Advanced Valve Solutions, Start-Stop Operation Summary

Introduction

Wind, solar power and other renewables energy generation creates a more flexible demand on gas fired power stations to balance the grid.
To operate in a reliable, quick, modulating and start/stop regime, some improvements are necessary.

To start and stop a CCGT installation takes time. The gas turbine should be warmed through as well as the rest of the power plant, the HRSG, (Heat Recovery Steam Generator) downstream of the gas turbine, the interconnecting steam pipework, the steam turbine and all other balance of plant items.

This should be done as quick as possible to limit the starting costs and to supply as soon as possible to the grid. For all CCGT plants the demand for being reliable and the need to be able to start the installation, to supply to the grid, is the single most important driving factor.

What Is Influencing This Reliability?

Primarily, the thermal stressed components of the boiler are representing a severe risk such as thermal fatigue in drums, headers, down comers and piping.
Secondary, components like the inter-stage and final attemperators, the HP and IP by pass valves, the main steam stop valve, the stop check valve and the hot reheat gate valve are seeing extreme heat gradients causing thermal stresses.
Thirdly, components such as drain valves, feed water control valves, startup blow off control valves, OTC level control valves in GT 24 and GT 26 turbine installations are also experiencing increased Flow Accelerated Corrosion (FAC) due to an increase in the flashing and cavitating conditions.
Further to this, the steam turbine itself is a crucial component to ensure the run up of the unit allows for gradual and controlled heat input.

The AVS Solution

Advanced Valve Solutions USA Inc. has a bespoke package of dedicated products to solve the majority valves problems, based on our specific and extensive experience in these types of operating regimes. With this package in place, it leads to reduced maintenance costs, to reduce starting time and to upgrade the reliability of your existing installation. With many years of experience and a group of high qualified European manufactures supporting our performance, we deliver a complete solution.

Maintaining Pressure Overnight

The reduction of starting time is achieved by maintaining pressure in the boiler during the shut-down overnight. If all valves are tight, such as the installed bypass stations, the main steam (stop-check) valves and the blow down and drains valves, the boiler can be kept under pressure and a hot start can be achieved.

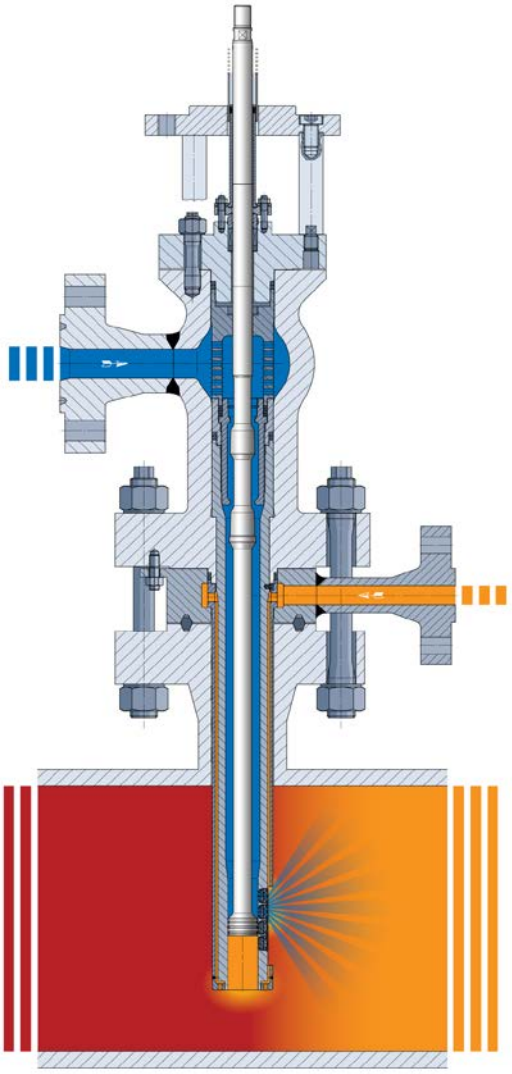
The Products

All control valves and attemperators are specific engineered items. AVS will engineer the valve based on the process conditions, and application. This results in the delivery of a mechanically optimized device.
All components can be fitted with either pneumatic, electric or hydraulic actuators. It is often possible as well to re-use existing actuators.

Attemperators

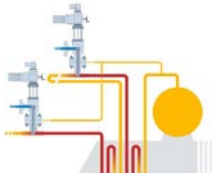
Steam attemperators, steam coolers or de-super heaters main purpose is to cool super-heated steam by spraying water into the process. Multi nozzle or fixed nozzle mast type and ring style attemperators are the most common used types.
The main issues for these devices is the creation of fine droplets, in combination with a wide range ability.

The multi nozzle mast type attemperator provides a constant pressure drop over the nozzles in all flow conditions, guaranteeing the smallest droplet size over the full range ability (1:100).
Ring style attemperators and fixed mast types have a limited range ability in which adequate sized droplets can be formed.
Secondary is the thermal stress problem. Located in the hot steam flow, the attemperator body and nozzle heads are exposed to the superheated steam temperature and will quickly heat up to the super-heated steam temperature. When attemperation is required, “cold” water is injected, causing thermal shock in the nozzles and valve body due to the great temperature differential between cooling water and the components, which leads to unpredicted damages and emergency shut downs.



