CLARK SOLUTIONS
Motor Actuated Valve Application Guide

Ball Valves, Globe Valves & Butterfly Valves

INTRODUCTION

The control valve is one of the most important items in a fluidic system. If greater attention were paid to the proper sizing and application of control valves there would be fewer flow control problems. A valve that is undersized can result in insufficient flow at design conditions. An oversized valve is subject to instability as it attempts to control flow over a very small portion of its overall flow range. In effect, an oversized valve will have a much greater change in flow for the same change in signal as a properly sized valve.

FLOW COEFFICIENT (CV)

The single most important piece of information needed to select a control valve is the valve sizing coefficient, Cv. Cv is defined as the flow rate in U.S.gallons of water (at 60°F) that will pass through the valve in one minute with a differential pressure across the valve of 1 PSI. A valve's Cv is unique to the size, angle of opening and manufacturer's style. The information to consider in determining the Cv includes:

Table A

Variable	Water	Steam	Chemicals
Line Size	size (inches)	size (inches)	size (inches)
Flow Rate of Application	GPM	LBS/Hr or BTUH	GPM
Pressure Drop (DP)of the Coil or Application	PSID	PSID	PSID
Temperature of Fluid	°F	°F	°F
Chemical Type	%Glycol (if any)	Any Additives?	Specify Type
Additive Concentration	NA	NA	%

When these variables are known, the Cv required for the application can be determined using the formulas on the following pages of this bulletin. Regardless of the Cv, the valve size should not exceed the line size. For modulating applications, it is typically one or two sizes smaller than line size.

CONTROL VALVE PRESSURE DROP

In most instances, the only variable when calculating the Cv required of the valve is the pressure drop (DP) across the valve. The pressure drop across a valve is always measured with the valve fully open. In HVAC applications the heat exchange coil has typically been selected (or already exists) before the valve is chosen, therefore the GPM and pressure drop of the coil should be known. For optimal control, the pressure drop across the control valve should be equal to, or slightly greater than, the pressure drop of the coil and its fittings. This will ensure that the valve will control the flow through the coil through its entire range of travel. When controlling flow for a non-coil application, the same principle applies as indicated above for coil applications. Whatever the valve is directly controlling should be viewed as a system with a specific opening at the valve. The pressure upstream and downstream of the system determine the amount of flow through the system. Therefore, the ideal pressure drop across the control valve should be equal to, or greater than, the pressure drop of the system that is being controlled.

WATER APPLICATIONS

Two-Position Control

–Ball,globe or butterfly valves can be used for this application.

–The pressure drop across the valve should be low (usually less than 2 PSI)in its open position.

–Valves for this purpose are typically selected at line size to minimize installation cost and pressure drop. In some applications, ball and butterfly valves can be used one size smaller than line size without dropping enough pressure to affect system performance.

Modulating Control

–The pressure drop across a two-way valve should be equal to,or slightly greater than,the pressure drop of the coil and its fittings. On a three-way valve,the pressure drop is based on the drop between the common port of the valve and the port which you are trying to control (with the port fully open). A typical coil pressure drop for HVAC applications is usually 3 PSI or less. This is the reason why a 3-5 PSI pressure drop across the valve has been used as a rule of thumb.

STEAM APPLICATIONS

Steam applications can be divided into two categories depending on the steam pressure present: inlet steam pressures that are less than or equal to 15 PSIG,and those that are greater than 15 PSIG. The standard pressure drop used in the Cv equation for saturated steam is 80% of the inlet gauge pressure for steam less than or equal to 15 PSIG,and 42%of the inlet absolute pressure for steam greater than 15 PSIG. A valve used for modulating control will typically be at least one size smaller than the line size and may be two or more sizes smaller.

Low Pressure Steam (less than or equal to 15 PSIG):

- –Two-Position Control:The valve is usually selected as line size.
- –Modulating Control: The pressure drop across the valve for proper modulation is typically 80%of the inlet gauge pressure. Use the steam equation below to determine the Cv.

Example : A system with a 10 PSIG inlet pressure should have a valve sized with an 8 PSI drop.10 PSIG x .8 =8 PSI

High Pressure Steam (greater than 15 PSIG):

- –Two-Position Control:The valve is usually selected to be line size.
- –Modulating Control:The pressure drop across the valve for proper modulation is typically 42%of the inlet absolute pressure (absolute pressure is gauge pressure plus local atmospheric pressure,14.7 PSIA at sea level).

