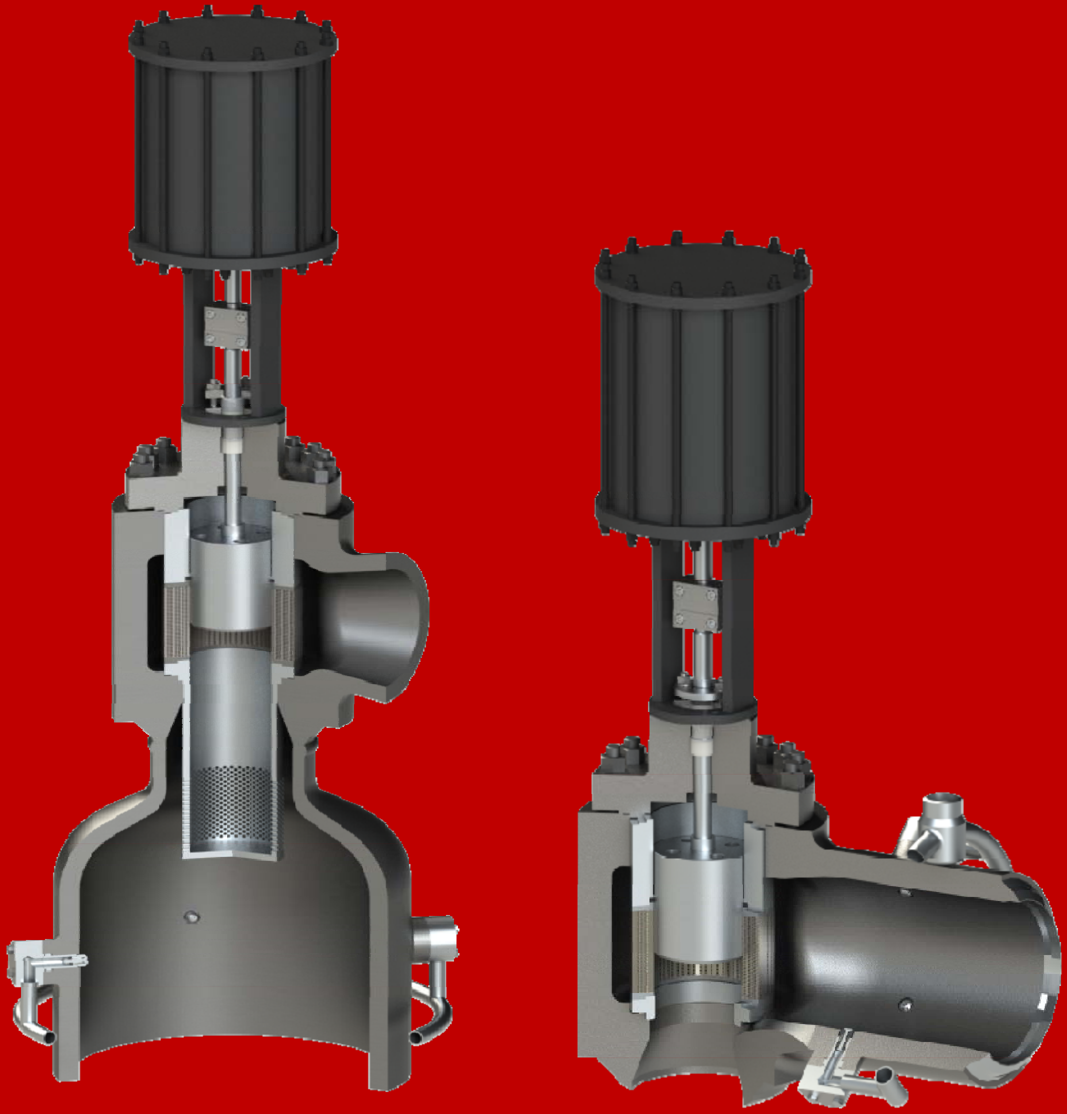
TBHP/TBLP/TBGT-Series

Turbine Bypass, Steam Conditioning Valve
Fossil, HRSG, Bio-mass



Introduction

Steam Turbine and Boiler protection at Steam Turbine trip. Steam Turbine bypass to Cold Reheat or Condenser while Boiler / Turbine start-up and shut-down.

Turbine bypass systems save energy, allow quicker start-up, cope better with load rejection, and help eliminate solid particles in steam. The bypass function requires the valve to quickly change load on the turbine during start-up, emergency, or clean-up situations. Desuperheating functions to control steam temperature are necessary to protect piping, reheaters, and the condenser. Valve noise and the damage it can cause are major concerns of the extended periods that turbine bypass and steam conditioning valves may operate. A combination of material choice and optimized trim designs makes the valve highly resistant to wear in spite of extreme operating conditions.

Contents

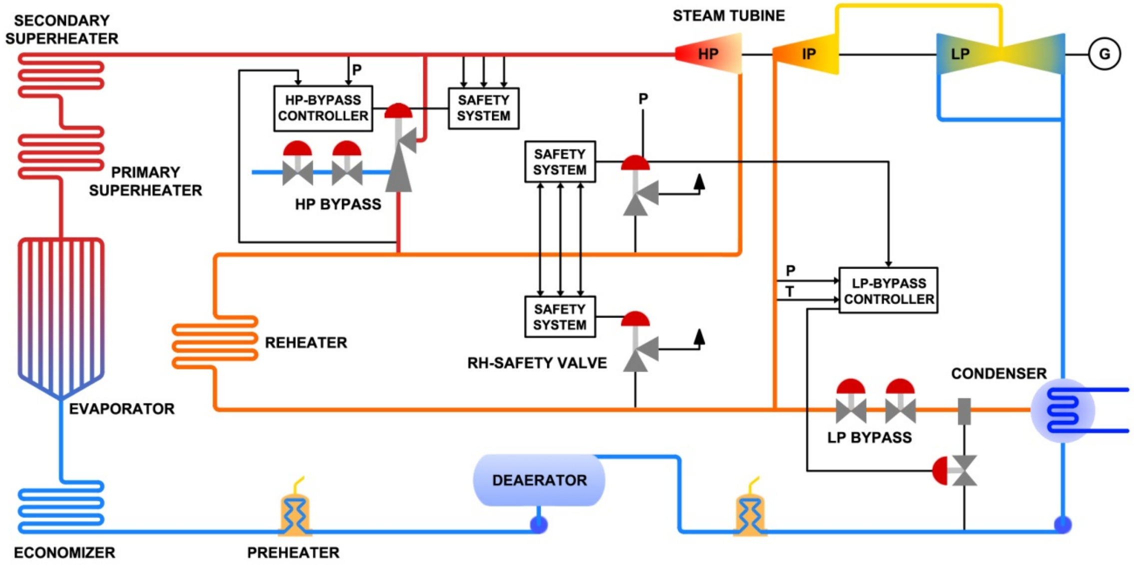
Model Numbering System

1. Body Series	**2. Trim Form**	**3. Trim Type**	**4. Pressure Rating**	**5. Process Connect.**
TBHP -HP Bypass	**G1**-Unbalanced	**S1**-Single Contoured	**01**-150# / 10K	**RF**-Raised Face
TBLP-LP Bypass	**G2**-Balanced	**C2**-Conventional Cage	**02**-300# / 20K	**RTJ**-Ring Type Joint
TBGT-Globe Style Bypass	**G3**-Aux.Pilot Balance	**M1**-Multi-Hole 1stage	**03**-600# / 40K	**SW**-Socket Welded
		M2-Multi-Hole 2stage.	**04**-900# / 62K	**BW**-Butt. Welded
		M3-Multi-Hole 3stage	**05**-1500#	**ET**-Etc
		XT-X[iks]-Trim	**5S**-1500S#	
			06-2500#	
			6S-2500S#	
			07-4500#	

