DSCV-SA
Frequently Asked Questions

Where Smart Solutions Meet Global Power Generation

DSCV-SA FAQ:140620-02

DSCV-SA

FAQs - INDEX

DSCV-SA

FAQs – 1a: MECHANICAL DESIGN: Pressure Boundary

Piping design engineers often use the turbine bypass valve or steam letdown valve as the point to transition pipe class both for pressure rating and material grade.

The DSCV-SA is an angle style valve. Normally the DSCV-SA is ordered and supplied in a split pressure rated design. The inlet part of the body will be of a higher pressure class than the outlet. The same is true for the for the pressure boundary materials with the inlet often being supplied in a different grade of material to the outlet.

Body – Inlet: The body inlet is the high pressure & temperature side. The standard body is produced from a casting in low alloy steels ASTM A217 WC6, WC9 and C12A or carbon steel ASTM A216 WCB. Forged bodies and other material grades can be supplied on request.

Standard Cast Body Inlet Materials (high pressure side)
ASTM A216 WCB
ASTM A217 WC6
ASTM A217 WC9
ASTM A217 C12A

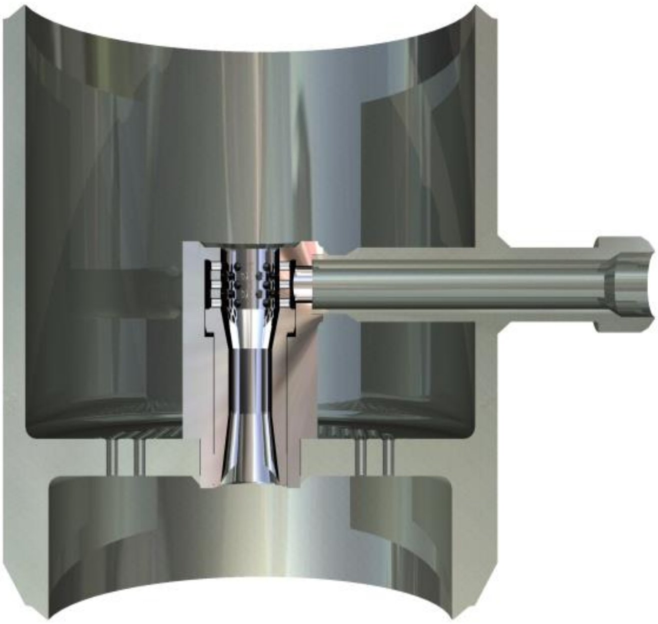
If forged bodies are preferred the body is supplied in the following standard materials :

Standard Forged Body Inlet Materials (high pressure side)
ASTM A105
ASTM A182 F11
ASTM A182 F22
ASTM A182 F91
ASTM A182 F92

The bonnet will be supplied in the same material grade as the body, either cast or forged.

Body – outlet: The body outlet is the lower pressure side. The standard body outlet is produced from a forgings in low alloy steels ASTM 217 WC6, WC9 and C12A or carbon steel ASTM A216 WCB.

Forged Body Outlet Materials (Low pressure side)
ASTM A105
ASTM A182 F11
ASTM A182 F22
ASTM A182 F91



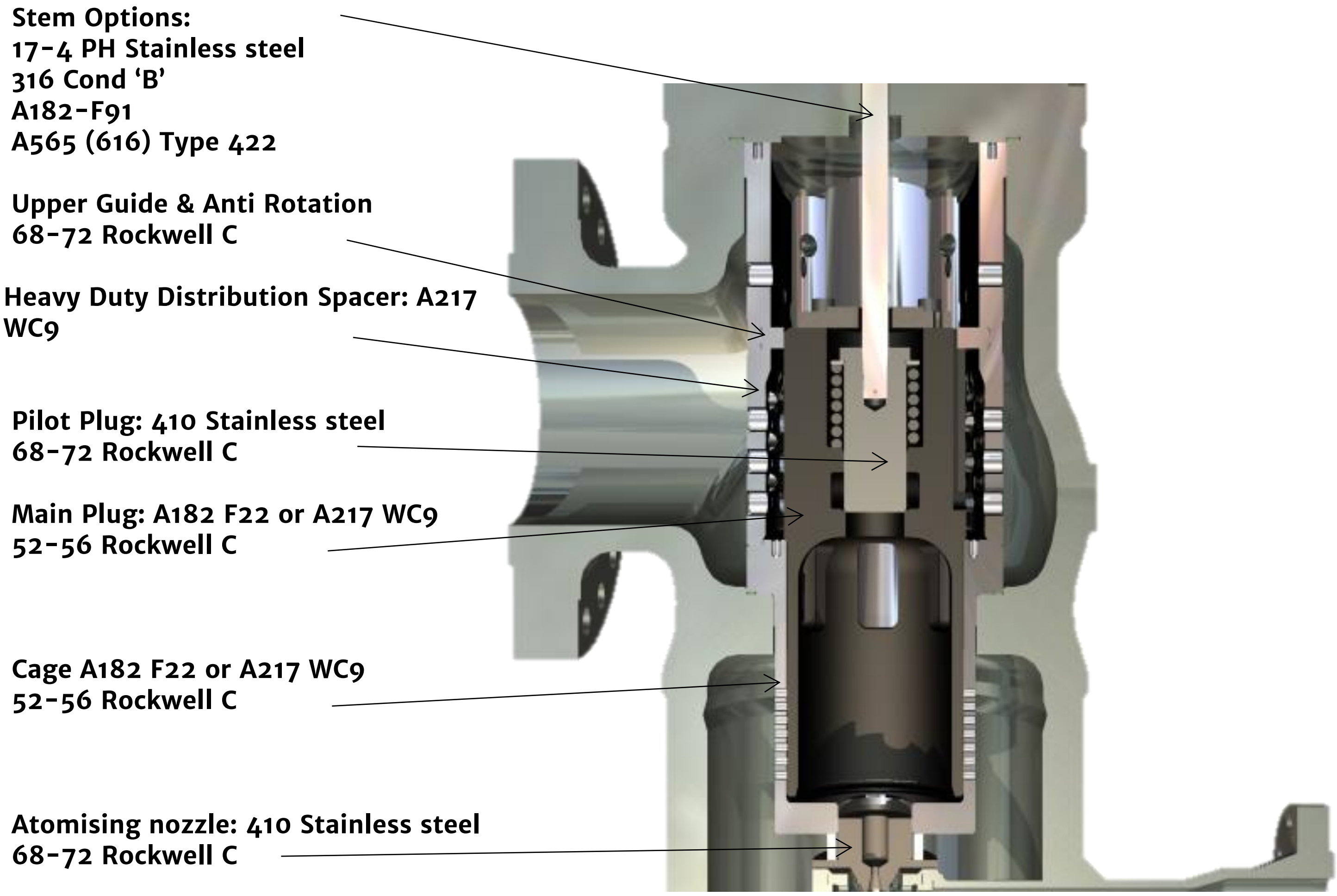
The outlet diffuser which produces the customer outlet connection can be made of a different material than the DSCV-SA outlet section so as to meet the customer pipe material and prevent on-site dissimilar welds.

DSCV-SA

FAQs – 1b: MECHANICAL DESIGN: Valve Trim

The trim is designed to expand equally with the pressure boundary in which it is contained to prevent high thermally induced stresses. A mandatory requirement of severe duty valves is that the plug is fully guided for stability. Therefore all guiding surfaces are hardened to a value of greater than 50 on the Rockwell C scale. This prevents any mechanical galling between the guiding surfaces.

The Seat is similarly hardened to > 50 Rockwell C. Although uncommon on bypass valves and not required a Stellite deposit on the seat can be supplied if specifically requested by the customer. Stellite is a more soft material, approximately 35 on the Rockwell C scale and thus more prone to wear. However as Stellite® is softer it can be machined if the seat becomes damaged. Normally a Stellite® seat is only specified by a very specific request due to a customer preference.

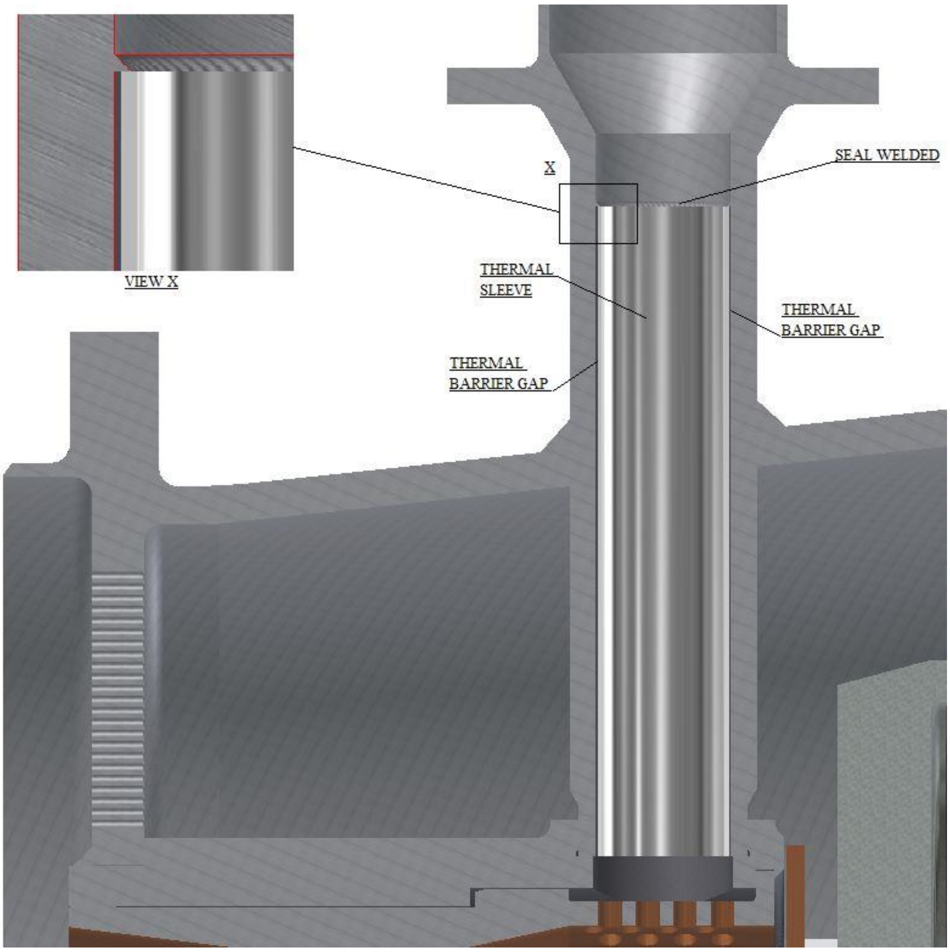


DSCV-SA

FAQs – 1c: MECHANICAL DESIGN: Cooling Water Branch Thermal Sleeve

When the temperature differential between the maximum inlet steam temperature and the minimum cooling water temperature exceeds 220ºC (400ºF) then a thermal sleeve is fitted. The thermal sleeve is a 316L stainless steel tube which the cooling water passes to the steam atomising head. This sleeve produces an annular gap between its outside diameter and the inside diameter of the water branch. This gap or thermal barrier protects the water branch from high thermally induced stresses.

The sleeve is seal welded at one end which allows it to freely expand and contract within the water branch.



DSCV-SA

FAQs – 2: MECHANICAL DESIGN: Connection Types & Sizes

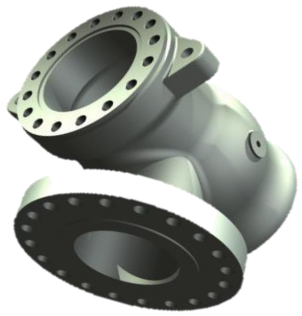
The DSCV-SA was designed with maximum flexibility in mind with regards to connections. When employed in a power station the vast majority of DSCV-SA installations have butt weld end connections. On small biomass plants, petrochemical, pulp & paper or similar industries where the DSCV-SA is used as a steam let-down station, the connections are generally flanged.

The DSCV-SA has both options weld ends or flanged ends.

Body – Steam Inlet Connection: Normally the body is produced from a casting. The body casting has two formats, weld end or flanged.

Butt weld end.

Note the drilled disc is only for the factory hydro pressure test

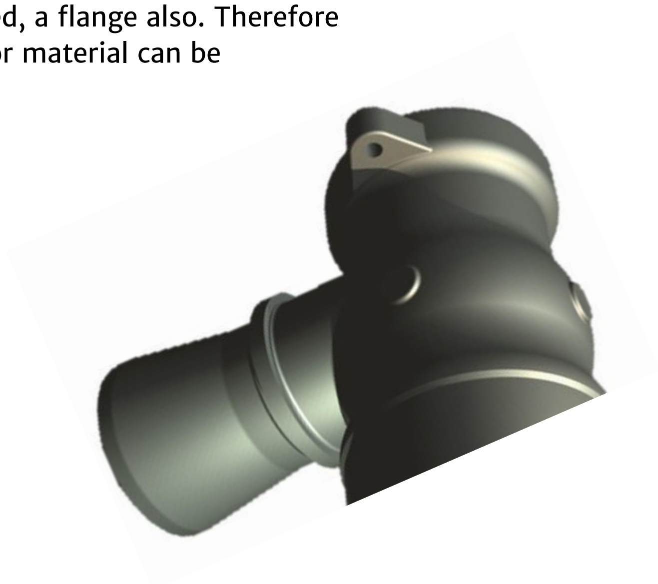


Flanged end.

The flange is an integral part of the casting.

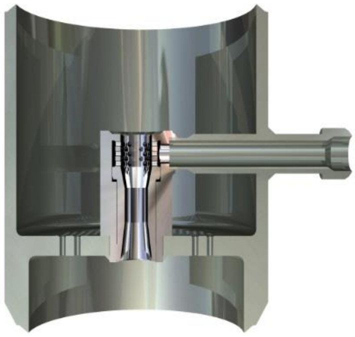
When the customer steam inlet connections cannot be achieved then an expander can be welded to the body inlet connection and, if required, a flange also. Therefore any steam inlet connection in terms of size, type or material can be accommodated.

Standard casting with steam inlet expander



Body – Steam outlet connection: The DSCV-SA outlet section is fully formed from a forging. Therefore full flexibility is available to produce any size, connection type or material.

Butt Weld, with or without material transition.



DSCV-SA

FAQs – 3: MECHANICAL DESIGN: Noise Attenuating Trim Options

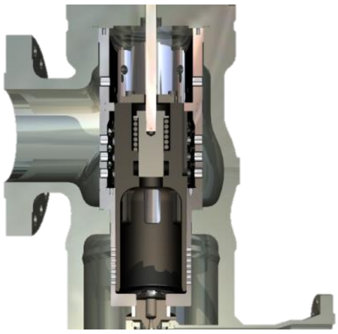
The DSCV-SA has several noise attenuating trim options. As standard the DSCV-SA is fitted with the Copes-Vulcan single stage HUSH™. The valve can also be fitted with either a multi stage HUSH™ trim or the multi disc, multi labyrinth RAVEN™ trim.

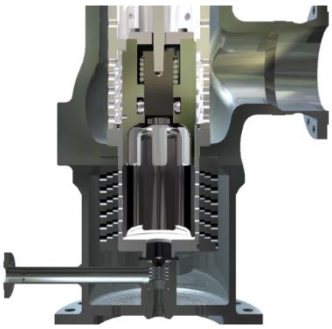
All of the trim options have active noise control throughout the full valve stroke and flow range. 1, 2 and 3 stage HUSH™ trims are available in standard trim configurations. Multi stage RAVEN™ trims are available upon request. The final pressure drop occurs through the final outlet diffuser, see FAQ sheet 11.

IMPORTANT: The noise levels shown on the Copes-Vulcan data sheets are calculated to the internationally recognised Aerodynamic noise prediction method; IEC 60534-8-3:2000. Other manufacturers show noise prediction levels based on their own in-house calculation routines, however these have not been internationally qualified or accepted.

Note: A number of bypass valve suppliers employ inlet and trim exit baffles for noise attenuation. However these are passive noise control elements as they have a fixed CV and only truly attenuate at one flow rate, normally maximum flow rate. As the flow rate reduces the passive baffle has little or no influence on the pressure drop and thus little or no noise attenuation.

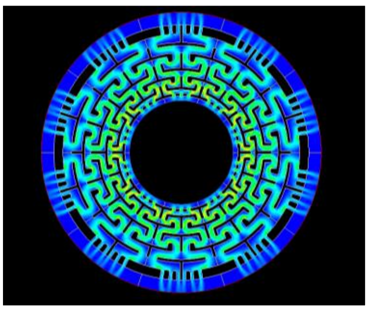
Single stage HUSH II or HUSH III™





Multi stage HUSH™,

2 & 3 stage trim options are available as standard options.



RAVEN™

Multi disc, multi path labyrinth

DSCV-SA

FAQs – 4: MECHANICAL DESIGN: Bonnet Designs

The DSCV-SA has two bonnet types, bolted and pressure seal.

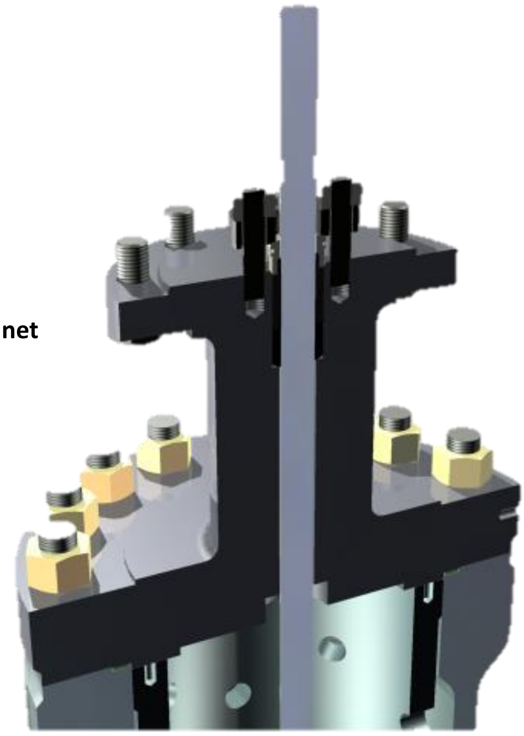
Pressure classes: ANSI 150 through and including ANSI 900: Bolted Bonnet.

Pressure classes: ANSI 1500 and higher: Pressure Seal Bonnet.

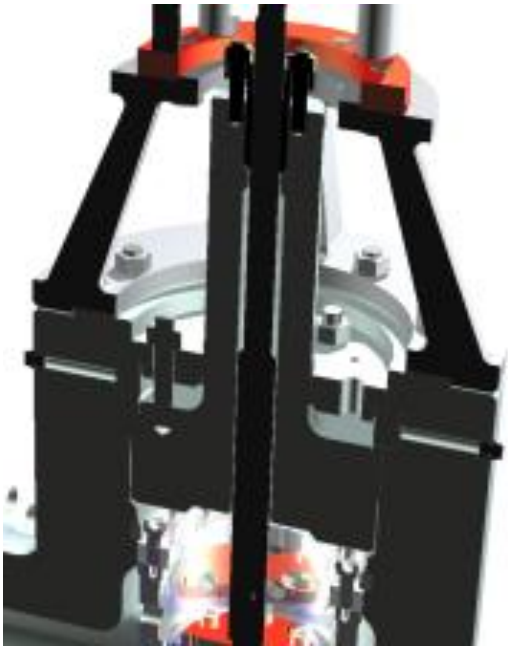
Cooling extended bonnets are supplied on most DSCV-SA. If the inlet steam temperature is above 250°C (482°F) then extended cooling bonnets are fitted as standard.

The cooling extension is designed to protrude 200mm (8 inches) to 300mm (12 inches) out of standard insulation thicknesses, depending on the size of the DSCV-SA.

The standard gland packing set is a lower carbon guide bushing, preformed Graphoil rings and a 431 stainless steel gland follower. Spring, live loaded packing is available with all bonnet options.



Bolted Bonnet



Pressure Seal Bonnet

DSCV-SA

FAQs – 5: MECHANICAL DESIGN: Trim Balancing

Turbine bypass valves are quite large and unbalanced trims on the majority of applications are not used due to the enormous actuation and stem forces that would be generated. Therefore the vast majority of trims in turbine bypass valves are balanced. The easiest and most economical method of balancing the trim is 'low pressure balancing'. Most other designs employ low pressure or P2 balancing; however, these low pressure balancing systems rely on auxiliary balancing seals such as piston rings and close tolerance sealing surfaces to prevent the high pressure steam unbalancing the trim. In operation, if these seals or surfaces wear or become damaged, the trim quickly becomes unbalanced and stem loads dramatically increase and fluctuate which can result in the valve oscillating violently or even unable to open on command.

The shutoff class and tight shutoff is also totally dependent on the performance of the balancing component parts. Tight shut, FCI 70-2 Class V, can be demonstrated in the factory with a newly assembled valve when piston rings and close tolerance sealing surfaces of the balancing cylinder are new. However, due to minimal wear or damage/scratching by small metallic particles in the steam on a new build power station the tight shut off will be lost.

Copes-Vulcan, during the early stages of the design of the DSCV-SA made the conscious decision to move away from low pressure balancing and hence remove all the risks and problems associated with low pressure balancing, witnessed numerous times on power stations.

HIGH PRESSURE BALANCING or P1 balancing is a key design feature of the DSCV-SA for reliable smooth operation. This design feature cannot be emphasised enough.

Benefits of high pressure balancing;

- ✓ **HIGH PRESSURE BALANCING** works in harmony with the dynamics of the high pressure steam rather than being in constant 'battle' with the high pressure steam trying resist it flowing into the low pressure areas of the trim.
- ✓ **NO** piston rings, sigma seals, etc. that wear and without very regular maintenance, cause:
    - Dramatically increases seat leakage.
    - Induce trim instability, dramatically increasing stem and actuator thrusts as the trim starts to go out of balance.
    - Bypass valve not opening to command signal as the leakage rate past the piston rings becomes so large the out of balance forces of the plug are too great for the actuator.
- ✓ **NO** close tolerance balancing cylinder surfaces that wear and become scratched with entrained small metallic debris in the steam. Without very regular maintenance, cause:
    - Dramatically increases seat leakage.
    - Induce trim instability, dramatically increasing stem and actuator thrusts as the trim starts to go out of balance.
    - Bypass valve not opening to command signal as the leakage rate past the piston rings becomes so large the out of balance forces of the plug are too great for the actuator.
- ✓ **NO** piston rings or seals required to be purchased as commission spares or held in the power plant stores as maintenance inventory or insurance spares.

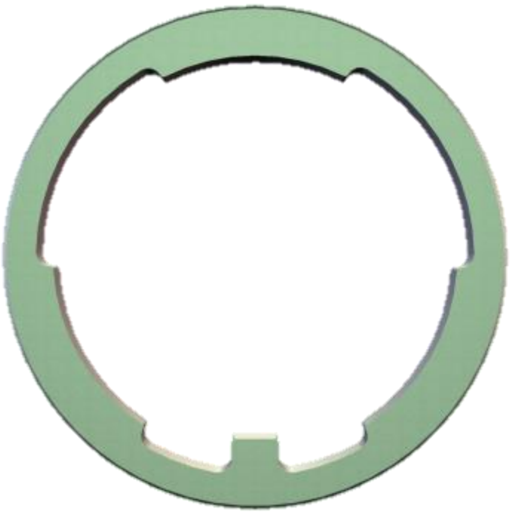
These benefits are very significant to the power plant owner and operator as high pressure balancing not only reduces maintenance and inventory costs but also removes the risk of the valve becoming unstable which may force an unscheduled maintenance outage. With repeatable tight shut off the DSCV-SA is also thermodynamically efficient by not leaking expensive high pressure steam.

The benefits for the EPC designing and erecting the power plant are reduced commissioning spares, a design that is more tolerant to entrained debris in the steam and thus giving far more confidence during commissioning and reliability runs.

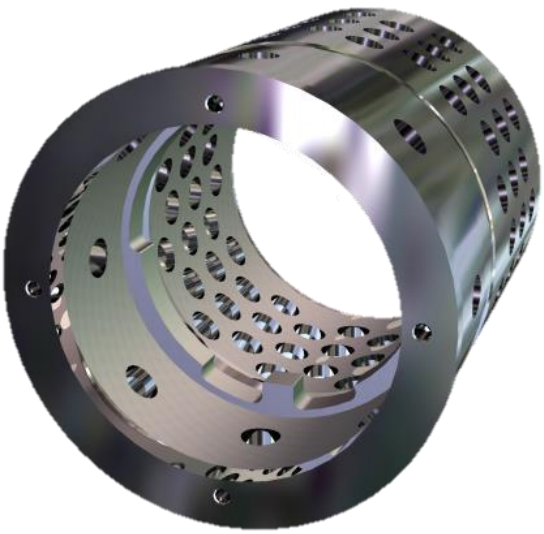
One of the key components of the high pressure balancing system is the E-A ring which has three important functions;

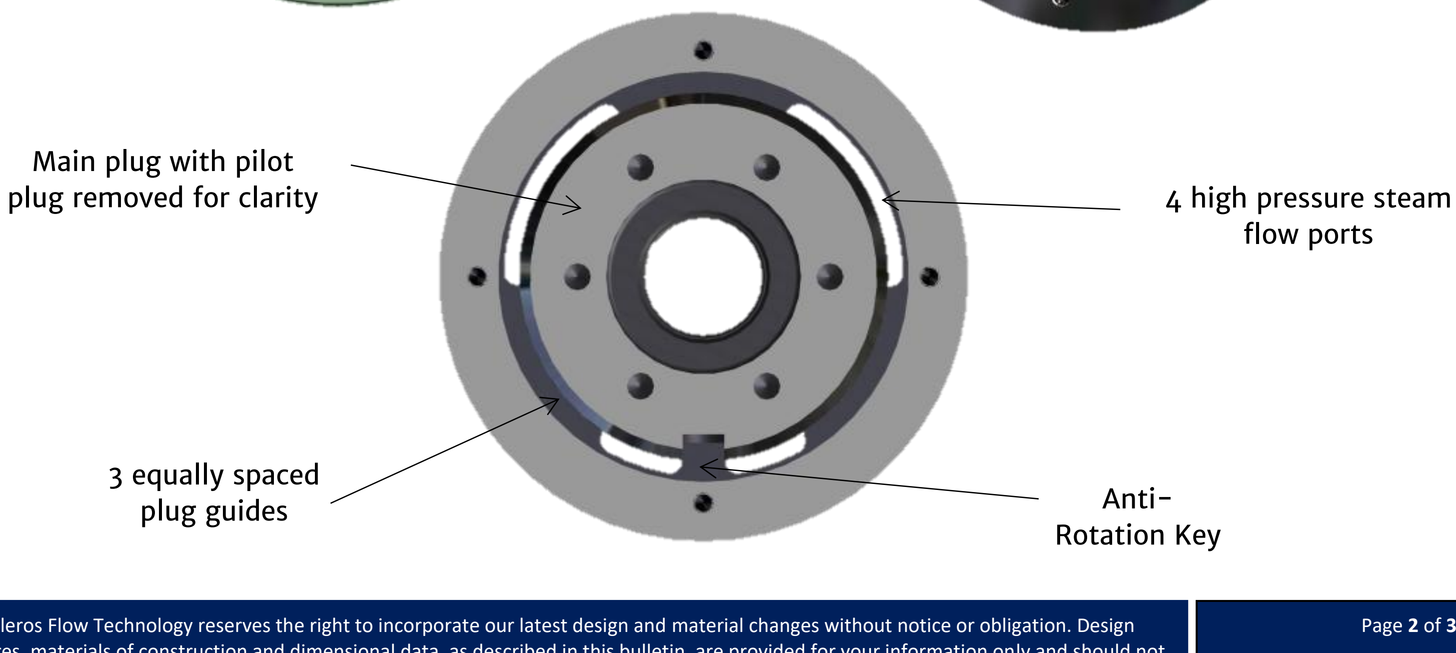
- Ensuring uniform high pressure steam pressure has unrestricted flow porting to both the top and bottom of the valve plug.
- Provides upper plug guiding for plug stability.
- Has an integrated and substantial plug anti-rotation key.

E-A Ring



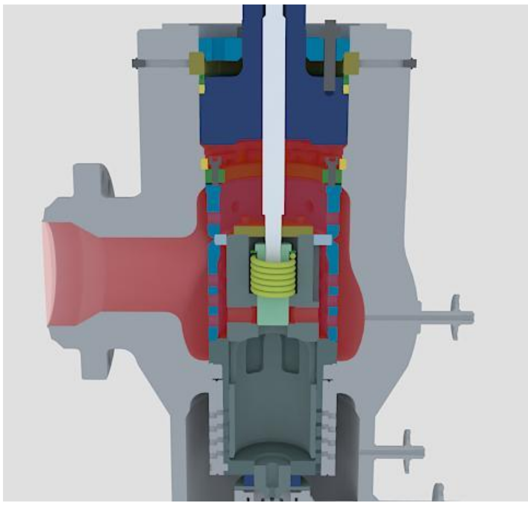
E-A Ring forms an integral part of the heavy duty distribution spacer





The DSCV-SA valve has a very tight shut off in the closed position, as a minimum ANSI FCI 70-2 Class V. It achieves this tight shut off by utilising a pilot plug design so that in the closed position the main plug is unbalanced with the full steam pressure acting on the top of the plug, white arrows indicating the steam pressure force on the plug. This load combined with the actuator thrust resulting in very high seat contact loads, which ensure a very tight shut off.

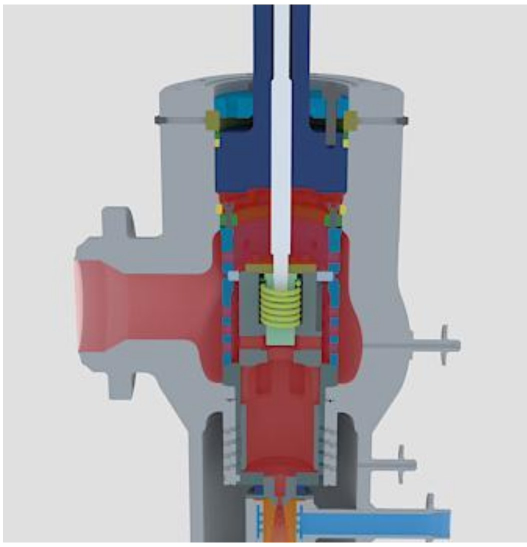
Not only is tight shut off required for plant thermal efficiency it also prevents leak induced 'wire drawing' damage across the seat which would otherwise result in frequent maintenance to repair or replace the seat.



When the DSCV-SA first opens the pilot plug opens and high pressure inlet steam floods the underside of the main plug. The plug is now high pressure balanced, high pressure steam is now on the bottom of the plug as well as the top.

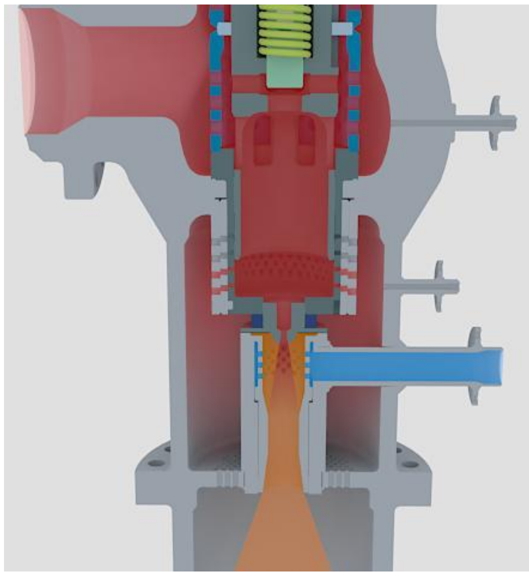
With the steam atomising nozzle connected to the main cage the steam atomising unit is now operating in preparation to receive the incoming cooling water from the water control valve.

The pilot plug CV is several times larger than the atomising nozzle which ensuring high pressure balancing.



As can be seen high pressure steam is freely allowed to flow both to the top and bottom of the plug, ensuring high pressure balancing.

The balancing system has NO piston rings or close tolerance balancing cylinders that can become worn or damaged.



High Pressure versus Low Pressure Trim Balancing Comparison Table

CELEROS FLOW TECHNOLOGY
COPES-VULCAN®

BALANCING COMPONENTS	High Pressure Trim Balancing		Low Pressure Trim Balancing	
PISTON RINGS	**HP Balancing does not require balancing components**		**LP Balancing requires balancing components**	
	With high pressure balancing **NO** balancing components are required. In fact rather than having specific sealing components to continuously battle high pressure steam from entering the low pressure balancing areas, with high pressure balancing the high pressure steam is encouraged to enter all areas.		With low pressure balancing a sealing arrangement is required to prevent the high pressure fluid from entering the low pressure side, normally the top side, of the plug. When the fluid is steam then due to the temperatures this seal is a piston ring. Piston rings wear in service and as they wear then the leakage rate increases. This increase in leakage rate continues to increase until the pilot plug cannot evacuate the high pressure steam from the low pressure side of the plug at a an equivalent rate. Therefore the pressure on the upper side of the plug increases which actuation forces. These increased actuator forces induce instability in the actuator and trim and eventually lead to the valve not opening on command or event stem breakage.	
	Risk of piston ring wear or breakage is negated	√	**High risk of valve instability and failure due to piston ring wear**	X
BALANCING CYLINDER	**HP Balancing does not require balancing components**		**LP Balancing requires balancing components**	
	With high pressure balancing **NO** balancing components are required. In fact rather than having specific sealing components to continuously battle high pressure steam from entering the low pressure balancing areas, with high pressure balancing the high pressure steam is encouraged to enter all areas.		With low pressure balancing a sealing arrangement is required to prevent the high pressure fluid from entering the low pressure side, normally the top side, of the plug. The balancing cylinder is required for the piston rings to operate in. The inside surfaces of the balancing cylinder must have finely machined surfaces for the piston rings to seal. These surfaces are susceptible to wear and damage. Any small particle debris in the steam that enters the balancing cylinder will score the surfaces and induce leakage and stem wire drawing. This will cause loss of balancing, instability, possible failure of the valve to open on command and stem breakage.	
	Risk of balancing cylinder wear or damage is negated	√	**High risk of valve instability and failure due to balancing cylinder wear or damage.**	X
BALANCING CYLINDER & CLOSE TOLERANCE PLUG	**HP Balancing does not require balancing components**		**LP Balancing requires balancing components**	
	With high pressure balancing **NO** balancing components are required. In fact rather than having specific sealing components to continuously battle high pressure steam from entering the low pressure balancing areas, with high pressure balancing the high pressure steam is encouraged to enter all areas.		With low pressure balancing a sealing arrangement is required to prevent the high pressure fluid from entering the low pressure side, normally the top side, of the plug. The balancing cylinder is required for the piston rings to operate in. The inside surfaces of the balancing cylinder must have finely machined surfaces for the close tolerance plug to seal. These surfaces are susceptible to wear and damage. Any small particle debris in the steam that enters the balancing cylinder will score the surfaces and induce leakage and stem wire drawing. This will cause loss of balancing, instability, possible failure of the valve to open on command and stem breakage. With a close tolerance plug and balancing cylinder any small debris will induce mechanical galling and possibility of the plug jamming in position.	
	Risk of balancing cylinder & plug wear or damage is negated	√	**High risk of valve instability and failure due to balancing cylinder & plug wear or damage.**	X
Stem Breakage	**HP Balancing by design ensures correct stem diameter and strength.**		**LP Balancing by design dictates the stem diameter and strength are not sufficient is low pressure balancing is lost.**	
	By design the stem size, diameter, and strength is suitable for full HP forces that can be applied.		The stem size, diameter, and strength are only designed for the low pressure balancing forces. Therefore if the balancing is lost then the stem will be subjected to forces far beyond those it is designed for. This leads to stem breakage.	
	Designed for maximum forces that can be applied.	√	**Only designed for low pressure forces and risk of stem breakage if balancing is lost.**	X
Actuator Size	**HP Balancing dictates the actuator is sized for the maximum forces that can be applied.**		**LP Balancing by design dictates the actuator is only sized for the low pressure balancing forces.**	
	By design the actuator is sized for the maximum forces that can be applied by the high pressure steam.		The actuator in low pressure balanced valve designs is only sized for the low pressure balanced thrusts generated. Therefore if partial or all of balancing is lost then the actuator will have insufficient thrust available, become unstable and may not even have sufficient thrust to open the valve.	
	Designed for maximum forces that can be applied.	√	**Only designed for low pressure forces and risk of insufficient actuator thrust available if balancing is lost.**	X
Maintenance	**HP Balancing does not require balancing components**		**LP Balancing requires balancing components**	
	As there are no balancing components then there is no maintenance or spare parts that are required to be held in the plant's inventory.		Low pressure balancing components, piston rings, balancing cylinder, close tolerance plug are all maintainable items. As wear accumulates, especially if the valve is mounted horizontally, all these parts will require maintenance. Piston rings, balancing cylinders and close tolerance plugs will all have to be held in the plant stores. These parts are critical to the valve performance and therefore classified as critical spares (insurance spares) and not just recommended spares.	
	No maintenance, No inventory.	√	**Require regular maintenance and high inventory costs.**	X

High Pressure versus Low Pressure Trim Balancing Comparison Table

CELEROS FLOW TECHNOLOGY
COPES-VULCAN®

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	Risk of piston ring wear or breakage is negated	√	**High risk of valve instability and failure due to piston ring wear**	X
BALANCING CYLINDER	**HP Balancing does not require balancing components**		**LP Balancing requires balancing components**	
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	Risk of balancing cylinder wear or damage is negated	√	**High risk of valve instability and failure due to balancing cylinder wear or damage.**	X
BALANCING CYLINDER & CLOSE TOLERANCE PLUG	**HP Balancing does not require balancing components**		**LP Balancing requires balancing components**	
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	Risk of balancing cylinder & plug wear or damage is negated	√	**High risk of valve instability and failure due to balancing cylinder & plug wear or damage.**	X
Stem Breakage	**HP Balancing by design ensures correct stem diameter and strength.**		**LP Balancing by design dictates the stem diameter and strength are not sufficient is low pressure balancing is lost.**	
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	Designed for maximum forces that can be applied.	√	**Only designed for low pressure forces and risk of stem breakage if balancing is lost.**	X
Actuator Size	**HP Balancing dictates the actuator is sized for the maximum forces that can be applied.**		**LP Balancing by design dictates the actuator is only sized for the low pressure balancing forces.**	
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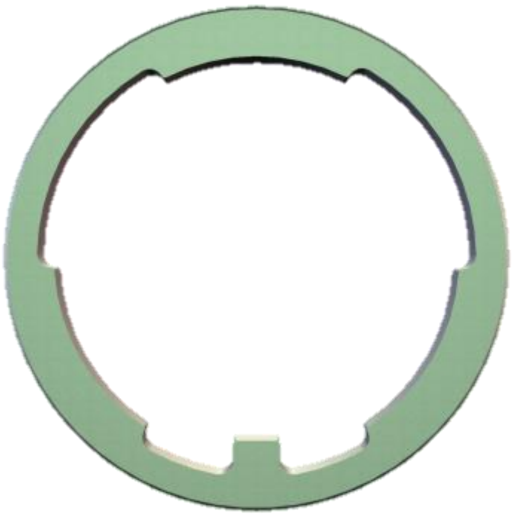
	No maintenance, No inventory.	√	**Require regular maintenance and high inventory costs.**	X

DSCV-SA

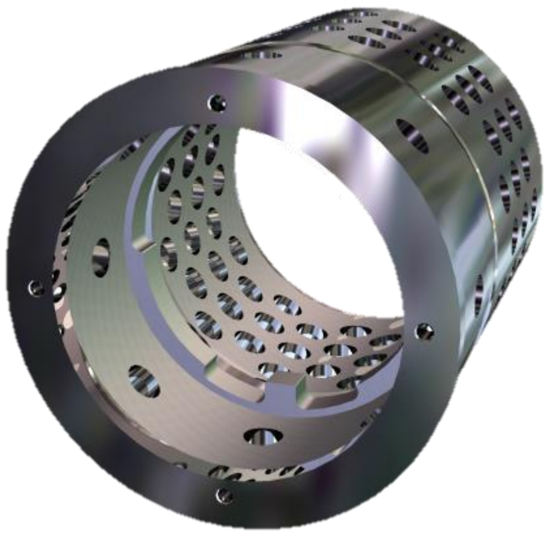
FAQs – 6: MECHANICAL DESIGN: Plug Anti-Rotation

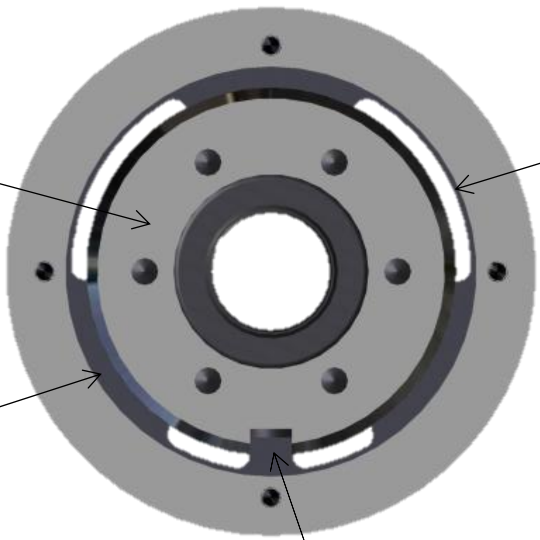
With large trims and especially large plugs rotational forces generated in the trim can be substantial. The magnitude of the rotational forces generated in a specific application and often unique installations is almost impossible to calculate or model. Therefore the DSCV-SA has an integrated anti-rotation key in the inlet heavy duty distribution spacer and matching key way in the plug. Therefore the risk of plug rotation and the damage that can cause is eliminated. The whole design philosophy of the DSCV-SA is, if any potential risk can be eliminated, it is.

E-A Ring



E-A Ring forms an integral part of the heavy duty distribution spacer



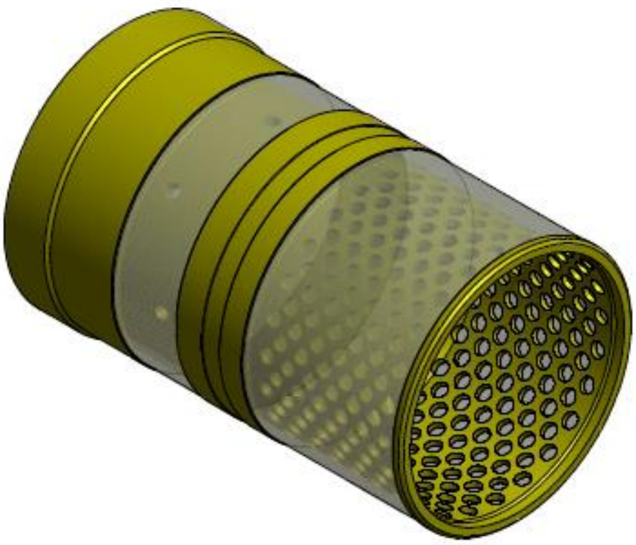


DSCV-SA

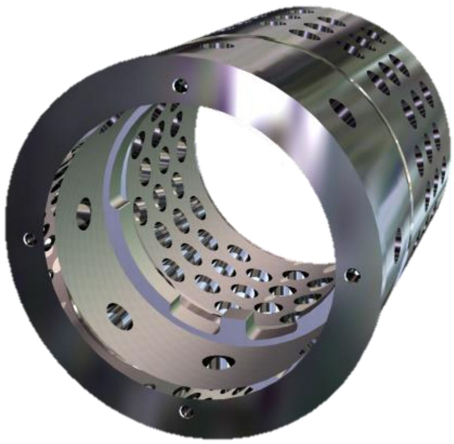
FAQs – 7: MECHANICAL DESIGN: Integral Steam Strainer

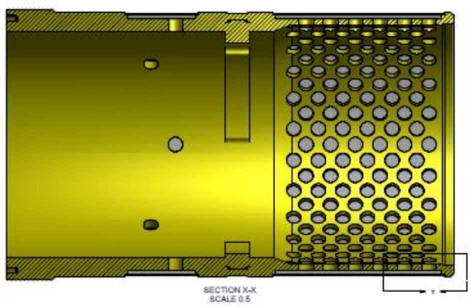
Although the DSCV-SA is quite tolerant to entrained debris in the steam as it has no piston rings, close tolerance balancing systems and natural self-clearing through the integral steam atomising nozzle it can be fitted with an integral steam inlet strainer. The strainer has a 3.0mm (0.118 inch) screen as per the requirements of TRD 421. The stainless steel screen is fixed to the outer diameter of the heavy duty inlet steam distribution spacer. The steam inlet strainer is an optional extra and should be requested at time of enquiry. It can also be supplied as an upgrade to installed DSCV-SA.

