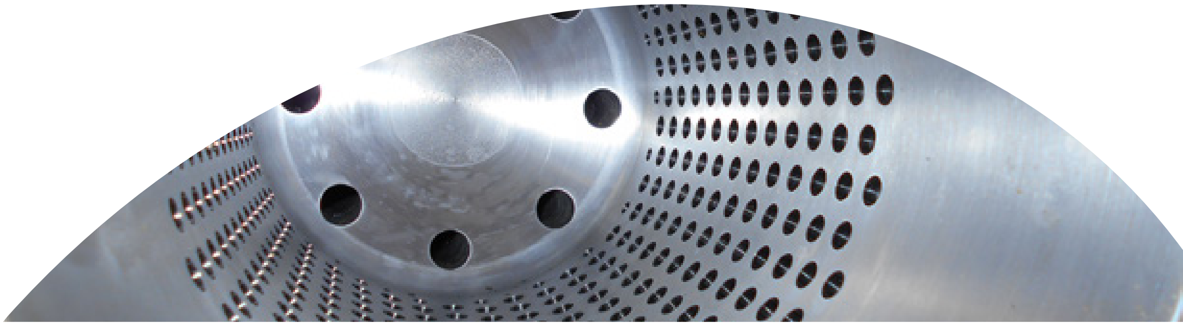
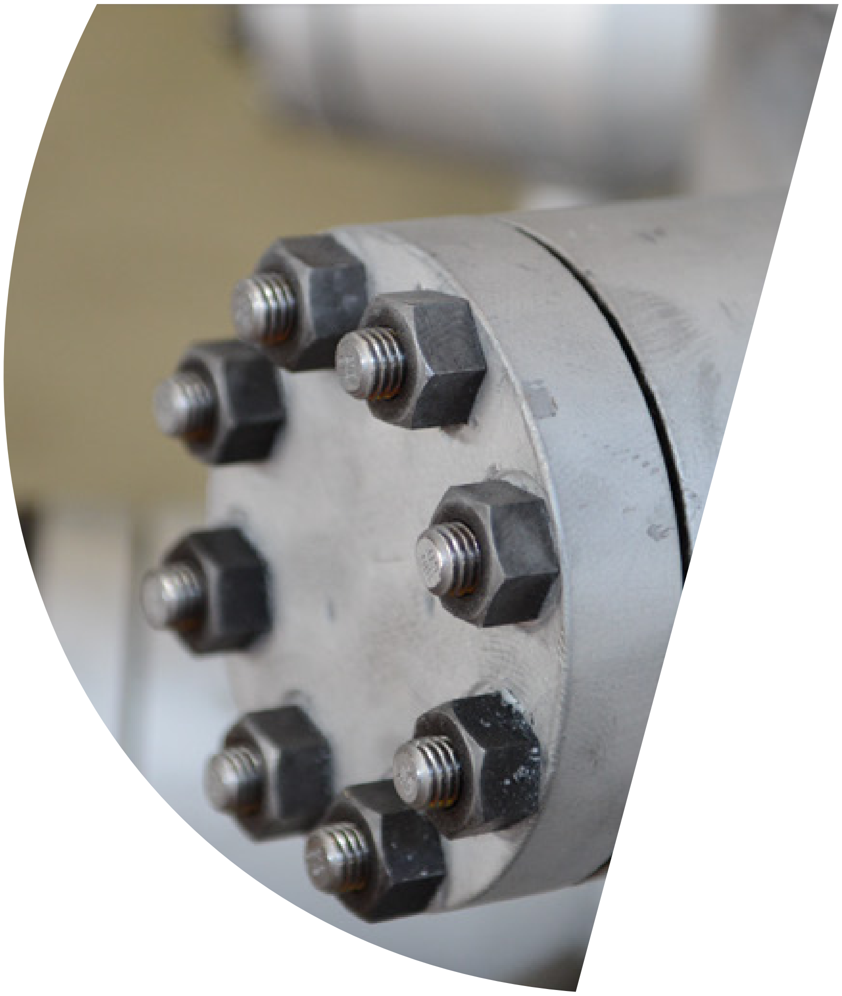
BLAKEBOROUGH®
TURBINE BYPASS VALVES





TRILLIUM
FLOW TECHNOLOGIES™

TRILLIUMFLOW.COM

A PROVEN TRACK RECORD

We have extensive references and a proven track record in the supply of valves across a number of key industries. Our valves are industry renowned brands, each with an established reputation for quality engineering and reliability.

VALVE TESTING

All pressure containing items are hydrostatically tested, seat leakage tested and functionally tested. We can also perform gas, packing emission, cryogenic and advanced functional testing, as well as seismic testing for nuclear applications.