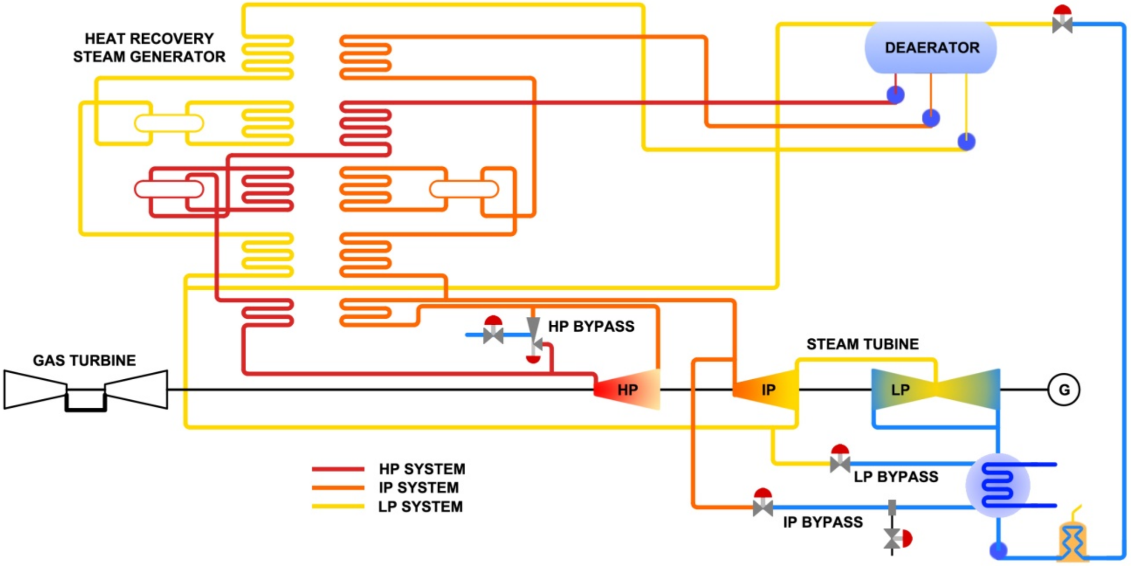
6. Model of Nozzle	**7. Quantity of Nozzle**	**8. Actuators**	**9. Hand-wheel**	**10. Option**
20-VN20	.**Actual Quantity**	**DR**-Diaphragm Revers.	**GB**-Gear Box	**DP**-Drain Plug
28-VN28	2EA - 02	**DD**-Diaphragm Direct	**HJ**-Hand Jack	**WV**-Warm-up Valve
40-VN40	10EA - 10	**CD**-Double Cylinder	**XX**-N/A	**DT**-Dump Tube
		CS-Spring Cylinder		**XX**-N/A
		HS-Hydraulic Cylinder		
		SH-Self Contained		

Best Flow Solution manufactures specialized Turbine Bypass Valves focused on Power Generation, Severe service and for arduous process applications, with wide application experience and our own designed software tools.

- ✓ **Typical Coal Fired Super-Critical-Pressure-Class-Boiler Plant Schematic.**



- ✓ **Typical Combined Cycle Power Plant Schematic**



STEAM CONDITIONING FOR TURBINE BYPASS SYSTEM

The constant search for improved heat rate and better thermal efficiency points up the need to precisely control temperature, pressure and quality of steam. Many power applications require either control of temperature to protect equipment or desuperheating to enhance heat transfer. The selection and application of these products is key to success.

This section will deal with basic information on desuperheater products and steam conditioning system..

Desuperheaters are devices which spray controlled amounts of water into steam flow lines to control steam temperature to a desired level. BFS design is available with variable area nozzles, mechanically atomized desuperheaters which provide high rangeability.

Steam conditioning valves are combination products which provide steam pressure reduction and temperature control within one unit. Steam conditioning valves give better performance than desuperheaters and require fewer piping and installation restrictions. The BFS TBHP-series turbine bypass valves are angle and globe style with the combined function of pressure reducing and desuperheating. The TBHP-series trim design provides noise reduction as well as instantaneous control of steam and water proportioning. The TBLP-series design provides high flow rates, tight shut-off and very high spray water quantity capability. It successfully handles a key and difficult power plant application.

Steam Conditioning valves represent the latest state-of-the-art for control of steam pressure and temperature. They were developed in response to need for better steam condition control brought on by increased energy costs. Combined steam conditioning valves allow more accurate control, lower installed cost and a simplified system. Diagrams of both systems are shown. The conventional arrangement relies on feedback of temperature offset to initiate spray-water flow. This is acceptable in applications requiring little or no turndown. However, when changes in flow conditions are rapid, response is inadequate and setpoint deviations result.

The all-in-one system provides for automatic proportioning of desuperheating water and steam. Thus, significant increases or decreases in steam flow are accompanied instantaneously by a proportional increases or decreases in spray-water. Response to changing conditions is both more rapid and more effective.

Steam conditioning products are required to match steam usage conditions to steam generation conditions. Attemperation is commonly desired to;

1) improve the efficiency of thermal transfer in heat exchangers,

2) reduce or control superheated steam temperatures which might otherwise be harmful to equipment, process or product, and

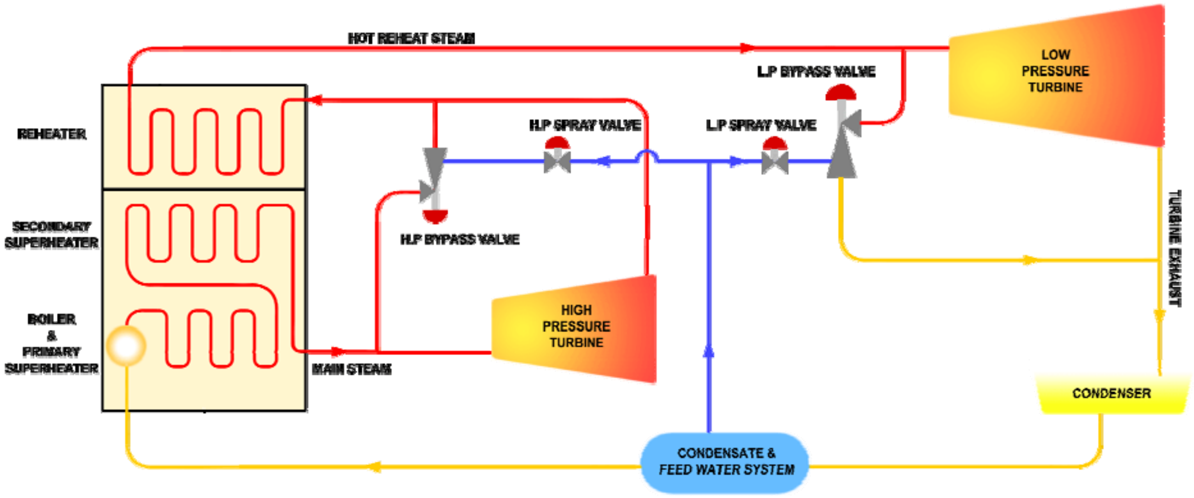
3) to control temperature and flow with load variation.

Steam which is generated to do mechanical work such as run turbines is typically utilized in a superheated state and condensate cannot be tolerated. However, utilization of superheated steam for thermal process is very inefficient. High temperature differentials are necessary to get sufficient thermal transfer. If the steam is treated to conditions closer to saturation its heat transfer properties are significantly improved. The resultant increase in efficiency will very quickly pay off the equipment required. In order to understand why a steam system requires desuperheating we will examine the relationships of temperature and enthalpy of water.

At temperature lower than32°F(0℃), the water is frozen. Addition of heat to the ice raises the temperature. It requires approximately 1/2-BTU of thermal energy to be added to a pound of ice to raise its temperature by 1°F (5/9 ℃)After reaching 32°F(0℃) the addition of further heat does not increase temperature. The ice begins to melt. Addition of 144-BTU's is required to melt one pound of ice and change it to water at 32°F(0℃).

Additional heat energy added to the water will again raise its temperature. 1-BTU of heat is required to raise the temperature of one pound of water by 1°F(5/9 ℃). This relationship holds constant until the boiling point (212°F/100℃)) is reached.

Further addition at this point of heat energy will not increase the temperature of the water any further. The water again begins to change state, in this case from water to steam. Evaporation of the water requires the addition of 970-BTU's per pound. We now have one pound of steam at 212°F(100℃). Addition further thermal energy to this steam will increase its temperature.



This process is known as superheating. To superheat one pound of steam by 1°F(5/9 ℃) requires the addition of approximately .4-BTU's of thermal energy.

The thermal energy resulting from a steam temperature change differs significantly on temperature depending on temperature and superheat condition. It is much more efficient to cool by addition of ice rather than by addition of cold fluids. Similarly, it is more efficient to heat with steam at temperatures near the saturation temperature rather than in the superheated region. In the saturated region much more heat is liberated per degree of temperature change than in the superheated range because production of condensate liberates the enthalpy of evaporation, the major component of the total thermal energy content.

BFS BYPASS SYSTEMS

BFS bypass system designs have continuously developed to satisfy the ever increasing demands of the power industry for this highly critical and integral process within a power generation station. The introduction of combined cycle power plants and the associated higher pressures and temperatures, in the search for greater efficiency, resulted in the need for HP bypass systems to operate at pressure up to 220bar (3200psig) and temperature approaching 590℃.

All bypass systems are custom designed and engineered for each installation to suit the various turbine designs and operating regimes. This ensures that the bypass system is ideally matched to fully satisfy the required performance envelope.

