# 05. SIZING AND SELECTION

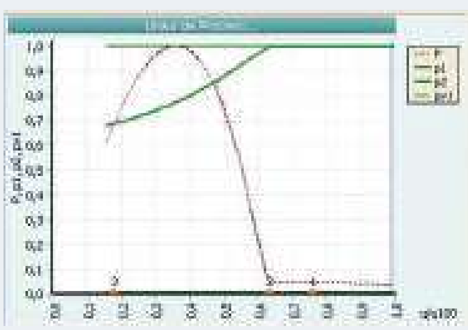
RV has specific control valve calculation software which is CONVAL™ 8. It calculates the flow properties based on client process specification, and select from the Ringo Valvulas database the control valve which is the most accurate for this process (size, pressure class, and trim type).

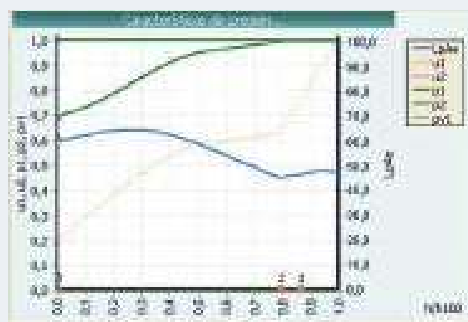
Some of the possible parameters which can be calculated with this program are:

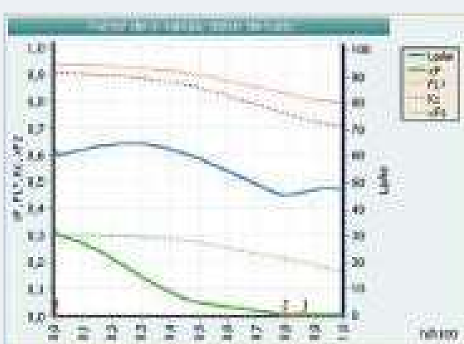
- Cv calculation and % of travel for the different operation points
- Fluid properties and state in the operation conditions
- Noise level
- Fluid velocities
- Power loss inside the valve
- Two-phase fluid conditions if it is required
- Actuator forces
- Internal valve parameters

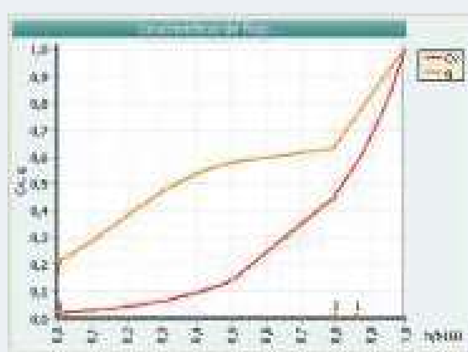
This software permits export of the  calculation results to Ringo Valvulas datasheet format.

Also CONVAL™ 8 has the possibility to include process graphs to the calculations to optimize the valve selection, the noise level control, the specific process conditions such as cavitation or flashing, etc.









## Noise reduction special designs

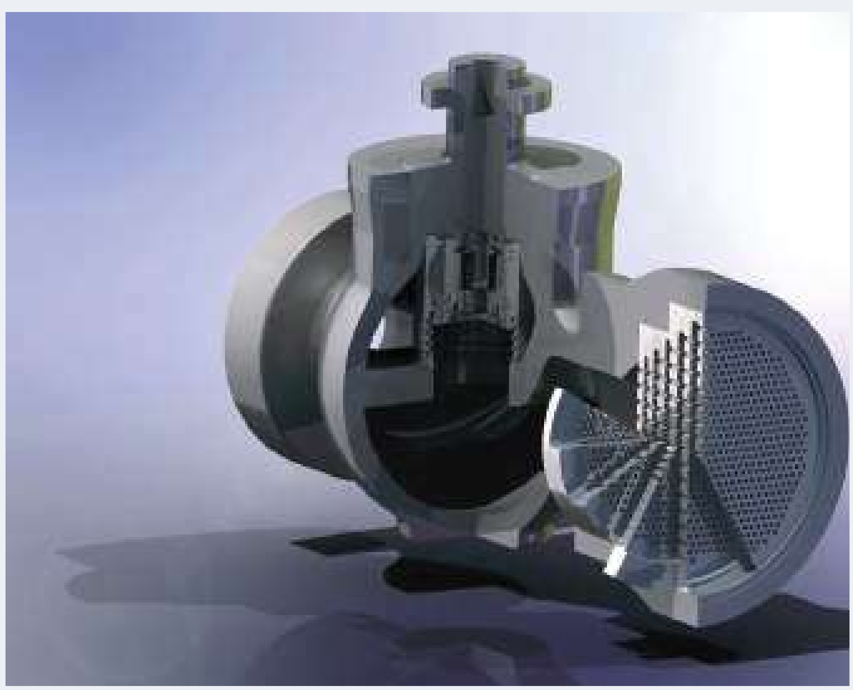
Large, medium size valve in gas or steam service, may give unacceptable noise levels, even if multistage cages are used, and sonic conditions avoided.

The answer to the problem is the increased number of holes of flow passages with the reduction of jet-diameters, and reduction of Fd factor. Depending on the size of the valve and the number of stage additional reductions, up to 25 dB(A) can be obtained. Again here, engineering programs let us to know the number of holes required to reduce noise level down to acceptable levels.

When high pressure drops applications in gas or steam recommend the outlet pipe to be larger than inlet pipe, a good recommendation is to have one or more diffuser plates downstream the valve to match the pipe size. The combination of valve and baffles, diffusers or multihole plates, when correctly calculated, offers several advantages:

- Reduce the velocity of gas/ steam at valve outlet
- Allows the use of smaller size valves,
- Reduces the valve and baffle overall noise levels
- Reduces noise and vibration transmitted by the downs-tream pipe

We have the technology and can advise on customers about the use, sizing and design of baffles or diffuser plates.



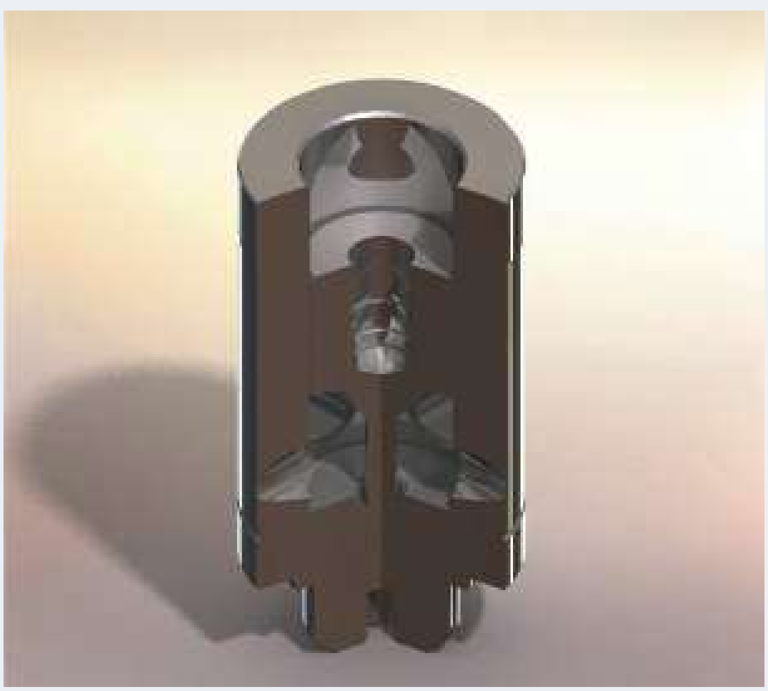
# 06. MINIFLOW

## SMALL FLOW VALVES

A complete series of Miniflow fluted plugs have been developed to cover the need of controlling small to very small flow rates combined with medium to high pressure drop applications.

Offered Cv values range from 3.84 to 0.02 covering most common applications.
Control characteristic can be linear or equal percentage.
Comparatively large strokes assure smooth, accurate control of small flows, and good rangeability.
High Fl, xT values offer protection against cavitation and additional noise reduction.
All plugs and seats are interchangeable within every valve body size.
Also the same internals can be used with all body ratings of the same size.

| SIZE | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CV10 | CV20 | CV30 | CV40 | CV50 | CV60 | CV70 | CV80 | CV90 | CV100 | |
| 0 | 0,0009 | 0,0019 | 0,0032 | 0,0046 | 0,0070 | 0,0094 | 0,0123 | 0,0153 | 0,0182 | 0,0200 | 26 |
| 1 | 0,0013 | 0,0029 | 0,0048 | 0,0070 | 0,0106 | 0,0141 | 0,0185 | 0,0229 | 0,0273 | 0,0300 | 26 |
| 2 | 0,0026 | 0,0058 | 0,0095 | 0,0139 | 0,0212 | 0,0282 | 0,0370 | 0,0459 | 0,0547 | 0,0600 | 26 |
| 3 | 0,0053 | 0,0116 | 0,0190 | 0,0290 | 0,0423 | 0,0565 | 0,0741 | 0,0920 | 0,1094 | 0,1200 | 26 |
| 4 | 0,0105 | 0,0233 | 0,0381 | 0,0558 | 0,0847 | 0,1129 | 0,1482 | 0,1835 | 0,2188 | 0,2400 | 26 |
| 5 | 0,0212 | 0,0466 | 0,0762 | 0,1115 | 0,1694 | 0,2260 | 0,2965 | 0,3670 | 0,4376 | 0,4800 | 26 |
| 6 | 0,0423 | 0,0932 | 0,1525 | 0,2230 | 0,3388 | 0,4518 | 0,5929 | 0,7341 | 0,8753 | 0,9600 | 26 |
| 7 | 0,0847 | 0,1863 | 0,3049 | 0,4461 | 0,6776 | 0,9035 | 1,1859 | 1,4682 | 1,7506 | 1,9200 | 26 |
| 8 | 0,1698 | 0,3737 | 0,6115 | 0,8945 | 1,3590 | 1,8118 | 2,3780 | 2,9441 | 3,5100 | 3,8500 | 26 |



