Advanced Valve Solutions, Summary Start-Stop

Introduction

The worldwide introduction of wind and sun power and the new environmental requirements for coal fired stations gives an increasing demand on gas fired power stations to balance the grid and to make a reliable quick start and stop regime possible.

To start and to stop a modern CCGT installation cannot be done instantaneously. The gas turbine has a certain time to get up to speed and to switch from full speed no load to full load. It should be warmed through first. The rest of the power plant, mainly the HRSG, the waste heat steam boiler downstream of the gas turbine, the interconnecting steam pipework, the steam turbine and the complete cooling circuit have to be brought up to working temperature as well.

This all has to be done within a certain time pressure to limit the starting costs and to supply as soon as possible to the grid. The demand to minimize the starting times is stronger in the continental theater due to the higher fuel costs. Remaining for all CCGT plants is the demand of being reliable and the need to be sure to be able to start the installation and to supply the electricity required to the grid.

What is influencing this reliability?

Primarily, the thermal and mechanically stressed components of the boiler are form the highest risk. For example the interstage and final attemporators and the HP and IP by pass valves are the first valves seeing big heat gradients.
Other components, such as drain valves, feed water control valves and start up blow off control valves are also contributing to the reliability of the plant.
Mechanically severe stressed control valves, such as for example the OTC level control valves in GT 24 and GT 26 turbine installations are causing problems as well.

Secondary are the components which are thermally stressed by high gradients, such as the main steam stop valve, the main steam line check valve or the stop-check valve, the hot reheat gate valve and many drain valves.

The third level components, requiring additional attention, is formed by the static components in the boiler, such as the drum and the headers, as well as the main steam lines.
The steam turbine itself is another very important component which has to be heated carefully.
Last but not least are the huge flexible joints in the vacuum lines to the air cooled condenser. These hinges and gimbals are designed for a limited number of movements. Although we are not aware of failing flexibles so far, these components have to be reviewed from time to time.

The AVS solution

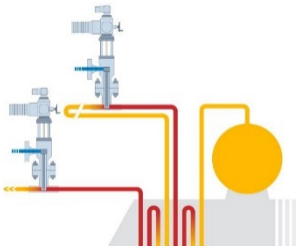
Advanced Valve Solutions USA Inc. is bringing a package of dedicated products to solve these problems, to save maintenance costs, to reduce starting time and to upgrade the reliability of you existing installation. Many years of experience and a group of high qualified European manufactures are supporting our performance.

The products

All control valve and attemporator components are engineered items. Based on the process conditions and the specific installation requirements we engineer a valve precisely for your application. This results in a mechanically optimized device. All components can be fitted with actuators of any kind to fit with your control system. Either pneumatic, electric of hydraulic, we supply the required actuator. It is often possible as well to re-use existing actuators.

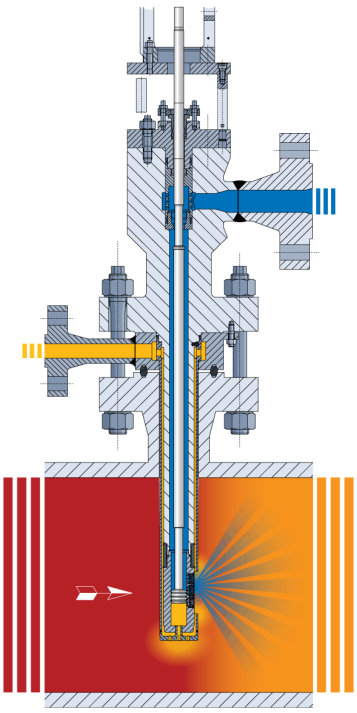
Attemporators

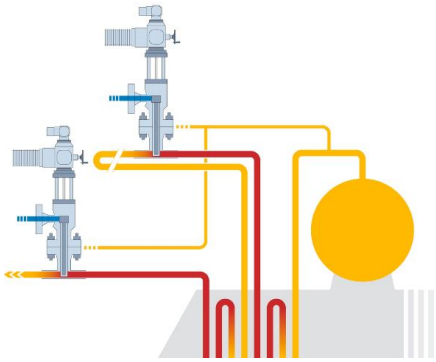
Steam attemporators, steam coolers or desuperheaters are devices which spray water into super-heated steam to cool it to a required temperature.

