



P-K MACH 'n' ROLL™

MnR300/MnR399/MnR500 &

MnR750/MnR1050

**CONDENSING INDIRECT DOMESTIC
HOT WATER SYSTEM**

Model #: _____ Serial # _____

Start-Up Date: _____

Harsco Industrial, Patterson-Kelley
155 Burson Street
East Stroudsburg, PA 18301
Telephone: 570.476.7261
Toll Free: 877.728.5351
Facsimile: 570.476.7247
www.harscopk.com

INSTALLATION
& OWNER'S
MANUAL

INSTALLATION
& OWNER'S
MANUAL

INSTALLATION
& OWNER'S
MANUAL

INSTALLATION
& OWNER'S
MANUAL

INSTALLATION
& OWNER'S
MANUAL

INSTALLATION
& OWNER'S
MANUAL

INSTALLATION
& OWNER'S
MANUAL

INSTALLATION
& OWNER'S
MANUAL

| | |
|--|-----------|
| 1.....INTRODUCTION | 4 |
| 2.....SAFETY | 4 |
| 2.1 General | 4 |
| 2.2 Training | 5 |
| 2.3 Safety Features | 5 |
| 2.4 Safety Labels | 5 |
| 2.5 Safety Precautions | 6 |
| 3.....INSTALLATION..... | 7 |
| 3.1 Receiving and Storage | 7 |
| 3.2 Compliance with Codes | 8 |
| 3.3 Setup | 8 |
| 3.4 Connection To The Domestic Hot Water System..... | 9 |
| 3.5 Electrical Connections | 15 |
| 3.6 Pre-Start Check List | 17 |
| 3.7 Safety Checks..... | 17 |
| 4.....CONTROL SYSTEM SETUP | 19 |
| 4.1 ENVI Control Panel | 19 |
| 4.2 Standalone Domestic Hot Water Setup..... | 20 |
| 4.3 Cascade System Setup | 23 |
| 5.....MAINTENANCE | 26 |
| 5.1 Maintenance and Inspection Schedule | 26 |
| 5.2 Accessing the Components (MnR750 & MnR1050)..... | 27 |
| 5.3 Troubleshooting | 28 |
| 6.....PARTS/TECHNICAL SUPPORT | 29 |
| 6.1 Wiring Diagram – Power For Standalone DHW Operation | 30 |
| 6.2 Wiring Diagram – Power For Cascade DHW Operation | 31 |
| 6.3 Wiring Diagram – Controls For Standalone DHW Operation | 32 |
| 6.4 Wiring Diagram – Controls For Cascade DHW Operation | 33 |
| 6.5 MnR300/399/500 Components..... | 34 |
| 6.6 MnR750/1050 Components – Boiler Side | 35 |
| 6.7 MnR750/1050 Components – Domestic Side | 36 |
| 7.....RECOVERY PERFORMANCE DATA | 37 |
| 7.1 P-K MACH 'n' Roll™ 300 Recovery Performance Data | 37 |
| 7.2 P-K MACH 'n' Roll™ 399 Recovery Performance Data | 38 |
| 7.3 P-K MACH 'n' Roll™ 500 Recovery Performance Data | 39 |
| 7.4 P-K MACH 'n' Roll™ 750 Recovery Performance Data | 40 |
| 7.5 P-K MACH 'n' Roll™ 1050 Recovery Performance Data | 41 |
| 8.....P-K MACH 'N' ROLL™ SYSTEM LIMITED WARRANTY | 42 |

1 INTRODUCTION

This manual describes the installation and operation of the P-K MACH 'n' Roll™ condensing indirect domestic hot water system for use with P-K MACH CM300, CM399, CM500, C750 & C1050 boilers. It is important to note that the P-K MACH 'n' Roll™ system is an add-on package to the standard P-K MACH boiler. Please refer to the latest edition of the P-K MACH CM300-CM500 or the C750-C1050 installation and operation manual for detailed boiler operation requirements before installing the P-K MACH 'n' Roll™ condensing indirect domestic hot water system.

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

The P-K MACH 'n' Roll™ system and P-K MACH boiler are only a part of a complete 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 storage tank temperature sensors, pumps, flow switches, balancing valves, and check valves will be required for satisfactory operation of any system. Harsco Industrial, Patterson-Kelley cannot be responsible for the design or operation of such systems and a qualified engineer or contractor must be consulted.

2 SAFETY

2.1 GENERAL

The P-K MACH 'n' Roll™ 300/399/500/750/1050 condensing 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.

NOTICE! Each safety device must be maintained and checked per the recommended schedule. Refer to Section 3.7 of this manual.

DANGER

The P-K MACH 'n' Roll™ is a dynamic system that is designed to heat domestic hot water in a storage tank to a wide range of temperatures. The P-K MACH 'n' Roll™ 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 may be required to prevent scalding.

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 Harsco Industrial, Patterson-Kelley representative.



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 fire or explosion and serious injury, death, and/or property damage.

Operating and service personnel must be thoroughly familiar with the basic construction of the P-K MACH CM300/CM399/CM500 or C750/C1050 boilers, the use and locations of the controls, the operation of the boilers, 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 Harsco Industrial, 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 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 Indicates a potentially hazardous situation which, if not avoided, **could** result in death or serious injury.

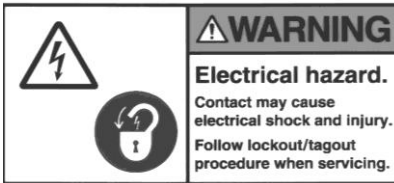
⚠ CAUTION Indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE/NOTE - 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 MACH 'n' Roll™ 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 boiler, P-K MACH 'n' Roll™ system, all piping, and accessories.

2.5.1 Electrical Hazards



- Shock hazard! Properly lockout/tag out the electrical service and all other energy sources before working on or near the boiler.
- Shock hazard! Do not spray water directly on this boiler or on any electrical components.
- Electrical hazard! Do not alter wiring connections.

2.5.2 Burn, Fire, and Explosion Hazards



- Burn, fire, and explosion hazards! Installation must be in strict conformance to all applicable codes and standards including NFPA 54, ANSI Z223.1 and CAN/CSA B.149.
- 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 boiler.
- Burn hazard! Hot fluids. Use caution when servicing or draining boiler.

! DANGER

The P-K MACH 'n' Roll™ is a dynamic system that is designed to heat domestic hot water in a storage tank to a wide range of temperatures. The P-K MACH 'n' Roll™ 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 may be required to prevent scalding.

2.5.3 Crush Hazards



- Lifting hazards! Use properly rated lifting equipment to lift and position the boiler. 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 | Shipping Weight in Pounds |
|---------|---------------------------|
| MnR300 | 1390 lbs |
| MnR399 | 1417 lbs |
| MnR500 | 1417 lbs |
| MnR750 | 1340 lbs |
| MnR1050 | 1440 lbs |

2.5.4 Chemical Hazards



- 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



- Pressure hazard! Hot fluids. Install isolation valves on boiler water inlet and outlet. Make sure 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



- Tripping hazard! Do not install piping on floor surfaces. Maintain clear path around the P-K MACH 'n' Roll™ 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 MACH 'n' Roll™ system or the P-K MACH boiler.

3 INSTALLATION

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 MACH 'n' Roll™ 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 MACH 'n' Roll™ 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 219 psig maximum operating pressure. However, certain components in the domestic piping have a maximum pressure rating of 150 psig. Therefore, the domestic side pressure must never exceed 150 psig.

Patterson-Kelley recommends a pressure-only relief valve constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII with a maximum 150 psig set pressure. Most MACH 'n' Roll installations will be piped to a storage tank which will feature a T&P relief valve. Ensure that any pressure relieving devices installed in the domestic hot water system prevent the pressure from exceeding 150 psig.

Please refer to the CM300-CM500 or C750-C1050 installation and operation manuals for code compliance related to the P-K MACH boiler.

3.3 SETUP

3.3.1 Foundation and Placement

Provide a firm, level foundation, preferably of concrete. The P-K MACH 'n' Roll™ system and P-K MACH boiler must be level to function properly. There are four leveling feet on the bottom of the P-K MACH 'n' Roll™ system which should be used to level the product.

NOTICE! The P-K MACH 'n' Roll™ system may be installed on a combustible floor; however, it must **never** be installed on carpeting.

3.3.2 Clearances

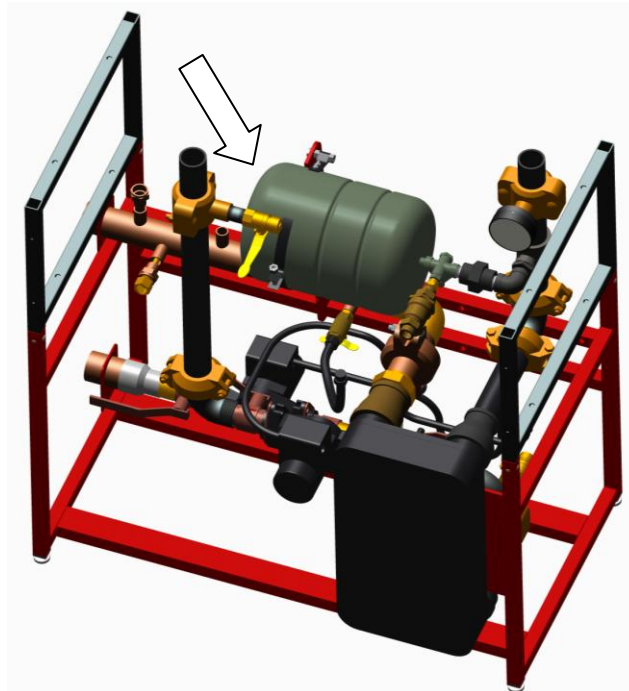
Since the P-K MACH 'n' Roll™ is designed to sit underneath the applicable P-K MACH boiler, it requires the same clearances as the boiler itself. Please refer to the CM300-CM500 or C750-C1050 installation and operation manuals for requires clearances. The P-K MACH 'n' Roll™ system is designed to be serviced from the front, so ensure there are no obstructions present in front of the unit.

3.4 CONNECTION TO THE DOMESTIC HOT WATER SYSTEM

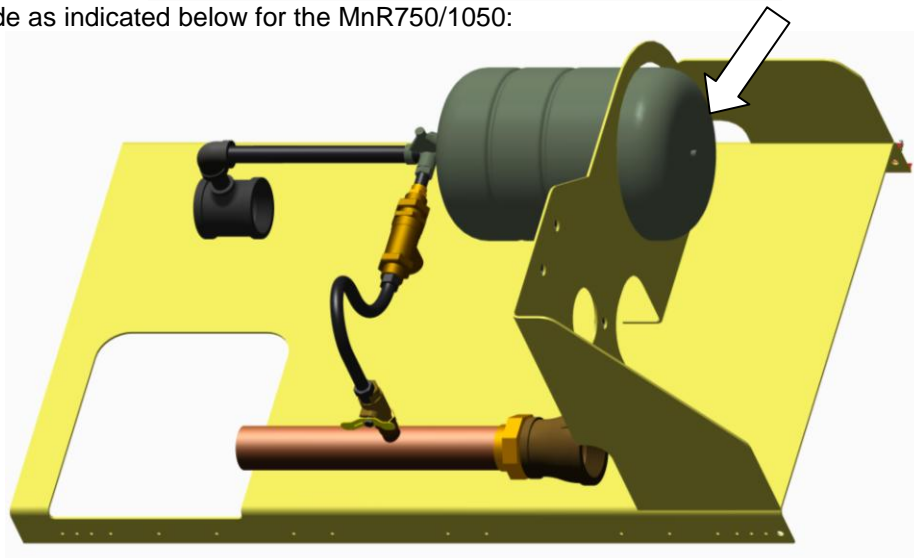
The P-K MACH 'n' Roll™ is designed to occupy the space underneath the applicable P-K MACH boiler. The steel piping is connected to & from the P-K MACH boiler, but the 2" copper piping must be connected to the domestic hot water system.

3.4.1 Expansion Tank / Fill System

Before making any mechanical connections to the P-K MACH 'n' Roll™ system or the P-K MACH boiler, it is imperative that the expansion tank / fill system be checked for a suitable fill pressure. The expansion tank ships with a 12 psig precharge, but it is possible this air pressure may reduce during shipment. A Schrader valve is located on the left side of the expansion tank as indicated below for the MnR300/399/500:



Or on the front side as indicated below for the MnR750/1050:



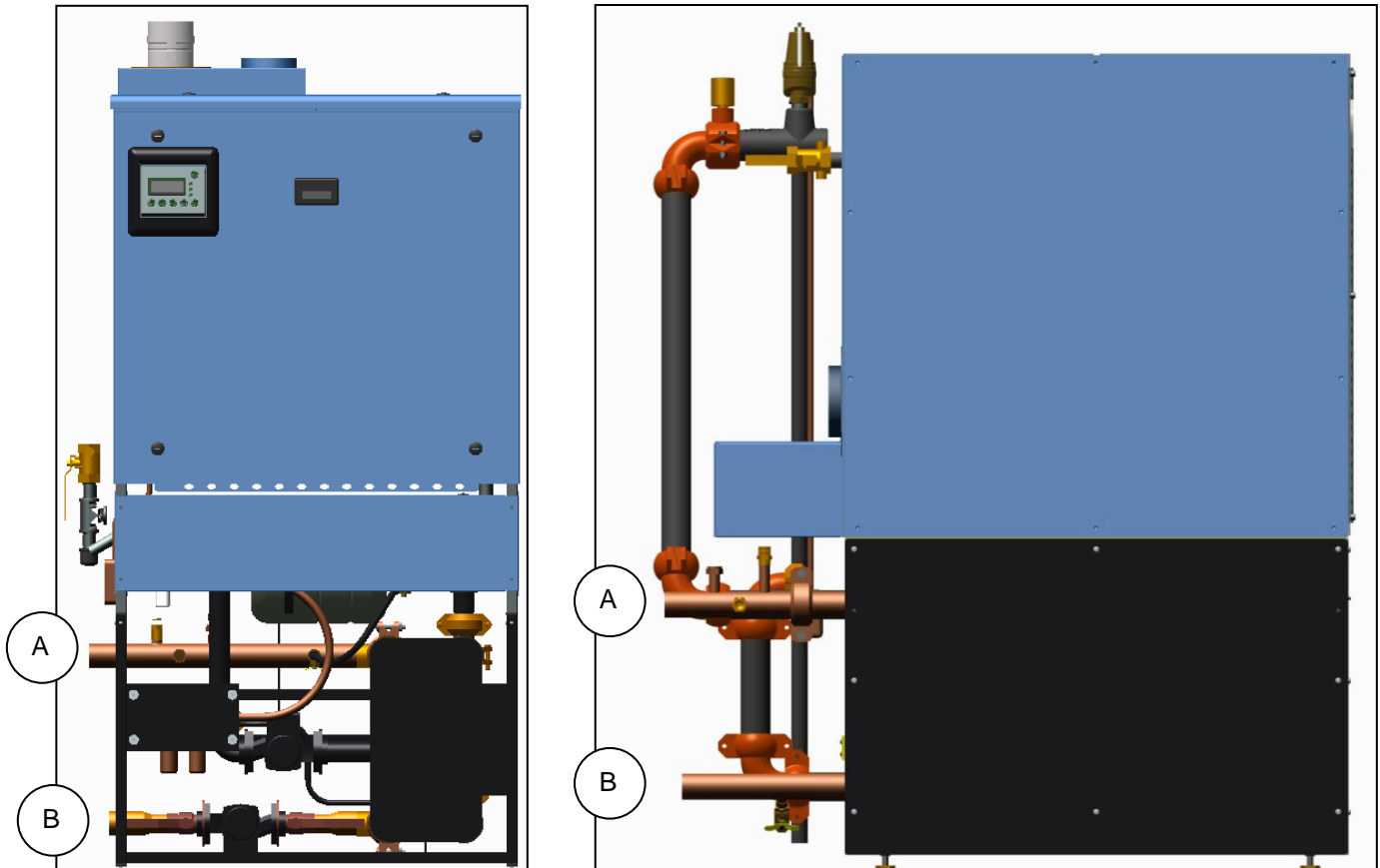
Use a pressure gauge to verify the air pressure is at least 12 psig. If the pressure is insufficient, use an air pump with built-in pressure gauge to charge the air pressure to a **minimum of 12 psig** before making ANY mechanical connections. The maximum air pressure need not exceed 20 psig.