Cooled Attemperator

The **“Cooled Attemperator”** is the only steam cooling device which operates without thermal shock. A small flow of saturated steam is continuously fed into a cooling jacket around the mast, keeping the attemperator body and mast at a low saturated steam temperature. This cooling steam passes over the nozzles and is then mixed up again with the main steam.

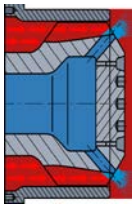


AVS have installed multiple cooled attemperators across in the most severe start stop applications in the European Market, all with great success.

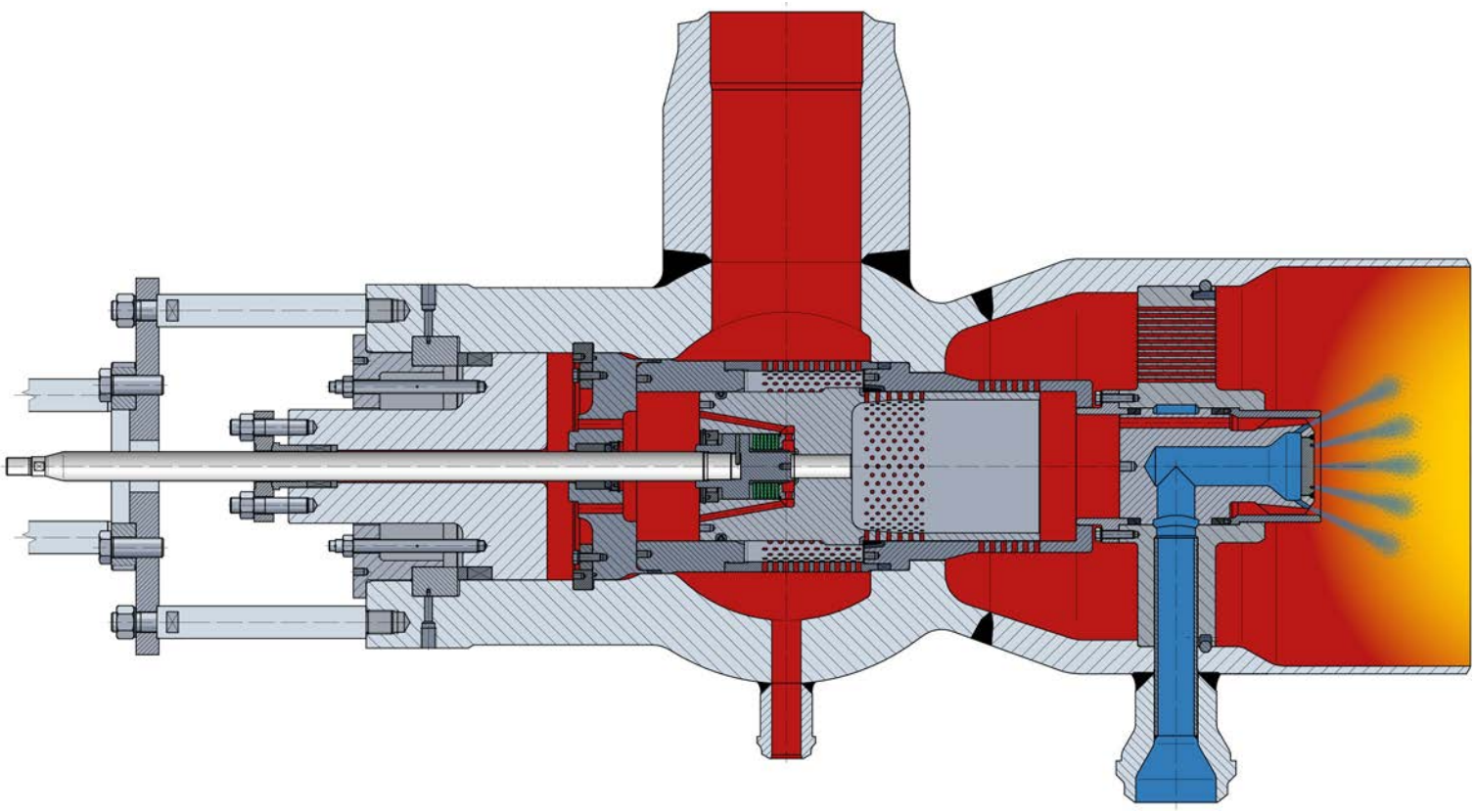
Bypass Stations

HP Bypass Stations are installed between the main steam line and the cold reheat. IP or HRH bypasses are operating between the hot reheat and the condenser. This cascade system is necessary to start the plant quickly and safely ensuring no damage is caused. It brings steam into the re-heaters to avoid an increasingly high thermal gradient.

HP Bypass Stations



The preferred method for HP bypasses in start-stop installations is the use of steam assisted atomizing heads. Critical expanding steam atomizes the cooling water in extreme small droplets. By spraying centrally in an axial direction there is no chance of spraying onto the hot trim parts or onto the downstream piping, in combination with a very good range ability.
The Sauter (D32), diameter of the droplets, is much smaller than droplets formed in a pressure difference driven cooler or spring loaded nozzles in a ring type cooler.

