Pneumatic Supplementary Loading System. Differences from other designs

Objectives of this Presentation.

The objective of this presentation is to give an **overview of the differentiating features between the pneumatic supplemental loading system and other designs**.

General. Pneumatic Supplementary Loading System.

LESER's **Pneumatic Supplementary Loading System** makes it possible to increase the system operating pressure to just below the operating pressure of the safety valve.

Benefits

- Enables higher operating pressures
- Seal tightness up to set pressure
- Shorter opening and closing times
- Less frequent opening of the safety valve

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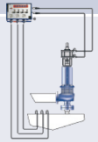
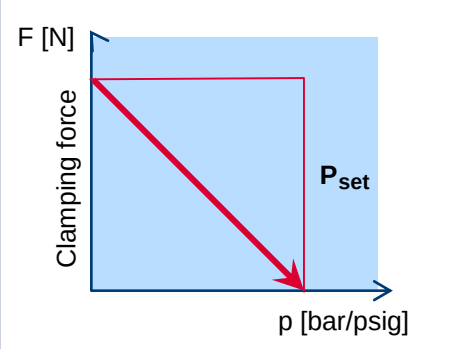
Breakdown of valve designs. Advantages.

Advantages of / over	Spring-loaded safety valve	Spring-loaded safety valve with supplemental loading	Pilot operated safety valve
Spring safety valve		▪ Seal tightness up to the set pressure ▪ higher operating pressures ▪ lower overpressure and blowdown differences ▪ fast and complete valve opening ▪ low medium loss	▪ small structural size, low weight ▪ seal tightness up to set pressure ▪ lower overpressure and blowdown differences ▪ higher set pressures ▪ higher operating pressures ▪ higher back pressures ▪ adjustable blowdown difference
Spring-loaded safety valve with supplemental loading	▪ technically simpler ▪ lower investment costs ▪ no supplemental energy needed		▪ small structural size, low weight ▪ suitable for larger operating pressure ranges ▪ lower investment costs ▪ lower installation effort ▪ no supplemental energy needed
Pilot safety valve	▪ less sensitive ▪ doesn't need a "clean" medium ▪ very good for high temperatures (superheated steam)	▪ individual switching of multiple safety valves possible with one control device ▪ very good for high temperatures (hot steam) ▪ triple redundancy for control lines - high operating safety ▪ retrofitting of third party valves	

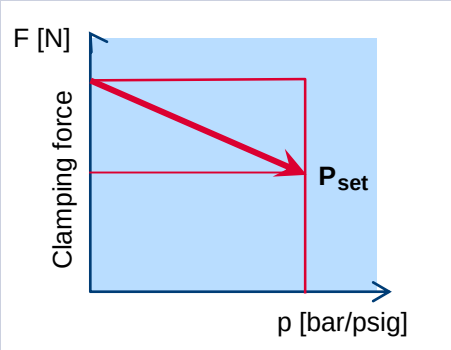
Breakdown of safety valve designs. Clamping forces.

1. Spring-loaded safety valve



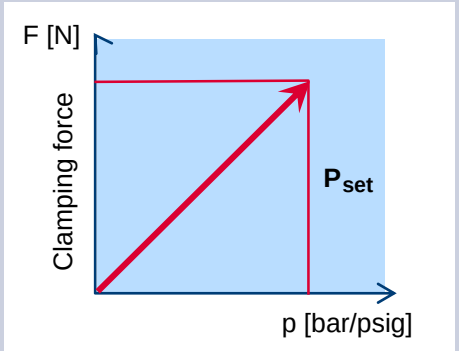
- The higher the system pressure, the lower the closing pressure on the seat and disc
- At the set pressure, the closing pressure is the same as the opening pressure of the medium

2. Spring-loaded safety valve with supplemental loading



- The pneumatic supplementary loading system applies a supplementary constant force in the closing direction through an actuator
- Without supplementary loading, the valve works like a normal spring-loaded safety valve

3. Pilot operated safety valve



- The higher the system pressure, the higher the closing pressure on the seat and disc
- This is due to the larger dome area compared to the seat area

Differences between the designs. Overview.

LESER High Efficiency Product Group			Other LESER Product Grp.
Feature / Product	**LESER Pilot-operated safety valve (Series 810, 820)**	**LESER Pneumatic Supplementary Loading (Series 700)**	**LESER Spring-Loaded Safety Valve (Series 526, 441, 459)**
Areas of application	▪ gas transport (compressors) ▪ oil and gas: upstream, downstream (refineries, storage tanks) ▪ pulp and paper ▪ pumps	▪ pulp and paper ▪ drum and overheating protection (sugar industry)	▪ chemical and petrochemical plants ▪ compressors ▪ pumps
Seat seal tightness	▪ sealed up to 97% of set pressure ▪ opens and closes close to set pressure ▪ corresponds to API std. 527	▪ sealed up to set pressure ▪ opens and closes close to set pressure ▪ corresponds to API standard 527	sealed up to 90% of set pressure
Completely open (overpressure)	▪ min.: 1% ▪ max: 10%	▪ min.: 1% ▪ max: 1%	▪ min.: 5% ▪ max: 10%
Blowdown	▪ min.: 2% ▪ max: 15%	▪ min.: 3% ▪ max: 3%	▪ min.: 7% ▪ max: 20%

Differences between the designs. Overview.

