

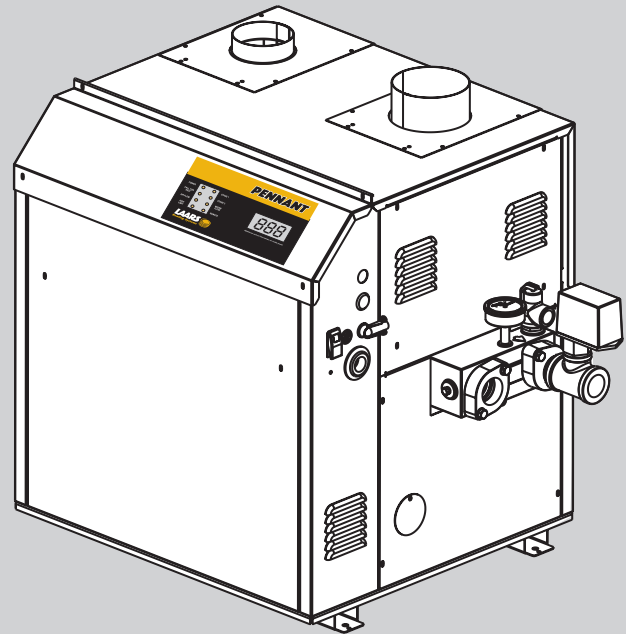
## Installation and Operation Instructions for

# Pennant™

## Hydronic Boiler Model PNCH

## Water Heater Model PNCV

### Sizes 200, 300, 400



**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. For indoor installations, as an additional measure of safety, Laars strongly recommends installation of suitable Carbon Monoxide detectors in the vicinity of this appliance and in any adjacent occupied spaces.

### ⚠ 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.

### ⚠ AVERTISSEMENT

Assurez-vous de bien suivre les instructions données dans cette notice pour réduire au minimum le risque d'incendie ou d'explosion ou pour éviter tout dommage matériel, toute blessure ou la mort.

Ne pas entreposer ni utiliser d'essence ni d'autres vapeurs ou liquides inflammables dans le voisinage de cet appareil ou de tout autre appareil.

#### QUE FAIRE SI VOUS SENTEZ UNE ODEUR DE GAZ:

- Ne pas tenter d'allumer d'appareils.
- Ne touchez à aucun interrupteur. Ne pas vous servir des téléphones dans le bâtiment où vous trouvez.
- Appelez immédiatement votre fournisseur de gaz depuis un voisin. Suivez les instructions du fournisseur.
- Si vous ne pouvez rejoindre le fournisseur de gaz, appelez le service des incendies.

L'installation et l'entretien doivent être assurés par un installateur ou un service d'entretien qualifié ou par le fournisseur de gaz.

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**LAARS**   
Heating Systems Company

A subsidiary of BRADFORD WHITE Corporation

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# SECTION 1. General Information

**USING THIS MANUAL – Because the Pennant Boilers and Pennant Water Heaters are identical appliances, with the exception of materials of manufacture, labels and ultimate use application, this manual provides information for the proper installation, operation and maintenance of both products. Where differences exist between the application of the appliances and their operation, the sections pertinent to only one appliance or the other will be so identified.**

In the Commonwealth of Massachusetts, this appliance must be installed by a licensed plumber or gas fitter.

## ⚠ WARNING

To minimize the risk of electric shock, fire or other hazards which could result in property damage, injury, or death. The Pennant hydronic, boiler or water heater **must** be installed in accordance with the procedures detailed in this manual, or the Laars Heating Systems warranty may be voided. The installation must conform to the requirements of the local jurisdiction having authority, and, in the United States, to the latest edition of the National Fuel Gas Code, ANSI Z223.1/NFPA54. In Canada, the installation must conform to the latest edition of the Natural Gas and Propane Installation Code, CSA B149.1 and/or applicable local codes. Where required by the authority having jurisdiction, the installation of Pennant appliances must conform to the Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1. Any modifications to the boiler, its gas controls, or wiring may void the warranty. If field conditions require modifications, consult the factory representative before initiating such modifications.

### 1.1 Introduction

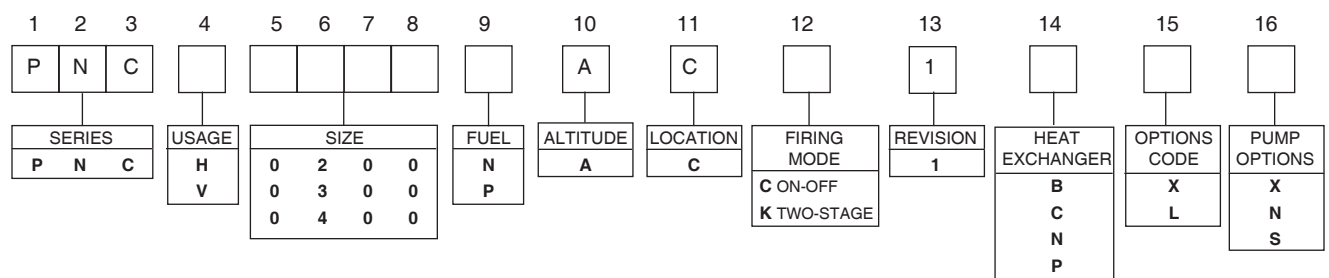
This manual provides information necessary for the installation, operation, and maintenance of Laars Heating Systems' Pennant copper tube appliances, sizes 200-400 MBTU/hr (larger models are covered in a separate manual). Read it carefully before installation.

## ⚠ AVERTISSEMENT

Afin de réduire au minimum les risques de commotion électrique, de feu ou d'autre nature, qui pourraient causer des dommages matériels, des blessures ou des accidents mortels, les chaudières à eau chaude ou les chauffe-eau Pennant **doivent** être installés conformément aux directives détaillées contenues dans ce manuel, à défaut de quoi la garantie fournie par Laars Heating Systems serait annulée. L'installation doit être conforme aux exigences de la réglementation locale en vigueur et, aux États-Unis, à l'édition la plus récente du Natural Fuel Gas Code (Code pour le gaz combustible naturel) ANSI Z223.1/NFPA54. Au Canada, l'installation doit respecter les exigences de la plus récente édition du Code d'installation du gaz naturel et du propane CSA B149.1, et/ou des codes locaux de construction en vigueur. Lorsque la réglementation locale l'exige, l'installation des appareils électroménagers Pennant doit respecter les exigences du Standard for Controls and Safety Devices for Automatically Fired Boilers (Code pour les équipements de commande et de sécurité des chaudières à combustion automatique), ANSI/ASME CSD-1. Toute modification apportée à la chaudière, aux régulateurs de gaz ou au câblage, peut compromettre la garantie. Si certaines conditions particulières rendent des adaptations nécessaires, consulter un représentant du fabricant avant d'entreprendre ces modifications.

All application and installation procedures should be reviewed completely before proceeding with the installation. Consult the Laars Heating Systems factory, or local factory representative, with any issues or questions regarding this equipment. Experience has shown that most operating issues are caused by improper installation.

The Pennant appliance is protected against over pressurization. A pressure relief valve is fitted to all appliances. It is installed on the outlet header, at the water outlet of the appliance.



**IMPORTANT:** The inlet gas pressure to the appliance must not exceed 13 in. w.c. (3.2 kPa).

All installations must be made in accordance with:

- 1) In the U.S., the "National Fuel Gas Code" ANSI Z223.1/NFPA54, Latest Edition and all applicable local codes as required by the Authorities Having Jurisdiction (AHJ), or
- 2) In Canada, the "Natural Gas and Propane Installation Code", CSA B149.1, latest edition and all applicable local codes as required by the AHJ.

All electrical wiring is to be done in accordance with:

- 1). In the U.S., the "National Electrical Code" (NEC), ANSI/NFPA 70, latest Edition and all applicable local codes as required by the AHJ, or
- 2). In Canada, the "Canadian Electrical Code - Part 1", CSA STD. C22.1 and all applicable local codes as required by the AHJ.

This appliance must be electrically grounded in accordance with the applicable codes and standards referenced above.

## 1.2 Model Identification

Consult the rating plate on the unit. The following information describes the model number structure.

### Model Character Designation

#### 1-3 Model Series Designation

P N C = Pennant

#### 4 Usage

H = Hydronic

V = Volume Water

#### 5-8 Size

0 2 0 0 = 199,900 BTU/h input

0 3 0 0 = 299,000 BTU/h input

0 4 0 0 = 399,900 BTU/h input

#### 9 Fuel

N = Natural Gas

P = Propane

#### 10 Altitude

A = 0-10,000 feet

#### 11 Location

C = Indoor and Outdoor

#### 12 Firing Mode

C = On-Off (standard)

K = Two-stage (optional)

#### 13 Revision

1 = Revision Level 1

#### 14 Heat Exchanger

B = Glass-lined CI / copper / brz trim (std. PNCV)

C = Glass-lined cast iron / copper (std. PNCH)

N = Glass-lined cast iron / cu-nickel

P = Glass-lined cast iron / cu-nickel / brz trim

#### 15 Option Code

X = Standard unit

L = Low temperature control (std. PNCV)

## 16 Pump Options

X = No Pump

N = Pump mounted, normal pump

S = Pump mounted, soft water pump (PNCV only)

## 1.3 Warranty

Laars Heating Systems' Pennant appliances are covered by a limited warranty. The owner should fill out the warranty registration card and return it to Laars Heating Systems.

All warranty claims must be made to an authorized Laars Heating Systems representative or directly to the factory. Claims must include the serial number and model (this information can be found on the rating plate), installation date, and name of the installer. Shipping costs are not included in the warranty coverage.

Some accessory items are shipped in separate packages. Verify receipt of all packages listed on the packing slip. Inspect everything for damage immediately upon delivery, and advise the carrier of any shortages or damage. 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.

## 1.4 Dimensions

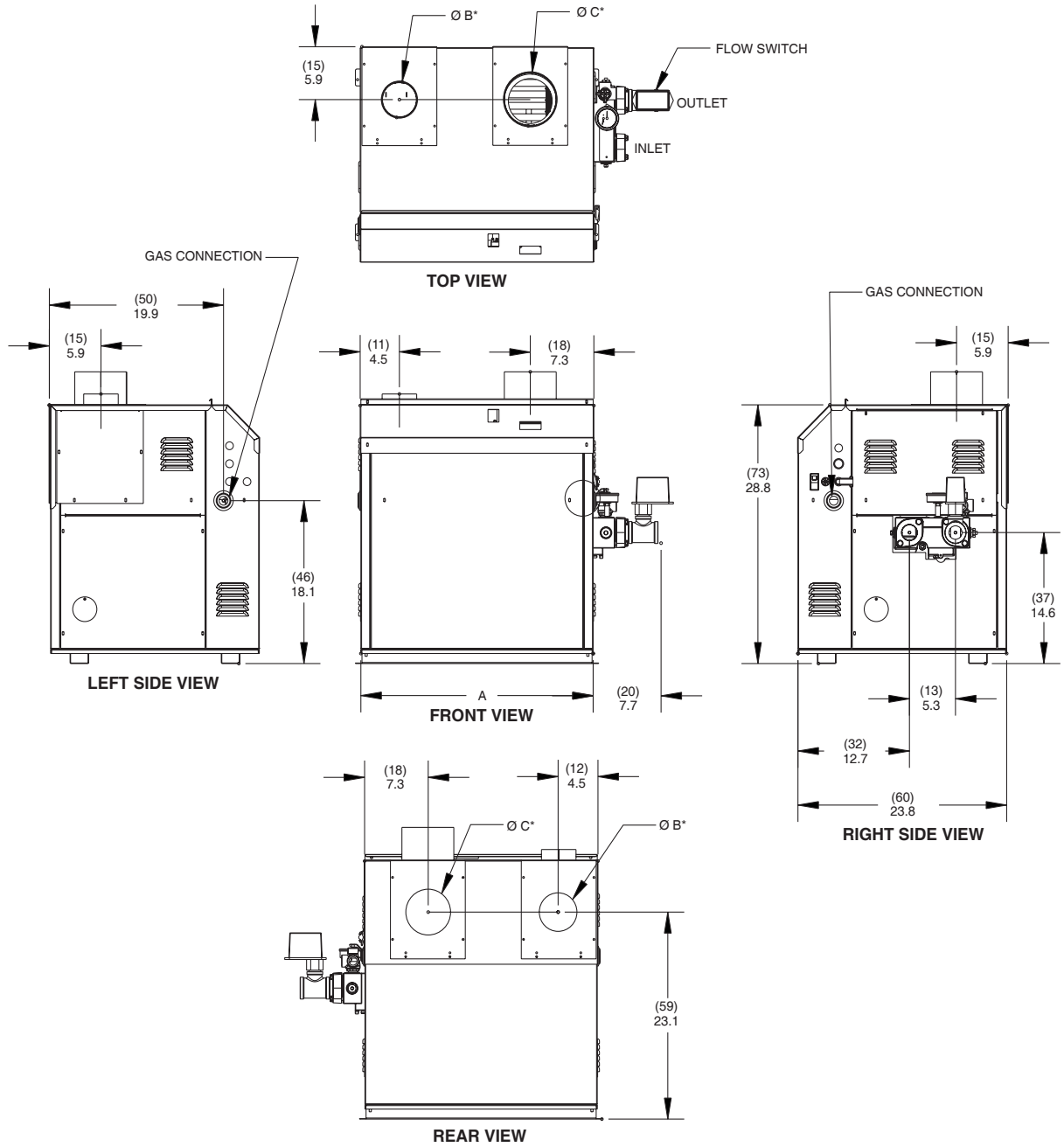
See Figure 1.

## 1.5 Locating the Appliance

The appliance should be located to provide clearances on all sides for maintenance and inspection. It should not be located in an area where leakage of any connections will result in damage to the area adjacent to the appliance or to lower floors of the structure.

When such a location is not available, it is recommended that a suitable drain pan, adequately drained, be installed under the appliance.

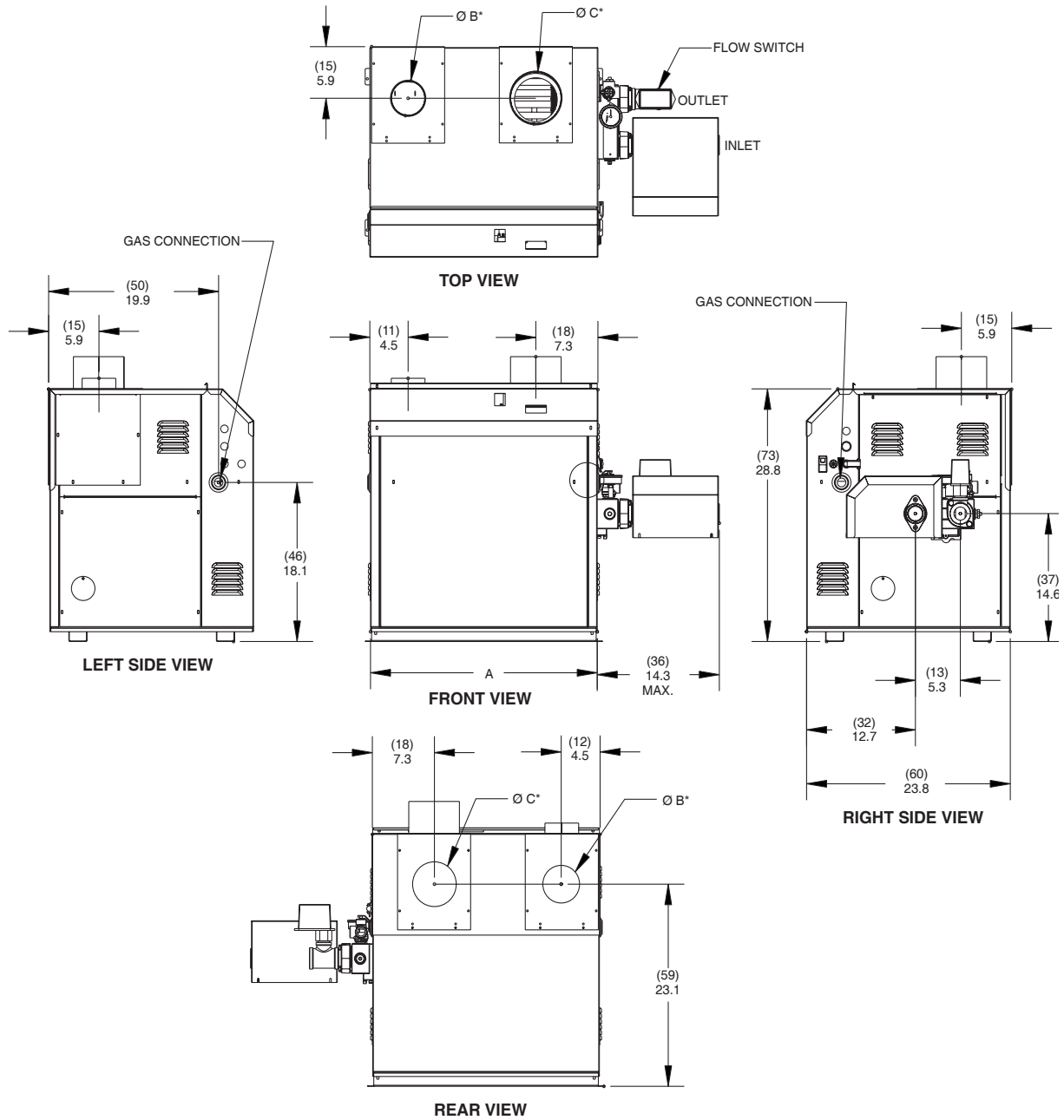
The appliance is design certified by CSA-International for installation on combustible flooring; in basements; in closets, utility rooms or alcoves. **Pennant Boilers or Water Heaters must never be installed on carpeting.** The location for the appliance should be chosen with regard to the vent pipe lengths and external plumbing. The unit shall be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during operation and service (circulator replacement, control replacement, etc.). When vented vertically, the Pennant must be located as close as practical to a chimney or outside wall. If the vent terminal and/or combustion air terminal terminate through a wall, and there is potential for snow accumulation in the local area, both terminals should be installed at an appropriate level above grade such that blockage of the terminal from accumulated debris or precipitation is prevented.



Model	A		Combustion Air Connection B*		Vent Connection C*		Horizontal (Cat III) Vent Pipe Size	
	in.	cm	in.	cm	in.	cm	in.	cm
200	20.5	52	4	10	5	13	4	10
300	26.5	67	4	10	6	15	5	13
400	33.6	85	6	15	7	18	6	15

\*Air and vent connections may be on top or back of the Pennant, and are field convertible.

Figure 1a. Dimensional Data - Non Pump Mounted.



Model	A		Combustion Air Connection B*		Vent Connection C*		Horizontal (Cat III) Vent Pipe Size	
	in.	cm	in.	cm	in.	cm	in.	cm
200	20.5	52	4	10	5	13	4	10
300	26.5	67	4	10	6	15	5	13
400	33.6	85	6	15	7	18	6	15

\*Air and vent connections may be on top or back of the Pennant, and are field convertible.

Figure 1b. Dimensional Data - Pump Mounted.

Heater Size	Vent Collar Size		Horizontal Vent Pipe Diameter		Intake Air Collar & Pipe Diameter		Max. Pipe Length		Max. No. of Elbows	Side Vent Terminal Part Number	Side Wall Combustion Air Terminal Part Number
	in	cm	in	cm	in	cm	ft	m			
200	5	13	4	10	4	10	50	15	3	CA003101	CA003201
300	6	15	5	13	4	10	50	15	3	CA003102	CA003201
400	7	18	6	15	6	15	50	15	3	CA003103	CA003202

**Table 1. Horizontal Vent / Combustion Air Parameters.**

Appliance Surface	Required Clearance From Combustible Material		Recommended Service Access Clearance	
	inches	cm	inches	cm
Left Side	1	2.5	24	61
Right Side	1	2.5	24	61
Top	1	2.5	12	30
Back	1	2.5	12**	30**
Front	1	2.5	36	91
Vertical (Category 1) Vent	6*	15.2*		
Horizontal (Category 3) Vent	per UL 1738 venting system supplier's instructions			
*1" (2.5 cm) when b-vent is used. **When vent and/or combustion air connects to the back, recommended clearance is 36" (91cm).				

**Table 2. Clearances.**

The dimensions and requirements that are shown in Table 2 should be met when choosing the locations for the appliance.

### 1.6 Locating Pump-Mounted Water Heater with Respect to Storage Tank(s)

For best results, a pump-mounted Pennant water heater should be located within 15 feet (4.6m) of the storage tank(s). The pump is sized for 30 feet (9.1m) of piping.

If the appliance must be installed with longer piping runs, then larger diameter pipe or tubing may be acceptable. Consult the factory for assistance.

### 1.7 Locating Pump-Mounted Boiler with Respect to Return/Supply Header

For the best results, a pump-mounted Pennant boiler should be located within 15 feet (4.6m) of the supply and return headers. The pump is sized for 30 feet (9.1m) of piping.

If the appliance must be installed with longer piping runs, then larger diameter tubing may be acceptable. Consult the factory for assistance.

## 1.8 Locating Appliance for Correct Horizontal Vent/Ducted Air Distance From Outside Wall

The forced draft combustion air blower in the appliance has sufficient power to pull air and vent properly when the guidelines for horizontal air and vent are followed (see Table 1).

**NOTE:** On some models, the vent collar size is larger than the size of the vent pipe that can be used. Vent collar size and horizontal pipe diameters can be found in Table 1. The larger vent collar size is to accommodate Category I (vertical) vent systems.

**NOTE:** When located on the same wall, the Pennant combustion air intake terminal must be installed a minimum of 12" (30cm) below the exhaust vent terminal and separated by a minimum of 36 inches (91cm) horizontally.