MATERIAL TESTING

- Non-destructive examination by radiography, ultrasonics, magnetic particle and liquid penetrant.
- Chemical analysis by computer controlled direct reading emission spectrometer.
- Mechanical testing for tensile properties at ambient and elevated temperatures, bend and hardness testing. Charpy testing at ambient, elevated and sub-zero temperatures.

AFTERMARKET SOLUTIONS

Our valve aftermarket solutions are based on our engineering heritage, applying our OEM knowledge and expertise to maintenance strategies, life extension and upgrade projects.Trillium Control & Choke Valves provides a wide range of control valves for the process industry. These include severe service, choke, desuperheating and turbine bypass applications.

Our world-wide reputation is based on engineering excellence applied to a comprehensive range of specialist products and effective customer support.

Trillium Fundamentals

- Health & Safety First
- Integrity & Customer Care
- Success Through Collaboration
- Embedded Quality
- Environmentally Responsible
- Focused on Your Profitability

ATWOOD & MORRILL®
Engineered Isolation & Check Valves

BATLEY VALVE®
Butterfly Valves

BLAKEBOROUGH®
Control, Choke & Steam Conditioning Valves

HOPKINSONS®
Isolation Valves

REDPOINT®
Specialised Isolation Valves

SARASIN-RSBD®
Safety & Safety Relief Valves

SEBIM®
Nuclear Pilot Operated Safety Valves

TRICENTRIC®
Triple Offset Butterfly Valves

Portfolio of engineered service solutions and aftermarket support

INTRODUCTION

The Trillium BV995 Turbine Bypass Valve is a highly sophisticated engineered control device. Conceptually, it is required to accurately control multiple operational variables, provide system protection to both upstream and downstream plant components, and sometimes perform these tasks all in a fraction of a second. Depending on the overall system size, bypass mode of operation and customer preference, there is almost an endless selection of options and configurations that can be applied to the BV995 bypass valve construction. The Trillium BV995 Turbine Bypass Valve design can be varied to accommodate the particular plant design, size, and application. It is available in a range of options and configurations to assure optimum performance regardless of the mode of operation.

HIGH PRESSURE (HP) BYPASS VALVE

The high pressure (HP) bypass valves are subject to some of the highest pressures and temperatures. They may be utilised in either a Parallel or Cascading Bypass System. If the plant is configured in a Parallel arrangement, the HP Bypass Valve will direct the outlet steam flow to the condenser. If the plant is configured as a Cascading system (the most common in today's plants) the steam will be directed to the Cold Reheat section of the boiler or steam generator. Regardless, these valves will warrant the highest pressure ratings which may go as high as ASME 4500. The valves are commonly manufactured from forged materials which allow for higher strength and ductility when compared to the equivalent cast material. The additional strength of the forged materials also provide greater manufacturing flexibility which allows for optimised contours and shapes that can result in thinner wall sections being applied to the valve body design. This helps in reducing the effect of thermal gradient stress across the body caused by the rapid and sudden opening of the valve during a turbine trip sequence.

HRH BYPASS VALVE (MP, IP, OR HRH)

The Hot Reheat (HRH) bypass valves (sometimes referred to as Intermediate or Medium Pressure) are used to bypass steam to the condenser regardless of whether the bypass system is configured as parallel or cascading. The required flow coefficient, Cv, for these valves is often the largest in the system due to the combination of lower steam pressures and higher temperatures emanating from the re-heater. They are used to convert the HRH steam to conditions more acceptable for admission into the condenser. As a result of the high steam temperatures entering these valves, they normally require a significant amount of desuperheating flow to reduce the outlet enthalpy to acceptable condenser inlet conditions.

HP Bypass valve

HRH Bypass valve

LOW PRESSURE BYPASS VALVE (LP)

The low pressure bypass valve is used to bypass the LP section of the turbine and also directs its steam discharge to the condenser. The low pressure valves are not subject to extremes of heat and pressure in the same way as the HP and HRH bypass valves. They are therefore mostly made from lower grade cast materials such as ASTM/ASME SA216 WCB or carbon steel forgings such as ASTMASME SA A105. Due to the lower inlet pressures and temperatures, the LP bypass design criteria are not as difficult and there are many possible valve solutions and configurations for this application.

