ESB

Quick Open Steam Conditioning

Quick Open PRDS

EXO Industries

Quick Open Steam conditioning valve / PRDS

- **Conditioned Steam to process in 4 Seconds**
- **Process uninterrupted during Turbine Trip**
- **Turbine bypass to condenser in 1 second**

Steam conditioning valve

A steam conditioning valve converts steam from an incoming state (pressure and temperature) to a predetermined required outlet state (pressure and temperature).
Pressure reduction is carried out with a pressure reducing trim within the valve body, usually multi-stage pressure reduction. The pressure is controlled by an upstream or downstream pressure controller, signaling the valve to modulate to maintain the pressure at the required set point.
Temperature is controlled by adding water to the steam in such way that it will get fully evaporated in the steam (termed desuperheating). A separate water valve supplies the correct amount of water to the desuperheating nozzles or desuperheating mechanism within the steam conditioning valve. A downstream temperature transmitter and a controller dictate the amount of water mixed with the steam.

1. General

The **EXO ESB valves** have originally been designed for use in the harsh environment of modern fossil-fuelled power plants where they are used as high pressure and/or low pressure Turbine Bypass valves with (**ESB**) or without (**ESR**) integrated cooling function.

1.1 Main duties of the valve

- Allows controlled start-up and shut-down of different loops in the power plant with a minimum of heat losses
- Handles abnormal conditions such as load rejection, turbine, pump or fan trips etc. – in a manner to return the system to normal operation with minimum delay
- Keeps the steam in balance with load requirements in e.g. process industries
- Customized for each specific application

Fig 1 EXO valve type ESB-B

1.2 Functions of the valve

Unlike steam turbines, bypass valves do not convert heat into mechanical work. The temperature drop during pressure reduction is relatively small hence the necessity for steam cooling.
This is achieved either by integrated or separate spray water coolers which reduce the downstream temperature to the level required for the heat balance of the power station.

The highest steam generator flexibility is achieved with bypass systems having 100% steam capacity, combined with sliding pressure operation of the boiler and the turbo-generator unit. This allows to keep the unit in operation during practically all disturbances and to run the unit safely back to the "household" and to reload the unit as soon as the disturbance is eliminated.

During the reloading or start-up phase, the bypass system enables adaption and adjustment of the superheated steam temperature to a gradual heating of the turbine thus preventing excessive thermal stresses detrimental to the lifetime of the unit.

1.3 Applications

The EXO **valve type ESB** has been designed as a steam conditioning valve for high pressure and/or low pressure net with integrated cooling function, or as a process valve.
The K_v/C_v-value of the valve depends on the pressure ratio p_1/p_2 and must for each valve be calculated in the EXO valve sizing program, where all throttling points in the valve are taken into consideration. Certified dimensional drawing will be supplied by EXO.

1.3.1 Main applications – High pressure system

- Pressure control / turbine bypass.
- Reheat cooling.
- Controlled pressure build-up in the boiler.
- Protection against exceeding design pressure.
- Cooling of final superheater - sliding pressure operation only.

1.3.2 Main applications – Low pressure system

- Controlled pressure build-up in the re-heater.
- Pressure control/bypass of the intermediate and low pressure section of the turbine. This will assist in avoiding release of the safety valves, and consequently helps to prevent large condensate losses.
- Protection of the condenser in case of disturbances.

1.3.3 Main applications – process industry

- Controlled pressure and temperature in steam pipes to the process – in parallel with the back pressure turbine.
- Fast take-over of the whole steam flow to process when the turbine stops/trips.
- Provides the process with steam flow during start-up of the turbine.
- Suitable with large quantities of cooling water.

2. Design

The EXO **bypass valves type ESB** have been furnished with a valve body designed to withstand rapid temperature changes. The body shape is of a "smooth" design with a constant material thickness. All valve body penetrations are circular to prevent asymmetrical stress patterns.

ESB type valves are combined pressure reducing valves with an integrated cooling system. The steam flow passes through the extended drilled bonnet before becomes throttled trough a cage type plug with multiple drilled holes, which provide optimum characteristics for control of the steam pressure. The extended bonnet prevents possible rotation forces occurred by the steam flow and works also as an extra pressure reducing stage to achieve lower vibrations and noise. Additionally the extended bonnet works also as a strainer to protect the valve seat and bonnet from damages.

The plug slides in a hard-faced seat body, thus uncovering a greater or smaller number of the throttling holes. In its closed position the plug seats on the hard-faced seat.

The facing is made of tough material with excellent sealing properties and good resistance against corrosion, erosion and thermal fatigue. All internal parts of the valve can be removed without the valve having to be dismantled from the pipe. The seat body is designed for field replacement.

The plug connects to its actuator via a straight stem. Plug and stem are made of heat and corrosion resistant material, hardened in a unique process. The stem is sealed with a conventional stuffing box.