Mode of opening	▪ Pop action: complete opening up to 1% overpressure ▪ Modulate action: proportional opening up to 10% overpressure	▪ Pop action: complete opening up to 1% overpressure	▪ Full lift valve: complete opening up to 5% overpressure ▪ Other valve types: proportional opening up to 10% overpressure
Back pressure ratio	▪ up to 70% possible ▪ absolute back pressure depends on outlet side flange pressure rating	▪ absolute back pressure depends on outlet side flange pressure rating and the design (conventional or with bellows)	▪ absolute back pressure depends on outlet side flange pressure rating and the design (conventional or with bellows)
Investment and installation costs	▪ Low	▪ Medium	▪ Low
Control	control without supplemental energy	control for multiple safety valves	no control possible, suppl. energy necessary
Design	▪ small size ▪ low weight	pneumatic actuator and control device	simple and robust design
Dirty applications	sensitive to impurities	▪ not sensitive to impurities in media ▪ requires clean instrument air	not sensitive to impurities in media

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Differences between the designs. Overview.

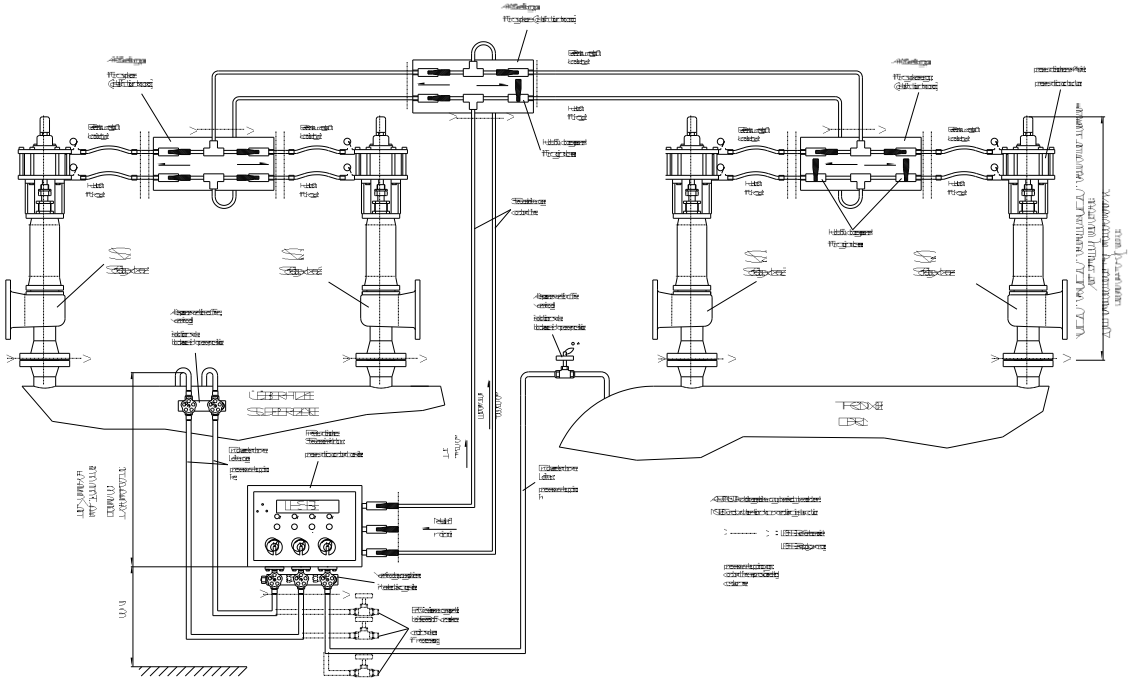
Temperature	▪ -49 to 392 °F (ASME) ▪ -45 to 200 °C (DIN)	suitable for superheated steam applications (with condensate separator in order to protect the control unit form the medium)	suitable for superheated steam applications
Approvals	worldwide approvals	as per pressure guidelines	worldwide approvals
Control line	individual pressure tapping lines to pilot valve	with triple redundancy for high operating reliability	no control line necessary
Interchangeability/ retrofitting	dimensions as per API standard 526 for easy interchangeability	existing valves can be retrofitted	dimensions as per API standard 526 for easy interchangeability
Valve size	▪ 1“ to 8“ ▪ DN 25 to DN 200	▪ 1“ to 16“ ▪ DN 25 to DN 400	▪ 1“ to 16“ ▪ DN 25 to DN 400
Set pressure	▪ 36 psig to 1480 psig (as per ASME B16.5) ▪ 2.5 bar to 63 bar (as per DIN EN 1092-1)	depends on the nominal pressure of the safety valve	▪ 1.5 psig to 4350psig ▪ 0.1 bar to 300 bar

Area of application.

LESER‘s **pneumatic supplemental loading system** is used in a great variety of areas. Areas of application are, among others:\

- greatest possible utilisation of the permissible operating pressure (e.g. in industrial steam boilers)
- Yankee cylinder in paper mills
- securing of the drum and superheater in steam boiler systems (e.g. in the chemicals industry)
- compensation for frequent pressure peaks (e.g. in waste incineration plants)
- productivity increase for "old plants" where the maximum operating pressure is exhausted

Area of application. Pneumatic Supplementary Loading System.



