EMERSON

SAPAG

Contents

IMPORTANT NOTICE

Do not install a SAPAG safety valve before reading and understanding the following instructions. SAPAG cannot be responsible for situations resulting from a poor knowledge by the installer or the user of the present instructions.

Each safety valve has been designed for a particular application corresponding to the information as included onto its nameplate and indicated on the test report supplied with the valve. The installer shall make sure that the safety valve he is to install is the one which has been designed for this application at this location. The tag of the safety valve must be checked and compared to its location, and the Set Pressure of the valve compared to the Design Pressure of the equipment. The Set Pressure of a safety valve as indicated on its nameplate cannot exceed the Design Pressure of the vessel on which it is installed. The Cold Differential Test Pressure as indicated on the nameplate may exceed the Design Pressure of the vessel by no more than 5%, only when the safety valve has to operate at elevated temperature.

SAPAG has delivered a safety valve corresponding to the service conditions as known when the order was registered. The materials used for the components are in accordance with SAPAG standard bills of materials. The materials have been selected together with the buyer within the various possibilities as offered by the SAPAG catalogue. For the main pressure retaining components these materials are certified in accordance with EN 10204 3.1.B.
SAPAG cannot be responsible for accelerated damages to components caused by corrosion or chemical attack by substances constituting or not the process fluid beyond reasonably foreseeable limits and provided the presence of these substances were clearly stated when the equipment was ordered.

The nature, the phase, the viscosity, the temperature of the fluid and all other relevant data taken into consideration by SAPAG are those known at the time of the request for quotation. SAPAG cannot be responsible for a safety valve operational accident resulting in the fact that one or several data wandered away from what was specified in the order.

The installation of a safety valve, as it relates to the inlet and outlet pressure drop, as well as the drainage of the exhaust piping, shall be in accordance with these instructions.

A safety valve is normally closed and should open only to overcome exceptional upset conditions. However the unexpected opening, full or partial, of a safety valve is an event that needs to be considered; the installer shall therefore connect the outlet port of the safety valve to a system allowing the flow to be piped away to an appropriate location. The installer shall consider the following dangers:

- The blast from the safety valve;
- The potential leakage from the safety valve exhaust of lethal, noxious or polluting substances;
- The temperature (elevated or cryogenic) of the exhausted fluid, and the warm-up or cool down of the connected exhaust pipe work;
- The loud noise generated by the safety valve when it opens.

The safety valves are supplied adjusted, sealed and gagged.
IT IS MANDATORY TO REMOVE THE GAG AFTER INSTALLATION AND BEFORE USE.

The adjustments of the valves are protected by seals. Breaking the seals will engage the responsibility of the person doing it. When the seals are broken, SAPAG cannot bear any responsibility for a valve adjustment carried out without its formal agreement.

The adjustment or modification of a safety valve setting can only be performed by competent and trained personal using an appropriate test installation fitted with accurate and calibrated pressure measuring equipment.

Further to any setting modification of a safety valve, a new nameplate, showing the new setting value and the identification of the authority having performed the adjustment must be affixed onto the valve.

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0. Valve identification

Each valve is identified by a nameplate showing, in addition to the CE mark, the following information:

- Name and address of the manufacturer: SAPAG, Armentières, France;
- Year and month of manufacture;
- Type of safety valve;
- Serial number;
- Set pressure;
- Cold Differential Test Pressure;
- Dimensions and rating of inlet and outlet connections;
- When applicable: the valve tag number.

The value of the Cold Differential Test Pressure is also stamped on the edge of the outlet flange.

The serial number of the valve is stamped on the bonnet flange edge.

1. Storage

The safety valves must be stored away from dust, moisture or weathering.
The valve openings are protected by taps. These taps should remain in place until the valve is installed.
The safety valve must be handled with care.
The gag on the top of the safety valve can be used as a lifting hook.

2. Installation

2.1 The vessel and the piping must be absolutely clean and free from any foreign matter before installing the safety valve.

2.2 The pressure drop between the protected vessel and the safety valve should not exceed 3% of the set pressure of the valve. The safety valve must be installed in the upright position, the spring on the top side.

2.3 The pressure drop of the exhaust piping should not exceed 10% of the set pressure if the safety valve is not fitted with a balancing bellows; this limit is extended to 50% if the valve is fitted with a balancing bellows.

2.4 Clean the flange on which the valve is to be installed using an appropriate solvent.

2.5 Check the dimensions of the ports of the safety valve in comparison to the piping connections. The inlet and outlet connections are always different the inlet NPS is smaller than the outlet NPS, so that installation of the safety valve in the wrong position is impossible.

2.6 Bring the valve carefully to its location.

2.7 Remove the port taps and clean up the flange facings with an appropriate solvent.

2.8 Check piping cleanness.

2.9 Fit the connecting gaskets and put the safety valve in position.

2.10 Tight the stud bolts evenly, commencing by the inlet flange.

2.11 Make sure that the connecting piping does not induce detrimental stresses on the safety valve body.

2.12 The body of the safety valve is fitted with a drain hole, closed at the factory with a plug. It is very important that the body of the valve is not continuously filled by a stagnating fluid, due to either the discharge medium, or the weather, or caused by the discharge of other pressure relieving or safety devices connected to the same header. The drain hole may be used for this purpose. It is also advisable to design the exhaust piping in such a way that the body is never filled in by a stagnating fluid.

3. Operation

3.1 The safety valve is supplied with a GAG. This GAG blocks the valve into the closed position. WITH THE GAG IN PLACE THE SAFETY VALVE CANNOT OPEN.

3.2 The safety valve must remain gagged if an hydraulic test has to be performed with the valve in place. SAPAG recommends that, whenever possible, the hydraulic test is performed without the safety valve, replacing it during the test procedure by a blank tap if it is impossible, then the hydraulic test may be performed with the safety valve in place, with its gag. The gag is normally hand tighten only excessive tightening may damage the safety valve trim.

3.3 After completion of the hydraulic test, and before use, THE GAG MUST BE REMOVED AND REPLACED BY THE PLUG (21) AND THE GASKET (22) supplied with the safety valve.

3.4 The set pressure tolerance is +/- 3%.
The maximum operating pressure should not exceed 90% of the set pressure.
The safety valve is adjusted to be tight at 90% of the set pressure.

3.5 The safety valves are set at ambient temperature. For elevated service temperature, a correction as per table 1 shall apply.

Table 1: temperature correction

Service temperature	Temperature correction
≤ 120°C (250°F)	none
121°C to 538°C (250°F to 1000°F)	+3%
> 538°C (>1000°F)	+5%

3.6 *Cold Differential Test Pressure change.*
The Cold Differential Test Pressure may be changed by +/- 5% from the pressure marked on the nameplate.
When the CDTP is to be modified it is necessary to change the marking accordingly and to affix a new nameplate showing the modified pressure value as well as the identification of the authority proceeding to the modification.
If the CDTP has to be modified beyond above limitation, consult the factory.

3.7 *Use of the lifting lever.*
If the safety valve is fitted with a lifting lever, it may be used to check periodically the valve operation.
To check the valve operation, the pressure underneath the disc shall not be less than 75% of the set pressure.

3.8 *Operation failures.*
Operation failures can be solved by applying information as per table 2.

4. Maintenance

Dismantling, maintenance, assembly and setting shall be performed only by trained and skilled operators using adequate equipment and calibrated measure tools.

The guarantee provided by SAPAG covers maintained and repaired safety valves only if the components, if replaced, are either SAPAG components or components certified by SAPAG.

The safety valves returned from the site to the maintenance shop should before any maintenance routine be decontaminated by appropriate media in order to preserve the health of the operators.

After overhaul, each safety valve shall be thoroughly and individually inspected and sealed by an individual authorised by the user. The individual performing the sealing of the safety valve shall fill in the corresponding Test Report and show his identification on the inspected valve. The valve shall be identified by an additional nameplate showing the authority proceeding to the adjustment.

4.1 *Dismantling (see Appendix A)*

a. Remove the cap (3) and gasket (23).
b. Measure and record the dimension between the top of the adjusting screw (19) and the topside of the adjusting screw nut (20).
c. Loosen the nut (20) and the adjusting screw (19).
d. Remove the bonnet bolts (18) and the bonnet (2).
e. Remove the spindle (15), the spring and its washers (26-27), the guide assembly (16-17), the disc holder assembly (14-13-9-7-8), gaskets and bellows if applicable.
f. Pull on the spindle to disconnect from disc holder.
g. Remove the disc (4) from the disc holder (9) by inserting a tool in the lateral hole in the disc holder (9); handle the disc (7) with extreme care.
If applicable, remove the bellows as follows: the bellows is screwed onto the disc holder with a right thread. Use a spanner wrench and unscrew by turning anti clockwise.
The wall thickness of the bellows is very thin and it must not be damaged at any time during dismantling. Remove the bellows gasket.
h. Loosen the nozzle ring screw (6) and its gasket (24).
i. Turn the nozzle ring (5) anti clockwise and remove it through the top of the body.
j. If the nozzle (4) needs to be lapped, jaw the base of the nozzle into a chuck and rotate the body anti clockwise to remove the nozzle.

4.2 *Inspection*

a. Check the spring for corrosion.
b. Check all guiding surfaces.
c. Check swivels: spindle/disc holder, disc holder/disc.
d. Check the seats: disc (7) and nozzle (4).

4.3 *Repair*

a. Lap the seats of the nozzle (4) and of the disc (7). See figures 15A and 15B.
b. NEVER lap the disc (7) against the nozzle (4).
c. In case of damage, the disc (7) and nozzle (4) can be re-machined according to appendix C.

4.4 *Assembly*

a. Use a new set of gaskets (23).
b. All components must be clean and dry.
c. Except for Oxygen service, all threads and spring load seating surfaces shall be lubricated using appropriate lubricant to avoid seizure. The guiding surfaces must be kept absolutely dry.
d. Assemble the nozzle (4) into the body (1) and tighten with an appropriate chuck.
e. Screw the nozzle ring (5) onto the nozzle (4) until its upper edge is below the nozzle seat level.
f. Assemble the disc (7) and its ring (8), the disc holder (9-13) and the spindle (15), and the bellows when applicable.
g. Assemble the body to bonnet gasket (23)
h. Assemble the moving trim into the body.
i. Assemble the spring and its washers (26-27).
j. Assemble the bonnet (2).
k. Hold the top of the spindle to prevent rotation whilst screwing in the adjusting screw (19) until the dimension recorded in paragraph 4.1.b is reached.

4.5 *Setting and test*

a. Put the valve on an appropriate test stand.
The test medium shall be either clean oil free compressed air for type 8100; de-mineralized water with corrosion inhibitor for type 8200.
b. Raise the nozzle ring (5) until it gets into contact with the disc holder (9) and turn it down by 3 notches. Lock the nozzle ring (5) in rotation with the nozzle ring screw (6), taking care that the nozzle ring screw edge inserts into a notch of the nozzle screw (5), i.e. between two teeth.
c. Increase the pressure underneath the disc and check the opening pressure.
The pressure measurement accuracy must be 1% or better.
d. To properly adjust the valve, use the adjusting screw (19). Before turning the adjusting screw (19), drop the pressure below 50% of the specified set pressure and prevent the spindle from rotating with a wrench.
e. When the specified set pressure has been reached, pop the valve three to four times to check its regularity.
f. Tighten the adjusting screw nut (20), fit the cap (3) and its gasket (23).
g. Check the tightness at 90% of the set pressure using a recognized standard, such as API 527.
h. Unscrew the nozzle ring screw (6), raise the nozzle ring (5) (anti clockwise) until it gets into contact with the disc holder, then lower it (clockwise) in order to reach the adjustment as per table 3.
i. Seal the valve, identify the valve with a plate showing the authority conducting the adjustments.

5. In service supervision of safety valves

As safety accessories, the safety valves shall be carefully supervised and this supervision needs to be documented.
SAPAG recommend that procedures as described (but not limited to) below be applied by the user in order to preserve the safety of the equipment, reduce the maintenance costs and be conform to the regulatory rules.

5.1. Data file: the user should maintain a data file showing the data relevant to each safety valve: identification, technical characteristics, flow rate, operation manual.

5.2. Maintain a Log book of all operations performed on a particular safety valve: inspection, periodic check, test reports.

5.3. Maintain statistics about consumption of spare parts.

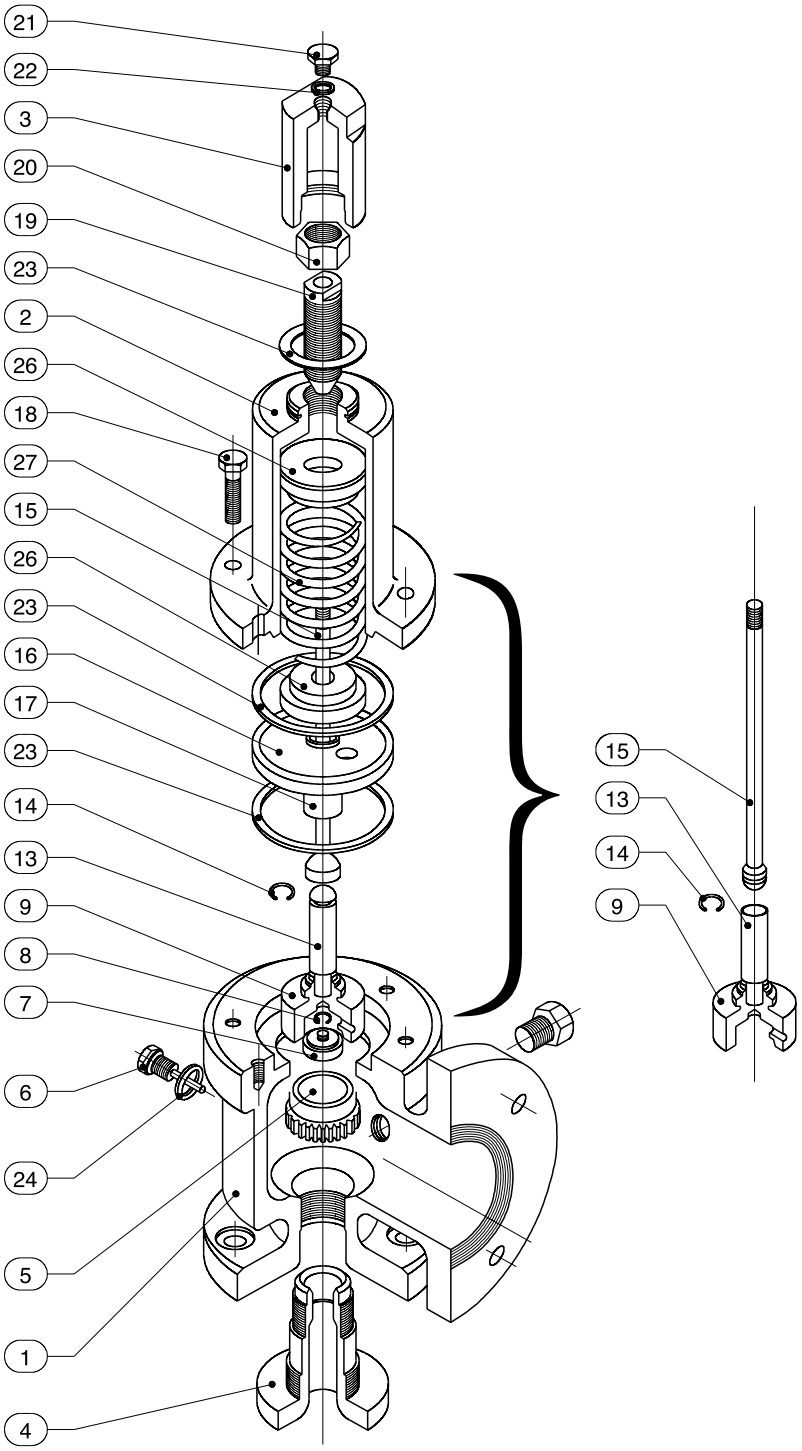
Note on periodicity of outage:
this periodicity is a function of numerous factors related to the operation: nature of the fluid, environment, pressure level as compared to the set pressure, temperature, installation set up, number of openings etc. so that it is impossible to specify a priori an optimum periodicity. The user shall have to establish this periodicity based on his own experience and his level of requirements.

Table 2: trouble shooting

Trouble	Cause	Solution
Leakage	Foreign matters on seats Seats damaged	Pull the lift lever Repair the valve
Chattering	Flow not sufficient Excessive back pressure	Check inlet pressure drop Check outlet pressure drop
The valve does not open	The gag is still in place	Remove the gag
The valve opens too often	The set pressure is too close to the operating pressure	Increase the set pressure
The valve opens too often	The temperature is higher than expected	Increase the set pressure or change spring material

Table 3: positions of the nozzle ring

Orifice size	Set pressure ≤ 7 bar	Set pressure > 7 bar
D-E	3	6
F-G	4	7
H-J	5	10
K	6	15
L	6	19
M-N	7	21
P	8	25
Q	8	22
R	30	38
T	32	40
V-W	35	45

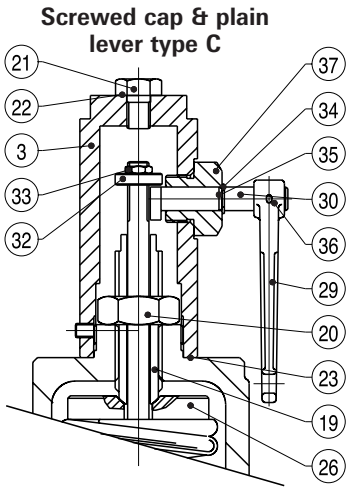


Parts list

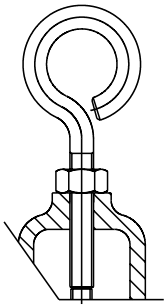
Ref	Designation
1	Body
2	Bonnet
3	Cap
4	Nozzle
5	Nozzle ring
6	Nozzle ring set screw
7	Disc
8	Elastic ring
9	Disc holder
10	Bellows
13	Spindle head
14	Elastic ring
15	Spindle
16	Guide plate
17	Guide
18	Bonnet bolt
19	Adjusting screw
20	Adjusting screw lock nut
21	Cap plug
22	Cap plug gasket
23	Gasket
24	Set screw gasket
25	Bellows gasket
26	Spring washer
27	Spring
29	Lever
30	Axle
31	Fork
32	Lift nut
33	Jam nut
34	Ring
35	Elastic ring
36	Pin
37	Bushing
38	Bushing gasket
39	O-ring
42	Nameplate

Parts list

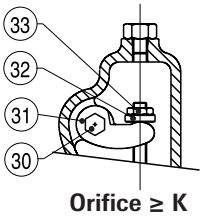
Ref	Designation
1	Body
2	Bonnet
3	Cap
4	Nozzle
5	Nozzle ring
6	Nozzle ring set screw
7	Disc
8	Elastic ring
9	Disc holder
10	Bellows
13	Spindle head
14	Elastic ring
15	Spindle
16	Guide plate
17	Guide
18	Bonnet bolt
19	Adjusting screw
20	Adjusting screw lock nut
21	Cap plug
22	Cap plug gasket
23	Gasket
24	Set screw gasket
25	Bellows gasket
26	Spring washer
27	Spring
29	Lever
30	Axle
31	Fork
32	Lift nut
33	Jam nut
34	Ring
35	Elastic ring
36	Pin
37	Bushing
38	Bushing gasket
39	O-ring
42	Nameplate



