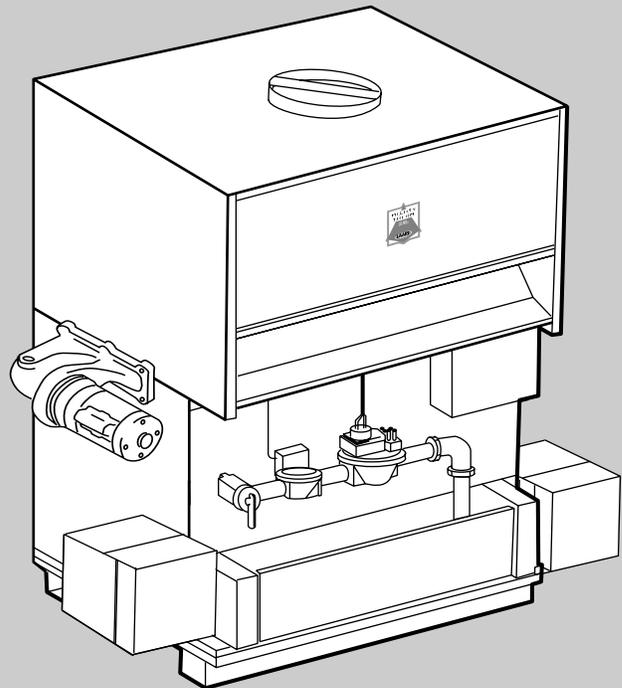
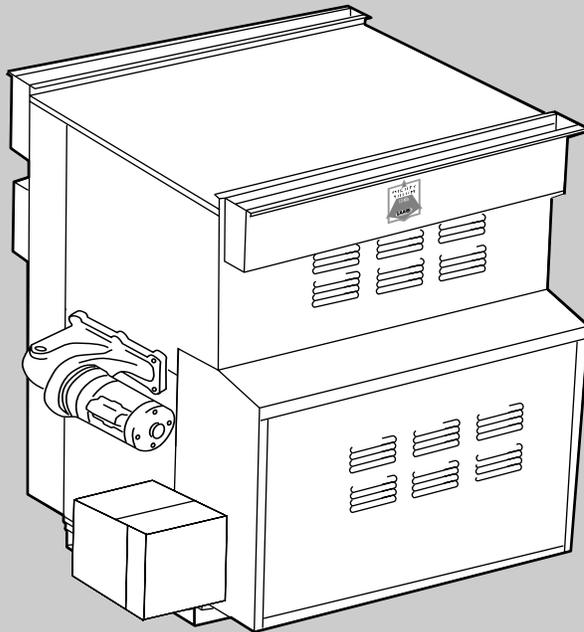


Installation and Operation  
Instructions for

# Mighty Therm Lo-NOx



Hydronic Boilers and  
Volume Water Heaters  
Models PH and PW  
Sizes 500-1825

These instructions are to be stored in the pocket provided on the boiler.

**FOR YOUR SAFETY:** This product must be installed and serviced by a professional service technician, qualified in hot water boiler installation and maintenance. Improper installation and/or operation could create carbon monoxide gas in flue gases which could cause serious injury, property damage, or death. Improper installation and/or operation will void the warranty.

## ⚠ WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

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

### WHAT TO DO IF YOU SMELL GAS

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

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

## TABLE OF CONTENTS

### SECTION 1.

#### General Information

1.1	Introduction .....	3
1.2	Heater Identification .....	3
1.3	General Flow Requirement .....	3

### SECTION 2.

#### Installation

2.1	Heater Placement .....	4
2.2	Installation of Indoor Heaters .....	4
2.2.1	Combustion Air Supply .....	4
2.2.1.a	Conventional Ventilation .....	4
2.2.1.b	Forced-Air Ventilation .....	5
2.2.2	Venting .....	5
2.2.3	Removal of Existing Heater .....	6
2.3	Installation of Outdoor Heaters .....	6
2.4	Gas Supply and Piping .....	6
2.5	Electrical Wiring .....	7

### SECTION 3.

#### Water Piping Instruction

3.1	General Piping Practice .....	8
3.2	Heating Boiler (PH Model) .....	8
3.2.1	Variable Water Flow System .....	8
3.2.2	System Pressure Requirements .....	8
3.2.3	Hot/Chilled Water Systems .....	8
3.2.4	Combined Space Heating/Potable Water Heating Systems .....	9
3.2.5	Piping System Requirements .....	10
3.2.6	Filling the System .....	10
3.3	Water Heater (PW Model) .....	10
3.3.1	Water Chemistry .....	10
3.3.2	Piping System Requirements .....	11
3.3.3	Water Expansion .....	11
3.3.4	Pump Requirements .....	11
3.3.5	Water Pressure .....	13
3.3.6	Tank Installation .....	14
3.3.7	Two-Temperature .....	14

### SECTION 4.

#### Operating Instructions

4.1	Controls - General .....	15
4.1.1	Electronic Ignition Control .....	15
4.1.2	Hot Surface Igniter .....	15
4.1.3	Combustion Air Pressure Switch .....	15
4.1.4	Operating Controls .....	15
4.1.5	High Limit Control .....	15

4.1.6	Flow Switch .....	16
4.1.7	Low Water Cut Off .....	16
4.2	Start-Up Requirements .....	16
4.3	Normal Operating Sequence .....	17
4.4	Hi-Limit Checkout .....	17
4.5	Start-Up Procedure .....	17
4.5.1	Lighting Instructions .....	18
4.5.2	To Turn Off Gas to Appliance .....	18
4.6	Setting the Temperature Controls .....	18
4.6.1	Hydronic Boilers .....	18
4.6.2	Water Heaters .....	18

### SECTION 5.

#### Maintenance

5.1	General Instructions .....	18
5.2	Combustion Air Blower .....	19
5.3	Heat Exchanger .....	19
5.3.1	External Cleaning of Heat Exchanger .....	19
5.3.2	Internal Cleaning of Heat Exchanger .....	20
5.4	Gas and Electric Controls .....	20
5.5	Burner Removal and Cleaning .....	20

### SECTION 6.

#### Troubleshooting

6.1	Sequence of Operation .....	20
6.2	Electrical Components .....	21
6.2.1	General Troubleshooting .....	21
6.2.2	Electrical Troubleshooting .....	21
6.3	Mechanical Components .....	23
6.3.1	Pressure Relief Valves Leaking Intermittently or Steadily .....	23
6.3.2	Heater is Pounding, Knocking or Emitting Steam from Relief Valves .....	23
6.3.3	Soot in Flueways or in Tubes, or Noxious Fumes Indicative of Bad Combustion .....	23
6.3.4	Water Dripping in Firebox .....	23

### SECTION 7.

#### Parts Descriptions and Order Numbers

7.1	Jack and Combustion Chamber Components .....	25
7.2	Water System .....	25
7.3	Electrical Components .....	26
7.4	Gas Train .....	26
7.5	Burner Tray .....	26
7.6	Outdoor Jacket .....	33

## SECTION 1. General Information

### 1.1 Introduction

This manual provides information for the installation and operation of Laars gas-fired hydronic boilers and water heaters. It is strongly recommended that all application and installation procedures be reviewed completely before proceeding with the installation. Consult the Laars factory, or local factory representative with any problems or questions regarding this equipment. Experience has shown that most problems are caused by improper installation, not system design.

Some accessory items are shipped in separate packages. Verify receipt of all items listed on the package slip. Inspect everything for possible damage upon delivery, and inform the carrier of any shortages or impairments. Any such claims should be filed with the carrier. The carrier, not the shipper, is responsible for shortages and damage to the shipment whether visible or concealed.

### IMPORTANT WARNING

The Laars heaters must be installed in accordance with the procedures outlined in this manual. The warranty does not apply to boilers not installed or operated in accordance with these procedures. Consult local building and safety codes

before proceeding with work. The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to the latest edition of the National Fuel Gas Code; ANSI Z223.1, National Electrical Code ANSI/NFPA 70 and/ or in Canada CAN 1 -13149 requirements.

When required by the authority having jurisdiction, the installation must conform to American Society of Mechanical Engineers safety codes for controls and safety devices for automatically fired boilers No. CSD-1, and in Canada CGA 3.3. Any modification to the boiler, its gas controls, gas orifices, wiring or draft diverter may void the Laars warranty. If field conditions require such modifications, consult factory.

### 1.2 Heater Identification

Consult rating plate on the boiler. The following example simplifies the boiler identification.

1	2	3	4	5	6
PH	1200	I	N	21	K

- (1) Basic heater model (see descriptions below).
- (2) Input rate x 1000 BTU/h.
- (3) Indoor (I) or Outdoor (E) installation.
- (4) Gas type: Natural (N).
- (5) Ignition system: (21) Hot surface (proved igniter) ignition system.
- (6) Firing modes:  
On/Off (C)  
2-stage (K)

**Model PH** hydronic heating boilers come with integrally mount pumps. Pumps are sized for pressure drop through the heat exchanger only.

**Model PW** water heaters for use with separate storage tank come with integrally mount pumps. Pumps are sized for pressure drop through the heat exchanger plus 30 feet (9.1m) of pipes and normal fitting.

Laars heaters are available in two configurations: an indoor version and an outdoor version. Both are available from the factory (see Figure 1).

### 1.3 General Water Flow Requirement

For proper operation, all low volume hot water heaters must have continuous flow through the heat exchanger when firing. The system pump must be capable of developing sufficient pressure to overcome the resistance of the heater plus the entire circulating system at the designed flow rate.

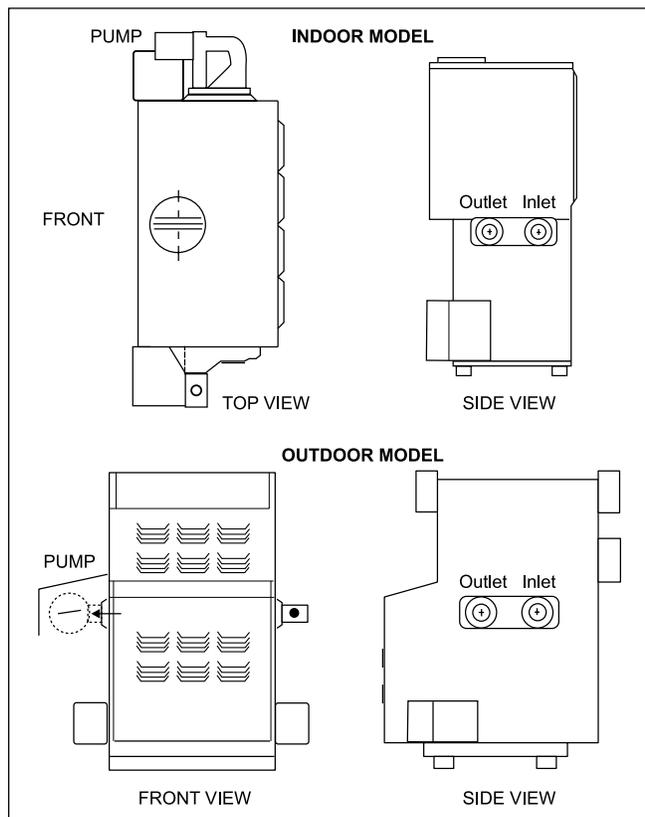


Figure 1. Boiler Configuration.

## SECTION 2. Installation

### 2.1 Heater Placement

The heater must be placed to provide specific clearances on all sides for maintenance and inspections. There must also be minimum distances maintained from combustible surfaces. These clearances also apply to noncombustible materials because the heater requires air circulation for proper operation.

The heater should be mounted on a level surface. An integral base for an installation on combustible flooring is provided as standard equipment on all models.

Do not install a heater on carpeting.

Under the national Fuel Gas Code, ANSI Z223.1, it is permissible to place the heater on floors other than noncombustible when the installation complies with the American Insurance Code. Figures 2, 3, and 4 show common installation on combustible flooring.

### 2.2 Installation of Indoor Heaters

Locate the heater to provide adequate clearance for inspection and service on all sides. See Table 1.

Install indoor heaters on a waterproof floor with an adequate floor drain and a 6" (152mm) minimum curb on all four sides to protect the building if heater repairs are required. **The manufacturer will not be held liable for any water damage in connection with this heater.**

#### 2.2.1 Combustion Air Supply

The heater location must provide sufficient air supply for proper combustion and ventilation of the surrounding area as outlined in the latest edition of ANSI standard Z223.1, and any local codes that may be applicable. Inadequate combustion air supply may result in incomplete combustion, sooting of the heat exchanger, and unsafe operation of the boiler.

##### 2.2.1.a Conventional Ventilation

In the United States, the most common requirements specify that the space shall communicate with the outdoors in accordance with method 1 or 2, which follow. Where ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect.

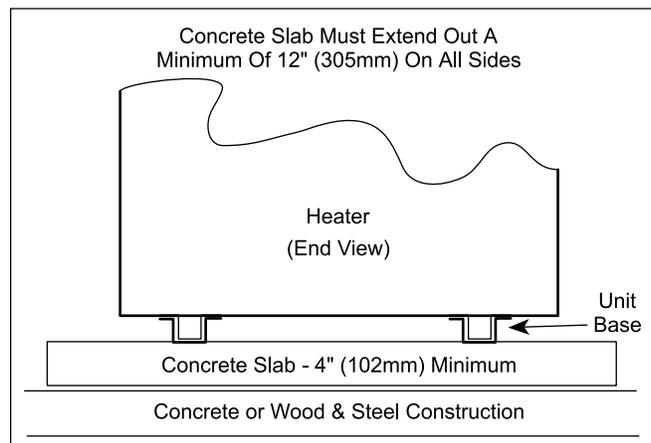
**Method 1:** Two permanent openings, one commencing within 12 inches (300 mm) of the top and one commencing within 12 inches (300 mm) of the bottom, of the enclosure shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors.. When directly communicating with the

Clearance from	Indoor in. mm	Outdoor in. mm
Top	30 762	unobstructed
Water Conn. side	12* 305	24 610
Pump side	6* 152	24 610
Front	Alcove*	unobstructed
Rear	8 203	24 610
Vent pipe**	6 152	- - -
Hot water pipes	per code	per code

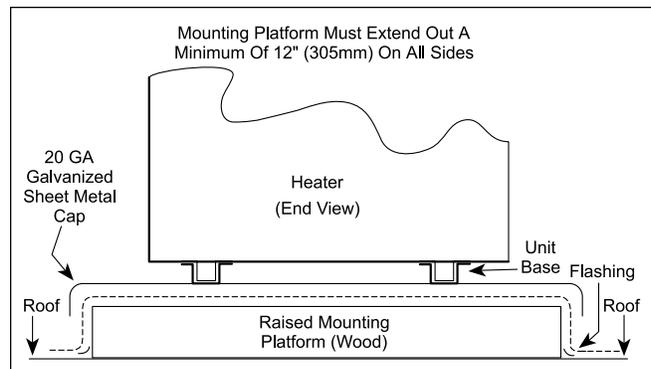
\* Water connection and pump side clearances of 24" (610mm) and front clearances of 48" (1219mm) will allow easier service access.

\*\* One inch using type B vent (refer to Manufacturer's Instructions).

**Table 1. Minimum Heater Clearances From Adjacent Surfaces.**

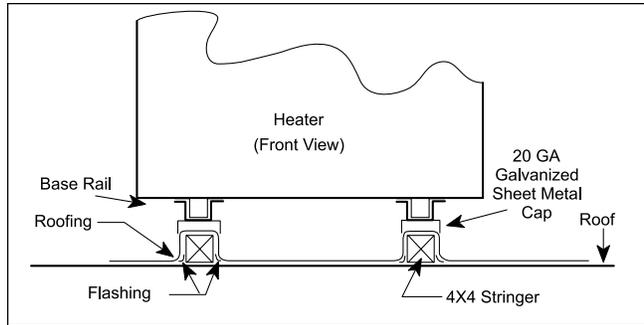


**Figure 2. Typical Heater Installation on Concrete Slab.**



**Figure 3. Typical Heater Installation on Roof Using Raised Platform (wood).**

outdoors, or when communicating to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4000 BTU/h (550 square mm/kW) of the total input rating of all equipment in the enclosure. When communicating to the outdoors through horizontal ducts, each opening shall have a minimum free area of not less than 1 square inch per 2000 BTU/h (1100 square mm/Kw) of the total input rating of all equipment in the enclosure.



**Figure 4. Typical Heater Installation on Concrete Slab.**

Heater Size	Each Opening*	
	square inches	square cm
500	125	807
715	179	1155
999	250	1613
1010	253	1632
1200	300	1936
1430	358	2310
1825	457	2950

\* Net Free Area.  
 Check with louver manufacturers for net free area of louvers. Correct for screen resistance to the net free area if a screen is installed. Check all local codes applicable to combustion air.  
 Area indicated is for one of two openings: one at floor level and one at the ceiling, so the total net free area could be double the figures indicated. For special conditions refer to the latest edition of ANSI Z223.1.  
 Consult factory if openings do not communicate directly through the walls with the outdoors.

**Table 2. Minimum Recommended Air Supply to Heater, Per Method 1.**

See Table 2 for recommended opening sizes pertaining to Method 1.

**Method 2:** One permanent opening, commencing within 12 inches (300 mm) of the top of the enclosure, shall be permitted. The opening shall directly communicate with the outdoors, or shall communicate through a vertical or horizontal duct to the outdoors or spaces that directly communicate with the outdoors, and shall have a minimum free area of 1 square inch per 3000 BTU/h (700 square mm/kW) of the total input rating of all equipment located in the enclosure. This opening must not be less than the sum of the areas of all vent connectors in the confined space.

Other methods of introducing combustion and ventilation air are acceptable, provided they conform to the requirements in the applicable codes.

In Canada, consult local building and safety codes or, in absence of such requirements, follow CAN/CGA B149.

An improperly ventilated equipment room can get excessively hot and cause accelerated deterioration of controls and electrical components.

In Canada, Table 2 does not apply. Consult local building codes or, in the absence of such requirements, follow CGA requirements and/or CAN/CGA B-149 standard.

