

Installation and Operation Instructions for

PENNANT™

Hydronic Boiler Model PNCH

Water Heater Model PNCV

Sizes 500-2000

U.S. Reg. 2,765,423

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 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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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

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 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. Read it carefully before installation.

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" w.c. (3.2kPa).

All installations must be made in accordance with:

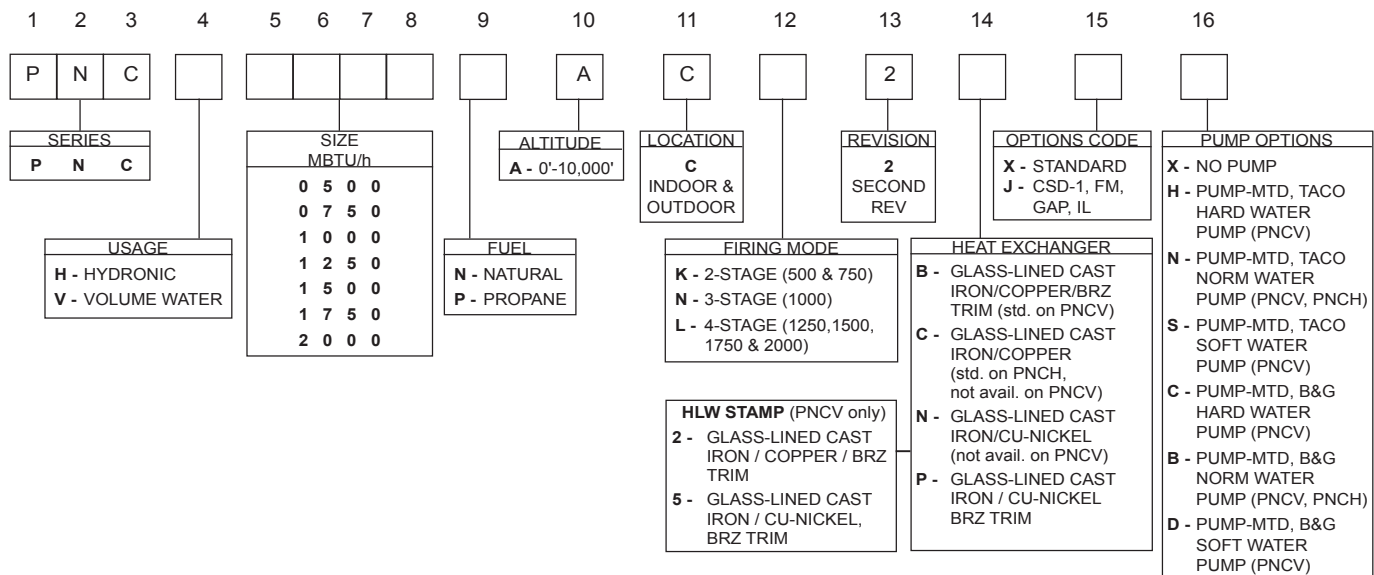
- 1) In the U.S., the "National Fuel Gas Code" ANSI Z223.1/NFPA54, Latest Edition and all applicable local codes as required by the Authorities Having Jurisdiction (AHJ), or
- 2) In Canada, the "Natural Gas and Propane Installation Code", CSA B149.1, latest edition and all applicable local codes as required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

Model Nomenclature



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 5 0 0 = 500,000 BTU/h input

0 7 5 0 = 750,000 BTU/h input

1 0 0 0 = 999,000 BTU/h input

1 2 5 0 = 1,250,000 BTU/h input

1 5 0 0 = 1,500,000 BTU/h input

1 7 5 0 = 1,750,000 BTU/h input

2 0 0 0 = 1,999,000 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

K = Two-stage (models 500 & 750)

N = Three-stage (model 1000)

L = Four-stage (models 1250 - 2000)

13 Revision

2 = Second version

14 Heat Exchanger

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

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

N = Glass-lined cast iron / cu-nickel

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

15 Option Code

X = Standard unit

J = CSD-1, FM, IRI, IL

16 Pump Options

X = No Pump

H = Pump mounted, TACO, hard water pump

N = Pump mounted, TACO, normal pump

S = Pump mounted, TACO, soft water pump

C = Pump mounted, B&G, hard water pump

B = Pump mounted, B&G, normal pump

D = Pump mounted, B&G, soft water pump

1.3 Warranty

Laars Heating Systems' appliances are covered by a limited warranty. Owners should submit online warranty registration at www.Laars.com.

All warranty claims must be made to an authorized Laars Heating Systems representative, directly to Customer Service, or online at www.Laars.com.

Claims must include the serial number and model number (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.

The dimensions and requirements that are shown in [Table 1](#) should be met when choosing the locations for the appliance.

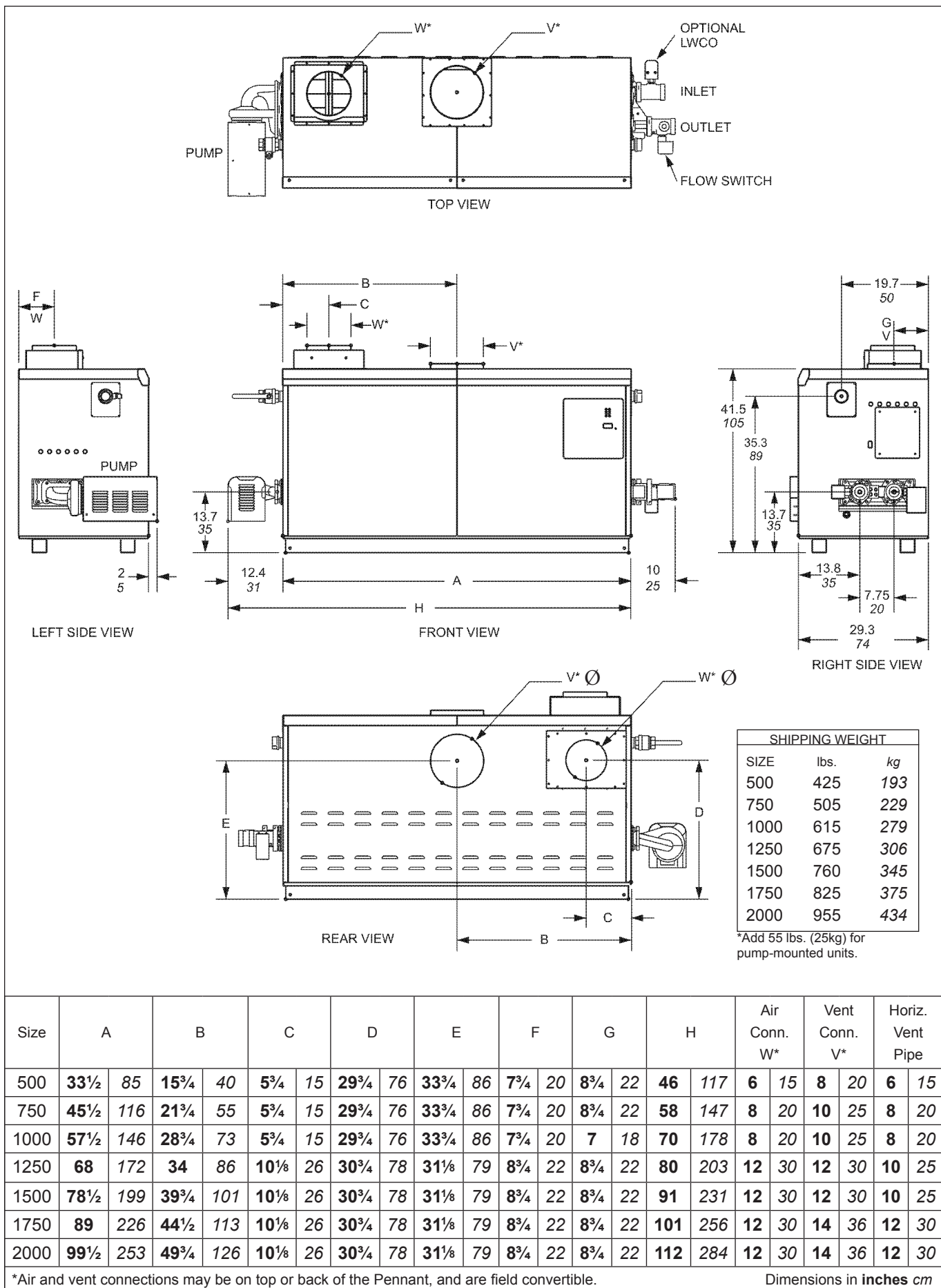


Figure 1. Dimensional Data.

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 shall be used. 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 shall be used. 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/blowers in the appliance has/have sufficient power to pull air and vent properly when the following guidelines for horizontal air and vent are followed (see Table 2).

NOTE: On all model sizes, 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 2. 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.

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 UL1738 venting system supplier's instructions			

*1" (2.5cm) when b-vent is used.
 **When vent and/or combustion air connects to the back, recommended clearance is 36" (91cm).

Table 1. Clearances.

SIZE	VENT COLLAR SIZE		HORIZONTAL VENT PIPE DIAMETER		INTAKE AIR PIPE DIAMETER		MAX. PIPE LENGTH		MAX. NO. OF ELBOWS	SIDE WALL VENT TERMINAL PART NUMBER	SIDE WALL COMBUSTION AIR TERMINAL PART NUMBER
	in.	cm	in.	cm	in.	cm	ft.	m			
500	8	20	6	15	6	15	50	15	3	CA001401	CA20260701
750	10	25	8	20	8	20	50	15	3	CA001402	CA20260703
1000	10	25	8	20	8	20	50	15	3	CA001402	CA20260703
1250	12	30	10	25	10	25	50	15	3	CA001405	CA20260705
1500	12	30	10	25	10	25	50	15	3	CA001405	CA20260705
1750	14	36	12	30	12	30	50	15	3	CA001404	CA20260706
2000	14	36	12	30	12	30	50	15	3	CA001404	CA20260706

Table 2. Horizontal Vent / Combustion Air Parameters.

SECTION 2. Venting and Combustion Air

2.1 Combustion Air

Pennant boilers and water heaters must have provisions for combustion and ventilation air in accordance with Section 5.3, Air for Combustion and Ventilation, of the National Fuel Gas Code, ANSI Z223.1, or Sections 7.2, 7.3 or 7.4 of CSA B149.1, Installation Codes, or applicable provisions of the local building codes.

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. 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.

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 2**). 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 2** 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

SIZE	EACH OPENING*	
	SQUARE INCHES	SQUARE CM
500	125	807
750	188	1213
1000	250	1613
1250	313	2020
1500	375	2420
1750	438	2826
2000	500	3226

*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.

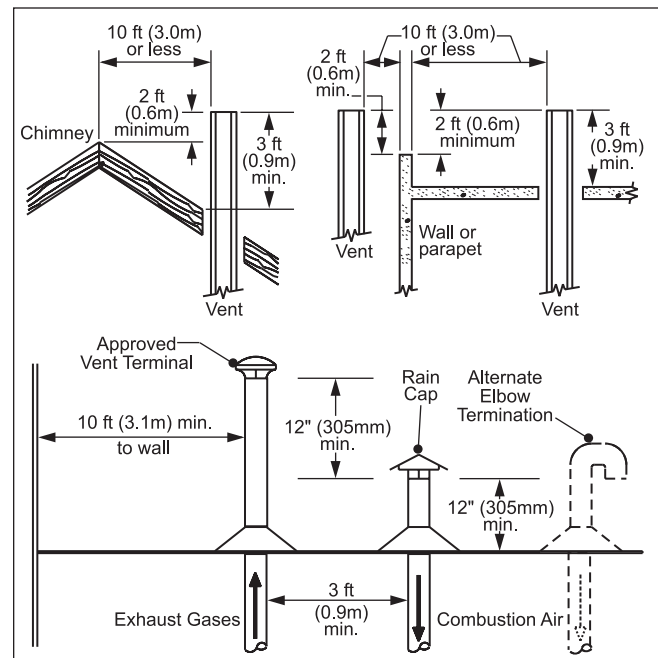


Figure 2. Combustion Air and Vent Through Roof.

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

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-Latest Edition), or in Canada the CSA B149.1 (latest edition), 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 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

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.

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" w.c.

If using a power venter for any type of Category I venting, the draft should be set between (negative) 0.01 and 0.10" 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 Cat III vent system (horizontal discharge or other configuration for Cat III), 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.

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 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 backpressure 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

	U.S. Installations (see note 1)	Canadian Installations (see note 2)
A = Clearance above grade, veranda, porch, deck, or balcony	12 inches (30 cm)	12 inches (30 cm)
B = Clearance to window or door that may be opened	4 feet (1.2 m) below or to side of opening; 1 foot (30 cm) above opening	36 inches (91 cm)
C = Clearance to permanently closed window	See note 4	See note 5
D = 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
E = Clearance to unventilated soffit	See note 4	See note 5
F = Clearance to outside corner	See note 4	See note 5
G = Clearance to inside corner	See note 4	See note 5
H = 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
I = Clearance to service regulator vent outlet	See note 4	3 feet (91 cm)
J = Clearance to nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	4 feet (1.2 m) below or to side of opening; 1 foot (30 cm) above opening	36 inches (91 cm)
K = Clearance to a mechanical air supply inlet	3 feet (91 cm) above if within 10 feet (3 m) horizontally	6 feet (1.83 m)
L = Clearance above paved sidewalk or paved driveway located on public property	Vent termination not allowed in this location for category IV appliances. For Category III appliances, vent must terminate at least 7 feet (2.13m) above the sidewalk or driveway.	Vent termination not allowed in this location for category IV appliances. A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings. For Category III appliances that do not violate the previous condition, vent must terminate at least 7 feet (2.13m) above the sidewalk or driveway.
M = Clearance under veranda, porch, deck, or balcony	See note 4	12 inches (30 cm) (see note 3)

Notes:

1. In accordance with the current ANSI Z223.1 / NFPA 54 National Fuel Gas Code.
2. In accordance with the current CSA-B149.1 Installation Codes.
3. Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.
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.

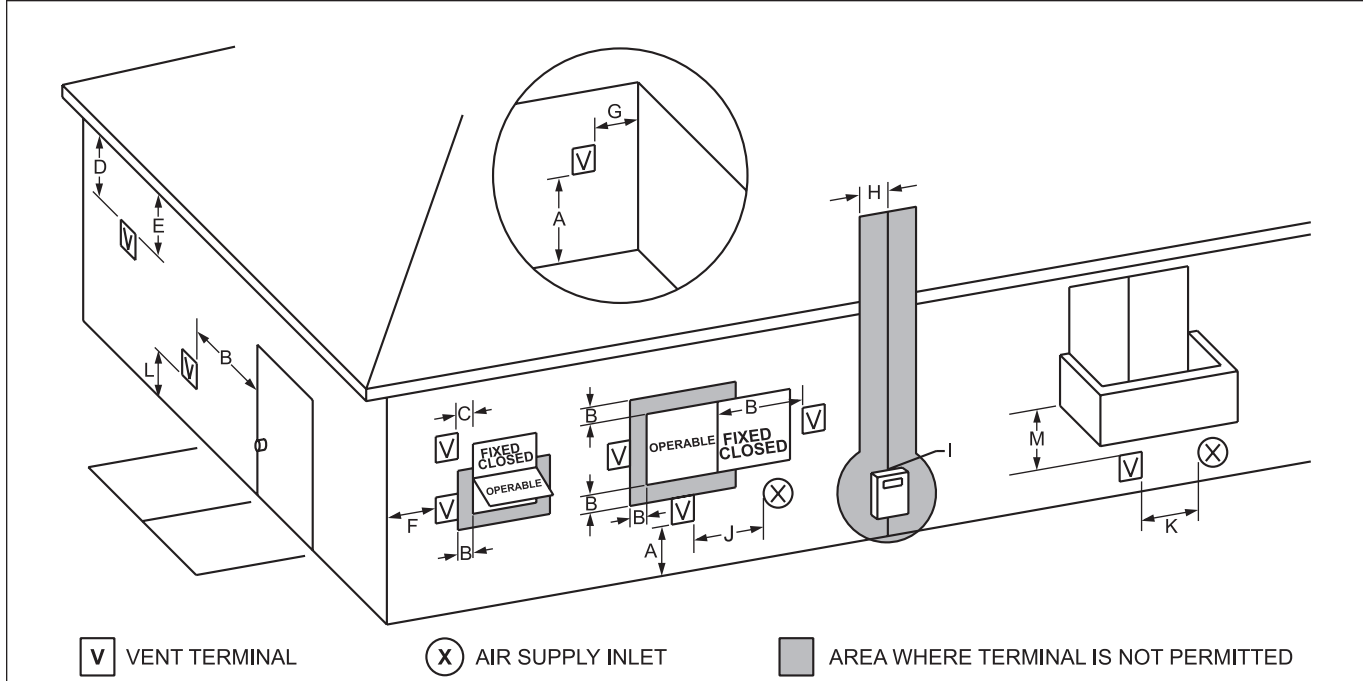


Figure 3. Combustion Air and Vent Through Side Wall.

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 listed on 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 gasses 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**.

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. Reference **Table 2** 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.

⚠ 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.

2.3 Locating Vent & Combustion Air Terminals

2.3.1 Side Wall Vent Terminal

The appropriate Laars side wall vent hood must be used, and is listed in the installation and operation

TERM	DESCRIPTION
Pipe	Must comply with UL Standard 1738 such as Type 29-4C Stainless Steel (either insulated or non-insulated).
Joint Sealing	Follow vent manufacturer’s instructions

Table 5. Required Horizontal Venting Material.

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 or .2 and local applicable codes. Consider the following when installing the terminal:

1. **Figure 3** shows the requirements for mechanical vent terminal clearances for the U.S. and Canada.
2. Vent terminals for condensing appliances or appliances with condensing vents are **not** permitted to terminate above a public walkway, or over an area where condensate or vapor could create a nuisance or hazard.
3. Locate the vent terminal so that vent gases cannot be drawn into air conditioning system inlets.
4. 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.
5. 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.
6. 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.
7. 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.

2.3.2 Side Wall Combustion Air Terminal

The Laars side wall combustion air terminal (listed in **Table 2**) 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 no 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 to the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or CSA B149.1, 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 Part II of the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or CSA B149.1, Installation Codes.

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.

If local codes allow, outdoor installations may use 1' of appropriately sized galvanized single wall or B-Vent and a rain cap for exhaust vent termination in the default configuration (venting out of the top). An appropriately sized galvanized 90° ell, positioned with the opening facing down, may be used on the combustion air inlet in the default configuration on the back of the unit. Note that some local codes may require a higher vertical vent height, extending above any perimeter fencing, etc. In installations where the appearance of the vent is objectionable, the low profile vent terminals in Table 6 may be used.

Part numbers for the low profile terminals to cover the vent and combustion air openings are shown in Table 6.

SIZE	OUTDOOR VENT TERMINAL	OUTDOOR COMBUSTION AIR TERMINAL
500	20254703	D2007900
750	20254705	D2008000
1000	20254705	D2008000
1250	D2007700	D2008200
1500	D2007700	D2008200
1750	D2007800	D2008200
2000	D2007800	D2008200

Table 6. Vent Terminals 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" w.c. (1.2kPa).
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 1/2 PSIG (3.45kpa).
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 1/2 PSIG (3.45kpa).
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.

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.

SIZE AND GAS TYPE	DISTANCE FROM GAS METER OR LAST STAGE REGULATOR					
	0-100'	0-31m	100-200'	31-61m	200-300'	61-91m
500 natural	1-1/2"	3.8cm	2"	5.1cm	2"	5.1cm
500 propane	1"	2.5cm	1-1/2"	3.8cm	1-1/2"	3.8cm
750 natural	2"	5.1cm	2"	5.1cm	2-1/2"	6.4cm
750 propane	1-1/2"	3.8cm	1-1/2"	3.8cm	2"	5.1cm
1000 natural	2"	5.1cm	2-1/2"	6.4cm	3"	7.6cm
1000 propane	1-1/2"	3.8cm	2"	5.1cm	2-1/2"	6.4cm
1250 natural	2-1/2"	6.4cm	2-1/2"	6.4cm	3"	7.6cm
1250 propane	2"	5.1cm	2"	5.1cm	2-1/2"	6.4cm
1500 natural	2-1/2"	6.4cm	3"	7.6cm	3"	7.6cm
1500 propane	2"	5.1cm	2-1/2"	6.4cm	2-1/2"	6.4cm
1750 natural	2-1/2"	6.4cm	3"	7.6cm	3"	7.6cm
1750 propane	2"	5.1cm	2-1/2"	6.4cm	2-1/2"	6.4cm
2000 natural	3"	7.6cm	3"	7.6cm	3-1/2"	8.9cm
2000 propane	2-1/2"	6.4cm	2-1/2"	6.4cm	3"	7.6cm

Notes:
 1. These figures are based on 1/2" (0.12kPa) 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.

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 psi (82.7kPa) 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 12psig (82.7kPa). Install shutoff valves where required by code.

Suggested piping diagrams are shown in **Figures 4 through 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.

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 re-circulates the same fluid in the piping system. As a result, no new minerals or oxygen is 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 headloss through the heater, plus 30 feet (9.1m) of full-sized piping (same size as boiler outlet) and a normal number of fittings.

Table 8 specifies water flow rates for boilers, which will enable the user to size a pump. The headloss shown is for the heater only, and the user will need to add the headloss 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.

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
500	43	1.7	34	1.1	28	0.9	24	0.7
750	64	3.3	51	2.3	43	1.7	36	1.2
1000	85	5.0	68	3.6	57	3.1	49	2.2
1250	106	8.1	85	6.1	71	4.7	61	3.4
1500	128	10.0	102	7.2	85	5.5	73	4.2
1750	N/R	N/R	119	10.5	99	8.4	85	5.8
2000	N/R	N/R	136	12.5	113	10.4	97	8.3

Metric Equivalent

SIZE	11°C		14°C		17°C		19°C	
	flow lpm	H/L m	flow lpm	H/L m	flow lpm	H/L m	flow lpm	H/L m
500	161	0.5	129	0.3	107	0.3	92	0.2
750	241	1.0	193	0.7	161	0.5	138	0.4
1000	321	1.5	257	1.1	214	0.9	184	0.7
1250	401	2.5	322	1.9	269	1.4	231	1.0
1500	483	3.0	386	2.2	322	1.7	276	1.3
1750	N/R	N/R	451	3.2	375	2.6	322	1.8
2000	N/R	N/R	515	3.8	429	3.2	368	2.5

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

Table 8. Water Flow Requirements - PNCH.