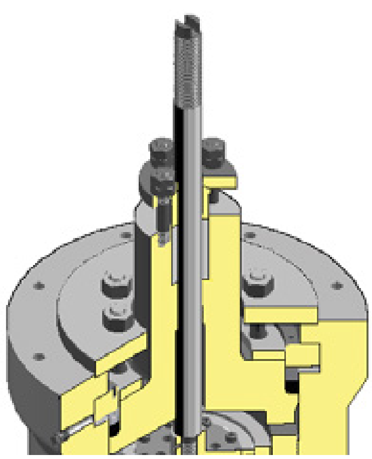
LP Bypass valve

BONNET DESIGN OPTIONS

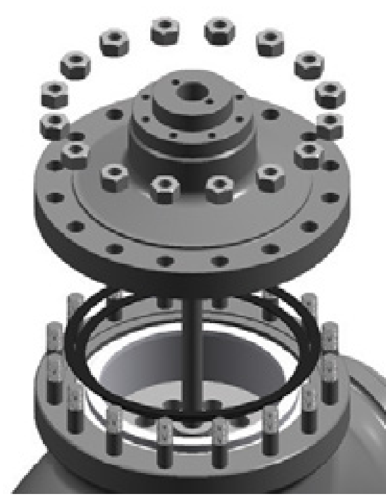
In the design of any pressure vessel, there will always be a requirement to allow access to the inside of the component via the penetration of the pressure retaining boundary. In the case of a turbine bypass valve, this is usually facilitated by the valves bonnet. Under pressurized or operational conditions, the bonnet serves the same purpose as the vessel wall in securely containing the pressure and flow. However, when it is time for inspection or maintenance, the bonnet can be removed and access to the valve trim and seat can be afforded. Depending on the system pressures, valve size, and customer preference there are two main bonnet designs that are quite typical for turbine bypass valves.

These are:

- Bolted Mechanical Bonnet
- Pressure Seal or Pressure Assisted Bonnet

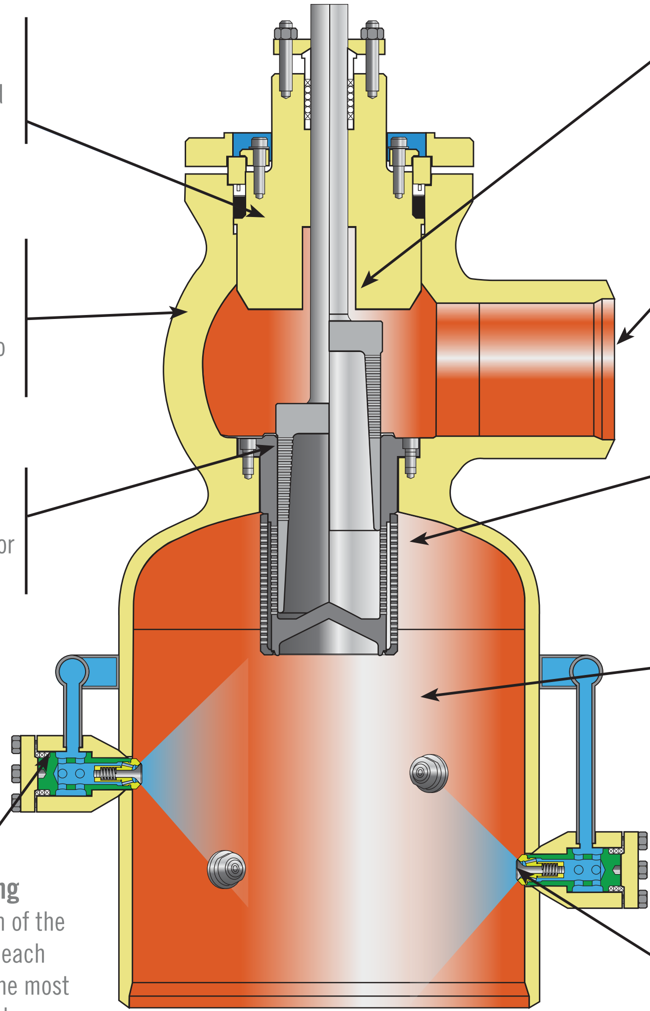


Pressure seal bonnet design



Typical bolted bonnet

STANDARD MATERIALS OF CONSTRUCTION



Pressure Boundary Integrity
Bonnet closure provided in either a pressure seal (High Pressure) or bolted (Low Pressure) design

Low Stress Configuration
The inside and outside body contours are fully machined to assure smooth transition with little or no stress due to thermal or mechanical loading

Fully Serviceable Trim
Seat ring and pressure reduction stages are fully removable for service or modification

Customised Desuperheating
The size, number, and location of the spray nozzles is optimised for each application so as to achieve the most advantageous distribution and coverage of the flow stream

Leakage Minimised
Available with three different plug configurations including pressure balanced for Class IV and Pilot balanced for Class V

Inlet/Outlet Connections
Size and materials selected to match customer's requirements

Noise Attenuation
Pressure reduction accomplished via two co-ordinated control surfaces and 1 or 2 outlet diffusers. Pressure reduction ratios balanced to eliminiate unwanted noise and vibration

