



## Installation & Operation Manual

### Models: 400 - 801



#### **⚠ WARNING**

This manual must only be used by a qualified heating installer / service technician. Read all instructions, including this manual and the Knight XL Service Manual, before installing. Perform steps in the order given. Failure to comply could result in severe personal injury, death, or substantial property damage.



# Lochinvar®

High Efficiency Water Heaters, Boilers and Pool Heaters

Save this manual for future reference.

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## Hazard definitions

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

### DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

### WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

### CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

### CAUTION

CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

### NOTICE

NOTICE indicates special instructions on installation, operation, or maintenance that are important but not related to personal injury or property damage.

## Please read before proceeding

### ⚠ WARNING

**Installer** – Read all instructions, including this manual and the Knight XL Service Manual, before installing. Perform steps in the order given.

**User** – This manual is for use only by a qualified heating installer/service technician. Refer to the User's Information Manual for your reference.

Have this boiler serviced/inspected by a qualified service technician, at least annually.

Failure to comply with the above could result in severe personal injury, death or substantial property damage.

### NOTICE

When calling or writing about the boiler – Please have the boiler model and serial number from the boiler rating plate.

Consider piping and installation when determining boiler location.

Any claims for damage or shortage in shipment must be filed immediately against the transportation company by the consignee.

Factory warranty (shipped with unit) does not apply to units improperly installed or improperly operated.

### ⚠ WARNING

Failure to adhere to the guidelines on this page can result in severe personal injury, death, or substantial property damage.

### ⚠ WARNING

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

This appliance **MUST NOT** be installed in any location where gasoline or flammable vapors are likely to be present.

#### 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 near by phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.
- Installation and service must be performed by a qualified installer, service agency, or the gas supplier.

### When servicing boiler –

- To avoid electric shock, disconnect electrical supply before performing maintenance.
- To avoid severe burns, allow boiler to cool before performing maintenance.

### Boiler operation –

- Do not block flow of combustion or ventilation air to the boiler.
- Should overheating occur or gas supply fail to shut off, do not turn off or disconnect electrical supply to circulator. Instead, shut off the gas supply at a location external to the appliance.
- Do not use this boiler if any part has been under water. The possible damage to a flooded appliance can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.

### Boiler water –

- Thoroughly flush the system (without boiler connected) to remove sediment. The high-efficiency heat exchanger can be damaged by build-up or corrosion due to sediment.
- Continual fresh make-up water will reduce boiler life. Mineral buildup in the heat exchanger reduces heat transfer, overheats the stainless steel heat exchanger, and causes failure. Addition of oxygen carried in by makeup water can cause internal corrosion in system components. Leaks in boiler or piping must be repaired at once to prevent makeup water.

### ⚠ CAUTION

Do not use petroleum-based cleaning or sealing compounds in the boiler system. Gaskets and seals in the system may be damaged. This can result in substantial property damage.

### ⚠ CAUTION

Do not use "homemade cures" or "boiler patent medicines". Serious damage to the boiler, personnel, and/or property may result.

### Freeze protection fluids –

- NEVER use automotive antifreeze. Use only inhibited propylene glycol solutions, which are specifically formulated for hydronic systems. Ethylene glycol is toxic and can attack gaskets and seals used in hydronic systems.

# The Knight XL - How it works...

## 1. **Stainless steel heat exchanger**

Allows system water to flow through specially designed coils for maximum heat transfer, while providing protection against flue gas corrosion. The coils are encased in a jacket that contains the combustion process.

## 2. **Combustion chamber access cover**

Allows access to the combustion side of the heat exchanger coils.

## 3. **Blower**

The blower pulls in air and gas through the venturi (item 5). Air and gas mix inside the blower and are pushed into the burner, where they burn inside the combustion chamber.

## 4. **Gas valve**

The gas valve senses the negative pressure created by the blower, allowing gas to flow only if the gas valve is powered and combustion air is flowing.

## 5. **Venturi**

The venturi controls air and gas flow into the burner.

## 6. **Flue gas sensor (limit rated)**

This sensor monitors the flue gas exit temperature. The control module will modulate and shut down the boiler if the flue gas temperature gets too hot. This protects the flue pipe from overheating.

## 7. **Boiler outlet temperature sensor (housed with the high limit sensor)**

This sensor monitors boiler outlet water temperature (system supply). If selected as the controlling sensor, the control module adjusts boiler firing rate so the outlet temperature is correct.

## 8. **Boiler inlet temperature sensor**

This sensor monitors return water temperature (system return). If selected as the controlling sensor, the control module adjusts the boiler firing rate so the inlet temperature is correct.

## 9. **Temperature and pressure gauge (field installed, not shown)**

Monitors the outlet temperature of the boiler as well as the system water pressure.

## 10. **Electronic LCD display**

The electronic display consists of 4 buttons, a navigation dial and a multiple line liquid crystal display.

## 11. **Flue pipe adapter**

Allows for the connection of the PVC vent pipe system to the boiler.

## 12. **Burner (not shown)**

Made with metal fiber and stainless steel construction, the burner uses pre-mixed air and gas and provides a wide range of firing rates.

## 13. **Water outlet (system supply)**

A 1-1/2" or 2" NPT (depending on the model) water connection that supplies hot water to the system.

## 14. **Water inlet (system return)**

A 1-1/2" or 2" NPT (depending on the model) water connection that returns water from the system to the heat exchanger.

## 15. **Gas connection pipe**

Threaded pipe connection of 1". This pipe should be connected to the incoming gas supply for the purpose of delivering gas to the boiler.

## 16. **SMART SYSTEM Control Module**

The SMART SYSTEM Control responds to internal and external signals and controls the blower, gas valve, and pumps to meet the heating demand.

## 17. **Manual air vent**

Designed to remove trapped air from the heat exchanger coils.

## 18. **Air intake adapter**

Allows for the connection of the PVC air intake pipe to the boiler.

## 19. **High voltage junction box**

The junction box contains the connection points for the line voltage power and all pumps.

## 20. **Boiler drain port**

Location from which the heat exchanger can be drained.

## 21. **Low voltage connection board**

The connection board is used to connect external low voltage devices.

## 22. **Low voltage wiring connections (knockouts)**

Conduit connection points for the low voltage connection board.

## 23. **Condensate drain connection**

Connects the condensate drain line to a 1/2" PVC union.

## 24. **Access cover - front**

Provides access to the gas train and the heat exchanger.

## 25. **Ignition electrode**

Provides direct spark for igniting the burner.

## 26. **Flame inspection window**

The quartz glass window provides a view of the burner surface and flame.

## 27. **Gas shutoff valve**

Manual valve used to isolate the gas valve from the gas supply.

## 28. **Relief valve**

Protects the heat exchanger from an over pressure condition. The relief valve provided with the unit is set at 50 PSI.

## 29. **Flame sensor**

Used by the control module to detect the presence of burner flame.

## 30. **Line voltage wiring connections (knockouts)**

Conduit connection points for the high voltage junction box.

## 31. **Top panel**

Removable panel to gain access to the internal components.

## 32. **Power switch**

Turns 120 VAC ON/OFF to the boiler.

## 33. **Leveling legs**

Used to allow the heat exchanger to be leveled. This is needed for the proper draining of the condensate from the combustion chamber.

## 34. **Air shroud (Model 501 only)**

The air shroud controls air and gas flow into the burner.

## 35. **Air pressure switch**

The air pressure switch detects blocked flue/inlet conditions. break the control circuit, shutting the boiler down.

## 36. **Pump relay board**

The pump relay board is used to connect the boiler, system and DHW pumps.

## 37. **Transformer**

The transformer provides 24V power to the integrated control.

## 38. **High limit sensor (housed with the outlet temperature sensor)**

Device that monitors the outlet water temperature. If the temperature exceeds its setting, the integrated control will break the control circuit, shutting the boiler down.

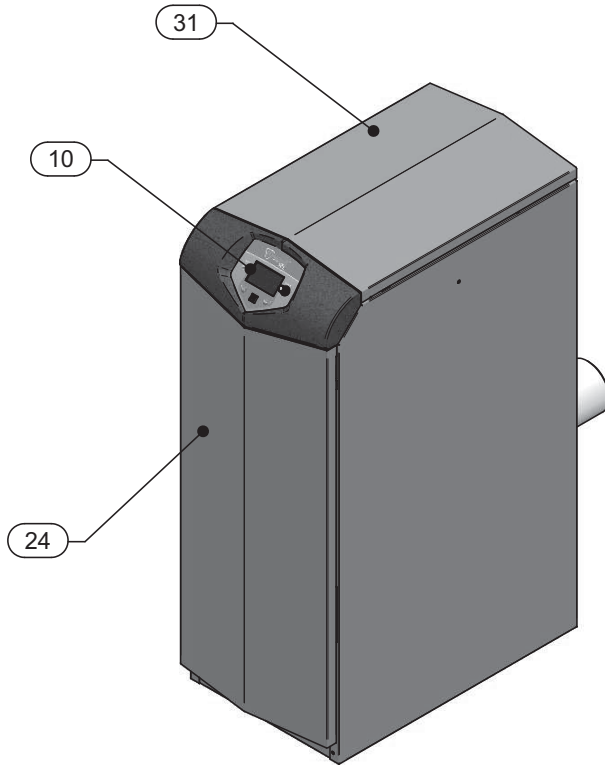
## 39. **Over-temp switch (located underneath access cover)**

Used to detect excessive temperatures on the upper coil of the heat exchanger.

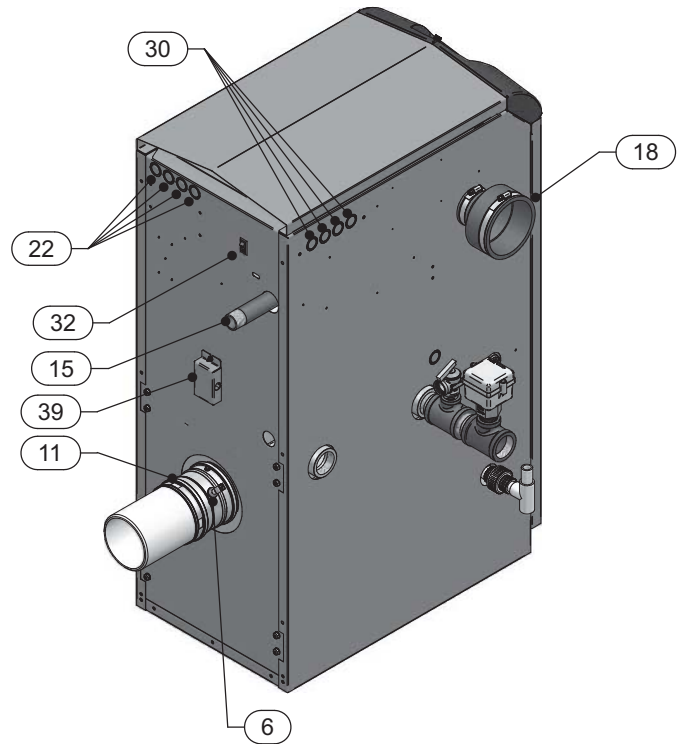


# The Knight XL - How it works... (continued)

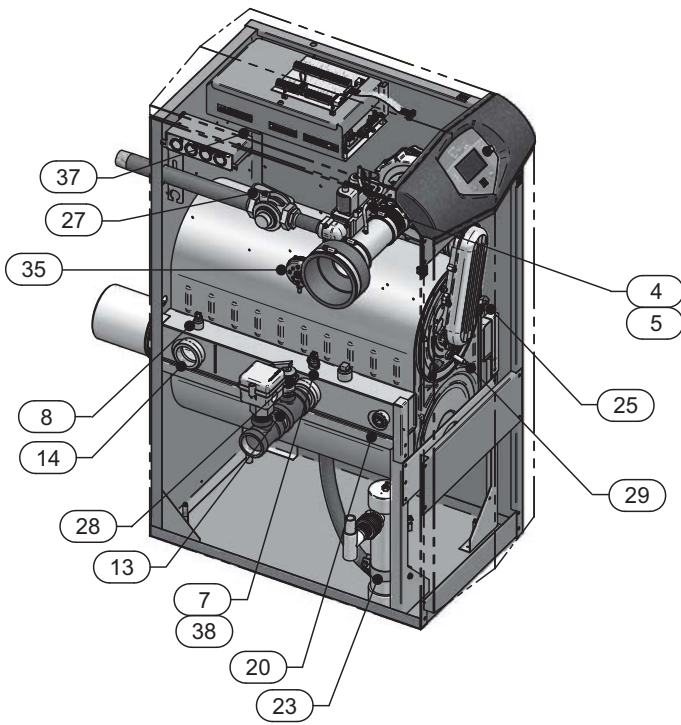
## Model 400



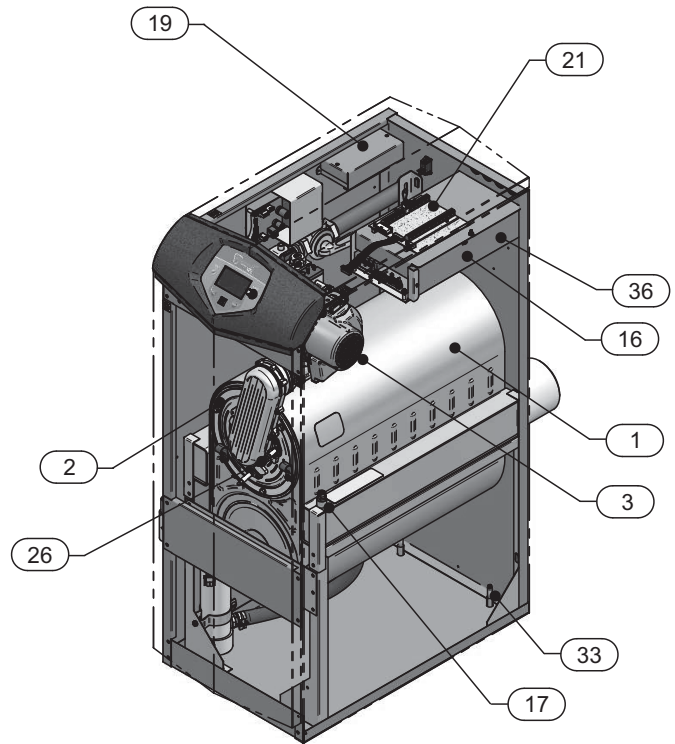
Front View - Model 400



Rear View - Model 400



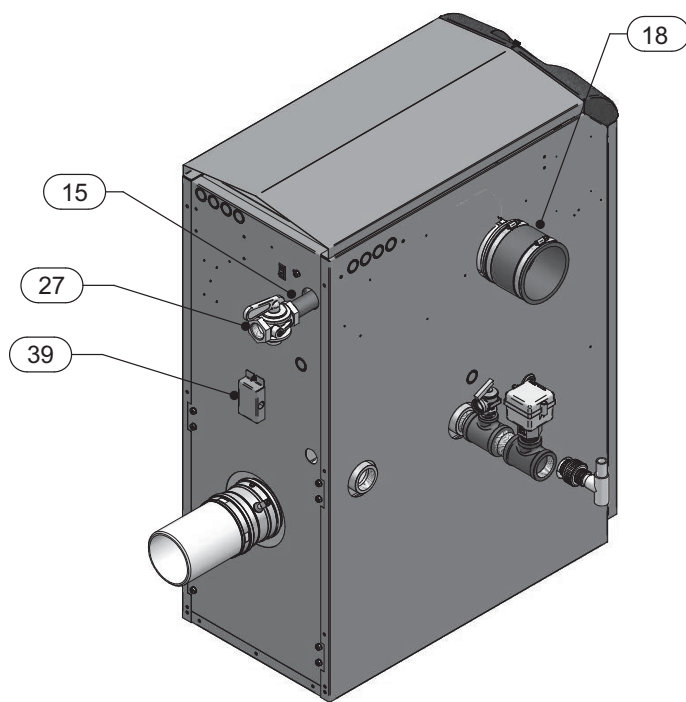
Left Side (inside unit) - Model 400



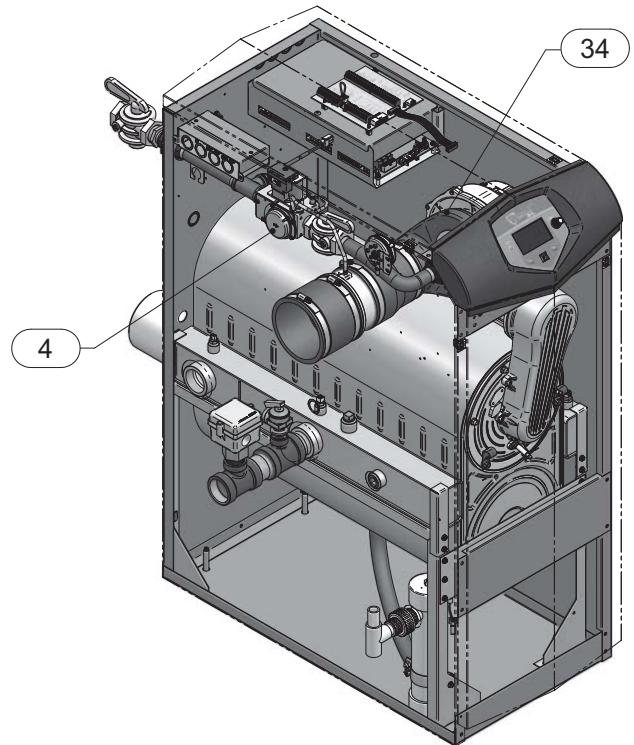
Right Side (inside unit) - Model 400

# The Knight XL - How it works...

## Model 501

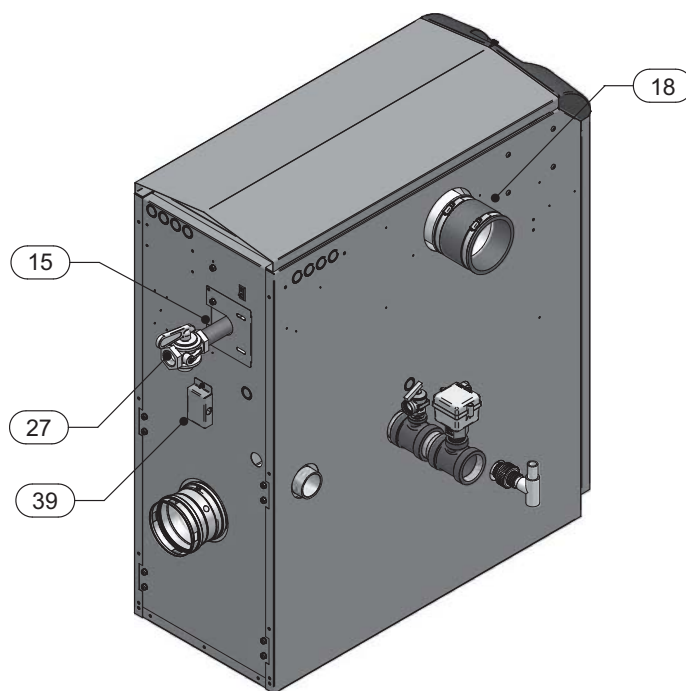


Rear View - Model 501

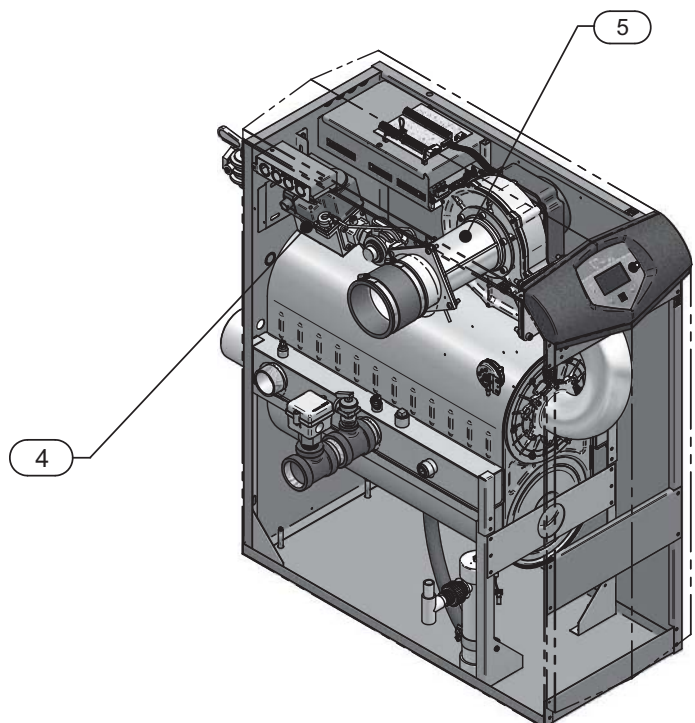


Left Side (inside unit) - Model 501

## Models 601 - 801



Rear View - Models 601 - 801



Left Side (inside unit) - Models 601 - 801

# Ratings



DOE

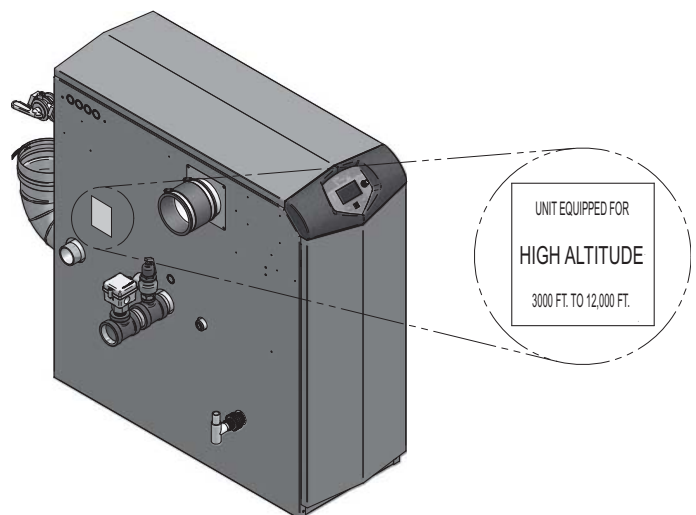
<div> <b>Knight XL Boiler</b>  <b>I=B=R Rating</b> </div>					Other Specifications				
Model Number  Note: Change "N" to "L" for L.P. gas models.	Input MBH (Note 4)		Gross Output MBH (Note 1)	Net I=B=R Ratings Water, MBH (Note 2)	Boiler Water Content Gallons	Water Connections	Gas Connections	Air Size	Vent Size (Note 3)
	Min	Max							
KBN400	80	399	373	324	3.4	1-1/2"	1"	4"	4"
KBN501	100	500	467	406	4.2	1-1/2"	1"	4"	4"
KBN601	120	600	567	493	4.2	2"	1"	4"	4"
KBN701	140	700	660	574	5.0	2"	1"	4"	6"
KBN801	160	800	752	654	5.7	2"	1"	4"	6"

## NOTICE

Maximum allowed working pressure is located on the rating plate.

### Notes:

- The ratings are based on standard test procedures prescribed by the United States Department of Energy.
- Net I=B=R ratings are based on net installed radiation of sufficient quantity for the requirements of the building and nothing need be added for normal piping and pickup. Ratings are based on a piping and pickup allowance of 1.15.
- Knight XL boilers require special gas venting. Use only the vent materials and methods specified in the Knight XL Installation and Operation Manual.
- Standard Knight XL boilers are equipped to operate from sea level to 4,500 feet **only** with no adjustments. The boiler will de-rate by 4% for each 1,000 feet above sea level up to 4,500 feet.
- High altitude Knight XL boilers are equipped to operate from 3,000 to 12,000 feet **only** with no field adjustments. The boiler will de-rate by 2% for each 1,000 feet above 3,000 feet. High altitude models are manufactured with a different control module for altitude operation, but the operation given in this manual remains the same as the standard boilers. A high altitude label (as shown in FIG. A) is also affixed to the unit.
- Ratings have been confirmed by the Hydronics Institute, Section of AHRI.
- Knight XL boilers comply with the requirements of CSD-1 Section CW-400 requirements as a temperature operation control. The manual reset high limit provided with the Knight XL is listed to UL353.



**Figure A** High Altitude Label Location

# 1 Determine boiler location

Installation must comply with:

- Local, state, provincial, and national codes, laws, regulations, and ordinances.
- National Fuel Gas Code, ANSI Z223.1 – latest edition.
- Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1, when required.
- National Electrical Code.
- For Canada only: B149.1 Installation Code, CSA C22.1 Canadian Electrical Code Part 1 and any local codes.

## NOTICE

The Knight XL gas manifold and controls met safe lighting and other performance criteria when the boiler underwent tests specified in ANSI Z21.13 – latest edition.

Before locating the boiler, check:

1. Check for nearby connection to:
  - System water piping
  - Venting connections
  - Gas supply piping
  - Electrical power
2. Locate the appliance so that if water connections should leak, water damage will not occur. When such locations cannot be avoided, it is recommended that a suitable drain pan, adequately drained, be installed under the appliance. The pan must not restrict combustion air flow. Under no circumstances is the manufacturer to be held responsible for water damage in connection with this appliance, or any of its components.
3. Check area around the boiler. Remove any combustible materials, gasoline and other flammable liquids.

## WARNING

Failure to keep boiler area clear and free of combustible materials, gasoline, and other flammable liquids and vapors can result in severe personal injury, death, or substantial property damage.

4. The Knight XL must be installed so that gas control system components are protected from dripping or spraying water or rain during operation or service.
5. If a new boiler will replace an existing boiler, check for and correct system problems, such as:
  - System leaks causing oxygen corrosion or heat exchanger cracks from hard water deposits.
  - Incorrectly-sized expansion tank.
  - Lack of freeze protection in boiler water causing system and boiler to freeze and leak.

## WARNING

This appliance is certified as an indoor appliance. Do not install the appliance outdoors or locate where the appliance will be exposed to freezing temperatures or to temperatures that exceed 100°F (37.8°C).

Failure to install the appliance indoors could result in severe personal injury, death, or substantial property damage.

## WARNING

This appliance requires a special venting system. The vent connection to the appliance must be made with the starter CPVC/stainless steel pipe section provided with the appliance. The field provided PVC vent fittings must be cemented to the CPVC pipe section. Use only the vent materials, primer and cement specified in this manual to make the vent connections. Failure to follow this warning could result in fire, personal injury, or death.

## Closet and alcove installations

A closet is any room the boiler is installed in which is less than 171 cubic feet for KBN400 models, 193 cubic feet for KBN501 models, 223 cubic feet for KBN601 models, 247 cubic feet for KBN701 models and 278 cubic feet for KBN801 models.

An alcove is any room which meets the criteria for a closet with the exception that it does not have a door.

**Example:** Room dimensions = 5 feet long, 4 feet wide, and 8 foot ceiling = 5 x 4 x 8 = 160 cubic feet. This would be considered a closet for a Knight XL Boiler.

## WARNING

For closet and alcove installations as shown in FIG.'s 1-1 and 1-2, CPVC or stainless steel vent material must be used inside the structure. The ventilating air openings shown in FIG.'s 1-1 and 1-2 are required for this arrangement. Failure to follow this warning could result in fire, personal injury, or death.

Provide clearances:

### Clearances from combustible materials

1. Hot water pipes—at least 1/4" (6 mm) from combustible materials.
2. Vent pipe – at least 1" (25 mm) from combustible materials.
3. See FIG.'s 1-1 and 1-2 on page 9 for other clearance minimums.

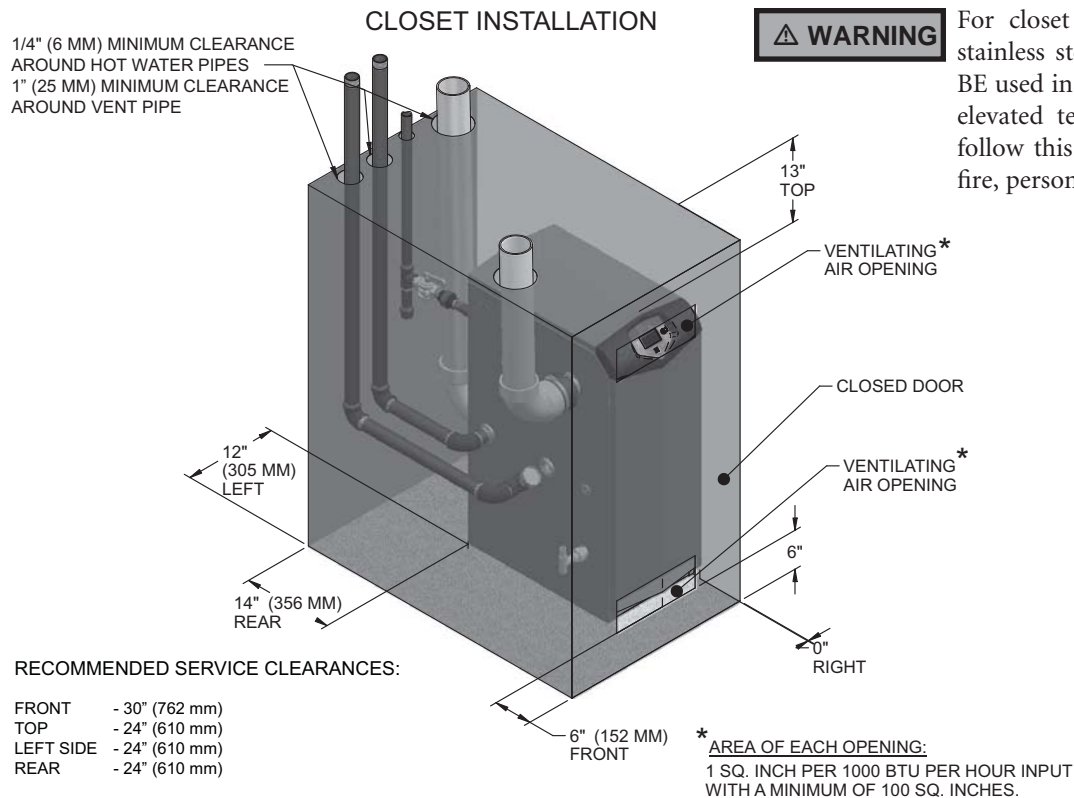
### Clearances for service access

1. See FIG.'s 1-1 and 1-2 on page 9 for recommended service clearances. If you do not provide the minimum clearances shown, it may not be possible to service the boiler without removing it from the space.

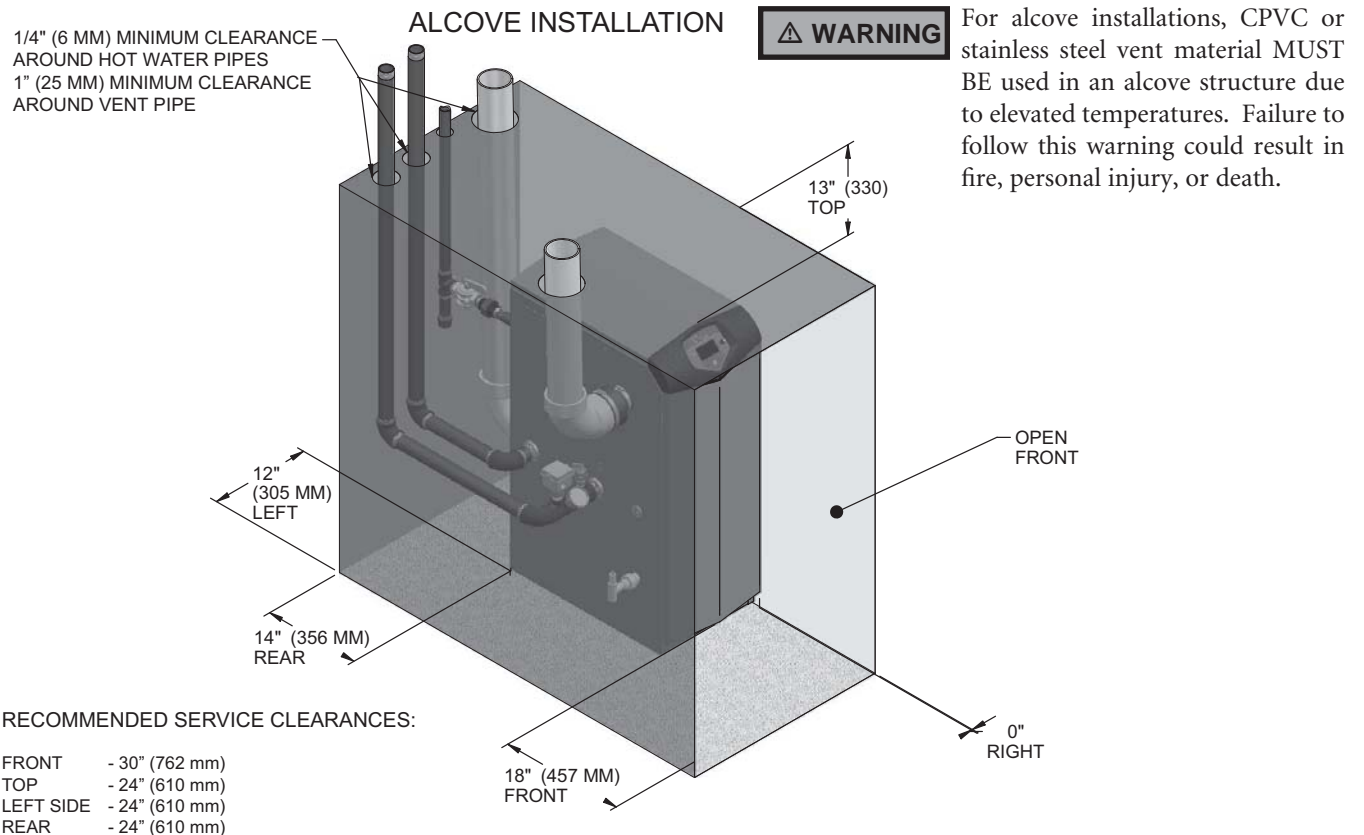


# 1 Determine boiler location *(continued)*

**Figure 1-1 Closet Installation - Minimum Required Clearances**



**Figure 1-2 Alcove Installation - Minimum Required Clearances**





# 1 Determine boiler location

Provide air openings to room:

## **Knight XL alone in boiler room**

1. No air ventilation openings into the boiler room are needed when clearances around the Knight XL are at least equal to the SERVICE clearances shown in FIG.'s 1-1 and 1-2. For spaces that do NOT supply this clearance, provide two openings as shown in FIG. 1-1. Each opening must provide one square inch free area per 1,000 Btu/hr of boiler input.

## **Knight XL in same space with other gas or oil-fired appliances**

1. Follow the National Fuel Gas Code (U.S.) or CSA B149.1 (Canada) to size/verify size of the combustion/ventilation air openings into the space.

### **⚠ WARNING**

The space must be provided with combustion/ventilation air openings correctly sized for all other appliances located in the same space as the Knight XL.

Do not install the boiler in an attic.

Failure to comply with the above warnings could result in severe personal injury, death, or substantial property damage.

2. Size openings only on the basis of the other appliances in the space. No additional air opening free area is needed for the Knight XL because it takes its combustion air from outside (direct vent installation).

## **Flooring and foundation**

### **Flooring**

The Knight XL is approved for installation on combustible flooring, but must never be installed on carpeting.

### **⚠ WARNING**

Do not install the boiler on carpeting even if foundation is used. Fire can result, causing severe personal injury, death, or substantial property damage.

If flooding is possible, elevate the boiler sufficiently to prevent water from reaching the boiler.

## **Residential garage installation**

### **Precautions**

Take the following precautions when installing the appliance in a residential garage. If the appliance is located in a residential garage, it should be installed in compliance with the latest edition of the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CGA-B149 Installation Code.

- Appliances located in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling shall be installed so that all burners and burner ignition devices are located not less than 18 inches (46 cm) above the floor.
- The appliance shall be located or protected so that it is not subject to physical damage by a moving vehicle.

## **Vent and air piping**

The Knight XL requires a special vent system, designed for pressurized venting.

The boiler is to be used for either direct vent installation or for installation using indoor combustion air. When room air is considered, see the General Venting Section. Note prevention of combustion air contamination below when considering vent/air termination.

Vent and air must terminate near one another and may be vented vertically through the roof or out a side wall, unless otherwise specified. You may use any of the vent/air piping methods covered in this manual. Do not attempt to install the Knight XL using any other means.

