

OPERATION AND MAINTENANCE MANUAL

ENDURANCE SERIES SE

6/29/23



-IMPORTANT-

Always reference the full model number and serial number when calling the factory.

HUBBELL ELECTRIC HEATER COMPANY 45 SEYMOUR STREET STRATFORD, CT 06615

> PHONE: (203) 378-2659 FAX: (203) 378-3593 <u>Hubbellheaters.com</u>

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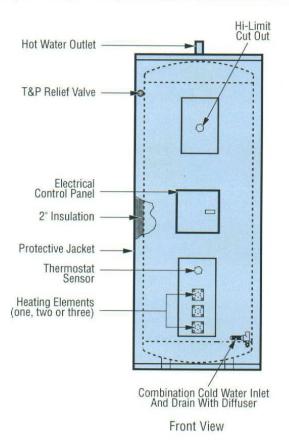
WARNING / CAUTION

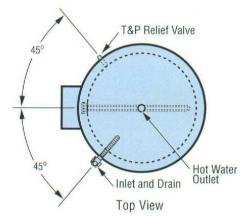
- 1. Tank is to be completely filled with water and all air is to be vented before energizing.
- 2. Due to the rigors of transportation, all connections should be checked for tightness before the heater is placed in operation.
- 3. Safety relief valve must be installed in tapping provided.
- 4. The refractory material used in heating elements may absorb some moisture during transit, periods of storage, or when subjected to a humid environment. This moisture absorption results in a cold insulation resistance of less than one (1) megohms. If this heater has been subjected to the above condition, each heating element must be checked for insulation resistance before energizing. A low megohm condition can be corrected byremoving the terminal hardware and baking the element in an oven at 300°F -500°F for several hours or until the proper megohm reading is obtained.
- 5. KEEP AWAY FROM LIVE ELECTRICAL CIRCUITS. Do not perform any maintenance, make any adjustments, or replace any componentsinside the control panel with the high voltage power supply turned on. Under certain circumstances, dangerous potentials may exist even when the power supply is off. Toavoid casualties, always turn the power supply safety switch to off, turn the charge orground the circuit before performing any maintenance or adjustment procedure.
- 6. The unit is designed to operate at pressure not more than 150 psi.
- 7. Generalized instructions and procedures cannot anticipate all situations. For this reason, only qualified installers should perform the installations. A qualified installer is a personwho has licensed training and a working knowledge of the applicable codes, regulations, tools, equipment, and methods necessary for safe installation of an electric resistance water heater. If questions regarding installation arise, check your local plumbing and electrical inspectors for proper procedures and codes. If you cannot obtain the required information, contact the company.

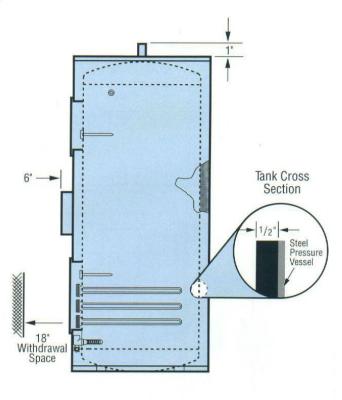
SECTION I - GENERAL DESCRIPTION AND CONSTRUCTION

Capacity Mo	Deee	Maximum KW Input	Dimensions (Inches)				
	Base Model Number		Diameter	Height	Floor to Inlet	Floor to T&P	
6	SE06	3	14	17.5	5	12	
10	SE10	10	20	21	7	15	
20	SE20	10	20	33	7	27	
30	SE30	20	20	41.5	7	34	
40	SE40	20	20	58.75	7	51	
50	SE50	58	22.75	51	7	43	
65	SE65	58	26	48	8	40	
80	SE80	58	26	58	8	51	
100	SE100	58	26	69.5	8	62	
120	SE120	58	28	69.25	8	62	
40	SEU40	58	26	33	7	24	











GENERAL DESCRIPTION

This book describes a packaged electric water heater that is a stationary, self-contained unit. The complete assembly consists of the storage tank, immersion electric heating element(s), thermostat, safety relief valve, safety high temperature cut out, magnetic contactor(s), and any other required electrical operating control. Optional equipment may be supplied with your unit. Please consult the product drawing for details specific to your assembly. The unit is factory assembled, insulated, jacketed, wired, tested, and ready for electrical and plumbing service connections.

CONSTRUCTION

<u>TANK</u>

Standard Tank Construction:

The standard storage tank is constructed of steel and internally lined with specially formulated HydraStone cement to a ½-inch minimum thickness. The tank is designed for a maximum allowable working pressure of 150 psi (300 psi TP).

Optional Tank Construction:

Optionally, the storage tank may be constructed of all welded solid copper-silicon alloy (ASTM B-96) or type 316L stainless steel for maximum tank longevity. For these options, no internal lining is required due to the non-ferrous materials used in the construction of the pressure vessel. The tank is designed for a maximum allowable working pressure of 150 psi (300psi TP).

TANK CONNECTIONS

The heater is supplied with separate cold water and hot water connections. Water entering the cold-water inlet is deflected by means of a baffle within the tank. The hot water outlet includes a built-in heat trap to prevent hot water from radiating out from the heater. A ¾-inch FNPT connection is located on the side of the heater for mounting a combination safety temperature and pressure relief valve. An overflow line should be installed from the relief valve outlet to a floor drain. A ¾-inch GHT connection is supplied for draining. See the drawing specific to your heater for locations and sizes.

