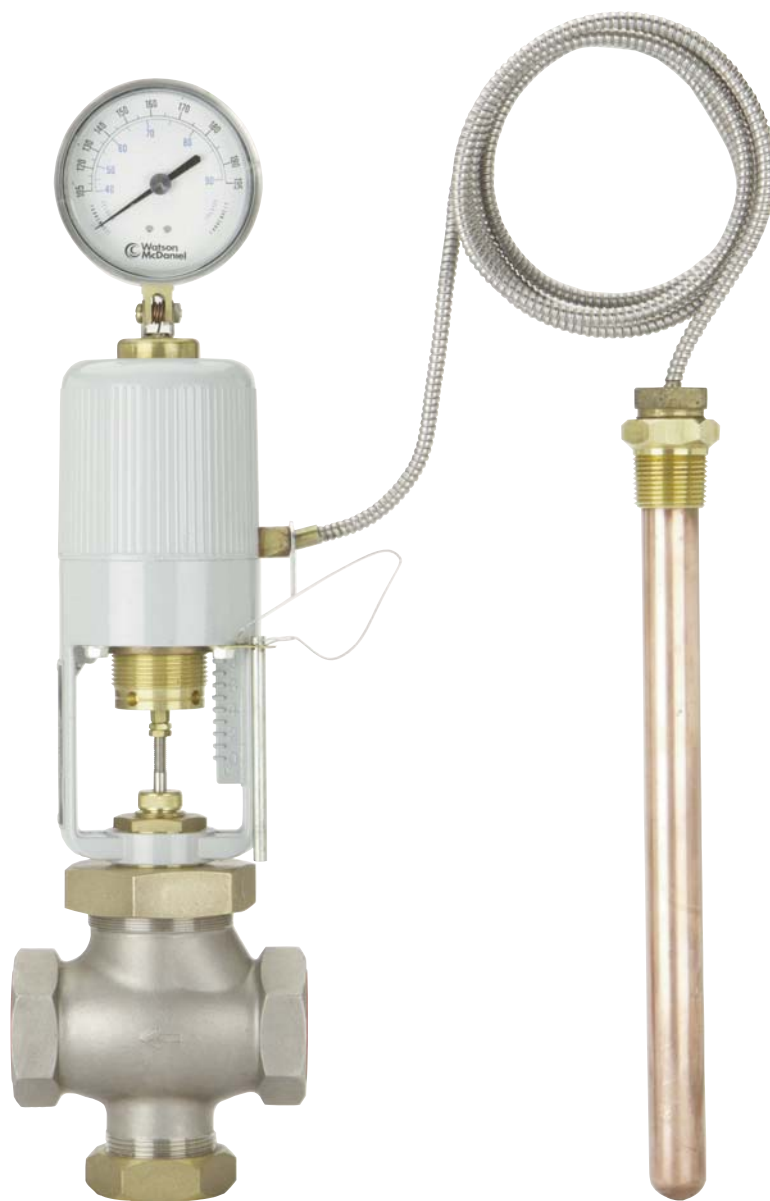


Direct-Operated Regulators
Temperature Regulators



TEMPERATURE
Regulators

W91 • Non-Indicating

W94 • Indicating - Dial Thermometer

For **Heating** with Steam
for **Cooling** with Water
Mixing/Diverting for Liquids

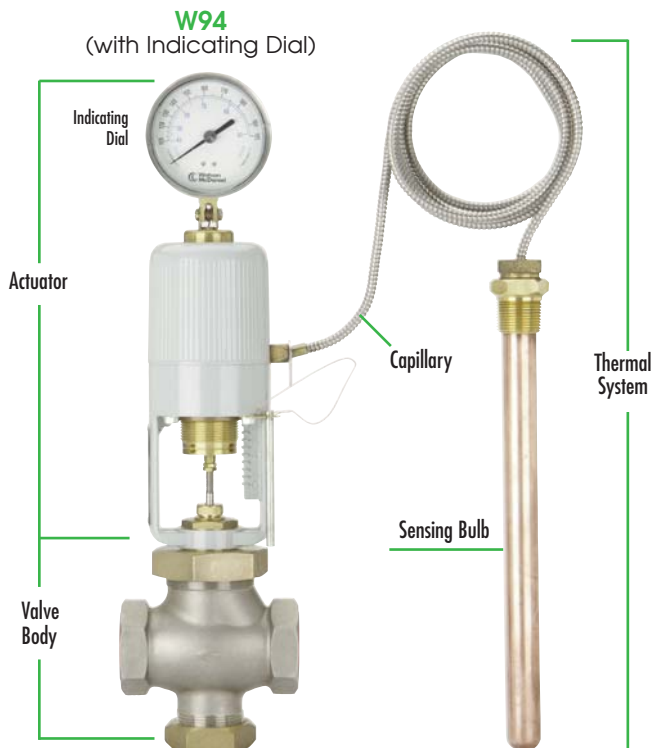
Description & Selection

The **W91/W94** Self-Operating Temperature Regulator is a mechanically operated device designed to regulate system temperature by modulating the flow of a heating or cooling fluid in response to temperature changes; requires no external power source. They are recommended for controlling temperature on relatively stable systems, where small valve stroke modulations will correct temperature drift. Where sudden or large load changes, or rapid temperature changes occur, a pneumatically-actuated Control Valve should be considered. Please consult the Control Valve Section of this catalog.

Principle of Operation

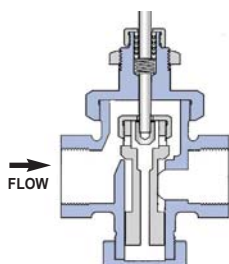
The **W91/W94** Temperature Regulator is a fully self-contained unit requiring no external power source (i.e., compressed air or electricity). Regulation takes place when the sensing element (bulb) of the thermal system is exposed to changes in temperature. The thermal system is charged with a predetermined amount of vapor fill, which, when heated, will cause the bellows within the unit's actuator housing to expand.

The valve action is either **In-To-Close for Heating** or **In-To-Open for Cooling**.



HEATING

Normally Open
(in-to-close)

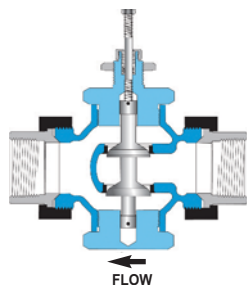


Normally Open Valves are used for **HEATING**, so the valve stem closes (**in-to-close**) as the control signal (temperature) increases.

Single-Seated Balanced Valves are used for Heating Applications (normally steam) where tighter shut-off is required. Leakage rate is approximately 0.01% of the maximum capacity (Class IV shut-off).

COOLING

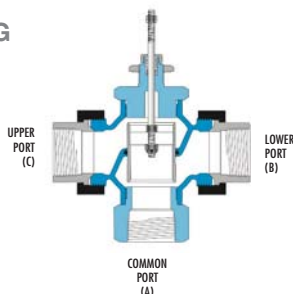
Normally Closed
(in-to-open)



Normally Closed Valves are used for **COOLING**, so the valve stem opens (**in-to-open**) as the control signal (temperature) increases.

Double-Seated Balanced Valves are used for Cooling Applications where larger flow rates of water are frequently required, and a small leakage rate through the valve is normally acceptable. Leakage rate can be up to 0.5% of the maximum valve capacity (Class II shut-off).