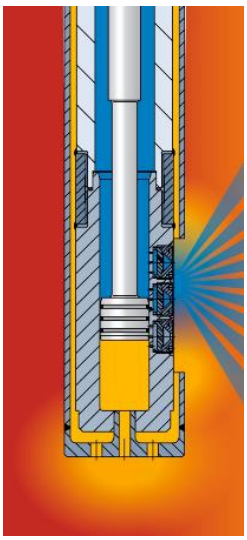


Multi nozzle and fixed nozzle mast type and ring type attemporators are the most common ones used. The main issues of these devices is the thermal stress problem. Placed in a hot steam flow, the valve body or the nozzle heads are heated up to the super-heated steam temperature. When attemporation is required “cold” water is injected, causing thermal shock on the nozzles and valve bodies, which leads to unpredicted damages and emergency shut downs.
Ring type coolers with spring loaded nozzles cannot achieve precise cooling. Separate fixed nozzles in combination with upstream control valves cannot cool the steam temperature very precisely either. There is no pressure drop left over the fixed nozzles in minimum flow conditions, and the atomizing is very poor. A liner is needed to protect the piping. To avoid too extreme a thermal shock some suppliers advise to use the attemporator on a minimum capacity continuously. The disadvantage of this is that the main steam is cooled even if this is not required and so negatively influences the efficiency.

The **“cooled desuperheater”** is the only steam cooling device which can operate without thermal shock. A saturated steam flow is bypassed from the superheater and is fed into a cooling jacket keeping the attemporator body at a low temperature level. The cooling steam is mixed up again with the main steam, resulting in no influence on the installation efficiency.





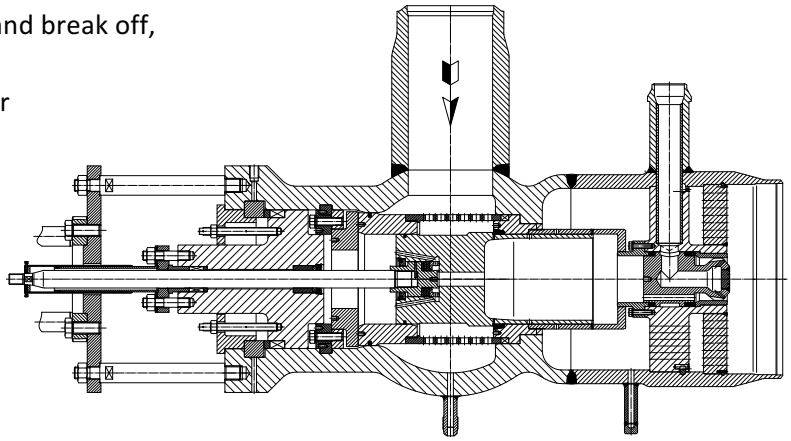


By pass stations

HP by pass stations are installed between the main steam line and the cold reheat. IP bypasses are operating between the hot reheat and the condenser. This cascade system is necessary to start the boiler plant quickly. It brings steam into the reheaters to avoid a too high thermal gradient.