# 07. MULTISTEP™ TRIM

## DESIGN

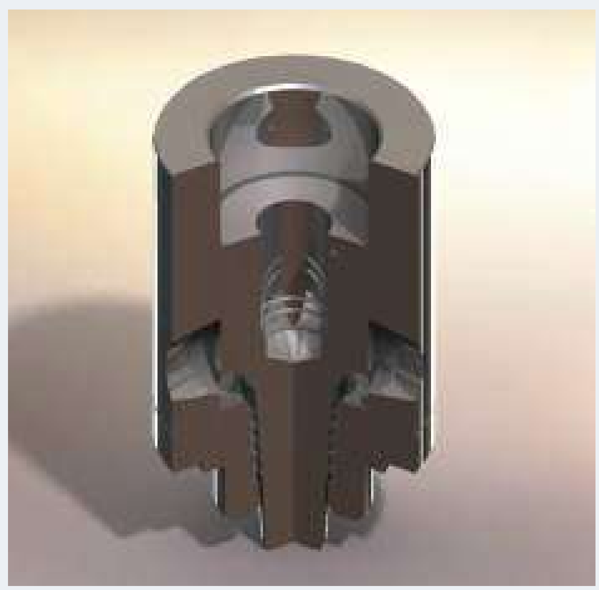
Specially designed for low and medium flows combined with medium to high pressure drops. Also recommended when high rangeability is required.
With this outstanding design the total pressure drop across the valve is splitted in several smaller, decreasing pressure drops.
In this way erosion or cavitation, and therefore wearing of the plug and seat, are avoided.
This is achieved by a series of grooves machined on the seat ring. The grooves increase in diameter and also in depth as the fluid passes through. This results is deacreasing values of individual pressure steps. The number of steps is constant whichever the position of the plug, thus being effective at low as well at high flow rates.
The plug and cage are designed so that a metal-to-metal contact is made on bevelled seating surfaces and the clearance between plug and seat ring cage in the labyrinth groove section is calculated for proper cascading effect.

## PERFORMANCE

The most difficult service conditions for a valve generally appears at low flow when the plug is just leaving the seat. At his position surface of seat ring and plug are subject to erosion and cavitation. Cavitation will occur when the liquid pressure falls down to or bellow the vapour pressure; at which point small bubbles are formed. When the pressure is recovered the bubbles will implode and cause shock waves that can cause severe damage of the trim and body. Our Multistep design minimizes these problems.
Multistep Trim features a series of labyrinth grooves, machined into the seat ring along its throttling surface. This serie of grooves provides a stepping effect, so that pressure drop is divided equally among the grooves, thus reducing the amount of inner valve pressure recovery and subsequent vapour formation.
Multistep Trim therefore is ideally suited for applications where cavitation exist. But the same principle applies to any pressure reducing service in gas or steam. Because the total pressure drop is broken down into stages and because the pressure is prevented from reaching critical conditions at any point, erosion is held to a minimum.
Our Multistep design is suited for service where pressure drop decreases when flow increases, as well as for services when pressure drop keeps constant at all flows.

## MATERIALS

Martensitic corrosion resistant steels are used for plug, cage and seat ring. Depending on the applicacion 420 or 440 hardenend steels are used.
Stellited 316 stainless steel can be used as an option.
Standard materials for body!bonnet are carbon steel A105, alloy steel F11, stainless steel 316 or others.



## APPLICATIONS

Multistep Trim solves the problems of short life and high replacement costs for valve trim in high pressure drop service.
This single-seated trim is designed primarly for high pressure drop liquid or steam applications.
Some examples are:

1. High pressure desuperheater-cooling water control
2. Supercritical boiler start-up
3. Reheat and super-heat spray control
4. Pump recirculation or by-pass in small size boiler

Due to the single seat design, it is equally applicable for on-off service, because it gives tight shut-off. This trim is not suited for non-deaerated liquid applications, but can be used for gas applications as well as steam or liquids.
Differential pressure ranges up to and including 300 bar.
Rangeability is good as 80 to 1.

## ■ Valve capacity (Cv) values

### Table 1

EQUAL PERCENTAGE inherent charasteristic curve. Cv values of the valve at 10% opening intervals

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 20 | 3/4 | 0,06 | 0,12 | 0,21 | 0,3 | 0,42 | 0,61 | 0,94 | 1,5 | 2,2 | 3,5 | 26 |
| 20\1 | 3/4\1 | 0,04 | 0,07 | 0,13 | 0,19 | 0,27 | 0,39 | 0,59 | 0,93 | 1,4 | 2,2 | 26 |
| 20\2 | 3/4\2 | 0,02 | 0,05 | 0,08 | 0,12 | 0,17 | 0,25 | 0,37 | 0,59 | 0,9 | 1,4 | 26 |
| 20\3 | 3/4\3 | 0,01 | 0,03 | 0,05 | 0,07 | 0,1 | 0,15 | 0,23 | 0,36 | 0,55 | 0,86 | 26 |
| 20\4 | 3/4\4 | 0,01 | 0,02 | 0,04 | 0,05 | 0,07 | 0,11 | 0,16 | 0,26 | 0,39 | 0,61 | 26 |
| 20\5 | 3/4\5 | 0,01 | 0,01 | 0,02 | 0,03 | 0,04 | 0,06 | 0,09 | 0,14 | 0,21 | 0,33 | 26 |
| 25 | 1 | 0,09 | 0,18 | 0,32 | 0,46 | 0,66 | 0,95 | 1,4 | 2,3 | 3,5 | 5,4 | 26 |
| 25\1 | 1\1 | 0,06 | 0,12 | 0,21 | 0,3 | 0,42 | 0,61 | 0,94 | 1,5 | 2,2 | 3,5 | 26 |
| 25\2 | 1\2 | 0,04 | 0,07 | 0,13 | 0,19 | 0,27 | 0,39 | 0,59 | 0,93 | 1,4 | 2,2 | 26 |
| 25\3 | 1\3 | 0,02 | 0,05 | 0,08 | 0,12 | 0,17 | 0,25 | 0,37 | 0,59 | 0,9 | 1,4 | 26 |
| 25\4 | 1\4 | 0,01 | 0,03 | 0,05 | 0,07 | 0,1 | 0,15 | 0,23 | 0,36 | 0,55 | 0,86 | 26 |
| 25\5 | 1\5 | 0,01 | 0,02 | 0,04 | 0,05 | 0,07 | 0,11 | 0,16 | 0,26 | 0,39 | 0,61 | 26 |
| 40 | 1,5 | 0,14 | 0,28 | 0,49 | 0,7 | 1,0 | 1,4 | 2,2 | 3,5 | 5,2 | 8,2 | 26 |
| 40\1 | 1,5\1 | 0,09 | 0,18 | 0,32 | 0,46 | 0,66 | 0,95 | 1,4 | 2,3 | 3,5 | 5,4 | 26 |
| 40\2 | 1,5\2 | 0,06 | 0,12 | 0,21 | 0,3 | 0,42 | 0,61 | 0,94 | 1,5 | 2,2 | 3,5 | 26 |
| 40\3 | 1,5\3 | 0,04 | 0,07 | 0,13 | 0,19 | 0,27 | 0,39 | 0,59 | 0,93 | 1,4 | 2,2 | 26 |
| 40\4 | 1,5\4 | 0,02 | 0,05 | 0,08 | 0,12 | 0,17 | 0,25 | 0,37 | 0,59 | 0,9 | 1,4 | 26 |
| 40\5 | 1,5\5 | 0,01 | 0,03 | 0,05 | 0,07 | 0,1 | 0,15 | 0,23 | 0,36 | 0,55 | 0,86 | 26 |
| 50 | 2 | 0,24 | 0,49 | 0,86 | 1,2 | 1,7 | 2,5 | 3,9 | 6,1 | 9,2 | 14,4 | 26 |
| 50\1 | 2\1 | 0,14 | 0,28 | 0,49 | 0,7 | 1,0 | 1,4 | 2,2 | 3,5 | 5,2 | 8,2 | 26 |
| 50\2 | 2\2 | 0,09 | 0,18 | 0,32 | 0,46 | 0,66 | 0,95 | 1,4 | 2,3 | 3,5 | 5,4 | 26 |
| 50\3 | 2\3 | 0,06 | 0,12 | 0,21 | 0,3 | 0,42 | 0,61 | 0,94 | 1,5 | 2,2 | 3,5 | 26 |
| 50\4 | 2\4 | 0,04 | 0,07 | 0,13 | 0,19 | 0,27 | 0,39 | 0,59 | 0,93 | 1,4 | 2,2 | 26 |
| 50\5 | 2\5 | 0,02 | 0,05 | 0,08 | 0,12 | 0,17 | 0,25 | 0,37 | 0,59 | 0,9 | 1,4 | 26 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cv/d2 | 0,04 | 0,09 | 0,17 | 0,25 | 0,32 | 0,35 | 0,79 | 1,25 | 1,90 | 2,97 |
| FL | 0,99 | 0,98 | 0,98 | 0,97 | 0,97 | 0,97 | 0,96 | 0,96 | 0,95 | 0,95 |
| Xt | 0,84 | 0,84 | 0,84 | 0,83 | 0,83 | 0,82 | 0,81 | 0,80 | 0,78 | 0,76 |

### Table 2

MODIFIED EQUAL PERCENTAGE inherent characteristic curve. Cv values of the valve at 10% opening intervals

