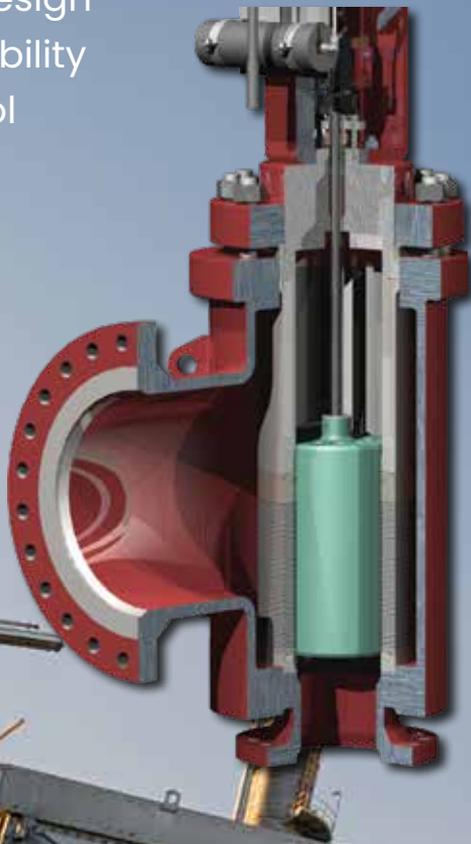


Masoneilan™ V-LOG™ Energy Management Trim

Integrated smart engineered solutions
for severe service applications

- Scalable trim design
- Operational stability
- Precision control



Masoneilan

a Baker Hughes business

V-LOG Trim Technology

Baker Hughes offers a broad portfolio of Masoneilan products consisting of general service and severe service control valves, actuators, pressure regulators, and valve-mounted smart instrumentation and accessories – all supported by an integrated network of sales offices. The breadth of our offerings enables us to help customers meet the demanding requirements of process control applications.

Masoneilan valve solutions, which include leading designs such as the *LincolnLog™* liquid letdown control valve, range from regulators to customized solutions, including the patented V-LOG labyrinth trim technology. We offer custom-tailored solutions configured for control performance, shut-off reliability and life-cycle cost-effectiveness. Leading product technology coupled with application expertise are the keys to our ability to meet customers' specifications.

Cost-Effective Engineered Solutions

We offer leading microprocessor-based field instrumentation technology. Award-winning HART communicating SVI™ digital positioners help improve your asset's effectiveness, resulting in higher returns on investment. By using patented tuning algorithms that optimize valve control performance, our digital positioners deliver improved process yields and lower maintenance cost.

Flexibility is built into each of Baker Hughes digital instrumentation offerings. SVI II AP and SVI FF valve positioners mount on any control valve actuator and interface effectively with HART and Foundation Fieldbus distributed control schemes, respectively (since SVI II AP is only Hart and SVI FF is only FF).

You can further increase flexibility and functionality with Baker Hughes smart instrument companion software such as *ValVue™*, a tool that monitors real-time device status. In addition, *ValvKeep™* valve database management and AMS Snap-on™ asset management software provide a comprehensive view into valve asset maintenance history and performance trends. These software support tools, in conjunction with the advanced diagnostic capabilities of smart devices, help significantly reduce operating costs

Innovative V-LOG Design

Our valve design innovation is at the foundation of our extensive portfolio of field-proven severe service products configured for the most challenging applications. Baker Hughes Masoneilan products have long been benchmarks for severe service innovation in industries such as power generation, oil and gas production and liquefied natural gas (LNG). These industries present many of the toughest control valve applications, particularly those involving large mass flow rate and high differential pressure such as compressor anti-surge, high pressure vents and turbine bypass.

Severe service applications present technical challenges associated with the high energy of the flow stream. V-LOG Energy Management trim meets these challenges, including the energy-related issues of noise and vibration, and stringent demands for control performance.

Benefiting from a very scalable trim design architecture, V-LOG trim offers a customized solution for a broad set of severe compressible fluid and liquid applications. Each V-LOG trim solution is designed to meet customer requirements including tight shutoff, fast opening speeds, operational stability, and precision control over a wide range of operating conditions.



