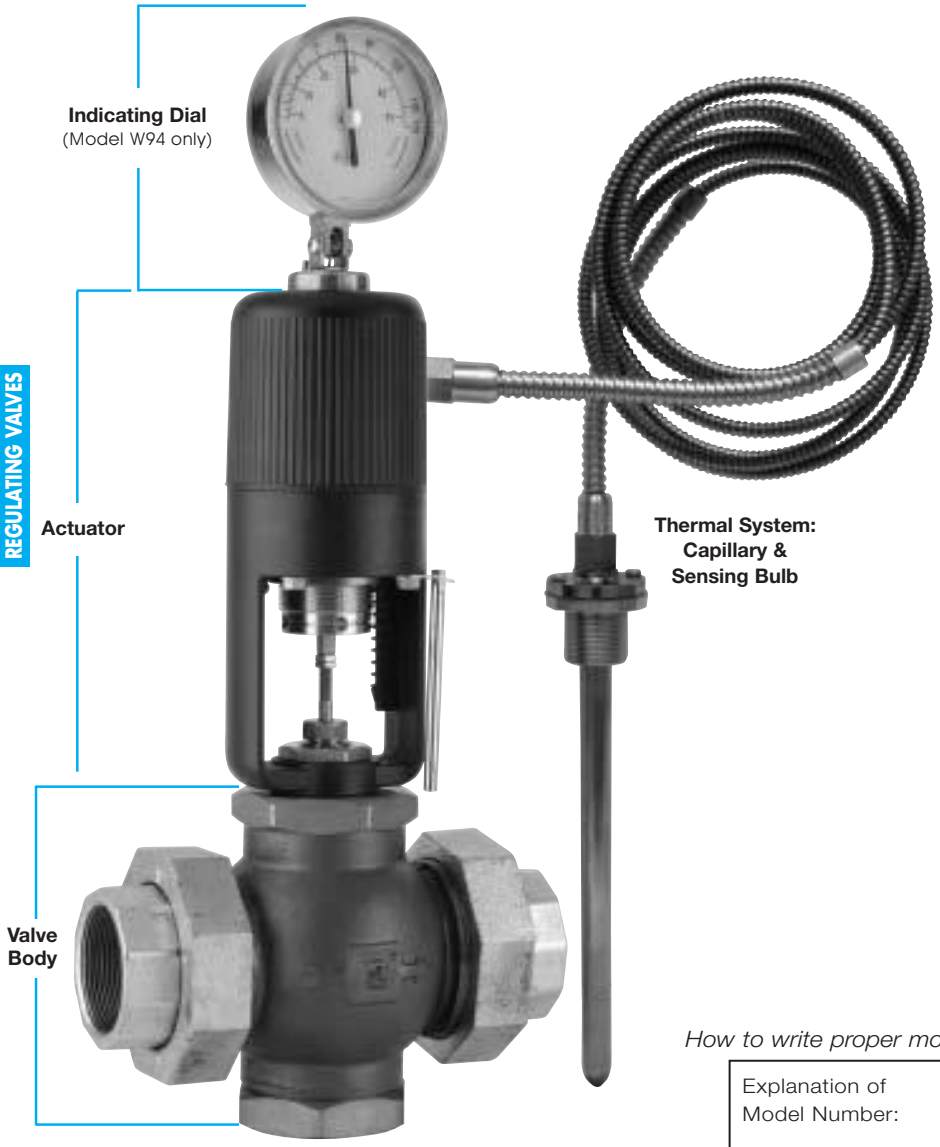
W91/W94 Series

Self-Operated Temperature Regulators



- **Self-Operating Design**
- **Indicating & Non-Indicating Models Available**
- **Heavy Duty Die Cast Aluminum Housing**
- **1/2" thru 4" Valve Sizes**
- **Fully Enclosed Bellows**
- **Internal Overrange protection**

The **W91 & W94** Self-Operating Temperature Regulators are the preferred choice of original equipment manufacturers, mechanical contractors and specifying engineers. These regulators require no external power source and are ideal for regulating the temperature of tanks, process streams and various types of industrial equipment. The Actuator is noted for its rugged die-cast aluminum housing, fully enclosed bellows assembly and internal overrange protection.

- Model **W91** (without indicating dial) features a lower profile and should be specified where space constraints may be an issue.
- Model **W94** (with indicating dial) will allow the operator to verify the process temperature and to aid in temperature adjustment.

Thermowells:
For applications in which the process media may be corrosive or contained under pressure, the use of a thermowell is required to prevent damage to the sensing bulb. A thermowell will also facilitate the removal of the sensing bulb and thermal system from the operating process.

How to write proper model number:

Explanation of Model Number:	W91	06	08	S15	175-13
	model	temp. range	cap. length	bulb type	valve body
Model Number:	W910608S15175-13				

HOW TO ORDER

Models	Temperature Range	Capillary Length	Bulb	Valve Body Selection
W91 Non-Indicating **W94** Indicating Dial	**01 – 14** Refer to Temperature Range Chart	**08** 8 Feet (std) **12** 12 Feet **16** 16 Feet **20** 20 Feet **24** 24 Feet	**S15** (brass bulb) (standard) **S16** (stainless bulb)	Refer to Valve Body Section *(Omit this selection if purchasing Actuator only)*

Note: Thermowells are ordered separately.
See page 175 for model numbers & lengths.

