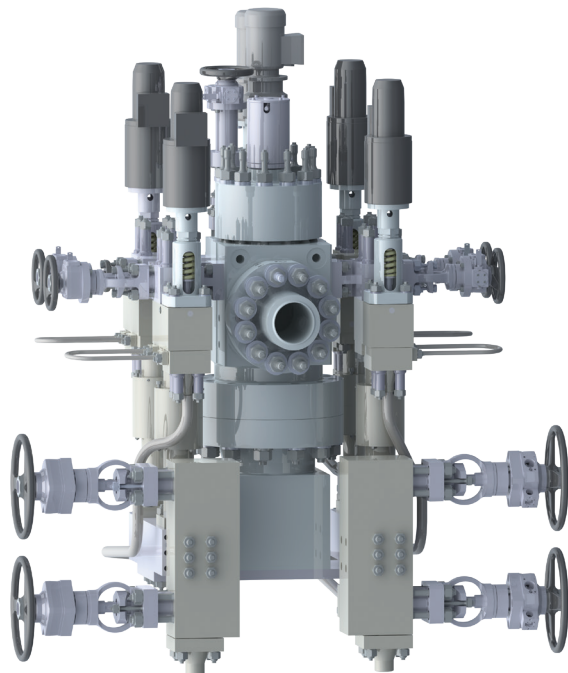


SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

The design, construction and activation of the safety valves depends on the design of the respective reactor and the corresponding specifications



FEATURES

- Extremely high sealing force, ensuring leak tightness up to the set pressure.
- Very precise reproducibility of set pressure and small operating pressure differences, accuracy of pilot set pressure opening value with repeats better 1%.
- All parts essential for function are kept at operating temperature, thus no thermal shock.
- The disc piston is the only moving part in the main valve, providing reduced maintenance.
- Low or high pressure in-situ test during operation to preventive maintenance.
- Compact design from forged stainless steel.
- Redundancy of pilot valves and diversity of function principle of pilot valves according to specification.
- Suitable for all types of nuclear reactors.

GENERAL APPLICATION

Pressurizer safety relief valves protect the pressurizer from overpressure and must ensure the following functions:

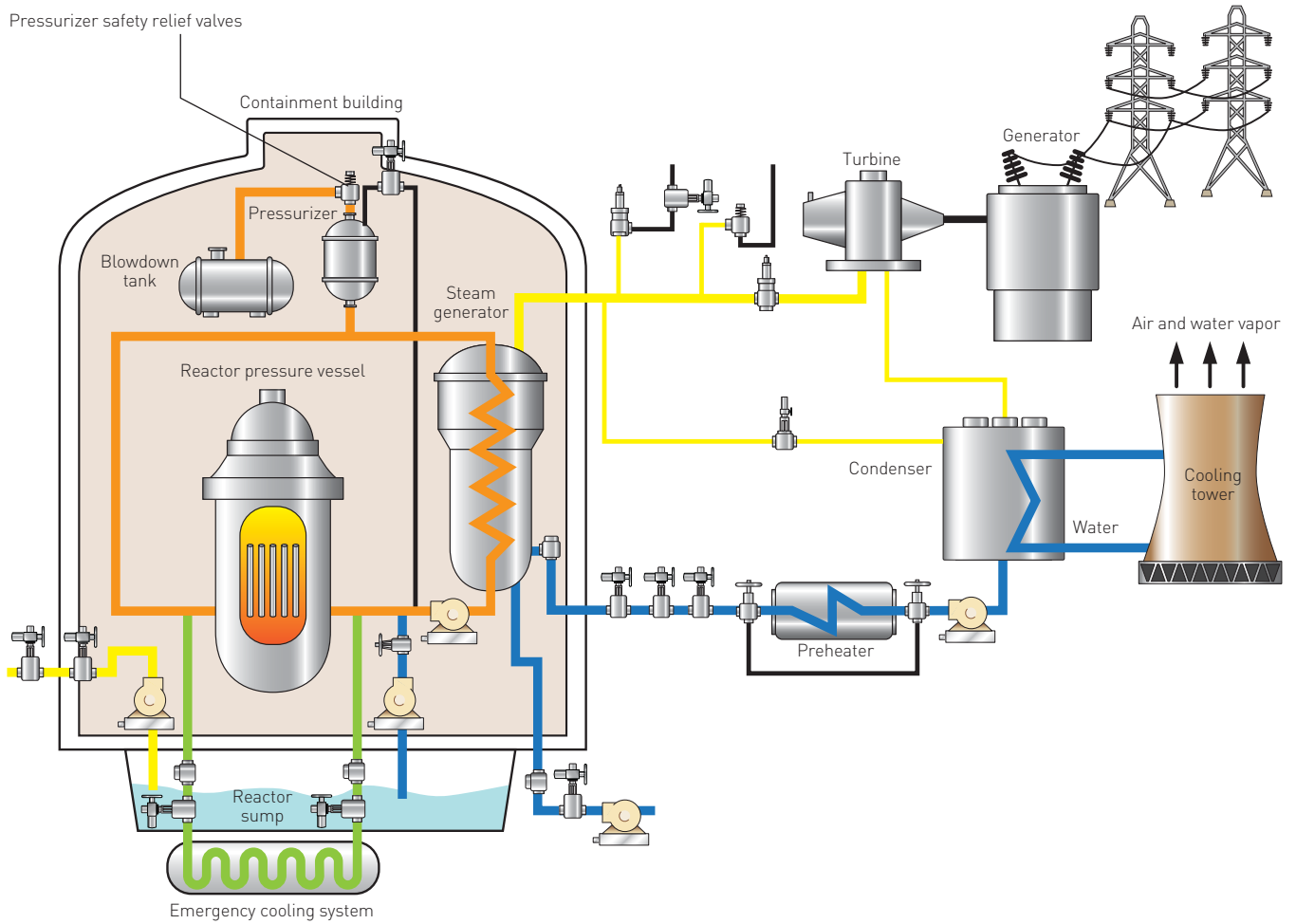
- Pressurizer relief for normal operating transients
- Hot and cold overpressure protection on liquid, steam, gas and steamwater-mixture
- Depressurization of reactor coolant system following an accident

TECHNICAL DATA

Size: Up to DN 200
 Temperature: Up to 371°C
 Pressure: Up to 200 bar
 According to customer requirements and specifications.

SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED



SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

INTRODUCTION

Pilot operated safety relief valves are used to protect the pressurizer against overpressure. In pressurized water reactors, the energy of the primary circuit is transferred to the secondary steam system by the steam generators. The pressurizer compensates for any expansion in the coolant volume occurring during operation and accidents. The design criterion for pressurizer safety valves is not the reactor power but the maximum possible volume expansion of the coolant in response to a temperature increase.

The valves' design takes into account the combination of failures which will produce the maximum possible pressure and temperature rise, leading to the maximum blowoff rates required. The VS99 is a pilot operated safety relief valve which operates to the relief principle. The operating pressure is applied to the valve disc. When the pressure increases, the sealing force on the valve seat rises.

The safety valve will follow the commands of the pilot valves: If the pilot valves open, the safety valve opens; if the pilot valves close, the safety valve closes.

Several pilot valves are assigned to each safety valve. Each pilot valve has a pressure relief line and a pilot line. Each pilot valve can be blocked for repair purposes. The corresponding stop valves are locked by valve locking devices according to the regulations, in such a way that each of the pressurizer safety relief valves is always kept ready for operation by at least one functioning pilot valve.

For the entire control system, i.e. for the main valve with the associated pilot valves, an earthquake-proof design with a compact arrangement is recommended. With such a design, pipelines as pilot lines are completely eliminated. Thus pressure chambers to be relieved are as small as possible. The dead times during discharge and loading are therefore small.

Sempell has a large installation base of pressurizer safety relief valves in all German Siemens/KWU reactors and in most of the Russian PWR reactors type VVER, as well as the GEN III reactors, such as the French EPR and the Korean APR1400.

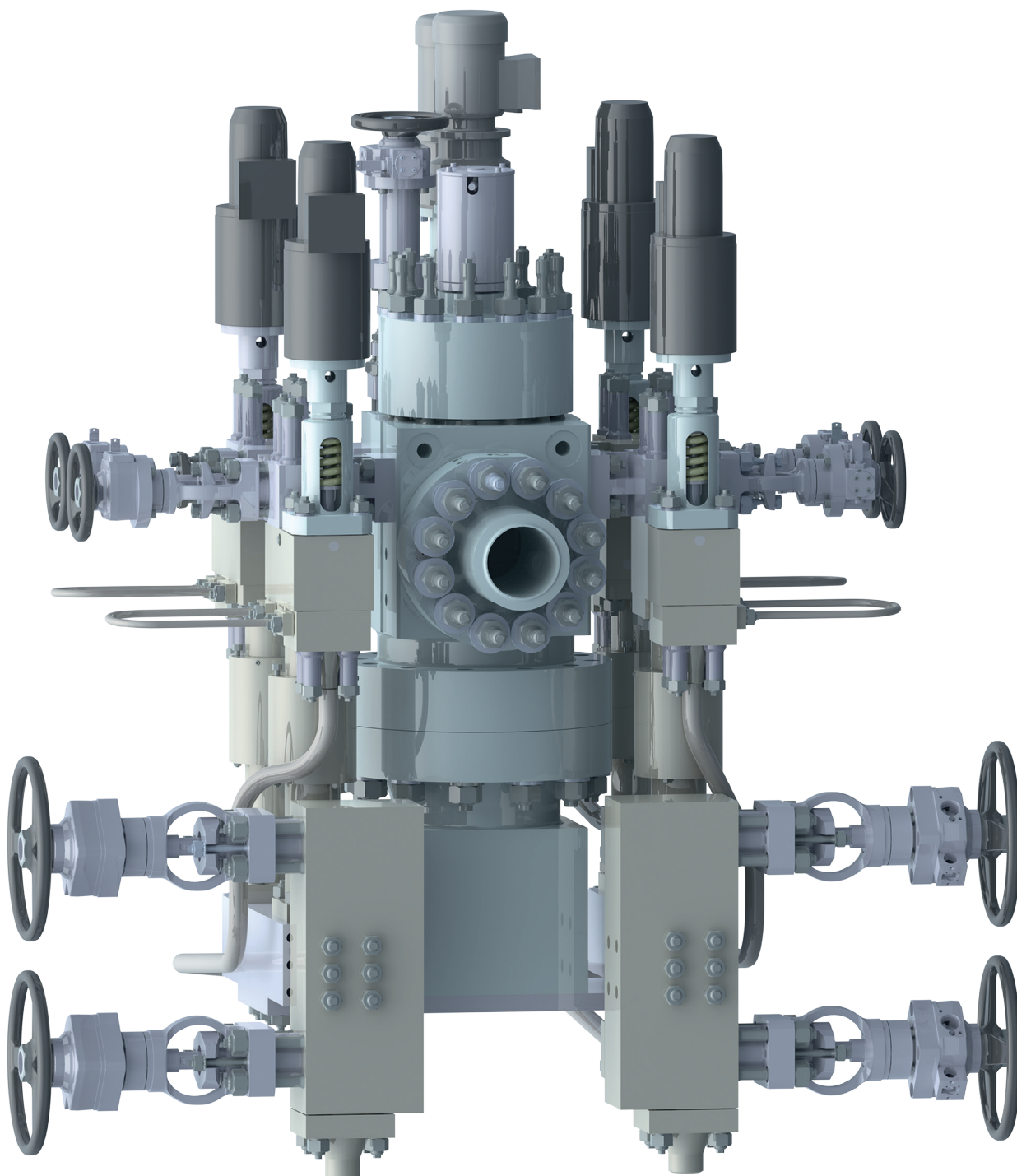
Over the years, comprehensive qualification programs for the different reactor types have been carried out. Sempell has the requisite quality assurance systems and is qualified in accordance with KTA and ASME III.

Based on this experience and the technological development, Sempell offers special solutions for the new GEN III reactors. The valves for the European EPR are delivered in accordance with RCC-M, the valves for the Russian PWR (type VVER) in accordance with NP-068-05 and the valves for the Korean APR1400 in accordance with ASME III (NV stamp).

HISTORY

1970	First delivery of pilot-operated safety valves to NPP Stade in Germany based on a conventional technology.
1980	Qualification under hot water conditions.
1985	ATWS qualification.
1990	First supply of PDE valves with Sieka actuator.
1992	First installation of degasification.
2003	ASME III qualification
2011	First delivery of pilot-operated safety valves with ASME NV stamp.

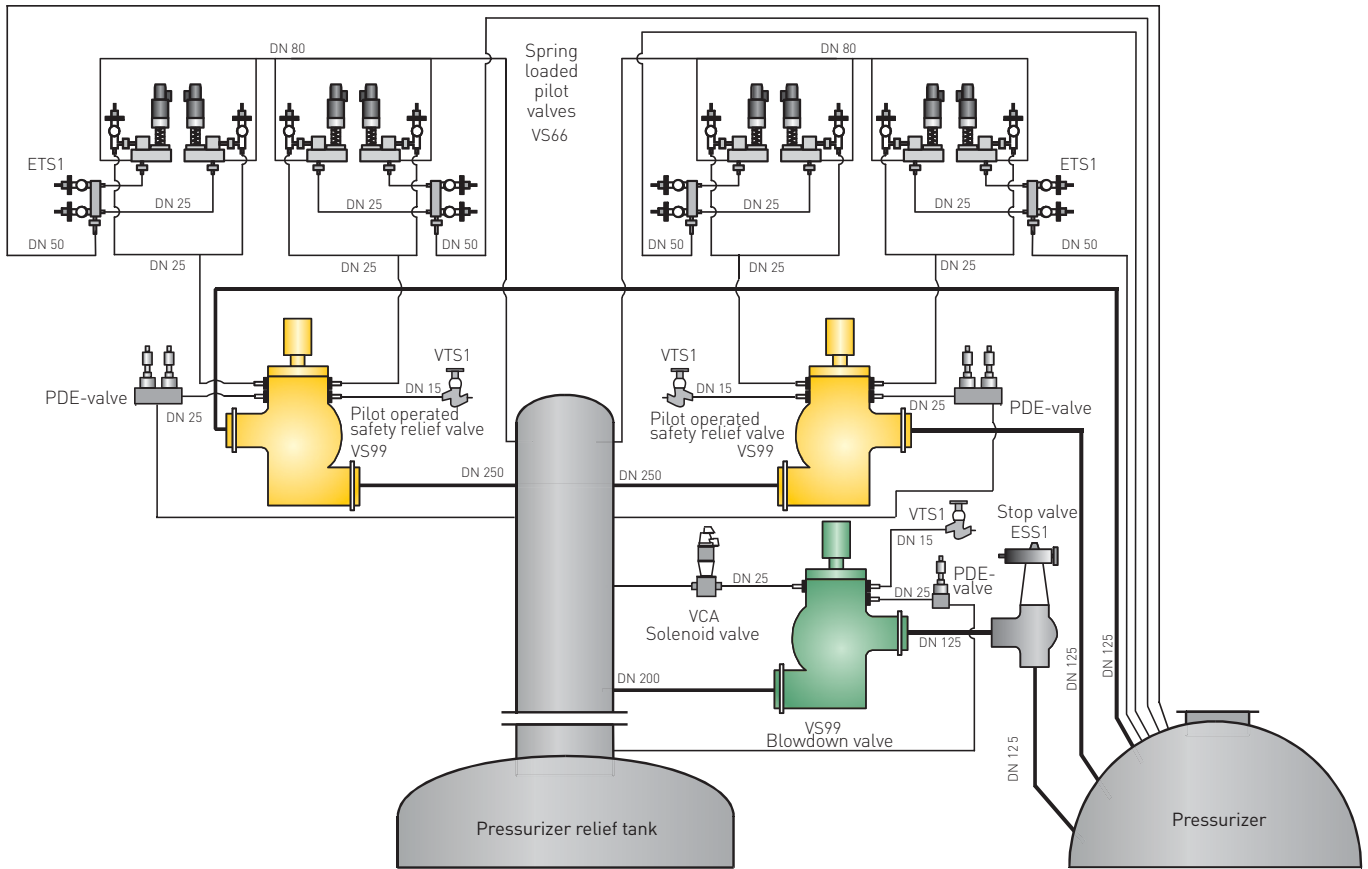
SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES
TYPE VS99 PILOT OPERATED



SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

THE GERMAN KWU-PWR SOLUTION



VALVE ASSEMBLY

At German pressurized water systems of the KWU, three main valves type VS99 are installed in the pressurizer system: two providing double redundancy plus one operational blow-down valve.

