



Installation, Operation & Maintenance Manual

DURAWATT®

Electric Water Heaters



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Manufacturing ASME Commercial Water Heaters Since 1961

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1 PRODUCT DESCRIPTION

WARNING: If the information in the supplied manual(s) is not followed exactly, a fire, electrical short or exposure to hazardous materials may result, causing property damage, personal injury or death.

FOR YOUR SAFETY

- **Do not** store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance.

WHAT TO DO IF YOU SMELL GAS

- **Do not** try to light any appliance.
- **Do not** touch any electric switch; do not use any phone in your building.
- **Immediately** call your gas supplier from a location away from your building and the smell of gas. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

Installation and service must be performed by a qualified installer, service agency or qualified electrical contractor.

WARNING: Installation and service must be performed by a qualified installer, service agency or qualified electrical contractor, who must read and follow the supplied instructions before installing, servicing or removing this appliance. Refer to the information contained in this manual. Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury, exposure to hazardous materials or death.

WARNING: Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the unit and to replace any part of the control system, all controls and all other items affecting safe appliance operation, and which has been under water.

WARNING: In an emergency disconnect all electrical power to the appliance from a location safely away from the emergency. Failure to follow these instructions can cause property damage, personal injury, and exposure to hazardous materials or death.

Read this Manual **BEFORE** using this equipment. Failure to read and follow all safety and use information can result in death, serious personal injury, property damage, or damage to the equipment.

Be aware local codes may require this product and/or the control to be installed or connected by an electrician. Leave this manual with the end user.

IMPORTANT

Read this Manual **BEFORE** using this equipment. Failure to read and follow all safety and use information can result in death, serious personal injury, property damage, or damage to the equipment.

Keep this Manual for future reference.

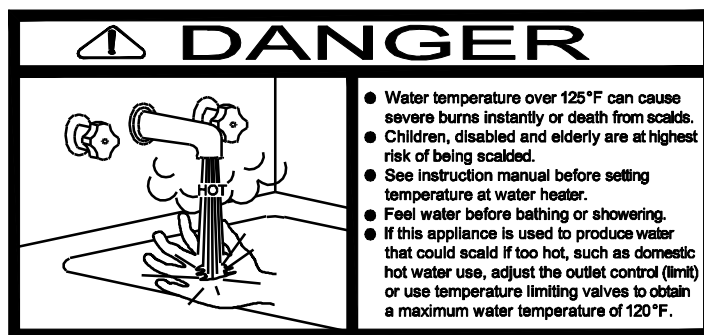
IMPORTANT SAFETY NOTE

It takes only 5 seconds of skin contact with 140°F water to cause a second degree burn! You must protect against high water temperatures at all lavatories, tubs, showers and other points of hot water contact.

Accidental scalding from high water temperatures is a greater risk in some types of installations. Some examples are:

**HOMES FOR THE MENTALLY HANDICAPPED
HOMES FOR THE PHYSICALLY HANDICAPPED
HOSPITALS AND NURSING HOMES
ELDER CARE FACILITIES AND REST HOMES
ORPHANAGES AND CHILDCARE FACILITIES**

OTHER INSTALLATIONS - WHERE RESPONSE TO CONTACT WITH HOT WATER MAY BE SLOWER OR WHERE THE DANGER OF HOT WATER CONTACT IS GREATER



Thermostatically controlled mixing valves must be used in the design of the potable hot water system.

Potable hot water should be tempered to no more than 110°F when used for bathing or other personal uses.

Good engineering practice mandates the use of thermostatically controlled mixing valves set at 120°F or less to keep the delivered water temperature below scalding temperatures.

1. PRODUCT DESCRIPTION

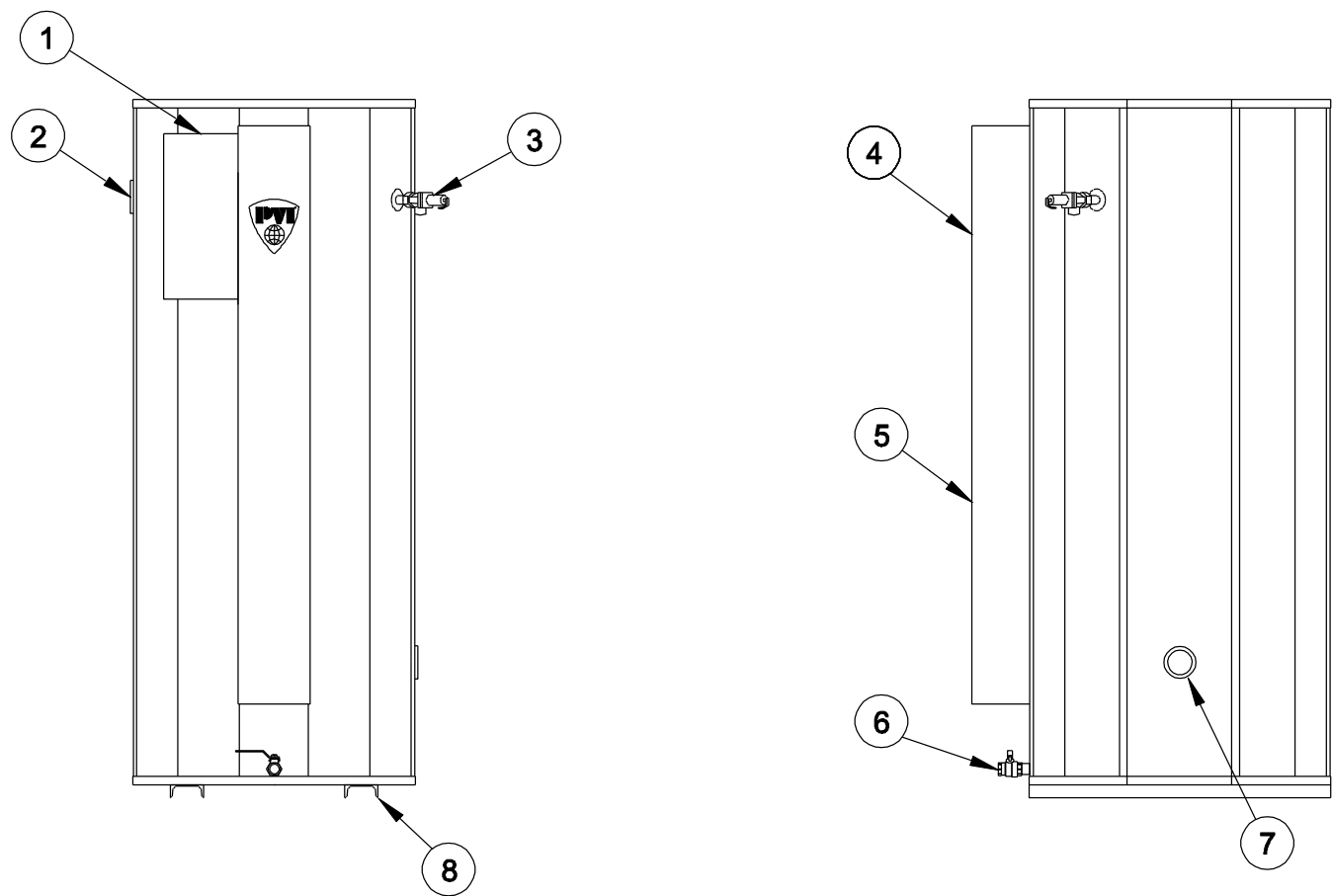
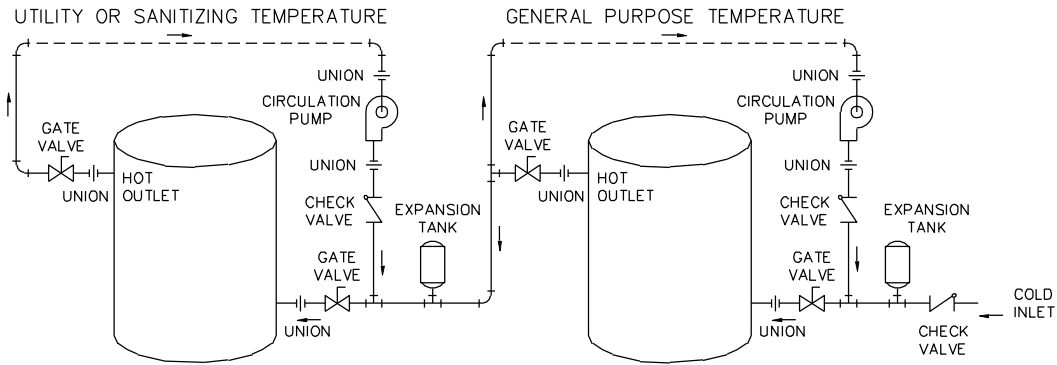


