



OPERATING AND MAINTENANCE MANUAL

SIGNATURE SH & H

7/6/23



-IMPORTANT-

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

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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 by removing 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 components inside 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. To avoid casualties, always turn the power supply safety switch to off, turn the charge or ground the circuit before performing any maintenance or adjustment procedure.
6. Generalized instructions and procedures cannot anticipate all situations. For this reason, only qualified installers should perform the installations. A qualified installer is a person who 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.

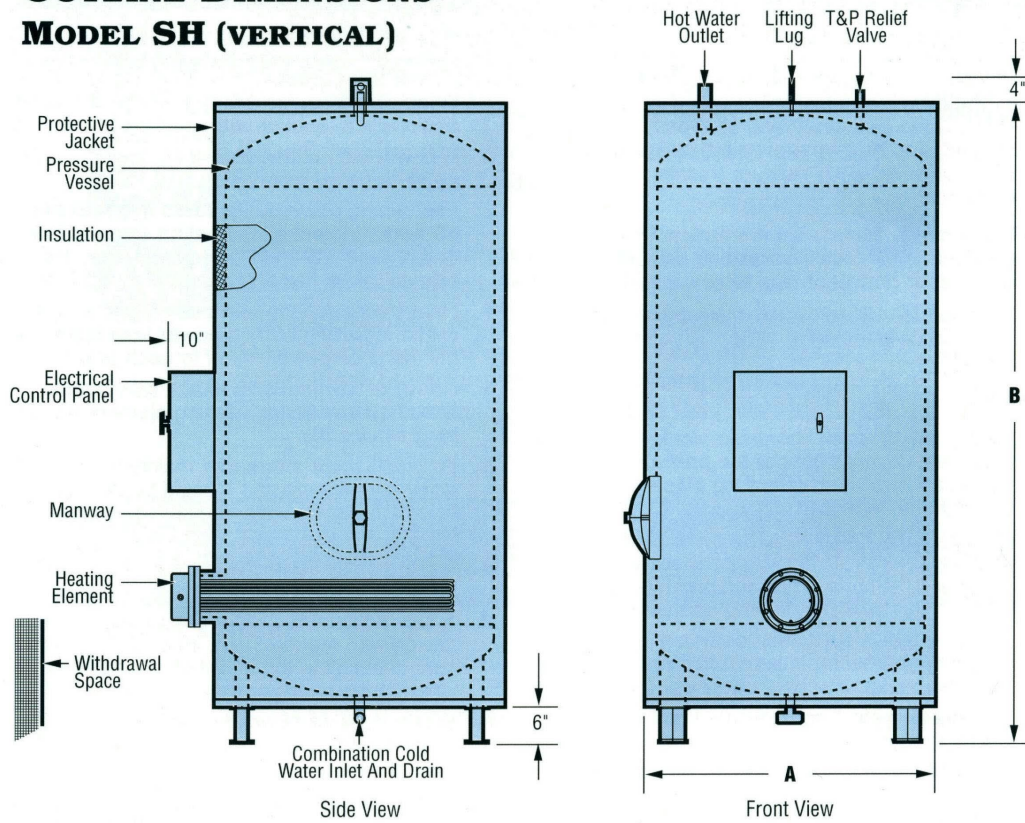
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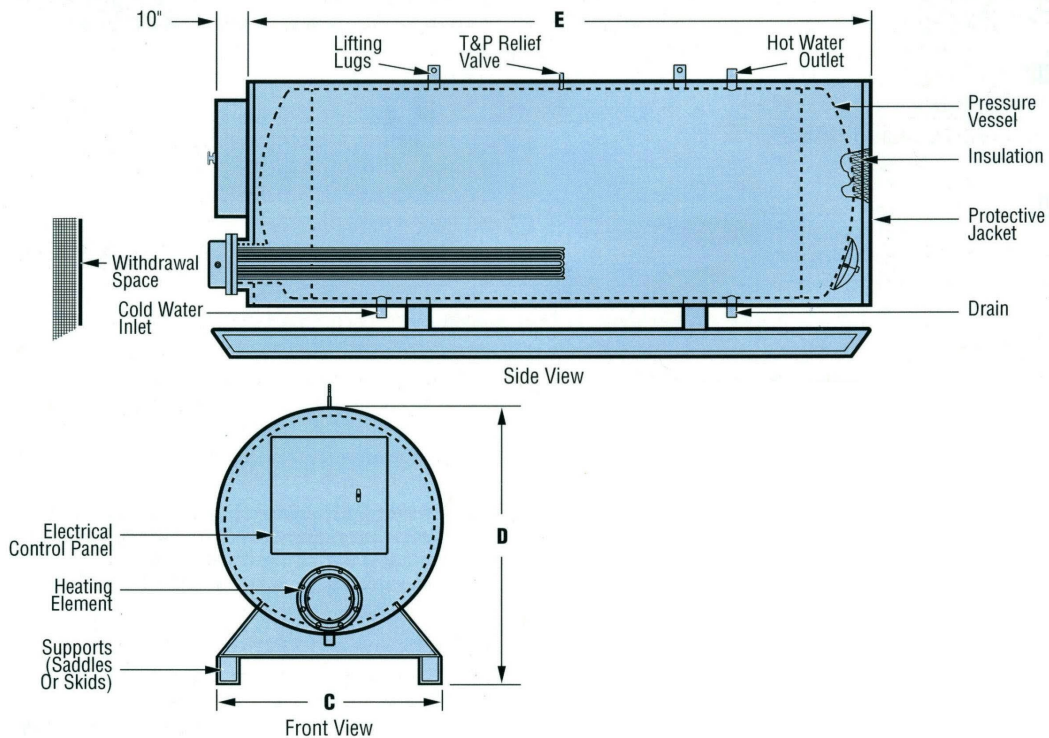
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SECTION I – OUTLINE DIMENSIONS

OUTLINE DIMENSIONS MODEL SH (VERTICAL)



MODEL H (HORIZONTAL)



OVERALL DIMENSIONS, MODELS SH AND H

Storage Capacity (Gallons)	Overall Dimensions (Inches)					Storage Tank Diameter x Length	Inlet Outlet Sizing (NPT)	Approx. Shipping Weight (Lbs.)
	Vertical		Horizontal					
	Diameter "A"	Height "B"	Width "C"	Height "D"	Length "E"			
80	28	56	28	34	50	24 x 46	1.5	1000
120	28	75	28	34	69	24 x 65	1.5	1150
150	34	65	34	40	59	30 x 55	1.5	1300
175	34	73	34	40	67	30 x 63	1.5	1500
200	34	82	34	40	76	30 x 72	1.5	1700
225	34	89	34	40	83	30 x 79	1.5	1750
250	40	74	40	46	68	36 x 64	1.5	1850
275	40	80	40	46	74	36 x 70	1.5	2000
300	40	88	40	46	82	36 x 78	1.5	2180
325	40	92	40	46	86	36 x 82	1.5	2300
350	40	94	40	46	88	36 x 84	1.5	2500
375	46	81	46	52	75	42 x 71	1.5	2600
400	46	85	46	52	79	42 x 75	1.5	2700
425	46	88	46	52	82	42 x 78	1.5	2900
450	46	93	46	52	87	42 x 83	1.5	3000
475	52	79	52	58	73	48 x 69	2	3100
500	52	82	52	58	76	48 x 72	2	3225
525	52	85	52	58	79	48 x 75	2	3350
550	52	89	52	58	83	48 x 79	2	3400
575	52	93	52	58	87	48 x 83	2	3500
600	52	95	52	58	89	48 x 85	2	3650
700	52	107	52	58	101	48 x 97	2	4000
800	52	119	52	58	113	48 x 109	2	4300
900	52	132	52	58	126	48 x 122	2	4800
1000	52	145	52	58	139	48 x 135	2	5200
1250	58	149	58	64	143	54 x 139	2	5600
1500	58	174	58	64	168	54 x 164	2	6000
1750	64	168	64	70	162	60 x 158	3	7400
2000	64	185	64	70	179	60 x 175	3	8100
2500	76	169	76	82	163	72 x 159	3	8200
3000	76	197	76	82	191	72 x 187	3	8300
3500	88	174	88	94	168	84 x 164	6 FLG.	8900
4000	88	195	88	94	189	84 x 185	6 FLG.	9800
4500	N/A	N/A	94	100	178	90 x 174	6 FLG.	10700
5000	N/A	N/A	94	100	100	90 x 196	6 FLG.	11600

