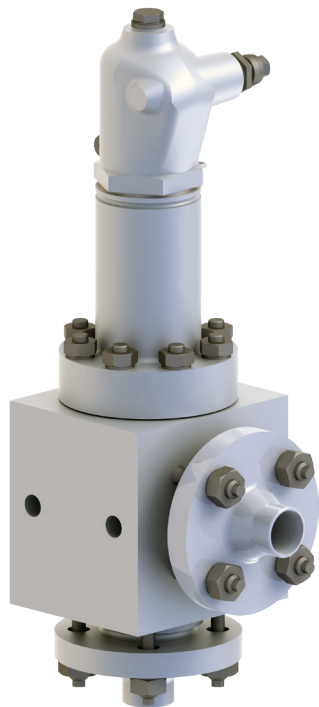




SEMPPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

Spring-loaded safety relief valves (PSE) with proportional opening characteristic



FEATURES

- Forged block-body design or casted body.
- Lift is proportional to the pressure increase.
- Prevention of shattering for liquid (incompressible) media.
- Functional qualification proven within extensive test program.
- Self-aligning spring assembly.
- Bellow sealed design available.
- Valves can also be equipped with a qualified supplementary loading device (solenoid).
- References in many nuclear power plants of different reactor designs with excellent operational feedback.

GENERAL APPLICATION

PSE spring-loaded safety relief valves are used specifically in liquid applications where a proportional characteristic is required. Above set pressure, these valves open steadily with increasing pressure ensuring only necessary capacity is relieved during opening. The design was developed for safety valves especially in degasser / condenser piping and is the preferred solution for liquid (incompressible) media in order to avoid shattering caused by Pipe Dynamics and pressure reflexions.