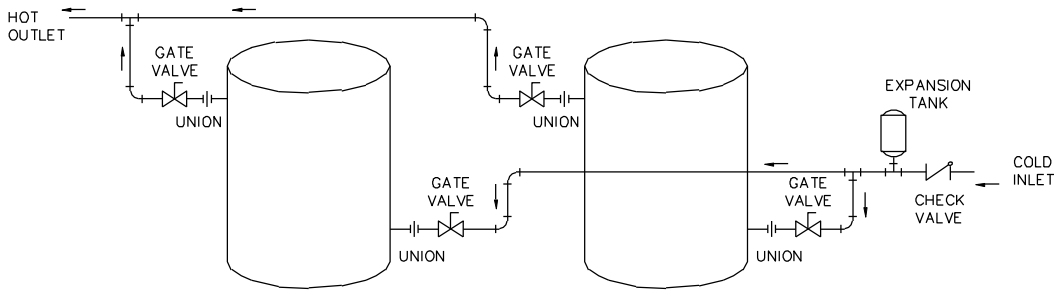
FIGURE 1

- | | |
|----------------------|-------------------------------------|
| 1. Electrical Entry | 5. Electric Element Enclosure |
| 2. Hot Outlet | 6. Drain Valve |
| 3. T&P Relief Valve | 7. Cold Inlet and Return Connection |
| 4. Control Enclosure | 8. Channel Skids |

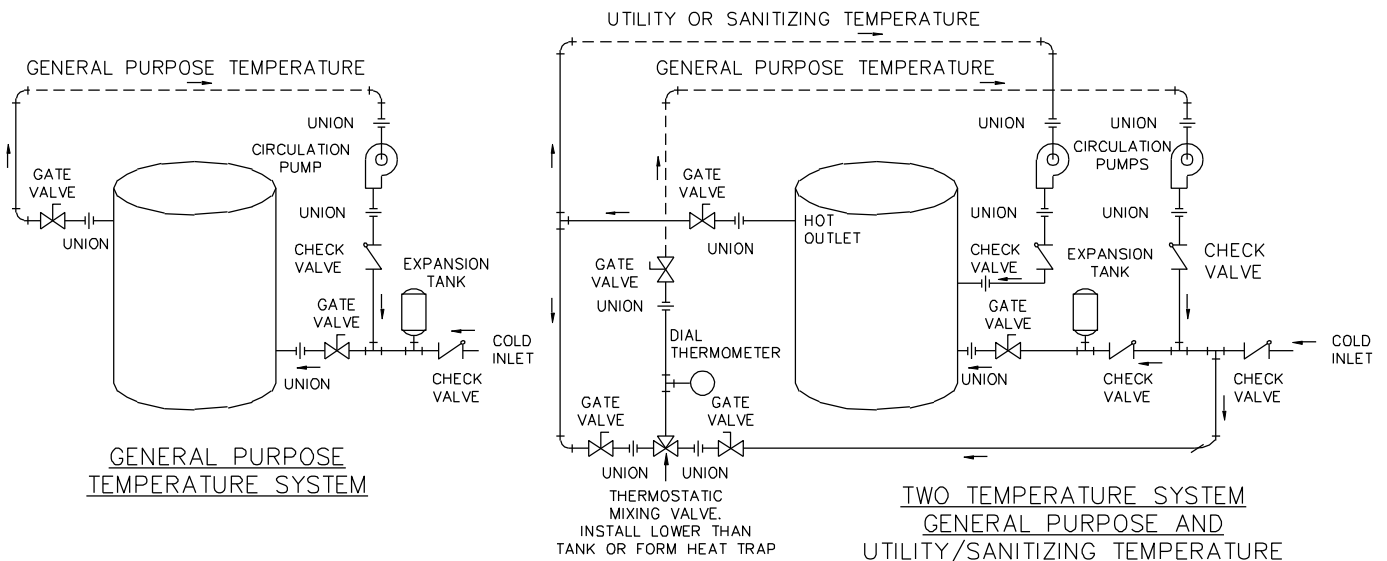
2. TYPICAL PIPING DIAGRAMS



TWO TEMPERATURE SYSTEM
GENERAL PURPOSE AND
UTILITY/SANITIZING TEMPERATURE



REVERSE DUOFLO MANIFOLD SYSTEM



3. WATER HEATER INSTALLATION

Checking Equipment Before You Install

Inspect the unit completely upon receipt from the freight carrier before signing the bill of lading. Inspect the appliance and all accompanying parts for signs of impact or mishandling. Verify the total number of pieces shown on packing slips with those actually received. Contact the freight carrier immediately if any damage or shortage is detected.

Codes

The equipment must be installed in accordance with those installation regulations in force in the local area where the installation is to be made. Authorities having jurisdiction must be consulted before installation is made. In the absence of such requirements, the installation shall be in accordance with the instructions in this manual, appliance markings and supplemental instructions and in compliance with the latest edition of the National Electrical Code, NFPA-70. Where required by the Canadian authority having jurisdiction, the equipment must be installed in accordance with the latest edition of the Canadian Electrical Code, C22.1 and applicable provincial regulations. All appliances conform to the current edition of the ASME Boiler and Pressure Vessel Code, Section IV, Part HLW or Section VIII.

Water Quality Requirements

To keep your water heater operating efficiently over its lifetime, it is critical to ensure that the chemical composition of incoming water is not harmful to the heater. To prevent corrosion, fouling, and other harmful effects on the heater, PVI requires feedwater to be within the EPA defined limits for potable water. Potable water is defined as complying with the U.S. EPA primary drinking water regulations and secondary drinking water standards.

