6.2 Installation of the Safety Valve

The correct installation within a plant is essential for the proper operation of a safety valve. Installation in this sense is e.g.

- the choice of the gaskets
- the flow direction
- the mounting position of the safety valves.

Furthermore this section deals with

- tests and inspections before and during installation
- the proper storage and handling of a safety valves before installation
- recommended spare parts for an easy and efficient maintenance

The recommendations provided in this section are mainly based on

- API RP 520 Part II, Installation, 5th Edition 2003
- The LESER Operating Instructions

6.2.1 Correct Connections

The connection including gasket between the safety valve and the plant must be sufficiently sized. It also has to be designed and selected in accordance with the applicable codes and standards to prevent the connection from failing.

Both, the flange connection of the inlet line and the inlet connection of the safety valve should be sized with the same pressure rating and for the same temperature.

6.2.2 Gaskets

The user is responsible for the correct fitting of gaskets for pipes leading into the valve (inlet line) and for discharge pipes (outlet line) as well as other connections to the safety valves (e.g. drain hole, bellows vent). It must be ensured that the flange sealing surfaces are not damaged during installation.

6.2.3 Flow Direction

The flow direction must be observed during installation. It can be recognized by the following features:

- Flow direction arrow on the body

- Diagrams
  - In the catalogue
  - In the operating instructions
  - In the data sheets and
  - In the installation instructions

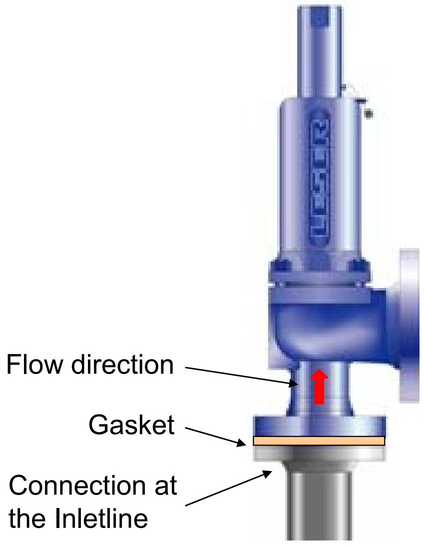


Figure 6.2.3-1: Flow direction

6.2.4 Location of the Safety Valve

6.2.4.1 Distance to Pressure Source

"The safety valve should normally be placed close to the protected equipment so that the pressure losses to the safety valve are within the allowable limits. For example, where protection of a pressure vessel is involved, mounting the safety valve directly on top of the vessel is suggested. However, on installations that have pressure fluctuations at the pressure source (as with valves on the compressor discharge) that peak close to the set pressure of the safety valve, the safety valve should be located farther from the source (e.g. behind a compressed air chamber) and in a more stable pressure region."[1)]

6.2.4.2 Distance to Other Valve Equipment

"The safety valves should not be located where unstable flow patterns are present (Figure 6.2.4.2-1). The branch entrance where the safety valve inlet line joins the main piping run should have a well rounded, smooth corner that minimizes turbulence and resistance to flow."[2)]

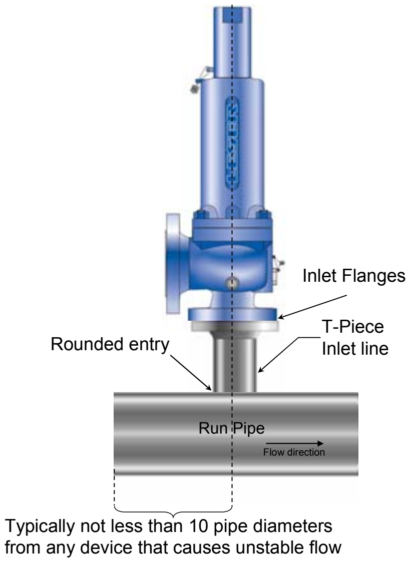


Figure 6.2.4.2-1: Distance to other valve equipment acc. to API 520 part II

6.2.4.3 Sources of Irritation

"Safety valves are often used to protect piping downstream from pressure reducing valves or control valves, where unstable flow usually occurs. Other valves and equipment in the system may also disturb the flow. This condition cannot be evaluated readily, but unsteady flow at valve inlets tends to generate instability. Therefore safety valves should be installed at least 10 pipe diameters away from the source of irritation."[3)]

"The proximity to orifice plates and flow nozzles may cause adverse performance of the safety valves. Also the use of other fittings, such as elbows, may create turbulent areas that could have an impact on the safety valve's performance."[4]