SECTION II – RECOVERY RATINGS AND AMPERAGE AT SELECTED KW

RECOVERY RATINGS AND AMPERAGE AT SELECTED KW

KW INPUT	BTU/HR RATING	Gallons Per Hour (GPH) Heated At Various Temperature Rises					Amperage Rating At Various Voltages				
		60°F Δ	80°F Δ	100°F Δ	120°F Δ	140°F Δ	208V 3Φ	240V 3Φ	380V 3Φ	415V 3Φ	480V 3Φ
15	51,195	103	77	62	51	44	42	36	23	21	18
20	68,260	137	103	82	68	59	56	48	30	28	24
25	85,325	171	128	103	85	73	69	60	38	35	30
30	102,390	205	154	123	103	88	83	72	46	42	36
35	119,455	239	179	144	120	103	97	84	53	49	42
40	136,520	273	205	164	137	117	111	96	61	56	48
45	153,585	308	231	185	154	132	125	108	68	63	54
50	170,650	342	256	205	171	146	139	120	76	70	60
55	187,715	376	282	226	188	161	153	132	84	77	66
60	204,780	410	308	246	205	176	167	145	91	84	72
65	221,845	444	333	267	222	190	181	157	99	91	78
70	238,910	478	359	287	239	205	195	169	106	97	84
75	255,975	513	384	308	256	220	208	181	114	104	90
80	273,040	547	410	328	273	234	222	193	122	111	96
85	290,105	581	436	349	290	249	236	205	129	118	102
90	307,170	615	461	369	308	264	250	217	137	125	108
95	324,235	649	487	390	325	278	264	229	145	132	114
100	341,300	683	513	410	342	293	278	241	152	139	120
110	375,430	752	564	451	376	322	306	265	167	153	132
120	409,560	820	615	492	410	351	333	289	183	167	145
125	426,625	854	641	513	427	366	347	301	190	174	151
150	511,950	1025	769	615	513	439	417	361	228	209	181
175	597,275	1196	897	718	598	513	486	421	266	244	211
200	682,600	1367	1025	820	683	586	556	482	304	279	241
225	767,925	1538	1153	923	769	659	625	542	342	313	271
250	853,250	1708	1281	1025	854	732	695	602	380	348	301
275	938,575	1879	1409	1128	940	805	764	662	418	383	331
300	1,023,900	2050	1538	1230	1025	879	834	723	456	418	361
325	1,109,225	2221	1666	1333	1110	952	903	783	494	453	391
350	1,194,550	2392	1794	1435	1196	1025	973	843	532	487	421
375	1,279,875	2563	1922	1538	1281	1098	1042	903	570	522	452
400	1,365,200	2733	2050	1640	1367	1171	1112	963	608	557	482
450	1,535,850	3075	2306	1845	1538	1318	1251	1084	685	627	542
500	1,706,500	3417	2563	2050	1708	1464	1390	1204	761	696	602
1000	3,412,000	6833	5125	4100	3417	2929	2779	2408	1521	1393	1204
1200	4094400	8200	6150	4920	4100	3514	3335	2890	1825	1671	1445
1400	4776800	9567	7175	5740	4783	4100	3891	3372	2130	1950	1686
1600	5459200	10933	8200	6560	5467	4686	4446	3854	2434	2229	1927

Notes:

1. The KW selections above are shown for convenience. A full selection of KW ratings from 1 to 1600 KW is available by entering the desired KW into the model number.

SECTION III – GENERAL DESCRIPTION AND CONSTRUCTION

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), power circuit fusing, fused low voltage control circuit transformer, 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

TANK

Standard Tank Construction:

The standard storage tank is constructed of all welded carbon steel, designed and built in accordance with ASME Section IV and stamped, certified, and registered with the National Board of Boiler and Pressure Vessel Inspectors. It is internally lined with specially formulated HydraStone cement to a 5/8- inch minimum thickness for superior protection and tank longevity.

Optional Tank Linings:

1. Phenolic – An epoxy coating applied in two coats to a total thickness of 10-12 mils. Typically used in process applications using low conductivity deionized (DI), distilled, or food grade water.
2. Copper – A 3lb./sq. ft. copper sheet approximately 0.0646-inches thick covers all interior surfaces. All copper sheet seams are factory tested to ensure long lasting protection of the steel vessel.
3. Flame-Spray Copper – Molten copper is sprayed on the interior surfaces to a thickness of 5-6 mils. The copper bonds to the steel, and an additional overcoat of Phenolic lining is applied on the copper to seal all pores.
4. Galvanizing – The steel pressure vessel is pickled and hot dipped in molten zinc to create a barrier which internally and externally protects the steel vessel for cold and hot water storage.

Optional Non-Ferrous Tank Materials:

1. Copper-Silicon – A copper-silicon alloy offers tremendous tank longevity due to its ability to withstand the cycling effects induced from changes in water temperature and pressure. This material is suitable for storage of hot potable water in a variety of commercial and industrial applications.
2. 90/10 Copper-Nickel – A 90% copper and 10% nickel alloy similar to copper-silicon, but with added strength and corrosion resistance. Typically used in applications with corrosive environments (salt water) or critical applications.
3. Stainless Steel – Stainless steel (type 304, 316, or 316L) is well suited for high purity applications requiring a corrosion resistant tank with minimal leaching of impurities into the water. Well suited for process, RO, and DI water systems in the pharmaceutical, food, and electronic industries.

Optional Working Pressures:

The tank may be supplied with optional working pressures (standard working pressure is 125 psi). See the drawing for details.

TANK CONNECTIONS

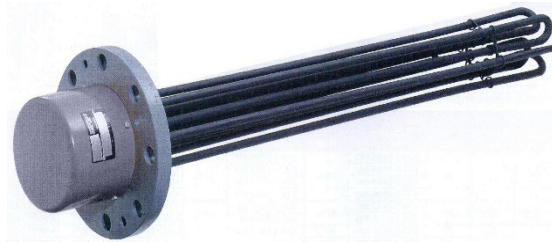
The heater is supplied with separate cold water and hot water connections. A FNPT connection is provided for mounting a combination safety temperature and pressure relief valve. An overflow line should be utilized from the relief valve outlet to a floor drain. See the drawing for locations and sizes.