The air intake terminal must be installed high enough to avoid blockage from snow, leaves and other debris.

## SECTION 2. Venting and Combustion Air

### WARNING

For indoor installations, as an additional measure of safety, Laars strongly recommends installation of suitable Carbon Monoxide detectors in the vicinity of this appliance and in any adjacent occupied spaces.

### AVERTISSEMENT

Pour des installations intérieures, Laars recommande fortement, comme mesure de sécurité supplémentaire, l'installation de détecteurs de monoxyde de carbone adaptés dans le voisinage de l'appareil et dans chacune des pièces habitées adjacentes.

## 2.1 Combustion Air

Pennant boilers and water heaters must have provisions for combustion and ventilation air in accordance with the applicable sections addressing requirements for air for combustion and ventilation of

the National Fuel Gas Code, ANSI Z223.1. In Canada, the applicable sections of the Natural Gas and Propane Installation Code (CSA B149.1) must be followed. In all cases any and all applicable local installation codes must also be followed.

A Pennant appliance may receive combustion air from the space in which it is installed, or it can be ducted directly to the unit from the outside. Proper ventilation air must be provided in either case.

### 2.1.1 Combustion Air From Room

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 (30 cm) of the top and one commencing within 12 inches (30 cm) 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 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/hr (5.5 square cm/kW) of 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/hr (11 square cm/kW) of total input rating of all equipment in the enclosure. Table 3 shows data for this sizing method, for each Pennant model.

**Method 2:** One permanent opening, commencing within 12 inches (30 cm) 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/hr (7 square cm/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, providing they conform to the requirements in the applicable codes listed above.

In Canada, consult local building and safety codes or, in absence of such requirements, follow CSA B149.1, the Natural Gas and Propane Installation Code.

Boiler Model	Each Opening*	
	Square inches	Square cm
200	50	323
300	75	484
400	100	645

\*Net Free Area in Square Inches / Square cm  
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.

This chart is for use when communicating directly with the outdoors. For special conditions and alternate methods, refer to the latest edition of ANSI Z223.1.

**Note:** 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.

Table 3. Combustion Air Openings.

### 2.1.2 Intake Combustion Air

The combustion air can be taken through the wall, or through the roof. When taken from the wall, it must be taken from out-of-doors by means of the Laars horizontal wall terminal (see Table 1). When taken from the roof, a field-supplied rain cap or an elbow arrangement must be used to prevent entry of rain water (see Figure 2).

Use single-wall galvanized pipe, per Table 4, for the combustion air intake (see Table 1 for appropriate size). Route the intake to the heater as directly as possible. Seal all joints with tape. Provide adequate hangers. The unit must not support the weight of the combustion air intake pipe. Maximum linear pipe length allowed is 50 feet (15.2m). Three elbows have been calculated into the 50-foot (15.2m) linear run. Subtract 10 allowable linear feet (3.0m) for every additional elbow used (see Table 1). When fewer

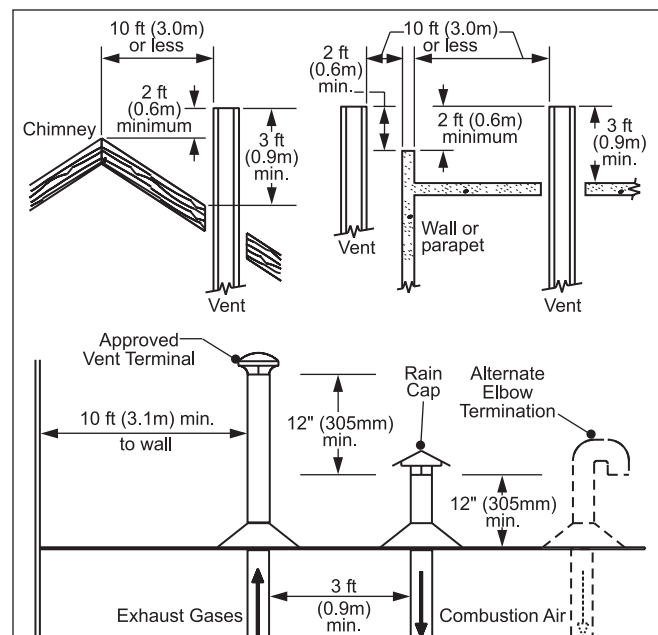


Figure 2. Combustion Air and Vent Through Roof.



than 3 elbows are used, the maximum linear pipe length allowed is still 50 feet (15.2m).

Term	Description
Pipe	Single-wall galvanized steel pipe, 24 gauge minimum (either insulated or non-insulated)
Joint Sealing	Permanent duct tape or aluminum tape

**Table 4. Required Combustion Air Piping Material.**

The connection for the intake air pipe is on the filter box. The Pennant appliances may have venting and combustion air ducting attached to the top or the back. They are shipped with the connections at the top. For attaching either or both pipes to the back, the mounting flanges are reversible by removing the mounting screws and orienting the flanges in the desired position. Replace the screws after positioning flanges. Run a bead of silicone around the collar and slide the pipe over the collar. Secure with sheet metal screws.

In addition to air needed for combustion, air shall also be supplied for ventilation, including all air required for comfort and proper working conditions for personnel. The Pennant loses less than 1 percent of its input rating to the room, but other heat sources may be present.

## 2.2 Venting

### 2.2.1 Vent Categories

Depending upon desired Pennant venting, it may be considered a Category I or a Category III appliance. In general, a vertical vent system will be a Category I system. However, in rare instances, a Pennant's vertical vent system may be considered Category III. In the U.S., the National Fuel Gas Code (ANSI Z223.1), or in Canada the Natural Gas and Propane Installation Code (CSA B149.1), defines a Category I vent system, and includes rules and tables to size these vent systems. If the Pennant's vertical vent system does not satisfy the criteria for Category I venting, it must be vented as a Category III system.

All Pennant vent systems which discharge horizontally (without the use of a power venter) are considered Category III vent systems.

### 2.2.2 Category I Vent

When vented as a Category I appliance, the vent system must conform to the National Fuel Gas Code (ANSI Z223.1-Latest Edition) in the U.S., or in Canada, to the Natural Gas and Propane Installation Code (CSA B149.1 latest edition). The vent system must be sized and installed for a Category I Fan-Assisted Appliance.

If chimney height is greater than 25 feet, or if multiple units are vented into the same vertical vent, a barometric damper must be installed on each appliance, such that the flue draft does not exceed (negative) 0.1 in. w.c.

If using a power venter for any type of Category I venting, the draft should be set between (negative) 0.01 and 0.05 in. w.c.

### 2.2.3 Common Venting Systems

Pennant units are Category I fan-assisted when vented vertically and adhering to all applicable codes. Pennant units are not allowed to be vented into a common horizontal vent system, unless a properly sized vent fan is used, and the common vent system is properly designed by the vent fan manufacturer or a qualified engineer. When common venting Pennant fan-assisted unit with other appliances through one shared vertical duct called a "common vent", special care must be taken by the installer to ensure safe operation. In the event that the common vent is blocked, it is possible, especially for fan-assisted devices, to vent backwards through non-operating appliances sharing the vent, allowing combustion products to infiltrate occupied spaces. **If the appliances are allowed to operate in this condition, serious injury or death may occur.**

#### WARNING

Operation of appliances with a blocked common vent may lead to serious injury or death. Safety devices must be implemented to prevent blocked common vent operation. If safe operation of all appliances connected to a common vent cannot be assured, including prevention of spillage of flue gasses into living spaces, common venting should not be applied, and appliances should each be vented separately.

#### AVERTISSEMENT

Le fonctionnement d'appareils connectés à un événement commun bouché peut provoquer de sérieuses blessures corporelles ou la mort. Des dispositifs de sécurité doivent être mis en place pour empêcher que les appareils soient utilisés avec un événement commun bouché. Si un fonctionnement sécuritaire de tous les appareils reliés à un événement commun et si la prévention des dégagements accidentels de gaz de combustion dans des zones habitées ne peuvent pas être assurés, un événement commun ne doit pas être mis en place et les appareils doivent être munis d'événements individuels séparés.

It is for this reason that, in addition to following proper vent sizing, construction and safety requirements from the National Fuel Gas Code, ANSI Z223.1 or in Canada, from the Natural Gas and Propane Installation Code (CSA B149.1) as well as all applicable local codes, it is required that installers provide some means to prevent operation with a blocked common vent. It is suggested that a blocked vent safety system be employed such that if the switch

from one appliance trips due to excessive stack spill or back pressure indicating a blocked vent condition, that all appliances attached to the vent be locked out and prevented from operating. Note that the Pennant is equipped with a blocked vent safety (pressure) switch, as shipped. However, this safety switch has only been designed and tested to be effective in installations where the Pennant is vented separately and NOT common vented with other appliances. As an additional precaution, it is recommended that a Carbon Monoxide (CO) alarm be installed in all enclosed spaces containing combustion appliances. If assistance is required in determining how a blocked vent safety system should be connected to a LAARS product, please call Applications Engineering at the Rochester phone number on the back cover of this manual.

Refer to the installation and operating instructions on all appliances to be common vented for instructions, warnings, restrictions and safety requirements. If safe operation of all appliances connected to a common vent cannot be assured, including prevention of spillage of flue gases into living spaces, common venting should not be applied, and appliances should each be vented separately.

### 2.2.4 Category III Vent

When the Pennant is vented with horizontal discharge, it must be installed per this installation manual and the venting system manufacturer's installation instructions. The vent system must be sealed stainless steel, per Table 5.

Term	Description
Pipe	Must comply with UL Standard 1738 such as Type AL29-4C Stainless Steel (either insulated or non-insulated).
Joint Sealing	Follow vent manufacturer's instructions.

**Table 5. Required Horizontal Venting Material.**

Route the vent pipe to the heater as directly as possible. Seal all joints and provide adequate hangers as required in the venting system manufacturer's installation instructions. Horizontal portions of the venting system must be supported to prevent sagging and may not have any low sections that could trap condensate.

The unit must not support the weight of the vent pipe. Horizontal runs must slope downwards not less than ¼ inch per foot (2 cm/m) from the unit to the vent terminal.

*L'appareil ne doit pas supporter le poids de la gaine d'évent. Les parties horizontales doivent être installées avec une pente de 2 cm/m (1/4 inch par pied) descendant de l'appareil vers la sortie de l'évent.*

Reference Table 1 for the size of the Category III vent system. Up to three elbows can be used with

50 linear feet (15.2m) of pipe. Subtract 10 allowable linear feet (3.0m) for every additional elbow used.

## 2.3 Locating Vent & Combustion Air Terminals

### 2.3.1 Side Wall Vent Terminal

The appropriate Laars side wall vent terminal must be used, and is listed in the installation and operation manual. The terminal provides a means of installing the vent piping through the building wall, and must be located in accordance with ANSI Z223.1/NFPA 54 and applicable local codes. In Canada, the installation must be in accordance with CSA B149.1 and local applicable codes. Consider the following when installing the terminal:

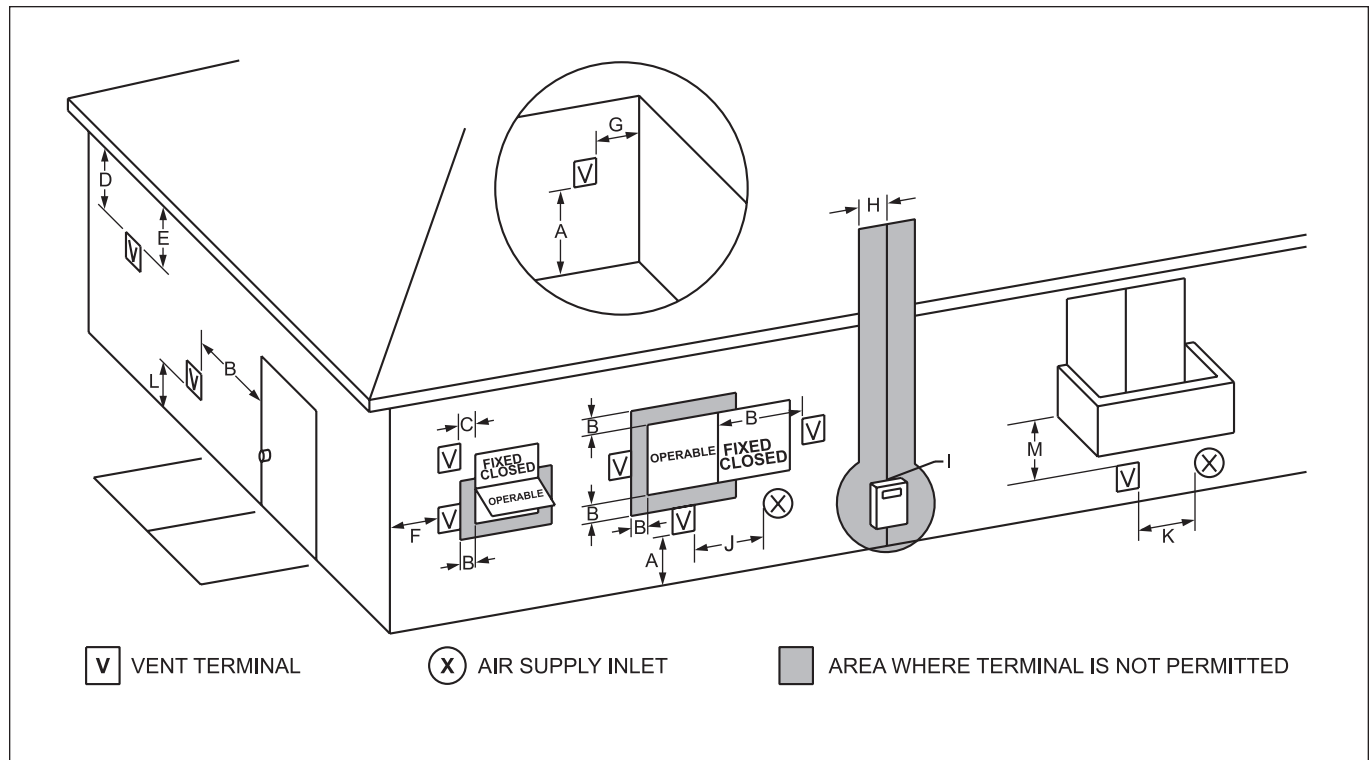
- Figure 3 shows the requirements for mechanical vent terminal clearances for the U.S. and Canada.
- Locate the vent terminal so that vent gases cannot be drawn into air conditioning system inlets.
- Locate the vent terminal so that vent gases cannot enter the building through doors, windows, gravity inlets or other openings. Whenever possible, locations under windows or near doors should be avoided.
- Locate the vent terminal so that it cannot be blocked by snow. The installer may determine that a vent terminal must be higher than the minimum shown in codes, depending upon local conditions.
- Locate the terminal so the vent exhaust does not settle on building surfaces or other nearby objects. Vent products may damage such surfaces or objects.
- If the boiler or water heater uses ducted combustion air from an intake terminal located on the same wall, locate the vent terminal at least 3 feet (0.9m) horizontally from the combustion air terminal, and locate the vent terminal at least 1 foot (0.3m) above the combustion air terminal.

#### WARNING

The outdoor vent terminal gets hot. Unit must be installed in such a way as to reduce the risk of burns from contact with the vent terminal.

#### AVERTISSEMENT

La sortie d'évent à l'extérieur devient très chaude. Elle doit être installée de façon à réduire le risque de brûlures au contact de l'extrémité de l'évent.



U.S. Installations (see note 1)	Canadian Installations (see note 2)	
<b>A=</b> Clearance above grade, veranda, porch, deck, or balcony	12 inches (30 cm)	12 inches (30 cm)
<b>B=</b> Clearance to window or door that may be opened	Direct Vent Only: 12 inches (30 cm) Other Than Direct Vent: 4 feet (1.2 m) below or to side of opening; 1 foot (30 cm) above opening	36 inches (91 cm)
<b>C=</b> Clearance to permanently closed window	See note 4	See note 5
<b>D=</b> Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 feet (61cm) from the center line of the terminal	See note 4	See note 5
<b>E=</b> Clearance to unventilated soffit	See note 4	See note 5
<b>F=</b> Clearance to outside corner	See note 4	See note 5
<b>G=</b> Clearance to inside corner	See note 4	See note 5
<b>H=</b> Clearance to each side of center line extended above meter/regulator assembly	See note 4	3 feet (91 cm) within a height 15 feet above the meter/regulator assembly
<b>I=</b> Clearance to service regulator vent outlet	See note 4	3 feet (91 cm)
<b>J=</b> Clearance to non mechanical air supply inlet to building or the combustion air inlet to any other appliance	Direct Vent Only: 12 inches (30 cm) Other Than Direct Vent: 4 feet (1.2 m) below or to side of opening; 1 foot (30 cm) above opening	36 inches (91 cm)
<b>K=</b> Clearance to a mechanical air supply inlet	3 feet (91 cm) above if within 10 feet (3 m) horizontally	6 feet (1.83 m)
<b>L=</b> Clearance above paved sidewalk or paved driveway located on public property	Vent termination not allowed in this location	Vent termination not allowed in this location
<b>M=</b> Clearance under veranda, porch, deck, or balcony	See note 4	12 inches (30 cm) (see note 3)
<b>Notes:</b>		
1. In accordance with the current ANSI Z223.1 / NFPA 54 National Fuel Gas Code.		
2. In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code.		
3. Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the door.		
4. For clearances not specified in ANSI Z223.1 / NFPA 54, clearance is in accordance with local installation codes and the requirements of the gas supplier.		
5. For clearances not specified in CSA B149.1, clearance is in accordance with local installation codes and the requirements of the gas supplier.		

Figure 3. Vent Terminal Clearance.

**Important Note: Massachusetts Code Requirement.**

**From Massachusetts Rules and Regulations 248 CMR 5.08:**

(a) **For all side wall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:**

1. **INSTALLATION OF CARBON MONOXIDE DETECTORS.**

At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard-wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard-wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard-wired carbon monoxide detectors.

- a. In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard-wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.
- b. In the event that the requirements of this subdivision cannot be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.

2. **APPROVED CARBON MONOXIDE DETECTORS.**

Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.

3. **SIGNAGE.**

A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (½) inch in size, "GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS".

4. **INSPECTION.**

The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a) 1 through 4.

(b) **EXEMPTIONS: The following equipment is exempt from 248 CMR 5.08(2)(a) 1 through 4:**

1. The equipment listed in Chapter 10 entitled "Equipment Not Required To Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and
2. Product Approved side wall horizontal vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

(c) **MANUFACTURER REQUIREMENTS – GAS EQUIPMENT VENTING SYSTEM PROVIDED. When the manufacturer of Product Approved side wall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:**

1. Detailed instructions for the installation of the venting system design or the venting system components; and
2. A complete parts list for the venting system design or venting system.

(d) **MANUFACTURER REQUIREMENTS – GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED. When the manufacturer of a Product Approved side wall horizontally vented gas fueled equipment does not provide the parts for venting the fuel gases, but identifies "special venting systems", the following requirements shall be satisfied by the manufacturer:**

1. The referenced “special venting system” instructions shall be included with the appliance or equipment installation instructions; and
  2. The “special venting systems” shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.
- (e) **A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.**

### 2.3.2 Side Wall Combustion Air Terminal

The Laars side wall combustion air terminal (listed in Table 1) must be used when the unit takes its combustion air through a duct from a side wall. Consider the following when installing the terminal:

1. Do not locate the air inlet terminal near a source of corrosive chemical fumes (e.g., cleaning fluid, chlorinated compounds, etc.)
2. Locate the terminal so that it will not be subject to damage by accident or vandalism.
3. Locate the combustion air terminal so that it cannot be blocked by snow. The National Fuel Gas Code requires that it be at least 12 inches (30 cm) above grade, but the installer may determine it should be higher, depending upon local conditions.
4. If the Pennant is side-wall vented to the same wall, locate the vent terminal at least 3 feet (0.9m) horizontally from the combustion air terminal, and locate the vent terminal at least 1 foot (0.3m) above the combustion air terminal (see Figure 3).

### 2.3.3 Vertical Vent Terminal

When the unit is vented through the roof, the vent must extend at least 3 feet (0.9m) above the point at which it penetrates the roof. It must extend at least 2 feet (0.6m) higher than any portion of a building within a horizontal distance of 10 feet (3.0m), and high enough above the roof line to prevent blockage from snow. When the combustion air is taken from the roof, the combustion air must terminate at least 12" (30cm) below the vent terminal (see Figure 2).

### 2.3.4 Vertical Combustion Air Terminal

When combustion air is taken from the roof, a field-supplied rain cap or an elbow arrangement must be used to prevent entry of rain water (see Figure 2). The opening on the end of the terminal must be at least 12" (30cm) above the point at which it penetrates the

roof, and high enough above the roof line to prevent blockage from snow. When the vent terminates on the roof, the combustion air must terminate at least 12" (30cm) below the vent terminal.

## 2.4 Common Vent Test — Boilers

When an existing boiler is removed from a common venting system, the common venting system is likely to be too large for proper venting of the appliances remaining connected to it.

At the time of removal of an existing boiler, 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 there is non blockage or restriction, leakage, corrosion and other deficiencies which could cause an unsafe condition.
3. Insofar as it is practical, close all building doors and windows and 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 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 doors, windows, exhaust fans, fireplace dampers and any other gas burning appliance to their previous conditions of use.
7. Any improper operation of the common venting system should be corrected so that the installation conforms with the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or CSA B149.1, Natural Gas and Propane Installation Codes. 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 F in the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or CSA B149.1, Natural Gas and Propane Installation Codes.

