

# Fisher™ CAV4 Control Valve

## CAV4 (globe)

- CAV4 (NPS 2)

## CAV4 (angle)

- CAV4 (NPS 2 through 6)

## CAV4 Series Valves

The Fisher CAV4 control valve with Cavitrol™ IV trim is designed specifically for liquid applications, such as boiler feedwater recirculation, where pressure drops are above 207 bar (3000 psi) and cavitation is a serious problem. The CAV4 valve is available in a broad range of valve body sizes and styles, including NPS 2 through 6 angle, globe, and offset globe.

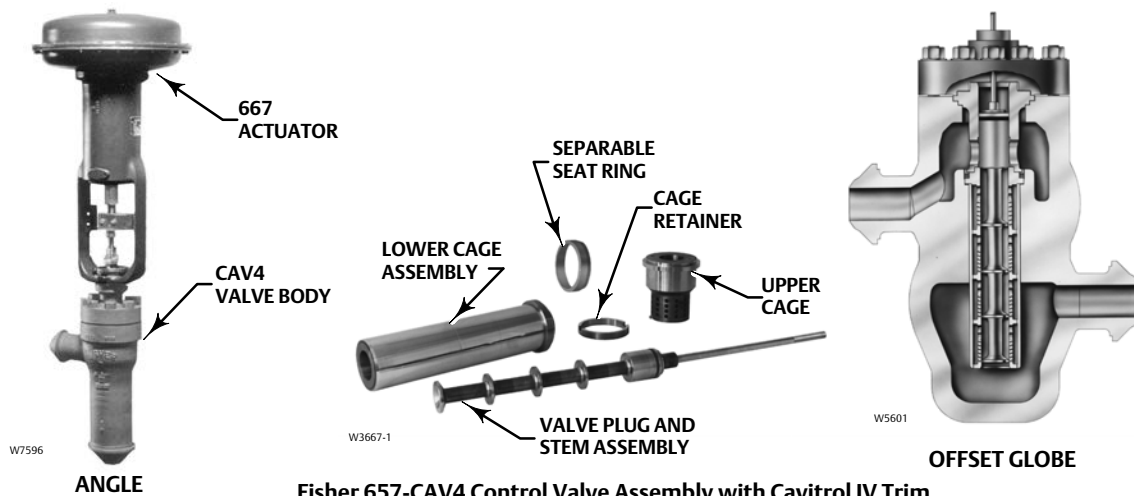
The CAV4 valve's various valve plug constructions (figure 1) provide temperature capabilities through 417°C (800°F). The seal ring construction is used where temperatures are equal to or lower than 232°C (600°F) (see figure 5), and both the stem-balanced and the piston ring constructions are used with temperatures up to 417°C (800°F). In addition, the CAV4 valve is offered with either a separable seat ring for moderate temperature (up to 232°C [450°F]) applications or with an integral seat cage for high-temperature (up to 417°C [800°F]) applications.

Unless otherwise noted, all NACE references are to NACE MRO175 2002. Contact your [Emerson sales office](#) for information on other NACE certifications.

## Features

- **Cavitation Decreased**—A properly sized CAV4 valve with Cavitrol IV trim decreases cavitation and its resultant damage and noise.
- **Long Trim Life**—Pressure-staging, separation of shutoff and throttling locations, and hardened trim materials result in improved wear resistance.
- **Tight Shutoff**—Soft metal-to-metal seat provides tight shutoff without the need for periodic lapping. The enhanced valve plug seal provides improved service life. (Angle valve bodies only.)
- **TSO (Tight Shutoff) Trim**—Valves with TSO trim (figure 1) are factory tested to a more stringent Emerson Automation Solutions test requirement of no leakage at time of shipment using ANSI/FCI Class V procedures.

(continued on page 3)



Fisher 657-CAV4 Control Valve Assembly with Cavitrol IV Trim

## Specifications

**Available Configurations and Valve Body Sizes**

**Common Characteristics:** CAV4 angle, globe, or offset globe valve with four-stage Cavitrol IV trim including soft metal-to-metal seat. Valve plug action is push-down-to-close

**Seal Ring Construction:** ■ NPS 2 angle, ■ 3, ■ 4, or ■ 6 valve body with pressure-balanced valve plug and spring-loaded PTFE seal ring. For use in low-temperature applications

**Stem-Balanced Construction:** ■ NPS 2 angle or ■ 4 valve body with stem-balanced valve plug (valve stem diameter—for that portion of stem that passes through bonnet—is equal to nominal port diameter). For use in high-temperature applications

**Piston Ring Construction:** NPS 6 valve body with pressure-balanced valve plug and five graphite piston rings. For use in high-temperature applications

**Unbalanced Construction:** NPS 2 globe

**End Connection Style<sup>(1)</sup>**

**Butt welding Ends:** All butt welding end schedules per ASME B16.25 that are compatible with ASME B16.34 valve body rating

**Raised-Face or Ring-Type Joint Flanged Ends:** Inlet connection is CL1500 or CL2500 flange per B16.5. Outlet connection mates with CL2500 flange and has tapped bolt holes

**Maximum Inlet Pressure and Temperatures<sup>(1)(2)</sup>**

Consistent with applicable CL1500 and 2500 pressure temperature ratings per ASME B16.34 unless limited by individual pressure drop limits shown in figure 5 or temperature limits shown in table 1

**Maximum Pressure Drop<sup>(2)</sup>**

See figure 5

**Material Temperature Capabilities<sup>(2)</sup>**

**Seal Ring Construction:** 18 to 232°C (0 to 450°F)  
**Stem-Balanced and Piston Ring Constructions:** Up to

427°C (800°F) unless limited by selection of other parts (table 1)

**Shutoff Classification**

**TSO (Tight Shutoff) Trim:** Valves with TSO trim are factory tested to a more stringent Emerson Automation Solutions test requirement of no leakage at time of shipment using ANSI/FCI 70-2 and IEC 60534-4 Class V procedures.