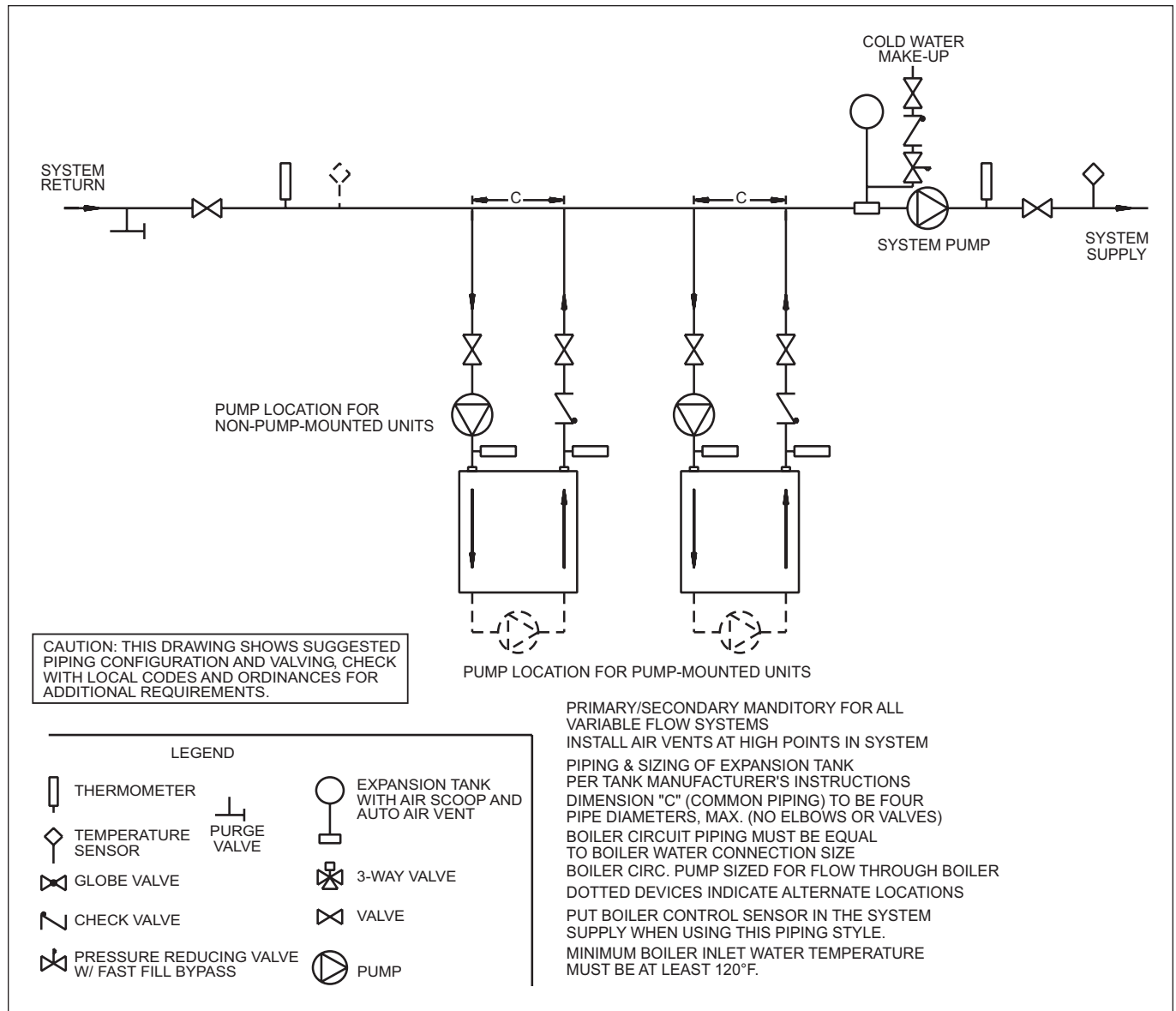


Figure 4. Hydronic Piping — Multiple Boilers, Primary Secondary System.

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 headloss 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.

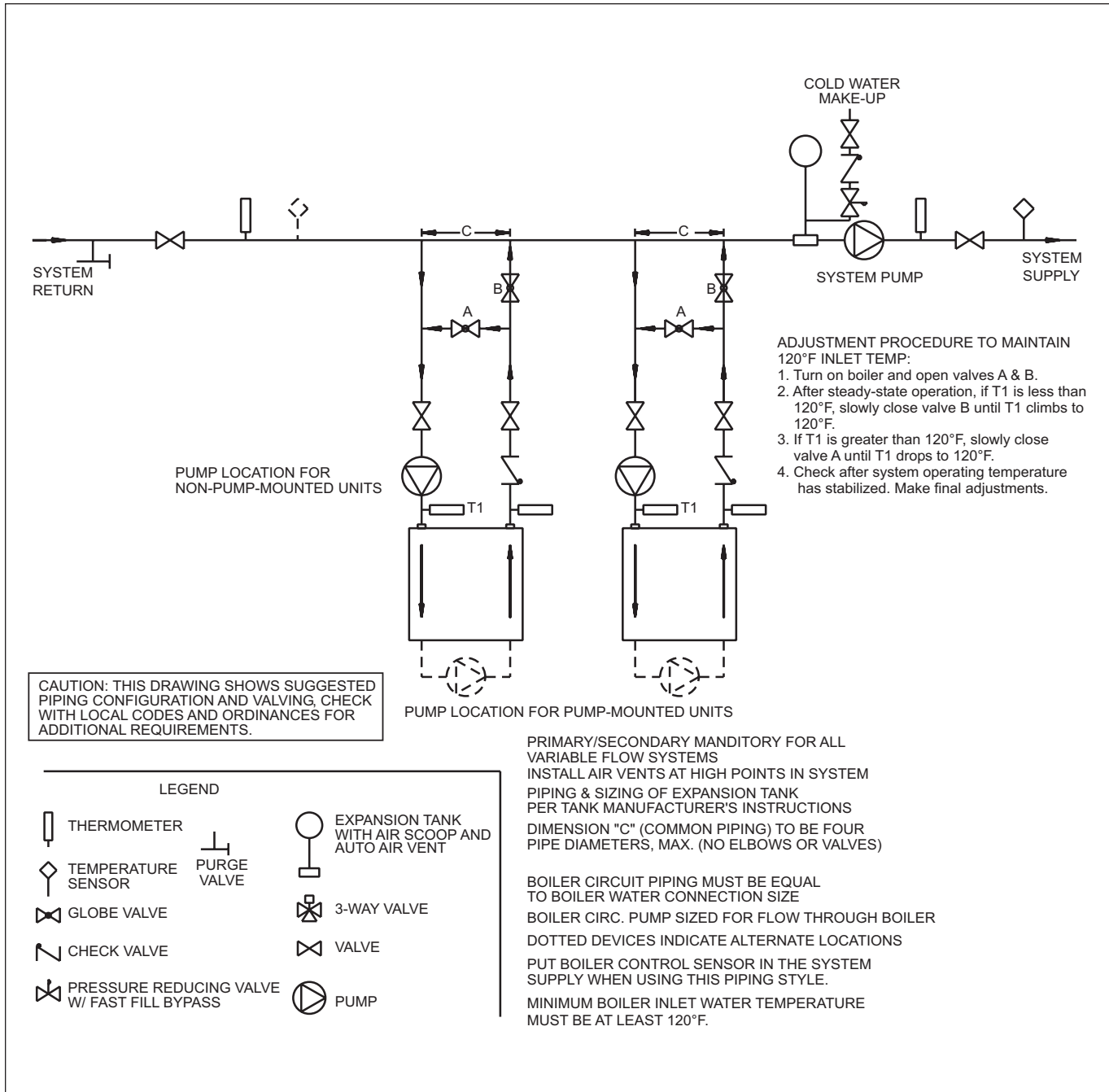


Figure 5. Hydraulic Piping — Multiple Boilers, Low Temperature System.

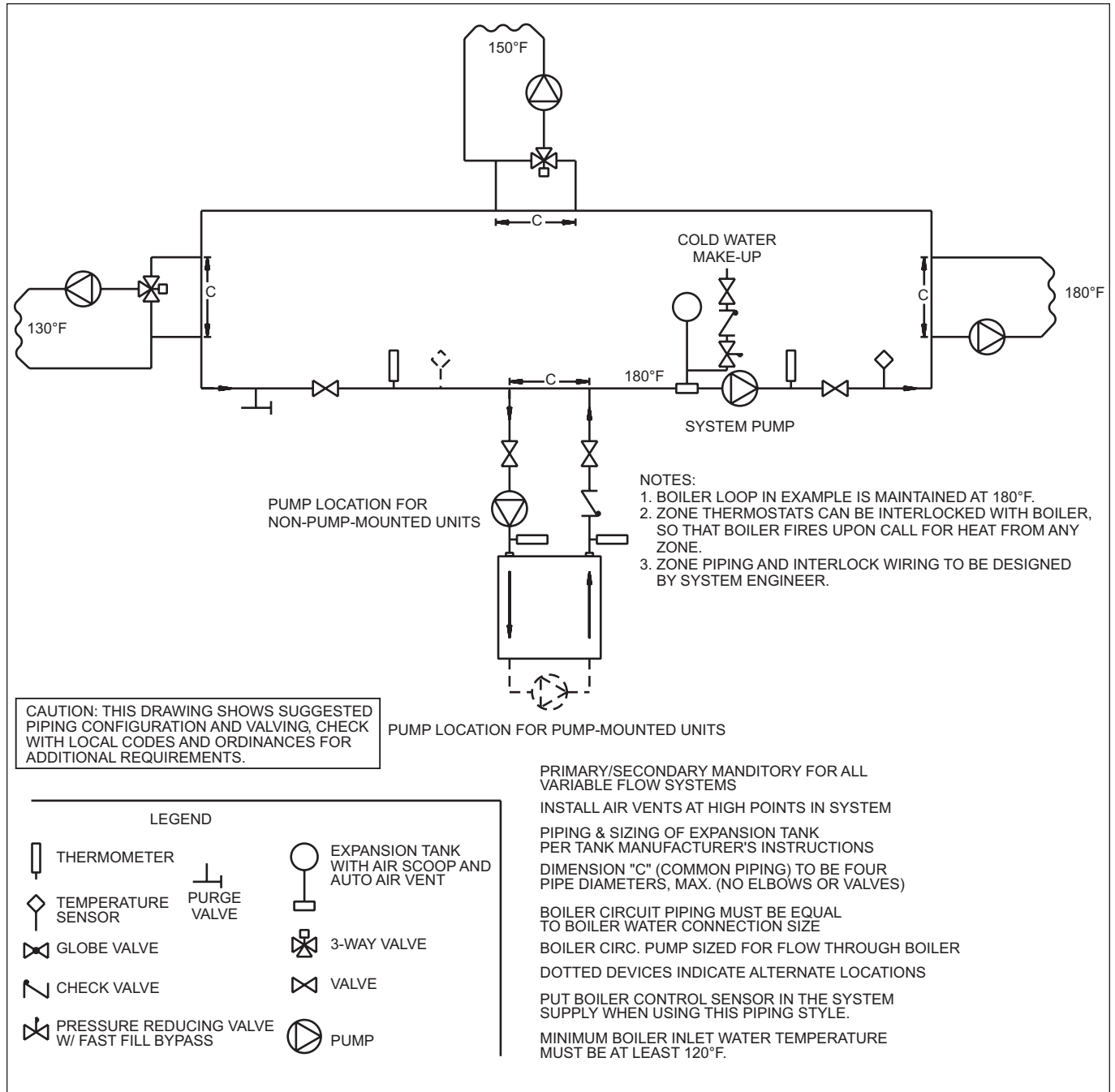


Figure 6. Hydronic Piping — One Boiler, Multi-Temperature System.

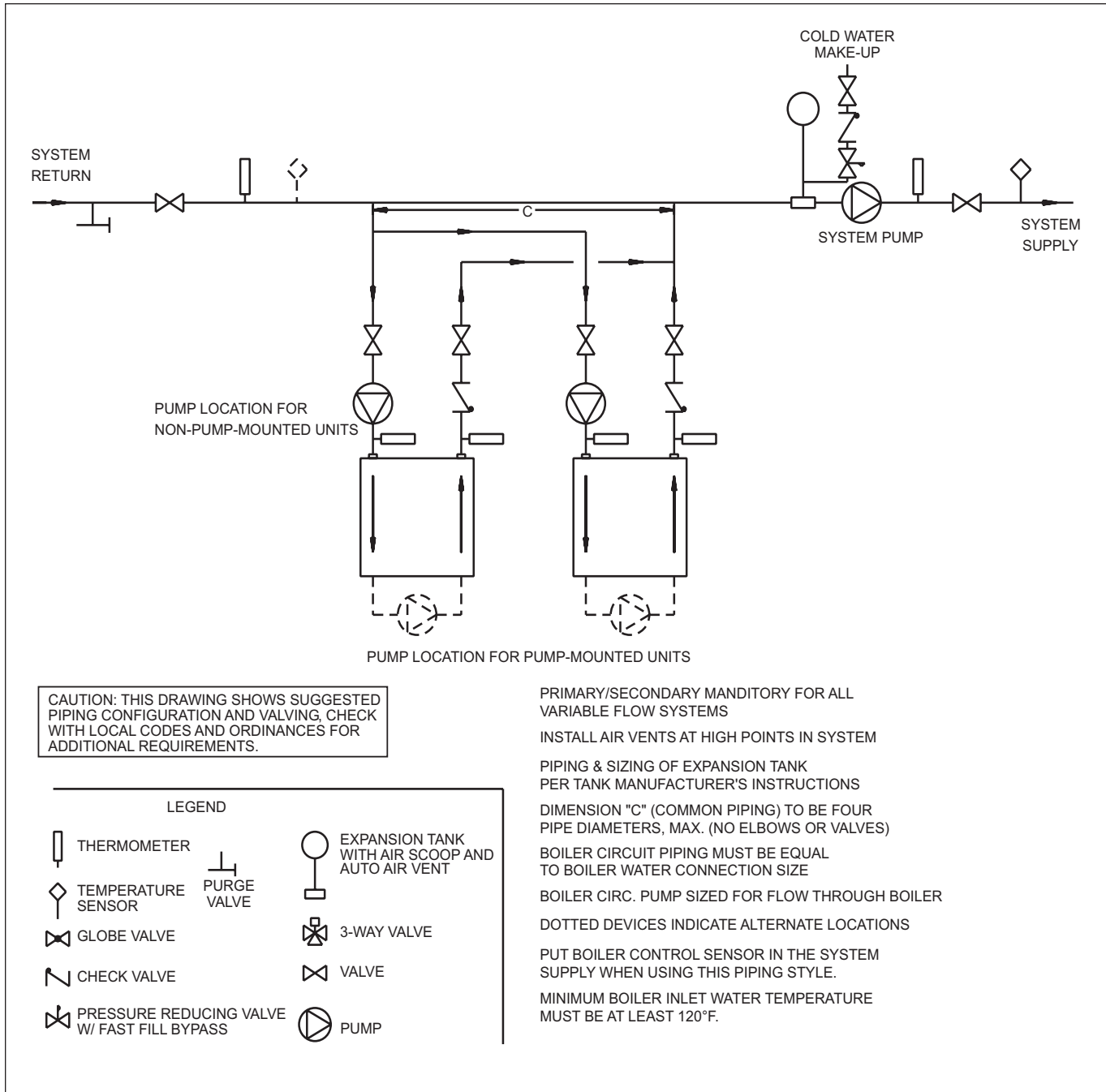


Figure 7. Hydronic Piping - Primary-Secondary, Reverse-Return.

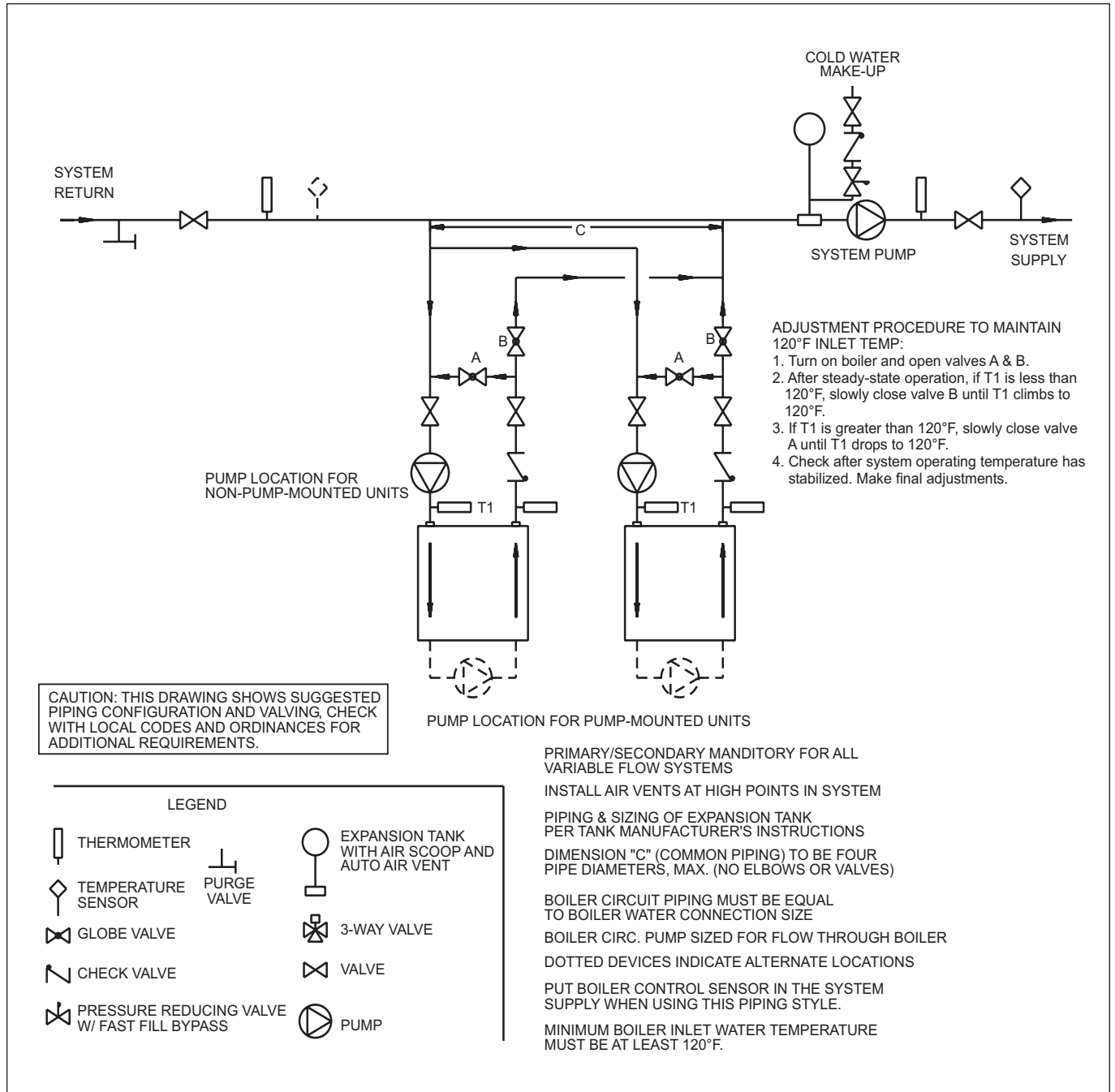


Figure 8. Hydronic Piping - Primary-Secondary, Reverse-Return, Low Temperature.

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 headloss through the heater, plus 30 feet (9.1m) 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 through 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.

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 headloss 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 headloss shown is for the heater only, and the user will need to add the headloss 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.

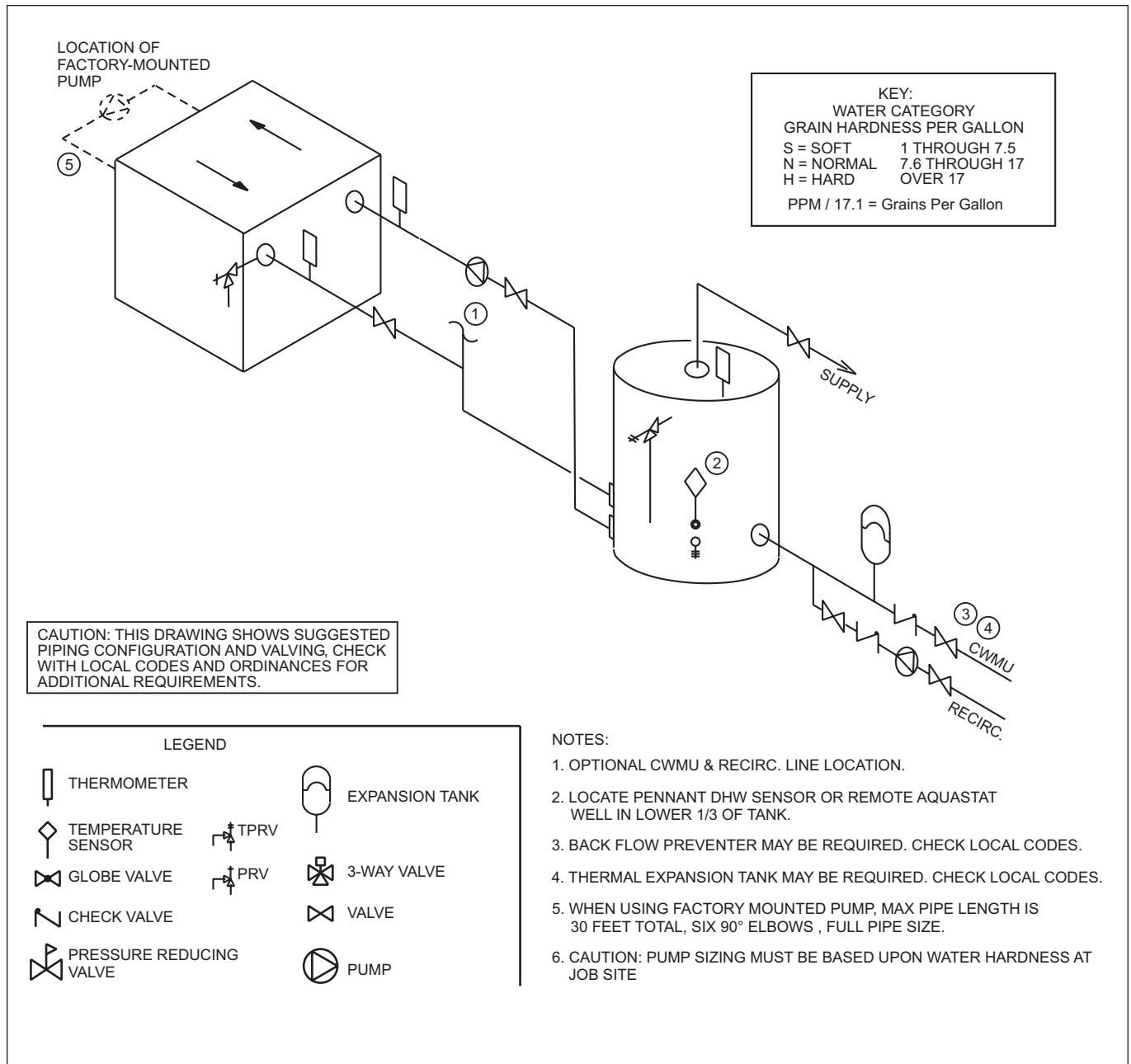


Figure 9. Water Heater Piping — One Heater, One Tank.

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.

