

Direct-Operated Regulators Temperature Regulators

W91/W94 Series

For **Heating & Cooling**

Model	W91 (No Indicating Dial) W94 (Temperature Indicating Dial)
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



TEMPERATURE Regulators

Typical Applications

The **W91 & W94** Self-Operating Temperature Regulators are the preferred choice of original equipment manufacturers, mechanical contractors and specifying engineers. They 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 over-temperature range protection.

Model W91

Non-Indicating (without indicating dial) features a lower profile and should be specified where space constraints may be an issue.

Model W94

Temperature Indicating (with indicating dial) will allow the operator to verify the process temperature and to aid in temperature adjustment.

Features

- Self-Operating (no external power source required)
- Temperature Indicating & Non-Indicating models available
- Heavy Duty Die-Cast Aluminum Housing
- 1/2" thru 4" Valve Sizes
- Fully Enclosed Bellows
- Temperature Over-range protection spring to protect thermal system

Specifications

Dial Thermometer:	3 1/2" dial, stainless steel case, swivel and angle adjustment (Model W94 only)
Housing:	Die-cast aluminum, epoxy powder coated grey finish
Bellows:	High-pressure brass, corrosion resistant, tin plated finish
Temperature Over-range Protection:	Protects Thermal System from damage up to 100°F over high limit of range

Temperature Regulator Valve Action

Application	Stem Action	Normal (Fail) Position
Heating	In-To-Close	Normally Open
Cooling	In-To-Open	Normally Closed

How to write proper model number:

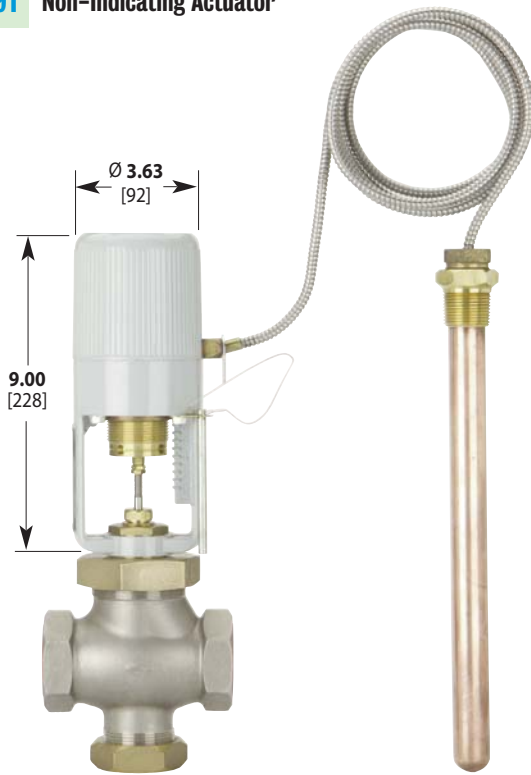
Explanation of Model Number:	W91 Model	06 Temp. Range	08 Cap. Length	S15 Bulb Type	H13N Valve Body
Model Number:	W91-06-08-S15-H13N				

Model Code Configuration

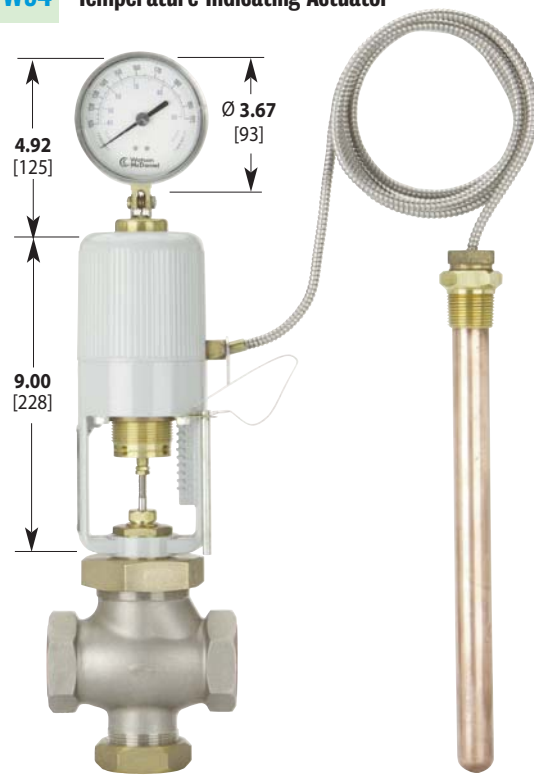
Models	Temperature Range	Capillary Length	Sensing Bulb	Valve Body Selection
W91 Non-Indicating	01 – 14 Refer to Temperature Range Chart	08 8 Feet (standard)	S15 Brass bulb (standard)	Refer to Valve Body Section <i>(Omit this selection if purchasing Actuator only)</i>
W94 Indicating Dial		12 12 Feet		
		16 16 Feet	S16 Stainless bulb	
		20 20 Feet		
		24 24 Feet		