The method of actuation also has to be carefully selected to meet the demands of the operating scenarios and failure modes. Normal actuation will be either hydraulic or pneumatic depending on the speed and accuracy that the plant operating characteristics demand.

1. HP Bypass Valves

Steam turbine and boiler protection at steam turbine trip.

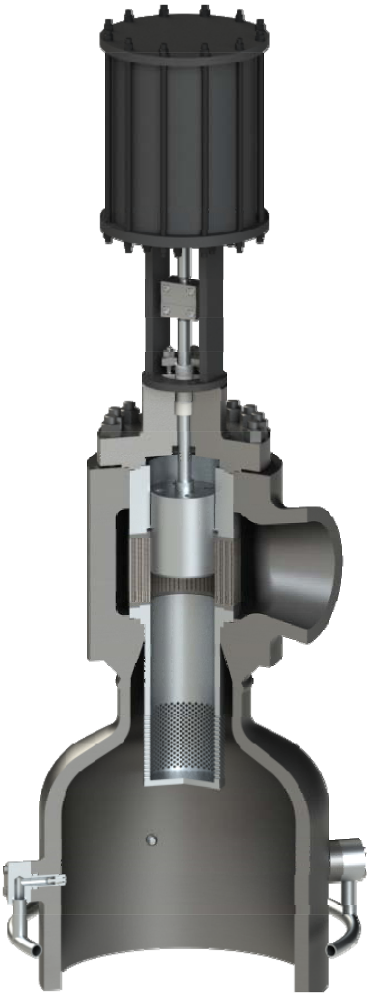
Steam turbine bypass to cold reheat or condenser while boiler / turbine start-up and shut-down.

Steam conditioning valve reduces steam pressure and temperature for extraction application within the plant or as part of a cogeneration.

The performance requirements of the HP Bypass valve present one of the most arduous and critical of all valve applications, demanding specific design to withstand the high pressure and temperature cycling to which it is subjected.

The HP Bypass valve has to rapidly condition up to 100% MCR boiler outlet steam by reducing both pressure and temperature to cold reheat conditions. On some application where there is no reheater, the steam has to be conditioned down to level acceptable to the condenser. Every component of the unit must be designed to remain dynamically stable while dissipating this vast amount of thermal energy.

All HP Bypass valves have cage guided trims ensuring stability and in most cases a disk stack type Labyrinth-Multi-Pass X[iks]-trim will be fitted for active noise attenuation.



HP Bypass Valve / TBHP-series

The final stage of pressure reduction is performed by a specifically designed diffuser arrangement mounted in the valve outlet.

There are several methods of introducing the cooling water depending on factors such as inlet steam to cooling water mass ratio and the cooling water pressure.

Drawing on many decades of experience in all forms of desuperheating, BFS will offer the most appropriate method of cooling water introduction for the specific application.

The method employed will be one of aspirations, variable area nozzle spray atomization.

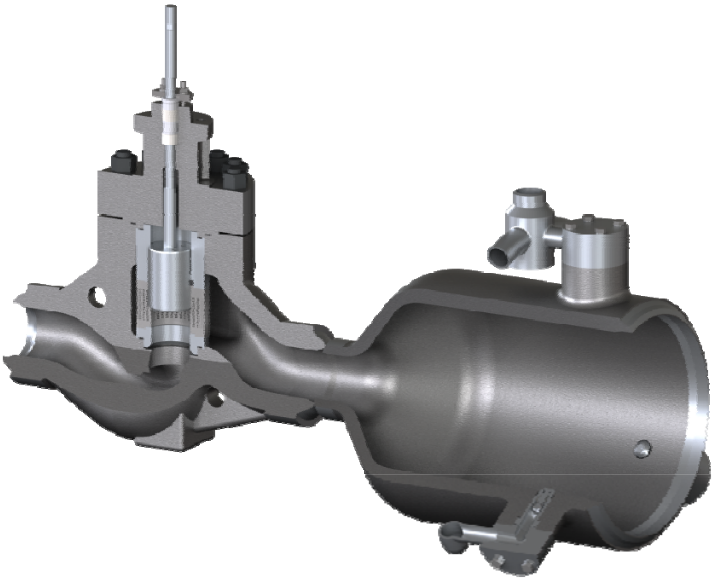
Rapid actuation is required to prevent the boiler safety valves from lifting and the turbine block valves from fast closing in the event of a turbine trip. Actuation is either hydraulic or pneumatic cylinder actuators.

Hydraulic actuators are generally adopted where rapid and accurate positioning is required, or where end user preference dictates. For HP bypass, the actuators are normally set in a fail-open mode either by mechanical springs, hydraulic accumulators or pneumatic volume tanks.

1-1. X[iks]-trim Application

Steam pressure and flow are controlled by the position of the valve plug within the control cage. A signal from the pressure control loop to the valve actuator moves the valve plug within the control cage to increase or decrease the amount of free flow area. The control cage has an array of calibrated orifices to provide the control characteristic specified. As the plug is lifted from the seat, steam is permitted to pass in to the center of the control X[iks]-trim cage and out through the seat ring. The outlet section of the valve has a combination cooler and silencer section. As the steam leaves the seat ring, it enters a diffuser designed to further decrease steam pressure energy in a controlled-velocity expansion. Flow is directed radially through the multiple-path & Multi-turns Disk-Stack (X[iks]-trim) cage or multiple orifice cage diffuser, exiting in to the enlarged outlet pipe section. This section has been sized to accommodate the large change in specific volume associated with the pressure drop of the steam and to keep steam velocities within limits to control noise generation. The outlet section is outfitted with a water supply manifold. The manifold (Multiple manifolds are also possible) provides cooling water flow to a number of individual spray nozzle installed in the pipe wall of the outlet section. The result is a fine spray mist injected in to the high turbulence of the radial steam flow. The combination of large surface is a contact of the water and high turbulence in the steam makes up for very efficient mixing and almost immediate vaporization.

X[iks]-trim Concept



TBGT-series / Globe Valve Style + MNSD-Series

1-2. Key Features

- Model : TBHP-series, TBGT-series
- Contract specific designs fully accommodate performance requirements.
- Disk stack type Labyrinth-Multi-Pass X[iks]-trim for active noise attenuation.
- Casting or Forged body design up to ANSI class 4500 with intermediate and split ratings being available.
- End connection to match pipe-work size and materials.
- Bolted or pressure seal bonnet.
- Trim removable in line through the bonnet connection.
- Integral, adjustable condensate drain and warming valve options.
- Installation in any orientation without actuator support.
- Shut-off up to ANSI/FCI 70-2 Class V.
- All methods of actuation are available.
- Type of Body
  ; Angle or Globe type
  ; Z-type / Option
- Body Materials :
  ; A216-WCB, A217-WC6, A217-WC9, C12a.
  ; A105, A182-F11, A182-F22, A182-F91, F182-F92.
- Pipe Size
  ; HP Bypass Valve / 3" to 20 inch.
  ; Steam Conditioning Valve / 3" to 32inch.
- Pressure Rating
  ; ANSI Class 900, 1500, 2500, 4500.
- Trim
  ; disk stack type X[iks]-trim Cage
  ; Drilled Multi-Hole-Multi-Stage Cage
  ; Cage with Diffuser

2. LP Bypass Valve

The LP Bypass valve is primarily a protection device for the condenser. The valve simultaneously reduces reheat steam to a condition acceptable to the condenser and is normally of a large size due to the radical increase in specific volume of the steam as it is let down to condenser pressures which are often sub-atmospheric.

For this reason it is often necessary to supply the bypass valve with either an integral or separate dump tube, depending upon the installation configuration and pipework layout. Separate dump tubes are normally installed directly into the condenser inlet duct some distance downstream of the LP Bypass valve.

The LP Bypass valve has to rapidly condition up to 100% MCR boiler outlet steam by reducing pressure and temperature to condenser conditions. All LP Bypass valves have cage-guided trims which ensure stability and in most cases a Multi-Hole Multi-Stage, pressure profiling MHMS trim will be fitted for active noise attenuation. The final stage of pressure reduction is performed by a specifically designed diffuser or dump tube arrangement either integral to the valve or supplied separately.

Drawing on many decades of experience in all forms of desuperheating, BFS will offer the most appropriate method of cooling water introduction for the specific application. The method employed will be one of aspirations, variable area nozzle spray atomization.

Rapid actuation is required in the event of turbine trip achieved with either hydraulic or pneumatic cylinder actuators. Hydraulic actuators are generally adopted where both rapid and accurate positioning is required, or where end user preference dictates. For LP Bypass, the actuators are normally set in a fail-closed mode either by mechanical springs, hydraulic accumulators or pneumatic volume tanks.

