Installation, Operating and Service Instructions for

APEX™

Commercial

- Condensing
- High Efficiency
- Direct Vent
- Gas-Fired
- Water Boiler

Models:

- **APX425C**
- **APX525C**
- **APX625C**
- **APX725C**
- **APX825C**

Manual Contents **Page**

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ASME H

⚠ WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury, or death. For assistance or additional information, consult a qualified installer, service agency or the gas supplier. This boiler requires a special venting system. Read these instructions carefully before installing.

106308-05 - 3/23

IMPORTANT INFORMATION - READ CAREFULLY

NOTE: The equipment shall be installed in accordance with those installation regulations enforced in the area where the installation is to be made. These regulations shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made.

All wiring on boilers installed in the USA shall be made in accordance with the *National Electrical Code* and/or local regulations.

All wiring on boilers installed in Canada shall be made in accordance with the *Canadian Electrical Code* and/or local regulations.

The City of New York requires a Licensed Master Plumber supervise the installation of this product.

The Massachusetts Board of Plumbers and Gas Fitters has approved the Apex™ Series boiler. See the Massachusetts Board of Plumbers and Gas Fitters website, https://licensing.reg.state.ma.us/pubLic/pl_products/pb_pre_form.asp for the latest Approval Code or ask your local Sales Representative.

The Commonwealth of Massachusetts requires this product to be installed by a Licensed Plumber or Gas Fitter.

The following terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning product life.

⚠ DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

⚠ WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

NOTICE: Indicates special instructions on installation, operation, or service which are important but not related to personal injury hazards.

⚠WARNING

Explosion Hazard. DO NOT store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance.

If you smell gas vapors, DO NOT try to operate any appliance - DO NOT touch any electrical switch or use any phone in the building. Immediately, call the gas supplier from a remotely located phone. Follow the gas supplier's instructions or if the supplier is unavailable, contact the fire department.

Special Installation Requirements for Massachusetts

A. For all sidewall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes and where the sidewall exhaust vent termination is less than seven (7) feet above grade, the following requirements shall be satisfied:

1. If there is no carbon monoxide detector with an alarm already installed in compliance with the most current edition of NFPA 720, NFPA 70 and the Massachusetts State Building Code in the residential unit served by the sidewall horizontally vented gas fueled equipment, a battery operated carbon monoxide detector with an alarm shall be installed in compliance with the most current edition of NFPA 720, NFPA 70 and the Massachusetts State Building Code.
2. In addition to the above requirements, if there is not one already present, a carbon monoxide detector with an alarm and a battery back-up shall be installed and located in accordance with the installation requirements supplied with the detector on the floor level where the gas equipment is installed. The carbon monoxide detector with an alarm shall comply with 527 CMR, ANSI/UL 2034 Standards or CSA 6.19 and the most current edition of NFPA 720. In the event that the requirements of this subdivision can not be met at the time of the completion of the installation of the equipment, the installer shall have a period of thirty (30) days to comply with this requirement; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed in compliance with the most current edition of NFPA 720, NFPA 70 and the Massachusetts State Building Code. In the event that the sidewall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the carbon monoxide detector may be installed on the next adjacent habitable floor level. Such detector may be a battery operated carbon monoxide detector with an alarm and shall be installed in compliance with the most current edition of NFPA 720, NFPA 70 and the Massachusetts State Building Code.
3. 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 (1/2) inch in size, "**GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS"**.
4. A final inspection by the state or local gas inspector of the sidewall horizontally vented equipment shall not be performed until proof is provided that the state or local electrical inspector having jurisdiction has granted a permit for installation of carbon monoxide detectors and alarms as required above.

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 sidewall horizontally 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. When the manufacturer of Product Approved sidewall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions for installation of the equipment and the venting system shall include:

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

D. When the manufacturer of a Product Approved sidewall horizontally vented gas fueled equipment does not provide the parts for venting flue gases, but identifies "special venting systems", the following shall be satisfied:

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 sidewall 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.

1 Product Description, Specifications and Dimensional Data

Apex Series boilers are condensing high efficiency gas-fired direct vent hot water boilers designed for use in forced hot water space or space heating with indirect domestic hot water heating systems, where supply water temperature does not exceed 210°F. These boilers have special coil type stainless steel heat exchangers, constructed, tested and stamped per Section 4 'Heating Boilers' of ASME Boiler and Pressure Vessel Code, which provide a maximum heat transfer and simultaneous protection against flue gas product corrosion. These boilers are not designed for use in gravity hot water space heating systems or systems containing significant amount of dissolved oxygen (swimming pool water heating, direct domestic hot water heating, etc.).

Table 1-1: Specifications

Specification	Boiler Model				
	APX425C	**APX525C**	**APX625C**	**APX725C**	**APX825C**
Altitude (ft. above sea level) [1]	**0-10,100**	**0-10,100 [2]**	**0-10,100**	**0-10,100 [3]**	**0-6,000 [4]**
Fuel	**Shipped for Natural Gas, Field Converted for LP Gas**		**Shipped for Natural Gas or Shipped for LP Gas (no Field Conversion)**		
Max. Allowable Water Temperature (°F)	210	210	210	210	210
Max. Allowable Working Pressure (psi)	160	160	160	160	160
Factory Supplied Safety Relief Valve (psi)*	50	50	60	60	60
Boiler Water Volume (gal.)	3.4	4.3	5.4	5.4	6.2
Heat Transfer Area (sq. ft.)	41.8	58.1	76.2	76.2	87.0
Approx. Shipping Weight (lb.)	316	368	458	458	500

* Optional 80 psi and 100 psi safety relief valves are available for all models.

[1] Follow Instructions for High Altitude Installations above 2,000 ft. (see Appendix A)

[2] APX525C LP cannot be installed above 6,000 ft.

[3] APX725C LP cannot be installed above 7,800 ft.

[4] APX825C natural gas cannot be installed above 6,000 ft. APX825C LP can be installed up to 10,100 ft.

Table 1-2: Dimensions (See Figures 1-3, 1-4, and 1-6)

Dimension	Boiler Model				
	APX425C	**APX525C**	**APX625C**	**APX725C**	**APX825C**
A - Inch (mm)	31-3/16 (792)	46-1/2 (1,181)	49-1/2 (1,258)	49-1/2 (1,258)	53-5/16 (1,258)
B - Inch (mm)	5-1/2 (140)	N/A	N/A	N/A	N/A
C - Inch (mm)	12-3/8 (314)	21-5/16 (541)	23-1/4 (591)	23-1/4 (591)	23-7/16 (596)
D - Inch (mm)	23 (584)	34-13/16 (884)	38-1/16 (967)	38-1/16 (967)	41-3/16 (1,046)
E - Inch (mm)	15-1/8 (384)	28-5/16 (719)	30-7/8 (784)	30-7/8 (784)	32-9/16 (827)
Gas Inlet G - Inch	3/4 (FPT)		1 (FPT)		
Return H - Inch	1-1/2 FPT	2 MPT			
Supply J - Inch	1-1/2 FPT	2 MPT			
PP Condensate Drain K - Inch	3/4 PVC Compression Coupling				
PVC Combustion Air Connector - Inch	4				
CPVC/PP/SS Vent Connector - Inch (mm)	4 (100)		6 (150)		

1 Product Description, Specifications and Dimensional Data *(continued)*

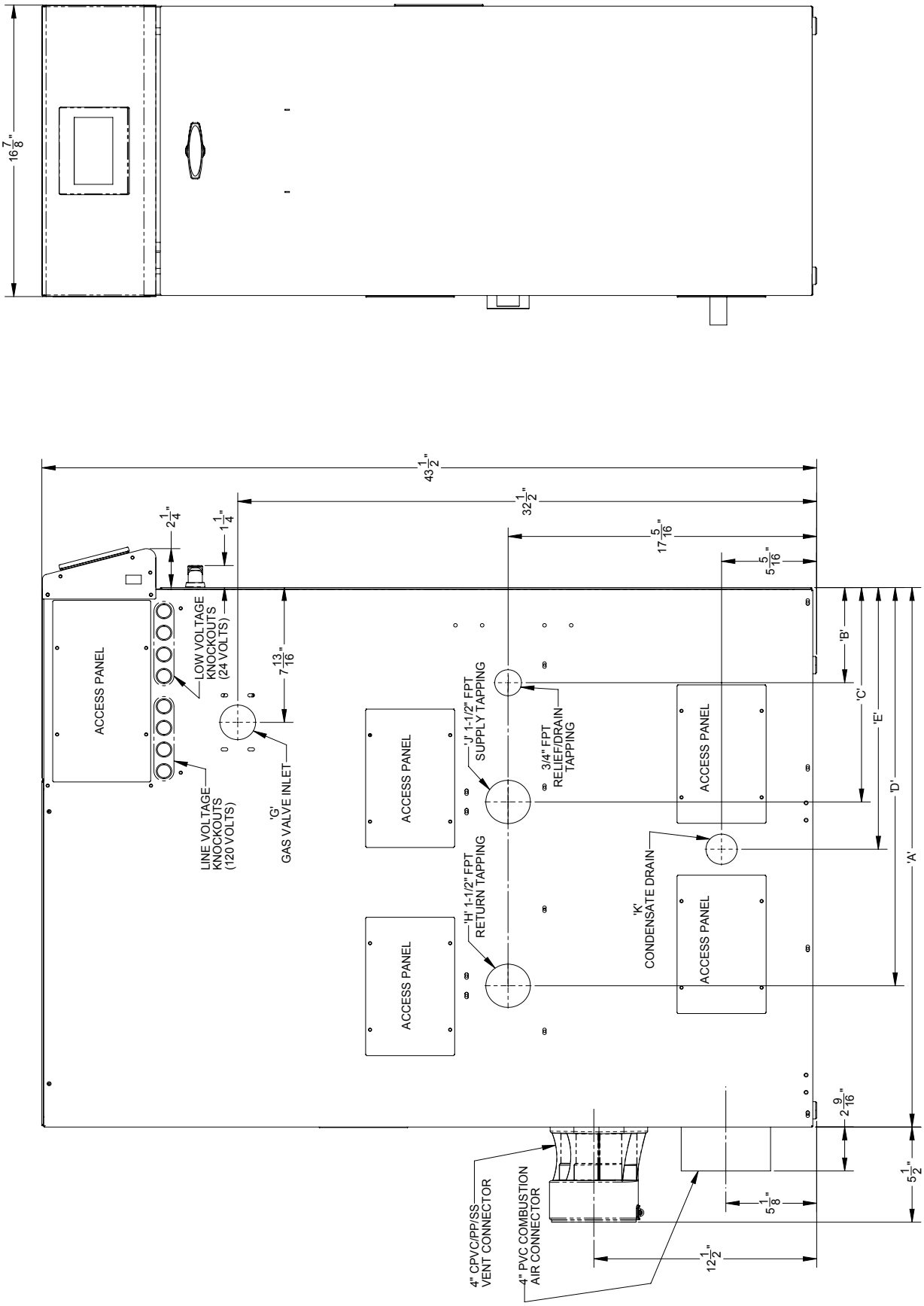


Figure 1-3: Apex - Model APX425C

1 Product Description, Specifications and Dimensional Data *(continued)*

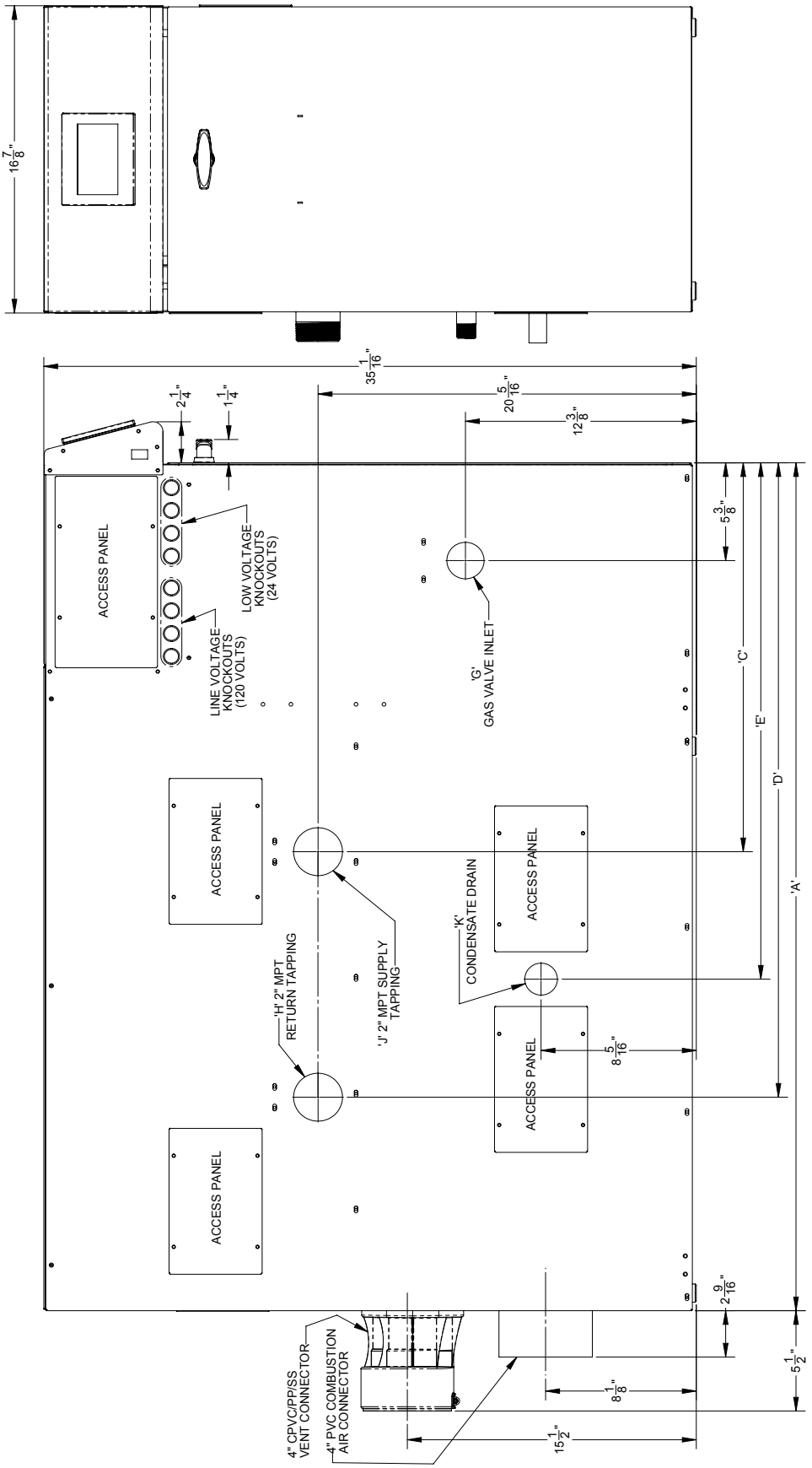


Figure 1-4: Apex - Model APX525C

1 Product Description, Specifications and Dimensional Data *(continued)*

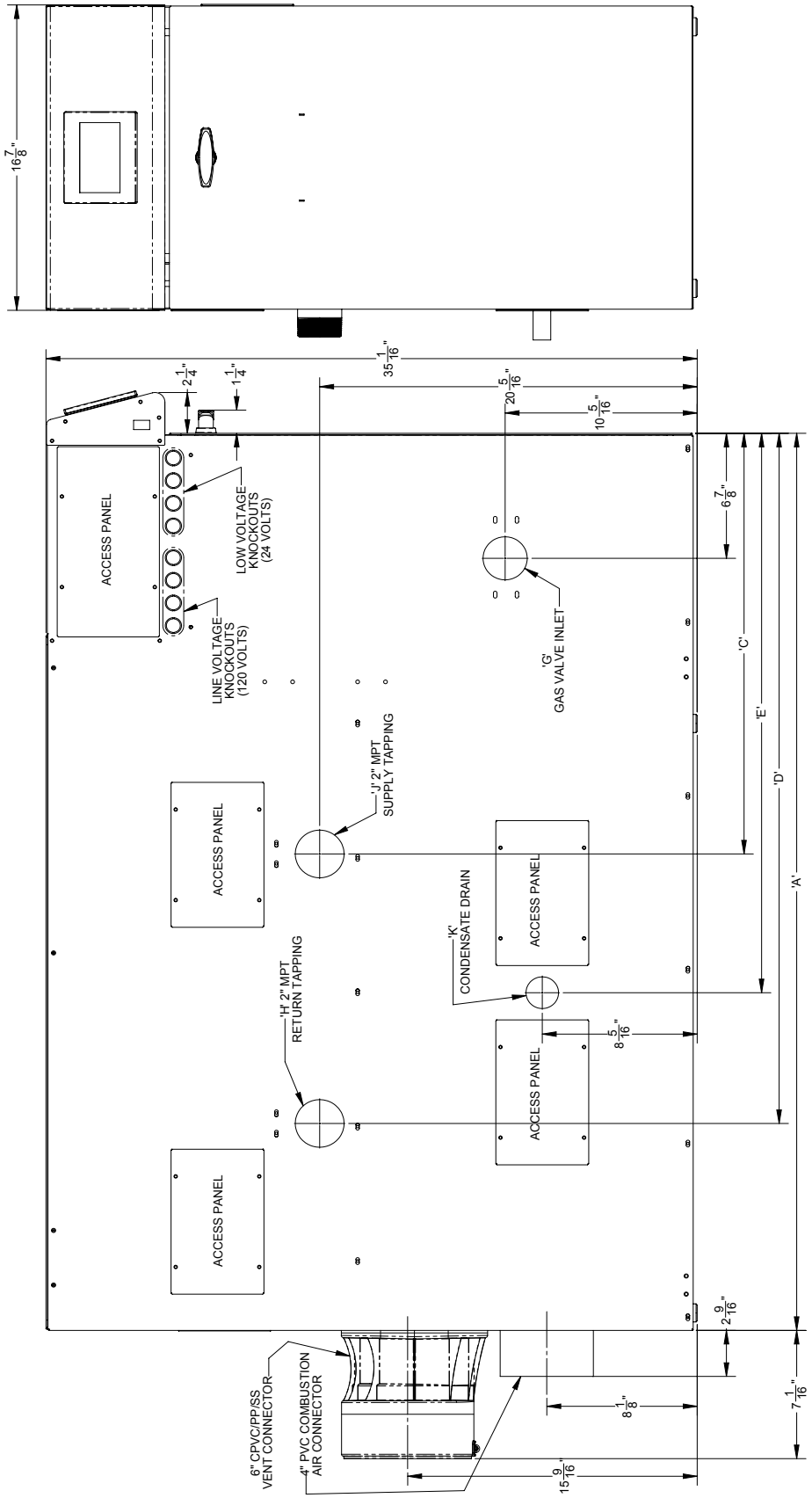


Figure 1-5: Apex - Models APX625C, APX725C and APX825C

1 Product Description, Specifications and Dimensional Data *(continued)*

Table 1-6: Ratings

Apex Series Gas-Fired Boilers						
Model Number	**Input (MBH)**		**Gross Output (MBH)**	**Net Ratings Water [1] (MBH)**	**Thermal Efficiency (%)**	**Combustion Efficiency (%)**
	Min.	**Max.**				
APX425C	80	399	375	326	94.1	94.5
APX525C	100	500	485	422	97.0	96.0
APX625C	125	625	594	517	95.0	96.0
APX725C	145	725	689	599	95.0	95.0
APX825C	160	800	760	661	95.0	94.0
Ratings shown are for installations at sea level and elevations up to 2,000 ft. at minimum vent length. For elevations above 2,000 ft., see Appendix A Instructions for High Altitude Installations above 2,000 ft.						
[1] Net AHRI Water Ratings based on allowance of 1.15. Consult manufacturer before selecting boiler for installations having unusual piping and pickup requirements, such as intermittent system operation, extensive piping systems, etc.						

2 Unpacking Boiler

NOTICE: Do not drop boiler.

A. **Move boiler** to approximate installed position.

B. **Remove all** crate fasteners.

C. **Lift and remove** outside container.

D. **Remove boiler** from cardboard positioning sleeve on shipping skid.

E. **Move boiler** to its permanent location.

3 Pre-Installation and Boiler Mounting

⚠ WARNING

Explosion Hazard. Asphyxiation Hazard. Electrical Shock Hazard.

- Installation of this boiler should be undertaken only by trained and skilled personnel from a qualified service agency. Follow these instructions exactly.
- Improper installation, adjustment, service, or maintenance can cause property damage, personal injury or death.

***NOTICE*:** Due to the low water content of the boiler, mis-sizing of the boiler with regard to the heating system load will result in excessive boiler cycling and accelerated component failure. Thermal Solutions DOES NOT warrant failures caused by mis-sized boiler applications. DO NOT oversize the boiler to the system. Multiple boiler installations greatly reduce the likelihood of boiler oversizing.

3 Pre-Installation and Boiler Mounting *(continued)*

⚠ WARNING

Asphyxiation Hazard.

Apply supplied dielectric grease to gasket inside vent connector. Failure to apply the grease could result in flue gas leaks from gasket rupture during vent pipe installation or gasket deterioration due to condensate exposure.

A. Installation must conform to the requirements of the authority having jurisdiction in or, in the absence of such requirements, to the *National Fuel Gas Code, ANSI Z223.1/NFPA 54, and/or Natural Gas and Propane Installation Code,* CAN/CSA B149.1.
Where required by the authority having jurisdiction, the installation must conform to the *Standard for Controls and Safety Devices for Automatically Fired Boilers*, ANSI/ASME CSD-1.

B. Boiler is certified for installation on combustible flooring. Do not install boiler on carpeting.

C. Provide clearance between boiler jacket and combustible material in accordance with local fire ordinance. Refer to Figure 3-3 for minimum listed clearances from combustible material. Recommended service clearance is 24 in. (610 mm) from left side, front, top and rear of the boiler. Recommended front clearance may be reduced to the combustible material clearance providing:

1. Access to boiler front is provided through a door or removable front access panel.
2. Access is provided to the condensate trap located underneath the heat exchanger.
3. Access is provided to thermal link located at boiler rear.

D. Protect gas ignition system components from water (dripping, spraying, rain, etc.) during boiler operation and service (circulator replacement, condensate trap, control replacement, etc.).

E. Provide combustion and ventilation air in accordance with applicable provisions of local building codes, or: USA - *National Fuel Gas Code*, ANSI Z223.1/NFPA 54, Air for Combustion and Ventilation; Canada - *Natural Gas and Propane Installation Code*, CAN/CSA-B149.1, Venting Systems and Air Supply for Appliances.

F. The boiler should be located so as to minimize the length of the vent system. Locate combustion air pipe termination away from areas that may contaminate combustion air, (see Table 3-1). In particular, avoid areas near chemical products containing chlorines, chlorofluorocarbons, paint removers, cleaning solvents and detergents. Avoid areas containing saw dust, loose insulation fibers, dry wall dust etc.

***NOTICE*:** Avoid operating this boiler in an environment where sawdust, loose insulation fibers, dry wall dust, etc. are present. If boiler is operated under these conditions, the burner interior and ports must be cleaned and inspected daily to ensure proper operation.

Table 3-1: Corrosive Combustion Air Contaminants and Sources

Contaminants to avoid:
Spray cans containing chloro/fluorocarbons (CFC's)
Permanent wave solutions
Chlorinated waxes/cleaners
Chlorine-based swimming pool chemicals
Calcium chloride used for thawing
Sodium chloride used for water softening
Refrigerant leaks
Paint or varnish removers
Hydrochloric acid/muriatic acid
Cements and glues
Antistatic fabric softeners used in clothes dryers
Chlorine-type bleaches, detergents, and cleaning solvents found in household laundry rooms.
Adhesives used to fasten building products and other similar products
Excessive dust and dirt
Areas likely to have contaminants:
Dry cleaning/laundry areas and establishments
Swimming pools
Metal fabrication plants
Beauty shops
Refrigeration repair shops
Photo processing plants
Auto body shops
Plastic manufacturing plants
Furniture refinishing areas and establishments
New building construction
Remodeling areas
Garages with workshops

3 Pre-Installation and Boiler Mounting *(continued)*

⚠ WARNING

Asphyxiation Hazard.

Adequate combustion and ventilation air must be provided to assure proper combustion. Install combustion air intake per Section 4 “Venting”.

G. General.

1. Apex boilers are intended for installations in an area with a floor drain, or in a suitable drain pan to prevent any leaks or safety relief valve discharge resulting in property damage.
2. Apex boilers are not intended to support external piping and venting. All external piping and venting must be supported independently of the boiler.
3. Apex boilers must be installed level to prevent condensate from backing up inside the boiler.
4. Boiler Installation:
   a. For basement installation provide a solid level base such as concrete where floor is not level or where water may be encountered on the floor around boiler. Floor must be able to support weight of boiler, water and all additional system components.
   b. Boiler must be level to prevent condensate from backing up inside the boiler.
   c. Provide adequate space for condensate piping or a condensate pump if required.

Boiler Clearances to Combustible (and Non-Combustible) Material:

Models APX425C and APX525C:

These boilers are listed for closet installation with the following minimum clearances – Top = 1 in. (25 mm), Front = 1 in. (25 mm), Left Side = 10 in. (250 mm), Right Side = 2 in. (50 mm), Rear = *6 in. (150 mm)

Models APX625C, APX725C and APX825C:

These boilers are listed for alcove installation with the following minimum clearances – Top = 1 in. (25 mm), Front = Open, Left Side = 10 in. (250 mm), Right Side = 2 in. (50 mm), Rear = *6 in. (150 mm)

*** Note:**

When boiler is vented vertically, the minimum clearance from the rear of the jacket is increased to 18 in. (460 mm) with a short radius 90° elbow provided in order to provide adequate space at boiler rear for installation of vent and air intake piping and service access.

Boiler Service Clearances – Applicable to all Boiler Models:

Top = 24 in. (610 mm), Front = 24 in. (610 mm), Left Side = 24 in. (610 mm), Right Side = 24 in. (610 mm), Rear = 24 in. (610 mm)

The above clearances are recommended for service access but may be reduced to the Combustible Material Clearances provided:

1. The boiler front is accessible through a door.
2. Access is provided to the condensate trap located on the left side of boiler.
3. Access is provided to thermal link located at the boiler rear.

Table 3-2: Vent Pipe Clearances to Combustible Material

Listed Direct Vent System	Vent Pipe Material	Vent Pipe Direction	Enclosure	Vent Pipe Nominal Diameter	Minimum Clearance to Combustible Material
Standard Two-Pipe CPVC/PVC Vent and PVC Combustion Air Intake	CPVC/PVC	Vertical or Horizontal	Unenclosed at all Sides	3 in. (80 mm), 4 in. (100 mm or 110 mm), 6 in.(150 mm or 160 mm)	1 in. (25 mm)
Optional Two-Pipe Rigid Polypropylene Vent (or, Flexible Polypropylene Liner for Vertical Venting only) and Rigid Polypropylene or PVC Combustion Air Intake	Rigid Polypropylene (or, Flexible Polypropylene Liner for Vertical Venting only)			3 in. (80 mm), 4 in. (100 mm or 110 mm), 6 in.(150 mm or 160 mm)	1 in. (25 mm)
Optional Two-Pipe Stainless Steel Vent and Galvanized Steel or PVC Combustion Air Intake	Stainless Steel			3 in. (80 mm), 4 in. (100 mm or 110 mm), 6 in.(150 mm or 160 mm)	1 in. (25 mm)

3 Pre-Installation and Boiler Mounting *(continued)*

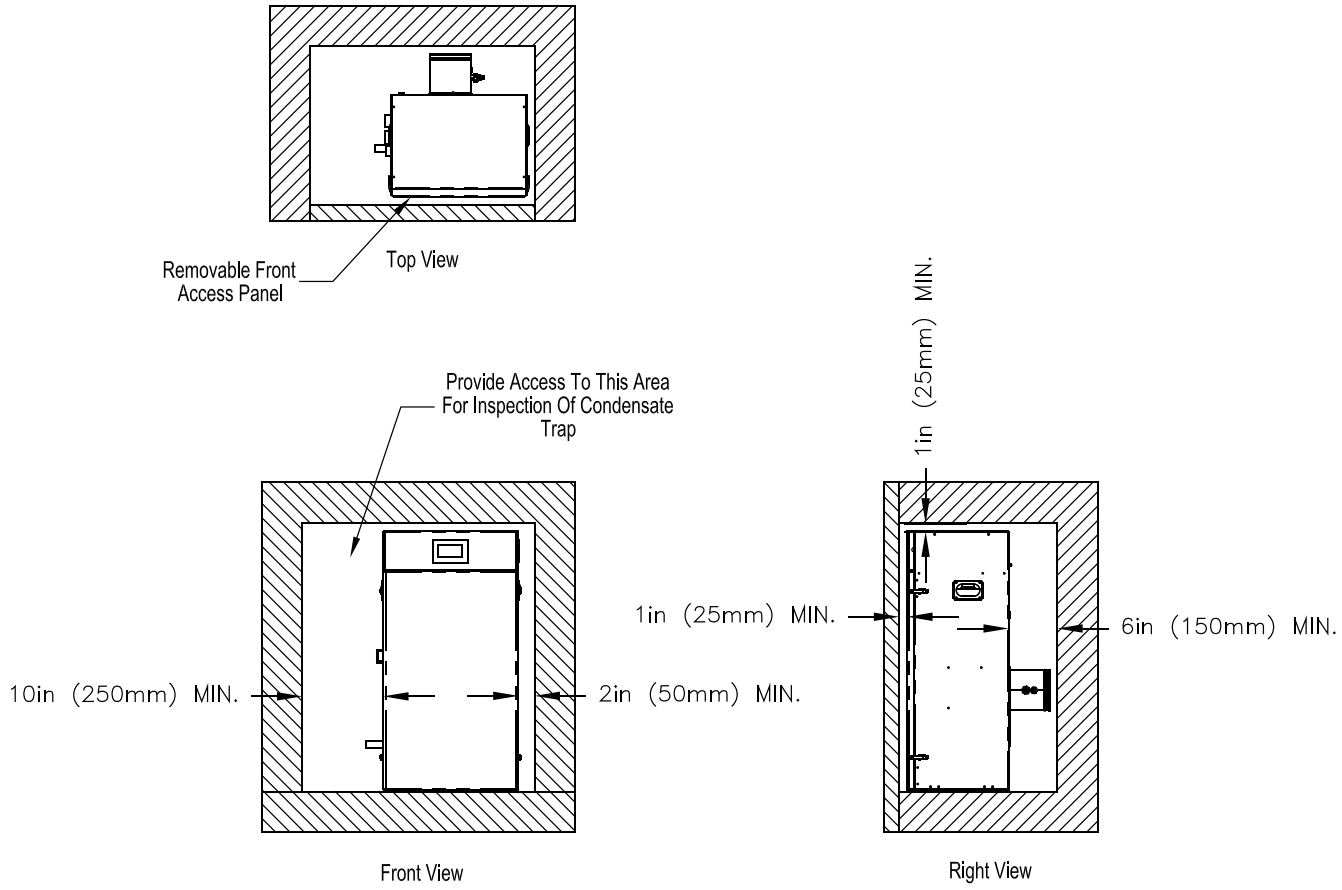


Figure 3-3: Clearances To Combustible and Non-combustible Material

H. Boiler Stacking

1. For installations with unusually high space heating and/or domestic hot water heating loads, where employing multiple boilers will offer the benefits of greater operational efficiency, floor space savings and boiler redundancy, boilers may be installed stacked maximum one boiler on top of another. Refer to Table 3-4 “Apex Boiler Model Stacking Combinations” for details.

Table 3-4: Apex Boiler Model Stacking Combinations

Bottom Boiler Model	Top Boiler Model
APX425C	APX425C
APX525C	APX425C or APX525C
APX625C	APX425C, APX525C or APX625C
APX725C	APX425C, APX525C, APX625C or APX725C
APX825C	APX425C, APX525C, APX625C, APX725C or APX825C

2. To field assemble individual Apex boilers into a stackable configuration, use the steps below:
   a. Position the bottom boiler first. Refer to Sections 2 “Unpacking Boiler” and 3 “Pre-Installation & Boiler Mounting” of the manual for details. **Always position higher input boiler model as bottom boiler.**
   b. Each Apex boiler is factory packaged with 2 stacking boiler attachment brackets (P/N 101679-01) and the bracket mounting hardware [six (6) self-drilling hex washer head plated #8 x ½ in. long screws, P/N 80860743]. Locate and remove the brackets and the hardware. The stacking boiler attachment bracket has three 7/32 in. diameter holes punched in a triangular pattern. See Figure 3-5 “Stacking Boiler Attachment Bracket Placement”.
   c. Apex boiler left and right side panels have a series of dimples at panel top and bottom. These dimples are positioning dimples for stacking boiler attachment bracket mounting screws. Side panel bottom positioning dimples are evenly spaced from boiler front and back, while side panel top positioning dimples follow specific pattern to compensate for Apex boiler model variable depth.

3 Pre-Installation and Boiler Mounting *(continued)*

d. Position the upper boiler on top of the bottom boiler and align boiler front doors and sides flush with each other.
   - Place first stacking boiler attachment bracket onto the upper boiler left side panel, at the panel lower left corner and align bracket two upper holes with corresponding side panel lower dimples.
   - The remaining lower bracket hole must align with a matching bottom boiler left side panel top positioning dimple.
   - Once bracket holes and side panel dimple alignment is verified, attach the bracket to top and bottom boiler left side panels with the mounting screws.

e. Repeat above procedure to install second stacking boiler attachment bracket and secure the stacked boiler right side panels together at the front right corner.

f. Install the third stacking boiler attachment bracket to secure top and bottom boiler left side panels at the rear left corner. Align the bracket holes with corresponding positioning dimples in the top boiler and bottom boiler left side panels, then secure bracket with the screws.

g. Repeat above procedure to install the fourth stacking boiler attachment bracket to secure stacked boiler right side panels at the rear right corner.

3. Tilt top boiler display downward as shown in Figure 3-5.
   a. Remove screws attaching display panel to boiler left and right side panels (two screws per side).
   b. On back side of display panel, disconnect three electrical connectors display, detach two strain relief cable screws from top of panel, and loosen two display mounting screws.
   c. Remove display, rotate panel 180° relative to display, reinstall display, and tighten display mounting screws. Interchange left and right display panel end caps.
   d. On back side of display panel, attach strain relief cable screws and reconnect three electrical connectors.
   e. Attach downward-tilted panel to top boiler.
4. When installing stackable boiler combinations observe the following guidelines:
   a. Venting - Top and bottom boilers must have their individual vent piping and vent terminals.

⚠ WARNING

Asphyxiation Hazard.

No common manifold venting is permitted. Each boiler must have its own individual vent and combustion air pipes and terminals.

For sidewall venting individual model vent terminals must terminate no closer than 12 in. (300 mm) horizontally and 3 ft. (900 mm) vertically from each other in order to prevent combustion air contamination. For vertical through the roof venting, individual vertical vent terminals, if level with each other, must be spaced no closer than 12 in. (300 mm) horizontally. If vertical terminals cannot end in one plane, they must be spaced no closer than 3 ft. (900 mm) horizontally.

Follow instructions in Section 4 “Venting” of the manual for specifics of individual boiler vent termination. Follow instructions in Section 5 “Condensate Disposal” for each individual boiler flue gas condensate line construction and condensate disposal. Terminating individual boiler condensate lines into common pipe prior to drain disposal is permissible, providing common pipe has sufficient flow capacity to handle combined condensate volume of stackable combination.

   b. Gas Piping - Follow instructions in Section 7 “Gas Piping” of the manual for sizing and installation of an individual boiler. When common gas piping is sized, ensure it will have adequate capacity for combined input (CFH gas flow) of the selected stackable boiler combination.
   c. Water Piping and Trim - Follow instructions in Section 6 “Water Piping and Trim” of the manual for system piping and boiler secondary piping selection/sizing based on combined heating capacity and/or gross output of the selected stackable boiler combination. Follow instructions of Section 6 “Water Piping and Trim” for each individual boiler trim installation.
   d. Electrical - Follow instructions in Section 8 “Electrical” of the manual to wire individual boilers.

3 Pre-Installation and Boiler Mounting *(continued)*

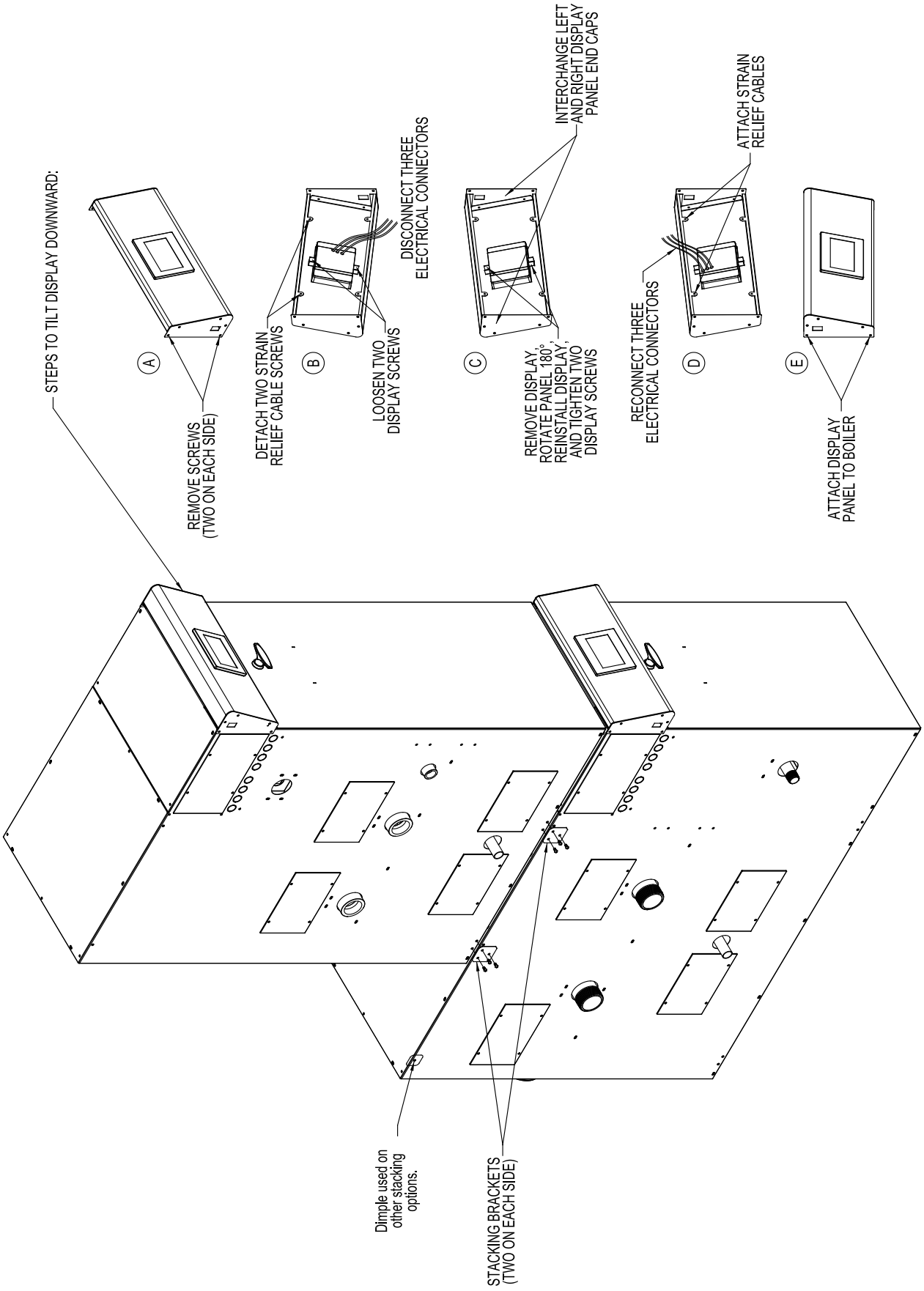


Figure 3-5: Boiler Stacking with Tilted Display Panel

4 Venting

⚠ WARNING

Asphyxiation Hazard.

- Failure to vent this boiler in accordance with these instructions could cause products of combustion to enter the building resulting in severe property damage, personal injury or death.
- Do not use a barometric damper, draft hood or vent damper with this boiler.
- Do not locate vent termination under a deck.
- Do not locate vent termination where exposed to prevailing winds.
- Do not locate combustion air termination where chlorines, chlorofluorocarbons (CFC's), petroleum distillates, detergents, volatile vapors or other chemicals are present. Severe boiler corrosion and failure will result.
- Use specified vent and combustion air pipe diameters.
- Do not interchange vent systems or materials unless otherwise specified.
- Do not apply thermal insulation to vent pipe or fittings.
- Moisture and ice may form on surface around vent termination. To prevent deterioration, surface must be in good repair (sealed, painted, etc.).
- Do not allow low spots in the vent where condensate may pool.
- The CPVC vent materials supplied with this boiler do not comply with Natural Gas and Propane Installation Code, CAN/CSA B149.1.S1-07 and are not approved for use in Canadian jurisdictions that require vent systems be listed to ULC S636-2008. In these jurisdictions, vent this boiler using either stainless steel Special Gas vent or a listed ULC S636 Class IIB venting system.

A. General Guidelines

1. Listed Vent/Combustion Air Systems
   a. Install vent system in accordance with *National Fuel Gas Code*, ANSI Z223.1/NFPA 54 or *Natural Gas and Propane Installation Code,* CAN/CSA B149.1 Installation Code for Canada, or, applicable provisions of local building codes. Contact local building or fire officials about restrictions and installation inspection in your area.
   b. The Apex may be installed as a direct vent/sealed combustion boiler or with optional room air for combustion. Direct vent is recommended for residential applications. For direct vent, pipe combustion air from the outdoors directly to the boiler cabinet. Room air is optional for commercial applications. For room air, provide combustion and ventilation air per the *National Fuel Gas Code*, ANSI Z223.1, or, in Canada, *Installation Code for Gas Burning Appliances and Equipment*, CGA Standard B149.
   c. The following combustion air/vent system options are listed for use with the Apex boilers (refer to Table 4-1):
      i. Two-Pipe CPVC/PVC Vent/Combustion Air System - Separate CPVC/PVC pipe serves to expel products of combustion and separate PVC pipe delivers fresh outdoor combustion air. Refer to Part B for specific details.
      ii. Two-Pipe Polypropylene Vent/Combustion Air System - Separate rigid or flexible polypropylene pipe serves to expel products of combustion and separate rigid polypropylene or PVC pipe delivers fresh outdoor combustion air. Refer to Part C for specific details.
      iii. Two-Pipe Stainless Steel Vent/Combustion Air System - Separate stainless steel pipe serves to expel products of combustion and separate PVC or galvanized steel pipe delivers fresh outdoor combustion air. Refer to Part D for specific details.
      iv. Room Air for Combustion – CPVC/PVC, polypropylene, or stainless steel pipe serves to expel products of combustion and combustion air is supplied from the boiler room. Refer to Part E for specific details.
2. Vent/Combustion Air Piping
   a. Do not exceed maximum vent/combustion air lengths listed in Table 4-2. Vent/combustion air length restrictions are based on equivalent length of vent/combustion air pipe (total length of straight pipe plus equivalent length of fittings). Table 4-3 lists equivalent lengths for fittings. Do not include vent/combustion air terminals in equivalent feet calculations. Use vent/combustion air equivalent length worksheet provided in Table 4-4.

4 Venting *(continued)*

b. Maintain minimum clearance to combustible materials. See Table 3-2 for details.

c. Enclose vent passing through occupied or unoccupied spaces above boiler with material having a fire resistance rating at least equal to the rating of adjoining floor or ceiling.

Note: For one or two family dwellings, fire resistance rating requirement may not need to be met, but is recommended.

d. Slope horizontal vent pipe minimum 1/4 in/ft. (21 mm/m) downward towards the boiler.

Table 4-1: Vent/Combustion Air Intake System Options

Vent & Intake Materials	Option		Penetration Through Structure	Termination	Figures	Component Table	Reference Section
Standard CPVC/PVC Two-Pipe, CPVC/PVC Vent and PVC Air Intake	1	Intake	Horizontal Sidewall	90° Elbow w/ Screen	4-6, 4-7	4-11, 4-12	A, B
		Vent	Horizontal Sidewall	Coupling w/ Screen			
	2	Intake	Horizontal Sidewall	Ipex Low Profile	4-8	4-13	
		Vent	Horizontal Sidewall				
	3	Intake	Horizontal Sidewall	90° Elbow w/ Screen	4-6, 4-7, 4-9	not provided	
		Vent	Vertical Roof	Coupling w/ Screen			
	4	Intake	Vertical Roof	(2) 90° Elbows w/ Screen	4-9	4-14	
		Vent	Vertical Roof	Coupling w/ Screen			
	5	Intake	N/A - Room Air		4-6, 4-7	not provided	A, B, E
		Vent	Horizontal Sidewall	90° Elbow or Tee w/ Screen			
	6	Intake	N/A - Room Air		4-9	not provided	
		Vent	Vertical Roof	Coupling w/ Screen			
Optional Polypropylene Two-pipe, Rigid PP Vent or Flexible PP Vent (Vertical Only) and Rigid PP or PVC Air Intake	7	Intake	Horizontal Sidewall	UV Resistant 90° Elbow w/Screen	4-6, 4-7	4-22, 4-23, 4-24	A,C
		Vent	Horizontal Sidewall	UV Resistant Straight Pipe w/Screen			
	8	Intake	Horizontal Sidewall	Ipex Low Profile	4-8	4-13, 4-22, 4-23, 4-24	
		Vent	Horizontal Sidewall				
	9	Intake	Horizontal Sidewall	UV Resistant 90° Elbow w/Screen	4-6, 4-7, 4-9	4-22, 4-23, 4-24	
		Vent	Vertical Roof	UV Resistant Straight Pipe w/Screen			
	10	Intake	Vertical Roof	(2) UV Resistant 90° Elbows w/Screen	4-9	4-22, 4-23, 4-24	
		Vent	Vertical Roof	UV Resistant Straight Pipe w/Screen			
	11	Intake	N/A - Room Air		4-6, 4-7	4-22, 4-23, 4-24	A,C, E
		Vent	Horizontal Sidewall	UV Resistant 90° Elbow w/Screen			
	12	Intake	N/A - Room Air		4-9	4-22, 4-23, 4-24	
		Vent	Vertical Roof	UV Resistant Straight Pipe w/Screen			
Optional Stainless Steel Two-pipe, SS Vent and Galvanized Steel or PVC Air Intake	13	Intake	Horizontal Sidewall	90° Elbow w/Screen	4-6, 4-7	4-30, 4-31, 4-32	A, D
		Vent	Horizontal Sidewall	Straight Termination w/Screen			
	14	Intake	Horizontal Sidewall	90° Elbow w/Screen	4-6, 4-7 ,4-9	4-30, 4-31, 4-32	
		Vent	Vertical Roof	Straight Termination w/Screen			
	15	Intake	Vertical Roof	(2) 90° Elbows w/Screen	4-9	4-30, 4-31, 4-32	
		Vent	Vertical Roof	Straight Termination w/Screen			
	16	Intake	N/A - Room Air		4-6, 4-7	4-30, 4-31, 4-32	A, D, E
		Vent	Horizontal Sidewall	90° Elbow or Tee w/Screen			
	17	Intake	N/A - Room Air		4-9	4-30, 4-31, 4-32	
		Vent	Vertical Roof	90° Elbow or Tee w/Screen			

4 Venting *(continued)*

Table 4-2: Vent and Combustion Air Pipe Sizes and Equivalent Lengths (Applies to All Listed Vent/Combustion Air System Options)

Boiler Model	Option	Combustion Air Length			Vent Length			Approx. Derate at Max. Length(%)
		Pipe Dia., in. (mm)	Min., ft. (m)	Max., ft. (m)	Pipe Dia., in. (mm)	Min., ft. (m)	Max., ft. (m)	
APX425C	Standard Diameter	4 (100 or 110)	0	100 (30.5)	4 (100 or 110)	2.5 (760)	100 (30.5)	5
	Reduced Diameter	3 (80)	0	50 (15.2)	3 (80)	2.5 (760)	50 (15.2)	5
APX525C	Standard Diameter	4 (100 or 110)	0	100 (30.5)	4 (100 or 110)	2.5 (760)	100 (30.5)	11
	Reduced Diameter	3 (80)	0	50 (15.2)	3 (80)	2.5 (760)	50 (15.2)	12
APX625C	Standard Diameter	4 (100 or 110)	0	100 (30.5)	6 (150 or 160)	2.5 (760)	200 (30.5)	7
	Reduced Diameter	4 (100 or 110)	0	50 (15.2)	4 (100 or 110)	2.5 (760)	50 (15.2)	10
APX725C	Standard Diameter	4 (100 or 110)	0	100 (30.5)	6 (150 or 160)	2.5 (760)	200 (30.5)	11
	Reduced Diameter	4 (100 or 110)	0	50 (15.2)	4 (100 or 110)	2.5 (760)	50 (15.2)	15
APX825C	Standard Diameter	4 (100 or 110)	0	100 (30.5)	6 (150 or 160)	2.5 (760)	200 (30.5)	14
	Reduced Diameter	4 (100 or 110)	0	50 (15.2)	4 (100 or 110)	2.5 (760)	50 (15.2)	15

Table 4-3: Vent System and Combustion Air System Component Equivalent Length (Applies to All Listed Vent/Combustion Air System Options)

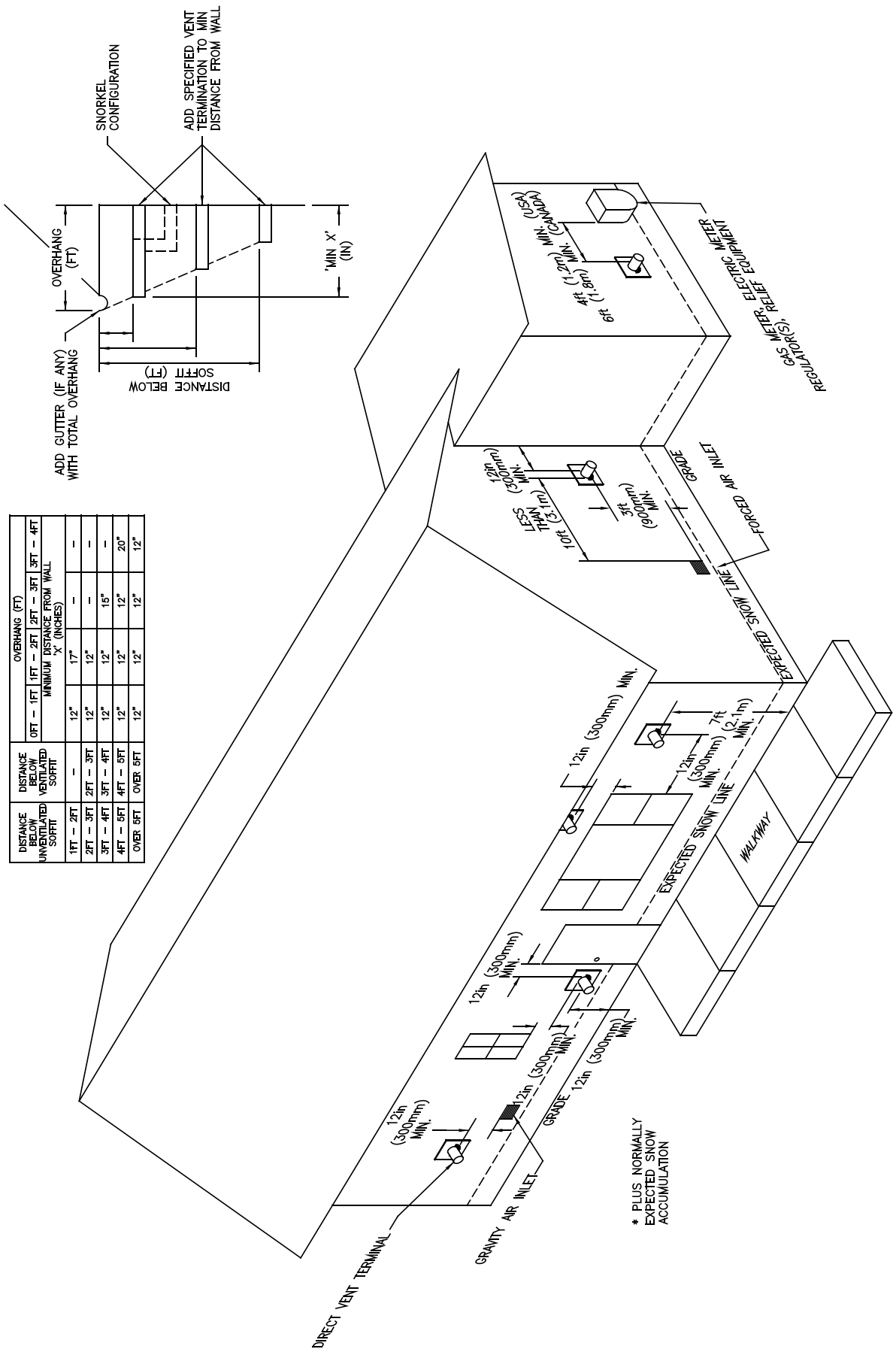
Component	Equivalent Length		
Nominal Diameter	3 in. (80 mm)	4 in. (100 or 110 mm)	6 in. (150 or 160 mm)
90° Elbow, Short Radius	10 ft. (3.0 m)	13 ft. (4.0 m)	22 ft. (6.7 m)
90° Elbow, Long Sweep/Sanitary	4.0 ft. (1.2 m)	9 ft. (2.7 m)	17 ft. (5.2 m)
45° Elbow	3.0 ft. (0.9 m)	4.5 ft. (1.4 m)	7.5 ft. (2.3 m)

Table 4-4: Vent and Combustion Air Equivalent Length Calculation Worksheet

Component	Combustion Air						Vent					
	Equivalent Length Per Piece	x	Quantity	=	Subtotal Equivalent Length		Equivalent Length Per Piece	x	Quantity	=	Subtotal Equivalent Length	
Straight Pipe		x		=		A						E
90° Elbow, Short Radius		x		=		B						F
90° Elbow, Long Sweep/ Sanitary		x		=		C						G
45° Elbow		x		=		D						H
	Combustion Air Total Equivalent Length			=		A+B+C+D	Vent Total Equivalent Length			=		E+F+G+H

Notes:
1. Total equivalent length cannot exceed maximum equivalent length shown in Table 4-2.
2. Use elbow equivalent lengths provided in Table 4-3.
3. Combustion air and vent terminations do not count towards total equivalent length.
4. Pressure drop for flexible polypropylene liner is 20% greater than for rigid pipe. Multiply measured flexible polypropylene liner length by 1.2 to obtain equivalent length.
   Example
   Measured length = 35 ft.
   Equivalent length =35 ft. x 1.2 = 42 ft.
5. Maximum equivalent length of flexible polypropylene liner is 48 ft. (14.6 m).

4 Venting *(continued)*



DISTANCE BELOW UNVENTILATED SOFFIT	DISTANCE BELOW VENTILATED SOFFIT	OVERHANG (FT) MINIMUM DISTANCE FROM WALL 'X' (INCHES)			
		0FT – 1FT	1FT – 2FT	2FT – 3FT	3FT – 4FT
1FT – 2FT	–	12"	17"	–	–
2FT – 3FT	2FT – 3FT	12"	12"	–	–
3FT – 4FT	3FT – 4FT	12"	12"	15"	–
4FT – 5FT	4FT – 5FT	12"	12"	12"	20"
OVER 5FT	OVER 5FT	12"	12"	12"	12"

Figure 4-5: Location of Vent Terminal Relative to Windows, Doors, Grades, Overhangs, Meters and Forced Air Inlets - Two-Pipe System Vent Terminal (Shown), Two-Pipe System Air Intake Terminal (Not Shown)

4 Venting *(continued)*

Les chaudières de catégories I, II et IV doivent présenter des tronçons horizontaux dont la pente montante est d'au moins 1/4 po par pied (21 mm/m) entre la chaudière et l'évent.

e. If possible, slope horizontal combustion air pipe minimum 1/4 in/ft. (21 mm/m) downward towards terminal. If not, slope towards boiler.

f. Use noncombustible ¾ in. pipe strap to support horizontal runs and maintain vent location and slope while preventing sags in pipe. Do not restrict thermal expansion or movement of vent system. Maximum support spacing 4 ft. (1.2 m). Avoid low spots where condensate may pool. Do not penetrate any part of the vent system with fasteners.

Les instructions d´installation du système d´évacuation doivent préciser que les sections horizontales doivent être supportées pour prévenir le fléchissement. Les méthodes et les intervalles de support doivent être spécifiés. Les instructions divent aussi indiquer les renseignements suivants:

les chaudières de catégories II et IV doivent être installées de façon à empêcher l´accumulation de condensat: et

si nécessaire, les chaudières de catégories II et IV doivent être pourvues de dispositifs d´évacuation du condensat.

g. For multiple boiler installations with vertical roof terminals, separate vent pipes from multiple boilers may be piped through a common conduit or chase so that one roof penetration may be made.

3. Vent/Combustion Air Terminals

Install venting system components on exterior of building only as specifically required by these instructions (refer to Figure 4-5).

a. Use only listed vent/combustion air terminals.

i. Horizontal Sidewall Venting: Use coupling for vent and 90° elbow pointed down for combustion air as shown in Figure 4-6 or Figure 4-7. If using room air for combustion, use 90° elbow or tee for vent. Alternate low profile termination is shown in Figure 4-8.

ii. Vertical Roof Venting: Use coupling on vent and two 90° elbows turned downwards for combustion air as shown in Figure 4-9 and Figure 4-10.

b. Maintain correct clearance and orientation between vent and combustion air terminals.

i. Space centerlines of vent and combustion air terminals minimum 12 in. (300 mm) apart. 36 in. (915 mm) spacing is recommended.

ii. If possible, locate vent and combustion air terminals on the same wall to prevent

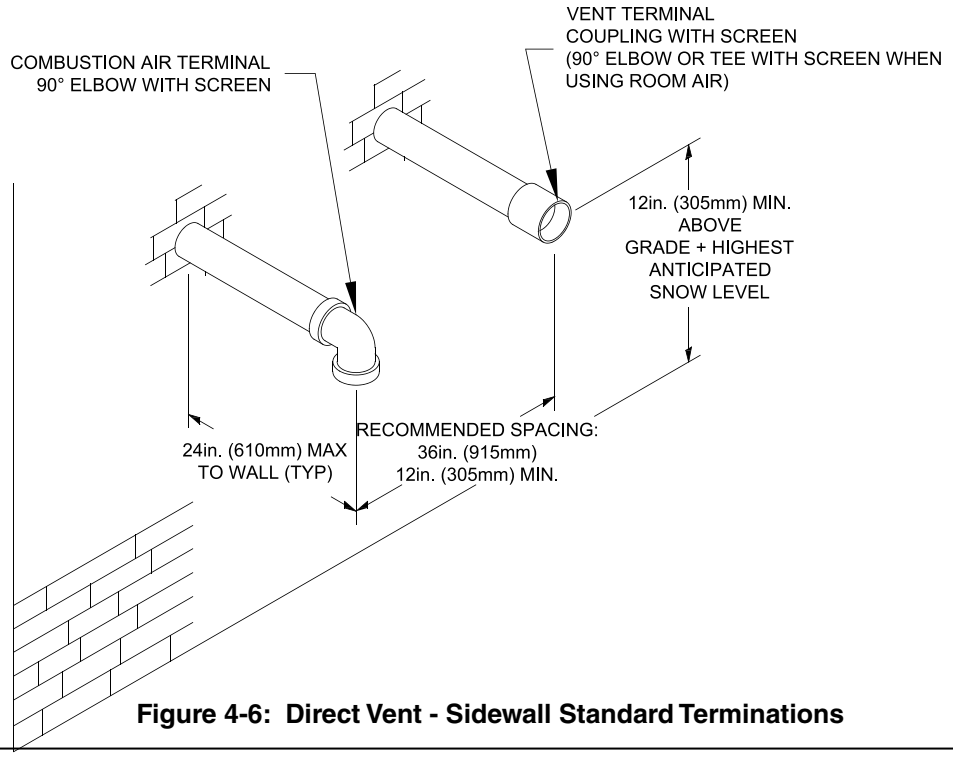


Figure 4-6: Direct Vent - Sidewall Standard Terminations

4 Venting *(continued)*

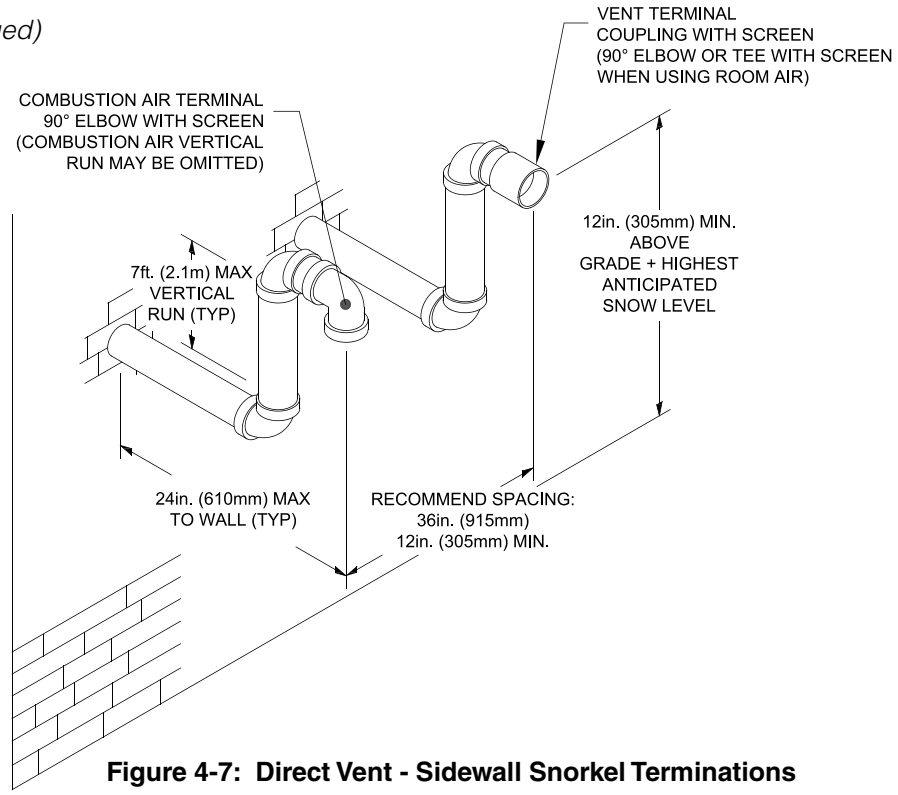


Figure 4-7: Direct Vent - Sidewall Snorkel Terminations

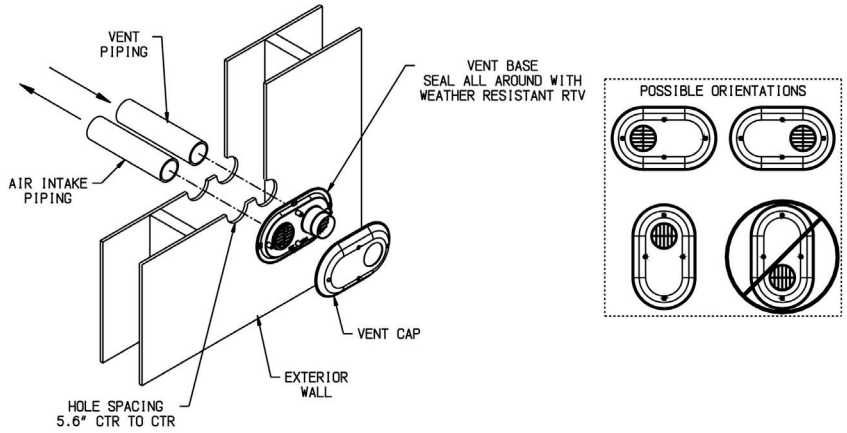


Figure 4-8: Direct Vent - Sidewall Low Profile Termination

nuisance shutdowns. If not, boiler may be installed with roof vent terminal and sidewall combustion air terminal.

iii. When installed on the same wall, locate vent terminal at same height or higher than combustion air terminal.

c. Locate bottom of vent and combustion air terminals at least 12 in. (300 mm) [18 in. (460 mm) in Canada] above the normal snow line and at least 12 in. (300 mm) above grade level.

d. Locate vent and combustion air terminals at least 12 in. (300 mm) from any door, window, or gravity inlet into the building.

e. Do not install vent terminal directly above windows or doors.

f. Locate bottom of vent terminal at least 3 ft. (900 mm)above any forced air inlet located within 10 ft. (3.0 m).

g. If window and/or air inlet is within 4 ft. (1.2 m)of an inside corner, maintain at least 6 ft. (1.8 m)spacing between terminal and adjoining wall of inside corner.

h. Locate bottom of vent terminal at least 7 ft. (2.1 m) above a public walkway.