Note: Thermowells are ordered separately. See Thermowell & Bulb Connections page.

W91 Non-Indicating Actuator



W94 Temperature Indicating Actuator



Dimensions: inches [mm]
Actuator Weight: 6 lbs.

TEMPERATURE
Regulators

Description of Working Span

The recommended working span typically falls within the upper third of the nominal range. Single-Seat In-To-Close, all Double-Seat, and all 3-Way valves have a recommended working span in this part of the nominal range. Using the valve in the recommended working span improves temperature response time of the system.

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

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

SENSING BULB & CAPILLARY Selection

Sensing Bulb Selection & Installation:

The sensing bulb and capillary are available in Copper (best heat transfer properties) or Stainless Steel (for corrosive applications). Copper has better heat transfer properties than stainless steel and should always be chosen for better temperature control unless used in corrosive service. The length of the sensing bulb is dependent upon the capillary length required (see chart). Longer capillary lengths require a longer length sensing bulb to operate the regulator. For installation, the Union Hub is threaded into a tank or piping system. The bulb slides through the Union Hub and is held in place by the Union Nut which spins freely around the armored capillary and threads into the Union Hub. The angled surface of the sensing bulb forms a metal-to-metal seal on the inner edge of the Union Hub to prevent leakage of the process fluid.

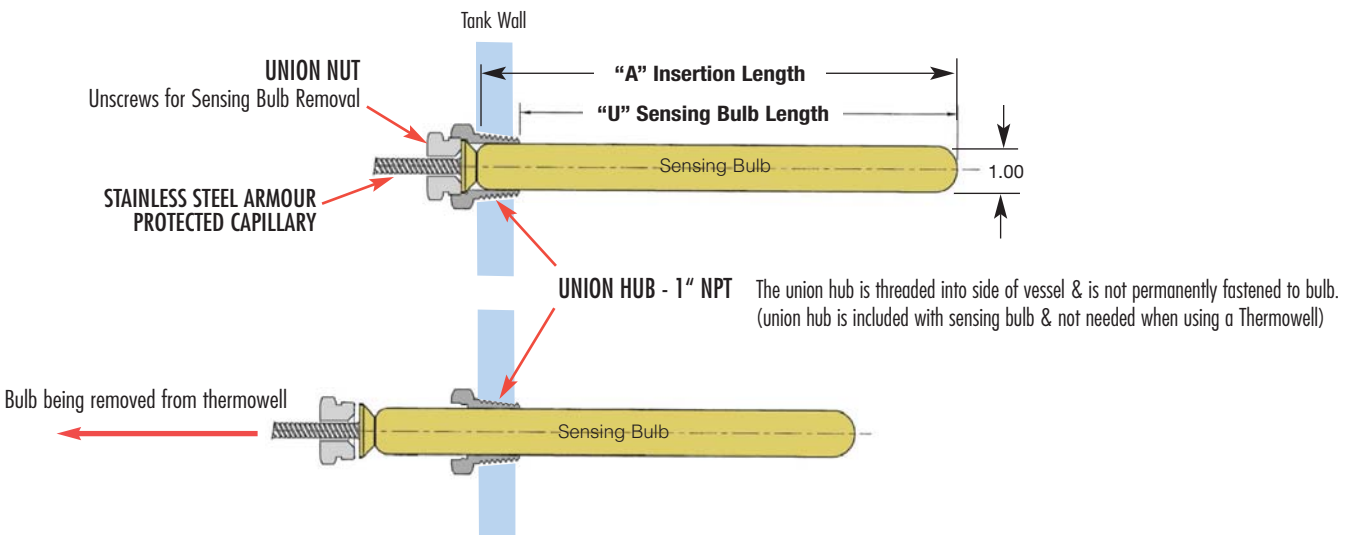
Thermowell Option (ordered separately)