The VS99 safety valve

For optimized availability, four self-acting spring-loaded pilot valves type VS66 were mounted redundantly to each main valve: two are in service, two rest in standby. These spring-loaded pilot valves operate autonomously; no external energy is needed to open them. Each pilot valve, as needed, can be blocked by a stop valve.

In the case of the emergency cooling, the system pressure must be reduced. This is accomplished with a pressure relief valve type PDE, which is electrically actuated and therefore can also be opened below the set pressure of the VS66. The process of the primary circuit pressure relief to ensure the emergency cooling supply is referred to as the "bleed and feed" process.

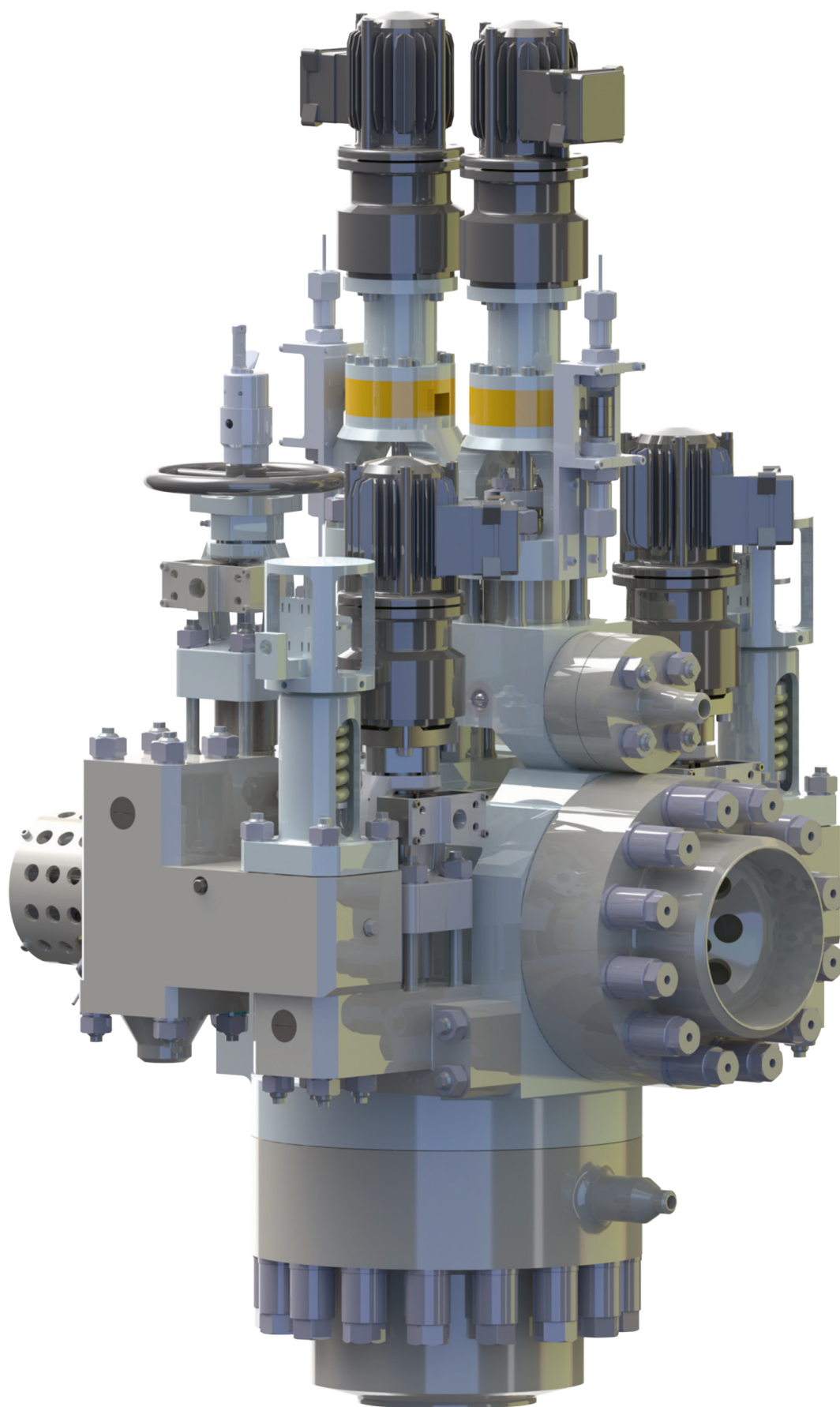
The VS99 blowdown valve

In addition to the pressurizer safety relief valves, a blowdown valve is arranged on the dome of the relief tank and connected with the steam chamber of the pressurizer by a blowdown line.

A stop valve is installed upstream of the blowdown valve. The construction of the blowdown valve corresponds to the construction of the pressurizer safety relief valve; nonetheless on the pressurizer blowdown valve, a solenoid valve is installed as pilot valve. In normal operation, the blowdown valve and the pilot valve are closed. When required, the pilot line is opened by the solenoid valve and opens the blowdown valve. The blowdown valve can also be actuated by the motor-driven bleed and feed valve.

2	VS99 safety valve
2 x 4	VS66 self-acting spring-loaded pilot valve with stop valve for the pilot line
2 x 2	ETS (doubled) stop valve
2 x 1	PDE (doubled) bleed and feed valve
2 x 1	VTS1 stop valve for pressure measurement
1	VS99 blowdown valve
1 x 1	VCA solenoid valve
1 x 1	PDE (single) bleed and feed valve
1 x 1	VTS1 stop valve for pressure measurement

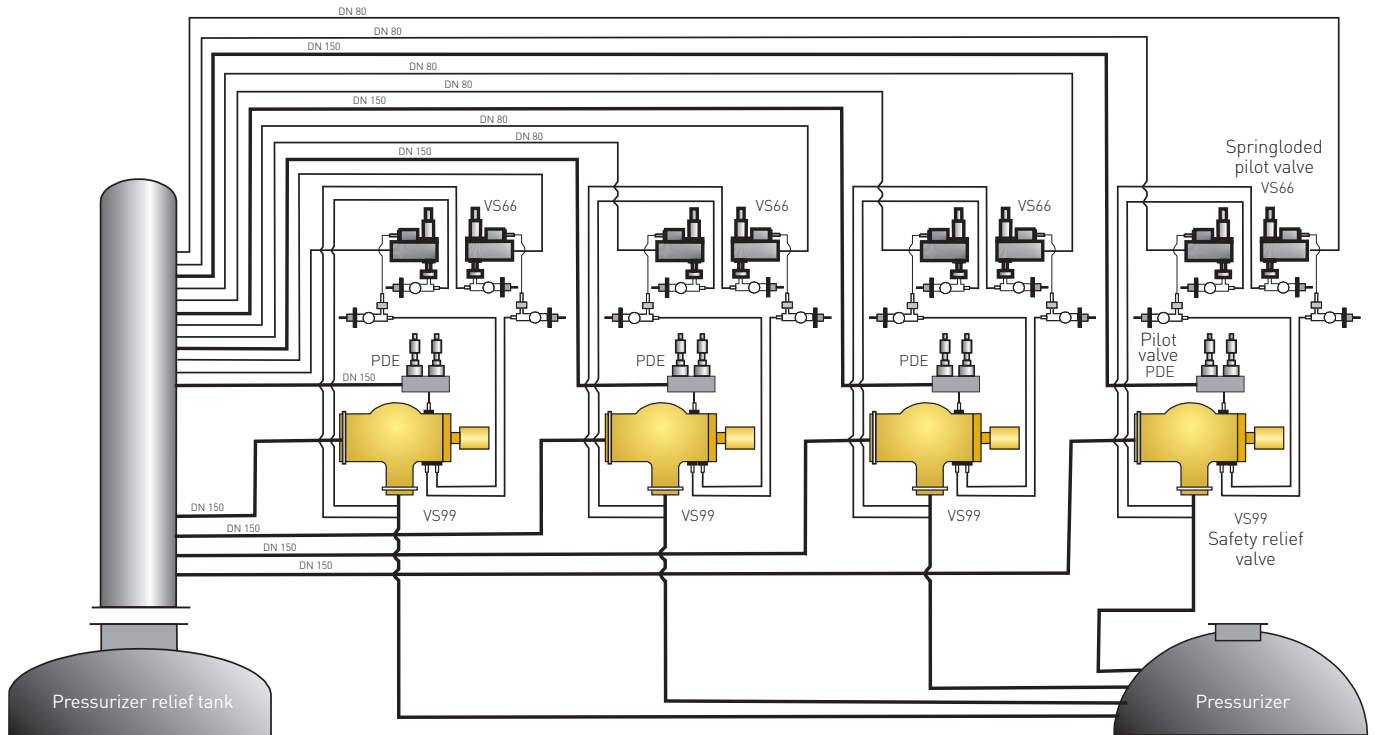
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES
TYPE VS99 PILOT OPERATED



SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

THE KOREAN APR1400 SOLUTION



VALVE ASSEMBLY

At the type APR 1400 reactors, four pressurizer safety relief valves type VS99 are mounted in a horizontal position directly on the pressurizer, to ensure a compact arrangement and optimized pipe conduction. Two proven self-acting spring-loaded pilot valves type VS66 per main valve are used for redundancy, whereby the impulse and pilot lines can be isolated by integrated stop valves.

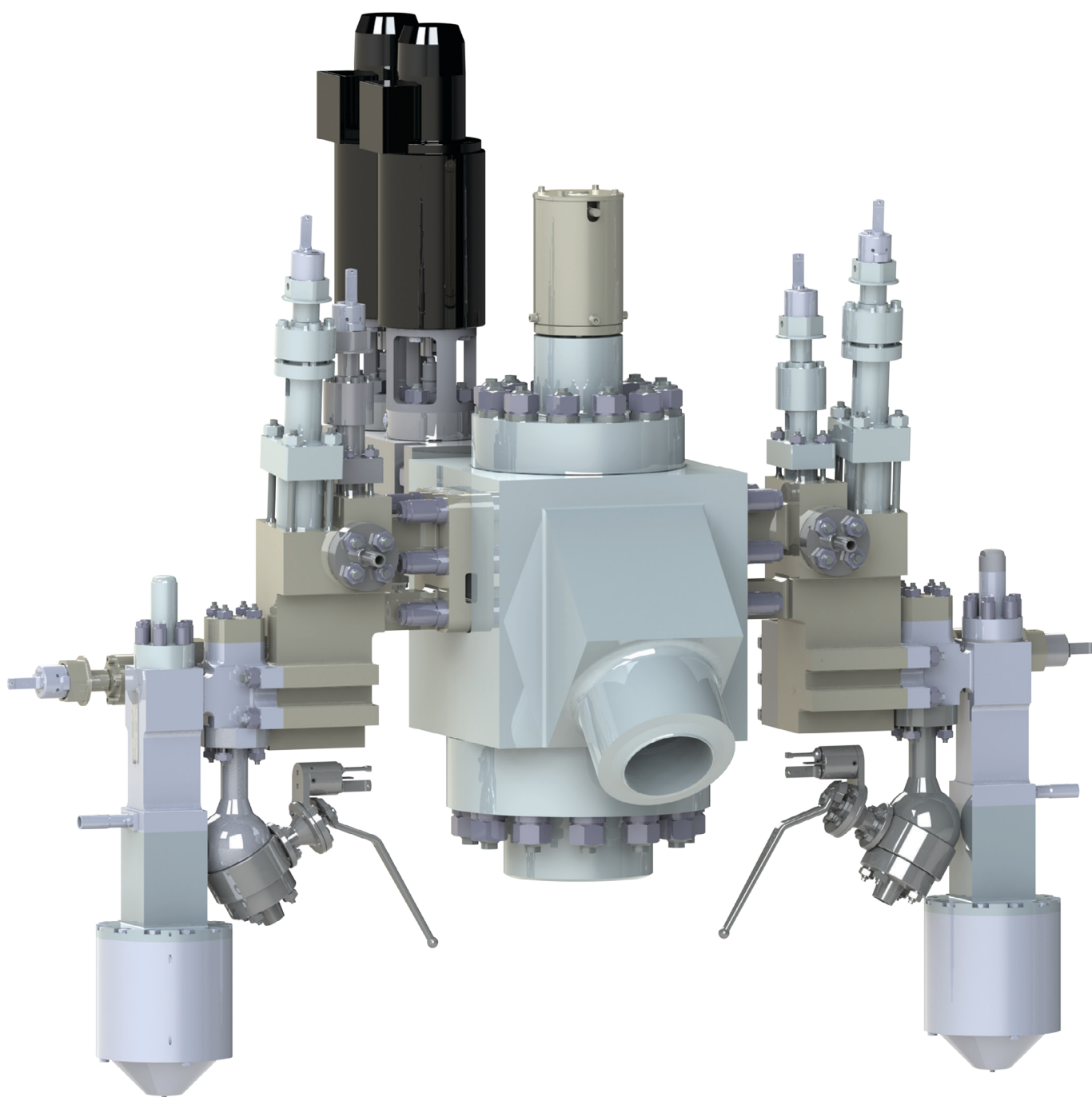
The steam pilot valves are connected to system pressure by independent feeding lines within the main valve inlet flange. No external lines are foreseen producing this compact design.

A double motor pilot valve type PDE serves as the so-called bleed and feed valve, to open the main valve under the set pressure of the VS66 pilot valve.

Comprehensive tests and qualifications for the horizontal position of the main valve have been successfully concluded. In December 2011, attended by the ANI (Authorized Nuclear Inspector), the design was granted the NV stamp. The valve station is qualified for steam, two-phase flow (water-steam) and supercooled water.