Energy Management Principles

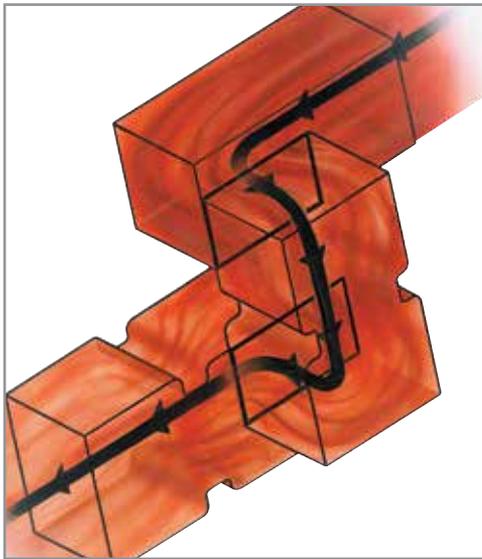
3-Dimensional Tortuous Path Flow

The three-dimensional tortuous path design of Baker Huges Masoneilan V-LOG trim controls pressure reduction through the management of process fluid energy. This is accomplished by directing the fluid through discrete flow channels which alternate across two adjacent planes to create a labyrinth effect. These flow channels contain multiple stages defined by 90 degree turns with intermediate contractions and expansions in the flow path.

Staged Pressure Drop

The labyrinth flow path of the V-LOG trim subjects the gas to a high level of friction as it is redirected through each turn in the flow path. V-LOG trim's patented flow contractions produce predictable and repeatable flow resistance that differentiates its design and performance from competing products. The V-LOG trim's design offers a unique flow path shape which maximizes valve efficiency and performance versus more traditional tortuous path trim technologies.

The enhanced flow geometry of the V-LOG trim creates a series of kinetic energy losses followed by partial energy recoveries at each stage. The staged reduction of the fluid pressure makes the gradual letdown process highly effective for noise attenuation.



The V-LOG Trim's Labyrinth Flow Path

Fluid Velocity Control

Each stage of the V-LOG trim is designed with an expansion in flow area, which is essential for managing fluid velocity that would otherwise increase as the pressure is reduced across each stage. The expanding area can compensate for the volumetric expansion of the gas, reducing any increase in the kinetic energy as the pressure is reduced.

Trim velocity control is important for maintaining low aerodynamic noise levels within the valve body and trim. High velocity trim exit flow will yield high magnitude sound waves, which lead to valve body vibration in high-pressure letdown applications.

Exit Flow Jet Spacing

By design, the process fluid is precisely separated into discrete flow jets upon exiting the V-LOG trim channels. The proper sizing and spacing of these channels prevents the exiting flow jets from reconverging, thus producing lower amplitude sound waves with higher peak frequencies. These lower sound pressure and higher frequency waves result in lower acoustical coincidence with the surrounding system and downstream piping. This reduces both the overall noise level and vibration effect of the throttling process.

Overall System Noise Reduction

As a gas experiences a large reduction in pressure, its volume expands. This phenomenon will yield a higher downstream velocity if the piping is configured without considering this volumetric expansion. Our angle body valve designs feature expanded outlet areas to accommodate this expansion and minimize the overall system noise level. (we consider both Outlet Mach Number and the Outlet Expansion Ratio for system noise calculation, per the IEC International Noise Prediction Standard [IEC-60534-8-3]).



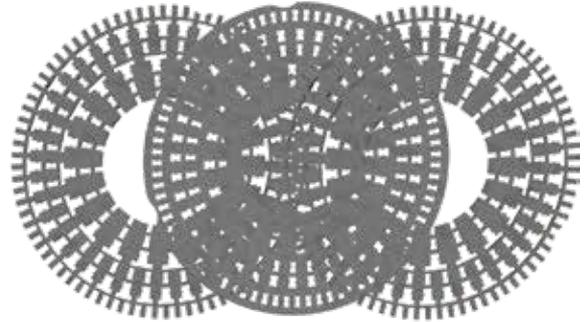
V-LOG Trim

Features & Benefits

Laser Cut Technology

The V-LOG trim's disks are laser cut, resulting in the tight tolerances and smooth surfaces which are required for throttling control. Precision trim-part cutting supports throttling area integrity that is necessary for fine control resolution and accuracy.

