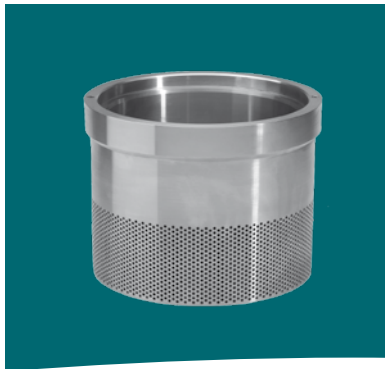




## *Flowserve Gaseous Noise Control*



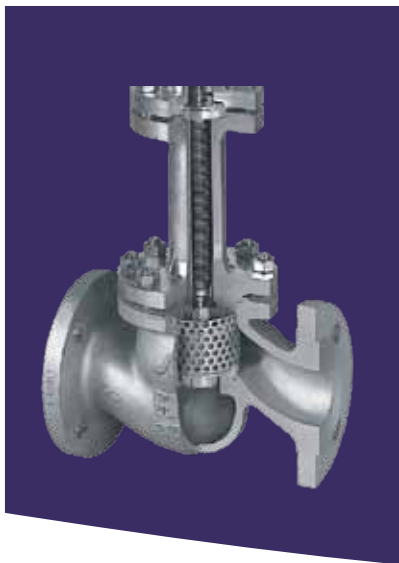
*Experience In Motion*



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The Bernoulli principle: When the fluid pressure in the valve drops, the fluid velocity rises.



## 1. Introduction to Noise

### 1.1 Pressure Profiles Through Control Valves

As a fluid travels through a conventional single-seated globe-style control valve, a vena contracta (point of narrowest flow restriction) develops directly downstream of the narrowest throttling point. At the point of vena contracta the fluid reaches a minimum pressure and maximum velocity which rapidly recovers to a lower pressure than the inlet pressure (see Figure 1.1: Pressure Drop through a Control Valve). Due to the Bernoulli principle, when the fluid pressure in the valve drops, the fluid velocity rises (see Figures 1.2: Velocity through a Control Valve). As the velocity of the fluid increases, the noise generated by turbulence in the fluid also increases. A significant rise in velocity can produce noise beyond safe limits.

### 1.2 Gaseous Severe Service

High pressure drops in gas services will generate turbulence in the fluid flow downstream of the pressure drop. As a direct result of the turbulence, noise is radiated to the surrounding area by the downstream piping system (Figure 1.3: Noise Radiating from Downstream Piping). In situations where equipment damage or personal injury could be caused by a noise source, attenuation is mandatory.

Tests have demonstrated that control valve noise increases proportional to the velocity cubed ( $SPL \sim V^3$ ). Moderately higher velocities can produce significantly louder noise. Substantial noise can be generated even when velocities are significantly less than sonic.

Mechanical vibration accompanies high acoustic noise levels. Acoustic noise and mechanical vibration levels are greatly compounded (up to 50 times) when the frequency of the excitation matches acoustic and/or mechanical natural frequencies of the system.

Noise suppression solutions should always be considered in high pressure drop, high flow rate or resonant noise applications.

Control Valve noise is measured in decibels (dBA). Decibels use a logarithmic scale, doubling the energy level of sound pressure wave will cause the noise level to increase by about 6 dBA. The dBA scale is structured to the human ear, the lowest noise a human can hear is around 0 dBA and a rivet gun is around 100 dBA. Ear protection should be considered when noise levels are above 85 dBA.

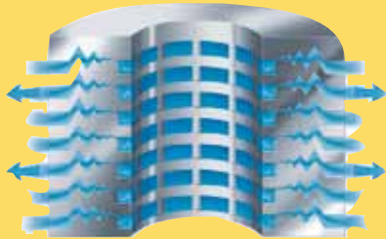
Uncontrolled noise is a significant problem that can lead to serious health problems, vibration and equipment damage. The health problems caused by noise are often thought to be limited to hearing damage. However, exposure to excessive noise can cause damage to internal organs, and in extreme cases, can kill. Vibration damage is the most common equipment damage, leading to worn, failed parts, broken support systems and sensor instability. In some rare cases, noise levels can spiral out of control even rupturing lines. Often equipment damage caused by noise is hidden, constantly wearing out parts that require frequent replacement. Noise predictions should be performed on all controls valves flowing gasses to verify the suitability of the equipment.

### 1.3 Factors Impacting Noise

#### Fluid Velocity

The most frequently used solution to high levels of control valve noise is to reduce the pressure from the valve inlet to outlet gradually, eliminating pressure and velocity spikes throughout the trim (Figure 1.4: Pressure through a Multi-Stage Valve). By lowering the pressure gradually, lower velocities are created. The lower velocities generate lower noise levels. Successfully applying this technique requires controlling the gas velocity through the valve trim and at all points from the inlet to the outlet of the valve.

Occasionally fluid velocities at the valve outlet or even in the downstream pipe can cause excessive noise. In these



Conception



Development



Manufacture

cases, simple trim solutions will not provide the needed noise attenuation.

Outlet velocities below 0.33 Mach are desirable. Higher velocities may be acceptable, but require an engineering review for each application. Velocities must be assessed for the most difficult flowing conditions at the following critical points (as shown in Figure 1.5: Critical Velocity Zones on page 6):

- The inlet passageway to the valve
- The internal flow area of the seat retainer at all plug positions
- The gallery flow area formed between the outside diameter of the seat retainer and the inside diameter of the valve body
- Outlet passage flow area

**$P_1/P_2$ , the Pressure Ratio**

The driving force behind velocity and noise is contained in the  $P_1/P_2$  ratio, which represents the energy available to generate noise. When this ratio is low, the energy con-

tained in the fluid stream will be low and the noise generated will typically be low as well. Each noise solution will have a range of pressure ratios where the design is most effective. Noise control trim is most effective when pressure ratio of the service is below the trim design limits.

**Reducing Pressure while Controlling Velocity**

The most common method to reduce noise is to separate a large pressure drop into smaller pressure steps which will produce far lower velocities at each step. A number of mechanisms are available to reduce the pressure without creating excessive velocity. Designs which make efficient use of these mechanisms will create the lowest noise possible.

**Sudden Expansion and Contraction**

A fluid that experiences a sudden expansion or contraction creates turbulent zones in the fluid flow. These turbulent zones take energy out of the fluid in the form of pressure. This is the primary effect used by orifice plates to create a pressure drop.

