RESEARCH CONTROL® Valve
Selection Guide for Standard Applications

This section of the catalog contains information applicable to the selection of control valves in applications from 0 to 5000 psig (0-340 bar) and/or 0 to 1000° F (-17 to 538° C). Most items in the selection process are covered, with the exception of innervalve sizing, which is covered under the Sizing tab. Specific technical information concerning individual designs can be found in the Tech Briefs.

If the application calls for a valve or component that falls outside the scope of this guide, the factory or your local representative should be consulted for assistance. The factory should be consulted with specific details on 3-way, sanitary, cryogenic or bellows sealed valves.

Selection Process

Step 1 - Data Gathering
The selection of a control valve is as important as the selection of any other component in a system. The more information you put in, the better the selection. **Page 2** of this guide entitled "Application Data Sheet," is provided for your assistance. Although a selection can be made without all the information listed, each item listed can affect the final valve design.

Step 2 - Calculation of Innervalve Size
Proper trim size and characteristic enables the system to function within its design specifications. The formulas and information behind the "Sizing" tab of the catalog will be of assistance in sizing your valve.

Step 3 - Select Body and Material
Body type, end fittings, and material are all important to system compatibility and function. The catalog contains many Tech Briefs, covering various configurations and their specifications. The factory should be consulted if a body of choice is not found.

Step 4 - Select Bonnet and Material
Proper bonnet selection is also important. **Page 3** of this guide covers three standard bonnet variations. Specific bonnet dimensions of these and others can be obtained from the Tech Briefs or the factory.

Step 5 - Select Stem Packing
Although TFE chevron rings are standard, several others are available. **Page 3** of this guide covers the capabilities of standard packing. If the application calls for another packing, consult the factory for its proper use.

Step 6 - Select Stem/Trim Guiding
The primary purpose of stem guiding is to prevent vibration of the trim under high pressure drops. Three different guiding types are available to fit standard valves. **Page 4** of this guide discusses their proper use.

Step 7 - Select Trim Material
Trim material can be a matter of customer choice or manufacturer's preference. **Page 5** makes several observations and offers several points that should be considered.

Step 8 - Select Actuator Type
The primary choice of actuator type and function rests with the customer. However, it can be dictated by valve design requirements. The standard actuator and those with top mounted positioners are covered in their respective Tech Briefs. Proper preloading and supply air requirements are covered on **Page 6**.

Step 9 - Select Accessories
Badger can provide a large variety of valve accessories. Some are manufactured by Badger and some are purchased from outside sources. Your local representative or the factory should be consulted with your requirements.

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Valve Application Data Sheet

Company Name_____ Contact Name_____
Address _____ Phone _____
City _____ Fax _____
State _____ Item _____ of _____
Zip _____ Tag No. _____

General Information

Pressures shown are: PSIG _____ PSIA _____ Bar _____ Kg/Cm2 _____ KPa _____Other _____
Flow is in: GPM _____CC/M _____ SCFH _____ PPH _____Other _____
Temperatures are in: Degrees F _____ Degrees C _____
System Pressure: Max P1 _____ Min P1 _____ Max P2 _____ Min P2 _____
Max. Fluid Temperature:_____
Ambient Temperature: Max _____ Min _____

Fluid Data

Fluid Name _____
Specific Gravity _____ or Density (pounds/cu.ft.) _____ Viscosity: SSU _____CP _____
Vapor Pressure _____ Critical Pressure _____ Critical Temp. _____

Pressure (For Calculations)

Upstream Pressure_____
Downstream Pressure _____or qP _____
Max. shut-off Pressure _____Shut-off Class Required _____

Flow Rates

Maximum Flow _____ Normal Flow _____ Minimum Flow _____
NOTE: TO PREVENT UNDERSIZING, CALCULATE CV AT LOWEST qP AND MAXIMUM FLOW RATE.
Valve Flow Characteristic Desired: Linear _____ =% _____ On-Off_____ Other _____