The pressure reduction continues in the outlet that is furnished with a silencer. The spraywater is injected into the steam where steam velocity and turbulence are at their highest, which gives quick and efficient cooling. The number and design of the atomizing nozzles on the low pressure section of the valve are determined by the cooling demand for the current installation. The cooling of the steam requires very finely atomized cooling water, which is achieved by multiple spray nozzles. This concept allows the use of condensate from the condenser branched off downstream of the condensate pump.

To obtain good temperature control it may be advisable to operate the nozzles in split-range, e.g. 25% of full load.

2.1 High Rangeability Designs

Steam conditioning applications require high turndown of desuperheated steam flow to maximize system output and provide for higher system reliability. Typically high pressure to process turbine bypass systems require 50 to 1 or greater turndown with respect to desuperheated steam flow. The EXO ESB-SE valves are designed to achieve higher MW and heat

generation outputs by minimizing the controllable steam flow to meet process demand. Immediate improvements in the performance of the plant can be realized.

2.2 Resist Thermal Shock

Steam turbine bypass valves are closed for long periods, therefore subjecting the valve and the piping to temperatures approaching saturation. In some cases valves will have to withstand temperature changes (thermal shock) greater than 200°C (393°F) in less than 2 seconds. The EXO ESB-SE(steam enhanced) valves are designed specifically to operate reliably in these conditions (with repeatable tight shutoff and no distortion.) A special two piece seat design provides extra thermal flexibility to ensure reliable shutoff.

2.3 Maximum Performance and Reliability

The ESB range of valves are primarily used in industrial (CP) and utility power plants for conditioning of auxiliary and process steam.

Availability of the ESB-SE in the turbine bypass application for steam supply to the process is critical. Reliability and performance are paramount to the operation of the plant.

The EXO ESB-SE design with its unique features stands alone in the industry for steam conditioning applications.

3. Requirements

During normal operation of the steam generating unit, the bypass valves shall remain closed. On a turbine trip or load rejection, they must open quickly, resulting in very fast heat-up of the valve body and corresponding high thermal stresses.

The temperature difference between steam and spraywater can often be as high as 450°C (840°F), a potential source for thermal fatigue problems.

An important demand is that the valve body must be shaped for minimum thermal stress. The spraywater atomization must be good over the entire range of operation, and the spraywater must

not hit heavy metal walls or other components sensitive to thermal shock.

Normally only upstream pipe preheating is needed, but for severe operating conditions with large temperature variations, we recommend continuous preheating of the valve inlet side.

Many industries such as pulp & paper, refineries, sugar and petro-chemical facilities require steam at a temperature very close to saturation. If the steam is supplied at a temperature too high, the product or equipment can be damaged. If the temperature is too low there will be excess water.

If the required control is lost, severe damage to piping and downstream equipment occur, resulting in expensive maintenance cycles and loss of production.

4. Advanced Desuperheating Capabilities

The ESB valve injects water with the steam as the flow transients occur (termed steam atomization desuperheating).

Spraywater for desuperheating is only introduced after final pressure reduction.

The final pressure reducing elements are specifically designed to optimize the flow pattern for desuperheating.

5. Fine Control at Low Flow Conditions

Steam is passed through the center of the valve steam to steam atomize the spraywater. At higher flow requirements of above 5% steam flow (above 15% stroke) the main cage is exposed and the steam flow modulates normally through the control section, providing a linear flow characteristic, maximizing steam flow at high flows.

For low flow requirements of 0-5% steam flow (0-15% stroke) the steam flow is only passed through the steam atomizing channel in the plug and is controlled by the position of the main plug, uncovering sequential holes leading to the atomizing channel as the stroke increases. Greater steam atomization at low flows is realized.

6. Noise abatement

The **EXO ESB-valves** are equipped with features to avoid supersonic velocities in the final pressure reducing step. This is of importance as supersonic velocities may cause shock cells, possible sources of noise and vibration. The valve outlet is therefore furnished with a multi-tube perforated diffuser package.

By this the number of expansion stages is increased and simultaneously the steam flow is broken up into a great number of partial fluid jets.

This helps the rapid dissipation of kinetic energy in the steam and results in a substantially reduced emission of noise and vibration.

As a special customer service, EXO can on request supply noise level predictions for each valve supplied and make specific recommendations regarding insulation, installation etc.,

7. Valve configurations

EXO turbine bypass valves are available in a number of designs, all derived from the **ESB** configuration.

ESB-T Unbalanced, tight design with leakage tightness according to ANSI B16.104 Class V.

ESB-B Balanced design. Leakage tightness according to ANSI B16.104 Class III or IV depending on type of seal.

ESB-BT Balanced, tight design Leakage tightness according to ANSI B16.104 Class V.