Be sure to locate the boiler such that the vent and air piping can be routed through the building and properly terminated. The vent/air piping lengths, routing and termination method must all comply with the methods and limits given in this manual.

## **Prevent combustion air contamination**

Install air inlet piping for the Knight XL as described in this manual. Do not terminate vent/air in locations that can allow contamination of combustion air. Refer to Table 1A, page 11 for products and areas which may cause contaminated combustion air.

### **⚠ WARNING**

You must pipe combustion air to the boiler air intake. Ensure that the combustion air will not contain any of the contaminants in Table 1A, page 11. Contaminated combustion air will damage the boiler, resulting in possible severe personal injury, death or substantial property damage. Do not pipe combustion air near a swimming pool, for example. Also, avoid areas subject to exhaust fumes from laundry facilities. These areas will always contain contaminants.

# 1 Determine boiler location *(continued)*

When using an existing vent system to install a new boiler:

**⚠ WARNING** Failure to follow all instructions can result in flue gas spillage and carbon monoxide emissions, causing severe personal injury or death.

Check the following venting components before installing:

- **Material** - For materials listed for use with this appliance, see Section 3 - General Venting, Table 3A. For stainless steel venting, an adapter of the same manufacturer (Table 3B) must be used at the flue collar connection.
- **Size** - To ensure proper pipe size is in place, see Table 3D. Check to see that this size is used throughout the vent system.
- **Manufacturer** - For a stainless steel application, you must use only the listed manufacturers and their type product listed in Table 3A for CAT IV positive pressure venting with flue producing condensate.
- **Supports** - Non-combustible supports must be in place allowing a minimum 1/4" rise per foot. The supports should adequately prevent sagging and vertical slippage, by distributing the vent system weight. For additional information, consult the vent manufacturer's instructions for installation.
- **Terminations** - Carefully review Sections 3 through 5 to ensure requirements for the location of the vent and air terminations are met and orientation of these fit the appropriate image from the Sidewall or Vertical options listed in the General Venting Section. For stainless steel vent, only use terminations listed in Table 3B for the manufacturer of the installed vent.
- **Seal** - With prior requirements met, the system should be tested to the procedure listed in parts (c) through (f) of the Removal of an Existing Boiler Section on page 12.

With stainless steel vent, seal and connect all pipe and components as specified by the vent manufacturer used; with PVC/CPVC vent, see the Installing Vent or Air Piping Section on page 17.

**⚠ WARNING** If any of these conditions are not met, the existing system must be updated or replaced for that concern. Failure to follow all instructions can result in flue gas spillage and carbon monoxide emissions, causing severe personal injury or death.

**Table 1A Corrosive Contaminants and Sources**

Products to avoid:
Spray cans containing chloro/fluorocarbons
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
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

# 1 Determine boiler location

When removing a boiler from existing common vent system:

**⚠ DANGER**

Do not install the Knight XL into a common vent with any other appliance. This will cause flue gas spillage or appliance malfunction, resulting in possible severe personal injury, death, or substantial property damage.

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.

- a. Seal any unused openings in the common venting system.
- b. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion, or other deficiencies, which could cause an unsafe condition.
- c. Test vent system – 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.
- d. Place in operation the appliance being inspected. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.
- e. 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.
- f. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined herein, return doors, windows, exhaust fans, fireplace dampers, and any other gas-burning appliance to their previous conditions of use.
- g. 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 CAN/CSA B149.1, Natural Gas and Propane Installation Code. 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 11 of the National Fuel Gas Code, ANSI Z223.1/NFPA and/or CAN/CSA B149.1, Natural Gas and Propane Installation Code.

## 2 Prepare boiler

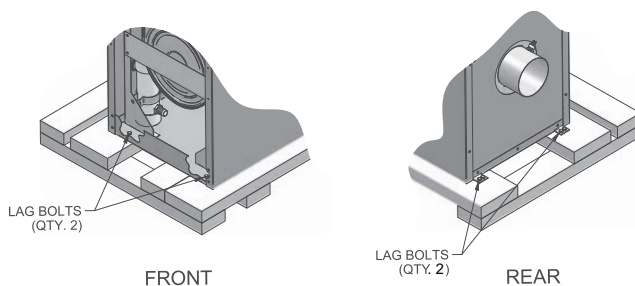
### Remove boiler from wood pallet

1. After removing the outer shipping carton from the boiler, remove the parts box.
2. Remove the front door to access the lag bolts in front of the unit (FIG. 2-1).
3. To remove the boiler from the pallet (after removing the front door):
  - a. Remove the two lag bolts from the wood pallet inside the boiler (FIG. 2-1).
  - b. Detach the boiler from the lag bolts in the rear of the unit, see FIG. 2-1.

#### NOTICE

Do not drop the boiler or bump the jacket on the floor or pallet. Damage to the boiler can result.

**Figure 2-1 Boiler Mounted on Shipping Pallet**



### Gas conversions

#### ⚠ WARNING

For a boiler already installed, you must turn off gas supply, turn off power and allow boiler to cool before proceeding. You must also completely test the boiler after conversion to verify performance as described under Start-up, Section 10 of this manual. Failure to comply could result in severe personal injury, death, or substantial property damage.

For the 400 Model you must install a propane orifice to operate the Knight XL on propane gas. Verify when installing that the orifice size marking matches boiler size (Model 400 - 8.0 LP orifice stamping).

Models 501 - 801 do not require an orifice installation for propane operation, but they will require a valve adjustment.

### Model 400

1. Remove the top and front access covers from the unit (no tools required for removal).
2. Remove the three screws securing the venturi to the blower. **Note:** When separating the venturi from the blower, take care not to damage the O-ring inside the blower (FIG. 2-2).
3. Remove the four star-drive screws securing the gas valve to the venturi (FIG. 2-2).
4. Locate the propane orifice disk from the conversion kit bag. Verify that the stamping on the orifice disk matches the boiler size (Model 400 - 8.0 LP orifice stamping).
5. Remove the existing orifice from the O-ring in the side of the gas valve and replace it with the orifice from the kit. Position and secure the orifice in the valve as shown in FIG. 2-2.
6. Reposition the gas valve against the venturi and replace the star-drive screws (FIG. 2-2) securing the valve to the venturi.
7. Inspect the O-ring inside the blower. Handle the O-ring with care, do not damage. Reposition the venturi against the blower and replace the screws securing the venturi to the blower (FIG. 2-2).
8. After installation is complete, attach the propane conversion label (in the conversion kit bag) next to the boiler rating plate. Attach the LP caution label (in the conversion kit bag) to the left side of the unit in the lower left corner.
9. Replace the top and front access covers.

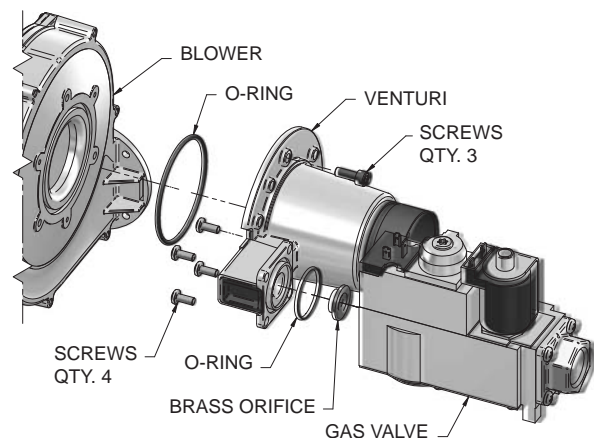
#### ⚠ WARNING

After converting to LP, check combustion per the Start-up procedure in Section 10 of this manual. Failure to check and verify combustion could result in severe personal injury, death, or substantial property damage.

#### ⚠ DANGER

Model 400: Inspect the O-ring when the blower is disassembled. The O-ring must be in good condition and must be installed. Failure to comply will cause a gas leak, resulting in severe personal injury or death.

**Figure 2-2 Installing Propane Orifice - Model 400**



## 2 Prepare boiler

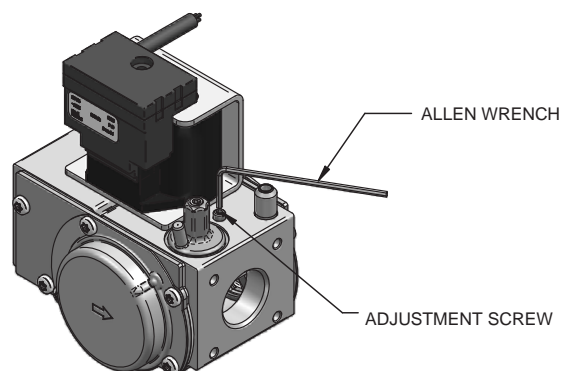
### Model 501

1. Remove the top access cover from the unit (no tools required for removal).
2. Turn the adjustment screw on the gas valve clockwise until it stops. Then turn the adjustment screw counterclockwise four and three quarter (4 3/4) turns (see FIG. 2-3).
3. Use a combustion analyzer to verify CO<sub>2</sub> is within the range of 9.6 – 10.5%. If not, adjust the screw **counterclockwise** incrementally to raise CO<sub>2</sub> and **clockwise** to lower CO<sub>2</sub> (FIG. 2-3).
4. After adjustment is complete, attach the propane conversion label (in the conversion kit bag) next to the boiler rating plate. Attach the LP caution label (in the conversion kit bag) to the left side of the unit in the lower left corner.
5. Replace the top access cover.

#### **WARNING**

After converting to LP, check combustion per the Start-up procedure in Section 10 of this manual. Failure to check and verify combustion could result in severe personal injury, death, or substantial property damage.

**Figure 2-3 Gas Valve Adjustment - Model 501**



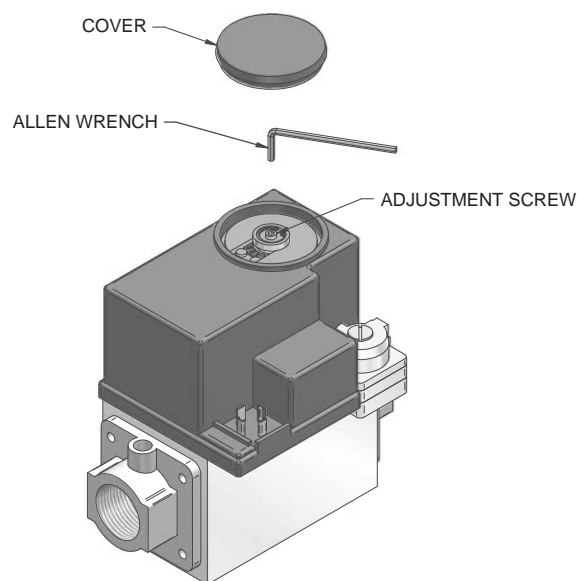
### Models 601 - 801

1. Remove the top access cover from the unit (no tools required for removal).
2. Remove the cover on top of the gas valve (FIG. 2-4).
3. Turn the adjustment screw on top of the gas valve clockwise one and three quarter (1 3/4) turns on the 601 Model, one and a half (1 1/2) turns on the 701 Model, and one turn on the 801 Model (see FIG. 2-4).
4. Use a combustion analyzer to verify CO<sub>2</sub> is within the range of 9.6 – 10.5%. If not, adjust the screw **counterclockwise** incrementally to raise CO<sub>2</sub> and **clockwise** to lower CO<sub>2</sub> (FIG. 2-4).
5. After adjustment is complete, attach the propane conversion label (in the conversion kit bag) next to the boiler rating plate. Attach the LP caution label (in the conversion kit bag) to the left side of the unit in the lower left corner.
6. Replace the gas valve cover along with the top access cover.

#### **WARNING**

After converting to LP, check combustion per the Start-up procedure in Section 10 of this manual. Failure to check and verify combustion could result in severe personal injury, death, or substantial property damage.

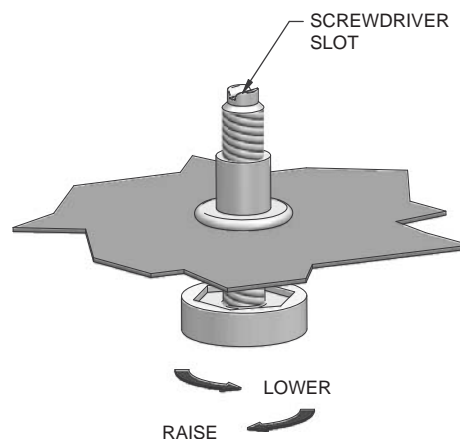
**Figure 2-4 Gas Valve Adjustment - Models 601 - 801**



### Leveling the boiler

1. Set the boiler in place and check level.
  - a) Adjust legs if necessary to level boiler, see FIG. 2-5 below.

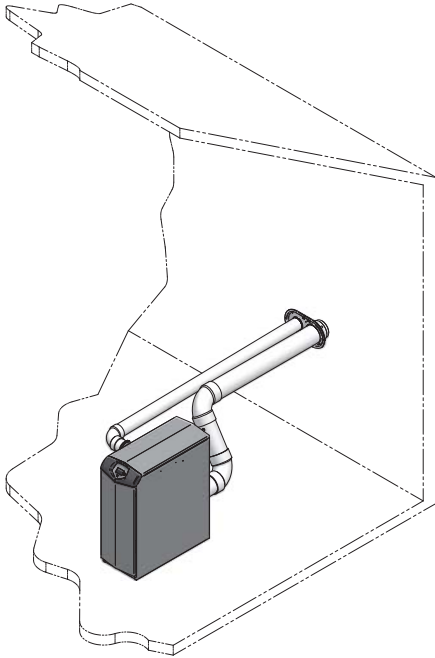
**Figure 2-5 Leveling Legs on the Boiler**



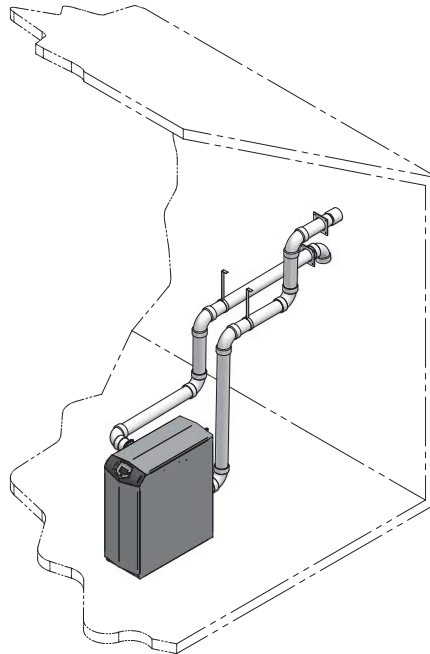


### 3 General venting

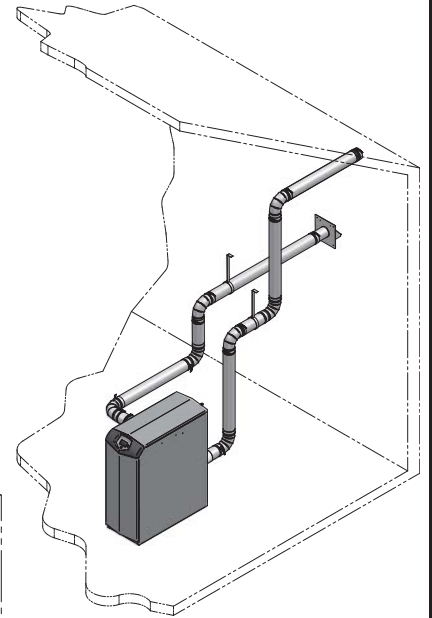
#### Direct venting options - Sidewall Vent



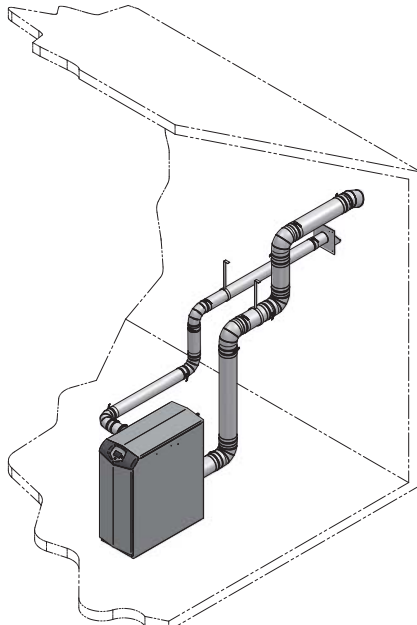
**PVC/CPVC Two Pipe**  
See Figure 4-1A



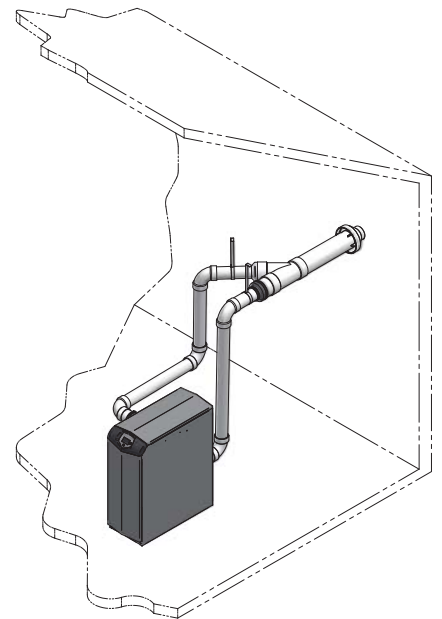
**PVC/CPVC Alternate Two Pipe**  
See Figure 4-2A



**Stainless Steel Two Pipe**  
See Figure 4-1C



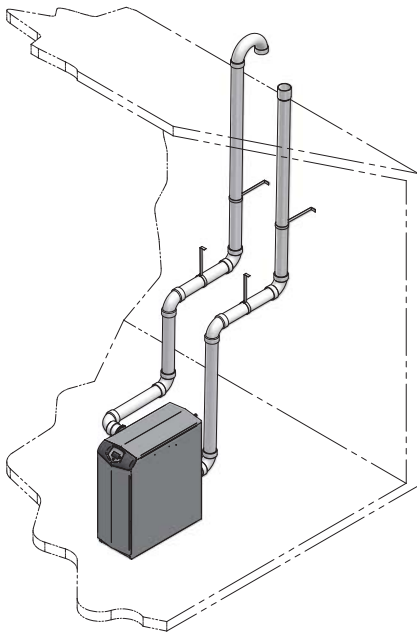
**Stainless Steel Alternate Two Pipe**  
See Figure 4-2B



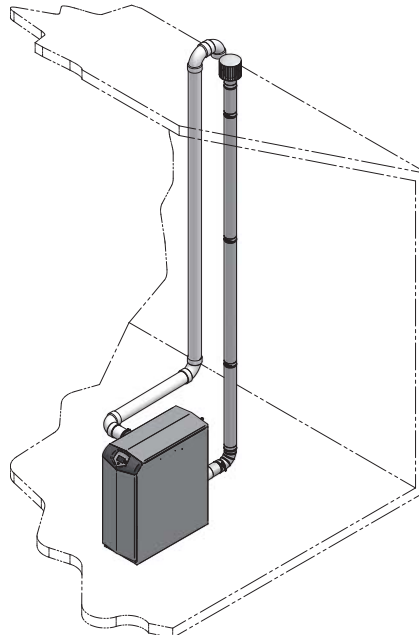
**PVC/CPVC Concentric**  
See Figure 4-7  
Models 400 - 601 Only

### 3 General venting

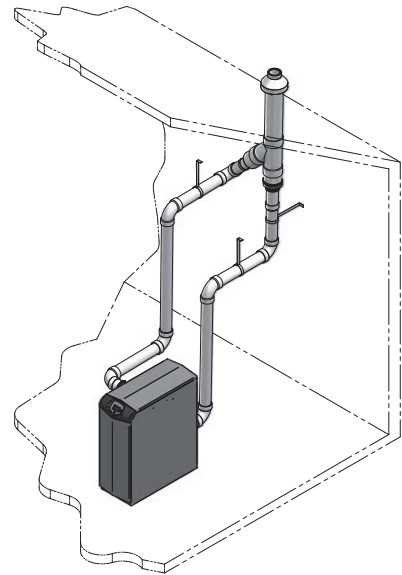
#### Direct venting options - Vertical Vent



**PVC/CPVC**  
Two Pipe  
See Figure 5-1A

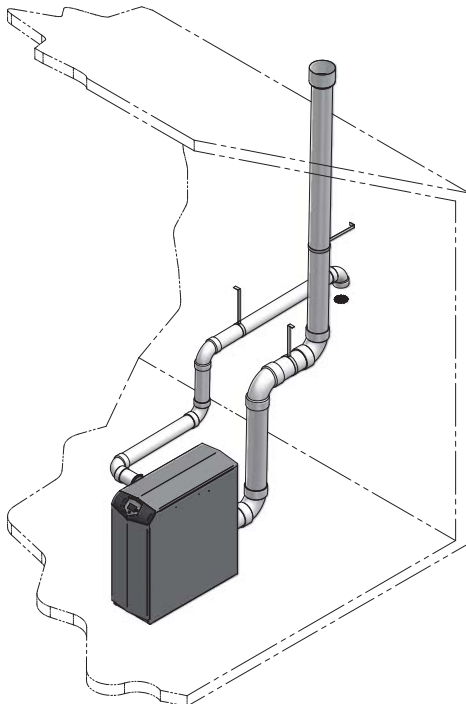


**Stainless Steel**  
Two Pipe  
See Figure 5-1B

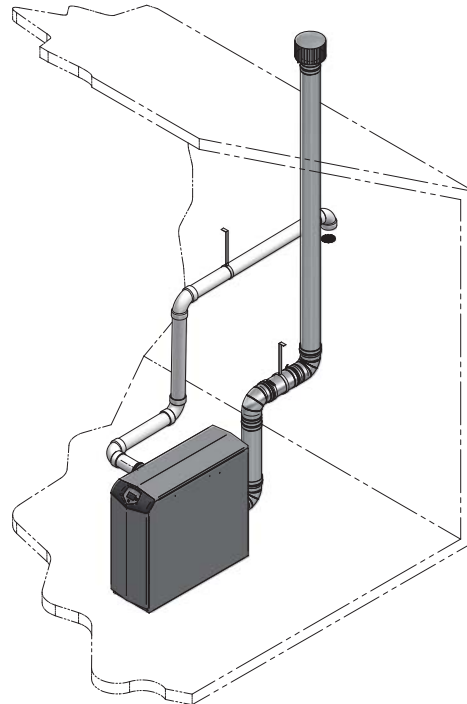


**PVC/CPVC**  
Concentric  
See Figure 5-5  
Models 400 - 601 Only

#### Direct venting options - Vertical Vent, Sidewall Air



**PVC/CPVC**  
Vertical Vent, Sidewall Air



**Stainless Steel**  
Vertical Vent, Sidewall Air

#### NOTICE

Stainless steel vent/air design and terminations will vary slightly by manufacturer.

### 3 General venting *(continued)*

#### Install vent and combustion air piping

##### **⚠ DANGER**

The Knight XL must be vented and supplied with combustion and ventilation air as described in this section. Ensure the vent and air piping and the combustion air supply comply with these instructions regarding vent system, air system, and combustion air quality. See also Section 1 of this manual.

Inspect finished vent and air piping thoroughly to ensure all are airtight and comply with the instructions provided and with all requirements of applicable codes.

Failure to provide a properly installed vent and air system will cause severe personal injury or death.

#### PVC/CPVC vent piping materials

##### **⚠ WARNING**

Use only the materials listed in Table 3A (pg. 18) for vent pipe, and fittings. Failure to comply could result in severe personal injury, death, or substantial property damage.

##### **NOTICE**

Installation must comply with local requirements and with the National Fuel Gas Code, ANSI Z223.1 for U.S. installations or CSA B149.1 for Canadian installations.

##### **⚠ WARNING**

For closet and alcove installations, CPVC or stainless steel material **MUST BE** used in a closet/alcove structure. Failure to follow this warning could result in fire, personal injury, or death.

##### **NOTICE**

All PVC vent pipes must be glued, properly supported, and the exhaust must be pitched a minimum of a 1/4 inch per foot back to the boiler (to allow drainage of condensate).

##### **⚠ WARNING**

This appliance requires a special venting system. The vent connection to the appliance must be made with the starter CPVC pipe section provided with the appliance if PVC/CPVC vent is to be used. For stainless steel venting use an adapter from Table 3B (page 20) that corresponds with the intended vent manufacturer to be used and discard the CPVC starter piece. The field provided vent fittings must be cemented to the CPVC pipe section using an "All Purpose Cement" suitable for PVC and CPVC pipe. Use only the vent materials, primer, and cement specified in this manual to make the vent connections. Failure to follow this warning could result in fire, personal injury, or death.

##### **⚠ WARNING**

Insulation should not be used on PVC or CPVC venting materials. The use of insulation will cause increased vent wall temperatures, which could result in vent pipe failure.

#### Requirements for installation in Canada

1. Installations must be made with a vent pipe system certified to ULC-S636.

IPEX is an approved vent manufacturer in Canada supplying vent material listed to ULC-S636.

2. The first three (3) feet of plastic vent pipe from the appliance flue outlet must be readily accessible for visual inspection.
3. The components of the certified vent system must not be interchanged with other vent systems or unlisted pipe/fittings. For concentric vent installations, the inner vent tube must be replaced with field supplied certified vent material to comply with this requirement.

##### **⚠ CAUTION**

Improper installation of PVC or CPVC systems may result in injury or death.

#### Installing vent or air piping

##### **NOTICE**

Use only cleaners, primers, and solvents that are approved for the materials which are joined together.

1. Work from the boiler to vent or air termination. Do not exceed the lengths given in this manual for the air or vent piping.
2. Cut pipe to the required lengths and deburr the inside and outside of the pipe ends.
3. Chamfer outside of each pipe end to ensure even cement distribution when joining.
4. Clean all pipe ends and fittings using a clean dry rag. (Moisture will retard curing and dirt or grease will prevent adhesion.)
5. Dry fit vent or air piping to ensure proper fit up before assembling any joint. The pipe should go a third to two-thirds into the fitting to ensure proper sealing after cement is applied.

### 3 General venting

6. Priming and Cementing:
  - a. Handle fittings and pipes carefully to prevent contamination of surfaces.
  - b. Apply a liberal even coat of primer to the fitting socket.
  - c. Apply a liberal even coat of primer to the pipe end to approximately 1/2" beyond the socket depth.
  - d. Apply a second primer coat to the fitting socket.
  - e. While primer is still wet, apply an even coat of approved cement to the pipe equal to the depth of the fitting socket.
  - f. While primer is still wet, apply an even coat of approved cement to the fitting socket.
  - g. Apply a second coat of cement to the pipe.
  - h. While the cement is still wet, insert the pipe into the fitting, if possible twist the pipe a 1/4 turn as you insert it. **NOTE:** If voids are present, sufficient cement was not applied and joint could be defective.
  - j. Wipe excess cement from the joint removing ring or beads as it will needlessly soften the pipe.

**Table 3A** Vent Pipe, and Fittings

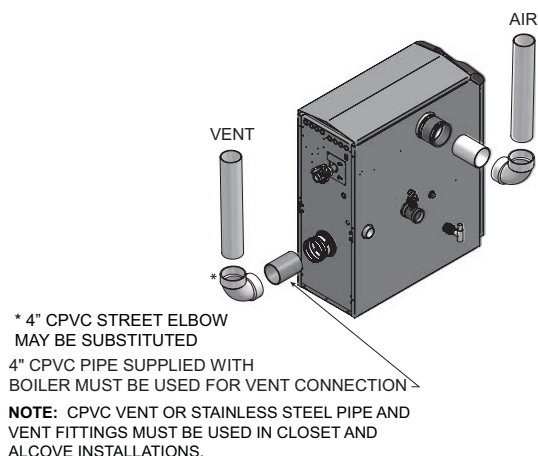
All vent pipe materials and fittings must comply with the following:			
Item	Material	Standards for installation in:	
		United States	Canada
Vent pipe and fittings	PVC Plastic Pipe, Schedules 40, 80, & 120	ANSI/ASTM D1785	CPVC and PVC venting must be ULC-S636 Certified. IPEX is an approved manufacturer in Canada supplying vent material listed to ULC-S636.
	PVC Plastic Pipe Fittings, Schedule 40	ANSI/ASTM D2466	
	PVC Plastic Pipe Fittings, Schedule 80	ANSI/ASTM D2467	
	PVC - DWV Pipe and Fittings	ANSI/ASTM D2665	
	CPVC Plastic Pipe, Schedule 40 & 80	ANSI/ASTM F441	
	CPVC Plastic Pipe Fittings, Schedule 80	ANSI/ASTM F439	
	AL29-4C	UL1738	ULC-S636
<b>NOTICE: DO NOT USE CELLULAR (FOAM) CORE PIPE</b>			
<b>Approved Stainless Steel Vent Manufacturers</b>			
Make		Model	
ProTech Systems (Simpson Dura-Vent Co.)		FasNSeal Vent / FasNSeal Flex* Vent	
Z-Flex (Nova Flex Group)		Z-Vent	
Heat Fab (Selkirk Corporation)		Saf-T Vent	

\*Use of FasNSeal Flex smooth inner wall vent is to be used in vertical or near vertical sections only, taking precaution to ensure no sagging occurs of the vent system. Connect to the FasNSeal rigid vent using specially designed adapters and sealing method, see manufacturer's instructions.

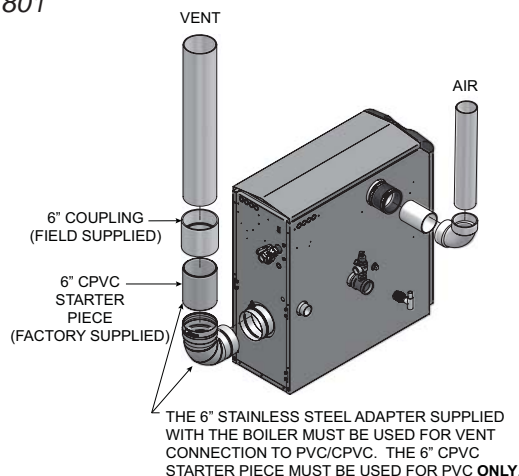
#### PVC/CPVC air intake/vent connections

1. **Combustion Air Intake Connector** (FIG.'s 3-9 and 3-10) - Used to provide combustion air directly to the unit from outdoors. A fitting is provided on the unit for final connection. Combustion air piping must be supported per guidelines listed in the National Mechanical Code, Section 305, Table 305.4 or as local codes dictate.
2. **Vent Connector** (FIG.'s 3-9 and 3-10) - Used to provide a passageway for conveying combustion gases to the outside. Transition fittings are provided with the unit for final connection. Vent piping must be supported per the National Building Code, Section 305, Table 305.4 or as local codes dictate.

**Figure 3-9** Near Boiler PVC/CPVC Venting - Models 400 - 601



**Figure 3-10** Near Boiler PVC/CPVC Venting - Models 701 - 801



### 3 General venting *(continued)*

#### Air inlet pipe materials:

The air inlet pipe(s) must be sealed. Choose acceptable combustion air inlet pipe materials from the following list:

- PVC, CPVC or ABS
- Dryer Vent or Sealed Flexible Duct (not recommended for rooftop air inlet)
- Galvanized steel vent pipe with joints and seams sealed as specified in this section.
- Type “B” double-wall vent with joints and seams sealed as specified in this section.
- AL29-4C, stainless steel material to be sealed to specification of its manufacturer.

\*Plastic pipe may require an adapter (not provided) to transition between the air inlet connection on the appliance and the plastic air inlet pipe.

#### **⚠ WARNING**

Using vent or air intake materials other than those specified, failure to properly seal all seams and joints or failure to follow vent pipe manufacturer’s instructions can result in personal injury, death or property damage. Mixing of venting materials will void the warranty and certification of the appliance.

#### **NOTICE**

The use of double-wall vent or insulated material for the combustion air inlet pipe is recommended in cold climates to prevent the condensation of airborne moisture in the incoming combustion air.

Sealing of Type “B” double-wall vent material or galvanized vent pipe material used for air inlet piping on a sidewall or vertical rooftop Combustion Air Supply System:

- a. Seal all joints and seams of the air inlet pipe using either Aluminum Foil Duct Tape meeting UL Standard 723 or 181A-P or a high quality UL Listed silicone sealant such as those manufactured by Dow Corning or General Electric.
- b. Do not install seams of vent pipe on the bottom of horizontal runs.
- c. Secure all joints with a minimum of three sheet metal screws or pop rivets. Apply Aluminum Foil Duct Tape or silicone sealant to all screws or rivets installed in the vent pipe.
- d. Ensure that the air inlet pipes are properly supported.

The PVC, CPVC, or ABS air inlet pipe should be cleaned and sealed with the pipe manufacturer’s recommended solvents and standard commercial pipe cement for the material used. The PVC, CPVC, ABS, Dryer Vent or Flex Duct air inlet pipe should use a silicone sealant to ensure a proper seal at the appliance connection and the air inlet cap connection. Dryer vent or flex duct should use a screw type clamp to seal the vent to the appliance air inlet and the air inlet cap. Proper sealing of the air inlet pipe ensures that combustion air will be free of contaminants and supplied in proper volume.

When a sidewall or vertical rooftop combustion air supply system is disconnected for any reason, the air inlet pipe must be resealed to ensure that combustion air will be free of contaminants and supplied in proper volume.

#### **⚠ DANGER**

Failure to properly seal all joints and seams as required in the air inlet piping may result in flue gas recirculation, spillage of flue products and carbon monoxide emissions causing severe personal injury or death.

#### Stainless steel vent

This product has been approved for use with stainless steel using the manufacturers listed in Table 3A.

#### **⚠ WARNING**

Use only the materials, vent systems, and terminations listed in Table 3B. DO NOT mix vent systems of different types or manufacturers, unless listed in this manual. Failure to comply could result in severe personal injury, death, or substantial property damage.

#### **NOTICE**

Installations must comply with applicable national, state, and local codes. Stainless steel vent systems must be listed as a UL-1738 approved system for the United States and a ULC-S636 approved system for Canada.

#### **NOTICE**

Installation of a stainless steel vent system should adhere to the stainless steel vent manufacturer’s installation instructions supplied with the vent system.

#### **NOTICE**

The installer must use a specific vent starter adapter at the flue collar connection, supplied by the vent manufacturer to adapt to its vent system. See Table 3B for approved vent adapters. Discard CPVC starter piece.



### 3 General venting

**Table 3B** Approved Stainless Steel Terminations and Adapters

Model	ProTech			Heat Fab				Z Flex		
	FasNSeal			Saf-T Vent				Z-Vent		
	Boiler Adapter	Flue Termination	Intake Air Termination	Boiler Adapter	Intermediate Adapter	Flue Termination	Intake Air Termination	Boiler Adapter	Flue Termination	Intake Air Termination
400-601	F303759	FSBS4 FSRC4(R.C)	FSAIH04 303888	KB285600	9454BUREZ-1*	9492 5400CI	9414TERM	2SVSLA04	2SVSTP04 2SVSRCX04	2SVSTEX0490
701-801	F303759 (Intake Only)	FSBS6	FSAIH04 303888							

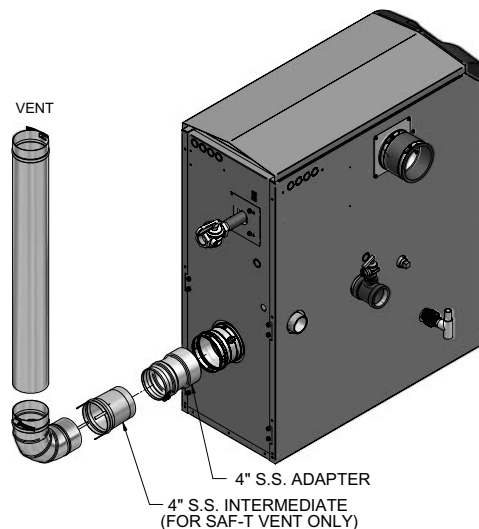
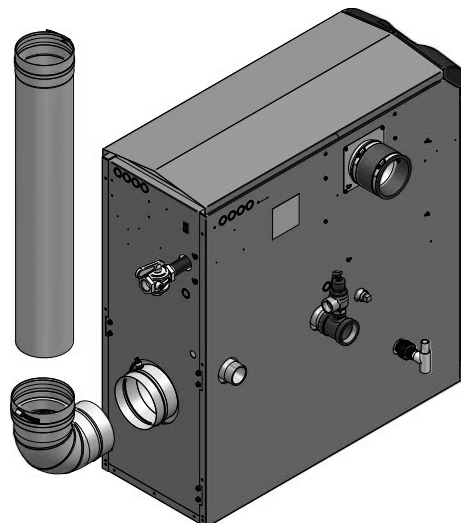
\* = This adapter must be used in addition to the boiler adapter for Saf-T vent pipe as shown in FIG. 3-11, unless approved vent other than standard diameter is used. Consult a Heat Fab representative for questions.