4	VS99 safety valve
4 x 2	VS66 self-acting spring-loaded pilot valve with stop valve for the pilot line
4 x 1	PDE (doubled) bleed and feed valve

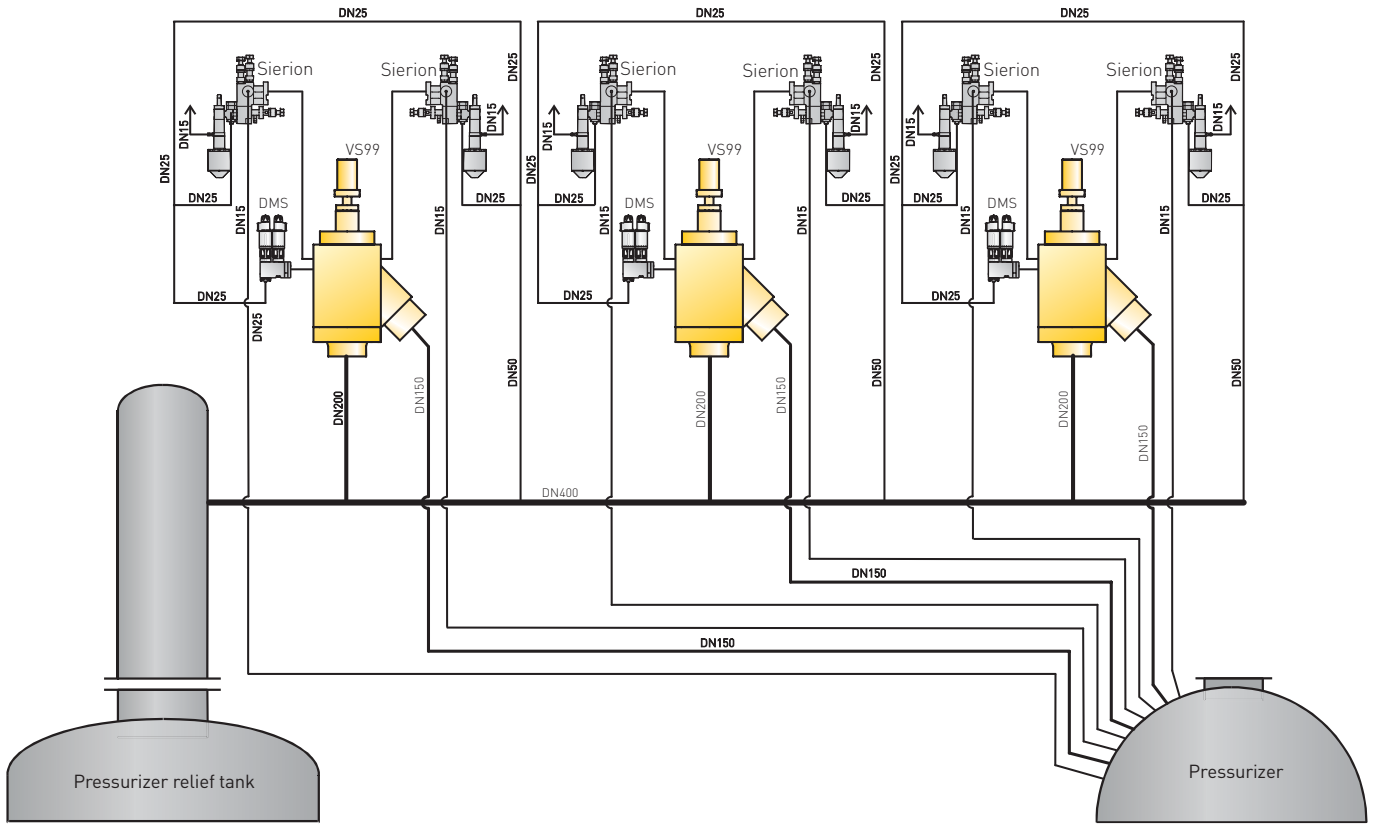
SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES
TYPE VS99 PILOT OPERATED



SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

THE EUROPEAN EPR SOLUTION



VALVE ASSEMBLY

At the reactor type EPR, three pressurizer safety relief valves type VS99 are mounted directly to the side of the pressurizer. The inlet is arranged at an angle of 45°. Therefore the valve is installed in a vertical position. A permanent water loop fills the main and pilot valves, so during blow down purely sub-cooled water will be relieved first.

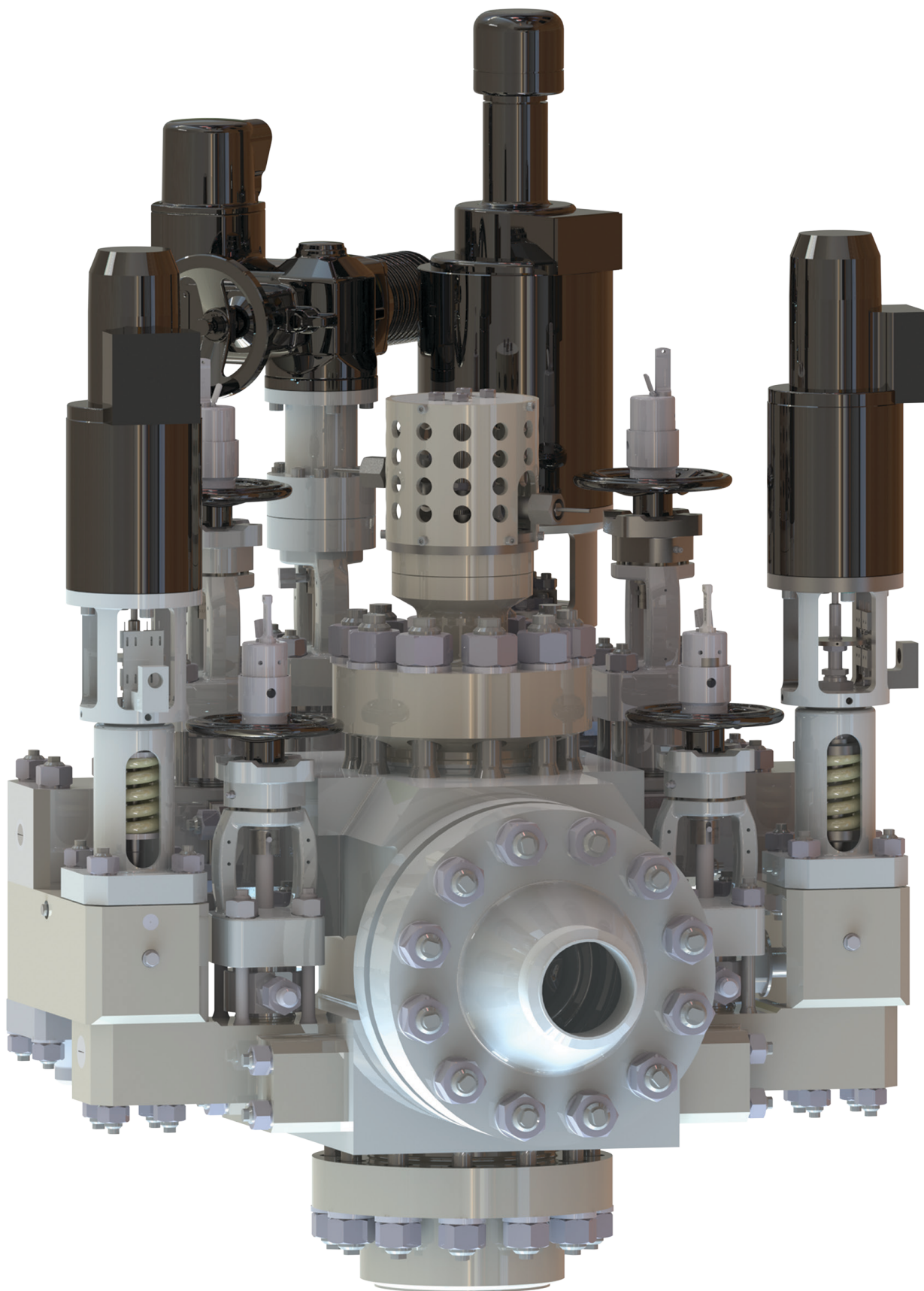
Two Sierion pilot valves are assigned to one pressurizer safety relief valve. The design of the Sierion pilot valve is in design ownership of the reactor company of EPR. Sempell is the manufacturer of the Sierion pilot valve under the design control of this reactor company. The Sierion is a non-floating pilot valve which functions well with a wide variety of media such as steam, water, two-phase flows and supercooled water.

Stop valves are attached between the main valve and the pilot valves for the impulse line and pilot line. Only one pilot valves is active at a time, while the other is blocked by the stop valve.

The Sierion pilot valve is set to a defined set pressure. The response of the main valve under this set pressure is ensured by activation through a double-solenoid valve type DMS. This is a further variant of the so-called bleed and feed valve for pressure relief during emergency supply.

3	VS99 safety valve
3 x 2	Sierion pilot valve with stop valves for the pilot and control line
3 x 1	DMS (doubled) bleed and feed valve

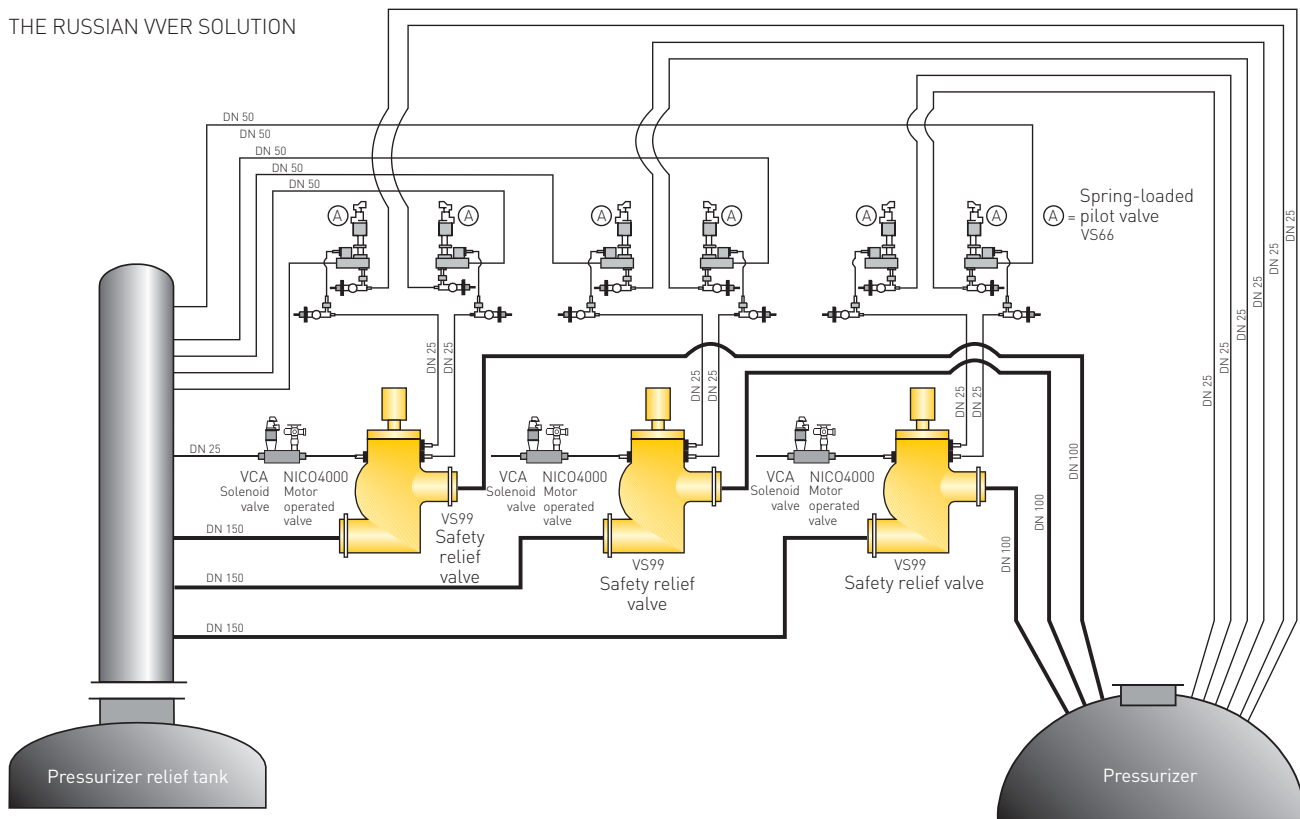
SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES
TYPE VS99 PILOT OPERATED



SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

THE RUSSIAN WER SOLUTION



VALVE ASSEMBLY

The pressurizer is equipped with three independent safety valves type VS99 which are installed in parallel on a steam collector pipeline. The main valve VS99 body is angular with a lateral inlet nozzle and vertical downward outlet nozzle. Two self-acting spring-loaded pilot valves type VS66 per main valve are installed. The steam pilot valves are equipped with a solenoid that provides supplementary seat tightness forces and assists opening and closing.

During normal operation, the solenoids are energized and the pilot valves are closed. If a solenoid fails (switch-off failure), the pilot valves still fulfill their function as spring-loaded safety valves, regardless of the solenoids. The steam pilot valves operate only with system pressure; no external energy is needed for the safety function. The pilot valves are connected to system pressure by independent lines connected to the inlet flange of the main valve.

The pressurizer safety relief valve is additionally equipped with a solenoid valve type VCA with integrated stop valve, connected through a separate impulse line, so the valve can also be opened under set pressure. This is a further variant of the so-called bleed and feed valve for pressure relief during emergency supply. The valve station is qualified for steam, two-phase flow (water-steam) and supercooled water.

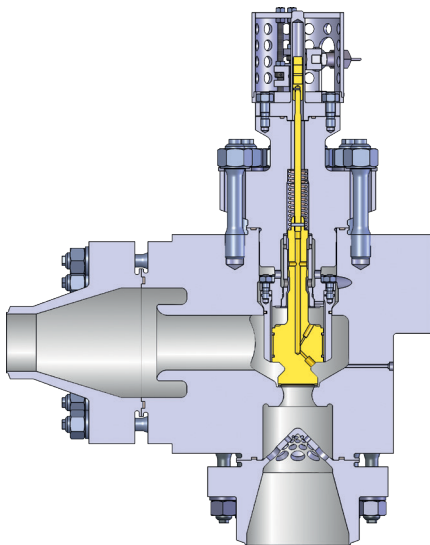
3	VS99 safety relief valves
3 x 2	VS66 self-acting spring-loaded pilot valves with stop valves for pilot line
3 x 1	VCA bleed and feed valve with stop valve

SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

TYPE VS 99 PRESSURIZER SAFETY RELIEF VALVE

As explained above, each construction of the pressurizer safety relief valve requires an individual solution. The solution is oriented to the construction of the reactor, the technical demands and the customized specifications. Different solutions for the control, construction and number of pilot valves also influence the construction of the main valve. The VS99 pressurizer safety relief valve operates according to the discharge principle. During normal operation, the valve is closed, system pressure is permanently exerted on the top side of the piston and presses the disc firmly to the seat. In the process, the interior parts are surrounded by medium and so are kept at temperature; thus there is no thermal shock upon opening.