1) API RP 520 Part II, 5th Edition 2003, Sect. 9.2

2) API RP 520 Part II, 5th Edition 2003, Sect. 9.3

3) API RP 520 Part II, 5th Edition 2003, Sect. 9.3.1

4) API RP 520 Part II, 5th Edition 2003, Sect. 9.3.2

6.2.4.4 Process Laterals Connected to the Inlet Line of Safety Valves

“Process laterals should generally not be connected to the inlet line of safety valves. Exceptions should be analyzed carefully to ensure that the allowable pressure loss at the inlet of the safety valve is not exceeded under simultaneous conditions of rated flow through the safety valve and maximum possible flow through the process lateral (Figure 6.2.4.4-1).”[5)]

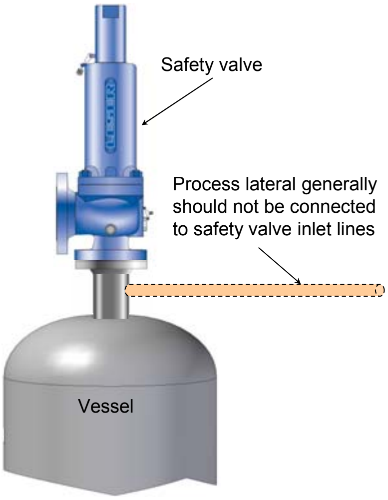


Figure 6.2.4.4-1: Process lateral acc. to API 520 part II

6.2.4.5 Partly Filled Liquid Vessel

The vessel is filled with liquid which is covered by gas. In this case the safety valve should be located at the gas phase. This saves the loss of the generally more valuable liquid medium.

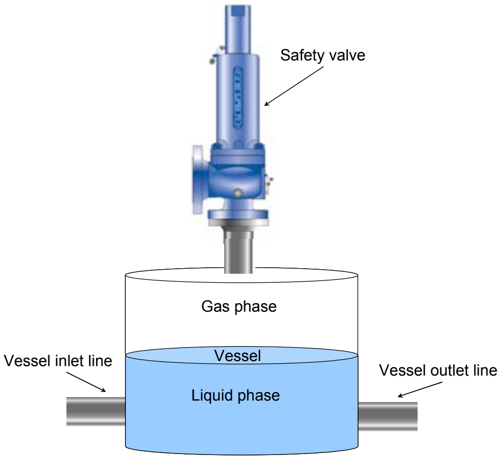


Figure 6.2.4.5-1: Partly filled vessel

5) API RP 520 Part II, 5th Edition 2003, Sect. 4.7

6.2.5 Mounting Position – Horizontal Installation

6.2.5.1 Codes and Standards which Direct an Installation in the Upright Position

Most international standards for safety valves specify an upright position for installation of direct loaded safety valves, e.g.

Code/ Standard	Installation of safety valve
ASME Sec. VIII, Div. 1, App. M-11	"Spring loaded safety valves and safety relief valves normally should be installed in the upright position with the spindle vertical. …"
ISO 4126.1	No statement
API 520, Part II – Installation, 7.4 - Mounting Position	"Pressure relief valves should be mounted in a vertical upright position. …"
AD 2000-Merkblatt A2, Part 6.1.2	"Direct-acting safety valves are generally installed in an upright position taking the direction of flow into consideration. …"

Table 6.2.5.1-1: Installation of direct loaded safety valves in upright position

6.2.5.2 Exceptions in Codes and Standards which allow the Non-upright Position

Some applications require an installation in the non-upright position e.g., because of space limitations. Therefore the following statements are applicable:

Code/ Standard	Installation of safety valve
ASME Sec. VIII, Div. 1, App. M-11	"Where space or piping configuration preclude such an installation, the valve may be installed in other than the vertical position provided that: a. the valve design is satisfactory for such position; b. the media is such that material will not accumulate at the inlet of the safety valve; and c. drainage of the discharge side of the valve body and discharge piping is adequate."
ISO 4126-9	"If valves are mounted in other than a vertical position, the valve manufacturer's recommendations shall be considered."
API 520, Part II – Installation, 9.4 - Mounting Position	"… Installation of a pressure relief valve in other than a vertical upright position may adversely affect its operation. The valve manufacturer should be consulted about any other mounting position, since mounting a pressure relief valve in other positions may cause a shift in the set pressure and a reduction in the degree of seat tightness."
AD 2000-Merkblatt A2, Part 2.1	"Safety valves shall comply with the latest technology and be suitable for the intended use."

Table 6.2.5.2-1: Exceptions in codes and standards which allow the non-upright position

6.2.5.3 LESER Safety Valves Installed in the Non-upright (horizontal) Position

Figure 6.2.5.3-1: LESER Safety Valves in the non-upright position

LESER safety valves, which are type test approved for the non-upright position
Table 6.2.5.3-1 shows LESER safety valves which are tested and approved for the non-upright position. The proper operation in the non-upright position is certified in the VdTÜV type test approval.