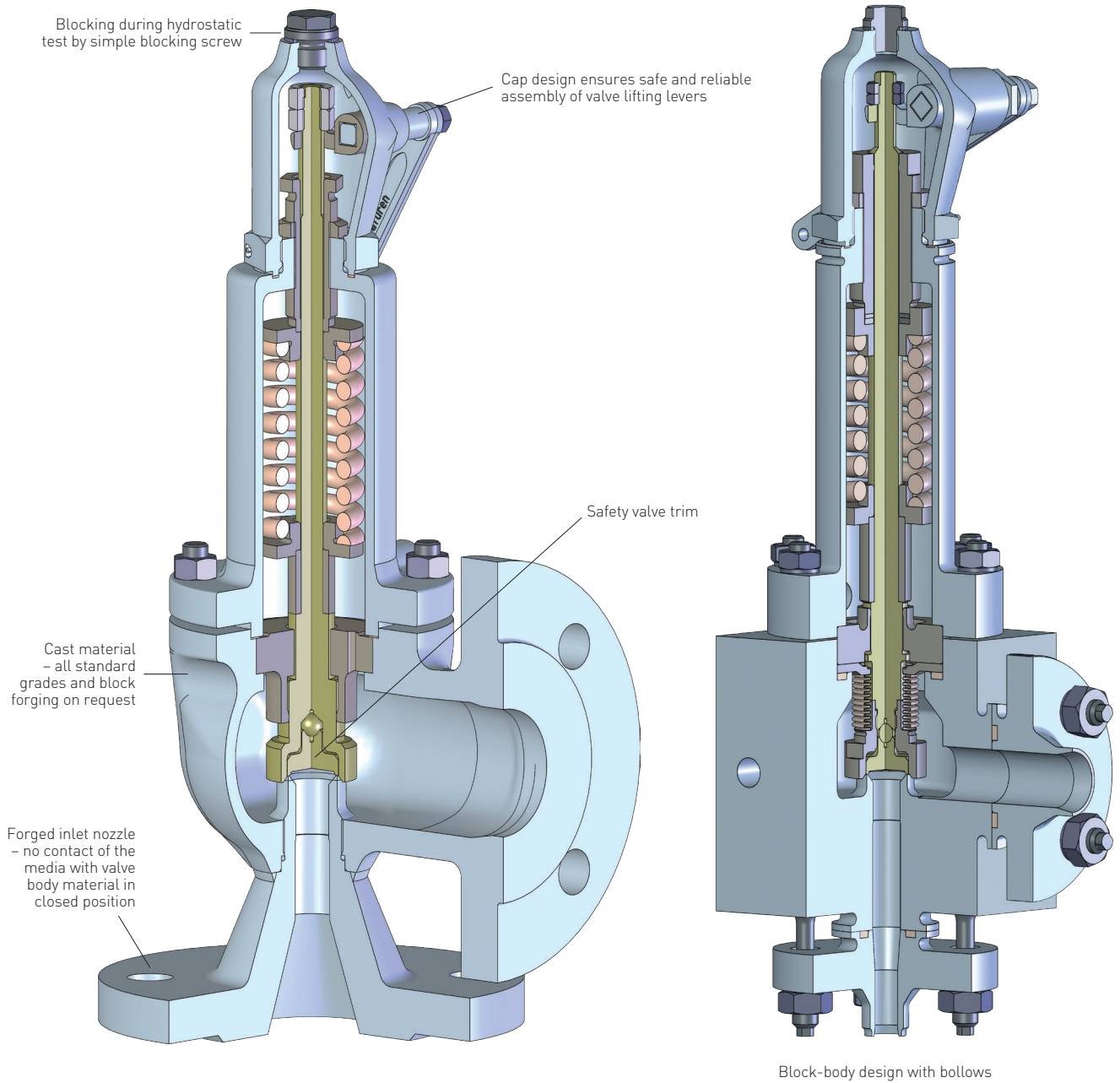
TECHNICAL DATA

Size:	DN 25 to DN 150 NPS 1 to 6
Pressure:	Up to PN 420 Up to Class 2500
Material:	Stainless steel or carbon steel
Qualification:	VdTUV type tested
References:	Germany, Sweden, Finland, Bulgaria, Czech Republic, Hungary, Slovakia, Russia, Ukraine

SEPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

FIGURE 1



SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

SEMPELL SAFETY VALVES

Sempell valves are currently used in hundreds of chemical plants as well as in conventional power plants and in over 80 nuclear power plants.

Great importance is given to the development of safety valves at Sempell. To a large degree, this pioneering effort has been focused on meeting technical challenges and market demands. The result has been the development of safety valves which satisfy the safety regulations for nuclear power plants with large capacity as well as small modular reactors (SMR). Sempell supported the introduction of type-testing for safety valves in order to establish generally binding standards for quality, performance and safe operation. The development of modern safety valves has been Sempell's contribution in increasing the safety of nuclear power plants.

DEFINITION OF OPENING CHARACTERISTIC

A full-lift safety valve is a valve which, after reaching the set pressure (start of lift) and within a 5% overpressure rise, opens in pop action up to the full lift as limited by the design. The amount of lift up to the sudden opening (proportional range) must not exceed 20% of the total lift.

In contrast, a proportional safety valve is a valve which opens steadily in relation to the increase in pressure. No sudden opening occurs unless the overpressure exceeds 10%. After reaching the set pressure (start of lift) within an overpressure of up to 10%, these safety valves achieve the lift necessary for the mass flow to be diverted.

PROPORTIONAL SAFETY VALVES

Proportional safety valves open after the set pressure p is exceeded, until a state of equilibrium is achieved between the flow force and the spring force. The resultant lift is proportional to the pressure. The proportional safety valve functions as a regulator.

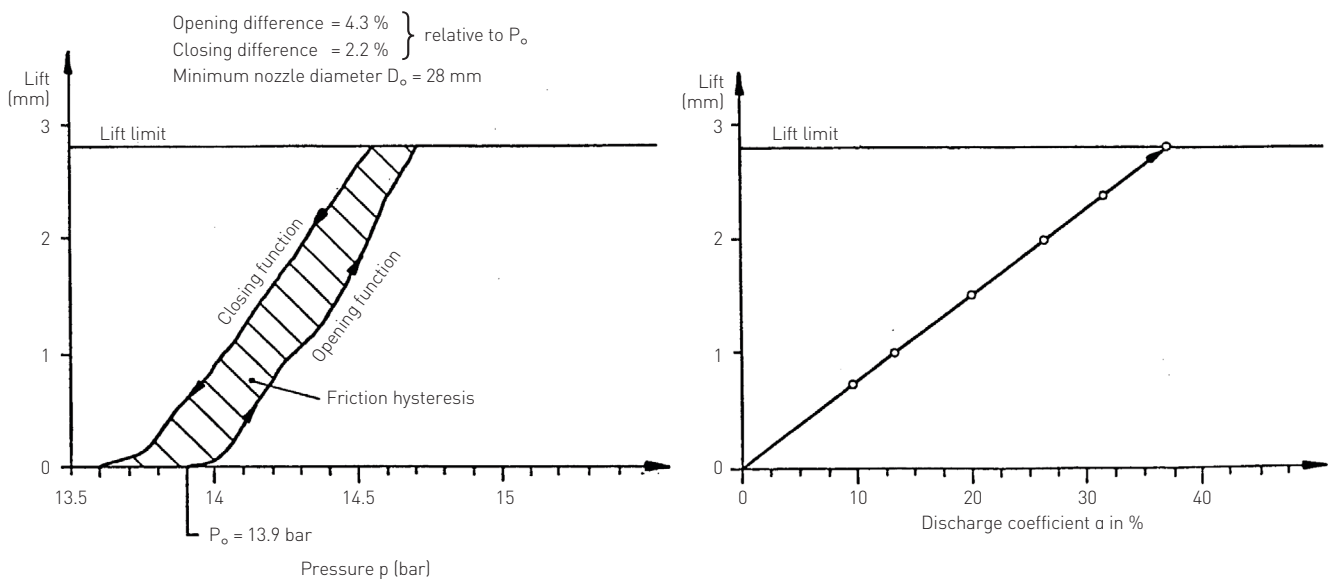
The proportional opening of a safety valve is a significant advantage with liquids, since the discharge mass flow is constantly and slowly changing.

The aim of the development work at Sempell was to design a genuine true proportional safety valve for incompressible media which had a reasonable ow discharge coefficient. The Sempell PSE proportional safety valve is the result of many years of extensive development work involving our in-house computer and laboratory tests.

