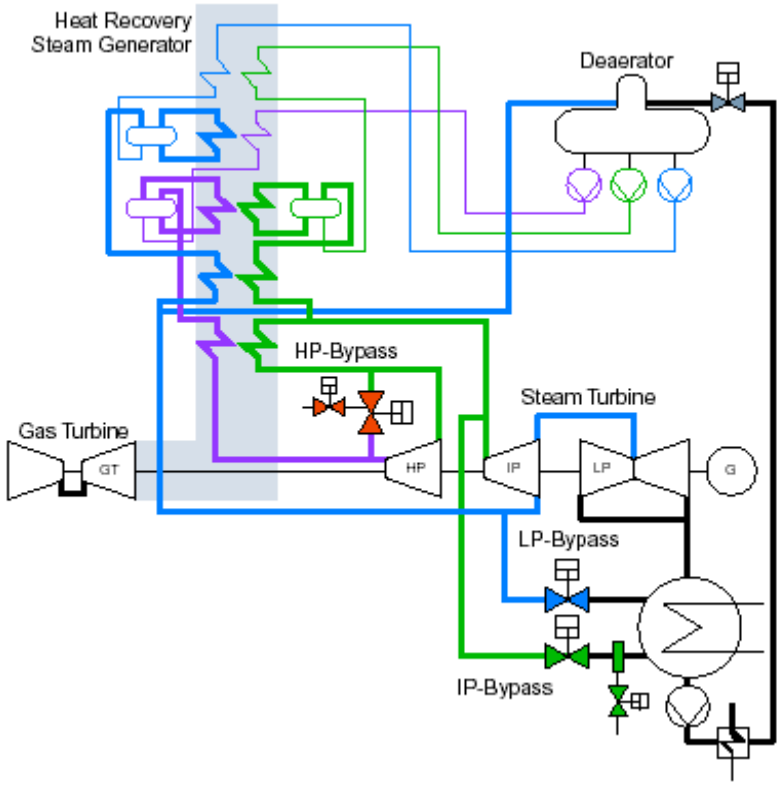
Application

A turbine bypass system permits operation of the boiler independently from the steam turbine during start-up, commissioning, turbine trip (shut down) and load alternations. It gives a higher plant availability and operational flexibility over all different operating conditions. The start-up time under cold, warm and hot conditions is reduced. Keeping the thermal transient in the boiler to a minimum continuous flow through superheater and reheater (maintained tube cooling) must be provided and the pressure during the entire start-up has to be controlled. A turbine bypass system is in operation until desired steam conditions from metal temperatures of rotor and casing of the turbine are matched. This method reduces the solid particle erosion to the turbine also, since the loss of material from the boiler internals most likely occurs during start-up. After a load rejection of the turbine the bypass valves operate the boiler at an optimal standby load and avoid a boiler trip. They equal the difference between the steam generator and the turbine flow. It is a big advantage that commissioning of the boiler can be carried out totally independent of the turbine. Boiler trials that are usual when commissioning the firing system are performed without stressing the turbine unnecessarily.



