



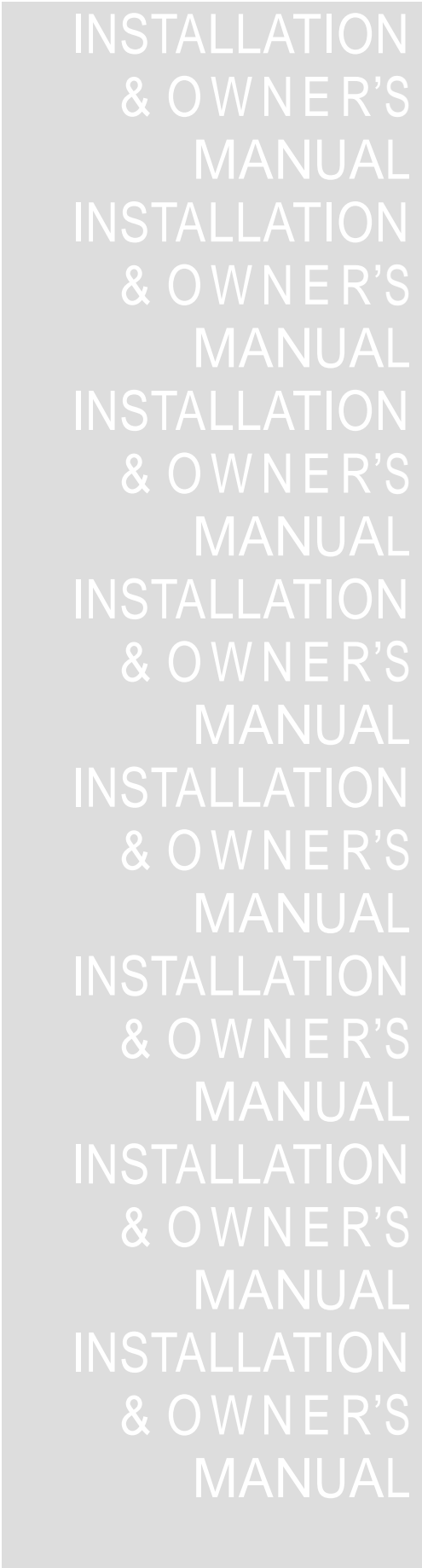
**P-K DURATION III™**  
**INSTANTANEOUS INDIRECT DOMESTIC HOT WATER SYSTEM**  
**D3-30I, D3-50I & D3-80I**  
**PUMPED INDIRECT DOMESTIC HOT WATER SYSTEM**  
**D3-30P, D3-30PE, D3-50P, & D3-50PE**  
**INDIRECT DOMESTIC HOT WATER SYSTEM**  
**D3-30, D3-50, & D3-80**



Part # 1004905984

Model Number: \_\_\_\_\_  
 Serial Number: \_\_\_\_\_  
 Start-Up Date: \_\_\_\_\_

Patterson-Kelley  
 155 Burson Street  
 East Stroudsburg, PA 18301  
 Telephone: 570.476.7261  
 Toll Free: 877.728.5351  
 Fax: 570.476.7247  
[www.pattersonkelley.com](http://www.pattersonkelley.com)



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## 1 INTRODUCTION

This manual describes the installation and operation of the P-K Duration III™ indirect domestic hot water heat exchanger package. It is important to note that the P-K Duration III™ is designed to operate in conjunction with a complete hydronic system and does require an external source of hot boiler water. The available boiler water temperature will have a profound impact on the performance and capacity of the P-K Duration III, and it must always exceed the desired domestic hot water supply temperature.

If you have any questions on the information contained within, or do not fully and completely understand the content, please contact Patterson-Kelley Technical Service at 570.476.7261 or toll free at 877.728.5351.

The P-K Duration III system is only a part of a complete water heating system. This add-on package may be fully operational and yet because of poor circulation, control, or other operating characteristics not deliver hot water to the desired location. Additional equipment such as pumps, flow switches, balancing valves, and check valves may be required for satisfactory operation of any system. Patterson-Kelley cannot be responsible for the design or operation of such systems and a qualified engineer or contractor must be consulted.

### 1.1 REFERENCE TABLE – MODELS

Model Number	Heat Exchanger Size	Power supply	Control valve	Domestic Pump	Boiler Pump	Expansion tank
<b>BASE MODEL</b>						
D3-30	30 plates	1Φ, 60 Hz, 15 amps	N/A	N/A	N/A	N/A
D3-50	50 plates					
D3-80	80 plates					
<b>PUMPED MODEL</b>						
D3-30P	30 plates	1Φ, 60 Hz, 15 amps	N/A	1-1/2 Bronze circulator		N/A
D3-30PE	30 plates					2 gallon 20psig max
D3-50P	50 plates			2" Bronze circulator	2" circulator	N/A
D3-50PE	50 plates					2 gallon 20psig max
<b>INSTANTANEOUS MODEL</b>						
D3-30I	30 plates	1Φ, 60 Hz, 10 amps	2" 3-way electric	1-1/2" Bronze circulator	N/A	N/A
D3-50I	50 plates					
D3-80I	80 plates					



## 2 SAFETY



**WARNING**

It is **essential** to read, understand, and follow the recommendations of this manual before installing, operating, or servicing this equipment. Failure to do so could result in serious injury, death, and/or property damage.



**CAUTION**

Installation and service must be performed by a qualified and knowledgeable installer or service agency.

### 2.1 GENERAL

The P-K Duration III indirect domestic hot water system **must** be:

Installed, operated, and serviced in accordance with instructions contained in this manual and other supplemental manuals.

Installed by qualified personnel in accordance with designs prepared by qualified facility engineers including: structural, mechanical, electrical, and other applicable disciplines.

Operated and serviced in accordance with a comprehensive safety program determined and established **by the customer**. Do not attempt to operate or service until such a program has been established.

Operated and serviced by experienced, qualified, and properly trained personnel in accordance with all applicable codes, laws, and regulations.

### 2.2 TRAINING



Proper training is the best protection against accidents. Factory training sessions are available to qualified individuals who are sponsored by the local Patterson-Kelley representative. Operating and service personnel must be thoroughly familiar with the basic construction of the P-K Duration III

system, the location and operation of the controls, adjustment of their various mechanisms, and all applicable safety precautions. If any of the provisions of this manual are not fully and completely understood, contact Patterson-Kelley Technical Service at 570.476.7261 or toll free at 877.728.5351.

### 2.3 SAFETY FEATURES

It is the responsibility of the customer to maintain the safety features, such as but not limited to: guards, safety labels, safety controls, interlocks, lockout devices and pressure relief valves.

### 2.4 SAFETY LABELS

The following words are used in this manual to de-note the degree of seriousness of the individual hazards.



**DANGER**

This label indicates an imminently hazardous situation which, if not avoided, **will** result in death or serious injury. This signal word is to be limited to the most extreme situations.



**⚠ WARNING** This label indicates a potentially hazardous situation which, if not avoided, **could** result in death or serious injury.

**⚠ CAUTION** This label indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury. It may also be used to alert against unsafe practices.



**NOTICE!** - NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol is not used with this signal word.

## 2.5 SAFETY PRECAUTIONS

Provide a suitable location for the P-K Duration III system, away from normal personnel traffic, with adequate working space, adequate clearances, proper ventilation and lighting, with a structure sufficiently strong and rigid to support the weight of the P-K Duration III system, all piping, and accessories.

**⚠ CAUTION** Proper lockout/tagout procedures must be employed whenever this unit is serviced.

### 2.5.1 Electrical Hazards


<p><b>⚠ AVERTISSEMENT</b>  <b>Risque électrique.</b>          Un contact causera un choc électrique et des blessures. Suivre les procédures de verrouillage/signalisation lors de l'entretien.</p>	 	<p><b>⚠ WARNING</b>  <b>Electrical hazard.</b>          Contact may cause electrical shock and injury. Follow lockout/tagout procedure when servicing.</p>
--	--	--

Shock hazard! Properly lockout/tag out the electrical service and all other energy sources before working on or near the P-K Duration III.

Shock hazard! Do not spray water directly on this system or on any electrical components.


Electrical hazard! Do not alter wiring connections.

### 2.5.2 Burn, Fire, and Explosion Hazards

  
 General Warning

Burn hazard! Possible hot surfaces. Pipes and internal components could be hot. Do not touch piping or internal components during operation or immediately after shutdown of the appliance.

Burn hazard! Hot fluids. Use caution when servicing or draining the P-K Duration III system.

  
 Hot Surface

Close the applicable isolation valves and allow the P-K Duration III to cool down to ambient temperature before servicing. Isolation valves are provided on all inlets and outlets on the instantaneous models for your convenience.

**⚠ DANGER** The P-K Duration III is a dynamic system that is designed to heat domestic hot water to a wide range of temperatures. The P-K Duration III system is capable of heating water to scalding temperatures. Refer to your local codes for guidelines on compliance for domestic hot water systems. A thermostatic mixing valve or other device may be required to prevent scalding.



### 2.5.3 Crush Hazards



General Warning

Lifting hazards! Use properly rated lifting equipment to lift and position the P-K Duration III system. The load is unbalanced. Test balance before lifting 3 ft. above the floor. Do not allow personnel beneath the lifted load. Refer to approximate weights in the table.

Model	Weight Instantaneous	Weight Pumped
30 Plates	360	360
50 Plates	450	475
80 Plates	500	

### 2.5.4 Chemical Hazards



General Warning

Chemical hazards from cleaning products. Use caution when cleaning the system. The use of professional assistance is recommended. Use safe procedures for the disposal of all cleaning solutions.

### 2.5.5 Pressure Hazards



General Warning

Pressure hazard! Hot fluids. Isolation valves are provided on all inlets and outlets for your convenience. Make sure all isolation valves are closed before servicing.  
Pressure hazard! Hot fluids. Annually test safety relief valve for proper operation. Do not operate with faulty relief valve(s).

### 2.5.6 Slip, Fall Hazards



General Warning

Tripping hazard! Do not install piping on floor surfaces. Maintain clear path around the P-K Duration III™ system.  
Slip and fall hazard! Use drip pan to catch water while draining. Maintain dry floor surfaces.  
Fall hazard! Do not stand on the P-K Duration III™ system.



### 3 INSTALLATION (INSTANTANEOUS VERSION)

**⚠ WARNING**

Installation and service must be performed by a qualified installer, service agency, or gas supplier.

#### 3.1 RECEIVING AND STORAGE

##### 3.1.1 Initial Inspection

Upon receiving the P-K Duration III system, inspect it for signs of shipping damage. Since some damage may be hidden, unpack the product, open the front, and side doors to inspect. Verify that the total number of pieces shown on the packing slip agrees with those actually received.

**NOTICE!** Note any damage, suspected potential damage, or shortage of materials on the freight bill and immediately notify the carrier. File all claims for shortage or damage with the carrier. Claims for hidden damages must be filed with your carrier within 7 days.

##### 3.1.2 Storage Prior to Installation

If the P-K Duration III system is not installed immediately, it must be stored in a location adequately protected from the weather, preferably indoors. If this is not possible, then it should remain in the shipping container and be covered by a tarpaulin or other waterproof covering.

**NOTICE!** Controls and other equipment that are damaged or fail due to weather exposure are not covered by warranty.

#### 3.2 COMPLIANCE WITH CODES

The brazed plate heat exchanger is constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 for 435 psig maximum operating pressure. However, certain components in the domestic piping have a maximum pressure rating of 150 psig. Therefore, the water pressure must never exceed 150 psig. If there are other components in the piping system that have a lower maximum allowable working pressure (MAWP) than 150 psig, then the installer must ensure the set point of the relief device is set at or below the lowest MAWP.

#### 3.3 SETUP

##### 3.3.1 Foundation and Placement

Provide a firm, level foundation, preferably of concrete. The P-K Duration III system must be level to function properly. Consult with a certified Professional Engineer regarding any seismic anchoring requirements.

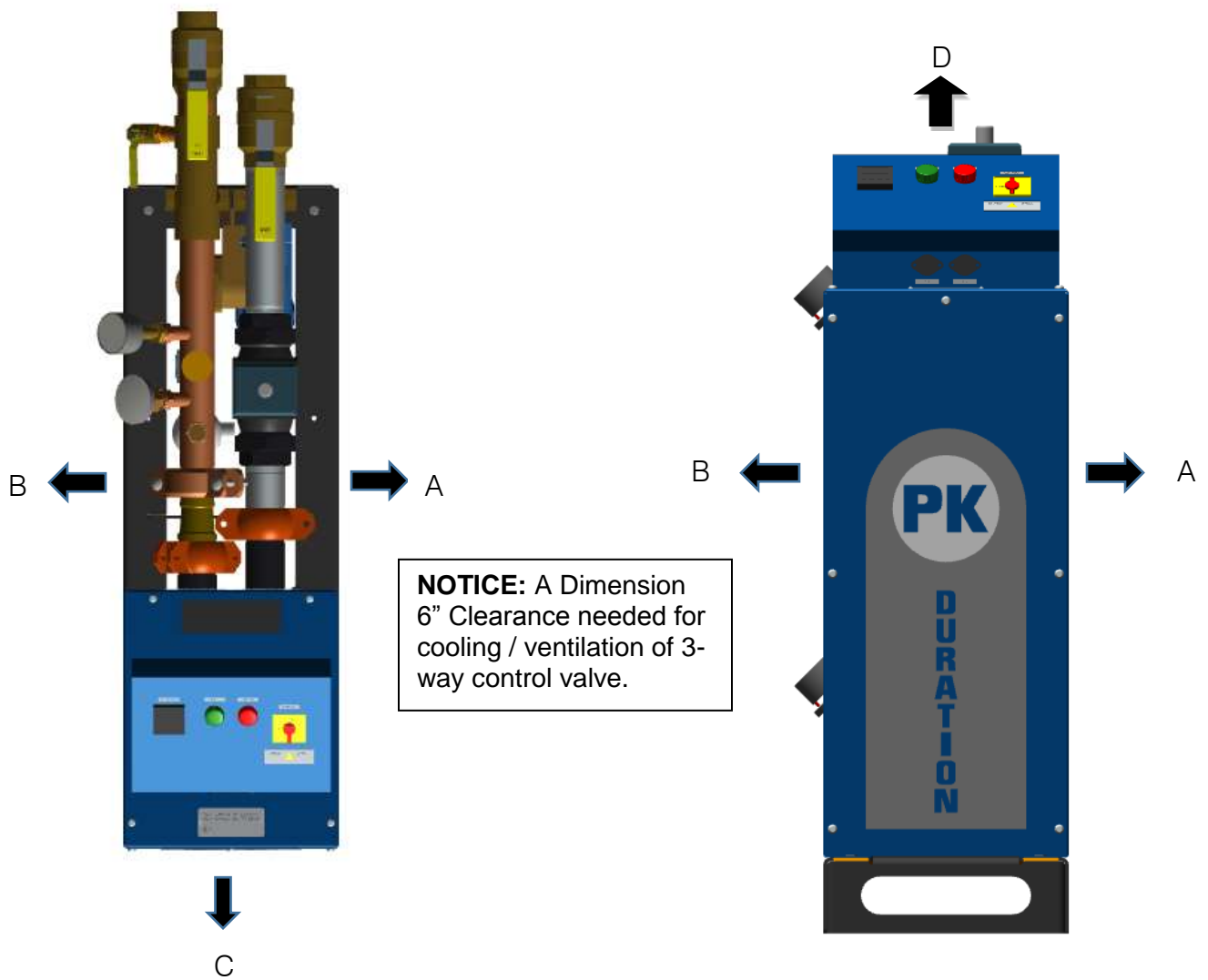




### 3.3.2 DURATION III Instantaneous Clearances

Since the P-K Duration III instantaneous indirect domestic hot water system is designed to operate in potentially remote mechanical rooms, it requires sufficient clearance for service and operation.

Clearance Dimensions	
A	6"
B	18"
C	24"
D	12"





### 3.4 DURATION III INSTANTANEOUS MECHANICAL CONNECTIONS

The P-K Duration III system is designed to provide substantial domestic hot water capacity in a small footprint (13" wide x 52" long) and requires only four (4) piping connections to operate as seen below:

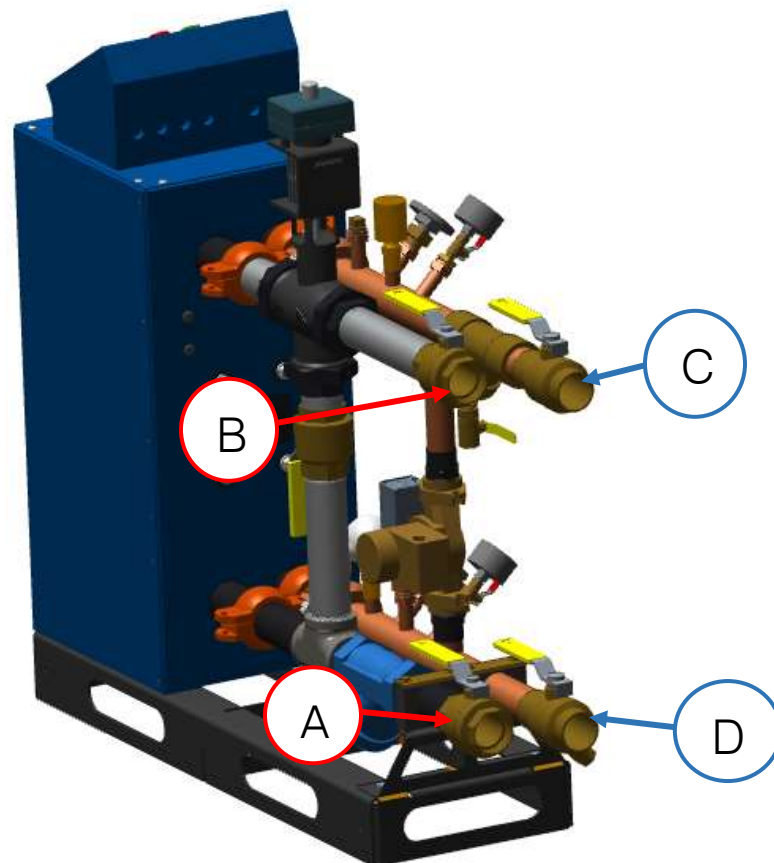
#### Boiler Water Piping Connections

- A. Boiler Water Inlet (Supply)  
(2" NPT-F Ball Valve)
- B. Boiler Water Outlet (Return)  
(2" NPT-F Ball Valve)

#### Domestic Hot Water Piping Connections

- C. Domestic Cold Water Inlet (Return from Building)  
(2" Sweat Ball Valve)
- D. Domestic Hot Water Outlet (Supply to Building)  
(2" Sweat Ball Valve)

**NOTICE:** If the D3-30, D3-50, or D3-80 will be installed as an instantaneous indirect water heater in the field, the contractor should ensure the unit will perform in the manner described in the following section and its subsequent sub-sections. The factory-supplied connections for these models are 2" grooved pipe. If a control valve is used to regulate the flow of water through the exchanger, the contractor must ensure an external controller is provided and properly installed.