With a discharge coefficient of $ow = 0.30$, a valve design was developed for the protection of piping systems with liquid operational media. The proportional safety valve is a proven design and exhibits excellent partial-load behavior.

Figure 2 shows the functional characteristics of a proportional safety valve with $D_o = 28$ mm with operation media water. The opening and closing functions were measured on a test rig.

FIGURE 2



SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

Figure 3 shows a testing set-up used to check the behavior of a proportional safety valve in water with and without air accumulation at the valve inlet. It was possible to simulate an enclosed, compressible medium with the stand- and fall pipe. In addition to pressures p_0 to p_2 , it was also possible to measure and record the discharge mass flow by measuring the differential pressure p_3 .

The results shown (Figure 4) are reflecting a test conducted with water. When the fast-acting safety valve opens suddenly, a short-term pressure peak is caused, followed by a pressure drop down to the opening pressure p_2 .

After closing of the fast-acting safety valve, the pressure drops and equalizes. The lift is following the pressure curve without oscillation. Thus, the partial lift adjusts to the discharge mass flow.

It was confirmed by tests that the proportional safety valve does not chatter if compressible medium [air] is enclosed in the inlet-line. It is difficult to adjust a valve for both media conditions – gas and liquid. With the PSE proportional safety valve, we are able to prevent the valve chattering, even when relieving compressible enclosed media. The functional behavior stabilizes in a few splits of a second.

FIGURE 3

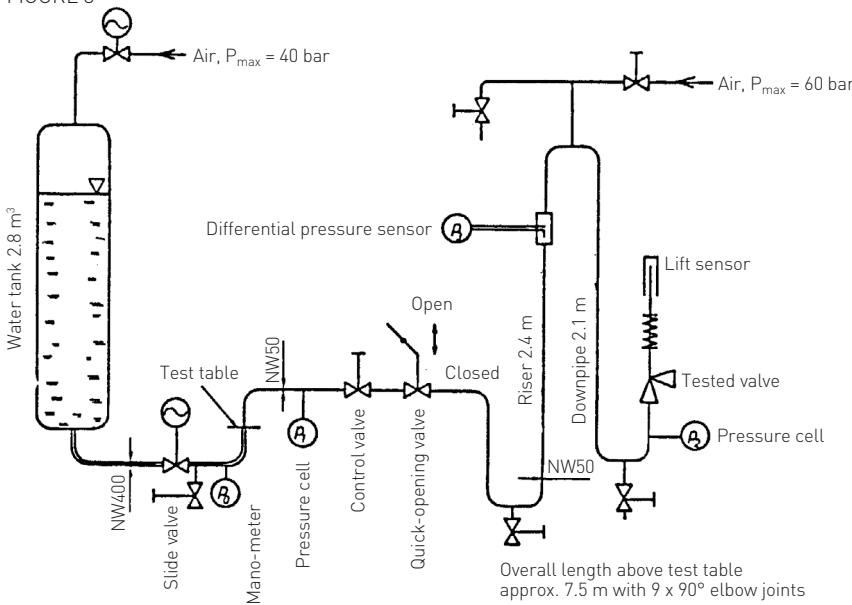
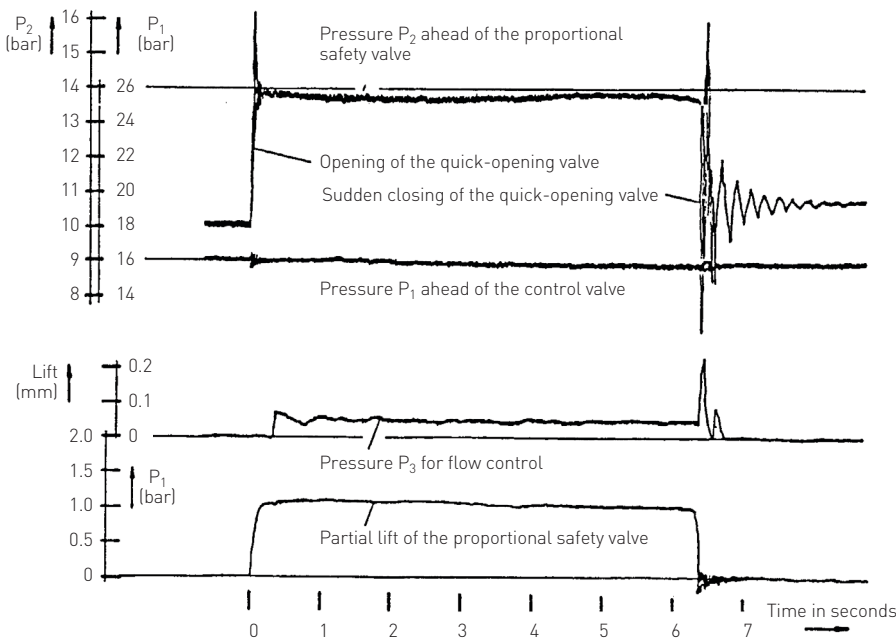


FIGURE 4



SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

Figure 5 shows a functional test on a PSE proportional safety valve using water with an air accumulation at the valve inlet. In the first relief phase a damped oscillation can be observed here during the air discharge. This is followed by a brief period of oscillation during the discharge of the water-air mixture. As soon as the water is discharged, the function of the valve immediately stabilizes.