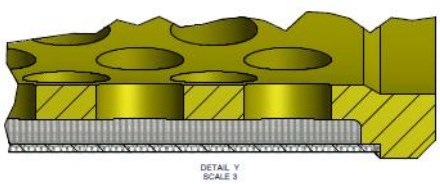
Heavy duty inlet distribution spacer fitted with 3.0mm screen steam strainer



Standard heavy duty inlet distribution spacer







DSCV-SA

FAQs – 8a: Actuation: Pneumatic

There are two types of pneumatic actuation within the Copes-Vulcan range, CV-700 & CV-1000 series spring opposed diaphragm actuators and CV-P800 single and double acting piston actuators. Pneumatic actuation represents approximately 80% to 85% of all the turbine bypass systems supplied, the rest being hydraulically actuated. The benefits of pneumatic actuation are significantly lower capital costs, reduced maintenance and no fire risk. Hydraulic actuation when using mineral oil can initiate a fire if an oil leak drips onto a hot surface.

Typical stroking speeds for turbine bypass systems are;

- Normal modulation; 10-15 seconds.
- Emergency fast mode (turbine trip): less than 1 to 3 seconds.

Actuation thrusts; as standard and unless specified differently by the customer all actuation thrusts calculated for the DSCV-SA are increased by a 30% safety factor.

Hand wheels; all models of pneumatic actuator have a hand wheel option. Generally side mounted with an additional top mounted option for the CV-700 series.

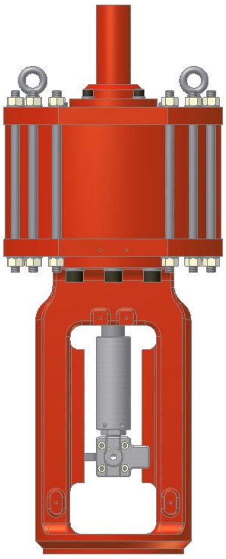
Only the smaller size DSCV-SA with relatively low thrust requirements short strokes will be fitted with the CV-700 or CV-1000 series diaphragm actuators. The majority of DSCV-SAs will be fitted with the CV-P800 piston actuators.

The CV-P800 piston actuator is either single acting with opposed spring or double acting. Due to the thrust requirements and stroke lengths most DSCV-SAs will be fitted with the CV-P800 double acting piston actuator.

CV-700 Series Diaphragm Actuator
Spring Opposed
Hand wheel top or side mounted
Low thrust
Limited to a maximum of 125mm stroke (5 inches)

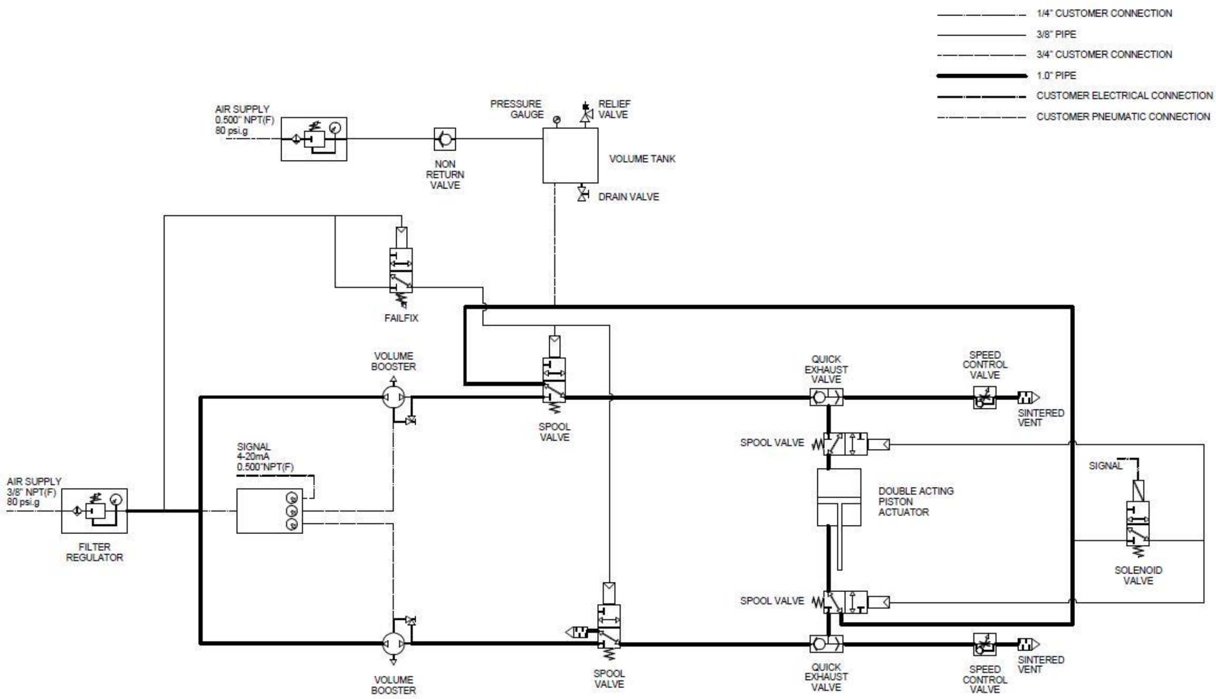
CV-1000 Series Diaphragm Actuator
Spring Opposed
Hand wheel side mounted
Low to medium thrust
Limited to a maximum of 75mm stroke (3 inches)

The CV-P800 double acting piston actuator is by far the most common actuator fitted to the DSCV-SA. Occasionally where thrusts and stroke lengths allow single acting units with springs are fitted.



CV-P800 Series Piston Actuator
Single or double acting
Hand wheel side mounted
High thrust
Limited to a maximum of 300mm stroke (12 inches), longer on request.

When an ‘air fail’ safety position is required, ‘Air Fail Closed’ or ‘Air Fail Open’, then an air volume tank will be supplied. Depending on the volume of air required the volume tank will either be mounted directly on the actuator or supplied as a vertical free standing tank. All air volume tanks are supplied as standard to ASME VIII div.1 design.



Typical Hook-Up drawing for double acting CV-P800 piston actuator, modulation stroking speed <10 seconds, air fail open with emergency fast open trip <2 seconds.

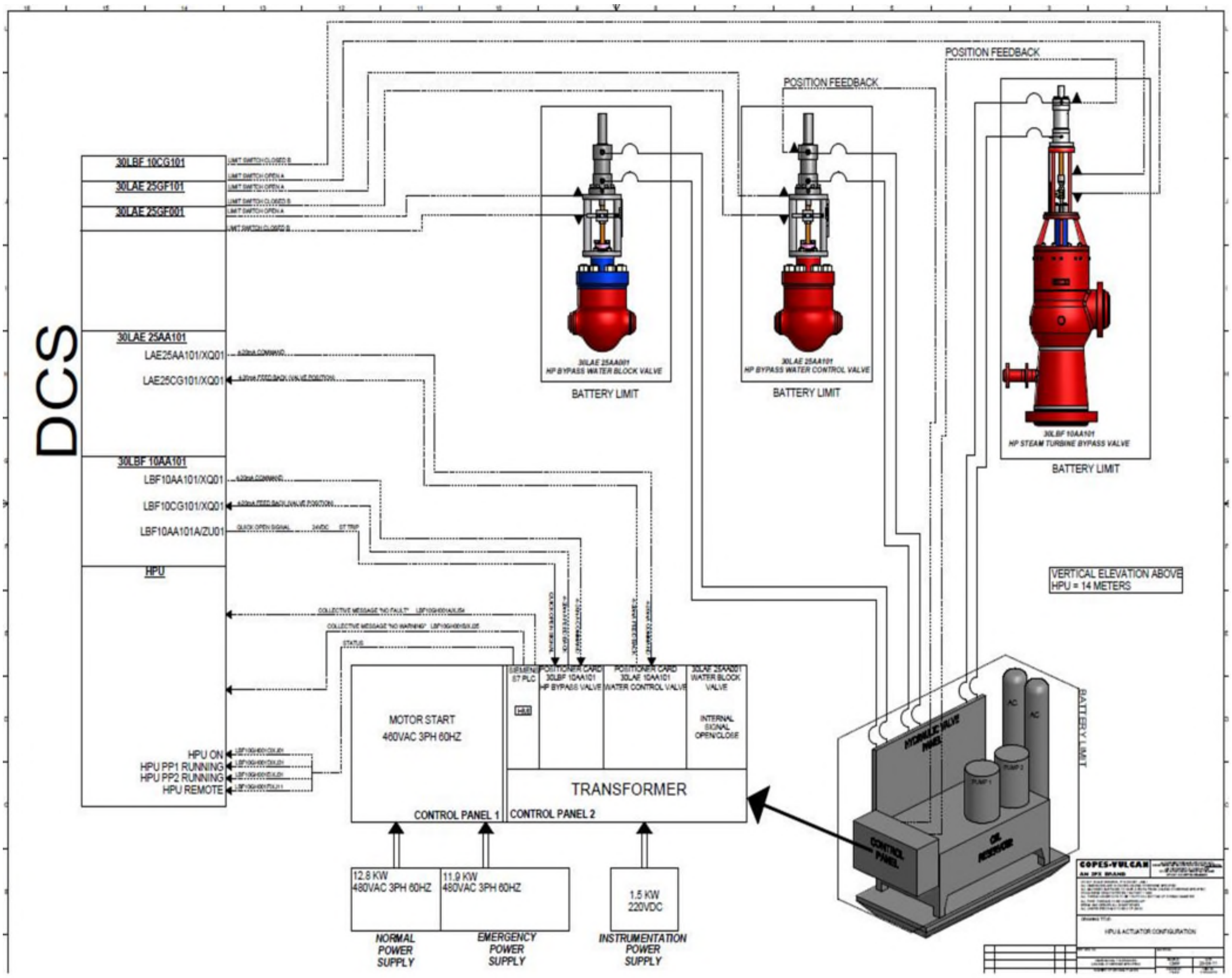
DSCV-SA

FAQs – 8b: Actuation: Hydraulic

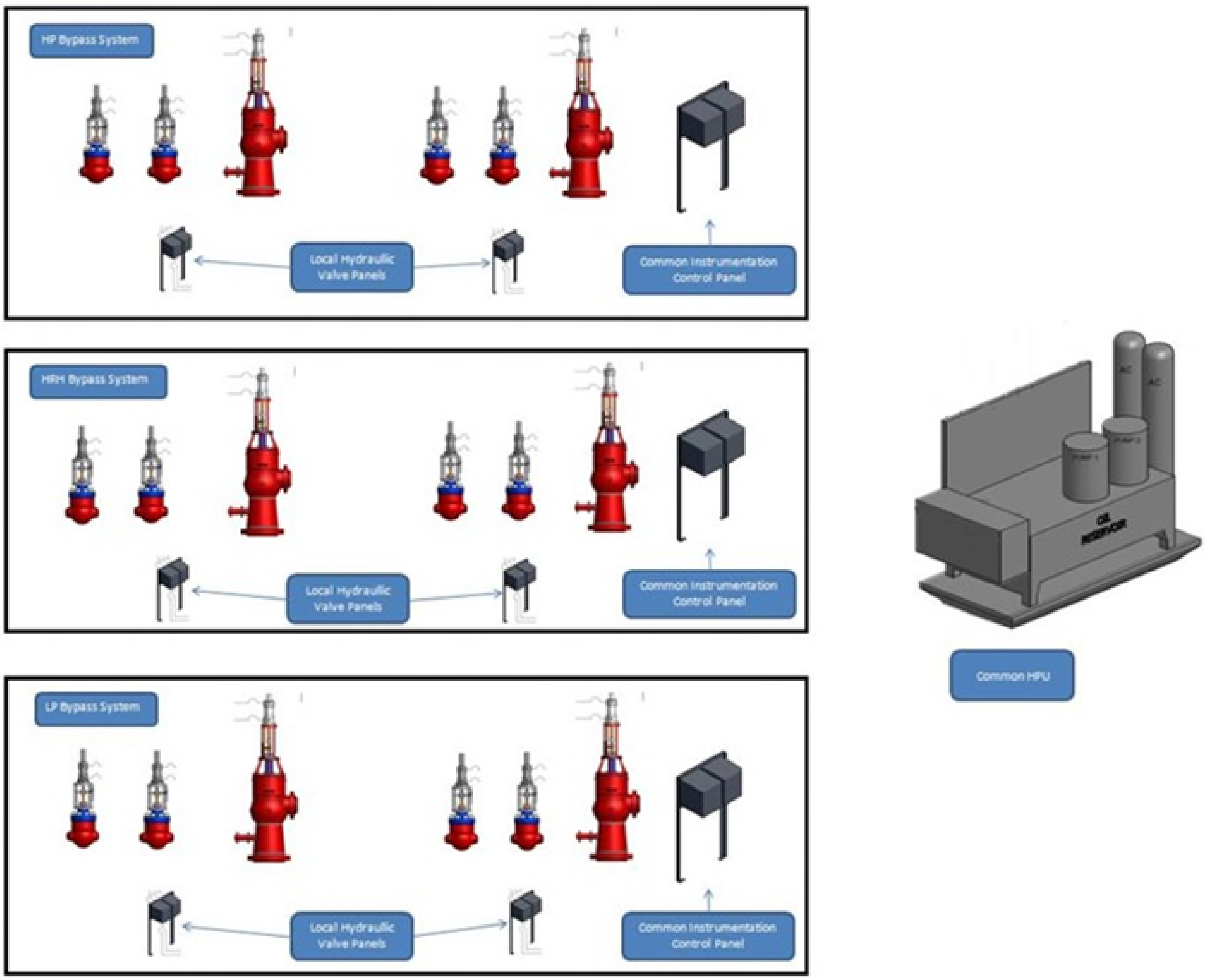
HYDRAULIC ACTUATORS WITH COMMON HYDRAULIC POWER UNIT (HPU)

Hydraulic actuation was the norm for turbine bypass valves. However over the last 15 years or so pneumatic actuation is now very much the predominant choice for power stations up to 600MW. Pneumatic actuation is far less costly, significantly lower on-site maintenance and has no fire risk associated with it unlike the mineral oil used on hydraulic systems. However some power engineering contractors and/or their customers still prefer hydraulic systems. In the power industry the actuators are motivated by hydraulic oil supplied from a common HPU (Hydraulic Power Unit). These HPUs can supply just a single bypass system or multiple bypass systems. Generally each system is design to suit the specific requirements of that power plant.

Below is a typical example of a single HP bypass system with a single HPU supplying the hydraulic oil to the HP bypass valve, water control valve and water block valve. The hydraulic valves and control panel are mounted on the HPU.



Below is a typical example of a HP, HRH & LP bypass systems with a single HPU supplying the hydraulic oil to all the bypass valves, water control valves and water block valves. With these systems the oil accumulators are normally located on the local hydraulic valve panels, close to the valves. This eliminates the need of large bore hydraulic pipe between the HPU and hydraulic valve panels



The actuators are relatively standard double acting pistons. The cylinder will contain a micro-pulse transducer for position feedback. On most applications the actuators are also fitted with end of travel limit switches. Drip trays are normally also fitted on the HP bypass actuator to prevent any hydraulic mineral oil dropping onto a hot surface. The two hydraulic connections on the actuator should be connected to the hydraulic oil supply stainless pipe work via high pressure flexible hoses. This prevents any strain on these connections. The actuators are perfectly suitable for installation either vertically or horizontally.

Copes-Vulcan does not manufacture the actuators or the HPUs. These are supplied via a number of specialist hydraulic companies that Copes-Vulcan has worked with over many years.

The HPUs have a number of standard features although each one will be contract specific to meet the exact requirements of the project and site.

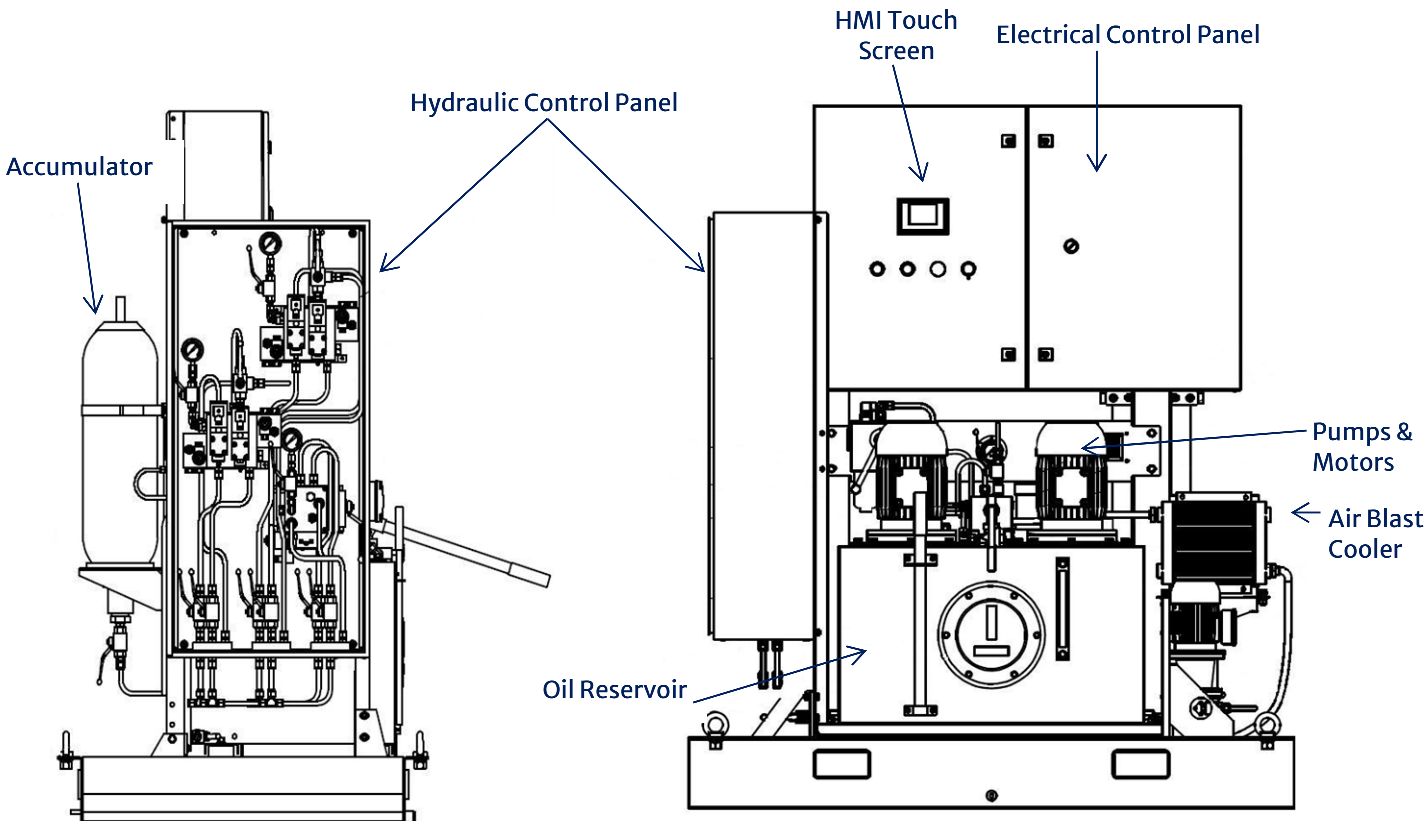
- Skid mounted with drip tray or full capacity bund (oil spill capture).
- Motor Pump Set: Dual pump sets are provided with automatic change over capable of charging the accumulator storage station in a time suitable for the application. Nominal power for each pump would be 2kw to 4 kw, depending on HPU size with an electrical supply of 400/480 volt AC 3 phase 50 or 60 Hz. Other voltages upon request.
- Accumulator Storage: The HPU will normally be supplied with sufficient storage for 3 operations of each valve, ie close/open/close. With certain installations the accumulator storage can be mounted local to the valve along with the hydraulic control valve panel.
- Filtration: An independent motorised filtration unit is fitted to the HPU requiring a power supply of 0.37 kw and can also be used for filling or draining the reservoir. Being an independent unit also allows for changing the filter element without switching off the HPU.
- Oil Cooling: An air blast cooler will be fitted within the system installed within the filtration unit and requiring a power supply of 0.37 kw. If preferred a small heat exchanger can be fitted using the power plant's utility water.
- System Condition Monitoring: Hydraulic system pressure, level and temperature can be visually monitored on the HPU. In addition the following monitoring instrumentation is available.
    - Pressure transducer for;
        - Pump Stop/Start and Auto Change Over
        - System High Pressure
        - System Low Pressure
        - System Low/Low Pressure
    - Oil Level Switch; Indicates and alarms Low Level and Low/Low Level
    - Oil Temperature; Indicates and alarms high oil temperature
    - Filter Condition; Indicates and alarms when filter is blocked and in bypass mode
    - Pump running signal; indicates which pump is running, operational or standby
- Hydraulic Control System: Mounted either on the HPU or local to the valves, within an IP65 enclosure, and comprises of a logic manifold assembly to include for the following functions;
    - Proportional Control for positional accuracy and fast response
    - Solenoid Control for Fast Open and/or Fast Close
    - Speed Control and Pressure Control
    - Utilisation for all required fail safe positions

NB: A key feature of our design is that all hydraulic solenoid valves, including the positioning solenoid valves, within our system are zero leakage. This ensures that when the bypass valves and water valves are in a static position there is no requirement for the motorised pumps to make up system pressure to compensate for leakage within normal spool type solenoid valves. This reduces power requirements and eliminates the need for continuous oil cooling.

- Electronic Control: The system will be controlled using a PLC having inputs and outputs both digital and analogue. Local display of the signals, system status and settings is provided using a 100mm (4") HMI operator display mounted on the electronic panel door. The PLC is as standard will be a Siemens S7 series. Typical I/O interface with the power plant's DCS is shown below.

Below is a typical Input/Output exchange between the HPU and the power plants DCS.

NO.	REV.	TAG NO.	SIG DEF.	SERVICE	STATUS	INPUT/OUTPUT SIGNAL				ENGINEERING DATA		FUNCTION			LOCATION		REMARKS
						I/O	SIGNAL		LOOP POWER	RANGE	UNIT	DCS	LCP	OTHER	FROM	TO	
		320-XV-1007	TBA	HP Water Block Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		320-XV-1007	TBA	HP Water Block Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		320-TV-1007	TBA	HP Spray Water Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		320-TV-1007	TBA	HP Spray Water Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		341-PV-1001	TBA	HP Bypass Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		341-PV-1001	TBA	HP Bypass Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		320-TV-1007	TBA	HP Spray Water Valve set point	Demand	AO	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		320-TV-1007	TBA	HP Spray Water Valve Position Feedback	Position Feedback	AI	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		341-PV-1001	TBA	HP Bypass Valve Set Point	Demand	AO	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		341-PV-1001	TBA	HP Bypass Valve Position Feedback	Position Feedback	AI	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		341-PV-1001	TBA	HP Bypass Valve Quick Opening	Quick Open Demand	DO	24 VDC		By DCS								Turbine Trip
		240-XV-1015	TBA	HRH Water Block Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		240-XV-1015	TBA	HRH Water Block Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		240-TV-1013	TBA	HRH Spray Water Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		240-TV-1013	TBA	HRH Spray Water Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		315-PV-1002	TBA	HRH Bypass Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		315-PV-1002	TBA	HRH Bypass Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		240-TV-1013	TBA	HRH Spray Water Valve set point	Demand	AO	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		240-TV-1013	TBA	HRH Spray Water Valve Position Feedback	Position Feedback	AI	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		315-PV-1002	TBA	HRH Bypass Valve Set Point	Demand	AO	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		315-PV-1002	TBA	HRH Bypass Valve Position Feedback	Position Feedback	AI	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		315-PV-1002	TBA	HRH Bypass Valve Quick Opening	Quick Open Demand	DO	24 VDC		By DCS								Turbine Trip
		240-XV-1035	TBA	LP Water Block Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		240-XV-1035	TBA	LP Water Block Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		240-TV-1036	TBA	LP Spray Water Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		240-TV-1036	TBA	LP Spray Water Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		343-PV-1012	TBA	LP Bypass Valve	Open	DI	Limit Switch	N/O	By DCS								Limit SW
		343-PV-1012	TBA	LP Bypass Valve	Closed	DI	Limit Switch	N/O	By DCS								Limit SW
		240-TV-1036	TBA	LP Spray Water Valve set point	Demand	AO	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		240-TV-1036	TBA	LP Spray Water Valve Position Feedback	Position Feedback	AI	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		343-PV-1012	TBA	LP Bypass Valve Set Point	Demand	AO	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		343-PV-1012	TBA	LP Bypass Valve Position Feedback	Position Feedback	AI	4-20 mA		By HPU	0-100	%						Via Signal Isolator
		343-PV-1012	TBA	LP Bypass Valve Quick Opening	Quick Open Demand	DO	24 VDC		By DCS								Turbine Trip
			TBA	Common Hydraulic Power Unit (HPU)	No Fault	DI	Dry Contact	N/O	By DCS								
			TBA	Common Hydraulic Power Unit (HPU)	No Warning	DI	Dry Contact	N/O	By DCS								
			TBA	Common Hydraulic Power Unit (HPU)	ON	DI	Dry Contact	N/O	By DCS								
			TBA	Common Hydraulic Power Unit (HPU) Pump 1	Pump 1 Running	DI	Dry Contact	N/O	By DCS								
			TBA	Common Hydraulic Power Unit (HPU) Pump 2	Pump 2 Running	DI	Dry Contact	N/O	By DCS								
			TBA	Common Hydraulic Power Unit (HPU)	Remote	DI	Dry Contact	N/O	By DCS								



TYPICAL HPU (Hydraulic Power Unit)

DSCV-SA

FAQs – 9: Actuation: Pneumatic Instrumentation

Copes-Vulcan does not manufacture instrumentation. Therefore Copes-Vulcan is free to offer any manufacturer's instrumentation. If no preference is stated by the customer then the positioner of choice will be the Siemens PS2 as SPX Copes-Vulcan has a global price agreement with Siemens.

Positioners:

- Siemens PS2 (Default)
- ABB TZID-C
- Emerson DVC models

Air Filter Regulators:

- SMC Range (Default)
- Norgren
- Bellofram

Limit Switches:

- Honeywell 1LS-4C (Default)
- Allan Bradley
- NAMCO

Solenoid Valves:

- ASCO (Default)
- MAC
- Skinner

Boosters:

- RK Instrumentation (Default)
- SMC

Quick Exhaust Valves:

- SMC (Default)

Instrument Air Tubing & Fittings:

- 316 Stainless Steel - Parker (Default)
- 316 Stainless Steel - Swagelok

The above is just a sample of the standard default options we would normally choose unless the customer specifications states differently. We can potentially fit any make and model of instrumentation.

DSCV-SA

FAQs – 10: OPERATION

What is the minimum water pressure required?

The DSCV-SA utilises a steam atomising desuperheater with a full venturi section to achieve the desired steam temperature reduction. As such, the coolant is not ***Injected*** into the steam flow as with spring loaded spray nozzle designs, the coolant is aspirated into the steam flow by utilising a small proportion of the HP Steam flow as the motive energy source. The coolant pressure required at the DSCV-SA cooling water branch connection therefore need only be the same pressure as the steam outlet pressure conditions; a small pressure drop should be incorporated to allow the separate cooling water control valve to 'control' the flow of coolant to the DSCV-SA in response to the system command signal.

With a spring loaded spray nozzle design the "atomisation" of the coolant is achieved by the pressure differential between the coolant pressure and the outlet steam pressure. This pressure drop causes the coolant to break up into a wide range of different coolant particle sizes – a large differential pressure will produce smaller coolant particle sizes, where as a small pressure differential will produce much larger coolant particle sizes. With these designs of desuperheater it is a fundamental requirement that the pressure differential is maintained as high as possible in order to achieve a reasonable level of atomisation and subsequently smallest particle size.

Spring loaded spray nozzles are limited in their turndown as the coolant atomisation and spray pattern degraded as the coolant flow rate and available pressure differential reduces. As the coolant demand reduces, the coolant control valve closes and the coolant valve trim absorbs the coolant pressure differential leaving little pressure differential for the spray nozzles. This lack of pressure differential at the spray nozzles does not allow them to atomise the coolant, leading to the coolant pouring into the steam rather than a fine atomised mist. Mechanical spray nozzles also rely on the surrounding steam velocity to provide adequate mixing. When the steam load reduces so does the steam velocity and the ability of mechanical spray nozzles equally reduce. This effect manifests itself with poor downstream steam temperature control and coolant ***'drop-out'***. Coolant drop-out can be very damaging as cold water will track along the bottom of the inside wall of the downstream pipe whilst un-cooled superheated steam travels along the top and sides. This produces high thermal shocks which can lead to steam header fracture.

With the steam atomiser incorporated into the DSCV-SA a pressure differential is NOT required as the atomising steam flow provides the motive energy required to atomise the coolant. As the atomising steam is at a higher temperature than the incoming coolant supply the latent heat transfer immediately commences providing pre-heat to the coolant. This results in a 'hot fog' being produced at the atomiser outlet which provides very fine coolant particle sizes, which are at or close to their temperature of evaporation. This results in the coolant being quickly absorbed into the main steam flow achieving the desired temperature control in the shortest distance and negates the requirement for any downstream thermal liners.

This lower pressure coolant supply requirement can also provide operational cost benefits to plant designers and operators as a much lower pressure (and subsequently lower cost) coolant source can be utilised to maximum effect without impacting the system performance. The steam atomising flow within the DSCV-SA design pre-heats the coolant prior to exit of the atomiser and as such is much more accommodating of the lower coolant temperatures usually associated with lower pressure coolant supplies without the need for thermal liners to be incorporated at the valve outlet.

DSCV-SA

FAQs – 11: OPERATION

Does the DSCV-SA have tight shut off?

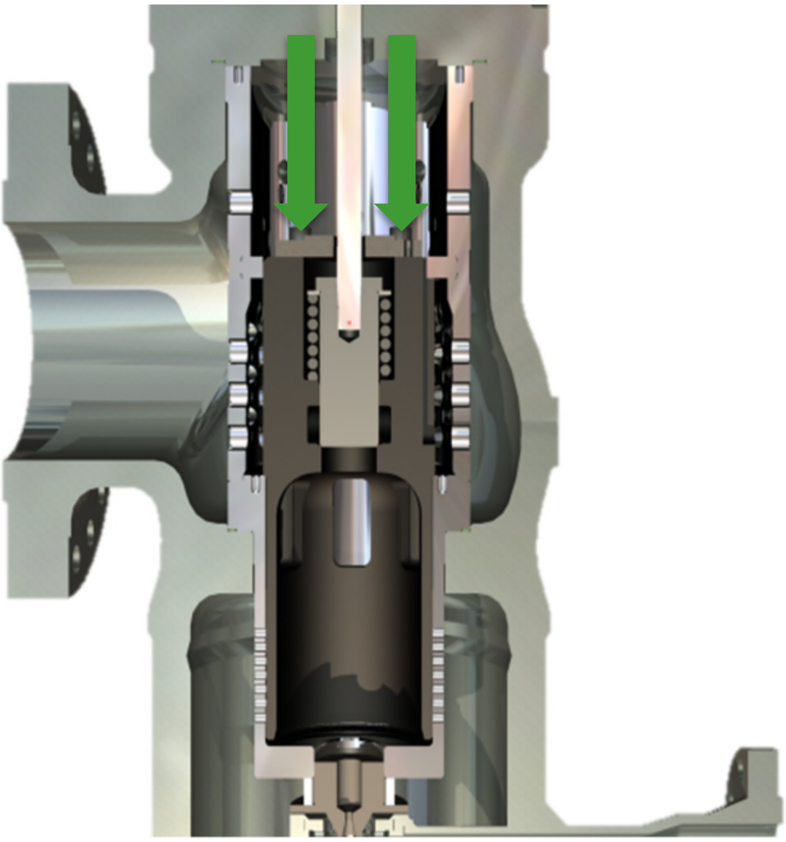
YES!

The DSCV-SA, unlike many alternative designs, utilises a high pressure balanced plug which is purposefully designed to work in harmony with the high pressure steam, rather than in a continuous battle to prevent high pressure inlet steam from leaking to the top side of a low pressure balanced plug design as used in many other steam conditioning valve designs. The DSCV-SA works with the high pressure steam, and as this is always the dominant pressure, the DSCV-SA simply cannot become "out of balance".

The DSCV-SA valve has a very tight shut off in the closed position, as a minimum ANSI FCI 70-2 Class V. It achieves this tight shut off by utilising a pilot plug design so that in the closed position the main plug is unbalanced with the full steam pressure acting on the top of the plug, this load combined with the actuator thrust resulting in very high seat contact loads, which ensures a very tight and repeatable shut off.

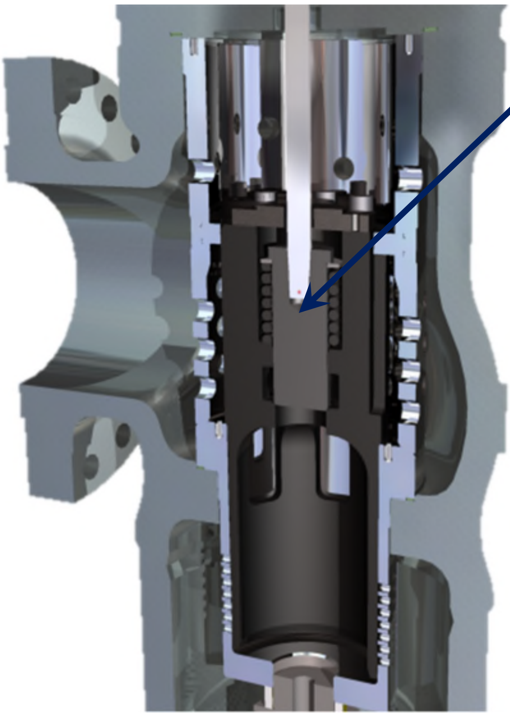
Not only is tight shut off required for plant thermal efficiency it also prevents leak induced 'wire drawing' damage across the seat which would otherwise result in frequent maintenance to repair or replace the seat.

As can be seen high pressure P1 steam is directed to the top of the plug and therefore negates any need for very close tolerance sealing surfaces or piston rings as used in low pressure balanced plug designs that are susceptible to wear and damage.



In the Closed Position both the main plug and pilot plug are closed.

P1 Pressure is present on top of the plug.



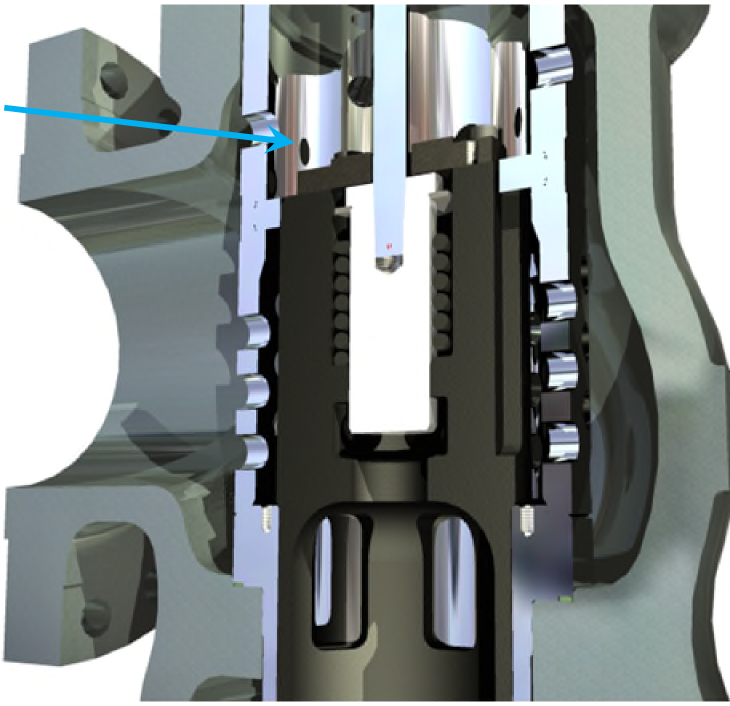
P2 Pressure is present on the downstream of the Plug

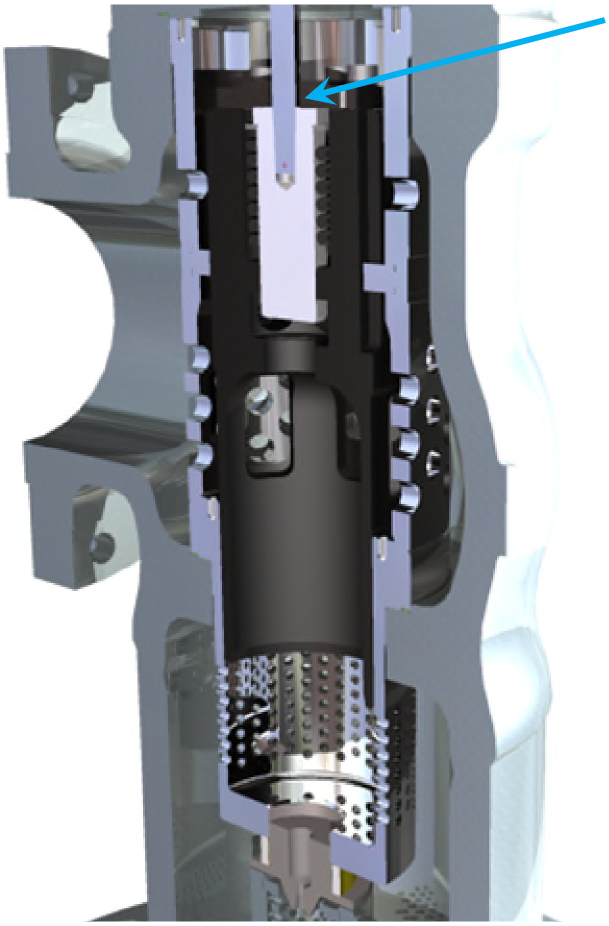
The white arrows demonstrate the high pressure steam augmenting the seat contact load resulting in a very tight shut off.

When an open command signal is received, the actuator retracts and the pilot plug is the first to open. This allows P1 steam to flood through the large pilot plug port to the underside of the main plug. The main plug is now balanced reducing the actuation thrusts required.

The capacity of the pilot plug port is several times greater than that of the atomising nozzle and designed leak paths in the cage guiding system ensure equal inlet pressure on the underside and top side of the main plug.

Now with the pilot plug open, high pressure inlet steam has flooded the underside of the main plug and the steam atomising unit is now operating in preparation to receive the incoming cooling water from the water control valve





When the Pilot Plug is fully open and engaged with the Tandem Cap, the main plug begins to open.

Steam Flows through the trim spacer and into the large feed ports of the plug flow then passes through the cage where it is pressure reduced prior to exiting the valve via the integral outlet diffuser plate.

The Principle and Effect of High Pressure Balancing

High pressure balancing can only occur when P1 pressure is present above and below the plug in normal operation. Flow OVER the web plug designs that utilise piston rings or close tolerance labyrinth seals are low pressure balanced design with the sealing mechanism trying to prevent the high pressure steam from entering the low pressure balancing area. This is a constant battle between the high pressure steam and the sealing mechanism and as a result any wear, erosion or debris damage that is caused to the seal under normal power plant operating condition can only result in the low pressure balance being lost and causing plug instability or the plug being unable to open or close on command. In either scenario a low pressure balanced plug causes a plant risk and must therefore be subject to a rigorous maintenance regime in order to maintain balance. The DSCV-SA uses a high pressure balancing system which works with the dominant pressure and eliminates all the associated operational problems caused by low pressure balancing.

In addition to these major operational benefits, a high pressure balanced plug also provides pressure induced seat contact loading when the valve is closed. This pressure induced seat contact loading occurs when the Main Plug and Pilot Plug are closed and Full P1 Pressure builds on the top of valve plug. In the closed condition, the DSCV-SA plug is essentially unbalanced (with high pressure on top of the plug and low pressure beneath the plug) and the steam pressure acting on this unbalanced plug area provides additional high levels of seat contact load. This ensures exceptional, continual and repeatable seat tightness.

Pressure Induced Contact Load

The DSCV-SA is designed to exceed the seat leakage requirements as defined in ANSI/FCI 70-2 Class V and is provided with an actuator suitably designed to provide the correct amount of seat contact load required to achieve this tight shut off.

In addition to this shut off class being achieved, the DSCV-SA can also meet the requirements of MSS-SP-61 which requires that an additional seat contact load of 1000 lbf per linear inch of seat diameter be provided. The DSCV-SA achieves this by utilising pressure induced contact load. Depending on the size of DSCV-SA utilised the following operational pressures are required to exceed the requirements of MSS-SP-61

DSCV-SA Unit Size		0	1	2	3	4	5	6
MSS-SP-61 Seat Contact Load	lbf	15,284	20,587	26,672	32,563	39,436	48,861	61,428
Minimum operating pressure to meet the requirements of MSS-SP-61 Seat Contact Load	Bar.a	59.19	43.68	33.47	27.64	22.88	18.42	14.45
	PSIA	858	633	485	401	332	267	209

DSCV-SA

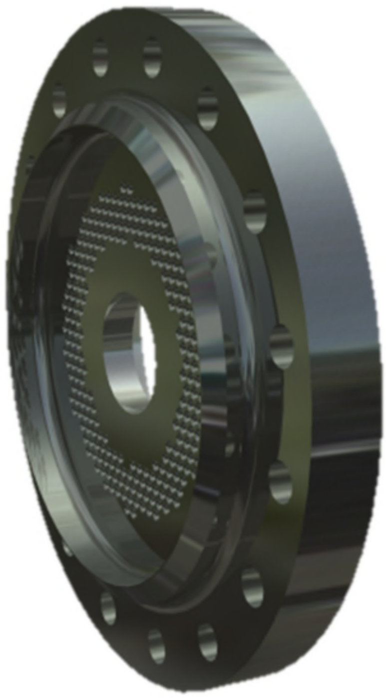
FAQs – 12: OPERATION

Does the DSCV-SA have an outlet diffuser?

YES!