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W91/W94 Series

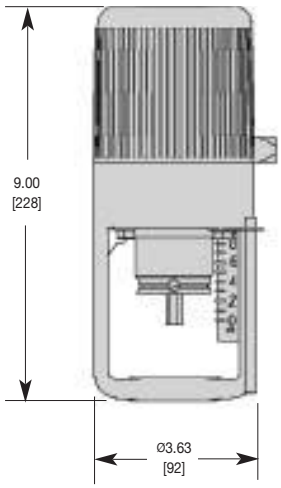
Self-Operated Temperature Regulators

Model	**W91/W94**
Service	**Water, Steam, Other Liquids**
Sizes	**1/2"– 4"**
Connections	**Threaded, Union Ends, 125# FLG** **250# FLG (optional)**
Body Material	**1/2" – 1 1/2"** **Bronze/Stainless Steel** **2"** **Cast Iron** (Direct-acting) **2"** **Bronze** (Reverse-acting) **2 1/2" – 4"** **Cast Iron**
Seat Material	**Stainless Steel**
Max. Inlet Pressure	**250 PSIG**

Dimensions: inches [mm]

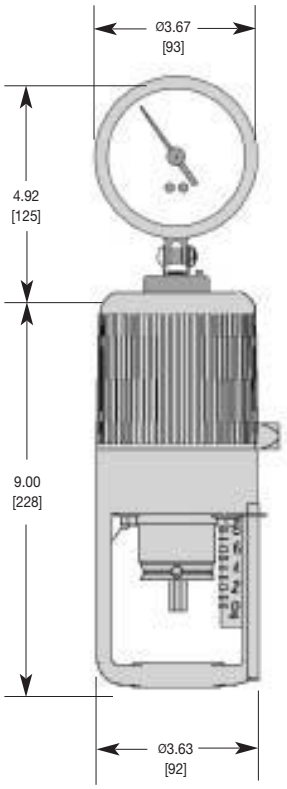
W91

Non-Indicating Actuator



W94

Indicating Actuator



Specifications

Actuator Models

W91 - Non-Indicating
W94 - Indicating Dial

Dial Thermometer
3 1/2" dial, stainless steel case, swivel and angle adjustment (Model W94 only)

Housing
Die cast aluminum, epoxy powder coated blue finish

Bellows
High pressure brass, corrosion resistant, tin plated finish

Overrange Protection
Upper range limit +100°F for temporary situations

Approximate Shipping Weight

Actuator
W91 6.0 lbs [2.7 kg]
W94 6.6 lbs [3.0 kg]

Valve
See Valve Selection tables

W91/W94 Series

Self-Operated Temperature Regulators

Temperature Range Chart

W91 & W94 Actuators

Range Code	Nominal Range		Recommended Working Span *	
01	20 to 70 °F	-10 to 20 °C	40 to 65 °F	5 to 20 °C
02*	40 to 90 °F	5 to 30 °C	65 to 85 °F	20 to 30 °C
03	30 to 115 °F	0 to 45 °C	85 to 110 °F	30 to 45 °C
04	50 to 140 °F	10 to 60 °C	110 to 135 °F	45 to 60 °C
05	75 to 165 °F	25 to 70 °C	135 to 160 °F	60 to 70 °C
06	105 to 195 °F	40 to 90 °C	160 to 190 °F	70 to 90 °C
07	125 to 215 °F	55 to 100 °C	190 to 210 °F	90 to 100 °C
09	155 to 250 °F	70 to 120 °C	210 to 245 °F	100 to 120 °C
10	200 to 280 °F	95 to 135 °C	245 to 275 °F	120 to 135 °C
11	225 to 315 °F	110 to 155 °C	275 to 310 °F	135 to 155 °C
12	255 to 370 °F	125 to 185 °C	305 to 365 °F	155 to 185 °C
13	295 to 420 °F	145 to 215 °C	365 to 415 °F	185 to 215 °C
14	310 to 440 °F	155 to 225 °C	415 to 435 °F	215 to 225 °C

* The recommended working span typically falls within the upper third of the nominal range.

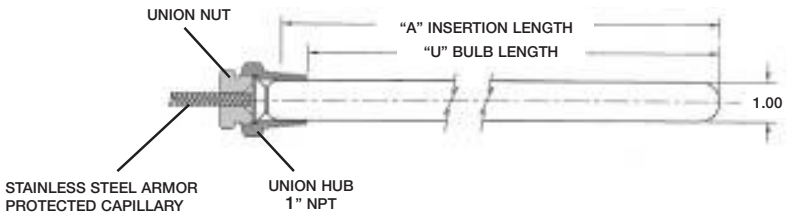
Bulb & Capillary Style

ORDER CODE	Connection Style & Material	Bulb Material	Capillary Tubing Material	Capillary Length in Ft.	8, 12, 16	20	24
S15	**Brass** Union Hub	**Copper**	Copper with Stainless Steel Spiral Armor	**A**	13"	16"	20"
				U	12.25"	15.25"	19.25"
S16	**Stainless Steel** Union Hub	**Stainless Steel**	Stainless Steel with Stainless Steel Spiral Armor	**A**	13"	16"	20"
				U	12.25"	15.25"	19.25"

Other Options available. Consult Factory.