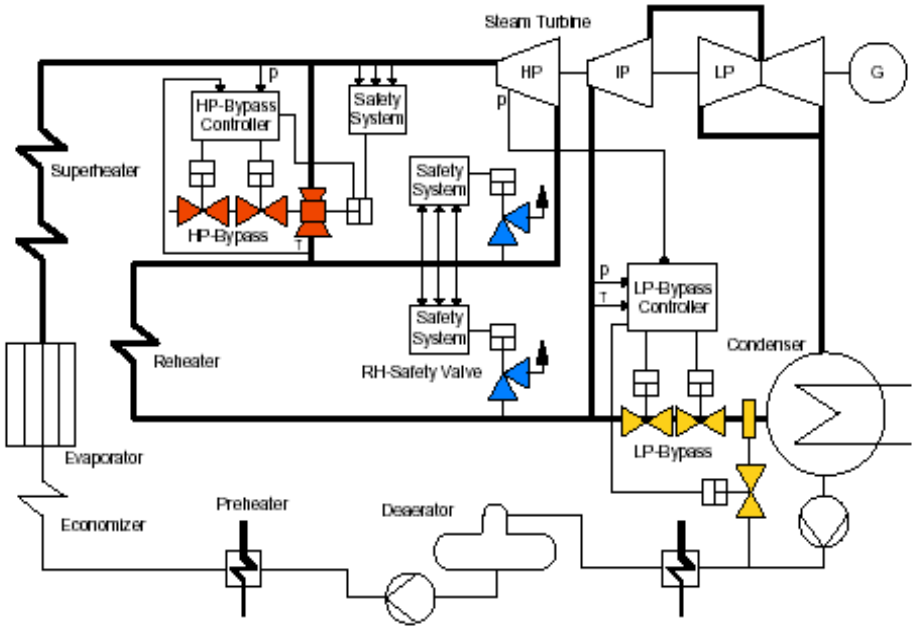
The HP-bypass valve is sized for 100% steam capacity of the boiler to reduce the pressure integrated with desuperheating (PRDS) to cold reheat conditions. It has to protect the live steam piping system. If there is no reheater the steam has to be conditioned down to acceptable condenser levels. The valve can operate as an safety valve with the necessary fast opening devices. With those fast acting actuators the lifting of the spring loaded safety valves with the associated seat maintenance can be avoided and energy and water keep in the water-steam-circle.

The IP(HRH)/ LP-bypass valves are typically used to divert the steam away from the turbine to the condenser. They have to protect the reheat piping system. A fast closing device for condenser protection during transient operating periods is also integrated. Due to the radical increase in the specific volume of the steam it is often necessary to use a dump tube downstream as a final pressure reduction to get a higher backpressure after the bypass valve. The size of the valve can be minimized.

In combined heat and power plants bypass valves are required to deliver steam with exact temperature and pressure to the process (e.g. paper mills). Because of the different steam demands the range draws from a various number of HP to LP bypass systems. In case of a back pressure turbine trip the process steam has to be produced over the PRDS.

Control concept

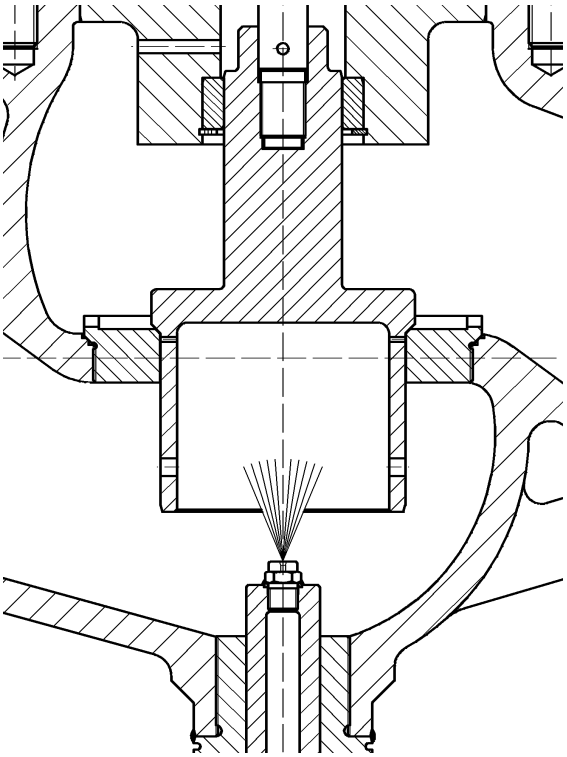
For normal bypass operation, no extraordinary demands are made on opening and closing times. The temperature after a HP bypass valve is used as control signal for the spray water control valve. To operate the PRDS as a safety valve at a turbine trip HORA recommends a “feed forward” signal before the control goes back to the temperature sensors. This is due to the loss of control of the spray water valve because it cannot follow the fast opening of the PRDS closely enough to keep the downstream temperature within normal operating limits. Too much unevaporated water or too little water leads to errors in the temperature readings. Therefore at first a heat balance calculation of the steam conditions and the valve position of the bypass valve determine the required water amount and related valve position followed by the control via the temperature sensors. For LP bypass valves the heat balance concept is used in general because the steam setpoint temperature is near or at saturation condition and therefore a temperature sensor cannot be used as control signal.