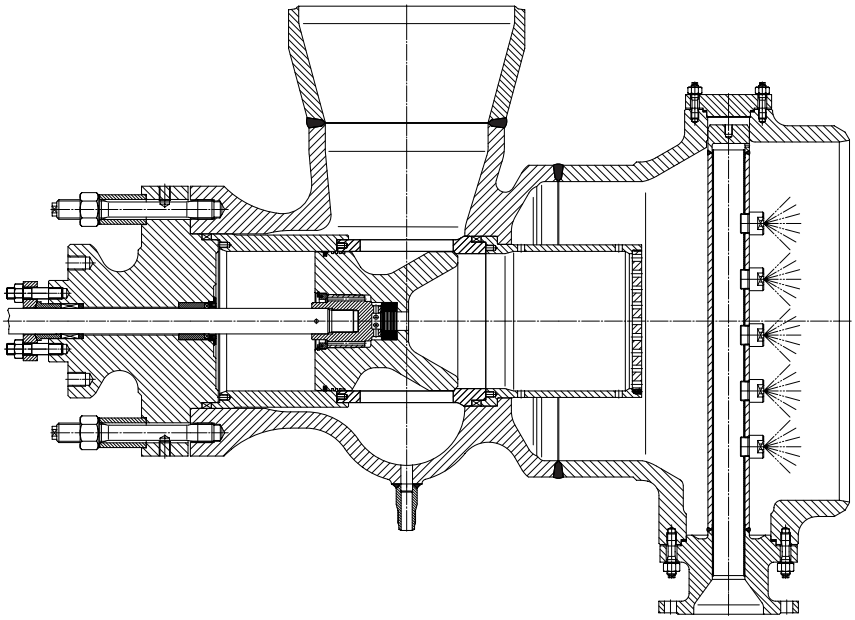
HP by pass stations

HP bypass stations are available in many configurations. Crucial is the range ability and the way the water is atomized and sprayed “with the flow” into the steam. Over the full control range the water has to be atomized and brought into the steam in the direction of the steam flow. The spray back situation, whereby water droplets are hitting the hot cages of the reducing station, must be avoided. This causes the hot cage to crack and break off, disappearing downstream.
The necessity to atomize the water into very fine droplets, also at minimum flow conditions without over- spraying is needed to control and cool the steam to set conditions.
A precise temperature control makes a quick start possible.



IP bypass stations

IP bypass stations are positioned between the hot reheat and the condenser, either a water cooled condenser or an air cooled condenser. The superheated steam now has to be reduced and cooled to preferably saturated conditions. We are using a spray bar with spring loaded nozzle with different spring settings spraying with the steam flow to create a water haze downstream the valve.

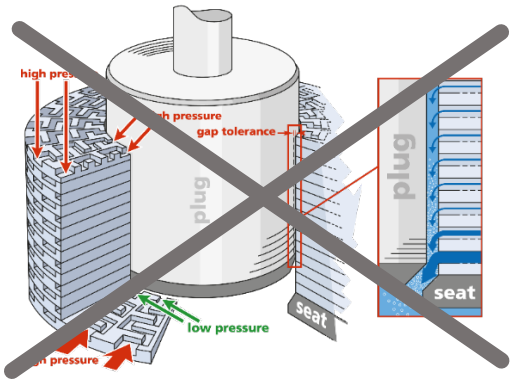


Again, the chance of backwards spraying should be avoided.

Range ability of the spray water is of lesser importance because the over saturated steam will be dumped in the condenser.

