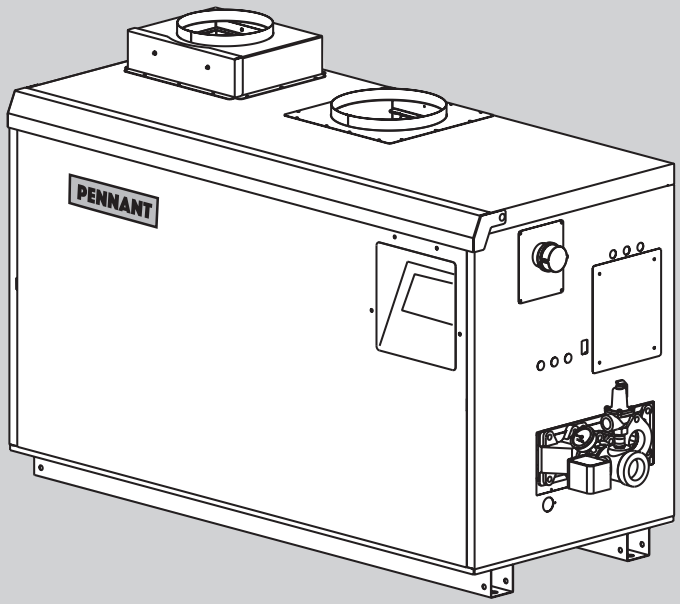


Installation and Operation Instructions for

PENNANT®

includes **LOW TEMP PENNANT®**

with Laars Linc®

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 suivres 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 dansle 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 sservice 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.

H237970OE

LAARS® Heating Systems Company

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SECTION 1 General Information

USING THIS MANUAL – Because these Boilers and 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.

1.A Introduction

This manual provides information necessary for the installation, operation, and maintenance of commerical hydronic boilers and volume water heaters (including the Low Temp units). Read this manual carefully before installation.

All application and installation procedures should be reviewed completely before proceeding with the installation. Consult the 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.

This unit is protected against over pressurization. A pressure relief valve is fitted to all units. 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.

⚠ WARNING

This hydronic boiler or water heater **must** be installed in accordance with the procedures detailed in this manual, or the manufacturers 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 this unit 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.

⚠ AVERTISSEMENT

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

WARNING:
Cancer and Reproductive Harm
www.P65Warnings.ca.gov

As required by the State of California Proposition 65.

1.B Warranty

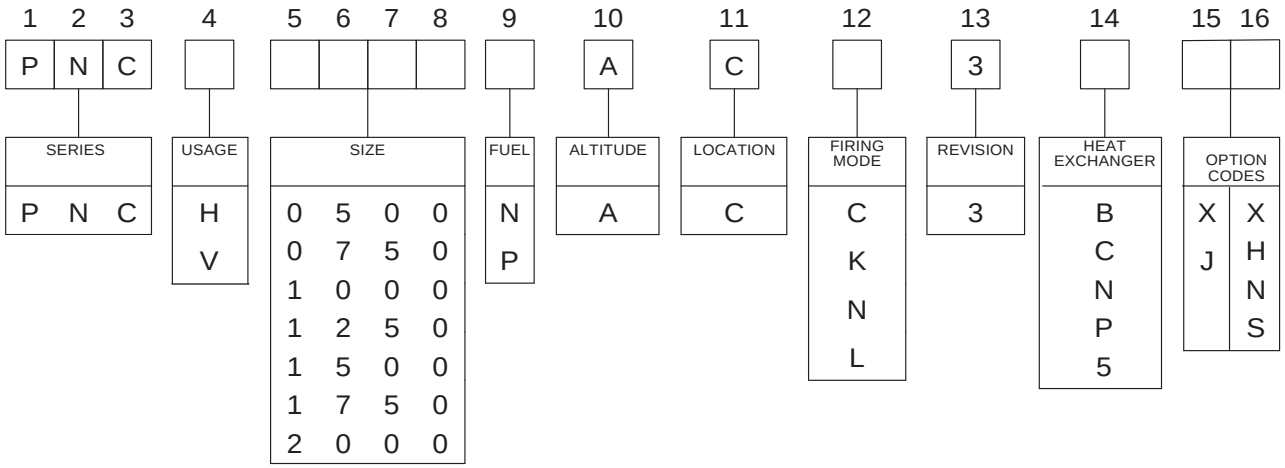
Laars Heating Systems' appliances are covered by a limited warranty. Owners should submit online warranty registration at ***www.Laars.com***.

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.C Model Identification (Nomenclature)



IST & 2ND CHARACTERS (MODEL SERIES)

PN: PENNANT

3RD CHARACTER (MODEL EFFICIENCY)

C: MID EFFICIENCY (NON-CONDENSING)

4TH CHARACTER (USAGE)

H: HYDRONIC
V: VOLUME WATER

5TH THROUGH 8TH CHARACTERS (SIZE)

0500: 500,000 BTU/HR INPUT
0750: 750,000 BTU/HR INPUT
1000: 1,000,000 BTU/HR INPUT
1250: 1,250,000 BTU/HR INPUT
1500: 1,500,000 BTU/HR INPUT
1750: 1,750,000 BTU/HR INPUT
2000: 2,000,000 BTU/HR INPUT

9TH CHARACTER (FUEL)

N: NATURAL GAS
P: PROPANE

10TH CHARACTER (ALTITUDE)

A: 0-10,000 FEET (0-3050 M)

11TH CHARACTER (LOCATION)

C: CONVERTIBLE (INDOOR/OUTDOOR)

12TH CHARACTER (FIRING MODE)

C: ON-OFF (PUMP MOUNTED WITH MIXING SYSTEMS)
K: TWO-STAGE (PNCH & PNCV 500-750)
N: THREE-STAGE (PNCH & PNCV 1000)
L: FOUR-STAGE (PNCH & PNCV 1250-2000)

13TH CHARACTER (REVISION)

ENGINEERING REVISION CHARACTER, IN SEQUENCE

14TH CHARACTER (HEAT EXCHANGER)

B: GLASS-LINED CAST IRON / COPPER / BRONZE TRIM (STD PNCP-PM, N/A PNCV, OPT PNCH)
C: GLASS-LINED CAST IRON / COPPER (STD PNCH, N/A PNCV-PNCP-PM)
N: GLASS-LINED CAST IRON / CUPRONICKEL (OPT PNCH, N/A PNCV-PNCP-PM)
P: GLASS-LINED CAST IRON / CUPRONICKEL / BRONZE TRIM (STD PNCV, OPT PNCH- PNCP-PM)
5: HLW STAMPED VERSION OF "P" HEAT EXCHANGER (OPT PNCV, N/A PNCH-PNCP-PM)

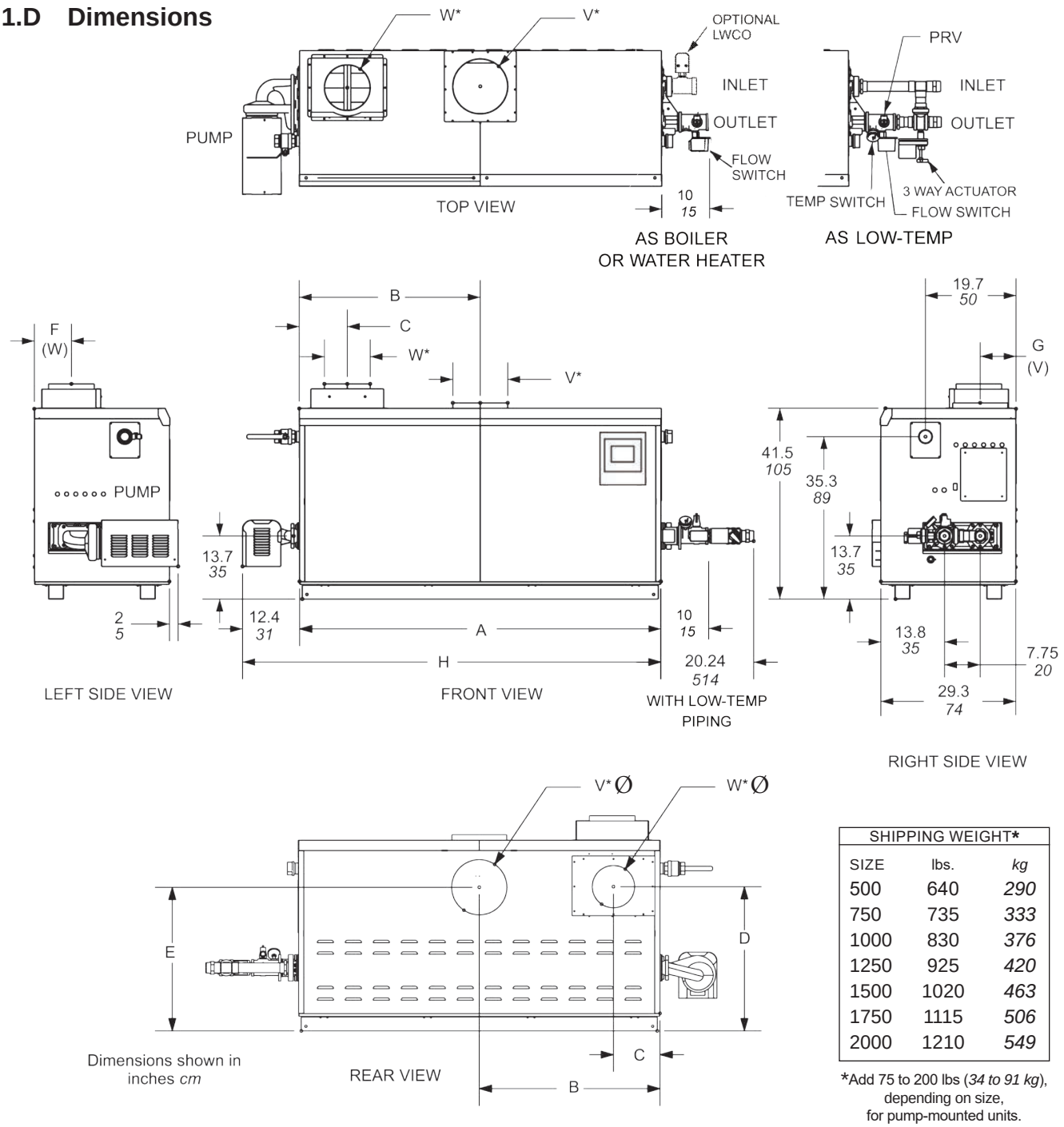
15TH CHARACTER (CONTROL OPTIONS)

X: STANDARD UNIT
J: CSD-1, FM, IL

16TH CHARACTER (PUMP OPTIONS)

X: NO PUMP
H: TACO HARD WATER PUMP (VOLUME WATER ONLY)
N: TACO NORMAL WATER PUMP
S: TACO SOFT WATER PUMP (VOLUME WATER ONLY)

1.D Dimensions



SHIPPING WEIGHT*		
SIZE	lbs.	*kg*
500	640	*290*
750	735	*333*
1000	830	*376*
1250	925	*420*
1500	1020	*463*
1750	1115	*506*
2000	1210	*549*

*Add 75 to 200 lbs (*34 to 91 kg*), depending on size, for pump-mounted units.

Size	A		B		C		D		E		F		G		H		Air Conn. W*		Vent Conn. V*		Horiz. Vent Pipe	
500	**33½**	*85*	**15¾**	*40*	**5¾**	*15*	**29¾**	*76*	**33¾**	*86*	**7¾**	*20*	**8¾**	*22*	**46**	*117*	**6**	*15*	**8**	*20*	**6**	*15*
750	**45½**	*116*	**21¾**	*55*	**5¾**	*15*	**29¾**	*76*	**33¾**	*86*	**7¾**	*20*	**8¾**	*22*	**58**	*147*	**8**	*20*	**10**	*25*	**8**	*20*
1000	**57½**	*146*	**28¾**	*73*	**5¾**	*15*	**29¾**	*76*	**33¾**	*86*	**7¾**	*20*	**8¾**	*22*	**70**	*178*	**8**	*20*	**10**	*25*	**8**	*20*
1250	**68**	*172*	**34**	*86*	**10⅛**	*26*	**30¾**	*78*	**31⅛**	*79*	**8¾**	*22*	**8¾**	*22*	**80**	*203*	**12**	*30*	**12**	*30*	**10**	*25*
1500	**78½**	*199*	**39¾**	*101*	**10⅛**	*26*	**30¾**	*78*	**31⅛**	*79*	**8¾**	*22*	**8¾**	*22*	**91**	*231*	**12**	*30*	**12**	*30*	**10**	*25*
1750	**89**	*226*	**44½**	*113*	**10⅛**	*26*	**30¾**	*78*	**31⅛**	*79*	**8¾**	*22*	**8¾**	*22*	**101**	*256*	**12**	*30*	**14**	*36*	**12**	*30*
2000	**99½**	*253*	**49¾**	*126*	**10⅛**	*26*	**30¾**	*78*	**31⅛**	*79*	**8¾**	*22*	**8¾**	*22*	**112**	*284*	**12**	*30*	**14**	*36*	**12**	*30*

*Air and vent connections may be on top or back of the unit, and are field convertible. Dimensions in **inches** *cm*

Table 1. Dimensional Data.

SIZE	VENT COLLAR SIZE		HORIZONTAL VENT PIPE DIAMETER		INTAKE AIR PIPE DIAMETER		MIN INTAKE AIR PIPE LENGTH***		MIN VENT PIPE LENGTH		INTAKE AIR MAX VENT 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*	**ft.**	*m*	**ft.**	*m*			
500	**8**	*20*	**6**	*15*	**6**	*15*	**0**	*0*	**3**	*1*	**50**	*15*	3	CA001401	CA20260701
750	**10**	*25*	**8**	*20*	**8**	*20*	**0**	*0*	**3**	*1*	**50**	*15*	3	CA001402	CA20260703
1000	**10**	*25*	**8**	*20*	**8**	*20*	**0**	*0*	**3**	*1*	**50**	*15*	3	CA001402	CA20260703
1250	**12**	*30*	**10**	*25*	**12**	*30*	**0**	*0*	**3**	*1*	**50**	*15*	3	CA001405	CA20260706
1500	**12**	*30*	**10**	*25*	**12**	*30*	**0**	*0*	**3**	*1*	**50**	*15*	3	CA001405	CA20260706
1750	**14**	*36*	**12**	*30*	**12**	*30*	**0**	*0*	**3**	*1*	**50**	*15*	3	CA001404	CA20260706
2000	**14**	*36*	**12**	*30*	**12**	*30*	**0**	*0*	**3**	*1*	**50**	*15*	3	CA001404	CA20260706

Table 2. Horizontal Vent / Combustion Air Parameters.

***Appliance needs to vent outdoors using approved vent caps and following all guidelines as noted in this Installation Manual. Proper protection against debris in the air intake (through using a downward spout and/or screen) to avoid debris pick-up / falling into the appliance is required.

1.E 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**. These 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 unit 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 3 should be met when choosing the locations for the appliance.

NOTE: Outdoor Installation of this unit as a volume water heater, is not permitted in Canada.

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 3. Clearances.

1.F Locating Pump-Mounted Water Heater w/ Respect to Storage Tank(s)

For best results, this pump-mounted 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.G Locating Pump-Mounted Boiler with Respect to Return/Supply Header

For the best results, this pump-mounted boiler must 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.H 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 on page 7).

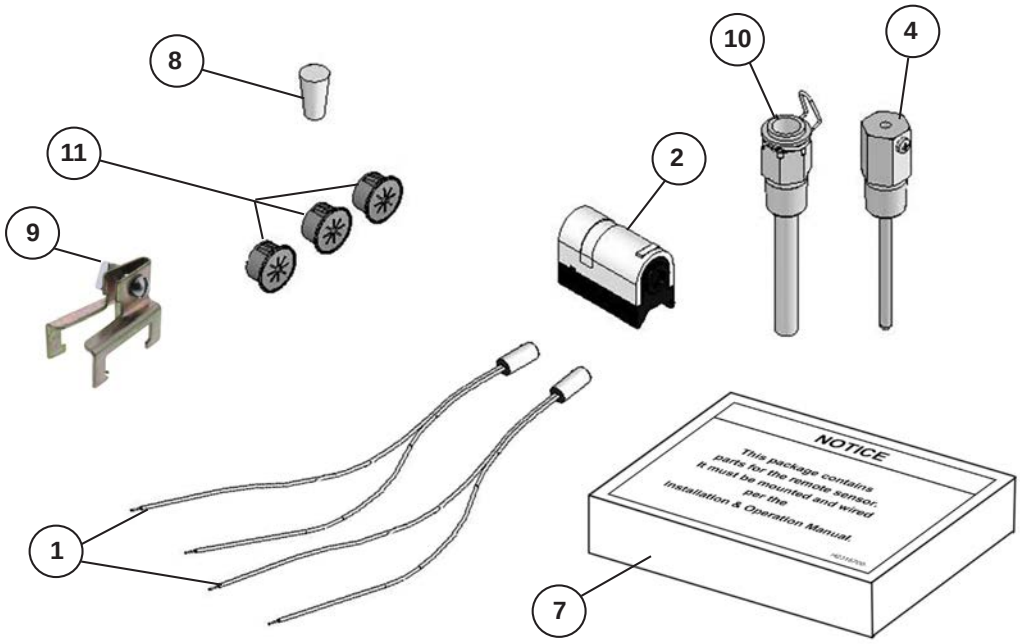
NOTE: On all model sizes, the vent collar size is larger than the size of the vent pipe that can be used. Vent collar size and horizontal pipe diameters can be found in Table 2 The larger vent collar size is to accommodate Category I (vertical) vent systems.

NOTE: When located on the same wall, the units 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.

1.I Installation Kit

All units are shipped with an Installation Kit which contains the following items.



Qty PNCV	Qty PNCH	Part Number	Description	Item
3	3	S0064900	BUSHING, NYLON, 7/8, SLIT	11
1	1	E2058300	WELL, IMMERSION, 1/2" NPT	10
1	1	E0083700	CLAMP, CAPILLARY	9
1	1	P2039100	STOPPER, RUBBER, TAPERED	8
1	1	H2315700	LABEL, BOX, REMOTE SENSOR	7
1	1	1-732	CARTON, 6 x 4 x 4 (not shown)	6
1	1	1-736	PLASTIC, BAG, 4" X 6" (not shown)	5
1	-	E2310500	SENSOR, TEMPERATURE, OUTDOORS	2
2	2	E2103300	SENSOR, INLET, TEMPERATURE, WATER (not shown)	1

Figure 1. Installation Kit Components

SECTION 2 Venting and Combustion Air

2.A Combustion Air

These 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.

The unit 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.A.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 4 shows data for this sizing method, for each 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.A.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 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

WARNING

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

⚠ AVERTISSEMENT

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

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 4. Combustion Air Openings.

unit must not support the weight of the combustion air intake pipe. Maximum linear pipelength 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 unit 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 unit loses less than 1 percent of its input rating to the room, but other heat sources may be present.

TERM	DESCRIPTION
Pipe	Single-wall galvanized steel pipe, 24 gauge minimum (either insulated or non-insulate
Joint Sealing	Permanent duct tape or aluminum tape

Table 5. Required Combustion Air Piping Material.

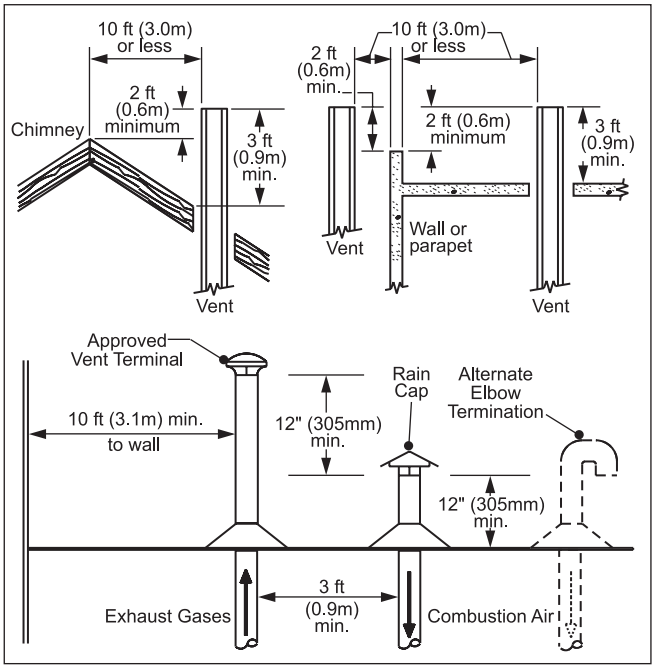


Figure 2. Combustion Air and Vent Through Roof.

NOTE: This appliance needs to vent outdoors using approved vent caps and following all guidelines as noted in this Installation manual. Proper protection against debris in the air intake (through using a downward spout and/or screen) to avoid debris pick-up / falling into the appliance is required.

2.B Venting

2.B.1 Vent Categories

Depending upon desired unit 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 unit'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 unit's vertical vent system does not satisfy the criteria for Category I venting, it must be vented as a Category III system.

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

2.B.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 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.B.3 Common Venting Systems

These units are Category I fan-assisted when vented vertically and adhering to all applicable codes. These 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 a fan-assisted unit with other appliances through one shared vertical duct called a "common vent", special care must be taken by the installer to ensure safe operation. In the event that the

common vent is blocked, it is possible, especially for fan-assisted devices, to vent backwards through non-operating appliances sharing the vent, allowing combustion products to infiltrate occupied spaces. **If the appliances are allowed to operate in this condition, serious injury or death may occur.**

⚠ WARNING

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

⚠ AVERTISSEMENT

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

It is for this reason that, in addition to following proper vent sizing, construction and safety requirements from the National Fuel Gas Code, ANSI Z223.1 or in Canada, from 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 unit 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 unit is vented separately and NOT common vented with other appliances. As an additional precaution, it is recommended that a Carbon Monoxide (CO) alarm be installed in all enclosed spaces containing combustion appliances. If assistance is required in determining how a blocked vent safety system should be connected to this product, please call the phone number listed on the back cover of this manual.

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

⚠ WARNING

When an existing Cat I appliance is removed or replaced, the original venting system may no longer be sized to properly vent the attached appliances. Under no circumstances should an improperly sized vent be used. An improperly sized vent may cause operational and safety problems, and could result in serious injury, death, or property damage.

⚠ CAUTION

CO needs to be less than 150 ppm.

⚠ ATTENTION

Le CO doit être inférieur à 150 ppm

NOTE: The installer must verify that at least one carbon monoxide alarm has been installed within a residential living space or home following the alarm manufacturer's instructions and applicable local codes before putting the appliance into operation. It is important for carbon monoxide alarms to be installed, maintained, and replaced following the alarm manufacturer's instructions and applicable local codes.

REMARQUER : L'installateur est tenu de vérifier qu'au moins une alarme de détection de monoxyde de carbone soit installée dans un espace résidentiel ou dans un domicile conformément aux directives du fabricant de l'alarme et aux codes locaux applicables avant de mettre l'appareil en service.

Locations for Vent Pipe Terminator

		Canadian Installations[1]	U.S. Installations[2]
A =	Clearance above grade, veranda, porch, deck, or balcony	12 in (30 cm)	12 in (30 cm)
B =	Clearance to window or door that may be opened	• 6 in (15 cm) for appliances ≤ 10,000 Btuh (3 kW) • 12 in (30 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW) • 36 in (91 cm) for appliances >100,000 Btuh (30 kW)	• 6 in (15 cm) for appliances ≤ 10,000 Btuh (3 kW) • 9 in (23 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 50,000 Btuh (15 kW) • 12 in (30 cm) for appliances >50,000 Btuh (15 kW)
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 ft (61 cm) 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 centerline extended above meter / regulator assy	3 ft (91 cm) within a height of 15 ft (4.6 m)	See Note 5
I =	Clearance to service regulator vent outlet	3 ft (91 cm)	See Note 5
J =	Clearance to nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	• 6 in (15 cm) for appliances ≤ 10,000 Btuh (3 kW) • 12 in (30cm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW) • 36 in (91 cm) for appliances > 100,000 Btuh (30 kW)	• 6 in (15 cm) for appliances ≤ 10,000 Btuh (3 kW) • 9 in (23cm) for appliances > 10,000 Btuh (3 kW) and ≤ 50,000 Btuh (15 kW) • 12 in (30 cm) for appliances > 50,000 Btuh (15 kW)
K =	Clearance to a mechanical air supply inlet	6 ft (1.83 m)	3 ft (91 cm) above if within 10 ft (3 m) horizontally
L =	Clearance above paved sidewalk or paved driveway located on public property	7 ft (2.13 m)†	7 ft (2.13 m) for mechanical draft systems (Category I appliances). Vents for Category II and IV appliances cannot be located above public walkways or other areas where condensate or vapor can cause a nuisance or hazard*
M =	Clearance under veranda, porch, deck, or balcony	12 in (30 cm)‡	See Note 5

† A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.
‡ Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.

Notes:
1) In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code.
2) In accordance with the current ANSI Z223.1/NFPA 54, Natural Fuel Gas Code.
3) If locally adopted installation codes specify clearances different than those illustrated, then the most stringent clearance shall prevail.
4) For clearances not specified in CAN/CSA-B149, clearance is in accordance with local installation codes and the requirements of the gas supplier.
5) 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.
6) IMPORTANT: Terminal must be placed such that it remains a minimum of 12” above maximum expected snow line. Local codes may have more specific requirements, and must be consulted.

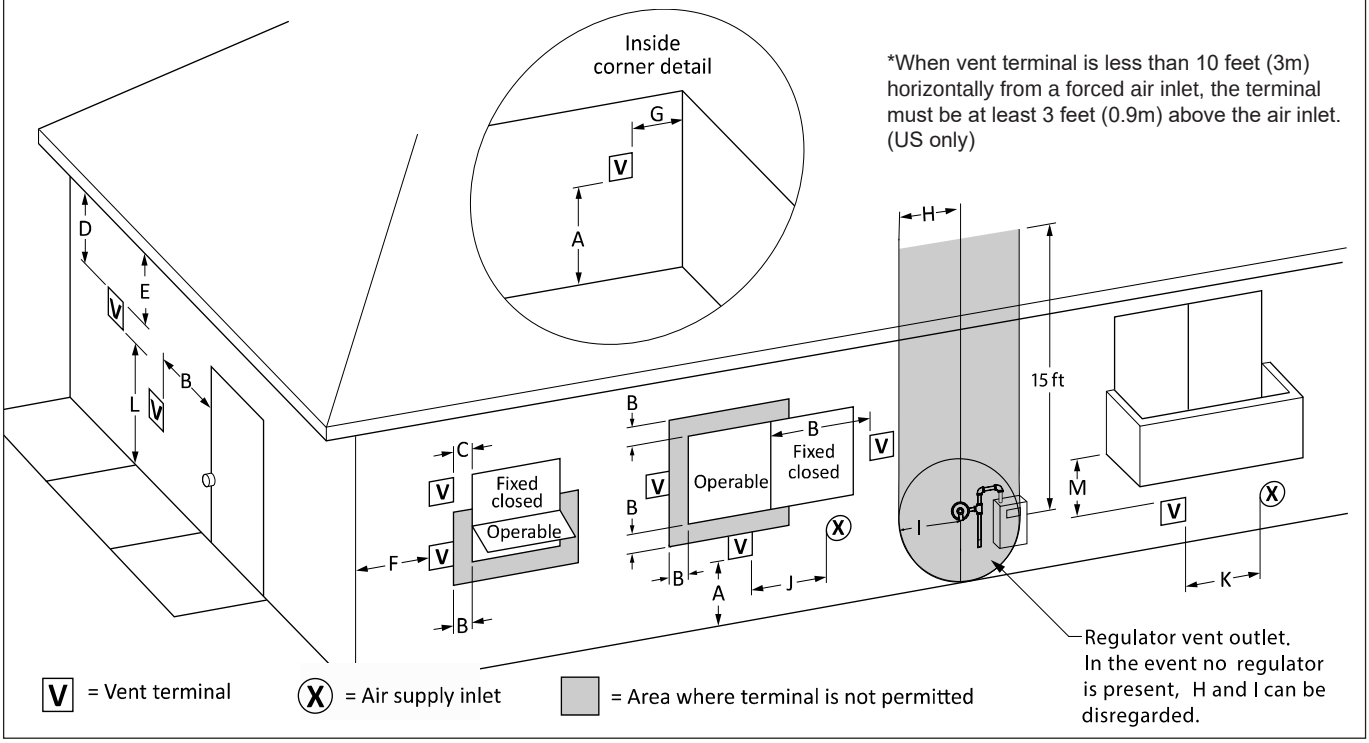


Figure 3. Combustion Air and Vent Through Side Wall.

2.B.4 Category III Vent

When the unit 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 6.

Route the vent pipe to the heater as directly as possible. Seal all joints and provide adequate hangers every 4' or as required in the venting system manufacturer's Installation Instructions. Horizontal portions of the venting system must be supported to prevent sagging and may not have any low sections that could trap condensate.

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

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

Reference Table 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.

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 6. Required Horizontal Venting Material.

⚠ WARNING

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

⚠ AVERTISSEMENT

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

2.C Locating Vent & Combustion Air Terminals

2.C.1 Side Wall Vent Terminal

An appropriate quality side wall vent hood must be used. See Table 2 on page 7 .

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.

Important Note: Massachusetts Code Requirement.

From Massachusetts Rules and Regulations 248 CMR 5.08:

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

1. INSTALLATION OF CARBON MONOXIDE DETECTORS.

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

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

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

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

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

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

1. The equipment listed in Chapter 10 entitled “Equipment Not Required To Be Vented” in the most current edition of NFPA 54 as adopted by the Board; and

2. Product Approved side wall horizontal vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

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

1. Detailed instructions for the installation of the venting system design or the venting system components; and

2. A complete parts list for the venting system design or venting system.

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

1. The referenced “special venting system” instructions shall be included with the appliance or equipment installation instructions; and

2. The “special venting systems” shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.

(e) A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.

2.C.2 Side Wall Combustion Air Terminal

The 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 unit 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.C.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.C.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.D Common Vent Test — Boilers

⚠ WARNING

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 or 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 gas burning appliance not connected to the common venting system. Turn 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 burner opening after five minutes of main burner operation.
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 the installation conforms with the National Fuel Gas Code, ANSI Z223.1. When re-sizing any portion of the common venting system, the common venting system should be re-sized to approach the minimum size as determined using the appropriate tables in Appendix G in the National Fuel Gas Code, ANSI Z223.1/NFPA 54.

2.E Test d'évent commun - chaudières

⚠ AVERTISSEMENT

Lorsqu'une chaudière existante est retirée d'un système de ventilation commun, le système de ventilation commun est susceptible d'être trop grand pour une ventilation adéquate des appareils qui y restent connectés.

Au moment du retrait d'une chaudiere existante, les mesures suivantes doivent etre prises pour chaque appareil toujours raccorde au systeme d'evacuation commun et qui fonctionne alors que d'autres appareils toujours raccordes au systeme d'evacuation ne fonctionnent pas:

1. Sceller toutes les ouvertures non utilisees du systeme d'evacuation.
2. Inspecter de fai;on visuelle le systeme d'evacuation pour determiner la grosseur et l'inclinaison horizontale qui conviennent et s'assurer que le syste'me est exempt d'obstruction, d'etranglement, de fuite, de corrosion et autres defaillances qui pourraient presenter des risques.
3. Dans la mesure du possible, fermer toutes les portes et les fenetres du bâtiment et toutes les portes entre l'espace all les appareils toujours raccordes au systeme d'evacuation sont installes et les autres espaces du bâtiment. Mettre en marche les secheuses, taus les appareils non raccordes au systéme d'évacuation commun et taus les ventilateurs d'extraction com me les hottes de cuisiniere et les ventilateurs des salles de bain. S'assurer que ces ventilateurs fonctionnent a la vitesse maximale. Ne pas faire fonctionner les ventilateurs d'éte. Fermer les registres des cheminées.
4. Mettre l'appareil inspecte en marche. Suivre les instructions d'allumage. Régler le thermostat de fai;on que l'appareil fonctionne de fai;on continue.
5. Faire fonctionner le brOleur principal pendant 5 min ensuite, determiner si le coupe-tirage déborde a l'ouverture de decharge. Utiliser la flam me d'une allumette au d'une chandelle au la fumee d'une cigarette, d'un cigare au d'une pipe.
6. Une fois qu'il a ete determine, selon la methode indiquee ci-dessus, que chaque appareil raccorde au systéme d'evacuation est mis a l'air libre de fai;on adequate. Remettre les portes et les fenétres, les ventilateurs, les registres de cheminees et les appareils au gaz a leur position originale.
7. Tout mauvais fonctionnement du systeme d'evacuation commun devrait etre corrige de fai;on que !'installation soit conforme au National Fuel Gas Code, ANSI Z223.1/NFPA 54 et (au) aux codes d'installation CAN/CSA-B149.1. Si la grosseur d'une section du systemed'evacuation doit etre modifiee, le systeme devrait etre modifie pour respecter les valeurs mini males des tableaux pertinents de l'appendice F du National Fuel Gas Code, ANSI Z223.1/ NFPA 54 et (au) les codes d'installation CAN/CSA-B149.1..

2.E 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 unit.

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 7 may be used.

Part numbers for the low profile terminals to cover the vent and combustion air openings are shown in Table 7.

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 7. Vent Terminals for Outdoor Units.

⚠ WARNING

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

⚠ AVERTISSEMENT

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

NOTE: Outdoor Installation of this unit as a volume water heater, is not permitted in Canada.

SECTION 3 Gas Supply and Piping

3.A Gas Supply and Piping

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

The unit'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. These units are equipped to operate at elevations up to 10,000 feet (3050m). These units may be adjusted to operate properly at altitudes above 2500 feet (see SECTION 8 on page 78) 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 10.5" w.c. (2.6kPa) for natural gas and 13" w.c. (3.2kPa) for propane. The minimum inlet gas pressure is 4" w.c. (1kPa) for natural gas and 8" w.c. (2kPa) for propane.

	Min	Max
Natural Gas	4" W.C.	10.5" W.C.
Propane	8" W.C.	13" W.C.

3. Refer to Table 8, 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.

NOTE: This unit 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 8. Gas Piping Size.

SECTION 4 Water Connections — BOILER or WATER HEATER

4.A Boiler

4.A.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 unit. This sensor may be strapped onto pipe from 1" to 4" diameter, or inserted into an immersion well.

4.A.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.

4.A.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 9 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 unit is 120°F (49°C) to avoid condensing on the copper coils.

4.A.4 Water Flow Requirements Low Temperature Boilers

are equipped with a mounted pump. The pumps are sized for the boiler's head loss and 30 feet of full-size piping (same size as boiler outlet), with a normal number of fittings. The boilers must be piped in a primary-secondary system, such that the boiler's pump only serves the boiler. Figure 9 and Figure 10 show examples of this type of piping.

The minimum inlet water temperature to the unit is 70°F (20°C). The mixing system on the unit will ensure that the heat exchanger in the unit does not see water that is less than 120°F (49°C), so that excessive condensation does not form on the heat exchanger.

Table 9 shows a relationship between water flow through the boiler and the temperature difference (rise) between the inlet and outlet of the boiler. This table will enable the user to test the boiler for proper

water flow. Since the boiler has a mixing system that sends a portion of the hot water from the boiler outlet to the boiler inlet, the water flow coming out of the mixing system will vary, depending on the return water temperature.

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 9. Water Flow Requirements - Boiler.

4.A.5 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.

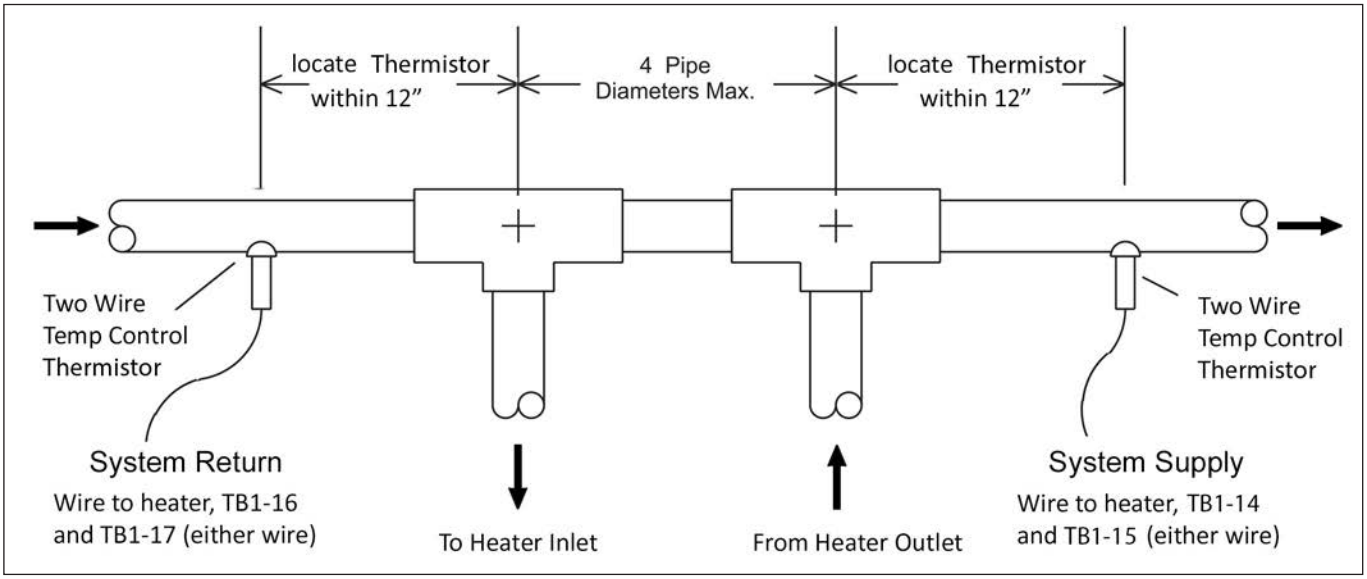


Figure 4. Low-Temp Heater Piping.

4.A.6 Sensor Locations

The install kit provides you with three identical sensors. These can be used in the System Return, System Supply and/or the Domestic Hot Water Sensor locations as well as a Boiler Inlet Sensor replacement.

One well is provided but the sensors are capable of surface mounting depending on application and desired sensitivity.

For Boilers & Low Temp Systems: Install the System Supply Sensor into the common system loop after the outlet tee from the heater. This is the target sensor when installed.

Run wires back to the heater terminal block located on the right side of the boiler. Using the provided insertion tool install the wires into TB1-14 and TB1-15. See Section 5.C.1.d on page 35

Install the System Return Sensor into the common system loop prior to the inlet tee to the heater. Run the wires to the TB1-16 and TB1-17 of the System Return terminals of the heater. This will display the temperature but has no control logic.

For Water Heaters: The DHW Sensor can be used to maintain your tank temperature. Install one of the sensors into the well of your tank and run the wires back to TB1-18 and 19. See Section 5.C.1.d on page 35.

The DHW icon under the configuration menu, lets you set your parameters See 6.E.3 on page 54



Figure 6. System Thermistor



Figure 5. System Supply Thermistor

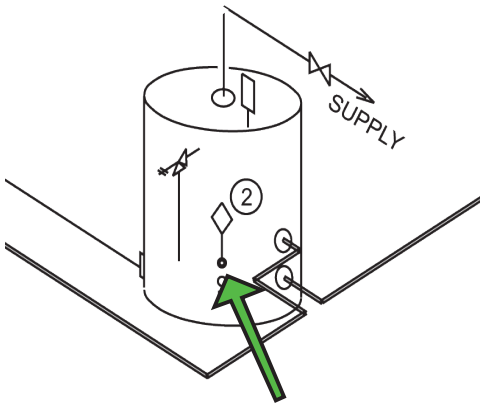


Figure 7. Location of DHW Tank Sensor

4.A.7 Boiler Suggested Piping Diagrams

The next several pages contain suggested piping diagrams for several scenarios.

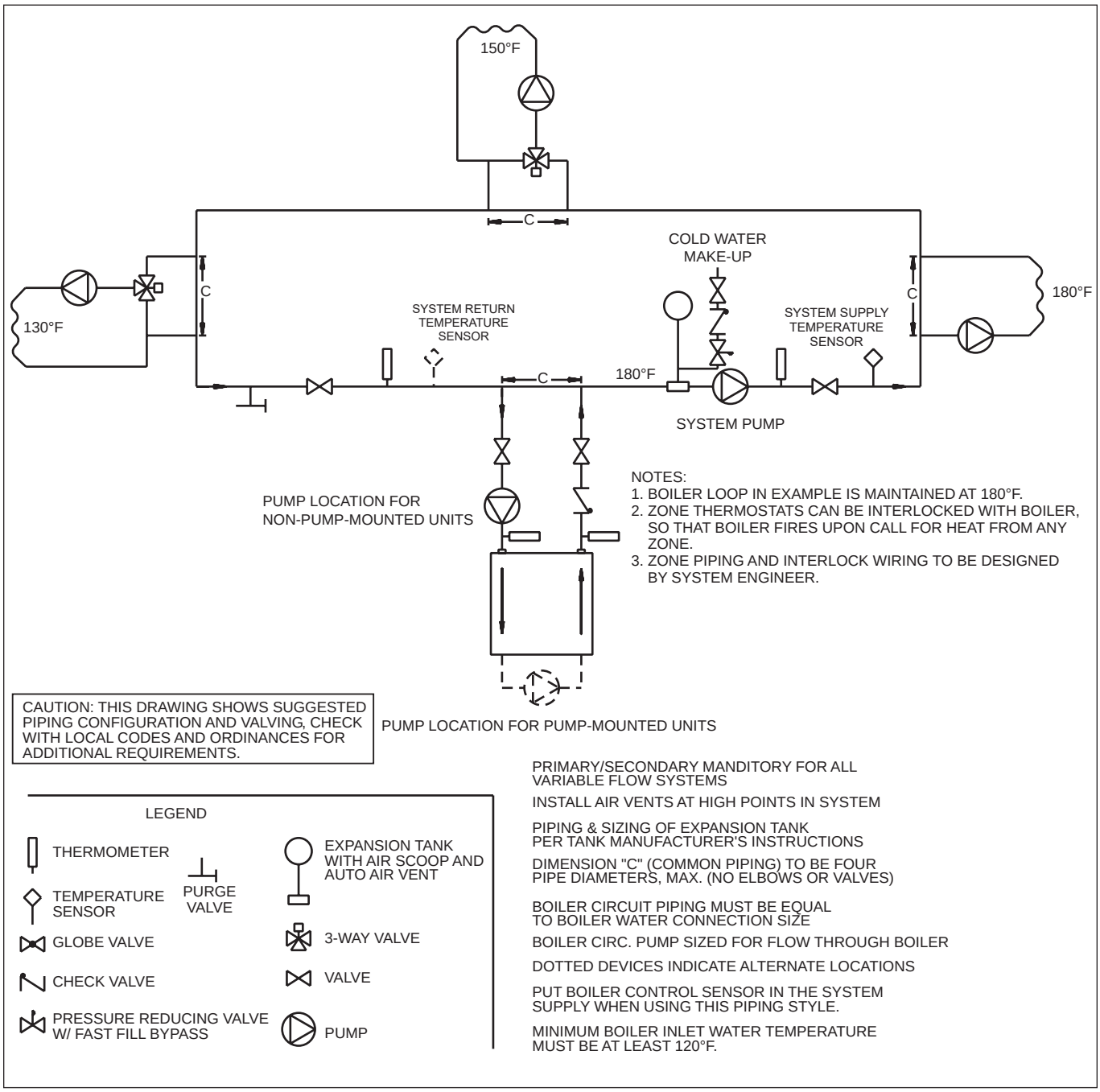


Figure 8. Hydronic Piping — One Boiler, Multi-Temperature System.