Electrical Requirements

1. Check rating plate on front for correct voltage, phase and amperage. Refer to the wiring diagram for control components mounted on the heater.
2. Use proper wire size and branch circuit protection as required by the latest edition of the National Electrical Code, NFPA-70 and state and local codes or in Canada, as required by the latest edition of the Canadian Electrical Code, C22.1 and provincial and local codes. The PVI electric water heater specification sheets show the number and size of power connectors furnished with the heater for minimum 90°C copper connecting wire.
3. Use proper wire size for the ground connection. Attach to the bottom ground terminal connection on the terminal block assembly marked with decal "GR". If required, an additional stud for grounding is provided on the pressure vessel in the bottom right corner of the main enclosure panel.
4. Connect supply feeders to the distribution block (or circuit interrupter if furnished) inside the electrical enclosure on the heater.

IMPORTANT: Check all wiring connections in heater and element enclosure to assure tightness prior to energizing.

NOTE: Use only copper wire of proper sizing for incoming service. Damage resulting from the use of aluminum wiring is excluded from coverage under the warranty of this unit.

Location

1. Locate the unit in a clean and dry area as close as possible to the greatest hot water usage and as near to electrical power as practical.
2. Install the unit on a firm, level foundation.
3. Locate the foundation on a pitched floor near a suitable drain or make other provisions to prevent contact to areas of the building subject to water damage should the water heater or a water connection leak. The drain must be sufficient to contain water in excess of 210°F.
4. Floor mounting provisions and tie down anchor points are provided. Pilot holes are indicated on the jacket for securing the equipment. Code requirements vary by geographical location, additional strapping or braces may be required. Please refer to your local codes for specific requirements.

Installation

WARNING: Use industry standard safe rigging methods when attempting to lift or move this product. Failure to follow these instructions could result in property damage, serious injury or death. One common method includes the use of straps and spreader bars, lifting from the water heater base skid assembly.

1. Check the data decal on the heater. Be sure the electrical supply is adequate for the installation.
2. Carefully remove all shipping supports and bracing. (Float type devices have shipping plugs blocking the float).
3. Install shut-off valves and unions on the inlet and outlet water piping for servicing. Use caution when threading pipe nipples into tank connections to prevent cross threading, or over-tightening. Always use a back-up wrench on tank nipples when tightening unions, valves, etc.

WARNING: As with any electrical product, care should be taken to guard against the potential risk of fire, electric shock, and injury to persons.

4. Insulate hot water and return circulation lines. Also, if subject to freezing during shutdown or during operation, insulate all water piping and take whatever steps are necessary to keep the appliance and all water containing pipes and components from freezing. **IMPORTANT:** Do not use the plumbing connected to the appliance as a ground for welding or any other purpose.
5. The water heater is equipped with a temperature and pressure relief valve(s) rated for the input. Pipe the relief valve discharge to a suitable open drain. The drainpipe may not be smaller than the relief valve opening and must be secured to prevent it from lifting out of the drain under discharge pressure. Do not install valves or restrictions in the discharge line.
6. Pipe the drain valve to a suitable open drain.
IMPORTANT: Do not use standard galvanized, steel or dielectric pipe nipples when making connections to the tank. Use only non-ferrous nipples.
7. A thermal expansion valve (or diaphragm-type expansion tank) should be installed in the cold-water line between the water heater and any check valve.

Service Clearances

Allow sufficient space to provide adequate clearances on all sides for service and inspection. Recommended clearance is 24" at the top and front, 18" at left and right sides of the appliance. Optional equipment may increase the clearance requirements. Allow sufficient space for installing and servicing connections such as water, electrical, pump and other auxiliary equipment.

Clearances to Combustible Surfaces

The appliance must not be installed on a combustible floor, or on a non-combustible floor covering combustible material. The minimum clearance to combustible material is 6" from the top, sides and rear, and 24" from the front.

Distance minimale aux matériaux combustibles est de 15 cm sur le dessus, les côtés et à l'arrière et 61 cm à l'avant et ne doit pas être installé sur un plancher combustible.

Electronic Low Water Cutoff

The device consists of a probe in the tank that acts as a switch, opening when submerged in water and closing when the water level is below the probe, preventing heating elements from energizing. The probe should be kept free of scale buildup to insure operation.

4. OPTIONAL EQUIPMENT

Proportional Sequencer (optional on models 72kW and greater): The contactors and heating elements are staged-on based on the demand on the water heater. The control gives visual indication of stages that are on. The heat elements stage on linearly (ON: 1, 2, 3, 4, ...; OFF: ..., 4, 3, 2, 1), energizing more stages the lower the temperature is below the programmed set point. Depending on the number of stages, each stage will energize at different setpoints in relation to the setpoint.

Stage Set Point Temperature (°F)									
	2 Stages	3 Stages	4 Stages	5 Stages	6 Stages	7 Stages	8 Stages	9 Stages	10 Stages
No Stages	ST1 + 0	ST1 + 0	ST1 + 0	ST1 + 0	ST1 + 0	ST1 + 0	ST1 + 0	ST1 + 0	ST1 + 0
Stage 1	ST1 - 1-6	ST1 - 1-4	ST1 - 1-3	ST1 - 1-3	ST1 - 1-2	ST1 - 1-2	ST1 - 1-2	ST1 - 1-2	ST1 - 1
Stage 2	ST1 - 7+	ST1 - 5-8	ST1 - 4-6	ST1 - 4-6	ST1 - 3-4	ST1 - 3-4	ST1 - 3-4	ST1 - 3-4	ST1 - 2
Stage 3		ST1 - 9+	ST1 - 7-9	ST1 - 7-9	ST1 - 5-6	ST1 - 5-6	ST1 - 5-6	ST1 - 5-6	ST1 - 3
Stage 4			ST1 - 10+	ST1 - 10-12	ST1 - 7-8	ST1 - 7-8	ST1 - 7-8	ST1 - 7-8	ST1 - 4
Stage 5				ST1 - 13+	ST1 - 9-10	ST1 - 9-10	ST1 - 9-10	ST1 - 9-10	ST1 - 5
Stage 6					ST1 - 11+	ST1 - 11-12	ST1 - 11-12	ST1 - 11-12	ST1 - 6
Stage 7						ST1 - 13+	ST1 - 13-14	ST1 - 13-14	ST1 - 7
Stage 8							ST1 - 15+	ST1 - 15-16	ST1 - 8
Stage 9								ST1 - 17+	ST1 - 9
Stage 10									ST1 - 10+

In the event of power interruption, all contactors are turned off. When power is resumed, the control will re-stage the elements beginning with number one.