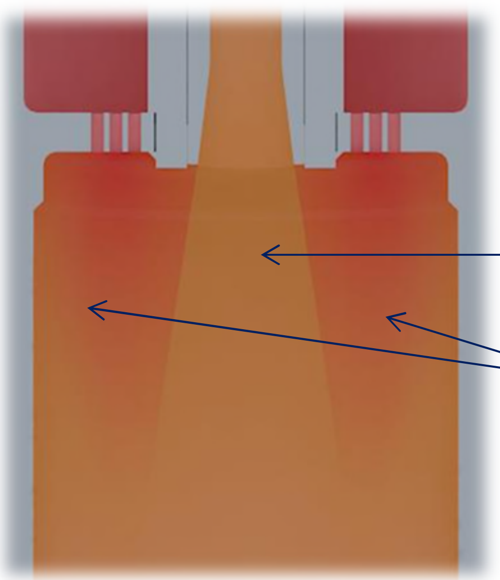
The DSCV-SA incorporates an outlet diffuser plate into the design that provides many additional features

- Outlet is fully forged piece with diffuser plate integral
- Generates a thermal barrier so no thermal liners are required.
- **NO** cooling water passes through the diffuser. Therefor no quenching or thermal shock of the diffuser.
- Provides centralised location and robust anchor point for Steam Atomiser Housing
- Provides the Butt Weld End or Flanged Outlet connection which is matched to the customers required downstream pipe size / pipe schedule requirements
- Provides an outlet material transition if required
- Provides BWE Prep for outlet fabrication
- Includes test ring for shop Hydrostatic Test



Outlet diffuser plates are designed to operate in conjunction with the valve trim over the valve's performance envelope and are designed per application.

The diffuser plate is available with a multitude of hole sizes for noise consideration and can be provided with high CV Porting & Flow Guides for low pressure drop applications.



The outlet Diffuser Straightens flow at outlet of the valve and provides ideal mixing zone for the exit of the steam atomising desuperheater. The final desuperheating takes place directly after the outlet diffuser section. With the outlet diffuser aligning the main steam flow to create an excellent mixing zone the final stage of desuperheating occurs rapidly and evenly without danger of thermal shock or water drop out in the downstream pipe work.

Finely atomised and preheated cooling water.

The main steam now at outlet pressure forms a 360 degree annulus that surrounds the finely atomised preheated cooling water providing a thermal barrier between the cooling water and downstream pipe work whilst the cooling water fully evaporates.

DSCV-SA

FAQs – 13: OPERATION

What is the rangeability / turndown of the DSCV-SA?

The DSCV-SA was specifically design to achieve extremely high rangeability/turndown and wide performance envelopes. This is achieved by the method of cooling water introduction employed, steam atomisation. Steam atomisation has several benefits over mechanically spraying the cooling water into the steam line.

To achieve high turndowns the unit has to be designed so that it is not dependant on the steam line velocity to promote mixing and evaporation without cooling water ***'drop-out'***. Steam atomisation achieves this as follows;

Pre-Heating: With steam atomisation of the cooling water a significant benefit is the pre-heating of the cooling water. The atomising steam raises the approach temperature of the cooling water close it its evaporation point. This promotes rapid final evaporation very quickly after leaving the atomising head. With this preheating no thermal liners are required to protect the valve or downstream pipe work from thermal shock.

The atomising steam entering the atomising head is accelerated to sonic velocity through a critically designed converging nozzle. These nozzles are specifically designed for each contract based on the P_1 steam conditions to fully utilise the amount of energy (enthalpy conversion) available. The cooling water is introduced into the steam atomising head via a converging tube again designed to suit the cooling water rate required to evenly introduce the steam circumferentially. The venturi effect of the motivating atomising steam exiting the steam nozzle and the converging/diverging venturi section finely atomise the cooling water and ensure a highly homogenous mix exiting the steam atomising head. This homogenous mix now enters the main steam which is exiting the diffuser plate in a ***'hot fog'*** or gaseous consistency. Therefore there are no cooling water droplets to fall out.

Note that steam atomisation cooling water introduction should not be confused with mechanical spray nozzles which present the cooling water into the steam as a spray of liquid and with mechanical spray type desuperheating, at low steam line velocities water ***'drop out'*** can occur.

Therefore there is <u>NO</u> lower limit for steam line velocities for the Copes-Vulcan DSCV-SA steam conditioning valve. The DSCV-SA has no dependency on steam line velocity to achieve its required turndown.

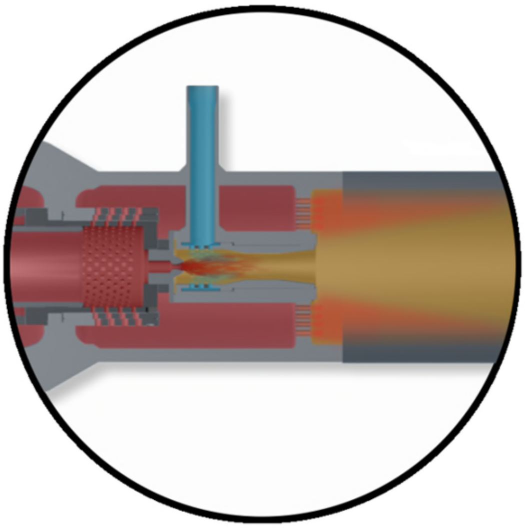
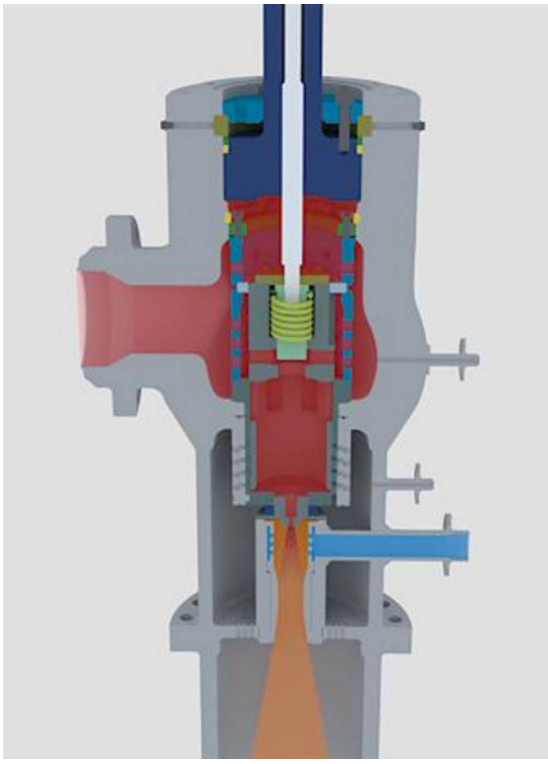


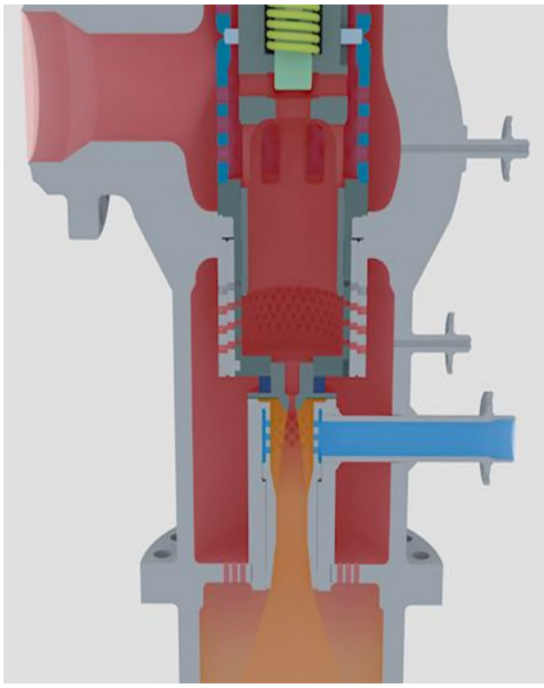
Diagram showing the steam atomising head of the Copes-Vulcan steam conditioning valve DSCV-SA.

Trim Turndown: The trim is high pressure balanced using a pilot plug. When the DSCV-SA first opens the pilot plug open and feeds steam to the inner cage area. Attached to the cage is the steam atomising nozzle Therefore when the pilot plug opens the only forward flow of steam is through the steam atomising nozzle. These nozzles are contract specific and designed to pass the correct amount of steam for the application, steam pressure and temperature.

On the diagram shown here only the pilot plug is open. High pressure steam is allowed to pass through to the steam atomising nozzle. Water can be introduced as the atomising steam will pre-heat, atomise and evaporate the cooling water.



On this diagram the main plug is now open. High pressure steam now passes through the main cage and the steam atomising nozzle.



DSCV-SA

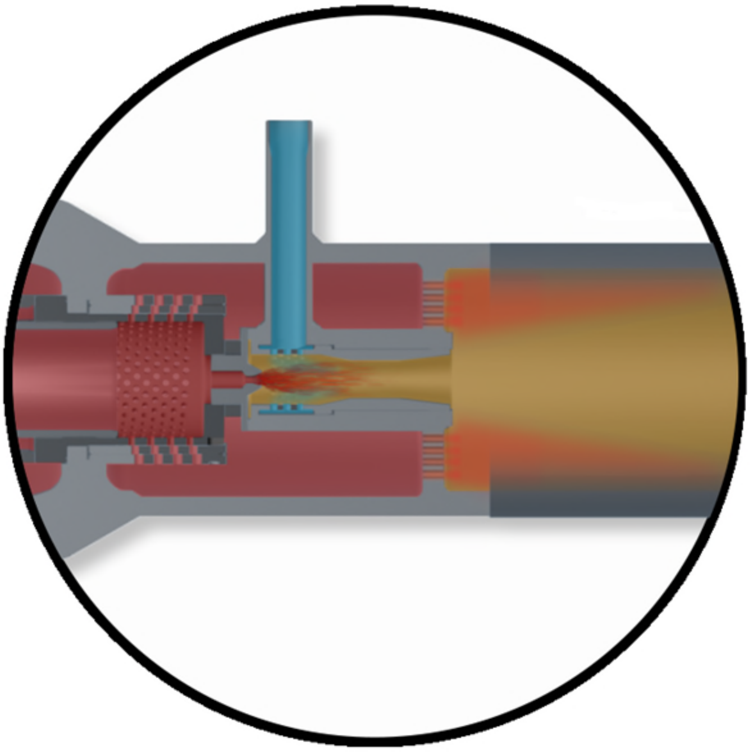
FAQs – 14: OPERATION

Is there a minimum outlet steam velocity required to prevent cooling water drop out?

When using a DSCV-SA valve design – NO!

The DSCV-SA was specifically design to achieve extremely high turndowns and wide performance envelopes. With a DSCV-SA there is **NO** downstream minimum steam velocity requirement. This is due to the unique method of coolant introduction utilising a steam atomising desuperheater which incorporates a **FULL** venturi section. Steam atomisation has several benefits over mechanically spraying the cooling water into the steam line. To achieve high turndowns the unit has to be designed so that it is not dependant on the steam line velocity to promote mixing and evaporation without cooling water ***'drop-out'***. Steam atomisation achieves this as follows:

Pre-Heating: With steam atomization of the cooling water a significant benefit is the pre-heating of the cooling water. The atomising steam raises the approach temperature of the cooling water close it its evaporation point. This promotes rapid final evaporation very quickly after leaving the atomising head. With this preheating no thermal liners are required to protect the valve or downstream pipe work from thermal shock.



The atomising steam entering the atomising head is accelerated to sonic velocity through a critically designed converging nozzle. These nozzles are specifically designed for each contract based on the P_1 steam conditions to fully utilise the amount of energy (enthalpy conversion) available. The cooling water is introduced into the steam atomising head via a converging tube again designed to suit the cooling water rate required to evenly introduce the steam circumferentially. The venturi effect of the motivating atomising steam exiting the steam nozzle and the converging/diverging venturi section finely atomise the cooling water and ensure a highly homogenous mix exiting the steam atomising head. This homogenous mix now enters the main steam which is exiting the diffuser plate in a ***'hot fog'*** or gaseous consistency. Therefore there are no cooling water droplets to fall out.

Note that steam atomisation cooling water introduction should not be confused with mechanical spray nozzles which present the cooling water into the steam as a spray of liquid and with mechanical spray type desuperheating, at low steam line velocities water ***'drop out'*** can occur.

Therefore there is **NO** lower limit for steam line velocities for the Copes-Vulcan DSCV-SA steam conditioning valve. The DSCV-SA has no dependency on steam line velocity to achieve its required turndown.

FAQs – 14a: OPERATION
What are the advantages of steam atomisation versus spray nozzles?

The DSCV-SA has a full venturi steam atomising system. This provides excellent water atomisation; preheating and homogenous mixing resulting is very rapid cooling water evaporation and negates any danger of thermal stress.

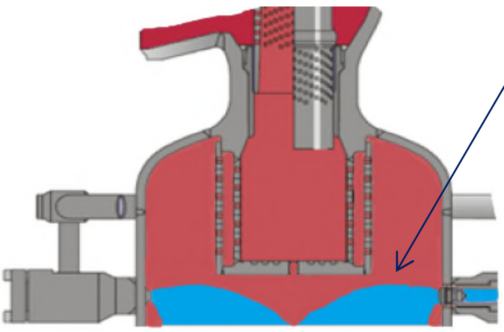
In many alternative steam conditioning valve designs a number of mechanical spray nozzles are utilised around the periphery of the valve's outlet section. Spray nozzles can only utilise the small amount of energy to atomise the cooling water that is available from the pressure differential between the steam and cooling water. The amount of pressure drop across the nozzle reduces as the water flow rate reduces from maximum as more and more pressure drop is taken across the water control valve to reduce the cooling water flow. The spray pattern and atomisation produced under minimum flow conditions are even less effective.

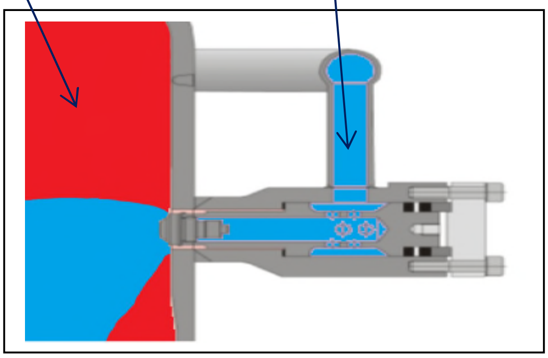
The very high thermal transient over the pressure boundary wall where the multiple cooling water nozzle housings are welded also gives rise to thermal stress induced cracking.

Below is shown a typical example of such a design utilising spring loaded nozzles:

The Bypass steam temperature can be extremely high + 560°C (+1040°F)

The Bypass Cooling Water Temperature can be quite low, less than 100°C





Cooling water is introduced via mechanical spray nozzles with very high temperature differentials that can lead to thermal stress induced failure of the pressure boundary.

These Applications have an Enormous Temperature Differential

Feature	Spring Loaded Spray Nozzles	Steam Atomisation utilising a full venturi section
Injects Coolant into highly turbulent zone	✔ Provided the spray nozzle is positioned correctly the steam turbulence created by the pressure drop over the valve's trim can be utilised to mix the steam and coolant flow. However, as this turbulence needs to be carefully predicted there is a chance this could result in injected coolant being 'thrown' against the downstream valve or pipe wall, causing thermal shock.	✔
Injects coolant after pressure reduction has been achieved	✔ Spray nozzles are usually positioned after the valve trim (in the low pressure zone) at the valve outlet. No coolant is injected as the steam is pressure reduced through the valve trim	✔ The steam atomising desuperheater design is positioned after the valve trim and in the low pressure zone at the valve outlet. No coolant is injected as the steam is pressure reduced through the valve trim
Variable Geometry Nozzles causes atomising efficiency to be compromised at low coolant flow rates	✘ A variable geometry nozzle uses a spring to "vary" the nozzle discharge aperture in an attempt to improve atomisation at low coolant flow rates. This results in a lower differential pressure (between steam and coolant) to be used which increases coolant particle size and as such the efficiency and rate of evaporation.	✔ The steam atomising desuperheater does not rely on spray nozzles to perform the atomisation. Atomising steam flow rate remains constant (when the valve is open) regardless of coolant flow rates required and as such atomising efficiency remains excellent throughout the range of operation.

Feature	**Spring Loaded Spray Nozzles**	**Steam Atomisation utilising a full venturi section**
Coolant is injected at the periphery of the outlet	The coolant is introduced on the periphery of the outlet which can cause issues with thermal shock due to direct coolant impingement with the valve outlet and downstream pipework and in many instances a thermal liner will be required to mitigate (but not eliminate) such thermal shock. On large diameter outlets the steam flow may suffer from poor coolant / steam mixing and temperature stratification further compounding temperature induced stress.	The DSCV-SA Atomiser outlet is purposefully positioned at the CENTRE of the valve outlet. The intimately mixed fluid exits the venture section with the consistency of a ‘hot fog. As the cooling water is finely atomised and pre-heated the final desuperheating takes place directly after the outlet diffuser section. With the outlet diffuser aligning the main steam flow to create an excellent mixing zone the final stage of desuperheating occurs rapidly and evenly without danger of thermal shock or water drop out in the downstream pipe work. As final evaporation occurs very quickly then the required downstream straight line lengths are kept to an absolute minimum.
Nozzles can be removed from the body housing and maintained	The spring loaded nozzles contain a number of moving parts that are subject to differential thermal cycling and fluid induced erosion. Access to these for maintenance purposes is provided for this reason	The DSCV-SA Steam atomiser contains no moving parts. The steam atomising nozzle is attached to the valve cage that can be removed via the valve bonnet. The combining tube and venturi section are considered maintenance free items, but can be removed from the valve should this be required.

Requires a thermal liner when ΔT between coolant / steam exceeds 250°C	With spring loaded nozzle designs of desuperheaters that are placed around the periphery of the valve outlet the potential for thermal shock can be high. To mitigate (but not eliminate) this problem thermal liners are often required due to the temperature differential between steam and coolant. These are permanent fixtures that are incorporated into the valve outlet which cannot easily be inspected or replaced should the thermal liner fail.	Due to the unique method of coolant introduction via the steam atomising desuperheater with a full venturi the coolant is preheated close to its evaporation temperature prior to exiting the atomiser venturi section into the downstream pipework. As the temperature differential between steam and water is not substantially reduced and that this 'hot fog' is introduced at the centre of the valve outlet NO Thermal liners are required.

Feature	Spring Loaded Spray Nozzles	Steam Atomisation utilising a full venturi section
Venturi used for homogenous mixing & preheat of coolant	With a spring loaded nozzle, no "pre-heat" is applied and the coolant is injected at temperature. There is no homogeneous mixing as the desuperheating principle relies upon: Sufficient pressure drop to be taken over the nozzle to atomise the coolant – this pressure drop reduces at low coolant flow rates with an exponential increase in mean coolant particle size. The mixing of the steam and coolant is totally reliant upon the downstream velocity to suspend the coolant particles in the flow whilst preheating and evaporation takes place. Subsequent temperature stratification is totally reliant upon downstream turbulence provide by the steam velocity Desuperheaters of this design will require a MINIMUM of 5 – 6 meters per second (1000 to 1200 feet/minute) steam velocity to avoid coolant drop out.	The DSCV-SA is the only steam conditioning valve available today that utilises a venturi within the desuperheater design to provide maximum preheating and mixing of the coolant prior to entering the main steam flow. This results in a 'hot fog' being created at the atomiser outlet which results in: a. Rapid evaporation b. Eliminates the risk of thermal shock by preheating the coolant to close to its evaporative temperature c. Minimal straight pipe lengths being required downstream.

Expanded HP Steam used to minimise coolant particle size	Spring loaded spray nozzles rely totally on the pressure differential between the coolant supply and steam pressure to atomise the coolant into particles. When coolant flow rates are reduced, this results in a smaller pressure differential being available (as the coolant pressure reduces the nozzle area closes under the induced spring load to reduce flow rate) This smaller pressure differential results in larger coolant particle sizes at low coolant flow rates.	The DSCV-SA utilises an innovative design to use a small proportion of the HP Steam within the steam atomising desuperheater. This HP Steam is integrally and automatically supplied to the desuperheater when the trim first begins to open. The HP Steam is expanded through a critical nozzle at which point coolant is introduced to the steam. This expanded HP Steam produces an instantaneous release of energy which is transferred to the incoming water flow. The homogeneous mixture of expanded HP Steam and coolant is then forced through a converging venturi section to further preheat and mix the flow and accelerate it to produce a very fine coolant particle size that produces a 'hot fog' at the desuperheater outlet.
Feature	**Spring Loaded Spray Nozzles**	**Steam Atomisation utilising a full venturi section**
Simple method of HP Steam Extraction and coolant introduction & maintenance	Coolant is introduced via a number of nozzles located around the periphery of the valve outlet. The number of nozzles used determines the maximum coolant flow rate that can be achieved. These spring loaded nozzles contain a number of moving parts that are subject to differential thermal cycling and fluid induced erosion, thus increasing valve maintenance time and the number of components required to be replaced. HP Steam extraction is not utilised in the spring loaded spray nozzle design.	Within the DSCV-SA all HP Steam extraction used within the steam atomising desuperheater is performed internally to the valve and automatically with no external control required. Coolant is regulated via a separate coolant control valve. The steam atomising nozzle is attached to the valve cage that is removed via the valve bonnet. The combining tube and venturi section are considered maintenance free items, but can be removed from the valve should this be required. The DSCV-SA requires minimal maintenance due to its many design features and should maintenance be required this can be achieved expediently without the need for special tooling or

		service personnel.

DSCV-SA

FAQs – 15 OPERATION

Are Dump Tubes Available?

YES!

Dump tubes are used in conjunction with the DSCV-SA valve in bypass to condenser applications and provide a back pressure at the valve outlet. This limits the intermediate discharge pipe specific volume and therefore velocity resulting in a smaller valve outlet connection and subsequent discharge piping.

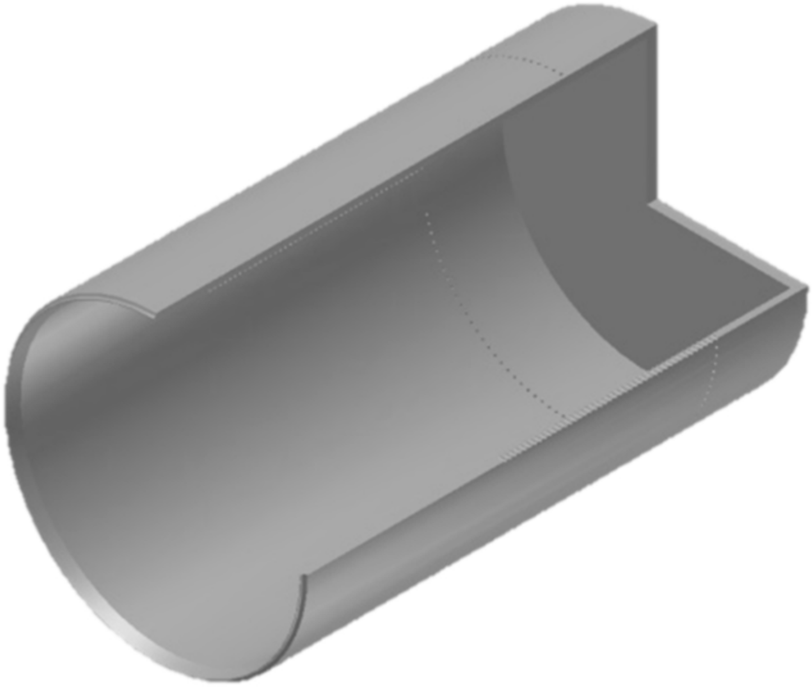
The use of Dump Tubes on a Turbine Bypass to Condenser application also provide the following benefits:

- Reduce Valve & Discharge Pipe Size (Lower Installed Cost)
- Ensure thorough mixing of coolant / steam prior to entry into condenser which protects the tube bundles from high temperature 'pockets' or water erosion
- Reduces system 'Bypass' system noise
- Used as 'flow meters' as part of a feed forward control system

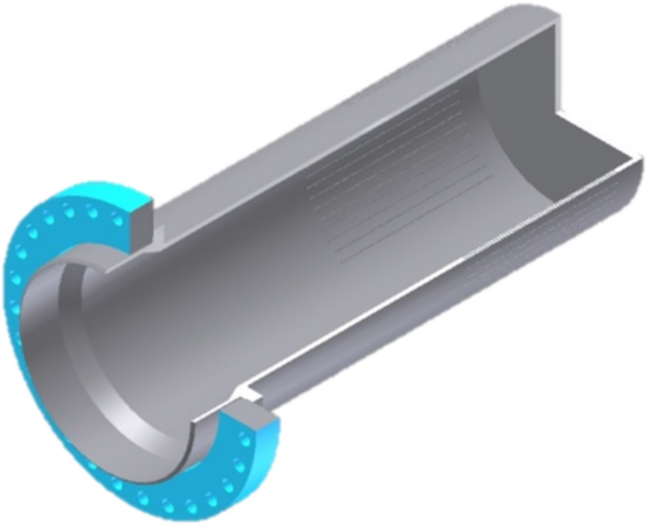
All dump tubes are custom engineered to the specific application and are designed to complement the requirements of the bypass valve, condenser and plant noise level requirements

Single Stage Dump Tubes

- Designed for ONE stage of pressure drop
- Consists of a number of holes drilled around the periphery of the tube with axial discharge
- Typically provides between 1.5 – 3.0 bar (20 - 45 PSI) back pressure to bypass valve at full flow (Noise level dependant)
- Simple Construction, lowest cost
- Multiple Hole Size for 'best' noise fit
- Constructed from ASTM A335 P11 (EN 10216-2 13CrMo4-5 (WERKSTOFF 1.7335) as standard
- Multiple mounting options
    - Flanged
    - Butt Weld
    - Mounting Cap



Single Stage Dump Tube with butt weld inlet connection

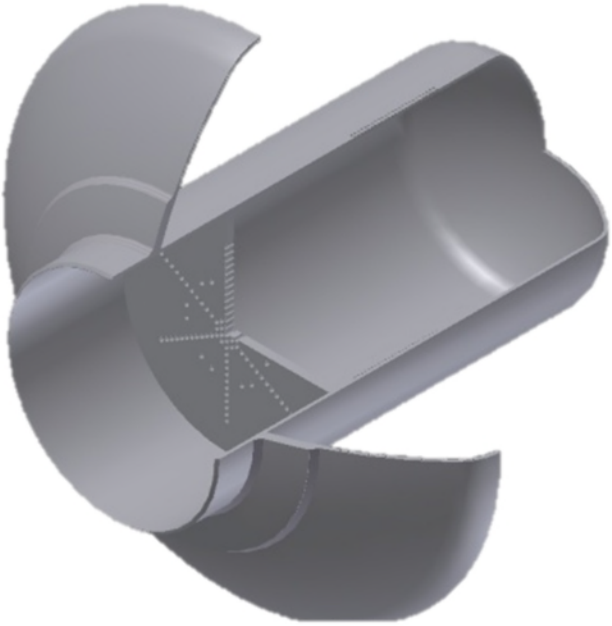


Single Stage Dump Tube With Flanged Inlet Connection

Single Stage Dump Tube with Butt Weld Inlet Connection and material Transition

Two Stage Dump Tubes

- Designed with Two stages of pressure drop
  - Stage 1 – Inlet Diffuser Plate
  - Stage 2 – Drilled holes in periphery of tube with axial discharge
- Typically provides between 2.0 – 5.0 bar (30 – 75 PSI) back pressure to bypass valve at full flow (Noise level dependant)
- Stages are designed for optimal pressure drop and noise characteristics
- Constructed from ASTM A335 P11 (EN 10216-2 13CrMo4-5 (WERKSTOFF 1.7335) as standard
- Multiple mounting options
  - Flanged
  - Butt Weld
  - Mounting Cap

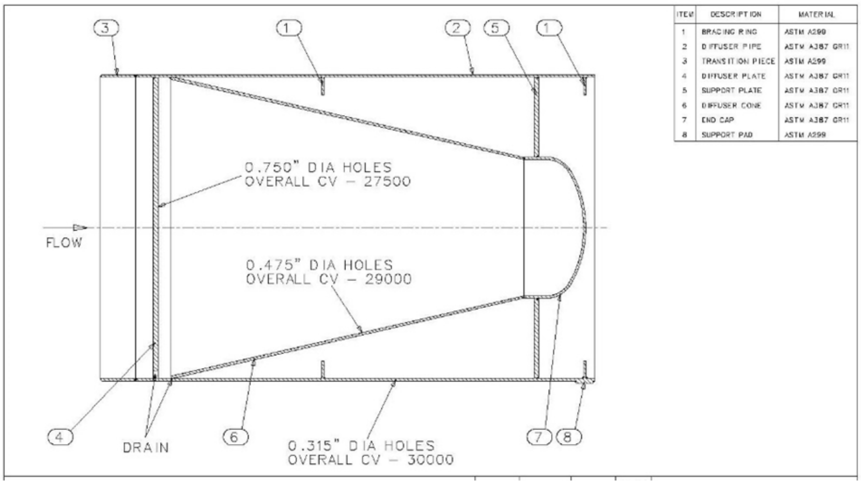


Two Stage Dump Tube with Mounting Cap

Two Stage Dump tube with mounting cap installed in the condenser ductwork.

Three Stage Dump Tubes

- Designed with Three stages of pressure drop
  - Stage 1 – Inlet Diffuser Plate
  - Stage 2 – Internal Cone with Drilled Holes
  - Stage 3 – Drilled holes in periphery of tube with axial discharge
- Typically provides between 4.0 – 8.0 bar (60 – 115 PSI) back pressure to bypass valve at full flow (Noise level dependant)
- Stages are designed for optimal pressure drop and noise characteristics
- Constructed from ASTM A335 P11 (EN 10216-2 13CrMo4-5 (WERKSTOFF 1.7335) as standard
- Multiple mounting options
  - Flanged
  - Butt Weld
  - Mounting Cap



ITEM	DESCRIPTION	MATERIAL
1	BRACING RING	ASTM A299
2	DIFFUSER PIPE	ASTM A387 GR11
3	TRANSITION PIECE	ASTM A299
4	DIFFUSER PLATE	ASTM A387 GR11
5	SUPPORT PLATE	ASTM A387 GR11
6	DIFFUSER CONE	ASTM A387 GR11
7	END CAP	ASTM A387 GR11
8	SUPPORT PAD	ASTM A299

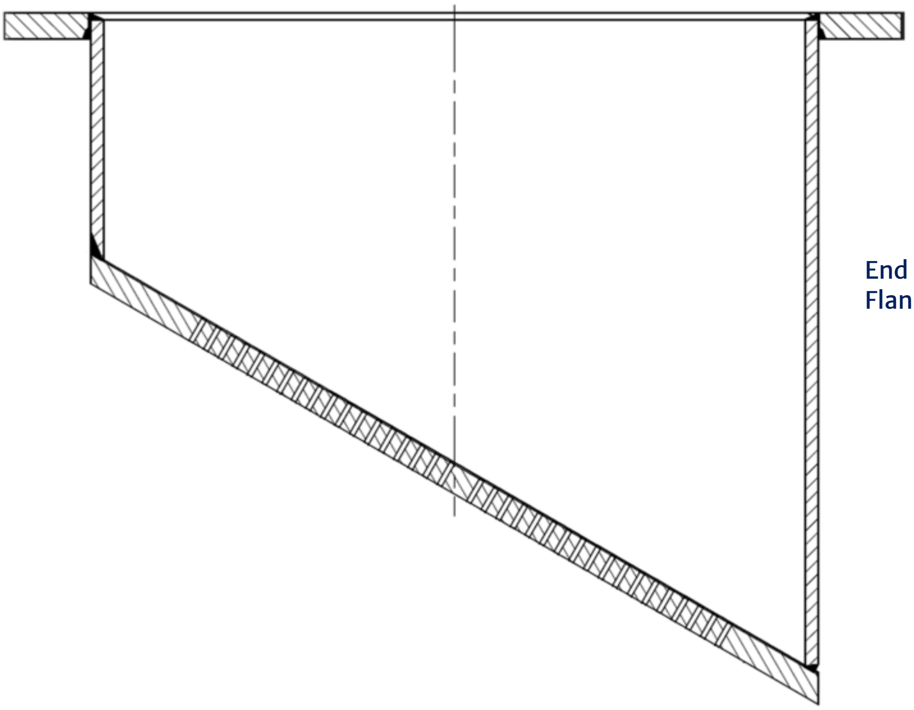
1st Stage
1500 off ¾" (19mm) holes
CV = 27500

2nd Stage (not Shown)
4000 off ½" (12mm) holes

3rd Stage
11616 off 5/16" (8mm) holes
CV = 30000
12 equi-spaced arrays

End Discharge Dump Tubes

- Designed with single stage of pressure drop
- Specifically designed to meet installation constraints
- Generally used on Water Cooled Condensers to avoid tube bundle impingement.
- Typically provides between 1.5 – 3.0 bar (20 – 45 PSI) back pressure to bypass valve at full flow (Noise level dependant)
- Designed for optimal pressure drop and noise characteristics
- Constructed from ASTM A335 P11 (EN 10216-2 13CrMo4-5 (WERKSTOFF 1.7335) as standard
- Multiple mounting options
    - Flanged
    - Butt Weld
    - Mounting Cap



End Discharge Dump Tube with Flanged Inlet Connection

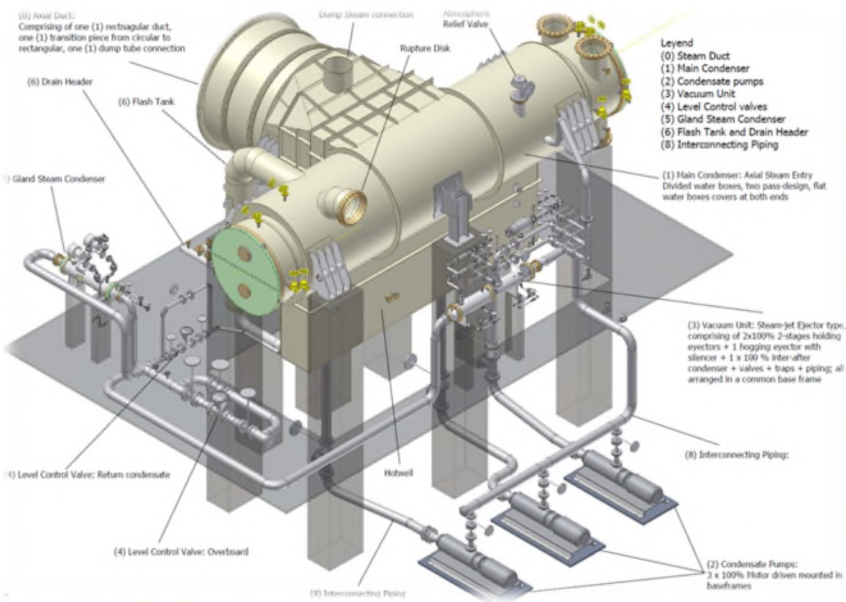
Installation

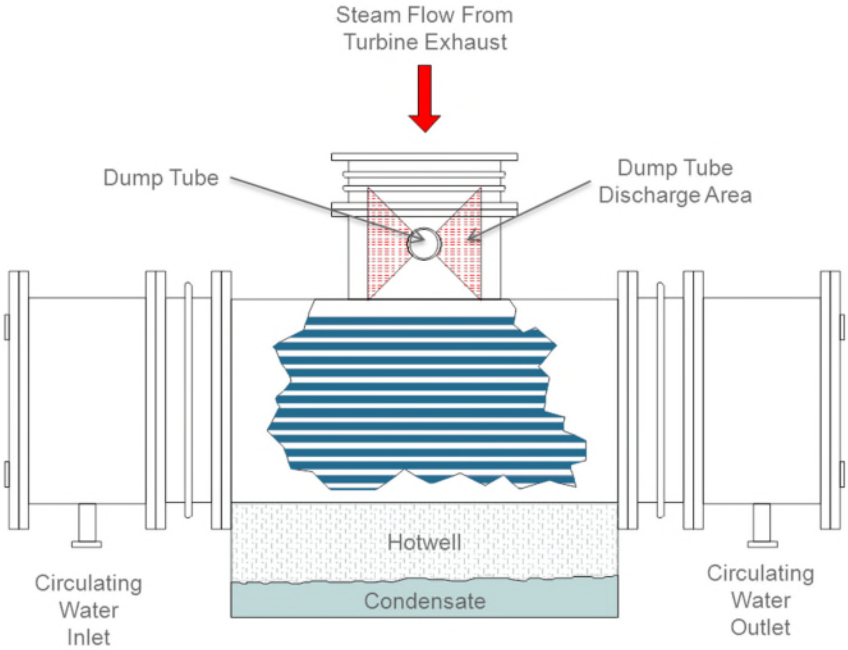
Depending on the 'type" of condenser being used will ultimately determine the design and placement of the dump tube in relation to the condenser. We shall discuss the installation arrangement for both water cooled condensers and air cooled condensers.

Water Cooled Condensers

On a Water Cooled Condenser the dump tube connection can be on the inlet to the condenser.

Flow Discharge holes of the dump tube should be positioned away from the tube bundles





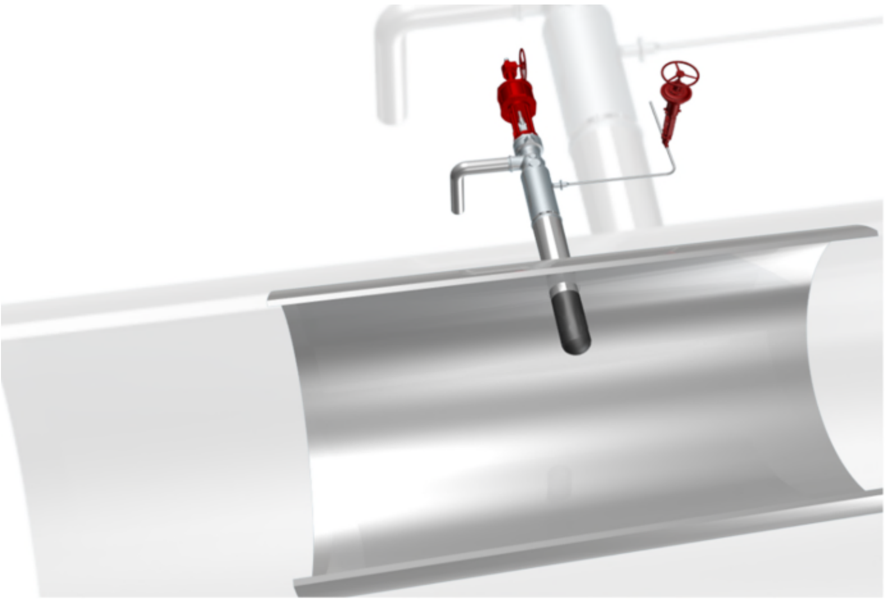
On water cooled condensers it is common to arrange the dump tube discharge holes in two 90° Arrays.

The Dump Tube discharge is directed away from turbine exhaust and the tubes of the condenser

The Dump Tube is positioned at the inlet neck to the condenser and not in the interconnecting ducting between the turbine exhaust and condenser inlet.

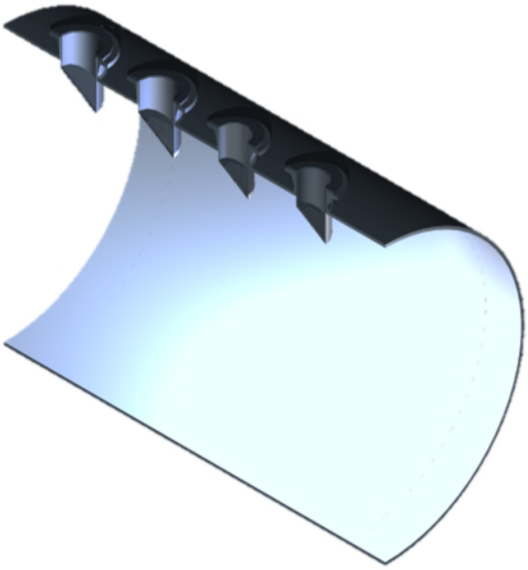
In designing the dump tube it is important to know the type of condenser that will be utilised as this will dictate the discharge hole pattern arrangement.

Air Cooled Condensers
Direct Insertion into the Condenser Duct



Direct insertion of the dump tube into the condenser duct work is an acceptable installation provided the following parameters are met:

- The 'Shadow' created by the dump tube insertion should be less than 5% of the total Duct Area. Shadows' higher than this percentage may affect turbine back pressure and MW output and may not be acceptable to the turbine manufacturer.
- SPX should be advised to ensure discharge hole pattern is developed accordingly

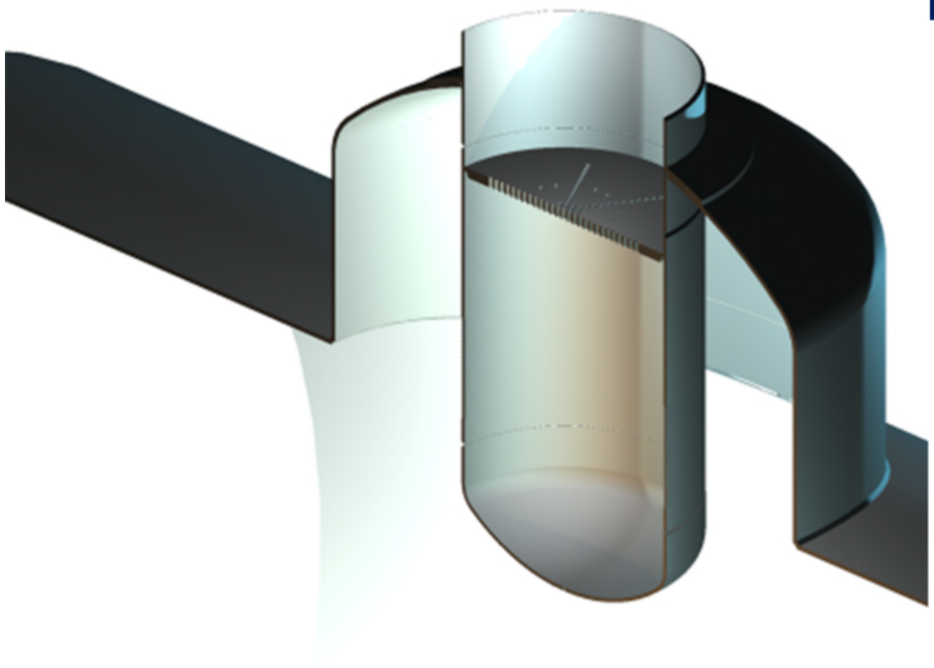


- Dump Tube Discharge holes are positioned facing directly downstream

Multiple Dump tubes in the array can be accepted providing that the maximum 5% shadow parameters can be achieved and that a minimum distance between each insertion is maintained to ensure flow discharge distribution is not adversely affected.

Air Cooled Condensers
Indirect Insertion into the Condenser Duct

When, due to the physical requirements of the dump tube for the application, a direct insertion cannot meet the maximum 'shadow' criteria an alternative indirect insertion can be made. This requires a suitably dimensioned branch connection on the duct work to allow for installation of the dump tube.