## 2.4 Vérification des événements communs — Chaudières

*Lorsqu'une chaudière existante est déconnectée du réseau d'événements commun, ce réseau d'événements commun devient probablement trop grand pour les appareils qui lui restent connectés. Lorsqu'une chaudière existante est retirée, les étapes suivantes doivent être accomplies pour chaque appareil qui reste connecté au réseau d'événements commun utilisé, alors que les autres appareils qui sont encore connectés au réseau commun d'événements ne sont pas en fonctionnement.:*

1. *Sceller toutes les ouvertures non utilisées du système d'évacuation.*
2. *Inspecter de façon visuelle le système d'évacuation pour déterminer la grosseur et l'inclinaison horizontale qui conviennent et s'assurer que le système est exempt d'obstruction, d'étranglement, de fuite, de corrosion et autres défaillances qui pourraient présenter des risques.*
3. *Dans la mesure du possible, fermer toutes les portes et les fenêtres du bâtiment et toutes les portes entre l'espace où les appareils toujours raccordés au système d'évacuation sont installés et les autres espaces du bâtiment. Mettre en marche les sècheuses, tous les appareils non raccordés au système d'évacuation commun et tous les ventilateurs d'extraction comme les hottes de cuisinière et les ventilateurs des salles de bain. S'assurer que ces ventilateurs fonctionnent à la vitesse maximale. Ne pas faire fonctionner les ventilateurs d'été. Fermer les registres des cheminées.*
4. *Mettre l'appareil inspecté en marche. Suivre les instructions d'allumage. Réglage le thermostat de façon continue.*
5. *Faire fonctionner le brûleur principal pendant 5 min ensuite, déterminer si le coupe-tirage déborde à l'ouverture de décharge. Utiliser la flamme d'une allumette ou d'une chandelle ou la fumée d'une cigarette, d'un cigare ou d'une pipe.*
6. *Une fois qu'il a été déterminé, selon la méthode indiquée ci-dessus, que chaque appareil raccordé au système d'évacuation est mis à l'air libre de façon adéquate. Remettre les portes et les fenêtres, les ventilateurs, les registres de cheminées et les appareils au gaz à leur position originale.*
7. *Tout mauvais fonctionnement du système d'évacuation commun devrait être corrigé de façon que l'installation soit conforme au National Fuel Gas Code, ANSI Z223.1/NFPA 54 et (ou) aux codes d'installation CSA-B149.1. Si la grosseur d'une section du système devrait être modifiée, le système devrait être modifié pour respecter les valeurs minimales des tableaux pertinents de l'appendice F du National Fuel Gas Code, ANSI Z223.1/NFPA 54 et (ou) les codes d'installation CSA-B149.1*

## 2.5 Vent Terminals for Outdoor Units

For outdoor applications, the vent and combustion air openings must be covered with proper terminals to prevent rain, snow and other objects from falling into the Pennant.

Outdoor Vent / Air kit part numbers are shown in Table 6. These kits contain parts for both combustion air inlet and exhaust vent connections. An angled sheet metal assembly with louvers replaces the sheet metal assembly with the air collar. An adapter, a 12" length of pipe, and a rain cap are included for the exhaust vent opening.

If local codes allow, Laars kits are not required for outdoor units. The installer may use 12" of appropriately sized galvanized single wall or b-type vent pipe and a rain cap for the exhaust vent. In addition, an appropriately sized galvanized 90° elbow, positioned with the opening facing down, may be used on the combustion air inlet.

Model (Size)	Outdoor Vent and Air Terminal Kit
200	CA003001
300	CA003002
400	CA003003

Table 6. Vent / Air Kits for Outdoor Units.

## SECTION 3. Gas Supply and Piping

### 3.1 Gas Supply and Piping

Gas piping should be supported by suitable hangers or floor stands, not by the appliance.

The Pennant's gas train allows the user to pipe the gas from either the right side or the left side of the unit. As shipped, the right side of the gas train is capped off, and there is a manual valve on the left side. If desired, the manual valve on the left side of the gas train may be moved to the right side, and the cap on the right side may be moved to the left.

Review the following instructions before proceeding with the installation.

1. Verify that the appliance is fitted for the proper type of gas by checking the rating plate. Pennant appliances are equipped to operate at elevations up to 10,000 feet (3050m). Pennant appliances may be adjusted to operate properly at altitudes above 2500 feet (see Section 6.5.2) and the input will be reduced if the heating value of the gas supply is below sea level values.
2. The maximum inlet gas pressure must not exceed 13" w.c. (3.2kPa). The minimum inlet gas pressure is 5 in. w.c. (1.2 kPa).
3. Refer to Table 7, size supply.
4. Run gas supply line in accordance with all applicable codes.

5. Locate and install manual shutoff valves in accordance with state and local requirements.
6. A sediment trap must be provided upstream of the gas controls.
7. All threaded joints should be coated with piping compound resistant to action of liquefied petroleum gas.
8. The appliance and its individual shutoff valve must be disconnected from the gas supply piping during any pressure testing of that system at test pressures in excess of 0.5 psig (3.45 kPa).
9. The unit must be isolated from the gas supply system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 0.5 psig (3.45 kPa).
10. The appliance and its gas connection must be leak tested before placing it in operation.
11. Purge all air from gas lines.

**⚠ WARNING**

Do not use open flame to check for leaks. An open flame could lead to explosion, which could result in property damage, serious injury or death.

**⚠ AVERTISSEMENT**

Ne recherchez pas les fuites avec une flamme nue. Une flamme nue peut provoquer une explosion qui peut causer des dommages matériels, de sérieuses blessures corporelles ou la mort.

**NOTE:** The Pennant appliance and all other gas appliances sharing the gas supply line must be firing at maximum capacity to properly measure the inlet supply pressure. The pressure can be measured at the supply pressure port on the gas valve. Low gas pressure could be an indication of an undersized gas meter, undersized gas supply lines and/or an obstructed gas supply line.

## SECTION 4A. Water Connections — Pennant Boiler

### 4A.1 Heating System Piping: Hot Supply Connections — Boiler

**NOTE:** This appliance must be installed in a closed pressure system with a minimum of 12 psig (82.7 kPa) static pressure at the boiler.

Hot water piping should be supported by suitable hangers or floor stands. Do not support piping with this appliance. Due to expansion and contraction of copper pipe, consideration should be given to the type of hangers used. Rigid hangers may transmit noise through the system resulting from the piping sliding in the hangers. It is recommended that padding be used when rigid hangers are installed. Maintain 1" clearance to combustibles for hot water pipes.

Pipe the discharge of the relief valve (full size) to a drain or in a manner to prevent injury in the event of pressure relief. Install an air purger, an air vent, a diaphragm-type expansion tank, and a hydronic flow check in the system supply loop. Minimum fill pressure must be 12 psig (82.7 kPa). Install shutoff valves where required by code.

Suggested piping diagrams are shown in Figures 4, 5, 6, 7 and 8. These diagrams are meant only as a guide. Components required by local codes must be properly installed.

Note the recommended location of the temperature sensor on the diagrams; you must provide a location for the additional sensor shipped with the Pennant. This sensor may be strapped onto pipe from 1" to 4" diameter, or inserted into an immersion well.

Distance from Gas Meter or Last Stage Regulator						
Model and Gas Type	0-100'	0-31 m	100-200'	31-61m	200-300'	61-91m
200 natural	1¼"	3.2 cm	1¼"	3.2 cm	1¼"	3.2 cm
200 propane	1"	2.5 cm	1"	2.5 cm	1¼"	3.2 cm
300 natural	1¼"	3.2 cm	1½"	4.0 cm	1½"	4.0 cm
300 propane	1"	2.5 cm	1¼"	3.2 cm	1¼"	3.2 cm
400 natural	1¼"	3.2 cm	1½"	4.0 cm	2"	5.0 cm
400 propane	1¼"	3.2 cm	1¼"	3.2 cm	1½"	4.0 cm

**Notes:**

1. These figures are based on 1/2" (0.12 kPa) water column pressure drop.
2. Check supply pressure and local code requirements before proceeding with work.
3. Pipe fittings must be considered when determining gas pipe sizing.

**Table 7. Gas Piping Size.**

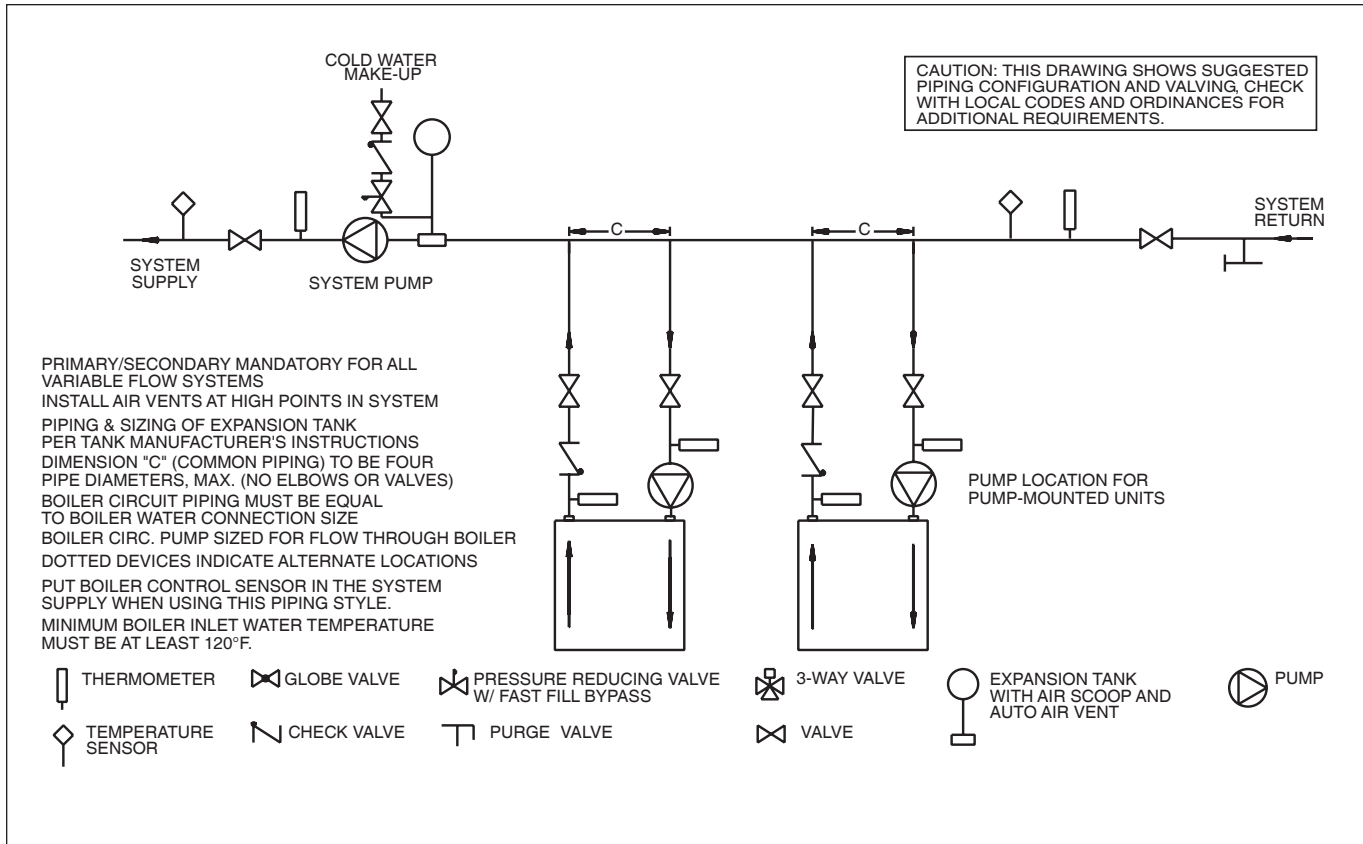


Figure 4. Hydronic Piping — Multiple Boilers, Primary Secondary System.

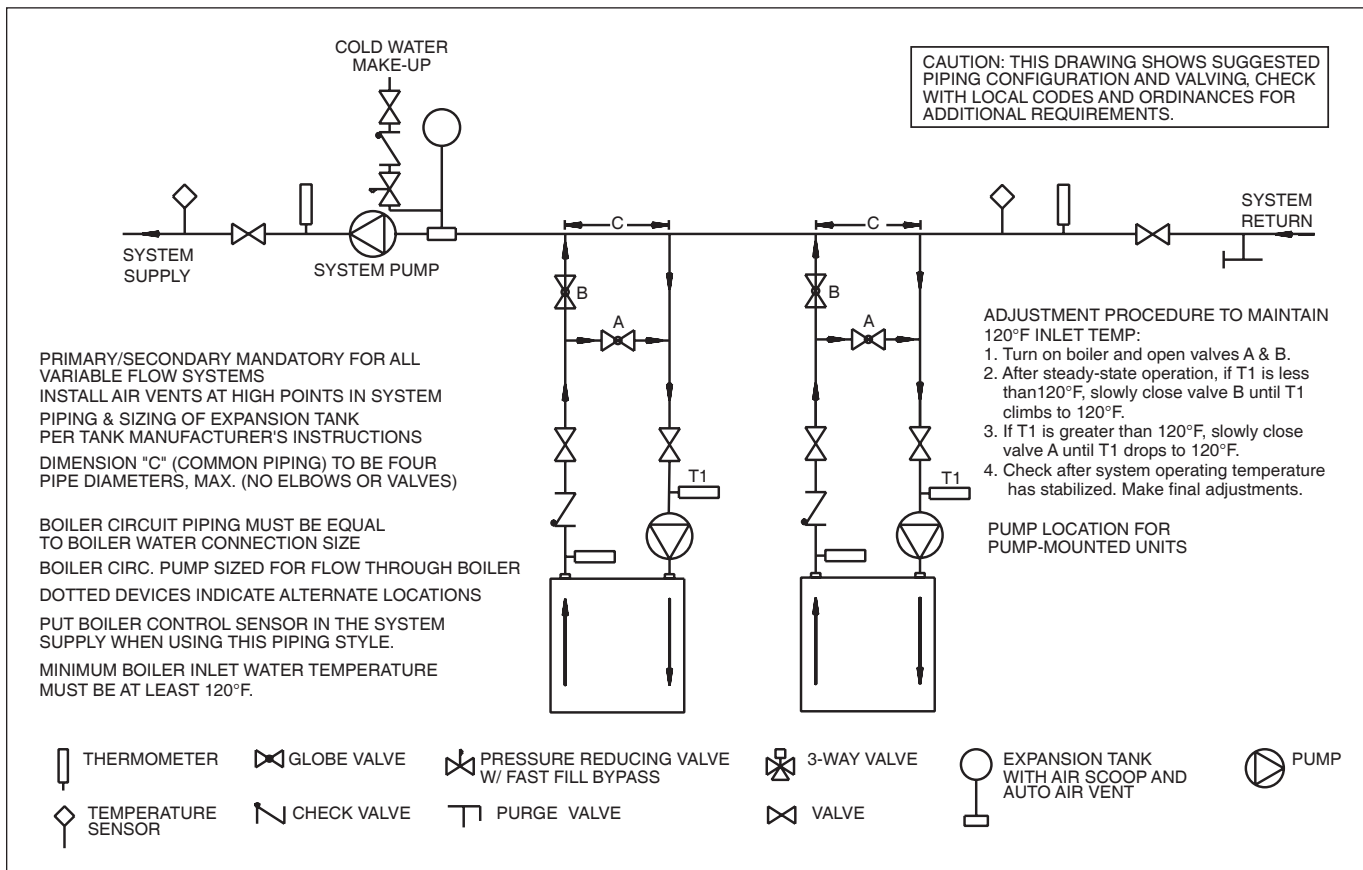


Figure 5. Hydronic Piping — Multiple Boilers, Low Temperature System.



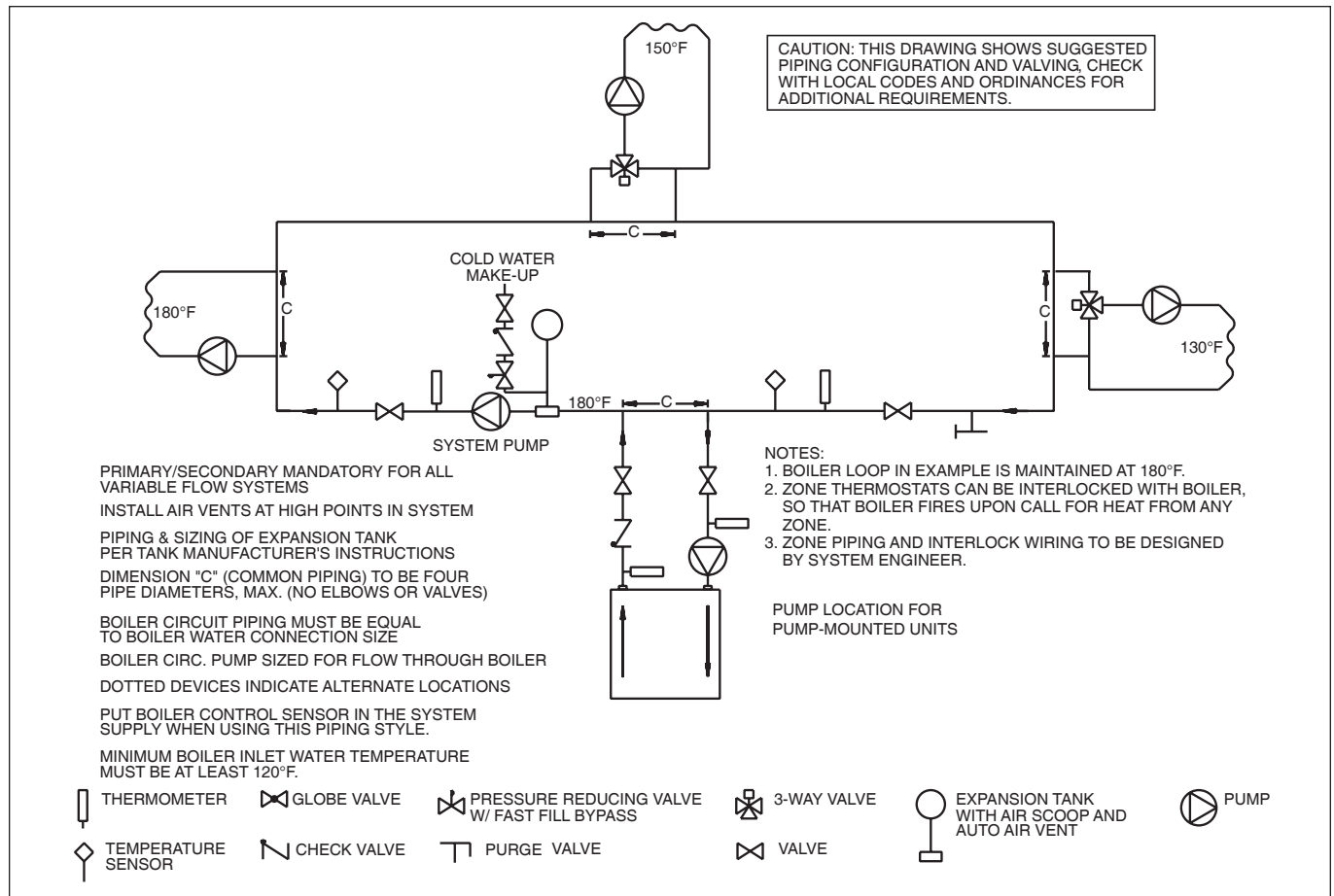


Figure 6. Hydraulic Piping — One Boiler, Multi-Temperature System.

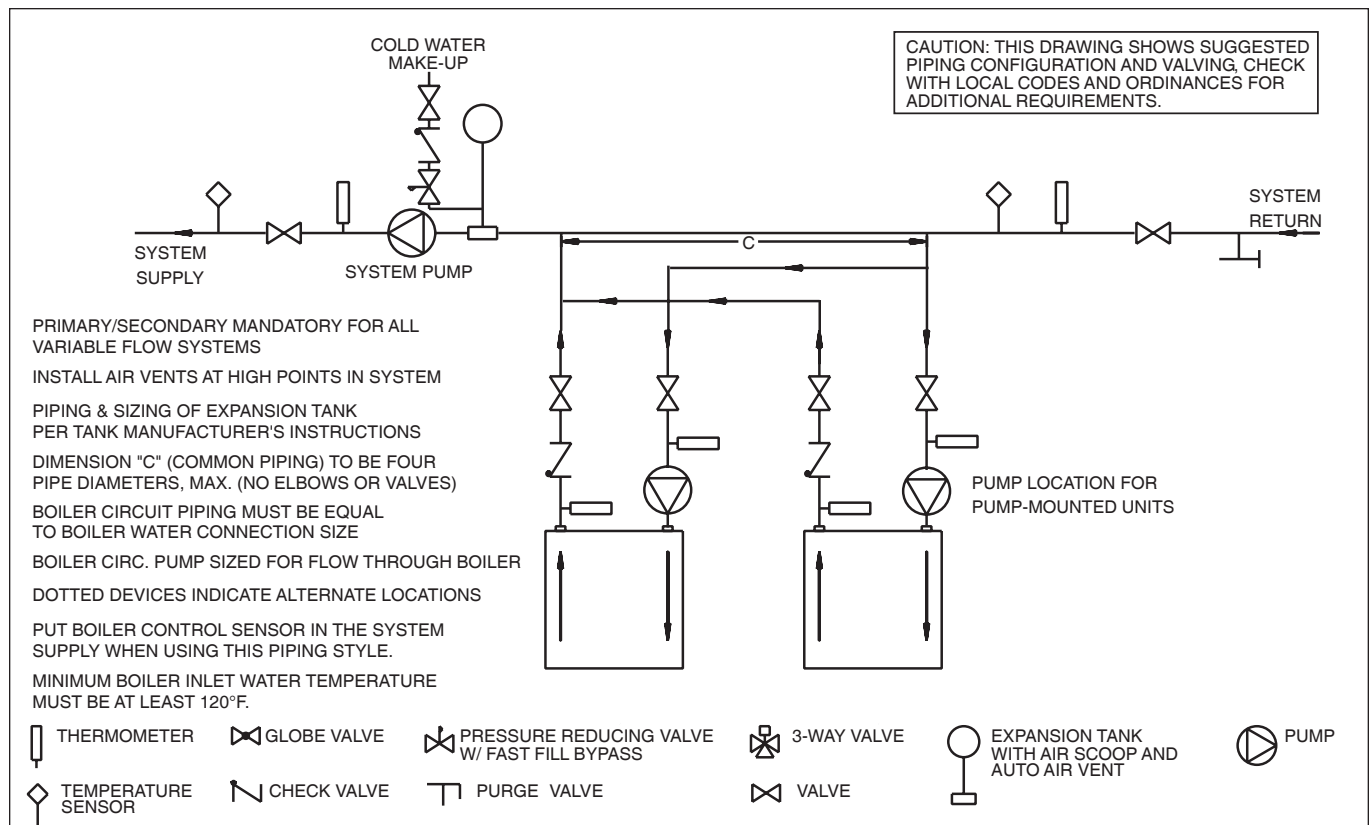


Figure 7. Hydraulic Piping — Primary-Secondary, Reverse-Return.