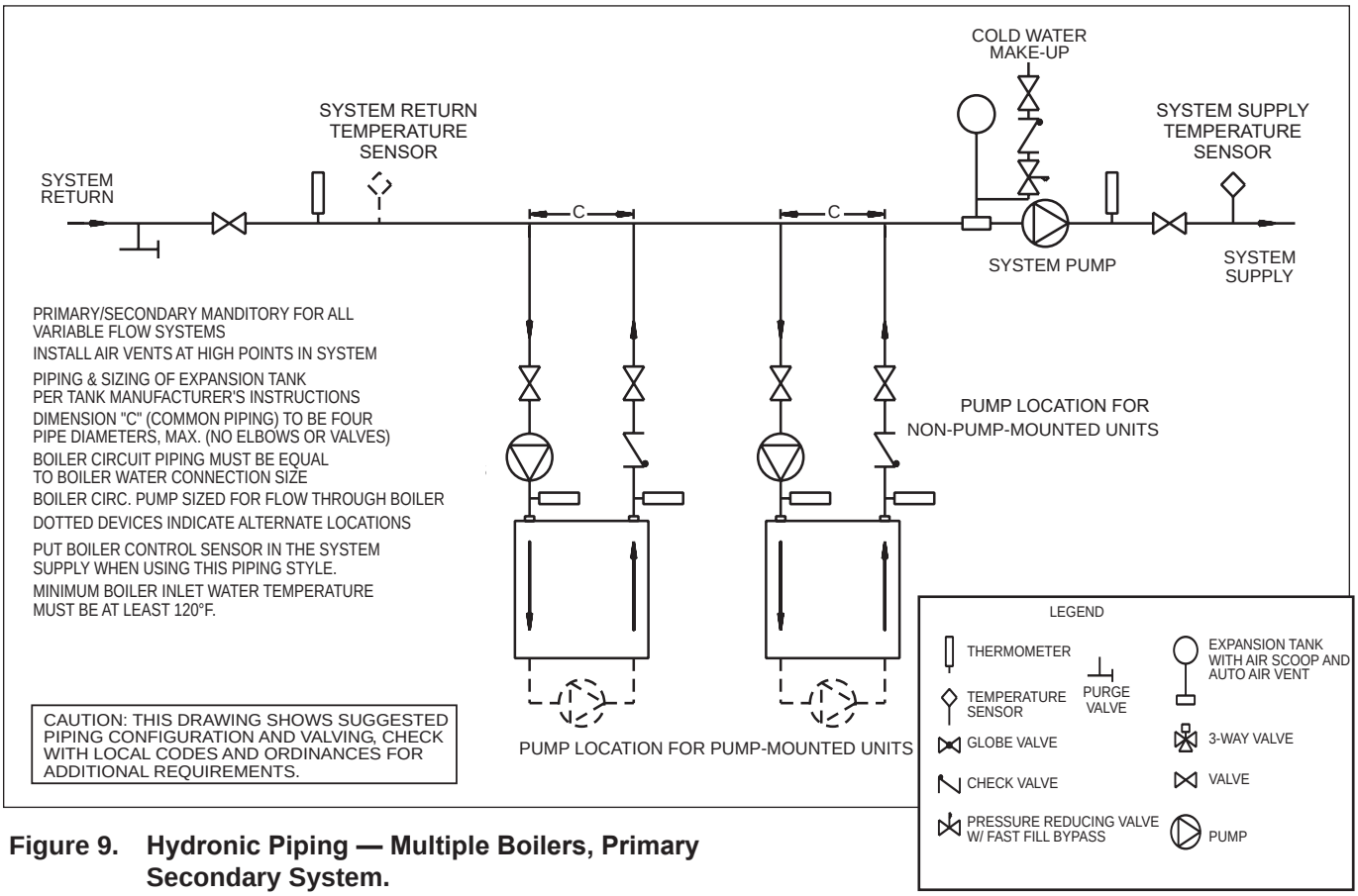


Figure 9. Hydronic Piping — Multiple Boilers, Primary Secondary System.

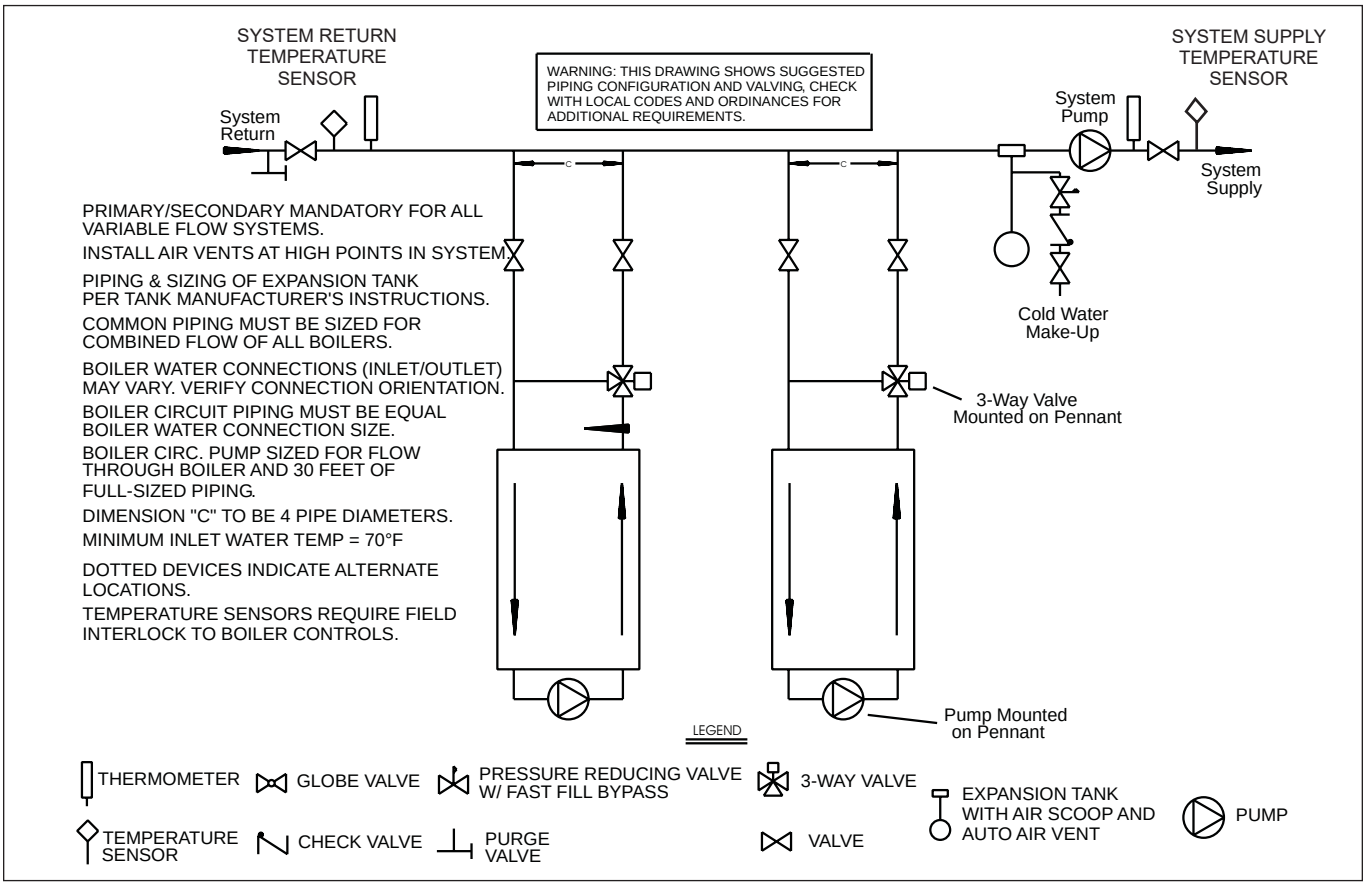


Figure 10. Low Temperature, Primary - Secondary System.

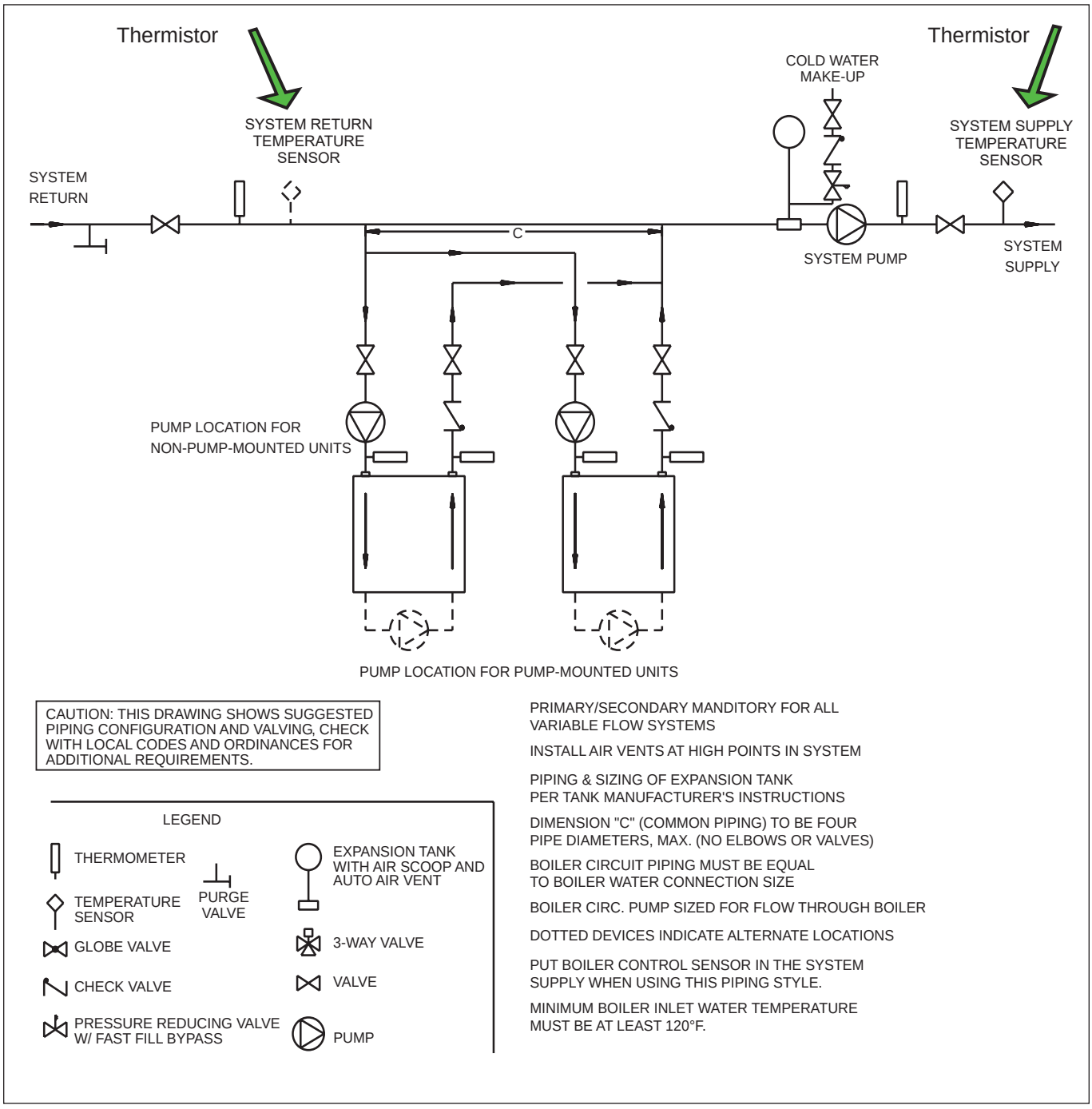


Figure 11. Hydronic Piping - Primary-Secondary, Reverse-Return.

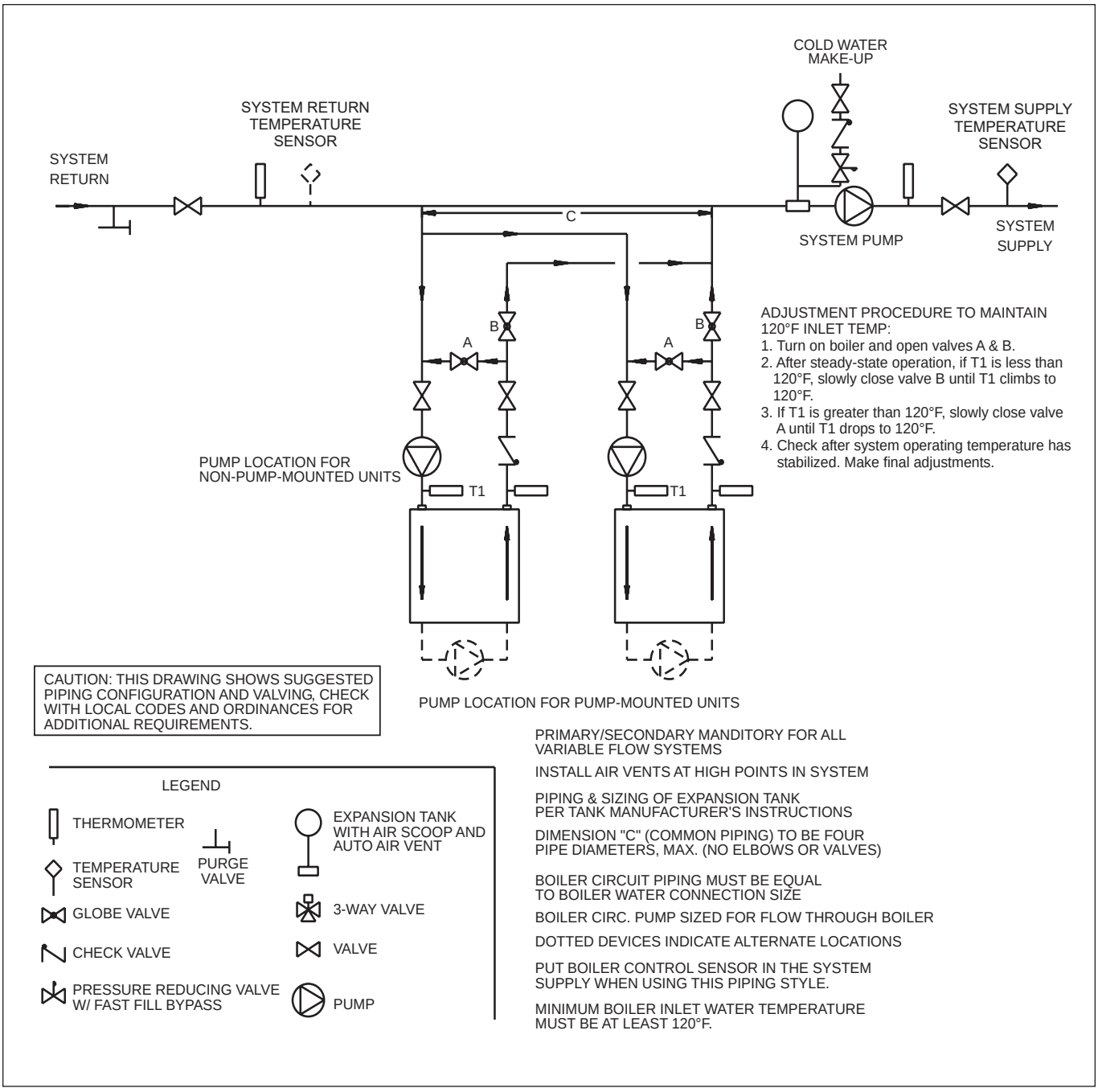


Figure 12. Hydronic Piping - Primary-Secondary, Reverse-Return, Low Temperature.

4.A.8 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 ¼ 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 ¼ 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 NOTE: 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.

4.B Water Heaters

4.B.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 unit 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 unit is shipped with an additional sensor that can be used the storage tank, in lieu of a separate tank thermostat, or 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 this Boiler / Water Heater is 120°F (49°C) to avoid condensing on the copper coils.

The minimum inlet water temperature for this Low-Temp unit is 70°F (20°C). The mixing system will ensure that the heat exchanger does not see water that is less than 120°F (49°C), so that excessive condensation does not form on the heat exchanger.

4.B.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 unit 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.

4.B.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 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 manufacturer's 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 10 on page 32 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.

4.B.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.

4.B.5 Freeze Protection – Water Heater

Although these 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 the manufacturer for additional information.

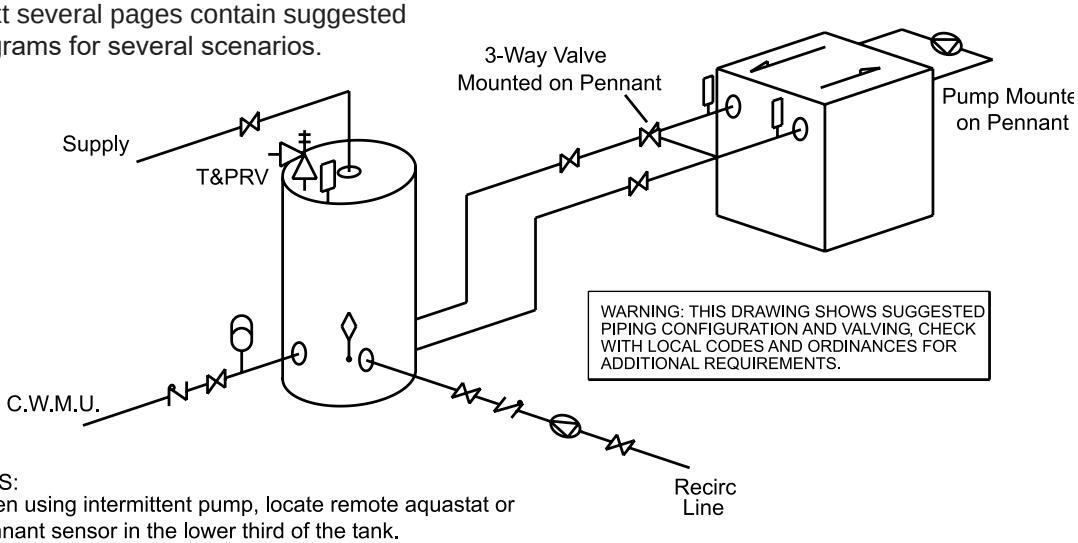
4.B.6 Sensor Locations

Same as for Boilers. For Sensor Locations with water heater installations, See 4.A.6 on page 20-

NOTE:	Outdoor Installation of this unit as a volume water heater, is not permitted in Canada.

4.B.7 Water Heater Suggested Piping Diagrams

The next several pages contain suggested piping diagrams for several scenarios.



NOTES:
1. When using intermittent pump, locate remote aquastat or Pennant sensor in the lower third of the tank.
2. Back flow preventer may be required. Check local codes.
3. Thermal expansion tank may be required. Check local codes.
4. Factory-mounted pump will serve the heater and 30 feet of full-size piping, with a normal number of fittings.
5. Factory-mounted pump is sized for water hardness.
   Soft water pumps: 1-7.5 grains per gallon
   Normal water pumps: 7.6-17 grains per gallon
   Hard water pumps: over 17 grains per gallon
6. Minimum inlet water temperature = 70°F (20°C)

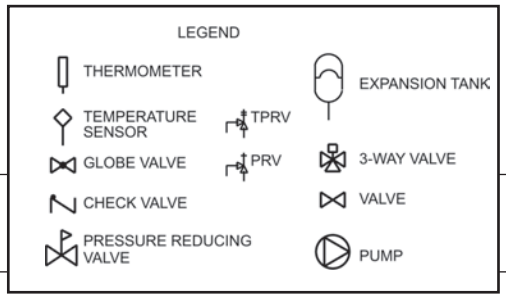


Figure 13. Water Heater Piping, Low Temperature System — One Heater, One Tank.

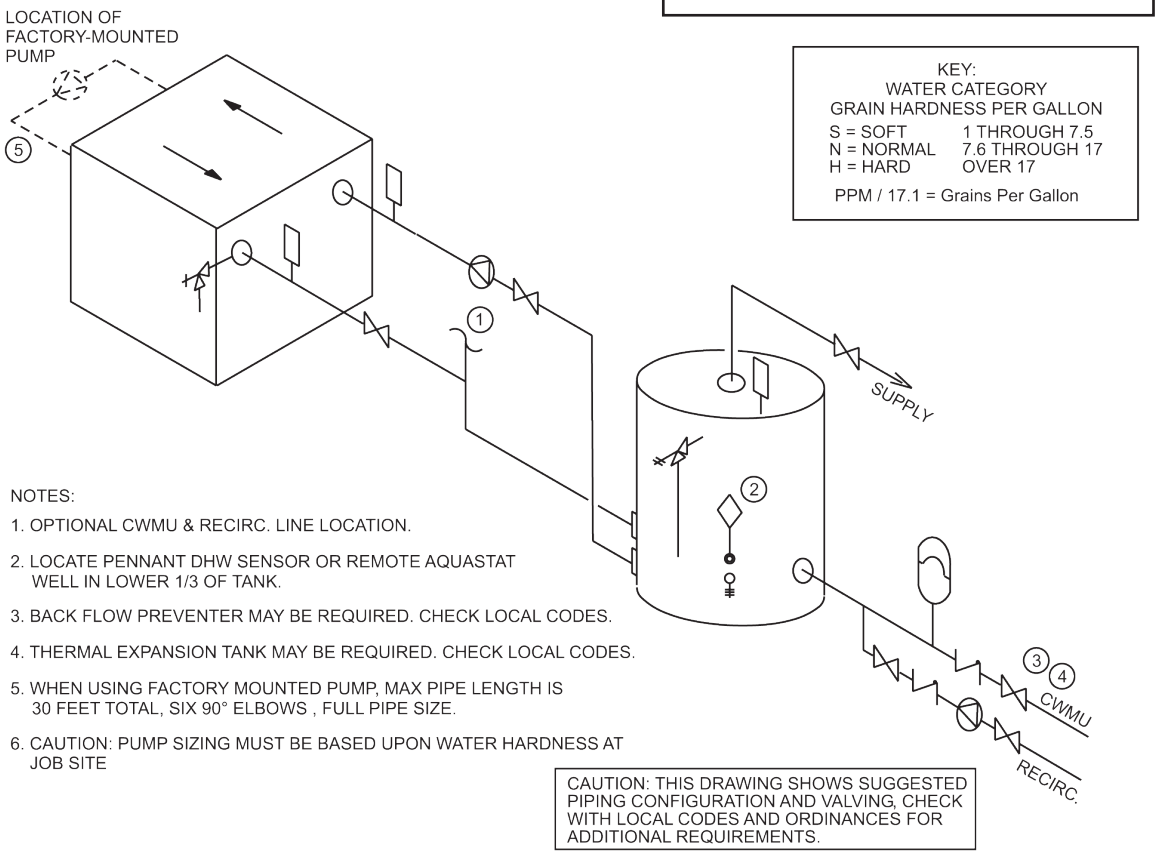


Figure 14. Water Heater Piping— One Heater, One Tank.

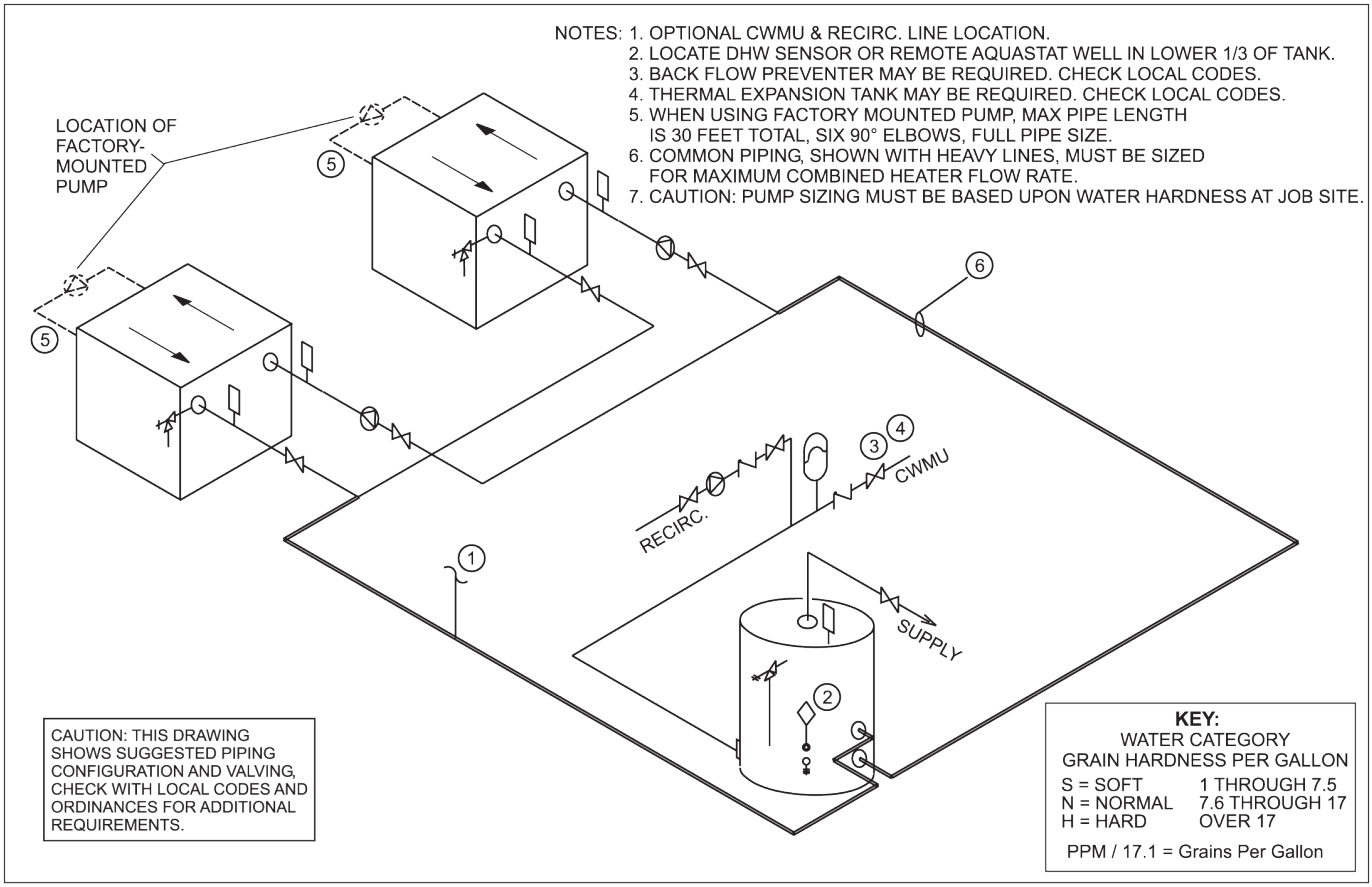


Figure 15. Water Heater Piping — Multiple Heaters, One Tank.

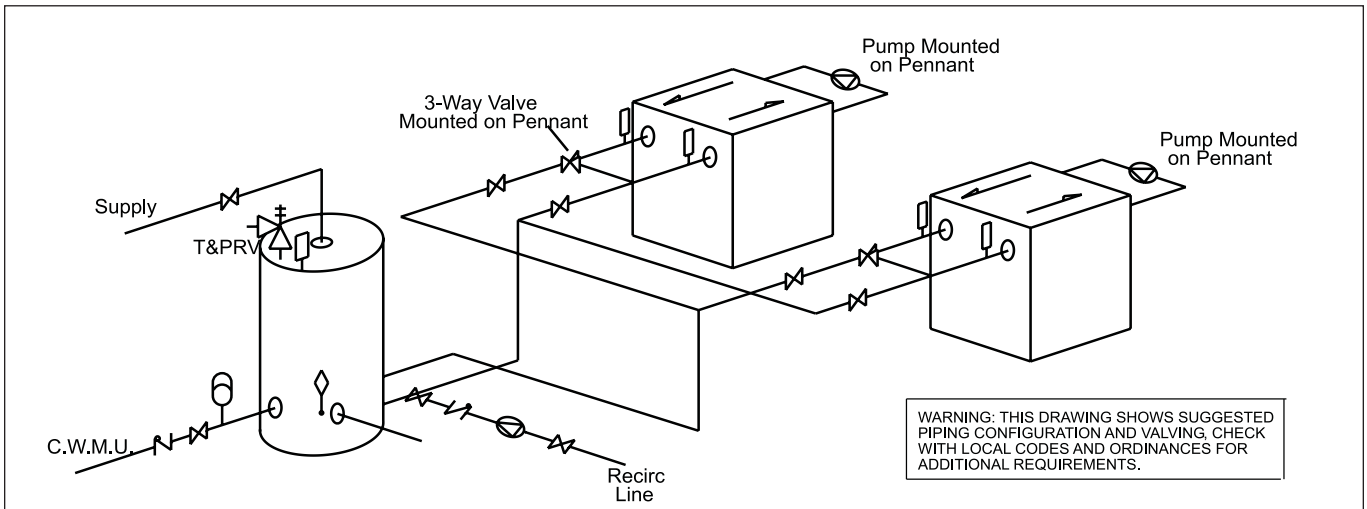


Figure 16. Suggested Piping, Low Temp System — Multiple Water Heaters, One Tank.

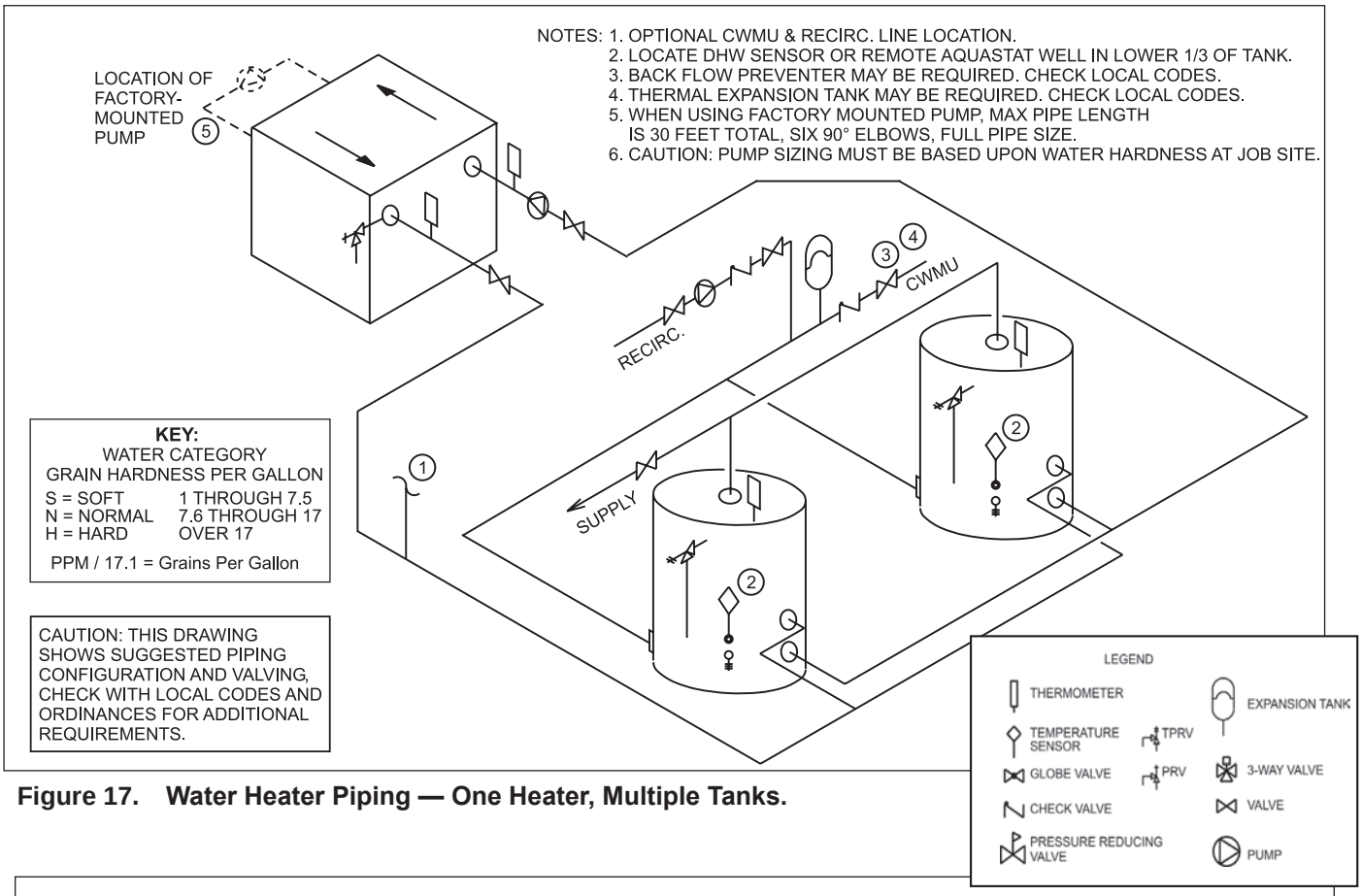


Figure 17. Water Heater Piping — One Heater, Multiple Tanks.

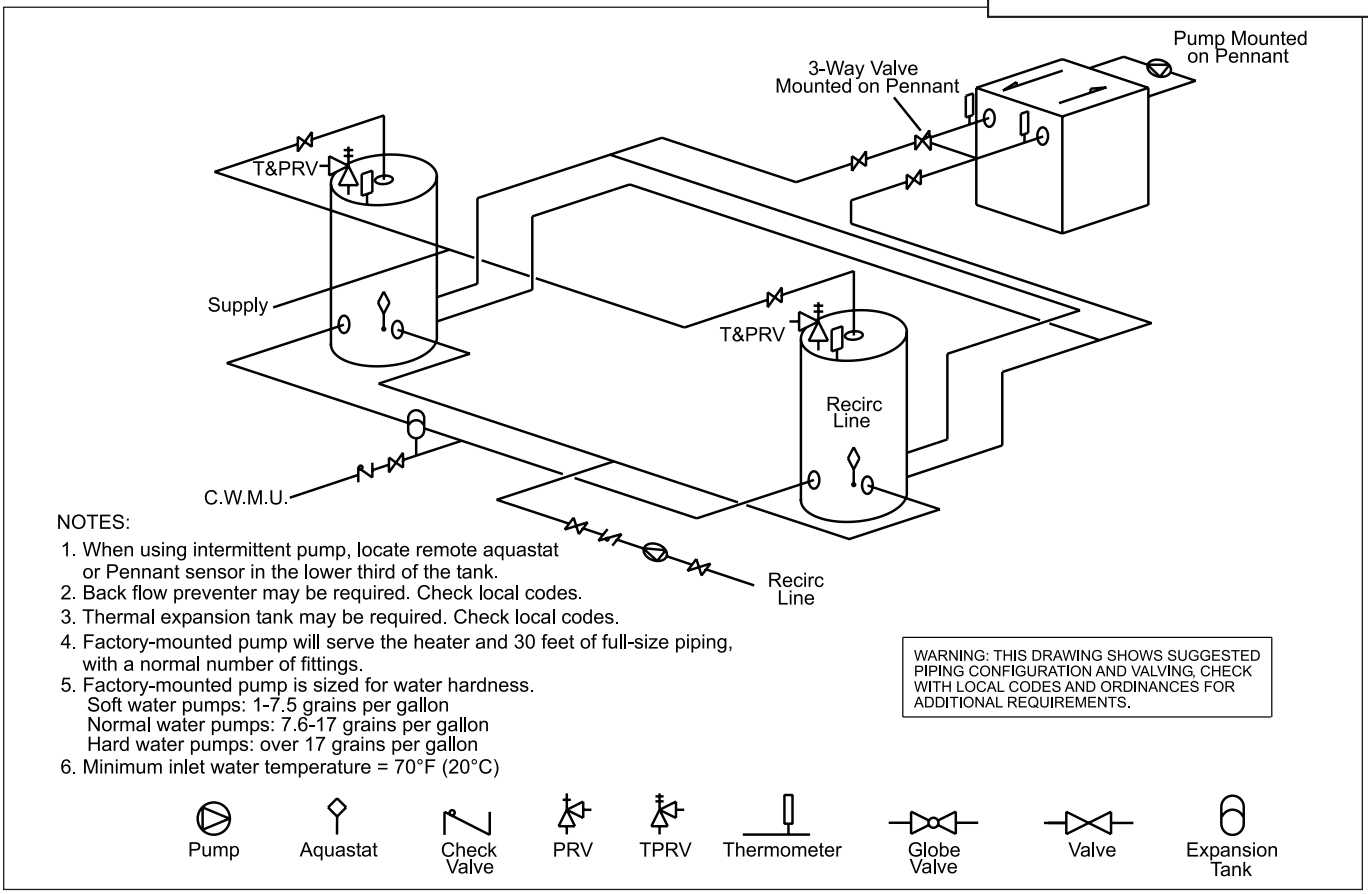


Figure 18. Suggested Piping, Low Temp System — One Water Heater, Multiple Tanks.

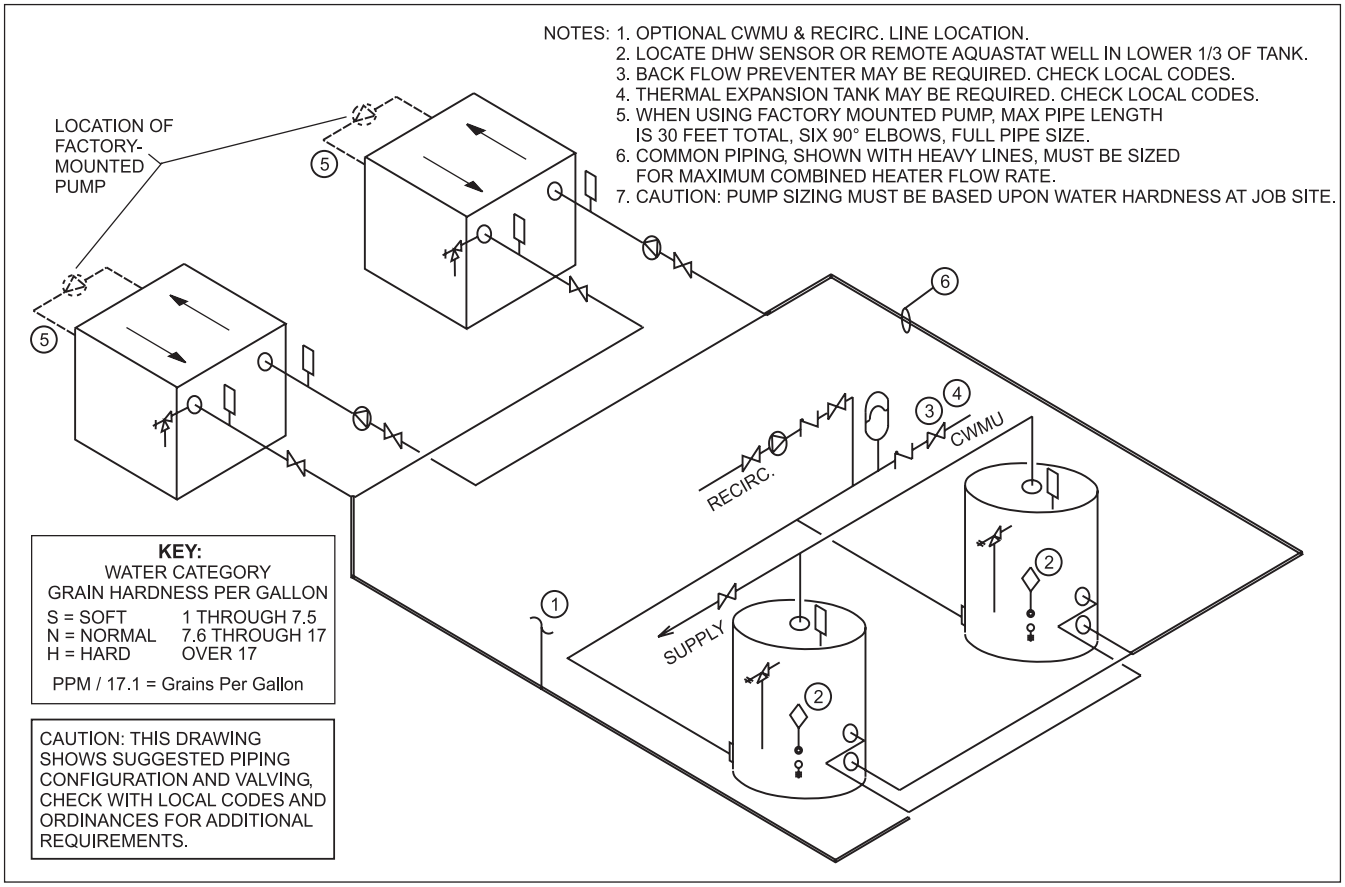


Figure 19. Water Heater Piping — Multiple Heaters, Multiple Tanks.

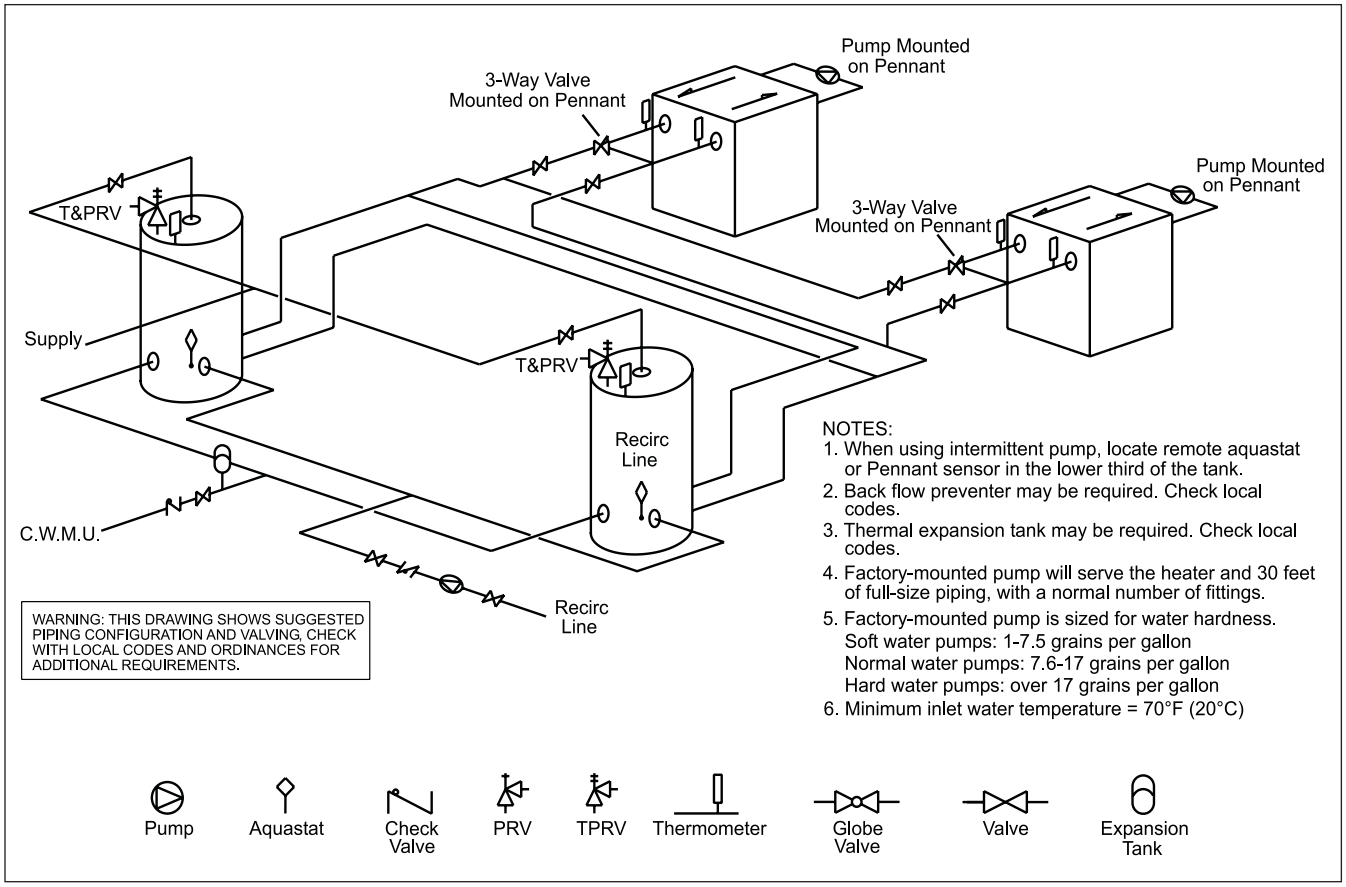


Figure 20. Suggested Piping, Low Temperature — Multiple Water Heaters, Multiple Tanks.

	GPM			FT			TEMP RISE °F			*LPM*			*M*			*TEMP RISE °C*		
SIZE	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 = headloss in feet, m = headloss in meters
5. Headloss is for heater's heat exchanger only

Table 10. Water Flow Requirements – Heater.

4.B.8 Filling the Water Heater 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 ¼ of the total, with the balance filled with air.
9. Start up the water heater 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 ¼ 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 the 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.

SECTION 5 Electrical Connections

5.A Installation Warnings

⚠ WARNING

This 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 the 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 could be electrocuted by an ungrounded boiler. Electrocution can result in severe injury or death.

