SHIELD™
COMMERCIAL WATER HEATER

Installation & Service Manual

Models: SNR150-100, SNR200-100, SNA285-125, SNA400-125, AND SNA500-125

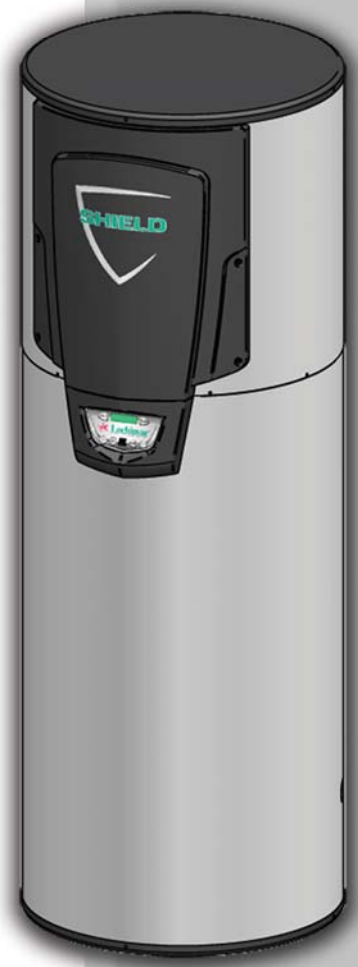
WARNING: If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

-- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

-- WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a 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.



DESIGN CERTIFIED®

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Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters

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

Save this manual for future reference.

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Please read before proceeding

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.

⚠ WARNING **Installer –** Read all instructions, in this manual before installing. Perform steps in the order given.

Have this water heater 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 water heater – Please have the water heater model and serial number from the water heater rating plate.

Consider piping and installation when determining water heater 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.

When servicing the water heater –

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

⚠ WARNING If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury or death

-- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

-- WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a 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.

Water heater operation –

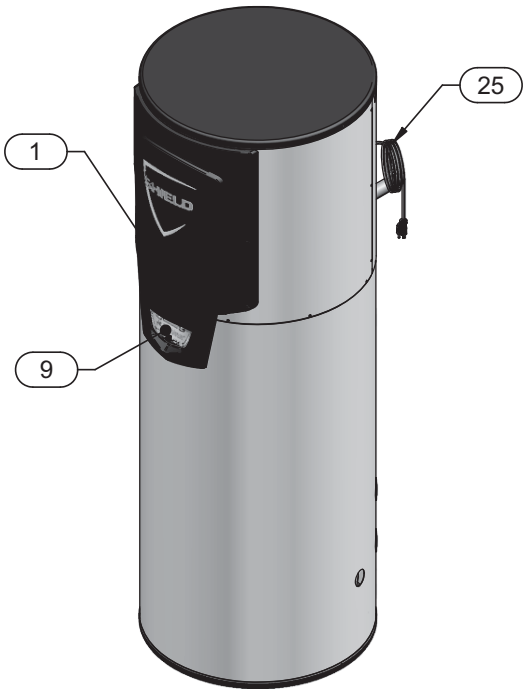
- Do not block flow of combustion or ventilation air to the water heater.
- Should overheating occur or gas supply fail to shut off, do not turn off or disconnect electrical supply to circulator. Instead, shut off the gas supply at a location external to the appliance.
- Do not use this water heater 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.

The Shield - How it works...