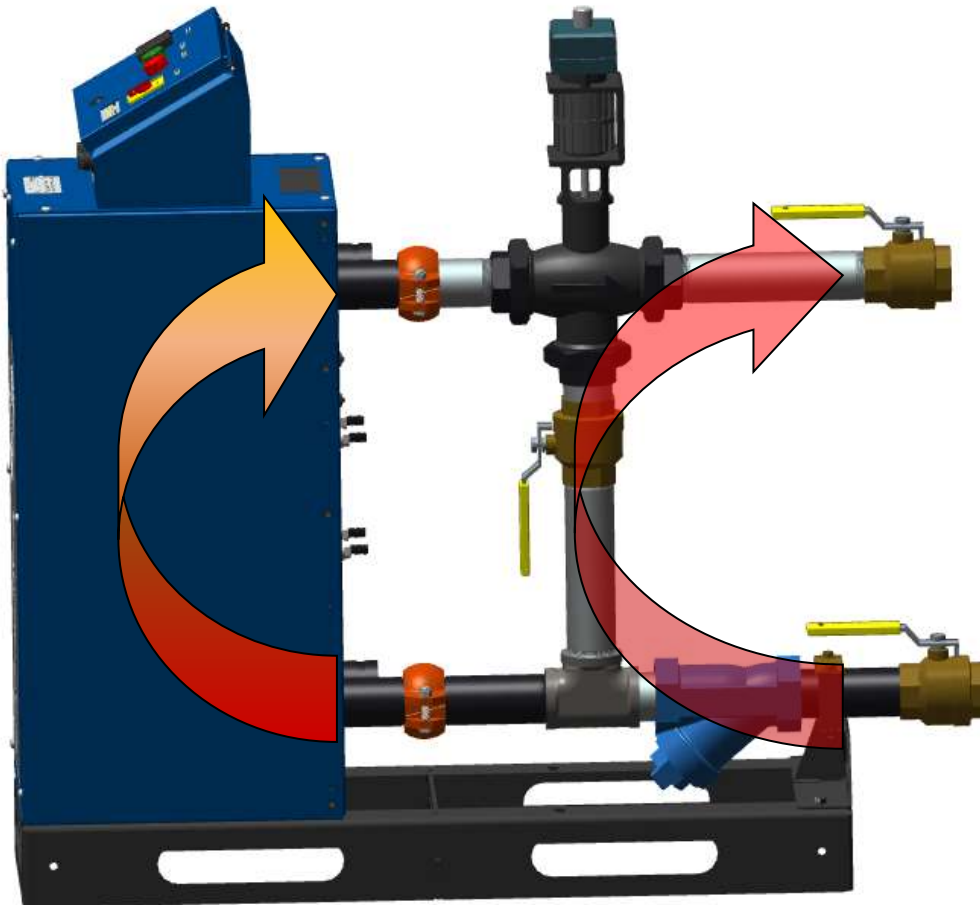


### 3.4.1 Boiler Piping (Simplified)

The energy source for the P-K Duration III system is hot boiler water from the hydronic system and is regulated by an electronic control valve. By default, this control valve is setup to operate as a 3-way valve since this is the recommended and preferred operating method. By closing the isolation valve below the control valve, it is also possible to operate this as a 2-way valve.

**NOTE:** 3-Way operation is the recommended/preferred configuration.

Assuming the Duration III system will be operated with 3-way control valve functionality, when the domestic hot water supply temperature is satisfied, the control valve bypasses all hot boiler water away from the brazed plate heat exchanger as shown below with the curved red arrow (Right):



As the domestic hot water supply temperature drops below the desired setpoint, the control valve actuates allowing the flow of hot boiler water into the brazed plate heat exchanger as shown above with the curved orange arrow (Left). As the DHW supply temperature drops below setpoint, the control valve allows more boiler water to enter the heat exchanger.

During this process, heat is transferred from the boiler water to the colder domestic water, reducing the outgoing boiler water temperature. As the DHW supply temperature approaches setpoint, the 3-way control valve will restrict the flow through the heat exchanger and will bypass more boiler water as shown by the curved red arrow (right). The boiler water flows through a grooved wye strainer. This helps protect the brazed plate heat exchanger from foreign debris which will reduce the operating efficiency and longevity of the equipment. The strainer is recommended to be cleaned every 6 months.

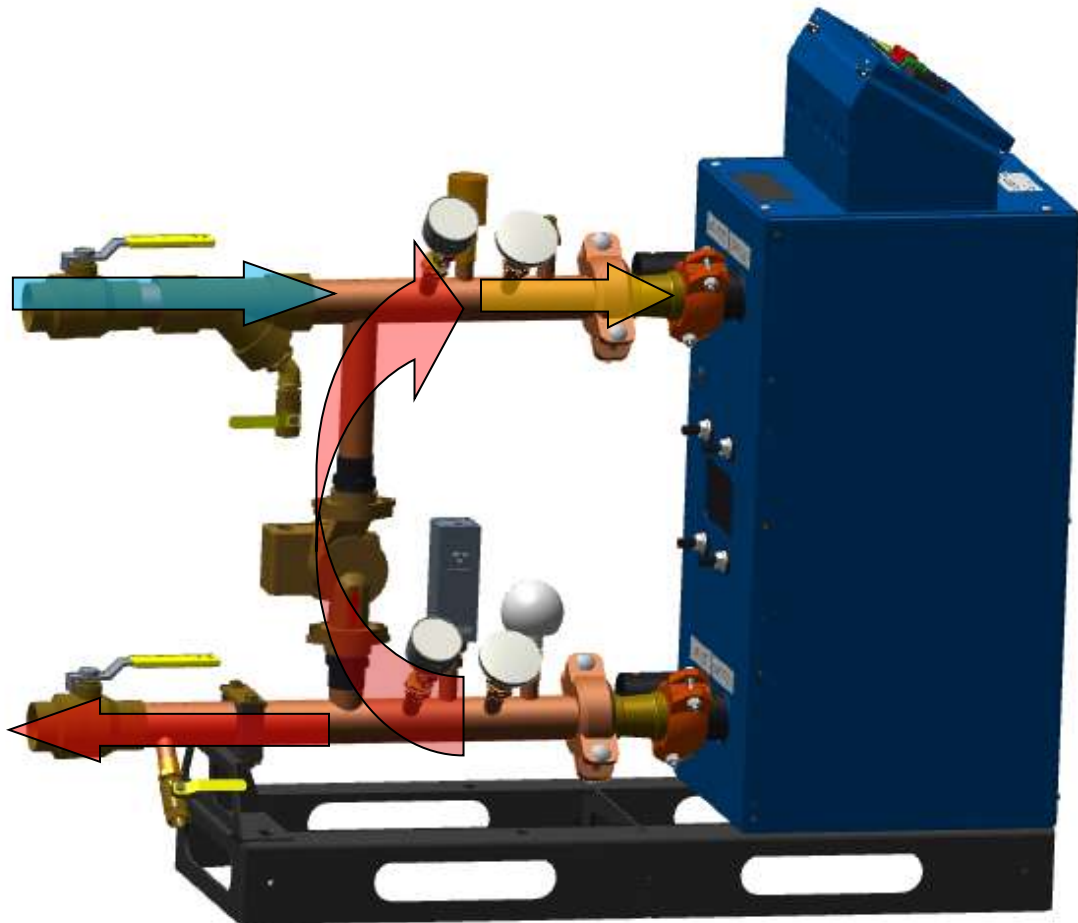


### 3.4.2 Domestic Water Piping (Simplified)

The P-K Duration III system features constant recirculation on the domestic hot water piping. This circulation pump offers 3-speed operation that can be selected by the operator. Constant circulation on the domestic hot water side offers several advantages:

- “Primes” the DHW loop ensuring the discharge water is at the correct temperature.
- Maintains accurate temperature readings by maintaining flow across the temp gauges and RTD.
- Minimizes heat exchanger scale formation by maintaining velocity across the plates.
- Inhibits bacterial growth by preventing stagnant water conditions.

As domestic hot water is consumed throughout the building, fresh makeup water will enter in the upper copper piping (blue arrow). The recirculation pump mixes some of the domestic hot water supply with the incoming fresh makeup before entering the heat exchanger (orange arrow). The hot water supply to the building will exit the Duration III in the lower copper piping (red arrow).

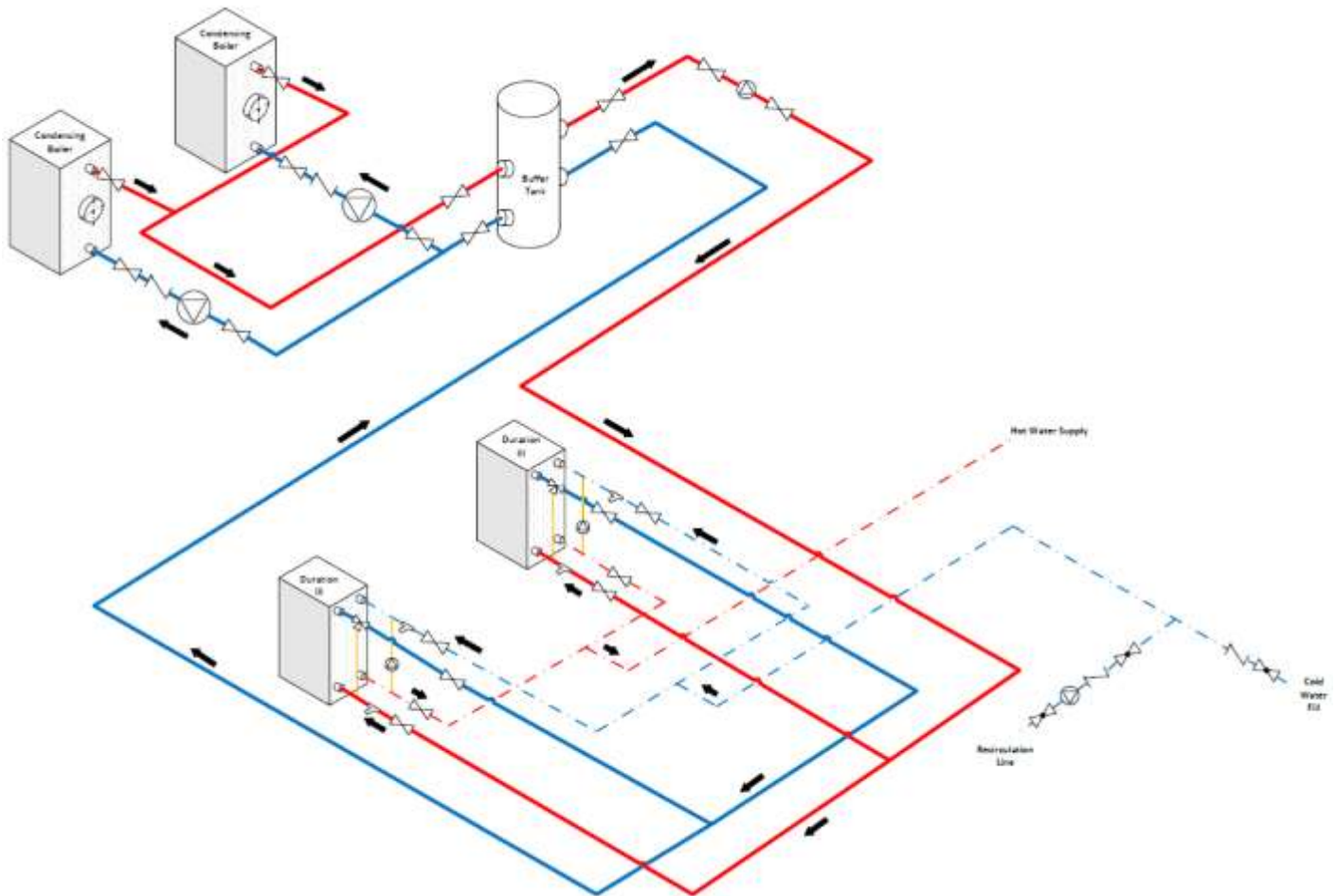




### 3.4.3 Example Domestic Hot Water Installation

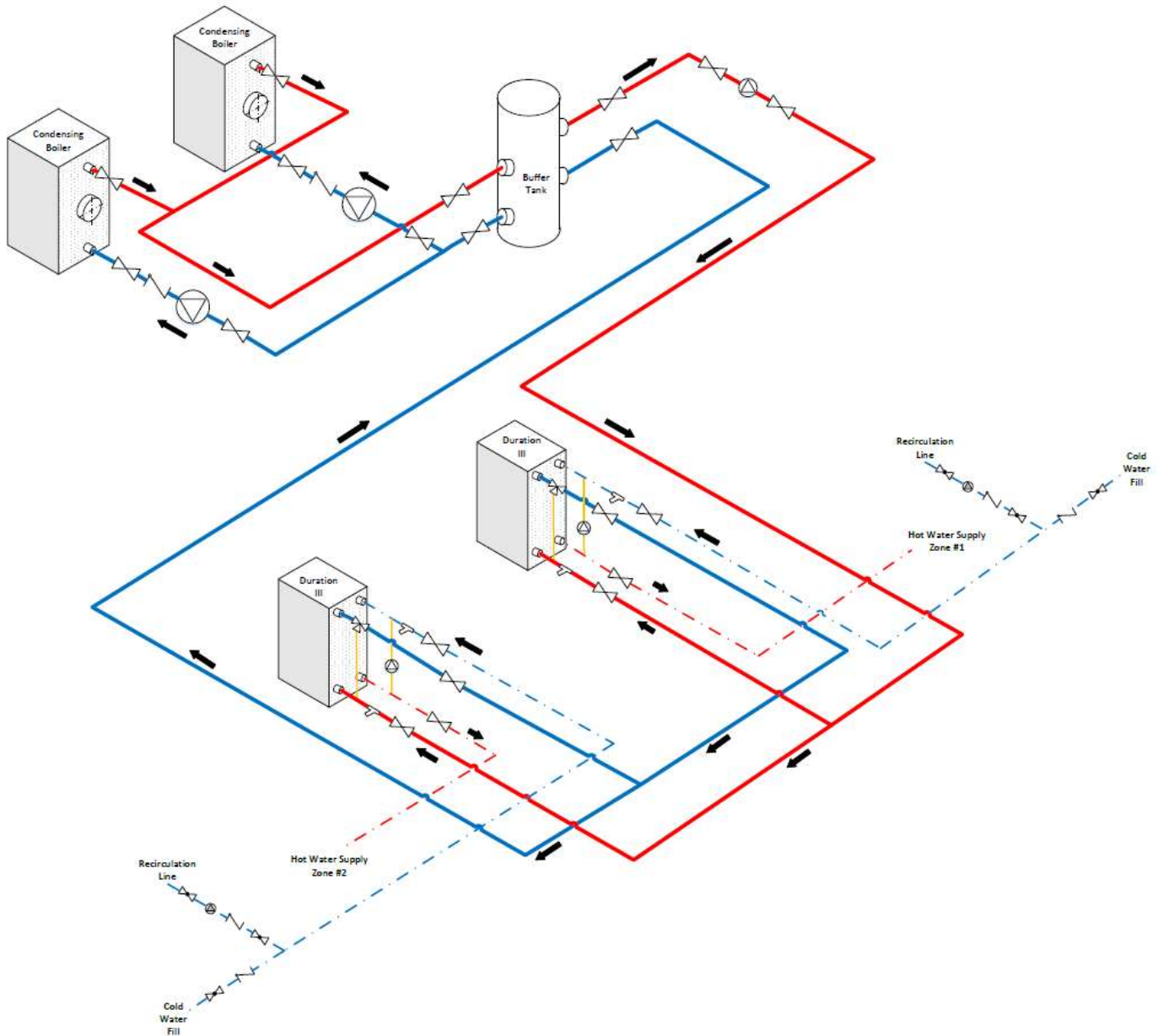
It is important to note that the P-K Duration III indirect domestic water heating system does not require a domestic water storage tank if hot boiler water is always available. When being used in conjunction with a boiler, the initial call for heat may take up to 5 minutes until the boiler operates at full capacity. If the unit is used in this manner, a hydronic buffer tank is recommended in order to provide sufficient hot water supply until the boiler is online.

