Two shift operation power plants

Power stations that were originally designed for base load applications are now increasingly being asked to operate on a two shift, stop start regime; this is more commonly known in the industry as dual shifting. The multiple start/stops that these stations are now experiencing is in some instances causing an increase of operational issues due to the to the constantly changing process parameters. For example dual shift stations will experience additional thermal stress in the headers, drums, high temperature piping, valves plus the auxiliary equipment leading to additional wear and tear of their systems and component parts. This is due to the more frequent use of the plant at severe service conditions. The consequences of the change in plant operation cannot be ignored. If the plant is not operated correctly or more importantly modified properly to handle these changes the lifetime of the components within the plant will decrease enormously.

The changing operational requirements of the plant require that the steam coolers, de-superheater valves, drains, feed water control valves, main steam isolation valves and the turbine quick closing valves are reviewed. These critical pieces of equipment have to be specifically designed to take the new duel shifting process requirements into consideration, once this has been done, operational performance of the plant can be improved and wear and tear of systems and components can be controlled and significantly reduced. Consequently as these pieces of equipment have been specifically designed for the new operating conditions of the station they are no longer a limiting factor to the start up time of the plant.

The following paper highlights some of the more common issues found in dual shifting power stations with special regards to steam control.

Drain valves

Drain valves are amongst the most complicated valves used in a power station.
The valves have to be designed for the primary pressure and temperature conditions, in this case 179.3 barg and 568 dgr C.

However in practice the working conditions of these valves can be totally different from the design conditions. When the station is starting up or shutting down, the collected condensate needs to be discharged during start up through the drain control valve into the drain vessel. Both pressures and temperatures can fluctuate across a wide range during this process.

The correct performance of the drain system is imperative on a station where the system is expected to perform multiple stop-start cycles as commonly seen when stations start to dual shift, as opposed to the drain valves on a base load station which are designed to operate only once or twice a year.

The actual situation

The problem commonly seen at the drain control valve is the phenomena of flashing.
By reducing the pressure a percentage of the condensate will evaporate and will transfer from water into a water/steam mixture creating extremely wet steam.
This medium will behave as steam and will reach a critical reduction with critical velocity.
The water droplets will be accelerated (up to 330 m/s and more, 1188 km/h or 742 miles/h) and will behave as destructive objects eroding everything in their path. We can imagine that the seat of the existing gate valve will be damaged due to this process and consequently the downstream pipe work could also show signs of erosion.

Below:
picture shows a P91 pipeline after a 1 stage globe valve on the steam turbine HP drain line.

The hole in the pipe is approx 8 x 5 mm

The "Advanced Valve" solution:

Drain valves in dual shift power stations are playing a crucial role in controlling the heat radiant of the pipe work. They are performing every day and need to be tight as soon as the station is on line. AVS, in conjunction with HORA have developed a drain control valve specially designed for power stations which have to be operated on a dual shift cycle.

The big advantage of this valve is the separation of the different functions, control and isolation.

1. The seating area of the valve is located outside the critical flashing flow. The valve is fitted with a control plug working against a high back pressure to minimize the flashing in the first stage of the valve.