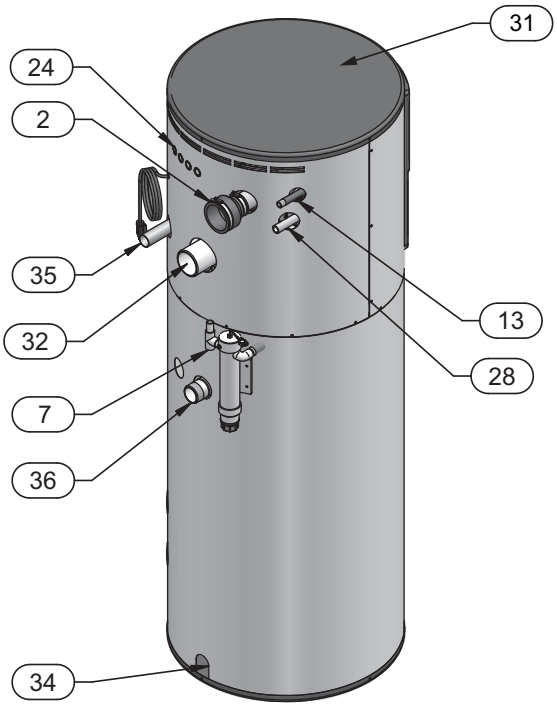
1. **Access cover - front**
   Provides access to the gas train and heat exchanger.
2. **Air intake adapter**
   Allows for the connection of the PVC air intake pipe to the water heater.
3. **Air pressure switch**
   The air pressure switch detects blocked inlet conditions.
4. **Air shroud (500-125 Model Only_Not Shown)**
   The air shroud directs air and gas flow into the blower.
5. **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.
6. **Burner (not shown)**
   Made with metal fiber and stainless steel construction, the burner uses pre-mixed air and gas and provides a 5 to 1 firing rate.
7. **Condensate drain connection**
   Connects the condensate drain line to 1/2" PVC.
8. **Electronic Control Module**
   The electronic control responds to internal and external signals and controls the blower, gas valve, and pumps to meet the demand.
9. **Electronic display**
   The electronic display consists of 7 buttons and a dual line 32-character liquid crystal display.
10. **Flame inspection window**
    The quartz glass window provides a view of the burner surface and flame.
11. **Flame sensor**
    Used by the control module to detect the presence of burner flame.
12. **Flue gas sensor (not shown)**
    This sensor monitors the flue gas exit temperature. The control module will modulate and shut down the water heater if the flue gas temperature gets too hot. This protects the flue pipe from overheating.
13. **Gas connection pipe**
    Threaded pipe connection, either 1/2", 3/4", or 1", depending on the model. This pipe should be connected to the incoming gas supply for the purpose of delivering gas to the water heater.
14. **Gas shutoff switch (150-100 - - 285-125 Models Only)**
    An electrical switch designed to cut power from the gas valve to prevent gas flow to the burner.
15. **Gas shutoff valve (400-125 -- 500-125 Models Only)**
    Manual valve used to isolate the gas valve from the gas supply.
16. **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.
17. **Heat exchanger access cover**
    Allows access to the combustion side of the heat exchanger coils.
18. **Heat exchanger inlet temperature sensor**
    This sensor monitors the inlet water temperature to the heat exchanger.
19. **Heat exchanger outlet temperature sensor**
    This sensor monitors heat exchanger outlet water temperature.
20. **High limit sensor**
    Device that monitors the outlet water temperature. If the temperature exceeds its setting, it will break the control circuit, shutting the water heater down.
21. **Ignition electrode**
    Provides direct spark for igniting the burner.
22. **Line voltage junction box**
    The junction box contains the connection points for the line voltage power.
23. **Low voltage connection board**
    The connection board is used to connect external low voltage devices.
24. **Low voltage wiring connections (knockouts)**
    Conduit entryway for the low voltage connection board.
25. **Power cord**
    Six foot cord allows for quick connection to 120V supply.
26. **Pump**
    Circulates water between the tank and the heat exchanger.
27. **Pump relay**
    Switches power to the pump.
28. **Relief valve discharge pipe**
    Protects the heat exchanger from over pressure and temperature conditions. The relief valve is set at 150 PSI.
29. **Stainless steel heat exchanger**
    Allows 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.
30. **Tank sensor**
    Used by the control to monitor the temperature of the tank.
31. **Top panel**
    Removable panel to gain access to the internal components.
32. **Vent pipe connection**
    Allows for the connection of the PVC/CPVC vent pipe system to the water heater.
33. **Venturi**
    The venturi controls air and gas flow into the burner.
34. **Water heater drain valve**
    Location from which the water heater can be drained.
35. **Water inlet**
    Copper sweat connection for cold water supply that returns water from the system to the heat exchanger, either 1-1/2" or 2", depending on the model.
36. **Water outlet**
    Male NPT water connection that supplies hot water to the system, either 1-1/2" or 2", depending on the model.

