SL-37, 38 Type Series Safety Relief Valve (Lift Type)

for Pressure Vessels, Hot Water Boilers, Heat Exchangers, Secondary Side of Pressure Reducing Valves, etc.

Safety relief valve is a category of valves with functions between those of safety valves, which are mainly for steam and gases, and those of relief valves, which are mainly for liquids.

Safety relief valve can be used for fluid, steam, gas, and liquid. The metal-seat type safety relief valve has simple structure, high corrosion resistance, and is made of high-grade materials. It is widely used as safety device for pressure vessels, machines/equipments, hot water boilers, water/hot water supply systems, air conditioning systems, and pressure reducing valves.

SL-37 Type Series

SL-38 Type Series

PRESSURE DIVISION (MPa)

Code No.	Pressure division
1	0.05~0.1
2	Over 0.1~0.2
3	Over 0.2~0.5
4	Over 0.5~1.0

FEATURES

- Bronze spring case, Stainless steel seat and disc, Stainless steel spring. A sealed type safety relief valve with high corrosion resistance.
- Suitable for three fluids, including steam, gas, and liquid (metal-seat type).
- 1~2 sizes smaller and lighter than prior products of the same type.

SPECIFICATIONS

Type		Standard item(Metal seat type)		Soft seat type	
Model name		SL-37	SL-38	SL-37V	SL-38V
Code name		SL37-D ☐	SL38-D ☐	SL37V-D ☐	SL38V-D ☐
		※ Code No. of pressure division is required in ☐.			
Cap type(Closed type)		With lever*1.	Without lever	With lever	Without lever
Applicable fluid		Steam, air, gases & liquids*2.		Air, gases & liquids*2.	
Fluid temperature		Max. 150℃(Max. 225℃*1.)	Max. 225℃	Max. 120℃	
Set pressure range		0.05~1.0MPa			
End connection		Screwed JIS Rc			
Materials	Body	Stainless steel(Spring case:Cast bronze)			
	Disc	Stainless steel		Stainless steel(Disc tip:Synthetic rubber)	
Valve body pressure test		Hydraulic 2.0MPa			

*1. For steam, the valve is provided with a release lever and can be used at steam temperature up to 225℃.
*2. For application in a system that deals with kerosene or solvent, please contact our agent in your area.

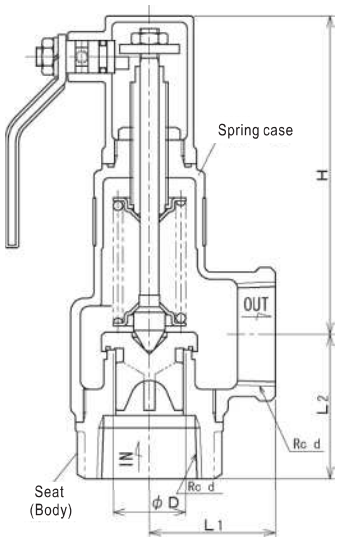
DIMENSIONS (mm)

Size	Seat opening dia. D	Effective area (mm²) π Dℓ	Lift ℓ	Face to Face L1	Face to Face L2	Height H SL-37,37V Type	Height H SL-38,38V Type	End connection d	Mass(kg) SL-37,37V Type	Mass(kg) SL-38,38V Type
15(½″)	14(13)	17.5	0.4(0.43)	30	36	94	84	½″	0.6	0.5
20(¾″)	19(18.6)	29.8	0.5(0.51)	35	40	99	89	¾″	0.7	0.6
25(1″)	23(21.9)	43.3	0.6(0.63)	40	46	102	92	1″	0.9	0.8
32(1¼″)	32(29.4)	80.3	0.8(0.87)	50	54	124	114	1¼″	1.5	1.4
40(1½″)	40(36.7)	125.6	1.0(1.09)	55	60	130	120	1½″	2	1.9
50(2″)	50(47.1)	204.1	1.3(1.38)	65	73	165	151	2″	3.6	3.4

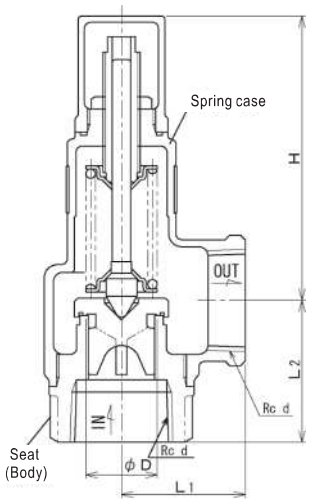
* Figures in ( ) are for SL-37V, 38V Type.