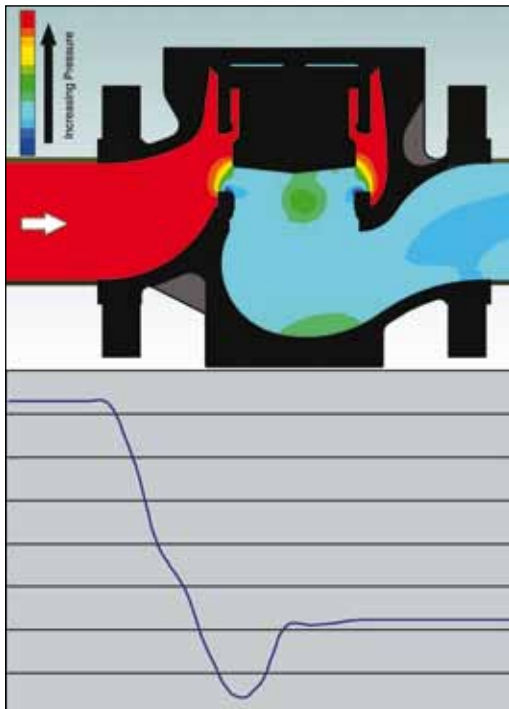


Figure 1.1: Pressure Drop Through a Control Valve

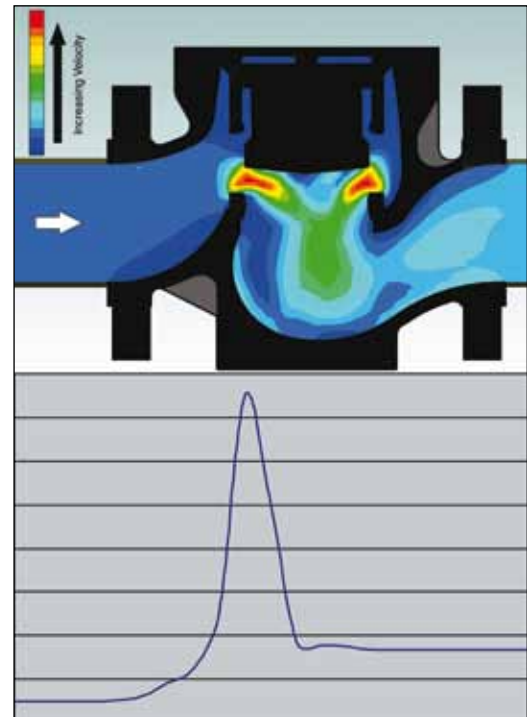
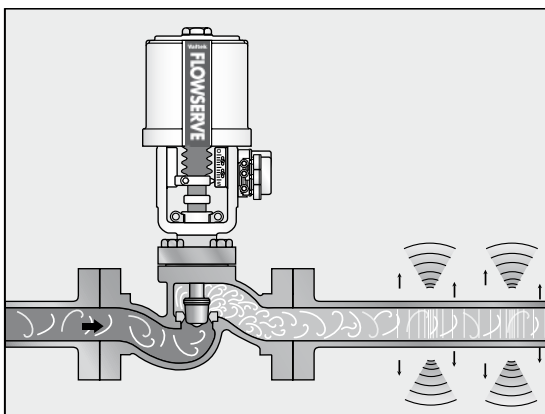


Figure 1.2: Velocity Through a Control Valve



**Figure 1.3: Noise Radiating from Downstream Piping**

**Small Flow Passages**

Small flow passages accentuate the friction formed by the passage walls. As the passage grows smaller, more pressure is required to force the fluid to flow. Many valve designs use small passages to create frictional losses to reduce the pressure.

**Mutual Impingement**

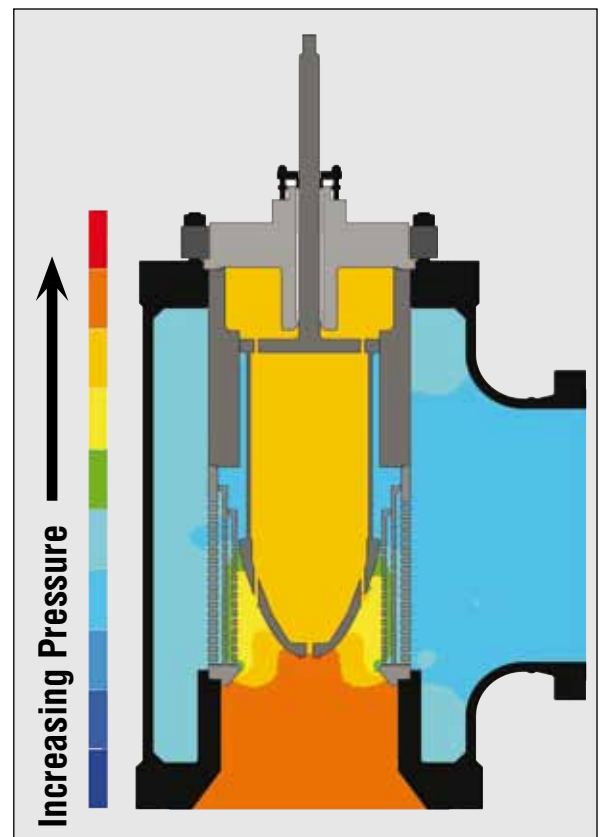
By directing two flows to impact each other at 180 degrees, a highly turbulent zone is created. This turbulent zone dissipates energy. With one flow working against the opposing flow, the pressure is reduced without adding velocity to the flow.

**Turns**

Each sudden turn in the fluid flow path will cause the pressure in a fluid to drop. A small velocity increase occurs as the fluid makes the turn. The angle of the turn can have a dramatic effect on the energy loss from the fluid as it makes the turn. Angles sharper than 90 degrees are difficult to manufacture, but have more of an effect on reducing pressure.