Example : A system with a 20 PSIG inlet pressure should have a valve sized with a 14.6 PSI drop.
(20 PSIG +14.7) x.42 =14.6 PSI

VALVE SIZING

The next step in sizing any valve is to calculate the Cv requirement using the information gathered from the outline on Table A. The Cv can be determined using several methods, but the most accurate method is to use the formulas listed below. The Cv calculated should always determine the valve size selected. Remember that different valve types of the same size (globe, ball or butterfly) will have different Cv ratings. After calculating the Cv with the equation listed below, if the valve size that you initially select is smaller than line size, refer to Tables B to H to determine the valve Cv adjusted for line size.

Water Valves

$Cv=Q/\sqrt{DP}$ Where:Cv =the valve sizing coefficient
Q =flow in gallons per minute (GPM)
DP =pressure drop across the valve (PSI)

Liquids other than water

$Cv=Q \times \sqrt{(Sg/DP)}$ Where:Cv =the valve sizing coefficient
Q =flow in gallons per minute (GPM)
Sg =specific gravity of the liquid
DP =pressure drop across the valve (PSI)

Steam (Saturated)

$Cv=Q/(3 \times \sqrt{(DP \times P_2)})$ Where:Cv =the valve sizing coefficient
Q =Steam flow in pounds per hour (Lbs/Hr)
DP =Pressure drop across the valve in PSI
=.80 (PSIG)of the valve inlet gauge pressure for steam <=15 PSIG
=.42 (PSIA)of the valve inlet absolute pressure for steam >15 PSIG
PSIG =Steam gauge pressure (PSIG)
PSIA =Steam absolute pressure (PSIA),equal to PSIG +14.7 (at sea level)
P_2 =Steam outlet absolute pressure (PSIA)=(Steam inlet gauge pressure +14.7) - DP

Note: It is extremely important to use PSIG for steam inlet 15 PSIG and under and PSIA for steam inlet greater than 15 PSIG.

VALVE SELECTION

Once the pressure drop and subsequent Cv requirement is established, the most appropriate and cost effective valve for the application can be determined. Factors that influence the decision are:

- –Fluid type (i.e.water,steam,chemicals,etc.)
- –Fluid pressure and temperature
- –Temperature fluctuation of the fluid (Example: Will the valve control fluid at 180 °F then 40 °F?)
- –Close-off requirements (the torque required at a specific differential pressure to close the valve)
- –Requirements for tight shut-off (allowable leakage rate; no leakage at specified differential or an acceptable %)
- –Ambient conditions (i.e.temperature, humidity, special conditions, indoor or outdoor applications, etc.)

Valve selection can be divided into the five common HVAC applications:

1)Two-position control of hot or chilled water
2)Two-position control of steam

3)Modulating control of hot or chilled water
4)Modulating control of steam.
5)Two-position or modulating control of water or steam with the valve subjected to a wide variation of temperature (Example:180°F hot water then 45°F chilled water)

These five applications will be examined separately and the most cost effective valve solution that provides proper control will be noted.

1)Two-Position Control: Isolation of Hot or Chilled Water

For valve sizes 1/2"to 2", the ball valve is a very cost effective choice. Ball valves provide tight close-off for the rated differential, and in this size range have female NPT threads which make installation easy. The trim materials are stainless steel ball and stem for extended valve life. The ball valve can produce cost savings as high as 50%over a comparable globe valve alternative. For three-way operation, ball valves should only be applied in diverting service to maintain their inherent equal percentage type flow characteristics and extend seal life. For valve sizes 2-1/2"and up, the butterfly valve is the most cost effective solution. Beginning at 2-1/2", material costs and increased actuator torque requirements increase ball valve pricing beyond that of the butterfly valve. Butterfly valves offer excellent temperature isolation between the fluid and actuator, as well as tight shut-off on resilient seated models, when applied for the correct differential pressure. Butterfly valves also provide flexibility, with options for choosing the material for the body, seat and disc to extend the temperature and application range of the product.

