge-starting pressure

(1) For steam

There is no provision on the relief pressure of safety valve for steam.

(2) For gases

For valve for gases, the allowed deviation of start to discharge pressure is set pressure $\pm 5\%$ (minimum pressure: $\pm 0.025\text{MPa}$). In case of allowed deviation, which is not allowed to exceed set pressure, add the "+" side to "-" side.

Note: For valves for gases, the set pressure is generally the start to discharge pressure.

■ Allowed deviation of opening pressure (popping pressure)

(1) For steam

See Table 1 for the deviation of opening pressure. In case of allowed deviation, which is not allowed to exceed set pressure, add the "+" side to "-" side.

(2) For gases

For safety valves for gases, the allowed deviation of discharge-starting pressure is less than 1.1 times of start to discharge pressure. However, in the case of setting opening pressure, the deviation should be $\pm 3\%$ set pressure (minimum $\pm 0.015\text{MPa}$).

In case of allowed deviation, which is not allowed to exceed set pressure, add the "+" side to "-" side.

■ BLOWDOWN

(1) For steam

See Table 2 for the blowdown pressure of safety valves for steam. For valves for steam used with through flow boilers, re-heater, and piping, which opening pressure exceeds 0.3MPa , the blowdown pressure can be less than 10% of set pressure.

(2) For gases

See Table 3 for blowdown pressure of safety valves for gases.

Note: Unless otherwise specified in JIS B8210, Blowdown Standard of VENN shall apply.

■ Restriction of material use (pressure parts of safety valve) (Source: JIS B8210-2009)

(1) For steam

Material of pressure parts	Allowed range
Cast iron	Set pressure: Max. 1.6MPa . Fluid temperature: Max. 230°C
Ductile iron casting	Set pressure: Max. 2.4MPa . Fluid temperature: Max. 350°C

(2) For gases

Gas type	Toxic,flammable gases		Gases other than toxic,flammable gases	Toxic, flammable gases, other gases
	Allowed range			
Material of pressure parts				
Cast iron	Not allowed	Set pressure: Max.0.2 MPa		Not allowed
Ductile cast iron	Set pressure: Max.0.2 MPa		Set pressure: Max.1.6 MPa	Not allowed
Ductile iron casting	A: Application in system for highly toxic gases such as phosgene and hydrogen cyanide, etc is not allowed. B: For gases other than those mentioned in A, the set pressure should be Max. 2.4 MPa. C: Fluid temperature should be higher than -5°C and lower than 350°C.			

TABLE1. TOLERANCE OF OPENING PRESSURE OF SAFETY VALVES FOR STEAM

(MPa)

Set pressure	Tolerance
Below 0.5	± 0.015
0.5 or more and less than 2.3	$\pm (3\% \text{ of set pressure})$
2.3 or more and less than 7.0	± 0.07
7.0 or more	$\pm (1\% \text{ of set pressure})$

*1. For steam, generally the set pressure is assumed to be the opening pressure.

*2. The tolerance of the opening pressure of the safety valves for steam used other than in boilers can be $\pm 3\%$ of the set pressure (minimum value $\pm 0.015\text{MPa}$).

TABLE2. BLOWDOWN PRESSURE OF SAFETY VALVES FOR STEAM

(MPa)

Set pressure	Blowdown
0.4 or less	0.03
Over 0.4	7%(4%) or less of set pressure

*1. Generally, the blowdown pressure for steam shall be the difference between the opening pressure and the reseating pressure.

*2. The figures in () can be determined in accordance with the agreement between the parties concerned.

TABLE3. BLOWDOWN PRESSURE OF SAFETY VALVES FOR GASES

(MPa)

Set pressure	Blowdown	
	Metal seat type	Soft seat type
0.2 or less	0.03 or less	0.05 or less
Over 0.2	15% or less of set pressure	25% or less of set pressure

*1. Generally, the blowdown pressure for gases shall be the difference between the start to discharge pressure and the reseating pressure. However, when set by the opening pressure, it shall be the difference between the opening pressure and the reseating pressure.

*2. The definition of the soft seated and metal seated types shall be in accordance with JIS B0100.

Note. Unless otherwise specified in JIS B8210, Blowdown Standard of VENN shall apply.

DATA/Safety Valves, Relief Valves

Applicable Laws & Regulations and Formulas for Calculating Relieving Capacity

Coefficients assigned to equations may be those specified in applicable laws/regulations or in-house data(※).

※In-house data

1. PRESSURE VESSEL CONSTRUCTION CODE (from JIS B8210-2009)

(1) For Steam

$$Q_m = 5.25 C' K_{dr}' A P$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

ℓ: Lift (mm)

d: Throat diameter (mm)

P: Absolute relieving pressure (MPa·A)

(Select the larger one of set pressure × 1.1 + 0.101 or set pressure + 0.020 + 0.101.)

C': Coefficient determined according to the property of steam
(See Tab.1 in Page 87.)

For saturated steam, see the following table:

Absolute relieving pressure (MPa·A)	C': Coefficient determined according to the property of steam
Max. 0.5	1*
over 0.5~1.0	0.98*
over 1.0~2.0	0.97*
over 2.0	0.96*

For superheated steam, See Tab.1. in Page 87.

K_{dr}': Relieving coefficient

Lift type: 0.864*

Full bore type: 0.777

(2) For Gases

$$Q_m = C'' K_{dr} P_1 A K_b \sqrt{\frac{M}{ZT}}$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

ℓ: Lift (mm)

d: Throat diameter (mm)

Z: Compression coefficient: 1* (See Fig.1 in Page 90)

T: Absolute temperature (K) of gases at relieving pressure

P₁: Relieving pressure (MPa·A)

(Select the larger one of set pressure × 1.1 + 0.101 or set pressure + 0.020 + 0.101.)

P₂: Back pressure (MPa·A)

C'': Coefficient determined according to κ (See Tab.5 in Page 88)

κ : Adiabatic exponent (Isentropic, See Tab.4 in Page 88).

The value will be 1.001 if it is not specified, in which case C''=23.95

K_{dr}': Relieving coefficient

Lift type: 0.864*

Full bore type: 0.777

K_b: Back pressure compensation coefficient (Depending on P₂/P₁ and κ .
See Tab.6 in Page 89)

M: Molecular weight of gas (See Tab.4 in Page 88)

■ Calculating maximum flow-in gas using the following formula:

$$G = 0.0028 v \rho d^2$$

G: Flow in gas (kg/h)

v : Velocity of gas (m/sec)

(More than 20 for saturated steam, or more than 30 for super-heated steam, or more than 10 for common gas)

ρ : Density of gas (kg/m³)

d : Internal diameter of pipe (mm)

(3) For water/hot water (also applicable for hot water with temperature higher than 120°C)

(1) In case of searching from relieving capacity:

$$S = \frac{W}{87.7 / ((P_1 + 0.1)^\kappa Y_1)}$$

(2) In case of searching from thermal input of pressure vessel or thermal output of hot water boiler:

$$S = \frac{Q_\varepsilon}{87.7 C / ((P_1 + 0.1)^\kappa Y_1)}$$

(If (P₁+0.1)^κ > (P₁-P₂) in formula (1) and (2), replace (P₁-P₂) with (P₁+0.1)^κ)S : Seat opening area (mm²)

W: Relieving capacity of valve (kg/h)

P₁: Relieving pressure (MPa) (See Note)

Lift type: set pressure × 1.1

For SL-37~40, 43, 44 type, see Page 65.