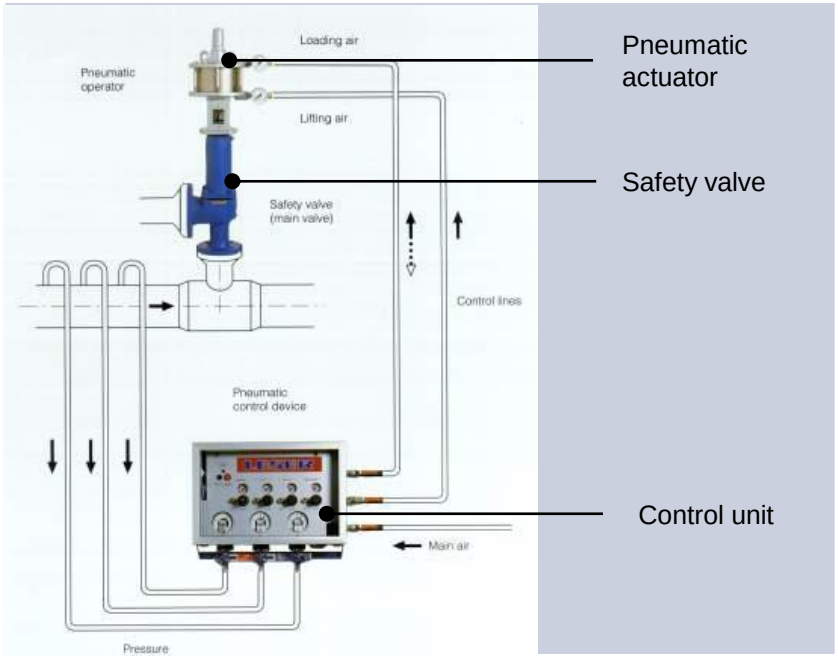
Code requirements.

- Automatic release of the additional controlling force if the set pressure is exceeded
- Three separate pressure tapping lines and sensing lines
- Control line interior diameter ≥ 15mm (BL)
- Release of controlling force by manual operation
- Lifting the safety valve by manual operation
- Monitoring of sensing lines during operation
- Unrestricted operation of the spring-loaded safety valve in the event of failure of external energy

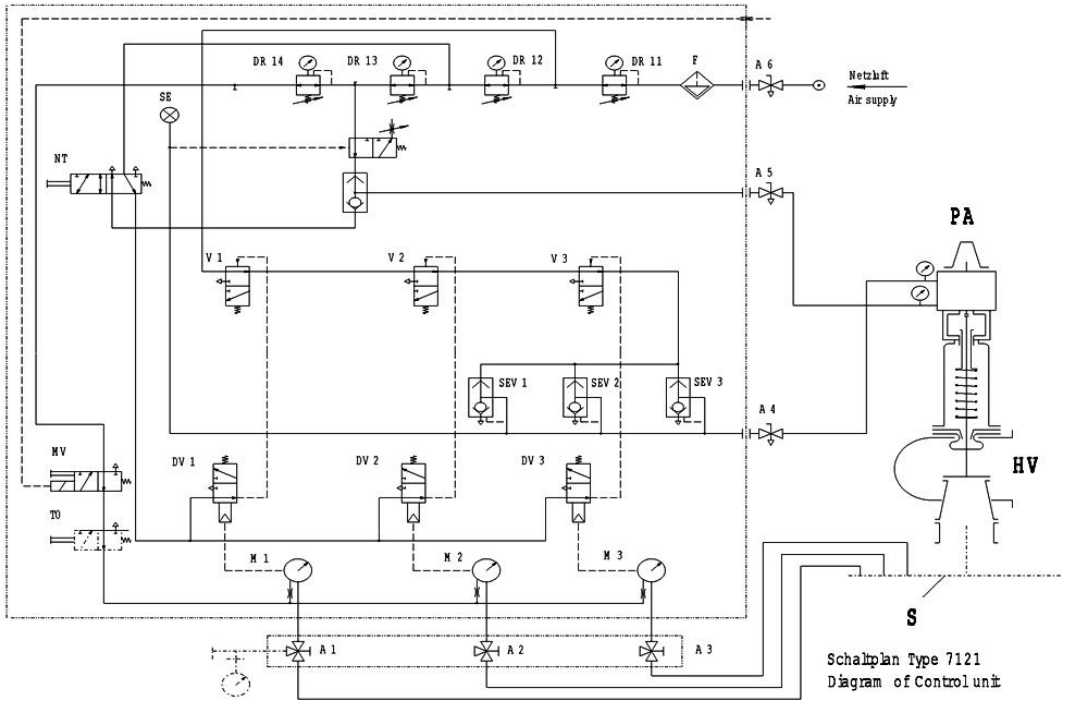
➔ **LESER meets these requirements in their entirety**

Components and design.