Bulb Installation: (refer to diagram below)

The 1" NPT Union Hub is not physically attached to the bulb. The 1" NPT Union Hub is threaded into a tank or vessel. The bulb slides thru the 1" NPT Union Hub and is held in place and sealed with the Union Nut, which freely turns on the stainless steel armor protected capillary. When using a Thermowell, the 1" NPT Union Hub is discarded and the Union Nut threads into the Thermowell.



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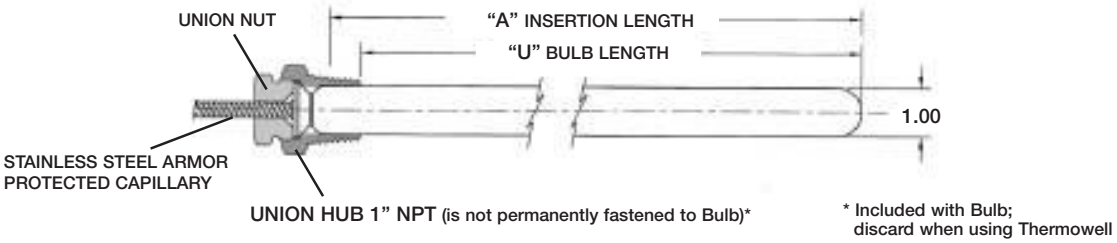
W91/W94 Series

Self-Operated Temperature Regulators

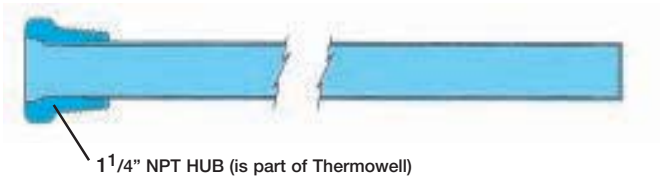
Thermowell Selection

Dimensions (inches)

BULB

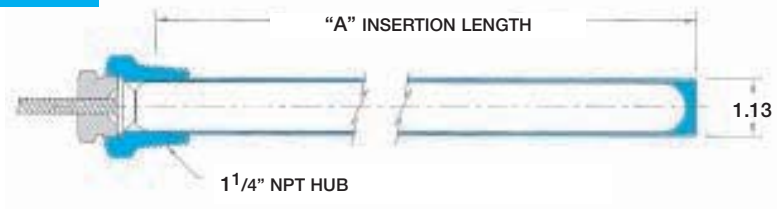


THERMOWELL



Note: to ensure minimum response time, Heat Transfer Paste should be applied to the sensing portion of the bulb before installation.

BULB inside THERMOWELL



For applications in which the process media may be corrosive or contained under pressure, the use of a thermowell is required to prevent damage to the sensing bulb. A thermowell will also facilitate the removal of the sensing bulb and thermal system from the operating process. Because the sensing bulb is isolated from the fluid, this allows the sensing bulb to be removed without having to drain the liquid below the bulb insertion point.

THERMOWELLS - Model Numbers & Lengths

Brass Model No.	Stainless Steel Model No.	Nominal Length	"A" INSERTION LENGTH (in.)		Capillary Length in Feet
			BULB	THERMOWELL	
536-S2	**536-S6**	13"	12.25	13.00	8, 12 or 16
536-SE2	**536-SE6**	16"	15.25	16.00	20
536-WE2	**536-WE6**	20"	19.25	20.00	24

Notes: 1) Other connections and lengths may be available, consult factory.
2) External pressure rating on Brass is 500 PSI max.
3) External pressure rating on 316 SS is 1000 PSI max.