A thermowell isolates the sensing bulb from the process fluid. It can be used to remove the sensing bulb while the system is filled with fluid or to protect the sensing bulb from corrosive liquids or excessive system pressures (see following page).

TEMPERATURE Regulators

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

Other Options available. Consult Factory.



SENSING BULB inside OPTIONAL THERMOWELL

Thermowell Option (ordered separately)

Thermowells isolate and protect the sensing bulb from the process fluid, and are available in either Brass (best heat transfer) or Stainless Steel (for corrosive applications). Thermowells allow for sensing bulb removal and replacement without having to drain liquid from the system. To maintain the best temperature control, always use a Copper Sensing bulb as opposed to a Stainless Steel sensing bulb. For corrosive applications, Stainless Steel thermowells (with a copper sensing bulb) can be used. Thermowells are also recommended for applications with excessive system pressures or extremely turbulent flow to protect the sensing bulb from damage.

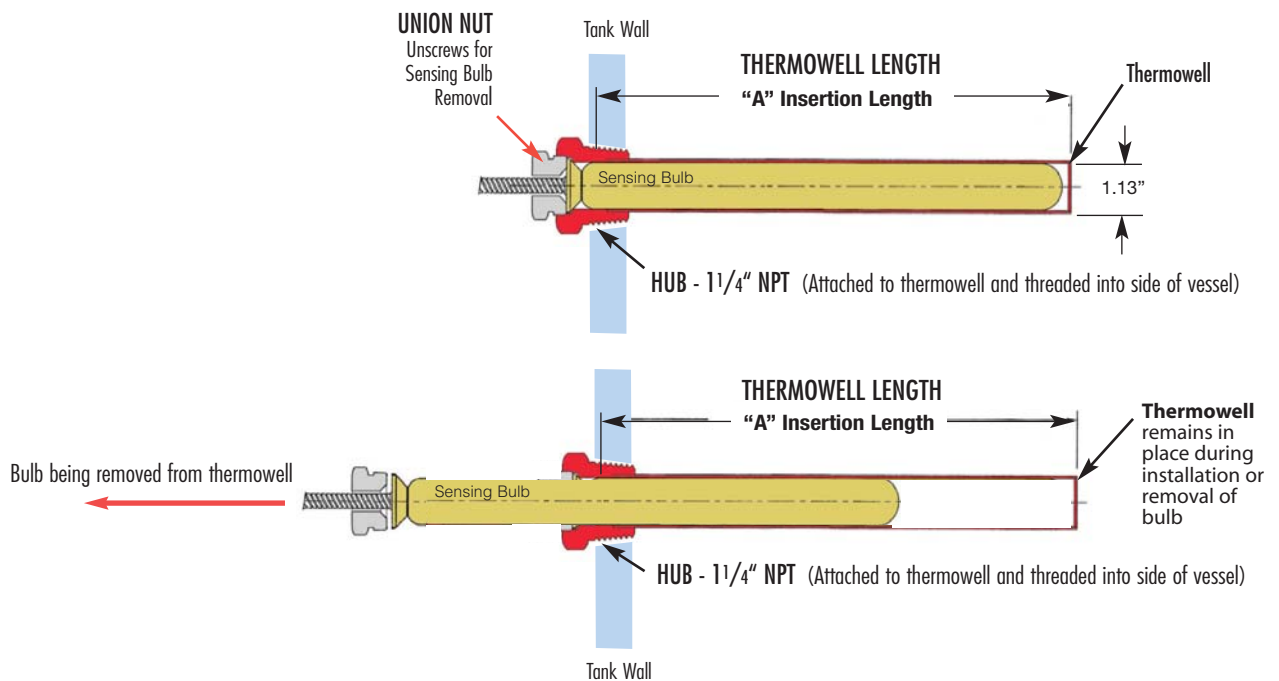
Thermowell Length must be selected based on the length of the sensing bulb. The sensing bulb length is based on the length of the Capillary used in the Thermal System. Longer capillary lengths require a longer sensing bulb to hold the additional actuator fluid inside the sensing bulb. Reference Sensing Bulb Chart for sensing bulb length.