Prior to being secured through vacuum-tight brazing, the V-LOG trim's disks are stacked together and aligned using precision tooling. Each disk is designed with maximum surface area to promote a secure bond between disks during the brazing process.



Laser Cut V-LOG Trim Disks

Customized Flow Characterization

The laser manufacturing process gives each disk in the V-LOG trim the necessary geometry to provide desired control. In addition, the V-LOG trim's stack can be configured with tiered capacities in each disk to produce specific flow characteristic across the entire range of travel. For example, the stack design may be configured with a highly resistant flow path (up to 40 stages) at low lift and then progressively less resistant flow paths as the valve opens to its full capacity. Some designs may also combine V-LOG trim's stacked disk technology with drilled-hole or ported-cage technology.

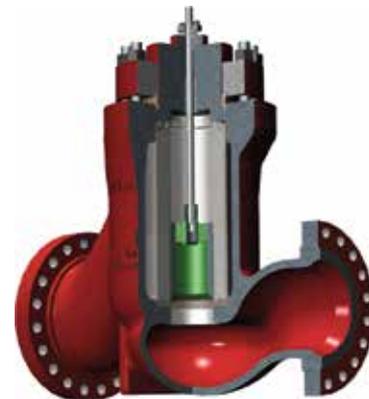
These combination trim configurations offer rangeability with excellent control. This is especially important for applications requiring the control valve to throttle during plant startup and at full load production.



Characterized V-LOG Trim & Ported Cage Design

Tight Shutoff

The full line of Baker Hughes Masoneilan V-LOG trim products achieve tight shutoff through seating-surface geometry and material selection. Shutoff performance consistent with ANSI/FCI Class IV and Class V leakage, as well as MSS-SP-61, is available. Tight shutoff performance is critical for preventing product loss, especially in applications that vent to atmosphere or burn off in a flare stack. Long-lasting tight shutoff is essential in turbine bypass and compressor surge applications to help protect critical equipment. To promote overall long-term trim integrity, V-LOG trim technology takes full advantage of hardened materials such as stellite and tungsten carbide.



49000 Series with V-LOG Trim Stack

Features

- 3-D Tortuous Path
- Patented Flow Contractions
- Multiple Stages
- Exit Flow Jet Spacing
- Expanded Outlet

-
- Laser Cut Disk
 - Precision Alignment
 - Flow Channel Characterization
 - Trim Technology Combinations
 - Masoneilan SVI II AP Valve Positioner Sensitivity and Accuracy

-
- Valve Aware (Valve Diagnostics)
 - Maximum Brazing Surface
 - Seating Geometry and Materials
 - Hardened Trim Materials
 - SVI II AP Valve Positioner Diagnostics

Benefits

Efficient scalable solution for high pressure drop applications. Trim technology can be packaged in a variety of valve sizes and designs to offer the cost benefit of standardization and the reduced downtime associated with easy retrofit.

Minimum system noise and vibration results in longer product life, lower life-cycle maintenance costs and reduced risk of critical equipment downtime.

Trim integrity yields high control resolution and unequalled control accuracy for optimum process efficiency.

Exceptional digital positioner control performance offers higher yield of “on-spec” product for maximized return on investment.