**Piston Ring Construction:** Class IV per ANSI/FCI 70-2 and IEC 60534-4

**All Other Angle Bodies:** Class VI per ANSI/FCI 70-2 and IEC 60534-4

**Globe Bodies:** Class V per ANSI/FCI 70-2 and IEC 60534-4

**Flow Direction**

In through the side connection and out the bottom connection. Globe valve is flow down

**Noise Levels**

Because of cavitation elimination, noise is typically not a problem with Cavitrol IV trim. For virtually all applications, noise levels will be below 90 dBA. If more stringent noise specifications must be met, contact your [Emerson sales office](#)

**Construction Materials**

See table 1

**Flow Characteristic**

Linear

**Maximum Flow Coefficients (C<sub>V</sub>)**

**Linear:** ■ NPS 2 valve, 8.25; ■ NPS 3 valve, 14.6;

■ NPS 4 valve, 21.9; ■ NPS 6 valve, 55.6

**Characterized:** ■ NPS 2 valve, 11.3; ■ NPS 3 valve, 24; ■ NPS 4 valve, 38.2; ■ NPS 6 valve, 89.1. Also see Fisher Catalog 12 and table 5

- continued -

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## Specifications (continued)

### Valve Recovery and Cavitation Coefficients

#### Recovery Coefficient

Linear:  $K_m = 0.99$  ( $F_L = 0.995$ ) Characterized:  $K_m = 0.98$  ( $F_L = 0.99$ ). This value defines the maximum allowable pressure drop that is effective in producing flow as shown in the following equation:

$$\Delta P_{\text{allowable}} = K_m (P_1 (\text{flowing}) - r_c P_v)$$

### Port Diameters and Unbalance Area

See table 3

### Minimum Seat Load Force

First refer to figure 6 to determine minimum seat load per inch of port circumference; then multiply that value by the port circumference from table 3

### Valve Plug Travel

See table 3

### Yoke Boss and Valve Stem Diameters

See table 3

### Approximate Weight

See table 3

### Options

- Flushing trim, two plates used in place of Cavitrol IV trim, to protect valve body surfaces and Cavitrol IV trim from damage during pipeline flushing:
- characterized cage; and ■ driver for installation and removal of cage retainer ■ ENVIRO-SEAL™ packing is available

1. PN (or other) ratings and end connections can usually be supplied: contact your [Emerson sales office](#).  
2. The pressure/temperature limits in this bulletin and any applicable linear limitation should not be exceeded.

## Features (continued)

- **Efficient Operation**—Expanding flow area design takes advantage of the ability of the liquid to undergo a greater pressure drop in initial stages without cavitating. This results in a much lower inlet pressure to the final stage.
- **Characterization**—Special characterized cages are available to provide customer specified rangeability for specific system requirements.
- **Easy Maintenance**—Design reduces maintenance downtime by permitting quick disassembly with easy access to valve trim and valve plug seat. Separable seat ring for low temperature applications (at or below 232°C [450°F]) makes maintenance easier.

**Table 1. Construction Materials and Temperature Capabilities**

PART	MATERIALS		TEMPERATURE CAPABILITIES	
			°C	°F
Valve Body and Bonnet	Standard	WCC Carbon steel casting	-29 to 427	-20 to 800
	Optional	WC9 alloy steel casting	-29 to 482	-20 to 900
		C5	-29 to 427	-20 to 800
		CD3MN <sup>(3)</sup>	-29 to 316	-20 to 600
		CD3MWCuN <sup>(3)</sup>	-29 to 316	-20 to 600
Valve Plug	Angle: NPS 2, 4, 6 (High Temperature Trim)	S44004 (440C stainless steel heat-treated)	-29 to 427	-20 to 800
	Angle: NPS 2, 3, 4, 6 (Standard Trim) Globe: NPS 2	S44004 (440C stainless steel heat-treated)	-29 to 232	-20 to 450
	Angle: NPS 2, 4	N07718/CoCr-A Seat & Guide	-101 to 166	-150 to 330
	Angle: NPS 6	N07718/CoCr-A Seat & Guide	-101 to 93	-150 to 200
	Angle: NPS 2, 3 (Tight shutoff Trim)	S44004/S41600	0 to 232	32 to 450
	Angle: NPS 4 (Tight shutoff Trim)	S44004/S17400	0 to 232	32 to 450
	Globe: NPS 2	Alloy 6B	-29 to 232	-20 to 450
Valve Stem	S20910		-254 to 427	-425 to 800
	S31600		-254 to 427	-425 to 800
	S32760		-51 to 316	-60 to 600
	S31600/S17400		-101 to 427	-150 to 800
Seat Ring	S17400/S31600		-29 to 232	-20 to 450
	S44004		-29 to 427	-20 to 800
	S31600		-254 to 427	-425 to 800
	Alloy 6B		-29 to 232	-20 to 450
O-ring (separable seat ring construction)	Angle: NPS 2, 4, 6	Ethylene propylene	-18 to 232	0 to 450
	Globe: NPS 2	Ethylene propylene	-29 to 232	-20 to 450
	Globe: NPS 2	Fluorocarbon	-18 to 204	0 to 400
Upper Cage, Seat Ring Retainer, and Lower Cage Assembly	Angle	S17400/S31600 stainless steel (cages) and S17400 H1075 SST CrCt (retainer)	-29 to 427	-20 to 800
Valve Plug Seal Ring <sup>(1)</sup>	Spring-loaded PTFE Seal		-18 to 232	0 to 450
Valve Plug Backup Ring <sup>(1)</sup>	S41600		-29 to 427	-20 to 800
Seal Ring Retainer <sup>(1)</sup>	S30200		-254 to 593	-425 to 1100
Piston Ring <sup>(2)</sup>	Graphite (FMS 17F27)		-46 to 427	-50 to 800
Bonnet Gasket	Angle	Silver-plated N04400 nickel alloy	-254 to 593	-425 to 1100
	Globe	S31600/graphite	-254 to 593	-425 to 1100
Cage Gasket	S31600 stainless steel/graphite		-254 to 593	-425 to 1100
Metal Packing Box Parts	S31600		-254 to 593	-425 to 1100
Body-to-Bonnet Bolting	Standard	Studs, SA-193-B7; Nuts, SA-194-2H	-29 to 427	-20 to 800
		Studs, SA-193-B7; Nuts, SA-194-2H	-29 to 232	-20 to 450 <sup>(3)</sup>
	Optional <sup>(3)</sup>	Studs, SA-193-B7M; Nuts, SA-194-2HM	-29 to 121	-20 to 250
Packing	Standard	Spring-loaded PTFE V-ring	-46 to 232	-50 to 450
	Optional	PTFE-impregnated composition	-73 to 232	-100 to 450
		Laminated graphite/filament	-18 to 427	0 to 800