Type	VdTÜV type test approval no.	Minimum set pressure	
		Bar	psig
Compact Performance 437	980	1,0	15,0
Compact Performance 438	980	5,0	72,5
Compact Performance 439	980	1,0	15,0
Clean Service 481	980	1,0	15,0
Clean Service 483	1047	1,0	15,0
Clean Service 484	1047	1,0	15,0
Clean Service 485	1047	1,0	15,0
All other types	see general statement	3,0	45,0

Table 6.2.5.3-1: LESER safety valves, approved for the non-upright position

General statement:
LESER confirms that it is possible to install all LESER spring loaded safety valves in a non-upright position.

- sufficient drainage is provided to prevent medium or condensate from parts which are important for the function of the safety valve, e.g. outlet facing downwards when installed horizontally
- minimum set pressure: 3 bar (45psig) unless the proper operation is confirmed by operating experience or tested at LESER test labs
- preventive maintenance ensures proper function of the safety valve, e.g. free drainage is checked periodically

LESERs design enables horizontal installation due to:

- one piece spindle and
- widely spaced top and bottom guiding for better alignment
- reduced guiding surface area and
- PTFE bushing between spindle and adjusting screw for less friction
- self-draining and flat bottomed body bowl

These features also allow shipment in the horizontal position, see section 6.2.13 Storage and Handling of Safety Valves.

6.2.6 Unfavourable Environmental Conditions

All LESER safety valves made from cast ductile iron or carbon steels are painted with a protective coating during manufacture which protects the safety valve during storage and transportation. In corrosive environments a further corrosion protection is required. Under extreme conditions, stainless steel safety valves are recommended.
Media from outside (e.g., rain water or dirt/dust) in the discharge pipe and near components important for operation (e.g., guides with open bonnets) have to be avoided.
Simple preventive measures are possible:
- Protection of the outlet chamber from extraneous media and dirt by flange protectors
- Protection of parts important to operation from extraneous media and dirt.

6.2.7 Impurities

Impurities must not remain in the installation (e.g., welding beads, sealing material such as Teflon tape, screws, etc.). They can cause damages and leaking of the safety valve with the start up of the facility and first opening of the safety valve. One option for avoiding extraneous bodies in the system is to rinse the system before commissioning. In the case of leakage caused by contamination between the sealing surfaces, the safety valve can be vented to clean the surfaces. If this does not remove the leak, the sealing surface (seat, disc) is probably damaged. In this case the safety valve has to receive maintenance.

6.2.8 Inlet Stresses that Originate from Installation

No high static, dynamic or thermal tensions may be transmitted to the safety valves. The tension can lead to distortion of the valve body which causes leaking. These tensions can be caused by installation under tension (static).

The following measures have to be taken:
- Install system so that it is able to expand without causing stress in the piping
- Attach pipes in such a way that tensions are not created
- Utilize safety valve brackets for secure attachment to the installation

For further information regarding proper plant design to avoid stress see sections 6.3 and 6.4 Plant Design.

6.2.9 Insulation

If the safety valve is supposed to be insulated, the bonnet and, if applicable, the bonnet spacer should not be insulated in order to prevent springs from heating up impermissibly. In case of increased operating temperature, it is permissible to set the safety valve at ambient temperature and correct the temperature influence by making use of a correction factor (see Cold Differential Test Pressure, CDTP in chapter 5).

6.2.10 Heating

During the operation of safety valves, media can freeze or solidify, preventing the safety valve from opening and closing. This can happen if the temperature falls below the freezing point of the medium or with media that congeal in cold so that the viscosity may drop significantly. Also freezing vapours contained in the medium can cause icing-up. Icing-up is increased by the expansion of gases during discharge as this causes the temperature to fall further. If there is a danger of freezing or icing, measures must be taken to ensure that the safety valve works correctly. One measure can be a heating jacket.

The LESER heating jacket is a welded design that covers the body, allowing heating media (steam, heat transfer oil, etc.) to pass through the space created between heating jacket and valve body.
For safety valves with balanced bellows, the bonnet spacer required to house the bellows is fitted with an additional heating jacket to heat the area around the bellows. LESER´s recommendation is to use the balanced bellows design including heated bonnet spacer for highly viscous media to protect the spindle and the moving parts from sticking after discharge. Both heating jackets are joined by a tubing.

If there is no risk of solidification of the media at the outlet a conventional safety valve without balanced bellows can be used as well.
The position of the heating connections is shown in the following figure.