Design

- Water injection with nozzle

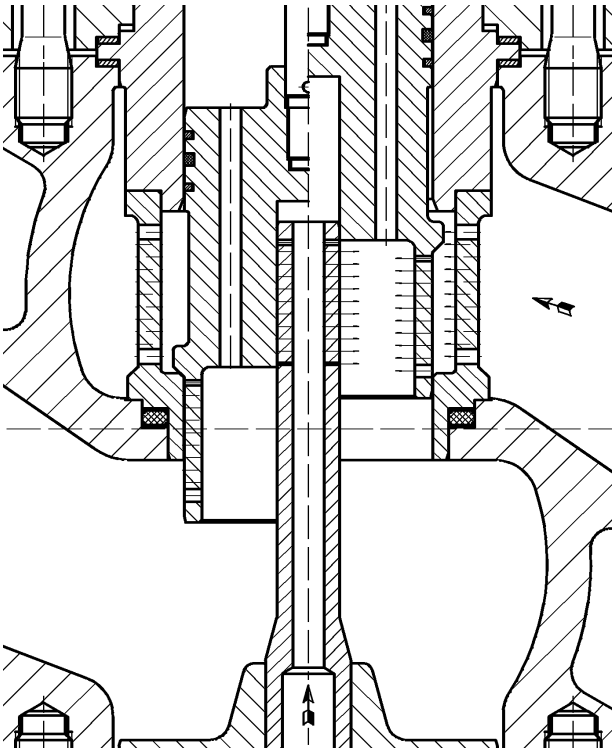
The HORA steam conditioning valve with a fixed size spray nozzle is specifically designed for low capacity applications where the load is fairly constant (process steam PRDS). The water is injected with a special axial full cone stainless steel spray nozzle directly in the seat area of the pressure reducing valve. This section has the highest steam velocity. The conditioning is realised by an ideal mixing of the turbulent steam with the atomized water. The result is a rapid evaporation with a good control.



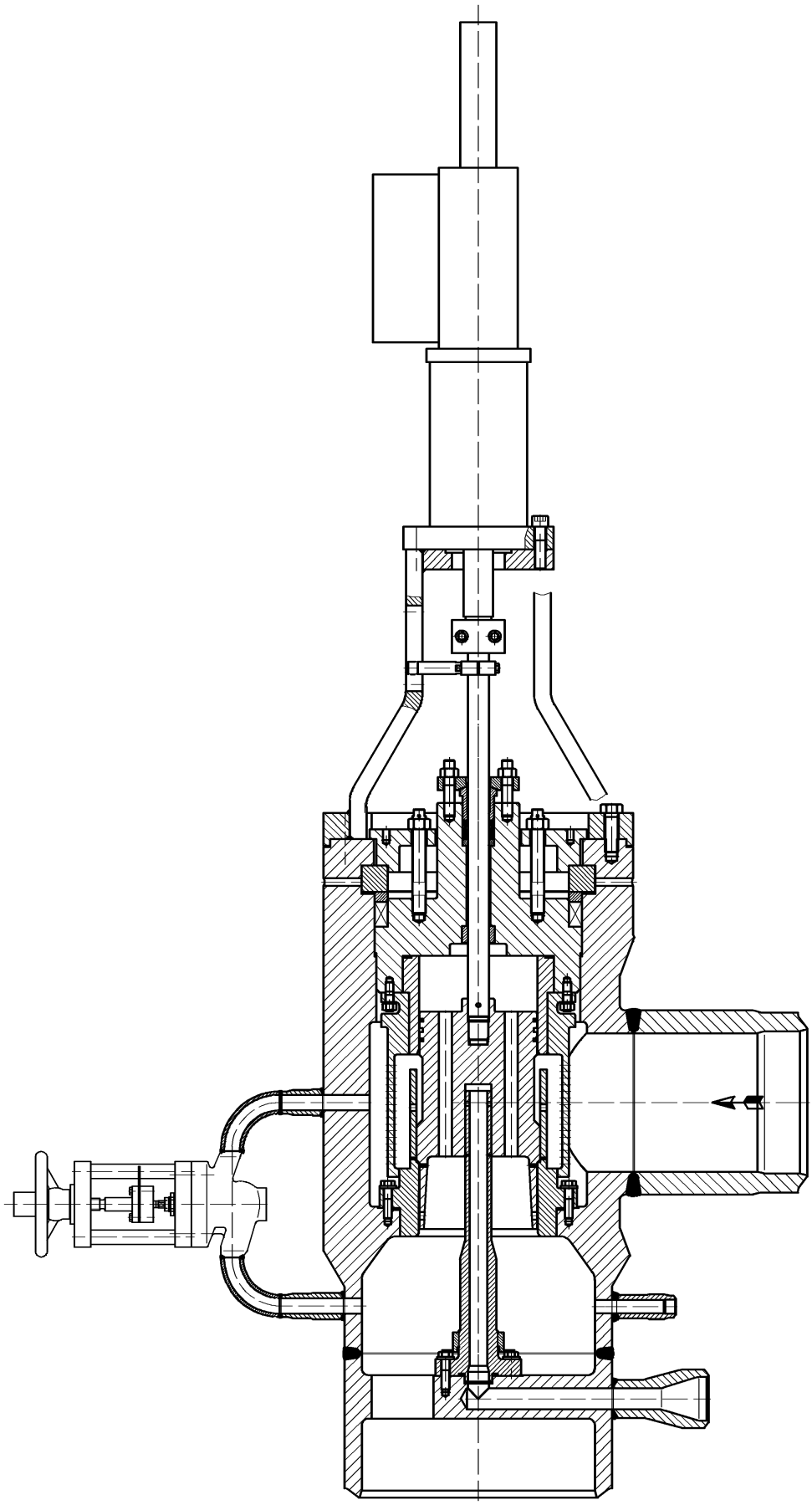
The water can have a share in comparison to the steam up to 20%. Above this ratio, a decent evaporation of the spray water is not guaranteed.