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 20 | 3/4 | 0,15 | 0,33 | 0,54 | 0,79 | 1,2 | 1,6 | 2,1 | 2,6 | 3,1 | 3,4 | 26 |
| 20\1 | 3/4\1 | 0,09 | 0,2 | 0,33 | 0,49 | 0,74 | 0,99 | 1,3 | 1,6 | 1,9 | 2,1 | 26 |
| 20\2 | 3/4\2 | 0,06 | 0,12 | 0,21 | 0,3 | 0,46 | 0,61 | 0,79 | 1 | 1,2 | 1,3 | 26 |
| 20\3 | 3/4\3 | 0,04 | 0,08 | 0,13 | 0,19 | 0,28 | 0,38 | 0,5 | 0,63 | 0,74 | 0,82 | 26 |
| 20\4 | 3/4\4 | 0,02 | 0,05 | 0,08 | 0,12 | 0,19 | 0,25 | 0,33 | 0,41 | 0,48 | 0,54 | 26 |
| 20\5 | 3/4\5 | 0,01 | 0,03 | 0,05 | 0,07 | 0,11 | 0,15 | 0,19 | 0,24 | 0,28 | 0,31 | 26 |
| 25 | 1 | 0,23 | 0,5 | 0,83 | 1,2 | 1,8 | 2,5 | 3,2 | 4,1 | 4,8 | 5,3 | 26 |
| 25\1 | 1\1 | 0,15 | 0,33 | 0,54 | 0,79 | 1,2 | 1,6 | 2,1 | 2,6 | 3,1 | 3,4 | 26 |
| 25\2 | 1\2 | 0,09 | 0,2 | 0,33 | 0,49 | 0,74 | 0,99 | 1,3 | 1,6 | 1,9 | 2,1 | 26 |
| 25\3 | 1\3 | 0,06 | 0,12 | 0,21 | 0,3 | 0,46 | 0,61 | 0,79 | 1 | 1,2 | 1,3 | 26 |
| 25\4 | 1\4 | 0,04 | 0,08 | 0,13 | 0,19 | 0,28 | 0,38 | 0,5 | 0,63 | 0,74 | 0,82 | 26 |
| 25\5 | 1\5 | 0,02 | 0,05 | 0,08 | 0,12 | 0,19 | 0,25 | 0,33 | 0,41 | 0,48 | 0,54 | 26 |
| 40 | 1,5 | 0,35 | 0,77 | 1,3 | 1,9 | 2,8 | 3,8 | 4,9 | 6,2 | 7,3 | 8,1 | 26 |
| 40\1 | 1,5\1 | 0,23 | 0,5 | 0,83 | 1,2 | 1,8 | 2,5 | 3,2 | 4,1 | 4,8 | 5,3 | 26 |
| 40\2 | 1,5\2 | 0,15 | 0,33 | 0,54 | 0,79 | 1,2 | 1,6 | 2,1 | 2,6 | 3,1 | 3,4 | 26 |
| 40\3 | 1,5\3 | 0,09 | 0,2 | 0,33 | 0,49 | 0,74 | 0,99 | 1,3 | 1,6 | 1,9 | 2,1 | 26 |
| 40\4 | 1,5\4 | 0,06 | 0,12 | 0,21 | 0,3 | 0,46 | 0,61 | 0,79 | 1 | 1,2 | 1,3 | 26 |
| 40\5 | 1,5\5 | 0,04 | 0,08 | 0,13 | 0,19 | 0,28 | 0,38 | 0,5 | 0,63 | 0,74 | 0,82 | 26 |
| 50 | 2 | 0,61 | 1,4 | 2,3 | 3,3 | 5 | 6,7 | 8,7 | 11 | 12,9 | 14,3 | 26 |
| 50\1 | 2\1 | 0,35 | 0,77 | 1,3 | 1,9 | 2,8 | 3,8 | 4,9 | 6,2 | 7,3 | 8,1 | 26 |
| 50\2 | 2\2 | 0,23 | 0,5 | 0,83 | 1,2 | 1,8 | 2,5 | 3,2 | 4,1 | 4,8 | 5,3 | 26 |
| 50\3 | 2\3 | 0,15 | 0,33 | 0,54 | 0,79 | 1,2 | 1,6 | 2,1 | 2,6 | 3,1 | 3,4 | 26 |
| 50\4 | 2\4 | 0,09 | 0,2 | 0,33 | 0,49 | 0,74 | 0,99 | 1,3 | 1,6 | 1,9 | 2,1 | 26 |
| 50\5 | 2\5 | 0,06 | 0,12 | 0,21 | 0,3 | 0,46 | 0,61 | 0,79 | 1 | 1,2 | 1,3 | 26 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cv/d2 | 0,12 | 0,27 | 0,45 | 0,67 | 1 | 1,36 | 1,77 | 2,24 | 2,64 | 2,9 |
| FL | 0,99 | 0,98 | 0,98 | 0,97 | 0,97 | 0,97 | 0,96 | 0,96 | 0,95 | 0,95 |
| Xt | 0,84 | 0,84 | 0,84 | 0,83 | 0,83 | 0,82 | 0,81 | 0,80 | 0,78 | 0,76 |

# 08. USS/STD™ O LDB™ CAGE

**DESIGN**

STD cage is a hole pattern drilled cage. It provides excellent rangeability for control valves with low cost cage design thus reducing trim prices.

LDB cages maintain the same philosophy as STD cages with excellent features in noise reduction.

STD cage and LDB cage can be used with unbalanced plug over 250ºC giving excellent solutions. Flow is going up through seat ring and out of cage.

Hole pattern design reduces the number of pieces for reduced trims and also provides excellent rangeability for reduced trims instead of reducing the travel. Spacing of the holes is carefully controlled to eliminate jet interaction and higher resultant noise levels.

STD and LDB cages give Cage characterized inherent characteristic curves (sizes from 2" through 8") and for sizes from 3/4" through 1 1/2" the inherent characteristic curve is given by the contoured plug.

**PERFORMANCE**

USS plug is used for general purpose in most liquid and gas for both modulating and on/off applications.

Trim flow characteristic (inherent characteristic curve) are Linear and Equal percentage. See attached CV values ant 10% different opening as follows:

- Table 1. Linear flow characteristic with Contoured Plug or STD Cages.
- Table 2. Equal percentage flow characteristic with Contoured Plug or STD Cages.
- Table 3. LDB cage, Linear flow characteristic.
- Table 4. LDB cage, Equal percentage flow characteristic.

Rated seat leakage is class IV as standard. Class VI is also available.

LDB trim offer some of the advantages of the multistage trims. LDB cage reduces the damaging effects of flashing and cavitation when using compressible and non-compressible fluids

**MATERIALS**

1. Standard:
   410/420 corrosion resistant steel.
   316 and stellited 316 stainless steel.
   440 and 17-4PH stainless steel.
2. Special:

Hastelloy®, Monel®, Colmonoy® and other high hardness coatings. Tungsten carbide for extra high hardness is a good choice for highly erosive fluids.

NACE materials are also offered at request.

Standard materials for body/bonnet are carbon steel, alloy steel, stainless steel and others.

**APPLICATIONS**

General purpose valve trim which can be used in most clean compressible and non-compressible fluid services for both modulating and on/off control.

Standard for 3/4" trim size and up to 8".

Unbalanced plug design offers capability of tight shutoff for service temperatures exceeding 250ºC.

Alternative to Balanced Single Seat (BSS) when temperature exceeds 250ºC. (See Bulletin VC152.)

USS with LDB cage for same applications as STD cage, when noise level is a factor in critical pressure drop compressible fluid service or when low level cavitation exist in liquid service.

**NOISE ATTENUATION**

In a closed system (not vented to the atmosphere) noise becomes airborne only by transmission through the valves and adjacent piping that contain the flowstream. The sound field in the flowstream forces these solid boundaries to vibrate, causing disturbances in the surrounding air to propagate as sound waves. Noise control techniques fall into one of two basic categories: Source treatment and Path treatment. While preventing noise at the source is the preferred approach to noise contro, it is sometimes economically or physically impractical due to particular application requirements. Path treatment is then a reasonable approach. There are also instances when source treatment alone does not provide sufficient noise reduction; path treatment is then used as a supplement.

We can analyze an example in source treatment. If we have two cages, one STD cage (1) and other one LDB cage (2) with more holes, and the low rate is the same, $(\text{Flow rate})_1 = (\text{Flow rate})_2$ and $(\text{Noise power})_1 = (\text{Noise power})_2$, then (dB)1 = (dB)2 + K.

K value could be between 10 and 15 dBA, which is the attenuation between the STD cage and LDB cage with little sacrifice in flow capacity.

Due to noise source combining, use of multiple orifice trims, as LDB cage, can reduce the flow rate related noise component.

The drilled LDB cage has been carefully engineered to reduce flow jet interaction and turbulence, thereby providing superior noise attenuation.

## Valve capacity (Cv) values

### Table 1

LINEAR inherent characteristic curve. Cv values of the valve at 10% opening intervals.

Cierre caracterizado

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 20 | 3/4 | 0,54 | 1,8 | 3,2 | 4,6 | 5,9 | 7,1 | 8,3 | 9,6 | 11 | 12 | 20 |
| 20\1 | 3/4\1 | 0,36 | 1,2 | 2,2 | 3 | 3,9 | 4,7 | 5,5 | 6,4 | 7,3 | 8 | 20 |
| 25 | 1 | 0,77 | 2,6 | 4,6 | 6,5 | 8,3 | 10 | 12 | 14 | 15 | 17 | 20 |
| 25\1 | 1\1 | 0,50 | 1,7 | 3 | 4,2 | 5,4 | 6,5 | 7,6 | 8,8 | 10 | 11 | 20 |
| 40 | 1,5 | 1,5 | 4,8 | 8,2 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 20 |
| 40/1 | 1,5\1 | 1 | 3,4 | 5,7 | 8 | 10 | 13 | 15 | 17 | 19 | 21 | 20 |

Caja STD

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 2,7 | 8,6 | 15 | 21 | 26 | 32 | 37 | 43 | 49 | 54 | 20 |
| 50/1 | 2\1 | 1,9 | 6 | 10 | 14 | 19 | 22 | 26 | 30 | 34 | 38 | 20 |
| 80 | 3 | 6 | 19 | 33 | 46 | 60 | 72 | 84 | 97 | 110 | 122 | 32 |
| 80/1 | 3\1 | 4,2 | 14 | 23 | 32 | 42 | 50 | 59 | 68 | 77 | 85 | 32 |
| 100 | 4 | 10,8 | 35 | 58 | 82 | 106 | 127 | 150 | 173 | 194 | 216 | 45 |
| 100/1 | 4\1 | 7,5 | 24 | 41 | 57 | 74 | 90 | 104 | 120 | 135 | 150 | 45 |
| 150 | 6 | 25 | 78 | 132 | 186 | 240 | 289 | 338 | 390 | 441 | 490 | 64 |
| 150/1 | 6\1 | 17 | 55 | 93 | 130 | 168 | 202 | 237 | 274 | 309 | 343 | 64 |
| 200 | 8 | 43 | 138 | 233 | 328 | 423 | 510 | 596 | 690 | 778 | 864 | 85 |
| 200/1 | 8\1 | 30 | 97 | 163 | 230 | 296 | 357 | 417 | 484 | 544 | 605 | 85 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,97 | 0,97 | 0,96 | 0,95 | 0,94 | 0,93 | 0,93 | 0,92 | 0,91 | 0,91 |
| Xt | 0,8 | 0,8 | 0,8 | 0,8 | 0,79 | 0,78 | 0,76 | 0,73 | 0,72 | 0,7 |

### Table 2

EQUAL PERCENTAGE inherent charasteristic curve. Cv values of the valve at 10% opening intervals.