2)Two-Position Control: Isolation of Low Pressure Steam (less than or equal to 15 PSIG)

On valves 1/2"to 6",the globe valve is the most common type, although a special ball valve assembly designed for steam has better close-off, less pressure drop, and a much higher flow rate than a globe valve of the same size. On 1/2” to 3” applications, ball valves are more cost effective than globe valves, with a much higher body pressure rating. Both the globe valve and our specially designed ball valve offer good temperature isolation between the valve and its actuator. Clark offers a complete line of globe and ball valve assemblies, with options for spring return and non-spring return actuators. On sizes 2-1/2"and up, butterfly valves should also be examined for cost effectiveness. Standard aluminum bronze valves are used for saturated steam applications <10 PSIG. For steam >10 PSIG, but <30 PSIG, butterfly valves should be equipped with Viton seats to handle the elevated steam temperatures (for pure steam only, chemical additives may cause damage to the seats). For 10 PSIG or greater, high performance butterfly valves are well suited for steam applications. Clark offers Viton seats for standard butterfly valves and high performance butterfly valves for higher temperatures and pressures.

3)Modulating Control: Hot Water or Chilled Water Two-Way & Three-Way Applications

For valve sizes 1/2"to 3"(Two-Way)and 1/2” to 2” (Three-Way), a ball valve is a very cost effective alternate choice for the standard globe valve, providing very accurate flow control when properly sized for the application. It also offers superior close-off to a globe valve and has an equal percentage flow curve that complements the flow curve of the coil. With a higher flow rate than a globe valve of the same NPT size, a ball valve sized for the same application will usually be smaller. For those people who prefer globe valves, Clark has a wide selection of globe valves to meet most applications.

For three-way diverting applications, the ball valve is an excellent choice. In a new construction or rework situation, a three-way ball valve placed upstream of the coil that diverts flow through the coil or bypasses the coil is a very cost effective alternative to a mixing globe valve placed on the downstream side of the coil. The ball valve will achieve the same results, offering very accurate control at a cost effective price. It also has the advantage of a packing nut that is adjustable for long term wear.

Special Note on Three-Way Ball Valves Piped for Mixing Applications:
When a three-way ball valve is piped as a mixing valve instead of a diverting valve (which it was designed to be) the flow is in the opposite direction of the valve's intended design. When piped this way, the valve will not respond with an equal percentage type curve. The flow curve is highly dependent on the pressure difference of the two flow streams being mixed. Also, the seats on either side of the ball were designed for a diverting flow pattern. If this flow direction is reversed, the seats will wear prematurely. When piped as a mixing valve, the valve may or may not provide good flow control.

Three-way mixing applications are one of the most common reasons for choosing a globe valve.

For valve sizes 2-1/2"and above, the butterfly valve is a good choice if the conditions are correct. For modulating control,the butterfly valve’s Cv at a 70° angle of opening should be used to size the valve properly. Butterfly valves can control flow most effectively when operating between a 20° to 70° angle of opening. As a general rule, therefore, a butterfly valve can be used to replace a globe valve whenever the minimum required Cv for the application exceeds the published flow rate of the butterfly valve with the disc at 20° open. If the minimum Cv required is less than the flow rate published for a 20° open position, a smaller ball or globe valve would have to be used in conjunction with the butterfly valve in order to provide good modulation throughout the complete flow range required of the coil. Example: Many large air handling units have minimum heating and cooling loads that exceed the flow rate of a properly sized butterfly valve at a 20° disc open position. In this application, a butterfly valve could be used effectively to control flow.

Special Note on Ball Valves:
Clark strongly recommends the use of a stainless ball and stem for all modulating ball valves. A chromium plated bronze ball will not withstand the continuous cycling encountered in a modulating service. The chromium plate will flake away in a short period of time, creating a leakage path and will score the seal material. The stainless steel ball has no plating to flake off and, therefore, the initial microscopic layer of Teflon that creeps into the surface pores of the ball remains there as a lubrication layer. Also, the slot on the top of a chrome plated ball (where the stem engages the ball) tends to widen with extensive modulation, allowing play when changing direction of travel (i.e. the actuator will rotate and the ball will not). The stainless ball and stem is much harder and does not widen.

4) Modulating Control: Low Pressure Steam (less than or equal to 15 PSI)
Globe valve sizes 1/2"to 6", or high temperature ball valve sizes 1/2"to 3", can effectively modulate flow. Factors that affect this decision include: the cost effectiveness of each valve assembly, Cv requirements, size constraints, close-off requirements and the temperature of the application. Clark's high temperature ball valve series with a standard port design should be applied only to low pressure steam applications when modulating the valve. At pressures above 15 PSIG, the ball valve is subject to a wear phenomenon known as wire draw, which erodes the lip of the opening of the ball and ultimately creates excessive valve leakage. For valve sizes 2-1/2"and above, butterfly valves should be considered. If the butterfly valve is being used for modulating control, the same issues apply as those discussed for modulating control of hot or chilled water. For modulating control, the valve should be used between 20° and 70° (disc position). Remember, however, that the standard aluminum bronze disc is recommended only to a temperature of 239°F (10 PSIG saturated steam). The EPDM seat, if used above the recommended temperature limit, will remold itself (permanently warp) and create a leakage path and possibly bind the valve.