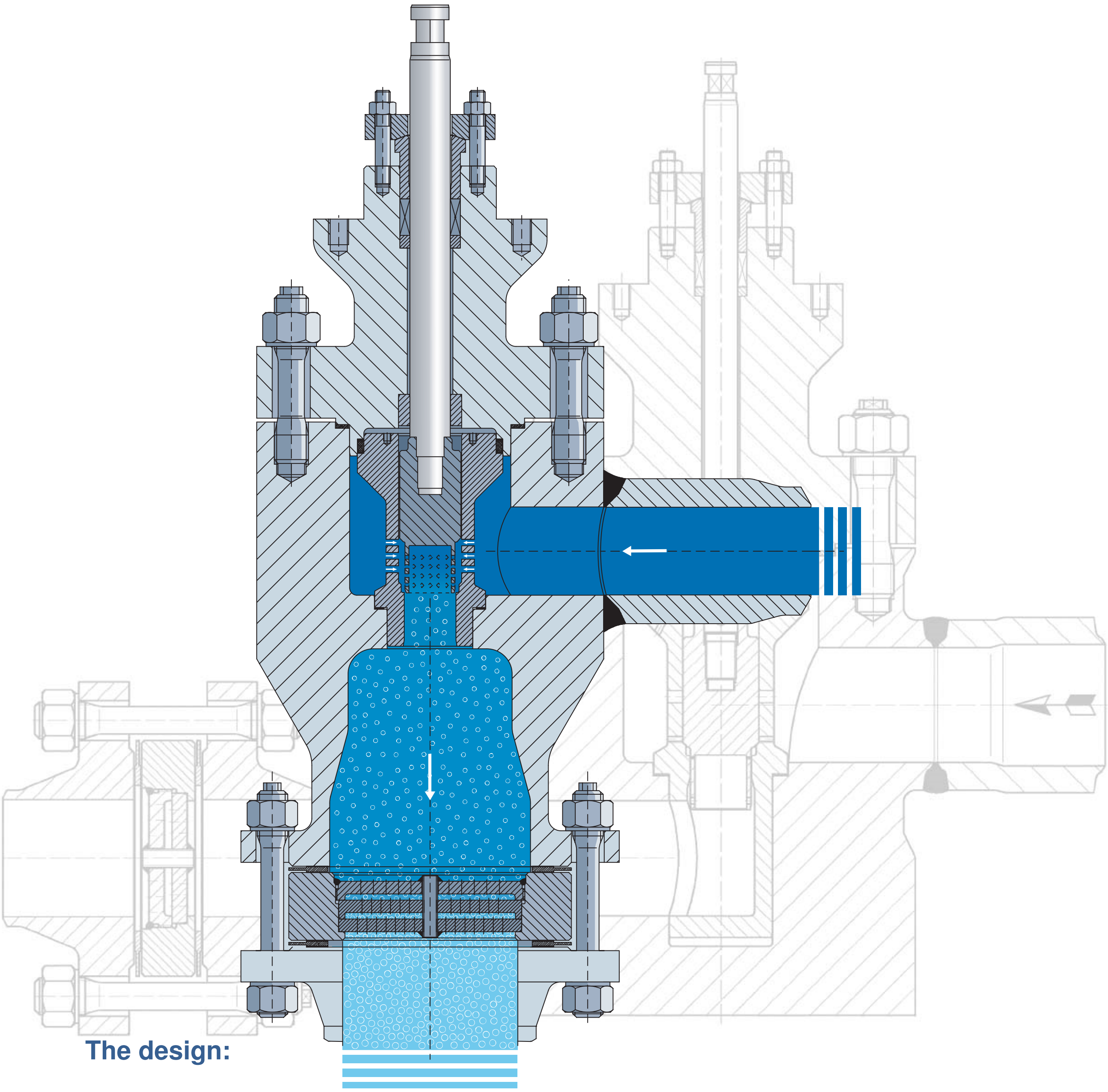
2. The seat / control valve cartridge made of hardened stainless steels which minimises wear and tear as well as the cartridge style trim which can be changed quickly.

3. The downstream outlet extension increases the diameter and reduces the steam velocity accordingly.

4. A set of three ridged throttling plates, to create enough back pressure on the plug and to "control" the flashing process. The throttling plates are designed to be sacrificial. Maintenance of the sacrificial throttling plates is designed with the minimum of downtime and cost in mind.

5. AVS would recommend an angle type valve for this application. The high erosive mass flow through the valve can then be discharged into the downstream pipe work and then on into the flash vessel. This is preferable to pushing the steam/water through an additional bend as would be required on a straight pattern design of valve.