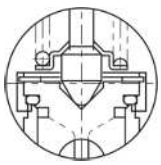
CONSTRUCTION

SL-37 Type

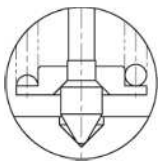


SL-38 Type





Soft-seat type



Size 50mm

Note: See Page 65 for relieving capacity.

Discharge Capacity

1. RELIEVING CAPACITY FOR STEAM
(Pressure Vessel Construction Code)

(kg/h)

Size	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
15(½″)	13.5	17.5	25.4	34.2	42	50.6	59.2	67.7	76.3	84	92.4
20(¾″)	23.1	29.8	43.3	58.2	71.6	86.2	100	115	129	143	157
25(1″)	33.5	43.4	63	84.6	104	125	146	167	188	207	228
32(1¼″)	62.2	80.4	116	156	193	232	271	310	350	385	424
40(1½″)	97.4	125	182	245	302	363	424	486	547	602	663
50(2″)	158	204	297	399	490	590	690	790	890	979	1070

※ In house data

Calculating formula:

$Qm=5.25CK_{dr}'AP$

Qm: Relieving capacity kg/h

K_{dr}' : 0.864※ (Certified derated coefficient of discharge)

A : Seat opening area mm^2

P : Absolute pressure at relieving capacity (MPa・A)

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

C': Coefficient depending on the nature of steam

(See Tab.1, Page 87.)

For saturated steam, see the following table:

Absolute pressure at relieving capacity (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 1 in Page 87.

2. RELIEVING CAPACITY FOR AIR
(Pressure Vessel Construction Code)

(kg/h)

Size	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
15(½″)	21.7	28.3	41.2	55.3	69.5	83.6	97.7	111	126	140	154
20(¾″)	37	48.3	70.2	94.3	118	142	166	190	214	238	262
25(1″)	53.8	70.2	102	137	171	206	241	276	311	346	381
32(1¼″)	99.8	130	189	254	318	383	448	513	578	643	708
40(1½″)	156	203	296	397	498	600	701	803	904	1000	1100
50(2″)	253	331	481	645	810	975	1140	1300	1470	1630	1790

※ In house data

Calculating formula:

$Qm=C''K_{dr}'P_1AK_b\sqrt{\frac{M}{ZT}}$

Qm : Relieving capacity kg/h

C" : 27.03 (coefficient)

K_{dr}' : 0.864※ (Relieving coefficient)

P_1 : Absolute pressure at relieving capacity (MPa・A)

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

A : Seat opening area mm^2

K_b: Back pressure compensation coefficient, which depends on P_2/P_1 and κ .

(See Tab.6, Page 89)

P_2: Absolute pressure of back pressure (MPa・A)

M : 28.96 (Molecular weight of air)

Z : 1※ (Compression coefficient)

T : 293 (Absolute temperature, K)

■Converting kg/h to m^3/h (standard state) (for reference only)

Density of air 1.226kg/m^3 (standard state, 15℃,1atm)

$$m^3/h(\text{standard state}) = \frac{\text{Value in the above table (kg/h)}}{1.226kg/m^3}$$

3. RELIEVING CAPACITY FOR WATER AND HOT WATER
(Pressure Vessel Construction Code)

(kg/h)

Size	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
15(½″)	375	531	742	875	976	1070	1150	1230	1310	1380	1450
20(¾″)	640	905	1260	1490	1660	1820	1970	2110	2240	2360	2470
25(1″)	930	1310	1830	2160	2410	2650	2860	3060	3250	3430	3600
32(1¼″)	1720	2430	3400	4010	4480	4910	5310	5680	6030	6360	6680
40(1½″)	2690	3810	5320	6280	7000	7690	8310	8890	9440	9950	10400
50(2″)	4380	6200	8650	10200	11300	12400	13500	14400	15300	16100	16900