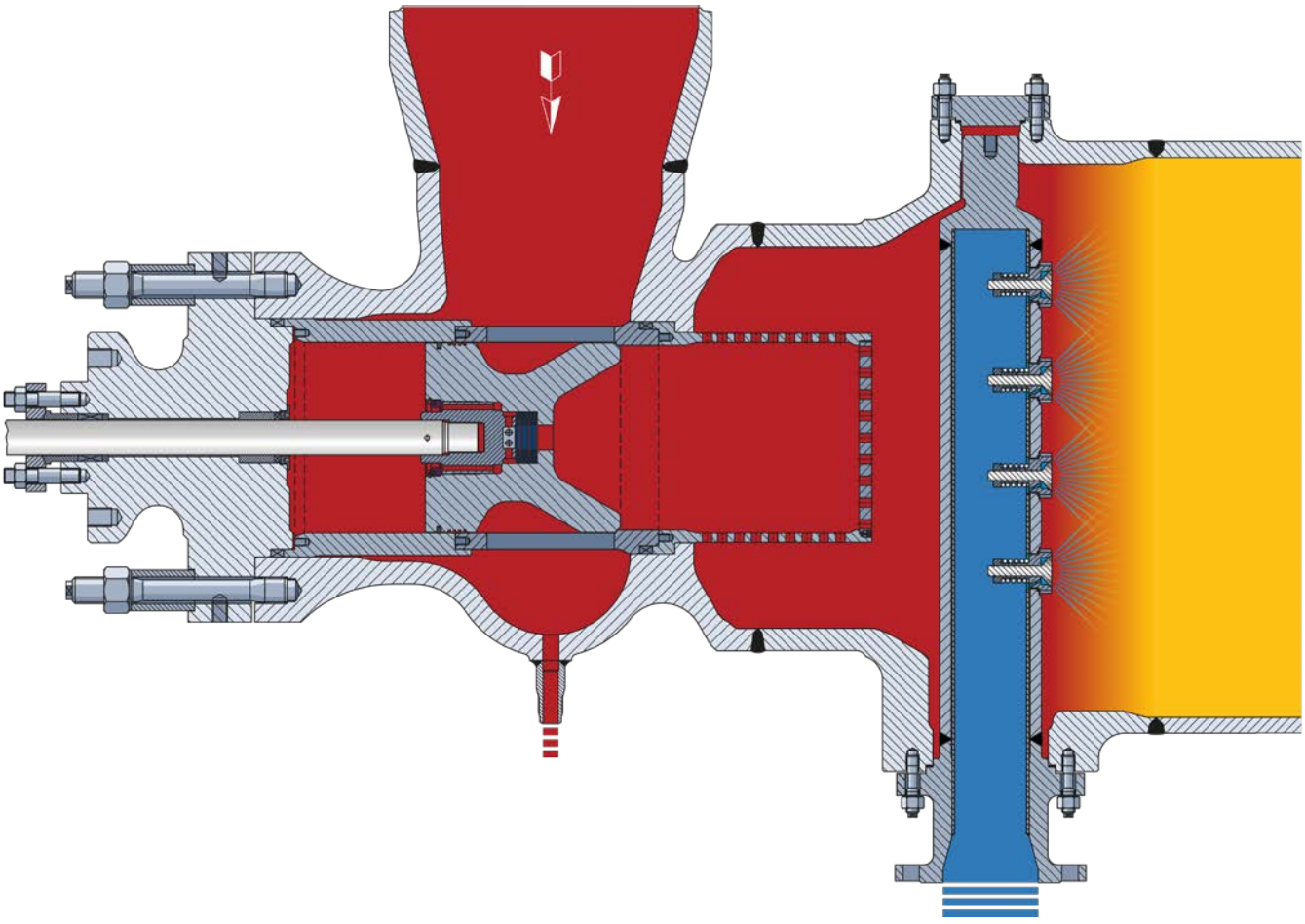


HP bypass, clamped trim, pressure seal, steam atomizing spray, spherical body.

IP or HRH Bypass Stations

IP or HRH bypass stations are positioned between the hot re-heat and the condenser. The superheated HRH steam must be reduced and cooled to preferably slightly over-saturated conditions. We are using a spray bar with spring loaded nozzles. Each nozzle has a different spring setting, allowing a more controlled spray. The Nozzle spray bar is spraying with the steam flow, this is to create a water haze downstream of the valve, not damaging the valve or hot parts.

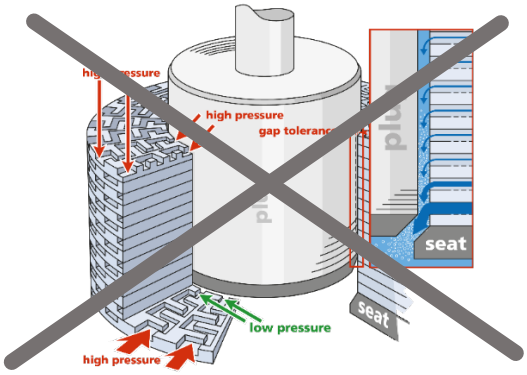
Range ability of the spray water is of lesser importance because the over saturated steam will be dumped in the condenser, meaning no specific temperature is required.
The pilot plug operated balanced trim guarantees tight shut off during the shutdown periods.

