Control Valve Selection Guide

Invensys
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Robertshaw
Robertshaw Industrial
Products Division

ROBERTSHAW CONTROL VALVE SELECTION GUIDE

Introduction

Selecting the correct control valve for a particular application requires a systematic approach. Understanding the process loop and knowing the basic Robertshaw product line will assure the proper selection of the control valve. Following a step by step approach will make the task of choosing a control valve more manageable.

In some cases, more than one valve will be acceptable. The final choice may depend on pricing or the customer's preferences. If the customer is replacing existing equipment, refer to the serial number on the valve and send the inquiry to the factory.

During the selection process several factors must be considered separately, permitting us to break the work down into smaller steps.

- **Materials of construction**
- **Style**
- **Characteristics**
- **Size**
- **Actuator action/size**
- **Accessory equipment**

Materials of construction

In most cases the materials of construction are specified by the customer and are determined by the chemical and physical properties of the process fluid such as its corrosive nature, flowing pressure and temperature. Generally speaking, the low pressure and low temperature water and steam applications use brass or cast iron bodies with brass or stainless steel trim. Whereas steel is used for high temperature water and steam applications and for practically all flammable materials such as lube oil. Stainless steel is usually chosen when the process fluid is corrosive or food products are the process fluids.

Table 1 shows the maximum inlet pressure for a given material and body rating at a specific service temperature. Note that pressures greater than the body rating are permitted depending on the temperature of the process.

Pressure (psi) — (°)F

Service Temp. (°)F.	CAST IRON	CAST CARBON STEEL			STAINLESS STEEL			Service Temp. (°t) F.
	125 lb.	150lb.	300 lb.	600 lb.*	150 lb.	300 lb.	600 lb.*	
-20	200	285	740	1480	275	720	1440	-20
0	200	285	740	1480	275	720	1440	0
100	200	285	740	1480	275	720	1440	100
150	200	270	705	1415	260	675	1340	150
200	190	260	675	1350	240	620	1240	200
250	175	245	665	1330	225	590	1180	250
300	165	230	655	1315	215	560	1120	300
350	150	215	645	1285	205	540	1075	350
400	140	200	635	1270	195	515	1030	400
450	125	185	615	1235	180	500	1005	450
500	—	170	600	1200	170	480	995	500
550	—	155	575	1145	165	465	930	550
600	—	140	550	1095	140	450	905	600
650	—	125	535	1075	125	445	890	650
700	—	110	535	1065	110	430	865	700
750	—	95	505	1010	95	425	845	750
800	—	80	410	825	80	415	830	800

*600 lb. Class may vary from ANSI standard — consult factory.

TABLE 1

The valve trim includes the plug, seat ring, cage, stem and the bushing. The valve plug and seat ring are the most suspect to damage by erosion caused by impingement of high velocity particles. Table 2 shows the pressure and temperature limitations for stainless steel trim.

Material Differential Pressure Limitation (Δ P)

Material	Limit
TRIM MATERIAL (Plug/Seat/Bushing)	
316/316/440c	200 psi
17-4/17-4/440c	*
316 Stellited/316 Stellited/440c	*

* Use maximum recommended working pressure/temperature table.

Material Temperature Limitation -50° to 750°F.

Material	Limit
TRIM (Plug/Seat/Bushing)	
316/316/440c	-50° to 600°F.
17-4/17-4/440c	-40° to 600° F
316 Stellited/316 Stellited/440c	-50° to 750°F

TABLE 2

Refer to Table 5 for the style of trim and trim materials for each valve type.

Style

Table 5 also summarizes the Robershaw valve styles (two-way, three-way, flanged, leakage rates, etc.) Table 3 shows the valve leakage rates and the related classifications.

TYPE LEAKAGE	MAX LEAKAGE RATE	CLASS
Tight shutoff	.01% of Cv	IV
	.1% of Cv	III
	.5% of Cv	II