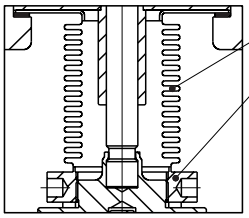
Screwed cap & plain lever type C



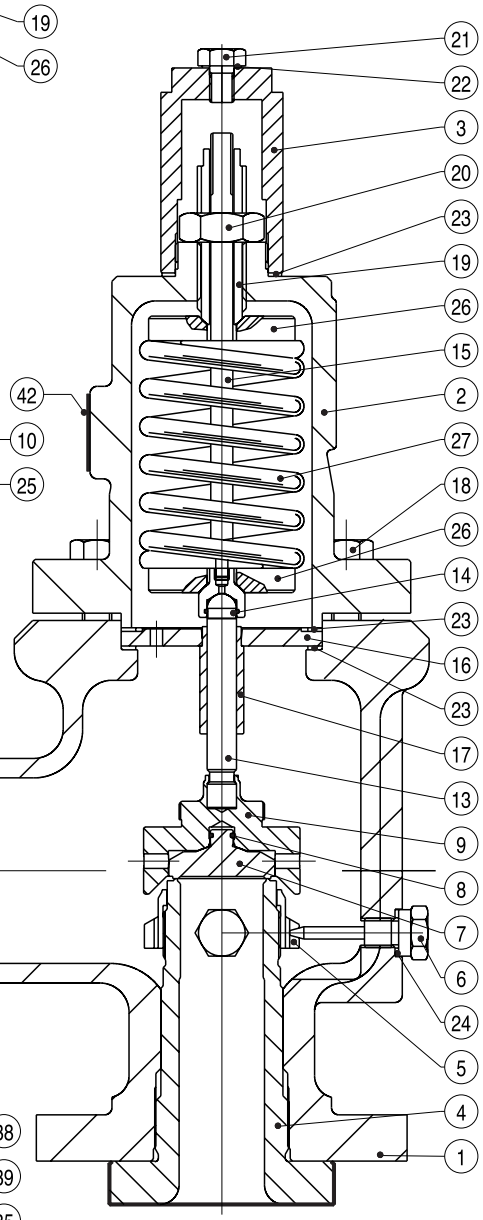
Gag



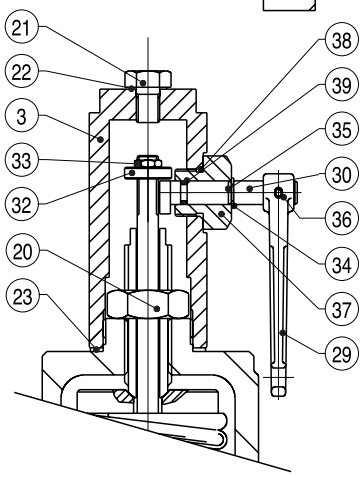
Orifice ≥ K



Bellows



Screwed cap type A



Screwed cap & packed lever type F Orifice < K

Dimensions

Orifice	D (min) mm	E mm	F mm	H mm	J mm
D	10,3	0,5	14,5	13,1	see table
E	11,9	0,65	20	17,4	see table
F	7,9	0,9	24,25	21,1	see table
G	7,9	0,9	27,8	24,2	see table
H	6,4	0,9	31,1	28,5	30,3
J	9,5	0,9	39,27	36,4	38
K	11,1	1,6	46,7	43,4	45,5
L	11,1	1,6	57,4	54,1	56,2
M	11,1	1,6	64,2	60,8	63
N	12,7	1,6	70,6	66,7	69
P	15,9	2,4	84,7	80,8	83,2
Q	22,2	2,4	110,18	106,2	109
R	25,4	2,4	129,9	125,9	128,5
T	19,1	2,4	158,4	153,3	156,5

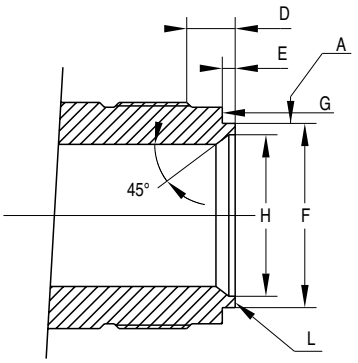


Figure 15

Dimensions J (mm)

Pressures \ Orifice	D	E	F	G
0 to 20 bar	14	19,45	23,15	26,65
20 to 40 bar	14	19,45	23,15	26,65
40 to 60 bar	14,5	19,45	23,15	26,65
60 to 80 bar	14,5	20	24,25	26,65
100 bar and above	14,5	20	24,25	27,8

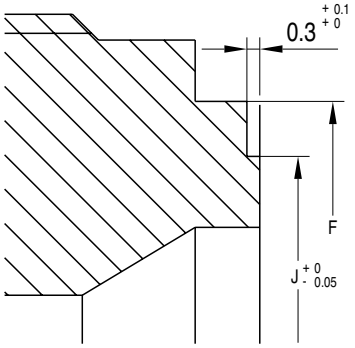


Figure 15A (continued) < 30bar

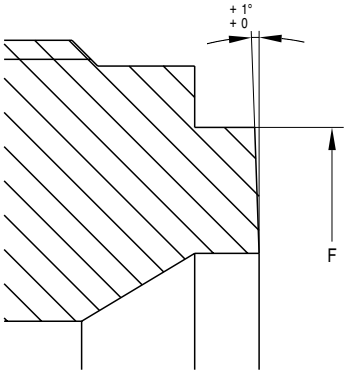


Figure 15B (continued) > 30bar

Re-machining of the disc and nozzle seats

The seat of the disc can be re- machined as follows:

- Use a 4-chuck and position the disc with copper sheets.
- Machine surface L until defect is removed.
- Machine as fine as possible.
- The disc is ready for a new lapping.
- When the minimum value of N is reached, scrap the disc.

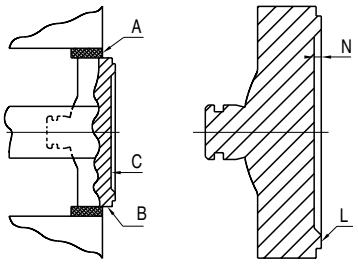


Figure 16

Dimensions

Orifice	N size (mm)
D.E	0,15
F.G.H.J	0,25
K to T	0,4

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A safety valve is normally closed and should open only to overcome exceptional upset conditions. However the unexpected opening, full or partial, of a safety valve is an event that needs to be considered; the installer shall therefore connect the outlet port of the safety valve to a system allowing the flow to be piped away to an appropriate location. The installer shall consider the following dangers:

- The blast from the safety valve discharge;
- The potential leakage from the safety valve exhaust of lethal, noxious or polluting substances;
- The temperature (elevated or cryogenic) of the exhausted fluid, and the warm-up or cool down of the connected exhaust pipe work;
- The loud noise generated by the safety valve when it opens.

The safety valves are supplied adjusted, sealed and gagged.
IT IS MANDATORY TO REMOVE THE GAG AFTER INSTALLATION AND BEFORE USE.

The adjustments of the valves are protected by seals. Breaking the seals will engage the responsibility of the personnel doing it. When the seals are broken, SAPAG cannot bear any responsibility for a valve adjustment carried out without its formal agreement.

The adjustment or modification of a safety valve setting can only be performed by competent and trained personal using an appropriate test installation fitted with accurate and calibrated pressure measuring equipment.

Further to any setting modification of a safety valve, a new nameplate, showing the new setting value and the identification of the authority having performed the adjustment must be affixed onto the valve.

Emerson reserves the right to change the contents without notice

0. Valve identification

Each valve is identified by a nameplate showing, in addition to the CE mark, the following information:

- Name and address of the manufacturer: SAPAG, Armentières, France;
- Year and month of manufacture;
- Type of safety valve;
- Serial number;
- Set pressure;
- Cold Differential Test Pressure;
- Dimensions and rating of inlet and outlet connections;
- When applicable: the valve tag number.

The value of the Cold Differential Test Pressure is also stamped on the edge of the outlet flange.

The serial number of the valve is stamped on the bonnet flange edge.

1. Storage

The safety valves must be stored away from dust, moisture or weathering.
The valve openings are protected by taps. These taps should remain in place until the valve is installed.
The safety valve must be handled with care.
The gag on the top of the safety valve can be used as a lifting hook.

2. Installation

2.1 The vessel and the piping must be absolutely clean and free from any foreign matter before installing the safety valve.

2.2 The pressure drop between the protected vessel and the safety valve should not exceed 3% of the set pressure of the valve. The safety valve must be installed in the upright position, the spring on the top side.

2.3 The pressure drop of the exhaust piping should not exceed 10% of the set pressure.

2.4 Clean the connections on which the valve is to be installed using an appropriate solvent.

2.5 Check the dimensions of the ports of the safety valve in comparison to the piping connections. The inlet and outlet connections are most of the time different; the inlet NPS is smaller than the outlet NPS, so that installation of the safety valve in the wrong position is impossible.

2.6 Bring the valve carefully to its location.

2.7 Remove the port taps and clean up the orifices with an appropriate solvent.

2.8 Check piping cleanness.

2.9 Fit the connecting gaskets if any and put the safety valve in position.

2.10 Connect the valve to the piping, commencing by the inlet.

2.11 Make sure that the connecting piping does not induce detrimental stresses on the safety valve body.

2.12 It is very important that the body of the valve is not continuously filled by a stagnating fluid, due to either the discharge medium, or the weather, or caused by the discharge of other pressure relieving or safety devices connected to the same header. It is mandatory to design the exhaust piping in such a way that the body is never filled in by a stagnating fluid.

3. Operation

3.1 The safety valve is supplied with a GAG. This GAG blocks the valve into the closed position. WITH THE GAG IN PLACE THE SAFETY VALVE CANNOT OPEN.

3.2 The safety valve must remain gagged if an hydraulic test has to be performed with the valve in place. SAPAG recommends that, whenever possible, the hydraulic test is performed without the safety valve, replacing it during the test procedure by a blank tap; if it is impossible, then the hydraulic test may be performed with the safety valve in place, with its gag.
The gag is normally hand tighten only; excessive tightening may damage the safety valve trim.

3.3 After completion of the hydraulic test, and before use, THE GAG MUST BE REMOVED AND REPLACED BY THE PLUG (17) AND THE GASKET (18) supplied with the safety valve.

3.4 The set pressure tolerance is +/- 3%.
The Maximum operating Pressure should not exceed 90% of the set pressure.

The safety valve is adjusted to be tight at 90% of the set pressure.

3.5 The safety valves are set at ambient temperature. For elevated service temperature, a correction as per table 1 shall apply.

Table 1: temperature correction

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The Cold Differential Test Pressure may be changed by +/- 5% from the pressure marked on the nameplate.

When the CDTP is to be modified it is necessary to change the marking accordingly and to affix a new nameplate showing the modified pressure value as well as the identification of the authority proceeding to the modification.

If the CDTP has to be modified beyond above limitation, consult the factory.

3.7 *Use of the lifting lever*

If the safety valve is fitted with a lifting lever, it may be used to check periodically the valve operation.

To check the valve operation, the pressure underneath the disc shall not be less than 75% of the set pressure.

3.8 *Operation failures*

Operation failures can be solved by applying information as per table 2.

4. Maintenance

Dismantling, maintenance, assembly and setting shall be performed only by trained and skilled operators using adequate equipment and calibrated measure tools.

The guarantee provided by SAPAG covers maintained and repaired safety valves only if the components, if replaced, are either SAPAG components or components certified by SAPAG.

The safety valves returned from the site to the maintenance shop should before any maintenance routine be decontaminated by appropriate media in order to preserve the health of the operators.

After overhaul, each safety valve shall be thoroughly and individually inspected and sealed by an individual authorized by the user. The individual performing the sealing of the safety valve shall fill in the corresponding Test Report and show his identification on the inspected valve. The valve shall be identified by an additional nameplate showing the authority proceeding to the adjustment.

4.1 *Dismantling (see Appendix A)*

a. Remove the cap (3) and gasket (19).
b. Measure and record the dimension between the top of the adjusting screw (15) and the topside of the adjusting screw nut (16).
c. Loosen the nut (16) and the adjusting screw (15).
d. Loosen the stop screw (9) and its gasket (21).
e. Remove the nozzle (4).
f. Remove the guide (8) from the nozzle (4).
g. Remove the spindle (11), the spring and its washers (22+23).
h. Remove the ring from the disc holder (6).
i. For O-ring or PTFE seats, remove the seat.

4.2 *Inspection*

a. Check the spring for corrosion.
b. Check all guiding surfaces.
c. Check swivels: spindle/disc holder, disc holder/disc.
d. Check the seats: disc (5) and nozzle (4).

4.3 *Repair*

a. Lap the seats of the nozzle (4) and of the disc (5). For PTFE or O ring seats, replace seat or O-ring.
b. NEVER lap the disc (5) against the nozzle (4).
c. In case of damage, the disc (5) and nozzle (4) can be re-machined according to appendix B.

4.4 *Assembly*

a. Use a new set of gaskets (20-21-19).
b. All components must be clean and dry.
c. Except for Oxygen service, all threads and spring load seating surfaces shall be lubricated using appropriate lubricant to avoid seizure. The guiding surfaces must be kept absolutely dry.
d. The disc holder (7) and guide (8) shall be kept absolutely clean and dry.
e. Insert carefully the disc (5) and the disc retainer (6) into the disc holder (7).
f. Assemble the elastic ring (10) into the groove in the disc holder (7).
g. Screw the spindle (11) into the disc holder (6).
h. Insert this sub assembly into the guide (8).
i. Assemble the spring (23) and washers (22) on the spindle (11).
j. Maintain the disc holder (7) in the upper position by pulling the spindle (11) while screwing the guide (8) onto the nozzle (4).
k. Screw and tighten the sub assembly with its gasket (20) into the body (1).
l. Screw the adjusting screw (15) in until the initial dimension is reached.

4.5 *Setting and test*

a. Put the valve on an appropriate test stand.
The test medium shall be either clean oil free compressed air or de-mineralized water with corrosion inhibitor for valves on liquid service.
b. Increase the pressure underneath the disc and check the opening pressure.
The pressure measurement accuracy must be 1% or better.
c. To properly adjust the valve, use the adjusting screw (15). Before turning the adjusting screw (15) drop the pressure below 50% of the specified set pressure and prevent the spindle from rotating with a wrench or a screwdriver.
d. When the specified set pressure has been reached, pop the valve three to four times to check its regularity.
e. Tighten the adjusting screw nut (16) and fit the cap (3) and its gasket (19).
f. Check the tightness at 90% of the set pressure using a recognized standard, such as API 527.
g. Seal the valve, identify the valve with a plate showing the authority conducting the adjustments.

5. In service supervision of safety valves

As safety accessories, the safety valves shall be carefully supervised and this supervision needs to be documented. SAPAG recommend that procedures as described (but not limited to) below be applied by the user in order to preserve the safety of the equipment, reduce the maintenance costs and be conform to the regulatory rules.

5.1. Data file: the user should maintain a data file showing the data relevant to each safety valve: identification, technical characteristics, flow rate, operation manual.

5.2. Maintain a Log book of all operations performed on a particular safety valve: inspection, periodic check, test reports.

5.3. Maintain statistics about consumption of spare parts.

Note on periodicity of outage:
this periodicity is a function of numerous factors related to the operation: nature of the fluid, environment, pressure level as compared to the set pressure, temperature, installation set up, number of openings etc...so that it is impossible to specify a priori an optimum periodicity. The user shall have to establish this periodicity based on his own experience and his level of requirements.

Table 2: trouble shooting

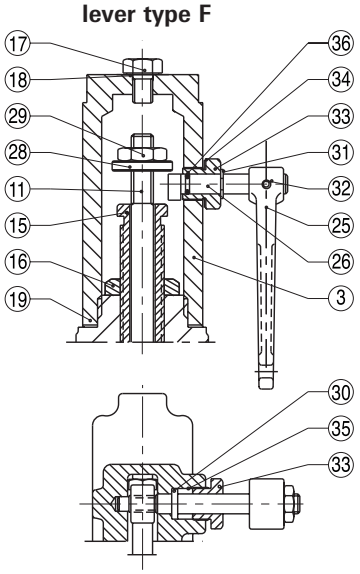
Trouble	Cause	Solution
Leakage	Foreign matters on seats Seats damaged	Pull the lift lever Repair the valve
Chattering	Flow not sufficient Excessive back pressure	Check inlet pressure drop Check outlet pressure drop
The valve does not open	The gag is still in place	Remove the gag
The valve opens too often	The set pressure is too close to the operating pressure	Increase the set pressure
The valve opens too often	The temperature is higher than expected	Increase the set pressure or change spring material

Parts list

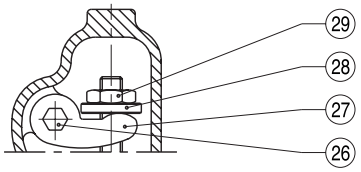
Ref	Designation
1	Body
3	Cap
4*	Nozzle #
5*	Disc #
6	Disc retainer
7	Disc holder
8	Guide
9	Stop screw
10	Elastic ring
11	Spindle
15	Adjusting screw
16	Adjusting screw nut
17	Cap plug
18*	Cap plug gasket
19*	Cap gasket
20*	Body gasket
21*	Stop screw gasket
22	Spring washer
23*	Spring
25	Lever
26	Axle
27	Fork
28	Lift nut
29	Jam nut
30	Ring
31	Elastic ring
32	Pin
33	Bushing
34	Bushing gasket
35	Packing
36	O-ring
37	Nameplate
38	Flanges

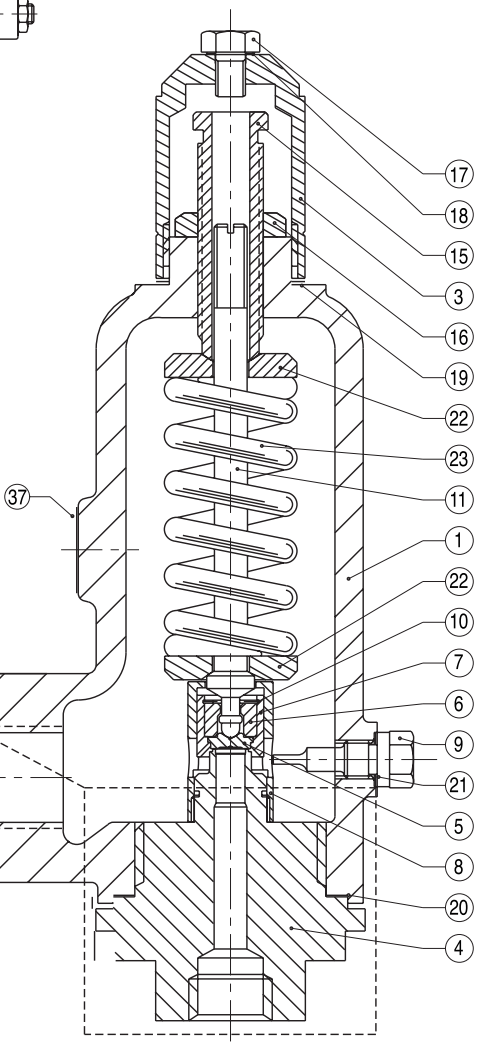
* spare parts
\# stellite on request

Screwed cap & packed lever type F

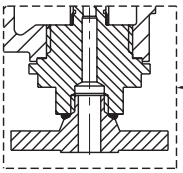


Screwed cap type A

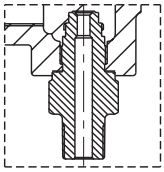


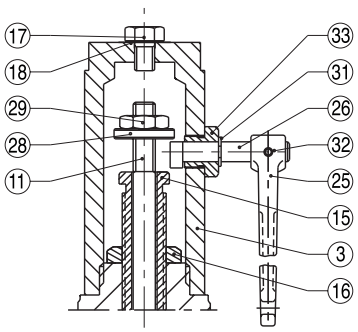


Flanged connections



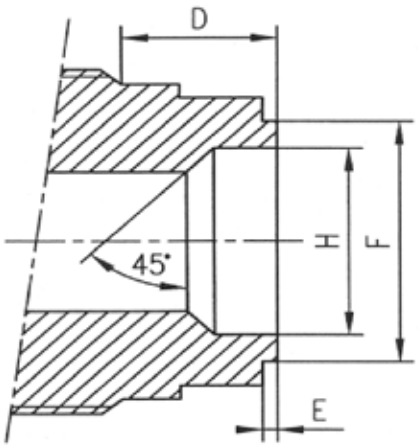
Male inlet



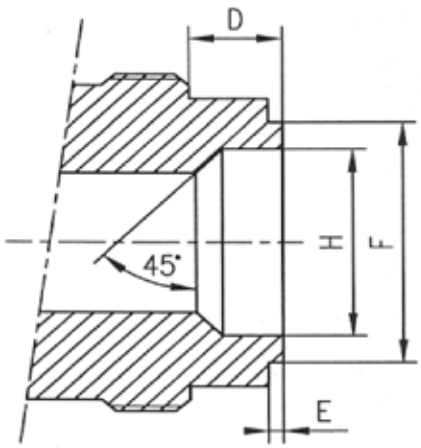


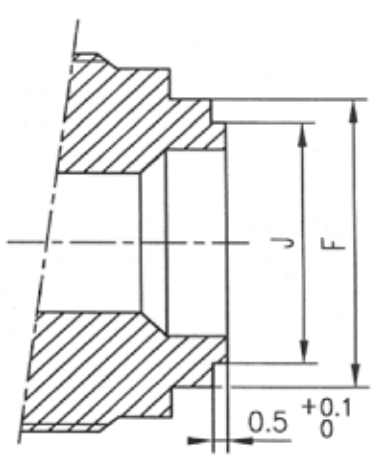
Screwed cap & plain lever type C

Re-machining of the disc and nozzle seats



Nozzle seat



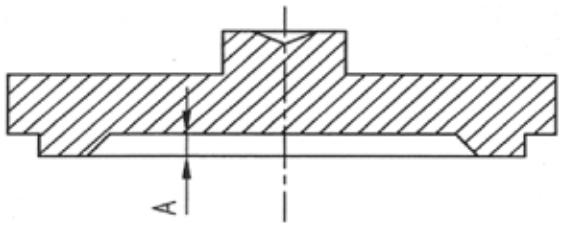


Pressure < 30bar

Dimensions (mm)

Type	Orifice	D mini	H $^{+0.05}_{0}$	E $^{\pm 0.1}$	F	J
5785	1	4,8	9,9	1,0	11.2 $^{+0}_{-0.1}$	10.45 $^{+0.1}_{-0}$
5780	2	4,8	10,3	1,0	12.0 $^{+0}_{-0.1}$	10.85 $^{+0.5}_{-0}$
5780	3	12,7	14,65	1,5	16.7 $^{+0}_{-0.1}$	15.25 $^{+0.1}_{-0}$
5780	4	23,8	21,7	1,5	24.1 $^{+0}_{-0.1}$	22.55 $^{+0.1}_{-0}$

* Not applicable for series 5790



Disc

Dimensions

Type	Orifice	A mini (mm)
5785	1	0,25
5780	2	0,25
5780	3	0,25
5780	4	0,25

SAPAG STEAM SAFETY VALVE
SERIES 9100

High performance safety valve for the protection of large boilers and superheaters, certified to ASME Section I

GENERAL

Product presentation and performance
The series 9100 is a high capacity Safety Valve designed for the overpressure protection of high pressure steam boilers and superheaters. It has been designed to meet the requirements of the ASME Code Section I, Power Boilers, and is National Board certified according to the Code rules.
The "V" Code symbol stamp may be applied to this valve.
The double adjusting ring control provides a sharp opening with minimum warn, full lift at no more than 3% over pressure and a blowdown adjustable to 2-4% of the set pressure.
This safety valve has a disc designed to enhance the precision of the set point (± 0.7 bar up to 70 bar, ± 1% of the set pressure and beyond).