Full bore type: select the larger one of set pressure × 1.15 or set pressure + 0.034

Relief valve (type E · ED): select the larger one of set pressure × 1.25
or set pressure + 0.034P₂: Outlet pressure (MPa)

κ : Coefficient correction (See Fig.2 in Page 90)

Δt: Difference between the saturated temperature of relieving pressure P₁ and the temperature of hot water at inlet. (°C)Y₁: Density of the hot water at inlet (kg/L) (See Tab.2 in Page 87)

Q : Thermal input of pressure vessel or thermal output of hot water boiler (kJ/h)

ε : Coefficient of volumetric expansion for water (1/°C) (See Tab.3 in Page 87)

C: Specific heat of water at constant pressure (kJ/kg°C) (See Tab.3 in Page 87)

Note: In the case of full-bore valve and relief valve, make sure the relieving pressure (P₁) does not exceed "maximum working pressure of pressure vessel or hot water boiler X 1.1" or "maximum working pressure + 0.034".

Applicable Laws & Regulations and Formulas for Calculating Relieving Capacity

Coefficients assigned to equations may be those specified in applicable laws/regulations or in-house data (※).

※ In-house data

2. BOILER CONSTRUCTION CODE (from JIS B8210-2009)

(1) For Steam

$$Q_m = 5.25 C' K_{dr} A P$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

 ℓ : Lift (mm)

d: Throat diameter (mm)

P: Absolute relieving pressure (MPa·A)

(Select the larger one of set pressure $\times 1.03 + 0.101$ or set pressure $+ 0.015 + 0.101$)

C': Coefficient determined according the property of steam (See Tab.1 in Page 87)

For saturated steam, see the following table:

Absolute relieving pressure (MPa·A)	C': Coefficient determined according the property of steam
Max. 0.5	1※
over 0.5~1.0	0.98※
over 1.0~2.0	0.97※
over 2.0	0.96※

For superheated steam, see Tab.1 in Page 87.

K_{dr}: Relieving coefficient

Lift type: 0.864※

Full bore type: 0.777

(2) For hot water (applicable when temperature is less than 120°C. If temperature is higher than 120 °C, then use the formula described in (1))

(1) In case of searching from relieving capacity:

$$S = \frac{W}{87.7 / (P_1 + 0.1) \kappa \gamma_1}$$

(2) In case of searching from thermal input of pressure vessel thermal output of hot water boiler:

$$S = \frac{Q_e}{87.7 C / (P_1 + 0.1) \kappa \gamma_1}$$

In formula (i) and (ii), if $(P_1 + 0.1) \kappa > (P_1 - P_2)$, then $(P_1 + 0.1) \kappa$ should be replaced by $(P_1 - P_2)$.S: Seat opening area (mm²)

W: Required relieving capacity of valve (kg/h)

Note: In the case of full-bore valve and relief valve, make sure the relieving pressure (P₁) does not exceed "maximum working pressure of pressure vessel or hot water boiler $\times 1.1$ " or "maximum working pressure $+ 0.034$ ".P₁: Relieving pressure (MPa) (see Note)Lift type: set pressure $\times 1.1$

For SL-37~40, 43, 44 type see Page 65.

Full bore type: select the larger one of set pressure $\times 1.15$ or set pressure $+ 0.034$ Relief valve (type E · ED): select the larger one of set pressure $\times 1.25$ or set pressure $+ 0.034$ P₂: Outlet pressure (MPa) κ : Coefficient correction (See Fig.2 in Page 90) Δt : Difference between the saturated temperature of relieving pressure P₁ and the temperature of hot water at inlet. (°C) γ_1 : Density of the hot water at inlet (kg/L) (See Tab.2 in Page 87)

Q : Thermal input of pressure vessel or thermal output of hot water boiler (kJ/h)

 ε : Coefficient of volumetrical expansion for water (1/°C) (See Tab.3 in Page 87)

C: Specific heat of water at constant pressure (kJ/kg°C) (See Tab.3 in Page 87)

NOTE

It is necessary installing safety valve when water temperature exceeds 120°C. The formula is as the following:

$$Q_m = 5.25 C' K_{dr} A P$$

In this case, the required relieving capacity (kg/h) of safety valve can be calculated using the following formula:

$$W = \frac{Q}{h_1 - h_2}$$

W: Required relieving capacity of safety valve (kg/h)

Q: Thermal output of hot water boiler (kJ/h)

h₁: Enthalpy of saturated steam that is equivalent to the maximum working pressure of boiler (kJ/kg).h₂: Enthalpy of water supply (kJ/kg)

$$W = \frac{Q_e}{C}$$

 ε : Coefficient of volumetrical expansion of water (1/°C) (See Tab.3 in Page 87)

C: Specific heat of water at constant pressure (kJ/kg°C) (See Tab.3 in Page 87)

(3) For dowerthm boiler

$$Q_m = C'' K_{dr} P_1 A K_b \sqrt{\frac{M}{ZT}}$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

 ℓ : Lift (mm)

d: Throat diameter (mm)

Z: Compression coefficient: 1※ (See Fig.1 in Page 90)

T: Absolute temperature (K) of gases at absolute relieving pressure

P₁: Absolute relieving pressure (MPa·A)(Select the larger one of set pressure $\times 1.1 + 0.101$ or set pressure $+ 0.020 + 0.101$)P₂: Absolute back pressure (MPa·A)C': Coefficient determined according to κ (See Tab.5, Page 88) κ : Adiabatic exponent (Isentropic, See Tab.4 in Page 88)

The value will be 1.001 if it is not specified, in which case C'=23.95

K_{dr}: Relieving coefficient

Lift type: 0.864※

Full bore type: 0.777

K_b: Back pressure compensation coefficient (Depending on P₂/P₁ and κ . See Tab.6 in Page 89)

M: Molecular weight of air (See Tab.4 in Page 88)

DATA/Safety Valves, Relief Valves

Applicable Laws & Regulations and Formulas for Calculating Relieving Capacity

Coefficients assigned to equations may be those specified in applicable laws/regulations or in-house data (※).