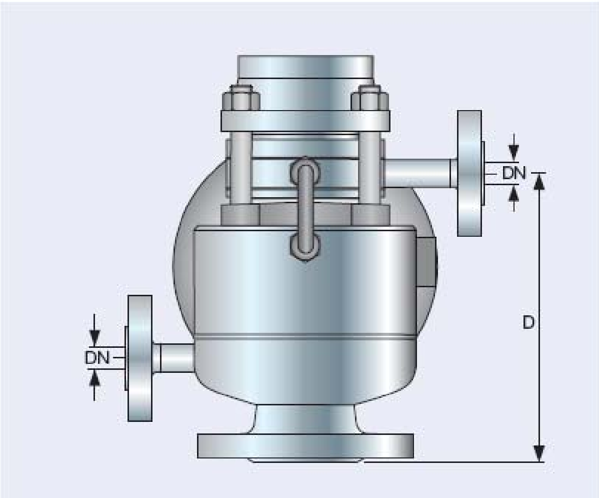


Figure 6.2.10-1: LESER Safety Valves with heating jacket - balanced bellows design

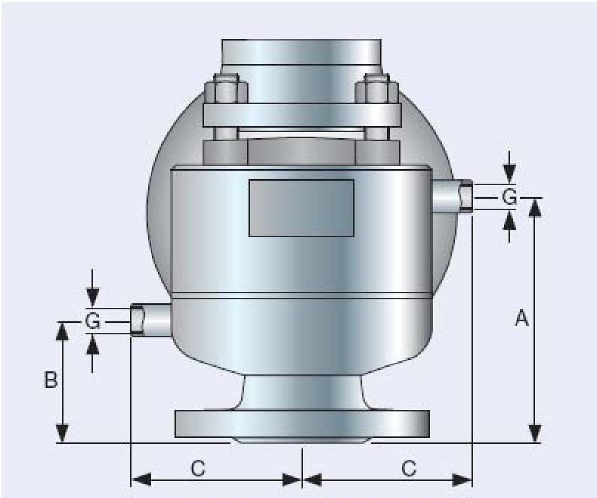


Figure 6.2.10-2: Leser Safety Valves with heating jacket – conventional design

6.2.11 Testing and Inspection of Safety Valves before Installation

"The condition of all safety valves should be visually inspected before installation. Before installation all protective materials on the valve flanges have to be completely removed. Bonnet shipping plugs must be removed from balanced safety valves."[6)]
API 520 Part II recommends that the inlet surface must be cleaned, since foreign materials clinging to the inside of the nozzle will be blown across the seats when the safety valve is operated. Some of these materials may damage the seats or get trapped between the seats in such a way that they cause leakage. Valves should be tested before installation to confirm their set pressure.

> LESER Note:
> Due to the LESER types of packing, LESER safety valves are delivered ready-to-install. As long as safety valves remain in the packing during storage, the safety valves do not need to be inspected, cleaned or tested before initial installation. For more details see the LESER operating instructions.

[6)] API RP 520 Part II, 5th Edition 2003, Sect. 12.3

6.2.11.1 Pressure Test before Operation

Before a plant can be started up a hydraulic pressure test has to be performed. For this test all safety valves in the system must be prevented from opening.
Three different possibilities are feasible:

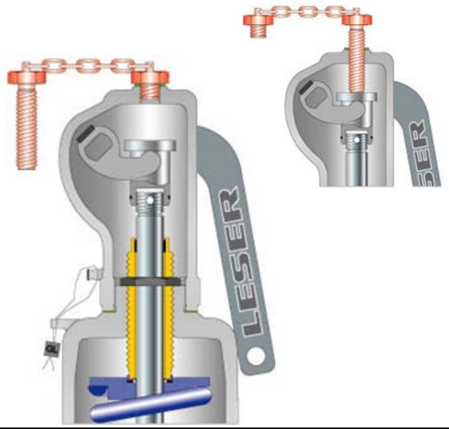
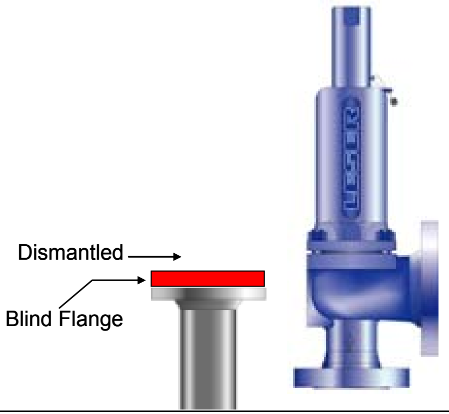
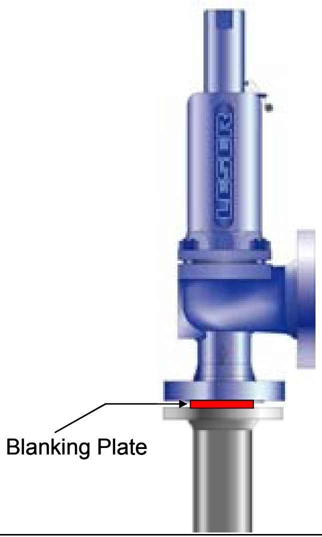
Possibility	Figure	Description
Test gag		The test gag blocks the spindle and keeps the safety valve tight while the system pressure exceeds the set pressure. Advantage: It is possible to perform pressure tests in a system without dismantling the safety valve. After testing, the test gag must be removed! Otherwise the safety valve cannot protect the system against unallowable overpressure.
Blind flange		The safety valve is replaced by a blind flange for the duration of the pressure test. After testing the safety valve has to be reinstalled.
Blanking plate/ Isolation plate		To block the safety valve during a pressure test a blanking plate is placed between inlet pipe and safety valve. After testing, the blanking plate must be removed! Otherwise the safety valve cannot protect the system against unallowable overpressure.