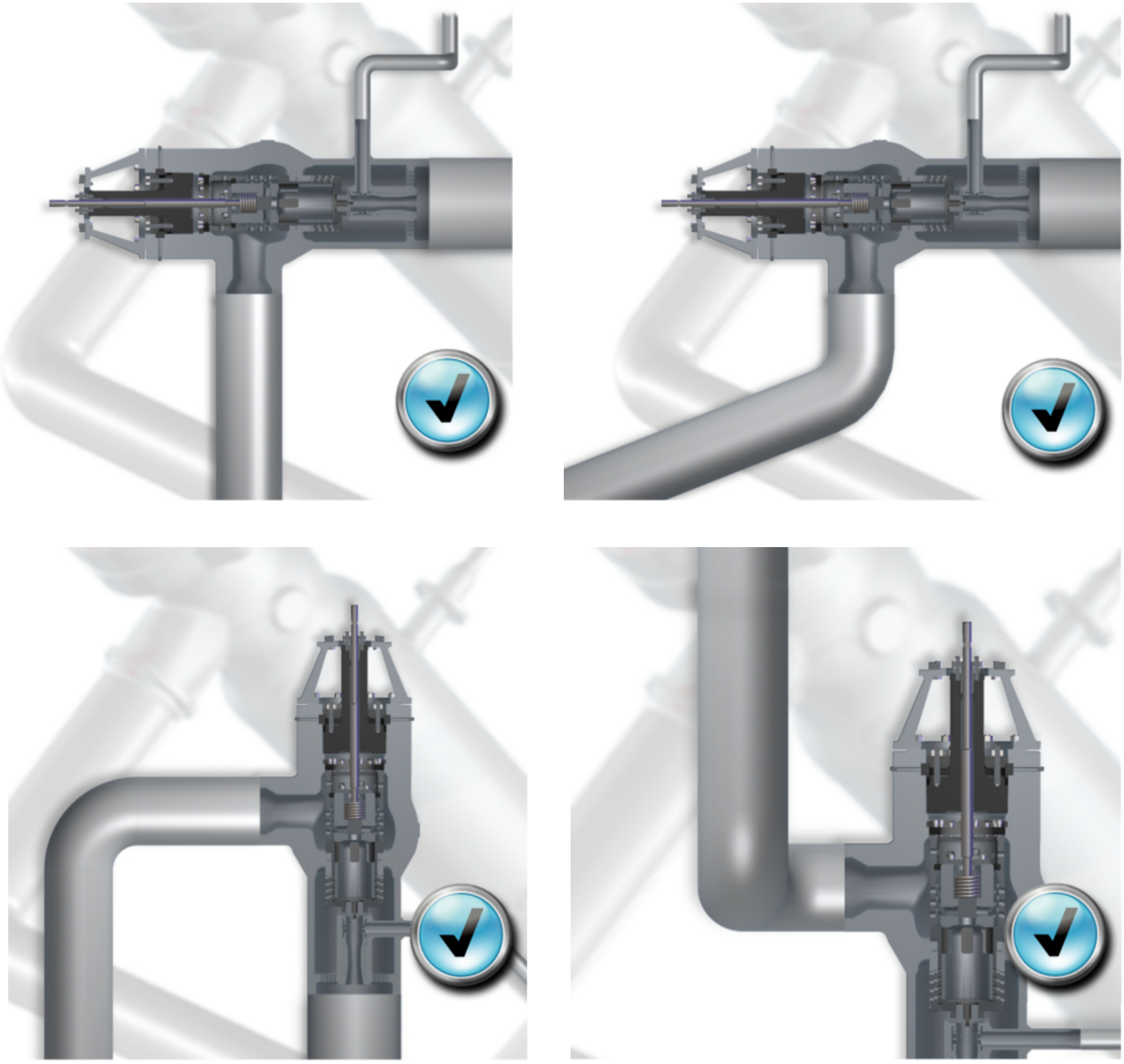
In this indirect insertion method, the dump tube discharge holes are positioned through 360 degrees, thus resulting in a shorter overall length. The branch connection withdraws the majority of the discharge area from the turbine exhaust flow and as such the minimum ‘shadow’ criteria can be met. The diameter of the branch is carefully calculated to ensure that velocities remain within acceptable limits and do not cause a source of secondary noise generation.

DSCV-SA

FAQs – 16a: INSTALLATION

What is the minimum upstream straight line length?

The DSCV-SA has been specially designed to meet market requirements for compact installation. The Heavy Duty distribution spacer negates the requirement for any straight length at the inlet of the DSCV-SA. Long Radius Bends or Isolation Valves can be fitted directly at the valve inlet.



FAQs – 16b: INSTALLATION

What is the minimum downstream straight line length?

Straight lengths are required after the valve to allow the evaporative process to take place.
Exact distances are calculated based on the thermodynamic parameters of the application and are shown on the DSCV-SA valve data sheets.

Factors Effecting Downstream Straight Length Requirements

- Residual Superheat in outlet flow
- Coolant Supply Temperature
- Inlet Steam Pressure & Temperature (This determines the available 'energy' through the atomiser)
- Valve Application (is a dump tube fitted?)

And ultimately

- Downstream Velocity

The Parameters above are used to determine an evaporative time. This is multiplied by the maximum steam velocity to determine a minimum straight length distance

As a general 'rule of thumb' an evaporative time of between
0.05 and 0.1 seconds is achieved with the DSCV-SA Steam Atomiser.
Multiply this evaporative time by velocity to determine the required distance

FAQs – 16c: INSTALLATION

What is the minimum distance to the temperature sensor?

Straight lengths are required after the valve to allow the evaporative process to take place.
Exact distances are calculated based on the thermodynamic parameters of the application and are shown on the DSCV-SA valve data sheets.

The downstream temperature sensor length after the DSCV-SA, is needed for the water to totally complete its vaporization into steam before interfacing with the temperature sensor in a feedback control system.

If the water has not completely vaporized, the resulting input control data will be inaccurate due to moisture contacting the sensing temperature element. The exact length required after the valve is a function of several of the factors previously described.

The temperature sensor can be located after a downstream bend (if fitted) and this may prove beneficial to the quality of the final temperature reading. Any entrained water that still exists after the minimum straight line distance from the DSCV-SA has been reached will be forced out of the flow by centrifugal forces as the flow passes around any downstream bend.

As a general 'rule of thumb' a factor of 0.18 - 0.2 seconds multiplied by the maximum pipe velocity should be applied, with a minimum recommended distance of 10 meters.

FAQs – 16d: INSTALLATION

What is the minimum distance to the pressure sensor?

Pressure Recovery at the valve outlet will be almost instantaneous and a minimum distance of 1.5m (5ft) should be allowed before placement of the pressure sensor.

Specific requirements from the sensor manufacturer should be sought to highlight any 'special' requirements of the sensor type / manufacturer. As with any feedback device incorrect placement of the sensor (too close or too far away) could result in faulty measurements or a slow system response time.

FAQs – 16e: INSTALLATION

What is the minimum distance to the dump tube?

Dump tubes are used in conjunction with the DSCV-SA valve in bypass to condenser applications and provide a back pressure at the valve outlet. This limits the intermediate discharge pipe specific volume and therefore velocity resulting in a smaller valve outlet connection and subsequent discharge piping.

When a dump tube to condenser is employed we are targeting an enthalpy value or temperature at the discharge of the dump tube (into the condenser duct) and as such the intermediate temperature between the DSCV-SA valve outlet and the dump tube inlet will not reach a dry saturated steam equilibrium as excess water (called dryness fraction) is usually carried along with the saturated steam flow to ensure the dump tube discharge conditions are met.

Exact distances are calculated based on the thermodynamic parameters of the application; however the following 'rule of thumb' can be applied

Where Coolant / Inlet Steam flow rates are less than 15%

- A distance of 0.05 seconds x maximum velocity should be applied with a minimum distance of 3 meters (10 feet) (straight length) being maintained.

Where Coolant / Inlet Steam flow rates are greater than 30%

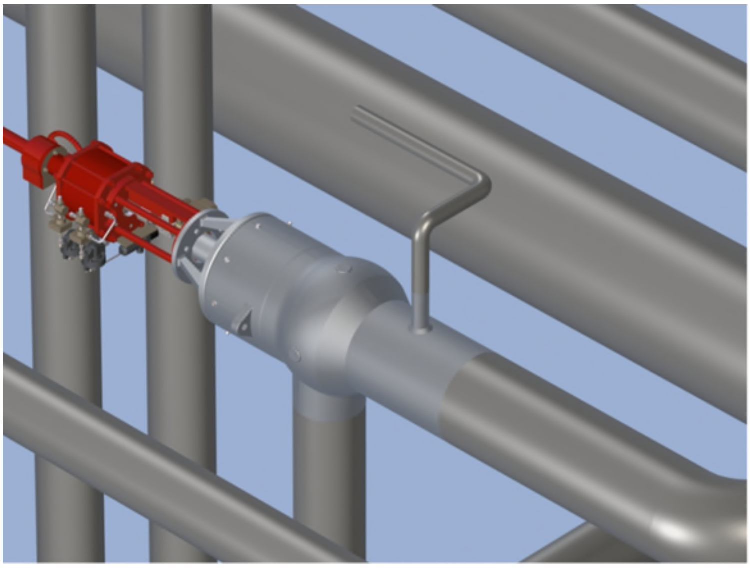
- A distance of 0.1 seconds x maximum velocity should be applied with a minimum distance of 5 meters (17 feet) (straight length) being maintained.

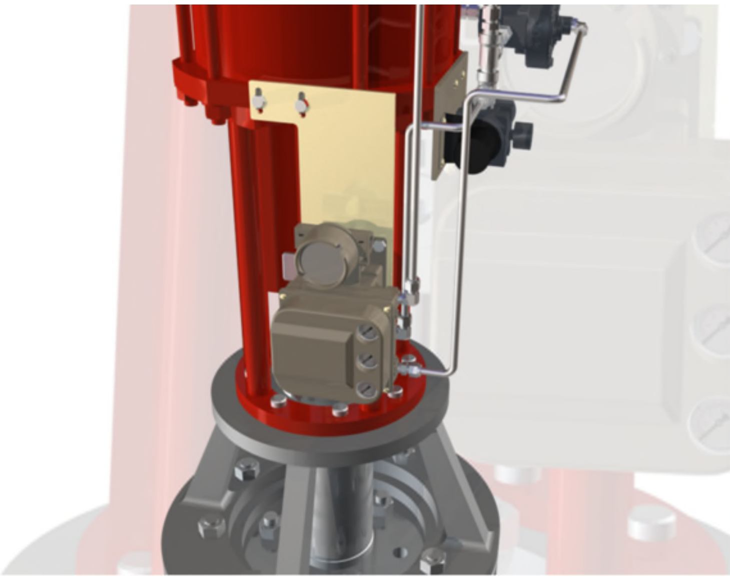
DSCV-SA

FAQs – 17: INSTALLATION

Can the DSCV-SA be installed horizontally and is there anything to consider when installing horizontally?

The DSCV-SA can be installed in ANY orientation although 'common sense' would dictate not to install the valve with the outlet vertically upwards to assist with ease of maintenance.





Actuators and yoke assemblies are designed to be 'self-supporting' and require no additional supports regardless of the intended orientation of installation

For installation other than vertical (Actuator vertical, outlet vertically downwards) consideration should be given to the requirement for service assistance fixtures as covered in FAQ section 24.

DSCV-SA

FAQs – 18: INSTALLATION

Are Thermal Liners Required?

Definition: Thermal liners are used to protect the steam pipe from sudden thermal shocks in the event cooling water is directly sprayed onto them through poor desuperheater design and/or coolant drop out.

Examples of Thermal Shock Caused by Poor desuperheater design and coolant impingement

- The use of a thermal liner is dependent upon the type of desuperheater design used within the bypass valve and the prevailing temperature (steam / coolant) conditions
- The thermal liner is used to prevent secondary thermal stress issues caused by the atomisation method
- The thermal liner should be fixed at one end and free at the other to allow independent thermal expansion / contraction

The DSCV-SA DOES NOT REQUIRE A THERMAL LINER TO BE USED

(see FAQ 12)

DSCV-SA

FAQs – 19: INSTALLATION

Does the Valve Require Warming and Draining?

Drains are generally required both upstream and downstream of any steam conditioning valve

- Drains are required to protect the valve and piping system by collecting and removing free 'water' that may have accumulated within the system
- This free 'water' may be as a result of condensation when the plant is shut down or the system inactive or can be as a result of a cooling water control system malfunction or incorrect setting
- Free 'Water' located upstream of the valve has the potential to be very damaging to valve trim components
- Free 'Water' located downstream of the valve present problems for piping, other instrumentation and can affect the temperature control efficiency

Experience with many installed bypass valve systems indicates that water collection in the piping is probably the most frequent single root cause for operating problems.

If water / condensate accumulates in the bypass piping and is not drained properly during plant start-up, this can cause system damage and a loss potential. Typical problems associated with water accumulation are water hammer, erosion or loss of temperature control through accumulated water.
Water hammer can lead to excessive damage in the plant with long downtimes and consequent lost production. Erosion problems in the piping can lead to expensive replacement or repair and causes excessive losses due to leakage and heat rate degradation over long operating periods.

Condensate can form and collect in the bypass piping during plant start-up, when the pipe walls are being heated by the steam flowing through the pipes. Condensate can also form during normal operation when there is no flow through the bypass valve system and the pipes are kept warm by condensation, this can be eliminated by allowing the Bypass valves and inlet piping to remain at or close to the normal operational temperature.

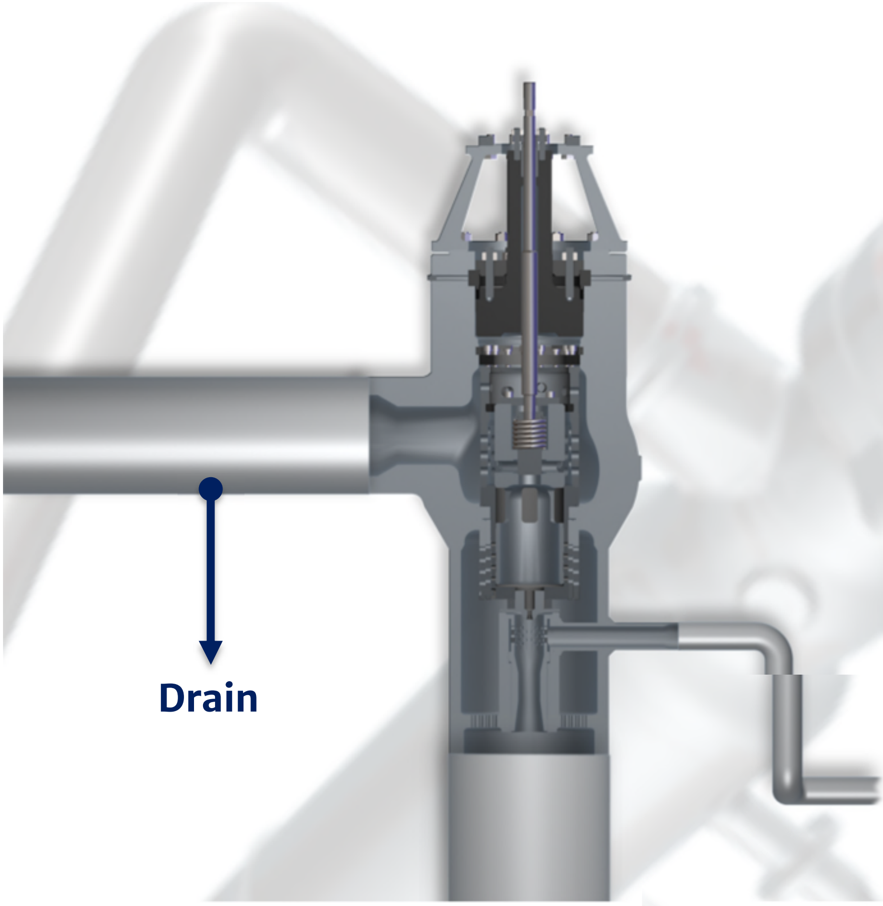
Under start-up conditions, condensation is unavoidable and the condensate must be removed through the piping system drains. If pipe layout drawings of the bypass system are provided, SPX can review the piping and drain arrangement prior to installation. A pipe with 1% slope back to the main steam pipe will be self-draining when the bypass valve is not in operation. However when the bypass is in operation and steam is flowing to the bypass valve, condensate will not flow back to the main steam pipe.

The piping configuration and orientation of installation will determine if the system is self-draining or if an additional valve body drain needs to be provided. This valve body drain is positioned at the lowest point on the high-pressure side of the valve. Automatic drain valves or manually actuated drain valves can be used (not supplied by Copes-Vulcan), however the operation of these drains during plant start-up and warming must be incorporated into the site procedures to ensure that the piping system and body of the DSCV-SA valve are free from condensate prior to operation of the valve. Irreparable damage can be caused to the valve trim components IF high velocity condensate is forced through the valve trim.

Inlet Drain Locations depending on valve orientation

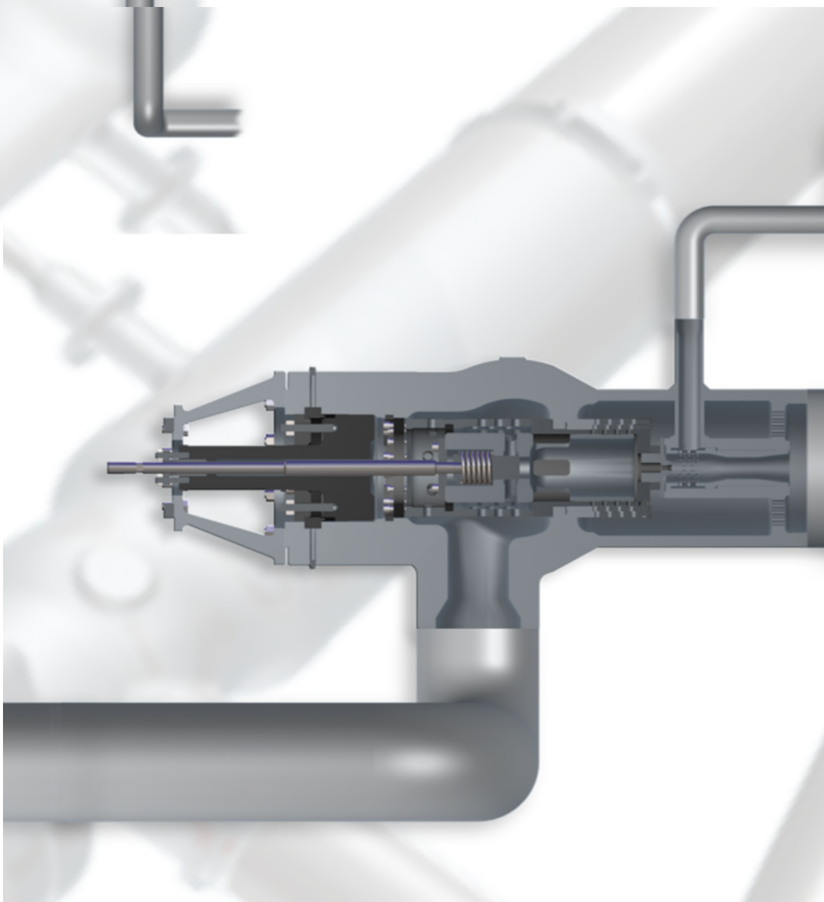
Vertical Installation
(Horizontal Inlet, Outlet Downwards)

In this orientation an upstream drain should be positioned at the lowest point of the inlet piping. The inlet pipe should slope away from the valve inlet to ensure sufficient drainage is achieved when the valve is not in operation.



Horizontal Installation
(Vertical Inlet, Outlet Horizontal)

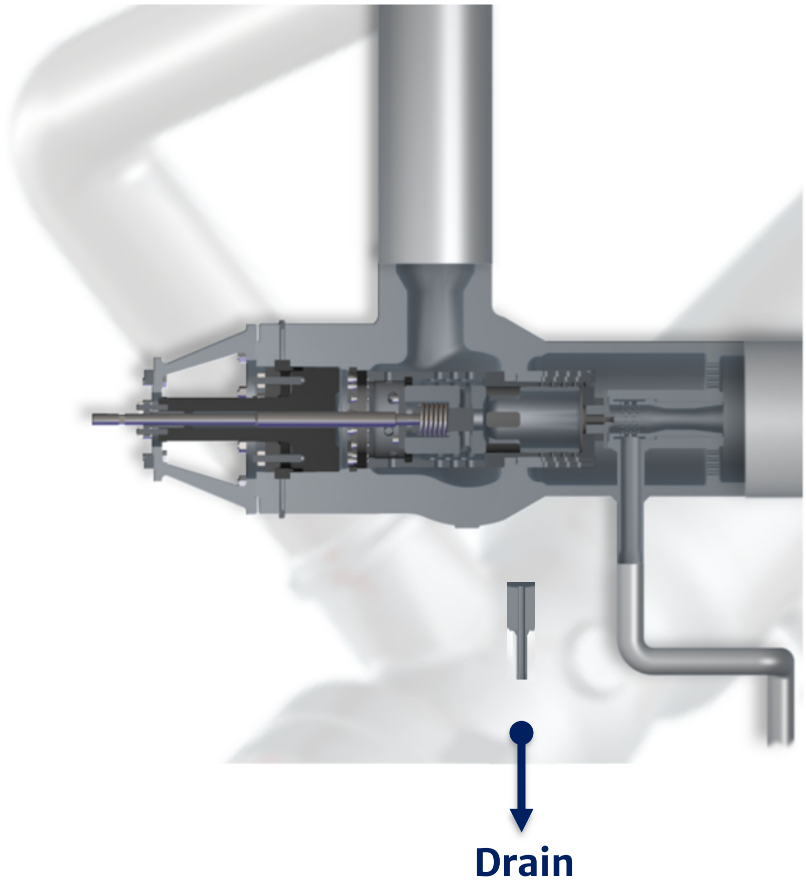
In this orientation an upstream drain should be positioned at the lowest point of the inlet piping. The inlet pipe should slope away from the valve inlet to ensure sufficient drainage is achieved when the valve is not in operation.



Horizontal Installation

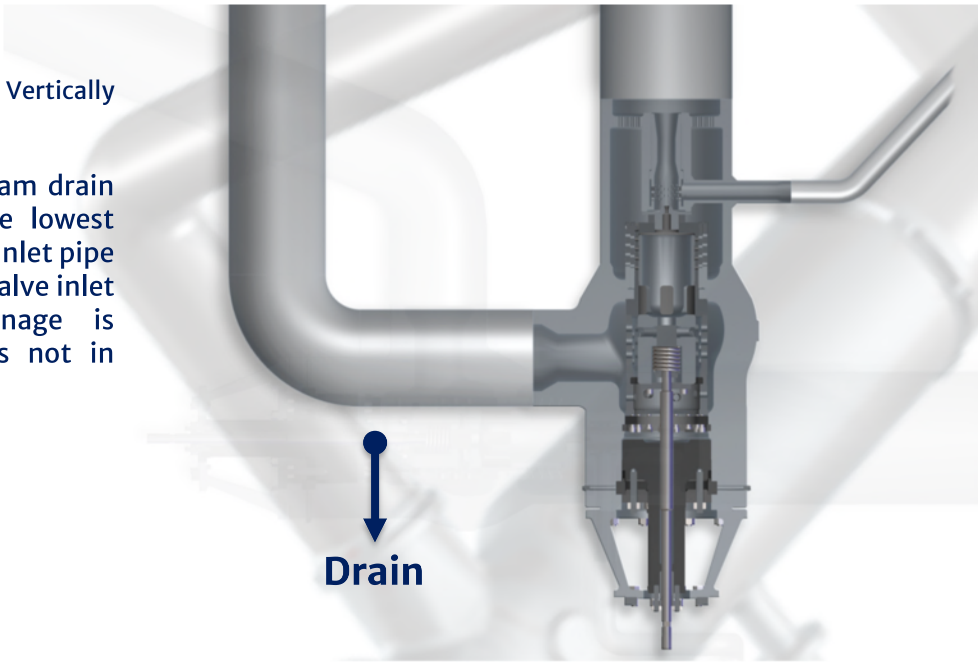
(
Vertical Inlet, Outlet Horizontal)

In this orientation it is recommended that the valve body be provided with an integral body drain connection point (drain system by others). This is because the inlet of the valve body is the lowest point in the piping system and will cause natural drainage into the valve inlet. Care must be taken to ensure any condensate formed and collected in the valve body in this orientation can be suitably removed prior to operation of the valve.



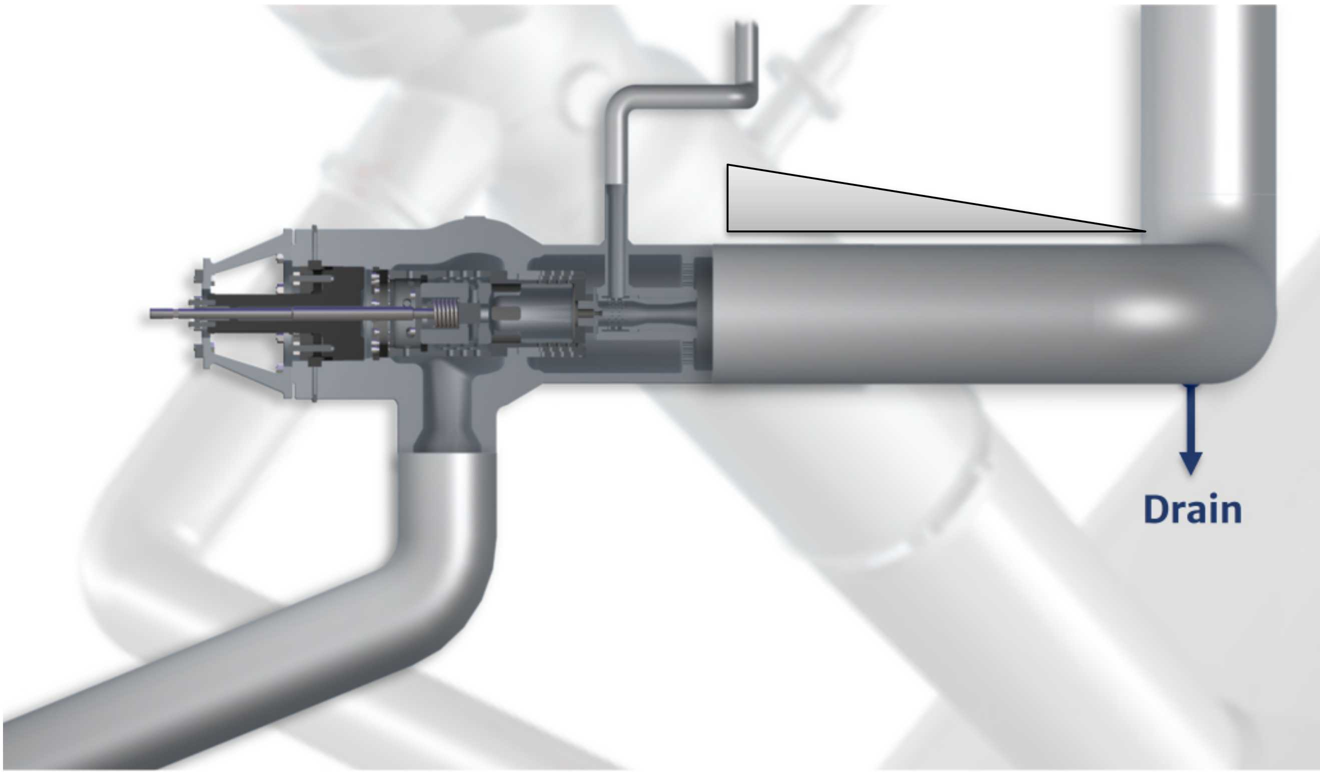
Vertical Installation
(Horizontal Inlet, Outlet Vertically Upwards)

In this orientation an upstream drain should be positioned at the lowest point of the inlet piping. The inlet pipe should slope away from the valve inlet to ensure sufficient drainage is achieved when the valve is not in operation.



This orientation of installation is NOT RECOMMENDED due to difficulties caused in suitable drain provision and difficulties in executing maintenance operations

Outlet Drain Locations



The drain should be positioned at the LOWEST point in the piping after the valve. It is recommended NOT to make the valve the lowest point to avoid accumulation issues. The slope to outlet drain should never be less than 100:1

VALVE WARMING

Preheating of the Steam Conditioning valve is not always necessary and depends on the nature of the application and the intended installation.

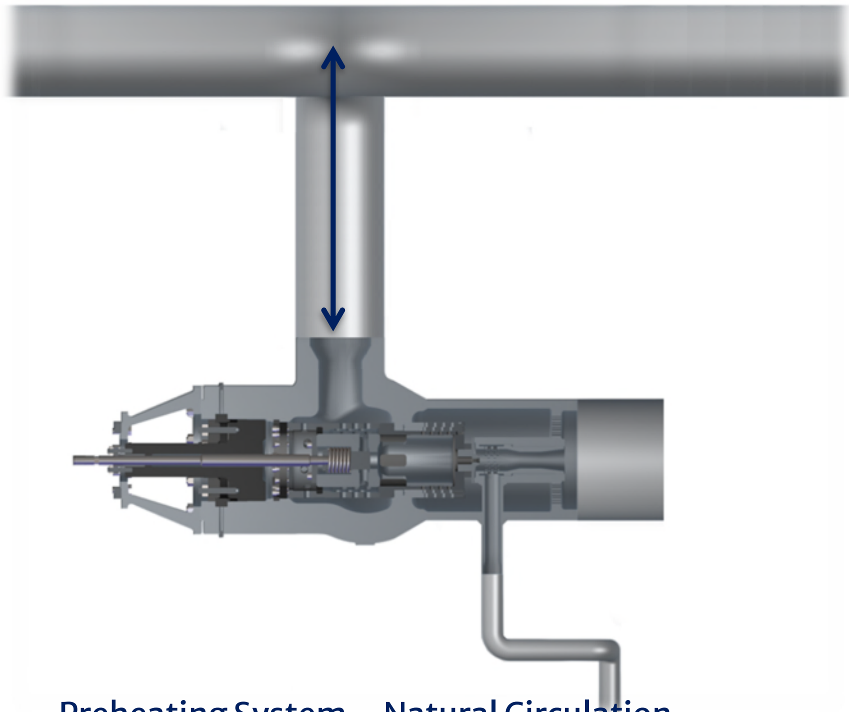
Preheating of the Steam Conditioning valve ensures metal temperatures are kept elevated and reduces:

- Condensate formation within the valve and piping system
- Thermal shock of the valve body and trim components (on high temperature applications)

There are many types of preheating system that can be utilised and the selection is generally based upon

- Creating a system that provides sufficient preheat and drainage
- Minimizing the system energy loss when utilising preheating steam
- Is the installation indoors or outdoors
- The Temperature difference at the outside of the insulation and the ambient temperature
- The Distance between the valve and the live steam line

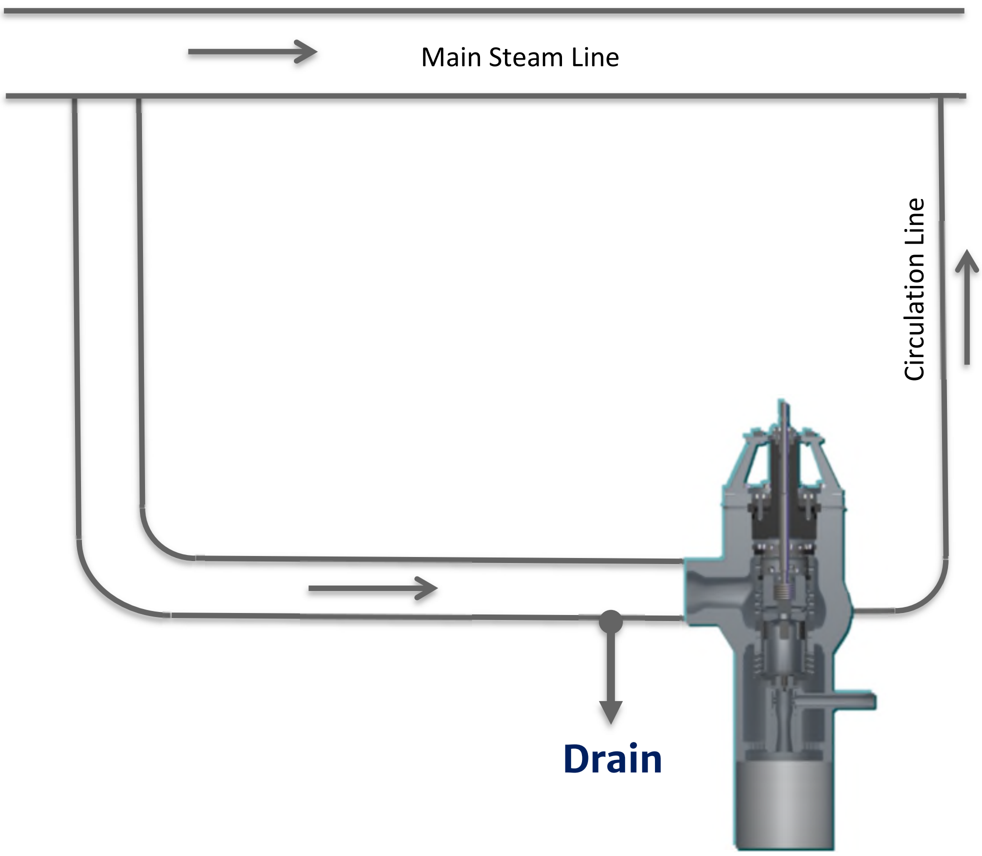
Preheating System examples



Generally in this installation additional preheating would not be required providing that the distance between the valve inlet connection and steam header is kept to a short distance.

Note that in this orientation an integral valve body drain would also be recommended.

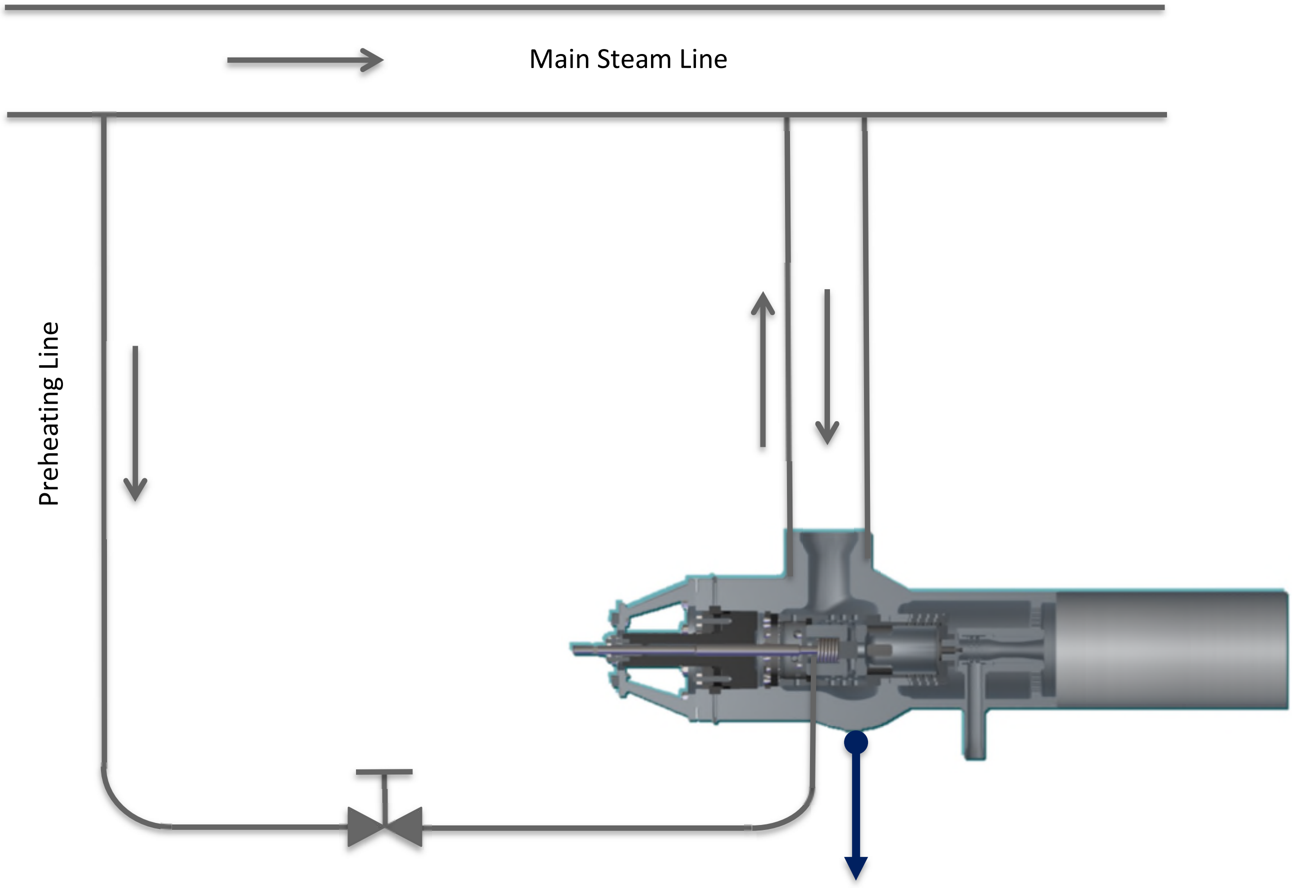
Preheating System – Natural Circulation



Bypass valve with a natural circulation system. The circulation pipe must be insulated to maintain thermal efficiency.

The DSCV-SA valve is provided with a preheating connection stub on the high pressure inlet side of the valve for connection to the circulation line at site (by others)

Preheating System – Balanced Pressure Drop

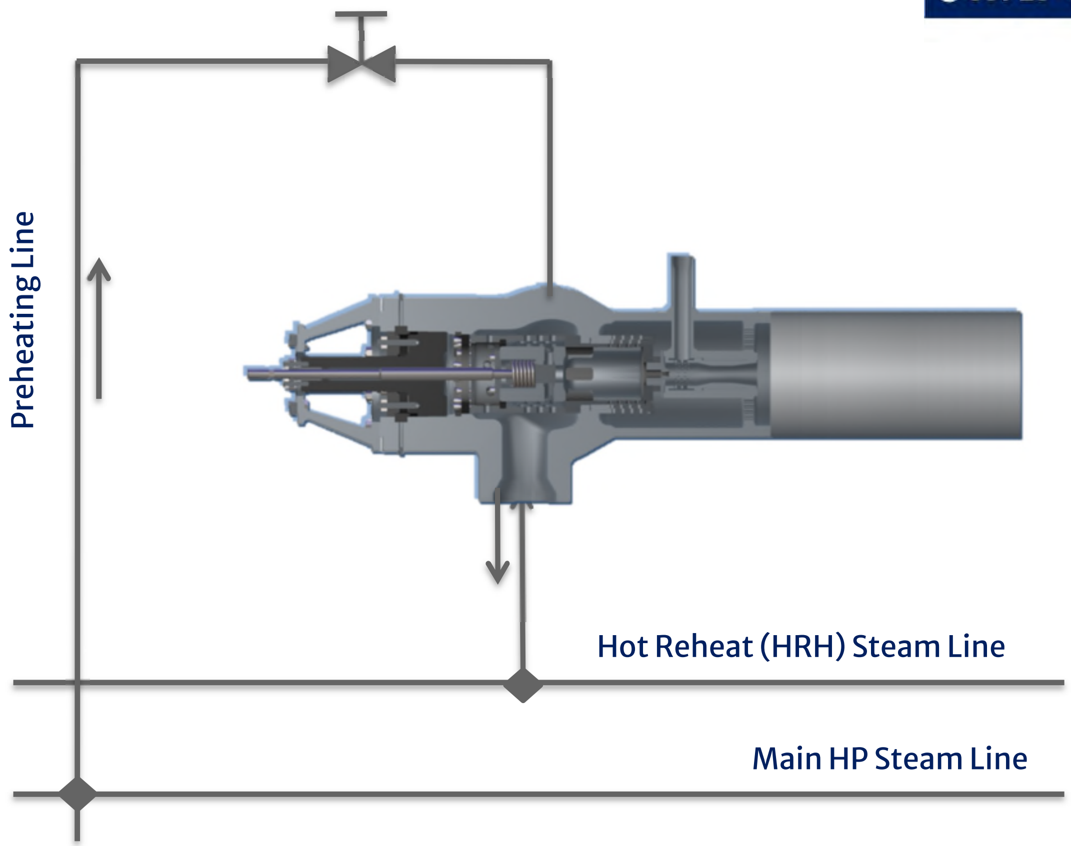


This method is the most energy efficient installation as little system heat loss is experience. This system does require a suitable design to ensure anticipated pressure drop between the preheating line take off and the subsequent inlet connection return.

With a suitable system design it should be possible to have a sufficiently large flow of steam through the system to keep the valve body and inlet piping at a suitable temperature and subsequently free of water.

The DSCV-SA valve is provided with a preheating connection stub on the high pressure inlet side of the valve for connection to the circulation line at site (by others)

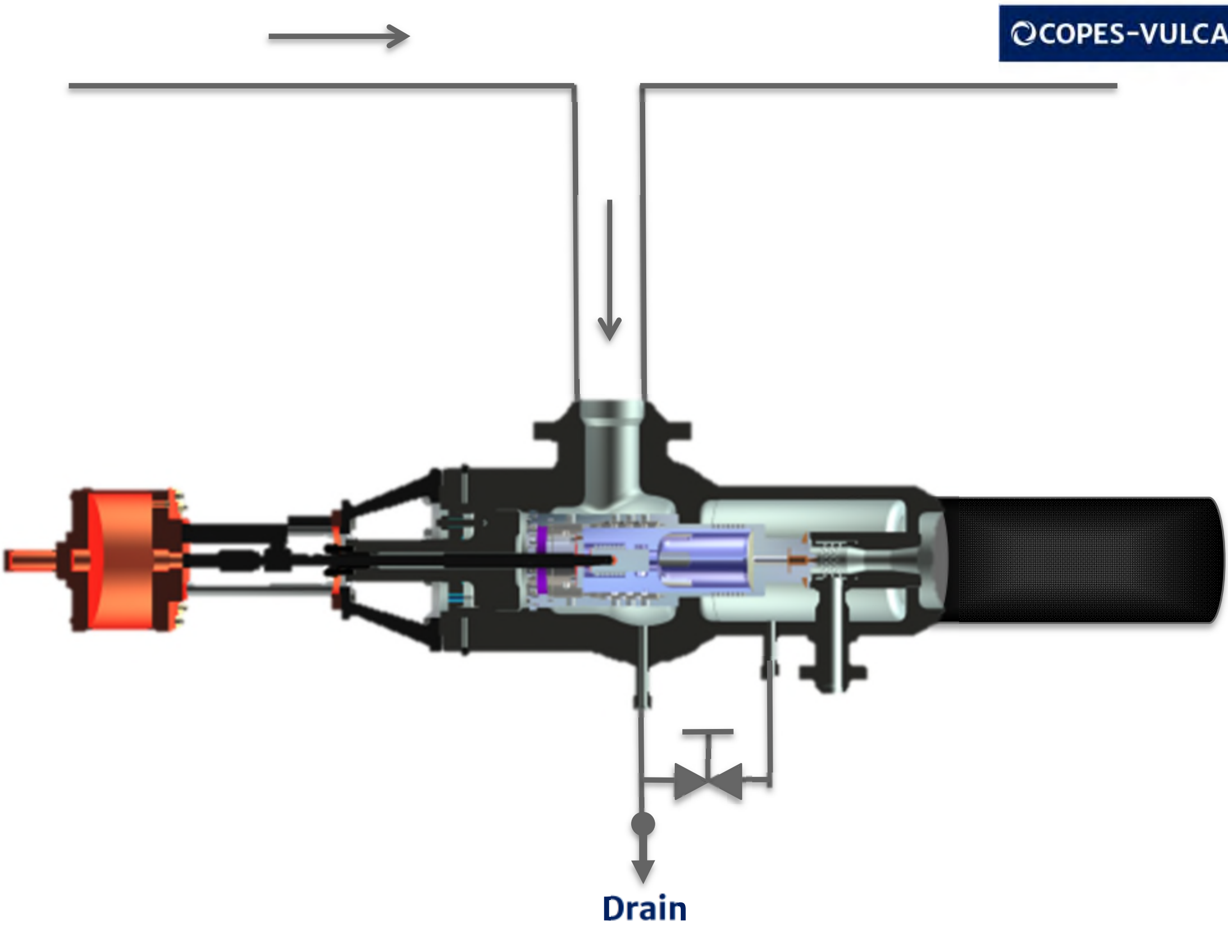
Preheating System – Utilising a Higher Pressure Steam Source



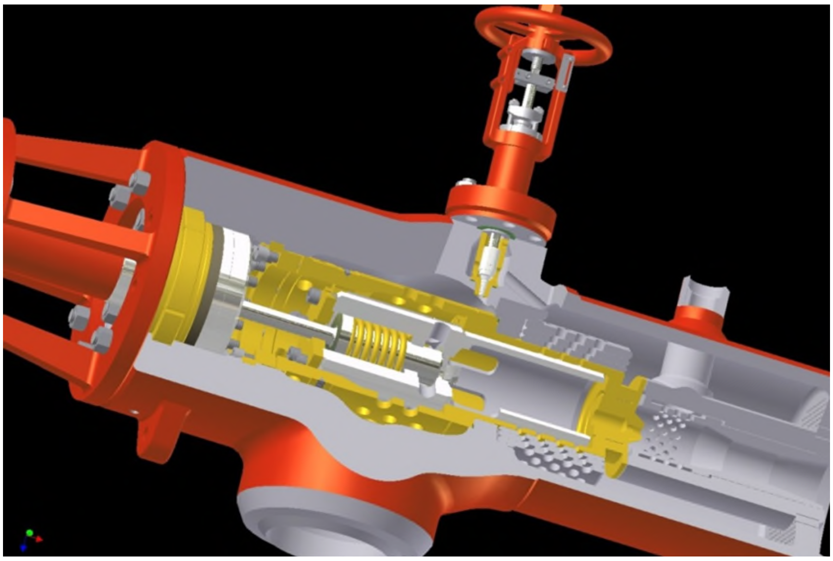
This method can be energy efficient however it can substantially increase the amount of piping required to complete the preheating line. Again, the DSCV-SA valve is provided with a preheating connection stub on the high pressure inlet side of the valve for connection to the circulation line at site (by others)

Preheating System – Upstream and Downstream Preheating

Main Steam Line



This method is the most common and usually easiest way of preheating the upstream piping leg. A preheating flow passes from the high pressure inlet to the lower pressure outlet via either an external restriction device or via an integrally mounted warming valve (as shown below).