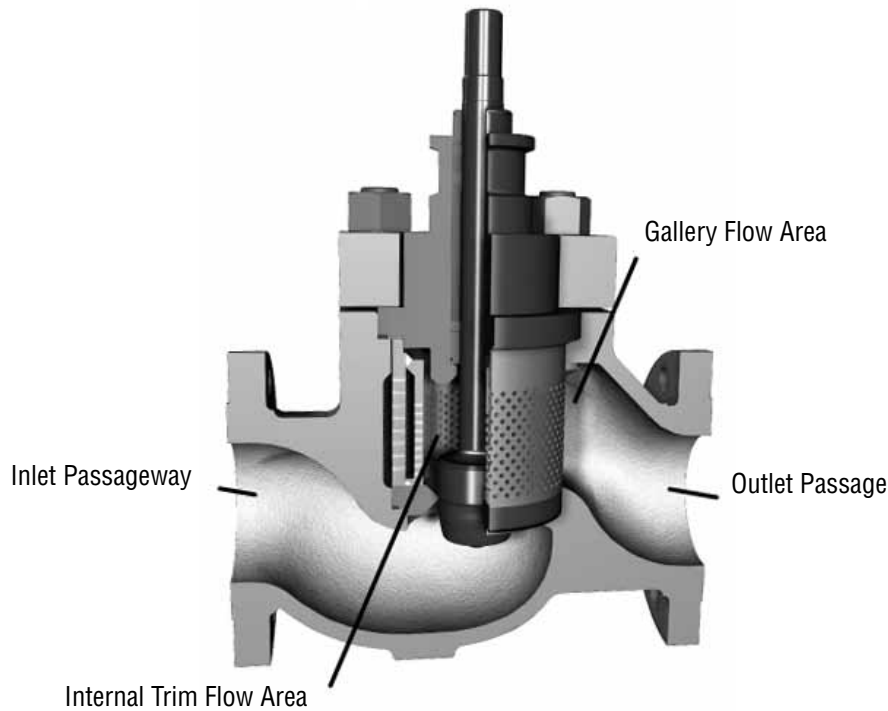
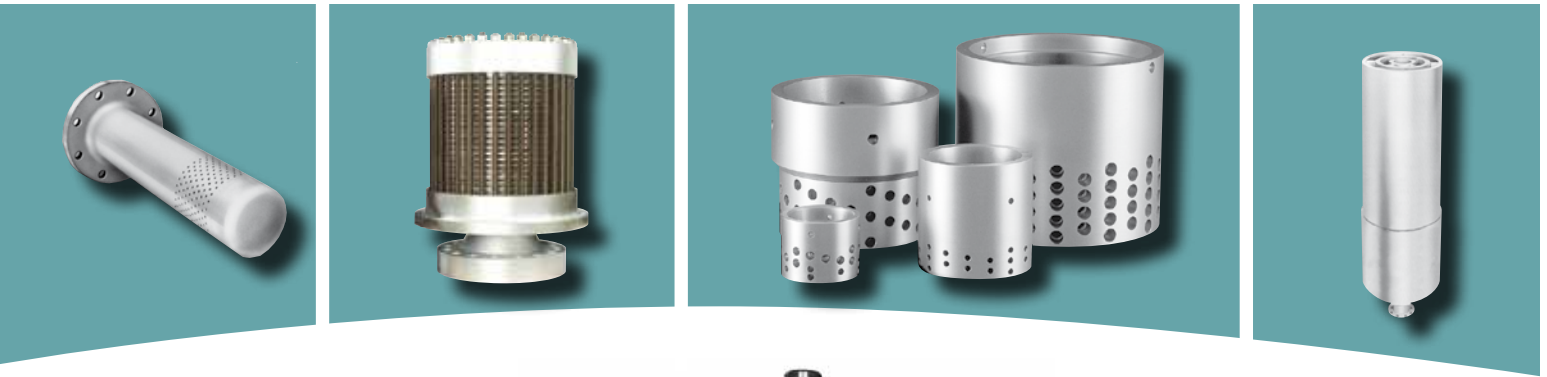
**Peak Frequency Effect**

Most noise in a control valve produces a range of frequencies which have a bell-curve type distribution and a peak frequency. Changes in the geometry of the valve design will shift this peak frequency.



**Figure 1.4: Pressure Through a Multi-Stage Valve**

Shifting the peak frequency higher is very desirable for two primary reasons. First, it can shift the frequency out of the range of human hearing. This lowers the perceived noise and reduces the damage to human organs. Second, it reduces the level of noise that can pass through the pipe. The natural frequency of pipe is low. When the frequency of the noise matches the natural frequency of the pipe, the pipe will resonate in sympathy, easily passing the noise from the inside to the outside of the pipe. Higher frequencies don't have this resonance and will pass less noise out of a pipe. Higher peak frequencies will be contained inside the pipe better than lower frequencies.



**Figure 1.5: Critical Velocity Zones**

A common method to raise the peak frequency is to make smaller outlet holes in the noise control device. Cutting a hole diameter in half can lower the overall noise level by up to five decibels.

**WaveCracker Technology**

WaveCracker is a technology that reduces noise as flow passes through passages with irregularly shaped cross sections. Tests have shown this technology effectively can reduce noise by more than ten decibels.

WaveCracker works by forming an irregular cross section shape (see Figure 1.6: WaveCracker Passages). Sound waves reflecting off the walls of the passage have irregular patterns. These irregular patterns cause the sound pressure wave to lose intensity as it moves down the passage.

**Mass Flow**

Lower pressure drops across control valves will produce significant noise if the mass flow rate is high. This happens most often in large valves when many small noise

generation sites combine to produce a loud cumulative noise level. Combating this problem is more difficult since taking the pressure drop in small stages may not be effective.

**Acoustical Attenuation**

Acoustical attenuation can provide a barrier which blocks noise. This can be done in many ways, from insulating the pipe to increasing the distance to the noise source. Careful engineering of a noise solution includes evaluating any existing or potential attenuation.

**Harmonic Vibration**

Harmonic vibration occurs when the natural frequency of the pipe and valve approach a common frequency. This causes a noise with a single frequency and a characteristic sound that is often called screech. Since screech occurs when the frequency of the valve and pipe match, it is not easily predicted. However, simple changes in the valve geometry can usually solve the problem.

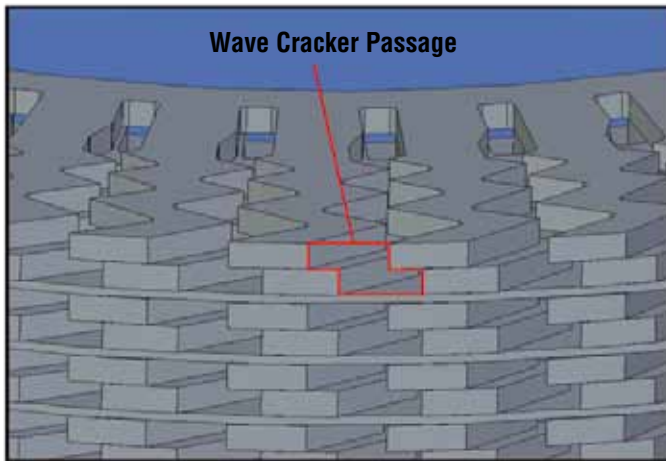


Figure 1.6: WaveCracker Passages

#### Reflective Surfaces

Noise coming from a pipe can be amplified by reflective surfaces. Noise predictions assume a free field, which is defined as no reflective surfaces. A single flat surface near the control valve, like a concrete floor, can add three decibels to the noise. Each flat hard surface can add another three decibels. Two hard flat surfaces that are parallel to each other will add substantially more than six decibels. Adding walls, a ceiling and a floor can add thirty to forty decibels.