ESB-C Valve with integrated cage, with screen function. Available with all types of plugs.

ESB-SE Valve with atomization nozzle. Suitable for large control ranges.

Valve designation guide

Type of valve	Plug diameter	Type of plug	Additional equipment
ESB	72	T	C

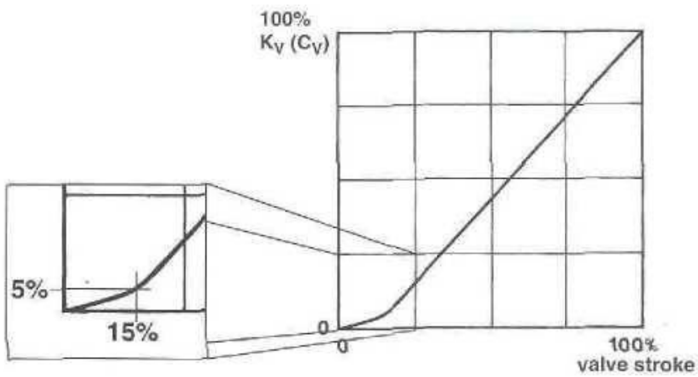


Fig 2 Example of modified linear valve characteristics which is standard; other plug characteristics on request

8. Valve Components
8.1 Valve body and bonnet

The valve body is usually fabricated from forged and fully machined parts assembled by high quality, fully inspected welds. Valves in larger sizes – 160 and above can instead, depending on pressure rating, have a body manufactured from prefabricated parts joined together by welds.The Pressure seal bonnet carries the stem guides and the gland.

On request, a bolted bonnet design is available using a spiral wound gasket.

The gland is equipped with a stuffing box packed with expanded graphite.

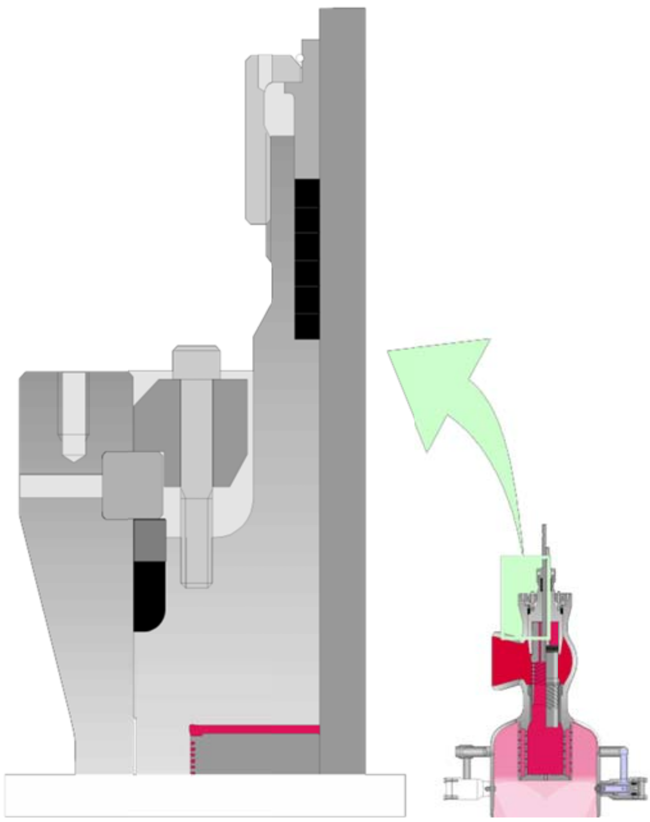


Fig 3 PRESSURE SEAL BONNET

8.2 Valve seat

The seat is fixed to the valve by a circular seal weld.

The sliding and seating surfaces are treated for high resistance to wear and galling. Judicious material selection minimize effects of possible erosion and corrosion.