4 Venting *(continued)*

i. Maintain minimum clearance of at least 4 ft. (1.2 m) [3 ft. (900 mm) in Canada] horizontally between vent terminal and gas meters, electric meters, regulators, and relief equipment. Do not install vent terminal above or below this equipment.

j. Do not locate the vent terminal under decks or similar structures.

k. Top of terminal must be at least 24 in. (600 mm) below ventilated eves, soffits, and other overhangs. In no case may the overhang exceed 48 in. (1,200 mm). Where permitted by the authority having jurisdiction and local experience, the terminal may be located closer to unventilated soffits. The minimum vertical separation depends upon the depth of the soffit. See Figure 4-5 for details.

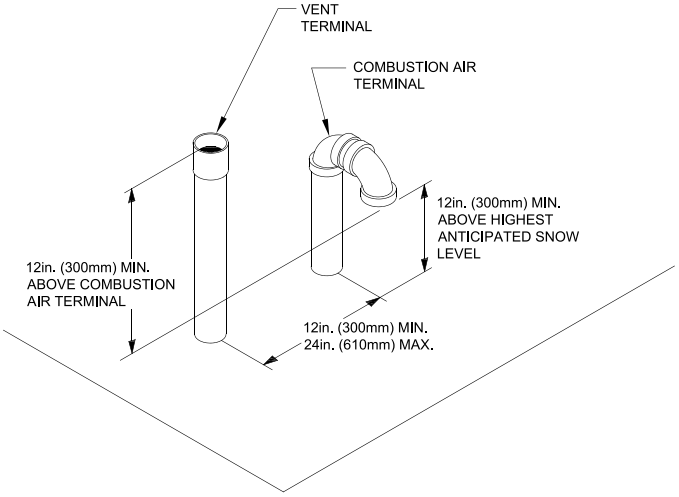


Figure 4-9: Direct Vent - Vertical Terminations

l. Maintain minimum 12 in. (300 mm) horizontal spacing between vent terminal and a building corner.

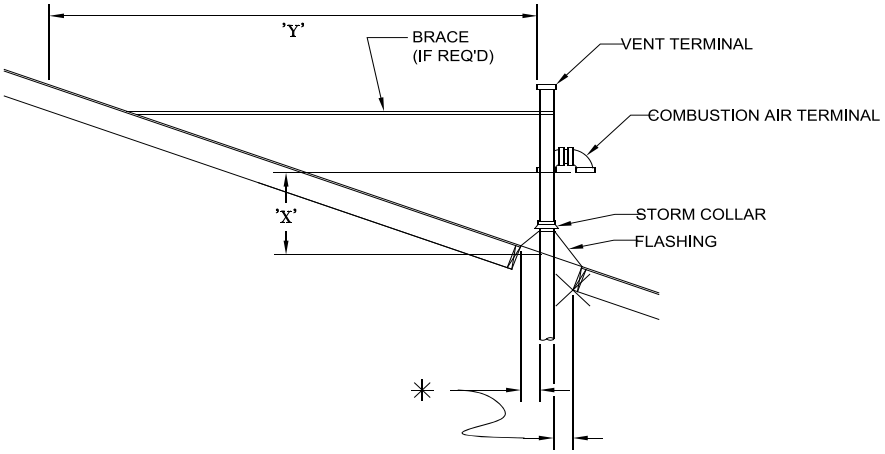
m. Under certain conditions, water in the flue gas may condense, and possibly freeze, on objects around the terminal including on the structure itself. If these objects are subject to damage by flue gas condensate, they should be moved or protected.

n. If possible, install the vent and combustion air terminals on a wall away from the prevailing wind. Reliable operation of this boiler cannot be guaranteed if terminals are subjected to winds in excess of 40 mph (64 km/hr).

o. Do not locate combustion air terminal in areas that might contain combustion air contaminates, such as near swimming pools.

p. For multiple boiler installations with horizontal wall terminals, maintain minimum 12 in. (300 mm) horizontal distance between adjacent boiler vent terminals. Maintaining greater spacing is recommended to avoid frost damage to building surfaces where vent terminations are placed.

q. For multiple boiler installations with vertical roof terminals, maintain minimum 12 in. (300 mm) horizontal distance between adjacent boiler vent terminals.



✳ VENT PIPE MINIMUM CLEARANCE TO COMBUSTIBLE MATERIAL IS 1in. (25mm). COMBUSTION AIR PIPE MINIMUM CLEARANCE TO COMBUSTIBLE MATERIAL IS ZERO.

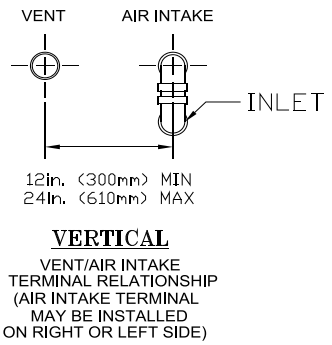


Figure 4-10: Direct Vent - Vertical Terminations with Sloped Roof

Extend vent/combustion air piping to maintain minimum vertical ('X') and minimum horizontal ('Y') distance of 12 in. (300 mm) [18 in. (460 mm) Canada] from roof surface. Allow additional vertical ('X') distance for expected snow accumulation.

4 Venting *(continued)*

B. CPVC/PVC Venting

⚠ WARNING

Asphyxiation Hazard.

- Failure to follow these instructions could cause products of combustion to enter the building, resulting in severe property damage, personal injury, or death.
- Use all CPVC vent components (supplied with boiler) for near-boiler vent piping before transitioning to Schedule 40 PVC pipe (ASTM 2665) components for remainder of vent system.
- Use CPVC vent components within any interior space where air cannot circulate freely, including through vertical or horizontal chase ways, inside a stud wall, in closets, and through wall penetrations.
- The use of cellular core PVC (ASTM F891), cellular core CPVC or Radel (polyphenolsulfone) is prohibited.
- All condensate that forms in the vent must be able to drain back to the boiler.

NOTICE: Do not exceed maximum vent/combustion air system length. Refer to "2. Vent/Combustion Air Piping" under "A. General Guidelines" of this section for maximum vent/combustion air system length.
Use only vent and combustion air terminals and terminal locations shown in "3. Vent/Combustion Air Terminals" under "A. General Guidelines" of this section.

1. Components
   a. See Table 4-11 for CPVC/PVC vent and combustion air components included with boiler.
   b. See Table 4-12 for CPVC/PVC installer provided vent and combustion air components required for optional horizontal snorkel terminals shown in Figure 4-7.
   c. See Table 4-13 for installer provided Ipex Low Profile Vent Termination Kits.
   d. See Table 4-14 for CPVC/PVC installer provided vent and combustion air components required for optional vertical roof terminals shown in Figure 4-9.
2. Field Installation of CPVC/PP/SS Vent Connector

   Refer to Figure 4-15 and following steps:
   a. Position the vent connector and gasket onto boiler rear panel and insert vent connector into heat exchanger vent outlet.
   b. Align vent connector plate and gasket clearance holes with rear panel engagement holes. Be sure combustion sample port is on left side looking at rear of boiler. Then, secure the connector and gasket to the panel with four mounting screws.
3. Near-Boiler Vent/Combustion Air Piping

Refer to Figure 4-16 and the following Steps:

   a. Apply supplied dielectric grease to gasket inside vent connector. The grease will prevent gasket rupture when inserting vent pipe and gasket deterioration due to condensate exposure.
   b. Install provided Schedule 40 x 30 in. (760 mm) long CPVC pipe into the vent section of the connector with a slight twisting motion and secure by tightening the clamp.
   c. All CPVC vent components supplied with boiler inside vent carton [Schedule 40 x 30 in. (760 mm) long CPVC pipe and Schedule 80 CPVC 90° Elbow] must be used for near-boiler piping before transitioning to Schedule 40 PVC (ASTM 2665) pipe components for remainder of vent system. The 30 in. (760 mm) long CPVC straight pipe may be cut to accommodate desired vent configuration provided both pieces are used in conjunction with CPVC 90° Elbow before any PVC components are used. Ensure that the CPVC 90° Elbow is the first elbow used in the vent system as it exits the boiler.
   d. Apply PVC primer and cement and insert Schedule 40 PVC combustion air pipe (installer provided) into the combustion air connector with a slight twisting motion.
4. System Assembly

⚠ WARNING

Asphyxiation Hazard.

CPVC/PVC vent piping and fittings rely on glued joints for proper sealing. Follow all manufacturer instructions and warnings when preparing pipe ends for joining and using the primer and the cement.

   a. Plan venting system to avoid possible contact with plumbing or electrical wires. Start at vent connector at boiler and work towards vent termination.

4 Venting *(continued)*

⚠ WARNING

Asphyxiation Hazard.

Apply supplied dielectric grease to gasket inside vent section of vent connector. Failure to apply the grease could result in flue gas leaks from gasket rupture during vent pipe installation or gasket deterioration due to condensate exposure.

Table 4-11: CPVC/PVC Vent & Air Intake Components Included With Boiler

Vent & Air Intake Components	Quantity	
	Models APX425C & APX525C Standard 4 in. Intake/4 in. Vent Kit includes	Models APX625C, APX725C & APX825C Standard 4 in. Intake/6 in. Vent Kit includes
Schedule 40 PVC Coupling	1	1
Schedule 40 PVC 90° Elbow	1	1
Stainless Steel Screen	2	2
30 in. Schedule 40 CPVC Pipe	1	1
Schedule 80 CPVC 90° Elbow	1	1

Table 4-12: CPVC/PVC Vent & Air Intake Components (Installer Provided) required for Optional Horizontal Snorkel Termination

Vent Components	Quantity	
	APX425C & APX525C Horizontal (Snorkel) 4 in. Intake/4 in. Vent	APX625C, APX725C & APX825C Horizontal (Snorkel) 4 in. Intake/6 in. Vent
Schedule 40 PVC Pipe x up to 7 ft. (2.1 m) max. vertical run	2	2
Schedule 40 PVC 90° Elbow	4	4
Schedule 40 PVC Pipe x 6 in. (150 mm) min. horizontal run	2	1
Schedule 40 PVC Pipe x 9 in. (230 mm) min. horizontal run	N/A	1

Table 4-13: Components Required for Optional Ipex Low Profile Sidewall Termination

Description	Ipex Part Number	Thermal Solutions Part Number	Applicable to Boiler Sizes
3 in. Low Profile Termination Kit	196985	106415-03	425 (reduced dia.) 525 (reduced dia.)
4 in. Low Profile termination Kit	196986	106415-04	425 (standard dia.) 525 (standard dia.) 625 (reduced dia.) 725 (reduced dia.) 825 (reduced dia.)

Table 4-14: CPVC/PVC Vent & Air Intake Components (Installer Provided) required for Optional Vertical Roof Termination

Vent Components	Quantity	
	APX425C & APX525C Vertical (Roof) Termination, 4 in. Intake/4 in. Vent	APX625C, APX725C & APX825C Vertical (Roof) Termination, 4 in. Intake/6 in. Vent
Schedule 40 PVC Coupler	1	1
Schedule 40 PVC 90° Elbow	2	2
Schedule 40 CPVC Pipe x 6 in. (150 mm) min. horizontal run	1	1

4 Venting *(continued)*

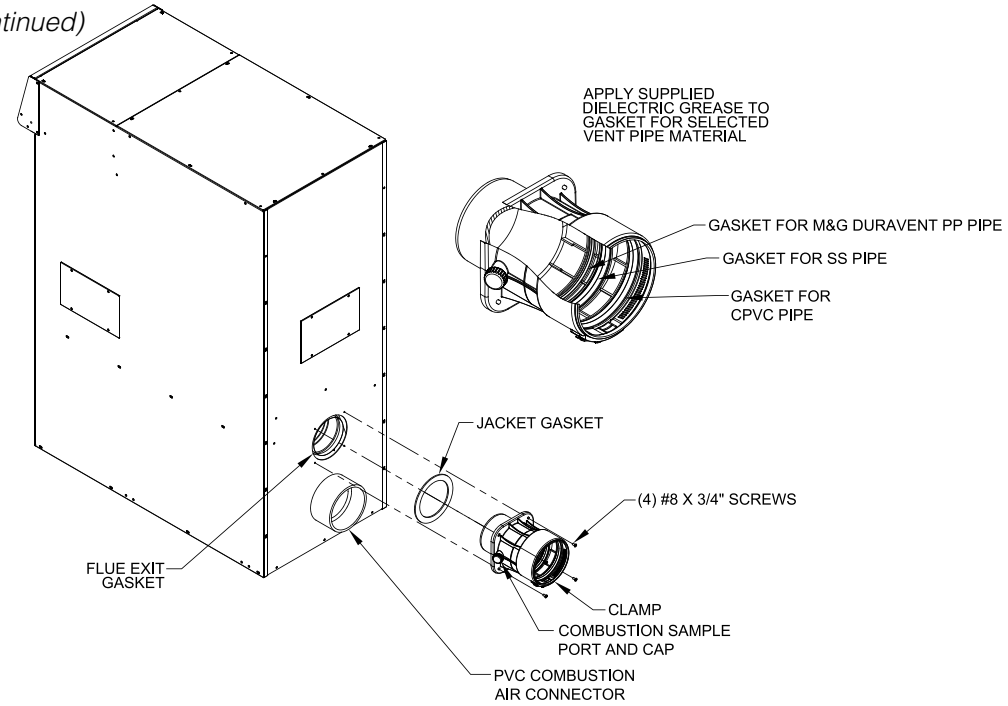


Figure 4-15: Field Installation CPVC/PP/SS Vent Connector

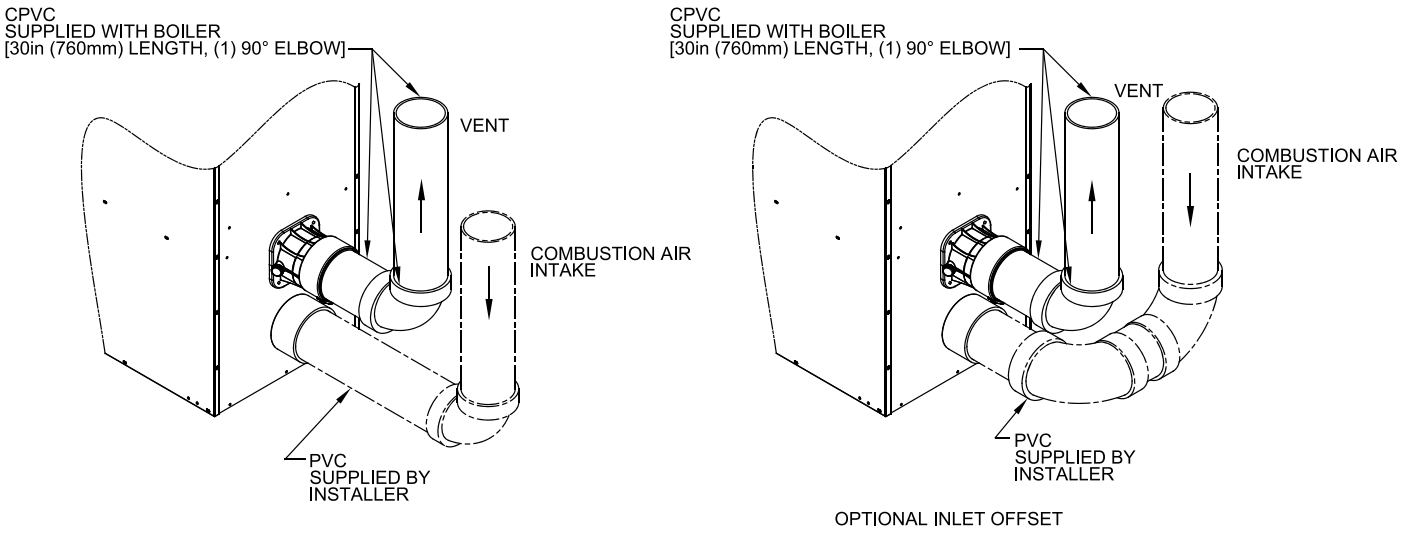


Figure 4-16: Near-Boiler Vent/Combustion Air Piping

b. Design the vent system to allow 3/8 in. (9.5 mm) of thermal expansion per 10 ft. (3.0 m) of CPVC/PVC pipe. Runs of 20 ft. (6.1 m) or longer that are restrained at both ends must use an offset or expansion loop. Refer to Figure 4-18 and Table 4-17.

c. All CPVC/PVC vent and combustion air pipe joints must be cleaned with primer and glued with cement. Follow all manufacturer instructions and warnings when preparing pipe ends for joining and using the primer and the cement.

5. Horizontal Sidewall Termination

   a. Standard Two-Pipe Termination

      See Figure 4-6.

i. Vent Piping

<u>Running PVC vent pipe inside Enclosures and through Walls</u>:

- PVC vent pipe must be installed in such way as to permit adequate air circulation around the outside of the pipe to prevent internal wall temperature rising above ANSI Z21.13 standard specified limit.
- Do not enclose PVC venting. Use higher temperature rated CPVC pipe in enclosed spaces or to penetrate combustible or non-combustible walls.

4 Venting *(continued)*

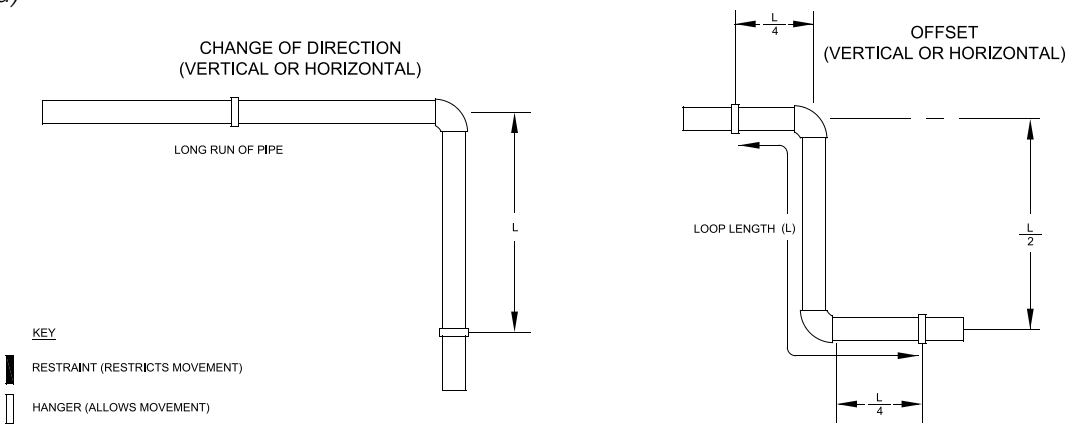


Table 4-17: Expansion Loop Lengths

Nominal Pipe Dia. (In.)	Length of Straight Run ft.	Length of Straight Run m	Loop Length "L" in.	Loop Length "L" mm
3	20	6.1	53	1350
	30	9.1	65	1650
	40	12	75	1900
	50	15	84	2130
	60	18	92	2340
4	20	6.1	60	1520
	30	9.1	74	1880
	40	12	85	2159
	50	15	95	2413
	60	18	104	2642
6	20	6.1	73	1850
	30	9.1	90	2290
	40	12	103	2620
	50	15	116	2950
	60	18	127	3230

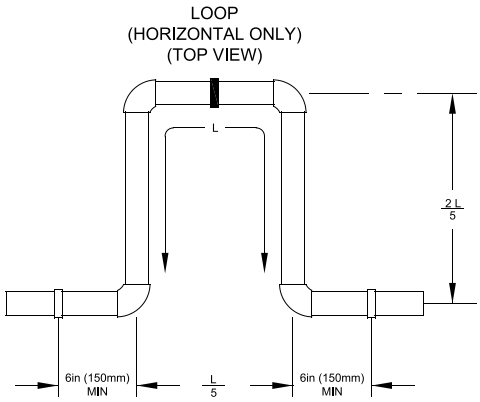


Figure 4-18: CPVC/PVC Expansion Loop and Offset

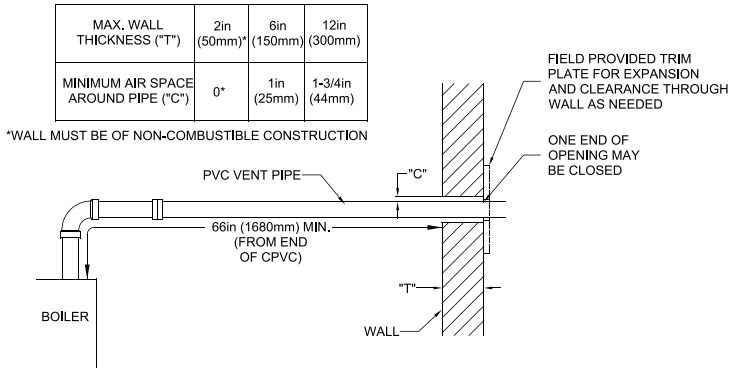


Figure 4-19: Wall Penetration Clearances for PVC Vent Pipe

- PVC vent pipe may not be used to penetrate combustible or non-combustible walls unless all following three conditions are met simultaneously (see Figure 4-19):
  - The wall penetration is at least 66 in. (1680 mm) from the boiler as measured along the vent
  - The wall is 12 in. (300 mm) thick or less
  - An air space of at least of that shown in Figure 4-19 is maintained around outside of the vent pipe to provide air circulation
- If above three conditions cannot be met simultaneously when penetrating a combustible wall, use CPVC pipe for wall penetration.
- Size and cut wall opening such that a minimal clearance is obtained and to allow easy insertion of vent pipe.

  Wall thimbles for CPVC/PVC pipe are available from Thermal Solutions: P/N's 102180-01 (3 in.), 102181-01 (4 in.), 103419-01(6 in.).
- Apply sealant between vent pipe and wall opening to provide weather-tight seal. Sealant should not restrain the expansion of the vent pipe.
- Install contractor provided optional trim plate on wall outside surface to cover wall opening (see Figure 4-19).
- Secure trim plate to wall with nails or screws and seal ID and plate OD or perimeter with sealant material.

4 Venting *(continued)*

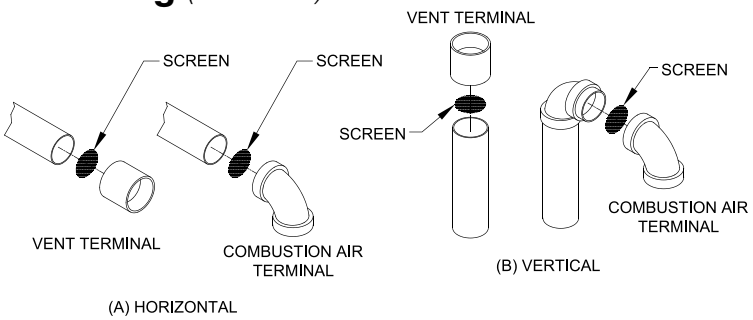


Figure 4-20: Screen Installation

- Install screen and vent terminal (supplied with boiler). See Figure 4-20 for appropriate configuration details.

NOTICE: Methods of securing and sealing terminals to the outside wall must not restrain the thermal expansion of the vent pipe.

ii. Combustion Air Piping

- Size combustion air pipe wall penetration opening to allow easy insertion of the pipe.
- Install screen and combustion air terminal (supplied with boiler). See Figure 4-20 for appropriate configuration details.
- Apply sealant between combustion air pipe and wall opening to provide weather-tight seal.

b. Optional Two-Pipe Snorkel Termination

See Figure 4-7.

This installation will allow a maximum of 7 ft. (2.1 m) vertical exterior run of the vent/combustion air piping to be installed on the CPVC/PVC horizontal venting application.

NOTICE: Exterior run to be included in equivalent vent/combustion air lengths.

i. Vent Piping

- After penetrating wall, install a Schedule 40 PVC 90° elbow so that the elbow leg is in the up direction.
- Install maximum vertical run of 7 ft. (2.1 m) of Schedule 40 PVC vent pipe. See Figure 4-8.
- At top of vent pipe length install another PVC 90° elbow so that elbow leg is opposite the building's exterior surface.
- Install screen and vent terminal (supplied with boiler), see Figure 4-20 for appropriate configuration.
- Brace exterior piping if required.

ii. Combustion Air Piping

- After penetrating wall, install a Schedule 40 PVC 90° elbow so that elbow leg is in the up direction.
- Install maximum vertical run of 7 ft. (2.1 m) of Schedule 40 PVC vent pipe. See Figure 4-7.
- At top of air pipe length install another PVC 90° elbow so that elbow leg is opposite the building's exterior surface.
- Install screen and combustion air terminal (supplied with boiler). See Figure 4-20 for appropriate configuration.
- Brace exterior piping if required.

6. Vertical Roof Termination

a. Standard Two-Pipe Termination

See Figures 4-9 and 4-10.

i. Vent Piping

- Install fire stops where vent passes through floors, ceilings or framed walls. The fire stop must close the opening between the vent pipe and the structure.
- Whenever possible, install vent straight through the roof. Refer to Figures 4-9 and 4-10.
  - Size roof opening to maintain minimum clearance of 1 in. (25 mm) from combustible materials.
  - Extend vent pipe to maintain minimum vertical and horizontal distance of 12 in. (300 mm) from roof surface. Allow additional vertical distance for expected snow accumulation. Provide brace as required.

NOTICE: Vertical venting and combustion air roof penetrations (where applicable) require the use of roof flashing and storm collar, which are not supplied with boiler, to prevent moisture from entering the structure.

  - Install storm collar on vent pipe immediately above flashing. Apply Dow Corning Silastic 732 RTV Sealant or equivalent between vent pipe and storm collar to provide weather-tight seal.

- Install screen and vent terminal (supplied with boiler). See Figure 4-20 for appropriate configuration.
- Brace exterior piping if required.

4 Venting *(continued)*

ii. Combustion Air Piping

- If possible, locate combustion air termination on the same roof location as the vent termination to prevent nuisance boiler shutdowns. Combustion air terminal may be installed closer to roof than vent. Alternatively, boiler may be installed with vertical roof vent terminal and sidewall combustion air terminal.
- Size roof opening to allow easy insertion of combustion air piping and allow proper installation of flashing and storm collar to prevent moisture from entering the structure.
  - Use appropriately designed vent flashing when passing through roofs. Follow flashing manufacturers' instructions for installation procedures.
  - Extend combustion air pipe to maintain minimum vertical and horizontal distance of 12 in. (300 mm) from roof surface. Allow additional vertical distance for expected snow accumulation. Provide brace as required.
  - Install storm collar on combustion air pipe immediately above flashing. Apply Dow Corning Silastic 732 RTV Sealant or equivalent between combustion air pipe and storm collar to provide weather-tight seal.
- Install screen and combustion air terminal (supplied with boiler). See Figure 4-20 for appropriate configuration.
- Brace exterior piping if required.

C. Polypropylene Venting

***NOTICE*:** Do not exceed maximum vent/combustion air system length. Refer to "2. Vent/Combustion Air Piping" under "A. General Guidelines" of this section for maximum vent/combustion air system length.
Use only vent and combustion air terminals and terminal locations shown in "3. Vent/Combustion Air Terminals" under "A. General Guidelines" of this section.

⚠ WARNING

Asphyxiation Hazard.

Apply supplied dielectric grease to gasket inside vent section of vent connector. Failure to apply the grease could result in flue gas leaks from gasket rupture during vent pipe installation or gasket deterioration due to condensate exposure.

1. Components
   a. Listed polypropylene vent system manufacturers are shown in Table 4-21 It is the responsibility of the installing contractor to procure polypropylene vent system pipe and related components.
      i. All listed polypropylene vent system manufacturers comply with the requirements of ULC-S636-08 'Standard for Type BH Gas Venting Systems'.
      ii. Centrotherm Eco Systems InnoFlue SW Rigid Vent and Flex Flexible Vent, and Z-Flex Z-Dens Single Wall Rigid Vent and Flexible Vent comply with the requirements of UL 1738 'Standard for Safety for Venting Systems'.
   b. See Table 4-22 for specific M&G Duravent components.
   c. See Table 4-23 for specific Centrotherm Eco Systems components.
   d. See Table 4-24 for specific Z-Flex Z-Dens components.
2. Field Installation of Polypropylene Adapters
   a. Vent Connector (see Figure 4-25)
      i. No adapter is required for M&G DuraVent PolyPro vent pipe unless vent diameter is reduced per Table 4-2. See Table 4-22 for M&G DuraVent boiler adapters for reduced vent diameter. An adapter is always required for Centrotherm InnoFlue vent pipe and Z-Flex Z-Dens vent pipe. See Table 4-23 for Centrotherm InnoFlue boiler adapters and Table 4-24 for Z-Flex Z-Dens boiler adapters.
      ii. Install CPVC/PP/SS vent connector. Follow instructions in "2. Field Installation of CPVC/PP/SS Vent Connector" under "B. CPVC/PVC Venting."
      iii. Apply provided dielectric grease to gasket inside vent connector that will be in contact with adapter.

4 Venting *(continued)*

iv. Push and twist adapter into vent system connector until adapter bottoms out.

v. Tighten clamp to secure adapter in CPVC/PP/SS vent connector.

b. Combustion Air Connector (see Figure 4-26)

i. No adapter is required if using PVC combustion air pipe. An adapter is required for both M&G DuraVent PolyPro (see Table 4-22) Centrotherm InnoFlue (see Table 4-23) and Z-Flex Z-Dens (see Table 4-26) combustion air pipes.

ii. Insert adapter into combustion air connector. Adapter has gasket to seal against combustion air connector.

3. System Assembly

⚠ WARNING

Asphyxiation Hazard.

- Vent systems made by listed PP vent system manufacturers rely on gaskets for proper sealing. When these vent systems are used, take the following precautions:
- Make sure that gasket is in position and undamaged in the female end of the pipe.
- Make sure that both the male and female pipes are free of damage prior to assembly.
- Only cut vent pipe as permitted by the vent manufacturer in accordance with their instructions. When pipe is cut, cut end must be square and carefully de-burred prior to assembly.
- Use locking band clamps at all vent pipe joints.

a. Plan venting system to avoid possible contact with plumbing or electrical wires. Start at vent connector at boiler and work towards vent termination.

b. Follow all manufacturer instructions and warnings when preparing pipe ends for joining and when assembling the vent/combustion air system.

c. Use locking band clamps at all vent pipe joints. See Figure 4-27 or Figure 4-28 for locking band clamp installation.

NOTICE: The venting system must be free to expand and contract and supported in accordance with installation instructions included by the original listed polypropylene venting component manufacturers, whichever applicable. Polypropylene pipe sections must be disengaged 1/4 to 5/8 in. (6 mm to 16 mm) per joint to allow for thermal expansion.

4. Terminations

a. For standard horizontal sidewall terminations, see Figures 4-6 and 4-7. For vertical roof terminations, see Figures 4-9 and 4-10. Use UV resistant components listed in Tables 4-22, 4-23 and 4-24.

b. If using M&G duravent PolyPro pipe, install screens per Figure 4-20. Remove gasket inside termination and install screen in place of gasket. If using Centrotherm InnoFlue or Z-Flex Z-Dens end pipe, screen fits onto end of pipe.

c. For low profile sidewall termination, see Figure 4-8. Use low profile termination listed in Table 4-13 and adapter kit listed in Tables 4-22, 4-23 and 4-24.

5. Running Flexible Polypropylene Vent (Liner) Through Unused Chimney Chase

⚠ WARNING

Asphyxiation Hazard.

Flexible polypropylene vent must be installed only in an UNUSED chimney. A chimney, either single or multiple flue type, is considered UNUSED when none of the flues is being used for any appliance venting. Where one of the multiple flues is being used for an appliance venting, the flexible vent installation is not permitted through any of adjacent flues.

Table 4-21: Listed Polypropylene Vent System Manufacturers

Make	Model
M&G/DuraVent	PolyPro Single Wall Rigid Vent PolyPro Flex Flexible Vent (APX425C and APX525C)
Centrotherm Eco Systems	InnoFlue SW Rigid Vent Flex Flexible Vent (APX425C and APX525C)
Z-Flex Z-Dens	Z-Dens Single Wall Rigid Vent Z-Dens Flexible Vent (APX425C and APX525C)

***NOTICE*:** Pressure drop for flexible polypropylene liner is 20% greater than from rigid pipe. Multiply measured flexible polypropylene liner length by 1.2 to obtain equivalent length.
Maximum equivalent length of flexible polypropylene liner is 48 ft. (14.6 m).

Table 4-22: M&G DuraVent PolyPro Polypropylene Vent/Combustion Air System Components

Boiler Model	Nominal Pipe Diameter	Pipe Joint Locking Band Clamp	Combustion Air			Vent			Ipex Low Profile Termination Adapter Kit: Pipe Adapter & Wall Plate
			Boiler Adapter	Sidewall Termination: UV Resistant 90°Elbow w/Screen	Roof Termination: (2) UV Resistant 90° Elbows w/Screen	Boiler Adapter	Sidewall* or Roof Termination: UV Resistant Straight Pipe w/ Screen	Flex Chimney Lining Kit	
APX425C (reduced dia. vent) APX525C (reduced dia. vent)	3 in. (80 mm)	3PPS-LB2 or 3PPS-LBC	4PPS-ADL with 4PPS-R3L	Elbow: 3PPS-E90BL Screen: 3PPS-BG	Elbow: 3PPS-E90BL Screen: 3PPS-BG	4PPS-R3L	Pipe: 3PPS-12BL Screen: 3PPS-BG	3PPS-FKL	3PPS-HLKL
APX425C (standard dia. vent) APX525C (standard dia. vent) APX625C (reduced dia. vent) APX725C (reduced dia. vent) APX825C (reduced dia. vent)	4 in. (100 mm)	4PPS-LB2 or 4PPS-LBC	4PPS-ADL	Elbow: 4PPS-E90BL Screen: 4PPS-BG	Elbow: 4PPS-E90BL Screen: 4PPS-BG	APX425C & APX525C: No Adapter Required; APX625C, APX725C, APX825C: 6PPS-R5L with 5PPS-R4L	Pipe: 4PPS-12BL Screen: 4PPS-BG	4PPS-FKL	4PPS-HLKL
APX625C (standard dia. vent) APX725C (standard dia. vent) APX825C (standard dia. vent)	6 in. (150 mm)	6PPS-LB2 or 6PPS-LBC	N/A	N/A	N/A	No Adapter Needed	Pipe: 6PPS-12BL Screen: 6PPS-BG	N/A	N/A

*** Note**: When using room air for combustion, use UV resistant 90° elbow or tee for sidewall vent termination. UV resistant 90° elbow part numbers: 3PPS-E90BL(3 in.), 4PPS-E90BL (4 in.), 6PPS-E90BL (6 in.).
UV resistant tee part numbers: 3PPS-TBL (3 in.), 4PPS-TBL (4 in.), 6PPS-TTBL (6 in.).

Table 4-23: Listed Polypropylene Pipe, Fittings and Terminations - Centrotherm Eco

Boiler Model	Nominal Pipe Diameter	Pipe Joint Locking Band Clamp	Combustion Air			Vent			Ipex Low Profile Adapter Kit: Pipe Adapter & Wall Plate
			Boiler Adapter	Sidewall Termination: UV Resistant 90° Elbow w/Screen	Roof Termination: (2) UV Resistant 90° Elbows w/Screen	Boiler Adapter	Sidewall* or Roof Termination: UV Resistant Straight Pipe w/Screen	Flex Chimney Lining Kit	
APX425C (standard dia. vent) APX525C (standard dia. vent) APX625C (reduced dia. vent) APX725C (reduced dia. vent) APX825C (reduced dia. vent)	3 in. (80 mm)	IANS03	ISAGL0404 with ISRD0403	Elbow: ISELL0387UV Screen: IASPP03	Elbow: ISELL0387UV Screen: IASPP03	ISAAL0404 and ISRD0403	Pipe: ISEP03 or ISEP0339 Screen: IASPP03	IFCK0325 or IFCK0335	ISLTK03
APX625C (reduced dia. vent) APX725C (reduced dia. vent) APX825C (reduced dia. vent)	4 in. (110 mm)	IANS04	ISAGL0404	Elbow: ISEL0487UV Screen: IASPP04	Elbow: ISEL0487UV Screen: IASPP04	APX425C & APX525C: ISAAL0404; APX625C, APX725C & APX825C: ISAAL0606 with ISRD0604	Pipe: ISEP04 or ISEP0439 Screen: IASPP04	IFCK0425 or IFCK0435	ISLTK04
APX625C (standard dia. vent) APX725C (standard dia. vent) APX825C (standard dia. vent)	6 in. (160 mm)	IANS06 or IADHC0606	N/A	N/A	N/A	ISAALE0606	Pipe: ISEP06 or ISEP0639 Screen: IASPP06	N/A	ISLTK06

*** Note**: When using room air for combustion, use UV resistant 90° elbow or tee for sidewall vent termination. UV resistant 90° elbow part numbers: ISEL0387UV (3 in.), ISEL0487UV (4 in.), ISEL0687UV (6 in.).
UV resistant tee part numbers: ISTT0320 (3 in.), ISTT0420 (4 in.), ISTT0620 (6 in.).
See Centrotherm InnoFlue literature for other required component part numbers such as straight pipe, elbows, firestops, and vent supports.

4 Venting *(continued)*

Table 4-24: Listed Polypropylene Pipe, Fittings and Terminations - Z-Flex Z-Dens

Boiler Model	Nominal Pipe Diameter	Pipe Joint Locking Band Clamp	Combustion Air: Boiler Adapter	Combustion Air: Sidewall Termination: UV Resistant 90° Elbow w/Screen	Combustion Air: Roof Termination: (2) UV Resistant 90° Elbows w/Screen	Vent: Boiler Adapter	Vent: Sidewall * or Roof Termination: UV Resistant Straight Pipe w/Screen	Vent: Flex Chimney Lining Kit	Ipex Low Profile Termination Adapter & Wall Plate
APX425C (reduced dia. vent) APX525C (reduced dia. vent)	3 in. (80 mm)	2ZDLC3	2ZDCPVC4 with 2ZDR43	Elbow: 2ZDE387UV Screen: 2ZDES3	Elbow: 2ZDE387UV Screen: 2ZDES3	2ZD144 with 2ZDR43	Pipe: 2ZDP3(*) UV Screen: 2ZDES3	2ZDFK325 or 2ZDFK335	N/A
APX425C (standard dia. vent) APX525C (standard dia. vent) APX625C (reduced dia. vent) APX725C (reduced dia. vent) APX825C (reduced dia. vent)	4 in. (100 mm)	2ZDLC4	2ZDCPVC4	Elbow: 2ZDE487UV Screen: 2ZDES4	Elbow: 2ZDE487UV Screen: 2ZDES4	2ZD144; APX625C, APX725C, & APX825C: 2ZDCPVCCG6 with 2ZDR65 & 2ZDR54	Pipe: 2ZDP4(*) Screen: 2ZDES4	2ZDFK425 or 2ZDFK435	N/A
APX625C standard dia. vent) APX725C standard dia. vent) APX825C standard dia. vent)	6 in. (150 mm)	2ZDLC6	2ZDCPVC4	Elbow: 2ZDE687 Screen: 2ZDES6	Elbow: 2ZDE687 Screen: 2ZDES6	2ZDCPVCCG6	Pipe: 2ZDP6(*) Screen: 2ZDES6	N/A	N/A

*** Note:** When using room air for combustion, use UV resistant 90° elbow or tee for sidewall vent termination. UV resistant 90° elbow part numbers: 2ZDE387UV (3 in.), 2ZDE487UV (4 in.), 2ZDE687UV (6 in.). UV resistant tee part numbers: 2ZDTT3 (3 in.), 2ZDTT4 (4 in.), 2ZDTT6 (6 in.).
See Z-Flex Z-Dens literature for other required component part numbers such as straight pipe, elbows, firestops and vent supports.
(*) - Pipe Length

a. Models APX425C and APX525C are listed for vertical venting by installing flexible vent in an UNUSED masonry chimney/chase and supplying combustion air through a separate wall or roof combustion air terminal.

b. Refer to Figure 4-29 for details of chimney chase installation.

c. Flexible polypropylene pipe must be treated carefully and stored at temperatures higher than 41°F (5°C).

d. Do not bend or attempt to install flexible pipe if it has been stored at lower ambient temperature without allowing the pipe to warm up to a higher temperature first.

⚠ WARNING

Asphyxiation Hazard.

- Bending or attempting to install flexible pipe if it has been stored at ambient temperature below 41°F (5°C) will cause material to become brittle and lead to cracks, resulting in flue gas leaks.
- Do not install flexible polypropylene pipe at an angle greater than 45 degrees from vertical plane when used for combustion product venting. Failure to do so will result in improper condensate drainage towards the boiler and possible subsequent vent pipe blockage.

e. When flexible polypropylene pipe (liner) is used for combustion product venting, it must not be installed at an angle greater than 45 degrees from vertical plane. This will ensure proper condensate flow back towards the boiler.

f. When flexible polypropylene pipe (liner) is used for combustion air supply to a boiler, the pipe (liner) can be installed in vertical or horizontal position.

g. Follow flexible polypropylene pipe (liner) manufacturer specific installation instructions regarding application/ listing, permits, minimum clearances to combustibles, installation details (proper joint assembly, pipe support and routing, gasket and fitting installation, optional tooling availability/usage, routing through masonry chimney for combustion product venting or, combination of combustion product venting and combustion air supply).

4 Venting *(continued)*

h. When there is a conflict between flexible polypropylene pipe (liner) manufacturer installation instructions and Apex boiler Installation, Operating and Service Instructions, the more restrictive instructions shall govern.

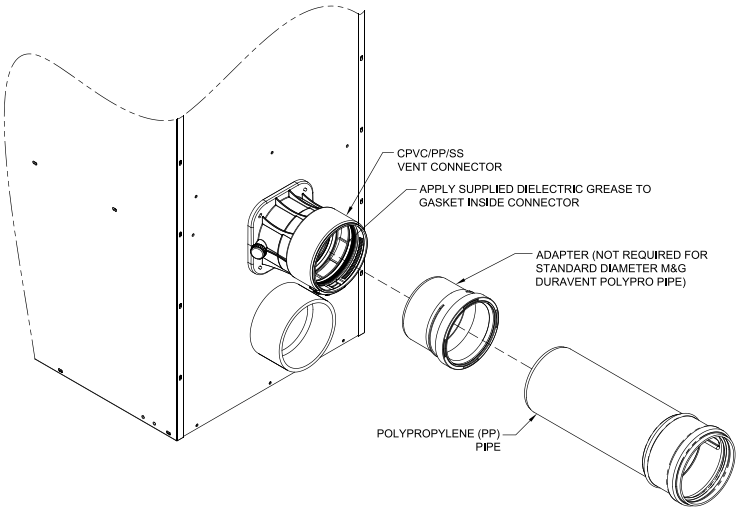


Figure 4-25: Field Installation of Polypropylene Vent Adapter

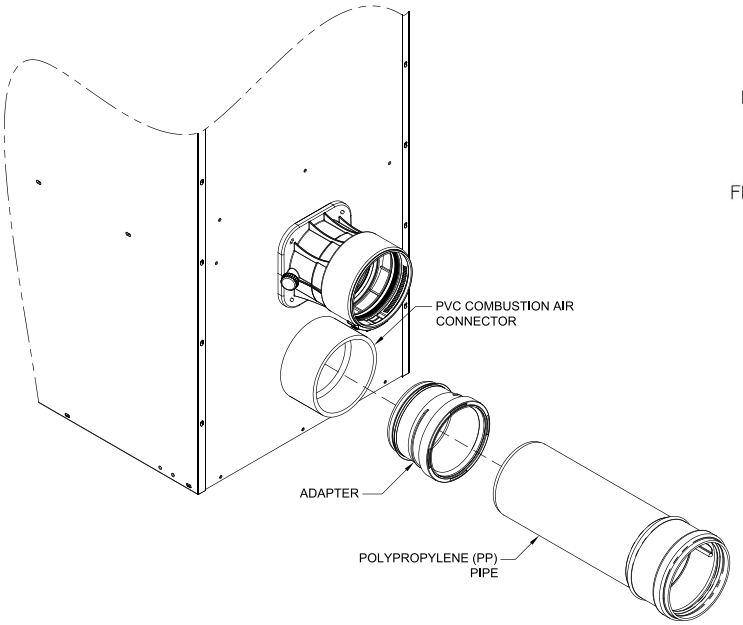


Figure 4-26: Field Installation of Polypropylene Combustion Air Adapter

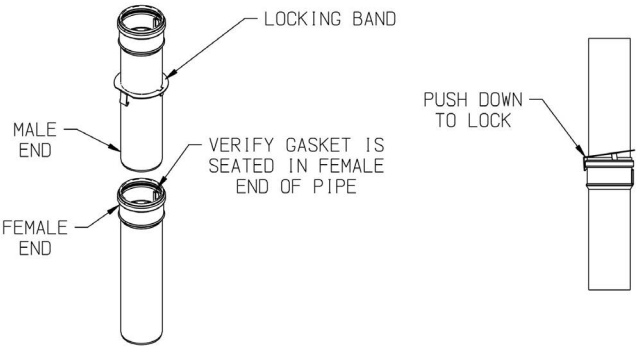


Figure 4-27: Locking Band Clamp Installation, M&G DuraVent or Centrotherm InnoFlue

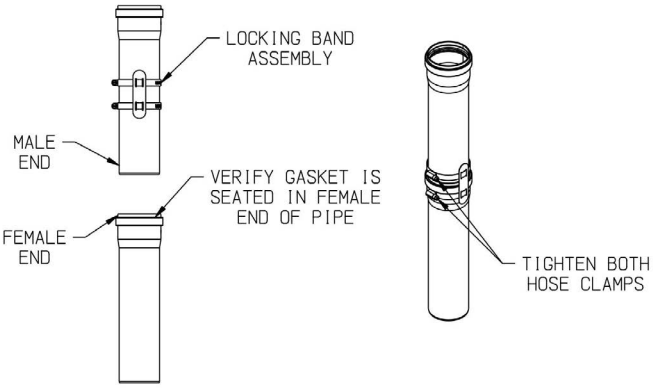
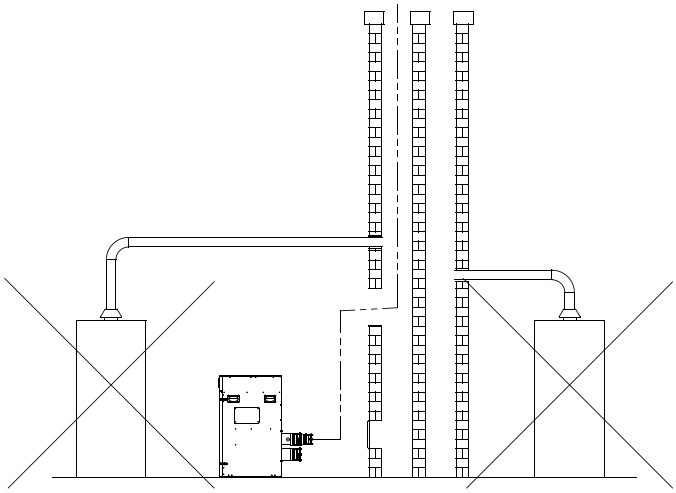


Figure 4-28: Alternate Locking Band Clamp Installation, M&G DuraVent

4 Venting *(continued)*



Venting of Other Appliances (or Fireplace) into Chase or Adjacent Flues Prohibited!

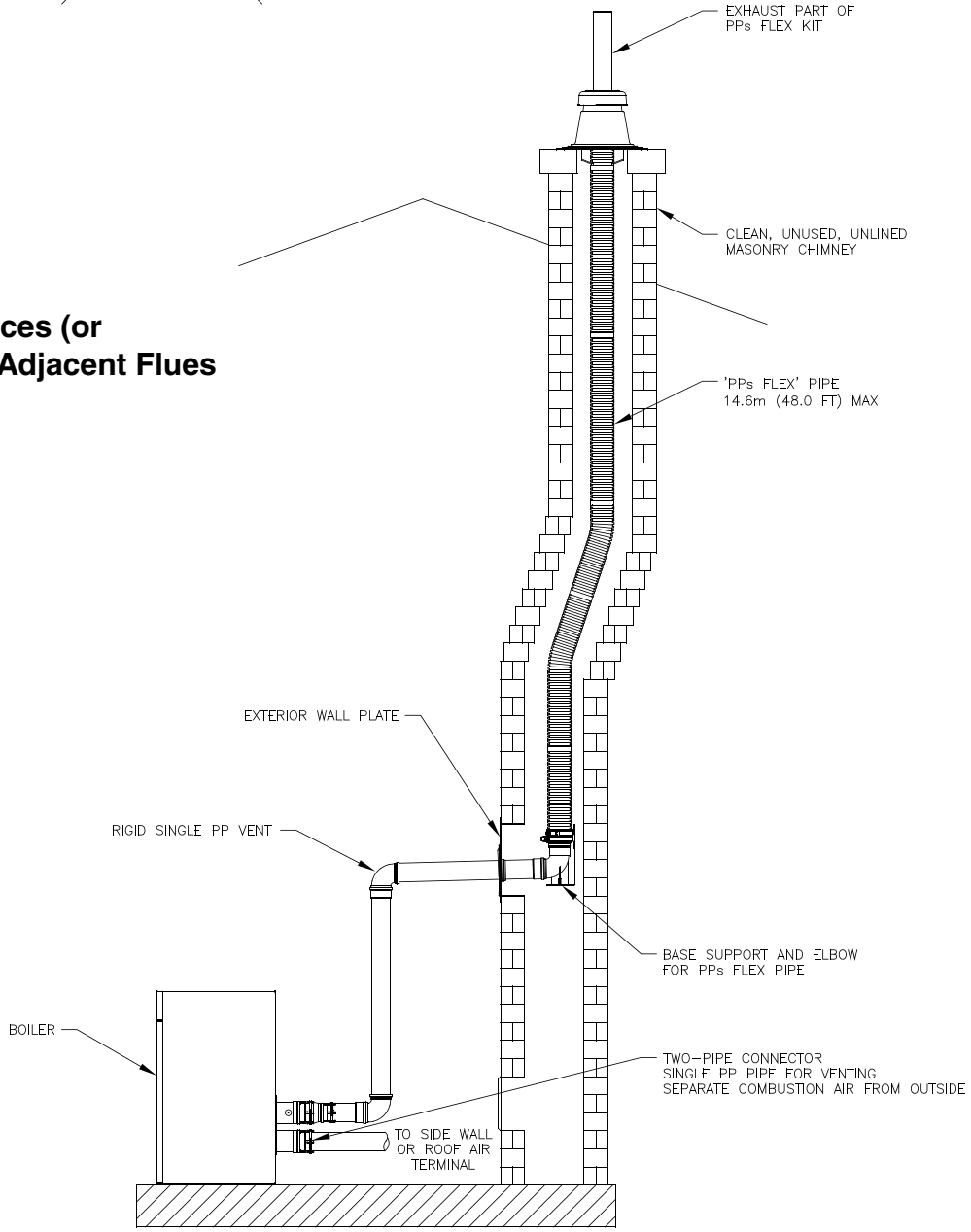


Figure 4-29: Flexible Vent in Masonry Chimney with Separate Combustion Air Intake

4 Venting *(continued)*

D. Stainless Steel Venting

⚠ WARNING

Asphyxiation Hazard.

- Follow these instructions and the installation instructions included by the original stainless steel venting component manufacturers, Heat Fab, M&G/DuraVent or Z-Flex, whichever applicable. Failure to do so could cause products of combustion to enter the building, resulting in severe property damage, personal injury or death. Where a conflict arises between Heat Fab, M&G/DuraVent or Z-Flex instructions and these instructions, the more restrictive instructions shall govern.
  Do not mix vent components from listed manufacturers.
- Examine all components for possible shipping damage prior to installation.
- All condensate that forms in the vent must be able to drain back to the boiler.

NOTICE: Do not exceed maximum vent/combustion air system length. Refer to "2. Vent/Combustion Air Piping" under "A. General Guidelines" in this section for maximum vent/combustion air system length.
Use only vent and combustion air terminals and terminal locations shown in "3. Vent/Combustion Air Terminals" under "A. General Guidelines" of this section.

1. Components
   a. For use on models APX425C and APX525C, Thermal Solutions offers size 4 in. vent pipe and fittings shown in Table 4-30. It is the responsibility of the installing contractor to procure stainless steel vent system pipe and related components.
   b. Alternate listed stainless steel vent system manufacturers and components are shown in Tables 4-31 and 4-32.
   c. Where the use of "silicone" is called for in the following instructions, use GE RTV 106 or equivalent for the vent collar. Seal galvanized combustion air piping sections with any general-purpose silicone sealant such as GE RTV102. Seal PVC combustion air piping sections with PVC cement.
   d. Do not drill holes in vent pipe.
2. Field Installation of Stainless Steel Vent Adapter (see Figure 4-33)
   a. No adapter is required for stainless steel vent pipe unless vent diameter is reduced per Table 4-2. See Table 4-30, 4-31, or 4-32 for adapters for reduced vent diameter.

Table 4-30: Thermal Solutions (Heat Fab) Vent System Components (Stainless Steel, 4 in. only)

Component	Part Number, 4 in. (100 mm)
Boiler Adapter	no adapter required
Straight Pipe, 1 ft. (0.3 m)	100176-01
Straight Pipe, 3 ft. (0.9 m)	100177-01
Straight Pipe, 5 ft. (1.5 m)	100178-01
Straight Pipe, Adjustable 1.06-1.64 ft. (0.3 m to 0.5 m)	100179-01
90° Elbow	100180-01
45° Elbow	100181-01
Horizontal Drain Tee	100182-01
Vertical Drain Tee	100183-01
Single Wall Thimble	100184-01

*** Note**: when using room air for combustion, use tee for sidewall vent termination.
Tee part number: 8116313 (4 in.).

Table 4-31: M&G DuraVent FasNSeal Stainless Steel Vent System Components, Single Wall

Boiler Model	Nominal Pipe Diameter	Boiler Adapter	Sidewall * or Roof Termination: Straight Termination w/Screen	Wall Thimble
APX425C (reduced dia. vent) APX525C (reduced dia. vent)	3 in. (80 mm)	FS0403TR	FSBS3	FSWT3
APX425C (standard dia. vent) APX525C (standard dia. vent) APX625C (reduced dia. vent) APX725C (reduced dia. vent) APX825C (reduced dia. vent)	4 in. (100 mm)	APX425C & APX525C: No Adapter Required; APX625C, APX725C, APX825C: FS0604TR	FSBS4	FSWT4
APX625C (standard dia. vent) APX725C (standard dia. vent) APX825C (reduced dia. vent)	6 in. (150 mm)	No Adapter Required	FSBS6 (23° angle)	FSWT6

Note: When using room air for combustion, use tee for sidewall vent termination. Termination tee part numbers: FSTT3 (3 in.), FSTT4 (4 in.) FSTT6 (6 in.)
See M&G DuraVent FasNSeal literature for other required component part numbers such as straight pipe, elbows, firestops, and vent supports.

4 Venting *(continued)*

Table 4-32: Z-Flex, Z-Vent (SVE Series III, Z-Vent III) Stainless Steel Vent System Components, Single Wall

Boiler Model	Nominal Pipe Diameter	Boiler Adapter	Sidewall * or Roof Termination: Straight Termination w/Screen	Wall Thimble
APX425C (reduced dia. vent) APX525C (reduced dia. vent)	3 in. (80 mm)	2SVSR0403	2SVSTPX03	2SVSWTF03
APX425C (standard dia. vent) APX525C (standard dia. vent) APX625C (reduced dia. vent) APX725C (reduced dia. vent) APX825C (reduced dia. vent)	4 in. (100 mm)	APX425C & APX525C: No Adapter Required; APX625C, APX725C, APX825C: 2SVSR0604	2SVSTPX04	2SVSWTF04
APX625C (standard dia. vent) APX725C (standard dia. vent) APX825C (standard dia. vent)	6 in. (150 mm)	No Adapter Required	2SVSTPX06	2SVSWTF06

*** Note:** When using room air for combustion, use 90° elbow or tee for sidewall vent termination. Termination elbow part numbers: 2SVSTEX0390 (3 in.), 2SVSTEX0490 (4 in.). Termination tee part numbers: 2SVSTTX03 (3 in.), 2SVSTTX04 (4 in.), 2SVSTTX06 (6 in.).
See Z-Flex literature for other required component part numbers such as straight pipe, elbows, firestops, and vent supports.

b. Install CPVC/PP/SS vent connector. Follow instructions in "2. Field Installation of CPVC/PP/SS Vent Connector" under "B. CPVC/PVC Venting."

c. Apply provided dielectric grease to gasket inside vent connector that will be in contact with adapter.

d. Push and twist adapter into vent system connector until adapter bottoms out.

e. Tighten clamp to secure adapter in CPVC/PP/SS vent connector.

3. System Assembly

⚠ WARNING

Asphyxiation Hazard.

- Vent systems made by Heat Fab, M&G / DuraVent and Z-Flex rely on gaskets for proper sealing. When these vent systems are used, take the following precautions:
- Make sure that gasket is in position and undamaged in the female end of the pipe.
- Make sure that both the male and female pipes are free of damage prior to assembly.
- Only cut vent pipe as permitted by the vent manufacturer in accordance with their Instructions. When pipe is cut, cut end must be square and carefully de-burred prior to assembly.

a. Plan venting system to avoid possible contact with plumbing or electrical wires. Start at vent connector at boiler and work towards vent termination.

b. Follow all manufacturer instructions and warnings when preparing pipe ends for joining and when assembling the vent/combustion air system.

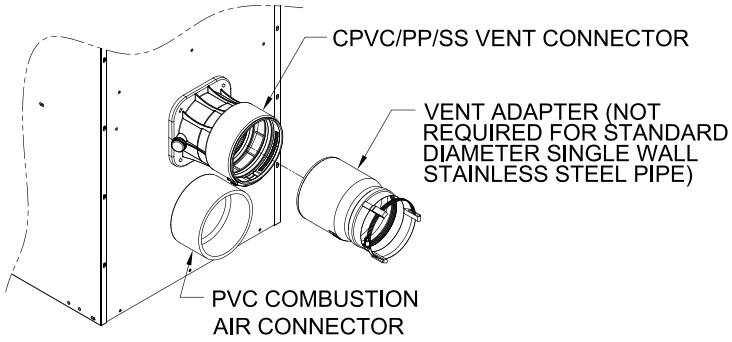


Figure 4-33: Field Installation of Stainless Steel Vent Adapter

NOTICE: The venting system must be free to expand and contract and supported in accordance with installation instructions included by the original stainless steel venting component manufacturers, Heat Fab, M&G / DuraVent or Z-Flex, whichever applicable.

c. On horizontal pipe sections, orient all welded seams at the 12:00 position. Do not place longitudinal welded seams at the bottom of horizontal sections of vent pipe.

d. Assemble the combustion air system using either galvanized or PVC pipe.

i. If PVC piping is used, use PVC cement to assemble the PVC intake system components. See "B. CPVC/PVC Venting" for combustion air pipe installation instructions.

ii. If galvanized piping is used, use at least two sheet metal screws per joint. Seal outside of all joints.

4. Horizontal Sidewall Vent Termination

a. Standard Two-Pipe Termination
See Figure 4-6.

4 Venting *(continued)*

i. Vent Termination

- Use components listed in Table 4-30, 4-31 or 4-32.

NOTICE: The joint between the terminal and the last piece of pipe must be outside of the building.

- Male end of terminal will fit into female end of any of the listed stainless vent systems.
- Apply a heavy bead of silicone to the male end of the terminal before inserting it into the last piece of pipe. Orient the terminal so that the seam in the terminal is at 12:00.
- Smooth the silicone over the seam between the terminal and the last piece of pipe, applying additional silicone if necessary to ensure a tight seal.
- Allow the silicone to cure per the silicone manufacturer's instructions before operating the boiler.

ii. Combustion Air Termination

- Use a 90° elbow directed downward.
- Install a screen in the inlet terminal. Use a screen having 1/2 in. x 1/2 in. (13 mm x 13 mm) mesh.

b. Optional Two-Pipe Snorkel Termination

See Figure 4-7.

This installation will allow a maximum of 7 ft. (2.1 m) vertical exterior run of the vent/combustion air piping to be installed on the approved AL29-4C stainless steel horizontal venting application.

i. Vent Termination

- After penetrating wall, install the appropriate manufacturer's 90° elbow so that the elbow leg is in the up direction.
- Install maximum vertical run of 7 ft. (2.1 m) of appropriate manufacturer's vent pipe as shown in Figure 4-7.
- At top of vent pipe length install another appropriate manufacturer's 90° elbow so that the elbow leg is opposite the building's exterior surface.
- Install horizontal vent terminal.
- Brace exterior piping if required.

ii. Combustion Air Termination

- After penetrating wall, install a 90° elbow so that the elbow leg is in the up direction.
- Install maximum vertical run of 7 ft. (2.1 m) of combustion air pipe as shown in Figure 4-7.
- At top of vent pipe length install another 90° elbow so that the elbow leg is opposite the building's exterior surface.
- Install screen and horizontal vent terminal.
- Brace exterior piping if required.

5. Vertical Vent Termination

a. Standard Two-Pipe Termination

See Figures 4-9 and 4-10.

i. Vent Termination

- Use the terminal supplied by the vent system manufacturer shown in Table 4-30, 4-31 or 4-32. Follow manufacturer's instructions to attach terminal to vent system.

ii. Combustion Air Termination

- Install vertical combustion air terminal. Vertical combustion air terminal consists of a 180° bend (comprised of two 90° elbows) as shown in Figure 4-9.
- Install screen in the combustion air terminal. Use a screen having 1/2 in. x 1/2 in. (13 mm x 13 mm) or larger mesh.

E. Optional Room Air for Combustion

1. General Guidelines

a. Room air is optional for commercial applications. Room air uses one pipe to expel products of combustion directly outdoors with combustion air supplied from boiler room or enclosure. Direct vent is recommended for residential applications. Direct vent uses two pipes, one to expel products of combustion directly outdoors and one to supply combustion air to the boiler directly from outdoors. See preceding sections A through D for direct vent instructions.

b. Avoid combustion air contaminants in the boiler room. See Table 3-1. Permanently remove any contaminants found in the boiler room. If contaminants cannot be removed, do not use room air for combustion.

4 Venting *(continued)*

⚠ WARNING

Sources of combustion air contaminants, including chlorines, chlorofluorocarbons (CFC's), petroleum distillates, detergents, volatile vapors or other chemicals must not be present in the boiler room. If any of these contaminants is present, severe boiler corrosion and failure will result.

2. Outdoor Openings to Boiler Room
   a. Provide combustion and ventilation air to the boiler room or enclosure. Follow the *National fuel Gas Code*, ANSI Z223.1, or, in Canada, *Installation Code for Gas Burning Appliances and Equipment,* CGA Standard B149 Code as well as all applicable local codes. Use one of the following two methods.
   b. Two Permanent Openings Method: Provide two permanent openings, once within 12 in. (300 mm) of the top of the enclosure and one within 12 in. (300 mm) of the bottom of the enclosure. Openings must communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors, as follows:
      i. Direct communication or through vertical ducts: minimum free area of each opening shall be 1 $in.^2$/4,000 Btu/hr (550 mm^2/kW) of total input rating of all appliances within the enclosure.
      ii. Horizontal ducts: minimum free area of each opening shall be 1 $in.^2$/2,000 Btu/hr (1,100 mm^2/kW) of total input rating of all appliances within the enclosure.
   c. One Permanent Opening Method: Provide one permanent opening, commencing within 12 in. (300 mm) of the top of the enclosure. The opening shall communicate through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors and shall have a minimum free area of the following:
      i. 1 $in.^2$/3,000 Btu/hr (700 mm^2/kW) of total input rating of all appliances located within the enclosure.
      ii. Not less than the sum of the areas of all vent connectors in the space.
   d. Motorized Louvers or Dampers: Motorized louvers or dampers must be interlocked with the boiler to allow ignition and firing of the burner only when louvers are in the fully-open position. Wire the interlock to the Auto Reset External Limit connections. See Section 8 "Electrical".
3. Terminations
   a. For standard horizontal sidewall terminations, see Figures 4-6 and 4-7. When using room air for combustion, use 90° elbow or tee for sidewall vent termination.

NOTICE: Use 90° elbow or tee for horizontal sidewall vent termination when using room air for combustion.

   b. For vertical roof terminations, see Figures 4-9 and 4-10.

F. Removing the Existing Boiler

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

1. Seal any unused openings in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion, and other deficiencies which could cause an unsafe condition.
3. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliance not connected to the common venting system. Turn on any exhaust fans, such as range-hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.
4. Place in operation the appliance being inspected. Follow the Lighting (or Operating) Instructions. Adjust thermostat so appliance will operate continuously.
5. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle, or smoke from a cigarette, cigar or pipe.