※In-house data

3. JIS B8210-2009: SPRING SAFETY VALVE FOR STEAM AND GAS

(1) For Steam

$$Q_m = 5.25 C' K_{d'} A P$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

ℓ: Lift (mm)

d: Throat diameter (mm)

P: Absolute relieving pressure (MPa·A)

Products for boiler: (Select the larger one of set pressure × 1.03 + 0.101 or set pressure + 0.015 + 0.101)

Products for pressure vessels: (Select the larger one of set pressure × 1.1 + 0.101 or set pressure + 0.020 + 0.101)

C': Coefficient determined according to the property of steam (See Tab.1 in Page 87.)

For saturated steam, see the following table:

Absolute flow rating pressure (MPa·A)	C': Coefficient depending on the nature of steam
Max. 0.5	1 [※]
Over 0.5~1.0	0.98 [※]
Over 1.0~2.0	0.97 [※]
Over 2.0	0.96 [※]

For superheated steam, See the table in Page 87.

K_{d'}: Relieving coefficientLift type: 0.864[※]

Full bore type: 0.777

(2) For Gases

$$Q_m = C'' K_{d'} P_1 A K_b \sqrt{\frac{M}{ZT}}$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

ℓ: Lift (mm)

d: Throat diameter (mm)

Z: Compression coefficient: 1[※] (See Fig. 1 in Page 90)

T: Absolute temperature (K) of gases at relieving pressure

P₁: Absolute relieving pressure (MPa·A)

(Select the larger one of set pressure × 1.1 + 0.101 or set pressure + 0.020 + 0.101)

P₂: Absolute back pressure (MPa·A)

C'': Coefficient determined according to κ (See Tab.5 in Page 88)

κ : adiabatic exponent (See Tab.4, Page 88)

The value will be 1.001 if it is not specified, in which case C''=23.95

K_{d'}: Relieving coefficientLift type: 0.864[※]

Full bore type: 0.777

K_b: Back pressure compensation coefficient (Depending on P₂/P₁ and κ . See Tab.6 in Page 89)

M: Molecular weight of air (See Tab.4 in Page 88)

4. ELECTRICITY BUSINESS ACT (Technical Standard for Thermal Equipments for Power Generation) (Formula source: JIS B8210-1994)

■ Applicable for boilers and supporting equipments

(1) For Steam

$$Q_m = 5.246 C K_{d'} A (P + 0.1) \times 0.9$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

ℓ: Lift (mm)

d: Throat diameter (mm)

P: Relieving pressure (MPa)

Set pressure ≤ 0.1 MPa: Set pressure + 0.02

Set pressure > 0.1 MPa: Set pressure × 1.03

C: Coefficient determined according to the property of steam (See Tab.1 in Page 87)

Set pressure is < 0.5 MPa·A, at saturated pressure: 1

Set pressure is ≥ 0.5 MPa·A, at saturated pressure: 0.98

Superheated steam: Please contact our agent in your area.

K_{d'}: Rated discharge coefficientLift type: 0.96[※]

Full bore type: 0.864

(2) For Gases

$$Q_m = C' K_{d'} A P_1 \sqrt{\frac{M}{ZT}} \times 0.9$$

Q_m: Relieving capacity (kg/h)A : Seat opening area (mm²)Lift type: $A = \pi D \ell$ Full bore type: $A = \frac{\pi d^2}{4}$

D: Seat opening diameter (mm)

ℓ: lift (mm)

d: throat diameter (mm)

Z: Compression coefficient: 1[※] (See Fig.1 in Page 90)

T: Absolute temperature (K) of gases at absolute relieving pressure

C': Coefficient determined according to κ and P₂/P₁ (See Fig.3 in Page 90)κ : Adiabatic exponent (C_p/C_v) (See Tab.4 in Page 88)

The value is considered as 1 if it is not clear.

P₂: Absolute back pressure (MPa·A)K_{d'}: Relieving coefficientLift type: 0.96[※]

Full bore type: 0.864

P₁: Absolute relieving pressure (MPa·A)

(Absolute value of "set pressure × 1.1")

M: Molecular weight of gas (See Tab.4 in Page 88)

DATA/Safety Valves, Relief Valves

Applicable Laws & Regulations and Formulas for Calculating Relieving Capacity

Coefficients assigned to equations may be those specified in applicable laws/regulations or in-house data (※).

※In-house data

5. IN-HOUSE STANDARDS (for liquids other than water and hot water)

$$W=161 \times AK \sqrt{PG}$$

W: Relieving capacity (kg/h)

A: Seat opening area (mm²)

Lift type: A=πDℓ

Full bore type: A=0.785d²

D: Seat opening diameter (mm)

ℓ: Lift (mm)

d: Throat diameter (mm)

G: Specific gravity upon the inlet side temperature

P: Relieving pressure (MPa)

K: Flow coefficient

Lift type: 0.55 for upper guide type

0.45 for blade type

Full bore type: 0.60

[The value may be different depending on type and accumulation]

TABLE1. COEFFICIENT ACCORDING TO PROPERTY OF STEAM C'

(JIS B8210-2009)

Absolute pressure (MPa)	Temp. (°C)	Saturated temperature	200	220	240	260	280	300	320	340	360	380	400	420	440	460
0.5		1.004	0.994	0.971	0.950	0.931	0.912	0.895	0.879	0.863	0.848	0.834	0.821	0.808	0.796	0.784
1.0		0.986	0.980	0.982	0.960	0.938	0.919	0.900	0.883	0.867	0.852	0.837	0.824	0.810	0.798	0.786
1.5		0.976	0.975	0.969	0.969	0.946	0.925	0.906	0.888	0.871	0.855	0.843	0.826	0.813	0.800	0.788
2.0		0.971		0.966	0.963	0.955	0.932	0.912	0.893	0.875	0.859	0.844	0.829	0.815	0.802	0.790
2.5		0.968			0.960	0.965	0.940	0.918	0.898	0.880	0.863	0.847	0.832	0.818	0.805	0.792
3.0		0.966			0.961	0.956	0.948	0.925	0.904	0.884	0.867	0.850	0.835	0.821	0.807	0.794
4.0		0.964				0.957	0.953	0.939	0.915	0.895	0.875	0.857	0.841	0.826	0.811	0.798
5.0		0.965					0.955	0.952	0.929	0.905	0.884	0.865	0.847	0.831	0.816	0.802
6.0		0.968					0.962	0.953	0.943	0.917	0.893	0.873	0.854	0.837	0.821	0.807
7.0		0.971						0.959	0.954	0.930	0.904	0.881	0.861	0.843	0.826	0.811
8.0		0.975						0.968	0.956	0.944	0.915	0.890	0.869	0.849	0.832	0.816
9.0		0.980							0.963	0.960	0.927	0.900	0.877	0.856	0.837	0.820
10.0		0.987								0.972	0.962	0.941	0.911	0.885	0.863	0.843
12.0		1.000									0.977	0.973	0.935	0.904	0.878	0.856
14.0		1.019										0.982	0.964	0.926	0.896	0.870
16.0		1.039											1.005	0.952	0.916	0.886
18.0		1.068												0.977	0.933	0.903
20.0		1.100													0.958	0.917

* When pressure/temperature is an intermediate value, it is necessary to take the minimum value of absolute pressure/temperature division and do not apply the proportional method. When absolute pressure is below 0.5 MPa·A, then 0.5 MPa·A should be used as absolute pressure. For example, when relieving pressure (absolute pressure) is 1.6 MPa·A and temperature is 245°C, C' = 0.946.