Plug characterized

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 20 | 3/4 | 0,16 | 0,3 | 0,6 | 0,9 | 1,3 | 1,8 | 2,7 | 4,2 | 6 | 9 | 20 |
| 20\1 | 3/4\1 | 0,11 | 0,2 | 0,4 | 0,6 | 0,8 | 1,2 | 1,8 | 2,8 | 4 | 6 | 20 |
| 25 | 1 | 0,25 | 0,5 | 1 | 1,4 | 2 | 2,8 | 4,2 | 6,5 | 9,3 | 14 | 20 |
| 25\1 | 1\1 | 0,16 | 0,3 | 0,6 | 0,9 | 1,3 | 1,8 | 2,7 | 4,2 | 6 | 9 | 20 |
| 40 | 1,5 | 0,41 | 0,9 | 1,6 | 2,3 | 3,2 | 4,6 | 6,9 | 10,6 | 15,3 | 23 | 20 |
| 40/1 | 1,5\1 | 0,29 | 0,6 | 1,1 | 1,6 | 2,2 | 3,2 | 4,8 | 7,4 | 10,7 | 16 | 20 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,97 | 0,97 | 0,96 | 0,95 | 0,94 | 0,93 | 0,93 | 0,92 | 0,91 | 0,91 |
| Xt | 0,8 | 0,8 | 0,8 | 0,8 | 0,79 | 0,78 | 0,76 | 0,73 | 0,72 | 0,7 |

STD Cage

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 0,80 | 1,6 | 2,8 | 4 | 6 | 8 | 12 | 19 | 26 | 40 | 20 |
| 50/1 | 2\1 | 0,56 | 1,1 | 2 | 2,8 | 4 | 6 | 8,4 | 13 | 18 | 28 | 20 |
| 80 | 3 | 1,8 | 3,6 | 6,3 | 9 | 13 | 18 | 27 | 41 | 59 | 90 | 32 |
| 80/1 | 3\1 | 1,2 | 2,5 | 4,4 | 6,3 | 9 | 13 | 19 | 29 | 42 | 63 | 32 |
| 100 | 4 | 3,2 | 6,4 | 11 | 16 | 22 | 32 | 48 | 74 | 106 | 160 | 45 |
| 100/1 | 4\1 | 2,2 | 4,5 | 7,8 | 11 | 16 | 22 | 34 | 52 | 74 | 112 | 45 |
| 150 | 6 | 7,2 | 15 | 25 | 36 | 50 | 72 | 108 | 166 | 238 | 360 | 64 |
| 150/1 | 6\1 | 5 | 10 | 18 | 25 | 35 | 50 | 76 | 116 | 166 | 252 | 64 |
| 200 | 8 | 13 | 26 | 45 | 64 | 90 | 128 | 192 | 294 | 422 | 640 | 85 |
| 200/1 | 8\1 | 9 | 18 | 32 | 45 | 63 | 90 | 135 | 207 | 297 | 450 | 85 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,97 | 0,97 | 0,96 | 0,95 | 0,94 | 0,93 | 0,93 | 0,92 | 0,91 | 0,91 |
| Xt | 0,8 | 0,8 | 0,8 | 0,8 | 0,79 | 0,78 | 0,76 | 0,73 | 0,72 | 0,7 |

## Valve capacity (Cv) values with LDB Cage

### Table 3

LINEAR inherent characteristic curve. Cv values of the valve at 10% opening intervals.

LDB Cage

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 2,4 | 7,7 | 13 | 18 | 24 | 29 | 34 | 39 | 44 | 49 | 20 |
| 50/1 | 2\1 | 1,7 | 5,4 | 9,2 | 13 | 17 | 20 | 23 | 27 | 31 | 34 | 20 |
| 80 | 3 | 5,5 | 18 | 30 | 42 | 54 | 65 | 76 | 88 | 99 | 110 | 32 |
| 80/1 | 3\1 | 3,8 | 13 | 21 | 29 | 38 | 45 | 53 | 62 | 69 | 77 | 32 |
| 100 | 4 | 9,7 | 31 | 53 | 74 | 96 | 115 | 135 | 156 | 176 | 195 | 45 |
| 100/1 | 4\1 | 6,8 | 22 | 37 | 52 | 67 | 81 | 94 | 109 | 123 | 137 | 45 |
| 150 | 6 | 22 | 70 | 119 | 167 | 216 | 260 | 304 | 352 | 396 | 440 | 64 |
| 150/1 | 6\1 | 16 | 50 | 84 | 118 | 152 | 183 | 214 | 248 | 279 | 310 | 64 |
| 200 | 8 | 39 | 125 | 211 | 296 | 382 | 460 | 538 | 624 | 702 | 780 | 85 |
| 200/1 | 8\1 | 27 | 86 | 146 | 205 | 265 | 319 | 373 | 432 | 486 | 540 | 85 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,98 | 0,98 | 0,97 | 0,96 | 0,95 | 0,94 | 0,94 | 0,93 | 0,92 | 0,92 |
| Xt | 0,81 | 0,81 | 0,81 | 0,81 | 0,8 | 0,79 | 0,77 | 0,74 | 0,73 | 0,71 |

### Table 4

EQUAL PERCENTAGE inherent characteristic curve. Cv values of the valve at 10% opening intervals.

LDB Cage

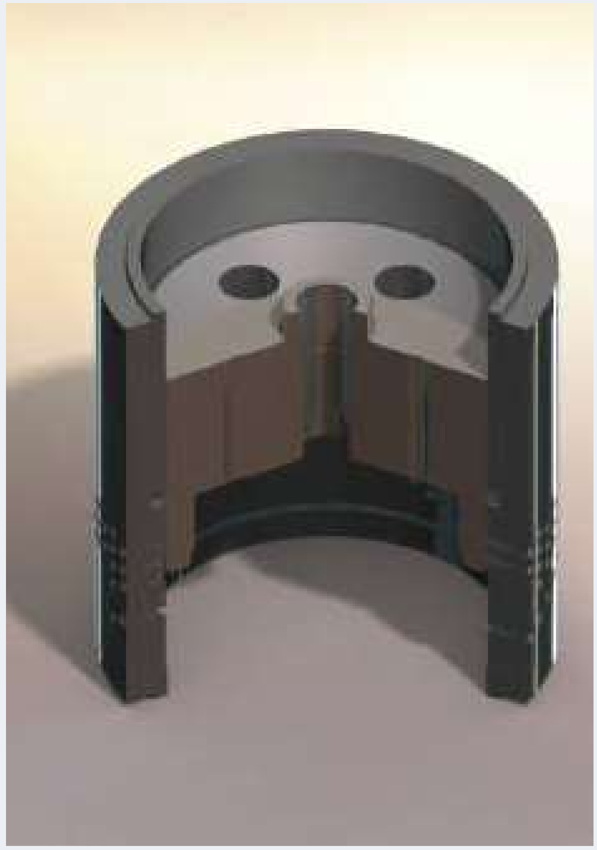
| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 0,72 | 1,4 | 2,5 | 3,6 | 5 | 7 | 11 | 17 | 24 | 36 | 20 |
| 50/1 | 2\1 | 0,5 | 1 | 1,7 | 2,5 | 4 | 5 | 8 | 12 | 17 | 25 | 20 |
| 80 | 3 | 1,6 | 3,2 | 5,6 | 8 | 12 | 16 | 24 | 37 | 53 | 81 | 32 |
| 80/1 | 3\1 | 1,1 | 2,2 | 4 | 5,6 | 8 | 12 | 17 | 26 | 37 | 57 | 32 |
| 100 | 4 | 2,9 | 5,7 | 10 | 14 | 20 | 29 | 43 | 66 | 95 | 144 | 45 |
| 100/1 | 4\1 | 2 | 4 | 7 | 10 | 14 | 20 | 30 | 46 | 66 | 100 | 45 |
| 150 | 6 | 6,5 | 13 | 23 | 33 | 46 | 65 | 98 | 150 | 215 | 325 | 64 |
| 150/1 | 6\1 | 4,6 | 9,2 | 16 | 23 | 32 | 46 | 69 | 106 | 152 | 230 | 64 |
| 200 | 8 | 11,5 | 23 | 41 | 58 | 81 | 116 | 174 | 267 | 383 | 580 | 85 |
| 200/1 | 8\1 | 8 | 16 | 28 | 41 | 57 | 81 | 122 | 186 | 267 | 405 | 85 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,98 | 0,98 | 0,97 | 0,96 | 0,95 | 0,94 | 0,94 | 0,93 | 0,92 | 0,92 |
| Xt | 0,81 | 0,81 | 0,81 | 0,81 | 0,8 | 0,79 | 0,77 | 0,74 | 0,73 | 0,71 |

# 09. BSS/STD™ & LDB™ CAGE

## DESIGN

STD cage is a hole pattern drilled cage. It provides excellent rangeability for control valves with low cost cage design thus reducing trim prices.
LDB cages mantain the same philosophy as STD cages with excellent features in noise reduction.
STD cage and LDB cage can be used with balanced plug (up to 250ºC) and unbalanced plug (over 250ºC) giving four excellent solutions:
- STD and LDB cage, balanced plug, flow into cage and down through seat ring.
- STD and LDB cage, unbalanced plug, flow up through seat ring and out of cage.
Hole pattern design reduces the number of pieces for reduced trims and also provides excellent rangeability for reduced trims instead of reducing the travel.
Spacing between holes is carefully controlled to eliminate jet interaction and higher resultant noise levels.