OUTER SHELL, INSULATION, AND SUPPORTS

The tank is encapsulated in 2-inches of high-density fiberglass insulation. The protective shell is constructed of galvaneal and is coated with a durable gray hammertone finish. The entire vessel is supported on heavy-duty integrally welded steel supports for sturdy floor mounting.

HEATING ELEMENT

The water heater is supplied with a flanged electric immersion heating element assembly, composed of copper, incoloy, or stainless-steel sheathed elements. Each assembly is fastened to a corresponding tank flange using a gasket and hex head steel bolts and nuts. Specialized heating element construction may be included. These options include special watt density ratings, passivation, electropolishing, or special materials. See drawing for voltage, power ratings, and special options.



ELECTRICAL ENCLOSURE

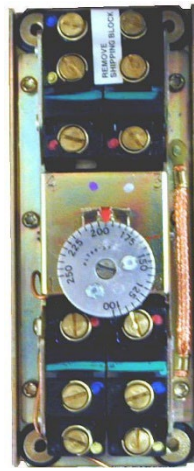
A louvered control panel available in various sizes and with assorted types of handles is supplied. The standard cabinet is rated NEMA 1, but other NEMA rated enclosures are available, consult drawing for further information. A list of NEMA ratings are available in Section VI.

CONTROL THERMOSTAT

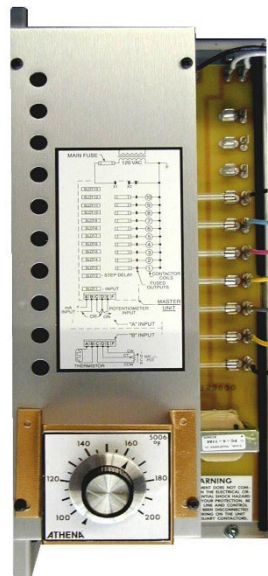
The control panel is supplied standard with a single-stage immersion thermostatic switch. As an optional any of the following may be supplied; a four-stage immersion thermostatic switch, a solid-state staging controller with thermistor, or a digital 1/16 DIN temperature controller with thermocouple. See the drawing for specific details. The single-stage immersion thermostat can be adjusted through a range of 100° - 190° F. A low range, (30° - 110° F), operating thermostat is also available in the single-stage version. The four-stage immersion thermostat can be adjusted through a range of 100° - 250° F and is capable of switching four stages. The solid-state staging controller has a range of 100° - 200° F and provides control of up to ten stages. This thermostat automatically brings on-line the required number of heating steps in order to meet the hot water demand and will also operate each circuit in a circular mode to allow for equal usage of all heating circuits. A 1/16 DIN electronic temperature control package may be installed. A separate manufacturer's operating manual will be supplied with all units except the single-stage immersion thermostat.



Single-Stage Immersion Thermostat



Four-Stage Immersion Thermostat



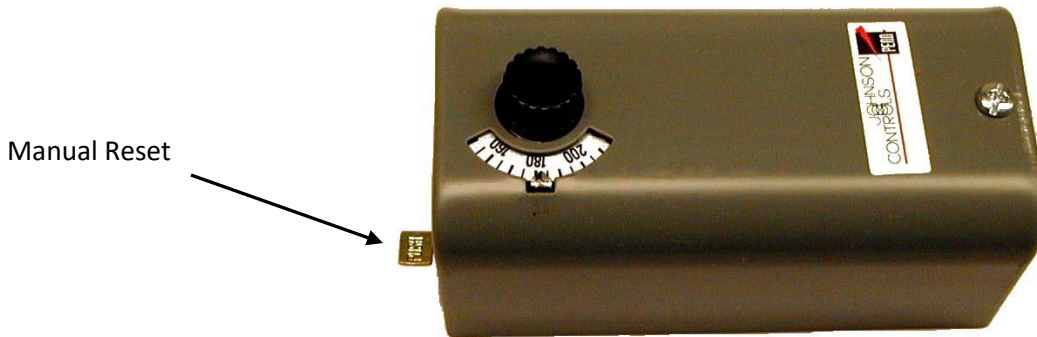
Solid State Staging Controller



1/16 DIN Digital Display

TEMPERATURE HIGH LIMIT SWITCH

As a safety device, an immersion high temperature cut-off switch with manual reset, adjustable through a range of 100° - 240° F, is provided. The high limit must be manually reset in order to engage the control circuit thereafter to restart the heater. Optionally a 1/16 DIN digital controller may be used as a high limit. A separate manufacturers operating manual will be supplied for this option.



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) based on the resistive load (non-inductive) of the heater 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.



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 safety when working with control circuits.



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.



OPTIONS

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

Stainless Steel Jacket

An optional stainless steel outer jacket may replace the standard galvanized covering. This optional jacket may be painted.

Skid Mounting

Optionally, the unit may be mounted on heavy-duty all welded I-beams.

On / Off Switch

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

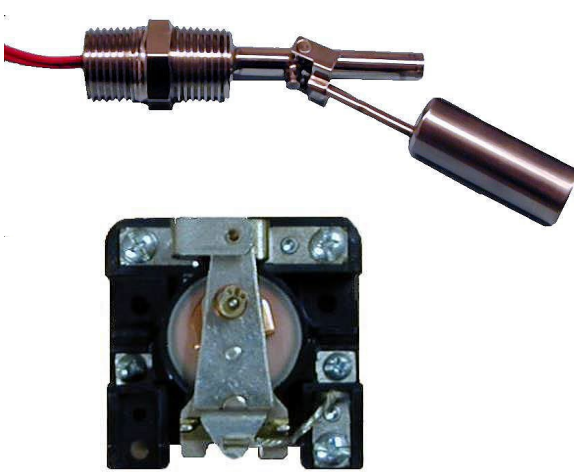
Built-In Circuit Breaker

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

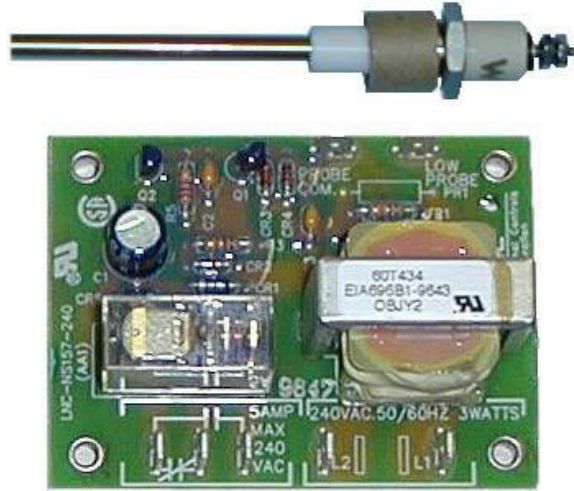


Low Water Cut-Off

Used as a safety device, the electronic low water cut-off is used to detect a low water situation and disengage the operating coils in the magnetic contactor(s). Once the condition is remedied, the low water cut-off switch is automatically reset. Two types of low water cut-offs are available; the float type and the conductive style.



Float Type Low Water Cut-Off
Probe and Relay



Conductive Type Low Water Cut-Off
Probe and Relay

Audible Alarm

An audible alarm may be installed on the outside of the control panel to give warning of a fault condition.



Building Management System (BMS)

A Building Management System control package may be supplied for remote operation and alarm capabilities.

Status Indicating Lamp(s)

Optional status indicating lamps may be installed to show when the unit is on, when the heating element is energized, or if there is an alarm condition.