Table 6.2.11.1-1:Options for the hydraulic pressure test

6.2.12 Recommendation for Testing and Inspection during Operation

When and how often safety valves should be inspected is a frequently asked question. This question cannot be answered in general but has to be regarded for each application individually.

6.2.12.1 Inspection Intervals for LESER Safety Valves

Due to the individual operating conditions and in consideration of the different mediums, LESER gives no general reference for an inspection time interval.

In coordination between LESER, different operators, and the notified body, the following procedure has proven itself:

1. Determination of an ininitial inspection time interval:

In accordance with the operating conditions an initial interval of 24 month has proven itself. If the safety valve opens frequently or the medium is corrosive the inspection time interval should be 12 months.

2. Inspection of safety valves after this period of time:

- Set pressure repeat accuracy (this requirement is fulfilled if the set pressure corresponds to the test pressure with a tolerance of ± 3 %)
- Tightness test of the safety valve (this requirement is fulfilled if the tightness is tested according to API standard 527 or LWN 220.01)
- Testing of the mobility (this requirement is fulfilled if the safety valve can be opened with the lifting device at an operating pressure >75 % without the use of any additional tools).

3. Adapting the inspection time interval

The inspection time interval can be increased if the safety valve fulfills the requirements of the above mentioned tests. If not, the interval should be reduced to 12 months or less. In case the following inspection fulfills the requirements again the inspection interval can be lengthened by two month.

If the safety valve is leaking the inspection has to be done immediately.

6.2.12.2 Statements in Codes and Standards

Within the below stated codes and standards the following guidelines for inspection intervals for LESER safety valves are important:

API Recommended Practice 576, Inspection of Pressure-Relieving Devices
Chapter 6.4:
“The inspection of pressure-relieving devices provides data that can be evaluated to determine a safe and economical frequency of scheduled inspections. This frequency varies widely with the various operating conditions and environments to which relief devices are subjected. Inspections may usually be less frequent when operation is satisfactory and more frequent when corrosion, fouling, and leakage problems occur. Historical records reflecting periodic test results and service experiences for each relief device are valuable guides for establishing safe and economical inspection frequencies.
A definite time interval between inspections or tests should be established for every pressure-relieving device on operating equipment. Depending on operating experiences, this interval may vary from one installation to another. The time interval should be sufficiently firm to ensure that the inspection or test is made, but it should also be flexible enough to permit revision as justified by past test records.”

In API 510, the subsection on pressure-relieving devices establishes a maximum interval between device inspections or tests of 10 years. It also indicates that the intervals between pressure relief device testing or inspection should be determined by the performance of the devices in the particular service concerned.

AD2000-Merkblatt A2: Safety Devices against excess pressure – Safety Valves
Chapter 4.7:
“Tests on the response pressure and checks on the smooth running of moving parts within the guides shall be carried out at regular intervals. The intervals for regular tests shall be stipulated by the user in accordance with the operating conditions, using as a basis the recommendations of the manufacturer and the relevant third party. These tests and checks shall be carried out at the latest on the occasion of the external or internal tests on the relevant pressure vessel.”