#### 1.4 Prediction Techniques

A number of prediction techniques exist with varying levels of accuracy for different applications. Using different prediction techniques to predict the noise of an application will often result in widely varying results. Unfortunately, no standard exists which is the most accurate for all possible conditions. Therefore, when noise is a critical factor a study of the flow conditions, valve design, and the available noise prediction methods should be undertaken.

#### Valve Manufacturer Standards

Most manufacturers have proprietary techniques which will produce acceptable predictions under a certain range of conditions and with equipment the manufacturer is familiar with. When used outside of the acceptable range or with other equipment, predicted noise calculations can be significantly different than actual noise produced.

#### IEC 60543-8-2







In an effort to provide an accurate standard that can be used to compare different manufacturers, the IEC committee has developed the IEC standard 60543-8-2. Although this prediction method is not perfect for all conditions or valve styles, this method does create a clear baseline to compare different valve models

#### 1.5 Additional Selection Factors

The following factors should be considered before applying expensive noise suppression equipment:

- How much noise attenuation is actually required?
- What are the low-cost alternatives to noise attenuation?
- If noise attenuation devices are necessary, what lower-cost equipment can be specified? If the predicted sound pressure level (SPL) exceeds 85 or 90 dBA, noise suppression devices should be considered. However, higher noise levels may be acceptable if the noise is not associated with equipment damage and is located in a remote location away from people. Other possible low-cost alternatives to noise suppression equipment are:
  - Piping insulation
  - Discharging the valve directly into a vessel (allowing the noise to be absorbed by the vessel)
  - Relocating the noise source (such as the downstream piping) outside an enclosed area
  - Reversing the flow direction through the valve
  - Reducing the pressure drop across the valve.

## 2. Product Comparison

Design	Globe, Multi-Stage Noise Control	Globe, Multi-Stage Noise Control	Globe, Multi-Stage Noise Control
			
<b>Type</b>	Stealth	TigerTooth	MegaStream
<b>Base Valve</b>	Mark Series	Mark Series	Mark Series
<b>Size Range</b>	3" to 36"	1½" to 36"	1" to 36"
<b>Cv Range</b>	to 4000	4 to 4000	5 to 10100
<b>Flow Direction</b>	Flow under the plug	Flow under the plug	Flow under the plug
<b>Pressure Stages</b>	6 to 20	2 to 8	1 to 7
<b>Features</b>	<ul style="list-style-type: none"> <li>• Attenuation of up to 40 dBa</li> <li>• WaveCracker</li> <li>• Stealth is the most efficient high pressure drop noise attenuation trim ever developed</li> <li>• Stealth uses laser-cut discs to create stacked disc seat retainers. The cuts in the discs form channels for the fluid to pass through.</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 30 dBa</li> <li>• Can be taken apart for cleaning or repair</li> <li>• TigerTooth uses stacked discs with grooves, or teeth, to take multiple staged pressure drops</li> <li>• Self-cleaning design with large passages</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 20 dBa</li> <li>• MegaStream uses nested cylinders in place of the seat retainer. Each drilled cylinder represents a stage of pressure reduction</li> </ul>
Design	Globe, Multi-Stage Noise Control	Globe, Multi-Stage Noise Control	Globe, Multi-Stage Noise Control
			
<b>Type</b>	RLS-System	MultiStream	Multi-hole plug
<b>Base Valve</b>	FlowTop, FlowPro	FlowTop, FlowPro	FlowTop, FlowPro
<b>Size Range</b>	1" to 12"	½" to 12"	½" to 12"
<b>Cv Range</b>	Engineered up to 820	4.6 to 1040	2.9 to 1040
<b>Flow Direction</b>	Bidirectional Flow, Liquid flow to close Gas flow to open	Flow under the plug	Bidirectional Flow
<b>Pressure Stages</b>	2 to 6	1 to 4	1
<b>Features</b>	<ul style="list-style-type: none"> <li>• Attenuation of up to 30 dBa depending on the operating conditions</li> <li>• Efficient, modular design</li> <li>• Every stage is controlled, which results in a high efficiency even at partial load</li> <li>• For gas, steam and liquid service to reduce noise</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 20 dBa depending on the operating conditions</li> <li>• Efficient, modular design</li> <li>• Easy upgrade from standard, no trim set changes</li> <li>• For gas, steam and liquid service to reduce noise</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 15 dBa depending on the operating conditions</li> <li>• Efficient, modular design</li> <li>• For gas, steam and liquid service to reduce noise</li> </ul>



Globe, Multi-Stage Noise Control	Globe, Multi-Stage Noise Control	Globe, Multi-Stage Noise Control	Design
			
Type III	Type II	Type I	<b>Type</b>
Kämmer Series	Kämmer Series	Kämmer Series	<b>Base Valve</b>
½" to 4"	½" to 4"	½" to 4"	<b>Size Range</b>
1.8 to 228		1.8 to 466	<b>Cv Range</b>
Flow under the plug	Flow under the plug	Flow under the plug	<b>Flow Direction</b>
2	1	1	<b>Pressure Stages</b>
<ul style="list-style-type: none"> <li>• Attenuation of up to 26 dBa</li> <li>• Both plug characterized or cage characterized designs available</li> <li>• Custom engineered to match the service conditions</li> <li>• As the plug opens in the seat, it simultaneously opens the cage for effective noise control over the entire stroke length</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 22 dBa</li> <li>• Customizable trim characteristics available</li> <li>• Combination with Type I possible (up to 29dBA)</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 23 dBa</li> <li>• 3 designs (single cage, double cage, double cage with silencer)</li> <li>• Easy retrofit</li> <li>• Standard Plug</li> </ul>	<b>Features</b>
Globe, Multi-Stage Noise Control	Ball Valve, Multi-Stage Noise Control	Downstream Orifice Plate, Multi-Stage Noise Control	Design
			