**2.2.1.b Forced-Air Ventilation**

In the United States: any equipment which exhausts air from the heater room can deplete the combustion air supply or reverse the natural draft action of the venting system. This could cause flue products to accumulate in the heater room. Additional air must be supplied to compensate for such exhaust. The information in Table 2 is not applicable in installations where exhaust fans or blowers of any type are used. Such installations must be designed by qualified engineers.

In Canada: follow Canadian standard, CAN/CGA B-149 or local codes.

If a blower or fan is used to supply air to the heater room, the installer should make sure it does not create drafts which could cause nuisance shutdowns. If a blower is necessary to provide adequate combustion air to the heater, a suitable switch or interlock must be wired into the heater control circuit to prevent the heater from firing unless the blower is operating.

The heater must be completely isolated and protected from any source of corrosive chemical fumes such as trichlorethylene, perchloroethylene, chlorine, etc.

**2.2.2 Venting**

**IMPORTANT NOTE:** Mighty Therm LO-NOx units are not fan-assisted. They are natural draft appliances. The fans on the Mighty Therm LO-NOx units are for combustion assistance only. Venting systems must be sized as natural draft, atmospheric vent, and not as fan-assisted vent systems.

1. Laars heaters have built-in draft diverters for natural draft operation and must not be connected to any portion of a mechanical draft system under positive pressure. The flue outlet must be connected to a clear, unobstructed vent of adequate capacity ending above the highest point of the building with an approved vent cap. The venting system should be installed according to Category 1, Natural Draft per the latest edition of ANSI Z223.1 and/or, in Canada, CAN/CGA B-149 and any local codes having jurisdiction.
2. Do not weld or fasten the vent pipe to the boiler drafthood. The weight of the stack must not rest on the heater. The drafthood and heater top must be easily removable for normal heater service and inspection.

**IMPORTANT NOTE:** Do not use sheet metal screws at the snap lock joints of Type B gas vents.

3. Avoid using long horizontal runs of the vent pipe, and too many 90° elbows, reductions or restrictions. Horizontal runs should have at least a 1/4" (6mm) rise per foot in the direction of flow. A vent connector should be supported for the design and weight of the material used to maintain clearances and prevent physical damage and separation of joints.

4. Avoid terminating heater vents near air conditioning or air supply fans. The fans can pick up exhausted flue products from the heater and return them inside the building creating a possible health hazard. A minimum of 4 feet (1.2m) horizontal distance must be maintained from electrical meters, gas meters, and relief equipment.
5. Always use double-wall or insulated vent pipe (Type B or equivalent). In cold weather, uninsulated outside vents can chill the rising flue products blocking the natural draft action of the venting systems. This can create a health hazard by spilling flue products in the heater room.
6. Avoid oversized vent piping or extremely long runs of pipe which may cause excessive cooling and condensation. Rule of Thumb: the total length of the vent, including the connector and any offset, should not exceed 15 feet (4.6m) for every inch (25mm) of vent diameter. Longer total lengths shown in venting tables are based on maximum capacity, not condensation factors.
7. When the installation of a draft fan is necessary in connecting a venting system to a Laars heater, the installation should be engineered by competent personnel following good engineering practices. The draft fan supplier should be consulted for correct size. The installation should be in accordance with the latest edition of ANSI Z223.1 and/or, in Canada, CAN/CGA B-149 and any local codes having jurisdiction. When a draft fan is installed, a suitable draft switch must be wired into the boiler control circuit at terminal designated "Field Interlock" to prevent firing of the boiler unless a positive draft has been established.

### 2.2.3 Removal of Existing Heater

At the time of removal of an existing heater, the following steps shall be followed with each appliance remaining connected to the common venting system placed in operation, while the other appliances remaining connected to the common venting system are not in operation.

1. Seal any unused openings in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine that there is no blockage or restriction, leakage, corrosion or other deficiencies which could cause an unsafe condition.
3. Insofar as is practical, close all building doors and windows, as well as all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliance not connected

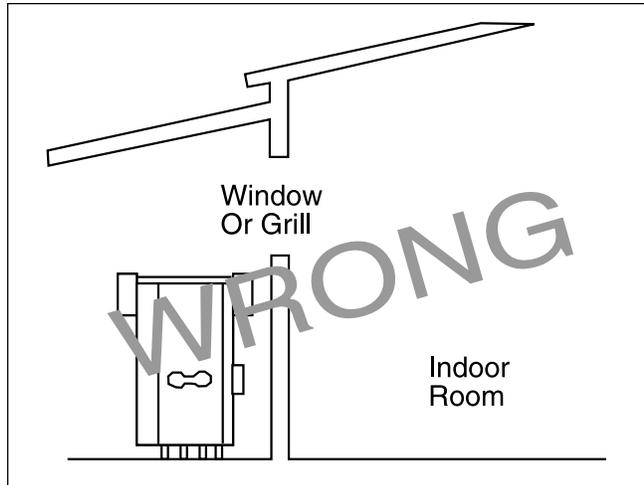
to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.

4. Place in operation the appliance being inspected. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.
5. Test for spillage at the draft hood relief opening (if the appliance is equipped with a draft hood), after 5 minutes of main burner operation. Use the flame of a match or candle, or smoke from a cigarette, cigar or pipe.
6. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return door, windows, exhaust fans, fireplace dampers and any other gas-burning appliances to their previous condition of use.
7. Any improper operation of the common venting system should be corrected so the installation conforms with the National Fuel Gas Code, ANSI Z223.1. When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate Tables in Appendix G in the National Fuel Gas Code, ANSI Z223.1.

In Canada, at the time the boiler is removed from common venting system, the common venting system should be resized so the installation conforms to CAN/CGA B149.1 or .2.

### 2.3 Installation of Outdoor Heaters (Not available in Canada)

1. Locate the heater to provide the clearances as listed in Table 1, "Minimum Heater Clearances."
2. Do not place the heater in an enclosure or wall recess. Avoid locations where wind deflection off structures might cause downdraft. When such wind conditions are possible, place the heater at least 3 feet (0.9m) from the structures.
3. Never install the heater under any kind of roof overhang. Do not place the heater below or adjacent to any doors, windows, louvers, grills, etc., which connect in any way with an inhabited area of a building. This includes other structures such as garages or utility rooms (see Figure 5).
4. Although the Laars models are CSA designed certified for outdoor installations, such installations are not recommended in areas where the danger of freezing exists unless proper precautions are taken for freeze protection. Outdoor installations are not recommended in areas where the danger of snow blockage exists.



**Figure 5. Incorrect Outdoor Installation.**

The heater should be located a safe distance from Propane gas storage and filling equipment. Consult local codes and fire protection authorities for advice on specific installation restrictions.

## 2.4 Gas Supply and Piping

*Review the following instructions before proceeding with the installation.*

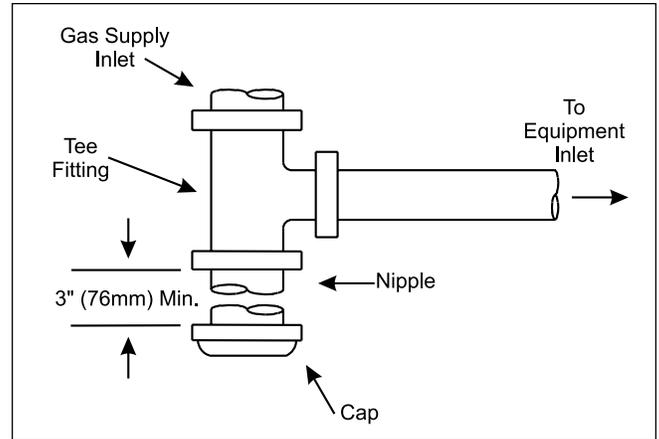
1. Verify that the heater is fitted for the proper type of gas by checking the rating plate. Laars heaters are normally equipped to operate below a 2000 foot (609.6m) altitude. Heaters equipped to operate at higher altitudes have appropriate stickers or tags attached, also printed information on rating plate.
2. Use the figures in Table 3 to provide adequate gas piping from the gas meter to the heater.

Size	Distance from Gas Meter or Last Stage Regulator		
	0-100'	100-200'	200-300'
500	1½"	2"	2"
715	2"	2"	2½"
999	2"	2½"	3"
1010	2"	2½"	3"
1200	2½"	3"	3"
1430	2½"	3"	3"
1825	2½"	3"	3½"

**NOTE:** These figures are for Natural Gas (.65 Sp. Gr.), and are based on 1/2" water column pressure drop. Check supply pressure with a manometer, and local code requirements for variations. An average number of tees and elbows have been taken into account.

**Table 3. Gas Piping Sizes.**

3. A sediment trap (drip leg) must be provided ahead of the gas controls (see Figure 6). A manual gas shutoff valve must also be provided for service convenience and safety. A cap must be provided for cleaning purposes. Check the local codes.



**Figure 6. Sediment Trap Installation.**

4. The heater and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of 1/2 psig. The heater must be isolated from the gas supply piping system by closing its individual manual gas shutoff valve during any pressure testing of the piping system at test pressures equal to or less than 1/2 psig.
5. Provide gas supply pressure to the heater as follows:

	Natural Gas
Max. (inches water column)	10
Min. (inches water column)	6.5

**NOTE:** the heater and all other gas appliances sharing the boiler gas supply line must be firing at maximum capacity to properly measure the inlet supply pressure. Low gas pressure could be an indication of an undersized gas meter and /or obstructed gas supply line.

6. The correct burner manifold gas pressure is stamped on the rating plate. The regulator is preset at the factory and normally requires no further adjustment.
7. The gas manifold and control assembly is factory tested and conforms to the safe lighting and other performance criteria specified in the latest editions of ANSI Z21.13 and CGA 3.3 Low Pressure Boiler Standard.
8. Before operating the heater, test the complete gas supply system and all connections for leaks using a soap solution. **Do not use raw flame.**

### **Caution**

Since some leak test solutions (including soap and water) may cause corrosion or stress cracking, the piping must be rinsed with water after testing, unless it has been determined that the leak test solution is noncorrosive.

## 2.5 Electrical Wiring

### **⚠ WARNING**

The heater must be electrically grounded in accordance with the most recent edition of the National Electrical Code, ANSI/NFPA 70. In Canada, all electrical wiring to the boiler should be in accordance with the latest edition of CSA C22.1 Canadian Electrical Code, Part 1. Do not rely on the gas or water piping to ground the metal parts of the boiler. Plastic pipe or dielectric unions often isolate the heater electrically. Service and maintenance personnel who work on or around the heater may be standing on wet floors and could be electrocuted by an ungrounded heater.

Wiring diagrams are included in the information packet provided with each unit.

1. All Laars heaters need 115V 60Hz supply voltage unless specifically ordered otherwise. Check heater wiring and pump for correct voltage, frequency and phase. Consult the National Electrical Code or the Canadian Electrical Code regarding branch circuit requirements for equipment with these motors.
2. The heater should be wired exactly as shown in the wiring diagram.
3. All field installed electrical safety devices and all field installed controllers (valve end switches, draft switches, relays, timers) can be connected to the heater control to the terminals shown in the wiring diagram designated "Field Interlock."
4. Where the heater is installed with a draft fan refer to the fan manufacturer's wiring diagram. The draft switch should be wired across the field interlock terminals in the heater control panel.

## SECTION 3. Water Piping Instruction

### 3.1 General Piping Practice

1. Be sure to provide valves at the inlet and outlet of the heater so it can be readily isolated for service. A butterfly, ball type or similar type of valve is recommended.
2. The pressure relief valve installed in the tapped opening provided in the outlet header (see Figure 7), must be piped, but not fastened, to a drain or floor sink. The drain pipe must be the same size as the valve outlet and must pitch downward from the valve. Pay special attention to relief valve settings in installations where the heater is located on the ground floor of a tall building, or where the operating temperature of the heater is

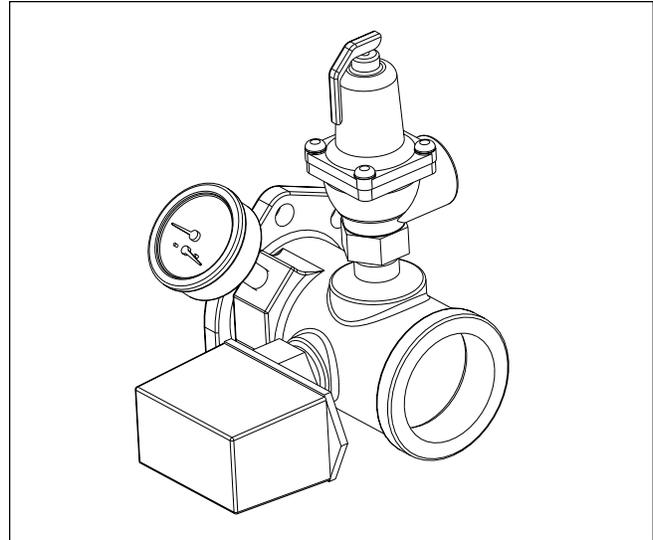


Figure 7. Pressure Relief Valve Location.

- above 210°F (99°C). In both instances, the static pressure of the system is elevated and could cause the relief valve to leak and bring considerable raw water into the system.
3. Where no special setting of the relief valve is ordered, the factory will furnish a 75 psi setting for heating boilers (PH models), and 125 psi for water heaters (PW models).
4. The pressure relief valve lever must be tripped at least once a year to insure that waterways are clean. When manually operating lever, water will discharge through the drain line. Precautions must be taken to avoid contact with hot water and water damage.

### 3.2 Heating Boiler (PH Model)

#### 3.2.1 Variable Water Flow System

Heating systems using zone valves, zone pumps or 3-way valves can experience reduced water flow through the boiler. This can result in an excessive water temperature rise and unstable boiler operation. If the system water flow is variable, the boiler's temperature sensor must be installed in the outlet water. Laars recommends primary-secondary pumping for all variable flow systems (see Figure 9). Primary-secondary pumping is **mandatory** for variable flow systems. The boiler pump in a primary-secondary system maintains constant flow through the boiler even though the system flow is variable. In a primary-secondary system the pressure drop of the boiler is not added to the system.

#### 3.2.2 System Pressure Requirements

The boilers are designed to operate on closed, pressurized systems. Maintain a minimum of 12 psi (81.8 kPa) on the system where boiler supply water temperature is 200°F (93°C) or less. If higher temperatures are required, the minimum system

pressure should be at least 15 psi (102.2 kPa) above the water vapor pressure corresponding to the elevated water temperature.

Heating boilers are not suitable for open systems unless the supply water temperatures are kept below 180°F (82°C), and a minimum of 5 psi (34.1 kPa) static head is maintained at the boiler.

### 3.2.3 Hot/Chilled Water Systems

When a boiler is connected to an air conditioning system where the same water is used for heating and cooling, you must prevent chilled water from entering the boiler. When changing such a system from cooling to heating, allow the chilled water to circulate through the building, after the chiller has been turned off, for a period long enough for the water to warm up to at least 105°F (41°C) before the water flows into the boiler. It is equally important to prevent hot water from entering the chiller. The system shown in Figure 8 is suggested to make sure the system water is neither too hot nor too cold when a changeover takes place. When a boiler is connected to heating coils located in air handling units (where they may be exposed to refrigerated air circulation), install a flow control valve or other automatic means to prevent gravity circulation of chilled water through the boiler. Chilled water in the boiler will create condensate on the boiler tubes. **Boilers installed in violation of the foregoing may void the warranty.**

### 3.2.4 Combined Space Heating/Potable Water Heating Systems

When using the Laars boiler as a source of heat for a combined space heating/potable water heating system, be sure to follow the instructions of the space heating system.

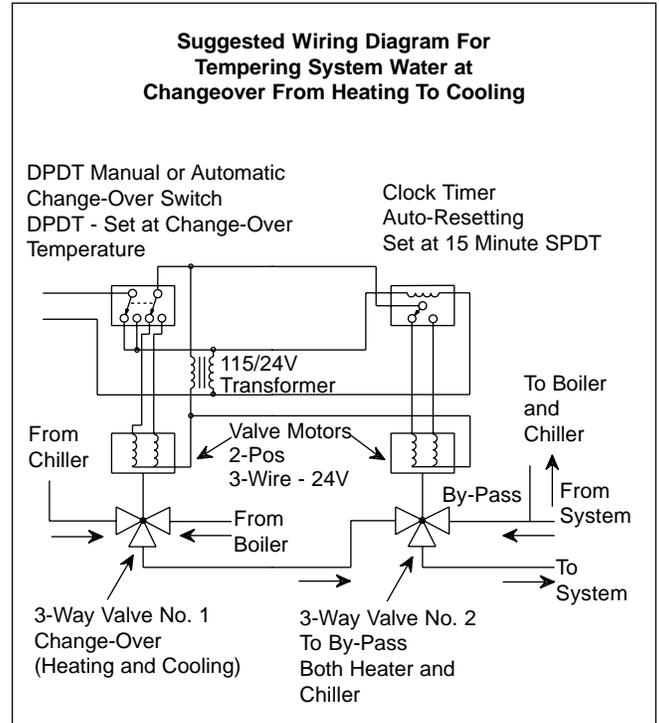


Figure 8. Boiler-Chiller Installation.