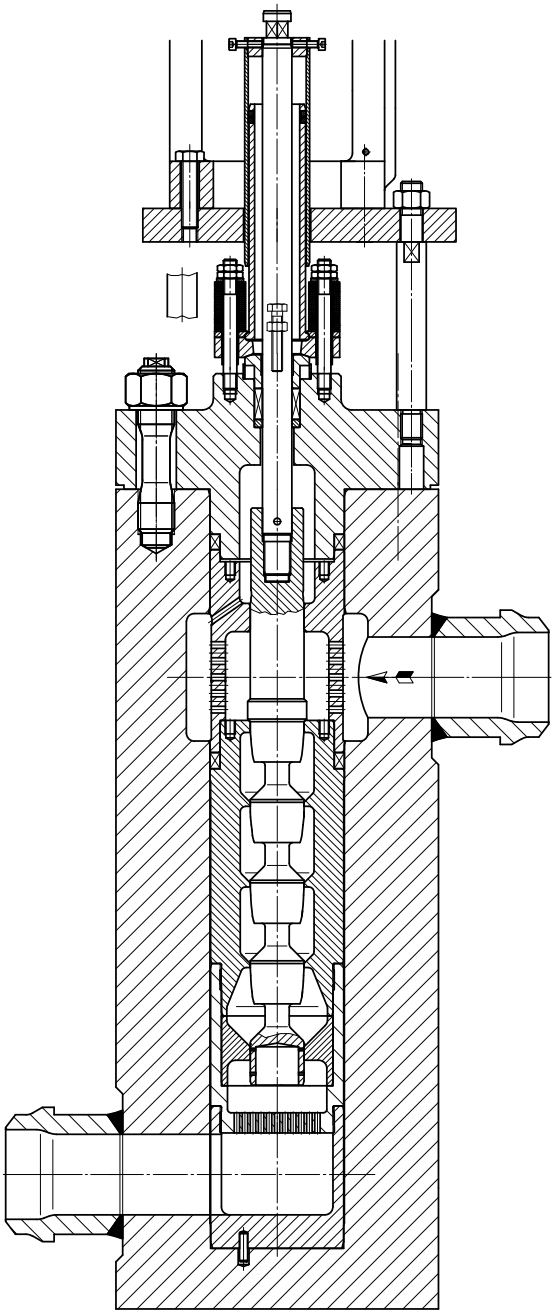
OTC valves

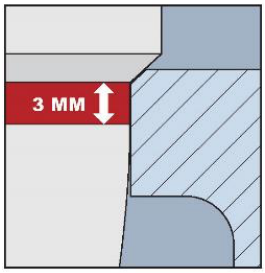
OTC level control valves are primarily used in CCGT installations based on GT 24 and GT 26 gas turbines . These valve are controlling the water level in the OTC. The range ability is enormous and often staggered trim designed valves are used.



Due to uncontrolled gap flows staggered trims are failing.

We developed a ridged multi staged control valve with a continuous flow control and exact defined pressure drops per stage to avoid cavitation and unstable control.



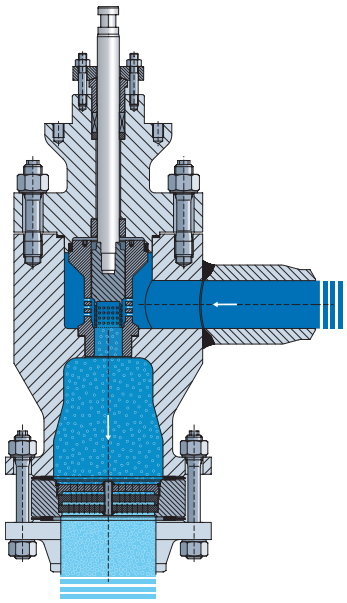


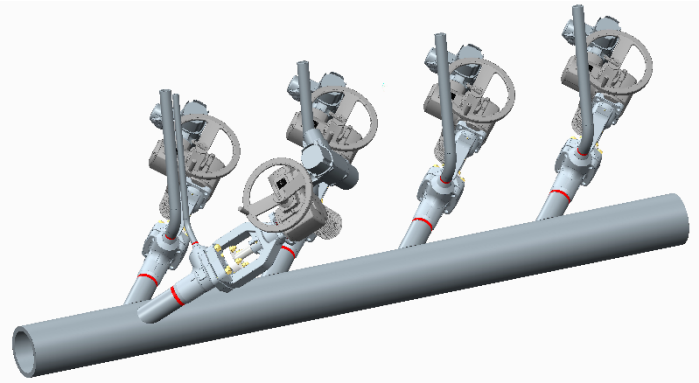
The first part of the stroke does not control any flow but is just energizing the different control stages. Moreover is it avoiding hammering during opening.

Our experience is, that these valves last between C-inspections.
Moreover are the valves competitive priced and are the spare prices very moderate.

Drain valves

Another source of concern is the situation of the drain valves. These valves now have to work every day dealing with the most aggressive process condition in the power plant: flashing high pressure water. Many different solutions are available.
We recommend an angle type valve with an increased outlet diameter, fitted with a quick changeable trim with a separate seat and control edge. Sometimes modifications on the pipe work arrangements are beneficial.