- Water injection with orificed tube

A advanced steam conditioning system is developed by HORA by means of a proportional water injection directly after the first stage of pressure reducing (e.g HP Turbine Bypass Valve). This way you have always the right mix, an optimal spray and a quick evaporation of the water is realised.



The cooling water is supplied through an orificed tube which is fixed within the valve body. The holes to let in the cooling water are covered by a perforated plug. A variable number of holes is opened through the axial movement of the plug. The appropriate number, size and arrangement of the holes determines the injection of the water so as to ensure the right proportion to the amount of steam reduced at any time. Therefore the atomization and evaporation is optimal over the complete range.
In case of supercritical pressure drops a further reduction of pressure and noise is implemented by a number of subsequently arranged perforated cages and discs



- Water injection with integrated atomizer unit

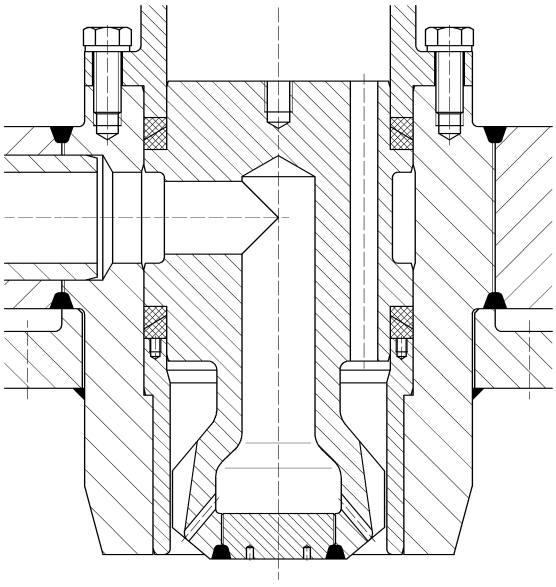
When critical requirements have to be fulfilled an integrated atomizer unit for the cooling water injection offers the best possible results by using the kinetic energy of the critical steam flow (e.g. IP/LP Turbine Bypass Valves). A separate arrangement of the cooler is also possible. An atomizer is particularly used at the following requirements:

- Steam cooling close to saturation temperature
- High water/ steam ratio (->high temperature drop)
- Large steam flows
- Available cooling water pressure is less than half the steam pressure