The Shield - How it works... *(continued)*

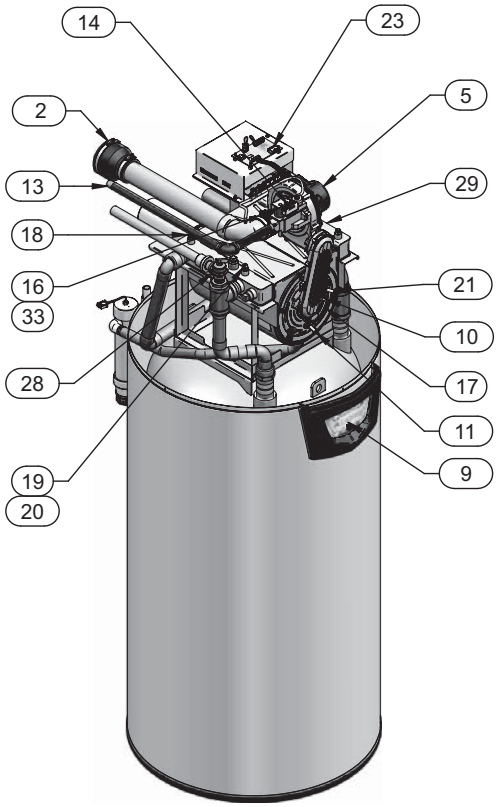
Models SNR150-100 – SNA285-125



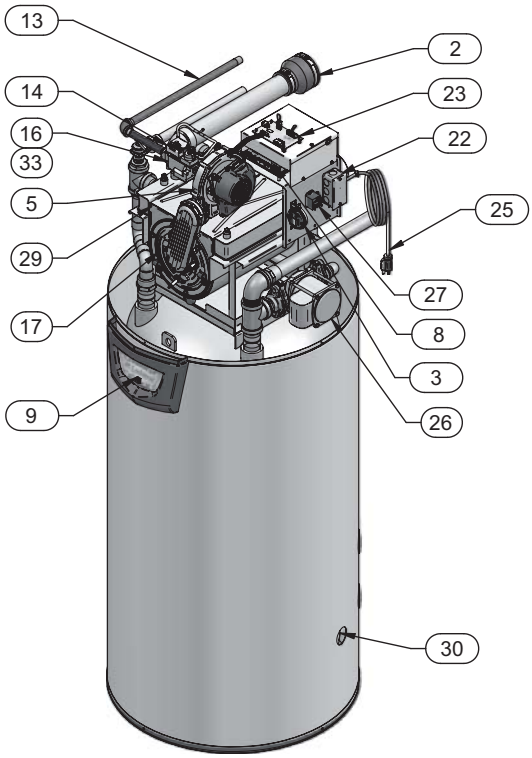
Front View - Models SNR150-100 -- SNA285-125



Rear View - Models SNR150-100 -- SNA285-125



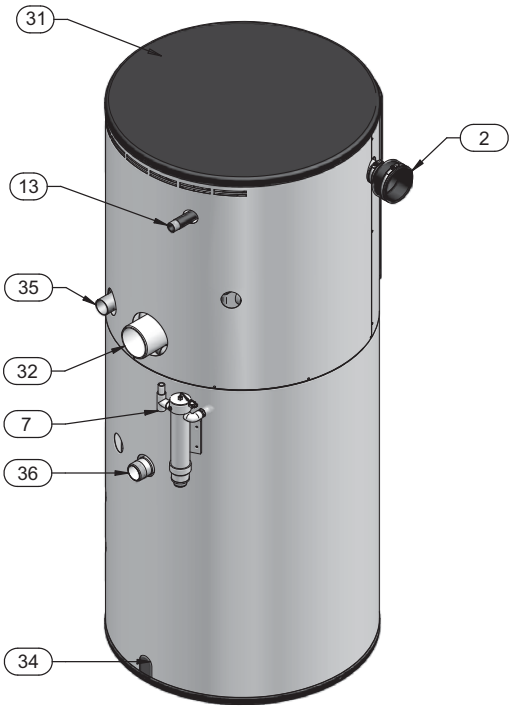
Left Side (inside unit) -- Models SNR150-100 - SNA285-125



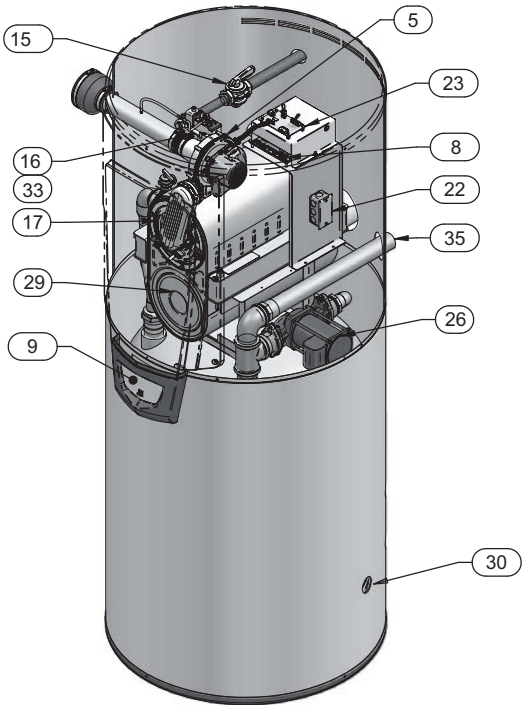
Right Side (inside unit) – Models SNR150-100 - SNA285-125

The Shield - How it works...