TABLE 3

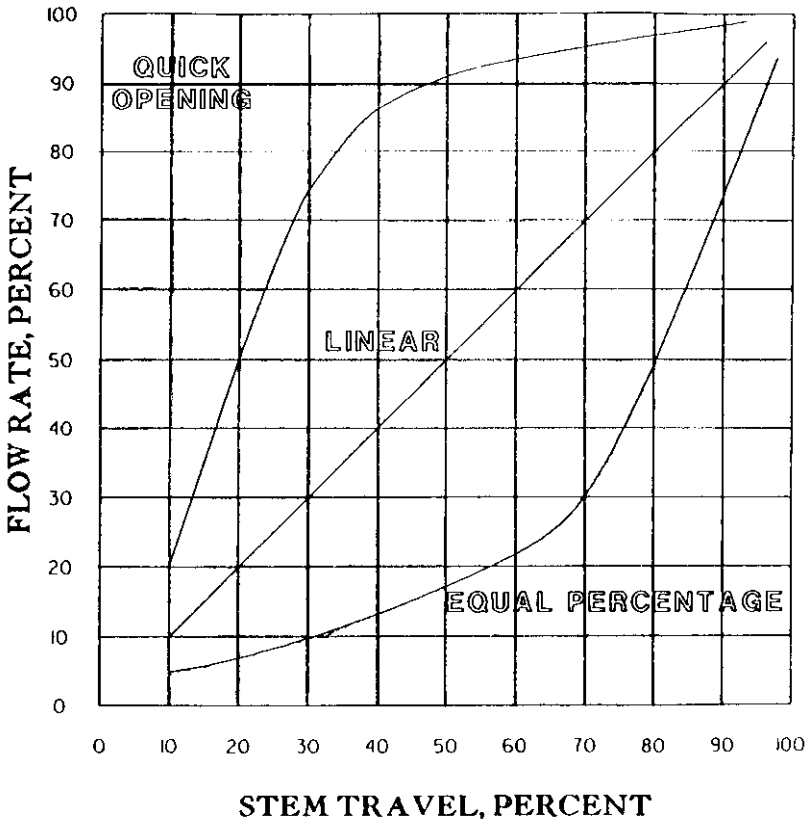
Characteristics

Valve characteristics define how much the valve opening or Cv changes as the stem is stroked throughout its rated travel. Valves using large blunt ended plugs usually achieve most of their flow during the first 30% of their stroke and are usually used for on/off non-throttling service and exhibit large full open Cv's.

As the shape of the plug becomes sharper and extends into the seat area the flow becomes more linear and the full open Cv usually decreases. Most 3-way valves have fairly linear characteristics.

Equal Percentage is probably the most common throttling characteristic and offers a more gradual change in Cv over the first 40% of valve travel.

FIGURE 1:



Size

Choosing the correct valve size will probably have the greatest impact on the performance of the control valve in the process environment. There are two major considerations when sizing control valves.

1. Size of the connecting pipe.
2. Cv to meet the flow requirements.

Unfortunately, however, these two requirements rarely coincide. In many cases it is desirable to choose the valve body size to mate with the piping and install restricted trim to meet the Cv. A classic example is the application for a process that is designed with large enough capacity to meet future growth expectations.

The basic flow equation is solved for Cv by using the Robertshaw Flo-rule or Valve sizing program. Refer to the engineering section of the sales catalog for a detailed explanation of Cv calculations.

Generally speaking, the valve is chosen to have a Cv ranging from 1.1 to 1.3 times the calculated Cv for maximum flow and maximum ΔP. Refer to Table 5 for Cv for each valve type and size. After choosing a valve based on maximum conditions, refer to the characteristic curve for that valve and determine what the position will be at normal flowing conditions. It may then become necessary to compromise the selection to more closely fit the normal flowing conditions.

Actuator Action/Size

Safety must always be the first consideration. In most cases the answer to one question will determine the control valve action. (What should the valve do if the control signal is lost)? The answer to this question should be provided by the user but generally speaking for heating applications, the valve should fail closed: whereas for cooling applications the valve should fail open.

When making this selection, both the action of the valve and the actuator must be considered.

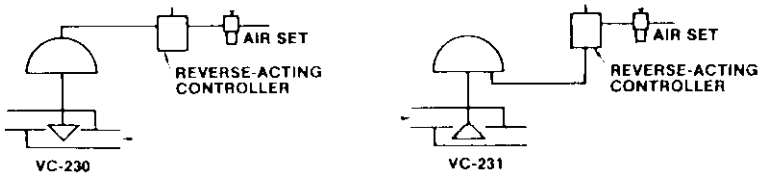
A direct acting valve is one that closes when the stem is pushed down. A reverse acting valve is one that opens when the stem is pushed down. Refer to Table 5 for valve action.

The direct acting actuator is one that pushes down with increasing signal and is distinguished by the signal connection above the diaphragm. The reverse acting actuator has the signal connection below the diaphragm and pushes up on increasing signal.

Figure 2 shows the 4 possible valve/actuator combinations and the resulting actions.

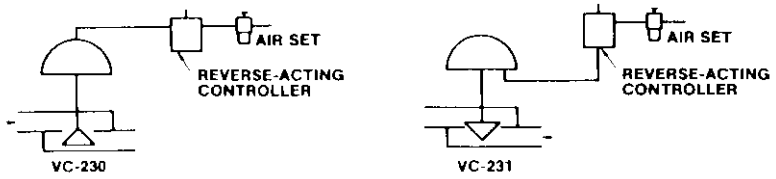
CONTROL VALVE APPLICATION

COOLING APPLICATIONS



Control Valve Action: Air to close. **Action on Air Failure:** Valve opens.
Controller Action: Output decreases with increasing temperature.