4 Venting *(continued)*

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/NFPA 54 and/or the *Natural Gas and Propane Installation Code*, CAN/CSA B149.1. When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate tables in Part II in the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or the Natural Gas and Propane Installation Code, CAN/CSA B149.1.

Au moment du retrait d'une chaudière existante, les mesures suivantes doivent être prises pour chaque appareil toujours raccordé au système d'evacuation commun et qui fonctionne alors que d'autres appareils toujours raccordés au système d'évacuation ne fonctionnent pas:

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

G. Multiple Boiler Installation Venting

1. Vent Piping and Terminations
   a. Multiple boiler vent terminations are shown in Figure 4-34.
   b. Each individual boiler must have its own vent pipe and vent terminal. Refer to Paragraphs A through F (as applicable) for individual boiler vent guidelines and options.

⚠ WARNING

Asphyxiation Hazard.

Use 90° elbow or tee for horizontal sidewall vent termination when using room air for combustion.

4 Venting *(continued)*

c. Do not exceed the individual boiler maximum vent length listed in Table 4-2.

d. For horizontal sidewall terminations, maintain at least 12 in. (300 mm) minimum horizontal distance between any adjacent individual boiler vent terminations. Additional horizontal spacing between any adjacent individual boiler vent terminations as well as extending the distance from building surfaces to vent termination end are recommended to avoid frost damage to building surfaces where vent terminations are placed.

NOTICE: Installing multiple individual boiler vent terminations too close together may result in combustion product water vapor condensation on building surfaces, where vent terminations are placed, and subsequent frost damage. To avoid/minimize frost damage, extend the distance from building surfaces to vent termination end and increase the horizontal distance between adjacent vent terminations.

e. Individual boiler sidewall vent terminals must be placed at least 12 in. (300 mm) [18 in. (460 mm) in Canada] above the ground plus the expected snow accumulation.

f. Multiple individual boiler vertical vent pipes may be piped through a common conduit or chase so that one roof penetration may be made.

g. For vertical roof terminations, maintain at least 12 in. (300 mm) minimum horizontal distance between adjacent individual boiler vent terminations.

2. Combustion Air Piping

a. Multiple boiler combustion air terminations are shown in Figure 4-34.

b. Each individual boiler must have own combustion air pipe and terminal. Refer to Paragraphs A through F (as applicable) for individual boiler combustion air guidelines and options.

c. Do not exceed the individual boiler maximum combustion air pipe length listed in Table 4-2.

d. If possible, locate vent and combustion air terminals for an individual boiler on the same wall to prevent nuisance shutdowns. If not, an individual boiler may be installed with a roof vent terminal and sidewall combustion air terminal.

4 Venting *(continued)*

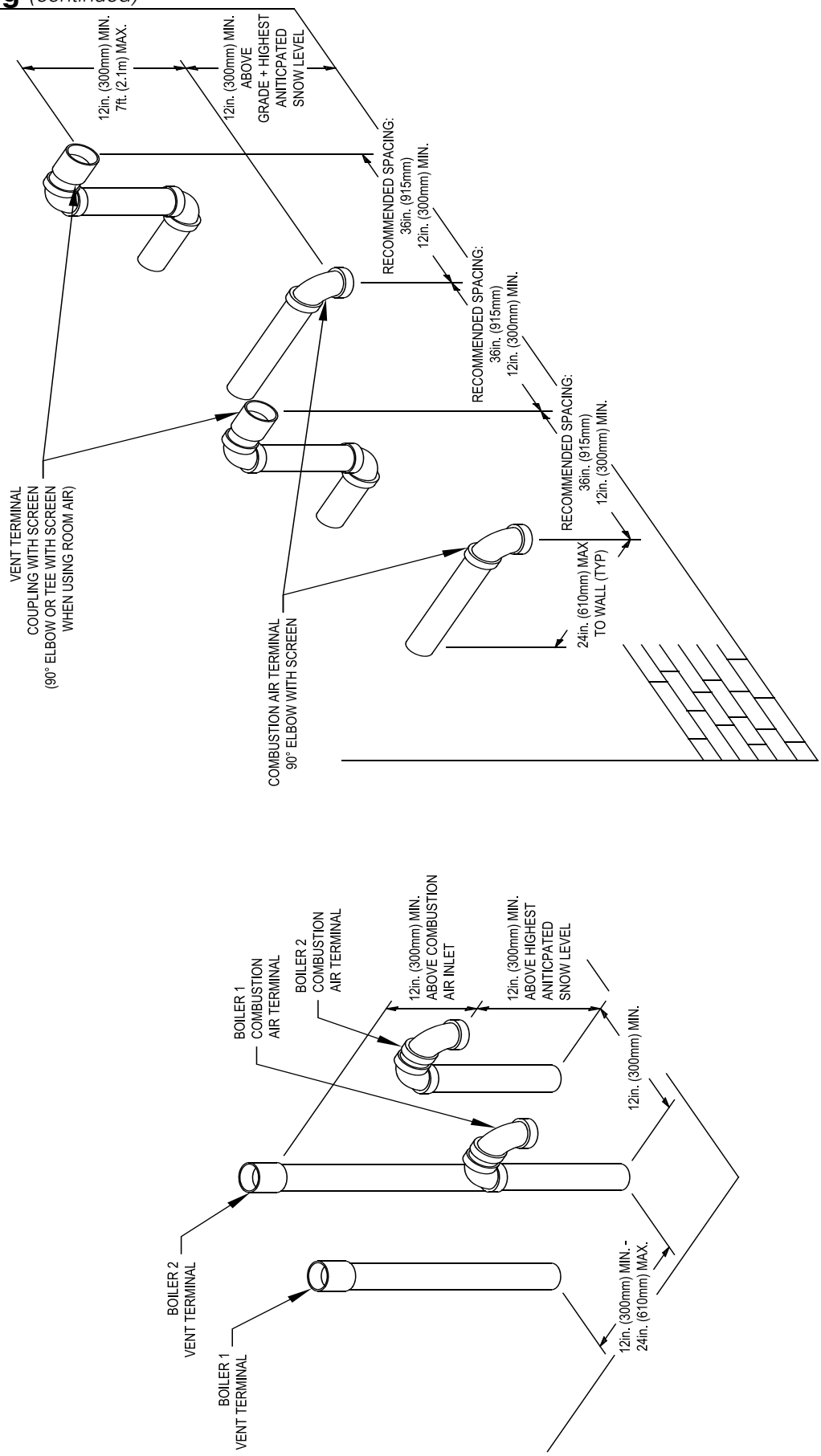


Figure 4-34: Multiple Boiler Direct Vent Termination

5 Condensate Disposal

A. Condensate Trap and Drain Line

1. All condensate which forms in the boiler or vent system collects in the sump under heat exchanger and leaves the boiler through factory installed condensate trap.
2. The trap allows condensate to drain from sump while retaining flue gases in the boiler. The trap has factory installed overflow switch, which shuts down the boiler in the event the drain line becomes obstructed, preventing proper condensate removal. Refer to Section 11 “Service and Maintenance” for condensate trap and condensate overflow switch removal and replacement procedure, if required.
3. Note the following when disposing of the condensate:
   a. Condensate is slightly acidic, typical pH around 3.5 - 4.5. Do not use metallic pipe or fittings in the condensate drain line. Do not route the drain line through areas that could be damaged by leaking condensate.
   b. Do not route or terminate the condensate drain line in areas subject to freezing temperatures.
   c. If the point of condensate disposal is above the trap, a condensate pump is required to move the condensate to the drain. Select a condensate pump approved for use with condensing furnaces. If overflow from the pump would result in property damage, select a pump with an overflow switch. Wire this switch in series with installer provided external high limit, to shut off the boiler, and, if desired, in series with installer-supplied alarm, to trigger an alarm in the event of overflow.
   d. Do not attempt to substitute another trap for one provided with the boiler.
   e. In order for boiler to work properly, the boiler must be leveled during installation.
4. The condensate trap connection is located at boiler left side, below inlet and outlet water pipe connections. Refer to Figures 1-3, 1-4, 1-5 and 5-2.
5. Condensate trap must be filled up with water, prior to boiler start-up and before connecting any condensate line to the boiler to ensure combustion products cannot escape from operating boiler. To fill the trap, inject water in the amount of 1 cup (240 ml) through condensate trap connection. Do not overfill the trap.
6. Install tee for condensate overflow and vent as shown in Figure 5-2.

⚠ WARNING

Asphyxiation Hazard.

Failure to fill the condensate trap with water prior to boiler start-up could cause flue gas to enter the building, resulting in personal injury or death.

7. If any additional condensate drain line is needed, construct the extension from PVC or CPVC Schedule 40 pipe. The factory supplied ¾ in. x 5-5/8 in. long PVC coupling, located in the miscellaneous parts carton, must be used to connect drain line to the condensate trap. Do not over tighten coupling compression nuts when connecting drain line and condensate trap.
8. Size condensate drain line, pump and neutralizer (if using other than manufacturer neutralizer kit) to accommodate maximum condensate flow shown in Table 5-1 “Maximum Condensate Flow”.

Table 5-1: Maximum Condensate Flow

Boiler Model	*Maximum Condensate Flow, GPH
APX425C	4.5
APX525C	5.6
APX625C	7.0
APX725C	8.1
APX825C	9.0

*Assumes 100% of water in fuel condenses.

⚠ WARNING

Asphyxiation Hazard.

Failure to install the condensate drain in accordance with the above instructions could cause flue gas to enter the building, resulting in personal injury or death.

NOTICE: Boiler condensate is corrosive. Route condensate drain line in a manner such that any condensate leakage will not cause property damage.
Some jurisdictions may require that condensate be neutralized prior to disposal.
Use materials approved by the authority having jurisdiction.

5 Condensate Disposal *(continued)*

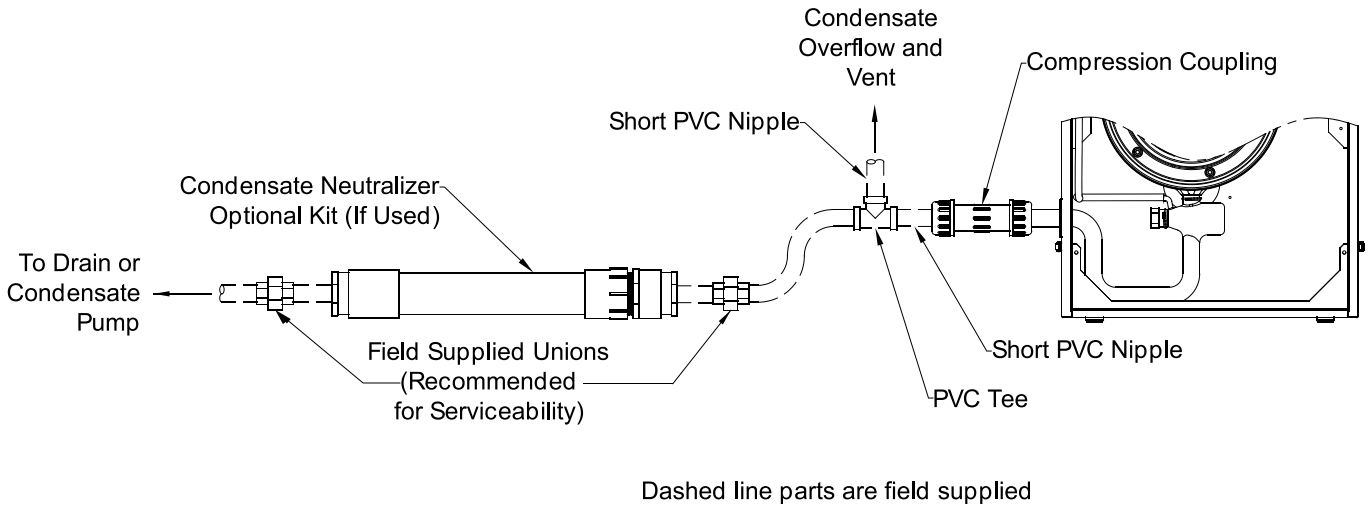


Figure 5-2: Condensate Trap and Drain Line

B. Condensate Neutralizer Installation

1. Some jurisdictions may require that the condensate be neutralized before being disposed of. Follow local codes pertaining to condensate disposal.
2. A condensate neutralizer kit (P/N 101867-01) is available as optional equipment. Follow local codes and instructions enclosed with the kit for condensate neutralizer installation.
3. Limestone chips will get coated by neutral salts (product of chemical reaction between limestone and acidic condensate) and lose neutralizing effectiveness over time. Therefore, periodic condensate neutralizer maintenance and limestone chip replacement must be performed. A pH test or acid test kits are available from HVAC/plumbing distributors and should be used to measure condensate acidity before/after neutralizer thus indicating a need for service and chip replacement.

6 Water Piping and Trim

NOTICE: Failure to properly pipe boiler may result in improper operation and damage to boiler or structure.
Install boiler so that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, etc.).
Oxygen contamination of boiler water will cause corrosion of iron and steel boiler components, and can lead to boiler failure. Thermal Solutions' Standard Warranty does not cover problems caused by oxygen contamination of boiler water or scale (lime) build-up caused by frequent addition of water.
Do not fill boiler with softened water to prevent chloride contamination.
Installation is not complete unless a safety relief valve is installed into the tapping located on left side of appliance or the supply piping.

A. Installation of Factory Supplied Piping and Trim Components

1. Install provided components per Figure 6-1 for APX425C or Figure 6-6 for APX525C through APX825C. Rear tapping is return/inlet. Front tapping (middle on APX425C) is supply/outlet. Piping and trim components are located in miscellaneous parts carton shipped with the boiler.
   a. Safety Relief Valve – Install on tee off 3/4 in. NPT tapping on APX425C or on tee off supply tapping on APX525C through APX825C. Use provided 10 in. long nipple to locate valve above heat exchanger top.
   b. Drain Valve – Install on tee off 3/4 in. NPT tapping on APX425C or on tee off supply tapping on APX525C through APX825C.
   c. Temperature and Pressure Gauge – Install on supply piping.
   d. Flow Switch – Install on supply piping. Use provided tee with 1 in. NPT outlet. Use correct paddle per Table 6-2. Refer to Section 8 "Electrical" for flow switch wiring.
   e. Install drain valve into tee bottom outlet.

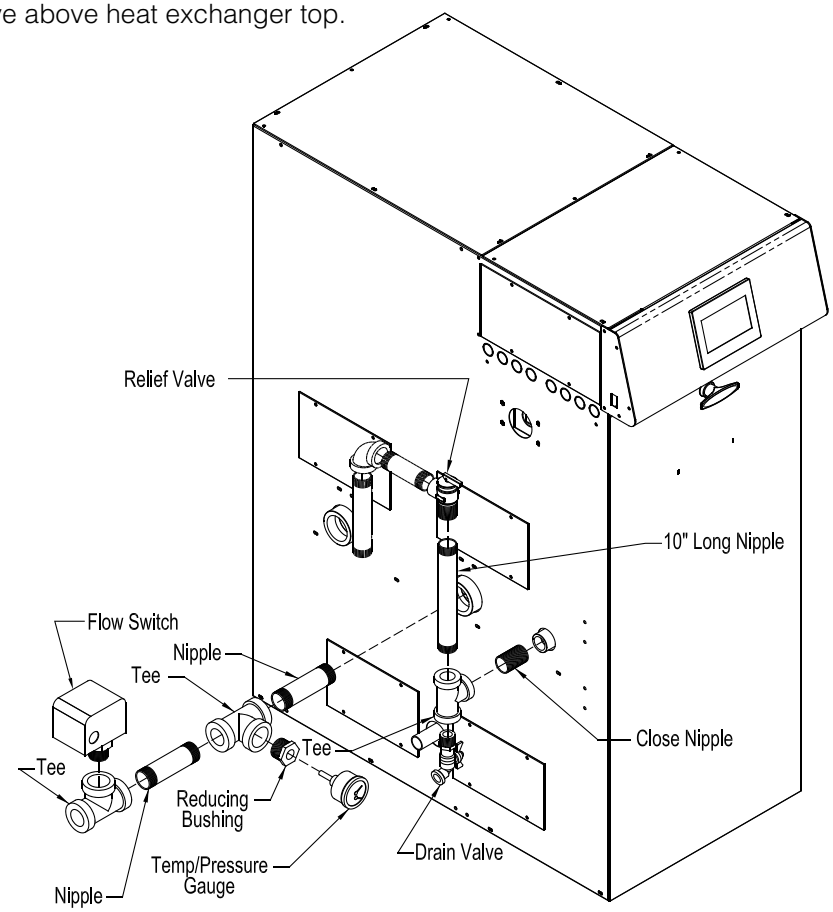


Figure 6-1: Factory Supplied Piping and Trim Installation - APX425C

6 Water Piping and Trim *(continued)*

Table 6-2: Flow Switch Paddle Application

Boiler	Flow Switch Paddle Marking
APX425C	1
APX525C	E
APX625C	3
APX725C	1
APX825C	1

B. Piping System To Be Employed

Apex boilers are designed to operate in a closed loop pressurized system. Minimum pressure in the boiler must be 14.5 psi (100 kPa). Proper operation of the Apex boiler requires that the water flow through the boiler remain within the limits shown in Table 6-3 any time the boiler is firing.

NOTICE: Failure to maintain the flow through boiler within specified limits could result in erratic operation or premature boiler failure.

1. Near boiler piping must isolate Apex boiler from system piping via closely spaced tees to ensure specified flow range through boiler any time the boiler is firing.
   a. The flow rate through the isolated near-boiler loop is maintained by installer supplied boiler circulator. See Tables 6-4 and 6-5 for recommended circulators.
   b. The flow rate through the isolated near-boiler loop is completely independent of the flow rate through the heating system loop(s).
   c. The flow rate through the heating system loop(s) is controlled by installer sized/ provided system loop circulator(s).
   d. This piping arrangement can be used either for space heating-only applications or space heating with indirect water heater(s) applications.
      i. Space heating only - refer to Tables 6-4 and 6-5 and Figure 6-9 “Near Boiler Piping - Heating Only” as applicable.
      ii. Space heating plus indirect water heater(s) – refer to Tables 6-4 and 6-5 and Figure 6-10 “Near Boiler Piping - Heating Plus Indirect Water Heater” as applicable.
      iii. If piping indirect water heater off boiler (see Figure 6-12), be sure that indirect water heater and domestic hot water circulator are sized to maintain flow through boiler within limits shown in Table 6-3.

***NOTICE*:** Where it is not possible to install a separate boiler loop, the system circulator must be sized to ensure that the flow through boiler stays within the defined parameters to prevent overheating when the boiler is fired at it’s full rated input. Install a flow meter to measure the flow, or fire the boiler at full rate and ensure the boiler DT does not exceed 35°F (19°C).

2. Direct connection of Apex boiler to heating system, similar to a conventional boiler, is **NOT RECOMMENDED because:**
   a. The flow rate through system must be the same as through boiler and fall within limits specified in Table 6-3.
   b. Pressure drop through entire system must be known, added to pressure drop through boiler, and a circulator selected to provide required flow at total calculated pressure drop.
   c. It is often very difficult to accurately calculate the pressure drop through the system.
   d. In replacement installations, it may be nearly impossible to get an accurate measurement of piping amount and number of fittings in the system. If system is zoned, the system flow rate may drop well below recommended minimum flow when only a single zone is calling for heat.

6 Water Piping and Trim *(continued)*

Table 6-3: Flow Range Requirement Through Boiler

Boiler Model	Supply Connection (in.)	Return Connection (in.)	DT= 35°F		ΔT = 30°F		ΔT = 25°F		ΔT = 20°F	
			Minimum Required Flow (GPM)	Boiler Head Loss (ft.)	Required Flow (GPM)	Boiler Head Loss (ft.)	Required Flow (GPM)	Boiler Head Loss (ft.)	Maximum Required Flow (GPM)	Boiler Head Loss (ft.)
APX425C	1-1/2	1-1/2	21.5	6.1	25.1	7.9	30.2	10.8	37.7	15.9
APX525C	2	2	27.7	5.2	32.3	6.8	38.8	9.3	48.5	13.6
APX625C	2	2	33.9	4.7	39.6	6.1	47.5	8.4	59.4	12.4
APX725C	2	2	39.4	6.0	45.9	7.9	55.1	10.9	68.9	16.1
APX825C	2	2	43.4	5.9	50.7	7.8	60.8	10.8	76.0	16.1

Notes: Required Flow = Output*1000/(500*ΔT), where flow rate is in GPM, output is in MBH, and ΔT is in °F

Outputs for specific boiler models are provided in Table 1-6. See also Tables 6-4 and 6-5 for near boiler piping sizing. Using boiler antifreeze will result in increased fluid density and may require larger circulators.

Table 6-4: Recommended Taco Circulators for 50 ft. Equivalent ft. Near Boiler Piping [Approximately 20 ft. Straight Pipe, (4) 90° Elbows, and (2) Full Port Ball Valves]

Boiler Model	Supply & Return Connection (in.)	Near Boiler Pipe Size (in.)	DT=35°F			DT=30°F			DT=25°F			DT=20°F		
			Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model	Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model	Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model	Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model
APX425C	1½	2	21.4	6.4	0014	25.0	8.3	0013	30.0	11.4	2400-60	37.5	16.8	2400-70
APX525C	2	2	27.7	5.8	0012	32.3	7.5	2400-60	38.8	10.3	2400-60	48.5	15.2	2400-65
APX625C	2	2	33.9	5.5	2400-60	39.6	7.2	2400-60	47.5	9.9	2400-65	59.4	14.7	2400-70
APX725C	2	2	39.4	7.1	2400-60	45.9	9.4	2400-65	55.1	12.9	2400-65	68.9	19.1	1935
APX825C	2	2½	43.4	6.4	2400-60	50.7	8.5	2400-65	60.8	11.8	2400-65	76.0	17.6	1935

Table 6-5: Recommended Grundfos Circulators for 50 Equivalent ft. Near Boiler Piping [Approximately 20 ft. Straight Pipe, (4) 90° Elbows, and (2) Full Port Ball Valves]

Boiler Model	Supply & Return Connection (in.)	Near Boiler Pipe Size (in.)	DT=35°F			DT=30°F			DT=25°F			DT=20°F		
			Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model	Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model	Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model	Flow (GPM)	Boiler & Piping Head Loss (ft.)	Circulator Model
APX425C	1½	2	21.5	6.4	UP26-64F	25.1	8.4	UP26-99F	30.2	11.5	UPS43-100F, Spd. 2	37.7	16.9	UPS43-100F, Spd. 3
APX525C	2	2	27.7	5.8	UPS43-44FC, Spd. 2	32.3	7.5	UPS43-44F	38.8	10.3	UPS43-100F, Spd. 2	48.5	15.2	UP50-60F, Spd. 3
APX625C	2	2	33.9	5.5	UPS43-44FC, Spd. 3	39.6	7.2	UPS43-100F, Spd. 2	47.5	9.9	UPS50-60F, Spd. 2	59.4	14.7	UPS40-80/2, Spd. 3
APX725C	2	2	39.4	7.1	UPS43-100F, Spd. 2	45.9	9.4	UPS43-100F, Spd. 3	55.1	12.9	UPS50-60F, Spd. 3	68.9	19.1	UP50-80/2, Spd 3
APX825C	2	2½	43.4	6.4	UPS43-100F, Spd. 2	50.7	8.5	UPS43-100F, Spd. 3	60.8	11.8	UP50-60F, Spd 3	76.0	17.6	UPS50-80/2, Spd. 3

6 Water Piping and Trim *(continued)*

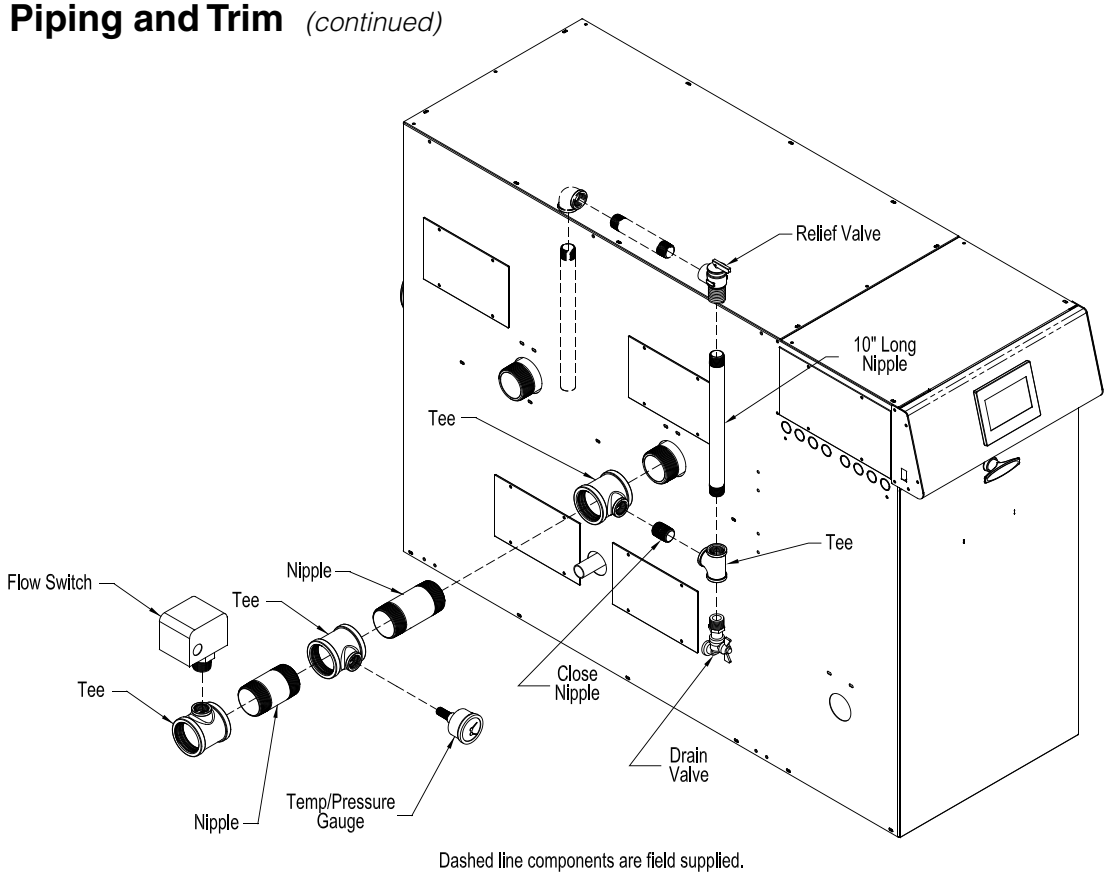


Figure 6-6: Factory Supplied Piping and Trim Installation - APX525C, APX625C, APX725C and APX825C

C. Standard Installation Requirements

Observe the following guidelines when making the actual installation of the boiler piping:

1. Safety Relief Valve (Required) – The safety relief valve is packaged loose with boiler and must be installed in the location shown in Figure 6-1 or 6-6 “Factory Supplied Piping and Trim Installation”. The safety relief valve must be installed with spindle in vertical position. Installation of the safety relief valve must comply with ASME Boiler and Pressure Vessel Code, Section IV. The standard factory shipped safety relief valve is set at 50 psi (340 kPa) on APX425C and APX525C and 60 psi (410 kPa) on APX625C, APX725C and APX825C. Optional 80 psi (550 kPa) and 100 psi (689 kPa) safety relief valve kits are available. If the safety relief valve is to be replaced, the replacement valve must have a relief capacity equal or exceeding the minimum relief valve capacity shown on the heat exchanger ASME plate. Also, when replacing the safety relief valve, verify the temperature and pressure gage meets ASME requirements for the replacement safety relief valve. Pipe the safety relief valve discharge to a location where hot water or steam will not create hazard or property damage if the valve opens.

   The end of the discharge pipe must terminate in an unthreaded pipe. If the safety relief valve is not piped to a drain, it must terminate at least 6 in. (150 mm) above the floor. Do not run safety relief valve discharge piping through an area prone to freezing. The termination of discharge piping must be in an area where it will not become plugged by debris.

⚠ WARNING

Burn Hazard.

Safety relief valve discharge piping must be piped such that the potential of severe burns is eliminated. DO NOT pipe in any area where freezing could occur. DO NOT install any shut-off valves, plugs or caps. Consult local codes for proper discharge piping arrangement.

6 Water Piping and Trim *(continued)*

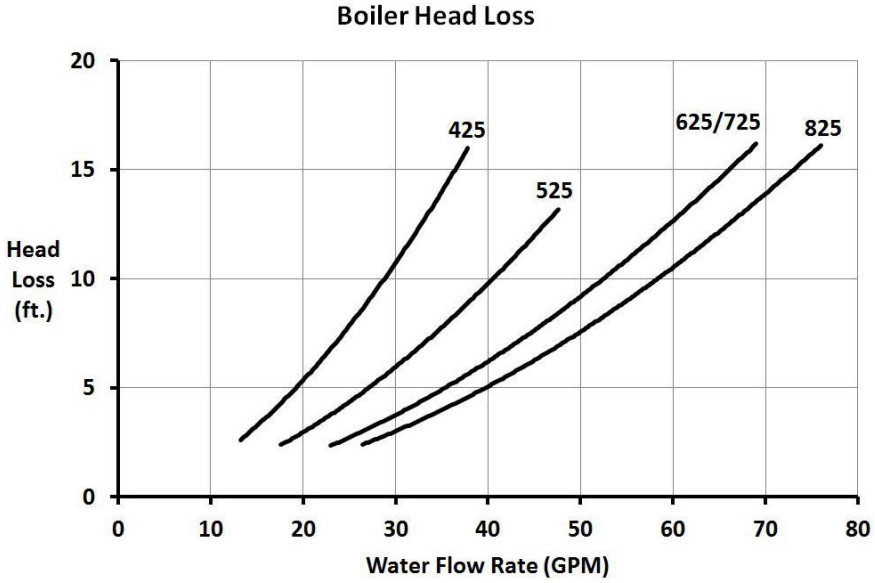


Figure 6-7: Boiler Head Loss

2. Flow Switch (Required) – A flow switch is required in lieu of manual reset low water cutoff (LWCO) for forced circulation coil-type water boilers to prevent overheating and heat exchanger failure in accordance with requirements of ASME Boiler and Pressure Vessel Code, Section IV, and ANSI/ASME CSD-1 – latest edition, "Controls and Safety Devices for Automatically Fired Boilers".

   The flow switch is factory provided. Follow Section 6, Paragraph A and Section 7 'Electrical' of these instructions to install and wire the flow switch.

3. Circulator (Required) – Usually at least two circulators will be required to properly install an Apex boiler. See Paragraph B above for information on sizing the circulators.

4. Expansion Tank (Required) – If this boiler is replacing an existing boiler with no other changes in the system, the old expansion tank can generally be reused. If the expansion tank must be replaced, consult the expansion tank manufacturer's literature for proper sizing.

5. Fill Valve (Required) – Either manual (recommended) or automatic fill valve may be used. However, if automatic refill is employed, a water meter must be added to evaluate the makeup water volume taken after initial fill and eliminate any water leakage as early as possible.

6. Automatic Air Vent (Required) –At least one automatic air vent is required. Manual vents will usually be required in other parts of the system to remove air during initial fill.

7. Manual Reset High Limit - Apex boilers have factory provided UL 353 listed boiler control and UL 1434 listed manual reset high limit. An optional manual reset external high limit is available from Thermal Solutions to meet local code requirements.

8. Y-strainer (Recommended) – A Y-strainer or equivalent strainer removes heating system debris from hydronic systems and protects boiler heat exchanger from fouling. Install the strainer downstream of full port isolation valve at the inlet side of the circulator for easy service.

9. Flow Control Valve (Strongly Recommended) – The flow control valve prevents flow through the system unless the circulator is operating. Flow control valves are used to prevent gravity circulation or "ghost flows" in circulator zone systems through zones that are not calling for heat.

10. Isolation Valves (Strongly Recommended) – Isolation valves are useful when the boiler must be drained, as they will eliminate having to drain and refill the entire system.

11. Drain Valve (Required) – Drain valve is packaged loose with boiler and must be installed in the location shown in Figure 6-1 or 6-6 "Factory Supplied Piping and Trim Installation".

12. An optional LWCO with manual reset is available from Thermal Solutions to meet local code requirements.

6 Water Piping and Trim *(continued)*

Table 6-8: Fitting and Valve Equivalent Length

Copper Fitting and Sweat Valve Equivalent Length (ft.)				
Fitting or Valve Description	**Copper Pipe or Valve Size**			
	1	**1¼**	**1½**	**2**
90° Elbow	2.5	3.0	4.0	5.5
45° Elbow	1.0	1.2	1.5	2.0
Tee (through flow)	0.5	0.6	0.8	1.0
Tee (Branch flow)	4.5	5.5	7.0	9.0
Diverter Tee (typical)	23.5	25.0	23.0	23.0
Gate Valve	0.3	0.4	0.5	0.7
Globe Valve	25.0	36.0	46.0	56.0
Angle Valve	5.3	7.8	9.4	12.5
Ball Valve (standard port)	4.3	7.0	6.6	14.0
Ball Valve (full port)	1.9	1.4	2.2	1.3
Swing Check Valve	4.5	5.5	6.5	9.0
Flow-Check Valve (typical)	54.0	74.0	57.0	177.0
Butterfly Valve	2.7	2.0	2.7	4.5

Table 6-8: Fitting and Valve Equivalent Length (continued)

Threaded Fitting and Valve Equivalent Length (ft.)				
Fitting or Valve Description	**Black Threaded Pipe or Valve Size**			
	1	**1¼**	**1½**	**2**
90° Elbow	2.6	3.5	4.0	5.2
Long Radius Elbow (45° or 90°)	1.4	1.8	2.2	2.8
Tee (through flow)	1.8	2.3	2.7	3.5
Tee (Branch flow)	5.3	6.9	8.1	10.0
Close Return Bend	4.4	5.8	6.7	8.6
Gate Valve (full open)	0.7	0.9	1.1	1.4
Globe Valve (full open)	30.0	39.0	46.0	59.0
Angle Valve (full open)	13.0	17.0	20.0	26.0
Swing Check Valve (full open)	8.7	12.0	13.0	17.0
Flow-Check Valve (typical)	42.0	60.0	63.0	83.0

NOTE: Table 6-8 is provided as reference to assist in piping design and specifies equivalent length of typical piping fittings and valves.

NOTICE:

- The Apex boiler heat exchanger is made from stainless steel tubular coil having relatively narrow waterways. Once filled with water, it will be subject to the effects of corrosion. Failure to take the following precautions to minimize corrosion and heat exchanger waterways overheating could result in severe boiler damage.
- Before connecting the boiler, ensure the system is free of impurities, grease, sediment, construction dust, sand, copper dust, flux and any residual boiler water additives. Flush the system thoroughly and repeatedly, if needed, with clear water mixed with concentrated rinse agent to remove these contaminants completely.
- Iron oxide (red oxide sludge Fe_2O_3) is produced during oxygenation. To minimize any oxygen presence in the system, the system must be air free and leak tight. Do not connect the boiler to radiant tubing without an oxygen barrier. Using automatic water refill is not recommended, however, if such refill is employed, a water meter must be added to evaluate the makeup water volume taken after initial fill and eliminate any water leakage as early as possible.
- Maintain the water pressure in the boiler at a minimum of 14.50 psi (100 kPa).
- The boiler water pH must be within $7.5 < pH < 9.5$. If the system contains any aluminum components, pH must be less than 8.5.
- Black oxide sludge (magnetite Fe_3O_4) forms as the result of continuous electrolytic corrosion in any system not protected by an inhibitor.
- Scale deposit is made up of lime scale contained in most distributed water and settles over the warmest surfaces of boiler heat exchanger causing subsequent overheating and eventual failure. Water hardness must be maintained within 3 to 9 grain/gal range.
- Refer to Section 11 “Service and Maintenance” for recommended heating system water treatment products (corrosion/scale inhibitors, cleaners etc) and their suppliers.

6 Water Piping and Trim *(continued)*

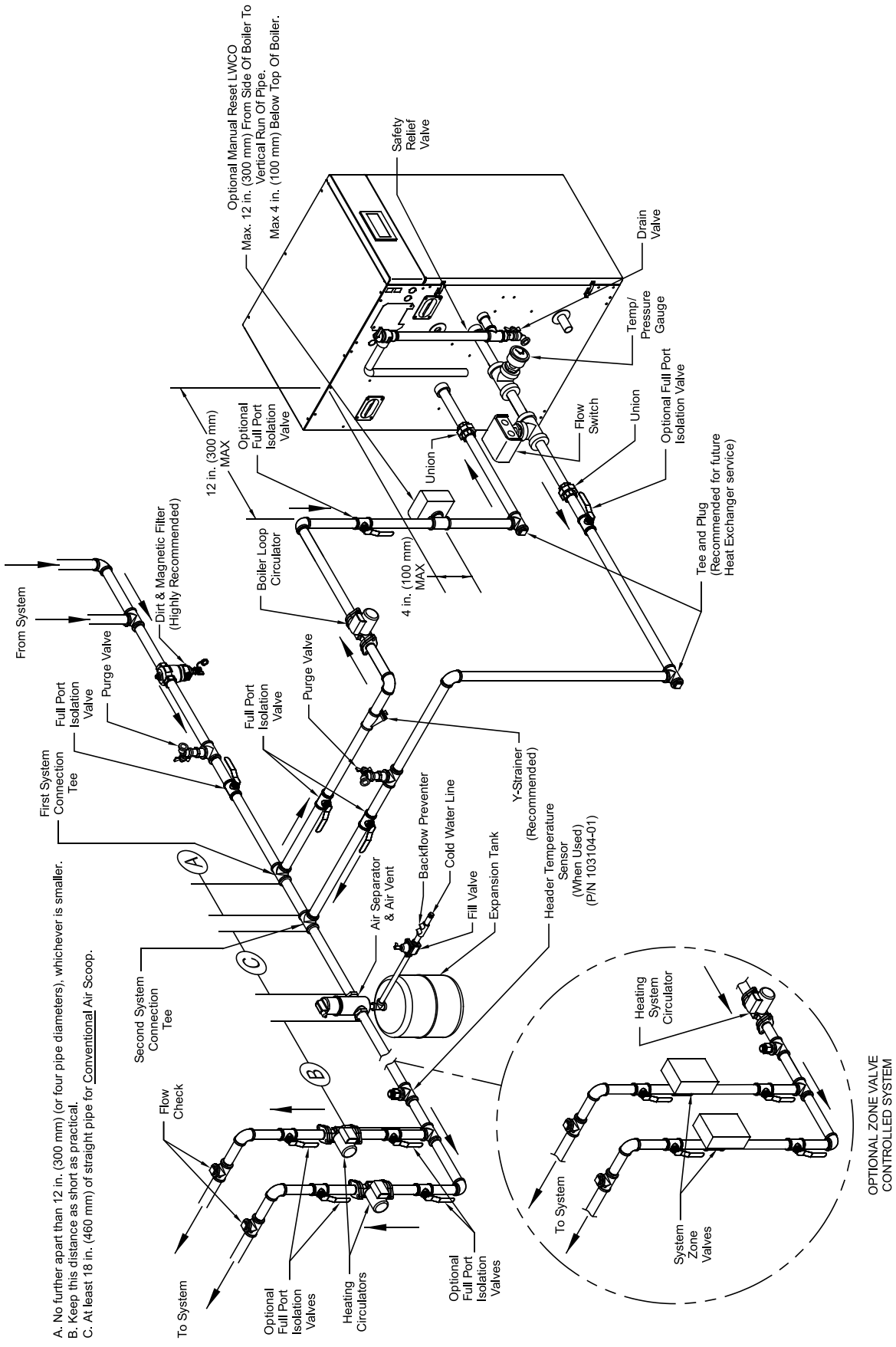


Figure 6-9: Near Boiler Piping - Heating Only

6 Water Piping and Trim *(continued)*

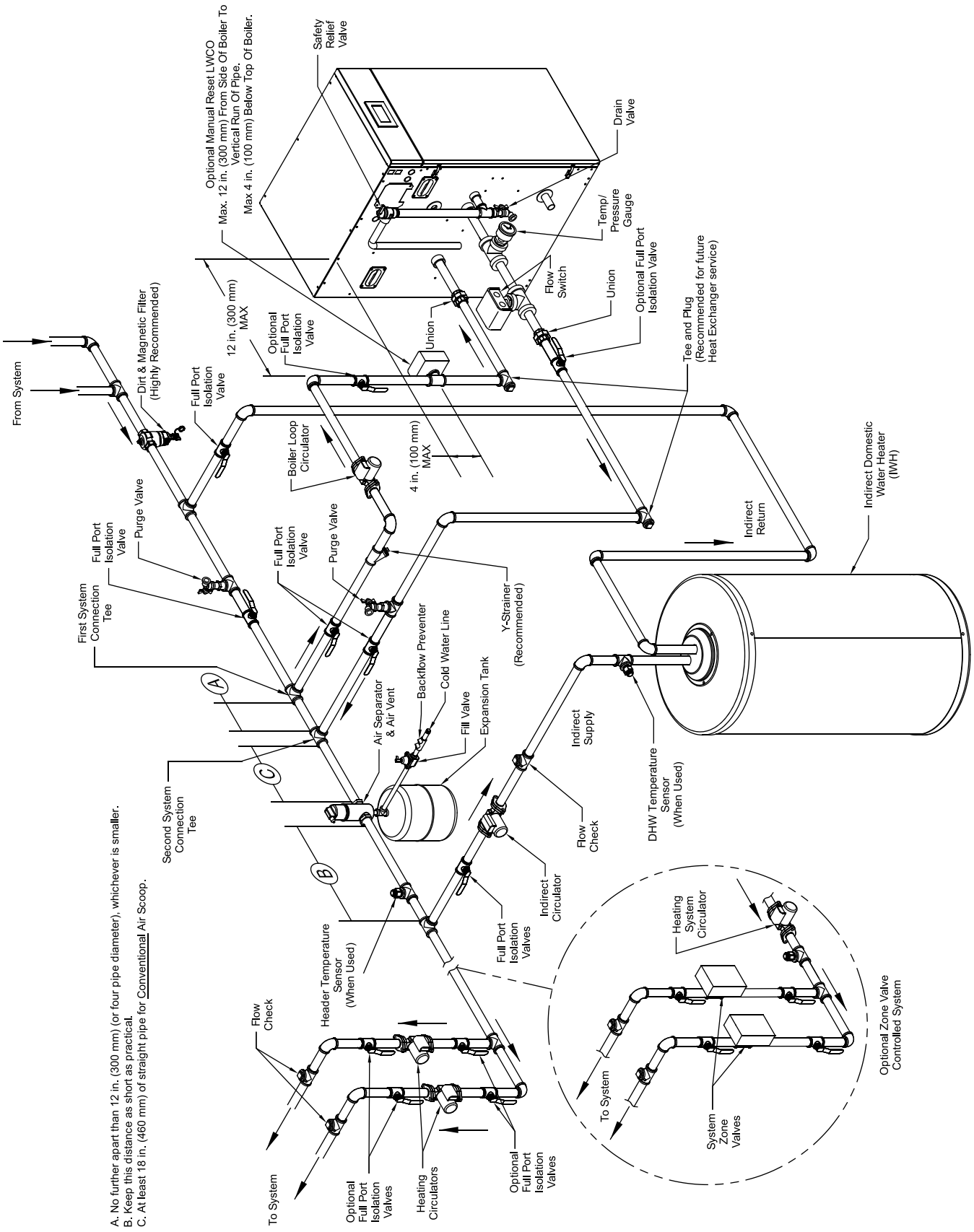


Figure 6-10: Near Boiler Piping - Heating Plus Indirect Water Heater

6 Water Piping and Trim *(continued)*

D. Special Situation Piping Installation Requirements

Observe the following guidelines when making the actual installation of the boiler piping for special situations:

1. Systems containing high level of dissolved oxygen – Many hydronic systems contain enough dissolved oxygen to cause severe corrosion damage to Apex boiler heat exchanger. Some examples include but not limited to:
   - Radiant systems employing tubing without oxygen barrier
   - Systems with routine additions of fresh water
   - Systems open to atmosphere

   If the boiler is used in such a system, it must be separated from oxygenated water being heated with a heat exchanger as shown in Figures 6-12 and 6-13. Consult the heat exchanger manufacturer for proper heat exchanger sizing as well as flow and temperature requirements. All components on the oxygenated side of the heat exchanger, such as the pump and expansion tank, must be designed for use in oxygenated water.
2. Piping with a Chiller - If the boiler is used in conjunction with a chiller, pipe the boiler and chiller in parallel. Use isolation valves to prevent chilled water from entering the boiler.
3. Boiler Piping with Air Handlers - Where the boiler is connected to air handlers through which refrigerated air passes, use flow control valves in the boiler piping or other automatic means to prevent gravity circulation during the cooling cycle.

Table 6-11: Multiple Boiler Water Manifold Sizing

Boiler Model	Number of Units						
	2	3	4	5	6	7	8
	Recommended Minimum Common Water Manifold Size (NPT)						
APX425C	2½ in.	3 in.	3 in.	4 in.	5 in.	5 in.	5 in.
APX525C	3 in.	4 in.	4 in.	5 in.	5 in.	6 in.	6 in.
APX625C	3 in.	4 in.	5 in.	5 in.	6 in.	6 in.	6 in.
APX725C	4 in.	4 in.	5 in.	6 in.	6 in.	8 in.	8 in.
APX825C	4 in.	5 in.	5 in.	6 in.	6 in.	8 in.	8 in.

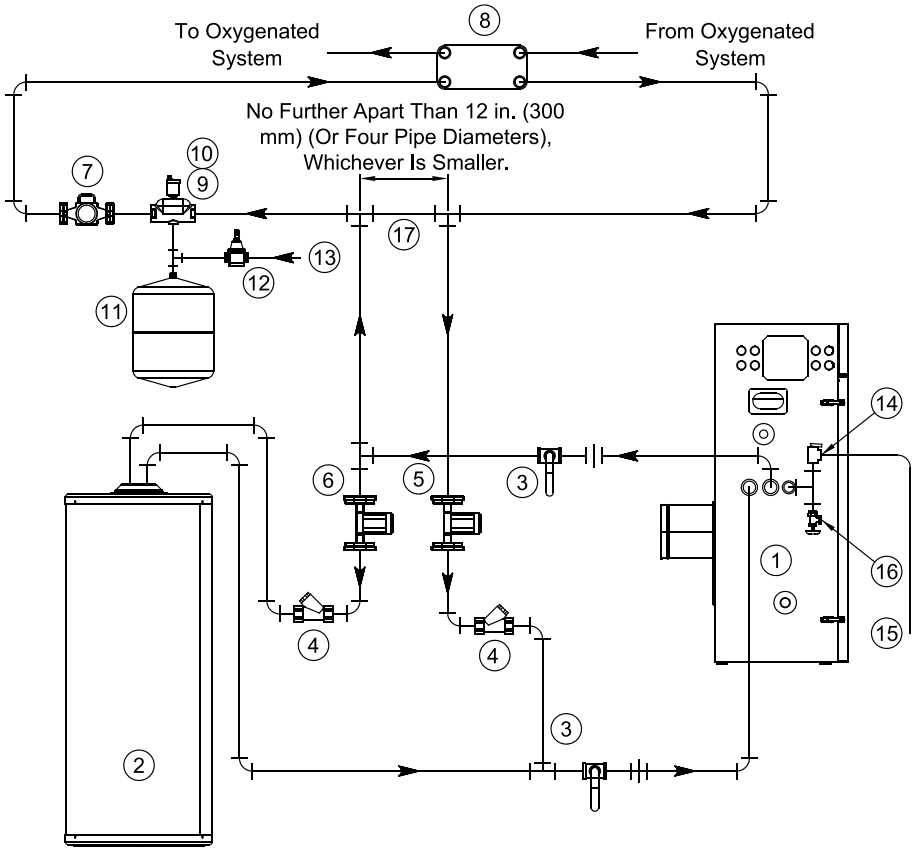


Figure 6-12: Isolation of the Boiler From Oxygenated Water with A Plate Heat Exchanger (IWH Piped as Part of Boiler Piping)

6 Water Piping and Trim *(continued)*

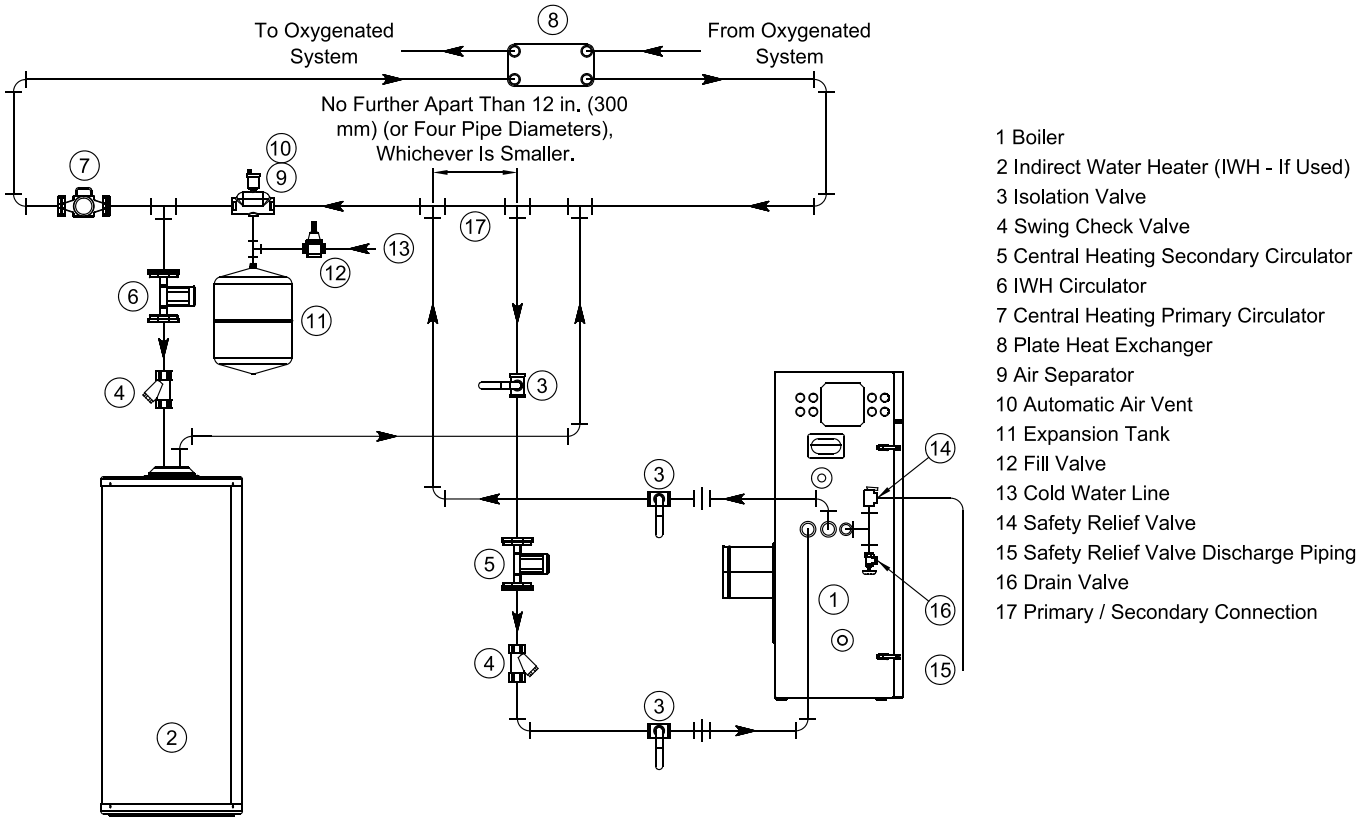


Figure 6-13: Isolation of the Boiler From Oxygenated Water with A Plate Heat Exchanger (IWH Piped Off System Header)

E. Multiple Boiler Water Piping

1. See Figure 6-16 for example multiple boiler piping.
2. Install one header sensor in system piping downstream of the boiler supply connection. See Figure 6-16 for header sensor location and Figures 6-14 and 6-15 for installation detail. Wire header sensor to Sequencer Master boiler. See also Section 8 "Electrical" and Section 10 "Operation".
3. For installations where indirect domestic hot water heater is combined with space heating, the Alliance SL™ model must be piped as a separate heating zone off the system header. The circulator must be sized based on the Alliance SL™ model coil flow and combined coil pressure drop and the zone piping total equivalent length. Refer to Alliance SL™ Indirect Water Heater literature for specific model coil flow and pressure drop. Refer to Figure 6-16.

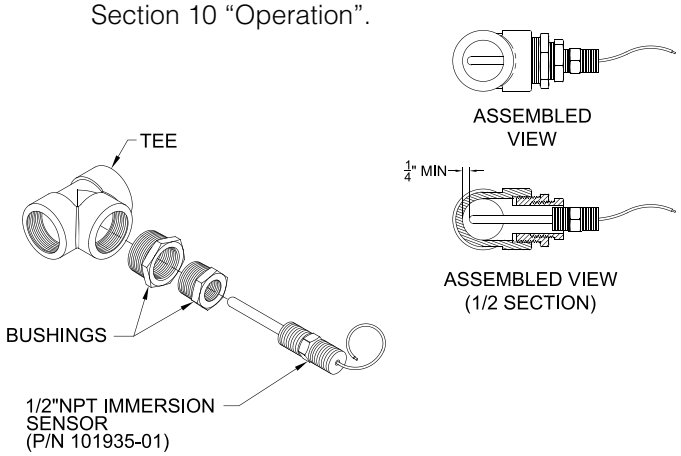


Figure 6-14: Recommended Direct Immersion Header Sensor or DHW Sensor Installation Detail

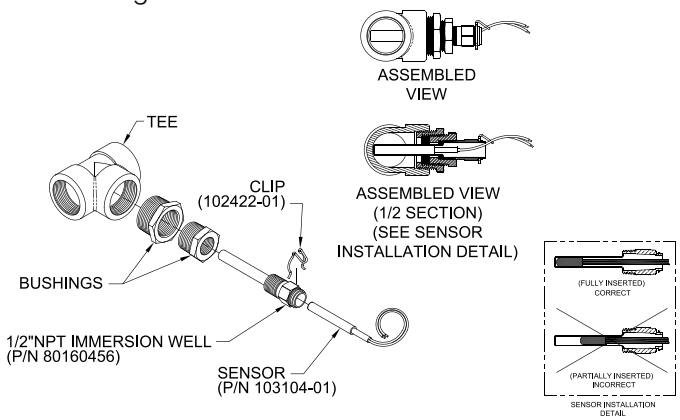
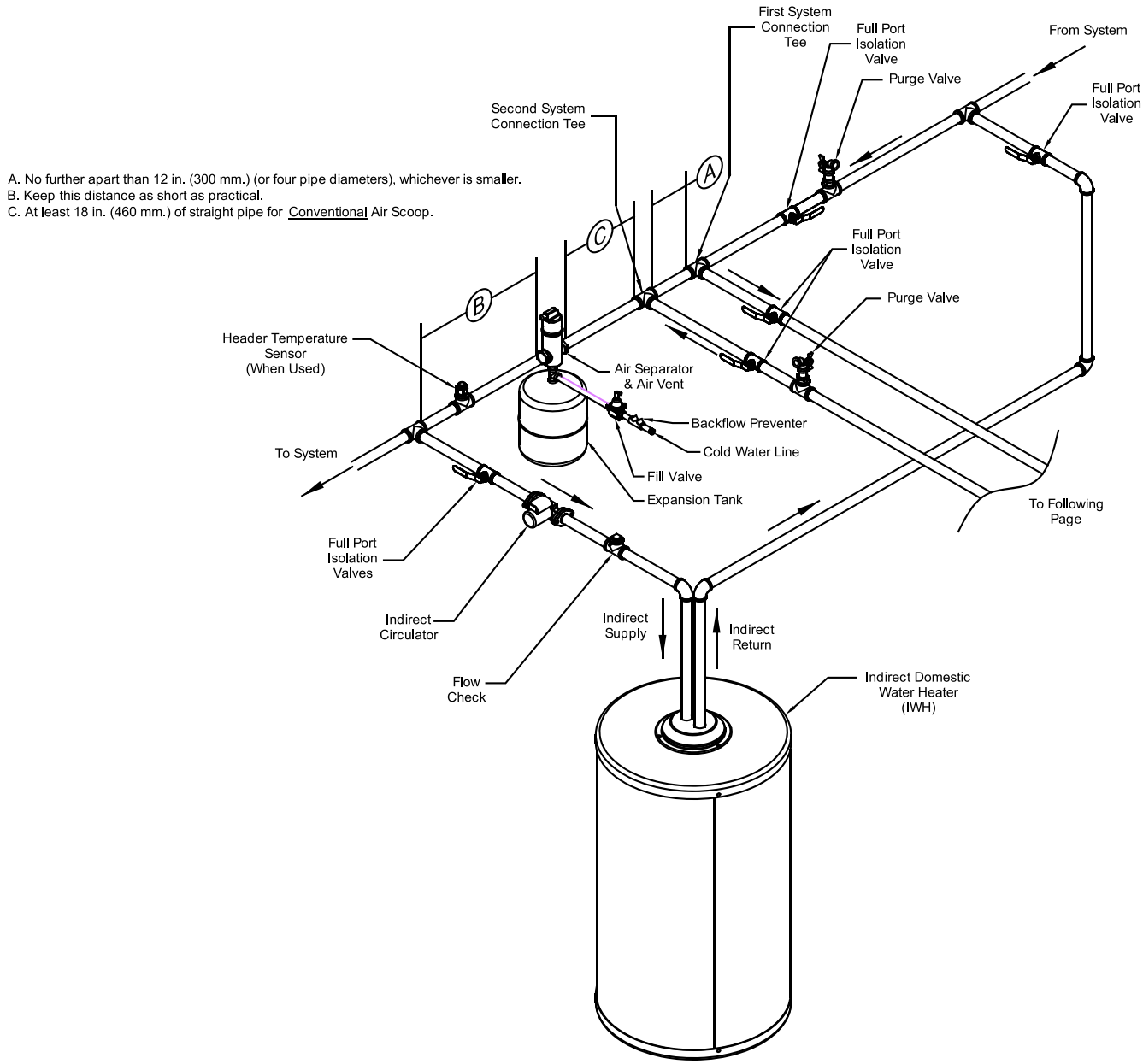


Figure 6-15: Alternate "Immersion" Type Header Sensor or DHW Sensor Installation Detail

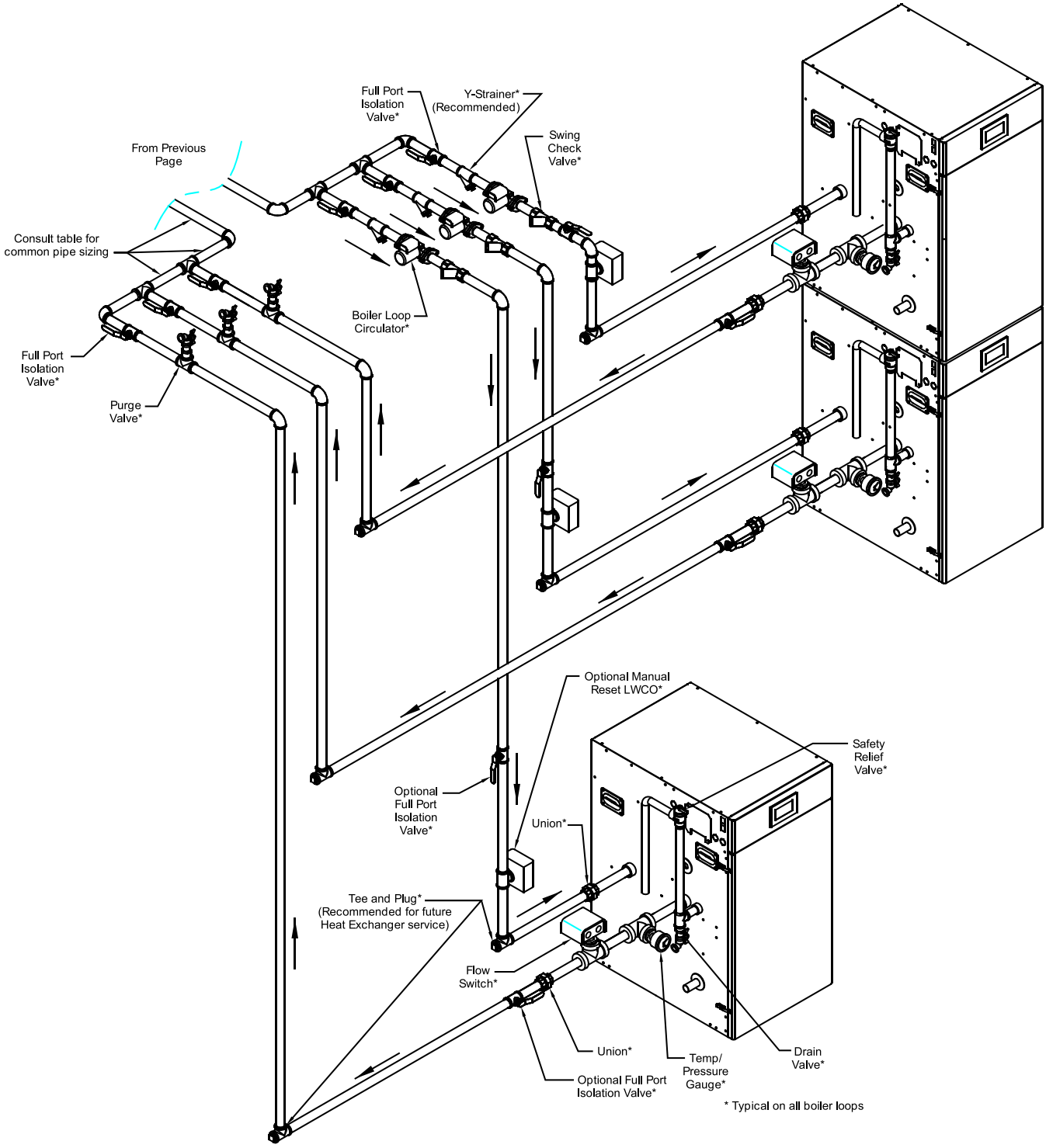
6 Water Piping and Trim *(continued)*



NOTICE: Installing a low water cutoff in the system piping of multiple boilers is strongly recommended and may be required by local codes.

Figure 6-16: Multiple Boiler Water Piping w/Domestic Hot Water Heater (Page 1 of 2)

6 Water Piping and Trim *(continued)*



NOTICE: Installing a low water cutoff in the system piping of multiple boilers is strongly recommended and may be required by local codes.

Figure 6-16, continued: Multiple Boiler Water Piping w/Domestic Hot Water Heater (Page 2 of 2)

7 Gas Piping

⚠ WARNING

Explosion Hazard.

Failure to properly pipe gas supply to boiler may result in improper operation and damage to the boiler or structure. Always assure gas piping is absolutely leak free and of the proper size and type for the connected load.

An additional gas pressure regulator may be needed. Consult gas supplier.

NOTICE: Size corrugated stainless steel tubing (CSST) to ensure proper capacity and minimize flow restrictions.

A. Size gas piping. Design system to provide adequate gas supply to boiler. Consider these factors:

1. Allowable pressure drop from point of delivery to boiler. Maximum allowable system pressure is ½ psig (3.4 kPa). Actual point of delivery pressure may be less; contact gas supplier for additional information. Minimum gas valve inlet pressure is printed on the rating label located in the boiler's vestibule compartment.
2. Maximum gas demand. Refer to the boiler's input as printed on its rating label. Also consider existing and expected future gas utilization equipment (i.e. water heater, cooking equipment).
3. Length of piping and number of fittings. Refer to Tables 7-1 (natural gas) or 30 (LP gas) for maximum capacity of Schedule 40 pipe. Table 7-3 lists equivalent pipe length for standard fittings.
4. Specific gravity of gas. Gas piping systems for gas with a specific gravity of 0.60 can be sized directly from Table 7-1 and gas with a specific gravity of 1.5 can be sized from Table 7-2, unless authority having jurisdiction specifies a gravity factor be applied. For other specific gravity, apply gravity factor from Table 7-4. If exact specific gravity is not shown choose next higher value.