5) Two-Position or Modulating Control of High Pressure Steam
Proper valve selection for high pressure steam is dependent upon the individual application. Our technical staff will gladly assist you in selecting the most appropriate and cost-effective valve solution for your application.

Globe Valve Linkages
The globe valve linkage converts the actuator's rotary motion to linear motion, which is necessary for a globe valve. The linkages are available in three types:

1) Zone up to 90 in-lb (depending on actuator's physical dimensions)
2) Low torque up to 200 in-lb
3) Medium torque up to 800 in-lb

The metallic linkage provides outstanding flexibility for custom applications and can be fitted with extra long legs for increased temperature isolation. The collar of the linkage can be custom machined, if necessary, to meet a wide variety of applications.

Clark High/Low Temperature Ball Valve Assemblies
Also in the 1/2"to 3"size, specially designed high/low temperature ball valves are a great alternative. A high/low temperature ball valve assembly includes upgraded trim materials with a stainless steel ball and stem, upgraded seat material,and a high stand-off stem adapter with extra-high brackets to further thermally isolate the actuator in high or low temperature applications.

Table B	Saturated Steam Table: Temperature (°F) of Inlet Pressure from 0°F to 600°F						
Pressure (PSIG)	**Temperature °F**	**Pressure (PSIG)**	**Temperature °F**	**Pressure (PSIG)**	**Temperature °F**	**Pressure (PSIG)**	**Temperature °F**
0	212	**125**	353	**250**	406	**450**	460
2	219	**130**	356	**255**	408	**460**	462
4	224	**135**	358	**260**	409	**470**	464
6	230	**140**	361	**265**	411	**480**	466
8	235	**145**	363	**270**	413	**490**	468
10	239	**150**	366	**275**	414	**500**	470
15	250	**155**	368	**280**	416	**510**	472
20	259	**160**	371	**285**	417	**520**	474
25	267	**165**	373	**290**	419	**530**	476
30	274	**170**	375	**295**	420	**540**	478
35	281	**175**	377	**300**	422	**550**	480
40	287	**180**	380	**310**	425	**560**	482
45	292	**185**	382	**320**	427	**570**	483
50	298	**190**	384	**330**	430	**580**	485
55	303	**195**	386	**340**	433	**590**	487
60	307	**200**	388	**350**	436	**600**	489
65	312	**205**	390	**360**	438		
70	316	**210**	392	**370**	441		
75	320	**215**	394	**380**	443		
80	324	**220**	395	**390**	446		
85	328	**225**	397	**400**	448		
90	331	**230**	399	**410**	451		
95	335	**235**	401	**420**	453		
100	338	**240**	403	**430**	455		
105	341	**245**	404	**440**	457		
110	344						
115	347						
120	350						

Table C	Two-Way Electronic Ball Valves: Adjusted Cv Ratings for Piping Geometry Factor (Fp)											
NPT	**Model Number**	**Line Size**										
		1/2″	**3/4″**	**1″**	**1 1/4″**	**1 1/2″**	**2″**	**2 1/2″**	**3″**	**4″**	**5″**	**6″**
1/2″	2-050-002	2.0	2.0	1.9	1.9	1.9	-	-	-	-	-	-
1/2″	2-050-004	4.0	3.8	3.6	3.5	3.5	-	-	-	-	-	-
1/2″	2-050-9.8	9.8	7.3	6.3	5.8	5.6	-	-	-	-	-	-
3/4″	2-075-025	-	25.0	19.5	16.3	14.8	13.4	-	-	-	-	-
3/4″	2-075-033	-	33.0	22.7	18.0	16.0	23.1	-	-	-	-	-
1″	2-100-035	-	-	35.0	31.1	27.4	23.8	22.4	-	-	-	-
1″	2-100-047	-	-	47.0	38.6	32.1	26.7	24.7	-	-	-	-
1 1/4″	2-125-047	-	-	-	47.0	44.0	37.6	34.5	32.9	-	-	-
1 1/4″	2-125-081	-	-	-	81.0	67.9	49.5	43.0	40.0	-	-	-
1 1/2″	2-150-081	-	-	-	-	81.0	68.0	58.8	54.3	50.1	-	-
1 1/2″	2-150-105	-	-	-	-	105.0	80.5	66.4	60.0	54.5	-	-
2″	2-200-105	-	-	-	-	-	105.0	97.9	90.1	81.7	77.8	-
2″	2-200-360	-	-	-	-	-	360.0	216.3	157.6	122.2	110.4	-
2 1/2″	2-250-440	-	-	-	-	-	-	440.0	329.8	217.3	184.3	-
3″	2-300-390	-	-	-	-	-	-	-	390.0	307.8	257.4	233.9