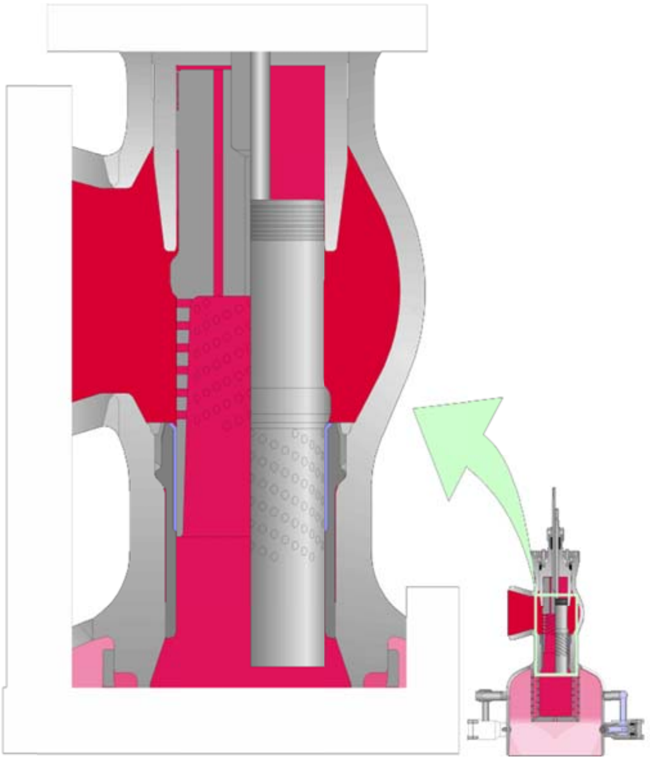


Fig 4 CAGE PLUG AND SEAT ARRANGEMENT

8.3 Spray Nozzles

The spray nozzles can be extracted for inspection and maintenance without removing the spraywater header.

The type of spray nozzles selected depend upon operating conditions.