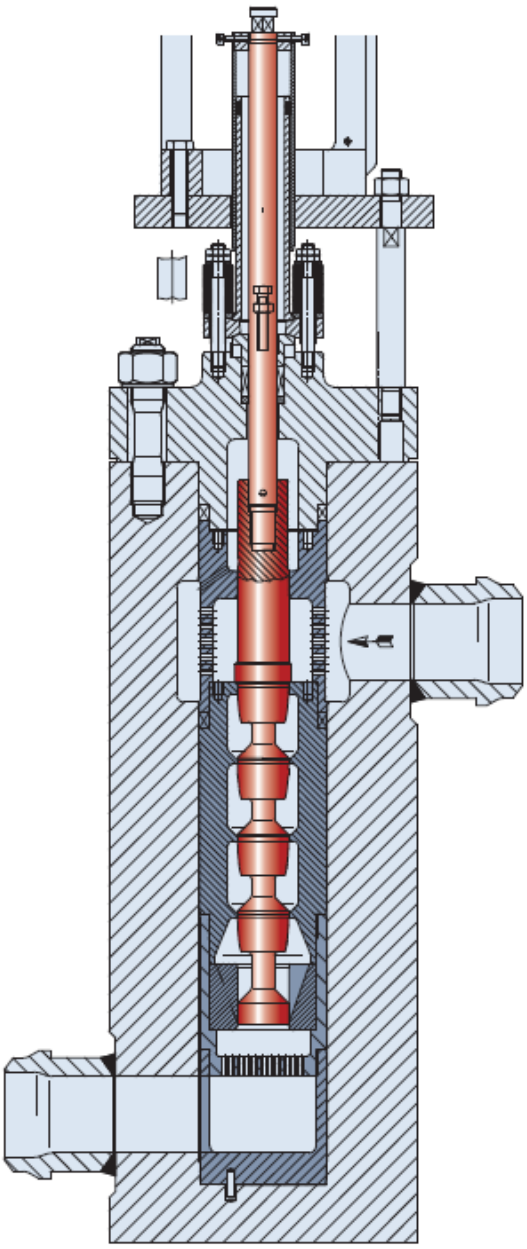


IP bypass, clamped trim, spray bar with spring loaded nozzles,

OTC Valves

OTC level control valves are used in CCGT installations based on GE/Alstom GT 24 and GT 26 gas turbines . These valves are controlling the water level in the OTC (Once through Cooler.
The range ability is enormous. Often staggered trim designed valves are used.

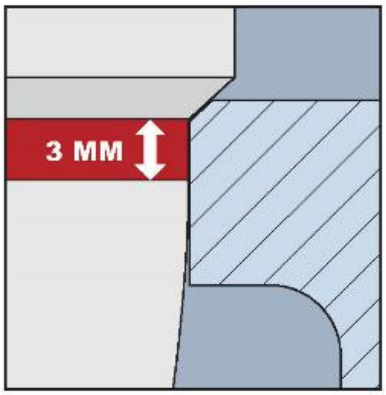




Due to an uncontrolled gap flow, staggered trims are failing.

We developed a ridged multi-staged 5 or 7 staged control valve with continuous flow control and an exact, defined pressure drop per stage to avoid any cavitation and unstable control.

The first part of the stroke does not control any flow but is just used to energize the different control stages, Moreover it avoids any hammering during opening.

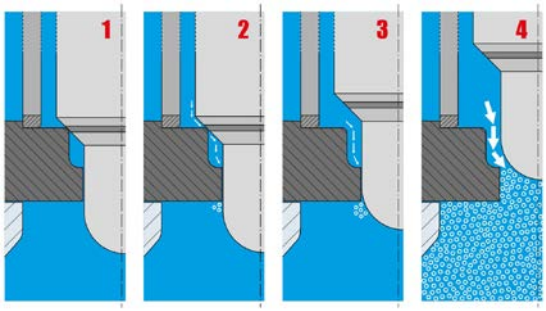


It is our experience, that these valves will now last between C-inspections. Furthermore, the spares prices are cheaper than that of a staggered trim design, and in most cases, the entire valve is more cost effective than replacing parts in a staggered trim design valve.