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

All electrical connections are made at the power terminals, which are located at the rear of the appliance, or at the input/output terminal strips which are located on the right side of the appliance.

All internal electrical components have been prewired. No attempt should be made to connect electrical wires to any other location except the terminal blocks.

5.B Line Voltage Connections

Incoming power must be protected by the appropriate circuit breaker (fuse) and installed by a qualified electrician or authorized/qualified personnel. Recommended over current protection ratings are shown in Table 11.

5.B.1 Main Power

All non-pump mounted units require a single 120-volt supply. Pump mounted sizes 500-1500 also use a single 120-volt supply, and sizes 1750-2000 require two separate 120-volt supplies.

Unit sizes 500-1500 main power (L1, N1, and Ground) shall be connected to the three wires supplied. This main power circuit is identified by three solid colored wires (10 AWG) – black (L1), white (N1), and green (Ground).

Unit sizes 1750-2000 main power (L1, N1, and Ground) is identified by three solid colored wires (10 AWG) – black (L1), white (N1), and green (Ground). The pump circuit is identified by three 12 AWG wires, as outlined in the next Section.

5.B.2 Pump Power

The pump circuit is identified by three 12 AWG wires: black with a white stripe (L2), white (N2), and green (Ground).

If desired, an installer can change the pump mounted single service units to use a separate circuit for the pump. Instructions to make this change are found in the next Section.

Over Current Recommendations (Amps)			
	Pennant		Pump Only
Size	Without Pump	With Pump	Taco Pump
500	15	20	15
750	15	20	15
1000	20	25	15
1250	25	30	15
1500	25	30	15
1750	25	–	15
2000	25	–	20

Table 11. Circuit Protection

5.B.3 Boiler/Heater Pump

Conversion to a separate pump circuit requires bringing in a separate circuit for the pump and removing the three jumper wires within the internal wiring of the 120-volt portion of the unit. This action should only be performed by qualified personnel, with the power disconnected from the unit.

To rewire the pump circuit, bring in a separate 120-volt circuit (L2, N2, and Ground). Remove the jumper wires shown in Figure 21 on page 34. Connect the incoming line voltage (L2) to the main power switch using a ¼" female insulated push on terminal. From the other side of the main power switch, connect to the main power terminal block, in the rear of the unit, using a ¼" female insulated push on terminal. This will be in the same position where the line voltage jumper terminated. Connect N2 and Ground to the main terminal block, in the rear of the unit, using ¼" female insulated push terminals. These connections will also be the same positions where the neutral and ground jumpers were terminated.

5.B.4 Auxiliary Power Output

The Auxiliary Power Output, if used, is controlled by Field Input 2. When Field Input 2 is closed, line voltage is supplied at terminal 7 and neutral on terminal 8 of the output terminal strip. This output is rated for 250VAC, 2.5A maximum.

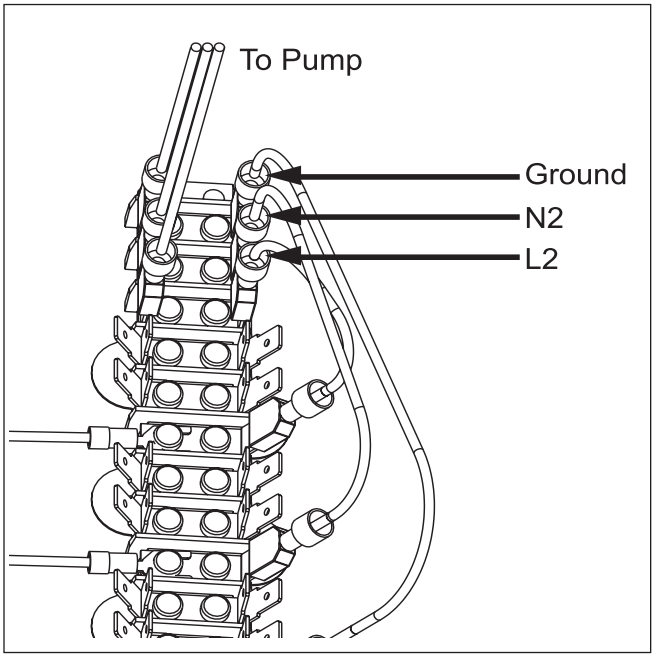


Figure 21. Removing Jumpers

5.C Low Voltage Connections

Route all field wiring through the knockouts on the right side of the unit and connect to the terminal strips as labelled in Figure 24 on page 36. Refer also to 5.E on page 38

5.C.1 Field Wiring - Inputs

5.C.1.a Safety Interlocks

Field Interlock: If the Field Interlock is utilized, remove the jumper from the terminals 1 and 2 of the input terminal strip and wire the interlock to these terminals. Only dry contacts can be connected to the Field Interlock terminals.

NOTE: Safety chain voltage is 24VDC.

5.C.1.b Boiler/Heater Heat Demands

CH1/DHW1: If the CH1/DHW1 field connection is utilized, remove the jumper from terminals 3 and 4 of the input terminal strip. Wire the thermostat/aquastat or end switch (isolated contact only) wires to terminals 3 and 4 of the input terminal strip.

CH2/DHW2: Connect an additional thermostat/ aquastat or end switch (isolated contact only) wires to terminals 7 and 8 of the input terminal strip.

DHW/DHW3: Connect the aquastat or end switch (isolated contact only) wires to terminals 5 and 6 of the input terminal strip. If preferred, a DHW tank sensor can be used in lieu of an aquastat to generate a heat demand, refer to Section 5.C.1.d.

NOTE: The heat demand contacts must be dry contacts. The controllers heat demand voltage is 24VDC.

5.C.1.c Field Inputs (Open/Closed)

Field Input 1: Field Input 1, if used, is connected across terminals 9 and 10 of the input terminal strip. When connected, Field Input 1 controls the Auxiliary Dry Contact. If Field Input 1 is open, the Auxiliary Dry Contact is open. If Field Input 1 is closed, the Auxiliary Dry Contact is closed. Only dry contacts can be connected to Field Input 1.

Field Input 2: Field Input 2, if used, is connected across terminals 11 and 12 of the input terminal strip. When connected, Field Input 2 controls the Auxiliary Power Output. If Field Input 2 is open, the Auxiliary Power Output is off. If Field Input 2 is closed, the controller turns power on at the Auxiliary Power Output.

NOTE: The controller applies 24VDC to the Field Inputs to detect the status of the contacts.

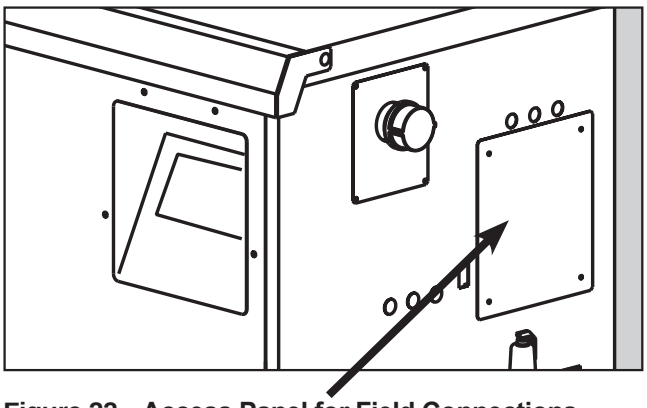


Figure 22. Access Panel for Field Connections

5.C.1.d Temperature Sensors

The System Supply:Sensor, if used, is connected to terminals 14 and 15 of the input terminal strip. See Figure 24 on page 36 When connected, the controller automatically detects the presence of this sensor. If installed, the unit controls the staging of the burners to maintain the system supply temperature to the heat demand set point. The system supply temperature is shown on the home screen above the red system input arrow, see Figure 29 on page 42. This sensor is supplied loose with the unit and is installed in the piping or tank per the suggested piping diagrams. See Figure 6 on page 20.

The System Return Sensor, if used, is connected to terminals 16 and 17 of the input terminal strip. See Figure 24 on page 36 When connected, the controller automatically detects the presence of this sensor. There is no control logic associated with this sensor. When connected, this temperature is shown on the home screen above the blue system output arrow. This sensor is supplied loose with the unit and is installed in the piping or tank per the suggested piping diagrams. See Figure 6 on page 20.

The Domestic Hot Water (DHW) Sensor, if used, is connected to terminals 18 and 19 on the input terminal strip. When connected, the unit will use this sensor to perform the DHW thermostat function. The controller automatically detects the presence of this sensor and initiates a call for heat when the DHW temperature drops below the DHW set point by the value of the DHW On Hysteresis (DHW Set Point – DHW On Hysteresis = DHW heat demand). The DHW heat demand is satisfied when the DHW temperature rises above the DHW set point by the value of the DHW Off Hysteresis (DHW Set Point + DHW Off Hysteresis = DHW heat demand satisfied). When connected, this temperature is shown on the home screen below the faucet icon. This sensor is supplied loose with the unit and is installed in the tank per the suggested piping diagrams.
See Figure 7 on page 20

The Outdoor Sensor/Warm Weather Shutdown, if used, is connected to terminals 20 and 21 of the input terminal strip. When connected, the controller automatically detects the presence of this sensor. If installed, options such as outdoor reset and warm weather shutdown can be enabled through the display. Always install the Outdoor Sensor at an outdoor location that is not affected by false temperature readings such as sunlight or hot equipment.

5.C.1.e Analog (BMS) Input

Building Management System (BMS): The BMS input, if used, is connected to terminals 22 and 23 of the input terminal strip. When making the connection, adhere to the polarity designations shown on the label or wiring diagram. The input signal can be 0 – 10 VDC or 4 – 20 mA, and can be used to control the firing rate or set point, refer to 6.E.9 on page 62. The factory default setting is for a 0 – 10VDC signal. Configure for 4 – 20 mA by placing a jumper on CN20 on the control board.

NOTE: The front panel must be removed to access the PCB that is illustrated in Figure 23 on page 35 and/or Figure 47 on page 81.

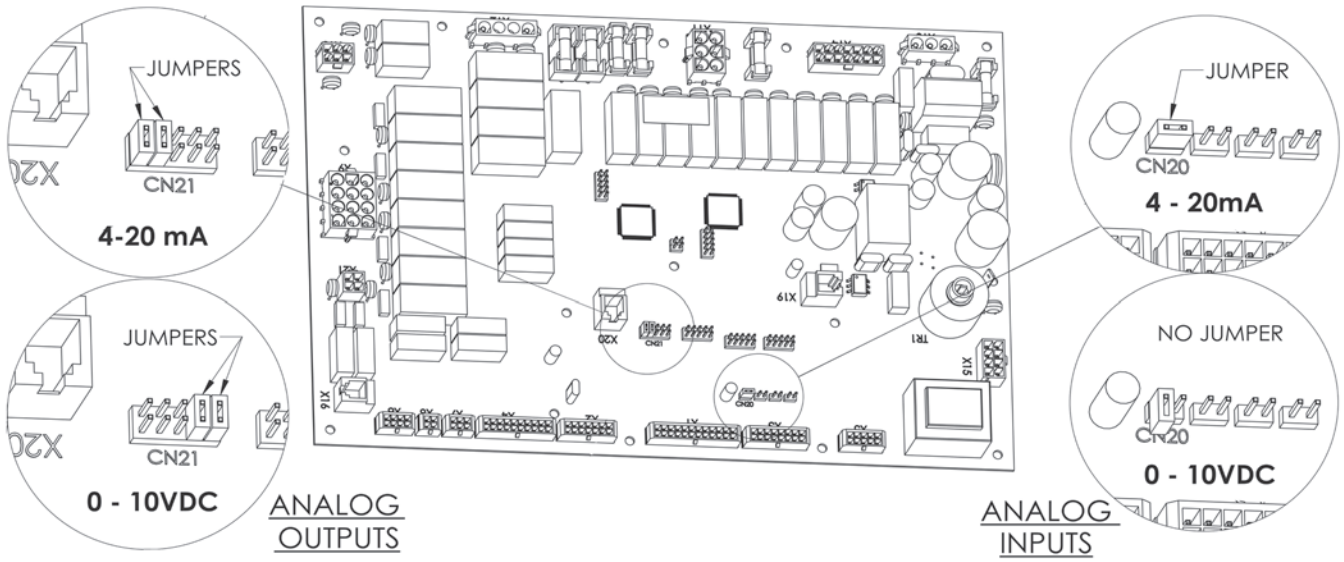


Figure 23. Analog Input and Output Jumper Placement

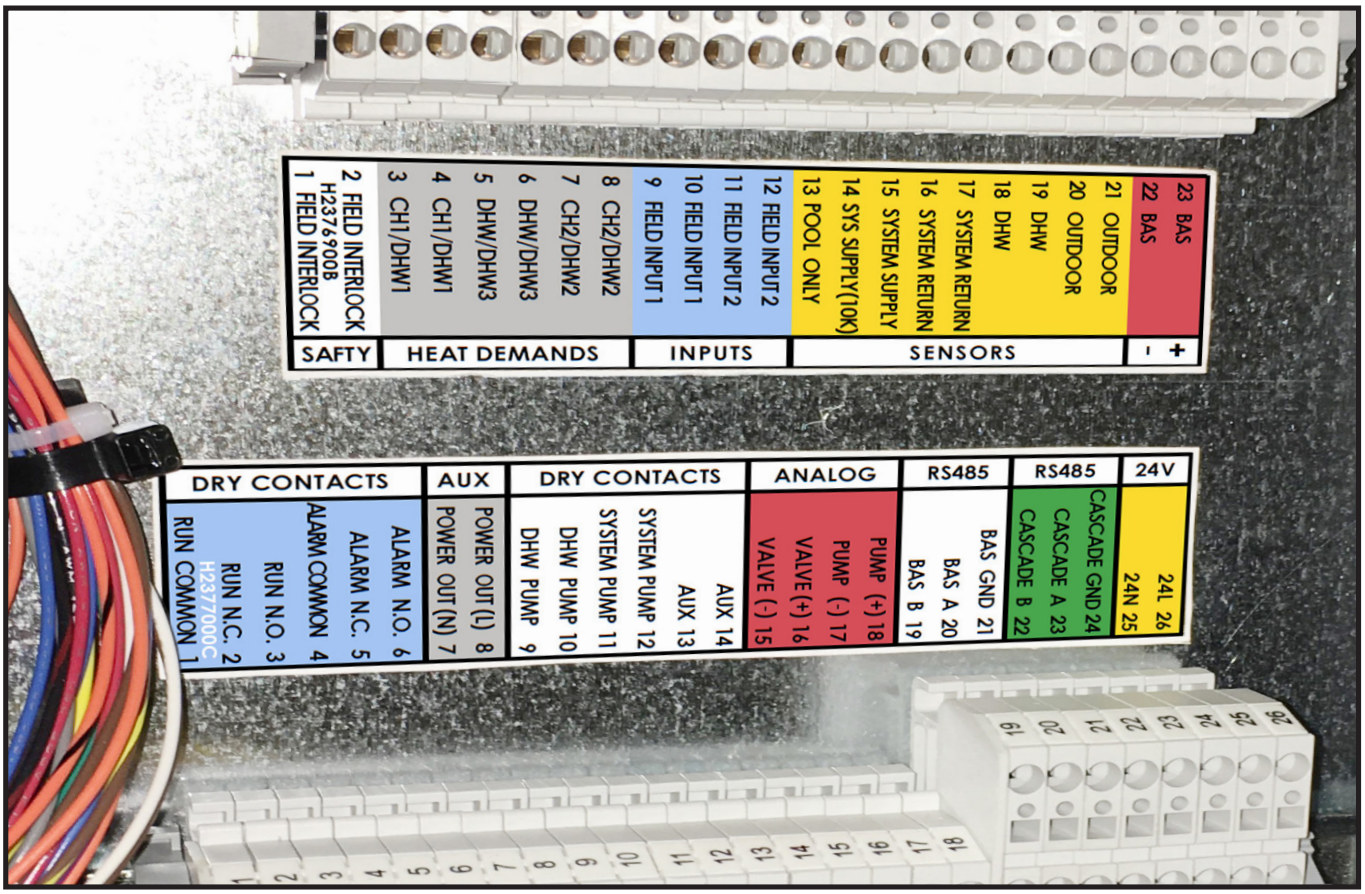


Figure 24. Input and Output Terminal Strips. Low Voltage Connections / Field Wiring

5.C.2 Field Wiring - Outputs

5.C.2.a Dry Contacts

Run: These contacts, when used, are connected to terminals 1 (common), 2 (normally closed), and 3 (normally open) of the output terminal strip. The controller closes the normally open set of contacts whenever the unit is running. This is typically used by a BMS to verify the unit is satisfying a heat demand. Contact ratings are 250VAC, 0.6A maximum.

Alarm: These contacts, when used, are connected to terminals 4 (common), 5 (normally closed), and 6 (normally open) of the output terminal strip. The controller closes the normally open set of contacts whenever the unit is locked out or power is turned off. Contact ratings are 250VAC, 0.6A maximum.

DHW Pump: When connecting a domestic hot water (DHW) pump, use terminals 9 and 10 of the output terminals strip. As this is a dry contact, the DHW pump contact must be wired with either the DHW pump supply voltage or DHW pump relay coil voltage. DHW pump functionality is configured using the touch screen. Contact ratings are 250VAC, 1.5A maximum.

System Pump: When connecting a system pump, use terminals 11 and 12 of the output terminal strip. As this is a dry contact, the system pump contact must be wired with either the system pump supply voltage or the system pump relay coil voltage. System pump functionality is configured using the touch screen. Contact ratings are 250VAC, 1.5A maximum.

AUX: These contacts, when used are connected to terminals 13 and 14 of the output terminal strip. The controller closes this contact when Field Input 1 is closed; otherwise, this contact remains open. Contact ratings are 250VAC, 1.5A maximum.

5.C.2.b Cascade RS485

Prior to wiring these units for cascade operations, select one unit as the lead boiler/heater. Other units connected to the lead boiler/heater will be referred to as lag units.

Communication between lead and lag units is accomplished using RS485. When wiring these units for cascade operations, use terminals 23 (A), 22 (B), and 24 (GND) of the output terminal strip. Use 3-wire shielded w/drain (communication cable)

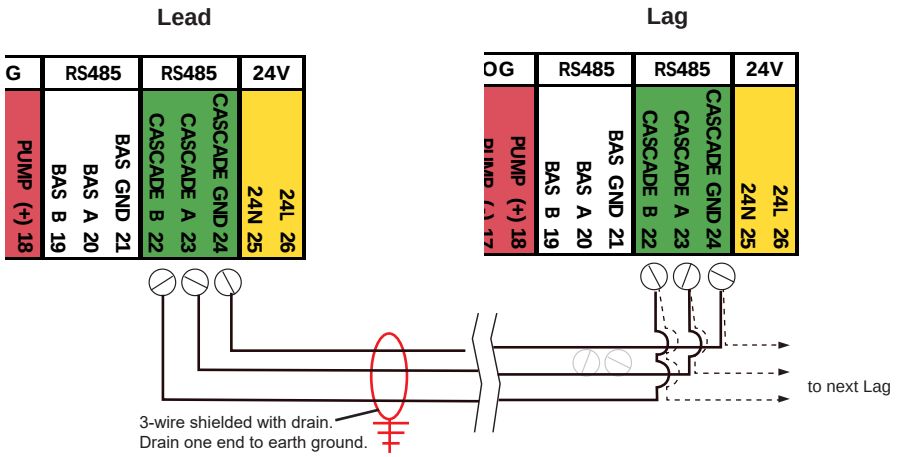


Figure 25. Cascade Wiring Connections

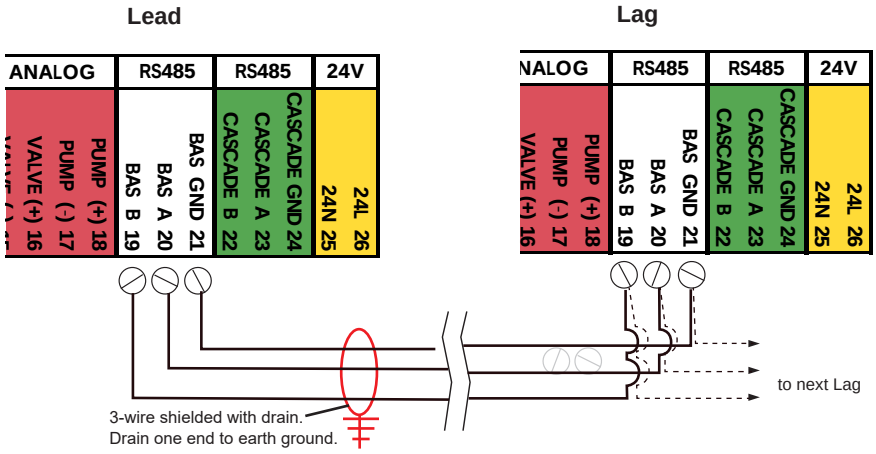


Figure 26. BMS Wiring Connections

between units. **See Figure 25**. Connect the first wire of the communication cable to A (terminal 23), and the second wire to terminal B (terminal 22), and the third wire to GND (terminal 24). Connect the other end of the cable to the next unit, matching the termination wiring on the previous unit. Only connect the drain wire to ground on one end of the cable to avoid ground loop issues. If more than two units are cascaded together, daisy chain the wiring from unit to unit, keeping the cables as short as possible.

A system supply sensor must be installed and connected to the lead boiler, see System Supply in 5.C.1.d on page 35 – Temperature Sensors. The lead boiler will use this system supply sensor as the temperature control sensor for cascade operations.

CH1 terminals are used to initiate a heat demand at the lead boiler, refer to CH1 in 5.C.1.b on page 34– Heat Demands.

5.C.2.c BMS RS485 (BACnet MS/TP or Modbus)

These terminals, when used, are for RS485 serial communication with a BMS system using BACnet MS/TP or Modbus protocols. Use 3-wire shielded w/drain (communication cable) between the BMS and the unit. **See Figure 26**

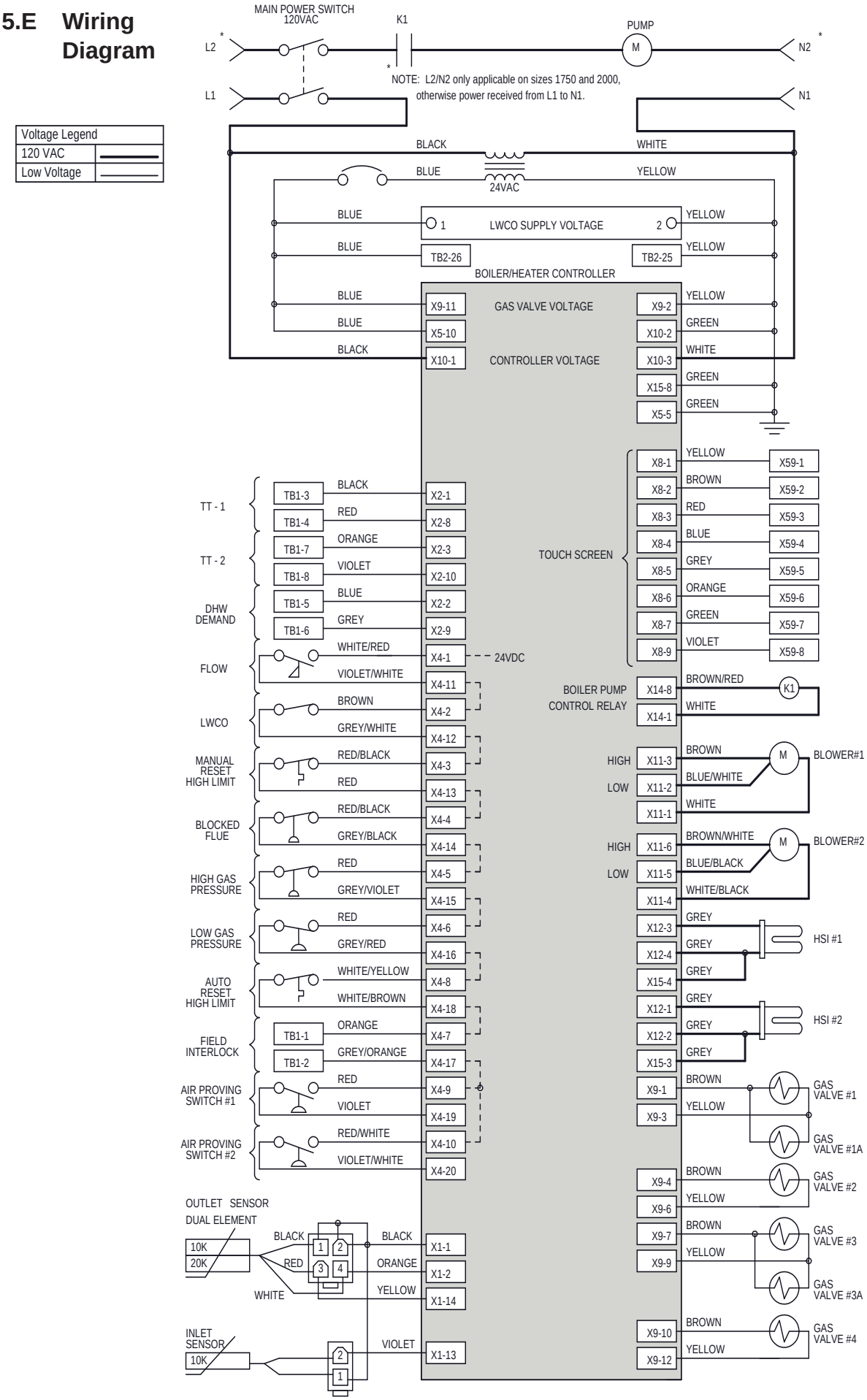
5.C.2.d 24VAC

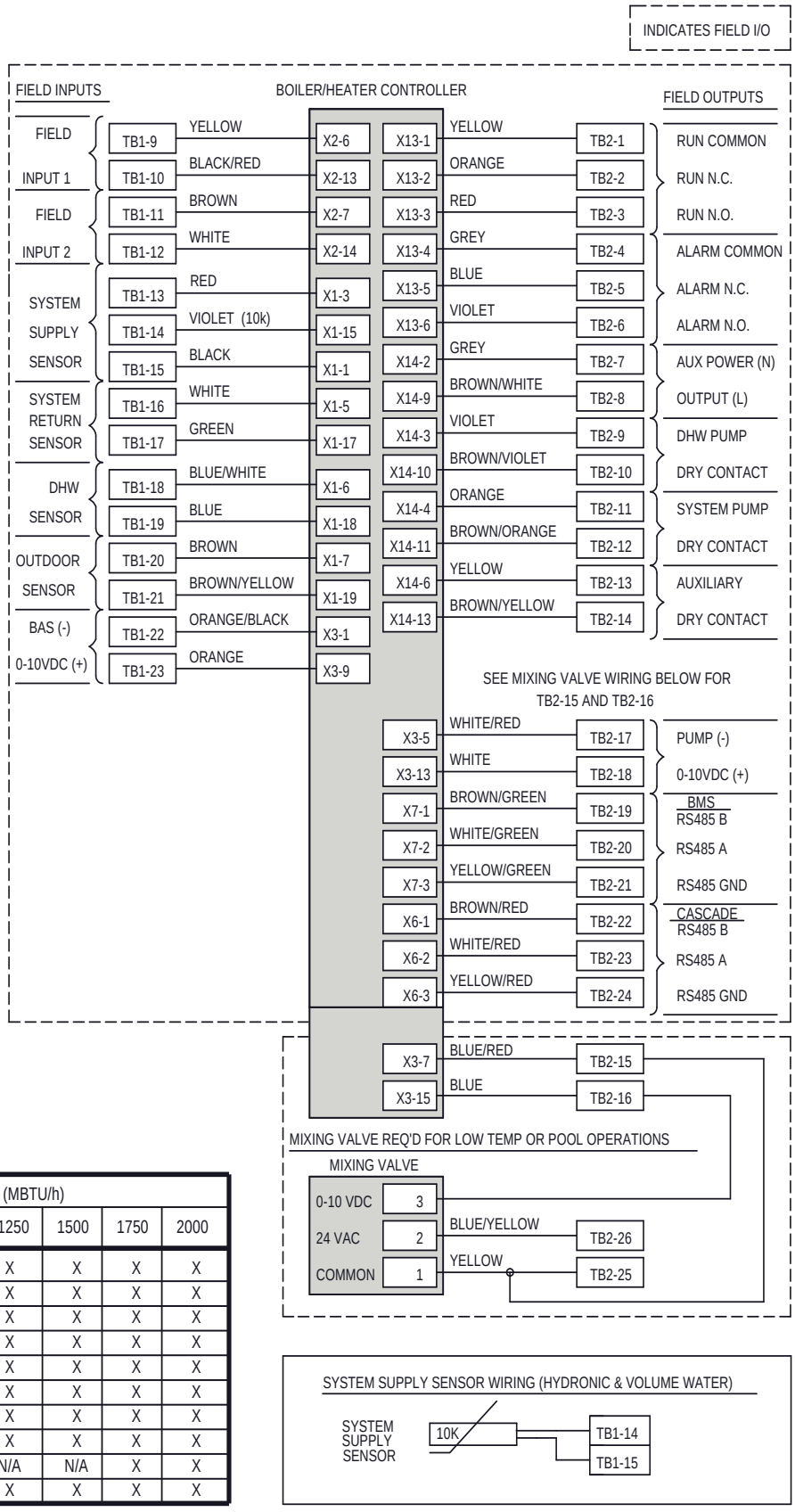
There are terminals for 24VAC on the output terminal strip. These terminals are reserved for low-temp units or a low water cutoff option kit.

5.D Cascade Wiring Connections

See Figure 25 and Figure 26

5.E Wiring Diagram





COMPONENT	SIZE (MBTU/h)						
	500	750	1000	1250	1500	1750	2000
BLOWER #1	X	X	X	X	X	X	X
BLOWER #2	N/A	N/A	N/A	X	X	X	X
HSI #1	X	X	X	X	X	X	X
HSI #2	N/A	N/A	X	X	X	X	X
GAS VALVE #1	X	X	X	X	X	X	X
GAS VALVE #1A	N/A	X	N/A	X	X	X	X
GAS VALVE #2	X	X	X	X	X	X	X
GAS VALVE #3	N/A	N/A	X	X	X	X	X
GAS VALVE #3A	N/A	N/A	N/A	N/A	N/A	X	X
GAS VALVE #4	N/A	N/A	N/A	X	X	X	X

Figure 27. Wiring Diagram. Sizes 500 - 2000.

5.F Ladder Diagram

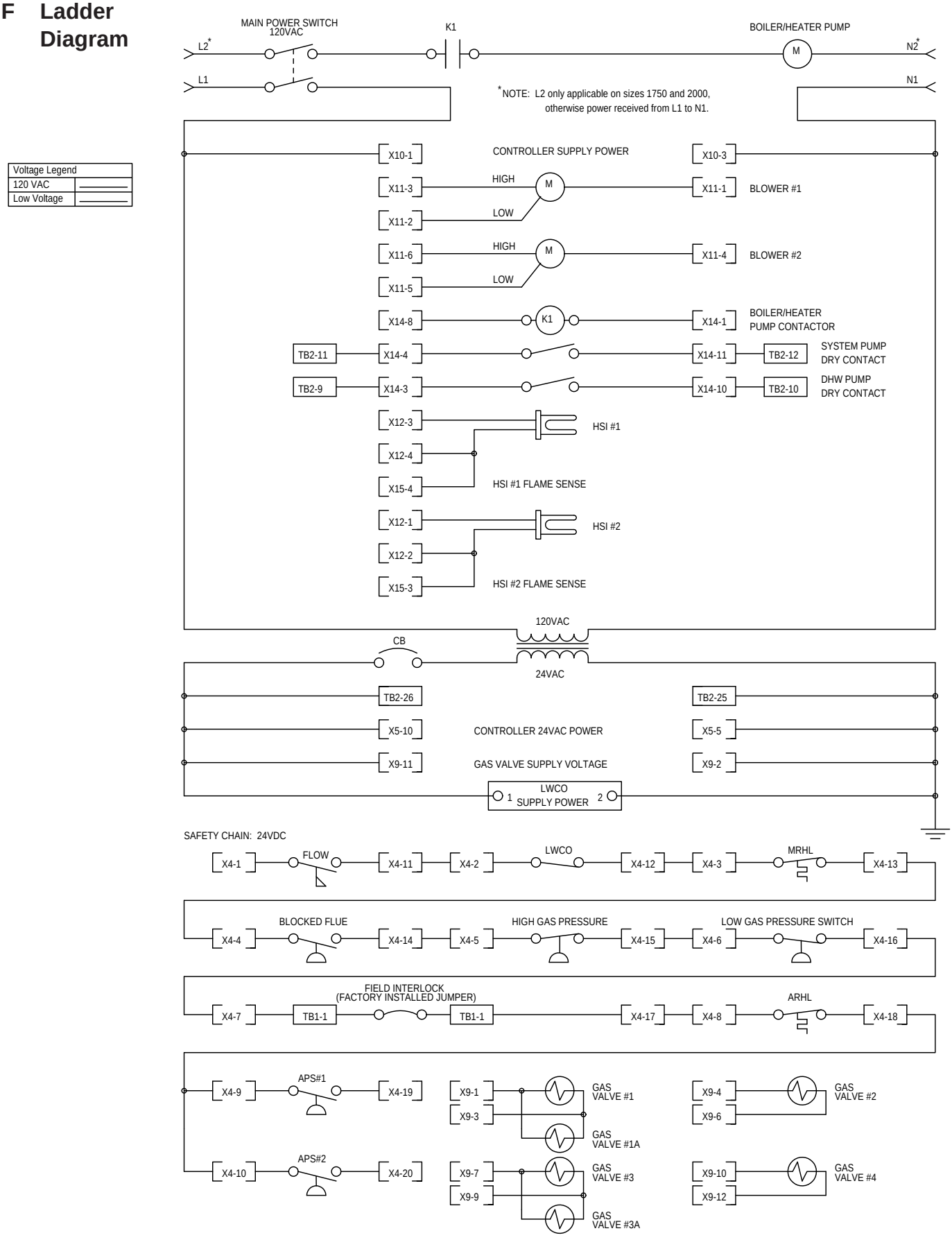
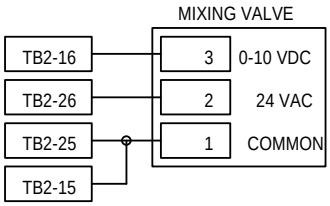
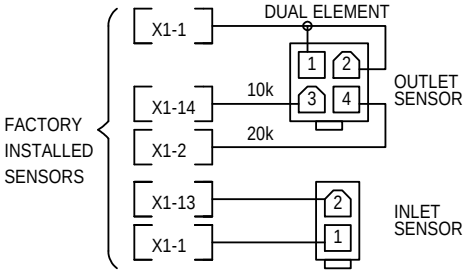


Figure 28. Ladder Diagram. Sizes 500 - 2000.



MIXING VALVE REQ'D FOR LOW TEMP OPERATIONS



COMPONENT	SIZE (MBTU/h)						
	500	750	1000	1250	1500	1750	2000
BLOWER #1	X	X	X	X	X	X	X
BLOWER #2	N/A	N/A	N/A	X	X	X	X
HSI #1	X	X	X	X	X	X	X
HSI #2	N/A	N/A	X	X	X	X	X
GAS VALVE #1	X	X	X	X	X	X	X
GAS VALVE #1A	N/A	X	N/A	X	X	X	X
GAS VALVE #2	X	X	X	X	X	X	X
GAS VALVE #3	N/A	N/A	X	X	X	X	X
GAS VALVE #3A	N/A	N/A	N/A	N/A	N/A	X	X
GAS VALVE #4	N/A	N/A	N/A	X	X	X	X

INDICATES FIELD I/O

FIELD INPUTS

TB1-1	FIELD	SAFETY CHAIN
TB1-2	INTLK	
TB1-3	CH1	HEAT DEMANDS
TB1-4	CH1	
TB1-5	DHW	
TB1-6	DHW	
TB1-7	CH2	
TB1-8	CH2	
TB1-9	FIELD	FIELD INPUTS
TB1-10	INPUT1	
TB1-11	FIELD	
TB1-12	INPUT2	
TB1-13	SYSTEM SUPPLY	SENSOR INPUTS
TB1-14		
TB1-15		
TB1-16	SYSTEM	
TB1-17	RETURN	
TB1-18	DHW	
TB1-19	DHW	
TB1-20	OUTDOOR	
TB1-21	OUTDOOR	
TB1-22	BAS (-)	ANALOG INPUT
TB1-23	0-10V (+)	

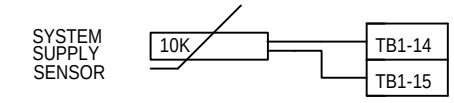
FIELD OUTPUTS

TB2-1	COMMON	RUN RELAY DRY CONTACTS
TB2-2	N.C.	
TB2-3	N.O.	
TB2-4	COMMON	ALARM RELAY DRY CONTACTS
TB2-5	N.C.	
TB2-6	N.O.	
TB2-7	AUX	POWER OUTPUTS
TB2-8	AUX	
TB2-9	DHW	DRY CONTACTS
TB2-10	PUMP	
TB2-11	SYSTEM	
TB2-12	PUMP	
TB2-13	AUX	
TB2-14	AUX	

SEE MIXING VALVE WIRING BELOW FOR TB2-15 AND TB2-16

TB2-17	PUMP(-)	ANALOG OUTPUT
TB2-18	0-10V(+)	
TB2-19	B	RS485 BMS
TB2-20	A	
TB2-21	GND	
TB2-22	B	RS485 CASCADE
TB2-23	A	
TB2-24	GND	

SYSTEM SUPPLY SENSOR WIRING (HYDRONIC & VOLUME WATER)



SECTION 6 Laars Linc® Touchscreen

6.A The Home Screen

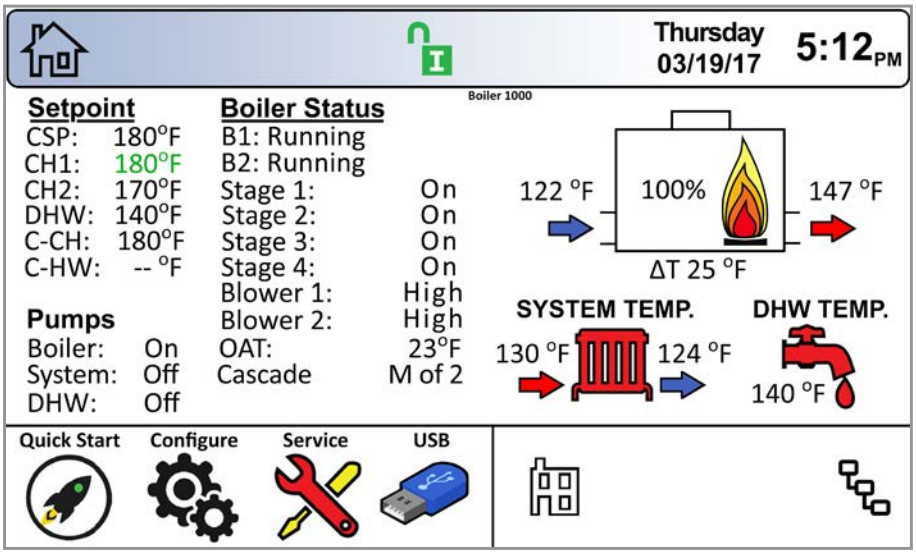


Figure 29. The Home Screen

Model	Stages
Low Temp	On/Off
500 - 750	2
1000	3
1250 - 2000	4

Table 12. Stages per Model

6.A.1 Home Screen Status Window

The central area of the home screen displays the current status information for the unit.

Heat Demand Set Points.

Pump Status.

Boiler Status (Boiler Bank).

System Temp.

DHW Temp (if installed).

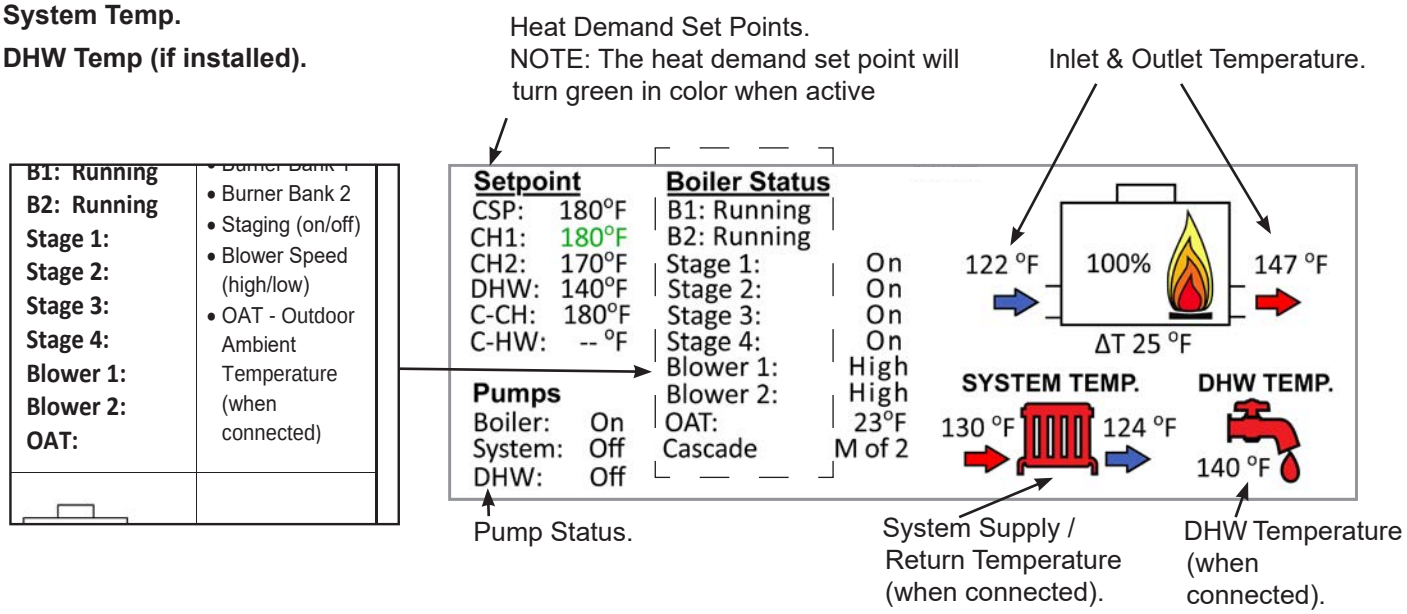


Figure 30. The Status Display Area, defined.

6.A.2 Home Screen Active Icons

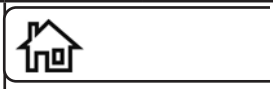
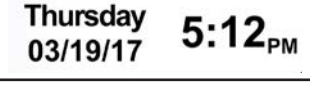
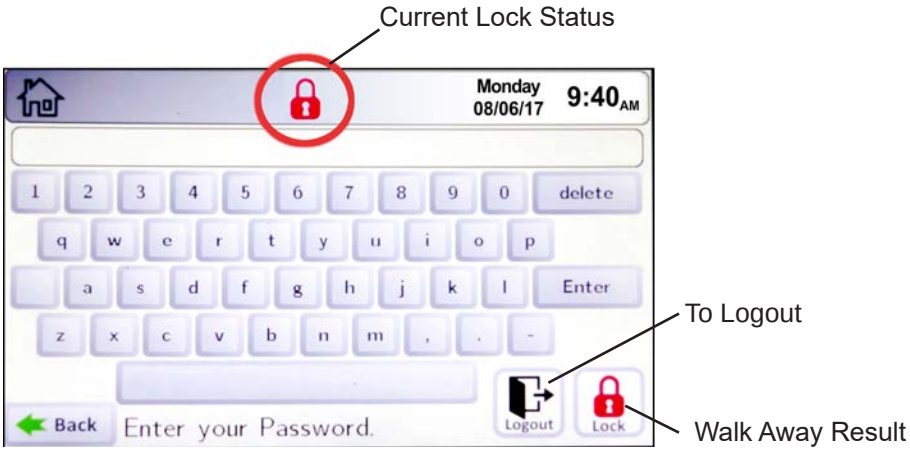
Name	Icon	Description
Security		Displays the current lock status. Touch the lock icon to lock or unlock the Touchscreen Display. See **Section 6.B on page 44**
Quick Start		Provides quick touch access to the most commonly used parameters for easy installation. See **Section 6.D on page 46**
Configure		Will take you to ALL of your configurations and parameters for a detailed setup of the unit. This is the largest group of menu screens. See **Section 6.E on page 49**
Service		Allows the service technician to access the basic diagnostic and troubleshooting information. See **Section 6.F on page 69**
Messages		Will show an 'Exclamation' when there is a message. Clicking onto the Message icon will take you to the message itself. The USB functionality will show the USB Icon at this location, if being used. See **Section 6.G on page 74** 
Active Demands		Will show icons that indicate the active parameters that are currently in demand. See **Section 6.H on page 75**
Navigation Bar		The Navigation Bar is the constant indicator of where you are as you navigate into and out of the touchscreens. See **Section 6.I on page 75** **ERROR** Codes also show in the ***Navigation Bar*** when there is one of several unit errors or shut-downs that have occured.
Date & Time		For Display Only. To change date and time, go to the Configuration menu. **Section 6.J on page 75**

Table 13. The Active Icons on the Home Screen, and what they do.