HEATING ELEMENT

The water heater is supplied with an electric immersion heating element assembly(s), composed of incoloy sheathed elements that are brazed into a brass flange. Each assembly is fastened to a



corresponding tank flange using a gasket and four (4) 3/8-16 x 1-inch-long hex head steel bolts and nuts. See the drawing specific to your heater for voltage and power ratings.

CONTROL THERMOSTAT

The water heater is supplied with either a surface mounted or immersion thermostatic switch that is installed and wired at the factory. See the drawing for specific details. The surface mounted thermostat can be adjusted through a range of 110° - 170° F. The immersion thermostat can be adjusted through a range of 100° - 190° F. Both thermostats are adjustable with a flat tip screwdriver.



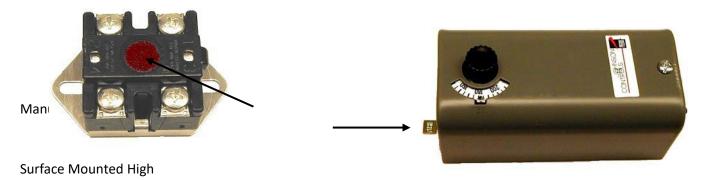
Surface Mounted Thermostat



Immersion Thermostat

TEMPERATURE HIGH LIMIT SWITCH

As a safety device, either a surface mounted high temperature cut-off switch with manual reset, factory set at 190° F, or an immersion high temperature cut-off switch with manual reset, factory set at 180° F, is provided. In the event of an over-temperature condition, the thermostat will disengage the operating coils in the magnetic contactor(s). The high limit must be manually reset thereafter to restart the heater.



Immersion High Temperature Cut-Off Switch

Temperature Cut-Off Switch

Hubbell Endurance Series SE

MAGNETIC CONTACTOR

The magnetic contactor(s) is a heavy-duty resistive load type rated for 100,000 cycles. The contactor supplies power to the heating element(s) and is sized based on the resistive load (non-inductive) rating of the circuit. The contactor supplies power only when the thermostatic switch is engaged, thereby pulling in the contacts until the desired temperature is reached. At this point, the contacts will drop out, which in turn disconnects power from the elements.

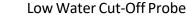
OUTER SHELL AND INSULATION

The tank is encapsulated in 2-inch-thick polyurethane foam insulation. The insulation is protected by a high impact non-corroding colorized composite protective jacket. <u>OPTIONS</u>

The following optional features may be included in your water heater. Reference included drawing specific to your heater for further details.

Low Water Cut-Off

Used as a safety device, the electronic low water cut-off is used to detect a low water situationand disengage the operating coils in the magnetic contactor(s). Once the condition is remedied, the low water cut-off switch is automatically reset.



Fused Low Voltage Transformer

A fused low voltage transformer may be supplied. This option is used to step down higher voltages to 120-volt for the control circuit.



Low Water Cut-Off Relay





control panel control and power circuit wiring.

Type JJS

On/Off Switch

installed in the tank.

Vacuum Relief Valve

Individually Fused Elements

To prevent the possibility of damage to circuits and elements in case of electrical overloads, fuses may be supplied for each circuit. Two types of fuses may be used: a type NON for voltages less than 250-volt or type JJS for voltages less than 600-volt.

A built-in non-fused On/Off disconnect switch may be supplied with the control panel to disconnect power to the

Built-in Circuit Breaker

A built-in circuit breaker may be provided with or without shunt trip protection for protection from circuit overload.

Horizontal Construction

The unit can be designed for horizontal installation, either ceiling hung or base mounted.

Building Management System (BMS)

A Building Management System control package may be supplied for remote operation and alarm capabilities. **Electro-Mechanical Timer**

An electro-mechanical 7-day time clock with battery back-up may be supplied for specific timing operations. A set of instructions will be supplied with the timer.

2½-inch dial may be supplied for in-line installation (shipped loose) or factory

A vacuum relief valve may be provided with the unit to reduce the risk of back siphonage and back pressure of the system. The valve will be shipped loose for in-line installation.

Instructions for installation are provided with the valve.









SECTION II - INSTALLATION

WARNING

DO NOT TURN ON THE ELECTRIC POWER SUPPLY to this equipment until the heater is **completely filled with water and all air has been released**. *If the heater is NOT filled with water when the power is turned on the heating elements will burn out.*

For protection against excessive pressures and temperatures, local codes require the installation of a temperature-and-pressure (T&P) relief valve certified by a nationally recognized laboratory that maintains periodic inspection of production of listed equipment of materials, as meeting the requirements for Relief Valves and Automatic Gas Shutoff for Hot

Water Supply Systems. ANSI Z21.22-1971. THE CUSTOMER IS RESPONSIBLE TO PROTECT PROPERTY AND PERSONNEL FROM HARM WHEN THE VALVE FUNCTIONS.

All water heaters have a risk of leakage at some unpredictable time. IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE A CATCH PAN OR OTHER ADEQUATE MEANS, SO THAT THE RESULTANT FLOW OF WATER WILL NOT DAMAGE FURNISHINGS OR PROPERTY.