MIXING & DIVERTING
3-Way Valves



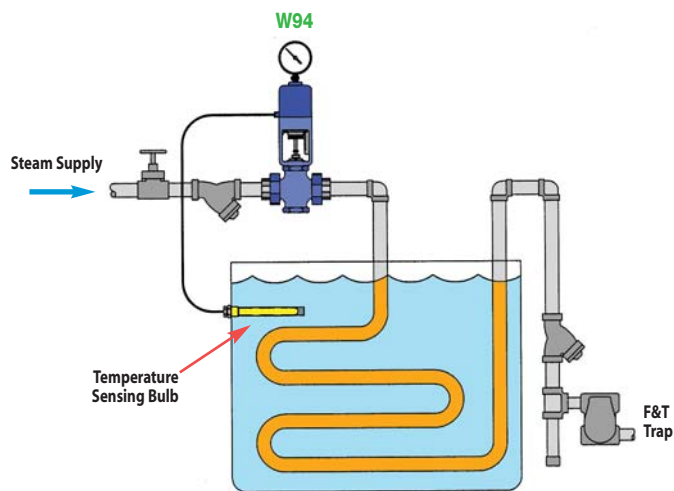
3-Way Valves are used for mixing two flows together, or for diverting a flow to or around a device (bypass). In order to produce consistent flow quantity for stable operation, the pressure drop across both flow paths (inlet to outlet) must be nearly equal. The Sleeve-Type (common port on the bottom) is most commonly used for diverting applications; however, due to its design, it can also be used for mixing applications (NOT for steam use). It is also suitable for water or glycol type service, up to a maximum temperature of 300°F. A higher temperature O-ring for use with other fluids, such as oil, or for temperatures up to 410°F, is available. Consult factory.

Introduction

HEATING

Regulating Temperature of a Plating or Finishing Tank

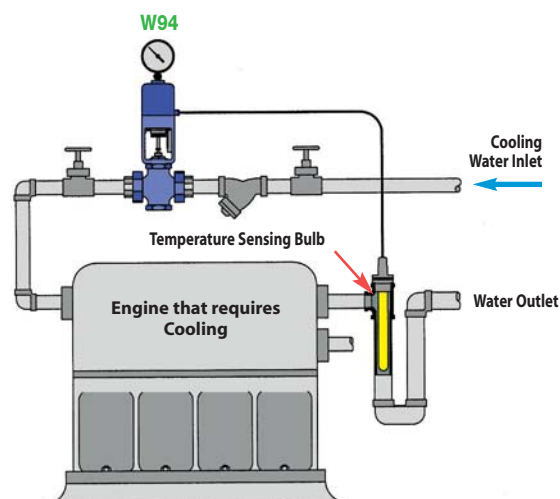
Valve Body determines the action of the Regulator
For Heating: use **Normally Open** Valve Body (in-to-close)



COOLING

Using Water to Cool Engine

Valve Body determines the action of the Regulator
For Cooling: use **Normally Closed** Valve Body (in-to-open)



Components of a Self-Operated Temperature Regulator



Model W91 Actuator is Non-indicating (without temperature indicating dial).



Model W94 Actuator is equipped with an integral dial thermometer to indicate sensing bulb temperature. The W94 displays the temperature at the sensing bulb. This allows for easy adjustment of the temperature set-point, as well as continuous monitoring of the application, without the installation of an additional thermometer.

The thermometer has a 3 1/2" diameter dial face and can be rotated and tilted for maximum readability.

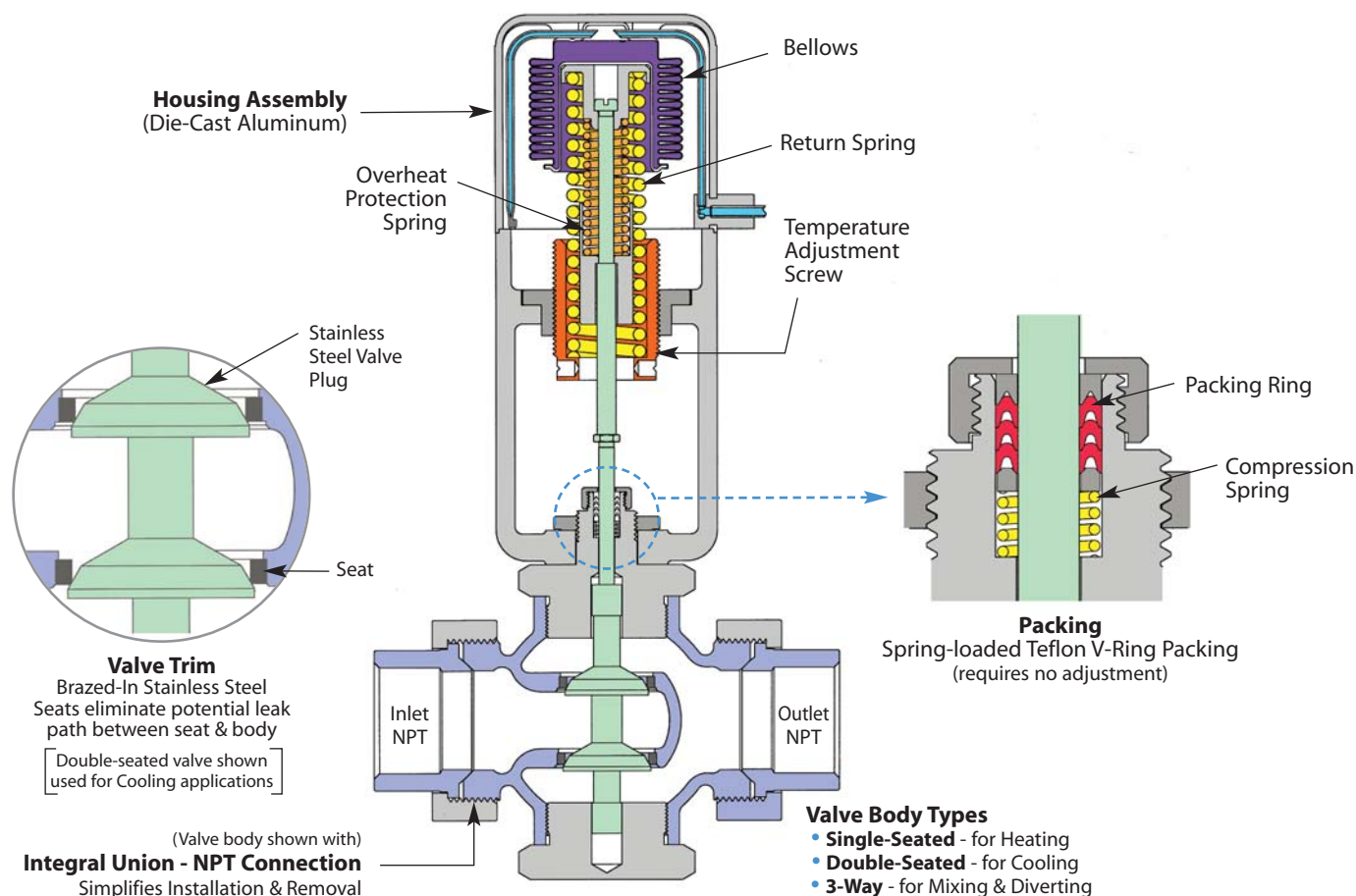
The **Sensing Bulb and Capillary** are available in either Copper (for best heat transfer) or Stainless Steel (for corrosive applications). The capillary tubing is protected by stainless steel flexible armor to resist damage during handling and installation. The sensing bulb is also available with an optional Teflon or Kynar coating; used for special corrosive applications such as plating tanks where stainless steel may not be acceptable.

Capillary lengths up to 24 feet are considered standard; non-standard lengths up to 52 feet are available. Longer capillary lengths require longer bulb length to contain the additional actuating fluid required (see selection chart).



Valve Body

Single-seated balanced valves are used on heating applications (most commonly steam) where tight shut-off is required. Double-seated valves are used on cooling applications because of the high flow rates often required. The balanced double-seated design also allows the temperature actuator to operate with higher differential pressures than would be possible using single-seated non-balanced valves. 3-way valves are used for mixing and diverting applications.