Figure 6 shows the same test set up for water with air accumulation at the valve inlet for a standard full-lift safety valve. While air is discharged, the valve operates normally; the damped oscillations are caused by the lack of discharge mass flow or by excessive pressure in the supply line. During the water phase, however, severe chattering of the valve occurs immediately.

The two functional diagrams show that PSE proportional safety valves are suitable for protecting a vessel and pipeline system for liquids if the influence of compressible media in the supply lines must be considered. This is a common challenge, for example, in auxiliary circuits piping within nuclear plant. Vessel systems for liquid media can be protected by Sempell proportional safety valves as well. An appropriate discharge is ensured with a partial lift in transients requiring a small mass flow. However, large mass flows are also under control, for example in case larger isolation valve is inadvertently opened. We also recommend our dynamic dampener design to be considered for applications of safety valves with liquid operational media at which functional stability is a major concern. Please contact us for additional information on the range of dampeners if required.

FIGURE 5

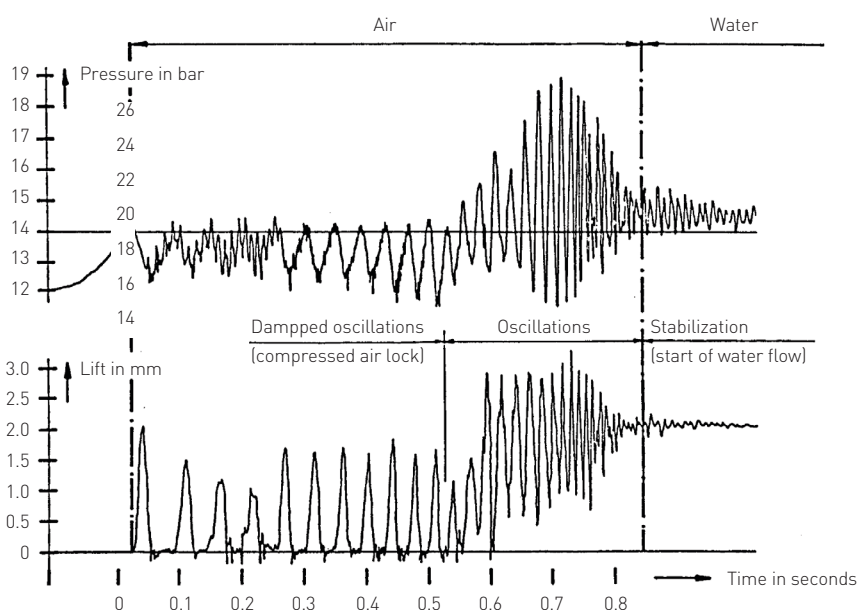
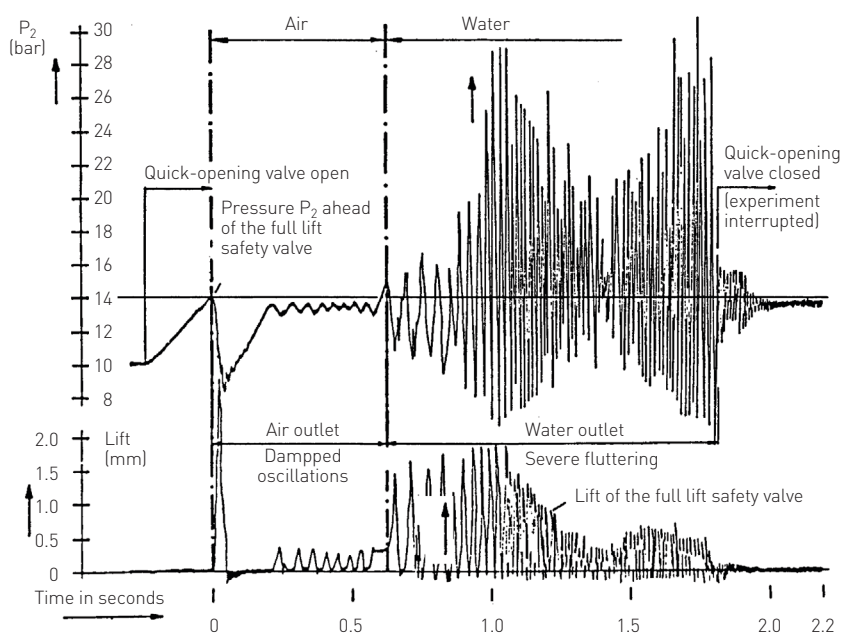