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 completely normal and is due to thermal expansion of the boiler water.

3.4.2 Domestic Water Piping

Locate the domestic water piping which has the following terminations:

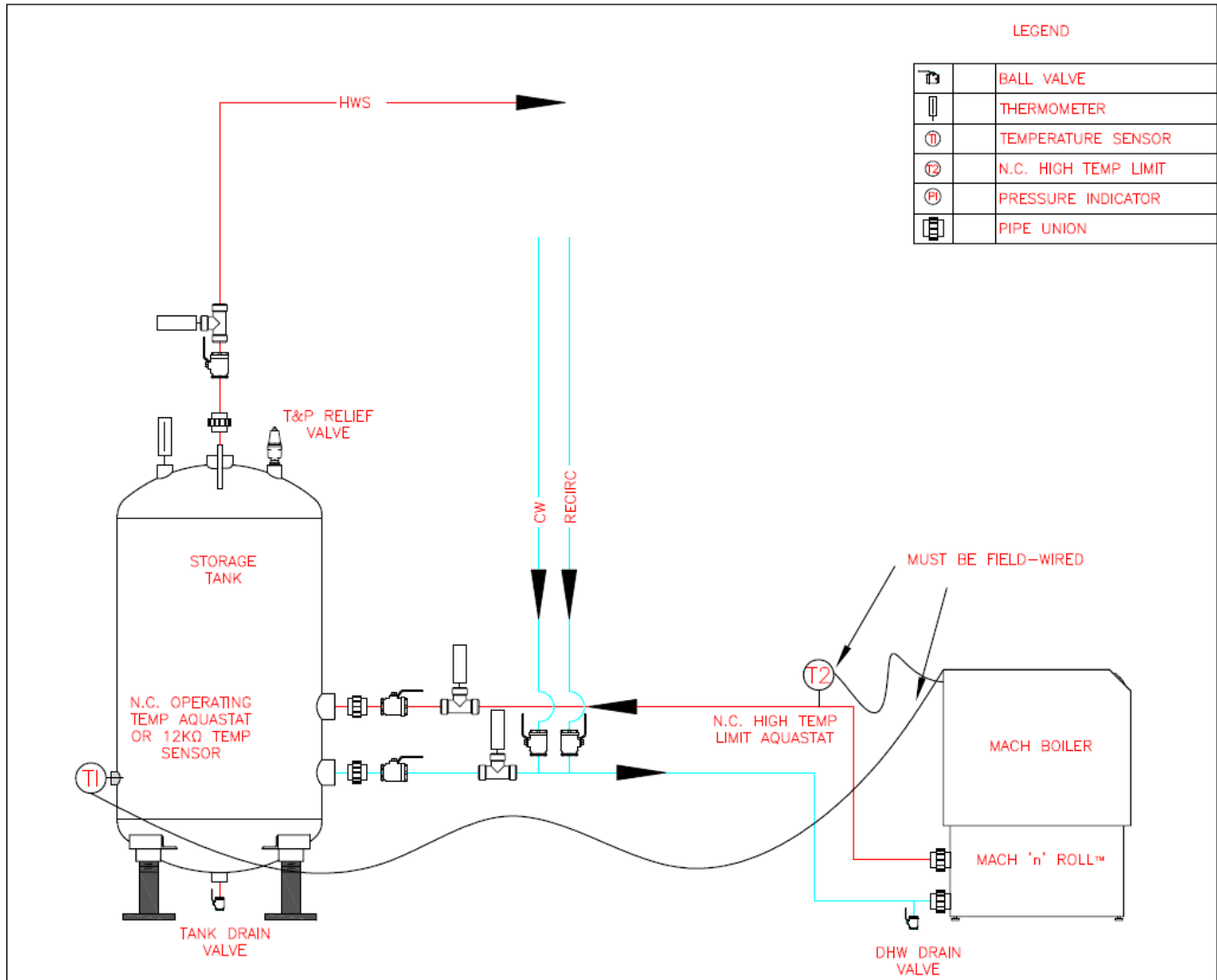
- A. 2" Type L Copper (Domestic Hot Water Supply)
- B. 2" Type L Copper (Domestic Water Return)



There are a variety of ways to connect to the domestic water piping on the MACH 'n' Roll™, but any sweat/soldered connections must use a lead-free solder. Also, any brass or bronze pipe fittings, isolation valves, unions, check valves, etc. must all be lead-free.

3.4.3 Example Standalone DHW Installation

It is important to note that the MACH 'n' Roll™ is designed to operate in conjunction with a domestic water storage tank. From the initial call for heat, it takes approximately two minutes until the P-K MACH boiler operates at maximum power, so the storage tank needs to be sized appropriately for the application.

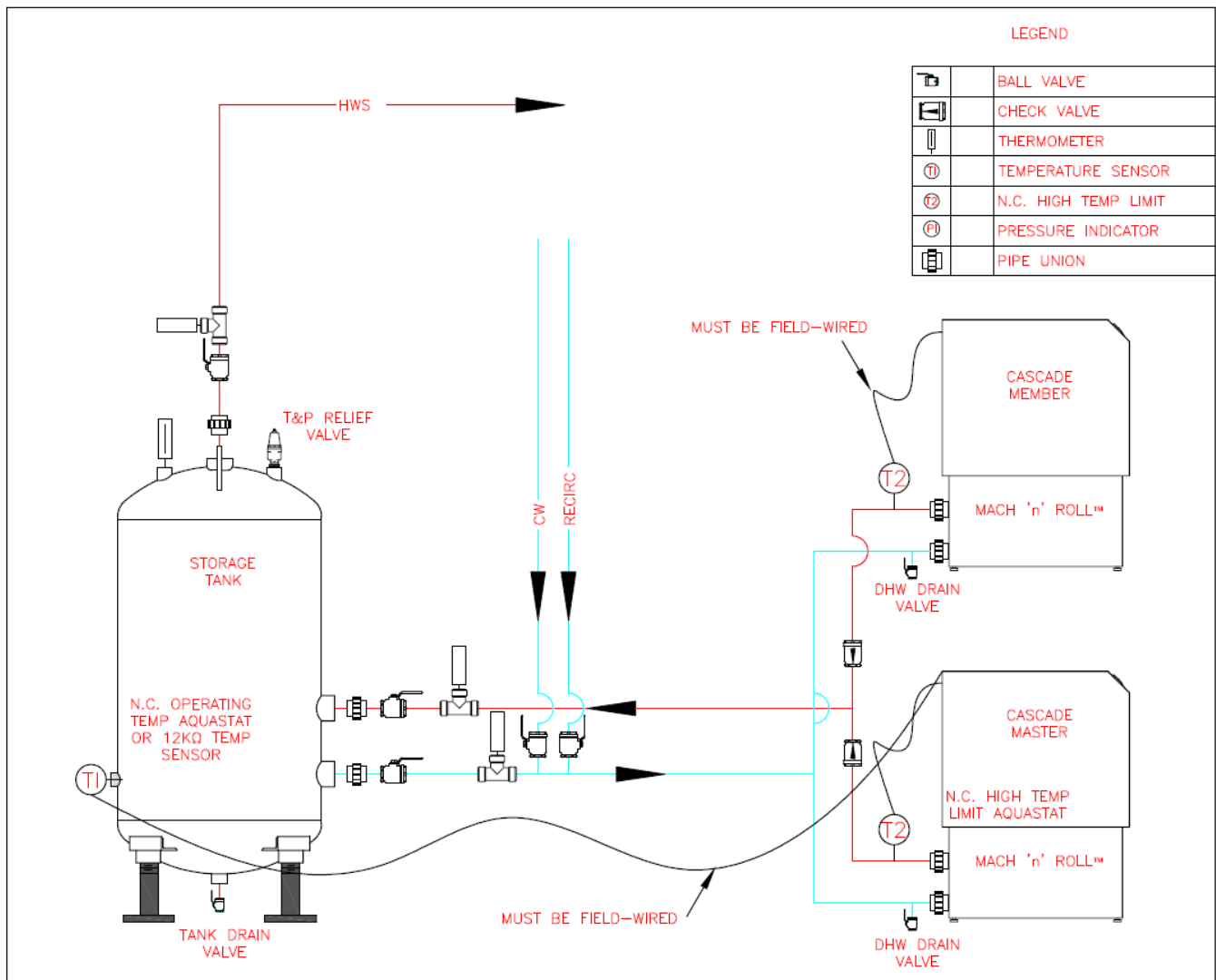


The P-K MACH 'n' Roll™ system features a thermowell in the domestic hot water supply connection which can be used for a normally closed high temperature limit aquastat. Alternatively, this high temperature limit aquastat can be installed in the domestic water storage tank. The normally closed and common terminals on the aquastat should be wired to the P-K MACH boiler's external interlock circuit terminals (TB1-3 & TB1-4). If the domestic water temperature exceeds the high temperature limit aquastat, the MACH 'n' Roll™ will go into a blocking error to prevent a high temperature condition. The system will remain in blocking for 5 minutes after which the ENVI control will lockout.

The P-K MACH 'n' Roll™ system requires either a normally-closed operating temperature aquastat or a 12kΩ thermistor-type temperature sensor installed in the lower 1/3rd of the domestic water storage tank. Ensure the insertion depth is sufficient to achieve an accurate tank temperature reading. If using a thermowell, thermal paste is recommended.

3.4.4 Example Cascade DHW Installation

Two or more MACH 'n' Roll™ units can be configured for cascade (lead/lag) operation. The master boiler must be equipped with a 12kΩ thermistor-type temperature sensor installed in the lower 1/3rd of the domestic water storage tank. Each individual MACH 'n' Roll™ in the cascade system must have its own high temperature limit installed on its DHW supply piping.



Ensure a check valve is installed on the DHW supply piping of each MACH 'n' Roll™ in the cascade system. This will ensure the hot water is directed to the storage tank, and isn't allowed to backflow through offline MACH 'n' Roll™ units. Refer to **Section 4.3** for setting up the ENVI controls for cascade operation. Also refer to **Sections 6.2 & 6.4** for detailed information on power wiring and controls wiring needed for cascade operation.

3.4.5 Flushing the Domestic Water

The P-K MACH 'n' Roll™ system features an expansion tank/fill valve assembly that provides water to the P-K MACH boiler and its piping. A dual-check valve ensures that the water in the boiler loop cannot re-enter the domestic loop. It is imperative that the water quality guidelines required for a P-K MACH boiler be strictly followed. The P-K MACH boiler heat exchanger is made of an aluminum alloy. All heat exchangers require proper water conditions to remain efficient and function properly. For information log on to our website: www.harscopk.com for Multi-Metal Systems Water Quality Standards information as this applies to the warranty of the boiler's heat engine.

NOTICE! Glycol or other treatment chemicals added to the system must be certified by the chemical manufacturer for use in multi-metal systems that include cast aluminum boilers.

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

NOTICE! Under no circumstances should the hydronic system be flushed while the boiler is attached to the system since the debris or corrosion products could accumulate in the boiler and plug the boiler heat exchanger.

NOTICE! Performance data for recovery capacity of the P-K MACH 'n' Roll™ system (see section 7) was performed with pure water with no additives. Chemical additives will impact the performance of the P-K MACH 'n' Roll™ system.

NOTICE! If the piping system attached to this unit will be chemically cleaned, the boiler must be disconnected from the system and a bypass installed so that the chemical cleaning solution does not circulate through the boiler. Following chemical cleaning, the system should be thoroughly rinsed to remove cleaning agents prior to reconnecting the boiler to the system.

Before the initial fill, ensure that any and all sediment or particulates have been removed from the domestic water. Ensure that any isolation valves between the domestic water storage tank and the P-K MACH 'n' Roll™ system are closed. If available, use a drain valve on the domestic water storage tank to purge sediment and particulates.

3.4.6 Filling the System

Before filling the system, ensure all the mechanical connections are complete. Also, refer to the P-K MACH CM300-CM500 or C750-C1050 installation and operation manual to ensure the boiler's pressure relief valve is installed correctly.

- **STEP 1** – Remove either the front or left panel from the P-K MACH 'n' Roll™ system to provide better access to the expansion tank/fill valve assembly isolation valve.
- **STEP 2** – If available, close the manual isolation valves in the domestic piping between the domestic water storage tank and the P-K MACH 'n' Roll™ system.
- **STEP 3** – Close the manual isolation valve ahead of the expansion tank/fill valve assembly. Refer to **Section 3.4.1** to ensure the expansion tank is charged to at least 12 psig and not more than 20 psig.
- **STEP 4** – Close the drain valves on the boiler and domestic piping.
- **STEP 5** – Open the cap on the automatic air vent in the boiler piping.
- **STEP 6** – Open the stem of the boiler's safety relief valve.
- **STEP 7** – If available, open the manual isolation valves in the domestic piping. This will fill the domestic side of the heat exchanger with water.
- **STEP 8** – Open the manual isolation valve ahead of the expansion tank/fill valve assembly. This will fill the boiler side of the heat exchanger with water.
- **STEP 9** – When water escapes from the boiler's safety valve discharge, close the stem of the safety relief valve.
- **STEP 10** – Ensure the water pressure is at least 12 psig in the boiler piping. If the water pressure is less than 12 psig, drain the water in the boiler piping and refer to **Section 3.4.1** to charge the expansion tank. When the expansion tank is charged properly, repeat Steps 1 through 9.
- **STEP 11** – Check for any leaks in the boiler piping, especially at the Victaulic couplings as these may have loosened during shipment. Tighten or reseal the connections if necessary.
- **STEP 12** – Check for any leaks in the domestic piping, especially at the Victaulic couplings and pump flanges which may have loosened during shipment. Tighten or reseal the connections if necessary.

3.5 ELECTRICAL CONNECTIONS

Only after all the mechanical connections have been completed and verified should any electrical connection be made. The P-K MACH 'n' Roll™ system can be configured to operate in several applications, so the electrical connections may need to be modified depending on the application. Please refer to Section 6.1 for a wiring diagram of the P-K MACH 'n' Roll™ system.

⚠ CAUTION

Be sure to check the nameplate on the equipment before connecting electrical supply.