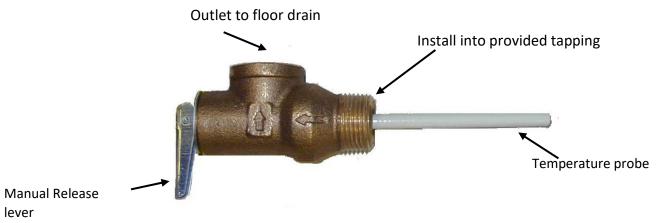
WATER HEATER PLACEMENT

- 1. Place the heater on a solid foundation in a clean, dry location nearest to the point of most frequent hot water use. If the heater is to be raised off the floor, the entire bottom of the heater should be supported by a solid surface.
- 2. The water heater should be protected from freezing and waterlines insulated to reduce energy and water waste.
- 3. Leave a minimum of 18" clearance for element withdrawal, if necessary.
- 4. Do not install in an area where flammable liquids or combustible vapors are present.

PIPING INSTALLATION

NOTE: The most effective means for preventing deterioration from accelerated corrosion due to galvanic and stray current is the installation of dielectric fittings/unions. The installation of these fittings is the responsibility of the installation contractor.

- 1. Connect the cold-water inlet and hot water outlet to the appropriate connections as shown; refer to the drawing for location and sizes.
- 2. Install in line vacuum breaker, if supplied
- 3. Install in line pressure and temperature gauge, if supplied.
- 4. Install the combination temperature and pressure safety relief value in the tapping provided. Note that this is required by law for safety considerations.
- 5. Install a relief valve overflow pipe to a nearby floor drain. CAUTION: No valve of any type should be installed between the relief valve and tank or in the drain line.



Temperature and Pressure Relief Valve

FILLING THE HEATER

- 1. Completely close the drain valve.
- 2. Open the highest hot water faucet to allow all air to escape from piping.
- 3. Open the value to the cold-water inlet and allow the heater and piping system to completely fill, as indicated by a steady flow of water from the open faucet.

ELECTRICAL INSTALLATION

- 1. Enter electric enclosure with properly sized feeder leads. Be sure to properly ground the water heater.
- 2. Install these power leads into the box lugs on the terminal block or magnetic contactor.
- 3. Torque screws per torque chart included in Section VI.
- 4. All other electrical connections are made at the factory; therefore, no other electrical connections are necessary.

FINAL CHECKS

- 1. Check all connections for tightness.
- 2. Ensure that all the above steps are completed.
- 3. After the water is heated for the first time, monitor the water temperature as described in Section III, Quarterly Inspection.

SECTION III - SCHEDULED MAINTENANCE AND OPERATION

WARNING

Before performing any maintenance procedure, make certain power supply is **OFF** and cannot accidentally be turned on.

MAINTENANCE AND OPERATION

The water heater is automatic in its operation. It will maintain a full tank of water at the temperature setting of the thermostat. The water heater should not be turned on without first making sure that the tank is full of water and that all air has been released.

<u>FREEZING</u>

The tank should be fully drained in the event the electricity has been turned off and if there is danger of freezing.

QUARTERLY INSPECTION

- 1. Monitor thermostat.
 - a. Let the water heater completely heat to a designated thermostat setting.
 - b. After the thermostat satisfies (that is, when the thermostat actually clicks off), draw water from heater.
 - c. Compare the water temperature of drawn water to the temperature setting of the thermostat when it satisfies. Normal variation between the two points is approximately \pm 5°F.
 - d. If these two readings do not coincide within acceptable tolerances and verification hasbeen made of the accuracy of the temperature-reading gauge, replace the thermostat.
- 2. Lift test lever on relief valve and let water run through valve for a period of approximately 10 seconds. This will help flush away any sediment that might build up inwater passageways.
- 3. Inspect element flange for leakage as follows:
 - a. Shut off Power Supply.
 - b. Remove element housing cover.
 - c. Visually inspect heating element gasket for evidence of leaks.
 - d. Rub finger around gasket that is between the heating element and tank flange for any evidence of moisture. If moisture is present or a water drip is observed, follow the procedure outlined in Section V.
- 4. Check for loose electrical connections. Tighten as necessary.

ANNUAL INSPECTION

- 1. Flush tank as follows:
 - a. Shut off the power supply.
 - b. Close valve on hot water outlet piping.
 - c. Open valve on drain piping.
 - d. Cold water inlet line pressure will be strong enough to flush sediment from the bottom of the tank out through the drain. Let the water run for 3-4 minutes.
 - e. Close drain valve.
 - f. Open hot water valve.
 - g. Turn the power supply ON.