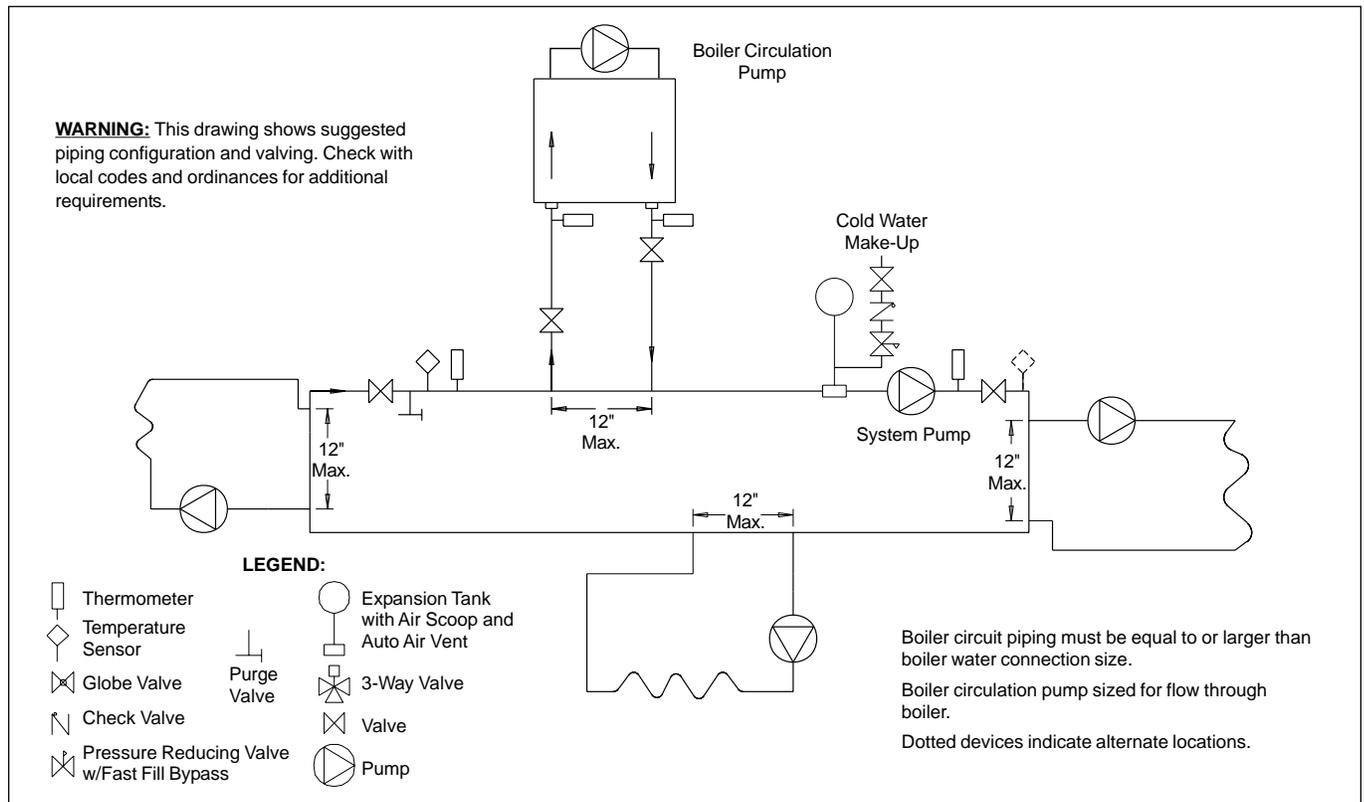


Figure 9. Primary-Secondary Plumbing.

Do not use water piping, fittings, valves, pumps, and any other components which are not compatible with potable water.

Do not connect the heater, which will be used to supply potable water, to any heating system or components previously used with a nonpotable water heating system.

Do not add boiler treatment or any chemicals to the heating system piping, since the piping contains water for potable use.

Do not use solder containing lead in the potable water lines.

Some jurisdictions may require a backflow preventer in the cold water line. In such cases, pressure relief valve may discharge water due to expansion. An expansion tank approved for potable water will eliminate this condition. Follow the manufacturer's instructions for installation of the expansion tank.

### 3.2.5 Piping System Requirements

1. Provide a boiler installed above radiation level with a low water cutoff device either as part of the boiler or at the time of boiler installation.
2. Install manual and/or automatic bleeding devices at high points in the system to eliminate air. Install a correctly sized expansion or compression tank with suitable air charger and tank drainer, as appropriate.
3. Support the weight of all water and gas piping by suitable hangers or floor stands.
4. Check piping diagrams with local applicable plumbing, heating and building safety codes.

### 3.2.6 Filling The System

1. Ensure the system is fully connected. Close all bleeding devices and open make-up water valve. Allow system to fill slowly.
2. If make-up water pump is employed, adjust pressure switch on pumping system to provide a minimum of 12 psi (81.8 kPa) at the highest point in the heating loop.
3. If a water pressure regulator is provided on the make-up water line, adjust the pressure regulator to provide at least 12 psi (81.8 kPa) at the highest point in the heating loop.
4. Open bleeding devices on all radiation units at the high points in the piping throughout the system, unless automatic air bleeders are provided at such points.
5. Run system circulating pump and boiler pump for a minimum of 30 minutes with the boiler gas shut off.
6. Open all strainers in the circulating system, check flow switch operation, and check for debris.
7. Recheck all air bleeders as described in Step 4 above.

8. Check liquid level in expansion tank. With the system full of water and under normal operating pressure, the level of water in the expansion tank should not exceed 1/4 of the total, with the balance filled with air.
9. Start up boiler according to procedure described in Section 4. Operate the entire system, including the pump, boiler, and radiation units for one (1) hour.
10. Recheck the water level in the expansion tank. If the water level exceeds 1/4 of the volume of the expansion tank, open the tank drainer and drain to that level.
11. Shut down the entire system and vent all radiation units and high points in the system piping as described in Step 4 above.
12. Close make-up water valve and check strainer in pressure reducing valve for sediment or debris from the make-up water line. Reopen make-up water valve.
13. Check gauge for correct water pressure and also check water level in system. If the height indicated above the boiler insures that water is at the highest point in the circulating loop, then the system is ready for operation.
14. Within three (3) days of start-up, recheck all air bleeders and expansion tank as described in Steps 4 and 8 above.

## 3.3 Water Heater (PW Model)

### 3.3.1 Water Chemistry

Laars equipment is designed for use in a wide variety of water conditions. The water velocity maintained in the heat exchanger tubes is kept high enough to prevent scaling from hard water and low enough to avoid corrosion from soft water. Ninety-five percent of the urban areas in the country have water that is compatible with this equipment, but in some areas a water supply will contain a large quantity of scaling chemicals or the water may be extremely soft and corrosive. In rare situations the water will contain both scaling chemicals and corrosive chemicals such as calcium or sodium chloride. These conditions may be the result of a nearby well or pumping station and the particular condition may not be characteristic of the entire city water system.

If an installer observes damage from these conditions to any water handling equipment in the area, a factory representative should be contacted immediately for assistance in minimizing maintenance costs. If erosion is present, the pump impeller can be replaced to reduce water velocity. If scaling conditions are bad, tube cleaning maintenance schedules can be established to prevent tube burn-out and cracking. Neglecting the problem could mean serious damage to the heater and water system.

Scaling can be recognized as a layer deposited

on the inner walls of the tube which reduces the inner diameter of the tube. Scale can be any color or texture; smooth or rough, granular or amorphous. Signs of erosion are generally pitting, cavitation, ridges and “islands” on the inner walls of the tubes. Since this condition results from extremely soft water sources, or as a result of a water softening program, the internal copper surfaces will be extremely shiny. Other chemicals, such as chlorine or chlorides in the water, will cause dark surfaces of erosion.

In areas where the water supply is extremely corrosive, it is advisable to order the heater with cupro-nickel tubes in the exchanger.

***Damage From Scaling, Corrosion, or Erosion is Not Covered by the Warranty.***

### 3.3.2 Piping System Requirements

1. Check piping diagrams with local applicable plumbing, heating and building safety codes.
2. All two-temperature systems using temperature valves must have forced recirculation in the low temperature building loop.
3. A check valve installed at the hot water inlet to the tempering valve will prevent cold water from being drawn in reverse through the tempering valve into the hot water.
4. When installing a tempering valve, place at bottom of antithermosyphon loop at least 24" high to prevent excessive hot water from entering mixed water supply. Bring the cold water supply up from the floor to the valve (see Figure 10).

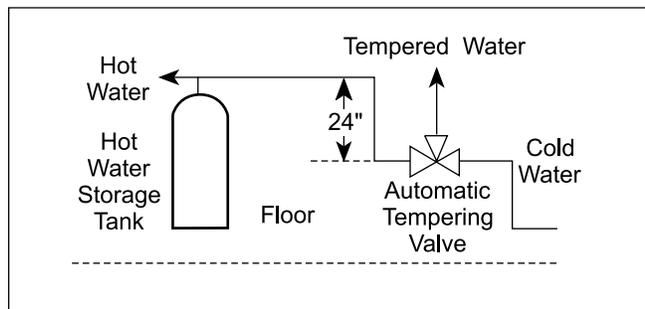


Figure 10. Tempering Valve Installation.

### 3.3.3 Water Expansion

When cold water is heated the water expands. If no water is being used during the heat-up period the expanded water will normally back up into the city mains.

A water pressure reducing valve installed in the incoming cold water line may act as a check valve and prevent the expanded water from moving backward. This will cause pressure to rise in the heater, which will be relieved by the pressure relief valve.

If the relief valve pops frequently a mineral deposit may build up on the valve seat, causing it to leak.

The following suggestions may solve the problem:

1. Replace the installed water pressure reducing valve with a suitable valve having a back flow port. These valves have a back flow port which allows water to flow backwards when the pressure in the system exceeds the pressure in the mains.
2. Install a check valve around the pressure reducing valve to permit reverse flow. This will allow the expanded water to back flow into the mains (see Figure 11).

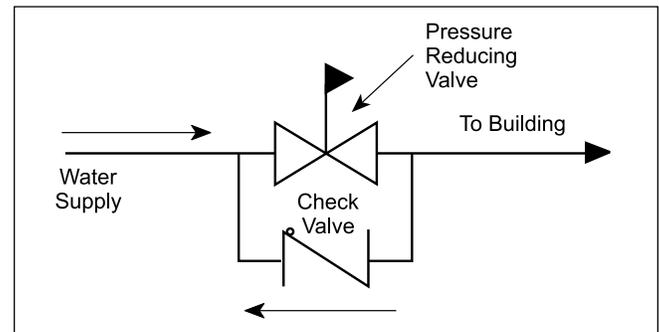


Figure 11. Check Valve/Pressure Reducing Valve Installation.

3. Install an auxiliary small relief valve set at 25 psi less than the main relief valve. The valve must be piped to a drain and may require occasional cleaning. It will bleed off the expanded water and protect the main pressure relief valve from becoming fouled.
4. Install a properly sized expansion tank.

### 3.3.4 Pump Requirements

1. The factory provided pump on **PW** heaters are sized to provide proper circulation through the heater and heater-to-tank circulation loop (see Figures 12, 13 and 14). If the heater-to-tank circulation loop **does not contain more than 6 elbows and 30 feet of pipe**, use pipe fittings in the loop no smaller than the following:

Model	Pipe Size
500 through 715	2"
999 through 1825	2-1/2"

If the heater-to-tank circulating loop contains **more than 6 elbows and 30 feet of pipe**, use pipe or fittings in the loop no smaller than the following:

Model	Pipe Size
500 through 715	2-1/2"
999 through 1825	3"

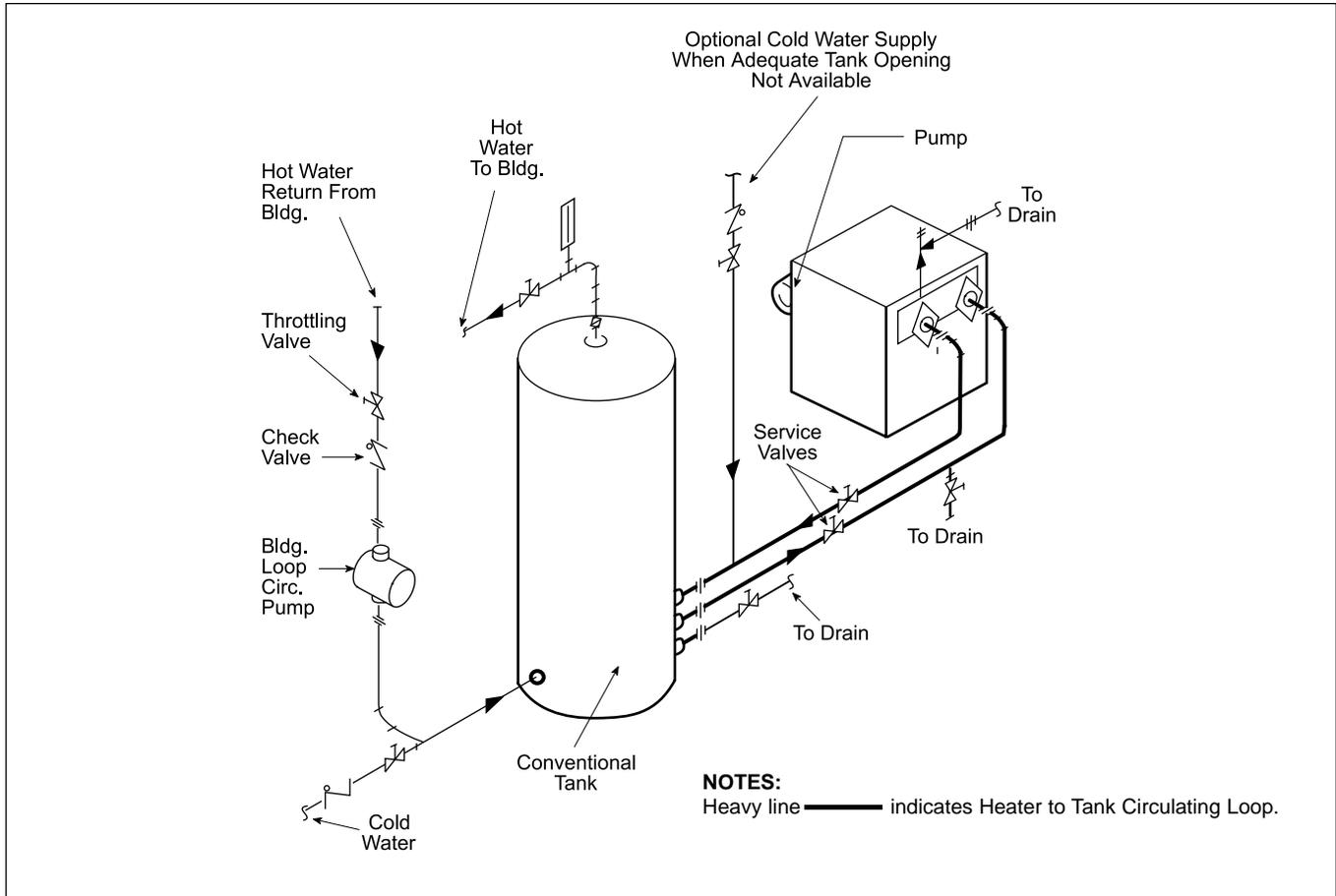


Figure 12. Hot Water Supply System with Vertical Tank.

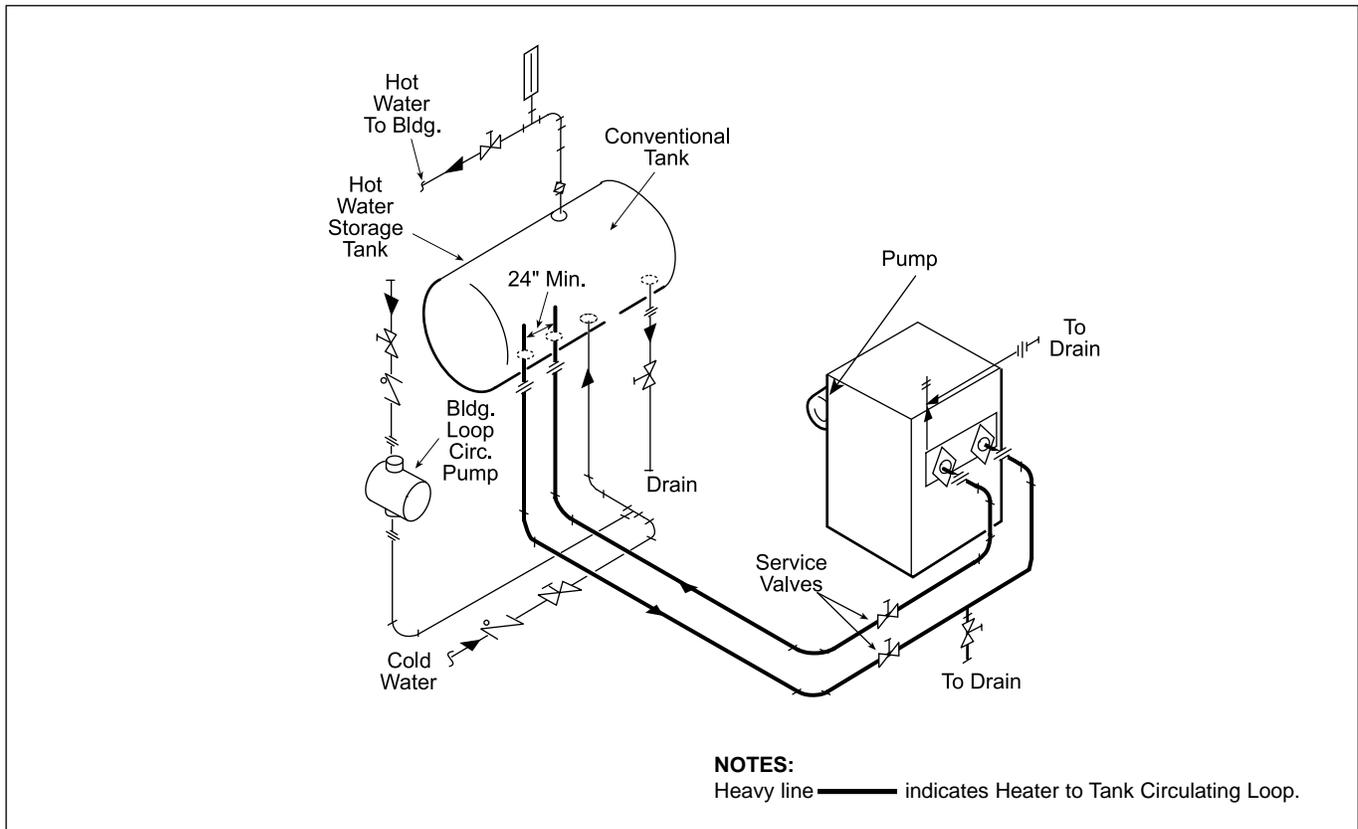


Figure 13. Hot Water Supply System with Horizontal Tank.