**Sample Piping Diagram # 1: 2 Duration III Units Piped in Parallel to DHW Zone w/ Buffer Tank**



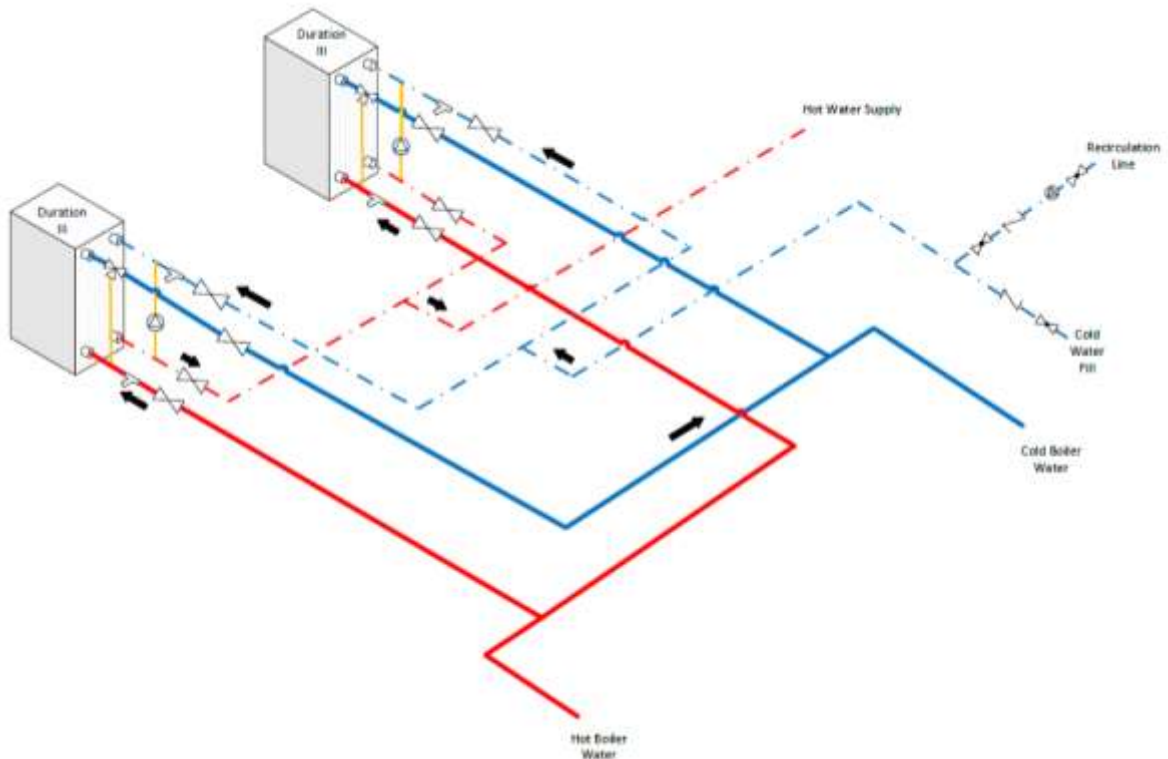


### Sample Piping Diagram # 2: 2 Duration III Units Piped to Independent DHW Zones w/ Buffer Tank

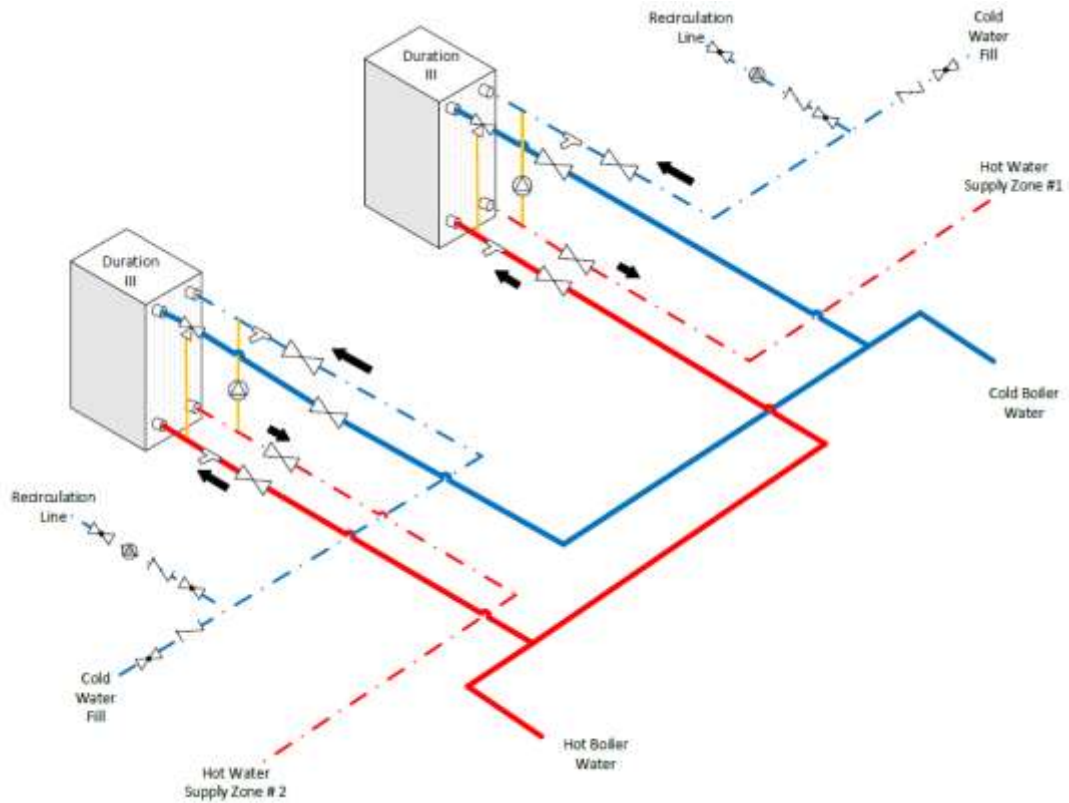




**Sample Piping Diagram # 3: 2 Duration III Units Piped in Parallel to DHW Load (No Buffer Tank)**



**Sample Piping Diagram # 4: 2 Duration III Units Piped to Independent DHW Zones (No Buffer Tank)**





### 3.4.4 Overpressure Protection

The Maximum Allowable Working Pressure (MAWP) of the double wall brazed plate heat exchanger is 435 PSIG, however some of the pipe fittings on the domestic hot water piping have a maximum working pressure of 150 PSIG. ASME Section VIII – Division 1 permits the equipment owner to perform an assessment if the system pressure is inherently self-limiting which would then not require the use of a safety relief valve.

For example, if the Duration III is installed in a 2 story building where the water pressure never exceeds 20 PSIG, the user can perform a due diligence analysis and operate without a pressure-only safety relief valve.

Another example may be a building with a booster pump system where the incoming water pressure from the street never exceeds 30 PSIG. If the user researches the booster pumps and determines that they are not capable of producing in excess of 150 PSIG, then the system pressure is inherently self-limiting. Here again, the user can perform a due diligence analysis and operate without a pressure-only safety relief valve.

Section **UG-140** of ASME Section VIII – Division 1 explains the requirements of the due diligence analysis needed to operate this system without a pressure-only safety relief valve.

**NOTICE!** Patterson-Kelley offers a 150# Section VIII – Division 1 pressure-only relief safety valve for purchase (P-K part # **10-0490-3946**). This will need to be installed on the outlet piping of the domestic water line.





### 3.5 FILLING THE DURATION III INDIRECT WATER HEATER

#### 3.5.1 Filling the DHW System

Before filling the system, ensure all the mechanical connections are complete.

- **STEP 1** – Connect a hose to the drain valve on the domestic water outlet line.
- **STEP 2** – If applicable, close the manual isolation valves in the domestic piping between the domestic water storage tank and the P-K Duration III system.
- **STEP 3** – Open drain valve on domestic piping.
- **STEP 4** – Slowly open the domestic water inlet ball valve to start filling with water.
- **STEP 5** – Close the drain valve on the domestic piping once a steady flow of water occurs.
- **STEP 6** – Open the cap on the automatic air vent in the domestic water piping.
- **STEP 7** – Open the manual isolation valves on the outlet of the domestic piping.
- **STEP 8** – Check for any leaks in all piping connections, especially at the Victaulic couplings. Tighten or reseal the connections if necessary.

**NOTICE!** Before the initial fill, ensure that any and all sediment or particulates have been removed from the domestic water. Ensure that the outlet isolation valve, if installed, on the P-K Duration III system is closed. Use the drain valve on the domestic water outlet line to purge sediment and particulates.

#### 3.5.2 Filling the Boiler System

Before filling the system, ensure all the mechanical connections are complete.

- **STEP 1** – Connect a hose to the drain valve on the boiler water strainer valve.
- **STEP 2** – Open drain valve on boiler piping.
- **STEP 3** – Slowly open the boiler water outlet ball valve to start filling with water.
- **STEP 4** – Close the drain valve on the boiler water strainer once a steady flow of water occurs.
- **STEP 5** – Open the manual isolation valves on the inlet of the boiler piping.

**NOTICE!** Under no circumstances should petroleum based cleaning or sealing compounds be used in the boiler system.

- **STEP 6** – Check for any leaks in all piping connections, especially at the Victaulic couplings. Tighten or reseal the connections if necessary.

#### 3.5.3 Flushing the Domestic Water

Flush the domestic water periodically by using the drain valve located on the lower DHW piping line (Bottom). At the same time, the strainer should be checked and cleaned properly.

### 3.6 ELECTRICAL CONNECTIONS

Only after all the mechanical connections have been completed and verified should any electrical connection be made. Please refer to [8.2](#) for a wiring diagram of the P-K Duration III system.

**NOTICE!** A dedicated earth ground (green wire) is required. Do not ground through the conduit.

The P-K Duration III system requires 120 volt, single phase, 60 hertz electrical service (10 amps). Size the supply circuit accordingly.



### 3.6.1 Incoming Electrical Supply

The control panel is located and accessed on the front of the P-K Duration III system. The 120 volt, single phase, 60 hertz, 10 amps electrical service should be routed to this panel. Knockouts are located in the rear of the panel.

### 3.6.2 High Voltage



#### **WARNING**

The P-K Duration III has inputs for line voltage (120VAC) connections.

- **120 VAC Supply:** Connect the incoming power supply directly to the disconnect switch.

### 3.6.3 Low Voltage

- **Communication Connection:** The controller is capable of MODBUS Communication. A Protocol Convertor is available to convert from MODBUS to BACNet or LONWORKS.
  - Connect BMS system to LOVE controller on terminals 9 (Data -) and 10 (Data +).
  - For connecting the Protocol Convertor to the system, please refer to the ProtoNode Startup Guide.

## 3.7 PRE-START CHECK LIST

Before attempting to start the P-K Duration III system, ensure the following items have been completed.

1. Inspect the P-K Duration III system for leaks in either the boiler side or domestic side piping. Correct any and all leaks promptly. If leaks occur at grooved fittings, refer to manufacturer's instructions for more information.
2. Ensure there is sufficient clearance around the unit, especially the front for access to control panel.
3. Verify the boiler water piping is installed correctly. Verify the domestic water piping is installed correctly and the water heater and domestic system have been completely filled with water and all the air has been purged.
4. Inspect the relief valve discharge piping (if applicable) and ensure this is routed to a nearby floor drain.
5. The P-K Duration III must be connected to a 120 volt / 60 Hz / 1 Ph power source with proper polarity, a dedicated earth ground, and an electrical disconnect having adequate overload protection (15 amps) according to the National Electrical Code (NFPA 70, latest edition).

## 3.8 SAFETY CHECKS

The following checks of safety systems must be made before putting the P-K Duration III™ system boiler into normal operation.



#### **WARNING**

Never attempt to operate a P-K Duration III system that has failed to pass all the safety checks described below.



#### **WARNING**

After checking controls by manual adjustment, make sure they are always reset to their proper settings.



### **3.8.1 Test of Circulation Pumps**

Once power has been turned on to the Duration III, ensure the domestic water pump is pumping water in the correct direction (up).

### **3.8.2 Test of High Temperature Limit Aquastat**

When the Duration III is powered on, adjust the dial on the high temperature limit aquastat to the lowest possible setting. Allow the Duration III to increase the domestic water temperature. Once the domestic water temperature exceeds this value, the high temperature limit aquastat should open and trigger the safety circuit. When this happens, the control valve is immediately disabled will close completely, and the circulating pumps will continue to run during this time in order to dissipate the heat.

If this does not work, check the wiring on the high temperature limit aquastat and ensure there is no jumper or other wiring attached to the Duration III safety circuit. If necessary, replace the high temperature limit aquastat.



## 4 OPERATION INSTANTANEOUS VERSION


### 4.1 LOVE CONTROLLER


#### **CAUTION**

Read instructions and understand operation before operating or making adjustments to the digital temperature controller.

A digital temperature controller (right) positions the valve in response to outlet water temperature. A 4-20 milliamp signal drives the valve actuator. The controller uses a type J thermocouple to sense the outlet domestic water temperature.

The default screen is shown. PV - the top number (red) - is the temperature of the water in the P-K Duration and SV - the lower number (green) - is the setpoint.

The index button  changes the parameters displayed on the screen. The PV line lists the parameter name and the SV line lists the parameter value.

Press the enter button  to store any value after it is changed.

The up  and down  buttons are used to change the values of the parameters.



#### 4.1.1 Controller Operation

To change the setpoint, press the up or down buttons to change SV to the desired value. Once the desired value is displayed, press the enter button to store the value.

The temperature control starts in the operation mode. The following table lists the operating parameters, their factory default settings, and a description of the parameters function. Parameters are accessed by repeatedly pressing the index key until the desired parameter is displayed.

Operational Mode		
Parameter	Default Value	Description of Parameter Function
Home Screen = Setpoint	120°F	Setpoint temperature of outlet water
r-S	RUN	Run – Stop output control. Must be in run for control to operate
SP	0	Sets the number of digits to the right of the decimal point
AL1H	20	Alarm 1 High Set Point, Alarms at setpoint + AL1H value
LoC	Off	Set front panel security, Off = no security, On = settings are locked
OUT1	###	Output value of controller, 0 – 100%



## 4.2 SETUP OF THE ELECTRIC VALVE

The valve should open when the hot water demand increases and close when the hot water demand decreases.

### **WARNING**

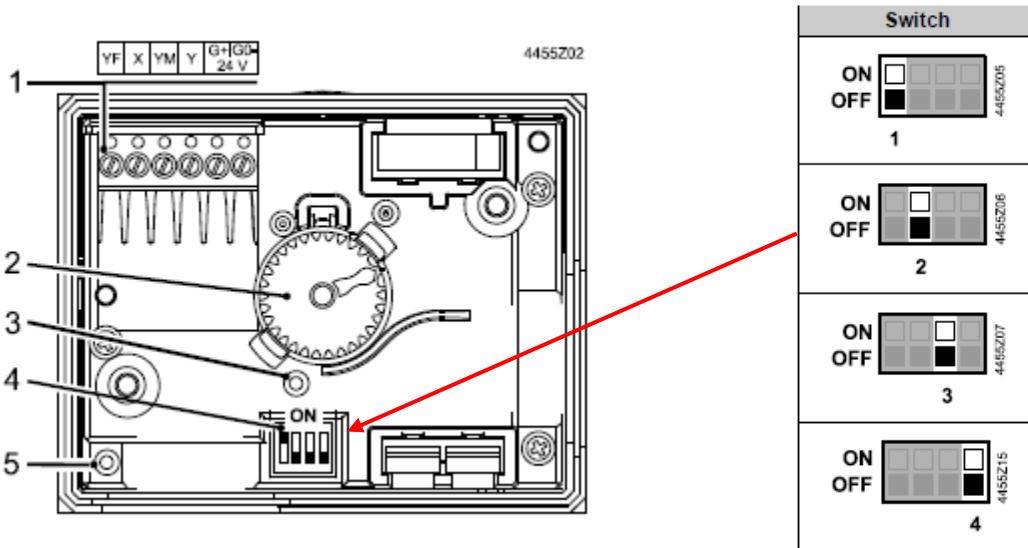
If power is removed, the valve should fail in the closed position. This must be verified prior to putting the unit in service.

During initial startup, check the DIP switches to verify correct positioning. The DIP switches are found in the valve actuator. The following pictures illustrate the correct positioning for the various valve actuators.

**NOTICE!** - For water to water applications or when valve is oversized, equal percentage valves are the preferred type.

### 4.2.1 Siemens MXG Valve Actuators:

All of the Siemens valves have a manual override control knob on the top of the valve actuator. The knob must be set to “Auto” for the valve to function. The style actuators used is the MXG. The MXG actuator is shown below.



Switch	Function	OFF	ON	Factory Setting
1	Valve Response Type	Linear	Equal Percent	ON
2	Control Signal Range	0-10 VDC	2-10 VDC or 4-20 mA	ON
3	Input Selector	0/2-10 VDC	4-20 mA	ON
4	Fluid Correction Factor	Other Fluid	Water	OFF



## 5 INSTALLATION DURATION III PUMPED-VERSION

### **▲ WARNING**

Installation and service must be performed by a qualified installer, service agency, or gas supplier.

### 5.1 RECEIVING AND STORAGE

#### 5.1.1 Initial Inspection

Upon receiving the P-K Duration III system, inspect it for signs of shipping damage. Since some damage may be hidden, unpack the product, open the front, and side doors to inspect. Verify that the total number of pieces shown on the packing slip agrees with those actually received.

**NOTICE!** Note any damage, suspected potential damage, or shortage of materials on the freight bill and immediately notify the carrier. File all claims for shortage or damage with the carrier. Claims for hidden damages must be filed with your carrier within 7 days.

#### 5.1.2 Storage Prior to Installation

If the P-K Duration III system is not installed immediately, it must be stored in a location adequately protected from the weather, preferably indoors. If this is not possible, then it should remain in the shipping container and be covered by a tarpaulin or other waterproof covering.

**NOTICE!** Controls and other equipment that are damaged or fail due to weather exposure are not covered by warranty.

### 5.2 COMPLIANCE WITH CODES

The brazed plate heat exchanger is constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 for 435 psig maximum operating pressure. However, the boiler MAWP is lower so the water pressure must never exceed the boiler's maximum rating. The installer must ensure the set point of the relief device is set at or below the lowest system MAWP.



For models D3-30P, D3-30PE, D3-50P and D3-50PE only. For your reference the following table provides the MAWP for the P-K MACH® and SONIC® condensing boilers:

Boiler Model	Duration III Model	Boiler's MAWP	Recommended Relief Valve Pressure
MACH CM300	D3-30P(E)	80 PSIG	30 PSIG
MACH CM399	D3-30P(E)	80 PSIG	30 PSIG
MACH CM500	D3-30P(E)	80 PSIG	30 PSIG
MACH C750	D3-50P(E)	80 PSIG	30 PSIG
MACH C900	D3-50P(E)	80 PSIG	30 PSIG
MACH C1050	D3-50P(E)	80 PSIG	30 PSIG
*SONIC SC650	D3-50P(E)	150 PSIG	30 PSIG
*SONIC SC750	D3-50P(E)	150 PSIG	30 PSIG
*SONIC SC850	D3-50P(E)	150 PSIG	30 PSIG
*SONIC SC1000	D3-50P(E)	150 PSIG	30 PSIG

The pressure-only relief valve on the boiler will determine the maximum operating pressure of the boiler side pressure.

**\*NOTICE!** The P-K SONIC boilers have a minimum static water pressure of 15 psig. The installer must ensure the boiler-side's normal operating pressure remains between 15 psig and relief valve pressure. It is recommended to operate the MACH boiler in the same way with the normal operating pressure remaining between 15 psig and relief valve pressure.

See Section [3.4.4](#) or [5.4.3](#) for more information.



Models D3-30, D3-50 & D3-80 ship without factory-installed safety devices. The installer must ensure there are proper safety components in place to prevent injury and death. This includes the proper installation of a hi-limit shutoff, proper electrical fusing to prevent overloading the circuits above design, and safety pressure relief valves.