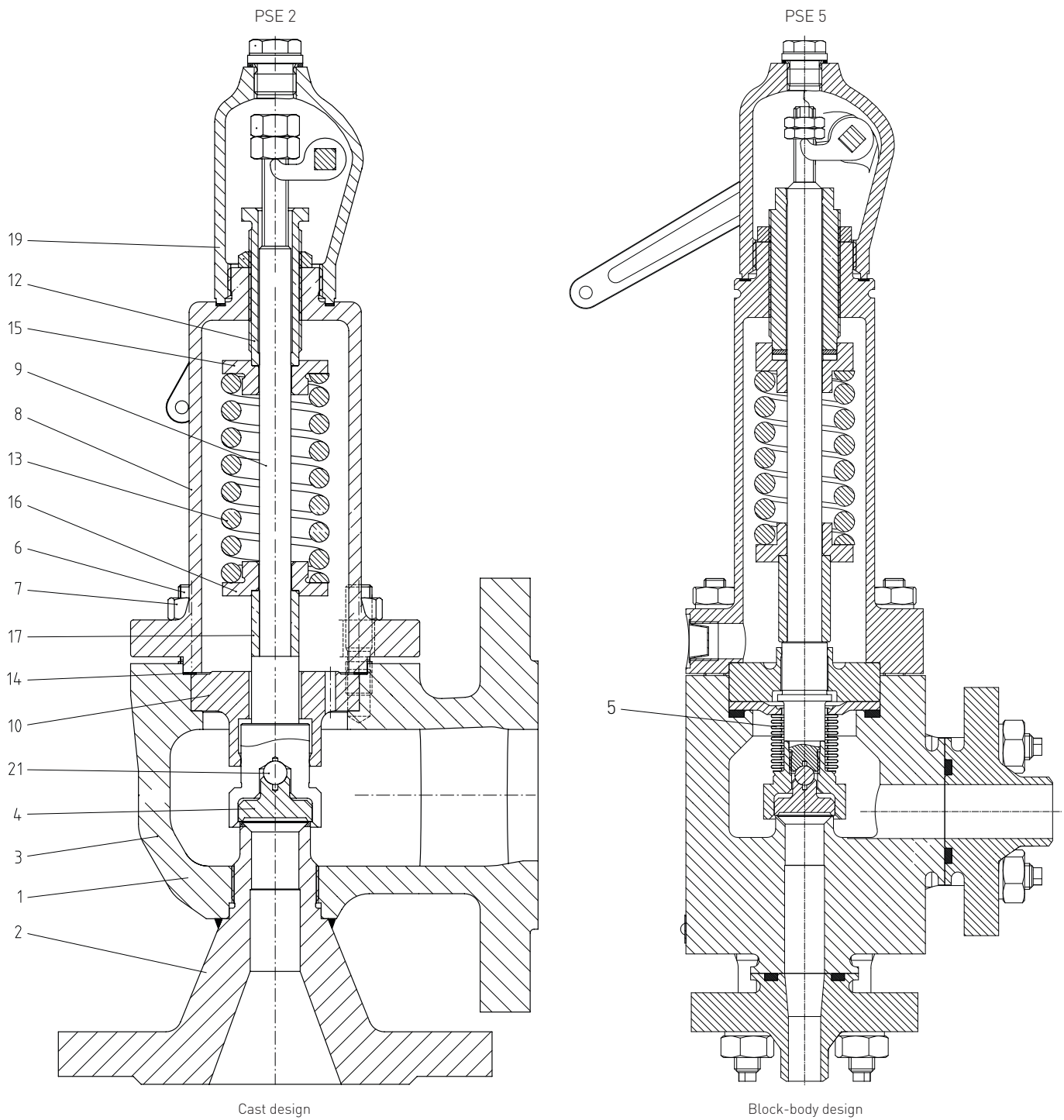
FIGURE 6



SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

FIGURE 7



SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

MATERIAL SPECIFICATION PSE 2

PARTS LIST

Temperature range		-10 to 400°C	-10 to 400°C	-100 to 300°C
Part	Name	22	29	26
1	Body complete	div.	div.	div.
2	Inlet nozzle	1.0460	1.0460	1.4301
3	Upper body	1.0619	1.0619	1.4308
4	Disc	1.4122	1.4122	1.4980
6	Stud bolt	1.1181	1.1181	1.4301
7	Hexagonal nut	1.1181	1.1181	1.4301
8	Spring bonnet	1.0619	1.0619	1.4301
9	Spindle	1.4021	1.4021	1.4580
10	Cover	1.4122	1.4122	1.4301
12	Adjusting screw	1.4021	1.4021	1.4021
13	Spring	1.8159	1.8159	1.8158
14	Gasket	graphite	graphite	graphite
15	Spring plate	1.4021	1.4021	1.4301
16	Spring plate	1.4021	1.4021	1.4301
19	Cap complete	div.	div.	div.
21	Ball	1.3541	1.3541	2.4819

MATERIAL SPECIFICATION PSE 5

PARTS LIST

Temperature range		-10 to 400°C	-10 to 400°C	-100 to 300°C
Part	Name	52	59	56
1	Body complete	1.4541	1.4541	1.4541
2	Inlet nozzle	1.0460	1.0460	1.4301
3	Upper body	1.0619	1.0619	1.4308
4	Disc	1.4122	1.4122	1.4980
5	Balanced bellows	1.4571	1.4571	1.4571
6	Stud bolt	1.7709	1.7709	1.7709
7	Hexagonal nut	1.7218	1.7218	1.7218
8	Spring bonnet	1.0460	1.0460	1.4301
9	Spindle	1.4021	1.4021	1.4580
10	Cover	1.4122	1.4122	1.4122
12	Adjusting screw	1.4021	1.4021	1.4021
13	Spring	1.8159	1.8159	1.8158
14	Gasket	graphite	graphite	graphite
15	Spring plate	1.4021	1.4021	1.4301
16	Spring plate	1.4021	1.4021	1.4021
17	Distance pipe	1.4021	1.4021	1.4021
19	Cap complete	div.	div.	div.
21	Ball	1.3541	1.3541	2.4819