SECTION IV TROUBLE SHOOTING

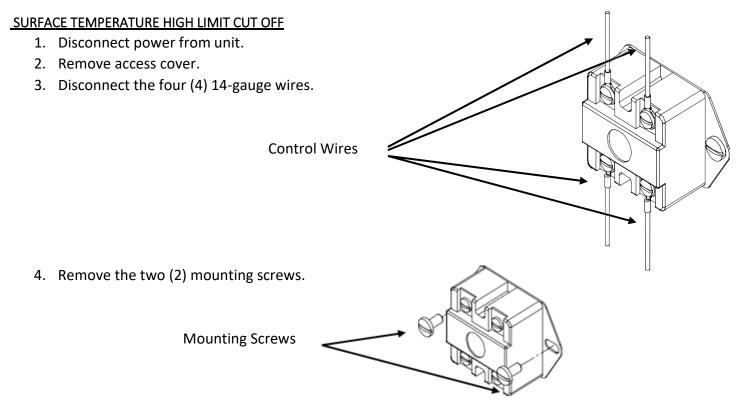
Symptom	Probable Cause	Corrective Action / Remedy		
No hot water	Circuit breaker tripped at	Reset Circuit breaker		
	source			
	On/Off switch in "OFF"	Turn switch to "ON" position		
	position, if installed			
	Circuit breaker at control	Reset circuit breaker		
	cabinet tripped, if installed			
	Blown fuse in element fuse	Replace fuse		
	block, if installed			
	Blown fuse in transformer, if installed	Replace fuse		
		Deast bisk limit av itak		
	High limit switch tripped	Reset high limit switch		
	Loose wires	Tighten wires. Torque screw2s per torque Hart included in Section VI.		
	Heating element inoperable	Check heating element operation by clamping an Amprobe around each wire to the element. The ampere reading should agree with the nameplate 'AMP' figure.		
	Low line voltage.	Have source electrical system checked by an electrician		
	Faulty thermostat	Move thermostat dial through full range. A definite 'click' should be heard. If not, replace thermostat.		
	Faulty low water cut-off, if installed.	Check to see if the tank is full of water. If not, fill the tank. If the problem continues and the tank is full, check for continuity between the common and normally open contact of the relay board. If continuity is not observed, replace low water cut-off.		
	Magnetic contactor does not energize	Replace complete magnetic contactor. Because of the design of this particular contactor, it is more desirable to replace complete control rather than rebuilding coil, contacts and springs, etc.		
Water temperature below settings at all times.	Faulty thermostat.	Check thermostat adjustment. Monitor thermostat as described in Section III, Quarterly Inspection. Replace if necessary.		
	Blown fuse in element fuse block, if installed	Replace fuse.		

Water temperature below	Heating element not working on	Check to see that heating element is
settings at all times	all phases	working on all phases, by checking the
(continued)		resistance (ohms) value for each element
		and comparingwith the chart included in
		Section VI.
	Heater improperly sized	Verify heater is properly sized for the
		flow rate and temperature rise of your
		system. See formulas included in Section
		VI. Replace elements with proper size as
		necessary
Relief valve discharges	Excessive temperature or	Temperature and pressure relief valves
continuously	pressure in tank	are made to operate if the water
		temperature exceeds 210°F or water
		pressure exceeds the pressure rating of
		the safety relief valve. If trouble is
		excessive temperature, then thermostat
		is not shutting off at the right setting and
		thermostat must be replaced

SECTION V - SERVICING & REPLACEMENT OF PARTS

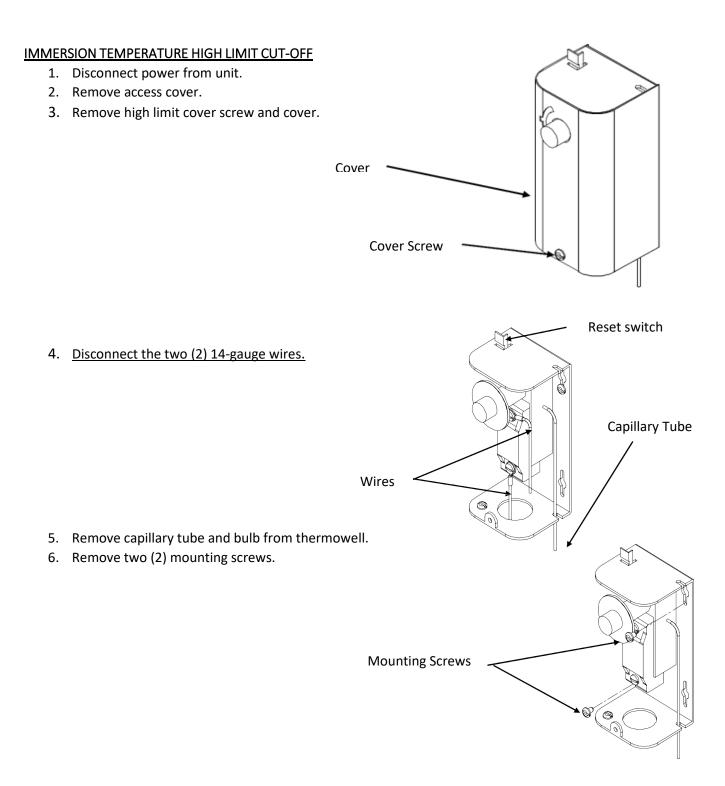
WARNING

Before servicing or replacing any part make sure to turn the power supply switch to the OFF position.



5. Replace control and install new high limit switch by performing above steps in reverse order.

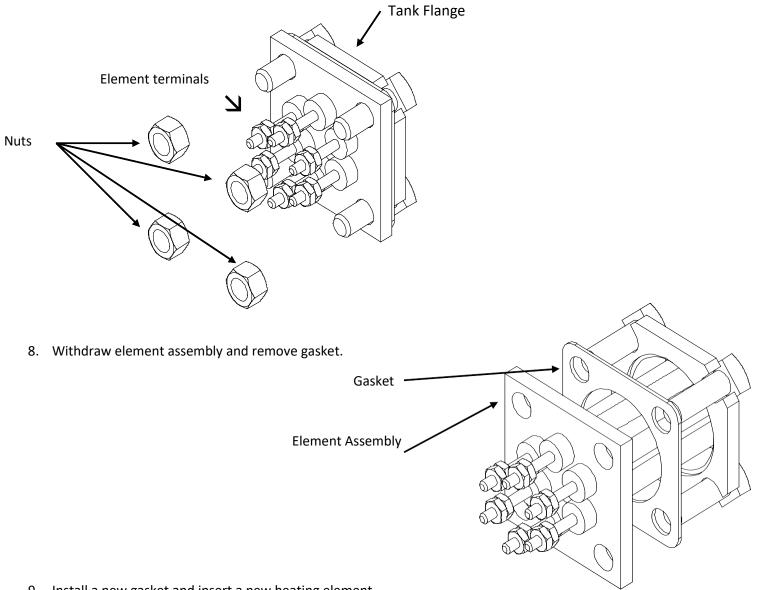
See the drawing specific for your heater.