Silicon Control Rectifier

A silicon control rectifier (SCR) “zero fired” power controller for 0-100% proportional control of heaters may be supplied.

Circulating Pump Package

An intra-tank circulation pump package with On/Off switch to continuously circulate water within the tank and thereby reduce stratification may be installed. An all-bronze circulator pump, rated 1/25 HP, 120V, 1Ph, is used.

Dial Temperature and Pressure Gauge

A combination temperature (70° - 250° F) and pressure (0 – 200 psi) gauge with 2½-inch dial may be supplied for in-line installation (shipped loose) or factory installed in the tank.



Vacuum Relief Valve

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.



Special Customized Features

Please reference the drawing for details.

SECTION IV – INSTALLATION

WARNING / CAUTION

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

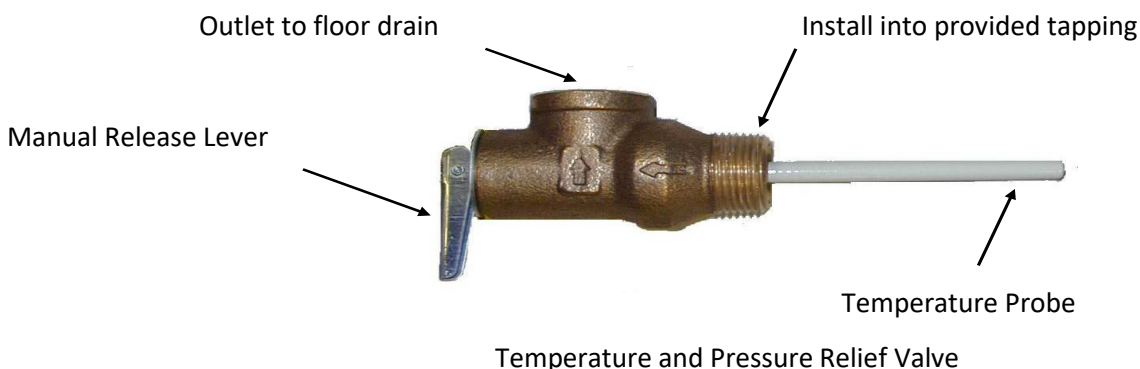
1. Place the heater on a solid foundation in a clean, dry location nearest to the point of most frequent hot water use.
2. The water heater should be protected from freezing and waterlines insulated to reduce energy and water waste.
3. Leave sufficient clearance for element withdrawal, if necessary.
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 installing 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 an in-line vacuum breaker and in-line pressure and temperature gauge, if supplied.
3. Install the combination temperature and pressure safety relief valve in the tapping provided.

*Note that this is required by law for safety considerations.



4. 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.

FILLING THE HEATER

1. Completely close the drain valve and open the highest hot water valve to allow all air to escape from piping.
2. Open the valve 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 (use 60° C copper wire for water heaters rated less than 100 amps; otherwise use 75°C copper wire). 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 VI, Quarterly Inspection.

SECTION V – TROUBLESHOOTING

Symptom	Probable Cause	Corrective Action / Remedy
No hot water	Circuit breaker tripped at source.	Reset circuit breaker.
	On/Off switch in 'OFF' position, if installed.	Turn switch to 'ON' position.
	Circuit breaker at control cabinet tripped, if installed.	Reset circuit breaker.
	Blown fuse in element fuse block, if installed.	Replace fuse.
	Blown fuse in transformer, if installed.	Replace fuse.
	High limit switch tripped.	Reset high limit switch.
	Loose wires.	Tighten wires. Torque screws per torque chart on Page 29.
	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 VI, Quarterly Inspection. Replace if necessary.
	Blown fuse in the element fuse block, if installed.	Replace fuse.
	Heating element not working on all phases	Check to see that heating element is working on all phases, by checking the resistance (ohms) value for each element and comparing with the chart included in Section VII.
	Heater improperly sized	Verify heater is properly sized for the flow rate and temperature rise of your system. See formulas included in Section VII. Replace elements with proper size as necessary.
Relief valve discharges continuously	Excessive temperature or pressure in tank	Temperature and pressure relief valves 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 VI – SCHEDULED MAINTENANCE AND OPERATION

WARNING / CAUTION

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 all air has been released.

FREEZING

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 thermostat satisfies (that is, when the thermostat actually clicks off), draw water from heater.
 - c. Compare water temperature of drawn water to the temperature setting of the thermostat when it satisfies. Normal variation between the two points is approximately + 5°F.
 - d. If these two readings do not coincide within acceptable tolerances and verification has been made of the accuracy of the temperature-reading gauge, replace 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 in water 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 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.

NOTE:

Cement lining is a durable lining that will provide many years of service protecting your steel pressure vessel from corrosion. The process of cement lining includes an inspection to ensure that the lining is applied to the correct thickness, covers all appropriate surfaces, and is free from defects or cracks greater than 3 mm (1/8") in width. Any deficiencies are repaired at the factory prior to shipment. However, it is characteristic to find hairline cracks in the cement lining prior to initial installation. After the vessel is first filled, the water will work its way into these cracks and begin the corrosion process. At the same time the cement lining undergoes a "wet curing" process whereby the cement absorbs water and expands. The water that is absorbed into the lining becomes trapped between the cement lining and the steel tank and once the cement is fully absorbed with water, the water in contact with the steel tank becomes deoxygenated which serves to protect the steel vessel. In addition, the cement leaches minerals and various impurities from the water which fills and "heals" the cracks. This "healing" together with the "wet curing" and expansion of the cement prevents any ongoing corrosion. In the unlikely event a crack greater than 3 mm (1/8") develops, the cement lining can be easily repaired in the field. For repair procedures please contact Hubbell.

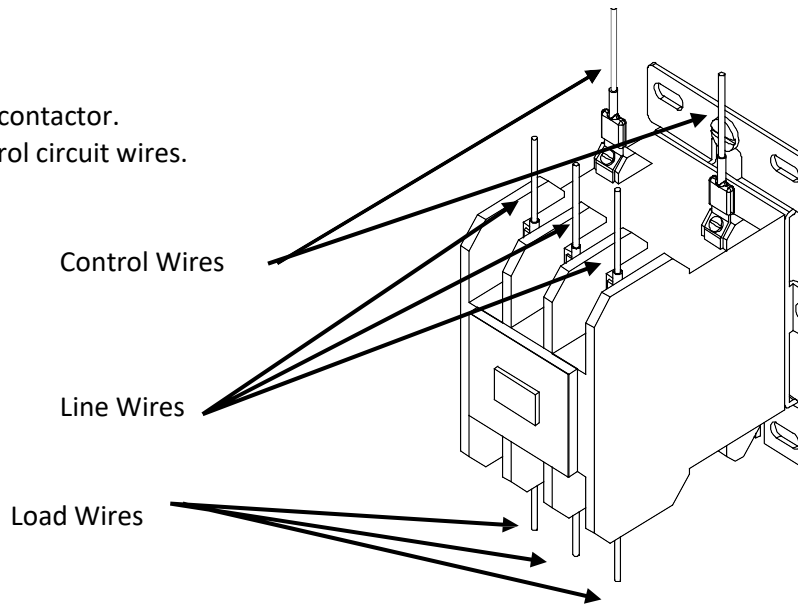
SECTION VII – SERVICING AND REPLACEMENT OF PARTS

WARNING / CAUTION

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

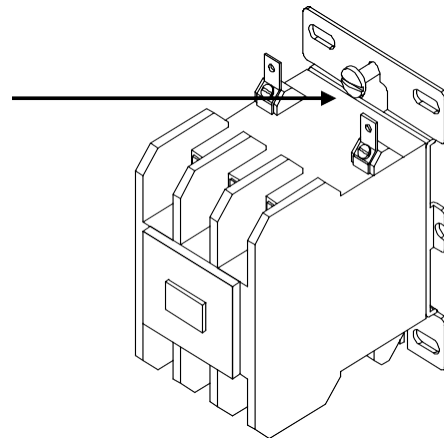
MAGNETIC CONTACTOR

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.