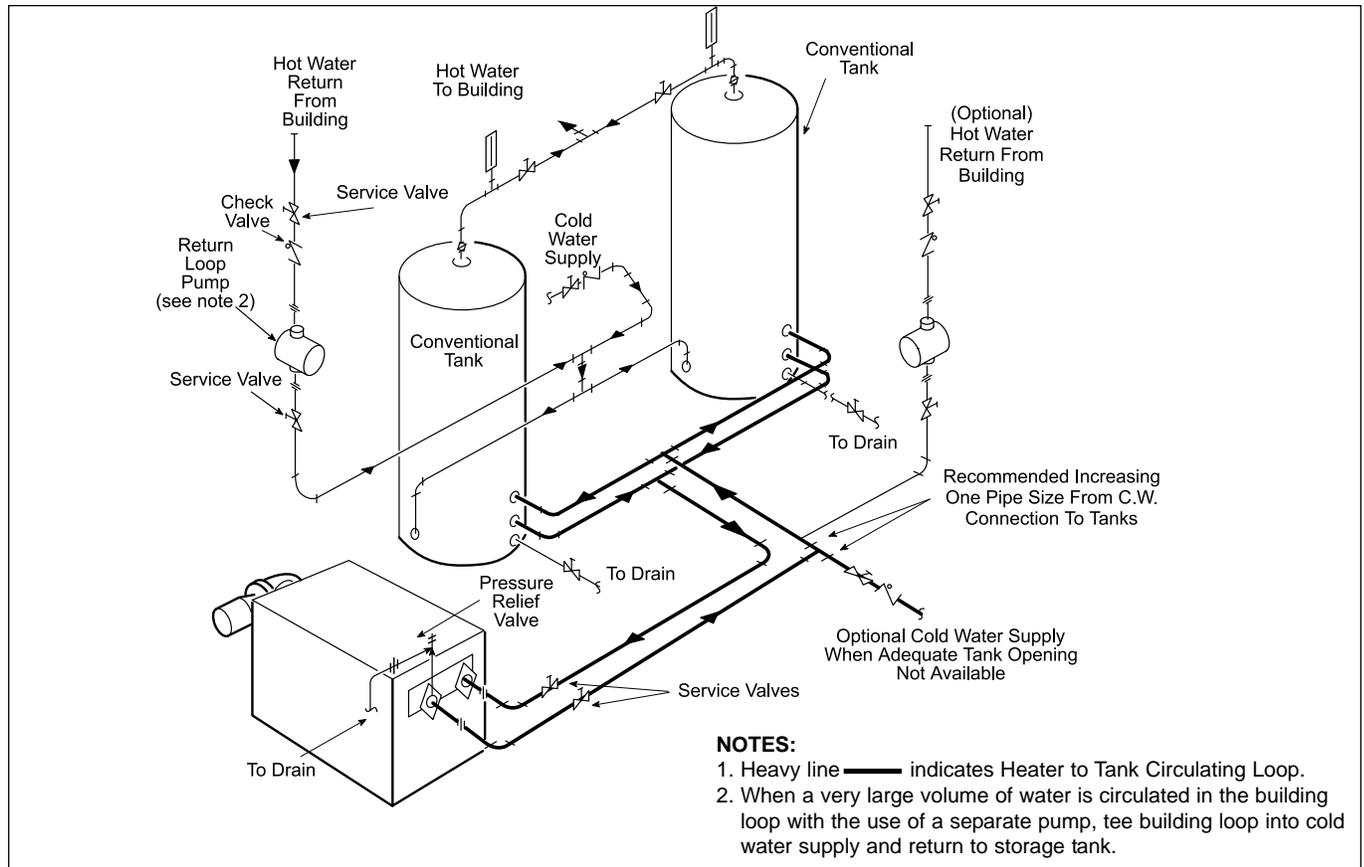


Figure 14. Hot Water Supply System Using Dual Tanks.

2. Model **PW** heater is not suitable for heating swimming pools or any other application where temperature of the water flowing through the heater remains below the dew point (110°F).

In applications requiring the rapid use of measured volumes of water, the recovery of the heater between the time intervals of use must equal the volume used. See the recovery table in the current **Document 2129 (Submittal Data)**.

3. **Pump Sizing:** the heater circulating pump is sized to provide enough flow to prevent damage to the heat exchanger. Specifications in Table 4 include allowance for 30 feet of piping and 6 elbows between heater and tank.

**IMPORTANT:** Check oil level in pump before starting. Oil pump every three (3) months. Fill bearing assembly to lower level of overflow vent. Add five (5) or six (6) drops of oil to front and rear of motor. Use 20W non-detergent oil. Pumps located in excessively hot or dusty locations should be oiled once a month. Self lubricating pumps do not require oiling.

4. The pump should be accessible for lubrication, inspection and service.

Model	Water Category	Flow Rate (GPM)	Head* Loss (ft.)	Temp. Rise Across Heater, (°F)
500	Soft	45	5.0	17
	Normal	68	9.9	11
	Hard	90	15.7	8
715	Soft	45	5.3	24
	Normal	68	11.0	16
	Hard	90	17.8	12
999 and 1010	Soft	45	3.9	35
	Normal	68	7.5	23
	Hard	90	11.7	18
1200	Soft	68	7.8	27
	Normal	68	7.8	27
	Hard	90	12.2	21
1430	Soft**	68	8.1	32
	Normal	68	8.1	32
	Hard	90	12.6	24
1825	Soft**	90	13.5	30
	Normal**	90	13.5	30
	Hard	90	13.5	30

<b>Water Category</b>	<b>Grain Hardness per Gal.</b>
Soft	1 through 7.5
Normal	7.6 through 17
Hard	Over 17

\* Pressure drop includes loss through 30 feet of pipe and normal fittings when heater is installed with storage tank. Pipe and fittings are assumed to be 2" on Models (500-715) and 2 1/2" on Models (1010-1825)

\*\* To prevent erosion, these models must be ordered with cupro-nickel heat exchanger tubes.

Table 4. Pump Performance Requirements.

### 3.3.5 Water Pressure

It is very important that water pressure in the system be maintained above 30 psi. If the system pressure should drop below this, the vapor pressure of water in the suction side of the pump can cause hammer and cavitation in the pump and damage the heater through lack of water circulation.

For protection against excessive pressure the water heater is equipped with a pressure relief valve.

When the water heater is connected to a separate storage vessel, a temperature and pressure relief valve must be installed on the storage vessel. The temperature and pressure relief valve must be design-certified in accordance with the requirements for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22. (in Canada, in accordance with the requirements for the Standard for Temperature and Pressure Relief Valves and Vacuum Relief Valves, CAN1-4.4).

The temperature and pressure relief valve must have a BTU/h (kW/h) capacity rating that is greater than the BTU/h (kW/h) input of the water heater. The temperature and pressure relief valve must be marked with a maximum working pressure not to exceed the maximum working pressure shown on the rating plate of the water heater, or the maximum working pressure of the separate storage vessel, whichever is the lower pressure. The temperature and pressure relief valve must have a *maximum* working temperature not to exceed 210°F (99°C).

Do not place any shutoff valves between the temperature and pressure relief valve and the storage vessel.

The relief valves discharge water in large quantities should circumstances demand.

### 3.3.6 Tank Installation

1. Be sure the floor is waterproof and structurally capable of supporting the tank when it is filled with water.
2. The tank should be placed so that manholes, inspection covers, nameplates and drain valves are accessible.
3. Be sure the tank is suitable for the water in the system. Some water is corrosive and requires a protected tank with a special lining.
4. If the tank is glass-lined, it should be equipped with a suitable magnesium anode. It is good practice to replace the anode when it is approximately 50% used. The factory warranty on a glass-lined tank, if provided, will be void if a satisfactory anode is not in place at the time of a failure or if it is consumed by cathodic action.
5. Make sure the tank connections in the heater-tank circulating loop are the proper size as listed in Section 3.3.4. If tappings are smaller than the recommended pipe size, a larger pump may be required. Consult the factory if in doubt.
6. Install a pipe in the tank drain fitting that goes to a floor sink, and install a drain valve. If a floor sink is not available, install a hose bib.

### 3.3.7 Two-Temperature System

See Figures 15 and 16 for piping schematics. This system is designed to maintain the tempered water circulating loop at the desired temperature

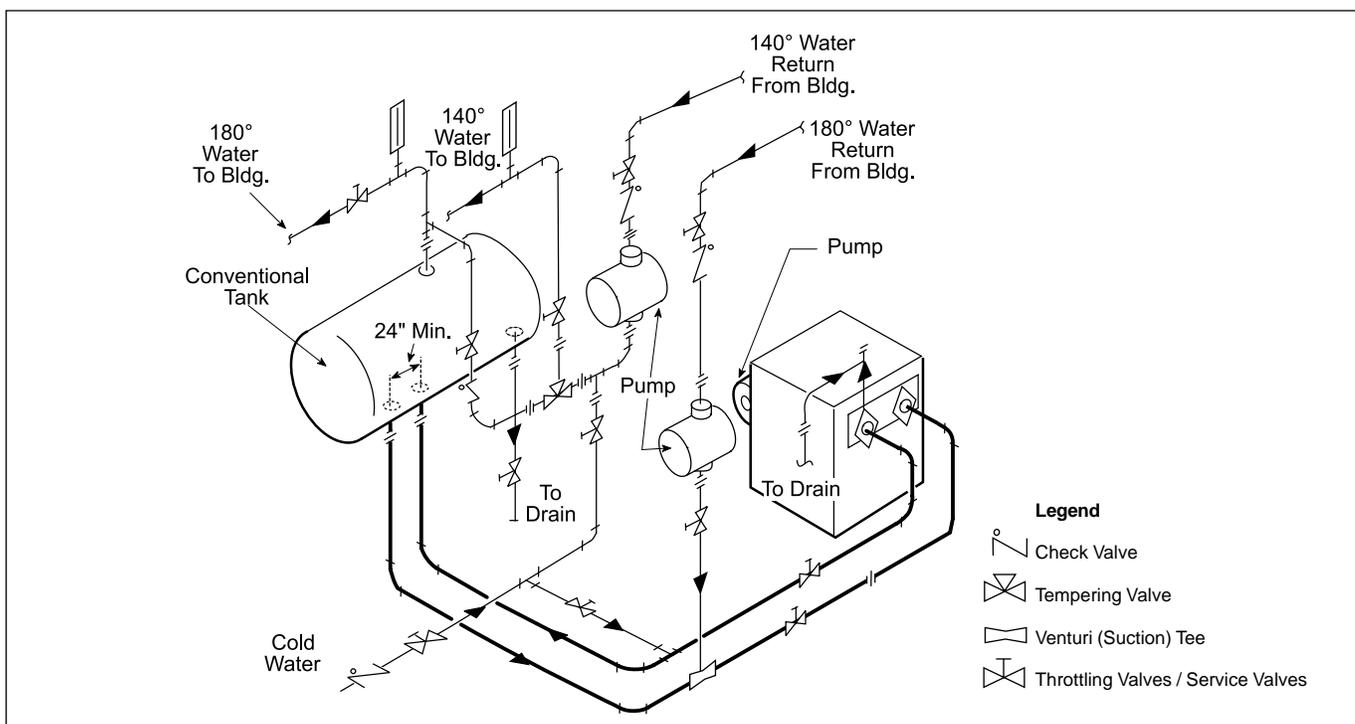


Figure 15. Two Temperature Hot Water Supply system with Horizontal Tank.

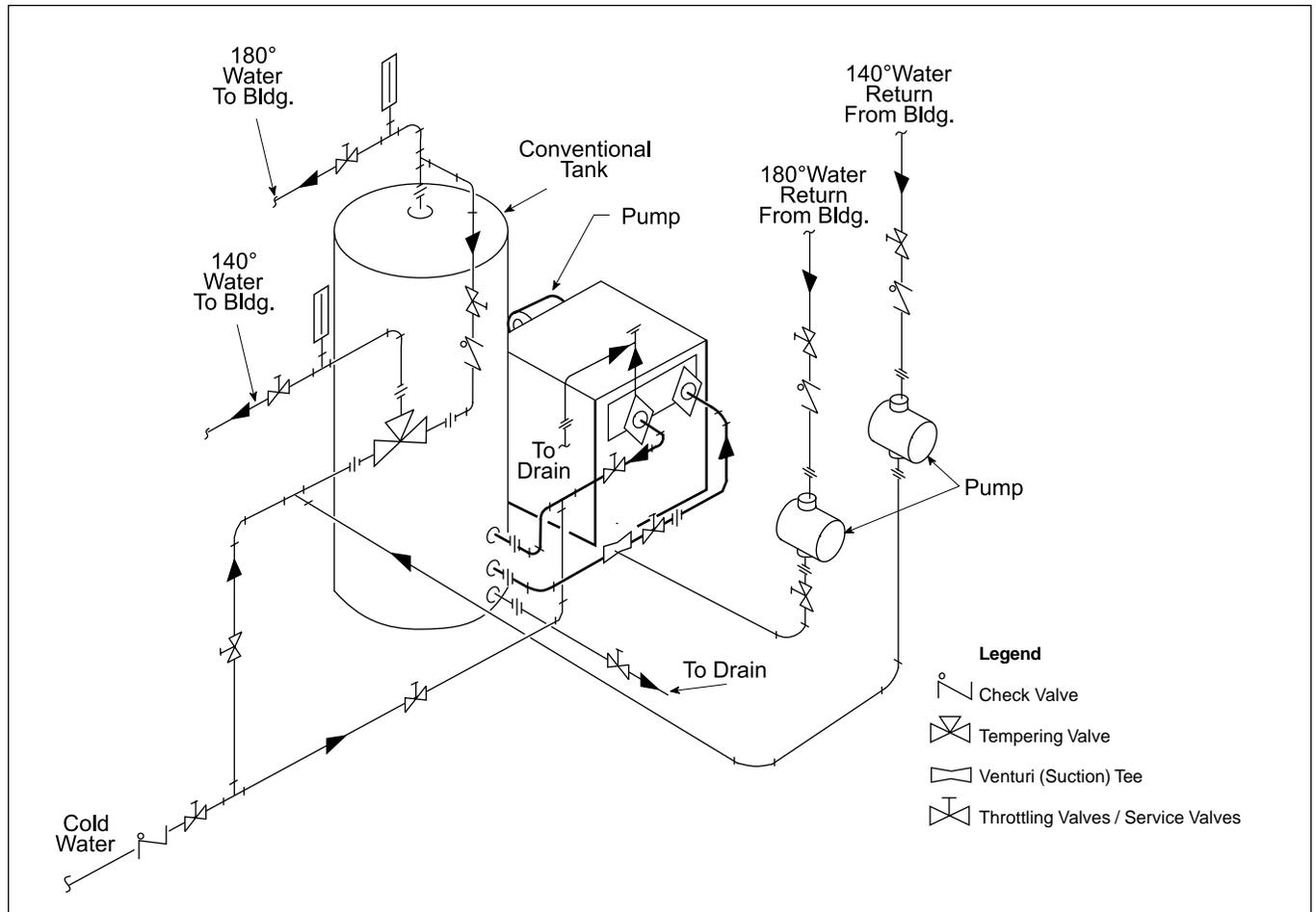


Figure 16. Two Temperature Hot Water Supply System with Vertical Tank.

during idle periods as well as when there is a demand for hot water. It is recommended for general purpose water supply including shower and bathing applications. Water at 180°F is available directly from the tank.

### **⚠ WARNING**

Hot water can scald! Hot water can produce third degree burns in 6 seconds at 140°F (60°C) and in 30 seconds at 130°F (54°C).

VAC establishing the flame at the burner(s). The control then switches to the sensing mode to monitor the flame presence. The unit performs its own safety check during trial for ignition period and if the flame is not established, the control interrupts the power to the main gas valve(s) and goes into lockout.

#### **4.1.2 Hot Surface Igniter**

This is a 120 VAC, silicon carbide igniter. During ignition cycle the igniter will glow for a few seconds until reaching the proper ignition temperature to ignite the gas at the burner ports.

## **SECTION 4. Operating Instructions**

### **4.1 Controls - General**

(See Figures 17 and 18)

#### **4.1.1 Electronic Ignition Control**

This is a proved hot surface ignition control. It combines a hot surface igniter and a flame sensor. Upon a call for heat, the igniter is energized from a nominal 120 VAC and is proven to be capable of ignition. The gas valve(s) is then powered with 24

#### **4.1.3 Combustion Air Pressure Switch**

The diaphragm type air pressure switch is provided to prove the combustion air flow required for proper combustion. Tube connection is attached to the positive barbed end.

#### **4.1.4 Operating Controls**

Single or two-stage aquastats are provided in models PH and PW heaters to control the desired service water temperature. The temperature sensing bulb is located either in the boiler inlet or outlet header.