**Table 3C** Stainless Steel Vent Termination Kit(s)

Model	Kit Number
701 - 801	KIT3137

#### Stainless steel air intake/vent connections

- Combustion Air Intake Connector** (FIG.'s 3-11 and 3-12) - Used to provide combustion air directly to the unit from outdoors. A fitting is provided on the unit for final connection. Combustion air piping must be supported per guidelines listed in the National Mechanical Code, Section 305, Table 305.4 or as local codes dictate.
- Vent Connector** (FIG.'s 3-11 and 3-12) - Used to provide a passageway for conveying combustion gases to the outside. A transition fitting is provided on the unit for final connection. Vent piping must be supported per the National Building Code, Section 305, Table 305.4 or as local codes dictate.

**Figure 3-11** Near Boiler Stainless Steel Venting Models 400 - 601

**Figure 3-12** Near Boiler Stainless Steel Venting Models 701 - 801


### 3 General venting *(continued)*

The Knight XL uses model specific combustion air intake and vent piping sizes as detailed in Table 3D below.

**Table 3D Air Intake/Vent Piping Sizes**

Model	Air Intake	Vent
400 - 601	4 inches (102 mm)	4 inches (102 mm)
701 - 801	4 inches (102 mm)	6 inches (152 mm)

#### NOTICE

Increasing or decreasing combustion air or vent piping is not authorized.

Minimum / Maximum allowable combustion air and vent piping lengths are as follows:

**Combustion Air** = 12 equivalent feet (3.7 m) minimum / 100 equivalent feet (30.5 m) maximum

**Vent** = 12 equivalent feet (3.7 m) minimum / 100 equivalent feet (30.5 m) maximum

When determining equivalent combustion air and vent length, add 5 feet (1.5m) for each 90° elbow and 3 feet (.9 m) for each 45° elbow.

**EXAMPLE:** 20 feet (6 m) of PVC pipe + (3) 90° elbows + (3) 45° elbows + (1) concentric vent kit (CVK3007) = 49 equivalent feet (15 m) of piping.

#### NOTICE

The appliance output rating will reduce by up to 1.5% for each 25 feet (68 m) of vent length.

**Table 3E Concentric Vent Kit Equivalent Vent Lengths**

Model	Kit Number	Equivalent Vent Length
400	CVK3007	5 Feet (1.5 m)
501	CVK3007	30 Feet (9 m)
601	CVK3007	30 Feet (9 m)

#### Removing from existing vent

Follow the instructions in Section 1, page 12 of this manual when removing a boiler from an existing vent system.

#### Vent and air piping

##### Vent and air system:

#### NOTICE

Installation must comply with local requirements and with the National Fuel Gas Code, ANSI Z223.1 for U.S. installations or CSA B149.1 for Canadian installations.

You must also install air piping from outside to the boiler air intake adapter. The resultant installation is direct vent (sealed combustion).

You may use any of the vent/air piping methods covered in this manual. Do not attempt to install the Knight XL using any other means.

#### WARNING

DO NOT mix components from different systems. The vent system could fail, causing leakage of flue products into the living space. Use only approved stainless steel, PVC or CPVC pipe and fittings. For PVC/CPVC use with primer and cement specifically designed for the material used.

##### Vent, air piping and termination:

The Knight XL vent and air piping can be installed through the roof or through a sidewall. Follow the procedures in this manual for the method chosen. Refer to the information in this manual to determine acceptable vent and air piping length.

#### Optional room air

#### NOTICE

Optional room air is intended for commercial applications. Combustion air piping to the outside is recommended for residential applications.

Commercial applications utilizing the Knight XL boiler may be installed with a single pipe carrying the flue products to the outside while using combustion air from the equipment room. In order to use the room air venting option the following conditions and considerations must be followed.

- The unit **MUST** be installed with the appropriate room air kit (Table 3F).
- The equipment room **MUST** be provided with properly sized openings to assure adequate combustion air. Please refer to instructions provided with the room air kit.
- There will be a noticeable increase in the noise level during normal operation from the inlet air opening.
- Using the room air kit makes the unit vulnerable to combustion air contamination from within the building. Please review Section 1, Prevent Combustion Air Contamination, to ensure proper installation.
- Vent system and terminations must comply with the standard venting instructions set forth in this manual.

### 3 General venting

**⚠ WARNING** When utilizing the single pipe method, provisions for combustion and ventilation air must be in accordance with Air for Combustion and Ventilation, of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of the local building codes.

**⚠ WARNING** If the boiler combustion air inlet is located in a laundry room or pool facility, for example, these areas will always contain hazardous contaminants.

**⚠ WARNING** To prevent the potential of severe personal injury or death, check for areas and products listed in Table 1A, page 11 before installing the boiler or air inlet piping.

If contaminants are found, you MUST:

- Remove products permanently.  
—OR—
- Relocate air inlet and vent terminations to other areas.

**Table 3F** *Optional Room Air Kit*

Model	Description	Kit Number
400 - 801	Filter Box Assembly	KIT30022
	90° Elbow with Screen	KIT30053

#### Air contamination

Pool and laundry products and common household and hobby products often contain fluorine or chlorine compounds. When these chemicals pass through the boiler, they can form strong acids. The acid can eat through the boiler wall, causing serious damage and presenting a possible threat of flue gas spillage or boiler water leakage into the building.

Please read the information given in Table 1A, page 11, listing contaminants and areas likely to contain them. If contaminating chemicals will be present near the location of the boiler combustion air inlet, have your installer pipe the boiler combustion air and vent to another location, per this manual.

## 4 Sidewall direct venting

### Vent/air termination – sidewall

**⚠ WARNING** Follow instructions below when determining vent location to avoid possibility of severe personal injury, death, or substantial property damage.

**⚠ WARNING** A gas vent extending through an exterior wall shall not terminate adjacent to a wall or below building extensions such as eaves, parapets, balconies, or decks. Failure to comply could result in severe personal injury, death, or substantial property damage.

**⚠ WARNING** Do not connect any other appliance to the vent pipe or multiple boilers to a common vent pipe. Failure to comply could result in severe personal injury, death, or substantial property damage.

**NOTICE** Installation must comply with local requirements and with the National Fuel Gas Code, ANSI Z223.1 for U.S. installations or CSA B149.1 for Canadian installations.

#### Determine location

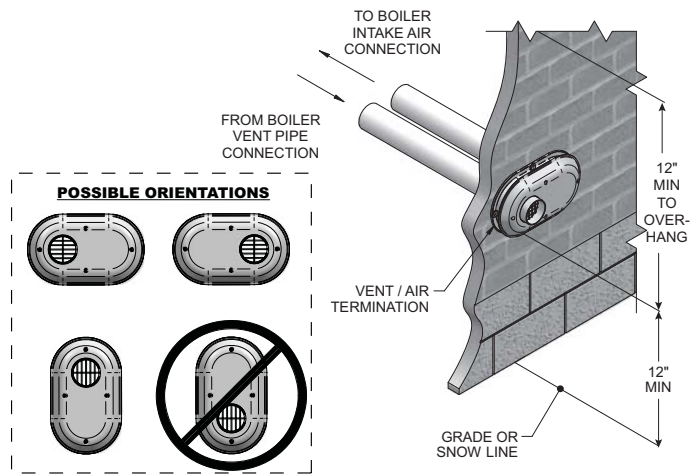
Locate the vent/air terminations using the following guidelines:

1. The total length of piping for vent or air must not exceed the limits given in the General Venting Section on page 21 of this manual.
2. You must consider the surroundings when terminating the vent and air:
  - a. Position the vent termination where vapors will not damage nearby shrubs, plants or air conditioning equipment or be objectionable.
  - b. The flue products will form a noticeable plume as they condense in cold air. Avoid areas where the plume could obstruct window views.
  - c. Prevailing winds could cause freezing of condensate and water/ice buildup where flue products impinge on building surfaces or plants.
  - d. Avoid possibility of accidental contact of flue products with people or pets.
  - e. Do not locate the terminations where wind eddies could affect performance or cause recirculation, such as inside building corners, near adjacent buildings or surfaces, window wells, stairwells, alcoves, courtyards, or other recessed areas.

**⚠ WARNING** Sidewall vent and air inlet terminations must terminate in the same pressure zone.

- f. Do not terminate above any door or window. Condensate can freeze, causing ice formations.
- g. Locate or guard vent to prevent condensate damage to exterior finishes.

**Figure 4-1A PVC/CPVC Sidewall Termination of Air and Vent**



**Table 4A Sidewall Vent Kits**

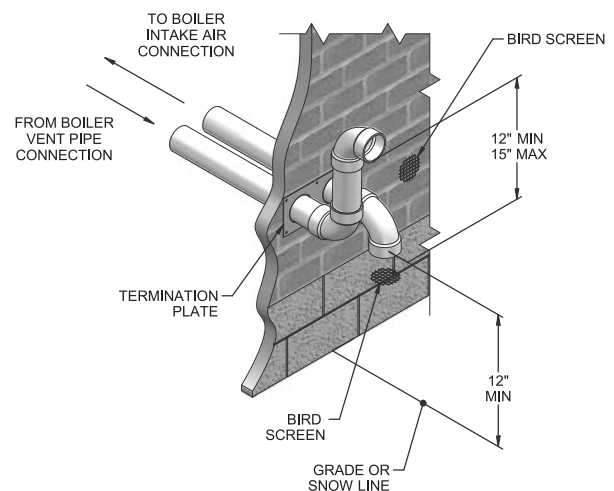
Model	Kit Number	Vent Size
400 - 601	KIT30046	4 inch vent
701 - 801	KIT30048	6 inch vent

#### If using the alternate sidewall termination:

3. The air piping must terminate in a down-turned elbow as shown in FIG. 4-1B. This arrangement avoids recirculation of flue products into the combustion air stream.
4. The vent piping must terminate in an elbow pointed outward or away from the air inlet, as shown in FIG. 4-1B.

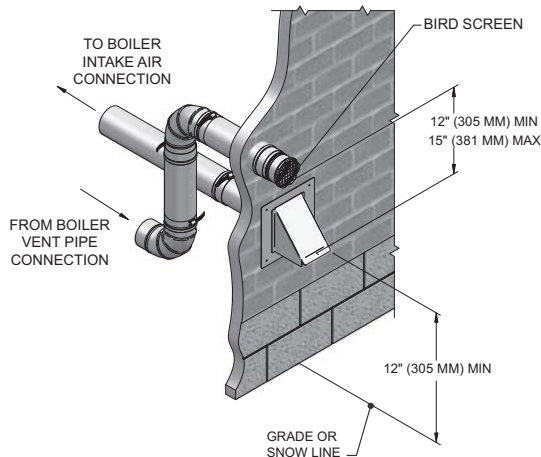
**⚠ WARNING** Do not exceed the maximum lengths of the outside vent piping shown in FIG. 4-1B. Excessive length exposed to the outside could cause freezing of condensate in the vent pipe, resulting in potential boiler shutdown.

**Figure 4-1B Alternate PVC/CPVC Sidewall Termination of Air and Vent w/Field Supplied Fittings**

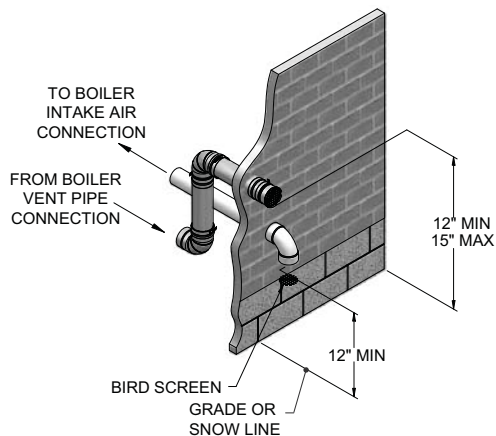


## 4 Sidewall direct venting Vent/air termination – sidewall

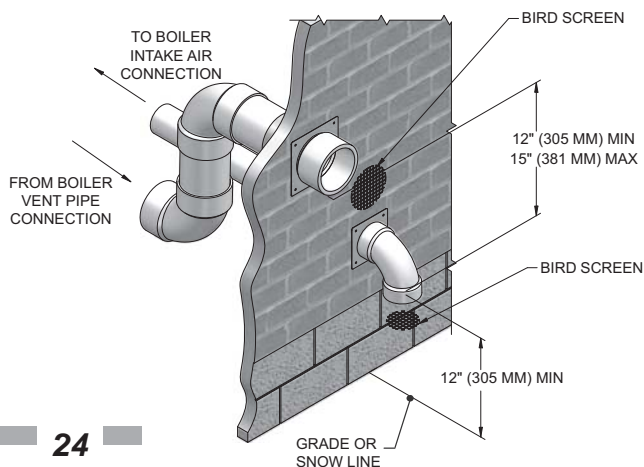
**Figure 4-1C Alternate Stainless Steel Vent Termination** - Typical Stainless Steel Sidewall Termination of Air and Vent Models 400 - 601 w/Field Supplied Fittings, Utilizing FasNSeal's Hood Intake. Available Through FasNSeal Only



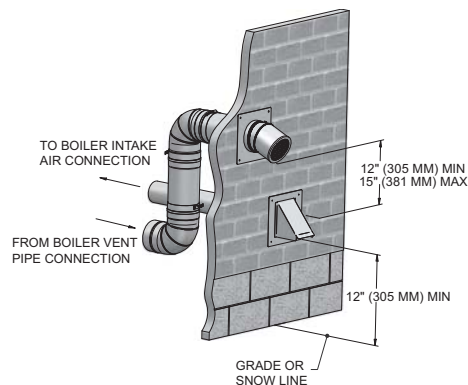
**Figure 4-1D Alternate PVC/CPVC/SS Vent Termination** - Typical Stainless Steel Sidewall Termination of Air and Vent Models 400 - 601 w/Field Supplied Fittings, Utilizing 90° Elbow Intake



**Figure 4-2A Alternate PVC/CPVC Sidewall Termination** Models 400 - 801 w/Field Supplied Fittings



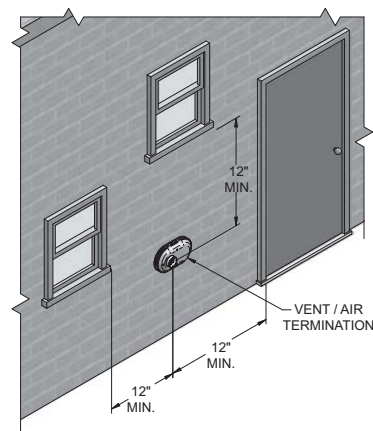
**Figure 4-2B Alternate Stainless Steel Sidewall Termination** Models 701 - 801 w/Field Supplied Fittings



**NOTICE** PVC/CPVC or ABS is acceptable air inlet pipe material.

5. Maintain clearances as shown in FIG.'s 4-1A thru 4-4B, pages 23 thru 25. Also maintain the following:
  - a. Vent must terminate:
    - At least 6 feet (1.8 m) from adjacent walls.
    - No closer than 12 inches (305 mm) below roof overhang.
    - At least 7 feet (2.1 m) above any public walkway.
    - At least 3 feet (.9 m) above any forced air intake within 10 feet (3 m).
    - No closer than 12 inches (305 mm) below or horizontally from any door or window or any other gravity air inlet.
  - b. Air inlet must terminate at least 12 inches (305 mm) above grade or snow line; at least 12 inches (305 mm) below the vent termination (FIG. 4-1B); and the vent pipe must not extend more than 24 inches (610 mm) vertically outside the building.
  - c. Do not terminate closer than 4 feet (1.2 m) horizontally from any electric meter, gas meter, regulator, relief valve, or other equipment. Never terminate above or below any of these within 4 feet (1.2 m) horizontally.
6. Locate terminations so they are not likely to be damaged by foreign objects, such as stones or balls, or subject to buildup of leaves or sediment.

**Figure 4-3A Clearance to Gravity Air Inlets**

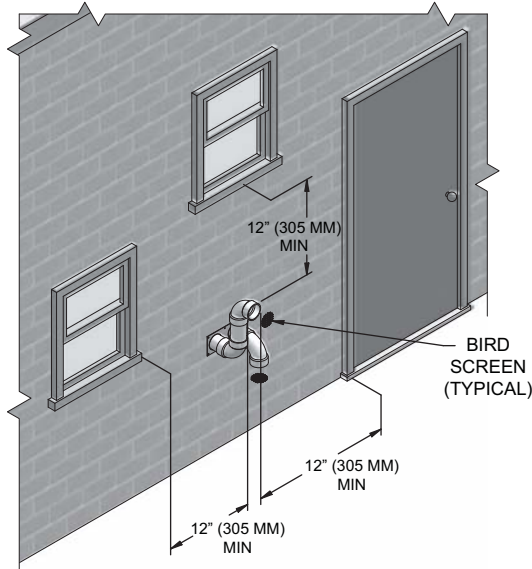




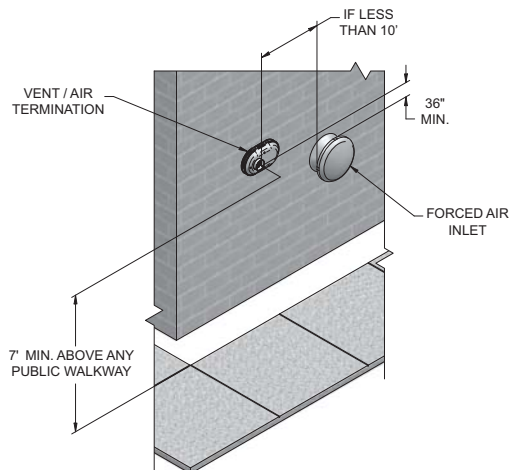
## 4 Sidewall direct venting *(continued)*

### Vent/air termination – sidewall

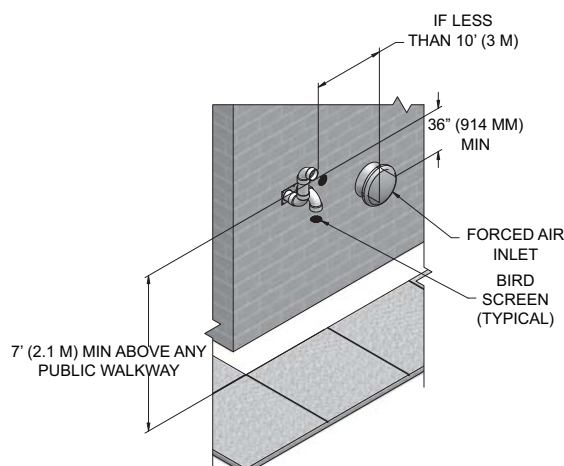
**Figure 4-3B** Alternate Clearance to Gravity Air Inlets w/Field Supplied Fittings



**Figure 4-4A** Clearance to Forced Air Inlets



**Figure 4-4B** Alternate Clearance to Forced Air Inlets w/Field Supplied Fittings



### Prepare wall penetrations

1. Use the factory supplied wall plate as a template to locate the vent and air intake holes and mounting holes.

#### Air pipe penetration:

- a. Cut a hole for the air pipe. Size the air pipe hole as close as desired to the air pipe outside diameter.

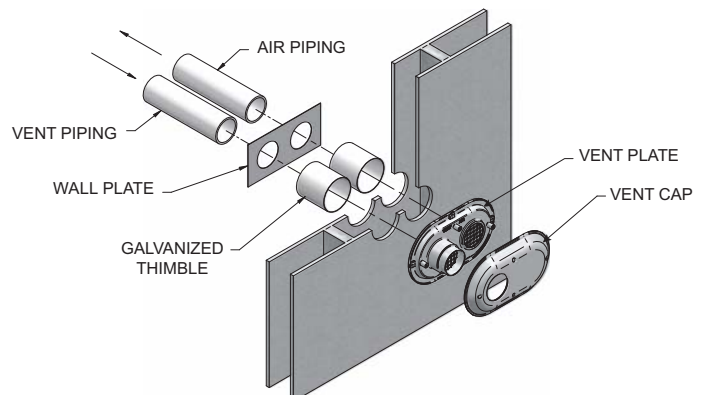
#### Vent pipe penetration:

- a. Cut a hole for the vent pipe. For either combustible or noncombustible construction, size the vent pipe hole with at least a 1/2 inch clearance around the vent pipe outer diameter:
  - 5½ inch hole (140 mm) hole for 4 inch (102 mm) vent pipe
  - 7½ inch hole (191 mm) hole for 6 inch (152 mm) vent pipe

Drill 3/16" diameter holes for inserting the plastic anchors into the wall.

2. Install the vent and air intake piping through the wall into the vent plate openings. Seal all gaps between the pipes and wall. Use RTV silicone sealant to seal the air pipe. Use the cement/primer listed in Table 3A on page 18 to seal the vent pipe.
3. Mount and secure the vent plate to the wall using stainless steel screws. Seal around the plate to the wall assuring no air gaps.
4. Assemble the vent cap to the vent plate (see FIG. 4-4A). Insert the stainless steel screws into the vent cap screw hole openings and securely attach the vent cap to the vent plate.
5. Seal all wall cavities.

**Figure 4-5A** Sidewall Termination Assembly

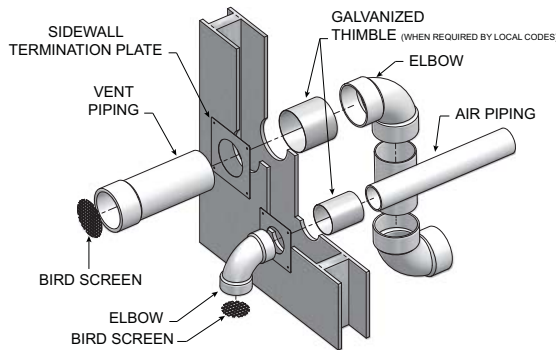


## 4 Sidewall direct venting

### Prepare wall penetrations (Alternate - Field Supplied Option)

- Air pipe penetration:
  - Cut a hole for the air pipe. Size the air pipe hole as close as desired to the air pipe outside diameter.
- Vent pipe penetration:
  - Cut a hole for the vent pipe. For either combustible or noncombustible construction, size the vent pipe hole with at least a 1/2 inch clearance around the vent pipe outer diameter:
    - 5½ inch hole (140 mm) hole for 4 inch (102 mm) vent pipe
    - 7½ inch hole (191 mm) hole for 6 inch (152 mm) vent pipe
  - Insert a galvanized metal thimble in the vent pipe hole as shown in FIG. 4-5B.
- Use a sidewall termination plate as a template for correct location of hole centers.
- Follow all local codes for isolation of vent pipe when passing through floors or walls.
- Seal exterior openings thoroughly with exterior caulk.

**Figure 4-5B** A Typical Sidewall Termination Assembly - Models 400 - 801 PVC/CPVC or Stainless Steel



### Termination and fittings

- Prepare the vent termination elbow and the air termination elbow (FIG. 4-5B) by inserting bird screens. Bird screens can be obtained locally.
- When completed, the air termination coupling must be oriented at least 12 inches (305 mm) below the vent termination and at least 12 inches (305 mm) above grade or snow line as shown in FIG. 4-1A, page 23.
- Maintain the required dimensions of the finished termination piping as shown in FIG. 4-1A, page 23.
- Do not extend exposed vent pipe outside of building more than shown in this document. Condensate could freeze and block vent pipe.
- PVC/CPVC terminations are designed to accommodate any wall thickness of standard constructions per the directions found in this manual.

- Stainless steel terminations are designed to penetrate walls with a thickness up to 9.25 inches of standard construction.

### Multiple vent/air terminations

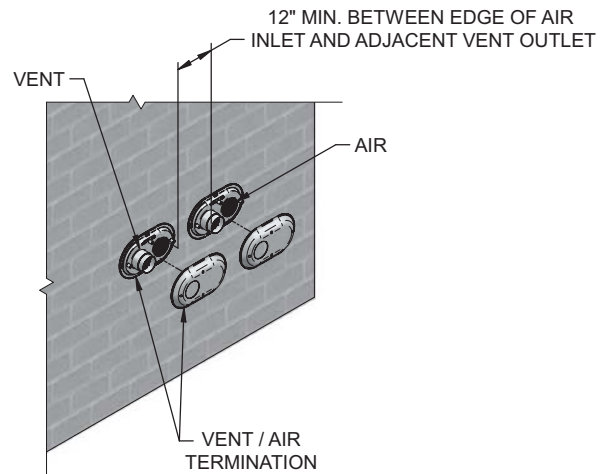
- When terminating multiple Knight XL's terminate each vent/air connection as described in this manual (FIG. 4-6A).

#### ⚠ WARNING

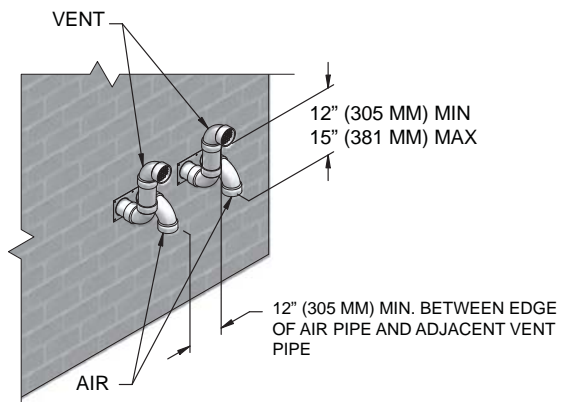
All vent pipes and air inlets must terminate at the same height to avoid possibility of severe personal injury, death, or substantial property damage.

- Place wall penetrations to obtain minimum clearance of 12 inches (305 mm) between vent pipe and adjacent air inlet elbow, as shown in FIG. 4-6A for U.S. installations. For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
- The air inlet of a Knight XL is part of a direct vent connection. It is not classified as a forced air intake with regard to spacing from adjacent boiler vents.

**Figure 4-6A** Multiple Vent Terminations (must also comply with **Figure 4-1A**)



**Figure 4-6B** Alternate Multiple Vent Terminations w/Field Supplied Fittings (must also comply with **Figure 4-1B**)



## 4 Sidewall direct venting *(continued)*

### Sidewall termination – optional concentric vent: Models 400 - 601 Only

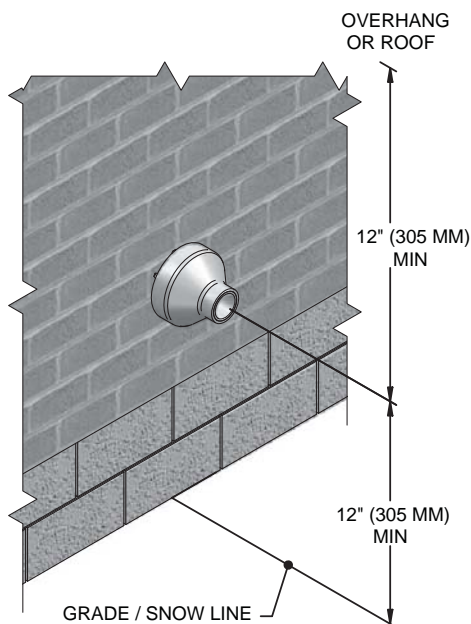
#### Description and usage

Lochinvar offers an optional concentric combustion air and vent pipe termination kit (#CVK3007 for 4" (102 mm) diameter - Models 400 - 601). Both combustion air and vent pipes must attach to the termination kit. The termination kit must terminate outside the structure and must be installed as shown below in FIG. 4-7.

Field supplied pipe and fittings are required to complete the installation.

The required combustion vent pipe materials are listed in Table 3A, on page 18 of this manual.

**Figure 4-7 Concentric Sidewall Termination - Models 400 - 601**

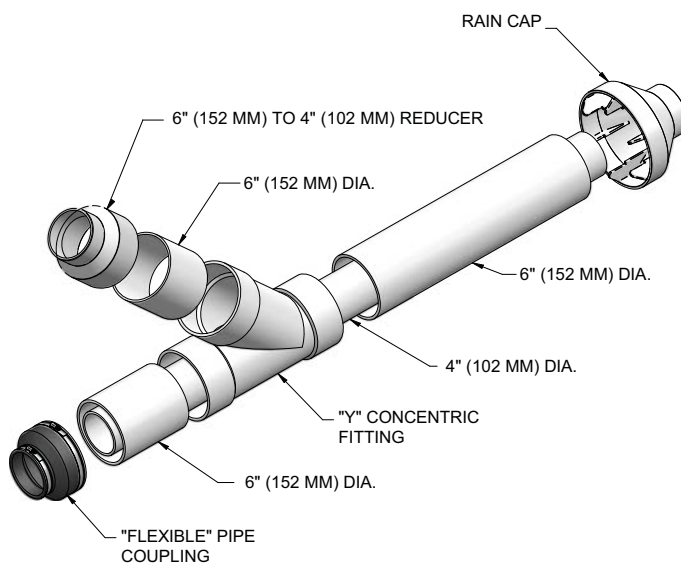


#### Sidewall termination installation

1. Determine the best location for the termination kit (see FIG. 4-7).
2. The total length of piping for vent or air must not exceed the limits given in the General Venting section on page 21 of this manual.

3. You must consider the surroundings when terminating the vent and air:
  - a. Position the vent termination where vapors will not damage nearby shrubs, plants or air conditioning equipment or be objectionable.
  - b. The flue products will form a noticeable plume as they condense in cold air. Avoid areas where the plume could obstruct window views.
  - c. Prevailing winds could cause freezing of condensate and water/ice buildup where flue products impinge on building surfaces or plants.
  - d. Avoid possibility of accidental contact of flue products with people or pets.
  - f. Do not terminate above any door or window. Condensate can freeze, causing ice formations.
  - g. Locate or guard vent to prevent condensate damage to exterior finishes.

**Figure 4-8 Kit Contents\_CVK3007 - Models 400 - 601**

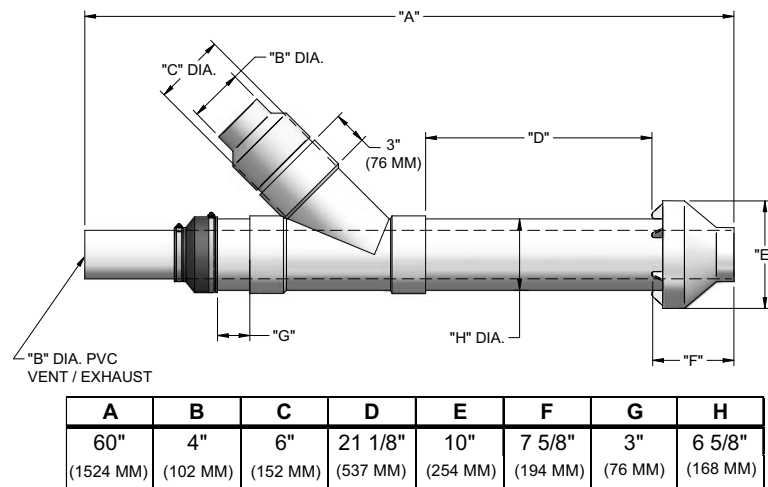


4. Cut one (1) hole (7 inch (178 mm) diameter for #CVK3007 installations into the structure to install the termination kit.
5. Partially assemble the concentric vent termination kit. Clean and cement using the procedures found in these instructions.
  - a. Cement the Y concentric fitting to the larger kit pipe (FIG. 4-8).
  - b. Cement the rain cap to the smaller diameter kit pipe (FIG. 4-8).

## 4 Sidewall direct venting

### Sidewall termination – optional concentric vent: Models 400 - 601 Only

**Figure 4-9 Concentric Vent Dimensional Drawing - Models 400 - 601**



#### NOTICE

Instead of cementing the smaller pipe to the rain cap, a field-supplied stainless steel screw may be used to secure the two (2) components together when field disassembly is desired for cleaning (see FIG. 4-10).

#### ⚠ WARNING

When using the alternate screw assembly method, drill a clearance hole in the rain cap and a pilot hole in the vent pipe for the screw size being used. Failure to drill adequate holes may cause cracking of PVC components, allowing combustion products to be recirculated. Failure to follow this warning could result in personal injury or death.

#### ⚠ WARNING

Do not operate the appliance with the rain cap removed or recirculation of combustion products may occur. Water may also collect inside the larger combustion air pipe and flow to the burner enclosure. Failure to follow this warning could result in product damage or improper operation, personal injury, or death.

- Install the Y concentric fitting and pipe assembly through the structure's hole from an inside wall.

#### NOTICE

Do not allow insulation or other materials to accumulate inside the pipe assembly when installing through the hole.

- Install the rain cap and small diameter pipe assembly into the Y concentric fitting and large pipe assembly from an outside wall. Ensure small diameter pipe is fastened tightly into the rubber adapter for #CVK3007 installations.
- Secure the assembly to the structure as shown in FIG. 4-11 using field-supplied metal strapping or equivalent support material.

#### NOTICE

Ensure termination location clearance dimensions are as shown in FIG. 4-7.

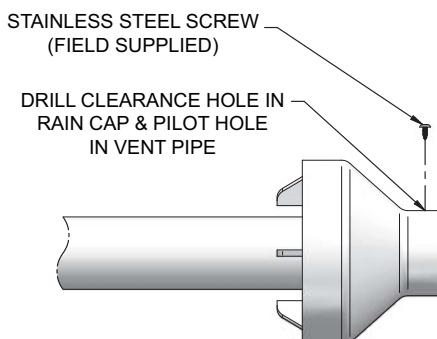
#### NOTICE

If assembly needs to be extended to allow sidewall thickness requirement, the two (2) pipes supplied in the kit may be replaced by using the same diameter, field-supplied standard schedule 40 PVC for CVK3007. Do not extend dimension D\* more than 60 inches (1524 mm) (see FIG. 4-9).

#### NOTICE

If assembly depth needs to be reduced, dimension D can be as short as possible.

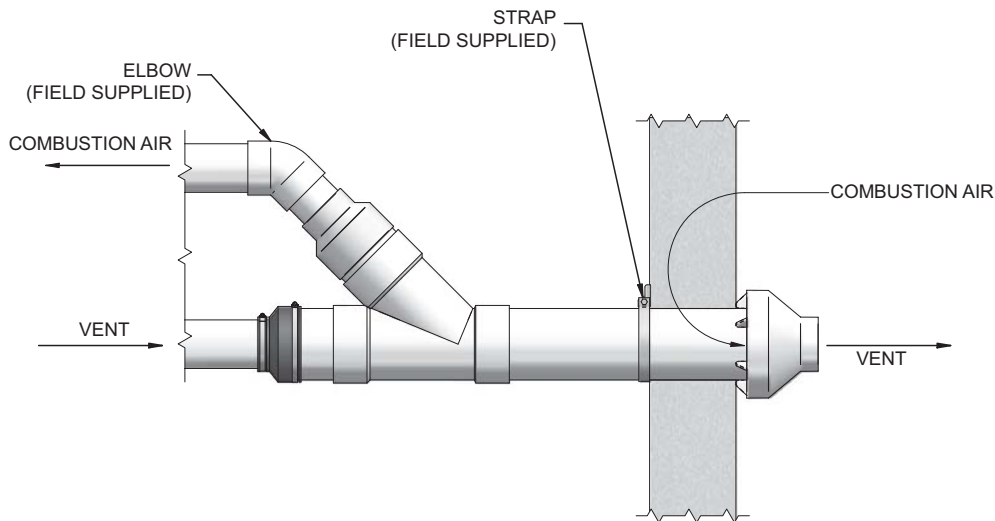
**Figure 4-10 Rain Cap to Vent Pipe Alternate Assembly**



## 4 Sidewall direct venting *(continued)*

### Sidewall termination – optional concentric vent: Models 400 - 601 Only

**Figure 4-11** Concentric Vent Sidewall Attachment



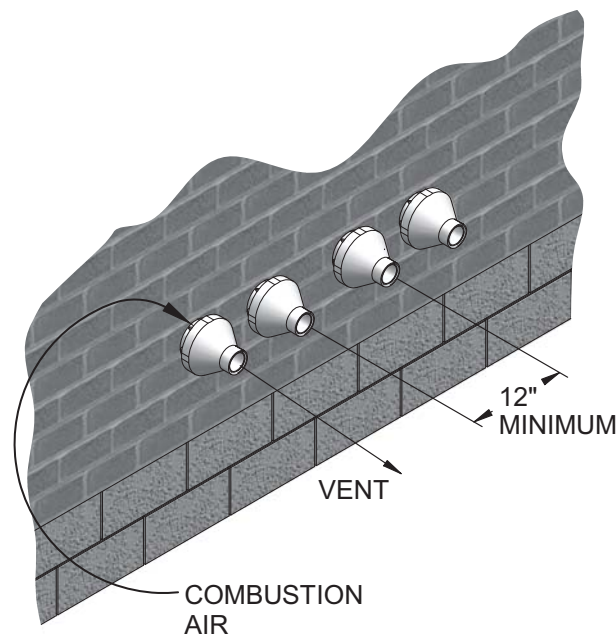
#### CAUTION

DO NOT use field-supplied couplings to extend pipes. Airflow restriction will occur and may cause intermittent operation.