Drain Valves

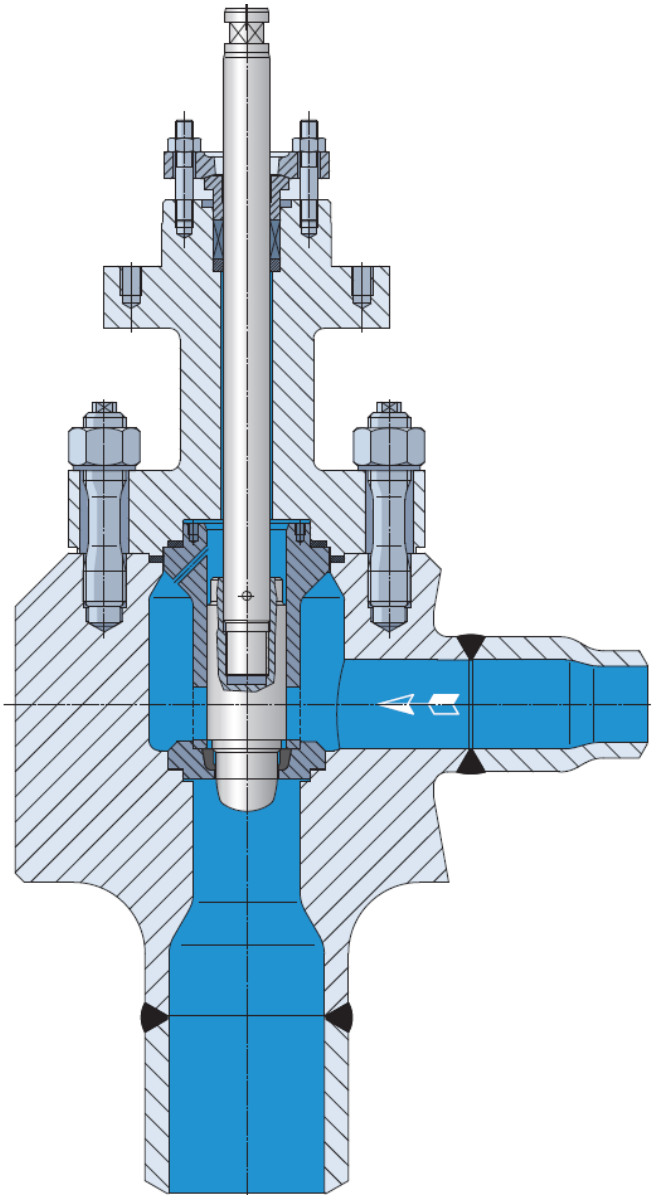
Another source of concern is the condition of the different types of drain valves.
The continuous, the dis-continuous blow down and the super heater drain valves must be monitored carefully.

In a start-stop regime these valves now must work every day, dealing with the most aggressive process conditions in the power plant: Flashing, high pressure water.



We strongly recommend an angle type valve with an increased outlet diameter, fitted with a quick changeable trim and a separate seat and control edge.
A full stellite seat in combination with a hardened cylindrical-parabolic disk protects the seat area. The control function is done by a second seat.

Sometimes modifications on the pipe work arrangements are beneficial. The preferred location is as close to the flash-drain tank as possible.