1. For only seal ring construction.  
2. For only 6-inch piston ring construction.  
3. For only NPS 2 Globe Body.

Table 2. Trim Descriptions

TRIM DESIGNATION	VALVE SIZE, NPS	VALVE PLUG	CAGE	SEAT RING	VALVE BODY MATERIAL	OPERATING TEMPERATURE	
						°C	°F
Standard Trim							
68	2 <sup>(2)</sup>	S44004	S17400 H1075	S44004	C5 WCC WC9	-29 to 232	-20 to 450
					CD3MN CD3MWCuN	-29 to 177	-20 to 350
69 <sup>(4)</sup>	2 <sup>(2)</sup>	Alloy 6B	S32550	Alloy 6B	C5 WCC WC9	-29 to 232	-20 to 450
					CD3MN CD3MWCuN	-29 to 177	-20 to 350
70	2 <sup>(1)</sup> , 4, and 6	S44004	S17400 H1075	S17400/S31600	C5 WCC WC9	-29 to 232	-20 to 450
72	2 <sup>(1)</sup> and 4	N07718/CoCr-A Seat/Guide	S17400/S31600	Not Required	C5 WCC WC9	-101 to 165	-150 to 330
72	6	N07718/CoCr-A Seat/Guide	S17400/S31600	Not Required	C5 WCC WC9	-101 to 93	-150 to 200
73	3 <sup>(3)</sup>	S44004	S17400 H1075	S31600	C5 WCC WC9	-29 to 232	-20 to 450
Tight Shutoff Trim							
74	2 <sup>(1)</sup> , 3 <sup>(3)</sup> , and 4	S44004/S41600	S17400 H1075	S44004	C5 WCC WC9	0 to 232	32 to 450
High Temperature Trim							
75	2 <sup>(1)</sup> , 4, and 6	S44004	S17400/S31600	Not Required	C5 WCC WC9	232 to 426	450 to 800
1. NPS 2 Angle Body only. 2. NPS 2 Globe Body only. 3. NPS 3 is available with a clamped-in lower cage and replaceable seat ring. 4. Trim 69 complies with NACE MR0175/ISO 15156.							

## Product Bulletin

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**CAV4 Valve**  
D101497X012

**Table 3. Additional Valve Body Specifications**

VALVE SIZE, NPS	BODY TYPE	VALVE STEM DIAMETER		YOKE BOSS DIAMETER		TRAVEL		PORT DIAMETER		PORT CIRCUMFERENCE		UNBALANCE AREA <sup>(1)</sup>		APPROX. WEIGHT	
		mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm <sup>2</sup>	Inch <sup>2</sup>	kg	lb
2	Globe	---	---	91	3-9/16	19	3/4	25.4	1	---	---	5.10	0.79	---	---
	Angle	19.0 38.1	3/4 1 <sup>(2)</sup>	91 127	3-9/16 5	38	1.5	38.1	1.5	119.6	4.71	1.10	0.17	167 182	369 401
3	Angle	19.0	3/4	91	3-9/16	51	2	55.6	1.1875	174.5	6.87	1.68	0.26	301	664
4	Angle	19.0	3/4	91	3-9/16	64	2.5	69.9	2.75	219.4	8.64	2.06	0.32	532	1172
		25.4 69.8	1 2-3/4 <sup>(3)</sup>	127 178	5 7									532 554	1172 1222
6	Angle	31.7	1-1/4	127	5 and 5H	102	4	111.1	4.375	349.2	13.75	3.29	0.51	1512	3334

1. For seal ring and piston ring constructions. For stem-balanced construction, use port area of 11.4 cm<sup>2</sup> (1.77 inch<sup>2</sup>) for NPS 2 valve and 38.3 cm<sup>2</sup> (5.94 inch<sup>2</sup>) for NPS 4 valve.  
2. Stem-balanced construction has 31.8 mm (1-1/4 inch) valve stem connection.  
3. Stem-balanced construction has 50.8 mm (2 inch) valve stem connection.

**Table 4. Additional Valve Body Specifications for TSO (Tight Shutoff) Trim — Angle Body**

VALVE SIZE, NPS	MAXIMUM TRAVEL		YOKE BOSS SIZE <sup>(1)</sup>		PORT DIAMETER				PORT CIRCUMFERENCE		C <sub>V</sub> REDUCTION AT 100% TRAVEL <sup>(2)</sup>
					Nominal		Actual TSO				
	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	
2	38	1.5	91 127	3-9/16 5	38.1	1.5	38.1	1.5	119.6	4.71	0%
3	50.8	2	91	3-9/16	55.6	2.1875	55.6	2.1875	174.5	6.87	0%
4	64	2.5	91 127	3-9/16 5	69.9	2.75	69.9	2.75	219.4	8.64	0%
1. Consult the factory for larger yoke boss sizes. 2. This column lists the percent reduction of published maximum C <sub>V</sub> of the trim listed in the TRIM column.											