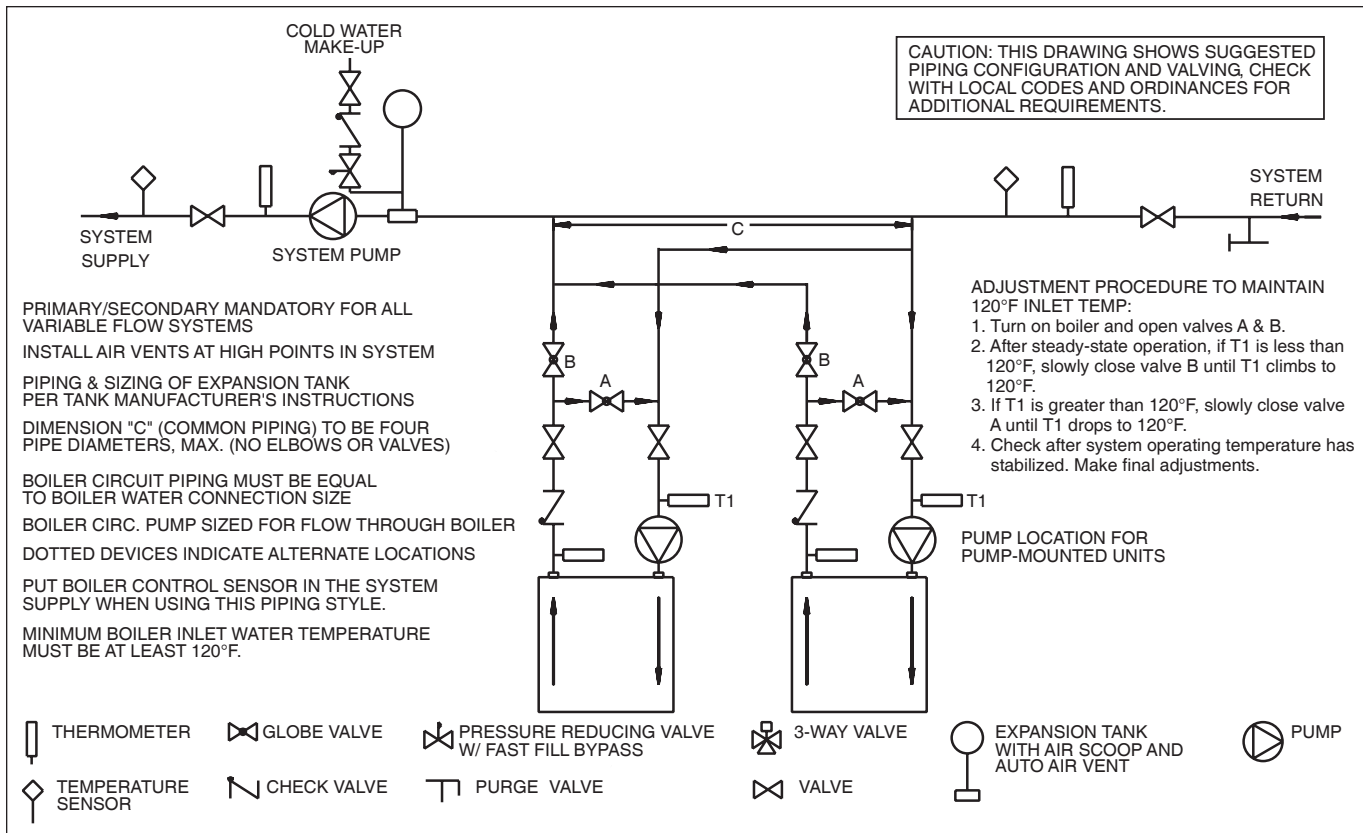


Figure 8. Hydronic Piping — Primary-Secondary, Reverse-Return, Low Temperature.

**4A.2 Cold Water Make-Up — Boiler**

1. Connect the cold water supply to the inlet connection of an automatic fill valve.
2. Install a suitable back flow preventer between the automatic fill valve and the cold water supply.
3. Install shut off valves where required.

**NOTE:** The boiler, when used in connection with a refrigeration system, must be installed so the chilled medium is piped in parallel with the boiler with appropriate valves to prevent the chilled medium from entering the boiler.

The boiler piping system of a hot water heating boiler connected to heating coils located in air handling appliances where they may be exposed to refrigerated air circulation must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

A boiler installed above radiation level, or as required by the authority having jurisdiction, must be provided with a low water cutoff device either as a part of the boiler or at the time of boiler installation.

**4A.3 Water Flow Requirements — Boiler**

A hydronic heating (closed loop) application recirculates the same fluid in the piping system. As a result, no new minerals or oxygen are introduced into the system. To ensure a proper operating temperature leading to long boiler life, a flow rate has been

established based on the fluid temperature rise for this specific size boiler.

Pump-mounted boilers can be ordered for use in primary secondary piping systems. The pumps used are sized for the head loss through the heater, plus 30 feet (9.1 m) of full-sized piping (same size as boiler outlet) and a normal number of fittings.

Model (Size)	20°F		25°F		30°F		35°F	
	flow gpm	H/L feet	flow gpm	H/L feet	flow gpm	H/L feet	flow gpm	H/L feet
200	17	1.6	14	1.0	11	0.7	10	0.5
300	26	3.5	20	2.3	17	1.6	15	1.2
400	34	6.3	27	4.0	23	2.8	19	2.1

*Metric Equivalent*

Model (Size)	11°C		14°C		17°C		19°C	
	ow lpm	H/L m	ow lpm	H/L m	ow lpm	H/L m	ow lpm	H/L m
200	64	0.5	51	0.3	43	0.2	37	0.2
300	97	1.1	77	0.7	64	0.5	55	0.4
400	129	1.9	103	1.2	86	0.9	74	0.6

**Notes:** gpm = gallons per minute, lpm = liters per minute, H/L = head loss, ft = head loss in feet, m = head loss in meters. Maximum temperature rise is 35°F (19°C), as shown. Head loss is for boiler's heat exchanger only. N/R = not recommended.

Table 8. Water Flow Requirements - PNCH.

Table 8 specifies water flow rates for boilers, which will enable the user to size a pump. The head loss shown is for the heater only, and the user will need to add the head loss of the system piping to properly size the pump.

The minimum inlet water temperature for the Pennant is 120°F (49°C) to avoid condensing on the copper coils.

#### 4A.4 Freeze Protection — Boiler

Boiler installations are not recommended in areas where the danger of freezing exists unless proper precautions are made for freeze protection. A non-toxic, heating system, anti-freeze may be added to the hydronic system provided that the concentration does not exceed 50% and the anti freeze contains an anti foamant. When a 50/50 mixture is used, increase the water flow requirements by 15%, and increase the head loss requirements by 20%.

Power outage, interruption of gas supply, failure of system components, activation of safety devices, etc., may prevent a boiler from firing. **Any time a boiler is subjected to freezing conditions, and the boiler is not able to fire, and/or the water is not able to circulate, there is a risk of freezing in the boiler or in the pipes in the system.** When water freezes, it expands. This can result in bursting of pipes in the system, or damage to the boiler, which could result in leaking or flooding conditions.

**IMPORTANT NOTES:** Different glycol products may provide varying degrees of protection. Glycol products must be maintained properly in a heating system, or they may become ineffective. Consult the glycol specifications, or the glycol manufacturer, for information about specific products, maintenance of solutions, and set up according to your particular conditions. Never use ethylene glycol (automotive antifreeze).

## SECTION 4B. Water Connections — Pennant Water Heater

### 4B.1 Water System Piping — Water Heater

Hot water piping should be supported by suitable hangers or floor stands. Do not support piping with this appliance. Due to expansion and contraction of copper pipe, consideration should be given to the type of hangers used. Rigid hangers may transmit noise through the system resulting from the piping sliding in the hangers. It is recommended that padding be used when rigid hangers are installed.

The Pennant can be used with several different types of readily available storage tanks. A pump draws water from the storage tank and pumps the water

through the heater and back into the tank. Pump-mounted units have a circulating pump built into the water heater. The pumps used are sized for the head loss through the heater, plus 30 feet (9.1 m) of full-sized piping (same size as boiler outlet) and a normal number of fittings. Pumps used on pump-mounted unit are sized for soft/normal or hard water, so make sure a pump-mounted unit matches the water quality of the installation.

Pipe the outlet from the heater's relief valve such that any discharge from the relief valve will be conducted to a suitable place for disposal when relief occurs. Do not reduce line size or install any valves in this line. The line must be installed to allow complete drainage of both the valve and the line.

Suggested piping diagrams are shown in Figures 9, 10, 11 and 12. These diagrams are meant only as a guide. Components required by local codes must be properly installed.

Note the recommended location of the temperature sensor on the diagrams. The Pennant is shipped with an additional sensor that can be used for more full-featured domestic water heating control. To get these features, you must provide a location for the additional sensor. It can be strapped to a pipe from 1" to 4" diameter, or inserted into a tank immersion well.

The minimum inlet water temperature for the Pennant is 120°F (49°C) to avoid condensing on the copper coils.

### 4B.2 Hot Water Supply Piping — Water Heater

Follow the tank manufacturer's guidelines for completion of the hot water system connections.

**NOTE: A listed temperature and pressure relief valve listed as complying with the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems (ANSI Z21.22/CSA 4.4), of suitable discharge capacity must be installed in the separate storage tank system.**

If the Pennant water heater is installed in a closed water supply system, such as one having a backflow preventer in the cold water supply line, the relief valve may discharge periodically, due to thermal expansion. Means (such as a properly-sized expansion tank) shall be provided to control thermal expansion. Contact the water supplier or local plumbing inspector on how to control this situation.

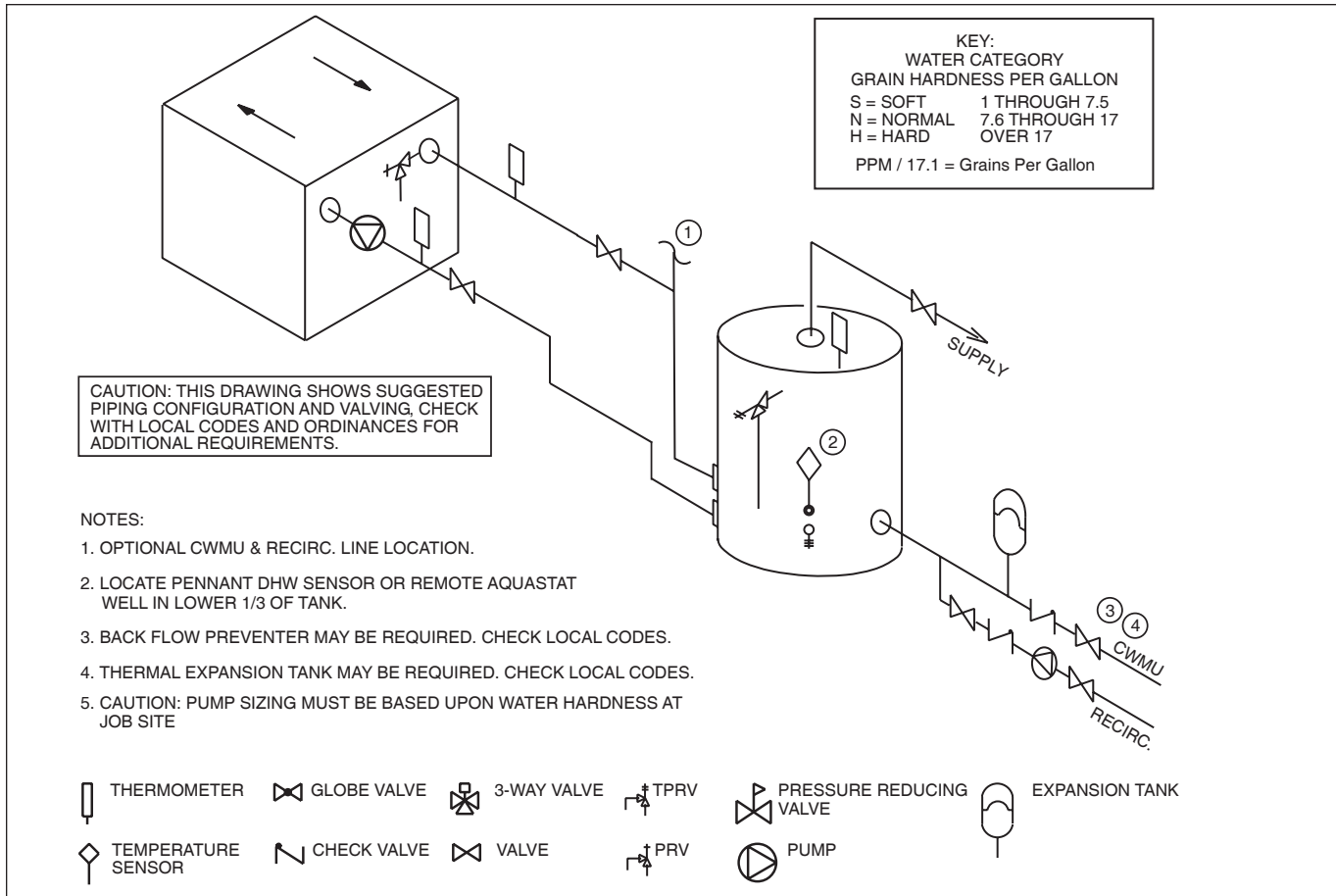


Figure 9. Water Heater Piping — One Heater, One Tank.

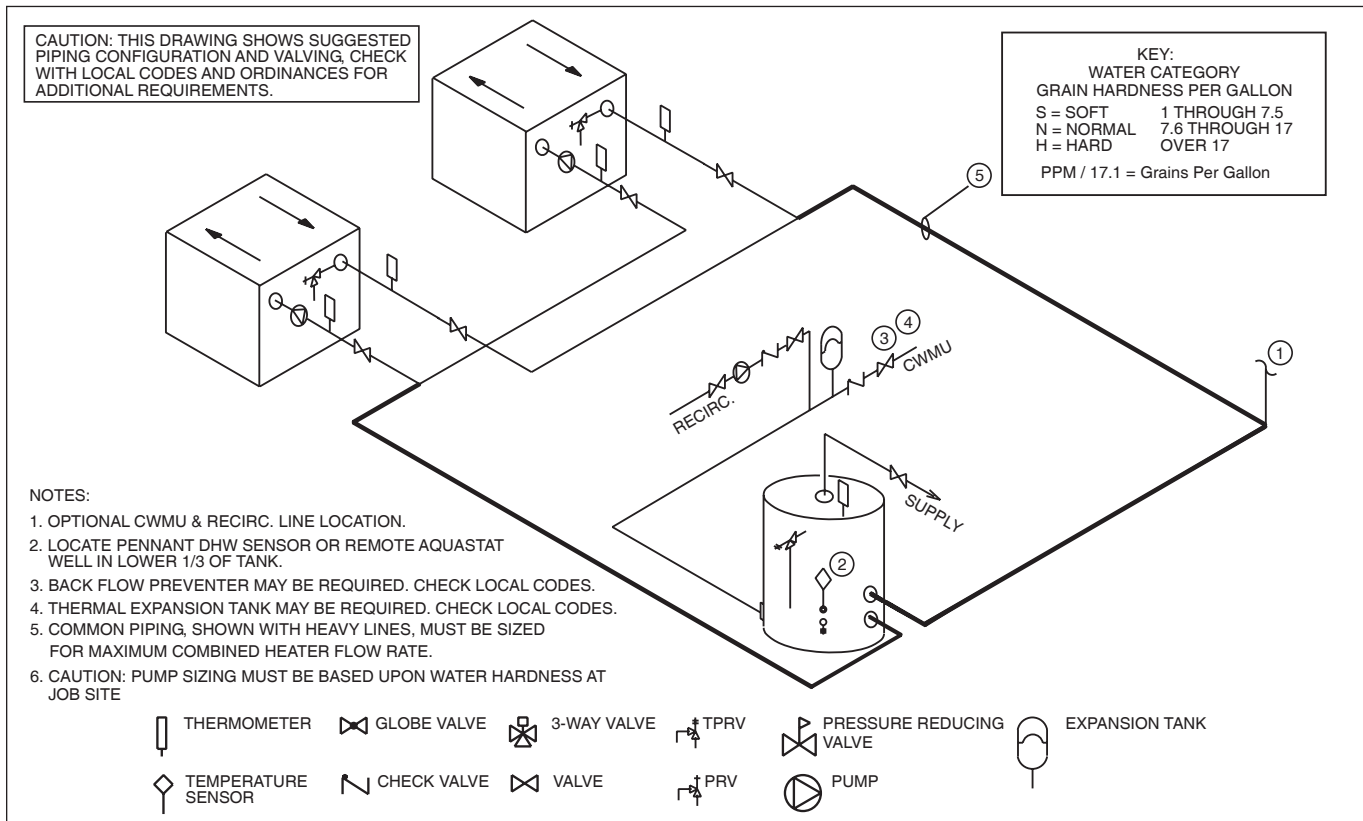
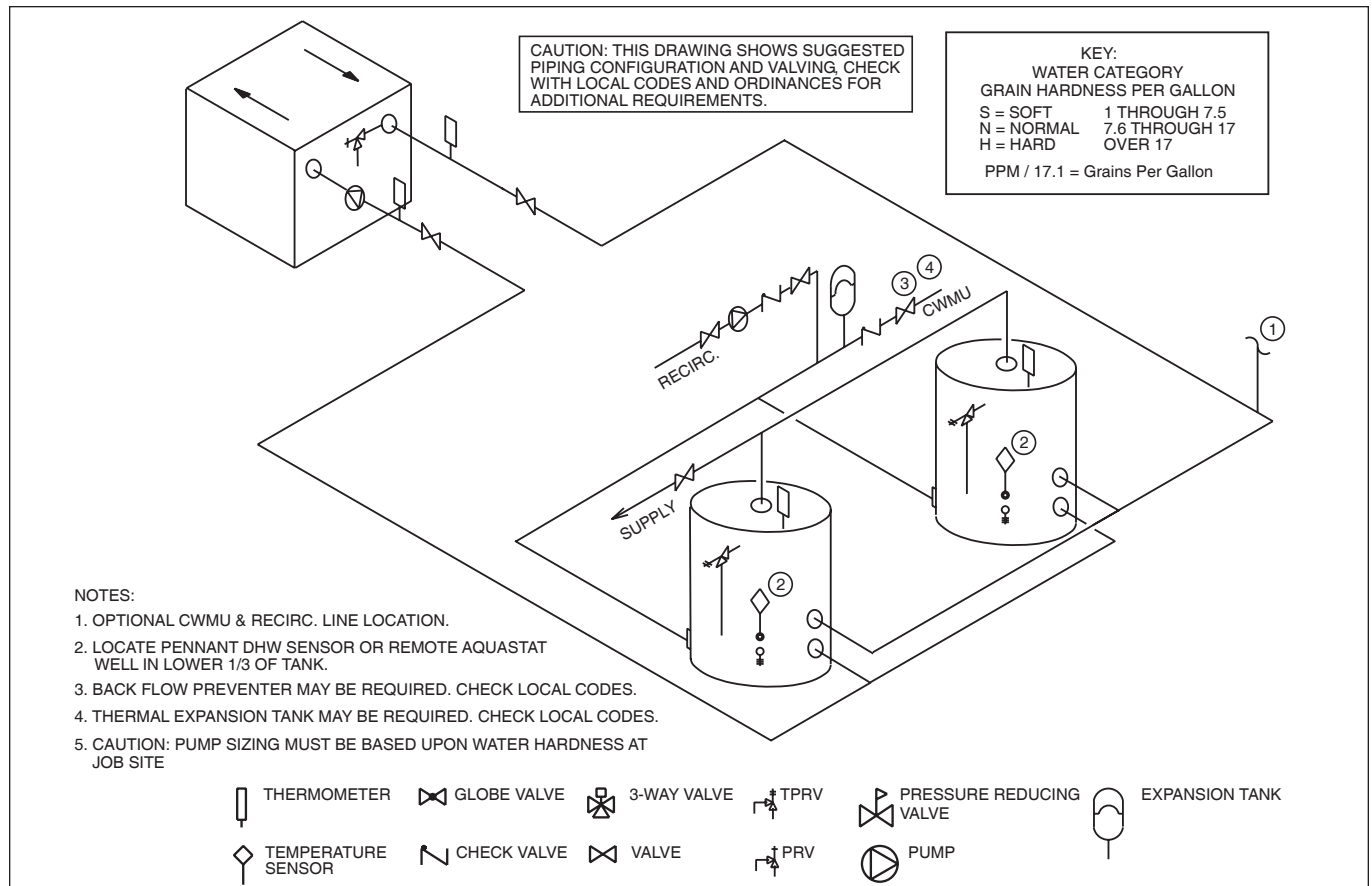
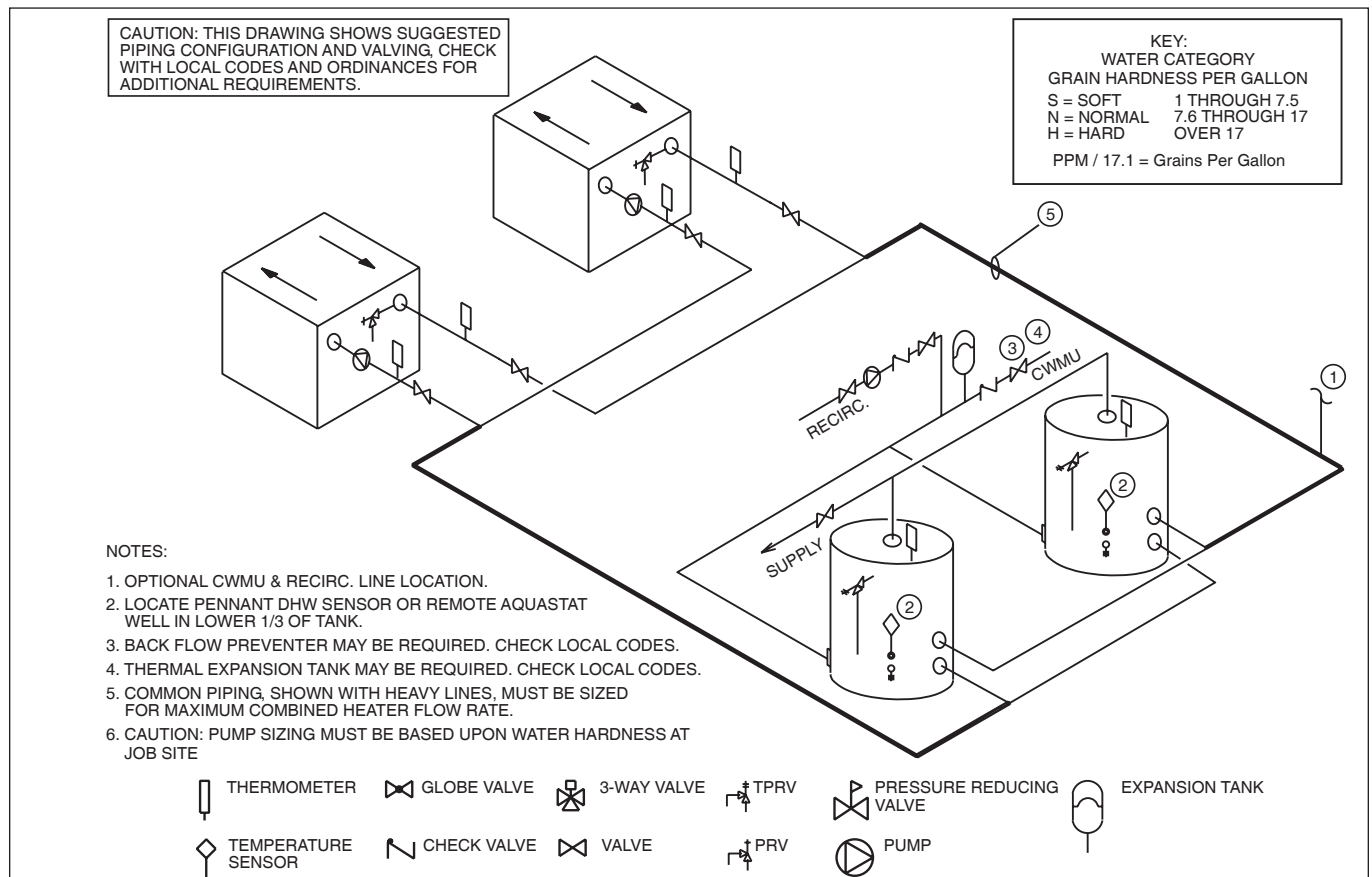