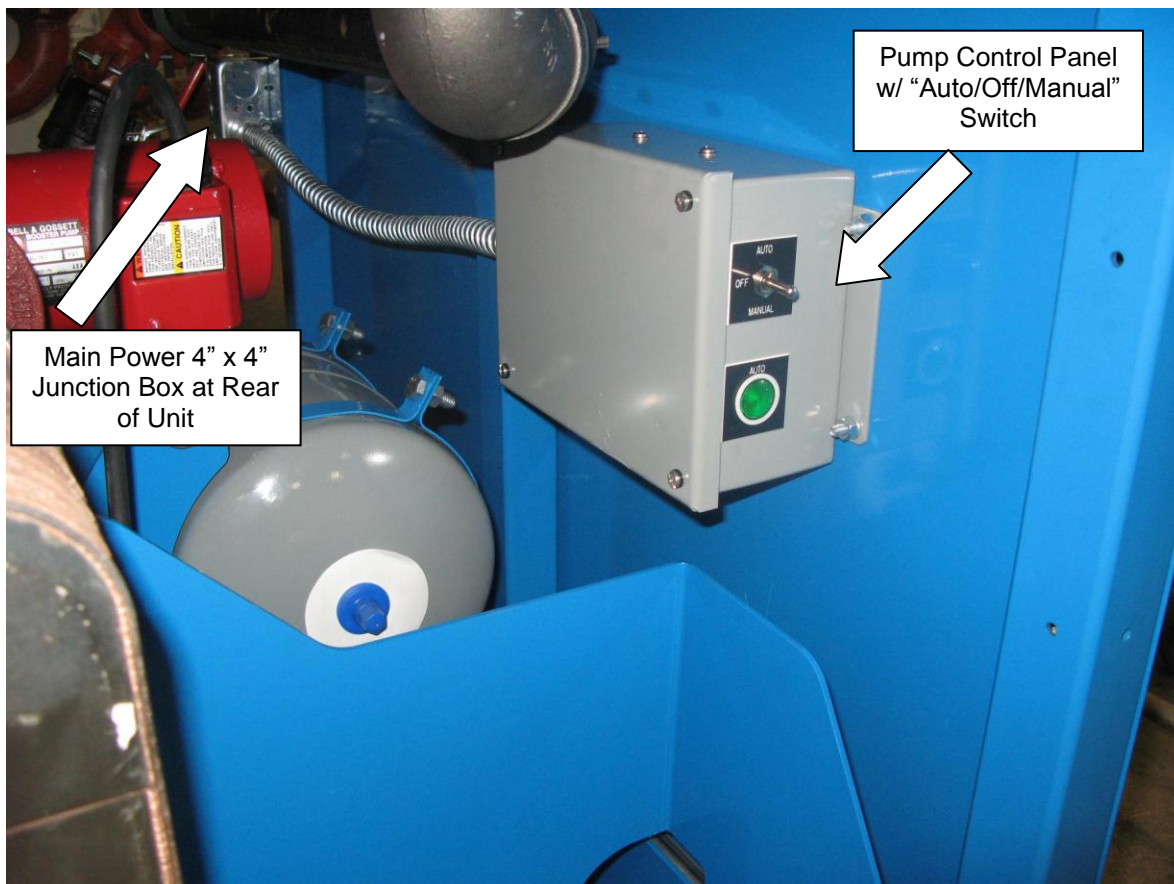
NOTICE! A dedicated earth ground (green wire) is required to avoid nuisance shutdowns. Do not ground through the conduit.

The P-K MACH 'n' Roll™ system requires 120 volt, single phase, 60 hertz electrical service (20 amps max). Size the supply circuit accordingly.

3.5.1 Power Distribution to Circulating Pumps

The main power junction box can be found and accessed at the rear of the P-K MACH 'n' Roll™ system. The 120 volt, single phase, 60 hertz, 20 amps electrical service should be routed to this junction box.

Open the front panel of the MnR750/1050 to reveal the pump control panel. This panel the MnR300/399/500 can be found on the left hand side. The Green LED will illuminate when the pumps are running in "Auto" mode.



NOTE: Image not representative of all models

Standalone DHW Operation:

When operating as a standalone unit in DHW mode, the P-K MACH 'n' Roll™ system uses the DHW PUMP CNTR (terminals TB2-5 and TB2-12) from the P-K MACH boiler's high voltage terminal block. When the P-K MACH boiler receives a domestic call for heat, the DHW PUMP CNTR provides a 0.5 amp pilot-duty 120VAC signal. Refer to Section 6.1 for more information.

Cascade Operation for DHW:

In a system where two or more P-K MACH 'n' Roll™ units are setup in Cascade Mode, the P-K MACH 'n' Roll™ must be modified to use the CIRC PUMP CNTR (terminals TB2-6 and TB2-13) from the P-K MACH boiler's high voltage terminal block. When the P-K MACH boiler receives a call for heat via the cascade system, the CIRC PUMP CNTR provides a 0.5 amp pilot-duty 120VAC signal. Refer to Section 6.2 for more information.

The pump signal is sent to the 120VAC coil on the pump relay, which provides continuity on the contactor side of the relay, allowing both circulating pumps to run. The pump relay box also features an "Auto/Off/Manual" switch:

- In the "Off" position, the circulating pumps will not run.
- In the "Manual" position, the circulating pumps will run continuously.
- In the "Auto" position, the circulating pumps will respond to the pump signal from the P-K MACH boiler's ENVI controls. "Auto" is the recommended setting.

NOTICE! The "Off" position on the pump relay switch is intended for use only when the P-K MACH 'n' Roll™ system is out of service for maintenance. **NEVER** change this switch to the "Off" position while the P-K MACH 'n' Roll™ system is in operation.

3.5.2 High Voltage (TB2) Terminal Block

WARNING

For P-K MACH boilers, the high voltage (TB2) terminal block has inputs for line voltage (120VAC) connections, all other connections are for pilot duty output use only.

Standalone DHW Operation:

- **120 VAC Neutral (TB2-5):** This terminal provides the neutral wires for the 120 VAC output.
- **DHW Pump Contactor (TB2-12):** This output is enabled when there is a call for DHW. When the call for heat is removed, the output remains enabled for the post pump time parameter within the DHW settings.

Cascade Operation for DHW:

- **120 VAC Neutral (TB2-6):** This terminal provides the neutral wires for the 120 VAC output.
- **Circ Pump Contactor (TB2-13):** This output is enabled when the boiler receives a call for heat from the cascade system. When the call for heat is removed, the output remains enabled for the post pump time parameter within the DHW settings.

3.5.3 Low Voltage (TB1) Terminal Block

- **External Interlock (TB1-3 & TB1-4):** Install a high temperature limit aquastat in the domestic supply piping or in a domestic water storage tank. Wire the normally closed contacts to the P-K MACH boiler's external interlock terminals (TB1-3 & TB1-4). When the domestic water temperature is below the setpoint on the high temperature limit aquastat, the normally closed terminals will provide continuity on the external interlock circuit, allowing the boiler to run. If the domestic water temperature exceeds the setpoint on the high temperature limit aquastat, the external interlock circuit will be opened, which will immediately disable the boiler and the domestic circulation pump while the boiler circulation pump continues to run to dissipate heat from the boiler. This circuit while open, will prevent the boiler from running. If open for 5 minutes, this will lock out the ENVI control, requiring a manual reset.

The external interlock circuit is energized by the boiler with a 5 V potential, so the high temperature limit aquastat must be rated for minimum 5V.

⚠ DANGER

High temperature limit aquastat **MUST NOT** be installed across the P-K MACH boiler's "enable" terminals. It **MUST** be installed across the P-K MACH boiler's "external interlock" terminals.

- **DHW Stat/Sensor** – Terminals TB1-7 & TB1-8 are connected to the DHW temperature sensor or thermostat. This circuit is energized by the boiler with a 5V potential. If a temperature sensor is used (preferred method), it must be 12kΩ thermistor type. Alternatively, a normally-closed, break on rise aquastat can be used to enable and disable the MACH 'n' Roll™ system.

Drain Valve and Piping

A drain valve is factory installed in the boiler piping. Prior to draining the boiler, electrical power and gas supply **MUST** be turned off to the boiler, and the boiler must be isolated from the system at the supply and return connections.

NOTICE! This drain valve is factory installed for draining of the boiler water only, not the entire system. Draining of the system through the boiler will result in depositing sediment from the system in the boiler which will result in poor heat transfer characteristics of the boiler and early boiler failure.

3.6 PRE-START CHECK LIST

Before attempting to start the P-K MACH 'n' Roll™ system and P-K MACH boiler, ensure the following items have been completed.

1. Refer to the P-K MACH CM300-CM500 or C750-C1050 installation and operation manual to ensure the boiler's pre-start check list has been followed.
2. Inspect the P-K MACH 'n' Roll™ system for leaks in either the boiler side or domestic side piping. Correct any and all leaks promptly.
3. Inspect the relief valve discharge piping and ensure this is routed to a nearby floor drain or safe point of discharge.
4. Ensure there is sufficient clearance around the unit, especially the front surface.

3.7 SAFETY CHECKS

The following checks of safety systems must be made before putting the P-K MACH 'n' Roll™ system boiler into normal operation.

⚠ WARNING

Never attempt to operate a P-K MACH 'n' Roll™ 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.

3.7.1 Test of Circulation Pumps

It is imperative to verify the correct operation of both the boiler circulation pump and the domestic circulation pump. Refer to section 3.4.5 to properly fill the domestic water and boiler water piping. Once the MACH 'n' Roll™ system is filled with water, move the pump control switch to the "On" position and verify that both the boiler circulation pump and domestic circulation pump operate properly. Listen for abnormal noises which might indicate cavitation, deadheading or general poor performance.

Once both pumps are verified to be working properly, move the pump control switch to the "Off" position and ensure both the boiler circulation pump and the domestic circulation pump turn off.

Finally, move the pump control switch to the "Auto" position and ensure both circulation pumps turn on when enabled by a call for heat from the boiler's control.

3.7.2 Test of High Temperature Limit Aquastat

Ensure that a normally-closed high temperature limit aquastat is installed either in the domestic hot water supply piping or the domestic water storage tank. The normally-closed terminals **MUST** be wired to the boiler's external interlock terminals (TB1-3 & TB1-4). Refer to Section 3.5.3 for more information on the installation.

NOTICE! Isolate the domestic hot water storage tank from the rest of the system before testing the high temperature limit aquastat.

When the boiler is powered on, adjust the dial on the high temperature limit aquastat to the lowest possible setting. Allow the boiler to start its normal firing sequence. Once the domestic water temperature exceeds this value, the high temperature limit aquastat should open the boiler's external interlock circuit. When this happens, the boiler is immediately disabled and the domestic circulation pump turned off while the boiler circulation pump continues to run to dissipate heat from the boiler.

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 boiler's external interlock circuit. If necessary, replace the high temperature limit aquastat.

3.7.3 Test of Domestic Water Temperature Sensor

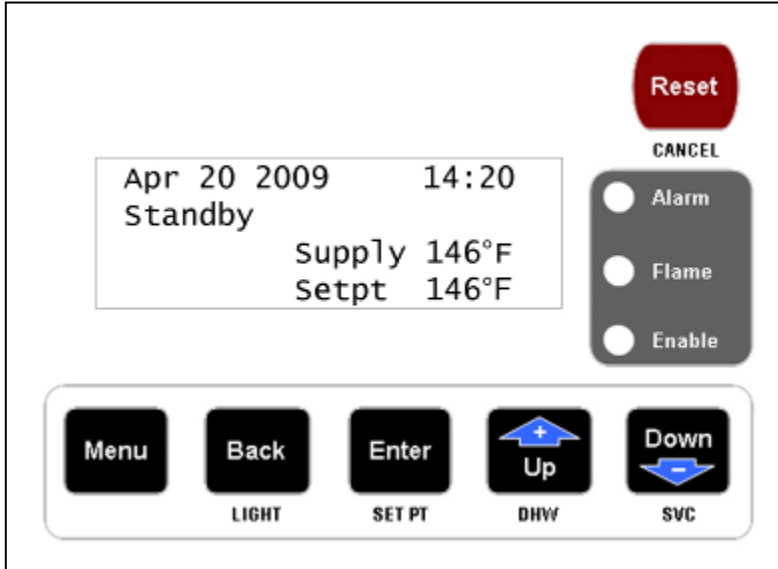
If using a 12kΩ thermistor-type temperature sensor in the domestic water storage tank, ensure the sensor is wired to the boiler's DHW SENSOR terminals (TB1-7 & TB1-8). From the boiler's home screen, press MENU, scroll down to "Information" and press ENTER. Scroll down to "DHW temp" which should show a read-only domestic water temperature value. If this temperature value is inaccurate, check the wiring and installation of the temperature sensor. Also, ensure the temperature sensor is of sufficient length to accurately measure the tank temperature. If necessary, replace the domestic water temperature sensor.

3.7.4 Test of Operating Aquastat

If using an aquastat (break on rise) in the domestic water storage tank, ensure the normally-closed terminals are wired to the boiler's DHW STAT terminals (TB1-7 & TB1-8). Adjust the aquastat until it provides a domestic call for heat to the P-K MACH boiler. If this does not happen, check the wiring and installation of the aquastat. Also, ensure the aquastat's temperature probe is of sufficient length to accurately measure the tank temperature. If necessary, replace the operating aquastat.

4 CONTROL SYSTEM SETUP

4.1 ENVI CONTROL PANEL



The P-K MACH boiler is equipped with the ENVI control; an intelligent control system with advanced features such as text-based display, communication capabilities, and boiler sequencing. Errors are date and time stamped providing built-in history of boiler status and performance. This control constantly tracks the load by recording burner high, low and mid run hours.

CAUTION

The user should become completely familiar with the operation of the boiler and controls before attempting to make any adjustments.

The boiler control has a text display panel. The display panel is used to setup and monitor boiler operation by means of six push buttons MENU, BACK, ENTER, UP, DOWN, and RESET as shown above. The buttons across the bottom are used to navigate through the various screens. The four line screen shows boiler operating information on various screens. The display screen is backlit for ease of viewing. Pressing any key will illuminate the backlight.

The standby screen is shown upon startup. This screen shows the date, time, boiler status, supply temp and setpoint temp. Pushing the menu button displays a menu of options.

The menu includes access to the Standby, Information, Errors, Program Parameters, Configuration, Cascade, and Service Menu. The Up and Down buttons are used to position the arrow next to the desired option and the enter button is pushed to enter that option. The list is displayed and may have more than four lines. Use the down arrow to view the complete list.

CAUTION

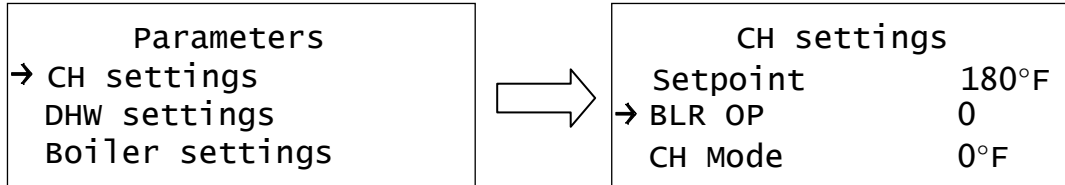
Changing parameters requires an understanding of the parameters and the functionality of the system. The system may not function properly when certain parameters are changed.

4.2 STANDALONE DOMESTIC HOT WATER SETUP

To configure the P-K MACH 'n' Roll™ unit for standalone DHW operation, push the MENU button on the ENVI keypad and select **"Program Parameters"** by pressing ENTER.

NOTE: This section is dedicated to standalone DHW. Refer to **Section 4.3** for cascade DHW systems.

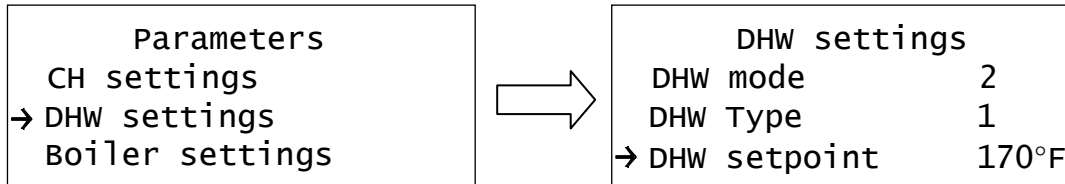
Scroll by pressing UP or DOWN to select **"CH settings"** and press ENTER.