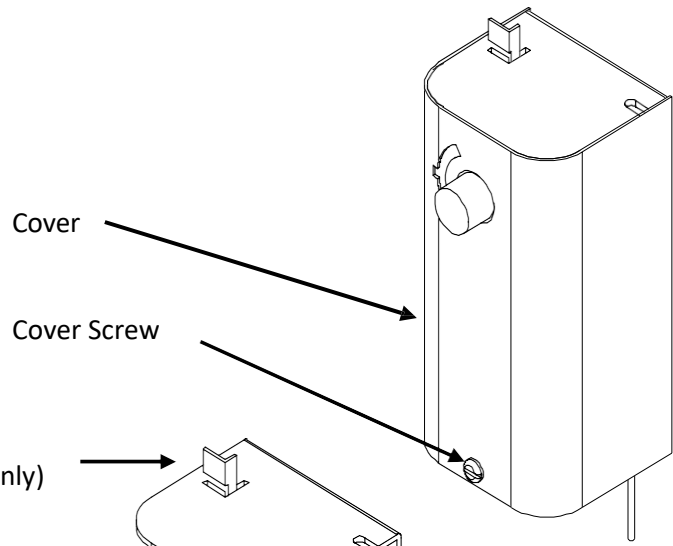
Mounting Screws
(Bottom screw not shown)



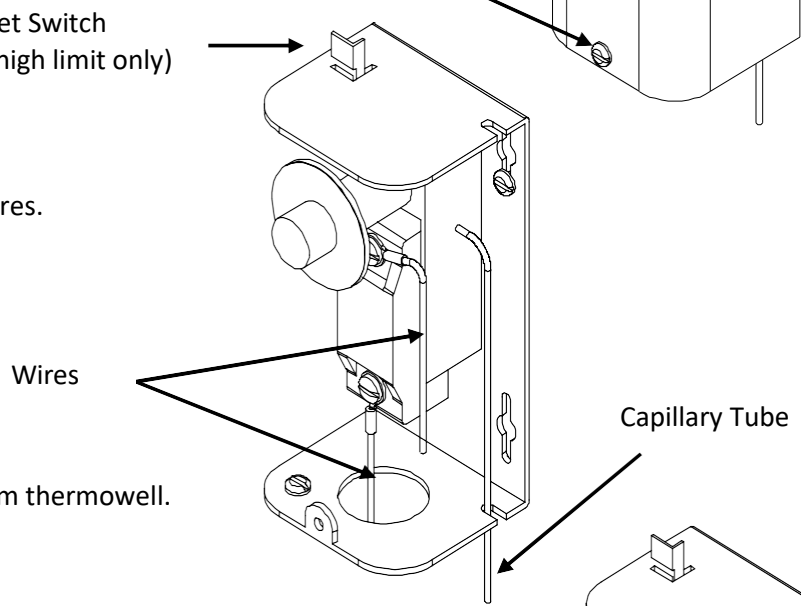
5. Replace with new contactor using reverse procedure.

IMMERSION TEMPERATURE CONTROLLER

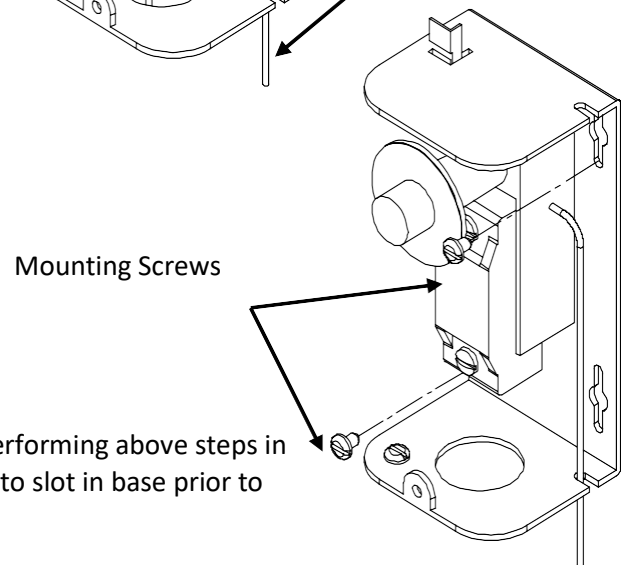
1. Disconnect power from the unit.
2. Remove access cover.
3. Remove high limit cover screw and cover.



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



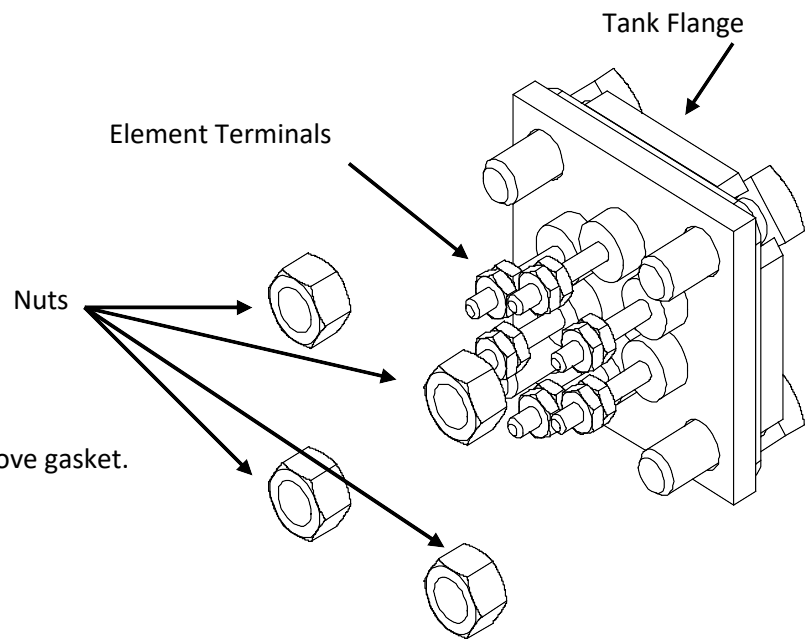
5. Remove capillary tube and bulb from thermowell.
6. Remove two (2) mounting screws.