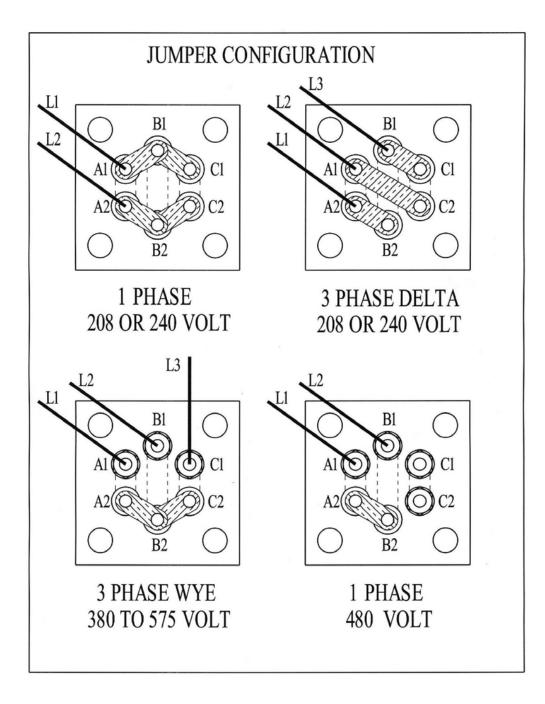
7. Remove control and install new high limit switch by performing above steps in reverse order. (Note: Be sure to place capillary tube into slot in base prior to installing cover.)

HEATING ELEMENT

- 1. Disconnect power from unit.
- 2. Shut off incoming water supply.
- 3. Attach hose to drain connection.
- 4. Lift manual release lever on relief valve to let air into system or break union on outgoing water line.
- 5. Drain water from tank.
- 6. Disconnect the wires from the heating element terminals.
- 7. Remove the 3/8 -16 nuts.

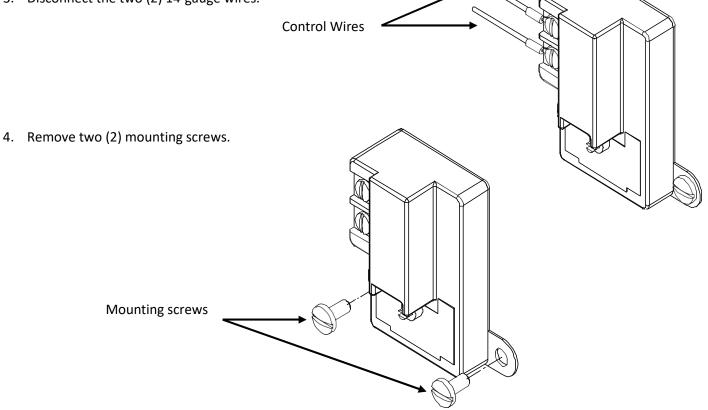


- 9. Install a new gasket and insert a new heating element.
- 10. Rewire element according to the voltage and phase rating of the unit as shown below.
- 11. Fill the tank and check around the gasket for any leaks.



SURFACE MOUNTED THERMOSTAT

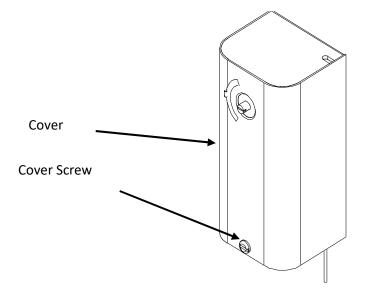
- 1. Disconnect power from unit.
- 2. Remove access cover and locate thermostat.
- 3. Disconnect the two (2) 14-gauge wires.



5. Replace thermostat using the reverse procedure.

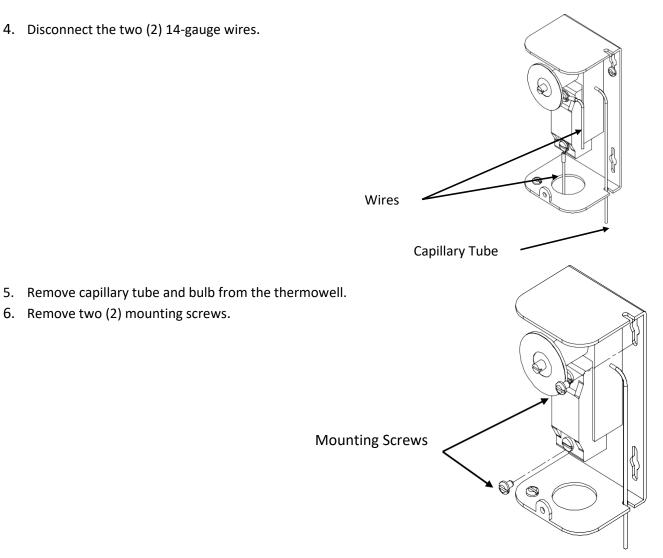
IMMERSION THERMOSTAT

- 1. Disconnect power from unit.
- 2. Remove access cover and locate thermostat.
- 3. Remove high limit over screw and cover.