Model SNA400-125

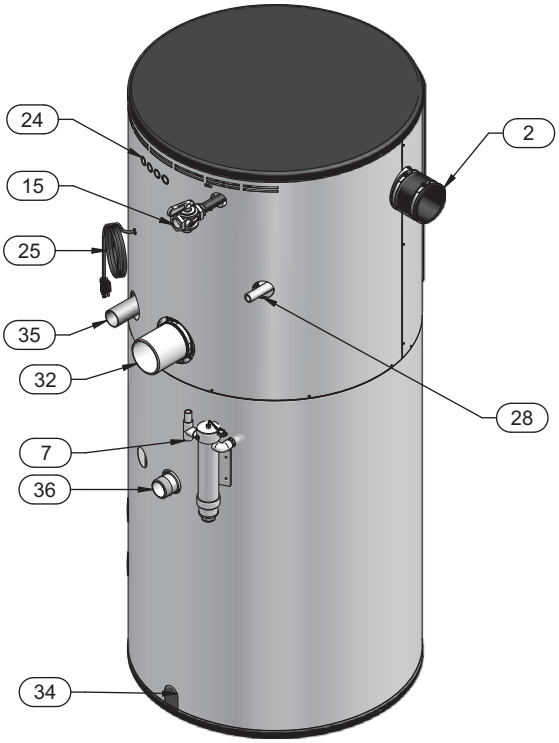


Rear View - Model SNA400-125

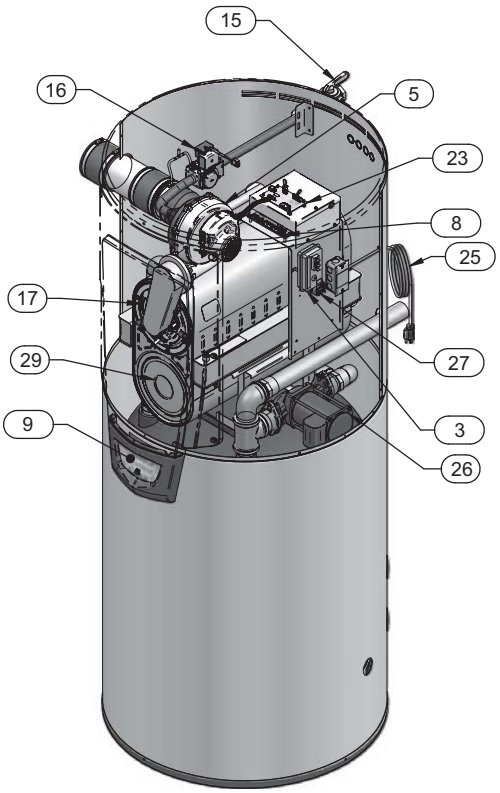


Right Side (inside unit) - Model SNA400-125

Model SNA500-125



Rear View - Model SNA500-125



Right Side (inside unit) - Model SNA500-125

Ratings

Model Number Note: Change "N" to "L" for L.P. gas models.	CSA Input Modulation Btu/hr (Note 2)		Water Content Gallons	Water Connections	Gas Connections	Vent/Air Size (Note 1)
	Min	Max				
SNR150-100	30,000 - 150,000		92	1-1/2"	1/2"	3"
SNR200-100	40,000 - 199,999		93	1-1/2"	1/2"	3"
SNA285-125	57,000 - 285,000		124	2"	3/4"	4"
SNA400-125	80,000 - 399,999		125	2"	1"	4"
SNA500-125	100,000 - 500,000		126	2"	1"	4"

NOTICE Maximum allowed working pressure is located on the rating plate.

Notes:

1. Shield water heaters require special gas venting. Use only the vent materials and methods specified in the Shield Installation and Service Manual.
2. Standard Shield water heaters are equipped to operate from sea level to 4,500 feet **only** with no adjustments. The water heater will de-rate by 4% for each 1,000 feet above sea level up to 4,500 feet.
3. High altitude Shield water heaters are equipped to operate from 3,000 to 12,000 feet **only** with no field adjustments. The water heater 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 models. A high altitude label (as shown in FIG. A) is also affixed to the unit.

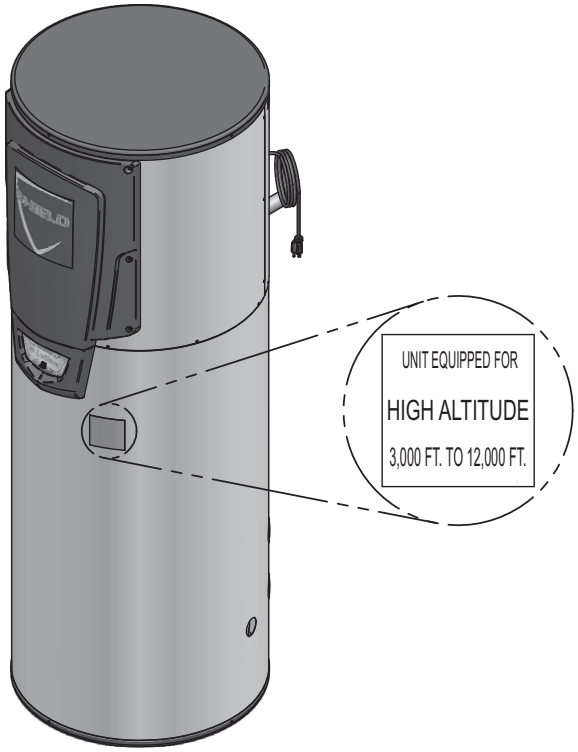


Figure A *High Altitude Label Location*

1 Determine water heater location

Installation must comply with:

- Local, state, provincial, and national codes, laws, regulations, and ordinances.
- National Fuel Gas Code, ANSI Z223.1 – latest edition.
- National Electrical Code.
- For Canada only: B149.1 Installation Code, CSA C22.1 Canadian Electrical Code Part 1 and any local codes.

NOTICE The Shield water heater gas manifold and controls met safe lighting and other performance under tests specified in ANSI Z21.10.3 – latest edition.

Before locating the water heater, check:

1. Check for nearby connection to:
   - 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. 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 water heater. Remove any combustible materials, gasoline and other flammable liquids.

⚠ WARNING Failure to keep water heater 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 Shield water heater must be installed so that gas control system components are protected from dripping or spraying water or rain during operation or service.

⚠ 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.

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 CPVC pipe section installed in the appliance. The field provided 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 water heater is installed in which is less than 455 cubic feet for SNR150-100 and SNR200-100 models and 671 cubic feet for the SNA285-125 through SNA500-125 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 = 6 feet long, 6 feet wide, and 9 foot ceiling = 6 x 6 x 9 = 324 cubic feet. This would be considered a closet for a Shield Water Heater.