Design

Compact block design with directly mounted pilot valves. The inlet is horizontal. The valves are installed vertically

Reference

PWR Germany and Brazil,
PWR (WER)

Size / DN

Up to 8" / up to 200 mm

Class / PN

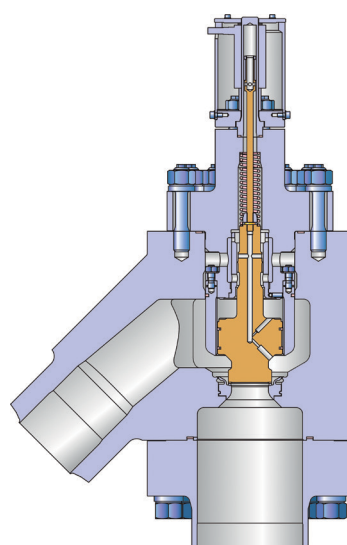
Class 1500 / PN 250

Body material

1.4553 / 1.4541

Qualification

Areva Laboratory Erlangen with steam, water and two-phase mixture and Karlstein; for compact design see APR1400 qualification



Design

Compact block design with directly connected pilot valves. The inlet angle is 45° so the valves can be installed in a vertical position

Reference

Reactor type: EPR
Olkiluoto 3, Flamanville 3,
Taishan 1 + 2

Size / DN

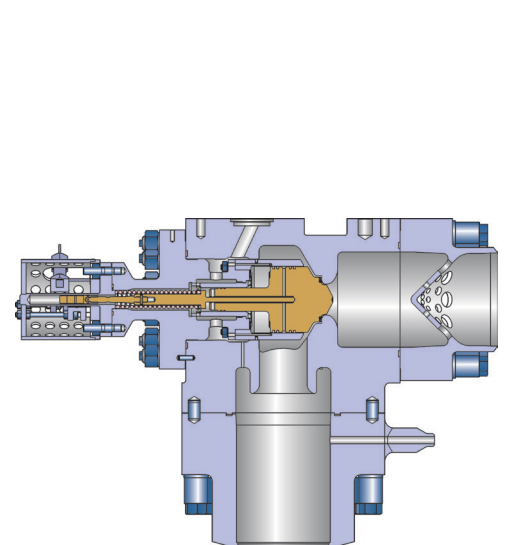
4" / 6" / 100 / 150 mm

Class / PN

Class 1500 / PN 250
Body material
Z2 CN 19-10 N2

Qualification

Areva Laboratory Erlangen with steam, water and two-phase mixture and Karlstein



Design

Compact block design with directly mounted pilot valves. The valve is installed horizontally so the inlet is vertical

Reference

Reactor type: APR 1400
Shin Kori 3+4,
Shin Hanul 1+2,
Barakah 1- 4

Size / DN

8" / 200 mm

Class / PN

Up to class 2500 / PN 400

Body material

A182 F316 LN (1.4406)

Qualification

Flow coefficient by NB, USA
Demonstration of function by Areva in Karlstein with steam, water and two-phase mixture

SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

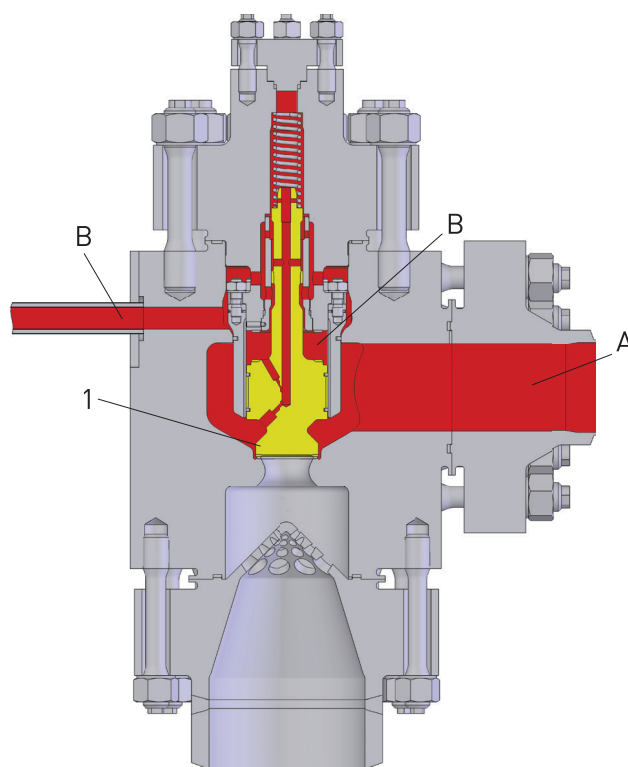
TYPE VS99 PILOT OPERATED

THE FUNCTION OF THE MAIN VALVE

System pressure at operating pressure

Disc 1	Closed
Chamber A	System pressure
Chamber B	System pressure

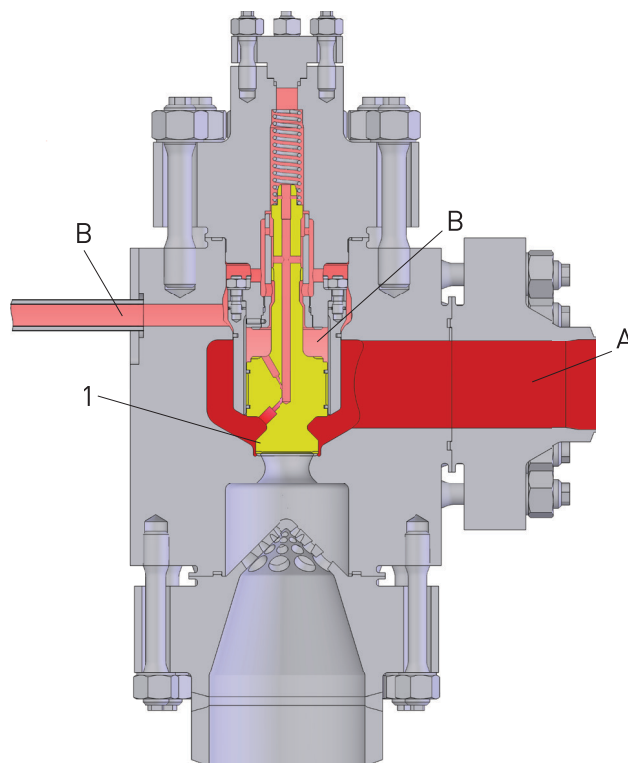
Under operating conditions, the same operating pressure predominates in all chambers of the safety valve including the pilot line.



System pressure through operating pressure

Disc 1	Closed
Chamber A	System pressure
Chamber B	Reduced pressure

If the system pressure exceeds the set pressure of the pilot valve, the pilot valve opens; therefore the pilot line opens also. The steam of the pilot chamber B is reduced.



SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

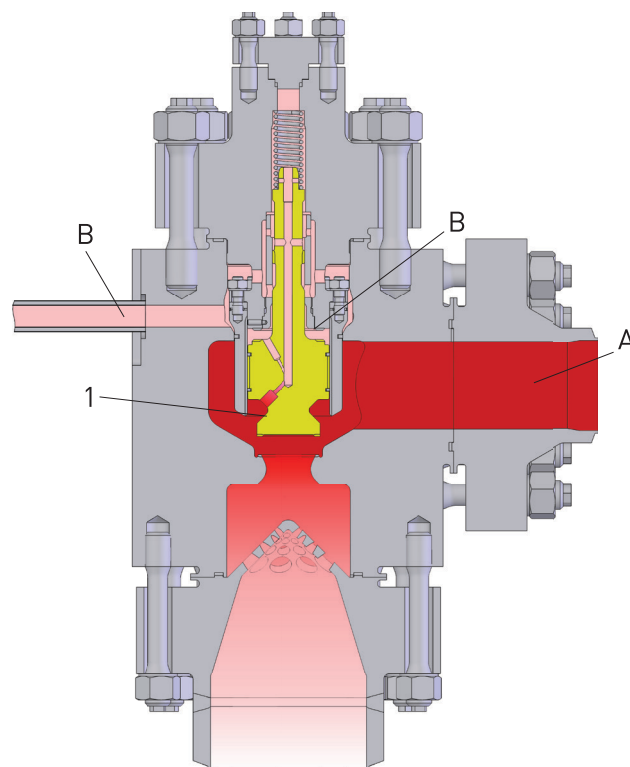
TYPE VS99 PILOT OPERATED

THE FUNCTION OF THE MAIN VALVE

System pressure through opening pressure

Disc 1	Open
Chamber A	System pressure
Chamber B	Further reduced pressure

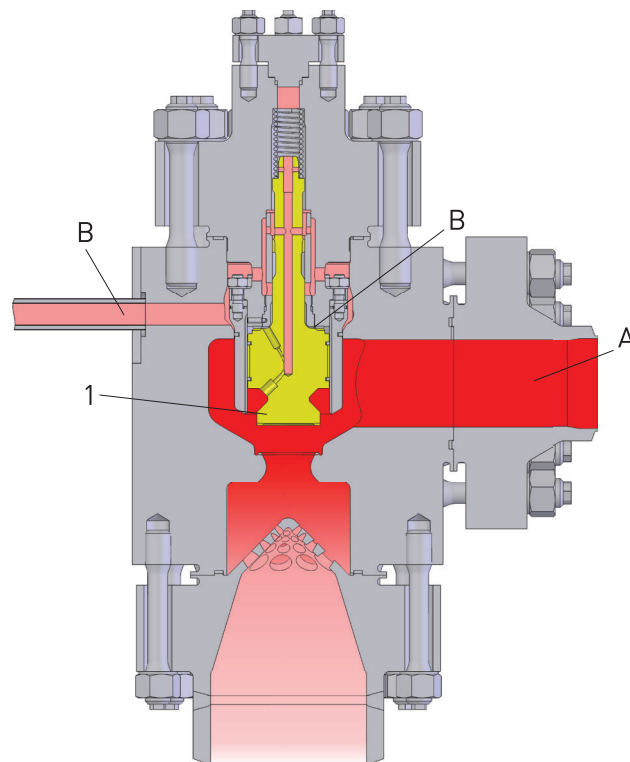
The pressure continues to drop in pilot chamber B and pressure differences arise at the actuating piston. These differences generate actuating forces in the opening direction, which cause the valve to open. The opening movement of the valve disc is damped because the steam volume is encased above the piston and compressed by additional stroke movements. In the open position of the valve disc, a refill bore is enabled. The size of this refill bore and the size of the other refill cross-sections are dimensioned so that the entire volume of medium flowing into the relief chambers can be safely released through the control line. Therefore a sufficient pressure difference remains at the actuating piston and the valve disc is held safety open.



System pressure under closing pressure

Disc 1	Open
Chamber A	System pressure
Chamber B	Rising pressure

If the pressure in the system or the pressure relief line to the pilot valve drops to the previously set closing pressure, the pilot valve closes again the pilot line is blocked again. The pressure equalizes in the relieved pilot chambers. Closing forces result from the pressure difference above and below the valve disc because of the flow and from the weight of the valve disc.



SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

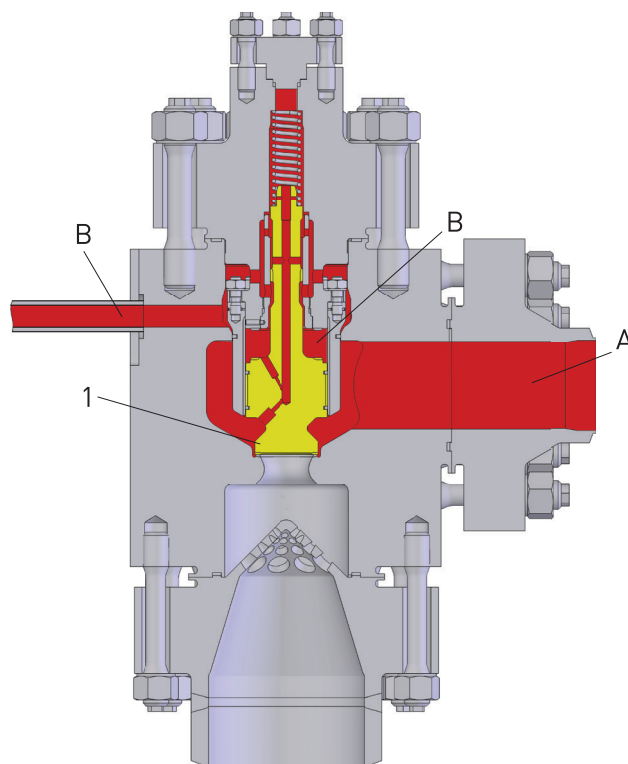
TYPE VS99 PILOT OPERATED

THE FUNCTION OF THE MAIN VALVE

System pressure at operating pressure

Disc 1	Closed
Chamber A	System pressure
Chamber B	System pressure

The same operating pressure again predominates in all chambers of the safety valve including the pilot line.

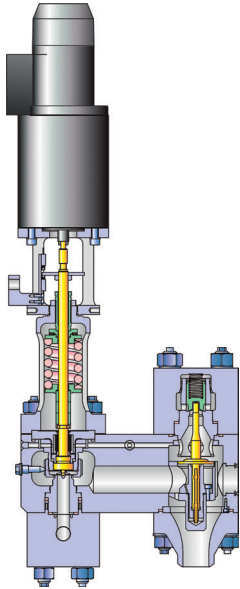


SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

TYPE VS66 SELF-ACTING SPRING-LOADED PILOT VALVE

The design of the spring-loaded steam pilot valve is adapted completely individually to the corresponding construction of the main valve. At least two pilot valves per main valve are required, because one valve is always switched active while the other is blocked. This is made possible by the available stop valves to the impulse and pilot lines. The stop valves are equipped with safety locking devices which facilitate a controlled blocking.



Design

Floating design with supplementary loading

Reference

PWR Germany and Brazil,
PWR (VVER)

Size / DN

1" / 25 mm

Class / PN

class 1500 / PN 250

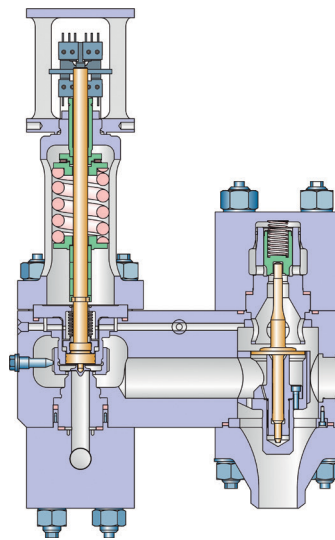
Body material

1.4553 / 1.4541

Qualification

Together with VS99

Stable valve performance when subject to two-phase flow or low-flow transient, no costly loop seal required



Design

Floating design

Reference

Shin Kori 3 and 4,
Shin Hanul 1 and 2,
Barakah 1 - 4

Size / DN

1" / 25 mm

Class / PN

Up to class 2500 / PN 400

Body material

A182 F316 LN (1.4406)

Qualification

ASME III NV (together with VS99)

Stable valve performance when subject to two-phase flow or low-flow transient, no costly loop seal required

SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

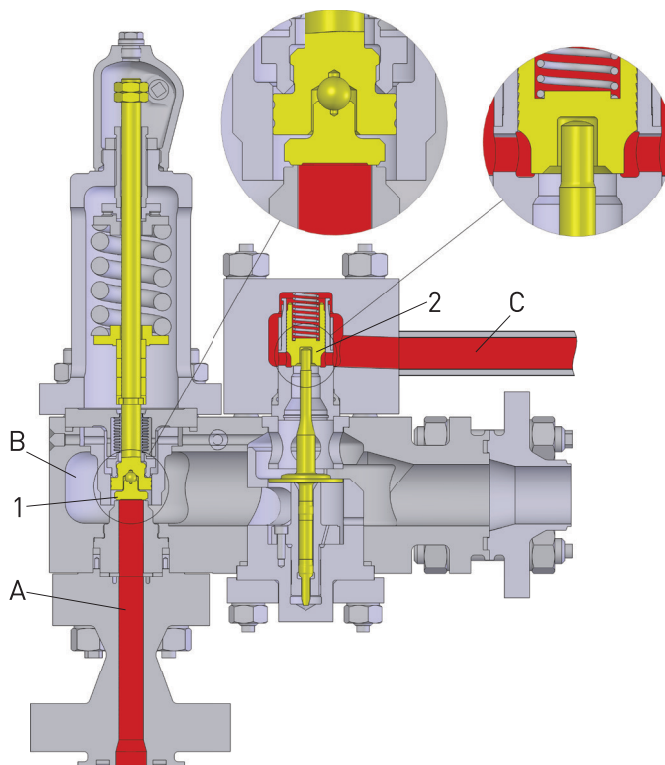
TYPE VS99 PILOT OPERATED

FUNCTION VS66

System pressure at operating pressure

Disc 1	Closed
Disc 2	Closed
Chamber A	System pressure
Chamber B	Atmosphere
Chamber C	System pressure

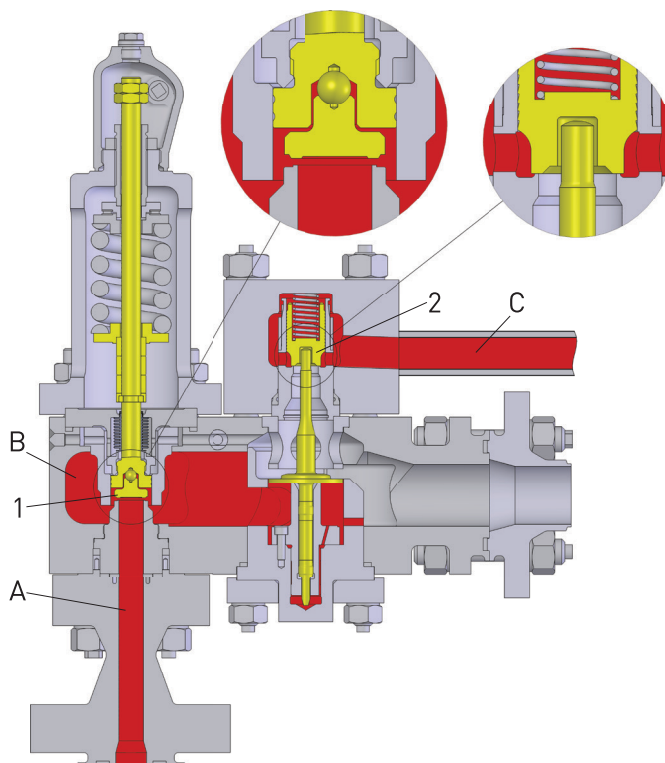
Under operating conditions, the steam pilot valve is closed. This valve consists of a spring-loaded impulse part with disc 1 and a check part with disc 2 which blocks the pilot line because the pressure on the disc is effected from above.