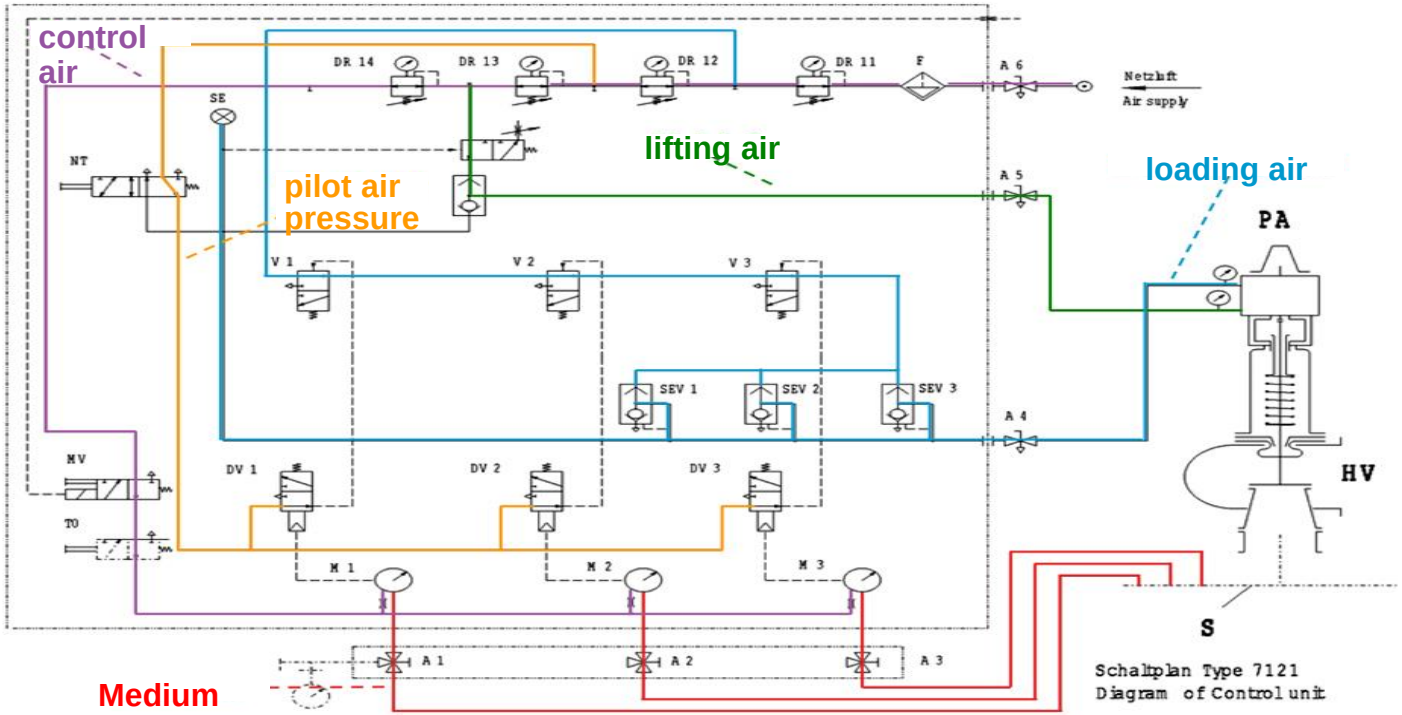
Series 700



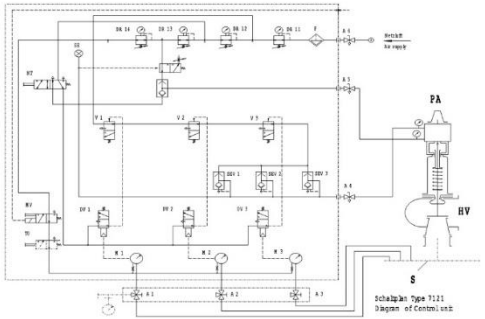
Components and design.



Components and design.



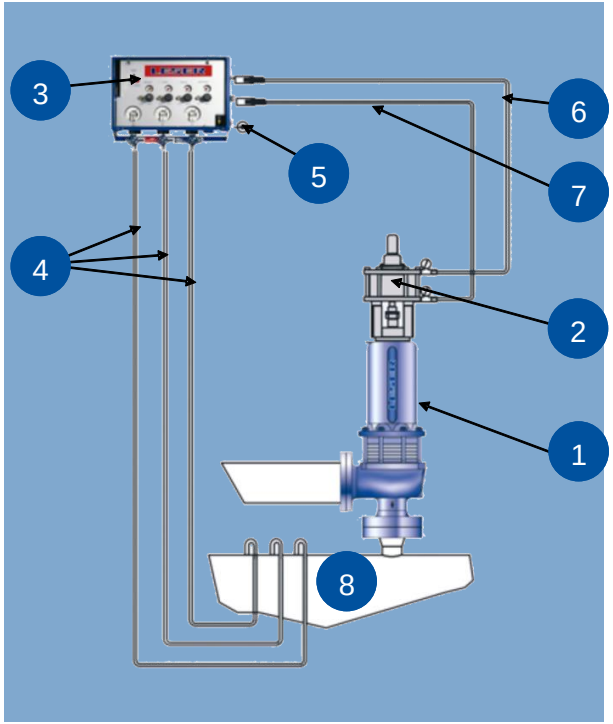
Components and design.



S	System to be protected
HV	Main valve
HV	Pneumatic actuator
BL	Loading air
HL	Lifting air
HR	Pressure indicator, loading air
PH	Pressure indicator, lifting air
P 11-14	Test connectors
M 1,2,3	Pressure switch
DV 1,2,3	Amplifying valves
V 1,2,3	Control valves
SEV 1,2,3	Rapid venting valves
A 1,2,3	Test and shut-off element
A4	Shut-off element for loading air
A5	Shut-off element for lifting air
A6	Shut-off element for air supply
F	Filter for air supply
DR 11	Pressure regulator for loading air
DR 12	Pressure regulator for working air DV
DR 13	Pressure regulator for lifting air
DR 14	Pressure regulator for controlling air
NT	Emergency key valve (for long-term lifting of HV, manual)
MV	Solenoid valve (for short-term lifting of HV, electric)
TO	Key valve (for short-term lifting of HV, manual), alternative to MV
SE	Indicator for operating position (green)