Actuator Housing Assembly

The housing consists of a cap and yoke constructed from precision die cast aluminum. This assembly ensures permanent alignment with the valve body, while protecting the bellows assembly. The yoke includes a set-point scale used to reference the setting of the temperature adjustment screw. The entire housing is finished in a corrosion resistant, baked grey epoxy.

Actuator Bellows & Spring Return Assembly

The accordion type bellows is corrosion resistant to provide accurate response for the life of the regulator. An adjusting bar is provided to turn the brass temperature adjustment screw, which compresses or expands the range adjustment spring, thereby setting the control-point of the unit.

Valve Body & Connection Type

W91/W94 Temperature Regulators available with NPT connection, Integral Union (with NPT connection) and Flanged.

Valve Trim

Valve Trim is composed of the plug and seat(s). Single and double-seated valves employ a stainless steel, tapered plug for enhanced modulation. The valve plug is both top and bottom guided to ensure positive seating alignment. 3-Way valves use a stainless steel sleeve and brass seating surface to change flow direction within the body.

Packing

Valves feature a self-energizing (spring-loaded) Teflon V-Ring packing, which reduces leakage around the valve stem. V-Ring packing is spring loaded to maintain proper compression and does not require manual adjustment.

Introduction • Design & Operation

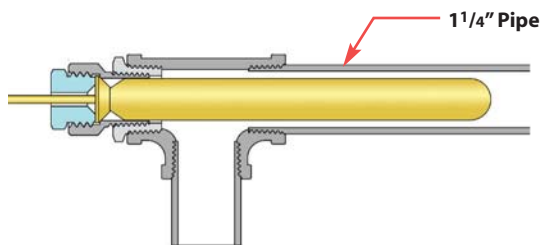
Sensing Bulb & Thermowells

Sensing Bulb

Sensing Bulb Installation

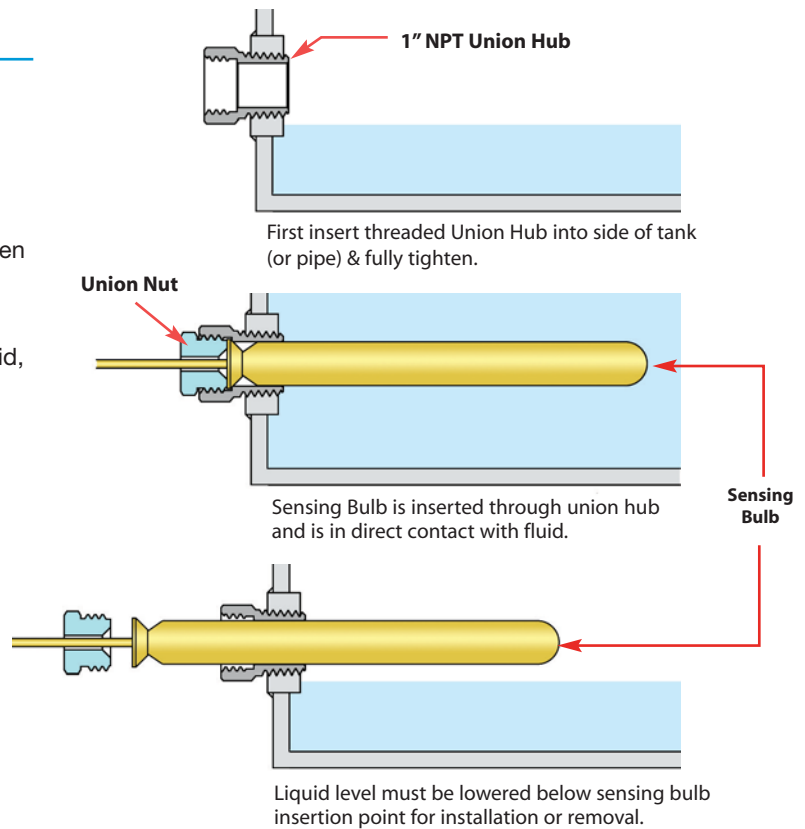
Care must be taken to ensure that the entire length of the sensing bulb is immersed into the medium at the sensing location. Partial immersion of sensing bulb in the process fluid can result in faulty control.

The sensing bulb is designed to be installed in either a horizontal or vertical orientation (with the tip down). If the tip must be installed upwards, please specify when ordering, as a special bulb construction is required. The sensing bulb material is available in either copper (best heat transfer) or stainless steel (corrosion resistant) and must be compatible with the process fluid, or an optional thermowell can be used for complete isolation of the sensing bulb from the process fluid.



Installed in Pipe Line:

Drawing shows Sensing Bulb installed in a 1" NPT pipe fitting. 1 1/4" is minimum pipe size for adequate clearance around sensing bulb.



TEMPERATURE
Regulators

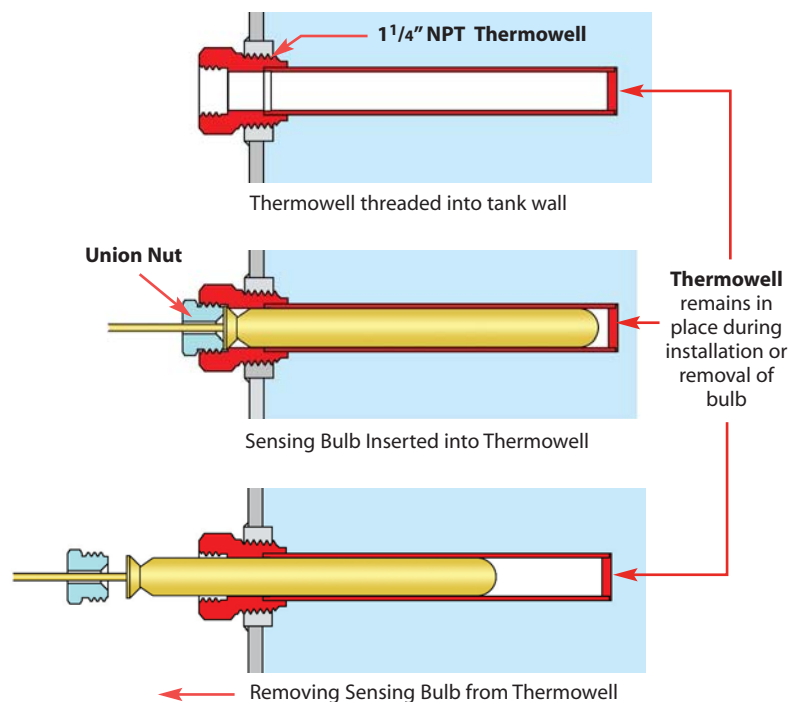
Sensing Bulb with Thermowell

Thermowell (isolates sensing bulb from process fluid)

Thermowells isolate the sensing bulb from the process fluid. For applications in which the process media may be corrosive or contained under excessive pressure, the use of a thermowell is required to prevent damage to the sensing bulb. A thermowell also allows the removal of the sensing bulb without having to drain liquid from the system. Thermowells are available in either brass (best heat transfer) or stainless steel (for corrosive applications). The 1 1/4" NPT hub of the thermowell can be installed into the side of a tank or female pipe connection, depending on the application. Three different length thermowells are available to match sensing bulb lengths.

To ensure minimum response time, Heat Transfer Paste (supplied with thermowell) should be applied to the sensing bulb prior to installation.

Thermowell remains installed into tank or pipeline; therefore, liquid does not require draining when replacing sensing bulb.