Calculating formula:

$$W=87.7S\sqrt{(P_1+0.1)\,\kappa\,\gamma_1}$$

$$\left(S=\frac{W}{87.7\sqrt{(P_1+0.1)\,\kappa\,\gamma_1}}\right)$$

(If $(P_1+0.1)\,\kappa > (P_1-P_2)$, replace $(P_1+0.1)\,\kappa$ with (P_1-P_2))

W: Relieving capacity kg/h

S: Seat opening area mm^2

P_1: Relieving pressure MPa

Set pressure×1.2: 0.05MPa≦set pressure<0.17MPa

Set pressure+0.034: 0.17MPa≦set pressure<0.34MPa

Set pressure×1.1: 0.34MPa≦set pressure

P_2: Outlet pressure MPa

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

Δt: difference between saturation temperature at P_1 (Relieving pressure) and the temperature of water/hot water at inlet side of valve℃

γ_1: Density of water/hot water at inlet side of valve kg/L (water(15℃)=1)

■Converting kg/h to L/min (for reference only)

Weight of 1 liter water (L)≒ 1kg,

$$L/min=\frac{\text{Value in the above table (kg/h=L/h)}}{60}$$

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 ±5% (minimum pressure: ±0.025MPa). 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 then1.1 times of star to discharge pressure. However, in the case of setting opening pressure, the deviation should be ±3% set pressure (minimum±0.015MPa).

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.1.6 MPa. Fluid temperature: Max.230°C
Ductile iron casting	Set pressure: Max.2.4 MPa. Fluid temperature: Max.350°C

(2) For gases

Gas type / Material of pressure parts	Toxic,flammable gases	Gases other than toxic,flammable gases	Toxic,flammable gases, other gases
	Allowed range		
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	±(3% of set pressure)
2.3 or more and less than 7.0	±0.07
7.0 or more	±(1% 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 ±3% of the set pressure (minimum value ±0.015MPa).

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 determinated 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.

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

$Qm=5.25C'K_{dr}'AP$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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 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 Tab1. in Page 87.

K_{dr}': Relieving coefficient

Lift type:0.864※

Full bore type:0.777

(2) For Gases

$Qm=C''K_{dr}'P_1AK_b\sqrt{\frac{M}{ZT}}$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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

P_1: Relieving pressure (MPa·A)

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

P_2: 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 P_2/P_1 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:

$G=0.0028\,\upsilon\rho d^2$

G: Flow in gas (kg/h)

υ : 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/m^3)

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:

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

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

$$S=\frac{Q\varepsilon}{87.7C\sqrt{(P_1+0.1)\,\kappa\,\gamma_1}}$$

(If $(P_1+0.1)^{\kappa} > (P_1-P_2)$ in formula (1) and (2), replace (P_1-P_2) with $(P_1+0.1)^{\kappa}$)

S : Seat opening area (mm^2)

W: Relieving capacity of valve (kg/h)

P_1: 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 +0.034

P_2: Outlet pressure (MPa)

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

Δt: Difference between the saturated temperature of relieving pressure P_1 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: In the case of full-bore valve and relief valve, make sure the relieving pressure (P_1) 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

$Qm=5.25C'K_{dr}'AP$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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 × 1.03 + 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:

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

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

$$S=\frac{Q\varepsilon}{87.7C\sqrt{(P_1+0.1)\,\kappa\,\gamma_1}}$$

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 (mm^2)

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

Note: In the case of full-bore valve and relief valve, make sure the relieving pressure (P_1) does not exceed "maximum working pressure of pressure vessel or hot water boiler X 1.1" or "maximum working pressure + 0.034".

P_1: 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 +0.034

P_2: Outlet pressure (MPa)

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

Δt: Difference between the saturated temperature of relieving pressure P_1 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 fomula is as the following:

$Qm=5.25C'K_{dr}'AP$

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

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

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

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

h_1: Enthalpy of saturated steam that is equivalent to the maximum working pressure of boiler (kJ/kg).

h_2: Enthalpy of water supply (kJ/kg)

$$W=\frac{Q\varepsilon}{C}$$

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 dowtherm boiler

$$Qm=C''K_{dr}'P_1AK_b\sqrt{\frac{M}{ZT}}$$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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

P_1: Absolute relieving pressure (MPa·A)

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

P_2: 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 P_2/P_1 and κ . See Tab.6 in Page 89)