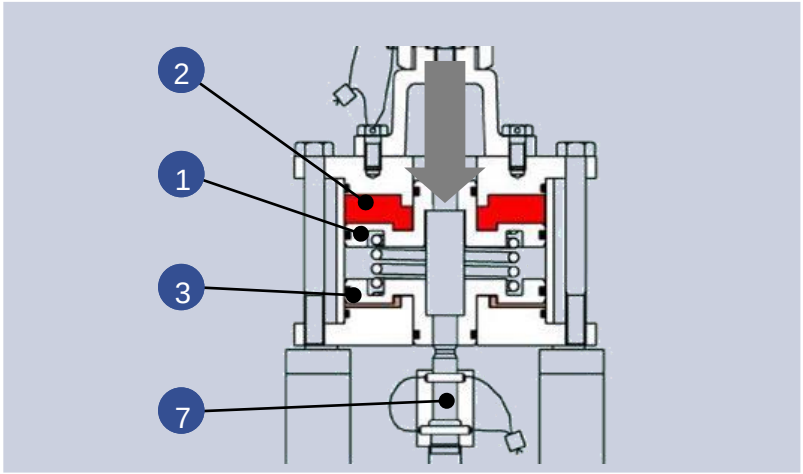
Functional description.

The control unit (3) of the pneumatic supplementary loading system uses three separate pressure tapping lines (4) and three sensing lines that are separate from each other to register the pressure of the medium (8).
It controls the actuator (2) depending on this. To do this, it channels the compressed air provided by the customer (= supply air) (5) in the form of loading air (6) and lifting air (7) to the actuator.
The actuator transfers the two compressive forces to the spindle of the safety valve (1) via two pistons.
The supplementary loading is secure. In the event of failure of the supply air, it is switched off automatically and the safety valve operates like a simple spring-loaded safety valve.



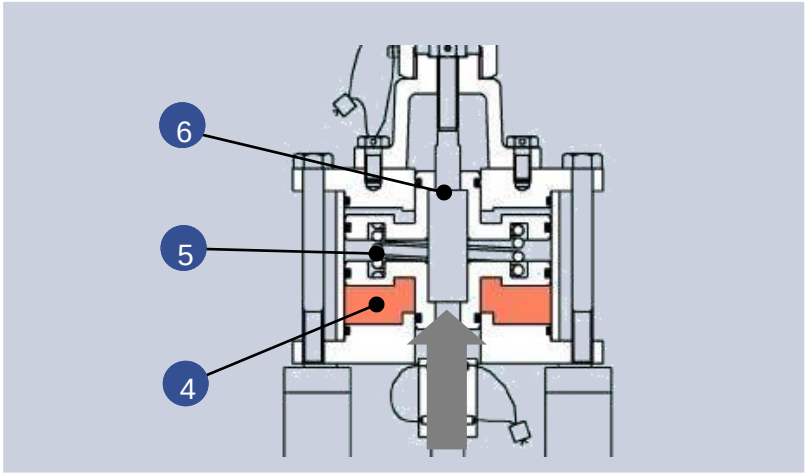
Functional description. Actuator Unit Type 702.

Loaded
(loading air active)



1. Top piston
2. Loading air
3. Bottom piston
4. Lifting air

Open
(loading air released, lifting air active)



5. Reset spring
6. Pressure pins
7. Valve spindle

Main functions of the control unit:

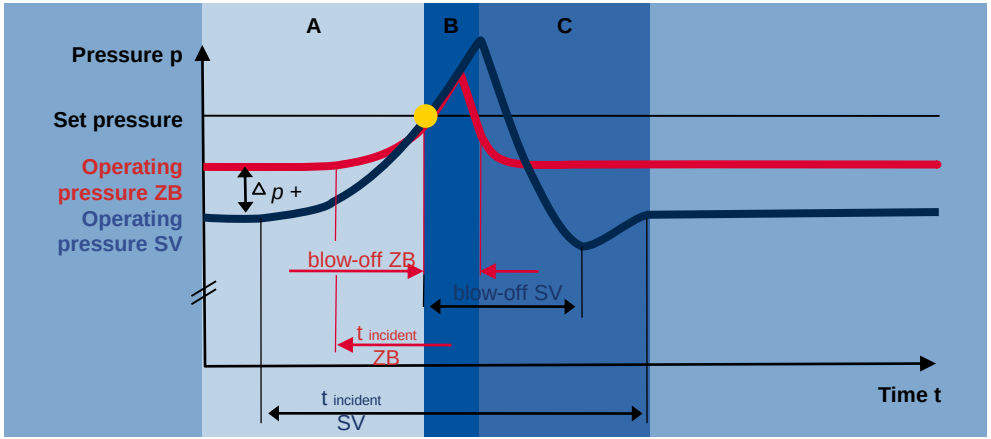
- Registration of the system pressure via the three pressure tapping lines
- Switching the loading air on or off depending on the system pressure.
  The lifting air is always on.
- Control of the working air and control air for the internal control elements within the control unit itself. All these pressures can be set on the control unit.
- The compressed air needed by the control unit, called the supply air, is provided by the customer via the supply air line. Details are described in the chapter entitled "Installation and Maintenance - Customer Requirements and Pipework“.