6.B Lock / Unlock the Display Screen

Password Protection:

To change parameters, a password is required. The control system includes three levels of password protection. Touch the 'Current Lock Status' Icon.



Screen 1. Sign in Screen

1-USER Password: Non-critical adjustments and functions. **The user password is lhs.** When unlocked in the User mode, the icon will change to-

2-INSTALLER Password: Setup and parameter changes made during the initial setup and commissioning. **The installer password is 17.**
When unlocked in the Installer mode, the icon will change to-

3-OEM Password: Setup and parameter changes available only to the factory.

Walk-Away Result. After a default time of 5 minutes, the unit will either Lock or stay Un-locked. This is called the 'Walk-Away Result'. What the unit will do is displayed in the bottom right corner. The delay time before locking, can be adjusted in Service -> Screen -> Auto Lock Timeout. And it can also be set up to never Lock.

Lock Unlock

Logout. If the Installer is done and wants to lock the display immediately, tap the Logout Icon to exit Installer or User Modes, essentially locking the unit.

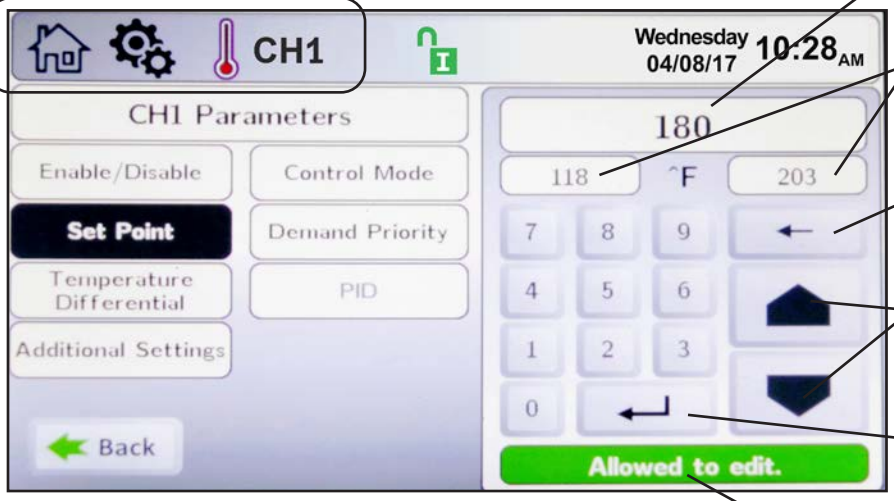
Logout

6.C Keypad Operations

As you navigate in, you find that all screens have either a numeric keypad to enter in your customizable parameters OR selection buttons to choose the options for your configuration.

NOTE: You can always tell exactly where you have navigated to by looking at the icons in the ***Navigation Bar.***

In this example you are in
Home/Configure/Central Heat/Central Heat One



Shows the current setting of the Parameter.

These windows will reflect the allowable ranges that the setting can be adjusted to.

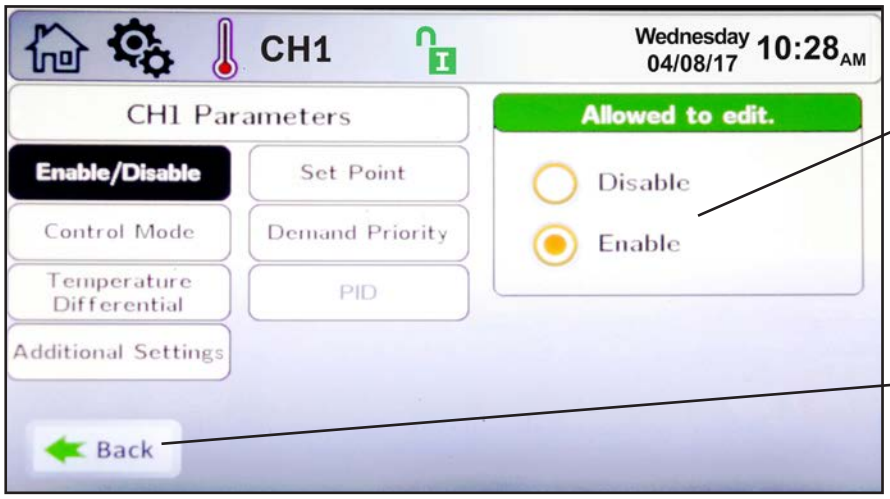
To delete the current setting before entering in the new value.

"Up and Down" arrows are used to increment the setting accordingly.

The "Enter" button is used to accept the new value that was just entered.

This is the indicator that will be shown when the correct password has been entered to allow the setting to change.

Screen 2. A typical numeric keypad entry screen.



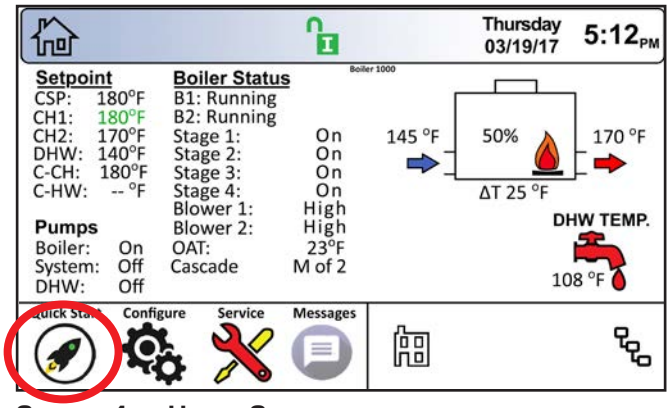
The highlighted button (orange) shows which one is selected. Some screens may only allow you to set one or the other, while some other screens (example: pump selection) will allow you to select any or all of the options.

The "Back" button jumps to the previous screen.

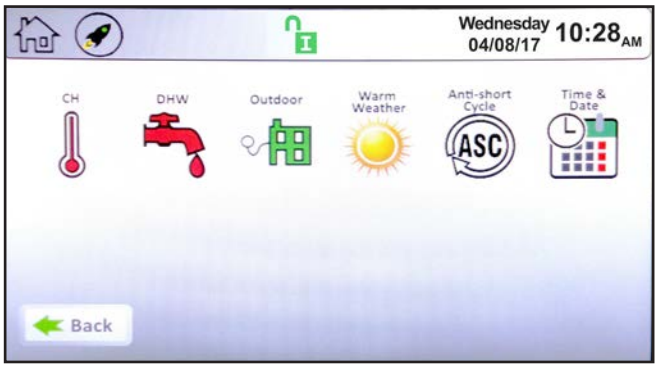
Screen 3. A typical selection screen.

6.D Quick Start

To navigate to the Quick Start Screen, touch the Quick Start Icon in the lower left-hand portion of the Home Screen.



Screen 4. Home Screen

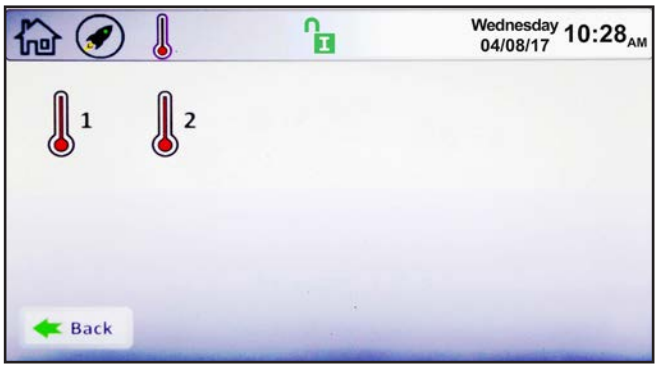


Screen 5. Quick Start Screen

6.D.1 CH

On the Quick Start Screen, touch the CH thermometer icon to navigate to the CH Selection Screen

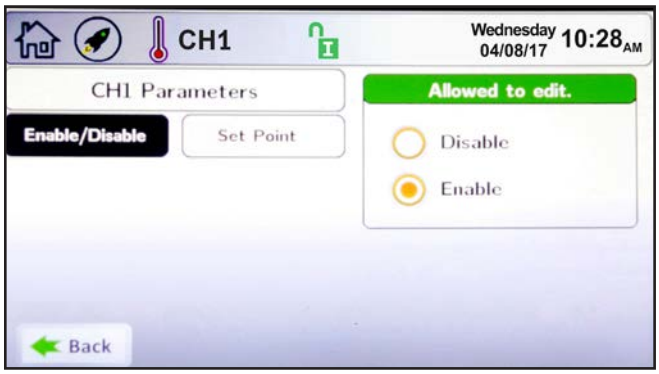
There are two identical heat demands, CH1 and CH2, each with independent control algorithms and independent inputs on the input terminal strip, see Figure 24 on page 36.



Screen 6. CH Quick Start Selection Screen

Touching CH1 navigates to the CH1 Quick Start Screen

6.D.1.a CH1 1

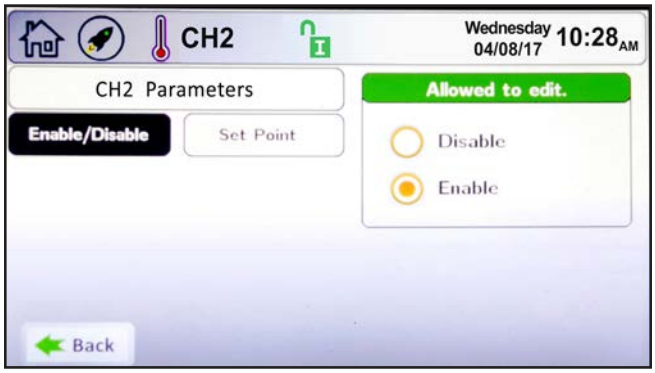


Screen 7. CH1 Quick Start Screen

- **Enable/Disable** – This allows CH1 to be enabled/disabled. The default setting is Enabled.
- **Set Point** – This is the temperature that this heat demand will control to.

6.D.1.b CH2 2

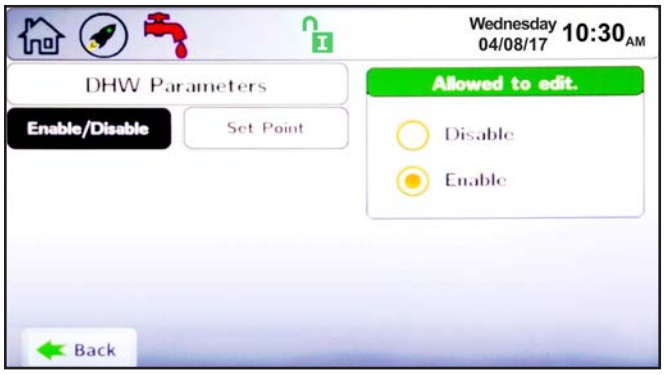
To navigate to the CH2 Quick Start Screen, touch the CH2 Icon on the CH Quick Start Selection Screen.



Screen 8. CH2 Quick Start Screen

6.D.2 DHW

To navigate to the DHW Quick Start Screen, touch the DHW faucet icon on the Quick Start Screen.



Screen 9. DHW Quick Start Screen

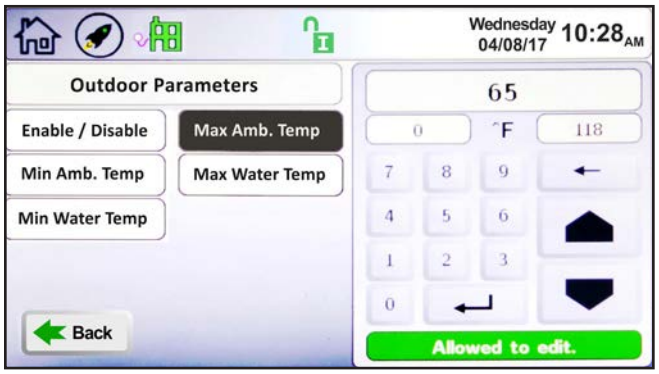
The DHW Quick Start Screen allows adjustment of the following parameter:

- **Enable/Disable** – This allows DHW to be enabled/disabled. The default setting is Enabled.
- **Set Point** – This is the temperature that this heat demand will control to.

NOTE: A DHW heat demand can be initiated by an aquastat or sensor, see Sections 5.C.1.b and 5.C.1.d respectively.

6.D.3 Outdoor Reset

To navigate to the Outdoor Quick Start Screen, touch the Outdoor Icon on the Quick Start Screen.



Screen 10. Outdoor Quick Start Screen

For all Sensor Connections at the low input terminal strip, please refer to 5.C.1.d on page 35

The Outdoor Quick Start Screen allows the adjustment of the following parameters:

- **Enable/Disable** – This allows Outdoor Reset to be enabled/disabled. The default setting is Enabled.
- **Maximum Ambient Temperature** – The outdoor temperature at which the unit will limit the boiler outlet temperature to the Minimum Water Temperature.
- **Minimum Ambient Temperature** – The outdoor temperature at which the unit will maximize the boiler outlet temperature to the Maximum Water Temperature.
- **Max Water Temp** – To set max water temp.
- **Min Water Temp** – To set minimum water temp.

NOTE: Outdoor functionality is applicable to hydronic units only and is explained in Section 6.E.4 on page 54. Wiring of the outdoor sensor is covered in Section 5.C.1.d on page 35

6.D.4 Warm Weather Shut Down

To navigate to the Warm Weather Quick Start Screen, touch the Warm Weather Icon on the Quick Start Screen.



Screen 11. Warm Weather Quick Start Screen

For all Sensor Connections at the low input terminal strip, please refer to 5.C.1.d on page 35

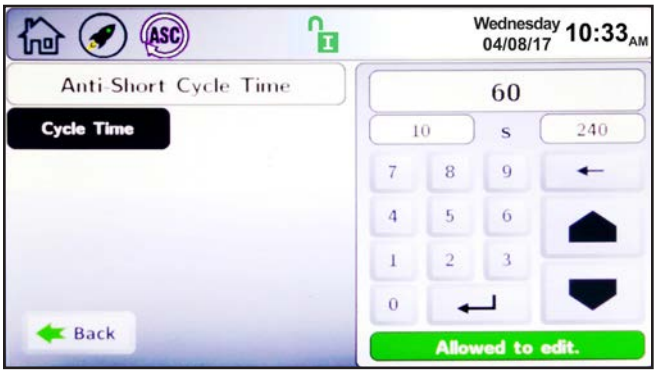
The Warm Weather Quick Start Screen allows adjustment of the following parameters:

- **Temp Min** – Upon an active warm weather shutdown condition, this is the temperature at which the unit will reset the shutdown condition to satisfy a heat demand.
- **Temp Max** – This is the temperature at which the warm weather shutdown condition will occur.
- **Feature Options** – This parameter provides the ability to either disable warm weather shutdown or upon a warm weather condition, configure the unit to shut down immediately or to shut down after the current heat demand is satisfied.

6.D Quick Start (continued)

6.D.5 Anti-Short Cycle

To navigate to the Anti-Short Cycle Quick Start Screen, touch the Anti-Short Cycle Icon on the Quick Start Screen.



Screen 12. Anti-Short Cycle Quick Start Screen

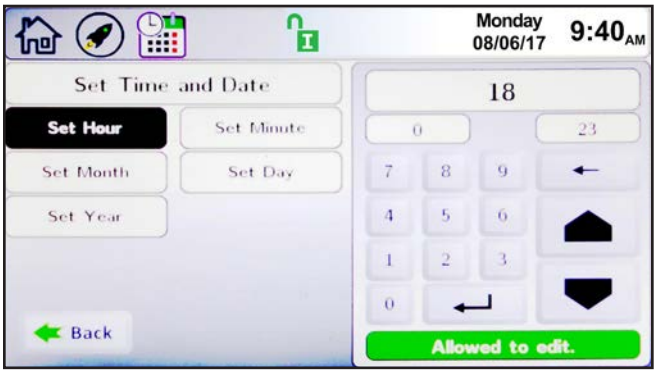
The Anti-Short Cycle Quick Start Screen allows adjustment of the following parameter:

• **Cycle Time** – The amount of time after a heat demand is satisfied that the unit will wait to satisfy the next active heat demand.

NOTE: Anti-Short Cycle Time does not apply to DHW heat demands.

6.D.6 Time & Date

To navigate to the Time & Date Quick Start Screen, touch the Time & Date Icon on the Quick Start Screen.



Screen 13. Time & Date Quick Start Screen

NOTE: The Time is set in a 24 hour parameter, but displays only as a 12 hour clock with the AM/PM automatically added.

The Time & Date Quick Start Screen allows adjustment of the following parameters:

• **Hour** – The hour that will be displayed in the upper banner on each screen, and the time captured in the date/time stamp for lock-out conditions displayed on the history screen.

• **Minute** – The minute that will be displayed in the upper banner on each screen, and the time captured in the date/time stamp for lock-out conditions displayed on the history screen.

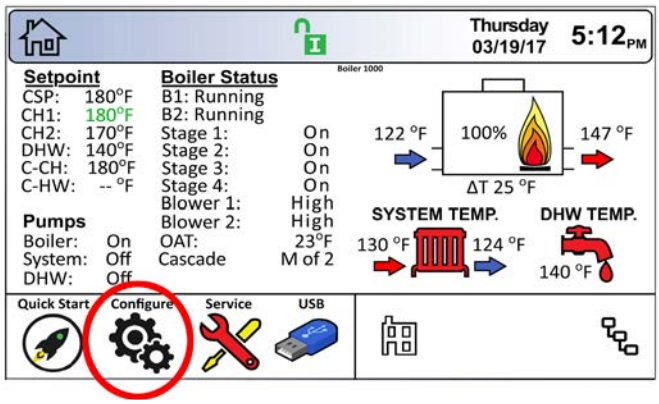
• **Month** – The month that will be displayed in the upper banner on each screen, and the date captured in the date/time stamp for lock-out conditions displayed on the history screen.

• **Day** – The day that will be displayed in the upper banner on each screen, and the date captured in the date/time stamp for lock-out conditions displayed on the history screen.

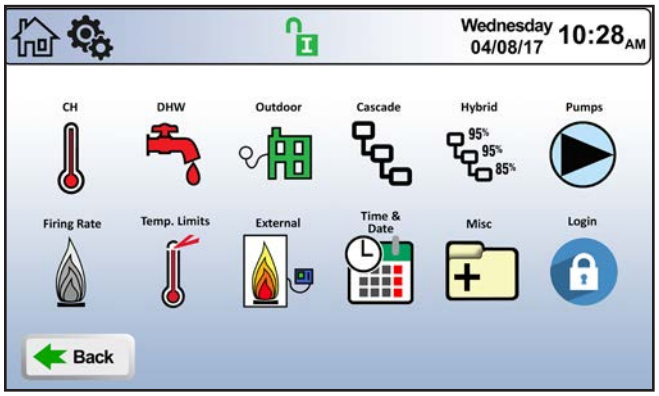
• **Year** – The month that will be displayed in the upper banner on each screen, and the date captured in the date/time stamp for lock-out conditions displayed on the history screen.

6.E Configure Screen

To navigate to the Configure Screen, touch the Configure Icon in the lower left-hand portion of the Home Screen.



Screen 14. Home Screen

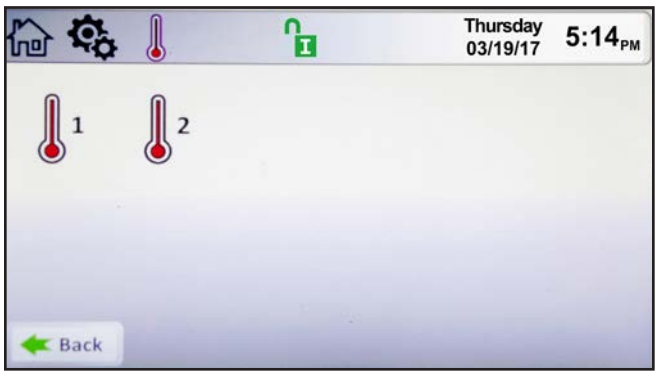


Screen 15. Configure Screen

From the Configure Screen, the units functionality can be configured for the specific application/ installation. The following sections give an overview of each configuration sub menu.

6.E.1 CH (Central Heat)

On the Configure Screen, touch the CH thermometer icon to navigate to the CH Selection Screen

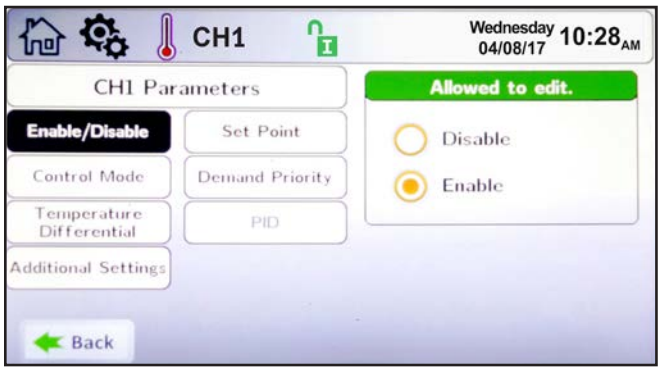


Screen 16. CH Selection Screen

There are two identical heat demands, CH1 and CH2, each with independent control algorithms and independent inputs on the input terminal strip, see Figure 24 on page 36.

From the CH Selection Screen, touching CH1/ navigates to the CH1.

6.E.1.a CH1 (Central Heat 1)



Screen 17. CH1 Configuration Screen

The CH1 Configuration Screen allows adjustment of the following seven (7) parameters:

6.E.1.a.1 Enable/Disable –

This allows CH1 to be enabled/disabled. The default setting is Enabled.

6.E.1.a.2 Control Mode –

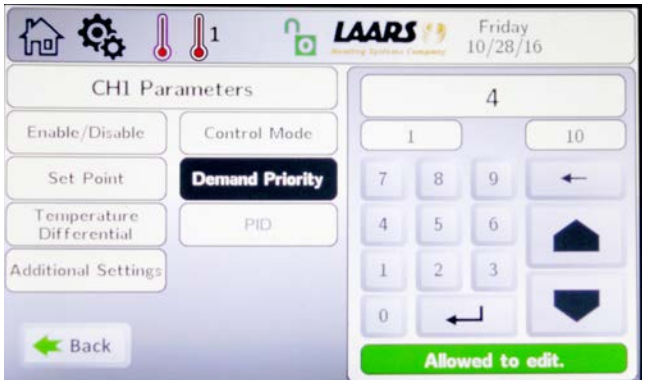
This provides the ability to select either Temperature Differential control or PID control. The default setting is Temperature Differential.

6.E.1.a.3 Set Point –

This is the temperature that this heat demand will control to.

6.E.1.a.4 Demand Priority

Demand Priority allows the user to prioritize the heat demand, such as DHW before CH. The higher the number, the higher the priority. See Table 14



Screen 18. Demand Priority Screen

Heat Demand	Source		Priority
	Boiler	Heater	
DHW	DHW	DHW3	90
	DHW Sensor (Section 5.3.1.4)		
Cascade	CH1	DHW1	80
	Applied at the lead boiler/heater (Section 5.3.2.2)		
TT1	CH1	DHW1	60
TT2	CH2	DHW2	50
External Demand	Analog Input (0 – 10VDC/4 – 20mA)		20
Frost Protection	Inlet Temperature		10

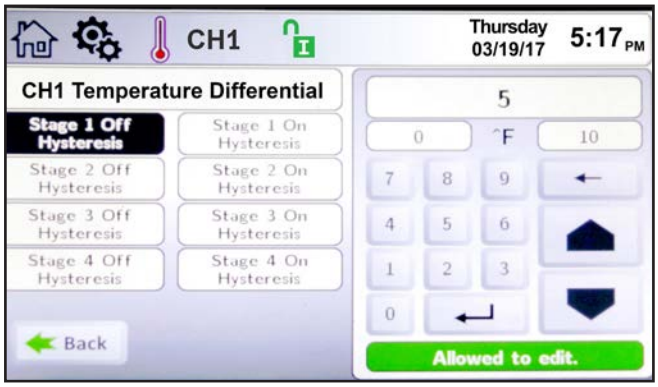
Table 14. Demand Priority

Temperature Control

The unit stages on & off burners to satisfy heat demands. Staging control is designed to operate up to 4 stages using two separate hot surface igniters (HSI) and multiple gas valves. The ignitors are associated with stages 1 and 3, and gas valves control stages 2 and 4. The control algorithm will treat stages 1 and 2 as a boiler, and on applicable units, stages 3 and 4 as a separate boiler. As a result, for sizes 1250 – 2000, if stage 1 is running, but stage 3 is not running, the fan for stage 3 would need to be running at low speed to prevent flue gases from recirculating. Similarly, if stage 3 is running, but stage 1 is not running, the fan for stage 1 would need to be running at low speed to prevent flue gases from recirculating. For single blower models, the fan operates only at high speed.

These units have two modes of temperature control, either Temperature Differential control or Proportional, Integral, Derivative (PID) control. Temperature Differential control is the default control mode. The heat demand set point is independent of the method of temperature control being used.

6.E.1.a.5 Temperature Differential



Screen 19. CH1 Temp Differential Screen

Figure 31. https://www.laarscom/products/product/magnatherm

The CH1 Temperature Differential Screen allows the adjustment of the following parameters:

- **Stage 1/2/3/4 Off Hysteresis** – an offset of the temperature set point at which the stage turns off. Each stage has an off hysteresis associated with it.
- **Stage 1/2/3/4 On Hysteresis** – an offset of the temperature set point at which the stage turns on. Each stage has an on hysteresis associated with it.

NOTE: Stage 3 applies to 1000 – 2000 sizes, and stage 4 applies to 1.250 – 2000 sizes. See Table 12 on page 42

Temperature Differential parameters are:

Stage Off Hysteresis – the temperature at which the next stage turns off. Each stage has an off hysteresis associated with it.

Stage On Hysteresis – the temperature at which the next stage turns on. Each stage has an on hysteresis associated with it.

Stage Delay On Time – the amount of time that must elapse prior to turning on the next stage.

Stage Delay Off Time – the amount of time that must elapse prior to turning off the next stage.

Minimum Stage On Time – the minimum time that a stage must be on before it is allowed to turn off.

Minimum Stage Off Time – the minimum time that a stage must be off before it is allowed to turn on.

Thermostat/Aquastat/Zone Control/BACnet

There are three "TT" or "CH" heat demand inputs available, CH1/CH2/DHW for Boiler, and DHW1/DHW2/DHW3 for Heater. Each demand has an independent set point and control settings.
See Section 5.C.1 on page 34 for wiring information and configuration information.

NOTE: BACnet can also be used to initiate a CH1/CH2/DHW (boilers) or DHW1/DHW2/DHW3 (water heaters) heat demand. See Section 6.E.11.e on page 67 for configuration information.

NOTE: If controlling to the system sensor, the unit will continue to use the outlet sensor for Auto/Manual Reset Limit conditions.

s.

Parameter	Value	Stage On/Off Temperature	Action
Stage 1 Off Hysteresis	5°F	Set Point + (Stage 1 Off + Stage 2 Off) 180°F + (5°F + 5°F) = 190°F	Turn Off Stage 1
Stage 2 Off Hysteresis	5°F	Set Point + (Stage 2 Off) 180°F + 5°F = 185°F	Turn Off Stage 2
Set Point	180°F	N/A	None
Stage 1 On Hysteresis	5°F	Set Point – (Stage 1 On) 180°F - 5°F = 175°F	Turn On Stage 1
Stage 2 On Hysteresis	5°F	Set Point – (Stage 1 On + Stage 2 On) 180°F - (5°F + 5°F) = 170°F	Turn On Stage 2
NOTE: Stage 1 will always ignite prior to stage 2 since the HSI is associated with stage 1.			

Table 15. Temperature Differential Staging of a 2 Stage Unit

Using a set point of 180°F and the default values for each stage on and off hysteresis, this table shows the temperatures at which stages 1 and 2 will turn on/off for a model 500/750.

Parameter	Value	Stage On/Off Temperature	Action
Stage 1 Off Hysteresis	5°F	Set Point + (Stage 1 Off + Stage 2 Off + Stage 3 Off) 180°F + (5°F + 5°F + 5°F) = 195°F	Turn Off Stage 1
Stage 2 Off Hysteresis	5°F	Set Point + (Stage 2 Off + Stage 3 Off) 180°F + (5°F + 5°F) = 190°F	Turn Off Stage 2
Stage 3 Off Hysteresis	5°F	Set Point + (Stage 3 Off) 180°F + 5°F = 185°F	Turn Off Stage 3
Set Point	180°F	N/A	None
Stage 1 On Hysteresis	5°F	Set Point – (Stage 1 On) 180°F - 5°F = 175°F	Turn On Stage 1
Stage 2 On Hysteresis	5°F	Set Point – (Stage 1 On + Stage 2 On) 180°F - (5°F + 5°F) = 170°F	Turn On Stage 2
Stage 3 On Hysteresis	5°F	Set Point – (Stage 1 On + Stage 2 On + Stage 3 On) 180°F - (5°F + 5°F + 5°F) = 165°F	Turn On Stage 3

Table 16. Temperature Differential Staging of a 3 Stage Unit

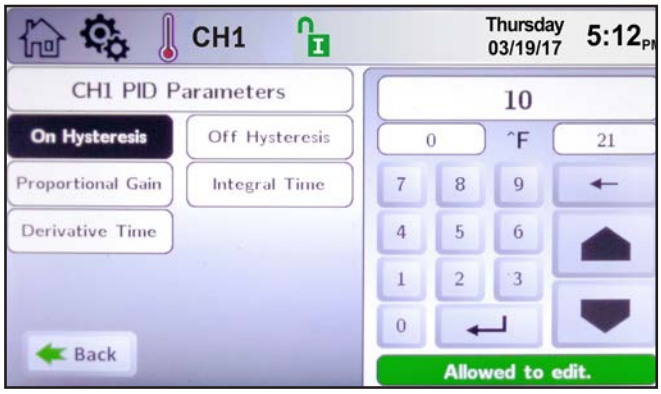
Using a set point of 180°F and the default values for each stage on and off hysteresis, this table shows the temperatures at which stages 1, 2, and 3 will turn on/off for model 1000.

Parameter	Value	Stage On/Off Temperature	Action
Stage 1 Off Hysteresis	5°F	Set Point + (Stage 4 Off + Stage 3 Off + Stage 2 Off + Stage 1 Off) 180°F + (5°F + 5°F + 5°F + 5°F) = 200°F	Turn Off Stage 1
Stage 2 Off Hysteresis	5°F	Set Point + (Stage 4 Off + Stage 3 Off + Stage 2 Off) 180°F + (5°F + 5°F + 5°F) = 195°F	Turn Off Stage 2
Stage 3 Off Hysteresis	5°F	Set Point + (Stage 4 Off + Stage 3 Off) 180°F + (5°F + 5°F) = 190°F	Turn Off Stage 3
Stage 4 Off Hysteresis	5°F	Set Point + (Stage 4 Off) 180°F + 5°F = 185°F	Turn Off Stage 4
Set Point	180°F	N/A	None
Stage 1 On Hysteresis	5°F	Set Point – (Stage 1 On) 180°F - 5°F = 175°F	Turn On Stage 1
Stage 2 On Hysteresis	5°F	Set Point – (Stage 1 On + Stage 2 On) 180°F - (5°F + 5°F) = 170°F	Turn On Stage 2
Stage 3 On Hysteresis	5°F	Set Point – (Stage 1 On + Stage 2 On + Stage 3 On) 180°F - (5°F + 5°F + 5°F) = 165°F	Turn On Stage 3
Stage 4 On Hysteresis	5°F	Set Point – (Stage 1 On + Stage 2 On + Stage 3 On + Stage 4 On) 180°F - (5°F + 5°F + 5°F + 5°F) = 160°F	Turn On Stage 4

Table 17. Temperature Differential Staging of a 4 Stage Unit

Using a set point of 180°F and the default values for each stage on and off hysteresis, this table shows the temperatures at which stages 1, 2, 3 and 4 will turn on/off for model 1250 - 2000.

6.E.1.a.6 PID



Screen 20. CH1 PID Screen

To activate the PID (*Proportional-Integral-Derivative*) control, you must first go into the Control Mode and select PID. You may be prompted to Save any configuration changes that you have made so far. Then come back CH1 Parameters and select PID.

The CH1 PID Screen allows adjustment of the following parameters:

- **On Hysteresis** – The temperature below the set point (Set Point – On Hysteresis) at which the control begins calculating the PID output to turn on stages.
- **Off Hysteresis** – The temperature above the set point (Set Point + Off Hysteresis) at which the controller will stop calculating the PID output and set the PID output to 0 to turn off all stages.
- **Proportional Gain** – This value is the corrective action that is proportional to the error (set point – control temperature).
- **Integral Time** – This value is applied to the sum of the error over a period of time.
- **Derivative Time** – This value is applied to the rate of change of the error.

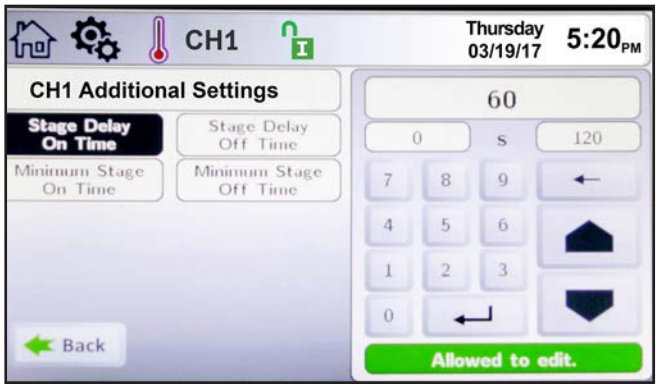
NOTE: By default, the control sensor is the units outlet sensor, or when installed, the system supply sensor.

Model 500/750		Model 1.0MM		Model 1.25–2.0MM	
# of Stages	% PID Output	# of Stages	% PID Output	# of Stages	% PID Output
				4	76 - 100
		3	67-100	3	51 – 75
2	51 - 100	2	34 – 66	2	26 – 50
1	1 – 50	1	1 - 33	1	1 – 25

Table 18. Pid Temperature Control PID Output Stage Firing

The PID control algorithm gives an output signal from 0 – 100% and makes a decision to turn a stage on/off. See

6.E.1.a.7 Additional Settings



Screen 21. CH1 Additional Settings Screen

The CH1 Additional Settings Screen allows the adjustment of the following parameters:

- **Stage Delay On Time** – The amount of time that must elapse prior to turning on the next stage.
- **Stage Delay Off Time** – The amount of time that must elapse prior to turning off the next stage.
- **Minimum Stage On Time** – The minimum time that a stage must be on before it is allowed to turn off.
- **Minimum Stage Off Time** – The minimum time that a stage must be off before it is allowed to turn on.

NOTE: These setting only apply to Temperature Differential control.

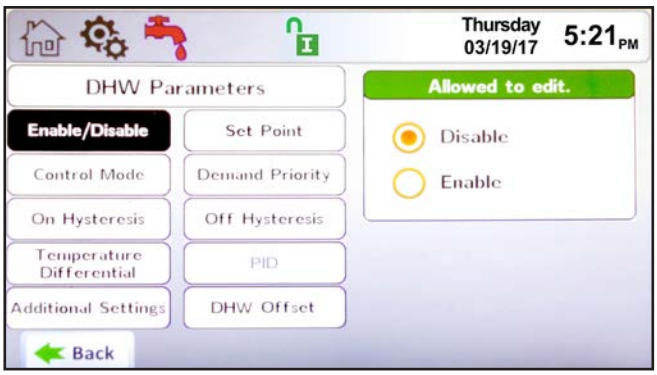
6.E.2 CH2 (Central Heat 2)

CH2 has all the same parameters as CH1.

NOTE: CH2 applies to hydronics units (boilers), while DHW2 applies to volume water units (water heaters).

6.E.3 DHW

To navigate to the DHW Screen, touch the DHW faucet icon on the Configure Screen.



Screen 22. DHW Configuration Screen

DHW has all the same parameters as CH1 and CH2 with one exception. DHW has the following additional parameter for adjustment:

• **DHW Offset** – Upon a DHW heat demand, the unit will control the boiler/heater outlet temperature to the DHW Set Point plus the DHW Offset (set point + DHW Offset). For example, with a DHW Set Point of 140°F and a DHW Offset of 40°F, the unit will control the boiler/heater outlet temperature to 180°F (140°F + 40°F) to satisfy the heat demand.

NOTE: A DHW heat demand can be initiated by an aquastat or sensor, see Sections 5.C.1.b on page 34 and 5.C.1.d on page 35 respectively.

6.E.4 Outdoor Reset

For all Sensor Connections at the low input terminal strip, please refer to 5.C.1.d on page 35

Outdoor Reset is applicable to hydronic units only, and since this functionality is not mandatory, it can be enabled/disabled on the outdoor reset configuration screen. Outdoor Reset varies the control set point based on the outdoor temperature. The Outdoor Reset parameters are:

When there is an active outdoor reset condition, the control set point (CSP) will vary from the programmed set point. For example, in the Boiler Status Window shown below, the Outdoor Ambient Temperature (OAT) is 88 °F. This OAT forces the non-DHW heat demand set point to the low point of the outdoor reset curve, which in the graph below is 140 °F. In the Boiler Status Window shown in Figure 32, the CH1 heat demand is active and the programmed set point is 180 °F, however, due to the OAT, the CSP is 140 °F – which is the temperature the unit will control to.



Screen 23. Outdoor Parameters Screen

The Outdoor Parameters Screen allows the adjustment of the following parameters:

• **Enable/Disable** – Enables and disables the outdoor reset functionality.

• **Maximum Ambient Temperature** – The outdoor temperature at which the unit will limit the boiler outlet temperature to the Minimum Water Temperature.

• **Minimum Ambient Temperature** – The outdoor temperature at which the unit will maximize the boiler outlet temperature to the Maximum Water Temperature.

• **Maximum Water Temperature** – The maximum boiler outlet temperature based on the Minimum Ambient Temperature.

• **Minimum Water Temperature** – The minimum boiler outlet temperature based on the Maximum Ambient Temperature.

Setpoint		Boiler Status	
CSP:	140°F	B1:	Running
CH1:	180°F	B2:	Running
CH2:	170°F	Stage 1:	On
DHW:	120°F	Stage 2:	On
		Stage 3:	On
		Stage 4:	On
		Blower 1:	High
Pumps		Blower 2:	High
Boiler:	On	OAT:	88 °F
System:	On		
DHW:	Off		

Figure 32. Boiler Status Window. CSP with an active outdoor reset condition

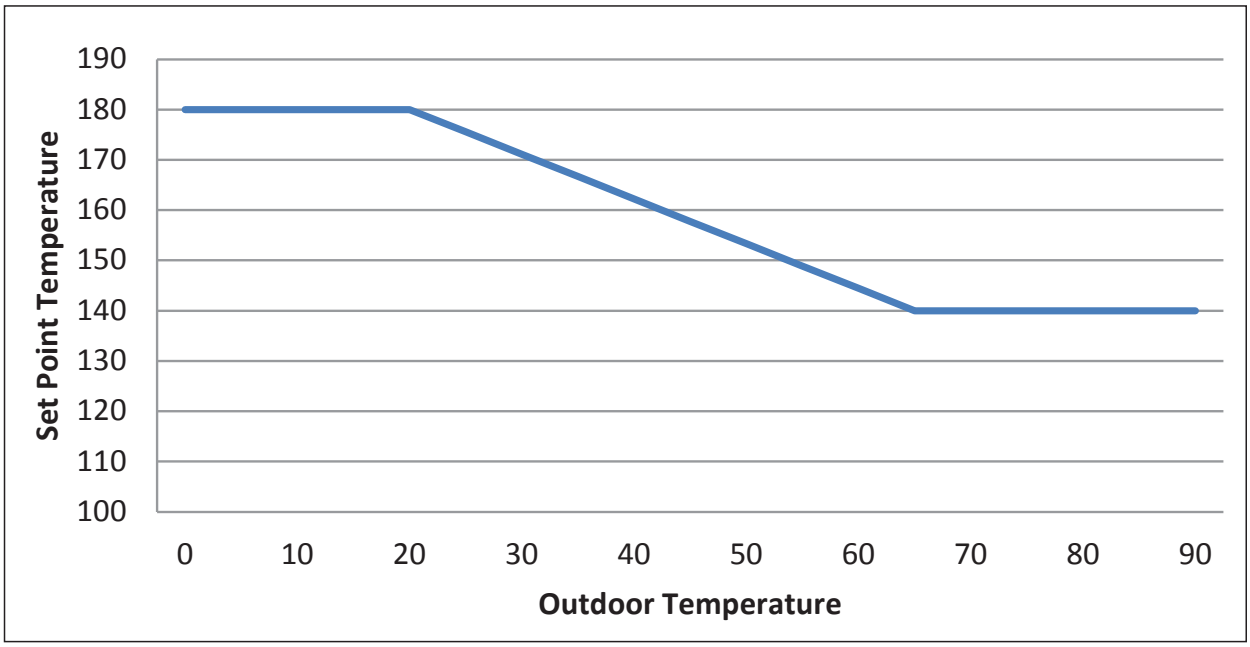


Table 19. Outdoor Reset Curve.

6.E.5 Cascade

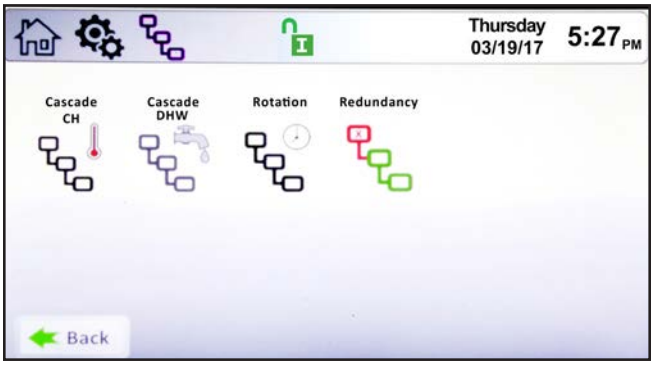
An installation with two or more units may be configured for cascade operations. A maximum of 8 units can be configured in a cascade installation. One unit will be configured as the lead unit, with the remaining units configured as lag units. Refer to Section 5.C on page 34 for details on wiring for cascade communication between the lead and lag units.

A system supply sensor must be installed and connected to the lead boiler/heater, see Section 5.C.1.d on page 35 – Temperature Sensors. The lead boiler will use this system supply sensor as the temperature control sensor for cascade operations.

A system pump may be wired to the lead unit, refer to Section 5.B.3 on page 33 for wiring and 6.E.6 on page 61 for pump configuration.

A cascade heat demand is made at the lead unit using CH1, external demand (0-10VDC or 4-20mA), or through an RS485 Building Management System (BMS) heat demand command.

Access the Cascade Configuration Screen by selecting Configuration/Cascade.



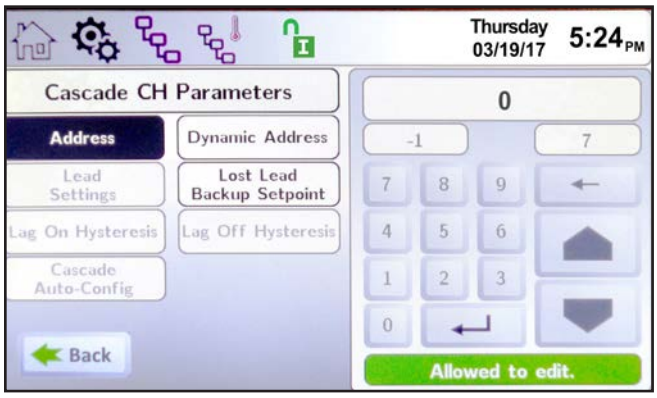
Screen 24. Cascade Configuration Screen

The Cascade Screen provides four navigation icons to configure the system for cascade operations. These navigation icons are:

- **Cascade CH** – This icon navigates to the setup screen for hydronic cascade operations. This icon is available on hydronic units only (boilers).
- **Cascade DHW** – This icon navigates to the setup screen for volume water cascade operations. This icon is available on volume water units only (water heaters).
- **Rotation** – This icon navigates to the cascade rotation screen.
- **Redundancy** – This icon navigates to the setup screen for cascade Leader redundancy functionality.