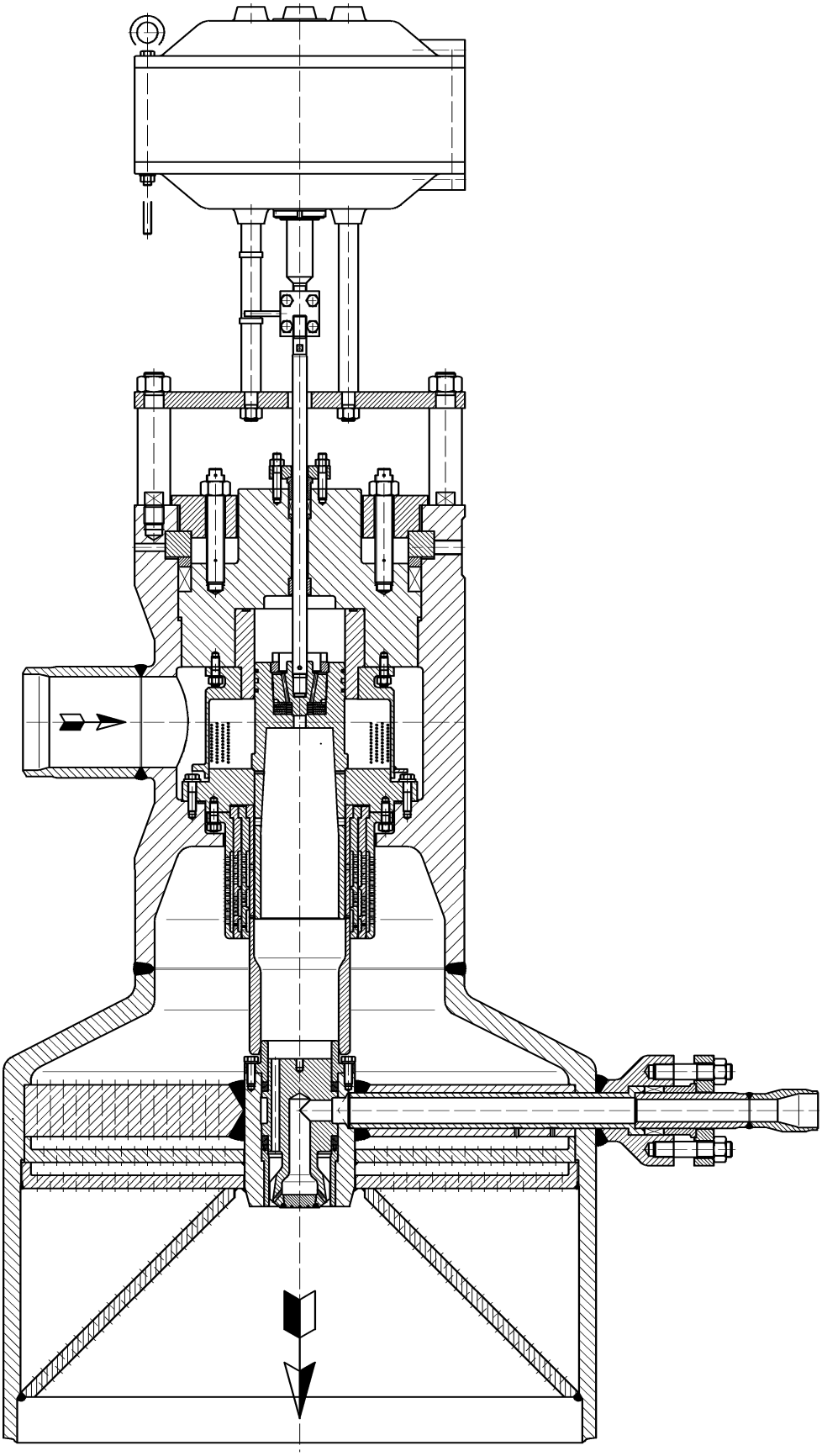
In a PRDS the high pressure steam is tapped after the first reducing stage - the perforated plug. If the perforated plug is closed the flow of the supporting steam to the atomizer is stopped too. Therefore an additional on-off valve is not required. The steam is introduced through steam ports to the spray water holes arranged in a circle and leaves the two component nozzle with supersonic speed. These jets of steam blast the cooling water to atomize it in order to cause fine droplets distributed into the steam header.