Ordinance on Industrial Safety and Health – BetrSichV (Betriebssicherheitsverordnung).
Section 15 – Recurrent inspection
“ (1) An installation subject to monitoring and its components shall be subjected to recurrent inspections in certain intervals by an approved body to ensure their proper condition with respect to its operation. The operator shall determine the inspection intervals of the entire installation and its components on the basis of a technical safety assessment...“

The following testing periods for category IV pressure equipment (including safety valves) are defined in section 15:

- External inspection: 2 Years
- Internal inspection: 5 Years
- Strength inspection: 10 Years

6.2.13 Storage and Handling of Safety Valves

"Because cleanliness is essential to the satisfactory operation and tightness of a safety valve, precautions should be taken to keep out all foreign materials during storage or transportation. Safety valves should be closed off properly at both inlet and outlet flanges. Specific care should be taken to keep the valve inlet absolutely clean.
If possible, safety valves should be stored indoors, on pallets, and away from dirt and other forms of contamination.
Safety valves should be handled with care and should not be subjected to shock. Otherwise, considerable internal damage or misalignment can occur and seat tightness may be adversely affected."[7)]
Depending on the size and weight of the safety valve, the quantity of safety valves in one shipment, and the shipping method, LESER offers different types of packing (see LWN 617.08), e.g.:

Individual safety valve in a cardboard box (Figure 6.2.13-1)
Tied-down on a pallet (Figure 6.2.13-2)
Cardboard or wooden crate (Figure 6.2.13-3)

Figure 6.2.13-1: Individual cardboard box

Figure 6.2.13-2: Tied-down on a pallet

Figure 6.2.13-3 Wooden crate

During storage until installation, safety valves should be kept in their own packaging. The advantages of the LESER types of packing are:

- Due to secure packaging, no damage during transport.
- Unpacking of safety valves before stocking is not necessary.
- Safety valves are protected against dust and dirt during storage.
- Easy and space-saving storage of safety valves on shelves or racking.
- Easy identification of the content from the outside via labels (Figure 6.2.13-4).

Figure 6.2.13-4: Outside label on a cardboard box

It is also possible to transport LESER Safety valves horizontally. The advantages of this kind of transportation are:

► requires little space
► less freight charge
► lower risk of damages in horizontal transport due to lower center of gravity

7) API RP 520 Part II, 5th Edition 2003, Sect. 12.2

6.2.14 Spare Parts Recommendation

The following recommendations for spare parts should be taken as a general guideline. The actual requirement for replacement parts depends on various conditions such as:

- ► Operating temperature
- ► Type of Fluid
- ► Set pressure and operating pressure
- ► Environment
- ► Material selection

These operating conditions have a significant influence on the product life of safety valves.

Remarks for the following tables

- ► 1 per valve: one piece shall be provided for each supplied safety valve
- ► 1 per 5 valves: one spare part per 5 supplied equal safety valves
- ► Ball bearings for the disc: 1 set = 15 pieces

Spare Parts for product group API

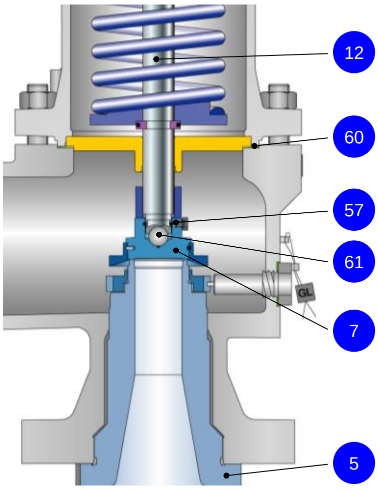


Figure 6.2.14-1: Spare parts API series 526 - Conventional Design

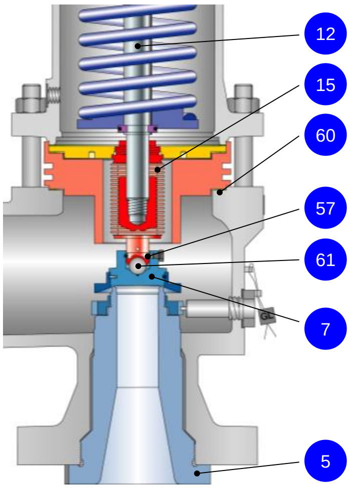


Figure 6.2.14-2: - Balanced Bellows Design

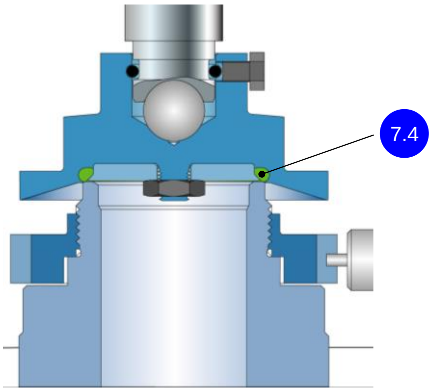


Figure 6.2.14-3: - O-Ring Disc Design

General components

Pos.	Component	Commission/ Start-up	Two Year Operation	Five Year Operation
5	Nozzle	0	0	1 per 5 valves
7	Disc	1 per 5 valves	2 per 5 valves	1 per valve
12	Spindle	0	0	1 per 5 valves
57	Ball bearings for the disc	1 set per 5 valves	2 sets per 5 valves	1 set per valve
60	Gasket	1 per valve	1 per valve	2 per valve
61	Ball	1 per 5 valves	2 per 5 valves	1 per valve