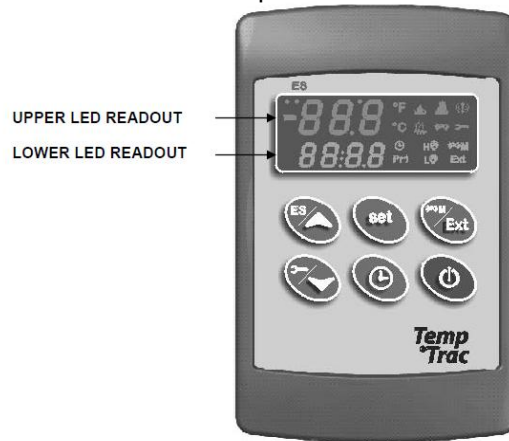
Shunt Trip Circuit Interrupter (optional on all models): The shunt trip, wired in the non-automatic circuit interrupter, is a safety device designed to open the circuit interrupter and prevent the elements from energizing if the control panel door is opened.

5 TEMPTRAC™ ELECTRONIC CONTROLLER PANEL

5. TEMPTRAC™ ELECTRONIC CONTROLLER PANEL

Principle of Operation

The water heater operates to satisfy the setpoint of the TempTrac digital control whose sensor is located near the energy source of the water heater tank. Demand (flow) will typically create a drop in temperature, thus activating the water heater to add heat to the stored water. This setpoint is the desired water temperature to maintain.



Upper LED Readout

The default display of the upper readout (Probe 2) is the water temperature near the hot water outlet. This readout can display additional information by pushing the EXT button to cycle through the following items:

- The modulation rate of the heater, if applicable, indicated by 0 to 100%.
- The temperature difference between Probe 1 and Probe 2.
- All information described above is available for monitoring through the optional MODBUS RTU interface.

Lower LED Readout

The default display of the lower readout (Probe 1) is the water temperature sensed near the middle of the water heater tank. This sensing location serves as the primary control temperature for the TempTrac.

Control Buttons

SET	Displays and modifies the temperature set points. In programming mode, it selects a parameter or confirms an operation.
UP	Displays and modifies the energy saving (Nighttime setback) settings. In programming mode, it browses the parameter codes or increases a displayed value.
DOWN	Displays the working hours of the load relays. In programming mode, it browses the parameter codes or decreases a displayed value.
CLOCK	Changes lower display from the stored water temperature to current time and day.
EXT	Changes upper display from Probe 1 temperature to Probe 3 temperature, displays the temperature difference of the stored water temperature minus Probe 2 temperature and firing rate of the burner from 0 to 100%. In programming mode, it sets the 4-20mA output (password is required).
ON/OFF	Switches the control ON or OFF.

(See TempTrac User Manual PV500-41 for full description)

- Use the **UP + DOWN** key to lock and unlock the keyboard.
- Use the **SET + DOWN** arrow to enter the programming mode.
- Use the **SET + UP** arrow to exit the programming mode.

LED Icon Legend

LED	MODE	Function
°F	ON	Temperatures are displayed in degrees Fahrenheit
°C	ON	Temperatures are displayed in degrees Celsius
	Flashing	Call for heat time delay or remote enable/disable is in standby (disabled)
	ON	Call for heat is on

5 TEMPTRAC™ ELECTRONIC CONTROLLER PANEL

	Flashing	Second stage time delay (<i>On 2-stage units only</i>)
	ON	Second stage on or the AL2 alarm output is enabled.
	Flashing	Output 3-time delay
	ON	Output 3 relay on
	ON	Modulation output signal is in manual control mode or forced to the i1S setting by digital input 1
	ON	Modulation output signal is automatically controlled by temperature probe 1
	Flashing	Modulation output time delay is activated.
Ext	ON	Probe 3 is displayed
	FLASHING	Digital input 2 (alarm) is activated
	FLASHING	Digital input 3 (alarm) is activated
	ON	Lower display is displaying the time
	FLASHING	Alarm signal
	FLASHING	Programmed working hours limit is exceeded
	ON	Working hours are displayed in Lower LED readout
ES	ON	The energy saving function is running

To View the Setpoint

- Push and release the **SET** key to see the set point value.
- To return to normal display, press **SET + UP** or wait 15 seconds without pressing any key.

To Change the Setpoint

- Push **SET** key. The upper display will show the “St1” parameter name, while the lower display will show its value.
- Use the **UP** or **DOWN** key to cycle through the parameter names.
- Push the **SET** key to modify a parameter value. The value starts flashing in the lower display.
- To change, push **UP** or **DOWN**. Push **SET** key again to confirm the value and pass to the setting of next set point.
- Repeat the operations described at points 3, 4, 5.
- **To Exit:** press **SET + UP** or wait 15 seconds without pressing any key.

NOTE: The set value is stored even when the procedure is exited by waiting for the time-out to expire.

To Set the Current Time and Day (Military Time)

- Push and hold the **CLOCK** key for more than 3 seconds. The LED icon starts flashing and the “Hur” (hour) parameter name is displayed in the Upper LED readout, its value is displayed in the Lower LED readout.
- Pushing the **UP** or **DOWN** key alternates the LED readouts between the following:
 - “Hur” (hour) in the Upper readout and its value in the lower readout
 - “Min” (minute) in the Upper readout, its value in the Lower readout
 - “DAY” (day) in the Upper readout, its value in the Lower readout
- To adjust a value, press the **SET** key and the value in the Lower LED will start flashing. Change the value by pressing the **UP** or **DOWN** keys. When correct, press the **SET** key.
- To exit push **SET + UP** keys or wait 15 seconds without pressing any keys.

NOTE: This device recognizes Sunday as the first day of the week and Saturday as the last.

To Set the Energy Saving Time (Nighttime Setback)

- Push and hold the **UP** key for more than 3 seconds and the first parameter of the energy saving will be displayed.
- Use the **UP** or **DOWN** keys to browse them.
- To change a value, push the **SET** key followed by **UP** or **DOWN** and then the **SET** key again.
- To exit from the menu, press **SET** and **UP** or wait for 30 seconds.

To Set Modulation Parameters

- Push and hold the **EXIT** key for more than 3 seconds and the LED will switch **ON** and a passkey will be required to view and manually change the modulation % value. Passkey is “321”.
- Upon entering the password, the modulation % value will be displayed in the lower display.
- To manually adjust this value, push the **SET** key; the value will start flashing. Adjust it by using the **UP** or **DOWN** keys and then the **SET** key again.
- To exit from the menu, press **SET** and **UP** keys together or wait for 30 seconds.

To Change Other Parameters

- Push the **SET** and **DOWN** arrow simultaneously for 3 seconds.
- Select the required parameter. The name of the parameter is on the upper display; its value is on the lower display.
- Press the **SET** key: the value of the parameter will start blinking.
- Use **UP** or **DOWN** to change the value.
- Press **SET** to store the new value and move to the following parameter.
- **To Exit:** Press **SET + UP** or wait 15s without pressing a key.

LED Display Alarm Messages

Alarm messages are displayed in the upper LED readout and alternate with the default display. An alarm LED ICON is also illuminated.