Figure 1. Sectional View of Fisher CAV4 Angle Valve Body with Cavitrol IV Trim

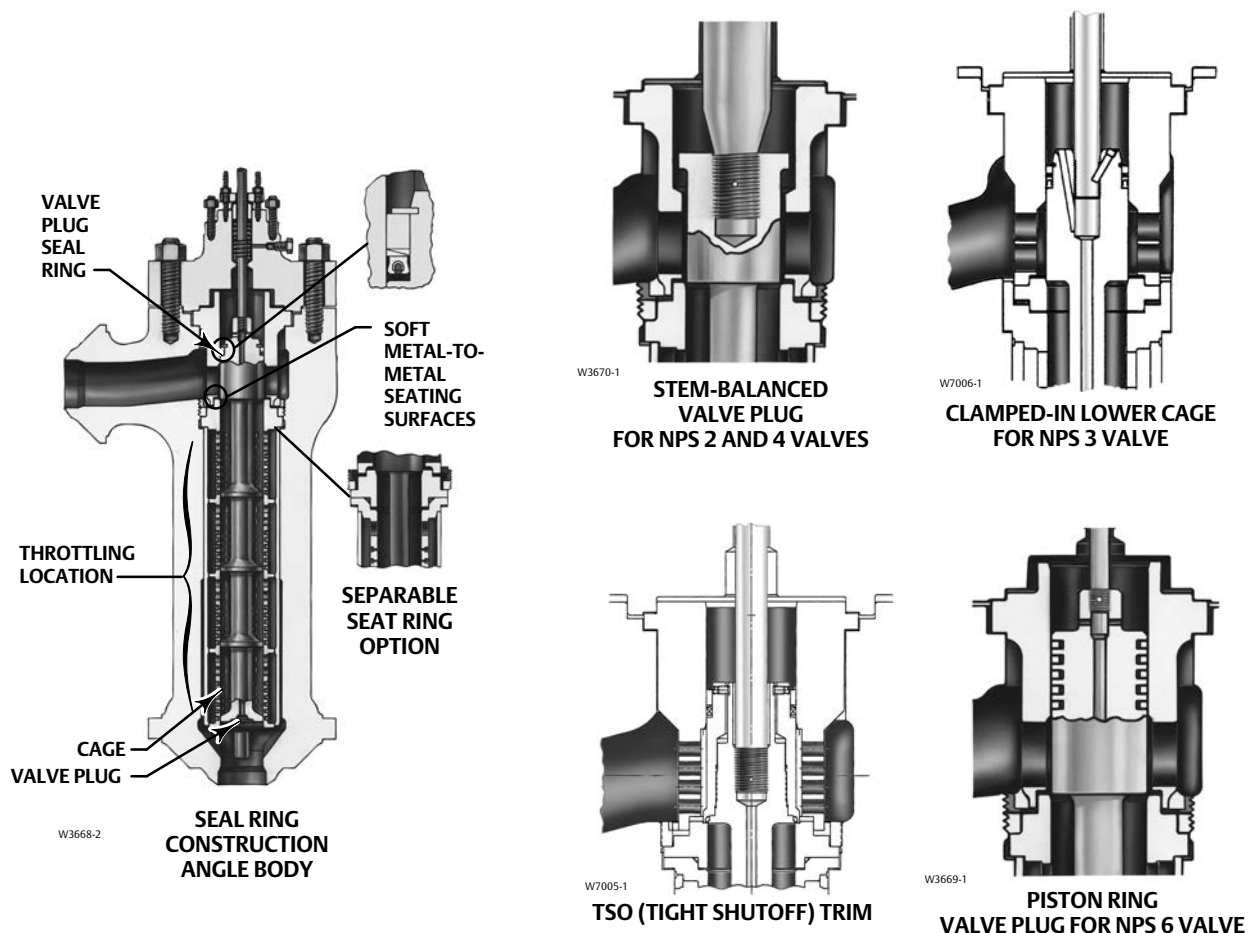
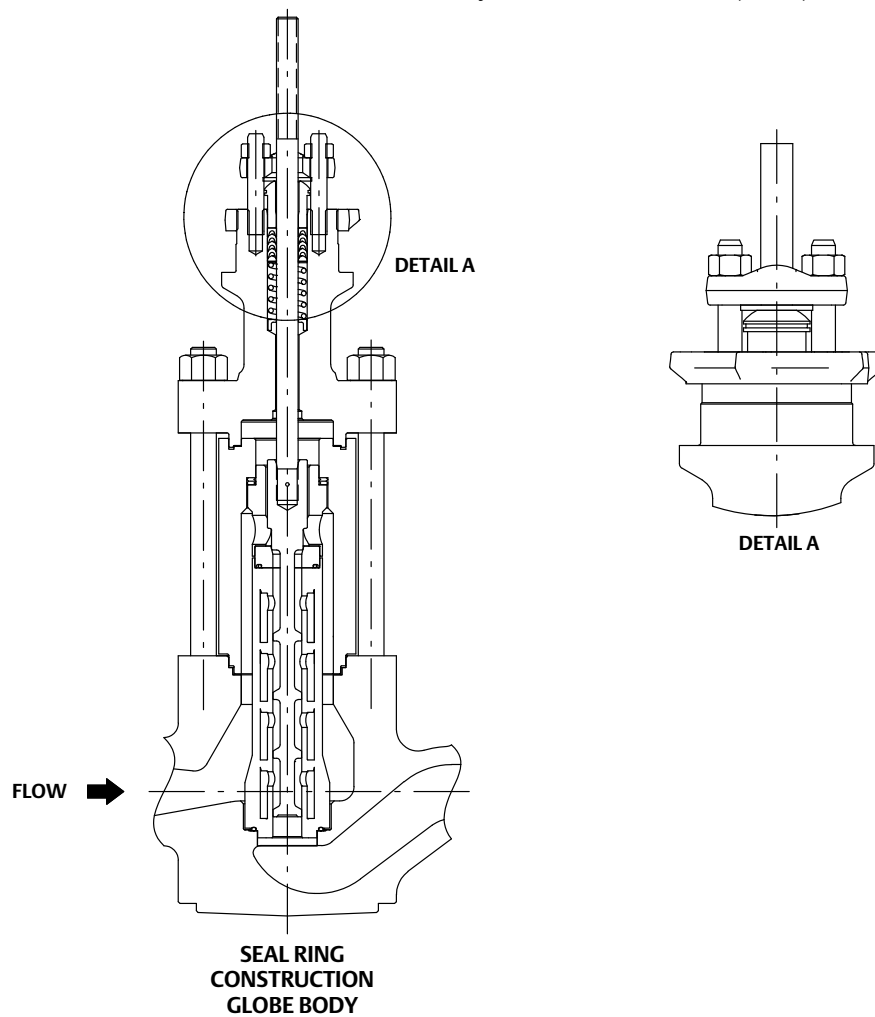
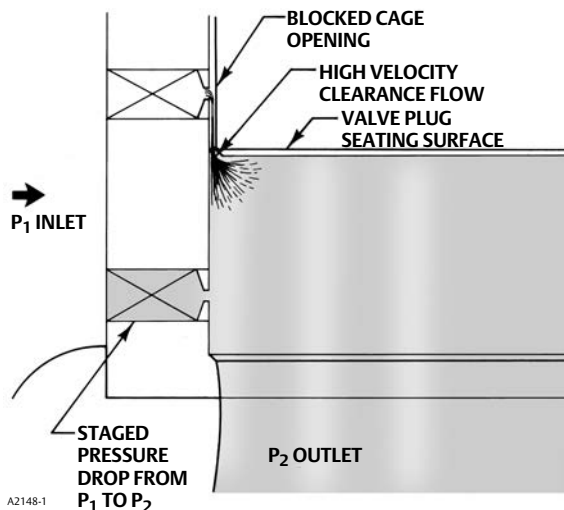