Table 7-1: Maximum Capacity of Schedule 40 Black Pipe in CFH* (Natural Gas) For Gas Pressures of 1/2 psi (3.4 kPa) or Less

Inlet Pressure 14.0 in wc (3.4 kPa)or less; 0.3 in wc (0.07 kPa) Pressure Drop											
Nominal Pipe Size, In.	Inside Diameter, In.	Length of Pipe, Ft.									
		10	20	30	40	50	60	70	80	90	100
½	0.622	131	90	72	62	55	50	46	42	40	38
¾	0.824	273	188	151	129	114	104	95	89	83	79
1	1.049	514	353	284	243	215	195	179	167	157	148
1¼	1.380	1060	726	583	499	442	400	368	343	322	304
1½	1.610	1580	1090	873	747	662	600	552	514	482	455
2	2.067	3050	2090	1680	1440	1280	1160	1060	989	928	877
2½	2.469	4860	3340	2680	2290	2030	1840	1690	1580	1480	1400
3	3.068	8580	5900	4740	4050	3590	3260	3000	2790	2610	2470

Inlet Pressure 14.0 in wc (3.4 kPa)or less; 0.5 in wc (0.12 kPa) Pressure Drop											
Nominal Pipe Size, In.	Inside Diameter, In.	Length of Pipe, ft.									
		10	20	30	40	50	60	70	80	90	100
½	0.622	172	118	95	81	72	65	60	56	52	50
¾	0.824	360	247	199	170	151	137	126	117	110	104
1	1.049	678	466	374	320	284	257	237	220	207	195
1¼	1.380	1390	957	768	657	583	528	486	452	424	400
1½	1.610	2090	1430	1150	985	873	791	728	677	635	600
2	2.067	4020	2760	2220	1900	1680	1520	1400	1300	1220	1160
2½	2.469	6400	4400	3530	3020	2680	2430	2230	2080	1950	1840
3	3.068	11300	7780	6250	5350	4740	4290	3950	3674	3450	3260

* 1 CFH of Natural Gas is approximately equal to 1 MBH; contact your gas supplier for the actual heating value of your gas.

7 Gas Piping *(continued)*

For materials or conditions other than those listed above, refer to National Fuel Gas Code, ANSI Z223.1/NFPA 54 or *Natural Gas and Propane Installation Code*, CAN/CSA B149.1, or size system using standard engineering methods acceptable to authority having jurisdiction.

Table 7-4: Specific Gravity Correction Factors

Specific Gravity	Correction Factor	Specific Gravity	Correction Factor
0.60	1.00	0.90	0.82
0.65	0.96	1.00	0.78
0.70	0.93	1.10	0.74
0.75	0.90	1.20	0.71
0.80	0.87	1.30	0.68
0.85	0.81	1.40	0.66

Table 7-2: Maximum Capacity of Schedule 40 Black Pipe in CFH* (LP Gas) For Gas Pressures of 1/2 psi (3.4 kPa) or Less

Inlet Pressure 11.0 in wc (2.7 kPa); 0.3 in wc (0.07 kPa) Pressure Drop											
Nominal Pipe Size, in.	Inside Diameter, in.	Length of Pipe, ft.									
		10	20	30	40	50	60	70	80	90	100
½	0.622	88	60	48	41	37	33	31	29	27	25
¾	0.824	184	126	101	87	77	70	64	60	56	53
1	1.049	346	238	191	163	145	131	121	112	105	100
1¼	1.380	710	488	392	336	297	269	248	231	216	204
1½	1.610	1064	732	588	503	446	404	371	346	324	306
2	2.067	2050	1409	1131	968	858	778	715	666	624	590
2½	2.469	3267	2246	1803	1543	1368	1239	1140	1061	995	940
3	3.068	5776	3970	3188	2729	2418	2191	2016	1875	1760	1662

Inlet Pressure 11.0 in wc (2.7 kPa); 0.5 in wc (0.12 kPa) Pressure Drop											
Nominal Pipe Size, in.	Inside Diameter, in.	Length of Pipe, ft.									
		10	20	30	40	50	60	70	80	90	100
½	0.622	116	80	64	55	48	44	40	38	35	33
¾	0.824	242	166	134	114	101	92	85	79	74	70
1	1.049	456	314	252	215	191	173	159	148	139	131
1¼	1.380	937	644	517	442	392	355	327	304	285	269
1½	1.610	1403	964	775	663	588	532	490	456	427	404
2	2.067	2703	1858	1492	1277	1131	1025	943	877	823	778
2½	2.469	4308	2961	2377	2035	1803	1634	1503	1399	1312	1239
3	3.068	7615	5234	4203	3597	3188	2889	2658	2472	2320	2191

* 1 CFH of LP Gas is approximately equal to 2.5 MBH; contact your gas supplier for the actual heating value of your gas.

Table 7-3: Equivalent Lengths of Standard Pipe Fittings & Valves (ft.)

Nominal Pipe Size, in.	Inside Diameter, in.	Valves (Screwed) - Fully Open				Screwed Fittings				
		Gate	Globe	Angle	Swing Check	45° Elbow	90° Elbow	180 Close Return Bend	90 Tee Flow Through Run	90 Tee, Flow Through Branch
½	0.622	0.4	17.3	8.7	4.3	0.7	1.6	3.5	1.6	3.1
¾	0.824	0.5	22.9	11.4	5.7	1.0	2.1	4.6	2.1	4.1
1	1.049	0.6	29.1	14.6	7.3	1.2	2.6	5.8	2.6	5.2
1¼	1.38	0.8	38.3	19.1	9.6	1.6	3.5	7.7	3.5	6.9
1½	1.61	0.9	44.7	22.4	11.2	1.9	4.0	9.0	4.0	8.0
2	2.067	1.2	57.4	28.7	14.4	2.4	5.2	11.5	5.2	10.3
2½	2.469	1.4	68.5	34.3	17.1	2.9	6.2	13.7	6.2	12.3
3	3.068	1.8	85.2	42.6	21.3	3.6	7.7	17.1	7.7	15.3

7 Gas Piping *(continued)*

⚠ WARNING

Explosion Hazard.

- Failure to use proper thread compounds on all gas connectors may result in leaks of flammable gas.
- Gas supply to boiler and system must be absolutely shut off prior to installing or servicing boiler gas piping.

B. Connect Boiler Gas Valve To Gas Supply System

1. Use methods and materials in accordance with local plumbing codes and requirements of gas supplier. In absence of such requirements, follow *National Fuel Gas Code*, ANSI Z223.1/ NFPA 54 and/or *Natural Gas and Propane Installation Code,* CAN/CSA B149.1.
2. Use thread (joint) compounds (pipe dope) resistant to action of liquefied petroleum gas.
3. Apex boilers have factory supplied miscellaneous parts cartons, which include gas-piping components to connect boiler gas valve(s) to gas supply system. Install these components prior to connecting boiler to gas supply system piping as follows:

Boiler Model	Miscellaneous Parts Carton
APX425C	106315-01
APX525C	106316-01
APX625C	106317-01
APX725C	
APX825C	

Models APX425C and APX525C

a. Locate and remove the ¾ in. NPT x 6 in. long black nipple and ¾ in. NPT external gas shutoff valve (required).

b. Insert nipple though grommet in left side panel. Apply pipe dope and thread nipple into gas valve (APX425C) or gas inlet tee (APX525C).

c. Mount the ¾ in. NPT external gas shutoff valve onto the nipple threaded end outside of the jacket left side panel.

d. Install sediment trap, ground-joint union and manual shut-off valve upstream of mounted factory supplied manual shut-off valve. See Figure 7-5 “Recommended Gas Piping”.

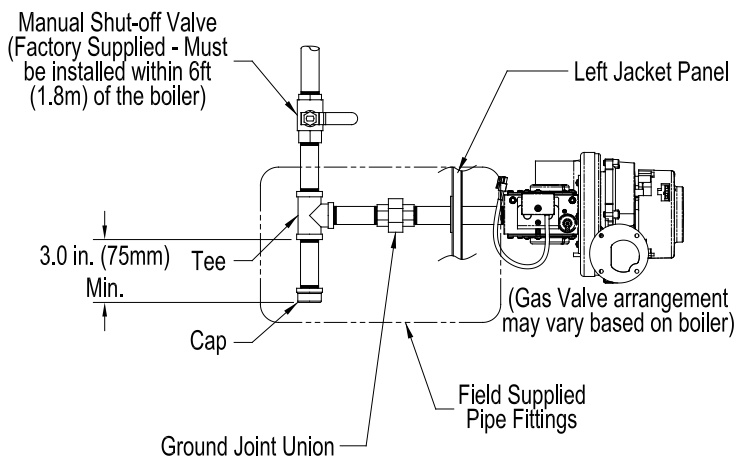


Figure 7-5: Recommended Gas Piping

Models APX625C, APX725C and APX825C

e. Locate and remove 1 in. NPT external gas shutoff valve (required).

f. Insert nipple through grommet in left side panel. Apply pipe dope and thread nipple into gas inlet tee or cross.

g. Mount the 1 in. NPT external gas shutoff valve onto the nipple threaded end outside of the jacket left side panel.

h. Install sediment trap, ground-joint union and manual shut-off valve upstream of mounted factory supplied manual shut-off valve. See Figure 7-5 “ Recommended Gas Piping”.

4. All above ground gas piping upstream from manual shut-off valve must be electrically continuous and bonded to a grounding electrode. Do not use gas piping as grounding electrode. Refer to *National Electrical Code*, NFPA 70 and/or *Canadian Electrical Code* Part 1, CSA C22.1, Electrical Code.

Table 7-6: Min./Max. Inlet Gas Pressure Ratings

Boiler Model	Natural/LP Gas Max, in. wc (kPa)	Natural Gas Min, in. wc (kPa)	LP Gas Min, in. wc (kPa)
APX425C	14.0 (3.49)	4.0 (1.00)	8.0 (1.99)
APX525C			
APX625C			
APX725C			
APX825C			

7 Gas Piping *(continued)*

C. Pressure Test

See Table 7-6 for Apex Min./Max. Pressure Ratings. The boiler and its gas connection must be leak tested before placing boiler in operation.

1. Protect boiler gas control valve. For all testing over ½ psig (3.4 kPa), boiler and its individual shutoff valve must be disconnected from gas supply piping. For testing at ½ psig (3.4 kPa) or less, isolate boiler from gas supply piping by closing boiler's individual manual shutoff valve.
2. Locate leaks using approved combustible gas non-corrosive leak detector solution.

⚠ DANGER

Asphyxiation Hazard.

Do not use matches, candles, open flames or other ignition source to check for leaks.

D. Apex Models APX525C, APX625C, APX725C, APX825C (if equipped with optional low and high gas pressure switches)

1. Verify low and high gas pressure switch settings are within the range shown in kit instructions. The switches are preset for natural gas. For LP gas, the low gas pressure switch setting must be adjusted.
2. The low gas pressure switch must be reset after the boiler is piped to the gas supply and before it is fired.
3. For the low and high gas pressure switches proper operation, the boiler inlet gas pressure must be within the range shown in Table 7-6.
4. The gas pressure can be measured at the gas valve inlet pressure port. Refer to Figure 7-7 "Gas Inlet Pressure Tap and Pressure Switch Location ".
5. If either pressure switch is tripped, it must be manually reset before the boiler can be restarted.

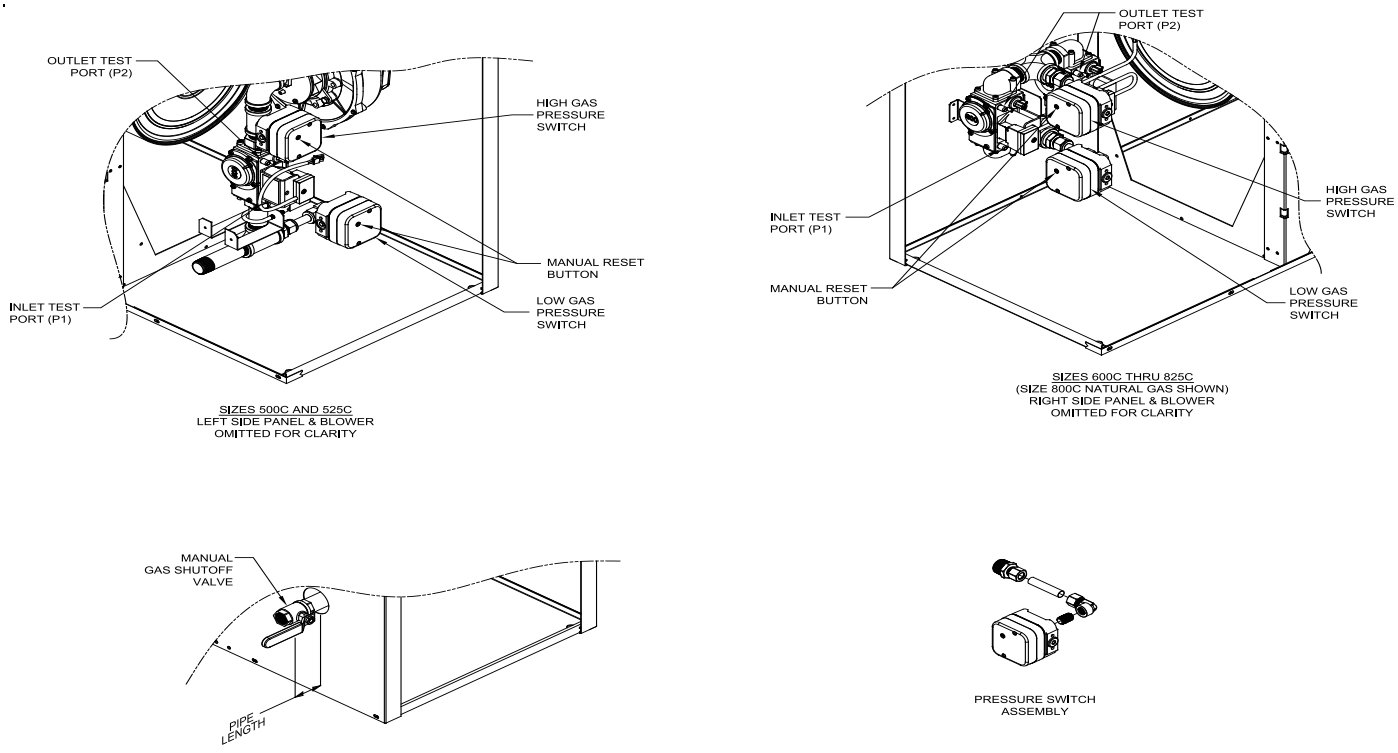


Figure 7-7: Gas Inlet Pressure Tap and Pressure Switch Location

7 Gas Piping *(continued)*

E. Gas Piping for Multiple Boiler Installation

1. Individual module (boiler) gas pipe sizing specific details - see Paragraph A.
2. Individual module (boiler) recommended gas piping detail - see Figure 7-5.
3. An additional gas pressure regulator(s) may need to be installed to properly regulate inlet gas pressure at the smallest individual module (boiler).

⚠ CAUTION

If gas pressure in the building is above ½ psig (3.4 kPa), an additional gas pressure regulator is required. Using one additional regulator for multiple boilers may result in unsafe boiler operation. The additional regulator must be able to properly regulate gas pressure at the input of the smallest boiler. If the regulator cannot do this, two or more additional regulators are required. Consult regulator manufacturer and/or local gas supplier for instructions and equipment ratings.

8 Electrical

⚠ DANGER

Electrical Shock Hazard.

Positively assure all electrical connections are unpowered before attempting installation or service of electrical components or connections of the boiler or building. Lock out all electrical boxes with padlock once power is turned off.

⚠ WARNING

Electrical Shock Hazard.

- Failure to properly wire electrical connections to the boiler may result in serious physical harm.
- Electrical power may be from more than one source. Make sure all power is off before attempting any electrical work.
- Each boiler must be protected with a properly sized over-current device.
- Never jump out or make inoperative any safety or operating controls.
- The wiring diagrams contained in this manual are for reference purposes only. Each boiler is shipped with a wiring diagram attached to the front door. Refer to this diagram and the wiring diagram of any controls used with the boiler. Read, understand and follow all wiring instructions supplied with the controls.

A. General Install wiring and electrically ground boiler in accordance with authority having jurisdiction or, in the absence of such requirements, follow the *National Electrical Code,* NFPA 70, and/or *Canadian Electrical Code* Part 1, CSA C22.1 Electrical Code. Provide over current protection not greater than 15A.

B. A Separate Electrical Circuit must be run from the main electrical service with an over-current device/disconnect in the circuit. A service switch is recommended and may be required by some local jurisdictions. Install the service switch in the line voltage "Hot" leg of the power supply. Locate the service switch such that the boiler can be shut-off without exposing personnel to danger in the event of an emergency.

C. Power Requirements

Nominal boiler current draw is provided in Table 8-1. These values are for planning purposes only and represent only the boiler's power consumption. To obtain total system power consumption add any selected circulator and component current draws.

Table 8-1: Boiler Current Draw

Model Number	Nominal Current (amps)
APX425C	< 7
APX525C	< 6
APX625C	< 8
APX725C	< 8
APX825C	< 8

D. Boiler Wiring

Refer to Figures 8-5 and 8-6.

1. Connect to field wiring inside the junction box, located on the upper left side of the boiler as shown in Figure 8-2. Inside the junction box are two printed circuit boards (PCB's), 120 VAC Connections on the left and Low Voltage Connections on the right.
2. 120 VAC connections (line voltage) are located on left PCB and are shown in Figure 8-3. Do not exceed 5.6A total pump current draw (system + DHW + boiler pumps). One 6.3A slow-blow pump fuse and spare are provided.

8 Electrical *(continued)*

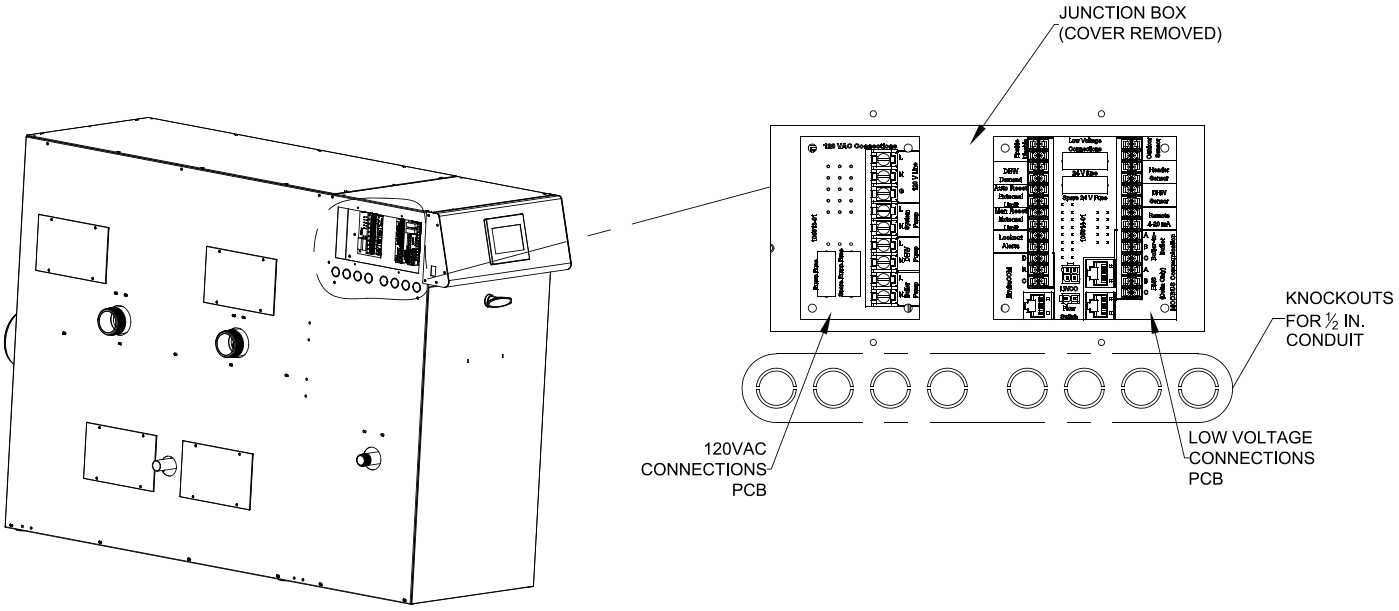


Figure 8-2: PCB Locations for Field Wiring

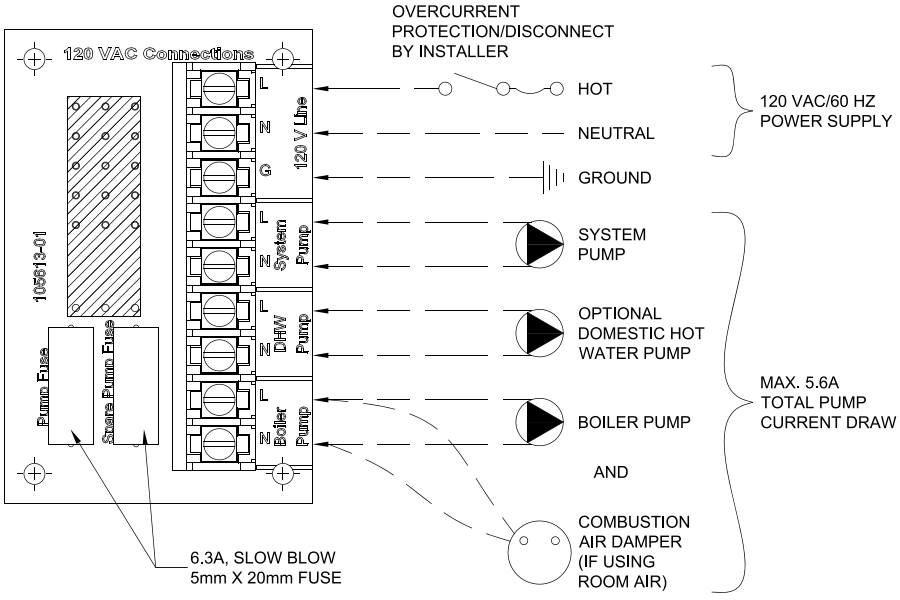


Figure 8-3: 120 VAC Field Wiring

8 Electrical *(continued)*

3. 24 VAC low voltage connections are located on left side of right PCB and are shown in Figure 8-4. One 24V fuse and spare are provided. APX425C and APX525C use 1.6A slow-blow fuse. APX625C, APX725C and APX825C use 2.0A fast-acting fuse.
4. 5VDC low voltage connections are located on right side of right PCB and are shown in Figure 8-3.
5. If the outdoor sensor is connected, the boiler will adjust the target space heating set point supply water temperature downwards as the outdoor air temperature increases. If used, this sensor should be located on the outside of the structure in an area where it will sense the average air temperature around the house. Avoid placing this sensor in areas where it may be covered with ice or snow. Locations where the sensor will pick up direct radiation from the sun should also be avoided. Avoid placing the sensor near potential sources of electrical noise such as transformers, power lines, and fluorescent lighting. Wire the sensor to the boiler using 22 gauge or larger wire. As with the sensor, the sensor wiring should be routed away from sources of electrical noise. Where it is impossible to avoid such noise sources, wire the sensor using a 2 conductor, UL Type CM, AWM Style 2092, 300 Volt 60°C shielded cable. Connect one end of the shielding on this cable to ground.

NOTICE: When making low voltage connections, make sure that no external power source is present in the thermostat or limit circuits. If such a power source is present, it could destroy the boiler's microprocessor control. One example of an external power source that could be inadvertently connected to the low voltage connections is a transformer in old thermostat wiring.

E. Flow Switch Wiring

Apex boilers require a flow switch to prevent boiler overheating. See Section 6 "Water Piping and Trim", and flow switch instruction sheet for piping details. The flow switch and flow switch wire harness are factory provided.

1. Wire flow switch harness to boiler. Connect Molex on harness to boiler low voltage connector P11, labeled "Flow Switch".
2. Wire flow switch harness to flow switch. Connect fork terminals on harness to flow switch NO (normally open) and COM (common) terminal screws.

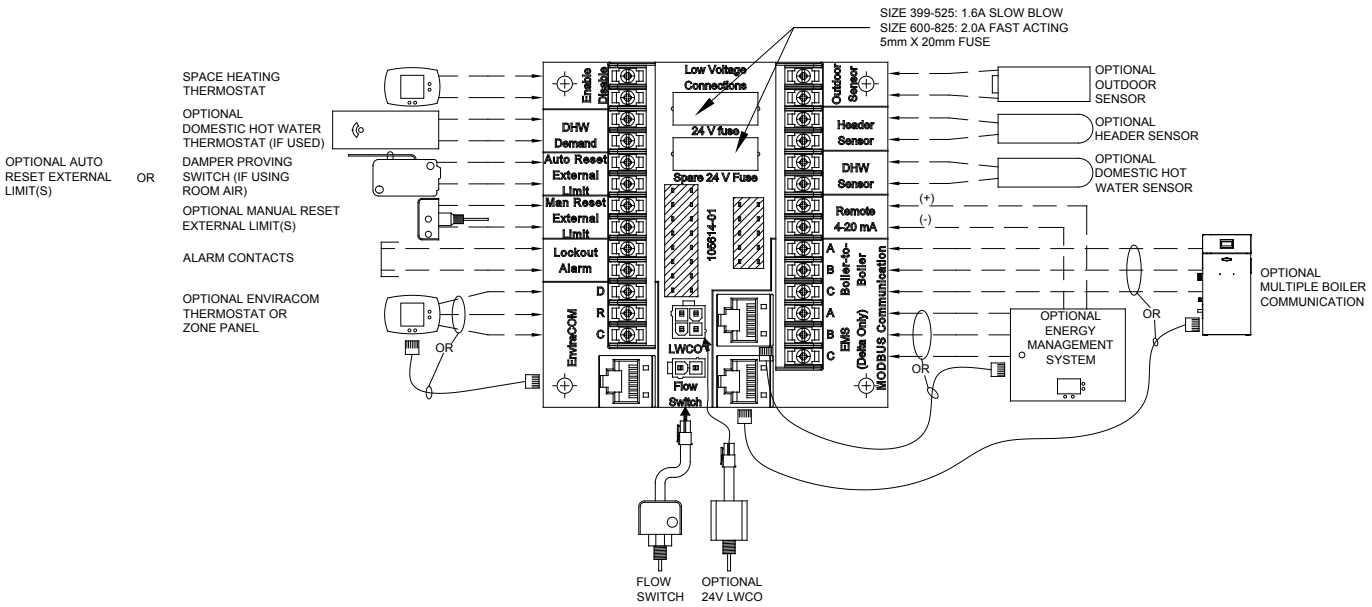


Figure 8-4: Low Voltage Field Wiring

8 Electrical *(continued)*

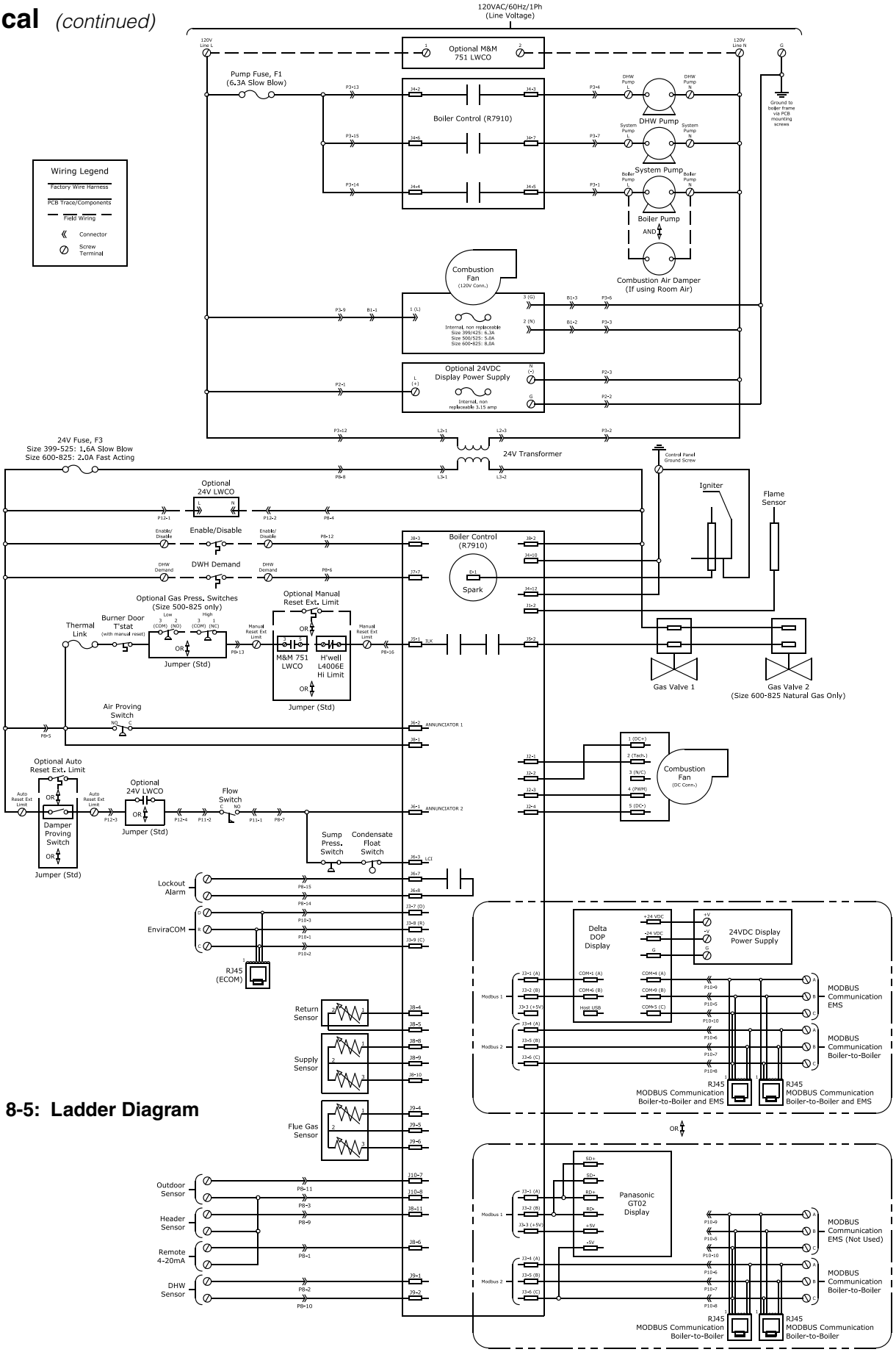
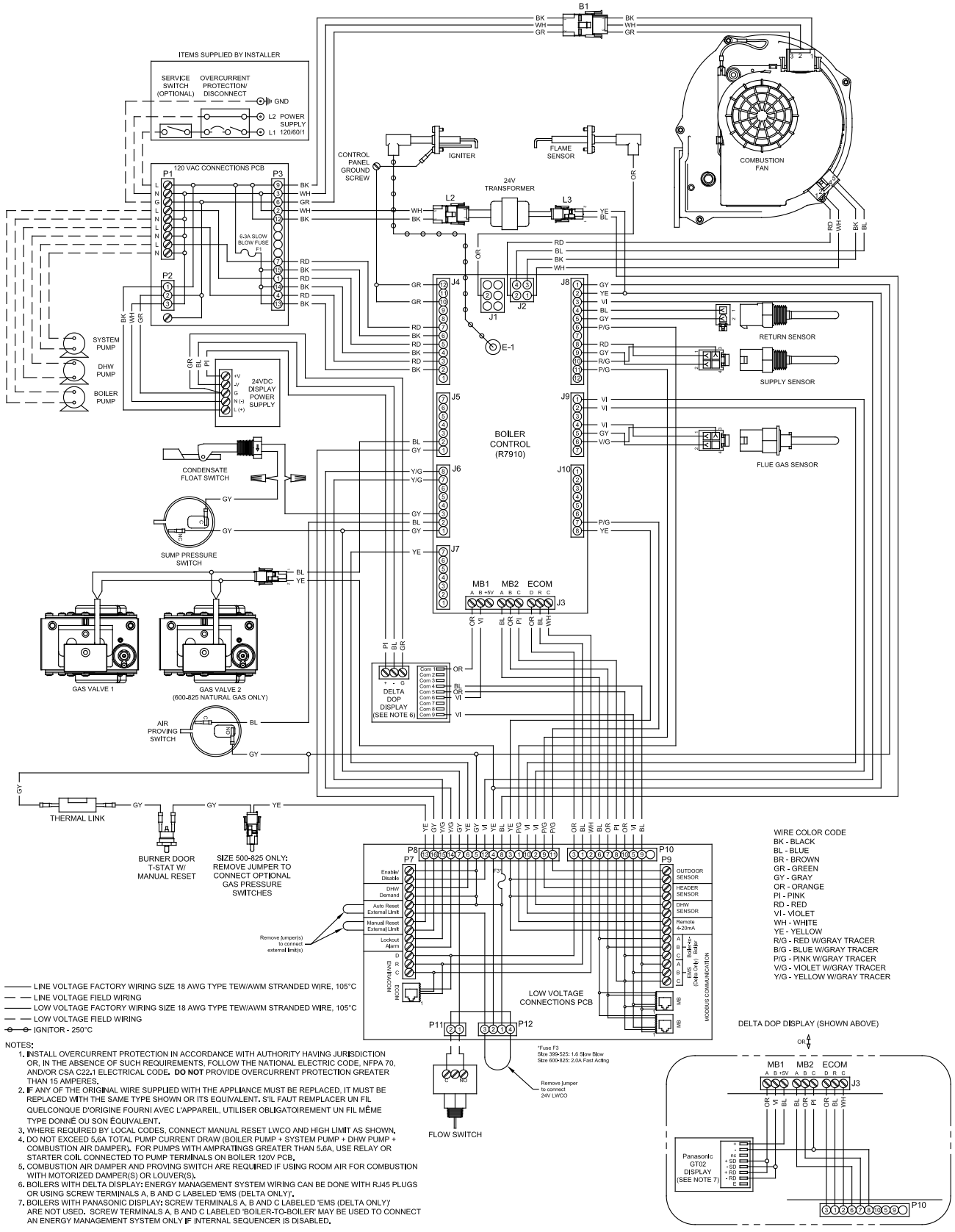


Figure 8-5: Ladder Diagram

8 Electrical *(continued)*



NOTES:

1. INSTALL OVERCURRENT PROTECTION IN ACCORDANCE WITH AUTHORITY HAVING JURISDICTION OR, IN THE ABSENCE OF SUCH REQUIREMENTS, FOLLOW THE NATIONAL ELECTRIC CODE, NFPA 70, AND/OR CSA C22.1 ELECTRICAL CODE. **DO NOT** PROVIDE OVERCURRENT PROTECTION GREATER THAN 15 AMPERES.
2. IF ANY OF THE ORIGINAL WIRE SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH THE SAME TYPE SHOWN OR ITS EQUIVALENT. S'IL FAUT REMPLACER UN FIL QUELCONQUE D'ORIGINE FOURNI AVEC L'APPAREIL, UTILISER OBLIGATOIREMENT UN FIL MÊME TYPE DONNÉ OU SON ÉQUIVALENT.
3. WHERE REQUIRED BY LOCAL CODES, CONNECT MANUAL RESET LWCO AND HIGH LIMIT AS SHOWN.
4. DO NOT EXCEED 5.6A TOTAL PUMP CURRENT DRAW (BOILER PUMP + SYSTEM PUMP + DHW PUMP + COMBUSTION AIR DAMPER). FOR PUMPS WITH AMPRATINGS GREATER THAN 5.6A, USE RELAY OR STARTER COIL CONNECTED TO PUMP TERMINALS ON BOILER 120V PCB.
5. COMBUSTION AIR DAMPER AND PROVING SWITCH ARE REQUIRED IF USING ROOM AIR FOR COMBUSTION WITH MOTORIZED DAMPER(S) OR LOUVER(S).
6. BOILERS WITH DELTA DISPLAY: ENERGY MANAGEMENT SYSTEM WIRING CAN BE DONE WITH RJ45 PLUGS OR USING SCREW TERMINALS A, B AND C LABELED 'EMS (DELTA ONLY)'.
7. BOILERS WITH PANASONIC DISPLAY: SCREW TERMINALS A, B AND C LABELED 'EMS (DELTA ONLY)' ARE NOT USED. SCREW TERMINALS A, B AND C LABELED 'BOILER-TO-BOILER' MAY BE USED TO CONNECT AN ENERGY MANAGEMENT SYSTEM ONLY IF INTERNAL SEQUENCER IS DISABLED.

Figure 8-6: Wiring Connections Diagram

8 Electrical *(continued)*

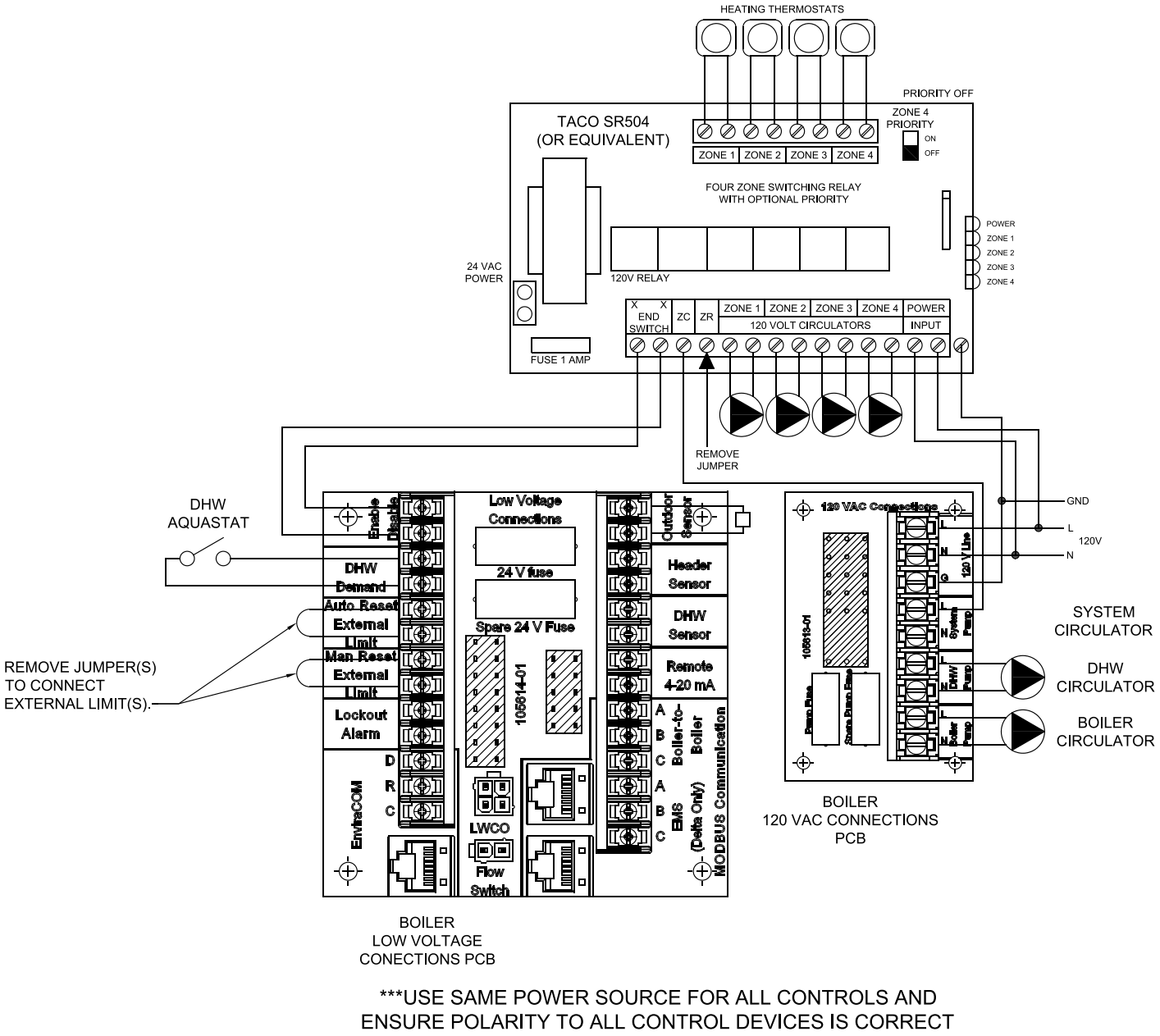


Figure 8-7: Modified Wiring For DHW Priority When Using Low Flow Circulator Piped Off System Header - Heating (with Central Heating Circulators) Plus Alternately Piped Indirect Water Heater

8 Electrical *(continued)*

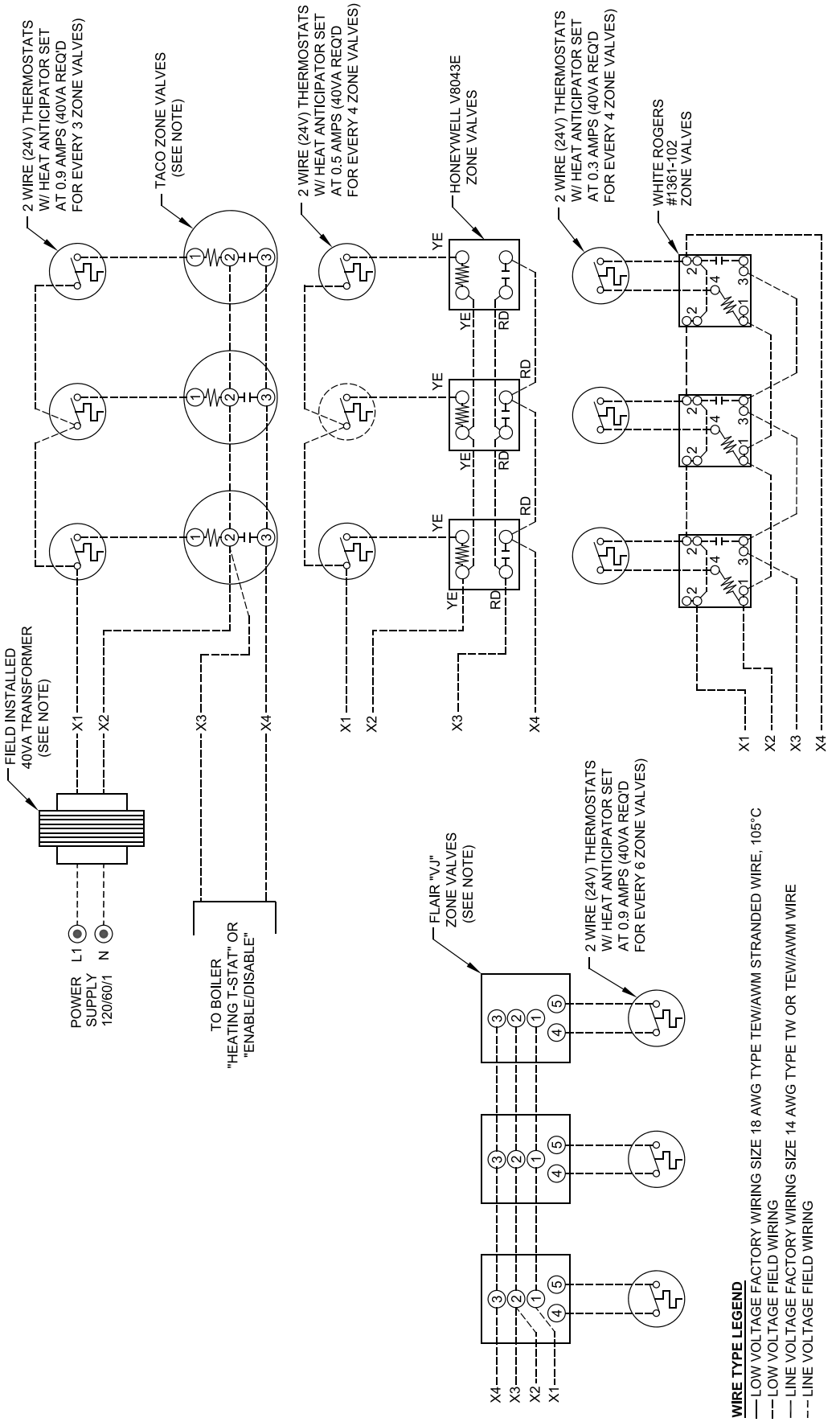


Figure 8-8: Modified Wiring For DHW Priority When Using Low Flow Circulator Piped Off System Header - Heating (with Central Heating Zone Valves) Plus Alternately Piped Indirect Water Heater

8 Electrical *(continued)*

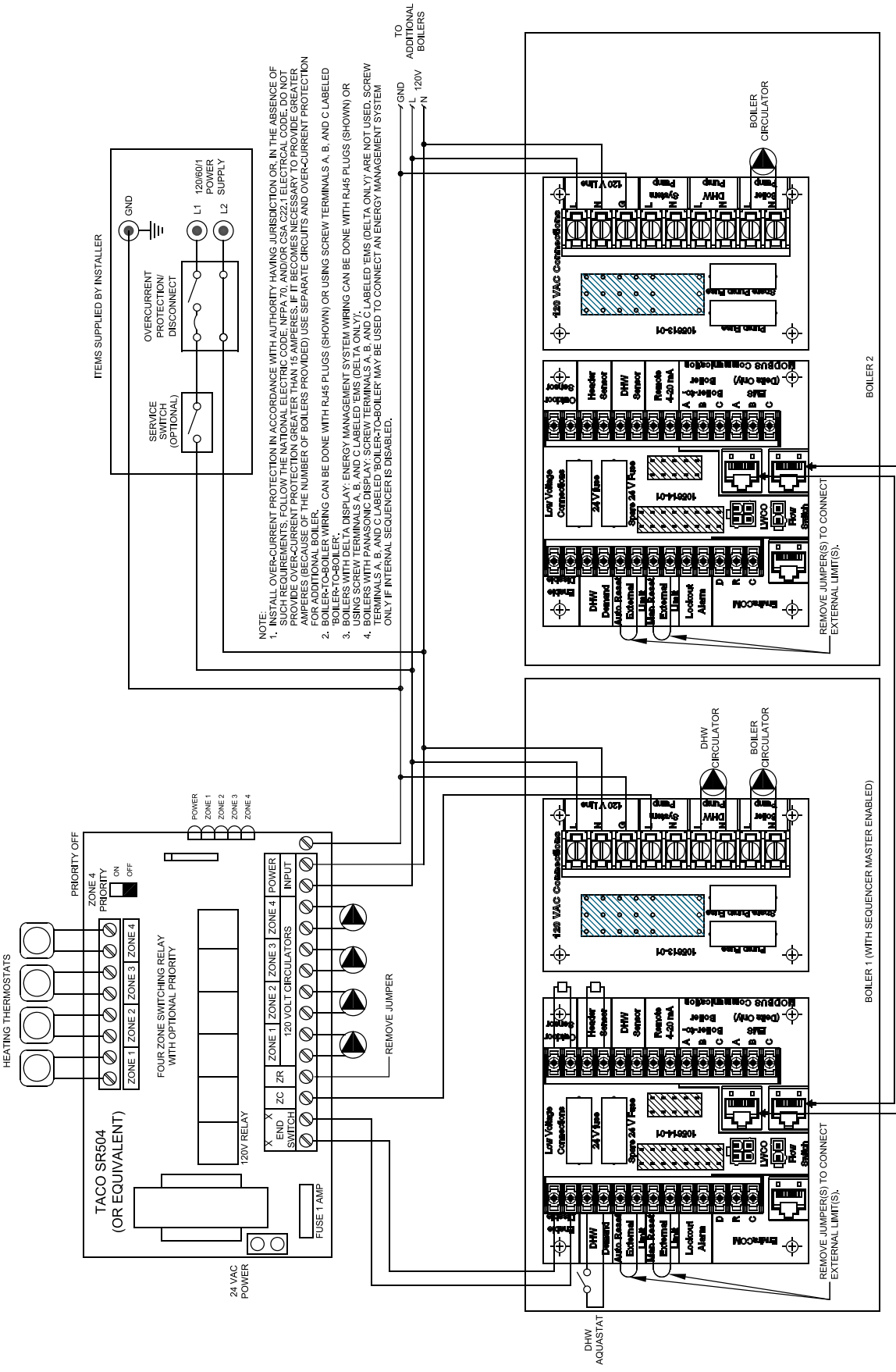


Figure 8-9: Multiple Boiler Wiring Diagram
Internal Multiple Boiler Control Sequencer
(Two Boilers Shown, Typical Connections for up to Eight Boilers)

8 Electrical *(continued)*

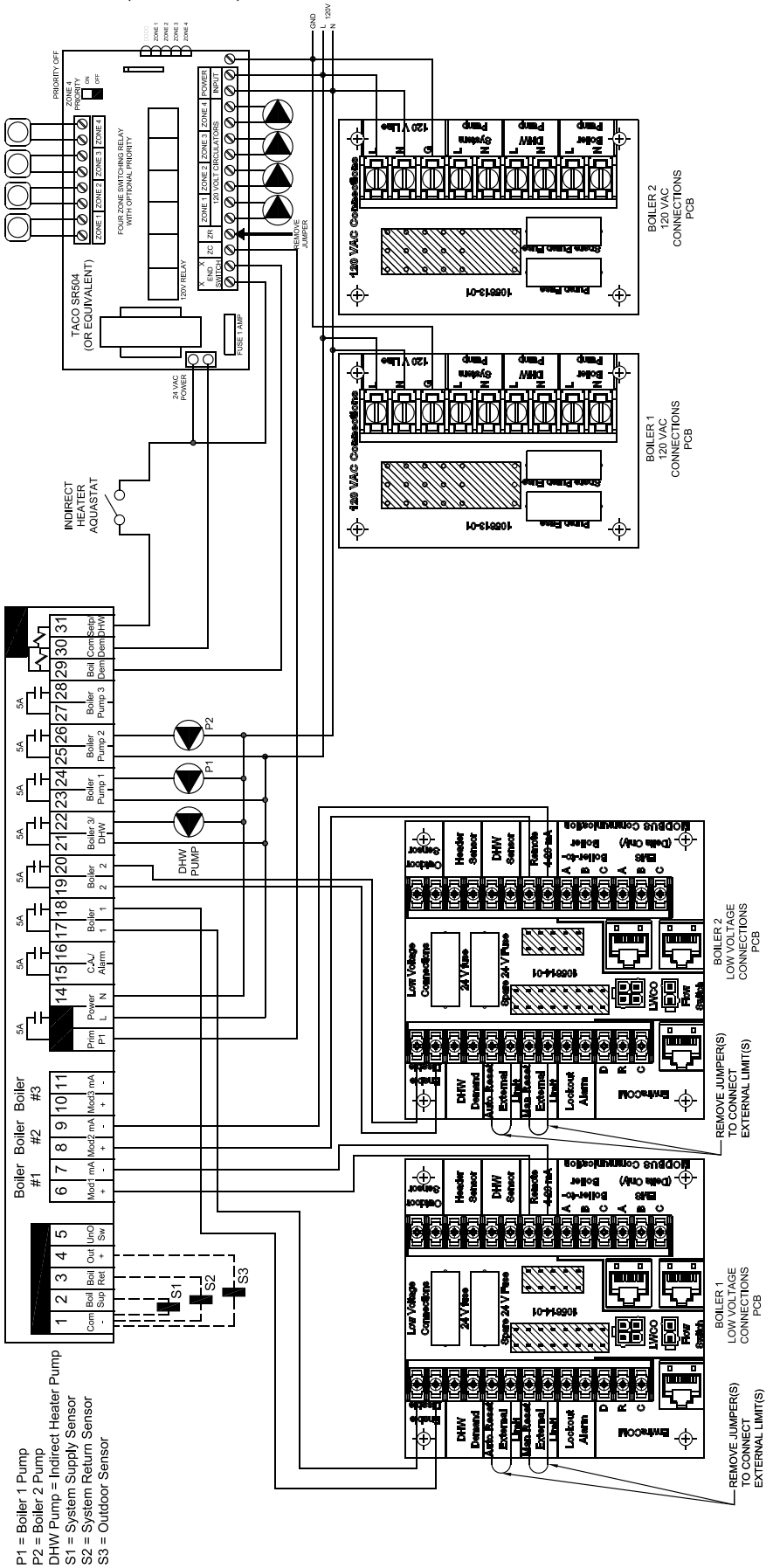


Figure 8-10: Multiple Boiler Wiring Diagram w/Tekmar 265 Control

Tekmar 265 Based Control System (or equal)
Sequence of Operation

The Tekmar 265 Control (or equal) can control up to three (3) boilers and an Indirect Water Heater. When a call for heat is received by the Tekmar 265 Control, the control will fire either one or more boilers in either parallel or sequential firing mode to establish a required reset water temperature in the system supply main based on outdoor temperature. The boilers will modulate based on an Analog communication signal established between the Tekmar 265 Control and each boiler's control. The boiler(s) and system supply water temperature will be reset together to maintain the input that is needed to the system. When a call for Indirect Hot Water is generated to the Tekmar 265, the control will de-energize the zone pump control (ZC terminal), energize the Indirect pump and modulate the boiler firing to establish a setpoint temperature in the main for the Indirect Heater using Priority. The Tekmar 265 also controls each boiler's pump and a post purge of leftover temperature in the boilers will occur at the end of the call for Indirect Hot Water.

8 Electrical *(continued)*

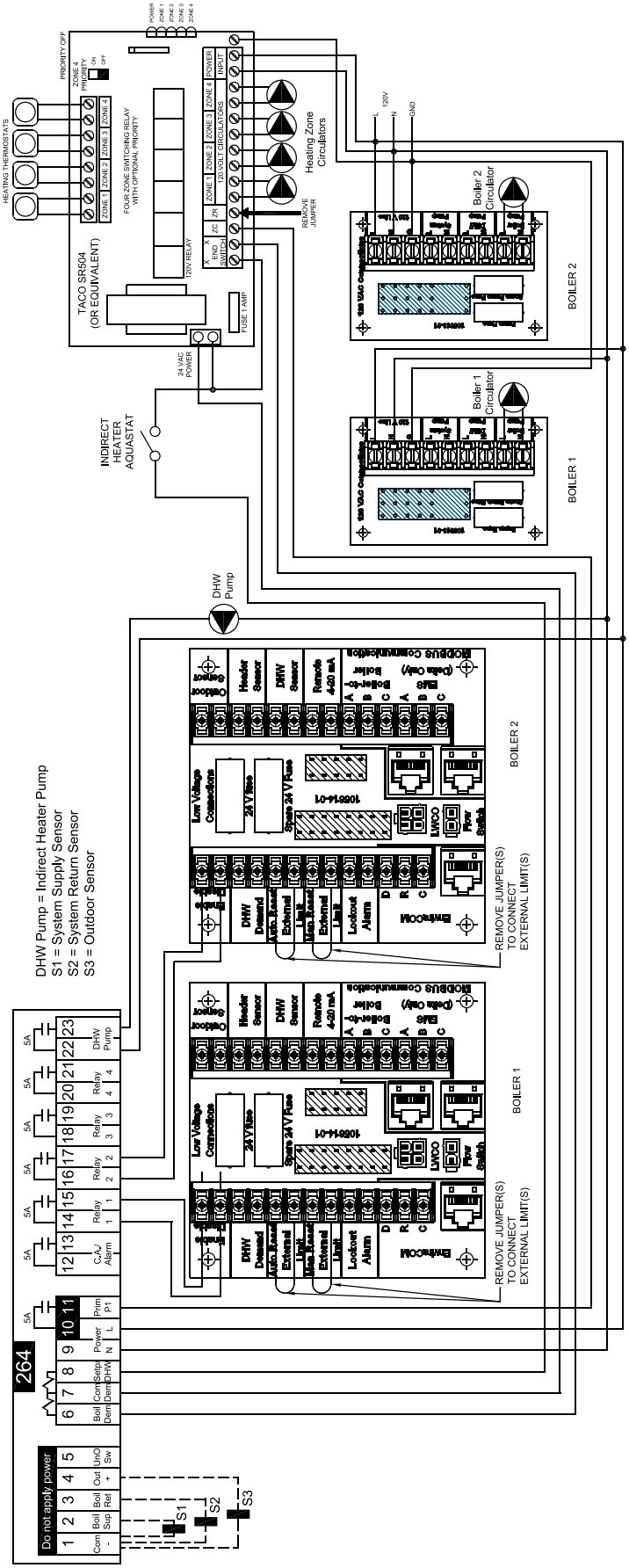


Figure 8-11: Multiple Boiler Wiring Diagram w/Tekmar 264 Control

Tekmar 264 Based Control System (or equal)
Sequence of Operation

The Tekmar 264 Control (or equal) can control up to four (4) boilers and an Indirect Water Heater by utilizing stage firing. When a call for heat is received by the Tekmar 264 Control, the control will fire either one or more boilers in sequential firing mode to establish a required reset water temperature in the system supply main based on outdoor temperature. The boilers will modulate on their own based on each boiler's control and will target a setpoint temperature to supply enough input to the system main to satisfy the desired reset water temperature in the main established by the Tekmar 264 Control. When a call for Indirect Hot Water is generated to the Tekmar 264, the control will de-energize the zone pump control (ZC terminal), energize the Indirect pump and sequentially fire the boilers to establish a setpoint temperature in the main for the Indirect Heater using Priority. The Tekmar 264 Control will disable the stage firing and post purge the Indirect Pump to reduce the temperature in the Supply Main near the end of the Indirect Mode to a point where it will need to be when it changes back to Space Heating Mode. The Tekmar 264 Control also has the ability to rotate the lead-lag firing of the boilers to establish equal operating time for each boiler stage.

8 Electrical *(continued)*

F. Multiple Boiler Wiring

1. Install over-current protection in accordance with authority having jurisdiction or, in the absence of such requirements, follow the National Electric Code, NFPA 70, and/or Canadian Electrical Code Part 1, CSA C22.1. Do not provide over-current protection greater than 15 amperes. If it becomes necessary to provide greater amperes (because of the number of boilers provided) use separate circuits and over-current protection for additional boilers.
2. Required Equipment and Setup
   a. Header Sensor (P/N 101935-01 or 103104-01).A header sensor must be installed and wired to the Sequencer Master boiler. The header sensor is installed on the common system piping and provides blended temperature information to the Sequence Master. Refer to Figure 6-16 for installation location and Figure 6-14 or 6-15 for installation detail.
   b. Ethernet Cables

      Ethernet cables are used to connect the boiler network together. These are standard "straight through" cables that can be purchased at electrical distributors.

      Alternately, the network can be wired together by simply wiring Modbus Boiler-to-Boiler terminals A, B, and C between each boiler. Refer to Figures 8-5, 8-6 and 8-9 for wiring location.

G. External Multiple Boiler Control System

As an alternate to the control internal sequencer, the control also accepts an input from an external sequencer. Follow multiple boiler control system manufacturer (Honeywell, Tekmar, etc.) instructions to properly apply a multiple boiler control system. The Tekmar Model 264 and Model 265 based control wiring diagrams (Figures 8-10 and 8-11) are provided as examples of typical multiple boiler control systems.

9 System Start-up

⚠ WARNING

Explosion Hazard. Asphyxiation Hazard. Electrical Shock Hazard.

Start-up of this boiler should be undertaken only by trained and skilled personnel from a qualified service agency. Follow these instructions exactly. Improper installation adjustment, service or maintenance can cause property damage, personal injury or death.

A. Verify that the Venting, Water Piping, Gas Piping and Electrical System are Installed Properly. Refer to installation instructions contained in this manual.

B. Confirm all Electrical, Water and Gas Supplies are Turned Off at the Source and that vent is clear of obstructions.

C. Confirm that all Manual Shut-off Gas Valves between the boiler and gas source are closed.

D. Heating System Cleaning and Treatment

⚠ CAUTION

Component Damage.

Proper flushing, cleaning, and water side maintenance is highly recommended to protect boiler heat exchanger. Scaling and sediment build up may not be covered under warranty.

1. Flush entire heating system to remove sediment, flux, and traces of boiler additives
2. It is recommended to clean the heating system with an approved cleaner such as the following or an equivalent:
   · Fernox F3 Cleaner
   · Sentinel X400 System Restorer

Follow the manufactures instructions for proper dosage and use.

Note: Cleaning the system prior to removing the old boiler or by isolating the new boiler from the system while cleaning it will be more beneficial

9 System Start-up *(continued)*

3. Once a system is cleaned, use of an inhibitor is also recommended such as the following or an equivalent:
   · Fernox F1 Protector
   · Sentinel X100 Inhibitor

   Follow the manufactures instructions for proper dosage, use. For long-term protection ensure concentration levels are maintained and checked annually as part of the boiler or system service.
4. Boiler system water should meet the following criteria. pH between 7.5 and 9.5.

   If system contains aluminum components, pH must be less than 8.5.

   Chlorides< 50 ppm.

   Total Dissolved Solids - less than 2500 PPM.

   Hardness - 3 to 9 grains/gallon.

Pressurize the system to at least 14.5 psi (100 kPa). Purge air from the system. A manual air vent is located on the right side of the heat exchanger.

⚠ WARNING

Burn Hazard.

The maximum operating pressure of this boiler is 30 psig (210 kPa), 50 psig (340 kPa), 60 psig (410 kPa), 80 psig (550 kPa) or 100 psig (689 kPa) depending on the model and safety relief valve option selected. Never exceed the maximum allowable working pressure on the heat exchanger ASME plate.

E. Confirm that the Boiler and System Have No Water Leaks

NOTICE: If it is required to perform a long term pressure test of the hydronic system, the boiler should first be isolated to avoid a pressure loss due to the escape of air trapped in the boiler.

To perform a long term pressure test including the boiler, ALL trapped air must first be removed from the boiler.

A loss of pressure during such a test, with no visible water leakage, is an indication that the boiler contained trapped air.

F. Check all Gas Piping for Leaks and purge piping sections that are filled with air. Refer to *National Fuel Gas Code*, ANSI Z223.1/NFPA 54 or, in Canada, *Natural Gas and Propane Installation Code*, CAN/CSA B149.1.

⚠ DANGER

Explosion Hazard.

Do not use matches, candles, open flames or other ignition source to check for leaks.

Make sure that the area around the boiler is clear and free from combustible materials, gasoline and other flammable vapors and liquids.

G. Confirm Vent System is Complete and free of obstructions before attempting to fire boiler.

H. Inspect all Wiring for loose, uninsulated, or miswired connections.

I. If Boiler is to be Converted to LP Gas (propane), convert as described in Part T of this section of the manual. Only models APX425C and APX525C can be converted to LP gas. Models APX625C, APX725C and APX825C are factory built for LP gas and cannot be converted.

J. If Boiler is Operating at Elevations Above 2,000 ft., see Appendix A for setup instructions.

K. Start Boiler Using Operating Instructions in Figure 9-1. After the boiler is powered up with a call for heat, the boiler should go through the sequence of operation shown in Table 10-11.

9 System Start-up *(continued)*

FOR YOUR SAFETY READ BEFORE OPERATING/POUR VOTRE SECURITE LISEZ AVANT DE METTRE EN MARCHE

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

AVERTISSEMENT: Quiconque ne respecte pas à la lettre les instructions dans la présente notice risque de déclencher un incendie ou une explosion entraînant des dommages, des blessures ou la mort.

A. This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.

B. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WHAT TO DO IF YOU SMELL GAS:

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

C. Use only your hand to turn the gas control knob. Never use tools. If the knob will not turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

D. 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 which has been under water.

A. Cet appareil ne comporte pas de veilleuse. Il est muni d'un dispositif d'allumage qui allume automatiquement le brûleur. Ne tentez pas d'allumer le brûleur manuellement.

B. AVANT DE FAIRE FONCTIONNER, reniflez tout autour de l'appareil pour déceler une odeur de gaz. Reniflez près du plancher, car certains gaz sont plus lourds que l'air et peuvent s'accumuler au niveau du sol.

QUE FAIRE SI VOUS SENTEZ UNE ODEUR DE GAZ:

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

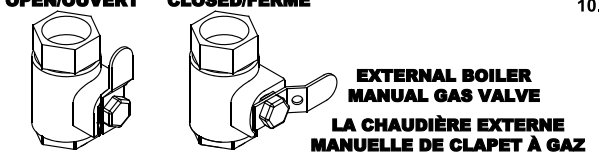
C. Ne poussez ou tournez la manette d'admission du gaz qu'à la main ; ne jamais utiliser d'outil. Si la manette reste coincée, ne pas tenter de la réparer ; appelez un technicien qualifié. Le fait de forcer la manette ou de la réparer peut déclencher une explosion ou un incendie.

D. N'utilisez pas cet appareil s'il a été plongé dans l'eau, même partiellement. Faites inspecter l'appareil par un technicien qualifié et remplacez toute partie du système de contrôle et toute commande qui ont été plongés dans l'eau.

OPERATING INSTRUCTIONS/ INSTRUCTIONS DE FONCTIONNEMENT

1. STOP! Read safety information above on this label.
2. Set the thermostat to lowest setting.
3. Turn off all electric power to the appliance.
4. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
5. Turn the external boiler manual gas valve handle clockwise ↷ to close the gas supply.
6. Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas, STOP! Follow "B" in the safety information above on this label. If you don't smell gas, go to the next step.
7. Turn the external boiler manual gas valve handle counterclockwise ↶ to open the gas supply.
8. Turn on all electric power to the appliance.
9. Set the thermostat to the desired setting.
10. If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

1. ARRÊTEZ ! Lisez les instructions de sécurité sur la portion supérieure cette étiquette.
2. Réglez le thermostat à la température la plus basse.
3. Coupez l'alimentation électrique de l'appareil.
4. Cet appareil est équipé de l' dispositif d'allumage qui automobile allume maticallyle brûleur. Ne tentez pas d'allumer le brûleur manuellement.
5. Tourner la chaudière externe manuelle poignée ↷ en clapet à gaz dans le sens des aiguilles d'une montre pour fermer l'offre de gaz.
6. Attendre cinq (5) minutes pour laisser échapper tout le gaz. Reniflez tout autour de l'appareil, y compris près du plancher, pour déceler une odeur de gaz. Si vous seutez une odeur de gaz, ARRÊTEZ ! Passez à l'étape B des instructions de sécurité sur la portion supérieure de cette étiquette. S'il n'y a pas d'odeur de gaz, passez à l'étape suivante.
7. Tourner la chaudière externe manuelle compteur de poignée ↶ en clapet à gaz ouvrir dans le sens des aiguilles d'une montre le gaz approvisionnement.
8. Mettez l'appareil sous tension.
9. Réglez le thermostat à la température désirée.
10. Si l'appareil ne se met pas en marche, suivez les instructions intitulées « Comment couper l'admission de gaz de l'appareil » et appelez un technicien qualifié ou le fournisseur de gaz.