ALARM MESSAGE	CAUSE	RESULTS OF ALARM CONDITION	RECOMMENDED ACTION
"P1"	TP1 probe failure	Inlet temperature sensor is not connected or is reading incorrectly. Call for heat and burner modulation output signal will revert to low fire.	Check wiring and sensor Terminals 14 & 17
"P2"	TP2 probe failure	Temperature sensor is not connected or is reading incorrectly.	Check wiring and sensor Terminals 15 & 17
"P3"	TP3 probe failure	Temperature sensor is not connected or is reading incorrectly, or flue gas temperature protection is disabled.	Check wiring and sensor Terminals 16 & 17
"HA"	High temperature limit setpoint exceeded	Audible alarm sounds, operation continues.	Manual reset required
"LA"	Low temperature alarm	Audible alarm sounds, operation continues.	
AL1	Digital input 1 is activated.	Unit de-energized after timer delay. Audible alarm sounds.	Manually reset required
AL2	Digital input 2 is activated. This alarm indication is dedicated to the Alarm On Any Failure feature of this product.	Unit de-energized after timer delay. Audible alarm sounds. Alarm contacts close for remote indication of alarm. Internal alarm register will communicate an alarm condition through the Modbus RTU communication link.	Manually reset required
AL3	Digital input 3 is activated.	Unit de-energized after timer delay. Audible alarm sounds.	
Mn1	Maintenance alarm for output 1	Buzzer sounds, operation continues	Check wiring and sensor
Mn2	Maintenance alarm for output 2	Buzzer sounds, operation continues	Check wiring and sensor
Mn3	Maintenance alarm for output 3	Buzzer sounds, operation continues	Check wiring and sensor
"rtc"	The real time clock has lost its setting	Energy saving function disabled	Reprogram clock
CONTROL MESSAGE	CAUSE	RESULTS OF CONTROL CONDITION	NOTES
 On	A call-for-heat condition	The burner operating sequence should begin.	If the burner does not operate, check safety devices or Remote Proving Interlock
 Flashing	The remote enable/disable has been triggered	The small flame icon will flash indicating the standby state	The R1-R2 terminals have been opened by the remote master control. The heater will remain in standby.
	Integral circulation pump	The integral circulation pump will operate until the water temperature has equalized	Pump may operate before, during or after the call-for-heat

Audible Alarm

The TempTrac audible alarm is activated each time a connected alarm condition occurs. The following are representative alarm conditions that may be connected to and activate the TempTrac audible alarm (some alarms may be connected to and operate separately from the TempTrac on some products).

- High/low water temperature alarm
- Probe failures
- External thermostat limit failure
- Low water

The audible alarm is silenced by pressing any button (alarm condition still present).

Alarm Recovery

- Probe failure alarm automatically ends after normal operation is re-established. Check connections before replacing the probe.
- Temperature alarms “**HA**” and “**LA**” automatically stop as soon as probe 1 senses temperatures within normal operating parameters.
- Digital input 2 & 3 alarms recover when condition(s) listed above are normalized and any button is pressed (if used). Resetting the alarm condition may require resetting individual safety devices or cycling main power switch.
- RTC alarm stops after programming the real time clock.
- RTF alarm requires the replacement of the real time clock.

For additional information, contact the PVI Industries Customer Service Dept at 800-433-5654.

6. START-UP PROCEDURES AND OPERATION

WARNING: Turn off all electrical service to the appliance when accessing the controls located inside the control cabinet. The cabinet contains high voltage wiring and terminals. If the electrical service is not turned off and these wires or terminals are touched, a dangerous shock causing personal injury or death could occur. Close the control cabinet before restoring electrical service to the appliance.

Coupez l'alimentation avant intervention sur l'appareil.

1. Use multimeter to check resistance to ground between all element terminals and the element mounting flange. (See table 1)

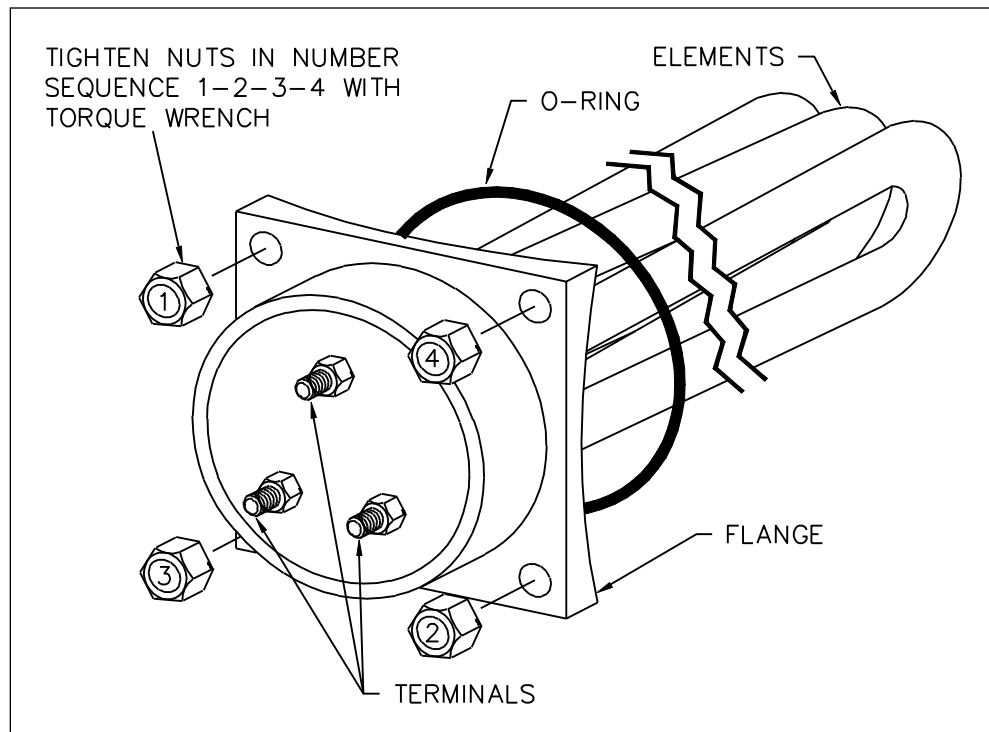
Fill the heater with water. Open the relief valve to allow air in the tank to escape. Be sure all connections into the tank are tight as leaks at tank fittings or heating elements can cause damage.

Check inside of electrical enclosure for leaks with tank full of water at water line pressure. Heating element gaskets are pressure tested at the factory but may leak if the unit has been in dry storage for a long period of time.

If leaks are present, tighten all four nuts uniformly on the element mounting flange in a crisscross pattern. Tighten one nut, then the nut on the diagonal from the first nut. Next, tighten the nut adjacent to the second nut, and then the nut diagonal from the third nut. Repeat this sequence until all nuts are tight. Each nut should be tightened to 11-foot pounds of torque. To avoid warping the flange, do not over tighten.

IMPORTANT: All leaks must be corrected prior to turning on electricity to avoid damage to electrical components within the enclosure.

Electric element (design may vary): 3 phase elements have 3 terminals; 1 phase elements have 6 terminals.



2. The tank must be full of water before turning on electricity. If elements are energized without water in the tank, they will burn out immediately. Warranty is void on dry starts.
3. Check all electrical connections for tightness before turning the unit on.
4. Energize manual disconnect switch. Check for proper voltage (with voltmeter) on power circuit. Voltage should not vary more than 5% from voltage shown on data plate. If voltage exceeds these limits, immediately turn off main disconnect and contact utility company.