Figure 10. Water Heater Piping — Multiple Heaters, One Tank.



**Figure 11. Water Heater Piping — One Heater, Multiple Tanks.**



**Figure 12. Water Heater Piping — Multiple Heaters, Multiple Tanks.**

Model (Size)	gpm			ft			Temp Rise °F			lpm			m			Temp. Rise °C		
	S	N	H	S	N	H	S	N	H	S	N	H	S	N	H	S	N	H
200	23	35	45	1.9	4.4	7.3	15	10	8	87	132	170	0.6	1.3	2.2	8	6	4
300	23	35	45	2.0	4.5	7.4	22	15	11	87	132	170	0.6	1.4	2.3	12	8	6
400	23	35	45	2.0	4.5	7.4	30	19	15	87	132	170	0.6	1.4	2.3	17	11	8

Notes:

1. S = soft water (1 to 7.5 grains hardness)
2. N = normal water (7.6 to 17 grains hardness)
3. H = hard water (more than 17 grains hardness)
4. gpm = gallons per minute, lpm = liters per minute, ft = head loss in feet, m = head loss in meters
5. Head loss is for heater's heat exchanger only

Table 9. Water Flow Requirements - PNCV.

### 4B.3 Water Flow Requirements — Water Heater

In a water heating application (an open system), new water is constantly being introduced. With the new water comes a fresh supply of minerals that can be deposited on the unit's heat exchanger. This is commonly known as scaling. The amount of minerals will depend upon the hardness of the water. Water can also be aggressive, and can erode metals, including copper, if the water is moved too quickly. The water flow requirements for the Pennant water heater are based upon the hardness of the water. The water flow is kept high enough to prevent scaling, but low enough to prevent tube erosion. For extremely soft or hard water, cupro-nickel tubes are available. Contact a Laars representative if you have questions or concerns about water quality.

Pump-mounted water heaters can be ordered with standard pumps for soft or normal water or with pumps for hard water. The pumps used are sized for the head loss through the heater, plus 30 feet (9.1m) of full-sized piping (same size as heater outlet) and a normal number of fittings.

Table 9 specifies water flow rates for water heaters, which will enable the user to size a pump. The head loss shown is for the heater only, and the user will need to add the head loss of the piping system to properly size the pump.

### 4B.4 Combined Water Heating (potable) and Space Heating — Water Heater

**NOTE:** These systems are not allowed in the Commonwealth of Massachusetts.

Piping and components connected to this water heater for the space heating application shall be suitable for use with potable water.

Toxic chemicals, such as used for boiler treatment, shall not be introduced into the potable water used for space heating.

This water heater when used to supply potable water shall not be connected to any heating system or component(s) previously used with a non-potable water heating appliance.

**When the system requires water for heating at temperatures higher than required for other uses, an anti-scald mixing or tempering valve shall be installed to temper the water for those uses in order to reduce scald hazard potential.**

### 4B.5 Freeze Protection — Water Heater

Although Pennant water heaters are design-certified for outdoor installations, such installations are not recommended in areas subject to freezing temperatures, unless proper precautions are taken.

Power outage, interruption of gas supply, failure of system components, activation of safety devices, etc., may prevent a heater from firing. **Any time a heater is subjected to freezing conditions, and the heater is not able to fire, and/or the water is not able to circulate, there is a risk of freezing in the heater or in the pipes in the system.** When water freezes, it expands. This can result in bursting of pipes in the system, or damage to the heater, which could result in leaking or flooding conditions.

Contact the local factory representative or Laars for additional information.

## SECTION 5. Electrical Connections

### WARNING

The appliance must be electrically grounded in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with the latest edition of the National Electrical Code, ANSI/NFPA 70, in the U.S. and with latest edition of CSA C22.1 Canadian Electrical Code, Part 1, in Canada. Do not rely on the gas or water piping to ground the metal parts of the boiler. Plastic pipe or dielectric unions may isolate the boiler electrically. Service and maintenance personnel, who work on or around the boiler, may be standing on wet floors and could be electrocuted by an ungrounded boiler.

**AVERTISSEMENT**

L'appareil doit être relié à la terre conformément aux exigences de la réglementation locale ou, en l'absence d'une telle réglementation, à la plus récente édition du National Electrical Code (Code national de l'électricité) ANSI/NFPA 70 aux États-Unis, et à la plus récente édition du Code Canadien de l'électricité 1<sup>ère</sup> partie (Canadian Electrical

Code Part 1) CSA C22.1, au Canada. N'utilisez pas les tuyauteries d'eau ou de gaz pour mettre à la terre les pièces métalliques de la chaudière; des tuyauteries en plastique ou des raccords union diélectriques peuvent isoler électriquement la chaudière. Les employés qui sont appelés à travailler sur la chaudière ou autour peuvent être électrocutés par une chaudière qui n'est pas mise à la terre.

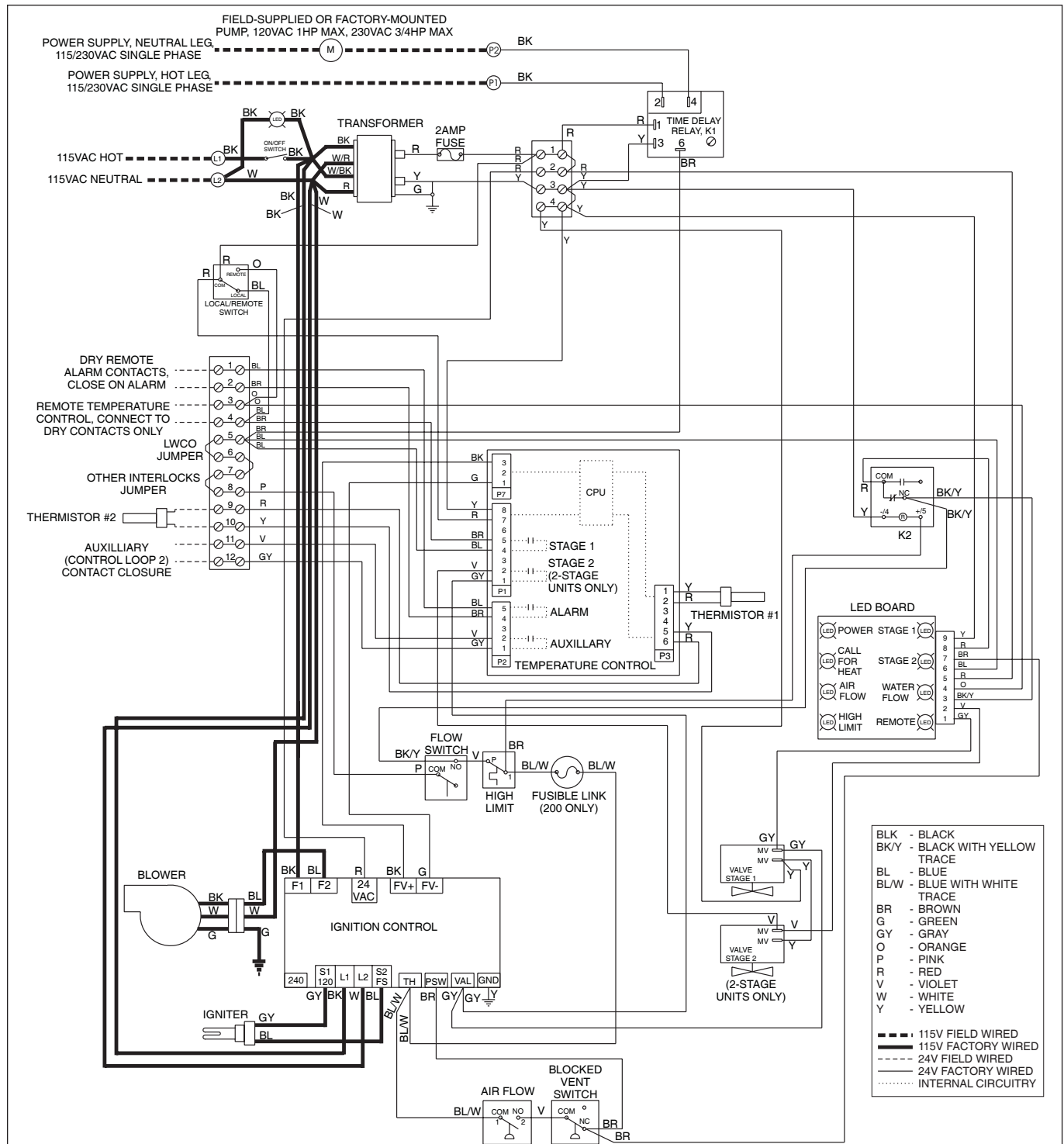


Figure 13. Wire Connection Diagram

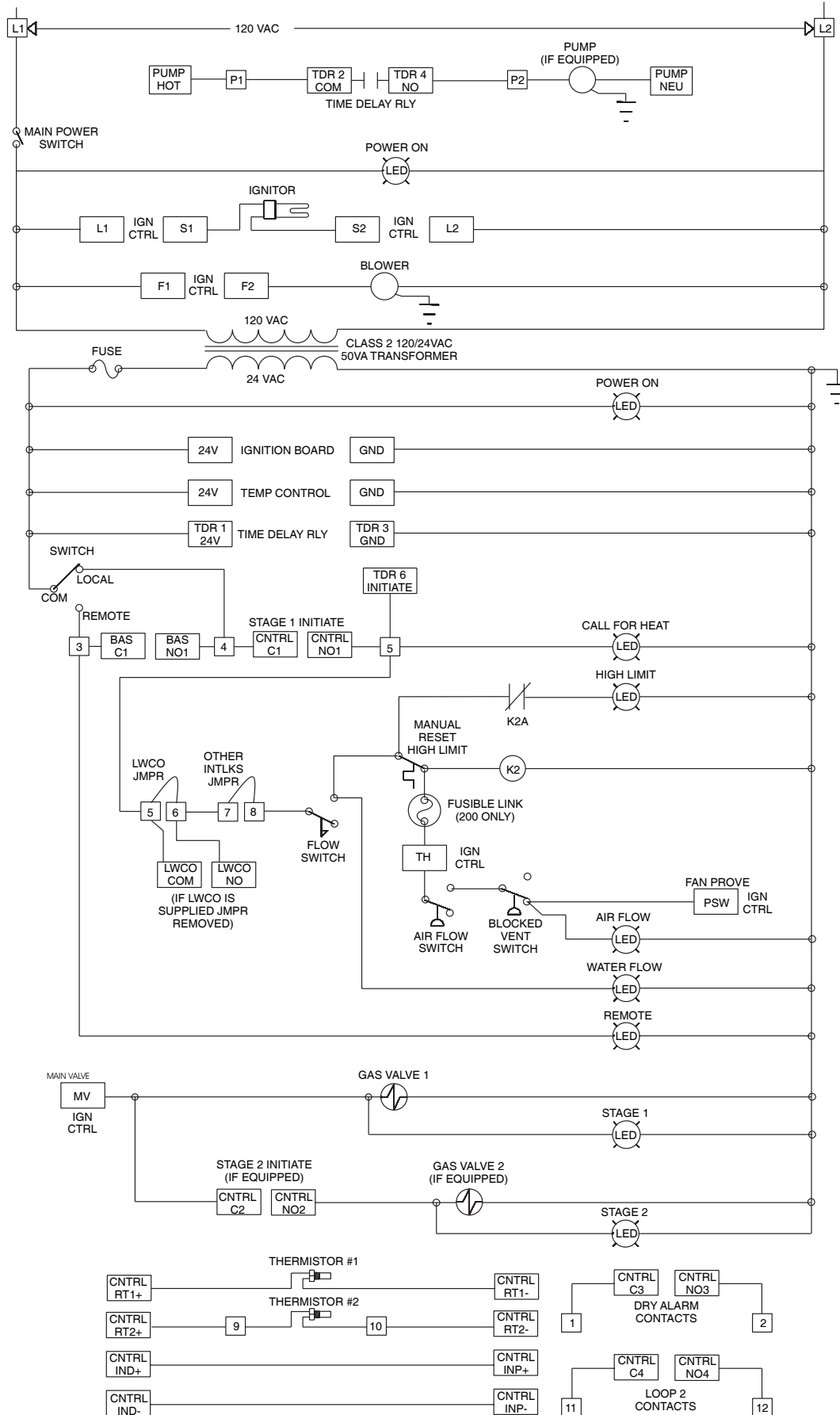


Figure 14. Wiring Schematic (Ladder Diagram).



Single pole switches, including those of safety controls and protective devices must not be wired in a grounded line.

All electrical connections are made in the field wiring terminal strip, which is located to the left of the blower.

**NOTE:** All internal electrical components have been pre-wired. No attempt should be made to connect electrical wires to any other location except the wiring box.

## 5.1 Main Power

Connect a 15 amp. fused, 120-volt supply to the main power switch (hot leg is connected directly to switch). Neutral leg is connected directly to the white wire. Ground wire can be connected to the grounding screw in the box or on the switch.

Wiring diagrams are shown in Figures 13 and 14.

## 5.2 Field Wiring

Terminal strips are supplied for field wiring connections under the flip-up control panel.

Connections must be made as specified by the Connection Diagram (Figure 13). The following may be connected to the terminal strips as field wiring:

**Temperature Sensor:** The sensor supplied loose with the Pennant is installed in the piping or tank, per the suggested piping diagrams. The sensor, Thermistor 2, is connected to the "9" and "10" terminals.

**Field Installed Pump:** A pump contactor can be wired to the "P1" and "P2" terminals. These terminals are attached to dry contacts of an adjustable delay on break relay. The contacts may be used to switch a larger pump contactor or can be used to directly switch the hot leg of a circulator pump, up to 1hp at 120 VAC or 3/4hp at 240 VAC.

Note that in some cases, the pump is run continuously.

**External Alarm:** An external power supply and alarm can be connected to the "1" and "2" terminals. In the event of an ignition time out, a contact closure occurs across these terminals.

**BAS Connections:** To use an external control to call Pennant units for heat, connect to terminals "3" and "4". Then put the Local/Remote Switch in the "Remote" mode.

**Other Field Interlocks:** To install other field-wired switches (proving switches, flow switches, etc.), remove the jumper between the terminals labeled "7" and "8".

**Auxiliary Contacts:** The contacts between terminals "11" and "12" will close whenever Loop 2 is enabled and there is a call for heat on Loop 2. Use these terminals to enable field devices under these circumstances

## SECTION 6. Operating Instructions

### 6.1 Filling the Boiler 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 for a minimum of 30 minutes with the boiler shut off.
6. Open all strainers in the circulating system, check flow switch operation, and check for debris. If debris is present, clean out to ensure proper circulation.
7. Recheck all air bleeders as described in Step 4.
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  $\frac{1}{4}$  of the total, with the balance filled with air.
9. Start up boiler according to the procedure in this manual. 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  $\frac{1}{4}$  of the volume of the expansion tank, open the tank drain, 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.
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 the 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. Refer to local codes and the make-up water valve manufacturer's instructions as to whether the make-up water valve should be left open or closed.

15. After placing the unit in operation, the ignition system safety shutoff device must be tested. First, shut off the manual gas valve, and call the unit for heat. After the pre-purge and ignitor heat-up time, the main gas terminals will be energized, attempting to light, for seven (7) seconds, and then will de-energize. The unit will attempt to light two more times, and then will go into lockout mode. Second, turn the power off and then on again, open the manual gas valve and allow the unit to light. While the unit is operating, close the manual gas valve and ensure that power to the main gas valve has been cut.
16. Within three (3) days of start-up, recheck all air bleeders and the expansion tank as described in Steps 4 and 8 above.

**Important:** The installer is responsible for identifying to the owner/operator the location of all emergency shutoff devices.

#### **WARNING**

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 any part of the control system and any gas control that may have been under water.

#### **AVERTISSEMENT**

N'utilisez pas cet appareil si l'une de ses pièces est passée sous l'eau. Appelez tout de suite un technicien en entretien et en réparation pour inspection de l'appareil et remplacement des pièces du système de commande, et des pièces de commande du circuit gaz, qui sont passées sous l'eau.

## 6.2 Pennant Controller

Pennant 200-400 units feature a custom-configured digital control system that is capable of monitoring the temperature in two different loops. Loop 1 is the Pennant loop, which uses thermistor 1, mounted in the inlet of the Pennant. Loop 2 is a secondary loop, using the auxiliary thermistor (called thermistor 2) provided loose with the Pennant.

Thermistor 2 can be installed where the user chooses (in a tank, or in system piping, etc.) and is connected to Pennant terminals 9 and 10. It is activated in the Pennant controller menu (see section 6.6). Auxiliary contacts in the Pennant controller will close when Loop 2 calls for heat, and these contacts can be used to energize a pump relay, or other device that the user chooses.

## 6.3 Local / Remote Switch

A call for heat can be initiated by the Pennant controller, or by an external controller. When an

external controller, such as a tank aquastat or multiple boiler control, is used, it is connected between Pennant terminals 3 and 4. With the switch in the Remote position, the external controller is included in the Pennant sequence of operation, and the Remote indicator light on the front panel is illuminated. If an external control is not used, put the switch in the Local position, and terminals 3 and 4 are left out of the sequence.

## 6.4 Sequence of Operation

The amber "Ready" light on the front panel indicates that the control system is energized. Upon a call for heat, the green "Call for Heat" indicator on the front panel will light.