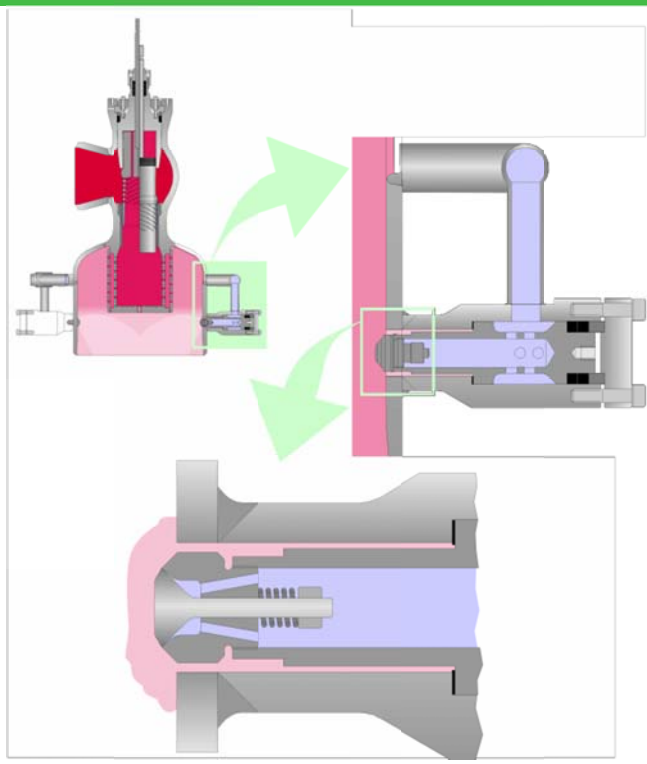


Fig 5 SPRAY WATER NOZZLE ARRANGMENT

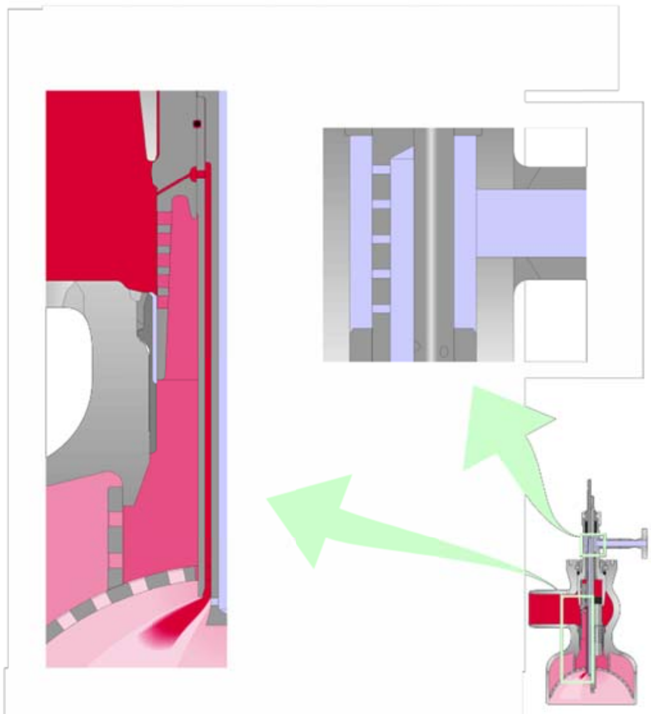


Fig 6 STEAM ATOMIZING OF SPRAY IN ESC-SE

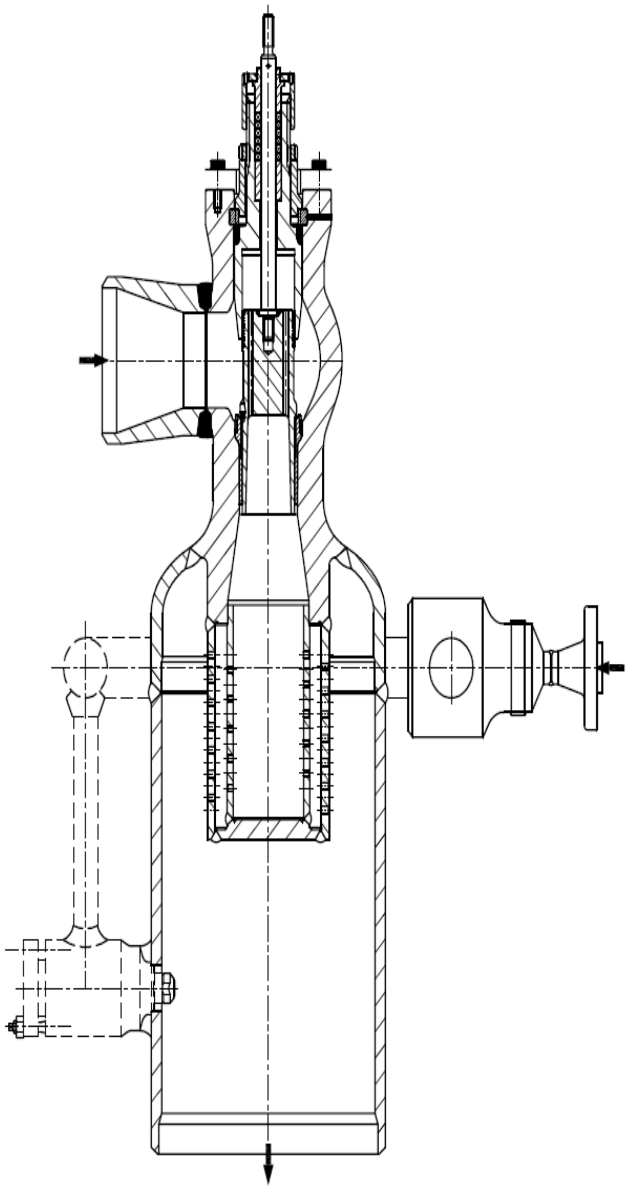


Fig 7 VALVE TYPE ESB-B