TO TURN OFF GAS TO APPLIANCE/ COMMENT COUPER L'ADMISSION DE GAZ DE L'APPAREIL

1. Set the thermostat to lowest setting.
2. Turn off all electirc power to the appliance if service is to be performed.
3. Turn the external boiler manual gas valve handle clockwise ↷ to close gas supply.

1. Réglez le thermostat à la température la plus basse.
2. Coupez l'alimentation électrique de l'appareil s'il faut procéder à l'entretien.
3. Tourner la chaudière externe manuelle poignée ↷ en clapet à gaz dans le sens des aiguilles d'une montre pour fermer l'offre de gaz.

Figure 9-1: Operating Instructions

9 System Start-up *(continued)*

L. Upon Initial Start-up, Gas Train Will be Filled with Air

Even if the gas line has been completely purged of air, it may take several tries for ignition before a flame is established. If more than 2 tries for ignition are needed, it will be necessary to press the reset button to restart the boiler. Once a flame has been established for the first time, subsequent calls for burner operation should result in a flame on the first try.

M. Check Burner Flame

Inspect the flame visible through the window. On high fire the flame should be stable and mostly blue (Figure 9-4). No yellow tipping should be present; however, intermittent flecks of yellow and orange in the flame are normal.

N. Check Gas Inlet Pressure

Check the inlet pressure and adjust if necessary. Verify that the inlet pressure is between the upper and lower limits shown on the rating plate with all gas appliances on and off.

⚠ WARNING

Asphyxiation Hazard.

The outlet pressure for the gas valve has been factory set and requires no field adjustment. This setting is satisfactory for both natural gas and propane. Attempting to adjust the outlet pressure may result in damage to the gas valve and cause property damage, personal injury or death.

O. Perform Combustion Test

⚠ WARNING

Asphyxiation Hazard.

Each Apex Series boiler is tested at the factory and adjustments to the air fuel mixture are normally not necessary. Improper gas valve or mixture adjustments could result in property damage, personal injury or death.

⚠ WARNING

Any gas valve adjustments (throttle and/ or offset) specified herein and subsequent combustion data (%O_2, %CO_2, CO air free ppm) collection must be performed using a calibrated combustion analyzer.

Failure to use combustion analyzer could result in property damage, personal injury or death.

1. Use a combustion analyzer to sample boiler flue gas and measure O_2 (or CO_2) and CO air free. Boilers are equipped with a screw cap in the vent connector. Be sure to replace this cap when combustion testing complete.
2. Verify O_2 (or CO_2) and CO air free are within limits specified in Table 9-2 for natural gas or Table 9-3 for LP gas (propane). **Note**: Tables 9-2 and 9-3 are for sea level only. For altitudes above 2,000 ft., see Appendix A.
   a. Lock boiler in high fire and allow fan speed and combustion analyzer reading to stabilize before taking combustion readings. To lock boiler in high fire, select MAIN MENU >> OPERATION. Select lock symbol, type password “86” and select ENTER. From the Operation screen, select Automatic / Manual Firing Rate Control >>Manual Modulation. Go back to Operation screen. Then select High Low >> High.

Table 9-2: Natural Gas Typical Combustion Readings (Sea level Only)

Boiler Model	CO_2 %	O_2 %	CO air free (PPM)
APX425C	8.6 - 9.2	4.7 - 5.8	Less than 200 PPM
APX525C	8.7 - 9.2	4.7 - 5.6	
APX625C	8.6 - 9.2	4.7 - 5.6	
APX725C	8.2 - 8.9	5.2 - 6.5	
APX825C	8.2 - 9.1	4.9 - 6.5	

Table 9-3: LP Gas (Propane) Typical Combustion Readings (Sea Level Only)

Boiler Model	CO_2 %	O_2 %	CO air free (PPM)
APX425C	9.4 - 10.2	5.4 - 6.6	Less than 200 PPM
APX525C	9.8 - 10.2	5.4 - 6.0	
APX625C	9.4 - 10.2	5.4 - 6.6	
APX725C	9.7 - 10.0	5.7 - 6.2	
APX825C	9.4 - 10.2	5.4 - 6.6	

9 System Start-up *(continued)*

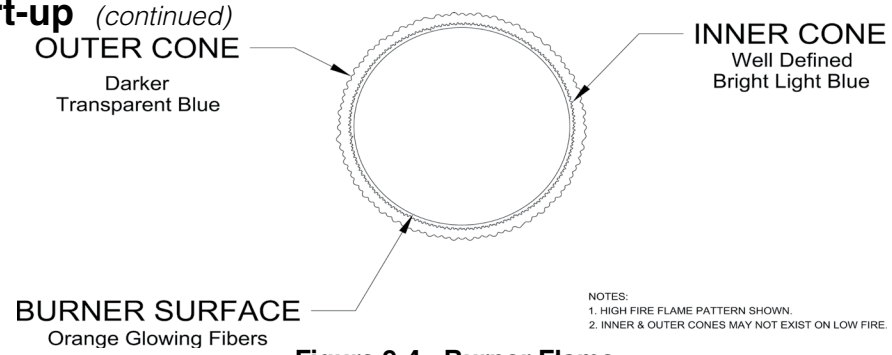


Figure 9-4: Burner Flame

⚠ WARNING

Make sure that all adjustments at high fire are made with the throttle, not offset screw (see Figure 9-5). The offset screw has been factory set using precision instruments and must never be adjusted in the field unnecessarily. Attempting to adjust the offset screw unnecessary could result in damage to the gas valve and may cause property damage, personal injury or death.

b. If high fire O_2 is too low (CO_2 is too high), increase O_2 (decrease CO_2) by turning the throttle screw clockwise in 1/4 turn increments and checking the O_2 (or CO_2) after each adjustment. If boiler is equipped with 2 gas valves, throttle screw adjustments must be done to both gas valves equally and simultaneously. Refer to Figure 9-5 for location of throttle screw. Verify CO air free is less than 200 ppm.

c. If high fire O_2 is too high (CO_2 is too low), decrease O_2 (increase CO_2) by turning the throttle screw counter-clockwise in 1/4 turn increments and checking the O_2 (or CO_2) after each adjustment. If boiler is equipped with 2 gas valves, throttle screw adjustments must be done to both gas valves equally and simultaneously. Refer to Figure 9-5 for location of throttle screw. Verify CO air free is less than 200 ppm.

d. Lock boiler in low fire and allow fan speed and combustion analyzer reading to stabilize before taking combustion readings. To lock boiler in low fire, select High Low >> Low.

⚠ WARNING

Asphyxiation Hazard.

Offset screw is adjusted at the factory to the specification. DO NOT touch the offset screw if measured low fire O_2 (or CO_2) is within limits specified in Table 9-2 or 9-3.

e. If low fire O_2 is too low (CO_2 is too high), increase O_2 (decrease CO_2) by turning offset screw counterclockwise in less than 1/8 turn increments and checking the O_2 (or CO_2) after each adjustment. If boiler is equipped with 2 gas valves, offset screw adjustments must be done to both gas valves equally and simultaneously. Refer to Figure 9-5 for location of offset screw. Verify CO air free is less than 200 ppm.

f. If low fire O_2 is too high (CO_2 is too low), decrease O_2 (increase CO_2) by turning offset screw clockwise in less than 1/8 turn increments and checking the O_2 (or CO_2) after each adjustment. If boiler is equipped with 2 gas valves, offset screw adjustments must be done to both gas valves equally and simultaneously. Refer to Figure 9-5 for location of offset screw. Verify CO air free is less than 200 ppm.

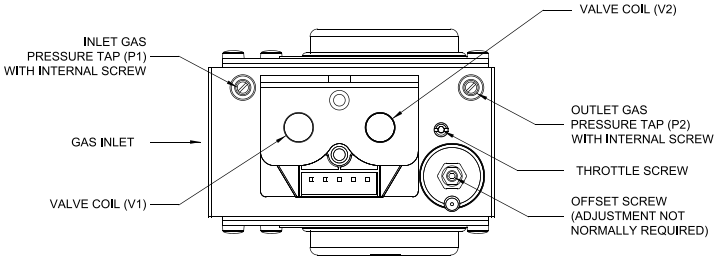


Figure 9-5: Gas Valve Detail

3. Remove analyzer probe and replace cap on boiler vent connector.
4. Return boiler to Automatic Mode. From Operation screen, select Automatic / Manual Firing Rate Control >> Automatic Modulation. Select HOME to return boiler to Home Screen.

P. Test Safety Limits Controls

1. Test the ignition system safety shut-off by disconnecting the flame sensor connector (black plug with orange wire) from the flame ionization electrode. See Figure 8-5. The boiler must shut down and must not start with the flame sensor disconnected.

9 System Start-up *(continued)*

2. Test the flow switch by disabling the primary loop circulator. The boiler must not start if flow is not present.
3. Test any other external limits or other controls in accordance with the manufacturer's instructions.

Q. Check Thermostat Operation

Verify that the boiler starts and stops in response to calls for heat from the heating thermostat and indirect water heater thermostat. Make sure that the appropriate circulators also start and stop in response to the thermostats.

R. Adjust Supply Water Temperature

As shipped, the heating set point supply temperature is set to 180°F (82.2°C) and, indirect water heater set point supply temperature is set to 170°F (76.7°C). If necessary, adjust these to the appropriate settings for the type of system to which this boiler is connected. See Section 10 "Operation" (Central Heat parameter table) of this manual for information on how to adjust supply setpoint.

S. Adjust Thermostats

Adjust the heating and indirect water heater thermostats to their final set points.

T. Field Conversion From Natural Gas to LP Gas (Propane)

Apex models APX425C and APX525C are factory shipped as natural gas builds and can be field converted to LP gas. Follow steps below for field conversion from natural gas to LP Gas.

Models APX625C, APX725C and APX825C are factory shipped as either natural gas build or LP gas build. Field conversions of models APX625C, APX725C and APX825C are not permitted.

1. Conversion of Apex models APX425C and APX525C from one fuel to another is accomplished using the throttle screw on the gas valve. Figure 9-5 "Gas Valve Detail" shows the location of the throttle screw on the valve. Locate the throttle screw on the boiler being converted.

⚠ WARNING

Explosion Hazard. Asphyxiation Hazard.

This conversion should be performed by a qualified service agency in accordance with the manufacturer's instructions and all applicable codes and requirements of the authority having jurisdiction. If the information in these instructions is not followed exactly, a fire, an explosion or production of carbon monoxide may result causing property damage, personal injury, or death. The qualified service agency is responsible for proper conversion of these boilers. The conversion is not proper and complete until the operation of the converted appliance is checked as specified in this manual.

2. If conversion is being made on a new installation, install the boiler in accordance with the installation instructions supplied with the boiler. If an installed boiler is being converted, connect the new gas supply to the boiler, check for gas leaks, and purge the gas line up to the boiler in accordance with the *National Fuel Gas Code*, ANSI Z223.1/NFPA 54 and/or *Natural Gas and Propane Installation Code*, CAN/CSA B149.1 or the requirements of the authority having jurisdiction.
3. Before attempting to start the boiler, make the number of turns to the throttle screw called for in Table 10-9.
4. Start the boiler using operating instructions in Figure 9-1. After the boiler is powered up with a call for heat, the boiler should go through the sequence of operation shown in Table 10-11. Even if the gas line has been completely purged of air, it may take several tries for ignition before a flame is established. If more than 2 tries for ignition are needed, it will be necessary to press the reset button to restart the boiler. If boiler does not light, turn the throttle screw counter-clockwise in 1/4 turn increments, allowing the boiler to make at least three tries for ignition at each setting, until the boiler lights.

Table 9-6: Approximate Clockwise Throttle Screw Turns for LP Gas (Propane) Conversion

Boiler Model	Approximate Throttle Screw Turns
APX425C	2¾
APX525C	3
APX625C	N/A - Factory LP Builds
APX725C	
APX825C	

9 System Start-up *(continued)*

⚠ WARNING

Asphyxiation Hazard.

The throttle adjustments shown in Table 9-6 are approximate. The final throttle setting must be found using a combustion analyzer. Leaving the boiler in operation with a CO air free level in excess of 200 ppm could result in injury or death from carbon monoxide poisoning.

5. After the burner lights, complete all steps outlined in Paragraph O "Perform Combustion Test" before proceeding.

⚠ WARNING

Asphyxiation Hazard.

These instructions include a procedure for adjusting the air-fuel mixture on this boiler. This procedure requires a combustion analyzer to measure the O_2 (or CO_2) and Carbon Monoxide (CO air free) levels in flue gas. Adjusting the air-fuel mixture without a proper combustion analyzer could result in unreliable boiler operation, personal injury, or death due to carbon monoxide poisoning.

6. Verify that the gas inlet pressure is between the upper and lower limits shown in Table 7-6 with all gas appliances (including the converted boiler) both on and off.
7. A label sheet is provided with the boiler for conversions from natural gas to LP gas. Once conversion is completed, apply labels as follows:
   a. Apply the "Rating Plate Label" adjacent to the rating plate.
   b. Apply the "Gas Valve Label" to a conspicuous area on the gas valve.
   c. Apply the "Boiler Conversion Label" to a conspicuous surface on, or adjacent to, the outer boiler jacket. Fill in the date of the conversion and the name and address of the company making the conversion with a permanent marker.

U. Correcting Throttle Screw Mis-Adjustment (if required)

Apex boilers are fire tested at factory and gas valve throttle screws are preset. However, if boiler does not start when first turned on, and, the problem cannot be remedied following "Help" prompts on the boiler control display, it may be necessary to reset and readjust the throttle screw according to the following instructions.

1. Fully close throttle by turning throttle screw clockwise until it fully stops.
2. Open throttle screw counter-clockwise the number of full (360 degrees) and partial turns listed in Table 9-7 for natural gas or Table 9-8 for LP gas.
3. Follow instructions in Paragraph O "Perform Combustion Test" to verify O_2 (or CO_2) is within the range specified in Table 9-2 for natural gas or Table 9-3 for LP gas at both high fire and low fire.

⚠ WARNING

The throttle adjustment values shown in Table 9-7 and Table 9-8 are approximate. The final throttle setting must be found using a combustion analyzer.

Table 9-7: Approximate Counter-Clockwise Throttle Screw Turns from Fully Closed Position, Natural Gas

Boiler Model	Approximate Throttle Screw Turns
APX425C	5¾
APX525C	6½
APX625C	6½
APX725C	10½
APX825C	11

Table 9-8: Approximate Counter-Clockwise Throttle Screw Turns from Fully Closed Position, LP Gas (Propane)

Boiler Model	Approximate Throttle Screw Turns
APX425C	3
APX525C	3½
APX625C	8
APX725C	12
APX825C	8½

9 System Start-up *(continued)*

⚠ WARNING

Asphyxiation Hazard.

- If the throttle is very far out of adjustment on the "rich" (counter-clockwise) side, the boiler burner may be running at 0% excess air or even with air deficiency. Operating the boiler in this condition may cause property damage, personal injury or death.
- At 0% excess air the CO_2 readings will be either 11.9% CO_2 for natural gas or 13.8% CO_2 for LP gas (O_2 will be 0%) and CO air free level will be extremely high (well over 1,000 PPM).
- If the burner operates with air deficiency, the following phenomena may be observed:

  % CO_2 will actually drop (% O_2 will increase) as the throttle is turned counter-clockwise

  % CO_2 will actually increase (% O_2 will drop) as the throttle is turned clockwise
- If the boiler appears to operate with air deficiency, shut down the boiler and follow instructions in Paragraph U "Correcting Throttle Screws Mis-Adjustment. Then, use a combustion analyzer to verify and adjust O_2 (or CO_2) and CO air free to values shown in Table 9-2 for natural gas or Table 9-3 for LP gas.

V. Controls Start-up Check List

Check field wiring and control parameters per below Table 9-9 and Table 9-10. The control is factory programmed with default parameters. Review parameters and adjust as necessary to conform to specific site requirements. From Home Screen, select ADJUST to access below listed parameters. Login as needed to make changes. For detailed login instructions, refer to Section 10 "Operation", Paragraph J. Parameter Adjustment.

Table 9-9: Field Wiring Checklist

Step	Wiring Location	Parameter	Description
1	120V PCB	120V Line	Is line voltage connected with overcurrent protection?
		Boiler, System, and DHW Pumps	Confirm pumps are connected. If using room air for combustion, confirm combustion air damper is connected.
2	Low Voltage Connections PCB	Enable/Disable	Is the space heating thermostat connected. Ensure thermostat is a "dry", non-powered input.
		DHW Demand	Is an indirect water heater (IWH) providing a heat demand?
		Auto Reset and Man Reset External Limit	Are external limits used? If so, ensure jumper is removed and limits properly connected. Also check that external limits are closed and any manual reset devices are reset.
		Lockout Alarm	Are alarm contacts connected?
		EnviraCOM	Are any EnviraCOM devices used?
		Outdoor Sensor	Is an outdoor sensor used? Refer to Steps 1 & 7 in Table 9-10.
		Header Sensor	Is a header sensor used? A header sensor is required for the master boiler in a multiple boiler installation. Refer to Step 8 in Table 9-10 to activate this input.
		DHW Sensor	For single boiler servicing indirect water heater (IWH), install DHW sensor at boiler-side inlet to IWH. Refer to Step 6 in Table 9-10 to activate this input.
		Remote 4-20mA	Is a 4-20mA input required for: 1) modulation input from an energy management system, or 2) Central Heat setpoint input from external multiple boiler control? If yes, refer to Step 11 in Table 9-10.
		Boiler-to-Boiler	Are multiple boilers connected? If yes, refer to Steps 8 & 9 in Table 9-10 to activate boiler-to-boiler communication.
		EMS	Is the boiler connected to an energy management system? If yes, refer to Step 10 in Table 9-10.
		Flow Switch	Is flow switch installed in piping and plugged in?
		LWCO	Is a 24V LWCO used? Check installation.

9 System Start-up *(continued)*

Table 9-10: Control Parameter Checklist

Step	Parameter Location	Parameter	Description
1	Adjust >> System	Outdoor Sensor Source	Select appropriate source: Not Installed, Wired, Wireless, or Modbus.
		Warm Weather Shutdown Enable/ Disable	Selecting Enable will restrict boiler start during warm weather, but only if an outdoor sensor is installed.
2	Adjust >> Modulation	Boiler Model	**WARNING!** Confirm correct boiler model is shown. Stop installation and contact factory if incorrect boiler model is shown.
3	Adjust >> Pumps	Boiler Pump	Ensure pump parameter selections are correct for your application.
		System Pump	
		Domestic Hot Water Pump	
4	Adjust >> Service Contacts	Contractor	Enter contact information. In the event of a fault, or the need to adjust a setting, the display will direct the user to the entered contact.
		Service Company	
		Sales Representative	
5	Adjust >> Central Heat	Setpoint	Ensure target space heating water temperature (Setpoint) is correct for your type of radiation.
6	Adjust >> Domestic Hot Water	Setpoint	Ensure target domestic hot water temperature (Setpoint) is correct.
		DHW Modulation Sensor	If using DHW Sensor, select DHW Sensor.
7	Adjust >> Outdoor Reset	Enable/Disable	If not using an outdoor sensor, select Disable.
8	Adjust >> Sequencer Master	Sequencer Master	If boiler is the master boiler in a multiple boiler installation, select Enable.
9	Adjust >> Sequencer Slave	Boiler Address	If boiler is a slave boiler in a multiple boiler installation, assign a unique boiler address.
10	EMS >> Modbus Setup	EMS Enable/Disable	If boiler is connected to an energy management system, select Enable.
11	EMS >> Remote Demand	Modulation Source	If using an external multiple boiler controller, set to 4-20 mA.
		Central Heat Setpoint Source	If an Energy Management System is sending a remote setpoint to the boiler, set to 4-20 mA.

10 Operation

A. Basic Operation

When a call for heat is provided, the boiler attempts to maintain a target supply (outlet) water temperature or header temperature (if header sensor enabled). The boiler control varies fan speed to modulate boiler output. As fan speed changes, the gas valve regulates fuel gas flow to match combustion air flow, resulting in a relatively constant fuel: air ratio across the modulation range. The control determines required output by looking at both current and recent differences between measured temperature and setpoint temperature. As measured temperature approaches setpoint temperature, the control reduces boiler output by reducing fan speed. The control also looks at return (inlet) water temperature and flue gas temperature when determining modulation rate.

B. Features

1. Boiler Control

   The Concert Boiler Control contains features and capabilities which help improve heating system operation, and efficiency. By including unique capabilities, the control can do more, with less field wiring, and fewer aftermarket controls and components – improving the operation of both new and replacement boiler installations.

2. Advanced Touch Screen Display

   Boiler status and setup selections are available from an easy to use, full color, Touch Screen Display. In the event of a fault condition the user is guided by blinking touch buttons to help screens that explain the problem, cause, and corrective action. Operation evaluation and problem-solving is enhanced by historical capability including graphic trends, lockout history records, as well as boiler and circulator cycle counts and run time hours.

3. Demand

   Two demand inputs are provided on the low voltage PCB: Enable/Disable for space heating (Central Heat), and DHW Demand for domestic hot water (DHW) or other heating demand. Enable/Disable and DHW Demand each have unique temperature and pump settings. In a multiple boiler installation, the sequencer control may also provide demand.

4. Outdoor Reset

   When selected, outdoor reset automatically adjusts supply water temperature based on outside air temperature, time of day, and length of demand (boost) settings for energy savings. Outdoor reset requires installation of an outdoor sensor. Hard-wired and wireless outdoor sensors are available.

5. Warm Weather Shutdown

   Some boilers are used primarily for heating buildings, and the boilers can be automatically shut down when outdoor air temperature is warm. When outside air temperature is above the WWSD setpoint, this function will shut down the boiler and system pump.

6. Pump Control

   Three pump outputs are provided on the 120V PCB: Boiler Pump, System Pump, and DHW Pump. Outputs are service rated relays. Simple parameter selections allow all three pumps to respond properly to various hydronic piping arrangements. To help prevent rotor seizing, pumps are automatically run for a 20 second exercise period after not being used for longer than seven days.

7. Multiple Boiler Sequencer Boiler-to-Boiler Network

   The control includes state-of-the-art modulating lead-lag sequencer for up to eight boilers capable of automatic rotation, outdoor reset, and boiler-to-boiler communication. Multiple boiler sequencing requires plug-and-play connections between boilers. Precise boiler coordination is provided as boilers are sequenced based on both header water temperature and boiler modulation rate. For example, the lead boiler (Sequencer Master) can be configured to start a lag boiler after operating at 50% modulation rate for longer than an adjustable time. The boilers are modulated in unison (parallel) modulation rate to ensure even heat distribution.

8. Energy Management System (EMS) Interface

   The control accepts a 4-20mA DC input from an energy management system (EMS) for either direct modulation rate or temperature setpoint. A factory configured RS485 Modbus interface is available for EMS monitoring, which can be used in conjunction with the multiple boiler sequencer.

9. Archives via USB Thumb Drive

   Archives allow easy transfer of parameters from one boiler to another using a USB thumb drive. Additionally, Archives are a valuable troubleshooting tool, providing alarm history and operating history in spreadsheet (.csv) format downloaded to a thumb drive.

10 Operation *(continued)*

C. Supply (Outlet) Water Temperature Regulation

1. Priority Demand

   When more than one demand is present, the higher priority demand is used to determine boiler settings as shown in Table 10-1. For example, when DHW priority is enabled, the setpoint, difference above, difference below and pump settings are taken from DHW selections. Active priority is displayed on the Home Screen (see Figure 10-3).

Table 10-1: Order of Priority

Priority	Demand	Boiler Responding to:
1	Sequencer Control	The boiler is connected in a boiler-to-boiler network. The boiler accepts demand from the Sequencer Master boiler.
2	Domestic Hot Water	DHW Demand is on and selected as the priority demand. DHW Demand is always higher priority than Central Heat. DHW Demand also has higher priority than the Sequencer Control when DHW priority is enabled (Priority Time greater than zero) and DHW Pump is set to Boiler Piped IWH.
3	Central Heat	Enable/Disable is on and there is no DHW demand or DHW priority time has expired.
4	Frost Protection	Frost Protection is active and there is no other call for heat. Frost protection will be a higher priority than Sequencer Control if the Sequence Master has no active call for heat.
5	Warm Weather Shutdown (WWSD)	WWSD is active and the boiler will not respond to Enable/Disable. DHW Demand is not blocked by WWSD.

2. Setpoint Purpose

   The control starts, stops, and modulates boiler output from minimum to maximum to heat water up to the active setpoint. Active setpoint is determined by priority as shown in Table 10-1.

3. Central Heat Setpoint

   With Enable/Disable demand, the active setpoint is either the Central Heat Setpoint, Central Heat Time of Day Setpoint (if thermostat is in Sleep or Away mode), Outdoor Reset setpoint, or a value set by 4-20mA input from an energy management system (EMS).

4. Outdoor Reset

   If an outdoor sensor is connected to the boiler and outdoor reset is enabled, the Central Heat Setpoint will automatically adjust downwards as the outdoor temperature increases. Room air temperature overshoot is minimized since water temperature is properly matched to heating needs. Outdoor reset saves energy by reducing room overheating, reducing boiler temperature, increasing efficiency, and reducing standby losses as boiler and system piping cool down to ambient following a heating cycle.

5. Boost Time

   When the Central Heat Setpoint is decreased by Outdoor Reset settings, the Boost function can be enabled to increase the setpoint in the event that central heat demand is not satisfied for longer than the Boost Time minutes. The Boost function increases the active setpoint by 10°F for every 20 minutes (field adjustable) the central heat demand continues unsatisfied. This process continues until central heat demand is satisfied, after which operating setpoint reverts to value determined by Outdoor Reset settings. Boost function is not used if Boost Time is zero.

6. Domestic Hot Water (DHW) Setpoint

   With DHW demand, the active setpoint is either the DHW Setpoint or DHW Time of Day Setpoint (if thermostat is in Sleep or Away mode). The optimal value is based on requirements of the specific indirect water heater (if used).

7. Domestic Hot Water (DHW) Priority

   If Domestic Hot Water Priority Time is greater than zero and there is a DHW demand, the system pump will be turned off (with System Pump parameter set to Central Heat, No Priority) and the DHW pump will be turned on. Additionally, if Outdoor Reset is enabled, the active setpoint is adjusted to the DHW Setpoint. Priority protection is provided to ensure Central Heat supply in event of an excessively long DHW demand.

8. Time of Day (Setback) Setpoints

   User-adjustable Time of Day Setpoints are provided for both Central Heat and DHW demands to save energy when a building is unoccupied. Time of Day Setpoints are active when an EnviraCOM thermostat is connected to the boiler and is in Sleep or Away mode. Example EnviraCOM thermostat: Honeywell VisionPro IAQ, model TH9421C1004.

D. Boiler Protection Features

1. Supply Water Temperature High Limit

   The boiler is equipped with a UL 353 listed boiler control and UL 1434 listed high limit sensor. Default response to supply temperature is as follows.

   - Supply exceeds 190°F (87.7°C) – output (fan speed) reduced
   - Supply exceeds 200°F (93.3°C) – recycle
   - Supply exceeds 210°F (98.9°C) – manual reset hard lockout

10 Operation *(continued)*

Additionally, a soft lockout occurs if the supply temperature rises to fast (i.e. faster than the degrees Fahrenheit per second limit). Output reduced and recycle responses are inactive for a stand-alone boiler without a header sensor. Temperatures are field adjustable except manual reset hard lockout cannot exceed 210°F (98.9°C).

2. High Limit Differential Temperature Limit

   The control monitors temperature difference between return and supply sensors. Default response to temperature difference is as follows.

   - Differential exceeds 43°F (23.9°C) – output (fan speed) reduced
   - Differential exceeds 53°F (29.4°C) – recycle
   - Differential exceeds 63°F (35°C) – shutdown; automatic restart after temperature difference has decreased and minimum off time has expired

3. Return Temperature Higher Than Supply Temperature (Inversion Limit)

   If return water temperature exceeds supply water temperature for longer than a limit time delay, the control shuts down the boiler and delays restart. If the inverted temperature is detected more than five times, the boiler shuts down with a hard lockout. Condition is caused by incorrect supply and return piping connections.

4. Flue Temperature High Limit

   The control monitors flue gas temperature sensor located in vent outlet at rear of heat exchanger. Response to flue temperature is as follows:

   - Flue exceeds 184°F (84.4°C) – output (fan speed) is reduced
   - Flue exceeds 194°F (90.0°C) – recycle
   - Flue exceeds 204°F (95.6°C) – manual reset hard lockout

   Temperature is field adjustable except manual reset hard lockout cannot exceed 204°F (95.6°C).

5. Flow Switch

   The flow switch shuts down the boiler when there is insufficient water flow in the boiler primary loop. When water flow is restored to a boiler-specific minimum value (see Table 6-3), the flow switch detects flow and automatically restarts the boiler. The flow switch is required and is factory provided.

6. Ignition Failure

   The control monitors ignition using a burner mounted flame sensor. Response on ignition failure is as follows:

   - Size 425: retries five times, then soft lockout for one hour
   - Size 525-825: retries one time, then manual reset hard lockout

7. Automatic Reset Limit Devices

   If any below listed limit opens, the boiler shuts down and provides an open limit indication. The boiler will automatically restart once the limit closes. An external limit control with its own manual reset button requires pressing external limit reset button after limit closes even when connected to Auto Reset External Limit terminals.

   - Sump pressure switch – opens if inadequate air flow is detected during operation
   - Condensate float switch – opens if condensate drain is blocked
   - 24V LWCO (if used) – opens if low water condition is detected
   - Device(s) connected to Auto Reset External Limit terminals

8. Manual Reset Limit Devices

   If any below listed limit opens, the boiler shuts down, provides an open limit indication, and closes the Lockout Alarm contact. The boiler will restart only after the limit closes and the boiler control manual reset button is depressed. During boiler start sequence, air proving switch must prove open before blower starts and closed after blower starts. If air proving switch is not in the required position, the control waits for a preset time period and then shuts down with a manual reset hard lockout.

   - Thermal link – opens if rear of combustion chamber overheats; one time use device
   - Burner door thermostat – opens if burner door overheats, manual reset button on thermostat
   - High and low gas pressure switches (if used, size 525-825 only) – open if gas pressure is outside of preset limits, manual reset button on each switch
   - Air proving switch – opens if inadequate air flow is detected prior to ignition
   - Device(s) connected to Man Reset External Limit terminals

10 Operation *(continued)*

Figure 10-2: Limit String Status Screen Showing Central Heat Demand

Figure 10-3: Home Screen

Table 10-4: Limit String

Limit String Type	Description	Action
STAT	Heat Demand	"ON" indicates heat demand and enables control to fire to maintain water temperature at setpoint. • Heat demand may be received from "Enable/Disable" terminals for Central Heat Demand, "DHW Demand" terminals for DHW Demand, the Sequencer Master, or EMS Modbus inputs. • Heat Demand input "ON" initiates pump and combustion air damper outputs.
A1	Annunciator 1	A1 is the air proving switch and must cycle "ON" and "OFF" at appropriate times in order for boiler to start. • A1 must prove "OFF" before blower starts. A1 "ON" before blower starts causes manual reset hard lockout after a delay. • A1 must prove "ON" after blower starts and before trial for ignition. A1 "OFF" during this time causes manual reset hard lockout after a delay.
A2/LCI	Annunciator 2/ Load Control Input	A2 limits are upstream of and connected in series with LCI limits. LCI must prove "ON" for boiler to start. Boiler will shut down if LCI is turned "OFF" during operation. • Hold message shown when LCI limit is "OFF" and Heat Demand is "ON". • LCI Hold will never cause a manual reset lockout. • Boiler may be disabled remotely by wiring an enable contact to the LCI "External Limit" terminals.
ILK	Interlock	ILK must prove "ON" for boiler to start. Boiler will shut down with manual reset hard lockout if ILK is turned "OFF" during operation. ILK OFF Lockout closes the Lockout Alarm contacts.

9. Central Heating System Frost Protection

   When enabled, Frost Protection starts the boiler and system pump and fires the boiler when low outside air and low supply water temperatures are sensed. The Control provides the following control action when frost protection is enabled:

FROST PROTECTION NOTE

The Control helps provide freeze protection for the boiler water. Boiler flue gas condensate drain is not protected from freezing. Since the Control only controls the system and boiler circulators individual zones are not protected. It is recommended that the boiler be installed in a location that is not exposed to freezing temperatures.

Table 10-5: Frost Protection

Device Started	Start Temperatures	Stop Temperatures
Boiler Pump	Outside Air < 0°F ° (-18°C) or Supply Water < 45°F (7.2°C)	Outside Air > 4°F (-16°C) or Supply Water > 50°F (10°C)
Boiler	Supply Water < 38°F (3.3°C)	Supply Water > 50°F (10°C)

E. Touch Screen Display Navigation

1. HOME SCREEN is the default state for the display, shown in Figure 10-3. The home screen displays basic operating information and provides access to other screens through icons at the top of the screen.

10 Operation *(continued)*

2. MAIN MENU provides access to all display functions. It is accessible from the Home Screen. The following major user interface areas are accessed from the Main Menu:
   a. STATUS provides a "walk" through of boiler operation. These screens provide an overview of boiler and networked boiler operation. Status screens include "Load Profile" for Central Heat and Domestic Demands. These profiles allow the user to review the Run Hour (%) versus Load (%). The "Load Profile" along with run hours and cycles provides a complete picture of boiler status.
   b. OPERATION screens allow the user to take manual or automatic control of the unit. These screens are intended to allow a technician to set firing rate to support combustion testing and provide trending and parameter adjusting to support fine tuning the boilers response to load changes. Operation screens may be used to speed up or slow down the boilers response to fast or slow system load changes.
   c. ARCHIVES collect history of how the boiler has operated and provide tools to review and improve system operation.
      i. Historical Trend – Up to four (4) months of data is collected and may be viewed on screen or saved to a Thumb Drive.
      ii. Lockout History – provides data on up to 15 manual reset Lockouts. Data collected includes cause of boiler trip, run hour and status when lockout occurred.
      iii. Cycle & Run Time History – collects the usual summary of cycles and hours of boiler and pump operation. All cycles and run hours other than the controller quantities may be reset to aid in identifying improvements made.
      iv. Alarm History – limit string faults, holds, manual reset lockouts and other alarms are recorded with time and date stamp.
      v. Thumb Drive Operation – these screens provide ability to save or load parameters as well as alarm and trend data.
   d. SENSORS provides status and details on all sensors connected to the control.

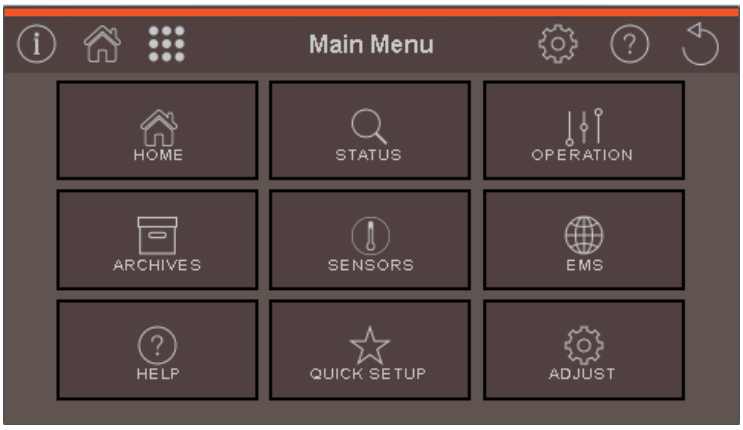


Figure 10-6: Main Menu Screen

   e. EMS allows the user to access setup options and status for an energy management system (EMS).
   f. HELP displays active alarms and corrective actions.
   g. QUICK SETUP presents commonly required parameters for quick review and adjustment.
   h. ADJUST presents each adjustable parameter for adjustment. Proper login is required.

F. Quick Setup

Quick Setup is accessed from the Main Menu. Quick Setup allows the user to review and adjust the most commonly adjusted parameters, such as setpoints and pump output settings, from one location. Refer to Parameter Adjustment section for additional information.

Table 10-7: Setpoints

Parameter and Description	Factory Setting (°F)	Range / Choices (°F)
Central Heat Setpoint	180	50 to 190
Central Heat Difference Above	7	2 to 25
Central Heat Difference Below	5	2 to 25
Domestic Hot Water Setpoint	170	50 to 190
Domestic Hot Water Difference Above	7	3 to 29
Domestic Hot Water Difference Below	5	3 to 29
Frost Protection Setpoint	0	-50 to 50
Warm Weather Shutdown Setpoint	70	20 to 100
Stop All Boilers	195	50 to 195

10 Operation *(continued)*

Table 10-8: Hydronic System

Parameter and Description	Factory Setting	Range/Choices
Boiler Pump	Any Demand	Never, Any Demand Central Heat, OFF DHW Demand Header Sensor Demand/ Combustion air Damper
System Pump	Any Demand	Never Any Demand Central Heat, No Priority Central Heat, Optional Priority, Fresh Air Damper
DHW Pump	Primary Loop Piped IWH	Never Primary Loop Piped IWH Boiler Piped IWH, Fresh Air Damper

Table 10-9: Comfort Settings

Parameter and Description	Factory/Setting (°F)	Range/Choices (°F)
Minimum Outdoor Temperature	0	-50 to 32
Maximum Outdoor Temperature	70	35 to 100
Low Water Temperature	110	70 to 180
Minimum Boiler Water Temperature	130	50 to 185

Table 10-10: Response Speed

Parameter and Description	Factory Setting	Range / Choices
Central Heat Response Speed	3	1 to 5
Central Heat Low Fire Hold Time	120 seconds	0 to 1800 seconds
Domestic Response Speed	3	1 to 5
Domestic Low Fire Hold Time	10 seconds	0 to 1800 seconds
Sequencer Response Speed	3	0 to 5

Table 10-11: Sequence of Operation

Status	Description
Standby	Boiler is not firing. Appropriate circulators are on if Priority is not Standby. With a central heat demand, sequence proceeds from Standby when supply temperature drops below Setpoint minus Difference Below.
Safe Startup	Flame circuit is tested.
Drive Purge	Blower is driven to purge speed.
Prepurge	Combustion chamber is purged for 10 s after reaching purge speed.
Drive Lightoff	Blower is driven to lightoff speed.
Preignition Test	Control conducts safety relay test.
Preignition	Spark is energized and it is confirmed that no flame is present.
Direct Ignition	Spark and gas valve are energized.
Running	After flame is proven, sequence continues with run stabilization and, when selected, low fire hold time and slow start ramp. Once field adjustable low fire hold time and ramp rate is completed, normal boiler operation begins with modulation rate dependent on temperature and setpoint selections.
Postpurge	When the call for heat ends, gas valve is closed. Combustion chamber is purged for 10 s after blower reaches postpurge speed.

10 Operation *(continued)*

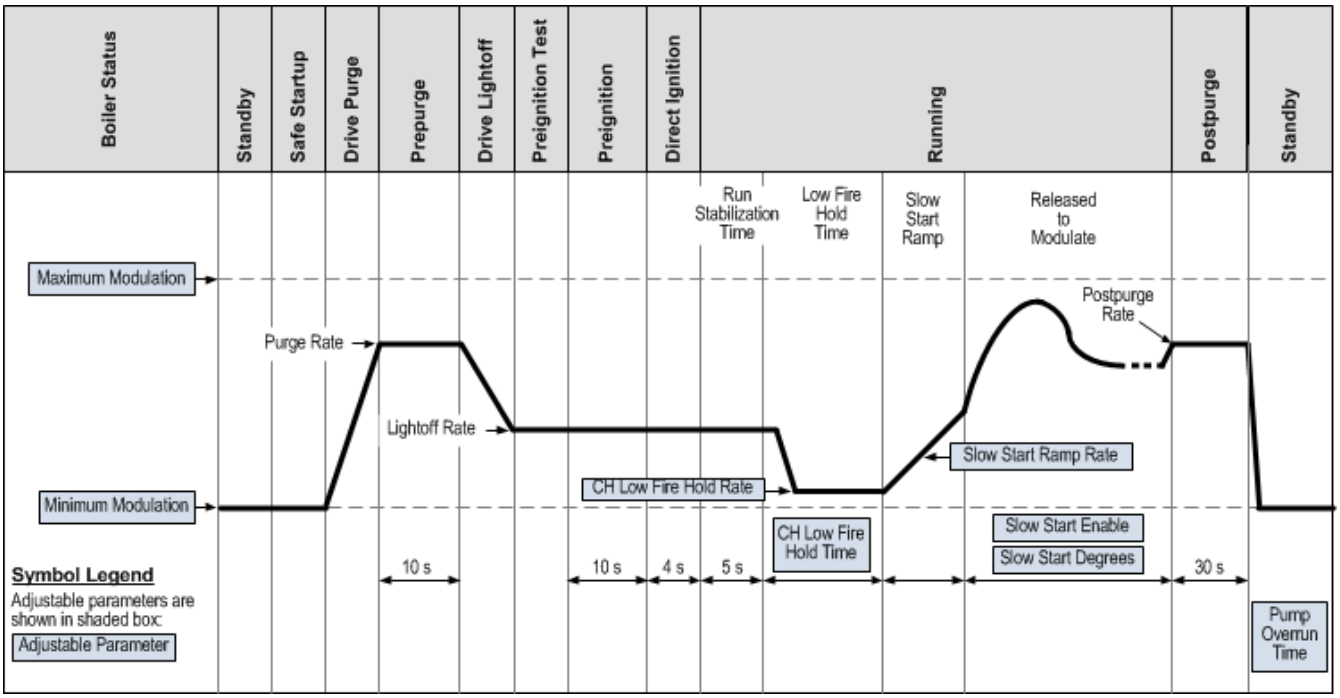


Figure 10-12: Sequence of Operation

G. Sequence of Operation

Boiler status is shown in the lower right corner of the Home Screen (see Figure 10-3). After limits have been established, the boiler sequence progresses as shown in Table 10-11 and Figure 10-12.

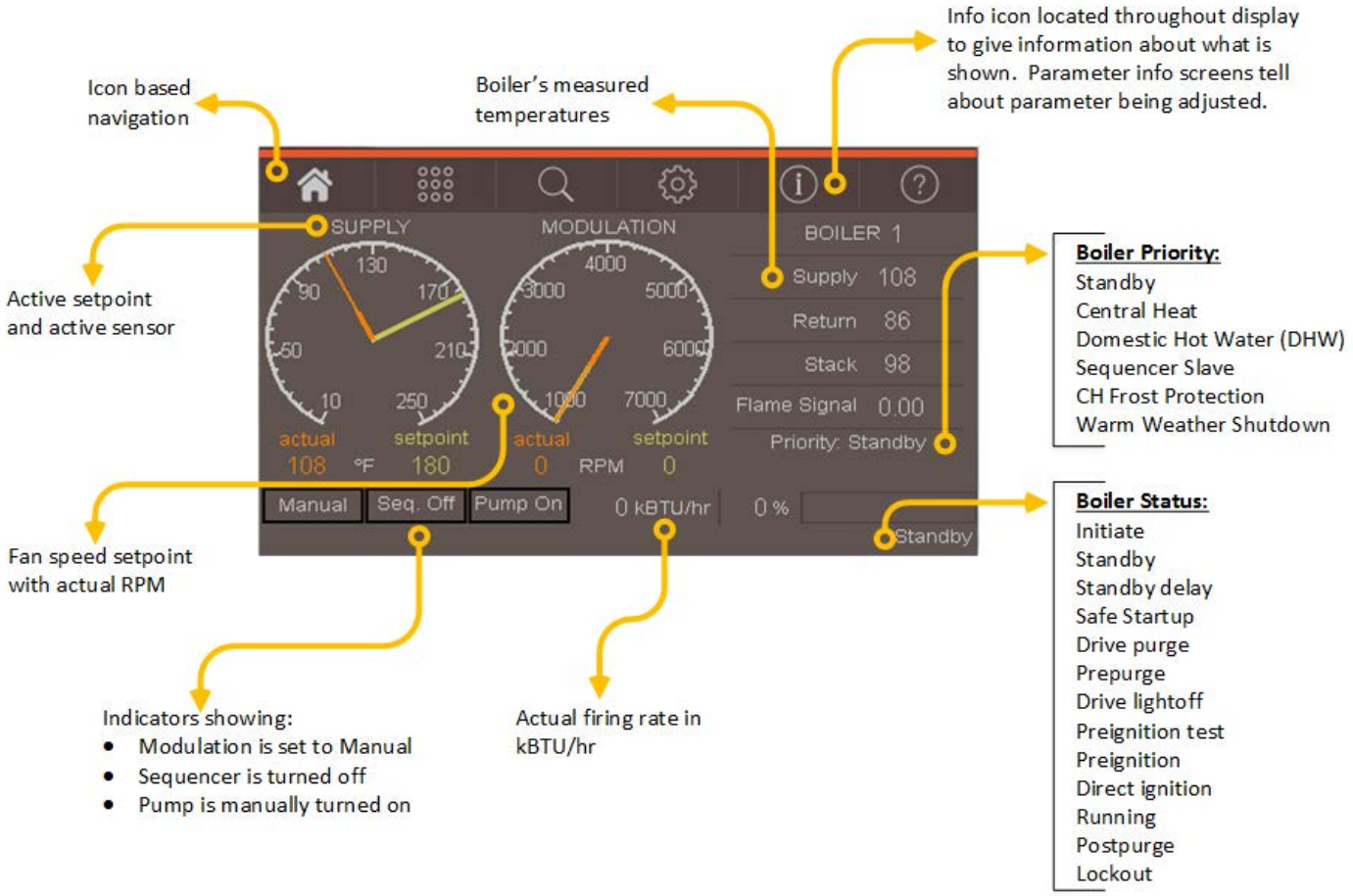


Figure 10-13: Home Screen Details

10 Operation *(continued)*

H. Status Screens

Boiler status screens are the primary boiler monitoring screens. The user may simply "walk" through boiler operation by repeatedly selecting the right or left "arrow" symbol. To access these screens, select STATUS from the Home Screen or Main Menu. See Figure 10-14 for screen navigation and Figure 10-15 for screen detail.

1. Sequencer Status

   This screen only appears when the Sequencer Master is enabled. It shows data involved with the network including active setpoint and sensor, the network priority, and the setpoint source. This status screen also displays all boilers in the boiler to boiler network. The status screen displays each boiler's assigned boiler number, current state, firing rate, and whether it is the current lead boiler.

2. Boiler Status

   This screen gives an overview of the current status of the boiler. The active setpoint and sensor which the boiler is currently modulating based on are displayed using a bar graph & numeric values. Also displayed are all current sensors installed in the boiler. These sensors will display red if there is an issue with any of them. Additional information shown includes current firing rate, boiler priority, current status, and setpoint source.

3. Demand Status

   This screen gives the demand status of the Central Heat, Domestic Hot Water, and Sequencer (Lead Lag). Along with this status, the boiler run hours, on/off status, and cycles are also shown. Pump information is also provided, including on/off status and cycles. Frost Protection status and Exercise will also appear when used. Additionally, the Load Profiles are on this page, which give historic data on the modulation of the boiler. This graph shows the percent of the total run hours the boiler spends modulating at each rate (%).

4. Boiler Monitoring

   This is an overview of all sensors installed on the boiler represented as bar graphs. Numeric values are also provided for accurate readings.

5. Hydronic Trending

   This screen allows the user to view from one to five variable trends. Selecting the check mark enables a variable to be added or removed from the trend.

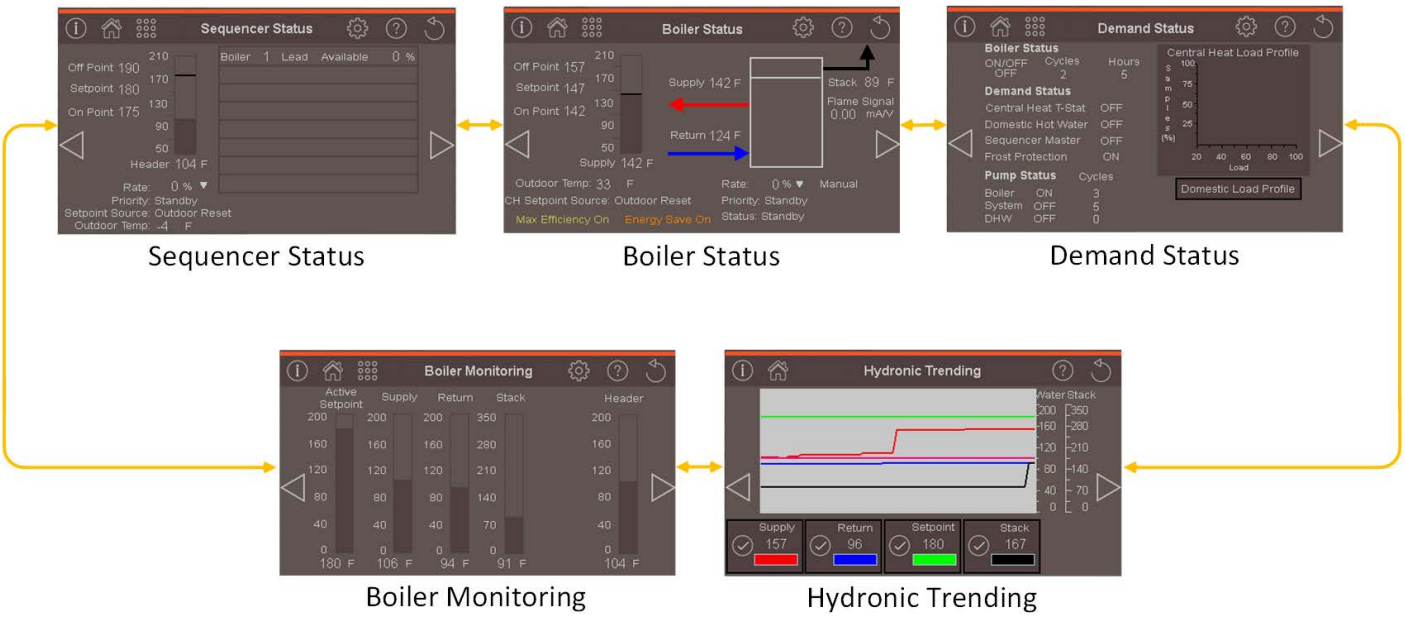


Figure 10-14: Status Screen Navigation

10 Operation *(continued)*

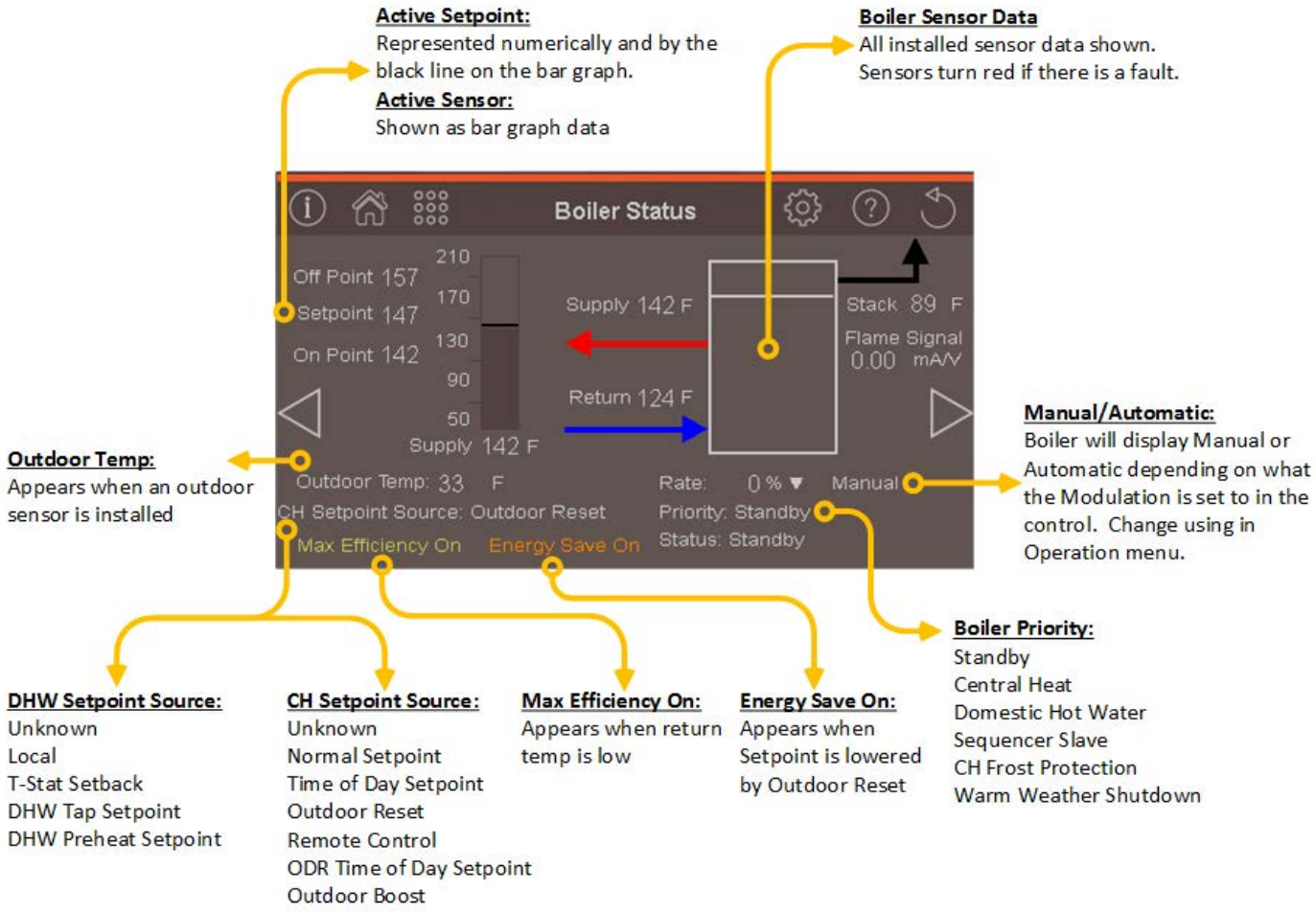


Figure 10-15: Status Screen Detail

10 Operation *(continued)*

I. Manual Operation and Tuning

Select Main Menu >> Operation to access the Operation screen shown in Figure 10-16. From the Operation screen, the user may manually adjust firing rate or exercise pumps, access a service trend, or tune the boiler.

NOTICE: When finished using manual mode, be sure to select Automatic to return boiler to normal operation. Otherwise the control will remain in Manual mode for one hour, or until power is cycled.

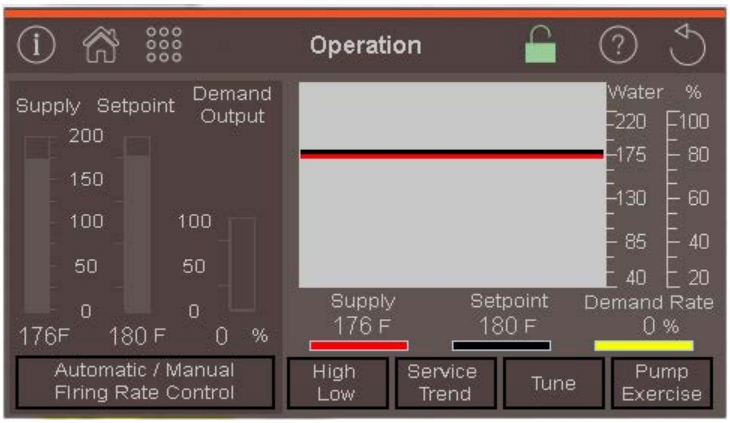


Figure 10-16: Operations Screen

1. Bar Graph & Trend – Shows active sensor, active setpoint, and modulation.
2. Automatic/Manual Firing Rate Control – User may adjust modulation manually. Menu also allows for switching of units from % (default) to RPM.
3. High/Low – Allows user to drive boiler to high or low fire when Manual Modulation is selected.
4. Service Trend – Shows boiler temperatures, firing rate, and demand statuses.
5. Tune – Allows for adjustment of parameters related to the rate of boiler response. This includes PID settings, ramp rates and more. Refer to Paragraph J, 14 for more details.
6. Manual Pump Exercise – Allows pumps to be set to either ON or Automatic. When ON is selected, pump will run. When Automatic is selected, pump will follow settings assigned in Pumps menu.

J. Parameter Adjustment

1. Entering Adjust Mode

NOTICE: Parameter adjustment may be performed only by a qualified service technician.

Control operation may be tailored to suit the application by adjusting parameters. To adjust parameters, select the ADJUST icon located throughout the display.

Press ADJUST icon to review and adjust all parameters.

Parameters are password protected to discourage unauthorized or accidental changes to settings. User login is required to adjust these settings. Parameters are locked and login requirement is shown when the padlock icon is not green.

- Press the Lock icon to access password screen.
- Use keypad to enter password.
- Press Enter Key when complete.

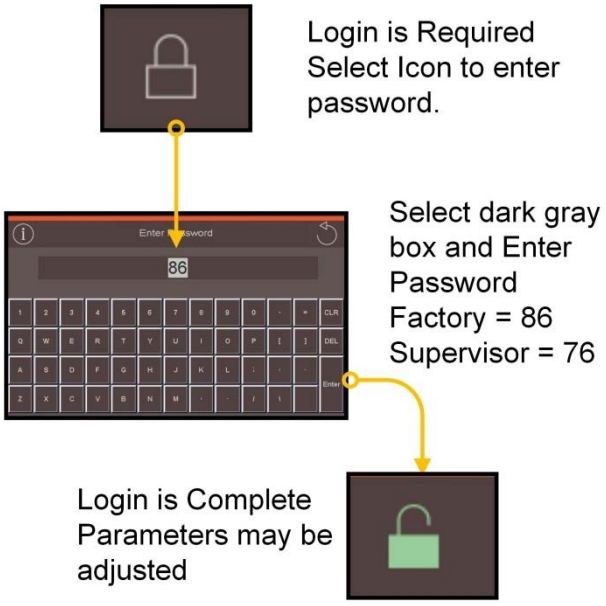


Figure 10-17: Entering Adjust Mode

NOTICE: A USB thumb drive may be used to transfer parameters from one boiler to another. See Paragraph K, “USB Thumb Drive Parameter Transfer”.

10 Operation *(continued)*

2. Adjusting Parameters

After entering the password, editing parameters is accomplished as follows:

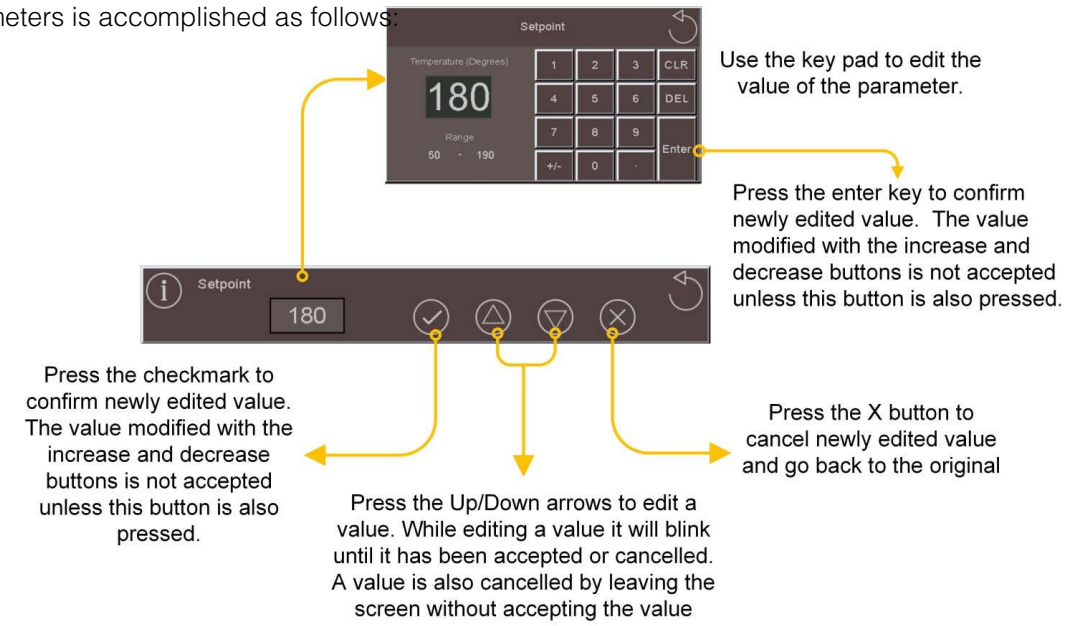


Figure 10-18: Adjusting Parameters

3. System Parameters

Select System to access the following parameters.

Parameter and Description		Factory Setting	Range / Choices
Temperature Units		Fahrenheit	Fahrenheit, Celsius
Outdoor Sensor Source			
Not Installed	Outdoor Sensor is not connected to the boiler. Sensor is not monitored for faults.	Wired	Not installed, Wired, Modbus, Wireless
Wired	Outdoor Sensor is wired to boiler low voltage PCB.		
Modbus	Outdoor temperature is retrieved through the Modbus connection from another boiler or Energy Management System.		
Wireless	Wireless outdoor sensor is installed. Honeywell Wireless Outdoor Air Reset Adapter part number 105766-01 is a wireless outdoor air sensor. The package includes a Wireless Receiver Module and Wireless Outdoor Sensor. The sensor communicates wirelessly to the receiver module. The receiver module is wired to the low voltage PCB EnviraCOM terminals. Refer to wiring section for more information.		
Outdoor Sensor Calibration Outdoor sensor calibration allows a single point adjustment of the outdoor sensor reading. This adjustment is a correction offset added to or subtracted from the outdoor temperature sensor reading. It is recommended to make any calibration when outdoor air temperature is at or near the most common operating point. For example, when necessary, calibrate the sensor when outdoor air is halfway between Minimum and a Maximum Outdoor Temperature parameter value is recommended.		0 degrees	-50 + 50°F tenths of degree (-45.6 to 10°C)
Anti-short Cycle Time Anti-short cycle is a tool that helps prevent excessive cycling resulting from a fast cycling enable-disable input. It provides a minimum delay time before the next burner cycle. DHW demand is serviced immediately, without any delay.		0 min.	0 - 20 min.

10 Operation *(continued)*

3. System Parameters (continued)

<table>
<tr><th>Parameter and Description</th><th>Factory Setting</th><th>Range / Choices</th></tr>
<tr><td>Installer's Password
Allows for custom password to be set. Must be 9 characters or less. Only allows adjustment of supervisor password (supervisor default: 76). Cannot change factory password.
• Must enter current installer password.
• Must enter new password and press enter.
• Must re-enter new password and press enter.
• Can be reset to supervisor default 76 if accessed with the Factory level password (86).</td><td>76</td><td>9 Character Maximum</td></tr>
<tr><td>CH Frost Protection
Disable Frost Protection is not used.
Enable Boiler and system circulators start and boiler fires when low out side air, supply and return temperatures are sensed as follows:
<table>
<tr><th>Device Started</th><th>Start Temperatures</th><th>Stop Temperatures</th></tr>
<tr><td>Boiler Pump</td><td>Outside Air < 0°F ° (-18°C) or Supply Water < 45°F (7.2°C)</td><td>Outside Air > 4°F (-16°C) or Supply Water > 50°F (10°C)</td></tr>
<tr><td>Boiler</td><td>Supply Water < 38°F (3.3°C)</td><td>Supply Water > 50°F (10°C)</td></tr>
</table></td><td>Enable</td><td>Enable, Disable</td></tr>
<tr><td>CH Frost Protection Setpoint
Outdoor Temperature at which pump is started for frost protection.</td><td>0°F (-18°C)</td><td>-50 to 50 (°F)
(-45.6 to 10.0°C)</td></tr>
<tr><td>Warm Weather Shutdown Enable/Disable
Disable Warm Weather Shutdown (WWSD) is not used.
Enable A central heat boiler start is prevented if the outside temperature is greater than the WWSD setpoint. WWSD is initiated as soon as outside air temperature is above WWSD Setpoint. The control does not require call for heat to be satisfied before entering WWSD. The boiler will still start in response to a Domestic Hot Water call for heat.</td><td>Disable</td><td>Enable, Disable</td></tr>
<tr><td>Warm Weather Shutdown Setpoint
The Warm Weather Shutdown (WWSD) Setpoint used to shut down the boiler when enabled by the "WWSD Enable" parameter.</td><td>70°F
(21.1°C)</td><td>20 to 100°F
(-6.7 to 37.8°C)</td></tr>
<tr><td>Auto Jump to Home Page
Enable After 15 minutes of no use, the display will automatically return to the Home Page.
Disable Display will not change screens to Home Page after 15 minutes.</td><td>Enabled</td><td>Enable/Disable</td></tr>
<tr><td>System Date
Date used by display Alarm History screen. A battery is provided to maintain the system date and time while the display is powered down.</td><td>xx/xx/xxxx</td><td>N/A</td></tr>
<tr><td>System Time
Time used by display Alarm History screen. A battery is provided to maintain the system date and time while the display is powered down.</td><td>xx:xx:xx</td><td>N/A</td></tr>
</table>

10 Operation *(continued)*

4. Modulation Parameters

⚠ WARNING

Asphyxiation Hazard.