SilentPack	Z-Trim	DownStream Plates	<b>Type</b>
FlowTop, FlowPro	Setball, Duball, ShearStream SB	Downstream of any valve	<b>Base Valve</b>
½" to 12"	2" to 20"	1 ½" to 24"	<b>Size Range</b>
0.73 to 925	90 to 15950	6 to 3340	<b>Cv Range</b>
Flow under the plug	Duball; Bidirectional Flow Setball; Shaft Downstream	Downstream of control valve	<b>Flow Direction</b>
1	1 to 5	1 to 3	<b>Pressure Stages</b>
<ul style="list-style-type: none"> <li>• Attenuation of up to 18 dBa depending on the operating conditions</li> <li>• Efficient, modular design</li> <li>• Easy upgrade from standard, no trim set changes</li> <li>• For gas and steam service to reduce noise</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 17 dBa</li> <li>• Pressure drops up to the valve limits</li> <li>• Tight Shutoff</li> <li>• The unique Z-trim design reduces noise by taking pressure drops in up to five steps</li> <li>• The design makes it possible to manage high pressure drops at low flows and small opening angles and still have high capacities (Cv) at larger opening angles</li> <li>• The Z-Trim is self cleaning for applications with entrained media</li> </ul>	<ul style="list-style-type: none"> <li>• Attenuation of up to 25 dBa</li> <li>• Downstream plates are installed downstream of a valve providing backpressure and noise attenuation</li> <li>• Noise control plates have multiple drilled holes to attenuate noise while taking the pressure load off the control valve</li> </ul>	<b>Features</b>



### 3. Stealth

#### Introduction

The most sophisticated noise attenuation design, Stealth trim effectively reduces sound pressure levels in the most demanding applications (Figure 3.1: Control Valve with Stealth Trim). The advanced Stealth design combines the most effective noise and pressure control mechanisms to produce the most efficient noise reduction trim ever created.

#### Design

Stealth is produced by laser cutting circular discs to form fluid passageways and then braising the discs together to form a seat retainer (Figure 3.2: Stealth Stack). Three different discs are cut and matched together to form a flow path set (Figure 3.3: Stealth Discs) (Figure 3.4: Stealth Flow Passage). A number of disc sets are then stacked together and the whole assembly is braised together to form a stack.

Similar to TigerTooth an important mechanism reducing the pressure in Stealth trim is the sudden expansion and contraction phenomenon that takes place as the flow passes over the teeth. The Stealth trim's ability to gradually reduce pressure without generating high velocities is important for the reduction of noise in the process line.

In addition to reducing the pressure gradually, Stealth takes advantage of frequency shifting by providing small outlet holes which raise the frequency and lower the noise.

An important feature in the noise control capabilities of the Stealth is the WaveCracker technology which provides extra noise attenuation without creating extra pressure drops in the valve.

Trim exit flow paths on the Stealth are angled to direct the flow to the valve exit. This feature increases the flow capacity of the valve and lowers the noise by reducing exit turbulence.

Combining the pressure reduction, and velocity control features with the noise elimination features of the Stealth produces the most advanced noise elimination technology available.

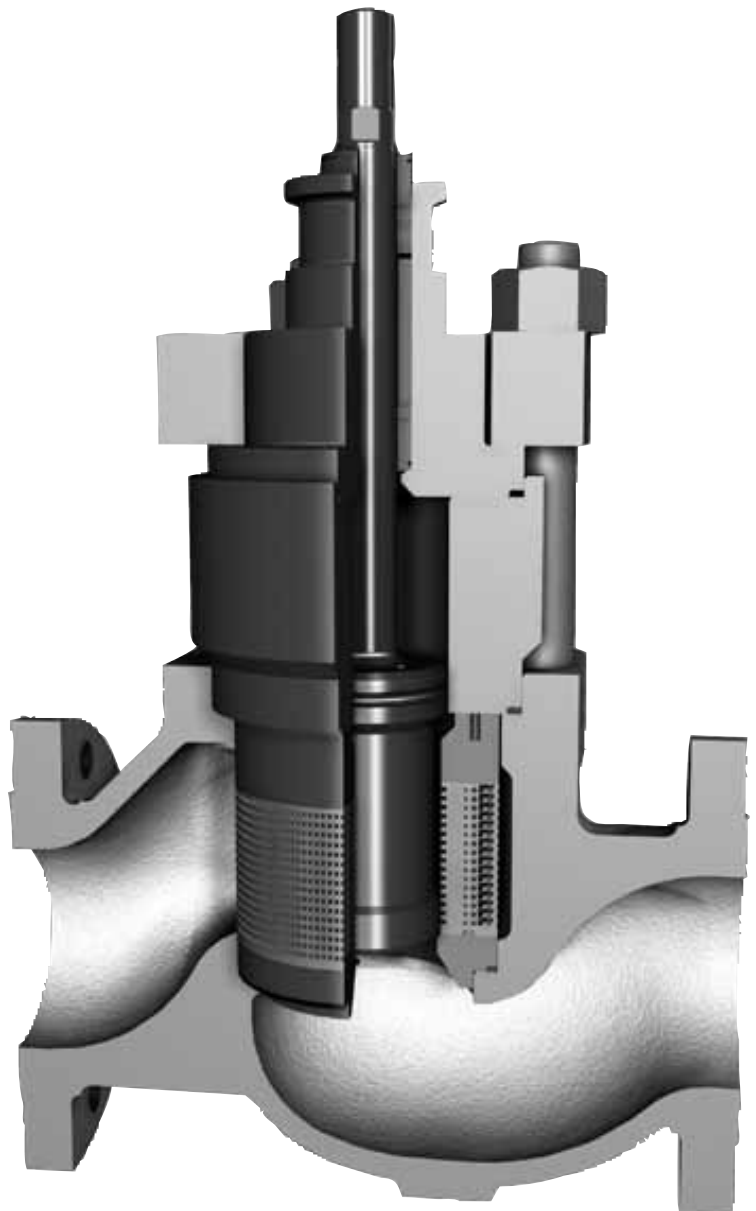


Figure 3.1: Control Valve with Stealth Trim



**Base Valve Design**

Base valves for the Stealth include the Mark One and Mark 100.