9. Cement appliance combustion air and vent pipes to the concentric vent termination assembly. See FIG. 4-11 for proper pipe attachment.
10. Operate the appliance one (1) heat cycle to ensure combustion air and vent pipes are properly connected to the concentric vent termination connections.

#### Multiventing sidewall terminations

When two (2) or more direct vent appliances are vented near each other, each appliance must be individually vented (see FIG. 4-12). NEVER common vent or breach vent this appliance. When two (2) or more direct vent appliances are vented near each other, two (2) vent terminations may be installed as shown in FIG. 4-12. It is important that vent terminations be made as shown to avoid recirculation of flue gases.



**Figure 4-12** Concentric Vent and Combustion Air Termination



## 5 Vertical direct venting

### Vent/air termination – vertical

**⚠ WARNING** Follow instructions below when determining vent location to avoid possibility of severe personal injury, death or substantial property damage.

**⚠ WARNING** Do not connect any other appliance to the vent pipe or multiple boilers to a common vent pipe. Failure to comply could result in severe personal injury, death, or substantial property damage.

**NOTICE** Installation must comply with local requirements and with the National Fuel Gas Code, ANSI Z223.1 for U.S. installations or CSA B149.1 for Canadian installations.

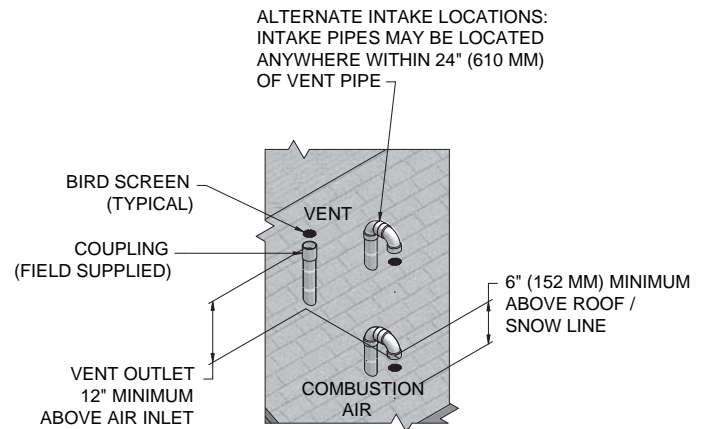
#### Determine location

Locate the vent/air terminations using the following guidelines:

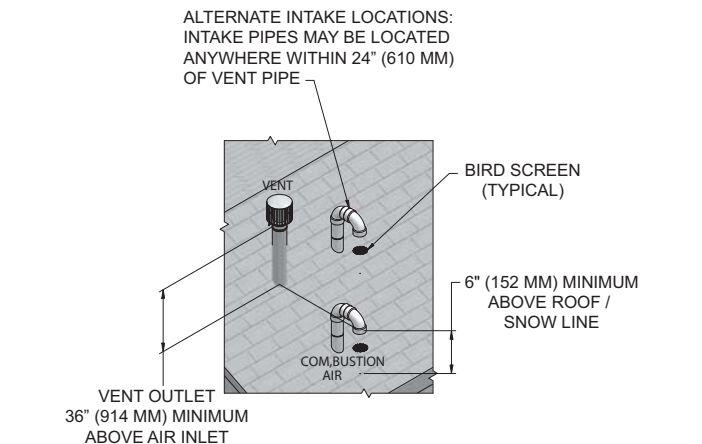
1. The total length of piping for vent or air must not exceed the limits given in the General Venting Section on page 21 of this manual.
2. The vent must terminate at least 3 feet above the highest place in which the vent penetrates the roof and at least 2 feet above any part of a building within 10 horizontal feet.
3. The air piping must terminate in a down-turned 180° return pipe no further than 2 feet (.6 m) from the center of the vent pipe. This placement avoids recirculation of flue products into the combustion air stream.
4. The vent piping must terminate in an up-turned coupling as shown in FIG. 5-1A. The top of the coupling must be at least 1 foot above the air intake. When the vent termination uses a rain cap as illustrated in FIG. 5-1B maintain at least 36" (914 mm) above the air inlet. The air inlet pipe and vent pipe can be located in any desired position on the roof, but must always be no further than 2 feet (.6 m) apart and with the vent termination at least 1 foot above the air intake.

**⚠ WARNING** Rooftop vent and air inlet terminations must terminate in the same pressure zone, unless vertical vent sidewall air is set up as shown in the General Venting - Vertical Vent, Sidewall Air Section.

**Figure 5-1A** PVC/CPVC Vertical Termination of Air and Vent



**Figure 5-1B** Stainless Steel Vertical Termination of Air and Vent



5. Locate terminations so they are not likely to be damaged by foreign objects, such as stones or balls, or subject to buildup of leaves or sediment.

## 5 Vertical direct venting *(continued)*

### Vent/air termination – vertical

#### Prepare roof penetrations

1. Air pipe penetration:
  - a. Cut a hole for the air pipe. Size the air pipe hole as close as desired to the air pipe outside diameter.
2. Vent pipe penetration:
  - a. Cut a hole for the vent pipe. For either combustible or noncombustible construction, size the vent pipe hole with at least a 1/2 inch clearance around the vent pipe outer diameter:
    - 5½ inch hole (140 mm) hole for 4 inch (102 mm) vent pipe
    - 7½ inch hole (191 mm) hole for 6 inch (152 mm) vent pipe
  - b. Insert a galvanized metal thimble in the vent pipe hole (when required by local codes).
3. Space the air and vent holes to provide the minimum spacing shown in FIG.'s 5-1A and 5-1B, page 30.
4. Follow all local codes for isolation of vent pipe when passing through floors, ceilings, and roofs.
5. Provide flashing and sealing boots sized for the vent pipe and air pipe.

#### Termination and fittings

1. Prepare the vent termination coupling and the air termination elbow (FIG.'s 5-1A and 5-1B) by inserting bird screens. Bird screens should be obtained locally.
2. The air piping must terminate in a down-turned 180° return bend as shown in FIG.'s 5-1A and 5-1B. Locate the air inlet pipe no further than 2 feet (.6 m) from the center of the vent pipe. This placement avoids recirculation of flue products into the combustion air stream.
3. The vent piping must terminate in an up-turned coupling as shown in FIG. 5-1A. The top of the coupling must be at least 1 foot (.3 m) above the air intake. When the vent termination uses a rain cap as illustrated in FIG. 5-1B maintain at least 36" (914 mm) above the air inlet. The air inlet pipe and vent pipe can be located in any desired position on the roof, but must always be no further than 2 feet (.6 m) apart and with the vent termination at least 1 foot (.3 m) above the air intake.
4. Maintain the required dimensions of the finished termination piping as shown in FIG.'s 5-1A and 5-1B.
5. Do not extend exposed vent pipe outside of building more than shown in this document. Condensate could freeze and block vent pipe.

#### Multiple vent/air terminations

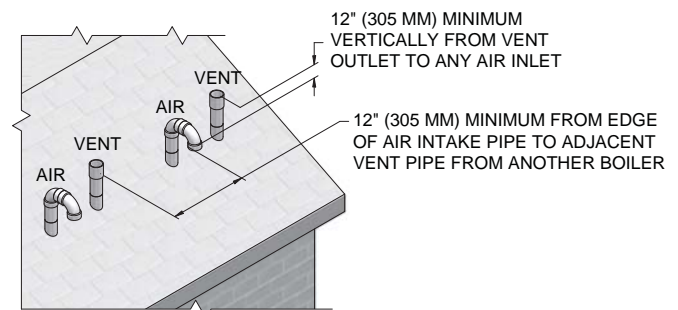
1. When terminating multiple Knight XL boilers, terminate each vent/air connection as described in this manual (FIG. 5-2).

#### **⚠ WARNING**

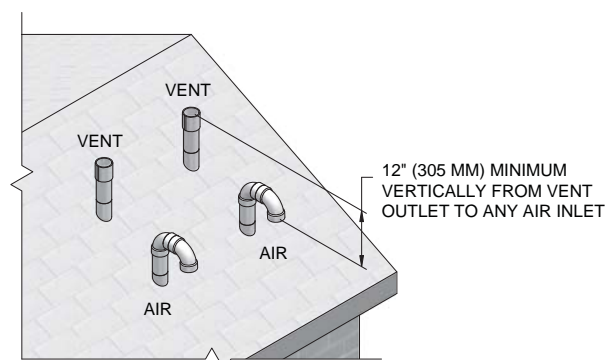
Terminate all vent pipes at the same height and all air pipes at the same height to avoid recirculation of flue products and the possibility of severe personal injury, death, or substantial property damage.

2. Place roof penetrations to obtain minimum clearance of 12 inches (305 mm) between edge of air intake elbow and adjacent vent pipe of another boiler for U.S. installations (see FIG. 5-2). For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
3. The air inlet of a Knight XL boiler is part of a direct vent connection. It is not classified as a forced air intake with regard to spacing from adjacent boiler vents.

**Figure 5-2 Vertical Terminations with Multiple Boilers**



**Figure 5-3 Alternate Vertical Terminations with Multiple Boilers**



## 5 Vertical direct venting

### Vertical termination – optional concentric vent: Models 400 - 601 Only

#### Description and usage

Lochinvar offers an optional concentric combustion air and vent pipe termination kit. Both combustion air and vent pipes must attach to the termination kit. The termination kit must terminate outside the structure and must be installed as shown in FIG. 5-4.

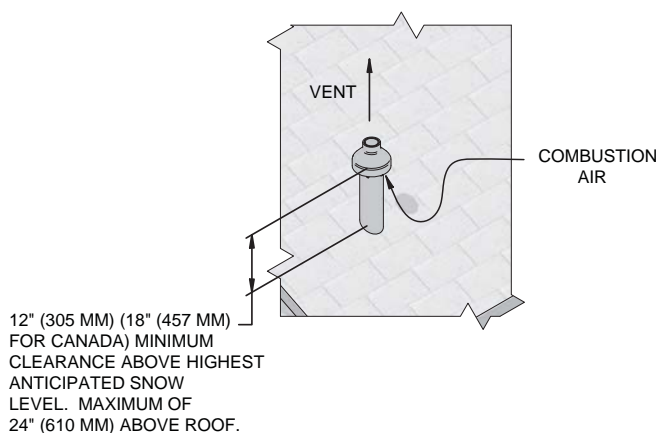
Field supplied pipe and fittings are required to complete the installation.

The required combustion vent pipe fittings are listed in Table 3A, on page 18 of this manual.

#### Vertical termination installation

1. See Section 5, Vertical Direct Venting - Determine Location (where applicable).

**Figure 5-4 Concentric Vertical Termination**



2. Cut one (1) hole (7 inch (178 mm) diameter for #CVK3007 installations) into the structure to install the termination kit.
3. Partially assemble the concentric vent termination kit. Clean and cement following the cleaning procedures in these instructions.
  - a. Cement the Y concentric fitting to the larger diameter kit pipe (see FIG. 4-8, page 27).
  - b. Cement rain cap to the smaller diameter kit pipe (see FIG. 4-8, page 27).

#### NOTICE

Instead of cementing the smaller pipe to the rain cap, a field supplied stainless steel screw may be used to secure the two (2) components together when field disassembly is desired for cleaning (see FIG. 4-10, page 28).

#### WARNING

When using the alternate screw assembly method, drill a clearance hole in the rain cap and a pilot hole in the vent pipe for the screw size being used. Failure to drill adequate holes may cause cracking of PVC components, allowing combustion products to be recirculated. Failure to follow this warning could result in personal injury or death.

**Figure 5-5 Do Not Install U-Bend to Rain Cap**



## 5 Vertical direct venting *(continued)*

### Vertical termination – optional concentric vent: Models 400 - 601 Only

#### ⚠ WARNING

Do not operate the appliance with the rain cap removed or recirculation of combustion products may occur. Water may also collect inside the larger combustion air pipe and flow to the burner enclosure. Failure to follow this warning could result in product damage or improper operation, personal injury, or death.

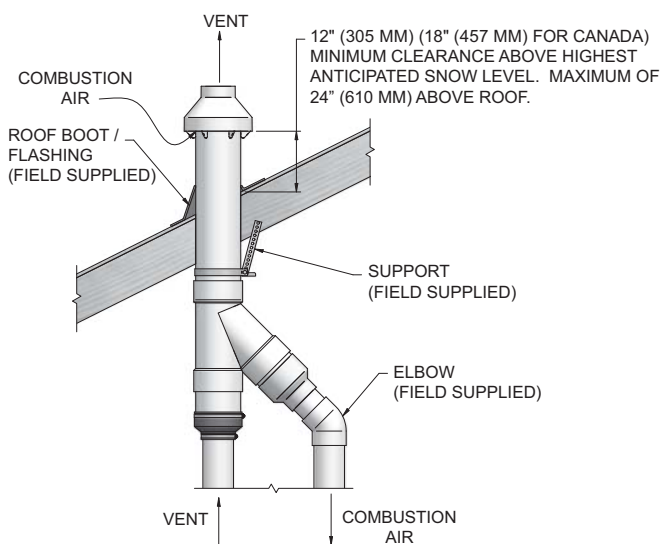
4. Install the Y concentric fitting pipe assembly up through the structure's hole and field supplied roof boot/flashing.

#### NOTICE

Do not allow insulation or other materials to accumulate inside the pipe assembly when installing through the hole.

5. Secure the assembly to the roof structure as shown below in FIG. 5-6 using field supplied metal strapping or equivalent support material.

**Figure 5-6 Concentric Vent Roof Installation**



#### NOTICE

Ensure termination height is above the roof surface or anticipated snow level (12 inches (305 mm) in U.S.A. or 18 inches (457 mm) in Canada) as shown in FIG. 5-4, page 32.

#### NOTICE

If assembly is too short to meet height requirement, the two (2) pipes supplied in the kit may be replaced by using the same diameter, field supplied standard schedule 40 PVC for CVK3007. Do not extend dimension D\* more than 60 inches (1524 mm) (see FIG. 4-9, page 28).

#### CAUTION

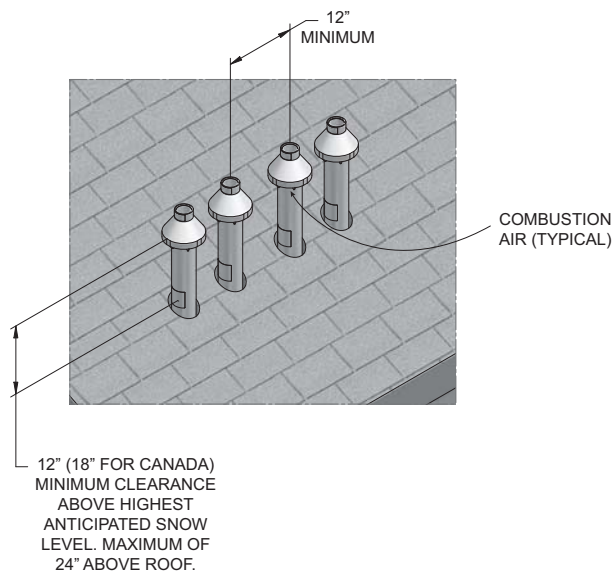
DO NOT use field-supplied couplings to extend pipes. Airflow restriction will occur.

6. Install the rain cap and the small diameter pipe assembly into the roof penetration assembly. Ensure the small diameter pipe is fastened tightly into the rubber adapter for #CVK3007 installations.
7. Cement the appliance combustion air and vent pipes to the concentric vent termination assembly. See FIG. 5-6 for proper pipe attachment.
8. Operate the appliance through one (1) heat cycle to ensure combustion air and vent pipes are properly connected to the concentric vent termination connections.

### Multiventing vertical terminations

When two (2) or more direct vent appliances are vented near each other, each appliance must be individually vented (see FIG. 5-7). NEVER common vent or breach vent this appliance. When two (2) or more direct vent appliances are vented near each other, two (2) vent terminations may be installed as shown in FIG. 5-7. It is important that vent terminations be made as shown to avoid recirculation of flue gases.

**Figure 5-7 Concentric Vent and Combustion Air Vertical Termination**



## 5 Vertical direct venting

### Alternate vertical concentric venting

This appliance may be installed with a concentric vent arrangement where the vent pipe is routed through an existing unused venting system; or by using the existing unused venting system as a chase for vent and combustion air routing.

#### Concentric Venting Arrangement

The venting is to be vertical through the roof. The annular space between the O.D. of the vent pipe and the I.D. of the existing unused venting system is utilized for the combustion air source.

The minimum size of the existing vent system required to achieve enough annular space for combustion air can be found in Table 5A.

The upper and lower termination as well as any other unsealed joints in the existing vent system **must be** sealed to ensure that all combustion air is drawn from under the vent cap as shown in FIG.'s 5-8 and 5-9.

Approved venting materials must be used as specified in Table 3A on page 18.

Follow all vent / air termination and clearance requirements per this section to the appropriate example. Installation must comply with local requirements and with the National Fuel Gas Code.

The maximum allowable equivalent vent and air intake lengths for this venting arrangement are to be determined from the General Venting Section.

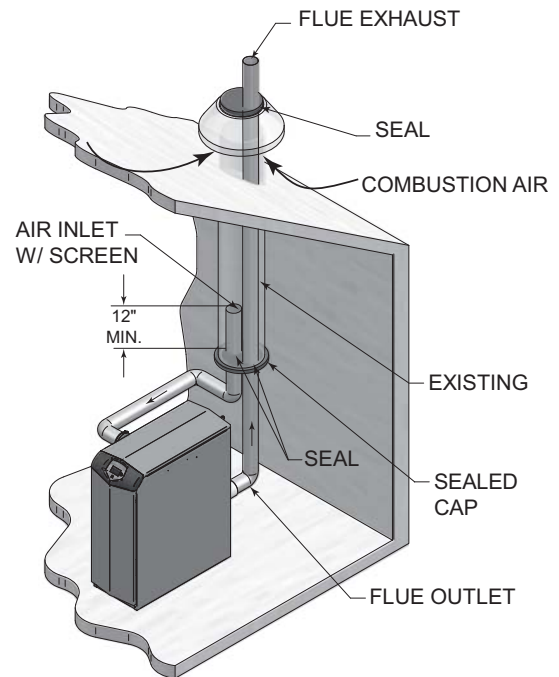
If an existing unused venting system is converted for use with this method of concentric venting, the installer must ensure that the existing venting system is clean and free from particulate contamination that will harm this appliance and cause increased nuisance calls or maintenance. See Table 1A on page 11 for a list of corrosive contaminants and sources.

Two example scenarios of a concentric venting arrangement are shown for illustrative purposes in FIG.'s 5-8 and 5-9.

**Table 5A** Alternate Vertical Concentric Vent / Chase Sizes

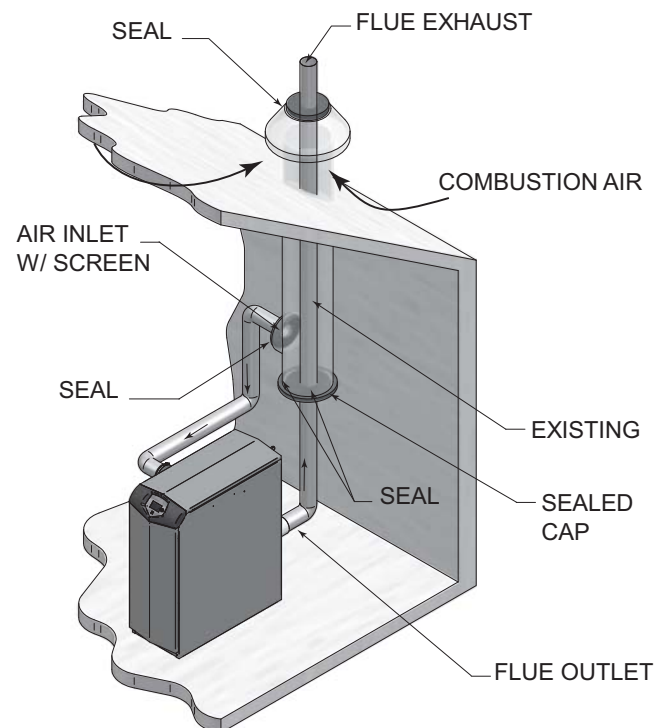
Model	Vent / Air Inlet Size	Minimum Existing Vent / Chase Size
400 - 601	4"	7"
701 - 801	6"	10"

**Figure 5-8** Concentric Vent Example 1



\*For concept illustration only. Individual installations may vary due to job site specific equipment.

**Figure 5-9** Concentric Vent Example 2



\*For concept illustration only. Individual installations may vary due to job site specific equipment.

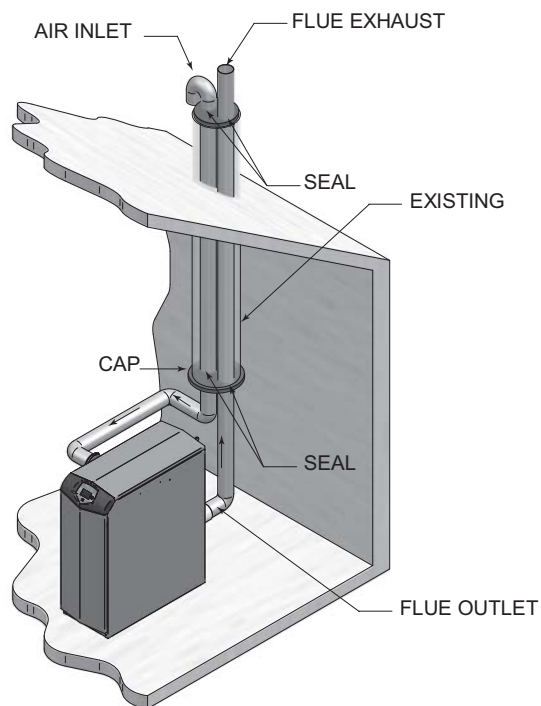


## 5 Vertical direct venting *(continued)*

### Existing vent as a chase

Follow all existing termination and clearance requirements and allowable pipe lengths. Use only approved venting materials listed in the General Venting Section of this manual.

**Figure 5-10** Existing Vent as a Chase



\*For concept illustration only. Individual installations may vary due to job site specific equipment.

## 6 Hydronic piping

### System water piping methods

The Knight XL is designed to function in a closed loop pressurized system not less than 12 psi (83 kPa). A temperature and pressure gauge is included to monitor system pressure and outlet temperature and should be located on the boiler outlet.

It is important to note that the boiler has a minimal amount of pressure drop which must be figured in when sizing the circulators. Each boiler installation must have an air elimination device, which will remove air from the system. Install the boiler so the gas ignition system components are protected from water (dripping, spraying, etc.) during appliance operation or basic service of circulator replacement, valves, and others.

Observe a minimum of 1/4 inch (6 mm) clearance around all un-insulated hot water pipes when openings around the pipes are not protected by non-combustible materials.

### Low water cutoff device

On a boiler installed above radiation level, some states and local codes require a low water cutoff device at the time of installation.

### Chilled water system

If the boiler supplies hot water to heating coils in air handler units, flow control valves or other devices must be installed to prevent gravity circulation of heater water in the coils during the cooling cycle. A chilled water medium must be piped in parallel with the heater.

### Freeze protection

Freeze protection for new or existing systems must use glycol that is specially formulated for this purpose. This includes inhibitors, which prevent the glycol from attacking the metallic system components. Make certain to check that the system fluid is correct for the glycol concentration and inhibitor level. The system should be tested at least once a year and as recommended by the producer of the glycol solution. Allowance should be made for the expansion of the glycol solution in the system piping.

#### WARNING

Use only inhibited propylene glycol solutions, which are specifically formulated for hydronic systems. Ethylene glycol is toxic and can attack gaskets and seals used in hydronic systems.

### General piping information

Basic steps are listed below along with illustrations on the following pages (FIG.'s 6-7 through 6-11), which will guide you through the installation of the Knight XL (reference FIG.'s 6-4A and 6-4B).

1. Connect the system return marked "Inlet".
2. Connect the system supply marked "Outlet".
3. Install purge and balance valve or shutoff valve and drain on system return to purge air out of each zone.
4. Install a backflow preventer on the cold feed make-up water line.
5. Install a pressure reducing valve on the cold feed make-up water line, (15 psi (103 kPa) nominal). Check temperature and pressure gauge (shipped separately), which should read a minimum pressure of 12 psi (83 kPa).
6. Install a circulator as shown on the piping diagrams in this section. Make sure the circulator is properly sized for the system and friction loss.
7. Install an expansion tank on the system supply. Consult the tank manufacturer's instruction for specific information relating to tank installation. Size the expansion tank for the required system volume and capacity.
8. Install an air elimination device on the system supply.
9. Install a drain valve at the lowest point of the system.  
**Note:** The boiler cannot be drained completely of water without purging the unit with an air pressure of 15 psi (103 kPa).
10. This appliance is supplied with a relief valve sized in accordance with ASME Boiler and Pressure Vessel Code, Section IV ("Heating Boilers"). Pipe the discharge of the safety relief valve to prevent injury in the event of pressure relief. Pipe the discharge to a drain. Provide piping that is the same size as the safety relief valve outlet. Never block the outlet of the safety relief valve.
11. On any pre-existing system, it is good practice to install a field supplied strainer to prevent damage to the heat exchanger.

#### WARNING

The relief valve, tee and any other necessary fittings are shipped in the install kit with the boiler and are to be field installed (FIG.'s 6-1 and 6-2).

See the piping illustrations included in this section, FIG.'s 6-7 and 6-11 for suggested guidelines in piping the Knight XL.

#### NOTICE

Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

## 6 Hydronic piping *(continued)*

### Flow switch, relief valve and temperature and pressure gauge installation

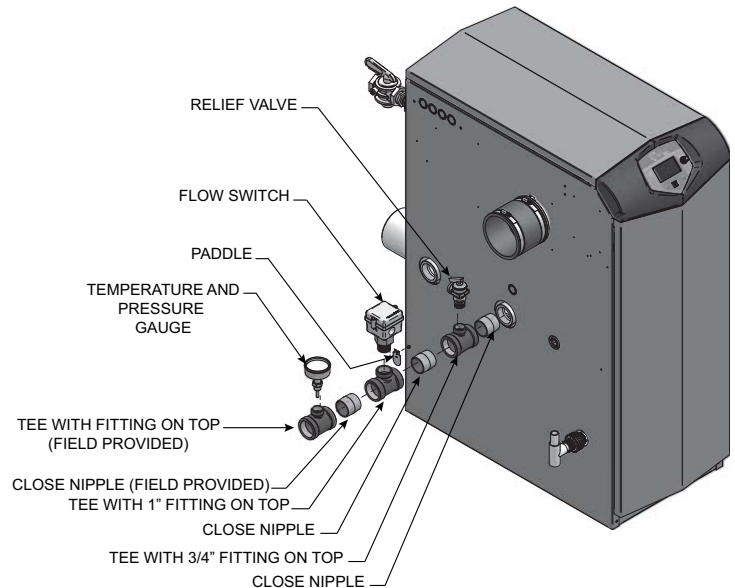
Basic steps are listed below to guide you through the installation of the flow switch, relief valve, and temperature and pressure gauge provided with the unit.

1. For Models 400 - 501 install the close nipple on the outlet connection of the heat exchanger. Install the tee with the 3/4 inch fitting positioned vertically and on the top as shown in FIG. 6-1. For Models 601 - 801 install the tee directly to the outlet connection of the heat exchanger with the 3/4 inch fitting positioned vertically and on the top (see FIG. 6-2).
2. For Models 701 - 801 install the 3/4 inch close nipple in the tee. Install the relief valve on the 3/4 inch close nipple (FIG. 6-2). For Models 400 - 601 install the relief valve directly into the 3/4 inch fitting on the tee (FIG. 6-1).
3. Install the close nipple on the downstream side of the relief valve tee (FIG. 6-1).
4. Install the tee with the 1 inch fitting positioned vertically and on the top (FIG. 6-1).
5. Attach paddle #3 to the flow switch per the manufacturer's instructions.
6. Install the assembled flow switch into the 1 inch fitting of the tee installed in Step 4 (see FIG. 6-1).
7. Install a field provided close nipple on the downstream side of the flow switch (see FIG.'s 6-1 and 6-2).
8. Install a field provided tee with the gauge fitting positioned vertically and on the top (FIG.'s 6-1 and 6-2)
9. Install the temperature and pressure gauge provided with the unit into the top fitting of the tee (a bushing may be necessary) installed in Step 8 (FIG.'s 6-1 and 6-2).

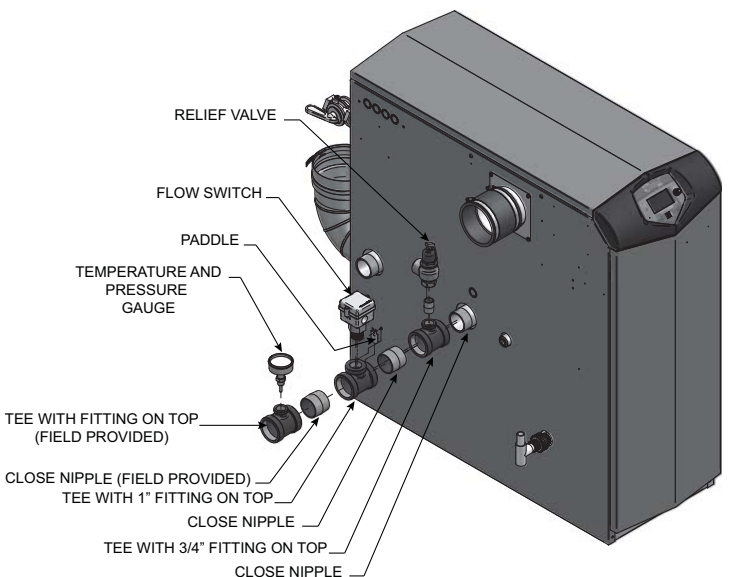
#### NOTICE

Be sure to install the flow switch so that the arrow on the flow switch is pointing in the direction of the flow (see FIG. 6-3).

**Figure 6-1** Flow Switch, Relief Valve and Temperature and Pressure Gauge Installation\_Models 400 - 501



**Figure 6-2** Flow Switch, Relief Valve and Temperature and Pressure Gauge Installation\_Models 601 - 801



## 6 Hydronic piping

### Flow switch adjustment

Refer to Table 6A for the proper setting of the sensitivity screw. For reference, the position of the screw prior to setting should be turned clockwise with a Phillips driver until it stops (FIG. 6-3). Proceed to turn the screw counterclockwise the amount of turns listed in Table 6A based on the model.

Consult the manufacturer's instructions for wiring the flow switch to your system.

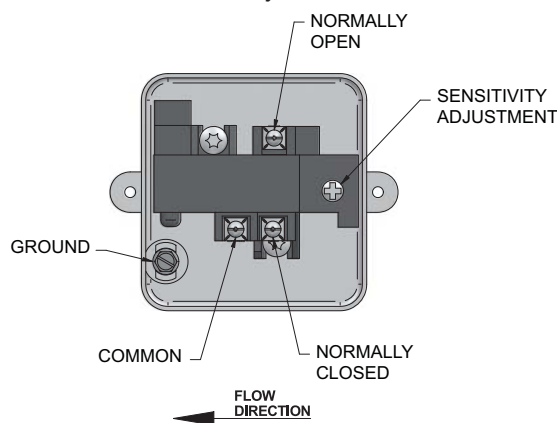
**Table 6A** Paddle Size / Sensitivity Screw Adjustment

MODEL	PADDLE SIZE	SENSITIVITY SCREW ADJUSTMENT
<b>Note: Paddles are included with the flow switch.</b>		
400	#3	7½ turns
501	#3	5½ turns
601	#3	7¼ turns
701	#3	5¼ turns
801	#3	3¼ turns

#### NOTICE

Turn the sensitivity screw clockwise to increase the flow rate required to activate the switch. Turn the sensitivity screw counterclockwise to decrease the flow rate required to activate the switch.

**Figure 6-3** Flow Switch Adjustment



### Near boiler piping components

#### 1. Boiler system piping:

Boiler system piping **MUST** be sized per the pipe requirements listed in Table 6B. Reducing the pipe size can restrict the flow rate through the boiler, causing inadvertent high limit shutdowns and poor system performance. Flow rates are based on 20 feet (6 m) of piping, 4 - 90° elbows, and 2 - fully ported ball valves.

#### 2. Boiler system circulating pump:

Field supplied. The boiler circulating pump should be based on 20 feet (6 m) of piping, 4 - 90° elbows, and 2 - fully ported ball valves.

#### 3. Domestic hot water circulating pump:

Field supplied. The pump **MUST** be sized to meet the specified minimum flow requirements listed in FIG.'s 6-5 and 6-6. Consult the indirect water heater operating guide to determine flow characteristics for the selected product used.

#### 4. Variable speed boiler system circulator:

Knight boilers are capable of controlling a variable speed boiler system circulator. Variable speed circulators **MUST** be sized to meet the specified minimum flow requirements listed in FIG.'s 6-5 and 6-6 on page 40 at full speed.

#### 5. Boiler isolation valves:

Field supplied. Full port ball valves are required. Failure to use full port ball valves could result in a restricted flow rate through the boiler.

#### 6. Check valves:

Field supplied. Check valves are recommended for installation as shown in FIG.'s 6-7 through 6-11. Failure to install check valves could result in a reverse flow condition during pump(s) off cycle.

#### 7. Domestic indirect hot water isolation valves:

Field supplied. Full port ball valves are required. Failure to use full port ball valves could result in a restricted flow rate through the boiler.

#### 8. Anti-scald mixing valve:

Field supplied. An anti-scald mixing valve is recommended when storing domestic hot water above 115°F (46°C).

#### 9. Unions:

Field supplied. Recommended for unit serviceability.

#### 10. Temperature and pressure gauge:

Factory supplied. The temperature and pressure gauge is shipped loose. It is the responsibility of the contractor to install the temperature and pressure gauge on the boiler water outlet.

#### 11. Pressure relief valve:

Factory supplied. The pressure relief valve is sized to ASME specifications.

## 6 Hydronic piping *(continued)*

### 12. Boiler purge valve:

Field supplied. The boiler purge valve is used to remove entrapped air from the heat exchanger during start-up.

### 13. System temperature sensor:

Lochinvar supplies a system temperature sensor. The sensor is to be installed in the heating loop downstream from the boiler hot water piping and heating loop junction. The sensor should be located far enough downstream to sense system diluted water temperature.