DR11:	Loading air
DR12:	Working air for the amplifying valves (not shown)
DR13:	Lifting air
DR14:	Control air for the pressure switches
M1 – M3:	Push-buttons for cutting off the internal flow of compressed air

Time/pressure behaviour. Overview.

The **time/pressure behaviour between opening and closing** of safety valves can be broken down into three phases.

This applies with or without supplementary loading:



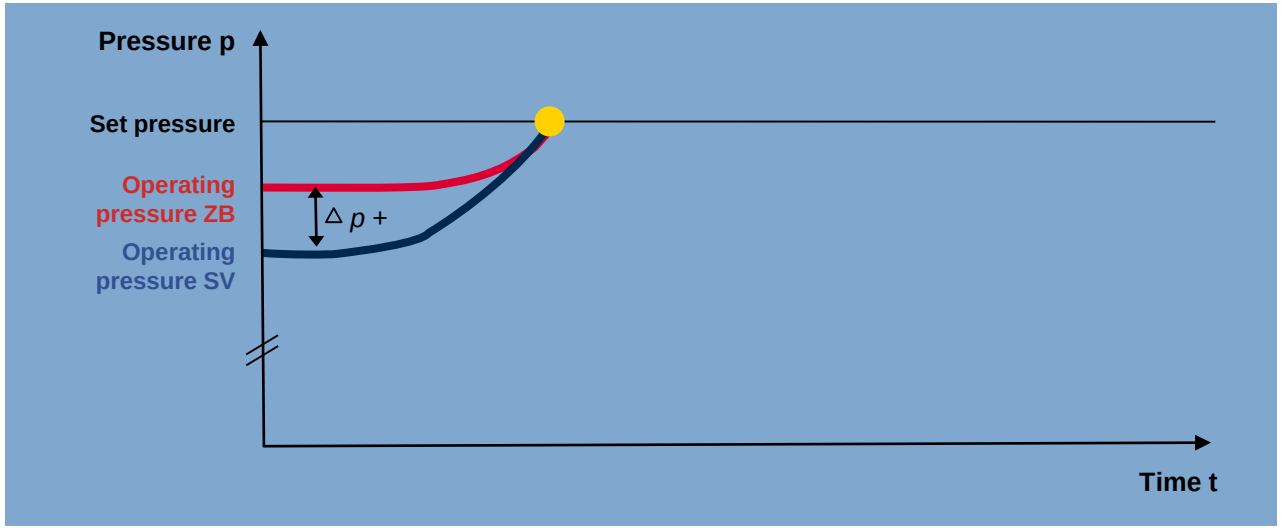
A Closed safety valve up to set pressure

B Opening and blow-off of the safety valve until closing pressure reached

C Closing of the safety valve and reaching of normal operating condition

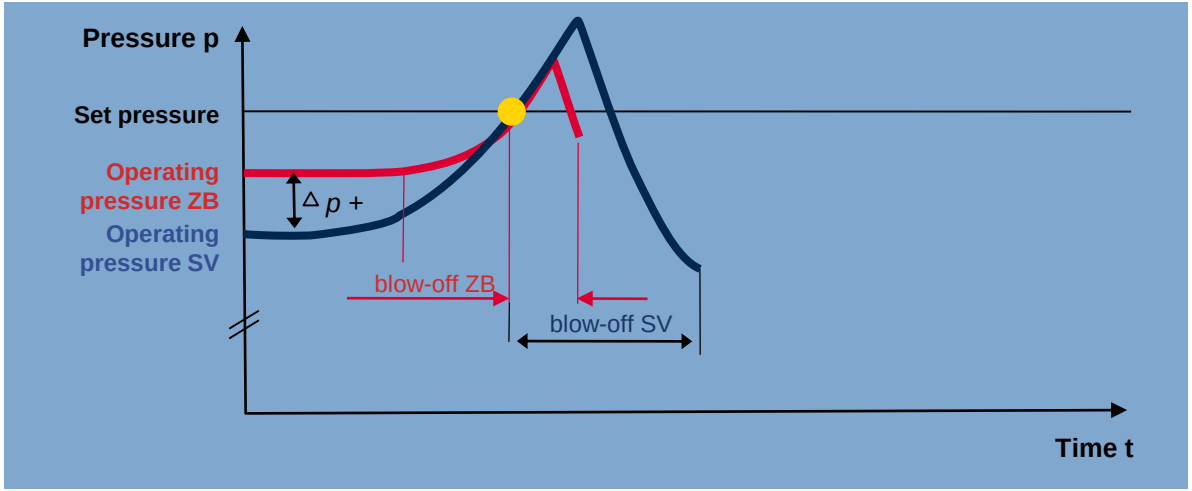
Time/pressure behaviour. Closed safety valve up to set pressure.

In normal operating condition below the set pressure, both the loading air as well as the lifting air act on the pistons of the pneumatic actuator. The considerably higher pressure of the loading air (approx. 2x the release pressure) reliably keeps the safety valve closed up to the set pressure (differential pressure principle).