TBLP-series, LP Turbine Bypass Valve

2-1. MH1S/MH2S/MHMS-Trim / Multi-Hole Device

The TBLP valve uses multi-hole cage technology to provide system noise attenuation through frequency shifting, which is a proven method of noise attenuation recognized by ISA Technical Standard SP 75.07 and by the IEC in Technical Standard 544-8-3. In frequency shifting the main flow stream is separated into hundreds of tiny jets. The size of jets, which are primarily based on hole size, determines the resulting noise frequency-the smaller the size of the jet or multi-hole, the higher the frequency, which in turn produces a lower turns meeting the required dBA level. Multi-hole cage technology is ideally suited for intermediate pressure combined-cycle and low pressure drum boiler turbine bypass applications. BFS TBLP multi-hole trim design uses tiny drilled holes(3-4 Ø) to ensure full jet separation, structural integrity, and maximum noise attenuation.

2-2. Key Features

- Model : TBLP-series, TBGT-series
- Contract specific designs fully accommodate performance requirements.
- Multi-Hole Multi-Stage pressure profiling MHMS trim for active noise attenuation.
  X[iks]-Trim (Option)
- Casting or forged body design up to ANSI Class1500 with split ratings available.
- End connections to match pipe-work sizes and materials.
- Bolted bonnets with quick change trims.
- Trim removable in line through the bonnet connection.
- Installation in any orientation without actuator support.
- Shut-off up to ANSI/FCI 70-2 Class V.
  MSS-SP-61
- All methods of actuation are available.
- Optional dump tubes with small hole technology for noise attenuation.
- Type of Body
  Angle or Globe type
- Body Materials :
  A216-WCB, A217-WC6, A217-WC9,
  A105, A182-F11, A182-F22,
- Pipe Size
  LP Bypass Valve / 3" to 24 inch.
  Steam Conditioning Valve / 3" to 32inch.
- Pressure Rating
  ANSI Class 300, 600, 900, 1500,
- Trim
  Drilled Multi-Hole-Multi-Stage Cage
  Diffuser Plate
- Dump Tube (Option)

X *[iks]-trim Concept*

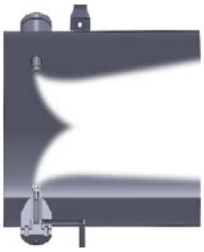
3. Desuperheating

The BFS desuperheater is designed to reduce the steam temperature by precisely injecting a finely atomized mist of water into a highly turbulent mixing area.

Variable Area Spray Nozzle

BFS achieves a wide range of control by using variable area , spring loaded spray nozzles. During low flow operation, the BFS spring loaded nozzles introduce a fine aerosol spray of water into the steam line by slowly easing the nozzles off the seat. This provides proper atomization of the spray water, even at minimal process flow. As the flow rate increases, the water pressure lifts the nozzle plug further off the seat and opens the orifice to provide a full conical spray pattern. BFS spring loaded nozzles can provide Cv ratios in excess of 50:1

Variable Nozzle Section View



Cooling Water Spray of Variable Nozzle

Variable Nozzle Installation

The BFS spray nozzle assembly design uses an easy to access, outlet area water injection system for low cost and ease of maintenance over the life of the valve. Locating the water injection system downstream of the trim eliminates unnecessary thermal stress on the valve trim, and reduces the complexity of the parts that are critical for operation. The TBHP-Series and TBLP-series desuperheating system provides reliable simplicity for technically demanding applications.

After final pressure reduction that is done through several basked-shaped pressure reducing pipes, that are designed to create a suitable pattern for desuperheating, the water is injected. The water injection itself is done through a number of spring-loaded variable area orifice type nozzle, thus ensuring small drops and good water distribution under all conditions.

Temperature Measurement

The distance from the water injection to the temperature measurement depends on steam velocity in the pipe, degree of superheat and the type of spraywater injection (in-body or spring-loaded nozzles). The recommended distance for typical HP-bypass configuration is 7 to 10m. If possible one or more elbows should be between the valve and the measuring point. The measuring device must not be placed where water can possibly collect (e.g. the outside of an elbow). The temperature measurement should be far enough from the inlet to the cold reheat steam temperature.

If the above mentioned distance is not available in the given piping arrangement BFS should be informed with exact pipe arrangement and dimensions.

4. Actuator

4-1. Technical Reason

In a utility plant steam conditioning valves are mostly used for turbine bypass during turbine trip and start-up.

At start-up the stroking time required can be 15-60sec. without problem.

At turbine trip the quick close valve before the turbine throttle valves typically closes in less than 0.2sec. The flow that was passing through the steam turbine before the turbine trip, must now be admitted through the bypass valve to avoid the lifting of the safety valves. How long this time takes depends on:

- The total volume upstream the valve (i.e. drum volume, superheater volume, pipe volume) m³.
- Flow from the boiler kg/sec.
- Pressure and specific volume MPa, m³/kg.
- Set point for the safety valves (percent overpressure)
- Capacity as a function of the stroke of the bypass valve m³/sec.

With this basic data, necessary stroking time can be calculated.

- Supercritical boiler and once through 0.2 - 2sec.
- High pressure reheat boiler 1 - 4sec.
- High pressure - more than 145bar.
- Medium pressure boiler 2 - 15sec.

Also to be considered:

- During start-up it is essential that the valve itself has a slow starting characteristic to avoid large flow changes with small stroke changes and that the valve design allows flow down to 1-2% with high stability.

- It is also of great value if the controller itself can be programmed with low gain at small stroke and increasing gain at increased stroke. Otherwise the typical problem is hunting and instability at small openings.

- To achieve very quick stroking times with pneumatic actuators, boosters and derivative relays, etc must be used. The booster especially, which is an amplifier, can create very unstable positioning small openings. It is therefore advantageous if separate quick open / quick close function is used.

- 100% stability cannot be achieved with pneumatic actuators as pressure or flow variations react on the plug. Air is compressible, and these fluctuations can cause the actuator to move (depending on how big the fluctuations are). To eliminate this, positioners with good exactness must be used together with double-acting piston actuators. Spring diaphragm actuators using lower air pressure and therefore larger volume are in most cases too unstable if high rangeability and good exactness are required.

Combined Cycle

Most combined cycles have a maximum steam flow of around 100ton/hr and pressure up to 100 bar and temperature up to 520℃. Typical stroking time 4-15sec.

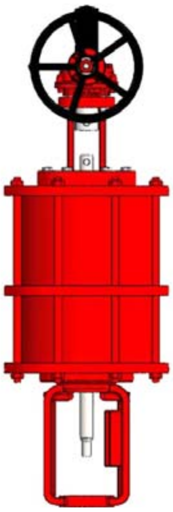
Only the largest systems with triple pressure cycle with reheat can reach up to 300ton/hrand pressure of 140bar and temperature of up to 575℃ with stroking time 4-6sec.

With this data, pneumatic piston actuators are in most cases acceptable.

4-2. Pneumatic Actuators

With BFS Turbine Bypass valves, it is often possible to utilize a more commercially attractive pneumatic actuation option due to the balanced design of the trim, resulting in relatively low actuation forces.

Cylinder actuators are commonly used for the bypass valve due to the stroke lengths often required.



Pneumatic Cylinder Actuator with Manual Handwheel

However on smaller installation and cooling water control valves, pneumatic spring diaphragm actuators can be successfully employed.

A critical function of any bypass system is its speed of response in the event of a turbine trip. Fast, full stroking speeds, which approach those gained with hydraulic actuation, are achieved with the addition of boosters and quick exhaust valves.

Pneumatic cylinder actuators are either double acting or spring-returned, according to the plant specifications. Both options are available with local accumulator tanks sized to perform the specified number of full stroke operations in the event of plant air failure.

4-3. Electro-Hydraulic Systems

Electro-Hydraulic actuation is often the preferred modulation method due to its speed and accuracy. Two types of electro-hydraulic actuation are available; HPU systems, where a centralized skid mounted hydraulic power unit, complete with control panel, provides the fluid power to all the actuated valves from a single source, or self-contained actuators mounted directly on the valve.

Hydraulic Power Unit / HPU

- All HPU's are contract specific, tailored to suit the power plants operating logic.
- Skid mounted design.
- Dual motorized fixed or variable displacement hydraulic pumps for 100% redundancy.
- Optional dual D.O.L starter gear complete with automatic changer over and local control.

Pumps are sized to recharge the accumulators from minimum to maximum in approximately one minute.