HEATING APPLICATIONS



Control Valve Action: Air to open. **Action on Air Failure:** Valve closes.
Controller Action: Output decreases with increasing temperature.

NOTE: Above configurations provide fail-safe action, i.e., on air failure a cooling valve will open and a heating valve will close. If this valve action is not desired, then reverse above applications and use a direct-acting controller where a reverse-acting controller is specified.

FIGURE 2

Table 4 describes the actuator action and diaphragm size.

Model Number		
Direct Acting	Reverse Acting	Actuator Size
VC-230A	VC-231A	30 Sq."
VC-300A	VC-301A	30 Sq."
VC-310	VC-311	40 Sq."
VC-320	VC-319	80 Sq."
VC-322	VC-321	80 Sq."

TABLE 4

Refer to Table 5 for the standard actuator for your valve type and size. Column 11 shows the maximum allowable inlet pressure for that standard actuator in closed position. This assumes the worst condition with downstream pressure at zero. Column 12 shows the standard actuator model numbers. If your application requires higher close off pressures, consult with the factory representative.

Accessory Equipment

All actuators can be equipped with the following accessories mounted on the actuator yoke and piped to the diaphragm.

No. 97478-D1 PRV
No. 84589-A2 Solenoid Valve
P-2 Positioner (no bypass or gauges)
P-2G Positioner (gauges only)
443A Transducer
Limit Switches

TABLE 5

	1		2			3							4			5			6
	VALVE ASSEMBLY		ACTION			TRIM FEATURES							CHARACTERISTICS			END CONNECTIONS			TRIM MAT'L
			DIRECT	REVERSE	3-WAY	UNBALANCED	BALANCED	SINGLE SEATED	DOUBLE SEATED	TOP/BTM GUIDED	CAGE GUIDED		Q.O.	= %	LINEAR	SCREWED	UNIONS	FLANGED	
			(10 SQ" ACTUATOR INCLUDED AS PART OF VC-210)																
1.	VC-210	½	X	X	X	X		X					X	X	3-WAY	X			316 SS
		¾	X	X	X	X		X					X	X	3-WAY	X			316 SS
		1	X	X	X	X		X					X	X	3-WAY	X			316 SS
2.	BC	1	X			X		X		X				X		X			
		1¼	X			X		X		X				X		X			BRASS
		1½	X			X		X		X				X		X			WITH
		2	X			X		X		X				X		X			SOFT
		2½	X	X		X		X		X				X					SEAT
		3	X	X		X		X		X				X				125 LB ANSI	DISC
		4	X	X		X		X		X				X					
3.	BG	½	X			X		X		X				X		X			316 SS
		¾	X			X		X		X				X		X			316 SS
		1	X			X		X		X				X		X			316 SS
		1¼	X			X		X		X				X		X			316 SS
		1½	X			X		X		X				X		X			316 SS
		2	X			X		X						X		X			316 SS
4.	CSS	½	X	X		X		X						X	X	X			316 SS
		¾	X	X		X		X						X		X			TEFLON
		1	X	X		X		X						X		X			O-RING
5.	FA	¾		X			SEMI-BALANCED		X	X			X				X		BRONZE
		1		X			SEMI-BALANCED		X	X			X				X		BRONZE
		1¼		X			SEMI-BALANCED		X	X			X				X		BRONZE
		1½		X			SEMI-BALANCED		X	X			X				X		BRONZE
		2		X			SEMI-BALANCED		X	X			X					X	BRONZE
		2½	X	X			SEMI-BALANCED		X	X			X					X	BRONZE
		3	X	X			SEMI-BALANCED		X	X			X					X	BRONZE
		4	X	X			SEMI-BALANCED		X	X			X					X	BRONZE
6.	MA	¾	X				X	X			X		X				X		316 SS
		1	X				X	X			X		X				X		316 SS
		1¼	X				X	X			X		X				X		316 SS
		1½	X				X	X			X		X				X		316 SS
		2	X				X	X			X		X					125 LB ANSI	316 SS
	MASS	¾	X				X	X			X		X			X			316 SS
	MASS	1	X				X	X			X		X			X		300 LB ANSI	316 SS
	MASS	1½	X				X	X			X		X			X		300 LB ANSI	316 SS
	MASS	2	X				X	X			X		X					X	316 SS
8.	WA	½			X	X							X				X		316 SS
		¾			X	X							X				X		316 SS
		1			X	X							X				X		316 SS
		1¼			X	X							X				X		316 SS
		1½			X	X							X				X		316 SS
9.	WCSS	½			X	X									X	X			316 SS
		¾			X	X									X	X			316 SS
		1			X	X									X	X			316 SS
																		150 LB ANSI	
10.	WD	2			X		X						X					X	BRASS
		2½			X		X						X					X	BRASS
		3			X		X						X					X	BRASS
		4			X		X						X					X	BRASS
		5			X		X						X					X	BRASS
		6			X		X						X					X	BRASS
11.	WE	½			X	X				X					X	X			BRASS
		¾			X	X				X					X	X			BRASS
		1			X	X				X					X	X			BRASS
		1¼			X	X				X					X	X			BRASS
		1½			X	X				X					X	X			BRASS
		2			X	X				X					X	X			BRASS
		2½			X	X				X					X			X	BRASS
		3			X	X				X					X			X	BRASS
		4			X	X				X					X			X	BRASS
12.	WESS	1½			X	X				X					X	X			316 SS
	WESS	2			X	X				X					X	X			316 SS