TECHNICAL DATA

Size:	NPS 1½ to 8 inlet
Orifice:	2.85 cm^2 to 129.3 cm^2
Set pressure:	up to 210 bar
Temperature:	up to 593°C.

FEATURES

- National Board Certified to ASME I (3% overpressure, 2 to 4% adjustable blowdown)
- A true main steam valve for boilers and superheaters
- Butt welded (BW) or flanged inlet
- Hard faced seat
- 2 adjusting rings
- Thermally balanced disc
- MONEL piston and guide
- Disc loaded at seat level
- Factory setting on steam

CONDITIONS OF DELIVERY

Series 9100 are delivered either in flanged or BW end version; in case of BW version, the valves are shipped with the hydraulic test plug in place instead of the disc which is packed separately. Flanged valves are shipped in as-set condition. Valves to be stamped with the "V" ASME I Code symbol stamp and those for which it is mentioned in the Purchase Order, will be set on saturated steam if the operating characteristics are within the capability of the boiler at the factory. If not, the valves will be set on dry air and a site adjustment shall have to be carried out by factory agreement. The valves are painted with an aluminium high temperature layer.

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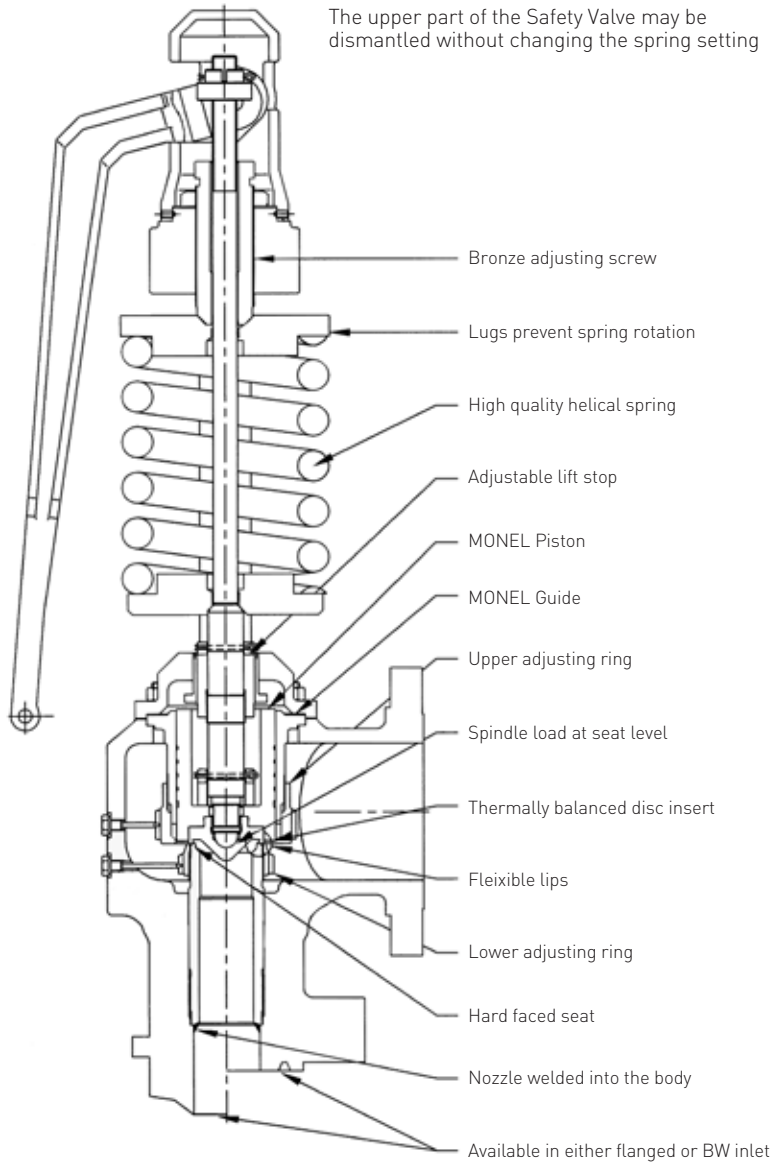
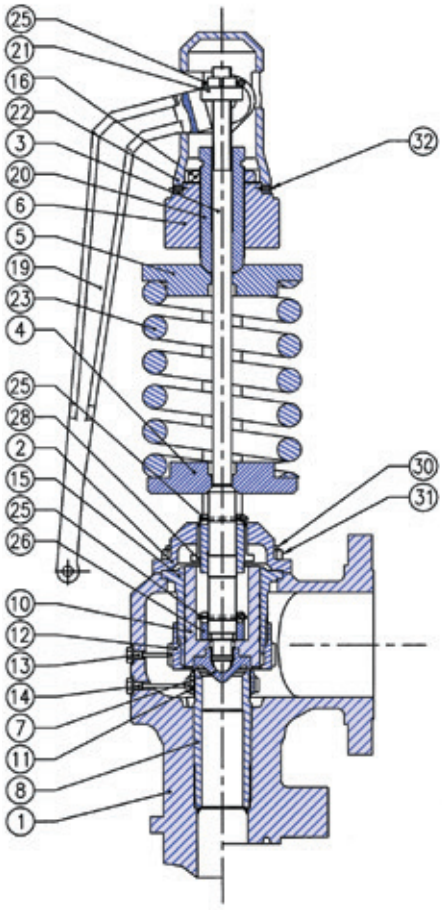


GENERAL CHARACTERISTICS

- Inlet can be either BW or flanged.
- The nozzle is welded into the body in order to provide greater seat tightness.
- The nozzle seat is stellited to prevent erosion and wear, thus reducing maintenance costs and improving seat tightness.
- The lower adjusting ring provides a sharp opening without simmer.
- The disc is designed with flexible lips to improve seat tightness under pressure. Due to the thermo-balanced design it takes advantage of the materials thermal expansion to increase the specific pressure of the disc onto its seat.
- The loading point of the spindle on the disc is at to the seat level to provide a superior set pressure tolerance.
- The upper adjusting ring allows an accurate opening/closing cycle of the valve.
- The sliding surfaces are in MONEL to maintain good guiding properties at high temperature.
- The spindle guide is stellited to avoid any risk of galling.
- The bronze adjusting screw minimizes the torque when setting the valve.
- Lugs prevent the spring from rotating during setting.
- The complete top of valve including piston, guide and spring assembly may be removed from the valve body without changing the spring setting, in order to insert the hydraulic plug in lieu of the disc for test or maintenance purpose.

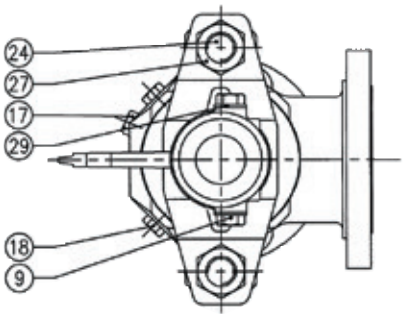
MATERIAL SELECTION

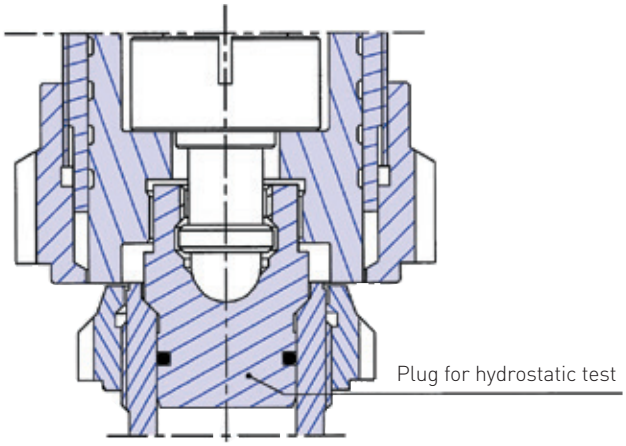
Item	Designation	9100-WCB	9100-WC9
1	Body	SA 216 WCB	SA 217 WC9
2	Bonnet	SA 216 WCB+ Stellite	SA 216 WCB+ Stellite
3	Spindle	Stainless steel	Stainless steel
4	L.spring washer	Carbon steel	Carbon steel
5	U.spring washer	Carbon steel	Carbon steel
6	Yoke	SA 216 WCB	SA 216 WCB
7	Disc	A565 gr 616	A565 gr 616
8	Nozzle	347 ss. Stellited	347 ss. Stellited
9	Lever axle	Carbon steel	Carbon steel
10	Piston	MONEL S	MONEL S
11	Lower adj.ring	Stainless steel	Stainless steel
12	Upper adj.ring	Stainless steel	Stainless steel
13	U.ring set screw	Stainless steel	Stainless steel
14	L.ring set screw	Stainless steel	Stainless steel
15	Guide	MONEL S	MONEL S
16	Hex nut	Carbon steel	Carbon steel
17	Drain plug	Carbon steel	Carbon steel
18	Plug	Carbon steel	Carbon steel
19	Lever	Carbon steel	Carbon steel
20	Adjusting screw	Bronze	Bronze
21	Spindle nut	Stainless steel	Stainless steel
22	Cap	Cast steel	Cast steel
23	Spring	Alloy steel	High temp.alloy
24	Yoke rod	SA 193 B7	SA 193 B16
25	Pin	Stainless steel	Stainless steel
26	Stem nut	Stainless steel	Stainless steel
27	Yoke rod nut	SA 194 gr 2H	SA 194 gr 2H
28	Stop collar	Stainless steel	Stainless steel
29	Lock washer	Carbon steel	Carbon steel
30	Bonnet stud	Carbon steel	Carbon steel
31	Bonnet nut	Carbon steel	Carbon steel
32	Cap screw	Carbon steel	Carbon steel



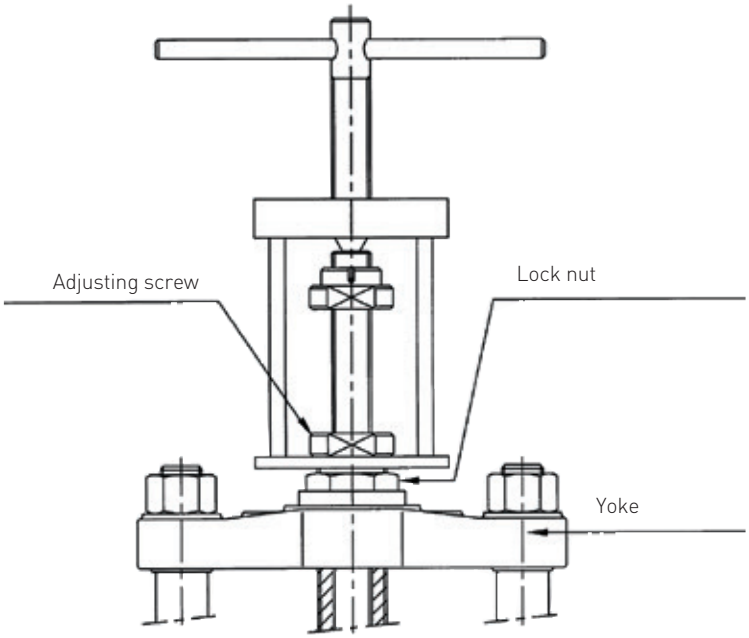
MATERIALS AND CONSTRUCTION

The valve body is SA216 WCB carbon steel (designation 9100-WCB) up to 400°C/750°F and SA217 WC9 2.5% Chromium alloy steel (designation 9100-WC9) up to 595°C/1100°F.
The disc is machined from a heat treated, high strength, wear resistant martensitic stainless steel, suitable for the more severe conditions.
The nozzle uses an austenitic stainless steel stabilised with Niobium, and the seat is hard faced.
MONEL S castings are used for guiding parts.
The spring is made from superior quality, high temperature alloy steel. The grade is selected according to the service conditions.





LOCKING GAG



The 9100 safety valves are delivered with an hydrostatic test plug. This plug has to be fitted in lieu of the disc if it is required to hydrotest the boiler with the safety valves in place. It is also recommended to let this plug in the valve when welding the BW on the boiler outlet nozzle.
The hydrostatic test plug has to be used together with the locking gag fixture. The purpose of this fixture is to maintain the spindle of the valve in the closed position.

Weather shield is also available for spring protection.

Lapping tools are available for seat reconditioning.

SIZING

The safety valve is defined by its orifice size. The orifice sizes are designated by figures corresponding to orifice areas between 2.85 cm^2 / 0,44 sq.in. and 129.3 cm^2 / 20 sq.in.

Orifice	-0	-1	-2	-3	-4	-5	-8	-6	-7	-9
cm^2	2.85	6.40	9.25	16.50	25.30	45.80	47.48	71.20	103.25	129.30
in^2	0.44	0.99	1.43	2.56	4.00	7.10	7.36	11.03	16.00	20.00

Knowing the required flow capacity of the valve at the desired set pressure, the orifice size can be determined either by using the capacity tables on pages 9 to 12 (kg/h) or Pages 13 to 16 (lbs/hr) or by calculation:

Metric units:

$$A \geq \frac{q_m}{52.5 \times P \times K_D \times K_A \times K_{SH} \times K_N}$$

US customary units:

$$A \geq \frac{q_m}{51.45 \times P \times K_D \times K_A \times K_{SH} \times K_N}$$

where:

Symbol	Designation	Metric unit	US customary
A	Orifice area	cm^2	sq.in.
q_v	Valve flow rate	kg/h	lbs/hr
q_m	Required flow rate	kg/h	lbs/hr
P	Relieving pressure, abs.	bar abs	psia
α	Overpressure	%	%
SP	Set pressure	bar	psig
K_D	Discharge coefficient	0.938	0.938
K_A	Derating coefficient	0.9	0.9
K_{SH}	Superheat correction factor	Table 4	Table 4
K_N	Napier coefficient		

P = Set Pressure + Overpressure + Atmospheric Pressure

$$P = \left(1 + \frac{\alpha}{100}\right) \times SP + 1.013 \quad \text{(bar abs.)} \quad \text{or} \quad P = \left(1 + \frac{\alpha}{100}\right) \times SP + 14.7 \quad \text{(psia)}$$

α = overpressure, 3% (ASME Section I) or 10% (according to regulation)

K_{SH} = obtained from page 17 for superheated steam
K_{cH} = 1.00 for saturated steam

K_N = NAPIER correction factor
K_N = 1.00 for up to 103 bar/1500 psig
beyond:

$$K_N = \frac{2.7644 \times P - 1000}{3.3242 \times P - 1061} \quad \text{(metric)} \qquad K_N = \frac{0.1906 \times P - 1000}{0.2292 \times P - 1061} \quad \text{(US customary)}$$

Valve flow rate:

$q_v = 52.5 \times A \times P \times K_D \times K_A \times K_{SH} \times K_N$ (metric)
$q_v = 51.45 \times A \times P \times K_D \times K_A \times K_{SH} \times K_N$ (US customary)

PRESSURE/TEMPERATURE RATING

When the orifice size has been selected, refer to page 8 to select the correct valve rating corresponding to the orifice size, the set pressure and the temperature.
Pressure ratings are based on ASME B16.34.
- type 9104 = Cl.600 lbs
- type 9105-6 = Cl. 900 lbs
- type 9107 = Cl.1500 lbs
- type 9108 = Cl. 2500 lbs
- type 9109 = Cl. 3000 lbs

DIMENSIONS AND WEIGHTS

Refer to page 7 for dimensional data and valve inlet x outlet sizes.

SELECTION GUIDE

Example:	9106	-3	WC9	2½" 900 RF	21/2" 900 RF
Type					
9104	Cl. 600 lbs				
9105-6	Cl. 900 lbs				
9107	Cl. 600 lbs				
9108	Cl. 600 lbs				
9109	Cl. 600 lbs				
Orifice					
-0	2.85 cm^2 (0.44 sq.in)				
-1	6.40 cm^2 (0.99 sq.in)				
-2	9.25 cm^2 (1.43 sq.in)				
-3	16.50 cm^2 (2.56 sq.in)				
-4	25.30 cm^2 (4.00 sq.in)				
-5	45.80 cm^2 (7.10 sq.in)				
-6	71.20 cm^2 (11.03 sq.in)				
-7	103.25 cm^2 (16.00 sq.in)				
-9	129.30 cm^2 (20.00 sq.in)				
Material and temperature					
WCB	T ≤ 400°C / 750°F				
WC9	T ≤ 595°C / 1100°F				
Inlet					
Size, rating and finish					
Outlet					
Size, rating and finish					

NOISE

The noise generated by the safety valve when discharging can be evaluated by the following formula.
Values for saturated steam are given on page 18.
The absorption of an exhaust pipe sch40 will be approximately -20 dB(A).
At a distance of 30 m, consider -30 dB(A).

$$\text{Sound} = 14 \log_{10}(0.963A) + 18 \log_{10} P_1 + 76$$

REACTION FORCE

The reaction force generated by a safety valve when discharging can be evaluated by the following formula.
Values for saturated steam are published on page 18.

$$F = \frac{q_v}{1563}\sqrt{T + 0.1 \times P \times S}$$

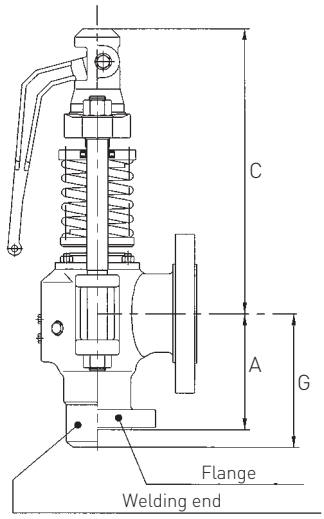
with
- T Absolute temperature (°K)
- q_v Valve flow rate (kg/h)
- P Relieving pressure (bar abs)
- S Area of valve outlet (cm^2)
- F Reaction force (daN)

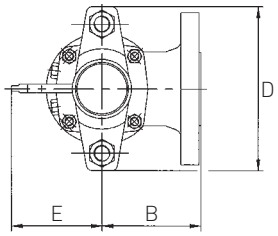
INSTALLATION

The boiler outlet nozzle shall have a cross section which is at least equal to the cross section of the inlet size of the safety valve.
The pressure drop between the header and any safety valve must be minimum, and in no circumstance be more than 3% of the set pressure when the valve is discharging its rated capacity.
The design of the boiler outlet nozzle should take into consideration the unbalanced reaction force generated by the safety valve when discharging; See above for reaction force evaluation.
The exhaust piping shall be simple and direct.
Care shall be taken to relief at a safe location.
The exhaust piping shall be equal or larger than the safety valve outlet.
The exhaust pipe shall be drained to avoid accumulation of condensate or rain water in the safety valve body.
The drain hole in the body wall should be piped to a drain line.
The exhaust piping shall be designed in such a way that no stress from pipe thermal expansion or misalignment is transmitted to the valve body.
The exhaust piping should be of a simple design, using large radius elbow, flexible joint and drip pan.