- Nitrogen filled bladder or piston type accumulators sized to match the system requirements.
- High-grade stainless steel high and low pressure filtration systems with visual condition indicator. Optional Pressure switches and automatic changeover.
- Stainless steel reservoir pipework and fittings. Control components are of a manifold design to ensure minimum pipework and are mounted within IP65 enclosures.
- Emergency Hand pump.
- Control panel containing positional modulating PLC instrumentation with DCS interface.
- Optional operating fluids-mineral oil or fire resistant fluids such as Phosphate Ester.
- Hydraulic fluid temperature control by means of Oil/Water or Oil/Air heat exchangers for cooling. For low ambient temperature installations, heaters can be installed to maintain correct operating temperature.

HS-Series / Hydraulic Power Unit

On smaller bypass installations, where there may be only two hydraulic actuated valves, it is commercially beneficial to fit self-contained electro-hydraulic actuators directly to the valves.

4-4. Self-Contained Electro-Hydraulic Actuator

BFS Self-Contained-Electro-Hydraulic-Cylinder Actuators vast experience with supporting the Power industries, Oil & Gas with valve automation solutions for the most critical applications in extreme operating environments has resulted in product designs that offer unsurpassed quality and reliability across all industries and applications.

- The same simplicity and low cost installation as provided by electric actuators.

Self Contained Electro-Hydraulic Actuator

- Fail safe or fail last operation.
- The power, precision and compact size of hydraulic systems.
- Partial valve stroking
- Control & Reciprocating(Linear) with Quarter turn(Rotary) valve positioning.
- On-shore and off-shore ESDV valves.

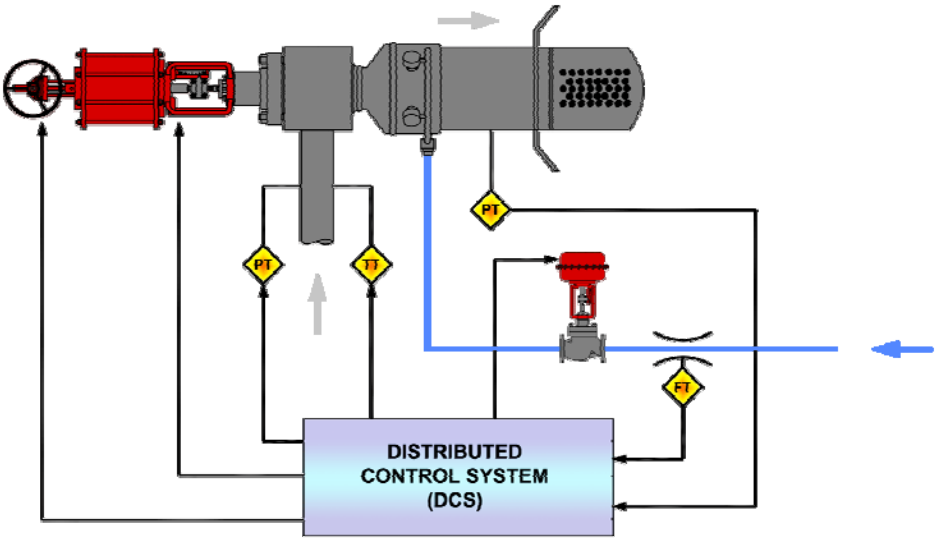
5. Dump Tube

5-1. Dump Tubes

BFS specializes in tailoring their bypass systems to fully complement specific plant requirement. An important part of any system discharging to a condenser is the dump tube. These industry proven devices are primary employed to minimize the size of the bypass valve where the specific volume of steam dramatically increase at low or subatmospheric pressures.

Normally fitted into the condenser inlet duct, the dump tubes are carefully designed to fulfill the final pressure reduction stage and allow the steam to expand and cool prior to entering the condenser. Careful consideration is given to the size, shape and profile of the dump tube to avoid interference with the turbine exhaust steam path under normal turbine operation. The array and size of holes in the dump tube are arranged to minimize noise generation and direct the steam away from the duct walls and towards the condenser inlet.

View of Dump Tube



Dump Tube Application Diagram

5-2. Dumping into Condenser

As the pressure in the condenser is very low, it is necessary to use a dumping device to make the final pressure reduction in order to avoid the need of unpracticle pipe diameters downstream of the bypass valve.

Admitting steam into the condenser is very arduous. Problems with condensers are a leading cause of unscheduled plant outages, particularly in large fossils-fuel-fired plants. A substantial portion of these problems is caused by damage from continuous or intermittent high energy fluid admission to condensers.

This paper is not intended to solve all problems regarding admission to the condenser in detail, but give some advice in how to minimize design stage problems at a reasonable cost.

The approximate cost relationship to solve these problems is:

At conceptual design stage	1
At specification stage	10
At commissioning stage	100
After commissioning	1000

It is great importance to take future investments into consideration, as replacement after commissioning could be very costly.

Even the most cost-efficient plant will sooner or later be less cost-effective than the next generation of power plants. The plant will therefore be used as peaking plant instead of base load. In order to avoid very high upgrading costs required for start and stop every day instead of once a year, it is much more cost-effective to spend a few percent more on bypass system design and purchase from the beginning.

5-3. Temperature Control

Advantages

This direct method simplifies the control considerably.

Disadvantage

- Requires long distance between the desuperheating point and measuring point which is expensive, both in terms of space and the cost of large diameter piping.
- High temperature of the steam entering the condenser, which causes large temperature variations between normal operation conditions and bypass conditions. This results in thermal stress, expansion problem, etc.
- A spray curtain inside the condenser can solve this problem, but at a high cost and with an increased risk of erosion problems.
- It is very common to have temperature spikes. The results will be an excess or a lack of water as the system reacts on deviations and more often reacts

Temperature Measurement

The distance from the water injection to the temperature measurement depends on steam velocity in the pipe, degree of superheat and the type of spray water injection (in-body or spring-loaded nozzles). The recommended distance for typical HP-bypass configurations is 7 to 10m. If possible one or more elbows should be between the valve and the measuring point. The measuring device must not be placed where water can possibly collect (e. g. the outside of an elbow). The temperature measurement should be far enough from the inlet to the cold reheat pipe that the measured temperature with closed bypass is considerably below cold reheat steam temperature.

If the above mentioned distance is not available in the given piping arrangement BFS should be informed with exact pipe arrangement and dimensions.

5-4. Enthalpy Control

Advantages

- Less spec consuming and therefore a less expensive system
- Better rangeability.
- Lower enthalpy can be achieved
- Reacts before an event, thus avoiding incorrect amount of spray water and, which improves exactness.
- Can easily be integrated into the DCS or PLC.

Disadvantage

- Requires more complicated control system and more knowledge.
- Indirect control which depends on knowledge of characteristics.

When these and other factors are considered, enthalpy control is technically and commercially superior.

After having decided that enthalpy control is superior
What method to use?

- Steam/water proportioning.
- Steam and water valve characteristic
- Steam valve characteristic with water flow measurements.
- Steam flow and water flow measurement.

5-5. Downstream Length

First of all, it is important to avoid bends downstream, since bends will separate water from steam owing to the difference in density. The distance to the dump tube from the point of injection should if possible be 0.05seconds x V max. or longer to minimize the risk of nonevaporated water. Our recommendations are based on frequent use. However, we have many installations with only half or less of this distance that have proven to operate for many years without problems.

5-6. Final Pressure Reduction to Condenser

Dump Tube Life Time

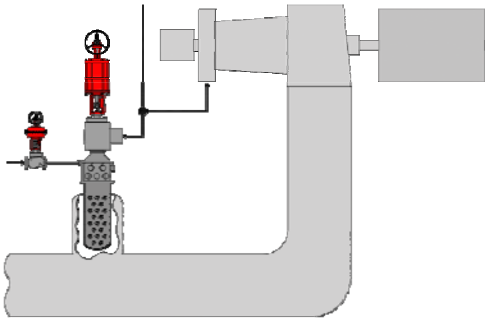
4～6% free water results in minimum 5,000 - 10,000 hours of operation before any erosion or damage is detected.
If the amount of free water is less than 4%, 10,000 - 20,000 hours operating time can be expected before damage is detected.
When the dump tube starts to be damaged it will be easy to detect, as the back pressure will drop. Rounded holes compared with sharp-edged holes create less of a pressure drop.

Condenser Risks

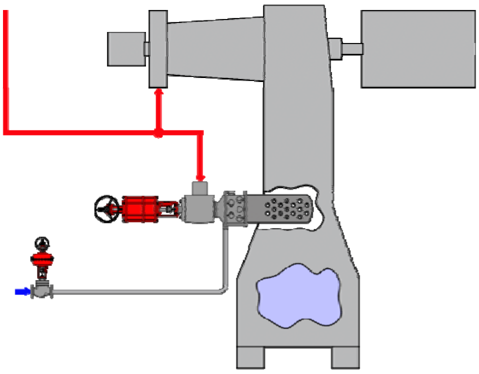
Downstream of the holes in the dump tube/hemisphere/ dump device, it is absolutely necessary to keep a certain free distance to avoid erosion. The dangerous distance is a function of several components.