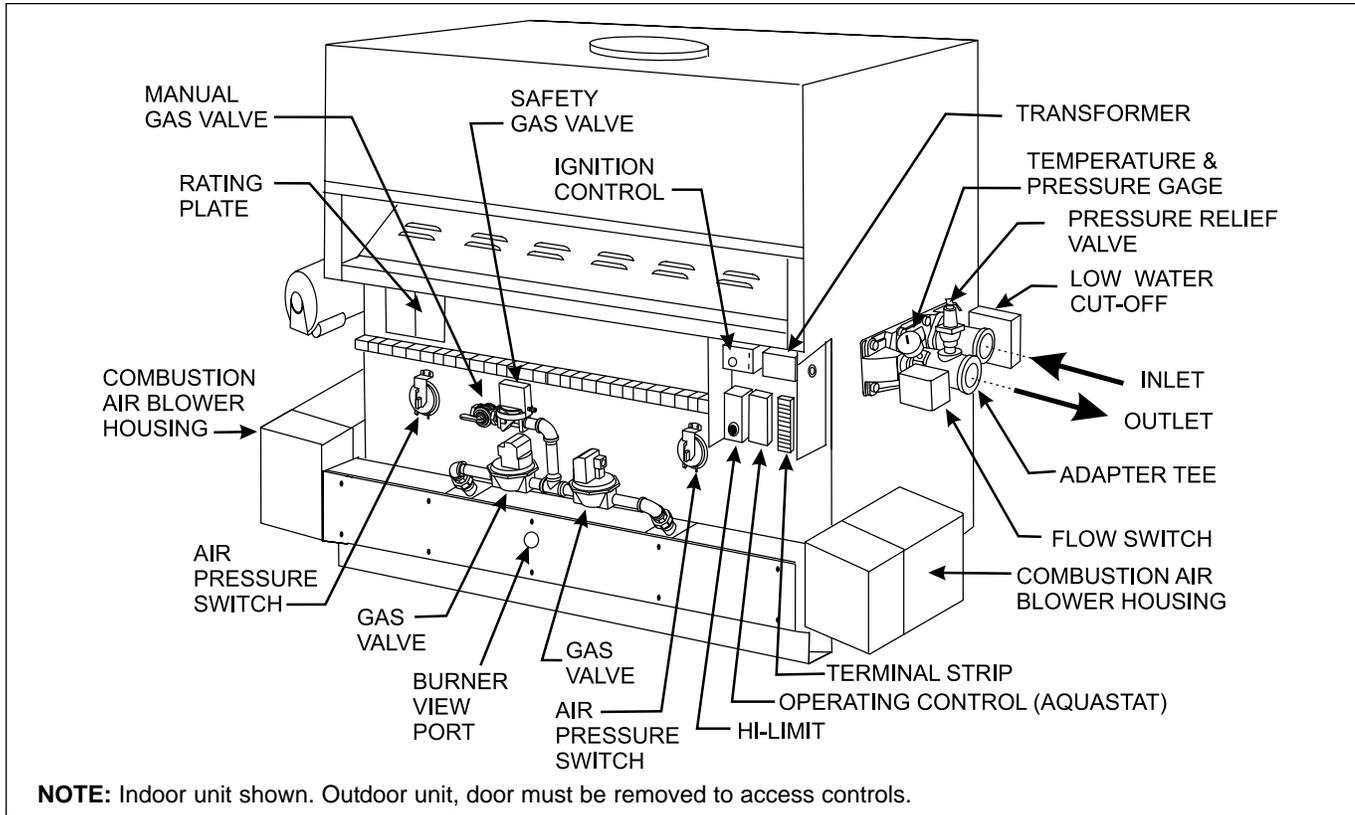


Figure 17. Controls Location.

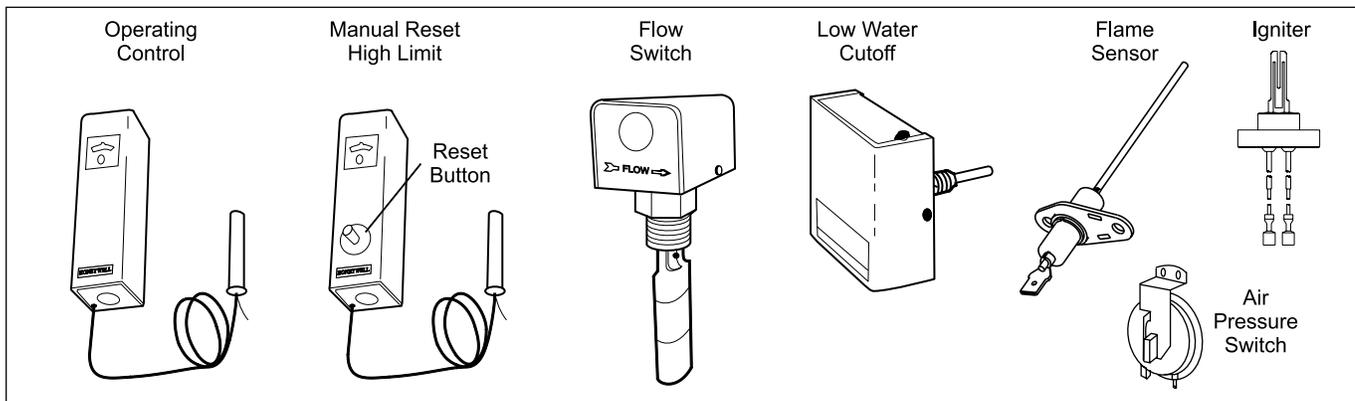


Figure 18. Operating and Safety Components.

**4.1.5 High Limit Control**

The manual reset high limit switches are provided as standard equipment on all heaters. Automatic reset switches are optionally provided. The temperature sensing bulb of the switch is always located in the heater outlet. Burners will automatically shut down whenever overheating of water occurs (exceeding the temperature set point of the switch).

**4.1.6 Flow Switch**

Standard on all models: The switch is mounted in the outlet “tee” connection. The flow switch shuts down all burners in case of pump failure and/or reduced water flow.

**4.1.7 Low Water Cut Off**

The low water cut off automatically shuts off the heater whenever water level drops below probe. The probe is located at the heater water inlet header.

**4.2 Start-Up Requirements**

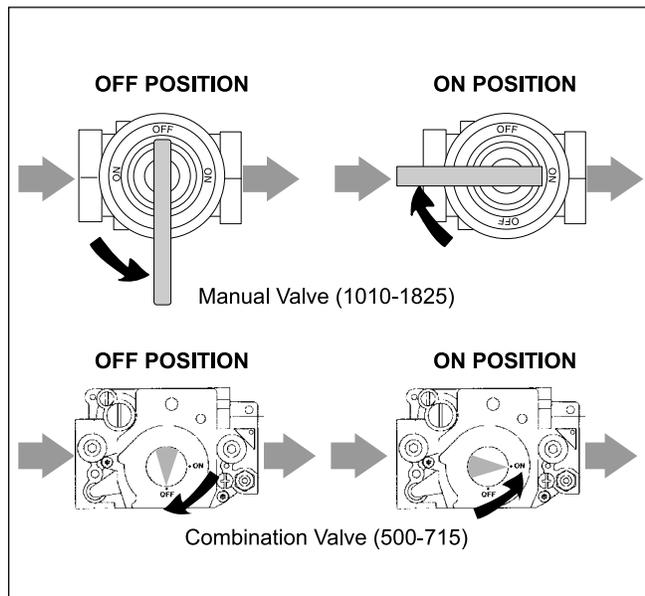
**⚠ WARNING**

Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the heater. The possible damage to a flooded appliance can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.

**NOTE:** Safe lighting and other performance criteria were met with the gas manifold and control assembly provided on the heater when it underwent tests specified in ANSI Z21.13 and CAN1-4.3-M85.

Before placing the heater in operation, check the automatic safety shutoff devices. Once the heater is connected to the gas piping and after all of the requirements in Sections 2 and 3 have been met, follow these procedures:

1. Before beginning the tests, make sure the main manual gas valve, and any other heater firing valves, are in the OFF position. The heater's gas valve is turned OFF as follows:
  - a. Sizes 500 and 715: Turn the gas control knob clockwise to OFF.
  - b. Sizes 1010 through 1825: Manual gas valve is OFF when handle is at right angle to the gas pipe (see Figure 19).



**Figure 19. Handle Position of Gas Valves.**

2. Before placing the heater in operation, be certain that the heater is filled with water and all air is purged from the system.
3. Make sure the power switch on the heater is in the ON position. Reset all safety devices (hi-limit, switch, low water cutoff, etc.).

### 4.3 Normal Operating Sequence

When the circulation pump is running, the heater will turn itself on and off via the temperature control. When the water temperature drops below the differential setting, below the set point, the following sequence happens:

1. The temperature control (aquastat) powers the ignition control.

2. The ignition control turns on the combustion blower. After about a 15 second pre-ignition purge, while the blower clears the combustion chamber, the igniter is turned on. The igniter takes about 25 seconds to heat up. A glow can be seen through the view port (see Figure 17).
3. The manual gas valve must be ON for the burner to ignite. This valve is turned ON as follows:
  - a. Size 500 and 715: Turn counterclockwise to ON (see Figure 19).
  - b. Sizes 1010 through 1825: Valve is ON when handle is parallel to the gas pipe (see Figure 19).

### 4.4 Hi-Limit Checkout

After running the boiler for a long enough period to bring the water temperature within the range of the hi-limit, slowly back off the high limit setting until the boiler shuts off. The main burners should re-ignite when the hi-limit is turned back up to its original setting and the hi-limit is reset.

### 4.5 Start-Up Procedure

(See Section 4.2 for Startup Requirements)

#### **⚠ WARNING**

If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

1. This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
2. BEFORE OPERATING, smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle to the floor.
 

#### WHAT TO DO IF YOU SMELL GAS

  - a. Do not try to light any appliance.
  - b. Do not touch any electric switch; do not use any phone in your building.
  - c. Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
  - d. If you cannot reach your gas supplier, call the fire department.
3. Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

- Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace the heater.

#### 4.5.1 Lighting Instructions

- STOP! Read the safety information (1 through 4) above.
- Turn off all electric power to the appliance.
- Remove control access panel.
- Set the thermostat or aquastat to lowest setting.
- This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
- Turn off manual gas valve. Valve is off when valve handle is at right angle to the gas pipe. On combination valves (size 500 and 715) turn gas control knob clockwise ↻ to OFF position (see Figure 19).
- Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas, STOP! Follow the safety information titled "Before Operating". If you don't smell gas, go to next step.
- Turn gas control knob counterclockwise ↻ to ON.
- Set thermostat or aquastat to desired setting.
- Replace control access panel.
- Turn on all electric power to the appliance.
- If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

#### 4.5.2 To Turn Off Gas to Appliance

- Turn off all electric power to the appliance if service is to be performed.
- Remove control access panel.
- Set the thermostat or aquastat to lowest setting.
- Turn the gas control knob clockwise ↻ to OFF. Do not force.
- Replace control access panel.

### 4.6 Setting the Temperature Controls

#### 4.6.1 Hydronic Boilers

To set the temperature and high-limit controls:

- Set the temperature controller at the system design temperature.

- Set the high-limit 40°F to 50°F above temperature controller setting.

#### 4.6.2 Water Heaters

The hi-limit switch is factory set and should not be adjusted.

#### WARNING

Adjusting the temperature control past the recommended setting can result in a scalding injury. Hot water can produce third degree burns in 6 seconds at 140°F (60°C) and in 30 seconds at 130°F (54°C).

Water temperature can be adjusted at the temperature control. The temperature control is adjusted to its lowest setting when it is shipped from the factory. The 130°F (54°C) setting is the recommended starting point for setting the temperature control. Make sure that the hi-limit switch is set 30°F (17°C) higher than the temperature control.

The recommended setting will result in satisfactory energy savings. Lowering the temperature may result in reduced energy costs. Connecting the heater to a separate storage vessel and lowering the temperature setting, may reduce energy losses during standby periods when hot water is not being used, and may meet normal hot water needs. For increased hot water usage, a higher temperature setting may be necessary to meet increased demand. Reset the temperature setting to a lower level after periods of increased usage are over.

## SECTION 5. Maintenance

#### Caution

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

### 5.1 General Instructions

- Oil the water circulating pump in accordance with the manufacturer's instructions.
- Oil the combustion air blower motor bearings every 6 months.
- If a strainer is used in a pressure reducing valve or in the piping, clean it every 6 months in accordance with the manufacturer's instructions.

4. At startup and every 6 months after, using the burners view port, look at the burner flame for proper performance. The burner should not require maintenance in normal operation. If any malfunction indicates that the burner needs service (e.g., a flame that is yellow, or entire burner surface glowing red), call a professional service technician. The flame should be checked for the following:
  - a. Normal Flame: Blue flame color, with slight yellow tips, with a well-defined inner cone.
  - b. Yellow Flames: Can be caused by blockage of primary air flow to the burner(s) or excessive gas input. This condition **MUST** be corrected immediately.
  - c. Lifting Flames: Lifting flames can be caused by over firing the burner(s) or excessive primary air.
5. Inspect the venting system for blockage, leakage, and corrosion at least once a year.
6. Keep the heater area clear of combustible material, gasoline, and other flammable liquids and vapors.
7. Be sure all combustion air and ventilation openings are not blocked.

## 5.2 Combustion Air Blower

This heater uses a fan assisted combustion process. For proper operation of the burners, inspect the air blower for contamination one week after start-up and every three (3) months thereafter. Blower housing inlet must be completely isolated and protected from any source of corrosive chemical fumes, and from exhaust vents of cleaning equipment or laundry establishments.

1. To inspect and service the blower, shut off all electrical and gas supply to the heater.
2. Remove the screws holding the blower housing cover to expose the blower (see Figure 20).
3. Remove filter and clean any contamination or debris (see Figure 20).
4. Remove the air orifice off the blower inlet to inspect the blower wheel. Clean the blower housing and its wheel from any contamination or debris.
5. Remove manifold compartment cover, inspect the compartment and around the gas manifold for lint or any other form of debris. If required, vacuum out all contamination.
6. Replace all parts securely in place.

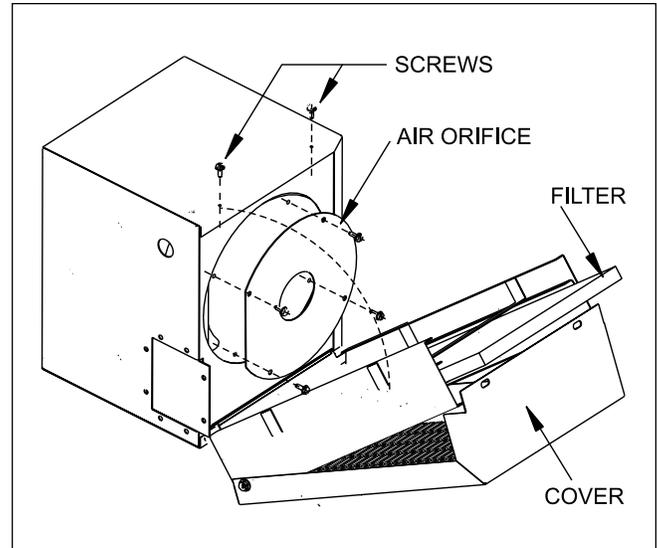


Figure 20. Blower-Housing.

## 5.3 Heat Exchanger

Check for fouling on the external surfaces of the heat exchanger every six months. (**NOTE:** After installation and first start-up, check the heat exchanger for fouling after the following periods of operation: 24 hours, 7 days, 30 days, 90 days, and once every six months thereafter).

### **⚠ WARNING**

Improper installation or maintenance can cause nausea or asphyxiation from carbon monoxide in flue gases which could result in severe injury, property damage, or death.

Fouling on the external surfaces of the heat exchanger is caused by incomplete combustion and is a sign of combustion air and/or venting problems. As soon as any fouling is observed, the cause of the fouling should be corrected. The heat exchanger can be checked by removing the venting and top panel as necessary to inspect from above. Also check the vent system for defects at this time.

### 5.3.1 External Cleaning of Heat Exchanger

1. If cleaning is required, disconnect electrical supply to the heater and remove wires and conduit from the heater's pump.
2. Turn off the gas supply by closing the manual gas valve on the heater.
3. Isolate the heat exchanger from water supply.
4. Remove the vent pipe (for outdoor units remove vent top assembly), top panel, upper jacket assembly and flue collector (see Figures 22 and 28).
5. Drain the heat exchanger.

6. Disconnect the flange and the adapter tee from the heat exchanger inlet and outlet.
7. Remove temperature-sensing probes from inlet and outlet header.
8. Remove the heat exchanger from the heater. *The heat exchangers are heavy and require minimum two people to remove to avoid personal injury*
9. Remove the tube's baffles from the heat exchanger.

### Caution

Black carbon soot buildup on a dirty heat exchanger can be ignited by a random spark or flame. To prevent this from happening, dampen the soot deposits with a wet brush or fine water spray before servicing the heat exchanger.

10. Clean the heat exchanger: A light accumulation of soot or corrosion on the outside of the heat exchanger can be easily removed after the heat baffles are removed. Use a wire brush to remove loose soot and scale from the heat exchanger. Do not use water or compressed air for cleaning.  
**NOTE:** While the heat exchanger is out of the heater, inspect the firewall refractory blocks for cracks, wear and breakage. Replace if necessary.
11. Reassemble in reverse order and be sure the heat exchanger baffles are replaced.

#### 5.3.2 Internal Cleaning of Heat Exchanger

1. To remove the heat exchanger, follow the procedure detailed in 5.3.2 (1 through 8).
2. Remove the inlet/outlet header of the heat exchanger.
3. Remove the return cover of the heat exchanger.
4. Clean the internal surface. (Laars offers a tube cleaning kit part no. R00100000.)
5. Reassemble in the reverse order.

#### 5.4 Gas and Electric Controls

The gas and electric controls on the heaters are designed for both dependable operation and long life. Safe operation of the heater depends on their proper functioning. A professional service technician should check the following basic items every year, and replace when necessary.

**NOTE:** the warranty does not cover damage caused by lack of required maintenance or improper operating practices.

1. Water temperature controls.
2. Ignition control system.

3. Air pressure proving switch(es).
4. Automatic electric and manual gas valve(s).
5. Water flow sensing safety device.
6. Low water cutoffs (every six months).

#### 5.5 Burner Removal and Cleaning

1. Disconnect electrical supply to the heater.
2. Turn off main manual gas valve on the heater.
3. Remove the cover of air mixture plenum.
4. Disconnect air tube(s) from air mixture plenum barb(s), and remove wires from igniter and flame sensor.
5. Disconnect gas valve train from the gas manifold.
6. Remove screws from manifold mounting brackets. Pull manifold/orifice assembly away from the burner panel.
7. Remove screws attaching air mixture plenum to the side air duct(s) and to the burner panel, and then slide away the mixture plenum.
8. Remove burner panel off the front lower jacket.
9. Disconnect burners from panel by removing mounting screws from each burner. Use caution to prevent damage to burner gaskets, insulation blanket, hot surface igniter or flame sensor.
10. Clean soot and any debris from burners with a stiff bristle brush. Damaged burners or burner gaskets must be replaced.

## SECTION 6. Troubleshooting

### 6.1 Sequence of Operation

To troubleshoot the heater properly you must first understand the sequence of operation of the heater:

1. Upon a call for heat a 24 VAC signal is sent through fusible links and high limit(s) to the ignition control "H" terminal.
2. The "IND" terminal of the ignition control is energized with 115 VAC for a (15) second pre-ignition purge period during which the combustion blower purges the combustion chamber.
3. After the purge period, terminal "S1" is energized with 115 VAC for (20 to 35) second igniter heat up period. The glow of the igniter can be seen through the heater view port.
4. Then there is a seven second trial for ignition. During this time the gas valves are energized with 24 VAC, and the main burner ignites. The gas valves will remain energized throughout the call for heat as long as the ignition control flame sensor senses a stable flame.