**Mechanisms at Work**

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting
- Noise Cancellation
- WaveCracker



Figure 3.2: Stealth Stack

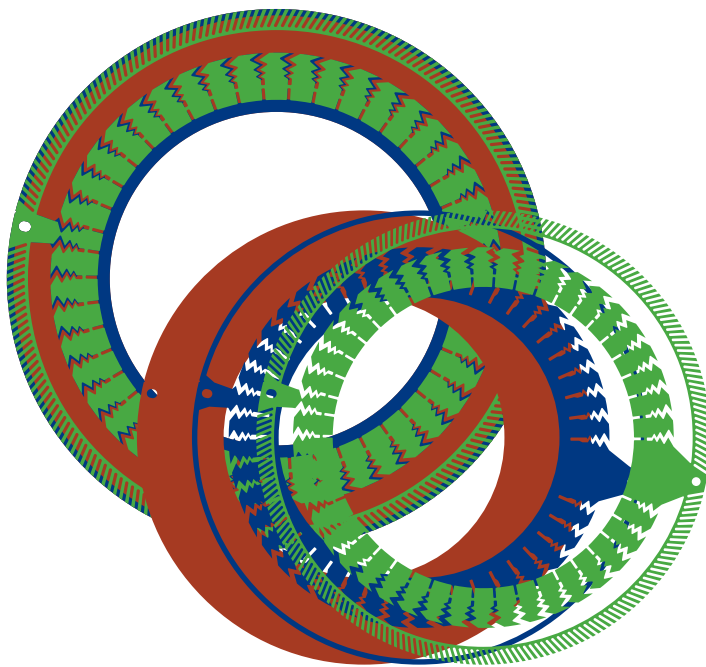


Figure 3.3: Stealth Discs



Figure 3.4: Stealth Flow Passage



## 4. TigerTooth

### Introduction

Decades of field experience has proven the sophisticated design of the TigerTooth to be one of the most effective noise reduction trims available. Designed to be most effective at high pressure drops, the TigerTooth design effectively reduces the sound pressure levels in the most demanding applications (Figure 4.1: Control Valve with TigerTooth Trim).

### Design

The TigerTooth design employs highly engineered concentric grooves (or teeth) machined into the face and backside of a series of circular stacked discs (called a stack), which form the seat retainer (Figure 4.2: Cross-Sectioned TigerTooth Seat Retainer). Legs separate one disc from another, providing a gap between individual discs, forming flow passages.



**Figure 4.2: Cross-Sectioned TigerTooth Seat Retainer**

An important mechanism reducing the pressure in TigerTooth trim is the sudden expansion and contraction phenomenon that takes place as the flow passes over the teeth. The TigerTooth valve's ability to gradually reduce pressure without generating high velocities is important for the reduction of noise in the process line.

In addition to the standard linear and bi-linear designs, TigerTooth can also be designed with a full-open area at the top of the stack to provide additional flow capacity. This design flexibility allows the TigerTooth to take very high pressure drops when throttling low and still deliver high capacities when required, while generating exceptionally low noise levels.

Passages in the TigerTooth design are self cleaning. Passages grow wider as the fluid passes from the inside to the outside. This allows large solids to easily pass through the trim.

### Base Valve Design

Base valves for the TigerTooth include the Mark One, Mark Two, Mark Eight, and Mark 100.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation



**Figure 4.1: Control Valve with TigerTooth Trim**



## 5. MegaStream

### Introduction

The MegaStream design employs a heavy duty drilled-hole seat retainer (cage) with up to seven stages to lower noise levels (Figure 5.1: Control Valve with Two Stage MegaStream Trim). With decades of proven experience, the MegaStream control valve is the one of the most common solutions to control valve noise.

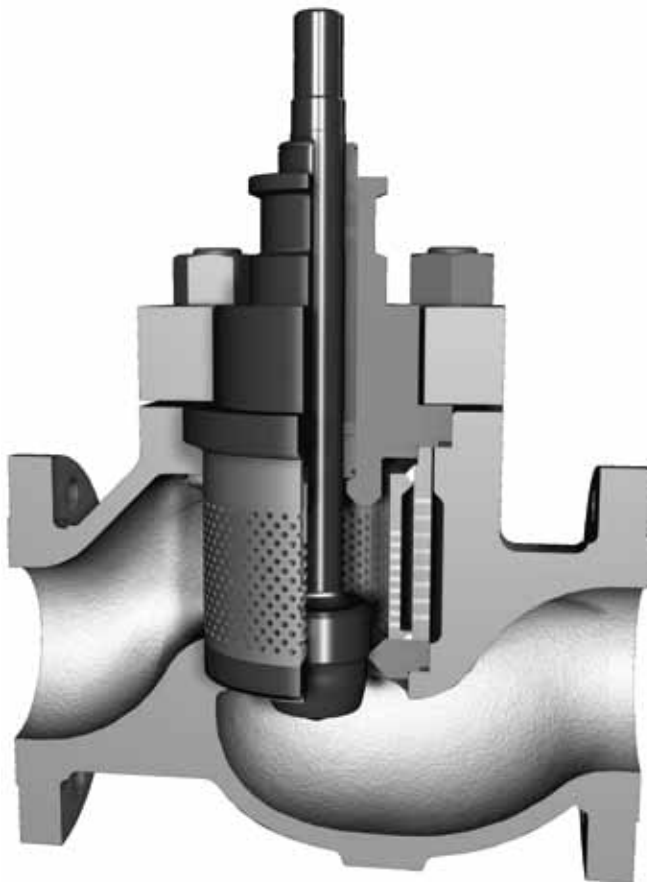


Figure 5.1: Control Valve with Two Stage MegaStream Trim

### Design

Pressure drops are distributed between the throttling point of the plug and seat ring as well as the stages of the retainer. Each stage is designed to take a small pressure drop, avoiding the high velocities present in single-throttling-point trims. Fluid expansion and velocity are controlled by increasing the flow areas of each subsequent stage.

Cutting the MegaStream retainer hole size in half will reduce the noise level by up to 7 dBA through frequency shifting effects. Holes sizes are optimized to balance noise and manufacturability.

A standard two stage MegaStream constructed from heavy duty drilled-hole cylinders. Standard designs eliminate special engineering which results in lower costs and quicker deliveries. Because of parts interchangeability with standard seat retainers, one and two-stage attenuators can be fitted into conventional Mark Series valves without special or additional parts.

When more attenuation is needed, seat retainers incorporating from three to seven drilled-hole stages are available. Most of the base valve parts are still interchangeable with standard valve construction.

Special designs are available when process conditions require a specialized solution. For example, guiding the plug in the cage eliminates the seat ring as a throttling point, which can provide more attenuation at low throttling points.

### Base Valve Design

Base valves for the MegaStream retainer include the Mark One, Mark Two, Mark Eight, and Mark 100.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting



## 6. Type III



Figure 6.1: Type III Trim

### Introduction

Using the same skirt guided drilled-hole plug as the Type II design and a heavy duty drilled-hole cage, the Type III design is created (Figure 6.1: Type III Trim). The Type III system is most effective at reducing noise generated by higher pressure drops. The Type III trim offers one or two stages of pressure reduction in a heavy duty design.