TABLE2. HOT WATER SPECIFIC GRAVITY γ_t(kg/L)

(Source: Interpretation of Boiler Structure Standard)

Pressure MPa·A	0.1	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.5
40	0.992	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.993	0.993	0.993	0.993	0.993
50	0.998	0.988	0.988	0.988	0.988	0.988	0.989	0.989	0.989	0.989	0.989	0.989	0.989
60	0.983	0.983	0.983	0.983	0.983	0.984	0.984	0.984	0.984	0.984	0.984	0.984	0.984
70	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.979	0.979	0.979	0.979
80	0.972	0.972	0.972	0.972	0.972	0.972	0.972	0.972	0.972	0.973	0.973	0.973	0.973
90	0.965	0.965	0.965	0.965	0.965	0.966	0.966	0.966	0.966	0.966	0.966	0.966	0.966
100		0.958	0.958	0.958	0.958	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959
110		0.951	0.951	0.951	0.951	0.951	0.951	0.951	0.951	0.951	0.952	0.952	0.952
120		0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.944	0.944	0.944	0.944	0.944
130			0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.936	0.936	0.936
140			0.926	0.926	0.926	0.926	0.926	0.926	0.927	0.927	0.927	0.927	0.927
150				0.917	0.917	0.917	0.917	0.917	0.918	0.918	0.918	0.918	0.918
160					0.907	0.908	0.908	0.908	0.908	0.908	0.908	0.908	0.908
170					0.897	0.897	0.898	0.898	0.898	0.898	0.898	0.898	0.898
180							0.887	0.887	0.887	0.887	0.888	0.888	0.888
190							0.876	0.876	0.876	0.877	0.877	0.877	0.877
200								0.865	0.865	0.865	0.865	0.865	0.865
210										0.853	0.853	0.853	0.853
220													0.841

Note: Intermediate value should be calculated using the proportional method.

* Water density should be "1" when temperature is lower than 40°C.

TABLE3. SPECIFIC HEAT AND EXPANSION COEFFICIENT OF HOT WATER

(Source: Interpretation of Boiler Structure Standard)

Temp. °C	Specific heat of water at constant pressure C _p kJ/kg°C	Expansion coefficient ε 1/°C
Below 40°C	4.150	0.00039
40	4.179	0.00039
50	4.181	0.00046
60	4.185	0.00053
70	4.190	0.00060
80	4.197	0.00066
90	4.205	0.00072
100	4.216	0.00079
110	4.229	0.00085
120	4.245	0.00090
130	4.263	0.00097
140	4.285	0.00103
150	4.310	0.00110
160	4.339	0.00118
170	4.371	0.00126
180	4.408	0.00134
190	4.449	0.00145
200	4.497	0.00155
210	4.551	0.00165
220	4.613	0.00179

Note: Intermediate value should be calculated using the proportional method.

DATA/Safety Valves, Relief Valves

Applicable Laws & Regulations and Formulas for Calculating Relieving Capacity

TABLE4. GAS PROPERTY

(JIS B8210-2009)

Gas names	Chemical symbol	Molecular weight M (kg/kmol)	Adiabatic (isentropic) index κ (1.013bar a, 15°C)	Critical pressure Pc (bar a.)	Critical temp. Tc (K)	Critical pressure ratio
Acetylene	C ₂ H ₂	26.02	1.26	62.82	309.15	0.553
Air	—	28.96	1.40	37.69	132.45	0.528
Ammonia	NH ₃	17.03	1.31	112.98	405.55	0.544
Argon	Ar	39.91	1.66	48.64	151.15	0.488
Normal butane	C ₄ H ₁₀	58.08	1.11	36.48	426.15	0.583
Carbon dioxide	CO ₂	44.00	1.30	73.97	304.25	0.546
Carbon monoxide	CO	28.00	1.40	35.46	134.15	0.528
Chlorine	Cl ₂	70.91	1.35	77.11	417.15	0.537
Chlorofluoromethane	CHClF ₂	86.47	1.18	49.14	370.15	0.568
Ethane	C ₂ H ₆	30.05	1.22	49.45	305.25	0.561
Ethylene	C ₂ H ₄	28.03	1.25	51.57	282.85	0.555
Hydrogen	H ₂	2.015	1.41	12.97	33.25	0.527
Hydrogen chloride	HCl	36.46	1.41	82.68	324.55	0.527
Hydrogen sulfide	H ₂ S	34.08	1.32	90.08	373.55	0.542
Isobutane	CH(CH ₃) ₂	58.08	1.11	37.49	407.15	0.583
Methane	CH ₄	16.03	1.31	46.41	190.65	0.544
Methyl chloride	CH ₃ Cl	50.48	1.28	66.47	416.25	0.549
Nitrogen	N ₂	28.02	1.40	33.94	126.05	0.528
Nitrogen suboxide	N ₂ O	44.02	1.30	72.65	309.65	0.546
Oxygen	O ₂	32.00	1.40	50.36	154.35	0.528
Propane	C ₃ H ₈	44.06	1.13	43.57	368.75	0.579
Propylene	C ₃ H ₆	42.05	1.15	46.60	365.45	0.574
Sulfur dioxide	SO ₂	64.07	1.29	78.73	430.35	0.548

TABLE5. COEFFICIENT DEPENDING ON ADIABATIC (ISENTROPIC) EXPONENT (κ) (C") (JIS B8210-2009)