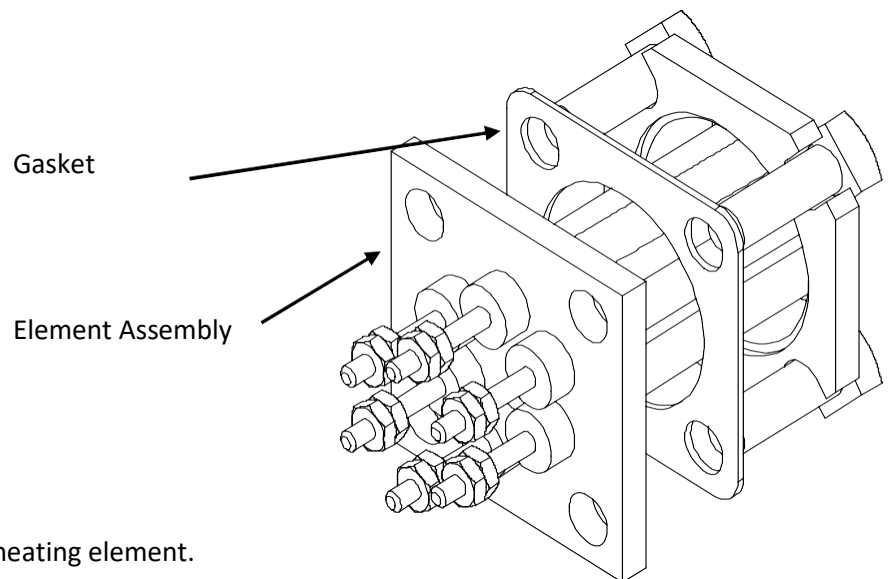
7. Remove control and install new high limit switch by performing above steps in reverse order. (Note: Be sure to place capillary tube into slot in base prior to installing cover.)

HEATING ELEMENT – STYLE A

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.

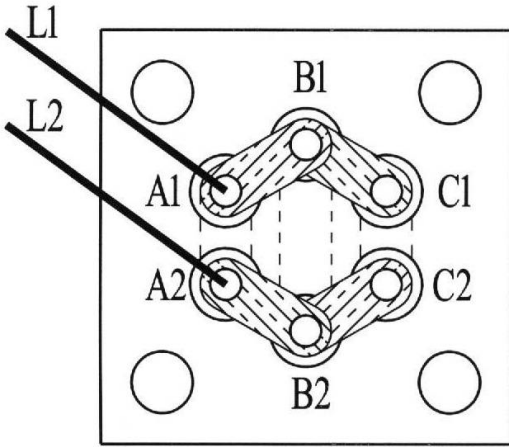


8. Withdraw element assembly and remove gasket.

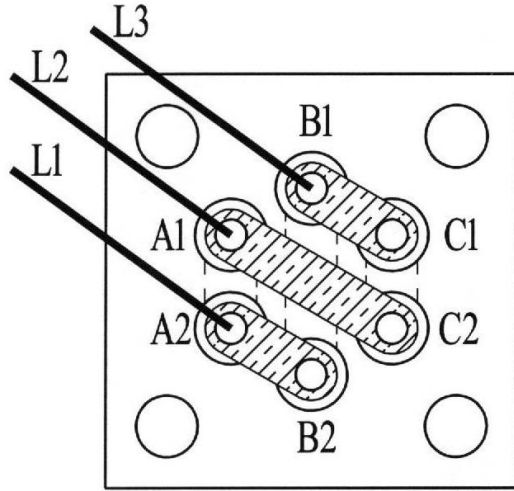


9. Install a new gasket and insert a new heating element.
10. Rewire element according to the voltage and phase rating of the unit as shown below.
11. Fill the tank and check around the gasket for any leaks.