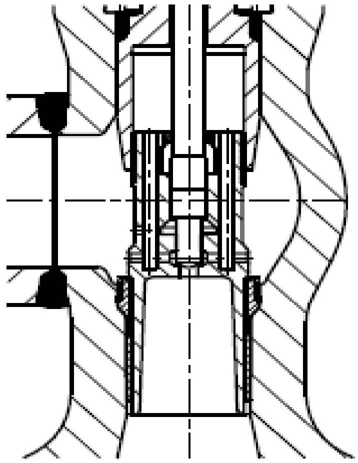


Fig 8 VALVE TYPE ESB-BT

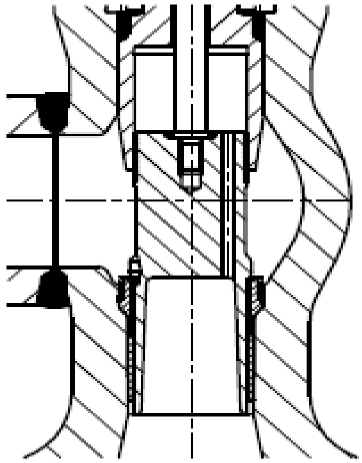


Fig 9 VALVE TYPE ESB-T

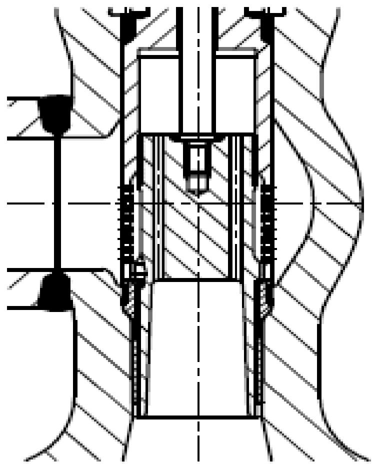


Fig 10 VALVE TYPE ESB-BC

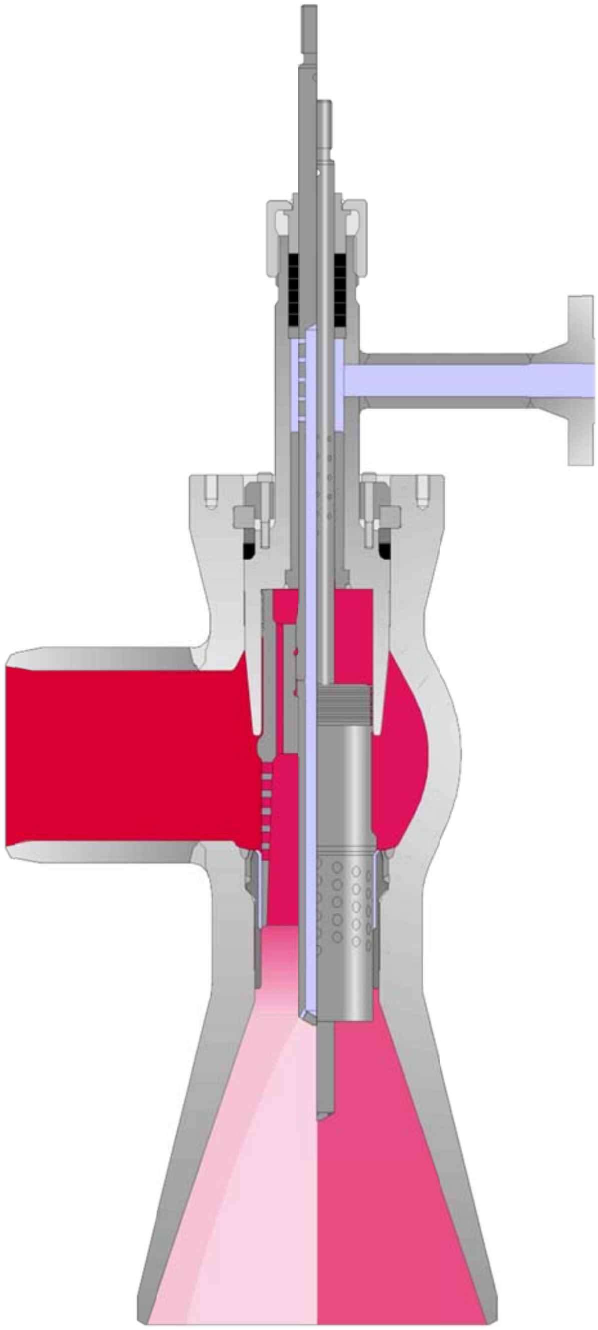