THERMOWELLS - Model Numbers & Lengths

Brass Model Code	Stainless Steel Model Code	Nominal Length	"A" INSERTION LENGTH (in.)		Capillary Length (Ft.)
			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	24	

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

The Thermowell isolates the sensing bulb from the process liquid and allows for easy and safe removal of the sensing bulb. 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. For corrosive applications, use a stainless steel thermowell & copper sensing bulb. To ensure minimum response time, Heat Transfer Paste should be applied to the sensing bulb prior to installation into the thermowell.



TEMPERATURE Regulators

HEATING

Model Codes in Chart are for complete Temperature Regulators.
This includes the Valve Body and Thermal Actuator with standard copper bulb and 8 ft. capillary.



W91

Non-Indicating Type Actuator
with valve body

X = Temperature Range
08 = Capillary Length 8ft.
S15 = Copper Bulb

Connection		PMO (PSI)
1/2" NPT	Standard Body	W91-X-08S15-H12N 250
	with Integral Union	W91-X-08S15-H12U 250
3/4" NPT	Standard Body	W91-X-08S15-H13N 250
	with Integral Union	W91-X-08S15-H13U 250
1" NPT	Standard Body	W91-X-08S15-H14N 200
	with Integral Union	W91-X-08S15-H14U 200
1 1/4" NPT	Standard Body	W91-X-08S15-H15N 200
	with Integral Union	W91-X-08S15-H15U 200
1 1/2" NPT	Standard Body	W91-X-08S15-H16N 200
	with Integral Union	W91-X-08S15-H16U 200
2" NPT	Standard Body	W91-X-08S15-H17N 150
2"	*Flanged with Standard Actuator	W91-X-08S15-H17F125 150
2 1/2"		W91-X-08S15-H18F125 65
3"		W91-X-08S15-H19F125 50
4"		W91-X-08S15-H20F125 40
2 1/2"	*Flanged with High-Force Actuator	W91H-X-08S15-H18F125 150
3"		W91H-X-08S15-H19F125 150
4"		W91H-X-08S15-H20F125 150

W94

Indicating Type Actuator
with valve body

X = Temperature Range
08 = Capillary Length 8ft.
S15 = Copper Bulb

	PMO (PSI)	Weight (lbs)
W94-X-08S15-H12N	250	21
W94-X-08S15-H12U	250	21
W94-X-08S15-H13N	250	21
W94-X-08S15-H13U	250	21
W94-X-08S15-H14N	200	21
W94-X-08S15-H14U	200	21
W94-X-08S15-H15N	200	24
W94-X-08S15-H15U	200	24
W94-X-08S15-H16N	200	25
W94-X-08S15-H16U	200	25
W94-X-08S15-H17N	150	57
W94-X-08S15-H17F125	150	57
W94-X-08S15-H18F125	65	65
W94-X-08S15-H19F125	50	80
W94-X-08S15-H20F125	40	105
N/A	-	96
N/A	-	118
N/A	-	60

* 250# Flange available. Consult Factory. The Special High-Force Actuator will allow the valve to be operated at a higher operating pressure.

Model Configuration Chart

Note: Thermowells for Models W91/W94 are ordered separately.