SAPAG STEAM SAFETY VALVE

SERIES 9100 / DIMENSIONS AND WEIGHTS





TYPE 9100 DIMENSIONS AND WEIGHTS

	Model N°	Inlet NPS	Inlet class (lbs)	Outlet NPS	Outlet class (lbs)	A mm	B mm	C mm	D mm	E mm	G mm	W kg
Orifice 0	9104	1½	600	3	150	171	137	510	232	130	185	45
2.85 cm²	9106	1½	900	3	150	181	137	510	232	130	185	48
0.44 in²	9107	1½	1500	3	300	181	137	510	232	130	185	48
	9108	1½	2500	3	300	190	137	510	232	130	185	52
	9109	1½	BW	3	300		137	510	232	130	185	45
Orifice 1	9104	1½	600	3	150	171	137	510	232	130	185	45
6.40 cm²	9106	1½	900	3	150	181	137	545	232	130	185	48
0.99 in²	9107	1½	1500	3	300	181	137	500	232	130	185	48
	9108	1½	2500	4	300	220	165	552	260	130	215	87
	9109	1½	BW	4	300		165	552	260	130	215	84
Orifice 2	9104	2	600	4	150	207	170	640	260	130	155	85
9.25 cm²	9106	2	900	4	150	220	170	640	260	130	155	85
1.43 in²	9107	2	1500	4	300	220	170	670	260	130	155	87
	9108	2	2500	4	300	230	177	680	330	200	155	93
	9109	2	BW	4	300		177	680	330	200	190	90
Orifice 3	9104	2½	600	6	150	215	179	730	330	200	185	111
16.5 cm²	9106	2½	900	6	150	228	179	730	330	200	185	116
2.56 in²	9107	2½	1500	6	300	228	179	765	330	200	185	116
	9108	2½	2500	6	300	275	200	776	415	200	220	184
	9109	2½	BW	6	300		200	776	415	200	220	180
Orifice 4	9104	3	600	6	150	251	188	815	415	200	300	175
25.8 cm²	9106	3	900	6	150	257	188	865	415	200	300	176
4.00 in²	9107	3	1500	6	150	266	188	940	415	200	300	184
	9108	3	2500	6	300	284	218	1020	422	245	300	229
	9109	3	BW	6	300		200	1020	422	245	300	218
Orifice 5	9104	4	600	6	150	251	212	900	415	200	310	254
45.8 cm²	9106	4	900	6	150	257	212	900	415	200	310	255
7.10 in²	9107	4	1500	6	150	266	212	1030	422	245	310	275
Orifice 8	9109	4	BW	8	300		270	1190	510	245	330	560
47.48 cm²												
7.36 in²												
Orifice 6	9104	6	600	8	150	301	260	1130	510	245	340	355
71.20 cm²	9106	6	900	8	150	308	260	1200	510	245	340	360
11.03 in²	9107	6	1500	8	150	335	260	1200	510	245	340	390
Orifice 7	9104	6	600	10	150	382	267	1230	568	245	390	550
103.25 cm²	9105	6	900	10	150	390	267	1230	568	245	390	560
16.00 in²												
Orifice 9	9104	8	600	10	150	309	260	1200	510	240	290	373
129.3 cm²	9105	8	900	10	150	316	260	1220	510	246	290	382
20.00 in²												

BW = Butt weld

ORIFICE 0 - 1 - 2 / MAX. SET PRESSURE: bar, psig

	Temp.		Valve type number									
			9104		9106		9107		9108		9109	
Body	°C	°F	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig
SA 216 WCB	316	600	76	1095	113	1640						
	343	650	74	1075	111	1610	185	2685				
	371	700	73	1065	110	1600	184	2665	207	3000	207	3000
	399	750	70	1010	104	1510	174	2520	207	3000	207	3000
SA 217 WC9	427	800	70	1015	105	1525	175	2540	207	3000	207	3000
	454	850	67	975	101	1460	168	2435	207	3000	207	3000
	482	900	62	900	93	1350	155	2245	207	3000	207	3000
	510	950	52	755	78	1130	130	1885	207	3000	207	3000
	538	1000	36	520	54	780	90	1305	150	2170	162	2355
	566	1050	24	350	36	525	60	875	100	1455	121	1750
	593	1100	15	220	23	330	38	550	63	915	76	1098

ORIFICE 3 - 4 / MAX. SET PRESSURE: bar, psig

	Temp.		Valve type number									
			9104		9106		9107		9108		9109	
Body	°C	°F	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig
SA 216 WCB	⩽ 399	⩽ 750	67	975	101	1460	168	2435	180	2610	207	3000
SA 217 WC9	427	800	67	975	101	1460	168	2435	180	2610	207	3000
	454	850	67	975	101	1460	168	2435	180	2610	207	3000
	482	900	62	900	93	1350	155	2245	180	2610	207	3000
	510	950	52	755	78	1130	130	1885	180	2610	207	3000
	538	1000	36	520	54	780	90	1305	150	2170	162	2355
	566	1050	24	350	36	525	60	875	100	1455	121	1750
	593	1100	15	220	23	330	38	550	63	915	76	1098

ORIFICE 5 - 7 / MAX. SET PRESSURE: bar, psig

	Temp.		Valve type number					
			9104		9106		9107	
Body	°C	°F	bar	psig	bar	psig	bar	psig
SA 216 WCB	⩽ 399	⩽ 750	67	975	79	1150	109	1580
SA 217 WC9	427	800	67	975	79	1150	109	1580
	454	850	67	975	79	1150	109	1580
	482	900	62	900	79	1150	109	1580
	510	950	52	755	78	1130	109	1580
	538	1000	36	520	54	780	90	1305
	566	1050	24	350	36	525	60	875
	593	1100	15	220	23	330	38	550

ORIFICE 8 / MAX. SET PRESSURE: bar, psig

	Temp.		Valve type number	
			9109	
Body	°C	°F	bar	psig
SA 216 WCB	⩽ 399	⩽ 750	207	3000
SA 217 WC9	427	800	207	3000
	454	850	207	3000
	482	900	207	3000
	510	950	207	3000
	538	1000	162	2355
	566	1050	121	1750
	593	1100	76	1098

ORIFICE 7 - 9 / MAX. SET PRESSURE: bar, psig

	Temp.		Valve type number			
			9104		9105	
Body	°C	°F	bar	psig	bar	psig
SA 216 WCB	⩽ 399	⩽ 750	40	580	57	820
SA 217 WC9	427	800	40	580	57	820
	454	850	40	580	57	820
	482	900	40	580	57	820
	510	950	40	580	57	820
	538	1000	36	520	45	650
	566	1050	24	350	30	438
	593	1100	15	220	19	275

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (kg/h)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (cm^2) A									
Set pressure (bar)	Relieving pressure (bar abs)	2.85	6.4	9.25	16.5	25.8	45.8	47.48	71.2	103.25	129.3
		Kg/h									
30	32	4035	9062	13097	23362	36530	64849	67227	100813	146193	183077
31	33	4166	9354	13520	24117	37709	66942	69397	104066	150911	188986
32	34	4296	9647	13943	24871	38888	69035	71567	107320	155629	194895
33	35	4426	9939	14365	25625	40068	71128	73737	110574	160348	200803
34	36	4556	10232	14788	26379	41247	73221	75906	113828	165066	206712
35	37	4687	10524	1s211	27133	42426	75314	78076	117081	169784	212621
36	38	4817	10817	15633	27887	43605	77407	80246	120335	174503	218530
37	39	4947	11109	16056	28641	44784	79500	82416	123589	179221	224439
38	40	5077	11402	16479	29395	45963	81593	84586	126843	183940	230348
39	41	5208	11694	16902	30149	47142	83686	86755	130096	188658	236257
40	42	5338	11987	17324	30903	48321	85779	88925	133350	193376	242165
41	43	5468	12279	17747	31657	49500	87872	91095	136604	198095	248074
42	44	5598	12571	18170	32411	50679	89965	93265	139858	202813	253983
43	45	5728	12864	18592	33165	51858	92058	95434	143111	207532	259892
44	46	5859	13156	19015	33919	53037	94151	97604	146365	212250	265801
45	47	5989	13449	19438	34673	54216	96244	99774	149619	216968	271710
46	48	6119	13741	19861	35427	55395	98337	101944	152873	221687	277619
47	49	6249	14034	20283	36181	56574	100430	104114	156126	226405	283527
48	50	6380	14326	20706	36935	57753	102523	106283	159380	231124	289436
49	51	6510	14619	21129	37689	58932	104616	108453	162634	235842	295345
50	53	6640	14911	21551	38443	60111	106709	110623	165888	240560	301254
51	54	6770	15204	21974	39197	61290	108802	112793	169141	245279	307163
52	55	6901	15496	22397	39951	62469	110895	114962	172395	249997	313072
53	56	7031	15789	22820	40705	63648	112988	117132	175649	254716	318981
54	57	7161	16081	23242	41459	64827	115081	119302	178903	259434	324889
55	58	7291	16374	23665	42213	66006	117174	121472	182156	264152	330798
56	59	7422	16666	24088	42967	67185	119267	123642	185410	268871	336707
57	60	7552	16959	24510	43721	68364	121360	125811	188664	273589	342616
58	61	7682	17251	24933	44475	69543	123453	127981	191918		
59	62	7812	17544	25356	45229	70722	125546	130151	195171		
60	63	7943	17836	25779	45983	71901	127639	132321	198425		
61	64	8073	18128	26201	46737	73080	129732	134490	201679		
62	65	8203	18421	26624	47491	74259	131825	136660	204933		
63	66	8333	18713	27047	48245	75438	133918	138830	208187		
64	67	8464	19006	27469	48999	76617	136011	141000	211440		
65	68	8594	19298	27892	49754	77796	138104	143170	214694		
66	69	8724	19591	28315	50508	78975	140197	145339	217948		
67	70	8854	19883	28738	51262	80154	142290	147509	221202		
68	71	8985	20176	29160	52016	81334	144383	149679	224455		
69	72	9115	20468	29583	52770	82513	146476	151849	227709		
70	73	9245	20761	30006	53524	83692	148569	154018	230963		
71	74	9375	21053	30428	54278	84871	150662	156188	234217		
72	75	9505	21346	30851	55032	86050	152755	158358	237470		
73	76	9636	21638	31274	55786	87229	154848	160528	240724		
74	77	9766	21931	31697	56540	88408	156941	162698	243978		
75	78	9896	22223	32119	57294	89587	159034	164867	247232		
76	79	10026	22516	32542	58048	90766	161127	167037	250485		
77	80	10157	22808	32965	58802	91945	163220	169207	253739		
78	81	10287	23100	33387	59556	93124	165313	171377	256993		
79	82	10417	23393	33810	60310	94303	167406	173546	260247		
80	83	10547	23685	34233	61064	95482	169499	175716	263500		
81	84	10678	23978	34656	61818	96661	171592	177886	266754		
82	85	10808	24270	35078	62572	97840	173685	180056	270008		

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+1.013)/(1.03 x SP + 1.013)]

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (kg/h) (CONTINUED)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (cm^2) A									
Set pressure	Relieving pressure	2.85	6.4	9.25	16.5	25.8	45.8	47.48	71.2	103.25	129.3
(bar)	(bar abs)	Kg/h									
83	87	10938	24563	35501	63326	99019	175778	182226	273262		
84	88	11068	24855	35924	64080	100198	177871	184395	276515		
85	89	11199	25148	36346	64834	101377	179964	186565	279769		
86	90	11329	25440	36769	65588	102556	182057	188735	283023		
87	91	11459	25733	37192	66342	103735	184150	190905	286277		
88	92	11589	26025	37615	67096	104914	186243	193074	289530		
89	93	11720	26318	38037	67850	106093	188336	195244	292784		
90	94	11850	26610	38460	68604	107272	190429	197414	296038		
91	95	11980	26903	38883	69358	108451	192522	199584	299292		
92	96	12110	27195	39305	70112	109630	194615	201754	302545		
93	97	12241	27488	39728	70866	110809	196708	203923	305799		
94	98	12371	27780	40151	71620	111988	198801	206093	309053		
95	99	12501	28073	40574	72374	113167	200894	208263	312307		
96	100	12631	28365	40996	73128	114346	202987	210433	315560		
97	101	12762	28657	41419	73882	115525	205080	212602	318814		
98	102	12892	28950	41842	74637	116704	207173	214772	322068		
99	103	12961	29106	42067	75039	117334	208290	215931	323805		
100	104	13101	29420	42522	75849	118601	210539	218262	327301		
101	105	13241	29735	42977	76661	119870	212793	220599	330805		
102	106	13382	30051	43433	77475	121143	215052	222940	334316		
103	107	13523	30367	43890	78291	122418	217316	225287	337836		
104	108	13664	30684	44348	79108	123696	219585	227639	341363		
105	109	13806	31002	44808	79927	124977	221859	229997	344898		
106	110	13947	31321	45268	80748	126261	224138	232360	348442		
107	111	14090	31640	45729	81572	127548	226423	234728	351993		
108	112	14232	31960	46192	82397	128838	228713	237102	355554		
109	113	14375	32281	46656	83224	130131	231008	239482	359122		
110	114	14518	32602	47120	84053	131428		241868			
111	115	14662	32925	47586	84884	132727		244259			
112	116	14806	33248	48053	85717	134030		246657			
113	117	14950	33572	48522	86552	135336		249060			
114	118	15095	33897	48991	87389	136645		251470			
115	119	15240	34222	49462	88229	137958		253886			
116	120	15385	34549	49934	89071	139274		256308			
117	122	15531	34876	50407	89915	140594		258737			
118	123	15677	35204	50881	90761	141917		261172			
119	124	15823	35533	51357	91610	143244		263614			
120	125	15970	35863	51834	92461	144547		266062			
121	126	16118	36194	52312	93314	145909		268518			
122	127	16266	36526	52792	94170	147247		270980			
123	128	16414	36859	53273	95028	148589		273450			
124	129	16563	37193	53756	95888	149935		275926			
125	130	16712	37528	54240	96752	151284		278410			
126	131	16861	37864	54725	97617	152638		280902			
127	132	17011	38201	55212	98486	153996		283401			
128	133	17162	38538	55700	99357	155358		285907			
129	134	17313	38877	56190	100231	156725		288422			
130	135	17464	39217	56681	101107	158095		290944			
131	136	17616	39559	57174	101987	159470		293475			
132	137	17768	39901	57669	102869	160850		296013			
133	138	17921	40244	58165	103754	162234		298561			
134	139	18075	40589	58663	104642	163622		301116			
135	140	18228	40934	59163	105533	165016		303680			

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+1.013)/(1.03 x SP + 1.013)]

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (kg/h) (CONTINUED)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (cm^2) A									
Set pressure	Relieving pressure	2.85	6.4	9.25	16.5	25.8	45.8	47.48	71.2	103.25	129.3
(bar)	(bar abs)	Kg/h									
136	141	18383	41281	59664	106428	166414		306253			
137	142	18538	41629	60167	107325	167817		308835			
138	143	18693	41978	60672	108225	169225		311426			
139	144	18850	42329	61178	109129	170638		314026			
140	145	19006	42681	61687	110036	172056		316636			
141	146	19163	43034	62197	110946	173479		319255			
142	147	19321	43388	62709	111860	174908		321884			
143	148	19480	43744	63223	112777	176342		324523			
144	149	19639	44101	63739	113697	177781		327173			
145	150	19798	44459	64258	114622	179226		329832			
146	151	19959	44819	64778	115549	180677		332502			
147	152	20119	45180	65300	116481	182134		335183			
148	153	20281	45543	65824	117416	183596		337874			
149	154	20443	45908	66351	118355	185065		340577			
150	156	20606	46273	66879	119299	186540		343291			
151	157	20770	46641	67410	120246	188021		346016			
152	158	20934	47010	67944	121197	189508		348753			
153	159	21099	47380	68479	122152	191002		351502			
154	160	21265	47752	69017	123112	192502		354264			
155	161	21431	48126	69558	124076	194009		357038			
156	162	21599	48502	70101	125044	195524		359824			
157	163	21767	48879	70646	126017	197045		362623			
158	164	21935	49258	71194	126994	198573		365436			
159	165	22105	49639	71744	127976	200109		368262			
160	166	22275	50022	72298	128963	201652		371102			
161	167	22447	50407	72854	129955	203202		373956			
162	168	22619	50793	73412	130952	204761		376824			
163	169	22792	51182	73974	131954	206327		379706			
164	170	22966	51573	74538	132960	207902		382604			
165	171	23141	51965	75106	133973	209484		385516			
166	172	23316	52360	75676	134990	211076		388445			
167	173	23493	52757	76250	136013	212675		391389			
168	174	23671	53156	76827	137042	214284		394349			
169	175	23850	53557	77407	138077	215901		397326			
170	176	24029	53960	77990	139117	217528		400319			
171	177	24210	54366	78576	140163	219164		403330			
172	178	24392	54775	79166	141216	220810		406359			
173	179	24575	55185	79760	142274	222465		409405			
174	180	24759	55598	80357	143339	224131		412470			
175	181	24944	56014	80958	144411	225807		415554			
176	182	25130	56432	81562	145489	227493		418657			
177	183	25317	56853	82171	146575	229189		421780			
178	184	25506	57277	82783	147667	230897		424923			
179	185	25696	57703	83399	148766	232616		428086			
180	186	25887	58133	84020	149873	234347		431271			
181	187	26080	58565	84644	150987	236089		434477			
182	188	26273	59000	85273	152109	237843		437705			
183	190	26468	59438	85907	153239	239610		440956			
184	191	26665	59879	86544	154376	241389		444230			
185	192	26863	60324	87187	155522	243181		447528			
186	193	27062	60772	87834	156677	244986		450850			
187	194	27263	61223	88486	157840	246804		454197			
188	195	27466	61677	89143	159012	248637		457569			

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+1.013)/(1.03 x SP + 1.013)]

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (kg/h) (CONTINUED)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (cm^2) A									
Set pressure (bar)	Relieving pressure (bar abs)	2.85	6.4	9.25	16.5	25.8	45.8	47.48	71.2	103.25	129.3
		Kg/h									
189	196	27670	62136	89805	160193	250484		460968			
190	197	27875	62597	90473	161383	252345		464393			
191	198	28083	63063	91145	162583	254221		467846			
192	199	28292	63532	91823	163793	256113		471327			
193	200	28502	64005	92507	165013	258020		474837			
194	201	28715	64482	93197	166243	259944		478377			
195	202	28929	64963	93892	167484	261884		481947			
196	203	29145	65449	94594	168735	263841		485549			
197	204	29363	65939	95302	169998	265815		489183			
198	205	29583	66433	96016	171272	267808		492849			
199	206	29806	66932	96737	172558	269819		496550			
200	207	30030	67435	97465	173856	271848		500285			
201	208	30256	67944	98200	175167	273898		504056			
202	209	30485	68457	98942	176490	275967		507864			
203	210	30716	68975	99691	177827	278056		511710			
204	211	30949	69499	100448	179177	280167		515595			
205	212	31184	70028	101212	180541	282300		519520			
206	213	31422	70563	101985	181919	284455		523486			
207	214	31663	71103	102766	183312	286633		527494			
208	215	31906	71649	103555	184720	288835		531546			
209	216	32152	72201	104353	186144	291061		535643			
210	217	32401	72760	105161	187584	293313		539787			

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+1.013)/(1.03 x SP + 1.013)]