Temperature Range

Nominal ranges from 20°F (-10°C) through 440°F (225°C) are available. The nominal range defines the entire temperature range of the unit. The service conditions and choice of valve style and action will determine the actual operating range (recommended working span) of the unit. Using the valve in the recommended working span improves temperature response time of the system. The nominal range should be selected so that the set-point falls within the recommended working span for the specified valve style and action. They include an over-range protection spring, which allows the sensing bulb to be heated 100°F above the upper limit of the unit's nominal range for system cleaning or temporary situations.

Accuracy

The W91/W94 Temperature Regulator is a "set-and-forget" regulating device. Once the proper control-point setting has been achieved, the unit requires virtually no adjustments and very little maintenance. Control-point accuracy is dependent upon the sensing bulb location, load change size and speed, and valve size. The sensing bulb must be installed in an area within the process that is most representative of overall process conditions. Care should be taken not to locate the bulb in close proximity to the valve, as the regulator might respond to temperature changes before the process has had time to reach the control-point. Where sudden or large load changes occur, a pneumatically or electrically-powered Control Valve should be specified. Consult the Control Valves section of this catalog.

Valve sizing also plays a major part in regulator performance. A valve that is too small will not be able to provide the desired capacity during peak load conditions, while a valve that is too large may overshoot the control-point and operate with the valve plug too close to the seat, resulting in undue wear of the plug and seat. As part of a well-designed system, a properly sized valve (operating in the 60-90% open position) can control to within 2 to 5 °F.

Size

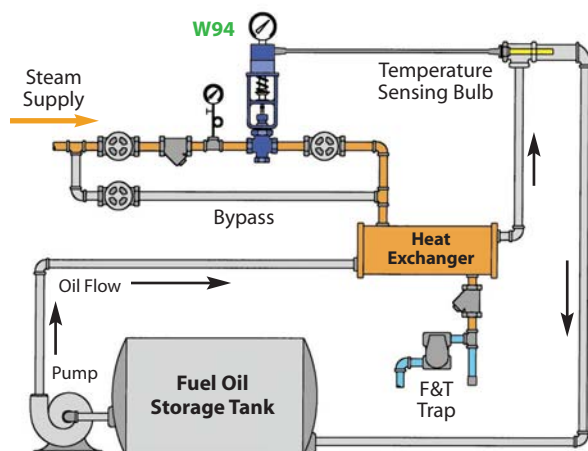
The proper sizing of a regulating valve is one of the most important factors in its selection. A valve that is too small will not be able to provide the desired capacity during peak load conditions, while a valve that is too large may overshoot the control-point and operate with the valve plug too close to the seat, resulting in premature wear of the plug and seat. The valve coefficient (Cv) is used to determine the maximum capacity of a valve. From this value, a valve body with the appropriate port size can be selected. Port sizes from 1/8" through 4" and connection sizes from 1/2" through 4" are available. Consult the Valve Selection section of this catalog.

Close-Off

Temperature Regulators are not considered shut-off valves. A pressure surge may force a single-seated valve plug open. The W91/W94 Temperature Regulator is a balanced equilibrium system and may not provide the force necessary to tightly seat the valve plug. A separate power-driven or hand-actuated valve is required to ensure tight shut-off when necessary.

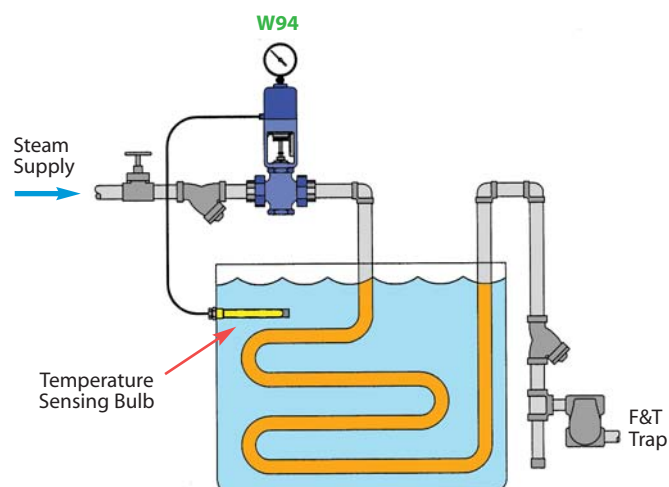
W94 Heating Fuel Oil to Proper Temperature

When the Sensing Bulb is mounted remotely from the actual point of heating (as shown) the Circulation Pump MUST continue to run so that the sensing bulb can sample the product temperature in the heat exchanger. Without product circulation, the temperature control valve will never shut off and the oil will be overheated



W94 Elevating Temperature of a Plating or Finishing Tank

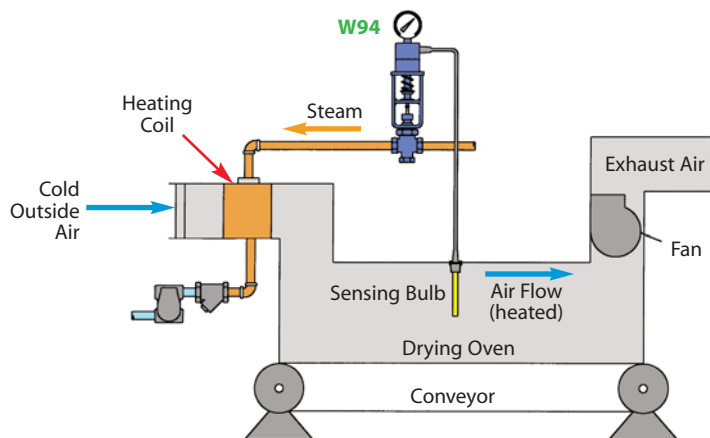
Sensing bulb should be properly placed inside tank for best temperature consistency. An optional Thermowell (Stainless Steel or Brass) may slightly reduce temperature sensitivity. However, it will isolate sensing bulb and allow for its removal without draining the tank.



Introduction

Typical Applications for Temperature Regulators for Heating & Cooling

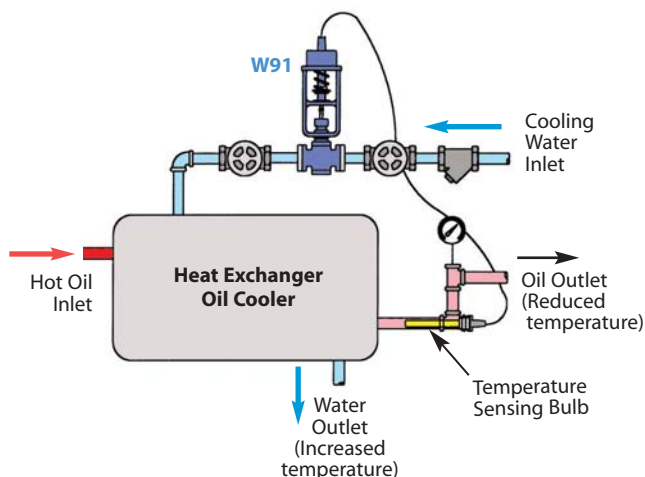
W94 Used in a Drying Oven Application



W94 Valve used to regulate the temperature of the air flow through an air heating duct. The sensing bulb is installed toward the end of the heating duct and will sense the temperature of the air flowing past the heating coils. When air temperature is below the set point, the valve will open to allow more steam through to the coils to heat the air passing through the duct. Once the desired air temperature is achieved, the valve will begin to modulate closed to maintain the air temperature.