The pump time delay relay will receive a signal to initiate. If the unit is pump-mounted, the pump will be energized. The pump terminals on the field-wiring terminals strip will energize a field pump that is properly interlocked with the Pennant. The green "Water Flow" indicator on the front panel will light, once proper flow has been established by the water flow switch.

Once the water flow switch makes, if all of the safety interlocks are closed, the ignition module will energize the blower(s) for a 15-second pre-purge, followed by a 40-second period to allow the ignitor to heat.

The ignition control energizes the blower. The blower pressurizes the air box (which supplies air to the burners) and closes the normally-open contact on the airflow pressure switch. The blocked vent pressure switch senses the pressure in the exhaust plenum. This switch opens if the pressure is excessive (as an indicator of a blocked vent). When these two pressure switches are closed, voltage is sent to the PSW terminal on the ignition control, which allows the ignition module to proceed with the ignition sequence.

If the airflow proving circuit is not proven, the ignition module will lock out, and the temperature controller will display the air flow fault, AFF. The ignition control LED will display its one-flash sequence, as well. Section 6.5 describes the result of air flow faults in more detail.

When the ignition control gets the signal at the PSW terminal, it will energize its MV terminal, which sends power to the stage one (or on/off) main valve. The green Stage 1 indicator on the front panel will light.

After a 7-second trial for ignition, the ignitor switches to flame sense mode. If a flame is not detected, the gas valve will close and the ignition module will attempt ignition again (up to two more times, for a total of three attempts.) If all three attempts fail, the ignition control will lock out.

If flame is sensed, the burner will continue to fire as long as there is a call for heat, and none of the safety circuit is interrupted.

If there is a call for stage 2 on a 2-stage unit, that valve will be energized, and the addition burner stage will be indicated on the front panel with a green stage 2 light.

If there is a loss of flame signal during a successful firing sequence, the ignition control will remove power from the gas valves, and then attempt to light up to two more times. If successful, the Pennant will fire normally. If unsuccessful, the ignition control will lock out.

Ignition lockout is noted on the ignition control LED with a three-flash sequence and is noted on the temperature control by displaying LOC.

When the call for heat is satisfied, the gas valve(s) closes, and the blower starts a 45 second post-purge. Any pump connected to the Pennant pump time delay relay will continue to run for the time delay period (dialed by the user, 0.1 to 10 minutes).

## 6.5 Ignition Control Reaction to Air Flow / Blocked Vent Pressure Switch

Air flow and blocked vent status are continuously monitored by the Pennant ignition control, at the control's PSW terminal.

At the start of an ignition sequence, if the ignition control sees power at PSW for 30 seconds, but the combustion blower has not yet been energized by the control (F1 and F2), an air flow fault is signaled. The ignition control will remain in this fault mode, with the blower off. If the power to PSW is removed while there is still a call for heat, the ignition sequence will start again, but the main valves will not be energized until PSW sees power during the ignition sequence.

At the start of an ignition sequence, the control sends the combustion blower output (F1 and F2). If the control does not see power at PSW for more than 30 seconds, an airflow fault is signaled, and the control will remain in this fault mode, with the blower on. If proper airflow is later detected on PSW, the control begins a pre-purge and a normal trial for ignition.

If the PSW signal is lost while the Pennant is firing, the control will immediately de-energize the gas valve terminal (MV). The blower will remain on for the post-purge period (45 seconds), and the control will continue to monitor the PSW input. If the signal is detected during the post-purge period, a normal trial for ignition will begin, starting with the 15-second pre-purge. If the signal is not detected during the post-purge, the control will lockout with the blower off.

## 6.6 Programming the Temperature Control

### 6.6.1 Initial Controller Start-Up

When the Pennant is first powered up, the temperature control display will show "801" (for a water heater) or "802" (for a boiler) for approximately one second. The default temperature parameter "°F1" is then displayed for approximately one second, which indicates that the default temperature parameter is

from thermistor 1, and is displaying in °F. Then, the temperature at thermistor 1 will be displayed.

To display the temperature at thermistor 2, push either the upper or lower button on the temperature controller, to the right of the display. Thermistor 2 reading will be displayed for 5 seconds. To make the thermistor 2 reading the default display, or to show the temperatures in °C, program the control as shown in sections 6.6.6 and 6.6.7.

### 6.6.2 Display Definitions

Tables 10 and 11 also show this information, consolidated for quick reference.

Default Temperature Display – This is what the user chooses to have displayed normally on the controller. It can be either the temperature at thermistor 1 (rt1) or at thermistor 2 (rt2) if used. While the default temperature is displayed, the user may look at the other temperature by pressing the upper or lower button on the control. To access the programming menu from here, press and hold the upper and lower buttons at the same time until "SEL" is displayed.

SEL – Displayed when the upper and lower buttons on the control are pressed and held while the default temperature is displayed. This indicates that you are entering the programming mode. When the buttons are released, the first menu item, Ch1, is displayed. If no buttons are pressed in 30 seconds, the control will return to the default display.

Ch1 – Control loop 1 (thermistor 1). This is the first display shown after entering the programming mode. It is related to the Pennant temperature sensor, thermistor 1. To view or make changes to the Ch1 parameters, press and hold the upper and lower buttons at the same time. The sub menu items are then displayed, one after another at approximately two-second intervals. When the buttons are released, the parameter that is showing can be changed by pressing the upper or lower buttons. The new value is functional immediately. To get to the next parameter, press and hold both buttons again. After 30 seconds of no button activity, the displays goes back to the default temperature.

SP1 – Control loop 1 (Pennant) temperature set point. Factory default is 165°F (74°C) for boilers, and 130°F (54°C) for water heaters. It is adjustable 130°F to 220°F (54°C to 104°C) for boilers and 130°F to 190°F (54°C to 88°C) for water heaters. Stage 1 is energized when the temperature at the Pennant sensor is less than or equal to SP1-td1. Stage 1 is de-energized when the temperature at the Pennant sensor is greater than, or equal to SP1.

td1 – Control loop 1 (Pennant) temperature set point differential. Factory default is 10°F (6°C) for boilers and 5°F (3°C) for water heaters. It is adjustable from 2°F to 20°F (1°C to 11°C). This defines the temperature below the setpoint that stage 1 is energized on a fall in temperature.


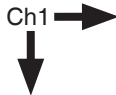
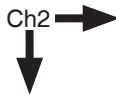




Display Symbol		Function	Adjustment Range	Factory Default	Description
Main Menu	Sub Menu				
	°F1 (°C1)	Selected Default Temperature Display (dEF)	N/A	°F1	°F1 indicates the temperature sensed by thermistor 1 is normally displayed.
					When the upper and lower buttons are pressed and held, SEL is displayed, indicating that you are entering the programming mode of the controller.
		SP1 Ch1 Temperature Set Point	130°F to 220°F (54°C to 104°C)	165°F	Stage 1 energized when the temperature is less than or equal to SP1-td1.
		td1 On/Off Temperature Differential	2°F to 20°F (1°C to 11°C)	10°F	Stage 1 energized when the temperature is less than or equal to SP1-td1.
		St2 Stage 2 Temperature Differential	0°F to 20°F (0°C to 11°C)	5°F	As long as stage 1 is successful, stage 2 is energized Std seconds after the temperature is less than or equal to SP1-td1-St2. If St2=0, stage 2 is energized after the Std time delay.
		Std Stage 2 Delay	0 to 300 seconds	10 s	As long as stage 1 is successful, stage 2 is energized Std seconds after the temperature is less than or equal to SP1-td1-St2. If St2=0, stage 2 is energized after the Std time delay.
		En2 Status of Ch2	on or oFF	on	Enables or disables loop 2, so the Pennant control knows whether or not to recognize that input.
		SP2 Ch2 Temperature Set Point	35°F to 240°F (2°C to 116°C)	180°F	Auxiliary is energized when the temperature is less than or equal to SP2-td2
		td2 On/Off Temperature Differential	2°F to 20°F (1°C to 11°C)	5°F	Auxiliary is energized when the temperature is less than or equal to SP2-td2
		ICE Enable response to low temp detection	on or oFF	on	Enables and disables the low temp assistance. Auxiliary is energized when the temperature is less than 40°F (4°C) and is de-energized when it is greater than 45°F (7°C).
		EP Enable auxiliary exercise	on or oFF	on	Enables and disables the auxiliary exercise. When EP=on, the auxiliary is energized for one minute if it has not been energized over the last 72 hours.
		 Default Temperature Display Selection	rt1 or rt2 Sensor Temperature	rt1	Toggles between which sensor is used for the default display temperature. rt1 is thermistor 1. rt2 is thermistor 2.
		 Units Selection – Temperature Scale	°F or °C	°F	Toggles between displaying values in °F and °C.

Table 10. Water Heater Parameters

Display Symbol		Function	Adjustment Range	Factory Default	Description
Main Menu	Sub Menu				
	°F1 (°C1)	Selected Default Temperature Display (dEF)	N/A	°F1	°F1 indicates the temperature sensed by thermistor 1 is normally displayed.
SEL ↓					When the upper and lower buttons are pressed and held, SEL is displayed, indicating that you are entering the programming mode of the controller.
Ch1 → ↓	SP1	Ch1 Temperature Set Point	130°F to 220°F (54°C to 104°C)	165°F	Stage 1 energized when the temperature is less than or equal to SP1-td1.
	td1	On/Off Temperature Differential	2°F to 20°F (1°C to 11°C)	10°F	Stage 1 energized when the temperature is less than or equal to SP1-td1.
	St2	Stage 2 Temperature Differential	0°F to 20°F (0°C to 11°C)	5°F	As long as stage 1 is successful, stage 2 is energized Std seconds after the temperature is less than or equal to SP1-td1-St2. If St2=0, stage 2 is energized after the Std time delay.
	Std	Stage 2 Delay	0 to 300 seconds	10 s	As long as stage 1 is successful, stage 2 is energized Std seconds after the temperature is less than or equal to SP1-td1-St2. If St2=0, stage 2 is energized after the Std time delay.
Ch2 → ↓	En2	Status of Ch2	on or off	on	Enables or disables loop 2, so the Pennant control knows whether or not to recognize that input.
	SP2	Ch2 Temperature Set Point	35°F to 240°F (2°C to 116°C)	180°F	Auxiliary is energized when the temperature is less than or equal to SP2-td2
	td2	On/Off Temperature Differential	2°F to 20°F (1°C to 11°C)	5°F	Auxiliary is energized when the temperature is less than or equal to SP2-td2
	ICE	Enable response to low temp detection	on or off	on	Enables and disables the low temp assistance. Auxiliary is energized when the temperature is less than 40°F (4°C) and is de-energized when it is greater than 45°F (7°C).
	EP	Enable auxiliary exercise	on or off	on	Enables and disables the auxiliary exercise. When EP=on, the auxiliary is energized for one minute if it has not been energized over the last 72 hours.
dEF ↓	→	Default Temperature Display Selection	rt1 or rt2 Sensor Temperature	rt1	Toggles between which sensor is used for the default display temperature. rt1 is thermistor 1. rt2 is thermistor 2.
Unl →	→	Units Selection – Temperature Scale	°F or °C	°F	Toggles between displaying values in °F and °C.

Table 11. Boiler Parameters

St2 – Stage 2 temperature differential, for 2-stage units. Factory default is 5°F (3°C). It is adjustable from 0°F to 20°F (0°C to 11°C). Stage 2 (high fire) is energized after the Std time delay, which begins when the Pennant sensor reads less than or equal to SP1-td1-St2. When set at 0°F/C, stage 2 is energized using only the time delay Std.

Std – Stage 2 time delay. Default is 10 seconds. It is adjustable from 0 to 300 seconds. Std and St2 work together to determine when stage 2 (high fire) is activated on a two-stage unit.

Ch2 – Control loop 2 (thermistor 2). It is accessed by pressing and holding the upper and lower buttons, so that SEL appears, and then pressing one of the buttons to scroll until Ch2 appears. This allows programming access for the auxiliary thermistor.

En2 – Status of control loop 2, either on or off. Default is on. Thermistor 2 will not be recognized when En2 is off. (ICE and EP can override Ch2.)

SP2 – Control loop 2 (auxiliary) temperature setpoint. Factory default is 180°F (82°C) for boilers, and 125°F for water heaters. It is adjustable 35°F to 240°F (2°C to 116°C) for boilers and 65°F to 190°F (18°C to 88°C) for water heaters. The Pennant is called for heat and the auxiliary contacts are closed when the temperature at the secondary sensor is less than or equal to SP2-td2. The Pennant call for heat ends, and the auxiliary contacts are opened when the temperature at the secondary sensor is greater than, or equal to SP2.

td2 – Control loop 2 (auxiliary) temperature setpoint differential. Factory default is 5°F (3°C). It is adjustable from 2°F to 20°F (1°C to 11°C). This defines the temperature below the setpoint that the Pennant is called for heat and the auxiliary contacts are closed on a fall in temperature.

ICE – Enables response from the low temperature protection feature. It can be turned on or off, and the default is on. When it is enabled, the Pennant is called for heat and the auxiliary contacts are energized when the temperature sensor detects less than 40°F (4°C), and are de-energized when the temperature rises above 45°F (7°C).

EP – Enables the exerciser feature. It can be turned on or off, and the default is on. When it is enabled, the auxiliary contacts are closed for one minute, if they have not been closed over the last 72 hours.

dEf – Default temperature display. Factory default is rt1, which is the temperature at the Pennant sensor (thermistor 1). The user may choose rt2, which is the temperature at the auxiliary sensor (thermistor 2). To access this, press and hold both upper and lower buttons. When “SEL” is displayed, press either the upper or lower button, until “dEf” is displayed.

UnI – Allows the user to choose between °F and °C. Factory default is °F. To access this, press and hold both upper and lower buttons. When “SEL” is displayed, press either the upper or lower button, until “UnI” is displayed.

### 6.6.3 Changing Control Loop 1 Parameters

There are four parameters that affect the operation of control loop 1. SP1 is the setpoint. td1 is the temperature differential. St2 is the stage 2 differential (when applicable) and Std is the stage 2 time delay. To change any of these parameters:

1. While the default temperature is displayed, press and hold the upper and lower buttons together until SEL is displayed.
2. Release the buttons, and CH1 will be displayed.
3. Within 30 seconds, press and hold the upper and lower buttons together until the parameter you want to change is displayed.
4. Release the buttons to displayed the value of that parameter.
5. Within 30 seconds, press the upper button to increase the value, or the lower button to decrease the value of the parameter.
6. When the desired value is shown, stop pushing the buttons. The revised value is effective immediately.
7. In 30 seconds of button inactivity, the display reverts back to the default temperature, and the new value is stored in nonvolatile memory.

### 6.6.4 Enabling and Disabling Control Loop 2

The Pennant must be told to recognize control loop 2, which uses thermistor 2. To enable or disable control loop 2:

1. While the default temperature is displayed, press and hold the upper and lower buttons together until SEL is displayed.
2. Release the buttons, and CH1 will be displayed.
3. Within 30 seconds, press the upper (or lower) button. CH2 will be displayed.
4. Within 30 seconds, press and hold the upper and lower buttons together until En2 is displayed.
5. Release the buttons. The current state, on or oFF, will be displayed.
6. Within 30 seconds, press the upper (or lower) button to toggle the En2 state, between on and oFF.
7. When the desired state is shown (on for enable, and oFF for disable), stop pushing the buttons. The revised state is effective immediately.
8. In 30 seconds of button inactivity, the display reverts back to the default temperature, and the En2 selection is stored in nonvolatile memory.

### 6.6.5 Changing Control Loop 2 Parameters

There are five parameters that affect the operation of control loop 1. En2 is the status. SP2 is the setpoint. td2 is the temperature differential. ICE

enables response to low temperature detection. EP enables energizing of the auxiliary contacts for the exercize feature. To change any of these parameters:

1. While the default temperature is displayed, press and hold the upper and lower buttons together until SEL is displayed.
2. Release the buttons, and CH1 will be displayed.
3. Within 30 seconds, press the upper (or lower) button. CH2 will be displayed.
4. Within 30 seconds, press and hold the upper and lower buttons together until the parameter you want to change is displayed.
5. Release the buttons to displayed the value of that parameter.
6. Within 30 seconds, press the upper button to increase the value, or the lower button to decrease the value of the parameter, or to toggle the selection.
7. When the desired value is shown, stop pushing the buttons. The revised value is effective immediately.
8. In 30 seconds of button inactivity, the display reverts back to the default temperature, and the new value is stored in nonvolatile memory.

### 6.6.6 Changing the Default Temperature Selection

You may change what is normally displayed on the temperature control to show the temperature at either thermistor 1 or thermistor 2:

1. While the default temperature is displayed, press and hold the upper and lower buttons together until SEL is displayed.
2. Release the buttons, and CH1 will be displayed.
3. Within 30 seconds, press the upper (or lower) button. CH2 will be displayed.
4. Within 30 seconds, press the upper (or lower) button. dEf will be displayed.
5. Within 30 seconds, press and hold the upper and lower buttons together until the current default (rt1 or rt2) is displayed.
6. Release the buttons.
7. Within 30 seconds, press the upper (or lower) button to toggle the dEf selection, between rt1 and rt2.
8. When the desired thermistor is shown (rt1 is thermistor 1, and rt2 is thermistor 2), stop pushing the buttons. In 30 seconds of button inactivity, the display shows the selected default temperature, and the selection is stored in nonvolatile memory, as the default temperature display.

### 6.6.7 Changing the Display Units

You may change what is normally displayed on the temperature control to show the temperature in either °F or °C:

1. While the default temperature is displayed, press and hold the upper and lower buttons together until SEL is displayed.
2. Release the buttons, and CH1 will be displayed.
3. Within 30 seconds, press the upper (or lower) button. CH2 will be displayed.
4. Within 30 seconds, press the upper (or lower) button. dEf will be displayed.
5. Within 30 seconds, press the upper (or lower) button. UnI will be displayed.
6. Within 30 seconds, press and hold the upper and lower buttons together until the current default (°F or °C) is displayed.
7. Release the buttons.
8. Within 30 seconds, press the upper (or lower) button to toggle the UnI selection, between °F and °C.
9. When the desired unit is shown, stop pushing the buttons. In 30 seconds of button inactivity, the display shows the selected default temperature with the selected units, and the selection is stored in nonvolatile memory, as the default temperature units.

## 6.7 Operating the Burner and Set-Up

### 6.7.1 Set-Up for 0 to 2500 Feet Altitude

The setup must be checked before the unit is put in operation. Problems such as failure to start, rough ignition, strong exhaust odors, etc. can be due to improper setup. Damage to the Pennant resulting from improper setup is not covered by the limited warranty.

1. Using this manual, make sure the installation is complete and fully in compliance with the instructions.
2. Determine that the appliance and system are filled with water and all air has been bled from both. Open all valves.
3. Observe all warnings on the Operating Instructions label and turn on gas and electrical power to appliance.
4. Switch on the appliance power switch located on the right side of the unit.
5. The Pennant will enter the start sequence, as long as the unit is being called for heat. The blower and pump come on for pre-purge, then the ignitor warm-up sequence starts and after the ignitor warm-up is complete and all safety devices are verified, the gas valves open. If ignition doesn't occur, check that there is proper gas supply. Wait 5 minutes and start the unit again. During initial start up, air in the gas line may cause the Pennant to "lock out" during the first few trials

for ignition. If the ignition control locks out, reset by cycling the power off and on using the main power switch on the right side of the cabinet.

6. When the unit is running, the supply gas pressure must be checked. Inlet gas pressure must not exceed 13 in. w.c. (3.2 kPa). The minimum inlet gas pressure is 5 in. w.c. (1.2 kPa) and 8 in. w.c. (2 kPa) for LP.
7. Once the inlet gas pressure is verified, the outlet gas pressure from each valve (manifold gas pressure) must be checked, and adjusted, if necessary. The manifold gas pressure must be 3.0 in. w.c. (0.62 kPa) for natural gas and 9.0 in. w.c. (2.2 kPa) for LP.
8. Complete the setup by checking the CO<sub>2</sub> at the outlet of the unit. The CO<sub>2</sub> should be 8% for natural gas, or 9.2% for LP.
9. **After placing the appliance in operation, the Burner Safety Shutoff Device must be tested.**  
To test:
  - (a) Close gas shutoff valve with burner operating.
  - (b) The flame will go out and blower will continue to run for the post purge cycle. Three attempts to light will follow. Ignition will not occur as the gas is off. The ignition control will lockout, and will have to be reset by cycling the power before the unit will operate.
  - (c) Open gas shutoff valve. Restart the appliance. The ignition sequence will start again and the burner will start. The appliance will return to its previous mode of operation.

### 6.7.2 High Altitude Adjustment and Set-Up

High altitude adjustment must not be made on appliances operating at elevations below 2500 ft. (762 m).

No orifice changes are required to adjust the Pennant appliances for high altitude. High altitude adjustment is accomplished by adjustment of the air shutter. A CO<sub>2</sub> or O<sub>2</sub> analyzer is required to make these adjustments.

Start the adjustment process by checking the CO<sub>2</sub> in the "as installed" condition. Adjust the air shutter(s) so that the CO<sub>2</sub> is about 8% or the O<sub>2</sub> is about 6.8% for appliances operating on natural gas. For appliances operating on LP Gas adjust the air shutter(s) so that the CO<sub>2</sub> is about 9.2% or the O<sub>2</sub> is about 6.8%.

If the appropriate CO<sub>2</sub> / O<sub>2</sub> levels cannot be achieved by adjusting the air shutter. Contact the Technical Services Department at (800) 900-9276.

The amount of derate will vary depending on heating value of the fuel and the elevation at the installation site.

#### Caution

Should any odor of gas be detected, or if the gas burner does not appear to be functioning in a normal manner, close main shutoff valve, do not shut off switch, and contact your heating contractor, gas company, or factory representative.