### 14. Y-Strainer:

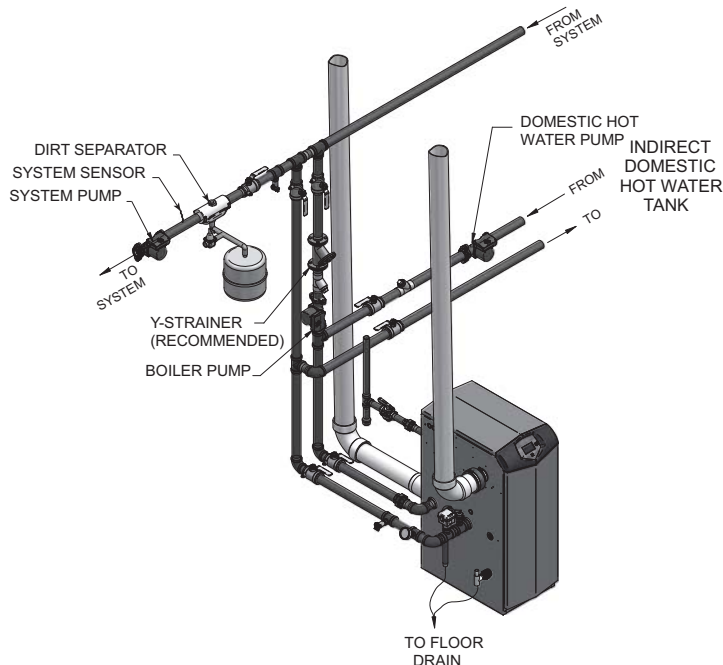
Field supplied. A Y-strainer or equivalent multipurpose strainer is recommended at the inlet of the heat exchanger to remove system particles from older hydronic systems and protect newer systems.

### Circulator sizing

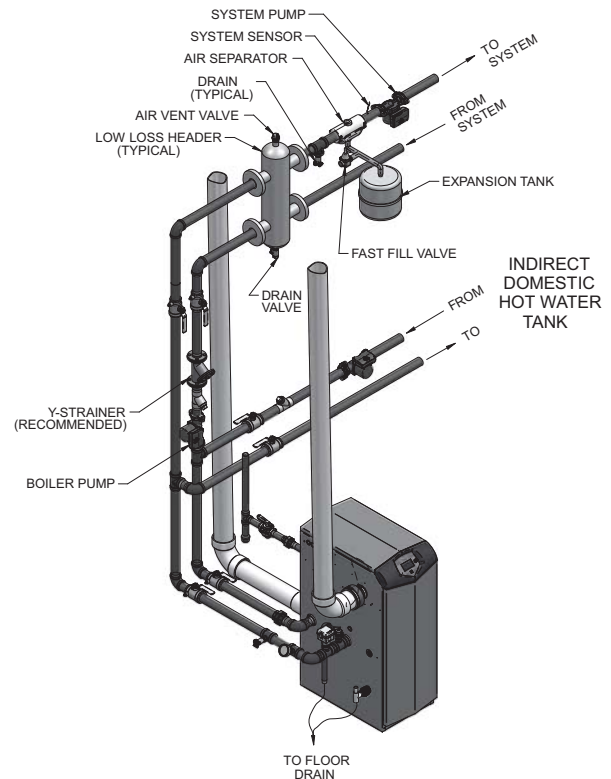
The Knight XL heat exchanger does have a pressure drop, which must be considered in your system design. Refer to the graphs in FIG's 6-5 and 6-6 for pressure drop through the Knight XL heat exchanger.

### Near boiler piping connections

**Figure 6-4A** Near Boiler Piping w/Y-Strainer



**Figure 6-4B** Near Boiler Piping w/Low Loss Header



### Variable speed pump option

#### Variable speed pump setup

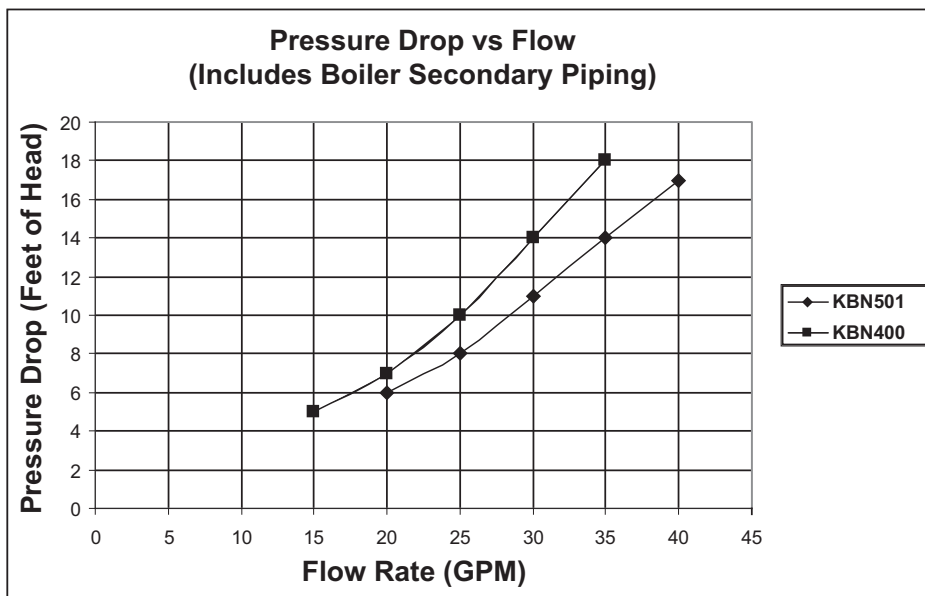
Before operation, ensure the following:

- Pump is set for an input signal of 0 - 10VDC by the dip switches on the pump control
- Pump is set for external signal control (if applicable)
- Pump is set for linear output (if applicable)
- If pump does not come equipped with a 0 - 10 VDC input option, an optional module will be required from the vendor

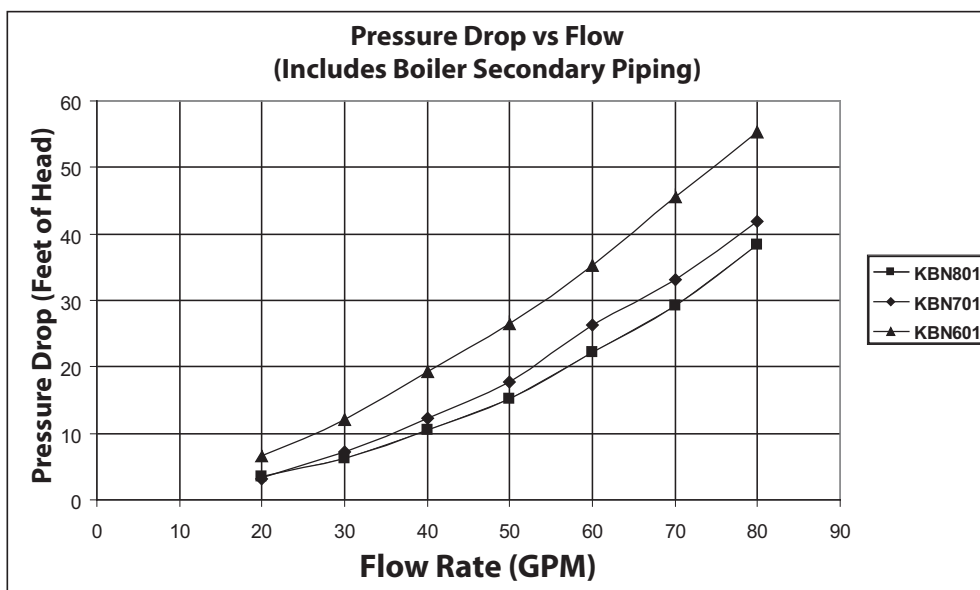


## 6 Hydronic piping

**Figure 6-5** Pressure Drop vs. Flow - Models 400 and 501



**Figure 6-6** Pressure Drop vs. Flow - Models 601 thru 801

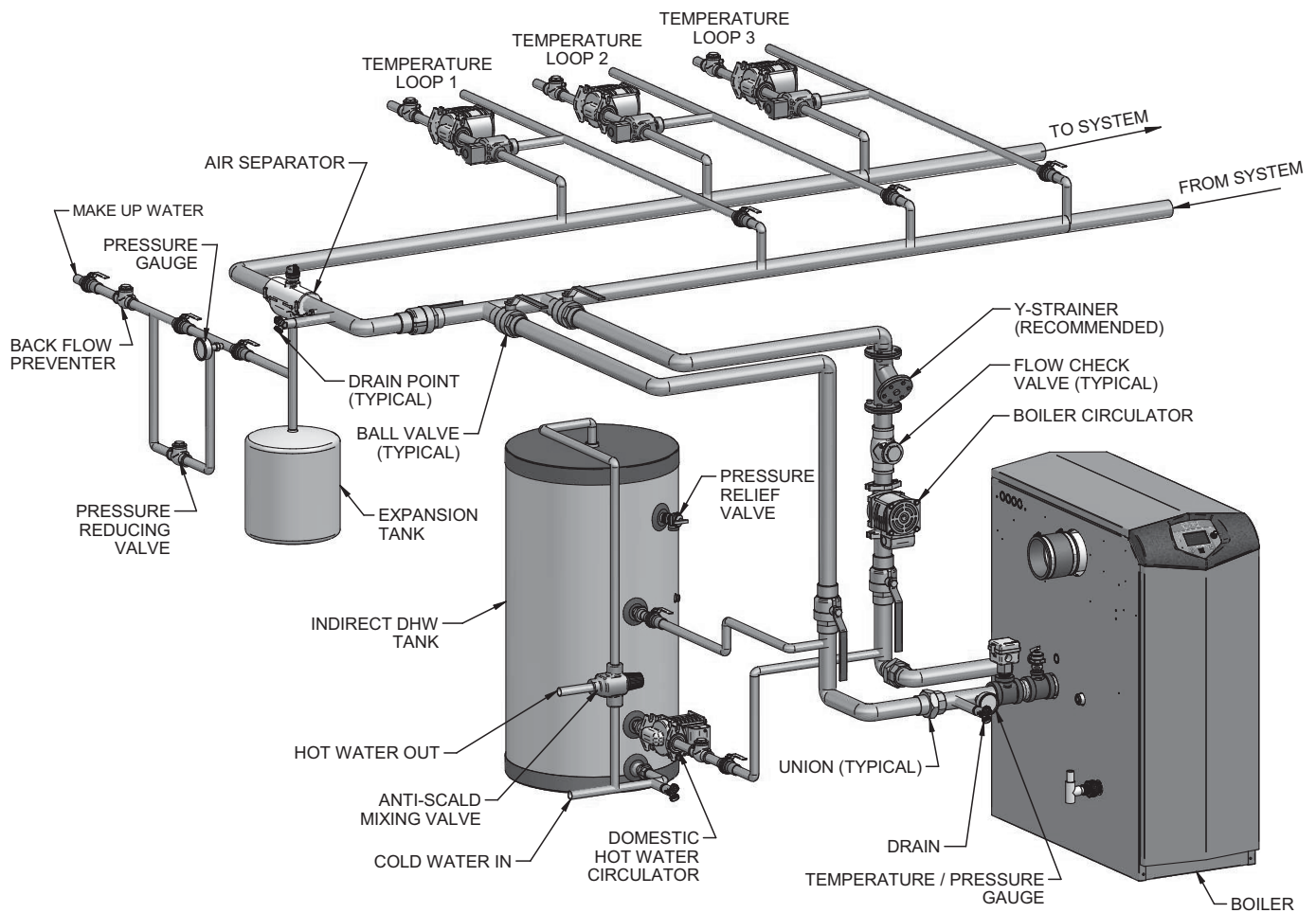


**Table 6B** Sizing Information for Temperature Rise Applications\_20°F, 25°F, 30°F and 35°F

TEMPERATURE RISE APPLICATIONS									
Model	MINIMUM PIPE SIZE	20°F		25°F		30°F		35°F	
		GPM	FT/HD	GPM	FT/HD	GPM	FT/HD	GPM	FT/HD
400	1 1/2"	37	21	30	14	26	11	21	8
501	1 1/2"	46	23	37	16	32	13	26	10
601	2"	55	31	44	22	38	18	32	13
701	2"	65	30	52	20	45	16	37	11
801	2"	74	33	60	23	51	18	42	12

## 6 Hydronic piping *(continued)*

**Figure 6-7** Single Boiler - Multiple Temperatures



### CAUTION

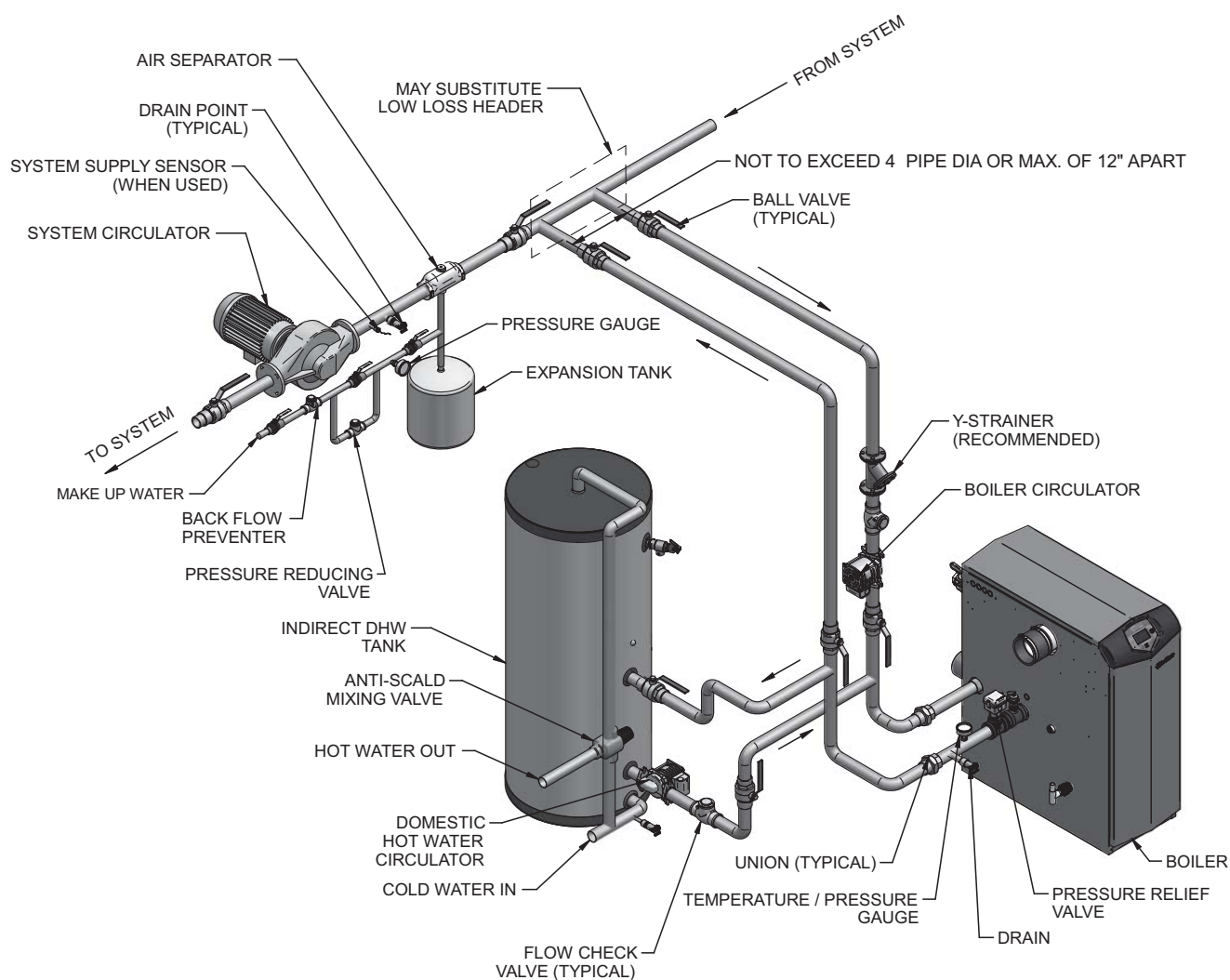
Mixing valves are required for the protection of low temperature loops.

### NOTICE

Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

## 6 Hydronic piping

**Figure 6-8** Single Boiler - Primary/Secondary Piping



### CAUTION

Indirect water heaters are capable of transferring a limited number of Btu's into the water. Ensure boiler output does not exceed indirect water heater transfer capabilities.

### NOTICE

Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

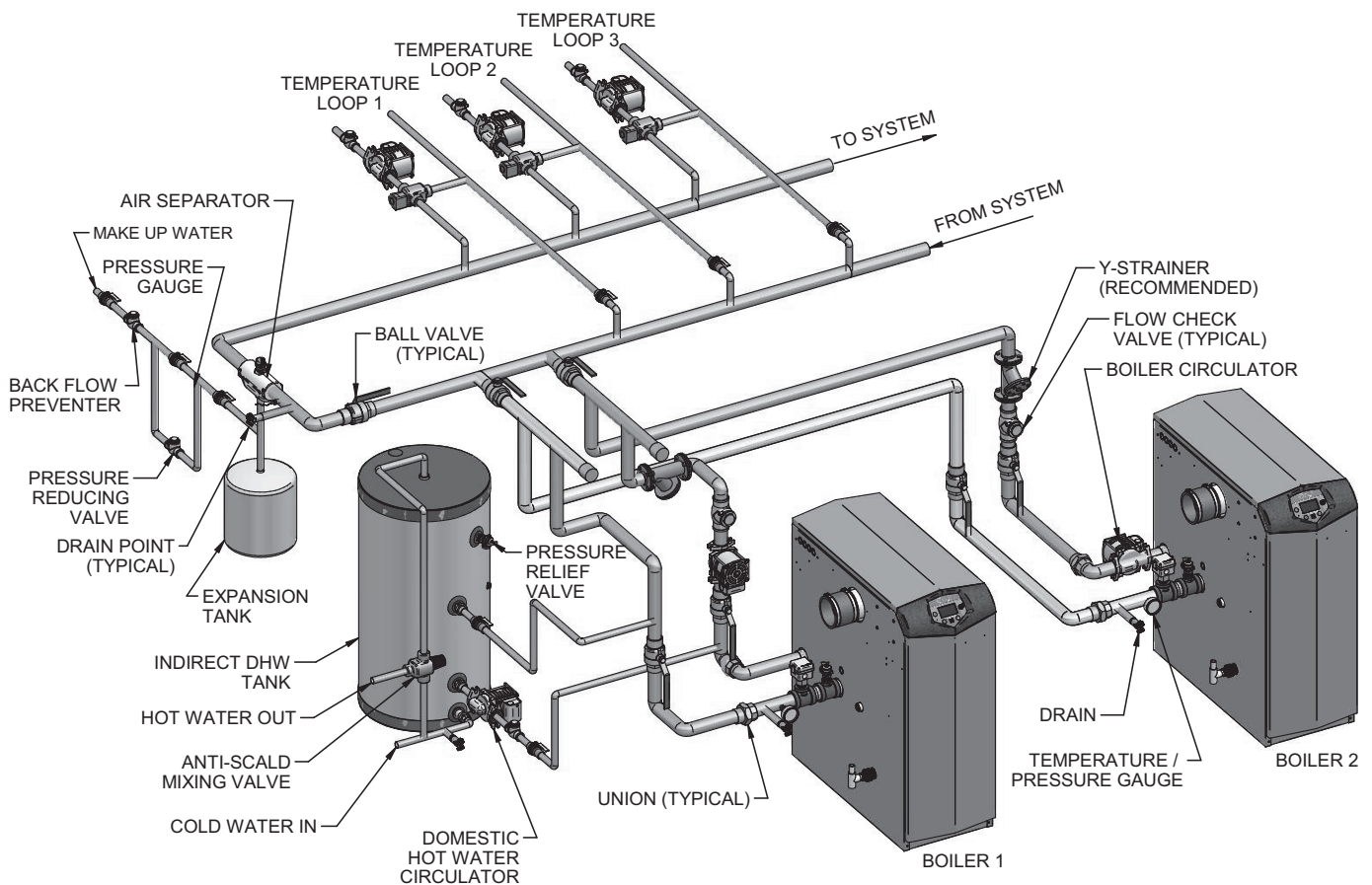
### NOTICE

System flow should always remain higher than the required flow for the boiler(s) when the boiler(s) is in operation to prevent short cycling and high limit issues.

## 6 Hydronic piping *(continued)*

**Figure 6-9 Multiple Boilers - Multiple Temperatures**

Model	Number of Units						
	2	3	4	5	6	7	8
	Manifold Pipe Sizes in Inches (mm)						
400	2 1/2 (64)	3 (76)	3 1/2 (89)	4 (102)	4 (102)	5 (127)	6 (152)
501	3 (76)	3 1/2 (89)	4 (102)	5 (127)	5 (127)	6 (152)	6 (152)
601	3 1/2 (89)	4 (102)	5 (127)	5 (127)	6 (152)	6 (152)	8 (203)
701	3 1/2 (89)	5 (127)	5 (127)	6 (152)	6 (152)	8 (203)	8 (203)
801	4 (102)	5 (127)	5 (127)	6 (152)	8 (203)	8 (203)	8 (203)



### CAUTION

Indirect water heaters are capable of transferring a limited number of Btu's into the water. Ensure boiler output does not exceed indirect water heater transfer capabilities.

### CAUTION

Mixing valves are required for the protection of low temperature loops.

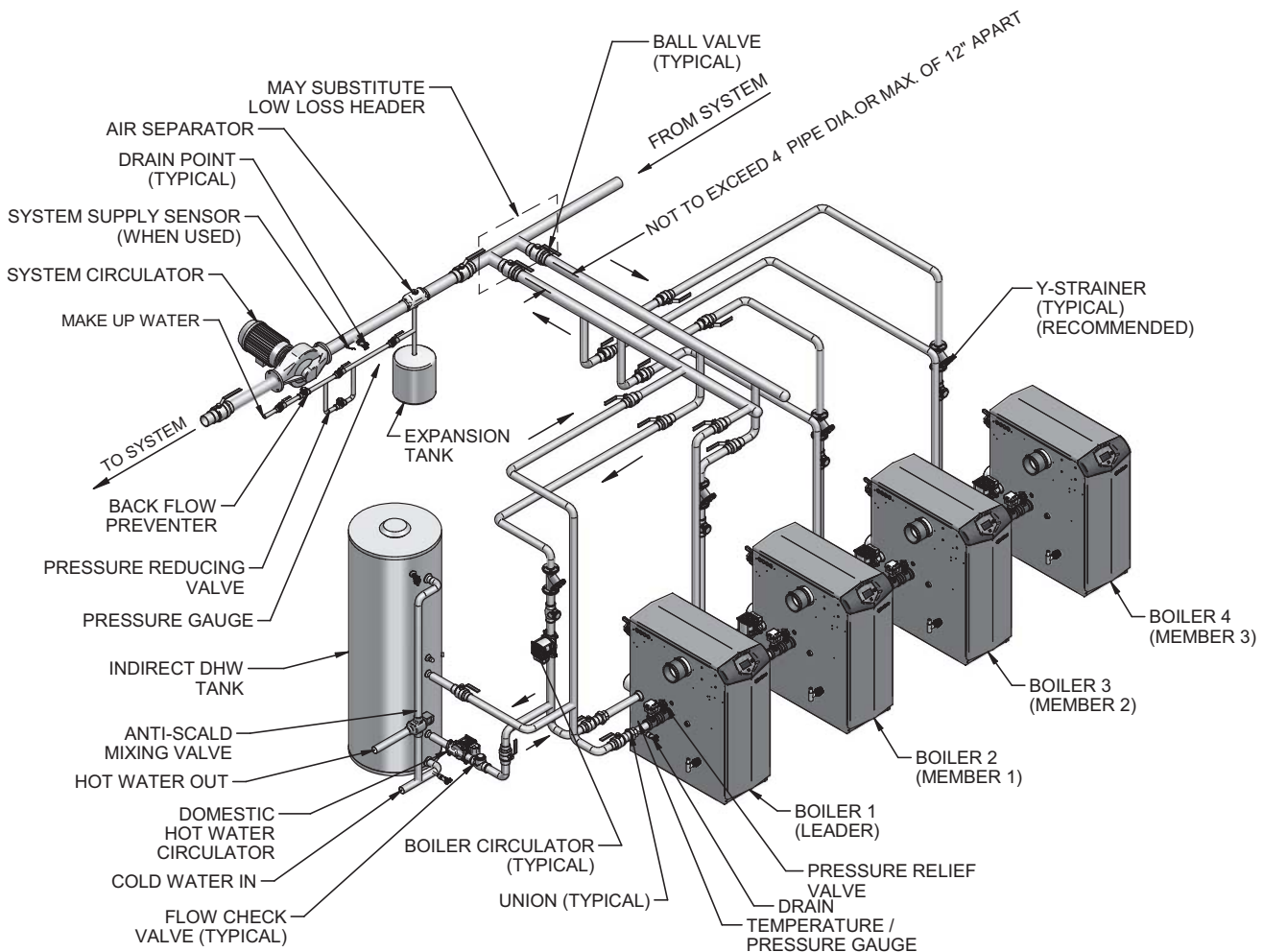
### NOTICE

Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

## 6 Hydronic piping

**Figure 6-10 Multiple Boilers - Primary/Secondary Piping**

Model	Number of Units						
	2	3	4	5	6	7	8
	Manifold Pipe Sizes in Inches (mm)						
400	2 1/2 (64)	3 (76)	3 1/2 (89)	4 (102)	4 (102)	5 (127)	6 (152)
501	3 (76)	3 1/2 (89)	4 (102)	5 (127)	5 (127)	6 (152)	6 (152)
601	3 1/2 (89)	4 (102)	5 (127)	5 (127)	6 (152)	6 (152)	8 (203)
701	3 1/2 (89)	5 (127)	5 (127)	6 (152)	6 (152)	8 (203)	8 (203)
801	4 (102)	5 (127)	5 (127)	6 (152)	8 (203)	8 (203)	8 (203)



### CAUTION

Indirect water heaters are capable of transferring a limited number of Btu's into the water. Ensure boiler output does not exceed indirect water heater transfer capabilities.

### NOTICE

Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

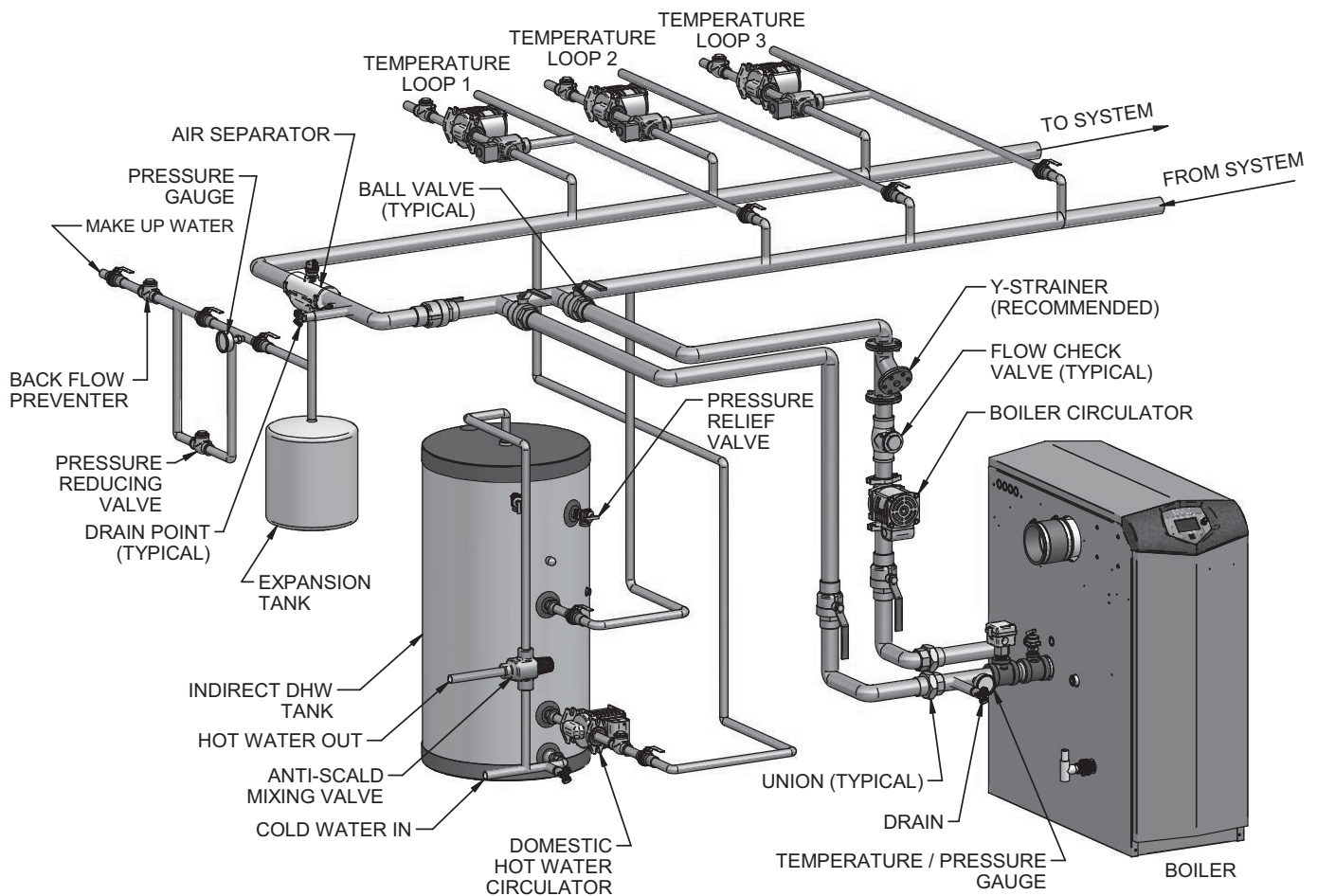
### NOTICE

System flow should always remain higher than the required flow for the boiler(s) when the boiler(s) is in operation to prevent short cycling and high limit issues.



## 6 Hydronic piping *(continued)*

**Figure 6-11** Single Boiler - Multiple Temperatures with DHW Piped as a Zone



### CAUTION

Indirect water heaters are capable of transferring a limited number of Btu's into the water. Ensure boiler output does not exceed indirect water heater transfer capabilities.

### CAUTION

Mixing valves are required for the protection of low temperature loops.

### NOTICE

Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

### NOTICE

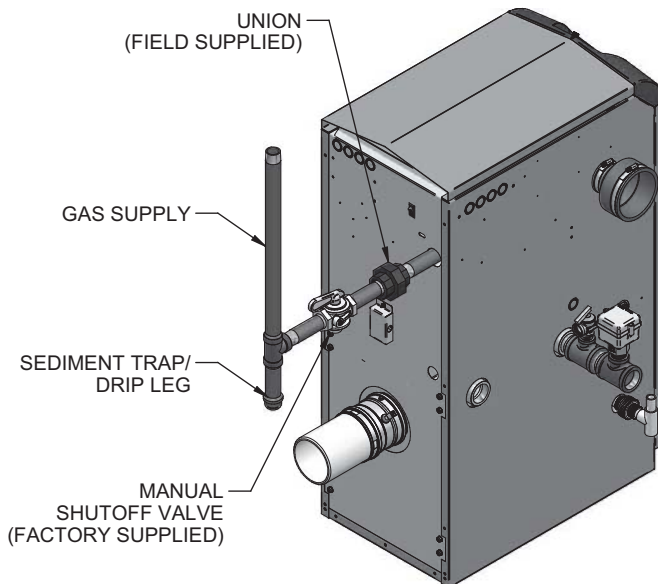
Please note that the installer is responsible for ensuring DHW prioritization when piped as a zone.

## 7 Gas connections

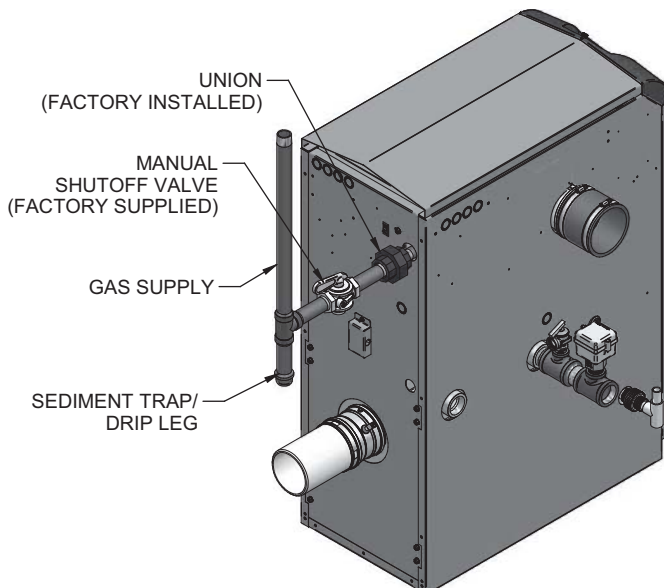
### Connecting gas supply piping

1. Remove the top access panel and refer to FIG.'s 7-1 thru 7-3 to pipe gas to the boiler.
  - a. Install ground joint union for servicing, when required.
  - b. Install a manual shutoff valve in the gas supply piping outside boiler jacket when required by local codes or utility requirements.
  - c. In Canada – When using manual main shutoff valves, it must be identified by the installer.
2. Install sediment trap / drip leg.

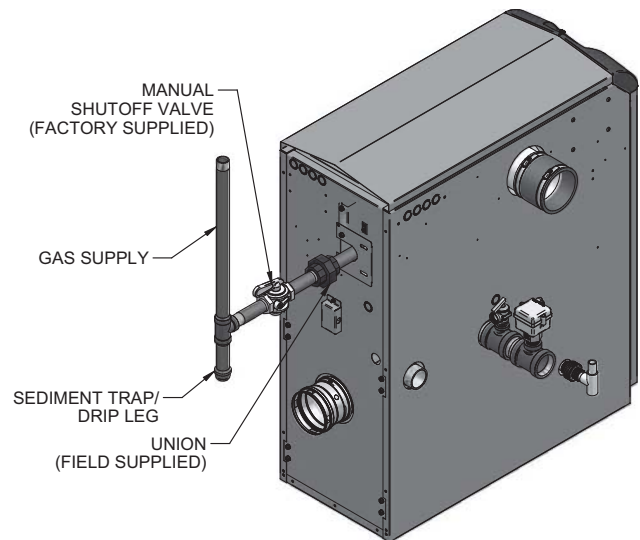
**Figure 7-1 Gas Supply Piping - Model 400**



**Figure 7-2 Gas Supply Piping - Model 501**



**Figure 7-3 Gas Supply Piping - Models 601 - 801**



3. Support piping with hangers, not by the boiler or its accessories.

#### **⚠ WARNING**

The gas valve and blower will not support the weight of the piping. Do not attempt to support the weight of the piping with the boiler or its accessories. Failure to comply could result in severe personal injury, death, or substantial property damage.

4. Purge all air from the gas supply piping.
5. Before placing the boiler in operation, check the boiler and its gas connection for leaks.
  - a. The appliance must be disconnected from the gas supply piping system during any pressure testing of that system at a test pressure in excess of 1/2 PSIG (3.5 kPa).
  - b. The appliance must be isolated from the gas supply piping system by closing a manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 1/2 PSIG (3.5 kPa).
  - c. The appliance and its gas connection must be leak tested before placing it in operation.

#### **⚠ WARNING**

Do not check for gas leaks with an open flame – use the bubble test. Failure to use the bubble test or check for gas leaks can cause severe personal injury, death, or substantial property damage.

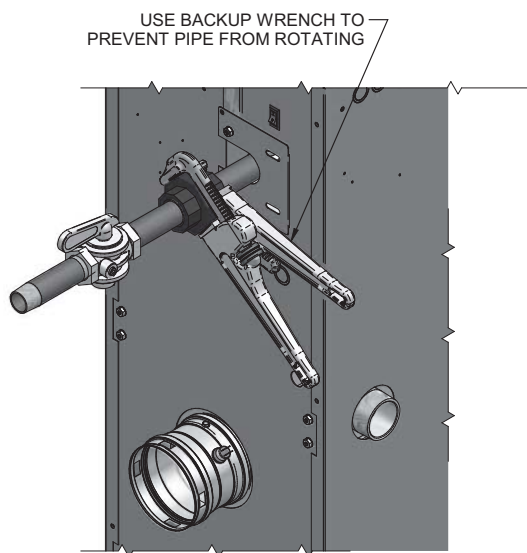
6. Use pipe sealing compound compatible with propane gases. Apply sparingly only to male threads of the pipe joints so that pipe dope does not block gas flow.