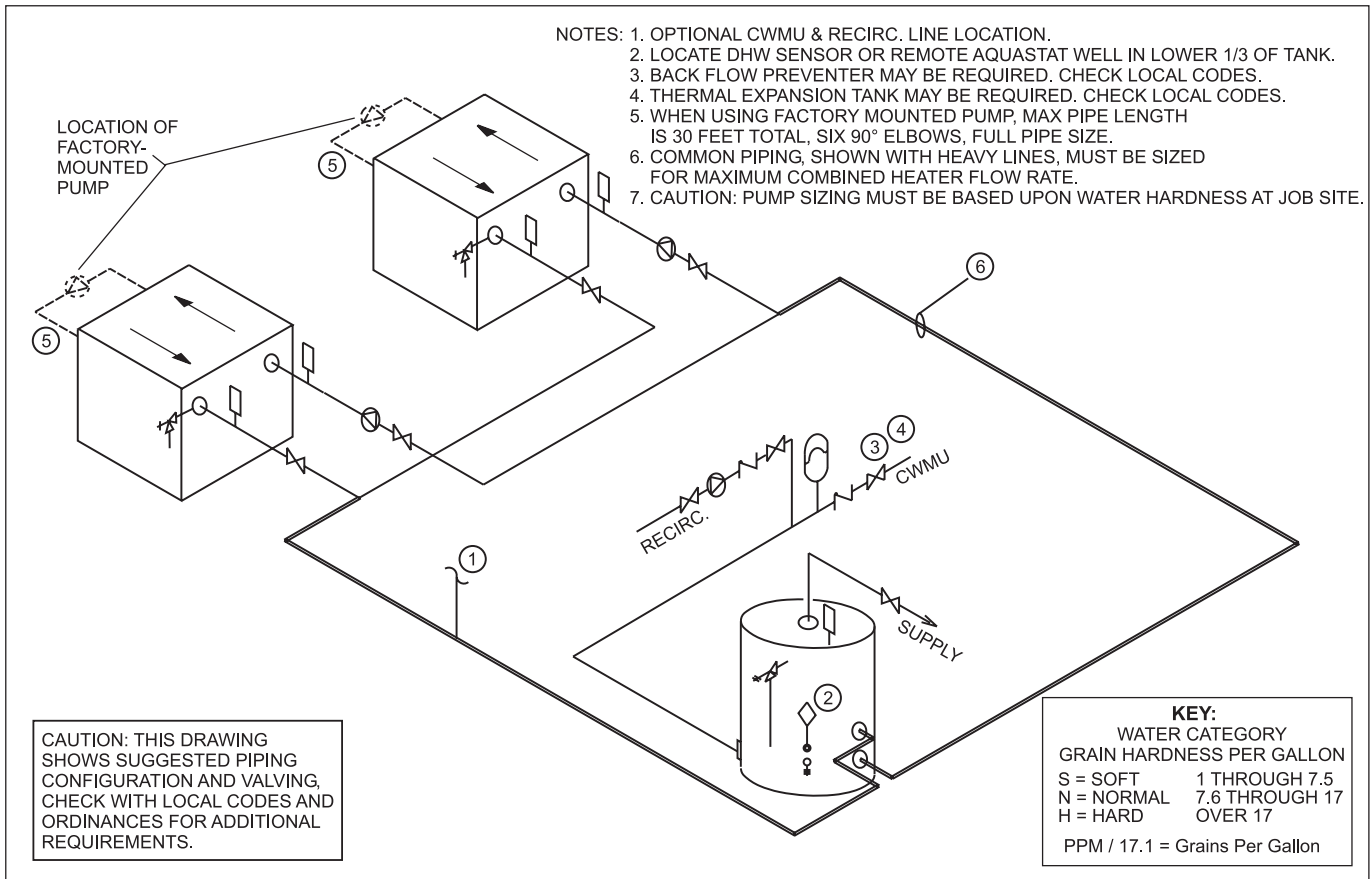


Figure 10. Water Heater Piping — Multiple Heaters, One Tank.

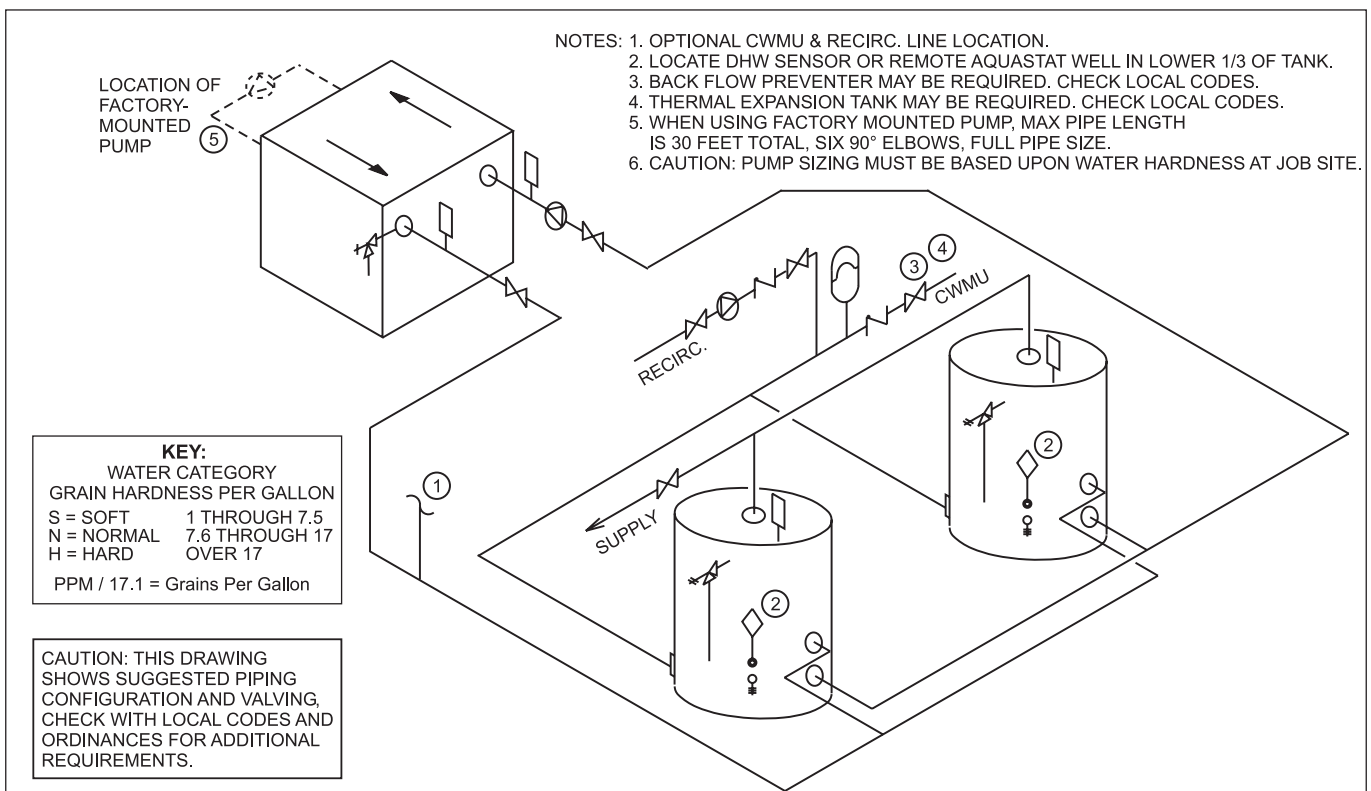


Figure 11. Water Heater Piping — One Heater, Multiple Tanks.

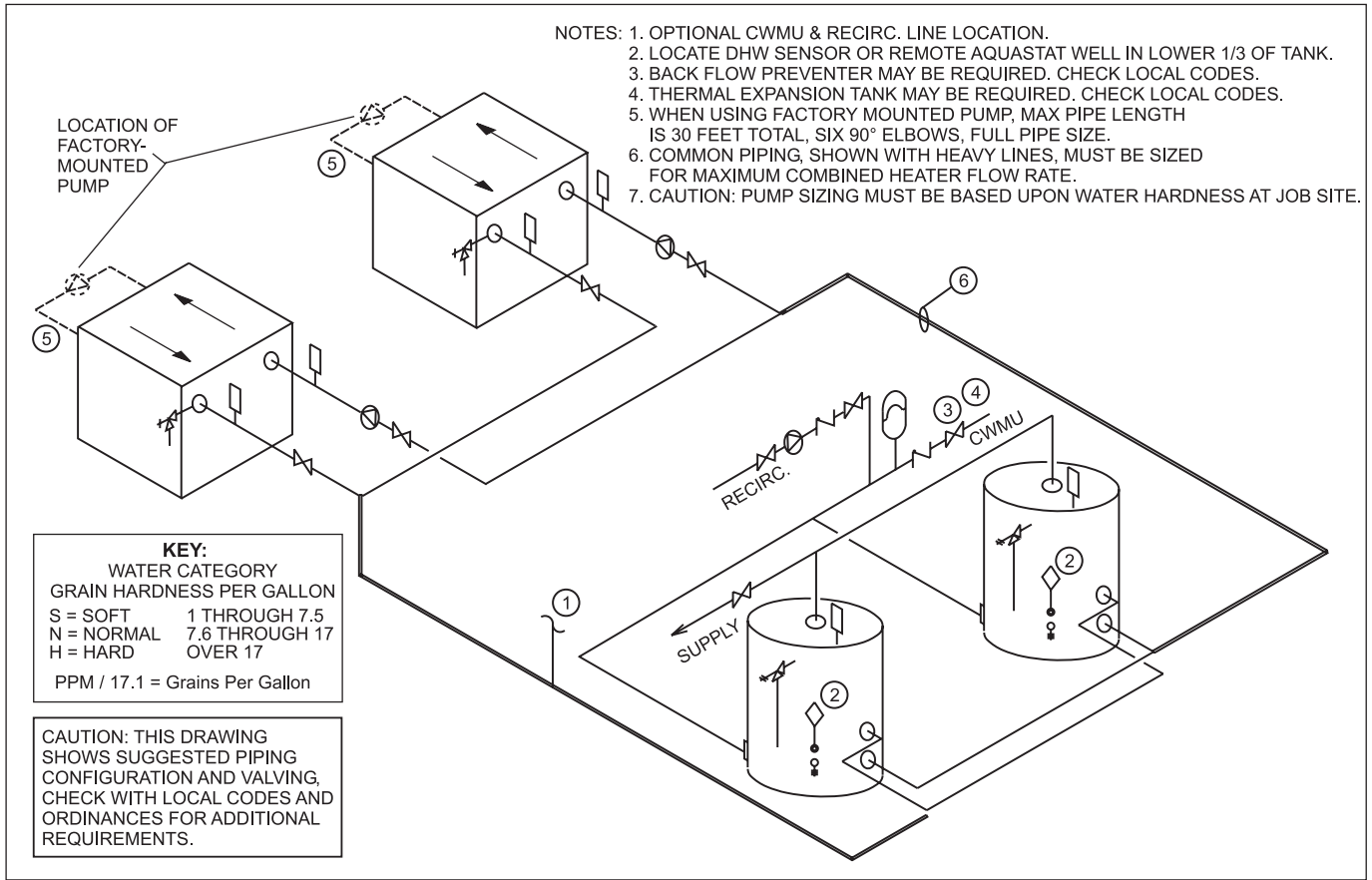


Figure 12. Water Heater Piping — Multiple Heaters, Multiple Tanks.

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
500	45	68	90	1.8	2.3	3.5	19	13	9	170	257	341	0.5	0.7	1.1	10	7	5
750	45	68	90	2.1	3.0	6.0	28	19	14	170	257	341	0.6	0.9	1.8	16	10	8
1000	45	68	90	2.3	3.6	6.1	38	25	19	170	257	341	0.6	1.1	1.9	21	14	10
1250	68	68	90	3.8	3.8	6.3	31	31	24	257	257	341	1.2	1.2	1.9	17	17	13
1500	68	68	90	3.9	3.9	6.5	38	38	28	257	257	341	1.2	1.2	2.0	21	21	16
1750	68	68	90	4.0	4.0	6.7	44	44	33	257	257	341	1.2	1.2	2.0	24	24	18
2000	112	112	112	10.0	10.0	10.0	30	30	30	424	424	424	3.0	3.0	3.0	17	17	17

- 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 minutes, lpm = liters per minute, ft = headless in feet, m = headloss in meters
 5. Headloss is for heater's heat exchanger only

Table 9. Water Flow Requirements – PNCV.

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.

5.1 Main Power

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 at the right side of the appliance.

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

5.1.1 Power Circuits

All Pennant non-pump-mounted heaters require a single 120-volt fused supply.

Pump-mounted Pennants models 500-1500 also uses a single 120-volt fused supply and models 1750-2000 use two 120-volt fused supplies.

The installer can change the pump mounted single service heaters to use a separate circuit for the pump, if desired. Instructions to make this change are found in [Section 5.1.2](#).

Pennant 500-1500 main power (L1, N1 & Ground) shall be connected to the three wires (10 AWG) supplied. Over current protection ratings can be found in [Table 10](#).

	SINGLE CIRCUIT CONNECTIONS HEATER		PUMP ONLY	
	W/O PUMP	WITH PUMP	TACO	B&G
500	15	20	15	15
750	15	20	15	15
1000	20	25 (TACO)	30 (B&G)	15 15
1250	25	30	15	15
1500	25	30	15	15
1750	25	—	15	20
2000	25	—	20	20

Table 10. Electrical Data.

Pennant 1750-2000 will require two 120-volt fused supplies. Heater circuit can be identified with 10AWG wires to include black, white and green (all solid colors). Pump circuit can be identified with three 12AWG wires to include a black wire with a white tracer (stripe), a white and green wire.

5.1.2 Pump Circuit

Conversion to separate pump circuit will necessitate removing the three jumpers within the internal wiring of the 120-volt portion of the heater (see [Figure 13](#)). Only do this with the power disconnected to the unit.

To rewire the pump circuit, bring in another 120-volt fused supply (L2, N2 & Ground). Connect incoming power (L2) to the main power switch using spade (fork) terminal. From the other side of the main power switch connect to the main terminal block using a ¼" female insulated quick connect. This will be the same position where the jumper had terminated. Connect N2 and Ground to the main terminal block using ¼" female insulated quick connect (refer to [Figure 13](#)).

Ladder diagrams are shown in [Figures 16 through 18](#), while wire diagrams are shown in [Figures 19 through 21](#).

5.2 Temperature Control

5.2.1 Temperature Control Description

The field wiring panel is located on the right side of the Pennant (shown in [Figure 14](#)). The following components are connected to the field wiring panel:

Temperature sensor: The sensor supplied loose with the Pennant is installed in the piping or tank,

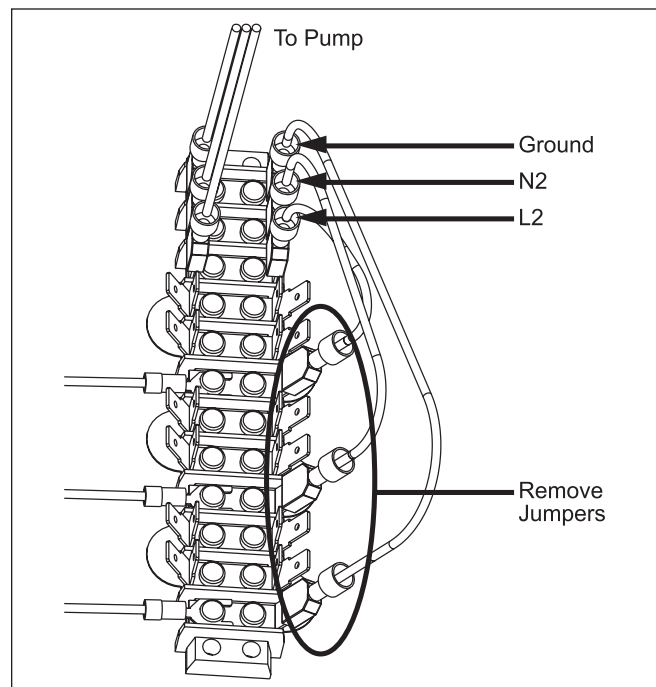


Figure 13. Removing Jumpers.

per the suggested piping diagrams, and connected to the “S C2” and “SUP S” terminals. See **Section 6.3** for “Mode” definitions and **Figures 22 to 24** for field wiring schematics.

Outdoor Reset Sensor: The outdoor reset sensor, if used, is connected to the “OD S” and “S C2” terminals.

Field Installed Pump: A pump contactor can be wired to the “PMP” and “PMP” terminals (these terminals supply 24VAC to close the contactor whenever the boiler pump would be operated). NOTE: In some cases, the boiler pump is operated continuously.

External Alarm: An external power supply and alarm can be connected to the “ALRM” and “ALRM” terminals. In the event of an ignition system lockout, a contact closure occurs across these terminals.

External Heat Demand Indication: 24VAC is present across the “HT OUT” and “LWCO GND” terminals whenever the temperature control sees a system heat demand. This can be used to power a contactor (0.5 Amp, maximum) for devices operated whenever the boiler could fire (combustion air fans, motorized louvers, etc.) NOTE: In some cases, the temperature control will always see a heat demand in the system, such as when the “Ht D” and Com D” terminals are jumpered.

Other Field Interlocks: To install other field-wired devices to interlock with the boiler (louver

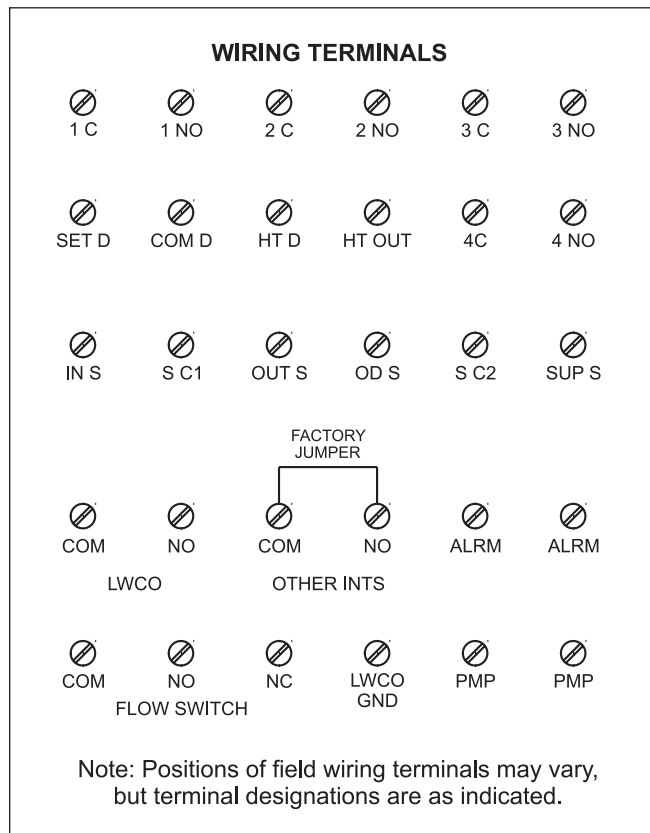


Figure 14. Field Wiring Panel

switches, flow switches, etc.), remove the jumper between the “COM” and “NO” terminals and wire the device in series across these terminals. (See **Section 5.3** for important information about external staging controls and building automation systems.)

System Heat Demand: Remove the jumper across the “COM D” and “Ht D” terminals, and connect the zone pump or valve end switch, thermostat, aquastat, or other indication of system heat demand to these terminals. If no indication of a system heat demand will be provided, the jumper must remain in place. When jumpered, the temperature control will always see a heat demand, and the Pennant pump (if equipped) or any pump with its contactor connected to the “PMP” and “PMP” terminals will run continuously. In addition, any device connected through the “HT OUT” and “LWCO GND” terminals for an external indication of the heat demand will run continuously. See **Section 6** for more information on the system heat demand for various modes of operation.

Refer to **Figures 22 through 24** for field wiring of additional components.

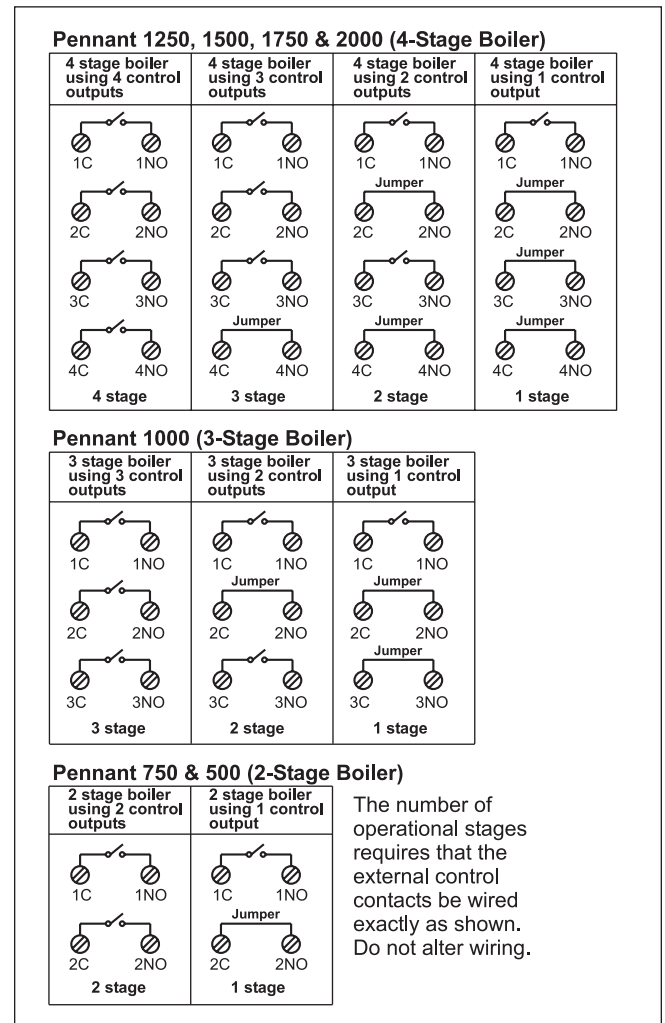


Figure 15. External Control Connection Wiring.

5.3 External Staging Control Wiring

⚠ WARNING

Improper field wiring may result in fire or explosion which can cause property damage, severe injury, or death. Make only wiring connections which are in accordance with the Installation and Operation manual.

⚠ AVERTISSEMENT

Un câblage incorrect lors de l'installation peut causer un incendie ou une explosion pouvant entraîner des dommages matériels, de graves blessures ou la mort. Ne faire seulement que les connexions conformes au Manuel d'installation et d'exploitation.

The wiring methods in this section must be used to connect an external staging control, such as a multiple boiler control, building automation system, energy management system, etc.) Other wiring methods may be unsafe.

Figure 15 shows how to wire the external controller to the Pennant's field wiring panel, which is located on the right side of the Pennant.

Most of the time, the number of stages from the external control will match the number of stages on the Pennant. However, in some instances, the controller will not have enough staging capability to work with all of the stages on a Pennant unit (for instance, using an 8-stage external control with four 4-stage Pennant units.) In these instances, it is very important to follow the instructions in this section **Figure 15** shows how to combine stages on the Pennant for those instances when the external controller cannot control all the stages available.

NOTE: The only time Pennant stages should be jumpered is when the Pennant has an external control, and the Pennant is used in Mode 6. In all other modes, when the Pennant controls its stages, the terminals shown in **Figure 15** must NOT be jumpered.