Table 6.2.14-1: Spare parts API Series 526 – conventional design

Balanced bellows design and soft seat design

Pos.	Component	Commission/ start-up	Two Year Operation	Five Year Operation
7.4	O-ring	1 per 5 valves	2 per 5 valves	1 per valve
15	Balanced bellows	1 per 5 valves	2 per 5 valves	1 per valve
60	Gasket	3 per valve	3 per valve	6 per valve

Table 6.2.14-2: Spare parts API Series 526 – balanced bellows design, soft seat design

Spare Parts for product group High Performance/ Modulate Action

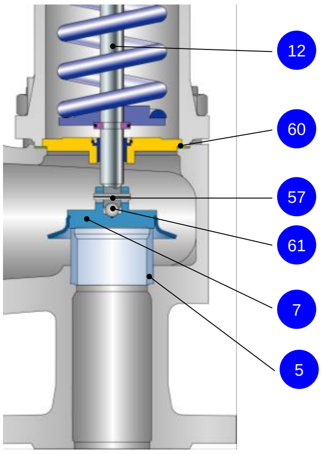


Figure 6.2.14-4: Spare parts High Performance/ Modulate Action -Conventional Design

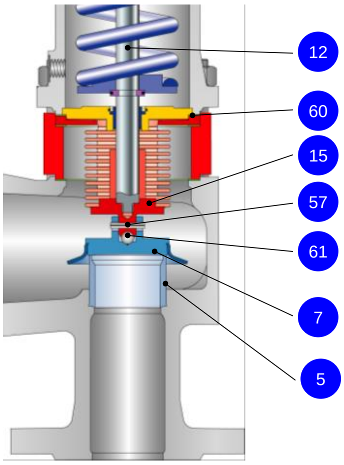


Figure 6.2.14-5: - Balanced Bellows Design

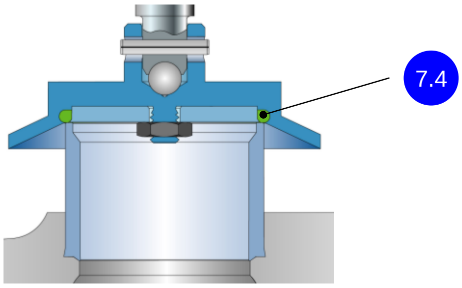


Figure 6.2.14-6: - O-Ring Disc Design

General components

Pos.	Component	Commission/ Start-up	Two Year Operation	Five Year Operation
5	Seat	0	0	1 per 5 valves
7	Disc	1 per 5 valves	2 per 5 valves	1 per valve
12	Spindle	0	0	1 per 5 valves
57	Pin	1 set per 5 valves	2 sets per 5 valves	1 set per valve
60	Gasket	1 per valve	1 per valve	2 per valve
61	Ball	1 per 5 valves	2 per 5 valves	1 per valve

Table 6.2.14-3: Spare parts High Performance / Modulate Action – conventional design

Balanced bellows design and soft seat design

Pos.	Component	Commission/ start-up	Two Year Operation	Five Year Operation
7.4	O-ring	1 per 5 valves	2 per 5 valves	1 per valve
15	Balanced bellows	1 per 5 valves	2 per 5 valves	1 per valve
60	Gasket	3 per valve	3 per valve	6 per valve

Table 6.2.14-4: Spare parts High Performance / Modulate Action – balanced bellows design, soft seat design