## 7 Gas connections *(continued)*

**⚠ WARNING** Failure to apply pipe sealing compound as detailed in this manual can result in severe personal injury, death, or substantial property damage.

**⚠ WARNING** Use two wrenches when tightening gas piping at boiler (FIG. 7-4), using one wrench to prevent the boiler gas line connection from turning. Failure to support the boiler gas connection pipe to prevent it from turning could damage gas line components.

**Figure 7-4 Inlet Pipe with Backup Wrench**



**NOTICE** Maximum inlet gas pressure must not exceed the value specified. Minimum value listed is for the purposes of input adjustment.

### Natural gas:

#### Pipe sizing for natural gas

1. Refer to Table 7A for pipe length and diameter. Based on rated boiler input (divide by 1,000 to obtain cubic feet per hour).
  - a. Table 7A is only for natural gas with specific gravity 0.60 inches, with a pressure drop through the gas piping of 0.5 inches w.c.
  - b. For additional gas pipe sizing information, refer to ANSI Z223.1 (or B149.1 for Canadian installations).

#### Natural gas supply pressure requirements

1. Pressure required at the gas valve inlet pressure port:
  - Maximum 14 inches w.c. (3.5 kPa) with no flow (lockup) or with boiler on.
  - Minimum 4 inches w.c. (.99 kPa) with gas flowing (verify during boiler startup).
2. Install 100% lockup gas pressure regulator in supply line if inlet pressure can exceed 14 inches w.c. (3.5 kPa) at any time. Adjust lockup regulator for 14 inches w.c. (3.5 kPa) maximum.

### Propane Gas:

**⚠ WARNING** Knight XL boilers are typically shipped ready to fire on natural gas. Check boiler rating plate to determine which fuel the boiler is set for. If set to natural gas, it may be converted to LP by installing an orifice or by making a gas valve adjustment (see pages 13 and 14). In order to operate on LP gas, an orifice **MUST BE** installed or a gas valve adjustment **MUST BE** made. Failure to comply could result in severe personal injury, death, or substantial property damage.

#### Pipe sizing for propane gas

1. Contact gas supplier to size pipes, tanks, and 100% lockup gas pressure regulator.

#### Propane Supply Pressure Requirements

1. Adjust propane supply regulator provided by the gas supplier for 14 inches w.c. (3.2 kPa) maximum pressure.
2. Pressure required at gas valve inlet pressure port:
  - Maximum 14 inches w.c. (3.2 kPa) with no flow (lockup) or with boiler on.
  - Minimum 8 inches w.c. (1.9 kPa) with gas flowing (verify during boiler startup).

**⚠ WARNING** Ensure that the high gas pressure regulator is at least 10 feet (3 m) upstream of the appliance.

## 7 Gas connections

**Table 7A** Natural Gas Pipe Size Chart

Nominal Iron Pipe Size (inches)	Natural Gas Pipe Capacity Chart Length of Pipe in Straight Feet														Maximum Capacity of Pipe in Thousands of Btu/hr per hour for gas pressures of 14 Inches Water Column (0.5 PSIG) or less and a pressure drop of 0.5 Inch Water Column (Based on NAT GAS, 1025 Btu/ hr per Cubic Foot of Gas and 0.60 Specific Gravity)
	10	20	30	40	50	60	70	80	90	100	125	150	175	200	
1/2	175	120	97	82	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
3/4	369	256	205	174	155	141	128	121	113	106	95	86	79	74	
1	697	477	384	328	292	267	246	236	210	200	179	164	149	138	
1-1/4	1400	974	789	677	595	543	502	472	441	410	369	333	308	287	
1-1/2	2150	1500	1210	1020	923	830	769	707	666	636	564	513	472	441	
2	4100	2820	2260	1950	1720	1560	1440	1330	1250	1180	1100	974	871	820	
2-1/2	6460	4460	3610	3100	2720	2460	2310	2100	2000	1900	1700	1540	1400	1300	
3	11200	7900	6400	5400	4870	4410	4000	3800	3540	3330	3000	2720	2500	2340	
4	23500	16100	13100	11100	10000	9000	8300	7690	7380	6870	6150	5640	5130	4720	

### Check inlet gas supply

**NOTICE**

CSA or UL listed flexible gas connections are acceptable, but you must exercise caution to ensure that the line has adequate capacity to allow your boiler to fire at full rate. Consult with local codes for proper installation or service procedures.

**⚠ WARNING**

DO NOT adjust or attempt to measure gas valve outlet pressure. Attempting to alter or measure the gas valve outlet pressure could result in damage to the valve, causing potential severe personal injury, death, or substantial property damage.

The gas piping must be sized for the proper flow and length of pipe, to avoid excessive pressure drop. Both the gas meter and the gas regulator must be properly sized for the total gas load.

If you experience a pressure drop greater than 1 inch w.c. (249 Pa), the meter, regulator, or gas line is undersized or in need of service. Perform the steps below when checking inlet gas supply:

- Turn the main power switch to the "OFF" position.
- Shut off gas supply at the manual gas valve in the gas piping to the appliance.
- On Models 400 - 501 loosen the set screw one (1) full turn from inside the pressure tap on top of the gas valve. On Models 601 - 801 remove the 1/8" (3 mm) pipe plug on the inlet flange to the valve and install a suitable 1/8" (3 mm) fitting (field supplied) for the manometer tubing. Place the tubing of the manometer over the tap once the set screw is loosened or the 1/8" (3 mm) fitting is installed (depending on model) as shown in FIG.'s 7-5 thru 7-7 on page 49.
- Slowly turn on the gas supply at the field installed manual gas valve.
- Turn the power switch to the "ON" position.
- Adjust the temperature set point on the control panel of the SMART SYSTEM control module to call for heat.
- Observe the gas supply pressure as the burner fires at 100% of rated input. Percent of burner input will be displayed on the control panel.
- Ensure inlet pressure is within specified range. Minimum and maximum gas supply pressures are specified in this section of the manual.
- If gas supply pressure is within normal range and no adjustments are needed, proceed on to Step 11.
- If the gas pressure is out of range, contact the gas utility, gas supplier, qualified installer or service agency to determine the necessary steps to provide proper gas pressure to the control.
- Turn the power switch to the "OFF" position.
- Shut off the gas supply at the manual gas valve in the gas piping to the appliance.
- Remove the manometer from the pressure tap on top of the gas valve. On Models 400 - 501 re-tighten the set screw inside the pressure tap. On Models 601 - 801 remove the 1/8" (3 mm) field supplied fitting and reinstall the pipe plug removed in Step 3.



## 7 Gas connections *(continued)*

### ⚠ WARNING

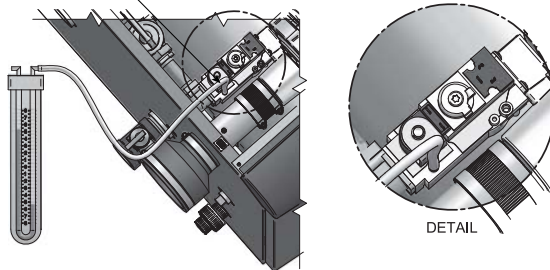
When re-tightening the set screw, be sure to tighten securely to prevent gas leaks.

Do not check for gas leaks with an open flame -- use the bubble test. Failure to use the bubble test or check for gas leaks can cause severe personal injury, death, or substantial property damage.

14. Turn on the gas supply at the manual gas valve.
15. Turn the power switch to the "ON" position.
16. Adjust the temperature set point on the control panel of the SMART SYSTEM control module to the desired water temperature so the appliance will call for heat.
17. Check burner performance by cycling the system while you observe burner response. The burner should ignite promptly. Flame pattern should be stable. Turn system off and allow burner to cool, then cycle burner again to ensure proper ignition and flame characteristics.

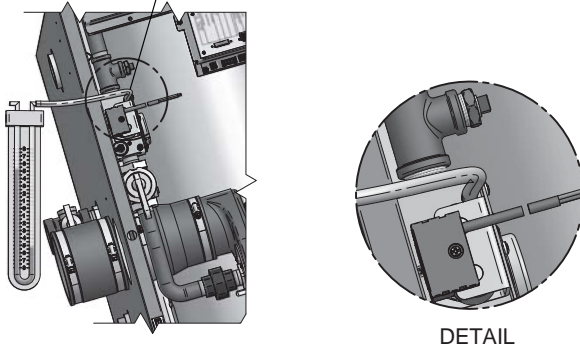
**Figure 7-5 Inlet Gas Supply Check - Model 400**

LOOSEN THE SET SCREW ONE (1) FULL TURN AND PLACE THE MANOMETER TUBING OVER THE PRESSURE TAP.



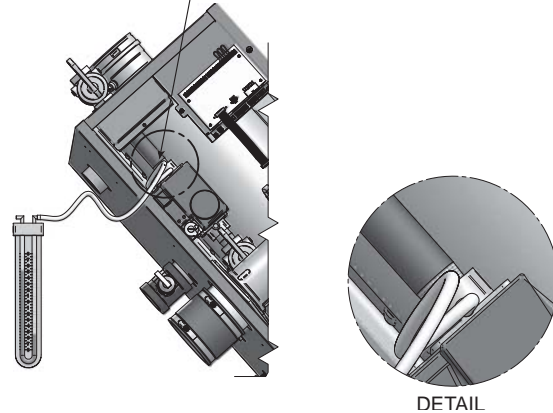
**Figure 7-6 Inlet Gas Supply Check - Model 501**

LOOSEN THE SET SCREW ONE (1) FULL TURN AND PLACE THE MANOMETER TUBING OVER THE PRESSURE TAP.



**Figure 7-7 Inlet Gas Supply Check - Models 601 - 801**

REMOVE THE 1/8" (3 MM) PIPE PLUG ON THE INLET FLANGE TO THE VALVE AND INSTALL A SUITABLE 1/8" (3 MM) FITTING (FIELD SUPPLIED) FOR THE MANOMETER TUBING.



### Gas Pressure

The gas pressure must remain between 4 inches w.c. (.99 kPa) minimum and 14 inches w.c. (3.5 kPa) maximum for Natural gas and between 8 inches w.c. (1.9 kPa) minimum and 14 inches w.c. (3.2 kPa) maximum for LP gas during standby (static) mode and while in operating (dynamic) mode. If an in-line regulator is used, it must be a minimum of 10 feet (3 m) from the Knight XL boiler. It is very important that the gas line is properly purged by the gas supplier or utility company. Failure to properly purge the lines or improper line sizing, will result in ignition failure.

The problem is especially noticeable in NEW LP installations and also in empty tank situations. This can also occur when a utility company shuts off service to an area to provide maintenance to their lines.

### Gas valve replacement

The gas valve MUST NOT be replaced with a conventional gas valve under any circumstances. As an additional safety feature, this gas valve has a flanged connection to the venturi and blower.

### ⚠ WARNING

Failure to follow all precautions could result in fire, explosion, or death!

### ⚠ WARNING

DO NOT adjust or attempt to measure gas valve outlet pressure. Attempting to alter or measure the gas valve outlet pressure could result in damage to the valve, causing potential severe personal injury, death, or substantial property damage.



## 8 Field wiring

### ⚠ WARNING

**ELECTRICAL SHOCK HAZARD** – For your safety, turn off electrical power supply before making any electrical connections to avoid possible electric shock hazard. Failure to do so can cause severe personal injury or death.

### NOTICE

Wiring must be N.E.C. Class 1.

If original wiring as supplied with boiler must be replaced, use only type 105°C wire or equivalent.

Boiler must be electrically grounded as required by National Electrical Code ANSI/NFPA 70 – latest edition.

### ⚠ CAUTION

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

Installation must comply with:

1. National Electrical Code and any other national, state, provincial, or local codes, or regulations.
2. In Canada, CSA C22.1 Canadian Electrical Code Part 1, and any local codes.

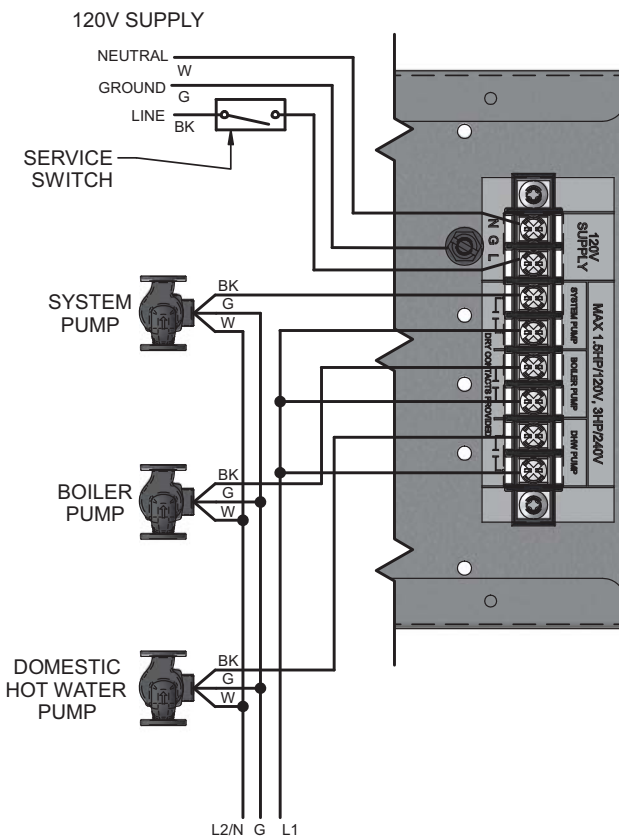
### Line voltage connections

1. Connect 120 VAC power wiring to the line voltage terminal strip in the junction box, as shown in FIG. 8-1.
2. Provide and install a fused disconnect or service switch (15 amp recommended) as required by the code (see FIG. 8-1).
3. When connecting a domestic hot water (DHW) pump, connect the wiring to the line voltage terminal strip as shown in FIG. 8-1.
4. To activate a system pump, wire as shown in FIG. 8-1. Dry contacts are sized for 1.5 hp/120V, 3 hp/240V or 30 amps.

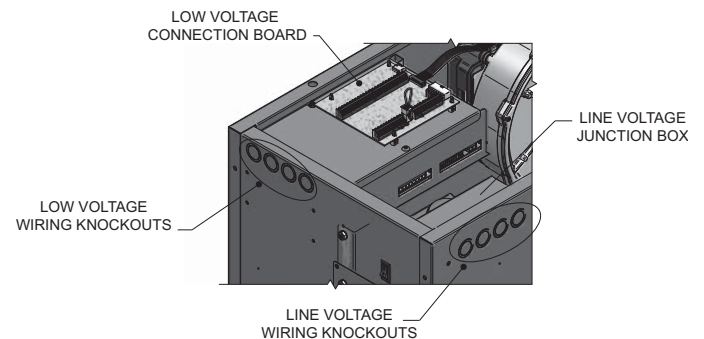
### Low voltage connections

1. Route all low voltage wires through the knockouts in the rear of the boiler, as shown in FIG. 8-2.
2. Connect low voltage wiring to the low voltage connection board as shown in FIG. 8-3 on page 53 of this manual and the boiler wiring diagram.

**Figure 8-1** Line Voltage Field Wiring Connections



**Figure 8-2** Routing Field Wiring



## 8 Field wiring *(continued)*

### Thermostat

1. Connect the room thermostats or end switches (isolated contact only) to room thermostat 1, 2, or 3, as shown in FIG. 8-3.
2. Install the thermostat on the inside wall away from influences of drafts, hot or cold water pipes, lighting fixtures, television, sunlight, or fireplaces.
3. Thermostat anticipator (if applicable):
  - a. If connected directly to boiler, set for 0.1 amps.
  - b. If connected to relays or other devices, set to match total electrical power requirements of connected devices. See device manufacturers' specifications and thermostat instructions for details.

### Outdoor temperature sensor

1. Mount the sensor on an exterior wall, shielded from direct sunlight or flow of heat or cooling from other sources.
2. Route sensor wires through a knockout at the rear of the boiler (see FIG. 8-2).
3. Connect the outdoor temperature sensor (FIG. 8-3) to the outdoor sensor terminals on the connection board to enable outdoor reset operation of the Knight XL. Do not install the outdoor sensor.

### DHW (Domestic Hot Water) thermostat

Connect storage indirect water heater (DHW) thermostat (FIG. 8-3) to the DHW thermostat terminals on the connection board. If a tank sensor is connected (see DHW Tank Sensor below) the tank thermostat is ignored.

### DHW tank sensor

By installing a tank sensor, the SMART SYSTEM control can perform the tank thermostat function. The SMART SYSTEM control automatically detects the presence of this sensor, and generates a DHW call for heat when the tank temperature drops 6°F (3°C) below the tank set point, and finishes the call for heat when the tank temperature reaches the tank set point. The tank sensor included with the Lochinvar Squire® indirect DHW tanks (TST20015) is the only sensor suitable for use with the SMART SYSTEM control. Connect the sensor leads to the Tank Sensor terminals on the low voltage connection board (FIG. 8-3). Consult the tank manufacturer for application and performance when used with any other indirect tank.

#### WARNING

Failure to use the correct sensor may result in the tank temperature being either above or below the set point. Failure to consult the manufacturer of the indirect tank, when the Squire is not used, may result in decreased performance or the risk of scald injury.

If TST20015 is not compatible with the indirect tank, a tank thermostat can be used to control the boiler. The tank thermostat should be installed per the manufacturer's instructions and wired to the DHW Thermostat terminals on the low voltage connection board (FIG. 8-3).

### Louver proving switch

1. When the operation of the louvers needs to be verified before the boiler fires, remove the jumper wire from these terminals and connect them to the normally open contacts on its proving switch (FIG. 8-3).

### High gas pressure switch

1. If a switch is provided to detect excessive gas pressure, remove the jumper wire from the terminals on the connection board, and then connect them to its normally closed contacts (FIG. 8-3).

### Low gas pressure switch

1. If a switch is provided to detect low gas pressure, remove the jumper wire from the terminals on the connection board and connect them to its normally open contacts (FIG. 8-3).
2. If both a high and low gas pressure switch is used, connect their respective contacts in series, and connect them to the terminals on the connection board (FIG. 8-3).

### Variable speed system pump

If a variable speed pump is used in the primary loop, and a 0-10V signal is available from the pump speed control, this signal can be used by the SMART SYSTEM control to anticipate changes in the building heat load. By connecting this 0 - 10V signal to the 0 - 10V SYS PUMP IN terminals, the boiler (or cascade) can modulate up and down as the primary flow increases and decreases.

### Boiler pump speed output

This 0 - 10V output is available to control the speed of a variable speed boiler pump. The SMART SYSTEM control will vary the speed of this pump in order to maintain a minimum  $\Delta T$  across the heat exchanger, as well as prevent high limit lockouts when the flow in the primary loop is extremely low. Connect this output to the 0 - 10V input on the boiler pump speed control.

### Rate output

This output provides a 0 - 10V signal that is proportional to the firing rate of the boiler. This may be used by a BMS system to monitor the actual rate of the boiler.

## 8 Field wiring

### Modbus

When the optional ModBus interface module is installed, the RS-485 ModBus cable is connected to these terminals. Use shielded, 2-wire twisted pair cable. If desired, the shield can be connected to ground by installing a jumper wire between terminals 1 and 3 on connector X5 on the optional ModBus interface module.

### Flow switch

1. A flow switch is used to guarantee flow through the boiler before allowing it to fire. The flow switch must be installed at the boiler outlet.
2. Remove the jumper wire from the terminals on the connection board and connect these terminals to the normally open contacts on the flow switch (FIG. 8-3).

### System supply sensor

1. By installing the system supply sensor into the supply of the primary loop, the temperature of the system supply can be controlled. The SMART SYSTEM control automatically detects the presence of this sensor, and controls the boiler firing rate to maintain the system supply temperature to the set point (if the outlet sensor control is currently selected). See the Knight XL Service Manual for instructions on how to use the inlet sensor as the controlling sensor. When the inlet sensor is programmed as the controlling sensor, it is vital that the SYSTEM SUPPLY sensor be installed. **DO NOT INSTALL THE SYSTEM SUPPLY SENSOR INTO THE SYSTEM RETURN.**
2. The TST2032 sensor provided with the boiler must be used for the system sensor.
3. Connect these terminals to the system supply sensor (FIG. 8-3).

### Boiler management system

1. An external control may be connected to control either the firing rate or the set point of the boiler. If the external control uses a set of contacts to enable the boiler, connect the contacts to the Room Thermostat 1 terminals. Otherwise, the SMART SYSTEM control will be enabled by the 0-10V signal.
2. Make sure the ground terminal is connected to the ground output terminal of the external control, and the 0 - 10 VDC terminal is connected to the 0 - 10 VDC terminal of the external control.

### Runtime contacts

The SMART SYSTEM control closes a set of dry contacts whenever the burner is running. This is typically used by Building Management Systems to verify that the boiler is responding to a call for heat.

### Alarm contacts

The SMART SYSTEM control closes another set of contacts whenever the boiler is locked out or the power is turned off. This can be used to turn on an alarm, or signal a Building Management System that the boiler is down.

### Wiring of the cascade

When wiring the boilers for Cascade operation, select one boiler as the Leader boiler. The remaining boilers will be designated as Members. See page 60 "Configuration of the Cascade" for a detailed explanation of this procedure.

Connect the system supply sensor and outdoor air sensor (if used) to the Leader boiler. For the Cascade system to work properly the system supply sensor must be installed. The location of the system supply sensor should be downstream of the boiler connections in the main system loop (FIG.'s 6-7 through 6-11). The system supply sensor should be wired to the Low Voltage Connection Board at the terminals marked for the system sensor (see FIG. 8-3). The Leader control will use the water temperature at the system supply sensor to control the operation of the Cascade.

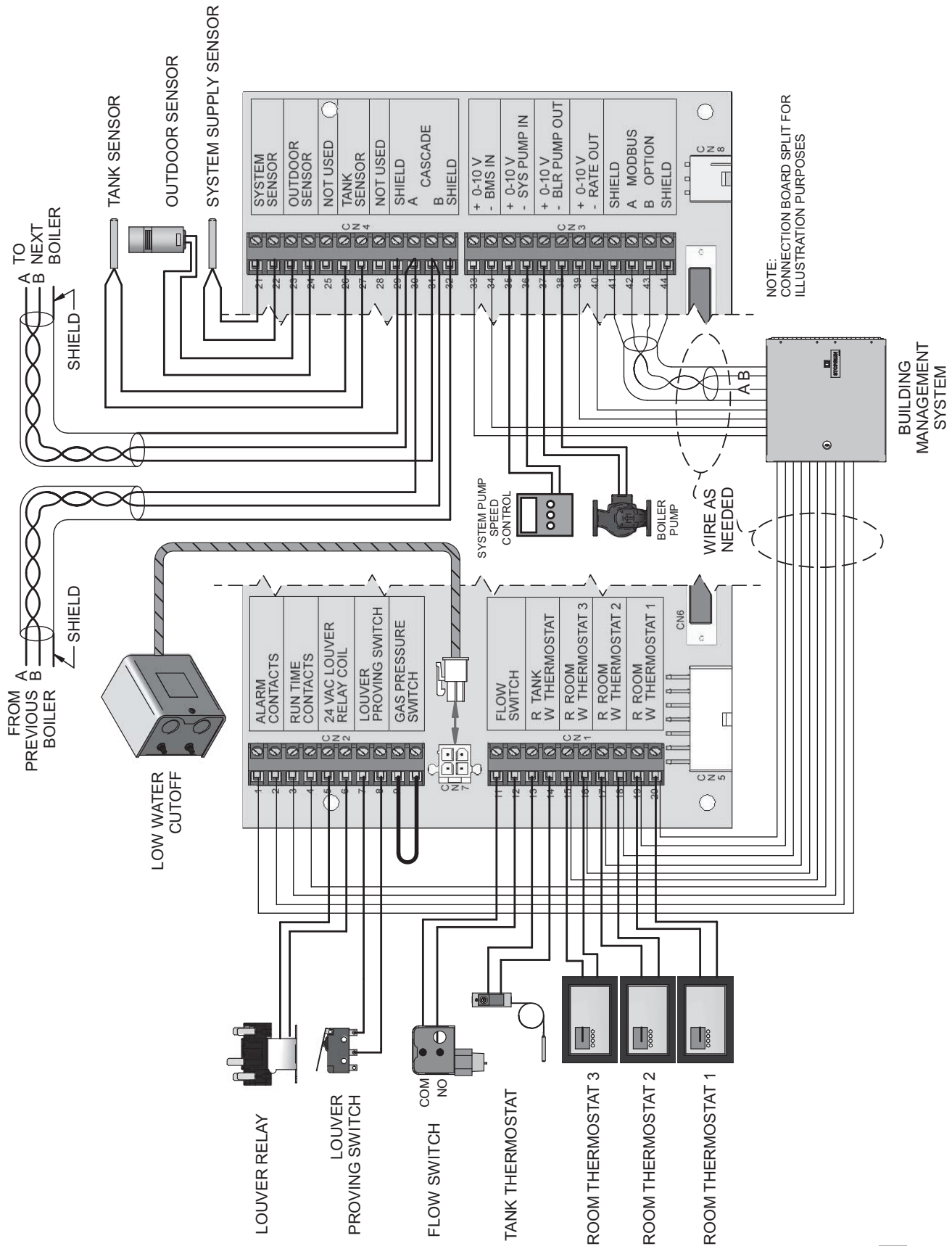
If outdoor air reset is desired, the outdoor air sensor should be wired to the Low Voltage Connection Board at the terminals marked for the outdoor air sensor (FIG. 8-3). If the outdoor air sensor is connected, the Leader control will calculate the water temperature set point based on the programmed reset curve parameters. If the outdoor air sensor is not connected, the Leader control will maintain the fixed water temperature set point that is programmed into the control.

If a Thermostat or Zone Control enable output is available, it should be wired to the Low Voltage Connection Board on the Leader boiler at the terminals marked for one of the Room Thermostats 1-3 (FIG. 8-3). If the boilers are to run continuously, connect a jumper wire between the R and W terminals for the Thermostat input. This will initiate a call for heat on the Cascade.

Communication between the Leader boiler and the Member boilers is accomplished by using shielded, 2-wire twisted pair communication cable. Connect one of the twisted pair wires to Cascade terminal A on each of the Low Voltage Connection boards, and the other wire of the twisted pair to Cascade terminal B on each of the Low Voltage Connection Boards. Connect the shield wires to one of the shield terminals on the Low Voltage Connection Boards (FIG. 8-3). If more than two boilers are on the Cascade, daisy chain the wiring from the Cascade terminals on the second boiler to the Cascade terminals on the third boiler, then from the third to the fourth, and so on. The connections between boilers can be made in any order, regardless of the addresses of the boilers. Try to keep each cable as short as possible.

## 8 Field wiring *(continued)*

**Figure 8-3** Low Voltage Field Wiring Connections



## 9 Condensate disposal

### Condensate drain

1. This boiler is a high efficiency appliance that produces condensate.
2. The side of the boiler has a 1/2 inch (12.7 mm) PVC union for connection of a 1/2 inch (12.7 mm) PVC pipe (FIG. 9-1).
3. Slope condensate tubing down and away from the boiler into a drain or condensate neutralizing filter. Condensate from the Knight XL will be slightly acidic (typically with a pH from 3 to 5). Install a neutralizing filter if required by local codes.

A Neutralizer Kit (FIG. 9-1) is available from the factory (KIT3087 for Models 400 - 501 and KIT3046 for Models 601 - 801).

4. Install the 1/2 inch (12.7 mm) PVC tee assembly (shipped with the unit) as shown in FIG. 9-1.
5. Leave the top of the 1/2 inch (12.7 mm) tee OPEN. This is needed as a vacuum break.
6. Do not expose condensate line to freezing temperatures.
7. Use only plastic tubing or piping as a condensate drain line (FIG. 9-1).

#### NOTICE

Use materials approved by the authority having jurisdiction. In the absence of other authority, PVC and CPVC pipe must comply with ASTM D1785 or D2845. Cement and primer must comply with ASME D2564 or F493. For Canada use CSA or ULC certified PVC or CPVC pipe, fittings, and cement.

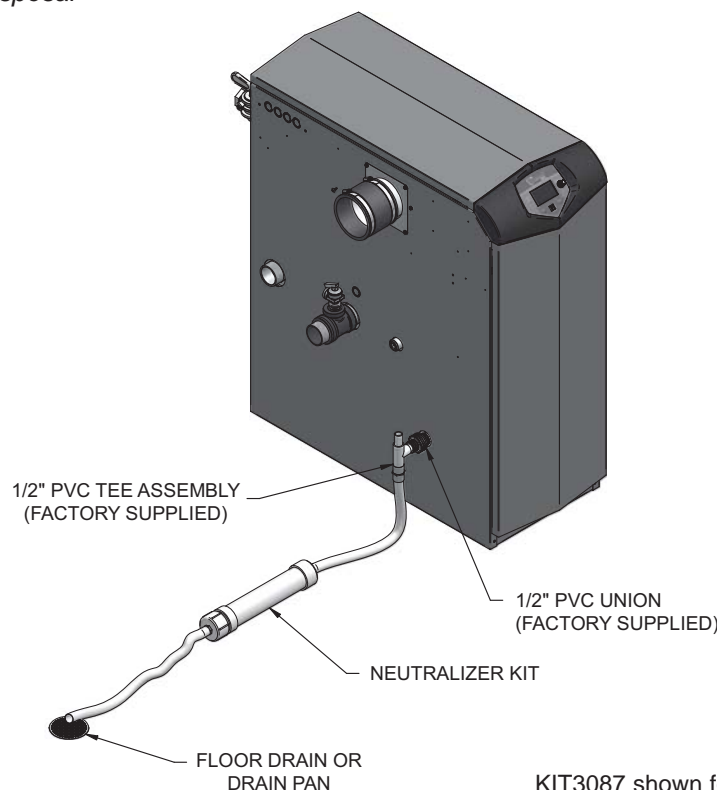
#### NOTICE

To allow for proper drainage on large horizontal runs, a second line vent may be required and tubing size may need to increase to 1 inch (25 mm).

The condensate line must remain unobstructed, allowing free flow of condensate. If condensate is allowed to freeze in the line or if the line is obstructed in any other manner, condensate can exit from the boiler tee, resulting in potential water damage to property.

8. A condensate removal pump is required if the boiler is below the drain. When installing a condensate pump, select one approved for use with condensing boilers and furnaces. The pump should have an overflow switch to prevent property damage from condensate spillage. The switch should be wired in series with the blocked drain switch inside the boiler (see FIG. 10-1 on page 56).

**Figure 9-1** Condensate Disposal



KIT3087 shown for illustration purposes.



# 10 Start-up

## Check/control water chemistry

### ⚠ CAUTION

Do not use petroleum-based cleaning or sealing compounds in the boiler system. Damage to elastomer seals and gaskets in the system could occur, resulting in substantial property damage.

### Hardness less than 7 grains

1. Consult local water treatment companies for hard water areas (above 7 grains hardness).

### Chlorine concentration less than 200 ppm

1. Do not fill boiler or operate with water containing chlorine in excess of 200 ppm.
2. Filling with chlorinated fresh water should be acceptable since drinking water chlorine levels are much lower.
3. Do not use the boiler to directly heat swimming pool or spa water.

### Test/replace freeze protection fluid

1. For systems using freeze protection fluids, follow fluid manufacturer's instructions.
2. Freeze protection fluid must be replaced periodically due to degradation of inhibitors over time. Follow all fluid manufacturer's instructions.

### Freeze protection (when used)

1. Determine freeze protection fluid quantity using system water content, following fluid manufacturer's instructions. Boiler water content is listed on page 7. Remember to include expansion tank water content.
2. Local codes may require a backflow preventer or actual disconnect from city water supply.
3. When using freeze protection fluid with automatic fill, install a water meter to monitor water makeup. Freeze protection fluid may leak before the water begins to leak, causing concentration to drop, reducing the freeze protection level.
4. The freeze protection set points may be lowered when freeze protection fluid is used (see the Knight XL Service Manual).

### Fill and test water system

1. Fill system only after ensuring the water meets the requirements of this manual.
2. Close manual and automatic air vents and boiler drain valve.

3. Fill to correct system pressure. Correct pressure will vary with each application.
  - a. The minimum cold water fill pressure for a commercial system is 12 psi (82.7 kPa).
  - b. Pressure will rise when boiler is turned on and system water temperature increases.
4. At initial fill and during boiler startup and testing, check system thoroughly for any leaks. Repair all leaks before proceeding further.

### ⚠ WARNING

Eliminate all system leaks. Continual fresh makeup water will reduce boiler life. Minerals can build up in the heat exchanger, reducing heat transfer, overheating the heat exchanger, and causing heat exchanger failure.

## Purge air from water system

1. Purge air from system:
  - a. Connect a hose to the purge valve (see purge/drain valves, in piping diagrams on page 46). Route the hose to an area where water can drain and be seen.
  - b. Close the boiler or system isolation valve between the purge valve and fill connection to the system.
  - c. Close zone isolation valves.
  - d. Open quick-fill valve on cold water makeup line.
  - e. Open purge valve.
  - f. One zone at a time, open the isolation valves. Allow water to run through the zone, pushing out the air. Run until no noticeable air flow is present. Close the zone isolation valves and proceed with the next zone. Follow this procedure until all zones are purged.
  - g. Close the quick-fill water valve and purge valve and remove the hose. Open all isolation valves. Watch that system pressure rises to correct cold-fill pressure.
  - h. After the system has operated for a while, eliminate any residual air by using the manual air vents located throughout the system.
  - i. If purge valves are not installed in the system, open the manual air vents in the system one at a time, beginning with the lowest floor. Close the vent when water squirts out. Repeat with remaining vents.
2. Open automatic air vent (diaphragm-type or bladder-type expansion tank systems only) one turn.
3. Open other vents:
  - a. Starting on the lowest floor, open air vents one at a time until water squirts out.
  - b. Repeat with remaining vents.
4. Refill to correct pressure.

# 10 Start-up

## Check for gas leaks

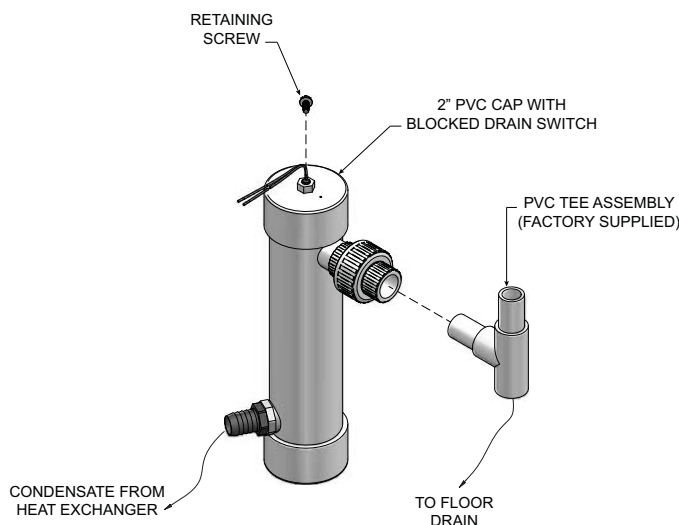
### ⚠ WARNING

Before starting the boiler, and during initial operation, smell near the floor and around the boiler for gas odorant or any unusual odor. Remove the top access panel and smell the interior of the boiler enclosure. Do not proceed with startup if there is any indication of a gas leak. Use an approved leak detection solution. Repair any leaks at once.

### ⚠ WARNING

DO NOT adjust or attempt to measure gas valve outlet pressure. The gas valve is factory set for the correct outlet pressure. This setting is suitable for natural gas and propane, requiring no field adjustment. Attempting to alter or measure the gas valve outlet pressure could result in damage to the valve, causing potential severe personal injury, death, or substantial property damage.

**Figure 10-1 Condensate Trap**



### ⚠ WARNING

Propane boilers only – Your propane supplier mixes an odorant with the propane to make its presence detectable. In some instances, the odorant can fade, and the gas may no longer have an odor. Before startup (and periodically thereafter), have the propane supplier verify the correct odorant level in the gas.