6.E.5.a Configure Lead Unit

To configure a unit as the lead unit, navigate to the Cascade Parameters Screen, shown below, and set the Address to “0”. The unit is now configured as the lead boiler/heater. Setting the address to a “-1” takes the unit out of cascade mode.



Screen 25. Cascade Parameters

Once configured as the lead unit, the “Lead Settings” button becomes selectable. Touching this button navigates to the “Lead Settings” screen.



Screen 26. Lead Settings

The Lead Settings Screen allows adjustment of the following parameters:

Set Point – This parameter is the system supply temperature the cascade heat demand is trying to satisfy.

Proportional Gain – This value is the corrective action that is proportional to the error (set point – control temperature). Increasing this parameter increases the response to the error.

Integral Time – This value is applied to the sum of the error over a period of time. Adding the integral term can help to achieve the set point.

Derivative Time – This value is applied to the rate of change of the error. Adding the derivative term can help with sudden changes in temperature, and may help prevent overshooting.

Demand Priority – This parameter sets the heat demand priority in relation to other heat demands. The higher the number, the higher the priority it is assigned.

Off Hysteresis – The temperature above the set point (Set Point + Off Hysteresis) at which the controller will turn off all stages.

On Hysteresis – The temperature below the set point (Set Point – On Hysteresis) at which the controller begins to turn on stages.

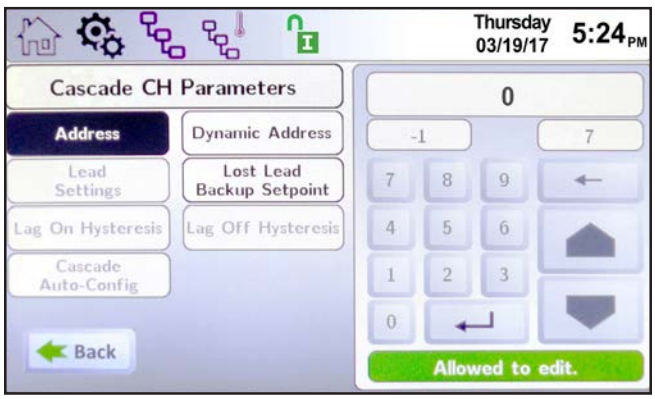
Max Lag Temp – The maximum outlet temperature the cascaded boilers/heaters are allowed to supply the system at their individual boiler/heater outlet water sensor.

The home screen of the lead boiler will reflect information regarding the cascade set up. See Screen 60. The C-CH is the set point of the Cascade CH system. An active heat demand is reflected by the cascade icon shown in the lower right hand section of the home screen, and the set point will be shown in green text. If configured for Cascade DHW, the cascade set point will be shown to the right of C-HW. The home screen will also reflect the address and number of units cascaded. In the image below, this unit is configured with an address “0” and is therefore the lead boiler/heater. The lead boiler/heater is denoted by the “M” in the “M of 4”. The “4” in the “M of 4” indicates that there are 4 boilers/heaters cascaded together. The CSP will reflect the “Max Lag Temp” which is the maximum outlet temperature the cascaded boilers/heaters are allowed to supply the system.

6.E.5.b Configure Lag Unit

To configure a unit as a lag unit, navigate to the Cascade Parameters Screen and set the Address to any number from 1 to 7. The lead boiler is configured as a “0”, therefore, the 8th cascaded boiler is configured with an address of 7. Setting the address to a “-1” takes the unit out of cascade mode.

To automatically configure lag units, after configuring the lead unit, press the Cascad Auto-Config on the Lead unit and it will automatically address the lag units.



Screen 27. Lag On, Lag Off Hysteresis

Once configured as a lag unit, the “Lag On Hysteresis” and “Lag Off Hysteresis” buttons are selectable. These parameters have the following functionality:

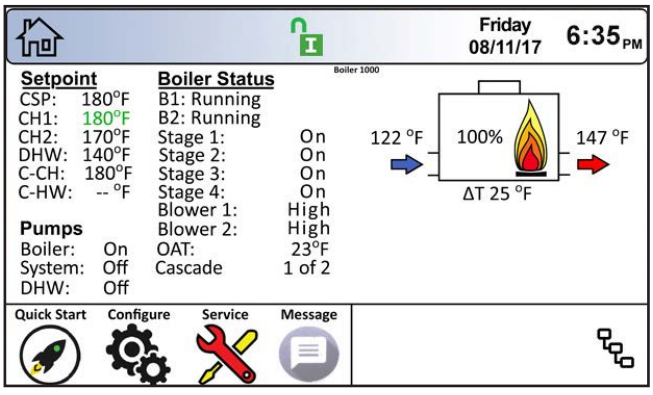
Lag On Hysteresis – the value below the “Max Lag Temp” (Max Lag Temp – Lag On Hysteresis) that the boiler/heater will turn on to satisfy an active cascade demand, based on their local outlet water sensor.

Lag Off Hysteresis – the value above the “Max Lag Temp” (Max Lag Temp + Lag Off Hysteresis) that the boiler/heater will turn off when satisfying an active cascade demand, based on their local outlet water sensor.

Lag boilers/heaters control to their outlet temperature, using the “Max Lag Temp” as the outlet temperature set point. With an active demand from the lead boiler/heater, the lag boilers/heaters will cycle on/off based on the “Lag On Hysteresis” and “Lag Off Hysteresis” set at each individual lag unit. A message will indicate when a unit is off due to a 'Max Lag Temp' condition.

The home screen of a lag boiler will reflect information regarding the cascade set up. See Screen 28.

The C-CH is the set point of the Cascade CH system. If configured for Cascade DHW, the cascade set point will be shown to the right of C-HW. The home screen will also reflect the address and number of units cascaded. In the image below, this unit is configured with an address “1” and is therefore a lag boiler/heater, and is 1 of 4 cascaded units. An active heat demand from the lead boiler is indicated by the cascade icon shown in the lower right hand portion of the home screen. The CSP will reflect the “Max Lag Temp” which is the maximum outlet temperature the cascaded boilers/heaters are allowed to supply the system. The “Max Lag Temp” parameter is covered in the lead boiler/heater settings.

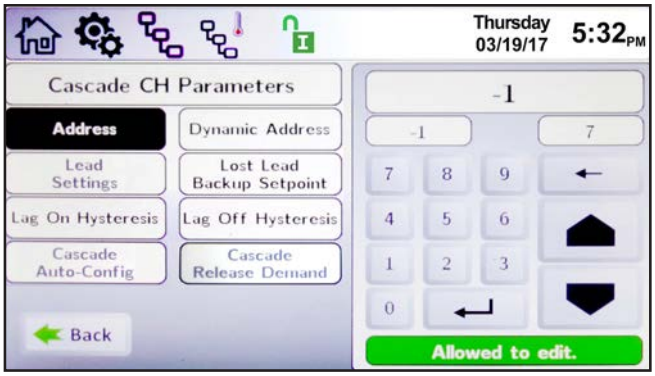


Screen 28. Home Screen of a Lag Boiler

6.E.5.c Cascade CH

An installation with two or more units may be configured for cascade operations. A maximum of 8 units can be cascaded.

To navigate to the Cascade CH Configuration Screen, touch the Cascade Icon on the Configure Screen, then touch the Cascade CH Icon on the Cascade Configuration Screen.



Screen 29. Cascade CH Configuration Screen

The Cascade CH Configuration Screen allows adjustment of the following parameters:

• **Address** – When manually addressing each boiler/heater for cascade operations, this parameter is used to set the local boiler/heater address. Each boiler/heater must have a unique address. A boiler/heater with a value of 0 is the lead boiler/heater. Lag boilers/heaters use values 1 through 7.

When automatically addressing each boiler/heater, set the lead boiler/heater to a value of 0. With a value of 0, the Cascade Auto-Config button is available to use, refer to this parameter below for instructions for automatic addressing the lag boilers/heaters.

• **Dynamic Address** – This function is used for individual boiler servicing as it will remove the boiler/heater from cascade operations.

Click into Dynamic Address and set this parameter to -1. When finished, return this number to it's previously assigned number.

• **Lead Settings** – This button is only selectable when configured as the lead boiler/heater. When configured as the lead boiler/heater, touching this button navigates to the Lead boiler/heater settings.

• **Lost Lead Backup Set Point** – This is used for cascade redundancy, see Section Screen 32 on page 60. When configured for Cascade Redundancy - Boiler Internal Set Point, this parameter is the maximum outlet temperature the local boiler/heater is allowed to supply the system.

• **Lag On Hysteresis** - The value below the Max Lag Temp (Max Lag Temp – Lag On Hysteresis) that the boiler/heater will turn on to satisfy an active cascade demand, based on the local boiler/heater outlet water temperature. Max Lag Temp is set at the Lead boiler/heater.

• **Lag Off Hysteresis** - The value above the Max Lag Temp (Max Lag Temp + Lag Off Hysteresis) that the boiler/heater will turn off when satisfying an active cascade heat demand, based on the local boiler/heater outlet water temperature. Max Lag Temp is set at the Lead boiler/heater.

• **Cascade Auto-Config** – This is only adjustable at the lead boiler/heater. Once configured as the lead boiler/heater, pressing this button will initiate the lead boiler/heater to find and address all lag boilers automatically.

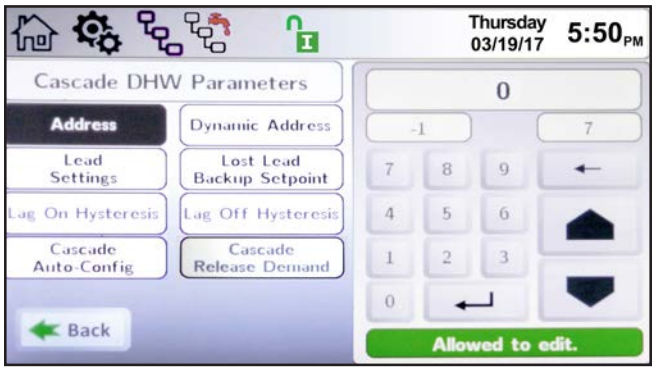
NOTE: All boilers/heaters must be wired for cascade operations prior to performing Cascade Auto-Config.

• **Cascade Release Demand -** When communications with the master is lost and the lag units continue to satisfy the cascade heat demand, pressing this button will remove the heat demand.

NOTE: This only applies when configured for cascade - Boiler Internal Set Point Control.

6.E.5.d Cascade DHW

To navigate to the Cascade DHW Configuration Screen, touch the Cascade Icon on the Configure Screen, then touch the Cascade DHW Icon on the Cascade Configuration Screen.



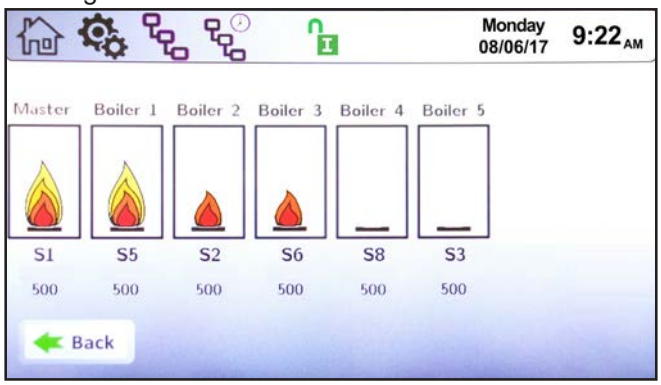
Screen 30. DHW Configuration Screen

Cascade DHW has the same parameters and setup as Cascade CH

NOTE: Cascade DHW applies to volume water (water heaters) units only.

6.E.5.e Rotation

To navigate to the Cascade Rotation Screen, touch the Cascade Icon on the Configure Screen, then touch the Rotation Icon on the Cascade Configuration Screen.



Screen 31. Cascade Rotation Screen

The Cascade Rotation Screen is a view only screen. This screen indicates how many units are connected in a cascade configuration, the order in which each unit will run, and the percent at which each unit is running.

6.E.5.f Cascade Redundancy

To navigate to the Cascade Redundancy Screen (Loss of Lead Setup), touch the Cascade Icon on the Configure Screen, then touch the Redundancy Icon on the Cascade Configuration Screen.



Screen 32. Cascade Redundancy Screen (Loss of Leader Setup)

In circumstances where the communication link between the lead and lag units has been disrupted, there are three options for how lag units respond to this disruption.

The Cascade Redundancy Screen allows the selection of one of three options for redundancy in cascade operations.

These options are:

Option 1: Boiler Internal Set Point – With this option selected, in a cascade configuration, upon loss of communication with the lead unit, the lag units will continue to operate. When running in this mode, the lag boiler will use the “Loss Lead Backup Set Point" parameter as the local boiler CSP. The “Loss Lead Backup Set Point" parameter is configured on the Cascade Parameter Screen. If communication to the lead boiler/heater is restored, the lag units will respond to the lead boiler/heater commands without user intervention. All lag units must have this option enabled for this functionality to work, as well as the Loss Lead Backup Set Point configured. If the lag boilers/heaters are not firing when communication with the lead unit is lost, they will not fire to satisfy a cascade heat demand until communications with the lead boiler/heater is restored.

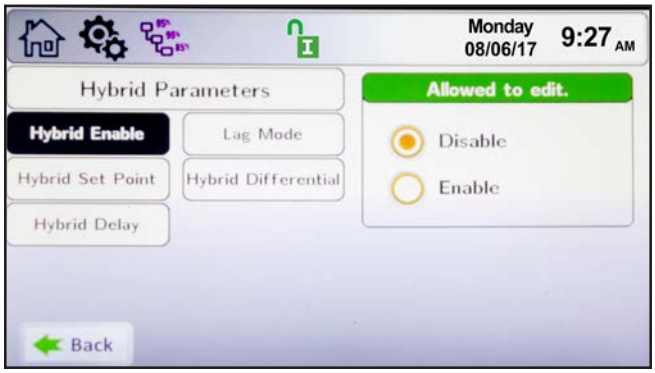
Option 2: Redundant Leader – With this option selected, in a cascade configuration, upon loss of communication with the lead unit, the lag boiler with the address of 1 will assume lead boiler responsibilities. This requires that the lead unit (address 0) and redundant lead (address 1) be addressed manually. The remaining cascaded units can be configured manually or automatically. This requires that the boiler/heater with the address of 1 have the same settings as the lead unit. This also requires that the boiler/heater with the address of 1 have a system supply sensor installed, and if applicable a system pump, or pump contactor. **All cascaded units must have this option selected for this functionality to work.**

Option 3: Disable Redundancy – With this option selected, in a cascade configuration, upon loss of communication with the lead unit, all lag boilers will no longer satisfy the cascade heat demand.

6.E.5.g Hybrid

NOTE: This Hybrid Screen is not currently active, but is included for future integration of condensing products.

To navigate to the Hybrid Configuration Screen, touch the Hybrid Icon on the Configure Screen.



Screen 33. Hybrid Configuration Screen

The Hybrid Configuration Screen allows adjustment of the following parameters:

- **Hybrid Enable –** This parameter allows Hybrid Mode to be enabled or disabled.
- **Lag Mode –** This parameter allows Lag Mode to be enabled or disabled.
- **Hybrid Set Point –** Based on the system return temperature, with Hybrid Mode enabled, this temperature set point determines which type of boiler (condensing or non-condensing) runs first to satisfy a heat demand.
- **Hybrid Differential –** This parameter is a +/- offset of the Hybrid Set Point used to prevent condensing in non-condensing units.
- **Hybrid Delay –** This parameter is a time delay that, in addition to Hybrid Differential, is used to prevent condensing in non-condensing units.

6.E.6 Pumps

The unit allows control of three pumps: boiler/heater pump, system pump, and DHW pump. Each pump has an adjustable post circulation time that allows the pump to run after a heat demand has been satisfied or a shutdown condition has occurred. See Section 5.B.2 on page 33. For wiring information, see Section 6.2.6 pump configuration information.

Boiler/Heater Pump

Upon a heat demand, the boiler/heater pump can be configured to operate as follows:

Auto – the pump will turn on automatically upon a call for heat.

Always On – the pump will run continuously, with or without a heat demand.

Off During DHW – the pump will not turn on during a DHW heat demand.

DHW Pump

Upon a heat demand, the boiler/heater pump can be configured to operate as follows:

Auto – the pump will turn on automatically upon a call for heat.

Always On – the pump will run continuously, with or without a heat demand.

Disable – the pump will not turn on upon a DHW heat demand.

System Pump

Upon a heat demand, the system pump can be configured to operate as follows:

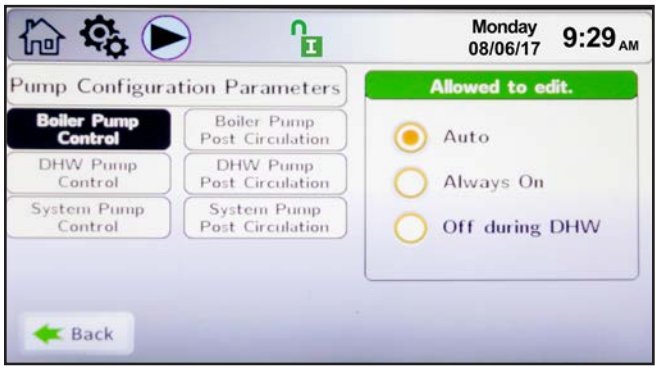
Auto – the pump will turn on automatically upon a call for heat.

Always On – the pump will run continuously, with or without a heat demand.

Off During DHW – the pump will not turn on during a DHW heat demand.

Disable – the pump will not turn on during a call for heat.

To navigate to the Pump Configuration Screen, touch the Pump Icon on the Configure Screen.



Screen 34. Pump Configuration Screen

The Pump Configuration Screen allows adjustment of the following parameters:

- **Boiler Pump Control –** The parameter provides the ability to set the boiler pump functionality to be: Auto, Always On, or Off during DHW.
- **Boiler Pump Post Circulation –** This parameter is the amount of time the boiler/heater pump will continue to run after a heat demand has been satisfied or after a lock-out condition has occurred.
- **DHW Pump Control –** This parameter provides the ability to set the DHW pump functionality to be: Auto, Disabled, or Always On.
- **DHW Pump Post Circulation –** This parameter is the amount of time the DHW pump will continue to run after a heat demand has been satisfied or after a lock-out condition has occurred.
- **System Pump Control –** This parameter provided the ability to set the system pump functionality to be: Auto, Always On, Off during DHW, or Disabled.
- **System Pump Post Circulation –** This parameter is the amount of time the System pump will continue to run after a heat demand has been satisfied or after a lock-out condition has occurred.

6.E.7 Firing Rate

Firing Rate refers to smooth modulation and is not applicable to this stage fired unit.

		Pennant Size		
		500/750	1MM	1.25-2MM
Stage 4	Blocked			AR - (5*SLH) = Blocked 195°F - (5*2°F) = 185°F
	Unblocked			AR - (6*SLH) = Unblocked 195°F - (6*2°F) = 183°F
Stage 3	Blocked		AR - (3*SLH) = Blocked 195°F - (3*2°F) = 189°F	AR - (3*SLH) = Blocked 195°F - (3*2°F) = 189°F
	Unblocked		AR - (4*SLH) = Unblocked 195°F - (4*2°F) = 187°F	AR - (4*SLH) = Unblocked 195°F - (4*2°F) = 187°F
Stage 2	Blocked	AR - SLH = Blocked 195°F - 2°F = 193°F	AR - SLH = Blocked 195°F - 2°F = 193°F	AR - SLH = Blocked 195°F - 2°F = 193°F
	Unblocked	AR - SLH = Blocked 195°F - 2°F = 193°F	AR - (2*SLH) = Unblocked 195°F - (2*2°F) = 191°F	AR - (2*SLH) = Unblocked 195°F - (2*2°F) = 191°F
Stage 1	Blocked	AR 195°F	AR 195°F	AR 195°F
	Unblocked	AR - RD 195°F - 5°F = 190°F	AR - RD 195°F - 5°F = 190°F	AR - RD 195°F - 5°F = 190°F

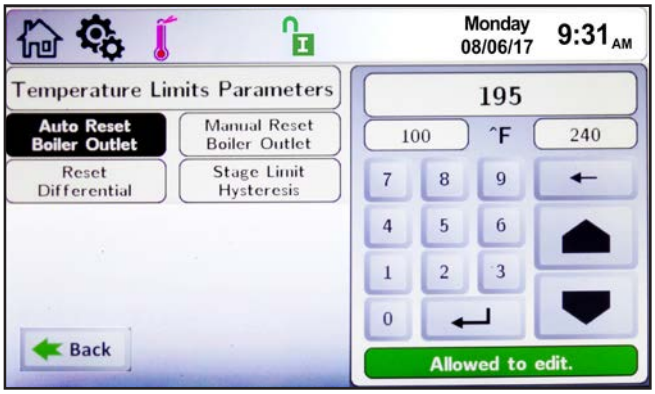
The number of available stages varies based on boiler/heater size and identifies when stages will be blocked/unblocked. The equations apply to both Boiler and Heater units.

- Stage Limit Hysteresis (SLH) = 2°F
- Auto Reset (AR) = 195°F (boilers)
- Reset Differential (RD) = 5°F

Table 20. Boiler/Heater blocking parameters

6.E.8 Temp Limits

To navigate to the Temp Limits Configuration Screen, touch the Temp Limits Icon on the Configure Screen (2nd Row).



Screen 35. Temp Limits Configuration Screen

The Temp Limits Configuration Screen allows adjustment of the following parameters:

• **Auto Reset Boiler Outlet–** The temperature at which the unit with shutdown on an outlet temperature auto reset condition.

• **Manual Reset Boiler Outlet–** The temperature at which the unit will shut down on an outlet temperature manual reset condition.

• **Reset Differential –** The value below the Auto Reset temperature at which the unit will automatically reset itself and resume functionality.

• **Stage Limit Hysteresis –** The temperatrue at which a staging boiler / heater will begin to block, or de-rate, to avoid tripping limits.

6.E.9 External

To navigate to the External Configuration Screen, touch the External Icon on the Configure Screen.



Screen 36. External Configuration Screen

The External Configuration Screen applies to the 0-10VDC (4-20mA) analog input BMS signal, and allows adjustment of the following parameters:

• **Control Mode –** This parameter provides the ability to either disable external control or configure the unit for External Set Point or Firing Rate control mode.

• **Priority –** This parameter sets the heat demand priority in relation to other heat demands. The higher the number, the higher the priority it is assigned.

• **Max Set Point –** When the Control Mode is set to External Set Point, this is the maximum value that corresponds to the Demand Max value.

• **Min Set Point –** When the Control Mode is set to External Set Point, this is the minimum value that corresponds to the Demand Min value.

• **Demand Max –** This is the maximum value

that corresponds to the control mode selected. With Firing Rate control mode selected, this is the maximum rate at which the boiler/heater will run. The unit of this parameter is %, so if the value of this parameter is 10000, or 100.00%, this equates to 10.0VDC or 20mA.

• **Demand Min –** This is the minimum value that corresponds to the control mode selected. With Firing Rate control mode selected, this is the minimum rate at which the boiler/heater will run. The unit of this parameter is %, so if the value of this parameter is 2000, or 20.00%, this equates to 2.0VDC or 4.8mA.

• **Demand On –** This is the threshold (VDC/mA) at which the input signal will initiate the selected control mode behavior. The unit of this parameter is %, so if the value of this parameter is 1500, or 15.00%, this equates to 1.5VDC or 4.6mA.

• **Demand Off –** This is the threshold (VDC/mA) at which the input signal will deactivate the selected control mode behavior. The unit of this parameter is %, so if the value of this parameter is 1000, or 10.00%, this equates to 1.0VDC or 4.4mA.

• **Input Type –** This parameter allows the user to select between voltage (0-10VDC) and current (4-20mA) input. Jumpers will need to be configured accordingly. See 5.C on page 34

6.E.9.a External – Remote Set Point

With External Set Point selected, the unit will initiate a heat demand once the analog input signal exceeds the Demand On value. Once the demand is initiated, the analog input signal must be lower than Demand Off to remove the heat demand. With an active demand, the unit will linearize the set point according to the analog input signal as shown in **Figure 33.**

Using the default values for Boiler Max Set Point (180°F), Boiler Min Set Point (140°F), Demand Minimum (2.5VDC), Demand Maximum (10.0VDC), the unit will linearize the set point, according to the formula in **Figure 33**.

External (0 – 10VDC or 4 – 20mA)

An External heat demand can be initiated by a Building Management System (BMS) using a 0 – 10 VDC or 4 – 20 mA signal. This input can be configured for Remote Set Point or External Firing Rate operations. See Section 5.C.1.e on page 35 for wiring and Section 6.E.11.e on page 67 for configuration information.

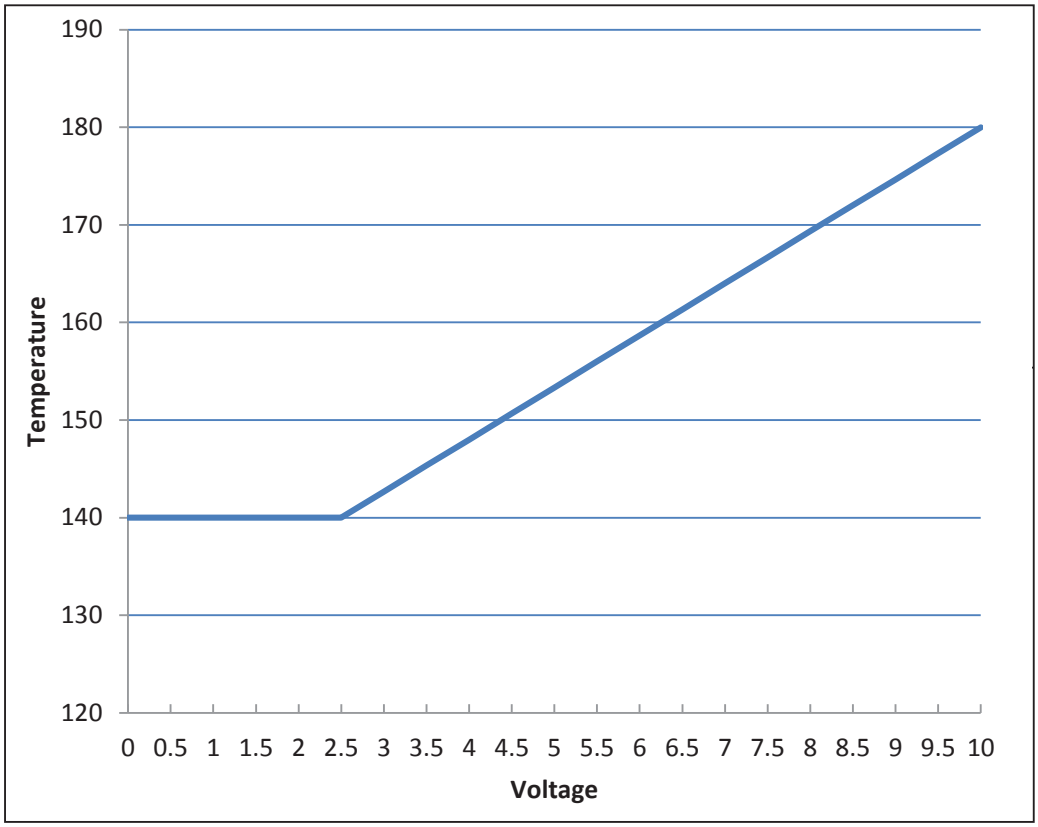


Figure 33. External Control Mode and Temperature

6.E.9.b External Firing Rate

With External Firing Rate selected, the unit will initiate a heat demand once the analog input signal exceeds the Demand On value. Once the demand is initiated, the analog input signal must be lower than Demand Off to remove the heat demand. The external analog signal will activate stages based on **Table 21.** In this control mode, if the unit outlet temperature exceeds the Auto Reset High Limit setting, the boiler will shut down and an "Auto Reset High Limit" condition will annunciate on the Messages screen. Once the outlet temperature decreases below the value of (Auto Reset High Limit – Reset Differential), the boiler will turn back on at the firing rate set by the analog input signal.

NOTE: Since Low-Temp units are On/Off, using external firing rate will turn all stages on/off once the Demand On Value has been exceeded.

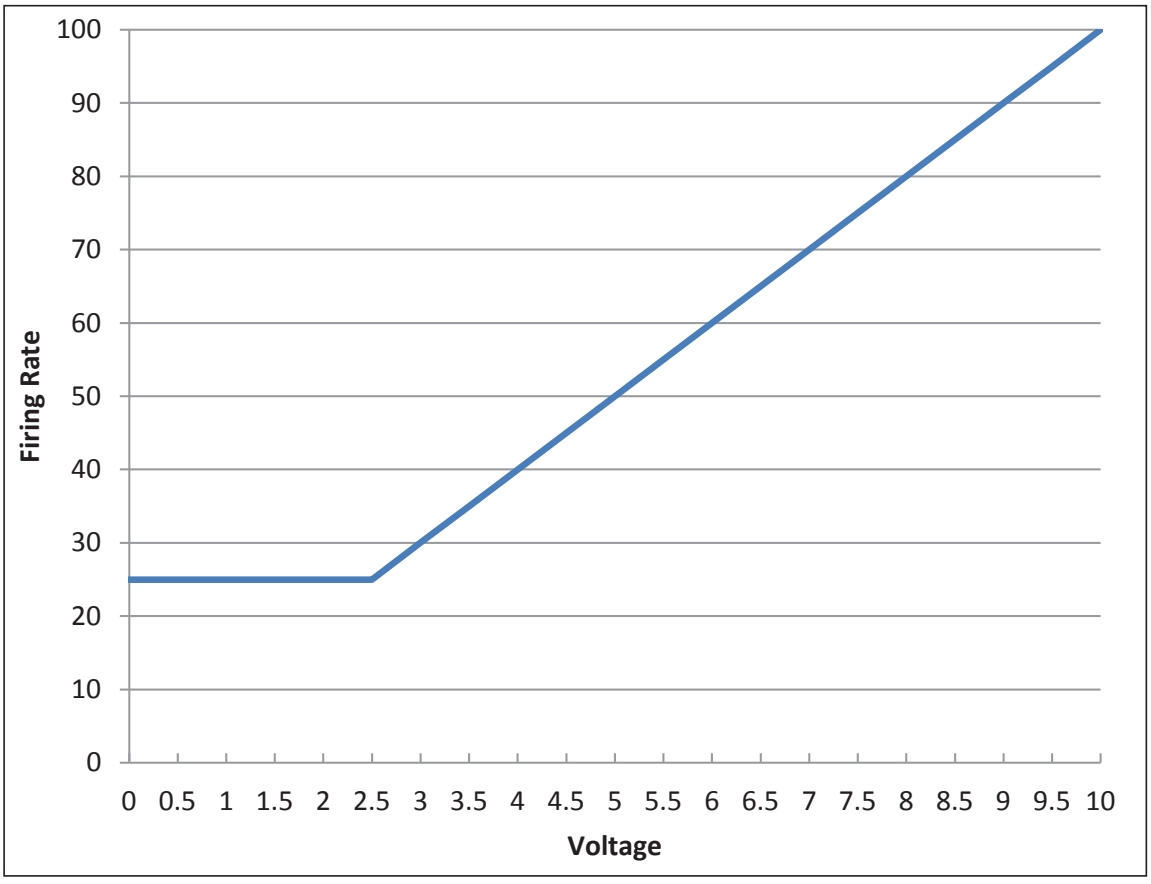


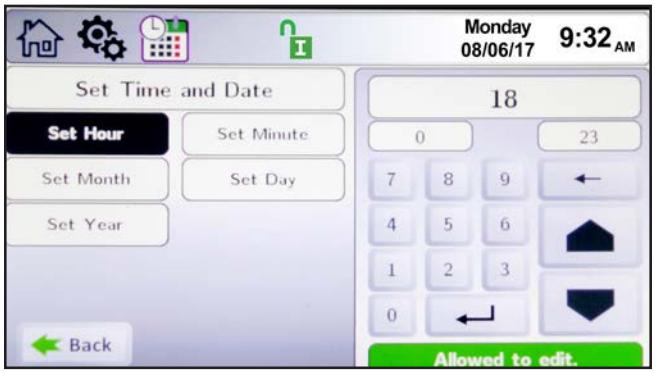
Figure 34. Firing Rate Control

Multi-stage External Demand Firing Rate Control									
		Stage 1		Stage 2		Stage 3		Stage 4	
Size	Stages	On	Off	On	Off	On	Off	On	Off
500 - 750	2	Demand On	Demand Off	6.5VDC 12.8mA	5.5VDC 11.2mA				
1000	3	Demand On	Demand Off	5.1VDC 10.1mA	4.1VDC 8.5mA	7.7VDC 15.4mA	6.8VDC 13.8mA		
1250 - 2000	4	Demand On	Demand Off	4.5VDC 8.8mA	3.5VDC 7.2mA	6.5VDC 12.8mA	5.5VDC 11.2mA	8.5VDC 16.8mA	7.5VDC 15.2mA

Table 21. External Demand - External Firing Rate Control

6.E.10 Setting the Time and Date

To navigate to the Time & Date Configuration Screen, touch the Time & Date Icon on the Configure Screen.



Screen 37. Time & Date Configuration Screen

NOTE: The Time is set in a 24 hour parameter, but displays only as a 12 hour clock with the AM/PM automatically added.

The Time & Date Configuration Screen allows adjustment of the following parameters:

•Hour – The hour that will be displayed in the upper banner on each screen, and the time captured in the date/time stamp for lock-out conditions displayed on the history screen.

• **Minute –** The minute that will be displayed in the upper banner on each screen, and the time captured in the date/time stamp for lock-out conditions displayed on the history screen.

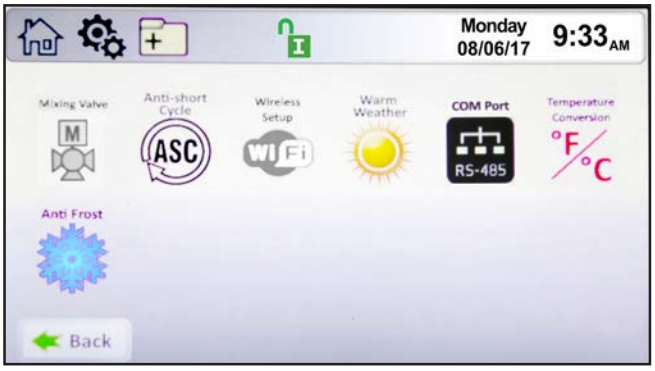
• **Month –** The month that will be displayed in the upper banner on each screen, and the date captured in the date/time stamp for lock-out conditions displayed on the history screen.

• **Day –** The day that will be displayed in the upper banner on each screen, and the date captured in the date/time stamp for lock-out conditions displayed on the history screen.

• **Year –** The month that will be displayed in the upper banner on each screen, and the date captured in the date/time stamp for lock-out conditions displayed on the history screen.

6.E.11 Miscellaneous Features

To navigate to the Miscellaneous Features Screen, touch the Miscellaneous Features Icon on the Configure Screen.



Screen 38. Miscellaneous Features Screen

The Miscellaneous Features screen provides navigation for the following items:

• **Mixing Valve –** This feature applies to Low-Temp Units.

• **Anti-short Cycle –** This icon navigates to the Anti-short Cycle Configuration Screen.

• **Wireless Setup –** This icon navigates to the Wireless Setup Screen, not available at this time.

• **Warm Weather –** This icon navigates to the Warm Weather Configuration Screen.

• **COM Port –** Icon navigates to a selection menu for either Modbus or BACnet MSTP protocols.

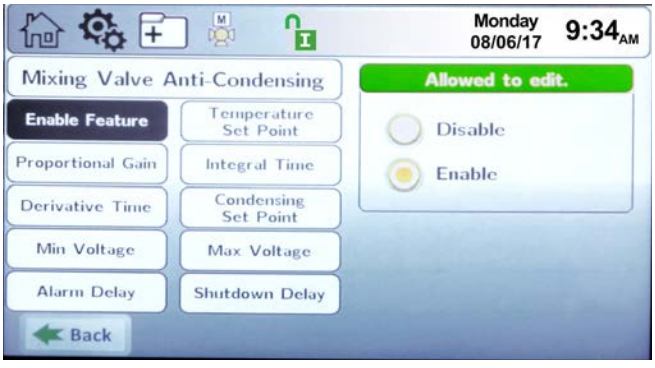
• **Temperature Conversion –** This icon navigates to the Temperature Conversion Configuration Screen.

• **Anti-Frost –** This icon navigates to the Anti-Frost Configuration Screen.

6.E.11.a Mixing Valve. Low Temp Models

Accessible ONLY on Low Temp Models.

To navigate to the Mixing Valve Configuration Screen, touch the Miscellaneous Features Icon on the Configure Screen, then touch the Mixing Valve Icon on the Miscellaneous Features screen.



Miscellaneous Features Screen

The Mixing Valve Configuration Screen allows adjustment of the following parameters:

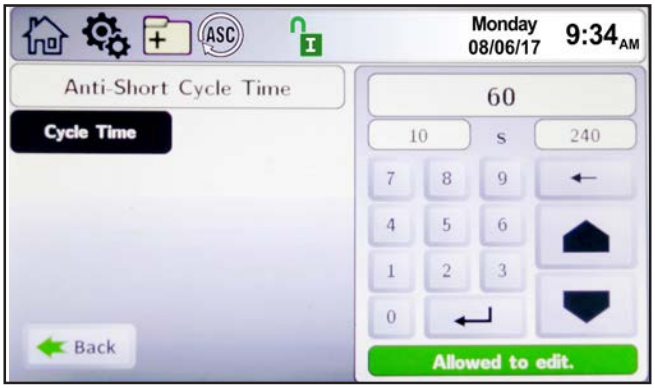
- **Enable Feature** – This allows the mixing valve to be enabled or disabled.
- **Temperature Set Point** – The mixing valve will maintain this temperature at the inlet to the boiler/heater.
- **Proportional Gain** – This value is the corrective action that is proportional to the error (set point – control temperature).
- **Integral Time** – This value is applied to the sum of the error over a period of time.
- **Derivative Time** – The value is applied to the rate of change of the error.
- **Condensing Set Point** – The condensing alarm and shutdown are based on this set point.
- **Min Voltage** – The minimum voltage the controller will send the mixing valve.
- **Max Voltage** – The maximum voltage the controller will send the mixing valve.
- **Alarm Delay** – If the boiler/heater inlet temperature is below Condensing Set Point for the duration of the Alarm Delay time, the boiler/heater will annunciate a condensing alarm.
- **Shutdown Delay** – If the boiler/heater inlet temperature is below the Condensing Set Point for the duration of the Shutdown Delay time, the boiler/heater will shut down and annunciate a condensing shutdown condition.

6.E.11.b Anti-Short Cycle

To navigate to the Anti-Short Cycle Configuration Screen, touch the Miscellaneous Features Icon on the Configure Screen, then touch the Anti-Short Cycle Icon on the Miscellaneous Features screen.

After a heat demand has been satisfied, the unit will wait the duration of the Anti-Short Cycle Time before satisfying the next heat demand.

NOTE: Anti-Short Cycle does not apply to DHW heat demands.



Screen 39. Anti-Short Cycle Configuration Screen

The Anti-Short Cycle Configuration Screen allows adjustment of the following parameter:

- **Cycle Time –** The amount of time after a heat demand is satisfied that the unit will wait to satisfy the next active heat demand.

6.E.11.c Wireless Setup

Wireless control is not available on this version of this Touchscreen Display System

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6.E.11.d Warm Weather

Warm Weather Shutdown (WWSD) is applicable to hydronic units only, and since it is not mandatory, it can be enabled/disabled on the WWSD configuration screen. There are three options for WWSD: shutdown immediately, shutdown after demand is satisfied and WWSD disabled. The default option is WWSD disabled. An outdoor sensor must be attached for WWSD operations. For all Sensor Connections at the low input terminal strip, please refer to 5.C.1.d on page 35
A unit in a WWSD condition will have a WWSD icon shown on the home screen.

WWSD - Shutdown Immediately

When the outdoor temperature, measured by the outdoor sensor, exceeds the WWSD set point, one of the following two conditions will occur. If the unit is idle, upon a call for heat, the unit will not turn on to satisfy a heat demand. If the unit is running to satisfy a call for heat, the unit will immediately shutdown. In either case, the WWSD icon will appear on the home screen.

WWSD – Shutdown After Demand is Satisfied

When the outdoor temperature, measured by the outdoor sensor, exceeds the WWSD set point, one of the following two conditions will occur. If the unit is ide, upon a call for heat, the unit will not turn on to satisfy a heat demand, and the WWSD icon will be shown on the home screen. If the unit is running to satisfy a call for heat, the unit will satisfy the heat demand and then the WWSD shutdown icon will appear. As long as the unit is in a WWSD condition, no additional heat demands will be satisfied.

WWWD – Disabled

When the outdoor temperature, measured by the outdoor sensor, exceeds the WWSD set point, nothing occurs.

To navigate to the Warm Weather Configuration Screen, touch the Miscellaneous Features on the Configure Screen, then touch the Warm Weather Icon on the Miscellaneous Features screen.



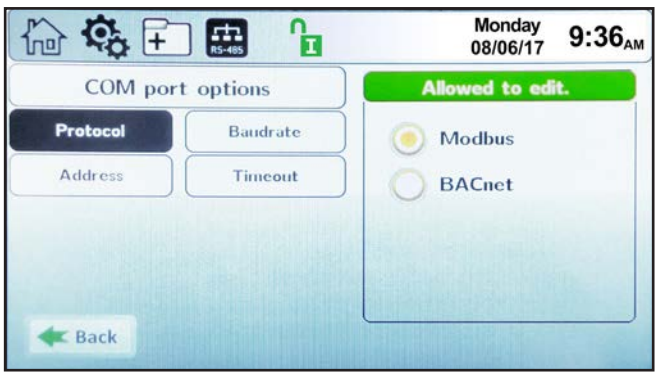
Screen 40. Warm Weather Configuration Screen

The Warm Weather Configuration Screen allows adjustment of the following parameters:

- **Temp Min –** Upon an active warm weather shutdown condition, this is the temperature at which the unit will reset the shutdown condition to satisfy a heat demand.
- **Temp Max –** This is the temperature at which the warm weather shutdown condition will occur.
- **Feature Options –** This parameter provides the ability to either disable warm weather shutdown or upon a warm weather condition, configure the unit to shut down immediately or to shut down after the current heat demand is satisfied.
- **Summer Kick CH –** This is the amount of time the pump is energized if it hasn't cycled for an extended period of time.
- **Summer Kick DHW –** This is the amount of time the DHW pump is energized if it hasn't cycled for an extended period of time.
- **Summer Kick SYS –** This is the amount of time the SYS pump is energized if it hasn't cycled for an extended period of time.
- **Summer Kick Period –** The duration of time between heat demands that the boiler will wait before exercising the boiler, DHW, and system pumps.

6.E.11.e COM Port

To navigate to the COM Port Configuration Screen, touch the Misc Icon on the Configure Screen, then touch the COM Port Icon on the Misc Configuration Screen.



Screen 41. COM Port Config Screen, ModBus

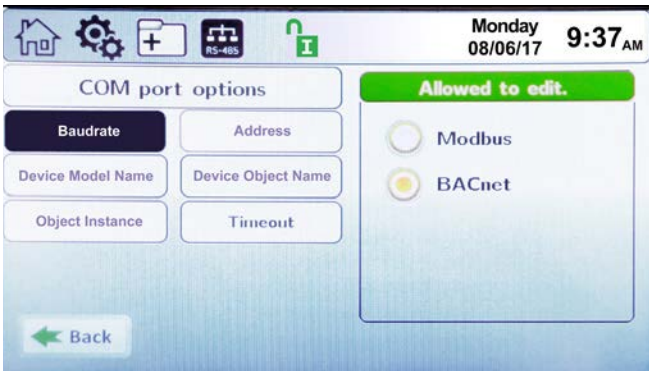
The COM Port Configuration Screen allows adjustment of the following parameters:

- **Protocol –** Allows selection of either Modbus or BACnet MSTP protocols.

NOTE: Changing the protocol requires a power cycle of the unit for the change to take effect.