Table D	Three-Way Electronic Ball Valves: Adjusted Cv Ratings for Piping Geometry Factor (Fp)									
NPT	**Model Number**	**Line Size**								
		1/2″	**3/4″**	**1″**	**1 1/4″**	**1 1/2″**	**2″**	**2 1/2″**	**3″**	**4″**
1/2″	3-050-002	2.0	2.0	1.9	1.9	-	-	-	-	-
1/2″	3-050-006	6.0	5.3	4.8	4.6	-	-	-	-	-
3/4″	3-075-012	-	12.0	11.2	11.2	10.0	-	-	-	-
1″	3-100-014	-	-	14.0	14.0	13.3	12.9	-	-	-
1 1/4″	3-125-022	-	-	-	-	21.7	20.8	20.2	-	-
1 1/2″	3-150-030	-	-	-	-	30.0	29.2	28.3	27.8	-
2″	3-200-050	-	-	-	-	-	50.0	49.2	48.1	46.7
2″	3-200-091	-	-	-	-	-	91.0	86.3	80.8	74.5

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Table E **Two-Way Electronic Globe Valves: Adjusted Cv Ratings for Piping Geometry Factor (Fp)**

NPT	Model Number	Line Size											
		1/2″	3/4″	1″	1 1/4″	1 1/2″	2″	2 1/2″	3″	4″	5″	6″	8″
1/2″	GS2A-1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-
1/2″	GS2A-1.6	1.6	1.6	1.6	1.5	1.5	-	-	-	-	-	-	-
1/2″	GS2A-2.5	2.5	2.4	2.4	2.4	2.3	-	-	-	-	-	-	-
1/2″	GS2A-4.0	4.0	3.7	3.6	3.5	3.4	-	-	-	-	-	-	-
3/4″	GS2A-6.3	-	6.3	6.2	6.0	6.0	-	-	-	-	-	-	-
1″	GS2A-10	-	-	10.0	9.9	9.7	9.6	-	-	-	-	-	-
1 1/4″	GS2A-16	-	-	-	16.0	15.9	15.5	15.3	-	-	-	-	-
1 1/2″	GS2A-25	-	-	-	-	25.0	24.5	24.0	23.7	-	-	-	-
2″	GS2A-40	-	-	-	-	-	40.0	39.6	39.0	38.2	-	-	-
2 1/2″	GS2A-63	-	-	-	-	-		63.0	62.5	61.1	60.2	59.6-	-
3″	GS2A-100	-	-	-	-	-		-	100.0	98.1	96.0-	94.6-	93.1
4″	GS2A-160	-	-	-	-	-		-	-	160.0	158.3	156.0	152.9
5″	GS2A-250	-	-	-	-	-		-	-	-	250.0	248.1	242.5
6″	GS2A-400	-	-	-	-	-	-	-	-	-	-	400.0	392.3

Table F **Three-Way Electronic Globe Valves: Adjusted Cv Ratings for Piping Geometry Factor (Fp)**

NPT	Model Number	Line Size											
		1/2″	3/4″	1″	1 1/4″	1 1/2″	2″	2 1/2″	3″	4″	5″	6″	8″
1/2″	GS3A-1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-
1/2″	GS3A-1.6	1.6	1.6	1.6	1.5	1.5	-	-	-	-	-	-	-
1/2″	GS3A-2.5	2.5	2.4	2.4	2.4	2.3	-	-	-	-	-	-	-
1/2″	GS3A-4.0	4.0	3.7	3.6	3.5	3.4	-	-	-	-	-	-	-
3/4″	GS3A-6.3	-	6.3	6.2	6.0	6.0	-	-	-	-	-	-	-
1″	GS3A-10	-	-	10.0	9.9	9.7	9.6	-	-	-	-	-	-
1 1/4″	GS3A-16	-	-	-	16.0	15.9	15.5	15.3	-	-	-	-	-
1 1/2″	GS3A-25	-	-	-	-	25.0	24.5	24.0	23.7	-	-	-	-
2″	GS3A-40	-	-	-	-	-	40.0	39.6	39.0	38.2	-	-	-
2 1/2″	GS3A-63	-	-	-	-	-	-	63.0	62.5	61.1	60.2	59.6	-
3″	GS3A-100	-	-	-	-	-	-	-	100.0	98.1	96.0	94.6	93.1
4″	GS3A-160	-	-	-	-	-	-	-	-	160.0	158.3	156.0	152.9
5″	GS3A-250	-	-	-	-	-	-	-	-	-	250.0	248.1	242.5
6″	GS3A-400	-	-	-	-	-	-	-	-	-	-	400.0	392.3