Upstream Pressure / Dump Tube Pressure

The higher the pressure, the longer the distance. It is also important to know, the higher dump tube pressure, the higher amount of free water.

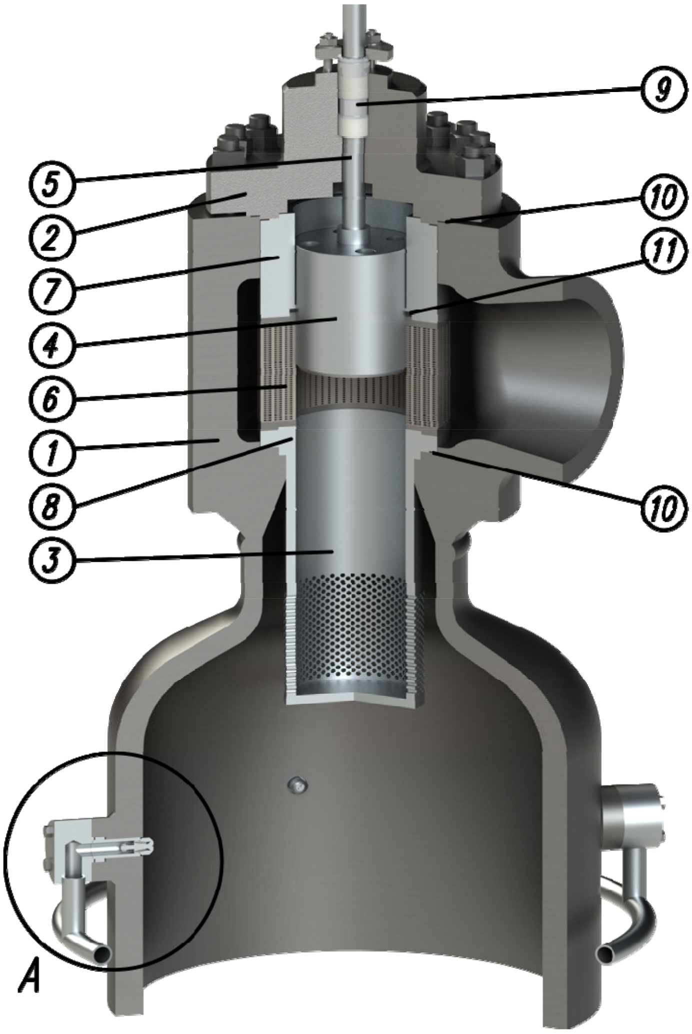


Arrangement for dumping steam into air cooled condenser



Bypass to water cooled condenser

6. Technical Specification and Materials. / TBHP-Series

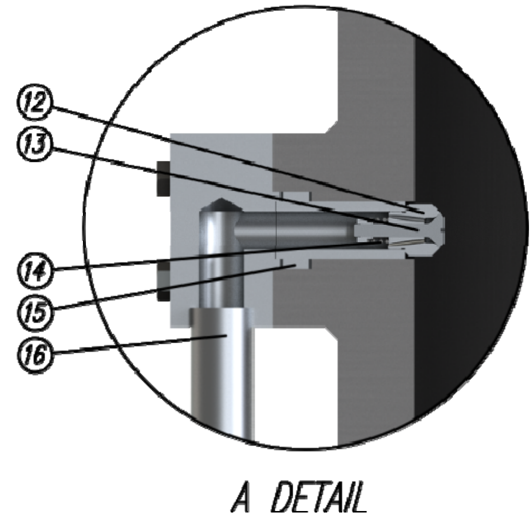


HP-Bypass Valve / Floe to Close Direction/ TBHP-Series

Table 1. HP Bypass Valve Materials.

No	Component	Materials of Construction
1	Body	A182-F11, F22 ,F91. F92. or Casting
2	Bonnet	A182-F11, F22, F91, F92. or Casting
3	Diffuser	A182-F11, F22, F91, F92
4	Plug	Alloy Steel w/ Stellite, overlay or Inconel, (A182-F11,22,91+STF)
5	Stem	Inconel 718
6	X[iks]-Trim	Inconel 718
7	Bal. Cylinder	A182-F11, F22 ,F91. F92.
8	Seat-Ring	Alloy Steel with Stellite overlay
9	Gland Packing	Live Loading Graphite
10	Gasket	316SS + Graphite
11	Balance Seal	Inconel 718 + Graphite
12	Nozzle Body	316 SS or Inconel 718
13	Nozzle Plug	316 SS or Inconel 718
14	Nozzle Spring	Inconel 718
15	Nozzle Holder	A182-F11, F22, F91, F92
16	Water Pipe	316 SS, P11, P22, P91, P92

Alternate materials available per customer's specific design Require.



Actuator Application

- ***Electro-Hydraulic Cylinder Actuator***
- ***Pneumatic Cylinder Actuator***
- ***Self Contained Electro-Hydraulic Cylinder Actiuator***