DSCV-SA

FAQs – 20: INSTALLATION
Materials and Pipe Class Transitions?

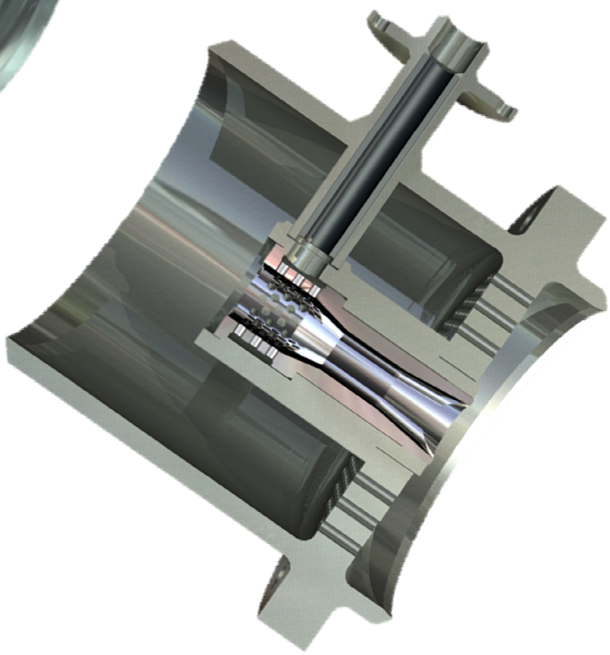
The Function of the DSCV-SA is to pressure reduce and desuperheat the inlet steam to a lower pressure, lower temperature condition at the outlet. This provides the piping designer with an ideal point at which to transition the piping class and piping material which are suitable for the downstream (outlet) conditions.

The DSCV-SA is an ideal point at which to make these transitions and due to the construction method employed within the DSCV-SA philosophy this requirement can easily be accommodated.

The DSCV-SA comprises of a high pressure inlet section, which is usually constructed from a casting.

The low(er) pressure outlet section is constructed from a fabrication (cone) and a forging (Outlet connection & Diffuser plate (where fitted) that incorporates the steam atomising desuperheater and water branch connections.

These two components are welded together using an ASME VIII compliant full penetration butt weld.



The high pressure inlet section is isolated from the lower pressure downstream section at the valve web and trim's seating point. At the connection between the two components provides an ideal point at which to make a pressure rating transition and, where possible, a material transition.

Inlet Connections

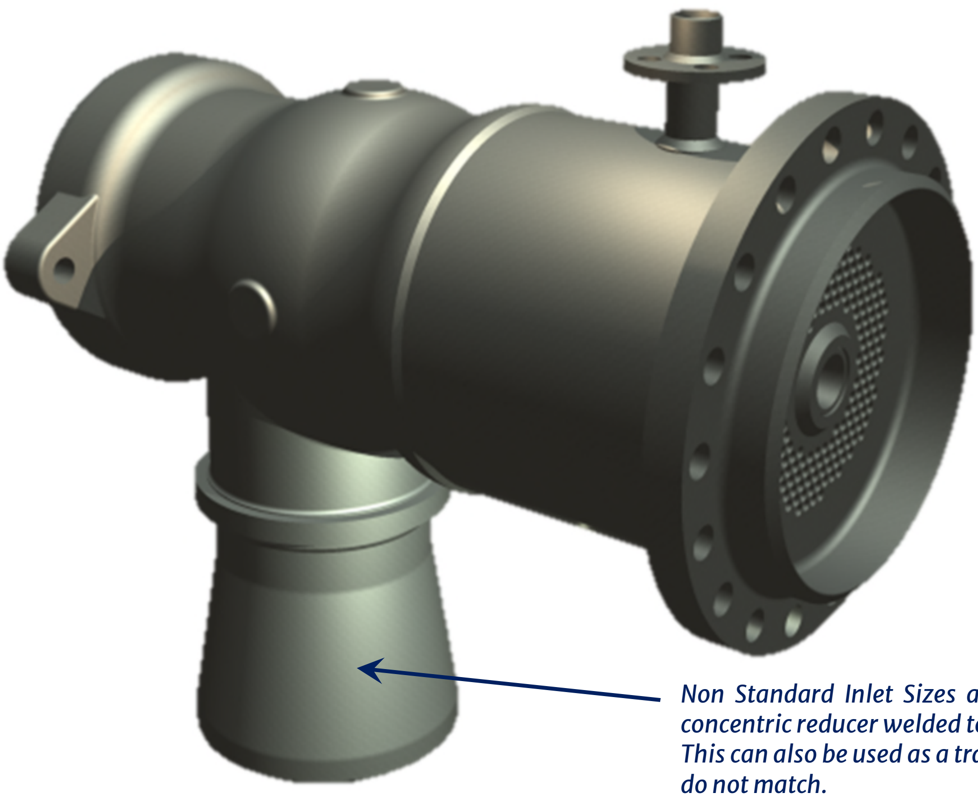
The inlet connection to the DSCV-SA is usually matched to the inlet pipework in terms of:

- Inlet Piping Size
- Inlet Piping Schedule
- Inlet Piping Material

The DSCV-SA is provided with a range of standard available inlet connection sizes based upon the DSCV-SA model size employed. The Table below indicates standard available sizes

DSCV-SA Body Size	0	1	2	3	4	5	6
Available Inlet Connection Sizes (Standard)	4” (DN100)	6” (DN150)	8” (DN200)	10” (DN250)	12” (DN300)	16” (DN400)	On Application
	6” (DN150)	8” (DN200)	10” (DN250)	12” (DN300)	14” (DN350)	18” (DN450)	
	8” (DN200)	10” (DN250)	12” (DN300)	14” (DN350)	16” (DN400)	20” (DN500)	
				16” (DN400)	18” (DN450)	22” (DN550)	
					20” (DN500)	24” (DN600)	

Where an available standard connection size does not match the customer’s inlet pipework size a standard concentric reducer can be incorporated onto the inlet connection as shown below



Non Standard Inlet Sizes are accomplished with the use of a concentric reducer welded to the inlet
This can also be used as a transition piece IF body / pipe material do not match.

Outlet Connections

Due to method of construction, the DSCV-SA can be provided with a virtually infinite range of outlet connection sizes, ratings and materials to suit any particular application. Downstream pipe size and schedules are usually matched to the customer pipework requirements, and where possible the outlet material will be matched to the customer pipework.

In determining the suitability of outlet connection materials and ratings we need to consider a number of parameters, not only what the customer's pipework requirements are.

Firstly, we must determine the outlet steam temperature due to an isentropic temperature reduction as the steam is pressure reduced from inlet conditions to outlet conditions. In this scenario the enthalpy values from inlet to outlet remain the same and as such no addition of cooling water is taken into account to ensure that should the cooling water supply fail for any reason, the selected outlet valve materials will be suitable for the anticipated temperatures. This calculation is performed on the customer provided design parameters (pressure and temperature) to ensure worst case scenario.

The following is a worked example:

Inlet Design Pressure : 110 bar.a (1595 PSIA) (Information provided by the Customer)
Inlet Design Temperature : 540 deg C (1004^{0}F) (Information provided by the Customer)

Outlet Pressure : 25 bar.a (363 PSIA) (control set point) (Information provided by the Customer)
Outlet Design Pressure : 30 bar.a (435 PSIA) (Information provided by the Customer)
Outlet Temperature : 330 deg C (626^{0}F) (Information provided by the Customer)

Based upon the inlet design parameters the valve inlet rating (ASME B16.34) will be:

ASTM A216-WCB - Inlet Design Temperature Exceeds the maximum limit for this material
ASTM A217-WC6 - Inlet Design Temperature Exceeds the maximum limit for this material
ASTM A217-WC9 - ANSI 2500 Standard Class
ASTM A217-C12A - ANSI 1500 Standard Class

Hence depending on the customer's inlet piping material either an ASTM A217-WC9 or an ASTM A217-C12A material is suitable for the inlet design parameters.

Based upon the customers provided OUTLET design parameters, we can determine the anticipated outlet rating (ASME B16.34) and material suitability. The outlet connection of the DSCV-SA is a forged material, hence the appropriate materials have been specified:

ASTM A105 - ANSI 300 Standard Class
ASTM A182-F11 - ANSI 300 Standard Class
ASTM A182-F22 - ANSI 300 Standard Class
ASTM A182-F91 - ANSI 300 Standard Class

As can be seen, all available outlet materials 'seem' to be suitable based upon the customer provided outlet design conditions.

However, let's determine what the steam temperature at the outlet of the DSCV-SA will actually be should the coolant supply fail. We can easily calculate this temperature based upon and Isentropic temperature reduction where steam enthalpy remains constant.

Inlet Design Pressure : 110 bar.a (1595 PSIA)
Inlet Design Temperature : 540 deg C (1004⁰F) Inlet Design Enthalpy: 3466.4 kJ/kg

Outlet Design Pressure : 30 bar.a (435 PSIA)
Resultant Outlet Temperature: TBA deg C Outlet Design Enthalpy: 3466.4 kJ/kg

Assuming that the steam enthalpy value remains constant from valve inlet to valve outlet, this would result in a steam temperature of 504.09 deg C (939⁰F) being experienced at the outlet connection of the valve should the cooling water supply fail. In this instance, we can recalculate the required ASME B16.34 pressure class and ascertain the material suitability

Outlet Design Pressure : 30 bar.a (435 PSIA)
Resultant Outlet Temperature: 504.09 deg C (939⁰F)

ASTM A105 - Inlet Design Temperature exceeds the maximum limit for this material
ASTM A182-F11 - ANSI 600 Standard Class
ASTM A182-F22 - ANSI 600 Standard Class
ASTM A182-F91 - ANSI 600 Standard Class

As can be seen, this re-calculation exceeds the rating previously determined based upon the customer's provided outlet design parameters. Due to the expected temperature at the outlet, ASTM A105 is now not a valid option.

Where, based upon the above calculation routine which is incorporated into our sizing calculations, it is not advisable to comply with a customer specified outlet rating and or material, we shall advise accordingly.

Where further piping material transitions are anticipated after the valve installation (for example a ASTM A335-P11 to ASTM A106 GrB transition based upon the final achieved outlet steam temperature) we would recommend that the alloy piping material be maintained for a minimum distance after the valve outlet to allow the desuperheating process to fully occur. Generally this would be in the range of 5 – 10 meters (16 – 33 feet) after the valve outlet and is dependent upon a number of factors. Further guidance on individual cases can be sought from the Copes-Vulcan team.

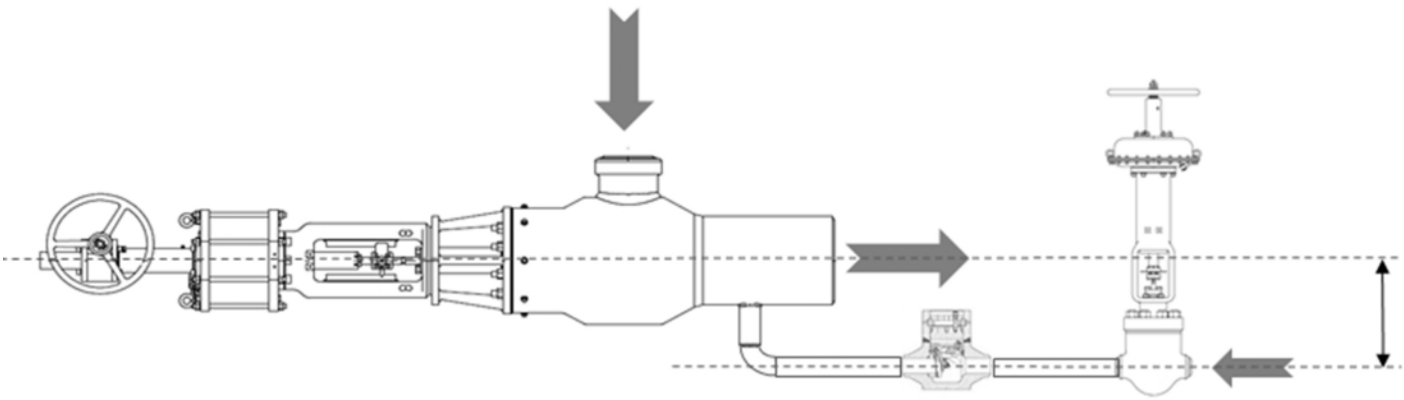
DSCV-SA

FAQs – 21: INSTALLATION

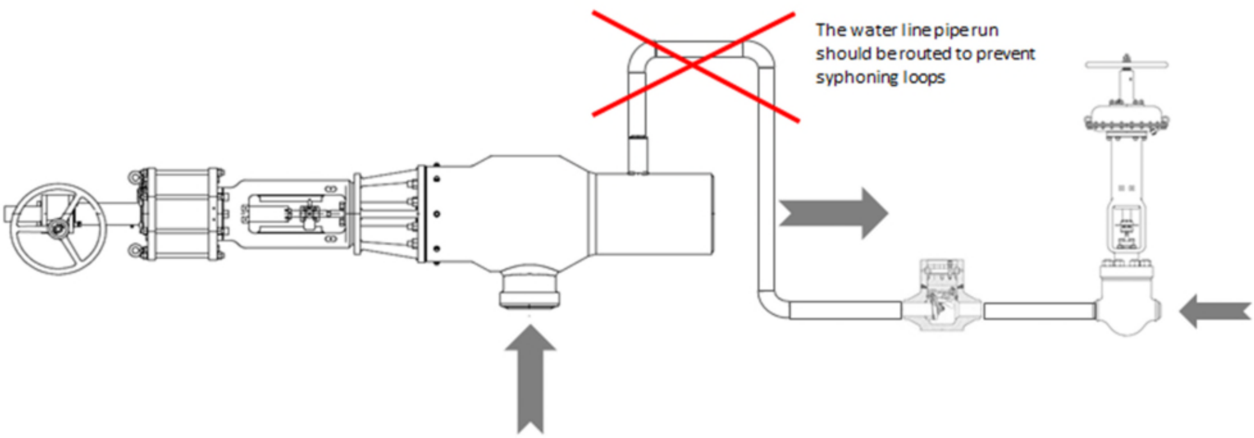
Where to position the cooling water valve?

The temperature (water) control valve should be located relatively close to the DSCV-SA bypass valve to prevent system lag. The temperature control valve should also be positioned taking into consideration access for maintenance. Below are some general guidelines for the positioning and integration of the temperature control valve:

1. It is common practice to have the temperature control valve to be within 10 meters (33 feet) of the water connection of the DSCV-SA steam bypass valve. This prevents large volumes of water between the temperature control valve outlet and the DSCV-SA steam turbine bypass valve.
2. If possible the temperature control valve should be positioned at a lower elevation that the DSCV-SA bypass valve to prevent draining of water into the DSCV-SA bypass valve.

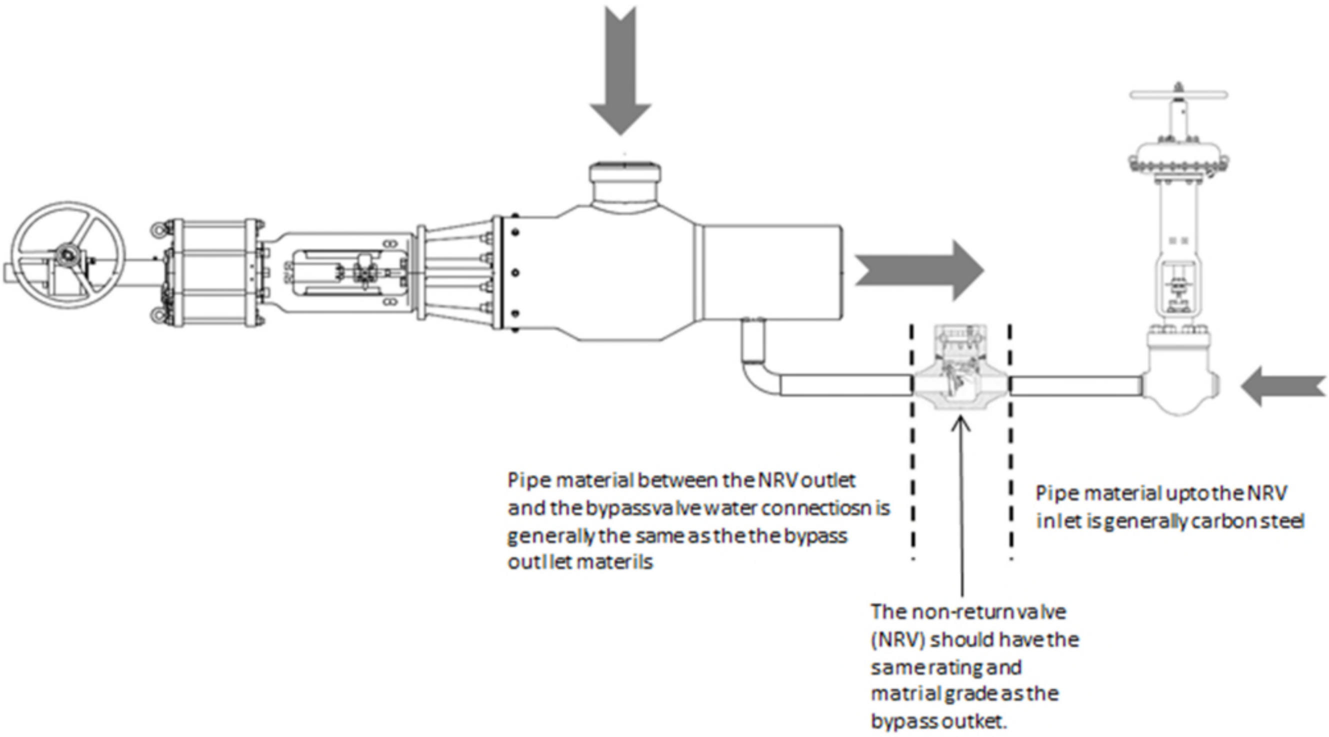


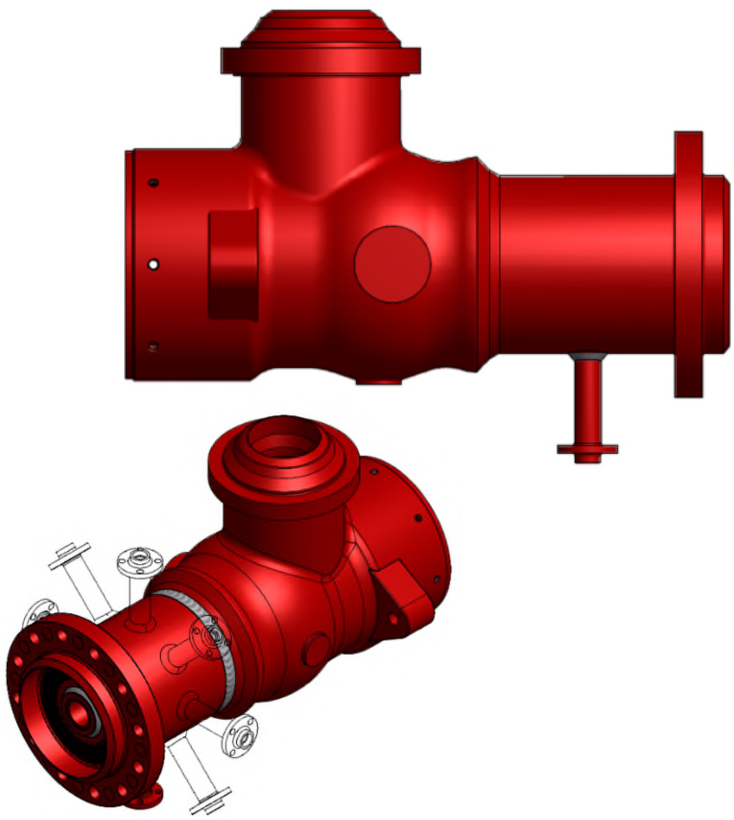
3. The cooling water pipe run after the temperature control valve should be routed so that there are no syphoning loops created.



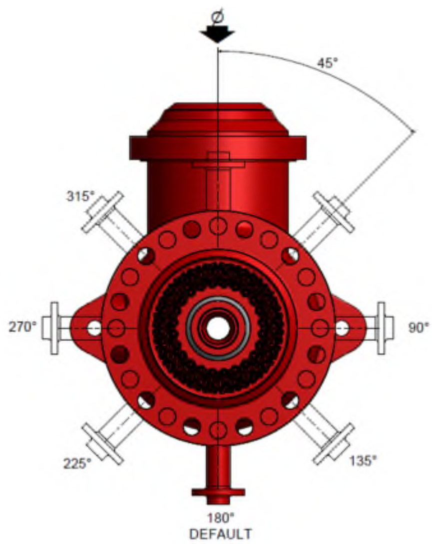
4. It is recommended to fit a non return valve between the temperature control valve outlet and the water connection of the DSCV-SA turbine bypass valve. This ensures that if there is a problem with the cooling water supply when the bypass valve opens no high temperature steam travels down the water line.
5. The non-return valve inlet connection is an ideal point to transition the water piping material grade. Normally the cooling water pipe up to the non-return valve inlet is carbon steel. The non-return valve and the water pipe between the NRV outlet to the bypass water connection is of the same rating and material as the bypass valve outlet.

The DSCV-SA can be supplied with water connection in any orientation relative to the steam inlet connection. In the absence of any information or direction from the customer the water connection will be orientated at 180 degrees from the steam inlet as the standard default position.





Water connection shown in its default position.



DSCV-SA

FAQs – 22: INSTALLATION

Are Hydro and Steam Blowing Trims Available?

YES! On major new build constructions or when major modifications are undertaken at an existing site, the process of cutting, preparing and welding of new pipes or equipment produces the possibility of entrapping debris into a piping system.

If this debris is not properly addressed and removed from the system it can cause significant damage to Turbine Bypass valve trim components, causing not only improper operation of the valve and subsequently the plant, but also increased maintenance, repair and even replacement of severely damaged trim components.

The best time to resolve this issue is during the construction and commissioning phase.

To avoid any problems with debris the best and most common solution is to flush the line with steam during the construction / commissioning stage.

The route for this steam flushing (or blowing as it is generally referred) is generally dependant on the piping installation and can be either:

- Blow Through, or
- Blow Out

Any Steam blowing through (or out) of Turbine Bypass valves requires the use of special equipment. Blow through valve trims allow the flow of flushing steam and debris to pass through the valve body without damaging important gasket surfaces and is removed further downstream, blow out valve trims provide a temporary pipe connection, to which a dedicated flushing line is attached. This vents the flushing steam through the valve bonnet and is usually directed towards a target plate, this being used to verify the cleanliness of the system.

Steam blowing is usually performed at lower pressures than those experienced during normal system operation. The flow rate of flushing steam used during this operation should result in a slightly higher dynamic pressure than that experienced during normal system operation. This ensures that any debris contained within the system can be transported by the steam and removed.

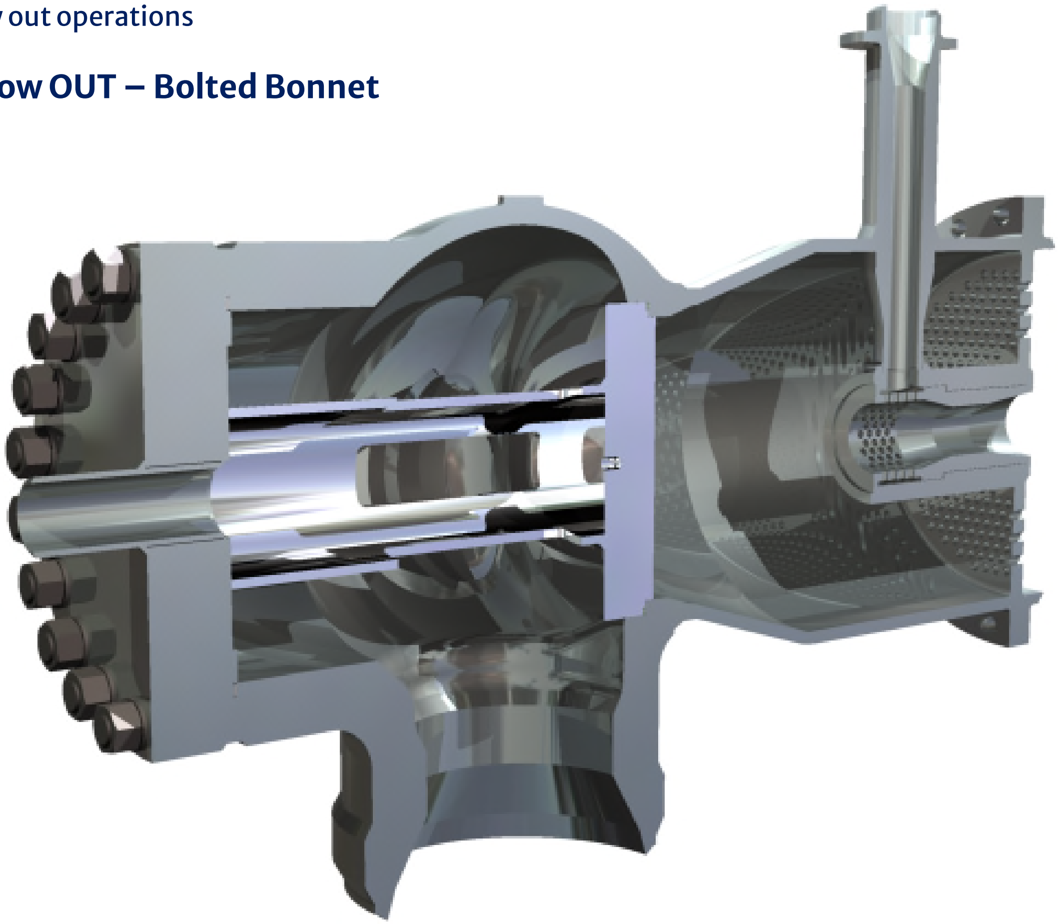
To assist this operation, specialised steam blowing trims can be provided by Copes-Vulcan.

Steam Blowing Trims – Blow OUT

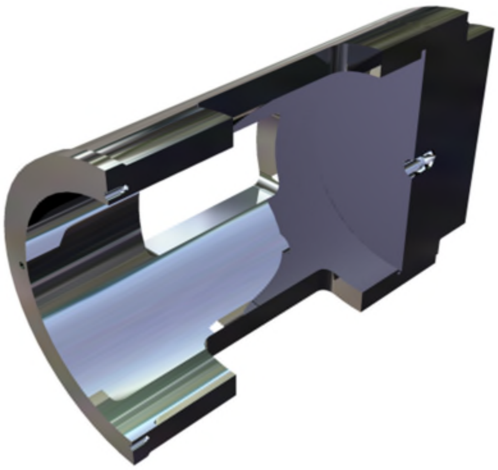
To protect the operational valve trim from this process it is recommend that the trim be removed and replaced by a specialised trim designed for the application. The type of equipment needed will be dependent on the system configuration and how the steam blowing is to be performed.

Depending on the bonnet style employed (Bolted or Pressure Seal) determines the components required for steam blow out operations

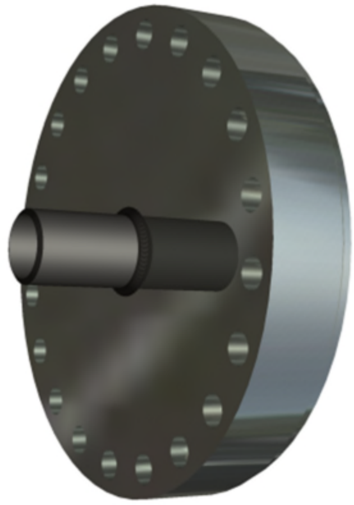
Steam Blow OUT – Bolted Bonnet



Steam Blow OUT (Bolted Bonnet) - Components
(Soft Spares – Gaskets & Gland Packing are also required)

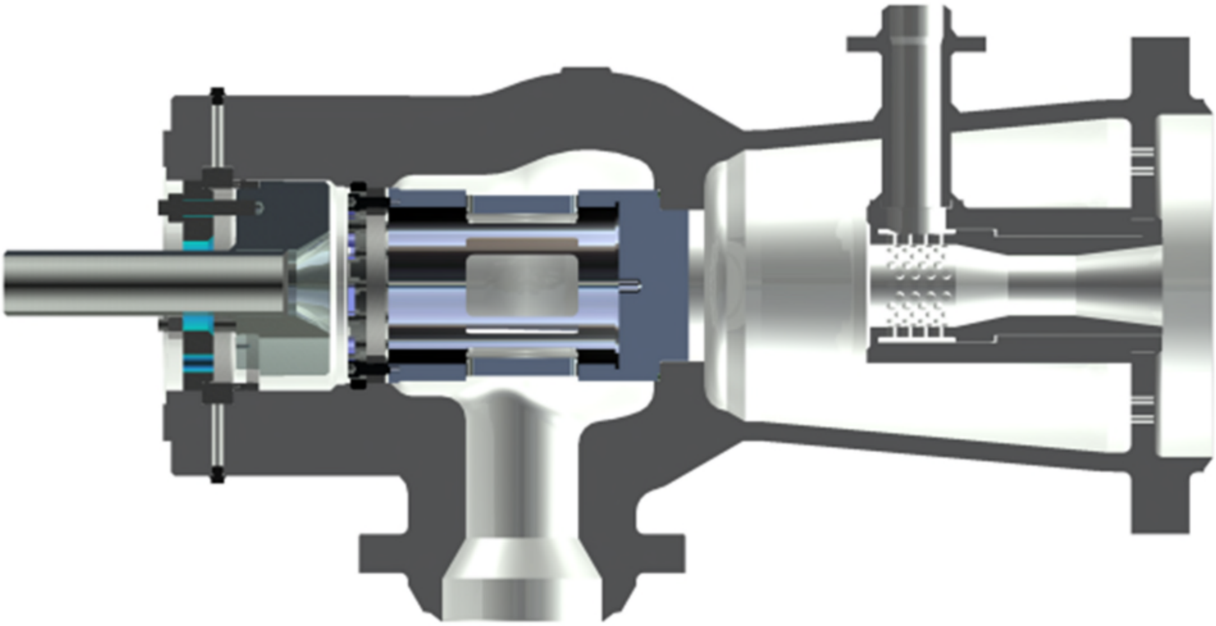


Steam Blow OUT Trim Insert



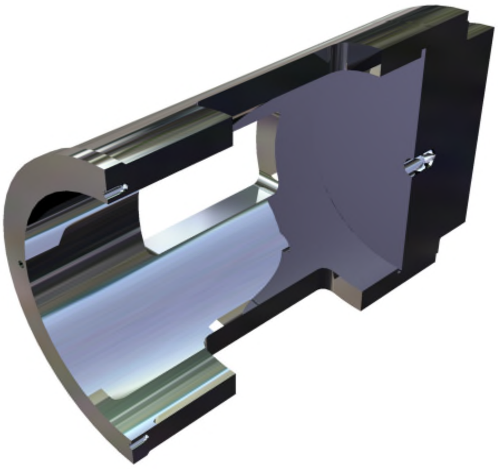
Steam Blow OUT Bonnet

Steam Blow OUT – Pressure Sealed Bonnet

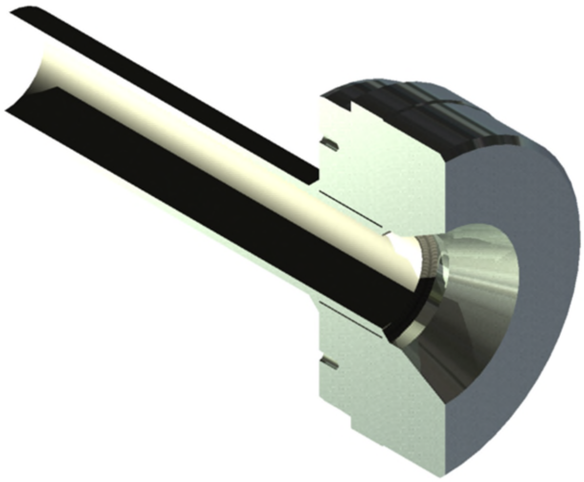


Steam Blow OUT (Pressure Sealed Bonnet) - Components

(Soft Spares – Pressure Seal Ring, Trim Gasket and Gland Packing are also required)



Steam Blow OUT Trim Insert

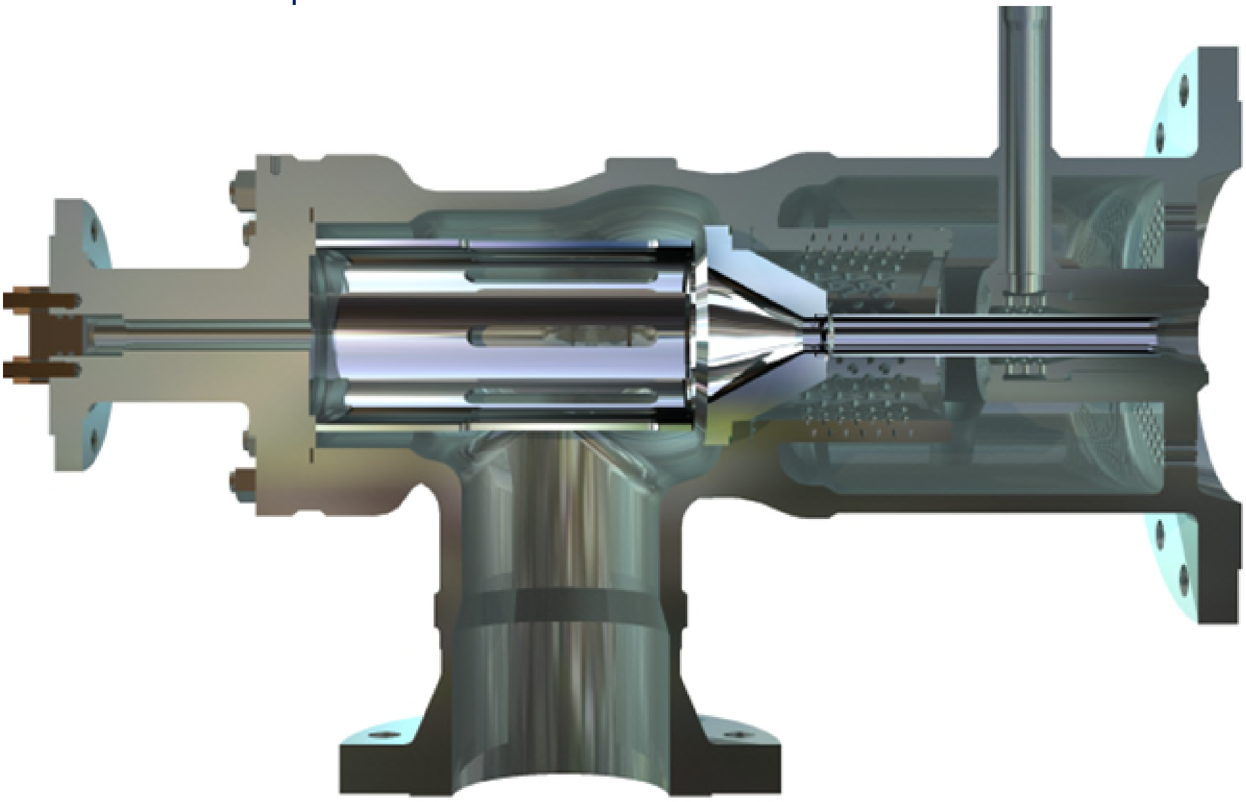


Steam Blow OUT Bonnet

Steam Blow THROUGH – Bolted or Pressure Sealed Bonnet

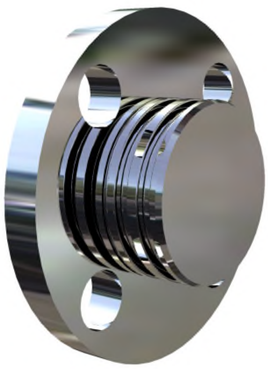
An additional option is to blow "through" the DSCV-SA into the downstream pipework. In some installations this may be beneficial to the system, however at some point in the downstream pipework provision should be made to ensure suitable removal of any entrained debris collected during steam blowing operations. Steam blowing flow can only be performed over the web. The trim is designed to isolate all critical internal components during steam blowing operations to ensure debris does not become trapped within the valve body or trim assembly.

The Large ports incorporated into the design allows for any entrained debris to pass through the valve and onto the final blow out point.



Steam Blow THROUGH – Components
(Soft Spares – Pressure Seal Ring OR Bonnet Gasket, Trim Gasket and Gland Packing are also required)

Steam Blow THROUGH Trim Insert



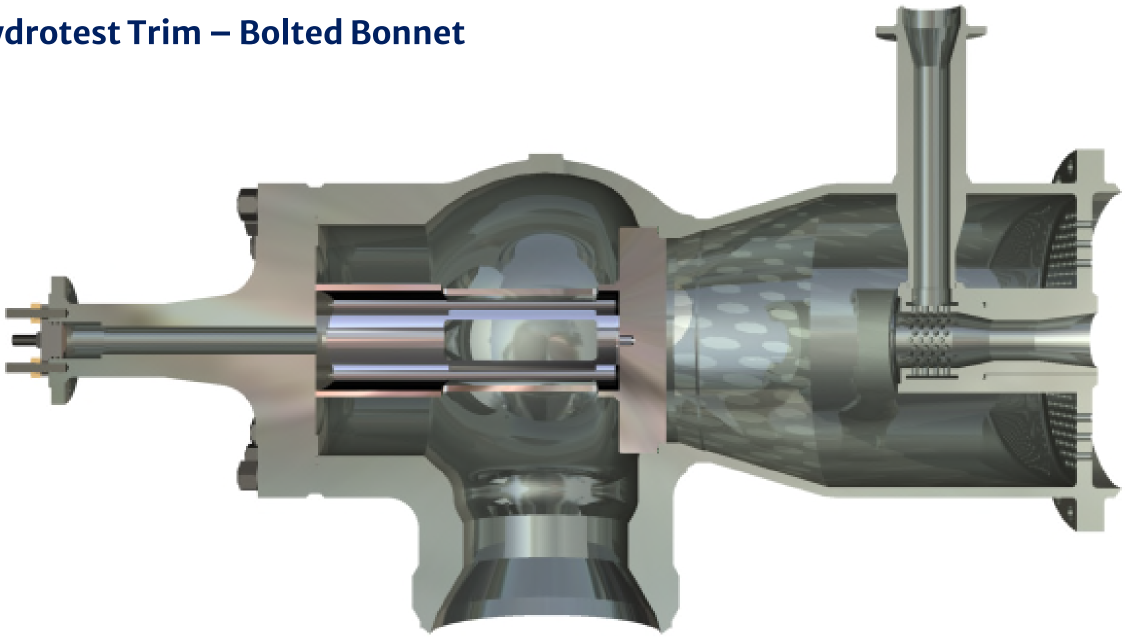
Gland 'Bung'

HYDROTEST TRIMS

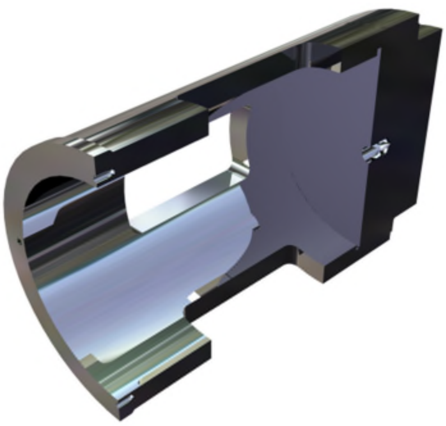
It is a common misconception that whilst performing a piping system hydrostatic test that the Turbine Bypass valve can be used as an end of line shut off. It should be noted that using a Turbine Bypass valve in this way is not recommended practice as these are generally split rated units with the outlet side of the valve being a much lower rating than the inlet. By applying system hydrostatic test pressure onto a valve trim in the wrong direction can also cause permanent mechanical damage to the valve stem, balancing arrangement and in extreme cases the valve actuator. For this reason, Copes-Vulcan can assist by providing a dedicated bi-directional hydrostatic test trim.

The hydrostatic test trim utilises the trim insert component from the steam blow “out” trim to reduce the overall quantity and cost of the parts. With the steam blow “out” trim inserted, the operational valve bonnet is used with the gland packing arrangement removed and a special gland bung being inserted into the gland area and held in place with the gland bridge. If a steam blow out trim has been purchased, the only additional component that is required to allow hydrostatic testing to be performed is the dedicated gland bung.