W91/W94 Series

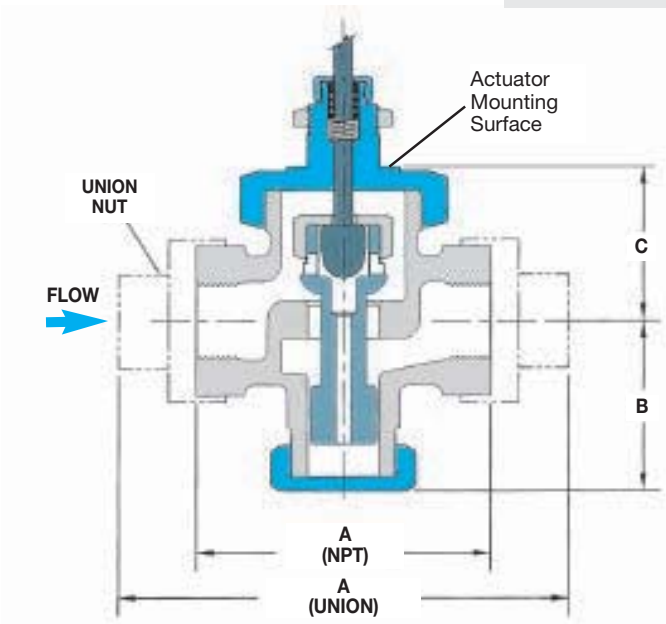
Single Seated Valve Bodies

HEATING

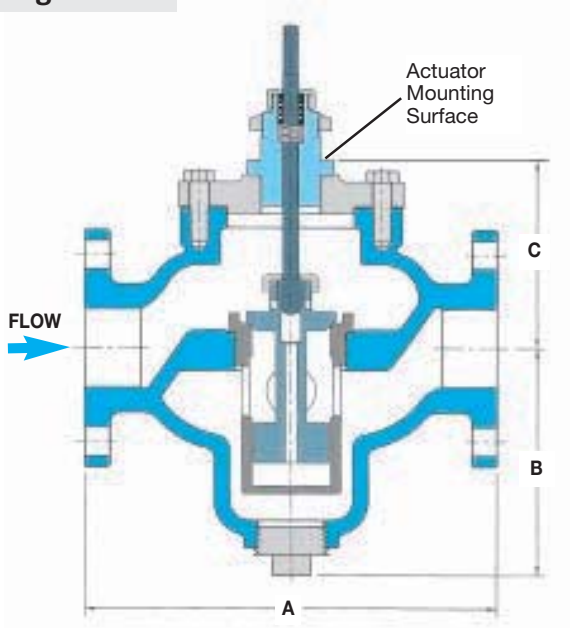
Single Seat • 1/2" – 4"

Dimensions in inches

Stem In-To-Close for Heating



THREADED & UNION



FLANGED

Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
1/2"- 1 1/2" Bronze/Stainless	Stainless Steel	Threaded or Malleable Iron Union Ends	125 PSI @ 450°F
2" Cast Iron	Stainless Steel	Threaded	250 PSI @ 450°F
2" - 4" Cast Iron	Stainless Steel	125# Flanged	125 PSI @ 450°F
		250# Flanged	250 PSI @ 450°F

Valve Body Selection

Valve Body Number (In-To-Close Heating) NPT	Union	Size Connection NPT	Capacity Cv	Maximum Close-Off Pressure (PSI ΔP)	Dimensions A Threaded	A 125# FLG	A 250# FLG	A Union	B	C	Approx. Ship. Wt. (lbs) [kg]
175-12-N	175-12-U	1/2"	3.2	250	4.125	x	x	6.50	2.375	2.12	14 [6.35]
175-13-N	175-13-U	3/4"	6.3	250	4.125	x	x	6.50	2.375	2.12	14 [6.35]
175-14-N	175-14-U	1"	10.8	200	4.125	x	x	7.00	2.375	2.12	14 [6.35]
175-15-N	175-15-U	1 1/4"	15.9	200	4.81	x	x	7.50	3.25	2.50	17 [7.7]
175-16-N	175-16-U	1 1/2"	22.4	200	5.19	x	x	8.00	3.50	2.69	18 [8.2]
175-17-N		2"	33.1	150	9.50	x	x	x	5.75	4.75	50 [22.7]
FLANGED 125#	250#			Valve Type Standard	Special						
175-17-125	175-17-250	2"	33.1	150	–	x	10.375	10.875	x	5.75	4.75	80 [36.3]
175-18-125	175-18-250	2 1/2"	47.5	65	150	x	10.625	11.25	x	7.00	5.00	96 [43.6]
175-19-125	175-19-250	3"	68.2	50	150	x	10.875	11.625	x	8.00	5.75	110 [49.9]
175-20-125	175-20-250	4"	109.5	40	150	x	10.50	13.125	x	8.75	6.50	160 [72.6]

Note: For 2 1/2" - 4" sizes, consult factory for proper actuators.

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W91/W94 Series

Capacity Chart for Single Seated Valves

CAPACITIES – *Steam (lbs/hr)* — SINGLE SEATED VALVES

Inlet Pressure (PSIG)	Size & Valve Body Number								
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
	175-12	175-13	175-14	175-15	175-16	175-17	175-18	175-19	175-20
1	91	180	309	454	640	946	1357	1949	3129
3	103	203	348	512	722	1066	1530	2197	3527
5	115	226	387	570	803	1187	1703	2445	3926
10	144	283	486	715	1007	1488	2135	3066	4922
15	173	341	584	859	1211	1789	2568	3686	5919
20	202	398	682	1004	1415	2090	3000	4307	6915
25	231	455	780	1149	1618	2392	3432	4928	7912
30	260	513	879	1294	1822	2693	3864	5548	8908
40	319	627	1075	1583	2230	3295	4729	6790	10,901
50	377	742	1272	1872	2638	3898	5593	8031	12,894
60	435	857	1468	2162	3045	4500	6458	9272	14,887
70	493	971	1665	2451	3453	5102	7322	10,513	16,880
80	552	1086	1861	2740	3861	5705	8187	11,755	18,873
90	610	1200	2058	3030	4268	6307	9051	12,996	20,866
100	668	1315	2255	3319	4676	6910	9916	14,237	22,859
125	814	1602	2746	4043	5695	8416	12,077	17,340	27,841
150	959	1888	3237	4766	6714	9922	14,238	20,443	32,823
175	1105	2175	3729	5490	7734				
200	1250	2462	4220	6213	8753				
250	1542	3035							

Notes: 1) For reduced-port 1/2" valves, consult factory. 2) All steam capacities based on Critical Drop (Choked Flow).