SEPELL NUCLEAR SAFETY RELIEF VALVE MODEL PSE

FIGURE 8

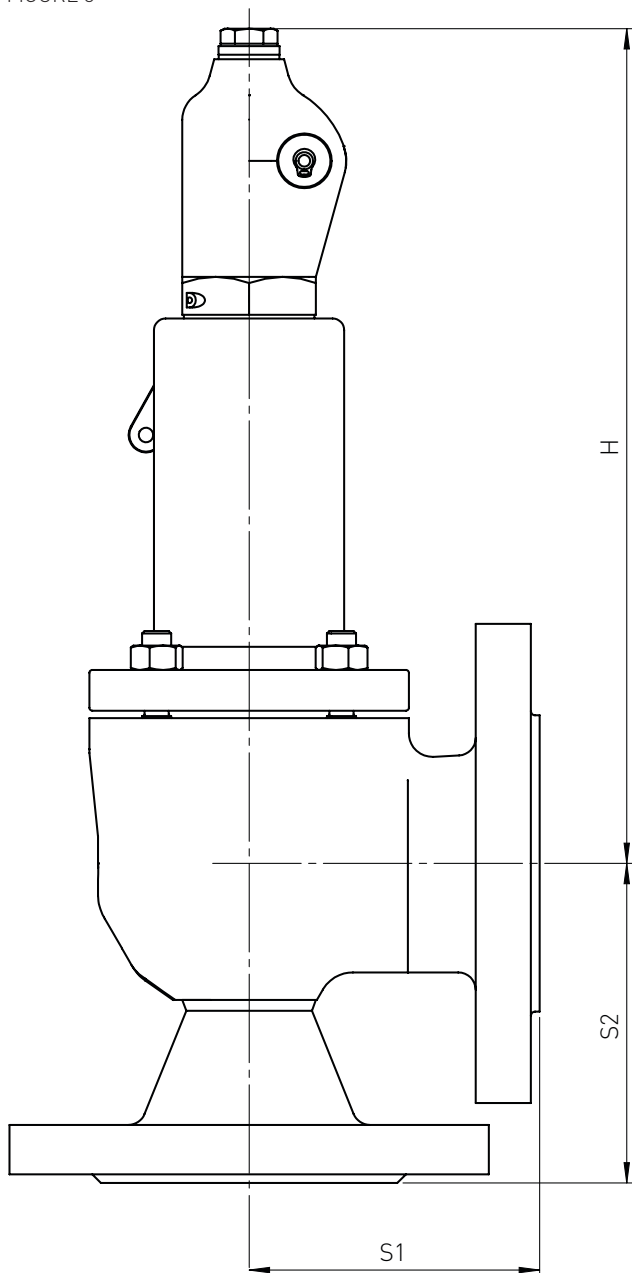
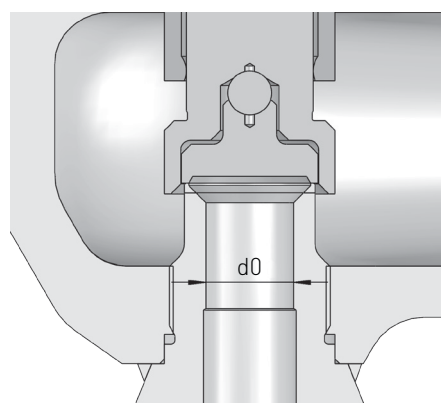


TABLE 1 - DIMENSIONS

SKB	d0	aw
A	13.0	
C	18.0	
E	24.5	
F	28.0	
G	33.0	
H	38.0	
J	44.0	
K	51.0	0.3
L	59.0	
M	69.0	
N	80.0	
P	93.0	
Q	107.0	
R	126.0	
T	175.0	

FIGURE 9



The seat identification SKB is assigned to a fixed smallest free cross-section under the disc, the d0 of the valve.

TABLE 2 - DIMENSIONS

Inlet DN	SKB	Outlet DN	d0 mm	aw	Opening pressure min. bar max. bar		Dimensions				H	Weight kg
							S1 Outlet flange		S2 Inlet flange			
							PN 40	PN 40	PN 64 - 160	PN 250 - 320		
15	A	15	13.0	0.3	1	250	95	90	95	100	290	8
15		25					95	90	95	100		
25		40					110	95	100	125		
25	C	25	18.0		1	125	95	95	100	125	340	25
25		40					110	95	100	125		
40	E	40	24.5		1	140	125	115	125	160	375	28
40		50		145			145	160	180			
50	G	50	33.0	1	100	145	145	160	180	500		
50		60				185	145	160	180			

SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

ACCESSORIES

A 153 Viscous damper

Vibrations of spring-loaded safety valves cannot always be removed by classical measures such as increase of the closing pressure difference or optimization of piping. This applies in particular to pipelines with liquids.