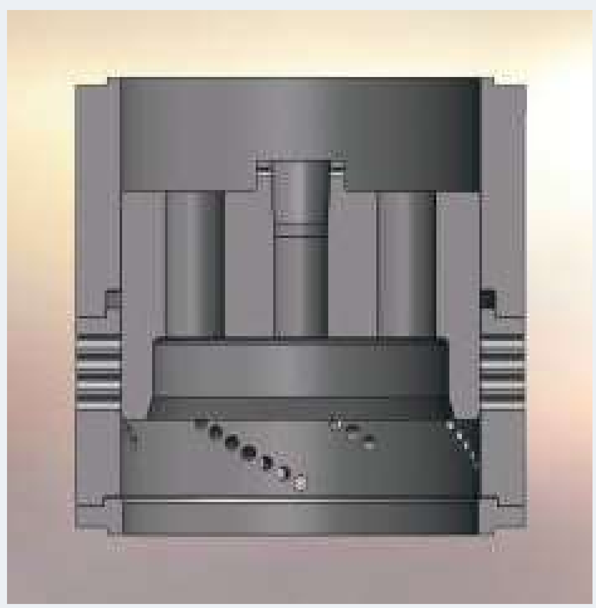


## PERFORMANCE

STD and LDB cage are used in general purpose services in most liquid and gas for both modulating and on/off applications.
Trim flow characteristic (inherent characteristic curve) are Linear an Equal percentage. See attached Cv values at 10% different opening as follows:

- Table 1. STD cage. Linear flow characteristic.
- Table 2. STD cage, Equal percentage flow characteristic.
- Table 3. LDB cage, Linear flow characteristic.
- Table 4. LDB cage. Equal percentage flow characteristic.

Rated seat leakage is class IV as standard. Class VI is also available.
LDB trim offer some of the advantages of the multistage trims. LDB cage reduces the damaging effects of flashing and cavitation when using compressible and non-compressible fluids.
The cage guided balanced plug provides for stable operation during valve throttling, in addition to tight shut-off capability.



## MATERIALS

1. Standard:
   410/420 corrosion resistant steel.
   316 and stellited 316 stainless steel.
   440 and 17 4PH stainless steel

2. Special:

Hastelloy, Monel, Colmonoy and other high hardness coatings. Tungsten carbide for extra high hardness is a good choice for highly erosive fluids.

NACE materials are also offered at request.

Standard materials for body/bonnet are carbon steel, ally steel, stainless steel and others.

## APPLICATIONS

1. STD cage

General purpose cage guided valve trim which can be used in most clean compressible and non-compressible fluid services for both modulating and on/off control.

The balanced plug design reduces actuator force requirements thus premitting use of smaller, less expensive actuators while mantaining tight shutoff capability. Standard for 1.5” trim size and up when service temperature is less than 250ºC.

Unbalanced plug design offers capability of thight shutoff for service temperatures exceeding 250ºC

2. LDB cage

Same applications as STD cage, when noise level is a factor in critical pressure drop compressible fluid service or when low level cavitation exist in liquid service.

## NOISE ATTENUATION

In a closed system (not vented to the atmosphere) noise becomes airborne only by transmission trough the valves and adjacent piping that contain the flowstream. The sound field in the flowstream forces these solid boundaries to vibrate, causing disturbances in the surrounding air to propagate as sound waves. Noise control techniques fall into one of two basic categories: Source treatment and Path treatment. While preventing noise at the sources is the preferred approach to noise control, it is sometimes economically or physically impractical due to particular application requirements. Path treatment is then a reasonable approach. There are also instances when source treatment alone does not provide sufficient noise reduction; path treatment is then used as a supplement.

We can analyze an example in source treatment. If we have two cages, one STD cage (1) and other one LDB cage (2) with more holes, and the flow rate is the same (Flow rate)1= (Flow rate)2 and (Noise power)1= (Noise power)2, then (dB)1=(dB)2 +K.

K value could be between 10 and 15 dBA, which is the attenuation between the STD cage and LDB cage with little sacrifice in flow capacity.

Due to noise source combining, use of multiple orifice trims, as LDB cage, can reduce the flow rate related noise component.

The drilled LDB cage has been carefully engineered to reduce flow jet interaction and turbulence, thereby providing superior noise attenuation.

## ■ Valve capacity (Cv) values

### Table 1

STD Cage. LINEAR inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 2,7 | 8,6 | 15 | 21 | 26 | 32 | 37 | 43 | 49 | 54 | 20 |
| 50/1 | 2\1 | 1,9 | 6 | 10 | 14 | 19 | 22 | 26 | 30 | 34 | 38 | 20 |
| 80 | 3 | 6 | 19 | 33 | 46 | 60 | 72 | 84 | 97 | 110 | 122 | 32 |
| 80/1 | 3\1 | 4,2 | 14 | 23 | 32 | 42 | 50 | 59 | 68 | 77 | 85 | 32 |
| 100 | 4 | 10,8 | 35 | 58 | 82 | 106 | 127 | 150 | 173 | 194 | 216 | 45 |
| 100/1 | 4\1 | 7,5 | 24 | 41 | 57 | 74 | 90 | 104 | 120 | 135 | 150 | 45 |
| 150 | 6 | 25 | 78 | 132 | 186 | 240 | 289 | 338 | 390 | 441 | 490 | 64 |
| 150/1 | 6\1 | 17 | 55 | 93 | 130 | 168 | 202 | 237 | 274 | 309 | 343 | 64 |
| 200 | 8 | 43 | 138 | 233 | 328 | 423 | 510 | 596 | 690 | 778 | 864 | 85 |
| 200/1 | 8\1 | 30 | 97 | 163 | 230 | 296 | 357 | 417 | 484 | 544 | 605 | 85 |
| 250 | 10 | 68 | 216 | 365 | 513 | 662 | 800 | 932 | 1.080 | 1.215 | 1.350 | 107 |
| 250/1 | 10/1 | 47 | 151 | 255 | 360 | 463 | 560 | 652 | 756 | 850 | 945 | 107 |
| 300 | 12 | 98 | 312 | 527 | 740 | 956 | 1.150 | 1.346 | 1.560 | 1.755 | 1.950 | 127 |
| 300/1 | 12/1 | 68 | 218 | 369 | 519 | 669 | 805 | 940 | 1.090 | 1.229 | 1.365 | 127 |
| 350 | 14 | 133 | 424 | 716 | 1.007 | 1.300 | 1.560 | 1.829 | 2.120 | 2.380 | 2.650 | 152 |
| 350/1 | 14/1 | 93 | 297 | 501 | 705 | 909 | 1.094 | 1.280 | 1.484 | 1.670 | 1.855 | 152 |
| 400 | 16 | 173 | 554 | 934 | 1.315 | 1.695 | 2.040 | 2.387 | 2.768 | 3.114 | 3.460 | 177 |
| 400/1 | 16/1 | 121 | 387 | 653 | 920 | 1.186 | 1.430 | 1.670 | 1.936 | 2.178 | 2.420 | 177 |

### Table 2

STD Cage. EQUAL PERCENTAGE inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 0,80 | 1,6 | 2,8 | 4 | 6 | 8 | 12 | 19 | 26 | 40 | 20 |
| 50/1 | 2\1 | 0,56 | 1,1 | 2 | 2,8 | 4 | 6 | 8,4 | 13 | 18 | 28 | 20 |
| 80 | 3 | 1,8 | 3,6 | 6,3 | 9 | 13 | 18 | 27 | 41 | 59 | 90 | 32 |
| 80/1 | 3\1 | 1,2 | 2,5 | 4,4 | 6,3 | 9 | 13 | 19 | 29 | 42 | 63 | 32 |
| 100 | 4 | 3,2 | 6,4 | 11 | 16 | 22 | 32 | 48 | 74 | 106 | 160 | 45 |
| 100/1 | 4\1 | 2,2 | 4,5 | 7,8 | 11 | 16 | 22 | 34 | 52 | 74 | 112 | 45 |
| 150 | 6 | 7,2 | 14,5 | 25 | 36 | 50 | 72 | 108 | 166 | 238 | 360 | 64 |
| 150/1 | 6\1 | 5 | 10 | 18 | 25 | 35 | 50 | 76 | 116 | 166 | 252 | 64 |
| 200 | 8 | 13 | 26 | 45 | 64 | 90 | 128 | 192 | 294 | 422 | 640 | 85 |
| 200/1 | 8\1 | 9 | 18 | 32 | 45 | 63 | 90 | 135 | 207 | 297 | 450 | 85 |
| 250 | 10 | 20 | 40 | 70 | 100 | 140 | 200 | 300 | 460 | 660 | 1.000 | 107 |
| 250/1 | 10/1 | 14 | 28 | 49 | 70 | 98 | 140 | 210 | 322 | 462 | 700 | 107 |
| 300 | 12 | 29 | 58 | 101 | 144 | 202 | 288 | 432 | 662 | 950 | 1.440 | 127 |
| 300/1 | 12/1 | 20 | 40 | 71 | 101 | 141 | 202 | 303 | 465 | 667 | 1.010 | 127 |
| 350 | 14 | 39 | 78 | 137 | 196 | 274 | 392 | 588 | 902 | 1.294 | 1.960 | 152 |
| 350/1 | 14/1 | 27 | 55 | 96 | 137 | 192 | 274 | 411 | 630 | 904 | 1.370 | 152 |
| 400 | 16 | 51 | 102 | 179 | 256 | 358 | 512 | 768 | 1.178 | 1.690 | 2.560 | 177 |
| 400/1 | 16/1 | 36 | 72 | 125 | 179 | 251 | 358 | 537 | 823 | 1.181 | 1.790 | 177 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL(1) | 0,97 | 0,97 | 0,96 | 0,95 | 0,94 | 0,93 | 0,93 | 0,92 | 0,91 | 0,91 |
| FL(2) | 0,87 | 0,87 | 0,85 | 0,85 | 0,84 | 0,83 | 0,83 | 0,82 | 0,81 | 0,81 |
| Xt(1) | 0,8 | 0,8 | 0,8 | 0,8 | 0,79 | 0,78 | 0,76 | 0,73 | 0,72 | 0,7 |
| Xt(2) | 0,75 | 0,75 | 0,73 | 0,72 | 0,7 | 0,68 | 0,68 | 0,67 | 0,65 | 0,65 |

NOTES

(1) FL and Xt values for flow up through seat ring and out of cage.

(2) FL and Xt values for flow into cage and down through seat ring.