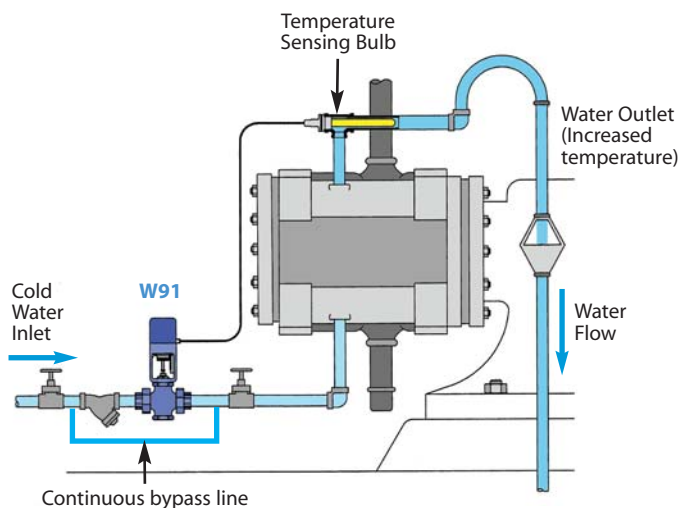
TEMPERATURE
Regulators

W91 Used to Reduce Oil Temperature In a Heat Exchanger



W91 Cooling valve controlling the flow of water through a heat exchanger to maintain the temperature of oil that is gaining heat by some process. The valve automatically shuts off when not required, greatly reducing cooling water usage. The source of the cooling water may be a well or city water supply and it can be circulated or dumped to drain. A 3-way valve may be used on cold water chiller systems so flow can be diverted from going through the heat exchanger when not required.

W91 Used to Control Water Flow to Air Compressor for Cooling Purposes



When the Sensing Bulb is mounted remotely from the actual point of Cooling (as shown), the water **MUST** continue to flow so that the sensing bulb can sample the product temperature of the unit being cooled. Without continuous water flow, the temperature control valve will never turn on, causing the unit to overheat. The bypass line provides a minimum continuous flow when temperature set point is achieved and the valve is closed.

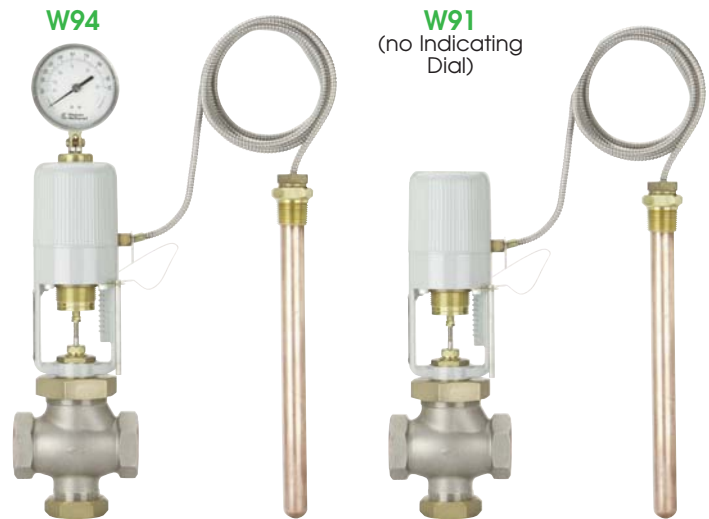
Direct-Operated Regulators

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



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:

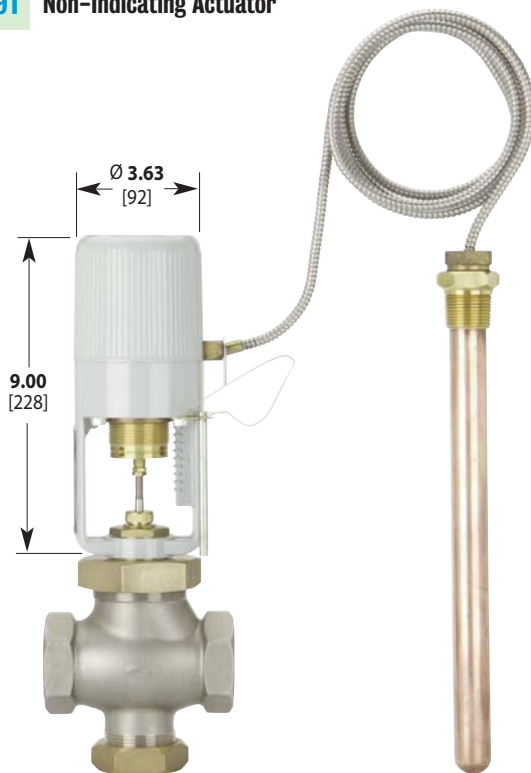
Explanation of Model Number:	W91	06	08	S15	H13N
	Model	Temp. Range	Cap. Length	Bulb Type	Valve Body
Model Number:	W91-06-08-S15-H13N				

Model Code Configuration

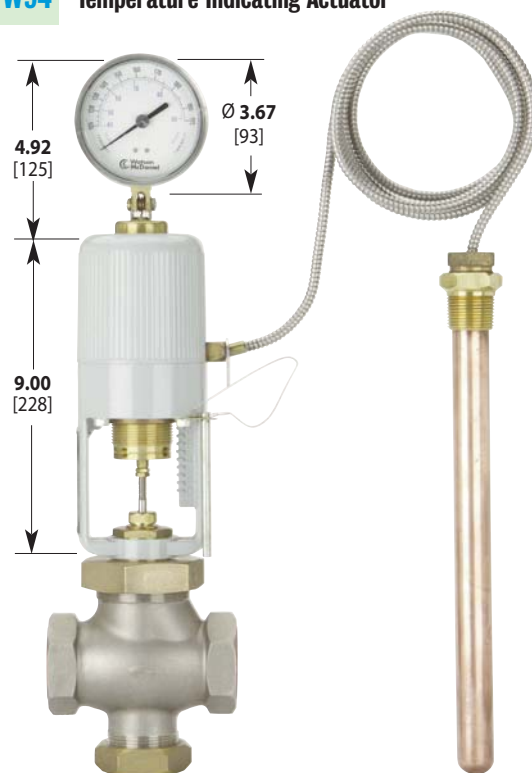
Models	Temperature Range	Capillary Length	Sensing Bulb	Valve Body Selection
W91 Non-Indicating	01 – 14 Refer to Temperature Range Chart	08 8 Feet (standard)	S15 Brass bulb (standard)	Refer to Valve Body Section
W94 Indicating Dial		12 12 Feet		
		16 16 Feet	S16 Stainless bulb	(Omit this selection if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

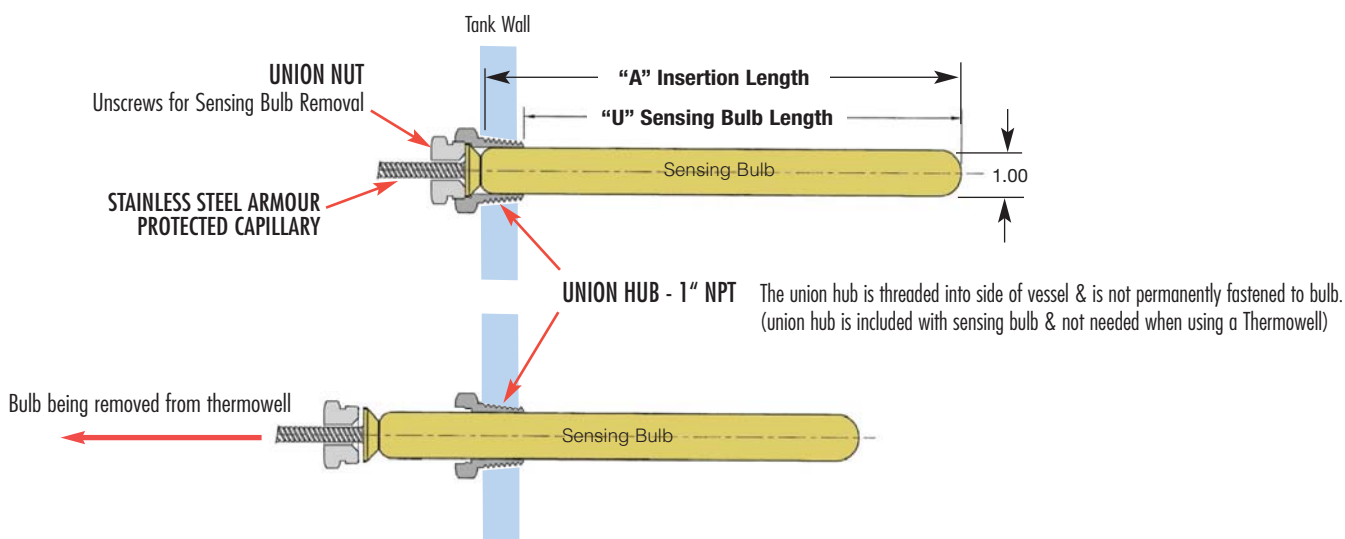
Thermowell Option (ordered separately)

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).