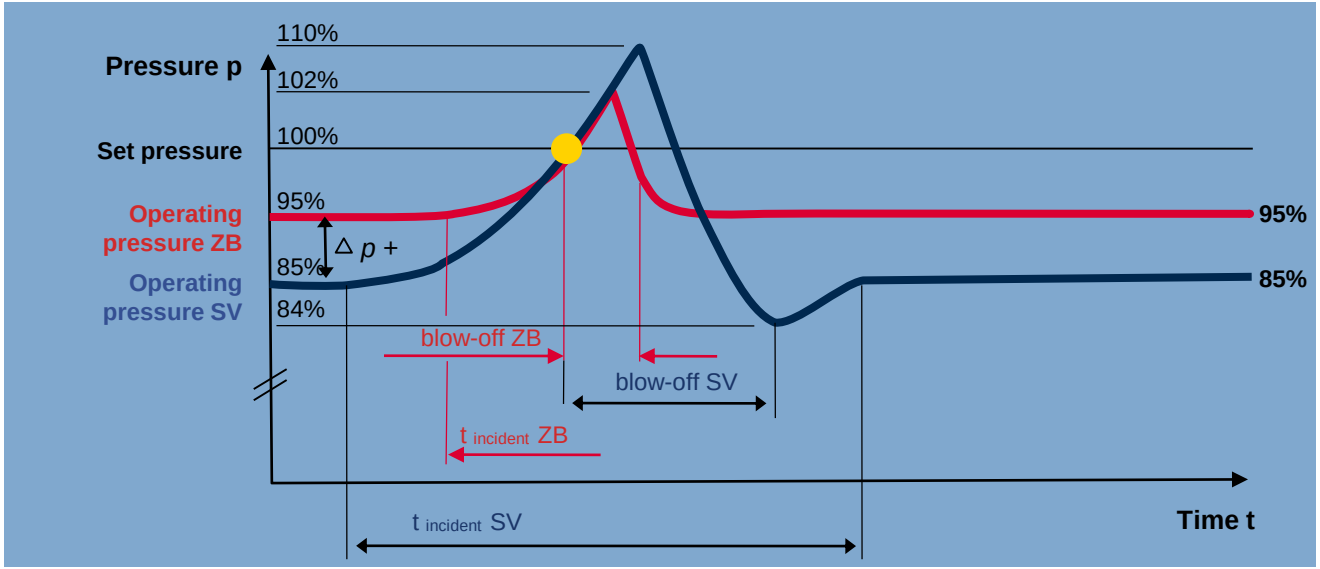
Time/pressure behaviour. Blow-off until closing pressure is reached.

When the set pressure is reached in the system, the control unit releases the loading air. The loading air is reduced immediately due to the rapid venting valves in the control unit. Then, only the lifting air has an effect, which is also reduced gradually with a delay. With the assistance of the lifting air pressure, the safety valve opens even with an overrun of the set pressure of approx. 1% independent of the back pressure. The overpressure in the system is relieved.

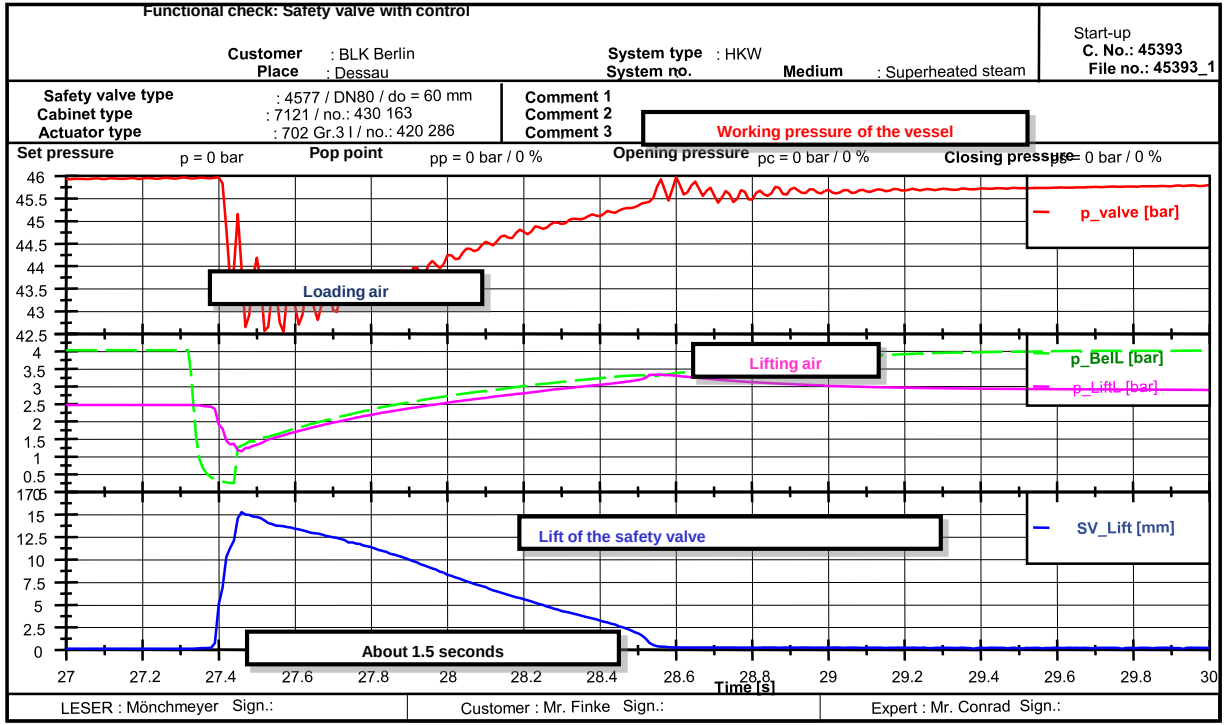


Time/pressure behaviour. Closing the safety valve.