Valve Information

List Tech Brief References _____
Body size _____ Body Style: Globe _____ Angle _____ 3-Way _____
End Connections _____
Pressure Rating _____
Body-Bonnet Material _____
Bonnet Type: Standard _____ Cooling Fin _____ Extended _____Other _____
Packing: TFE Chevron Ring_____ Grafoil _____Other _____
Bellows Seal: No _____Yes _____If yes, list pressure rating and material _____
Innervalve Size _____or Cv from calc. above _____
Innervalve Material _____
Guiding: Standard _____ Medium _____ Heavy Duty _____

Actuator Information

List Tech Brief References _____
Actuator Type: Pneumatic _____ Electric: Power 110vac/12vdc _____ 230vac/12vdc _____
Action on increasing signal: Opens Valve _____ Closes Valve _____
Position on loss of signal: Closes Valve _____ Opens Valve_____
Input Signal (pneumatic): 3-15 psig _____ 6-30 psig _____ 3-9 psig _____ 9-15 psig _____ Other _____
Supply Press. Avail _____ Supply Press. Req. _____ NOTE: 6PSIG SPLIT RANGE REQUIRES POSITIONER.
Input signal (electrical): 4-20 mA/DC _____ Other _____
I/P Transducer Required: Yes _____ No _____ Rating: Expl. Proof _____ Non-Expl. Proof _____
Brand Preference: No ____Yes – specify brand _____
Filter Reg. Required: No ____Yes ____ Brand Preference: No ____ Yes- specify _____
Gauges: No _____Yes _____ Specify Quantity _____Other Requirements _____

RESEARCH CONTROL® Valve
Bonnet Selection

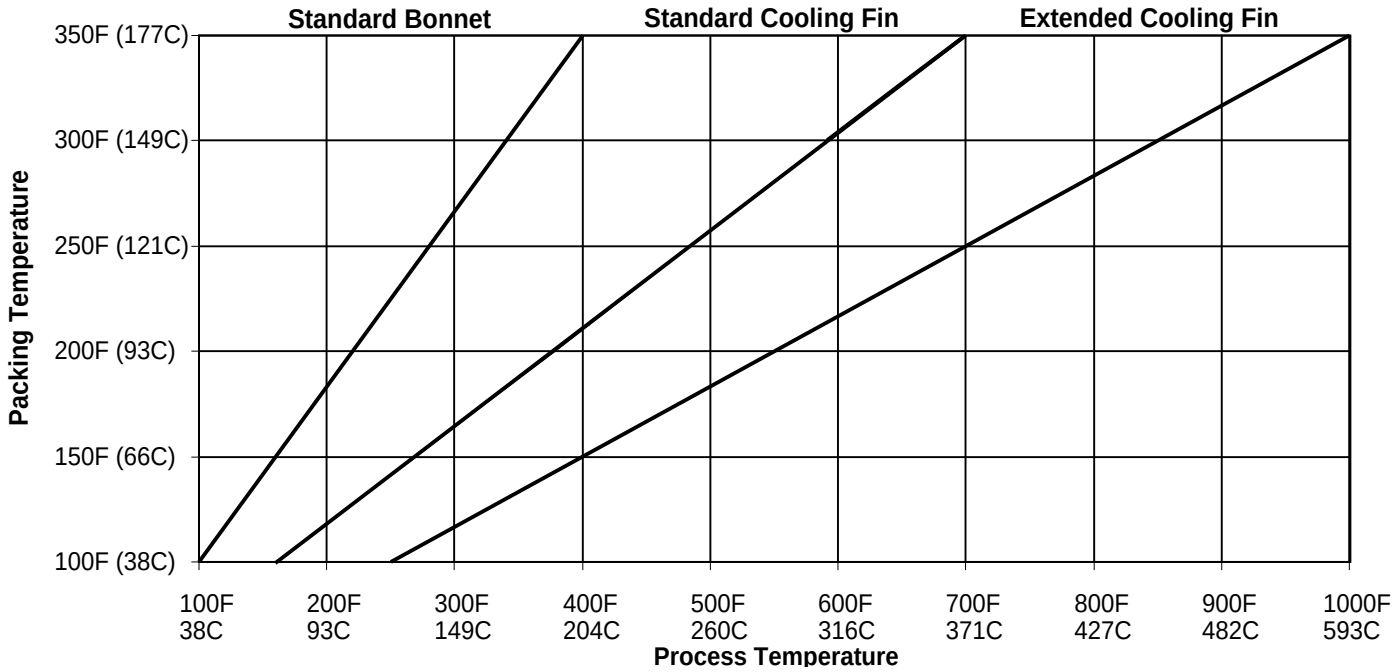
Bonnet Length Selection

Chart 1 can be used to determine the actual temperature at the packing for standard, cooling fin, and extended cooling fin bonnets.