5. After the call for heat is satisfied the ignition control closes the gas valves and operates the blower for a thirty (30) second post purge cycle. This clears the combustion chamber of combustion products.

The ignition is attempted one time. If ignition is not successful, the control shuts down and “locks out.” It remains in the lockout condition until the lockout reset button on the ignition control is reset.

## 6.2 Electrical Components

This section describes guidelines for checking the operation of electrical components installed on the heater. Refer to the wiring diagram for correct connection locations.

### 6.2.1 General Troubleshooting

This section describes guidelines for checking the electrical components of the heater. Experience has shown that most complaints about heaters failing to fire have nothing to do with the heater itself. Usually, one of the protective switches in the heater system has shut down operation.

Any of the following can prevent proper operation. Check these items first:

1. Be sure the heater has been properly installed (see Section 2 and 3).
2. Make sure the pump is not airlocked, clogged or otherwise inoperative.
3. Make sure the gas valve is on and there is sufficient gas pressure in the line. All external gas valves must be open.

#### Caution

The ignition control and igniter operate on 115VAC power. Keep this in mind while servicing the heater, and take care to avoid electrical shock.

4. Verify that the electrical circuit serving the heater is ON.
5. Make sure the toggle switch on the right side of the heater is ON.
6. Check the fuse inside the black, twist-lock fuse holder. If it is burned, replace it.
7. With the power off inspect all electrical connections and wiring. Finding a loose connection or charred wire can save a lot of time and money.
8. Make sure the temperature controller is set high enough to call for heat.

9. Make sure none of the manual reset controls, i.e., low water cutoff, high limit, etc., have tripped. Reset any tripped switches.

If the pump is circulating water and the foregoing items check out okay, the trouble may be in the heater control system.

**IMPORTANT:** Disconnect power to the heater before removing or replacing any component or wire connection. If the power is not disconnected, “jumping” the gas valve or accidentally grounding the wire harness or component terminals to the heater frame or jacket could cause the ignition control fuse to blow.

### 6.2.2 Electrical Troubleshooting

Troubleshooting procedures should only be performed by professional service technicians qualified in heater maintenance.

Some electrical components are wired in parallel, so it is necessary to troubleshoot in the order that they appear on the wiring diagram or the troubleshooting flow chart (see Figure 21).

The following steps should be used when troubleshooting the heater:

1. Remove the control panel cover of heater.
2. Turn the manual gas valve on the heater off.
3. If the heater has locked out turn the toggle switch off for 5 seconds then back on to reset the heater.
4. Use the troubleshooting flow chart (see Figure 21) to determine what components and wiring should be tested first.
5. Test each component by checking for 24 VAC or 115 VAC entering and exiting the device. If there is voltage entering the safety device, but none leaving then there is an open circuit and it must be determined why it is open. When testing components between “MV” of the ignition control and the gas valve install a meter and let the heater cycle through one complete sequence of operation. During the sequence of operation these safeties will only be energized for the seven second trial for ignition.
6. Turn the manual gas valve of the heater on and fire the heater.

#### Caution

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

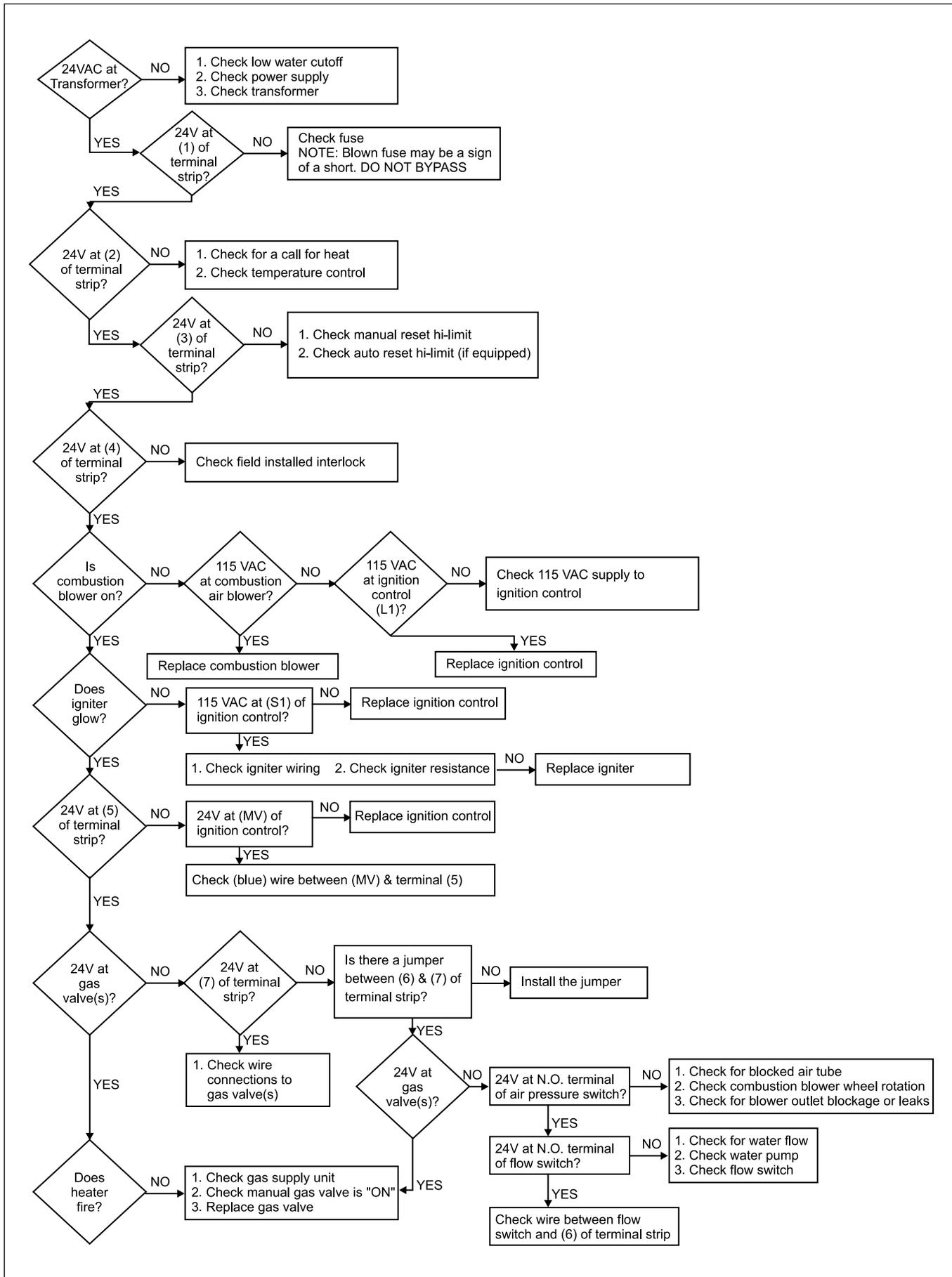


Figure 21. Troubleshooting Chart.

## 6.3 Mechanical Components

### 6.3.1 Pressure Relief Valves Leaking Intermittently or Steadily

Possible Cause	Remedy
A. Static pressure in system exceeds setting of relief valve.	A. Calculate height of water in system above heater. Install new valve with psi setting 25% above required static system working pressure. Do not exceed 160 psi.
B. Expansion tank is waterlogged (if installed).	B. Drain expansion tank, then reopen it to the system. Look for leaks in expansion tank or fittings. Calculate required volume of expansion tank in relation to system to determine that tank is adequate.

### 6.3.2 Heater is Pounding, Knocking or Emitting Steam from Relief Valves

A. Low or no water flow.	A. This condition is usually caused by lack of adequate water flow through heater. Check the following: <ol style="list-style-type: none"> <li>1. Is the heater wired into the pump circuit so that the heater cannot fire unless the pump is running?</li> <li>2. Check to see that all valves in system are open to be sure that water can circulate through the heater and the system.</li> <li>3. If the system has automatic water valves (2-way or 3-way) that can cut off the water flow through the heater, check to see that they are equipped with end-switches which shut the heater down when the water flow through the heater is reduced by 70% from full flow</li> <li>4. Examine pump for clogged impeller.</li> </ol>
B. Low or no system pressure.	B. Clean strainer in pressure reducing valve. Look for closed valve water line or a leak in the system.
C. Clogged "Y" strainer.	C. Remove strainer element and clean screen.
D. Debris from system piping is blocking tubes.	D. Remove header covers. Examine all tubes and waterways. Use new gaskets when reassembling. Clean out tubes.
E. Scale has formed in tubes.	E. PH - Check for inflow of raw water (is due to system leak). See Section 3.2. PW - Water chemistry or flow problems, see Section 3.3.

### 6.3.3 Soot in Flueways or in Tubes, or Noxious Fumes Indicative of Bad Combustion

A. Combustion air supply to heater room is inadequate.	A. Check air supply opening. Look for debris in screen or louver which covers combustion air opening, or for material blocking the opening.
B. Stack or vent is blocked or restrictive.	B. Look for blocked stack and excessive number of elbows in stack or excessive length of horizontal runs.
C. Severe down draft is causing spillage of flue products into room.	C. Check for (1) proper vent cap on stack; (2) adequate height of stack above roof; (3) equipment exhausting air from inside of building; and (4) proper installation of draft diverter.
D. Gas pressure to burners is excessive.	D. Check gas pressure with manometer, and adjust with heater firing at full rate.
E. Heater not fitted for the fuel being supplied.	E. See nameplate for correct fuel.

### 6.3.4 Water Dripping in Firebox

A. Tube in heat exchanger has overheated and ruptured.	A. A tube failure is almost always caused by (a) scale formation in the tube or (b) inadequate water flow through the boiler.
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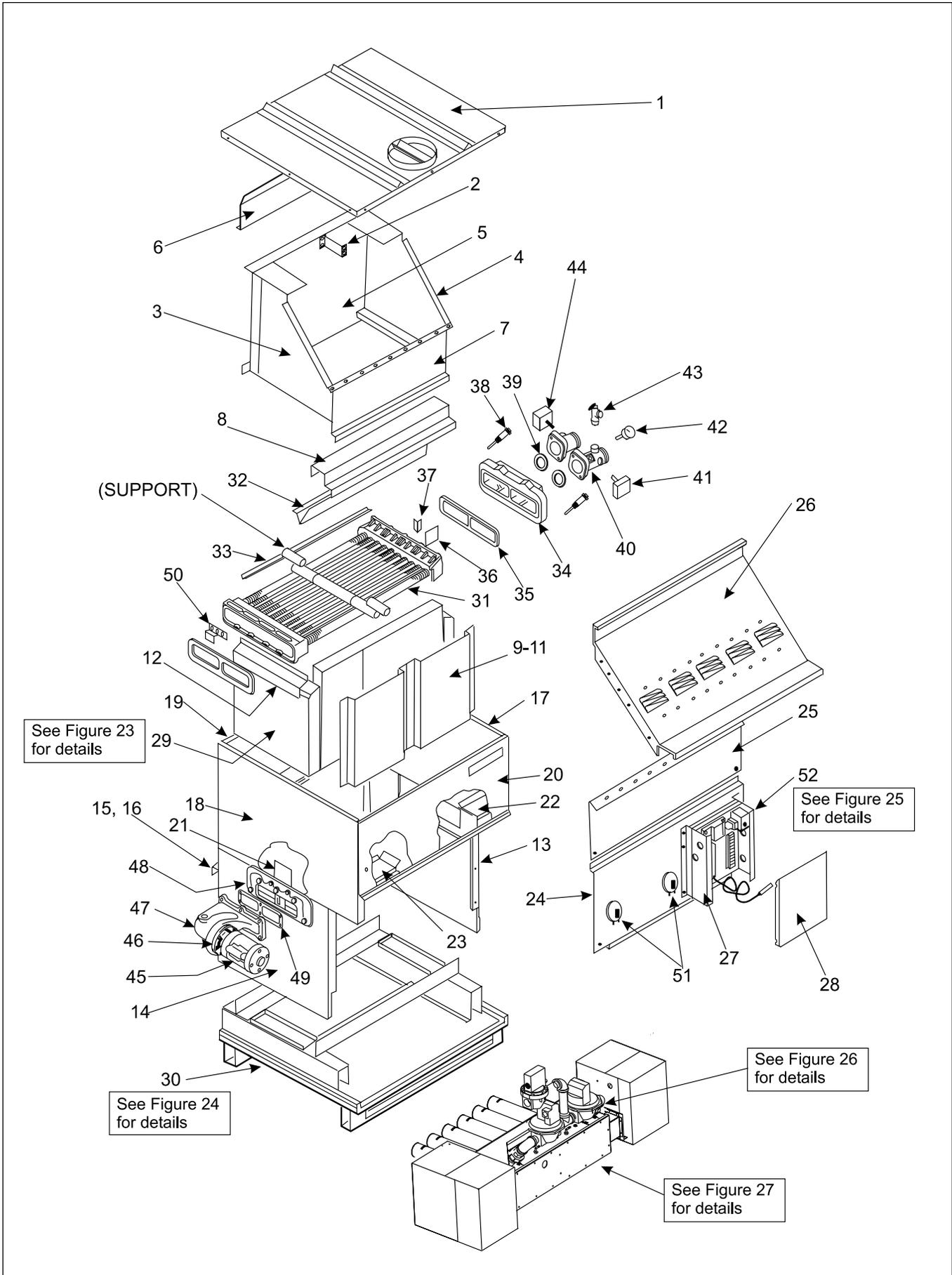


Figure 22. Parts Identification.

## SECTION 7.

### Parts Descriptions and Order Numbers

Key Description No	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
<b>7.1 Jacket and Combustion Chamber Components</b>						
1 Top Panel Assembly (Indoor)	10535701	10535703	10535705	10535706	10535707	10535709
2 Spacer, Flue Collector	-	-	10540800	10540800	10540800	10540800
3 End panel, Flue Collector, Left	10533700	10533700	10533700	10533700	10533700	10533700
4 End Panel, Flue Collector, Right	10533800	10533800	10533800	10533800	10533800	10533800
5 Rear Panel, Flue Collector	10661701	10661703	10661705	10661706	10661707	10661709
6 Rear Panel, Ext., Flue Collector (Indoor)	10661801	10661803	10661805	10661806	10661807	10661809
7 Front Support, Flue Collector	10662101	10662103	10662105	10662106	10662107	10662109
8 Tile Cover, Front/Rear	10661501	10661503	10661505	10661506	10661507	10661509
	(2)	(2)	(4)	(4)	(4)	(4)
9 Tile Heat Shield/Spacer Front and Rear	10560100 (2)	-	-	-	-	-
10 Tile Heat Shield/Spacer, Front	-	10547902	-	10547903	10547901	10547903
Tile Heat Shield/Spacer, Front	-	-	10548003	10548101	-	10548001
Tile Heat Shield/Spacer, Front	-	-	-	-	10548102	10548104
11 Tile Heat Shield/Spacer, Rear	-	10548202	-	10548203	10548201	10548203
Tile Heat Shield/Spacer, Rear	-	-	10548303	10548401	-	10548301
Tile Heat Shield/Spacer, Rear	-	-	-	-	10548402	10548404
12 Saddle Assembly, End Tile	10533600 (2)	10533600 (2)	10533600 (2)	10533600 (2)	10533600 (2)	10533600 (2)
13 Lower End Panel/ Heat Shield Weldment, Right	10540701	10540701	10540701	10540701	10540701	10540701
14 Lower End Panel/ Heat Shield Weldment, Left	10540702	10540702	10540702	10540702	10540702	10540702
15 Lower Rear Panel Weldment	10532901	10532903	10532905	10532906	10532907	10532909
16 Middle Rear Panel/ Heat Shield Weldment	10540401	10540403	10540405	10540406	10540407	10540409
17 End Panel, Upper Right	10531600	10531600	10531600	10531600	10531600	10531600
18 End Panel, Upper Left	10534000	10534000	10534000	10534000	10534000	10534000
19 Upper Rear Panel/ Heat Shield Weldment (Indoor)	10540501	10540503	10540505	10540506	10540507	10540509
20 Front Panel, Upper (Indoor)	10531501	10531503	10531505	10531506	10531507	10531509
21 Bracket, Support, End Tile	10551000 (2)	10551000 (2)	10551000 (2)	10551000 (2)	10551000 (2)	10551000 (2)
22 Drafthood, Relief Baffle, Right (Indoor)	10540901	10540903	10540905	10540906	10540907	10540909
23 Drafthood, Relief Baffle, Left (Indoor)	10541001	10541003	10541005	10541006	10541007	10541009
24 Lower Front Panel/ Heat Shield Weldment	10554601	10554603	10554605	10554606	10554607	10554609
25 Middle Front Panel	10662001	10662003	10662005	10662006	10662007	10662009
26 Sweep Sheet, Flue Collector	10662201	10662203	10662205	10662206	10662207	10662209
27 Control Box Weldment	10545800	10545800	10545800	10545800	10545800	10545800
28 Control Box Cover (Indoor)	10547200	10547200	10547200	10547200	10547200	10547200
Control Box Cover (Outdoor)	10630300	10630300	10630300	10630300	10630300	10630300
29 Tile Assembles	<b>(Refer to Figure 23 for Configurations and Part Numbers)</b>					
30 Base/Tile Support Assembly	<b>(Refer to Figure 24 for Configurations and Part Numbers)</b>					
<b>7.2 Water System</b>						
31 10-Tube Assembly, Copper Tube/ Cast Iron Tubs	10665901	10665903	10665905	10665906	10665907	10665909
10-Tube Assembly, Copper Tube/ Bronze Tubs	20001101	20001103	20001105	20001106	20001107	20001109
10-Tube Assembly, CU-NI Tubes/ Cast Iron Tubs	20001001	20001003	20001005	20001006	20001007	20001009
10-Tube Assembly, CU-NI Tubes/ Bronze Tubs	10670401	10670403	10670405	10670406	10670407	10670409

NOTE: Numbers in ( ) represent quantity required for each size. Quantity is one otherwise.