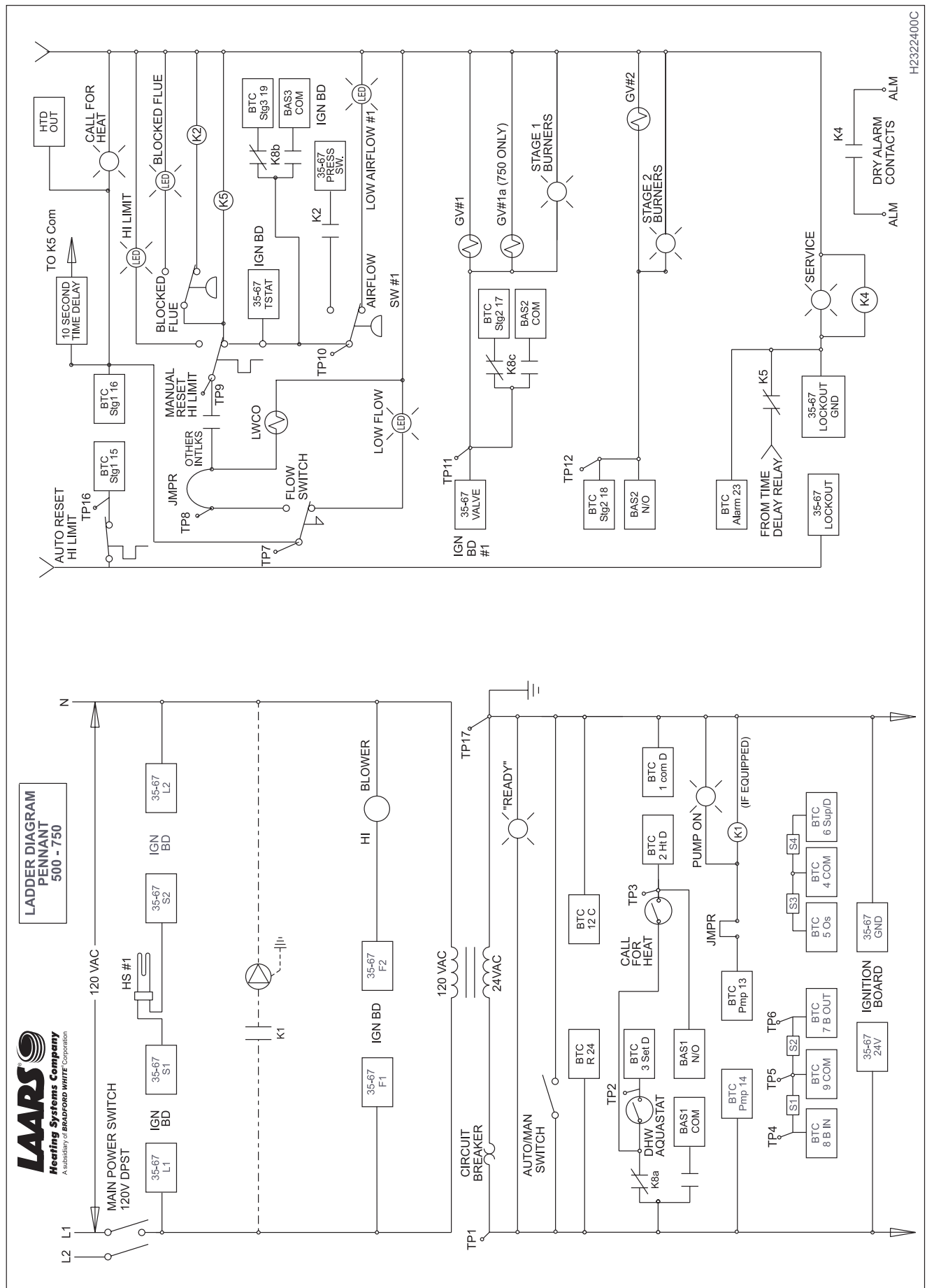
5.4 Low Water Cut-Off

When this boiler is installed above radiation level, it is required that a Low Water Cut-Off (LWCO) be installed unless this requirement is superseded by Jurisdictional requirements. Specific instructions for the installation are the following:

Locate the wiring diagram within this manual. On the wiring diagram, locate the connection points marked LWCO or Field Interlocks. These are the electrical connection points for the LWCO. Follow LWCO Manufacturer's Wiring Instructions.

Mechanically, install the LWCO device in a tee fitting in the supply piping above the highest point of the boiler (unless the boiler has an existing fitting for that purpose). Follow LWCO Manufacturer's Instructions for minimum pipe sizing.

Note: This boiler is a water tube boiler that requires water flow through the heat exchanger for proper operation. It does not have an operating water level and must be full at all times. In accordance with ANSI/ASME CSD-1 Section CW-210 and The National Fuel Gas Code ANSI Z223.1/NFPA 54 Section 10.3.5 a water tube boiler shall have a water flow proving device in lieu of a Low Water Cut Off.



H2322400C

Figure 16. Pennant 500 - 750 Ladder Diagram.

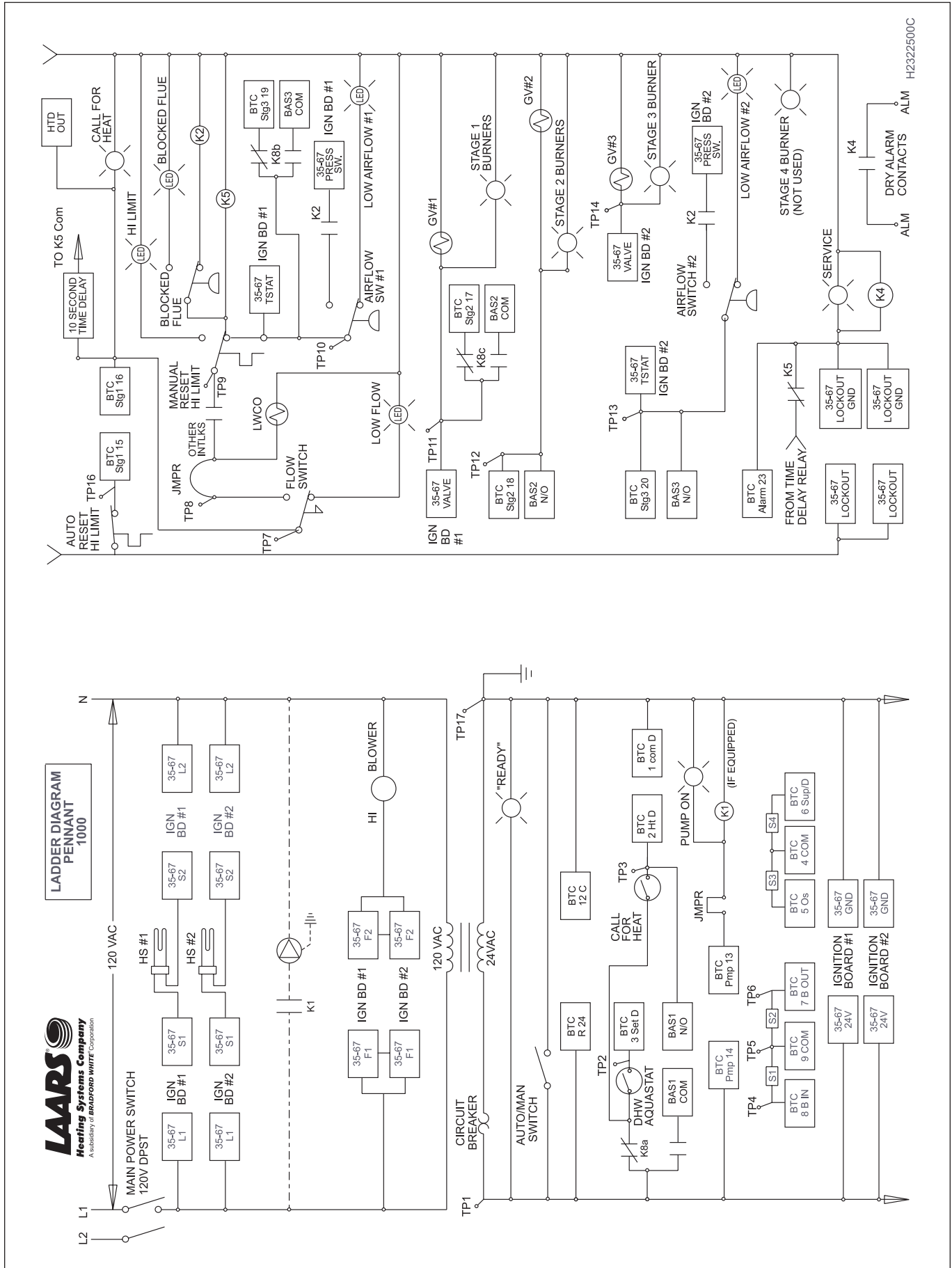


Figure 17. Pennant 1000 Ladder Diagram.

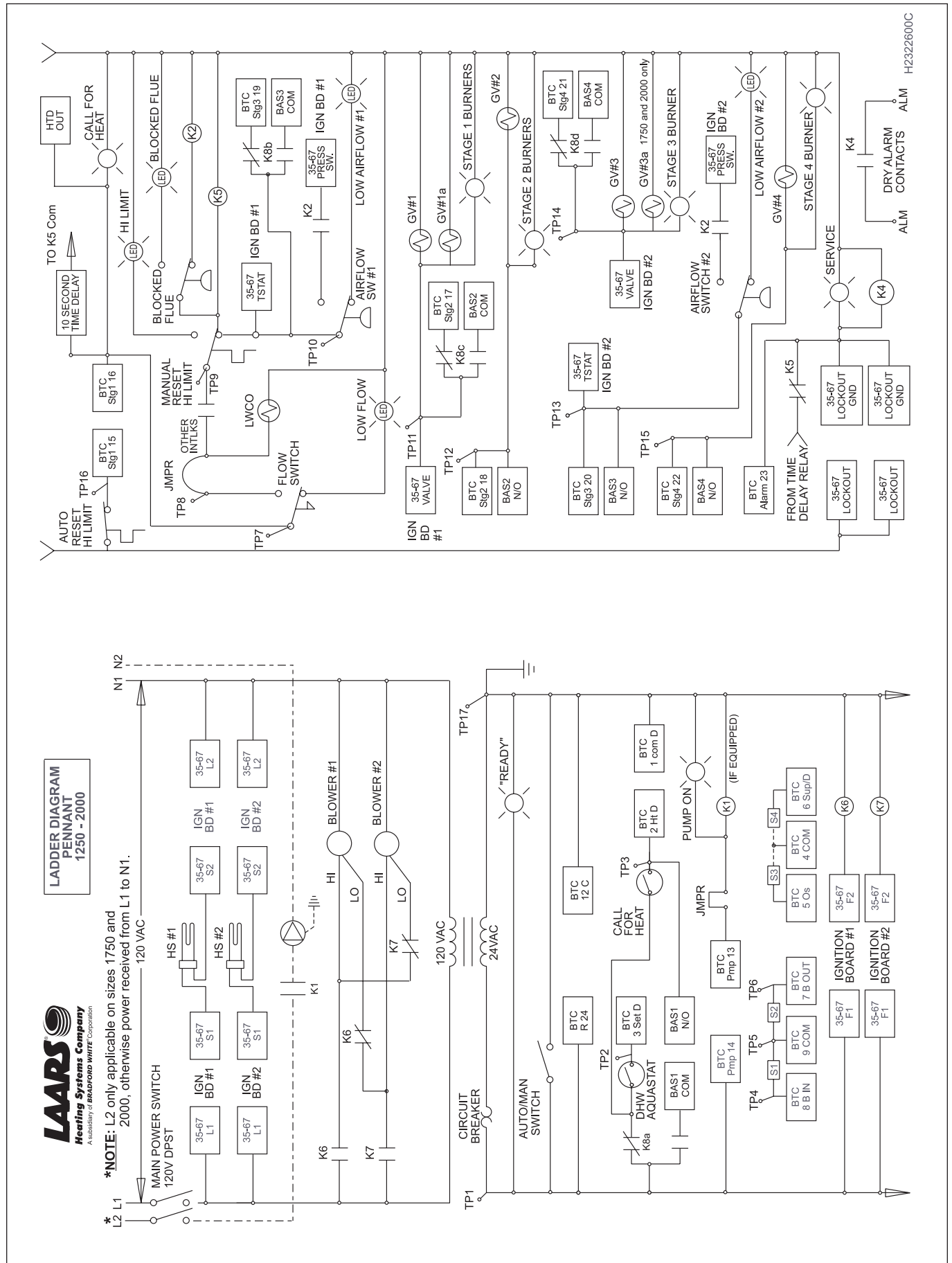


Figure 18. Pennant 1250 - 2000 Ladder Diagram.

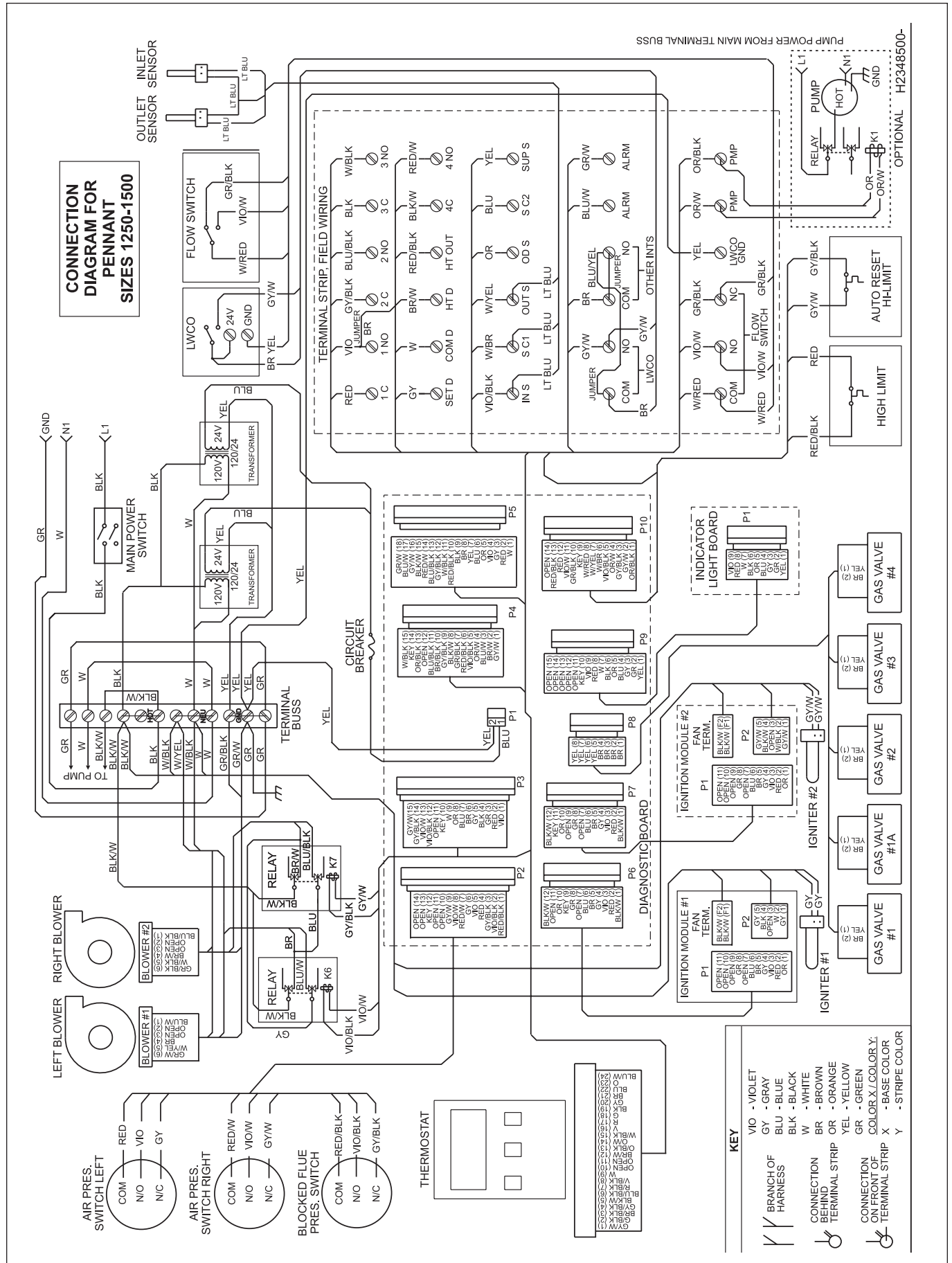


Figure 20. Pennant 1250 - 1500 Wiring Schematic.

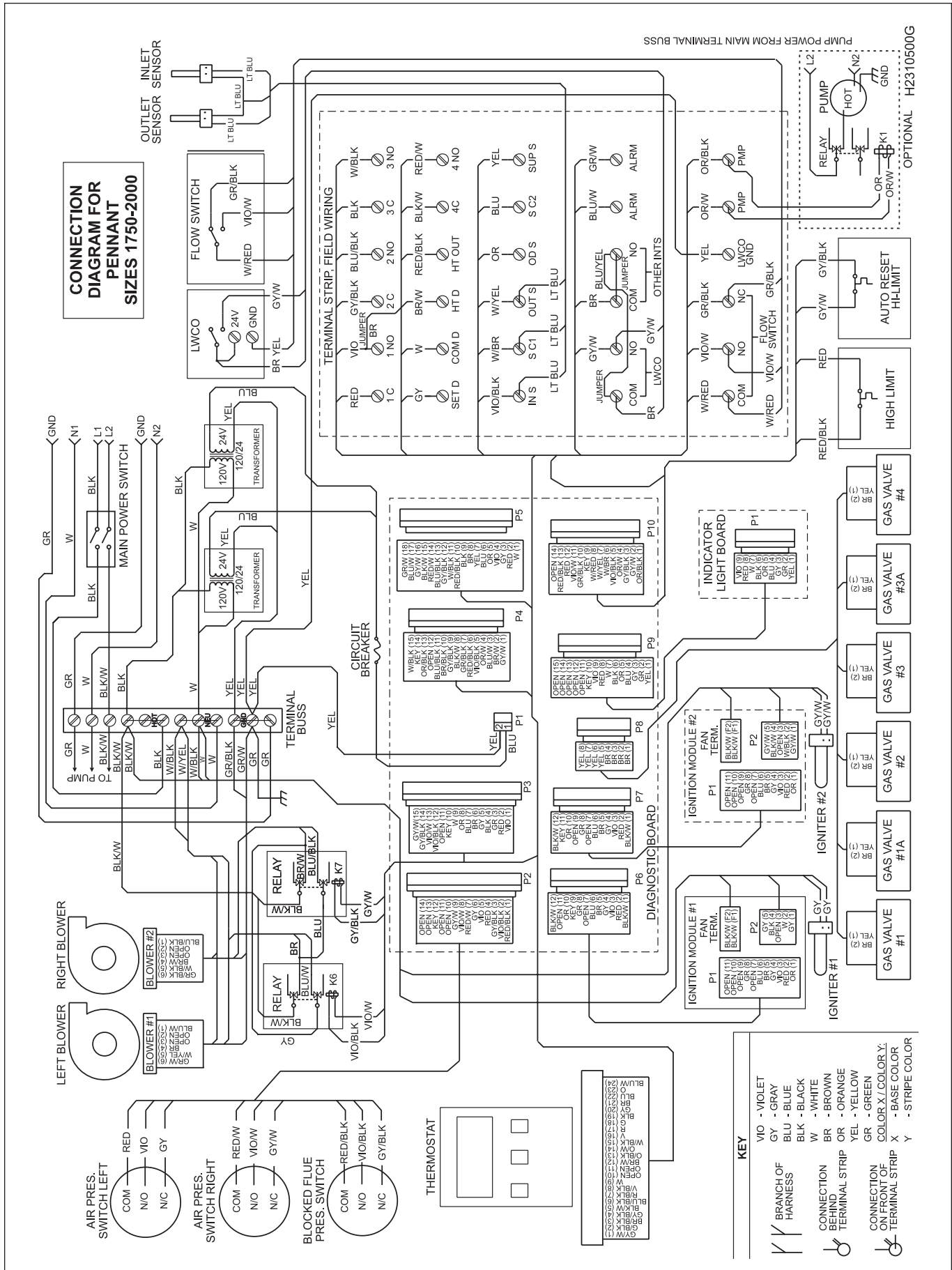
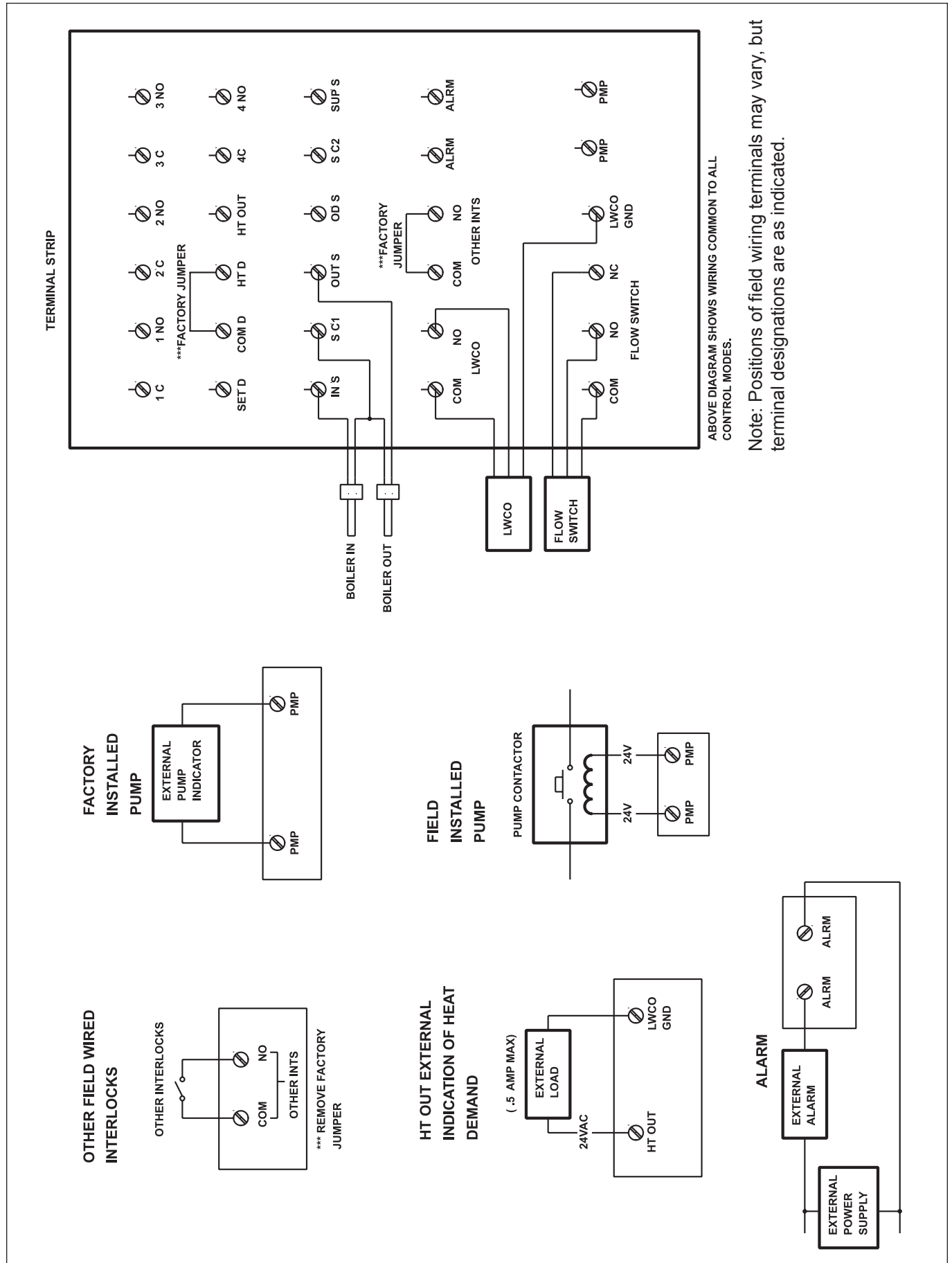


Figure 21. Pennant 1750 - 2000 Wiring Schematic.