Fig 11 ESC

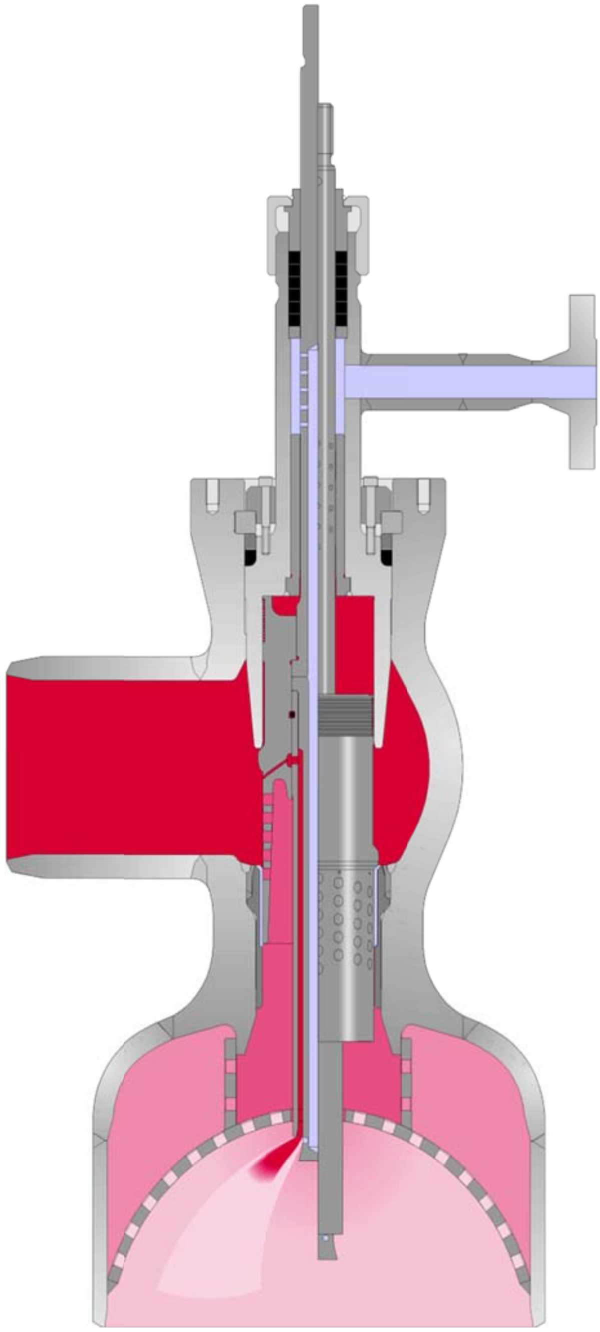


Fig 12   ESC-SE

9. Installation examples

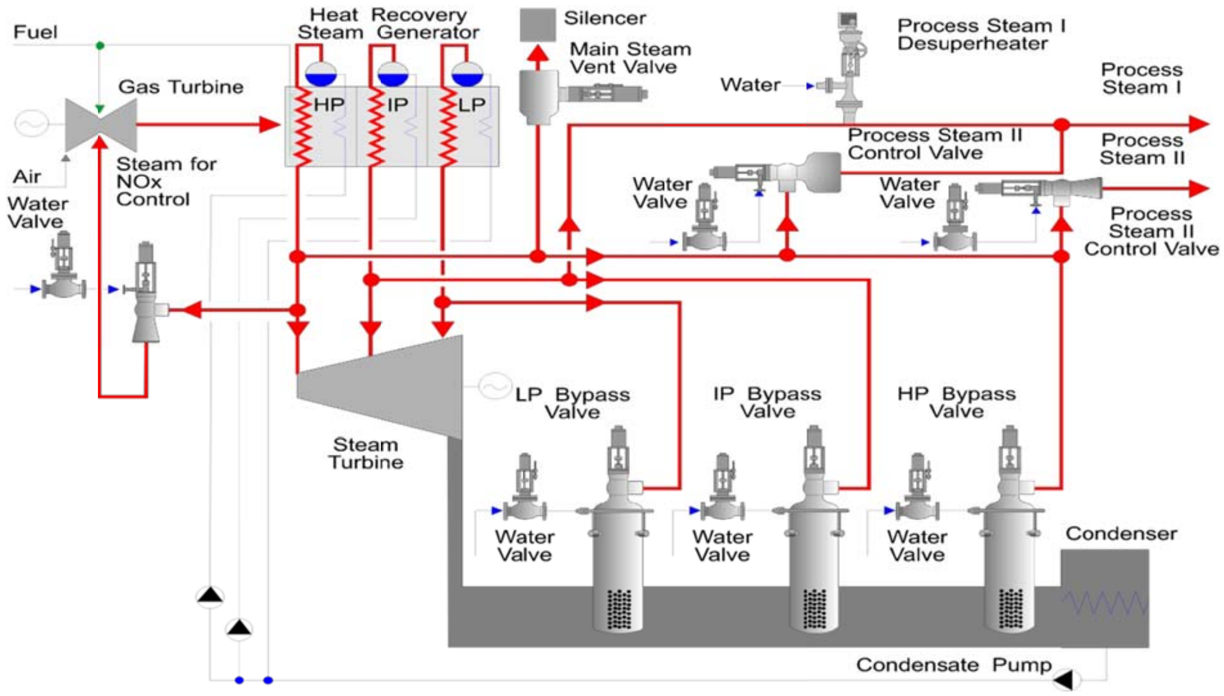


Fig 13 Typical installation of steam conditioning valve type ESB in Triple pressure combined cycle.