## Check thermostat circuit(s)

1. Disconnect the two external wires connected to each of the room thermostat terminals on the connection board.
2. Connect a voltmeter across these two incoming wires. Close each thermostat, zone valve, and relay in the external circuit one at a time and check the voltmeter reading across the incoming wires.
3. There should NEVER be a voltage reading.
4. If a voltage does occur under any condition, check and correct the external wiring. (This is a common problem when using 3-wire zone valves.)
5. Once the external thermostat circuit wiring is checked and corrected if necessary, reconnect the external thermostat circuit wires to the connection board. Allow the boiler to cycle.

## Inspect/fill condensate system

### Inspect/check condensate lines and fittings

1. Inspect the condensate drain line, condensate PVC fittings and condensate trap.

### Fill condensate trap with water

1. Remove the PVC cap retaining screw from the PVC cap (FIG. 10-1).
2. Remove the 2 inch PVC cap with the switch located at the top of the trap (FIG. 10-1).
3. Fill with fresh water until the water begins to pour out of the drain.
4. Replace the cap. Press the cap onto the trap until the cap makes contact with the drain.
5. Replace the retaining screw.

### ⚠ WARNING

The condensate trap (FIG. 10-1) must be filled with water during all times of boiler operation to avoid flue gas emission from the condensate drain line. Failure to fill the trap could result in severe personal injury or death.

# 10 Start-up *(continued)*

## Final checks before starting the boiler

- ❑ Read the Knight XL Service Manual to familiarize yourself with SMART SYSTEM control module operation. Read this manual, page 58 for proper steps to start boiler.
- ❑ Verify the boiler and system are full of water and all system components are correctly set for operation.
- ❑ Verify the preparation procedures of Section 10, pages 55 and 56 have been completed.
- ❑ Fill the vent condensate trap with water (removing the retaining screw in order to remove the 2 inch PVC cap with the switch located at the top of the trap). Replace the cap. Press the cap onto the trap until the cap makes contact with the drain. Replace the retaining screw.
- ❑ Verify electrical connections are correct and securely attached.
- ❑ Inspect vent piping and air piping for signs of deterioration from corrosion, physical damage or sagging. Verify air piping and vent piping are intact and correctly installed per this manual.

## Start the boiler

1. Read and follow the Operating instructions in FIG. 10-2, page 58.

## If boiler does not start correctly

1. Check for loose connections, blown fuse or service switch off?
2. Is boiler water temperature above 200°F (93°C)?
3. Is thermostat set below room temperature?
4. Is gas turned on at meter or boiler?
5. Is incoming gas pressure less than 4 inches w.c. (.99 kPa)?

If none of the above corrects the problem, refer to the Troubleshooting Section of the Knight XL Service Manual.

## Check system and boiler

### ❑ Check water piping

1. Check system piping for leaks. If found, shut down the boiler and repair immediately. (See WARNINGS on pages 55 and 56 (startup) regarding failure to repair leaks.)
2. Vent any remaining air from the system using manual vents. Air in the system will interfere with circulation and cause heat distribution problems and noise.

### ❑ Check vent piping and air piping

1. Check for gastight seal at every connection, seam of air piping, and vent piping.

#### **WARNING**

Venting system must be sealed gastight to prevent flue gas spillage and carbon monoxide emissions, which will result in severe personal injury or death.

### ❑ Check gas piping

1. Check around the boiler for gas odor following the procedure on page 46 of this manual (connecting gas supply piping).

#### **WARNING**

If you discover evidence of any gas leak, shut down the boiler at once. Find the leak source with a bubble test and repair immediately. Do not start the boiler again until corrected. Failure to comply could result in severe personal injury, death, or substantial property damage.

### ❑ Propane boilers – verify conversion

1. Verify propane conversion has been completed per the Propane Conversion instructions.

#### **WARNING**

DO NOT adjust or attempt to measure gas valve outlet pressure. The gas valve is factory-set for the correct outlet pressure. This setting is suitable for natural gas and propane, requiring no field adjustment. Attempting to alter or measure the gas valve outlet pressure could result in damage to the valve, causing potential severe personal injury, death, or substantial property damage.

#### **WARNING**

Knight XL boilers are typically shipped ready to fire on natural gas. Check boiler rating plate to determine which fuel the boiler is set for. If set to natural gas, it may be converted to LP by installing an orifice or by making a gas valve adjustment (see pages 13 and 14). In order to operate on LP gas, an orifice **MUST BE** installed or a gas valve adjustment **MUST BE** made. Failure to comply could result in severe personal injury, death, or substantial property damage.

## Check flame and combustion

1. Turn the main power off to the boiler by placing the “On/Off” switch in the OFF position.
2. Remove the flue temperature sensor from the flue pipe connection. **NOTE:** Combustion measurements will be made at this point.
3. Turn the main power on to the boiler by placing the “On/Off” switch in the ON position.

# 10 Start-up

**Figure 10-2 Operating Instructions**

## FOR YOUR SAFETY READ BEFORE OPERATING

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

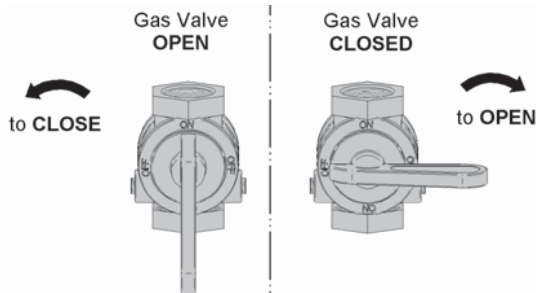
- A. This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
  - B. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.
  - C. Use only your hand to turn the gas control knob. Never use tools. If the handle 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.
- 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.

### 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.

## OPERATING INSTRUCTIONS

1. **STOP!** Read the 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. Remove top cover.
6. Turn gas shutoff valve counterclockwise to "OFF". Handle will be perpendicular to pipe. Do not force.
7. Wait five (5) minutes to clear out any gas. If you then smell gas, **STOP!** Follow "B" in the safety information above on this label. If you don't smell gas, go to next step.
8. Turn gas shutoff valve clockwise to "ON". Handle will be parallel to pipe.
9. Install top cover.
10. Turn on all electric power to appliance.
11. Set thermostat to desired setting.
12. If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.



## TO TURN OFF GAS TO APPLIANCE

1. Set the thermostat to lowest setting.
2. Turn off all electric power to the appliance if service is to be performed.
3. Remove top cover.
4. Turn gas shut off valve counterclockwise to "OFF". Handle will be perpendicular to pipe. Do not force.
5. Install top cover.

LBL2284 REV -

# 10 Start-up *(continued)*

## Check flame and combustion *(continued)*

4. Place the boiler into the active position by pressing the RIGHT SELECT [ON] key (FIG. 11-1, page 67).
5. Locate the pinhole button below the RESET button on the display board (FIG. 11-1). Insert a thin wire (such as a paper clip) into the hole and press the button once and hold for 5 seconds to place the boiler into Service Mode. In Service Mode the boiler will fire at ignition speed and will then modulate up to full fire.
6. Insert the probe from a combustion analyzer into the hole left by the removal of the flue temperature sensor.
7. Once the boiler has modulated up to full fire, measure the combustion. The values should be in the range listed in Table 10A below. The CO levels should be less than 150 ppm for a properly installed unit.

If the combustion is not within the specified range, reference the Troubleshooting Section of the Knight XL Service Manual for possible causes and corrective actions.

**Table 10A Flue Products Chart**

Natural Gas		Propane	
CO <sub>2</sub>	O <sub>2</sub>	CO <sub>2</sub>	O <sub>2</sub>
8.0% - 10%	3.0% - 6.5%	9.0% - 11%	4.1% - 6.9%

8. Once the combustion analysis is complete, test the safety shutoff device by turning the manual shutoff valve to the OFF position and ensuring that the boiler shuts down and registers an alarm. Open the manual shutoff valve, reset the control, and return to Service Mode.
9. Turn the main power off to the boiler and replace the flue temperature sensor into the flue pipe connection.
10. Place the boiler back into normal operation.

**⚠ WARNING** You must replace the flue gas temperature sensor to prevent flue gas spillage into the room. Failure to comply could result in severe personal injury, death, or substantial property damage.

## Set space heating operation

### Determine controlling sensor

For space heating systems, the temperature control can be based on one of three sensors; the inlet, outlet, or system supply sensor. The SMART SYSTEM control is programmed at the factory to control the temperature of the outlet sensor. The control will automatically switch to the system supply sensor once it is connected. If it is desired to base the temperature control on the inlet sensor, the appropriate parameter must be changed in the control. See the Knight XL Service Manual for a detailed explanation of this procedure.

### Verify space heat circulator mode

The Space Heating Mode controls both the system (primary) pump (if connected), and the boiler (secondary) pump. When the SMART SYSTEM control receives a space heating call for heat, it turns on the system pump. If the boiler is not heating an indirect DHW (Domestic Hot Water) tank, and the set point is not met, it also turns on the boiler pump. After the space heating call for heat ends, the system pump continues to run for a short period of time. The system pump can be programmed to run continuously, except during outdoor shutdown. If the boiler pump was running, it continues to run for a short period of time as well. These pump delays are factory set to 30 seconds. If different delays are desired, the appropriate parameters in the control must be changed. See the Knight XL Service Manual for a detailed explanation of this procedure.

### Adjust set point temperature

#### NOTICE

Please note that the brackets ([ ]) denote screen status.

The NAVIGATION dial may be used during normal operation to adjust the space heating and tank set point temperatures.

1. From the Status Screen press the NAVIGATION dial.
2. Turn the NAVIGATION dial counterclockwise to select the appropriate set point.
3. Press the NAVIGATION dial to adjust the temperature.
4. Once the desired temperature is displayed, press the RIGHT SELECT [SAVE] key.
5. If necessary repeat Steps 3 and 4 to make adjustments to additional set points.
6. Press the RIGHT SELECT [HOME] key to upload the changes.
7. If the RIGHT SELECT [SAVE] key is not pressed, the new settings will be discarded.



# 10 Start-up

## Set domestic hot water (DHW) operation

### Verify DHW mode

There are two (2) modes of operation for DHW. In Normal Mode, when a DHW demand begins, the control will start the DHW pump, turn off the boiler pump (if running), and modulate to bring the outlet temperature to the DHW boiler set point. The maximum firing rate may be limited in this mode if desired.

In Zone Mode it is assumed that the indirect DHW tank is piped as a zone on the primary loop. When a DHW demand begins, the control will turn on the DHW pump output, and raise the system temperature set point to the DHW boiler set point (if higher). The system pump and the boiler pump will be turned on. In this mode, any low temperature zones (such as radiant heating) may need additional controls to limit the water temperature sent to those zones.

### Set DHW target temperature

When in the DHW Mode, the control will modulate to maintain the boiler outlet temperature or system supply temperature to a set point. This set point is set at the factory to 180°F. If a different set point is desired, the appropriate parameter in the control must be changed. See the Knight XL Service Manual for a detailed explanation of this procedure.

### Set maximum DHW fan speed

If the rated input of the indirect tank is less than the maximum output of the boiler, change the maximum DHW fan speed setting to limit the boiler output accordingly, see the Knight XL Service Manual for a detailed explanation of this procedure.

### Set clock

#### NOTICE

Please note that the brackets ([ ]) denote screen status.

The SMART SYSTEM control has a built-in clock that it uses for its night setback feature and for logging events. This clock must be set when the boiler is installed, and anytime the boiler has been powered off for more than 4 hours. Use the following procedure to set the clock:

1. Press and hold the LEFT SELECT [MENU] key for at least 5 seconds.
2. The display changes to read [PASSWORD], with four (4) zeros below it.
3. Press the RIGHT SELECT [SAVE] key.
4. The display will then show a menu with the time and date and temperature unit.
5. Press the NAVIGATION dial twice.
6. Turn the NAVIGATION dial to adjust the hours. Press the NAVIGATION dial.

7. Turn the NAVIGATION dial to adjust the minutes. Press the NAVIGATION dial.
8. Turn the NAVIGATION dial to adjust the month. Press the NAVIGATION dial.
9. Turn the NAVIGATION dial to adjust the date. Press the NAVIGATION dial.
10. Turn the NAVIGATION dial to adjust the year. Press the RIGHT SELECT [SAVE] key.
11. Press the RIGHT SELECT [HOME] key.

#### NOTICE

The internal clock does not adjust for Daylight Savings Time and therefore, will require a manual adjustment.

### Configuration of the cascade

#### NOTICE

Please note that the brackets ([ ]) denote screen status.

When installed in a Cascade system, the individual controls must be programmed for cascade operation. This is accomplished by accessing the control parameters.

Press the [MENU] key for at least five (5) seconds. Input the Installer code as described in the Knight XL Service Manual. Once the control parameters have been accessed, use the NAVIGATION DIAL to select the Control Mode parameters. Press the NAVIGATION DIAL to access these parameters.

Rotate the NAVIGATION dial to select the parameter "Cascade Address". Press the NAVIGATION dial to access this parameter. Each appliance in the Cascade system must be programmed with its own address. The boiler designated as the Leader will have an address of 0. The remaining boilers in the Cascade will be Members and have addresses from 1 - 7. Rotate the NAVIGATION dial to select the appropriate address. Press the RIGHT SELECT [SAVE] key. If installing the boilers in an existing system, the new boilers should be programmed as the Leader and/or the higher number addresses.

Press the RIGHT SELECT [HOME] key to upload the address into the control. Repeat this procedure for all boilers in the Cascade, designating the Leader control and the Member controls.

# 11 Operating information

## General

### How the boiler operates

The Knight XL uses an advanced stainless steel heat exchanger and electronic control module that allows fully condensing operation. The blower pulls in air and pushes flue products out of the boiler through the heat exchanger and flue piping. The control module regulates blower speed to control the boiler firing rate. The gas valve senses the amount of air flowing into the boiler and allows only the right amount of gas to flow.

### How the control module operates

The SMART SYSTEM control module receives inputs from boiler sensors and external devices. The control module activates and controls the blower and gas valve to regulate heat input and switches the boiler, Domestic Hot Water (DHW), and system pumps on and off as needed. The user programs the module to meet system needs by adjusting control parameters. These parameters set operating temperatures and boiler operating modes. Boiler operation can be based on boiler outlet water temperature, boiler inlet water temperature, system temperature, a 0 - 10V signal, or Modbus, depending on the parameter settings.

## Control inputs and outputs

### Room thermostat

There are three (3) thermostat connections available on this control. These inputs tell the boiler to provide water for space heating. Each thermostat connection has its own set point and outdoor air reset curve. When multiple thermostats have a call for heat the control will give priority to the demand with the highest set point.

*Example:* Assume that both Room Thermostat 1 and Room Thermostat 2 have a call for heat. Room Thermostat 1 has a set point of 110°F. Room Thermostat 2 has a set point of 140°F. The boiler will regulate the system temperature to 140°F until Room Thermostat 2 has been satisfied. Once Room Thermostat 2 has been satisfied the boiler will provide 110°F water to the system.

#### ⚠ CAUTION

When multiple temperature loops are used, thermostatic mixing valves are required for the protection of any low temperature loops.

### 0 - 10V input (set point or power)

The Knight XL can be controlled by a Building Management System (BMS) using a 0 - 10 VDC signal. The control can be configured by the installer to use this signal to either control set point or firing rate.

The Knight XL can also be programmed to accept a call for heat from a 0 - 10V signal, reference the Knight XL Service Manual for a detailed explanation of this procedure.

### DHW priority

The SMART SYSTEM control allows the connection of a DHW thermostat or tank sensor to the low voltage connection board. When a tank sensor is connected, the DHW thermostat input is ignored.

### DHW / space heating (SH) cycling

If a DHW call for heat is received while a space heating call is in progress and the DHW is in Normal Mode, the control will start the DHW pump and shut the boiler pump off. The system pump will remain on. If the space heating call is still active while the DHW call is in operation, the control will wait for 30 minutes (time adjustable by installer) then it will switch back to the space heating demand. There is a timer to switch from space heating to DHW and a timer to switch from DHW to space heating. The control will switch back and forth until one of the heat demands end. This function does not apply to cascade systems.

### Programmable controlling sensor

The control module is programmed to use the outlet sensor as the control sensor by default. If a system supply sensor is connected, the control automatically uses it as the control sensor. The control sensor can be changed by the installer to the inlet sensor. If the inlet sensor is chosen as the controlling sensor, it is recommended that the system supply sensor be installed in the system supply in order to provide the best control of the inlet temperature.

### Anti-cycling

After the burner turns off, the control will delay the next burner cycle for a set time period (time is adjustable by the installer). The time delay will be bypassed if the inlet water temperature drops too far during the delay.

### Boiler and system pump control

The boiler pump will run whenever the burner is firing, unless the DHW is programmed for Normal Mode and the boiler is heating the DHW tank. The boiler pump will run during Freeze Protection Mode as well. It will continue to run for a short time after the burner turns off or the Freeze Protection Mode ends.

The system pump will run whenever there is a space heating call for heat, or the boiler goes into Freeze Protection Mode. It will continue to run for a short time after the end of the heat demand or the Freeze Protection Mode. The system pump can be programmed to run continuously if desired. In either case, it will not run during outdoor shutdown.

## Temperature control

### Modulation

The Knight XL is capable of modulating its firing rate from a minimum of 20% to a maximum of 100%. The firing rate is dictated by the call for heat (i.e., space heating or domestic hot water), the heating load, ramp delay (if enabled), and various other temperature limitations.

# 11 Operating information

## Ramp delay

For systems with lower flow, the SMART SYSTEM can limit the firing rate (when enabled) when a space heating call for heat starts, or when switching from a DHW call for heat to a space heating call for heat. There are six (6) limits that can be programmed, as well as six (6) time intervals corresponding to each limit. The sixth limit will also limit the firing rate for the rest of the call for heat.

## Gradient limiting

If during operation of the boiler the outlet water temperature is rising too quickly, the control will reduce the firing rate to its lowest setting.

## Outdoor air reset

If an outdoor air sensor is connected, the control module will calculate the set points of the three (3) space heating demands based on the programmed reset curves. The installer can change the slope of the reset curves by several adjustable parameters. The user can limit the maximum set point for the system using the space heating set points.

## Boost function

If outdoor air reset is active, and any space heating demand has been active continuously for a set period of time (time adjustable by installer) and there has been no DHW demands, the control will increase the set point of that demand by a fixed number of degrees (adjustable by installer). This process will continue until the space heating demand ends, the set point reaches the programmed set point or a maximum of 20 increases has occurred. Once the system heat demand is satisfied, the set point will revert to the value determined by the reset curve.

## Night setback

The controller may be programmed to reduce the space heating and DHW set points during certain times each week. Seven different start and stop times may be programmed for the space heating setback and seven start and stop times for the DHW setback.

## Flame current support

To prevent nuisance shutdowns when the boiler is firing at minimum rates, the control will increase the firing rate when the flame signal drops too low.

## Protection features

### Outlet temperature, flue temperature, and temperature rise limiting

The outlet temperature is monitored by the boiler outlet temperature sensor. When the outlet temperature exceeds 185°F, the unit will reduce the fan speed. If the outlet water temperature exceeds 195°F (90°C) the control will shut the unit down until it cools off.

The control module monitors the flue temperature by a sensor located in the flue exhaust. If the flue temperature exceeds 215°F (102°C) the control will reduce the maximum fan speed. If the flue temperature exceeds 240°F (115°C) the control will shut the unit down. The unit will restart automatically once the flue temperature drops 25°F (-4°C) and the minimum off time has expired.

The control monitors the temperature difference between the inlet and the outlet sensor. If this difference exceeds 55°F (13°C) the control will reduce the maximum fan speed. If the temperature difference exceeds 60°F (15°C) the control will shut the unit down. The unit will restart automatically once the temperature difference has dropped below 55°F (13°C) and the minimum off time has expired.

### Freeze protection

DO NOT install the boiler in a room likely to freeze.

The following integral feature of the SMART SYSTEM control module provides some protection for the boiler only -- not for the system.

- The SMART SYSTEM control module provides freeze-up protection as follows when the boiler water temperature drops below 45°F (7°C):
- Below 45°F (7°C), the boiler and system pumps operate constantly.
- Below 37°F (3°C), the boiler turns on.
- Boiler and pumps turn off if boiler water temperature rises above 45°F (7°C).
- Lower temperatures may be programmed for systems with anti-freeze solutions.

#### NOTICE

When system return temperatures are maintained below the dew point, condensation will form on the inside of the boiler jacket causing some internal sheet metal components to rust.

#### CAUTION

This feature of the SMART SYSTEM control module does not eliminate the possibility of freezing. The installation must still use recognized design, installation and maintenance practice to prevent freeze potential for the boiler and system.

# 11 Operating information *(continued)*

## Monitor external limits

Connections are provided on the connection board for external limits such as flow switch, low water cutoff, gas pressure switches, and a louver proving switch. The SMART SYSTEM will shut off the burner and inhibit relighting whenever any of these external limits open.

## Run-time and alarm outputs

The boiler provides dry contacts for indicating when the boiler is running, and when it is unable to operate.

## Run-time and cycle counting

The control uses two timers to monitor the total hours of burner operation. One timer monitors the time the boiler is in the Space Heating Mode. The other timer monitors the time the boiler is firing in the DHW Mode.

The control uses two (2) ignition counters to monitor the amount of boiler cycles. The first counter counts all ignitions of the control. The second counter counts only ignition attempts that have failed.

## Service reminder

The control can be programmed for service reminder notification. This notification will become active when either a set time frame has expired, or a set amount of running hours or cycles has expired (all adjustable by the installer). The display will show a Maintenance Required screen. The service reminder notification can be reset or disabled by the installer.

The time dependent feature has been disabled by the manufacturer. To enable this feature change parameter **K1** to the desired time range, reference the Knight XL Service Manual for details regarding parameters.

## Error logging

The control will hold in memory the last 10 lockouts as well as the last 10 blockings. The date and time of the occurrence will be recorded as well. Only the 10 most current occurrences of each will be held in memory.

## Boiler temperature regulation

### Operating temperature (target)

The SMART SYSTEM control module senses water temperature and regulates boiler firing and firing rate to achieve a target temperature. The target temperature can be set between 70°F (21°C) and 190°F (88°C).

- Target temperature is fixed when the outdoor sensor is not installed.
- Target temperature is calculated as described on this page under “Outdoor Reset Operation” and “Target Temperature Boost” when the outdoor sensor is connected.

## High limit operations

The Knight XL is equipped with adjustable automatic reset and manual reset high limits. The automatic reset high limit has a maximum set point of 200°F and the manual reset high limit has a maximum set point of 210°F.

When the outlet temperature exceeds 200°F, the automatic high limit action occurs. The boiler shuts down until the outlet water temperature cools below 190°F, and a 60 second timer has expired. If the outlet temperature continues to increase, the manual reset high limit action will occur at 210°F.

## High limit test procedure

### NOTICE

Please note that the brackets ([ ]) denote screen status.

1. Turn ON the main power to the boiler by placing the ON/OFF switch in the ON position.
2. If boiler status reads [SHUTDOWN] place the boiler into the active position by pressing the RIGHT SELECT [ON] key.
3. Locate the pinhole (SERVICE button) below the RESET button on the display board. Insert a thin wire (such as a paper clip) into the hole and press the button once, hold for five (5) seconds to place the boiler into Service Mode. In Service Mode the boiler will fire at ignition speed and will then modulate up to full fire.
4. From the Status Screen, press the NAVIGATION dial to access the Set Points Screen.
5. Press the LEFT SELECT [LIMITS] key.
6. Select the manual reset high limit (MRHL) by pressing the NAVIGATION dial.
7. Decrease the set point of the MRHL below the outlet temperature by turning the NAVIGATION dial counterclockwise.
8. Press the RIGHT SELECT [SAVE] key.
9. Press the RIGHT SELECT [HOME] key.
10. The new parameters will upload to the control and the MRHL will function causing boiler shutdown and [LOCKOUT] to be displayed.
11. Press the RESET button to clear the lockout.
12. Repeat Steps 4, 5 and 6.
13. Set the MRHL to the appropriate set point by turning the NAVIGATION dial clockwise.
14. Repeat Steps 8 and 9.



# 11 Operating information

## Low water cutoff protection

1. The SMART SYSTEM control module uses temperature sensing of both supply and return areas of the heat exchanger. If the flow rate is too low or the outlet temperature too high, the control module modulates and shuts the boiler down. This ensures boiler shutdown in the event of low water or low flow conditions.
2. Some codes and jurisdiction may accept these integral features of the control in lieu of requiring an additional limit control or low water cutoff. Consult local jurisdiction to determine. A low water cutoff is available from the factory (WTR20009).

## Outdoor reset operation, if used

### Target temperature with outdoor reset

This feature improves the system's efficiency as the outdoor temperature warms up.

See the Knight XL Service Manual to change the settings.

### Reset curve

The reset curves look at outdoor air temperature and adjusts the set points.

## Cascade

When multiple boilers are installed, they can be wired together in a cascade sequence. A maximum of eight boilers can be controlled from a single control. In this application one boiler would be designated as the Leader control and all others would be designated as Member controls. If installing the boilers in an existing system, the new boilers should be programmed as the Leader and/or the higher number addresses. The Leader control can be programmed to use Lead/Lag or Efficiency Optimization control methods.

Once the Leader boiler receives a call for heat from a room thermostat, BMS, or Modbus, the control will determine what the set point will be. If outdoor air reset is desired, connect the outdoor air sensor to the terminals on the Low Voltage Connection Board on the Leader boiler. The set point will be calculated based on the programmed reset curve parameters. See the Knight XL Service Manual to program the reset curve. If outdoor air reset is not desired, do not connect the outdoor air sensor. A fixed temperature set point can be programmed into the control. See page 59 of this manual to program the set point.

If the water temperature at the system supply sensor is less than the set point + the turn-off offset - the off-on differential, then the control will initiate a call for heat on the Cascade (see the Knight XL Service Manual for an explanation of the offset and differential). The Leader will energize the lead boiler on the Cascade. For a new startup this will be the Leader boiler.

## Sequence of the cascade

To equalize the run time of all boilers on the Cascade, the firing sequence will automatically be changed at set intervals.

For the first 24 hours after initializing the Cascade, the sequence will be changed every hour. After that the sequence will be changed once every 24 hours. The switching on/off sequence will be as follows:

DAY	SWITCHING ON SEQUENCE
Day 1	L-M1-M2-M3-M4-M5-M6-M7
Day 1 + 1 hour	M1-M2-M3-M4-M5-M6-M7-L
Day 1 + 2 hours	M2-M3-M4-M5-M6-M7-L-M1

If a boiler is used to heat an indirect DHW tank, it will automatically be given the lowest priority.

## DHW, Night Setback, and Ramp Delay operation with cascade

For normal mode DHW operation any boiler(s) in the Cascade can be selected to provide heat for a DHW call. Select a boiler to be designated as the DHW boiler. Connect the DHW thermostat or sensor to the terminals on the Low Voltage Connection Board marked for the corresponding device. When the boiler receives a DHW call, the Leader control will take that boiler out of the Cascade sequence. If another boiler is available, the Leader will start it up to take its place.

The DHW boiler will adjust its set point to the programmed DHW set point and will adjust its firing rate to maintain this. Once the DHW call has been satisfied, the Leader control will place that boiler back into the Cascade sequence.

Switching of the boiler between DHW operation and SH operation when there is a call for both does not occur in Cascade Mode.

When DHW is programmed for Zone Mode, connect the DHW thermostat or tank sensor to the Leader boiler. When a DHW call is received, the Leader will modulate the entire Cascade to bring the system supply temperature up to the DHW boiler set point (if higher).

Night Setback operation of the boilers within the Cascade is available. Programming of the Night Setback will be done through the Leader boiler. Refer to the Knight XL Service manual for information regarding Night Setback.

Ramp Delay operation of the boilers as described in the Knight XL Service Manual is available when the boilers are part of a Cascade system.













# 11 Operating information *(continued)*

## Sequence of operation

OPERATION	DISPLAY
1. Upon a call for heat, the gas pressure switch(es) must be closed.	<b>START</b> 1 SYSTEM: 116°F TANK: 128°F(125) OUTDOOR: 56°F MENU   SCREEN SHDN
2. Once the gas pressure switch(es) are closed, the control turns on the appropriate pumps (system and boiler pumps for space heating, DHW pump for DHW). The flow switch and/or LWCO must close.	<b>START</b> 1 SYSTEM: 116°F TANK: 128°F(125) OUTDOOR: 56°F MENU   SCREEN SHDN
3. The control turns on power to the louver relay. The louver proving switch, air pressure switch, and blocked drain switch must close.	<b>START</b> 1 SYSTEM: 116°F TANK: 128°F(125) OUTDOOR: 56°F MENU   SCREEN SHDN
4. The control starts a 15 second prepurge cycle by initiating the blower.	<b>PRE-PURGE</b> 1 SYSTEM: 117°F(118) TANK: 128°F(130) OUTDOOR: 56°F MENU   SCREEN SHDN
5. The control starts a 4 second trial for ignition by firing the spark electrode and opening the gas valve.	<b>IGNITION</b> 1 SYSTEM: 117°F(118) DHW TANK: 128°F(130) OUTDOOR: 56°F MENU   SCREEN SHDN
6. If flame is not detected within 1 second after the sparking ends, the control will perform a 10 second post-purge, then start another prepurge cycle and try to light the burner again. On the 501 and larger models, the control will lock out if this second attempt also fails. On the 400 model, the control will perform a total of 4 attempts before locking out.	<b>POST-PURGE</b> 1 SYSTEM: 117°F(118) TANK: 128°F(130) OUTDOOR: 56°F MENU   SCREEN SHDN
7. If flame is detected, it holds the firing rate steady for 5 seconds to let the flame stabilize, then it begins to modulate the firing rate based on a set point or some other command (such as a 0-10V BMS signal).	<b>42%</b> 1 SYSTEM: 117°F(118) TANK: 128°F(130) OUTDOOR: 56°F MENU   SCREEN SHDN

# 11 Operating information

## Sequence of operation *(continued)*

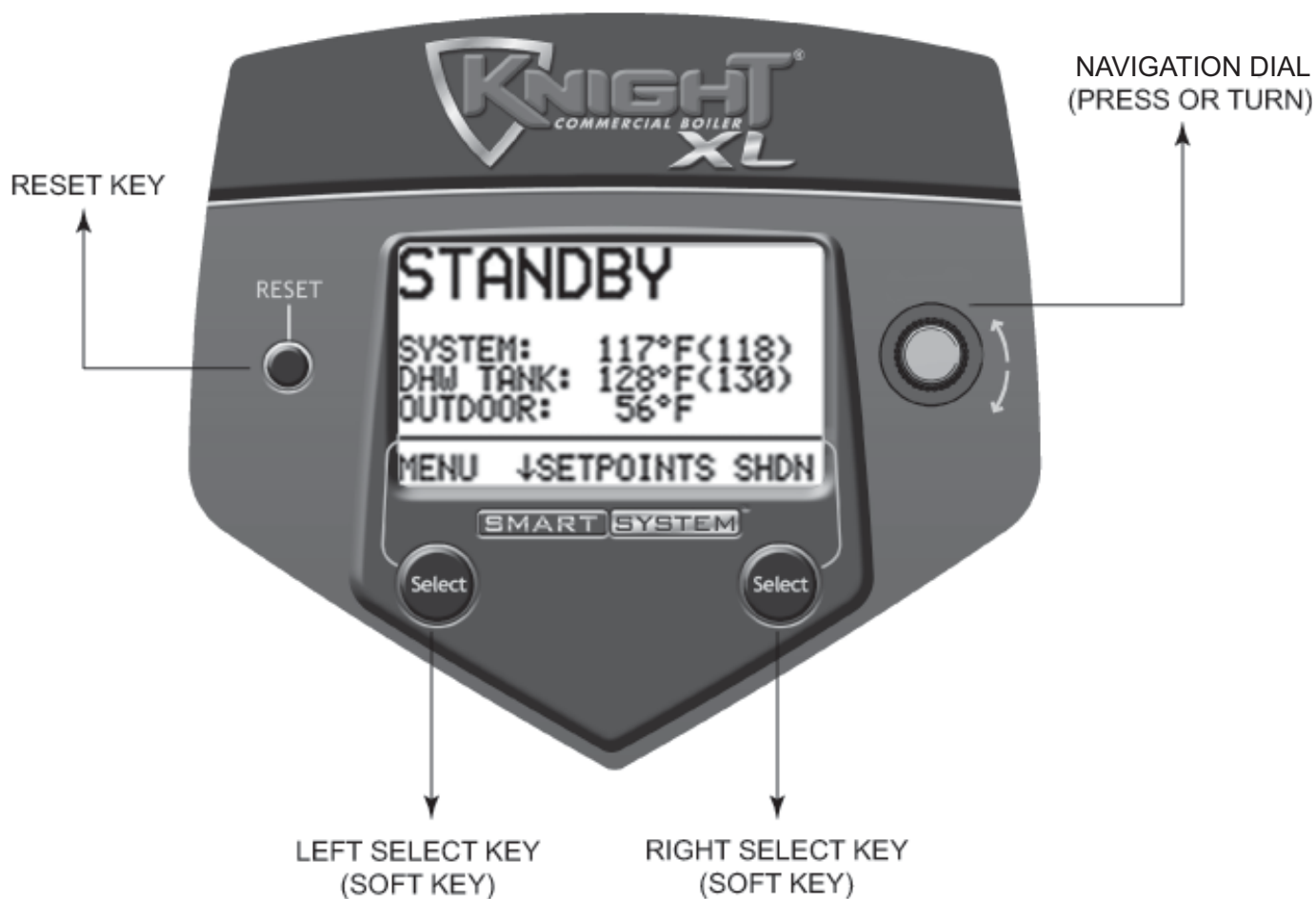
OPERATION	DISPLAY
8. If the space heating call for heat is active, and the tank thermostat or sensor starts a DHW call for heat, the boiler will switch to the DHW mode. If programmed for normal DHW operation (not as a zone), the DHW pump will turn on first, then the boiler pump will turn off 2 seconds later. This will divert the boiler's outlet water from the heating system and send it to the tank coil instead. The control will then modulate to maintain the outlet temperature to the DHW boiler set point.	<p><b>42%</b>  1 </p> <p>SYSTEM: 117°F(118) TANK: 124°F(130) OUTDOOR: 56°F</p> <p>MENU  SCREEN SHDN</p>
9. If the boiler is not part of a Cascade, and both the space heating and DHW calls for heat remain active long enough, the boiler will switch back and forth between the two heating modes until one of them is satisfied.	<p><b>42%</b>   </p> <p>SYSTEM: 117°F(118) TANK: 124°F(130) OUTDOOR: 56°F</p> <p>MENU  SCREEN SHDN</p>
10. Once both calls for heat are satisfied, the control will turn off the burner. The blower will continue to run during a 10 second postpurge.	<p><b>POST-PURGE</b></p> <p>ANTI-CYCLING</p> <p>SYSTEM: 117°F(118) TANK: 128°F(130) OUTDOOR: 56°F</p> <p>MENU  SCREEN SHDN</p>
11. Any pumps that are running will continue to run for their respective pump delay times before turning off, unless programmed to remain on continuously. A 60 second anti-cycle period will start, which will delay any new call for heat until it times out.	<p><b>BLOCKED</b></p> <p>ANTI-CYCLING</p> <p>SYSTEM: 117°F(118) TANK: 124°F(130) OUTDOOR: 56°F</p> <p>MENU  SCREEN SHDN</p>
12. In Standby, ready to start a new cycle.	<p><b>STANDBY</b></p> <p>SYSTEM: 117°F DHW TANK: 128°F(130) OUTDOOR: 56°F</p> <p>MENU  SETPOINTS SHDN</p>

# 11 Operating information *(continued)*

## **SMART SYSTEM**™ Knight XL control module

Use the control panel (FIG. 11-1) to set temperatures, operating conditions, and monitor boiler operation.

**Figure 11-1** Control Panel



The information on the bottom of the display shows the functions of the two SELECT keys (on either corner), and the NAVIGATION dial (in the center):

MENU = Left SELECT Key

SETPOINTS = NAVIGATION Dial - Pressing Down

SHDN = Right SELECT Key

# 11 Operating information

## Access modes

### User

The user can adjust space heating and tank target temperatures by pressing the NAVIGATION dial when “↓SETPOINTS” is flashing at the bottom of the display. The date and time, and the temperature units can also be changed (see page 60).