Note: Verify that Maximum Close-Off Pressure for 2" - 4" models does not exceed max rating for selected Valve Body Number and Type. (Refer to Valve Body Number chart on previous page)

CAPACITIES – *Water (GPM)* — SINGLE SEATED VALVES

Pressure (PSI ΔP)	Size & Valve Body Number								
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
	175W-12	175W-13	175W-14	175W-15	175W-16	175W-17	175W-18	175W-19	175W-20
1	3.2	6.3	11	16	22	33	48	68	110
3	5.5	11	19	28	39	57	82	118	190
5	7.2	14	24	36	50	74	106	152	245
10	10	20	34	50	71	105	150	216	346
15	12	24	42	62	87	128	184	264	424
20	14	28	48	71	100	148	212	305	490
25	16	32	54	80	112	166	238	341	548
30	18	35	59	87	123	181	260	374	600
40	20	40	68	101	142	209	300	431	693
50	23	45	76	112	158	234	336	482	774
60	25	49	84	123	174	256	368	528	848
70	27	53	90	133	187	277	397	571	916
80	29	56	97	142	200	296	425	610	979
90	30	60	102	151	213	314	451	647	1039
100	32	63	108	159	224	331	475	682	1095
125	36	70	121	178	250	370	531	762	1224
150	39	77	132	195	274	405	582	835	1341
175	42	83	143	210	296				
200	45	89	153	225	317				
250	51	100							

Note: When **175** Type Single Seated Valves are used with water, add **W** to the Valve Body Number.

Example:
175-17-N becomes **175W-17-N**

Note: Verify that Maximum Close-Off Pressure for 2" - 4" models does not exceed max rating for selected Valve Body Number and Type. (Refer to Valve Body Number chart on previous page)

W91/W94 Series

Steam Required for Heating Water

Steam flow required through a temperature regulator (lbs/hr) to heat a specified number of gallons of water per hour (gal/hr)

TABLE 1 - Steam Flow Required in Pounds Per Hour (lbs/hr)

Temp Increase (˚F)	*Gallons of Water per Hour To Be Heated*												Temp Increase (˚F)
	25	50	100	200	300	500	700	1000	2000	4000	10,000	20,000	
5°	1	2	4	8	12	21	29	41	83	166	415	830	5°
10°	2	4	8	16	25	41	58	83	166	332	830	1660	10°
15°	3	6	12	25	37	62	87	124	249	498	1245	2490	15°
20°	4	8	17	33	50	83	116	166	332	664	1660	3320	20°
25°	5	10	20	42	62	104	145	207	415	830	2075	4150	25°
30°	6	12	25	50	75	124	174	249	498	996	2490	4980	30°
40°	8	16	33	66	100	166	232	332	664	1328	3320	6640	40°
50°	10	21	42	83	124	207	290	415	830	1660	4150	8300	50°
60°	12	25	50	100	149	249	348	498	996	1992	4980	9960	60°
70°	15	29	58	116	174	290	407	581	1162	2324	5810	11,620	70°
80°	17	33	67	133	199	332	465	664	1328	2656	6640	13,280	80°
90°	19	38	75	149	224	373	523	747	1494	2988	7470	14,940	90°
100°	21	42	83	166	249	415	581	830	1660	3320	8300	16,600	100°
115°	24	48	95	191	286	477	668	955	1909	3818	9544	19,088	115°
130°	27	54	108	216	324	539	755	1079	2158	4316	10,790	21,580	130°
145°	30	60	120	241	361	601	842	1200	2400	4812	12,030	24,060	145°
160°	33	66	133	266	398	664	929	1328	2656	5312	13,280	26,560	160°
175°	36	72	145	290	436	726	1017	1452	2900	5810	14,524	29,048	175°
200°	41	83	166	332	498	830	1162	1660	3320	6640	16,600	33,200	200°
225°	47	94	187	374	560	934	1307	1867	3735	7470	18,680	37,360	225°
250°	52	104	207	415	622	1037	1452	2075	4150	8300	20,750	41,500	250°

HEATING WATER: The amount of steam required to heat water can be found using chart above.
Example: **To heat 1000 gallons per hour of water from 40˚F to 140˚F (Temp. increase 100˚F) requires 830 lbs/hr of steam.**

HEATING FUEL OIL: The amount of steam required to heat fuel oil is half of that to heat water. Use half the value found in chart above.
Example: **To heat 1000 gallons per hour of fuel oil from 40˚F to 140˚F (Temp. increase 100˚F) requires 415 lbs/hr of steam.**

CAPACITY FORMULAS FOR STEAM LOADS

When BTU Load is Known	Capacity of steam required (lbs/hr)	= BTU / 1000
When Square Feet Equivalent Direct Radiation (EDR) is Known	Capacity of steam required (lbs/hr)	= Sq. ft. of EDR / 4
When Heating Water with Steam	Capacity of steam required (lbs/hr)	= GPM x Temp Rise °F / 2
When Heating Fuel Oil with Steam	Capacity of steam required (lbs/hr)	= GPM x Temp Rise °F / 4
When Heating Air with Steam Coils	Capacity of steam required (lbs/hr)	= CFM x Temp Rise °F / 900