Boiler type is factory set and must match the boiler model. Only change the boiler type setting if you are installing the boiler at altitudes above 2,000 ft. or if you are replacing the control. The boiler type setting determines minimum and maximum blower speeds. Incorrect boiler type can cause hazardous burner conditions and improper operation that may result in PROPERTY LOSS, PHYSICAL INJURY, OR DEATH.

Select Modulation to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Boiler Model To verify the boiler model selection, a qualified technician should do the following: 1. Check boiler's label for actual boiler model. 2. Set "Boiler Model" to match actual boiler model. 3. Select "Confirm". The Boiler Model parameter changes the minimum and maximum modulation settings. This parameter is intended to allow a user to set parameters for altitudes above 2,000 ft. or in a spare part control to a particular boiler model. See Figure 10-19.	varies by model	see Figure 10-19
CH Max Modulation Speed This parameter defines the highest modulation rate the control will go to during a central heat call for heat. If the rated input of the installed radiation is less than the maximum output of the boiler, change the Central Heat Maximum Modulation (fan speed) setting to limit the boiler output accordingly.	varies by model	Minimum to Maximum Modulation
DHW Max Modulation Speed This parameter defines the highest modulation rate the control will go to during a Domestic Hot Water call for heat. If the rated input of the indirect water heater is less than the maximum output of the boiler, change the DHW Maximum Modulation (fan speed) setting to limit the boiler output accordingly.	80% of CH Maximum Modulation Speed	Minimum to Maximum Modulation
Minimum Modulation Speed This parameter is the lowest modulation rate the control will go to during any call for heat.	varies by model	Minimum to Maximum Modulation
Lightoff Rate This is the blower speed during ignition and flame stabilization periods.	varies by model	425: 3,500-4,000 rpm 525-825: non-adjustable

NOTICE: If boiler is being installed at elevation above 2,000 ft., refer to Appendix A: Instructions for High Altitude Installations Above 2,000 ft.

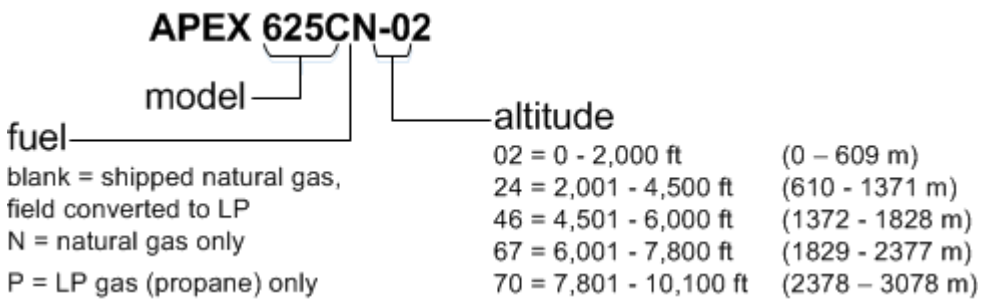


Figure 10-19: Boiler Model (Boiler Type) Decoding

10 Operation *(continued)*

5. Pump Parameters

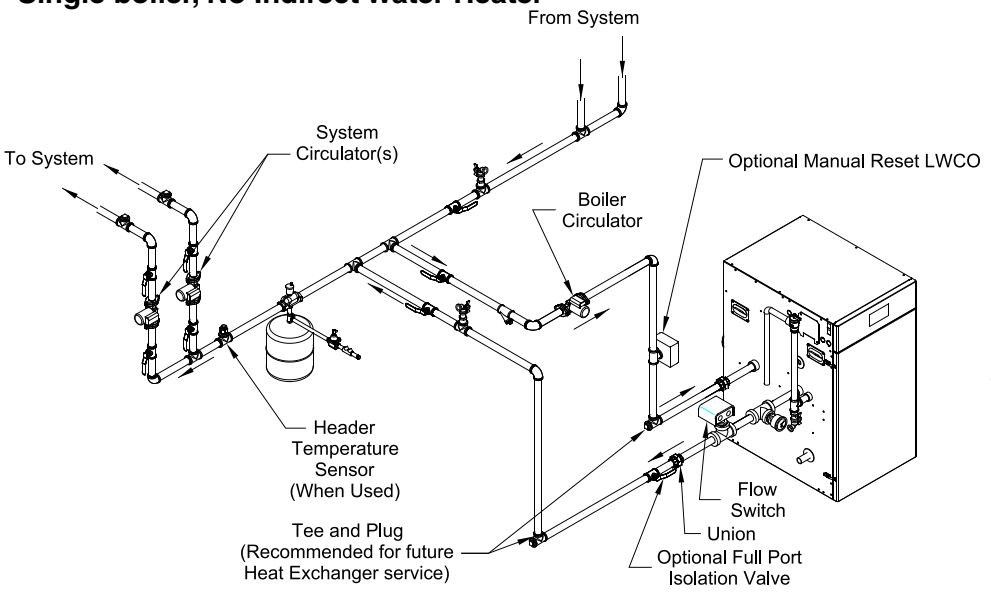
Select Pumps to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
System Pump Activates system pump output according to selected function: Never: Pump is disabled and not shown on status screen. Any Demand: Pump runs for any demand. Central Heat, No Priority: Pump runs during central heat and frost protection demand. Pump does not start for a DHW demand and continues to run during DHW Priority. Central Heat, Optional Priority: Pump Runs during central heat and frost protection demand. Pump does not start for a DHW demand and will be forced off if there is a DHW demand and DHW Priority is active.	Any Demand	Never Any Demand Central Heat, No Priority Central Heat, Optional Priority Fresh Air Damper
Boiler Pump Activates boiler pump and combustion air damper (if using room air) output according to selected function: Any Demand: Pump runs/damper opens for any demand. Central Heat, off DHW Demand: Make sure indirect water heater and DHW circulator are sized to maintain flow through boiler within limits shown in Table 6-3. Pump runs during central heat and frost protection call for heat and will be forced off if there is a DHW call for heat and DHW priority is active. Header Sensor/ Combustion Air Damper: Pump runs when boiler is firing to satisfy any call for heat. Used when header sensor is enabled to prevent unnecessary operation of boiler pump. Also used when combustion air damper is wired to Boiler Pump output. **NOTE**: Header Sensor must be used when combustion air damper output is required.	Any Demand	Never Any Demand Central Heat, off DHW demand, Header Sensor Demand/ Combustion Air Damper
DHW Pump Activates domestic hot water pump output according to selected function: Never: Pump is disabled and not shown on status screen. Primary Loop Piped IWH: Pump runs during DHW demand. DHW Priority enable/ disable does not affect pump operation. Boiler Piped IWH: Make sure indirect water heater and DHW circulator are sized to maintain flow through boiler within limits shown in Table 6-3. Pump runs during DHW demand. Pump is forced off during central heat demand when 1) DHW Priority is disabled or 2) DHW priority is enabled and DHW demand has remained on for longer than Priority Time.	Primary Loop Piped IWH	Never Primary Loop Piped IWH Boiler Piped IWH Fresh Air Damper
Overrun Time: System Pump Time that pump runs after demand is satisfied. Used to dissipate heat within the system.	0 min.	0 to 60 min.
Overrun Time: DHW Pump Time that pump runs after demand is satisfied. Used to dissipate heat within the system.	0 min.	0 to 60 min.
Overrun Time: Boiler Pump/Combustion Air Damper Time that pump runs after demand is satisfied. Used to dissipate heat within the system.	30 seconds	0 to 60 min.
Pump Exercise Interval The number of days the pump is inactive before the pump will be activated for the Pump Exercise Time.	7 days	0 to 40 days
Pump Exercise Time The amount of time the pump runs for exercise. This feature helps prevent pump seizing due to inactivity periods.	20 seconds	0 to 10 min.

10 Operation *(continued)*

6. Example Pump Parameter Selections

Single boiler, No Indirect Water Heater



Parameter Selections:

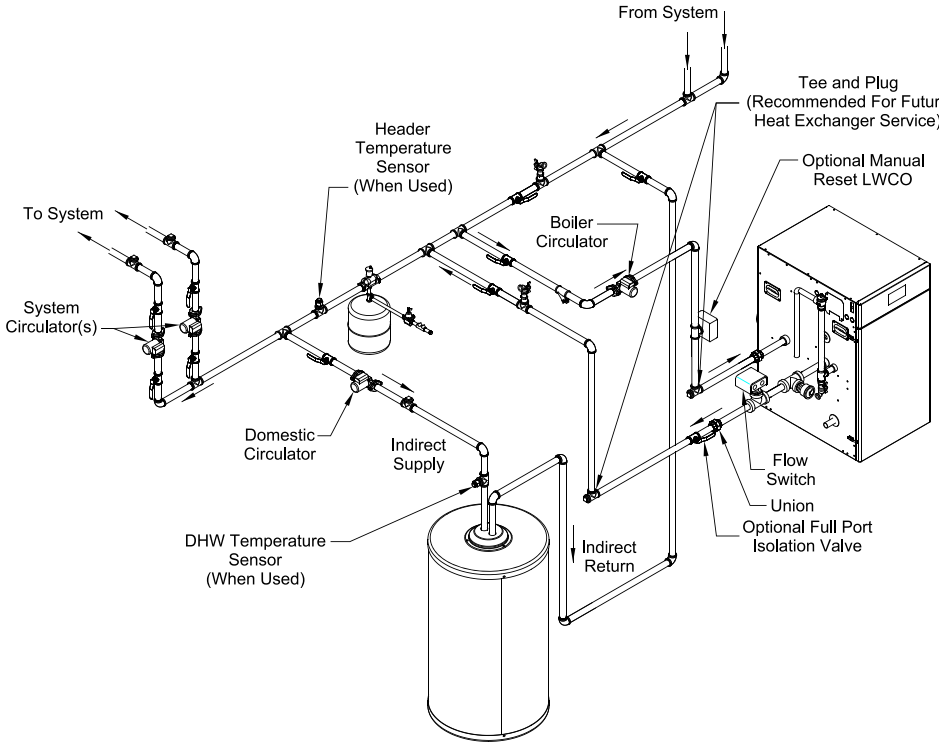
System Pump= “any demand”
Boiler Pump = “any demand”
DHW Modulation Sensor = “DHW Sensor”

DHW Pump = “never”

Explanation:

This piping arrangement only services central heat. When there is any demand both boiler and system pumps turn on.

Single Boiler, Primary Piped Indirect Water Heater, Optional DHW Priority



Parameter Selections:

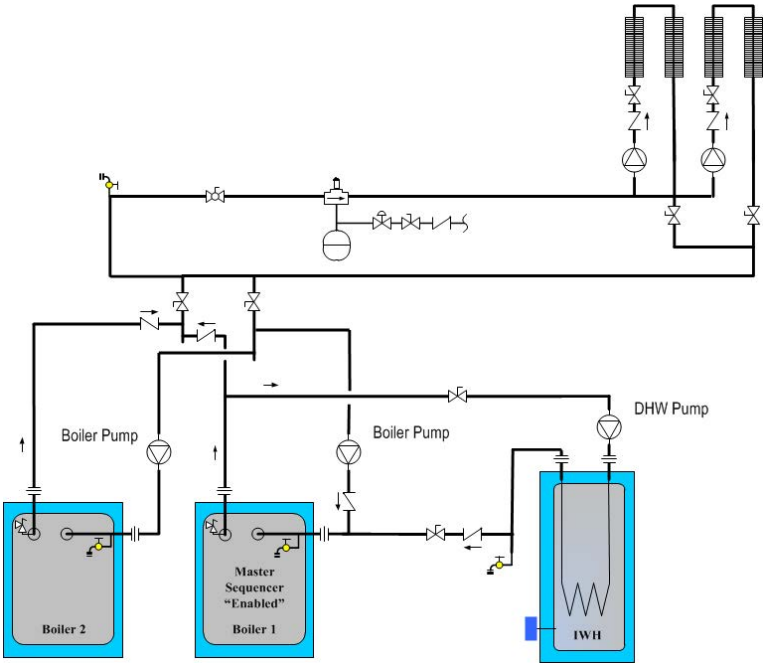
System Pump= “Central Heat , Optional Priority”
Boiler Pump = “any demand”
DHW Pump = “Primary Loop Piped IWH”
DHW Priority Enable is optional

Explanation:

This piping arrangement permits the system pump to run or not run when there is a domestic hot water call for heat. Domestic hot water priority is optional. It is permissible for the domestic and system pumps to run at the same time. The boiler pump must run for every call for heat.

10 Operation *(continued)*

Multiple Boilers, Boiler Piped Indirect Water Heater

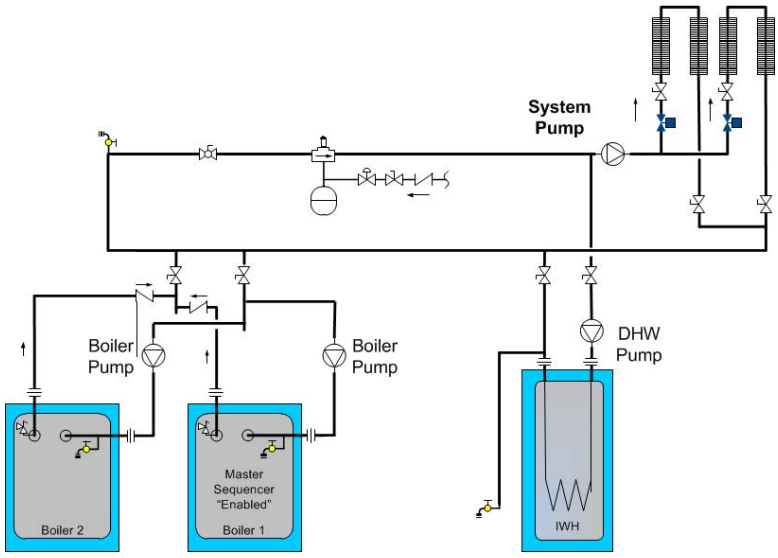


	Sequencer Master (Boiler 1)	Boiler 2
Wiring locations:		
Enable/Disable	X	
DHW Demand	X	
System pump	X	
DHW pump	X	
Boiler Pump	X	X
Sequencer Master Parameter Selections:		
Sequencer Master	Enabled	
Indirect Water Heater	"Boiler Piped"	
Pump Parameter Selections:		
System Pump =	Central Heat, No Priority	Never
Boiler Pump =	Central Heat, Off DHW Priority	Any demand
DHW Pump =	Boiler Piped IWH	Never

Explanation:

Make sure indirect water heater and DHW pump are sized to maintain flow though boiler within limits shown in Table 6-3.
This piping arrangement does not allow both the Slave 1's boiler and domestic hot water pump to run at the same time. When call for Domestic Hot Water is received the DHW pump is turned on and the boiler pump is turned off. However, the system pumps may run to satisfy a central heat demand that is being satisfied by a different slave. The central heat demand is ignored by Slave 1 until the domestic hot water demand is ended. If domestic hot water priority is enabled and priority protection time is exceeded the domestic hot water pump turns off to allow the boiler pump to run.

Multiple Boilers, Primary Piped Indirect Water Heater, Optional DHW Priority



	Sequencer Master (Boiler 1)	Boiler 2
Wiring locations:		
Enable/Disable	X	
DHW Demand	X	
System pump	X	
DHW pump	X	
Boiler Pump	X	X
Sequencer Master Parameter Selections:		
Sequencer Master	Enabled	
Indirect Water Heater	"Primary Piped"	
Pump Parameter Selections:		
System Pump =	Central Heat, Optional Priority	Never
Boiler Pump =	Any demand	Any demand
DHW Pump =	Primary Loop Piped IWH	Never

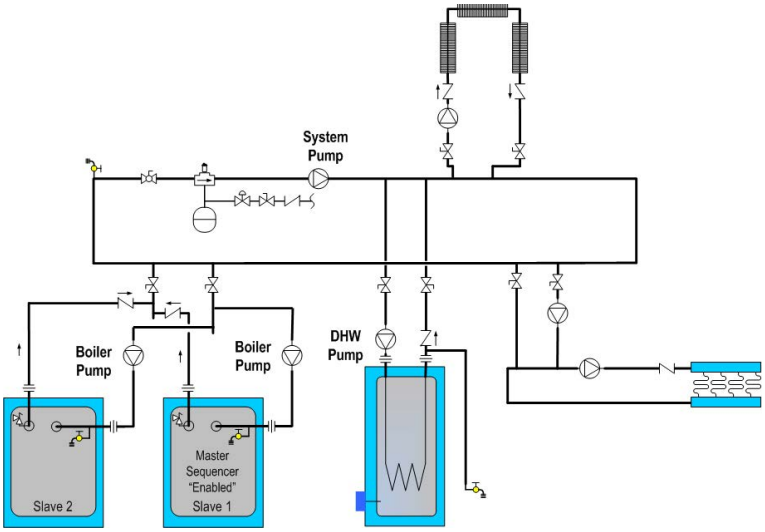
Explanation:

This piping arrangement permits the system pump to run or not run when there is a domestic hot water call for heat. Domestic hot water priority is optional. It is permissible for the domestic and system pumps to run at the same time. The boiler pump must run for every call for heat.

10 Operation *(continued)*

Example Pump Parameter selections (continued)

Multiple Boilers, Primary Piped Indirect Water Heater, System Pump Run for Any Demand



	Sequencer Master (Boiler 1)	Boiler 2
Wiring locations:		
Enable/Disable	X	
DHW Demand	X	
System pump	X	
DHW pump	X	
Boiler Pump	X	X
Sequencer Master Parameter Selections:		
Sequencer Master	Enabled	
Indirect Water Heater	"Primary Piped"	
Pump Parameter Selections:		
System Pump =	Any demand	Never
Boiler Pump =	Any demand	Any demand
DHW Pump =	Primary Loop Piped IWH	Never

Explanation:
This piping arrangement requires the system pump to be running for any calls for heat. Also the boiler pump must run for any call for heat.

7. Service Contacts

This information may be entered from a USB thumb drive or from the screen. Refer to Paragraph K. "USB Thumb Drive Parameter Transfer". USB Port Parameter Transfer for thumb drive instructions.

Select Service Contacts to access the following parameters.

Parameter and Description	Factory Setting
Contractor Select the line of information to edit. Use key pad to input data and press ENT to enter data into Contractor Info.	Enter name Enter address line 1 Enter address line 2 Enter phone number Enter email
Service Company Select the line of information to edit. Use key pad to input data and press ENT to enter data into Service Company Info.	Enter name Enter address line 1 Enter address line 2 Enter phone number Enter email
Sales Representative Select the line of information to edit. Use key pad to input data and press ENT to enter data into Sales Representative Info.	Enter name Enter address line 1 Enter address line 2 Enter phone number Enter email

10 Operation *(continued)*

8. Central Heat Parameters

Select Central Heat to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Central Heat Setpoint Target temperature for the central heat priority. Value also used by the outdoor air reset function.	180°F (82.2°C)	50 to 190°F (10 to 87.8°C)
Time of Day Setpoint Used when an EnviraCOM thermostat is connected to the boiler and is in Sleep or Away mode. When setback is "on" the time of day setback setpoint shifts the reset curve to save energy while building is in a reduced room temperature mode. The reset curve is shifted by the difference between the High Boiler Water Temperature and the TOD Setback Setpoint.	170°F (76.7°C)	50 to 190°F (10 to 87.8°C)
Difference Above The boiler stops when the water temperature rises 'Difference Above' degrees above the setpoint.	10°F (-12.2°C)	2 to 25°F (-16.7 to -3.9°C)
Difference Below The boiler starts when the water temperature drops 'Difference Below' degrees below the setpoint.	5°F (-15°C)	2 to 25°F (-16.7 to -3.9°C)
Response Speed This parameter adjusts the Central Heat temperature controller Proportion Integral Derivative (PID) values. Higher values cause a larger firing rate change for each degree of temperature change. If set too high firing rate "overshoots" required value, increases to high fire causing the temperature to exceed the "Difference Above" setpoint and cycle the boiler unnecessarily. Lower values cause a smaller firing rate change for each degree of temperature change. If set too low, the firing rate response will be sluggish and temperature will wander away from setpoint. Refer to Table 10-20 for PID values used by these selections.	3	1 to 5
Central Heat Low Fire Hold Time "Low Fire Hold Time" is the time the control will wait at low fire modulation rate before being released to modulate. After ignition and flame stabilization periods, firing rate is held at low fire for "Low Fire Hold Time". This delay allows heat to travel out to the system and provide system feedback prior to the control modulating firing rate.	120 seconds	0 to 1,800 seconds
CH Modulation Sensor Determines which temperature sensor the boiler responds to with Central Heat demand. Outlet Sensor is the boiler's internal supply sensor. When Header Sensor is selected the boiler is fired in response to the sensor wired to Header Sensor terminals. **NOTE**: When Header Sensor is selected, also set Boiler Pump parameter to Header Sensor / Combustion Air Damper.	Outlet Sensor	Outlet Sensor Header Sensor

10 Operation *(continued)*

Table 10-20: Response Speed Adjustment Guidelines-20

Slower Response ⟷ Faster Response

Faster Response

Slower Response

Gain (P)	Integral (I) Repeats/Minute				
	0.5	1.0	2.0	3	4
103	17	35.0	70	105.0	140
89	15	30.0	60	90.0	120
74	12	25.0	50	75.0	100
59	10	20.0	40	60.0	80
44	8	15.0	30	45.0	60
30	5	10.0	20	30.0	40
26	5	9.0	18	27.0	36
22	4	7.5	15	22.5	30
19	3	6.5	13	19.5	26
15	3	5.0	10	15.0	20
11	2	4.0	8	12.0	16
9	2	3.0	6	9.0	12
7	1	2.5	5	7.5	10
6	1	2.0	4	6.0	8

CH and DHW Response Speed Settings	Sequence Master Response Speed Settings
5: P=59, I=40 4: P=45, I=60 3: P=44, I=45 2: P=30, I=30 1: P=30, I=20	5: P=30, I=10 4: P=29, I=9 3: P=22, I=7 2: P=19, I=6 1: P=15, I=5

9. Domestic Hot Water Parameters

Select Domestic Hot Water to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Priority Time When Priority Time is greater than zero and Domestic Hot Water (DHW) heat demand is “on”, DHW demand will take “Priority” over Central Heat (space heating) demand. When the System and Boiler pumps are configured as “Central Heat (off DHW priority)” or “Central Heat, Optional Priority” then they will be forced “off” during Priority Time. Priority Time provides “Priority Protection” time for the event of a failed or excessive long DHW demand. “Priority Time” is the time that the priority of the boiler will shift away from Central Heat to satisfy a Domestic Hot Water call for heat.	60 min	0 to 90 min
Setpoint Setpoint is used to create a boiler water temperature setpoint that is used when DHW heat demand is “on”. When the DHW heat demand is not “on” (i.e. the contact is open or not wired), this setpoint is ignored.	170°F (76.7°C)	50 to 190°F (10 to 87.8°C)
Time of Day Setpoint Used when an EnviraCOM thermostat is connected to the boiler and is in Sleep or Away mode. When setback is “on” the time of day setback setpoint shifts the DHW setpoint to lower the DHW temperature and to save energy while building is in a reduced room temperature mode.	160°F (71.1°C)	50 to 190°F (10 to 87.8°C)
Difference Above The boiler stops when the water temperature rises ‘Difference Above’ degrees above the setpoint.	7°F (-13.9°C)	3 to 29°F (-16.1 to 1.7°C)
Difference Below The boiler starts when the water temperature drops ‘Difference Below’ degrees below the setpoint.	5°F (-15°C)	3 to 29°F (-16.1 to 1.7°C)
Domestic Low Fire Hold Time “Low Fire Hold Time” is the number of minutes the control will wait at low fire modulation rate before being released to modulate. After ignition and flame stabilization periods the firing rate is held at low fire for “Low Fire Hold Time”. This delay allows heat to travel out to the system and provide system feedback prior to the control modulating firing rate.	10 seconds	0 to 1,800 seconds
Response Speed This parameter adjusts the Domestic Hot Water temperature controller Proportion Integral Derivative (PID) values. Higher values cause a larger firing rate change for each degree of temperature change. If set too high firing rate “overshoots” required value, increases to high fire causing the temperature to exceed the “Difference Above” setpoint and cycle the boiler unnecessarily. Lower values cause a smaller firing rate change for each degree of temperature change. If set too low, the firing rate response will be sluggish and temperature will wander away from setpoint. Refer to Table 10-20 for PID values used by these selections.	3	1 to 5

10 Operation *(continued)*

9. Domestic Hot Water Parameters, continued

Parameter and Description	Factory Setting	Range / Choices
DHW Modulation Sensor Outlet Sensor: Boiler modulates for DHW demand in response to supply/outlet sensor in boiler. DHW Sensor: Boiler modulates for DHW demand in response to DHW sensor at boiler-side inlet to indirect water heater. Use for single boiler servicing indirect water heater.	Outlet Sensor	Outlet Sensor, DHW Sensor

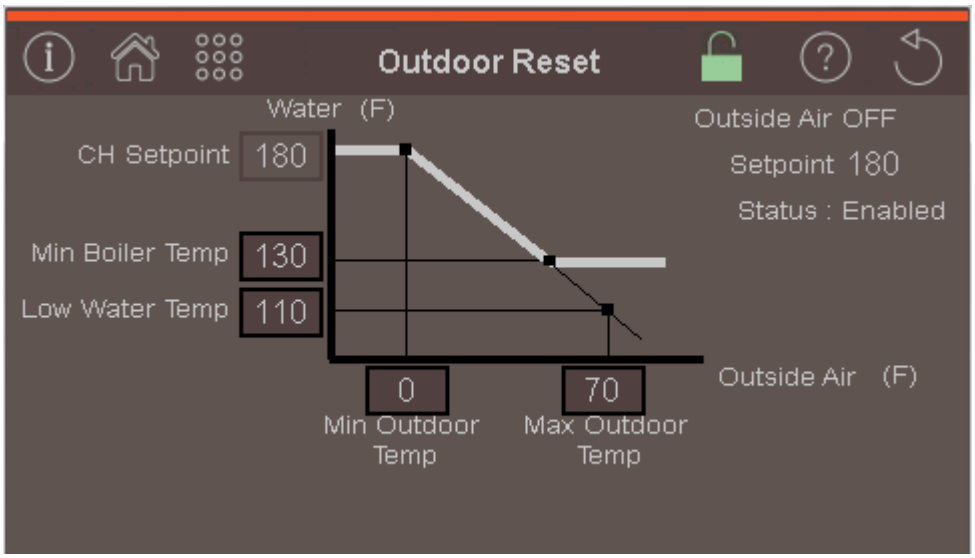


Figure 10-21: Outdoor Reset Curve

10 Operation *(continued)*

10. Outdoor Reset Parameters

Select Outdoor Reset to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Outdoor Reset Enable If an outdoor sensor is installed and Outdoor Reset is Enabled, the boiler will automatically adjust the heating set point temperature based on the outdoor reset curve in (see Figure 10-21). The maximum set point is defined by the Central Heat Setpoint (default 180°F) when the outdoor temperature is Min Outdoor Temp (default 32°F) or below. The minimum set point temperature shown is 130°F when the outdoor temperature is 50°F or above. As the outdoor temperature falls the supply water target temperature increases. Disable Do Not Calculate setpoint based on outdoor temperature Enable Calculate the temperature setpoint based on outdoor temperature using a reset curve defined by Low Outdoor Temp, High Outdoor Temp, Low Boiler Water Temp, Min Boiler Temp and Central Heat Setpoint and Boost Time parameters.	Enabled	Enable Disable
Minimum Outdoor Temperature Also called "Outdoor Design Temperature". This parameter is the outdoor temperature used in the heat loss calculation. It is typically set to the coldest outdoor temperature.	0°F (-18°C)	-50 to 32°F (-45.6 to 0°C)
Maximum Outdoor Temperature Outdoor temperature at which the Low Water Temperature is supplied. This parameter is typically set to the desired building temperature.	70°F (21.1°C)	35 to 100°F (1.7 to 37.8°C)
Low Water Temperature Operating setpoint when the Maximum Outdoor Temperature is measured. If the occupied space feels cool during warm outdoor conditions, the Low Water Temperature parameter should be increased.	110°F (43.3°C)	70 to 180°F (21.1 to 82.2°C)
Minimum Boiler Water Temperature Sets a low limit for the Reset setpoint. Set this parameter to the lowest supply water temperature that will provide enough heat for the type radiation used to function properly. Always consider the type of radiation when adjusting this parameter.	130°F (54.4°C)	50 to 185°F (10 to 85°C)
Central Heat Outdoor Reset Max Off Point Maximum value the setpoint can reach due to boost function. Should be set to match Central Heat Setpoint plus Differential Above.	190°F (87.8°C)	50 to 190°F (10 to 87.8°C)
Lead/Lag CH Outdoor Reset Max Off Point Maximum value the setpoint can reach due to boost function. Should be set to match Central Heat Setpoint plus Differential Above.	190°F (87.8°C)	50 to 190°F (10 to 87.8°C)
Boost Time When the Central Heat Setpoint is decreased by Outdoor Reset settings, the Boost Time parameter is used to increase the operating setpoint when the space heat demand is not satisfied after the Boost Time setting is exceeded. When heat demand has been "on" continuously for longer than the Boost Time parameter the operating setpoint is increased by 10°F (5.6°C). The highest operating setpoint from Boost Time is current Central Heat Setpoint minus the Central Heat "Diff Above" setting. A setting of 0 seconds disables this feature.	0 min.	0 to 30 min.

10 Operation *(continued)*

11. Sequencer Master

NOTICE: Enable only one Sequencer Master boiler within a group of networked boilers. Erratic behavior will result if more than one Sequencer Master is enabled.

Select Sequencer Master to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Sequencer Master The Sequencer Master Enable/Disable is used to "turn on" the multiple boiler lead-lag control.	Disabled	Enable Disable
Indirect Water Heater (IWH) Boiler Piped — Sequencer to respond to an Isolated DHW demand that is piped to a single boiler. The individual boiler goes on "Leave" from the Sequencer Master and goes to DHW Service. Primary Piped — The Sequence Master responds to the DHW Call For Heat. This allows one or more boilers to provide heat to the IWH.	Boiler Piped	Boiler Piped Primary Piped
DHW Two Boiler Start If enabled, the sequencer will immediately start two boilers for a DHW call for heat. Used when DHW is the largest demand. Only relevant when "Primary Piped IWH" is selected.	One Boiler	One Boiler Two Boiler
Boiler Start Delay Slave boiler time delay after header temperature has dropped below Setpoint minus Difference Below. Longer time delay prevents nuisance starts due to short temperature swings.	5 min.	0.5 to 20 min.
Boiler Stop Delay Slave boiler time delay after header temperature has risen above Setpoint plus Difference Above. Longer time delay prevents nuisance stops due to short temperature swings.	1 min.	0.5 to 5 min.
Base Load Rate To maximize boiler efficiency, firing rate is limited to an adjustable value. Boilers are kept at or below this firing rate as long as the boilers can handle the load. After last available boiler has started, the modulation rate limit is released up to 100%.	70%	25 to 100 %
Lead Rotation Time Time boilers will act as the lead before switching the lead to another boiler in the boiler to boiler network.	24 hours	8 to 48 hours
Response Speed This parameter adjusts the Central Heat temperature controller Proportion Integral Derivative (PID) values. Higher values cause a larger firing rate change for each degree of temperature change. If set too high firing rate "overshoots" required value, increases to high fire causing the temperature to exceed the "Difference Above" setpoint and cycle the boiler unnecessarily. Lower values cause a smaller firing rate change for each degree of temperature change. If set too low, the firing rate response will be sluggish and temperature will wander away from setpoint. Refer to Table 4-11 for PID values used by these selections.	3	0 to 5
Stop All Boilers When this temperature is reached, all networked boilers are stopped at once without any time delay. This setting allows the sequencer to respond to rapid load increases.	195°F (90.6°C)	Central Heat Setpoint to 195°F (90.6°C)

10 Operation *(continued)*

12. Sequencer Slave

Select Sequencer Slave to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Boiler Address Each boiler must be given a unique address. When Slave Selection Order is set to Use Normal Order, the boiler address is used by the Sequence Master as the boiler start order.	None	1 to 8
Slave Selection Order First Boiler will always be first to start. Normal Boiler start order follows boiler address number. Last Boiler will always be last to start.	Normal	First Normal Last

13. Limits

Select Limits to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Stepped Modulation Start Offset Reduces firing rate when supply, differential, or stack temperature is Stepped Modulation Start Offset degrees below the high limit setting to help avoid lockouts. For example, when the setting is 20°F, maximum modulation rate will begin to be reduced when stack temperature is 20°F below the Stack High Limit and will be at minimum modulation when stack temperature is 10°F below the limit. **Note**: Feature is only active for supply temperature when Header Sensor is selected as modulation sensor, when a boiler is a slave, or when a boiler is responding to a remote demand (4-20mA or Modbus).	20°F (-6.7°C)	(Stepped Modulation Recycle Offset +6°F) to 30°F
Stepped Modulation Recycle Offset Recycles boiler when supply, differential, or stack temperature is Stepped Modulation Recycle Offset degrees below the high limit setting to help avoid lockouts. For example, when the setting is 10°F, the boiler will recycle when temperature is 10°F below the limit. **Note**: Feature is only active for supply temperature when Header Sensor is selected as modulation sensor, when a boiler is a slave, or when a boiler is responding to a remote demand (4-20mA or Modbus).	10°F (-12.2°C)	10°F to (Stepped Modulation Start Offset - 6 °F)
Preferred Supply High Limit Adjustable high limit for supply temperature. Adjustable only up to control maximum value. **Note**: Included to allow installers and inspectors to test the limits.	210°F (98.9°C)	60 to 210°F (16 to 98.9°C)
Preferred Stack High Limit Adjustable high limit for stack temperature. Adjustable only up to control maximum value. **Note**: Included to allow installers and inspectors to test the limits.	204°F (95.6°C)	150 to 204°F (65.6 to 95.6°C)

10 Operation *(continued)*

14. Tune

Select Tune to access the following parameters.

Select Central Heat to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Response Speed Adjusts Central Heat temperature control Proportion Integral Derivative (PID) values. A higher value causes a larger firing rate change per degree of requested temperature change. If set too high, firing rate overshoots required value, temperature exceeds Difference Above, and boiler cycles unnecessarily. A lower value causes a smaller firing rate change per degree of requested temperature change. If set too low, firing rate response will be sluggish and temperature will wander away from setpoint. Refer to Table 10-20 for PID values used by these selections.	3	1 to 5
Proportional Rate Proportional gain value for Central Heat temperature control. A higher value yields tighter, more active, PID control. Proportional Rate is the primary PID modulation rate tuning adjustment and provides the immediate modulation rate response. Select value based on desired initial response. If set too high, burner modulation rate can oscillate.	26	0 to 400
Integral Rate Integral gain value for Central Heat temperature control. A higher value yields faster ramp rate. Integral is a secondary PID modulation rate tuning adjustment that ramps the output over time (typically minutes). Based on the selected Local PID P, select the corresponding (from above table) Integral value. Repeats per minute between 0.5 and 2.0 are typical. If set too high, burner modulation rate can oscillate.	9	0 to 400

10 Operation *(continued)*

Select Domestic Hot Water to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Response Speed Adjusts Domestic Hot Water temperature control Proportion Integral Derivative (PID) values. A higher value causes a larger firing rate change per degree of requested temperature change. If set too high, firing rate overshoots required value, temperature exceeds Difference Above, and boiler cycles unnecessarily. A lower value causes a smaller firing rate change per degree of requested temperature change. If set too low, firing rate response will be sluggish and temperature will wander away from setpoint.	3	1 to 5
Proportional Rate Proportional gain value for Domestic Hot Water temperature control. A higher value yields tighter, more active, PID control. Proportional Rate is the primary PID modulation rate tuning adjustment and provides the immediate modulation rate response. Select value based on desired initial response. If set too high, burner modulation rate can oscillate.	26	0 to 400
Integral Rate Integral gain value for Domestic Hot Water temperature control. A higher value yields faster ramp rate. Integral is a secondary PID modulation rate tuning adjustment that ramps the output over time (typically minutes). Based on the selected Local PID P, select the corresponding (from above table) Integral value. Repeats per minute between 0.5 and 2.0 are typical. If set too high, burner modulation rate can oscillate.	9	0 to 400

Select Lead Lag to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Response Speed Adjusts Sequence Master temperature control Proportion Integral Derivative (PID) values when boiler is connected in boiler-to-boiler network. A higher value causes a larger firing rate change per degree of requested temperature change. If set too high, firing rate overshoots required value, temperature exceeds Difference Above, and boiler cycles unnecessarily. A lower value causes a smaller firing rate change per degree of requested temperature change. If set too low, firing rate response will be sluggish and temperature will wander away from setpoint.	3	1 to 5
Proportional Rate Proportional gain value for Sequencer Master temperature control. A higher value yields tighter, more active, PID control. Proportional Rate is the primary PID modulation rate tuning adjustment and provides the immediate modulation rate response. Select value based on desired initial response. If set too high, burner modulation rate can oscillate.	22	0 to 400
Integral Rate Integral gain value for Sequencer Master temperature control. A higher value yields faster ramp rate. Integral is a secondary PID modulation rate tuning adjustment that ramps the output over time (typically minutes). Based on the selected Local PID P, select the corresponding (from above table) Integral value. Repeats per minute between 0.5 and 2.0 are typical. If set too high, burner modulation rate can oscillate.	7	0 to 400

10 Operation *(continued)*

Select Fan Tune to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Fan Speed-Up Ramp Maximum fan ramp rate when fan speed is increasing.	0	0 to 12,000 rpm
Fan Speed-Down Ramp Maximum fan ramp rate when fan speed is decreasing.	0	0 to 12,000 rpm
Fan Gain Up Fan gain when fan speed is increasing.	15	1 to 100
Fan Gain Down Fan gain when fan speed is decreasing.	5	1 to 100
CH Slow Start Enable/Disable Enables or disables the slow start limit function for Central Heat and Sequence Master demand sources. Uses the CH Low Fire Hold Rate parameter as the starting point for the slow start.	Disabled	Enable Disable
DHW Slow Start Enable/Disable Enables or disables the slow start limit function for DHW demand source. Uses the DHW Low Fire Hold Rate parameter as the starting point for the slow start.	Disabled	Enable Disable
Slow Start Degrees If Slow Start is enabled and supply temperature is less than setpoint minus Slow Start Degrees, then slow start rate limiting is effective. Slow start rate limiting has no effect when supply temperature is greater than setpoint minus Slow Start Degrees.	20°F (11°C)	0 to 180°F (0 to 82.2°C)
Slow Start Ramp When slow start rate limiting is in effect, the modulation rate will increase no more than the amount per minute given by this parameter. Although provided as a per-minute value, the Control will calculate and apply this as a stepped function using step duration of 10 seconds.	200 % / min.	0 to 1,000 rpm

Select Sequencer On/Off to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Sequencer On/Off Turns control internal sequencer on or off.	On	On Off

10 Operation *(continued)*

K. USB Thumb Drive Parameter Transfer

A USB port is provided on left side of boiler display panel. When used with a thumb drive, this port can be used to save parameters from boiler to thumb drive and load parameters from thumb drive to boiler. This feature allows for easy transfer of boiler parameters from one boiler to another. Refer to Table 10-22 for a list of parameters transferrable by USB port.

USB Thumb Drive Requirements

The thumb drive must be formatted as a FAT32 for use with the display. In order to check the format of a USB thumb drive, follow these instructions:

- Plug the USB drive into a computer
- Ensure that the USB drive does not have anything currently saved on it.
- Go to My Computer (Select Start >> Computer)
- Right click on Removable Disk and select Properties
- Under the General tab, confirm File system: FAT32
- If it does not say FAT32, close window, return to My Computer
- Right Click on Removable Disk and select Format
- Select File system = FAT32
- Select Start and then select OK to format the USB Thumb Drive.
- The USB Thumb Drive is now FAT32 format

Save Parameters to USB

Saves the current parameter settings of the boiler, including the contact information of the contractor, Service Company, and sales representative, to a USB Drive. Follow these steps to save parameters.

- Plug USB thumb drive into boiler USB port
- Select Main Menu >> Archives >> Save Parameters to USB
- Confirm or Save Parameters
- Once procedure is complete the display saves two files: a parameter file called Recipe.csv, and a contact information file called Recipe32.csv. Select My Computer >> Removable Disk >> HMI > HMI000 to access these files.

Load Parameters from USB

Loads the current saved parameter settings from a USB drive. Parameter files must be stored in My Computer >> Removable Disk >> HMI >> HMI000. Two files should be stored: a parameter file called Recipe.csv, and a contact information file called Recipe32.csv. Follow these steps to load parameters.

- Plug USB thumb drive into boiler USB port
- Select Main Menu >> Archives >> Load Parameters from USB
- Confirm or Cancel Load of Parameters.
- Confirm or Cancel Load of Contact Information.

Table 10-22: Parameters Summary

Parameter	Security	USB Load/Save
SYSTEM		
Temperature Units	Basic	X
Outdoor Sensor Source	Basic	X
Outdoor Sensor Calibration	Basic	X
Anti short Cycle Time	Basic	X
CH Frost Protection	Basic	X
CH Frost Protection Setpoint	Basic	X
Installer Password	Factory	X
Warm Weather Shutdown Enable	Basic	X
Warm Weather Shutdown Setpoint	Basic	X
System Date	Basic	
System Time	Basic	
Auto Jump To Home Page	Basic	X
MODULATION		
Boiler Type	Factory	
CH Max Modulation Rate	Factory	
DHW Max Modulation Rate	Factory	
Minimum Modulation Rate	Factory	
Lightoff Rate	Factory	
OPERATION		
Auto/Manual	Supervisor	
Rate	Supervisor	

10 Operation *(continued)*

Table 10-22: Parameters Summary (continued)

Parameter	Security	USB Load/Save
PUMPS		
System Pump	Supervisor	X
Boiler Pump	Supervisor	X
DHW Pump	Supervisor	X
CH pump overrun time	Supervisor	X
DHW pump overrun time	Supervisor	X
Boiler pump overrun time	Supervisor	X
Pump exercise interval	Supervisor	X
Pump exercise time	Supervisor	X
CENTRAL HEAT		
CH Setpoint	Basic	X
CH TOD Setback Setpoint	Basic	X
CH Difference Above	Basic	X
CH Difference Below	Basic	X
CH Response Speed	Supervisor	X
CH Modulation Sensor	Supervisor	X
Central Heat Low Fire Hold Time	Supervisor	X
DOMESTIC HOT WATER		
DHW Priority Time	Basic	X
DHW Setpoint	Basic	X
DHW TOD Setback Setpoint	Basic	X
DHW Difference Below	Basic	X
DHW Difference Above	Basic	X
DHW Response Speed	Supervisor	X
Domestic Low Fire Hold Time	Supervisor	X
DHW Modulation	Supervisor	X
OUTDOOR RESET		
Outdoor Reset Enable/Disable	Basic	X
Minimum Outdoor Temperature	Basic	X
Maximum Outdoor Temperature	Basic	X
Low Water Temperature	Basic	X
Minimum Boiler Water Temperature	Basic	X
Boost Time	Basic	X
Central Heat ODR Max Off Point	Basic	X
Lead Lag CH ODR Max Off Point	Basic	X
SEQUENCER MASTER		
Master Enable/Disable	Supervisor	
Base Load Common Rate	Supervisor	
Indirect Water Heater	Supervisor	
Boiler Start Delay	Supervisor	
DHW Two Boiler Start	Supervisor	
Stop All Boilers	Basic	
Boiler Stop Delay	Supervisor	
Lead Rotation Time	Basic	
Response Speed	Supervisor	

Table 10-22: Parameters Summary (continued)

Parameter	Security	USB Load/Save
SEQUENCER SLAVE		
Slave Selection Order	Supervisor	
Boiler Address	Supervisor	
LIMITS		
Stepped Modulation Start Offset	Factory	X
Stepped Modulation Recycle Offset	Factory	X
Preferred Stack Limit Setpoint	Factory	X
Preferred Outlet Limit Setpoint	Factory	X
EMS REMOTE DEMAND		
Modulation Source	Supervisor	
CH Demand Switch	Supervisor	
LL Demand Switch	Supervisor	
4mA Water Temp	Supervisor	
Lead Lag Setpoint Source	Supervisor	
Central Heat Setpoint Source	Supervisor	
20mA Water Temp	Supervisor	
Analog Input Hysteresis	Supervisor	
FAN TUNE		
Fan speed - up ramp	Supervisor	X
Fan slow - down ramp	Supervisor	X
Fan gain up	Factory	X
Fan gain down	Factory	X
CH slow start enable/disable	Supervisor	X
DHW slow start enable/disable	Supervisor	X
Slow start ramp	Supervisor	X
Slow start degrees	Supervisor	X

10 Operation *(continued)*

L. Multiple Boiler Control Sequencer

1. Setup

NOTICE: Enable only one Sequencer Master boiler within a group of networked boilers. Erratic behavior will result if more than one Sequencer Master is enabled. Assign all boilers a unique address. Undesirable simultaneous operation occurs when two boilers' addresses are the same.

Complete steps shown in Table 10-23 to set up a multiple boiler system. Refer to J. Parameter Adjustment, parts 11 and 12.

Table 10-23: Multiple Boiler Setup Procedure

Step	Description	Comments
1	Wire the header sensor	Wire a header sensor to Header Sensor terminals of the boiler to be used as the Sequencer Master. See Figures 6-14 and 6-15 for header sensor installation detail. **NOTE**: This step cannot be skipped. The Sequencer Master cannot be enabled unless a Header Sensor is installed.
2	Install Ethernet cables between boilers	See Figure 8-9. Use standard Ethernet type cables to make connection between boilers. Alternatively, terminal screws A, B, and C labeled Boiler-to-Boiler may be used.
3	Set unique boiler addresses	Assign all boilers a **unique** Boiler Address using any number from 1 through 8. Select Main Menu >> Adjust >> Sequencer Slave >> Boiler Address.
4	Enable one Sequencer Master boiler	Enable the Sequencer Master on the boiler with header sensor installed. Enable only **one** boiler as the Sequencer Master. Select Main Menu >> Adjust >> Sequencer Master >> Enable.
5	Confirm communication	Power down all boilers. Power up Sequencer Master boiler first. On the Sequencer Master boiler, select Status. The Sequencer display should show boiler addresses of communicating boilers. If a boiler is not shown, check Ethernet cable connections and confirm all boilers have unique addresses.

2. Features

Sequencer Master

A single boiler is selected to be the permanent Sequencer Master (i.e. does not rotate). The call for heat, outdoor and header sensors, and common pumps are wired to the Sequencer Master boiler.

Lead/Slave Sequencing

The Sequencer Master is independent of the lead boiler. One boiler is a lead boiler and the remaining networked boilers are slaves. When demand is increasing, the lead boiler is the first to start and the slave boilers are started in sequential order (1, 2, 3,…) until the demand is satisfied. When demand is decreasing, the boilers are stopped in reverse order with the lead boiler stopped last (…, 3, 2, 1). To equalize the run time, the sequencer automatically rotates the lead boiler after 24 hours of run time.

Sequence of Operation

Multiple boiler sequence of operation is illustrated in Figure 10-24. After there is a demand, both header water temperature and boiler firing rate percent are used to start and stop networked boilers. The control starts and stops boilers when water temperature is outside Difference Above and Difference Below settings. To minimize temperature deviations, the control adjusts the number of boilers running based on the firing rate. This combination allows the boilers to anticipate slow load changes before they disrupt water temperature, yet still respond quickly to sudden load changes. These special sequencer features help reduce energy wasting system temperature swings and the resulting unnecessary boiler cycling.

(1) Lead Boiler Start - Temperature below setpoint by more than Difference Below

(2) Temperature Based Lag Boiler Start - Temperature below setpoint by more than Difference Below for longer than Boiler Start Delay (adjustable parameter)

(3) Modulation % Based Lag Boiler Start – Firing rate has been at maximum for longer than 20 min.

(4) Lag Boiler Stop – Firing rate has been at minimum for longer than 20 min. Additionally, lag boilers are stopped when water temperature is above setpoint by more than Difference Above for longer than Boiler Stop Delay.

(5) Lead Boiler Stop – Lead boiler fires until water temperature is above setpoint more than Difference Above for longer than Boiler Stop Delay.

10 Operation *(continued)*

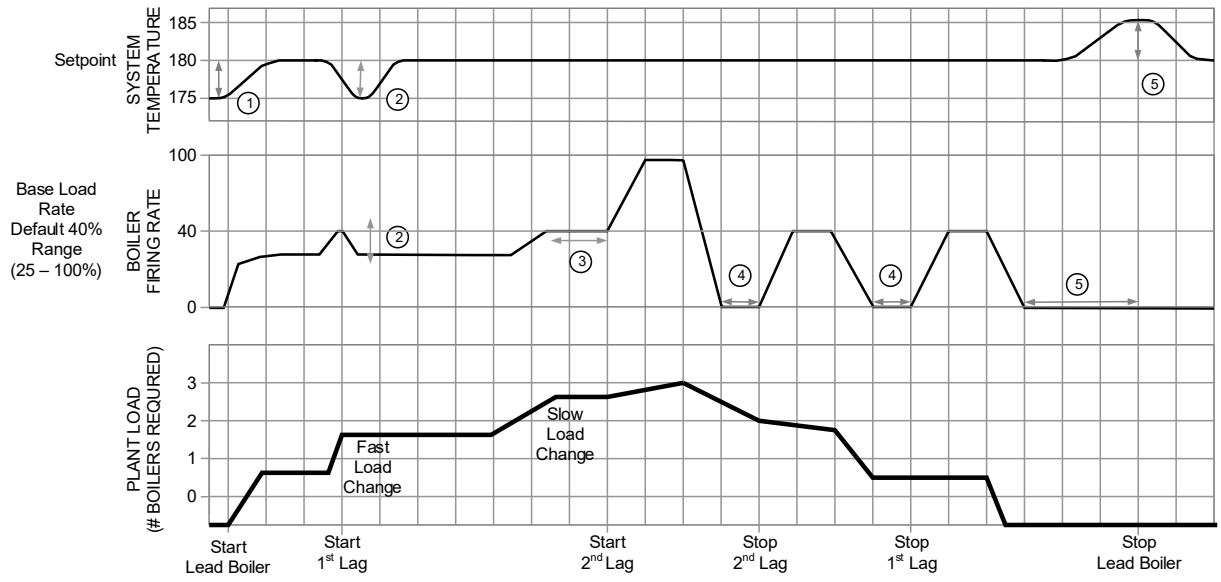


Figure 10-24: Multiple Boiler Sequence Diagram (3 boiler system shown, typical for up to 8 boilers)

Optimized Boiler Modulation

Boiler firing rate is managed to increase smoothly as boilers are started. For example, when a second boiler is started the initial firing rate is 100%/2 or 50%, when the third boiler is started the firing rate starts at 200%/3 or 66%. After the initial start, the Sequencer Master develops a unison firing rate demand based on its setpoint and header temperature.

Base Load Rate

During low loads, the Sequencer Master limits firing rates to a Base Load Rate to ensure modulating condensing boiler peak operating efficiency. Lower firing rates boost efficiency by helping increase the amount of flue gas water vapor condensation. The control maintains a Base Load Rate until the last lag boiler is started. At this point, the Base Load Rate is released to allow boilers to modulate as required to meet heat load.

Customized Sequences

Normally, boilers are started and stopped in numerical order. However, custom sequences may be established to optimize the heat delivery. For example, in order to minimize boiler cycling, a large boiler may be selected to run first during winter months and then selected to run last for the remainder of the year.

Multiple Demands

The Sequencer Master responds to Central Heat, DHW and frost protection demands similar to a stand-alone boiler. For example, when DHW Priority Time is nonzero and DHW priority is active, the Sequencer Master uses DHW setpoint, Differential Above, Differential Below and pump settings. However, the Sequencer Master always uses the header sensor and does not use the DHW sensor.

DHW Two boiler Start

When the DHW Pump parameter is set to DHW Pump: Primary Loop Piped IWH and the Sequencer Master DHW Two Boiler Start parameter is set to Two Boiler, two boilers are started without delay in response to DHW demand. This feature allows rapid recovery of large indirect water heaters (IWH's) and multiple IWH's.

Shared or Isolated DHW Demand

When the DHW Pump parameter is set to Primary Loop Piped IWH, the Sequence Master sequences all required boilers to satisfy the DHW demand. When the DHW Pump parameter is set to Boiler Piped IWH, only the individual slave boiler, with wired DHW Demand or DHW Sensor and pump, fires to satisfy DHW demand.

10 Operation *(continued)*

Backup Header Sensor

If the header sensor fails, the Sequencer Master uses the lead boiler's supply sensor to control firing rate. This feature allows continued coordinated sequencer control even after a header sensor failure.

Improved Availability

The following features help improve the heat availability:

- Slave Boiler Rate Adjustment – Each slave boiler continues to monitor supply, return and flue gas temperatures and modifies the Sequencer Master firing rate demand to help avoid individual boiler faults, minimize boiler cycling and efficiently provide heat to the building.
- Slave Boiler Status Monitoring – Sequencer Master monitors slave boiler lockout status and automatically skips over disabled boilers when starting a new slave boiler.
- Stand Alone Operation Upon Master Failure – Individual boilers are configured to continue to operate in the event the Sequencer Master control is powered down, disabled or boiler-to-boiler communication is lost. The following are design considerations for backup "Stand Alone" operation. Once the Sequence Master is restored to operation the individual boilers automatically resume their position as sequencer slaves.
  - o Enable/Disable – Upon loss of Sequencer Master, each boiler will automatically begin local control. This means it will operate only if it has a call for heat. For this reason slave boilers should have their Enable/Disable terminals jumpered so each boiler has demand if Sequencer Master is lost.
  - o Modulation – Once running, each slave boiler will use its selected central heat modulation sensor and setpoint to produce heat for the building. To allow continued header water temperature control, slave boilers may have separate header sensors wired with the CH Modulation Sensor parameter selected as Header Sensor.
  - o Pumping – Consideration must be given to how the system pump is powered. If the Sequencer Master enabled boiler is powered down, how will the system pump be operated? It may be required to wire the system pump to multiple boilers.

10 Operation *(continued)*

M. Energy Management System (EMS) Interface

The control system has a fully featured ability to interface with an Energy Management System (EMS). The control system allows remote control and monitoring via RS485 Modbus or through direct wiring. The following sections outline setup of the EMS interface and adjustable EMS interface parameters. Select Main Menu >> EMS to access EMS parameters.

1. Setup

Complete steps shown in Table 10-25 to set up a multiple boiler system with EMS interface.

Table 10-25: Energy Management System Setup Procedure

Step	Description	Comments
1	Install Ethernet cables between boilers	See Figure 8-9. Use standard Ethernet type cables to make connection between boilers. Alternatively, terminal screws A, B, and C labeled Boiler-to-Boiler may be used. **NOTE**: The same Ethernet cable that connects the Boiler-To-Boiler Sequence Master also connects the EMS Modbus signals.
2	Enable EMS communication	Select Main Menu >> EMS >> Modbus Setup >> EMS Enable/Disable >> Enable.
3	Set unique Modbus addresses **"Comm HMI Station"**	 **SEE MODBUS SETUP PARAMETERS BEFORE PROCEEDING** Program COM2 only The EMS Modbus address may be independent to the Boiler number or boiler address. Select Main Menu >> EMS >> Modbus Setup >> EMS Modbus Parameters. Follow on screen instructions. **NOTE**: Each boiler must have a unique **Comm HMI Station** address.
4	Adjust communication parameters	Communication parameters are adjustable. Select Main Menu >> EMS >> Modbus Setup >> EMS Modbus Parameters. Follow on screen instructions. **NOTE: Baud Rate** and **Parity** must match the EMS settings for communication to be established.
5	Confirm communication	The display provides a list of all EMS signals. Select Main Menu >> EMS >> Points List. Use the list to verify signals sent and received from the EMS.

2. Remote Demand Parameters

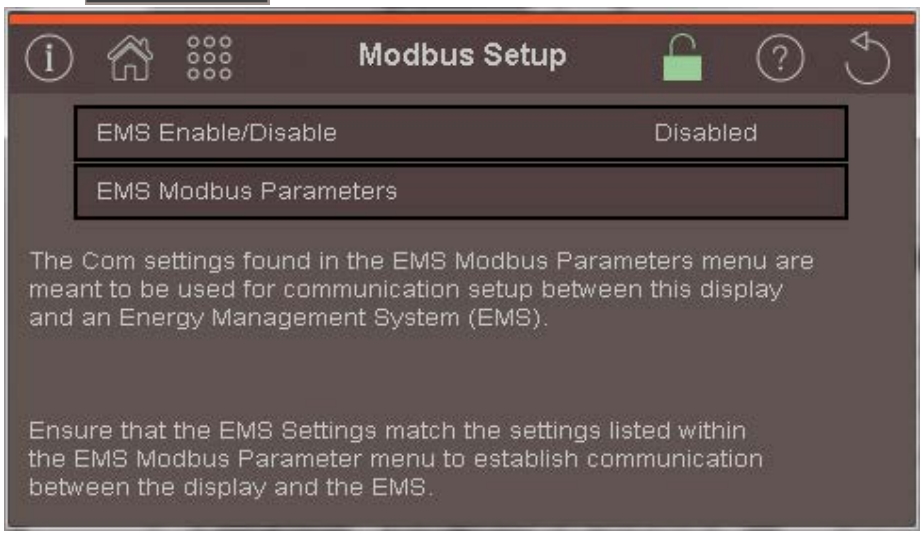
Select  to access the following parameters.

Parameter and Description	Factory Setting	Range / Choices
Modulation Source The boiler can modulate (vary boiler heat input) based on local or remote (4-20 mA or Modbus) signals. Modulation begins after the start sequence finishes and the boiler is released to modulate. Modulation Source has the following selections: Local Local setpoint and control is used to create firing rate. 4-20mA Input wired to Remote 4-20 mA terminals is used as modulation rate. Modbus Modbus signal is used as modulation rate.	Local	Local, 4-20 mA, Modbus
Central Heat Setpoint Source & Lead Lag Setpoint Source The setpoint may be based on local (customer entered value or outdoor reset) or remote (4-20mA or Modbus) signals. Setpoint Source has the following selections: Local Local setpoint and control is used to create firing rate. 4-20mA Input wired to Remote 4-20 mA terminals is used as modulation rate. Modbus Modbus signal is used as modulation rate.	Local	Local, 4-20 mA, Modbus
CH Demand Switch The Central Heat demand (Enable Disable) can be directly wired to the boiler or provided by the Modbus interface. Ignored when boiler is controlled by sequencer. Local Enable Disable terminals provide demand. Modbus Modbus signal provides demand.	Local	Local, Modbus
LL Demand Switch The Sequencer Master's demand (Enable Disable) can be directly wired to the boiler or provided by the Modbus interface. Used only on Sequencer Master boiler. Local Enable Disable terminals provide demand Modbus Modbus signal provides demand.	Local	Local, Modbus
4-20 mA Water Temp Sets the Central Heat Setpoint temperature corresponding to 4 mA.	130°F (54.4°C)	50°F (10°C) - Central Heat Setpoint
20 mA Water Temp Sets the Central Heat Setpoint temperature corresponding to 20 mA.	180°F (82.2°C)	50°F (10°C) - Central Heat Setpoint

10 Operation *(continued)*

3. Modbus Setup Parameters

Select Modbus Setup to bring up the following sub-menu.



Select EMS Modbus Parameters to view and/or adjust COM port parameters as needed to communicate with an EMS. Follow on screen instructions. COM 1 is used for communication between touch screen display and the boiler control and does not require adjustment. COM 2 is used for communication between an EMS and the boiler control and may require adjustment to suit the EMS.

NOTICE: Do NOT change COM 1 settings. Loss of communication between control and display could result. Read all on screen instructions before entering System Menu.

Select System Menu >> System Setting >> COM Port to access the following parameters. To exit System Menu, cycle power or select open blue area of screen.

COM Port	COM 1	COM 2
COM Port Configure For Control: communication between boiler display and boiler control EMS: communication between EMS and boiler control	Control	EMS
Port Type (non-adjustable)	Modbus Master	Modbus Slave
Special Notes	***NOTICE*:** Do not change any of these settings. Loss of communication to control could result.	Adjust these settings to suit the EMS
COM Mode	RS 485	RS 485
Baud Rate	38400	38400
Stop Bits	1 bit	1 bit
Data Bits	8 bit	8 bit
Parity Bits	None	None
Comm. Delay (ms)	10 ms	10 ms
Comm. Timeout (ms)	1000 ms	1000 ms
Comm. Retry Times	2	2
Comm. HMI Station This is Modbus Slave Address.	0 (not used)	1
Baud Rate Fine Tuning	0	0
PLC Default Station This is address Modbus Master is reading.	1	1 (not used)

10 Operation *(continued)*

4. Modbus Register List

A list of available Modbus registers and descriptions is stored in the display and provided in Table 10-26. To access

Select Points List to access the list of available Modbus registers.