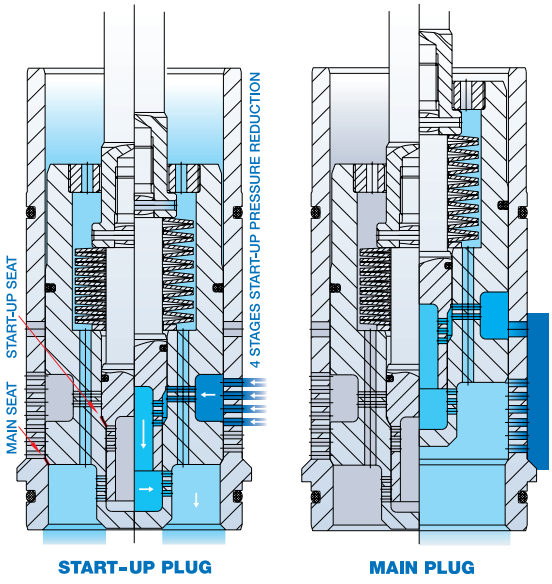


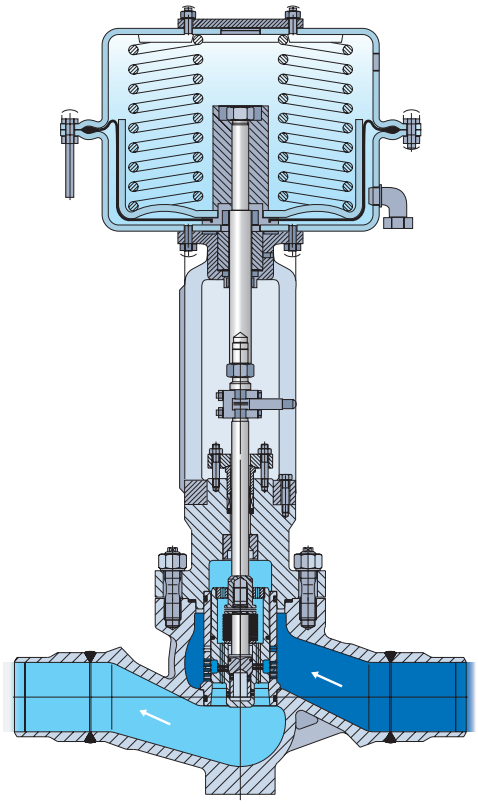


Throttling plates can be used to control the flow between the valve and the drain vessel.

Feed water control valves

Feed water control valves are not thermally stressed during daily cycling. The switchover from the 30% start up valve to the 100% FWCV however is stressful and is often done manually.
We supply an “all in one” feed water control valve with a controlled, multi stage pilot plug and a 100% main plug. Simple, cheap and a severe reduction of maintenance costs.

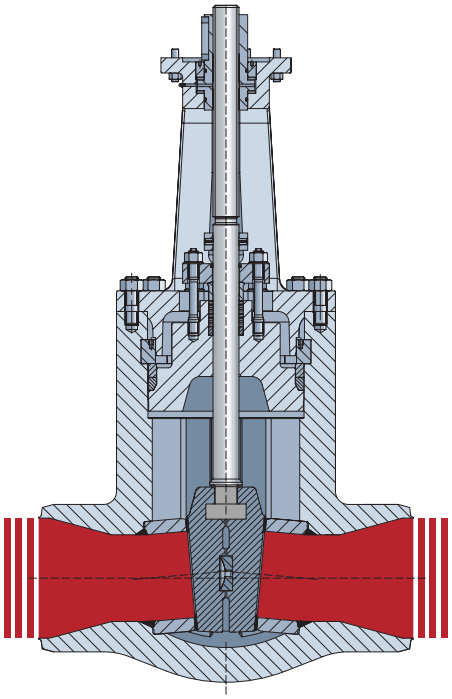




The on-off valves

Secondary problems due to start stop applications are seen at the on – off gate, check and globe valves.