## 5.3 SETUP

### 5.3.1 Foundation and Placement

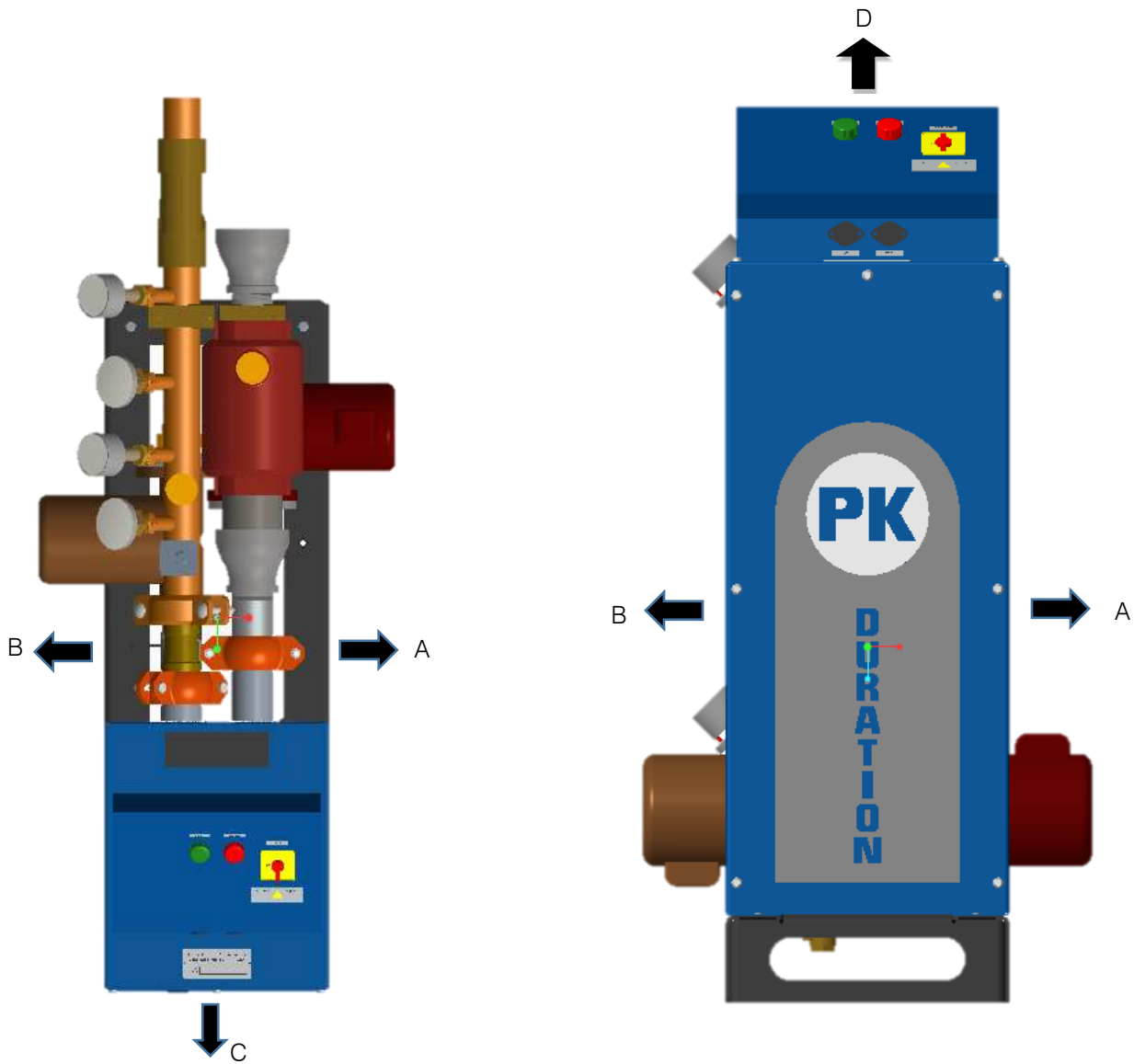
Provide a firm, level foundation, preferably of concrete. The P-K Duration III system must be level to function properly. Consult with a certified Professional Engineer regarding any seismic anchoring requirements.



### 5.3.2 DURATION III Pumped-version Clearances

Since the P-K Duration III pumped-version indirect domestic hot water system is designed to operate in potentially remote mechanical rooms, it requires sufficient clearance for service and operation.

Clearance Dimensions	
A	6"
B	18"
C	24"
D	12"







## 5.4 DURATION III PUMPED-VERSION MECHANICAL CONNECTIONS

The P-K Duration III system is designed to provide substantial domestic hot water capacity in a small footprint (21" wide x 52" long) and requires only four (4) piping connections to operate as seen below:

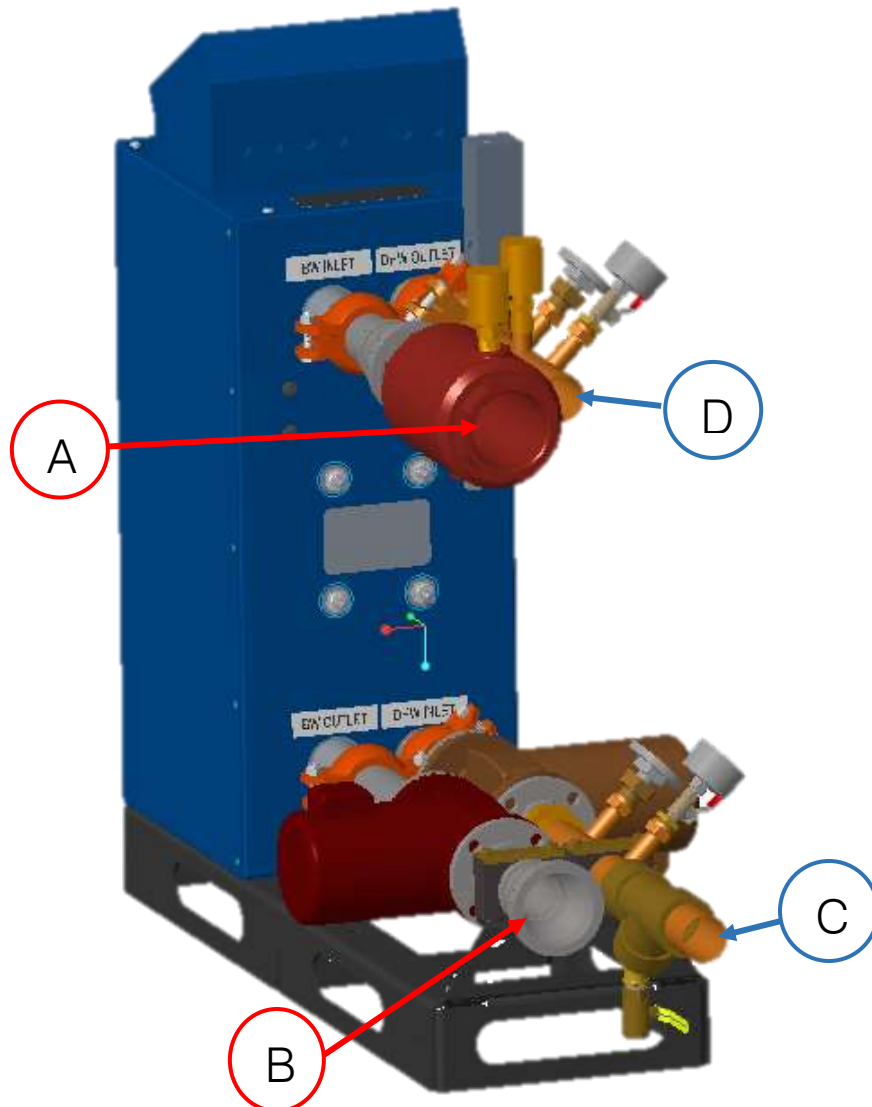
### Boiler Water Piping Connections

- A. Boiler Water Inlet (Supply)  
D3-30P & D3-30PE: 2" NPT-F  
D3-50P & D3-50PE: 3" NPT-F
- B. Boiler Water Outlet (Return)  
D3-30P & D3-30PE: 2" NPT-F  
D3-50P & D3-50PE: 3" NPT-F

### Domestic Hot Water Piping Connections

- C. Domestic Cold Water Inlet (Return from Building)  
(2" Sweat)
- D. Domestic Hot Water Outlet (Supply to Building)  
(2" Sweat)

**NOTICE:** If the D3-30, D3-50 or D3-80 will be installed with a storage tank in the field, the contractor should ensure the unit will perform in the manner described in this section and its subsequent subsections. The factory-supplied connections for these models are 2" grooved pipe.

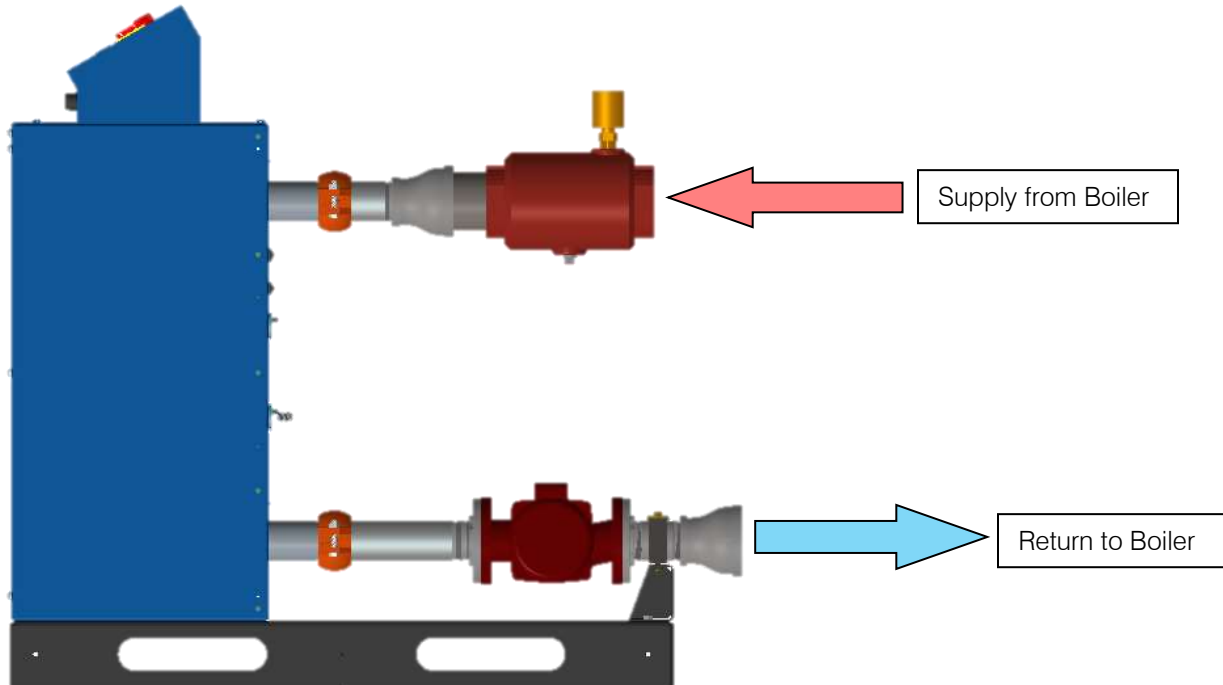




### 5.4.1 Boiler Piping (Simplified)

The energy source for the P-K Duration III system is hot boiler water from a high efficiency condensing boiler and is regulated by a tank sensor (preferred) or an aquastat located in a storage tank.

Assuming the Duration III system will be operated with NURO® control technology, when the domestic hot water supply temperature is satisfied, the NURO's Domestic Hot Water relay opens. This de-energizes the motor contactor and stops the boiler pump.



As the domestic hot water supply temperature drops below the desired setpoint, the NURO® closes the Domestic Hot Water relay which energizes the motor contactor, starting the pumps, which begins the flow of hot boiler water into the brazed plate heat exchanger as shown above. As the DHW supply temperature drops further below setpoint, the NURO® control increases the boiler's firing rate, increasing the temperature of the boiler water entering the heat exchanger.

During this process, heat is transferred from the boiler water to the colder domestic water, reducing the outgoing boiler water temperature. As the DHW supply temperature approaches setpoint, the NURO® control will reduce the boiler's firing rate, reducing the boiler water temperatures passing through the heat exchanger.

For installations without the NURO® control, the DURATION III must be wired such that the boiler's control provides the necessary contact closure for the motor contactor inside the DURATION III's electric panel when there is a call for domestic hot water and/or the tank temperature drops below the designated setpoint.

**NOTICE:** A wye strainer, with at least a 20 mesh screen, should be installed in the boiler piping to protect the brazed plate heat exchanger and the boiler's heat exchanger from foreign debris which will reduce operating efficiency and decrease the longevity of the equipment. The strainer is recommended to be cleaned every six months.

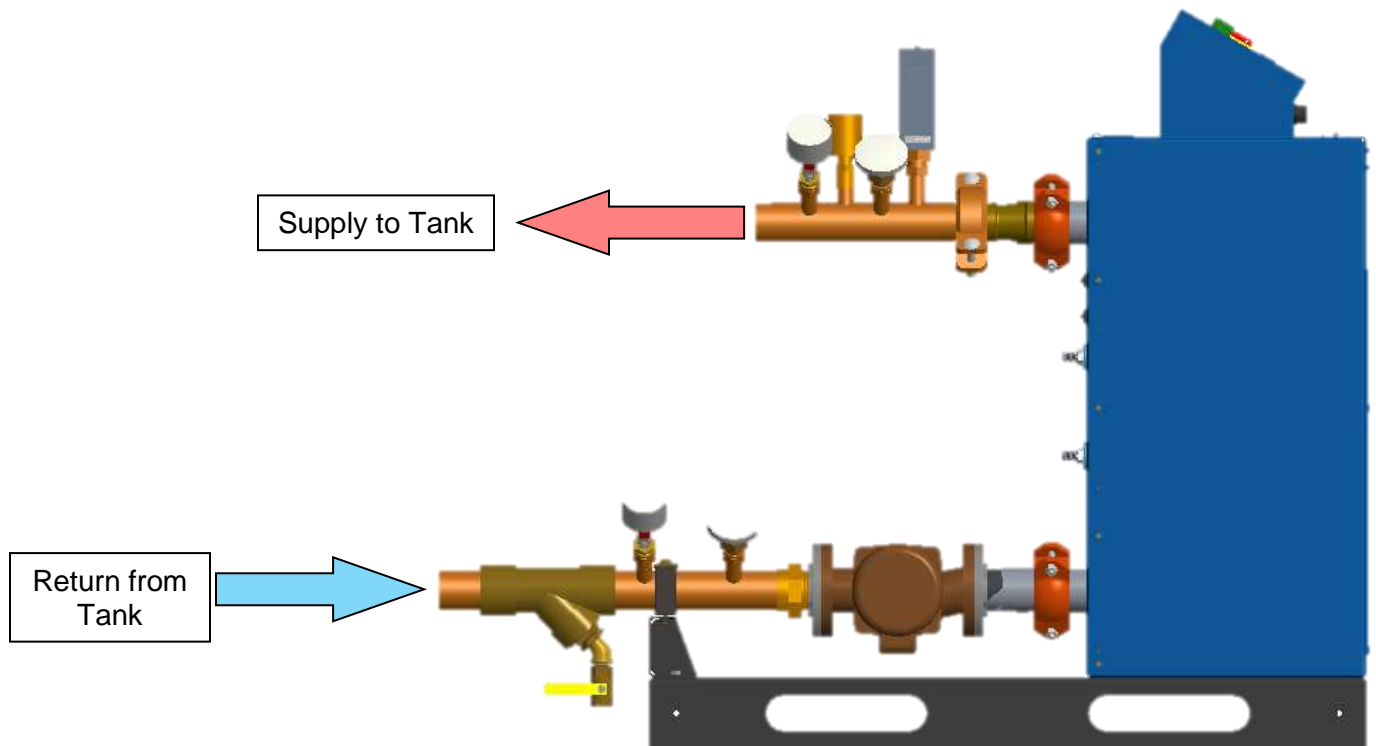


### 5.4.2 Domestic Water Piping (Simplified)

The system features intermittent recirculation on the domestic hot water piping from the DURATION III and storage tank(s).

As domestic hot water is consumed throughout the building, fresh makeup water should enter in the copper piping (lower arrow). The recirculation pump mixes some of the domestic hot water supply from the tank with the incoming fresh makeup before entering the heat exchanger (blue arrow). The hot water return to the tank will exit the Duration III in the upper copper piping (red arrow).

**NOTICE:** The factory-supplied wye strainer is recommended to be cleaned every six months.



### 5.4.3 Overpressure Protection

The Maximum Allowable Working Pressure (MAWP) of the double wall brazed plate heat exchanger is 435 PSIG, however some of the pipe fittings on the domestic hot water piping have a maximum working pressure of 150 PSIG. ASME Section VIII – Division 1 permits the equipment owner to perform an assessment if the system pressure is inherently self-limiting which would then not require the use of a safety relief valve.

**NOTICE:** To ensure proper performance of the appliance, the domestic water flow should be balanced to match the boiler water flow. A lead-free balancing valve may be required to ensure equal flow rates through both sides of the heat exchanger. Contact your local Patterson-Kelley representative for additional information or to order this equipment.



For example, if the Duration III is installed in a 2 story building where the water pressure never exceeds 20 PSIG, the user can perform a due diligence analysis and operate without a pressure-only safety relief valve.

Another example may be a building with a booster pump system where the incoming water pressure from the street never exceeds 30 PSIG. If the user researches the booster pumps and determines that they are not capable of producing in excess of 150 PSIG, then the system pressure is inherently self-limiting. Here again, the user can perform a due diligence analysis and operate without a pressure-only safety relief valve.

Section **UG-140** of ASME Section VIII – Division 1 explains the requirements of the due diligence analysis needed to operate this system without a pressure-only safety relief valve.