System pressure through operating pressure

Disc 1	Open
Disc 2	Closed
Chamber A	System pressure
Chamber B	Pressure buildup
Chamber C	System pressure

If the system pressure reaches the set pressure adjusted with the spring at the impulse part, the impulse part opens suddenly at additional pressure increase. The steam flows into chamber B, strikes the impact plate and causes it to rise.



SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

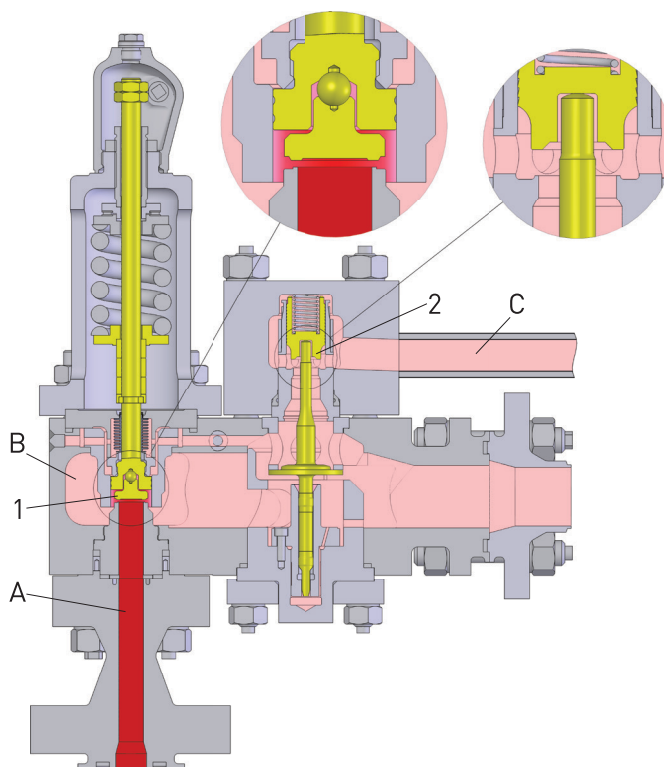
TYPE VS99 PILOT OPERATED

FUNCTION VS66

System pressure through opening pressure

Disc 1	Open
Disc 2	Open
Chamber A	System pressure
Chamber B	Pressure increase
Chamber C	Pressure relief

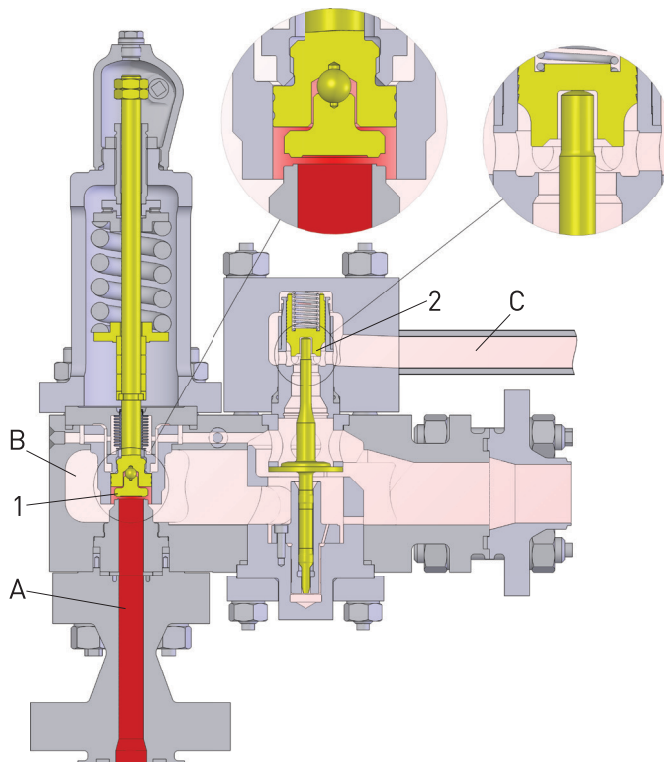
The pressure transfers its opening force through the impact plate to the check disc 2 of the pilot part. Because the opening forces of the impact plate, as conditioned by the large surface, exceeds the closing forces of check disc 2, the check disc opens and immediately initiates pressure relief of pilot line C for the main valve.



System pressure through opening pressure

Disc 1	Open
Disc 2	Open
Chamber A	System pressure
Chamber B	Pressure filled
Chamber C	Pressure relief

The main valve opens and remains open as long as the pilot valve is open.



SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

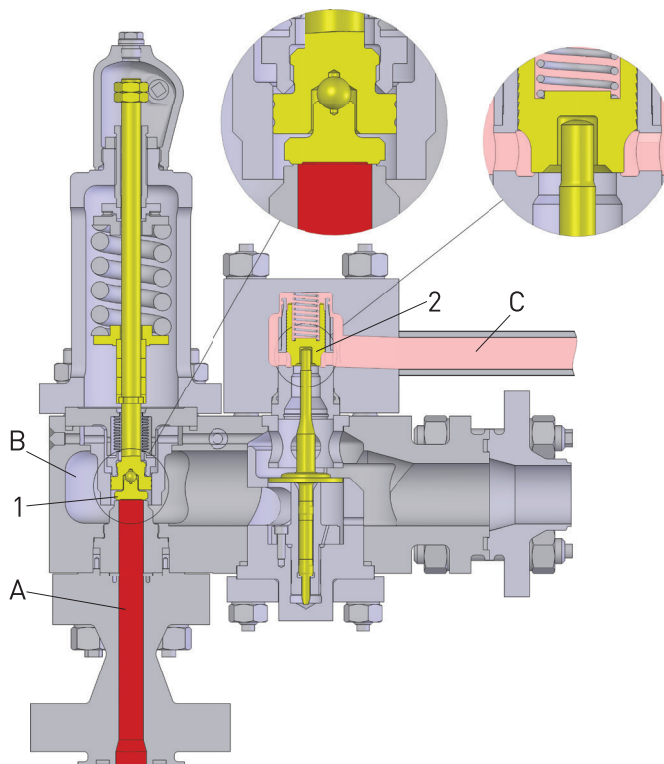
TYPE VS99 PILOT OPERATED

FUNCTION VS66

System pressure under closing pressure

Disc 1	Closed
Disc 2	Closed
Chamber A	System pressure
Chamber B	Atmosphere
Chamber C	Pressure increase

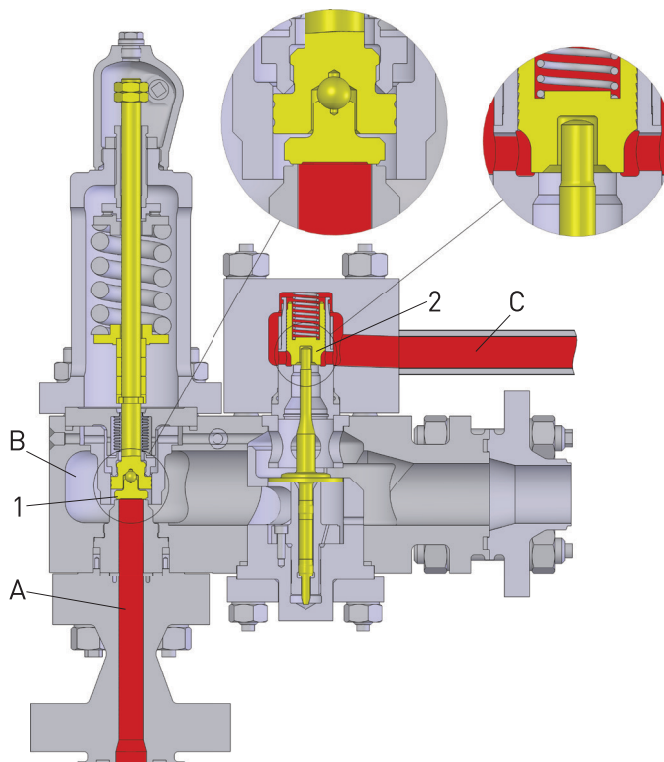
If system pressure drops, the pilot valve closes again when the set closing pressure is reached. The pressure below the impact plate of the check piece drops and check disc 2 closes to block pilot line C.



System pressure at operating pressure

Disc 1	Closed
Disc 2	Closed
Chamber A	System pressure
Chamber B	Atmosphere
Chamber C	System pressure

The pressure in pilot line C increases and the main valve closes again.

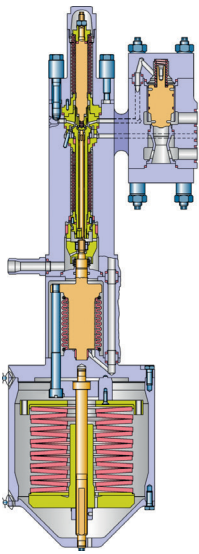


SEMPPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

TYPE SIERION PILOT VALVE

The reactor company of EPR has developed a new pilot valve especially for application in EPR pressurizer systems and together with Sempell, has brought it to functional maturity and through all required qualification. The design of the Sierion pilot valve is in design ownership of the reactor company. Sempell is the manufacturer of the Sierion pilot valve under the design control of the reactor company. The special feature of this valve is that after opening, it is closed to flow. Due to its design, it could be achieved that the pilot valve featured nearly identical functional values for all different media states. Whether the medium is pure steam or a mixture of steam and water, or if the system medium is already pure water, is largely irrelevant. In addition, the accrual of pure hydrogen is controlled. To ensure this good functional behavior, no isolation was used, because the accumulating medium should always condense into water within the interior chambers of the pilot valve.



Design

Non-floating design

Reference

Olkioto 3, Flamanville 3,
Taishan 1 + 2, PWE Gösgen

Size / DN

1" / DN 25

Class / PN

Class 1500 / PN 250

Body material

Z2 CN 19-10 N2

Qualification

Areva Laboratory Erlangen with steam, water
and two-phase mixture and Karlstein

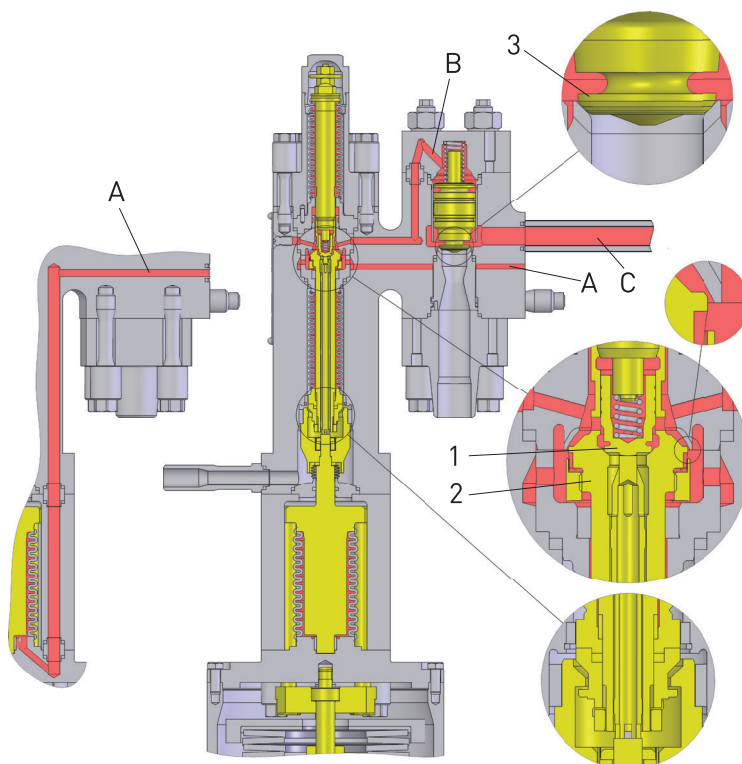
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION SIERION

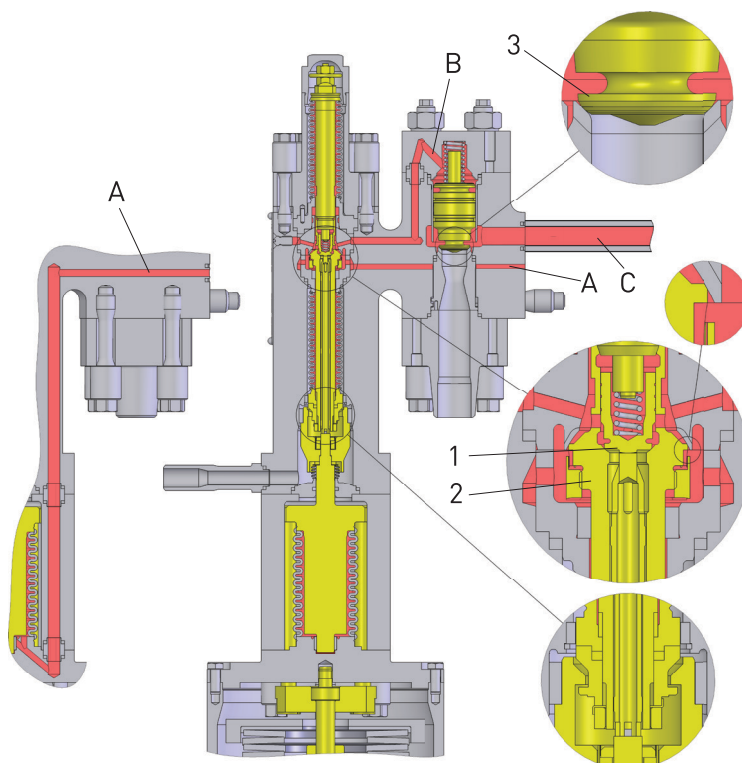
Disc 1	Closed
Disc 2	Open
Disc 3	Closed
Chamber A	System pressure
Chamber B	System pressure
Chamber C	System pressure

In normal operation, pre-pilot disc 1 is closed and disc 2 opened. Disc 3 is also closed and system pressure predominates in the chambers A, B and C. The system pressure in the lower bellows attempts to push the flange upwards, but this is prevented by the attached disc spring package.



Disc 1	Closed
Disc 2	Closed
Disc 3	Closed
Chamber A	System pressure
Chamber B	System pressure
Chamber C	System pressure

As system pressure rises in the bellows chamber, the plunger is moved below disc 1 and attempts to detach it from its seat in disc 2. Because of the Δp existing here, however, this cannot be accomplished at first and disc 2 is also lifted, up to its seat. Disc 2 is closed. Disc 1 is still closed and seals to the atmosphere.