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W91/W94 Series

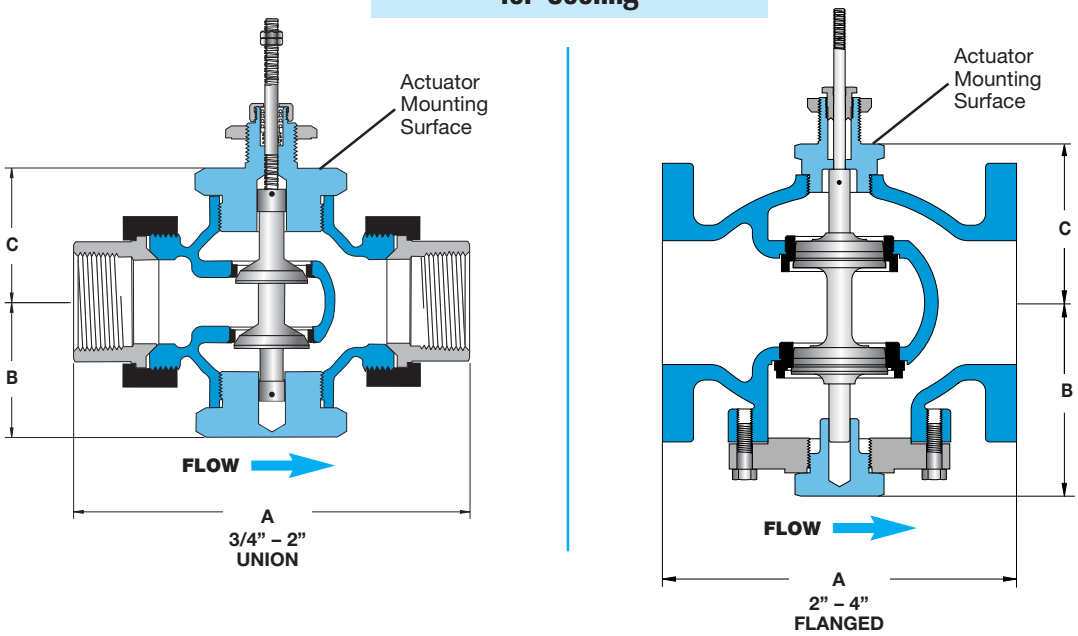
COOLING

Double Seated Valve Bodies

Dimensions in inches [mm]

Double Seat • 3/4" – 4"

Stem In-To-Open for Cooling



Specifications

Body Material	Trim Material	Trim Style Connection	Pressure & Temperature Rating
3/4" - 2" Bronze	Stainless Steel	Threaded with Malleable Iron Union Ends	250 PSI @ 410°F (210°C)
2 1/2" - 4" Cast Iron	Stainless Steel	125# Flanged	125 PSI @ 350°F (149°C)

Valve Body Selection – Threaded

Valve Body Number (In-To-Open Cooling)	Size		Capacity C_V	Maximum Close-Off Pressure (PSI ΔP)	Dimensions			Approximate Shipping Wt. (lbs) [kg]
	Connection (NPT)	Nominal Port			A	B	C	
A24	3/4	3/4"	8	250	5.6 [142]	2.3 [58]	2.3 [58]	5.0 lbs [2.25 kg]
A33	1	1"	12	250	6.0 [152]	2.3 [58]	2.3 [58]	6.1 lbs [2.75 kg]
A44	1 1/4	1 1/4"	21	250	7.2 [183]	2.6 [66]	2.6 [66]	10.1 lbs [4.55 kg]
A55	1 1/2	1 1/2"	30	250	7.7 [196]	2.6 [66]	2.6 [66]	11.1 lbs [5.00 kg]
A66	2	2"	47	250	8.6 [218]	3.1 [79]	3.1 [79]	17.0 lbs [7.65 kg]

Valve Body Selection – Flanged

Valve Body Number (In-To-Open Cooling)	Size		Capacity C_V	Maximum Close-Off Pressure (PSI ΔP)	Dimensions			Approximate Shipping Wt. (lbs) [kg]
	Connection	Nominal Port			A	B	C	
B74	2 1/2"	2 1/2"	69	65	7.8 [198]	4.8 [122]	5.4 [137]	45 lbs [20 kg]
B79	3"	3"	90	50	9.0 [229]	5.0 [127]	5.6 [142]	70 lbs [32 kg]
B84	4"	4"	196	40	11.4 [290]	6.3 [160]	6.5 [165]	100 lbs [45 kg]