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (lbs/hr)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (in^2) A									
Set pressure (psig)	Relieving pressure (psia)	0.44	0.99	1.43	2.56	4	7.1	7.36	11.03	16	20
		Lbs/hr									
435	463	8853	19919	28772	51509	80482	142856	148087	221930	321929	402411
450	478	9139	20562	29701	53171	83080	147467	152867	229092	332319	415399
464	493	9424	21205	30630	54833	85677	152077	157646	236255	342709	428386
479	508	9710	21848	31558	56496	88275	156688	162426	243418	353099	441374
493	522	9996	22491	32487	58158	90872	161298	167205	250580	363489	454361
508	537	10282	23134	33415	59821	93470	165909	171984	257743	373879	467349
522	552	10567	23777	34344	61483	96067	170519	176764	264906	384269	480337
537	567	10853	24420	35273	63145	98665	175130	181543	272068	394659	493324
551	582	11139	25062	36201	64808	101262	179741	186323	279231	405049	506312
566	597	11425	25705	37130	66470	103860	184351	191102	286394	415440	519299
580	612	11710	26348	38059	68133	106457	188962	195882	293556	425830	532287
595	627	11996	26991	38987	69795	109055	193572	200661	300719	436220	545275
609	642	12282	27634	39916	71458	111652	198183	205440	307882	446610	558262
624	657	12567	28277	40844	73120	114250	202794	210220	315044	457000	571250
638	672	12853	28920	41773	74782	116847	207404	214999	322207	467390	584237
653	687	13139	29563	42702	76445	119445	212015	219779	329370	477780	597225
667	702	13425	30206	43630	78107	122043	216625	224558	336532	488170	610213
682	717	13710	30848	44559	79770	124640	221236	229338	343695	498560	623200
696	732	13996	31491	45487	81432	127238	225847	234117	350858	508950	636188
711	747	14282	32134	46416	83094	129835	230457	238897	358020	519340	649175
725	761	14568	32777	47345	84757	132433	235068	243676	365183	529730	662163
740	776	14853	33420	48273	86419	135030	239678	248455	372346	540120	675151
754	791	15139	34063	49202	88082	137628	244289	253235	379508	550510	688138
769	806	15425	34706	50130	89744	140225	248900	258014	386671	560901	701126
783	821	15710	35349	51059	91407	142823	253510	262794	393833	571291	714113
798	836	15996	35991	51988	93069	145420	258121	267573	400996	581681	727101
812	851	16282	36634	52916	94731	148018	262731	272353	408159	592071	740088
827	866	16568	37277	53845	96394	150615	267342	277132	415321	602461	753076
841	881	16853	37920	54774	98056	153213	271953	281911	422484		
856	896	17139	38563	55702	99719	155810	276563	286691	429647		
870	911	17425	39206	56631	101381	158408	281174	291470	436809		
885	926	17711	39849	57559	103043	161005	285784	296250	443972		
899	941	17996	40492	58488	104706	163603	290395	301029	451135		
914	956	18282	41135	59417	106368	166200	295006	305809	458297		
928	971	18568	41777	60345	108031	168798	299616	310588	465460		
943	985	18853	42420	61274	109693	171395	304227	315367	472623		
957	1000	19139	43063	62202	111355	173993	308837	320147	479785		
972	1015	19425	43706	63131	113018	176590	313448	324926	486948		
986	1030	19711	44349	64060	114680	179188	318059	329706	494111		
1001	1045	19996	44992	64988	116343	181785	322669	334485	501273		
1015	1060	20282	45635	65917	118005	184383	327280	339265	508436		
1030	1075	20568	46278	66846	119668	186980	331890	344044	515599		
1044	1090	20854	46921	67774	121330	189578	336501	348824	522761		
1059	1105	21139	47563	68703	122992	192176	341112	353603	529924		
1073	1120	21425	48206	69631	124655	194773	345722	358382	537087		
1088	1135	21711	48849	70560	126317	197371	350333	363162	544249		
1102	1150	21996	49492	71489	127980	199968	354943	367941	551412		
1117	1165	22282	50135	72417	129642	202566	359554	372721	558575		
1131	1180	22568	50778	73346	131304	205163	364165	377500	565737		
1146	1195	22854	51421	74274	132967	207761	368775	382280	572900		
1160	1210	23139	52064	75203	134629	210358	373386	387059	580063		
1175	1224	23425	52707	76132	136292	212956	377996	391838	587225		
1189	1239	23711	53349	77060	137954	215553	382607	396618	594388		

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+14.7)/(1.03 x SP + 14.7)]

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (lbs/hr) (CONTINUED)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (in^2) A									
Set pressure	Relieving pressure	0.44	0.99	1.43	2.56	4	7.1	7.36	11.03	16	20
(psig)	(psia)	Lbs/hr									
1204	1254	23997	53992	77989	139616	218151	387218	401397	601551		
1218	1269	24282	54635	78917	141279	220748	391828	406177	608713		
1233	1284	24568	55278	79846	142941	223346	396439	410956	615876		
1247	1299	24854	55921	80775	144604	225943	401049	415736	623039		
1262	1314	25139	56564	81703	146266	228541	405660	420515	630201		
1276	1329	25425	57207	82632	147929	231138	410270	425294	637364		
1291	1344	25711	57850	83561	149591	233736	414881	430074	644527		
1305	1359	25997	58493	84489	151253	236333	419492	434853	651689		
1320	1374	26282	59135	85418	152916	238931	424102	439633	658852		
1334	1389	26568	59778	86346	154578	241528	428713	444412	666014		
1349	1404	26854	60421	87275	156241	244126	433323	449192	673177		
1363	1419	27140	61064	88204	157903	246723	437934	453971	680340		
1378	1434	27425	61707	89132	159565	249321	442545	458751	687502		
1392	1448	27711	62350	90061	161228	251918	447155	463530	694665		
1407	1463	27997	62993	90989	162890	254516	451766	468309	701828		
1421	1478	28282	63636	91918	164553	257113	456376	473089	708990		
1436	1493	28568	64278	92847	166215	259711	460987	477868	716153		
1450	1508	28854	64921	93775	167877	262309	465598	482648	723316		
1465	1523	29140	65564	94704	169540	264906	470208	487427	730478		
1479	1538	29425	66207	95633	171202	267504	474819	492207	737641		
1494	1553	29711	66850	96561	172865	270101	479429	496986	744804		
1508	1568	29976	67447	97423	174408	272513	483711	501424	751455		
1523	1583	30287	68145	98432	176214	275335	488720	506617	759237		
1537	1598	30598	68846	99444	178025	278164	493741	511821	767037		
1552	1613	30910	69547	100457	179839	280999	498773	517038	774855		
1566	1628	31223	70251	101473	181658	283841	503818	522268	782692		
1581	1643	31536	70956	102492	183482	286690	508875	527509	790547		
1595	1658	31850	71663	103513	185309	289546		532764			
1610	1672	32165	72371	104536	187141	292408		538032			
1624	1687	32481	73081	105562	188978	295278		543312			
1639	1702	32797	73793	106591	190820	298155		548606			
1653	1717	33114	74507	107622	192666	301040		553914			
1668	1732	33433	75223	108656	194516	303932		559235			
1682	1747	33751	75941	109692	196372	306832		564570			
1697	1762	34071	76660	110732	198233	309739		569919			
1711	1777	34392	77382	111774	200099	312654		575283			
1726	1792	34713	78105	112819	201969	315577		580662			
1740	1807	35036	78831	113867	203845	318508		586055			
1755	1822	35359	79558	114917	205726	321447		591463			
1769	1837	35683	80288	115971	207613	324395		596887			
1784	1852	36009	81019	117028	209505	327351		602326			
1798	1867	36335	81753	118088	211402	330316		607781			
1813	1882	36662	82489	119151	213305	333289		613253			
1827	1897	36990	83227	120217	215214	336272		618740			
1842	1911	37319	83968	121287	217128	339263		624244			
1856	1926	37649	84710	122359	219049	342264		629765			
1871	1941	37980	85455	123435	220975	345274		635304			
1885	1956	38312	86203	124515	222908	348293		640859			
1900	1971	38645	86952	125598	224846	351322		646433			
1914	1986	38980	87704	126684	226791	354361		652025			
1929	2001	39315	88459	127774	228742	357410		657635			
1943	2016	39652	89216	128868	230700	360469		663263			
1958	2031	39989	89976	129965	232665	363539		668911			

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+14.7)/(1.03 x SP + 14.7)]

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (lbs/hr) (CONTINUED)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (in²) A									
Set pressure	Relieving pressure	0.44	0.99	1.43	2.56	4	7.1	7.36	11.03	16	20
(psig)	(psia)	Lbs/hr									
1978	2046	40328	90738	131066	234636	366618		674578			
1987	2061	40668	91503	132171	236614	369709		680265			
2001	2076	41009	92271	133280	238599	372811		685972			
2016	2091	41352	93041	134393	240591	375923		691699			
2030	2106	41695	93814	135509	242590	379047		697447			
2045	2121	42040	94590	136630	244597	382182		703216			
2059	2135	42386	95369	137755	246611	385329		709006			
2074	2150	42734	96151	138885	248633	388488		714818			
2088	2165	43083	96936	140018	250662	391659		720653			
2103	2180	43433	97724	141156	252699	394843		726510			
2117	2195	43784	98515	142299	254745	398039		732391			
2132	2210	44137	99309	143446	256798	401247		738295			
2146	2225	44492	100106	144598	258860	404469		744223			
2161	2240	44847	100907	145754	260931	407704		750175			
2175	2255	45205	101711	146916	263010	410952		756153			
2190	2270	45564	102518	148082	265097	414215		762155			
2204	2285	45924	103329	149253	267194	417491		768184			
2219	2300	46286	104143	150429	269300	420782		774238			
2233	2315	46650	104962	1s1611	271416	424087		780320			
2248	2330	47015	105783	152798	273541	427407		786429			
2262	2345	47382	106609	153990	275675	430742		792566			
2277	2359	47750	107438	155188	277820	434093		798731			
2291	2374	48121	108271	156392	279974	437460		804926			
2306	2389	48493	109108	157601	282139	440842		811150			
2320	2404	48867	109950	158816	284314	444241		817404			
2335	2419	49242	110795	160037	286501	447657		823689			
2349	2434	49620	111645	161265	288698	451090		830006			
2364	2449	49999	112499	162498	290906	454540		836354			
2378	2464	50381	113357	163738	293125	458008		842736			
2393	2479	50764	114220	164984	295357	461495		849150			
2407	2494	51150	115087	166237	297600	465000		855599			
2422	2509	51538	115960	167497	299855	468523		862083			
2436	2524	51927	116836	168764	302123	472066		868602			
2451	2539	52319	117718	170038	304403	475629		875158			
2465	2554	52713	118605	171318	306696	479212		881751			
2480	2569	53110	119497	172607	309002	482816		888382			
2494	2584	53509	120394	173903	311322	486441		895051			
2509	2598	53910	121297	175206	313656	490087		901761			
2523	2613	54313	122205	176518	316004	493756		908510			
2538	2628	54719	123118	177837	318366	497447		915302			
2552	2643	55128	124037	179165	320743	501160		922135			
2567	2658	55539	124962	180501	323135	504898		929012			
2581	2673	55953	125893	181846	325542	508659		935933			
2596	2688	56369	126830	183199	327965	512446		942900			
2610	2703	56788	127774	184562	330404	516257		949913			
2625	2718	57210	128723	185934	332860	520094		956973			
2639	2733	57635	129680	187315	335333	523958		964082			
2654	2748	58063	130642	188706	337823	527848		971241			
2668	2763	58494	131612	190107	340331	531767		978451			
2683	2778	58928	132589	191518	342857	535714		985713			
2694	2793	59366	133573	192939	345401	539689		993028			
2712	2808	59806	134564	194371	347965	543695		1000399			
2726	2822	60250	135563	195814	350548	547731		1007825			

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+14.7)/(1.03 x SP + 14.7)]

CAPACITY: 3% OVERPRESSURE SATURATED STEAM (lbs/hr) (CONTINUED)

		Size orifice									
		1.5"x3"	1.5"x3" and 4"	2"x4"	2.5"x6"	3"x6"	4"x6"	4"x8"	6"x8"	6"x10"	8"x10
		Orifice									
		0	1	2	3	4	5	8	6	7	9
		Area (in^2) A									
Set pressure (psig)	Relieving pressure (psia)	0.44	0.99	1.43	2.56	4	7.1	7.36	11.03	16	20
		Lbs/hr									
2741	2837	60698	136570	197268	353151	551798		1015309			
2755	2852	61149	137585	198733	355775	555898		1022852			
2770	2867	61603	138607	200211	358419	560030		1030455			
2784	2882	62062	139639	201700	361085	564196		1038121			
2799	2897	62524	140678	203202	363774	568397		1045850			
2813	2912	62990	141727	204716	366485	572633		1053644			
2828	2927	63460	142784	206244	369219	576905		1061506			
2842	2942	63934	143851	207784	371978	581215		1069436			
2857	2957	64412	144927	209339	374761	585564		1077437			
2871	2972	64895	146013	210908	377569	589951		1085511			
2886	2987	65382	147109	212491	380403	594380		1093659			
2900	3002	65873	148215	214089	383264	598850		1101883			
2915	3017	66370	149332	215702	386152	603362		1110187			
2929	3032	66871	150460	217331	389068	607919		1118571			
2944	3047	67377	151599	218976	392013	612521		1127039			
2958	3061	67889	152749	220638	394988	617169		1135592			
2973	3076	68405	153912	222317	397994	621866		1144233			
2987	3091	68927	155086	224014	401031	626611		1152965			
3002	3106	69455	156273	225728	404101	631408		1161790			
3016	3121	69988	157473	227462	407204	636256		1170711			
3031	3136	70527	158687	229214	410341	641158		1179732			
3045	3151	71073	159914	230987	413514	646116		1188854			

To obtain capacity at 10% overpressure multiply by [(1.1 x SP+14.7)/(1.03 x SP + 14.7)]

SUPERHEAT CORRECTION FACTOR K_{SH}

K_{SH}		Temperature									
Set pressure		**300 °F**	**400 °F**	**500 °F**	**600 °F**	**700 °F**	**800 °F**	**900 °F**	**1000 °F**	**1100 °F**	**1200 °F**
psig	**bar**	**149 °C**	**204 °C**	**260 °C**	**316 °C**	**371 °C**	**427 °C**	**482 °C**	**538 °C**	**593 °C**	**649 °C**
15	1	1.00	0.98	0.93	0.88	0.84	0.80	0.77	0.74	0.72	0.70
20	1.4	1.00	0.98	0.93	0.88	0.84	0.80	0.77	0.74	0.72	0.70
40	2.8	1.00	0.99	0.93	0.88	0.84	0.81	0.77	0.74	0.72	0.70
60	4.1	1.00	0.99	0.93	0.88	0.84	0.81	0.77	0.75	0.72	0.70
80	6	1.00	0.99	0.93	0.88	0.84	0.81	0.77	0.75	0.72	0.70
100	7	1.00	0.99	0.94	0.89	0.84	0.81	0.77	0.75	0.72	0.70
120	8	1.00	0.99	0.94	0.89	0.84	0.81	0.78	0.75	0.72	0.70
140	10	1.00	0.99	0.94	0.89	0.85	0.81	0.78	0.75	0.72	0.70
160	11	1.00	0.99	0.94	0.89	0.85	0.81	0.78	0.75	0.72	0.70
180	12	1.00	0.99	0.94	0.89	0.85	0.81	0.78	0.75	0.72	0.70
200	14	1.00	0.99	0.95	0.89	0.85	0.81	0.78	0.75	0.72	0.70
220	15	1.00	0.99	0.95	0.89	0.85	0.81	0.78	0.75	0.72	0.70
240	17	1.00	1.00	0.95	0.90	0.85	0.81	0.78	0.75	0.72	0.70
260	18	1.00	1.00	0.95	0.90	0.85	0.81	0.78	0.75	0.72	0.70
280	19	1.00	1.00	0.96	0.90	0.85	0.81	0.78	0.75	0.72	0.70
300	21	1.00	1.00	0.96	0.90	0.85	0.81	0.78	0.75	0.72	0.70
350	24	1.00	1.00	0.96	0.90	0.86	0.82	0.78	0.75	0.72	0.70
400	28	1.00	1.00	0.96	0.91	0.86	0.82	0.78	0.75	0.72	0.70
500	34	1.00	1.00	0.96	0.92	0.86	0.82	0.78	0.75	0.73	0.70
600	41	1.00	1.00	0.97	0.92	0.87	0.82	0.79	0.75	0.73	0.70
800	55	1.00	1.00	1.00	0.95	0.88	0.83	0.79	0.76	0.73	0.70
1000	69	1.00	1.00	1.00	0.96	0.89	0.84	0.78	0.76	0.73	0.71
1250	86	1.00	1.00	1.00	0.97	0.91	0.85	0.80	0.77	0.74	0.71
1500	103	1.00	1.00	1.00	1.00	0.93	0.86	0.81	0.77	0.74	0.71
1750	121	1.00	1.00	1.00	1.00	0.94	0.86	0.81	0.77	0.73	0.70
2000	138	1.00	1.00	1.00	1.00	0.95	0.86	0.80	0.76	0.72	0.69
2500	172	1.00	1.00	1.00	1.00	0.95	0.85	0.78	0.73	0.69	0.66
3000	207	1.00	1.00	1.00	1.00	1.00	0.82	0.74	0.69	0.65	0.62

REACTION FORCE in daN, CALCULATION FOR SATURATED STEAM (AT 10% OVERPRESSURE)

			Orifice No										
			0	1	1	2	3	4	5	8	6	7	9
			Orifice 'A' (cm²)										
			2.85	6.4	6.4	9.25	16.5	25.8	45.8	47.48	71.2	103.25	129.3
			Outlet NPS										
			3	3	4	4	6	6	6	8	8	10	10
			Outlet DN										
			80	80	100	100	150	150	150	200	200	250	250
			Outlet section (cm²)										
Set pressure	Relieving	Temperature	45.60	45.60	81.07	81.07	182.41	182.41	182.41	324.29	324.29	506.71	506.71
(bar)	bar abs	°C	daN										
40	45	260	276	392	534	627	1270	1574	2229	2852	3628	5407	6260
45	51	268	311	442	602	707	1431	1775	2515	3216	4094	6100	7064
50	56	275	346	492	670	787	1593	1977	2803	3582	4561	6797	7873
55	62	281	381	543	738	868	1756	2180	3092	3949	5031	7497	8685
60	67	287	416	593	806	949	1919	2384	3383	4318	5503	8199	9501
65	73	293	451	644	875	1030	2082	2588	3675	4688	5977	8904	10320
70	78	298	487	695	943	1111	2246	2792	3967	5059	6452	9612	11142
75	84	304	522	746	1012	1192	2410	2998	4261	5431	6930	10322	11967
80	89	308	558	798	1081	1274	2575	3204	4556	5804	7408		
85	95	313	593	849	1150	1356	2740	3410	4851	6179	7888		
90	100	318	629	900	1220	1438	2905	3617	5148	6554	8369		
100	111	326	700	1004	1358	1602	3236	4032	5744	7306	9336		
110	122	334	771	1108	1498	1767	3569	4449	6342	8062	10308		
120	133	341	843	1212	1637	1933	3902	4868	6944	8821	11283		
130	144	348	915	1316	1777	2099	4236	5288	7548	9582	12264		
140	155	354	987	1421	1918	2266	4572	5709	8155	10347	13247		
150	166	360	1059	1526	2058	2433	4908	6132	8764	11113	14235		
160	177	366	1131	1632	2199	2601	5245	6556	9375	11882	15226		
170	188	372	1204	1738	2341	2769	5582	6981	9989	12653	16220		
180	199	377	1276	1844	2482	2938	5921	7407	10604	13426	17218		
190	210	382	1349	1950	2624	3107	6260	7835		14202			
200	221	387	1422	2057	2766	3276	6600	8263		14979			
210	232	392	1495	2164	2909	3446	6940	8693		15758			

NOISE LEVEL AT 30 m (AT 10% OVERPRESSURE)

		Orifice 'A'									
		0	1	2	3	4	5	8	6	7	9
		Area (cm²)									
Set pressure	Relieving	2.85	6.4	9.25	16.5	25.8	45.8	47.48	71.2	103.25	129.3
bar	bar abs	dB(A)									
40	45	112	117	119	123	125	129	129	131	134	135
45	51	113	118	120	123	126	130	130	132	135	136
50	56	114	119	121	124	127	130	131	133	135	137
55	62	114	119	121	125	128	131	131	134	136	138
60	67	115	120	122	126	128	132	132	135	137	138
65	73	116	121	123	126	129	133	133	135	137	139
70	78	116	121	123	127	130	133	133	136	138	139
75	84	117	122	124	127	130	134	134	136	139	140
80	89	117	122	124	128	131	134	134	137		
85	95	118	123	125	128	131	135	135	137		
90	100	118	123	125	129	132	135	135	138		
100	111	119	124	126	130	132	136	136	139		
110	122	120	125	127	130	133	137	137	139		
120	133	120	125	128	131	134	137	137	140		
130	144	121	126	128	132	134	138	138	141		
140	155	122	126	129	132	135	138	139	141		
150	166	122	127	129	133	135	139	139	142		
160	177	123	128	130	133	136	139	140	142		
170	188	123	128	130	134	136	140	140	143		
180	199	124	128	131	134	137	140	141	143		
190	210	124	129	131	135	137		141			
200	221	124	129	131	135	138		141			
210	232	125	130	132	135	138		142			

EMERSON

SAPAG

Attention
The safety of lives and property often depends on the proper operation of the pressure relief valves. Consequently, the valves should be kept clean and should be periodically tested and reconditioned to make sure they function properly.

WARNING

Suitability of the material and product for the use contemplated by the buyer is the sole responsibility of the buyer. Also storage, installation and proper use and application are the sole responsibility of the purchaser. Emerson disclaims any and all liability arising out of same.
Any installation, maintenance, adjustment, repair and testing performed on pressure relief valves should be done in accordance with the requirements of all applicable Codes and Standards under which those performing such work should maintain proper authorization through appropriate governing authorities.
No repair, assembly and test work done by other than Emerson shall
be covered by the warranty extended by Emerson to its customers. You assume full responsibility for your work. In maintaining and repairing
Emerson products you should use only parts manufactured by Emerson. Call your nearest Emerson regional sales
office or representative for a Emerson service engineer should you wish assistance with your field needs.