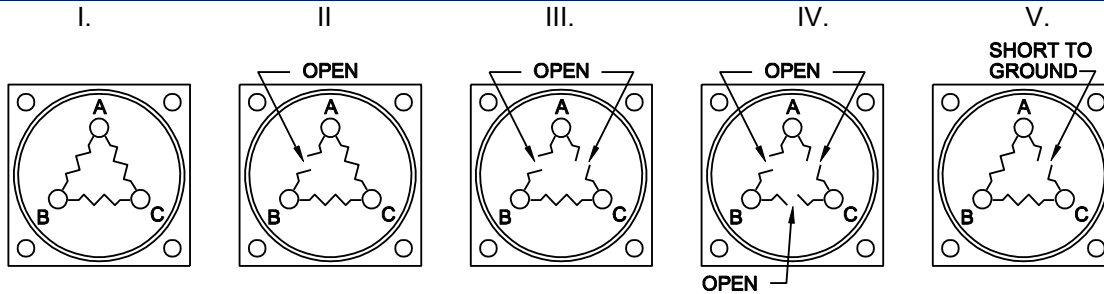
6 START-UP PROCEDURES AND OPERATION

5. Energize control circuit switch. Check for proper voltage.
6. Check for proper amperage with ammeter on power circuit. Amperage should not vary more than 5%, when under full load, from amperage shown on data plate. (Table 2). If amperage exceeds these limits, immediately turn off main manual disconnect and refer to Electric Water Heater Trouble Shooting Guide.
7. Check magnetic contactors for noise. If noisy, i.e., buzzing or chattering, turn off main power disconnect, disassemble contactor and blow out foreign particles. Drill filings, dirt or other particles can cause pitting of points which will in turn burn out contactor and/or wire. Extra care has been taken during fabrication and inspection for cleanliness; however, field installation is often responsible for debris collecting on the contactor points.
8. The top thermostat is a temperature limiting safety device set at 200°F. The upper operating thermostat is factory set at 130°F. The lower operating thermostat is set at 120°F. Adjust stored water temperature by turning the Operating thermostat dial to the desired temperature. The Upper Operating and Operating thermostats should be set to a minimum of 10°F higher.

Le thermostat est réglé à environ 49 degrés Celsius. Températures de l'eau supérieures à 52 degrés Celsius peut causer instantanément de graves brûlures ou la mort de brûlures. Suivez les instructions dans le manuel d'installation et de maintenance pour modifier la température de l'eau.
9. If an optional proportional sequencer is furnished, adjust set point to desired water temperature. (All other temperature controls must be set above the sequencer's set point.) Refer to manufacturer's product literature for servicing, operation and maintenance of proportional sequencer.
10. After startup and with the water heater operating, allow the water in the tank to reach the desired temperature and de-energize the heating elements. Draw hot water from a nearby faucet or outlet until the heating elements come back on. This will check for proper operation of the thermostats and other operating controls.

IMPORTANT: After approximately 30 minutes of operation, turn off all power to the unit. With the main disconnect off, check each wire connection and fuse clip for elevated temperature. If an elevated temperature is noted, there is a loose connection at the point of greatest heat. All connections must be tight for proper performance.

7. ELEMENT CONTINUITY CHECKS



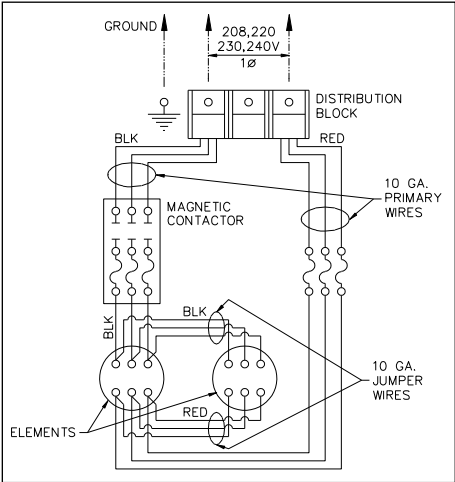
NOTE: ELEMENT WIRE LEADS MUST BE DISCONNECTED TO PREVENT FALSE OHM READINGS.

ELEMENT RATING		CHECK OPEN COILS	I. OHM READING NORMAL	II. OHM READING 1 LEG OPEN	III. OHM READING 2 LEGS OPEN	IV. OHM READING 3 LEGS OPEN	V. OHM READING TERMINAL TO FLANGE
KW	VOLT						
18	600	A-B	40	120	∞	∞	Depending on the severity of the short, the OHM reading may vary from zero, (direct short) to several hundred ohms (partial short). In any case where the OHM reading is not infinity, the element should be replaced.
		B-C	40	60	60	∞	
		C-A	40	60	∞	∞	
18	480	A-B	26	78	∞	∞	
		B-C	26	39	39	∞	
		C-A	26	39	∞	∞	
18	380	A-B	17	50	∞	∞	
		B-C	17	25	25	∞	
		C-A	17	25	∞	∞	
18	240	A-B	7	20	∞	∞	
		B-C	7	10	10	∞	
		C-A	7	10	∞	∞	
15	208	A-B	7	19	∞	∞	
		B-C	7	10	10	∞	
		C-A	7	10	∞	∞	
9	600	A-B	80	240	∞	∞	
		B-C	80	120	120	∞	
		C-A	80	120	∞	∞	
9	480	A-B	52	154	∞	∞	
		B-C	52	77	77	∞	
		C-A	52	77	∞	∞	
9	380	A-B	33	98	∞	∞	
		B-C	33	49	49	∞	
		C-A	33	49	∞	∞	
9	240	A-B	14	40	∞	∞	
		B-C	14	20	20	∞	
		C-A	14	20	∞	∞	
9	208	A-B	10	30	∞	∞	
		B-C	10	15	15	∞	
		C-A	10	15	∞	∞	
4.5	600	A-B	160	480	∞	∞	
		B-C	160	240	240	∞	
		C-A	160	240	∞	∞	
4.5	480	A-B	103	308	∞	∞	
		B-C	103	154	154	∞	
		C-A	103	154	∞	∞	
4.5	380	A-B	65	194	∞	∞	
		B-C	65	97	97	∞	
		C-A	65	97	∞	∞	
4.5	240	A-B	26	78	∞	∞	
		B-C	26	39	39	∞	
		C-A	26	39	∞	∞	
4.5	208	A-B	20	58	∞	∞	
		B-C	20	29	29	∞	
		C-A	20	29	∞	∞	