κ	C"	κ	C"	κ	C"	κ	C"	κ	C"	κ	C"
0.41	16.65	0.71	20.96	1.01	24.04	1.31	26.41	1.61	28.34	1.91	29.96
0.42	16.82	0.72	21.08	1.02	24.12	1.32	26.49	1.62	28.40	1.92	30.01
0.43	17.00	0.73	21.20	1.03	24.21	1.33	26.56	1.63	28.46	1.93	30.06
0.44	17.17	0.74	21.31	1.04	24.30	1.34	26.63	1.64	28.52	1.94	30.10
0.45	17.33	0.75	21.43	1.05	24.39	1.35	26.69	1.65	28.58	1.95	30.15
0.46	17.50	0.76	21.54	1.06	24.47	1.36	26.76	1.66	28.63	1.96	30.20
0.47	17.66	0.77	21.65	1.07	24.56	1.37	26.83	1.67	28.69	1.97	30.25
0.48	17.82	0.78	21.76	1.08	24.64	1.38	26.90	1.68	28.74	1.98	30.30
0.49	17.98	0.79	21.87	1.09	24.72	1.39	26.97	1.69	28.80	1.99	30.34
0.50	18.13	0.80	21.98	1.10	24.81	1.40	27.03	1.70	28.86	2.00	30.39
0.51	18.29	0.81	22.09	1.11	24.89	1.41	27.10	1.71	28.91	2.01	30.44
0.52	18.44	0.82	22.19	1.12	24.97	1.42	27.17	1.72	28.97	2.02	30.49
0.53	18.58	0.83	22.30	1.13	25.05	1.43	27.23	1.73	29.02	2.03	30.53
0.54	18.73	0.84	22.40	1.14	25.13	1.44	27.30	1.74	29.08	2.04	30.58
0.55	18.88	0.85	22.51	1.15	25.21	1.45	27.36	1.75	29.13	2.05	30.63
0.56	19.02	0.86	22.61	1.16	25.29	1.46	27.43	1.76	29.18	2.06	30.67
0.57	19.16	0.87	22.71	1.17	25.37	1.47	27.49	1.77	29.24	2.07	30.72
0.58	19.30	0.88	22.81	1.18	25.45	1.48	27.55	1.78	29.29	2.08	30.76
0.59	19.44	0.89	22.91	1.19	25.53	1.49	27.62	1.79	29.34	2.09	30.81
0.60	19.57	0.90	23.01	1.20	25.60	1.50	27.68	1.80	29.40	2.10	30.85
0.61	19.71	0.91	23.11	1.21	25.68	1.51	27.74	1.81	29.45	2.11	30.90
0.62	19.84	0.92	23.20	1.22	25.76	1.52	27.80	1.82	29.50	2.12	30.94
0.63	19.97	0.93	23.30	1.23	25.83	1.53	27.86	1.83	29.55	2.13	30.99
0.64	20.10	0.94	23.39	1.24	25.91	1.54	27.93	1.84	29.60	2.14	31.03
0.65	20.23	0.95	23.49	1.25	25.98	1.55	27.99	1.85	29.65	2.15	31.07
0.66	20.35	0.96	23.58	1.26	26.05	1.56	28.05	1.86	29.71	2.16	31.12
0.67	20.48	0.97	23.67	1.27	26.13	1.57	28.11	1.87	29.76	2.17	31.16
0.68	20.60	0.98	23.76	1.28	26.20	1.58	28.17	1.88	29.81	2.18	31.21
0.69	20.72	0.99	23.86	1.29	26.27	1.59	28.23	1.89	29.86	2.19	31.25
0.70	20.84	1.001	23.95	1.30	26.34	1.60	28.29	1.90	29.91	2.20	31.29

Note: Intermediate value should be calculated using the interpolational method.

Calculation formula

$$C = 39.48 \sqrt{\kappa \left(\frac{2}{\kappa + 1} \right)^{\frac{\kappa + 1}{\kappa - 1}}}$$

DATA/Safety Valves, Relief Valves

3

SAFETY VALVES, RELIEF VALVES

Fig.1 Coefficient of compressibility Z (JIS B8210-2009)

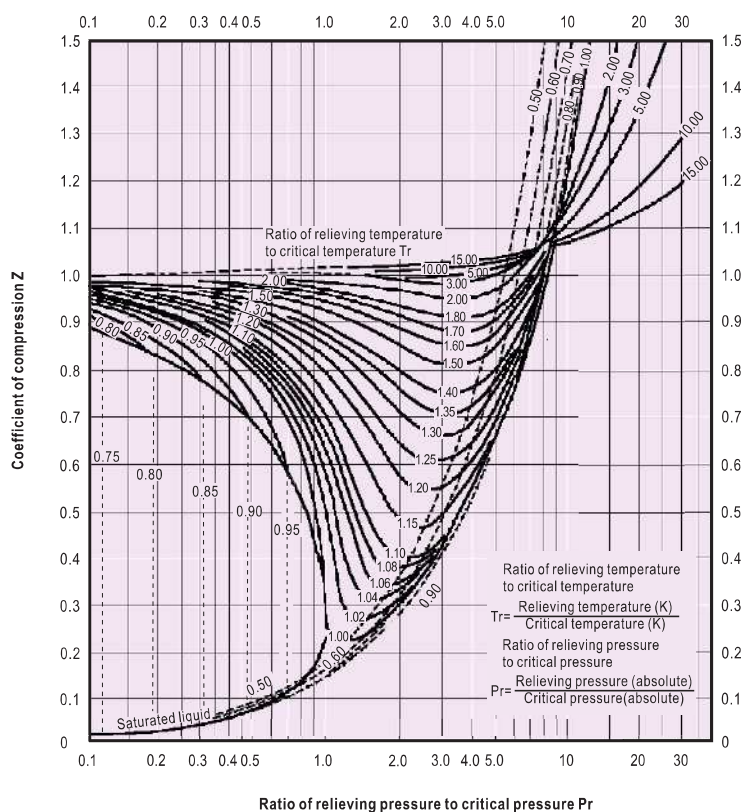


Fig.2 $\Delta t^\circ\text{C}$ correction coefficient κ

(Source: Interpretation of Boiler Structure Standard)