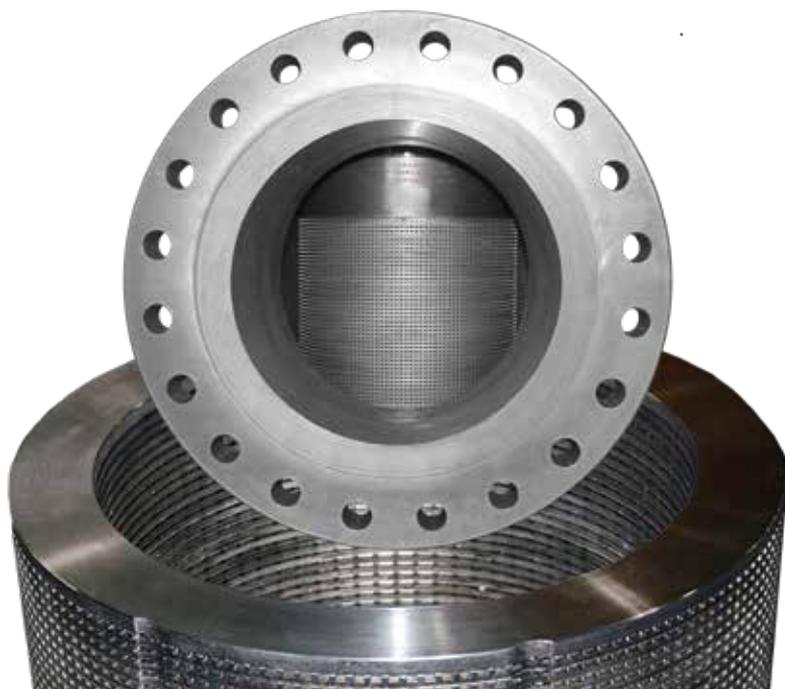
High rangeability satisfies varying process demands. The “two-valves-in-one” approach reduces life-cycle maintenance costs.

Performance reliability of integrated, smart-engineered control solutions results in faster startups and accelerated “time to revenue.”

Trim integrity and reliability minimizes maintenance and overall life-cycle costs.

Diagnostic information enables preventive maintenance and provides substantial life-cycle cost savings due to less process downtime.

Reliable tight shutoff minimizes loss of revenue-generating process fluid (steam, natural gas, etc.).



Typical V-LOG Trim Applications

Liquefied Natural Gas

V-LOG trim technology can be applied throughout the entire Liquefied Natural Gas (LNG) process. From the gas production and receiving stage through the compression and processing stages, V-LOG trim technology can help keep the plant running in a stable and continuous mode of operation. In addition, fast and precise control with actuator stroke speeds measured in milliseconds makes V-LOG trim suitable for compressor surge control. With expanded outlets, extension bonnets and energy management trim, V-LOG trim technology often is a solution for the high-fluid-energy applications in LNG liquefaction and re-gasification processes.

Vent-to-Flare

As an LNG train comes online, it is essential to achieve a stable and controllable gas flow before the gas is passed into the separators, strippers, compressors, and other critical process equipment. The gas flow is passed through a vent-to-flare valve until the unit reaches the desired level of capacity.

Baker Hughes Masoneilan 72000 Series is available with single or double stage *Lo-dB*[™] trim, as well as V-LOG trim for higher-pressure drop applications. These valves are available with a number of different instrument packages to meet various specifications, including a fast stroke of one second or less, or precise control with resolution to 1/10,000th of an inch.



72000 Series Severe Service Control Valve

Reliable gas venting in less than one second	Protects costly downstream equipment and reduces downtime
Class V and MSS-SP-61 tight shutoff	Grows revenue by preventing loss of process flow
Lo-dB and V-LOG trims reduce the pressure drop across multiple stages	Reduces noise through staged pressure reduction and minimizes velocity