Key Description No	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
32 Baffle Heat Exchanger Front/Rear	20020101 (2)	20020103 (2)	20020105 (4)	20020106 (4)	20020107 (4)	20020109 (4)
33 Baffle, Heat Exchanger (10-Tube)	10667701 (9)	10667703 (18)	10667705 (18)	10667706 (18)	10667707 (36)	10667709 (18)
Baffle, Heat Exchanger (10-Tube)	-	-	-	-	-	10667702 (18)
34 Inlet/Outlet Header (Glassed Cast Iron)	10364304	10364304	10364304	10364304	10364304	10364304
Inlet/Outlet Header (Bronze)	10364305	10364305	10364305	10364305	10364305	10364305
35 Gasket w/Barrier, Header	S0095100 (2)	S0095100 (2)	S0095100 (2)	S0095100 (2)	S0095100 (2)	S0095100 (2)
36 Barrier, Water	20230101 (2)	20230101 (2)	20230101 (2)	20230101 (2)	20230101 (2)	20230101 (2)
37 Baffle, Water Inlet	10338300	10338300	10338300	10338300	10338300	10338300
38 Well, Immersion	RE2058300 (2)	RE2058300 (2)	RE2058300 (2)	RE2058300 (2)	RE2058300 (2)	RE2058300 (2)
39 Gasket, Flange Tee	S0063700 (2)	S0063700 (2)	S0063700 (2)	S0063700 (2)	S0063700 (2)	S0063700 (2)
40 Tee, Flange (Bronze)	R20150302 (2)	R20150302 (2)	R20150303 (2)	R20150303 (2)	R20150303 (2)	R20150303 (2)
41 Flow Switch (Indoor)	E0013100	E0013100	E0013100	E0013100	E0013100	E0013100
Flow Switch (Outdoor)	RE0013000	RE0013000	RE0013000	RE0013000	RE0013000	RE0013000
42 Temperature Gauge	A2089500 (2)	A2089500 (2)	A2089500 (2)	A2089500 (2)	A2089500 (2)	A2089500 (2)
43 Valve, Pressure Relief (PH Model) 3/4 NPT 75 PSI 125 PSI (PW Model)	A0063300 RA0001200	A0063300 RA0001200	A0063600 RA0001200	A0063600 RA0001200	A0063600 RA0001200	A0063600 RA0063500
44 M/R Low Water Cutoff Switch	RE2075100	RE2075100	RE2075100	RE2075100	RE2075100	RE2075100
45 Pump, Motor/Impeller (PH Models)	A2000700	A2000700	A2000800	A2000800	A2000900	A2000900
Pump, Motor/Impeller (PW Models) Soft	RA2000700	RA2000700	RA2000700	RA2000700	RA2000700	RA2000900
Pump, Motor/Impeller (PW Models) Normal	RA2000700	RA2000700	RA2000800	RA2000800	RA2000800	RA2000900
Pump, Motor/Impeller (PW Models) Hard	RA2000900	RA2000900	RA2000900	RA2000900	RA2000900	RA2000900
46 Gasket Pump Motor	A0021400	A0021400	A0021400	A0021400	A0021400	A0021400
47 Pump Housing (Glassed Cast Iron)	R10261501	R10261501	R10261501	R10261501	R10261501	R10261501
Pump Housing (Bronze)	10483301	10483301	10483301	10483301	10483301	10483301
48 Pump Adapter (Glassed Cast Iron)	10364200	10364200	10364200	10364200	10364200	10364200
Pump Adapter (Cast Bronze)	10364201	10364201	10364201	10364201	10364201	10364201
49 Gasket, Pump Adapter	S0024600	S0024600	S0024600	S0024600	S0024600	S0024600
50 Baffle, Diffuser	10338400	10338400	10338400	10338400	10338400	10338400

### 7.3 Electrical Components

51 Switch, Air Pressure E00161400 E00161400 E00161400 E00161400 E00161400 E00161400

52 Control Panel Components

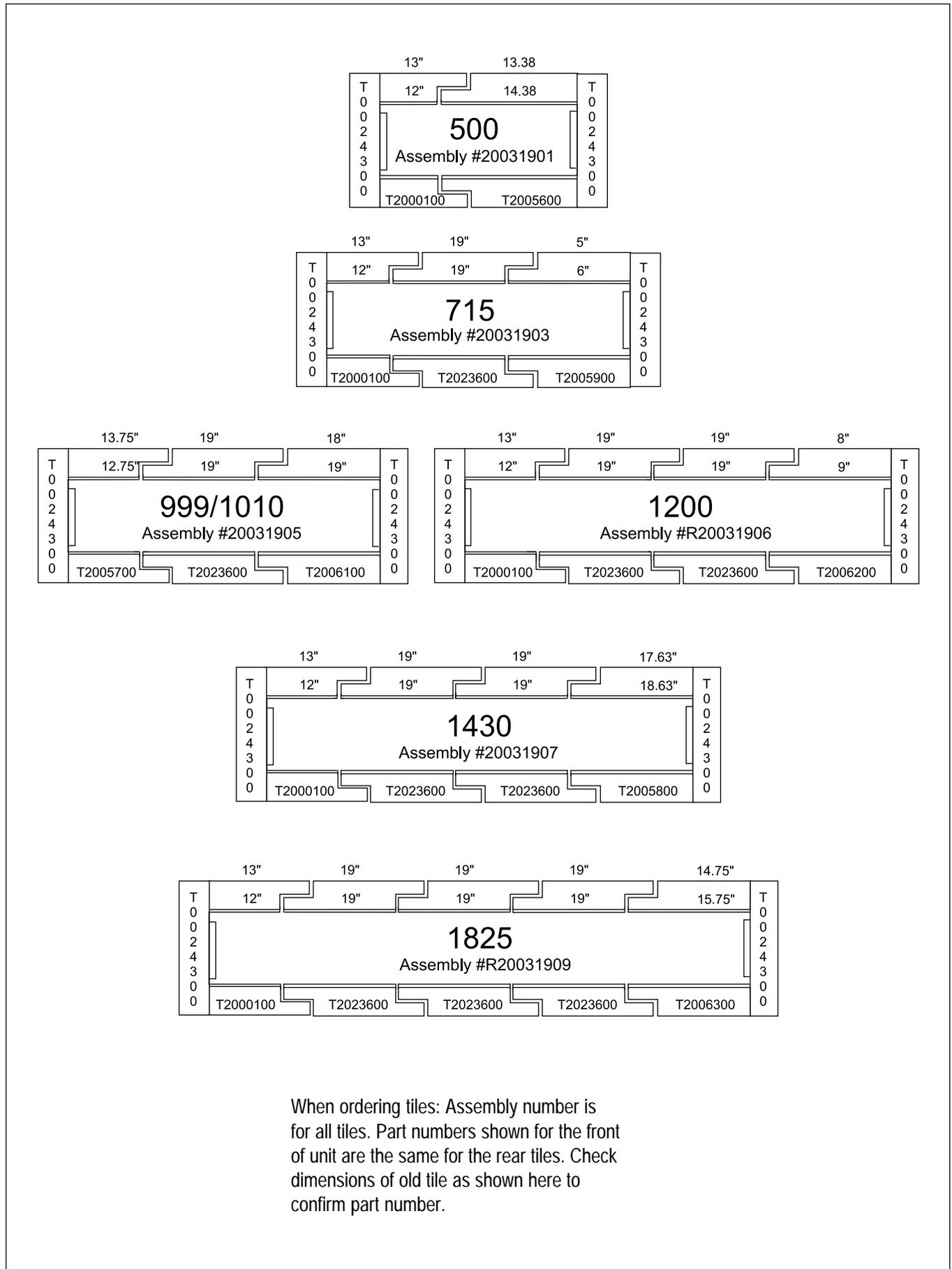
(Refer to Figure 25 for Details and Part Numbers)

### 7.4 Gas Train

(Refer to Figure 26 for Details and Part Numbers)

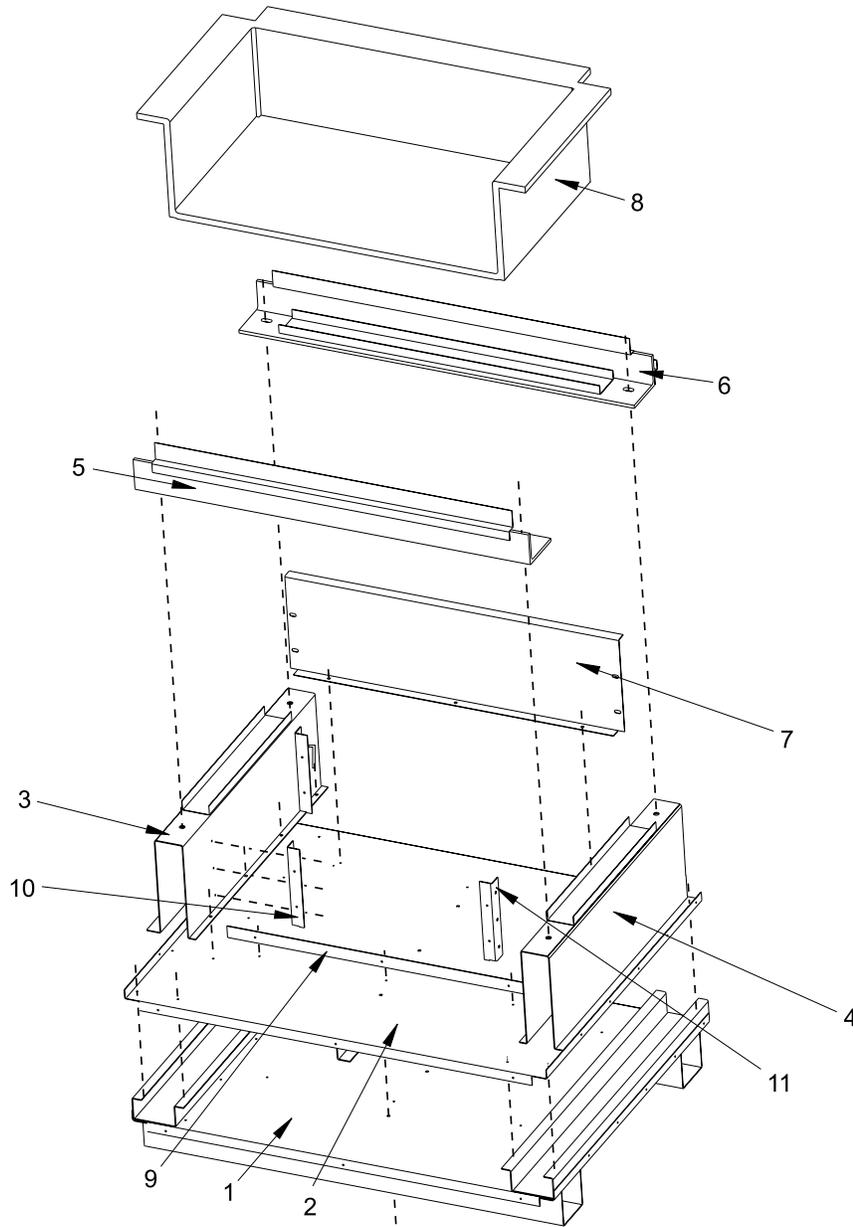
### 7.5 Burner Tray

(Refer to Figure 27 for Details and Part Numbers)



When ordering tiles: Assembly number is for all tiles. Part numbers shown for the front of unit are the same for the rear tiles. Check dimensions of old tile as shown here to confirm part number.

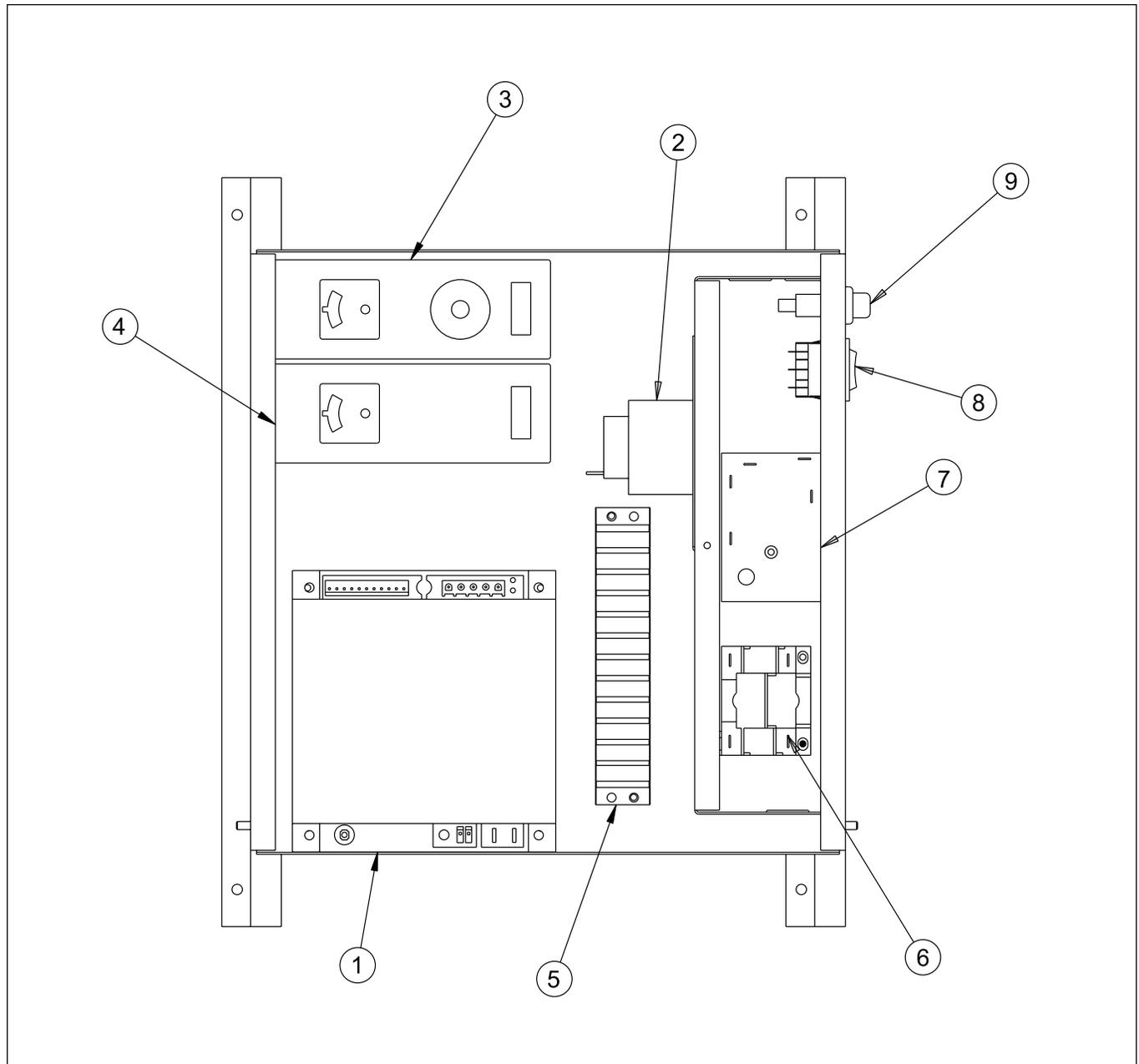
Figure 23. Tile Assemblies.



Key No	Description	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
1	Base, Lower Section	10602001	10602003	10602005	10602006	10602007	10602009
2	Base, Upper Section	10602101	10602103	10602105	10602106	10602107	10602109
3	Tile Rail, Left Support	10955000	10955000	10955000	10955000	10955000	10955000
4	Tile Rail, Right Support	10954500	10954500	10954500	10954500	10954500	10954500
5	Front Tile Support	10536501	10536503	10536505	10536506	10356507	10356509
6	Rear Tile Support	10955101	10955103	10955105	10955106	10955107	10955109
7	Rear Base Closure Panel	10950901	10950903	10950905	10950906	10950907	10950909
8	Base Insulation	10954601	10954603	10954605	10954606	10954607	10954609
9	Bracket, Burner Panel, Front	10950701	10950703	10950705	10950706	10950707	10950709
10	Bracket, Burner Panel, Left	10950801 (2)	10950801 (2)	10950801 (2)	10950801 (2)	10950801 (2)	10950801 (2)
11	Bracket, Burner Panel, Right	10950802 (2)	10950802 (2)	10950802 (2)	10950802 (2)	10950802 (2)	10950802 (2)

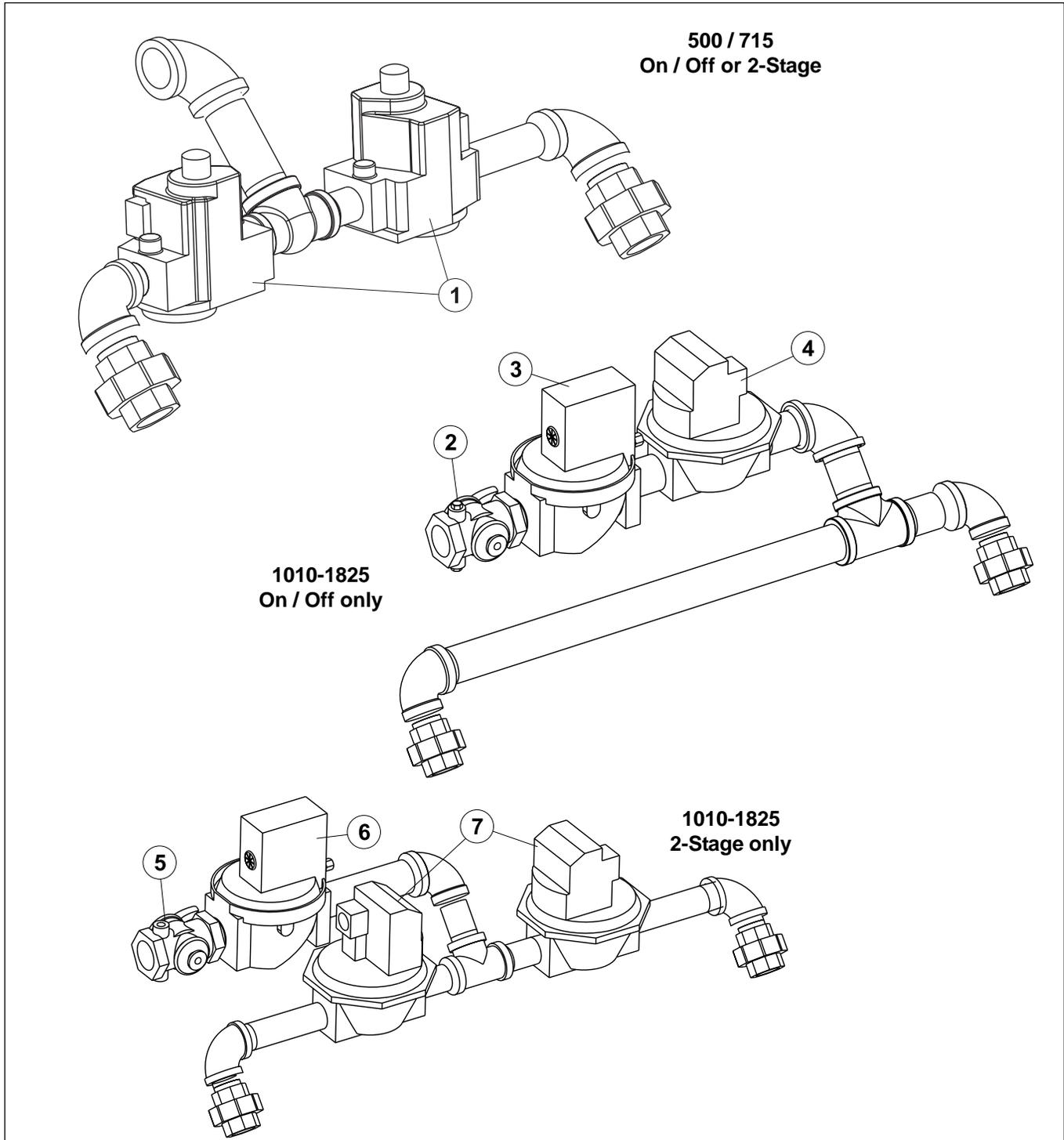
NOTE: Numbers in ( ) represent quantity required for each size. Quantity is one otherwise.