6. A straight pipe run downstream of the valve and throttling plates to the flash vessel is recommended. If required the throttling plates can be located close to the flash tank for ease of access and subsequent weight saving at the valve location.



The design:

If the pressure increases and/or the heating process continues then the mass flow will change. Fresh steam and less condensate will be discharged into the flash vessel. In order to cope with the unknown mass flow and its effect on a valve trim the design philosophy is that the pressure of the water steam mixture through the valve is reduced by a plug and a set of throttling plates.

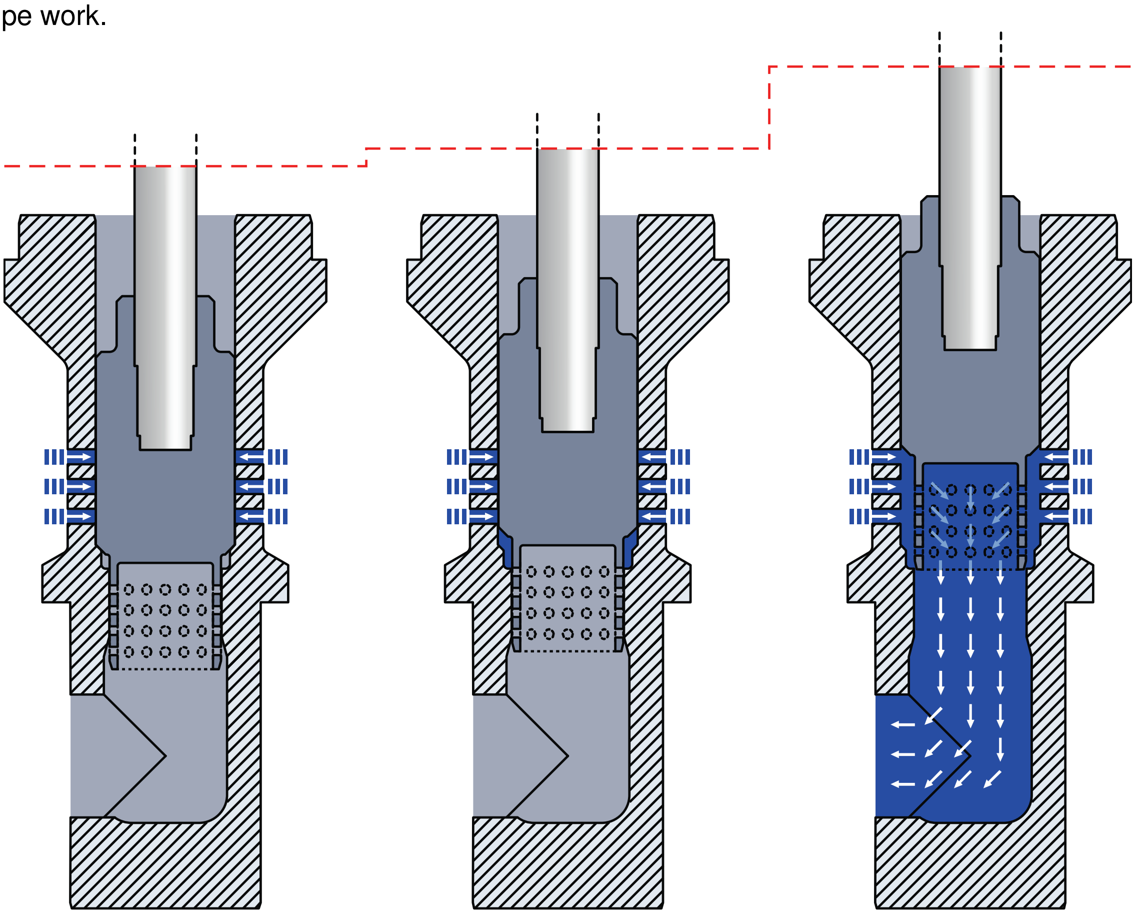
The multi stage pressure reduction will build up a back pressure to the control plug which will reduce the flashing and erosion in the first stage of the trim