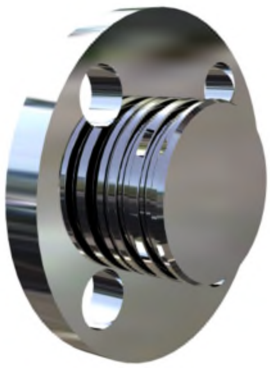
Hydrotest Trim – Bolted Bonnet



Hydrotest Trim (Bolted Bonnet) - Components
(Soft Spares – Gaskets & Gland Packing are also required)

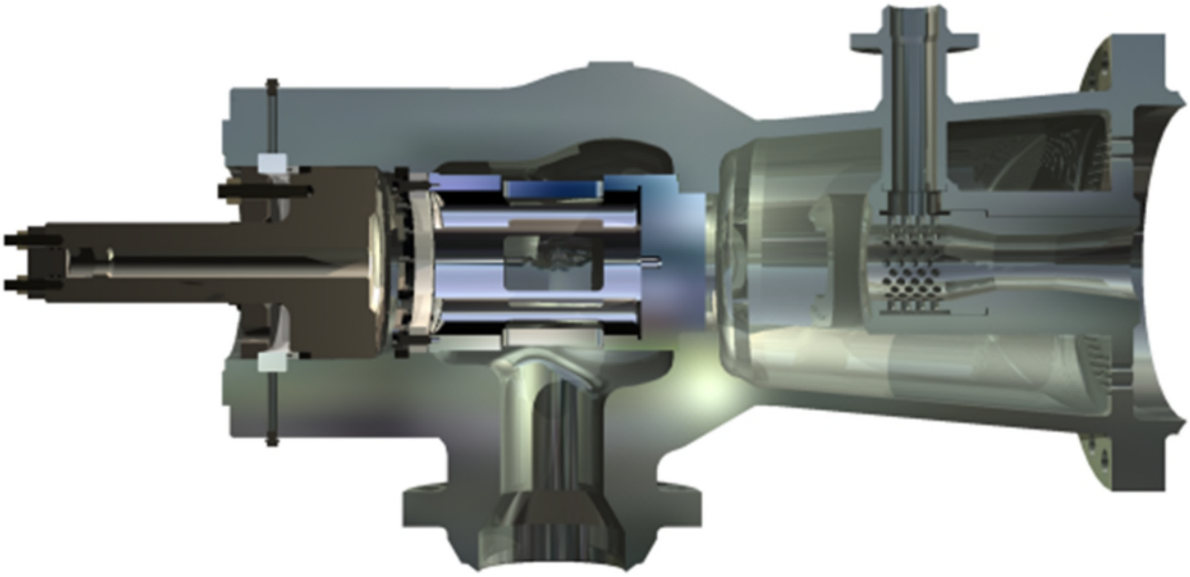


Steam Blow OUT Trim Insert
(Already Available IF Blow Out Trim Components have been Purchased)

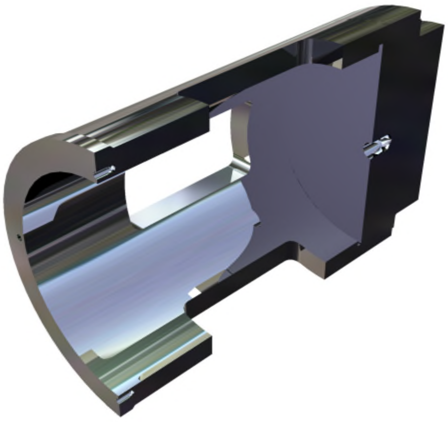


Gland Bung

Hydrotest Trim – Pressure Sealed Bonnet



Hydrotest Trim (Pressure Sealed Bonnet) - Components
(Soft Spares – Pressure Seal Ring, Trim Gasket and Gland Packing are also required)



Steam Blow OUT Trim Insert
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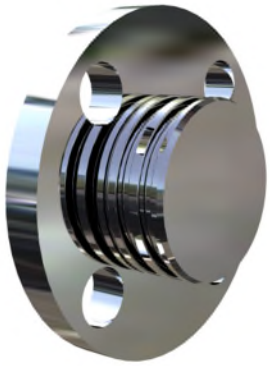


Gland Bung

DSCV-SA

FAQs – 23: INSTALLATION
Are Control Algorithms Available?

YES, and can be supplied as part of the contract documentation.

The aim of this document is to outline the various control options and algorithms that are available.

Steam Turbine Bypass to Condenser

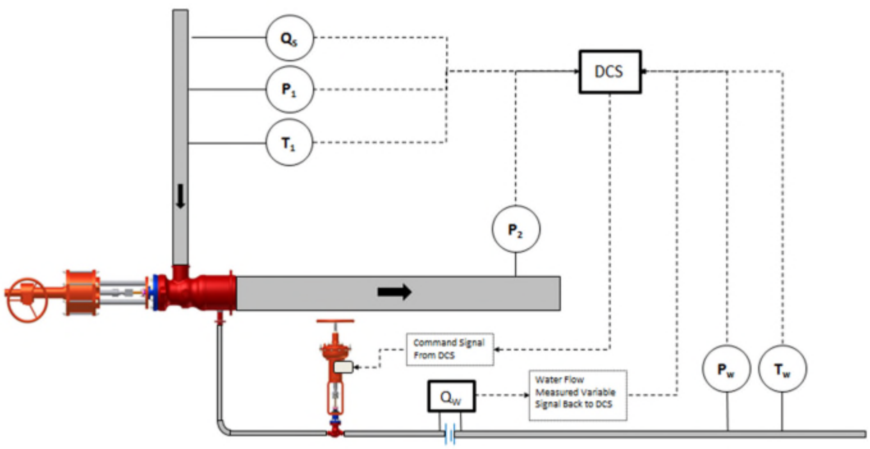
For bypass systems that dump directly to condenser via a dump tube it is often the case that the final steam temperature or required enthalpy dictates that the steam is at or very close to saturation temperature. This prevents the use of standard closed loop temperature control due to instrumentation accuracy, full evaporation of the water cannot be achieved due to relatively short pipe runs and rapid steam velocities or the final enthalpy target results in steam with a dryness fraction <1.0. In these cases then a feed-forward enthalpy control algorithm is recommended. The feed-forward enthalpy control algorithm is similar for all applications but can me modified depending on the available field inputs and measured variables. This FAQ shows typical algorithms.

The feed forward algorithm calculates the amount of cooling water required and the DCS positions the water control valve accordingly by process measured variables, calculated constants and/or variables.

In its simplest format the water flow rate is based on a standard heat balance calculation. The mass flow rate of cooling water required for any operating condition of the steam turbine bypass valve can be determined by;

$$W_c = W_1 \ x \left(\frac{h_1 - h_2}{h_2 - h_c}\right)$$

W_c = Water Mass Flow Rate (kg/hr) *[calculated]*
W_1 = Inlet Steam Mass Flow Rate (kg/hr) *[measured variable]*
h_1 = Inlet Steam Enthalpy (kj/kg) *[measured variable]*
h_2 = Outlet Steam Enthalpy (kj/kg) *[measured variable]*
h_w = Cooling Water Enthalpy (kj/kg) *[measured variable or can be a fixed constant*]*
** If the cooling water pressure and temperature is relatively stable then the enthalpy value can be fixed*



1. **h_1**: The measurement of the inlet steam pressure P_1 & temperature T_1 allows the DCS to determine the inlet steam enthalpy h_1 from steam tables.
2. **h_2**: Is either a fixed target value or can be a sliding value based on the measured downstream pressure P_2 with the DCS determining the enthalpy value from steam tables.
3. **h_w**: Can be a fixed value if the cooling water supply is relatively stable as pressure and temperature movements in cooling water only have a small effect on the water enthalpy. If the water pressure P_w and temperature T_w is a measured variable then the DCS can determine the water enthalpy from steam tables.
4. **Q_s**: The upstream (inlet) steam flow can be a measured variable from a steam flow meter and then given as an input into the DCS. Alternatively the steam turbine bypass valve lift versus Cv curve can be used to determine steam flow. Utilising the steam inlet measured values of pressure P_1 & temperature T_1 along with the downstream pressure P_2 and steam turbine bypass valve lift the steam flow can be determined from transposing the Cv calculation and a look up routine for the Cv versus lift curve.
5. **Q_w**: The required water flow rate can now be calculated by the simple heat balance calculation shown above. This calculated water flow rate is then compared to the water flow rate measured variable from the water flow meter and then the DCS positions the water control valve by constantly matching the calculated water flow rate to the measured variable water flow rate. Alternatively if a water flow meter is not available then the water control valve Cv versus lift curve can be used. By measuring the water pressure P_w and temperature P_t upstream of the water control valve and using the steam downstream pressure P_2 (with the DSCV-SA design steam P_2 pressure always equals the water valve P_2) the required water valve Cv can be calculated. Using the water control valve Cv versus lift curve the DCS can position the water valve accordingly.

It is often the case that a dedicated steam flow meter is not available to measure the inlet steam flow rate to the steam turbine bypass valve. If a dump tube (sparger) is employed as the final pressure drop device into the ACC duct or condenser neck then the dump tube can be used as a very effective method to measure the steam flow.

Calculating Steam Flow Rate to Determine Coolant Flow Rate

Using the Condenser Dump Tube (Sparger) to determine mass steam flow rate

In order to calculate the required water flow rate we utilise the fact that the total flow rate through the dump tube is a direct function of the pressure inside the dump tube (or within the section between DSCV-SA Valve outlet and Dump tube inlet). The *Total* flow through the dump tube is the combination of both superheated steam flow passing through the DSCV-SA Valve and the water flow used to cool this superheated steam.

We consider that the dump tube is a fixed restriction device allowing for isentropic flow through all of the individual flow paths of the dump tube. This hypotheses allows us to use a number of relations derived from the thermodynamic theory of isentropic flow to calculate the total steam flow rate as described below

Determine total steam flow rate passing through the dump tube

Calculated as a function of the dump tube pressure, we utilise the following formula

$$W_2 = 63.3 \; x \; F_p \; x \; C_v \; x \; Y \; x \sqrt{\frac{X \; x \; P1}{V1}}$$

Where:
W_2 = Total Steam Flow Rate (lb/hr)
Fp = Piping Geometry Factor (assumed as 1.0 if not calculated)
Y = Expansion Factor

$$Y = 1 - \frac{X}{3 \; x \; LimX}$$

Cv = Installed Dump Tube Cv
X = Pressure Drop Ratio Factor

$$X = \frac{P1 - P2}{P1}$$

When the value of X = LimX, LimX shall be used.

Where
P2 = Condenser Pressure (psi.a)

LimX = 0.753
P1 = Dump Tube Inlet Pressure *(psi.a - Measured Variable)*
V1 = Dump Tube Inlet Volume *(Determined from steam table by P1 and Target Condenser Enthalpy)*

Determine Water Flow Rate

Having previously calculated the total steam flow rate (W_2) at the dump tube we use the following equation to determine the desired cooling water flow

$$W_c = W_2 \ x \left(\frac{H_1 - H_2}{H_1 - H_c}\right)$$

H_1 = Measurement of the steam turbine bypass valve inlet temperature and inlet temperature will give the inlet enthalpy (H_1) via steam tables.

H_2 = The Condenser enthalpy (H_2) is the desired condition of the steam in the condenser

H_c = Measurement of the cooling water inlet pressure and inlet temperature will give the cooling water enthalpy (H_c). Alternatively, as the cooling water temperature is usually low, a fixed design point value can be used with minimal error.

To provide a degree of adjustability within the system the calculated coolant flow rate can be multiplied by an adjustable factor to either increase or decrease the calculated coolant flow rate depending upon site experience.

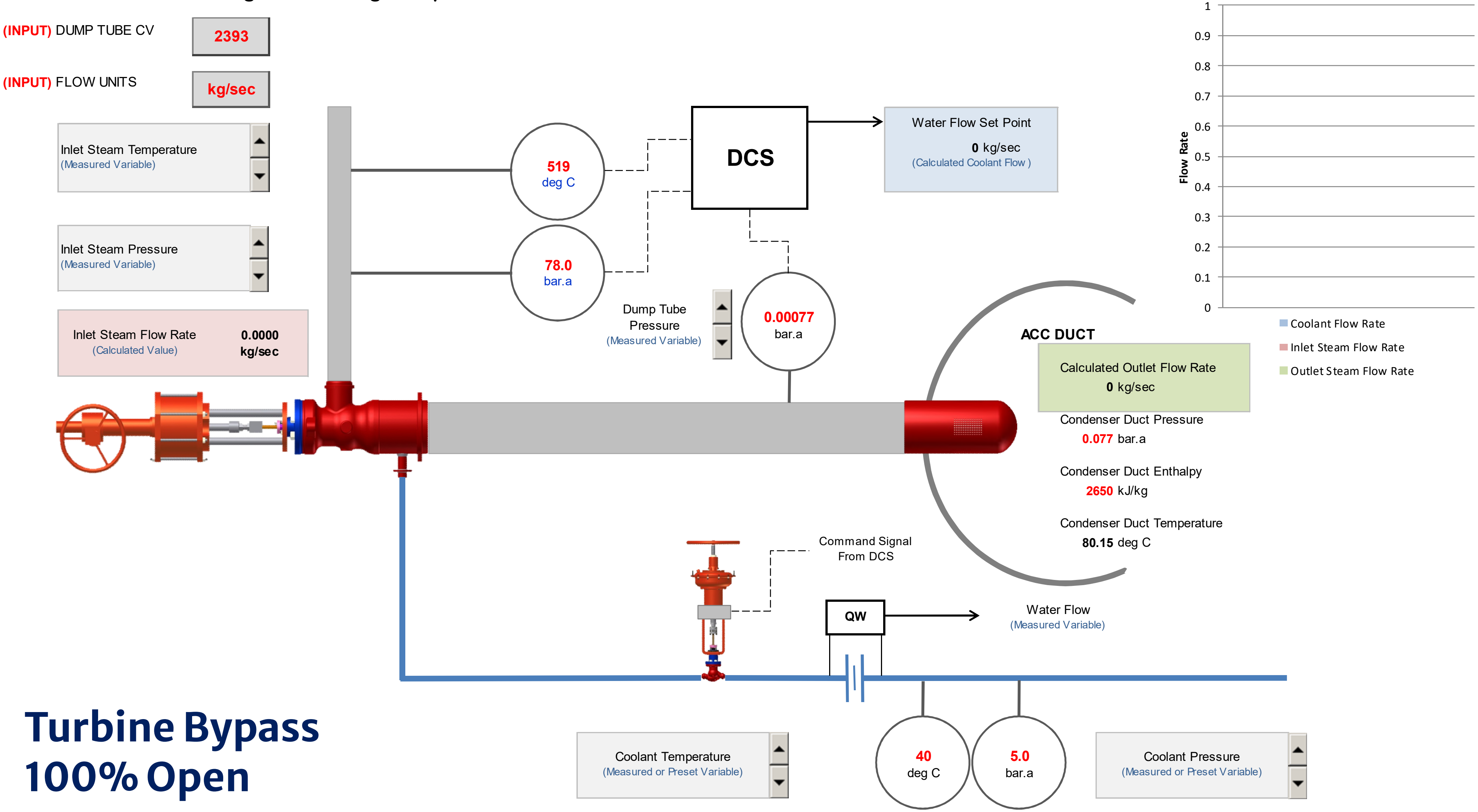
This calculated water flow rate is then compared to the water flow rate measured variable from the water flow meter and then the DCS positions the water control valve by constantly matching the calculated water flow rate to the measured variable water flow rate. Alternatively if a water flow meter is not available then the water control valve Cv versus lift curve can be used. By measuring the water pressure P_w and temperature P_t upstream of the water control valve and using the steam downstream (or dump tube) pressure P_2 (with the DSCV-SA design steam P_2 pressure always equals the water valve P_2) the required water valve Cv can be calculated. Using the water control valve Cv versus lift curve the DCS can position the water valve accordingly.

Determine Inlet Steam Flow

The Inlet steam flow to the steam turbine bypass valve is calculated as follows

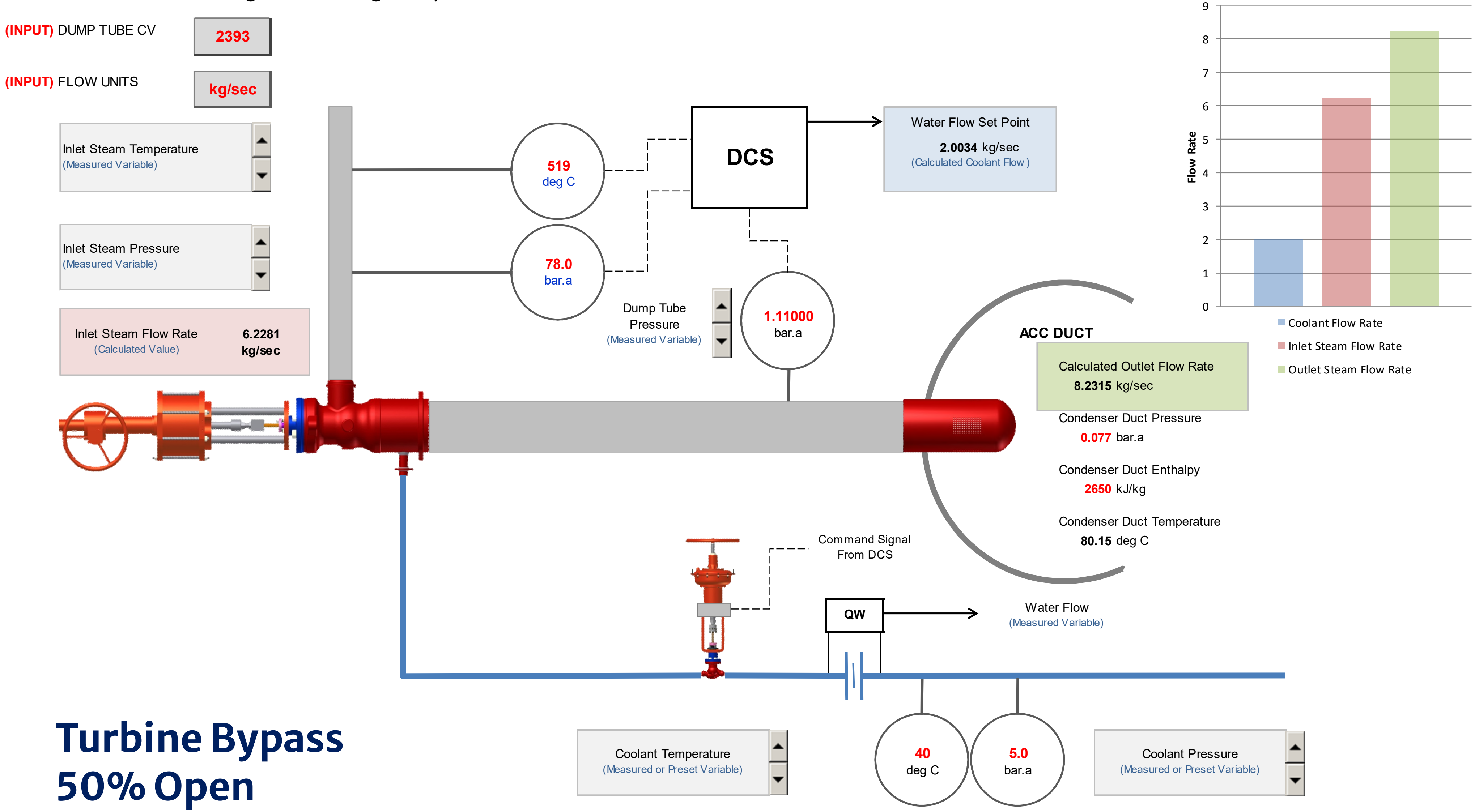
$$W_1 = W_2 - W_c$$

Feed Forward Control Algorithm Using Dump Tube Back Pressure to Determine Steam Flow Rate



Turbine Bypass 100% Open

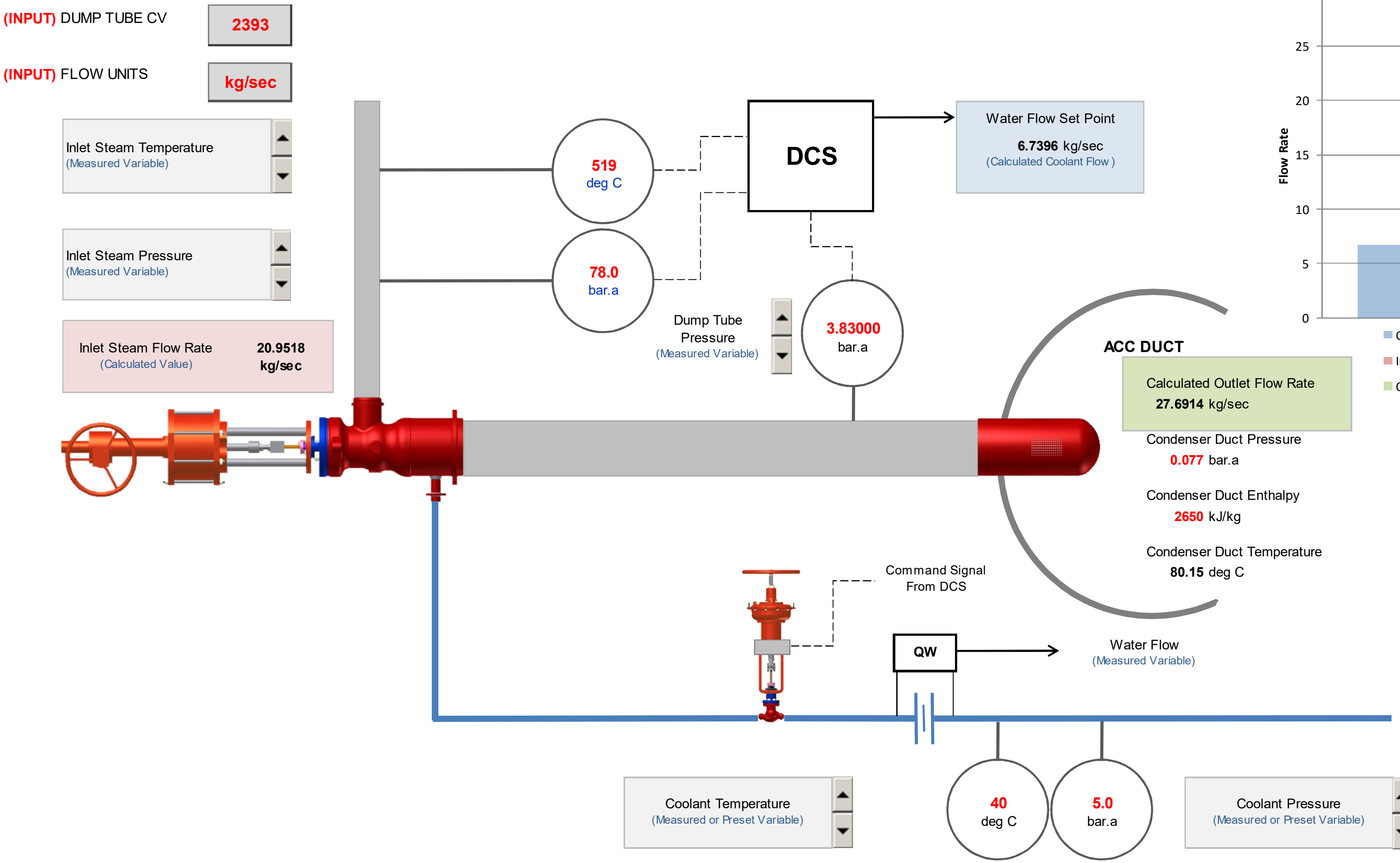
Feed Forward Control Algorithm Using Dump Tube Back Pressure to Determine Steam Flow Rate

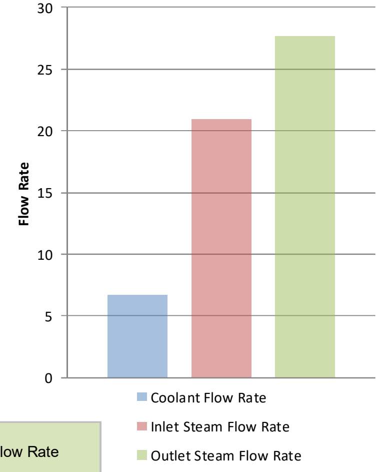


Turbine Bypass 50% Open

CELEROS FLOW TECHNOLOGY
COPES-VULCAN®

Feed Forward Control Algorithm Using Dump Tube Back Pressure to Determine Steam Flow Rate





Turbine Bypass Valve Closed

Calculating Steam Flow Rate to Determine Coolant Flow Rate
Using the DSCV-SA Turbine Bypass Valve Characteristic to determine mass steam flow rate

When there is no possibility of using a dump tube to calculate the total mass flow rate, the DSCV-SA Turbine bypass valve characteristic can be used. The DSCV-SA characteristic is recalculated depending upon the actual inlet pressure and inlet temperature, which provides the steam flow for different DSCV-SA valve strokes. From this the cooling water flow rate can be calculated.

a. Determine DSCV-SA Turbine Bypass Valve Characteristics

The inlet pressure and inlet temperature gives two constants, used for correction of the DSCV-SA valve characteristics to actual operating conditions. These constants are provided in a tabulated format, which are UNIQUE to each valve and each valve application and are based around a reference condition. The Steam flow is then calculated based upon the DSCV-SA valves stroke (%) and adjusted for variations in inlet pressure and temperature from the reference condition as follows: -

$$W_1 = W_{ref} \; x \; K_1 \; x \; K_2$$

Where:
W_1 = Calculated Inlet Steam Flow Rate
W_{ref} = Reference Steam Flow Rate based on Valve Lift (%)
K_1 = Pressure Constant
K_2 = Temperature Constant

An Example of the reference tables are shown below

Table 1 - Qref - Characteristic

Stroke %	Flow (kg/sec)
100%	20.99024
95%	19.67914
90%	18.48239
85%	17.14893
80%	15.66895
75%	14.14379
70%	12.57347
65%	10.95800
60%	9.38686
55%	7.89535
50%	6.19995
45%	4.43543
40%	2.63684
35%	1.09225
30%	0.55766
25%	0.55556
20%	0.55556
15%	0.55556
10%	0.55556
5%	0.55556
0%	0.00000

Table 2 - K1 - Pressure Constant

Pressure (bar.a)	K1
80	1.02556
78	1.00000
75	0.96173
70	0.89818
65	0.83487
60	0.77182
55	0.70903
50	0.64647
45	0.58416
40	0.52210
35	0.46027
30	0.39866
25	0.33728
20	0.27613
15	0.21520
10	0.15412
5	0.09398
0	0.00000

Table 3 - K2 - Temperature Constant

Temperature (Deg C)	K2
525	0.99547
519	1.00000
500	1.01493
475	1.03613
450	1.05943
425	1.08538
400	1.11475
375	1.14877
350	1.18952
325	1.24104
300	1.31331

These Correction Factors are UNIQUE to each valve and each valve application.

Example Calculation:
Calculate the inlet steam flow (W_1) based on the following parameters

Valve Lift : 65%
Inlet Pressure : 55 bar.a *(Measured Variable)*
Inlet Temperature : 475 deg C *(Measured Variable)*

W_{ref} (table 1) : 10.9580 kg/sec
K_1 (table 2) : 0.70903
K_2 (table 3) : 1.03613

Therefore

$$W_1 = 10.9580 \; x \; 0.70903 \; x \; 1.03613$$

W_1 = 8.05026 kg/sec

b. Determine Cooling Water Flow Rate (W_c)

Having previously calculated the DSCV-SA valve inlet steam flow rate (W_1) we use the following equation to determine the desired cooling water flow

$$W_c = W_1 \; x \left(\frac{H_1 - H_2}{H_2 - H_c}\right)$$

H_1 = Measurement of the steam turbine bypass valve inlet temperature and inlet temperature will give the inlet enthalpy (H_1) via steam tables.

H_2 = The Condenser enthalpy (H_2) is the desired condition of the steam in the condenser

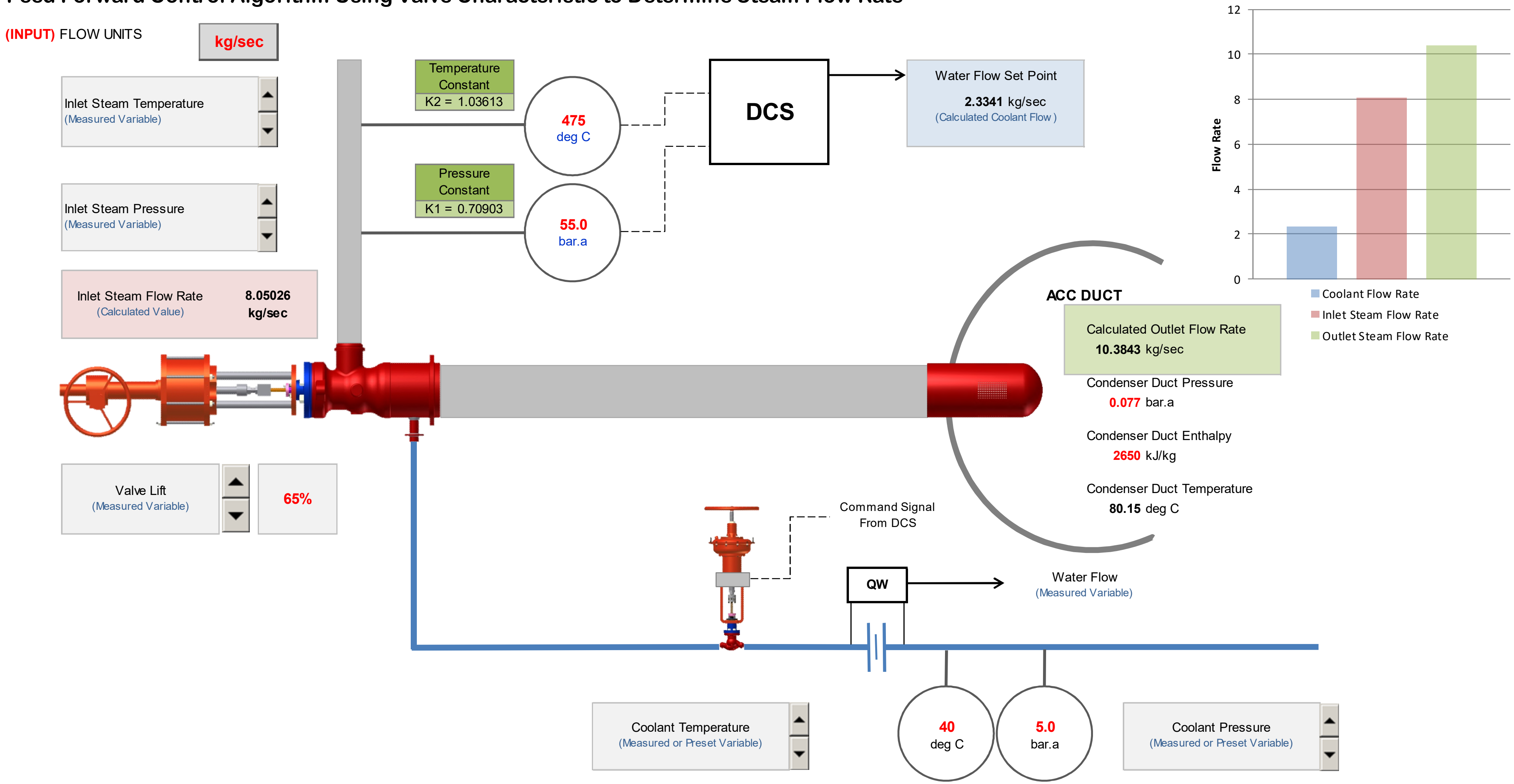
H_c = Measurement of the cooling water inlet pressure and inlet temperature will give the cooling water enthalpy (H_c). Alternatively, as the cooling water temperature is usually low, a fixed design point value can be used with minimal error.

To provide a degree of adjustability within the system the calculated coolant flow rate can be multiplied by an adjustable factor to either increase or decrease the calculated coolant flow rate depending upon site experience.

This calculated water flow rate is then compared to the water flow rate measured variable from the water flow meter and then the DCS positions the water control valve by constantly matching the calculated water flow rate to the measured variable water flow rate. Alternatively if a water flow meter is not available then the water control valve Cv versus lift curve can be used. By measuring the water pressure P_w and temperature P_t upstream of the water control valve and using the steam downstream (or dump tube) pressure P_2 (with the DSCV-SA design steam P_2 pressure always equals the water valve P_2) the required water valve Cv can be calculated. Using the water control valve Cv versus lift curve the DCS can position the water valve accordingly.

This system can also be utilised when a dump tube is not installed – e.g. HP Bypass to Cold Reheat applications.

Feed Forward Control Algorithm Using Valve Characteristic to Determine Steam Flow Rate



Turbine Bypass
65% Open

Required Instrumentation

The MINIMUM required instrumentation for correct operations of the two systems described above as are follows:

a. When Using the Condenser Dump Tube (Sparger) to determine mass steam flow rate

- Upstream Pressure Transmitter *(Valve Inlet)*
- Upstream Temperature Transmitter *(Valve Inlet)*
- Downstream Pressure Transmitter *(Dump Tube Inlet)*
- Water Flow Meter with High Rangeability *(Coolant Valve Inlet)*

b. When Using the DSCV-SA Turbine Bypass Valve Characteristic to determine mass steam flow rate

- Upstream Pressure Transmitter *(Valve Inlet)*
- Upstream Temperature Transmitter *(Valve Inlet)*
- Water Flow Meter with High Rangeability

Additional Instrumentation

The Following instrumentation applies to both systems and could be considered desirable to improve system operating efficiencies

- Steam Flow Measurement *(Valve Inlet)*
- Cooling Water Pressure Measurement *(Coolant Valve Inlet)*
- Cooling Water Temperature Measurement *(Coolant Valve Inlet)*

Recommended System Interlocks

The following system interlocks should be considered for incorporation into the control philosophy in order to protect the turbine bypass valve and interconnecting piping systems.

- Cooling Water Control Valve should be interlocked to the DSCV-SA steam turbine bypass valve to ensure that the cooling water control valve CANNOT open without the DSCV-SA valve being open and steam flowing.
- The DSCV-SA should be prevented from opening before the upstream steam temperature has 20 –25 deg C of superheat. This is to prevent water from passing into the valve.
- To avoid excess water leakage when the bypass system is closed (operating in stand-by mode) it is recommended that the coolant isolation valve be closed whenever the steam valve is closed.

Other Recommendations for consideration

- In the operating case of Bypass to Condenser, the condenser will need its own trip signals (designed by the condenser supplier) which will close the bypass system to protect the condenser
- The cooling water supply will usually incorporate a low pressure alarm which should close the bypass system when coolant pressure falls below a predetermined minimum value to prevent excessively hot steam from being admitted into the condenser.
- For trip or other events with a known steam flow rate, the control algorithm should be programmed to open the DSCV-SA bypass valve to a predetermined position before releasing to automatic control mode.

Operational Considerations

The DSCV-SA steam turbine bypass system is design to operate under the following basic modes of operation

- Steam Turbine Trip
- Steam Turbine Start-up
- Steam Turbine Back Pressure Control

Steam Turbine Trip

In case of a Steam Turbine Trip condition, the DSCV-SA Turbine Bypass valve should be opened to a predetermined position based upon:

  - Steam Flow Meter output
  - Calibrated Steam Turbine Power Output to Inlet Steam Flow

Once inlet steam flow (i.e. the steam flow rate through the steam turbine just prior to a trip condition) is established, the DSCV-SA Turbine Bypass characteristic curve can be utilised to determine an appropriate valve trip 'open' position.

Steam Turbine Start-Up

When the Steam turbine is started up after a trip or on initial plant start-up, the DSCV-SA Turbine Bypass Valve should be gradually closed whilst the turbine is loaded. This operation lasts until the DSCV-SA Turbine Bypass Valve is closed.

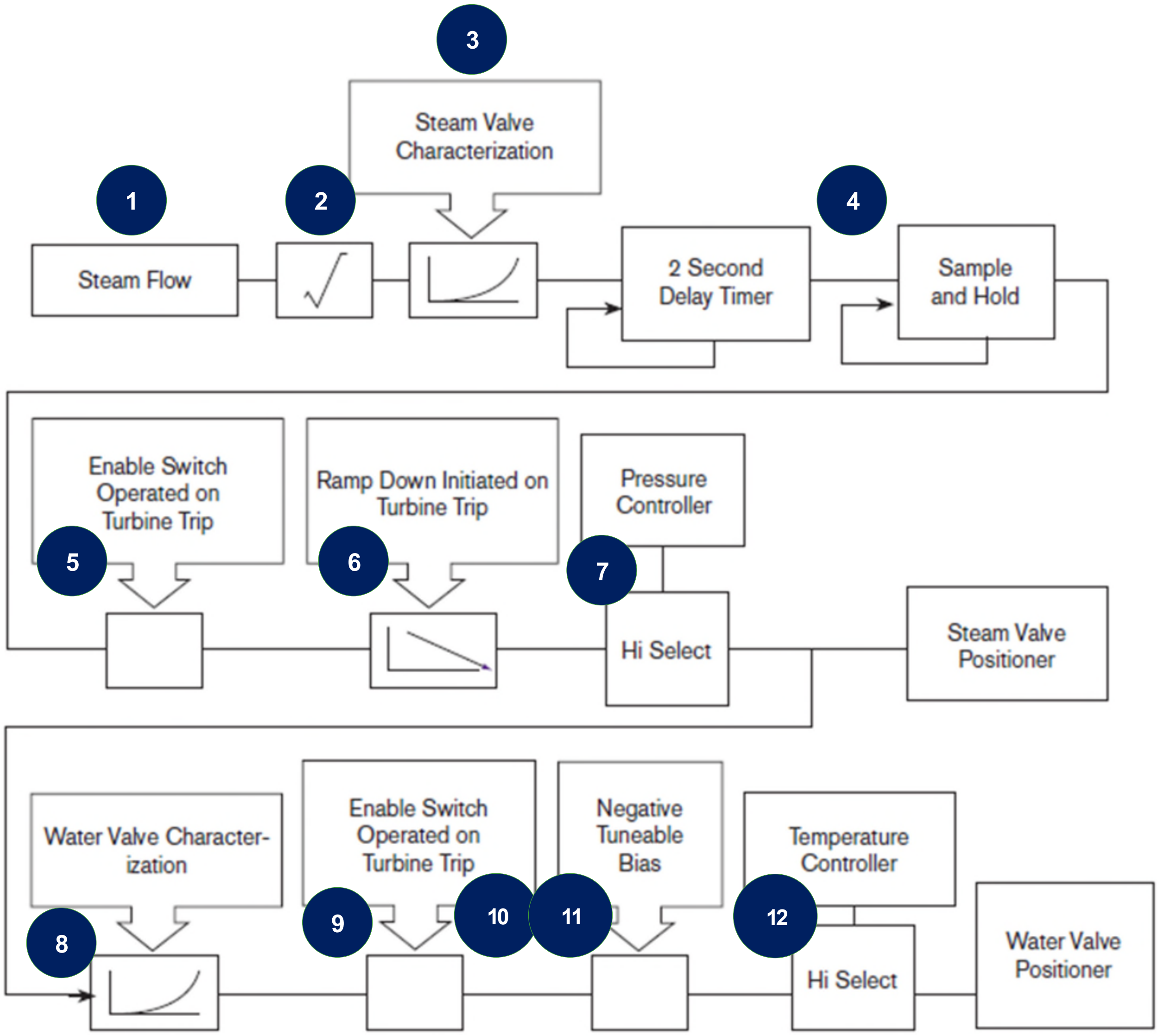
Steam Turbine Back Pressure Control

When the DSCV-SA Turbine Bypass valve is utilised to regulate steam pressure into the Steam Turbine (whether on fixed or sliding pressure mode) the upstream pressure sensor is utilised to determine DSCV-SA Turbine Bypass valve position. Steam flow through the DSCV-SA is unlikely to be known (unless independently metered) and as such the DSCV-SA characteristic curve can be utilised to determine partial bypass flow and associated cooling water flow rate IF measurement of the downstream temperature is not feasible (i.e. Bypass to condenser applications)

In case of a Steam Turbine Trip condition, the DSCV-SA Turbine Bypass valve should be opened to a predetermined position based upon:

- Steam Flow Meter output
- Calibrated Steam Turbine Power Output to Inlet Steam Flow

Once inlet steam flow (i.e. the steam flow rate through the steam turbine just prior to a trip condition) is established, the DSCV-SA Turbine Bypass characteristic curve can be utilised to determine an appropriate valve trip 'open' position. Below is a basic philosophy of how this can be incorporated into the valve control system. The data is constantly measured by the DCS and the calculations below are continuously performed so that at any load when a trip occurs the steam turbine bypass system is in a state on continual readiness



1 Steam flow to be bypassed (i.e. the steam flow rate through the steam turbine just prior to a trip condition) is established together with the Inlet Pressure and inlet temperature measurements

2 Cv Calculation. The Cv (Valve Capacity) is determined by the above inlet operating conditions and the required outlet pressure. This determines the DSCV-SA percentage (%) opening and 4-20mA command signal. Under emergency Trip conditions the condenser will be at normal operating pressure (Either a measured variable or fixed for the purpose of trip condition) and therefore a Cv calculation can be performed.

3 After calculating the required condition Cv for the DSCV-SA the corresponding opening percentage is determined from the DSCV-SA Cv vs Percentage lift curve. This is converted to the 4-20mA command signal

4 To ensure a 'clean' stable reading the signal is passed through a 2 second delay timer and sample and hold loop. This prevents erroneous readings at the time of a trip condition. Due to the normal scan times of most DCS systems which can be 200 to 300 milliseconds and the rapid response of the steam turbine isolation valve. Without a sample delay loop steam flows may have significantly reduced when the next can captures the steam flow rate

5 The Enable Switch is activated by the Turbine Trip Alarm

6 The Adjustable ramp down timer is initiated on Turbine Trip. This decays the calculated command signal over the adjustable time period, normally set for approximately 10 seconds. However this time is adjustable and can be tuned to specific site installations.

7 The High Selector receives the calculated command signal from point (3) above, which is now being constantly reduced over a period of time set in the ramp down timer. It also receives the PIC loop command signal which is now catching up after the turbine trip. The Hi-Selector only allows the highest of these two command signals through to the DSCV-SA Turbine Bypass Valve positioner. As soon as the PIC loop command signal is greater than the continuously reducing calculated command signal the DSCV-SA Turbine Bypass bumplessly transfers to PIC control.

In some instances, where pneumatic actuator are utilised, it may prove beneficial to utilise a fast start solenoid valve (not shown in system diagram). A Fast start adjustable timer is required to give an initial digital signal to a 3/2 override solenoid valve fitted to the actuators pneumatic control circuit. This digital signal is held for approximately 1.5 seconds and is adjustable to allow for tuning during system commissioning. The Solenoid valve diverts instrument air directly into the valve actuator which opens the valve bypassing the valve positioner. This short burst of instrument air into the actuator will open the DSCV-SA Turbine Bypass valve by approximately 25-40% which negates the initial delay if only the calculated command signal was applied to the valve positioner.

8 For the first few seconds of operation of the desuperheating algorithm (used to determine coolant flow rate) cannot be used as the pressure in the dump tube is unstable. However the relationship of percentage lift of the DSCV-SA Turbine Bypass Valve and the percentage lift of the water control valve can be used. Having already determined the required DSCV-SA Turbine Bypass Valve lift then the corresponding water control valve lift (command signal) can be determined from the DSCV-SA percentage lift versus water control valve percentage lift curve.

9 Enable switch activated by Turbine Trim Alarm

10 The Adjustable ramp down timer (if required, not shown) is initiated on Turbine Trip. This decays the calculated command signal over the adjustable time period, normally set for approximately 10 seconds. However this time is adjustable and can be tuned to specific site installations.