With Modbus protocol selected, the following parameters are adjustable on this screen:

- **Baud-rate –** Modbus can be configured for the following standard baud-rated: 9600, 19200, 38400, and 57600.
- **Address –** The address of the unit on the Modbus network.
- **Timeout –** Upon loss of communication, this is the duration of time in which the unit will wait prior to a timeout conditions occurring.



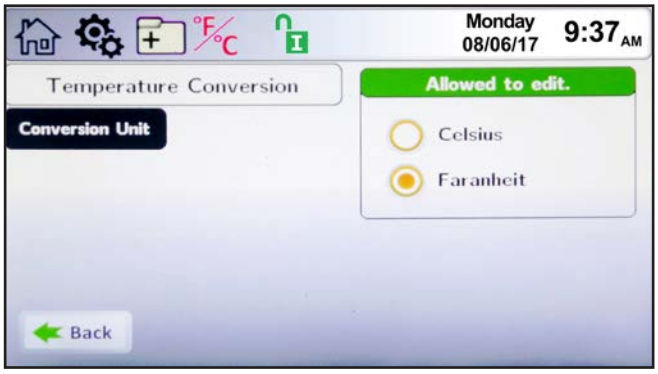
Screen 42. COM Port Config Screen, BACnet

With BACnet protocol selected, the following parameters are adjustable on this screen:

- **Baud-rate –** BACnet can be configured for the following standard baud-rates: 9600, 19200, 38400, and 76800.
- **Address –** The address of the unit on the BACnet network.
- **Device Model Name –** The name of that Units Model on the BACnet network.
- **Device Object Name –** The name of that Units Object on the BACnet network.
- **Object Instance –** The object number of that Unit on the BACnet network.
- **Timeout –** Upon loss of communication, this is the duration of time in which that Unit will wait prior to a timeout conditions occurring.

6.E.11.f Temperature Conversion

To navigate to the Temperature Conversion Configuration Screen, touch the Miscellaneous Features Icon on the Configure Screen, then touch the Temperature Conversion Icon on the Miscellaneous Features screen.



Screen 43. Temp Conversion Config Screen

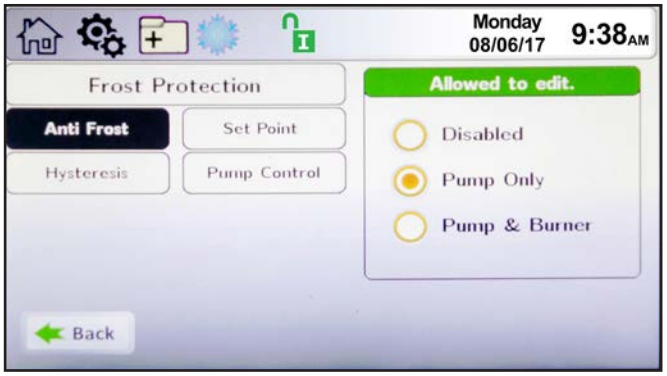
The Temperature Conversion Configuration Screen allows adjustment of the following parameter:

• **Conversion Unit –** This parameter can be changed between Fahrenheit and Celsius.

6.E.11.g Frost Protection

Frost protection provides some protection for the boiler, and if configured/installed properly, the system as well.

To navigate to the Anti-Frost Configuration Screen, touch the Miscellaneous Features Icon on the Configure Screen, then touch the Anti-Frost Icon on the Miscellaneous Features screen.



Screen 44. Anti-Frost Configuration Screen

The Anti-Frost Configuration Screen allows adjustment of the following parameters:

• **Anti-Frost –** This parameter provides the ability to either disable anti-frost or upon an anti-frost condition, configure the unit to only turn on the pump or to turn on the pump and fire the burner.

• **Set Point –** The temperature at which the unit will apply the Hysteresis value to enable the Anti-Frost mode. For example, if the Set Point is 44°F, and the Hysteresis is 4, the Anti-Frost action will initiate at 40°F (set point – hysteresis) and then will end at 48°F (set point + hysteresis).

• **Hysteresis –** This parameter is a +/- offset of the Anti-Frost Set Point used to turn on/off the Anti-Frost mode.

• **Pump Control –** This parameter provides the ability to select which pump(s) to apply the Anti-Frost Mode to. At least one pump must be selected, but all three pumps (Boiler, System, or DHW) can be selected.

If Anti-Frost mode is active, a snow flake icon will appear above the unit inlet temperature on the home screen. See Figure 35

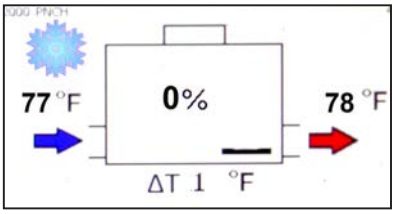
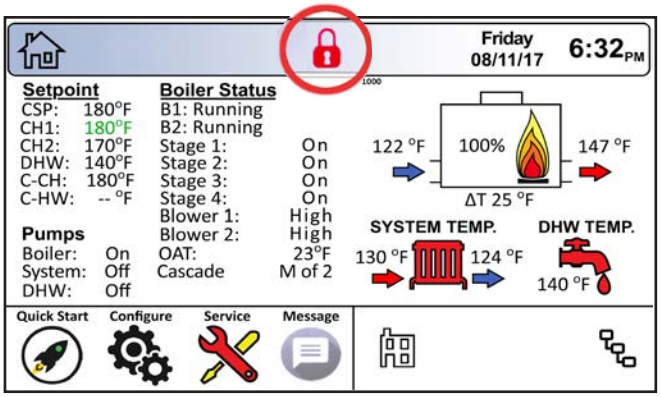


Figure 35. Active Anti Frost Condition

6.E.12 Login

To navigate to the Login Screen, touch the Login Icon on any of the menus.

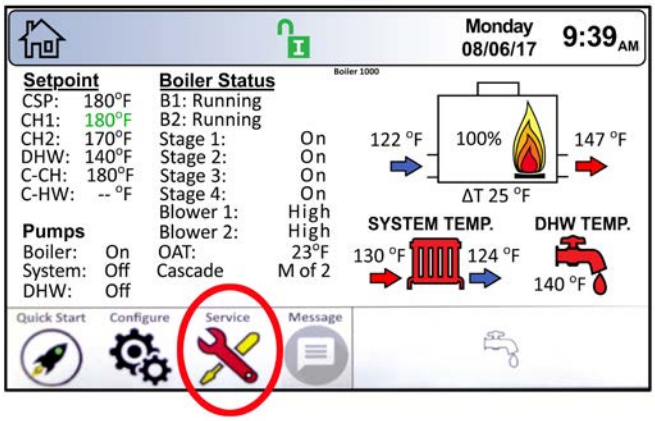
See Section 6.B on page 44



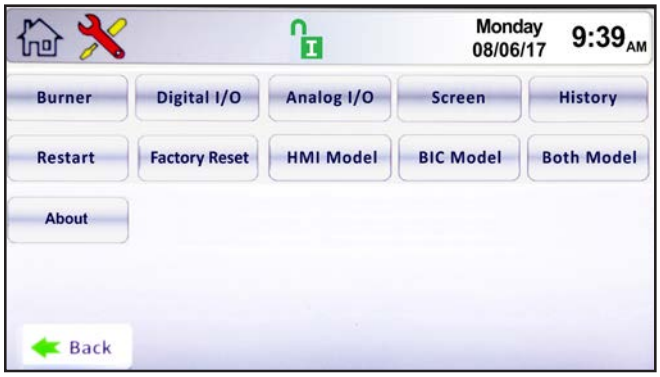
Screen 45. Touch the lock on any screen.

6.F Service Screens

To navigate to the Service Screen, touch the Service Icon in the lower left-hand portion of the Home Screen.



Screen 46. Home Screen



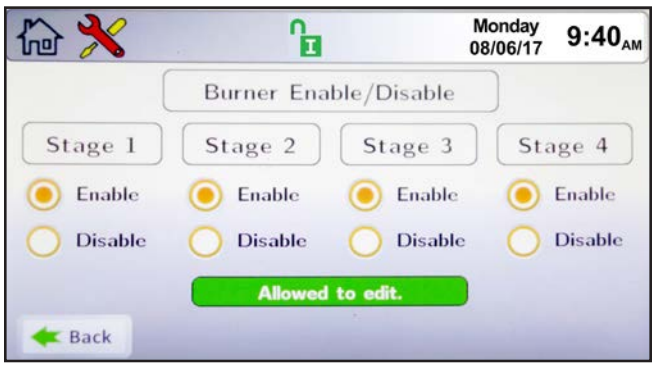
Screen 47. The Service Screen

NOTE: The Navigation Bar does not populate with new icons as you navigate into the various Service Screens.

From the Service Screen, basic diagnostic or service modes can be configured. The following sections give an overview of each service sub menu.

6.F.1 Burner

Navigate to the Burner Screen by touching the Burner Button on the Service Screen.



Screen 48. The Burner Screen

The Burner Screen allows each stage to be enabled or disabled for troubleshooting and/or diagnostic purposes. This screen will only display the number of stages associated with the size of the unit. For example, Sizes 500/750 have two stages, size 1000 has three stages, and sizes 1250/1500/1750/2000 have four stages. Low-Temp units are On/Off units only. See Table 12 on page 42

NOTE: The hot surface ignitors (HSI) are associated with Stages 1 and 3. If Stage 1 is disabled, then Stage 2 will automatically be disabled. If Stage 3 is disabled, then Stage 4 will automatically be disabled.

6.F.1.a Combustion Setup

Setting up your boiler or water heater for maximum combustion efficiency
Required tools: Manometer, Amp Tester, Allen Wrench Set, Combustion Analyzer.

1. Log in at the touchscreen as an installer.

> **WARNING**
> Improper adjustment may lead to poor combustion quality, increasing the amount of carbon monoxide produced. Excess carbon monoxide levels may lead to personal injury or death.

2. Disable Warm Weather Shut Down and Outdoor Reset if your unit is equipped with those options.

3. With a gas manometer, test the supply gas pressure. This unit requires a minimum supply gas pressure of 4" w.c. with a max of 13" wc.

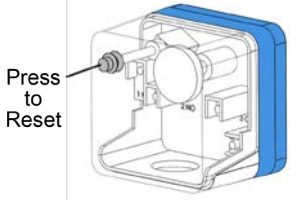


Figure 36. Measure Supply Gas Pressure

		Natural Gas	Propane
Supply Gas Pressure	Typical	7" w.c. (1.7kPa)	11" w.c. (2.7kPa)
	Range	4" w.c. (1kPa) to 10.5" w.c (2.6kPa)	8" w.c. (2kPa) to 13" w.c (3.2kPa)
Manifold Gas Pressure		2.5" w.c. (0.62 kPa)	
		8%	9.2%

Table 22. Gas Pressure Range

4. If you have a CSD-1 boiler, reset the 'Low Gas Pressure Switch' by pressing the reset button.



5. Optional. Adjust your 'Stage Delay On Time' to 20 seconds so that this combustion test doesn't pre-heat the building loop.

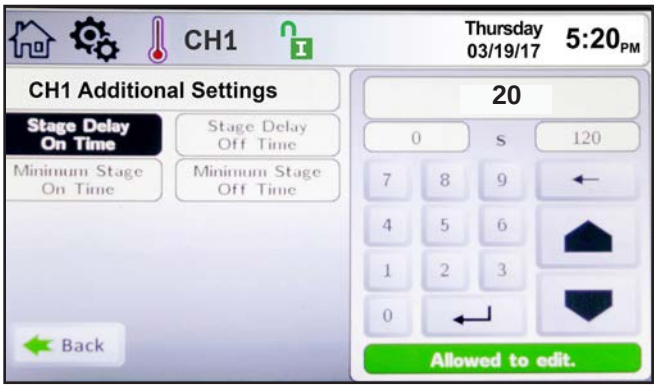


Figure 37. Stage Delay On Time

6. Check Manifold Gas Pressure at each gas valve. To check manifold gas pressure at each valve, the other valves/stages must be shut off/disabled. There are two ways to do this, Manually at the valve, or Electronically at the touchscreen display. If you have a 1 million BTU or larger unit, it is recommended to enable and disable your valves/ stages electronically thru the display.

To electronically enable and disable the valves, go to the Service Screen and select 'Burner'.

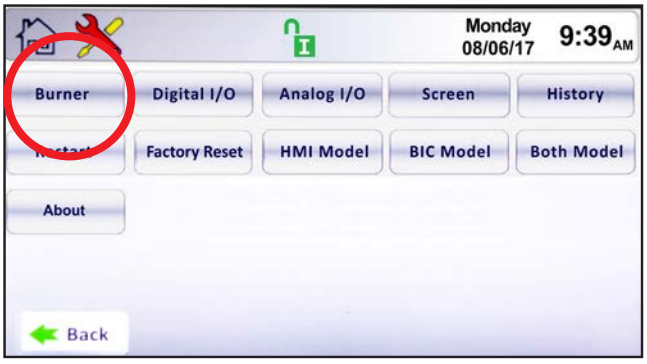


Figure 38. Service Screen

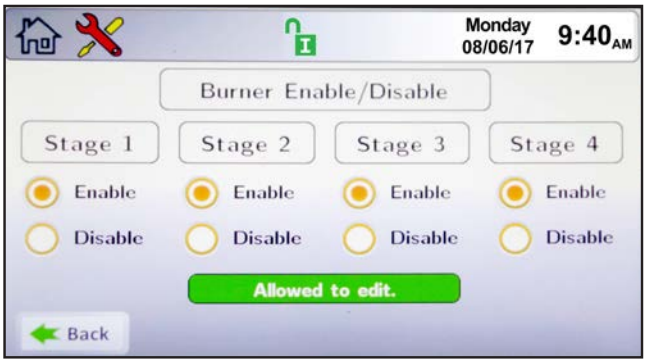


Figure 39. Burner Enable/Disable Screen

At this screen, you will notice that you can enable and disable all of the burner/stages on your unit. If you have a smaller model, you will have fewer burner/ stages.

Enable 'Burner Stage 1' and disable the other Burners. Then measure the manifold gas pressure at

the outlet side of valve 1. Remove the metal cap at the location on the valve shown in Figure 40 and adjust the manifold gas pressure using a screw driver.

Turn the adjustment screw clockwise to increase the gas pressure. Turn the adjustment screw counter clockwise to decrease the pressure. See Table 22 on page 70 for acceptable pressures for both Natural gas and Propane. Thread metal cap back into place.

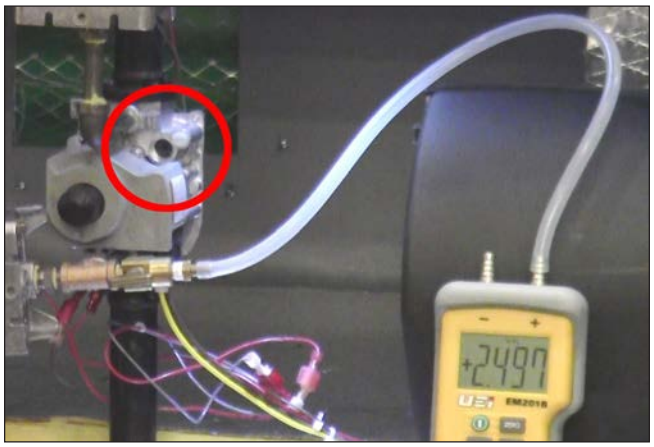


Figure 40. Measure/Adjust Manifold Pressure.

To Manually Enable and Disable each valve, there is a black switch on each valve. With valve 1 on, turn off the other valves, then measure the manifold gas pressure at the outlet side of valve 1. See Table 22 on page 70 for acceptable pressures for both Natural gas and Propane. Remove the metal cap at the location on the valve shown in Figure 40 and adjust the manifold gas pressure using a screw driver.

Turn the adjustment screw clockwise to increase the gas pressure. Turn the adjustment screw counter clockwise to decrease the pressure. See Table 22 on page 70 for acceptable pressures for both Natural gas and Propane. Thread metal cap back into place.

Repeat this step for each valve individually. When done, enable all valves.

7.A Optional. Check the amperage at your hot surface ignitor. Locate the hot surface ignitor wires and place your amp meter around one of the wires. . The hot surface ignitor wires pass thru the top of the burner chamber. This can be done quickly while the unit is in 'HSI Warm-up' stage. So move on to the next Step. See Figure 42

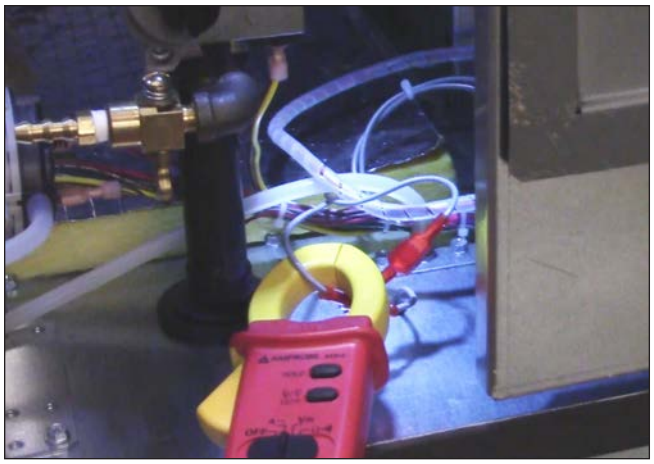


Figure 42. Amp Meter looped around an HSI wire.

7.B. Give the unit a call for heat, and then while the unit is in HSI Warm-up, read your amp meter. A good ignitor will be using 3.4 to 4.2 amps.

Note: If your hot surface ignitor is not performing properly, you will need to turn off the unit and replace the ignitor before continuing with this combustion test.

8. Close the front panel of the unit. But don't fasten it into place yet.

At this point you have done all the prep work and your stages are coming on and soon your boiler will be firing at 100%. It's time to measure CO_2 and adjust combustion.

9 Place your combustion analyzer into the vent test port. Wait for the CO_2 reading on your analyzer to steady. See Table 22 for acceptable CO_2 readings.

10. Open the front panel and locate the air damper which is next to the combustion fan. The larger units have 2 air dampers as they have two combustion fans. Loosen the two fasteners to the right of the combustion fan, to allow the damper to move a little.

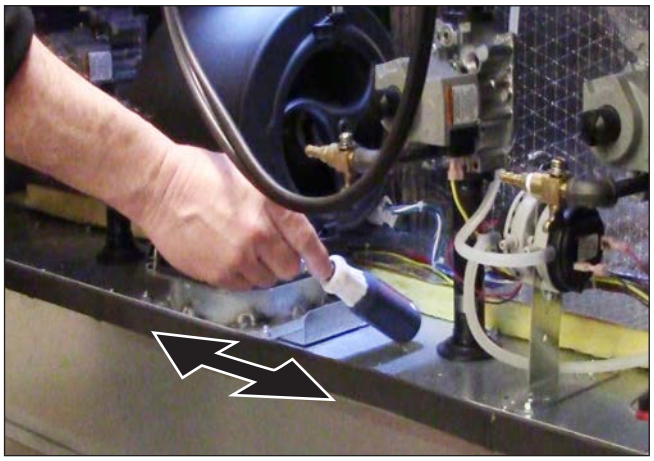


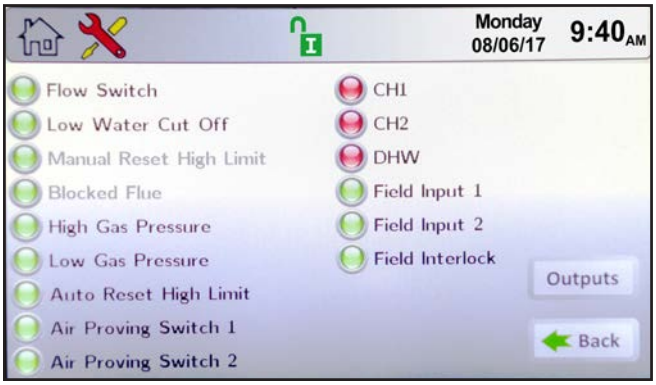
Figure 41. Adjust CO_2 at the air damper

If the CO_2 is too low, reduce the amount of air by closing the air damper. If it is too high, tap the damper open just a little. Slight adjustments are typically all that is needed.

Repeat Steps 8 thru 10 until the CO_2 shown on the combustion analyzer at an acceptable level.
Re-tighten the screws on the damper, when CO_2 is adjusted properly.

6.F.2 Digital I/O (Input / Output)

Navigate to the Digital I/O Screen by touching the Digital I/O Button on the Service Screen.

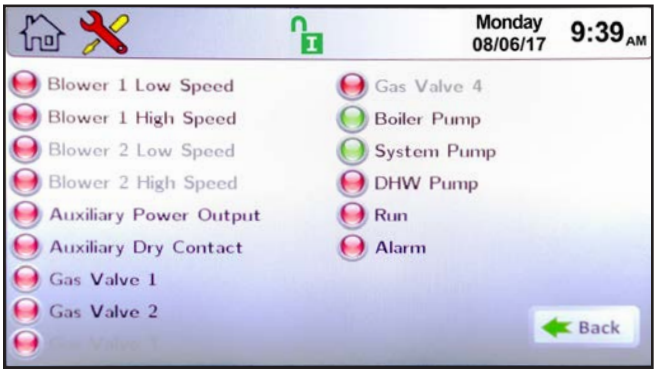


Screen 49. Digital I/O Screen - Inputs

There are two screens associated with the Digital I/O,
1. the Digital I/O Screen – Inputs, see above, and
2. Digital I/O Screen – Outputs, see below.

For digital (on/off) INPUTS, if the input is satisfied, the indicator light associated with that input is green. For example, if there is adequate flow, the flow switch is satisfied, and the flow switch digital input indicator light is green. Similarly, if the input is not satisfied, the indicator light associated with that input is red. For example, if the blower is off, then the air proving switch is not satisfied and the air proving switch digital input indicator light is red.

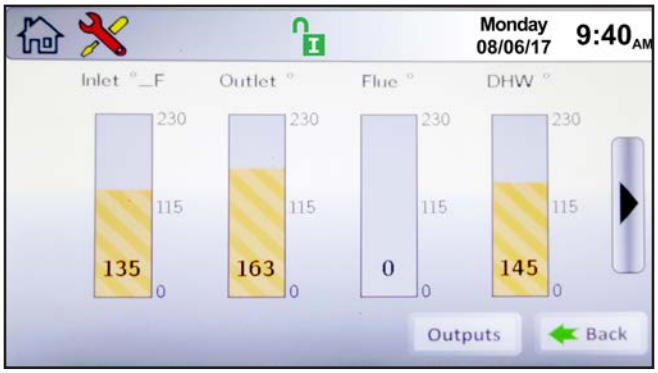
For digital (on/off) OUTPUTS, if the output is on, the indicator light associated with that output is green. For example, if the boiler pump is running, then the boiler pump output indicator light will be green. Similarly, if the output is off, the indicator light associated with that output is red. For example, if there is no call for heat, then the gas valves are off, and the gas valve indicator lights will be red.



Screen 50. Digital I/O Screen - Outputs

6.F.3 Analog I/O

Navigate to the Analog I/O Screen by touching the Analog I/O Button on the Service Screen.



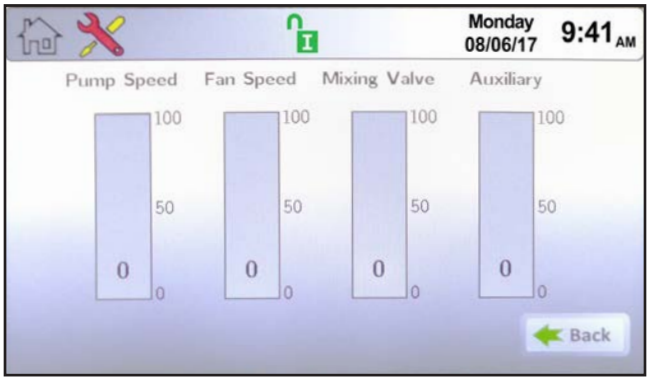
Screen 51. Analog I/O Screen - Inputs

NOTE: This unit does not use a flue stack sensor.

There are two screens associated with the Analog I/O, the Analog I/O Screen – Inputs, see above, and the Analog I/O Screen – Outputs, see below.

For analog inputs, there are three types of analog inputs: sensors, flame signal, and voltage/current (VDC/mA). Wiring of these inputs are covered in Section SECTION 5

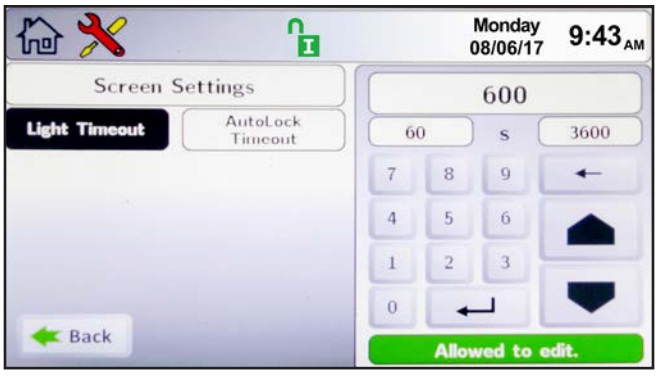
NOTE: If the input is not attached, the value will be zero.



Screen 52. Analog I/O Screen - Outputs

6.F.4 Screen Settings

Navigate to the Screen Settings Screen by touching the Screen Button on the Service Screen.

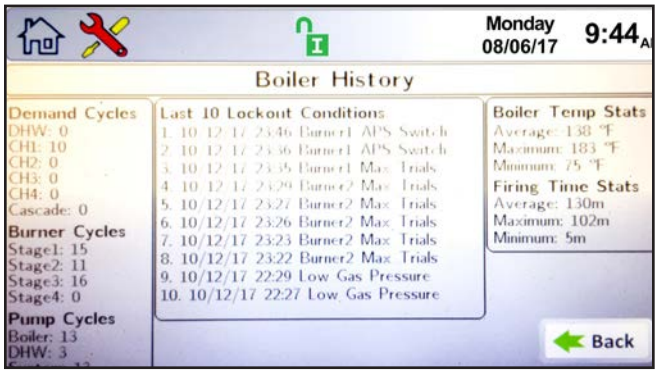


Screen 53. Screen Settings Screen

There are two adjustable screen settings: Light Timeout and AutoLock Timeout. Light Timeout allows the user to adjust the amount of time the touch screen backlight will remain lit after user interaction has ceased. AutoLock Timeout allows the user to adjust the amount of time the touch screen will remain unlocked with no user interaction.

6.F.5 History

Navigate to the History Screen by touching the History Button on the Service Screen.

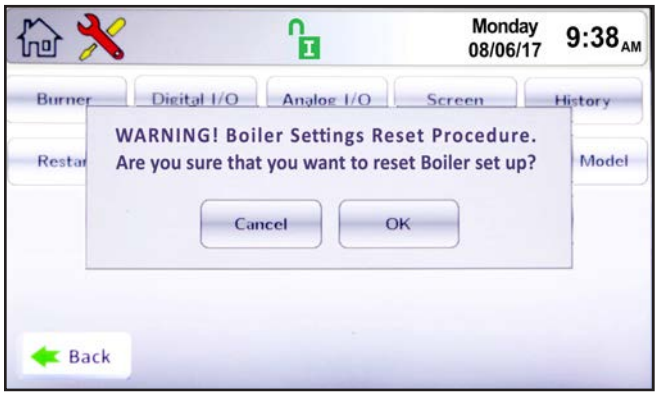


Screen 54. History Screen

The History Screen provides information on boiler operations and cycle counts. The control accumulates and displays the number of heat demand cycles, burner cycles, and pump cycles. It displays the 10 most recent lock-out conditions, and unit temperature and firing statistics.

6.F.6 Restart

Touching the Restart Button on the Service Screen reboots the display. If the touchscreen seems to be out of alignment, this is used to recalibrate the touchscreen.



Screen 55. Restart Screen

To recalibrate the touch screen. After pressing the Restart Button, promptly touch the touch screen and follow the calibration procedure as shown on the touch screen.

6.F.7 Factory Reset

Touching the Factory Reset Button on the Service Screen will allow the installer to reset all touch screen adjustable parameters back to the factory default setting. The installer will be prompted with a Warning before the unit's service settings are reset back to the original factory settings.



Screen 56. Factory Reset Screen

The next 4 Service Menus can only be accessed by a factory certified technician.

6.F.8 HMI Model

6.F.9 BIC Model

6.F.10 Both Model

6.F.11 About

6.G Messages and USB

6.G.1 Messages

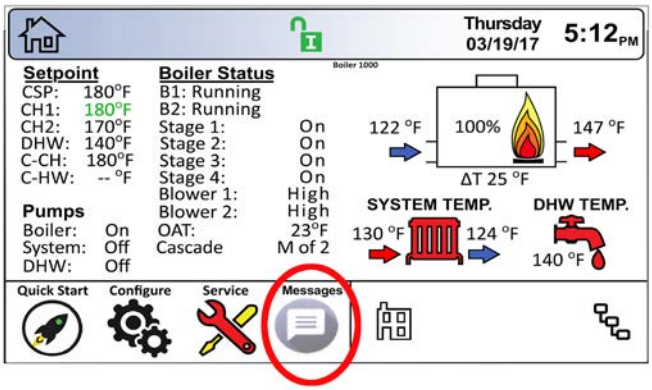
The 'Message' icon at the bottom of the home screen will display an 'Exclamation' when there is a message. Press the icon to see what the message is.

Messages are generally self explanatory and will guide a qualified service technician to the issue or parameter that needs to be adjusted and/or serviced.

A 'Message' will not be a 'Lock-Out' condition which is discussed in Section 10.A on page 83.

Additionally, this area of the home screen will indicate that a USB device has been inserted into the USB port which is located behind the touchscreen display. See Figure 43 on page 74.

6.G.1 Messages



Screen 59. Home Screen, Typical

6.G.2 USB Functionality

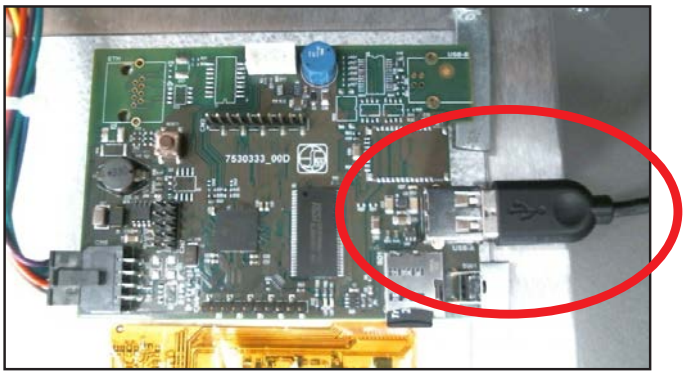


Figure 43. Photo of USB Slot on the back of touchscreen display.

The Display has a USB port that can be used to perform the following tasks:

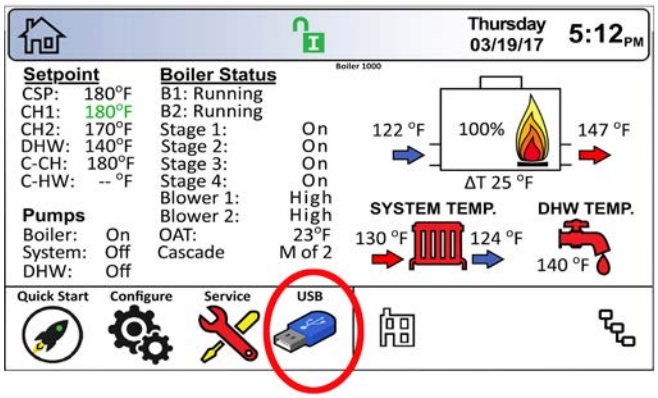
a. Download parameters from a thumb drive to a boiler.

b. Upload parameters from a boiler to a thumb drive.

c. Upload data from the boiler to a thumb drive.

The USB port is integrated into the back of the touchscreen display. To access it, the front panel of the unit must be removed and then the touchscreen removed from it's mounted location. The USB port can then be seen on the back of the touchscreen display.

Once a USB thumb drive has been inserted into the USB port, the USB icon will pop up on the home screen.



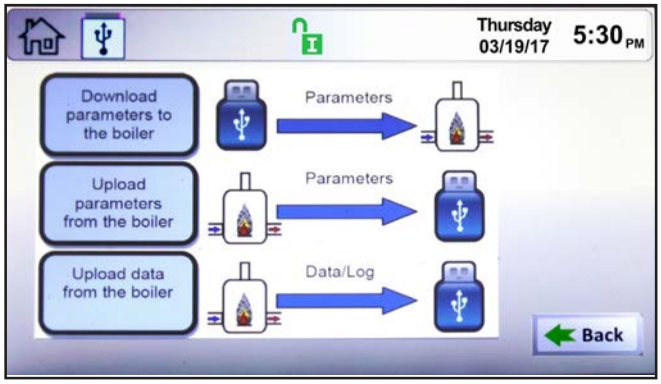
Screen 57. Home Screen showing USB

Once the USB icon has appeared over the Message icon, you can then select the USB icon and it will switch to the USB menu (See Screen 58). Here you can perform these 3 tasks.

Download Parameters from the boiler: This saves time during a cascade setup or a control replacement where the contractor only has to enter the values in 1 boiler instead of upwards of 8 boilers.

Upload Parameters from the boiler: This feature is to upload all parameters and settings into a thumb drive for documentation purposes or to be able to copy these settings from boiler to boiler without having to re-enter them individually.

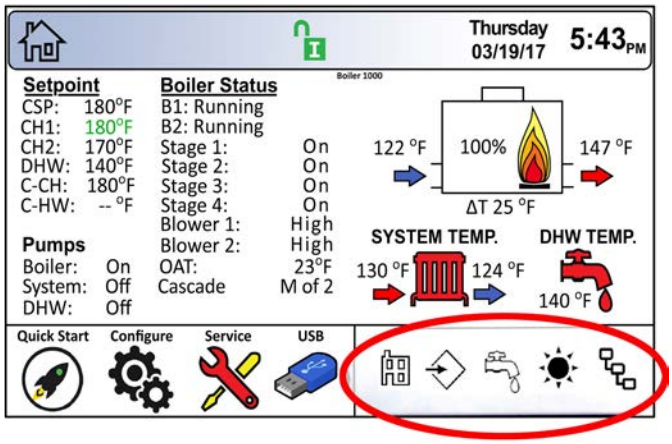
Upload DATA from the boiler: This is used to retrieve runtime data, history, as well as capture all settings in a tab delimited Excel format document.



Screen 58. Data Tasks for the USB Port

6.H Active Demands

The Active Demand Window indicates the status of active heat demands.



Screen 60. Active Demand Window

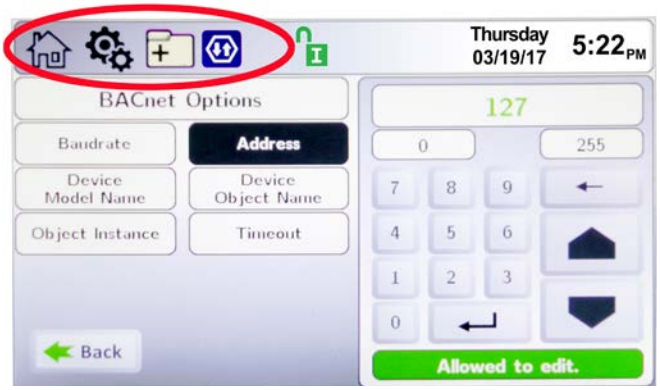
The **darker** Active Deman Icon indicates the heat demand that is currently being satisfied. A 'greyed out' Active Demand Icon is either lower in priority than the heat demand that is currently being satisfied, or the heat demand has reached set point, but remains active.

	CH1/2 or DHW1/2
	DHW or DHW3
	External
	Warm Weather Shutdown **NOTE:** Warm Weather Shutdown is not a heat demand. This icon indicates that a space heating demand is disabled due to high outdoor ambient temperature.
	Cascade

Figure 44. Active Demand Examples

6.I The Navigation Bar

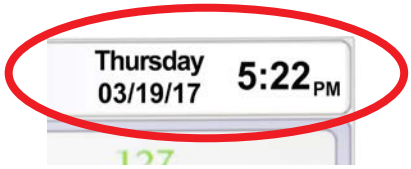
The Navigation Bar is a touch sensitive area at the top left of every screen, that shows you where you are at any time as you navigate into and out of the touchscreens. The further in that you go, the more icons will appear in the Navigation Bar. If you are 4 icons in and want to go back to the Home Screen, simply click onto the Home Icon. If you click onto any icon in the Navigation Bar, you will go to that location directly. If you want to go back just one step, you can click onto the next Icon back, OR ust the Back button.



Screen 61. The Navigation Bar

Lock-out Conditions will also display inside the Navigation Bar. Refer to Table 24 on page 85 for a list of possible Lock-out conditions.

6.J Date and Time Display Area



The top right portion of the Home Screen shows the Date and Time. To set the Date and Time, **please refer to Section 6.E.10 on page 65.**

SECTION 7 Sequence of Operation

7.A Restarting the Unit

If drained, follow 4.A.8 on page 25 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.

7.B Sequence of Operation

NOTE: Models 1000 – 2000 have two ignition sources. The controller treats the burners associated with each ignitor as an independent boiler/heater. If one ignitor should fail for any reason, the remaining ignitor and burner(s) will operate independently.

Standby

Upon a call for heat, the pump is energized and once the adequate liquid flow is establish, the flow switch is satisfied. If all other safety interlocks are satisfied, the Pre-Purge cycle begins.

Pre-Purge

In Pre-Purge, the units blower turns on high speed and confirms that the Air Proving Switch (APS) transitions from open to closed. The gas valves and Hot Surface Ignitor (HSI) are off. The duration of Pre-Purge is 15 seconds, and once expired, the unit transitions to HSI Warmup. If the APS remains open, or if there is a separate lock-out condition, the unit locks out and transitions to the Lock-out mode. If the call for heat is removed, the boiler/heater will transition back to the Standby mode.

NOTE: The duration of Pre-Purge is established to ensure proper evacuation of any unspent fuel in the combustion chamber and flue collector.

HSI Warmup

In HSI Warmup, the blower continues to run at high speed, the gas valves remain off, and power is applied to the HSI. The current flowing through the HSI must be between 3.1 – 6.0 Amps 20 seconds. If the HSI amperage meets the threshold and time requirements, the boiler/heater will transition to the Ignition mode.

Start Up and Shut Down must be performed by a qualified service person.

If the amperage doesn't meet the threshold and time requirements, or if there is a separate lock-out condition, the unit will transition to Lock-out mode. If the call for heat is removed, the unit will return to Standby.

Ignition

In Ignition, the blower continues to run at high speed, the HSI is on, and the gas valve associated with the HSI is energized. Proper ignition has occurred if the flame signal is greater than or equal to 1.1 uAmps in 4 seconds. If a proper flame has been established, the unit will transition to Run mode. If proper ignition does not occur, and the maximum attempts for ignition has not occurred, the boiler/heater will transition to Inter-Purge mode. If proper ignition does not occur, and the maximum attempts for ignition has been reached, the boiler/heater will transition to Lock-out mode. If the call for heat is removed, the boiler/heater will transition to Standby.

NOTE: Three attempts for ignition, prior to lock-out, is standard. CSD-1 units have a single attempt for ignition prior to lock-out.

Run

In Run, the blower continues to run at high speed, the HSI is off, and the gas valve associated with the HSI is energized. The stage 2 or stage 4 gas valve will stage on/off as required to satisfy a call for heat. If there is a loss of flame during Run mode, the unit will transition to Inter-Purge mode. If a lock-out condition occurs during Run mode, the unit will transition to Lock-out mode. If the call for heat is removed, the unit will transition to Post-Purge prior to returning to Standby

Inter-Purge

In Inter-purge, the blower continues to run at high speed, the HSI is off, and the gas valves are off. The unit will stay in Inter-Purge for 15 seconds. After 15 seconds, the unit will transition to HSI Pre-Heat. If a lock-out condition occurs during Inter-Purge, the unit will transition to Lock-out. If the call for heat is removed during Inter-Purge, the unit will transition to Post-Purge prior to returning to Standby.

Post-Purge

In Post-purge, the blower continues to run at high speed, the HSI is off, and the gas valves are off. The unit will stay in Post-purge for 30 seconds. After this time, the unit will return to Standby.

NOTE: The duration of Post-Purge is establish to ensure proper evacuation of any unspent fuel in the combustion chamber and flue collector.

Lock-out

In Lock-out, the blower continues to run at high speed, the HSI is off, and the gas valves are off. The unit blower will stay on for 30 seconds. The lock-out condition will remain until it has been manually reset. Once reset, the unit will transition to Standby mode.

7.C Shutting Down the Unit

1. Switch off the main electrical disconnect switch.
2. Close all manual gas valves.
3. If freezing is anticipated, drain the unit and be sure to also protect building piping from freezing.

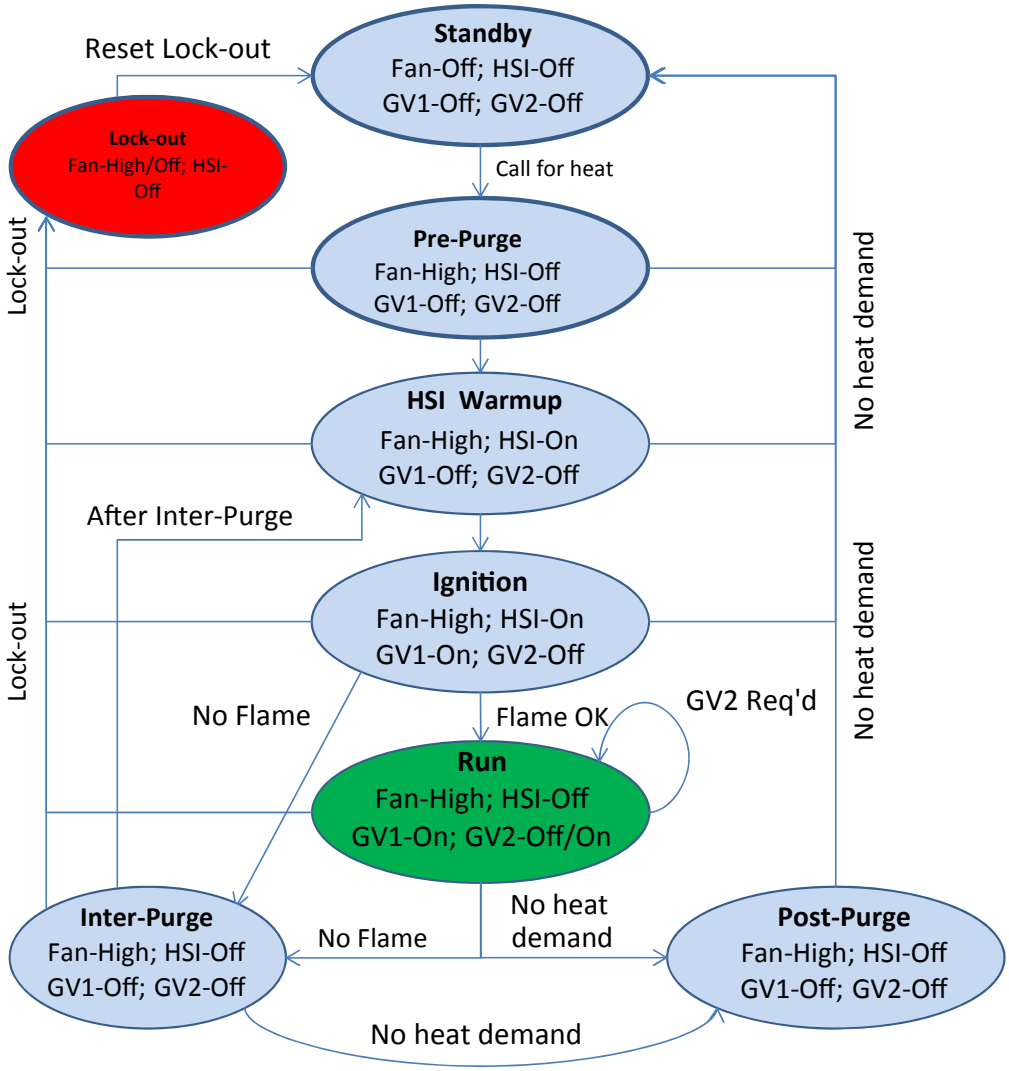


Figure 45. Timing and Ignition Flow

SECTION 8 Burner Set Up

8.A Set Up for 0 to 2500 Feet Altitude

This unit 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 unit resulting from improper setup is not covered by the limited warranty.