Note: Positions of field wiring terminals may vary, but terminal designations are as indicated.

Figure 22. Field Wiring.

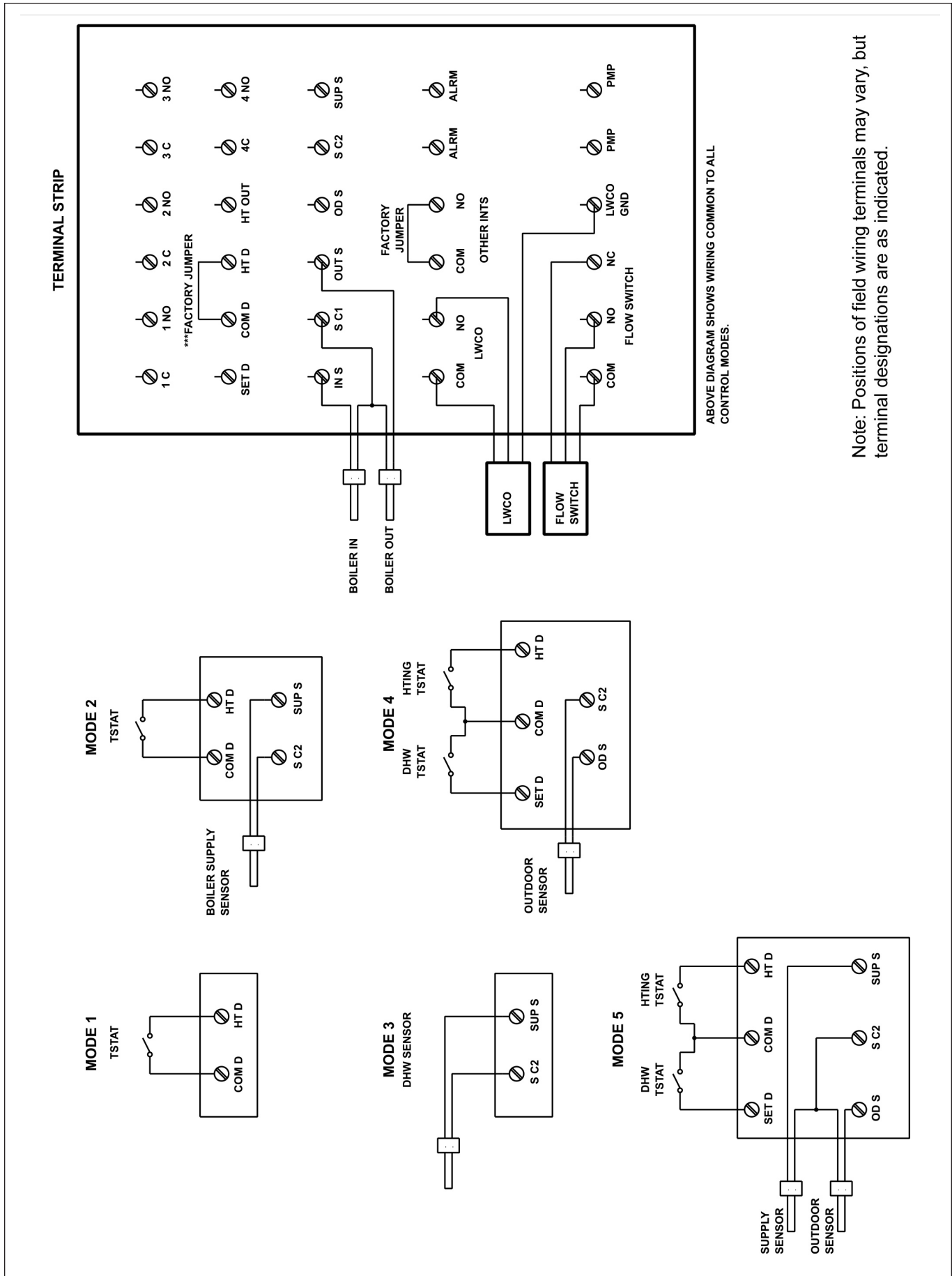


Figure 23. Field Wiring for Modes 1 - 5.

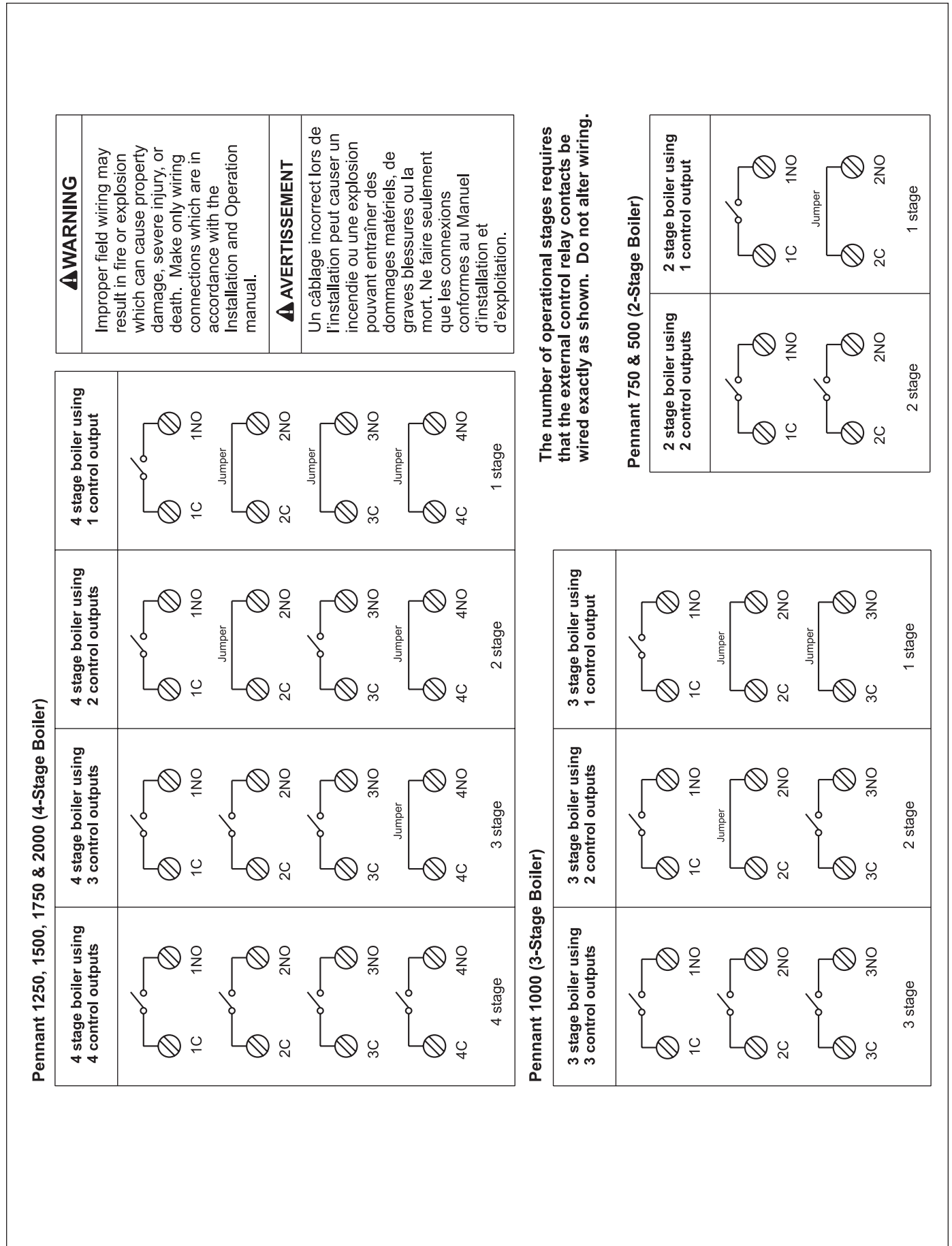


Figure 24. Field Wiring for Mode 6.

SECTION 6. Operating Instructions

6.1 Sequence of Operation

A call for heat can be initiated either automatically (auto mode) under thermostatic control by the Pennant temperature control, or by an external contact closure (manual mode).

In auto mode, the Pennant burner will fire its stages of input to maintain a target temperature programmed into the temperature control. The controller can be programmed per [Section 6.3](#).

In manual mode, an external control will control the Pennant stages, as long as the Pennant control is set to mode 6, and the auto/manual switch (located inside the control compartment) is set to manual.

The amber **READY** light on the front panel indicates that the control system is energized. Upon a call for heat, the green **HEAT** indicator on the front panel will light.

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 **PUMP** indicator on the front panel will light.

Once the water flow switch makes, and 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 20-second period to allow the ignitor to heat.

Energizing the blower pressurizes the air box (which supplies air to the burners) and closes the normally-open contact(s) of the airflow pressure switch(es). This allows the ignition module to proceed with the ignition sequence.

The blocked flue pressure switch senses the pressure in the plenum. It will interrupt the airflow sensing circuit if this pressure exceeds a maximum value. If airflow is not proven, the ignition module will lockout.

The ignition module checks that the ignitor current has reached a minimum value and energizes the gas valve at the end of the ignitor heating period. The green **STAGE 1** indicator on the front panel will light, indicating that the stage 1 gas valve is open.

After a 4-second trial for ignition, the ignitor switches off, and unless a flame is detected by the flame sensor, the gas valve will close and the ignition module will either attempt ignition again (up to three times) or will lockout (if the optional lockout ignition module is used).

If flame is sensed, the burner will continue to fire as long as there is a call for heat. In Auto mode, additional stages are delayed by a minimum of 60 seconds (less prepurge and ignitor warm-up time) and once energized, must fire for at least 30 seconds. The request for additional stages is indicated on the control display, and the energizing of additional burner stages

is indicated by front panel lights.

If there is a subsequent loss of flame signal, the burner will attempt re-ignition up to three times (only once if optional lockout ignition module is used.)

When the call for heat is satisfied, the gas valve(s) closes and the blower(s) continues to run for 30 seconds. The pump will continue to run for a minimum of 20 seconds and up to a programmable maximum of 10 minutes.

If a call for heat is prevented from being satisfied either by a safety interlock or due to an ignition lockout, the red **SERVICE** indicator on the front panel will light. To reset the standard ignition module, the reset button on the module must be pressed. Interrupting power to this module will not reset the lockout.

The Pennant 1000–2000 models have two ignition modules that control different burners. If one module should fail for any reason, the remaining module can operate its burner(s) independently.

6.2 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 four (4) seconds, and then will de-energize. The unit 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.

6.3 Programming the Temperature Control

The same temperature control is used on all versions of the Pennant (in two-and four-stage configurations), providing maximum flexibility to meet the needs of any system. Before start-up, you must program the temperature control for the type of system you have. You must determine the type of piping the system has, the mode the temperature control will operate in, and the various settings for that mode.

6.3.1 System Piping

“Primary Secondary Piping”

In the context of these instructions, “primary

secondary piping” means the boiler provides heat to a plumbing loop that has, in turn, one or more plumbing loops connected to it, which provide heat to radiant tubing, radiators, DHW heat exchangers, etc. This plumbing loop is the “primary loop.”

In primary secondary piping modes, the temperature control monitors the primary loop temperature. The extra sensor that is shipped loose with Pennant is installed in the primary loop. The temperature control fires the boiler stages to provide the “target temperature” at that sensor. Over time, the temperature control will learn the system curve and adjust the firing of the stages to meet the demand in the most efficient way.

For complex systems, with variable speed injection circulators, multiple temperature zones, etc., you may need to consult with a qualified engineer or Laars Applications Engineering.

“Parallel Piping”

The term “parallel piping” means the Pennant is supplying heat directly to one or more storage tanks, radiators, radiant zones, etc., plumbed in series. In these systems, the target temperature is the boiler's outlet temperature. An exception is for domestic hot water systems using mode 3, where the extra sensor is placed in the tank.

6.3.2 Choosing the Mode

There are six modes of operation for the Pennant temperature control. The loose sensor must be installed and connected prior to programming the temperature control, as it provides sensing the “target” temperature. The location of the sensor is dependent on the type of piping used. [Figures 4 through 8](#) show suggested locations for the temperature sensor in various hydronic piping configurations.

Modes 1 through 5 are the automatic modes, requiring the diagnostic panel's AUTO/MAN switch (located on the slide-out control drawer) to remain in the default AUTO position. These modes enable the temperature control to fire the Pennant's stages to meet the demand of the system. In these modes, the Pennant temperature control continuously samples the inlet, outlet and target temperatures.

Mode 6 is the manual mode, and the AUTO/MAN switch must be moved to the MAN position. An external control, such as a building automation system or multiple boiler control, just be wired to the field wiring panel in order to fire the boiler, bypassing the temperature control (see [Section 5.3](#) for important information about external staging controls and building automation systems).

[Table 11](#) contains information to identify the mode you should use for your system.

6.3.3 Programming

Before programming, you must determine the type of piping you have, the mode you will use, and

install the extra sensor *if required* for that mode. See **Sections 6.3.1 and 6.3.2** for more information, or contact the factory.

There are three black programming buttons on the Temperature Control (see **Figure 25**). Press and hold all three programming buttons until the word **ADJUST** appears in the upper right corner of the LCD display (it replaces the word **VIEW**).

Pressing **ITEM** cycles you through the items you need to program. **UP ARROW** increases the value of that item, while **DOWN ARROW** decreases it. **ADJUST** mode exits if you don't press a button for 20 seconds. To return to **ADJUST** mode, simply press and hold the three buttons again.

The first item is **MODE**; enter the mode number as determined above. The Temperature Control will then present you with some or all of the following options, depending on the mode you have chosen:

In mode 6 (external boiler control), you will not see the following options. Refer to **Section 6.4.10** for setup information for mode 6.

APPLICATION	MODE SETTING	SYSTEM SENSORS USED
<ul style="list-style-type: none"> Parallel piping (non-primary/secondary) hydronic system DHW with or without a tank aquastat 	1	<ul style="list-style-type: none"> None
<ul style="list-style-type: none"> Primary/secondary hydronic system (preferred by Laars) No outdoor reset 	2	<ul style="list-style-type: none"> Laars System Sensor (shipped with each Pennant)
<ul style="list-style-type: none"> Parallel piping (non-primary/secondary) hydronic system DHW Advanced control capability No outdoor reset 	3	<ul style="list-style-type: none"> Laars System Sensor (shipped with each Pennant)
<ul style="list-style-type: none"> Parallel piping (non-primary/secondary) hydronic system Advanced control capability Outdoor reset 	4	<ul style="list-style-type: none"> Laars outdoor reset sensor (optional part #R2014000)
<ul style="list-style-type: none"> Primary/secondary hydronic system (preferred by Laars) Outdoor reset 	5	<ul style="list-style-type: none"> Laars System Sensor (shipped with each Pennant) Laars outdoor reset sensor (optional part # R2014000)
<ul style="list-style-type: none"> Building automation control Multiple boiler system control Energy management system Other external control 	6	<ul style="list-style-type: none"> None

Table 11. Modes and Sensors for Applications.

FOR ALL OTHER MODES:

BOIL MASS (Boiler Mass): Always choose “1”.

BOIL TARGET (Boiler Target Temperature): Your desired set-point temperature. See **Section 6.4.5** and **Figure 26** for more information.

BOIL MIN (Boiler Minimum Temperature): This setting tells the Temperature Control to maintain at least this temperature, even if the PID logic determines a lower setting would save energy. The BOIL MIN should always be 120°F (49°C) or higher to prevent condensation, and can be set up to 10°F below your BOIL TARGET temperature. See **Section 6.4.3** for more information.

BOIL MAX (Boiler Maximum Temperature): This setting tells the Temperature Control to limit the maximum outlet temperature to this setting or below, and determines how quickly the temperature control “stages down” or off. If the BOIL MAX setting is much higher than the BOIL TARGET temperature, the temperature control will fire all stages until the target temperature is reached, and then shut down all stages at once. To enable gradual staging down of the boiler as you approach your target temperature, set the BOIL MAX to the same setting as the target temperature. See **Section 6.4.4** for more information.

DIFF (Boiler Differential): This setting is divided above and below the target temperature. The water will be allowed to cool ½ this setting below the target temperature before first stage fires, and will heat to ½ this setting above the target temperature before staging the boiler down. See **Section 6.4.1** and **Figure 28** for more information.

PUMP DLY (Pump Delay): On pump mounted units, the boiler mounted pump continues to run for the time selected after the *heat demand in the system is satisfied*. This setting also affects the 24VAC output on the “PMP” “PMP” terminals (see **Section 5.2**).

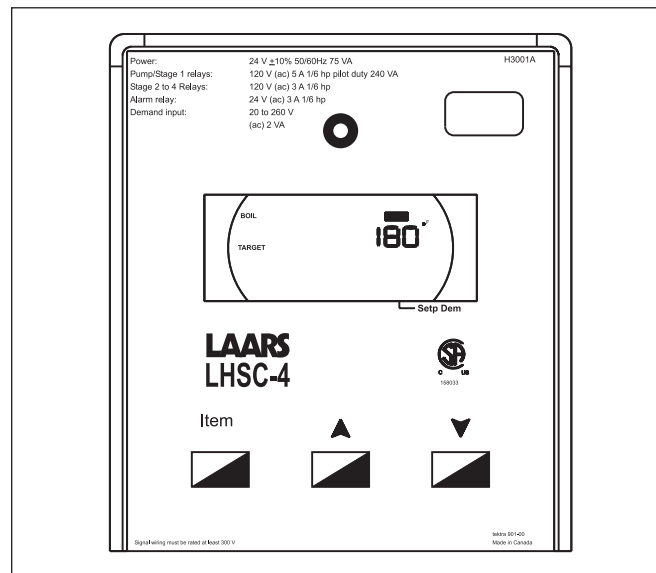


Figure 25. Temperature Control.

These terminals can power a contactor for a larger system pump. Laars recommends a minimum pump delay setting of 5 minutes. See [Section 6.4.6](#) for more information.

NOTE: In modes other than mode 6, the pump will run continuously if the “HtD” and “ComD” terminals are jumpered and not connected to a zone valve or pump end switch, or other “contact closure” device to indicate when the heat demand in the system is satisfied. The pump will never run, and the boiler will never fire, if the jumper is removed and the terminals left empty.

OUTDOOR RESET (modes 4 and 5): Outdoor reset adjusts the target temperature based on the outdoor air temperature and reset ratio. The reset ratio is determined from the Boiler Start, Boiler Design, Outdoor Start and Outdoor Design settings.

HEAT DEMAND – For heat demand to exist, there must be continuity between the Com D (common demand) and Ht D (heat demand) terminals. The Pennant ships with a jumper between these terminals.

The control also evaluates the sensor(s) installed in the system. If the control is not in warm weather shutdown (WWSD), and the sensor(s) are below the target temperature, the “Dem” segment is turned on in the display. The control energizes the pump (on pump mounted boilers) and energizes both “PMP” terminals. The pump symbol appears in the display (see [Figures 25 and 26](#)). The control then operates the stages to maintain the setpoint temperature.

Boil Start (Boiler Start): The BOIL START temperature is the theoretical boiler supply temperature that the heating system requires when the outdoor air temperature equals the OUTDR START temperature setting.

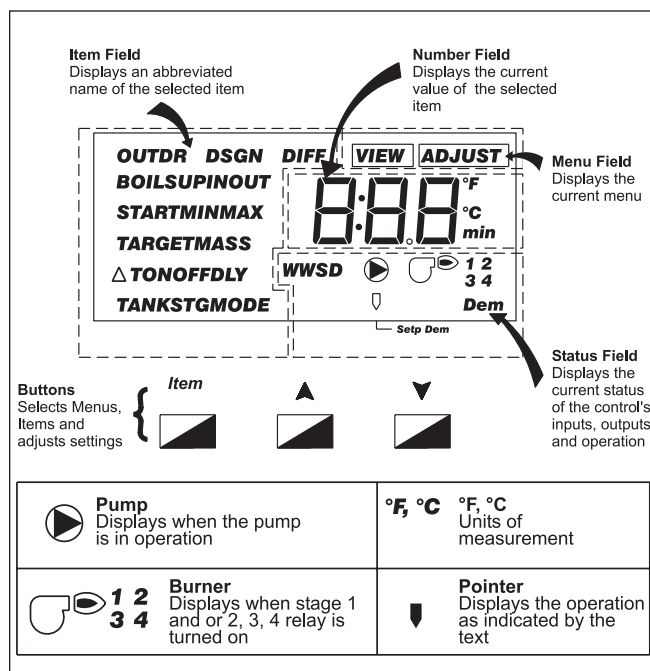


Figure 26. Temperature Control Symbol Description.

EXAMPLE 1

DHW (Mode 3) Programming. For domestic hot water systems up to 175°F / 79°C, use mode 3 as described below.

Step 1: Install the additional sensor into the storage tank, wiring it to “SC2” and “SUPS” terminals on the field wiring panel ([Figure 23](#)).

Step 2: Press the three programming buttons to enter **ADJUST** mode ([Figure 25](#)). Press **ITEM** to select the programming item, and the arrow keys to adjust the setting. **TARGET TANK** is desired tank temperature. Recommended settings with a desired tank temperature of 125°F:

Example DHW Programming

Item	F°	C°
MODE	3	3
BOIL TARGET	140°F	60°C
TARGET TANK	125°F	52°C
DIFF TANK	2°F	1°C
BOIL MASS	1	1
DIFF	2°F	1°C
DLY	5:00	5:00
F°	F°	°C

Step 4: See [Section 6.4.11 Limit Controls](#). Set both high limits 25°F / 14°C higher than **BOIL TARGET** to allow for temperature rise across heat exchanger. Manual high limits on water heaters have a maximum 200°F / 93°C setting. (If water must be at 175°F / 79°C or higher with a volume water heater model, use mode 1. For volume water applications exceeding 200°F / 93°C, contact the factory.)

Fine tuning: For faster staging, increase **BOIL TARGET** setting. Larger **DIFF TANK** and **DIFF** settings will slow response to demand, but may save energy.

If unit short cycles, enter Advanced Programming mode ([Section 6.4](#)) and increase **BOILER MAX** setting to the **BOIL TARGET** setting or higher. Set **BOILER MIN** to 120°F / 49°C, and **STGMODE** to **PID**. See [Section 6.4.12 Advanced Programming Mode](#) to enter Advanced Programming mode, or contact the factory for assistance.

EXAMPLE 2

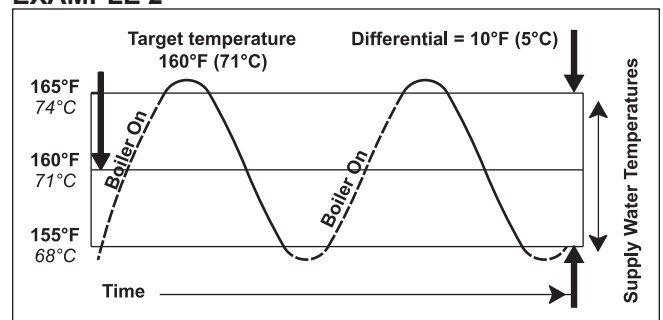


Figure 27. Temperature Control Target Temperature Graph.

Hydronic Primary/Secondary (Mode 2)

Programming. Mode 2 is used in primary-secondary piping hydronic systems without outdoor reset. Mode 5 adds outdoor reset.

Step 1: Install the additional sensor in the primary loop (see [Figure 4](#)), and wired to the “SC2” and “SUPS” terminals on the field wiring panel ([Figure 23](#)).