7				8			9	10			11			12	13	14
BODY MATERIAL				SEAT LEAKAGE			CV	PACKING			MAXIMUM ALLOWABLE ΔP (PSIG) WITH STANDARD ACTUATORS			ACTUATOR	TEMP RANGE	BODY RATING PSIG
BRASS	CLASS B GRAY IRON	CFBM SST	WCB STEEL	CLASS II	CLASS III	CLASS IV		TEFLON	GRAPHITE	U-CUP	ATC	ATO	3-WAY			
ASTM-B62																
X		X			X		.3-.6-2.3	BELLOWS			90	100	60			
X		X			X		7.3	SEAL			50	100	35	10 SQ IN	-20°F TO 350°F	300 PSIG
X		X			X		9.5	↓			30	50	20			
X					X		9.3	X			40					
X					X		17	X			40			VC-230A		300 PSIG
X					X		25	X			40			VC-231A		AT
X					X		40	X			40				-20°F TO 300°F	100°F
	X				X		72	X			15			VC-300A		
	X				X		102	X			10			VC-301A		175 PSIG
	X				X		164	X			5					AT 100°F
X					X		2	X			125					
X					X		5.3	X			125			VC-230A		
X					X		9.5	X			125			VC-231A	-20°F TO 300°F	300 PSIG
X					X		15	X			125					AT
X					X		23	X			100					100°F
X					X		52	X			35			VC-300A, VC-301A		
		X			X		.3-.6-2.3	X			100			VC-230A		
		X			X		7.3	X			100			VC-231A	-20°F TO 350°F	450 PSIG
		X			X		9.5	X			100					AT 100°F
X				X			9.3			X	125					
X				X			17.6			X	125					200 PSIG
X				X			22.5			X	125					AT
X				X			30.4			X	125			VC-230A	-20°F TO 400°F	100°F
X	X			X			59.3			X	125			VC-231A		
X	X			X			82.5	X		X	125					175 PSIG
X	X			X			130	X		X	125					AT
X	X			X			226	X		X	125					100°F
X						X	9.8	X			250					
X						X	12.8	X			250					
X						X	18.6	X			250			VC-230A	-20°F TO 400°F	250 PSIG
X						X	26.0	X			250			VC-231A		
	X					X	47.5	X			150				-20°F TO 350°F	125 PSIG
		X	X			X	10.5	X			250					
		X	X			X	12	X			250			VC-230A	-20°F TO 400°F	300 PSIG
		X	X			X	30	X			250			VC-231A		AT
		X	X			X	49	X			150					500°F
							B-A B-C									
X				X			4.2 3.1			X	75					
X				X			7.8 5.6			X	75					225 PSIG
X				X			11.1 8.8			X	75			VC-230A	-20°F TO 400°F	AT
X				X			23.5 18.1			X	75			VC-231A		100°F
X				X			31.7 25			X	75					
		X			X		2.2	X					40	VC-230A		450 PSIG
		X			X		4.6	X					40	VC-231A	-20°F TO 350°F	AT
		X			X		9.0	X					40			100°F
							E-B E-C									
X							64 64			X			40			
X							81 88			X			40			
X							115 106			X			40	VC-230A	-20°F TO 200°F	150 PSIG
X							220 237			X			40	VC-231A		
X							344 385			X			40			
X							506 563			X			40			
X							2.2			X			50			
X							4.6			X			50			
X							9			X			50	VC-230A		300 PSIG
X							18			X			50	VC-231A		
X							25			X			50		-20°F TO 250°F	
X							40			X			50			
	X						72			X			20	VC-300A		
	X						94			X			20	VC-301A		150 PSIG
	X						170			X			5			
		X					20			X			50	VC-230A		
		X					40			X			50	VC-231A	-20°F TO 250°F	

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