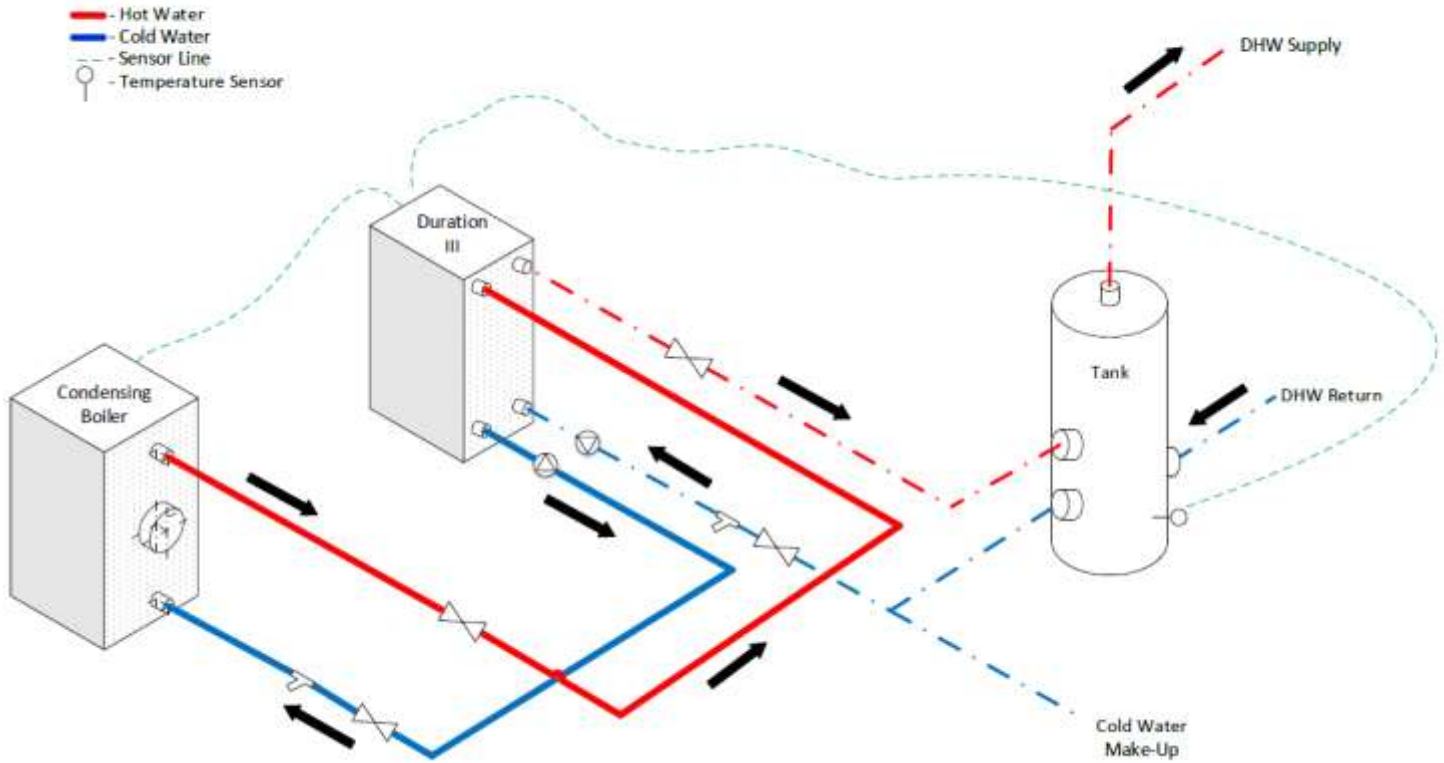
**NOTICE!** Patterson-Kelley offers a 150# Section VIII – Division 1 pressure-only relief safety valve for purchase (P-K part # **10-0490-3946**). This will need to be installed on the outlet piping of the domestic water line.



### 5.4.1 Example Domestic Hot Water Installation

It is important to note that the P-K Duration III indirect domestic water heating system requires a domestic water storage tank. If using in conjunction with a boiler, the initial call for heat may take up to 5 minutes until the boiler operates at full capacity. If the unit is used in this manner, the storage tank must provide a minimum capacity for 5 minutes of demand in order to provide sufficient hot water supply until the boiler is online.

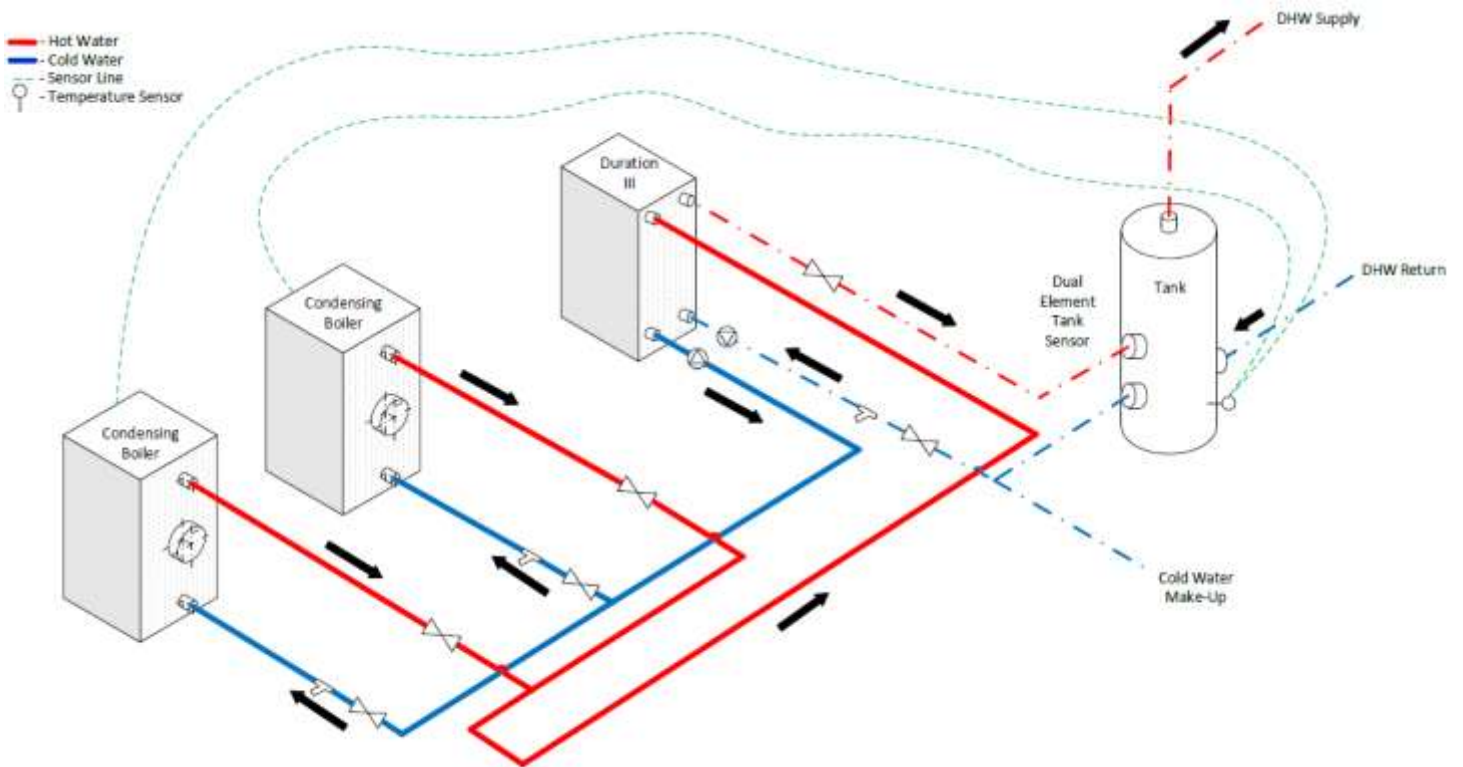
**Sample Piping Diagram # 1:** Duration III Unit piped into a storage tank using hot boiler water



**NOTICE:** P-K recommends the use of a BP-480 tank temperature sensor installed in the lower 1/3<sup>rd</sup> of the storage tank.



### Sample Piping Diagram # 2: Duration III unit piped in single storage tank using two parallel boilers



**NOTICE:** For 2 boiler DHW systems, P-K recommends BP-599a dual-element sensor installed in the lower 1/3<sup>rd</sup> of the storage tank.



## 5.5 FILLING THE DURATION III INDIRECT WATER HEATER

### 5.5.1 Filling the DHW System

Before filling the system, ensure all the mechanical connections are complete.

- **STEP 1** – Isolate the duration from the rest of the domestic water system
- **STEP 2** – Connect a hose to the drain valve on the domestic water inlet line.
- **STEP 3** – If applicable, close the manual isolation valves in the domestic piping between the domestic water storage tank and the P-K Duration III system.
- **STEP 4** – Open drain valve on domestic piping.
- **STEP 5** – Slowly open the domestic water inlet ball valve to start the flow of water.
- **STEP 6** – Close the drain valve on the domestic piping once a steady flow of water occurs.
- **STEP 7** – Open the cap on the automatic air vent in the domestic water inlet piping.
- **STEP 8** – Open the manual isolation valves on the outlet of the domestic piping.
- **STEP 9** – Check for any leaks in all piping connections, especially at the Victaulic couplings. Tighten or reseal the connections if necessary.

**NOTICE!** Before the initial fill, ensure that any and all sediment or particulates have been removed from the domestic water. Recommendation would be to flush the system prior to the filling of the duration package. Ensure that the outlet isolation valve, if installed, on the P-K Duration III system is closed. Use the drain valve on the domestic water outlet line to purge sediment and particulates.

### 5.5.2 Filling the Boiler System

**Notice!** When filling the appliance with optional factory-installed expansion tank (D3-30P and D3-50P models only), make sure to adhere to the following:

Before making any mechanical connections to the DURATION III system it is imperative that the expansion tank / fill system be checked for a suitable fill pressure. The expansion tank ships with a 12 psig pre-charge, but it is possible that air pressure may reduce during shipment. Locate the Schrader valve on the expansion tank opposite the boiler piping connection.

Use a pressure gauge to verify the air pressure is at least 12 psig. If the pressure is insufficient, use an air pump with built-in pressure gauge to charge the air pressure to a minimum of 12 psig before making ANY mechanical connections. The maximum air pressure need not exceed 20 psig. The expansion tank assembly features an integral fill valve which floods the boiler loop with water to the same air pressure that exists on the bladder. As the boiler operates, you may notice that the boiler loop pressure exceeds the initial fill pressure which is normal and is due to thermal expansion of the boiler water.

Before filling the system, ensure all the mechanical connections are complete.

- **STEP 1** – Connect a hose to the drain valve on the boiler water strainer valve.
- **STEP 2** – Open drain valve on boiler piping.
- **STEP 3** – Slowly open the boiler water outlet ball valve to start the flow of water.
- **STEP 4** – Close the drain valve on the boiler water strainer once a steady flow of water occurs.
- **STEP 5** – Open the manual isolation valves on the inlet of the boiler piping.
- **STEP 6** – Check for any leaks in all piping connections, especially at the Victaulic couplings. Tighten or reseal the connections if necessary.

**NOTICE!** Under no circumstances should petroleum based cleaning or sealing compounds be used in the boiler system.



### 5.5.3 Flushing the Domestic Water

Flush the domestic water periodically by using the drain valve located on the DHW lower piping line (Bottom). At the same time, the strainer should be checked and cleaned properly.

## 5.6 ELECTRICAL CONNECTIONS

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Only after all the mechanical connections have been completed and verified should any electrical connection be made. Please refer to [8.2](#) for a wiring diagram of the P-K Duration III system.

The P-K Duration III system requires 120 volt, single phase, 60 hertz electrical service (15 amps). Size the supply circuit accordingly.

**NOTICE!** A dedicated earth ground (green wire) is required. Do not ground through the conduit.

**NOTICE!** Be sure to properly lockout/tagout the Duration III for any electrical work that needs to be made.

### 5.6.1 Incoming Electrical Supply

The control panel is located and accessed on the front of the P-K Duration III system. The 120 volt, single phase, 60 hertz, 15 amps electrical service should be routed to this panel. Knockouts are located in the rear of the panel.

### 5.6.2 Auxiliary High Voltage Relay

The pumped-version models are equipped with an additional high voltage auxiliary relay. This relay is closed whenever the DURATION III's pumps are operating.

If multiple DURATION III's are installed in parallel for dual operation, the additional DURATION III's may be enabled using the auxiliary relay from the primary DURATION III control panel.

For additional information on wiring to the auxiliary relay refer to [8.3](#).

### 5.6.3 Low Voltage

The DURATION III provides low voltage terminal blocks for the tank sensor or aquastat to connect to the boiler's controller, if desired. This allows the installer to bring all the boiler's wiring to the DURATION III electrical panel. If desired, the tank sensor or aquastat may be wired directly to the NURO® controller.

### 5.6.4 Test of Circulation Pumps

Once power has been turned on to the DURATION III, apply power to the motor contactor. Ensure the boiler water pump is pumping water in the correct direction (away from the exchanger) and the domestic water pump is pumping water in the correct direction (into the exchanger).

### 5.6.5 Test of High Temperature Limit Aquastat

When the Duration III is powered on, adjust the dial on the high temperature limit aquastat to the lowest possible setting. Allow the Duration III to increase the domestic water temperature. Once the domestic water temperature exceeds this value, the high temperature limit aquastat should open and trigger the safety circuit. When this happens, the domestic circulator pump should stop circulating water back to the tank. The boiler water circulator will continue to operate during this time to dissipate heat from the boiler and avoid possible damage to the boiler equipment.

If this does not work, check the wiring on the high temperature limit aquastat and ensure there is no jumper or other wiring attached to the Duration III safety circuit. If necessary, replace the high temperature limit aquastat.





## 6 OPERATION PUMPED VERSION

The following provides necessary setup instructions for the NURO® control. For boiler’s without the NURO® controller, the installer must provide contact closure to the motor contactor in the DURATION III electrical panel when there is a call for domestic hot water and/or the tank temperature drops below the desired setpoint.

### 6.1 DOMESTIC HOT WATER SETUP WIZARD

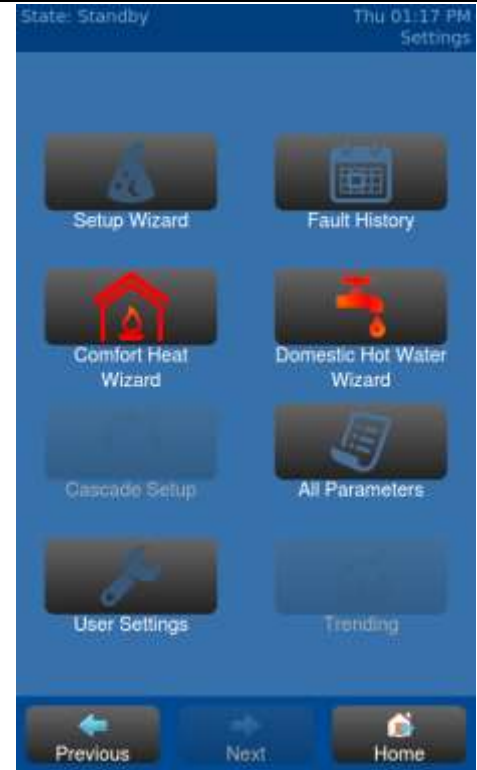
From the Home Screen, press **<SETTINGS>** in the lower right corner to load the “Main Menu” screen shown to the right.

Touch **<Setup Wizard>** to launch the “Setup Wizard” screen shown at the far right. If prompted for a Service Level 1 passcode, enter “4321” and press **<ACCEPT PASSWORD>** to proceed.

The first step of the Setup Wizard asks if the boiler unit is operating as “Standalone Boiler” or “Boiler in Cascade System”. Select the appropriate option and press **<NEXT>** to proceed.

Next, the Setup Wizard asks which modes the boiler is using: “Comfort Heat” or “Domestic Hot Water”. Make the appropriate selection and press **<NEXT>**.

The next step of the Setup Wizard explains the Relay Instructions. The NURO® control system features four configurable relay outputs labeled RELAY A through RELAY D. The factory-default settings are recommended for most installations, but customization is possible. For more information on the configurable relay outputs, please refer to the NURO Boiler Controller: Advanced User’s Guide, Part Number is 1004905979. Press **<NEXT>** to proceed.



**NOTICE:** The relay assignments **must** agree with the wiring to/from the boiler. For example, if Relay A is user-configured to enable/disable the Boiler Pump, the control wires to operate the boiler pump must be properly wired to the Relay A terminals in the High Voltage (TB2) terminal block.

Make sure that RELAY C is assigned to “**DHW Boiler Side Pump**”. If not, press **<RELAY C>**, then select **<DHW Boiler Side Pump>** and press **<NEXT>** to continue.

**NOTICE:** If using an aquastat installed in the domestic water storage tank, proceed to [6.1.2](#). If using a temperature sensor installed in the domestic water storage tank, proceed to [6.1.1](#).



### 6.1.1 Domestic Hot Water Control (Temperature Sensor in Storage Tank) – Preferred

The preferred method for controlling the DURATION is to use a 12kΩ thermistor-type temperature sensor installed in the domestic water storage tank, ensure the sensor is wired to the P-K boiler's DHW STAT/SENSOR terminals (TB1-9 & TB1-10). To simplify wiring, the tank sensor may be wired directly in the low voltage terminal blocks of the DURATION III electrical panel. The NURO's temperature sensor should be installed in the lower 1/3 portion of the storage tank and be of sufficient length to obtain an accurate temperature reading.

On the Setup Wizard, select **<Temperature Sensor in Storage Tank>** and press **<NEXT>** to proceed. The NURO® control allows the user to change the behavior of the temperature sensor to two different settings: “Sensor as an Aquastat” or “Sensor for Remote Modulation”.

- **Sensor as an Aquastat**

- The 12kΩ temperature sensor will remotely monitor the domestic water tank temperature and enable/disable the P-K boiler according to the temperature setpoint and differentials.
- The P-K boiler will PID modulate to its own supply (outlet) temperature but will not PID modulate to the tank temperature conditions.
- **NOTICE:** If “Sensor as an Aquastat” is selected, press proceed to [Section 6.1.2.1](#)

- **Sensor for Remote Modulation**

- The 12kΩ temperature sensor will remotely monitor the domestic water tank temperature and enable/disable the P-K boiler according to the temperature setpoint and differentials.
- The P-K boiler will PID modulate to the tank temperature conditions.
- **NOTICE:** If “Sensor for Remote Modulation” is selected, proceed to [Section 6.1.2.2](#)

Press **<NEXT>** to proceed to the next Setup Wizard screen, and refer to either [Section 6.1.2.1](#) or [6.1.2.2](#).

### 6.1.2 Domestic Hot Water Control (Aquastat in Storage Tank)

The next screen of the Setup Wizard allows the user to choose how the boiler's system is controlled for Domestic Hot Water (DHW) operation. If the installation features a normally-closed (break on rise) aquastat installed in the domestic water storage tank and wired to the P-K boiler's DHW STAT/SENSOR terminals (TB1-9 & TB1-10), select **<Aquastat in Storage Tank>** and press **<NEXT>** to proceed.

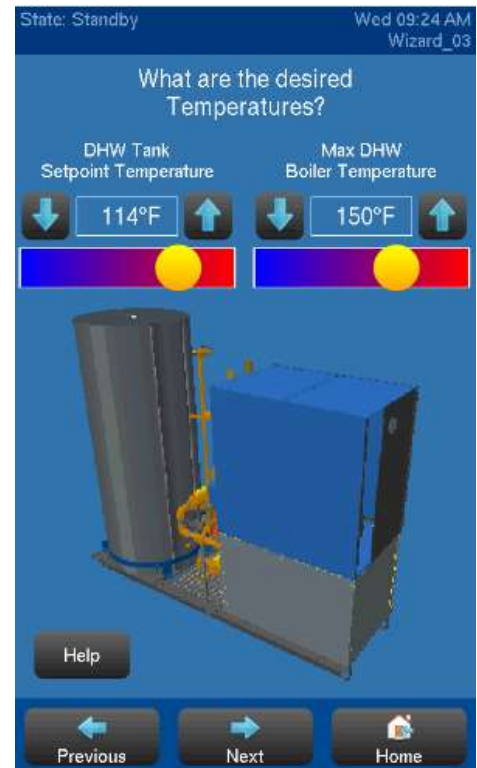
The next screen of the setup wizard allows the user to adjust three settings:

- **DHW Boiler Setpoint Temperature**

- This is the supply temperature setpoint for the P-K boiler during a domestic call for heat from the aquastat in the storage tank.