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

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

$Qm=5.25C'K_{dr}'AP$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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_{dr}': Relieving coefficient

Lift type:0.864※

Full bore type:0.777

(2) For Gases

$Qm=C''K_{dr}'P_1AK_b\sqrt{\frac{M}{ZT}}$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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

P_1: Absolute relieving pressure (MPa·A)
(Select the larger one of set pressure × 1.1 + 0.101 or set pressure + 0.020 + 0.101)

P_2: 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_{dr}': Relieving coefficient

Lift type:0.864※

Full bore type:0.777

K_b: Back pressure compensation coefficient (Depending on P_2/P_1 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

$Qm=5.246CK_d'A(P+0.1)\times 0.9$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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<0.5MPa·A, at saturated pressure:1

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

Superheated steam: Please contact our agent in your area.

K_d': Rated discharge coefficient

Lift type:0.96※

Full bore type:0.864

(2) For Gases

$Qm=C'Kd'AP_1\sqrt{\frac{M}{ZT}}\times 0.9$

Qm: Relieving capacity (kg/h)

A : Seat opening area (mm^2)

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 P_2/P_1 (See Fig.3 in Page 90)

κ : Adiabatic exponent (C_ρ/C_υ) (See Tab.4 in Page 88)
The value is considered as 1 if it is not clear.

P_2: Absolute back pressure (MPa·A)

K_d': Relieving coefficient

Lift type:0.96※

Full bore type:0.864

P_1: Absolute relieving pressure (MPa·A)
(Absolute value of "set pressure×1.1")

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

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 (mm^2)
Lift type: $A=\pi D\ell$
Full bore type: $A=0.785d^2$
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 [The value may be different depending on type and accumulation]
Full bore type: 0.60

TABLE1. COEFFICIENT ACCORDING TO PROPERTY OF STEAM C'

(JIS B8210-2009)

Absolute pressure (MPa) \ Temp. (℃)	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	0.825
12.0	1.000								0.977	0.973	0.935	0.904	0.878	0.856	0.836
14.0	1.019								1.005	0.982	0.964	0.926	0.896	0.870	0.848
16.0	1.039									1.005	1.001	0.952	0.916	0.886	0.861
18.0	1.068									1.044	1.007	0.977	0.933	0.903	0.875
20.0	1.100										1.036	1.011	0.958	0.917	0.890

* 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)

Temp.℃ \ 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	0.978	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	0.972	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	0.935	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	0.917	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
200									0.865	0.865	0.865	0.865	0.865
210											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.℃	Specific heat of water at constant pressure C kJ/kg℃	Expansion coefficient ε 1/℃
Below 40℃	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.

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℃)	Critical pressure *Pc* (bar a.)	Critical temp. *Tc* (K)	Critical pressure ratio
Acetylene	C_2H_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_4H_{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_2H_6	30.05	1.22	49.45	305.25	0.561
Ethylene	C_2H_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_2S	34.08	1.32	90.08	373.55	0.542
Isobutane	$CH(CH_3)_3$	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_3Cl	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_2O	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_3H_3	44.06	1.13	43.57	368.75	0.579
Propylene	C_3H_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