Water Injection
All desuperheating is conducted after the pressure reduction is complete, assuring little or no thermal shocking to termperature sensitive trim

Variable Geometry Nozzles
Spring-loaded, backpressure activated, variable geometry nozzles provide an excellent spray pattern for quick mixing and evaporation

PART NO.	DESCRIPTION	MATERIAL STANDARD	COMMENTS
1	Valve Stem	AISI 616	Surface Hardened
2	Packing Hardware	AISI 420	
3	Packing	Graphite	
4	Segment/Spacer Ring	SA182-F22/F91/F92	
5	Pressure Seal Gasket	Graphite	SST Reinforced
6	Bonnet	SA105/SA182-F11,F22,F91/F92	
7	Valve Body	SA105/SA182-F11,F22,F91/F92	
8	Control Plug	SA182-F22/F91/F92	Alloy 6 Overlay
9	Seat Ring	SA182-F22/F91/F92	Alloy 6 Overlay
10	Pressure Reduction Stages	SA182-F22/F91/F92	
11	Outlet	SA106/SA335-P11,P22,P91	
12	VG Nozzle	AISI 410	

Plug Configurations

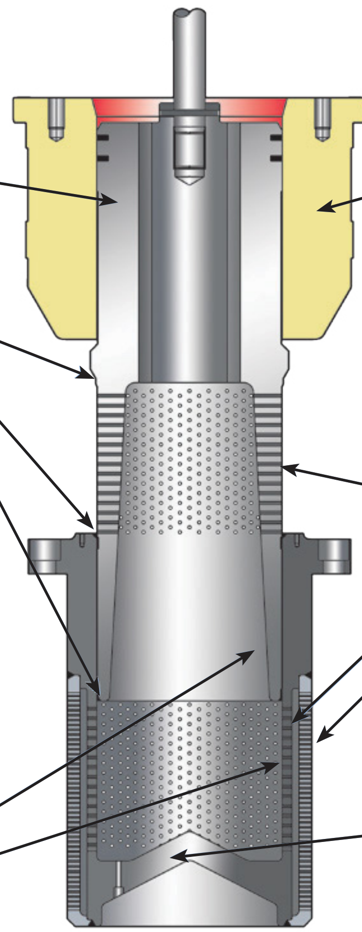
The control plug is available in either a balanced, unbalanced, or pilot balanced balanced, unbalanced, or pilot balanced actuating requirements

Hardened Surfaces

All seating and guide surfaces overlaid with alloy 6 material to provide smooth stroking and tight shut-off

Co-ordinated Control Surfaces

Trim provides a minimum of two stages of co-ordinated control and pressure reduction thus lowering noise and providing excellent rangeability



Hung Cage Trim

Allows for free axial expansion of the trim due to thermal expansion

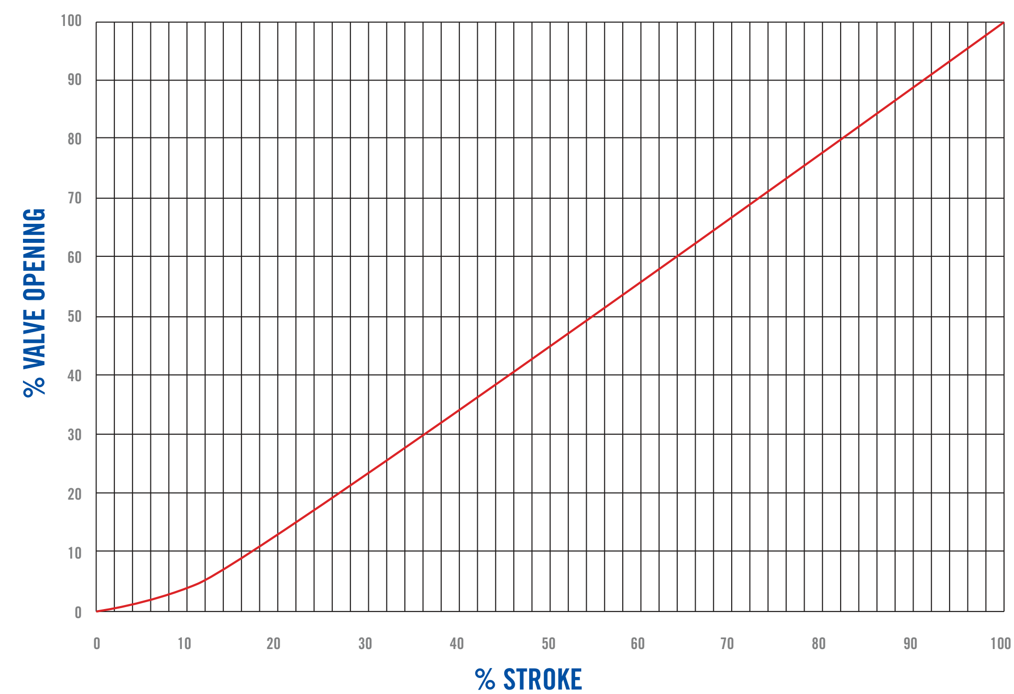
Low Noise Trim

Three stages of expansion controlled trim provide a solution to meet noise specifications