W91/W94 Series

Capacity Chart for Double Seated Valves

COOLING

CAPACITIES – *Water (GPM)* **DOUBLE SEATED VALVES**

Pressure Drop (PSI ΔP)	Size, Valve Body Number & Coefficient (Cv)							
	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
	A24 ITO Cv = 8	A33 ITO Cv = 12	A44 ITO Cv = 21	A55 ITO Cv = 30	A66 ITO Cv = 47	B74 ITO Cv = 69	B79 ITO Cv = 90	B84 ITO Cv = 196
1	8	12	21	30	47	69	90	196
3	14	21	36	52	81	120	156	339
5	18	27	47	67	105	154	201	438
10	25	38	66	95	149	218	285	620
15	31	46	81	116	182	267	349	759
20	36	54	94	134	210	309	402	877
25	40	60	105	150	235	345	450	980
30	44	66	115	164	257	378	493	1074
40	51	76	133	190	297	436	569	1240
50	57	85	148	212	332	488	636	
60	62	93	163	232	364			
70	67	100	176	251	393			
80	72	107	188	268	420			
90	76	114	199	285	446			
100	80	120	210	300	470			
125	89	134	235	335	525			
150	98	147	257	367	576			
175	106	159	278	397	622			
200	113	170	297	424	665			
225	120	180	315	450	705			
250	126	190	332	474	743			

ITO = In-to-Open

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W91/W94 Series

BRONZE

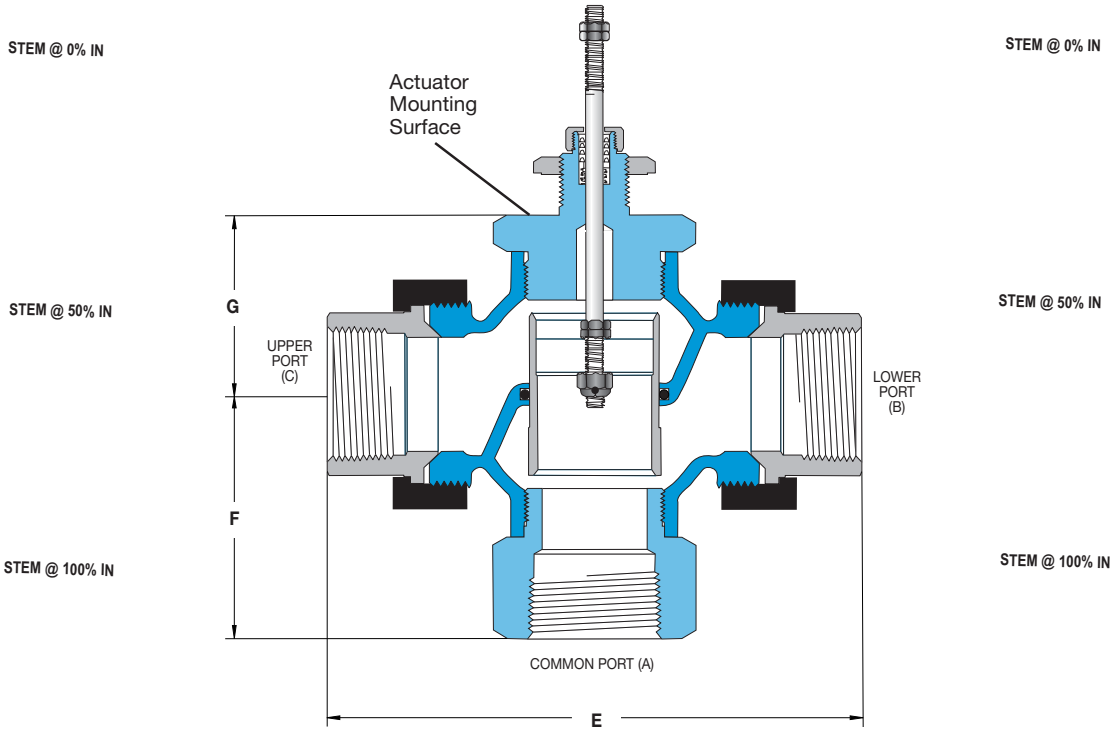
3-Way Valve Bodies

Dimensions in inches [mm]

3-Way • 1/2" – 2"

for Mixing or Diverting

MIXING FLOW DIAGRAM **DIVERTING FLOW DIAGRAM**



CAUTION: 3-Way Valves are not designed for use in steam applications.
To properly control the mixing of two flows, inlet pressures at ports B and C should be as equal as possible.

Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
Bronze	Bronze	Threaded with Malleable Iron Union Ends	250 PSI @ 300°F (149°C)

Valve Body Selection

Valve Body Number	Size		Capacity	Maximum Close-Off Pressure	Dimensions			Approximate Shipping Wt.
	Connection (NPT)	Nominal Port	C_v	(PSI ΔP)	E	F	G	
A18	1/2"	1/2"	2.8	250	4.8 [122]	1.8 [46]	1.8 [46]	2.9 lbs [1.31 kg]
A25	3/4"	3/4"	5.6	250	5.6 [142]	2.3 [58]	2.3 [58]	4.7 lbs [2.12 kg]
A34	1"	1"	8.4	250	6.0 [152]	2.3 [58]	2.3 [58]	5.7 lbs [2.57 kg]
A45	1 1/4"	1 1/4"	15	250	7.2 [183]	2.8 [71]	2.6 [66]	9.5 lbs [4.28 kg]
A56	1 1/2"	1 1/2"	21	250	7.7 [196]	3.5 [89]	2.6 [66]	11.1 lbs [5.00 kg]
A67	2"	2"	33	250	8.6 [218]	4.1 [104]	3.1 [79]	16.7 lbs [7.55 kg]