## Valve capacity (Cv) values for LDB Cage

### Table 3

LDB Cage. LINEAR inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 2,4 | 7,7 | 13 | 18 | 24 | 29 | 34 | 39 | 44 | 49 | 20 |
| 50/1 | 2\1 | 1,7 | 5,4 | 9,2 | 13 | 17 | 20 | 23 | 27 | 31 | 34 | 20 |
| 80 | 3 | 5,5 | 18 | 30 | 42 | 54 | 65 | 76 | 88 | 99 | 110 | 32 |
| 80/1 | 3\1 | 3,8 | 13 | 21 | 29 | 38 | 45 | 53 | 62 | 69 | 77 | 32 |
| 100 | 4 | 9,7 | 31 | 53 | 74 | 96 | 115 | 135 | 156 | 176 | 195 | 45 |
| 100/1 | 4\1 | 6,8 | 22 | 37 | 52 | 67 | 81 | 94 | 109 | 123 | 137 | 45 |
| 150 | 6 | 22 | 70 | 119 | 167 | 216 | 260 | 304 | 352 | 396 | 440 | 64 |
| 150/1 | 6\1 | 16 | 50 | 84 | 118 | 152 | 183 | 214 | 248 | 279 | 310 | 64 |
| 200 | 8 | 39 | 125 | 211 | 296 | 382 | 460 | 538 | 624 | 702 | 780 | 85 |
| 200/1 | 8\1 | 27 | 86 | 146 | 205 | 265 | 319 | 373 | 432 | 486 | 540 | 85 |
| 250 | 10 | 61 | 194 | 328 | 462 | 595 | 717 | 838 | 972 | 1.094 | 1.215 | 107 |
| 250/1 | 10/1 | 43 | 136 | 230 | 323 | 417 | 502 | 587 | 680 | 765 | 850 | 107 |
| 300 | 12 | 87 | 280 | 472 | 665 | 857 | 1.032 | 1.207 | 1.400 | 1.575 | 1.750 | 127 |
| 300/1 | 12/1 | 61 | 196 | 331 | 465 | 600 | 723 | 845 | 980 | 1.102 | 1.225 | 127 |
| 350 | 14 | 119 | 381 | 643 | 904 | 1.166 | 1.404 | 1.642 | 1.904 | 2.142 | 2.380 | 152 |
| 350/1 | 14/1 | 84 | 267 | 451 | 635 | 818 | 985 | 1.152 | 1.336 | 1.503 | 1.670 | 152 |
| 400 | 16 | 156 | 498 | 840 | 1.182 | 1.542 | 1.835 | 2.146 | 2.488 | 2.799 | 3.110 | 177 |
| 400/1 | 16/1 | 109 | 348 | 587 | 827 | 1.066 | 1.283 | 1.501 | 1.740 | 1.958 | 2.175 | 177 |

### Table 4

LDB Cage. EQUAL PERCENTAGE inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 0,72 | 1,4 | 2,5 | 3,6 | 5 | 7 | 11 | 17 | 24 | 36 | 20 |
| 50/1 | 2\1 | 0,5 | 1 | 1,7 | 2,5 | 4 | 5 | 8 | 11,5 | 17 | 25 | 20 |
| 80 | 3 | 1,6 | 3,2 | 5,6 | 8 | 12 | 16 | 24 | 37 | 53 | 81 | 32 |
| 80/1 | 3\1 | 1,1 | 2,2 | 4 | 5,6 | 8 | 12 | 17 | 26 | 37 | 57 | 32 |
| 100 | 4 | 2,9 | 5,7 | 10 | 14 | 20 | 29 | 43 | 66 | 95 | 144 | 45 |
| 100/1 | 4\1 | 2 | 4 | 7 | 10 | 14 | 20 | 330 | 46 | 66 | 100 | 45 |
| 150 | 6 | 6,5 | 13 | 23 | 33 | 46 | 65 | 98 | 150 | 215 | 325 | 64 |
| 150/1 | 6\1 | 4,6 | 9,2 | 16 | 23 | 32 | 46 | 69 | 106 | 152 | 230 | 64 |
| 200 | 8 | 11,5 | 23 | 41 | 58 | 81 | 116 | 174 | 267 | 383 | 580 | 85 |
| 200/1 | 8\1 | 8 | 16 | 28 | 41 | 57 | 81 | 122 | 186 | 267 | 405 | 85 |
| 250 | 10 | 18 | 36 | 63 | 90 | 126 | 180 | 270 | 414 | 594 | 900 | 107 |
| 250/1 | 10/1 | 12,5 | 25 | 44 | 63 | 88 | 126 | 189 | 290 | 416 | 630 | 107 |
| 300 | 12 | 26 | 52 | 91 | 130 | 182 | 260 | 390 | 598 | 858 | 1.300 | 127 |
| 300/1 | 12/1 | 18 | 36 | 64 | 91 | 127 | 182 | 273 | 419 | 601 | 910 | 127 |
| 350 | 14 | 35 | 70 | 123 | 176 | 246 | 352 | 528 | 810 | 1.162 | 1.760 | 152 |
| 350/1 | 14/1 | 25 | 49 | 86 | 123 | 172 | 246 | 369 | 566 | 812 | 1.230 | 152 |
| 400 | 16 | 46 | 92 | 161 | 230 | 322 | 460 | 690 | 1.058 | 1.518 | 2.300 | 177 |
| 400/1 | 16/1 | 32 | 64 | 113 | 161 | 225 | 322 | 483 | 741 | 1.063 | 1.610 | 177 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL(1) | 0,98 | 0,98 | 0,97 | 0,96 | 0,95 | 0,94 | 0,94 | 0,93 | 0,92 | 0,92 |
| FL(2) | 0,88 | 0,88 | 0,87 | 0,86 | 0,85 | 0,84 | 0,84 | 0,83 | 0,82 | 0,82 |
| Xt(1) | 0,81 | 0,81 | 0,81 | 0,81 | 0,8 | 0,79 | 0,77 | 0,74 | 0,73 | 0,71 |
| Xt(2) | 0,77 | 0,77 | 0,76 | 0,74 | 0,72 | 0,71 | 0,71 | 0,69 | 0,67 | 0,67 |

NOTES

(1) FL and Xt values for flow up through seat ring and out of cage.

(2) FL and Xt values for flow into cage and down through seat ring.

# 10. CAVLESS™ TRIM

## DESIGN

The Cavless trim consists of a cage which has, double drilled, a serie of timed radial holes which provides a nozzle effect. Each nozzle is diametrically opposed by an identical nozzle.
Using a balanced plug it acts as a control device which covers and uncovers those holes, thus controlling the flow fluid.
The design can control the location of the vena-contracta and therefore control the location where cavitation occurs. When the plug is throtling a number of nozzles will be uncovered and the resulting jet stream of cavitation liquid will be directed into the cage center. This diverts the harmful effects of cavitation away from the plug and cage.
The Cavless cage could be used with two types of plug, balanced or unbalanced, giving two excellent solutions:
- Cavless cage, balanced plug, flow into cage and down through seat ring for cavitation service.
- Cavless cage, unbalanced plug, flow up through seat ring and out of cage for flashing service.

## PERFORMANCE

Cavless trim takes its name because it reduce the problem of cavitation, "less cavitation". Cavless trim does not eliminate cavitation but it reduces the resultant effects of cavitation and flashing and its associated noise, vibration and erosion problems.
Cavless trim should be used only where low level cavitation exist.
The Cavless trim with balanced plug, for cavitation service, utilizes a cage guided design with "U" cup seal for thight shut-off capabilities. The maximum allowable service temperature for Cavless trim with balanced plug is 300°C. For Cavless trim with unbalanced plug (flashing service) the temperature limits are according material selection.
The cage guided balanced plug provides for stable operation during valve throtting, in addition to tight shut-off capability.
Our standard Caveless cage features excellent vibration and Sound Pressure Level (SPL) reduction combined with high flow capacity.

## MATERIALS

Martensitic corrosion resistant steels type 420 are used for plug, cage and seat ring. Hardfaced 316 stainless steel and 17-4PH can be used as an option.
Standard materials for body/bonnet are carbon steel, alloy steel, stainless steel and others.

## APPLICATIONS

The Cavless trim is designed primarily for liquid service where low level cavitation is evident. Some examples are:

1. Feedwater systems.
2. Flashing services.
3. Condensate systems (deaerator level control, drain services, etc.)
4. Condensate recirculation systems.

Standard rated seat leakage class IV according ANSI B16. 104.
Rangeability is good as 25 to1.
Direction of flow from over the seat for cavitating applications and from under the seat for flashing applications.