### Installer

Most parameters are available only to the installer, accessible by entering the installer password, see the Knight XL Service Manual.

Saving parameters *(reference the Parameter Table in the Knight XL Service Manual)*

**NOTICE**

Please note that the brackets ([ ]) denote screen status.

#### To save parameters and exit programming:

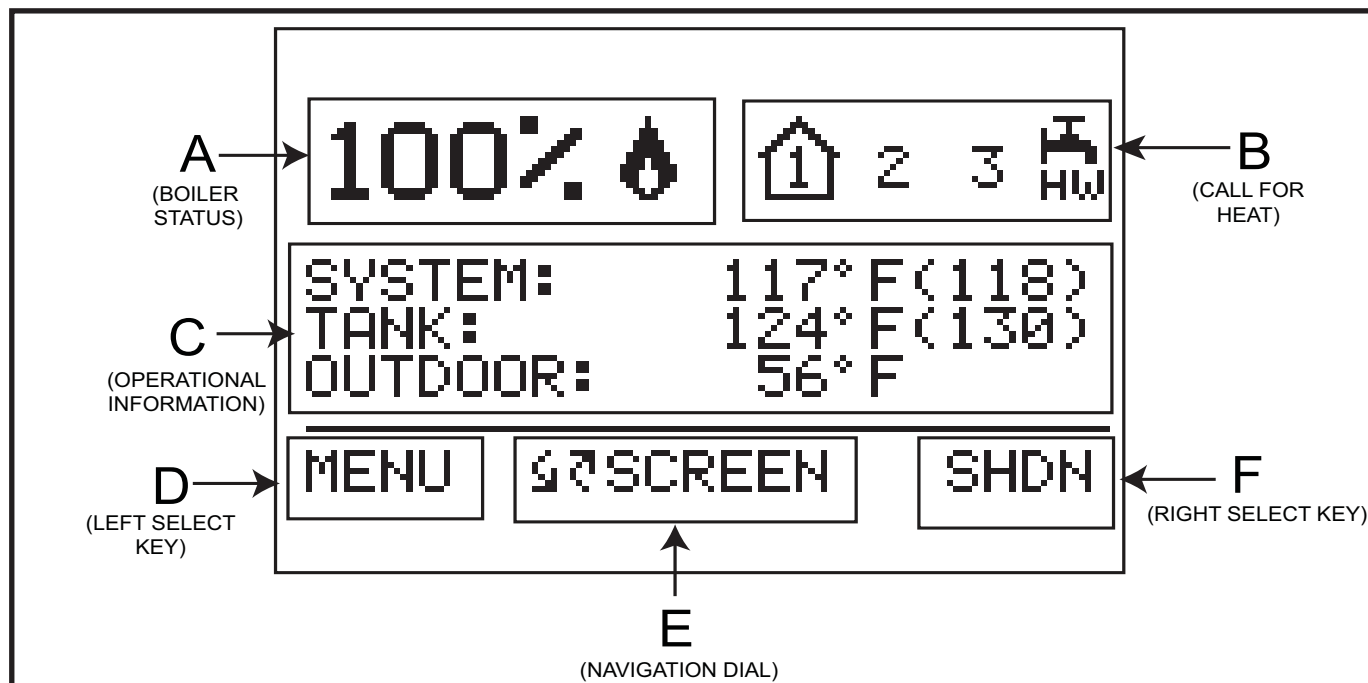
Press the RIGHT SELECT [SAVE] key and then press the RIGHT SELECT [HOME] key.

#### To enter a parameter and continue programming:

Press the RIGHT SELECT [SAVE] key 1 time to return to the parameter listings; press again to return to the menu listings. Remember to press the RIGHT SELECT [HOME] key when finished programming in order to save the changes made.

See the Knight XL Service Manual for a detailed description of parameters and access modes.

# 11 Operating information *(continued)*

**Figure 11-2 Status Display Screen**


Status Display Screens		
Section	Display	Description
<b>A</b> (Boiler Status Bar)	STANDBY	The unit has not received a call for heat from a remote thermostat nor has it received a call for heat from a DHW thermostat.
	START	The unit has begun a burn cycle and is checking all safety circuits.
	PREPURGE	The unit has initiated a 10 second purge period on a call for heat.
	IGNITION	The unit has begun a 4 second spark period to ignite the main burner.
	% 🔥	The unit has fired and is running at the displayed percentage.
	POSTPURGE	The call for heat has been satisfied and the unit runs the fan for an additional 10 seconds to clear the combustion chamber and vent system of residual flue products.
	SHUTDOWN	The unit has been placed in the OFF position.
	SETPOINT MET	The controlled temperature has exceeded its set point and its offset.
	BLOCKED	The unit has detected a condition that has temporarily interrupted the current call for heat.
<b>B</b> (Call for Heat Indicators)	1	Room Thermostat 1 has a call for heat.
	2	Room Thermostat 2 has a call for heat.
	3	Room Thermostat 3 has a call for heat.
	🔥 HW	The tank thermostat or sensor has a call for heat.
	🏠 1 2 3	Indicates which room thermostat demand shows priority.
	🏠 V	The unit is being controlled by a 0 - 10V BMS signal.
	🏠 C	The member unit is supplying heat while in Cascade Mode.



# 11 Operating information

Status Display Screens (cont'd)		
Section	Display	Description
<b>C</b> <b>(Operational Information)</b>	<b>SYSTEM:</b>	The temperature read by the system supply sensor (if connected).
	<b>TANK:</b>	The temperature read by the tank sensor (if connected).
	<b>OUTDOOR:</b>	The temperature read by the outdoor sensor (if connected).
	<b>INLET TEMP:</b>	The temperature read at the inlet to the heat exchanger.
	<b>OUTLET TEMP:</b>	The temperature read at the outlet of the heat exchanger.
	<b>DELTA T:</b>	The temperature difference between the inlet and the outlet of the heat exchanger.
	<b>FLUE TEMP:</b>	The temperature read by the flue sensor.
	<b>FLAME CURRENT:</b>	The current measured by the flame sense circuit.
	<b>FAN SPEED:</b>	The speed of the combustion blower.
	<b>BOILER PUMP:</b>	The status of the boiler pump output.
	<b>SYSTEM PUMP:</b>	The status of the system pump output.
	<b>DHW PUMP:</b>	The status of the DHW pump output.
	<b>BMS VOLTAGE:</b>	The voltage received from a BMS system.
	<b>BLR PUMP OUTPUT:</b>	The speed signal sent to a variable speed boiler pump in percent.
	<b>SYS PUMP INPUT:</b>	The speed signal received from a variable speed system pump control.
	<b>RATE OUTPUT:</b>	A 0 - 10V signal indicating the firing rate of the boiler.
	<b>SH RUN HOURS:</b>	The total hours of operation in the Space Heating Mode.
	<b>SH CYCLES:</b>	The total burner cycles in the Space Heating Mode.
	<b>DHW RUN HOURS:</b>	The total hours of operation in the DHW Mode.
	<b>DHW CYCLES:</b>	The total burner cycles in the DHW Mode.
	<b>LAST 10 FAULTS NO:*</b>	The last 10 lockouts.
<b>D</b> <b>(LEFT SELECT key function)</b>	<b>MENU</b>	Press and hold the LEFT SELECT key for 5 seconds to enter the Menu Screen.
	<b>EXIT</b>	Press the LEFT SELECT key to exit the current screen or setting.
	<b>YES</b>	Press the LEFT SELECT key to confirm that the boiler needs to shutdown.
	<b>LIMITS</b>	Press the LEFT SELECT key to enter the screen that allows you to adjust the limit settings.
	<b>HOME</b>	Press the LEFT SELECT key to return to the Status Screen and upload parameter changes.

# 11 Operating information *(continued)*

## Status Display Screens *(cont'd)*

Section	Display	Description
<b>E</b> <b>(NAVIGATION</b> <b>Dial Function)</b>	↻ SCREEN	Turning the NAVIGATION dial will select the next or previous Status Screen.
	↓ NEXT	Pressing the NAVIGATION dial will show the next fault, NSB (Night Setback) trigger, or ramp delay setting.
	↓ SELECT	Pressing the NAVIGATION dial will select the setting indicated by the cursor.
	↓ SETPOINTS	Pressing the NAVIGATION dial will display the Set Points Screen.
	↻ SCROLL	Turning the NAVIGATION dial will move the cursor up or down.
	↻ ADJUST	Turning the NAVIGATION dial will increase or decrease the current setting.
<b>F</b> <b>(RIGHT SELECT</b> <b>key function)</b>	SHDN	Press the RIGHT SELECT key to turn the boiler OFF.
	ON	Press the RIGHT SELECT key to turn the boiler ON.
	NO	Press the RIGHT SELECT key to cancel the shutdown operation.
	SAVE	Press the RIGHT SELECT key to save the current change.
	HOME	Press the RIGHT SELECT key to return to the Status Screen and upload parameter changes.

# 12 Maintenance

## Maintenance and annual startup

**Table 12A** Service and Maintenance Schedules

Service technician (see the following pages for instructions)		Owner maintenance (see the Knight XL User's Information Manual for instructions)	
ANNUAL START-UP	<b>General:</b> <ul style="list-style-type: none"> <li>• Address reported problems</li> <li>• Inspect interior; clean and vacuum if necessary;</li> <li>• Clean condensate trap and fill with fresh water</li> <li>• Check for leaks (water, gas, flue, condensate)</li> <li>• Verify flue and air lines in good condition and sealed tight</li> <li>• Check system water pressure/system piping/expansion tank</li> <li>• Check control settings</li> <li>• Check ignition and flame sense electrodes (sand off any deposits; clean and reposition)</li> <li>• Check wiring and connections</li> <li>• Perform start-up checkout and performance verification per Section 10.</li> <li>• Flame inspection (stable, uniform)</li> <li>• Flame signal (at least 10 microamps at high fire)</li> <li>• Clean the heat exchanger if flue temperature is more than 54°F (30°C) above return water temperature.</li> </ul> <b>If combustion or performance indicate need:</b> <ul style="list-style-type: none"> <li>• Clean heat exchanger</li> <li>• Remove and clean burner using compressed air only</li> <li>• Clean the blower wheel</li> </ul>		<b>Daily</b> <ul style="list-style-type: none"> <li>• Check boiler area</li> <li>• Check pressure/temperature gauge</li> </ul>
		<b>Monthly</b> <ul style="list-style-type: none"> <li>• Check vent piping</li> <li>• Check air piping</li> <li>• Check air and vent termination screens</li> <li>• Check relief valve</li> <li>• Check condensate drain system</li> <li>• Check air vents</li> </ul>	
		<b>Periodically</b> <ul style="list-style-type: none"> <li>• Test low water cutoff (if used)</li> <li>• Reset button (low water cutoff)</li> </ul>	
		<b>Every 6 months</b> <ul style="list-style-type: none"> <li>• Check boiler piping (gas and water) for leaks</li> <li>• Operate relief valve</li> </ul>	
		<b>End of season months</b> <ul style="list-style-type: none"> <li>• Shut boiler down (unless boiler used for domestic hot water)</li> </ul>	

## 12 Maintenance *(continued)*

### **⚠ WARNING**

Follow the Service and maintenance procedures given throughout this manual and in component literature shipped with the boiler. Failure to perform the service and maintenance could result in damage to the boiler or system. Failure to follow the directions in this manual and component literature could result in severe personal injury, death, or substantial property damage.

### **⚠ WARNING**

The boiler should be inspected annually only by a qualified service technician. In addition, the maintenance and care of the boiler designated in Table 12A and explained on the following pages must be performed to assure maximum boiler efficiency and reliability. Failure to service and maintain the boiler and system could result in equipment failure.

### **⚠ WARNING**

Electrical shock hazard – Turn off power to the boiler before any service operation on the boiler except as noted otherwise in this instruction manual. Failure to turn off electrical power could result in electrical shock, causing severe personal injury or death.

### Address reported problems

1. Inspect any problems reported by the owner and correct before proceeding.

### Inspect boiler area

1. Verify that boiler area is free of any combustible materials, gasoline and other flammable vapors and liquids.
2. Verify that air intake area is free of any of the contaminants listed in Section 1 of this manual. If any of these are present in the boiler intake air vicinity, they must be removed. If they cannot be removed, reinstall the air and vent lines per this manual and the Knight XL Service Manual.

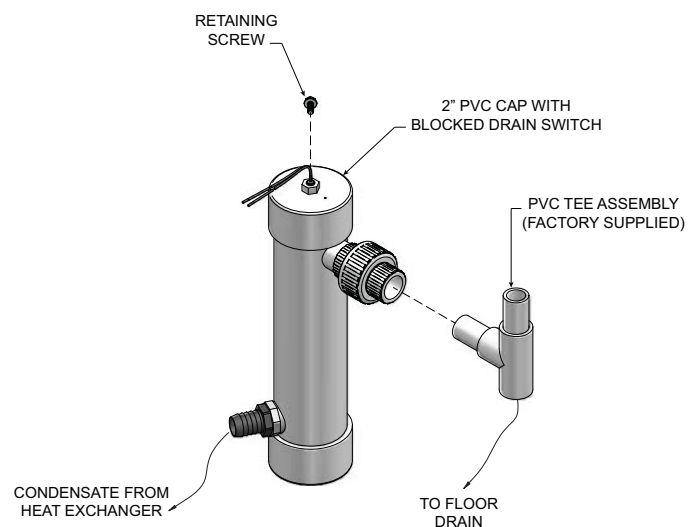
### Inspect boiler interior

1. Remove the front access cover and inspect the interior of the boiler.
2. Vacuum any sediment from inside the boiler and components. Remove any obstructions.

### Clean condensate trap

1. Inspect the condensate drain line, condensate PVC fittings, and condensate trap.
2. Remove the PVC cap retaining screw from the PVC cap (FIG. 12-1).
3. Remove the 2 inch PVC cap with the switch located at the top of the trap (FIG. 12-1).
4. Remove any sediment in the trap.
5. Fill with fresh water until the water begins to pour out of the drain.
6. Replace the cap. Press the cap onto the trap until the cap makes contact with the drain.
7. Replace the retaining screw.

**Figure 12-1** Condensate Trap



### **⚠ WARNING**

The condensate trap must be filled with water during all times of boiler operation to avoid flue gas emission from the condensate drain line. Failure to fill the trap could result in severe personal injury or death.

### Check all piping for leaks

### **⚠ WARNING**

Eliminate all system or boiler leaks. Continual fresh makeup water will reduce boiler life. Minerals can build up in sections, reducing heat transfer, overheating heat exchanger, and causing heat exchanger failure. Leaking water may also cause severe property damage.

1. Inspect all water and gas piping and verify to be leak free.
2. Look for signs of leaking lines and correct any problems found.
3. Check gas line using the procedure found in Section 7 - Gas Connections.

# 12 Maintenance

## Flue vent system and air piping

1. Visually inspect the entire flue gas venting system and air piping for blockage, deterioration or leakage. Repair any joints that show signs of leakage. Verify that air inlet pipe is connected and properly sealed.
2. Verify that boiler vent discharge and air intake are clean and free of obstructions.

**⚠ WARNING** Failure to inspect for the above conditions and have them repaired can result in severe personal injury or death.

## Check water system

1. Verify all system components are correctly installed and operational.
2. Check the cold fill pressure for the system. Verify it is correct (must be a minimum of 12 psi (82.7 kPa)).
3. Watch the system pressure as the boiler heats up (during testing) to ensure pressure does not rise too high. Excessive pressure rise indicates expansion tank sizing or performance problem.
4. Inspect automatic air vents and air separators. Remove air vent caps and briefly press push valve to flush vent. Replace caps. Make sure vents do not leak. Replace any leaking vents.

## Check expansion tank

1. Expansion tanks provide space for water to move in and out as the heating system water expands due to temperature increase or contracts as the water cools. Tanks may be open, closed or diaphragm or bladder type. See Section 6 - Hydronic Piping for suggested best location of expansion tanks and air eliminators.

## Check boiler relief valve

1. Inspect the relief valve and lift the lever to verify flow. Before operating any relief valve, ensure that it is piped with its discharge in a safe area to avoid severe scald potential. Read Section 6 - Hydronic Piping before proceeding further.

### **⚠ WARNING**

Safety relief valves should be re-inspected AT LEAST ONCE EVERY THREE YEARS, by a licensed plumbing contractor or authorized inspection agency, to ensure that the product has not been affected by corrosive water conditions and to ensure that the valve and discharge line have not been altered or tampered with illegally. Certain naturally occurring conditions may corrode the valve or its components over time, rendering the valve inoperative. Such conditions are not detectable unless the valve and its components are physically removed and inspected. This inspection must only be conducted by a plumbing contractor or authorized inspection agency – not by the owner. Failure to re-inspect the boiler relief valve as directed could result in unsafe pressure buildup, which can result in severe personal injury, death, or substantial property damage.

### **⚠ WARNING**

Following installation, the valve lever must be operated AT LEAST ONCE A YEAR to ensure that waterways are clear. Certain naturally occurring mineral deposits may adhere to the valve, rendering it inoperative. When manually operating the lever, water will discharge and precautions must be taken to avoid contact with hot water and to avoid water damage. Before operating lever, check to see that a discharge line is connected to this valve directing the flow of hot water from the valve to a proper place of disposal. Otherwise severe personal injury may result. If no water flows, valve is inoperative. Shut down the boiler until a new relief valve has been installed.

2. After following the above warning directions, if the relief valve weeps or will not seat properly, replace the relief valve. Ensure that the reason for relief valve weeping is the valve and not over-pressurization of the system due to expansion tank waterlogging or undersizing.



# 12 Maintenance *(continued)*

## Inspect ignition and flame sense electrodes

1. Remove the ignition and flame sense electrodes from the boiler heat exchanger access cover.
2. Remove any deposits accumulated on the ignition/flame sense electrode using sandpaper. If the electrodes cannot be cleaned satisfactorily, replace with new ones.
3. Replace ignition/flame sense electrode, making sure gasket is in good condition and correctly positioned.

## Check ignition ground wiring

1. Inspect boiler ground wire from the heat exchanger access cover to ground terminal strip.
2. Verify all wiring is in good condition and securely attached.
3. Check ground continuity of wiring using continuity meter.
4. Replace ground wires if ground continuity is not satisfactory.

## Check all boiler wiring

1. Inspect all boiler wiring, making sure wires are in good condition and securely attached.

## Check control settings

1. Set the SMART SYSTEM control module display to Parameter Mode and check all settings. See Section 1 of the Knight XL Service Manual. Adjust settings if necessary. See Section 1 of the Knight XL Service Manual for adjustment procedures.
2. Check settings of external limit controls (if any) and adjust if necessary.

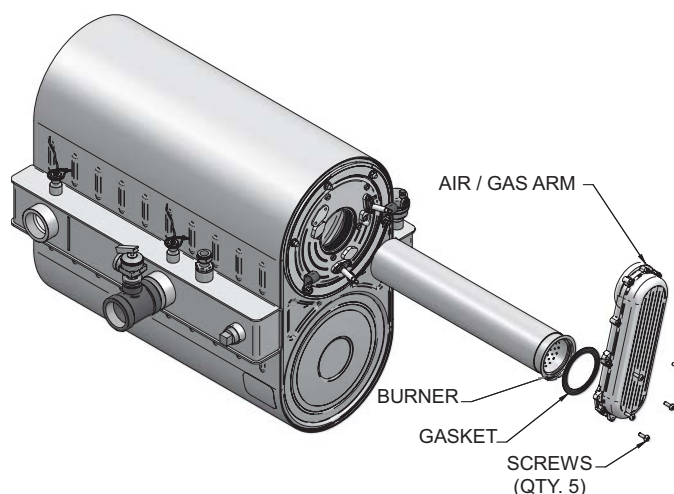
## Perform start-up and checks

1. Start boiler and perform checks and tests specified in Section 10 - Start-up.
2. Verify cold fill pressure is correct and that operating pressure does not go too high.

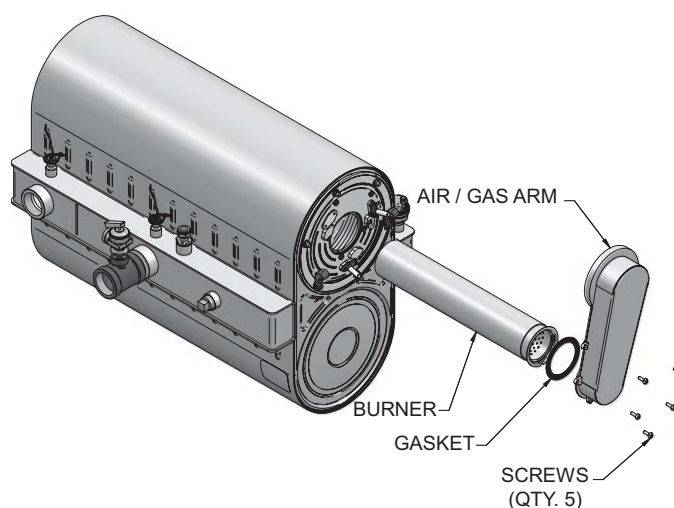
## Check burner flame

1. Inspect flame through observation window.
2. If the flame is unsatisfactory at either high fire or low fire, turn off boiler and allow boiler to cool down. Remove the burner and clean it thoroughly using a vacuum cleaner or compressed air. Do not use compressed air to clean burner if performed inside a building.
3. Remove the burner, reference FIG.'s 12-2 thru 12-4.
4. When replacing the burner, ensure gasket is in good condition and positioned correctly (FIG.'s 12-2 thru 12-4).

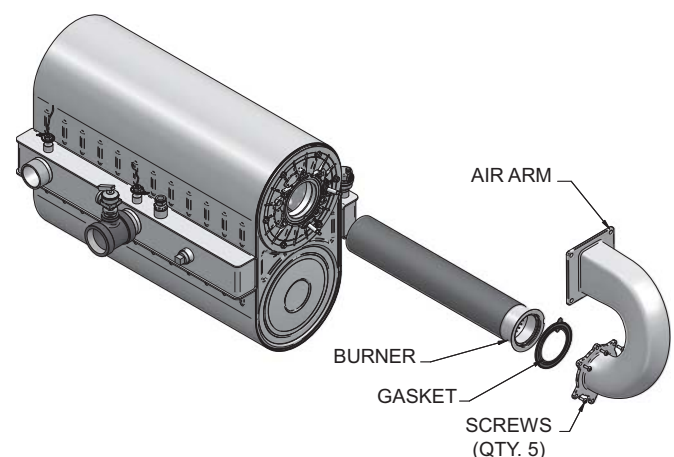
**Figure 12-2 Burner Assembly - Model 400**



**Figure 12-3 Burner Assembly - Model 501**



**Figure 12-4 Burner Assembly - Models 601 - 801**



# 12 Maintenance

## Check flame signal

1. At high fire the flame signal shown on the display should be at least 10 microamps.
2. A lower flame signal may indicate a fouled or damaged flame sense electrode. If cleaning the flame sense electrode does not improve, ground wiring is in good condition, and ground continuity is satisfactory, replace the flame sense electrode.
3. See Section 3 - Troubleshooting in the Knight XL Service Manual for other procedures to deal with low flame signal.

## Review with owner

1. Review the Knight XL User's Information Manual with the owner.
2. Emphasize the need to perform the maintenance schedule specified in the Knight XL User's Information Manual (and in this manual as well).
3. Remind the owner of the need to call a licensed contractor should the boiler or system exhibit any unusual behavior.
4. Remind the owner to follow the proper shutdown procedure and to schedule an annual start-up at the beginning of the next heating season.

## Cleaning boiler heat exchanger

For recommended materials; including brush, appropriate extension(s), refractory cover, and detailed instructions see Table 12B - Heat Exchanger Cleaning Kits.

1. Shut down boiler:
  - Follow the "To Turn Off Gas to Appliance" instructions for the boiler in Section 10 - Startup.
  - Do not drain the boiler unless it will be exposed to freezing temperatures. If using freeze prevention fluid in system, do not drain.
2. Allow time for the boiler to cool to room temperature if it has been firing.
3. Remove the nuts securing the heat exchanger access cover to the heat exchanger and set aside.
4. Remove the heat exchanger access cover, burner, and gas/air arm assembly.

### ⚠ WARNING

The boiler contains ceramic fiber materials. Use care when handling these materials per instructions in the Service Manual. Failure to comply could result in severe personal injury.

5. Remove the condensate hose from the heat exchanger end. Connect a field supplied 3/4" diameter hose to a drain pan. Using field supplied means, cover the refractory in the back of the combustion chamber of the heat exchanger.

6. Use a vacuum cleaner to remove any accumulation on the boiler heating surfaces. Do not use any solvent.
7. Brush the heat exchanger while dry using a nylon bristle brush. **Caution:** DO NOT use a metal brush. Re-vacuum the heat exchanger.
8. Finish cleaning using a clean cloth dampened with warm water. Rinse out debris with a low pressure water supply.
9. Allow the heat exchanger to thoroughly dry.
10. Remove the field supplied rear refractory cover from the back of the combustion chamber of the heat exchanger and reassemble.
11. Close isolation valves on piping to isolate boiler from system. Attach a hose to the boiler drain and flush boiler thoroughly with clean water by using purging valves to allow water to flow through the water make-up line to the boiler.
12. Perform start-up and check-out procedures in the Check Flame and Combustion - Section 10 - Startup on pages 57 and 59 of this manual.
13. Replace the access cover and restore boiler to operation.

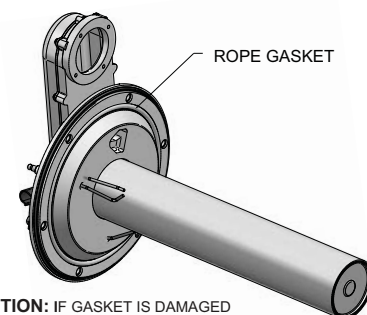
**Table 12B Heat Exchanger Cleaning Kits**

Model	Kit Number	Part Number	Component Description
400	KIT30063	CTN20005	Rear Refractory Cover
		MSC20083*	Nylon 4" Wheel Brush*
		MSC20084	3mm Allen Wrench
		MSC20086	1/4" x 24" Drill Extension
501 - 801	KIT30064	CTN20005	Rear Refractory Cover
		MSC20083*	Nylon 4" Wheel Brush*
		MSC20085	1/4" x 12" Drill Extension
		MSC20086	1/4" x 24" Drill Extension

### ⚠ CAUTION

\* Do NOT use a metal brush. Only use the kit provided brush or an equivalent replacement nylon brush.

**Figure 12-5 Rope Gasket - Heat Exchanger Door**



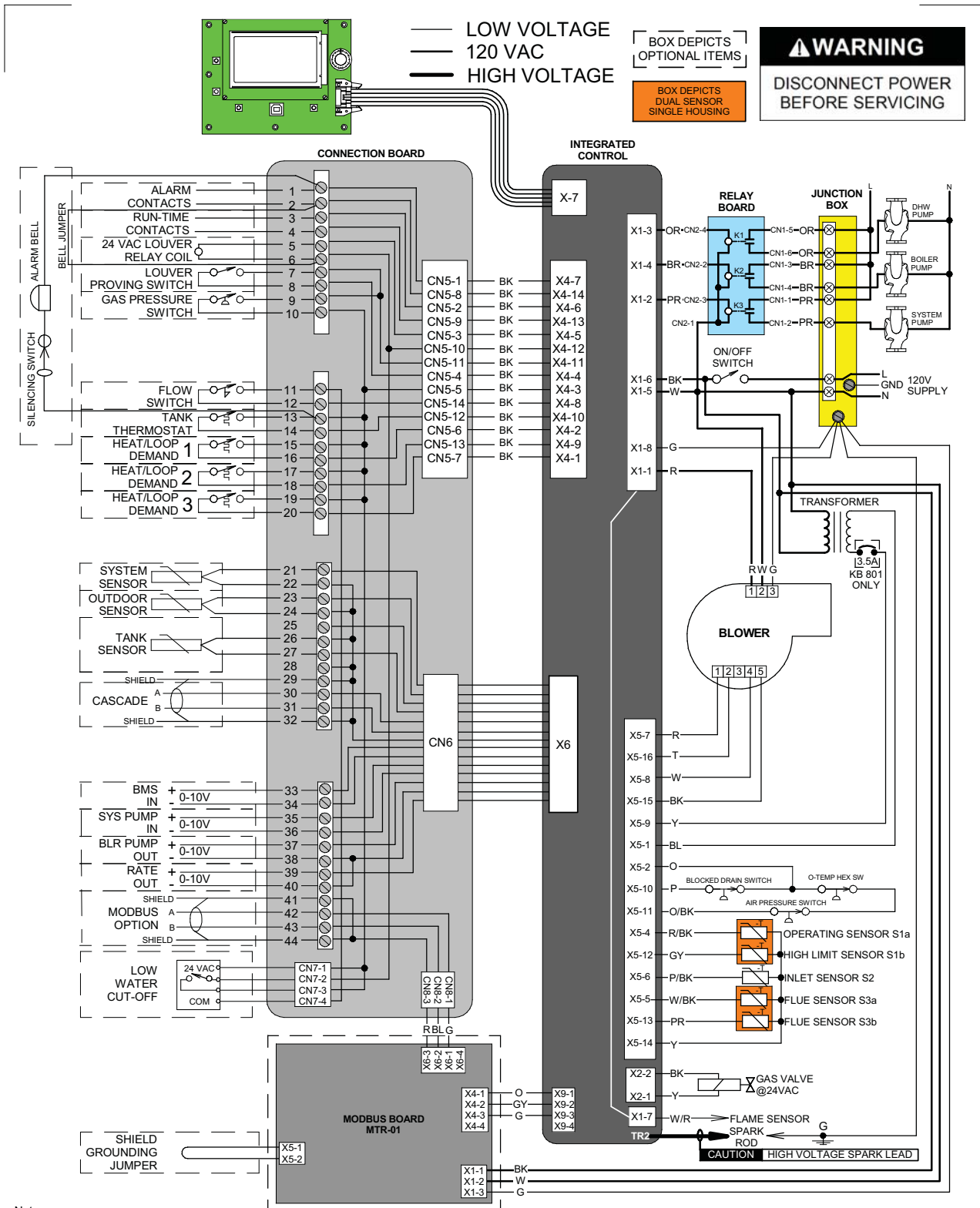
**CAUTION:** IF GASKET IS DAMAGED DO NOT REUSE, THE HEAT EXCHANGER DOOR MUST BE REPLACED.

### NOTICE

Rope gasket is intended for sealing combustion (FIG. 12-5). If damaged DO NOT reuse, the heat exchanger door must be replaced. Consult factory for replacement heat exchanger door (kit WTR3080 and WTR3086).

# 13 Diagrams

**Figure 13-1 Wiring Diagram**



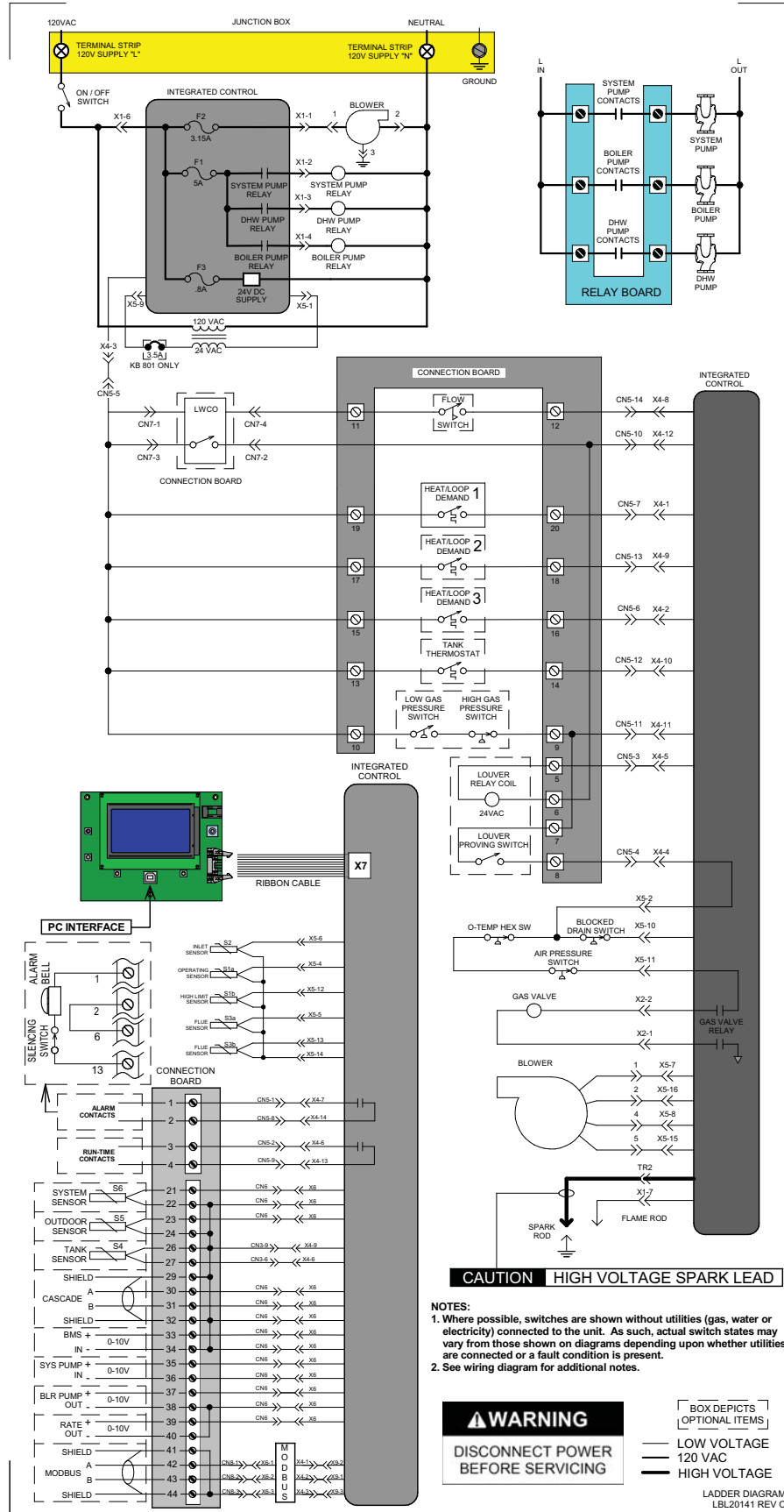
**Notes:**

1. All wiring must be installed in accordance with: local, state, provincial and national code requirements per either N.E.C. in USA or C.S.A. in Canada.
2. If any original equipment wire as supplied with the appliance must be replaced, it must be replaced with wire having same wire gauge (AWG) and rated for a minimum of 105°C. Exceptions: Replacement high voltage spark lead and ribbon cables must be purchased from the factory. Use of a non-approved spark lead or ribbon cables can lead to operational problems which could result in non-repairable damage to the integrated controller or other components.
3. Actual connector block locations may vary from those shown on diagrams. Refer to actual components for proper connector block locations when using diagrams to troubleshoot unit.

WIRING DIAGRAM  
 LBL20116 REV C

# 13 Diagrams

**Figure 13-2 Ladder Diagram**



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# Notes



**Revision Notes:** Revision A (ECO #C05747) initial release. Reflects the new model numbers for the Knight XL upgrade.

Revision B (ECO #C06188) reflects changes made to FIG. 6-10 (ECR #R03474) remove ghost pipe, changes made to FIG.'s 6-7, 6-9, and 6-11 (R03563) change the direction of the arrows, and edits made to the ladder and wiring diagrams (ECO #C06158).

Revision C (ECO #C06234) reflects changes made to the Service Reminder feature.

Revision D (ECO #C07981) reflects the layout in InDesign, edits made ECR04077 - combustible water pipes change from 1" to a 1/4", changes made to Table 3B on page 20, ECR03940 - addition of the rope gasket warning, ECR03740 - changes made to FIG's 7-1 thru 7-4 pages 46 and 47, changes made to Table 3A on page 18, ECR03727 - 400 - 601 reference applied incorrectly on pages 15 and 16, add O-temp switch.