**NOTICE:** The “DHW Boiler Setpoint Temperature” must exceed the desired domestic hot water temperature. For the most efficient and reliable operation, it is recommended to find the lowest possible boiler setpoint which satisfies the domestic hot water load requirements.

**NOTICE:** The “DHW Boiler Setpoint Temperature” will typically need to exceed the setpoint on the storage tank aquastat by at least 10°F-20°F. Some fine-tuning of this value will be required in order to satisfy the domestic hot water load requirements.





- **DHW Boiler Max Setpoint Temperature**

- The NURO control system provides the ability to increment the “DHW Boiler Setpoint Temperature” in order to maintain the desired domestic hot water temperature. For example, in periods of high demand, the NURO® control may require the P-K boiler to operate to a higher supply temperature setpoint.

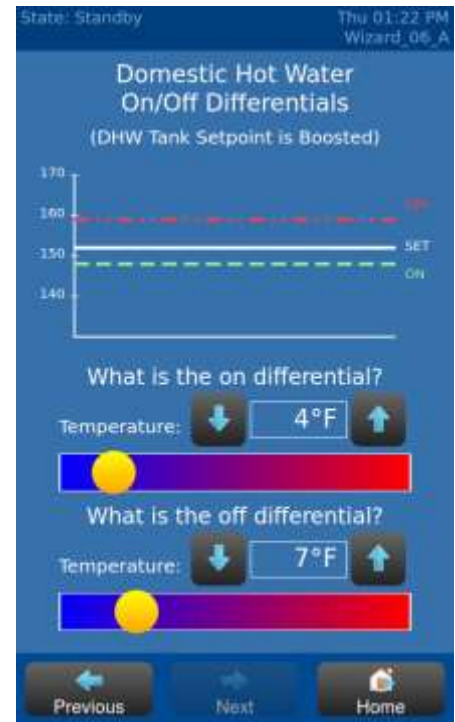
**NOTICE:** The “DHW Boiler Max Setpoint Temperature” must exceed the desired domestic hot water temperature. For the most efficient and reliable operation, it is recommended to find the lowest possible boiler setpoint which satisfies the domestic hot water load requirements.

**NOTICE:** Setting “DHW Boiler Max Setpoint Temperature” equal to “DHW Boiler Setpoint Temperature” means the P-K boiler will always operate to the same setpoint during DHW operation.

- **Max DHW Boiler Temperature**

- This is the maximum allowable supply temperature for the P-K boiler during domestic hot water operation. If the P-K boiler’s supply temperature reaches this value, the boiler will be forced to return to “Standby”.

**NOTICE:** The “Max DHW Boiler Temperature” must exceed the desired domestic hot water temperature. For the most efficient and reliable operation, it is recommended to find the lowest possible boiler setpoint which satisfies the domestic hot water load requirements.



These setpoint temperatures can be adjusted in one of 3 methods:

1. Use the <UP> or <DOWN> arrows to adjust the setpoint in increments of 1°F.
2. Move the slider bar left or right to perform quick adjustments to the setpoint.
3. Press the numeric temperature value to access a numeric 0-9 keypad. Once the keypad is displayed, the user can enter the desired setpoint value.

After the “DHW Boiler Setpoint Temperature”, “DHW Boiler Max Setpoint Temperature” and “Max DHW Boiler Temperature” values have been programmed, press <NEXT> to continue.

The final screen of the Setup Wizard asks the user to adjust the “on differential” and the “off differential” as shown above. A visual representation of the boiler’s “DHW Boiler Setpoint Temperature” is shown by the horizontal white line. The “on differential” is the lower temperature deadband which will enable the P-K boiler for operation and is represented by the dashed green line. The “off differential” is the upper temperature deadband which will disable the P-K boiler and is represented by the dashed red line.

In the example above, the “DHW Boiler Setpoint Temperature” is 153°F, the “on differential” is 4°F, and the “off differential” is 7°F. In this scenario, upon a domestic call for heat from the aquastat, the P-K boiler will be enabled when its supply temperature drops below  $153^{\circ}\text{F} - 4^{\circ}\text{F} = 149^{\circ}\text{F}$ . The P-K boiler will continue to operate until either the domestic call for heat is removed by the aquastat, or its supply temperature exceeds  $153^{\circ}\text{F} + 7^{\circ}\text{F} = 160^{\circ}\text{F}$ .

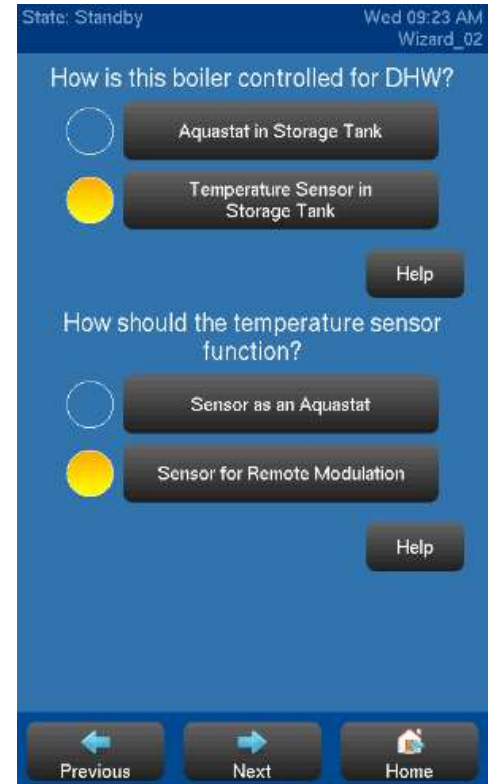
Once the “on differential” and “off differential” are programmed, press <NEXT> to proceed. The NURO® will present a confirmation screen with a 30 second countdown timer. Press <HOME> to return to the home screen, or simply wait for the timer to expire. The boiler system is now programmed to respond to the aquastat installed in the domestic water storage tank.



### 6.1.2.1 Sensor as an Aquastat

If “Sensor as an Aquastat” is selected, the next screen allows the user to adjust four settings:

- **DHW Tank Setpoint Temperature**
  - This is the desired domestic hot water setpoint temperature to maintain in the storage tank.
- **DHW Tank Setpoint Boost**
  - The NURO® will control the P-K boiler to a “DHW Boiler Temperature Setpoint”. Initially, this setpoint will exceed the “DHW Tank Setpoint Temperature” by the “DHW Tank Setpoint Boost”.
  - For example, if the “DHW Tank Setpoint Temperature” is 140°F, and the “DHW Tank Setpoint Boost” is 10°F, the NURO® will initially control the P-K boiler to a “DHW Boiler Temperature Setpoint” of 140°F + 10°F = 150°F.
- **DHW Boiler Max Setpoint Temperature**
  - The NURO® control system provides the ability to increment the “DHW Boiler Temperature Setpoint” in order to maintain the desired domestic hot water temperature. For example, in periods of high demand, the NURO® control may require the P-K boiler to operate to a higher supply temperature setpoint.
  - **NOTICE:** The “DHW Boiler Max Setpoint Temperature” must exceed the desired domestic hot water temperature. For the most efficient and reliable operation, it is recommended to find the lowest possible boiler setpoint which satisfies the domestic hot water load requirements.
  - **NOTICE:** Setting “DHW Boiler Max Setpoint Temperature” equal to “DHW Boiler Setpoint Temperature” means the P-K boiler will always operate to the same setpoint during DHW operation.
- **Max DHW Boiler Temperature**
  - This is the maximum allowable supply temperature for the P-K boiler during domestic hot water operation. If the P-K MACH® boiler’s supply temperature reaches this value, the boiler will be forced to return to “Standby”.
  - **NOTICE:** The “Max DHW Boiler Temperature” must exceed the desired domestic hot water temperature. For the most efficient and reliable operation, it is recommended to find the lowest possible boiler setpoint which satisfies the domestic hot water load requirements.



These setpoint temperatures can be adjusted in one of 3 methods:

1. Use the <UP> or <DOWN> arrows to adjust the setpoint in increments of 1°F.
2. Move the slider bar left or right to perform quick adjustments to the setpoint.
3. Press the numeric temperature value to access a numeric 0-9 keypad. Once the keypad is displayed, the user can enter the desired setpoint value.

After the “DHW Tank Setpoint Temperature”, “DHW Tank Setpoint Boost”, “DHW Boiler Setpoint Temperature” and “Max DHW Boiler Temperature” values have been programmed, press <NEXT> to continue. Proceed to [Section 6.1.3](#).



### 6.1.2.2 Sensor for Remote Modulation

If “Sensor for Remote Modulation” is selected, the next screen allows the user to adjust two settings:

- **DHW Tank Setpoint Temperature**
  - This is the desired domestic hot water setpoint temperature to maintain in the storage tank.
- **Max DHW Boiler Temperature**
  - This is the maximum allowable supply temperature for the P-K boiler during domestic hot water operation. If the P-K MACH® boiler’s supply temperature reaches this value, the boiler will be forced to return to “Standby”.
  - **NOTICE:** The “Max DHW Boiler Temperature” must exceed the desired domestic hot water temperature. For the most efficient and reliable operation, it is recommended to find the lowest possible boiler setpoint which satisfies the domestic hot water load requirements.

These setpoint temperatures can be adjusted in one of 3 methods:

1. Use the <UP> or <DOWN> arrows to adjust the setpoint in increments of 1°F.
2. Move the slider bar left or right to perform quick adjustments to the setpoint.
3. Press the numeric temperature value to access a numeric 0-9 keypad. Once the keypad is displayed, the user can enter the desired setpoint value.

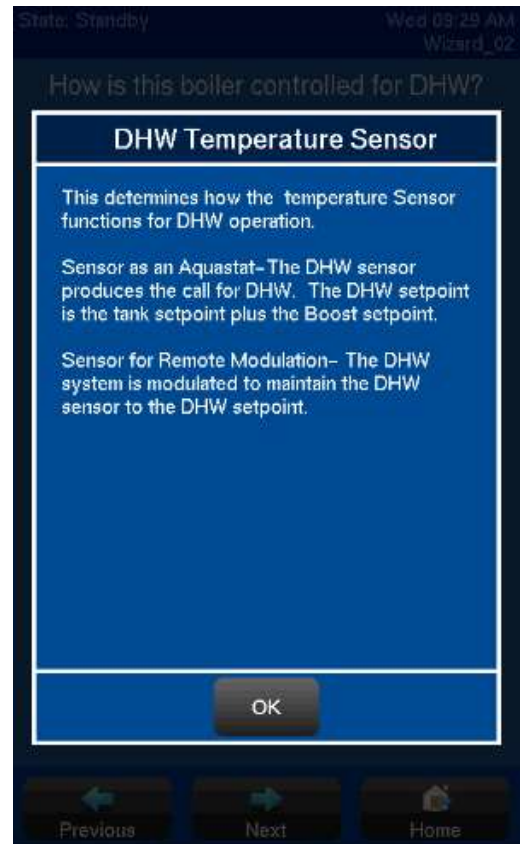
After the “DHW Tank Setpoint Temperature” and “Max DHW Boiler Temperature” values have been programmed, press <NEXT> to continue. Proceed to [Section 6.1.3](#).

### 6.1.3 On/Off Differentials

The final screen of the Setup Wizard asks the user to adjust the “on differential” and the “off differential” as shown to the right. A visual representation of the boiler’s “DHW Tank Setpoint Temperature” is shown by the horizontal white line. The “on differential” is the lower temperature deadband which will enable the P-K boiler for operation and is represented by the dashed green line. The “off differential” is the upper temperature deadband which will disable the P-K boiler and is represented by the dashed red line.

In the example to the right, the “DHW Tank Setpoint Temperature” is 153°F, the “on differential” is 4°F, and the “off differential” is 7°F. In this scenario, the P-K boiler will be enabled when the tank temperature drops below  $153^{\circ}\text{F} - 4^{\circ}\text{F} = 149^{\circ}\text{F}$ . The P-K boiler will continue to operate until the tank temperature exceeds  $153^{\circ}\text{F} + 7^{\circ}\text{F} = 160^{\circ}\text{F}$ .

Once the “on differential” and “off differential” are programmed, press <NEXT> to proceed. The NURO® will present a confirmation screen with a 30 second countdown timer. Press <HOME> to return to the home screen, or simply wait for the timer to expire. The P-K boiler and DURATION system is now programmed to respond to the aquastat installed in the domestic water storage tank.





## 7 MAINTENANCE

### 7.1 MAINTENANCE AND INSPECTION SCHEDULE

**⚠ WARNING**

unit.

Proper lockout/ tag out procedure must be employed when servicing this

**⚠ CAUTION**

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.

Label all wires prior to disconnection when servicing controls. Wiring

**⚠ WARNING**

Determine the cause of any lockout or errors before resetting the boiler. If able to determine cause of lockout, then appropriate corrective action should be taken. If unable to determine cause of the problem, call a qualified service technician.

Determine the cause of any lockout or errors before resetting the boiler. If

**⚠ WARNING**

Verify proper operation after operation servicing.

#### 7.1.1 Daily

- Observe operating temperature and general conditions.
- Listen to the performance of the P-K Duration III system.
  - If you hear a “sloshing” noise that means air is present in the system. Ensure the vent cap on the automatic air vent is open.
  - If the pumps are making noise, ensure they are not deadheaded or cavitating. Refer to [Section 7.2](#) for troubleshooting information.

#### 7.1.2 Weekly

- Check for leaks in the boiler piping and the domestic piping. Correct immediately if discovered.

#### 7.1.3 Monthly

- Check all relief valves by slightly opening the stem. Once you see a small amount of water exit the discharge, close the relief valve’s stem. Once the stem is closed, ensure there is no additional water that exits the relief valve.
- On the Instantaneous Models verify the domestic temperature sensor reading is accurate on the Temperature Controller.
- Ensure the high temperature limit aquastat is functioning properly.

#### 7.1.4 Annually

- The brazed plate heat exchanger can scale up with calcium and other minerals present in the domestic water. This will inhibit heat transfer and it may be necessary to clean or replace the brazed plate heat exchanger.
- Remove and inspect the circulating pumps for signs of deterioration. Repair or replace if needed.
- Clean and inspect the P-K Duration III™ system for any signs of cracks, leaks, or loose connections. Repair or replace if needed.



## 7.2 TROUBLESHOOTING

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### 7.2.1 Circulation Pump Deadhead

Deadheading occurs when the circulation pump is unable to deliver any flow. Ensure that any isolation valves installed in the system are OPEN.

### 7.2.2 Circulation Pump Cavitation

Cavitation occurs when the water pressure at the suction side of the pump is below the pump's required suction head pressure. Ensure that any isolation valves on the suction side of both circulation pumps are OPEN. Also, ensure that there is a sufficient static fill pressure of the system.

### 7.2.3 Poor Heat Transfer

Poor heat transfer can be caused by insufficient flow, insufficient boiler water temperature, or scaling of the heat exchanger.

- Ensure both the boiler side and domestic side has sufficient flow, and that all circulation pumps are moving water at the desired rate. (Pumps may be supplied by others depending on model)
- Next, increase the boiler supply temperature in small increments to ensure there is sufficient temperature to produce the desired domestic water temperature. If these two steps are unable to restore heat transfer, it may be necessary to clean or replace the brazed plate heat exchanger.

### 7.2.4 Erratic Temperature Control

- Check for proper operation of the temperature control.
- Check for proper rotation of integral circulation pump.
- Check for flow of circulator pump. (Be sure water is flowing through the recirculation pipe)
- Check valves in pipe line must be operational.
- Check for proper boiler water flow.

### 7.2.5 Domestic Water Supply Temperature Above or Below Setpoint

- Check the setting of the temperature control.
- Check temperature sensing element for malfunction.
- Check for proper boiler water temperature and flow rate.
- Check to be sure heater design rating is not being exceeded.



### 7.3 HEAT EXCHANGER CLEANING

Brazed plate heat exchangers operate with high turbulence flow, even at low flow rates. This high turbulence keeps small particles in suspension minimizing fouling and scaling. However, in some applications the fouling tendency can be very high, e.g. when using extremely hard water at high temperatures. To clean the heat exchanger use the following procedure:

1. Clean exchanger subject to fouling (scale, sludge deposits, etc.) periodically, depending on specific conditions. A sludge or scale coating on the plates can reduce effectiveness and overall performance. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary.
2. As suggested under [Sections 3.4.1](#) and [5.4.1 “Boiler Piping \(Simplified\)”](#) and [3.4.2](#) and [5.4.2 “Domestic Water Piping \(Simplified\)”](#), the use of a strainer is recommended, especially if the fluid quality is poor (extensive dirt, debris, and contaminants).
3. Some suggested methods of cleaning either side of the heat exchanger are listed below:
  - Back flush with a high pressure stream of hot water to remove loose deposits;
  - Circulate an oil or light distillate cleaning solution to remove sludge or similar soft deposits;
  - Use a 5% solution of phosphoric acid or oxalic acid to remove more stubborn deposits. For optimum results, the solution should be in a back flush type flow pattern. Rinse heat exchanger with clean fresh water after use.
4. If the heat exchanger is excessively fouled and it cannot be cleaned by commercial cleaning methods, then replacement of the unit is suggested. For replacement parts see [Section 8.1](#).

#### **WARNING**

If the heat exchanger is chemically cleaned, it is important that full characteristics of the fouling material and the chemical cleaning agent be known and care exercised in handling them according to instructions. Use eye protection to prevent damage to your eyes. Wear a respirator when required.

#### **CAUTION**

Do not exceed design conditions of heat exchanger or the system during maintenance.

**Notice:** Use in accordance with the manufacturer’s instructions and check that cleaning compounds are compatible with the materials of the heat exchanger, DURATION III, and the system. Since there are a wide variety of cleaning compounds available which are compatible with certain metals and alloy, it is recommended that you contact a representative of the above commercial cleaning products to determine which particular cleaning fluid they would suggest for your type of scaling problem.





## 8 PARTS/TECHNICAL SUPPORT

Spare parts and replacement parts can be ordered from Patterson-Kelley by calling toll free (877) 728-5351. The fax number is (570) 476-7247. Refer to the parts list shown on the assembly drawing provided in this manual. Technical information is also available at the above number and at the -Kelley website [www.pattersonkelley.com](http://www.pattersonkelley.com).