#### Attention

Si vous sentez une odeur de gaz ou si le brûleur à gaz ne parait pas fonctionner de manière normale, fermez la vanne d'isolement, ne fermez aucun interrupteur, et appelez votre entreprise de chauffage, la compagnie de gaz ou un représentant du fabricant..

## 6.8 Shutting Down the Pennant

1. Switch off the main electrical disconnect switch.
2. Close all manual gas valves.
3. If freezing is anticipated, drain the Pennant and be sure to also protect building piping from freezing.  
**This step to be performed by a qualified service person.**

## 6.9 To Restart the Pennant

If drained, follow Section 6.1 in this manual for proper filling and purging.

1. Switch off the main electrical disconnect switch.
2. Close all manual gas valves.
3. **WAIT FIVE (5) MINUTES.**
4. Set the aquastat or thermostat to its lowest setting.
5. Open all manual gas valves.
6. Reset all safety switches (pressure switch, manual reset high limit, etc.).
7. Set the temperature controller to the desired temperature setting and switch on electrical power.
8. Burner will go through a pre-purge period and ignitor warm-up period, followed by ignition.

## SECTION 7. Maintenance

### 7.1 System Maintenance

1. Lubricate the system water-circulating pump, if required, per the instructions on the pump.
2. If a strainer is employed in a pressure reducing valve or the piping, clean it every six months.
3. Inspect the venting system for obstruction or leakage at least once a year. Periodically clean the screens in the vent terminal and combustion air terminal (when used).



4. Keep the appliance area clear and free from combustible materials, gasoline, and other flammable vapors and liquids.
5. If the appliance is not going to be used for extended periods in locations where freezing normally occurs, it should be isolated from the system and completely drained of all water. All systems connected to it should also be drained or protected from freezing.
6. Low water cutoffs, if installed, should be checked every 6 months. Float type low water cutoff should be flushed periodically.
7. Inspect flue passages, and clean with brushes/vacuums, if necessary. Sooting in flue passages indicates improper combustion. Determine the cause and correct.
8. Inspect the vent system and air intake system, and if the vent system is Category III, ensure that all joints are sealed properly. If joints need to be resealed, follow venting manufacturer's instructions to clean and reseal vent system.

## 7.2 Appliance Maintenance and Component Description

Only genuine Laars replacement parts should be used.

### Caution

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

### Attention

Lors d'entretien ou de réparation des commandes, étiquetez tous les câbles avant de les déconnecter. Des erreurs de câblage peuvent provoquer des fonctionnements incorrects et dangereux. Après toute intervention d'entretien ou de réparation, vérifiez que l'appareil fonctionne correctement.

The gas and electric controls on the appliance are engineered for long life and dependable operation, but the safety of the equipment depends on their proper functioning. It is strongly recommended that a qualified service technician inspect the basic items listed below every year.

- a. Ignition control
- b. Ignitor
- c. Water temperature control
- d. Automatic gas valve
- e. Pressure switches and tubing
- f. Blower
- g. High limit
- h. Pump (if required)
- i. Low water cutoff
- j. Relays

- k. Flow switch
- l. Gas train
- m. Control components

### 7.2.1 Burners

Close main manual gas valve before proceeding. Checking the burners for debris - Remove the ignitor/burner access panel and ignitor, and inspect the burners through the ignitor hole using a flashlight to illuminate. If there is any indication of debris on the burners that is visible, all the burners will need to be inspected more thoroughly. Remove the gas manifold assemblies and the burner assemblies. Inspect the burners. Clean burners, if necessary, by blowing compressed air from the outside of the burners into the center of the burner. A dirty burner may be an indication of improper combustion or dirty combustion air. Determine the cause, and correct. Replace the burners in the reverse order.

### 7.2.2 Filter

The filter used in the Pennant is washable and has an 80% arrestance rating. Since the filter is washable, it will only need replacement occasionally. If filter replacement is needed, it should only be replaced with a factory part. Inspect the air filter monthly, or more often in dirty environments. If there is debris on the air filter, remove it from the filter frame, and wash it with mild soap and water. Ensure that the filter is completely dry before reinstalling.

### 7.2.3 Gas Valves

The gas valves are designed to operate with supply pressures of 4-13 in. w.c. (1.0 to 3.2 kPa).

To remove a valve, shut off 120-volt power and the manual gas shutoff valve. Remove the front panels from the unit. Disconnect the wires to the valve. Disengage the unions before and after the valve, and remove the valve. Pull the pipe nipples from the inlet and outlet of the valve, and clean the threads on the pipe nipples for reuse. Apply new tape or pipe dope to the pipe nipples (threaded joints should be coated with piping compound resistant to action of liquefied petroleum gas), and reinstall in reverse order. Turn on manual gas shutoff valve and 120 volt power and check appliance operation and tightness of gas valve connections.

### 7.2.4 Manual Reset High Limit Control

The high limit switch is a manual reset, non-adjustable switch with a remote bulb-type sensor. Switches for water heaters and low temperature boiler models are set at 200°F. Switches for standard boilers are set at 240°F.

The control is located behind the front door, on a panel in front of the blower. The probe is in the outlet side of the header.

To reset the switch, unscrew the black cover that is over the reset button, and push the button. Replace the cover after the switch is reset.

To replace, shut off power to the appliance. Remove the cover that is over the button, and remove the nut that is around the button. Pull the control through the panel, and remove the spade terminals. Replace in reverse order.

### 7.2.5 Temperature Control

The temperature control works with the ignition control to ensure proper operation of the Pennant. To replace the control, shut off the 120-volt power to the appliance. Remove the cover from the control panel, and remove the mounting screws to remove the controller. Replace in reverse order.

### 7.2.6 Ignition Control

The ignition control controls the hot surface ignitor and proves that the flame signal is appropriate for powering the gas valves. It also controls the blower's pre-purge and post-purge.

To replace a control, shut off the 120-volt power to the appliance. Remove the cover from the control panel. Remove the electrical connectors from the ignition control. Take out the controller's mounting screws, and pull the controller out. Replace in reverse order.

### 7.2.7 Ignitor

The ignitor used is a 120v "Hot Surface" type. It is energized whenever there is a call for heat and switched off when ignition is established and the flame has been sensed. To replace the ignitor, shut off the 120-volt power to the appliance, remove the ignitor/burner access panel, disconnect the Molex connector, remove the two mounting screws on the ignitor flange, and pull the ignitor out. Install in reverse order, always using a new ignitor gasket with the replacement ignitor.

#### **Caution**

Ignitor gets hot. To avoid injury, handle the ignitor with caution.

#### **Attention**

Le dispositif d'allumage devient très chaud. Manipulez le dispositif d'allumage avec précaution.

### 7.2.8 Transformer

The Pennant's transformer is not capable of supplying control voltage for external devices such as zone valves, which must have their own separate power supply. Should a transformer need replacing, shut off the 120-volt power. Unplug the transformer wires, remove the mounting screws and remove the transformer. Replace transformer in the reverse order.

### 7.2.9 Flow Switch

The Pennant uses a paddle-type flow switch to ensure that the unit has water flow before ignition is allowed. To replace the flow switch, turn off the 120-volt power to the appliance. Isolate the boiler or water heater from the system by closing the isolation valves.

#### **Caution**

Water may be hot enough to scald. Allow water to cool before proceeding.

#### **Attention**

L'eau peut être chaude au point de vous brûler. Laissez refroidir l'eau avant d'intervenir.

Release pressure in the system by actuating the pressure relief valves or field supplied boiler drain valve. Remove cover from the flow switch and disconnect the wires. Unthread the flow switch from piping. Ensure the new flow switch paddles are trimmed to the same size as the original paddles, and reinstall in the reverse order. For boiler and other static pressure systems, restore the system pressure to the original setting, (or 10 psi minimum).

### 7.2.10 Heat Exchanger Coil

#### **WARNING**

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

#### **AVERTISSEMENT**

L'accumulation de suie sur un échangeur thermique sale peut s'enflammer au contact d'une étincelle ou d'une flamme et présenter un risque d'incendie ou d'explosion. Afin d'empêcher que cela se produise, humidifier les dépôts de suie à l'aide d'une brosse mouillée ou par une pulvérisation fine d'eau avant d'effectuer l'entretien de l'échangeur thermique.

The Pennant has a premixed burner system. These systems provide the burners with sufficient air for complete combustion, and black carbon sooting is seldom experienced. If sooting is suspected, view ports for inspection of the heat exchanger are provided on the side of the boiler. In the unlikely event that there is a buildup of black carbon soot or other debris on the heat exchanger, clean per the following:

1. Disconnect the electrical supply to the unit.
2. Turn off the gas supply by closing the manual gas valve on the heater.

3. Disconnect and remove the wires, conduit and sensors from all components that are attached to the inlet/outlet header.
  4. Isolate the heat exchanger from the water supply.
  5. Disconnect the header flanges from the inlet and outlet.
  6. Allow the heat exchanger to drain. Remove the venting and remove the top, by removing the screws that attach the top to the side panels. Remove the side panels.
  7. Remove the heat exchanger from the unit.  
NOTE: Heat exchangers are heavy and may require two people to remove to avoid personal injury.
  8. Clean the heat exchanger: A light accumulation of soot or corrosion on the outside of the heat exchanger can be easily removed. Use a wire brush to remove loose soot and scale from the heat exchanger.
  9. NOTE: While the heat exchanger is out of the unit, inspect the firewall refractory insulation. Replace if necessary.
  10. Inspect the inside of the copper tubes for scale buildup. Scale can build up on the inner surface of the heat exchanger tubes, which can restrict water flow. If the tubes show signs of scaling, clean the internal surface.
  11. Reassemble in the reverse order, and check appliance operation after start-up.  
**NOTE: The warranty does not cover damage caused by lack of required maintenance, lack of water flow, or improper operating practices.**
2. Poor Combustion: Poor combustion should be suspected if there is a strong flue gas odor. The odor may result from an improper gas/air ratio (high or low O<sub>2</sub> or CO<sub>2</sub>). Pennant appliances operate best with 45% excess air (8% CO<sub>2</sub> on natural gas, 9.2% CO<sub>2</sub> on LP). Check the CO<sub>2</sub> of the appliance and adjust if necessary.
  3. Ignitor failure: If the boiler goes through a normal start cycle but combustion does not occur, ignitor failure should be suspected. Check the ignitor by unplugging the ignitor plug and measuring the ignitor resistance. It should be 50-80 ohms. If the resistance is not 50-80 ohms, replace the ignitor. If the resistance is correct, reset the boiler and check for 120 VAC at the ignitor plug during the start cycle. If there is no voltage, replace the faulty ignitor wire harness or the ignition control.

## 8.2 Delayed Ignition — Possible Causes

A defective burner can cause a delayed ignition. If the gas supply pressure is proper and the gas valves are functioning properly, then burners should be inspected. There should be no distortion or perforations in the burners outside of the active burner port area. Replace if indicated.

## 8.3 Short Cycling — Boiler

Boiler short cycling is caused when the load on the boiler system swings rapidly causing frequent cycling between call for heat and satisfied conditions. This condition is greatly reduced on two stage units or stage controlled multiple boiler systems which can change heat input to better match the load. If short cycling is a problem, it may be due to an oversized boiler, improper control strategy, incorrect set points or a load distribution problem. The boiler controls must be set such that the heating loop temperature setpoint, SP2 (if used), does not interfere with the setpoint of the boiler operating control, SP1. If the set points are correct and the system design, controls scheme, etc. are fixed, the temperature differentials may be increased to reduce short cycling. If desired temperature response is not achievable without short cycling it may be necessary to install a buffer tank in the system. Contact your Laars representative to discuss possible remedies.

## 8.4 Short Cycling — Water Heater

Short cycling will generally occur only in combination space heating and water heating applications when the water heater is operating in the space-heating mode. If the heating load drops below the minimum input of the water heater for an extended period, the water heater will have a tendency to short cycle. If short cycling is frequently experienced, regardless of the control's attempt to limit it, the heating load should be redistributed to control it.

## SECTION 8. Trouble Shooting

### 8.1 Resolving Lockouts

There are many causes of lockouts. The three most common causes are: (1) inadequate gas supply, (2) poor combustion, (3) ignitor failure.

1. Inadequate gas supply: Before proceeding, ensure that the gas supply has not been shutoff or the LP tank (LP boilers) is not empty. Then, restart the boiler and observe the operational cycle. After a 15-second fan pre-purge, the ignitor will heat up for 40 seconds, and then the unit will light. If it does not, check the gas supply pressure to the appliance, after resetting the appliance and attempting another start-up. The gas pressure to the appliance must be above 5 in. w.c. (1.2 kPa) throughout the entire start-up cycle. If it is not, correct the supply problem (check gas valves or supply piping). If the supply pressure is adequate, consult the factory for assistance.

If short cycling occurs in a water heater application, it is probably caused by undersized piping between the water heater and the storage tank or by some other factor that restricts proper water flow through the water heater. The cause should be determined and corrected.

### 8.5 High Gas Consumption

Appliances operating with an improper air/fuel ratio are very inefficient and consequently, have very high gas consumption. Because efficiency is high when the CO<sub>2</sub> is high (or O<sub>2</sub> is low), appliances operating with low CO<sub>2</sub> or high O<sub>2</sub> (especially LP appliances) consume more gas. Adjust the CO<sub>2</sub> or O<sub>2</sub> for optimum efficiency. If no combustion analyzing equipment (CO<sub>2</sub> or O<sub>2</sub>) is available then a proper adjustment of the air/fuel ratio (CO<sub>2</sub> or O<sub>2</sub>) cannot be accomplished. The CO<sub>2</sub> should be 8% at high fire for natural gas and 9.2% at high fire for LP. To check the CO<sub>2</sub>, first verify that the supply gas pressure is within 5 to 13 in. w.c. (1.2 to 3.2 kPa). With the Pennant running with all stages firing, set the air box pressure to 1.8 in. w.c. (0.42 kPa) (as a starting point), by adjusting the air shutter(s) at the intake of the fan(s). Check the CO<sub>2</sub>, and adjust the air shutters if further adjustment to the CO<sub>2</sub> is needed.

### 8.6 Troubleshooting Pennant Controls

The field wiring board along with the diagnostic LEDs can be used to troubleshoot the Pennant controls. Terminals on the field wiring board are provided as test points and allow troubleshooting of most Pennant control functions from a single location. The terminals are identified in the Ladder Wiring Schematic (Figure 14).

Certain control elements may be connected in the field to the field wiring board. In addition to the ladder wiring schematic, refer to the Connection Diagram (Figure 13) to verify that field connections have been made correctly.

The Pennant temperature control and ignition control both have fault indicators. The temperature control fault codes are shown in Table 12. The ignition control fault codes are shown in Table 13.

Fault Code	Description
NoA	No acknowledged call-for-heat signal received (K1 energizes and the contacts close, but 24V is not shown on the downstream side of the K1 contact) (This code is normal when operating in "Remote" mode.)
I-F	Ignitor fault signal received from ignition control
AFF	Air flow fault
FLE	Flame error – flame detected with no call for heat
Loc	Ignition lockout signal received from ignition control
Ito	Ignition time-out
P1H	RT1 sensor shorted or high out-of-range temperature signal received
P1L	RT1 sensor open or low out-of-range temperature signal received
P2H	RT2 sensor shorted or high out-of-range temperature signal received
P2L	RT2 sensor open or high out-of-range temperature signal received

Table 12. Fault Codes.

LED State	Indication
Steady On	Control Fault
1 Flash	Air Flow Fault
2 Flashes	Flame Attempt With No Call For Heat
3 Flashes	Ignition Lockout
4 Flashes	Burner On

Table 13. Ignition Control LED Description

## SECTION 9. Replacement Parts

Only genuine Laars replacement parts should be used.

### 9.1 General Information

To order or purchase parts for the Laars Pennant, contact your nearest Laars dealer or distributor. If they cannot supply you with what you need, contact Customer Service (see back cover for address, telephone and fax numbers).

### 9.2 Parts List

Item	Description	Model 200	Model 300	Model 400
<b>COMBUSTION CHAMBER COMPONENTS</b>				
<b>See Figure 15</b>				
1	Base Assembly	2C1000	3C1000	4C1000
2	Support, Tile Notch	2C2019	3C2019	4C2019
3	Chamber, Refractory, Heat Exchanger	T2108802	T2108803	T2108804
4	Assembly, Front Panel, Combustion Chamber	2C2023	3C2023	4C2023
5	Panel, Rear, Combustion Chamber	2C2006	3C2006	4C2006
6	Panel, Top, Combustion Chamber	2C2001	3C2001	4C2001
7	Chamber, Right Side, Bottom	2C2201	2C2201	2C2201
8	Chamber, Left Side, Bottom	2C2601	2C2601	2C2601
9	Chamber, Side, Top	2C2002	2C2002	2C2002
10	Panel, Right Side, Air Box	2C2016	2C2016	2C2016
11	Panel, Left Side, Air Box	2C2015	2C2015	2C2015
12	Weldment, Duct, Blower	2C2500	2C2500	2C2500
13	Panel, Top, Air Box	2C2008	3C2008	4C2008
14	Plate, Spacer, Burner/Manifold	2C2017	3C2017	4C2017
15	Panel, Front, Air Box	2C2009	3C2009	4C2009
16	Assembly, Exhaust Vent, Vertical	2C2100	3C2100	4C2100
17	Weldment, Flue	2C2300	2C2300	2C2300
18	Assembly, Air Shutter, Blower	2C5000	2C5000	2C5000
19	Assembly, Filter Housing	2C3800	2C3800	2C3800
20	Media, Filter	2C3803	2C3803	2C3803
21	Clip, Retaining, Filter Media	F2022300	F2022300	F2022300
22	Hose, Duct, Flexible, 4" Dia.	P0101402	P0101403	P0101404
23	Blower/Motor	E0254000	E0254000	E0254000
24	Gasket, Blower	S2104400	S2104400	S2104400
25	Assembly, Sight Glass	10956000	10956000	10956000
26	Ignitor, Hot Surface	W2002300	W2002300	W2002300
27	Gasket, Burner	S2102300	S2102300	S2104300
28	Burner, Main (Pressure Port)	L0063301	L0063301	L0063301
29	Burner, Main	L0063300	L0063300	L0063300
30	Gasket, Blower Duct	S2104500	S2104500	S2104500
31	Kit, Insulation, Combustion Chamber	T2015808	T2015809	T2015810
32	Gasket, Flue Housing	S2104600	S2104600	S2104600

**JACKET COMPONENTS****See Figure 16**

40	Panel, Front, Jacket	2C3320	3C3320	4C3320
41	Panel, Rear, Jacket	2C3220	3C3220	4C3220
42	Panel, Top, Jacket	2C3021	3C3021	4C3021
43	Panel, Jacket, Control Access	2C3019	3C3019	4C3019
44	Panel, HX Side Access, Jacket	2C3620	2C3620	2C3620
45	Panel, Right Side, Upper, Jacket	2C3621	2C3621	2C3621
46	Panel, Right Side, Jacket	2C3520	2C3520	2C3520
47	Panel, Left Side, Jacket	2C3420	2C3420	2C3420

Item	Description	Model 200	Model 300	Model 400
<b>JACKET COMPONENTS (continued)</b>				
<b>See Figure 16</b>				
48	Panel, Lower Access, Jacket	2C3622	2C3622	2C3622
49	Panel, Filter Side, Upper, Jacket	2C3623	2C3623	2C3623
50	Panel, Filter Access, Jacket	2C3010	2C3010	2C3010
51	Weldment, Cover, Air Inlet	2C3700	2C3700	4C3700
52	Panel, Cover, Exhaust	2C3702	3C3701	4C3701
53	Plate, Cover, Sight Glass	10338600	10338600	10338600
54	Side Panel, Pump Cover, Jacket	2C3015	2C3014	2C3014
55	Cover, Pump	2C3016	2C3016	2C3016
<b>HEAT EXCHANGER COMPONENTS</b>				
<b>See Figure 17</b>				
60	Assembly, Tube, Heat Exchanger, Copper	2C4100	3C4100	4C4100
	Assembly, Tube, Heat Exchanger, Copper-Nickel	2C4120	3C4120	4C4120
61	Header, Inlet/Outlet	2C4102	2C4102	2C4102
62	Header, Return	2C4103	2C4103	2C4103
63	Chamber, Header, Heat Exchanger	2C4001	2C4001	2C4001
64	Base, End, Heat Exchanger Tube	2C4002	2C4002	2C4002
65	Flange, Connection, 1-1/2" NPT, Cast Iron	S0077700	S0077700	S0077700
	Flange, Connection, 1-1/2" NPT, Bronze	S0077800	S0077800	S0077800
66	Gasket, Connection Flange, 1-1/2"	S0076500	S0076500	S0076500
67	Valve, Pressure Relief, 3/4" NPT X 75 PSI	A0063300	A0063300	A0063300
	Valve, Pressure Relief, 3/4" NPT X 125 PSI	A0001200	A0001200	A0001200
68	Gauge, Temperature/Pressure	A0079000	A0079000	A0079000
69	Well, Immersion, Hi-Limit Temperature	E0234201	E0234201	E0234201
70	Probe, Thermistor	E0253900	E0253900	E0253900
71	Switch, Water Flow	E0013000	E0013000	E0013000
72	Pump, Circulator, Hydronic	A0076700	A0076800	A0076800
	Pump, Circulator, Volume Water	A0095700	A0095700	A0095700
73	Gasket, 5/8" Tube, 7/32" Thk. Heat Exchanger	S0070800	S0070800	S0070800
<b>GAS TRAIN COMPONENTS</b>				
<b>See Figure 18</b>				
80	Weldment, Gas Manifold, Main	L0063702	L0063703	L0063704
81	Manifold, Gas, On/Off	L0063414	L0063416	L0063418
82	Manifold, Gas, 2 Stage Left Bank	L0063404	L0063413	L0063414
83	Manifold, Gas, 2 Stage Right Bank	L0063402	L0063403	L0063405
84	Orifice, Nat. Gas	L0062900	L0062900	L0062900
	Orifice, LP Gas	L0063000	L0063000	L0063000
85	Spacer, Gas Orifice	F2022400	F2022400	F2022400
86	Gas Valve, Combination, Nat. (DSI) 3/4" NPT x 3/4" NPT	V0079400	V0079400	V0079400
	Gas Valve, Combination, LP (DSI) 3/4" NPT x 3/4" NPT	V0079500	V0079500	V0079500
87	Cover, Gas Inlet, Air Box	2C2018	2C2018	2C2018