Table 10-26: Modbus Register List

ENABLE/DISABLE			
Modbus Register	**Protocol Name**	**Description**	**Read (R) / Write (W)**
400577	Central Heat Enable/Disable	Central Heat Enable/Disable 0 = Disable 1 = Enable When this register is not written every “Modbus Command Time Out” parameter seconds (default 30 seconds), CH Modbus Stat is reverted to 0 no demand.	W
400563	LLCH Modbus Stat	LL CH Modbus STAT 0 = no demand 1 = demand When this register is not written every “Modbus Command Time Out” parameter seconds (default 30 seconds), CH Modbus Stat is reverted to 0 no demand.	W
400203	Burner on/off	Burner On/Off burner. 1 = on 0 = off	R
400006	Demand source	0 = Unknown 1 = No source demand 2 = Central heat 3 = Domestic hot water 4 = Lead Lag slave 5 = Lead Lag master 6 = Central heat frost protection 7 = Domestic hot water frost protection 8 = No demand due to burner switch turned off 9 = Domestic hot water storage 11 = Warm weather shutdown	R
400066	CH heat demand	0=Off, 1=On	R
400083	DHW heat demand	0=Off, 1=On	R
400123	Low Temperature Loop heat demand	0=Off, 1=On	R
SETPOINTS			
410579	CH Modbus Setpoint	Use this register to change the boiler setpoint. When this register is not written every “Modbus Command Time Out” parameter seconds (default 30 seconds), setpoint reverts to local setpoint valid range 60°F to 190°F	W
410562	CH Sequencer Modbus Setpoint	Use this register to change the multiple boiler Sequencer setpoint. When this register is not written every “Modbus Command Time Out” parameter seconds (default 30 seconds), setpoint reverts to local setpoint valid range 60°F to 190°F	W
410211	CH setpoint	Status of local setpoint	R
410453	DHW setpoint	Status of local setpoint	R
410546	Lead Lag setpoint	Status of local setpoint	R
410212	CH TOD setpoint	Status of local setpoint	R

10 Operation *(continued)*

Table 10-26: Modbus Register List (continued)

SETPOINTS			
Modbus Register	**Protocol Name**	**Description**	**Read (R) / Write (W)**
410065	CH setpoint source	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 3=Outdoor reset, 4=Remote control (4-20mA), 7=Outdoor reset time of day	R
410016	Active CH setpoint	-40 F (-40°C) to 266°F (130°C) Setpoint determined by CH setpoint source (register 65).	R
410081	DHW setpoint source	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 5=DHW tap setpoint, 6=DHW preheat setpoint	R
410017	Active DHW setpoint	-40°F (-40°C) to 266°F (130°C) Setpoint determined by DHW setpoint source (register 81).	R
410162	Lead Lag master setpoint source	0=Unknown, 1=CH setpoint, 2=CH TOD setpoint, 3=Outdoor reset, 4=Remote control (4-20mA), 5=DHW setpoint, 6=DHW TOD setpoint, 7=Outdoor reset time of day, 8=Mix setpoint	R
410018	Active LL setpoint	-40 F (-40°C) to 266 F (130°C) Setpoint determined by LL setpoint source (register 162).	R
410643	Low Temperature setpoint	Setpoint entered on the local user interface. valid range 79°F (26.1°C) to 191°F (88.3°C)	R
410121	Low Temperature setpoint source	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 3=Outdoor reset, 4=Remote control, 7=Outdoor reset time of day, 9=Outdoor boost	R
410024	Active Low Temperature setpoint	-40 F (-40°C) to 266°F (130°C) Setpoint determined by Low Temp setpoint source (register 121).	R

10 Operation *(continued)*

Table 10-26: Modbus Register List (continued)

TEMPERATURE SENSORS			
Modbus Register	**Protocol Name**	**Description**	**Read (R) / Write (W)**
410007	Supply sensor	-40 F (-40°C) to 266 F (130°C)	R
410011	Return sensor	-40 F (-40°C) to 266 F (130°C)	R
410013	Header sensor	-40 F (-40°C) to 266 F (130°C)	R
410014	Stack sensor	-40 F (-40°C) to 266 F (130°C)	R
410170	Outdoor sensor	-40 F (-40°C) to 266 F (130°C)	R
400015	4 - 20 mA sensor	mA value for S2 (J8-6) parameter selectable as (remote set point) & (remote modulation)	R
410817	Modbus Outdoor Temp	Building Automation may send the controller the outdoor air temperature. Use this register to change the outdoor temperature. When this register is not written every "Modbus Command Time Out" parameter seconds (default 30 seconds), temperature is set to bad data quality and outdoor air reset is set back to local setpoint. valid range -40°F to 302°F	W
BURNER			
400581	CH Modbus Rate	Use this register to drive individual boiler firing rates. This register is used when firing rate control is performed by an external building automation system. Firing rate reverts to local control when register is not written every "Modbus Command Time Out" parameter seconds (default 30 seconds), Range is 0 to 200 % provides 0-100% firing rate.	W
400008	Fan Speed Measured	Speed of the combustion air blower in rpm	R
400009	Fan Speed Commanded	Speed of the combustion air blower in rpm	R
400010	Flame signal	0.01V or 0.01µA precision (0.00-50.00V)	R
400033	Burner control state	0 Initiate 1 Standby Delay 2 Standby 3 Safe Startup 4 Prepurge - Drive to Purge Rate 5 Prepurge – Measured Purge Time 6 Prepurge – Drive to Lightoff Rate 7 Preignition Test 8 Preignition Time 9 Pilot Flame Establishing Period 10 Main Flame Establishing Period 11 Direct Burner Ignition 12 Run 13 Postpurge 14 Lockout	R

10 Operation *(continued)*

Table 10-26: Modbus Register List (continued)

TROUBLESHOOTING			
Modbus Register	**Protocol Name**	**Description**	**Read (R) / Write (W)**
410034	Lockout code	Reasons for burner lockout 0 No lockout, 4 Supply high limit 5 DHW high limit 6 Stack High limit 12 Flame detected out of sequence 18 Lightoff rate proving failed 19 Purge rate proving failed 20 Invalid Safety Parameters 21 Invalid Modulation Parameter 22 Safety data verification needed 23 24 VAC voltage low/high 24 Fuel Valve Error 25 Hardware Fault 26 Internal Fault 27 Ignition Failure	R
410040	Hold code	Reason for burner hold 0 None 1 Anti short cycle 2 Boiler Safety Limit Open 3 Boiler Safety Limit Open, (ILK Off) 7 Return sensor fault 8 Supply sensor fault 9 DHW sensor fault 10 Stack sensor fault 11 Ignition failure 13 Flame rod shorted to ground 14 Delta T inlet/outlet high 15 Return temp higher than supply 16 Supply temp has risen too quickly 17 Fan speed not proved 23 24 VAC voltage low/high 25 Hardware Fault 27 Ignition Failure	R
STATISTICS			
400763	Modbus command timeout	This parameter sets the amount of time the control will wait for input from the Building Automation System (BAS). If the BAS does not write to the following register within the “Modbus Command timeout” seconds the following inputs are considered invalid: CH Modbus Stat, CH Modbus Setpoint, CH Sequencer Modbus Setpoint CH Modbus Rate range 30 – 120 Default 30 seconds Other R/W registers should only be written when a value is needed to be changed. Only the above listed registers are stored in non-volatile registers.	R/W

10 Operation *(continued)*

Table 10-26: Modbus Register List (continued)

PUMP STATUS			
Modbus Register	**Protocol Name**	**Description**	**Read (R) / Write (W)**
400096	CH pump status	See Table 10-27.	R
400100	DHW pump status	See Table 10-27.	R
400108	Boiler pump status	See Table 10-27.	R
400128 - 400129	Burner cycle count	0-999,999 (U32)	R/W
400130 - 400131	Burner run time	Hours (U32)	R/W
400132 - 400133	System pump cycle count	0-999,999 (U32)	R/W
400134 - 400135	DHW pump cycle count	0-999,999 (U32)	R/W
400138 - 400139	Boiler pump cycle count	0-999,999 (U32)	R/W

Table 10-27: Pump Status Codes

Status	Description
92	Forced On from manual pump control
93	Forced On due to Outlet high limit is active
94	Forced On from burner demand
95	Forced On due to Lead Lag slave has demand
96	Forced Off from local DHW priority service
97	Forced Off from Lead Lag DHW priority service
98	Forced Off from Central Heat anti-condensation
99	Forced Off from DHW anti-condensation
100	Forced Off due to DHW high limit is active
101	Forced Off from EnviraCOM DHW priority service
102	On due to local CH frost protection is active
103	On due to Lead Lag CH frost protection is active
104	On due to local DHW frost protection is active
105	On due to Lead Lag DHW frost protection is active
106	On from local Central Heat demand
107	On from Lead Lag Central Heat demand
108	On from local DHW demand
109	On from Lead Lag DHW demand

Status	Description
110	On from local Mix demand
111	On from Lead Lag Mix demand
112	On from local Central Heat service
113	On from Lead Lag Central Heat service
114	On from local DHW service
115	On from Lead Lag DHW service
116	On from local Mix service
117	On from Lead Lag Mix service
118	On from Lead Lag auxiliary pump X
119	On from Lead Lag auxiliary pump Y
120	On from Lead Lag auxiliary pump Z
121	On, but inhibited by pump start delay
122	On from pump override
123	Off, not needed
124	On from burner demand
125	On from exercise
126	On from local Lead Lag service
127	On from local Lead Lag pump demand

11 Service and Maintenance

Important Product Safety Information: Refractory Ceramic Fiber Product

⚠ WARNING

Some boiler components use materials that contain refractory ceramic fibers (RCF). RCF has been classified as a possible human carcinogen. When exposed to elevated temperatures, RCF may change into crystalline silica, a known carcinogen. When disturbed as a result of servicing or repair, these substances become airborne and, if inhaled, may be hazardous to your health. Avoid breathing RCF particulates and dust.

Precautionary Measures:

- Do not handle RCF parts or attempt any service or repair work involving RCF without wearing the following protective gear:
    1. A properly fitting National Institute for Occupational Safety and Health (NIOSH)-certified air-purifying respirator with a filter efficiency of at least 95%. Respirator should also include a full facepiece when handling used RCF. Other types of respirators may be required depending on site conditions. Current NIOSH recommendations may be found on the NIOSH website http://www.cdc.gov/niosh/homepage.html NIOSH-approved manufacturers, respirators and associated user instructions are listed on the NIOSH website.
    2. Long sleeved, loose fitting clothing that is sufficiently tight around potential entry points for RCF dust.
    3. Gloves.
    4. Eye protection, such as goggles, safety glasses with side shields, or full facepiece.
- Take steps to assure adequate ventilation.
- Handle RCF carefully to minimize airborne dust. Use hand tools whenever possible.
- Dampen used RCF with light water spray prior to removal to prevent airborne dust.
- Do not use compressed air or dry sweeping for clean-up. Frequently clean work area with a vacuum or by wet sweeping to minimize debris accumulation.
- Vacuum work clothes before leaving work area. Wash work clothes separately from other laundry and rinse washing machine after use to avoid contaminating other clothes.
- Wash all exposed body areas gently with soap and water after contact.
- Discard used RCF components by sealing in an airtight plastic bag or container. Refer to local, regional, state or provincial regulations to identify applicable disposal requirements.

First Aid Procedures:

- Eye contact: Flush with water for at least 15 minutes. **Do not rub eyes**. Seek immediate medical attention if irritation persists.
- Skin contact: Wash affected area gently with soap and water. Do not rub or scratch affected skin. Seek immediate medical attention if irritation persists.
- Nose and throat contact: If these become irritated, leave the area and move to a location with clean fresh air. Drink water and blow nose. Seek immediate medical attention if symptoms persist.

11 Service and Maintenance *(continued)*

⚠ WARNING

- **Asphyxiation Hazard.** This boiler requires regular maintenance and service to operate safely. Follow the instructions contained in this manual**.**
- Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or death. Read and understand the entire manual before attempting installation, start-up operation, or service. Installation and service must be performed only by an experienced, skilled, and knowledgeable installer or service agency
- This boiler must be properly vented.
- This boiler needs fresh air for safe operation and must be installed so there are provisions for adequate combustion and ventilation air.
- The interior of the venting system must be inspected and cleaned before the start of the heating season and should be inspected periodically throughout the heating season for any obstructions. A clean and unobstructed venting system is necessary to allow noxious fumes that could cause injury or death to vent safely and will contribute toward maintaining the boiler's efficiency.
- Installation is not complete unless a safety relief valve is installed into the tapping located on left side of appliance or the supply piping. - See the Water Piping and Trim Section of this manual for details.
- This boiler is supplied with safety devices which may cause the boiler to shut down and not re-start without service. If damage due to frozen pipes is a possibility, the heating system should not be left unattended in cold weather; or appropriate safeguards and alarms should be installed on the heating system to prevent damage if the boiler is inoperative.
- **Burn Hazard.** This boiler contains very hot water under high pressure. Do not unscrew any pipe fittings nor attempt to disconnect any components of this boiler without positively assuring the water is cool and has no pressure. Always wear protective clothing and equipment when installing, starting up or servicing this boiler to prevent scald injuries. Do not rely on the pressure and temperature gauges to determine the temperature and pressure of the boiler. This boiler contains components which become very hot when the boiler is operating. Do not touch any components unless they are cool.
- **Respiratory Hazard.** Boiler materials of construction, products of combustion and the fuel contain alumina, silica, heavy metals, carbon monoxide, nitrogen oxides, aldehydes and/or other toxic or harmful substances which can cause death or serious injury and which are known to the state of California to cause cancer, birth defects and other reproductive harm. Always use proper safety clothing, respirators and equipment when servicing or working nearby the appliance.
- Failure to follow all instructions in the proper order can cause personal injury or death. Read all instructions, including all those contained in component manufacturers manuals which are provided with the boiler before installing, starting up, operating, maintaining or servicing.
- All cover plates, enclosures and guards must be in place at all times.

NOTICE: This boiler has a limited warranty, a copy of which is included with this boiler. It is the responsibility of the installing contractor to see that all controls are correctly installed and are operating properly when the installation is complete.

11 Service and Maintenance *(continued)*

⚠ DANGER

Explosion Hazard. Electrical Shock Hazard. Burn Hazard.

- This boiler uses flammable gas, high voltage electricity, moving parts, and very hot water under high pressure. Assure that all gas and electric power supplies are off and that the water temperature is cool before attempting any disassembly or service.
- Do not attempt any service work if gas is present in the air in the vicinity of the boiler. Never modify, remove or tamper with any control device.

⚠ WARNING

- This boiler must only be serviced and repaired by skilled and experienced service technicians.
- If any controls are replaced, they must be replaced with identical models.
- Read, understand and follow all the instructions and warnings contained in all the sections of this manual.
- If any electrical wires are disconnected during service, clearly label the wires and assure that the wires are reconnected properly.
- Never jump out or bypass any safety or operating control or component of this boiler.
- Read, understand and follow all the instructions and warnings contained in ALL of the component instruction manuals.
- Assure that all safety and operating controls and components are operating properly before placing the boiler back in service.
- Annually inspect all vent gaskets and replace any exhibiting damage or deterioration.

NOTICE: Warranty does not cover boiler damage or malfunction if the following steps are not performed at the intervals specified.

A. Continuously:

1. Keep the area around the boiler free from combustible materials, gasoline and other flammable vapors and liquids.
2. Keep the area around the combustion air inlet terminal free from contaminates.
3. Keep the boiler room ventilation openings open and unobstructed.

B. Monthly Inspections:

1. Inspect the vent piping and outside air intake piping to verify they are open, unobstructed and free from leakage or deterioration. Check screens in vent and air intake terminations to verify they are clean and free of debris. Call the service technician to make repairs if needed.
2. Inspect the condensate drain system to verify it is leak tight, open and unobstructed. Call the service technician if the condensate drain system requires maintenance.
3. Inspect the water and gas lines to verify they are free from leaks. Call the service technician to make repairs if required.

NOTICE: Water leaks can cause severe corrosion damage to the boiler or other system components. Immediately repair any leaks found.

C. Annual Inspections and Service:

In addition to the inspections listed above the following should be performed by a service technician once every year.

1. Test the flow switch by disabling the boiler primary loop circulator. The boiler must not start when there is not water flow.
2. Follow the procedure for turning the boiler off per Figure 9-1 “Operating Instructions”.
3. Inspect the wiring to verify the conductors are in good condition and attached securely.

11 Service and Maintenance *(continued)*

⚠ WARNING

Electrical Shock Hazard.

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

Au moment de l´entretien des commandes, étiquetez tous les fils avant de les débrancher. Les erreurs de câblage peuvent nuire au bon fonctionnement et être dangereuses.

S´assurer que l´appareil fonctionne adéquatement une fois k´entretien terminé

4. Remove the igniter assembly and flame sensor and inspect them for oxide deposits. Clean the oxide deposits from the igniter electrodes and flame sensor rod with steel wool. Do not use sandpaper for the cleaning. Inspect the ceramic insulators for cracks and replace the igniter assembly and/or flame sensor if necessary. Check the igniter electrode spacing gap. Refer to Figure 11-1 "Igniter Electrode Gap" for details.

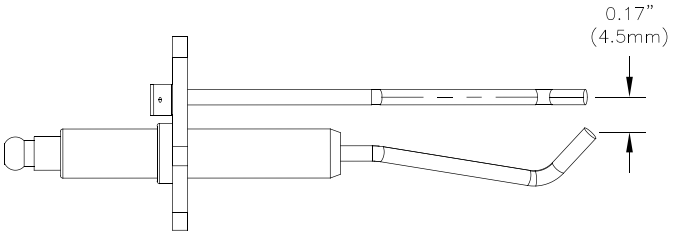


Figure 11-1: Igniter Electrode Gap

5. To gain access to boiler burner and combustion chamber, first disconnect and remove gas inlet piping from gas valve. Then, remove six M6X1 hex flange nuts and take out the burner/blower/gas valve assembly from the boiler. To prevent stud breakage, apply a generous amount of good quality penetrating oil to nuts and let it soak in prior to attempting nut removal.
6. Inspect the assembly for lint and dust presence. If significant lint and dust accumulations are found, disassemble the blower/gas valve assembly to expose the swirl plate and blower inlet. For parts identification, refer to Section 13 "Service Parts". Vacuum these parts as required, being careful not to damage the vanes on the swirl plate.
7. Vacuum any dust or lint from the burner if present. If the burner shows any visual deterioration or corrosion signs, replace it immediately. Inspect the burner gasket and replace if necessary.
8. Inspect the heat exchanger combustion chamber, clean and vacuum any debris found on the surfaces. If required, brush the coils of the heat exchanger using a non-abrasive, non-metal bristle brush. Any cleaning of the combustion chamber with acid or alkali products is prohibited. Do not use any cleaning agents or solvents. If insulation disc has signs of damage, it must be replaced.
9. Inspect the condensate trap to verify it is open and free from debris. Inspect condensate line integrity between boiler and condensate neutralizer (if used), condensate neutralizer and the drain. Clean/repair if needed.

   If the condensate neutralizer is used, check pH before and after the neutralizer to determine neutralizing effectiveness. Replace limestone chips and clean out the neutralizer if needed.
10. Inspect vent connections and vent connector to heat exchanger seals to verify that they are free from leakage and deterioration. Repair as needed. Follow all instructions in Section 4 "Venting" when reassembling vent system.
11. Check for vent and air intake terminal for obstructions and clean as necessary. Check screens in vent and air intake terminations to verify they are clean and free of debris.

⚠ WARNING

Failure to properly secure the burner/blower/gas valve assembly to the heat exchanger could lead to property damage, personal injury or death.

12. Reinstall the burner/blower/gas valve assembly and secure with M6X1 hex flange nuts.
13. Reconnect any wiring which has been disconnected.
14. Verify that the system pH is between 7.5 and 9.5.
15. Inspect the heating system and correct any other deficiencies prior to restarting the boiler.
16. Follow Section 9 "System Start-up" before leaving installation.
17. Perform the combustion test outlined in Section 9 "System Start-up".

D. Recommended Heating System Water Treatment Products:

1. System Cleaning and Conditioning:
   a. The following heating system water treatment products are recommended for an initial existing heating system sludge removal, initial boiler cleaning from copper dust, flux residue and any boiler debris and for preventive treatment as corrosion/scale inhibitors:
      i. Fernox™ Restorer (universal cleaner, sludge remover, scale remover, flux residue/debris remover, corrosion inhibitor)
      ii. Fernox™ Protector (Alphi 11, CH#, Copal) (sludge remover, corrosion inhibitor)

11 Service and Maintenance *(continued)*

Follow manufacturer application procedure for proper heating system/boiler cleaning and preventive treatment.

Above referenced products are available from Alent plc, Consumer Products Division, 4100 6th Avenue, Altoona, PA 16602, Tel: (972) 547-6002 and/or selected HVAC distributors. Contact Thermal Solutions for specific details.

iii. Sentinel® X400 System Restorer (For Older Closed Loop Hydronic Heating Systems)

iv. Sentinel® X300 System Cleaner (For New Heating Systems)

v. Sentinel® X100 Inhibitor (For Protecting Closed Loop Hydronic Heating Systems Against Lime scale And Corrosion)

Follow manufacturer application procedure for proper heating system/boiler cleaning and preventive treatment.

Above referenced products are available from Douglas Products and Packaging, 1550 E. Old 210 Highway, Liberty, MO 64068, Tel:(877) 567-2560 (Toll Free) and/or selected HVAC distributors.
Contact Thermal Solutions for specific details.

b. Equivalent system freeze protection products may be used in lieu of product referenced above. In general, freeze protection for new or existing systems must use specially formulated glycol, which contains inhibitors, preventing the glycol from attacking the metallic system components. Ensure that system fluid contains proper glycol concentration and inhibitor level. The system should be tested at least once a year and as recommended by the manufacturer of the glycol solution. Allowance should be made for expansion of the glycol solution.

⚠ WARNING

Poison Hazard.

Use only inhibited propylene glycol solutions specifically formulated for hydronic systems. Do not use ethylene glycol, which is toxic and can attack gaskets and seals used in hydronic systems. Use of ethylene glycol could result in property damage, personal injury or death.

E. Condensate Overflow Switch and Condensate Trap Removal and Replacement:

For removal or replacement of the condensate overflow switch and/or condensate trap follow the steps below. For parts identification, refer to Section 13 “Service Parts”.

1. Condensate Overflow Switch Removal and Replacement:
   a. Disconnect power supply to boiler.
   b. Remove 2 wire nuts and disconnect overflow switch wire pigtails from boiler wiring.
   c. Using pliers, release spring clip securing the overflow switch to condensate trap body and remove the switch. Note that the switch has factory applied silicon adhesive seal, which may have to be carefully cut all around to facilitate the switch removal.
   d. Ensure the trap overflow switch port is not obstructed with silicon seal debris, clean as needed.
   e. Apply silicon sealant to the replacement switch threads and install the switch into the trap body making sure it is properly oriented - the arrow molded into the switch hex end side must face down for proper switch operation. See Figure 11-2 “Condensate Overflow Switch Orientation” for details.
   f. Reconnect the switch wire pigtails to the boiler wiring and secure with wire nuts.
   g. Restore power supply to boiler. Fill up the trap (see Section 5 “Condensate Disposal”) and verify the switch operation.

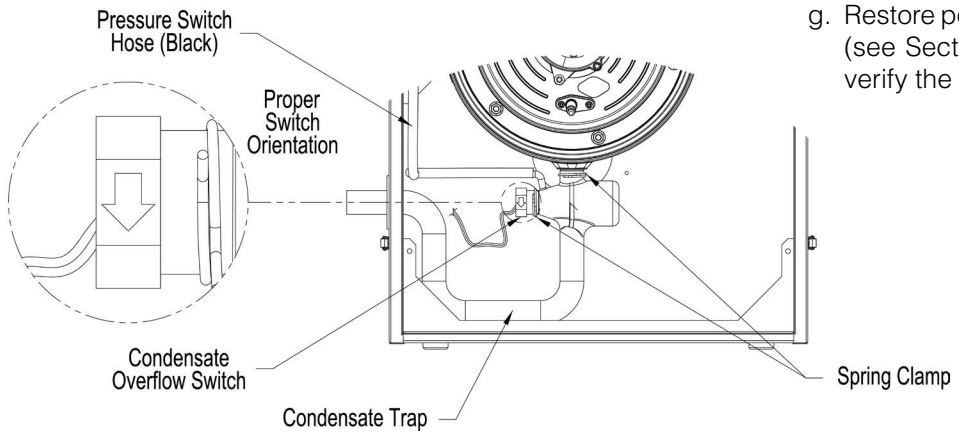


Figure 11-2: Condensate Overflow Switch Orientation

11 Service and Maintenance *(continued)*

2. Condensate Trap Removal and Reinstallation:
   a. Disconnect power supply to boiler.
   b. Remove 2 wire nuts and disconnect overflow switch wire pigtails from boiler wiring.
   c. Disconnect pressure switch hose from condensate trap.
   d. Disconnect outside condensate compression fitting from condensate trap.
   e. Using pliers, release spring clip securing the overflow switch to condensate trap body and remove the switch. Note that the switch has factory applied silicon adhesive seal, which may have to be carefully cut all around to facilitate the switch removal.
   f. Using pliers, release spring clip securing condensate trap body to the heat exchanger bottom drain connection.
   g. First, pull the trap downwards to release from the heat exchanger. Second, pull the trap end from left side jacket panel sealing grommet and remove the trap from boiler.
   h. To reinstall the trap, reverse above steps.
   i. If the original condensate overflow switch is to be re-used, follow the appropriate switch removal steps from Condensate Overflow Switch Removal and Replacement procedure above.
   j. Ensure that fresh silicon sealant is applied to the overflow switch threads and the switch is properly oriented relative to the trap body - the arrow molded into the switch hex side end must face down for proper switch operation. See Figure 11-2 "Condensate Overflow Switch Orientation" for details.
   k. Ensure that pressure switch hose is reconnected to the trap.
   l. Restore power supply to boiler. Fill up the trap (see Section 5 "Condensate Disposal") and verify the switch operation.

F. Control Compartment Access

1. Non-stacked boiler installations: Remove top front panel to access control compartment.
2. Stacked boiler installations: Remove front door and display panel. As shown in Figure 11-3, remove two screws, one inside junction box and one on right side panel. Swing control panel downward to access control compartment.

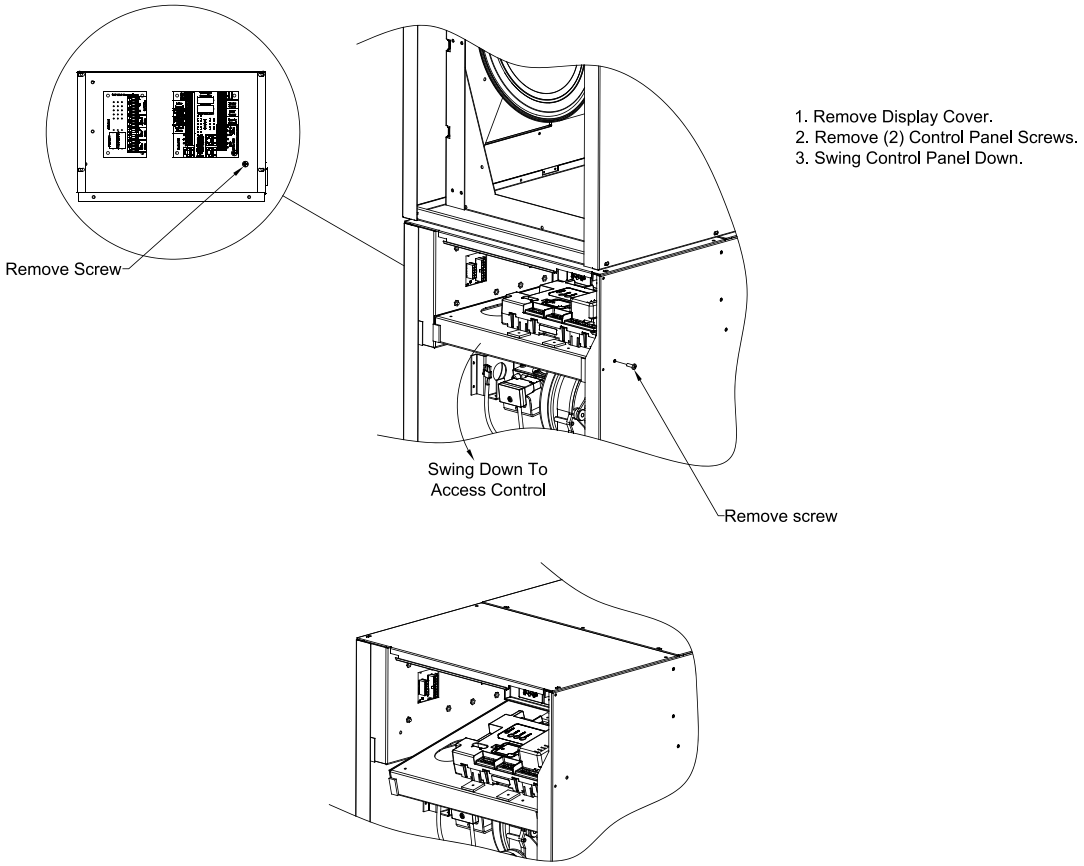


Figure 11-3: Control Compartment Access for Stacked Boiler Installations

12 Troubleshooting

⚠ WARNING

Electrical Shock Hazard.
Turn off power to boiler before working on wiring.

A. Help Menu Navigation

When a fault is active, the Help icon flashes red on the Home Screen. See Figure 12-1. To investigate a fault, select Help. Continue selecting the flashing icons to be directed to the fault cause.

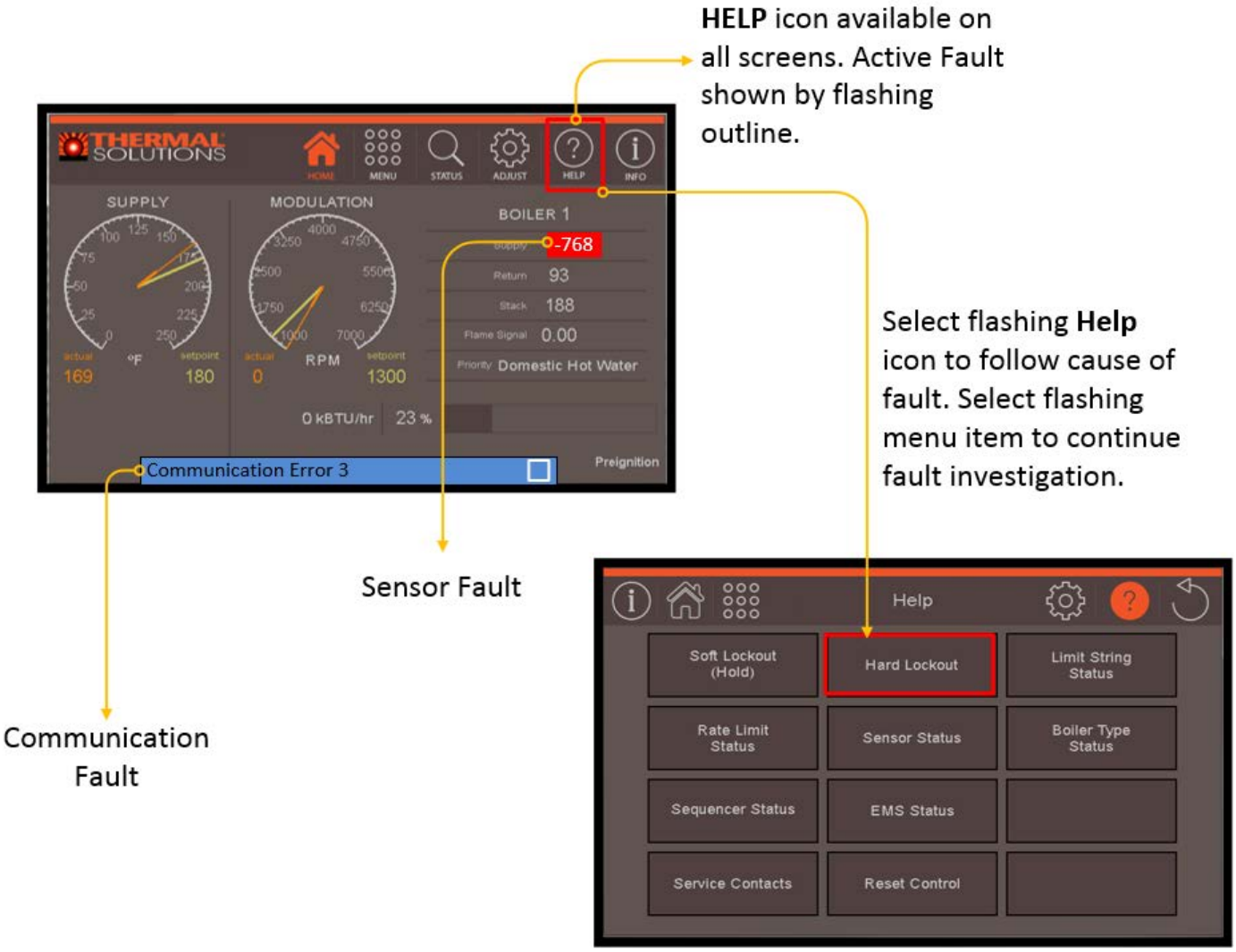


Figure 12-1: Help Menu Navigation

12 Troubleshooting *(continued)*

B. Troubleshooting when Help  icon NOT flashing:

Indication	Condition	Possible Cause
Boiler not responding to demand. Status and Priority show Standby.	Demand not detected	• Boiler not seeing Enable/Disable or DHW Demand input. Check wiring for loose connections or miswiring. • If DHW Demand is expected, check that Domestic Hot Water parameters are selected properly.
Boiler not responding to demand. Status shows Standby and Priority shows Central Heat or Domestic Hot Water.	Boiler not running, pump(s) running	Boiler not firing because temperature greater than Setpoint. Wait for temperature to drop below Setpoint minus Differential Below or adjust Setpoint as needed.
Boiler running but System Pump or Boiler Pump is not running	Pump(s) not running	• Check wiring for loose connections or miswiring. • When there is DHW Demand: Boiler Pump will be off if set to Central Heat, Off DHW Demand and System Pump will be off if set to Central Heat, Optional Priority. This feature allows for fast indirect water heater recovery. After Priority Time has expired or DHW Demand ends, Boiler Pump and System Pump are free to run for Enable/Disable demand.
Display completely dark, fan off, LWCO lights off, no green power light on boiler control	No 120 VAC power at boiler	Circuit breaker tripped. Check breaker and wiring between breaker and boiler.
Display completely dark, green power light illuminated on boiler control	No 24VDC power at display	• Loose 120 VAC wiring connection between J-box and display power supply. • Loose 24VDC wiring connection between power supply and display.
Display blank with “Reading” shown	Display lost communication with control	Failure to establish communication upon display boot-up. After establishing communication, reboot display to read controller and setup display properly.
Communication Error 2	Communication Fault	The display write attempt has failed. • Password level is too low for parameter being changed • Boiler control is un-configured or has a memory failure. Lockout 20 Safety Data Verification will be displayed if control is not configured or has had a memory loss. In this case replace control.
Communication Error 3	Communication Fault	Display has lost communication with control. If no green power light on control, check for: • Blown 24V fuse on low voltage PCB. Check for 24V shorts before replacing fuse. • Loose or defective wiring between transformer and control. • Bad transformer If green power light is illuminated on control, check for: • Loose or defective wiring between display and control • Defective display • Defective control • Incorrect COM Port parameters. Refer to EMS Modbus Parameters in Parameter Adjustment section.
Blinking green power light on boiler control	Control Fault	The green light is connected to internal power supply. The power supply is repeatedly starting and stopping (not normal) making the light flash. The microprocessors are not running. Try disconnecting all terminals except 24 VAC to power the control. The green light should be steady. If it is not, then the control is defective. If steady, start plugging in all the connectors while watching the green light. When faulty wiring is reconnected, green light will begin to flash.

12 Troubleshooting *(continued)*

C. Soft Lockout (Hold)

From the Help menu, select the blinking Soft Lockout (Hold) icon to determine the cause of the soft lockout. See Figure 12-2. The boiler will automatically restart once the condition that caused the lockout is corrected.

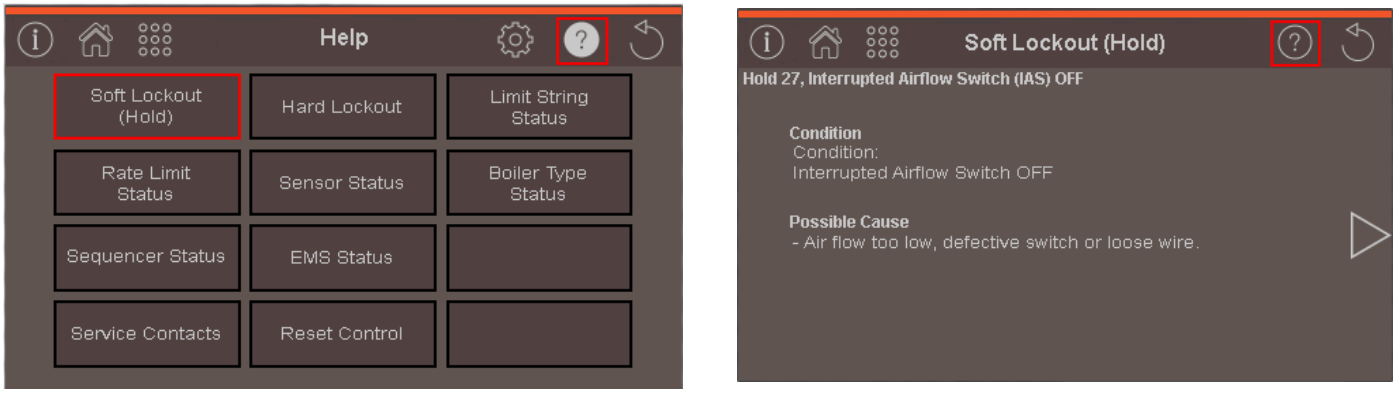


Figure 12-2: Example Soft Lockout

The Soft Lockout (Hold) screen will display the hold number, name, condition that caused the hold, possible causes, and a basic description of corrective actions that may be taken to fix the problem. An in-depth guide to possible soft lockouts is provided in Table 12-3.

Table 12-3: Soft Lockout (Hold) Codes

Lockout Number	Condition	Possible Cause
1 Anti-Short Cycle	Minimum time between starts has not been reached. Normal delay used to avoid excessive cycles.	Faulty contact provided by the EMS system.
2 Boiler Recycling Limits Open (LCI OFF)	LCI safety limit input not energized.	Limit Control Input (LCI) is not ON. Refer to Limit String Status screen for list of limits. • Auto Reset Ext. Limit device open or jumper not installed • Low water condition (if using 24V LWCO) • Flow switch open. Check boiler pump and flow switch wiring. • Sump pressure switch open. Check for vent or combustion air pipe blockage. • Condensate float switch open. Check for condensate drain blockage. • Loose or defective limit string wiring
3 Burner Interlock Open (ILK OFF)	ILK safety limit input not energized.	Lockout input (ILK) is not ON. Refer to Limit String Status screen for list of limits. • Man Reset Ext. Limit device open or jumper not installed • High or low gas pressure switch open or jumper not installed • Thermal link open • Burner door thermostat open • Loose or defective limit string wiring
4 Outlet/Supply High Limit	Supply temperature exceeds Preferred Supply High Limit minus Stepped Modulation Recycle Offset, default 200°F (93.3°C).	• Heating load much less than boiler minimum firing rate. • Defective system pump or no flow in primary loop. • Defective boiler pump, no flow or insufficient flow in boiler loop. • Control system miswired so that the boiler operation is permitted when no zones are calling.
6 Stack High Limit	Flue temperature exceeds Preferred Stack High Limit minus Stepped Modulation Recycle Offset, default 194°F (90°C).	• Heat exchanger needs to be cleaned • Boiler over-fired • Air-fuel mixture out of adjustment

12 Troubleshooting *(continued)*

Table 12-3: Soft Lockout (Hold) Codes (continued)

Lockout Number	Condition	Possible Cause
7 Return Sensor Fault	Shorted or open return temperature sensor.	• Shorted or miswired return sensor wiring • Defective return sensor
8 Supply Sensor Fault	Shorted or open supply temperature sensor.	• Shorted or miswired supply sensor wiring • Defective supply sensor
9 DHW Sensor Fault	Shorted or open Domestic Hot Water (DHW) temperature sensor.	• Shorted or miswired DHW sensor wiring • Defective DHW sensor
10 Stack Sensor Fault	Shorted or open flue gas (stack) temperature sensor.	• Shorted or miswired flue sensor wiring • Defective flue sensor
13 Flame rod shorted to ground	Flame rod shorted to ground	• Shorted or miswired flame rod wiring • Defective flame rod
14 Delta T Inlet/ Outlet High	Temperature rise between supply and return is too high.	Inadequate boiler water flow. • Boiler pump not operating • Boiler pump undersized • Valve closed
15 Return Temperature Higher Than Supply	Return temperature was greater than supply temperature for at least 75 seconds.	• Reversed flow through boiler. Verify correct piping and circulator orientation. • No boiler water flow. Verify system is purged of air and appropriate valves are open. • Defective supply or return sensor
16 Supply Temperature Risen Too Quickly	Supply water temperature has risen too quickly.	Inadequate boiler water flow. See also causes for Hard Lockout 4. • Boiler pump not operating • Boiler pump undersized • Valve closed
17 Fan Speed Not Proved	Normal waiting for blower speed to match purge and light-off setpoint.	N/A
27 Interrupted Airflow Switch (IAS) ON	Air proving switch failed to open.	Air proving switch closed before Prepurge. • Failed air proving switch. Check switch for proper operation. • Short in limit string wiring
27 Interrupted Airflow Switch (IAS) OFF	Air proving switch failed to close.	Air proving switch open during Prepurge or Drive Lightoff. • Check for vent or combustion air pipe blockage. • Confirm air proving switch hose connected to gas valve outlet tapping and outlet tapping internal screw is open. • Loose or defective limit string wiring

12 Troubleshooting *(continued)*

D. Hard Lockout

From the Help menu, select the blinking Hard Lockout icon to determine the cause of the hard lockout. See Figure 12-4. The boiler will automatically restart once the condition that caused the lockout is corrected.

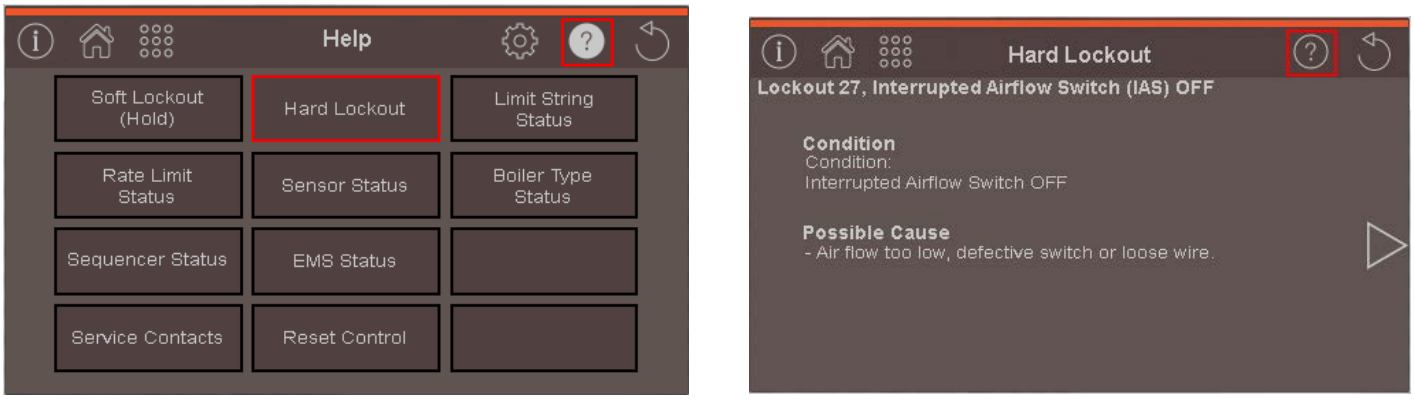


Figure 12-4: Example Hard Lockout

The Hard Lockout screen will display the lockout number, name, condition that caused the lockout, possible causes, and a basic description of corrective actions that may be taken to fix the problem. An in-depth guide to possible hard lockouts is provided in Table 12-5.

Table 12-5: Hard Lockout Codes

Lockout Number	Condition	Possible Cause
3 Burner Interlock Open (ILK OFF)	ILK safety limit input not energized	Lockout input (ILK) is not ON. Refer to Limit String Status screen for list of limits. • Man Reset Ext. Limit device open or jumper not installed • High or low gas pressure switch open or jumper not installed • Thermal link open • Burner door thermostat open • Loose or defective limit string wiring
4 Outlet/Supply High Limit	Supply temperature exceeded fixed high limit, 210°F (98.9°C).	• Heating load much less than boiler minimum firing rate. • Defective system pump or no flow in primary loop. • Defective boiler pump, no flow or insufficient flow in boiler loop. • Control system miswired so that the boiler operation is permitted when no zones are calling.
6 Stack High Limit	Flue temperature exceeded 204°F (95.6°C).	• Heat exchanger needs to be cleaned • Boiler over-fired • Air-fuel mixture out of adjustment
12 Flame detected out of sequence	A flame signal was present when there should be no flame.	- Defective gas valve - make sure inlet pressure is below maximum on rating plate before replacing valve.
14 Delta T Inlet/ Outlet High	Temperature rise between supply and return is too high.	Inadequate boiler water flow. • Boiler pump not operating • Boiler pump undersized • Valve closed

12 Troubleshooting *(continued)*

Table 12-5: Hard Lockout Codes (continued)

Lockout Number	Condition	Possible Cause
15 Return Temperature Higher Than Supply	Return temperature was greater than supply temperature for at least 75 seconds.	• Reversed flow through boiler. Verify correct piping and circulator orientation. • No boiler water flow. Verify system is purged of air and appropriate valves are open. • Defective supply or return sensor
16 Supply Temperature Risen Too Quickly	Supply water temperature has risen too quickly.	• Inadequate boiler water flow. See also causes for Hard Lockout 4. • Boiler pump not operating • Boiler pump undersized • Valve closed
18 Light-off Rate Proving Failed	Blower not running at requested light-off rate or blower speed signal not detected	• Loose connection in 120 VAC blower wiring • Loose or miswired blower speed harness • Defective blower
19 Purge Rate Proving Failed	Blower not running at requested purge rate or blower speed signal not detected	• Loose connection in 120 VAC blower wiring • Loose or miswired blower speed harness • Defective blower
20 Configuration Fault	Unacceptable control safety parameter detected. See display for details.	Safety parameter verification required. Contact factory.
21 Invalid Modulation Parameters	Unacceptable control modulation parameter detected.	Reset control. If problem persists, contact factory.
22 Safety Data Verification Needed	Safety parameter change detected and verification has not been completed.	• Safety related control parameter has been changed and verification has not been performed. • Control not programmed. Contact factory.
23 24 VAC Voltage Low/High	Control 24 VAC control power is high or low.	• Loose connection in 24 VAC power wiring. • Loose or miswired 24 VAC harness. • Miswired wiring harness causing power supply short to ground. • Defective transformer. • Transformer frequency, voltage and VA do not meet specifications.
24 Fuel Valve Error	Power detected at fuel valve output when fuel valve should be off.	• Loose or defective gas valve harness. Check electrical connections. • Defective gas valve. Before replacing valve, check for 24 VAC at gas valve connector during trial for ignition.
25 Hardware Fault	Internal control failure. See display for details.	Reset control. If problem recurs, replace control.
26 Internal Fault	Internal control failure.	Reset control. If problem recurs, replace control.
27 Ignition Failure	Flame not detected at end of ignition sequence.	• Gas line not completely purged of air. • Gas pressure too low. See minimum on boiler rating label. • Air-fuel mixture out of adjustment. See System Start-Up Section. • Disconnected or defective igniter wire. • Disconnected or defective flame sensor wire. • Defective igniter electrode. • Defective flame sensor. • Defective gas valve. Before replacing valve, check for 24 VAC at gas valve connector during trial for ignition.

12 Troubleshooting *(continued)*

Table 12-5: Hard Lockout Codes (continued)

Lockout Number	Condition	Possible Cause
27 Interrupted Airflow Switch (IAS) ON	Air proving switch failed to open.	Air proving switch closed before Prepurge. • Failed air proving switch. Check switch for proper operation. • Short in limit string wiring
27 Interrupted Airflow Switch (IAS) OFF	Air proving switch failed to close.	Air proving switch open during Prepurge or Drive Lightoff. • Check for vent or combustion air pipe blockage. • Confirm air proving switch hose connected to gas valve outlet tapping and outlet tapping internal screw is open. • Loose or defective limit string wiring
42 AC Phase Fault	AC inputs phase reversed	• Check control and display connections. • Verify line voltage frequency and voltage meet specifications. • Verify 24 VAC transformer functioning properly.
47 Flame Lost	Flame lost at some stage. See display for details.	• Gas pressure too low. See minimum on boiler rating label. • Air-fuel mixture out of adjustment. See System Start-up Section. • Disconnected or defective flame sensor wire. • Defective flame sensor. • Defective gas valve. Before replacing valve, check for 24 VAC at gas valve connector during trial for ignition.
284 Memory Reset To Default	OEM Memory Lost, Honeywell Default Memory Restored	• Control failure • Consult factory • Replace control

12 Troubleshooting *(continued)*

E. Limit String Status

From the Help Menu, select Limit String Status to view status of individual safety limits. See Figure 12-6. ON indicates closed limit contact. OFF with red background indicates open limit contact. When a limit is OFF, all limits connected to the same control terminal (e.g. A2) and will show OFF. Limits downstream (below) the OFF limit and connected to a different control terminal may also show OFF. When troubleshooting, check OFF limits in order from top to bottom to isolate the problem. Air proving switch and flow switch limits cycle normally based on function of boiler. Refer to Figure 8-5, Ladder Diagram for limit string details.

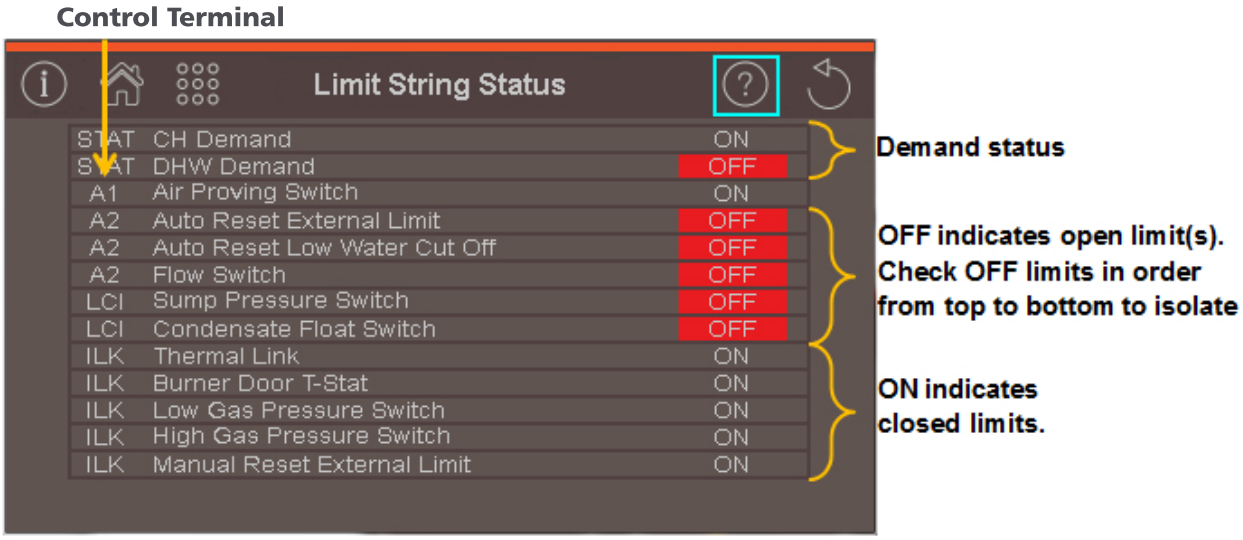


Figure 12-6: Limit String Status

F. Sensor Status

Select Sensor Status from the Help Menu or Sensors from the Main Menu to view status of individual sensors. Select an individual sensor to display gauge reading on right side of display. A failed sensor is shown with a red background as in Figure 12-7. See Table 12-8 for sensor fault diagnostic help and Tables 12-9 through 12-12 for sensor temperature versus resistance values.

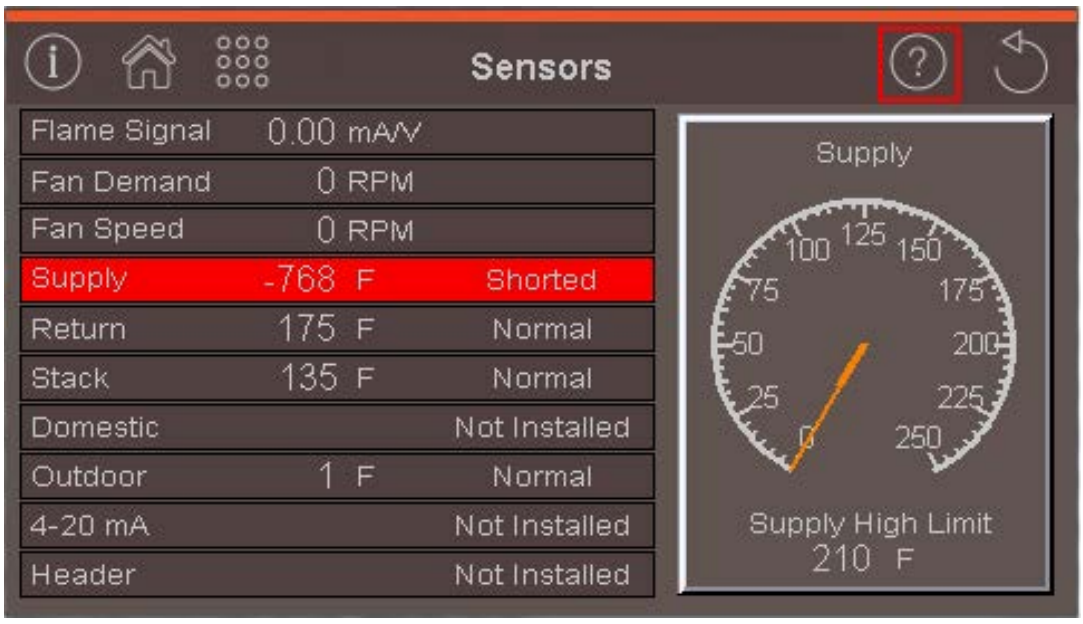


Figure 12-7: Sensors Screen with Shorted Supply Sensor

12 Troubleshooting *(continued)*

Table 12-8: Sensor Fault Diagnostic Help

Indication	Possible Cause
Not Installed	Sensor has not been selected. For example, in Figure 12-7, the Header Sensor has not been selected. Refer to Operations Section, Parameter Adjustment for information on how to select sensors.
Open	Sensor not connected or loose wire. Check sensor wiring.
Shorted	Sensor terminals connected to each other or sensor has failed. • Check sensor wiring. • Check sensor resistance. See Tables 12-9 through 12-12 for temperature versus resistance values.
Outside low range Outside high range	Sensor input out of range. Sensor is defective or is being subjected to electrical noise.
Not reliable	Sensor is defective or is being subjected to electrical noise.

Table 12-9: Supply and Flue Sensor Temperature vs. Resistance, 10kOhm NTC, Beta = 3977K

Temperature		Ohms of Resistance
°F	°C	
32	0	32650
41	5	25390
50	10	19900
59	15	15710
68	20	12490
77	25	10000
86	30	8057
95	35	6531
104	40	5327
113	45	4369
122	50	3603
131	55	2986
140	60	2488
149	65	2083
158	70	1752
167	75	1481
176	80	1258
185	85	1072
194	90	918
203	95	789
212	100	680

Table 12-10: Return Sensor Temperature vs. Resistance, 12kOhm NTC, Beta = 3750K

Temperature		Ohms of Resistance
°F	°C	
32	0	36100
50	10	22790
68	20	14770
77	25	12000
86	30	9810
104	40	6653
122	50	4610
140	60	3250
158	70	2340
176	80	1710
194	90	1270
212	100	950
230	110	730
248	120	560

12 Troubleshooting *(continued)*

Table 12-11: Outdoor Sensor Temperature vs. Resistance, 10kOhm NTC, Beta = 3435K

Outdoor Temperature		Ohms of Resistance
°F	°C	
-20	-28.9	106926
-10	-23.3	80485
0	-17.8	61246
10	-12.2	47092
20	-6.7	36519
30	-1.1	28558
40	4.4	22537
50	10.0	17926
60	15.6	14356
70	21.1	11578
76	24.4	10210
78	25.6	9795
80	26.7	9398
90	32.2	7672
100	37.8	6301
110	43.3	5203
120	48.9	4317

Table 12-12: Header Sensor Temperature vs. Resistance, 10kOhm NTC, Beta = 3950K

Temperature		Ohms of Resistance
°F	°C	
32	0	32648
50	10	19898
68	20	12492
77	25	10000
86	30	8057
104	40	5327
122	50	3602
140	60	2488
158	70	1752
176	80	1256
194	90	916
212	100	697
248	120	386

12 Troubleshooting *(continued)*

G. Additional Help Menu Icons

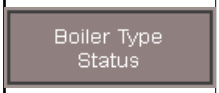
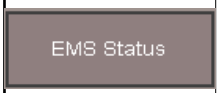
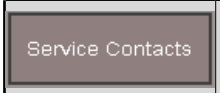
A summary of additional icons that may be flashing on the Help Menu is provided in Table 12-13.

⚠ WARNING

Asphyxiation Hazard.

Boiler type is factory set and must match the boiler model. Only change the boiler type setting if you are installing the boiler at altitudes above 2,000 ft. or if you are replacing the control. The boiler type setting determines minimum and maximum blower speeds. Incorrect boiler type can cause hazardous burner conditions and improper operation that may result in PROPERTY LOSS, PHYSICAL INJURY, OR DEATH.

Table 12-13: Additional Help Menu Icons

Flashing Red Outline	Condition	Possible Cause
	Boiler firing rate is limited	Firing rate is limited or reduced to help avoid unnecessary cycling or lockout. Refer to Soft and Hard Lockout sections for potential corrective action. Rate limiting occurs during normal operation under any of these conditions. • Minimum Modulation (normal start/stop sequence) • Forced Modulation (normal start/stop sequence) • Burner Control Rate (normal start/stop sequence) • Manual Firing Rate (user selected) • Low Fire Hold Time period after startup (user adjustable) Rate limiting occurs for boiler protection under any of these conditions. • Supply temperature > Stepped Modulation Start Offset • Differential temperature > Stepped Modulation Start Offset • Flue Temperature > Stepped Modulation Start Offset
	Boiler size fault	Boiler Type/Size setting may not match actual boiler size. This setting determines min, max and light-off blower speeds
	Sequencer communication fault	Slave boiler has lost communication with Sequencer Master. Restore communication or cycle power to clear fault. Check for the following: • Loose or defective boiler-to-boiler communication wiring • Sequencer Master was Enabled and then Disabled • Loss of power to Sequencer Master boiler
	EMS interface fault	There is a fault with the Energy Management System (EMS) interface. Signals received from the EMS are listed with selection status and present value.
	Service Contact *	User is given contact information of the responsible installing contractor, service company, representative and manufacturer. Refer to Parameter Adjustment, Service Contacts section.
	Manual reset hard lockout *	When the lockout condition has been cleared, manual reset hard lockouts may be reset here or by pressing button on top of control.

12 Troubleshooting *(continued)*

H. Archives

Select Archives from the Main Menu to view boiler historic boiler operating data. See Figure 12-14. Archives allow user to review up to four months of sensor values, up to 3,000 alarms, lockout history, and cycle and run time history. Data may be viewed on screen or exported to a thumb drive for detailed analysis.

Figure 12-14: Archives Screen

1. Supply/Return Temperature History / Flame Intensity History / Fan Rate History

   Supply, return, flame and fan data provides an opportunity to investigate issues, learn about system operation or fine tune the boiler. Historical data values are viewed by scrolling left and right; the further left, the older the data. As shown in Figure 12-15, touch the trend at any location to display exact data points as well as date and time at which they were recorded.

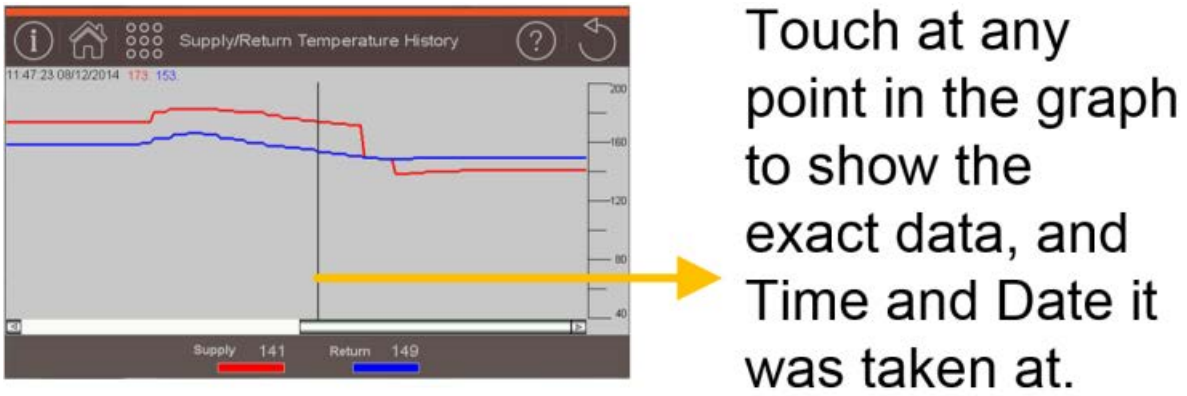


Figure 12-15: Display of Exact Data Points with Date and Time

2. Lockout History

   Lockout History stores up to 15 lockouts in a first-in, first-out basis, 1 being the newest. See Figure 12-16. Each lockout file is stored with boiler run hour of when the lockout occurred, status at time of lockout, and limit string annunciator that caused the lockout (if applicable). Touch a specific lockout to display more information.

Figure 12-16: Lockout History

12 Troubleshooting *(continued)*

3. Cycle & Run Time History

   Cycle and Run time data is provided for control, boiler and pumps. Additionally, a load profile is collected. Graphs are provided that show amount of time the boiler operated at each load point. Data may be reset. See Figure 12-17.

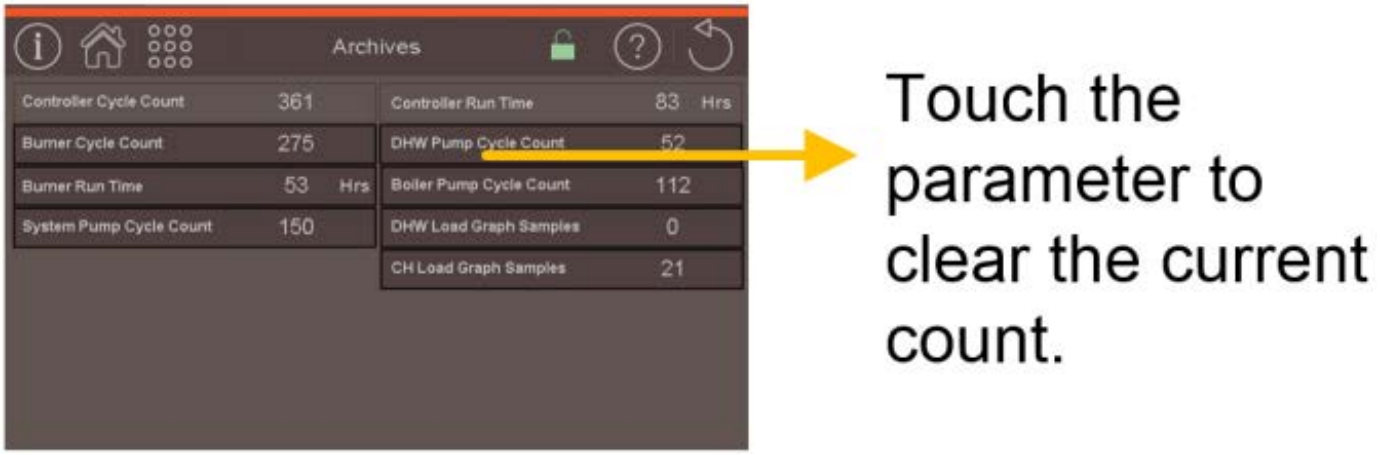


Figure 12-17: Example Cycle & Run Time History

4. Alarm History

   Up to 3,000 alarms may be recorded with date and time stamp. These include lockouts, holds, sensor faults, EMS communication error or loss, boiler-to-boiler communication loss, 4-20mA errors, and limit string cycling. Scroll through alarm list to investigate most recent and past alarms on screen, most recent appearing at bottom. See Figure 12-18. Use the Save Historical Data function to download alarm list to a USB thumb drive in spreadsheet form for better troubleshooting.

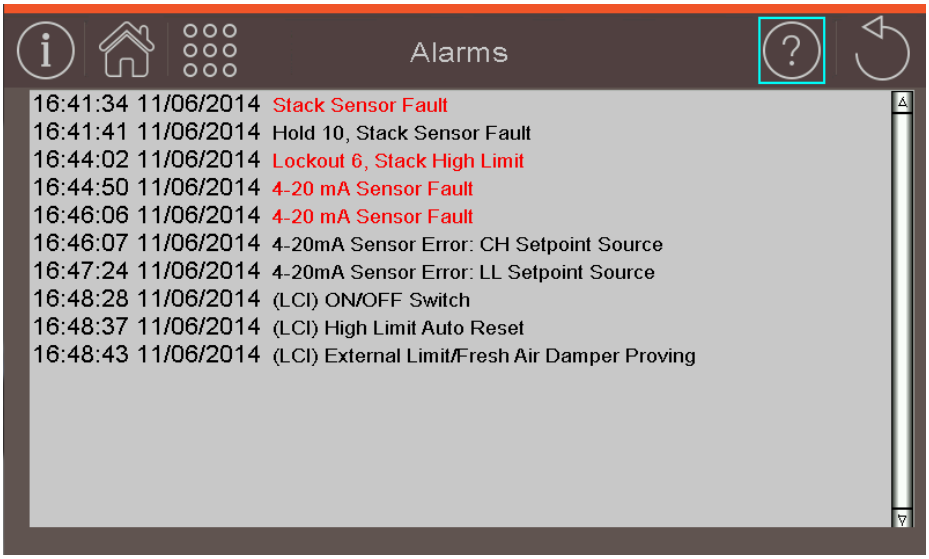


Figure 12-18: Example Alarm List

5. Save Historical Data to USB

NOTICE: Save Historical Data to USB takes several minutes to complete. Do not remove flash drive until display shows download is complete.

Insert USB thumb drive into USB port, then Select Save Historical Data to USB to download historical parameters and alarms as spreadsheets. See Operation Section, Parameter Adjustment for USB thumb drive requirements.

Files are saved as with a date code when they were saved from the boiler. For example, 20140612 = June 12, 2014. An example file path is shown in Figure 12-19: My Computer >> Removable Disk >> HMI >> HMI-000 >> @HMI0001 >> CSV. The highest number folder name is the newest data. In example shown, @HMI0001 is newer than @HMI0000. If another set of historical data is saved, the new file will be @HMI0002.