NOTE: If prompted for Service Level 1 password, enter "1234" with the UP, DOWN, and ENTER buttons.

Scroll DOWN to select "BLR OP" and press ENTER. **Change this value from 1 to 0**, which will disable Comfort Heat (CH) operation entirely. Press the BACK button to return to the "Program Parameters" menu.

Scroll DOWN to select **"DHW settings"** and press ENTER.



NOTE: If prompted for Service Level 1 password, enter "1234" with the UP, DOWN, and ENTER buttons.

4.2.1 Standalone DHW Operation with Temperature Sensor (Recommended Method)

⚠ DANGER

The P-K MACH 'n' Roll™ is a dynamic system that is designed to heat domestic hot water in a storage tank to a wide range of temperatures. The P-K MACH 'n' Roll™ 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 may be required to prevent scalding.

Some applications use a 12kΩ thermistor-type temperature sensor installed in the lower 1/3rd of domestic water storage tank. The temperature sensor creates a call for heat to the MACH 'n' Roll™ when the storage tank water temperature is less than **"Tank set"** minus the **"Tank on diff"**. The call for heat is removed when the storage tank water temperature exceeds the **"Tank set"** plus the **"Tank off diff"**.

In addition, the MACH 'n' Roll™ is PID controlled to its own supply temperature versus the **"DHW setpoint"**. When a call for heat is received from the temperature sensor and the boiler's supply temperature is below the **"DHW setpoint"** minus the **"ON different"**, the unit will be enabled. If the boiler's supply temperature ever exceeds the **"DHW setpoint"** plus the **"OFF different"**, the MACH 'n' Roll™ will be disabled. In between this "deadband", the MACH 'n' Roll™ is PID controlled to the **"DHW setpoint"**. If at any point the call for heat from the temperature sensor is removed, the unit will return to standby.

NOTE: The 12kΩ temperature sensor should be installed in a thermowell of sufficient length and thermal conductivity to retrieve an accurate tank temperature reading. A minimum insertion depth of 6" is recommended. Also, thermal paste is recommended to maximize the thermal conductivity between the thermowell and the temperature sensor.

Scroll to "**DHW mode**" and press ENTER. Change "**DHW mode**" to 1 "Storage & Sensor" and press ENTER to store this value.

| DHW settings | | | DHW settings | |
|--------------|-------|---|----------------|-------|
| → DHW mode | 2 | ⇒ | DHW mode | 1 |
| DHW Type | 1 | | DHW Type | 1 |
| DHW setpoint | 170°F | | → DHW setpoint | 130°F |

Scroll to "**DHW setpoint**" and press ENTER. The "**DHW setpoint**" must be greater than "**Tank set**", typically by 10-25°F.

| DHW settings | | | DHW settings | |
|---------------|-------|---|-----------------|-------|
| → Tank set | 120°F | ⇒ | Tank set | 120°F |
| On different | 4°F | | On different | 5°F |
| off different | 10°F | | → off different | 10°F |

Scroll to "**ON different**" and press ENTER. This is the boiler's lower deadband below "**DHW setpoint**". If the boiler's supply temperature is below "**DHW setpoint**" minus "**On different**" and there is a call for heat from the tank temperature sensor, the MACH 'n' Roll™ will be enabled.

Scroll to "**OFF different**" and press ENTER. This is the boiler's upper deadband above "**DHW setpoint**." If the boiler's supply temperature exceeds "**DHW setpoint**" plus "**OFF different**", the MACH 'n' Roll™ will be disabled.

| DHW settings | |
|---------------|------|
| off different | 10°F |
| → Tank on dif | 4°F |
| Tank off diff | 4°F |

Next, scroll to "**Tank set**" and press ENTER. Adjust this value to the desired tank setpoint (Example 120°F).

Scroll to "**Tank on diff**" and press ENTER. Adjust this value to the desired lower band below the tank setpoint. When the tank temperature drops below "**Tank set**" minus "**Tank on diff**", the MACH 'n' Roll™ will be enabled.

Scroll to "**Tank off diff**" and press ENTER. Adjust this to the desired upper band above the tank setpoint. When the tank temperature exceeds "**Tank set**" plus "**Tank off diff**", the MACH 'n' Roll™ will be disabled.

In the example above, "**DHW setpoint**" is 130°F, "**On different**" is 5°F and "**Off different**" is 10°F. In addition, "**Tank set**" is 120°F, "**Tank on dif**" is 4°F and "**Tank off diff**" is 4°F.

When the tank temperature drops below 116°F, the MACH 'n' Roll™ is enabled. When the tank temperature exceeds 124°F, the call for heat is removed and the unit is disabled. The tank temperature sensor provides an operating deadband which will help prevent short-cycling of the equipment.

When the temperature sensor provides a call for heat, if the boiler's supply temperature is below 125°F, the MACH 'n' Roll™ will be enabled. The boiler will modulate according to its PID settings to maintain the desired "**DHW setpoint**". If the boiler's supply temperature exceeds 140°F, the MACH 'n' Roll™ will be disabled. The circulation pumps will continue to run after the unit is disabled until the "**Post pmp time**" timer has expired.

4.2.2 Standalone DHW Operation with Aquastat (Alternate Method)

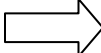
DANGER

The P-K MACH 'n' Roll™ is a dynamic system that is designed to heat domestic hot water in a storage tank to a wide range of temperatures. The P-K MACH 'n' Roll™ 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 may be required to prevent scalding.

Some applications will use a normally-closed aquastat installed in the lower 1/3rd of the domestic water storage tank. When the domestic water temperature is below the aquastat's setpoint, the aquastat provides contact closure to the DHW STAT terminals (TB1-7 & TB1-8) which creates a call for heat to the MACH 'n' Roll™. The unit is then PID controlled to its own supply temperature versus the "**DHW setpoint**".

When a call for heat is received from the aquastat and the boiler's supply temperature is below the "**DHW setpoint**" minus the "**ON different**", the MACH 'n' Roll™ will be enabled. If the boiler's supply temperature ever exceeds the "**DHW setpoint**" plus the "**OFF different**", the unit will be disabled. In between this "deadband", the MACH 'n' Roll™ is PID controlled to the "**DHW setpoint**". If at any point the call for heat from the aquastat is removed, the unit will return to standby.

On the ENVI keypad, scroll DOWN to "**DHW setpoint**". Adjust this value to the desired boiler supply setpoint.

| DHW settings | | | DHW settings | |
|----------------|-------|--|----------------|-------|
| DHW mode | 2 |  | DHW mode | 2 |
| DHW Type | 1 | | DHW Type | 1 |
| → DHW setpoint | 170°F | | → DHW setpoint | 130°F |

Scroll DOWN to "**ON different**" and press ENTER. This is the boiler's lower deadband below "**DHW setpoint**". If the boiler's supply temperature is below "**DHW setpoint**" minus "**On different**" and there is a call for heat from the tank temperature sensor, the MACH 'n' Roll™ will be enabled.

Scroll to "**OFF different**" and press ENTER. This is the boiler's upper deadband above "**DHW setpoint**." If the boiler's supply temperature exceeds "**DHW setpoint**" plus "**OFF different**", the MACH 'n' Roll™ will be disabled.

| DHW settings | | | DHW settings | |
|----------------|-------|---|----------------|-------|
| Tank set | 135°F | ➡ | Tank set | 135°F |
| ➡ On different | 4°F | | ➡ On different | 5°F |
| off different | 10°F | | off different | 10°F |

In this example, "**DHW setpoint**" is 130°F, "**On different**" is 5°F, and "**Off different**" is 10°F. The operating aquastat installed in the domestic water storage tank provides a call for heat and if the boiler's supply temperature is below 125°F, the MACH 'n' Roll™ will be enabled. The MACH 'n' Roll™ will be PID controlled until its supply temperature exceeds 140°F, at which point the unit will be disabled. If at any point the operating aquastat removes the call for heat, the unit will be disabled. The circulation pumps will continue to run after the MACH 'n' Roll™ is disabled until the "**Post pmp time**" timer has expired.

4.3 CASCADE SYSTEM SETUP

To configure a cascade DHW system, first refer to **Sections 6.2 & 6.4** to ensure the power wiring and control wiring is properly installed for the master and all member MACH 'n' Roll™ units. Each MACH 'n' Roll™ features a Master/Member toggle switch on the relay board. Make sure this is set to the "Master" position for the master MACH 'n' Roll™, or set to the "Member" position for each member MACH 'n' Roll™. Please refer to the latest edition of the P-K MACH CM300-CM500 or the C750-C1050 installation and operation manual for more information on the Master/Member toggle switch or the relay board.

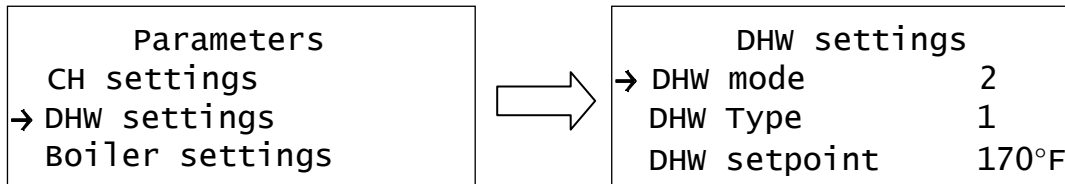
NOTE: This section is dedicated to cascade DHW systems. Refer to **Section 4.2** for standalone DHW.

⚠ DANGER

The P-K MACH 'n' Roll™ is a dynamic system that is designed to heat domestic hot water in a storage tank to a wide range of temperatures. The P-K MACH 'n' Roll™ 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 may be required to prevent scalding.

On each MACH 'n' Roll™ unit, push the MENU button on the ENVI keypad and select "**Program Parameters**" by pressing ENTER.

Scroll by pressing UP or DOWN to select "**DHW settings**" and press ENTER.

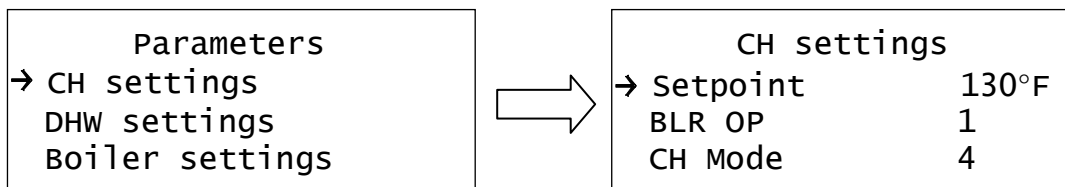


NOTE: If prompted for Service Level 1 password, enter "1234" with the UP, DOWN, and ENTER buttons.

Scroll by pressing UP or DOWN to select "**DHW mode**" and press ENTER. **Change this value to 0 "None"**.

NOTE: The ENVI cascade system operates on Comfort Heat (CH) & Cascade parameters, so it is recommended to disable the standalone DHW operating mode.

Press BACK to return to the Parameters menu and scroll up to "**CH settings**" and press ENTER.



NOTE: If prompted for Service Level 1 password, enter "1234" with the UP, DOWN, and ENTER buttons.

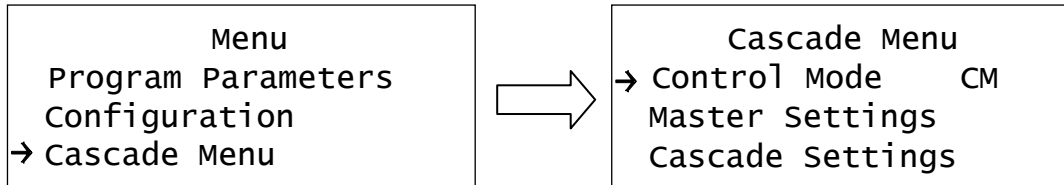
Scroll UP or DOWN to "**Setpoint**" and press ENTER.

- On the **MASTER** MACH 'n' Roll™ unit, change "**Setpoint**" to the desired tank setpoint (Example: 130°F)
- On each **MEMBER** MACH 'n' Roll™ unit, change "**Setpoint**" to 10°F above the desired tank setpoint. This is a failsafe setpoint in the event communication to the master MACH 'n' Roll™ unit is interrupted, each member MACH 'n' Roll™ will default to this setpoint. It is recommended that "**Setpoint**" be about 10°F above the desired tank setpoint.

Scroll DOWN to “**CH Mode**” and press ENTER.

- On the **MASTER** MACH 'n' Roll™ unit, change CH Mode to 4 “Header & Stat”. This will ensure the master boiler operates to the 12kΩ tank temperature sensor.
- On each **MEMBER** MACH 'n' Roll™ unit, change CH Mode to 0 “Setpoint & Stat”.

Press BACK twice to return to the Menu and scroll DOWN to “**Cascade Menu**” and press ENTER.



NOTE: If prompted for a Service Level 1 password, enter “1234” with the UP, DOWN, and ENTER buttons. If prompted for a Service Level 2 password, enter “2345”.

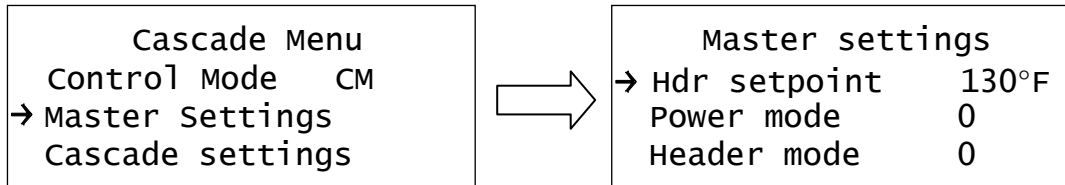
Scroll to “**Control Mode**” and press ENTER.

- On the **MASTER** MACH 'n' Roll™, change Control Mode to CM “Cascade Master”. Make sure the Master/Member toggle switch on the relay board is in the “Master” position.
- On the first **MEMBER** MACH 'n' Roll™, change Control Mode to CS1. Make sure the Master/Member toggle switch on the relay board is in the “Member” position.
- On the second **MEMBER** MACH 'n' Roll™, change Control Mode to CS2, etc. Make sure Master/Member toggle switch on the relay board is in the “Member” position.

At this point, setup should be complete for the **MEMBER** MACH 'n' Roll™ units. Press BACK several times to return to the home screen. There are several additional parameters which must be adjusted on the **MASTER** MACH 'n' Roll™ which is continued on the next page.

4.3.1 Master Parameters

On the **MASTER** boiler, scroll down to “**Master Settings**” in the Cascade Menu.



Scroll DOWN to “**Hdr setpoint**” and press ENTER. Change this to the desired tank setpoint (Example: 130°F).

Scroll DOWN to “**Header mode**” and press ENTER. Verify this value is 0 “Header & stat”.

Scroll DOWN to “**Hyst start blr**” and press ENTER. This value is the temperature band below the tank setpoint. When the tank temperature drops below “Hdr setpoint” minus “Hyst start blr”, the “Wait blr sw on” timer begins counting down. If this timer expires and the tank temperature is still low, a MACH 'n' Roll™ will be enabled.

Scroll down to “**Hyst stop blr**” and press ENTER. This value is the temperature band above the tank setpoint. When the tank temperature exceeds “Hdr setpoint” plus “Hyst stop blr”, the “Wait blr sw off” timer begins counting down. If this timer expires and the tank temperature is high, a MACH 'n' Roll™ will be disabled.

Scroll to “**Wait blr sw on**” and press ENTER. This timer (in minutes) defines how quickly MACH 'n' Roll™ units will be enabled when the tank temperature is below “Hdr setpoint” minus “Hyst start blr”. A larger value will enable MACH 'n' Roll™ units more slowly, which is recommended for systems with large storage volume. A smaller value will enable MACH 'n' Roll™ units more quickly, which may be required in systems with smaller storage volume. The default value is 8 minutes.