In recent years, several manufacturers developed damping facilities which act directly at the safety valves.

With the SN153 accessory, Sempell offers a type-tested viscous damper for the above-mentioned critical endangered by vibration e.g. due to pressure loss at the inlet, back pressure, oversized safety valve or installation behind a control.

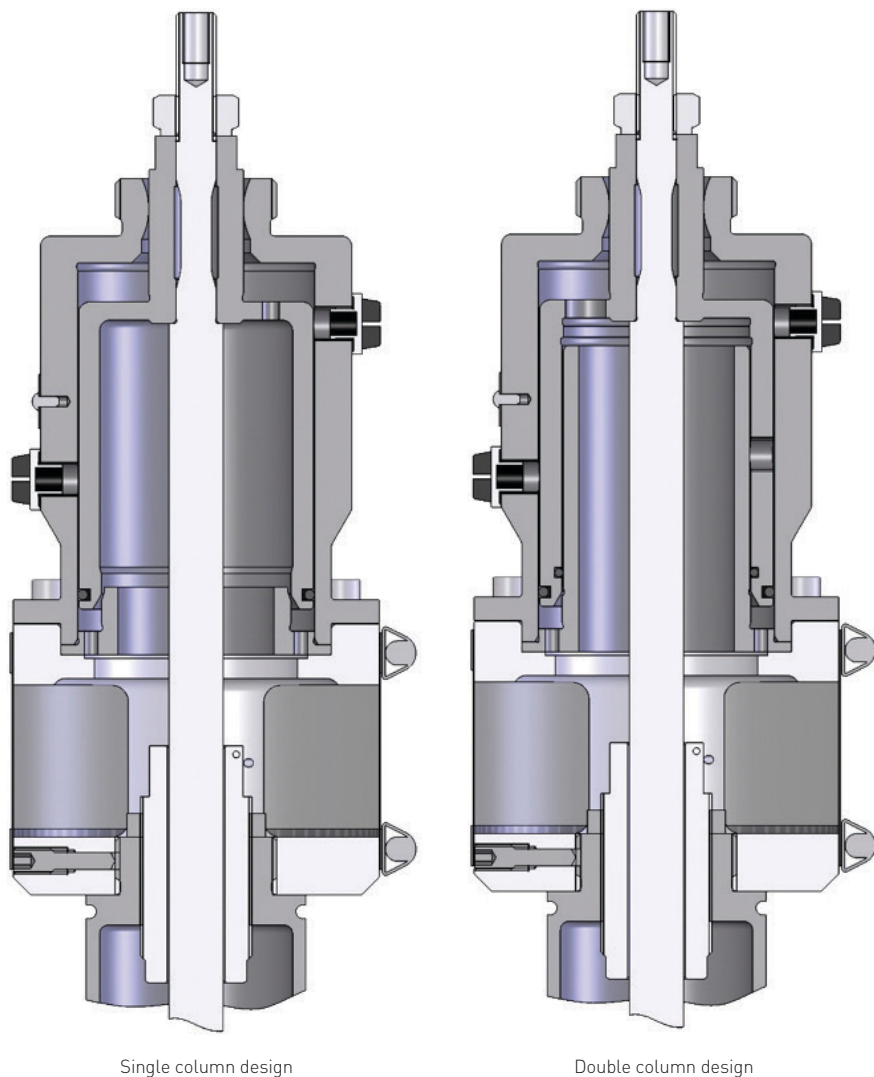
The damper is wear-free. By wetting the active surfaces with the viscous medium, all functional surfaces are simultaneously protected against corrosion. The viscous medium used by Sempell is resistant to temperatures from - 30°C to + 200°C.

TABLE 3 - A 153 SIZES AND DESIGNS

Piston ϕ in mm	A 153 size	Possible columns
50	05	single
70	07	single double
140	14	single double
180	18	single double
200	20	single double

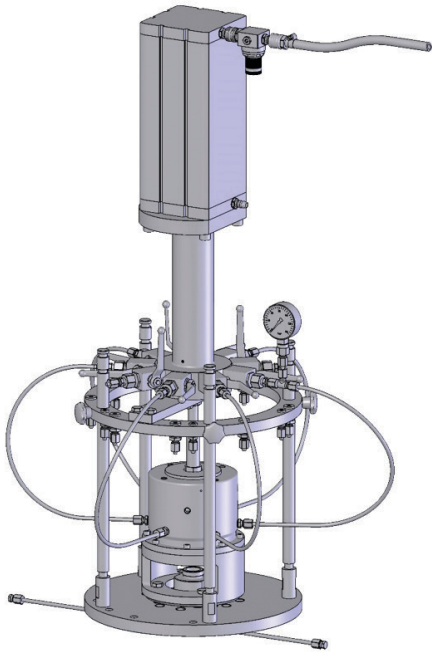
Sizing by our engineering-based request.