Trim Arrangement

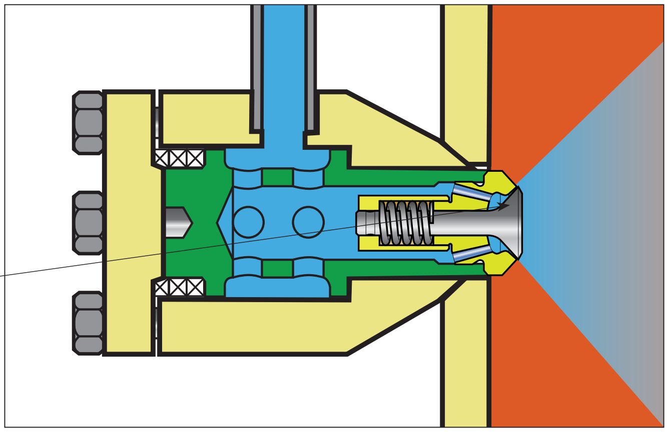
The selection, number, and nesting of the appropriate pressure reduction stages is optimised to achieve a balance in the pressure drop ratio across the trim assembly and minimise noise and vibration. The plug has a single flow coefficient per valve size, the 2nd stage has five different capacities, and the 3rd stage has 10 different capacities. In this way, they can be mixed and matched to achieve maximum stability and control

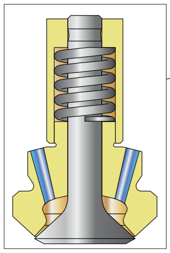
LINEAR VALVE CHARACTERISTIC (SPECIAL CHARACTERISTICS AVAILABLE ON REQUEST)



SPRAY NOZZLES

The advantage of the VG nozzle is its pressure activated variable geometry. No flow is allowed to pass through the nozzle until a definitive minimum pressure differential has been achieved. The established minimum pressure differential varies between each nozzle, but is normally in the 20-35 PSID (1.4-2.4 BarD) range. In this manner, the nozzle never has low flow spray pattern decay or collapse. If the differential should happen to fall below this minimum pressure limit, the flow element will re-seat itself and stop the flow of water until the pressure once again increases. As with most mechanical devices, there is an upper as well as a lower limit with respect to the allowable pressure differential. For long term performance, it is recommended that the nozzle not be used with differentials greaterthan 500 PSID or 35 BarD without consulting a Trillium X-Pert.

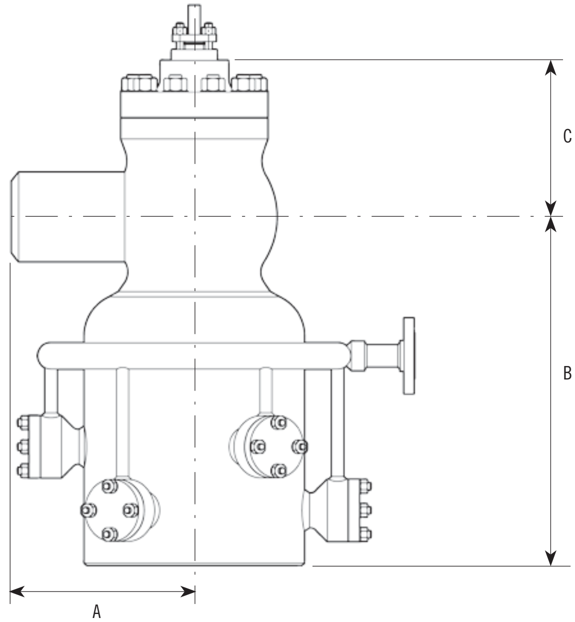




VG FAMILY OF NOZZLE SIZES										
Nozzle Size	10	14	17	20	24	28	32	35	40	44
Nozzle Cv	0.5	1.2	1.4	1.9	2.5	3	3.4	3.6	4.4	4.8

STANDARD DIMENSIONS

Note: Dimensions can be adjusted to suit plant requirements.