Figure 24. Base / Tile Support Assembly.



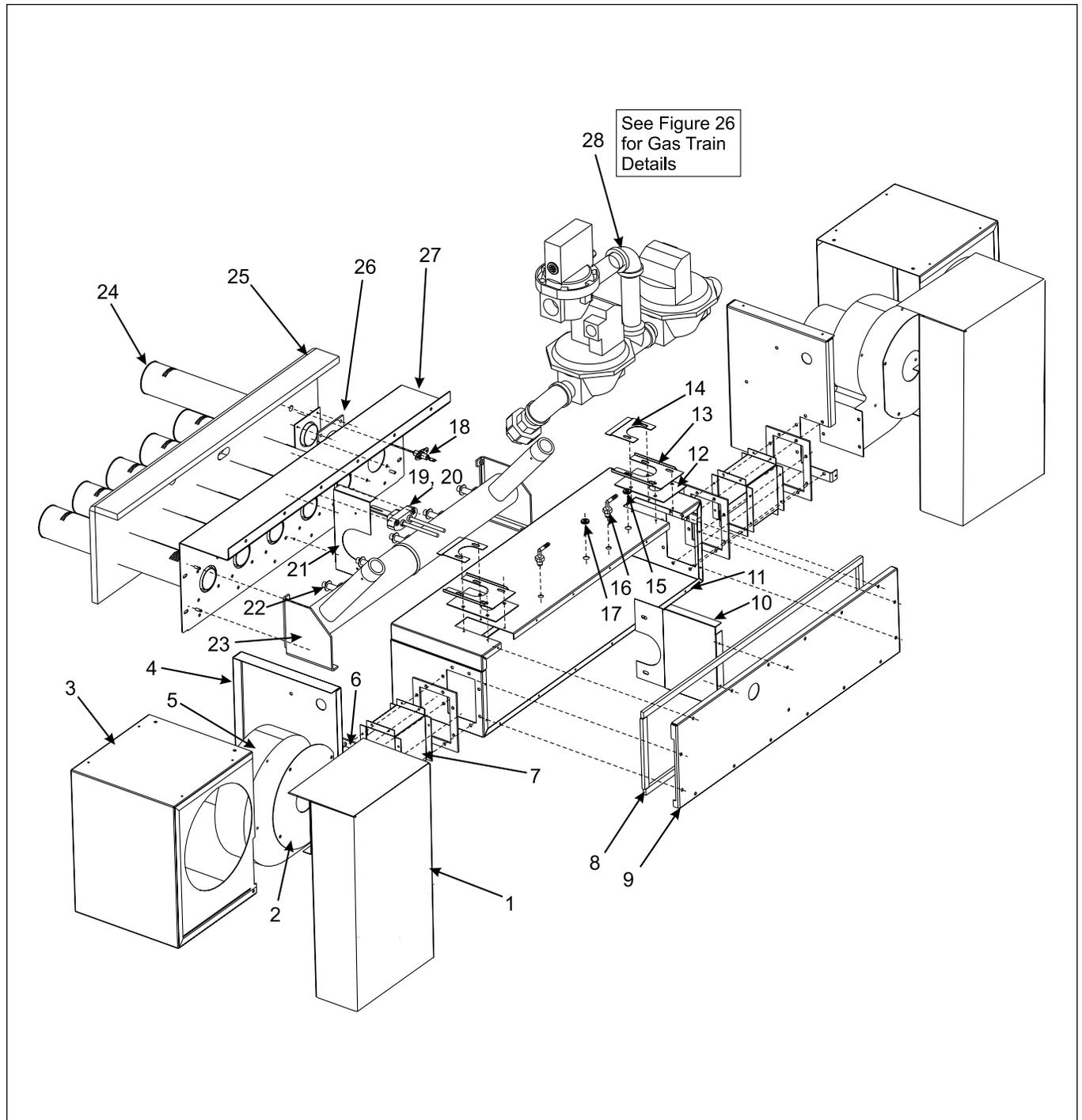
Key Description No	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
1 Ignition Control, Electronic	E0234900	E0234900	E0234900	E0234900	E0234900	E0234900
2 Transformer, 115V/24V	E0086100	E0086100	E0086100	E0086100	E0086100	E0086100
3 Switch, High Limit, Manual Reset	RE0015900	RE0015900	RE0015900	RE0015900	RE0015900	RE0015900
4 Controller, Water Temp (2-stage)	E0093200	E0093200	E0093200	E0093200	E0093200	E0093200
Controller, Water Temp (on-off)	RE0014400	RE0014400	RE0014400	RE0014400	RE0014400	RE0014400
5 Terminal Strip	E0101800	E0101800	E0101800	E0101800	E0101800	E0101800
6 Relay, SPST, 24 Volt	E0098300	E0098300	E0098300	E0098300	E0098300	E0098300
7 Relay, Time Delay	E2077700	E2077700	E2077700	E2077700	E2077700	E2077700
8 Switch, Toggle Main Power	E0234800	E0234800	E0234800	E0234800	E0234800	E0234800
9 Light, Indicator, Amber, 110V	E0071300	E0071300	E0071300	E0071300	E0071300	E0071300

Figure 25. Control Panel and Electrical Components.



Key Description No	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
1 Valve, Gas, Combination, Dual	V0077200	V0077200	—	—	—	—
2 Valve, Gas, Manual	—	—	V0004300	V0004300	V0004300	V0004300
3 Valve, Gas, Safety	—	—	RV0046700	RV0046700	RV0046700	RV0046800
4 Valve, Gas, Combination	—	—	RV0047700	RV0047700	RV0047700	RV0047800
5 Valve, Gas, Manual	—	—	V0004300	V0004300	V0004300	V0001800
6 Valve, Gas, Safety	—	—	RV0046700	RV0046700	RV0046700	V0046800
7 Valve, Gas, Combination	—	—	V0047600	V0047600	RV0047700	RV0047700

Figure 26. Gas Train Components.



Key No	Description	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
1	Housing, Inlet Air, Blower	10953500	10953500	10953500	11015000	10953500	10953500
2	Orifice, Air (Dual)	10953902	10953903	10953905	10953906	10953907	10953909
	Orifice, Air (Single)	10953905	10953907	—	—	—	—
3	Housing, Blower, Right	10955901	10955901	10955901	10955901	10955901	10955901
	Housing, Blower, Left	10955902	10955902	10955902	10955902	10955902	10955902
4	Panel, Right Mount, Blower	10953401	10953401	10953401	10953401	10953401	10953401
	Panel, Left Mount, Blower	10953402	10953402	10953402	10953402	10953402	10953402
5	Blower, Right side	A2088100	A2088100	A2088100	A2088100	A2088100	A2088100
	Blower, Left side	A2088101	A2088101	A2088101	A2088101	A2088101	A2088101
6	Gasket, Blower Inlet	S0108300	S0108300	S0108300	S0108300	S0108300	S0108300
		(4)	(4)	(4)	(4)	(4)	(4)

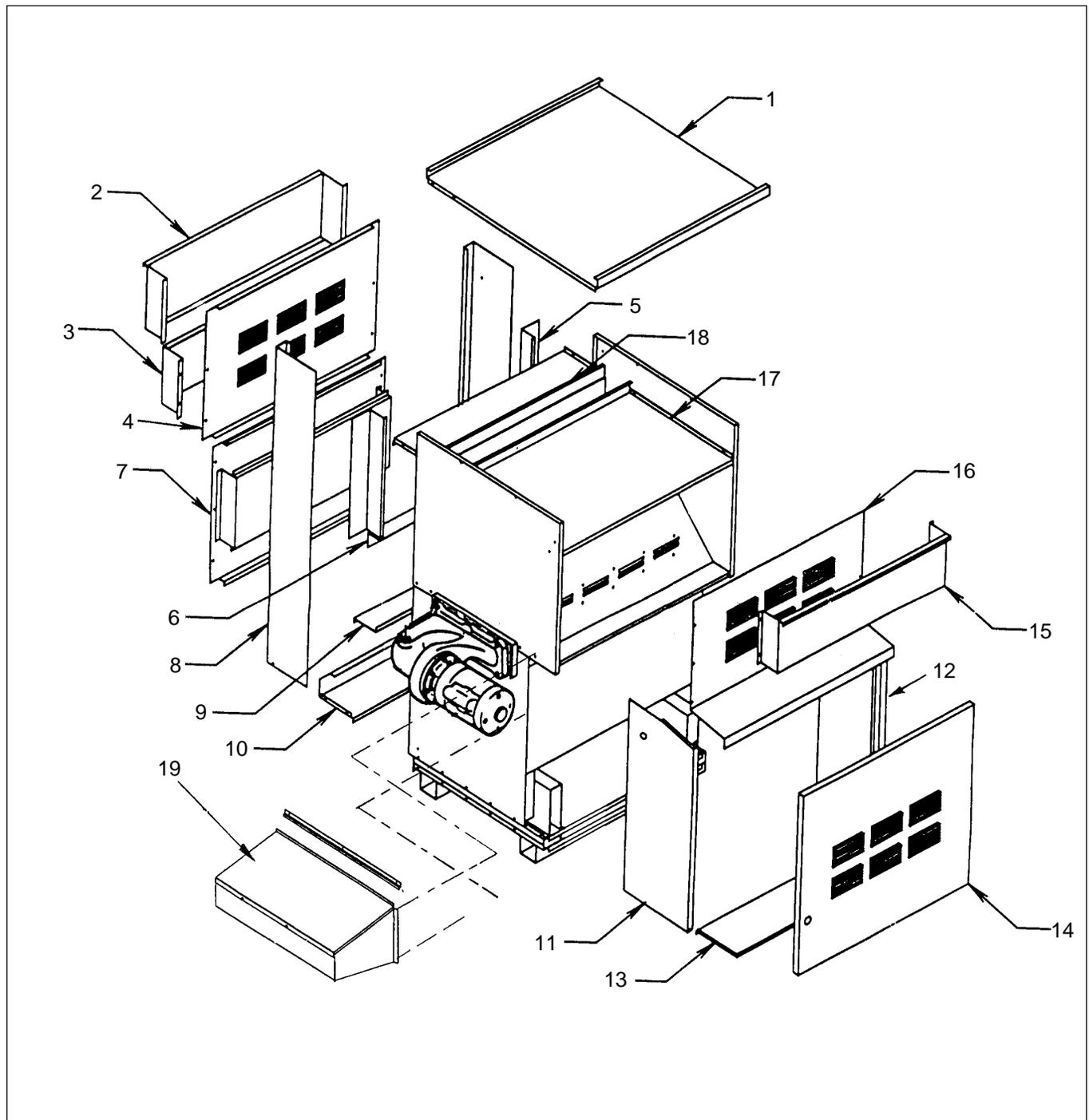
Figure 27. Burner Tray.

**Burner Tray (continued)**

Key No	Description	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
7	Air Duct	10953000 (2)	10953000 (2)	10953000 (2)	10953000 (2)	10953000 (2)	10953000 (2)
8	Gasket, Cover	30-268	30-268	30-268	30-268	30-268	30-268
9	Cover, Air Mixture, Plenum	10956401	10956403	10956405	10956406	10956407	10956409
10	Divider, Air Mixture, Front	10956600	10956600	10956600	10956600	10956600	10956600
11	Air Mixture Box	10950501	10950503	10950505	10950506	10950507	10950509
12	Gasket, Plenum/Manifold Inlet	A0109700 (2)	A0109700 (2)	A0109700 (2)	A0109700 (2)	A0109800 (2)	A0109800 (2)
13	Plate, Front, Inlet, Air Box	10969901 (2)	10969901 (2)	10969901 (2)	10969901 (2)	10969902 (2)	10969902 (2)
14	Plate, Rear, Inlet, Air Box	10969801 (2)	10969801 (2)	10969801 (2)	10969801 (2)	10969802 (2)	10969802 (2)
15	Grommet, Seal	E0198300	E0198300	E0198300	E0198300	E0198300	E0198300
16	Elbow, Barb	P0092900 (2)	P0092900 (2)	P0092900 (2)	P0092900 (2)	P0092900 (2)	P0092900 (2)
17	Grommet, Seal	E0095500	E0095500	E0095500	E0095500	E0095500	E0095500
18	Sensor, Flame	W0041600	W0041600	W0041600	W0041600	W0041600	W0041600
19	Igniter, Hot Surface	W0042000	W0042000	W0042000	W0042000	W0042000	W0042000
20	Gasket, Igniter	W0038100	W0038100	W0038100	W0038100	W0038100	W0038100
21	Divider, Air Mixture, Rear	10956800	10956801	10956800	10956800	10956800	10956801
22	Orifice, Gas, 1st. Right Side	L0060700	L0060700	L0060700	L0060700	L0060700	L0060700
	Orifice, Gas	L0060200 (5)	L0060200 (7)	L0060200 (11)	L0060200 (13)	L0060200 (15)	L0060200 (19)
23	Manifold, Gas, Dual	10952801	10952803	10952805	10952806	10952807	10952809
24	Burner, Gas	L0057700 (6)	L0057700 (8)	L0057700 (12)	L0057700 (14)	L0057700 (16)	L0057700 (20)
25	Insulation, Burner Panel	10953801	10953803	10953805	10953806	10953807	10953809
26	Gasket, Burner	S0108400 (6)	S0108400 (8)	S0108400 (12)	S0108400 (16)	S0108400 (16)	S0108400 (20)
27	Panel, Burner	10950101	10950103	10950105	10950106	10950107	10950109
28	Gas Train						

**See Figure 26 for details**

NOTE: Numbers in ( ) represent quantity required for each size. Quantity is one otherwise.



Key Description No	Size 500	Size 715	Sizes 999/1010	Size 1200	Size 1430	Size 1825
<b>7.6 Outdoor Jacket</b>						
1 Top Panel	10660701	10660703	10660705	10660706	10660707	10660709
2 Rear Windshield	10658101	10658103	10658105	10658106	10658107	10658109
3 Upper Rear Louver Shield	10657101	10657103	10657105	10657106	10657107	10657109
4 Upper Rear Panel	10658701	10658703	10658705	10658706	10658707	10658709
5 Gap Closure-Side	10660200	10660200	10660200	10660200	10660200	10660200
	(2)	(2)	(2)	(2)	(2)	(2)
6 Gap Closure-Middle	10660101	10660103	10660105	10660106	10660107	10660109
7 Lower Rear Panel Assembly	10660501	10660503	10660505	10660506	10660507	10660509
8 Rear End Panel Left and Right	10657700	10657700	10657700	10657700	10657700	10657700
	(2)	(2)	(2)	(2)	(2)	(2)

Figure 28. Outdoor Parts.

**Outdoor Parts (continued)**

<b>Key No</b>	<b>Description</b>	<b>Size 500</b>	<b>Size 715</b>	<b>Sizes 999/1010</b>	<b>Size 1200</b>	<b>Size 1430</b>	<b>Size 1825</b>
9	Lower Rear Shield -Inner	10659901	10659903	10659905	10659906	10659907	10659909
10	Rear Base Extension	10658501	10658503	10658505	10658506	10658507	10658509
11	Left Front End Panel	10936300	10936300	10936300	10936300	10936300	10936300
12	Right Front End Panel	10657502	10657502	10657502	10657502	10657502	10657502
13	Front Base Extension	10659701	10659703	10659705	10659706	10659707	10659709
14	Door Panel Weldment	20050401	20050403	20050405	20050406	20050407	20050409
	Door Panel Weldment, Left	-	-	20100705	20100706	20100707	20100709
15	Front Windshield	10659101	10659103	10659105	10659106	10659107	10659109
16	Upper Front Panel	10658901	10658903	10658905	10658906	10658907	10658909
17	Flue Panel, Front	10659501	10659503	10659505	10659506	10659507	10659509
18	Flue Panel, Rear	10659301	10659303	10659305	10659306	10659307	10659309
19	Pump Cover Assembly	20050100	20050100	20050100	20050100	20050100	20050100

NOTE: Numbers in ( ) represent quantity required for each size. Quantity is one otherwise.





Waterpik Technologies, Inc.  
6000 Condor Drive, Moorpark, CA 93021 • 805.529.2000 • FAX 805.529.5934  
20 Industrial Way, Rochester, NH 03867 • 603.335.6300 • FAX 603.335.3355  
480 S. Service Road West, Oakville, Ontario, Canada L6K 2H4 • 905.844.8233 • FAX 905.844.2635  
[www.laars.com](http://www.laars.com)