Figure 1. Sectional View of Fisher CAV4 Globe Valve Body with Cavitrol IV Trim (cont.)



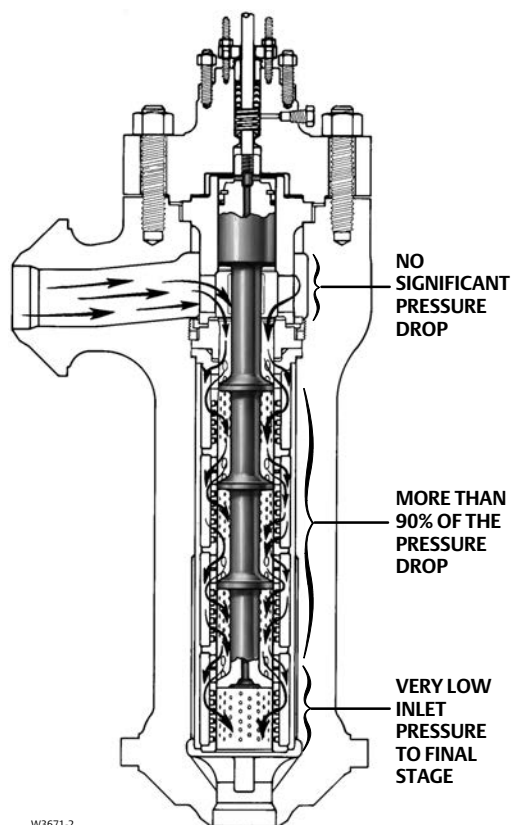
GE96163

Figure 2. Standard Cage-Style Anti-cavitation Trim



A2148-1

Figure 3. Cavitrol IV Trim Operation



W3671-2

## Principle of Operation

The advantage of the CAV4 valve with Cavitrol IV trim is a result of the following three technological advancements not found in any other anti-cavitation control valve.

1. All clearance flow subjected to staged pressure drop.
2. Separation of shutoff and throttling locations.
3. An expanding flow area design.

As shown in figure 2, the linear cage openings below the valve plug seating surface are open to fluid flow and are staging the pressure drop from  $P_1$  to  $P_2$  as designed. However, the cage openings above the valve plug seating surface are nearly blocked by the valve plug. Even though a small clearance passage between the cage and the valve plug does exist, the fluid flow rate through this small clearance passage is so small that the cage is ineffective in staging the pressure drop. Consequently, the clearance flow pressure drop from  $P_1$  to  $P_2$  occurs between the valve plug surface blocking the cage opening and the seating surface of the valve plug. The resultant cavitation and erosive flow across the seat damages the valve plug seating surface. Even with valve plug/cage diametrical clearances as small as 0.20 mm (0.008 inch), this clearance flow damage still occurs and becomes worse with higher pressure drops.

The CAV4 valve with Cavitrol IV trim addresses this clearance flow issue by not taking any significant pressure drop until the fluid is downstream of the seating surfaces (figure 3). As the flow then passes from stage to stage, even the clearance flow is subjected to a staged pressure drop. Therefore, unlike the linear cage-style anti-cavitation trims, there are no flowing conditions where pressure can go directly from  $P_1$  to  $P_2$ .