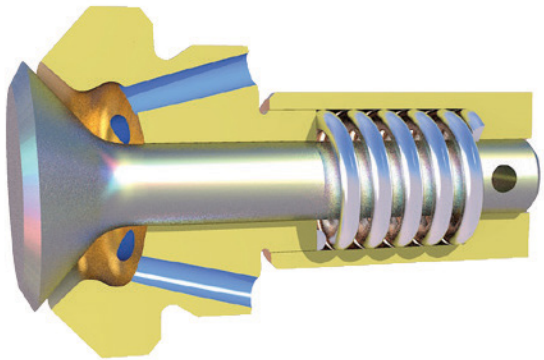
BV995 BASIC DIMENSIONS							
MODEL	STROKE	CV	A	B	C	INLET RANGE	OUTLET RANGE
BV995-40	32	40	100	240	130	1”-4”	6”-16”
BV995-50	40	60	130	300	160	1”-6”	6”-16”
BV995-60	48	80	155	365	190	2”-6”	8”-20”
BV995-70	56	110	180	425	220	2”-8”	8”-20”
BV995-80	64	140	210	490	250	3”-8”	8”-20”
BV995-90	72	175	230	550	280	3”-8”	8”-20”
BV995-100	80	215	260	610	310	4”-10”	10”-24”
BV995-110	88	260	290	670	350	4”-10”	10”-24”
BV995-120	96	310	310	730	380	4”-10”	12”-24”
BV995-130	104	360	340	790	410	4”-10”	12”-24”
BV995-145	116	450	380	880	460	6”-12”	14”-30”
BV995-160	128	550	420	980	500	6”-12”	14”-30”
BV995-175	140	660	460	1070	550	6”-12”	16”-30”
BV995-190	152	775	500	1160	600	8”-14”	16”-30”
BV995-210	168	945	550	1280	660	8”-14”	18”-32”
BV995-230	184	1135	600	1400	730	8”-14”	18”-32”
BV995-250	200	1340	650	1520	790	10”-16”	20”-36”
BV995-275	220	1620	720	1680	870	10”-16”	20”-36”
BV995-300	240	1925	790	1830	950	10”-16”	24”-48”
BV995-330	164	2325	860	2010	1040	12”-18”	24”-48”
BV995-360	288	2765	940	2200	1140	14”-20”	30”-60”
BV995-400	320	3410	1050	2440	1260	16”-22”	30”-60”
BV995-435	348	4030	1140	2660	1370	18”-24”	30”-60”
BV995-480	384	4860	1260	2930	1510	20”-26”	36”-72”
BV995-525	420	5900	1380	3200	1660	22”-28”	36”-72”
BV995-575	460	7000	1500	3510	1810	24”-30”	42”-72”
BV995-630	504	8400	1650	3840	1990	30”-36”	42”-72”

DESUPERHEATING FUNCTION

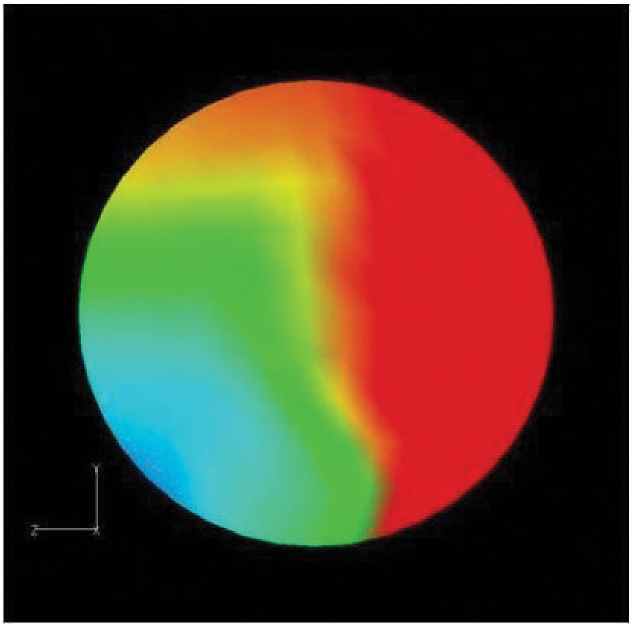
For turbine bypass applications, the most common nozzle used with the Trillium Bypass valves is the BV984-VG (Variable Geometry) nozzle. It is a back pressure activated, variable geometry injection device.