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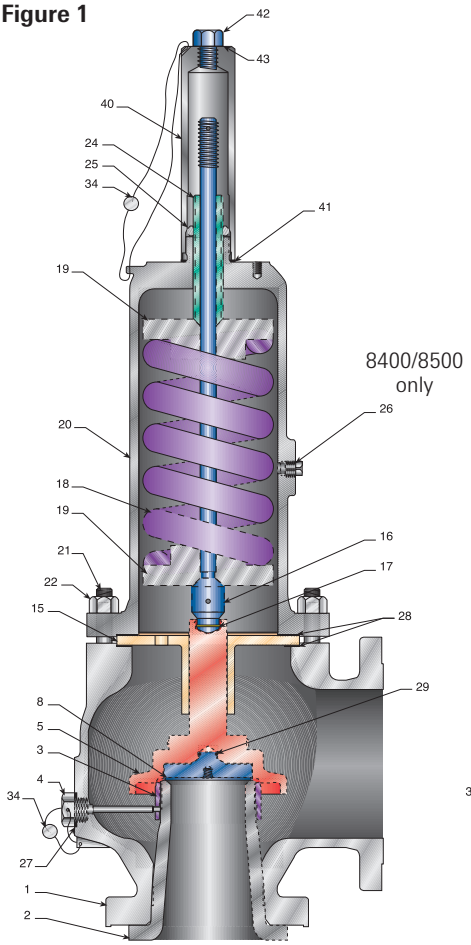
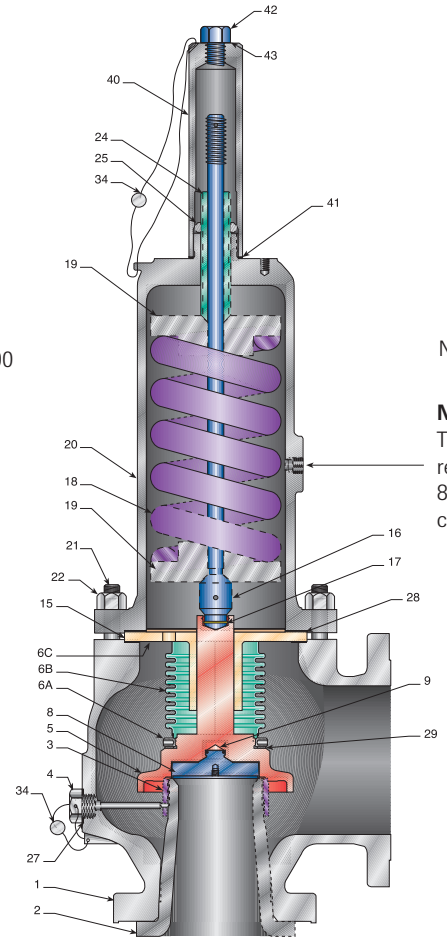
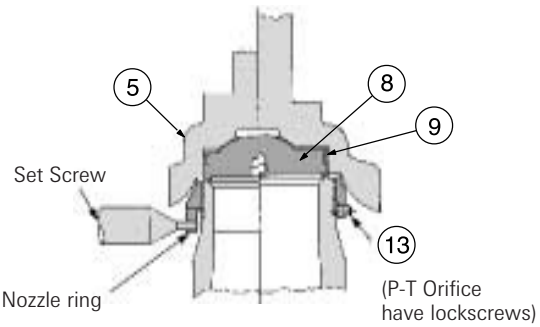
Figure 1



Style 8400

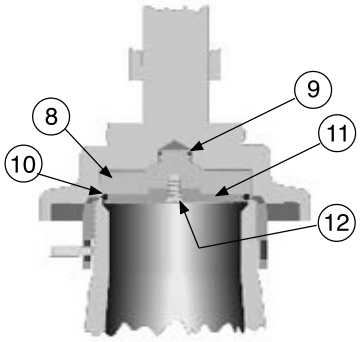


Style 8490



Style 8500
D-N Orifice
construction

Note:
This vent must remain open on 8490/8590 construction



Soft Seat

Parts list

No.	Part Name	Notes	No.	Part Name	Notes
1	Body		17	Spindle Cotter Pin	1 (L-T orifice)
2	Nozzle		18	Spring	3
3	Nozzle Ring	3	19	Spring Washers	3
4	Set screw	3, except P-T Orifice 8500/8590	20	Bonnet	
4A	Set Screw	3, (M-T Orifice)	21	Bonnet Stud	
4B	Set Screw Rod	3, (M-T Orifice)	22	Bonnet Stud Nut	
4C	Set Screw Pin	3, (M-T Orifice)	24	Adjusting Bolt	
5	Disc Holder	2	25	Adjusting Bolt Nut	
6A	Bellows Tailpiece	2	26	Pipe Plug	
6B	Bellows	2	27	Set Screw Gasket	1
6C	Bellows Flange	2	28	Guide Gasket	2
8	Disc Insert	1	29	Tailpiece Gasket	1
9	Retention Clip	1	34	Seal & Wire	
10	O-Ring	1	35	Seal Clip	
11	O-Ring Retainer	2	36	Nameplate	
12	Retainer Screw(s)	2	40	Screwed Cap	
13	Nozzle Ring Lockscrew	P-T Orifice 8500/8590	41	Cap Gasket	1
14	Set Screw Plug	P-T Orifice 8500/8590 (not shown)		Gasket Kit	1,4
15	Guide	3	42	Test Gag/Plug (Plug only shown)	
16	Spindle	3	43	Test Gag plug gasket	1

Notes

1. Consumable Spare Parts: Valve parts which should be replaced as part of any disassembly, and discs and disc inserts which must be replaced if seats are damaged.
2. Repair Spare Parts: Valve parts exposed to wear and/or corrosion during normal operation. They are in fluid flow paths and may require replacement as part of any repair.
3. Insurance Spare Parts: Valve parts exposed to process or environmental wear and/or corrosion and may require replacement as part of a major repair.
   Emerson Valves & Controls recommends that sufficient inventory of spare parts be maintained to support process requirements.
   Always be sure to use genuine Emerson parts to ensure continued product performance and warranty.
4. Contains complete set of gaskets for all style of valves

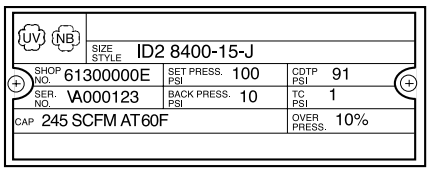


Figure 2
Sample nameplate

Ordering Spare Parts
When ordering spare parts, the valve size, style and assembly number and/or serial number should be given together with set pressure, part name and reference number from page 2. The valve serial number is shown on the valve nameplate. Spare parts may be ordered from any Emerson Valves & Controls Regional Sales Office or Representative.

Safety Precautions
Proper handling, storage, installation, maintenance and operation is essential to the safe and reliable functioning of any pressure relief product.
Precautionary statements in the form of warnings, cautions and notes are used throughout this instruction to emphasize important and critical factors where applicable.
Examples:

WARNING: An operating procedure or practice which if not strictly observed may result in injury to personnel or loss of life.

CAUTION: An operating procedure or practice which if not strictly observed may result in damage to or destruction of equipment.

These precautionary statements are by no means exhaustive.
Emerson Valves & Controls cannot be expected to know, evaluate, and advise customers of all the possible applications and operating conditions for its products or of the possible hazardous consequences which may result from the misapplication or misuse of such products. Consequently, the improper handling, storage, installation, use or maintenance of any Emerson Valves & Controls Product by a non Emerson Valves & Controls employee may void any Emerson Valves & Controls guarantees or warranties with respect to such Product.
All personnel working with Emerson Valves & Controls products should be adequately trained and thoroughly familiar with the contents of the appropriate instruction manual(s).

Emerson Valves & Controls cannot evaluate all conditions in which the products may be used. However, Emerson Valves & Controls offers the following general safety suggestions:

- Never subject valves to sharp impact loads.
  Rough handling (striking, bumping, dropping, etc.) may alter the pressure setting, deform valve parts and adversely affect seat tightness and valve performance. Striking a valve which is under pressure can cause premature actuation.
- Always lower the system pressure to the pressure level specified in the instruction before making any adjustment to the valve. Furthermore, always install a proper test rod to gag an installed valve before making any ring adjustments on the valve.
- Ear and eye protection should be used when working on a valve which has pressure.
- Never stand in front of the discharge outlet of a pressure relief valve which is under pressure.
- Always stand to the side of and at a safe distance from the valve discharge and use extreme care when observing a valve for leakage.

The above precautions and suggestions are by no means exhaustive and the user should always approach and use any pressure relief valve with great care.

Operation, Installation and Safety Instructions are available at www.valves.emerson.com or from your local Emerson regional sales office or representative.

1. Introduction

Sapag Series 8000 pressure relief valves have been selected for installation because of their performance features, reliability and ease of maintenance.
Adherence to the installation and maintenance procedures specified herein will provide the utmost in safety, a minimum of maintenance, and a long service life. Sapag type 8400/8500/8490/8590 Valves are manufactured in accordance with the requirements of Section VIII Pressure Vessels, ASME Boiler and Pressure Vessel Code. Type 8400 is a conventional closed bonnet valve. Type 8490 has a balanced bellows for minimizing the effect of back pressure.
Style 8500 is a high performance valve designed specifically for liquid service. The 8500 features patented contoured liquid trim in a standard 8400/8490 envelope.

2. Storage and Handling

Valves are often on hand at the job site months before they are installed. Unless properly stored and protected, valve performance may be adversely affected.
Rough handling and dirt may damage or cause misalignment of the valve parts. It is recommended that the valves be left in their original shipping containers and that they be stored in a warehouse or at a minimum on a dry surface with a protective covering until they are used.

3. Installation

Care in Handling
Pressure relief valves must be handled carefully and never subjected to sharp impact loads. They should not be struck, bumped or dropped. Rough handling may alter the pressure setting, deform valve parts and adversely affect seat tightness and valve performance.

When it is necessary to use a hoist, the chain or sling should be placed around the valve body and bonnet in a manner that will ensure that the valve is in a vertical position to facilitate installation. The valve should never be lifted or handled using the lifting lever.
Inlet and outlet protectors should remain in place until the valve is ready to be installed on the system.

Inspection
Pressure relief valves should be visually inspected before they are installed to ensure that no damage has occurred during shipment or while in storage.
All protective material, sealing plugs and any extraneous material inside the valve body or nozzle must be removed.

The valve nameplate and other identifying tags should be checked to ensure that the particular valve is being installed at the location for which it was intended.
The valve seals protecting the spring setting and ring adjustments should be intact. If seals are not intact, the valve should be inspected, tested and seals properly installed before use.

Inlet Piping
Pressure relief valves should be mounted vertically in an upright position either directly on a nozzle from the pressure vessel or on a short connecting fitting that provides direct and unobstructed flow between the vessel and the valve. Installing a pressure relief valve in other than this recommended position might adversely affect its operation. Where rounded or beveled approaches cannot be provided ahead of the valve it is recommended that one size larger nozzle or fitting be used. A valve should never be installed on a fitting having a smaller inside diameter than the inlet connection of the valve.

Inlet piping (nozzles) must be designed to withstand the total resultant forces due to the valve discharging at the maximum accumulated pressure and the expected piping loads. The magnitudes of the bending moment exerted on the inlet piping will depend on the configuration and method of supporting the outlet piping.

Many valves are damaged when first placed in service because of failure to clean the connections properly when installed. Both the valve inlet and the vessel and/or line on which the valve is mounted must be thoroughly cleaned of all foreign material. The inlet connection bolts or studs should be drawn down evenly to avoid straining the valve body with possible distortion of the nozzle flange or base.

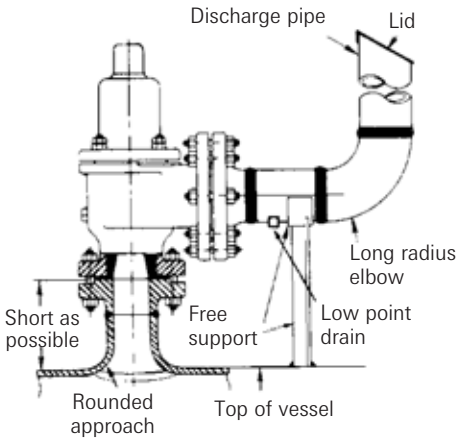


Figure 3
Recommended installation-discharging to atmosphere

Outlet Piping
Outlet piping should be simple and direct. Where possible, for non-hazardous fluids, a short discharge pipe or vertical riser connected through a long radius elbow venting directly to atmosphere is recommended. Such discharge piping should be at least the same size as the valve outlet.
All discharge piping should be run as direct as is practicable to the point of final release for disposal. Valve effluent must discharge to a safe disposal area.
Where discharge piping is long, due consideration shall be given to the use of long radius elbows, and the reduction of excessive line strains through the use of expansion joints and proper means of support to minimize line sway and vibration under operating conditions. Adequate drainage is required to prevent corrosive media from collecting in the discharge side of the pressure relief valve. When required, low point drains shall be provided in the discharge pipe. Particular care must be observed to ensure that the drains are directed or piped to a safe disposal area.
In installations where the pressure relief valve discharges into a closed system, care must be taken to ensure that built up and superimposed back pressure has been properly calculated, specified, and accounted for when sizing and selecting the valve.
Where built up back pressure is expected to exceed 10% of set pressure or if superimposed back pressure is variable, a bellows valve is required.

4. Hydrostatic Pressure Tests

Hydrostatic Test of Vessel or System
When a pressure vessel or system is to be hydrostatically tested, it is recommended that the pressure relief valve be removed and a blank flange be installed in its place. This practice precludes the possibility of any damage to the pressure relief valve. Bent spindles and damaged valve seats are problems that can be caused by improper hydrostatic test procedures.
Blank flanges must be removed and the pressure relief valve reinstalled before the vessel is placed in service.
When the hydrostatic test must be performed with the valve in place, a test gag may be used. Sapag Series 8000 are provided with test gags as standard. In the case of the Type C cap with lifting lever, the lifting lever assembly must be replaced with a hydrostatic test cap and test rod prior to hydrostatic testing. When test rods are used, care must be exercised to prevent overtightening that could damage the valve spindle and valve seats. A test rod which is hand tight will generally provide sufficient force to hold the valve closed.
After the hydrostatic test, the test rod (gag) must be removed and replaced by either a cap plug or a cap not fitted with a test rod.

Hydrostatic Test of Outlet System
When a hydrostatic test must be conducted on the outlet piping system, with the valve in place, special consideration must be given not to exceed the design pressure limits of the downstream side of the pressure relief valve. The outlet side of a pressure relief valve is known as the secondary pressure zone. This zone is normally designed to a lower pressure rating than the inlet and frequently is designed to a lower pressure rating than the outlet flange. This is particularly true in the case of balanced bellows designs and in the larger valve sizes.
Consult Sapag products specifications for the back pressure design limits of the Series 8000 valves.

5. Setting, Testing and Adjustments

New Valves
Each Sapag pressure relief valve is carefully set and tested at the factory prior to shipment. However, it is good practice to inspect the valve prior to installation.
This inspection determines any damage which may have occurred due to rough handling in transit or storage and initiates appropriate service records.

Reconditioned Valves
Valves which have not been in service for extended periods due to plant shutdown or long term storage, or valves which have been repaired or reconditioned, should also be tested before being put into operation.

CAUTION: Improper testing may cause valve damage and seat leakage.

Valves Removed From Service
Valves being removed from service should be tested on a shop test bench before being disassembled to determine the set pressure and seat tightness. This is an important phase of the maintenance routine and the test results should be recorded for review and determination of necessary corrective action.
The "as received from service" condition of a pressure relief valve is a most useful tool in establishing the proper time interval between inspections.

The Test Bench
The quality and condition of the shop test bench is paramount to obtaining proper test results. The test bench must be free of leaks and the test fluid must be clean. Solids or other foreign material in the test medium will damage the seating surfaces of the pressure relief valve being tested. The test pressure gage must be calibrated and have a range proper to the pressure level of the valve setting. Set pressure should fall within the middle third of the dial range of the test gage. The test bench provides an accurate and convenient facility for determining valve set pressure and seat tightness. It does not duplicate all of the field conditions to which a pressure relief valve will be exposed while in service. It is not practical to attempt to measure relieving capacity or blowdown using a test bench.

Test Fluids - Set Pressure Test
The Test Fluid should be air or nitrogen for valves used on gas and vapor service and water for valves used on liquid service. Valves for steam service should be tested on steam. It may be necessary to make a correction to the adjusted set pressure to compensate for the difference in temperature of the test fluids(see appropriate instruction).

Valve Operation
Sapag Series 8000 valves intended for compressible fluid service and tested with air or steam will open with a sharp clear popping action at the set point. Valves for liquid service tested with water are considered open when there is a continuous unbroken stream of liquid flowing from the valve.

Set Pressure Changes
Set pressure changes beyond the Sapag specified spring range will necessitate a change in the valve spring assembly consisting of the spring and two fitted spring washers. The new spring and washers must be obtained from Sapag and the valve must be reset and the nameplate restamped by an authorized valve repair facility.

Set Pressure Adjustment
Before making any adjustments reduce the pressure under the valve seat to at least 10% below the stamped opening pressure. This will prevent seat damage due to turning of the disc on the nozzle seat and minimize the chance of an inadvertent valve opening. A strong (high) ring position is necessary to obtain a good clean popping action of the valve on air or gas with the limited volume available on the test bench.

a. (Not required for testing on liquid.) Remove the nozzle ring set screw and raise the nozzle ring until it touches the disc holder, then back it down two (2) notches. Exercise care in counting the number of notches moved so that the ring can be returned to its proper position following testing.
   Moving the notches on the nozzle ring to the left will lower the nozzle ring.
   Replace the nozzle ring set screw before each set pressure test. The set screw must engage one of the ring notches, being careful that it does not bear on the top of a tooth.
b. Remove the cap or lifting lever following the instruction for valve disassembly. (See paragraph 6)
c. Loosen the adjusting bolt nut and turn the adjusting bolt clockwise to increase set pressure or counterclockwise to reduce set pressure.
d. Retighten the adjusting bolt nut following each adjustment.
e. Two or three consecutive valve openings at the same pressure are necessary to accurately verify the opening pressure.
f. Once the set pressure has been established, lower the nozzle ring to the installed ring position as indicated in Table 1 and replace the nozzle ring set screw as described above. Seal wire the adjusting bolt and adjusting ring set screw with identifying seals.

Nozzle Ring Settings
The nozzle ring adjustment is made at the factory and resetting in service is seldom necessary. Should it be necessary to change blowdown or reduce valve simmer, the nozzle ring may be adjusted as follows: (See the next paragraph for P, Q, R and T OrificeType 8500/8590)
a) Remove the nozzle ring set screw and insert a screwdriver to engage the ring notches.
b) Turning the ring to the right raises the ring, thereby increasing blowdown. Turning the ring to the left lowers the ring, thereby decreasing the blowdown.
c) Do not lower the nozzle ring to the point where the valve begins to have excessive simmer. Raising of the ring will reduce simmer.
d) The nozzle ring should not be moved more than two notches before retesting. When making adjustments, always keep count of the number of notches and the direction in which the nozzle ring is moved. This will permit returning to the original setting in case of error.

CAUTION: Should any adjustments be made while the valve is installed on a pressurized system, the valve should be gagged while ring adjustments are made.

• *Type 8500/8590*

The Type 8500/8590 in the P, Q, R and T Orifice sizes is preset at the factory and cannot be externally adjusted in the field, since the special contoured skirt on the disc holder prevents engagement of the set screw with the nozzle ring. As a result the nozzle ring is not slotted and is held in place by three set screws. The position of the nozzle ring must be set prior to valve assembly as follows:

a. Screw the nozzle ring (3) on to the nozzle. The top of the nozzle ring should be below the nozzle seating surface.
b. Install the disc insert retention clip (9) onto the disc insert. Assemble the disc insert (8) and disc holder (5). The disc insert should snap into place using hand force only.
c. Lower the disc holder and disc insert carefully onto the nozzle.
d. Reach through the valve body outlet and turn the nozzle ring until it lightly touches the disc holder. This is the highest lock position.
e. Carefully remove the disc holder and disc insert from the valve.
f. Lower the nozzle ring (turn to the left) the total number of revolutions shown in Table 2.
g. Carefully tighten each of the set screws on the nozzle ring to hold the ring in position.

Table 2

8500/8590 Orifice Size	Nozzle Ring Setting Total revolutions below highest lock position
P and Q	3/4 Revolution
R and T	1 Revolution

Table 1

Service	Orifice size	Nozzle ring setting (Below Highest Lock Position)
Styles 8400/8490 Pressure Relief Valve Recommended Nozzle Ring Settings		
Vapor & Gases	D through J	-5
	K through N	-10
	P through T	-15
Liquids	D through G	-5
	H through K	-10
	L through N	-20
	P through T	-30
Styles 8500/8590 Pressure Relief Valve Recommended Nozzle Ring Settings		
Liquids & Gases	D, E, and F	-3
	G, H, and J	-5
	K and L	-10
	M and N	-15
	P and Q	(See table 2)
	R and T	(See table 2)

Minus sign: indicates number of ring notches below starting position of nozzle ring which is the highest position with the valve closed (contact with disc holder)

Table 3

Operating Temperature	% Excess Pressure
0-150°F	None
151-600°F	1%
601-800°F	2%
801-1000°F	3%

Table 4 - (8400 Style Only)

Orifice Size	Saturated Steam Set Pressure (max)
D, E, F, G, H, J, K, L	1500 psig
M	1100 psig
N, P	1000 psig
Q	600 psig
R, T, T_2	300 psig

Table 5 - Saturated Steam Service

Air Set Pressure Correction Factors at Ambient Temperature

Set Pressure (psig)	% Increase in Spring Set Pressure
15-400	3%
401-1000	4%
1001-1500	5%

Cold Differential Test Pressure Adjustments

When a pressure relief valve is on a test bench at room temperature and atmospheric pressure, and is to be installed on a system operating at a higher temperature and/or a higher back pressure, a compensating adjustment is necessary. The test pressure required to have the valve open at the desired set pressure under actual service conditions is known as the cold differential test pressure.