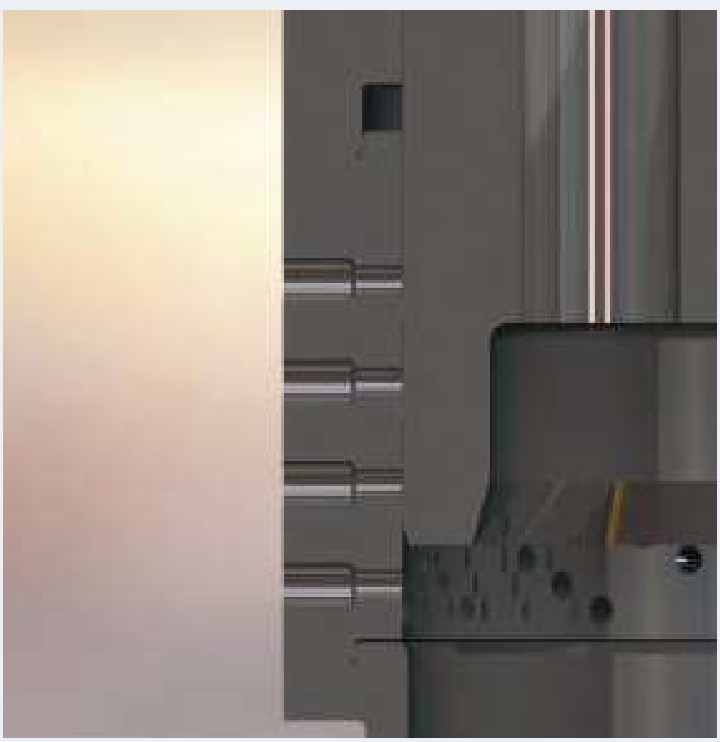
## Valve capacity (Cv) values

**Table 1**
Cv values of the valve at 10% opening intervals.
LINEAR inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 50 | 2 | 1,5 | 5 | 9 | 13 | 16,5 | 20 | 23,5 | 27,5 | 31 | 35 | 26 |
| 50/1 | 2\1 | 1 | 3,7 | 6,5 | 9,5 | 12 | 14,5 | 17 | 19,5 | 22,5 | 25 | 26 |
| 80 | 3 | 3,5 | 11,7 | 21 | 29,5 | 38 | 45,5 | 53 | 62 | 70 | 78 | 38 |
| 80/1 | 3\1 | 2,3 | 7,8 | 14 | 20 | 25,5 | 31 | 36 | 42 | 47,5 | 53 | 38 |
| 100 | 4 | 4,8 | 16,5 | 29,5 | 41 | 53 | 64 | 74,5 | 87 | 98,5 | 110 | 45 |
| 100/1 | 4\1 | 3,2 | 11 | 19,5 | 27,5 | 35,5 | 43 | 50,5 | 58,5 | 66,5 | 74 | 45 |
| 150 | 6 | 11 | 36,5 | 65 | 92 | 118 | 142 | 167 | 194 | 219 | 245 | 64 |
| 150/1 | 6\1 | 7 | 24 | 43 | 61 | 78 | 94 | 110 | 129 | 145 | 162 | 64 |
| 200 | 8 | 21,5 | 73 | 130 | 183 | 236 | 284 | 333 | 388 | 438 | 490 | 76 |
| 200/1 | 8\1 | 14 | 48 | 84 | 119 | 153 | 185 | 216 | 252 | 285 | 318 | 76 |
| 250 | 10 | 32 | 107 | 191 | 268 | 346 | 417 | 488 | 568 | 642 | 717 | 107 |
| 250/1 | 10/1 | 20 | 68 | 121 | 171 | 221 | 266 | 311 | 362 | 410 | 457 | 107 |
| 300 | 12 | 56 | 189 | 336 | 474 | 611 | 735 | 860 | 1.002 | 1.133 | 1.265 | 127 |
| 300/1 | 12/1 | 34.5 | 116 | 206 | 291 | 375 | 451 | 527 | 615 | 695 | 776 | 127 |
| 350 | 14 | 78 | 263 | 467 | 657 | 842 | 1.020 | 1.192 | 1.389 | 1.568 | 1.754 | 152 |
| 350/1 | 14/1 | 48 | 162 | 288 | 406 | 524 | 630 | 737 | 859 | 971 | 1.084 | 152 |
| 400 | 16 | 105 | 355 | 631 | 888 | 1.145 | 1.379 | 1.613 | 1.879 | 2.125 | 2.372 | 177 |
| 400/1 | 16/1 | 65 | 218 | 388 | 546 | 704 | 848 | 991 | 1.155 | 1.306 | 1.458 | 177 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL(1) | 0,96 | 0,96 | 0,95 | 0,94 | 0,93 | 0,92 | 0,92 | 0,91 | 0,9 | 0,9 |
| FL(2) | 0,86 | 0,85 | 0,84 | 0,83 | 0,83 | 0,82 | 0,81 | 0,81 | 0,8 | 0,8 |
| Xt(1) | 0,82 | 0,82 | 0,82 | 0,82 | 0,81 | 0,8 | 0,78 | 0,75 | 0,74 | 0,72 |
| Xt(2) | 0,73 | 0,72 | 0,7 | 0,68 | 0,68 | 0,67 | 0,65 | 0,65 | 0,64 | 0,64 |

NOTES
(1) FL and Xt values for flow under the seat (flashing)
(2) FL and Xt values for flow over the seat (cavitating)



# 11. PILOT™/STD™ & LDB™ CAGE

## DESIGN

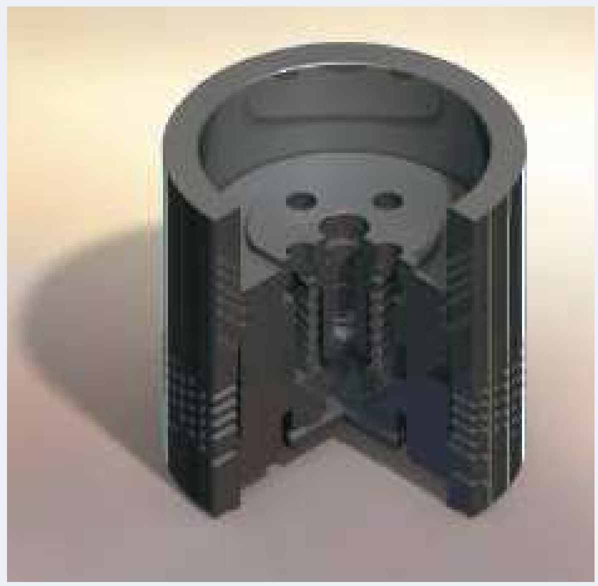
Pilot plug is specially designed for large size valves, 4in and above, to give tight shut-off with balanced trim at high temperature.
Pilot plug permits minimum actuator size when tight shut-off is required.
Pilot plug can be combined with STD and LDB cages with excellent solutions.
STD cage is a hold pattern drilled cage. It provides excellent rangeability for control valves with low cost cage design thus reducing trim prices.
LDB cages mantain the same philosophy as STD cages with excellent features in noise reduction.
Hole pattern design reduces the number of pieces for reduced trims and also provides excellent rangeability for reduced trims instead of reducing the travel.
Spacing between holes is carefully controlled to eliminate jet interaction and higher resultant noise levels.

## PERFORMANCE

Pilot plug with flow direction from over the seat and down through the seat ring.
Rangeability of 25:1
Temperature limits from 30ºC to 565ºC.
Leakage class V acc. ANSI B16.104
STD and LDB cage are for general purpose in most liquid and gas for both modulating and on/off applications.
Trim flow characteristic (inherent characteristic curve) are Linear or Equal percentage. See attached Cv values at 10% different opening as follows:

- Table 1. STD cage, Linear flow characteristic.
- Table 2. STD cage, Equal percentage flow characteristic.
- Table 3. LDB cage, Linear flow characteristic.
- Table 4. LDB cage, Equal percentage flow characteristic.

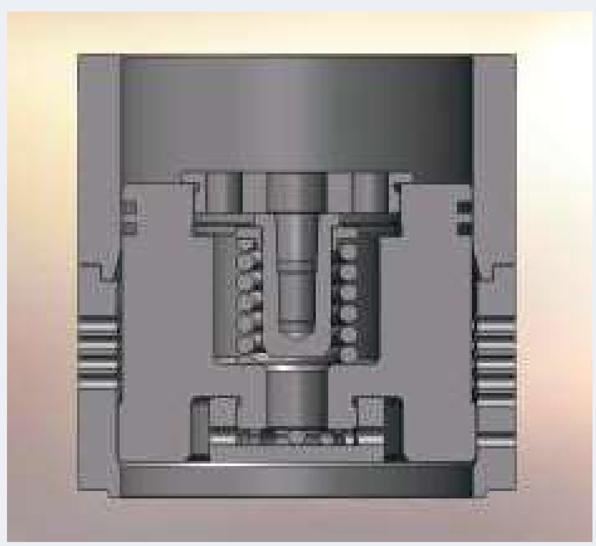
The cage guided balanced plug provides for stable operation during valve throttling, in addition to tight shut-off capability.



## MATERIALS

1. Standard:
   - 410/420 corrosion resistant steel.
   - 316 and stellited 316 stainless steel.
   - 440 and 17 4PH stainless steel
2. Special:
   - Hastelloy™, Monel™, Colmonoy™ and other high hardness coatings. Tungsten carbide for extra high hardness is a good choice for highly erosive fluids.

NACE materials are also offered at request.
Standard materials for body/bonnet are carbon steel, ally steel, stainless steel and others.



## APPLICATIONS

Pilot plug for large size valves, 4in and above, to give thight shut-off with balanced trim at high temperature, Main applications are:

1. HP and LP Turbine Bypass
2. Steam dump.
3. Steam and water pressure reducing.
4. Liquids where flashing and cavitation do not exist.
5. High temperature service (up to 565°C)
6. Medium and large flows.
7. Tight shut-off
8. Steam throttling to atmosphere or to a condenser.
9. Isolation
10. Super-critical boiler start-up

## NOISE ATTENUATION

In a closed system (not vented to the atmosphere) noise becomes airborne only by transmission trough the valves and adjacent piping that contain the flowstream. The sound field in the flowstream forces these solid boundaries to vibrate, causing disturbances in the surrounding air to propagate as sound waves. Noise control techniques fall into one of two basic categories: Source treatment and Path treatment. While preventing noise at the sources is the preferred approach to noise control, it is sometimes economically or physically impractical due to particular application requirements. Path treatment is then a reasonable approach. There are also instances when source treatment alone does not provide sufficient noise reduction; path treatment is then used as a supplement.

We can analyze an example in source treatment. If we have two cages, one STD cage (1) and other one LDB cage (2) with more holes, and the flow rate is the same (Flow rate)1= (Flow rate)2 and (Noise power)1= (Noise power)2, then (dB)1=(dB)2 +K.

K value could be between 10 and 15 dBA, which is the attenuation between the STD cage and LDB cage with little sacrifice in flow capacity.

Due to noise source combining, use of multiple orifice trims, as LDB cage, can reduce the flow rate related noise component. The drilled LDB cage has been carefully engineered to reduce flow jet interaction and turbulence, thereby providing superior noise attenuation.