Item	Description	Model 200	Model 300	Model 400
<b>CONTROL PANEL COMPONENTS</b>				
<b>See Figure 19</b>				
90	Panel, Mounting, Electrical Components	2C7002	3C7002	4C7002
91	Panel, LED/Control	2C7003	2C7003	2C7003
92	Bracket, Mounting, Hi-Limit/Pressure Switch	2C7004	2C7004	2C7004
93	Switch, Pressure, Diaphragm, SPST	E0255500	E0255500	E0255500
94	Switch, Pressure, Diaphragm, SPDT	E0240900	E0240900	E0240900
95	Switch, Limit, High Temperature, Hydronic	E2304800	E2304800	E2304800
	Switch, Limit, High Temperature, Volume Water	E2324200	E2324200	E2324200
96	Transformer, 24, 120 V, 50VAC	E0180500	E0180500	E0180500
97	Ignition Control, Hot Surface Ignition	E0253400	E0253400	E0253400
98	Switch, Toggle, SPDT	E0109200	E0109200	E0109200
99	Module, Relay, Encapsulated, 24VAC	E2306700	E2306700	E2306700
100	Relay, Time Delay, (24VAC) Delay On Break, Adjustable	E2077700	E2077700	E2077700
101	Board, Diagnostic, LED	E2105600	E2105600	E2105600
102	Controller, Digital, Temp., Dual Loop, Hydronic	E0253200	E0253200	E0253200
	Controller, Digital, Temp., Dual Loop, Volume Water	E0253100	E0253100	E0253100
103	Switch, Rocker, 15A, 125 VAC, 1/2 HP	E2322700	E2322700	E2322700
104	Switch, Temperature, Manual Reset, SPST, 250° F	E2103200	E2103200	E2103200
105	Cover, Transformer	2C7005	2C7005	2C7005

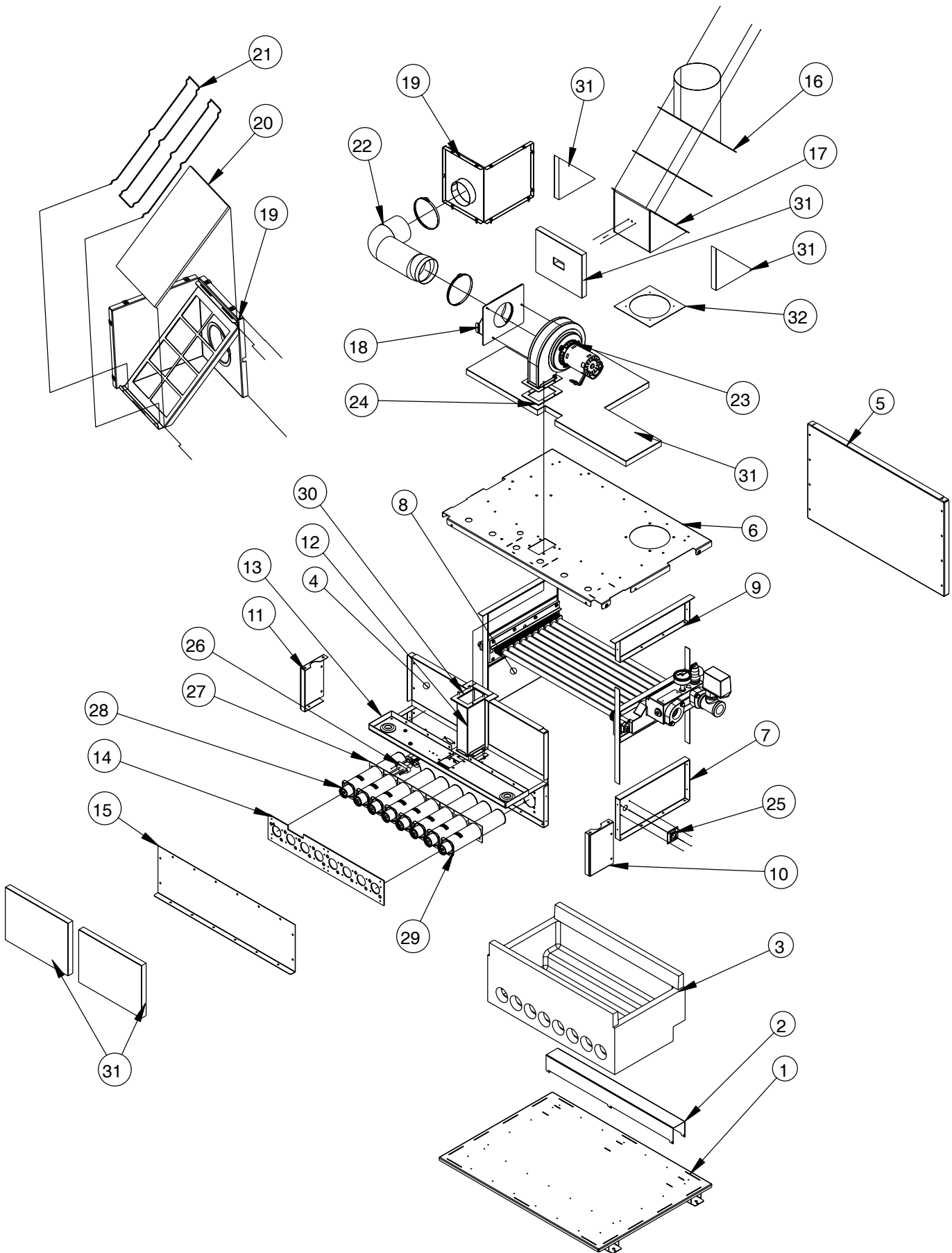


Figure 15. Combustion Chamber Components.



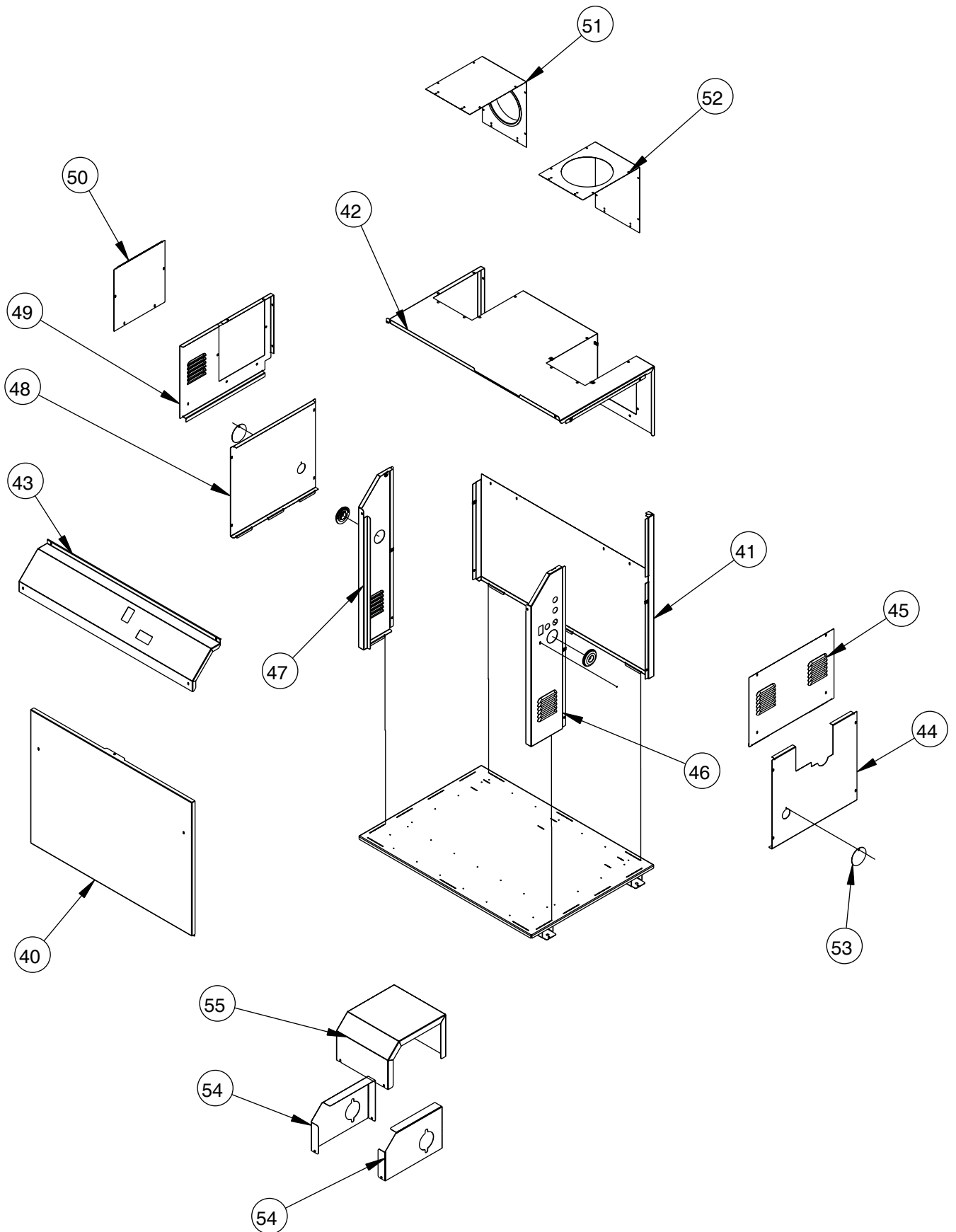


Figure 16. Jacket Components.

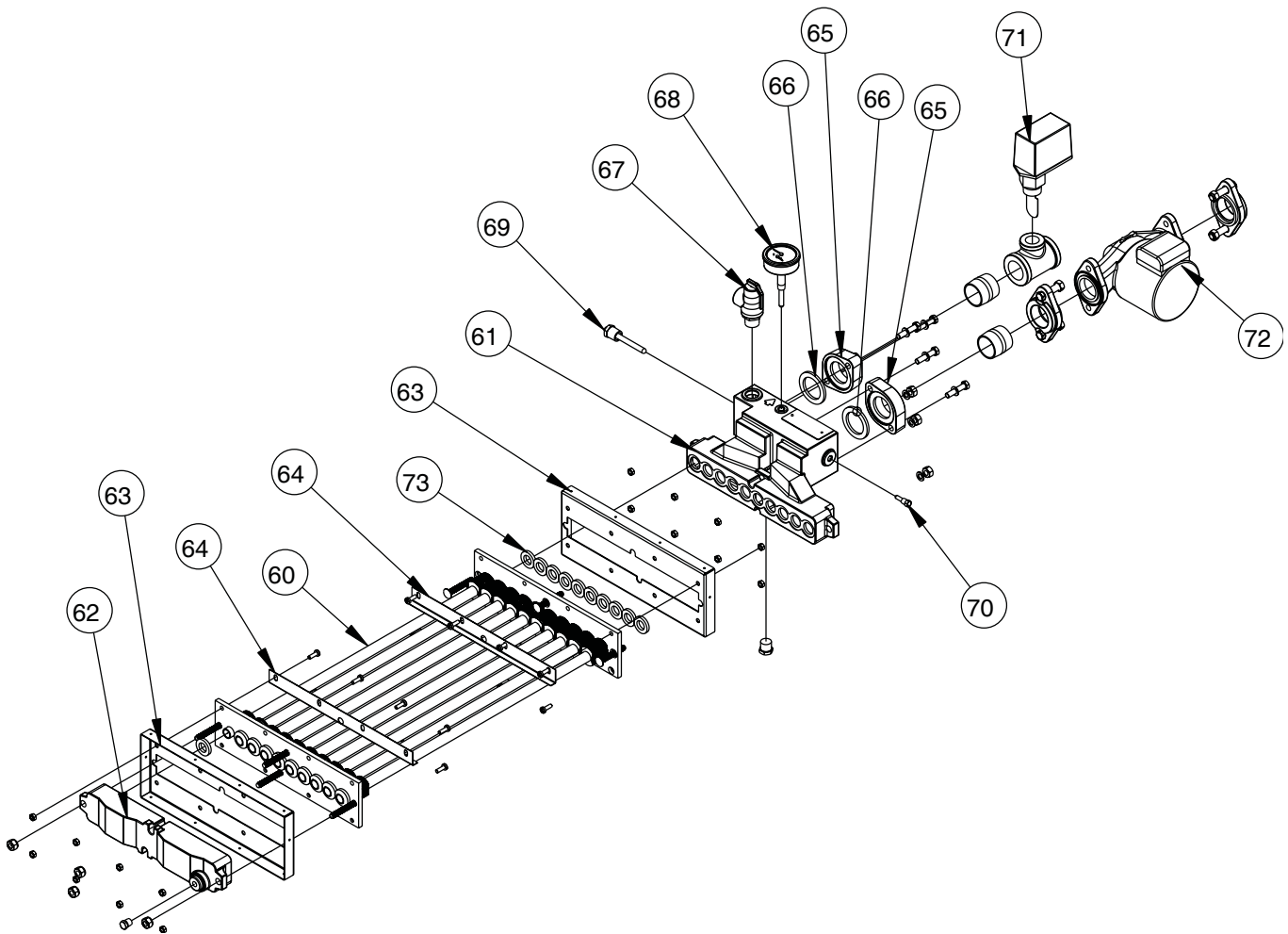


Figure 17. Heat Exchanger Components.

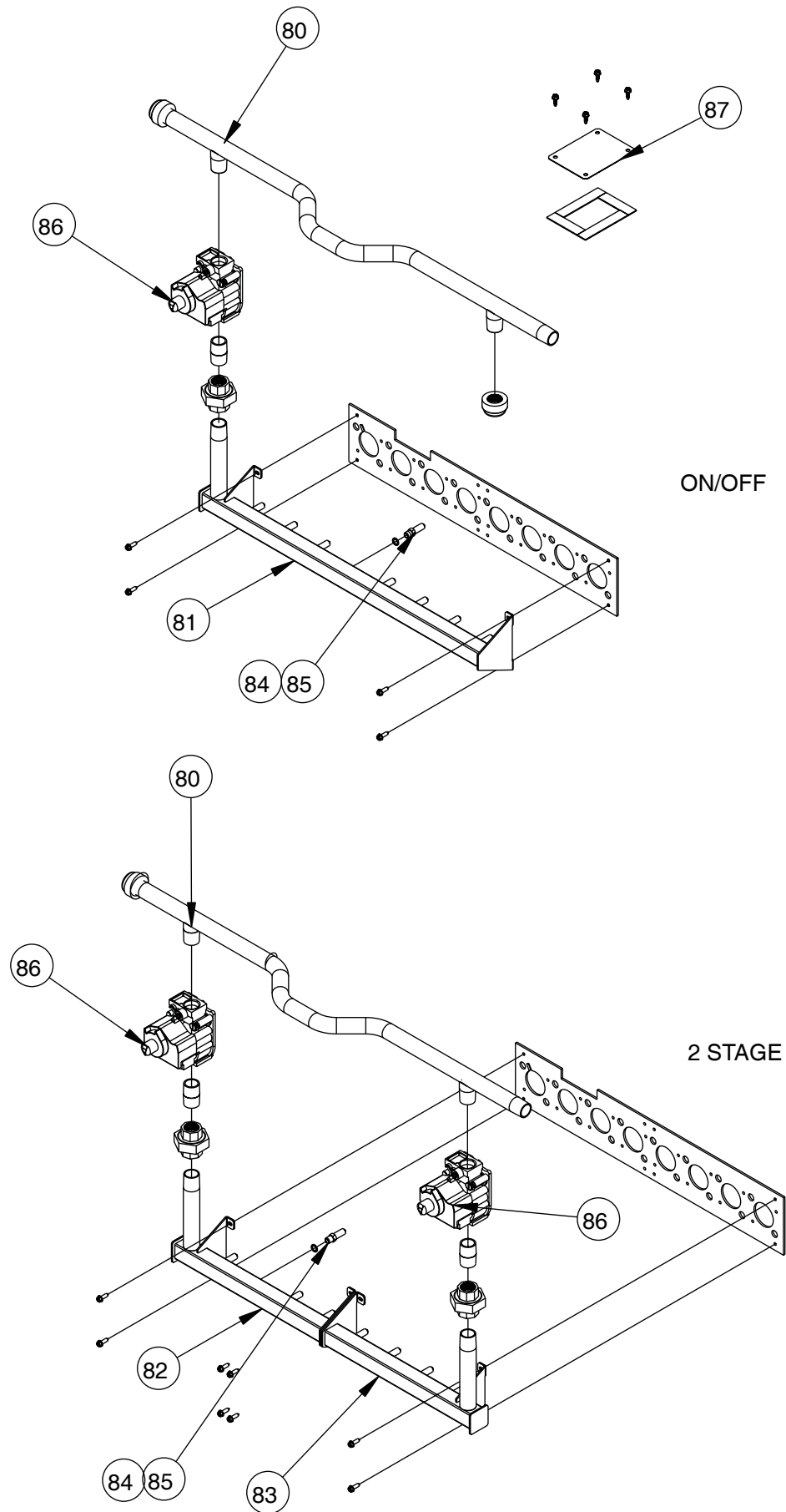
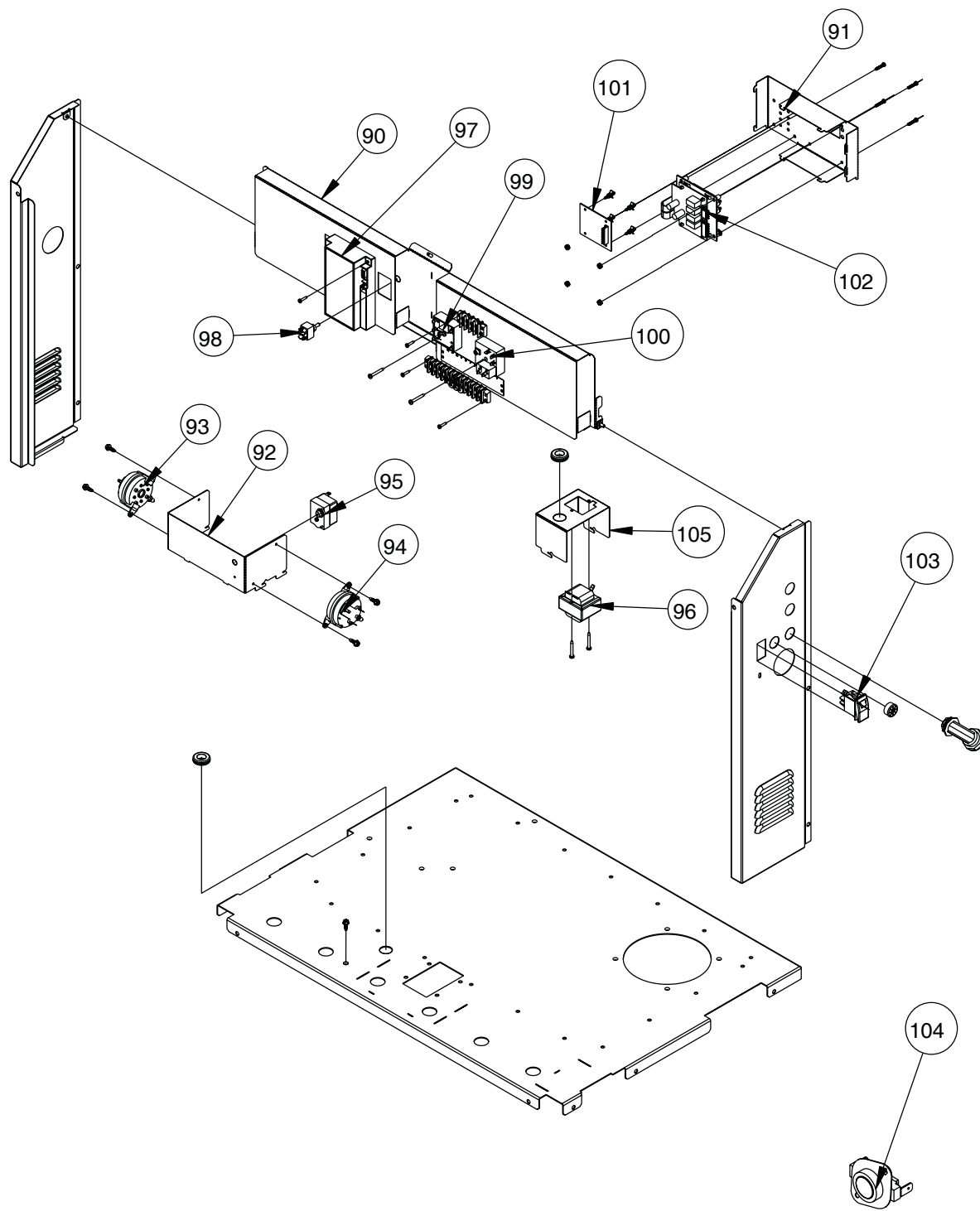


Figure 18. Gas Train Components.



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Figure 19. Controls Components.



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