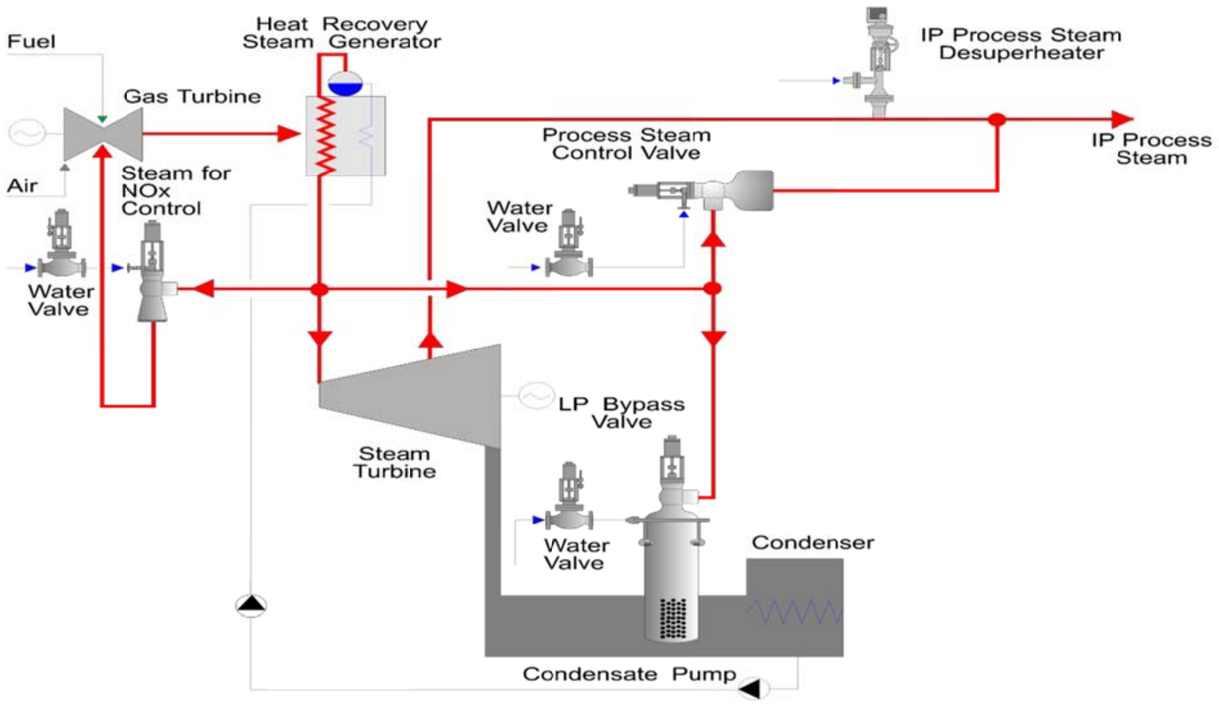
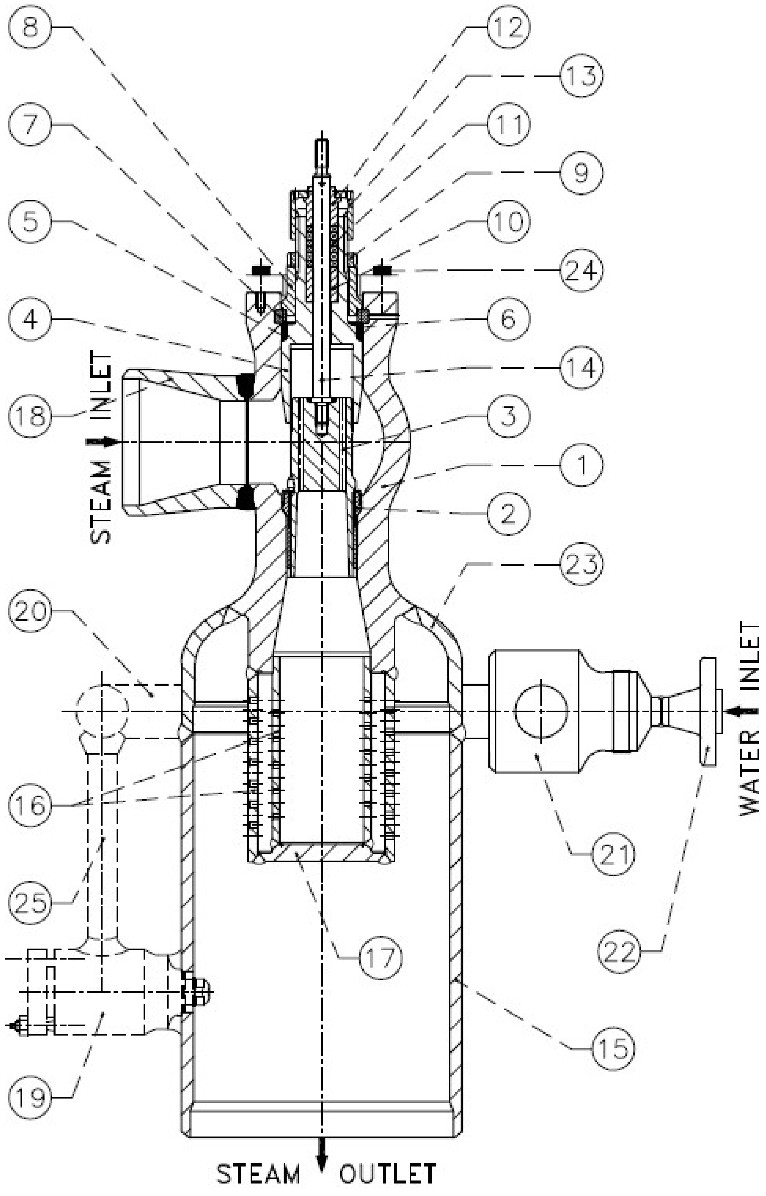


Fig 14 Typical installation of steam conditioning valve type ESB in a combined cycle.

Fig 15 Typical installation of EXO steam conditioning valve type ESB in a Process Plant.

10. MAJOR COMPONENTS



SR.NO.	NAME
25	WATER PIPE
24	ALLEN BOLT
23	DISH END
22	FLANGE
21	WATER STUD CONN.
20	WATER RING PIPE
19	NOZZLE ASS.
18	INLET
17	SILENCER END CAP
16	SILENCER
15	OUTLET PIPE
14	STEM
13	GLAND NUT
12	GLAND
11	STEM PACKING
10	STEM GUIDE
9	LOCK NUT
8	DISTANCE RING
7	SEGMENT RING
6	SPACER RING
5	PRESSURE SEAL GASKET
4	BONNET
3	PLUG
2	SEAT
1	BODY

Fig 16 Steam conditioning valve ESB
Major Components

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