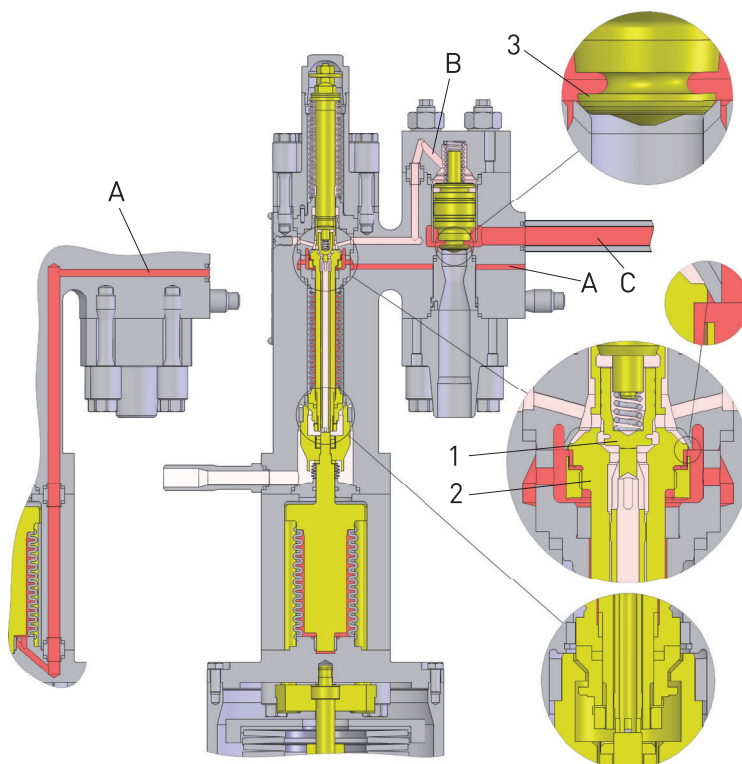
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION SIERION

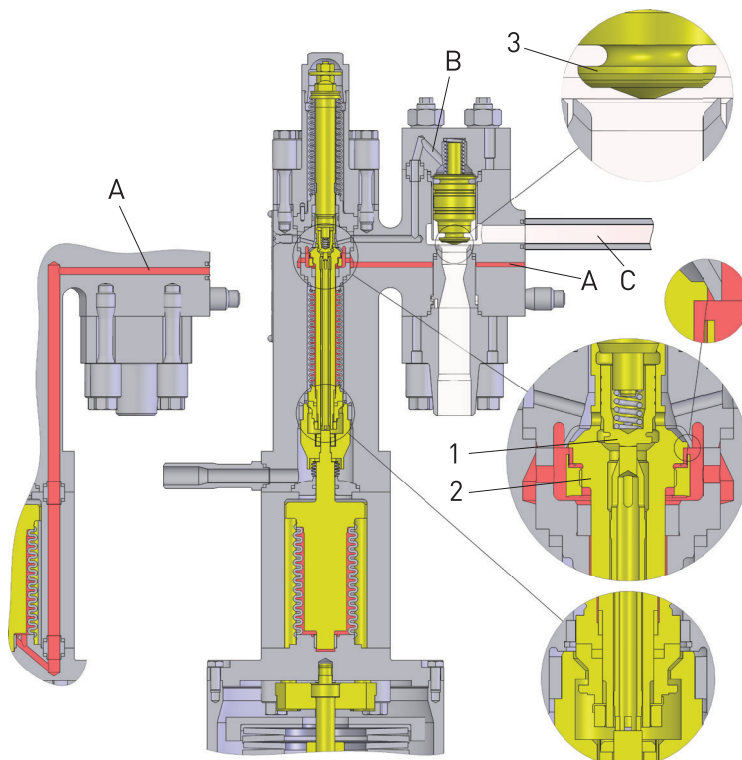
Disc 1	Open
Disc 2	Closed
Disc 3	Closed
Chamber A	System pressure
Chamber B	Reduced pressure
Chamber C	System pressure

When the set pressure is reached, the opening force on disc 1 is greater than the Δp existing there and disc 1 opens suddenly.



Disc 1	Open
Disc 2	Closed
Disc 3	Open
Chamber A	System pressure
Chamber B	Atmospheric pressure
Chamber C	Reduced pressure

If disc 1 is opened, chamber B is relieved above disc 3 and disc 3 opens. The pilot line C to the main valve is relieved and the main valve also opens.



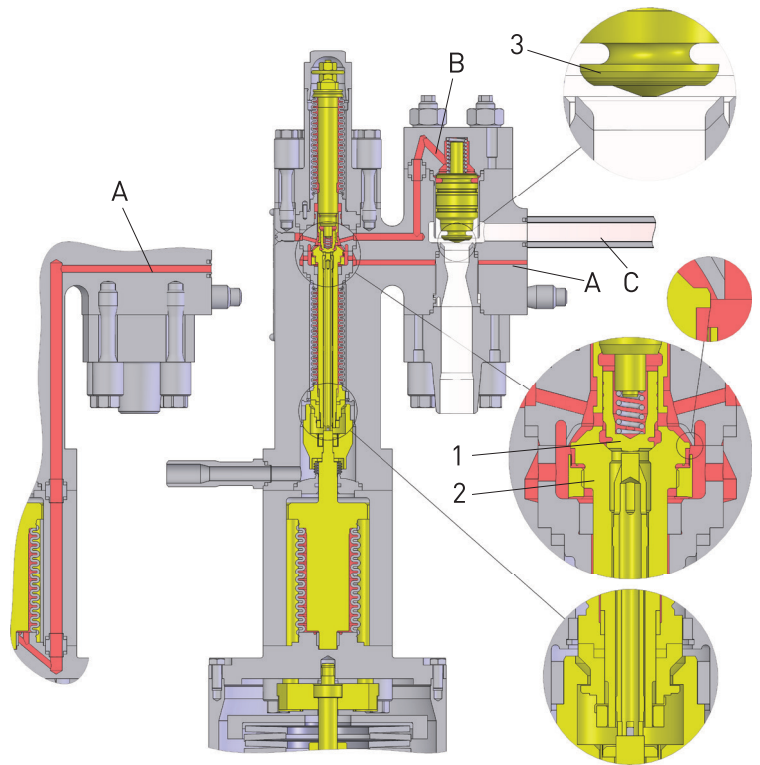
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION SIERION

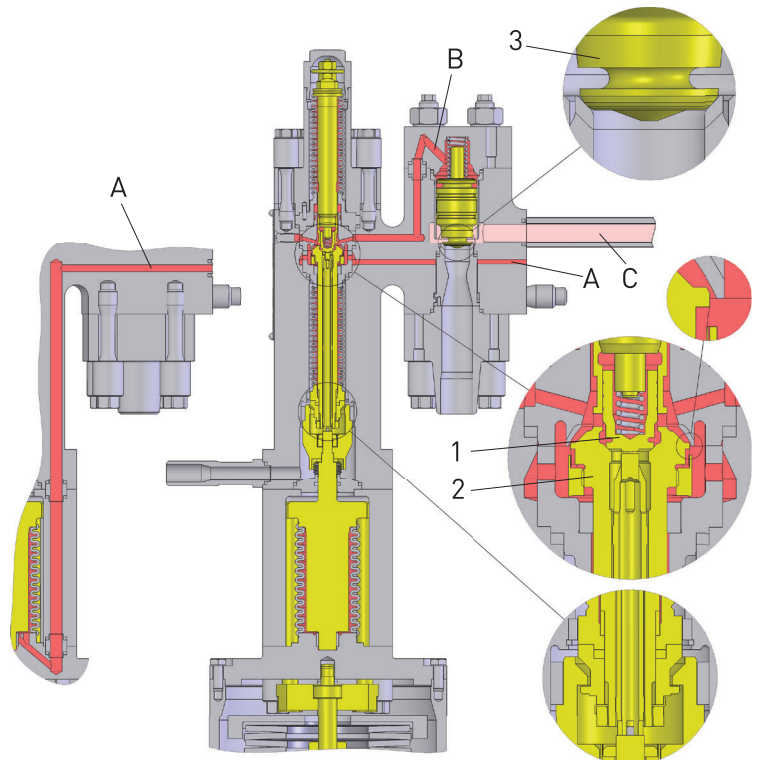
Disc 1	Closed
Disc 2	Closed
Disc 3	Open
Chamber A	System pressure
Chamber B	Atmospheric pressure
Chamber C	Reduced pressure

Because the plunger below disc 1 is directly dependent on pressure, as pressure decreases it lowers and pushes disc 1 back to its seat in disc 2. Due to the available Δp , at first disc 2 remains closed, although the coupling attempts to separate disc 2 from its seat.



Disc 1	Closed
Disc 2	Open
Disc 3	Closed
Chamber A	System pressure
Chamber B	System pressure
Chamber C	Rising pressure

Only with rising pressure is the force great enough to separate disc 2 from its seat by the coupling. The pressure in the chamber above disc 2 increases and therefore also the pressure in chamber B above disc 3. Disc 3 closes again with the support of the pressure spring, thus closing pilot line C to the main valve. The pressure in pilot line C increases again and the main valve closes.



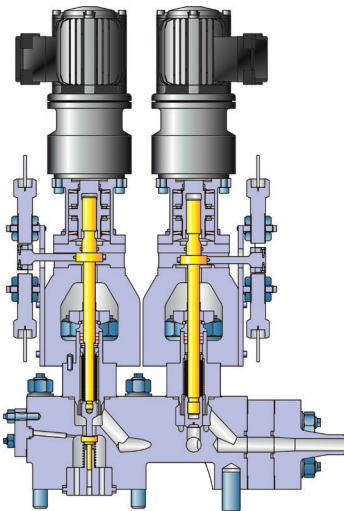
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

BLEED AND FEED VALVE WITH MOTOR

Because the VS99 safety valve, according to requirements, must be actuated by a pilot valve independently of external energy, it is not possible to open this valve at low pressures. However, in order to be able to supply the emergency cooling, the system pressure must be lowered. This is accomplished with the so-called bleed and feed valve, which is electrically actuated and therefore can also be opened below the set pressure. Furthermore, the "cold overpressure function" is fulfilled with this valve. In principle, this means only that a pilot valve can be opened by external energy at any pressure.

TYPE DPDE



Design

Motor-operated pilot valve with integrated isolation valve in one forged body

Reference

Shin Kori 3 and 4,
Shin Hanul 1 and 2,
Barakah 1 - 4

Size / DN

1" / 25 mm

Class / PN

Up to class 2500 / PN 400

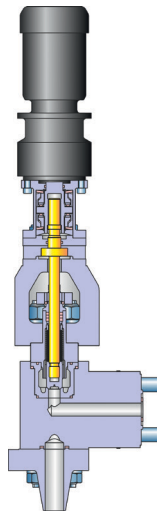
Body material

A182 F316 LN (1.4406)

Qualification

ASME III NV (together with VS99)

TYPE EPDE



Design

Motor-operated pilot valve

Reference

German PWR
Russian PWR (WER)

Size / DN

1" / 25 mm

Class / PN

Up to class 2500 / PN 400

Body material

1.4550, 1.4553

Qualification

Together with VS99

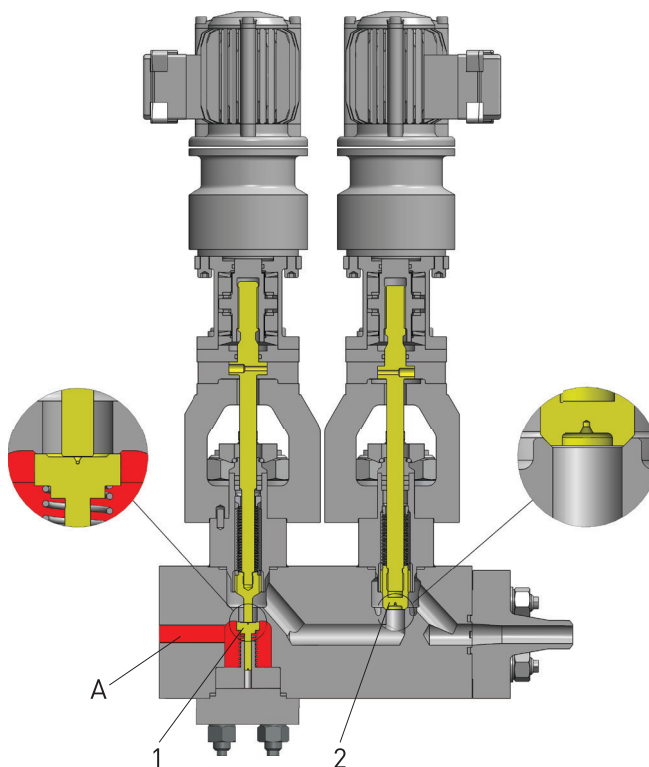
SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION DPDE

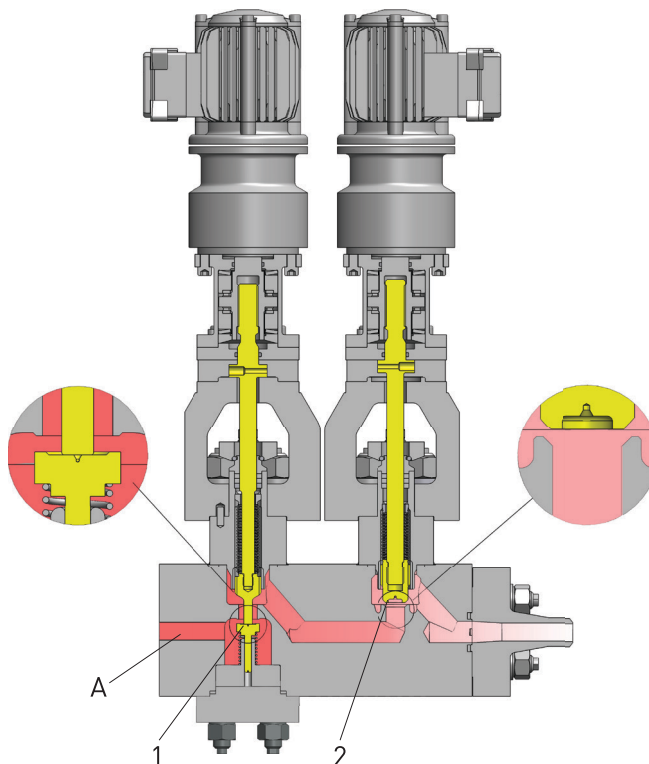
Motors	Close signal
Disc 1	Closed
Disc 2	Closed
Chamber A	System pressure

The DPDE consists of a body with two valve inserts for reliable closing function. Both valves function differently. Disc 1 closes the valve through the system pressure and the pressure spring below the disc, while disc 2 closes the valve against system pressure by means of a motor. In normal operation, both valve discs 1 and 2 are closed and therefore, so is the pilot line A to the main valve.



Motors	Open signal
Disc 1	Open
Disc 2	Open
Chamber A	Reducing pressure

If the motors receive the signal to open from the pilot chamber, disc 1 in the first valve is pushed open by the plunger. In the second valve, disc 2 is raised. The pressure in pilot line A to the main valve is reduced.