1. Locate your actual process temperature along the bottom of the chart.
2. Follow the temperature up the chart, noting the intersection point with one of the three diagonal lines.
3. Follow the intersection point to the left, noting the actual packing temperature.
4. A bonnet should be selected that corresponds to the packing requirements covered in Chart 2.

Note: Type 752 3/4" and 1" valves are considered "Standard Cooling Fin length" for selection purposes.
Note: Chart 1 is applicable to stainless steel only. Carbon steel standard bonnets should not be used above 350ºF process temperature with TFE packing.

Chart 1: Bonnet Length Selection

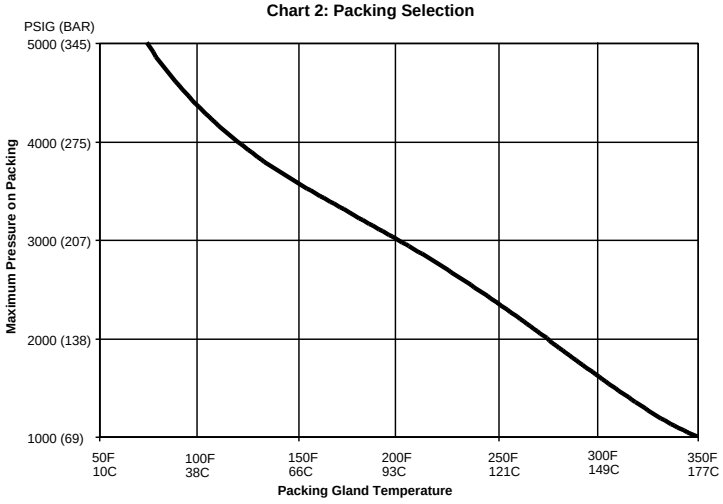


Packing Selection

Chart 2 should be used to determine pressure limits for TFE Cv ring packing. If concerned as to the proper selection of packing, the factory should be consulted.

1. Locate the actual packing temperature along the top of Chart 2.
2. Follow this temperature down until it intersects with the diagonal line.
3. The pressure on the left indicates the maximum allowable for that temperature.
4. If the pressure shown is too low for your choice, refer back to Chart 1 and try the cooling fin or extended cooling bonnet. If a proper match cannot be found, contact the factory for assistance.

Chart 2: Packing Selection



Optional Packing

If the application will not accept the use of TFE or if the temperature pressure limits are above the range of TFE, other packings such as Grafoil®, graphite, and glass filled TFE are available. Although graphite can be used in applications up to 1500ºF, its use and function should be discussed with the factory. Also, other types of bonnets, including bellows sealed, are available. Consult the factory with complete application data.

RESEARCH CONTROL® Valve
Standard, Medium and Heavy Duty Guided Innervalves

Chart 3 will assist in determining the appropriate innervalve guide type to obtain optimum serviceability under varying pressures. The chart covers Throttling and On-Off applications up to 5000 psig (340 barg). This chart governs the selection of the type of guide and does not take into consideration the material of the valve or innervalve assembly. Page 5 discusses innervalve materials.

Definitions:

Top: A top guided innervalve is stem guided at the packing. Some innervalves, due to the inherent close fit between the plug and the seat, could also be considered "seat guided."

Medium: A medium guided trim is guided at the packing and in the bonnet. The medium guided style was developed to provide a guide option to those wishing to use standard bonnets rather than the heavy duty version. Medium guided trims, when available, will fit standard bonnets.

Heavy Duty: The HD guide provides maximum resistance to actuator forces and pressure-induced vibration. The bonnet and trim will not interchange with the standard bonnet designs.