### Design

When using two stages of pressure drop, the Type III design has a skirt guided drilled-hole plug, and a heavy duty drilled-hole cage. In the single stage style, the heavy duty drilled-hole cage is used. Both styles use cage guiding to throttle each stage for effective noise control over the complete range. Each stage takes part of the pressure drop to produce the minimum noise while still attenuating noise generated upstream. Both design work by attenuating upstream noise and shifting the noise frequency higher.

Standardized designs allow for quicker deliveries and lower costs.

### Base Valve Design

Available in a number of Kammer platforms, the most commonly used is the 35000 series control valve.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting

## 7. Type II



Figure 7.1: Type II Trim

### Introduction

By adding a skirt guided drilled-hole plug to the attenuators used in the Type I design, the Type II design is created (Figure 7.1: Type II Trim). The Type II system is most effective at reducing noise generated by moderate to high pressure drops. The Type II trim offers up to four stages of pressure reduction.

### Design

When using all four stages of pressure drop, the Type II design has a skirt guided drilled-hole plug, an inner perforated metal stage, a metal mesh silencer and an outer perforated metal stage. Each stage takes part of the pressure drop to produce the minimum noise while still attenuating noise generated upstream. When only a single stage is required, the skirt guided drilled-hole plug is used. The three stage design uses a skirt guided drilled-hole plug along with both the inner and outer stages of the cage. Adding the baffle creates the four stage style. All three designs work by attenuating upstream noise and shifting the noise frequency higher.

Standardized designs allow for quicker deliveries and lower costs.

### Base Valve Design

Available in a number of Kammer platforms, the most commonly used is the 35000 series control valve.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting



As a fluid travels through a conventional single-seated globe-style control valve, a vena contracta (point of narrowest flow restriction) develops directly downstream of the narrowest throttling point.



## 8. Type I

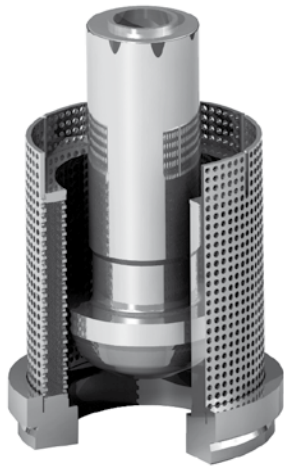


Figure 8.1: Type I Trim



The Type I low noise baffles reduce noise generated by moderate pressure drops (Figure 8.1: Type I Trim). By only changing a few of parts, the noise reducing cage can be added to the standard valve without special plugs or seat rings. Control of the process is through the standard contoured plug, yielding high turndown and great control. Available with one stage, two stages or two stages with baffles, the Type I trim offers up to three stages of pressure reduction.

When using all three stages of pressure drop, the Type I design has an inner perforated metal stage, a metal mesh silencer and an outer perforated metal stage. Each stage takes part of the pressure drop to produce the minimum noise while still attenuating noise generated upstream. When only a single stage is required, the outer perforated metal stage is used. The two stage design uses both the outer and inner stages to create two pressure drops. Adding the baffle creates the three stage style. As the number of stages increase, the noise attenuation also in-

creases. All three designs work by attenuating upstream noise while shifting the noise frequency higher.

Standardized designs allow for quicker deliveries and lower costs.

Available in a number of Kammer platforms, the most common is the 35000 series control valve.

- Pressure Control
- Frequency Shifting
- Velocity Control
- Attenuation



## 9. RLS-System

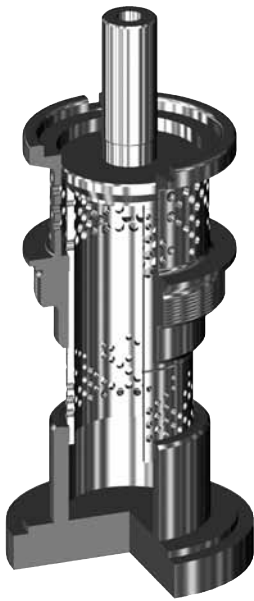


Figure 9.1: RLS-System Trim

### Introduction

Available with two or three individually throttled stages, (Figure 9.1: RLS-System Trim) the RLS-System eliminates noise in moderate to high pressure drops.

### Design

By individually throttling each stage, fluid expansion and velocity is tightly controlled for maximum efficiency at all plug positions. Available with two or three stages, the RLS-System is simple, robust and effective. Using a four flange body, the three stage RLS-System provides for more pressure drop than the two stage system. Using small holes in each stage for frequency shifting, the RLS-System produces lower noise levels while attenuating upstream noise. Standardized designs allow for quicker deliveries and lower costs.

### Base Valve Design

Available in the FlowTop, FlowPro.

### Mechanisms at Work

- Velocity Control
- Attenuation
- Frequency Shifting

## 10. MultiStream



Figure 10.1: MultiStream Trim

### Introduction

Available with five stages, (Figure 10.1: MultiStream Trim) the MultiStream eliminates noise in moderate to high pressure drops.

### Design

Using four drilled hole stages (three downstream of the plug and one upstream) and a contoured plug, the MultiStream provides exceptional noise reduction and excellent turndown. Using small holes in each stage for frequency shifting, the MultiStream produces lower noise levels while attenuating upstream noise.

### Base Valve Design

Available in the FlowTop and FlowPro.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting





## 11. Multi-Hole

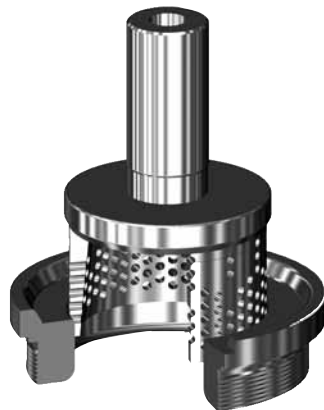


Figure 11.1: Multi-Hole Trim

### Introduction

Using a cost effective skirt guided plug head with drilled holes (Figure 11.1: Multi-Hole Trim) the Multi-Hole reduces noise generated by moderate pressure drops. Using special plugs and seat rings, all other valve parts remain the same.

### Design

The Multi-Hole generates less noise than conventional designs by using small drilled holes in the plug skirt to shift the frequency and lower noise. Small holes provide effective attenuation of noise generated upstream of the plug skirt, lowering the noise transmitted downstream.

Standardized designs allow for quicker deliveries and lower costs.