### 8.1 REPLACEMENT PARTS

Replacement Part	D3-30I, D3-50I & D3-80I	D3-30P & D3-30PE	D3-50P & D3-50PE
Domestic Circulator Pump	10-0510-0358	10-0490-7895	10-0490-8074
Boiler Circulator Pump		10-0490-7895	10-0490-8437
Dial Thermometers		86-8670-0240	
Pressure Gauge		10-0490-8375	
Thermostat for over-temperature control		10-0490-9187	
RTD Temperature sensor	10-0490-9668		
3-Way Boiler Control Valve	10-0350-0204		
Electronic Temperature Controller	10-0490-1962		
Automatic Air Vent (Domestic)		10-0490-7147	
Automatic Air Vent (Boiler)		10-0490-8343	
Air separator		26-0000-0530	26-0000-0478
Expansion tank (optional)		86-8560-0100	
Backflow preventer (optional)		86-0402-0100	
Tank sensor - dual-element (optional)		BP-0000-0480	
Replacement 30 Plate Heat Exchanger		BP-0000-0646	
Replacement 50 Plate Heat Exchanger		BP-0000-0647	
Replacement 80 Plate Heat Exchanger		BP-0000-0648	

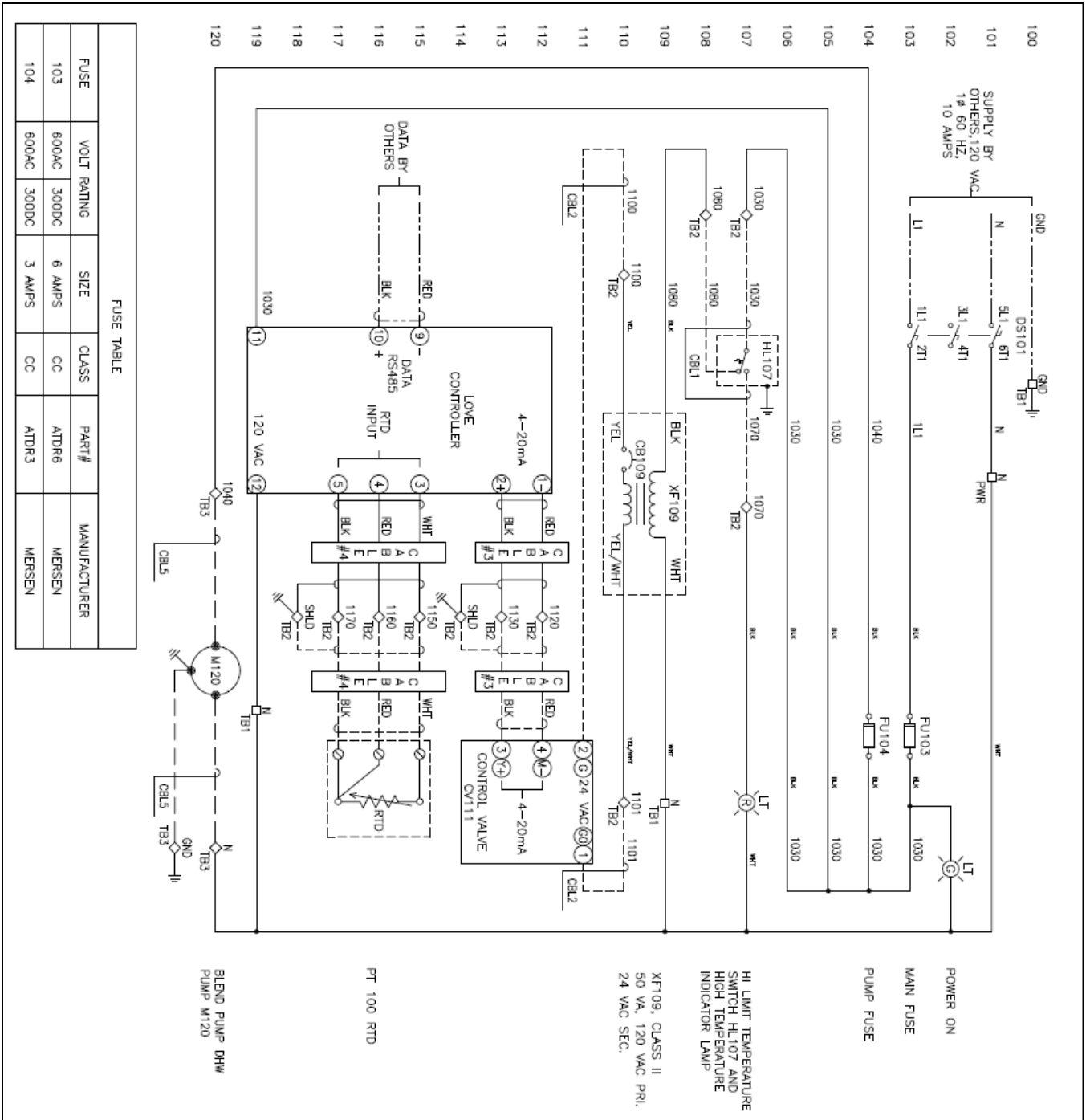
#### **WARNING**

Use of Non-Factory Authorized replacement parts are not recommended for this equipment. All control components are engineered for safety and are designed to work in unison with each of the other components. Use of non-factory authorized replacement parts jeopardizes the functionality of the safety features as well as the performance of the appliance.

When ordering replacement parts please have the **model number or serial number** of your product. Typical schematic drawings are shown on the following pages.

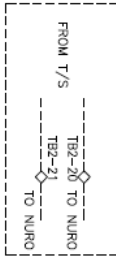
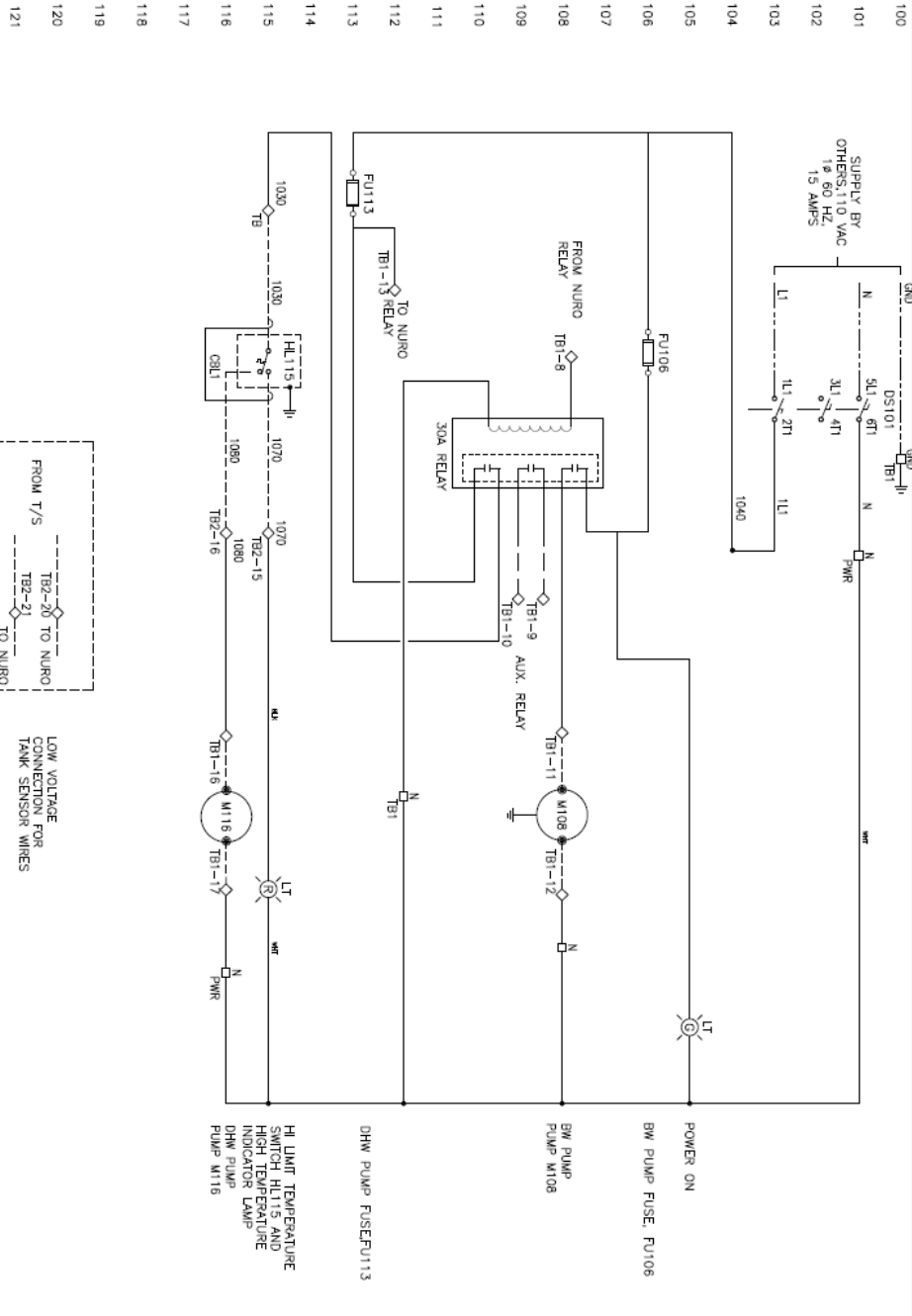


## 8.2 WIRING DIAGRAM (D3-30I, D3-50I AND D3-80I MODELS ONLY)





### 8.3 WIRING DIAGRAM (D3-30, D3-30P, D3-30PE, D3-50, D3-50P AND D3-50PE MODELS ONLY)



LOW VOLTAGE CONNECTION FOR TANK SENSOR WIRES

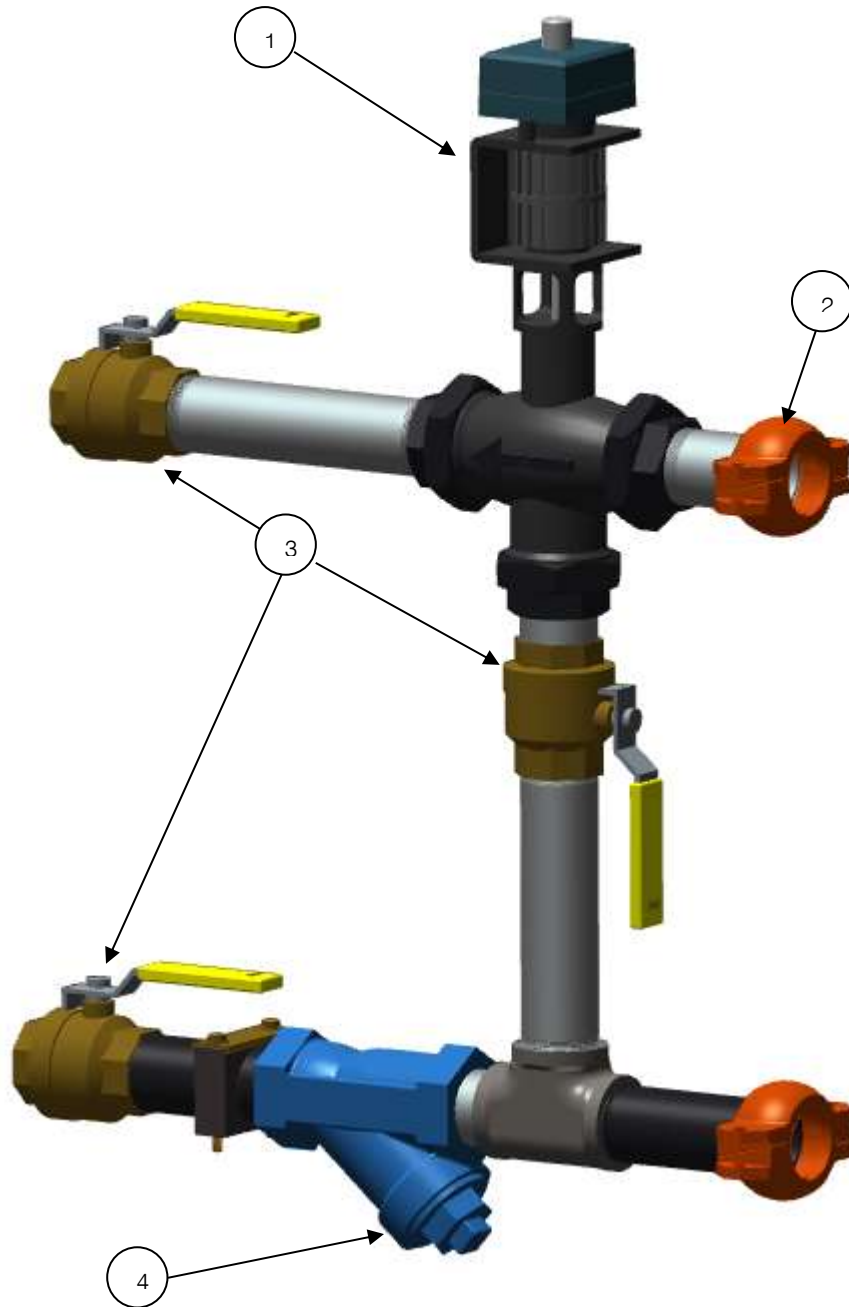
FUSE TABLE

FUSE	VOLT RATING		FUSE CLASS	FUSE PART#	MANUFACTURER
	300-500	750-1050			
106	600AC	300DC	5 AMP	ATDR5=5A	MERSEN
113	600AC	300DC	7.5 AMP	ATDR7.5=7.5A	MERSEN



## 8.4 MODELS (D3-30I, D3-50I AND D3-80I ONLY)

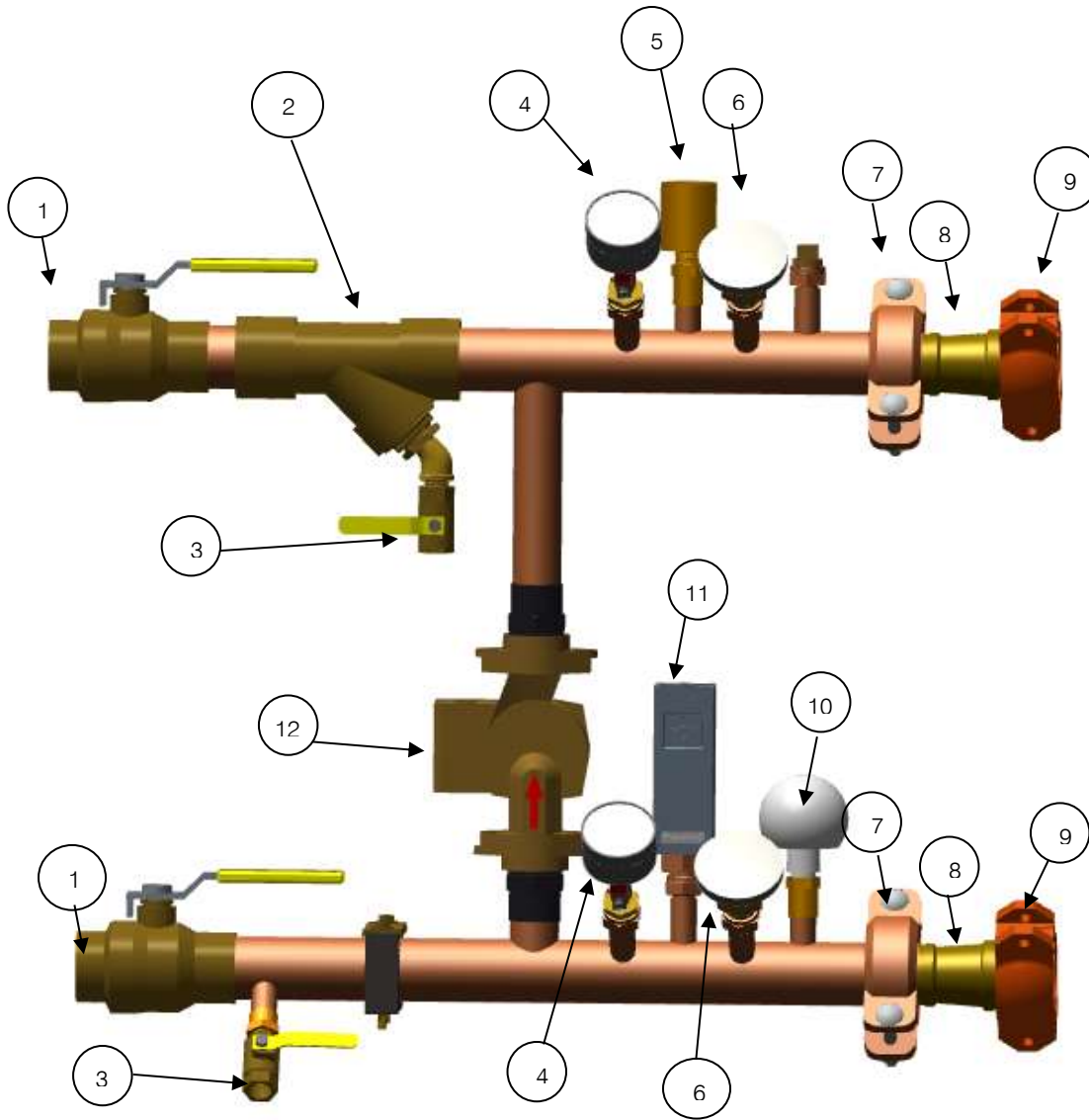
### 8.4.1 Boiler Piping



Tag Number	Part Description	P-K Part #
1	2" Electronic Control Valve (3-Way)	10-0530-0204
2	2" Grooved Coupling	26-0000-0460
3	2" Ball Valves (NPT-F Connection)	10-0510-1152
4	2" Wye Strainer	86-8030-0600



### 8.4.2 DHW Piping



Tag Number	Part Description	P-K Part #
1	2" Ball Valves (Sweat Connection)	10-0510-1153
2	2" Wye-Strainer	10-0490-7569
3	Blow Down Valve	10-0510-1150
4	Pressure Gauge (0-160 PSIG)	10-0490-8375
5	Automatic Air Vent	10-0490-7147
6	Temperature Gauge (20-240°F)	86-8670-0240
7	2" Grooved Coupling (Copper Tubing)	85-2351-3872
8	Dielectric Pipe Nipple	28-0000-0005
9	2" Grooved Coupling	26-0000-0460
10	RTD – DHW Supply Temperature Sensor	10-0490-9668
11	Manual Reset High Limit (100-240°F)	10-0490-9187
12	Recirculation Pump	10-0510-0358