In the Cavitrol IV trim design, trim life is lengthened by the separation of the shutoff and throttling locations. Just as all significant pressure drop is taken downstream of the shutoff seating surfaces, all significant throttling action occurs as the liquid passes through the four sets of holes downstream of the shutoff seating surfaces. As a result, the seating surfaces are normally not worn away by throttling control action (unless throttling at very nearly closed for a long time). Also, the throttling areas are not required to have the superior surface condition otherwise needed by seating surfaces for tight shutoff.

In conventional staged-trim designs, cavitation usually does not exist until the final stage. Figure 4 illustrates

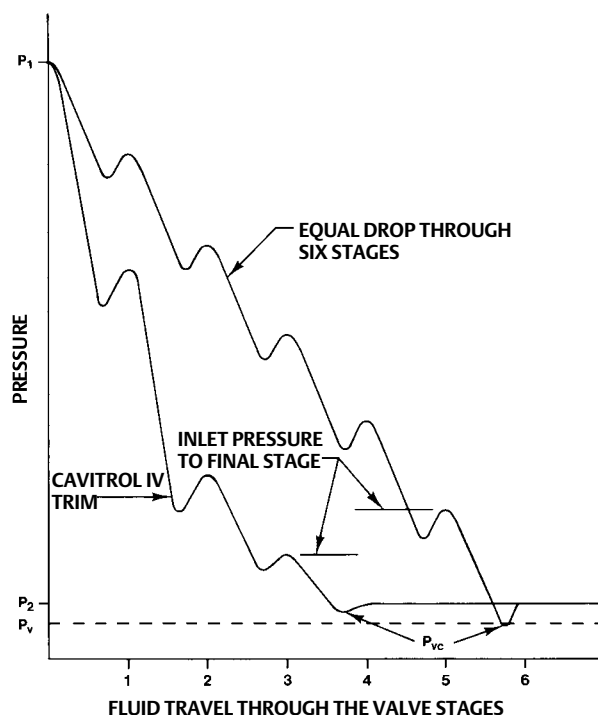
why this happens. As shown, the greater the pressure drop through the final stage, the lower the vena contracta pressure ( $P_{vc}$ ). If  $P_{vc}$  is less than or equal to  $P_v$ , and  $P_2$  is greater than  $P_v$ , then cavitation will result.

The CAV4 valve avoids this by means of its unique expanding flow area design. Each of the four Cavitrol IV trim stages has a successively larger flow area. The result is very efficient operation because more than 90 percent of the overall pressure drop is taken in the first three stages where there is low risk of bubble formation.

Consequently, a relatively low inlet pressure to the final stage is achieved. Figure 4 also compares the pressure drop pattern through the four stages in the expanding area Cavitrol IV design with a pattern representing a six-stage trim design with each stage taking an equal portion of the total pressure drop. As can be seen, the inlet pressure to the last stage of Cavitrol IV trim is always less than the inlet pressure to the sixth stage of an equal-drop cage. Therefore the  $P_{vc}$  of the Cavitrol IV cage remains higher than the  $P_{vc}$  of an equal-drop cage.

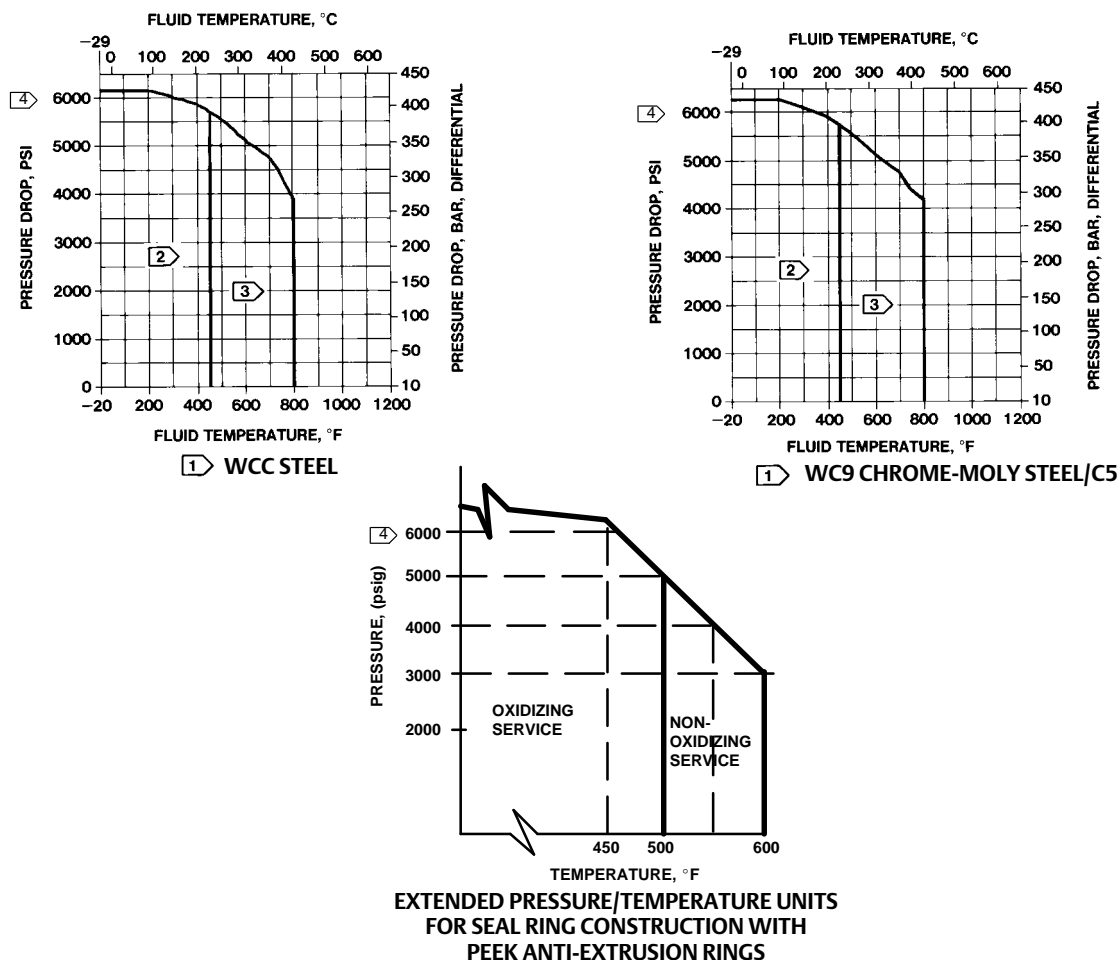
To determine if the CAV4 valve with Cavitrol IV trim should be used, contact your [Emerson sales office](#).