1. Using this manual, make sure the installation is complete and fully in compliance with the instructions.
2. Determine that the appliance and system are filled with water and all air has been bled from both. Open all valves.
3. Observe all warnings on the Operating Instructions label and turn on gas and electrical power to appliance.
4. Switch on the appliance power switch located on the right side of the unit.
5. The unit 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 unit 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 unit.
6. With the unit running, verify the supply gas pressure, manifold gas pressure, and CO2. Please refer to Section 6.F.1.a on page 70

		Natural Gas	Propane
Supply Gas Pressure	Typical	7" w.c. (1.7kPa)	11" w.c. (2.7kPa)
	Range	4" w.c. (1kPa) to 10.5" w.c (2.6kPa)	8" w.c. (2kPa) to 13" w.c (3.2kPa)
Manifold Gas Pressure		2.5" w.c. (0.62 kPa)	
		8%	9.2%

Table 23. Supply Gas Pressure

7. **After placing the appliance in operation, the Burner Safety Shutoff Device must be tested**. To test:
   (a) Close gas shutoff valve with burner operating.
   (b) The flame will go out and blower will continue to run for the post purge cycle. 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.

8.B Set Up for High Altitude (>2500 Feet)

These units 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 unit 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 CO_2 or O_2 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 CO_2 in the "as installed" condition. Adjust the air shutter(s) so that the CO_2 is about 8% or the O_2 is about 6.8% for appliances operating on Natural Gas. For appliances operating on LP Gas adjust the air shutter(s) so that the CO_2 is about 9.2% or the O_2 is about 6.8%. Appliances with two blowers should be adjusted so that the air shutters below each blower are open the same amount.

Please refer to Section 6.F.1.a on page 70

Once the CO_2 or O_2 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 CO_2 or O_2 must be reset. CO_2 or O_2 will have changed when the manifold pressure was adjusted. Open the air shutter(s) to reduce the CO_2 or O_2 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 CO_2 is adjusted to 8.0% for Natural Gas appliances or 9.2% for LP appliances. When using an O_2 analyzer, the correct O_2 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.

8.C Combustion Setup

For the complete process of Combustion Setup for this unit, See Section 6.F.1.a on page 70

SECTION 9 Maintenance

9.A 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.

9.B Appliance Maintenance and Component Description

Only genuine 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 Figure 46 and Figure 47 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. Controller	d. Pressure switches
b. Ignitors	f. Blowers
c. Automatic gas valve	

9.B.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.

9.B.1.a Combustion Setup

For the complete process of Combustion Setup for this unit, please refer to Section 6.F.1.a on page 70

9.B.2 Filter

The filter used in this unit 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.

9.B.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.

9.B.4 Manual Reset High Limit Control

When used, the high limit switch is a 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 capilliary and bulb from the thermal well located in the header. Replace in reverse order.

9.B.5 Automatic Reset High Limit Control

When used, an automatic reset 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 capilliary and bulb from the thermal well located in the header. Replace in reverse order.

9.B.6 Controller

The controller is a proprietary BIC. The controller ensures the proved interrupted-type ignition system. It controls the hot surface ignitor(s) and prove that the flame signal is appropriate for powering the gas valves. It also controls the blower's pre-purge and post-purge.

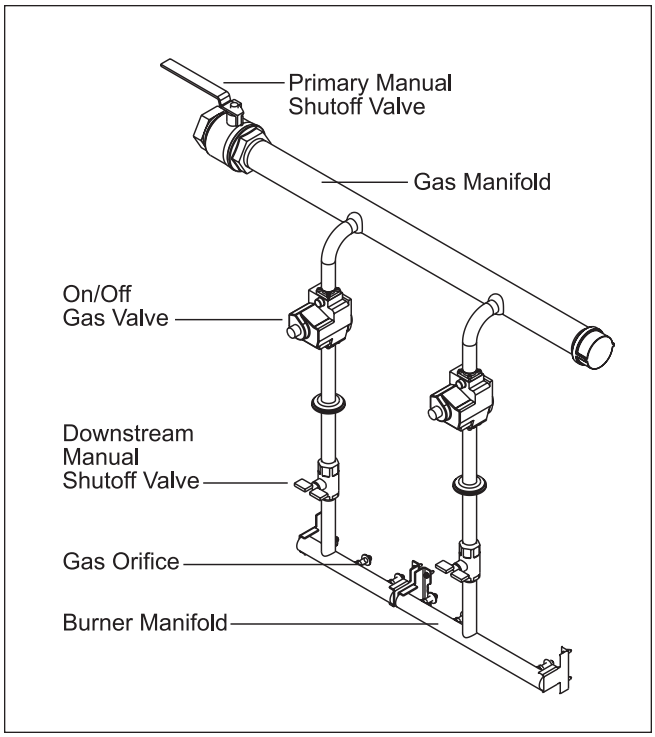


Figure 46. Typical Gas Train Configuration.

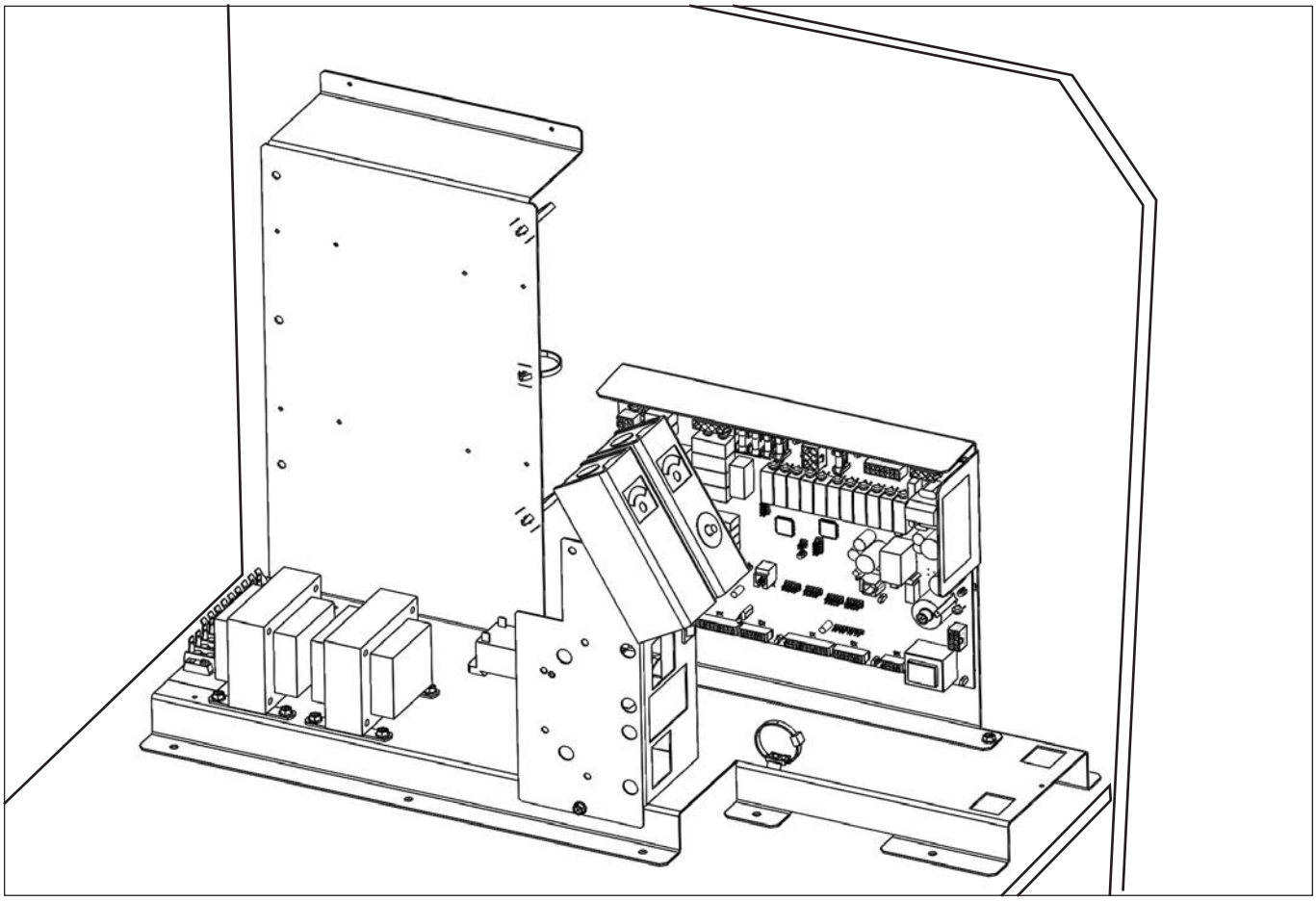


Figure 47. Typical Control Panel.

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

9.B.7 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. 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.

9.B.8 Ignition Sensors

The ignition sensors ensure that the main flame is ignited, so that raw gas is not allowed to fill the combustion chamber. Sizes 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 these units. There are no separate ignition sensors.

9.B.9 Transformer

The unit'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.

9.B.10 Blowers

The combustion air blowers bring the combustion air for the unit 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.

9.B.11 Flow Switch

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

9.B.12 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 unit 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.
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 10 Trouble Shooting

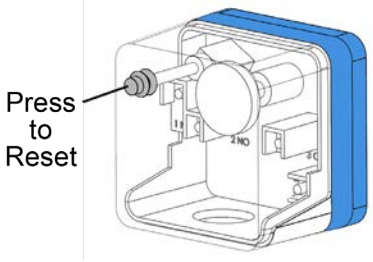
10.A Resolving Lockouts

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

The Troubleshooting Errors & Lockouts list is shown on Table 10.F on page 85.

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.



After resetting, 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 O_2 or CO_2). This unit will operate best with 45% excess air (8% CO_2 on natural gas, 9.2% CO_2 on LP). Check the CO_2 of the unit 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.

10.B 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.

10.C Short Cycling — Boiler

Because the unit 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 Set Points, or a load distribution problem. Contact your manufacturers representative to discuss possible remedies.

10.D 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 unit 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.

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.

10.E High Gas Consumption

Appliances operating with an improper air/fuel ratio are very inefficient and consequently, have very high gas consumption. Because efficiency is high when the CO_2 is high (or O_2 is low), appliances operating with low CO_2or high O_2 (especially LP appliances) consume more gas. Adjust the CO_2 or O_2 for optimum efficiency. If no combustion analyzing equipment (CO_2 or O_2) is available then a proper adjustment of the air/fuel ratio (CO_2 or O_2) cannot be accomplished. However, by briefly sniffing the flue gases it is possible to determine if the CO_2 or O_2 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 CO_2 or high O_2 . The CO_2 should be 8% at high fire. To check the CO_2, first verify that the supply gas pressure is within 5" to 13" w.c. (1.2 to 3.2 kPa) With the unit 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 CO_2, and adjust the air shutters if further adjustment to the CO_2 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.

10.F Troubleshooting Errors & Lockouts

<table>
<tr><th>Error</th><th>Description</th><th>Corrective Action</th></tr>
<tr><td>Flow Switch</td><td>Insufficient flow at the outlet of the boiler/heater.</td><td>• Faulty boiler/heater pump – replace pump.
• Faulty pump contactor – replace contactor.
• Blown boiler/heater pump fuse – replace fuse F14 on the control board.</td></tr>
<tr><td>Low Water Cut Off</td><td>Insufficient water level in the boiler/heater heat exchanger.</td><td>• Reset the LWCO from the reset button on the LWCO module.
• Verify the system is full of water and all air has been purged from the system.
• Check for loose jumpers if the LWCO is not installed.</td></tr>
<tr><td>Man Reset High Limit</td><td>Outlet water temperature has exceeded the manual reset high limit setting.</td><td>• Verify the system is full of water and all air has been purged from the system.
• Verify the boiler/heater is piped properly into the heating system.
• Check for proper pump operations.
• Check the manual reset high limit set point.</td></tr>
<tr><td>Auto Reset High Limit</td><td>Outlet water temperature has exceeded the auto reset high limit setting.</td><td>• Verify the system is full of water and all air has been purged from the system.
• Verify the boiler/heater is piped properly into the heating system.
• Check for proper pump operations.
• Check the manual reset high limit set point.</td></tr>
<tr><td>Pressure Switch</td><td>Blocked flue switch contacts are open.</td><td>• Check the wiring connections to the switch. The wires should be connected to the common and normally open terminals.
• Check reference hose and tubing connected to the pressure switch for blockage/obstruction.
• Faulty switch – replace switch.
• Verify blower is operating – replace if necessary.
• Blown blower fuse – replace fuse F12 on the control board for blower1 or fuse F13 for blower2.</td></tr>
<tr><td>High Gas Pressure</td><td>The high gas pressure switch has tripped.</td><td>• Refer to Section 3 for Gas Supply and Piping information.
• Verify supply and manifold gas pressures satisfy requirements in Section 8 – correct if necessary.</td></tr>
<tr><td>Low Gas Pressure</td><td>The low gas pressure switch has tripped.</td><td>• Refer to Section 3 for Gas Supply and Piping information.
• Verify supply and manifold gas pressures satisfy requirements in Section 8 – correct if necessary.</td></tr>
<tr><td>Field Interlock</td><td>Field interlock is open.</td><td>• Check for loose or misplaced jumper if no field interlock device is installed.</td></tr>
<tr><td>Outlet Sensor</td><td>Outlet probe is not connected.</td><td>• Check the sensor and wiring. Repair or replace as needed.
• The outlet probe is a dual element probe with 10K and 20K thermistors. A quick test is to measure resistance and verify one resistance is double the other. Replace if necessary.
• Measure the resistance of each element of the sensor and compare to the resistance table below. Replace if necessary.
<table>
<tr><th></th><th>10K</th><th>20K</th></tr>
<tr><th>Temp (°F)</th><th>Resistance (Ω)</th><th>Resistance (Ω)</th></tr>
<tr><td>68</td><td>12555</td><td>25099</td></tr>
<tr><td>86</td><td>8025</td><td>16057</td></tr>
<tr><td>104</td><td>5279</td><td>10569</td></tr>
<tr><td>122</td><td>3563</td><td>7139</td></tr>
<tr><td>140</td><td>2463</td><td>4937</td></tr>
<tr><td>158</td><td>1739</td><td>3489</td></tr>
<tr><td>176</td><td>1253</td><td>2514</td></tr>
<tr><td>194</td><td>919</td><td>1845</td></tr>
<tr><td>212</td><td>685</td><td>1376</td></tr>
</table></td></tr>
<tr><td>Outlet Sensor Drift</td><td>Dual element sensor readings do not agree.</td><td>• Check the sensor and wiring. Repair or replace as needed.
• The outlet probe is a dual element probe with 10K and 20K thermistors. A quick test is to measure resistance and verify one resistance is double the other. Replace if necessary.
• Measure the resistance of each element of the sensor and compare to the resistance table below. Replace if necessary.
<table>
<tr><th></th><th>10K</th><th>20K</th></tr>
<tr><th>Temp (°F)</th><th>Resistance (Ω)</th><th>Resistance (Ω)</th></tr>
<tr><td>68</td><td>12555</td><td>25099</td></tr>
<tr><td>86</td><td>8025</td><td>16057</td></tr>
<tr><td>104</td><td>5279</td><td>10569</td></tr>
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<tr><td>158</td><td>1739</td><td>3489</td></tr>
<tr><td>176</td><td>1253</td><td>2514</td></tr>
<tr><td>194</td><td>919</td><td>1845</td></tr>
<tr><td>212</td><td>685</td><td>1376</td></tr>
</table></td></tr>
<tr><td>Inlet Sensor</td><td>Inlet sensor is damaged or not connected.</td><td>• Check the sensor and wiring. Repair or replace as needed.
• Measure the resistance of the sensor and compare to the resistance table below. Replace if necessary.
<table>
<tr><th>Temp (°F)</th><th>Temp (°C)</th><th>Resistance (Ω)</th></tr>
<tr><td>68</td><td>20</td><td>12555</td></tr>
<tr><td>86</td><td>30</td><td>8025</td></tr>
<tr><td>104</td><td>40</td><td>5279</td></tr>
<tr><td>122</td><td>50</td><td>3563</td></tr>
<tr><td>140</td><td>60</td><td>2463</td></tr>
<tr><td>158</td><td>70</td><td>1739</td></tr>
<tr><td>176</td><td>80</td><td>1253</td></tr>
<tr><td>194</td><td>90</td><td>919</td></tr>
<tr><td>212</td><td>100</td><td>685</td></tr>
</table></td></tr>
</table>

Table 24. Troubleshooting Error Codes.

(cont)

Error	Description	Corrective Action
Burner1 APS Switch	Burner1 air proving switch contacts are open.	• Check the wiring connections to the switch. The wires should be connected to the common and normally open terminals. • Check reference hose and tubing connected to the pressure switch for blockage/obstruction. • Faulty switch – replace switch. • Verify blower is operating – replace if necessary. • Blown blower fuse – replace fuse F12 on the control board for blower1.
Burner2 APS Switch	Burner2 air proving switch contacts are open. **NOTE:** 1.25MM – 2.0MM Only	• Check the wiring connections to the switch. The wires should be connected to the common and normally open terminals. • Check reference hose and tubing connected to the pressure switch for blockage/obstruction. • Faulty switch – replace switch. • Verify blower is operating – replace if necessary. • Blown blower fuse – replace fuse F13 on the control board for blower2.
Burner1 Parasitic Flame	Sensing flame on burner1 prior to ignition.	• Inspect HSI and wiring for damage and continuity. Replace if necessary. • Check HSI by unplugging the ignitor, remove from the system, and measure resistance. It should be between 50Ω - 80Ω, if it is not in this range, replace the HSI.
Burner2 Parasitic Flame	Sensing flame on burner2 prior to ignition. **NOTE:** 1.0MM – 2.0MM Only	• Inspect HSI and wiring for damage and continuity. Replace if necessary. • Check HSI by unplugging the ignitor, remove from the system, and measure resistance. It should be between 50Ω - 80Ω, if it is not in this range, replace the HSI.
Burner1 Max Trials	The maximum attempts for ignition has occurred, without sensing flame.	• Verify supply and manifold gas pressures satisfy requirements in Section 8 – correct if necessary. • Verify the proper intake and venting. • Inspect the burner. • During ignition, see Section 7, verify 24VAC at gas valve associated with the HSI.
Burner2 Max Trials	The maximum attempts for ignition has occurred, without sensing flame. **NOTE:** 1.0MM – 2.0MM Only	• Verify supply and manifold gas pressures satisfy requirements in Section 8 – correct if necessary. • Verify the proper intake and venting. • Inspect the burner. • During ignition, see Section 7, verify 24VAC at gas valve associated with the HSI.
Burner1 Max Flame Lost	The maximum allowable occurrences of the unit running and losing flame signal have occurred.	• Inspect HSI and wiring for damage and continuity. Replace if necessary. • Check HSI by unplugging the ignitor, remove from the system, and measure resistance. It should be between 50Ω - 80Ω, if it is not in this range, replace the HSI. • Verify supply and manifold gas pressures satisfy requirements in Section 8 – correct if necessary. • Verify the proper intake and venting. • Check combustion. • Inspect the burner. • Inspect the heat exchanger.
Burner2 Max Flame Lost	The maximum allowable occurrences of the unit running and losing flame signal have occurred. **NOTE:** 1.0MM – 2.0MM Only	• Inspect HSI and wiring for damage and continuity. Replace if necessary. • Check HSI by unplugging the ignitor, remove from the system, and measure resistance. It should be between 50Ω - 80Ω, if it is not in this range, replace the HSI. • Verify supply and manifold gas pressures satisfy requirements in Section 8 – correct if necessary. • Verify the proper intake and venting. • Check combustion. • Inspect the burner. • Inspect the heat exchanger.
Burner1 Proven HSI	Burner1 proven HSI failed	• Inspect HSI and wiring for damage and continuity. Replace if necessary. • Check HSI by unplugging the ignitor, remove from the system, and measure resistance. It should be between 50Ω - 80Ω, if it is not in this range, replace the HSI. • During the HSI Warmup stage of ignition, see Section 7, verify 120VAC at the HSI. • Blown HSI fuse – replace fuse F10 on the control board for HSI1.
Burner2 Proven HSI	Burner2 proven HSI failed **NOTE:** 1.0MM – 2.0MM Only	• Inspect HSI and wiring for damage and continuity. Replace if necessary. • Check HSI by unplugging the ignitor, remove from the system, and measure resistance. It should be between 50Ω - 80Ω, if it is not in this range, replace the HSI. • During the HSI Warmup stage of ignition, see Section 7, verify 120VAC at the HSI. • Blown HSI fuse – replace fuse F11 on the control board for HSI2.

10.G Parameter Tables

10.G.1 Boiler (including Low Temp)

	User	Installer	Minimum	Maximum	Default
Time & Date					
Hour	x	x	NA	NA	NA
Minute	x	x	NA	NA	NA
Month	x	x	NA	NA	NA
Day	x	x	NA	NA	NA
Year	x	x	NA	NA	NA
CH1					
CH1 Enable/Disable	x	x	Disable	Enable	Enable
CH1 Setpoint	x	x	120 F	240 F	180 F
CH1 Priority		x	1	97	60
CH1 Control Mode		x	PID	Temp Differential	Temp Differential
CH1 Stage 1 OFF Hysteresis		x	0 F	10 F	5 F
CH1 Stage 1 ON Hysteresis		x	0 F	10 F	5 F
CH1 Stage 2 OFF Hysteresis		x	0 F	10 F	5 F
CH1 Stage 2 ON Hysteresis		x	0 F	10 F	5 F
CH1 Stage 3 OFF Hysteresis		x	0 F	10 F	5 F
CH1 Stage 3 ON Hysteresis		x	0 F	10 F	5 F
CH1 Stage 4 OFF Hysteresis		x	0 F	10 F	5 F
CH1 Stage 4 ON Hysteresis		x	0 F	10 F	5 F
CH1 Stage Delay On Time		x	0 secs	120 secs	30 secs
CH1 Stage Delay Off Time		x	0 secs	120 secs	0 secs
CH1 Minimum Stage On Time		x	0 secs	120 secs	10 secs
CH1 Minimum Stage Off Time		x	0 secs	120 secs	10 secs
CH1 PID On Hysteresis	x	x	0 F	21 F	10 F
CH1 PID Off Hysteresis	x	x	0 F	21 F	10 F
CH1 Proportional Gain		x	0	32767	250
CH1 Integral Time		x	0	32767	100
CH1 Derivative Time		x	0	32767	0
CH2					
CH2 Enable/Disable	x	x	Disable	Enable	Enable
CH2 Setpoint	x	x	120 F	240 F	170 F
CH2 Priority		x	1	97	50
CH2 Control Mode		x	PID	Temp Differential	Temp Differential
CH2 Stage 1 OFF Hysteresis		x	0 F	10 F	5 F
CH2 Stage 1 ON Hysteresis		x	0 F	10 F	5 F
CH2 Stage 2 OFF Hysteresis		x	0 F	10 F	5 F
CH2 Stage 2 ON Hysteresis		x	0 F	10 F	5 F
CH2 Stage 3 OFF Hysteresis		x	0 F	10 F	5 F
CH2 Stage 3 ON Hysteresis		x	0 F	10 F	5 F
CH2 Stage 4 OFF Hysteresis		x	0 F	10 F	5 F
CH2 Stage 4 ON Hysteresis		x	0 F	10 F	5 F
CH2 Stage Delay On Time		x	0 secs	120 secs	60 secs
CH2 Stage Delay Off Time		x	0 secs	120 secs	0 secs
CH2 Minimum Stage On Time		x	0 secs	120 secs	10 secs
CH2 Minimum Stage Off Time		x	0 secs	120 secs	10 secs
CH2 PID On Hysteresis	x	x	0 F	21 F	20 F
CH2 PID Off Hysteresis	x	x	0 F	21 F	20 F

Boiler continued	User	Installer	Minimum	Maximum	Default
CH2 Proportional Gain		x	0	32767	250
CH2 Integral Time		x	0	32767	100
CH2 Derivative Time		x	0	32767	0
DHW					
DHW Enable/Disable	x	x	Disable	Enable	Disable
DHW Setpoint	x	x	120 F	200 F	180 F
DHW Priority		x	1	97	90
DHW Control Mode		x	PID	Temp Differential	Temp Differential
DHW PID On Hysteresis	x	x	0 F	21 F	10 F
DHW PID Off Hysteresis	x	x	0 F	21 F	10 F
DHW Stage 1 OFF Hysteresis		x	0 F	10 F	5 F
DHW Stage 1 ON Hysteresis		x	0 F	10 F	5 F
DHW Stage 2 OFF Hysteresis		x	0 F	10 F	5 F
DHW Stage 2 ON Hysteresis		x	0 F	10 F	5 F
DHW Stage 3 OFF Hysteresis		x	0 F	10 F	5 F
DHW Stage 3 ON Hysteresis		x	0 F	10 F	5 F
DHW Stage 4 OFF Hysteresis		x	0 F	10 F	5 F
DHW Stage 4 ON Hysteresis		x	0 F	10 F	5 F
DHW Stage Delay On Time		x	0 secs	120 secs	60 secs
DHW Stage Delay Off Time		x	0 secs	120 secs	0 secs
DHW Minimum Stage On Time		x	0 secs	120 secs	10 secs
DHW Minimum Stage Off Time		x	0 secs	120 secs	10 secs
DHW Offset		x	0 F	72 F	18 F
DHW Proportional Gain		x	0	32767	250
DHW Integral Time		x	0	32767	100
DHW Derivative Time		x	0	32767	0
Outdoor					
Outdoor Reset Enable/Disable	x	x	Disable	Enable	Enable
Maximum Ambient Temperature		x	0 F	120 F	65 F
Minimum Ambient Temperature		x	0 F	100 F	0 F
Maximum Water Temperature		x	120 F	240 F	180 F
Minimum Water Temperature		x	120 F	240 F	120 F
Cascade CH					
Address		x	-1	7	-1
Dynamic Address		x	-1	7	-1
Lost Lead Backup Setpoint		x	120 F	240 F	180 F
Lag On Hysteresis		x	0 F	21 F	10 F
Lag Off Hysteresis		x	0 F	21 F	10 F
Cascade CH Setpoint	x	x	120 F	240 F	180 F
Cascade CH On Hysteresis		x	0 F	21 F	10 F
Cascade CH Off Hysteresis		x	0 F	21 F	10 F
Cascade CH Priority		x	1	97	70
Cascade CH Proportional Gain		x	0	32767	250
Cascade CH Integral Time		x	0	32767	10
Cascade CH Derivative Time		x	0	32767	0
Cascade CH Maximum Lag Temperature		x	120 F	240 F	180 F
Cascade Redundancy					
Loss of Lead Setup		x	Disable	Boiler Internal Setpoint/ Redundant Lead	Boiler Internal Setpoint
Hybrid					
Hybrid Enable/Disable		x	Disable	Enable	Disable

Boiler continued	User	Installer	Minimum	Maximum	Default
Lag Mode Enable/Disable		x	Disable	Enable	Disable
Hybrid Setpoint		x	82 F	181 F	130 F
Hybrid Differential Temperature		x	0 F	21 F	10 F
Hybrid Delay Time		x	0 min	720 min	30 min
Pump Configuration					
Boiler Pump Control		x	Auto	Auto/ Always On/ Off During DHW	Auto
Boiler Pump Post Circulation		x	0 secs	600 secs	60 secs
DHW Pump Control		x	DIsable	Auto/ Always On	Auto
DHW Pump Post Circulation		x	0 secs	600 secs	60 secs
System Pump Control		x	DIsable	Auto/ Always On/ Off During DHW	Auto
System Pump Post Circulation		x	0 secs	600 secs	60 secs
Temperature Limits					
Auto Reset Boiler Outlet Limit		x	100 F	240 F	195 F
Manual Reset Boiler Outlet Limit		x	100 F	240 F	210 F
Reset Differential		x	1 F	10 F	5 F
Stage Limit Hysteresis		x	0 F	10 F	2 F
External Control					
Control Mode		x	Disable	Extenal Setpoint/ Firing Rate	Disable
External Control Priority		x	1	97	20
Maximum Setpoint		x	120 F	240 F	180 F
Minimum Setpoint		x	120 F	240 F	120 F
Maximum Firing Rate		x	0	10000	10000
Minimum Firing Rate		x	0	10000	0
Demand Max		x	0%	100%	100%
Demand Min		x	0%	100%	20%
Demand On		x	0%	25%	15%
Demand Off		x	0%	25%	10%
Anti- Frost					
Anti Frost Mode		x	Disable	Pump Only/ Pump & Burner	Pump Only
Anti- Frost Setpoint		x	32 F	120 F	40 F
Anti- Frost Hysteresis		x	3 F	10 F	5 F
Anti- Frost Pump Control		x	NA	Boiler/ DHW/ System	Boiler
Warm Weather Shutdown					
Temperature Minimum		x	50 F	140 F	90 F
Temperature Maximum		x	50 F	140 F	95 F
Feature Options		x	Disable	Shutdown Immediately/ Shutdown After Demand is Satisfied	Shutdown Immediately
Summer Kick CH		x	0 secs	600 secs	30 secs
Summer Kick DHW		x	0 secs	600 secs	30 secs
Summer Kick System		x	0 secs	600 secs	30 secs
Summer Kick Period		x	10 min	2000 min	1440 min
Anti- Short Cycle Time					
Cycle Time		x	10 secs	240 secs	60 secs
Temperature Conversion					
Conversion Unit	x	x	Celsius	Fahrenheit	Fahrenheit

Boiler continued	User	Installer	Minimum	Maximum	Default
BACnet					
Baudrate		x	9600	76800	76800
Address		x	0	255	127
Device Model Name		x	NA	NA	NA
Device Object Name		x	NA	NA	NA
Object Instance		x	0	4194303	600000
Timeout		x	0 secs	300 secs	300 secs
Mixing Valve Anti- Condensing (Low Temp Models ONLY)					
Mixing Valve Anti-Condensing Enable/Disable		x	Disable	Enable	Enable
Mixing Valve Anti-Condensing Temperature Setpoint		x	120 F	180 F	120 F
Mixing Valve Anti-Condensing Proportional Gain		x	0	32767	250
Mixing Valve Anti-Condensing Integral TIme		x	0	32767	15
Mixing Valve Anti-Condensing Derivative Time		x	0	32767	0
Condensing Alarm Setpoint		x	100 F	120 F	110 F
Minimum Voltage Output		x	0 mV	4000 mV	3500 mV
Maximum Voltage Output		x	4000 mV	10000 mV	6500 mV
Condensing Alarm Delay		x	0 mins	20 mins	10 mins
Condensing Shutdown Delay		x	0 mins	40 mins	20 mins
Service					
Stage 1 Burner Enable/Disable		x	Disable	Enable	Enable
Stage 2 Burner Enable/Disable		x	Disable	Enable	Enable
Stage 3 Burner Enable/Disable (Applicable to 1MM-2MM only)		x	Disable	Enable	Enable
Stage 4 Burner Enable/Disable (Applicable to 1.25MM-2MM only)		x	Disable	Enable	Enable
Screen Settings					
Light Timeout	x	x	0 secs	3600 secs	600 secs
AutoLock Timeout	x	x	0 secs	3600 secs	600 secs

10.G.2 Heater (including Low Temp)	User	Installer	Minimum	Maximum	Default
Time & Date					
Hour	x	x	NA	NA	NA
Minute	x	x	NA	NA	NA
Month	x	x	NA	NA	NA
Day	x	x	NA	NA	NA
Year	x	x	NA	NA	NA
DHW1					
DHW1 Enable/Disable	x	x	Disable	Enable	Enable
DHW1 Setpoint	x	x	120 F	200 F	140 F
DHW1 Priority		x	1	97	60
DHW1 Control Mode		x	PID	Temp Differential	Temp Differential
DHW1 Stage 1 OFF Hysteresis		x	0 F	10 F	5 F
DHW1 Stage 1 ON Hysteresis		x	0 F	10 F	5 F
DHW1 Stage 2 OFF Hysteresis		x	0 F	10 F	5 F
DHW1 Stage 2 ON Hysteresis		x	0 F	10 F	5 F
DHW1 Stage 3 OFF Hysteresis		x	0 F	10 F	5 F
DHW1 Stage 3 ON Hysteresis		x	0 F	10 F	5 F
DHW1 Stage 4 OFF Hysteresis		x	0 F	10 F	5 F
DHW1 Stage 4 ON Hysteresis		x	0 F	10 F	5 F
DHW1 Stage Delay On Time		x	0 secs	120 secs	30 secs
DHW1 Stage Delay Off Time		x	0 secs	120 secs	0 secs
DHW1 Minimum Stage On Time		x	0 secs	120 secs	10 secs
DHW1 Minimum Stage Off Time		x	0 secs	120 secs	10 secs
DHW1 PID On Hysteresis	x	x	0 F	21 F	10 F
DHW1 PID Off Hysteresis	x	x	0 F	21 F	10 F
DHW1 Proportional Gain		x	0	32767	250
DHW1 Integral Time		x	0	32767	100
DHW1 Derivative Time		x	0	32767	0
DHW2					
DHW2 Enable/Disable	x	x	Disable	Enable	Enable
DHW2 Setpoint	x	x	120 F	200 F	130 F
DHW2 Priority		x	1	97	50
DHW2 Control Mode		x	PID	Temp Differential	Temp Differential
DHW2 Stage 1 OFF Hysteresis		x	0 F	10 F	5 F
DHW2 Stage 1 ON Hysteresis		x	0 F	10 F	5 F
DHW2 Stage 2 OFF Hysteresis		x	0 F	10 F	5 F
DHW2 Stage 2 ON Hysteresis		x	0 F	10 F	5 F
DHW2 Stage 3 OFF Hysteresis		x	0 F	10 F	5 F
DHW2 Stage 3 ON Hysteresis		x	0 F	10 F	5 F
DHW2 Stage 4 OFF Hysteresis		x	0 F	10 F	5 F
DHW2 Stage 4 ON Hysteresis		x	0 F	10 F	5 F
DHW2 Stage Delay On Time		x	0 secs	120 secs	60 secs

Heater continued	User	Installer	Minimum	Maximum	Default
DHW2 Stage Delay Off Time		x	0 secs	120 secs	0 secs
DHW2 Minimum Stage On Time		x	0 secs	120 secs	10 secs
DHW2 Minimum Stage Off Time		x	0 secs	120 secs	10 secs
DHW2 PID On Hysteresis	x	x	0 F	21 F	20 F
DHW2 PID Off Hysteresis	x	x	0 F	21 F	20 F
DHW2 Proportional Gain		x	0	32767	250
DHW2 Integral Time		x	0	32767	100
DHW2 Derivative Time		x	0	32767	0
DHW3					
DHW3 Enable/Disable	x	x	Disable	Enable	Enable
DHW3 Setpoint	x	x	120 F	200 F	120 F
DHW3 Priority		x	1	97	90
DHW3 Control Mode		x	PID	Temp Differential	Temp Differential
DHW3 PID On Hysteresis	x	x	0 F	21 F	10 F
DHW3 PID Off Hysteresis	x	x	0 F	21 F	10 F
DHW3 Stage 1 OFF Hysteresis		x	0 F	10 F	5 F
DHW3 Stage 1 ON Hysteresis		x	0 F	10 F	5 F
DHW3 Stage 2 OFF Hysteresis		x	0 F	10 F	5 F
DHW3 Stage 2 ON Hysteresis		x	0 F	10 F	5 F
DHW3 Stage 3 OFF Hysteresis		x	0 F	10 F	5 F
DHW3 Stage 3 ON Hysteresis		x	0 F	10 F	5 F
DHW3 Stage 4 OFF Hysteresis		x	0 F	10 F	5 F
DHW3 Stage 4 ON Hysteresis		x	0 F	10 F	5 F
DHW3 Stage Delay On Time		x	0 secs	120 secs	60 secs
DHW3 Stage Delay Off Time		x	0 secs	120 secs	0 secs
DHW3 Minimum Stage On Time		x	0 secs	120 secs	10 secs
DHW3 Minimum Stage Off Time		x	0 secs	120 secs	10 secs
DHW3 Offset		x	0 F	72 F	18 F
DHW3 Proportional Gain		x	0	32767	250
DHW3 Integral Time		x	0	32767	100
DHW3 Derivative Time		x	0	32767	0
Outdoor (NOT Available on Volume Water Units)					
Cascade CH (NOT Available on Volume Water Units)					
Cascade DHW					
Address		x	-1	7	-1
Dynamic Address		x	-1	7	-1
Lost Lead Backup Setpoint		x	120 F	200 F	140 F
Lag On Hysteresis		x	0 F	21 F	10 F
Lag Off Hysteresis		x	0 F	21 F	10 F
Cascade DHW Setpoint	x	x	120 F	200 F	140 F
Cascade DHW On Hysteresis		x	0 F	21 F	10 F
Cascade DHW Off Hysteresis		x	0 F	21 F	10 F
Cascade DHW Priority		x	1	97	80
Cascade DHW Proportional Gain		x	0	32767	250
Cascade DHW Integral Time		x	0	32767	10
Cascade DHW Derivative Time		x	0	32767	0
Cascade DHW Maximum Lag Temperature		x	120 F	200 F	140 F

Heater continued

Cascade Redundancy					
Loss of Lead Setup		x	Disable	Boiler Internal Setpoint/ Redundant Lead	Boiler Internal Set point
Hybrid					
Hybrid Enable/Disable		x	Disable	Enable	Disable
Lag Mode Enable/Disable		x	Disable	Enable	Disable
Hybrid Setpoint		x	82 F	181 F	130 F
Hybrid Differential Temperature		x	0 F	21 F	10 F
Hybrid Delay Time		x	0 min	720 min	30 min
Pump Configuration					
Boiler Pump Control		x	Auto	Auto/ Always On/ Off During DHW	Auto
Boiler Pump Post Circulation		x		600 secs	60 secs
DHW Pump Control		x	DIsable	Auto/ Always On	Auto
DHW Pump Post Circulation		x	0 secs	600 secs	60 secs
System Pump Control		x	DIsable	Auto/ Always On/ Off During DHW	Auto
System Pump Post Circulation		x	0 secs	600 secs	60 secs
Variprime (Not Available on Volume Water Units)					
Temperature Limits					
Auto Reset Boiler Outlet Limit		x	100 F	200 F	180 F
Manual Reset Boiler Outlet Limit		x	100 F	200 F	190 F
Reset Differential		x	1 F	10 F	5 F
Stage Limit Hysteresis		x	0 F	10 F	2 F
External Control					
Control Mode		x	Disable	Extenal Setpoint/ Firing Rate	Disable
External Control Priority		x	1	97	20
Maximum Setpoint		x	120 F	200 F	140 F
Minimum Setpoint		x	120 F	200 F	120 F
Maximum Firing Rate		x	0	10000	10000
Minimum Firing Rate		x	0	10000	0
Demand Max		x	0%	100%	100%
Demand Min		x	0%	100%	20%
Demand On		x	0%	25%	15%
Demand Off		x	0%	25%	10%
Anti- Frost					
Anti Frost Mode		x	Disable	Pump Only/ Pump & Burner	Pump Only
Anti- Frost Setpoint		x	32 F	120 F	40 F
Anti- Frost Hysteresis		x	3 F	10 F	5 F
Anti- Frost Pump Control		x	NA	Boiler/ DHW/ System	Boiler
Warm Weather Shutdown (NOT Available on Volume Water Units)					
Anti- Short Cycle Time					

Heater continued

Cycle Time		x	10 secs	240 secs	60 secs
Temperature Conversion					
Conversion Unit	x	x	Celsius	Fahrenheit	Fahrenheit
BACnet					
Baudrate		x	9600	76800	76800
Address		x	0	255	127
Device Model Name		x	NA	NA	NA
Device Object Name		x	NA	NA	NA
Object Instance		x	0	4194303	600000
Timeout		x	0 secs	300 secs	300 secs
Mixing Valve Anti- Condensing (Low Temp Models ONLY)					
Mixing Valve Anti-Condensing Enable/Disable		x	Disable	Enable	Enable
Mixing Valve Anti-Condensing Temperature Setpoint		x	120 F	180 F	120 F
Mixing Valve Anti-Condensing Proportional Gain		x	0	32767	250
Mixing Valve Anti-Condensing Integral TIme		x	0	32767	15
Mixing Valve Anti-Condensing Derivative Time		x	0	32767	0
Condensing Alarm Setpoint		x	100 F	120 F	110 F
Minimum Voltage Output		x	0 mV	4000 mV	3500 mV
Maximum Voltage Output		x	4 mV	10000 mV	6500 mV
Condensing Alarm Delay		x	0 mins	20 mins	10 mins
Condensing Shutdown Delay		x	0 mins	40 mins	20 mins
Service					
Stage 1 Burner Enable/Disable		x	Disable	Enable	Enable
Stage 2 Burner Enable/Disable		x	Disable	Enable	Enable
Stage 3 Burner Enable/Disable (Applicable to 1MM-2MM only)		x	Disable	Enable	Enable
Stage 4 Burner Enable/Disable (Applicable to 1.25MM-2MM only)		x	Disable	Enable	Enable
Screen Settings					
Light Timeout	x	x	0 secs	3600 secs	600 secs
AutoLock Timeout	x	x	0 secs	3600 secs	600 secs

10.G.3 Modbus Memory Map

MODBUS Address	Type	Bit	Read/Write	Value
0	S16		Read Only	Inlet Temp
1	S16		Read Only	Outlet Temp
2	S16		Read Only	Not used
3	S16		Read Only	DHW Temp
4	S16		Read Only	System Inlet Temp
5	S16		Read Only	System Outlet Temp
6	S16		Read Only	Outdoor Temp
7	S16		Read Only	Aux1 Temp
8	S16		Read Only	Aux2 Temp
9	S16		Read Only	Aux3 Temp
10	S16		Read Only	Aux4 Temp
11	S16		Read Only	Aux5 Temp
12	S16		Read Only	Flame Signal 1
13	S16		Read Only	Flame Signal 2
14	S16		Read Only	Analog Input 1
15	S16		Read Only	Analog Input 2
16	S16		Read Only	Analog Input 3
17	S16		Read Only	Analog Input 4
18	BitField	b0	Read Only	Flow Switch
		b1	Read Only	Low Water Cut Off
		b2	Read Only	Man Reset High Limit
		b3	Read Only	Pressure Switch
		b4	Read Only	High Gas Pressure Switch
		b5	Read Only	Low Gas Pressure Switch
		b6	Read Only	Field Interlock Swicth
		b7	Read Only	Spare Safety Chain Swicth
		b8…b15	Read Only	Not used
19	BitField	b0	Read Only	Damper Interlock Swicth
		b1	Read Only	Spare1 Swicth
		b2…b15	Read Only	Not used
20	S16		Read Only	Current Demand Source 0 -> No Demand 1 -> Anti Short Cycle 2 -> Service 3 -> DHW 4 -> Slave Cascade 5 -> External 6 -> CH1 7 -> CH2 8 -> CH3 9 -> CH4 10 -> Antifrost
21	BitField	b0	Read Only	Boiler Run Contact
		b1	Read Only	Alaram Contact
		b2	Read Only	DHW Pump
		b3	Read Only	System Pump
		b4	Read Only	Louver Contact
		b5	Read Only	Spare1 Contact
		b6	Read Only	Spare2 Contact
		b7	Read Only	Boiler Pump
		b8	Read Only	Spare Output
		b9…b15	Read Only	Not used
22	BitField	b0	Read Only	Not used
		b1	Read Only	Valve 1 Stage 1
		b2	Read Only	Valve 2 Stage 1
		b3	Read Only	Not used
		b4	Read Only	Valve 1 Stage 2
		b5	Read Only	Valve 2 Stage 2
		b6..b15	Read Only	Not used
23	S16		Read Only	Analog Output 1
24	S16		Read Only	Analog Output 2
25	S16		Read Only	Analog Output 3
26	S16		Read Only	Analog Output 4
27	S16		Read Only	Not used
28	S16		Read Only	Not used