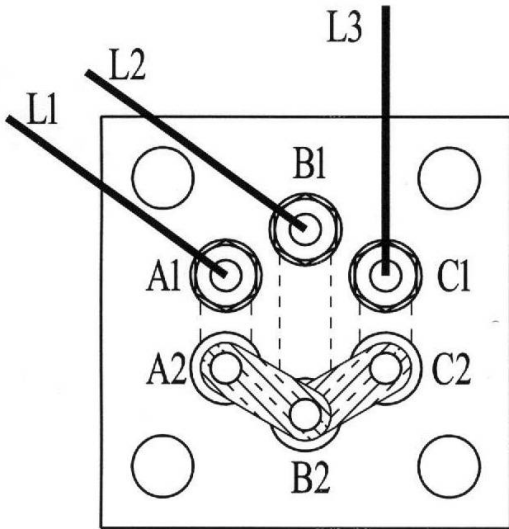
JUMPER CONFIGURATION



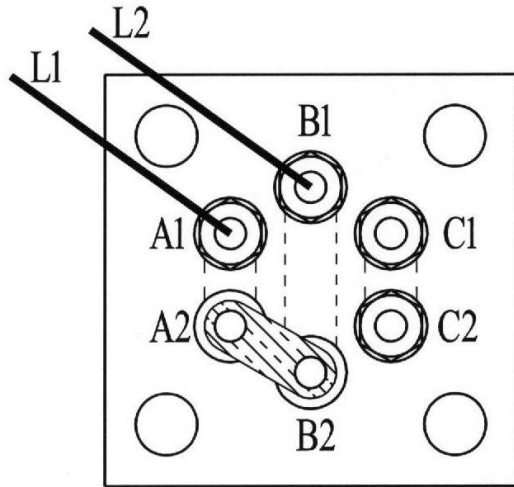
1 PHASE
208 OR 240 VOLT



3 PHASE DELTA
208 OR 240 VOLT



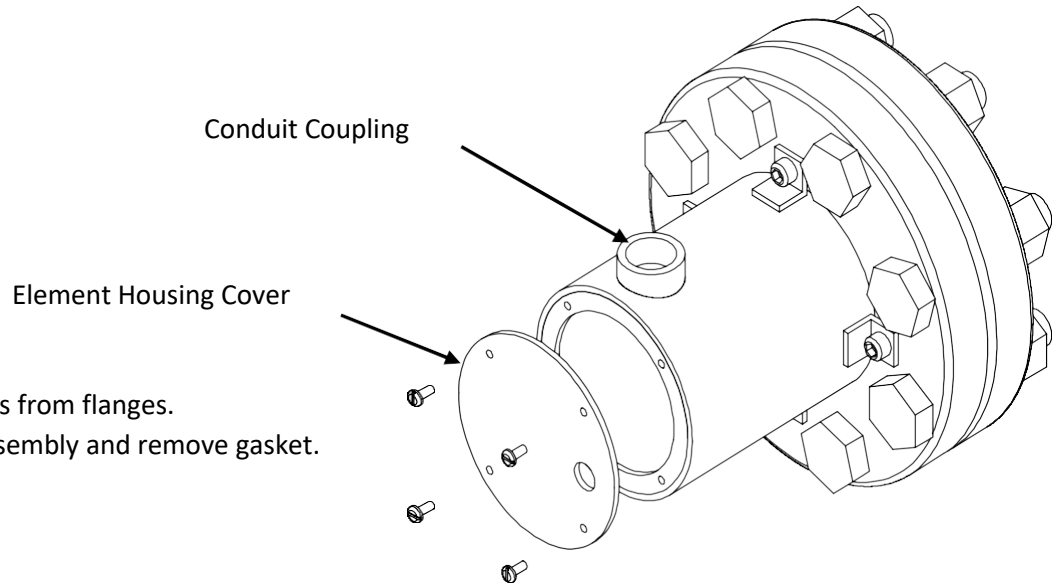
3 PHASE WYE
380 TO 575 VOLT



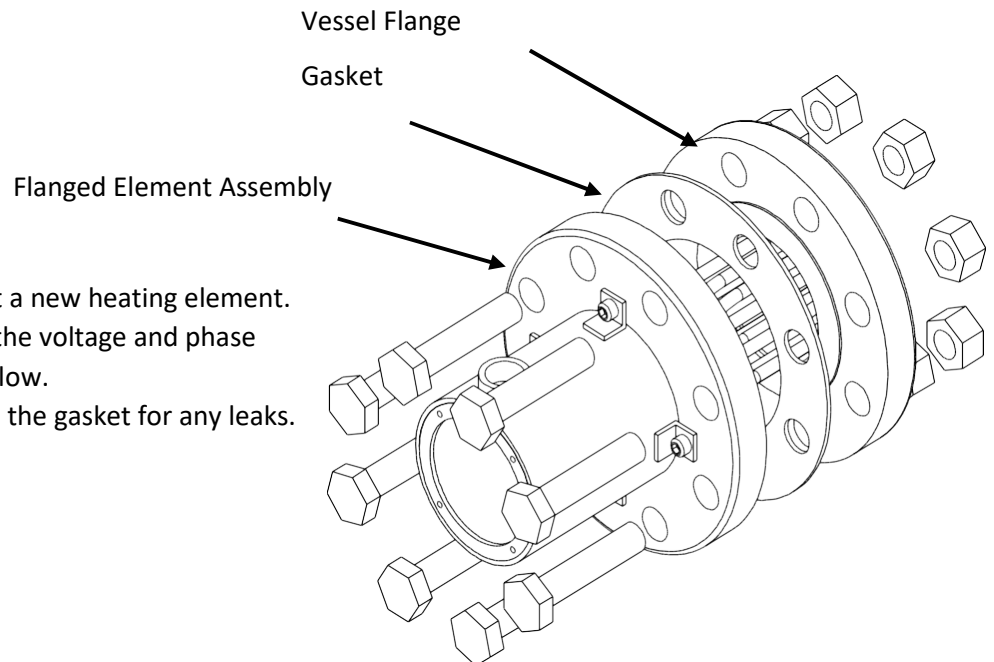
1 PHASE
480 VOLT

HEATING ELEMENT – STYLE B

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. Remove element housing cover.
7. Disconnect the wires from the heating element terminals.
8. Disconnect conduit from coupling.



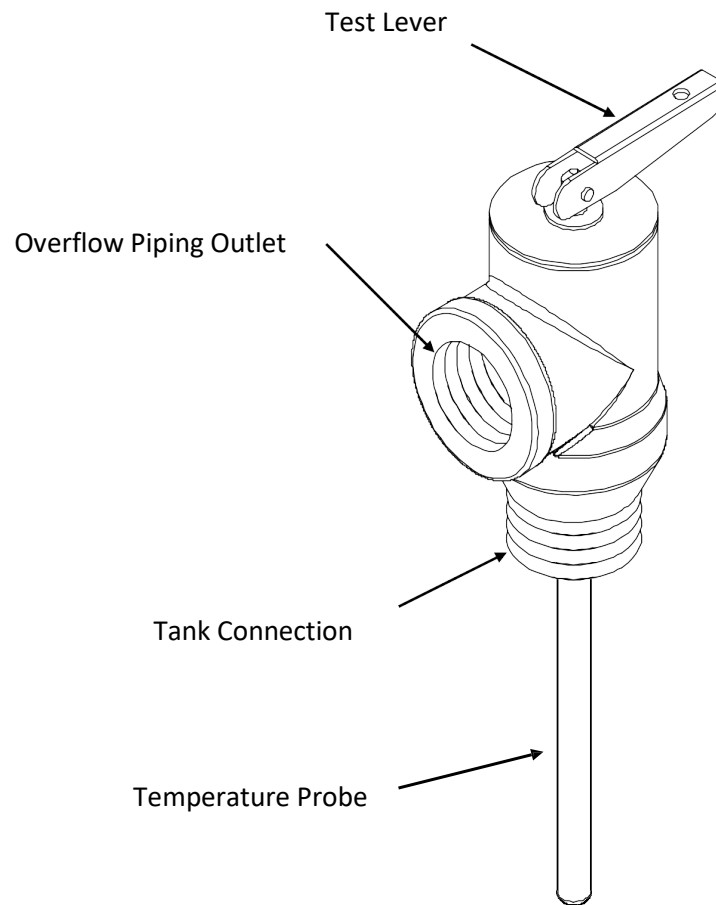
9. Remove nuts and bolts from flanges.
10. Withdraw element assembly and remove gasket.



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

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 the safety switch to ON position.



SECTION VII – MISCELLANEOUS CHARTS AND FORMULAS

NEMA ENCLOSURES

Type	Intended Use and Description
1	Enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment or locations where unusual service conditions do not exist.
2	Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.
3	Enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain, and sleet; undamaged by the formation of ice on the enclosure.
4	Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against wind-blown dust and rain, splashing water, and hose-directed water; undamaged by the formation of ice on the enclosure.
4X	Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water; undamaged by the formation of ice on the enclosure.
12	Enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids.
13	Enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant.

The preceding descriptions are not intended to be complete representations of National Electrical Manufacturers Association standards for enclosures.

Table 1. COMPARISON OF SPECIFIC APPLICATIONS OF ENCLOSURES FOR INDOOR NON-HAZARDOUS LOCATIONS

Provides a Degree of Protection Against the Following Environmental Conditions	Type of Enclosure											
	1*	2*	4	4X	5	6	6P	11	12	12K	13	
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing		X	X	X		X	X	X	X	X	X	X
Dust, lint, fibers, and flyings†			X	X	X	X	X		X	X	X	X
Hosedown and splashing water			X	X		X	X					
Oil and coolant seepage									X	X		X
Oil or coolant spraying and splashing												X
Corrosive agents				X			X	X				
Occasional temporary submersion						X	X					
Occasional prolonged submersion							X					

* These enclosures may be ventilated. However, Type 1 may not provide protection against small particles of falling dirt when ventilation is provided in the enclosure top.

† These fibers and flyings are nonhazardous materials and are not considered the Class III type ignitable fibers or combustible flyings. For Class III type ignitable fibers or combustible flyings see the National Electrical Code®, Section 500-8(a).

Table 2. COMPARISON OF SPECIFIC APPLICATIONS OF ENCLOSURES FOR OUTDOOR NON-HAZARDOUS LOCATIONS

Provides a Degree of Protection Against the Following Environmental Conditions	Type of Enclosure							
	3	3R**	3S	4	4X	6	6P	
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	
Rain, snow, and sleet§	X	X	X	X	X	X	X	
Sleet††			X					
Windblown dust	X		X	X	X	X	X	
Hosedown				X	X	X	X	
Corrosive agents					X		X	
Occasional temporary submersion						X	X	
Occasional prolonged submersion							X	

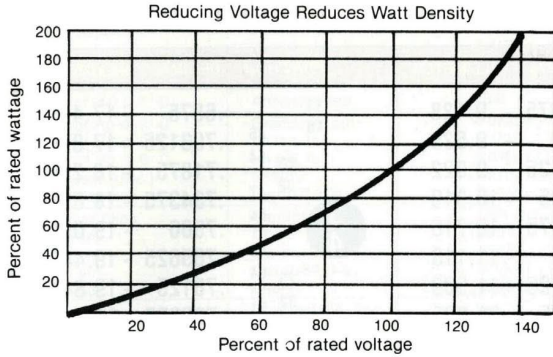
§ External operating mechanisms are not required to be operable when the enclosure is ice covered.