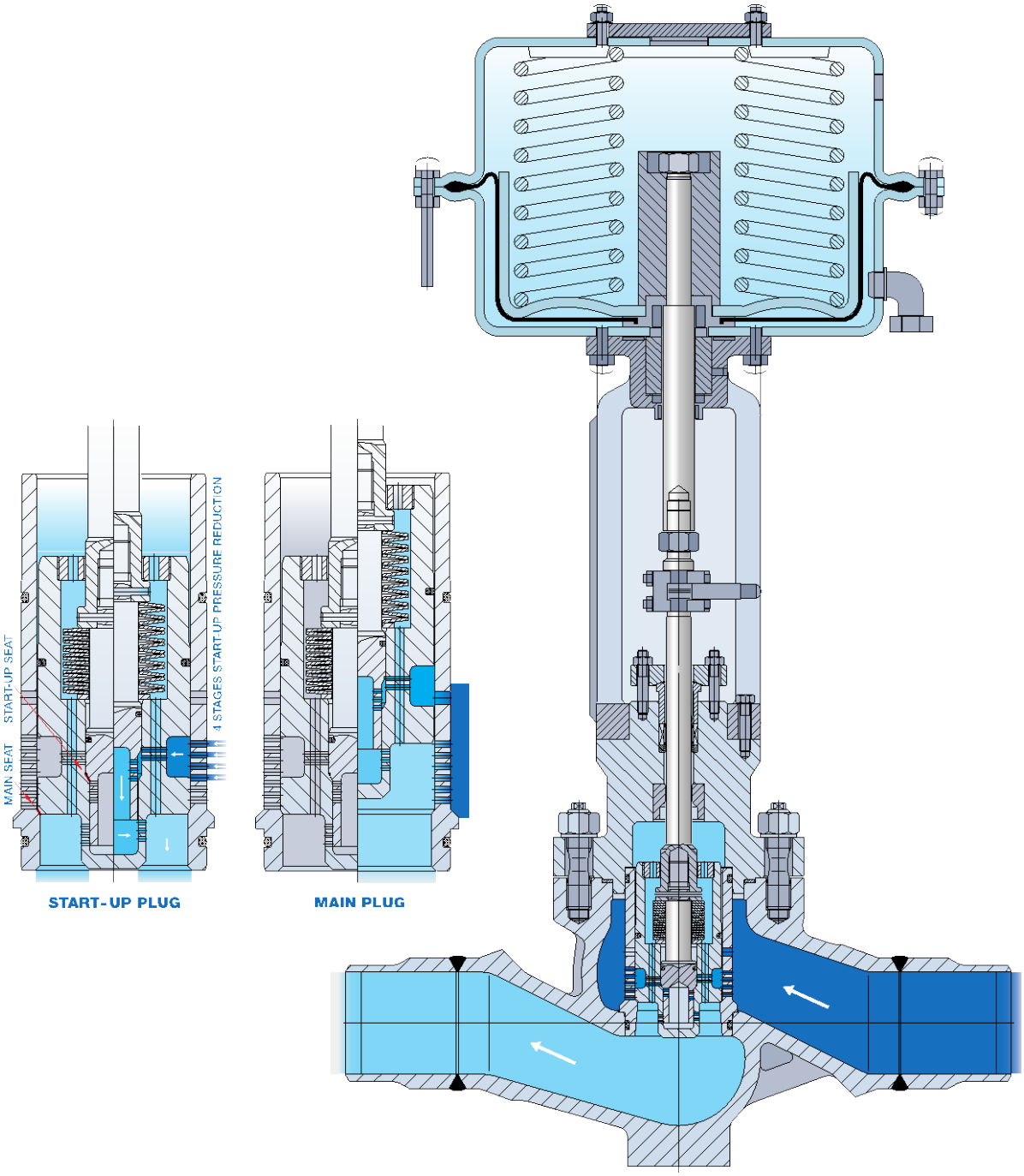


Typical drain valve, clamped trim, separated control and sealing edge, extended outlet size, forged body.

Feedwater Control Valves

Feed water control valves (FWCV) are not thermally stressed during daily cycling. These valves are venerable for FAC (flow acceleration corrosion)
The daily switchover from the 30% start up to the 100% FWCV is stressful and 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 significant reduction in maintenance costs.



Typical combi feed water control valve.

The On/Off Valves

The main steam stop valves, the cold and hot reheat gate valves and the stop check valves. These valves have a crucial function in isolating the boiler, this in increasingly more import in the case of a start-stop regime.

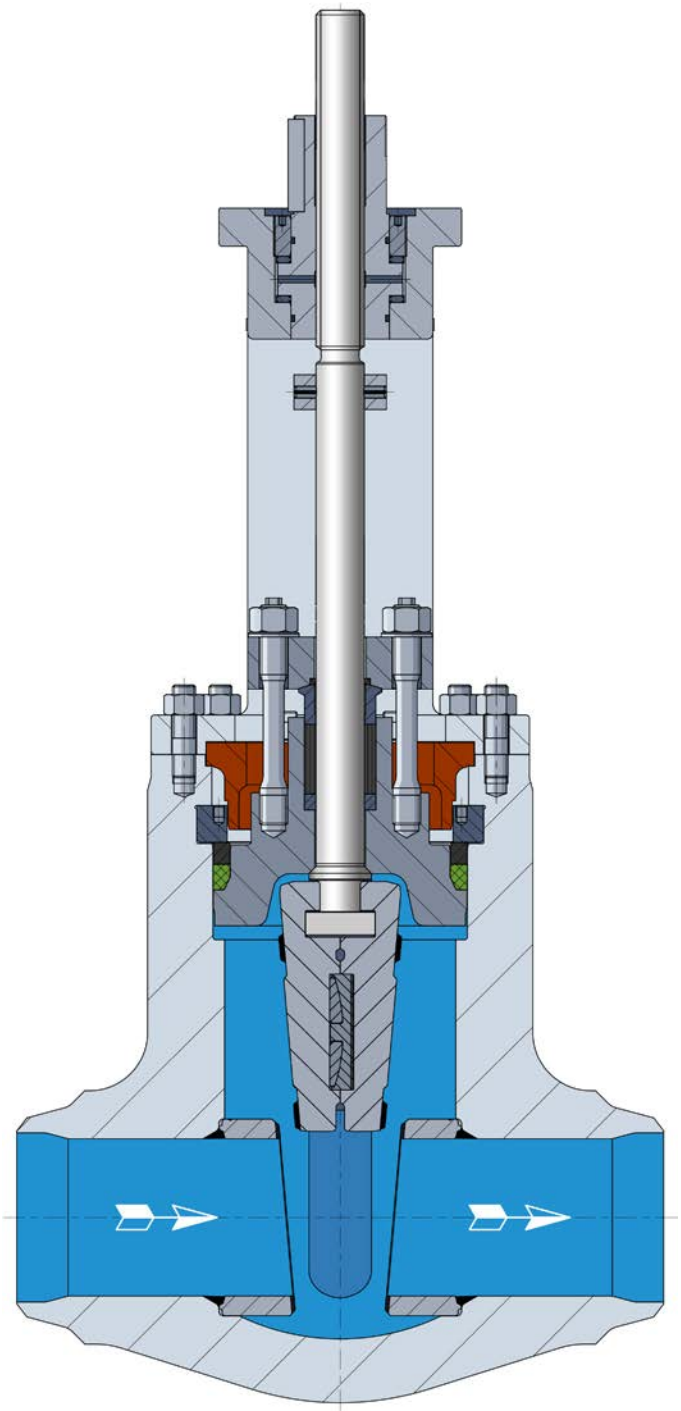
Main Steam Stop Valves

Main steam stop valves and stop-check valves are operated to start and stop a boiler.