4. Disconnect the two (2) 14-gauge wires.

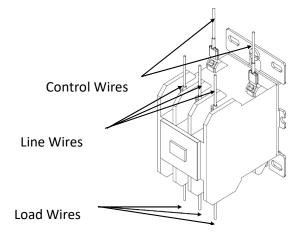
6. Remove two (2) mounting screws.



7. Replace thermostat using reverse procedure. (Note: Be sure to place capillary tube into slot in base prior to installing cover.

MAGNETIC CONTACTOR

- 1. Disconnect power from unit.
- 2. Disconnect line and load wires to contactor.
- 3. Disconnect two (2) 14-gauge control circuit wires.



4. Loosen two (2) holding screws and remove contactor.

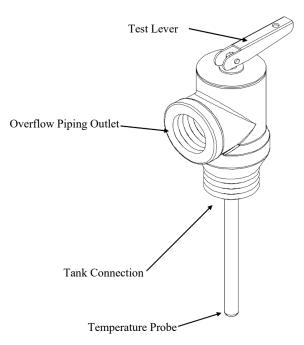
Mounting Screws

(Botton screw not shown)

5. Replace with new contactor using reverse procedure

RELIEF VALVE

- 1. Disconnect power from unit.
- 2. Shut off incoming water supply.
- 3. Lift test lever on relief valve to relieve pressure in tank.
- 4. Disconnect overflow piping.
- 5. Unscrew relief valve, remove assembly, and replace with new one.
- 6. Connect overflow piping.
- 7. Turn on incoming water supply and check for leaks.
- 8. Turn safety switch to ON position



SECTION VI – MISCELLANEOUS CHARTS AND FORMULAS

Element	Immersion	Resistance (Ohms)				
Part #	Length	Hairpin	1Φ	3 Φ DELTA	3 Φ WYE	
<mark>2-38683N</mark>	13"	57.6	19.2	57.6	38.6	
3-38683N	13"	43.2	14.4	43.2	28.9	
<mark>4-38683N</mark>	13"	34.4	11.5	34.4	23.0	
<mark>5-38683N</mark>	13"	27.9	9.3	27.9	18.7	
<mark>6-38683N</mark>	13"	21.6	7.2	21.6	14.5	
7-38683N	13"	17.1	5.7	17.1	11.5	
<mark>8-38683N</mark>	13"	14.4	4.8	14.4	9.6	
<mark>9-38683N</mark>	15"	12.1	4.0	12.1	8.1	
10-38683N	15"	9.1	3.0	9.1	6.1	
11-38683N	15"	7.5	2.5	7.5	5.0	

ELEMENT CHART

FORMULAS

RECOVERY

GPH x	$^{\circ}$ F Δ T x 0.00244 = KW
KW x 410 \div GPH =	°F Δτ
KW x 410 ÷	
and a second second second	

Note: 1 KW will heat 4.1 GPH at a $100^{\circ}F \Delta T$

ELECTRICAL

- $\frac{\text{KW x 1000}}{\text{Volts}} \div 1.73 = \text{Amps 3} \Phi$
- $\frac{KW \times 1000}{Volts} = Amps \ 1 \ \Phi$

METRIC CONVERSION

Liters x 0.2641 = Gallons Gallons x 3.79 = Liters Gallons x 0.003785 = m³ m³ x 264.2 = Gallons 1°C Δ T = 1.8°F Δ T °F = (°C x 1.8) + 32 °C = (°F - 32) x 0.556 psi x 0.06896 = Bar Bar x 14.5 = psi psi x 6.86 = kPa kPa x 0.1456 = psi Lbs x 0.4536 = Kg Kg x 2.2 = Lbs Watts/Sq.Cm. x 6.4 = Watts/Sq.In. Watts/Sq.In. x 0.155 = Watts/Sq.Cm. Torque Values