Compressor Recycle & Anti-Surge

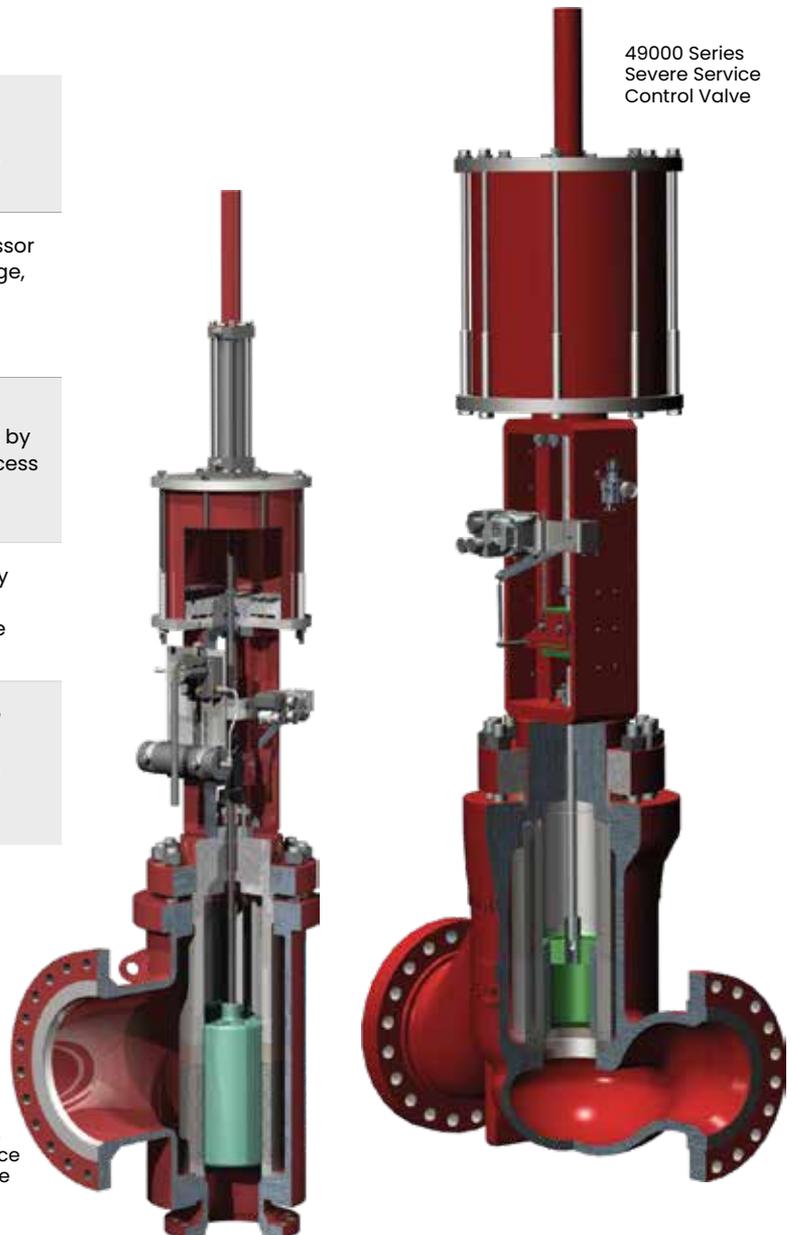
To achieve maximum efficiency, compressors are challenged to operate as close as possible to their surge limits. The risk of control loop instability is magnified with reduced surge operating margins.

The technology offered with the low vibration V-LOG trim, combined with the precision control and fast response of the SVI II AP valve positioner, offer the security needed for this critical service application. Coupling this technology with Valve Aware for real-time asset management helps to protect your system.

Baker Hughes Masoneilan 49000 Series and 72000 Series control valves are available with several features that help meet the demands of these severe service applications.

Our compressor anti-surge package offers reliability for not only LNG plant operation, but all compressor applications. The V-LOG Trim manages the fluid energy as pressure is drastically reduced across as many as 40 stages, while the valve is fully stroked in as little as a half second.