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"
			U	12.25"	15.25"
S16	Stainless Steel (Stainless Steel Union Hub)	Stainless Steel with Stainless Steel Spiral Armour	A	13"	16"
			U	12.25"	15.25"

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.

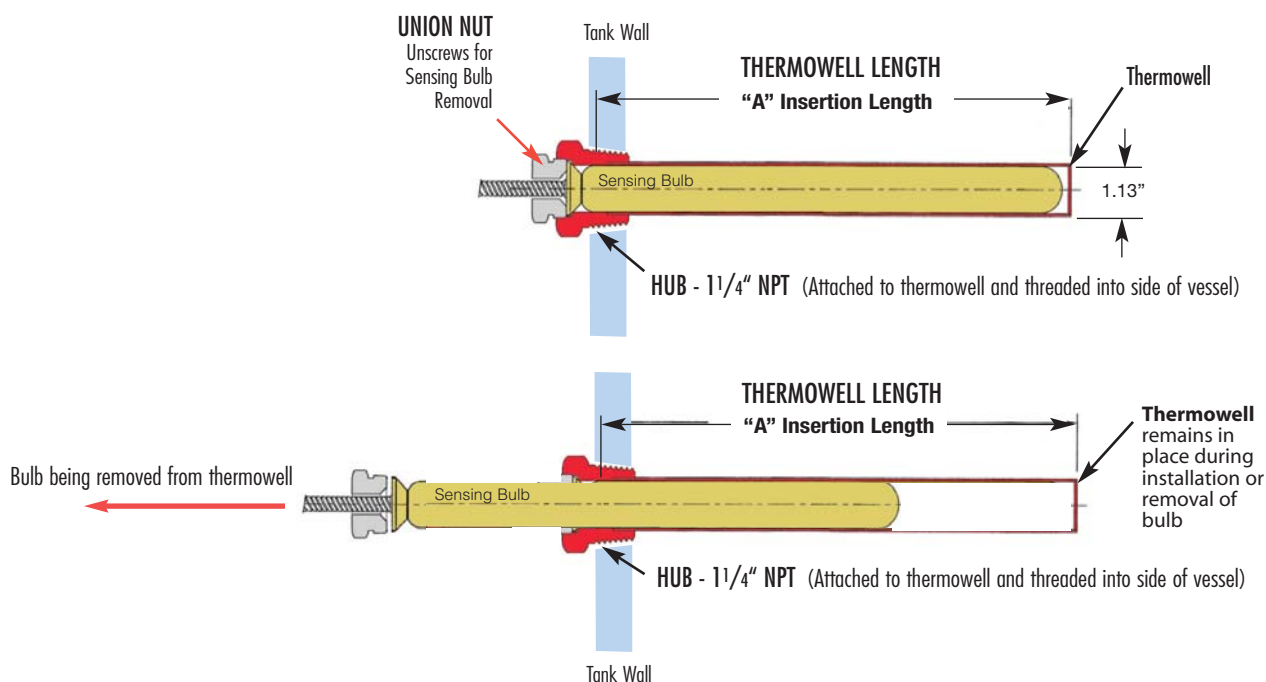
Thermowell Length must be selected based on the length of the sensing bulb. The sensing bulb length is based on the length of the Capillary used in the Thermal System. Longer capillary lengths require a longer sensing bulb to hold the additional actuator fluid inside the sensing bulb. Reference Sensing 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	20.00	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.



Direct-Operated Regulators Temperature Regulators

W91/W94 Series

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	01 – 14 (Refer to Temperature Range Chart)	08	8 Feet (std)	S15	Copper Bulb (std) (with Brass Union Hub)	Included in Model Code in above chart.
W94	Indicating Dial		12	12 Feet			
W91H High-Force			16	16 Feet	S16	Stainless Steel Bulb (with SS Union Hub)	
			20	20 Feet			
			24	24 Feet			

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**)

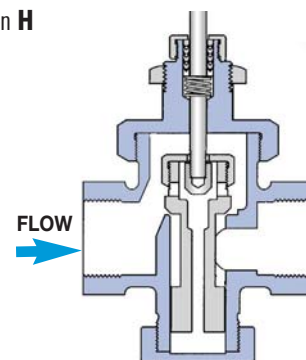
Normally Open

(IN-TO-CLOSE)

Single-seated

Balanced Valve with

Class IV shut-off



HEATING

Direct-Operated Regulators Single-Seated Valve Bodies

for Temperature Regulators

W91/W94 Series

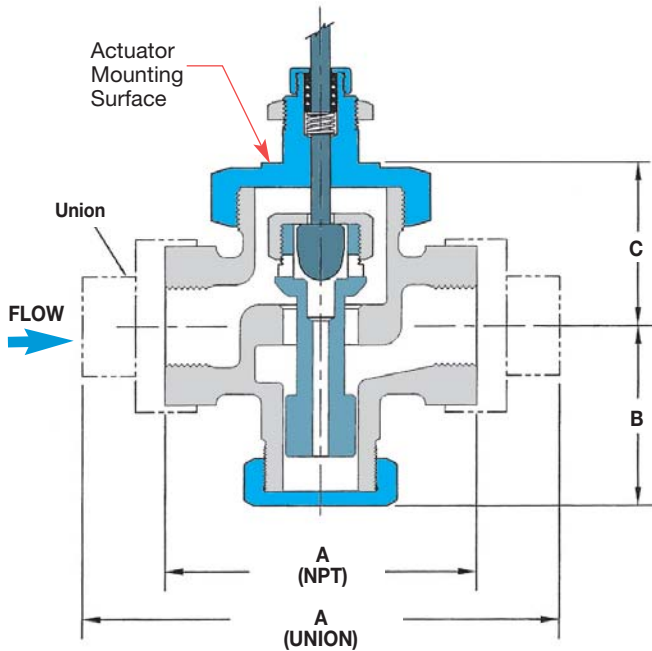
Single Seat • 1/2" – 4"

HEATING

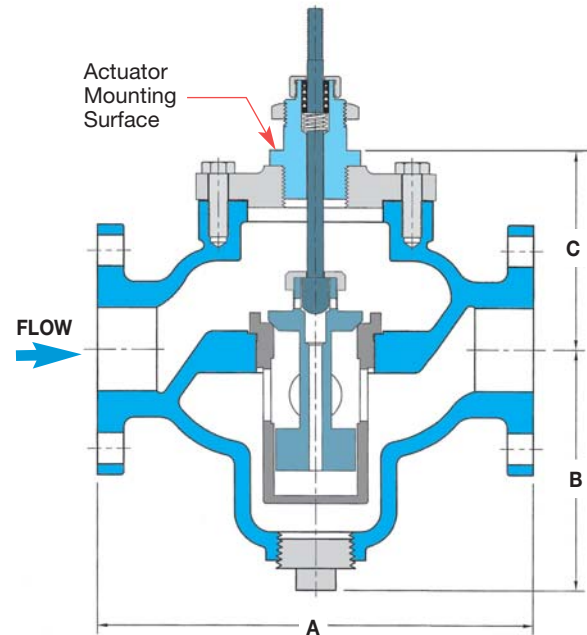
NORMALLY OPEN

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) NPT Union		Size Connection NPT	Capacity Cv	Maximum Close-Off Pressure (PSI△P)	Dimensions						Approx. Ship. Wt. (lbs) [kg]	
					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 125# 250#				Valve Type								
				Standard	Special*							
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.