Main steam stop valves

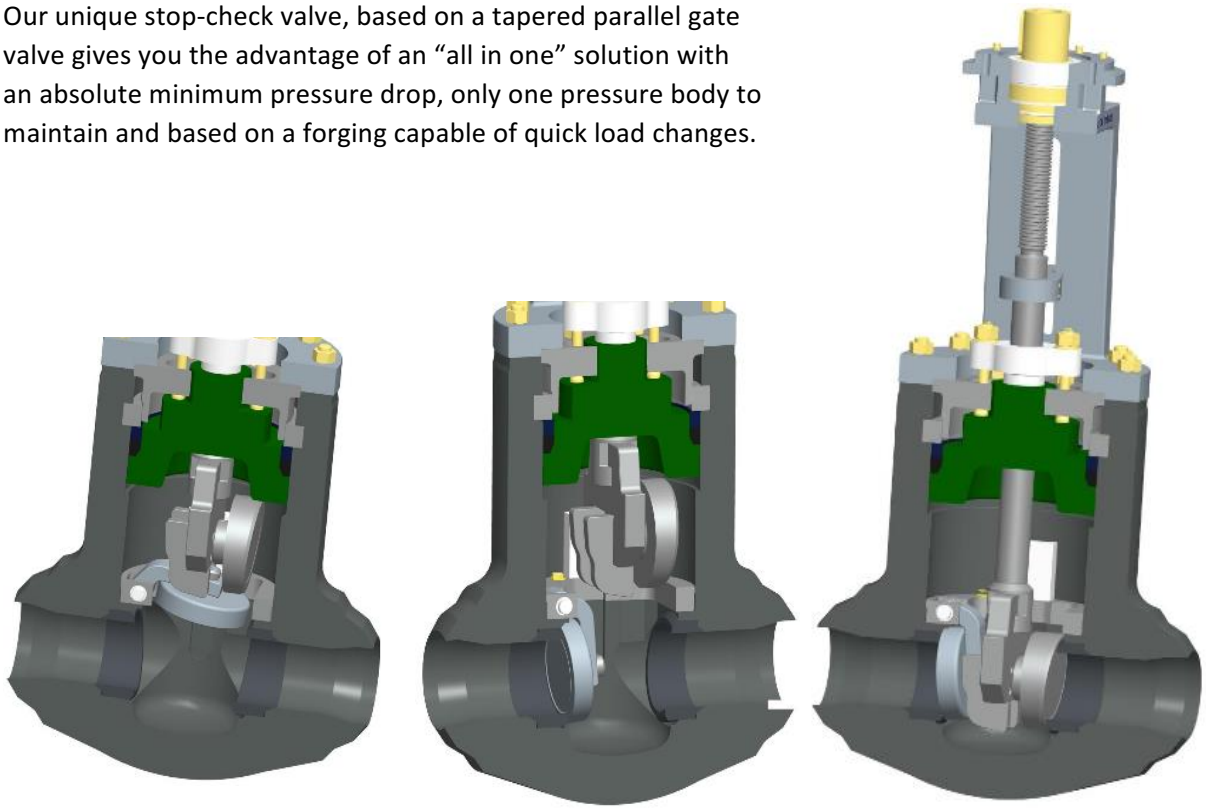


Main steam stop valves and check valves are operated to start a boiler.
They are thermally stressed, and are suffering the way they are operated. Heavy cast bodies, based on pressure classes are simply too heavy and it takes too much time to heat the whole valve body up. Internal material stress, material cracks and delaminating stellite seats are all causing problems.

Together with our suppliers we can offer light weight stop check valves and high pressure tapered parallel slide gate valves based on forged body materials.
Designed to pressure and temperature we can offer valves with heat gradients of 30 degC/min and more.
Minimum weight and a maximum capability to cope with thermal stresses.

Stop-check valve

Our unique stop-check valve, based on a tapered parallel gate valve gives you the advantage of an “all in one” solution with an absolute minimum pressure drop, only one pressure body to maintain and based on a forging capable of quick load changes.