Step 2: Remove the factory-installed jumper between the “HtD” and “ComD” terminals on the field wiring panel ([Figure 14](#)), and connect a zone valve or pump end switch or other contact closure device (aquastat, etc.) to these terminals to provide an indication of heat demand in the system.

Note: The boiler must have an indication of heat demand to fire. If a zone valve or pump end switch is not connected to the “HtD” and “ComD” terminals, the jumper must be left in place. However, the boiler pump (if equipped) and any pump connected to a contactor wired to the PMP-PMP terminals on the field wiring panel will run *continuously* and not cycle off according to the setting for the Pump Delay. In addition, the LCD screen will always show “dem” (demand) and will not allow cycling of the display to verify all the sensor settings.

Step 3: Press the three programming buttons to enter **ADJUST** mode ([Figure 25](#)). Press **Item** to select the programming item, and the **ARROW** keys to adjust the setting. See [Section 6.3 Programming the Temperature Control](#) if more programming instructions are needed.

Recommended settings for hydronic system with 180°F / 83°C primary loop temperature:

Item	F°	C°
MODE	2	2
BOIL TARGET	180	83
BOIL MASS	1	1
DIFF	20	10
DLY	5:00	5:00
F°	F°	°C

Step 4: See [Section 6.4.11 Limit Controls](#). Set both high limit controls at least 25°F / 14°C higher than the **BOIL TARGET** to allow for temperature rise across the heat exchanger.

6.3.4 Choosing the Mode for your Application

This section describes various applications and the recommended field wiring and Mode selections.

Mode 1: Boiler operates using its own inlet and outlet sensors only, not relying on a remote thermostat, aquastat, or external sensor.

This setup is most commonly found in domestic

hot water applications with a continuous run pump. This is not recommended for other applications.

The Pennant is shipped with a jumper between the “Com D” and “Ht D” terminals, which must remain in place to allow the unit to fire. The unit will fire whenever the outlet temperature cools below the target temperature.

Important Note: If the Pennant is pump-mounted at the factory, or if a field-supplied pump contractor is connected to the Pennant’s pump contactors (Pmp Pmp), the user **must** program the controller’s pump delay (DLY) setting to ON. When ON is selected, pump operation is continuous. The unit’s inlet and outlet sensors must be able to detect the temperature in the storage tank in order to control it. Without the tank water continuously running through the heater, the heater will have no way of knowing what the temperature in the tank is, and will not be able to respond to a change in tank temperature. Short cycling or lack of hot water may result if the pump does not run continuously.

Mechanical aquastat in a domestic hot water storage tank.

Remove the jumper from the “Com D” and “HtD” terminals and connect the aquastat’s leads to these terminals. This connection uses a standard, non-powered mechanical aquastat. When the aquastat calls for heat, the Pennant’s temperature control will respond and start the boiler pump (if equipped) and fire the boiler.

If the Pennant is not a pump mounted model, a 24VAC pump contactor may be connected to the “PMP” terminals to control a field installed pump. (If desired, the pump can run continuously, with the aquastat telling the heater when to fire.)

Program the temperature control to use Mode 1. The AUTO/MAN switch must be in the AUTO position in this mode.

Mode 3: Laars R2014800 sensor installed in the domestic hot water storage tank.

The Pennant ships with a jumper between the “Com D” and “Ht D” terminals. Verify this jumper is in place, and connect the sensor leads to the “S C2” and “SUP S” terminals. When the sensor detects a temperature below the target temperature, the control will respond and start the heater pump (if equipped) and fire the heater.

If the heater is not a pump mounted model, a 24VAC pump contactor may be connected to the “PMP” terminals to control a field installed pump. (If desired, the pump can run continuously).

Program the temperature control to use Mode 3. The AUTO/MAN switch must be in the AUTO position in this mode.

⚠ Caution

If the tank temperature control is set too high, a potential for hot water scalding may exist.

Mode 2: Primary secondary piping.

Install a “supply sensor” in the primary loop using the Laars part number R2014800 sensor (included with every Pennant unit). Connect the sensor to the “S C2” and “SUP S” terminals.

You must provide an indication of the system’s heat demand by removing the jumper across the “ComD” and “HtD” terminals on the field wiring panel and connecting a zone valve or zone pump end switch, thermostat, aquastat or other contact closure to these terminals. If the “ComD” and “HtD” terminals are left jumpered, the control will always see a heat demand and remain in “Dem” mode, with the boiler pump running continuously. See [Section 5.2](#) for more information.

A secondary aquastat, such as for a separate heat exchanger for DHW, can be connected to the “Set D” and “Com D” terminals. A call for heat from these controls will start the boiler pump and cause the boiler to fire.

If the boiler is not a pump mounted model, a 24VAC pump contactor may be connected to the “PMP” terminals to control a field installed pump.

Program the temperature control to use Mode 2. The AUTO/MAN switch must be in the AUTO position in this mode.

Mode 4: Hydronic outdoor reset system without primary / secondary piping.

Laars strongly suggests the use of primary secondary piping with the Pennant boiler. This piping style best ensures that the Pennant will have proper water flow. However, non-primary secondary methods can be used successfully, so this section has been included.

Install the outdoor reset sensor, Laars part number R2014000, and connect the leads to the “OD S” and “S C2” terminals.

You must provide an indication of the system’s heat demand by removing the jumper across the “ComD” and “HtD” terminals on the field wiring panel and connecting a zone valve or zone pump end switch, thermostat, aquastat or other contact closure to these terminals. If the “ComD” and “HtD” terminals are left jumpered, the control will always see a heat demand and remain in “Dem” mode, with the boiler pump running continuously. See [Section 5.2](#) for more information.

Reset Override: An additional thermostat or aquastat may be connected to the “Set D” and “Com D” terminals. A call for heat from either of these controls will start the boiler’s pump and cause the boiler to fire.

If the boiler is not a pump mounted model, a

24VAC pump contactor may be connected to the “PMP” terminals to control a field installed pump.

Program the temperature control to use Mode 4. The AUTO/MAN switch must be in the AUTO position in this mode.

Mode 5: Primary secondary piping with outdoor reset.

Install the outdoor reset sensor, **Laars part number R2014000**, and connect the leads to the “OD S” and “S C2” terminals. Install a “supply sensor” in the primary loop using the **Laars part number R2014800 sensor** (included with every Pennant unit). Connect the sensor to the “S C2” and “SUP S” terminals.

You must provide an indication of the system’s heat demand by removing the jumper across the “ComD” and “HtD” terminals on the field wiring panel and connecting a zone valve or zone pump end switch, thermostat, aquastat or other contact closure to these terminals. If the “ComD” and “HtD” terminals are left jumpered, the control will always see a heat demand and remain in “Dem” mode, with the boiler pump running continuously. See [Section 5.2](#) for more information.

A secondary aquastat, such as for a separate heat exchanger for DHW, can be connected to the “Set D” and “Com D” terminals. A call for heat from these controls will start the boiler pump and cause the boiler to fire.

If the boiler is not a pump mounted model, a 24VAC pump contactor may be connected to the “PMP” terminals to control a field installed pump.

Program the temperature control to use Mode 5. The AUTO/MAN switch must be in the AUTO position in this mode.

Mode 6: Boiler with external staging control (multiple boiler control, building automation system, energy management system, etc.)

Leave the jumper installed between “Ht D” and “Com D” terminals. There are terminals on the field wiring panel that must be wired per the instructions in [Section 5.3](#) of this manual. **Other wiring methods may be unsafe. The wiring in Section 5.3 of this manual must be used.**

The AUTO/MAN switch is located on the circuit board in the slide-out control panel on the front of the Pennant. This switch is placed in the manual position (MAN) when an external control is controlling the Pennant stages.

Program the temperature control to use Mode 6. Mode 6 tells the Pennant control that an external staging control is being used.

6.4 Advanced Topics

For most installations, [Section 6.3](#) provides all the information required to set up the Pennant boiler, and this section should be skipped. Continue setup in [Section 6.5](#).

This section provides definitions of the programming parameters, advanced programming topics, and other information that may be of interest.

Advanced programming mode allows the installer to set the temperature control for proportional staging. In advanced programming mode, the interstage differential, interstage delay, interstage on and off delay, and minimum time on and off are all set manually.

NOTE: Advanced programming mode is not required in most applications, and is intended for advanced installers only.

To enter advanced programming mode, remove the bezel on the temperature control by pulling out at the bottom. Remove the small phillips head screw to access the dip switch. The dip switch is mounted on a circuit board. Locate the letter “A” *on the circuit board* and slide the corresponding dip switch toward the letter “A”. The default setting of this dip switch is toward the OFF lettering on the circuit board.

6.4.1 Differential

Differential has an abbreviated name of DIFF. An on/off heat source must be operated with a differential in order to prevent short cycling. The differential is divided around the boiler target temperature (see [Figure 28](#)). The first stage contact will close when the water temperature at the operating sensor is one-half of the differential setting below the target temperature. It will open when the water temperature at the operating sensor is one-half of the differential setting above the target temperature. The remaining stages will operate sequentially, based on the staging mode selected.

6.4.2 Staging Mode

The Pennant 500 and 750 control operates two stages. The Pennant 1000 control operates three stages. The Pennant control for models 1250–2000 operates four stages. The method of staging used by the control is either P (proportional) or PID (proportional & integral & derivative), and is selected using the **STGMODE** item in the **ADJUST** menu.

Proportional (P) – Proportional staging, also known as step staging, is based on manually adjusted settings which determine when the next stage is required to turn on. These manual settings are based on temperature and time. The interstage differential sets the temperature drop at which the next stage turns on. However, in order for a stage to fire, the interstage delay on and minimum off times must first elapse.

Interstage Differential (STG DIFF) – The

interstage differential is the temperature drop at which the next stage will turn on. Once a stage turns on, the next stage cannot turn on until the temperature drops the interstage differential below the temperature at which the previous stage turned on. The interstage differential is adjustable through the **STG DIFF** setting in the **Adjust** menu (see [Figure 28](#)).

Interstage Delay On (ON DLY) – The interstage delay on is the amount of time that must elapse before turning on the next stage. Once a stage turns on, the next stage cannot turn on until the interstage delay on time elapses. The interstage delay on is adjustable through the **ON DLY** setting in the **Adjust** menu.

Interstage Delay Off (OFF DLY) – The interstage delay off is the amount of time that must elapse before turning off the next stage. Once a stage turns off, the next stage cannot turn off until the interstage delay off time elapses. The interstage delay off is adjustable through the **OFF DLY** setting in the **Adjust** menu.

Minimum On Time (MIN ON) – The minimum on time is the minimum amount time that a stage must be on before it is allowed to turn off. Once a stage turns on, it cannot turn off until a minimum on time elapses. The minimum on time is adjustable through the **MIN ON** setting in the **Adjust** menu.

Minimum Off Time (MIN OFF) – The minimum off time is the minimum amount time that a stage must be off before it is allowed to turn on. Once a stage turns off, it cannot turn on until a minimum off time elapses. The minimum off time is adjustable through the **MIN OFF** setting in the **Adjust** menu.

Proportional & Integral & Derivative (PID) – PID staging allows the control to determine when the next stage is required to turn on. The control automatically determines the settings that are manually selected in proportional staging mode. After each stage is turned on in the firing sequence, the control waits a minimum amount of time before turning on the next

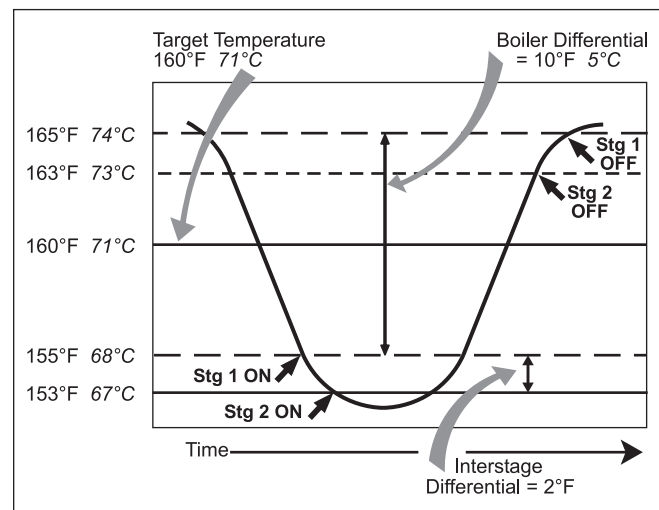


Figure 28. Temperature Control Interstage Differential.

stage. After the minimum time delay between stages has expired, the control examines the control error to determine when the next stage is to fire. The control error is determined using PID logic.

Proportional compares the actual operating sensor temperature to the boiler target temperature. The colder the temperature, the sooner the next stage is turned on.

Integral compares the actual operating sensor temperature to the boiler target temperature over a period of time.

Derivative determines how fast or slow the operating sensor temperature is changing. If the temperature is increasing slowly, the next stage is turned on sooner. If the temperature is increasing quickly, the next stage is turned on later, if at all.

Boiler Mass (BOIL MASS) – The boiler mass setting allows the installer to adjust the control to the thermal mass of different types of heat sources used. The boiler mass setting automatically determines the interstage differential, interstage delay on, interstage delay off, minimum on time and minimum off time of the stages when PID staging is used. A higher thermal mass setting provides slower staging, while a lower thermal mass setting provides faster staging. Pennant boilers and water heaters are low-mass appliances, and therefore, should be used with the lower thermal mass setting. Set **BOIL MASS** to “1”.

6.4.3 Boiler Minimum (BOIL MIN)

The minimum boiler setting (**BOIL MIN**) is the lowest water temperature that the control is allowed

to use as a target temperature. During mild conditions, if the control calculates a target temperature that is below this setting, the target temperature is adjusted to at least the minimum setting. During this condition, if the unit is operating, the MIN segment turns on in the LCD while the target temperature or operating sensor temperature is viewed. For Pennant units, this must be set no lower than 120°F (49°C) to protect the unit from condensing on the heat exchanger (see [Figure 29](#)).

6.4.4 Boiler Maximum (BOIL MAX)

The boiler maximum (**BOIL MAX**) is the highest water temperature that the control is allowed to use as a target temperature. If the control does target **BOIL MAX**, and the boiler outlet sensor is near the **BOIL MAX** temperature, the MAX segment turns on in the LCD while the target, inlet, outlet or supply temperature is viewed (see [Figure 29](#)).

6.4.5 Boiler Target Temperature

The target temperature is determined from the mode of operation. The control displays the temperature that is currently trying to maintain at the operating sensor as **BOIL TARGET** in the View menu. The operating sensor for modes 1, 3 and 4 is the outlet sensor (on the Pennant). The operating sensor for modes 2 and 5 is the supply sensor (in the system or primary loop). If the control does not presently have a requirement for heat, it displays “- -” in the LCD. There is no target temperature generated in mode 6 (external controller mode).

6.4.6 Pump Operation

The pump terminals (Pmp Pmp) are energized with 24 VAC to control a field supplied pump contactor. During setpoint operation (modes 1 and 2), the terminals are energized whenever there is a heat demand. During dedicated DHW operation (mode 3), the terminals are energized whenever there is an internal heat demand. During outdoor reset (modes 4 and 5), the terminals are energized whenever there is either a heat demand and the control is not in Warm Weather Shut Down (WWSD), or whenever there is a setpoint demand. During WWSD, if the pump has not operated at least once every 70 hours, the control energizes the terminals for 10 seconds. This minimizes the possibility of the pump seizing during a long period of inactivity. During External Boiler Operation (mode 6), the pump contact closes whenever there is a heat demand.

Boiler Purge (PUMP DLY) – After a demand is satisfied, the control continues to operate the pump for a period of time. The length of time that the pump continues to run is based on the pump delay setting. Once the last stage of the control turns off, the control keeps the pump contacts energized for the time selected (between 0 and 10 minutes). When OFF is selected, there is no purging. When ON is

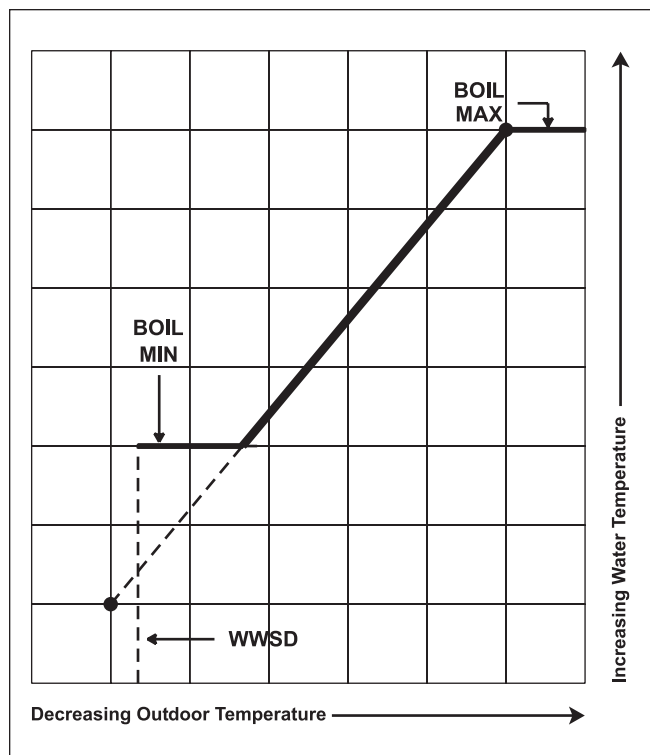


Figure 29. Temperature Control Min & Max.

selected, pump operation is continuous. Also, during outdoor reset, with the pump delay set to ON, the pump continues to run even during Warm Weather Shut Down.

6.4.7 Setpoint Operation

When either mode 1 or 2 is selected, the control controls the water temperature based on a fixed setpoint. The setpoint temperature is set using the **BOIL TARGET** item in the **ADJUST** menu.

Heat Demand – For “heat demand” to exist, there must be continuity between the Com D (common demand) and the Ht D (heat demand) terminals. The Pennant ships with a jumper between these terminals.

The control also evaluates the sensor(s) installed in the system, including the outlet sensor provided on the boiler when using mode 1. When the control senses continuity between Com D and Ht D terminals, and that the sensor reading is below the target temperature, the control will activate the Dem segment in the display.

The control energizes the pump (on pump mounted boilers) and energizes the Pmp Pmp terminals. The boiler pump segment is turned on in the display. The control then operates the stages to maintain the setpoint temperature.

6.4.8 Dedicated Domestic Hot Water

When mode 3 is selected, the control provides dedicated domestic hot water operation.

Internal DHW Demand – A sensor is required to be connected on the SC2 and Sup/S terminals. An internal demand for DHW is generated when the temperature demand for DHW sensor drops $\frac{1}{2}$ of the tank differential setting below the desired DHW tank temperature. The **TANK TARGET** setting is used to set the desired DHW tank temperature.

Once an internal demand is generated, the Dem segment turns on in the LCD. The control then closes the Pmp Pmp contact, which starts the pump and the control turns on the boiler pump segment in the display. The control then operates the stages to maintain the programmed boiler target temperature at the boiler outlet sensor.

The boiler target temperature is set using the **BOIL TARGET** item in the **Adjust** menu. NOTE: External demand is not required in this mode of operation.

Tank Differential – A differential setting that operates $\frac{1}{2}$ above and below the **TANK TARGET** is selectable using the **TANK DIFF** item in the **Adjust** menu.

6.4.9 Outdoor Reset Operation

When either mode 4 or 5 is selected, the control uses outdoor reset to control the water temperature. Outdoor reset adjusts the target temperature based on the outdoor air temperature and reset ratio. The

reset ratio is determined from the Boiler Start, Boiler Design, Outdoor Start and Outdoor Design settings.

Heat Demand – For “heat demand” to exist, there must be continuity between the Com D (common demand) and the Ht D (heat demand) terminals. The Pennant ships with a jumper between these terminals.

The control also evaluates the sensor(s) installed in the system. If the control is not in warm weather shutdown (WWSD), and the sensor(s) are below the target temperature, the Dem segment is turned on in the display. The control energizes the pump (on pump mounted boilers) and energizes the Pmp-Pmp terminals, and the boiler pump segment is turned on in the display. The control then operates the stages to maintain the setpoint temperature.

Boiler Start (BOIL START) – The BOIL START temperature is the theoretical boiler supply water temperature that the heating system requires when the outdoor air temperature equals the OUTDR START temperature setting. The BOIL START is typically set to the desired building temperature (see Figure 30).

Outdoor Start (OUTDR START) – The OUTDR START temperature is the outdoor air temperature at which the control provides the BOIL START water temperature to the system. The OUTDR START is typically set to the desired building temperature.

Outdoor Design (OUTDR DSGN) – The OUTDR DSGN is the outdoor air temperature that is the typical coldest temperature of the year where the building is located. This temperature is used when doing heat loss calculations for the building.

Boiler Design (BOIL DSGN) – The BOIL

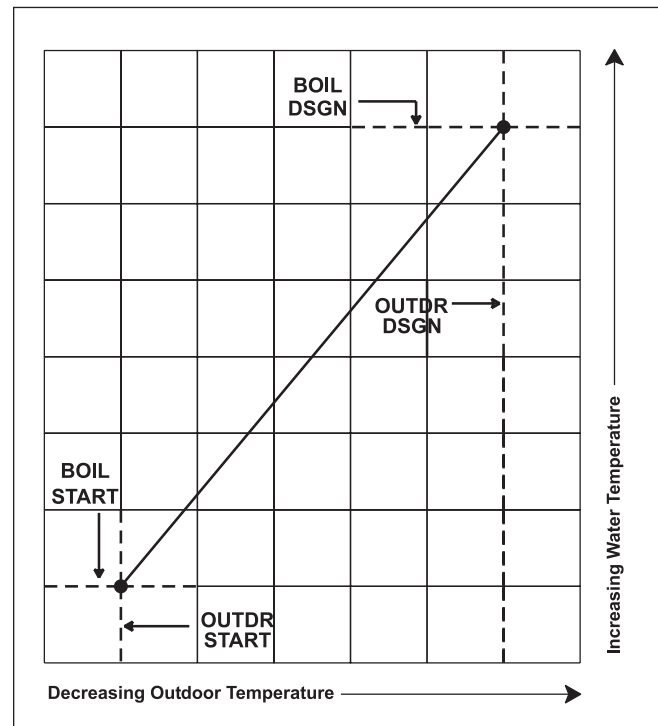


Figure 30. Temperature Control Outdoor Start Graph.

DSGN temperature is the water temperature required to heat the boiler zones when the outdoor air is as cold as the OUTDR DSGN temperature.

Warm Weather Shut Down (WWSD) – When the outdoor air temperature rises above the WWSD setting, the control turns on the WWSD segment in the display. When the control is in WWSD, the Dem segment is displayed if there is a heat demand. However, the control does not operate the heating system to satisfy this demand. The control does respond to a setpoint demand and operates as described in the Reset Override section (next).

Reset Override (SETPOINT DEMAND) – This is used when override of the outdoor reset curve is needed, such as when an indirect water heater is served by the heating system. A setpoint demand is required whenever heat is required for the setpoint load. The setpoint demand overrides the reset water temperature. The control turns on the Setp Dem pointer in the display. The control energizes the pump (on pump-mounted boilers), energizes the Pmp-Pmp terminals, and turns on the boiler pump segment in the display. The control then operates the boiler stages to maintain the programmed boiler target temperature. The reset override operation is not affected by WWSD.