Direct-Operated Regulators

Capacity Charts • Single-Seated Valve Bodies

W91/W94 Series

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).

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							

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)

Direct-Operated Regulators

Capacity Charts • Single-Seated Valve Bodies

W91/W94 Series

for Temperature Regulators

HEATING

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°

TEMPERATURE
Regulators

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.

COOLING

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 8 ft.
S15 = Copper Bulb

Connection			PMO (PSI)
3/4" NPT	with Integral Union	W91-X-08S15-C13U	250
1" NPT	with Integral Union	W91-X-08S15-C14U	250
1 1/4" NPT	with Integral Union	W91-X-08S15-C15U	250
1 1/2" NPT	with Integral Union	W91-X-08S15-C16U	250
2" NPT	with Integral Union	W91-X-08S15-C17U	250
2 1/2"	125# FLG	W91-X-08S15-C18F125	65
3"	125# FLG	W91-X-08S15-C19F125	50
4"	125# FLG	W91-X-08S15-C20F125	40



W94

Indicating Type Actuator
with valve body

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

	PMO (PSI)	Weight
W94-X-08S15-C13U	250	12
W94-X-08S15-C14U	250	13
W94-X-08S15-C15U	250	17
W94-X-08S15-C16U	250	18
W94-X-08S15-C17U	250	24
W94-X-08S15-C18F125	65	55
W94-X-08S15-C19F125	50	80
W94-X-08S15-C20F125	40	105

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	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

C15U (1 1/4" NPT)

Example Model Code configured: **W91-05-12-S15-C15U**

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

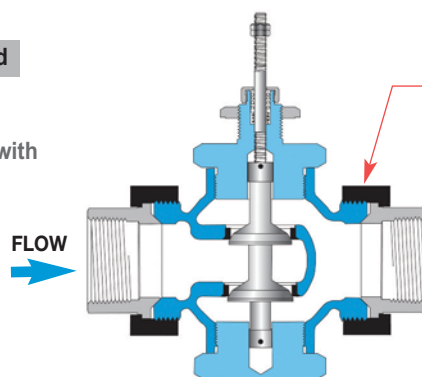
Range Code	Nominal Temperature Range *	
01	20 - 70°F	10 - 20°C
02	40 - 90°F	5 - 30°C
03	30 - 115°F	0 - 45°C
04	50 - 140°F	10 - 60°C
05	75 - 165°F	25 - 70°C
06	105 - 195°F	40 - 90°C
07	125 - 215°F	55 - 100°C
09	155 - 250°F	70 - 120°C
10	200 - 280°F	95 - 135°C
11	225 - 315°F	110 - 155°C
12	255 - 370°F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

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

Valve bodies used for COOLING have designation **C**
(Example: **C15U**)

Normally Closed

(IN-TO-OPEN)
Double-seated
Balanced Valve with
Class II shut-off



3/4" - 2" NPT
with Integral Union
for Easy Removal
from the piping system

COOLING

Direct-Operated Regulators Double-Seated Valve Bodies

for Temperature Regulators

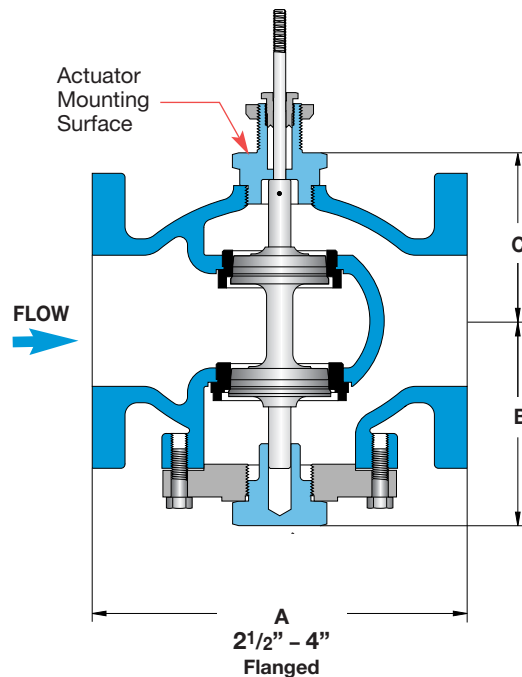
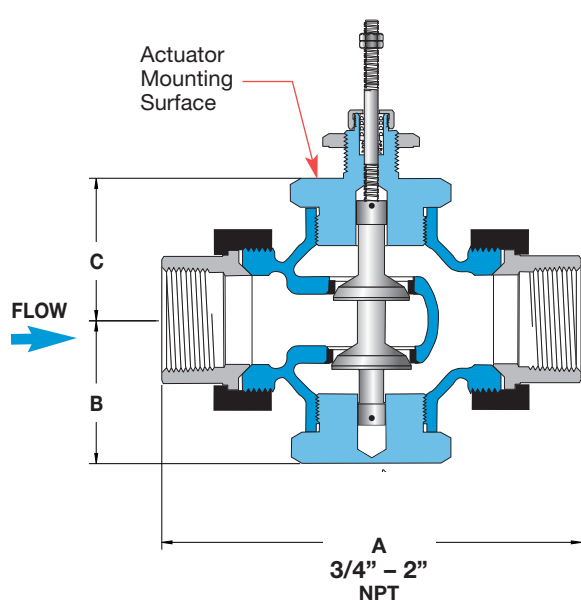
W91/W94 Series

Double Seat • 3/4" – 4"
COOLING

NORMALLY CLOSED

Stem In-To-Open
for Cooling

Dimensions in inches [mm]



TEMPERATURE
Regulators

Valve Body Specifications

Body Material	Trim Material	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	
C13U	3/4	3/4"	8	250	5.6 [142]	2.3 [58]	2.3 [58]	5.0 lbs [2.25 kg]
C14U	1	1"	12	250	6.0 [152]	2.3 [58]	2.3 [58]	6.1 lbs [2.75 kg]
C15U	1 1/4	1 1/4"	21	250	7.2 [183]	2.6 [66]	2.6 [66]	10.1 lbs [4.55 kg]
C16U	1 1/2	1 1/2"	30	250	7.7 [196]	2.6 [66]	2.6 [66]	11.1 lbs [5.00 kg]
C17U	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	
C18F125	2 1/2"	2 1/2"	69	65	7.8 [198]	4.8 [122]	5.4 [137]	45 lbs [20 kg]
C19F125	3"	3"	90	50	9.0 [229]	5.0 [127]	5.6 [142]	70 lbs [32 kg]
C20F125	4"	4"	196	40	11.4 [290]	6.3 [160]	6.5 [165]	100 lbs [45 kg]

MIXING & DIVERTING

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 8 ft.
S15 = Copper Bulb

Connection		PMO (PSI)
1/2" NPT with Integral Union	W91-X-08-S15-A18	250
3/4" NPT with Integral Union	W91-X-08-S15-A25	250
1" NPT with Integral Union	W91-X-08-S15-A34	250
1 1/4" NPT with Integral Union	W91-X-08-S15-A45	250
1 1/2" NPT with Integral Union	W91-X-08-S15-A56	250
2" NPT with Integral Union	W91-X-08-S15-A67	250
2 1/2" 125# FLG	W91-X-08-S15-B75	125
3" 125# FLG	W91-X-08-S15-B80	125
4" 125# FLG	W91-X-08-S15-B85	125