12 Troubleshooting *(continued)*

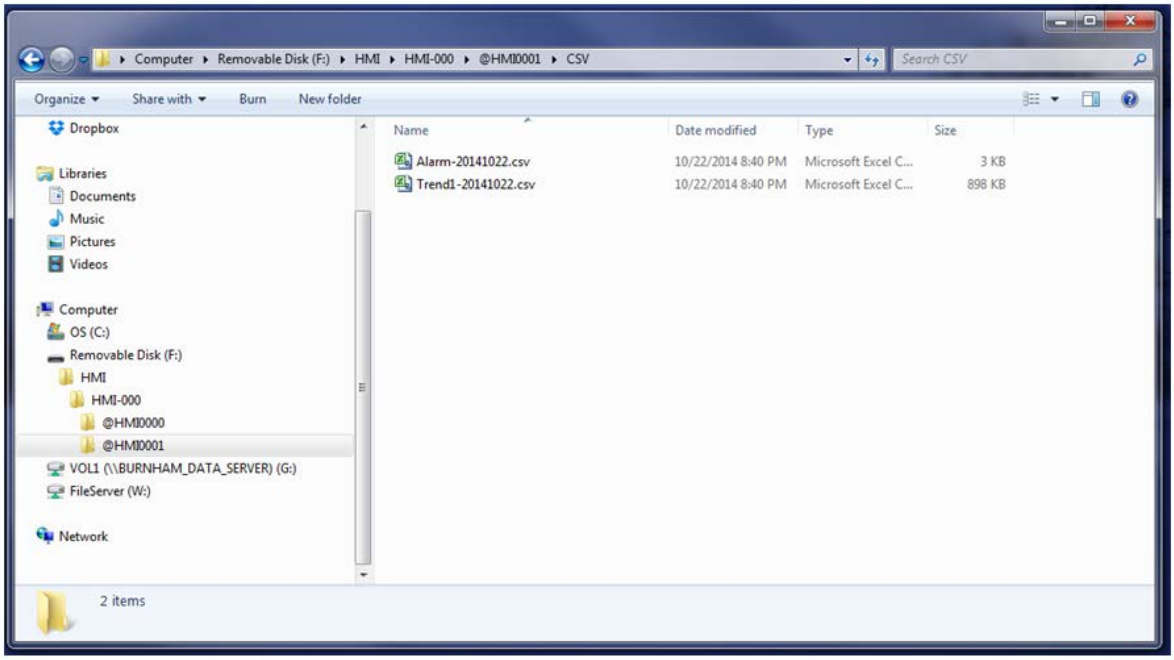


Figure 12-19: Example USB Drive File Path

Figure 12-20 shows an example of the Trend1-20141022.csv file contents. Boiler state is defined in Table 12-22. Figure 12-21 shows an example of the Alarm-20140612.csv file contents.

Supply, Return, Header, & Stack are all sensor data.

Setpoint is the active setpoint of the boiler at time data was taken.

Fan speed and **Fan Demand** show the modulation of the boiler.

Flame Signal is in shown mA/V and should have the form 00.00. (eg. At time 20:19:55 above it is 12.39)

CH Demand & **DHW Demand** show what demands were active at what time.
1 = Demand
0 = No demand.

Boiler State is the current status of the boiler the list of boiler states can be found in Table 12

Outdoor Temp is sensor data. (-32256 value indicates no sensor data)

		SUPPLY	RETURN	HEADER	STACK	SETPOINT	FAN SPEED	FAN DEMAND	FLAME SIGNAL	CH DEMAND	DHW DEMAND	BOILER STATE	OUTDOOR TEMP
20:13:38	10/15/2014	120	100	117	78	179	5650	5650	0	1	0	12	-32256
20:14:39	10/15/2014	125	101	117	78	179	5650	5650	0	1	0	12	-32256
20:15:40	10/15/2014	130	101	117	78	179	5650	5650	0	1	0	12	-32256
20:18:54	10/15/2014	133	101	117	78	179	5650	5650	1238	1	0	12	-32256
20:19:55	10/15/2014	136	101	117	78	179	5650	5651	1239	1	0	12	-32256
20:20:55	10/15/2014	140	101	117	78	179	5650	5651	1239	1	0	12	-32256
20:21:56	10/15/2014	145	101	117	78	179	5650	5651	1235	1	0	12	-32256

Figure 12-20: Example Trend File Contents

12 Troubleshooting *(continued)*

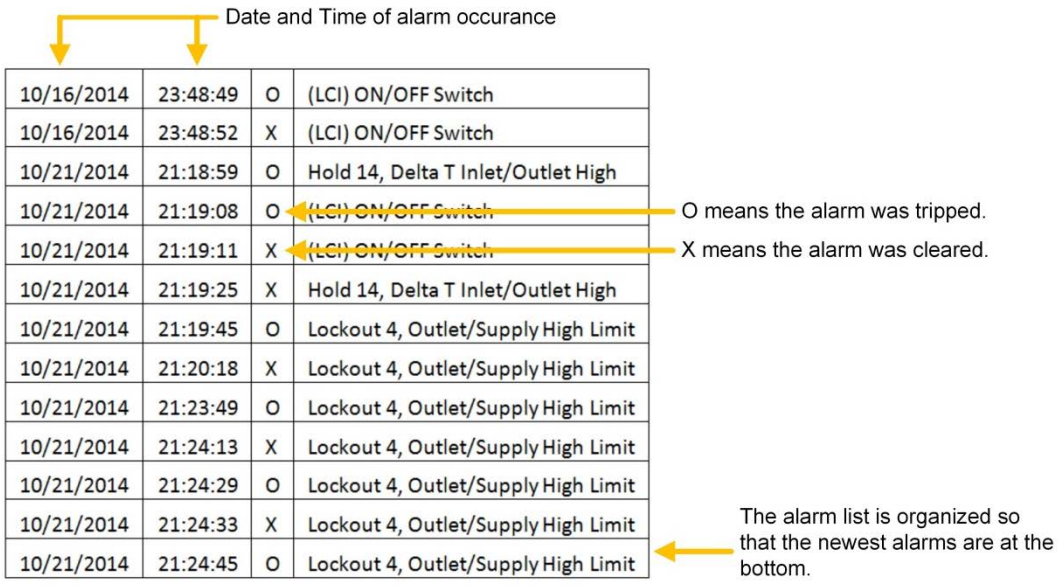


Figure 12-21: Example Alarm File Contents

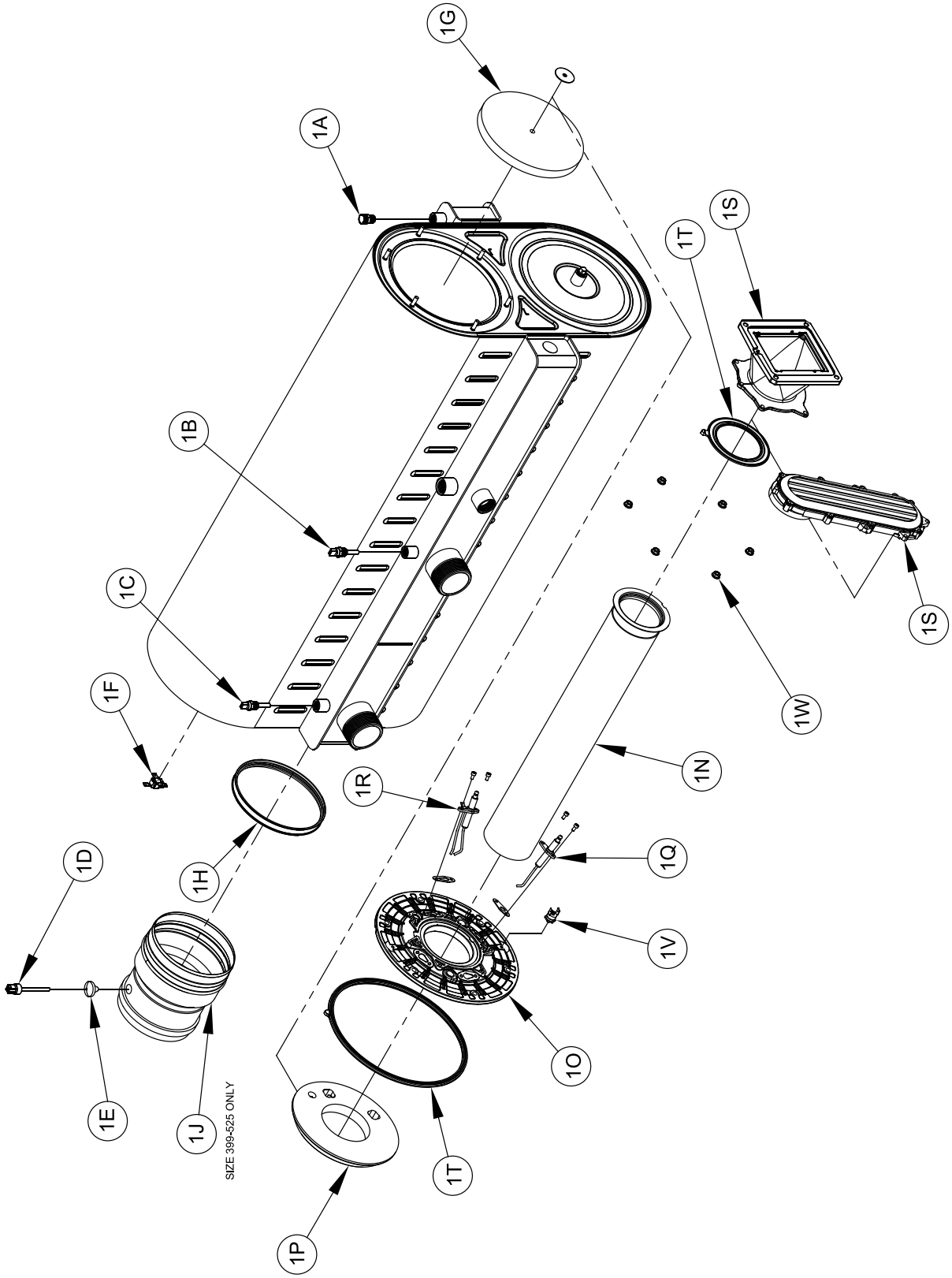
Table 12-22: Boiler State

No.	Boiler State
0	Initiate
1	Standby delay
2	Standby
3	Safe Startup
4	Drive Purge
5	Prepurge
6	Drive Lightoff
7	Preignition Test
8	Preignition
9	PFEP (pilot flame establishing period)
10	MFEP (main flame establishing period)
11	Direct Ignition
12	Running
13	Postpurge
14	Lockout

13 Service Parts

All Apex Repair Parts may be obtained through your local authorized Thermal Solutions representatives or outlets. Should you require assistance in locating a Thermal Solutions representative or outlet in your area, or have questions regarding the availability of Thermal Solutions products or repair parts, please contact Thermal Solutions Customer Service at (717) 239-7642 or Fax (877) 501-5212.

13 Service Parts *(continued)*

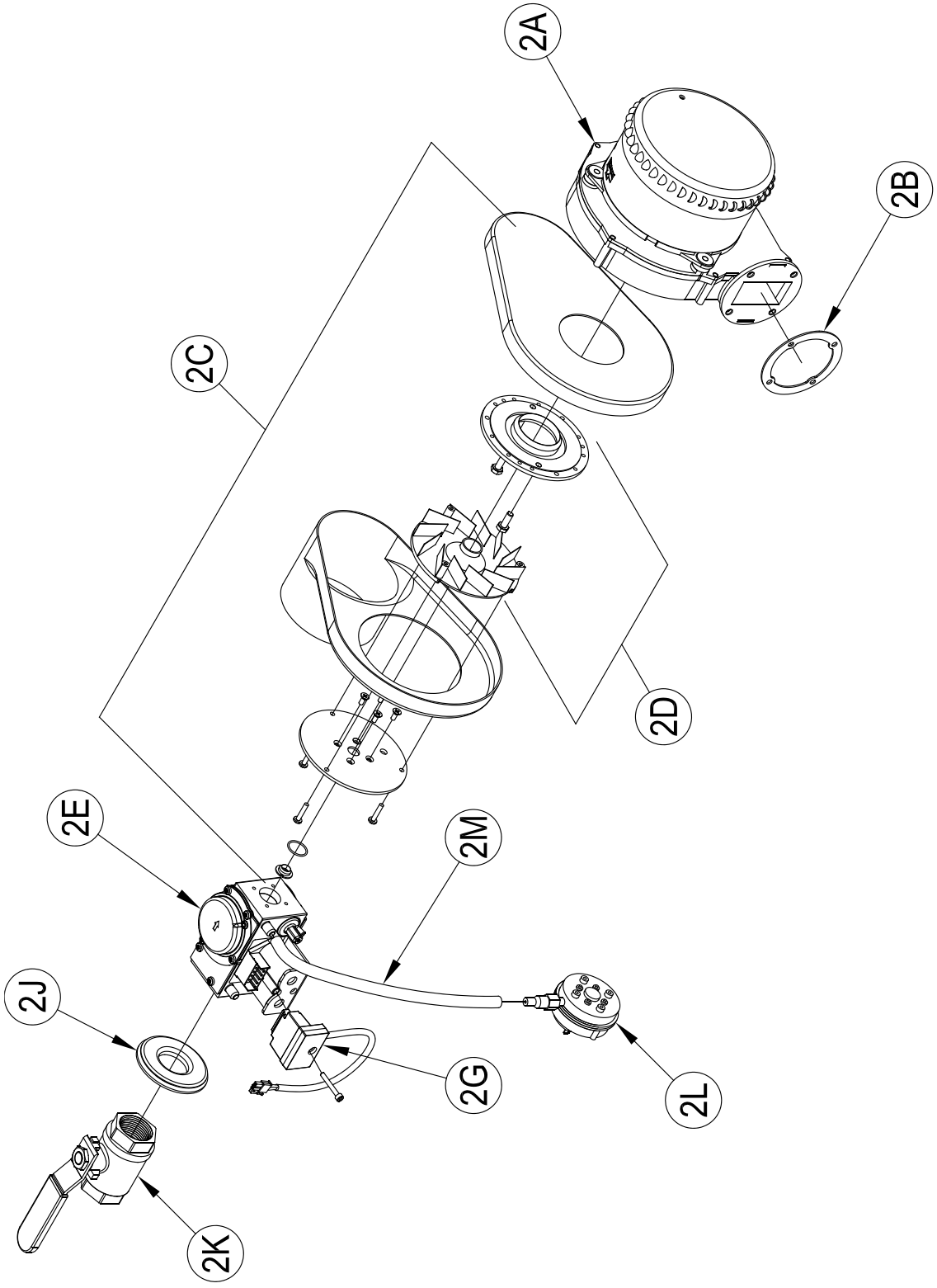


13 Service Parts *(continued)*

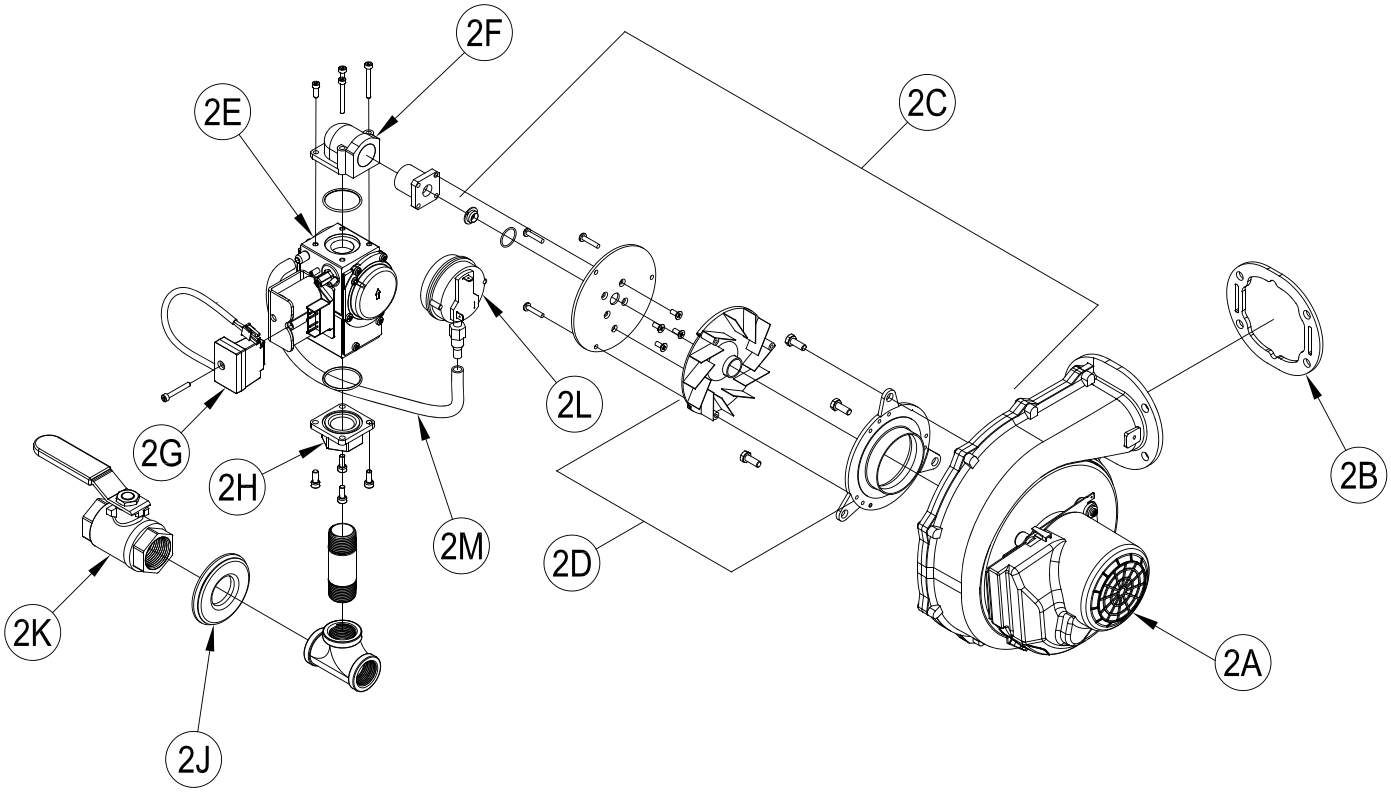
Heat Exchanger Components						
Key No.	Description	Part Number				
		APX425C	APX525C	APX625C	APX725C	APX825C
	Replacement Heat Exchanger Assembly (includes bare heat exchanger, supply and return water temperature sensors, air vent valve and water gaskets)	109102-01	109103-01	109104-01		109105-01
1A	Air Vent Valve	108760-01				
1B	Supply Water Temperature Sensor / High Limit Sensor	109202-01				
1C	Return Water Temperature Sensor	107503-01				
1D	Flue Temperature Sensor	109109-01				
1F	Replacement Thermal Link and Rear Insulation Disc Kit (includes thermal link, disc, hardware, and instructions)	104998-01				
1G	Replacement Rear Insulation Disc Kit (includes disc, hardware, and instructions)	105651-01				
1H	Flue Exit Gasket Replacement Kit (includes gasket and dielectric grease)	104501-01		104502-01		
1J	4 in. Flue Collar Adapter	109203-01		N/A		
1K	Temperature and Pressure Gauge (not shown)	105894-01		109221-01		
1L	Safety Relief Valve (not shown)	50 PSI: 109039-01		60 PSI: 109222-01		
	Alternate Safety Relief Valve Kit (not shown, includes safety relief valve and temperature and pressure gauge)	80 PSI: 104200-01 100 PSI: 104201-01				
1M	Boiler Drain Valve, 3/4 in. NPT (not shown)	108709-01				

Burner Components						
Key No.	Description	Part Number				
		APX425C	APX525C	APX625C	APX725C	APX825C
1N	Replacement Burner Kit (includes burner, burner gasket, and hardware)	104988-01	104990-01			104991-01
1O	Replacement Burner Door Kit (includes door with inner and outer seals, gaskets for sensor and igniter, insulation, and thermostat; does not include igniter or flame sensor)	104992-01	104993-01			
1P	Burner Door Insulation Kit (**WARNING**: Contains RCF)	105650-01	105674-01			
1Q	Replacement Flame Sensor Kit (includes sensor, gasket, and hardware)	103339-01	103310-01			
1R	Replacement Igniter Kit (includes igniter, gasket, and hardware)	103005-01	103308-01			
1S	Replacement Gas/Air Duct Kit (includes duct, gaskets, and hardware)	104994-01	106510-01	104996-01		
1T	Burner Gasket	107500-01	109219-01			
1V	Burner Door Thermostat with Manual Reset	107413-01				
1W	Burner Door Hex Flange Nut, M6 x 1.0 mm (6 per boiler)	101724-01				

13 Service Parts *(continued)*



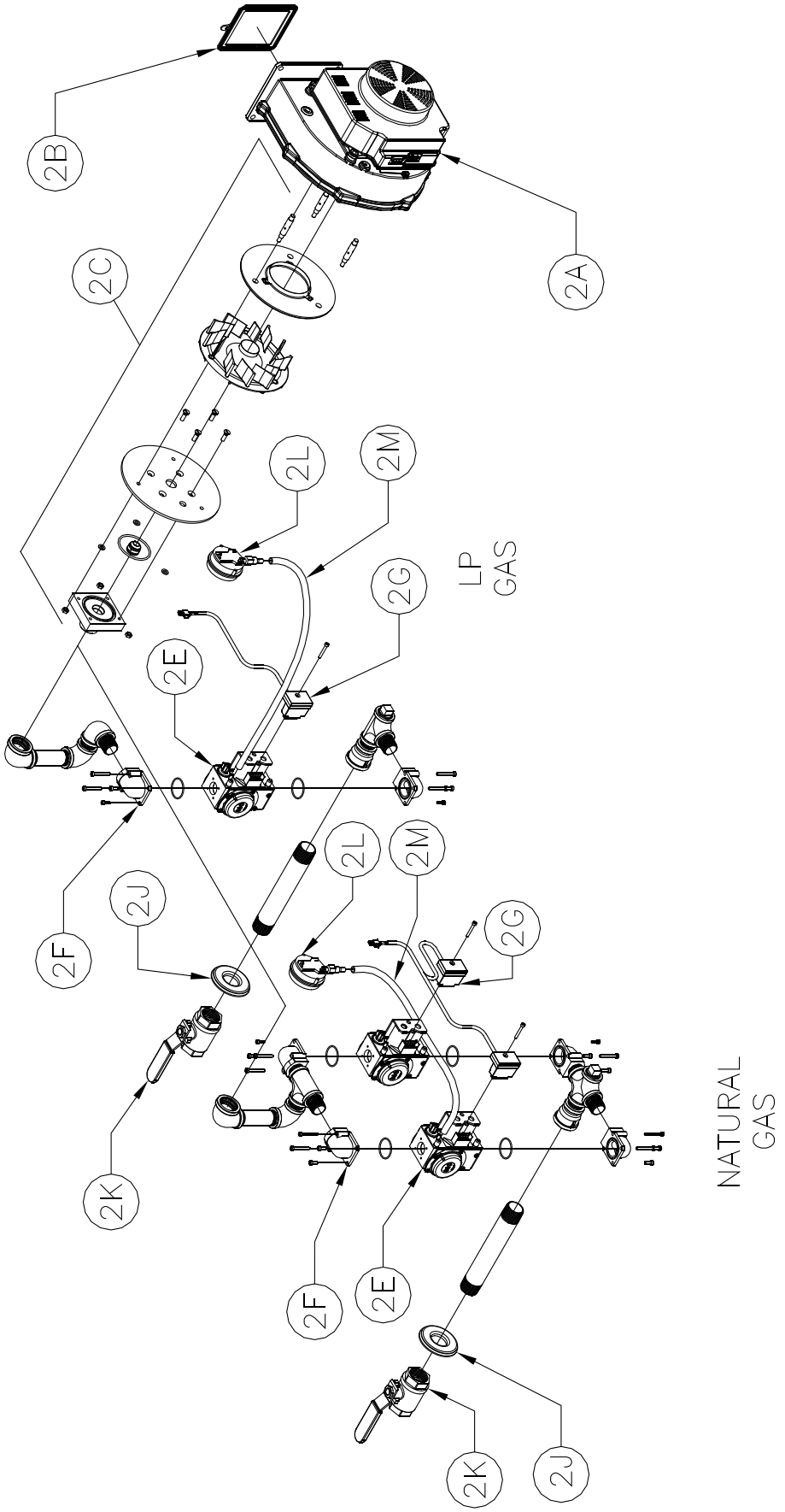
13 Service Parts *(continued)*



Blower / Gas Train Components			
Key No.	**Description**	**Part Number**	
		APX425C	**APX525C**
2A	Replacement Blower Kit (includes blower, blower outlet gasket and hardware)	104999-01	104999-02
2B	Blower Outlet Gasket	106209-01	109208-01
2C	Blower Inlet Assembly (includes gas orifice, injector flange, inlet shroud (425C only), swirl plate, blower adapter plate, and mounting hardware)	110037-01	110038-01
2D	Blower Inlet Replacement Kit (includes swirl plate, blower adapter plate, and mounting hardware)	104620-04	104620-05
2E	Replacement Gas Valve Kit (includes one gas valve and o-rings)	105004-01	105004-04
2F	Gas Valve 90° Flange Kit (includes one 90° flange, o-ring, and hardware)	N/A	108103-01
2G	Gas Valve Wire Harness (includes harness with plug and M4 x 30 mm screw)	108880-01	
2H	Gas Valve Straight Flange Kit (includes one straight flange, o-ring, and hardware)	N/A	108104-01
2J	Gas Line Rubber Grommet	3/4 in. NPT: 108889-01	
2K	Gas Shutoff Valve	3/4 in. NPT: 101615-01	
2L	Air Proving Switch	109108-01	109113-01
2M	Air Proving Switch Tubing, silicone, 5/16 in. ID x 0.07 in. Wall Thickness x 18 in. long	109116-01	

13 Service Parts *(continued)*

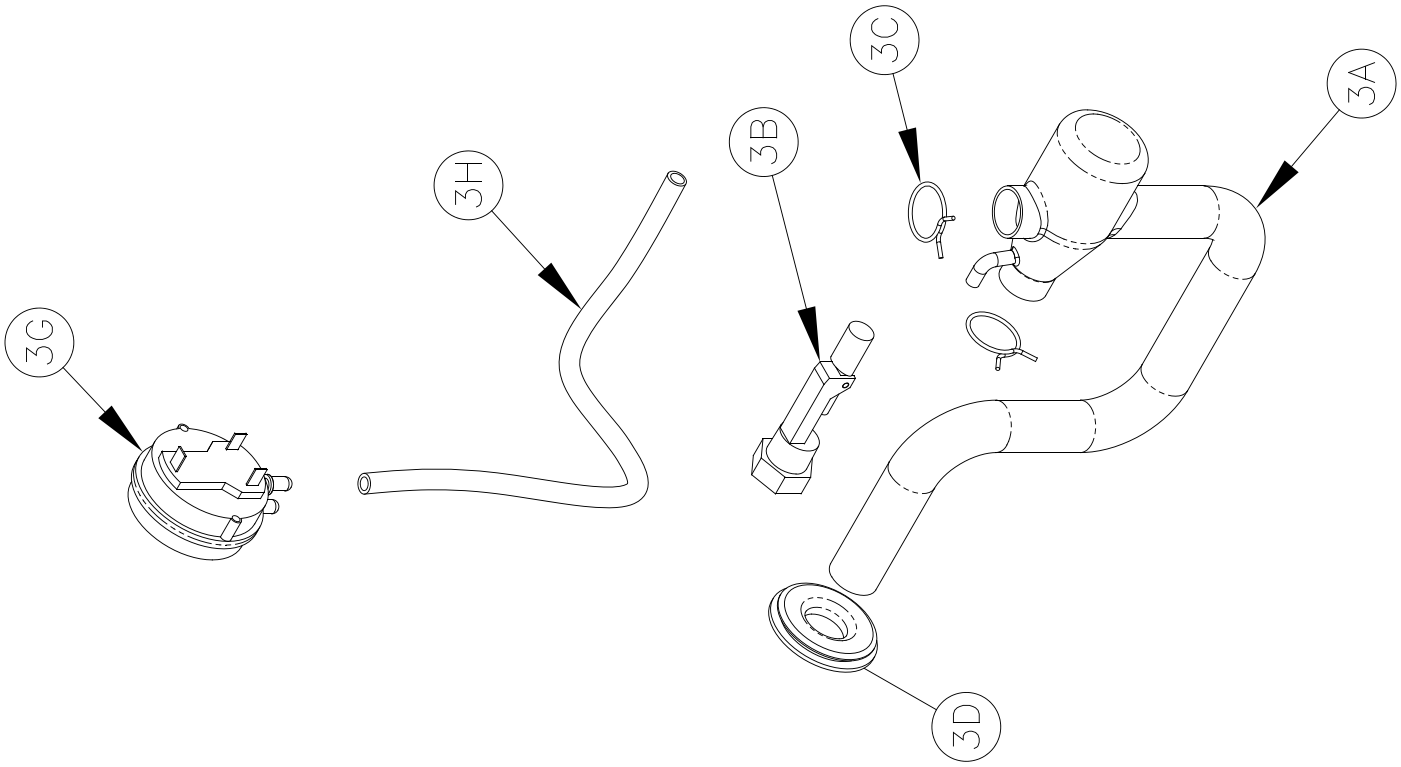
APX625C, APX725C and APX825C (APX825C shown)



13 Service Parts *(continued)*

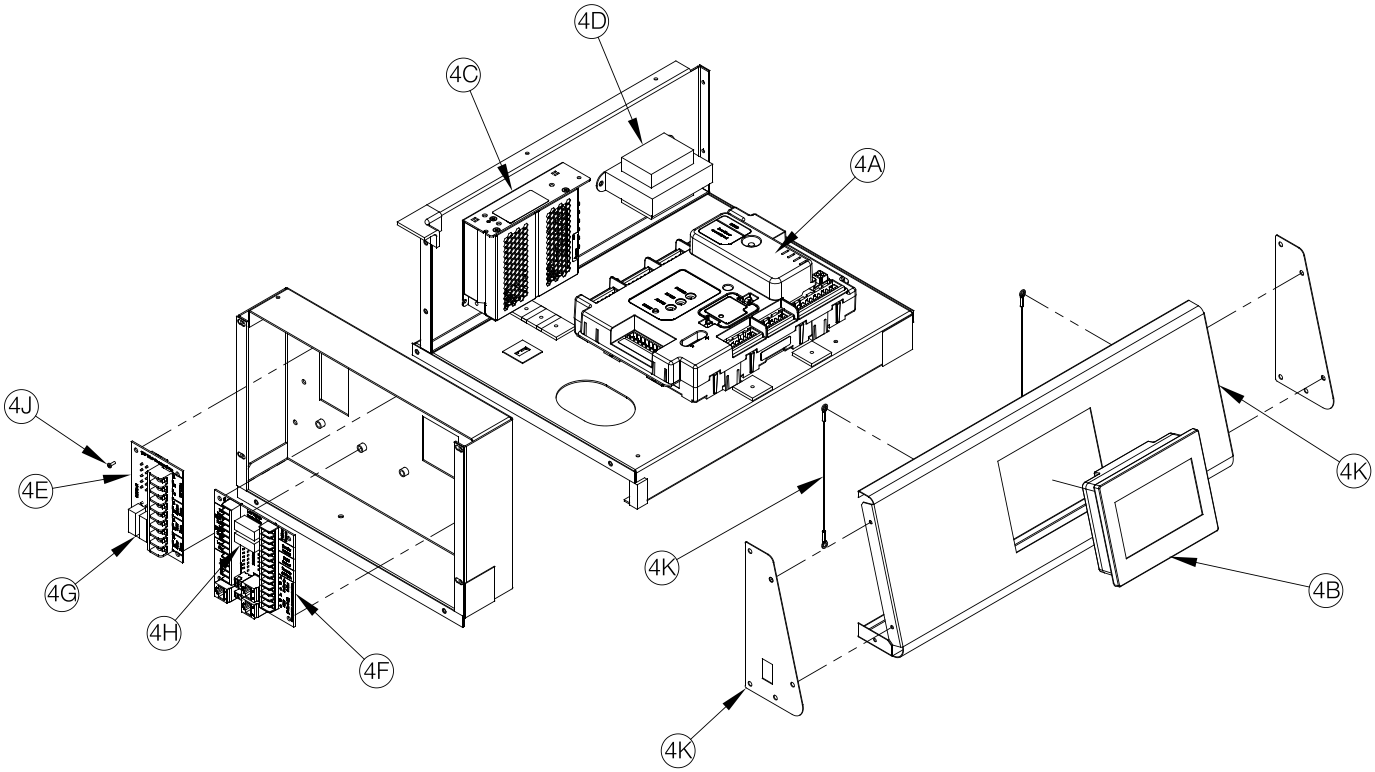
Blower / Gas Train Components				
Key No.	**Description**	**Part Number**		
		APX625C	**APX725C**	**APX825C**
2A	Replacement Blower Kit (includes blower, blower outlet gasket and hardware)	104999-03		
2B	Blower Outlet Gasket	109223-01		
2C	Blower Inlet Assembly (includes gas orifice, injector flange, inlet shroud (425 only), swirl plate, blower adapter plate, and mounting hardware)	Natural Gas: 110041-01	Natural Gas: 110042-01	110043-01
		LP Gas: 110039-01	LP Gas: 110040-01	
2E	Replacement Gas Valve Kit (includes one gas valve and o-rings)	Natural Gas: 105004-04		
		LP Gas: 105004-03		
2F	Gas Valve 90° Flange Kit (includes one 90° flange, o-ring, and hardware)	108103-01		
2G	Gas Valve Wire Harness (includes harness with plug and M4 x 30 mm screw)	Natural Gas: 109225-01		
		LP Gas: 109224-01		
N/A	Gas Line Rubber Grommet	1 in. NPT: 109226-01		
2K	Gas Shutoff Valve	1 in. NPT: 816SOL0015		
2L	Air Proving Switch	109114-01	109115-01	
2M	Air Proving Switch Tubing, silicone, 5/16 in. ID x 0.07 in. Wall Thickness x 18 in. long	109116-01		

13 Service Parts *(continued)*



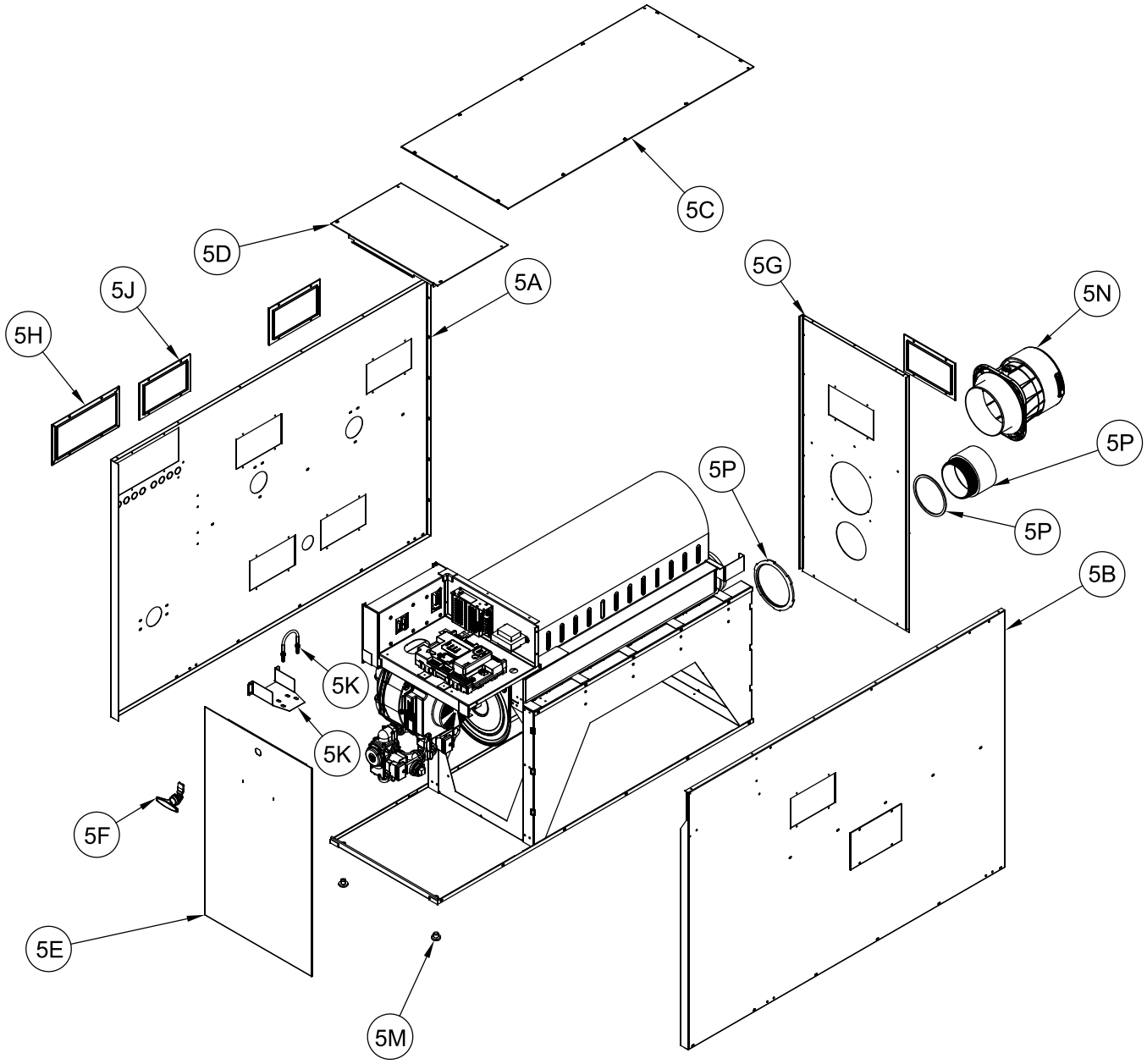
Condensate Trap and Related Components						
Key No.	Description	Part Number				
		APX425C	APX525C	APX625C	APX725C	APX825C
3A	Replacement Condensate Trap Kit (includes trap, float switch, grommet, coupling, and clamps)	109111-01	110044-01			
3B	Replacement Condensate Float Switch Kit (includes float switch and clamp)	105005-01				
3C	Spring Hose Clamp, 15/16 in. OD hose	110046-01				
3D	Rubber Grommet, Condensate Trap	110047-01				
3E	Condensate Neutralizer Kit (not shown, includes limestone chips)	101867-01				
3F	Limestone Chips, 2 lb. bag (not shown)	101873-01				
3G	Sump Pressure Switch	108893-01	106988-01			109228-01
3H	Air Pressure Switch Tubing, Silicone, 3/16 in. ID x 0.07 in. Wall Thickness	109116-01				

13 Service Parts *(continued)*



Control Components						
Key No.	**Description**	**Part Number**				
		APX425C	**APX525C**	**APX625C**	**APX725C**	**APX825C**
4A	Replacement Control Kit (programmed)	106499-01	106499-02			
4B	Replacement Display Kit (programmed, includes mounting hardware)	106507-01				
4C	Display Power Supply	105994-01				
4D	Transformer	106034-01		109220-01		
4E	Replacement 120V PCB Kit (includes PCB, fuses, and hardware)	106512-01				
4F	Replacement Low Voltage PCB Kit (includes PCB, fuses, and hardware)	106513-01				
4G	Pump Fuse, 5 x 20 mm, 6.3A Slow Blow	109155-01				
4H	24V Fuse, 5 x 20 mm	1.6A, Slow-Blow 109156-01		2.0A, Fast-Acting 109157-01		
4J	Machine Screw, 8-32 x 1/2 in.	101033-01				
4K	Display Panel Assembly	106271-01				

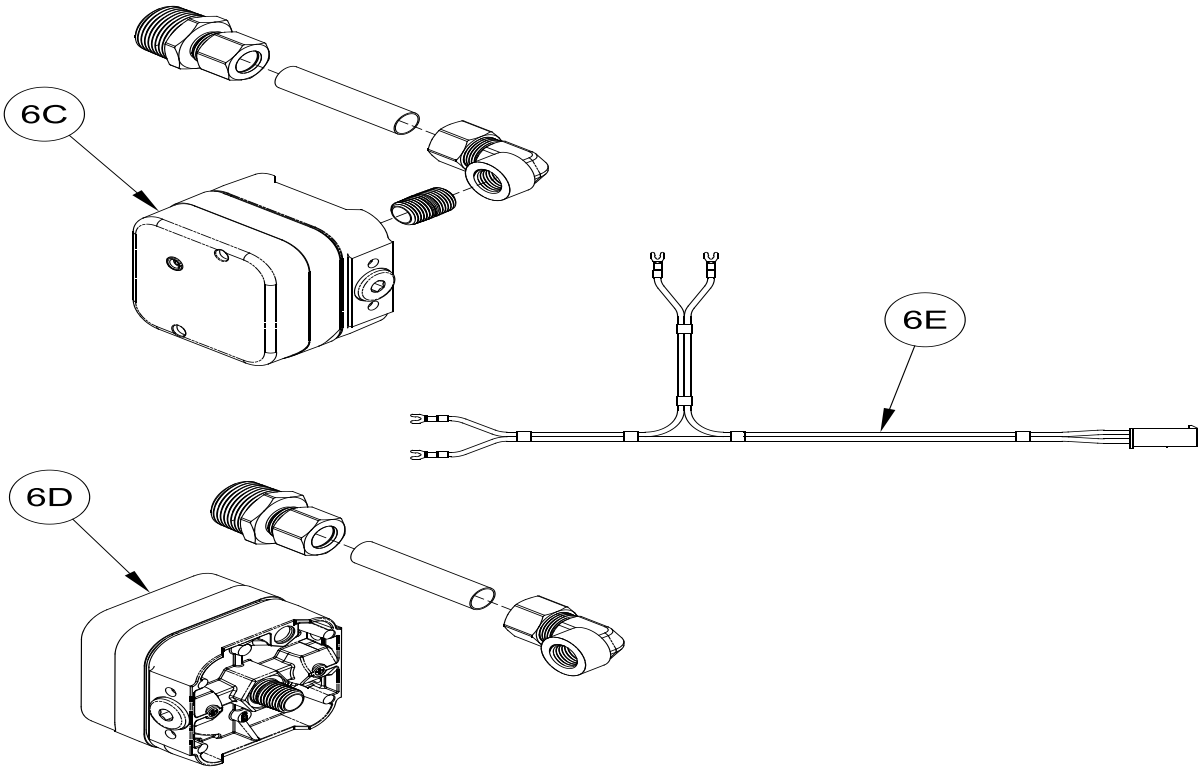
13 Service Parts *(continued)*



13 Service Parts *(continued)*

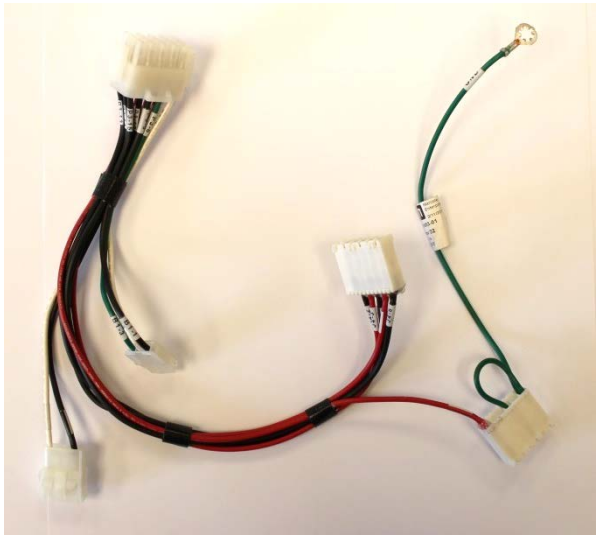
Jacket and Trim Components						
Key No.	Description	Part Number				
		APX425C	APX525C	APX625C	APX725C	APX825C
5A	Left Side Panel	106249-01	106249-02	106249-03		106249-04
5B	Right Side Panel (includes rating label instructions)	106517-01	106517-02	106517-03		106517-04
5C	Top Panel (includes gaskets)	106254-01	106254-02	106254-03		106254-04
5D	Top Control Access Panel (includes label)	106518-01				
5E	Front Door (includes gaskets and labels)	106516-01	106516-02			
5F	Replacement Door Latch Kit (includes latch, cam, and hardware)	106509-01				
5G	Rear Panel (includes gaskets)	106253-01	106253-02	106253-03		
5H	Junction Box Access Panel, 5.5 in. x 10.5 in.	109175-01				
5J	Access Panel, 5 in. x 8 in. (includes gasket)	109176-01				
5K	Gas Train Support Bracket (includes U-bolt)	109185-01	109187-01	109188-01		
5M	Nylon Glide Replacement Kit	105014-01				
5N	Vent Connector for CPVC/PP/SS (includes jacket gasket and vent pipe gaskets)	4 in. (100 or 110 mm) 108866-01		6 in. (150 or 160 mm) 109227-01		
5P	Combustion Air Connector Gasket	109189-01				

13 Service Parts *(continued)*



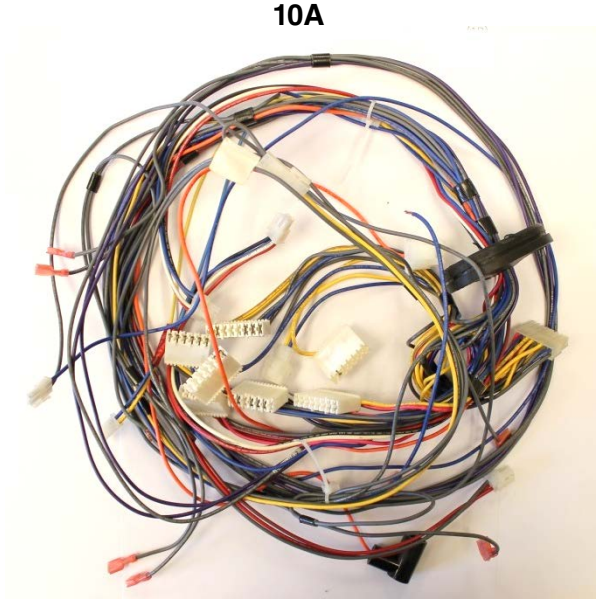
Additional Components						
Key No.	Description	Part Number				
		APX425C	APX525C	APX625C	APX725C	APX825C
6A	CSD-1 Kit (not shown, includes gas pressure switches) Contact Thermal Solutions for LP boilers	106056-01	107421-01			
6B	Gas Pressure Switch Assembly	N/A	109205-01			
6C	Low Gas Pressure Switch	N/A	109191-01			
6D	High Gas Pressure Switch	N/A	109190-01			
6E	Gas Pressure Switch Wire Harness	N/A	109194-01			
6F	Flow Switch Kit (not shown, includes switch and paddles)	109195-01				
6G	Flow Switch Repair Paddle Kit (not shown, includes paddles and hardware)	110077-01				
6H	Outdoor Temperature Sensor (not shown)	108681-01				
6J	Header Sensor for Direct Immersion, 1/2 in. NPT (not shown)	109196-01				
6K	Header Sensor Kit (not shown, includes mounting hardware)	108703-01				
6L	30 in. Long Schedule 40 CPVC Pipe (not shown)	4 in. 102193-02		6 in. 103267-01		
6M	Schedule 80 CPVC 90° Elbow (not shown)	4 in. 102192-02		6 in. 103268-01		
6N	Rodent Screen (not shown)	4 in. 102191-02		6 in. 102191-03		

13 Service Parts *(continued)*



10A

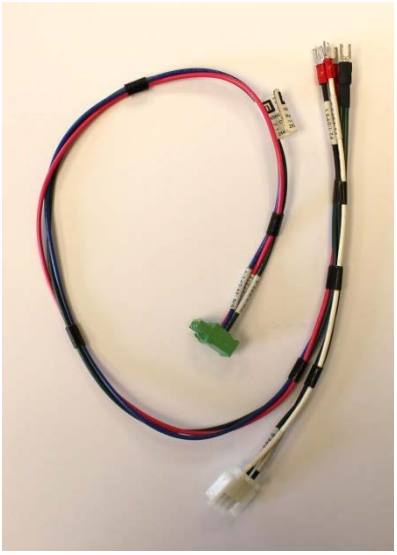
10D



10B

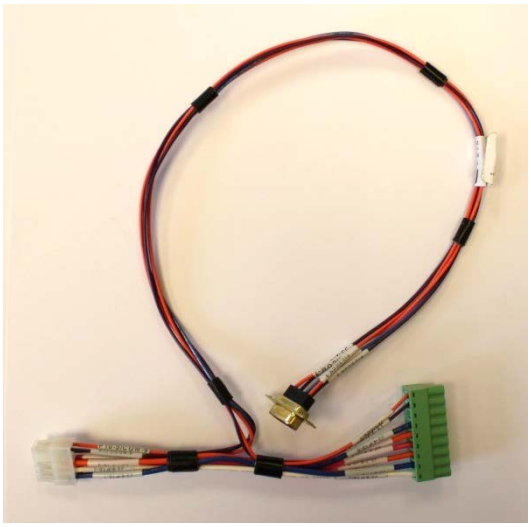
10E

10C



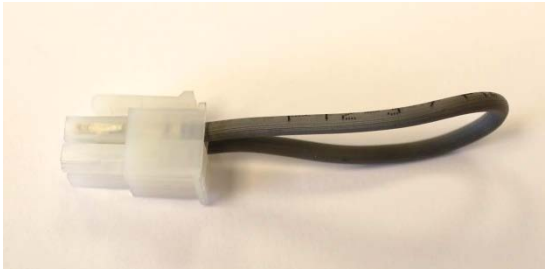
10F

13 Service Parts *(continued)*



10G

10H



10J

Wiring Harnesses							
Key No.	Description	Part Number					
		APX425C	APX525C	APX625C	APX725C	APX825C	
10A	120V Harness	109193-01					
10B	Low Voltage Harness	109201-01					
10C	Fan Power Harness	109198-01					
10D	Ignition Harness	109192-01					
10E	USB Harness	106001-01					
10F	Delta Display Power Harness	106006-01					
10G	Delta Display Communication Harness	106004-01					
10H	Flow Switch Harness	109199-01					
10J	LWCO Jumper	105908-01					

Appendix A Instructions for High Altitude Installations Above 2,000 ft.

⚠ WARNING

- If installing APX525C or APX725C: Do not convert APX525C to LP gas (propane) at altitudes above 6,000 ft. Also, do not install APX725C LP gas (propane) at altitudes above 7,800 ft. Attempts to do so may result in unreliable operation, property damage, personal injury or death due to carbon monoxide (CO air free) poisoning.
- LP Conversions - Apex boiler setup from factory is configured for use with natural gas installed from 0 - 2,000 ft above sea level only. For APX425C or APX525C conversion to LP at altitude above 2,000 ft., follow these instructions as specific instructions must be followed when converting for use with LP. If the information in these instructions is not followed exactly, a fire, an explosion or production of carbon monoxide may result causing property damage, personal injury or death. The qualified service agency is responsible for proper installation of this boiler for use with LP gas. The installation is not proper and complete until the operation of the converted appliance is checked as specified in the manufacturer's instructions supplied. APX625C, APX725C and APX825C are factory shipped as either natural gas build or LP gas build. Field conversions of APX625C, APX725C and APX825C are not permitted.
- Failure to set up the Boiler in accordance with these instructions could result in high amount of Carbon Monoxide to be produced which could result in death, serious injury, and/or reduced component life.

These instructions apply only to the following Apex boiler configurations: **2,001 ft.- 4,500 ft., 4,501 ft- 6000 ft., 6,001 ft.- 7,800 ft., 7,801 ft. - 10,000 ft.**

These instructions contain specific instructions to properly set up your boiler to ensure proper operation.

⚠ DANGER

These instructions include a procedure for adjusting the air-fuel mixture on this boiler. This procedure requires a combustion analyzer to measure the CO_2 (or Oxygen) and Carbon Monoxide (CO air free) levels in flue gas. Adjusting the air-fuel mixture without a proper combustion analyzer could result in unreliable boiler operation, personal injury, or death due to carbon monoxide poisoning.

Adjusting Boiler Type (must be completed first)

Select the correct Apex boiler size and altitude range using the touch screen display as follows:

1. Check boiler's label for actual boiler size.
2. Confirm installation altitude
3. Power up the boiler. Display will show the Home screen.
4. Press main menu on home screen.
5. Press Adjust.
6. Press Modulation.
7. Press Lock. Enter password "86" and select enter.
8. Press Boiler Model.
9. Press Adjust on Boiler Type screen.
10. Use the ↓ ↑ arrows to select the correct size and altitude of your boiler. Press the ✓ button to enter your selection. See Figure 10-19.
11. Press "Confirm" until display stops blinking.
12. Press return arrow to go back to home screen.

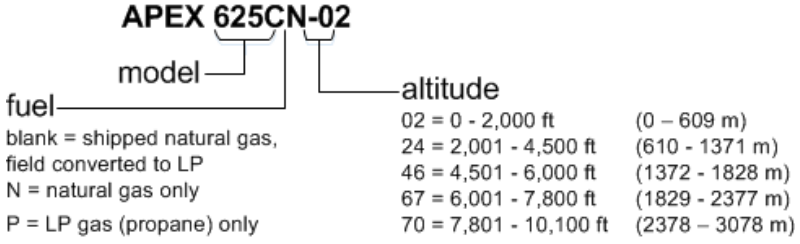


Figure A-1: Boiler Model (Boiler Type) Decoding

Appendix A Instructions for High Altitude Installations Above 2,000 ft.

(continued)

Start-up Instructions for Natural Gas or LP

1. Confirm Apex boiler size, type and installed altitude prior to startup.
2. APX425C or APX525C LP conversion only: Adjust throttle screw to preliminary setting per Table A-2.
3. Start boiler as described in boiler Installation manual and lock boiler in high fire (See Section 9 “System Start-up”). If boiler does not light, turn throttle screw in ¼ turn increments in a counterclockwise direction until boiler fires. Do not stop here, follow Steps 4-7.
4. Verify CO_2 is within range shown in Table A-4 and CO air free is less than 200 ppm. If CO_2 and CO air free are within these limits, move to Step 6 and check fan speed at high fire operation only.
5. If CO_2 is outside the window outlined in Table A-4, adjust throttle screw such that the CO_2 falls in this range while boiler is locked manually in high fire. Turning throttle screw counter-clockwise increases the CO_2, while clockwise rotation leans the mixture, reducing the CO_2. Once CO_2 is within the limits in Table A-4, check CO air free again to ensure it is below 200 ppm. If CO air free is above 200 ppm turn throttle screw clockwise in ¼ increments until CO air free is below 200 ppm, while ensuring CO_2 remains in the range specified in Table A-4. If CO air free is still above 200 ppm, reduce fan speed in 100 rpm increments until CO air free is less than 200 ppm.

⚠ WARNING

Asphyxiation Hazard. Offset screw is adjusted at the factory. DO NOT touch the offset screw if measured low fire CO_2 is within limits specified in Table A-4.

6. Lock boiler in low fire (see Section 9 “System Start-up”). Verify CO_2 is within range shown in Table A-4 and CO air free is less than 200 ppm.
7. If low CO_2 is too high, decrease CO_2 by turning offset screw counter-clockwise in less than 1/8 turn increments and checking the CO_2 and CO air free after each adjustment. If boiler is equipped with 2 gas valves, offset screw adjustments must be done to both gas valves equally and simultaneously. See Figure A-3 for location of offset screw. Verify CO air free is less than 200 ppm.
8. If low fire CO_2 is too low, increase CO_2 by turning offset screw clockwise in less than 1/8 turn increments and checking the CO_2 and CO air free after each adjustment. If boiler is equipped with 2 gas valves, offset screw adjustments must be done to both gas valves equally and simultaneously. See Figure A-3 for location of offset screw. Verify CO air free is less than 200 ppm.
9. Start boiler five times at the above settings to ensure boiler lights off without delay and without noise. Check CO_2 and CO air free to ensure that the CO_2 is within the range specified in Table A-4 and CO air free is below 200 ppm. Be sure to replace the screw cap in the vent adapter when combustion testing is complete.
10. Verify that the gas inlet pressure is between the following limits with all gas appliances (including the converted boiler) both on and off:
    - Natural Gas: 4.0 - 14.0 inches w.c.
    - LP Gas: 8.0 - 14.0 inches w.c.

    If inlet pressure is not within limits, adjust before performing high altitude setup procedure.
11. Return boiler to automatic mode. From Operation Screen, select Automatic/Manual Firing Rate Control >> Automatic Modulation. Select HOME to return boiler to home screen.

Table A-2: Approximate Clockwise Throttle Screw Turns for LP Gas (Propane) Conversion

Boiler Model	Approximate Throttle Screw Turns
APX425C	2¾
APX525C	3
APX625C	N/A - Factory LP Builds
APX725C	
APX825C	

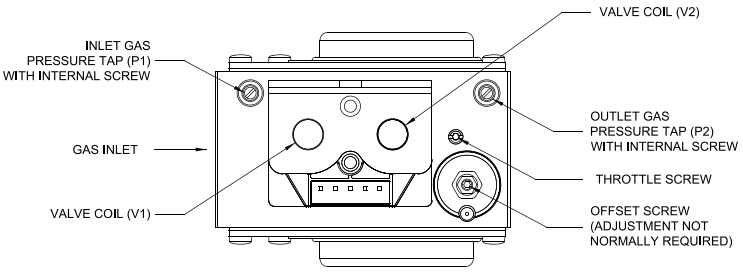


Figure A-3: Gas Valve Detail

Appendix A Instructions for High Altitude Installations Above 2,000 ft.

(continued)

Table A-4: Apex Altitude Adjustments

Altitude	Model	Fuel	Recommended CO_2 Range	Percentage Derate (approx. per 1,000 ft.)
2,001 ft. to 4,500 ft.	APX425C	NG	8.6-9.2	2.3%
		LP	9.4-10.2	
	APX525C	NG	8.7-9.2	4.1%
		LP	9.8-10.1	
	APX625C	NG	8.6-9.2	0.0%
		LP	9.4-9.9	
	APX725C	NG	8.2-8.7	1.7%
		LP	9.2-9.7	
	APX825C	NG	8.2-9.1	1.2%
		LP	9.4-10.0	0.0%
4,001 ft. to 6,000 ft.	APX425C	NG	8.6-9.2	2.3%
		LP	9.4-10.2	
	APX525C	NG	8.7-9.2	4.1%
		LP	9.8-10.1	
	APX625C	NG	8.6-9.2	0.0%
		LP	9.4-9.9	
	APX725C	NG	8.2-8.7	0.0%
		LP	9.2-9.7	
	APX825C	NG	8.2-9.1	1.2%
		LP	9.4-10.0	0.0%
6,001 ft. to 7,800 ft.	APX425C	NG	8.6-9.2	2.2%
		LP	9.4-10.0	
	APX525C	NG	8.7-9.2	3.6%
		LP	No Application	No Application
	APX625C	NG	8.6-9.2	0.7%
		LP	9.4-9.7	1.2%
	APX725C	NG	8.2-8.7	0.8%
		LP	9.2-9.5	
	APX825C	NG	No Application	No Application
		LP	9.4-9.8	1.4%
7,801 ft. to 10,100 ft.	APX425C	NG	8.6-9.2	2.2%
		LP	9.4-9.8	
	APX525C	NG	8.7-9.2	3.4%
		LP	No Application	No Application
	APX625C	NG	8.6-9.2	2.0%
		LP	9.4-9.8	
	APX725C	NG	8.2-8.7	2.0%
		LP	No Application	No Application
	APX825C	NG	No Application	No Application
		LP	9.4-9.7	2.8%

NOTE: De-rate's per 1,000 ft. are approximate
Based on minimum vent length

LIMITED WARRANTY FOR APEX COMMERCIAL GRADE BOILERS

Stainless Steel Heat Exchangers and Parts/Accessories

Subject to the terms and conditions set forth below, Thermal Solutions, Lancaster, Pennsylvania hereby extends the following limited warranties to the original owner of a commercial grade water boiler or Thermal Solutions supplied parts and/or accessories manufactured and shipped on or after January 1, 2014:

ONE YEAR LIMITED WARRANTY ON COMMERCIAL GRADE BOILERS AND PARTS / ACCESSORIES SUPPLIED BY THERMAL SOLUTIONS. Thermal Solutions warrants to the original owner that its commercial grade stainless steel water boilers and parts/accessories comply at the time of manufacture with recognized hydronic industry standards and requirements then in effect and will be free of defects in material and workmanship under normal usage for a period of one year from the date of original installation. If any part of a commercial grade boiler or any part or accessory provided by Thermal Solutions is found to be defective in material or workmanship during this one year period, Thermal Solutions will, at its option, repair or replace the defective part (not including labor).

HEAT EXCHANGER WARRANTIES

Thermal Solutions warrants to the original owner that the heat exchanger of its commercial grade stainless steel boilers will remain free from defects in material and workmanship under normal usage for the time period specified in the chart below to the original owner at the original place of installation. If a claim is made under this warranty during the "No Charge" period from the date of original installation, Thermal Solutions will, at its option, repair or replace the heat exchanger (not including labor). If a claim is made under this warranty after the expiration of the "No Charge" period from the date of original installation, Thermal Solutions will, at its option and upon payment of the pro-rated service charge set forth below, repair or replace the heat exchanger. The service charge applicable to a heat exchanger warranty claim is based upon the number of years the heat exchanger has been in service and will be determined as a percentage of the retail price of the heat exchanger model involved at the time the warranty claim is made as follows:
NOTE: If the heat exchanger involved is no longer available due to product obsolescence or redesign, the value used to establish the retail price will be the published price as set forth in Thermal Solutions Repair Parts Pricing where the heat exchanger last appeared or the current retail price of the then nearest equivalent heat exchanger, whichever is greater.

	Service Charge as a % of Retail Price									
Years of Service	1	2	3	4	5	6	7	8	9	10+
Stainless Steel	No Charge					20	40	60	80	100

ADDITIONAL TERMS AND CONDITIONS

1. Applicability: The limited warranties set forth above are extended only to the original owner at the original place of installation within the United States and Canada. These warranties are applicable only to boilers, parts, or accessories designated as commercial grade by Thermal Solutions and installed and used exclusively for purposes of commercial space heating or domestic hot water generation through a heat exchanger (or a combination for such purposes) and do not apply to residential grade products or industrial uses.
2. Components Manufactured by Others: Upon expiration of the one year limited warranty on commercial grade boilers, all boiler components other than heat exchangers manufactured by others but furnished by Thermal Solutions (such as circulator and controls) will be subject only to the manufacturer's warranty, if any.
3. Proper Installation: The warranties extended by Thermal Solutions are conditioned upon the installation of the commercial grade boiler, parts, and accessories in strict compliance with Thermal Solutions installation instructions. Thermal Solutions specifically disclaims liability of any kind caused by or relating to improper installation.
4. Proper Use and Maintenance: The warranties extended by Thermal Solutions conditioned upon the use of the commercial grade boiler, parts, and accessories for its intended purposes and its maintenance accordance with Thermal Solutions recommendations and hydronics industry standards. For proper installation, use, and maintenance, see all applicable sections of the Installation and Operating, and Service Instructions Manual furnished with the unit.
5. This warranty does not cover the following:
a. Expenses for removal or reinstallation. The owner will be responsible for the cost of removing and reinstalling the alleged defective part or its replacement and all labor and material connected therewith, and transportation to and from Thermal Solutions.
b. Components that are part of the heating system but were not furnished by Thermal Solutions as part of the commercial boiler.
c. Improper burner set-up or adjustment, control settings, care or maintenance.
d. This warranty cannot be considered as a guarantee of workmanship of an installer connected with the installation of the Thermal Solutions boiler, or as imposing on Thermal Solutions liability of any nature for unsatisfactory performance as a result of faulty workmanship in the installation, which liability is expressly disclaimed.
e. Boilers, parts, or accessories installed outside the 48 contiguous United States, the State of Alaska and Canada.
f. Damage to the boiler and/or property due to installation or operation of the boiler that is not in accordance with the boiler installation and operating instruction manual.
i. Any damage or failure of the boiler resulting from hard water, scale buildup or corrosion the heat exchanger. Any damage caused by improper fuels, fuel additives or contaminated combustion air that may cause fireside corrosion and/or c logging of the burner or heat exchanger.
j. Any damage resulting from combustion air contaminated with particulate which cause clogging of the burner or combustion chamber including but not limited to sheetrock or plasterboard particles, dirt, and dust particulate. Any damage, defects or malfunctions resulting from improper operation, maintenance, misuse, abuse, accident, negligence including but not limited to operation with insufficient water flow, improper water level, improper water chemistry, or damage from freezing.
k. Any damage caused by water side clogging due to dirty systems, corrosion products from the system, or improperly maintained water conditions.

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