Figure 4. Staged Pressure Drop Patterns



A2149-1

Figure 5. Pressure Drop/Temperature Capabilities



B1605-1

Notes:

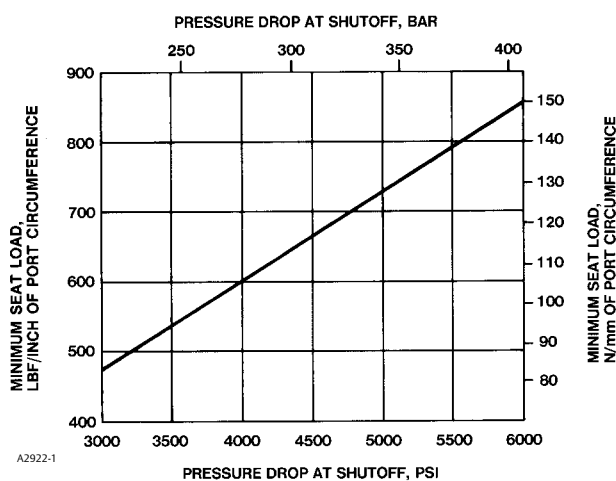
- ① Do not exceed the maximum pressure and temperature for the class rating of the body material.
- ② For all constructions.
- ③ For only stem balanced and piston ring constructions.
- ④ Maximum trim pressure drop is 414 bar (6000 psi) for linear trim and 310 bar (4500 psi) for approximate linear trim.

## Installation

The CAV4 valve with Cavitrol IV trim must be installed with the actuator mounted vertically above the valve body. Nonvertical positions may cause uneven trim wear and decrease trim life. Flow through the valve body must be in the direction indicated by the flow arrow on the valve. For long service life and effective operation, the flowing media should be clean.

Dimensions are shown in figure 7.

Figure 6. Recommended Seat Load Force for All Constructions



## Ordering Information

When ordering, specify:

### Application Information

1. Process liquid—State particle size and type of entrained impurities, if any

2. Specific gravity of liquid
3. Temperature and vapor pressure of liquid
4. Critical pressure
5. Range of flowing inlet pressures
6. Maximum outlet pressure
7. Pressure drops
  - a. Range of flowing pressure drops
  - b. Maximum at shutoff
8. Flow rates
  - a. Minimum controlled flow
  - b. Normal flow
  - c. Maximum flow
9. Required  $C_v$
10. Line size and schedule
11. Angle, globe or offset globe valve body

## Valve Information

To determine what information is needed for ordering the valve and trim, refer to the specifications. Review the description at the right of each specification or in the referenced tables, figures, and bulletins, and indicate the desired choice wherever there is a selection to be made.

## Actuator and Accessory Information

Select the specific actuator and accessories from the appropriate bulletins. Piston or diaphragm actuators may be used. Specify any additional ordering information as required from actuator or accessory bulletins.

Table 5. Capacities for CAV4 Valve Bodies

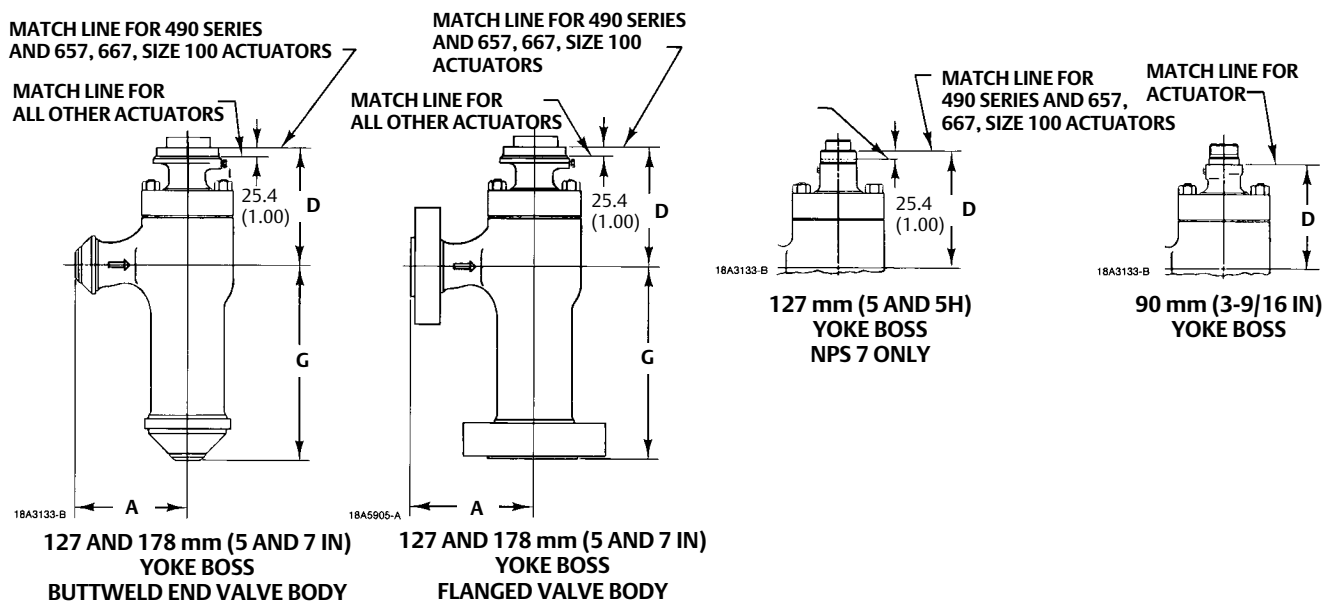
VALVE SIZE, NPS	FLOW CHARACTERISTIC	BODY TYPE	AVAILABLE CAPACITIES	
			Min Cv	Max Cv
2	Linear	Globe	0.01 0.01 0.01	1.1 1.6 2.9
	Linear Characterized	Angle	4.6 4.6	8.25 11.3
3	Linear Characterized	Angle	0.65 0.65	14.6 24.0
4	Linear Characterized	Angle	0.81 0.81	21.9 38.2
6	Linear Characterized	Angle	1.30 1.30	55.6 89.1