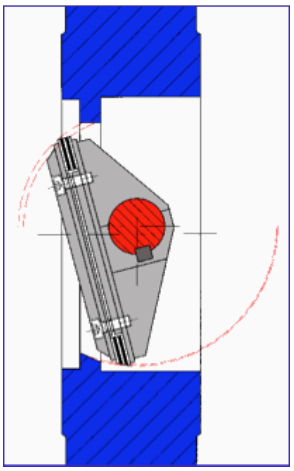


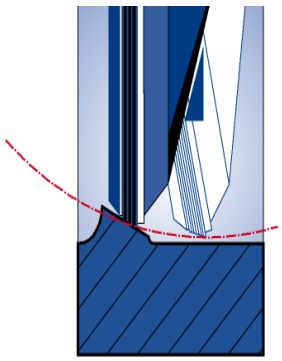
Hot reheat gate valve

The hot reheat main stop valve is normally based on a very heavy casting with all its disadvantages. We supply, based on F22 or P91 plated and forged material a fabricated gate valve or stop check valve with a minimum wall thickness capable of coping with the required heat gradients.

Cold reheat on-off and control valves

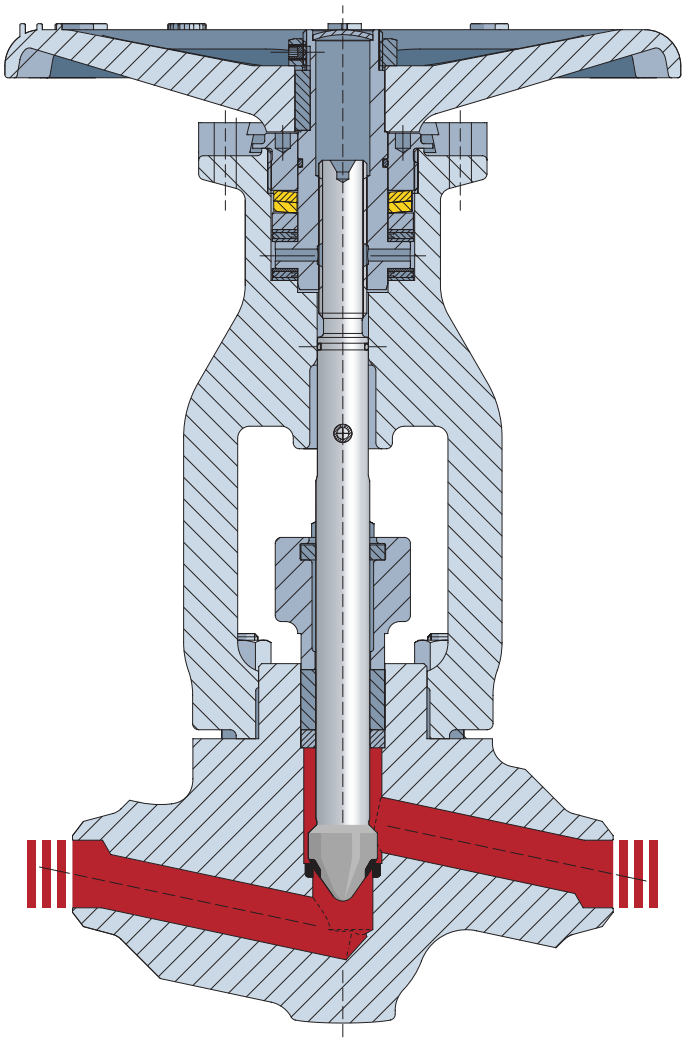
Many installations are based on the gas turbines, two HRSG's and one steam turbine.
In these cases a control element in the cold reheat is needed to guarantee an equal distribution of the steam over both boilers.
Tight shut off is another requirement.
Our special triple offset butterfly valve is capable of controlling and shutting off the cold reheat. With a key fixed disk thermal differences do not influence the sealing.





Globe valve

In normal installations many standard globe valves are used. In case an installation in often changing in pressure and temperature it is of importance to have a Bellville washer to compensate the expansion of the spindle versus the yoke. This device maintains an acceptable material stress between spindle and spindle nut arrangement and keeps the plug tight on the seat, by compensating the spindle length changes due to temperature.



Third level

A third level of consequences is formed by installed components such as expansion bellows, hinges and gimbles in air condenser lines. These components are calculated for a limited number of movements. Although no failures have been identified yet there is a risk for a leakage path.

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