### Base Valve Design

Available in the FlowTop and FlowPro.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting

## 12. SilentPac



Figure 12.1: SilentPac Trim

### Introduction

The SilentPac low noise baffles (Figure 12.1: SilentPac Trim) reduce noise generated by moderate pressure drops. By only changing a couple of parts, the noise reducing cage can be added to the standard valve without special plugs or seat rings. Control of the process is through the standard contoured plug, yielding high turndown and great control.

### Design

Stainless steel wire mesh attenuator. The stainless steel attenuator is welded together to form a single robust part. The process fluid diffuses through the cage silencing noise generated upstream with very little noise generation.

Standardized designs allow for quicker deliveries and lower costs.

### Base Valve Design

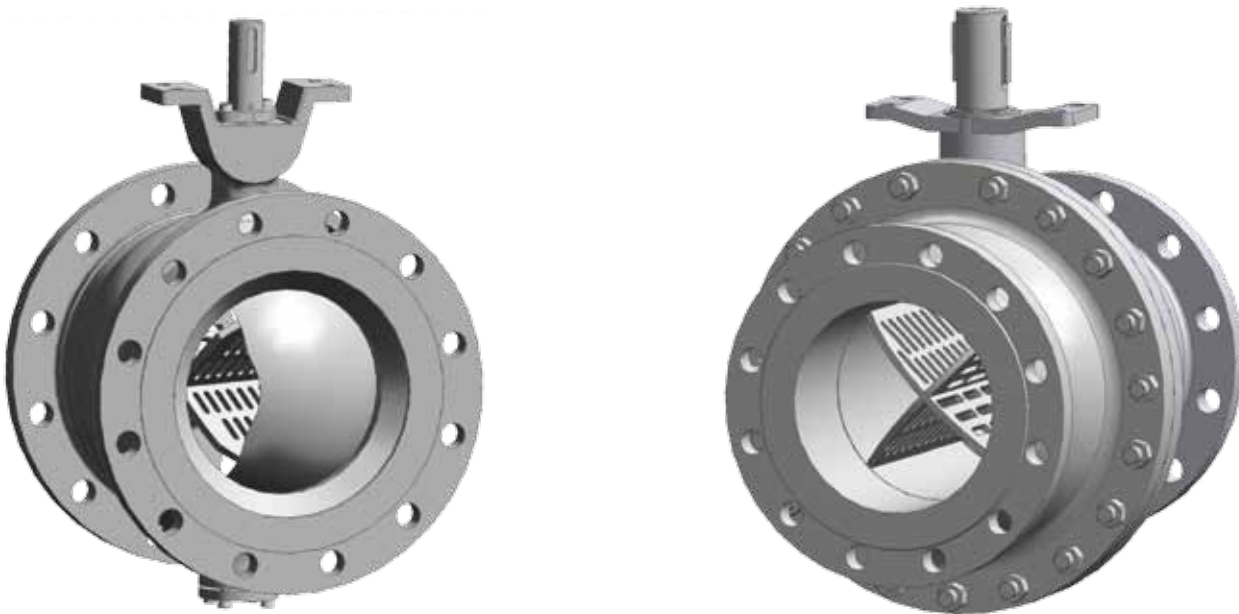
Available in the FlowTop and FlowPro.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting



## 13. Z-Trim



**Figure 13.1: Setball Control Valve with Z-Trim**

### Introduction

Z-Trim combines the benefits of an advanced control valve with the simplicity of a ball valve. Most effective with low to medium pressure drops, the Z-trim excels at eliminating noise in high flow services. Using the standard Setball (Figure 13.1: Setball Control Valve with Z-Trim) or Duball (Figure 13.2: Duball Control Valve Z-Trim) as a platform, adding the Z-Trim requires only one part to be changed.

### Noise Control Design

The simple design of the Z-Trim gets its effective noise reduction by passing the fluid through as many as five stages of pressure reduction. Increasing passage areas of each subsequent stage of the Z-Trim allows the gas to expand while maintaining low velocities for lower noise.

Each stage provides both attenuation of upstream noise and limits the velocity through the trim minimizing noise generation. As the valve opens, fewer stages are taken until the ball is open

and the valve develops full capacity. This feature gives effective noise attenuation at the low end, where pressure drops are high, and still delivers the high capacity expected from a ball valve.

### Base Valve Design

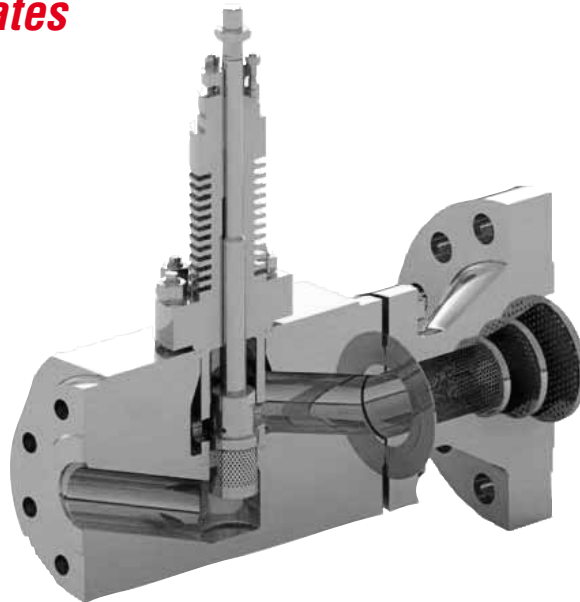
The Z-Trim is available in the Duball, Setball and ShearStream SB control valves.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting



## 14. Downstream Plates



**Figure 14.1: Control Valve with Downstream Plates**

### Introduction

Installing anti-noise plates downstream of a control valve is a simple, cost effective way to reduce control valve noise, without making any changes to the valve (see Figure 14.1: Control Valve with Downstream Plates). Plates provide lower noise by lowering turbulence, providing back pressure to the valve and providing attenuation on noise generated inside the valve. To provide successful noise attenuation downstream plates need to be fit for the individual application. Plates are most effective in low to medium pressure drop applications.

### Noise Control Design

Each plate incorporates one or more stages. Noise control plates are similar to orifice plates, but have many small passages instead of one large hole. Some may have metal mesh or other devices to attenuate noise. Several plate designs are offered by Flowserve, all incorporating the same basic operating principles. To control downstream line turbulence, each stage absorbs a portion of the pressure drop. As each stage absorbs

pressure, it also attenuates noise and turbulence developed upstream of the plate.

### Base Valve Design

Noise control plates are used with all styles of Flowserve control valves.

### Mechanisms at Work

- Pressure Control
- Velocity Control
- Attenuation
- Frequency Shifting



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