Class V and MSS-SP-61 tight shutoff	Increases efficiency by reducing leakage to latter stages of the compressor system
Fast response, less than one second	Prevents the compressor from going into a surge, which prevents down time and increases production
SVI II AP precision positioning, and quick response (1-3 seconds) through complete range of travel during recycle operation	Increases profitability by reducing wasted process energy
High turndown characterized V-LOG trim	Reduces initial cost by allowing single-valve control over the entire range of operation
Low noise V-LOG trim	Reduces the pressure drop across multiple stages, which lessens noise, vibration and maintenance cost



Typical V-LOG Trim Applications

Gas Production

Oil and gas applications often involve extremely erosive flow streams, which dictate the proper trim design and material selection. Many hardened materials, including full tungsten carbide trim in extreme cases, are used as a rugged barrier on critical surfaces for extended protection against entrained particles traveling within the flow stream. V-LOG trim technology is well suited for the challenges of highly erosive service.

Stellite or equivalent clad guiding for corrosion and vibration resistance	Trim integrity extends valve life and minimizes life-cycle costs
Inconel clad valve bodies offer long lasting reliability	
Tungsten carbide trim and seat help protect against wear	

Wellhead choke applications often are an ideal use for V-LOG trim technology. These valves are available as both ANSI or API-rated designs with enlarged and expanding flow orifices to reduce blockage caused from loose debris picked up from the inside of the well. When enhanced with the hardness and ruggedness of tungsten carbide disks, V-LOG labyrinth trim yields extended life in these typically high-wear applications.

A compact valve package can be a big benefit in offshore production facilities. V-LOG trim can be fitted into a lightweight globe or angle- style body for easy installation. We also offer a range of actuation options, including a very compact, self-contained, electro-hydraulic option that is ideal for tight installations between platform decks, as well as a wide range of packing designs to reduce the release of fugitive emissions in sour applications.



SE-20 Forged Body Control Valve



Large Flow Path, Tungsten Carbide V-LOG Trim Disks



49000 Series
with V-LOG Trim in a
Gas Storage Field



Gas Storage & Well Re-Injection

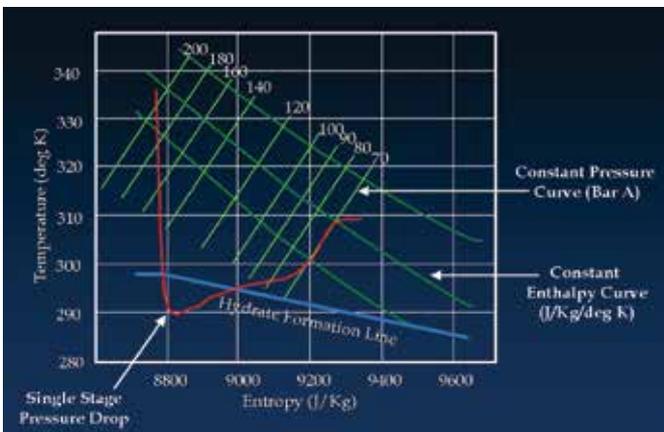
Gas delivery companies can quickly run out of capacity during peak seasons due to spikes in demand. To limit the risk of interrupted supply, gas reserves are typically stockpiled in underground salt caverns, mines, aquifers, depleted reservoirs and other natural storage facilities.

Natural gas is compressed for delivery to these storage areas. This process is regulated by control valves, which must also limit the formation of hydrates, or fluid icing, that can block small flow passages. To prevent this icing formation, gas companies must invest in large and expensive heaters to elevate and maintain the gas temperature above the hydrate level – unless they use multi-stage V-LOG trim technology.

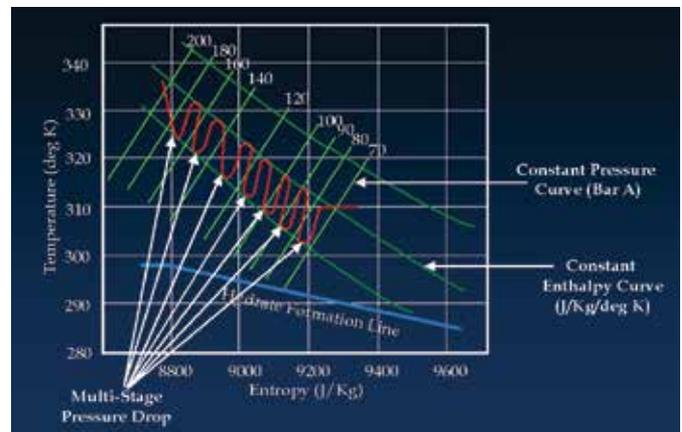
By reducing gas pressure gradually across a smooth and controlled process, V LOG trim keeps gas temperature above the hydrate level without the assistance of additional heaters.