Scroll to “**Wait blr sw off**” and press ENTER. This timer (in minutes) defines how quickly MACH 'n' Roll™ units will be disabled with the tank temperature exceeds “Hdr setpoint” plus “Hyst stop blr.” A larger value will disable MACH 'n' Roll™ units more slowly, which is helpful in systems with small storage volume. A smaller value will disable MACH 'n' Roll™ units more quickly, which is helpful in systems with large storage volume. The default value is 2 minutes.

At this point, setup should be complete for the **MASTER** MACH 'n' Roll™ unit. Press BACK several times to return to the home screen.

NOTE: It is important to observe the operation of the cascade system for a period of time after the initial startup. Every building has a unique and dynamic Domestic Hot Water system, and it may be necessary to adjust the Master Settings values described above in order to maximize the cascade system performance.

5 MAINTENANCE

5.1 MAINTENANCE AND INSPECTION SCHEDULE

This schedule applies when the MACH 'n' Roll™ is in use. Verify proper operation after servicing.

WARNING

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

CAUTION

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

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.

WARNING

Verify proper operation after operation servicing.

5.1.1 Daily

- Observe operating temperature and general conditions.
- Check the pressure/temperature gauge on the boiler's supply manifold to ensure there is a sufficient water pressure.
- Listen to the performance of the P-K MACH 'n' Roll™ system and P-K MACH boiler.
 - A "sloshing" noise indicates that air is present in the system, most likely inside the MACH boiler. Ensure the vent cap on the automatic air vent is open.
 - If the pumps are making excessive noise, ensure they are not deadheaded or cavitating. Refer to **Section 5.3** for troubleshooting information.

5.1.2 Weekly

- Check for leaks in the boiler piping and the domestic piping. Correct immediately if discovered.
- Scroll through the boiler's **"Information"** menu and record the supply temperature, return temperature, firing rate, and domestic water temperature.

5.1.3 Monthly

- Check the pump relay and ensure the pumps stop running when switched to "Off". Also ensure the pumps run continuously when switched to "Manual". Finally, turn the switch back to "Auto" and ensure the pumps respond to the ENVI control.
- 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.
- Scroll through the boiler's **"Information"** menu and record the supply temperature, return temperature, firing rate, burner high hours, burner medium hours, burner low hours, and domestic water temperature.
- If applicable, verify the domestic temperature sensor reading is accurate in the **"Information"** menu.
- Ensure the high temperature limit aquastat is functioning properly.
- If applicable, verify the operating aquastat is functioning properly.

5.1.4 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. Cleaning the brazed plate heat exchanger may be needed to ensure continued performance.
- Remove and inspect the circulating pumps for signs of deterioration. Repair or replace if needed.
- Clean and inspect the P-K MACH 'n' Roll™ system for any signs of cracks, leaks, or loose connections. Repair or replace if needed.

5.2 ACCESSING THE COMPONENTS (MnR750 & MnR1050)

The P-K MACH 'n' Roll™ MnR750/1050 is designed to allow the user to pull out the components for easier access and service.

1. Lockout/tag out gas supply to the boiler.
2. Lockout/tag out electrical service to the boiler and P-K MACH 'n' Roll™ system.
3. If available, close the isolation valves in the domestic piping between the storage tank and the P-K MACH 'n' Roll™ system.
4. Open the drain valves on the boiler piping and the domestic piping. Allow the water content to drain completely.
5. Open the Victaulic couplings on the boiler piping at the rear of the P-K MACH 'n' Roll™ system.
6. Open the 2" copper Victaulic coupling on the domestic piping at the rear of the P-K MACH 'n' Roll™ system.
7. Remove the 2" pump flange on the domestic piping at the rear of the P-K MACH 'n' Roll™ system.
8. Remove the front panel of the P-K MACH 'n' Roll™ system.
9. Pull the components out the front surface by grabbing either the brazed plate heat exchanger or the supporting tray. The components should pull out smoothly to allow for easier access and inspection.

CAUTION

Use caution when moving the lower tray in and out. Avoid placing hands or fingers near moving parts or pinch points.

NOTE: THE ABOVE LISTED MAINTENANCE ITEMS ARE FOR THE MACH-N-ROLL PORTION OF THIS UNIT. SEE THE MACH BOILER O&M MANUAL FOR IMPORTANT MAINTENANCE ITEMS REQUIRED FOR THE MACH BOILER.

5.3 TROUBLESHOOTING

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. It may be necessary to slightly restrict isolation valves on the pump discharge to achieve the desired flow rate, but they should never be completely closed unless the unit is turned off and being serviced.

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. Refer to **Section 3.4.1** for more information on the expansion tank/fill valve assembly. If there are any strainers on the domestic circulation line, these may be clogged and should be thoroughly cleaned to restore flow.

ENVI Error A07: "Low Flow / ILK"

The P-K MACH 'n' Roll™ system requires a high temperature limit aquastat be wired into the P-K MACH boiler's external interlock terminals. If the domestic water temperature exceeds the high temperature limit aquastat's setpoint, the external interlock circuit will open which can cause this alarm. Wait until the domestic water temperature has dropped, and then reset the ENVI control to clear the alarm.

ENVI Error A38: "Max DT Exceeded"

The P-K MACH boiler requires sufficient water flow at all times in order to operate safely. A "Max DT Exceeded" error indicates the boiler's supply temperature has departed too far from the boiler's return temperature. This is usually due to insufficient water flow on the boiler loop. Ensure that all of the isolation valves are open and that the circulating pumps aren't deadheading or cavitating.

ENVI Error A43: "Low Water Level"

The boiler loop must be completely full of water at all times in order to operate. The P-K MACH boiler features a low water cutoff probe that will put the boiler into alarm if water is not detected inside the boiler's heat engine. Check the water pressure on the boiler piping to ensure there is a sufficient water pressure. Also, ensure the automatic air vents are able to purge any air that has accumulated within the boiler. Refer to **Section 3.4.7** for instructions on filling the P-K MACH boiler.

Poor Heat Transfer

Poor heat transfer can be caused by insufficient flow, insufficient boiler water temperature, or scaling of the heat exchanger. First, ensure that both the boiler side and domestic side circulation pumps are moving water at the desired rate. Next, increase the boiler's setpoint 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.

6 PARTS/TECHNICAL SUPPORT

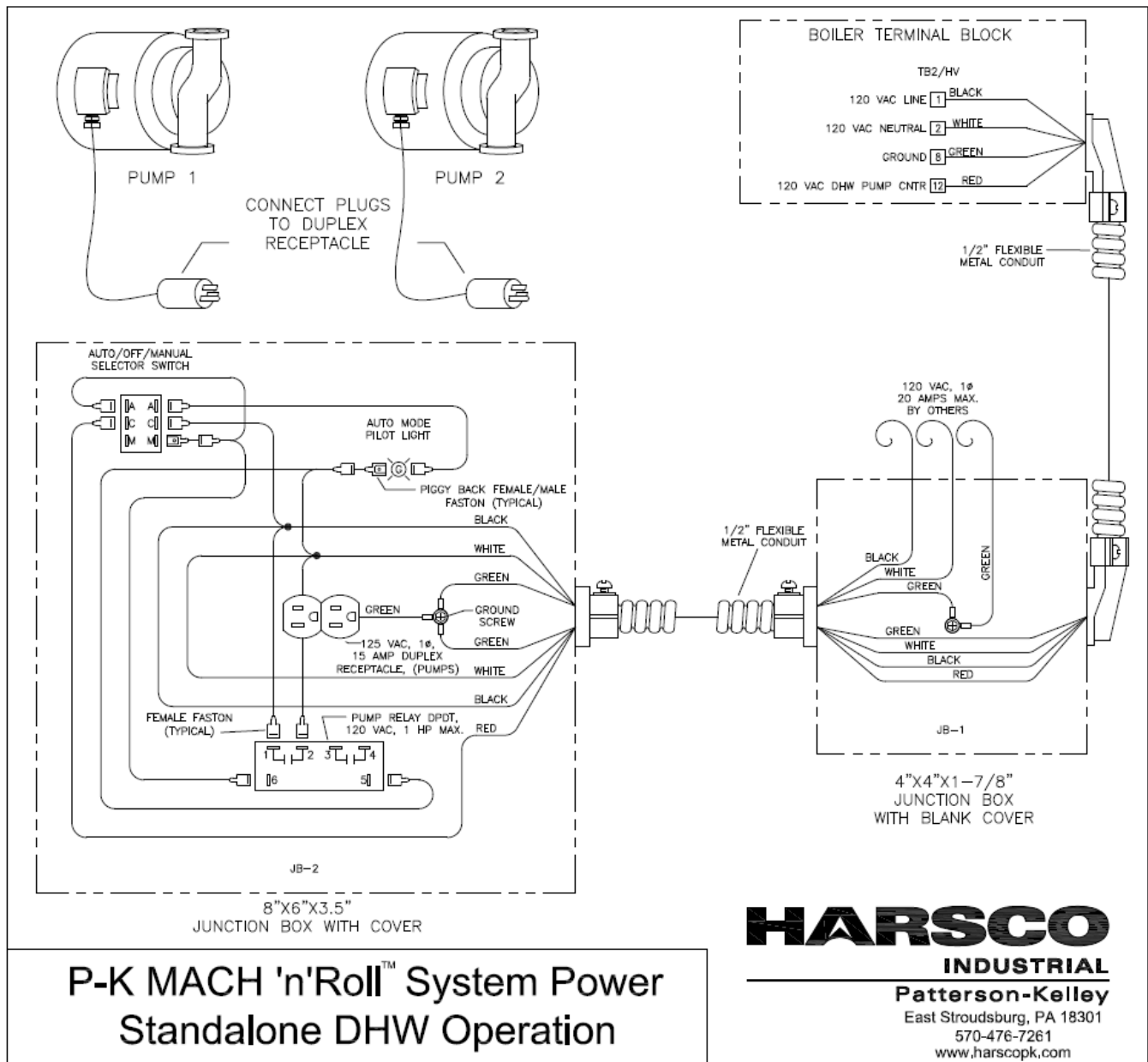
Spare parts and replacement parts can be ordered from Harsco Industrial, Patterson-Kelley by calling toll free (877) 728-5351. The fax number is (570) 476-7247. Refer to the parts list shown on the assembly drawing provided in this manual. Technical information is also available at the above number and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

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 boiler.

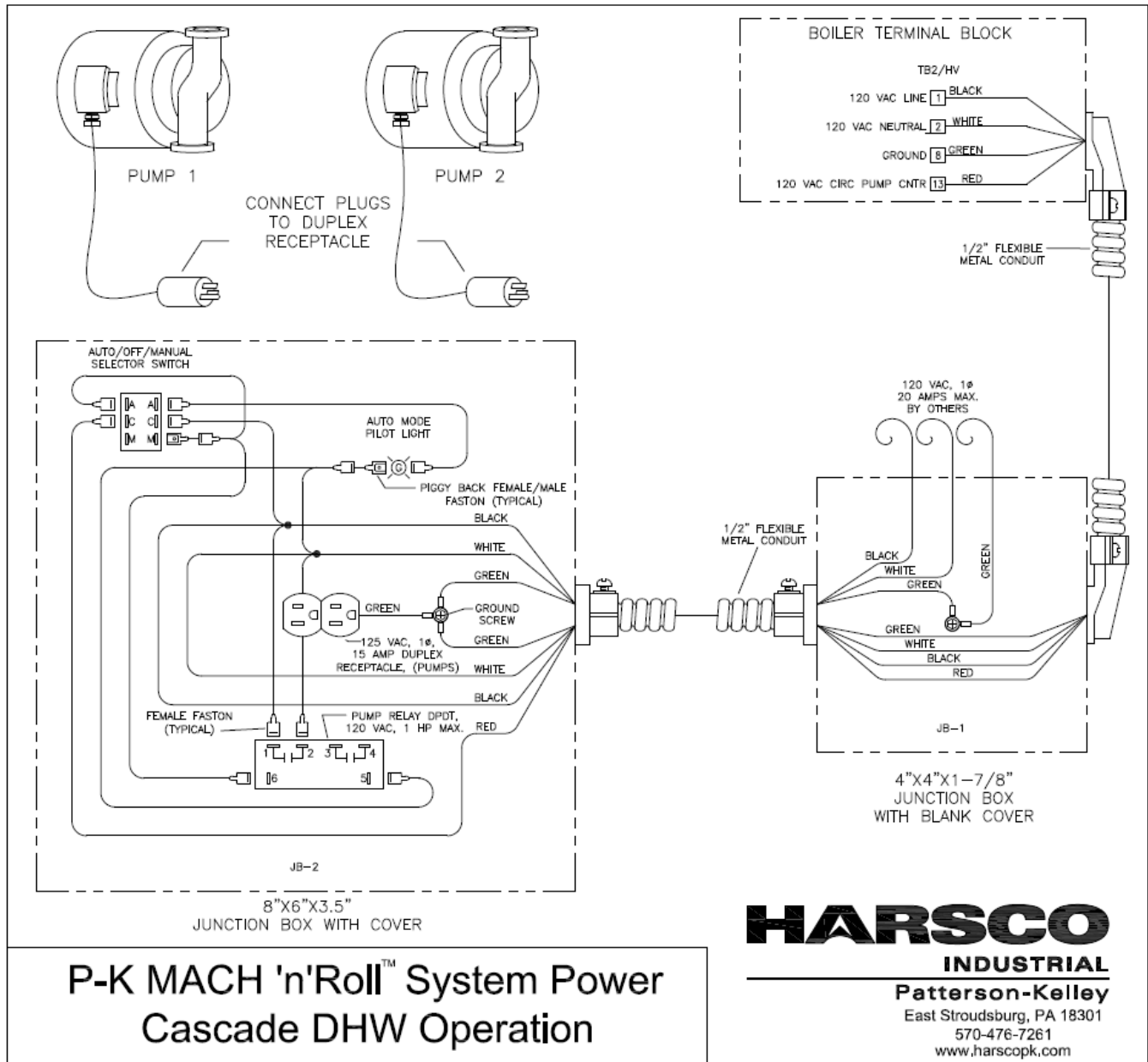
When ordering replacement parts please have the **model number** and **serial number** of your product. Typical schematic drawings are shown on the following pages. Drawings specific to your particular product can also be supplied by your local Harsco Industrial, Patterson-Kelley representative.

6.1 WIRING DIAGRAM – POWER FOR STANDALONE DHW OPERATION



NOTE: The power distribution on the P-K MACH 'n' Roll™ condensing indirect domestic hot water system provides power to the circulation pumps as well as to the P-K MACH boiler. This allows the user to bring a single code-compliant disconnect to the junction box and power the entire system. Connect a single grounded, code-compliant disconnect to JB-1 (Junction Box 1) to the three wire pig-tails (black, white and green). By default, the MACH 'n' Roll™ is wired for standalone DHW operation as shown above.