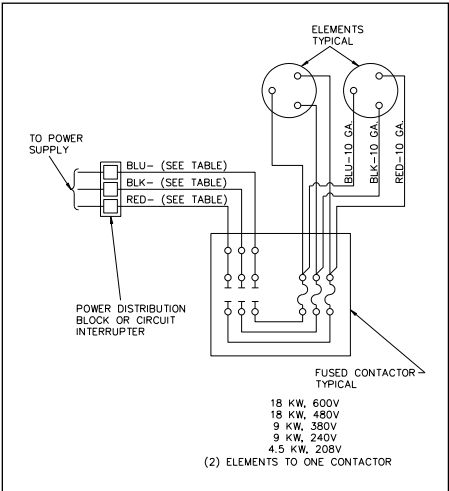
TABLE 1

TYPICAL CURRENT MEASUREMENTS

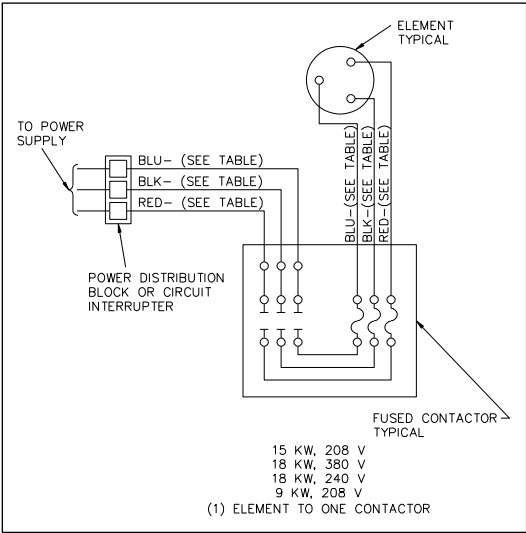
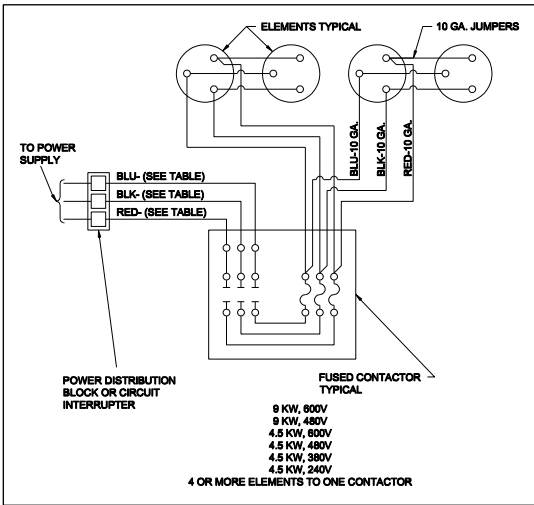
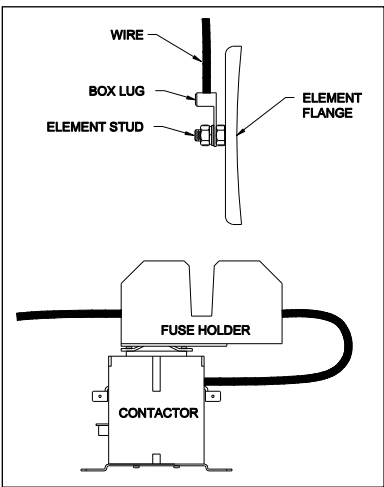
TYPICAL SINGLE-PHASE WIRING



TYPICAL THREE PHASE WIRING

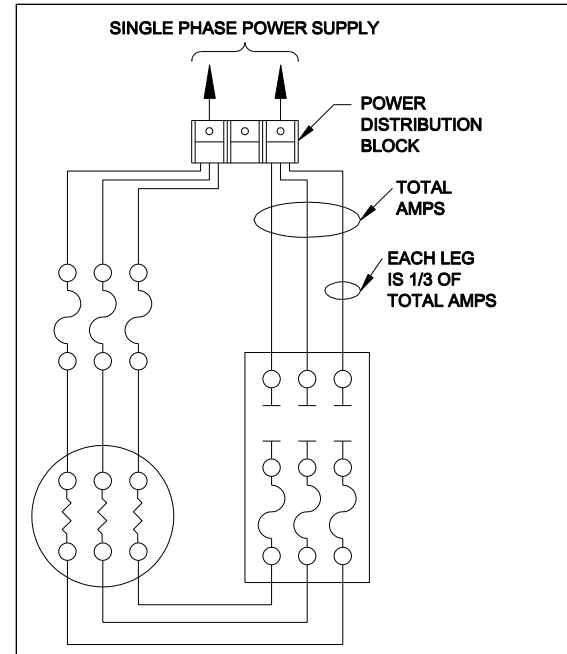
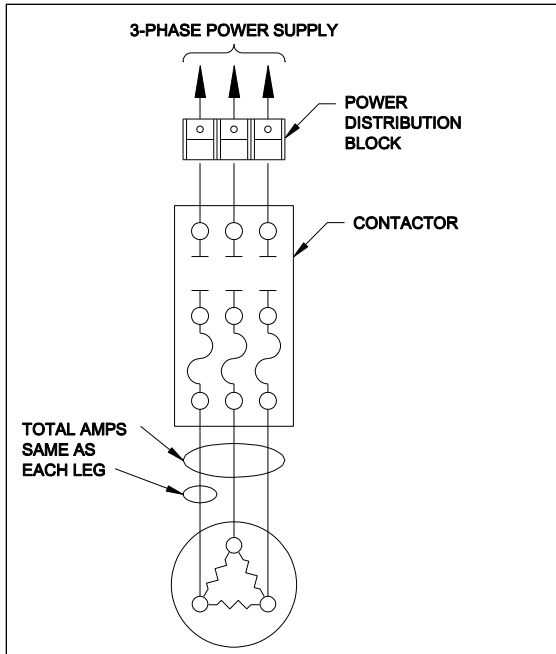


TYPICAL WIRE TERMINATIONS



REQUIRED WIRE SIZE	
Contactor Fuseholder Rating	Wire Size
600V – 30A	10 AWG
300V – 60A	6 AWG
600V – 60A	6 AWG

TORQUEING REQUIREMENTS		
Wire Size	Terminal Type	In-lbs
10 AWG	RING	25
8 AWG	BOX	40
6 AWG	BOX	45



KW-VOLTAGE	3 Ø AMPS PER ELEMENT		1 Ø AMPS PER ELEMENT	
	AMPS PER LEG	AMPS TOTAL	AMPS PER LEG	AMPS TOTAL
*14 kW-600V	13-1/2	13-1/2	—	—
*7 kW-600V	7	7	—	—
18 kW-600V	18	18	—	—
9 kW-600V	9	9	—	—
4.5 kW-600V	4-1/2	4-1/2	—	—
18 kW-480V	22	22	—	—
9 kW-480V	11	11	—	—
4.5 kW-480V	5-1/2	5-1/2	—	—
18 kW-380V	28	28	—	—
9 kW-380V	14	14	—	—
4.5 kW-380V	7	7	—	—
18 kW-240V	44	44	25	75
9 kW-240V	22	22	13	38
4.5 kW-240V	11	11	6	18
15 kW-208V	41-2/3	41-2/3	29	87
9 kW-208V	25	25	15	44
4.5 kW-208V	12-1/2	12-1/2	7	22

TABLE 2

NOTE: Elements are usually wired to contactors in groups, in order to maintain an amperage draw of close to, but not more than, 50 amps per contactor.

*Applications for 600V may be a re-rated 480V element. Therefore, the 40W/in.² may be rated for 14 kW instead of 9 kW.

8. MAINTENANCE

A preventative maintenance program is required to ensure a long trouble-free life of the water heater.