### 8.4.3 Control Panel and Heat Exchanger

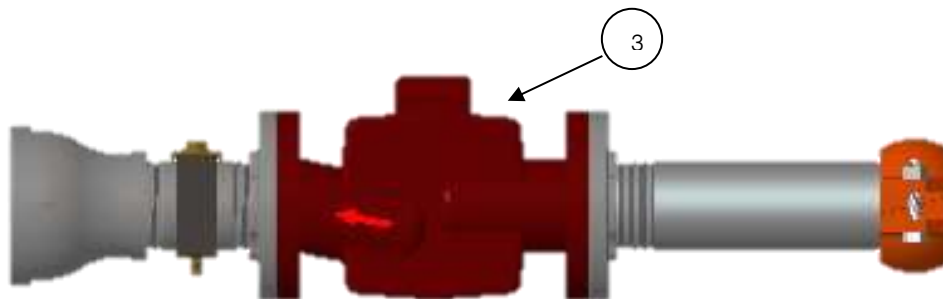
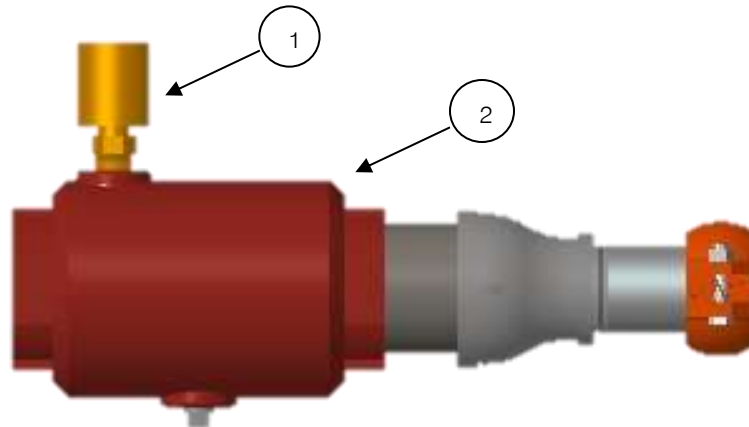
Tag Number	Part Description	P-K Part #
1	Power Light (Green)	
2	High Limit Light (Red)	
3	Disconnect Switch	
4	PID Temperature Controller (D3-30I and D3-80I only)	10-0490-1962
5A	6Amp Class CC Fuse (DHW Pump) D3-30I & D3-80I only	
5A	5Amp Class CC Fuse (DHW Pump) D3-30, D3-30P & D3-30PE only	
5A	7.5Amp Class CC Fuse (DHW Pump) D3-50, D3-50P & D3-50PE only	
5B	3Amp Class CC Fuse (Control valve) D3-30I & D3-80I only	
5B	5Amp Class CC Fuse (Boiler Pump) D3-30, D3-30P & D3-30PE only	
5B	7.5Amp Class CC Fuse (Boiler Pump) D3-50, D3-50P & D3-50PE only	
6A	30 Plate Heat Exchanger	26-0000-0543
6B	50 Plate Heat Exchanger	28-0000-0071
6C	80 Plate Heat Exchanger	26-0000-0548





## 8.5 MODELS (D3-30P, D3-30PE, D3-50P, AND D3-50PE ONLY)

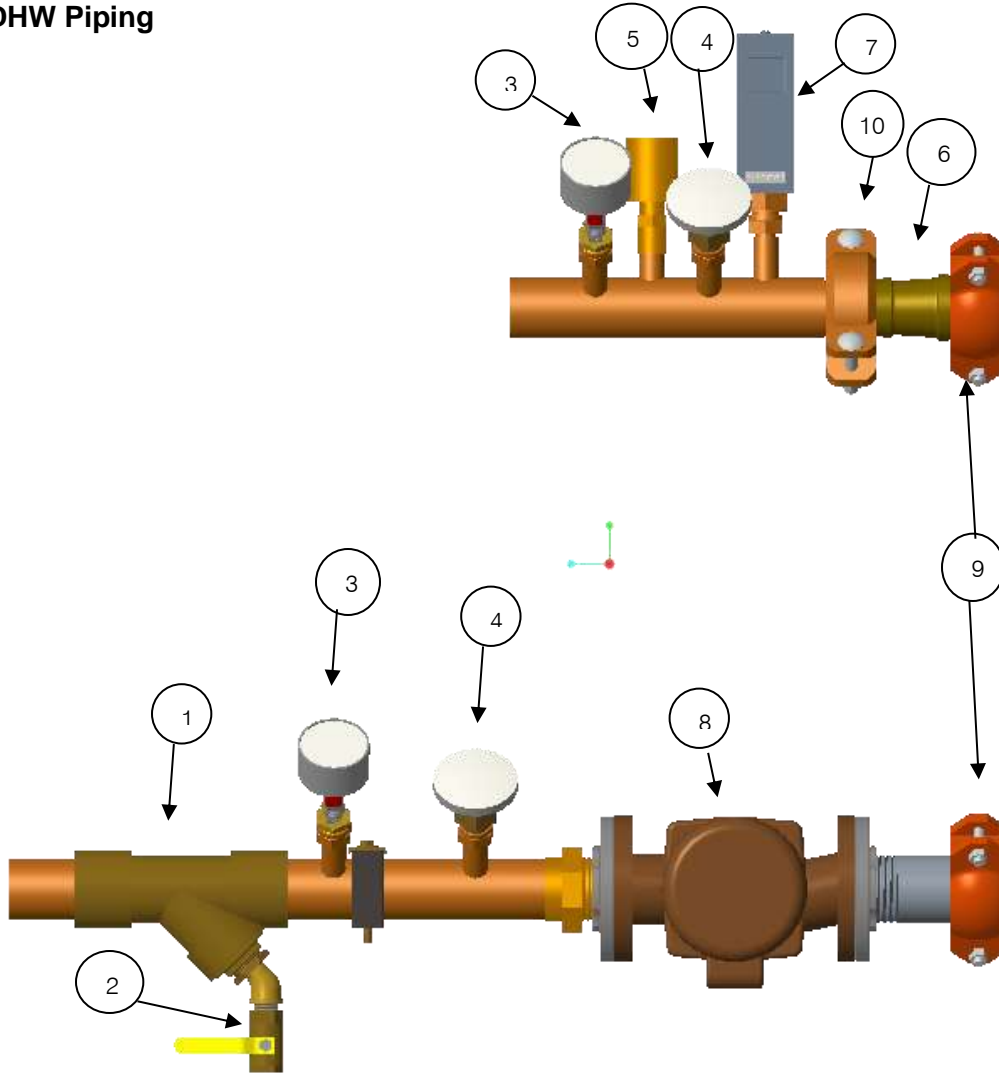
### 8.5.1 Boiler Piping



Tag Number	Part Description	P-K Part #
1	¾" Air Vent	10-0490-8343
2A	2" Air Separator (D3-30P & D3-30PE)	26-0000-0530
2B	3" Air Separator (D3-50P & D3-50PE)	26-0000-0478
3A	Boiler circulator pump (D3-30P & D3-30PE)	10-0490-7895
3B	Boiler circulator pump (D3-50P & D3-50PE)	10-0490-8437



8.5.2 DHW Piping



Tag Number	Part Description	P-K Part #
1	2" Wye-Strainer	10-0490-7569
2	Blow Down Valve	10-0510-1150
3	Pressure Gauge (0-160 PSIG)	10-0490-8375
4	Temperature Gauge (20-240°F)	86-8670-0240
5	Automatic Air Vent	10-0490-7147
6	Dielectric Pipe Nipple	28-0000-0005
7	Manual Reset High Limit (100-240°F)	10-0490-9187
8A	Domestic Recirculation Pump (D3-30P & D3-30PE)	10-0490-7895
8B	Domestic Recirculation Pump (D3-50P & D3-50PE)	10-0490-8074
9	2" Grooved Coupling	26-0000-0460
10	2" Grooved Coupling (Copper Tubing)	85-2351-3872





## 9 DURATION III™ SPECIFIC LIMITED WARRANTY

*Last Updated 11/17/2016*

Subject to the terms and conditions herein and the Terms and Conditions of Sale (as defined herein), Patterson-Kelley (“Seller”) warrants to the purchaser of the product (“Buyer”) that the product will be free of defects in material and workmanship, when operated in accordance with the conditions stated herein, for a period of three (3) years on the heat exchanger and one (1) year on all other parts, commencing on the date of shipment or, if a start-up report is furnished to Seller, on the start-up date shown on the report furnished to Seller (the “Warranty Period”), provided that startup is completed within six (6) months of shipment and the start-up report is furnished to Seller within thirty (30) days of startup (this “Specific Limited Warranty”). The Exclusions and limitations of liability set forth in the Terms and Conditions of Sale (as defined herein) apply to this Specific Limited Warranty. Capitalized terms used but not defined herein have the meanings ascribed to them under Seller’s terms and conditions of sale, which can be found at <http://pattersonkelley.com/warranty.php> (the “Terms and Conditions of Sale”). This Specific Limited Warranty is transferrable to the owner that utilizes the product for its intended use at the original installation site (the “Original Owner”). This Specific Limited Warranty is non-transferable to anyone who subsequently receives or purchases products from the Original Owner. If the Original Owner did not purchase the product directly from Seller, the Original Owner should contact the reseller from whom it purchased the product for a copy of the Terms and Conditions of Sale attached to the Order Acknowledgement received by the original purchaser of the product from Seller.

### I. REMEDY

Seller’s obligations under this Specific Limited Warranty is limited to repairing or, if in Seller’s judgment it seems more appropriate, to furnishing without charge (installation not included), FCA Seller’s factory (Incoterms 2010), a similar part to replace any part which after examination shall, to Seller’s own satisfaction be determined to have been defective at the time it was shipped. In the event that a replacement is provided by Seller, the defective item will become the property of Seller. Transportation to Seller’s facility or other designated facility for repairs of any products or party alleged defective shall, in all events, be at Buyer’s sole risk and cost. This warranty applies only if the original installer and Seller (Attention: Patterson-Kelley, 155 Burson Street, East Stroudsburg, PA 18301) receive, within the Warranty Period, an immediate written notice, providing a detailed description of all claimed defects, upon discovery of such defects together with proof of purchase (invoice or Order Acknowledgment) and a copy of the start-up report for the affected product. Seller may seek reimbursement of any costs incurred by Seller where the product is found to be in good working order, or when it has been determined that this Specific Limited Warranty does not apply as per the exclusions set forth below. The remedies available to Buyer set forth herein are exclusive remedies, and all other remedies, statutory or otherwise, including but not limited to the right of redhibition, are waived by Buyer. Buyer acknowledges that the exclusion of remedies is neither unreasonable nor unconscionable. Buyer shall indemnify and hold Seller harmless against, any claim due to any injury or death to any person or damage to any property resulting in whole or in part from any modification or alteration Buyer makes to any product sold hereunder.

### II. EXCLUSIONS

To the full extent permitted by law, Seller shall have no liability for and the Warranties do not cover:

- (A) any product which has been altered or repaired by other than Seller's personnel;
- (B) deterioration or failure of any product due to
  - (i) abrasion, corrosion, erosion or fouling,
  - (ii) misuse,
  - (iii) modification not authorized by Seller in writing or
  - (iv) improper installation, lack of or improper maintenance or operation;
- (C) equipment not furnished by Seller by the owner, either mounted or unmounted, or when contracted for by a party or parties other than Seller to be installed or handled;
- (D) the suitability of any product for any particular application;
- (E) the design or operation of owner’s plant or equipment or of any facility or system of which any product may be made a part;
- (F) any damage to the product due to abrasion, erosion, corrosion, deterioration, abnormal temperatures or the influence of foreign matter or energy;
- (G) the performance of any product under conditions varying materially from those under which such product is usually tested under industry standards at the time of shipment;
- (H) leakage or other malfunction caused by:
  - (i) defective installations in general and specifically, any installation which is made
    - (a) in violation of applicable state or local plumbing, housing or building codes or
    - (b) contrary to the written instructions furnished with the product,
  - (ii) adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes, headers and/or shells or corrosive elements in the water, heating medium or atmosphere, or



(iii) misuse in general and, specifically, operation and maintenance contrary to the written instructions furnished with the unit, disconnection, alteration or addition of components or apparatus, not approved by Seller, operation with heating media, fuels or settings other than those set forth on the rating plate or accidental or exterior damage;

(I) production of noise, odors, discoloration or rusty water;

(J) damage to surrounding area or property caused by leakage or malfunction;

(K) costs associated with the replacement and/or repair of the unit including: any freight, shipping or delivery charges, any removal, installation or reinstallation charges, any material and/or permits required for installation, reinstallation or repair, charges to return the boiler and/or components;

(L) INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, SUCH AS LOSS OF THE USE OF PRODUCTS, FACILITIES OR PRODUCTION, INCONVENIENCE, LOSS OF TIME OR LABOR EXPENSE INVOLVED IN REPAIRING OR REPLACING THE ALLEGED DEFECTIVE PRODUCT;

(M) any claim due to any injury or death to any person or damage to any property resulting in whole or in part from any modification or alteration Buyer makes to any product sold hereunder; and

(N) design defects where Seller has complied with Buyer's design specifications .

### III. PROOF OF PURCHASE

Proof of purchase (invoice or Order Acknowledgement) and a copy of the start-up report for the affected product must be provided to Seller when requesting service under this Specific Limited Warranty.

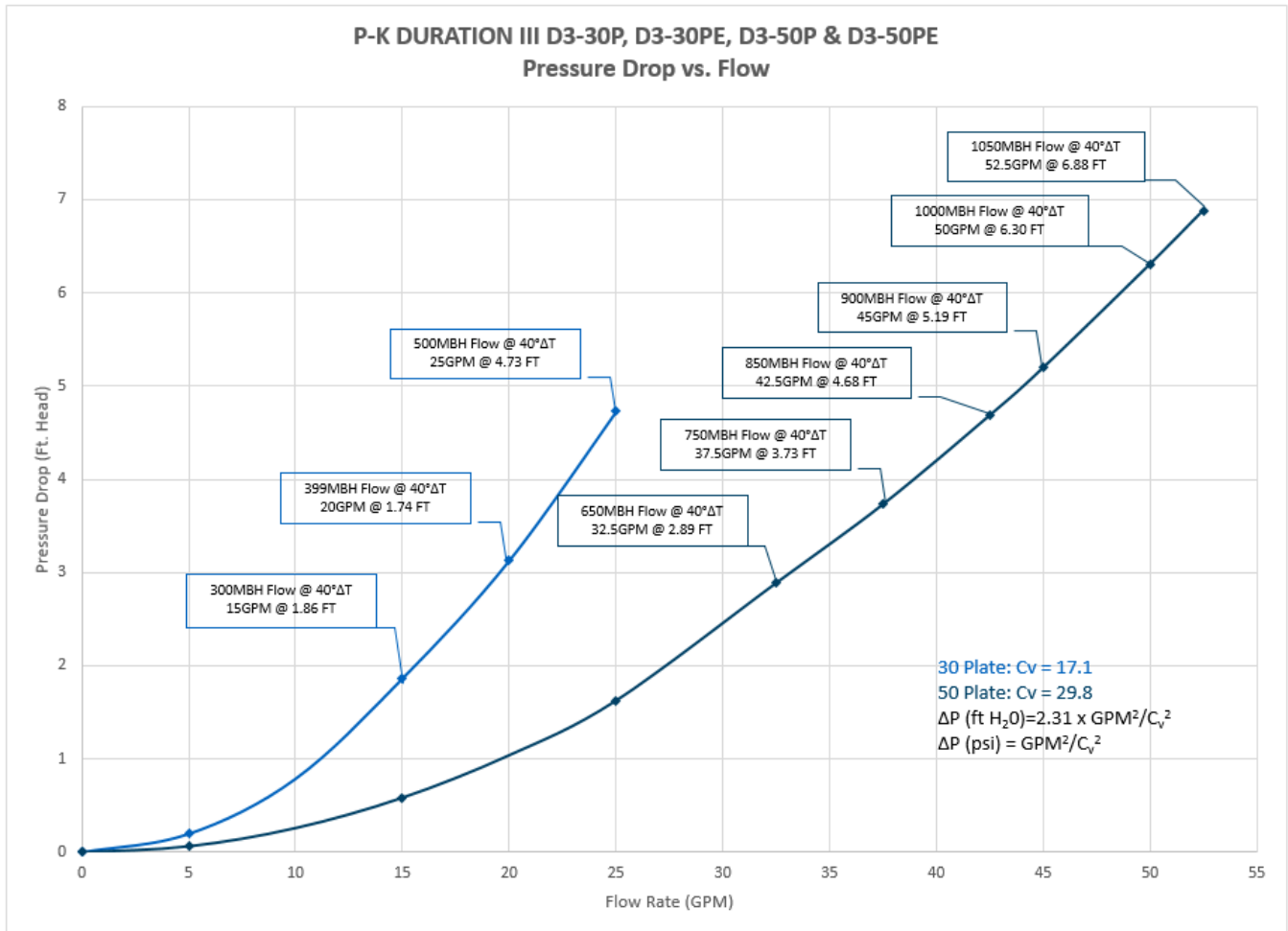
### IV. ORDER OF PRECEDENCE

The Standard Limited Warranty, which can be found at <http://pattersonkelley.com/warranty.php> , (b) this Specific Limited Warranty, which can be found at <http://pattersonkelley.com/warranty.php> and (c) any applicable Extended Limited Warranty exclusively govern and control Seller's and Buyer's respective rights and obligations regarding the warranty of the products. In case of any inconsistency, conflict, or ambiguity between the Standard Limited Warranty, this Specific Limited Warranty and any applicable Extended Limited Warranty (collectively, the "Warranty Documents"), the documents shall govern in the following order: (w) any applicable Extended Limited Warranty; (x) this Specific Limited Warranty; (y) the Standard Limited Warranty and (z) other provisions in the Terms and Conditions of Sale. Information identified in one Warranty Document and not identified in another shall not be considered a conflict or inconsistency. No sales representative, agent, or employee of Seller or any reseller in the chain of sale of the product is authorized to make any modification, extension, or addition to this Specific Limited Warranty, unless agreed to in writing by Seller.



## 10 PRESSURE DROP INFORMATION

### 10.1 PRESSURE DROP VS. FLOW CURVE





### 10.1.1 Pressure Drop and Pump Head

PK Boiler Series	Design Flow Rate (GPM)	Boiler-Side Pressure Drop (ft. hd.)	Pump Head Available for BW Piping Loss	Pump Head Available for DHW Piping Loss
C300	15.0	15.0	23.0	18.1
C399	20.0	0.0	18.0	11.5
C500	25.0	0.0	13.0	3.0
C750	37.5	0.0	17.5	10.6
C900	45.0	0.0	17.0	8.7
C1050	52.5	0.0	16.3	6.6
S650	32.5	0.0	18.0	11.0
S750	37.5	0.0	17.5	8.3
S850	42.5	0.0	17.3	6.4
S1000	50.0	0.0	16.8	1.9