How to use the chart:

Select an innervalve size. The column "Throttling" under Maximum Pressure Drop indicates the maximum allowable pressure drop recommended for the type of guiding listed under "Guide Type." Example: an "A" linear trim in a ½" valve is desired for a 600 psi pressure drop. Since the medium guided version is only rated to 500 psi, the heavy duty version should be used.

Chart 3: Trim Guide Chart

Valve Size (in)	Trim Size	Orifice Dia. In.	Orifice Area In^2	Guide Type	Maximum Pressure Drop in PSI	
					Throttling	On-Off
1	5.0-6.0	0.625	0.307	Medium	300	600
1	4.5	0.500	0.197	Medium	350	700
¾, 1	3.5-4.0	0.500	0.197	Medium	400	800
½	A-B	0.375	0.1105	Top	100	300
½ to 1	A-B	0.375	0.1105	Medium	500	1500
½	A-B	0.375	0.1105	Heavy	1750	See note 3
½	C	0.281	0.0621	Top	200	600
½ to 1	C	0.281	0.0621	Medium	700	2000
½	C	0.281	0.0621	Heavy	3000	See note 3
½	D-E	0.250	0.0491	Top	300	900
½ to 1	D-E	0.250	0.0491	Medium	900	4000
½	D-E	0.250	0.0491	Heavy	4000	See note 3
¼	F-J	0.156	0.0191	Top	800	1500
½	F-J	0.156	0.0191	Top	1000	5000
¼	F-J	0.156	0.0191	Medium	2000	3000
½-1	F-J	0.156	0.0191	Medium	3000	5000
½	F-J	0.156	0.0191	Heavy	5000	5000
¼ to 1	K-O	0.086	0.0058	Top	5000	5000
¼, ½	All "P"	All		Top	5000	5000

Notes:

1. For maximum allowable pressure drops on cooling fin bonnets, use 75% of the pressures listed. For other designs, consult the factory.
2. Orifice diameters in special valves (sanitary, manual, and throttling soft seats) may vary from those listed.
3. The upper limits are dictated by stem diameter and/or maximum allowable actuator thrust.
4. The standard stem diameters are: ¼" = 0.125", ½" top and medium guided = 0.187", HD guided = 0.250."
5. The standard for 3/4" and 1" Type 752 valves is medium guided.
6. Bellow seal trims are considered HD guiding up to 1500 psi throttling.

RESEARCH CONTROL® Valve
Innervalve Materials

The choice of innervalve material can be dictated by personal preference, past experience, or physical necessity. Corrosion, high pressure, or temperature are normally the three factors of concern for both body and innervalve material. It is company policy to allow the user the choice of valve material. However, there are instances where assistance becomes necessary. In those cases, and wherever possible, a choice of materials will be offered.

The purpose of this sheet is to identify several of the more common materials and instances where they might be considered. Corrosive applications present the area of greatest difficulty, due to the infinite variety of conditions. Concentration, temperature, and pressure can all have a bearing on how successfully a given material resists corrosion. The following list of materials and conditions was arrived at by combining information from published valve and material handbooks and from information gained from past experience. Due to unknown factors, the pressure/ temperature figures are based on non-corrosive fluids.

The innervalve material is generally the same as the body, unless specified otherwise either by the user or by the factory. The least noble material used is 316 SST. Optional materials are available for almost all valve designs.

The standard material for "P" series innervalves is a Stellite® plug and 416 SST seat which provides good service in non-corrosive applications. These innervalve sizes are also available with an optional Stellite inlaid SST seat for increased corrosion, erosion, and galling resistance. Optional phosphor bronze, as well as titanium nitride-coated trims, is also available in some sizes. The TN2 coating on Stellite provides a hard, corrosion-resistant innervalve, capable of withstanding greater abuse than an uncoated innervalve.

If the material of choice is not listed, consult the factory for availability.

Due to normal wear and an infinite variety of applications, this information should be used only as a guideline.