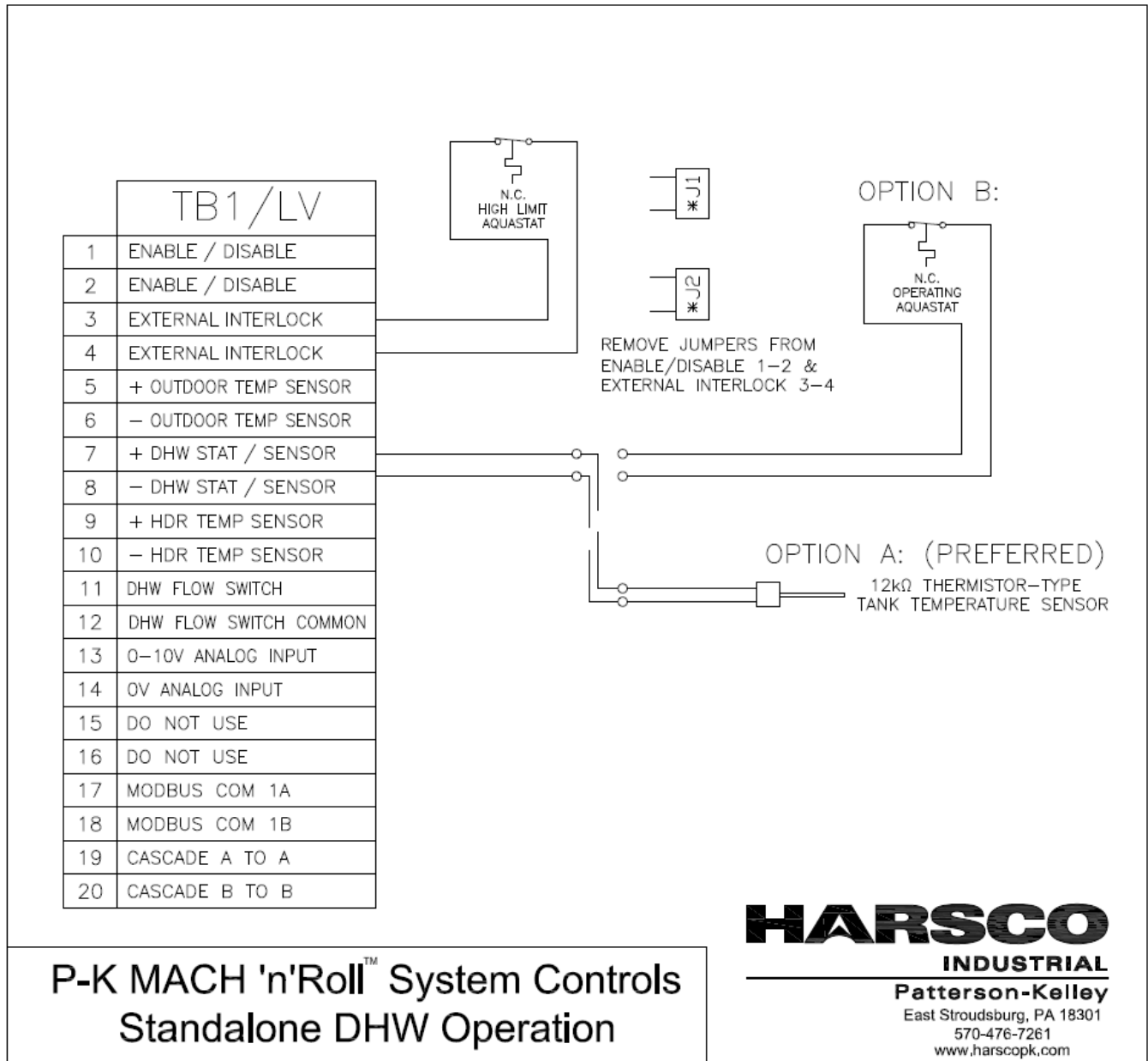
6.2 WIRING DIAGRAM – POWER FOR CASCADE DHW OPERATION



NOTE: The power distribution on the P-K MACH 'n' Roll™ condensing indirect domestic hot water system provides power to the circulation pumps as well as to the P-K MACH boiler. This allows the user to bring a single code-compliant disconnect to the junction box and power the entire system. Connect a single grounded, code-compliant disconnect to JB-1 (Junction Box 1) to the three wire pig-tails (black, white and green).

IMPORTANT: For Cascade DHW operation (2 or more MACH 'n' Roll™ units programmed for lead/lag operation), you must move the **RED** wire from the boiler's TB2-12 (120VAC DHW PUMP CNTR) terminal to TB2-13 terminal (120VAC CIRC PUMP CNTR).

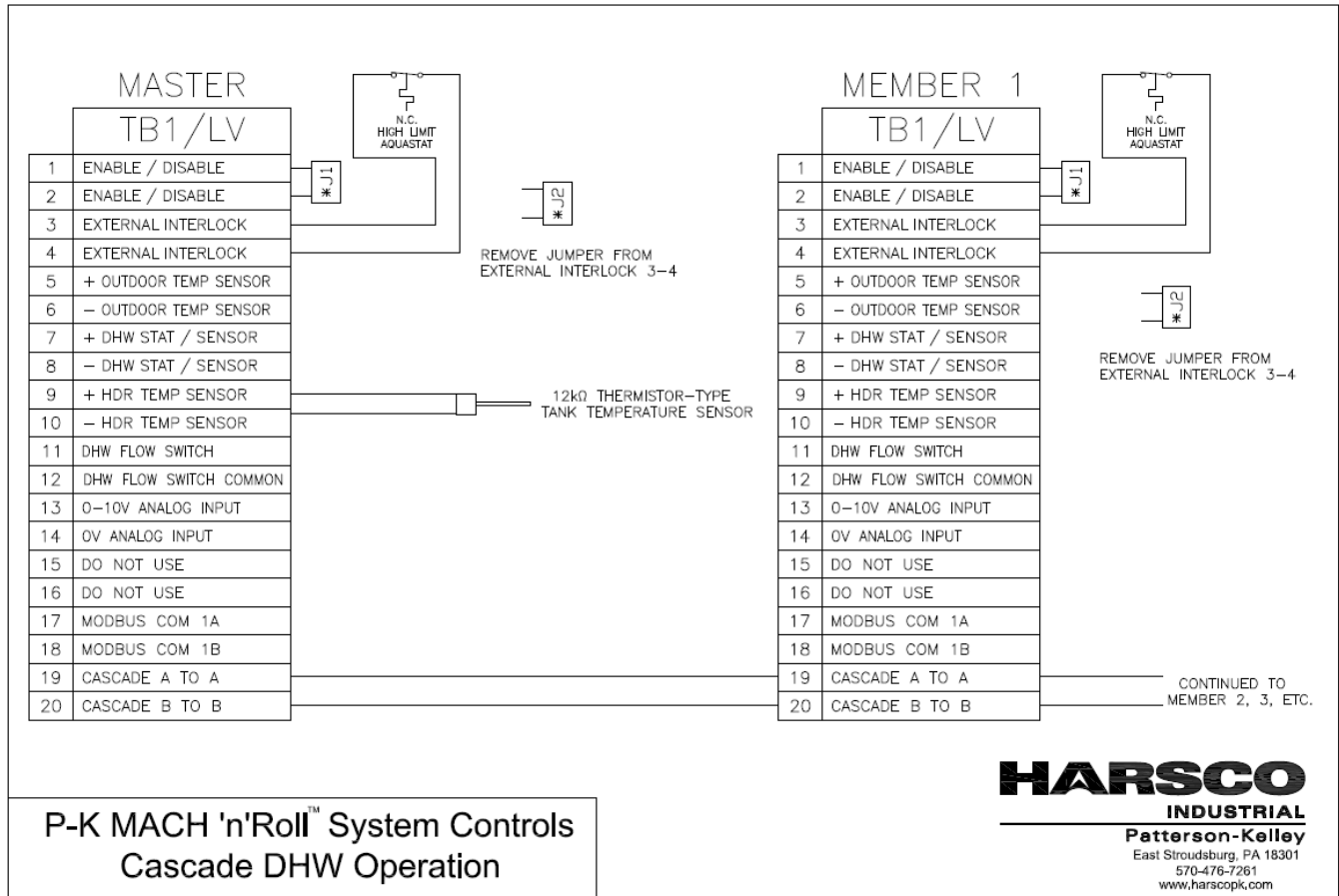
6.3 WIRING DIAGRAM – CONTROLS FOR STANDALONE DHW OPERATION



In standalone DHW operation, the P-K MACH 'n' Roll™ system is capable of operating to either a normally-closed aquastat, or a 12kΩ thermistor-type temperature sensor (preferred). This aquastat or temperature sensor should be installed in the lower 1/3rd of a domestic water storage tank of suitable size for the application. It is important that the sensing element is of sufficient length to accurately measure the storage tank temperature. Wire either the aquastat's normally-closed terminals or the 2 sensor wires to the boiler's DHW STAT/SENSOR terminals (TB1-7 & TB1-8).

A normally-closed high temperature limit aquastat MUST be installed either in the domestic hot water supply pipe exiting the P-K MACH 'n' Roll™ system, or in the storage tank or domestic hot water pipe which supplies the building. Wire the normally-closed terminals of the high temperature limit aquastat to the boiler's EXTERNAL INTERLOCK terminals (TB1-3 & TB1-4).

6.4 WIRING DIAGRAM – CONTROLS FOR CASCADE DHW OPERATION



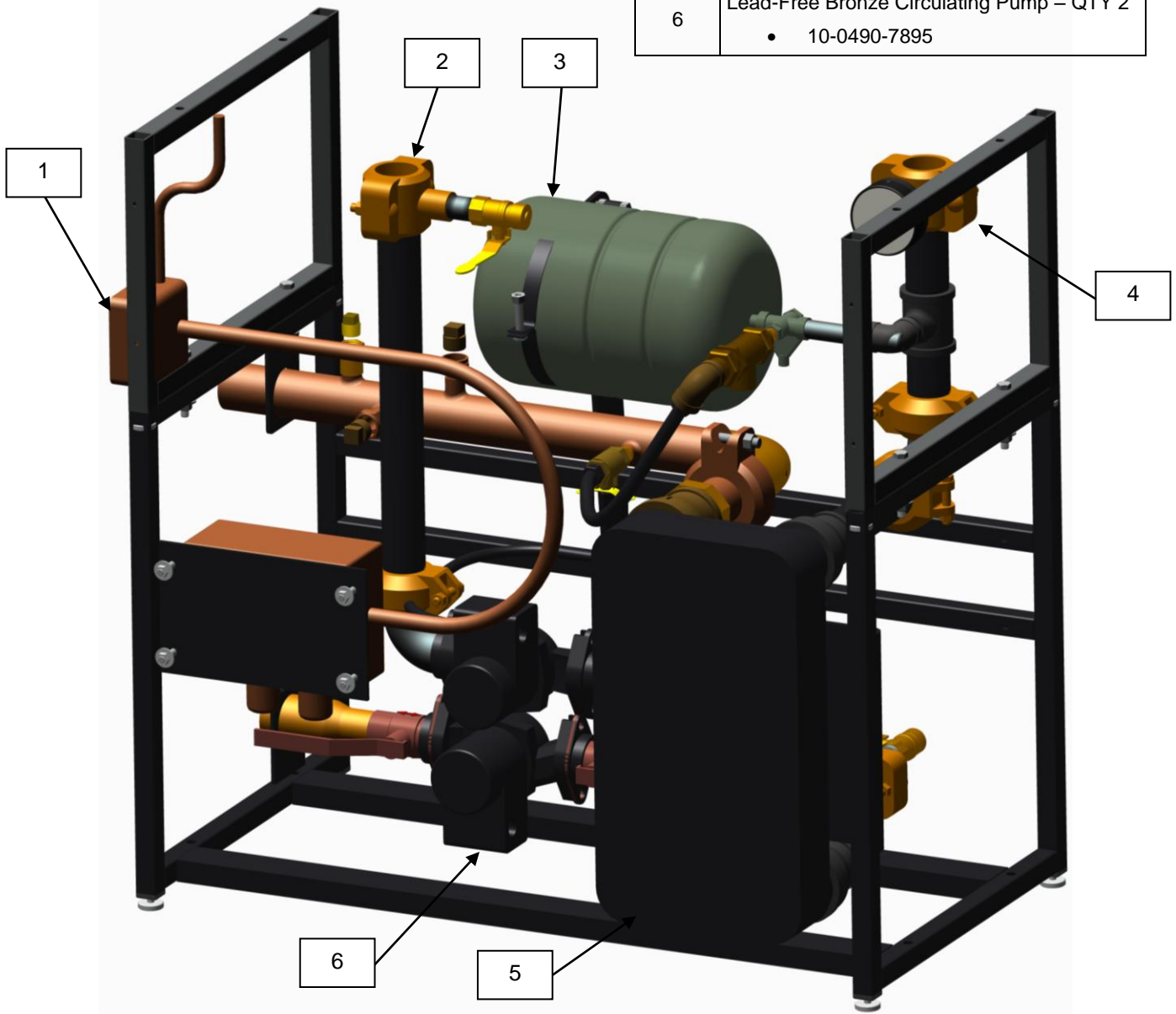
In cascade DHW operation, two or more P-K MACH 'n' Roll™ units are programmed to operate together in a lead/lag system. The master boiler must have a 12kΩ thermistor-type tank temperature sensor wired to the HDR TEMP SENSOR terminals (TB1-9 & TB1-10). This temperature sensor should be installed in the lower 1/3rd of a domestic water storage tank of suitable size for the application. It is important that the sensing element is of sufficient length to accurately measure the storage tank temperature.

In addition, a 2-wire communication link must daisy-chained from the master boiler, to member #1, to member #2, etc. on the CASCADE terminals (TB1-19 & TB1-20).

A normally-closed high temperature limit aquastat **MUST** be installed in the domestic hot water supply pipe exiting each P-K MACH 'n' Roll™ unit in the cascade. Wire the normally-closed terminals of the high temperature limit aquastat to the respective unit's EXTERNAL INTERLOCK terminals (TB1-3 & TB1-4).