⚠ WARNING For closet and alcove installations as shown in FIG.'s 1-1 and 1-2, CPVC 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

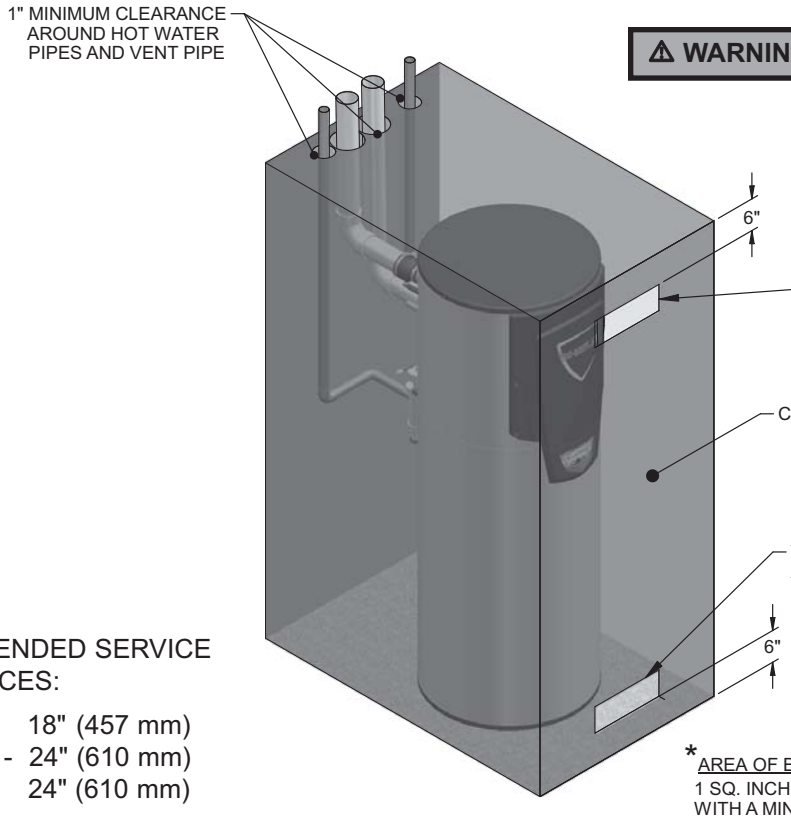
1. Hot water pipes—at least 1" from combustible materials.
2. Vent pipe – at least 1" from combustible materials.
3. See FIG.'s 1-1 and 1-2 on page 9 for other clearance minimums.

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 water heater without removing it from the space.

1 Determine water heater location *(continued)*

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



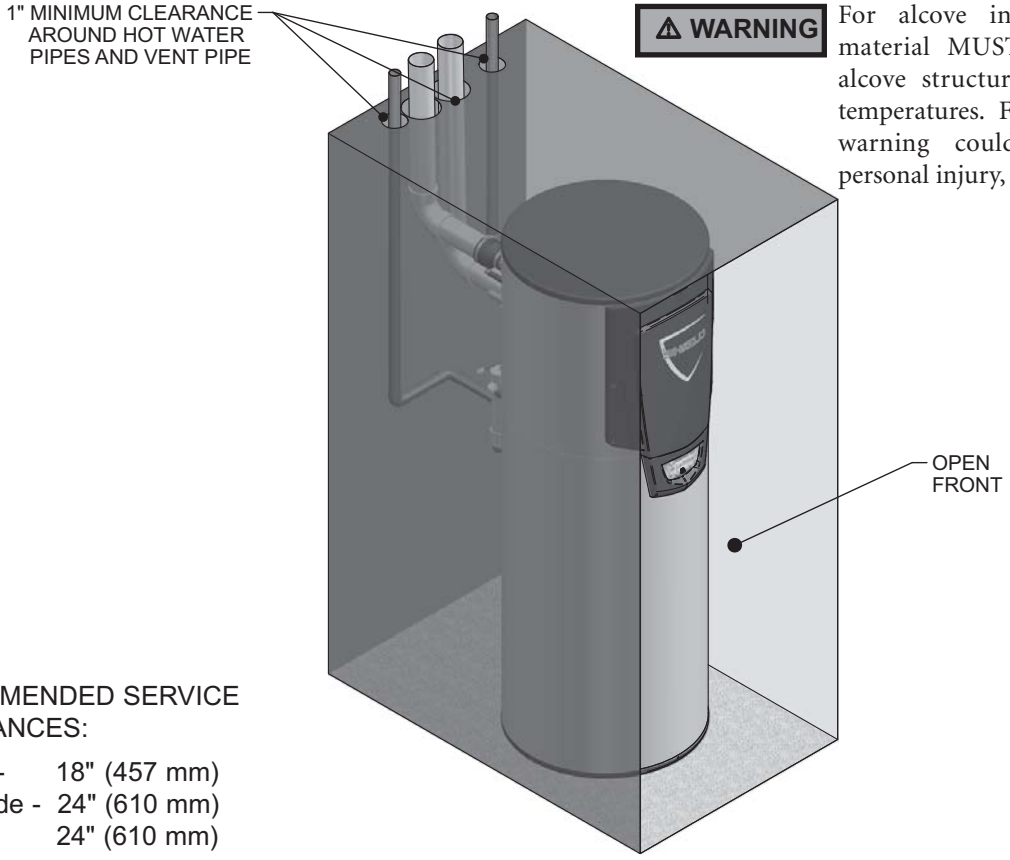
⚠ WARNING

For closet installations, CPVC material MUST BE used in a closet structure due to elevated temperatures. Failure to follow this warning could result in fire, personal injury, or death.