Table G **Electronic Butterfly Valves: Adjusted Cv Ratings for Two-Way & Three-Way Valves with 70^{o} Angle of Opening**

NPT	Model Number	Line Size											
		1/2″	3/4″	1″	1 1/4″	1 1/2″	2″	2 1/2″	3″	4″	5″	6″	8″
1/2″	GS3A-1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-
1/2″	GS3A-1.6	1.6	1.6	1.6	1.5	1.5	-	-	-	-	-	-	-
1/2″	GS3A-2.5	2.5	2.4	2.4	2.4	2.3	-	-	-	-	-	-	-
1/2″	GS3A-4.0	4.0	3.7	3.6	3.5	3.4	-	-	-	-	-	-	-
3/4″	GS3A-6.3	-	6.3	6.2	6.0	6.0	-	-	-	-	-	-	-
1″	GS3A-10	-	-	10.0	9.9	9.7	9.6	-	-	-	-	-	-
1 1/4″	GS3A-16	-	-	-	16.0	15.9	15.5	15.3	-	-	-	-	-
1 1/2″	GS3A-25	-	-	-	-	25.0	24.5	24.0	23.7	-	-	-	-
2″	GS3A-40	-	-	-	-	-	40.0	39.6	39.0	38.2	-	-	-
2 1/2″	GS3A-63	-	-	-	-	-	-	63.0	62.5	61.1	60.2	59.6	-
3″	GS3A-100	-	-	-	-	-	-	-	100.0	98.1	96.0	94.6	93.1
4″	GS3A-160	-	-	-	-	-	-	-	-	160.0	158.3	156.0	152.9
5″	GS3A-250	-	-	-	-	-	-	-	-	-	250.0	248.1	242.5
6″	GS3A-400	-	-	-	-	-	-	-	-	-	-	400.0	392.3

Table H **Electronic Butterfly Valves: Adjusted Cv Ratings for Two-Way & Three-Way Valves with 90^{o} Angle of Opening**

NPT	Model Number	Line Size											
		1/2″	3/4″	1″	1 1/4″	1 1/2″	2″	2 1/2″	3″	4″	5″	6″	8″
1/2″	GS3A-1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-
1/2″	GS3A-1.6	1.6	1.6	1.6	1.5	1.5	-	-	-	-	-	-	-
1/2″	GS3A-2.5	2.5	2.4	2.4	2.4	2.3	-	-	-	-	-	-	-
1/2″	GS3A-4.0	4.0	3.7	3.6	3.5	3.4	-	-	-	-	-	-	-
3/4″	GS3A-6.3	-	6.3	6.2	6.0	6.0	-	-	-	-	-	-	-
1″	GS3A-10	-	-	10.0	9.9	9.7	9.6	-	-	-	-	-	-
1 1/4″	GS3A-16	-	-	-	16.0	15.9	15.5	15.3	-	-	-	-	-
1 1/2″	GS3A-25	-	-	-	-	25.0	24.5	24.0	23.7	-	-	-	-
2″	GS3A-40	-	-	-	-	-	40.0	39.6	39.0	38.2	-	-	-
2 1/2″	GS3A-63	-	-	-	-	-	-	63.0	62.5	61.1	60.2	59.6	-
3″	GS3A-100	-	-	-	-	-	-	-	100.0	98.1	96.0	94.6	93.1
4″	GS3A-160	-	-	-	-	-	-	-	-	160.0	158.3	156.0	152.9
5″	GS3A-250	-	-	-	-	-	-	-	-	-	250.0	248.1	242.5
6″	GS3A-400	-	-	-	-	-	-	-	-	-	-	400.0	392.3