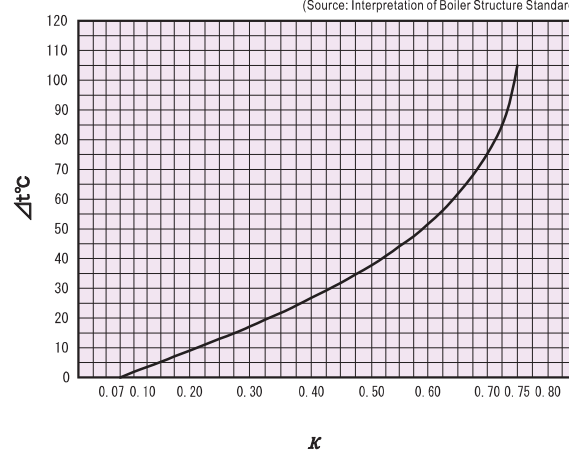
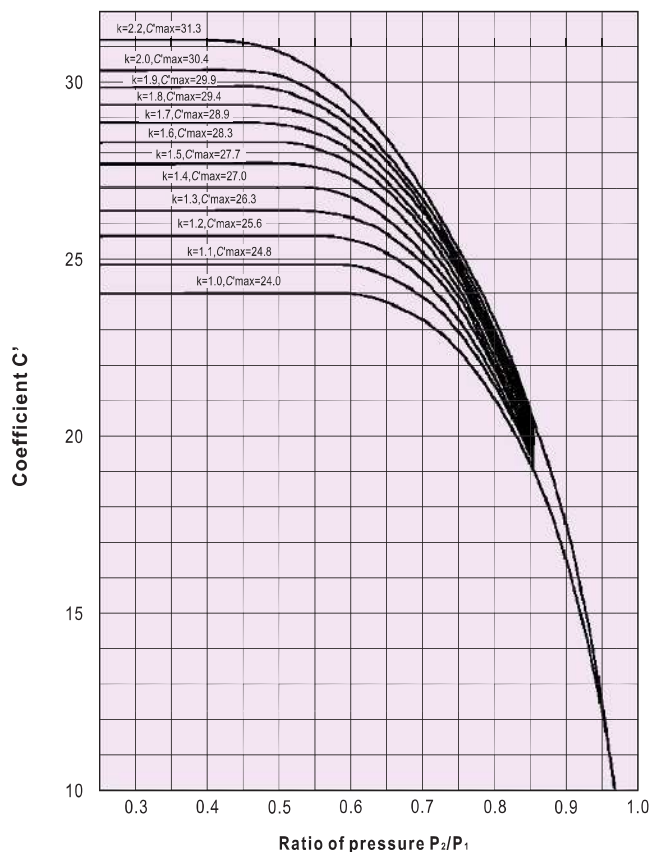


Fig.3 Coefficient (C') based on κ and P_2/P_1 (JIS B8210-2009)



Key Points for Installation of Safety Valves and Relief Valves

1. Installation

- ❶ Safety valve should be vertical to pipe. Before installation, remove scale and dust and clean the surfaces that contact with gasket.
- ❷ The diameter of the installation pipe should be larger than the diameter of valve. To reduce pressure loss to minimum degree, the stand pipe should be as short as possible.
- ❸ The stand pipe should be rigid and hard enough to bear the compression force, shearing force, bending stress or other counterforce caused by relieving of safety valve.
- ❹ Compared with the diameter of the outlet of safety valve, the diameter of the discharge pipe should be as large as possible. The discharge pipe should be as short as possible, without any bending, lead to outside of the door or other safe place, and be properly supported to avoid the occurrence of undesired stress (including thermal stress).

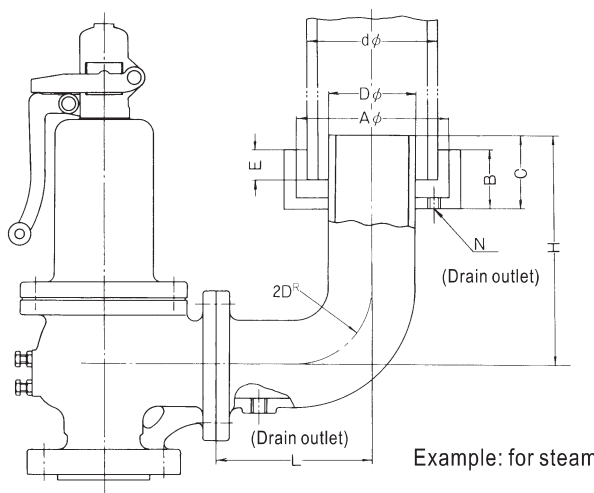
When deciding the place that the outlet of the discharge pipe faces, pay attention to the following issues.

- To avoid installation place where is influenced by explosive sound and blast.
- Avoid damage to electrical equipments, machines, tools etc. in the case the fluid is steam or water.
- Avoid corrosion, poisoning, anoxia etc. in the case the fluid is harmful gas.

- ❺ In the case of screwed type safety valve or relief valve, install union joint at the discharge pipe of the outlet side to allow easy dismounting (see Fig.1 in next page).
- ❻ At parts of the discharge pipe where drain or rain may accumulate, install the drain outlet, which is possible to discharge drain completely, and connect to dike.
- ❼ In the case of full bore type safety valve for liquids or harmful gases and have faucet for adjusting back pressure, install the valve on the outlet discharge pipe (see Fig.3 in next page).

- ❼ To avoid adverse impact on safety valve that is caused by thermal expansion of devices or discharge pipe, install proper expansion joint at the outlet of valve and install a discharge pipe at the end (see the figure below). To limit counterforce, the distance between the axes of the valve and the center of discharge pipe should be as short as possible, and the radius of the elbow pipe should be at least $2D$ (D : the internal diameter of the elbow). below figure also shows the standard dimensions of the discharge pipe of safety valve.

- ❽ Cares should be paid on installation of valves with lever (open type). It may effuse fluid from upper cap when such valves are operating (see Fig.5 in the next page).



REFERENCE DIMENSION FOR EXHAUST PIPE

(mm)

Outlet size	D	d	(A)	B	C	E	L	H	N
40(1½")	40	65	130	60	80	30	130	220	Rc¾"
50(2")	50	80	150	60	90	40	150	230	Rc½"
65(2½")	65	100	200	60	100	40	180	270	Rc½"
80(3")	80	125	200	70	120	50	200	310	Rc½"
100(4")	100	150	250	70	140	60	250	370	Rc¾"
125(5")	125	200	300	80	160	70	300	430	Rc1"
150(6")	150	200	300	80	180	70	350	500	Rc1"
200(8")	200	250	380	100	220	80	450	610	Rc1"

2. Maintenance and operating instructions

- ❶ At the installation of safety valves avoid the place where there is possibility to obstruct their functions by vibration or corrosion and do not give impact from outside.
- ❷ After installation, make sure the pressure of the device has reached at least 75% discharge pressure of the valve before using the test lever to start the valve.
- ❸ Normal working pressure of the equipment shall not exceed 90% of the blowdown pressure of the valve and 80 to 85% when pulsation is expected.

- ❹ If possible, remove safety valve before making water pressure test. To make water pressure test without removing safety valve, pay attention to the following below (see Fig.4 in the next page).
 - Ⓐ To prevent valve from being damaged due to improper load, when the pressure of the device reaches 80~90% of discharge pressure, install test gag* and press lightly on the end of valve shaft. The test gag must be rotated using hand. If you rotate it using

spanner or other tools, there may have excessively large pressing force, the seat may be damaged, the shaft may be bent, and the valve may not function normally.

- Ⓑ After water pressure test and the pressure reduces to 80~90% relieving pressure, remove test gag immediately.

※ The test gag is optional item.