Standard Material Application of TBHP/TBLP-Series

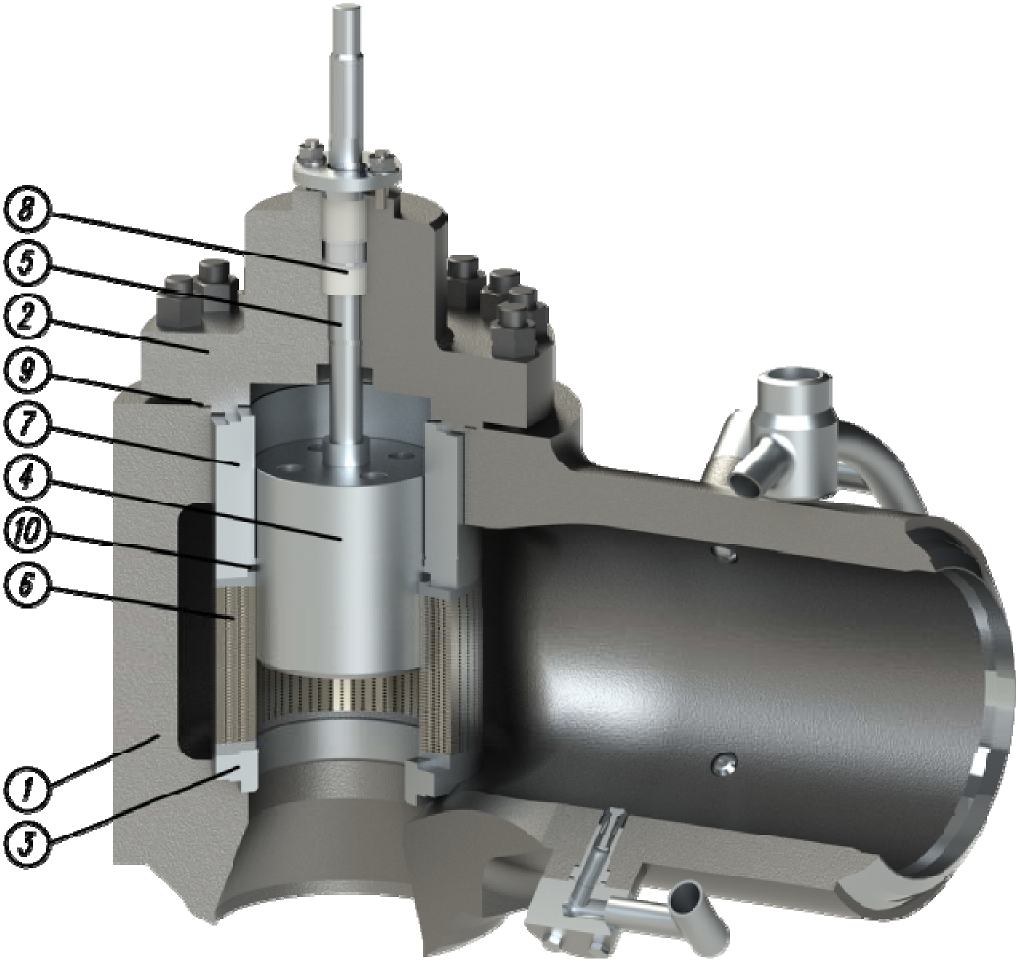
<table>
<tr><th colspan="2">Fluid Temperature / ℃</th><th colspan="10">-196 -45 -29 0 +270 +425 +450 +480 +566 +620 +70</th></tr>
<tr><th>Ref. No</th><th>Parts Name</th><th colspan="10">Application Materials</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Body</td><td colspan="2">▨</td><td colspan="3">A216-WCB / A105</td><td colspan="5">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="6">A217-WC6,WC9, C12a / A182-F11, F22, F91,</td><td colspan="2">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="7">A217-C12A, A182-F91</td><td>A182-F92</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Bonnet</td><td colspan="2">▨</td><td colspan="3">A216-WCB / A105</td><td colspan="5">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="6">A217-WC6,WC9, C12a / A182-F11, F22, F91,</td><td colspan="2">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="7">A217-C12A, A182-F91</td><td>A182-F92</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Diffuser</td><td colspan="2">▨</td><td colspan="6">A217-WC6,WC9, C12a / A182-F11, F22, F91,</td><td colspan="2">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="7">A217-C12A, A182-F91</td><td>A182-F92</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Plug</td><td colspan="8">316 SS or 316 SS + Stellited.</td><td colspan="2">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="3">410 SS</td><td colspan="5">A182-F11,F22,F91 + Stellited, Inconel + Stellited.</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Plug Stem</td><td colspan="8">316 SS, A182-F11/F22</td><td colspan="2">▨</td></tr>
<tr><td colspan="5">17-4PH/630SS</td><td colspan="5">▨</td></tr>
<tr><td colspan="10">Inconel, A286 Super Alloy. ASTM A638 Gr. 660</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">X[iks]-Trim</td><td colspan="8">316 SS or 316 SS + Stellited</td><td colspan="2">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="3">410 SS</td><td colspan="5">A182-F11,F22 + Stellited / Inconel</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Bal. Cylinder</td><td colspan="8">316 SS or 316 SS + Stellited</td><td colspan="2">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="3">410 SS</td><td colspan="5">A182-F11,F22 + Stellited / Inconel</td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">Seat Ring</td><td colspan="8">316 SS or 316 SS + Stellited</td><td colspan="2">▨</td></tr>
<tr><td colspan="2">▨</td><td colspan="3">410 SS</td><td colspan="5">A182-F11 ,F22+ Stellited / Inconel</td></tr>
<tr><td rowspan="2">9</td><td rowspan="2">Gland Packing</td><td colspan="4">Braided Teflone or V-Teflone.</td><td colspan="6">▨</td></tr>
<tr><td>▨</td><td colspan="9">Molded Graphite, Flexible Graphite</td></tr>
<tr><td rowspan="2">10</td><td rowspan="2">Body Gasket</td><td colspan="4">316 SS Teflon Filler / Spiral Wound</td><td colspan="6">▨</td></tr>
<tr><td colspan="10">316 SS with Flexible Graphite Filler / Spiral Wound</td></tr>
<tr><td rowspan="3">11</td><td rowspan="3">Balance Seal</td><td colspan="4">RTFE+316SS</td><td colspan="6">▨</td></tr>
<tr><td colspan="3">▨</td><td colspan="7">Graphite+Inconel</td></tr>
<tr><td colspan="2">▨</td><td colspan="8">Carbon-Ring / Metal-Ring</td></tr>
<tr><td>12</td><td>Nozzle Body</td><td colspan="2">▨</td><td colspan="3">316 SS</td><td colspan="5">Inconel</td></tr>
<tr><td>13</td><td>Nozzle Plug</td><td colspan="2">▨</td><td colspan="3">316 SS</td><td colspan="5">Inconel</td></tr>
<tr><td>14</td><td>Nozzle Spring</td><td colspan="2">▨</td><td colspan="8">Inconel</td></tr>
<tr><td>15</td><td>Nozzle Holder</td><td colspan="2">▨</td><td colspan="3">A105</td><td colspan="4">A182-F11/F22/F91</td><td>A182-F92</td></tr>
<tr><td>16</td><td>Water Pipe</td><td>▨</td><td>▨</td><td colspan="3">P106</td><td colspan="4">P11/P22/P91</td><td>A182-P92</td></tr>
<tr><td rowspan="6">**</td><td rowspan="3">Body Studs</td><td>▨</td><td colspan="5">SNB7</td><td colspan="4">SNB16</td></tr>
<tr><td>▨</td><td colspan="9">Alloy Steel ASTM A193 Gr. B7</td></tr>
<tr><td colspan="8">304 SS</td><td colspan="2">▨</td></tr>
<tr><td rowspan="3">Body Stud Nuts</td><td>▨</td><td colspan="5">S45 C</td><td colspan="4">ASTM A194 Gr. 4</td></tr>
<tr><td>▨</td><td colspan="9">Alloy Steel ASTM A194 Gr. 2H</td></tr>
<tr><td colspan="8">304 SS</td><td colspan="2">▨</td></tr>
</table>

* Body Materials Application : A216-WCB, A217-WC6, A217-WC9, A217-C12a, A105, A182-F11, A182-F22,
A182-F91, A182-F92, Inconel, Others

* Trim Materials Application : 304 SS, 316 SS, 316 SS+Stellited, 410 SS, 416 SS, 420 SS, 630 SS (17-4PH)
, A182-F11/22/F91 + Stellited, Inconel, Others.

** BFS Standard

7. Technical Specification and Materials / TBLP-Series

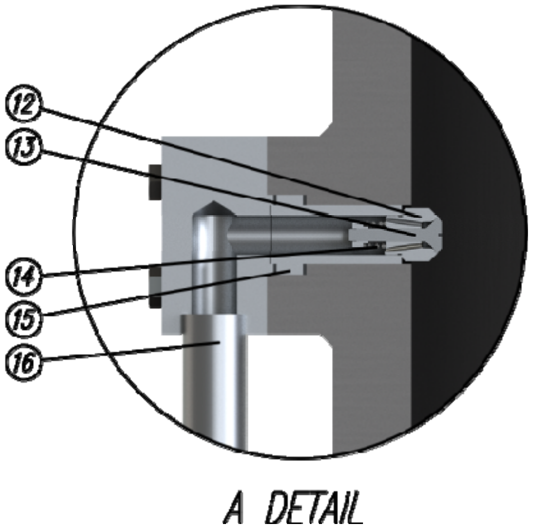


LP-Bypass Valves / Flow to Open Direction / TBLP-Series

Table 2. LP Bypass Valve Materials

No	Component	Materials of Construction
1	Body	A216-WCB,A217-WC6, WC9 or Forging
2	Bonnet	A216-WCB,A217-WC6, WC9 or Forging
3	Diffuser	A105, A182-F11, F22.
4	Plug	Alloy Steel w/Stellite, overlay or 410 SS Inconel, (A182-F11,F22,F91 +STF)
5	Stem	17-4PH,310 SS,Inconel718,A182-F11/F22
6	MHMS-Trim	410 SS,310 SS,Inconel718,A182-F11/F22
7	Bal. Cylinder	410 SS, A182-F11, F22.
8	Seat-Ring	Alloy Steel, A182-F11/F22, 410SS
9	Gland Packing	Live Loading Graphite
10	Gasket	316SS + Graphite
11	Balance Seal	Inconel 718 + Graphite
12	Nozzle Body	316 SS or Inconel 718
13	Nozzle Plug	316 SS or Inconel 718
14	Nozzle Spring	Inconel 718
15	Nozzle Holder	A105, A182-F11, F22,
16	Water Pipe	316 SS, P106, P11, P22,

Alternate materials available per customer's specific design Require.



Actuator Application

- ***Electro-Hydraulic Cylinder Actuator***
- ***Pneumatic Cylinder Actuator***
- ***Self-Contained Electro-Hydraulic Cylinder Actuator***

7. Standard Valve Body Size & Trim Size, Cv Value

7-1. TBHP-series, TBGT-series / X[iks]-trim Application

Unit / inch

Inlet Size	3" (80A)						4" (100A)						5" 6"					8"				
Outlet size	8"	10"	12"	16"	18"	20"	8"	10"	12"	16"	18"	20"	14"	16"	18"	20"	22"	14"	16"	18"	20"	22"
Trim Size	3"						3"						4"					4"				
Rated Cv	125						125						248					248				

Inlet Size	8"						10"						10"					12"				
Outlet size	16"	18"	20"	28"	30"	32"	16"	18"	20"	28"	30"	32"	22"	24"	26"	40"	42"	22"	24"	26"	40"	42"
Trim Size	5"						5"						6"					6"				
Rated Cv	390						390						630					630				

1. Buttweld per ANSI B 16.25 & mating pipe schedule for steam connection.

2. Water connection is ANSI B16.5 RF flange or SW, BW / Customer specific design requirements.

3. Option / X[iks]-trim with Diffuser Application and over 12" valve size.

7-2. TBLP-series, TBGT-series / Drilled Multi-Hole Trim with Application.