11

The adjustable bias is for fine tuning during commissioning to allow for any inaccuracies in the calculated results and the overall plant set-up

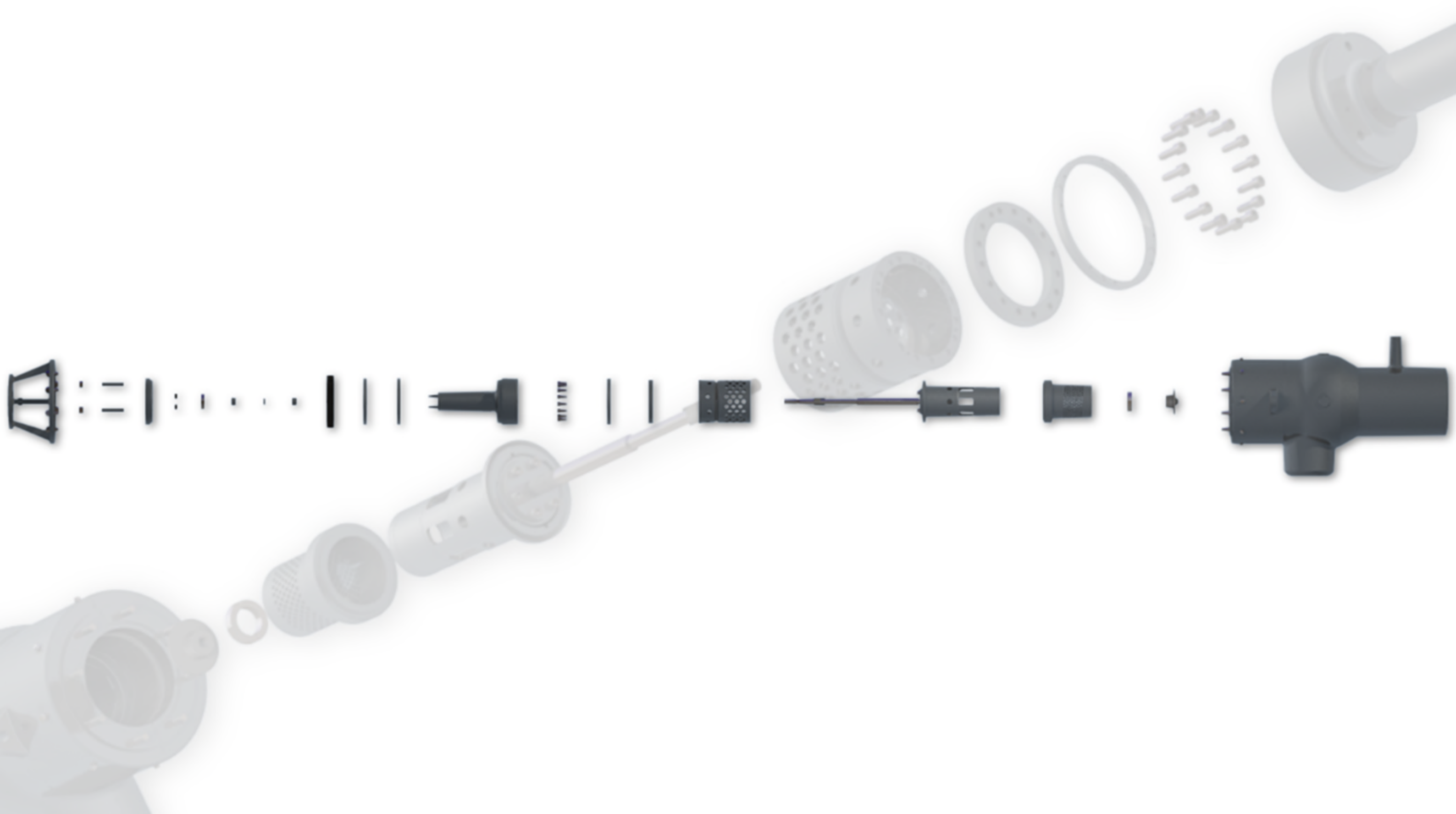
12

The High Selector receives the calculated command signal from point (8) above, which is now being constantly reduced over a period of time set in the ramp down timer. It also receives the PIC loop command signal which is now catching up after the turbine trip and pressure starts to stabilise in the dump tube. The Hi-Selector only allows the highest of these two command signals through to the water control valve positioner. As soon as the desuperheating algorithm command signal is greater than the continuously reducing calculated command signal the water control valve bumplessly transfers to algorithmic control

In some instances, where pneumatic actuator are utilised, it may prove beneficial to utilise a fast start solenoid valve (not shown in system diagram). A Fast start adjustable timer is required to give an initial digital signal to a 3/2 override solenoid valve fitted to the actuators pneumatic control circuit. This digital signal is held for approximately 1.5 seconds and is adjustable to allow for tuning during system commissioning. The Solenoid valve diverts instrument air directly into the valve actuator which opens the valve bypassing the valve positioner. This short burst of instrument air into the actuator will open the water control valve by approximately 20-40% which negates the initial delay if only the calculated command signal was applied to the valve positioner.

DSCV-SA

FAQs – 24: MAINTENANCE
Are Any Special Tools Required?



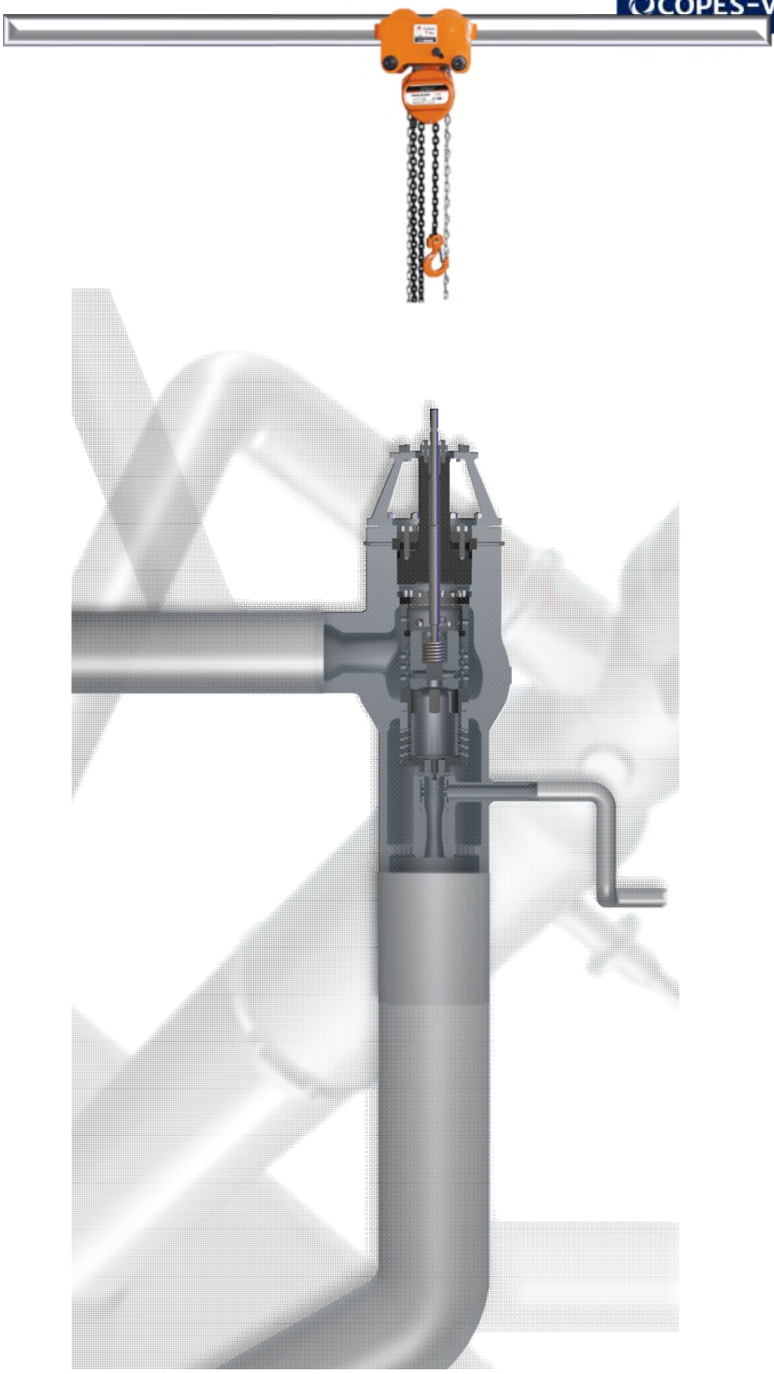
The DSCV-SA is not a high maintenance valve - the Copes-Vulcan engineering team were tasked with 'easy maintenance' within their design brief.

The complete trim is a 'Quick-Change' style with no welded in components or large internal threaded parts. The whole trim assembly is held in compression by either a compression ring or the bonnet. By simply removing the compression ring or bonnet the whole trim simply slides out of the top of the valve. Therefore in-situ maintenance, should it be required, is both expeditious and uncomplicated with no need for any specialised tooling or training.

The DSCV-SA can usually be maintained with standard maintenance tooling that is normally available within most power plant maintenance departments.

However, SPX does provide service assistance fixtures to assist the client with performing maintenance activities should they be required. These service assistance fixtures are utilised when large DSCV-SA's are installed in a horizontal orientation as the trim components can be of considerable weight and as such can prove difficult for maintenance personnel to manually handle.

INSTALLATION ORIENTATION:
Actuator Vertically Upwards with outlet vertically downwards



In this orientation provision should be made for a fixed lifting point suitable for the installation of a chain block (or similar) to ease any future maintenance interventions. The Lift point should ideally have a SWL of 5 tonnes (11,000 lbs) (Note that this SWL can be reduced where smaller DSCV-SA sizes are installed).

Large Trim components within the DSCV-SA are provided with blind drilled and tapped holes to allow lifting eyes to be installed. The chain block is then employed to simply ‘lift’ the trim components from the valve.

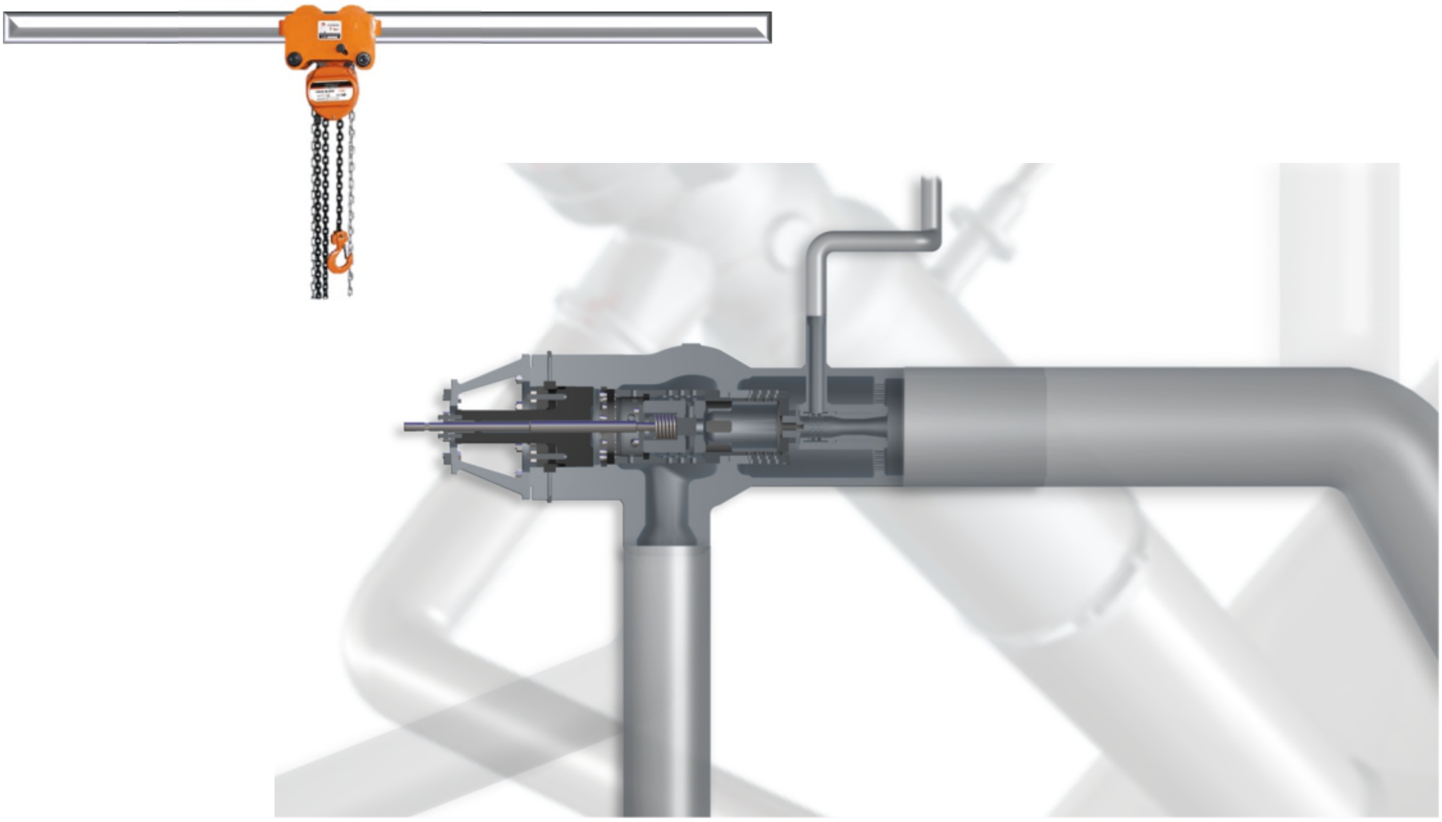
INSTALLATION ORIENTATION:

Actuator Horizontal with outlet Horizontal

In this orientation removal of the trim components can be a little more difficult than in a vertically (Outlet downwards) installation simply due to the weight involved in the trim components of larger size DSCV-SA valves.

A simple service assistance fixture may assist the site maintenance personnel in removing and installing the larger trim components within the assembly.

As per the previous orientation provision should be made for a fixed lifting point suitable for the installation of a chain block (or similar) to ease any future maintenance interventions. The Lift point should ideally have a SWL of 5 tonnes (Note that this SWL can be reduced where smaller DSCV-SA sizes are installed).

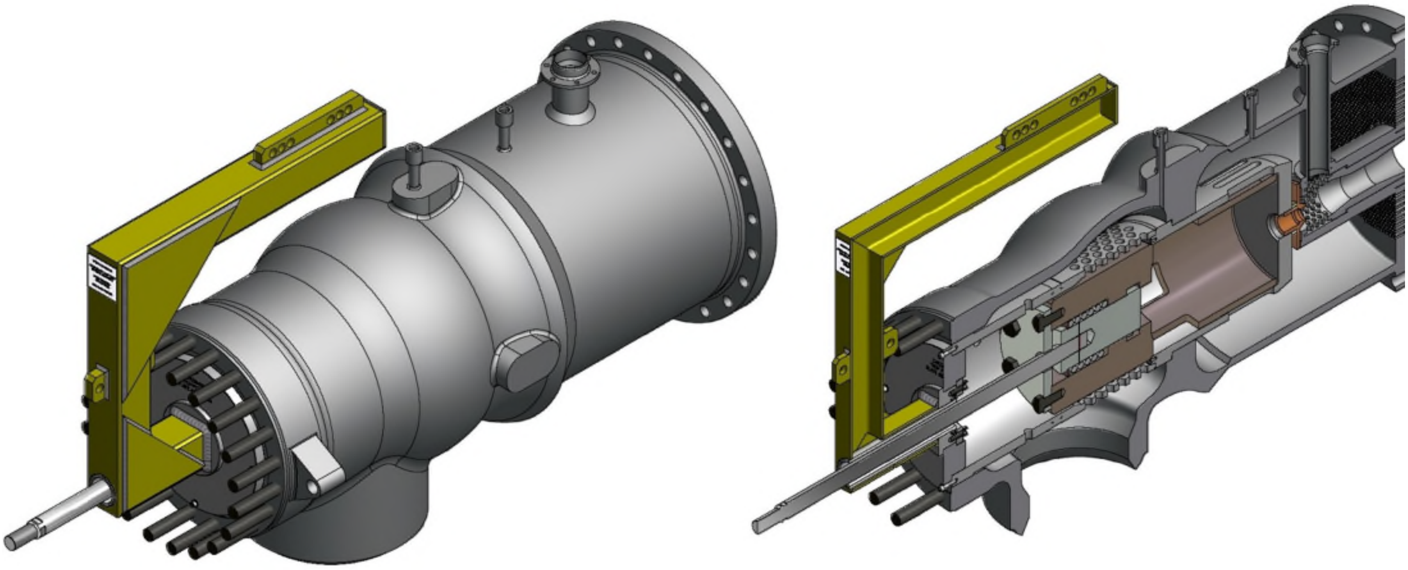


The Service Assistance fixtures are:

- Designed to assist service technicians with the removal of heavy trim components
- Multiple designs available depending on space availability and orientation
- Not required for actuator vertically upwards / outlet vertically downwards installations

INSTALLATION ORIENTATION:
Actuator Horizontal with outlet Horizontal

Example of Service Assistance Fixture installed in DSCV-SA Valve.

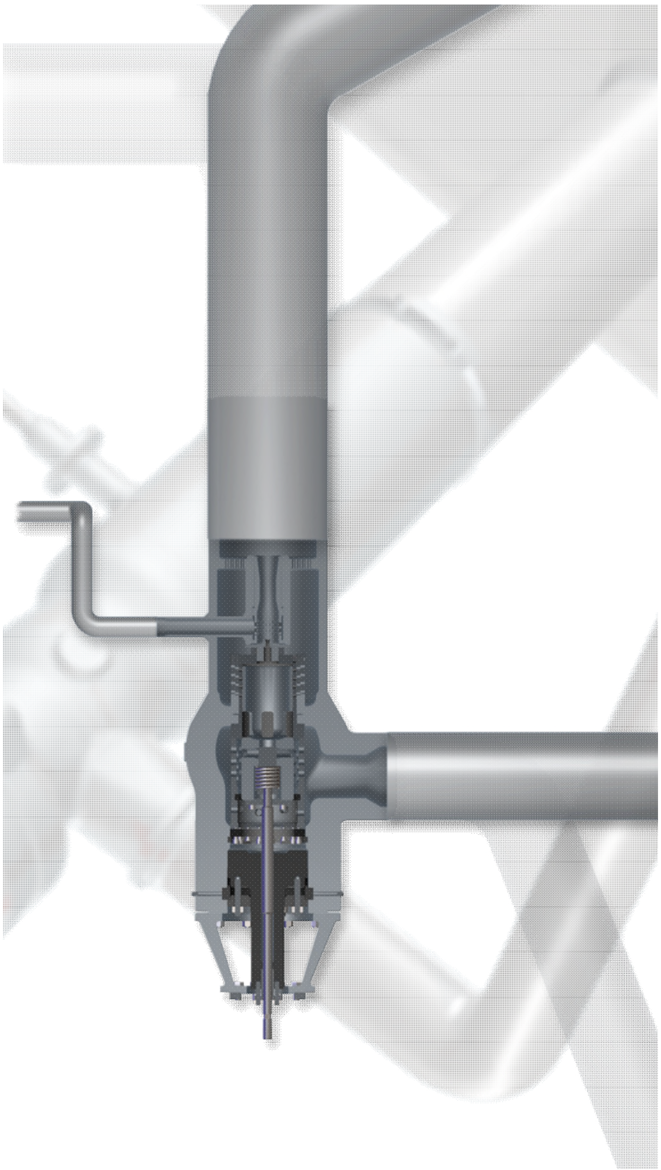


Example of Service Assistance Fixture ready for shipment.

INSTALLATION ORIENTATION:

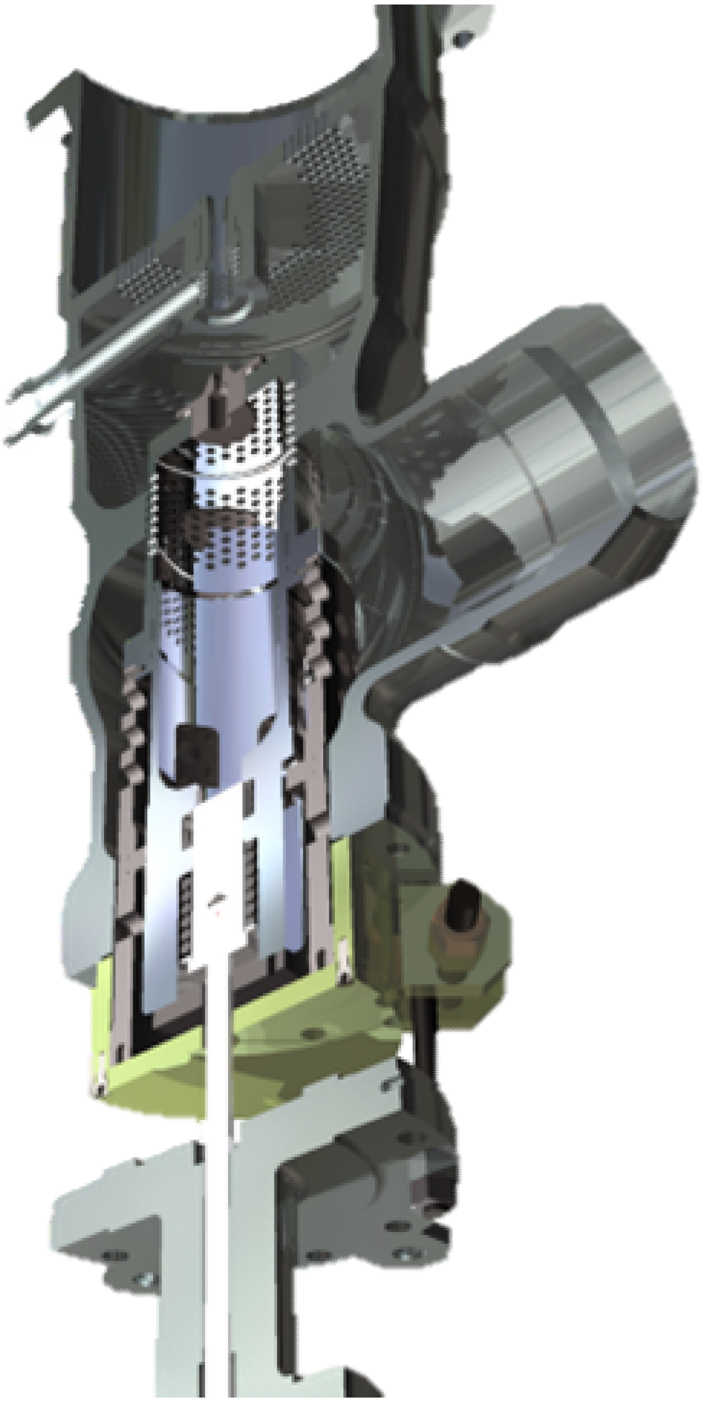
Actuator Vertically Downward with outlet vertically upwards

Whilst the DSCV-SA can be installed in this orientation it is not recommended practise as this results in any future required maintenance being extremely difficult to perform. In this orientation it is strongly recommended that service assistance fixtures are utilised to enable removal and subsequent installation of the valve trim components.



INSTALLATION ORIENTATION:

Actuator Vertically Downward with outlet vertically upwards

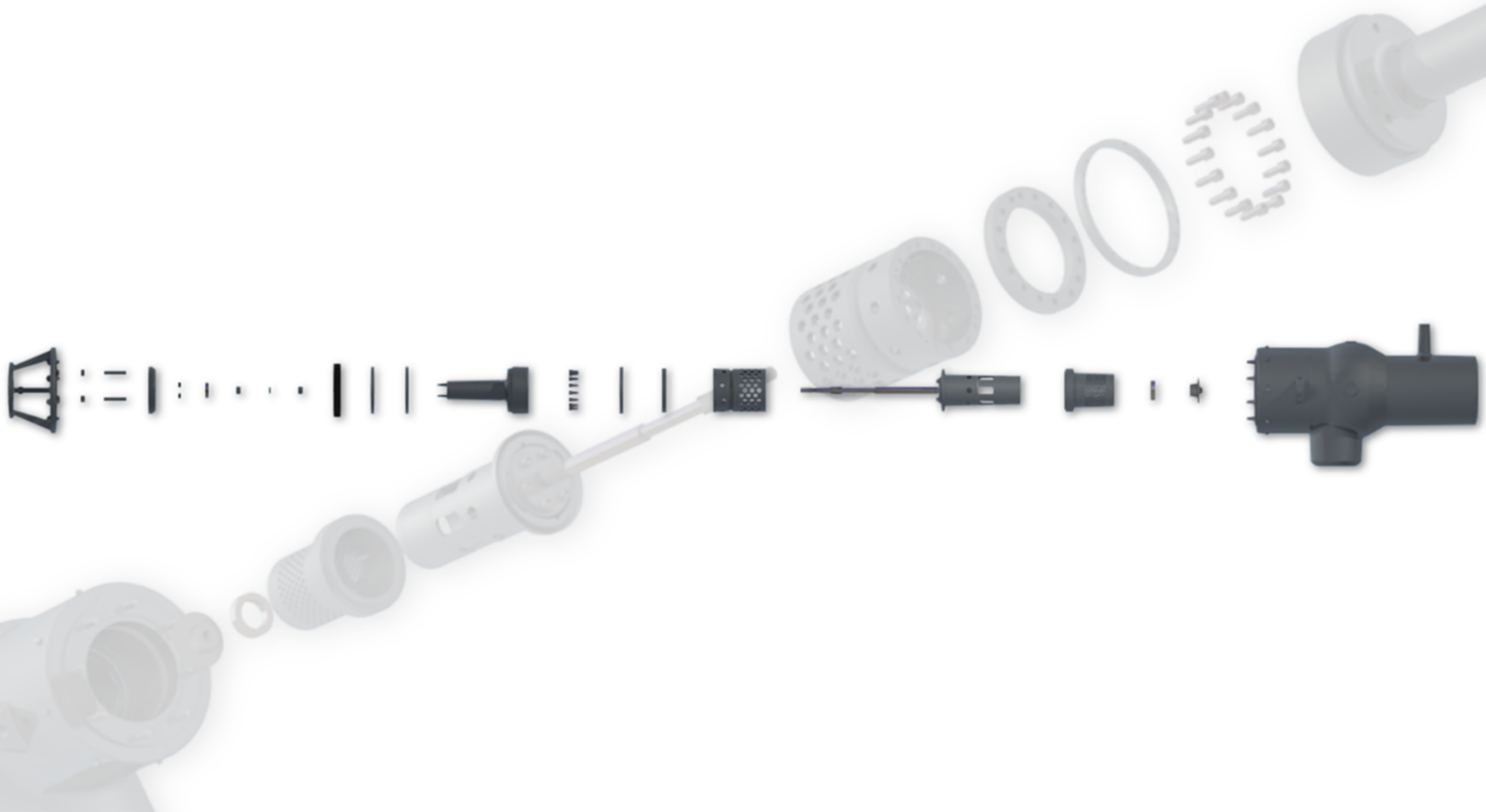


Service Assistance Fixtures for Outlet Vertically Upward installations

DSCV-SA

FAQs – 25: MAINTENANCE

Are Specialist Field Service Engineers or Special Training Required?



NO! The DSCV-SA is not a high maintenance valve - the Copes-Vulcan engineering team were tasked with 'easy maintenance' within their design brief.

The complete trim is a 'Quick-Change' style with no welded in components or large internal threaded parts. The whole trim assembly is held in compression by either a compression ring or the bonnet. By simply removing the compression ring or bonnet the whole trim simply slides out of the top of the valve. Therefore in-situ maintenance, should it be required, is both expeditious and uncomplicated with no need for any specialised tooling or training.

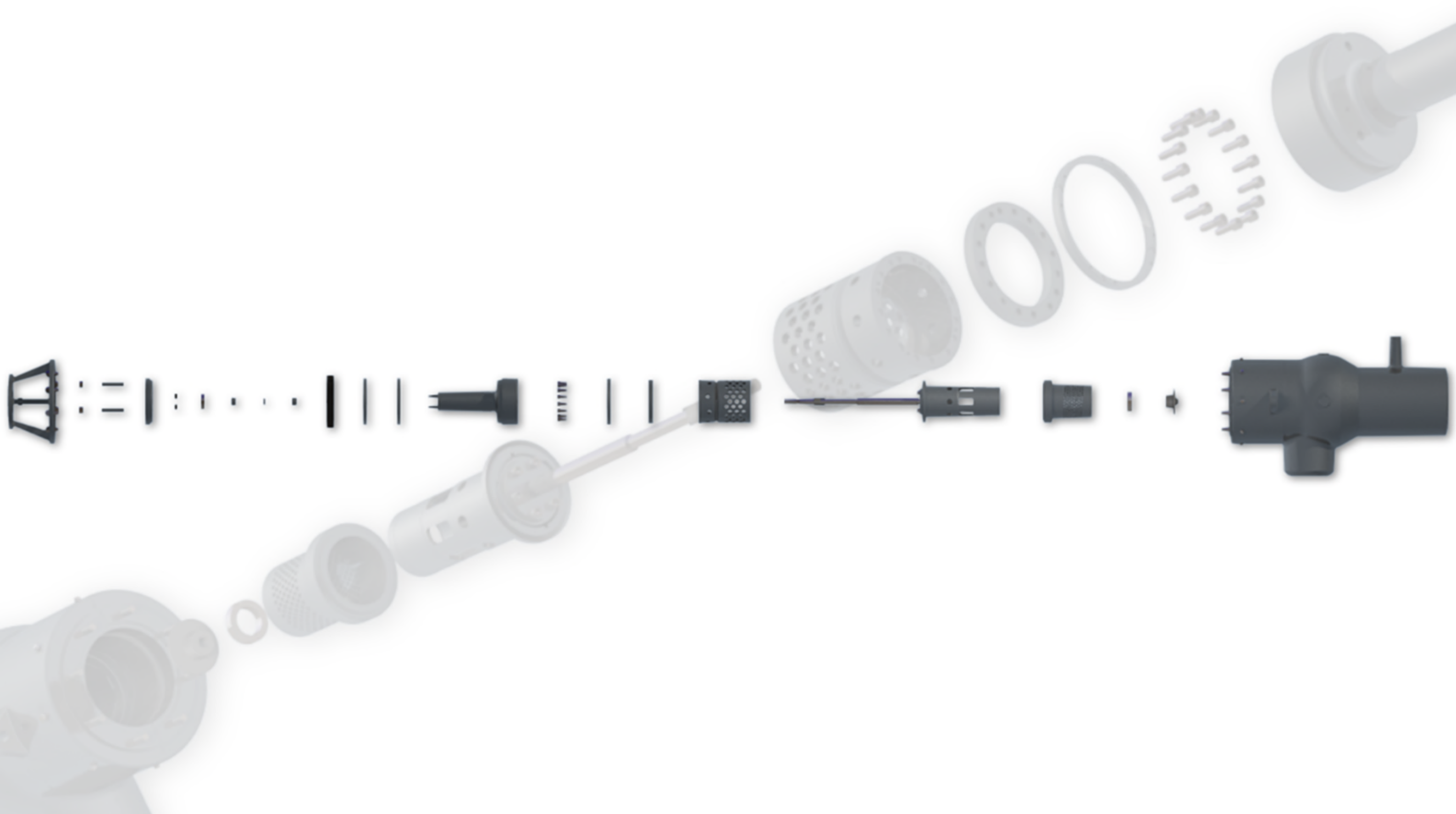
The DSCV-SA can usually be maintained with standard maintenance tooling that is normally available within most power plant maintenance departments. Anyone with experience of maintaining normal globe control valves will have sufficient knowledge and experience to tackle maintenance interventions of the DSCV-SA.

Of course, SPX can provide qualified field service engineers to perform on-site maintenance works should the client / end user not have sufficient capacity or manpower to perform maintenance during a major planned plant shutdown.

DSCV-SA

FAQs – 26: MAINTENANCE

Does the valve have a 'Quick-Change' trim design?

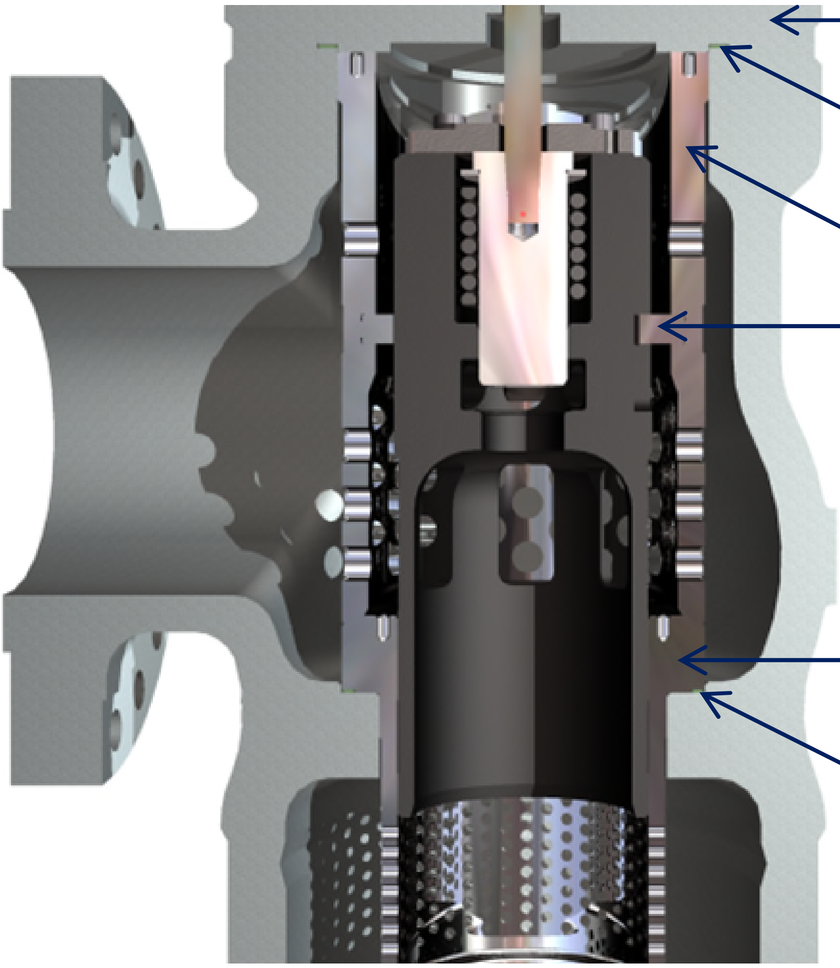


YES! The DSCV-SA is not a high maintenance valve - the Copes-Vulcan engineering team were tasked with 'easy maintenance' within their design brief.

The complete trim is a 'Quick-Change' style with no welded in components or large internal threaded parts. The whole trim assembly is held in compression by either a compression ring or the bonnet. By simply removing the compression ring or bonnet the whole trim simply slides out of the top of the valve. Therefore in-situ maintenance, should it be required, is both expeditious and uncomplicated with no need for any specialised tooling or training.

DSCV-SA WITH BOLTED BONNET

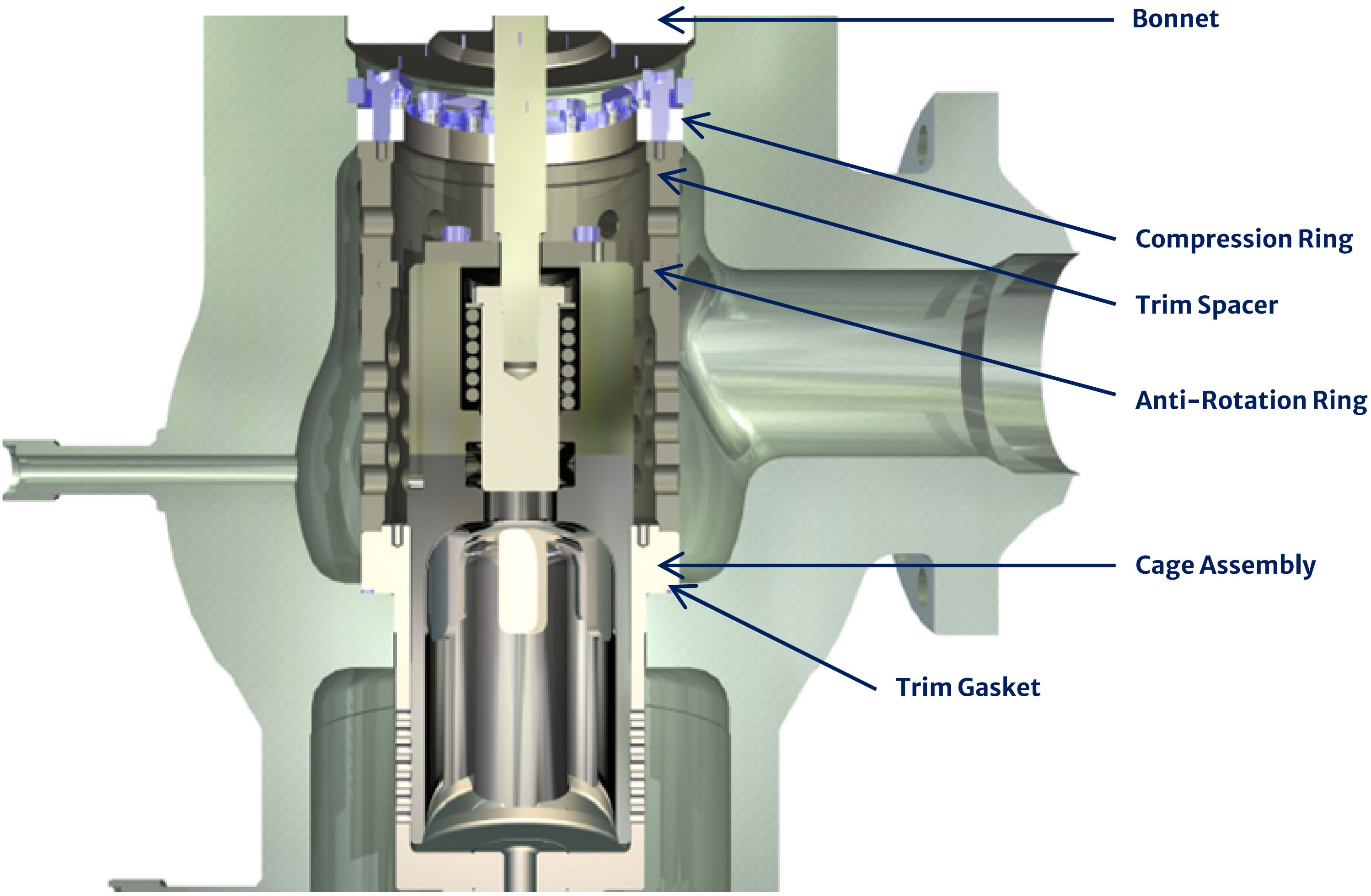
(Applicable to Valves with a Pressure Class Rating of ANSI 900 or less)



DSCV-SA is shown with a BOLTED bonnet arrangement. The Bonnet holds the spacer and cage in compression.

DSCV-SA WITH PRESSURE SEALED BONNET

(Applicable to Valves with a Pressure Class Rating of ANSI 1500 or Higher)



DSCV-SA

FAQs – 27: MANUFACTURE

Typical Inspection and Test Plans (ITP)

There are a number of standard inspection and test plans available depending on the level of certification required, where the valve will be installed and the required design code. The table below should enable you to make an appropriate selection.

All inspection and test plans can be modified and adjusted to meet specific customer and/or end user requirements of the specific project.

ITP Designation Number	Material Certification Level	Valve Design Code	CE Marked	Applicable Welding Specification
ITP 19	3.1	ASME VIII	NO	WS/402
ITP 20	3.1	ASME VIII	YES	WS/402
ITP 65	3.1	EN 13445	NO	WS/452
ITP 66	3.1	EN 13445	YES	WS/452

Where Smart Solutions Meet Global Power Generation

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Local International Contact Visit:
Copes-Vulcan | Celeros Flow Technology | Celeros Flow Technology (celerosft.com)

DSCV-SA FAQ:140109-01

FREQUENTLY ASKED QUESTIONS

DSCV-SA

FREQUENTLY ASKED QUESTIONS

DSCV-SA FAQ:140109-01

WHERE SMART SOLUTIONS MEET GLOBAL POWER GENERATION

DSCV-SA FAQs – INDEX

MECHANICAL DESIGN

1. What are the materials of construction?
    a. Pressure boundary, castings & forgings.
    b. Trim
    c. Water branch thermal sleeve
2. What are the connection types and sizes available?
3. Are noise attenuating trims available?
4. What is the bonnet design, bolted or pressure seal and is it high temperature extended?
5. Is the trim balanced?
    a. Benefits of high pressure balancing versus low pressure balancing.
    b. HP Balancing vs LP Balancing Table
6. Does the plug have anti-rotation?
7. Is an inlet steam strainer available?

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8. What actuation is available and stroking speeds?
    a. Pneumatic
        i. Single & double acting
    b. Hydraulic
        i. Hydraulic Power Units (HPU) and PLC control.
        ii. Self-contained actuators
    c. Electric
9. Instrumentation

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10. What is the minimum water pressure required?
11. Does the DSCV-SA have tight shut off?
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13. What is the rangeability, turndown, of the DSCV-SA?
14. Is there a minimum outlet steam velocity required to prevent cooling water drop out?
    a. Advantages of steam atomisation versus spray nozzles
15. Are dump tubes available?

INSTALLATION

16. Distances;
    a. What is the minimum upstream straight line length?
    b. What is the minimum downstream straight line length?
    c. What is the minimum distance to the temperature sensor?
    d. What is the minimum distance to the pressure sensor?
    e. What is the minimum distance to the dump tube?
17. Can the DSCV-SA be installed horizontally and is there anything to consider when installing horizontally?
18. Are thermal liners required?
19. Does the valve require warming and draining?
20. Material & pipe class transitions?
21. Where should the water control valve be positioned?
22. Are hydro and steam blowing trims available?
23. Are control algorithms available for bypass to condenser?

MAINTENANCE

24. Are any special tools required?
25. Are specialist field service engineers or special training required?
26. Does the valve have 'Quick-Change' trim design?

DSCV -
FREQUENTLY ASKED QUESTIONS

DSCV-SA FAQ:140109-01

MANUFACTURE

27. Typical inspection and test plan (ITP)

Global locations

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COPES-VULCAN, USA
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+1 (281) 498-0550
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Local International Contact Visit:
Copes-Vulcan | Celeros Flow Technology | Celeros Flow Technology (celerosft.com)

DSCV-SA

FAQs – 1a: MECHANICAL DESIGN: Pressure Boundary

Piping design engineers often use the turbine bypass valve or steam letdown valve as the point to transition pipe class both for pressure rating and material grade.

The DSCV-SA is an angle style valve. Normally the DSCV-SA is ordered and supplied in a split pressure rated design. The inlet part of the body will be of a higher pressure class than the outlet. The same is true for the for the pressure boundary materials with the inlet often being supplied in a different grade of material to the outlet.

Body – Inlet: The body inlet is the high pressure & temperature side. The standard body is produced from a casting in low alloy steels ASTM A217 WC6, WC9 and C12A or carbon steel ASTM A216 WCB. Forged bodies and other material grades can be supplied on request.

Standard Cast Body Inlet Materials (high pressure side)
ASTM A216 WCB
ASTM A217 WC6
ASTM A217 WC9
ASTM A217 C12A

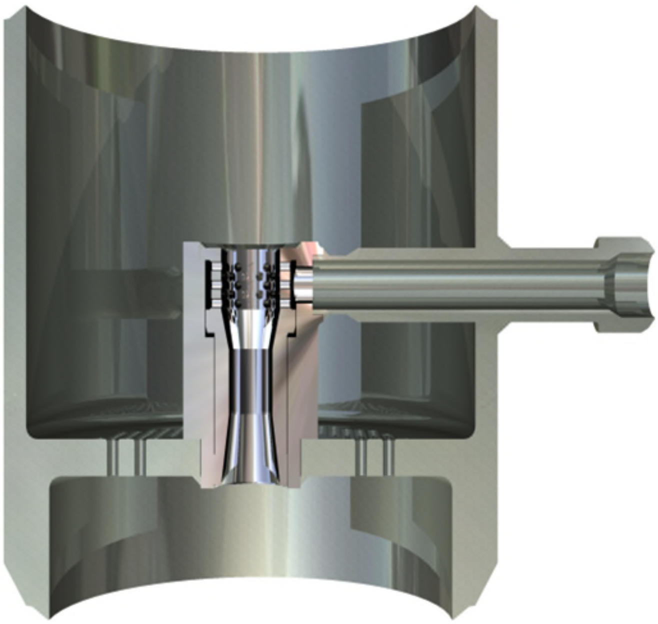
If forged bodies are preferred the body is supplied in the following standard materials :

Standard Forged Body Inlet Materials (high pressure side)
ASTM A105
ASTM A182 F11
ASTM A182 F22
ASTM A182 F91
ASTM A182 F92

The bonnet will be supplied in the same material grade as the body, either cast or forged.