RECOMMENDED SERVICE CLEARANCES:

Top - 18" (457 mm)
Right Side - 24" (610 mm)
Front - 24" (610 mm)

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



⚠ WARNING

For alcove installations, CPVC material MUST BE used in an alcove structure due to elevated temperatures. Failure to follow this warning could result in fire, personal injury, or death.

RECOMMENDED SERVICE CLEARANCES:

Top - 18" (457 mm)
Right Side - 24" (610 mm)
Front - 24" (610 mm)

1 Determine water heater location

Flooring and foundation

Flooring

The Shield water heater is approved for installation on combustible flooring, but must never be installed on carpeting.

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

When local codes require compliance with NSF 5, the heater must be sealed to the floor with a food grade silicone to prevent debris and harborage of vermin under the heater.

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

Remove water heater from wood pallet

1. Remove the sides and the top of the crate.
2. Remove the blocks on the base of the crate to allow for easier removal.
3. The water heater can then be slid off the base of the crate for installation.

NOTICE Do not drop the water heater or bump the jacket on the floor or pallet. Damage to the water heater can result.

Prevent combustion air contamination

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

⚠ WARNING Ensure that the combustion air will not contain any of the contaminants in Table 1A. Contaminated combustion air will damage the water heater, 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.

***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 water heater location *(continued)*

When using an existing vent system to install a new water heater:

⚠ 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 2A. 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 2C. 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 2A 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 2 through 4 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 2B 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 Water Heater Section.

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 16.

⚠ 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.

When removing a water heater from existing common vent system:

⚠ DANGER Do not install the Shield water heater 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.

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

At the time of removal of an existing water heater, 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.

1 Determine water heater location

Maintain minimum specified clearances for adequate operation. All installations must allow sufficient space for servicing the vent connections, water pipe connections, piping and other auxiliary equipment, as well as the appliance. The clearance labels on each appliance note the same service and combustible clearance requirements as shown above.

Multiple appliances may be installed in a modular water heater installation. Multiple appliances may be installed side by side with no clearance between adjacent appliances because this appliance is approved for zero clearance from combustible surfaces.

Consult the *Venting* section of this manual for specific installation instructions for the appropriate type of venting system that you will be using.

Combustion and ventilation air requirements for appliances drawing air from the equipment room

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.

The equipment room MUST be provided with properly sized openings to assure adequate combustion air and proper ventilation.

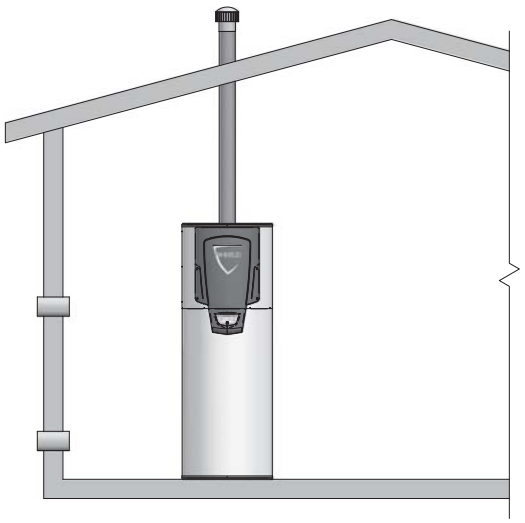


***Figure 1-3**_Combustion Air Direct from Outside*

1. If air is taken directly from outside the building with no duct, provide two permanent openings to the equipment room (see FIG. 1-3):

   (a) Combustion air opening, with a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm^2 per kW). This opening must be located within 12" (30 cm) of the bottom of the enclosure.

   (b) Ventilation air opening, with a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm^2 per kW). This opening must be located within 12" (30 cm) of the top of the enclosure.

***Figure 1-4**_Combustion Air Through Ducts*

2. If combustion and ventilation air is taken from the outdoors using a duct to deliver the air to the equipment room, each of the two openings should be sized based on a minimum free area of one square inch per 2000 Btu/hr (11 cm^2 per kW) of input (see FIG. 1-4).