• *Temperature Correction*

When a Sapag Series 8000 valve is set on air or water at room temperature and then used at a higher service temperature, the test pressure shall be corrected to exceed the set pressure using the temperature correction shown in Table 3.

Note: this table is not applicable to steam service valves.

• *Back Pressure Correction*

Conventional valves without balancing bellows set with atmospheric pressure at the outlet and intended for use under elevated constant back pressure conditions shall be adjusted so that the test pressure is equal to the set pressure minus the expected back pressure. See example below:

Set Pressure	100 PSI
Constant Back Pressure	10 PSI
Cold Differential Test Pressure	90 PSI

In all instances, the spring should be selected based on the cold differential test pressure; in the example above, 90 PSI. See sample nameplate on page 3 which shows how temperature and back pressure is indicated.

Saturated Steam Correction Factors

Sapag Style 8400 pressure relief valves that are used for saturated steam service and are within the set pressure limits established in Table 4 may be set on air at ambient temperature, provided the correction factors in Table 5 are applied to the valve set pressure.

Seat Leakage Tests

Ambiguous terms such as "bubble tight", "drop tight", "zero leakage" and "commercial tightness" are sometimes used to describe seat tightness. These terms, however, lack uniform definition and true practical meaning.

• *Test Procedure*

API Standard 527 provides a standard for "commercial" tightness and has been adopted by industry and users in order to clarify testing methods and tightness criteria. This standard applies to flanged inlet nozzle type pressure relief valves.

• *Test Apparatus*

A typical test arrangement for determining seat tightness for pressure relief valves per API Standard 527 is shown in Figure 4. Leakage is measured using a 5/16 in. OD tube with 0.035 in. wall. The tube end is cut square and smooth, is parallel to and 1/2 inch below the surface of the water. A snap-on type test clamp shown in Figure 5 is available .

• *Procedure*

With the valve mounted vertically, the leakage rate in bubbles per minute shall be determined with pressure at the pressure relief valve inlet raised up to and held at 90 percent of the set pressure (or cold differential test pressure - CDTP) immediately after popping. This applies except for valves set at 50 psig or below, in which case the pressure shall be held at 5 psig below the set pressure immediately after popping. The test pressure shall be applied for a minimum of one minute for valves of inlet sizes through 2"; two minutes for sizes 21/2", 3" and 4"; five minutes for sizes 6" and 8". Air (or nitrogen) at approximately ambient temperature shall be used as the pressure medium.

• *Tightness Standard*

a. Metal-to-Metal Seated Valves. The leakage rate in bubbles per minute shall be observed for at least one minute and shall not exceed the values indicated in table 6 below.
b. Soft Seated Valves. For soft seated valves there shall be no leakage for one minute (zero bubbles for one minute).

Table 6 - Maximum seat leakage rate - Metal seated pressure relief valves

Set Pressure PSIG (BarG)	Effective Orifice Sizes 0.307 In² and Smaller			Effective Orifice Sizes Larger than 0.307 In²		
	Max. Bubbles per Minute	Approximate Leakage Rate Per 24 Hours		Max. Bubbles per Minute	Approximate Leakage Rate Per 24 Hours	
		Standard Cubic Feet	Standard Cubic Meters		Standard Cubic Feet	Standard Cubic Meters
15-1000 (1.03-68.9)	40	0,6	0,017	20	0,3	0,0085
1500 (103.4)	60	0,9	0,026	30	0,45	0,013
2000 (137.9)	80	1,2	0,034	40	0,6	0,017
2500 (172.4)	100	1,5	0,043	50	0,75	0,021
3000 (206.8)	100	1,5	0,043	60	0,9	0,026
4000 (275.8)	100	1,5	0,043	80	1,2	0,034
5000 (344.8)	100	1,5	0,043	100	1,5	0,043
6000 (413.7)	100	1,5	0,043	100	1,5	0,043

• *Sapag Seat Tightness Standard-Liquid Service Valves (Style 8500/8590)*

Sapag liquid service pressure relief valves are checked for seat tightness by a quantitative seat leakage test.

All of the test fluid passing through an assembled valve is collected and measured per the following test procedure:

1. The inlet pressure is adjusted to a test pressure which is 90% of the Cold Differential Test Pressure.
   Valves set below 50 psig are tested at 5 psig below the cold differential test pressure.
2. The test pressure is maintained for a period of not less than ten minutes.

• *Allowable Leak Rate*

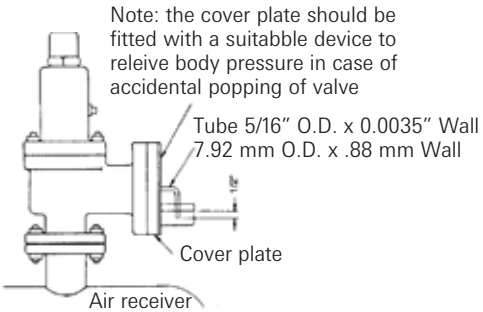
The maximum allowable leakage rate should not exceed 10 cubic centimeters per hour per inch of diameter of nominal valve inlet size. For nominal valve sizes of 1 inch or less, the leakage rate shall not exceed 10 cubic centimeters per hour. For soft seated valves there shall be no leakage for one minute.

• *Soft Seated Valves*

For exceptional seat tightness, Sapag offers an O-ring soft seat design. Refer to Figure 13 on page 15.

The Sapag soft seat design will provide a valve that has no visible leakage at a test pressure of 90 percent of the set pressure or cold differential test pressure. Soft seated valves are tested using the same test procedure used for metal-to-metal seated valves.

Figure 4 - Typical test arrangement



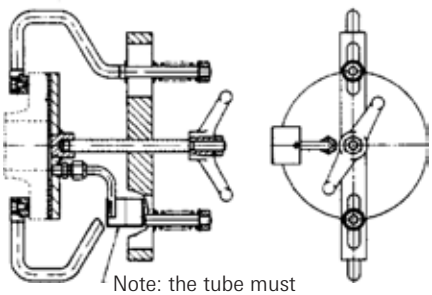


Figure 5 - Seat leak apparatus for 150 & 300 lb. outlets 1 inch through 10 inch sices

CAUTION: Valves in hazardous fluid service and any other materials classified as dangerous must be neutralized immediately after removal from service.

6. Valve Maintenance

Visual Inspection and Neutralizing

A visual inspection shall be made when valves are first removed from service. The presence of deposits or corrosion products in the valve and in the piping should be recorded and valves should be cleaned to the extent possible prior to disassembly. Check the condition of external surfaces for any indication of corrosive atmospheric attack or evidence of mechanical damage.

Disassembly

Sapag Series 8000 valves should be disassembled as described below. Parts identification may be found in Figure 1 on page 2. The parts from each valve should be properly marked and segregated to keep them separate from parts used in other valves.

a. Remove the cap (40) and cap gasket (41). If the valve has a lifting lever device follow the instructions on pages 15.
b. Remove the nozzle ring set screw (4) and set screw gasket (27).
   Record the position of the nozzle ring (3) with respect to the disc holder (5) by counting the number of notches required to raise the ring until it just touches the disc holder. This information will be needed again when reassembling the valve. (Measure the revolutions for P, Q, R and T Orifice Style 8500/8590. See Table 2)
c. Loosen the adjusting bolt nut (25). Before releasing the spring load, make note of the depth of the adjusting bolt in the bonnet and count the number of turns required to remove the spring load. This information will help when reassembling the valve to its approximate original setting.
d. Release all of the spring load by rotating the adjusting bolt (24) in a counterclockwise direction.
e. Remove the bonnet stud nuts (22).
f. Lift the bonnet (20) straight up to clear the spindle (16) and valve spring (18). Exercise care when lifting the bonnet as the spring and spindle will then be free to fall aside.
g. The spring and spring washers (19) can now be lifted off the spindle (16). The spring and spring washers are fitted together and must be kept together as a subassembly. Spring washers are not interchangeable between ends of the spring.
h. Remove the spindle, guide (15), disc holder and disc insert (8). For balanced bellows valves (Style 8490/8590) special care must be taken not to damage the bellows subassembly (6).
   If parts are difficult to remove, due to the presence of corrosive or foreign materials, soaking in a suitable solvent may be required.
i. Remove the spindle from the disc holder.
j. Lift the guide off the disc holder.
k. Disc Insert Removal

• *Orifice Sizes D through M (Metal Seats)*

Screw a standard bolt into the tapped hole (see table 7) in the face of the disc insert. Using hand force pull the bolt straight out. The disc insert with the retention clip (9) should come out with moderate force.

If the valve has been in dirty service it may be necessary to use a suitable solvent to aid in removal. If additional pullout force is required, a bolt with a T handle may be used. The method described below for Orifice sizes N through T may be used if necessary.

• *Orifice Sizes N through T (Metal Seats)*

Safety precautions should be followed whenever heavy parts are being lifted or transported. Dropping disc holder assembly may dislodge the insert.

The removal of the insert is accomplished by the use of a tool as shown in Figure 6. This tool consists of a rectangular steel bar which spans the outside diameter of the disc holder with a center hole through which the standard bolt can be inserted before screwing into the disc insert. A nut and washer is also required as shown. Tightening the nut with a wrench will exert a pulling force on the disc insert and cause it to be removed from the disc holder.

• *Orifice Sizes D through K (O-Ring Seats)*

The O-Ring seat design for Orifice sizes D through K has a retaining screw in the center of the disc insert. A drilled and tapped hole (4-40 UNC) is provided in the center of the retaining screw for removal of the disc insert (Figure 7). Screw a standard bolt into the hole in the retaining screw. Using hand force pull the bolt straight out. The disc insert with the retention spring should come out with moderate force.

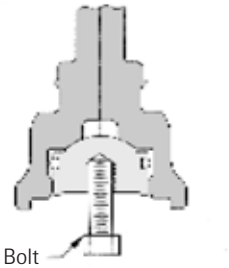
• *Orifice Sizes L through T (O-Ring Seats)*

Safety precautions should be followed whenever heavy parts are being lifted or transported. Dropping the disc holder may dislodge the insert.

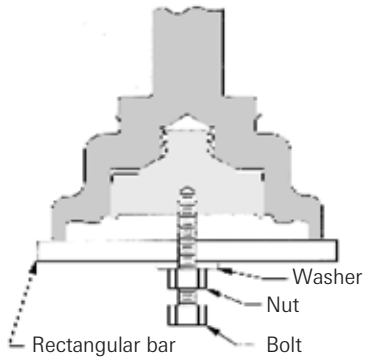
Remove the three retaining screws from the insert. Remove the retainer and O-ring seat. A tapped hole (refer to table 7) is provided in the disc insert for insertion of a removal bolt. Follow instructions for metal seated insert removal.

Table 7 - Series 8000 disc insert threaded hole sizes

Orifice Size	Thread Size
D & E	# 10-24 UNC
F, G H	1/4 - 20 UNC
J, K, L	1/4 - 20 UNC
M, N, P, Q, R, T	3/8 - 16 UNC



Remove disc insert by pulling on bolt



Remove disc insert by turning nut with wrench

Figure 6

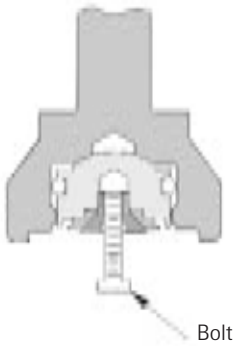


Figure 7
Remove disc insert by pulling on bolt

l. For bellows valves only, place the disc holder in a vise (the larger sizes may require a 3-jaw vise) as shown in Figure 8. Using a suitable wrench unscrew the tailpiece and bellows from the disc holder.
m. Remove the nozzle ring (3) from the nozzle (2).
n. Remove the nozzle (2) from the valve body (1) if necessary. Unless the valve seat on the nozzle has been mechanically damaged or shows signs of corrosive attack, it will not be necessary to remove the nozzle. In most cases the nozzle can be reconditioned without removal from the valve body.
To remove the nozzle, turn the valve body over taking care not to damage the bonnet studs (21).
Turn the nozzle counterclockwise by using the wrench flats on the nozzle flange or a nozzle wrench designed to clamp onto the nozzle flange.

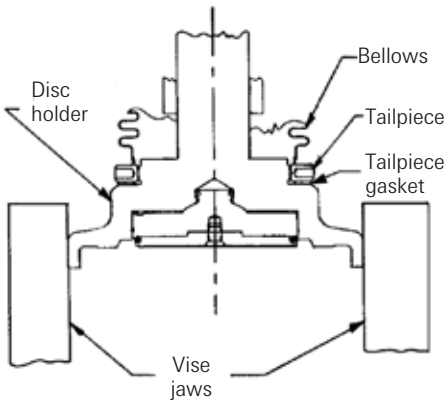
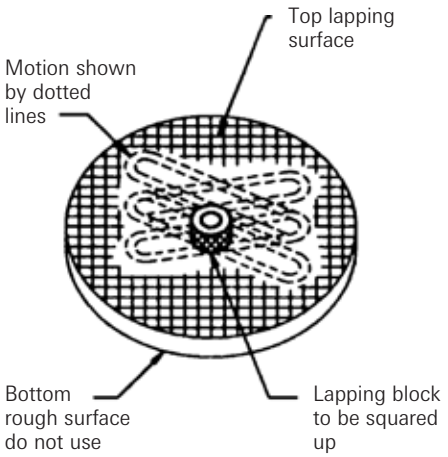


Figure 8

Cleaning
External parts such as the valve body, bonnet and cap should be cleaned by immersion in a bath such as hot Oakite solution or equivalent. These external parts may be cleaned by wire brushing, provided the brushes used do not damage nor contaminate the base metals. Only clean stainless steel brushes should be used on stainless steel components.
The internal parts such as the guide, disc holder, disc insert, nozzle ring and spindle should be cleaned by immersion in a commercial high alkaline detergent.
Guiding surfaces on the disc holder and guide may be polished using a fine emery cloth. The bellows and other metal parts may be cleaned using acetone or alcohol, then rinsed with clean tap water and dried.

Inspection
Check all valve parts for wear and corrosion. The valve seats on both the nozzle and disc insert must be examined to determine if they have been damaged. Most often, lapping the valve seats is all that is necessary to restore them to their original condition.
If the inspection shows that the valve seats are badly damaged, remachining will be necessary or it may be advisable to replace these parts. When the time element is a factor, it may be advantageous to replace damaged parts from spare parts stock, thereby permitting the replaced part to be checked and reworked at leisure. (See Figure 10 and Table 8 for critical dimensions.)
The valve spring (18) should be inspected for evidence of cracking, pitting or deformation.
The bellows (6B) in a Style 8490/8590 valve should be inspected for evidence of cracking, pitting or deformation that might develop into a leak.
The bearing surfaces on the guide and disc holder should be checked for residual product build up and any evidence of scoring. Inspection of valve components is important to ensure proper valve performance. Damaged valve parts must be repaired or replaced.



Reconditioning of Valve Seats
The tightness of a valve and its proper operation depend directly on the condition of the seats. Many pressure relief valve problems are due to eroded or damaged seats.
The standard Sapag Series 8000 valve is constructed with a flat metal-to-metal seat. It is important that seating surfaces be properly refurbished by lapping with a flat cast iron lap coated with the correct lapping compound.

• *Lapping Procedures*
Unless the seats have been badly damaged by dirt or scale, lapping the seating surfaces should restore them to their original condition. Never lap the disc insert against the nozzle. Lap each part separately against a cast-iron lapping block of the proper size. These blocks hold the lapping compound in their surface pores and must be recharged frequently.
Lap the block against the seat. Never rotate the block continuously, but use an oscillating motion. Extreme care should be taken throughout to make certain that the seats are kept perfectly flat.
If considerable lapping is required, spread a thin coat of medium coarse lapping compound on the block. After lapping with the medium coarse compound, lap again with a medium-grade compound. Unless much lapping is called for, the first step can be omitted. Next, lap again using a fine grade compound. When all nicks and marks have disappeared remove all the compound from the block and seat. Apply polish compound to another block and lap the seat.
As the lapping nears completion only the compound left in the pores of the block should be present. This should give a very smooth finish. If scratches appear the cause is probably dirty lapping compound. These scratches should be removed by using compound free from foreign material.
Disc inserts should be lapped in the same way as nozzles. The disc insert must be removed from the holder before lapping. Before the disc insert is placed back in the holder all foreign material should be removed from both parts. The insert must be free when in the holder. If the disc insert is damaged too badly to be reconditioned by lapping, it should be replaced.
Remachining the insert will change critical dimensions, affect the action of the valve and is not recommended.

Lapping block resurfacing plate

Lapping block

Figure 9

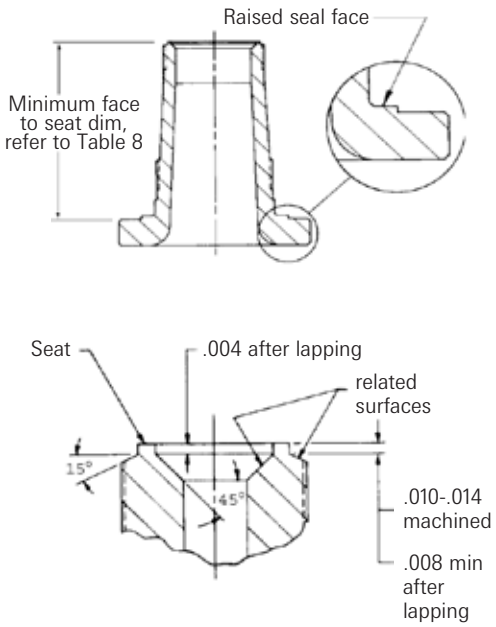


Figure 10 - Nozzle seat critical dimensions

• *Lapping Blocks*

Lapping blocks are made of a special grade of annealed cast iron. There is a block for each orifice size. Each block has two perfectly flat working sides and it is essential that they retain this high degree of flatness to produce a truly flat seating surface on either the disc insert or the nozzle. Before a lapping block is used, it should be checked for flatness and reconditioned after use on a lapping plate. The block should be lapped in a figure eight motion, applying uniform pressure while rotating the lapping block against the plate as shown in Figure 9.

• *Lapping Compounds*

Experience has proven that medium coarse, medium fine, and polish lapping compounds will properly condition any damaged pressure relief valve seat except where the damage requires remachining. The following lapping compounds, or their commercial equivalents are suggested:

Grit Compound No.	Description
320	Medium Coarse
400	Medium
600	Fine
900	Polish

• *Machining of Nozzle Seats*

If machining of the nozzle seat or other major repairs are necessary it is recommended that the valve be returned to a Emerson Valves & Controls facility for repair. All parts must be accurately machined per Sapag specifications. No pressure relief valve will be tight, nor will it operate properly unless all parts are correctly machined. The most satisfactory way to machine a nozzle is to remove it from the valve body. However, it may also be machined while assembled within the valve body.

In any event it is vitally important that the seating surfaces run absolutely true before machining. Machining dimensions for Sapag Series 8000 valves with metal-to-metal nozzle seats are shown in Figure 10 and Table 8. Remove only enough metal to restore the surface to its original condition. Turning to the smoothest possible finish will facilitate lapping.

The nozzle must be replaced when minimum face to seat dimension is reached. This critical dimension is shown in Table 8.

• *Machining of Disc Insert Seats*

When the damage to the disc insert seat is too severe to be removed by lapping, the disc insert may be machined and lapped provided that minimum seat height is maintained (Figure 11 and table 9).