Body – outlet: The body outlet is the lower pressure side. The standard body outlet is produced from a forgings in low alloy steels ASTM 217 WC6, WC9 and C12A or carbon steel ASTM A216 WCB.

Forged Body Outlet Materials (Low pressure side)
ASTM A105
ASTM A182 F11
ASTM A182 F22
ASTM A182 F91



The outlet diffuser which produces the customer outlet connection can be made of a different material than the DSCV-SA outlet section so as to meet the customer pipe material and prevent on-site dissimilar welds.

DSCV-SA

FAQs – 1a: MECHANICAL DESIGN: Pressure Boundary

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ASTM A105
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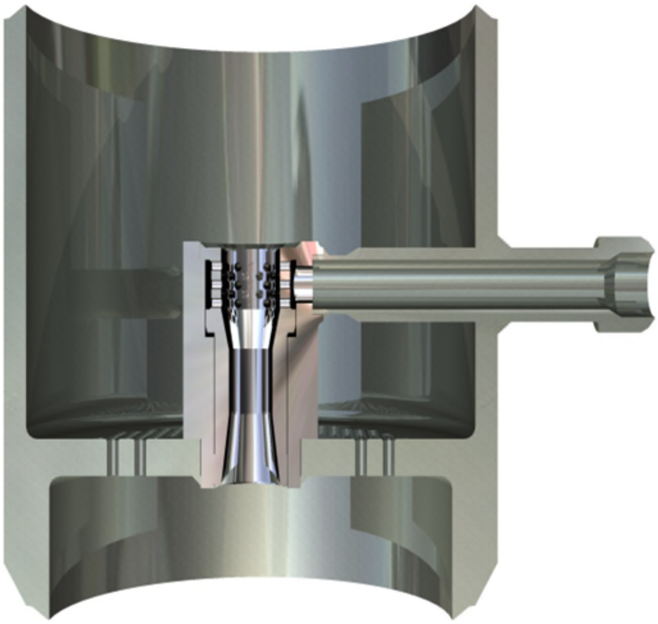


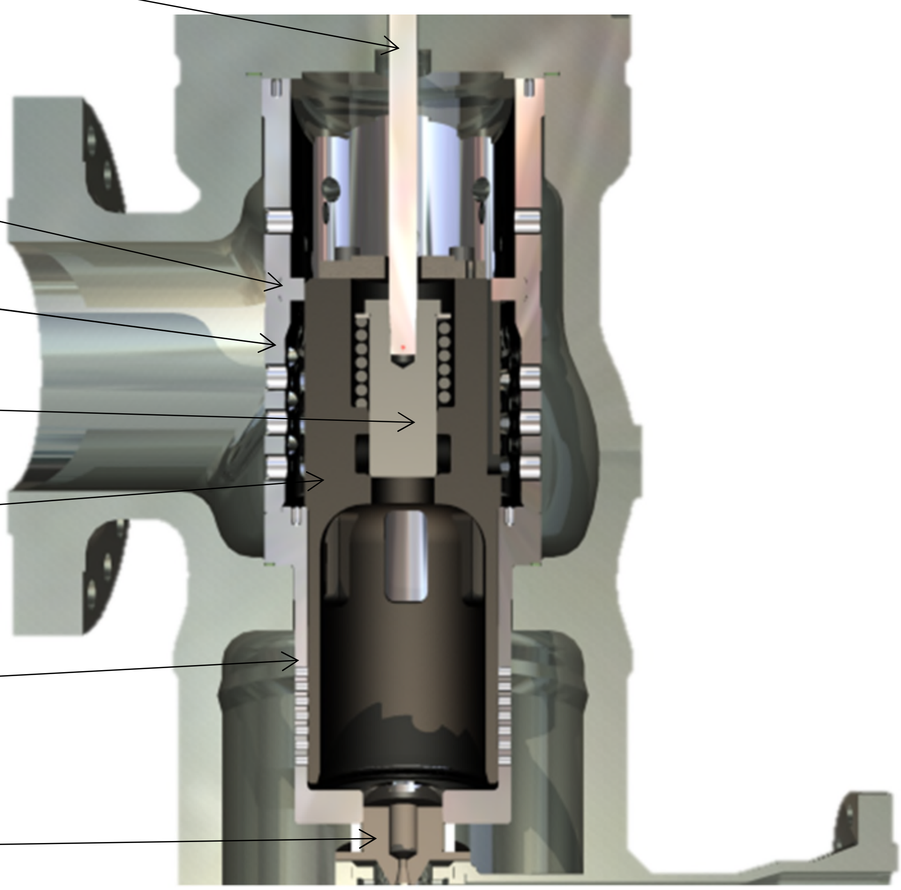
The outlet diffuser which produces the customer outlet connection can be made of a different material than the DSCV-SA outlet section so as to meet the customer pipe material and prevent on-site dissimilar welds.

DSCV-SA

FAQs – 1b: MECHANICAL DESIGN: Valve Trim

The trim is designed to expand equally with the pressure boundary in which it is contained to prevent high thermally induced stresses. A mandatory requirement of severe duty valves is that the plug is fully guided for stability. Therefore all guiding surfaces are hardened to a value of greater than 50 on the Rockwell C scale. This prevents any mechanical galling between the guiding surfaces.

The Seat is similarly hardened to > 50 Rockwell C. Although uncommon on bypass valves and not required a Stellite deposit on the seat can be supplied if specifically requested by the customer. Stellite is a more soft material, approximately 35 on the Rockwell C scale and thus more prone to wear. However as Stellite® is softer it can be machined if the seat becomes damaged. Normally a Stellite® seat is only specified by a very specific request due to a customer preference.

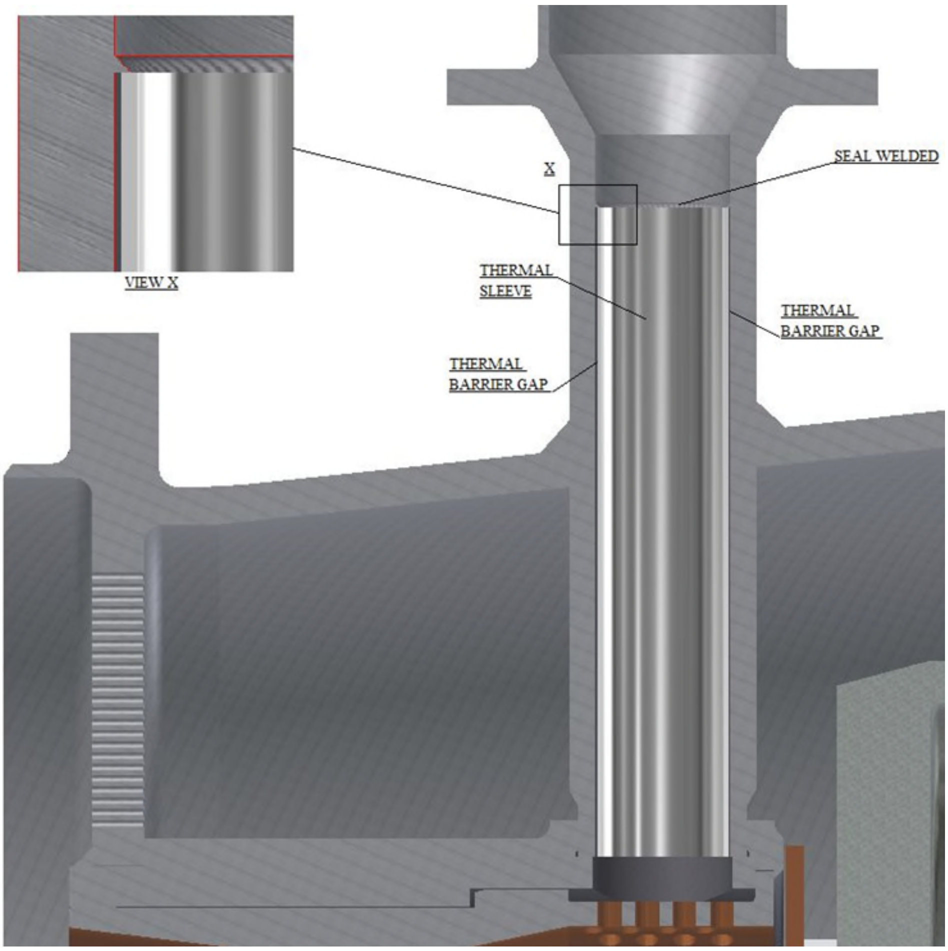


DSCV-SA

FAQs – 1c: MECHANICAL DESIGN: Cooling Water Branch Thermal Sleeve

When the temperature differential between the maximum inlet steam temperature and the minimum cooling water temperature exceeds 220ºC (400ºF) then a thermal sleeve is fitted. The thermal sleeve is a 316L stainless steel tube which the cooling water passes to the steam atomising head. This sleeve produces an annular gap between its outside diameter and the inside diameter of the water branch. This gap or thermal barrier protects the water branch from high thermally induced stresses.

The sleeve is seal welded at one end which allows it to freely expand and contract within the water branch.



DSCV-SA

FAQs – 2: MECHANICAL DESIGN: Connection Types & Sizes

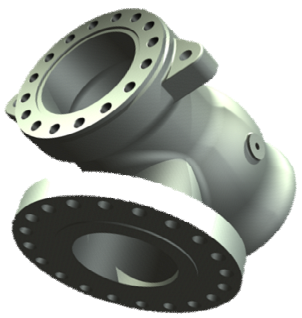
The DSCV-SA was designed with maximum flexibility in mind with regards to connections. When employed in a power station the vast majority of DSCV-SA installations have butt weld end connections. On small biomass plants, petrochemical, pulp & paper or similar industries where the DSCV-SA is used as a steam let-down station, the connections are generally flanged.

The DSCV-SA has both options weld ends or flanged ends.

Body – Steam Inlet Connection: Normally the body is produced from a casting. The body casting has two formats, weld end or flanged.

Butt weld end.

Note the drilled disc is only for the factory hydro pressure test

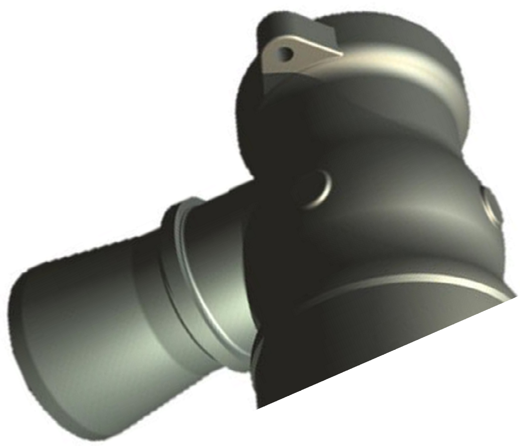


Flanged end.

The flange is an integral part of the casting.

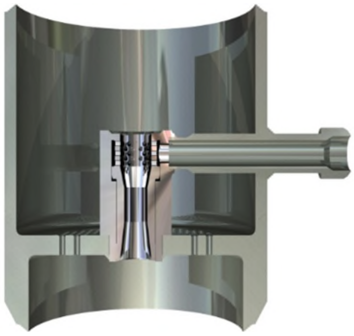
When the customer steam inlet connections cannot be achieved then an expander can be welded to the body inlet connection and, if required, a flange also. Therefore any steam inlet connection in terms of size, type or material can be accommodated.

Standard casting with steam inlet expander



Body – Steam outlet connection: The DSCV-SA outlet section is fully formed from a forging. Therefore full flexibility is available to produce any size, connection type or material.

Butt Weld, with or without material transition.



DSCV-SA

FAQs – 3: MECHANICAL DESIGN: Noise Attenuating Trim Options

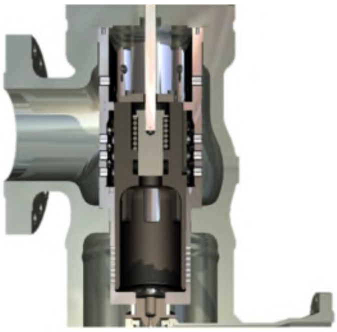
The DSCV-SA has several noise attenuating trim options. As standard the DSCV-SA is fitted with the Copes-Vulcan single stage HUSH™. The valve can also be fitted with either a multi stage HUSH™ trim or the multi disc, multi labyrinth RAVEN™ trim.

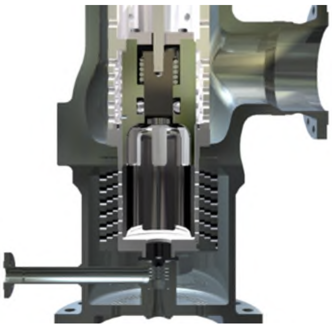
All of the trim options have active noise control throughout the full valve stroke and flow range. 1, 2 and 3 stage HUSH™ trims are available in standard trim configurations. Multi stage RAVEN™ trims are available upon request. The final pressure drop occurs through the final outlet diffuser, see FAQ sheet 11.

IMPORTANT: The noise levels shown on the Copes-Vulcan data sheets are calculated to the internationally recognised Aerodynamic noise prediction method; IEC 60534-8-3:2000. Other manufacturers show noise prediction levels based on their own in-house calculation routines, however these have not been internationally qualified or accepted.

Note: A number of bypass valve suppliers employ inlet and trim exit baffles for noise attenuation. However these are passive noise control elements as they have a fixed CV and only truly attenuate at one flow rate, normally maximum flow rate. As the flow rate reduces the passive baffle has little or no influence on the pressure drop and thus little or no noise attenuation.

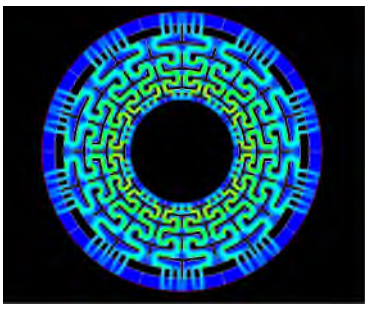
Single stage HUSH II or HUSH III™





Multi stage HUSH™,

2 & 3 stage trim options are available as standard options.



RAVEN™

Multi disc, multi path labyrinth

DSCV-SA

FAQs – 4: MECHANICAL DESIGN: Bonnet Designs

The DSCV-SA has two bonnet types, bolted and pressure seal.

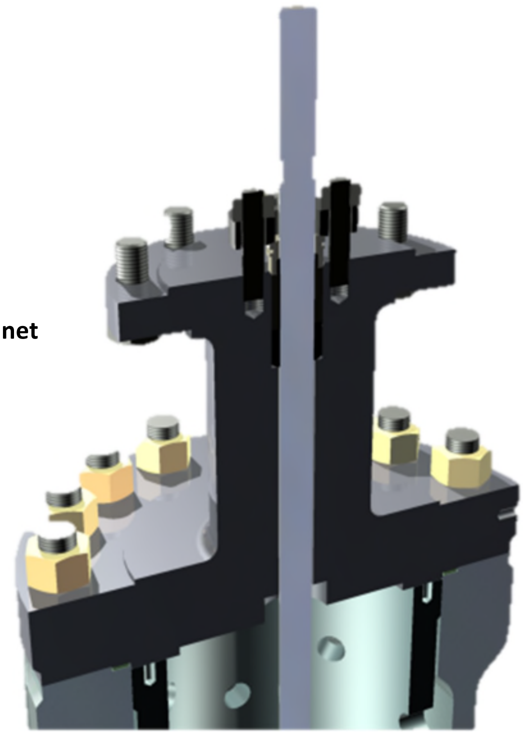
Pressure classes: ANSI 150 through and including ANSI 900: Bolted Bonnet.

Pressure classes: ANSI 1500 and higher: Pressure Seal Bonnet.

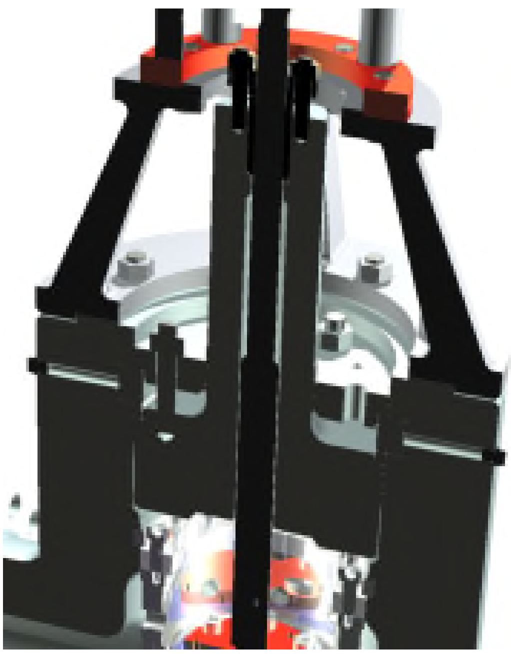
Cooling extended bonnets are supplied on most DSCV-SA. If the inlet steam temperature is above 250$_0$C (482$_0$F) then extended cooling bonnets are fitted as standard.

The cooling extension is designed to protrude 200mm (8 inches) to 300mm (12 inches) out of standard insulation thicknesses, depending on the size of the DSCV-SA.

The standard gland packing set is a lower carbon guide bushing, preformed Graphoil rings and a 431 stainless steel gland follower. Spring, live loaded packing is available with all bonnet options.



Bolted Bonnet



Pressure Seal Bonnet

DSCV-SA

FAQs – 5: MECHANICAL DESIGN: Trim Balancing

Turbine bypass valves are quite large and unbalanced trims on the majority of applications are not used due to the enormous actuation and stem forces that would be generated. Therefore the vast majority of trims in turbine bypass valves are balanced. The easiest and most economical method of balancing the trim is 'low pressure balancing'. Most other designs employ low pressure or P2 balancing; however, these low pressure balancing systems rely on auxiliary balancing seals such as piston rings and close tolerance sealing surfaces to prevent the high pressure steam unbalancing the trim. In operation, if these seals or surfaces wear or become damaged, the trim quickly becomes unbalanced and stem loads dramatically increase and fluctuate which can result in the valve oscillating violently or even unable to open on command.

The shutoff class and tight shutoff is also totally dependent on the performance of the balancing component parts. Tight shut, FCI 70-2 Class V, can be demonstrated in the factory with a newly assembled valve when piston rings and close tolerance sealing surfaces of the balancing cylinder are new. However, due to minimal wear or damage/scratching by small metallic particles in the steam on a new build power station the tight shut off will be lost.

Copes-Vulcan, during the early stages of the design of the DSCV-SA made the conscious decision to move away from low pressure balancing and hence remove all the risks and problems associated with low pressure balancing, witnessed numerous times on power stations.

HIGH PRESSURE BALANCING or P1 balancing is a key design feature of the DSCV-SA for reliable smooth operation. This design feature cannot be emphasised enough.

Benefits of high pressure balancing;

- ✓ **HIGH PRESSURE BALANCING** works in harmony with the dynamics of the high pressure steam rather than being in constant 'battle' with the high pressure steam trying resist it flowing into the low pressure areas of the trim.
- ✓ **NO** piston rings, sigma seals, etc. that wear and without very regular maintenance, cause:
  - Dramatically increases seat leakage.
  - Induce trim instability, dramatically increasing stem and actuator thrusts as the trim starts to go out of balance.
  - Bypass valve not opening to command signal as the leakage rate past the piston rings becomes so large the out of balance forces of the plug are too great for the actuator.
- ✓ **NO** close tolerance balancing cylinder surfaces that wear and become scratched with entrained small metallic debris in the steam. Without very regular maintenance, cause:
  - Dramatically increases seat leakage.
  - Induce trim instability, dramatically increasing stem and actuator thrusts as the trim starts to go out of balance.
  - Bypass valve not opening to command signal as the leakage rate past the piston rings becomes so large the out of balance forces of the plug are too great for the actuator.
- ✓ **NO** piston rings or seals required to be purchased as commission spares or held in the power plant stores as maintenance inventory or insurance spares.

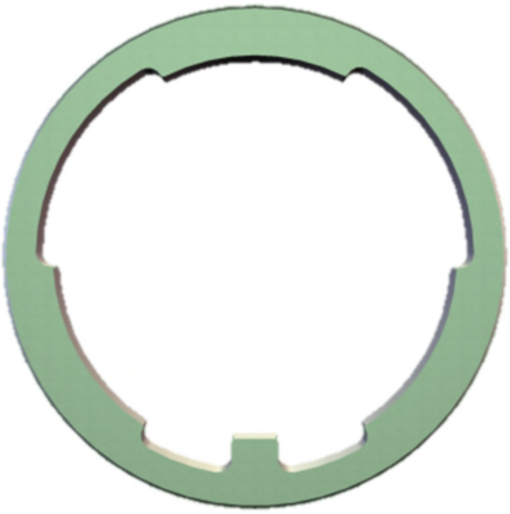
These benefits are very significant to the power plant owner and operator as high pressure balancing not only reduces maintenance and inventory costs but also removes the risk of the valve becoming unstable which may force an unscheduled maintenance outage. With repeatable tight shut off the DSCV-SA is also thermodynamically efficient by not leaking expensive high pressure steam.

The benefits for the EPC designing and erecting the power plant are reduced commissioning spares, a design that is more tolerant to entrained debris in the steam and thus giving far more confidence during commissioning and reliability runs.

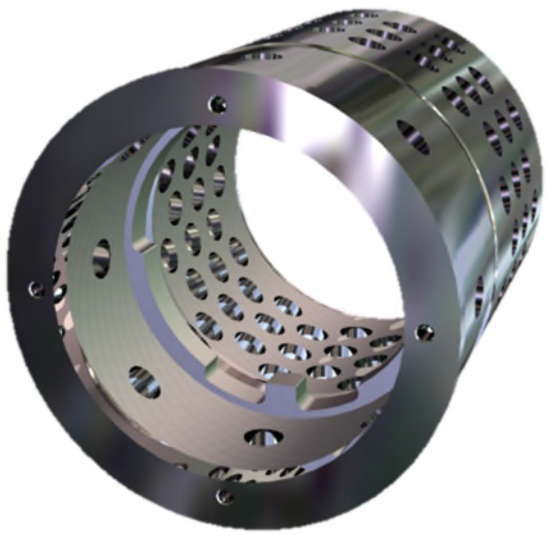
One of the key components of the high pressure balancing system is the E-A ring which has three important functions;

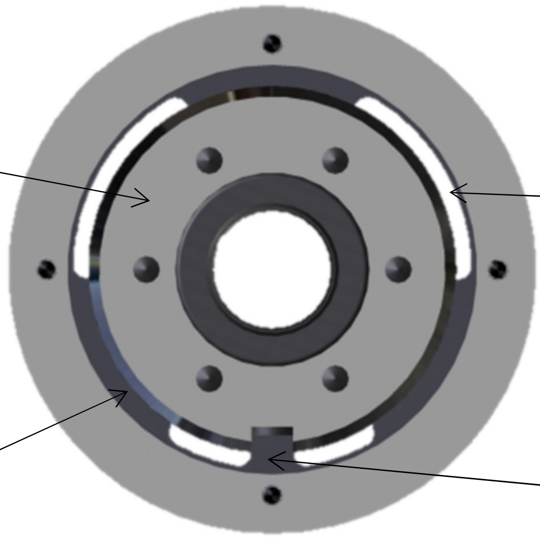
- Ensuring uniform high pressure steam pressure has unrestricted flow porting to both the top and bottom of the valve plug.
- Provides upper plug guiding for plug stability.
- Has an integrated and substantial plug anti-rotation key.

E-A Ring



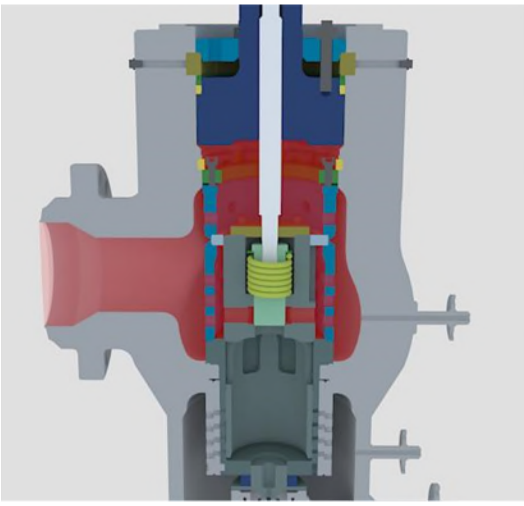
E-A Ring forms an integral part of the heavy duty distribution spacer





The DSCV-SA valve has a very tight shut off in the closed position, as a minimum ANSI FCI 70-2 Class V. It achieves this tight shut off by utilising a pilot plug design so that in the closed position the main plug is unbalanced with the full steam pressure acting on the top of the plug, white arrows indicating the steam pressure force on the plug. This load combined with the actuator thrust resulting in very high seat contact loads, which ensure a very tight shut off.

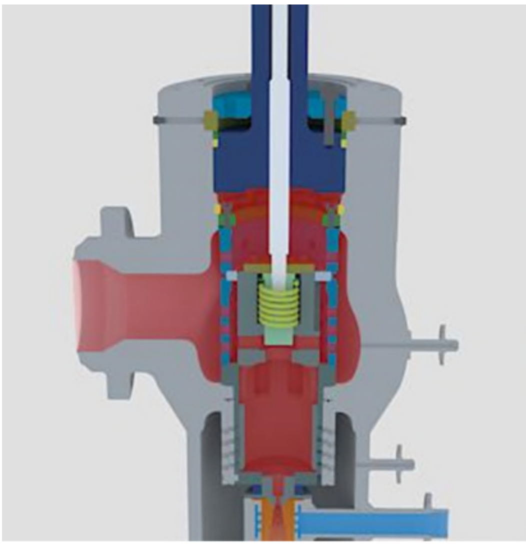
Not only is tight shut off required for plant thermal efficiency it also prevents leak induced 'wire drawing' damage across the seat which would otherwise result in frequent maintenance to repair or replace the seat.



When the DSCV-SA first opens the pilot plug opens and high pressure inlet steam floods the underside of the main plug. The plug is now high pressure balanced, high pressure steam is now on the bottom of the plug as well as the top.

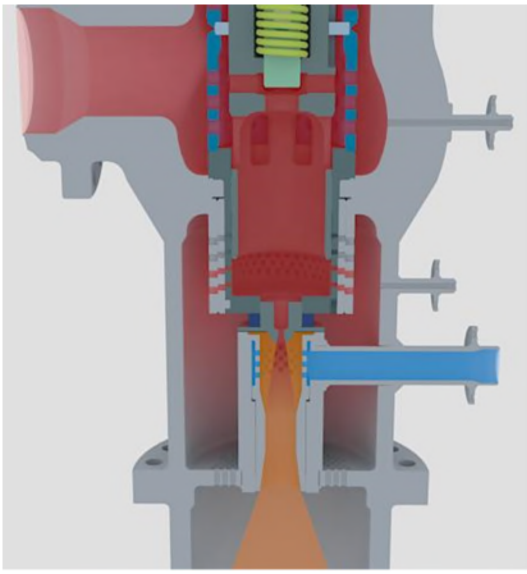
With the steam atomising nozzle connected to the main cage the steam atomising unit is now operating in preparation to receive the incoming cooling water from the water control valve.

The pilot plug CV is several times larger than the atomising nozzle which ensuring high pressure balancing.



As can be seen high pressure steam is freely allowed to flow both to the top and bottom of the plug, ensuring high pressure balancing.

The balancing system has NO piston rings or close tolerance balancing cylinders that can become worn or damaged.

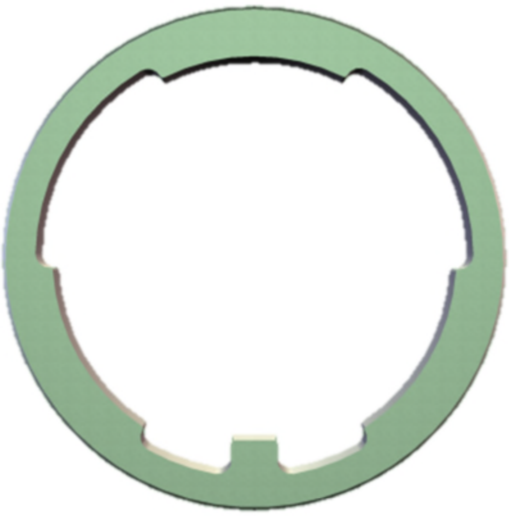


DSCV-SA

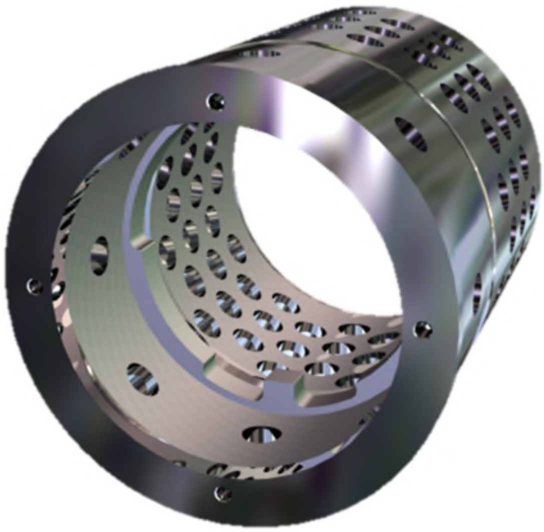
FAQs – 6: MECHANICAL DESIGN: Plug Anti-Rotation

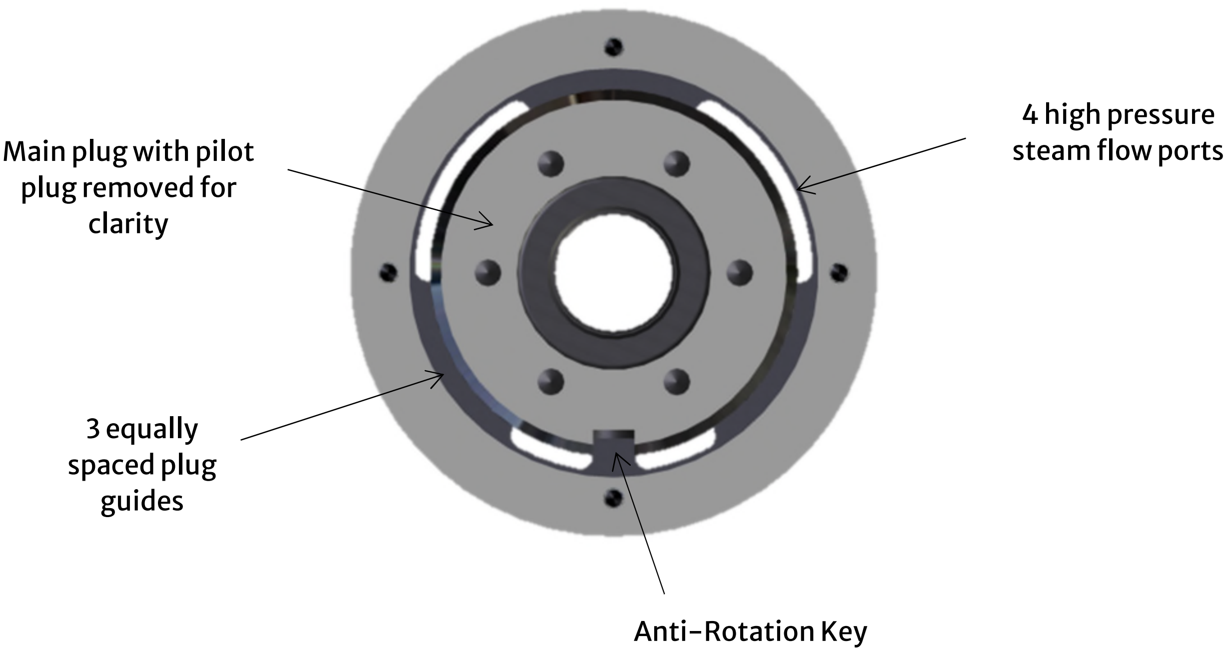
With large trims and especially large plugs rotational forces generated in the trim can be substantial. The magnitude of the rotational forces generated in a specific application and often unique installations is almost impossible to calculate or model. Therefore the DSCV-SA has an integrated anti-rotation key in the inlet heavy duty distribution spacer and matching key way in the plug. Therefore the risk of plug rotation and the damage that can cause is eliminated. The whole design philosophy of the DSCV-SA is, if any potential risk can be eliminated, it is.

E-A Ring



E-A Ring forms an integral part of the heavy duty distribution spacer



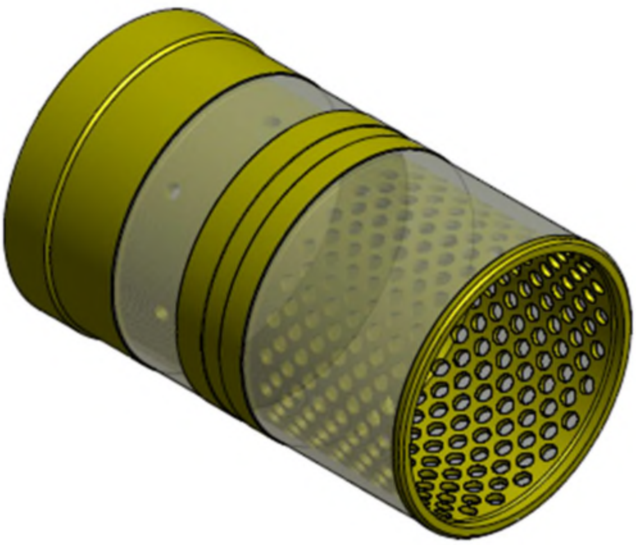


DSCV-SA

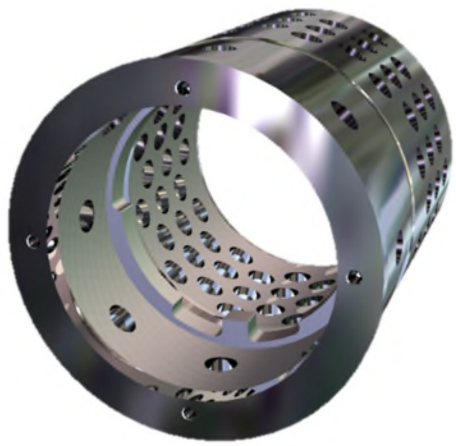
FAQs – 7: MECHANICAL DESIGN: Integral Steam Strainer

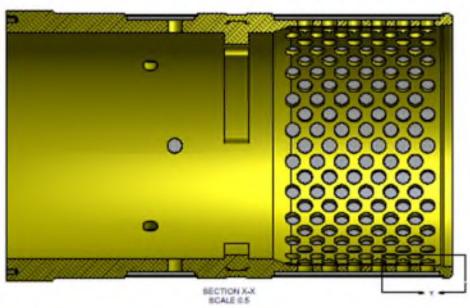
Although the DSCV-SA is quite tolerant to entrained debris in the steam as it has no piston rings, close tolerance balancing systems and natural self-clearing through the integral steam atomising nozzle it can be fitted with an integral steam inlet strainer. The strainer has a 3.0mm (0.118 inch) screen as per the requirements of TRD 421. The stainless steel screen is fixed to the outer diameter of the heavy duty inlet steam distribution spacer. The steam inlet strainer is an optional extra and should be requested at time of enquiry. It can also be supplied as an upgrade to installed DSCV-SA.

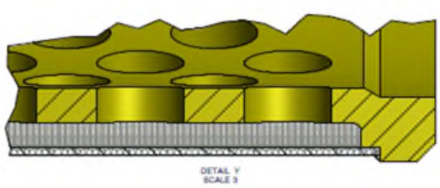
Heavy duty inlet distribution spacer fitted with 3.0mm screen steam strainer



Standard heavy duty inlet distribution spacer







DSCV-SA

FAQs – 8a: Actuation: Pneumatic

There are two types of pneumatic actuation within the Copes-Vulcan range, CV-700 & CV-1000 series spring opposed diaphragm actuators and CV-P800 single and double acting piston actuators. Pneumatic actuation represents approximately 80% to 85% of all the turbine bypass systems supplied, the rest being hydraulically actuated. The benefits of pneumatic actuation are significantly lower capital costs, reduced maintenance and no fire risk. Hydraulic actuation when using mineral oil can initiate a fire if an oil leak drips onto a hot surface.

Typical stroking speeds for turbine bypass systems are;

- Normal modulation; 10-15 seconds.
- Emergency fast mode (turbine trip): less than 1 to 3 seconds.

Actuation thrusts; as standard and unless specified differently by the customer all actuation thrusts calculated for the DSCV-SA are increased by a 30% safety factor.

Hand wheels; all models of pneumatic actuator have a hand wheel option. Generally side mounted with an additional top mounted option for the CV-700 series.

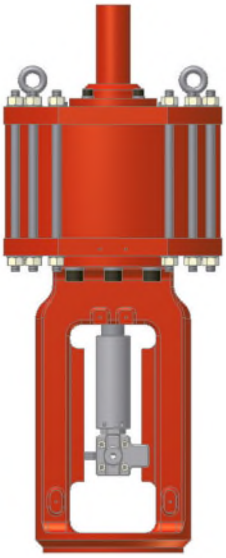
Only the smaller size DSCV-SA with relatively low thrust requirements short strokes will be fitted with the CV-700 or CV-1000 series diaphragm actuators. The majority of DSCV-SAs will be fitted with the CV-P800 piston actuators.

The CV-P800 piston actuator is either single acting with opposed spring or double acting. Due to the thrust requirements and stroke lengths most DSCV-SAs will be fitted with the CV-P800 double acting piston actuator.

CV-700 Series Diaphragm Actuator
Spring Opposed
Hand wheel top or side mounted
Low thrust
Limited to a maximum of 125mm stroke (5 inches)

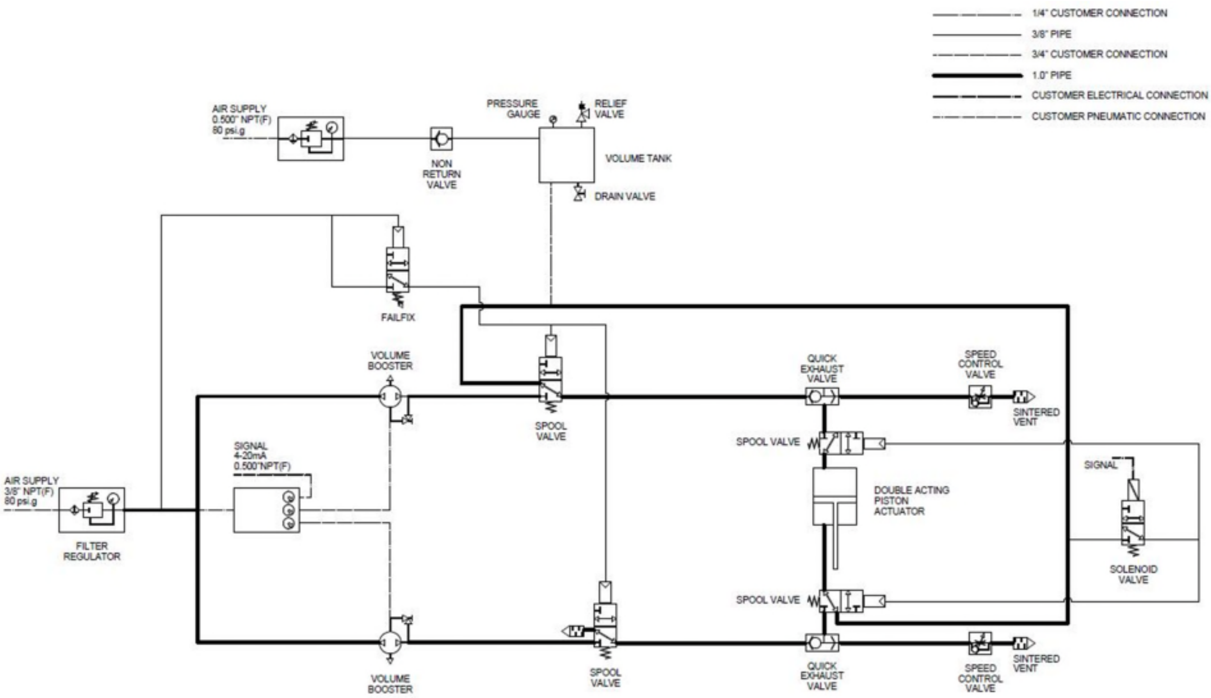
CV-1000 Series Diaphragm Actuator
Spring Opposed
Hand wheel side mounted
Low to medium thrust
Limited to a maximum of 75mm stroke (3 inches)

The CV-P800 double acting piston actuator is by far the most common actuator fitted to the DSCV-SA. Occasionally where thrusts and stroke lengths allow single acting units with springs are fitted.



CV-P800 Series Piston Actuator
Single or double acting
Hand wheel side mounted
High thrust
Limited to a maximum of 300mm stroke (12 inches), longer on request.

When an 'air fail' safety position is required, 'Air Fail Closed' or 'Air Fail Open', then an air volume tank will be supplied. Depending on the volume of air required the volume tank will either be mounted directly on the actuator or supplied as a vertical free standing tank. All air volume tanks are supplied as standard to ASME VIII div.1 design.



Typical Hook-Up drawing for double acting CV-P800 piston actuator, modulation stroking speed <10 seconds, air fail open with emergency fast open trip <2 seconds.

The Modern Steam Turbine Bypass Valve

Finding innovative ways to help the world meet its ever growing demand for power is a key focus for SPX. As a multi-industry Fortune 500 manufacturer, we provide creative solutions that serve global energy markets in a myriad of ways. Our ideas are helping to build more efficient new power plants and renovate older existing facilities. And, at thousands of power stations in more than 60 countries across several continents, our evaporative and dry cooling solutions are hard at work. We also supply a wide range of components — from air preheaters to filter systems for nuclear, coal-fired, combined cycle, solar, thermal and geothermal power plants.

Copes-Vulcan has been providing control valves and attemperators for the conventional & nuclear power generation industries since 1903. Copes-Vulcan provides a wide range of valves for the control of pressure, temperature and flow-induced noise in all types of power plants. Our strength lies in our ability to provide innovative valve solutions for our customers' application needs. The DSCV-SA steam turbine bypass valve demonstrates this innovative engineering philosophy perfectly.

DSCV-SA (Direct Steam Conditioning Valve – Steam Atomization)

The DSCV-SA is a leading, world class product that was specifically designed to meet today's increased demands of reliable high frequency operations, rapid pressure & temperature ramp rates, repeatable very tight shut off, eliminate thermal shocks (without the need of mechanical thermal liners), high rangeability, size and installation flexibility and low maintenance requirements.

The following information has been compiled to address and answer most of the questions raised with regards to steam turbine bypass systems. The information is comprehensive but not exhaustive and therefore please do not hesitate to direct any specific questions to Copes-Vulcan or your local representative.

Enclosed Sections cover:

- FAQs – Frequently Asked Questions
- High Pressure versus Low Pressure Trim Balancing
- Turndown (rangeability)
- Technical Advantages
- Rapid Ramp Rate Fatigue Analysis
- DSCV-SA Product Brochure