When peak season arrives, these storage reservoirs must be depleted to return gas to the pipelines for distribution.

The 49000 series with V-LOG trim is capable of bidirectional operation, making it well suited for gas injection and withdrawal. Furthermore, V-LOG trim can be characterized to effectively manage both storage and withdrawal operations; this capability offers savings by limiting the number of valves and complexity of the control scheme. During the non-peak season, gas travels through valving with a small pressure drop and a very large Cv to fill the storage area. As the gas is later withdrawn from storage, it flows with a high pressure drop and a low Cv. A Better Fit solution for this application is a combination trim: V-LOG trim at low lift and drilled-hole or ported-cage at high lift. Similar design principles are applied for wellhead reinjection applications, making the NACE-compliant 49000 Series an ideal fit for performance and control.



T&E Diagram for Methane (Single Stage Valve)



T&E Diagram for Methane (Multi-Stage V-LOG Valve)

Typical V-LOG Trim Applications

Power Generation

Power plants are home to a variety of severe service control valve applications with high pressure drop ratios that may result in excessive levels of noise and vibration. Older power plants were outfitted with available severe service technology, namely drilled-hole cage valve trim. In many of the most severe applications, this trim technology only lessened the noise or vibration problem. Using the latest control valve technology, V-LOG trim can help eliminate the problems associated with the most demanding services in both new and old power plant designs.

Today, Baker Hughes Masoneilan Lo-dB or V-LOG trim technology is helping to solve noise and vibration problems in the most demanding applications.

Vent-to-Atmosphere

Similar to the Vent-to-Flare application, the Vent-to-Atmosphere valve must contend with the problems of high-pressure, high noise and gas expansion. In most vent applications the process pressure is so extreme that conventional drilled-hole cage control valves are not suitable.

Reduces noise through staged pressure reduction and minimizes velocity:

- Large valve body gallery minimizes trim exit velocity
- Expanded valve outlet accommodates the volumetric expansion of steam
- V-LOG trim reduces the high pressure drop across multiple stages

Baker Hughes engineered solution for this application is the Masoneilan 72000 Series control valve with V-LOG trim in series with a downstream silencer. The 72000 Series valve is a rugged reliable solution that reduces inherent problems, extends valve life and minimizes costly process downtime.

Soot Blower & Auxiliary Steam

Depending on the power plant design, soot blower and auxiliary steam process applications can exhibit a wide range of pressure drops. Because of the wide range of pressure drop ratios, no one valve or trim design is best suited to serve all possible variations of soot blower and auxiliary steam process applications. Depending on the severity of the application, globe or forged bodies, single stage drilled-hole cages (Lo-dB Trim) or V-LOG trims may be applied.

Baker Hughes cost effective valve and trim solutions for high pressure steam include:

- 21000 Cast globe or angle control valve to ANSI 2500 with single or double stage Lo-dB trim.
- 49000 Cast globe or angle control valve to ANSI 2500 with single or double stage Lo-dB and V-LOG trim.
- SE-20 Forged globe or angle control valve ANSI 4500 with single or double stage Lo-dB and V-LOG trim.

Liquid V-LOG Trim Technology

Liquid V-LOG labyrinth trim technology is offered in many high-turndown, liquid applications where special trim characterization is required to meet the full range of operating conditions.

Within a liquid V-LOG trim stack, each 90-degree turn in flow direction acts as a step reduction in pressure, simulating the gradual pressure reduction effect caused by head loss through a long radius pipe elbow. The gradual pressure reduction produces less pressure recovery per stage, thus eliminating the potential for cavitation.