†† External operating mechanisms are operable when the enclosure is ice covered.

** These enclosures may be ventilated.

ELECTRICAL DATA

Wattage Change with Voltage Change



PERCENT RATED WATTS ON REDUCED VOLTAGE

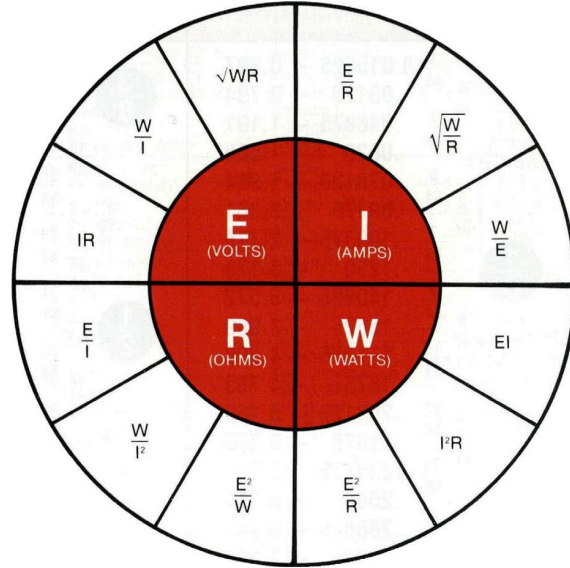
- 230-volt heater on 208 volts—82%
- 240-volt heater on 208 volts—75%
- 480-volt heater on 277 volts—33%
- 480-volt heater on 440 volts—84%
- 480-volt heater on 318 volts—44%
- 550-volt heater on 480 volts—76%

$$W_2 = W_1 \times \left(\frac{e_2}{e_1}\right)^2$$

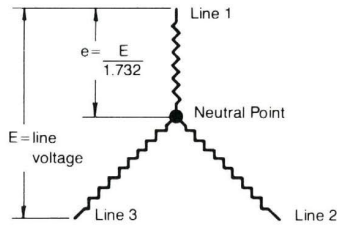
Where:

- w_2 = New wattage output
- w_1 = Rated wattage
- e_2 = Applied voltage
- e_1 = Rated voltage

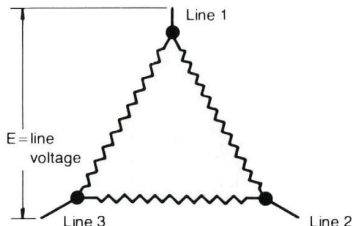
ohms Law



Three Phase Circuits



WYE OR STAR



DELTA

If elements are designed for 3-phase Delta connection, wattage output may be reduced to 1/3 by reconnecting to 3-phase WYE

For current in 3-phase circuits
$$I = \frac{W}{E \times 1.732}$$

For resistance in 3 phase circuit (across any two terminals)

$$R = \frac{E^2}{\frac{1}{2}W}$$

Amperage Conversion Table

Watts	Volts, Single Phase			Volts 3 Phase Balanced Load		Watts
	120	240	480	240	480	
100	.83	.42	.21	.24	.13	100
150	1.25	.63	.31	.36	.18	150
200	1.67	.83	.42	.49	.25	200
250	2.08	1.04	.52	.61	.30	250
300	2.50	1.25	.63	.73	.37	300
350	2.92	1.46	.73	.85	.43	350
400	3.33	1.67	.84	.97	.49	400
450	3.75	1.88	.93	1.10	.55	450
500	4.17	2.08	1.04	1.20	.60	500
600	5.00	2.50	1.25	1.45	.73	600
700	5.83	2.92	1.46	1.70	.85	700
800	6.67	3.33	1.67	1.93	.97	800
900	7.50	3.75	1.87	2.17	1.09	900
1000	8.33	4.17	2.10	2.41	1.21	1000
1100	9.17	4.58	2.30	2.65	1.33	1100
1200	10.0	5.00	2.51	2.90	1.45	1200
1250	10.4	5.21	2.61	3.10	1.55	1250
1300	10.8	5.42	2.71	3.13	1.57	1300
1400	11.7	5.83	2.91	3.38	1.69	1400
1500	12.5	6.25	3.12	3.62	1.82	1500
1600	13.3	6.67	3.34	3.86	1.93	1600
1700	14.2	7.08	3.54	4.10	2.05	1700
1800	15.0	7.50	3.75	4.34	2.17	1800
1900	15.8	7.92	3.96	4.58	2.29	1900
2000	16.7	8.33	4.17	4.82	2.41	2000
2200	18.3	9.17	4.59	5.30	2.65	2200
2500	20.8	10.4	5.21	6.10	3.05	2500
2750	23.0	11.5	5.73	6.63	3.32	2750
3000	25.0	12.5	6.25	7.23	3.62	3000
3500	29.2	14.6	7.30	8.45	4.23	3500
4000	33.3	16.7	8.33	9.64	4.82	4000
4500	37.5	18.8	9.38	10.84	5.42	4500
5000	41.7	20.8	10.42	12.1	6.1	5000
6000	50.0	25.0	12.50	14.50	7.25	6000
7000	58.3	29.2	14.59	16.9	8.5	7000
8000	66.7	33.3	16.67	19.3	9.65	8000
9000	75.0	37.5	18.75	21.7	10.85	9000
10000	83.3	41.7	20.85	24.1	12.1	10000

FORMULAS

RECOVERY

$$\text{GPH} \times \text{_____} \text{ } ^\circ\text{F } \Delta\text{T} \times 0.00244 = \text{KW}$$

$$\text{KW} \times 410 \div \text{GPH} = \text{_____} \text{ } ^\circ\text{F } \Delta\text{T}$$

$$\text{KW} \times 410 \div \text{_____} \text{ } ^\circ\text{F } \Delta\text{T} = \text{GPH}$$

Note: 1 KW will heat 4.1 GPH at a 100°F ΔT

ELECTRICAL

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

$$\frac{\text{KW} \times 1000}{\text{Volts}} = \text{Amps } 1 \Phi$$

METRIC CONVERSION

$$\text{Liters} \times 0.2641 = \text{Gallons}$$

$$\text{Gallons} \times 3.79 = \text{Liters}$$

$$\text{Gallons} \times 0.003785 = \text{m}^3$$

$$\text{m}^3 \times 264.2 = \text{Gallons}$$

$$1^\circ\text{C } \Delta\text{T} = 1.8^\circ\text{F } \Delta\text{T}$$

$$^\circ\text{F} = (^\circ\text{C} \times 1.8) + 32$$

$$^\circ\text{C} = (^\circ\text{F} - 32) \times 0.556$$

$$\text{psi} \times 0.06896 = \text{Bar}$$

$$\text{Bar} \times 14.5 = \text{psi}$$

$$\text{psi} \times 6.86 = \text{kPa}$$

$$\text{kPa} \times 0.1456 = \text{psi}$$

$$\text{Lbs} \times 0.4536 = \text{Kg}$$

$$\text{Kg} \times 2.2 = \text{Lbs}$$

$$\text{Watts/Sq.Cm.} \times 6.4 = \text{Watts/Sq.In.}$$

$$\text{Watts/Sq.In.} \times 0.155 = \text{Watts/Sq.Cm.}$$

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	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
1-8	3440	2815	3185	2205	3595	4130
1-14	3110	2545	2885	1995	3250	3730