They are severely thermally stressed, and are often being damaged simply by the way they are operated. Heavy cast bodies, based on pressure classes, are simply too heavy and it takes too long to heat the whole valve body up. Internal material stress, material cracks and delaminating stellite seats are the typical problems we see.

We can offer a 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 up to 30 degC/min and more.
Minimum weight and a maximum capability to cope with thermal stresses.

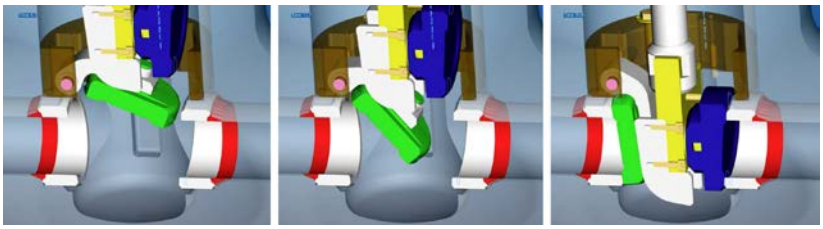
A brought spectrum of body materials and welding procedures make it possible to deliver fit for purpose optimized gate valves.



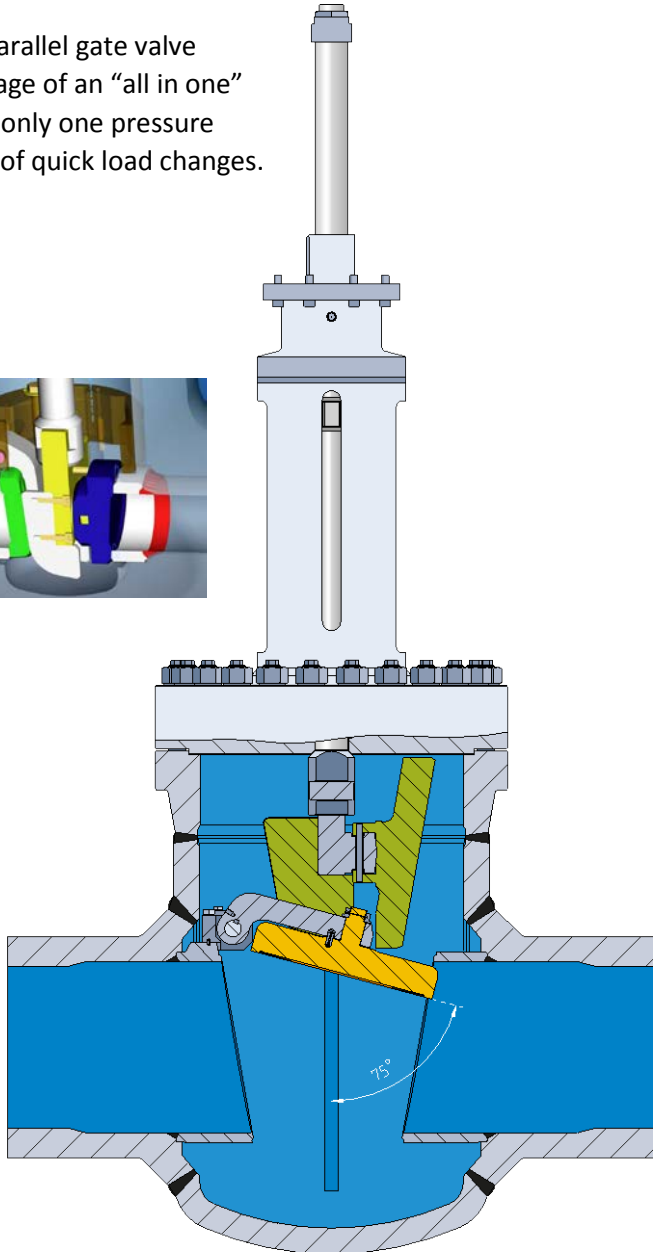
Main steam stop valve, pressure seal, tapered parallel design, forged body