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

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

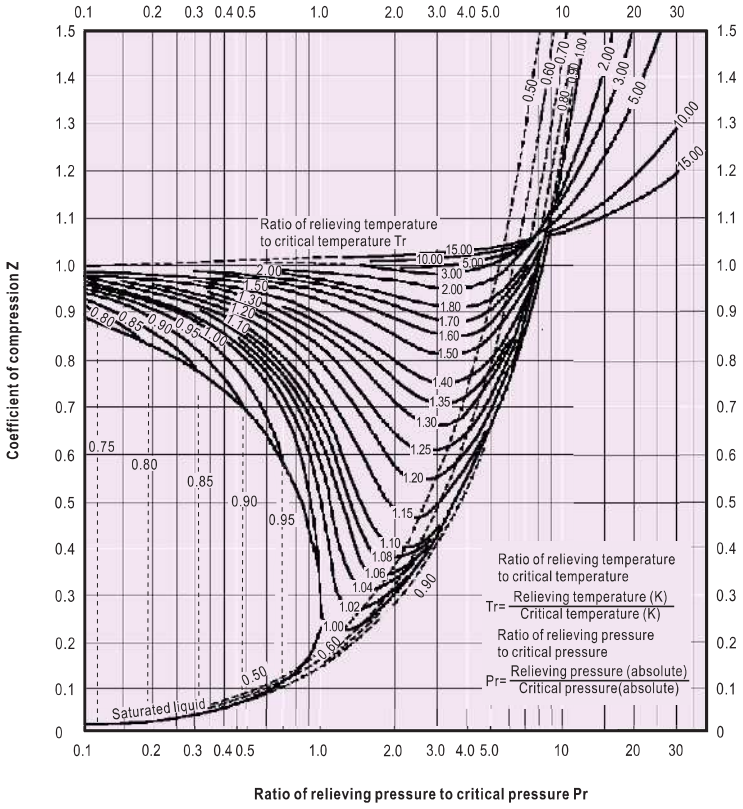


Fig.2 Δt°C correction coefficient κ

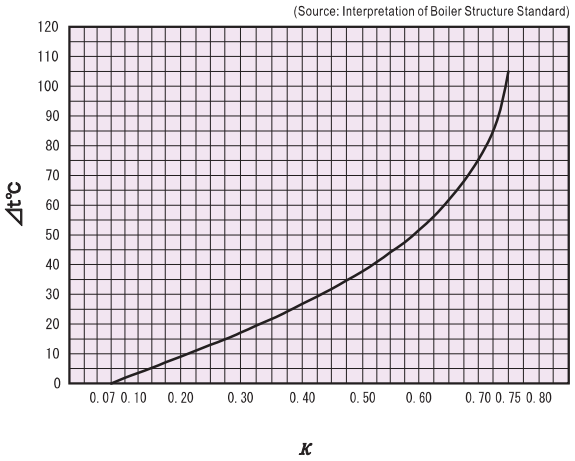
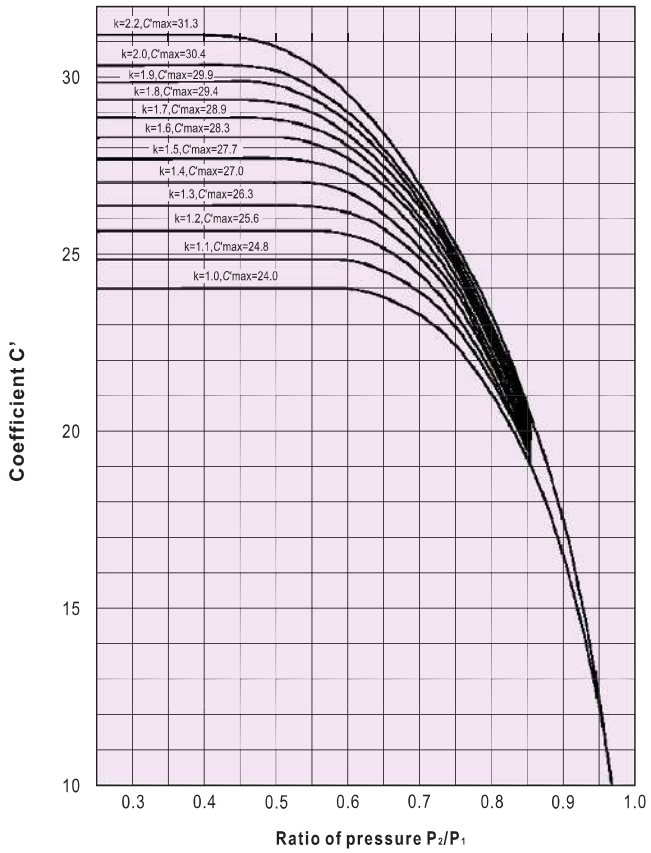


Fig.3 Coefficient (C') based on κ and P_2/P_1 (JIS B8210-2009)



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.