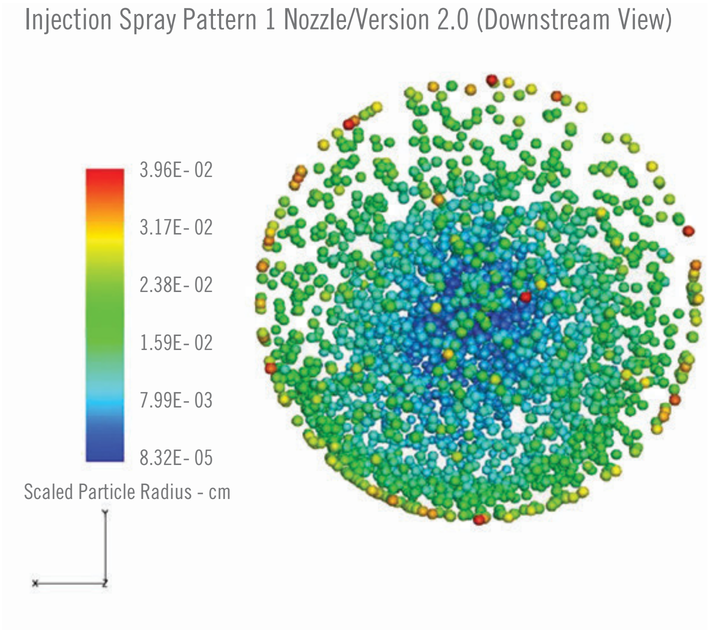
Depending on the required spray water requirements, a number of nozzles are located radially around the outlet pipe. Selecting the right number of nozzles with a suitable pressure drop across each nozzle is crucial to obtaining an efficient spray injection pattern in the valve outlet. The number and location of the nozzles is critical to assure good spray penetration, complete flow area coverage, and minimise the formation of thermal stratification, a problem particularly prone in large diameter pipelines.

In the case of the BV984-VG nozzle, the internal spring keeps the flow element seated until a minimum pressure differential is reached. At this point, increasing pressure surpasses the seating load of the spring and the flow element moves in an axial direction. This axial motion of the flow element with respect to the spray head creates an annular flow area between the two components. The flow through the annular area extrudes a thin sheet of water with a uniform thickness. Due to pressure perturbations, the sheet almost immediately begins to breakup, first into ligaments and then further into fine spray particles in the range of 50- 200µm.



BV984-VG Nozzle Design





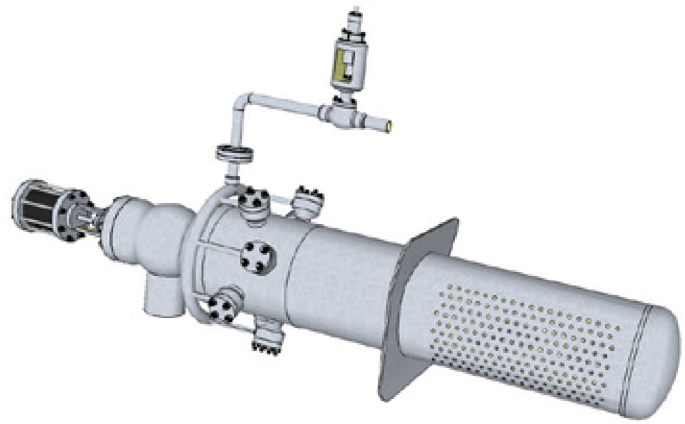
Examples of thermal stratification in a large diameter pipeline and analysis of spray particle distribution and coverage in a bypass application.

BACKPRESSURE DEVICE

The backpressure device, also referred to as a dump tube or sparger, is utilised to create a positive pressure downstream of the valve. Without this device, the vacuum conditions of the condenser would exist in the discharge piping.

At these extremely low pressures, the velocity of the steam exiting the valve would reach sonic or choked conditions almost immediately unless the outlet pipe size and resultant cross-sectional flow area, were sized to accommodate the large specific volume of the free expanding steam. As this is normally not economically feasible or logistically possible, the backpressure device is installed to provide a fixed resistance to the flow entering the condenser.

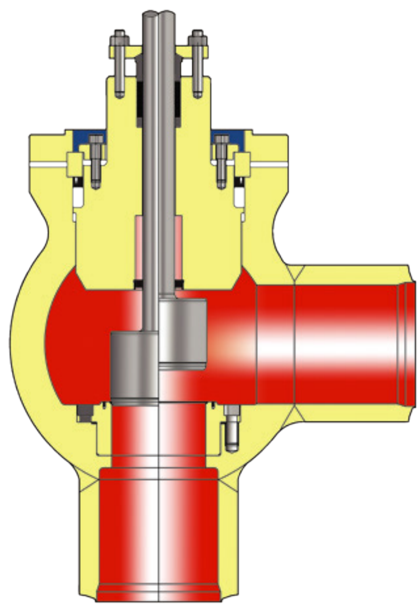
Trillium can provide engineering assistance or complete production of the backpressure device for whatever the application requires.