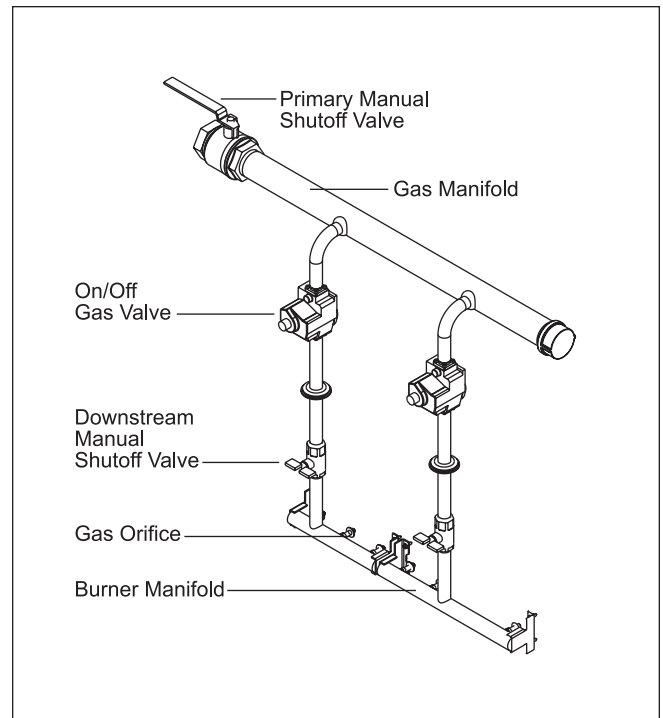


Figure 31. Typical Gas Train Configuration.

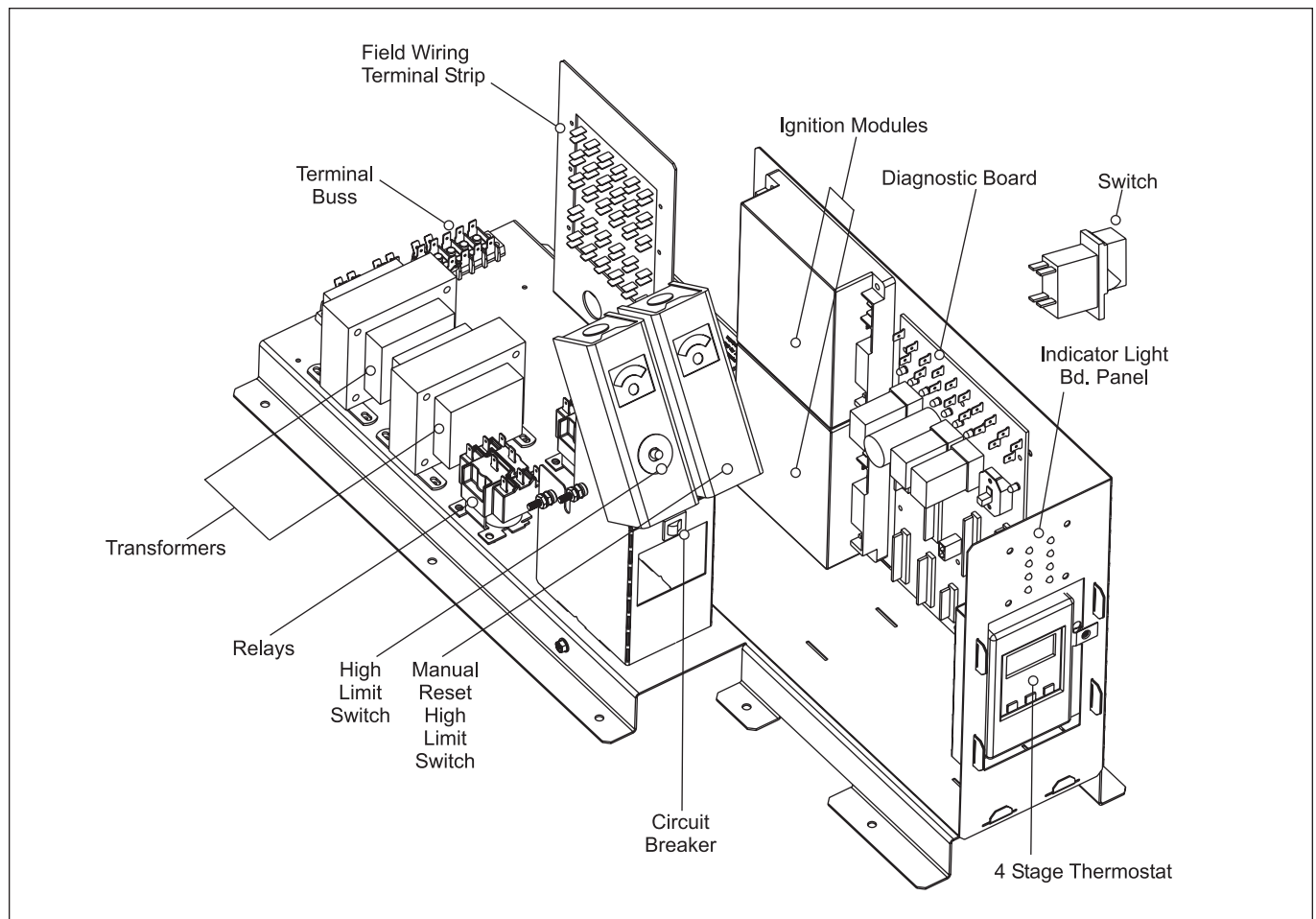


Figure 32. Typical Control Panel.

6.4.10 External Boiler Operation

When mode 6 is selected, the control allows for an external control to operate the Pennant's stages. In this mode, the control operates the pump in order to provide purging and exercising. The staging operation is provided by an external device such as an Energy Management System (EMS) or External Staging Control.

Heat Demand – A heat demand is generated when stage one is wired properly, and the external control closes the contacts on the stage one terminals (1C-1NO), calling the Pennant for heat. The Pennant is shipped with a jumper between the Com D and Ht D terminals, and this jumper must remain in place when an external control is providing the heat demand signal to these terminals. The control energizes the boiler pump (if equipped), energizes the Pmp-Pmp terminals, and turns on the boiler pump segment in the display. The control also turns on stage 1 of the boiler. **Section 5.3** contains important information about external staging controls and building automation systems. **Other wiring methods may be unsafe. The wiring in Section 5.3 of this manual must be used.**

6.4.11 Limit Controls

In addition to the temperature control, Pennant appliances are fitted with a manual reset high limit and an automatic reset high limit. These are located near the rear of the cabinet on the right side, behind the slide out drawer (see **Figure 32**). Both controls should be set at least 25°F higher than the target temperature to avoid short cycling. To set these controls, remove the control panel cover and pull the control panel out to gain access. Appliances with reversed heat exchangers have the limit controls relocated to the left side of the appliance. The left access door must be removed to gain access to the limit controls on these appliances.

6.4.12 Advanced Programming Mode

Advanced programming mode allows the installer to set the temperature control for proportional staging. In advanced programming mode, the interstage differential, interstage delay, interstage on and off delay, and minimum time on and off are all set manually.

NOTE: Advanced programming mode is rarely required. It is intended for advanced installers, and only when the application demands such programming.

To enter advanced programming mode, remove the bezel on the temperature control by pulling out at the bottom. Remove the small phillips head screw to access the dip switch. The dip switch is mounted on a circuit board.

Locate the letter "A" on the circuit board and slide the corresponding dip switch toward the letter "A". The default setting of this dip switch is toward the OFF lettering on the circuit board.

6.5 Operating the Burner and Set Up

6.5.1 Set Up for 0 to 2500 Feet Altitude

The Pennant appliance utilizes a modular design to achieve its stage-firing. 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.

- Using this manual, make sure the installation is complete and fully in compliance with the instructions.
- Determine that the appliance and system are filled with water and all air has been bled from both. Open all valves.
- Observe all warnings on the Operating Instructions label and turn on gas and electrical power to appliance.
- Switch on the appliance power switch located on the right side of the unit.
- 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. Depending on the ignition modules installed, the manual reset button on the ignition modules may need to be depressed to restart the Pennant.
- When the unit is running, the supply gas pressure must be checked. Inlet gas pressure must not exceed 13" w.c. (3.2kPa). The minimum inlet gas pressure is 5" w.c. (1.2kPa).
- 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 2.5" w.c. (0.62kPa).
- Complete the setup by checking the CO₂ at the outlet of the unit. The CO₂ should be 8% for natural gas, or 9.2% for propane.
- After placing the appliance in operation, the Burner Safety Shutoff Device must be tested.** To test:
 - Close gas shutoff valve with burner operating.
 - The flame will go out and blower will continue to run for the post purge cycle. One additional attempt to light will follow. Ignition will not occur as the gas is off. The ignition control will lockout, and will have to be reset 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.

NOTE: Sizes 1000–2000 have two ignition controls and two ignitors, which work independently of one another. If the ignition control for stages 1 and 2 fails to properly light the main burners for those stages, the second ignition control will still be active, and will be able to energize stages 3 and 4. This, of course, will only occur if all other safety devices confirm that the unit will run in a safe condition.

6.5.2 High Altitude Adjustment and Set Up

Pennant appliances may be operated at high altitude (7700 ft., 2347 m) with a reduction in output of approximately 10%. At altitudes of less than or more than 7700 ft. (2347 m) the appliance will perform equally as well, but with differing reductions in output. At elevations higher than 7700 ft. (2347 m) the reduction in output will exceed 10% and at elevations below 7700 ft. (2347 m) it will be less than 10%. 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 gas valve manifold pressure and the air shutter(s). The required instruments used to assist in these adjustments are a CO₂ or O₂ Analyzer and a U-Tube Manometer or other device capable of reading a pressure of 2.5-3.0 inches w.c. (0.62-0.75 kPa).

Start the adjustment process by checking the CO₂ in the “as installed” condition. Adjust the air shutter(s) so that the CO₂ is about 8% or the O₂ is about 6.8% for appliances operating on Natural Gas. For appliances operating on LP Gas adjust the air shutter(s) so that the CO₂ is about 9.2% or the O₂ is about 6.8%. Appliances with two blowers should be adjusted so that the air shutters below each blower are open the same amount.

Once the CO₂ or O₂ has been set, the manifold pressure may be adjusted. Remove the 1/8 NPT plug from the lower side of the gas valve that is to be set and install a fitting, hose and manometer. Start the appliance and observe the manifold pressure. Manifold pressure must be adjusted to 3.0 in. w.c. (0.75 kPa) (for high altitude only, standard operating pressure is 2.5 in. w.c. (0.62 kPa)). It is adjusted by removing the slotted cap on the gas valve and turning the adjustment screw (beneath the cap) clockwise to increase pressure and replaced after the adjustments have been completed and the fitting, hose and manometer have been removed and the 1/8" plug has been replaced. Repeat this process until all gas valves have been set. **Note:** The pressure can be set only when the appliance is operating and only when the particular gas valve

being adjusted is energized by a call for heat from the staging control.

After all of the gas valve manifold pressures have been set, the CO₂ or O₂ must be reset. CO₂ or O₂ will have changed when the manifold pressure was adjusted. Open the air shutter(s) to reduce the CO₂ or O₂ to the values achieved previously.

The procedure is complete when all gas valves are adjusted to a manifold pressure of 3.0 in. w.c. (0.75 kPa) and the CO₂ is adjusted to 8.0% for Natural Gas appliances or 9.2% for LP appliances. When using an O₂ analyzer, the correct O₂ is 6.8% for both Natural Gas and LP appliances.

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.

6.6 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.

6.7 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 prepurge 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, completely remove existing sealing material, and clean with alcohol. Apply new sealing material, and re-assemble.

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.

See [Figures 31 and 32](#) for location of gas train and control components.

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 controls | d. Automatic gas valve |
| b. Ignitors | e. Pressure switches |
| c. Water temperature control | f. Blowers |

7.2.1 Burners

Close main manual gas valve before proceeding. Checking the burners for debris - Remove the ignitor inspection panels(s) and ignitor(s) and inspect the burners through the ignitor hole(s) using a flashlight to illuminate. If there is any indication of debris on the burners that are visible, all the burners will need to be inspected more thoroughly. Remove the screws from around the front of the air box (large panel from which the ignitor inspection panel(s) were removed), and remove the large panel. Remove the gas manifold assemblies and the burner panels. 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 with an 83% arrestance. Since the filter is washable, it will only need replacement when unwashable, deteriorated or damaged. If filter replacement is needed, it should only be replaced with a factory part. Inspect the air filter. If there is debris on the air filter, remove it from the filter box, and wash it with mild soap and water. Ensure that the filter is completely dry before re-installing, in reverse order.

7.2.3 Gas Valves

The gas valves are designed to operate with supply pressures of 4-13 inches 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 top front panel from the unit. Disconnect the wires to the valve. Disengage the flanged fitting before and after the valve, and remove the valve. Re-install in reverse order. Ensure o-rings are properly installed for both inlet and outlet. 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 manual reset switch with an adjustable set point, up to 240°F (116°C) on boiler models and 200°F (93°C) on water heater models and boilers ordered with low temperature controls. To replace the switch, shut off the 120-volt power to the appliance. Remove the cover from the switch to access the mounting screws. Remove the screws, and pull the switch off the control panel. Remove the capillary and bulb from the thermal well located in the header. Replace in reverse order.

7.2.5 Automatic Reset High Limit Control

An automatic reset high limit is used in addition to the manual reset high limit. The high limit switch has an adjustable set point, up to 240°F (116°C) on boiler models and 200°F (93°C) water heater models

and boilers ordered with low temperature controls. To replace the switch, shut off the 120-volt power to the appliance. Remove the cover from the switch to access the mounting screws. Remove the screws, and pull the switch off the control panel. Remove the capillary and bulb from the thermal well located in the header. Replace in reverse order.

7.2.6 Temperature Control

The temperature control is a Laars LHSC. 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.

7.2.7 Ignition Controls

The ignition controls ensure the proved interrupted-type ignition system. They control the hot surface ignitors and prove that the flame signal is appropriate for powering the gas valves. It also controls the blower's pre-purge and post-purge. Pennant sizes 500 and 750 have one ignition control. Sizes 1000 to 2000 have two ignition controls. On sizes 1000, one ignition control controls stages 1 and 2, and the second ignition control controls stage 3. On sizes 1250–2000, one ignition control is for stages 1 and 2, and the other is for stages 3 and 4.

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.

7.2.8 Ignitors

The ignitors used are 120v "Hot Surface" type. They are energized whenever there is a call for heat and switched off when ignition is established and the flame has been sensed. Pennant sizes 500 and 750 have one ignitor. Sizes 1000 to 2000 have two ignitors. To replace the ignitor, shut off the 120-volt power to the appliance, remove the ignitor 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.

7.2.9 Ignition Sensors

The ignition sensors ensure that the main flame is ignited, so that raw gas is not allowed to fill the combustion chamber. Pennant sizes 500 and 750 have one sensor. Sizes 1000 to 2000 have two sensors (one for each ignition control). The ignitors are the ignition sensors on Pennant appliances. There are no separate ignition sensors.

7.2.10 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.

7.2.11 Blowers

The combustion air blowers bring the combustion air for the Pennant from the upper chamber to the lower chamber. Mixing of the gas and air occurs in the burners. Sizes 500, 750 and 1000 each have one blower, and sizes 1250 to 2000 each have two blowers (one blower for stages 1 and 2, and one for stages 3 and 4). If a blower change is required, turn off the 120-volt power and gas supply to the unit. Remove the front panel. Disconnect the blower's wire harness. Remove the screws at the blower flange, and pull the blower out. Replace blower in reverse order, ensuring that all joints are made correctly. After replacement, ensure that the unit operates properly, by following the set-up procedure in this manual.

7.2.12 Flow Switch

The Pennant uses a paddle-type flow switch to ensure that the unit has water flow before ignition is allowed.

7.2.13 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.

The Pennant has a pre-mixed 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 both sides of the boiler. They are located below the headers, and are accessed by opening the small round cover that is attached by one screw. 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 header flanges from inlet and outlet.

6. Allow the heat exchanger to drain. Remove the front cover(s) by removing the rubber access strip(s) and the retaining screws. Remove the venting and remove the top, by removing the screws that attach the top to the side panels. Remove the side panels. Remove the front lower panels sealing the combustion area. To remove the gas train, disconnect the unions located below the intermediate pan and the field installed union located outside the cabinet, and pull up, bringing the union end connectors through the grommets in the intermediate pan. To remove the intermediate pan, remove the slide out control assembly and blower(s) to reveal the screws. Remove the screws holding the intermediate pan, and lift up to remove it. The heat exchanger has integral metal sections attached, which connect to the frame of the boiler. Locate and remove the screws along the front, rear and bottom of the integral metal sections, and remove the heat exchanger and metal sections by lifting up. On the larger appliances, a center heat exchanger support must be unbolted before it can be removed.
7. Remove the heat exchanger from the unit.

NOTE: The 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. Do not use water or compressed air for cleaning.
9. 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. Laars offers a tube cleaning kit **part number R0010000**.
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.

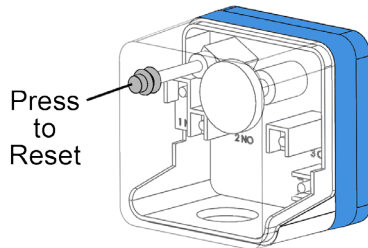
SECTION 8. Trouble Shooting

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.

If your boiler is equipped with the optional gas pressure switches, then the Low Pressure switch might have tripped and will need to be reset.



Then, restart the boiler and observe the operational cycle. After a 15-second fan pre-purge, the ignitor will heat up for 20 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" w.c. (1.2kPa) 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.

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 O₂ or CO₂). Pennant appliances operate best with 45% excess air (8% CO₂ on natural gas, 9.2% CO₂ on LP). Check the CO₂ 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

Because the Pennant is a stage-fired boiler, and its input will decrease when there is a reduction in heating load, short cycling is greatly reduced. If the heating load drops below the minimum input of the boiler for an extended period, the boiler will have a tendency to short cycle. This can be a symptom of improper control strategy or setpoints, or a load distribution problem. See [Section 6.3](#) regarding controller setup. 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. Because the Pennant is a stage-fired water heater and its input will reduce when there is a reduction in heating load, short cycling is greatly reduced. 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. See [Section 6.3](#) regarding controller setup.

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 CO₂ is high (or O₂ is low), appliances operating with low CO₂ or high O₂ (especially LP appliances) consume more gas. Adjust the CO₂ or O₂ for optimum efficiency. If no combustion analyzing equipment (CO₂ or O₂) is available then a proper adjustment of the air/fuel ratio (CO₂ or O₂) cannot be accomplished. However, by briefly sniffing the flue gases it is possible to determine if the CO₂ or O₂ is within the proper range. No significant flue gas odor should be detected when combustion is proper. A strong piercing smell indicates poor combustion and generally a lean mixture - low CO₂ or high O₂. The CO₂ should be 8% at high fire. To check the CO₂, first verify that the supply gas pressure is within 5" to 13" w.c. (1.2 to 3.2 kPa) With the Pennant running with all stages firing, set the air box pressure to 1.5" w.c. (0.37

kPa) (as a starting point), by adjusting the air shutter(s) at the bottom of the fan(s). Check the CO₂, and adjust the air shutters if further adjustment to the CO₂ is needed. Sizes 1250 to 2000 have two blowers and two air chambers (boxes). The pressure of each air box must be equal when the final adjustment is made.

8.6 Troubleshooting the Temperature Control

See [Table 12](#).

8.7 Troubleshooting Pennant Controls

The Pennant series consists of two 2-stage models (500 and 750), one 3-stage model (1000), and four 4-stage models (1250 to 2000). The 2-stage models have one ignition module, and the 3- and 4-stage models have two ignition modules capable of independent operation.

A diagnostic panel, that includes test points, as well as diagnostic lights, is provided in the control module. It is located on the right side of the module, behind the display. To access, remove the retaining screws from the display cover panel and remove it. Grasp the control module at its base and pull it outward. Ladder diagrams are shown in [Figures 16 through 18](#). Voltage test points on the diagnostic panel are indicated by solid circles connected by short diagonal lines.

[Figure 16](#) shows the diagram for the 2-stage sizes 500 and 750. These have one blower and one ignition module. The blower is energized directly through the “inducer” terminals F1 and F2 of the (Fenwal) ignition module. The 24V power to the 2nd stage gas valve is routed through the 1st stage VALVE terminal, so that stage 2 cannot fire unless the stage 1 gas valve is open. The 750 differs from the 500 only in that the 750 has two gas trains in stage 1, while the 500 has only one.

The ladder diagram for the size 1000 is shown in [Figure 17](#). Ignition module #1 handles stages 1 and 2, and ignition module #2 handles stage 3. The single blower is energized directly through the “inducer”

terminals of either ignition module. The 24V power to the T’STAT terminal of both ignition modules is routed through the safety interlocks.

The ladder diagram for sizes 1250 to 2000 is shown in [Figure 18](#). These 4-stage models have two ignition modules, each with its own blower, and each controlling 2 stages. The blowers are energized by the ignition modules indirectly via switching relays. When either ignition module receives a call for heat, it switches its blower to high speed and the blower of the idle ignition module to low speed.

The wiring schematics for the Pennant 500 – 1000 are shown in [Figure 19](#), the schematics for the 1250–1500 are shown in [Figure 20](#), and [Figure 21](#) shows the schematic for 1750–2000. All 24V wiring is routed through the diagnostic PC board. Wiring harnesses connect between the diagnostic PC board and the control components, indicator board, or field wiring terminal strip. The diagnostic board contains LEDs that indicate open status of the safety interlocks, and quick-connect terminals that provide tests points for checking voltage/continuity at various points in the control circuit. Line-voltage connections are routed via the line-voltage terminal buss.

Certain control elements that may need to be re-wired in the field are connected via the field wiring terminal strip rather than to the diagnostic PC board. These include the low-water cutoff (LWCO), water flow switch, and inlet/outlet water temperature sensors.