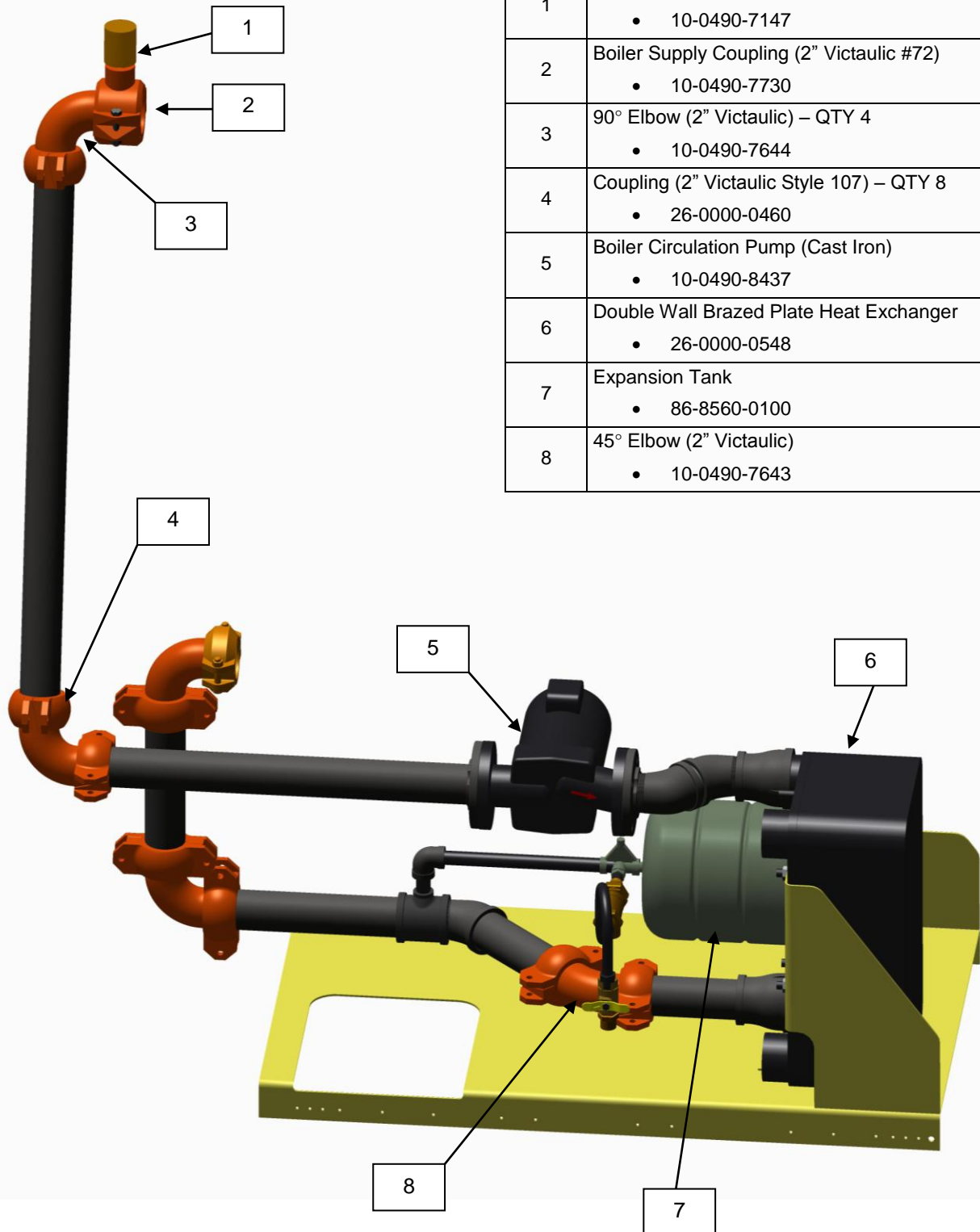
6.5 MNR300/399/500 COMPONENTS

| Mark | Description |
|------|--|
| 1 | Electrical Assembly / Pump Control Panel <ul style="list-style-type: none"> 10-0490-8715 |
| 2 | Boiler Return Coupling (1-1/2" Victaulic #72) <ul style="list-style-type: none"> 26-5000-0101 |
| 3 | Expansion Tank <ul style="list-style-type: none"> 86-8560-0100 |
| 4 | Boiler Supply Coupling (1-1/2" Victaulic #72) <ul style="list-style-type: none"> 26-5000-0101 |
| 5 | 30 Plate DW Brazed Heat Exchanger <ul style="list-style-type: none"> 26-0000-0543 |
| 6 | Lead-Free Bronze Circulating Pump – QTY 2 <ul style="list-style-type: none"> 10-0490-7895 |



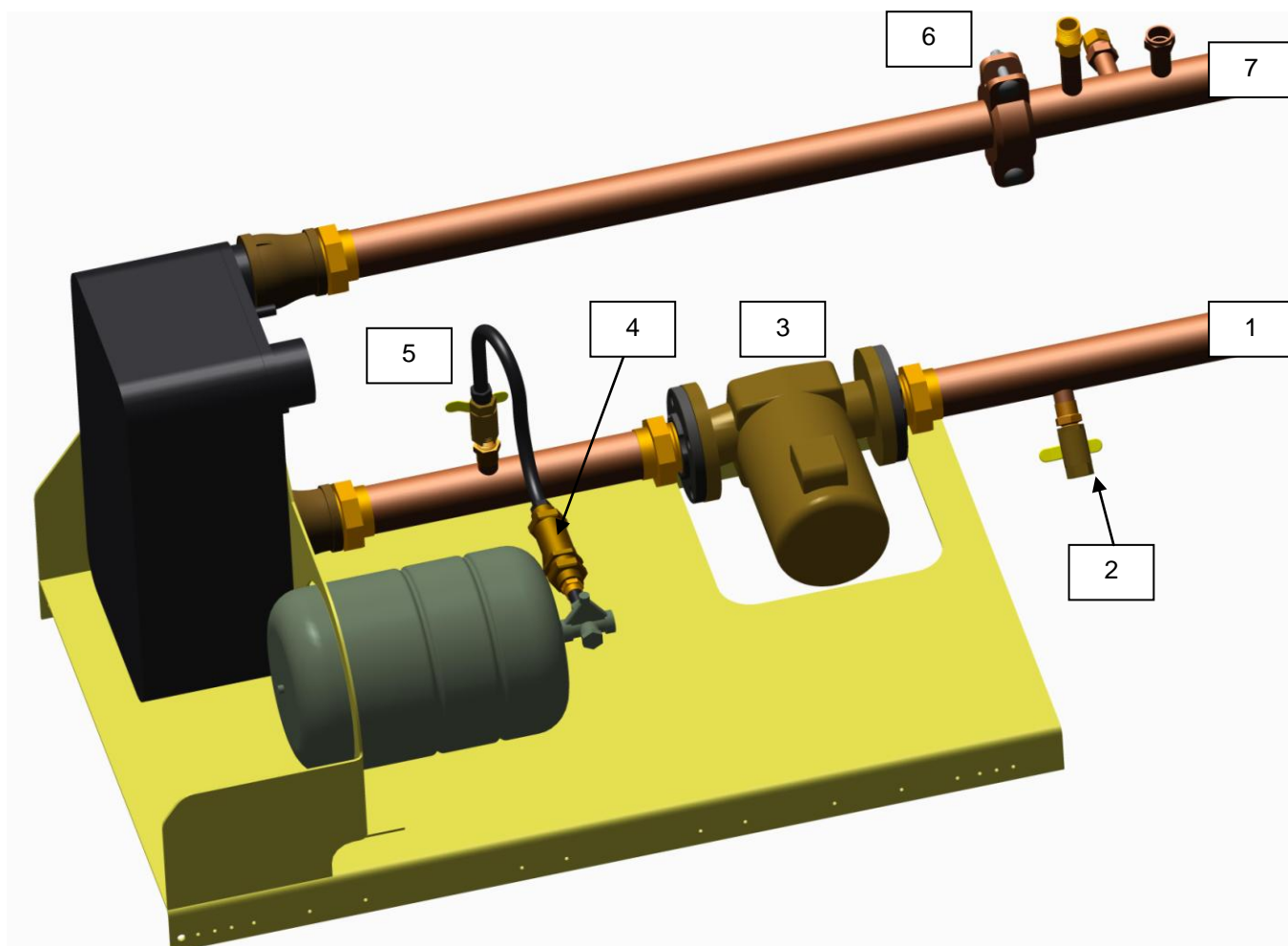
6.6 MNR750/1050 COMPONENTS – BOILER SIDE

| Mark | Description |
|------|---|
| 1 | Automatic Air Vent (1/2" NPT-M) • 10-0490-7147 |
| 2 | Boiler Supply Coupling (2" Victaulic #72) • 10-0490-7730 |
| 3 | 90° Elbow (2" Victaulic) – QTY 4 • 10-0490-7644 |
| 4 | Coupling (2" Victaulic Style 107) – QTY 8 • 26-0000-0460 |
| 5 | Boiler Circulation Pump (Cast Iron) • 10-0490-8437 |
| 6 | Double Wall Brazed Plate Heat Exchanger • 26-0000-0548 |
| 7 | Expansion Tank • 86-8560-0100 |
| 8 | 45° Elbow (2" Victaulic) • 10-0490-7643 |



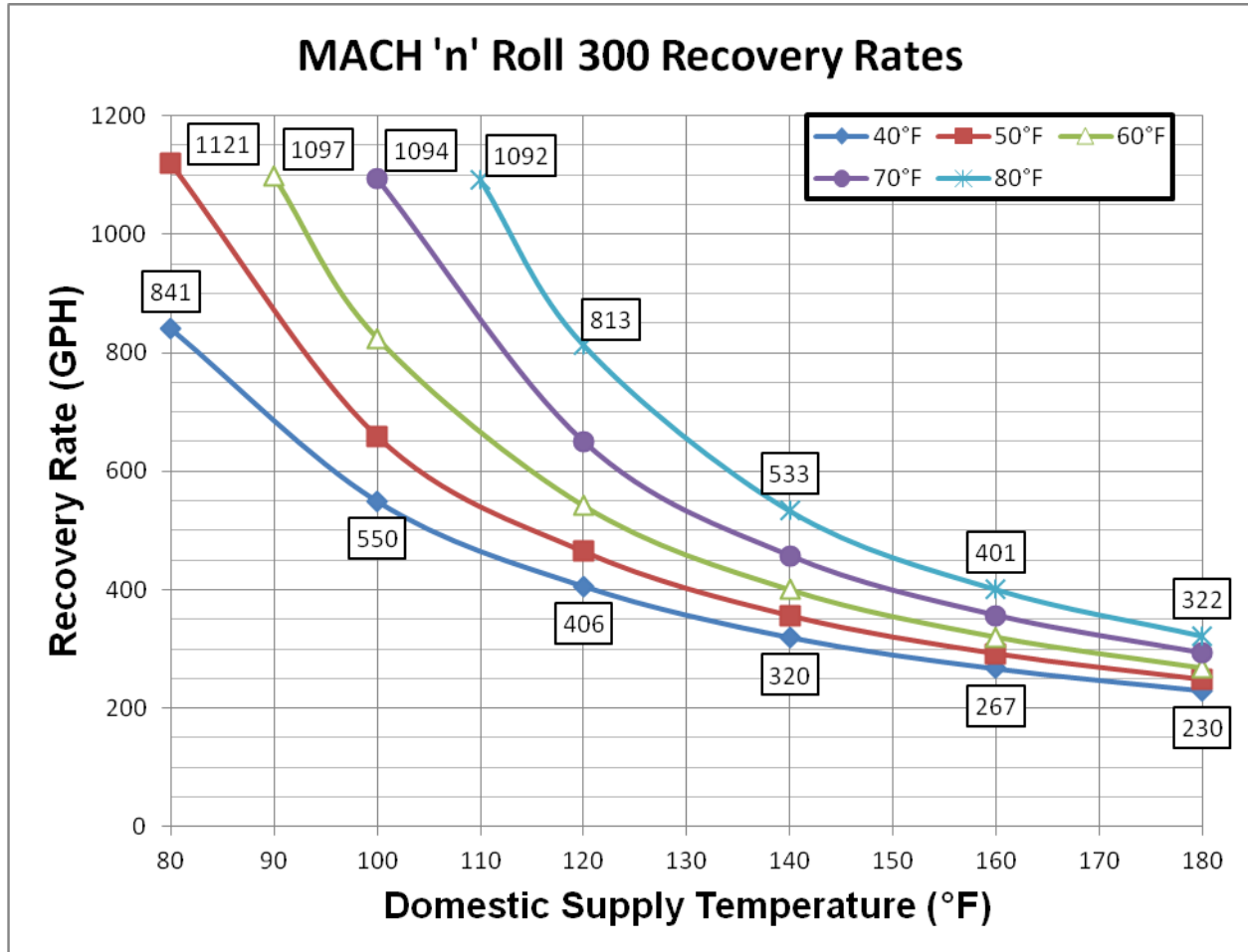
6.7 MNR750/1050 COMPONENTS – DOMESTIC SIDE

| Mark | Description |
|------|---|
| 1 | Domestic Cold Water Return (2" Copper) |
| 2 | Manual Drain Valve (1/2" NPT) – QTY 2 <ul style="list-style-type: none"> 86-0P00-8721 |
| 3 | Domestic Circulation Pump (All Bronze) <ul style="list-style-type: none"> 10-0490-8074 |
| 4 | Dual-Check Backflow Preventer <ul style="list-style-type: none"> 86-0402-0100 |
| 5 | 1/2" Flexible Tube <ul style="list-style-type: none"> 10-0510-0235 |
| 6 | Coupling (2" Victaulic Copper) <ul style="list-style-type: none"> 85-2351-3872 |
| 7 | Domestic Hot Water Supply (2" Copper) |