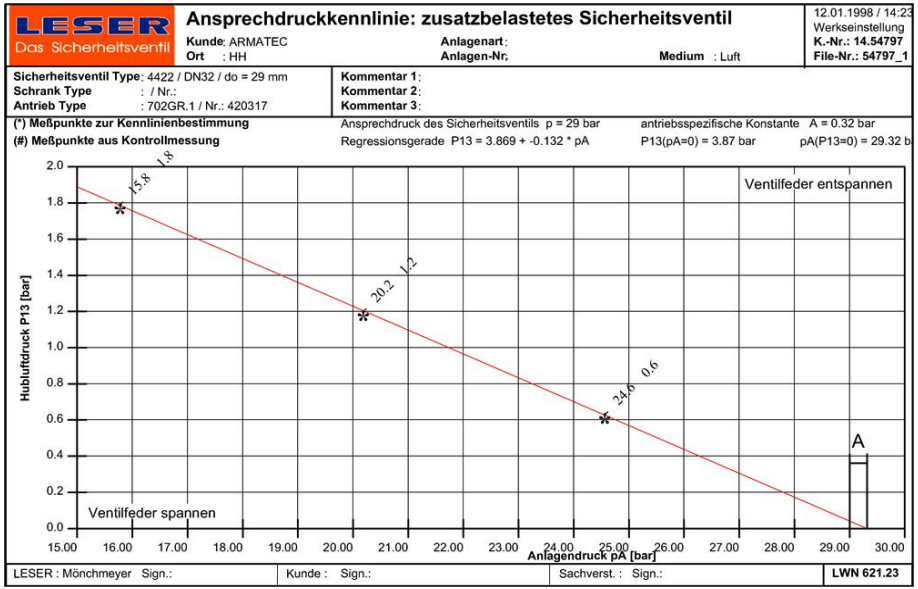
If the system pressure drops below the set pressure after the pressure release, then the loading air is switched on again. As a result, the safety valve closes rapidly. It is again completely closed if the pressure drops below the set pressure by -3%.



Time/pressure behaviour. Closing the safety valve.



Valve setting characteristic curve.



- Checking/adjusting the setting of the controlled SV in ongoing system operation without raising the system pressure up to activation of the SV
- Procedure recommended by TÜV for checking the set pressure

Valve setting characteristic curve.

- Determination of the lifting air associated with the current system pressure (intersection of the pressure lifting air/system pressure coordinates)
- Increasing the compressed air using pressure regulator DR13 until the safety valve activates.

Correct setting of the SV

If the measured point of intersection of the lifting air pressure and actual system pressure is on the characteristic curve, then the SV setting is correct

Determination of deviations

Respective correction of the spring setting of the SV

- Intersection above the line: valve spring to be loosened
- Intersection below line: valve spring to be tightened

Key features. Standard combinations and areas of application.

LESER supplies the type 702 actuator. This actuator can be used for the following LESER safety valves

Series 458

Series 526

Type 441 XXL
Type 442 XXL

Actuator type 702 is available in

- 3 actuator sizes
- 5 connector sizes of the LESER safety valves

Variations in control devices.

The control unit is **available in two technically different types**:

- **Type 712**: with pneumatic pressure switch
- **Type 714**: with electronic-pneumatic pressure switch

The two control units differ by the components integrated in the control cabinet. Control unit **Type 712** operates with **pneumatic pressure switches** and **Type 714** with **electronic pressure switches**.

The advantages of Type 714 are:

- greater resistance to system-related vibrations, and pulsations in the system
- greater maximum distance between the control unit and controlled safety valve (> 300 m for Type 714 compared to max. 30 m for Type 712).
- Additional system monitoring is possible with the assistance of a free contact relay in the electronic pressure switch.

Please note that **Type 714 must not be installed in explosion protected areas.**

Variations in control devices.

Types 712 and 714 are each available in two functional designs:

- Types 7121 and 7141 **with discharge of the loading air** during the functional check of the control unit

Discharge of the loading air during a functional check means that the controlled safety valve cannot have any supplementary loading in that time. During the testing time period, the characteristics of the spring-loaded safety valve apply.

- Types 7122 and 7142 **without discharge of the loading air** during the functional check

During execution without discharge of the loading air, the supplementary loading is maintained during the functional check. This uninterrupted supplementary loading may be necessary, for example, if unintentional release of the medium (e.g. expensive or toxic media) or an interruption of the system (e.g. combined with the risk of the paper web tearing) must be avoided at all costs when testing at operating pressures that are close to the set pressure.

Requirements on the system side.

- Three pressure tapping points on the system to be protected
- Installation of the pressure tapping lines in combination with a water supply to protect the control unit from medium temperatures in excess of +60°C
- Pressure tapping lines to be protected from undue effects of temperature (heating or cooling).
- Supply air must be clean and free from water and oil (instrument air).
- Min. internal diameter of control lines: 15 mm

Valve prerequisites.

- The necessary supply air pressure of min. 4 bar and max. 10 bar.
- The pneumatic control unit that is connected to the actuator must have a minimum internal diameter of 15 mm (bore).
- Regular annual field testing of the safety valves and their control unit
- Threaded spindle (standard for types 455-458)
- Adjusting screw with 4 point head
- Bonnet with fastening thread for the actuator

Pneumatic Supplementary Loading System

Thank you for your attention.