Table 6. Dimensions

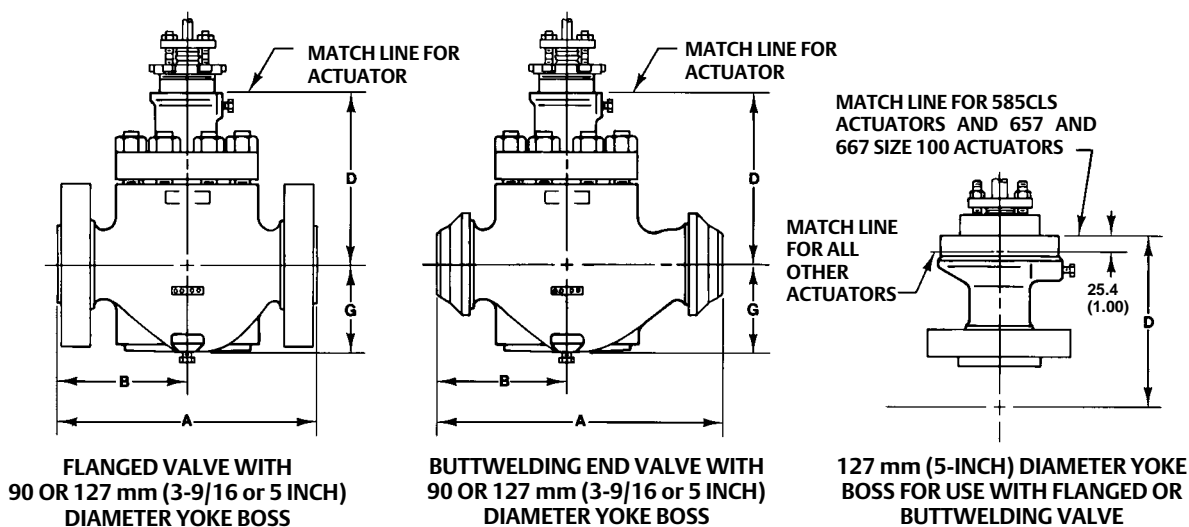
VALVE SIZE, NPS	BODY TYPE	PRESSURE CLASS	END CONNECTION CL2500 RF/RTJ <sup>(1)</sup>	A		G		D YOKE BOSS DIAMETER, mm (INCH)							
				mm	Inch	mm	Inch	90 (3-9/16)		127 (5)		127 (5H)		178 (7)	
								mm	Inch	mm	Inch	mm	Inch	mm	Inch
2	Globe	CL1500	BWE	375	14.75	109	4.31	458	18.03	521	20.53	---	---	---	---
			RF	375	14.75	109	4.31	458	18.03	521	20.53	---	---	---	---
			RTJ	378	14.88	109	4.31	458	18.03	521	20.53	---	---	---	---
	Globe	CL2500	BWE	400	15.75	108	4.25	505	19.88	538	21.19	---	---	---	---
			RF	400	15.75	108	4.25	505	19.88	538	21.19	---	---	---	---
			RTJ	403	15.88	108	4.25	505	19.88	538	21.19	---	---	---	---
	Angle	CL2500	BWE	249	9.81	406	16.00	324	12.75	360	14.19	---	---	---	---
			RF	249	9.81	406	16.00	324	12.75	360	14.19	---	---	---	---
			RTJ	251	9.87	408	16.06	324	12.75	360	14.19	---	---	---	---
3	Angle	CL2500	BWE	256	10.06	552	21.75	324	12.75	---	---	---	---	---	---
4	Angle	CL2500	BWE	344	13.56	618	24.31	430	16.94	454	17.88	---	---	454	17.88
			RF	344	13.56	618	24.31	430	16.94	454	17.88	---	---	454	17.88
			RTJ	349	13.75	622	24.50	430	16.94	454	17.88	---	---	454	17.88
6	Angle	CL2500	BWE	457	18.00	1038	40.88	---	---	432	17.00	432	17.00	---	---
			RF	457	18.00	1038	40.88	---	---	432	17.00	432	17.00	---	---
			RTJ	464	18.25	1045	41.13	---	---	432	17.00	432	17.00	---	---

1. BWE—butt weld end; RF—raised flange; RTJ—ring type joint.

Figure 7. Dimensions (See table 6)



B1607-1



A2719-4 / IL

mm  
(INCHES)

Note:  
For dimensions of valves with PN (or other) end connections, consult your [Emerson sales office](#).



## Product Bulletin

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**CAV4 Valve**  
D101497X012

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