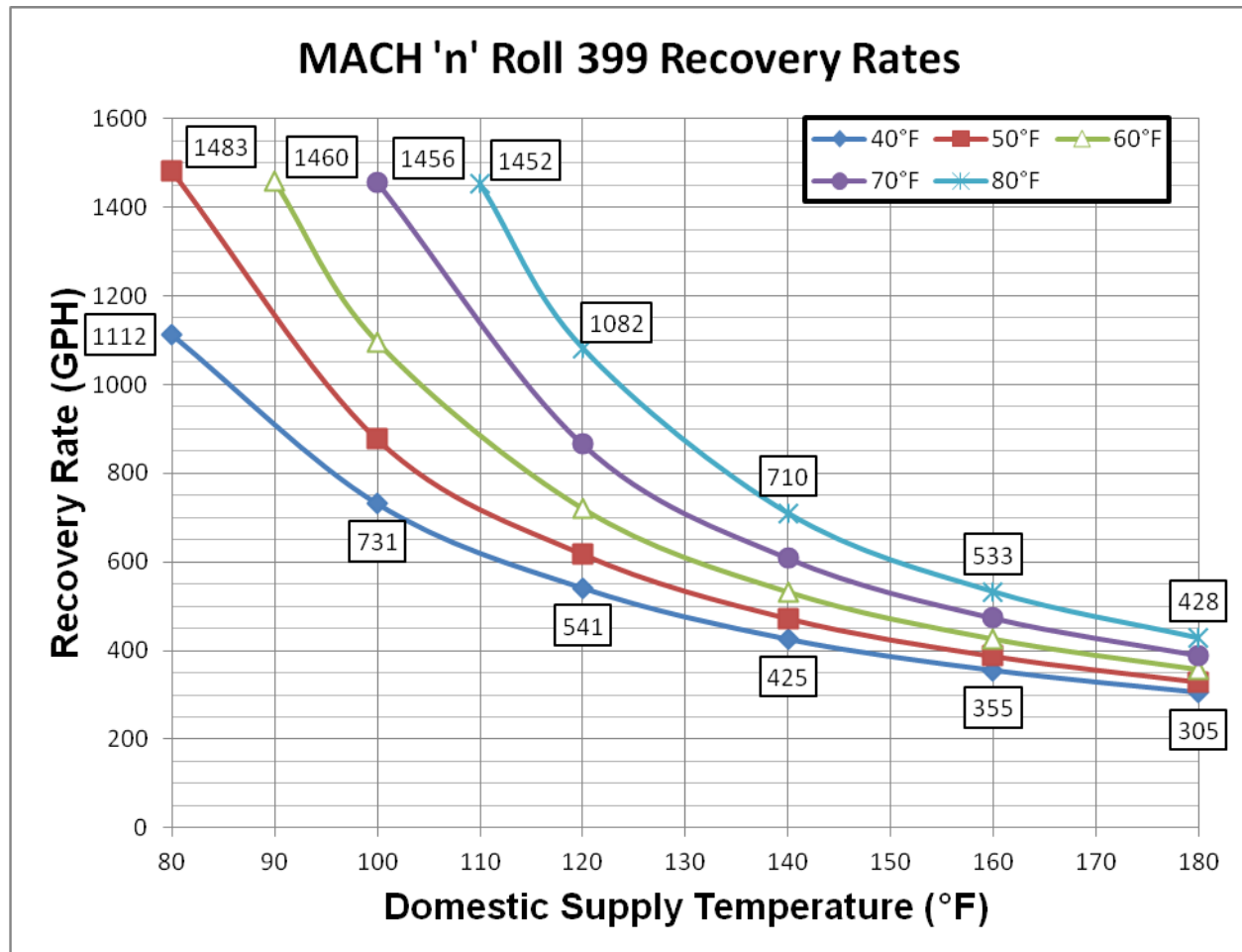
7 RECOVERY PERFORMANCE DATA

7.1 P-K MACH 'n' ROLL™ 300 RECOVERY PERFORMANCE DATA



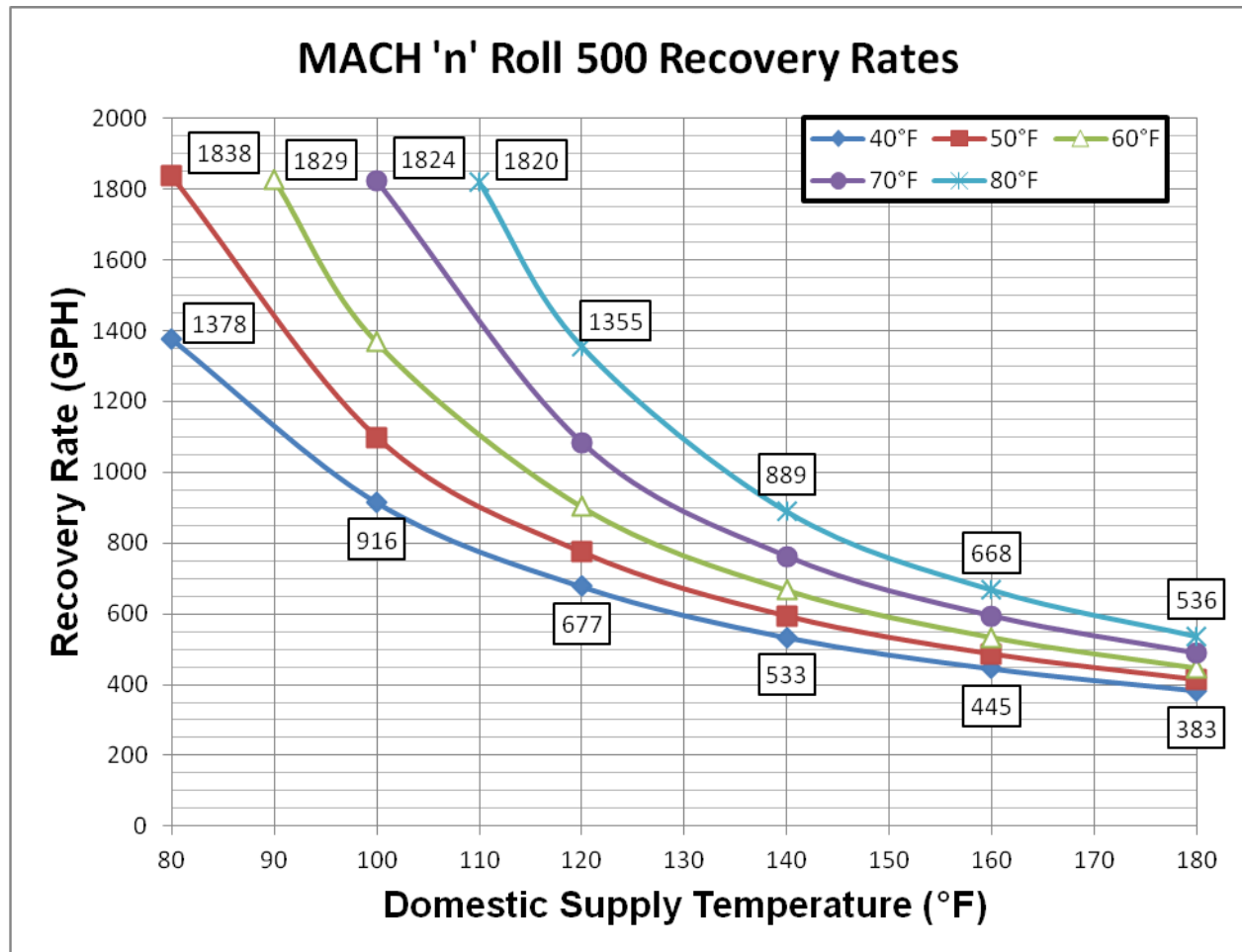
Choose the curve which most closely represents the incoming cold water temperature (40°F, 50°F, 60°F, 70°F, or 80°F). Move along the x-axis to the desired domestic hot water supply temperature. Move vertically until the intersection with the applicable curve. From this intersection, move horizontally to the left to determine the recovery rate of the MnR750 from the y-axis. Several sample recovery rate data points are included for reference.

7.2 P-K MACH 'n' ROLL™ 399 RECOVERY PERFORMANCE DATA



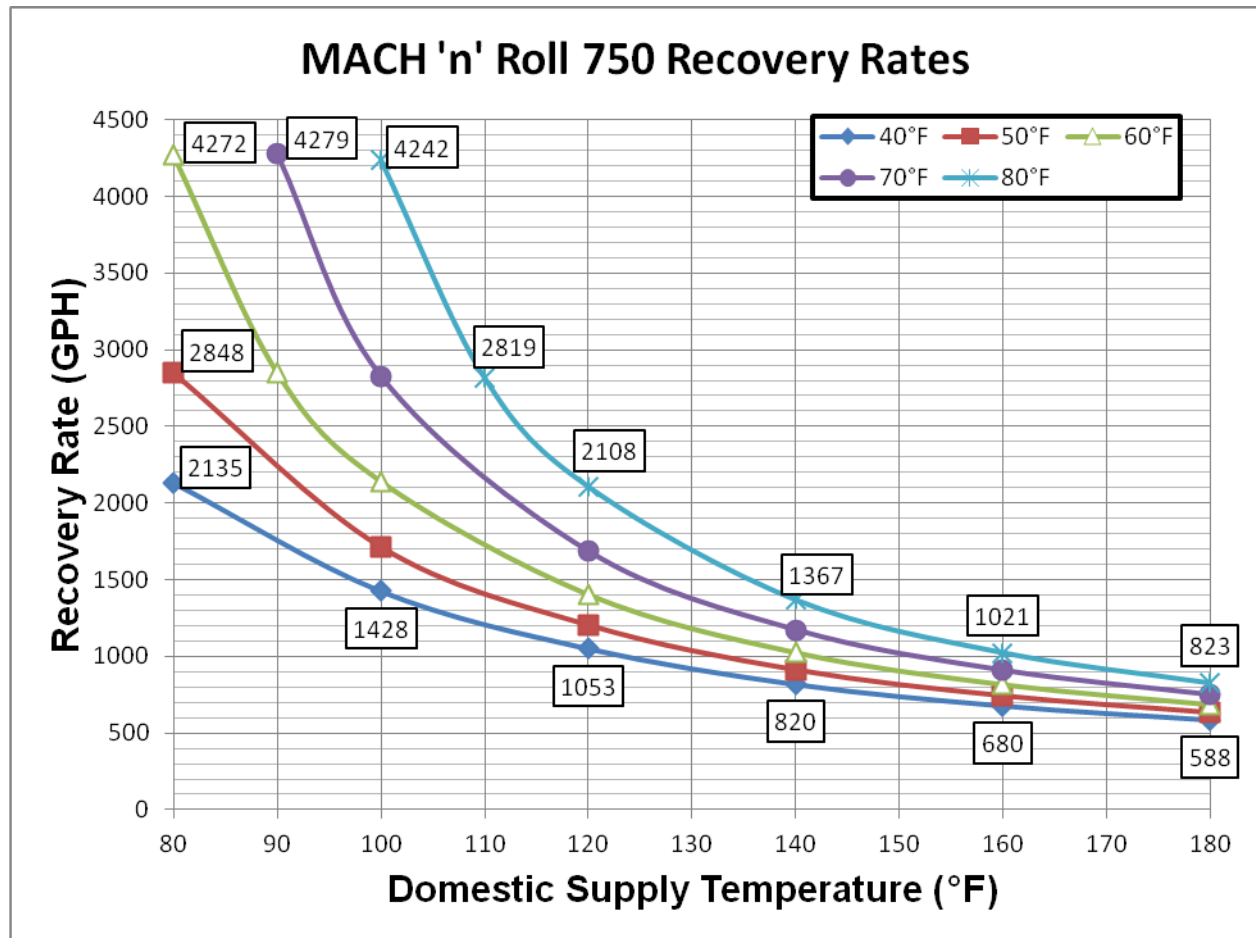
Choose the curve which most closely represents the incoming cold water temperature (40°F, 50°F, 60°F, 70°F, or 80°F). Move along the x-axis to the desired domestic hot water supply temperature. Move vertically until the intersection with the applicable curve. From this intersection, move horizontally to the left to determine the recovery rate of the MnR750 from the y-axis. Several sample recovery rate data points are included for reference.

7.3 P-K MACH 'n' Roll™ 500 RECOVERY PERFORMANCE DATA



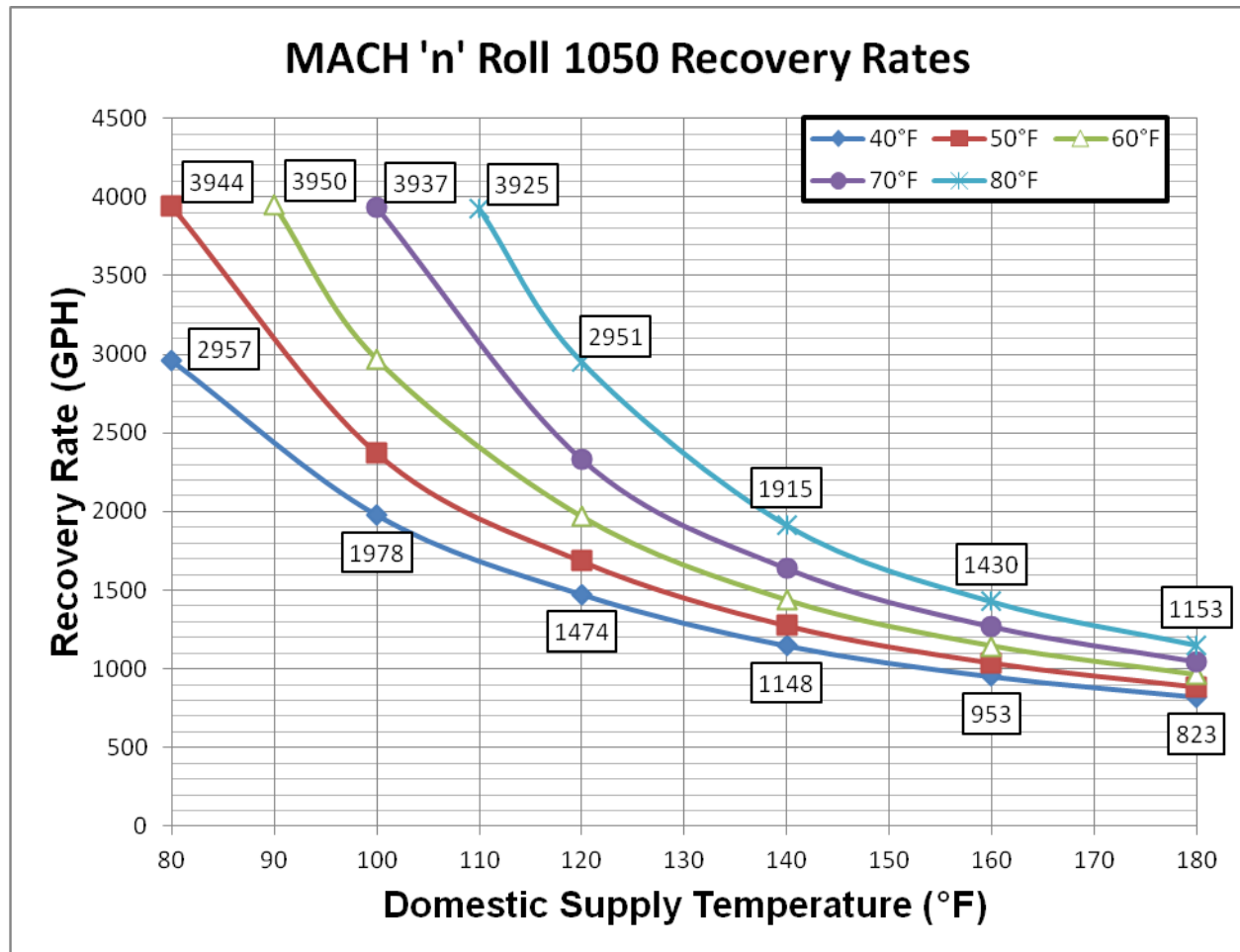
Choose the curve which most closely represents the incoming cold water temperature (40°F, 50°F, 60°F, 70°F, or 80°F). Move along the x-axis to the desired domestic hot water supply temperature. Move vertically until the intersection with the applicable curve. From this intersection, move horizontally to the left to determine the recovery rate of the MnR750 from the y-axis. Several sample recovery rate data points are included for reference.

7.4 P-K MACH 'n' ROLL™ 750 RECOVERY PERFORMANCE DATA



Choose the curve which most closely represents the incoming cold water temperature (40°F, 50°F, 60°F, 70°F, or 80°F). Move along the x-axis to the desired domestic hot water supply temperature. Move vertically until the intersection with the applicable curve. From this intersection, move horizontally to the left to determine the recovery rate of the MnR750 from the y-axis. Several sample recovery rate data points are included for reference.

7.5 P-K MACH 'n' Roll™ 1050 RECOVERY PERFORMANCE DATA



Choose the curve which most closely represents the incoming cold water temperature (40°F, 50°F, 60°F, 70°F, or 80°F). Move along the x-axis to the desired domestic hot water supply temperature. Move vertically until the intersection with the applicable curve. From this intersection, move horizontally to the left to determine the recovery rate of the MnR1050 from the y-axis. Several sample recovery rate data points are included for reference.

8 P-K MACH 'N' ROLL™ SYSTEM LIMITED WARRANTY

LIMITED WARRANTY

Subject to the terms and conditions herein, Harsco Industrial, Patterson-Kelley, Seller, warrants to the original owner at the original installation site that products manufactured by Seller will be free from defects in materials and workmanship for a period of one (1) year from date of start up (the "Warranty Period"), provided that start up is completed within six months from the date of shipment.

REMEDY

The sole remedy of this warranty is expressly limited to the repair or replacement of any part found to be defective under conditions of normal use within the Warranty Period. Installation is not included.

Warranty - The owner must notify the original installer of the Product and Seller (Attention: Harsco Industrial, Patterson-Kelley, 100 Burson Street, East Stroudsburg, PA 18301), in writing, within the Warranty Period, providing a detailed description of all claimed defects. Transportation to the factory or other designated facility for repairs of any products or items alleged defective shall, in all events, be the responsibility and at the cost of the owner.

EXCLUSIONS

Seller shall have no liability for and this warranty does not cover:

- A. 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.
- B. 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
- C. Any damage to the Product due to abrasion, erosion, deterioration, abnormal temperatures or the influence of foreign matter or energy.
- D. 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.
- E. The suitability of any Product for any particular application.
- F. Any failure resulting from misuse, modification not authorized by Seller in writing, improper installation or lack of or improper maintenance.
- G. Equipment furnished by the owner, either mounted or unmounted, or when contracted for by the owner to be installed or handled.
- H. Leakage or other malfunction caused by:
 - 1. Defective installations in general and specifically, any installation which is made:
 - a. in violation of applicable state or local plumbing housing or building codes,
 - b. contrary to the written instructions furnished with the unit
 - 2. Adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes and/or headers or corrosive elements in the atmosphere.
 - 3. 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 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. Seller's liability under this warranty shall not in any case exceed the amount paid for the Product found to be defective.

THIRD-PARTY WARRANTIES

For goods or components not manufactured by Seller, the warranty obligations of Seller shall, in all respects, conform and be limited to one (1) year from the date of shipment.

SEVERABILITY

To the extent that any provision of this warranty would be void or prohibited under applicable law, such provisions shall be limited in effect to the minimum extent necessary to render the remaining provisions hereof enforceable.

NO OTHER WARRANTIES

Seller makes no implied warranty of merchantability or fitness for a particular purpose or other warranties with respect to any products or services except as expressly set forth in this limited warranty.

Note: Rev. June 11, 2012