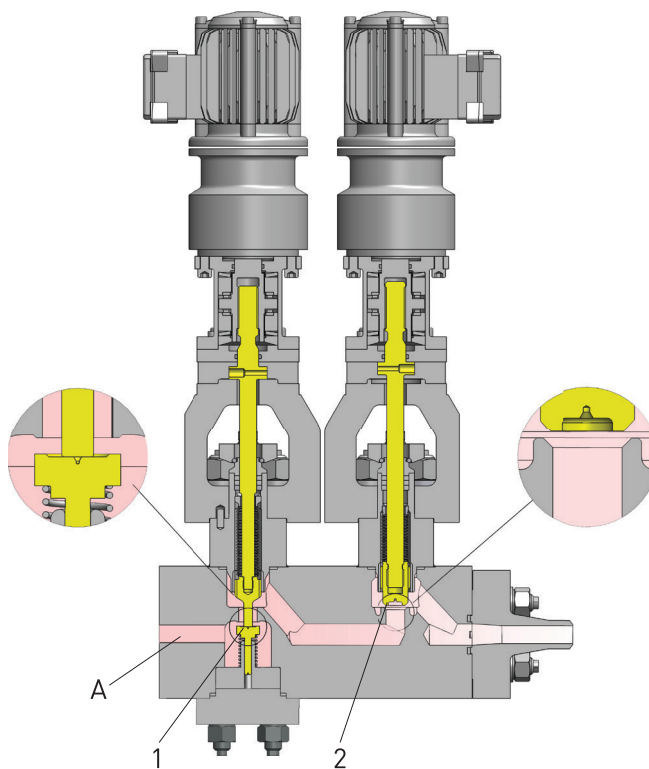
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION DPDE

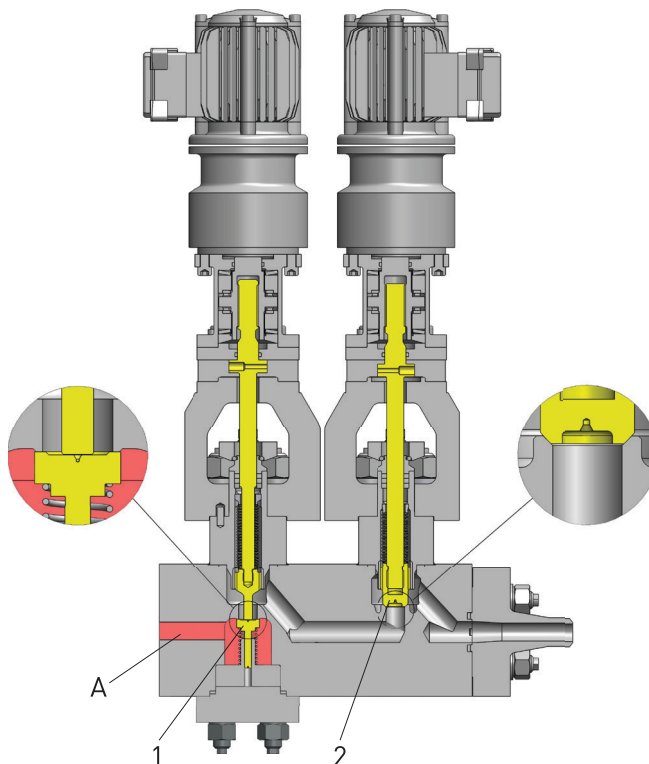
Motors	Open signal
Disc 1	Open
Disc 2	Open
Chamber A	Reduced pressure

If the falling pressure in pilot line A reaches the response pressure of the main valve, the main valve opens.



Motors	Close signal
Disc 1	Closed
Disc 2	Closed
Chamber A	Rising pressure

If the signal to close the valve is given, in the first valve the plunger is pulled back and with the help of the spring and system pressure, disc 1 closes again. At the same time, in the second valve disc 2 is pressed back to its closed position.



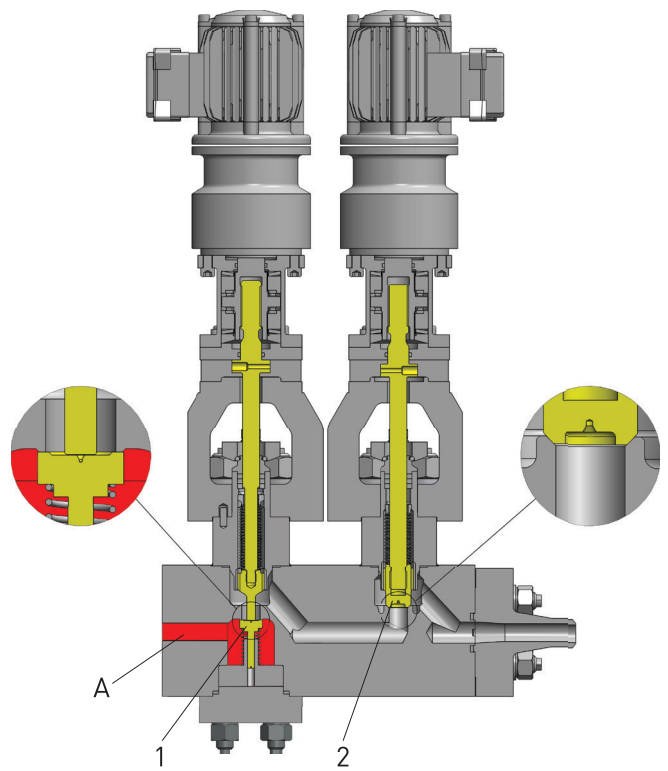
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION DPDE

Motors	Close signal
Disc 1	Closed
Disc 2	Closed
Chamber A	System pressure

After both valves have closed again and the system pressure in pilot chamber A has risen, the main valve closes again.



SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

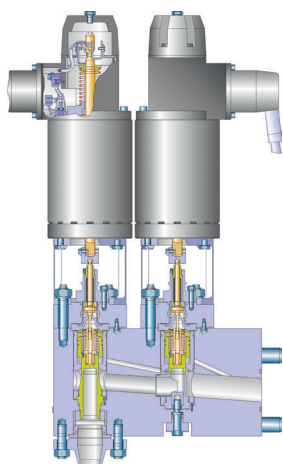
TYPE VS99 PILOT OPERATED

BLEED AND FEED VALVE WITH SOLENOID

The products DMS 5/6 and EMS 5/6 were developed especially for nuclear applications and were first used on the FSA-station (main steam valve set) of the KWU pressurized water reactors. The type DMS 5/6 double-solenoid valves are the most widely distributed. The double-solenoid valve consists of two nearly identical valves, the inner valve facing the main valve, and the outer valve. Due to design requirements, the inner valve is not completely tight while the outer valve is absolutely tight at the seat. This design permits the alternating functional testing of the inner and the outer valves without actuating the main valve in the process.

The digits 5 and 6 identify the de-energized open circuit or energized open principles. The valves EMS 5 and DMS 5 function according to the de-energized open principle, whereas the valves EMS 6 and DMS 6 function according to the energized open principle.

TYPE DMS 5/6



Design

Forged one-piece body with 2 nearly identical valves for alternating testing during operation

Reference

First used for Main steam valve set
Approx. 1000 pilot valves in use

Size / DN

1½" / DN 32

Class / PN

Class 1500 / PN 250

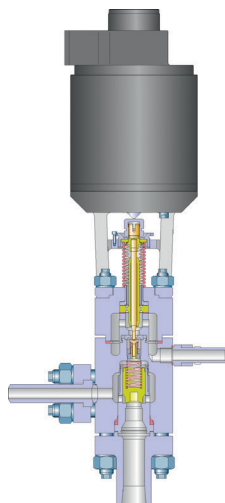
Body material

Z2 CN 19-10 N2, 1.4313

Qualification

Full-scale tested together with Main steam isolation valve and Main steam safety valve, IEEE-qualified solenoid by Whyte Inspection Laboratories, California

TYPE EMS 5/6



Design

The EMS is just half of a DMS, when alternating actuation during operation is not needed.

Reference

Belgium PWR,
Russian PWR (VVER)
China (HTR)

Size / DN

1½" / DN 32

Class / PN

Class 1500 / PN 250

Body material

1.4313

Qualification

IEEE-qualified solenoid by Whyte Inspection Laboratories, California

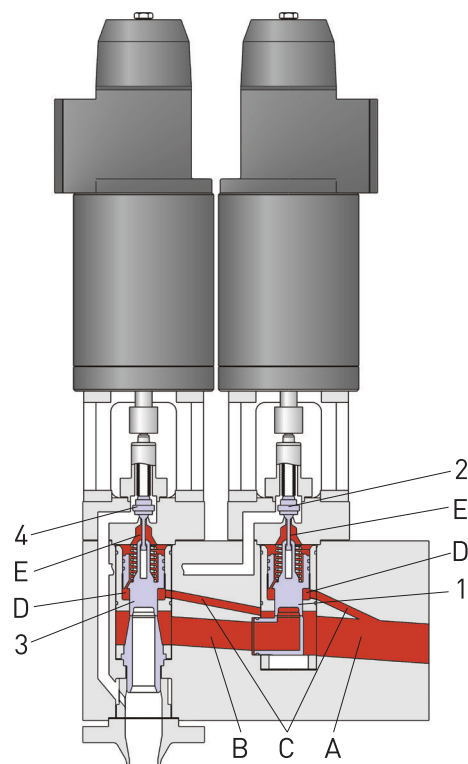
SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION DMS 6 (energized open principle)

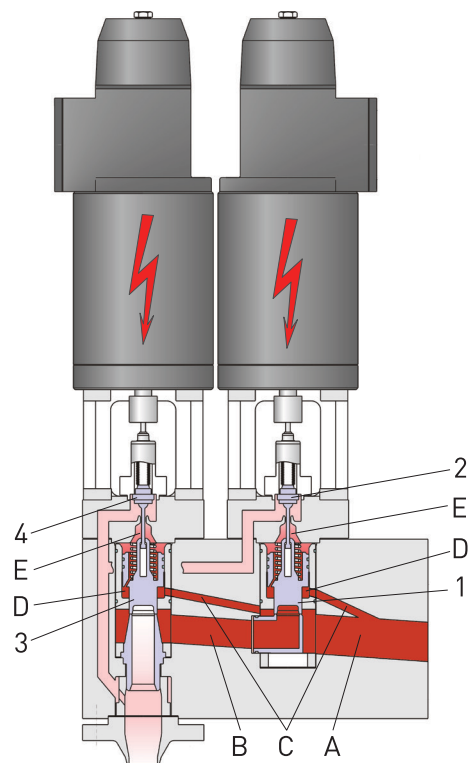
Solenoid 1	De-energized
Solenoid 2	De-energized
Disc 1	Closed
Disc 2	Closed
Disc 3	Closed
Disc 4	Closed
Chamber A	System pressure
Chamber B	System pressure
Chamber C	System pressure
Chamber D	System pressure
Chamber E	System pressure

During normal operation, the valve is closed. All discs of the valve are closed. The solenoids are not energized.



Solenoid 1	Energized
Solenoid 2	Energized
Disc 1	Closed
Disc 2	Open
Disc 3	Closed
Disc 4	Open
Chamber A	System pressure
Chamber B	System pressure
Chamber C	System pressure
Chamber D	System pressure
Chamber E	Pressure relief

If both solenoids are energized, pre-pilot discs 2 and 4 are lifted. Therefore the pressure in chambers E above the discs is relieved and discs 1 and 3 can open. The upward motion of discs 1 and 3 is supported by the system pressure below discs 1 and 3.



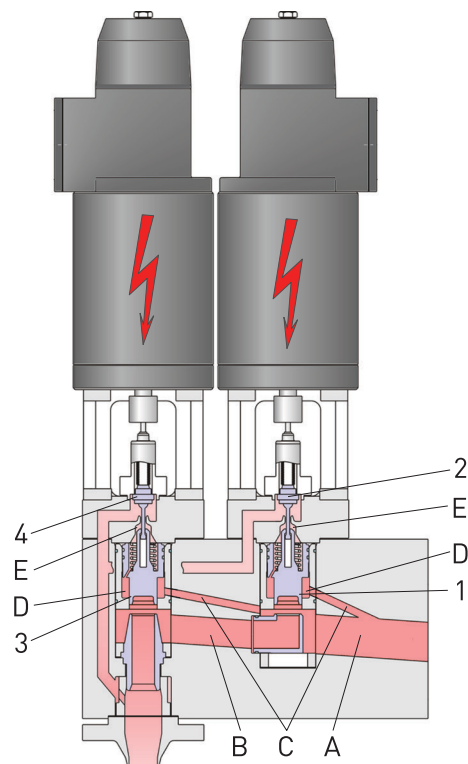
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION DMS 6 (open circuit principle)

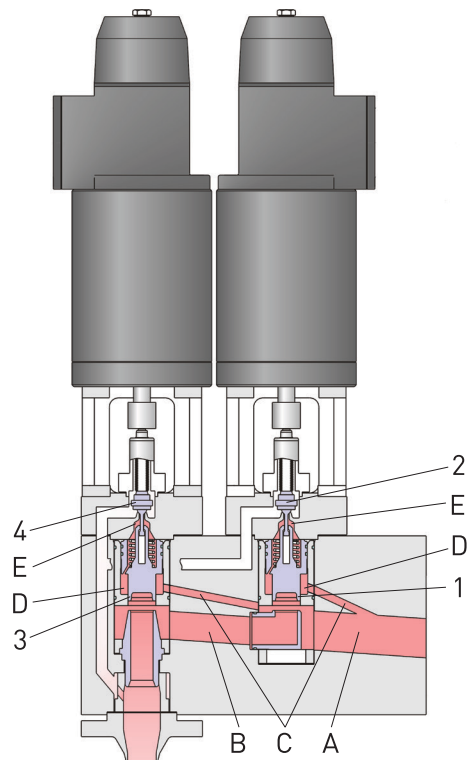
Solenoid 1	Energized
Solenoid 2	Energized
Disc 1	Open
Disc 2	Open
Disc 3	Open
Disc 4	Open
Chamber A	Pressure relief
Chamber B	Pressure relief
Chamber C	Pressure relief
Chamber D	Pressure relief
Chamber E	Lower pressure

The pressure relief in chambers B, C and D causes the pressure to be reduced in pilot line A as well, and the main valve opens.



Solenoid 1	De-energized
Solenoid 2	De-energized
Disc 1	Open
Disc 2	Closed
Disc 3	Open
Disc 4	Closed
Chamber A	Lower pressure
Chamber B	Lower pressure
Chamber C	Lower pressure
Chamber D	Lower pressure
Chamber E	Rising pressure

If the solenoids are once again de-energized, pre-pilot discs 2 and 4 close. Because of the increasing pressure in chambers E above discs 1 and 3, the discs close again.



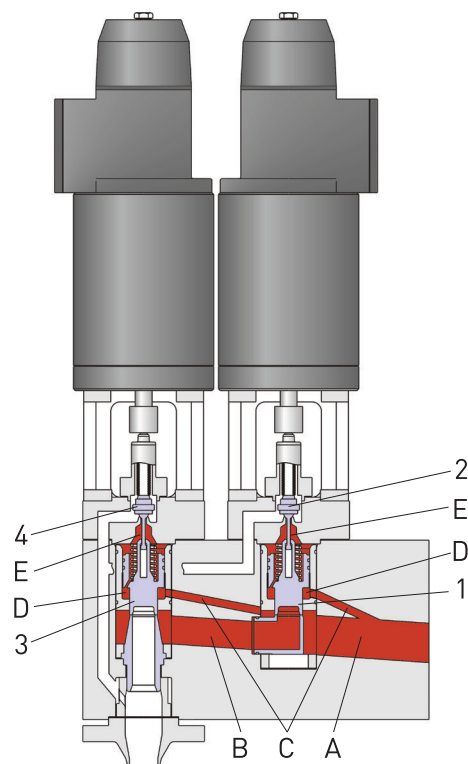
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION DMS 6 (open circuit principle)

Solenoid 1	De-energized
Solenoid 2	De-energized
Disc 1	Closed
Disc 2	Closed
Disc 3	Closed
Disc 4	Closed
Chamber A	System pressure
Chamber B	System pressure
Chamber C	System pressure
Chamber D	System pressure
Chamber E	System pressure

Once discs 1 and 3 are closed again, the pressure in pilot line A can increase again and the main valve closes.