FIGURE 10



SEMPELL NUCLEAR SAFETY RELIEF VALVE MODEL PSE

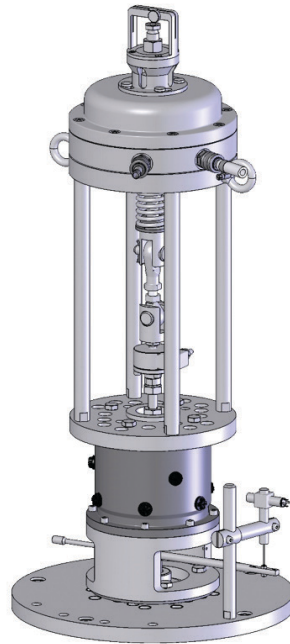
FIGURE 11



A154 Filling device

Proper filling of the damper is an essential condition for correct function. To obtain optimum filling, a filling device had been developed which is designed in such a manner that all damper sizes can be filled uniformly and free from air.

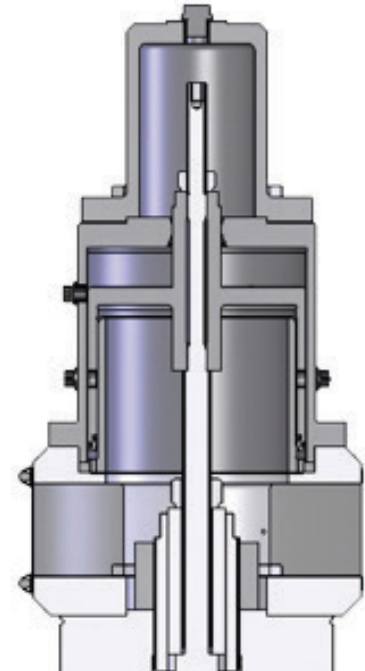
FIGURE 12



A155 Testing device

For measuring the damper, a testing device had been developed, thus ensuring a diagnostic of damper functionality. If during testing the damper has not reached required values, the damper must be disassembled, cleaned, refilled with viscous medium and re-assembled.

FIGURE 13

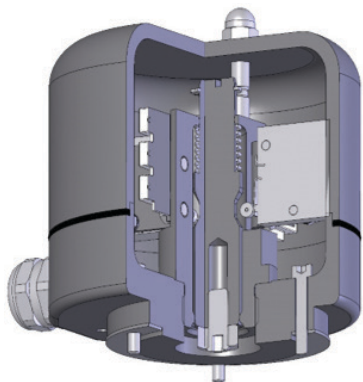


SN 102 Cap without lifting device

SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

FIGURE 14



SN112 electric position indicator
“closed-open”

Two switches for position indicator with two circuits each.

SPDT switch

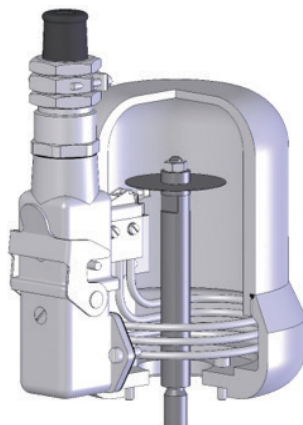
Voltage	Resistance
up to 74 V	= 1 A
up to 250 V	~ 1 A

Protection class: IP 40
 Operating temperature: -20 °C to 85 °C

SN 111 supplementary loading device

With the supplementary loading device the tightening forces are improved considerably. The additional supplementary seating force is supplied by a solenoid. This seating force is released by switching one of three pressure switches, when the set pressure is approached. The supplementary loading device is recommended, when the distance between set pressure and working pressure is less than 10 percent of the set pressure. With the solenoid deenergized there is no mechanical connection between the spindle of the safety valve and the solenoid anker. This design ensures that in case of loss of power supply the safety valve acts like a purely spring loaded valve. Control systems are available on request. The supplementary loading equals in the standard design 20 percent of the force arising from the set pressure and the sealing surface of the safety valve. The value might be adapted to customer specification.

FIGURE 15



SN107X special position indicator

Qualified for safety related applications in nuclear power plants. Use in environment subjected to radiations and under thermodynamic accident conditions (LOCA).

SPDT switch

Voltage	Resistance
24-48 V	= 3 mA-2A
137 V	= 0.5 A
250 V	~ 2 A

Operating temperature: +5°C to +140°C
 Radiations
 (integrated dose): 1000 kGy (100 Mrad)
 Accident conditions: +185°C - 5 min /
 5.2 bars abs.

Solenoid voltage:	110 V = 220 V = 220 V ~
Working time:	100%
Protection:	IP55
Max. ambient temp.:	+90°C

FIGURE 16



SEMPELL NUCLEAR SAFETY RELIEF VALVE

MODEL PSE

SELECTION GUIDE

Example:	PSE 5	40	25	C	50	52	102
Valve type							
PSE 2							
PSE 5							
PN inlet							
PN 40	PN 160						
PN 64	PN 250						
PN 100	PN 320						
DN inlet							
DN 15	DN 40						
DN 25	DN 50						
Seat size SKB							
A	E						
C	G						
DN outlet							
DN 15	DN 40						
DN 25	DN 50						
Material code							
22	52						
26	56						
29	59						
Accessories							
A153	SN107X						
A154	SN111						
A155	SN112						
SN102							

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