Material	Fluid	Temp. (F)	ΔP (psi)	Notes
316 ST	Gas	-450/600	0-300	"K" – "O" trims may be used on gas to 70 psi ΔP @ 200ºF if Stellite cannot be used.
		-450/200	0-500	
	Liquid	-450/600	0-150	
		-450/200	0-300	
Stellite	Gas	-450/1500	0-5000	
	Liquid	-450/900	0-3000	Subject to erosion and cavitation damage.
Stellite & 416 SST	Gas	-450/200	0-5000	This standard "P" trim material is NOT recommended for hydrogen service or other dry gases. Stellite, bronze or a coated seat is recommended.
		-20-/800	0-5000	
	Liquid	-20/200	0-1000	Subject to erosion and cavitation damage.
Stellite & Phos. Brz.	Liquid	-20/200	0-1000	Can be used on "P" trims to reduce galling in applications of hydrogen or other non-corrosive dry gases.
	Gas	-20/300	0-3000	
Other materials and their temperature limits				
Alloy C		To 1000		These alloys are normally used on corrosive or high temperature applications. Material handbooks should be consulted prior to their use, as factors unknown to the factory can affect material performance.
Alloy B		To 700		
Alloy 20		-50/600		
Monel®		-400/900		
Titanium		To 600		
Inconel (general)		-400/1200		

Note: Applications containing solids can plug and/or erode small innervalves. Consult factory for assistance.

RESEARCH CONTROL® Valve
Actuator Force Spring Preloaded

Charts 4 and 5 can be used to determine required spring preloading to assure proper innervalve closing force. Forces opposing the actuator are created by 1: the up-stream pressure against the innervalve, and 2: the downstream pressure against the stem.

Directions:

- Multiply the innervalve orifice area (from Tech Briefs) by the maximum shut-off pressure.
- Multiply the maximum downstream pressure by the stem area. Note: Stem diameters are shown on the back of each Tech Brief. ½" valves with heavy duty guided innervalves have ¼" diameter stem (A=.0491 sq.in.) Bellows seals have an area of 0.16 sq. in. and should be calculated the same as the stem diameter.
- Whichever is greater, find the corresponding "Unbalanced Force" in column A. Use Chart 4 for ¼" valves and Chart 5 for ½", 3/4", and 1" valves.
- Column B indicates the amount of air preload required to obtain valve closure.
- Column C indicates the spring color. Note: Maximum preload on all black springs is 9 psig.
- Column D shows the required supply pressure to the positioner.

Note: Columns E and F on Chart 5 cover the heavy red spring for ½" valves.

Chart 4: Preload for 1/4" ATO Positioner Actuators

Column A	Column B	Column C	Column D
Unbalanced Force (lbs)	Required Preload (PSI)	Spring Color	Supply Press. (PSI)
5	1.0	Black	22
10	1.5	Black	22
15	2.5	Black	22
20	3.0	Black	22
25	3.5	Black	22
30	4.5	Black	22
35	5.0	Black	22
40	5.5	Black	25
45	6.5	Black	25
50	7.0	Black	25
55	8.0	Black	25
60	8.5	Black	25
65	9.0	Black	26

Chart 5: Preload for 1/2", 3/4" and 1" ATO Positioner Actuators*

Column A	Column B	Column C	Column D	Column E	Column F
Unbalanced Force (lbs)	Required Preload (PSI)	Standard Spring & Required Supply Pressure		Optional Spring & Required Supply Pressure	
		Color	PSI Air	Color	PSI Air
10	1.0	Black	22	Red	30
20	2.0	Black	22	Red	30
30	3.0	Black	22	Red	30
40	4.0	Black	22	Red	40
50	4.5	Black	22	Red	40
60	5.5	Black	22	Red	40
70	6.5	Black	22	Red	40
80	7.5	Black	25	Red	45
90	8.0	Black	25	Red	45
100	9.0	Black	25	Red	45
110	10.0		25	Red	50
120	11.0		25	Red	50
130	12.0		26	Red	55
140	12.5			Red	55
150	13.5			Red	55
160	14.5			Red	55
170	15.5			Red	55
180	16.0			Red	60

* Used on 1/2", 3/4" and 1" Research Valves.

Due to continuous research, product improvements and enhancements, Badger Meter reserves the right to change product or system specifications without notice, except to the extent that an outstanding bid obligation exists.

This document should be considered a guideline for the selection of a valve and is not intended to provide definitive information, since unforeseen factors affect both selection and performance.