Spare Parts for product group Compact Performance

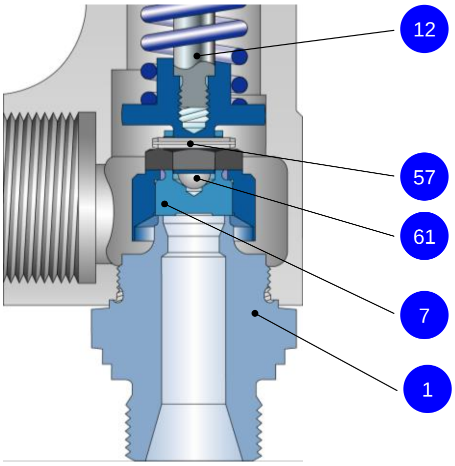


Figure 6.2.14-7: Spare parts Compact Performance -Conventional Design

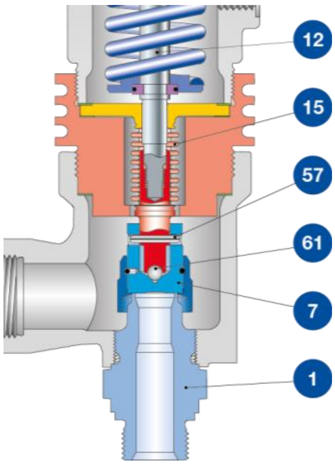


Figure 6.2.14-8: - Balanced Bellows Design

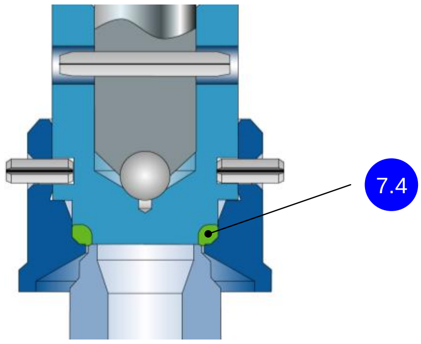


Figure 6.2.14-9: - O-Ring Disc Design

General components

Pos.	Component	Commission/ Start-up	Two Year Operation	Five Year Operation
1	Inlet body	0	0	1 per 5 valves
7	Disc	1 per 5 valves	2 per 5 valves	1 per valve
12	Spindle	0	0	1 per 5 valves
57	Pin	1 set per 5 valves	2 sets per 5 valves	1 set per valve
61	Ball	1 per 5 valves	2 per 5 valves	1 per valve

Table 6.2.14-5: Spare parts Compact Performance - conventional design

Balanced bellows design and soft seat design

Pos.	Component	Commission/ start-up	Two Year Operation	Five Year Operation
7.4	O-ring	1 per 5 valves	2 per 5 valves	1 per valve
15	Balanced bellows	1 per 5 valves	2 per 5 valves	1 per valve

Table 6.2.14-6: Spare parts Compact Performance – balanced bellows design

Spare Parts for Clean Service Design

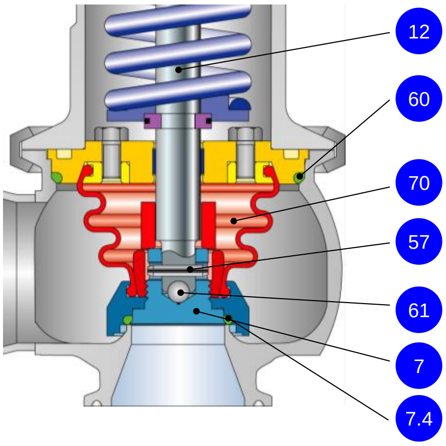


Figure 6.2.14-10: Spare parts for Clean Service design

Pos.	Component	Commission/ start-up	Two Year Operation	Five Year Operation
7	Disc	1 per 5 valves	2 per 5 valves	1 per valve
7.4	O-ring	1 per 5 valves	2 per 5 valves	1 per valve
12	Spindle	0	0	1 per 5 valves
57	Pin	1 per 5 valves	2 per 5 valves	1 per valve
60	O-ring	1 per 5 valves	2 per 5 valves	1 per valve
61	Ball	1 per 5 valves	2 per 5 valves	1 per valve
70	Elastomer bellows	1 per 5 valves	2 per 5 valves	1 per valve

Table 6.2.14-7: Spare parts Clean Service

Spare Parts for Critical Service

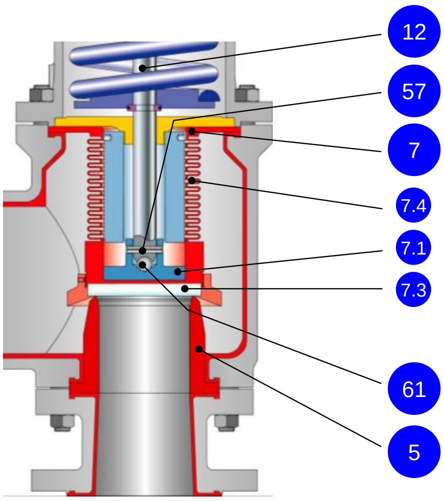


Figure 6.2.14-11: Spare parts Critical Service

Pos.	Component	Commission/ start-up	Two Year Operation	Five Year Operation
5	Seat	0	0	1 per 5 valves
7.1	Disc	1 per 5 valves	2 per 5 valves	1 per valve
7.3	Sealing plate	1 per 5 valves	2 per 5 valves	1 per valve
7.4	Bellows	1 per 5 valves	2 per 5 valves	1 per valve
12	Spindle	0	0	1 per 5 valves
57	Pin	1 per 5 valves	2 per 5 valves	1 per valve
61	Ball	1 per 5 valves	2 per 5 valves	1 per valve

Table 6.2.14-8: Spare parts Critical Service