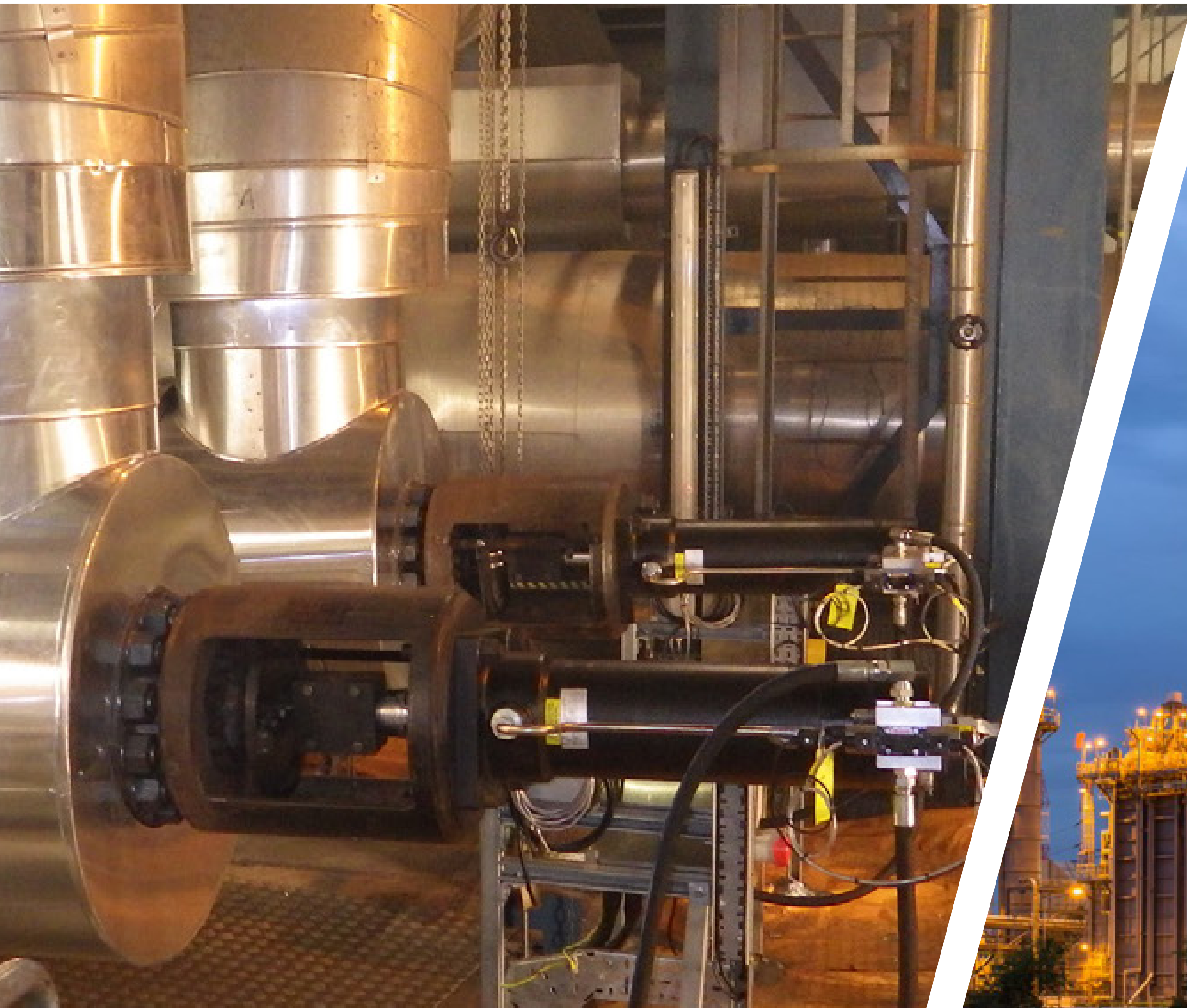
STOP VALVE

The BV995 Turbine Bypass Valve is capable of providing excellent shutoff; and therefore no additional shut-off or isolation valves are required. However, if code or mode of operation should deem the use of an independent stop valve for either redundancy or shut-off safety function, Trillium offers the BV995SV. The design includes many of the physical features of the bypass valve including forged contoured bodies, matching inlet & outlet sizes, field removable seat ring, various body materials, and bonnet designs.

The BV995SV is designed to withstand the thermal cycling requirements of bypass service while at the same time providing low pressure drop and a high degree of seat integrity even when vacuum conditions are involved. It is recommended that the stop valves should remain open when the plant is in operation to assist in the preheating of the bypass valve.



NOTES:



TRILLIUM FLOW TECHNOLOGIES UK LTD

Britannia House, Huddersfield Road, Elland, West Yorkshire, HX5 9JR, England
T: +44 (0) 1422 282 000;
F: +44 (0) 1422 282 100;
E: controlvalves@trilliumflow.com

TRILLIUMFLOW.COM