Models	Temperature Range = X	Capillary Length	Sensing Bulb	Valve Body Selection
W91 Non-Indicating W94 Indicating Dial W91H High-Force	01 - 14 (Refer to Temperature Range Chart)	08 8 Feet (std) 12 12 Feet 16 16 Feet 20 20 Feet 24 24 Feet	S15 Copper Bulb (std) (with Brass Union Hub) S16 Stainless Steel Bulb (with SS Union Hub)	Included in Model Code in above chart.

W91 **05** (75 - 165°F) **12** **S15** **H15N** (1 1/4" NPT)

Range Code	Nominal Temperature Range *	
01	20 - 70°F	10 - 20°C
02	40 - 90°F	5 - 30°C
03	30 - 115°F	0 - 45°C
04	50 - 140°F	10 - 60°C
05	75 - 165°F	25 - 70°C
06	105 - 195°F	40 - 90°C
07	125 - 215°F	55 - 100°C
09	155 - 250°F	70 - 120°C
10	200 - 280°F	95 - 135°C
11	225 - 315°F	110 - 155°C
12	255 - 370°F	125 - 185°C
13	295 - 420°F	145 - 215°C
14	310 - 440°F	155 - 225°C

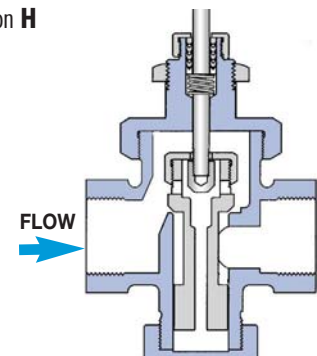
* The recommended working span falls within the upper third of the nominal range.

Example Model Code configured: **W91-05-12-S15-H15N**

(W91, 75-165 °F Temp. Range, 12 ft. capillary, Std. Copper Sensing Bulb, 1 1/4" NPT Valve Body)

Valve bodies used for HEATING have designation **H**
(Example: **H15N**)

Normally Open
(IN-TO-CLOSE)
Single-seated
Balanced Valve with
Class IV shut-off



HEATING

Direct-Operated Regulators Single-Seated Valve Bodies

W91/W94 Series

for Temperature Regulators

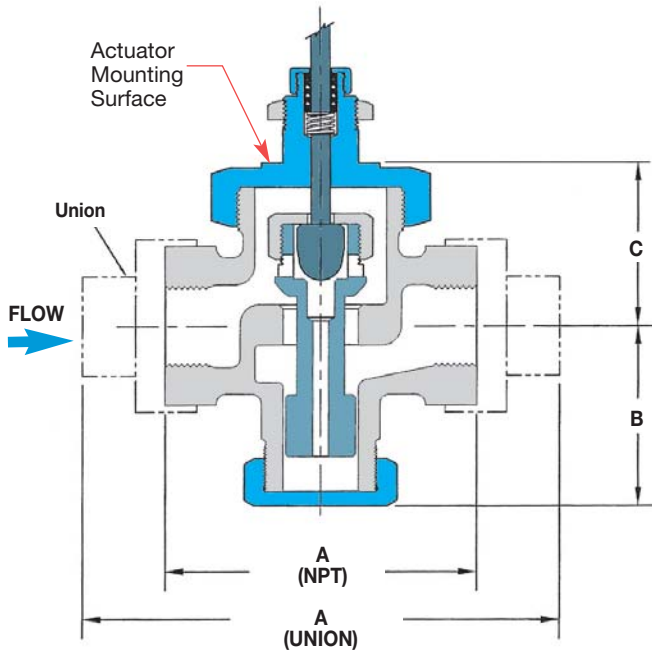
Single Seat • 1/2" – 4"