W91/W94 Series

3-Way Valve Bodies

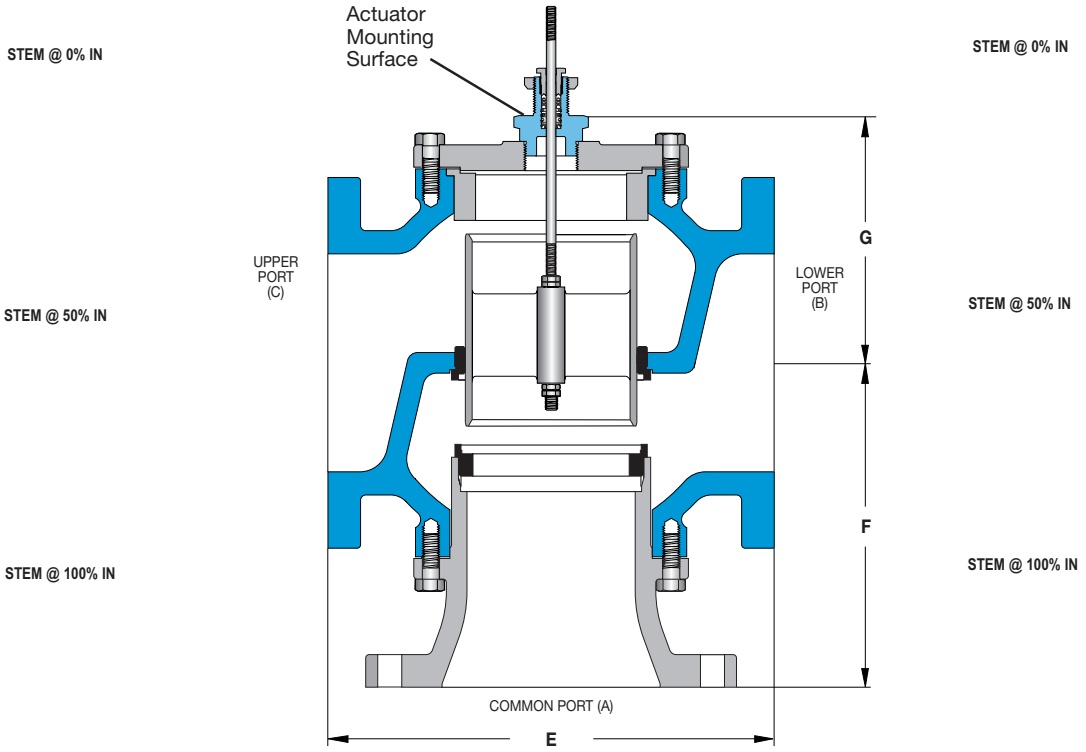
CAST IRON

3-Way • 2½" – 4"

Dimensions in inches [mm]

for Mixing or Diverting

MIXING FLOW DIAGRAM



DIVERTING FLOW DIAGRAM

CAUTION: 3-Way Valves are not designed for use in steam applications.
To properly control the mixing of two flows, inlet pressures at ports B and C should be as equal as possible.

Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
Cast Iron	Bronze	125# Flanged	125 PSI @ 300°F (149°C)

Valve Body Selection

Valve Body Number	Size		Capacity C_v	Maximum Close-Off Pressure (PSI ΔP)	Dimensions			Approximate Shipping Wt.
	Connection	Nominal Port			E	F	G	
B75	2½"	2½"	58	125	9.0 [229]	7.1 [180]	5.2 [132]	62 lbs [28 kg]
B80	3"	3"	72	125	10.0 [254]	8.0 [203]	6.0 [152]	80 lbs [36 kg]
B85	4"	4"	102	125	13.0 [330]	10.0 [254]	6.9 [175]	140 lbs [64 kg]

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W91/W94 Series

Capacity Chart for 3-Way Valves

CAPACITIES – *Water (GPM)* **3-WAY VALVES**

Pressure Drop (PSI ΔP)	Size, Valve Body Number & Coefficient (Cv)								
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
	A18 Cv = 2.8	A25 Cv = 5.6	A34 Cv = 8.4	A45 Cv = 15	A56 Cv = 21	A67 Cv = 33	B75 Cv = 58	B80 Cv = 72	B85 Cv = 102
1	2.8	5.6	8.4	15	21	33	58	72	102
3	4.8	10	15	26	36	57	100	125	177
5	6.3	13	19	34	47	74	130	161	228
10	8.9	18	27	47	66	104	183	228	323
15	11	22	33	58	81	128	225	279	395
20	13	25	38	67	94	148	259	322	456
25	14	28	42	75	105	165	290	360	510
30	15	31	46	82	115	181	318	394	559
40	18	35	53	95	133	209	367	455	645
50	20	40	59	106	148	233	410	509	721
60	22	43	65	116	163	256	449	558	790
70	23	47	70	125	176	276	485	602	853
80	25	50	75	134	188	295	519	644	912
90	27	53	80	142	199	313	550	683	968
100	28	56	84	150	210	330	580	720	1020
125	31	63	94	168	235	369	648	805	1140
150	34	69	103	184	257	404			
175	37	74	111	198	278	437			
200	40	79	119	212	297	467			
225	42	84	126	225	315	495			
250	44	89	133	237	332	522			

Note: Oil service or high temperature service requires special O-ring.