BOLT SIZE 18-8 S/S IN-LBS. BRASS IN-LBS. SILICON BRONZE IN-LBS. ALUMINUM 2024-T4 IN-LBS. 316 S/S IN-LBS. MONEL IN-LBS. 4-40 5.2 4.3 4.8 2.9 5.5 5.3 4-48 6.6 5.4 6.1 3.6 6.9 6.7 5-40 7.7 6.3 7.1 4.2 8.1 7.8 5-44 9.4 7.7 8.7 5.1 9.8 9.6 6-32 9.6 7.9 8.9 5.3 10.1 9.8 6-40 12.1 9.9 11.2 6.6 12.7 12.3 8-32 19.8 16.2 18.4 10.8 20.7 20.2 8-36 22.0 18.0 20.4 12.0 23.0 22.4 10-24 22.8 18.6 21.2 13.8 23.8 25.9 10-32 31.7 25.9 29.3 19.2 33.1 34.9 1/4-20 75.2 61.5 <							
4.48 6.6 5.4 6.1 3.6 6.9 6.7 5.40 7.7 6.3 7.1 4.2 8.1 7.8 5.44 9.4 7.7 8.7 5.1 9.8 9.6 6.32 9.6 7.9 8.9 5.3 10.1 9.8 6.40 12.1 9.9 11.2 6.6 12.7 12.3 8.32 19.8 16.2 18.4 10.8 20.7 20.2 8.36 22.0 18.0 20.4 12.0 23.0 22.4 10.24 22.8 18.6 21.2 13.8 23.8 25.9 10.32 31.7 25.9 29.3 19.2 33.1 34.9 $1/4-20$ 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-14$ 752 615 697 456 787 855 $5/8-11$ 110 907 1030 715 1160 1330 $5/8-18$	BOLT SIZE			BRONZE	2024-T4		
5-407.7 6.3 7.1 4.2 8.1 7.8 $5-44$ 9.4 7.7 8.7 5.1 9.8 9.6 $6-32$ 9.6 7.9 8.9 5.3 10.1 9.8 $6-40$ 12.1 9.9 11.2 6.6 12.7 12.3 $8-32$ 19.8 16.2 18.4 10.8 20.7 20.2 $8-36$ 22.0 18.0 20.4 12.0 23.0 22.4 $10-24$ 22.8 18.6 21.2 13.8 23.8 25.9 $10-32$ 31.7 25.9 29.3 19.2 33.1 34.9 $1/4-20$ 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-24$ 259 212 240 157 271 294 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110	4-40	5.2	4.3	4.8	2.9	5.5	5.3
5-44 9.4 7.7 8.7 5.1 9.8 9.6 $6-32$ 9.6 7.9 8.9 5.3 10.1 9.8 $6-40$ 12.1 9.9 11.2 6.6 12.7 12.3 $8-32$ 19.8 16.2 18.4 10.8 20.7 20.2 $8-36$ 22.0 18.0 20.4 12.0 23.0 22.4 $10-24$ 22.8 18.6 21.2 13.8 23.8 25.9 $10-32$ 31.7 25.9 29.3 19.2 33.1 34.9 $1/4-20$ 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-24$ 259 212 240 157 271 294 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ <td>4-48</td> <td>6.6</td> <td>5.4</td> <td>6.1</td> <td>3.6</td> <td>6.9</td> <td>6.7</td>	4-48	6.6	5.4	6.1	3.6	6.9	6.7
6-329.67.98.95.310.19.8 $6-40$ 12.19.911.26.612.712.3 $8-32$ 19.816.218.410.820.720.2 $8-36$ 22.018.020.412.023.022.4 $10-24$ 22.818.621.213.823.825.9 $10-32$ 31.725.929.319.233.134.9 $1/4-20$ 75.261.568.845.678.885.3 $1/4-28$ 94.077.087.057.099.0106.0 $5/16-18$ 13210712380138149 $5/16-24$ 14211613186147160 $3/8-16$ 236192219143247266 $3/8-24$ 259212240157271294 $7/16-14$ 376317349228393427 $7/16-20$ 400327371242418451 $1/2-13$ 517422480313542584 $1/2-20$ 541443502328565613 $9/16-12$ 682558632413713774 $9/16-18$ 752615697456787855 $5/8-11$ 1110907103071511601330 $5/8-18$ 12441016115479813011482 $3/4-10$ 1530 <td>5-40</td> <td>7.7</td> <td>6.3</td> <td>7.1</td> <td>4.2</td> <td>8.1</td> <td>7.8</td>	5-40	7.7	6.3	7.1	4.2	8.1	7.8
6-4012.19.911.26.612.712.3 $8-32$ 19.816.218.410.820.720.2 $8-36$ 22.018.020.412.023.022.4 $10-24$ 22.818.621.213.823.825.9 $10-32$ 31.725.929.319.233.134.9 $1/4-20$ 75.261.568.845.678.885.3 $1/4-28$ 94.077.087.057.099.0106.0 $5/16-18$ 13210712380138149 $5/16-24$ 14211613186147160 $3/8-16$ 236192219143247266 $3/8-24$ 259212240157271294 $7/16-14$ 376317349228393427 $7/16-20$ 400327371242418451 $1/2-13$ 517422480313542584 $1/2-20$ 541443502328565613 $9/16-18$ 752615697456787855 $5/8+11$ 1110907103071511601330 $5/8-18$ 12441016115479813011482 $3/4-16$ 14901220138295815581790 $7/8-9$ 232819052140149524302775 $7/8-14$ <	5-44	9.4	7.7	8.7	5.1	9.8	9.6
8-32 19.8 16.2 18.4 10.8 20.7 20.2 $8-36$ 22.0 18.0 20.4 12.0 23.0 22.4 $10-24$ 22.8 18.6 21.2 13.8 23.8 25.9 $10-32$ 31.7 25.9 29.3 19.2 33.1 34.9 $1/4-20$ 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-$	6-32	9.6	7.9	8.9	5.3	10.1	9.8
8-36 22.0 18.0 20.4 12.0 23.0 22.4 $10-24$ 22.8 18.6 21.2 13.8 23.8 25.9 $10-32$ 31.7 25.9 29.3 19.2 33.1 34.9 $1/4-20$ 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-16$ 1490 1220 1382 958 1558 1790 $7/8$	6-40	12.1	9.9	11.2	6.6	12.7	12.3
10-24 22.8 18.6 21.2 13.8 23.8 25.9 $10-32$ 31.7 25.9 29.3 19.2 33.1 34.9 $1/4-20$ 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-16$ 1490 1220 1382 958 1558 1790 $7/8-9$ 2328 1905 2140 1495 2430 2775 $7/$	8-32	19.8	16.2	18.4	10.8	20.7	20.2
10-32 31.7 25.9 29.3 19.2 33.1 34.9 $1/4-20$ 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-16$ 1490 1220 1382 958 1558 1790 $7/8-9$ 2328 1905 2140 1495 2430 2775 $7/8-14$ 2318 1895 2130 1490 2420 2755 1	8-36	22.0	18.0	20.4	12.0	23.0	22.4