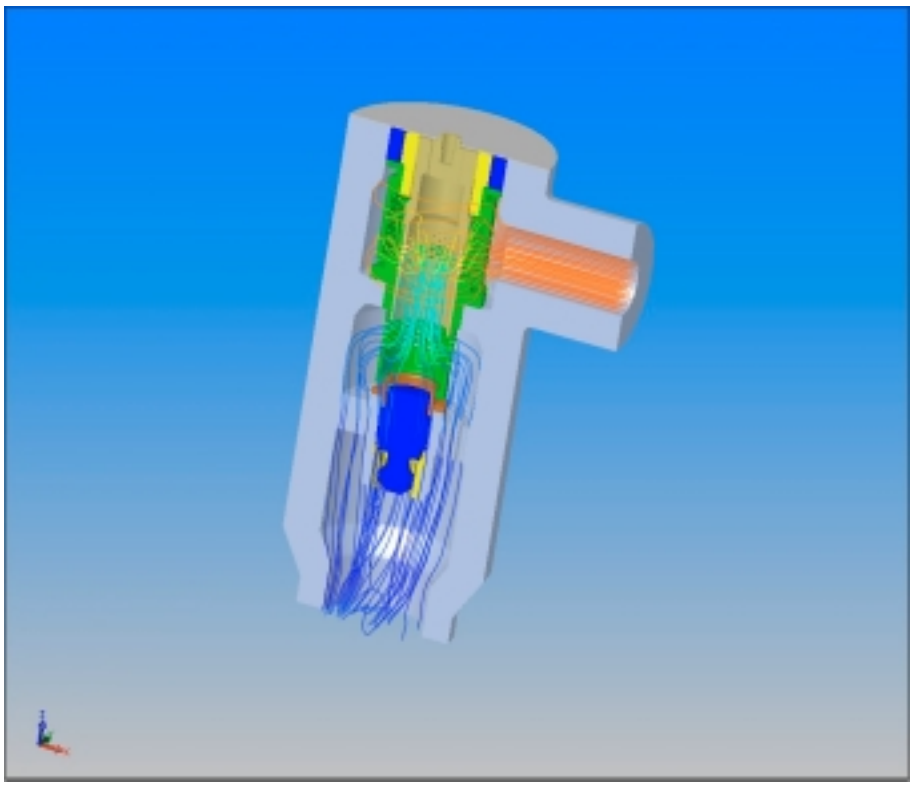
Steam

Water



The water enters the centre of the spray head and then the number of radial holes, sized to suit quantity and pressure drop in accordance to the requested flow. There at the narrowest crossection (highest speed) the water is dragged along and atomized by the tapped high pressure steam. The evaporation of the finest droplets is rapid. The flow of the water is controlled by a separate spray water valve. An atomizer is very effective under partial load conditions because the atomizing steam is constantly flowing when the valve is in use. With it an inner protection pipe is not required.





General installation instructions

- We recommend a minimum straight pipeline before the valve of 5 x DN and downstream 10 x DN. In this pipe section there should not be any components present; T-shaped junctions must be avoided.

- The injection water must be clean water (e.g. boiler feedwater) with a constant pressure as indicated on the HORA data sheet and a temperature near to saturation (>100°C). We recommend a strainer with a fine sieve (aperture width: 0,5mm) ahead of the water control valve.

- The spray water control valve should always be installed below the level of the injection point to ensure that the line remains full under low load conditions.

- In order to be able to carry out any mounting work on the control valve during operation, tight shut-off valves in a appropriate distance before and after the valve and a bypass are required. It must be possible to drain the shut-off pipe section.

- In non critical conditions a distance to the temperature sensor of min. 5m is required. In range applications an arrangement of 3 sensors with a high value selection is recommended

- For immediate operational use the valve should be heated (kept warm). Depending on use and application (e.g. stand-by operation) warm up lines are required to prevent the collection of condensate and critical thermal stress (thermoshock) within the valve.

- A drain line at the lowest point of the system is required. Accumulation of condensate has to be avoided absolutely because of danger from water hammer and erosion.