MODBUS Address	Type	Bit	Read/Write	Value
29	S16		Read Only	Blower 1 Speed 0 -> Off 1 -> Low 2 -> High
30	S16		Read Only	Blower 2 Speed 0 -> Off 1 -> Low 2 -> High
31	S16		Read Only	HSI1 Current
32	S16		Read Only	HSI2 Current
33	S16		Read Only	Burner 1 Power Rating
34	S16		Read Only	Burner 2 Power Rating
35	S16		Read Only	Lockout Code
36	S16		Read Only	Blocking Code
37	S16		Read Only	Not used
38	U16		Read Only	DHW Call For Heat / 10
39	U16		Read Only	CH1 Call For Heat / 10
40	U16		Read Only	CH2 Call For Heat / 10
41	U16		Read Only	Not used
42	U16		Read Only	Not used
43	U16		Read Only	Cascade Call For Heat / 10
44	U16		Read Only	Valve 1 Stage1 Cycles / 10
45	U16		Read Only	Valve 2 Stage1 Cycles / 10
46	U16		Read Only	Valve 1 Stage2 Cycles / 10
47	U16		Read Only	Valve 2 Stage2 Cycles / 10
48	U16		Read Only	Boiler Pump Cycles / 10
49	U16		Read Only	DHW Pump Cycles / 10
50	U16		Read Only	System Pump Cycles / 10
51	S16		Read Only	Average Outlet Temp
52	S16		Read Only	Max Outlet Temp
53	S16		Read Only	Min Outlet Temp
54	U16		Read Only	Average Firing Time
55	U16		Read Only	Max Firing Time
56	U16		Read Only	Min Firing Time
57	U16		Read Only	Not used
58	U16		Read Only	Not used
59	U16		Read Only	Not used
60	U16		Read Only	Not used
61	U16		Read Only	Not used
62	U16		Read Only	Not used
63	S16		Read Only	Not used
64	S16		Read Only	Modulation Sensor 0 -> None 1-> Outlet 2 -> DHW 3 -> System 4 -> Inlet 5 -> Flue 6 -> Sys return
65	U16		Read Only	Activate Service
66	U16		Read Only	Slave 1 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out
67	U16		Read Only	Slave 1 Firing Rate
68	U16		Read Only	Slave 2 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out
69	U16		Read Only	Slave 2 Firing Rate
70	U16		Read Only	Slave 3 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out

MODBUS Address	Type	Bit	Read/Write	Value
71	U16		Read Only	Slave 3 Firing Rate
72	U16		Read Only	Slave 4 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out
73	U16		Read Only	Slave 4 Firing Rate
74	U16		Read Only	Slave 5 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out
75	U16		Read Only	Slave 5 Firing Rate
76	U16		Read Only	Slave 6 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out
77	U16		Read Only	Slave 6 Firing Rate
78	U16		Read Only	Slave 7 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out
79	U16		Read Only	Slave 7 Firing Rate
80	U16		Read Only	Master State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out
81	U16		Read Only	Master Firing Rate
82	S16		Read Only	Not used
83	U16		Read Only	Active CH Setpoint
84	U16		Read Only	Burner 1 Status
85	U16		Read Only	Burner 2 Status
86	U16		Read Only	Not used
87	U16		Read Only	Not used
88	U16		Read Only	Not used
89	U16		Read Only	Boiler Pump Status
90	U16		Read Only	Master Demand
91	U16		Read Only	Burner 1 Run Time
92	S16		Read Only	Burner 2 Run Time
...	S16		Read Only	Not used
127	S16		Read Only	Not used
128	S16		Read/Write	CH1 Enable/Disable
129	S16		Read/Write	CH1 Setpoint
130	S16		Read/Write	CH1 P
131	S16		Read/Write	CH1 I
132	S16		Read/Write	CH1 D
133	S16		Read/Write	CH2 Enable/Disable
134	S16		Read/Write	CH2 Setpoint
135	S16		Read/Write	CH2 P
136	S16		Read/Write	CH2 I
137	S16		Read/Write	CH2 D
138	S16		Read/Write	Not used
139	S16		Read/Write	Not used
140	S16		Read/Write	Not used
141	S16		Read/Write	Not used
142	S16		Read/Write	Not used
143	S16		Read/Write	Not used
144	S16		Read/Write	Not used
145	S16		Read/Write	Not used
146	S16		Read/Write	Not used
147	S16		Read/Write	Not used
148	S16		Read/Write	DHW Enable/Disable

MODBUS Address	Type	Bit	Read/Write	Value
149	S16		Read/Write	DHW Setpoint
150	S16		Read/Write	DHW P
151	S16		Read/Write	DHW I
152	S16		Read/Write	DHW D
153	S16		Read/Write	Not used
154	S16		Read/Write	Not used
155	S16		Read/Write	Cascade Setpoint
156	S16		Read/Write	Cascade P
157	S16		Read/Write	Cascade I
158	S16		Read/Write	Cascade D
159	S16		Read/Write	Not used
160	S16		Read/Write	Not used
161	S16		Read/Write	Not used
162	S16		Read/Write	Not used
163	S16		Read/Write	Hybrid Setpoint
164	S16		Read/Write	Hybrid Differential Temp
165	S16		Read/Write	Not used
166	S16		Read/Write	Not used
167	S16		Read/Write	Not used
168	S16		Read/Write	Not used
169	U16		Read/Write	AntiCondens Enable
170	S16		Read/Write	AntiCondens Temp
171	S16		Read/Write	AntiCondens P
172	S16		Read/Write	AntiCondens I
173	S16		Read/Write	AntiCondens D
174	S16		Read/Write	DHW demand
175	S16		Read/Write	CH1 demand
176	S16		Read/Write	CH2 demand
177	S16		Read/Write	Not used
178	S16		Read/Write	Not used
179	S16		Read/Write	Parameters enable

10.G.4 BACnet MSTP Memory Map

BacNet Address	BacNet Type	Bit	Value	Unit
0	AI		Inlet Temp	[C]/[F]
1	AI		Outlet Temp	[C]/[F]
2	AI		Not used	
3	AI		DHW Temp	[C]/[F]
4	AI		System Inlet Temp	[C]/[F]
5	AI		System Outlet Temp	[C]/[F]
6	AI		Outdoor Temp	[C]/[F]
7	AI		Aux1 Temp	[C]/[F]
8	AI		Aux2 Temp	[C]/[F]
9	AI		Aux3 Temp	[C]/[F]
10	AI		Aux4 Temp	[C]/[F]
11	AI		Aux5 Temp	[C]/[F]
12	AI		Flame Signal 1	[uA]
13	AI		Flame Signal 2	[uA]
14	AI		Analog Input 1	[mv]
15	AI		Analog Input 2	[mv]
16	AI		Analog Input 3	[mv]
17	AI		Analog Input 4	[mv]
18	AI	b0	Flow Switch	bit
		b1	Low Water Cut Off	bit
		b2	Man Reset High Limit	bit
		b3	Pressure Switch	bit
		b4	High Gas Pressure Switch	bit
		b5	Low Gas Pressure Switch	bit
		b6	Field Interlock Swicth	bit
		b7	Spare Safety Chain Swicth	bit
		b8…b15	Not used	bit
19	AI	b0	Damper Interlock Swicth	bit
		b1	Spare1 Swicth	bit
		b2…b15	Not used	bit
20	AI		Current Demand Source 0 -> No Demand 1 -> Anti Short Cycle 2 -> Service 3 -> DHW 4 -> Slave Cascade 5 -> External 6 -> CH1 7 -> CH2 8 -> CH3 9 -> CH4 10 -> Antifrost	
21	AI	b0	Boiler Run Contact	bit
		b1	Alaram Contact	bit
		b2	DHW Pump	bit
		b3	System Pump	bit
		b4	Louver Contact	bit
		b5	Spare1 Contact	bit
		b6	Spare2 Contact	bit
		b7	Boiler Pump	bit
		b8	Spare Output	bit
		b9…b15	Not used	bit
22	AI	b0	Not used	bit
		b1	Valve 1 Stage 1	bit
		b2	Valve 2 Stage 1	bit
		b3	Not used	bit
		b4	Valve 1 Stage 2	bit
		b5	Valve 2 Stage 2	bit
		b6..b15	Not used	bit
23	AI		Analog Output 1	[mV]
24	AI		Analog Output 2	[mV]
25	AI		Analog Output 3	[mV]
26	AI		Analog Output 4	[mV]
27	AI		Not used	[rpm]
28	AI		Not used	[rpm]
29	AI		Blower 1 Speed 0 -> Off 1 -> Low 2 -> High	
30	AI		Blower 2 Speed 0 -> Off 1 -> Low 2 -> High	

BacNet Address	BacNet Type	Bit	Value	Unit
31	AI		HSI1 Current	[mA]
32	AI		HSI2 Current	[mA]
33	AI		Burner 1 Power Rating	[%]
34	AI		Burner 2 Power Rating	[%]
35	AI		Lockout Code	
36	AI		Blocking Code	
37	AI		Not used	
38	AI		DHW Call For Heat / 10	[cycles * 10]
39	AI		CH1 Call For Heat / 10	[cycles * 10]
40	AI		CH2 Call For Heat / 10	[cycles * 10]
41	AI		Not used	[cycles * 10]
42	AI		Not used	[cycles * 10]
43	AI		Cascade Call For Heat / 10	[cycles * 10]
44	AI		Valve 1 Stage1 Cycles / 10	[cycles * 10]
45	AI		Valve 2 Stage1 Cycles / 10	[cycles * 10]
46	AI		Valve 1 Stage2 Cycles / 10	[cycles * 10]
47	AI		Valve 2 Stage2 Cycles / 10	[cycles * 10]
48	AI		Boiler Pump Cycles / 10	[cycles * 10]
49	AI		DHW Pump Cycles / 10	[cycles * 10]
50	AI		System Pump Cyclces / 10	[cycles * 10]
51	AI		Average Outlet Temp	[C]/[F]
52	AI		Max Outlet Temp	[C]/[F]
53	AI		Min Outlet Temp	[C]/[F]
54	AI		Average Firing Time	[h]
55	AI		Max Firing Time	[h]
56	AI		Min Firing Time	[h]
57	AI		Not used	
58	AI		Not used	
59	AI		Not used	
60	AI		Not used	
61	AI		Not used	
62	AI		Not used	
63	AI		Not used	
64	AI		Modulation Sensor 0 -> None 1-> Outlet 2 -> DHW 3 -> System 4 -> Inlet 5 -> Flue 6 -> Sys return	
65	AI		Activate Service	
66	AI		Slave 1 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	
67	AI		Slave 1 Firing Rate	
68	AI		Slave 2 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	
69	AI		Slave 2 Firing Rate	
70	AI		Slave 3 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	
71	AI		Slave 3 Firing Rate	
72	AI		Slave 4 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	
73	AI		Slave 4 Firing Rate	
74	AI		Slave 5 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	

BacNet Address	BacNet Type	Bit	Value	Unit
75	AI		Slave 5 Firing Rate	
76	AI		Slave 6 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	
77	AI		Slave 6 Firing Rate	
78	AI		Slave 7 State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	
79	AI		Slave 7 Firing Rate	
80	AI		Master State 0 -> Not Present 1 -> Not Available 2-> Available 3 -> Running 4 -> Locked Out	
81	AI		Master Firing Rate	
82	AI		Not used	
83	AI		Active CH Setpoint	
84	AI		Burner 1 Status	
85	AI		Burner 2 Status	
86	AI		Not used	
87	AI		Not used	
88	AI		Not used	
89	AI		Boiler Pump Status	
90	AI		Master Demand	
91	AI		Burner 1 Run Time	[h]
92	AI		Burner 2 Run Time	[h]
			Not used	
			Not used	
0	AV		CH1 Enable/Disable	
1	AV		CH1 Setpoint	[C]/[F]
2	AV		CH1 P	
3	AV		CH1 I	
4	AV		CH1 D	
5	AV		CH2 Enable/Disable	
6	AV		CH2 Setpoint	[C]/[F]
7	AV		CH2 P	
8	AV		CH2 I	
9	AV		CH2 D	
10	AV		Not used	
11	AV		Not used	[C]/[F]
12	AV		Not used	
13	AV		Not used	
14	AV		Not used	
15	AV		Not used	
16	AV		Not used	[C]/[F]
17	AV		Not used	
18	AV		Not used	
19	AV		Not used	
20	AV		DHW Enable/Disable	
21	AV		DHW Setpoint	[C]/[F]
22	AV		DHW P	
23	AV		DHW I	
24	AV		DHW D	
25	AV		Not used	
26	AV		Not used	[C]/[F]
27	AV		Cascade Setpoint	[C]/[F]
28	AV		Cascade P	
29	AV		Cascade I	
30	AV		Cascade D	
31	AV		Not used	
32	AV		Not used	
33	AV		Not used	
34	AV		Not used	
35	AV		Hybrid Setpoint	[C]/[F]
36	AV		Hybrid Differential Temp	[C]/[F]
37	AV		Not used	
38	AV		Not used	

BacNet Address	BacNet Type	Bit	Value	Unit
38	AV		Not used	
39	AV		Not used	
40	AV		Not used	[C]/[F]
41	AV		AntiCondens Enable	
42	AV		AntiCondens Temp	[C]/[F]
43	AV		AntiCondens P	
44	AV		AntiCondens I	
45	AV		AntiCondens D	
0	BV		DHW demand	
1	BV		CH1 demand	
2	BV		CH2 demand	
3	BV		Not used	
4	BV		Not used	

SECTION 11 Replacement Parts

Only genuine replacement parts should be used.

11.A General Information

To order or purchase parts for your boiler or water heater, contact your nearest manufactures representative or distributor. If they cannot supply you with what you need, contact Customer Service (see back cover for address, telephone and fax numbers).

11.B Parts List

Item	Description	Size 500	Size 750	Size 1000	Size 1250	Size 1500	Size 1750	Size 2000
	Sheet Metal Components							
	See Figure 48 on page 105							
1	Panel, Jacket, Side Left	5C3420	5C3420	5C3420	5C3420	5C3420	5C3420	5C3420
2	Panel, Jacket, Side Right	5C3521	5C3521	5C3521	5C3521	5C3521	5C3521	5C3521
3	Panel, Jacket, Front	R2081301	R2081302	R2081303	R2081304			
3	Panel, Jacket, Front, Left					R2081305	R2081308	R2081311
4	Panel, Jacket, Front, Right					R2081306	R2081309	R2081312
5	Panel, Jacket, Rear	5C3220	7C3220	10C3220	12C3220	15C3220	17C3220	20C3220
5A	Panel, Jacket, Rear, Filter Enclosure					15C3026	15C3026	15C3026
6	Panel, Jacket, Top	5C3021	7C3021	10C3021	12C3021			
	Panel, Jacket, Top, Left					15C3021	17C3021	20C3021
7	Panel, Jacket, Top Right					15C3025	17C3025	20C3025
8	Alcove Assembly (touchscreen and panel)	5C723200	5C723200	5C723200	5C723200	5C723200	5C723200	5C723200
8A	Touchscreen	RE2404900	RE2404900	RE2404900	RE2404900	RE2404900	RE2404900	RE2404900
9	Plate, Gas Pipe Seal	5C3304 (2)	5C3304 (2)	10C3304 (2)	20C3304 (2)	20C3304 (2)	20C3304 (2)	20C3304 (2)
10	Access Panel for Field Connections	5C3502	5C3502	5C3502	5C3502	5C3502	5C3502	5C3502
11	Plate, Vent	5C3004	5C3004	10C3004	20C3004	20C3004	20C3004	20C3004
12	Cover, Vent Plate				20C3006	20C3006	20C3006	20C3006
13	Plate, Cover, Filter	5C3002	5C3002	5C3002	20C3002	20C3002	20C3002	20C3002
14	Collar, Vent	5C3106	10C3100	10C3100	15C3100	15C3100	20C3100	20C3100
16	Air Filter	R2014700 (1)	R2014700 (1)	R2014700 (1)	R2014700 (2)	R2014700 (2)	R2014700 (2)	R2014700 (2)
16A	Trim, Jacket, Front	5C3019	7C3019	10C3019	12C3019	15C3019	17C3019	20C3019
16B	Pump Housing Right Side	5C3018	5C3018	5C3018	5C3018	5C3018	5C3018	5C3018
16C	Pump Housing Left Side	5C3019	5C3019	5C3019	5C3019	5C3019	5C3019	5C3019
16D	Pump Housing Cover	5C3020	5C3020	5C3020	5C3020	5C3020	5C3020	5C3020

Item	Description	Size 500	Size 750	Size 1000	Size 1250	Size 1500	Size 1750	Size 2000
	Internal Components							
	See Figure 49 on page 106							
17	Base Assembly	5C1020	7C1020	10C1020	12C1020	15C1020	17C1020	20C1020
18	Chamber, Front	5C2003	7C2003	10C2003	12C2003	15C2003	17C2003	20C2003
18A	Chamber, Left Side, Front	5C2015	5C2015	5C2015	5C2015	5C2015	5C2015	5C2015
18B	Chamber, Right Side, Front	5C2016	5C2016	5C2016	5C2016	5C2016	5C2016	5C2016
19	Chamber, Rear	5C2006	7C2006	10C2006	12C2006	15C2006	17C2006	20C2006
20	Chamber Assembly, Left, Bottom	5C2602	5C2602	5C2602	5C2602	5C2602	5C2602	5C2602
21	Chamber Assembly, Right, Bottom	5C2200	5C2200	5C2200	5C2200	5C2200	5C2200	5C2200
22	Chamber, Top	5C2001	7C2001	10C2001	12C2001	15C2001	17C2001	20C2001
23	Chamber, Side, Top	5C2002	5C2002	5C2002	5C2002	5C2002	5C2002	5C2002
24	Exhaust Plenum	5C2007	10C2007	10C2007	20C2007	20C2007	20C2007	20C2007
25	Bracket, Chamber, Front	5C2009	7C2009	10C2009				
	Bracket, Chamber, Front Left				12C2011	15C2011	17C2011	20C2011
26	Bracket, Chamber, Front Right				12C2009	15C2009	17C2009	20C2009
27	Divider, Chamber, Front						15C2010	20C2002
27A	Divider, Upper, Chamber, Front				15C2005	15C2005		
27B	Divider, Lower, Chamber, Front				15C2002	15C2002		
28	Cover, Chamber	5C2004	7C2004					
	Cover, Chamber, Front Left			10C2004	12C2010	15C2004	17C2010	20C2010
29	Door, Chamber Access	5C2005 (1)	5C2005 (1)	5C2005 (1)	5C2005 (2)	5C2005 (2)	5C2005 (2)	5C2005 (2)
30	Cover, Chamber, Front Right			10C2010	12C2008	15C2004	17C2008	20C2008
32	Ignitor, Hot Surface, with Gasket	2400-286 (1)	2400-286 (1)	2400-286 (2)	2400-286 (2)	2400-286 (2)	2400-286 (2)	2400-286 (2)
33	Tile, Side (Right and Left)	T2015600 (2)	T2015600 (2)	T2015600 (2)	T2015600 (2)	T2015600 (2)	T2015600 (2)	T2015600 (2)
34	Tile, Front	T2017300 (1)						
35	Tile, Front, Left Side		T2016200 (1)	T2016800 (1)	T2016800 (1)	T2016800 (1)	T2016800 (1)	T2016800 (1)
35A	Tile, Front, Right Side		T2016300 (1)	T2017100 (1)	T2017900 (1)	T2017100 (1)	T2017900 (1)	T2017100 (1)
35B	Tile, Front, Center				T2016900	T2016900	T2016900	T2016900

Item	Description	Size 500	Size 750	Size 1000	Size 1250	Size 1500	Size 1750	Size 2000
					(1)	(1)	(2)	(2)
36	Tile, Rear	T2015700 (1)						
37	Tile, Rear, Left Side		T2017500 (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)
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)
39A	Tile, Bottom, Right Side		T2016500 (1)	T2017400 (1)	T2018000 (1)	T2017400 (1)	T2018000 (1)	T2017400 (1)
39B	Tile, Bottom, Center				T2015900 (1)	T2015900 (1)	T2015900 (2)	T2015900 (2)
	Heat Exchanger Components							
	See Figure 50 on page 107							
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	S2115601	S2115601	S2115601	S2115601	S2115601	S2115601	S2115601
49	Relief Valve, Boiler, 75 PSI	RA2138800	RA2138801	RA2138801	RA2138801	RA2138802	RA2138802	RA2138802

Item	Description	Size 500	Size 750	Size 1000	Size 1250	Size 1500	Size 1750	Size 2000
	Relief Valve, Water heater, 125 PSI	RA2138900	RA2138900	RA2138900	RA2138900	RA2138900	RA2138900	RA2138900
50	Tee, Adapter, Outlet, Cast Iron	20130001	20130001	20130001	20130002	20130002	20130002	20130002
	Tee, Adapter, Outlet, Bronze	R20150301	R20150301	R20150301	R20150301	R20150301	R20150301	R20150301
51	Flow Switch	RE0013000	RE0013000	RE0013000	RE0013000	RE0013000	RE0013000	RE0013000
52	Gauge, Temperature/Pressure	RA0079000	RA0079000	RA0079000	RA0079000	RA0079000	RA0079000	RA0079000
54	Low Water Cutoff	R0021901	R0021901	R0021901	R0021901	R0021901	R0021901	R0021901
55	Pump Housing, Glass-lined, Cast Iron	R20607600	R20607600	R20607600	R20607600	R20607600	R20607600	R20607600
	Pump Housing, Bronze	10483300	10483300	10483300	10483300	10483300	10483300	10483300
56	Gasket, Pump Adapter	S0024600	S0024600	S0024600	S0024600	S0024600	S0024600	S0024600
57	Pump Adapter, Glass-lined Cast Iron	10364200	10364200	10364200	10364200	10364200	10364200	10364200
	Pump Adapter, Bronze	10364201	10364201	10364201	10364201	10364201	10364201	10364201
58	Baffle, Diffuser, Pump Inlet	10338400	10338400	10338400	10338400	10338400	10338400	10338400
59	Pressure Switch	RE0240900 (2)	RE0240900 (2)	RE0240900 (2)	RE0240900 (3)	RE0240900 (3)	RE0240900 (3)	RE0240900 (3)
60	Blower	A2111900 (1)	A2111900 (1)	A2111900 (1)	A2111900 (2)	A2111900 (2)	A2111900 (2)	A2111900 (2)
61	Weldment, Blower Mount	5C5300 (1)	5C5300 (1)	5C5300 (1)	5C5300 (2)	5C5300 (2)	5C5300 (2)	5C5300 (2)
62	Damper, Duct Assembly, Blower				15C5400 (2)	15C5400 (2)	15C5400 (2)	15C5400 (2)
	Electrical Components							
	See Figure 51 on page 108							
64	Bracket, Base Controls	5C7205	5C7205	5C7205	5C7205	5C7205	5C7205	5C7205
65	Bracket, Terminal Strip, Controls	5C7204	5C7204	5C7204	5C7204	5C7204	5C7204	5C7204
66	Bracket, PCB Mounting, Controls	5C7209	5C7209	5C7209	5C7209	5C7209	5C7209	5C7209
67	Bracket, Mounting, Safety	5C7112	5C7112	5C7112	5C7112	5C7112	5C7112	5C7112
68	Board, Control, Commercial	R2079300	R2079300	R2079300	R2079300	R2079300	R2079300	R2079300
69	High Limit, Auto Reset, Boiler	RE0014400	RE0014400	RE0014400	RE0014400	RE0014400	RE0014400	RE0014400
	High Limit, Auto Reset, heater, 210F Max	E2217700	E2217700	E2217700	E2217700	E2217700	E2217700	E2217700
70	High Limit, Manual Reset, Boiler	RE0015900	RE0015900	RE0015900	RE0015900	RE0015900	RE0015900	RE0015900
	High Limit, Manual Reset, Heater, 210F Max	E2217800	E2217800	E2217800	E2217800	E2217800	E2217800	E2217800
71	Relay, Pump (SPST)	E2367900	E2367900	E2367900	E2367900	E2367900	E2367900	E2367900

Item	Description	Model 500	Model 750	Model 1000	Model 1250	Model 1500	Model 1750	Model 2000
72	Terminal Bus (12 Position)	E2342600	E2342600	E2342600	E2342600	E2342600	E2342600	E2342600
73	Transformer	E2310400	E2310400	E2310400	E2318800 (x2)	E2318800 (x2)	E2318800 (x2)	E2318800 (x2)
74	Circuit Breaker	E2106200	E2106200	E2106200	E2318800	E2318800	E2318900	E2318900
75	Switch, Rocker (main power) *not shown*	E2343300	E2343300	E2343300	E2343300	E2343300	E2343300	E2343300
	Gas Train Components							
	See Figure 49 on page 106							
76	Manifold, Gas Supply	5C6700	7C6700	10C6700	12C6700	15C6700	17C6700	20C6700
77	Valve, Ball	V2003100	V2003100	V2003200	V2003300	V2003300	V2003300	V2003300
	Burner Trays							
	Note: Burner Manifold Assemblies contain item numbers 78 through 81.							
	Burner Manifold Assy, 3 Burners, Right, Nat	5C6600 (1)	5C6600 (1)		5C6600 (2)	5C6600 (1)	5C6600 (1)	
	Burner Manifold Assy, 3 Burners, Left, Nat	5C6500 (1)	5C6500 (2)		5C6500 (3)	5C6500 (1)	5C6500 (2)	
	Burner Manifold Assy, 4 Burners, Right, Nat			10C6600 (1)		10C6600 (1)	10C6600 (1)	10C6600 (2)
	Burner Manifold Assy, 4 Burners, Left, Nat			10C6500 (2)		10C6500 (2)	10C6500 (2)	10C6500 (4)
	Burner Manifold Assy, 3 Burners, Right, LP	5C6620 (1)	5C6620 (1)		5C6620 (2)	5C6620 (1)	5C6600 (1)	
	Burner Manifold Assy, 3 Burners, Left, LP	5C6520 (1)	5C6520 (1)		5C6520 (3)	5C6520 (1)	5C6500 (2)	
	Burner Manifold Assy, 4 Burners, Right, LP			10C6620 (1)		10C6620 (1)	10C6620 (1)	10C6620 (2)
	Burner Manifold Assy, 4 Burners, Left, LP			10C6520 (2)		10C6500 (2)	10C6520 (2)	10C6520 (4)
78	Valve, Gas, Combination	V2017600 (2)	V2017600 (3)	V2017600 (3)	V2017600 (5)	V2017600 (5)	V2017600 (6)	V2017600 (6)
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)

Item	Description	Model 500	Model 750	Model 1000	Model 1250	Model 1500	Model 1750	Model 2000
	Orifice, Gas, Propane	L2012400 (6)	L2012400 (9)	L2012400 (12)	L2012400 (15)	L2012400 (18)	L2012400 (21)	L2012400 (24)
81	Burner Manifold, 3 Burners, Right	L2012900 (1)	L2012900 (1)		L2012900 (2)	L2012900 (1)	L2012900 (1)	
	Burner Manifold, 3 Burners, Left	L2012800 (1)	L2012800 (1)		L2012800 (3)	L2012800 (1)	L2012800 (2)	
	Burner Manifold, 4 Burners, Right			L2012700 (1)		L2012700 (1)	L2012700 (1)	L2012700 (2)
	Burner Manifold, 4 Burners, Left			L2012600 (2)		L2012600 (2)	L2012600 (2)	L2012600 (4)
82	Burner Tray, 3 Burners	L2012200 (2)	L2012200 (3)		L2012200 (5)	L2012200 (2)	L20122000 (3)	
	Burner Tray, 4 Burners			L2012500 (3)		L2012500 (3)	L2012500 (3)	L2012500 (6)
82A	Gasket, Burner Tray, 3 Burner	S2012700 (2)	S2012700 (3)		S2012700 (5)	S2012700 (2)	S2012700 (3)	
	Gasket, Burner Tray, 4 Burner			S2012500 (3)		S2012500 (3)	S2012500 (3)	S2012500 (6)
83	Kit, Diverting Valve	R2027402	R2027402	R2027402	R2027402	R2027402	R2027402	R2027402
84	Actuator, Valve	R2027500	R2027500	R2027500	R2027500	R2027500	R2027500	R2027500
	Tapes (Not shown in parts diagrams)							
	Gasket Tape, RR, Base (43')	R2014500	R2014500	R2014500	R2014500	R2014500	R2014500	R2014500
	Gasket Tape, Ft Air Chamber (63')	R2014600	R2014600	R2014600	R2014600	R2014600	R2014600	R2014600
	Sensors (Not shown in parts diagrams)							
	Inlet Sensor	E2103300	E2103300	E2103300	E2103300	E2103300	E2103300	E2103300
	Inlet Immersion Well	E2058300	E2058300	E2058300	E2058300	E2058300	E2058300	E2058300
	Outlet Sensor	E2366900	E2366900	E2366900	E2366900	E2366900	E2366900	E2366900
	Outlet Immersion Well	E2366700	E2366700	E2366700	E2366700	E2366700	E2366700	E2366700
	DHW Sensor	E2103300	E2103300	E2103300	E2103300	E2103300	E2103300	E2103300
	System Supply Sensor	E2366900	E2366900	E2366900	E2366900	E2366900	E2366900	E2366900
	System Return Sensor	E2103300	E2103300	E2103300	E2103300	E2103300	E2103300	E2103300

11.C Parts Illustrations

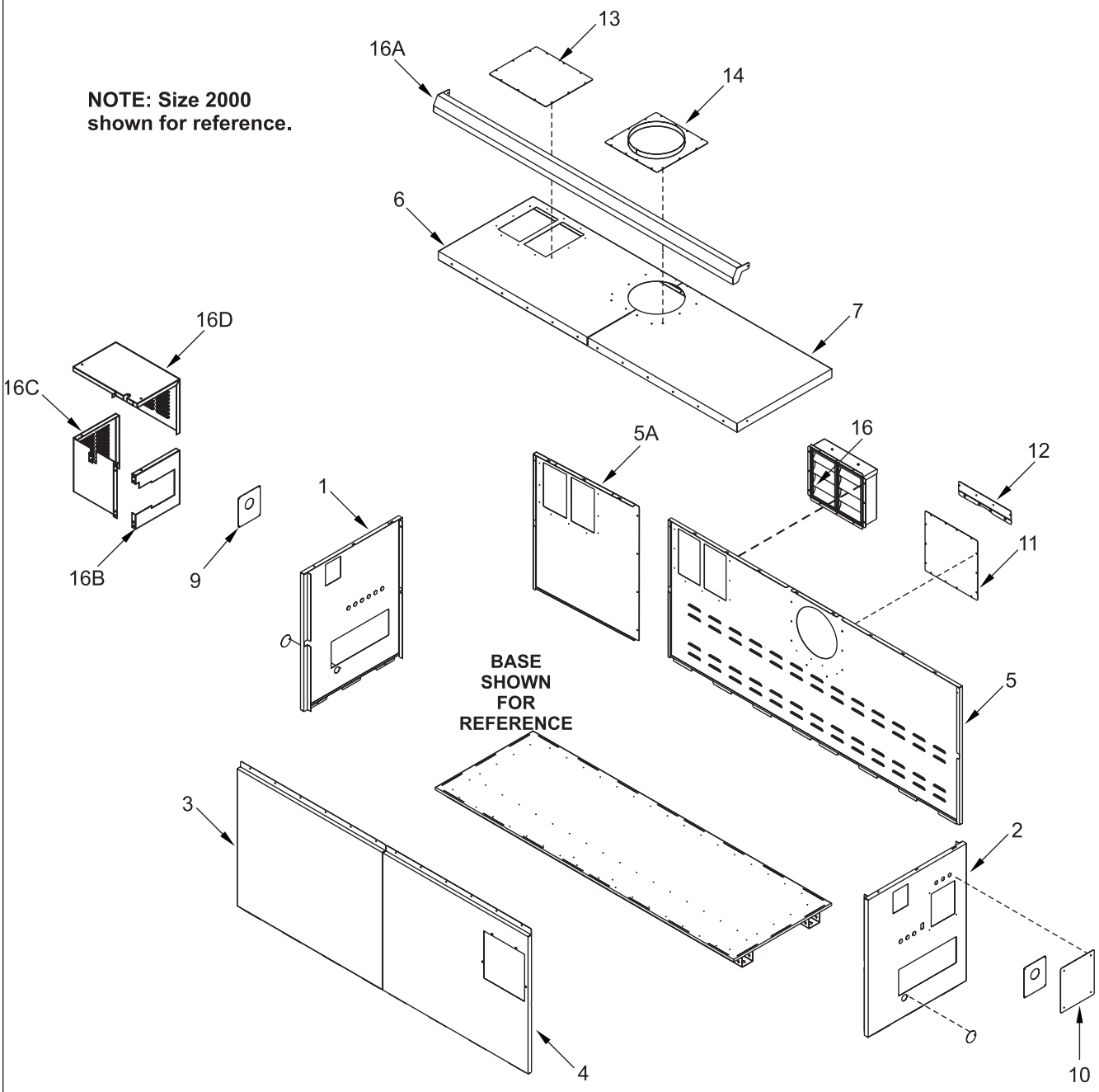


Figure 48. Sheet Metal Components.

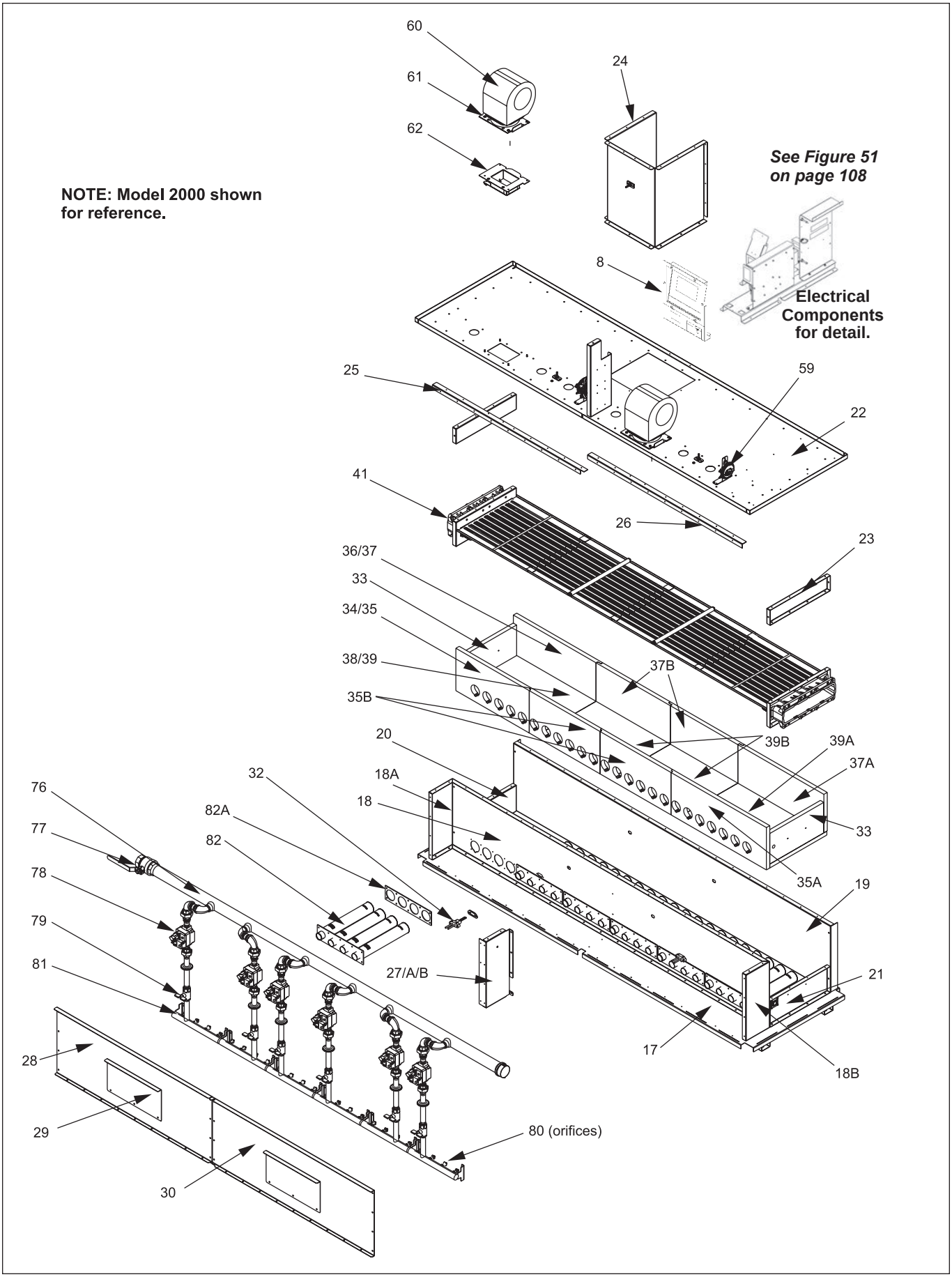
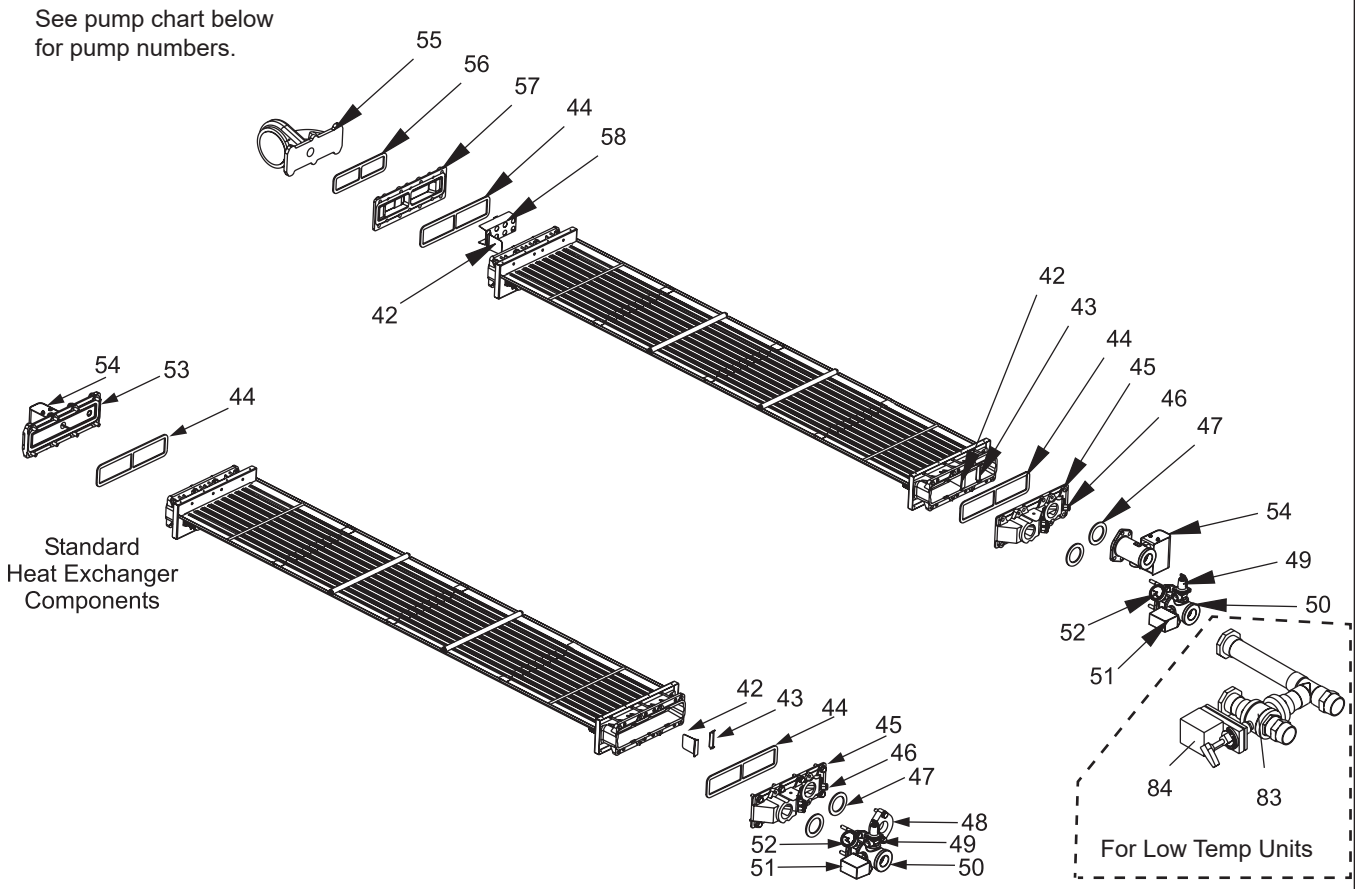


Figure 49. Internal Components.



Hydronic Boiler

SIZE	**TACO** PUMP P/N
500	A2117201
750	A2117201
1000	A2117202
1250	A2117202
1500	A2117203
1750	A2117203
2000	A2117204

Water Heater with TACO Pump

	TACO PUMP P/N		
SIZE	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

Figure 50. Heat Exchanger Components.

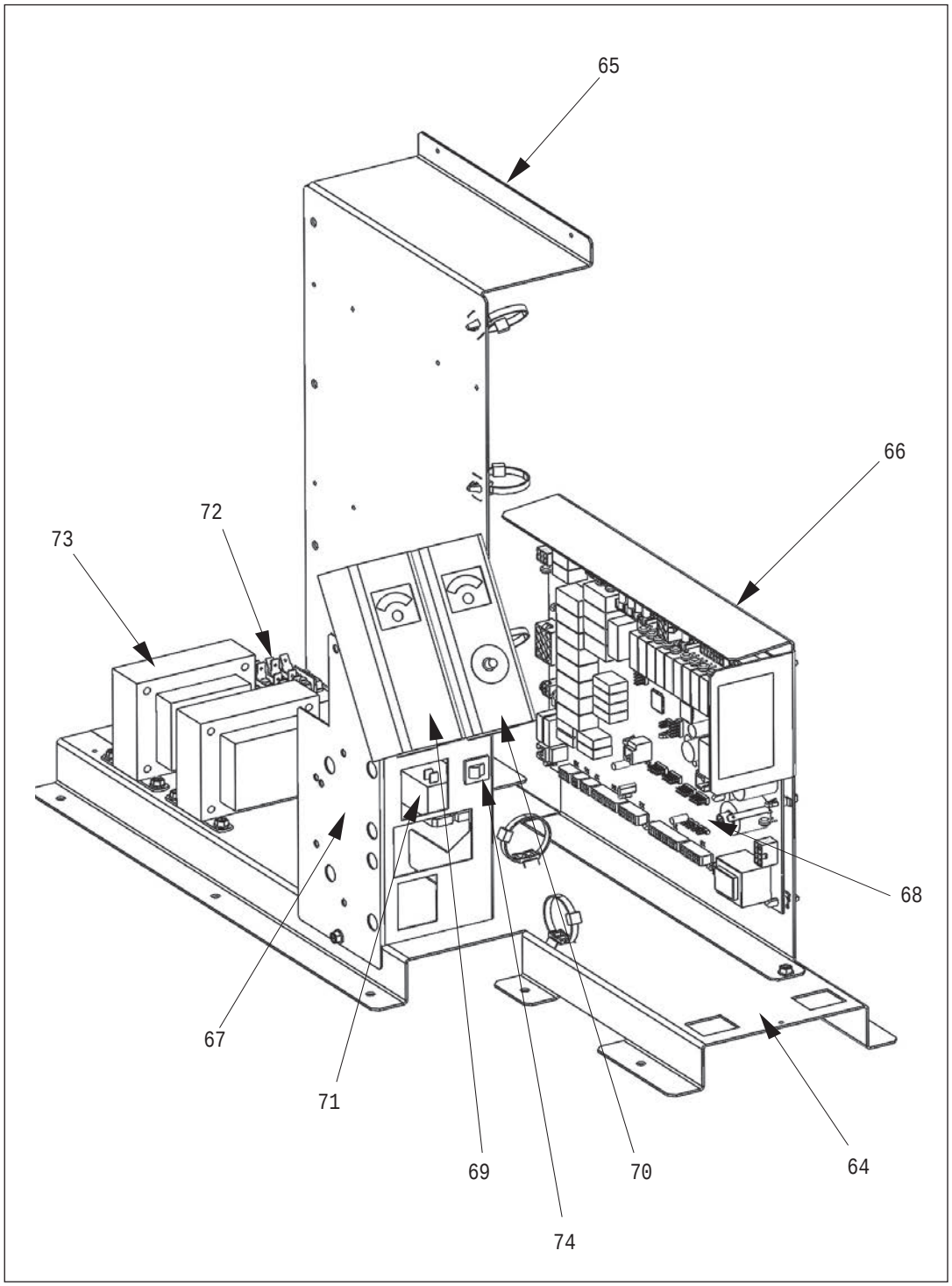


Figure 51. Electronic Components.

All Manuals (Install & Operate, Start Up, and Service Manuals) can be downloaded at

www.laars.com

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https://www.youtube.com/user/LaarsHeating

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H2379700E

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