1 Determine water heater location *(continued)*

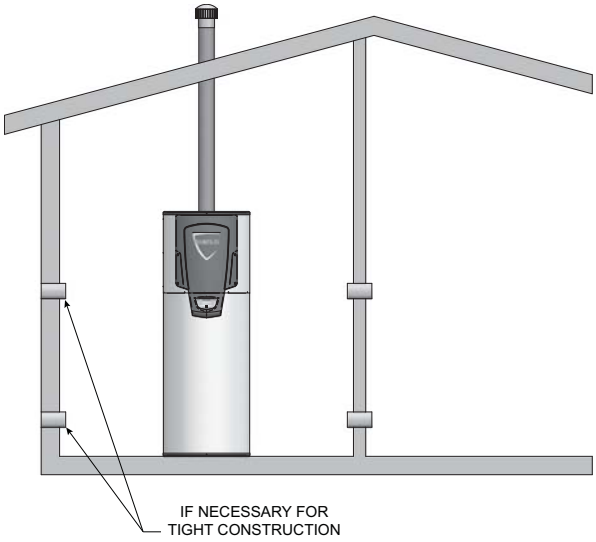


***Figure 1-5**_Combustion Air from Interior Space*

3. If air is taken from another interior space, each of the two openings specified above should have a net free area of one square inch for each 1000 Btu/hr (22 cm^2 per kW) of input, but not less than 100 square inches (645 cm^2) (see FIG. 1-5).

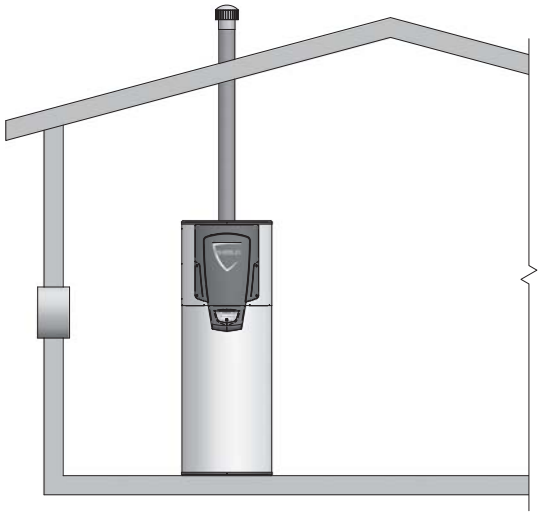


***Figure 1-6**_Combustion Air from Outside - Single Opening*

4. If a single combustion air opening is provided to bring combustion air in directly from the outdoors, the opening must be sized based on a minimum free area of one square inch per 3000 Btu/hr (7 cm^2 per kW). This opening must be located within 12" (30 cm) of the top of the enclosure (see FIG. 1-6).

TABLE - 1B
MINIMUM RECOMMENDED COMBUSTION AIR SUPPLY TO EQUIPMENT ROOM

Model Number	FIG. 1-3		FIG. 1-4		FIG. 1-5		FIG. 1-6
	*Outside Air from 2 Openings Directly from Outdoors		*Outside Air from 2 Ducts Delivered from Outdoors		**Inside Air from 2 Ducts Delivered from Interior Space		*Outside Air from 1 Opening Directly from Outdoors, in^2
	Top Opening, in^2	Bottom Opening, in^2	Top Opening, in^2	Bottom Opening, in^2	Top Opening, in^2	Bottom Opening, in^2	
SNR150-100	38 (246 cm^2)	38 (246 cm^2)	75 (484 cm^2)	75 (484 cm^2)	150 (968 cm^2)	150 (968 cm^2)	50 (323 cm^2)
SNR200-100	50 (323 cm^2)	50 (323 cm^2)	100 (646 cm^2)	100 (646 cm^2)	200 (1,291 cm^2)	200 (1,291 cm^2)	67 (433 cm^2)
SNA285-125	72 (465 cm^2)	72 (465 cm^2)	143 (923 cm^2)	143 (923 cm^2)	285 (1,839 cm^2)	285 (1,839 cm^2)	95 (613 cm^2)
SNA400-125	100 (646 cm^2)	100 (646 cm^2)	200 (1,291 cm^2)	200 (1,291 cm^2)	400 (2,581 cm^2)	400 (2,581 cm^2)	134 (865 cm^2)
SNA500-125	125 (807 cm^2)	125 (807 cm^2)	250 (1,613 cm^2)	250 (1,613 cm^2)	500 (3,226 cm^2)	500 (3,226 cm^2)	167 (1,078 cm^2)

*Outside air openings shall directly communicate with the outdoors. When combustion air is drawn from the outside through a duct, the net free area of each of the two openings must have twice (2 times) the free area required for Outside Air/2 Openings. The above requirements are for the water heater only; additional gas fired appliances in the equipment room will require an increase in the net free area to supply adequate combustion air for all appliances.

Combined interior space must be 50 cubic feet per 1,000 Btu/hr input. **Buildings MUST NOT be of *"Tight Construction". For buildings of ***"Tight Construction",** provide air openings into the building from outside.

*No combustion air openings are needed when the water heater is installed in a space with a volume NO LESS than 50 cubic feet per 1,000 Btu/hr of all installed gas fired appliances. **Buildings MUST NOT be of *"Tight Construction".**

***"Tight Construction"** is defined as a building with less than 0.40 ACH (air changes per hour).

1 Determine water heater location

Combustion air requirements are based on the latest edition of the National Fuel Gas Code, ANSI Z223.1; in Canada refer to the latest edition of CGA Standard CAN B149.1. Check all local code requirements for combustion air.