Table 8 - Minimum nozzle face to seat dimensions (See Figure 10)

	Valve Type								
Orifice	**12, 13, 14, 15,16**	**22, 23, 24, 25, 26**	**32, 33, 34, 35, 36, 37**	**47**	**42, 43, 44, 45, 46**	**57**	**55, 56**	**65, 66, 67**	**75, 76, 77**
D	3,465	3,465	3,465	3,465	3,465	3,687	3,687	3,687	4,808
E	3,465	3,465	3,465	3,465	3,465	3,687	3,687	3,687	4,808
F	4,027	4,027	4,027	4,027	4,027	4,027	4,027	4,027	4,647
G	3,777	3,777	3,777	3,777	3,777	3,777	3,777	4,777	4,777
H	3,903	3,903	3,903	3,903	4,840	4,840	4,840	4,840	-
J	4,340	4,340	4,340	4,340	5,121	5,121	6,455	6,455	-
K	4,715	4,715	4,715	4,715	5,840	5,840	7,027	7,027	-
L	5.059	5.059	5,277	5,277	5,277	6,250	6,250	6,250	-
M	5,59	5,59	5,59	5,59	5,59	6,403	6,403	-	-
N	6,121	6,121	6,121	6,121	6,121	-	-	-	-
P	5,871	5,871	7,621	7,621	7,621	-	-	-	-
Q	7,746	7,746	7,746	7,746	7,746	-	-	-	-
R	8,121	8,121	8,121	8,121	8,121	-	-	-	-
T	9,59	9,59	9,59	-	9.590 (*)	-	-	-	-

* Type 42,43,44 not available

Table 9 - Disc insert minimum seat heights

Orifice	D & E	F	G	H	J	K	L	M	N	P	Q	R	T
"A"	0,332	0,370	0,369	0,398	0,429	0,531	0,546	0,605	0,632	0,692	0,783	0,781	0,839
"B"	0.021	0.025	0.030	0.036	0.044	0.051	0.063	0.070	0.076	0.091	0.118	0.139	0.176
	0.023	0.027	0.032	0.038	0.046	0.053	0.065	0.072	0.078	0.093	0.120	0.141	0.178

Assembly

All components should be clean. Before assembling the following parts, lubricate with pure nickel "Never-Seez".

- Nozzle and body threads
- Nozzle and body sealing surface
- All studs and nut threads
- Spindle and threads
- Set screw threads
- Spring washer bevels
- Adjusting bolt and bonnet threads
- Bonnet pipe plug
- Cap threads
- Dog shaft bearing threads
- Disc holder threads (bellows valves only)

Lubricate the spindle point thrust bearing and disc insert bearing with pure nickel "Never-Seez". Special attention should be given to the guiding surfaces, bearing surfaces and gasket surfaces to ensure that they are clean, undamaged and ready for assembly. (Figure 12)

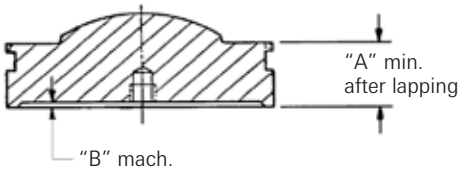


Figure 11 - Disc Insert Minimum Seat Height (Table 9)

For parts identification, refer to Figure 1.

a. Before installing the nozzle (2) apply lubricant to the flange surface in contact with the valve body (1) and on the body to nozzle threads. Screw the nozzle (2) into the valve body (1) and tighten with a nozzle wrench.

b. Screw the nozzle ring (3) onto the nozzle (2).
Note: The top of the nozzle ring should be above the nozzle seating surface. For P, Q, R and T Orifice Style 8500/8590, position the nozzle ring per table 2.

c. For bellows valves only, place the disc holder in a vise (larger sizes may require a 3 jaw vise) as shown in Figure 8. Install the tailpiece gasket (29).
Screw the bellows assembly onto the disc holder. Tighten with a suitable wrench.

d. Assemble the disc insert (8) and the disc holder (5).
(See page 15 for O-ring soft seat assembly)
Install the disc insert retention clip (9) onto the disc insert.
Install the disc insert into the disc holder. The disc insert should snap into place using hand force only.
Safety precautions should be followed whenever heavy parts are being lifted or transported. Dropping disc holder assembly may dislodge the insert.

e. Assemble the disc holder (5) and guide (15) by sliding the guide over the disc holder.
Note: The guide for D and E orifice valves protrudes up into the valve bonnet.

f. Install the two guide gaskets (28), one above and one below the guide.
Note: When assembling bellows valves, the bellows flange eliminates the need for a bottom guide gasket.

g. While holding the top of the disc holder, install the guide into the body. Align the hole of the guide with the body outlet. Once the guide is seated, the disc holder and disc insert can be lowered onto the nozzle.
Note: Lower the nozzle ring below the seats so that it moves freely.

h. Place the spring (18) and washers (19) onto the spindle (16) and assemble the spindle to the disc holder (5) with the spindle cotter pins.
Note: No cotter pins are required in D through K orifice sizes all other orifice sizes use two cotter pins.

i. Lower the bonnet (20) over the spindle and spring assembly onto the bonnet studs (21) in the body. Position the bonnet counter bore on the O.D. of the guide and lower the bonnet onto the guide.

j. Screw the bonnet nuts (22) onto the bonnet studs and tighten down evenly to prevent unnecessary strain and possible misalignment.

k. Screw the adjusting bolt (24) and nut (25) into the top of the bonnet to apply force on the spring. (The original set pressure can be approximated by screwing the adjusting bolt down to the predetermined measurement.)

l. Move the nozzle ring up until it touches the disc holder, then lower it two notches. This is a test stand setting only.

m. Place the set screw gasket (27) onto the set screw (4) and screw the set screw into the body engaging the nozzle ring. The nozzle ring should move back and forth slightly after the set screw is tightened.

n. The valve is now ready for testing.

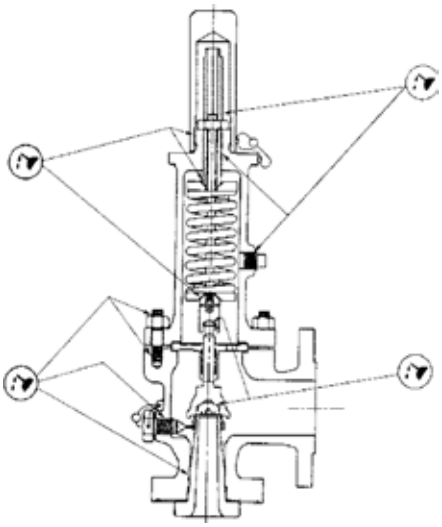
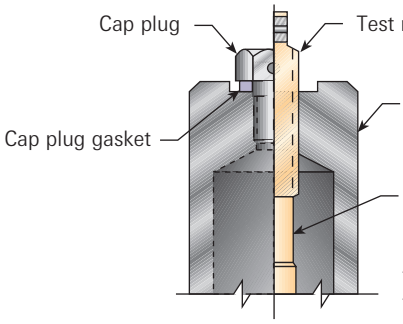


Figure 12 - Recommended lubrication points

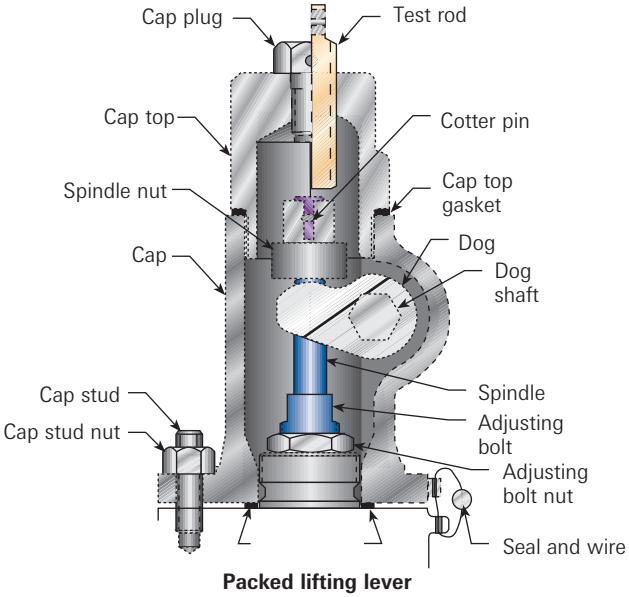
After testing, the following measures should be taken:

- Be sure that adjusting bolt nut (25) is locked.
- Return the nozzle ring to either the original recorded position or to the recommended position shown in Table 1.
- Install the cap or lifting device. See Figure 13 for lifting lever assembly.
- Seal the cap or lifting lever device and nozzle ring set screw to prevent tampering.



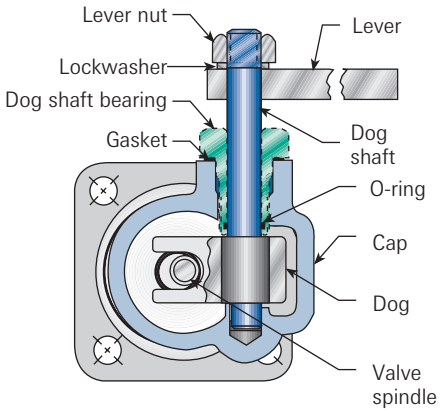
Cap test rod

Type B - Threaded cap (Low profile)
Type E - Packed lifting lever
Type H - Bolted cap (Low profile)
Type K - Threaded cap (standard)
Type M - Bolted cap (standard)



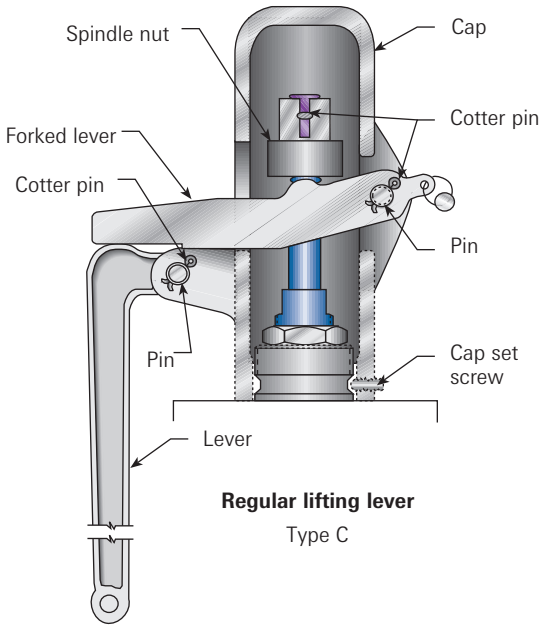
Packed lifting lever with test rod

Type E



Packed lifting lever

Type E
(Top view)



Regular lifting lever

Type C

Assembly of Cap and Lifting Lever Devices
Series 8000 pressure relief valves are furnished with several different caps and lifting lever devices. The following describes assembly of the available types of cap construction. (Disassembly is the reverse of assembly). For part identification refer to Figure 13.

• *Type B and K*
Install the cap gasket and screw the cap onto the top of the bonnet. Tighten the cap with a strap wrench. Install the cap plug gasket and screw cap plug into the cap. The test rod is installed only during system hydrostatic testing. Never install the test rod unless performing system hydrostatic testing.

• *Type C*
Screw the spindle nut onto the spindle.
Place the cap on the bonnet. Install the forked lever and forked lever pin. Attach the lever to the cap using the lever pin and secure with the lever pin cotter.
Adjust the spindle nut until the forked lever rests on the lever and there is a 1/16 inch minimum of play between the forked lever and the spindle nut. The spindle nut may be adjusted by removing the forked lever pin, forked lever and cap. When the spindle nut is in proper adjustment, install the spindle nut cotter pin. Replace the cap and forked lever and install the forked lever pin and forked lever pin cotter.
Position the lever opposite the valve outlet and install the four (4) cap set screws and tighten them against the groove in the top of the bonnet.

• *Type D*
Install the cap gasket on the bonnet. Screw the spindle nut onto the spindle. Place the dog in the cap and install the dog shaft so that the dog is horizontal and the square on the end of the dog shaft has a corner on top. With the dog shaft in the position above, scribe a horizontal line on the end of the dog shaft. This line must be horizontal when the lifting gear is finally installed on the valve. Install the dog shaft O-ring in the dog shaft bearing and place the dog shaft bearing gasket on the dog shaft bearing.
Screw the dog shaft bearing into the cap. Rotate the dog shaft so that the dog is pointing down and install the cap assembly onto the bonnet. Rotate the dog shaft so that the dog contacts the spindle nut. With the scribed line horizontal, remove the assembly and adjust the position of the spindle nut. Repeat the operation until the scribed line is horizontal when the dog contacts the spindle. Remove the assembly and install the spindle nut cotter pin.
Install the lifting gear assembly onto the bonnet and secure it with cap studs and nuts.
For Type D lifting levers that have two part caps (cap and cap top) the above procedure is more easily accomplished. After the cap is screwed to the bonnet, the positioning of the dog shaft is the same as above except that the positioning of the spindle nut is performed last through the open end of the cap.
With the dog in the horizontal position, screw the spindle nut onto the spindle until it contacts the dog. Install the spindle nut cotter, cap top gasket and screw the cap top into the cap.

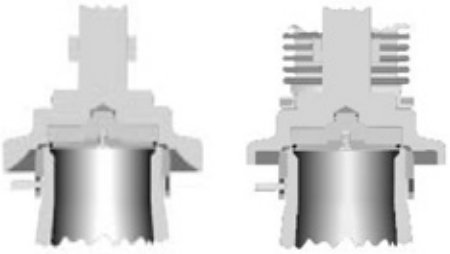
• *Type E*
Assembly of Type E lifting lever is identical to Type D with the addition of the cap plug gasket and cap plug. The test rod is installed only during system hydrostatic testing. Never install the test rod unless performing system hydrostatic test.

• *Type H and M*
Assembly of Type H and M is identical to Type G and L with the addition of the cap plug gasket and cap plug. The test rod is installed only during system hydrostatic testing. Never install the test rod unless performing system hydrostatic test.

Soft Seat Construction
Coat O-ring with Parker Super O-Lube and place a small amount of Loctite 242 (or equivalent removable thread lock) onto retainer screw before assembly. Securely tighten retainer screw(s).

• *O-Ring Soft Seats*
Sapag Series 8000 metal-to-metal seated pressure relief valves may be converted to an O-ring soft seat by replacing the standard disc insert and nozzle with those parts designed to house the O-ring soft seat or vice versa.

Figure 14



8500 O-ring Soft seat

8400/8490 O-ring Soft seat

Table 10 - soft seat o-ring sizes

Orifice	O-ring size
D & E	2-013 All Elastomers
	2-014 Teflon Only
F	2-113
G	2-116
H	2-120
J	2-125
K	2-130
L	2-226
M	2-228
N	2-230
P	2-337
Q	2-346
R	2-352
T	2-438

7. Style Variations

The Sapag Style 8400 pressure relief valve was designed with flexibility and interchangeability in mind. Retrofitting from conventional to balanced bellows high performance liquid trim or soft seat design is accomplished with a minimum number of new parts. These style retrofits can be accomplished at lowest possible cost.

• *Balanced Bellows*
A Sapag 8400 conventional non-bellows pressure relief valve may be converted to a Style 8490 balanced bellows valve simply by adding the bellows assembly and tailpiece gasket.

• *8500/8590 Liquid Trim*
Sapag Style 8400/8490 pressure relief valves in D to N orifice sizes may be converted to high performance 8500/8590 liquid service design simply by replacing the standard disc holder with a 8500/8590 disc holder, or vice versa. For P to T orifice sizes a new nozzle ring is also required.

• *O-Ring Soft Seat Design*
Sapag Series 8000 pressure relief valves in all orifice sizes may be converted from the standard metal-to-metal seats to an exceptionally tight soft seat design. This style conversion can be accomplished by replacing the standard disc insert and nozzle with parts adapted to accommodate the soft seat design.
The Sapag soft seat design uses standard size O-rings and is capable of handling pressures to 1480 PSIG. Standard O-ring materials include Buna N, EPR, Viton, Kalrez, Silicone and Teflon. (See Figure 14 and Table 10).

8. Service Records

Service records should be completed before a valve is returned to service. These records are important and will provide guidance on establishing time intervals between repairs as well as providing the historical record of repairs and service conditions. Well kept records will be useful in predicting when to retire a valve and which spare parts should be maintained in inventory to ensure uninterrupted plant operation.

9. Spare Parts

When ordering spare parts, the valve serial number should be given together with set pressure, part name and item number, valve size and style. On the valve nameplate the valve serial number is shown.
Spare parts may be ordered from any Emerson Valves & Controls Regional Sales Office or Representative.

10. Trouble Shooting Pressure Relief Valves

Troubles encountered with pressure relief valves can vitally affect the life and performance of the valve and must be corrected at the first possible opportunity.
Failure of a pressure relief valve to function properly could result in the rupture of a line or vessel jeopardizing the safety of personnel and causing damage to property and equipment. Some of the most common troubles and the recommended correction measures are discussed in the following paragraphs.

Seat Leakage
Of all the problems encountered with pressure relief valves, seat leakage is the most common and the most detrimental. A leaking valve allows fluids to circulate into the secondary pressure zone of the valve where it can cause corrosion of the guide and valve spring.
When a leaking valve problem is not immediately addressed, the leakage itself will further contribute to seat damage through erosion (wire-drawing).

• *Seats Damaged by Foreign Matter*
Seating surfaces may be damaged when hard foreign particles such as mill scale, welding spatter, coke and dirt are trapped between the seats. While this type of damage usually occurs while the valve is in service, it may also happen in the maintenance shop.
Every precaution should be taken to clean the process system before installing a pressure relief valve and to test the valve using only clean fluids.
Damaged seating surfaces are generally reconditioned by lapping. Most often small pits and scratches may be removed by lapping alone. More extensive damage will also require remachining prior to lapping.
In some instances valve construction can be changed to reduce the effects of seat leakage. The use of an O-ring soft seat when applicable will minimize leakage and thus eliminate the associated corrosion and erosion problems. If it is not possible to use a soft seated valve, or if the corrosive media is present in the exhaust system, conversion to a Style 8490/8590 bellows seated valve will isolate and protect the guides and valve spring from any corrosive fluids.

• *Distortion from Piping Strains*
Valve bodies can be distorted by excessive piping loads causing seat leakage. Both inlet and discharge piping must be properly supported and anchored so that high bending loads are not transmitted to the valve body.

• *Operating Pressure Too Close to Set Pressure*
A carefully lapped metal-to-metal seated valve will be commercially tight at a pressure approximately ten percent under the set pressure or 5 PSI, whichever is greater. Consequently, this minimum pressure differential should be maintained between set and operating pressure to avoid seat leakage problems.

• *Chatter*
Oversized valves, excessive pressure drop in the inlet lines, restrictions in the inlet line, too great a build up of back pressure or pulsating inlet pressure will cause instability to the pressure relief valve. In such installations, the pressure under the valve disc may be great enough to cause the valve to open, but as soon as flow is established, the pressure drops allowing the valve to immediately close. This cycle of opening and closing sometimes occurs at very high frequency causing severe seat damage, sometimes beyond repair.
Proper valve selection and installation techniques are paramount to reliable valve performance.

• *Incorrectly Adjusting Lifting Gear*
A space of 1/16 inch minimum should always be provided between the lifting device and the spindle lift nut. Failure to provide sufficient clearance may result in inadvertent contact causing a slight shift in the opening pressure.

• *Other Causes of Seat Leakage*
Improper alignment of the spindle, too much clearance between the valve spring and the spring washers, or improper bearing contact between the adjusting bolt and the spring washers, spindle and disc holder or spindle and lower spring washer may cause seat leakage problems. Spindles should be checked for straightness and springs and spring washers should be properly fitted and kept together as a spring assembly.

• *Corrosion*
Corrosion may result in pitting of valve parts, failure of various valve parts, build up of corrosive products and general deterioration of the valve materials.
Corrosive attack is generally controlled through selection of suitable materials or by employing a bellows seal to isolate the valve spring, adjusting bolt, spindle and guiding surfaces from the corrosive attack of the process fluid.
Environmental corrosion attacks all exposed surfaces, including studs and nuts. In general, the materials required for a particular service are dictated by the temperature, pressure and the degree of corrosion resistance required.

11. Emerson Valves & Controls field service and repair programs field service

Emerson Valves & Controls Field Service provides on-site, in line testing and repair capability for all types of pressure relief devices.

• **Parts**
Emerson Valves & Controls will help you establish the right mix of on-site spares with Emerson Valves & Controls' own distribution and manufacturing support.

• **Training**
Emerson offers intensive factory or on-site seminars to improve maintenance and application skills.

• **Testing**
Emerson Valves & Controls has the capability to evaluate pressure relief valve operability either in the field or at various Emerson Valves & Controls facilities. Special qualifications programs may also be conducted in our laboratories.

• **Contract Management**
Emerson Valves & Controls will combine a group of services to satisfy your special maintenance needs.

WARNING

The Product is a safety related component intended for use in critical applications. The improper application, installation or maintenance of the Product or the use of parts or components not manufactured by Emerson may result in failure of the Product. The advice of a qualified engineer should be sought prior to any use of the Product.
Any installation, maintenance, adjustment, repair or test performed on the Product must be done in accordance with the requirements of all applicable Codes and Standards.
The information, specifications and technical data (the "Specifications") contained in this document are subject to change without notice. Emerson does not warrant that the Specifications are current and assumes no responsibility for the use or misuse thereof.
The Purchaser should verify that there have been no changes to the Specifications prior to use.