Key Points for Installation of Safety Valves and Relief Valves

PIPING EXAMPLE

Fig.1 Example: Pressure tank installation

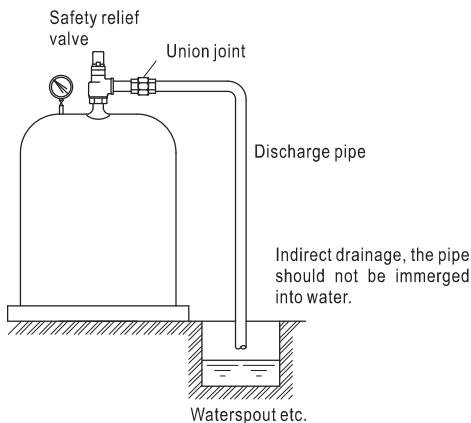


Fig.2 Example: Installation of the secondary side of pressure reducing valve

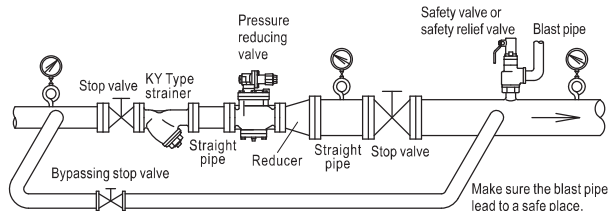


Fig.3 Example connection of back pressure adjusting cock

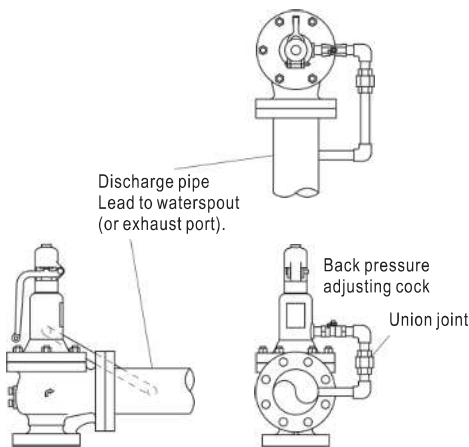


Fig.4 Installation of test gag

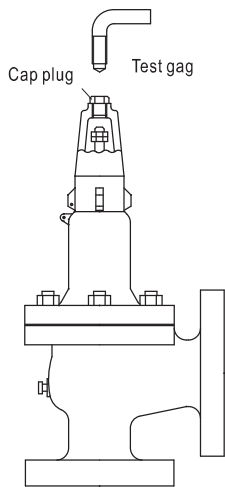
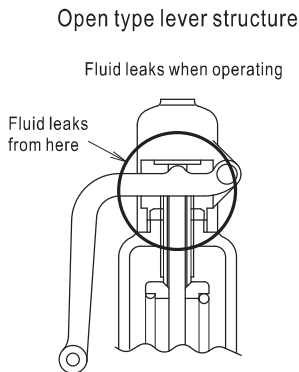
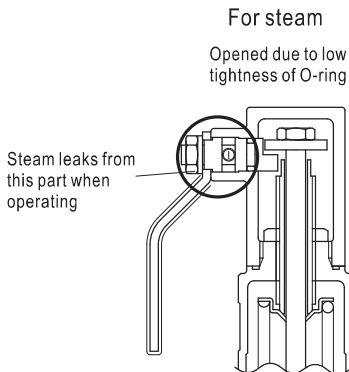
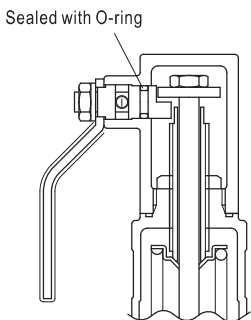


Fig.5 Lever structure

Lever structure of SL-37, 39, 39F, 43 Type
For air, gas, or liquid



■ FULL BORE TYPE

Qm=5.25C'Kdr'AP

$$\left\{ \begin{array}{l} C'=1 \text{ (when } P \leq 0.5 \text{ MPa} \cdot A \text{) or } 0.98 \text{ (when } P \text{ is over } 0.5 \sim 1.0 \text{ MPa} \cdot A \text{) or } 0.97 \text{ (when } P \text{ is over } 1.0 \sim 2.0 \text{ MPa} \cdot A \text{) or } 0.96 \text{ (when } P > 2.0 \text{ MPa} \cdot A \text{)} \\ Kdr'=0.777, P \text{ (MPa} \cdot A \text{); the larger one of (set pressure} \times 1.1 + 0.101 \text{) or (set pressure} + 0.02 + 0.101 \text{).)} \end{array} \right\}$$

(kg/h)