Maintenance Schedule

COMPONENT	OPERATION	INTERVAL	REQUIRED
Tank	Sediment Removal	Every 3 Months	Flushing
Relief Valve	Inspect	Every 6 Months	Test
Electrical Connections	Inspect	Monthly	Inspect for wire discoloration
Electric Elements	Check	Every 6 Months	Amp Draw
Electric Elements	Remove & Clean	See Page 9	

Flushing

1. Turn off the heater electrical disconnect switch.
2. Open the drain valve and allow water to flow until it runs clean.
3. Close the drain valve when finished flushing.
4. Turn on the heater electrical disconnect switch.

Draining the Tank

The heater must be drained if it is to be shut down and exposed to freezing temperature. Maintenance and service procedures may also require draining the heater.

1. Turn off the heater electrical disconnect switch.
2. Close the cold-water inlet and hot water outlet valve to heater.
3. Open a relief valve to vent the tank pressure.
4. Open the heater drain valve.
5. If the heater is being drained for an extended shutdown, it is suggested the drain valve be left open during this period.

Sediment / Lime Scale Removal

Waterborne impurities consist of the particles of soil and sand which settle out and form a layer of sediment on the bottom of the tank and adhere to heat exchange surfaces. The amount of calcium carbonate (lime) released from water is in direct proportion to water temperature and usage. The higher the water temperature or water usage, the more lime deposits are dropped out of the water. Lime accumulation not only reduces the life of the equipment but also reduces efficiency of the heater.

Temperature and Pressure Relief Valve

The relief valve should be checked at regular intervals by manually opening the valve. The openings inside the valve may become restricted by a buildup of scale and become inoperative. If the valve does not open and close properly and does not blow off internal pressure when tested, it must be replaced. Shut down heater, relieve internal pressure and replace relief valve with a like kind or one meeting the requirements stated on the rating decal located adjacent to the relief valve mounting location.

Low Water Cutoff

The standard low water control is electronic. Inspection should be made of the electrode on water heaters equipped with electronic low water devices.

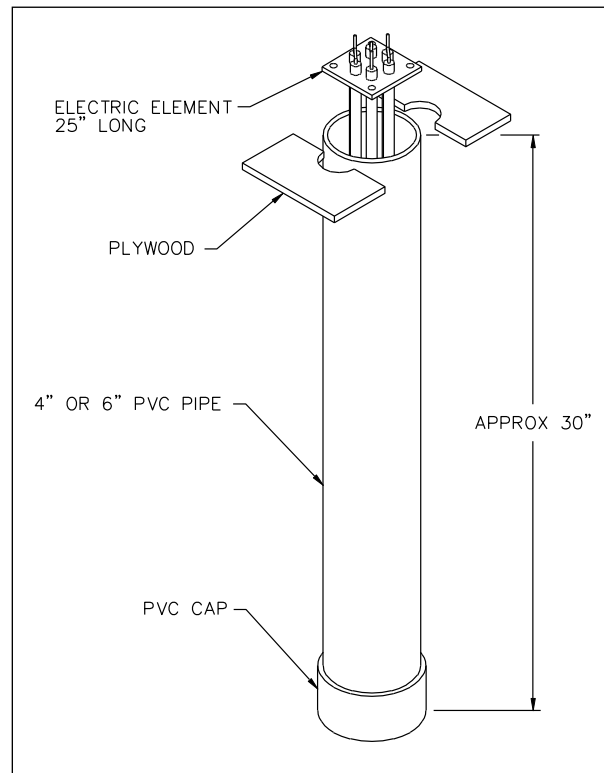
Electrical Connections

Check all electrical connections approximately one to two weeks after initial start-up to assure tightness. Heating and cooling from operation can loosen connections. Visually inspect wire terminal points for any discoloration on a monthly basis. Discoloration is likely due to a loose connection at the point nearest discoloration. Check contactors periodically and clean if necessary and repair or replace pitted points caused by foreign particles. Check fuses periodically for continuity and replace them if necessary with the same type and rating.

Cleaning Electric Elements

Electric immersion INCOLOY® sheath elements are wound at high wattage ratings and must be completely covered by water while in operation. Otherwise, they overheat and burn out. Scale from the water will collect on the sheathing of the element over a period of time and must be removed periodically to extend the life of the element. Water in some areas will produce a scale buildup more rapidly than other areas. The rapidity of the scale buildup is also determined by the watt density of the element.

It is good maintenance practice to remove and clean 80 W/in² (18kW) density elements on a monthly basis. The interval between removal and cleaning can usually be extended to six months when 40 W/in² (9kW) density elements are installed. Most installations where 20 W/in² (4 1/2kW) density elements are used, require only annual cleaning. Elements are cleaned by soaking in a scale dissolving solution. A 30" piece of four- or six-inch PVC pipe with a cap on one end makes an ideal container for element cleaning. (See figure 2.) Contact a chemical supply house for advice on the proper cleaning solution for your area.

Element Cleaner**FIGURE 2**

9. TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	CORRECTIVE ACTION
No hot water	Thermostat(s)	Check to assure proper thermostat setting.
	Contactors will not pull in	Check continuity between all three thermostats or pressure controls. Complete circuit. If one is open, it must be replaced.
	Control circuit switch is in OFF position	Close switch. (Turn to ON position)
	Control circuit fuse blown	Isolate cause for failure and replace fuse.
	Contactor(s) coil open	Check continuity. Replace coil if not a complete circuit.
	Time delay sequencer not operating	Check for 120 volts to coil on first sequencer step. Allow ample time for additional steps to energize. If steps do not energize in reasonable time, replace only the defective relay step. See wiring diagram.
	Proportional sequencer not operating	Check for 120 volts to line connection (L) on sequencer. Check fuse for continuity. See wiring diagram. Consult factory.
	Low water cutoff closed	Check for open circuit. Check the water level in tank. Replace low water cutoff if defective.
	Heating elements	Check for open legs. (See table 2).
Insufficient hot water	Heater not large enough to satisfy peak demands	Add booster or additional kw input. Consult local PVI representative.
	Hot water lines not insulated	Add insulation; it will protect against heat loss and save on cost of operation.
	Power fuse(s) blown	Check fuses for continuity. Replace if blown. If blown, determine cause of break before replacing with same type fuse.
	Contactor(s) not closing	Check coil for continuity. If defective, replace.
	Thermostat(s) not correctly set	Check to assure proper thermostat control setting.
	Element(s) not heating	Check for proper amperage draw. Check for proper ohm resistance. Replace if defective. Consult factory. (See table 1)
Burned or discolored wires	Loose connections	Tighten all connections. If charred, replace wire with wire of same type and size.
	Dirty or pitted contactor points	Remove contactor points and inspect. If dirty, clean with emery paper. CAUTION: Point must remain flat. If pitted or burned, contactor points must be replaced.
Blown fuses	Loose connection. Defective element	Check all connections for tightness. Check ohm resistance in electric elements. Replace.
High or low voltage	Local utility	Check with local utility.
High or low amperage	High or low voltage. Defective element	Check with local utility. Low amperage, check fuses, tighten connections. Check ohm resistance on elements.
Wire burned or melted at element	Loose connections. Water leaking on elements	Tighten connection and replace wire. Isolate leaking water and repair. Replace wire with same type and size.