A comparison between one-step and gradual multistep pressure reduction solutions is shown in Figures 1 & 2. The direct pressure reduction scheme (Figure 1) results in a single, dramatic pressure drop and recovery, which can lead to cavitation if the initial drop falls below the fluid vapor pressure. In contrast, the high flow resistance of V-LOG trim tortuous path trim creates a multi-step pressure drop profile (similar to that shown in Figure 2). By managing the energy throughout the pressure reduction process, V-LOG trim technology can address cavitation problems at the source.

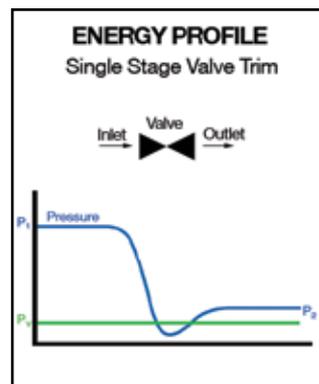


Figure 1
Single-Stage Pressure Reduction

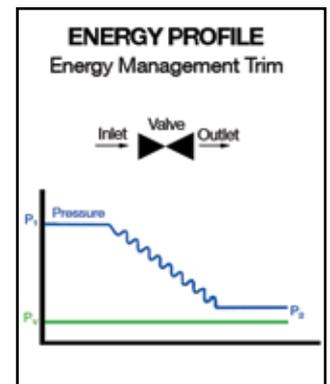


Figure 2
10-Stage Pressure Reduction

Boiler Feedwater Start-up and Regulator Valves

Conventional power plants often are designed with feedwater systems using two separate control valves. The first control valve is used for startup, as the conditions yield a low amount of flow with severe pressure drop. This startup condition exhibits high cavitation risk and requires a very rugged valve solution. Typically, a second control valve is used to regulate the feedwater conditions when the plant operates at full capacity. This valve experiences a much higher flow rate, but across a very moderate pressure drop. This main feedwater regulator valve does not experience cavitation.

In many of today's power plants, specifically the combined-cycle plants, engineers often prefer to combine these two valves into a single control valve to make maintenance easy and the control scheme simple. Liquid V-LOG trim technology is configured to manage and control process fluid energy over this wide range of operation. This involves characterizing the trim design to match the characteristic of the feedwater pump's operating curve, with the low travel range to include multiple stages of anti-cavitation stacked disk, while drilled holes on the high range of travel provide for the large flow capacities required.

- 49000 Series with quick change trim for ease of maintenance
- Precision control using Baker Hughes Masoneilan SVI II AP Valve Positioner
- High turndown, characterized trim
 - Multi-stage anti-cavitation V-LOG trim at low lift for high resistance
 - Drilled-hole or ported-cage at full opening for high capacity

49000 Series
Globe Control
Valve



Turbine Bypass Systems

Steam turbine generators create power by passing high-pressure steam through a series of stages that propel the turbine blades at high speeds. At high-pressure-drop ratios, the turbine design is a very effective model for the multi-stage pressure letdown process. During startup or upset conditions, the turbine bypass system is used to divert steam around the turbine, which maintains stability in the closed loop system. For high-pressure bypass, the V-LOG trim follows the same principles of pressure letdown as the steam turbine, i.e., letdown across multiple stages of expanding area to reduce damage resulting from sudden and severe pressure reduction.

The V-LOG trim is ideal for supercritical and conventional power applications where there is no reheat section in the boiler. Both of these applications take steam at very high pressure down to condenser. Regardless of whether the bypass system involves desuperheating or not, V-LOG trim technology can be integrated into the right valve solution.

Baker Hughes Masoneilan 84003 Series *SteamForm™* steam conditioning control valve uses patented desuperheating technology to meet the demands of turbine bypass.

- Expanded outlet to accommodate the change in steam density and minimize valve outlet noise
- Low noise V-LOG trim to reduce the pressure across stages
- Class IV, Class V, and MSS-SP-61 tight shutoff
- Fast stoking actuation package to prevent safety valves from lifting

84003 Series SteamForm
Steam Conditioning
Control Valve



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