Model name	Size (mm)	dt	Set pressure MPa	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
SF-1H, 2H	20	15	176.6	159	231	310	381	459	537	614	692	762	839	916	992	1060	1140	1220	1300	1370	1430	1510	1590										
	25	19	283.3	255	370	498	612	737	861	986	1110	1220	1340	1460	1590	1710	1830	1960	2080	2200	2300	2430	2550										
	40	30	706.5	636	925	1240	1520	1830	2140	2460	2770	3040	3350	3660	3970	4270	4580	4890	5200	5500	5750	6060	6360										
	50	38	1133.5	1020	1480	1990	2450	2940	3440	3940	4440	4890	5380	5870	6370	6860	7360	7850	8340	8840	9230	9720	10200										
SF-19L, 20L	15	11	94.9	85.5	124	166	205	246	288	330	372	409	450	492	533	574	616	657	698	740	773	814	855	896	936	977	1010	1050	1100	1140	1180	1220	1260
	20	15	176.6	159	231	310	381	459	537	614	692	762	839	916	992	1060	1140	1220	1300	1370	1430	1510	1590	1660	1740	1810	1890	1970	2040	2120	2190	2270	2350
	25	19	283.3	255	370	498	612	737	861	986	1110	1220	1340	1460	1590	1710	1830	1960	2080	2200	2300	2430	2550	2670	2790	2910	3040	3160	3280	3400	3520	3650	3770
SF-13L, 14L	25	19	283.3	255	370	498	612	737	861	986	1110	1220	1340																				
SF-13L	40	25	490.6	442	642	862	1060	1270	1490	1700	1920	2110	2330	2540	2750	2970	3180	3390	3610	3820	3990	4200	4420	4630	4840	5050	5260	5470	5680	5900	6110	6320	6530
	30	34	706.5	636	925	1240	1520	1830	2140	2460	2770	3040	3350	3660	3970	4270	4580	4890	5200	5500	5750	6060	6360	6670	6970	7270	7580	7880	8190	8490	8800	9100	9400
	50	34	907.4	818	1180	1590	1960	2360	2760	3150	3550	3910	4310	4700	5100	5490	5890	6280	6680	7070	7390	7780	8170	8560	8950	9340	9740	10100	10500	10900	11300	11600	12000
	38	38	1133.5	1020	1480	1990	2450	2940	3440	3940	4440	4890	5380	5870	6370	6860	7360	7850	8340	8840	9230	9720	10200	10700	11100	11600	12100	12600	13100	13600	14100	14600	15000
SF-16L (0.1~1MPa)	65	43	1451.4	1300	1900	2550	3130	3770	4410	5050	5690	6260	6890	7520	8160	8790	9420	10000	10600	11300	11800	12400	13000	13700	14300	14900	15500	16200	16800	17400	18000	18700	19300
	49	49	1884.7	1690	2460	3310	4070	4900	5730	6560	7390	8130	8950	9770	10500	11400	12200	13000	13800	14600	15300	16100	16900	17700	18600	19400	20200	21000	21800	22600	23400	24200	25100
SF-17L SF-18L (1~2MPa)	80	55	2374.6	2140	3100	4170	5130	6170	7220	8260	9310	10200	11200	12300	13300	14300	15400	16400	17400	18500	19300	20300	21300	22400	23400	24400	25400	26500	27500	28500	29500	30600	31600
	69	61	2920.9	2630	3820	5130	6310	7600	8880	10100	11400	12600	13800	15100	16400	17600	18900	20200	21500	22700	23800	25000	26300	27500	28800	30000	31300	32600	33800	35100	36300	37600	38900
SF-19L SF-20L (2~3MPa)	100	69	3737.3	3360	4890	6570	8080	9720	11300	13000	14600	16100	17700	19300	21000	22600	24200	25800	27500	29100	30400	32000	33600	35200	36800	38500	40100	41700	43300	44900	46500	48100	49700
	76	76	4534.1	4080	5930	7970	9800	11700	13700	15700	17700	19500	21500	23500	25400	27400	29400	31400	33300	35300	36900	38900	40800	42800	44700	46700	48600	50600	52500	54500	56400	58400	60300
	125	86	5805.8	5230	7600	10200	12500	15100	17600	20200	22700	25000	27500	30100	32600	35100	37600	40200	42700	45200	47300	49800	52300	54800	57300	59800	62300	64800	67300	69800	72300	74800	77300
	95	95	7084.6	6380	9270	12400	15300	18400	21500	24600	27700	30500	33600	36700	39800	42900	46000	49000	52100	55200	57700	60700	63800	66800	69900	72900	76000	79000	82100	85200	88200	91300	94300
	150	105	8654.6	7800	11300	15200	18700	22500	26300	30100	33900	37300	41100	44800	48600	52400	56100	59900	63700	67400	70500	74200	77900	81700	85400	89100	92800	96600	100000	104000	107000	111000	115000
	115	115	10381.6	9350	13500	18200	22400	27000	31500	36100	40700	44800	49300	53800	58300	62800	67400	71900	76400	80900	84600	89000	93500	98000	102000	106000	111000	115000	120000	124000	129000	133000	138000

dt: Throat dia. (mm), A: Seat opening area (mm²)

■ LIFT TYPE

Qm=5.25C'Kdr'AP

$$\left\{ \begin{array}{l} C'=1 \text{ (when } P \leq 0.5 \text{ MPa} \cdot A \text{) or } 0.98 \text{ (when } P \text{ is over } 0.5 \sim 1.0 \text{ MPa} \cdot A \text{) or } 0.97 \text{ (when } P \text{ is over } 1.0 \sim 2.0 \text{ MPa} \cdot A \text{) or } 0.96 \text{ (when } P > 2.0 \text{ MPa} \cdot A \text{)} \\ Kdr'=0.864, P \text{ (MPa} \cdot A \text{); the larger one of (set pressure} \times 1.1 + 0.101 \text{) or (set pressure} + 0.02 + 0.101 \text{).)} \end{array} \right\}$$

(kg/h)

Size (mm)	D	Set pressure MPa A	Set pressure MPa																														
			0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
15	15	18.8	14.5	18.8	27.3	36.7	45.2	54.4	63.5	72.7	81.9	90.2	99.3	108	117	126	135	144	153	163	170	179	188	197	206	215	224	233	242	251	260	269	278
20	20	31.4	24.3	31.4	45.7	61.3	75.5	90.8	106	121	136	150	165	181	196	211	226	241	257	272	284	299	314	329	344	359	374	389	404	419	434	449	465
25	25	54.9	42.5	55	79.9	107	132	158	185	212	239	263	290	316	343	369	396	422	449	476	497	523	550	576	602	628	655	681	707	734	760	786	813
32	32	80.3	62.2	80.4	116	156	193	232	271	310	350	385	424	463	502	540	579	618	657	696	727	766	804	843	881	919	958	996	1030	1070	1110	1150	1180
40	40	125.6	97.4	125	182	245	302	363	424	486	547	602	663	724	785	846	906	967	1020	1080	1130	1190	1250	1310	1370	1430	1490	1550	1610	1670	1730	1790	1860
50	50	204.1	158	204	297	399	490	590	690	790	890	979	1070	1170	1270	1370	1470	1570	1670	1770	1840	1940	2040	2140	2240	2330	2430	2530	2630	2720	2820	2920	3020
65	65	346.9	269	347	505	678	834	1000	1170	1340	1510	1660	1830	2000	2160	2330	2500	2670	2840	3000	3140	3300	3470	3640	3800	3970	4140	4300	4470	4630	4800	4970	5130
75	75	447.4	347	448	651	874	1070	1290	1510	1730	1950	2140	2360	2580	2790	3010	3230	3440	3660	3870	4050	4260	4480	4690	4910	5120	5340	5550	5760	5980	6190	6410	6620
80	78.4	492.3	381	493	716	962	1180	1420	1660	1900	2140	2360	2600																				
100	100	785.0	608	786	1140	1530	1880	2270	2650	3030	3420	3760	4140	4520	4900	5280	5660	6040	6420	6800	7110	7480	7860	8240	8610	8990	9360	9740	10100	10400	10800	11200	11600
	99.4	780.2	605	782	1130	1520	1870	2250	2630	3020	3400	3740	4120																				
125	125	1256.0	974	1250	1820	2450	3020	3630	4240	4860	5470	6020	6630	7240	7850	8460	9060	9670	10200	10800	11300	11900	12500	13100	13700	14300	14900	15500	16100	16700	17300	17900	18600
	130	1347.0	1040	1350	1960	2630	3230	3890	4550	5210	5870	6460	7110																				
150	150	1789.8	1380	1790	2600	3490	4300	5170	6050	6920	7800	8590	9450	10300	11100	12000	12900	13700	14600	15500	16200	17000	17900	18700	19600	20500	21300	22200	23000	23900	24700	25600	26500
	160	2009.6	1550	2010	2920	3920	4830	5810	6790	7780	8760	9640	10600																				