Unit / inch

Inlet Size	3"		4"		5"			6"			8"			10"			12"			14"		
Outlet size	8"	10"	8"	10"	6"	8"	10"	6"	8"	10"	8"	10"	12"	10"	12"	14"	16"	18"	20"	16"	18"	20"
Trim size	3"		4"		5"			6"			8"			10			12"			14"		
Cv / Reduced	53/60		100		140			210			300			460			608			800		
Cv / Standard	70		180		250			420			630			840			1,100			1,450		

Inlet Size	16"			16"			18"			20"			20"			22"			24"			
Outlet size	16"	18"	20"	22"	24"	26"	22"	24"	26"	22"	24"	26"	26"	28"	30"	26"	28"	30"	26"	28"	30"	60"
Trim Size	16"			16"			18"			12", 14"			16", 18"			16", 18"			20", 24"			
Cv / Reduced	1055			1230			1360			1600			2280/3000			1			1600/2300			
Cv / Standard	1,600			1850			1900			2300			6000/7700			6000/7700			6000/7700			

1. Buttweld per ANSI B 16.25 & mating pipe schedule for steam connection.

2. Water connection is ANSI B16.5 RF flange or SW, BW / Customer specific design requirements.

3. Option / X[iks]-trim with Diffuser Application

4. Option / over 24" size

Steam Conditioning Valve

Steam conditioning valves shown in the diagram as H.P and LP bypass valves as examples are reducing valves in which the steam pressure and at the same time the steam temperature are reduced.

As HP and LP bypass valves, they serve to bypass the turbine. Another function of the steam conditioning valve is to supply superheated steam to district heating systems. Inaddition to the described functions, these valves are also used as safety valves with quick-opening or quick closing function according to TRD 421. Thus, they ensure protection of the boiler plants or parts thereof.

HP Bypass Valve with Safety Function

The HP Bypass valve is from the function point of veiw a steam conditioning valve. With the suitable selection and safety arrangement, TRD 421. this valve in addition becomes a safety valve.

Without safety control, the valve is suitable for application as HP or LP bypass valve.

The Valve performs the following functions:

1. Optimum start-up and shut-down of the turbine and boiler independent of each other
2. On turbine trip, the valve is quickly opened via a step load change relay. Thus, no unallowable overpressure can build up in the boiler
3. In combined heat and power plants continuous operation for heating steam supply is ensured even without turbine. In this case, the valve operates as a bypass valve.
4. Independent of the above mentioned functions, the valve operates as a safety valve and opens on reaching the licence pressure.

8. Turbine Bypass Valves Ordering Information

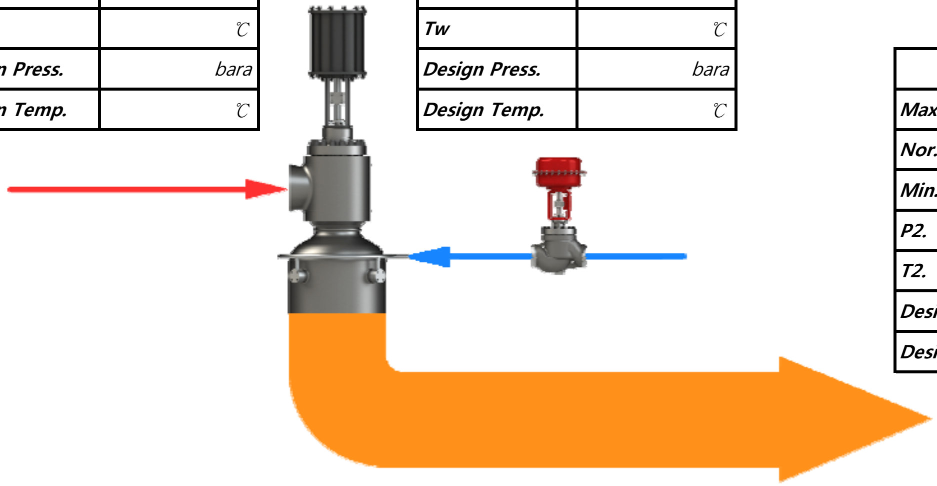
Data Required Following Specification

Working conditions when you request us to select the best Steam Conditioning Valves for you.

Service Condition

Inlet Steam Condition	
Max. Flow	*kg/hr*
Nor. Flow	*kg/hr*
Min. Flow	*kg/hr*
P1.	*bara*
T1.	℃
Design Press.	*bara*
Design Temp.	℃

Cooling water condition	
Pw.	*bara*
Tw	℃
Design Press.	*bara*
Design Temp.	℃



Outlet Steam Condition	
Max. Flow	*kg/hr*
Nor. Flow	*kg/hr*
Min. Flow	*kg/hr*
P2.	*bara*
T2.	℃
Design Press.	*bara*
Design Temp.	℃

Application

Application	☐ HP Bypass ☐ IP Bypass ☐ LP Bypass ☐ Steam Conditioning
Valve body type	☐ Angle ☐ Globe
Bonnet type	☐ Bolted ☐ Pressure Seal
Steam pipe size	Inlet / ( ) inch x ( ) sch Outlet / ( ) inch x ( ) sch
Steam inlet connection	☐ Buttweld ☐ Raised Face Flange ☐ Ring Type Joint Flange
Steam outlet connection	☐ Buttweld ☐ Raised Face Flange ☐ Ring Type Joint Flange
Plug type	☐ Unbalanced ☐ Balanced ☐ Auxily Pilot
Seat ring type	☐ Quick Change ☐ Seal Welded
Allowable noise generation level	/ dBA
Actuator type	☐ Pneumatic ☐ Hydraulic ☐ Self Contained Hydraulic
Handwheel	☐ Worm Gear Box ☐ Hydraulic Hand Jack
Valve stroking time	/ sec.
Valve seat leakage class	ANSI/FCI 70-2 Class V is standard.
Operation input signal	☐ mA. ☐ Others.
Supplied air pressure or Electric power	☐ BarG. ☐ V. Hz.
Steam flow direction	☐ Flow to Close ☐ Flow to Open
Air fail position	☐ Close ☐ Open ☐ Lock
Signal fail position	☐ Close ☐ Open ☐ Lock

10. Metric Conversion Tables

LENGTH

Multiply	By	To Obtain
millimeters	0.039	inches
centimeters	0.394	inches
inches	2.54	centimeters
feet	30.48	centimeters
feet	0.304	meters

VOLUME AND CAPACITY

Multiply	By	To Obtain
cubic feet	28.32	liters
cubic feet	7.4805	gallons
liters	61.02	cubic inches
liters	0.03531	cubic feet
liters	0.264	gallons
gallons	3785.0	cubic centimeter
gallons	231.0	cubic inches
gallons	0.1337	cubic feet

AREA

sq. centimeters	0.155	sq. inches
sq. centimeters	0.001076	sq. feet
sq. inches	0.452	sq. centimeter
sq. inches	0.00694	sq. feet
sq. feet	929	sq. centimeter

WEIGHT

pounds	0.453	kilogram
kilgram	2.205	pounds

FLOW RATES

gallons US Minute	3.785	liters/min
gallons US Minute	0.133	cubic feet/hour
gallons US Minute	0.227	cubic meter/hour
cubic feed minute	7.481	GPM
cubic feed hour	0.1247	GPM
cubic feed hour	0.01667	cubicfeet/min
cubic meter hour	4.403	GPM
cubic meter hour	35.31	cubic feet / hour

PRESSURE AND HEAD

pound / sq. inches	0.06895	bar
pound / sq. inches	0.06804	atmosphere
pound / sq. inches	0.0703	kg/cm2
pound / sq. inches	2.307	ft of H2O (4℃)
pound / sq. inches	0.703	m of H2O (4℃)
pound / sq. inches	5.171	centimeter of hg (4℃)
pound / sq. inches	2.0	inch of hg (4℃)
atmosphere	14.7	psi
atmosphere	1.013	bar
atmosphere	1.033	kg/cm2
atmosphere	101.3	kPa
bar	14.5	psi
kilogram/sq cntimeter	14.22	psi
kilo Pascal	0.145	psi

VELOCITY

feed per second	0.3048	meter/second
feed per second	1.097	km/hour
feed per second	0.6818	miles/hr

Temperature Conversion

F (Fahrenheit) = C (9/5)=32

C (Celsius) = (F-32)5/9

Best Flow Solution

BFS Incorporation

23block-3lot, Geumdan-Industrial-Complex

#17, 114beongil, Geumdan-ro, Seo-gu, Incheon-city, Korea

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