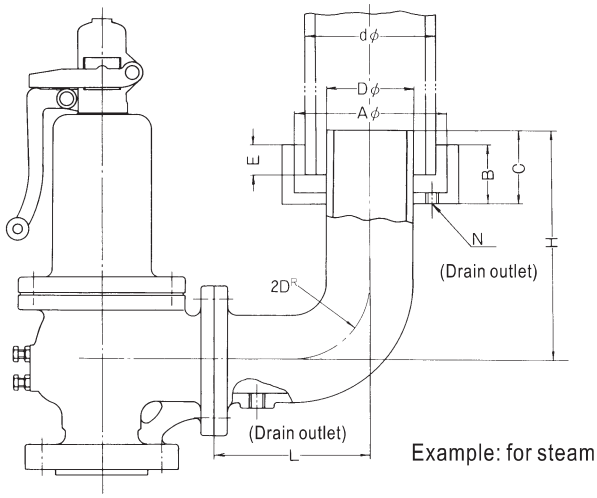
- To avoid installation place where is influenced by explosive sound and blast.
- Avoid damage to electrical equipments, machines, tools etc. in the case the fluid is steam or water.
- Avoid corrosion, poisoning, anoxia etc. in the case the fluid is harmful gas.
- In the case of screwed type safety valve or relief valve, install union joint at the discharge pipe of the outlet side to allow easy dismounting (see Fig.1 in next page).

❺ 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.

❻ 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).



Example: for steam

■ 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	Rc⅜″
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 bended, 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

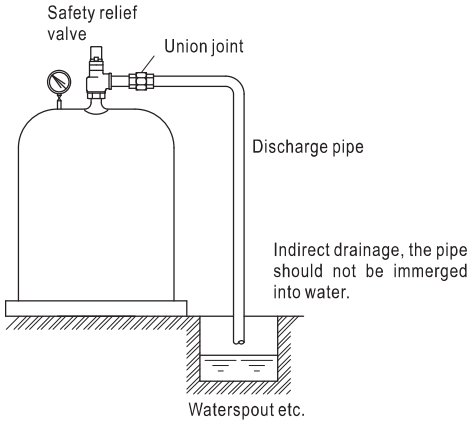


Fig.2 Example: Installation of the secondary side of pressure reducing valve

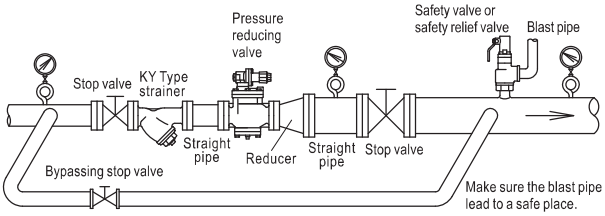


Fig.3 Example connection of back pressure adjusting cock

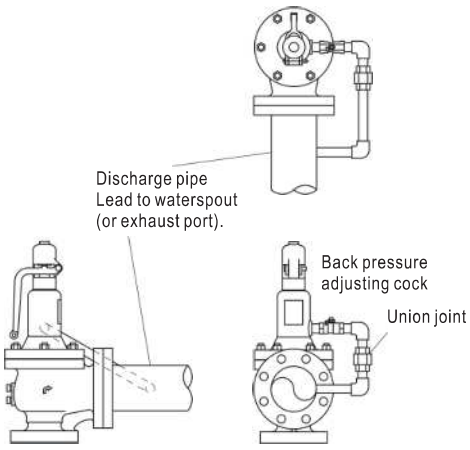


Fig.4 Installation of test gag

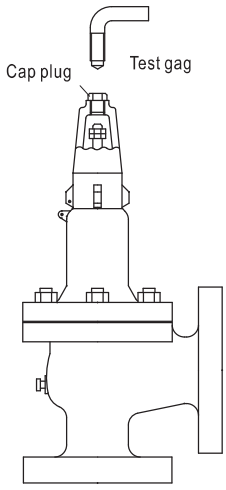
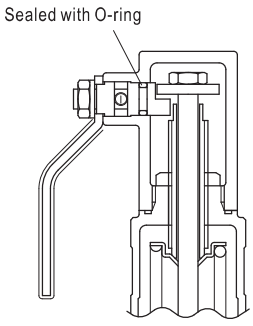
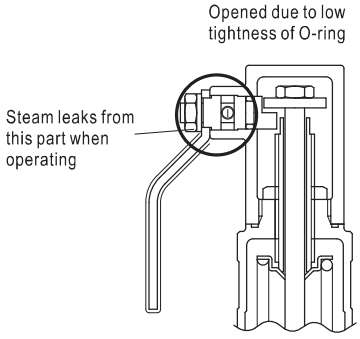


Fig.5 Lever structure

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



For steam



Open type lever structure