W94

Indicating Type Actuator
with valve body

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

	PMO (PSI)	Weight
W94-X-08-S15-A18	250	10
W94-X-08-S15-A25	250	12
W94-X-08-S15-A34	250	13
W94-X-08-S15-A45	250	17
W94-X-08-S15-A56	250	18
W94-X-08-S15-A67	250	24
W94-X-08-S15-B75	125	55
W94-X-08-S15-B80	125	80
W94-X-08-S15-B85	125	105

Model Configuration Chart

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

Models	Temperature Range = X	Capillary Length	Bulb	Valve Body Selection
W91 Non-Indicating W94 Indicating Dial	01 - 14 (Refer to Temperature Range Chart on next page)	08 8 Feet (standard) 12 12 Feet 16 16 Feet 20 20 Feet 24 24 Feet	S15 Copper Bulb (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** **A45** (1 1/4" NPT)

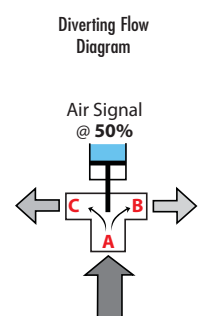
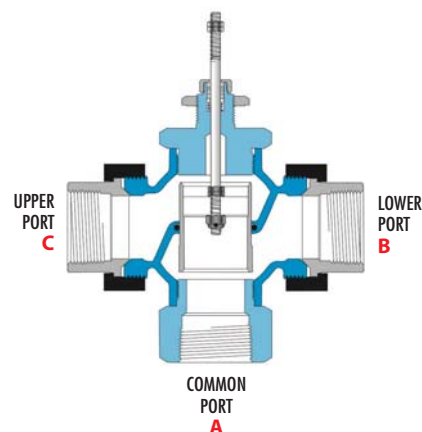
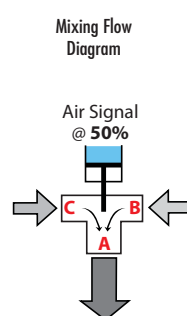
Example Model Code configured: **W91-05-12-S15-A45**

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

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 typically falls within the upper third of the nominal range.

Valve Body for MIXING & DIVERTING



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.

Direct-Operated Regulators 3-Way Valve Bodies

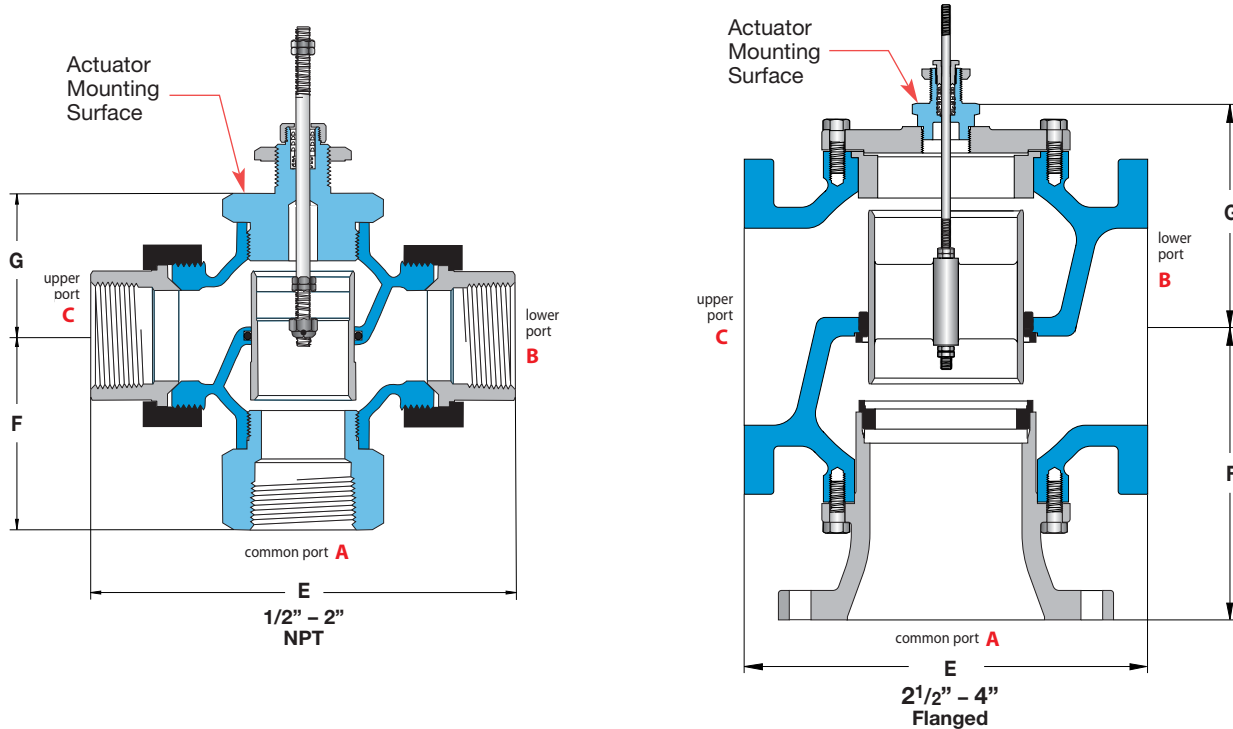
for Temperature Regulators

W91/W94 Series

3-Way • 1/2" – 4"

Dimensions in inches [mm]

for Mixing or Diverting



TEMPERATURE
Regulators

CAUTION: Watson McDaniel 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.

Valve Body Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
1/2" - 2" Bronze	Bronze	Threaded with Malleable Iron Union Ends	250 PSI @ 300°F (149°C)
2 1/2" - 4" 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 (NPT)	Nominal Port			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]

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	2 1/2"	2 1/2"	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]

for Temperature Regulators

Capacity Charts

COOLING Double-Seated Valve Bodies

CAPACITIES — Water (GPM)					DOUBLE-SEATED VALVES			
Pressure Drop (PSI△P)	Size, Valve Body Number & Coefficient (Cv)							
	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
	C13U Cv = 8	C14U Cv = 12	C15U Cv = 21	C16U Cv = 30	C17U Cv = 47	C18F125 Cv = 69	C19F125 Cv = 90	C20F125 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			

Note: Double-seated valves have In-to-Open (ITO) stem action for cooling applications.

MIXING & DIVERTING 3-Way Valve Bodies

CAPACITIES — Water (GPM)							3-WAY VALVES		
Pressure Drop (PSI△P)	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.

for Temperature Regulators

Replacement Actuators

W91
Non-indicating
Replacement Actuator



W94
Indicating
Replacement Actuator



TEMPERATURE
Regulators

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

Replacement Actuator Model Configuration

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

Models	Temperature Range = X	Capillary Length	Bulb
W91 W94	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 (with Brass Union Hub) S16 Stainless Steel Bulb (with SS Union Hub)
W91	05 (75 - 165°F)	12	S15

Thermowells for W91 & W94 Series Self-Operated Temperature Regulators

Capillary Length (ft.)	Bulb Length Required	Thermowell Length (in.)	Connection Size NPT	Brass Model #	Stainless Steel Model #
8', 12' or 16'	12.25"	13.0"	1 1/4"	536S2	536S6
20'	15.25"	16.0"	1 1/4"	536SE2	536SE6
24'	19.25"	20.0"	1 1/4"	536WE2	536WE6

Note: Thermowell Length chosen is based on the Length of the Capillary used in the Thermal System. (See chart above)