HEATING

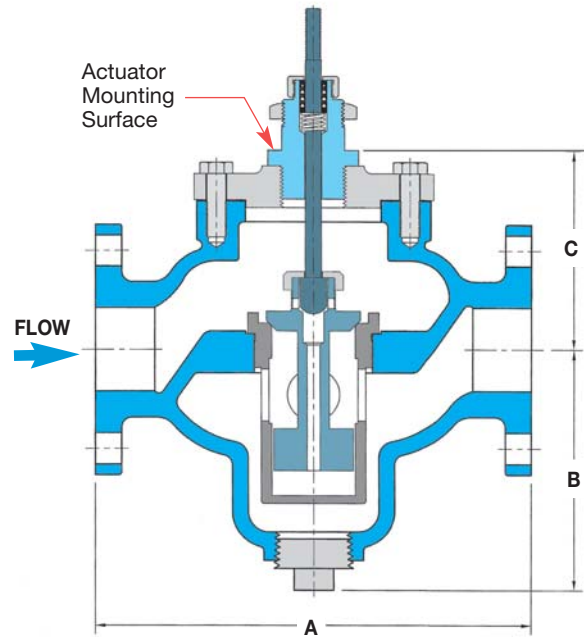
NORMALLY OPEN

Stem In-To-Close
for HEATING

Dimensions in inches



THREADED & UNION



FLANGED

TEMPERATURE
Regulators

Valve Body Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
1/2" - 1 1/2" Stainless/Bronze	Stainless Steel	Threaded or Malleable Iron Union Ends	250 PSI @ 410°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)		Size Connection	Capacity Cv	Maximum Close-Off Pressure (PSI ΔP)	Dimensions						Approx. Ship. Wt. (lbs) [kg]	
NPT	Union				A Threaded	A 125# FLG	A 250# FLG	A Union	B	C		
H12N	H12U	1/2"	3.2	250	4.125	x	x	6.50	2.375	2.12	14 [6.35]	
H13N	H13U	3/4"	6.3	250	4.125	x	x	6.50	2.375	2.12	14 [6.35]	
H14N	H14U	1"	10.8	200	4.125	x	x	7.00	2.375	2.12	14 [6.35]	
H15N	H15U	1 1/4"	15.9	200	4.810	x	x	7.50	3.250	2.50	17 [7.7]	
H16N	H16U	1 1/2"	22.4	200	5.190	x	x	8.00	3.500	2.69	18 [8.2]	
H17N	-	2"	33.1	150	9.500	x	x	x	5.750	4.75	50 [22.7]	
FLANGED		Size Connection	Capacity Cv	Valve Type		Dimensions						Approx. Ship. Wt. (lbs) [kg]
125#	250#			Standard	Special*	A	A	A	A	B	C	
H17F125	H17F250	2"	33.1	150	-	x	10.375	10.875	x	5.75	4.75	80 [36.3]
H18F125	H18F250	2 1/2"	47.5	65	150	x	10.625	11.250	x	7.00	5.00	96 [43.6]
H19F125	H19F250	3"	68.2	50	150	x	10.875	11.625	x	8.00	5.75	110 [49.9]
H20F125	H20F250	4"	109.5	40	150	x	10.500	13.125	x	8.75	6.50	160 [72.6]

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

* With High-Force Actuator, which allows the valve to operate at a higher differential pressure.

for Temperature Regulators

HEATING

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"
	H12	H13	H14	H15	H16	H17	H18	H19	H20
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							

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 in chart).

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

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Note: When used with water, add **W** to the Valve Body Number.

Example:
H17N becomes HW17N

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"
	HW12	HW13	HW14	HW15	HW16	HW17	HW18	HW19	HW20
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							

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°

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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 Heat Load or Heat Transfer Rate (E) is Known	Capacity of steam required (lbs/hr)	=	$\frac{E \text{ (Btu/hr)}}{1000}$
When Square Feet Equivalent Direct Radiation (EDR) is Known	Capacity of steam required (lbs/hr)	=	$\frac{\text{Sq. ft. of EDR}}{4}$
When Heating Water with Steam	Capacity of steam required (lbs/hr)	=	$\frac{\text{GPM} \times \text{Temp Rise (°F)}}{2}$
When Heating Fuel Oil with Steam	Capacity of steam required (lbs/hr)	=	$\frac{\text{GPM} \times \text{Temp Rise (°F)}}{4}$
When Heating Air with Steam Coils	Capacity of steam required (lbs/hr)	=	$\frac{\text{CFM} \times \text{Temp Rise (°F)}}{900}$

Note: Above formulas based on steam containing approximately 1000 Btu's of Latent Heat per pound.