## ■ Valve capacity (Cv) values with STD Cage

### Table 1

PILOT plug with STD cage. Cv values of the valve at 10% opening intervals.
LINEAR inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 100 | 4 | 10,8 | 35 | 58 | 82 | 106 | 127 | 150 | 173 | 194 | 216 | 51 |
| 100/1 | 4/1 | 7,5 | 24 | 41 | 57 | 74 | 90 | 104 | 120 | 135 | 150 | 51 |
| 150 | 6 | 25 | 78 | 132 | 186 | 240 | 289 | 338 | 390 | 441 | 490 | 72 |
| 150/1 | 6/1 | 17 | 55 | 93 | 130 | 168 | 202 | 237 | 274 | 309 | 343 | 72 |
| 200 | 8 | 43 | 138 | 233 | 328 | 423 | 510 | 596 | 690 | 778 | 864 | 95 |
| 200/1 | 8/1 | 30 | 97 | 163 | 230 | 296 | 357 | 417 | 484 | 544 | 605 | 95 |
| 250 | 10 | 68 | 216 | 365 | 513 | 662 | 800 | 932 | 1.080 | 1.215 | 1.350 | 117 |
| 250/1 | 10/1 | 47 | 151 | 255 | 360 | 463 | 560 | 652 | 756 | 850 | 945 | 117 |
| 300 | 12 | 98 | 312 | 527 | 740 | 956 | 1.150 | 1.346 | 1.560 | 1.755 | 1.950 | 139 |
| 300/1 | 12/1 | 68 | 218 | 369 | 519 | 669 | 805 | 940 | 1.090 | 1.229 | 1.365 | 139 |
| 350 | 14 | 133 | 424 | 716 | 1.007 | 1.300 | 1.560 | 1.820 | 2.120 | 2.380 | 2.650 | 164 |
| 350/1 | 14/1 | 93 | 297 | 501 | 705 | 909 | 1.094 | 1.280 | 1.484 | 1.670 | 1.855 | 164 |
| 400 | 16 | 173 | 554 | 934 | 1.315 | 1.695 | 2.040 | 2.387 | 2.768 | 3.114 | 3.460 | 191 |
| 400/1 | 16/1 | 121 | 387 | 653 | 920 | 1.186 | 1.430 | 1.670 | 1.936 | 2.178 | 2.420 | 191 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,87 | 0,87 | 0,85 | 0,85 | 0,84 | 0,83 | 0,83 | 0,82 | 0,81 | 0,81 |
| Xt | 0,75 | 0,75 | 0,73 | 0,72 | 0,7 | 0,68 | 0,68 | 0,67 | 0,65 | 0,65 |

### Table 2

PILOT plug with STD cage. Cv values of the valve at 10% opening intervals.
EQUAL PERCENTAGE inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 100 | 4 | 3,2 | 6,4 | 11 | 16 | 22 | 32 | 48 | 74 | 106 | 160 | 51 |
| 100/1 | 4/1 | 2,2 | 4,5 | 7,8 | 11 | 16 | 22 | 34 | 52 | 74 | 112 | 51 |
| 150 | 6 | 7,2 | 14,5 | 25 | 36 | 50 | 72 | 108 | 166 | 238 | 360 | 72 |
| 150/1 | 6/1 | 5 | 10 | 18 | 25 | 35 | 50 | 76 | 116 | 166 | 252 | 72 |
| 200 | 8 | 13 | 26 | 45 | 64 | 90 | 128 | 192 | 294 | 422 | 640 | 95 |
| 200/1 | 8/1 | 9 | 18 | 32 | 45 | 63 | 90 | 135 | 207 | 297 | 450 | 95 |
| 250 | 10 | 20 | 40 | 70 | 100 | 140 | 200 | 300 | 460 | 660 | 1.000 | 117 |
| 250/1 | 10/1 | 14 | 28 | 49 | 70 | 98 | 140 | 210 | 322 | 462 | 700 | 117 |
| 300 | 12 | 29 | 58 | 101 | 144 | 202 | 288 | 432 | 662 | 950 | 1.440 | 139 |
| 300/1 | 12/1 | 20 | 40 | 71 | 101 | 141 | 202 | 303 | 465 | 667 | 1.010 | 139 |
| 350 | 14 | 39 | 78 | 137 | 196 | 274 | 392 | 588 | 902 | 1.294 | 1.960 | 164 |
| 350/1 | 14/1 | 27 | 55 | 96 | 137 | 192 | 274 | 411 | 630 | 904 | 1.370 | 164 |
| 400 | 16 | 51 | 102 | 179 | 256 | 358 | 512 | 768 | 1.178 | 1.690 | 2.560 | 191 |
| 400/1 | 16/1 | 36 | 72 | 125 | 179 | 251 | 358 | 537 | 823 | 1.181 | 1.790 | 191 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,87 | 0,87 | 0,85 | 0,85 | 0,84 | 0,83 | 0,83 | 0,82 | 0,81 | 0,81 |
| Xt | 0,75 | 0,75 | 0,73 | 0,72 | 0,7 | 0,68 | 0,68 | 0,67 | 0,65 | 0,65 |

NOTE
(*) Indicated travel includes pilot travel plus main plug travel.

## ■ Valve capacity (Cv) values with LDB Cage

### Table 3

PILOT plug with LDB cage. Cv values of the valve at 10% opening intervals.
LINEAR inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 100 | 4 | 9,7 | 31 | 53 | 74 | 96 | 115 | 135 | 156 | 176 | 195 | 51 |
| 100/1 | 4/1 | 6,8 | 22 | 37 | 52 | 67 | 81 | 94 | 109 | 123 | 137 | 51 |
| 150 | 6 | 22 | 70 | 119 | 167 | 216 | 260 | 304 | 352 | 396 | 440 | 72 |
| 150/1 | 6/1 | 16 | 50 | 84 | 118 | 152 | 183 | 214 | 248 | 279 | 310 | 72 |
| 200 | 8 | 39 | 125 | 211 | 296 | 382 | 460 | 538 | 624 | 702 | 780 | 95 |
| 200/1 | 8/1 | 27 | 86 | 146 | 205 | 265 | 319 | 373 | 432 | 486 | 540 | 95 |
| 250 | 10 | 61 | 194 | 328 | 462 | 595 | 717 | 838 | 972 | 1.094 | 1.215 | 117 |
| 250/1 | 10/1 | 43 | 136 | 230 | 323 | 417 | 502 | 587 | 680 | 765 | 850 | 117 |
| 300 | 12 | 87 | 280 | 472 | 665 | 857 | 1.032 | 1.207 | 1.400 | 1.575 | 1.750 | 139 |
| 300/1 | 12/1 | 61 | 196 | 331 | 465 | 600 | 723 | 845 | 980 | 1.102 | 1.225 | 139 |
| 350 | 14 | 119 | 381 | 643 | 904 | 1.166 | 1.404 | 1.642 | 1.904 | 2.142 | 2.380 | 164 |
| 350/1 | 14/1 | 84 | 267 | 451 | 635 | 818 | 985 | 1.152 | 1.336 | 1.503 | 1.670 | 164 |
| 400 | 16 | 156 | 498 | 840 | 1.182 | 1.524 | 1.835 | 2.146 | 2.488 | 2.799 | 3.110 | 191 |
| 400/1 | 16/1 | 109 | 348 | 587 | 827 | 1.066 | 1.283 | 1.501 | 1.740 | 1.958 | 2.175 | 191 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL | 0,88 | 0,88 | 0,87 | 0,86 | 0,85 | 0,84 | 0,84 | 0,83 | 0,82 | 0,82 |
| Xt | 0,77 | 0,77 | 0,76 | 0,74 | 0,72 | 0,71 | 0,71 | 0,69 | 0,67 | 0,67 |

### Table 4

PILOT plug with LDB cage. Cv values of the valve at 10% opening intervals.
EQUAL PERCENTAGE inherent characteristic curve.

| SIZE | | Relative opening h | | | | | | | | | | TRAVEL (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | INCH | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| 100 | 4 | 2,9 | 5,7 | 10 | 14 | 20 | 29 | 43 | 66 | 95 | 144 | 51 |
| 100/1 | 4/1 | 2 | 4 | 7 | 10 | 14 | 20 | 30 | 46 | 66 | 100 | 51 |
| 150 | 6 | 6,5 | 13 | 23 | 33 | 46 | 65 | 98 | 150 | 215 | 325 | 72 |
| 150/1 | 6/1 | 4,6 | 9,2 | 16 | 23 | 32 | 46 | 69 | 106 | 152 | 230 | 72 |
| 200 | 8 | 11,5 | 23 | 41 | 58 | 81 | 116 | 174 | 267 | 383 | 580 | 95 |
| 200/1 | 8/1 | 8 | 16 | 28 | 41 | 57 | 81 | 122 | 186 | 267 | 405 | 95 |
| 250 | 10 | 18 | 36 | 63 | 90 | 126 | 180 | 270 | 414 | 594 | 900 | 117 |
| 250/1 | 10/1 | 12,5 | 25 | 44 | 63 | 88 | 126 | 189 | 290 | 416 | 630 | 117 |
| 300 | 12 | 26 | 52 | 91 | 130 | 182 | 260 | 390 | 598 | 858 | 1.300 | 139 |
| 300/1 | 12/1 | 18 | 36 | 64 | 91 | 127 | 182 | 273 | 419 | 601 | 910 | 139 |
| 350 | 14 | 35 | 70 | 123 | 176 | 246 | 352 | 528 | 810 | 1.162 | 1.760 | 164 |
| 350/1 | 14/1 | 25 | 49 | 86 | 123 | 172 | 246 | 369 | 566 | 812 | 1.230 | 164 |
| 400 | 16 | 46 | 92 | 161 | 230 | 322 | 460 | 690 | 1.058 | 1.518 | 2.300 | 191 |
| 400/1 | 16/1 | 32 | 64 | 113 | 161 | 225 | 322 | 483 | 741 | 1.063 | 1.610 | 191 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FL(1) | 0,88 | 0,88 | 0,87 | 0,86 | 0,85 | 0,84 | 0,84 | 0,83 | 0,82 | 0,82 |
| FL(2) | 0,77 | 0,77 | 0,76 | 0,74 | 0,72 | 0,71 | 0,71 | 0,69 | 0,67 | 0,67 |

# 12. MULTICYL/BSS™ PLUG: MULTISTAGE VALVES

When pressure drops ratio (x=ΔP/P1) reaches some values close to 0.5 there will be sonic conditions with the associated vibration and noise, in gas or steam applications.

In liquid service, when downstream pressure approaches vapour pressure at fluid temperature, cavitation will appear, with noise increase and damage to the valve components. This will happen whenever the cavitation index xF=(P1-P2)/ ΔP reaches the valve FL2 value.
Our approach to both problems, either gases (sonic conditions) or liquids (cavitation), is based on the "source treatment" principle: this is to suppress the source of the problem, which is the high pressure drop.

With our multicylinder cage the fluid goes through a stepped pressure reduction process, the number of steps being as large as necessary to keep pressure drop under critical values.
We have the technology to calculate, design and manufacture the valve internals best suited for every set of conditions. We calculate, for every particular application,
-the number of steps necessary to avoid critical conditions at any stage,
-the partial pressure drops at every stage,
-the Cv value of every cylinder
to achieve a non critical pressure profile.
This is equivalent to say that xT and Fl values of every valve will be as high as required by the given conditions.
In small Cv, small size valves, the same results are obtained by our Multistep design.