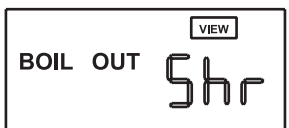
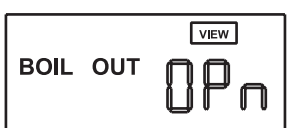
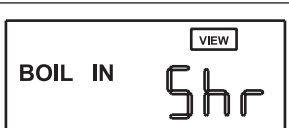
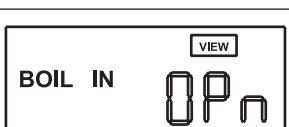

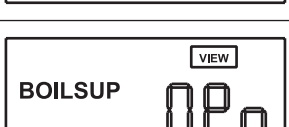
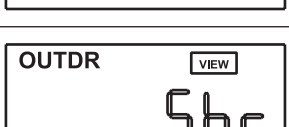
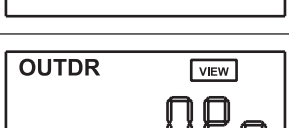
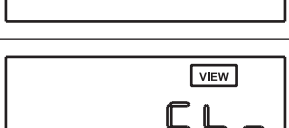
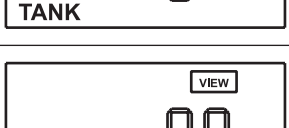
ERROR DISPLAYED	DESCRIPTION OF ERROR
	<p>The control was unable to read a piece of information from its EEPROM. The control will stop operation until all settings in the Adjust menu have been checked by the user or installer.</p>
	<p>The control is no longer able to read the boiler outlet sensor due to a short circuit. In this case, if the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the boiler stages.</p>
	<p>The control is no longer able to read the boiler outlet sensor due to an open circuit. In this case, if the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the boiler stages.</p>
	<p>The control is no longer able to read the boiler inlet sensor due to a short circuit. In this case, the control will continue operation.</p>
	<p>The control is no longer able to read the boiler inlet sensor due to an open circuit. In this case, the control will continue operation.</p>
	<p>The control is no longer able to read the boiler supply sensor due to a short circuit. In this case, if the boiler outlet sensor is present and operational, the control will operate based on the boiler outlet sensor. If the boiler outlet sensor is not available and the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the boiler stages.</p>
	<p>The control is no longer able to read the boiler supply sensor due to an open circuit. In this case, if the boiler outlet sensor is present and operational, the control will operate based on the boiler outlet sensor. If the boiler outlet sensor is not available and the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the boiler stages.</p>
	<p>The control is no longer able to read the outdoor sensor due to a short circuit. In this case, the control assumes an outdoor temperature of 32°F and continues operation.</p>
	<p>The control is no longer able to read the outdoor sensor due to an open circuit. In this case, the control assumes an outdoor temperature of 32°F and continues operation.</p>
	<p>The control is no longer able to read the tank sensor due to a short circuit. In this case the control will not operate the boiler stages.</p>
	<p>The control is no longer able to read the tank sensor due to an open circuit. In this case the control will not operate the boiler stages.</p>

Table 12. Troubleshooting Error Codes.

Item	Description	Size	Size	Size	Size	Size	Size	Size	Size
		500	750	1000	1250	1500	1750	2000	
36	Tile, Rear	T2015700 (1)							
37	Tile, Rear, Left Side		T2017500 (1)	T2016600 (1)	T2016600 (1)	T2016600 (1)	T2016600 (1)	T2016600 (1)	T2016600 (1)
37A	Tile, Rear, Right Side		T2016600 (1)	T2016600 (1)	T2018100 (1)	T2016600 (1)	T2018100 (1)	T2016600 (1)	T2016600 (1)
37B	Tile, Rear, Center				T2017200 (1)	T2017200 (1)	T2017200 (2)	T2017200 (2)	
38	Tile, Bottom	T2015500 (1)							
39	Tile, Bottom, Left Side		T2017400 (1)	T2017400 (1)	T2017400 (1)	T2017400 (1)	T2017400 (1)	T2017400 (1)	T2017400 (1)
39A	Tile, Bottom, Right Side		T2016500 (1)	T2017400 (1)	T2018000 (1)	T2017400 (1)	T2018000 (1)	T2017400 (1)	T2017400 (1)
39B	Tile, Bottom, Center				T2015900 (1)	T2015900 (1)	T2015900 (2)	T2015900 (2)	

Heat Exchanger Components

See Figure 35

41	Heat Exchanger, Copper	R2014901	R2014902	R2014903	R2026701	R2014904	R2026702	R2014905	
	Heat Exchanger, Cupro-Nickel	R2027801	R2027802	R2027803	R2027804	R2027805	R2027806	R2027807	
42	Water Barrier, Inlet/Outlet	20305101	20305101	20305101	20305101	20305101	20305101	20305101	
43	Water Barrier, Inlet	10338300	10338300	10338300	10338300	10338300	10338300	10338300	
44	Gasket, Header	S0095100 (2)	S0095100 (2)	S0095100 (2)	S0095100 (2)	S0095100 (2)	S0095100 (2)	S0095100 (2)	
45	Cover, In/Out, Glass-Lined Cast Iron	10364504	10364504	10364504	10364504	10364504	10364504	10364504	
	Cover, In/Out, Bronze	10364501	10364501	10364501	10364501	10364501	10364501	10364501	
46	Well, Temperature Control	RE2058300	RE2058300	RE2058300	RE2058300	RE2058300	RE2058300	RE2058300	
47	Gasket, Flange	S0063700 (2)	S0063700 (2)	S0063700 (2)	S0063700 (2)	S0063700 (2)	S0063700 (2)	S0063700 (2)	
48	Flange, Cast Iron	10391302	10391302	10391302	10391302	10391302	10391302	10391302	
	Flange, Bronze	20255401	20255401	20255401	20255401	20255401	20255401	20255401	
49	Relief Valve, PNCH, 75 PSI	A0063300	A0063600	A0063600	A0063600	A0063600	A0063600	A0063600	
	Relief Valve, PNCV, 125 PSI	RA0001200	RA0001200	RA0001200	RA0001200	RA0001200	RA0064400	A0066400	

Item	Description	Model 500	Model 750	Model 1000	Model 1250	Model 1500	Model 1750	Model 2000
78	Valve, Gas, Combination	V2017600 (2)	V2017600 (3)	V2017600 (2)	V2017600 (5)	V2017600 (2)	V2017600 (2)	V2017600 (4)
79	Valve, Manual Shutoff	V2000200 (2)	V2000200 (3)	V2000200 (3)	V2000200 (5)	V2000200 (5)	V2000200 (6)	V2000200 (6)
80	Orifice, Gas, Natural	L2013000 (6)	L2013000 (9)	L2013000 (12)	L2013000 (15)	L2013000 (18)	L2013000 (21)	L2013000 (24)
81	Orifice, Gas, Propane	L2012400 (6)	L2012400 (9)	L2012400 (12)	L2012400 (15)	L2012400 (18)	L2012400 (21)	L2012400 (24)
	Burner Manifold, 3 Burners, Right	L2012900 (1)	L2012900 (1)	L2012900 (1)	L2012900 (2)	L2012900 (1)	L2012900 (1)	L2012900 (1)
	Burner Manifold, 3 Burners, Left	L2012800 (1)	L2012800 (1)	L2012800 (1)	L2012800 (3)	L2012800 (1)	L2012800 (2)	L2012800 (2)
	Burner Manifold, 4 Burners, Right	L2012700 (1)	L2012700 (1)	L2012700 (1)	L2012700 (3)	L2012700 (1)	L2012700 (1)	L2012700 (2)
	Burner Manifold, 4 Burners, Left	L2012600 (2)	L2012600 (2)	L2012600 (2)	L2012600 (2)	L2012600 (2)	L2012600 (2)	L2012600 (4)
82	Burner Tray, 3 Burners	L2012200 (2)	L2012200 (3)	L2012200 (2)	L2012200 (5)	L2012200 (2)	L2012200 (3)	L2012200 (6)
	Burner Tray, 4 Burners	L2012500 (2)	L2012500 (3)	L2012500 (3)	L2012500 (5)	L2012500 (3)	L2012500 (3)	L2012500 (6)
82A	Gasket, Burner Tray, 3 Burner	S2012700 (2)	S2012700 (3)	S2012700 (2)	S2012700 (5)	S2012700 (2)	S2012700 (3)	S2012700 (6)
	Gasket, Burner Tray, 4 Burner	S2012500 (2)	S2012500 (3)	S2012500 (3)	S2012500 (5)	S2012500 (2)	S2012500 (3)	S2012500 (6)
	Gasket Tape, RR, Base (43')	R2014500 (2)	R2014500 (3)	R2014500 (3)	R2014500 (5)	R2014500 (2)	R2014500 (3)	R2014500 (6)
	Gasket Tape, FtAir Chamber (63')	R2014600 (2)	R2014600 (3)	R2014600 (3)	R2014600 (5)	R2014600 (2)	R2014600 (3)	R2014600 (6)

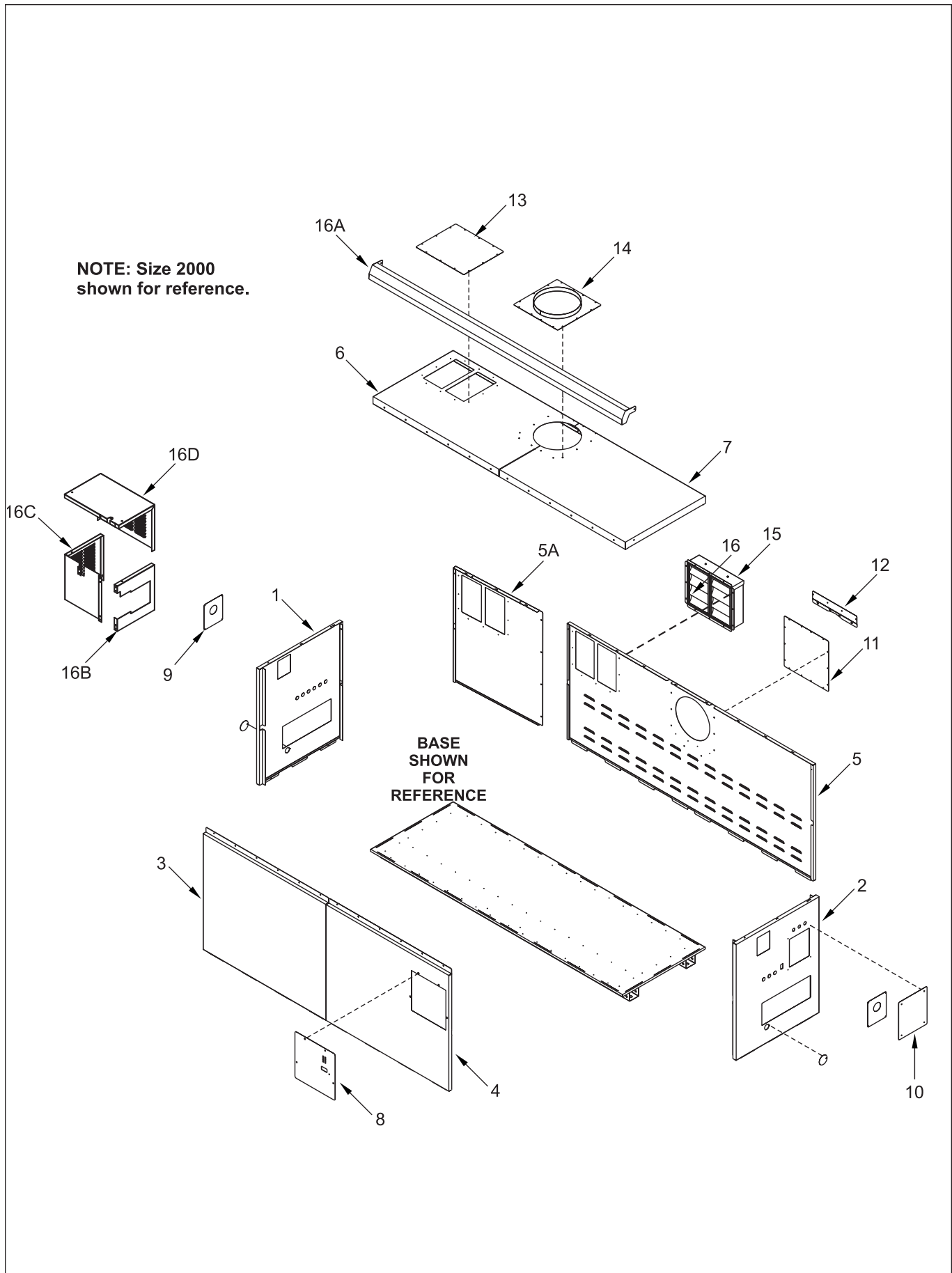


Figure 33. Sheet Metal Components.

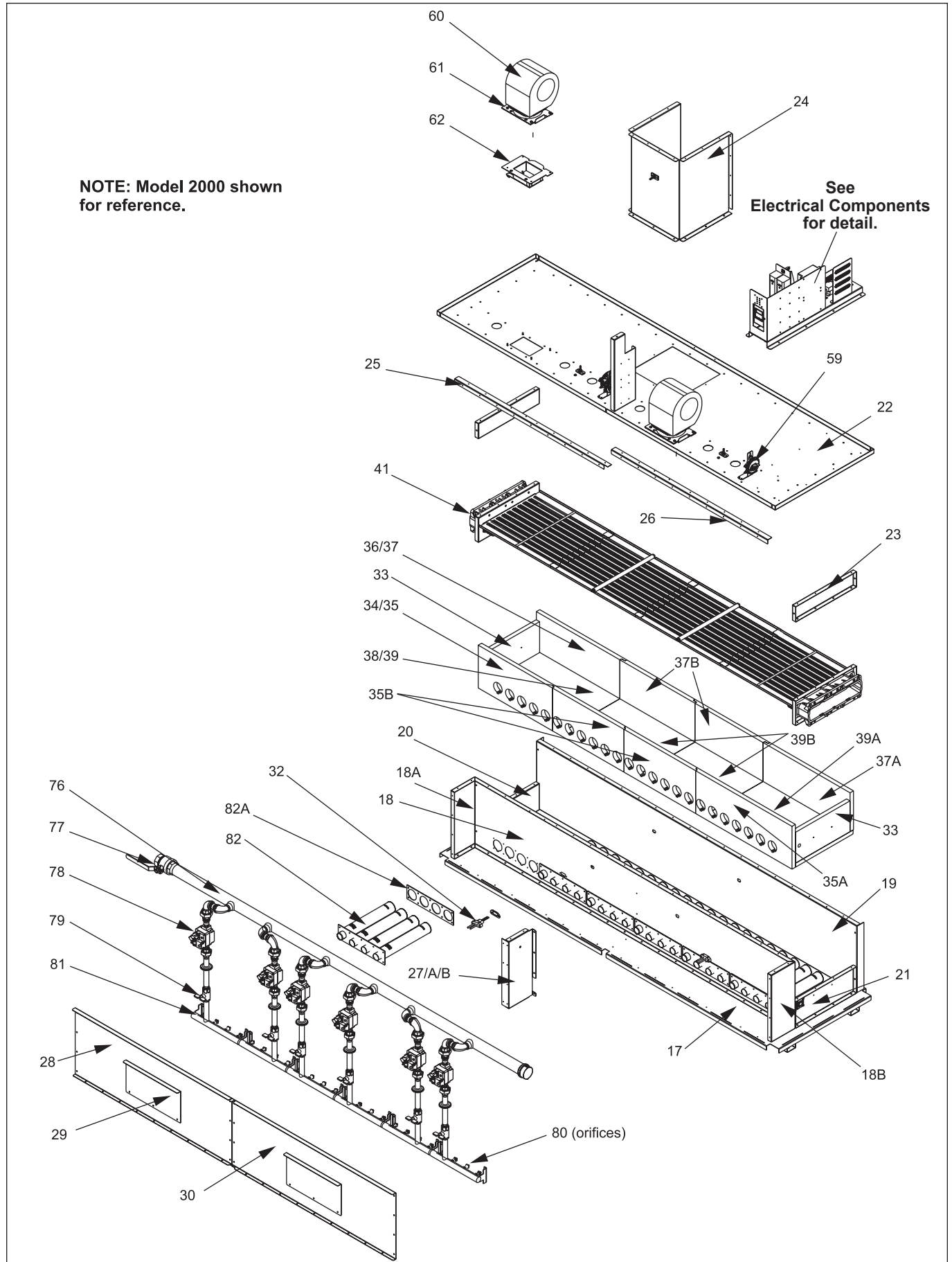
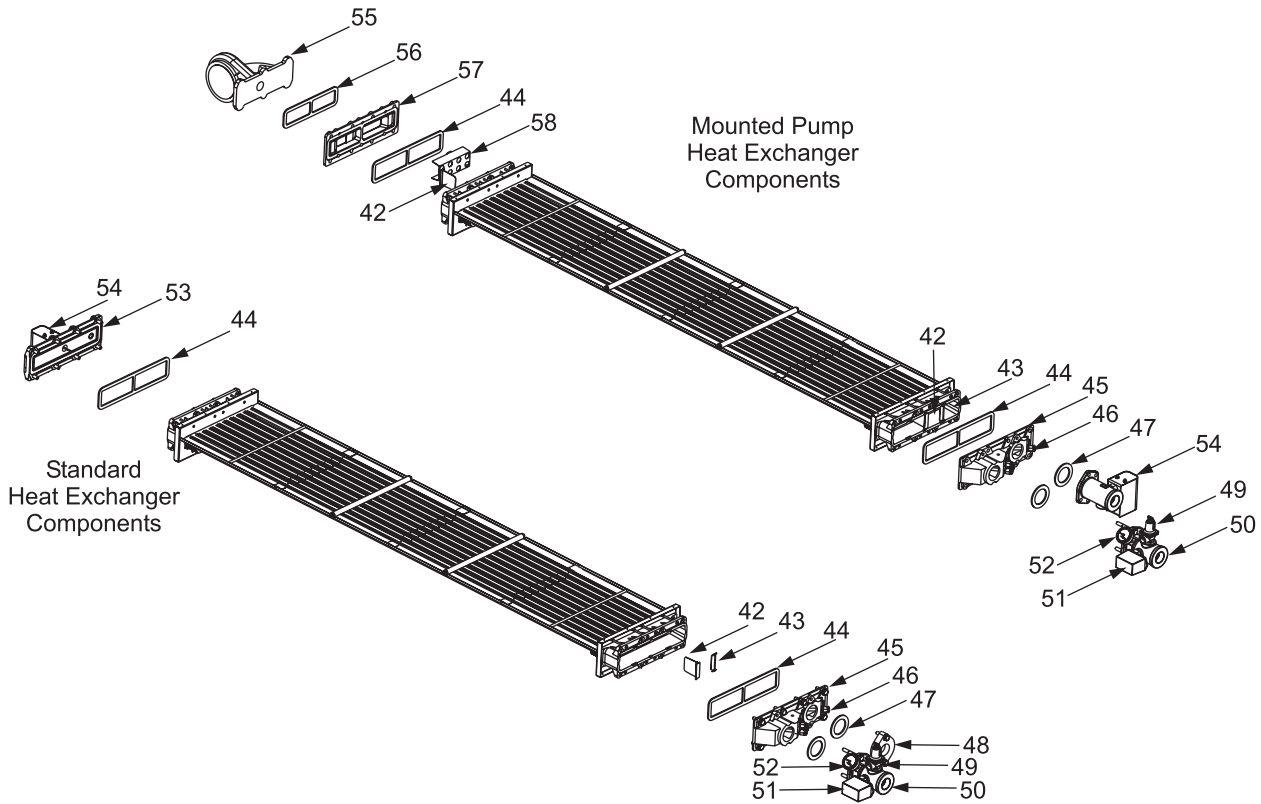


Figure 34. Internal Components.

See pump chart below for pump numbers.



Pennant Hydronic Boiler

SIZE	TACO PUMP P/N	B&G PUMP P/N
500	A2117201	A2121803
750	A2117201	A2121803
1000	A2117202	A2121802
1250	A2117202	A2121802
1500	A2117203	A2121801
1750	A2117203	A2121801
2000	A2117204	A2121800

Pennant Water Heater with TACO Pump

SIZE	TACO PUMP P/N		
	Soft Water	Normal Water	Hard Water
500	A2117201	A2117201	A2117203
750	A2117201	A2117201	A2117203
1000	A2117201	A2117202	A2117203
1250	A2117201	A2117202	A2117203
1500	A2117201	A2117203	A2117203
1750	A2117203	A2117203	A2117203
2000	A2117204	A2117204	A2117204

Pennant Water Heater with B&G Pump

SIZE	B&G PUMP P/N		
	Soft Water	Normal Water	Hard Water
500	A2121803	A2121803	A2121801
750	A2121803	A2121803	A2121801
1000	A2121803	A2121802	A2121801
1250	A2121803	A2121802	A2121801
1500	A2121803	A2121801	A2121801
1750	A2121801	A2121801	A2121801
2000	A2121800	A2121800	A2121800

Figure 35. Heat Exchanger Components.

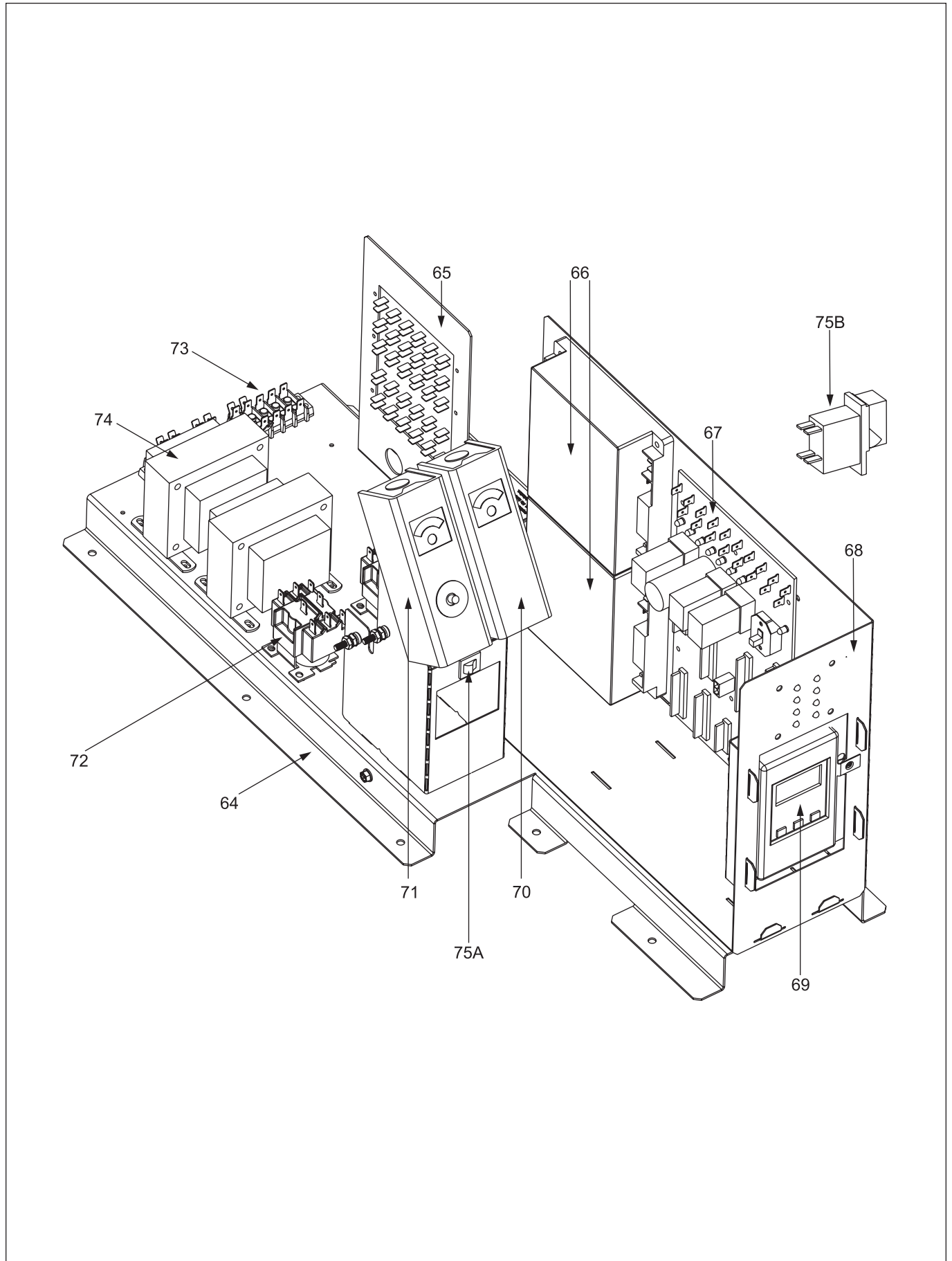


Figure 36. Electrical Components.