1/4-20 75.2 61.5 68.8 45.6 78.8 85.3 $1/4-28$ 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-10$ 1530 1249 1416 980 1582 1832 $3/4-16$ 1490 1220 1382 958 1558 1790 $7/8-9$ 2328 1905 2140 1495 2430 2775 $7/8-14$ 2318 1895 2130 1490 2420 2755 1	10-24	22.8	18.6	21.2	13.8	23.8	25.9
1/4-28 94.0 77.0 87.0 57.0 99.0 106.0 $5/16-18$ 132 107 123 80 138 149 $5/16-24$ 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-10$ 1530 1249 1416 980 1582 1832 $3/4-16$ 1490 1220 1382 958 1558 1790 $7/8-9$ 2328 1905 2140 1495 2430 2775 $7/8-14$ 2318 1895 2130 1490 2420 2755 $1-8$ 3440 2815 3185 2205 3595 4130 <td>10-32</td> <td>31.7</td> <td>25.9</td> <td>29.3</td> <td>19.2</td> <td>33.1</td> <td>34.9</td>	10-32	31.7	25.9	29.3	19.2	33.1	34.9
5/16-18132107123801381495/16-24142116131861471603/8-162361922191432472663/8-242592122401572712947/16-143763173492283934277/16-204003273712424184511/2-135174224803135425841/2-205414435023285656139/16-126825586324137137749/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	1/4-20	75.2	61.5	68.8	45.6	78.8	85.3
5/16-24 142 116 131 86 147 160 $3/8-16$ 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-10$ 1530 1249 1416 980 1582 1832 $3/4-16$ 1490 1220 1382 958 1558 1790 $7/8-9$ 2328 1905 2140 1495 2430 2775 $7/8-14$ 2318 1895 2130 1490 2420 2755 $1-8$ 3440 2815 3185 2205 3595 4130	1/4-28	94.0	77.0	87.0	57.0	99.0	106.0
3/8-16 236 192 219 143 247 266 $3/8-24$ 259 212 240 157 271 294 $7/16-14$ 376 317 349 228 393 427 $7/16-20$ 400 327 371 242 418 451 $1/2-13$ 517 422 480 313 542 584 $1/2-20$ 541 443 502 328 565 613 $9/16-12$ 682 558 632 413 713 774 $9/16-18$ 752 615 697 456 787 855 $5/8-11$ 1110 907 1030 715 1160 1330 $5/8-18$ 1244 1016 1154 798 1301 1482 $3/4-10$ 1530 1249 1416 980 1582 1832 $3/4-16$ 1490 1220 1382 958 1558 1790 $7/8-9$ 2328 1905 2140 1495 2430 2775 $7/8-14$ 2318 1895 2130 1490 2420 2755 $1-8$ 3440 2815 3185 2205 3595 4130	5/16-18	132	107	123	80	138	149
3/8-242592122401572712947/16-143763173492283934277/16-204003273712424184511/2-135174224803135425841/2-205414435023285656139/16-126825586324137137749/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	5/16-24	142	116	131	86	147	160
7/16-143763173492283934277/16-204003273712424184511/2-135174224803135425841/2-205414435023285656139/16-126825586324137137749/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	3/8-16	236	192	219	143	247	266
7/16-204003273712424184511/2-135174224803135425841/2-205414435023285656139/16-126825586324137137749/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	3/8-24	259	212	240	157	271	294
1/2-135174224803135425841/2-205414435023285656139/16-126825586324137137749/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	7/16-14	376	317	349	228	393	427
1/2-205414435023285656139/16-126825586324137137749/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	7/16-20	400	327	371	242	418	451
9/16-126825586324137137749/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	1/2-13	517	422	480	313	542	584
9/16-187526156974567878555/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	1/2-20	541	443	502	328	565	613
5/8-1111109071030715116013305/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	9/16-12	682	558	632	413	713	774
5/8-18124410161154798130114823/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	9/16-18	752	615	697	456	787	855
3/4-10153012491416980158218323/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	5/8-11	1110	907	1030	715	1160	1330
3/4-16149012201382958155817907/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	5/8-18	1244	1016	1154	798	1301	1482
7/8-92328190521401495243027757/8-142318189521301490242027551-8344028153185220535954130	3/4-10	1530	1249	1416	980	1582	1832
7/8-142318189521301490242027551-8344028153185220535954130	3/4-16	1490	1220	1382	958	1558	1790
1-8 3440 2815 3185 2205 3595 4130	7/8-9	2328	1905	2140	1495	2430	2775
	7/8-14	2318	1895	2130	1490	2420	2755
1-14 3110 2545 2885 1995 3250 3730	1-8	3440	2815	3185	2205	3595	4130
	1-14	3110	2545	2885	1995	3250	3730

HUBBELL ELECTRIC HEATER COMPANY 45 SEYMOUR STREET STRATFORD, CT 06615

PHONE: (203) 378-2659 FAX: (203) 378-3593 <u>Hubbellheaters.com</u>