FUNCTIONAL TEST

The double design of the valve permits the functional testing of the both inner and the outer valves without actuating the main valve in the process. To do so, the respective solenoid is energized and the corresponding pre-pilot disc is lifted. Therefore the chamber E above the respective disc is relieved and the disc can open. The system pressure below the disc supports the upward movement of the disc. The pilot line to the main valve remains closed by the other valve.

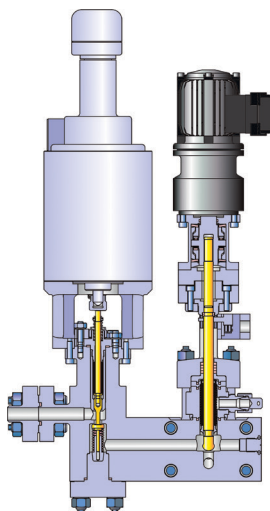
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

BLEED AND FEED VALVE WITH SOLENOID

The VCA solenoid valve is used solely to actuate the VS99 pressurizer safety relief valve. In de-energized state, it is always closed. Because the disc is always pressed against the seat from below by a small spring and this is supported by system pressure, there is no pressure relief. Thus there is a very tight seal at the seat.

TYPE VCA



Design

Solenoid valve energized open principle with integrated isolation valve in one forged body design

Reference

PWR Germany
PWR (VER)

Size / DN

1" / 25 mm

Class / PN

class 1500 / PN 250

Body material

1.4553 / 1.4541

Qualification

Together with VS99

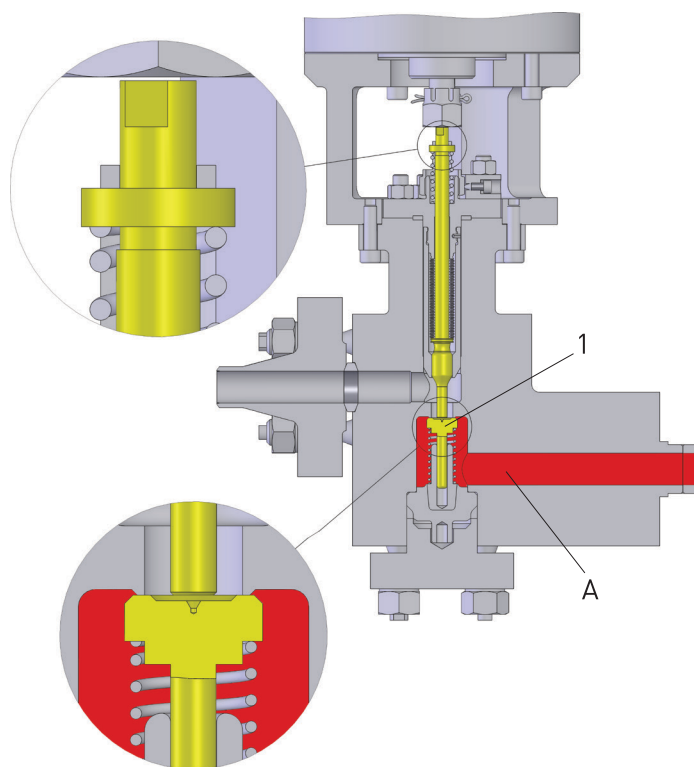
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION VCA

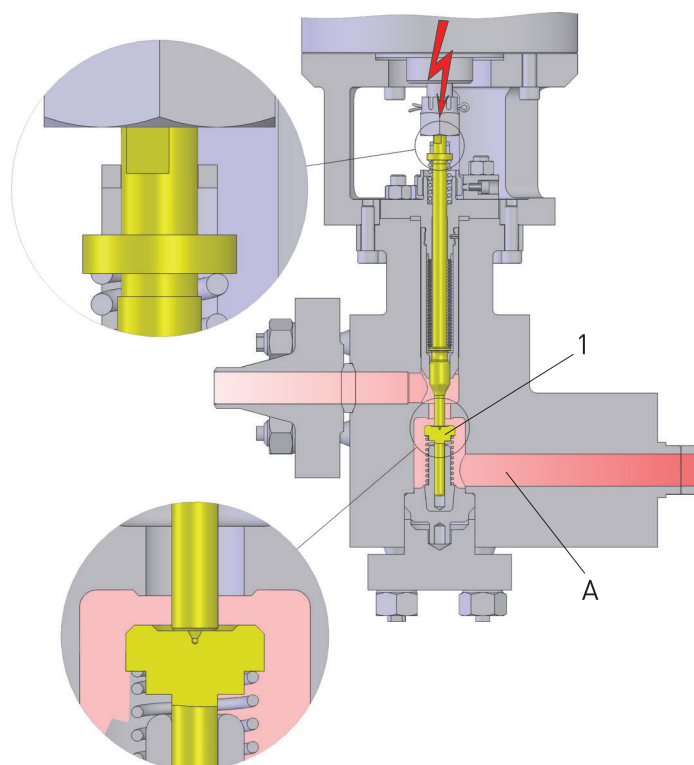
Solenoid 1	De-energized
Disc 1	Closed
Chamber A	System pressure

In normal operation, the solenoid is de-energized and disc 1 is closed. System pressure predominates in pilot line A, which keeps the solenoid valve and the main valve closed.



Solenoid 1	Energized
Disc 1	Open
Chamber A	Start of the pressure reduction

Once the solenoid is energized, the solenoid plunger presses onto the bottom side of disc 1 from above and opens the disc. Pilot chamber A is momentarily relieved.



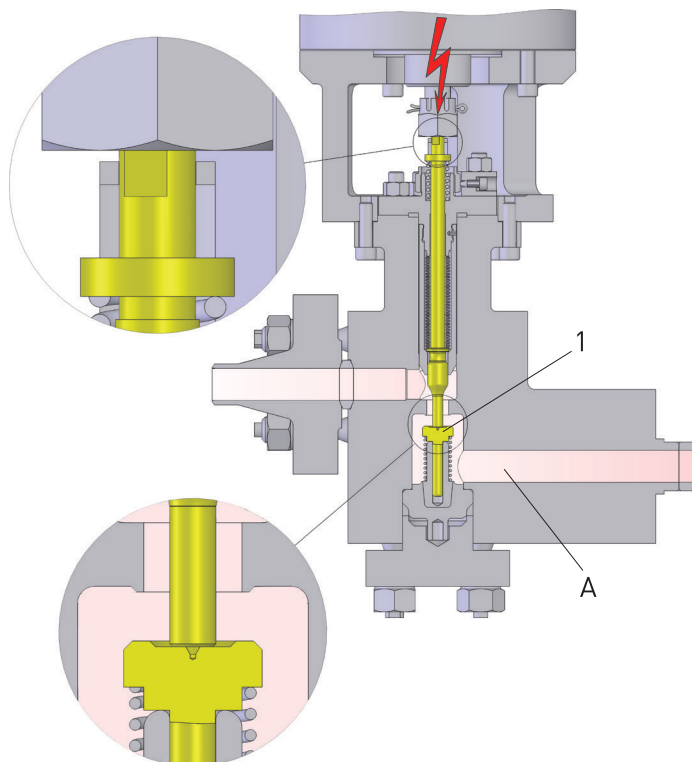
SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION VCA

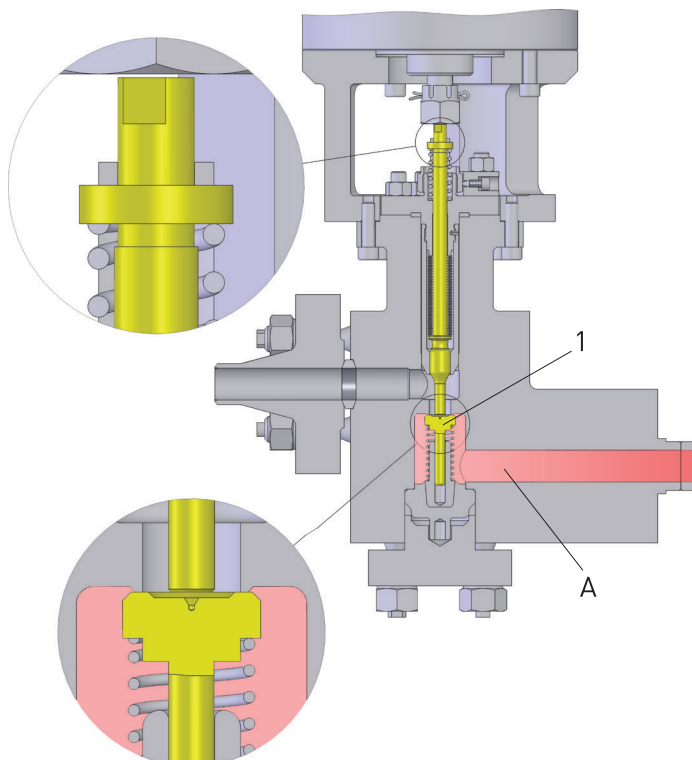
Solenoid 1	Energized
Disc 1	Open
Chamber A	Reduced pressure

Because of the pressure relief in pilot chamber A, the main valve opens suddenly in milliseconds.



Solenoid 1	De-energized
Disc 1	Closed
Chamber A	Pressure increase

If the solenoid is de-energized again, the anchor together with the stem moves to the upper position together with the stem; disc 1 follows this movement. After the VCA is closed, pilot chamber A is refilled at the same time.



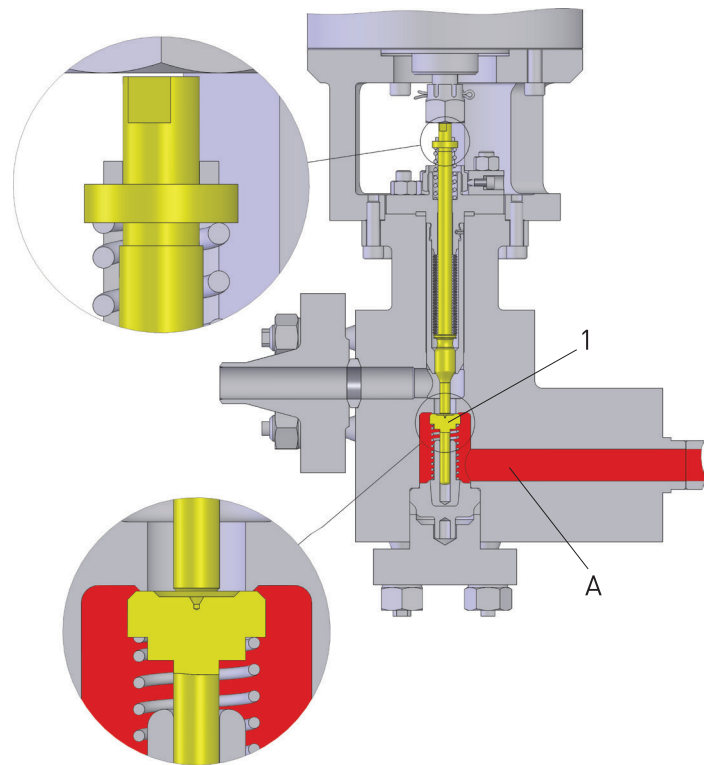
SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

FUNCTION VCA

Solenoid 1	De-energized
Disc 1	Closed
Chamber A	System pressure

After a corresponding pressure increase in pilot chamber A, the main valve closes also.



SEPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED

WORLDWIDE REFERENCES

Federal Republic of Germany		
Biblis A	PWR	1200 MW
Biblis B	PWR	1300 MW
Brokdorf	PWR	1200 MW
Emsland	PWR	1300 MW
Grafenrheinfeld	PWR	1300 MW
Greifswald 1 - 4	PWR - VVER	400 MW
Grohnde	PWR	1400 MW
Isar 2	PWR	1400 MW
Mühtheim-Kärlich	PWR	1300 MW
Neckarwestheim 1	PWR	840 MW
Neckarwestheim 2	PWR	1400 MW
Philippsburg 2	PWR	1400 MW
Stade	PWR	700 MW
Unterweser	PWR	1300 MW
Brazil		
Angra 2 + 3	PWR	1300 MW
Bulgaria		
Kozlodui 1 - 4	PWR - VVER	440 MW
Kozlodui 5 + 6	PWR - VVER	1000 MW
Czech Republic		
Dukovany 1 - 4	PWR - VVER	440 MW
Temelin 1 + 2	PWR - VVER	1000 MW
Finland		
Loviisa 1 + 2	PWR	440 MW
Olkiluoto 3	PWR - EPR	1600 MW
France		
Flamanville 3	PWR - EPR	1600 MW
Hungary		
Paks 1 - 4	PWR - VVER	440 MW
People's Republic of China		
Taishan 1 + 2	PWR - EPR	1600 MW
Russia		
Balakovo 1 - 3	PWR - VVER	1000 MW
Novovoronezh 5	PWR - VVER	1000 MW
Novovoronezh II 1 + 2	PWR - VVER	1200 MW
South Korea		
Shin Kori 3 + 4	PWR - APR	1400 MW
Shin Hanul 1 + 2	PWR - APR	1400 MW
Spain		
Trillo	PWR	1066 MW
Switzerland		
Gösgen-Däniken	PWR	1020 MW
The Netherlands		
Borssele	PWR	480 MW
Ukraine		
Chmelnyzky 1 + 2	PWR - VVER	1000 MW
Juschno Ukrainsk 1 - 3	PWR - VVER	1000 MW
Rovno 4	PWR - VVER	1000 MW
Zaporozhye 1 - 6	PWR - VVER	1000 MW
United Arab Emirates		
Barakah 1 - 4	PWR - APR	1400 MW

SEMPELL MODEL PSRV - PRESSURIZER SAFETY RELIEF VALVES

TYPE VS99 PILOT OPERATED



QUALITY CERTIFICATIONS AND STANDARDS

Our Quality Management System ranges from raw materials purchasing and rigorous preliminary checks on blanks, semi-finished products etc., and through all other manufacturing stages. Throughout, international quality standards apply with strict controls ensuring they are met at all times. Therefore, regardless of country or industry, all our customers can be sure that the quality parameters valid in their national market or field are met without fail.

Yet quality assurance doesn't end with delivery. In addition, we provide worldwide assistance and backup in installation and plant commissioning, as well as detailed maintenance recommendations, regularly updated parts information, and individual service plans.

The efficiency of our Quality Management System follows the international rules below:

ASME Section III N. NV. NPT certification

Rules for construction of nuclear valves for Class 1, 2, 3

ASME Section VIII UV certification

Rules for construction of pressure relief valves

RCC-M

Design and construction rules for mechanical components of PWR nuclear islands

KTA 1401

Nuclear Safety Standards Commission (KTA)
General requirements on quality assurance

KTA 3201.3

Nuclear Safety Standards Commission (KTA)
Components of the reactor coolant pressure boundary of light water reactors

DIN EN ISO 3834-2

Quality requirements for fusion welding of metallic materials - Part 2: Comprehensive quality requirements (ISO 3834-2:2005).

DIN EN ISO 9001:2008

Quality management systems - Requirements (ISO 9001:2008)

ISO 14001:2004

Environmental management systems
Requirements with guidance for use
(ISO 14001:2004)

PED 97/23/EC

Pressure Equipment Directive
(Full quality assurance)

OHSAS 18001:1999

Certificate for an occupational health safety management system

CSEI

Manufacture License of Special Equipment
People's Republic of China

SCCP

SGU Management System in conformity with the standard SCCP petrochemistry

IAEA 50 CQ

Quality assurance for safety in Nuclear Power Plants

HAF 604

NNSA approval for design and manufacturing of valves class 1, 2, 3