In the case where there is high pressure and a super heated temperature, let's say the last stage of the start-up procedure, the steam reducing capacity is limited and therefore the loss of steam is limited. The mass flow is difficult to calculate as it is a derivative of the highly fluctuating process parameters,

Separated seat and control edge:

Of most importance is the repeatable sealing performance of the seat and plug.
The plug is designed with a "separated seat and sealing/control edge". The principle is simple. The sealing surfaces of the plug and seat are away from the mass flow during the pressure reducing process. Before the first control bore in the cage is exposed the valve has to be stroked over a certain length. During this first part of the stroke no flow can pass through the valve. When the plug is lifted further the first control bores are opened. The sealing surfaces of the plug and seat are away from the mass flow so they will not be damaged.

In case of a Z pattern valve the cartridge is fitted with a oversized bottom so the eroding flow is not able to damage the valve body. In the case of the (preferred) angle type pattern valve the mass flow can expand in the valve outlet and then into the downstream
pipe work.



closed

open/no flow

open/max flow

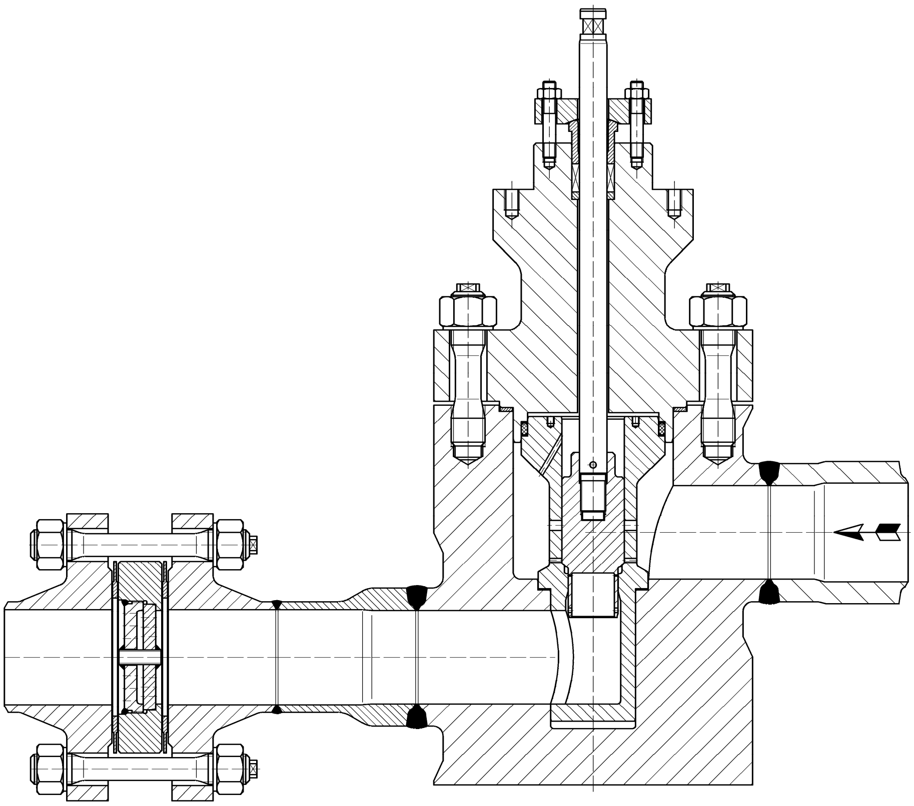
Advanced Valve solutions support

We hope that the remarks above have been of interest, and we would welcome the opportunity of discussing the valve design with you more thoroughly. If however you have any immediate questions regarding the valve design principles please do not hesitate to contact us.

references:

1. ESB Coolkeeragh, Northern Ireland,

2. GDF Suez, Eems power station



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