Stop-Check Valve

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



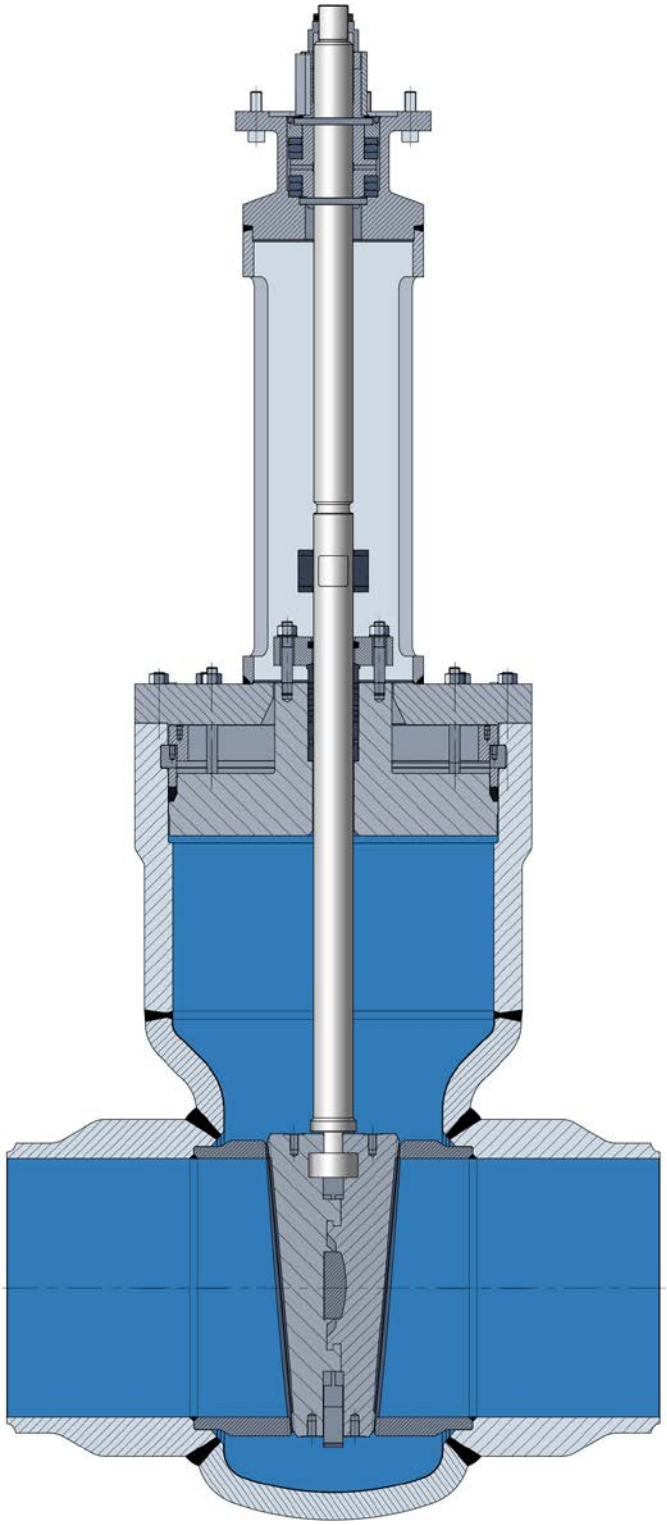
swing check valve based gate valve



Tapered parallel slide stop-check valve, fabricated body,

Hot Reheat Gate Valve

The hot reheat main stop valve is normally based on a very heavy casting with all the previously mentioned 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.



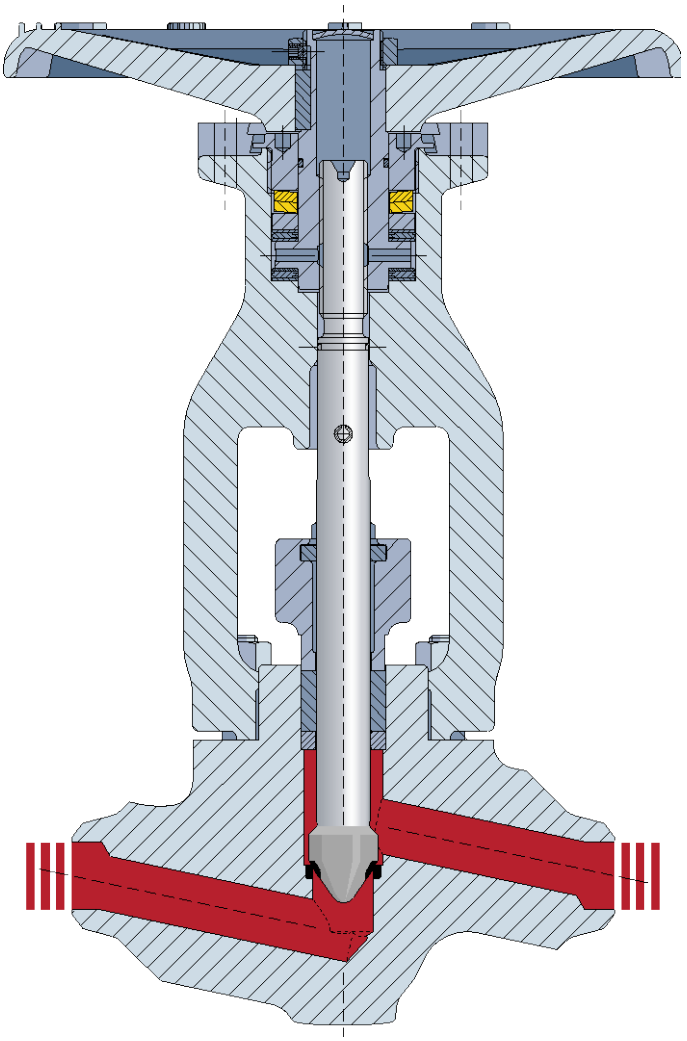
fabricated tapered parallel slide gate valve, hot reheat

Cold Reheat On/Off and Control Valves

Many installations are based on around 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
can control precisely and shut off
the cold reheat. With a key fixed disk, thermal differences do not influence the sealing.

Globe Valve

In 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.



globe valve with thermal compensation

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