All dimensions based on net free area in square inches. Metal louvers or screens reduce the free area of a combustion air opening a minimum of approximately 25%. Check with louver manufacturers for exact net free area of louvers. Where two openings are provided, one must be within 12" (30cm) of the ceiling and one must be within 12" (30cm) of the floor of the equipment room. Each opening must have net free area as specified in the chart above (Table 1B). Single openings shall commence within 12" (30cm) of the ceiling.

⚠ CAUTION Under no circumstances should the equipment room ever be under negative pressure. Particular care should be taken where exhaust fans, attic fans, clothes dryers, compressors, air handling units, etc., may take away air from the unit.

The combustion air supply must be completely free of any flammable vapors that may ignite or chemical fumes which may be corrosive to the appliance. Common corrosive chemical fumes which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as Freon, trichlorethylene, perchlorethylene, chlorine, etc. These chemicals, when burned, form acids which quickly attack the stainless steel heat exchanger, headers, flue collectors, and the vent system.

The result is improper combustion and a non-warrantable, premature appliance failure.

EXHAUST FANS: Any fan or equipment which exhausts air from the equipment room may deplete the combustion air supply and/or cause a downdraft in the venting system. Spillage of flue products from the venting system into an occupied living space can cause a very hazardous condition that must be immediately corrected. If a fan is used to supply combustion air to the equipment room, the installer must make sure that it does not cause drafts which could lead to nuisance operational problems with the appliance.

2 General venting

Direct venting options - Sidewall Vent

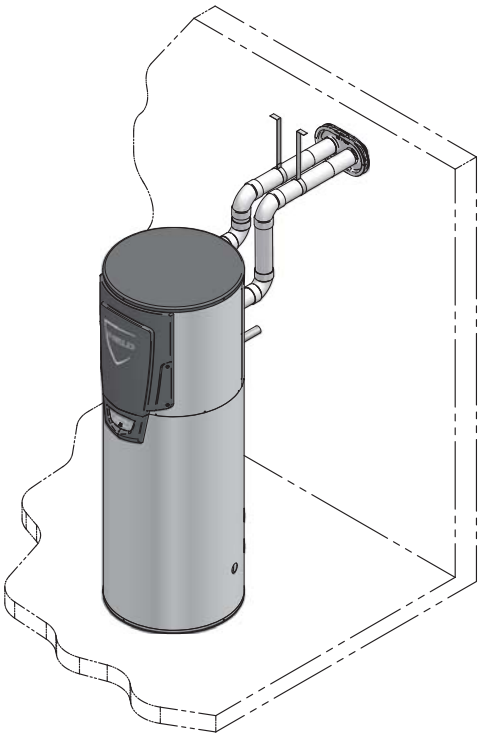


Figure 2-1 *PVC/CPVC Two-Pipe Sidewall Termination - See page 22 for more details*

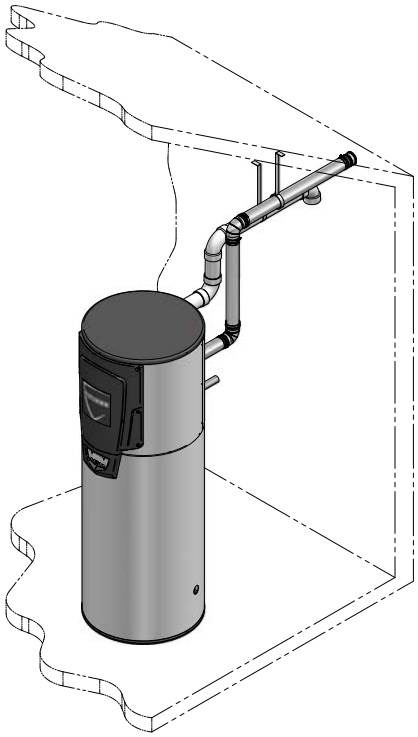


Figure 2-2 *Stainless Steel Two-Pipe Sidewall Termination - See page 23 for more details*

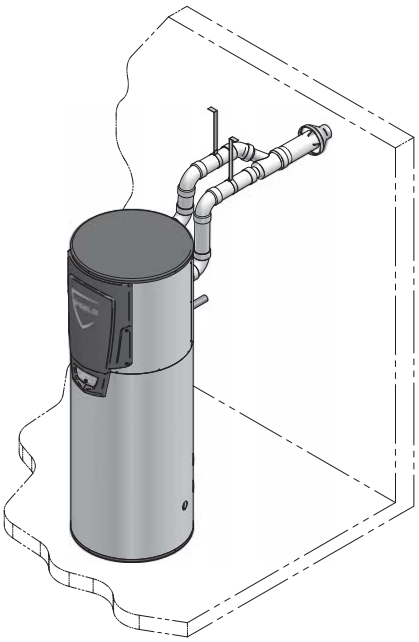


Figure 2-3 *PVC/CPVC Concentric Sidewall Termination - See page 26 for more details*

2 General venting

Direct venting options - Vertical Vent

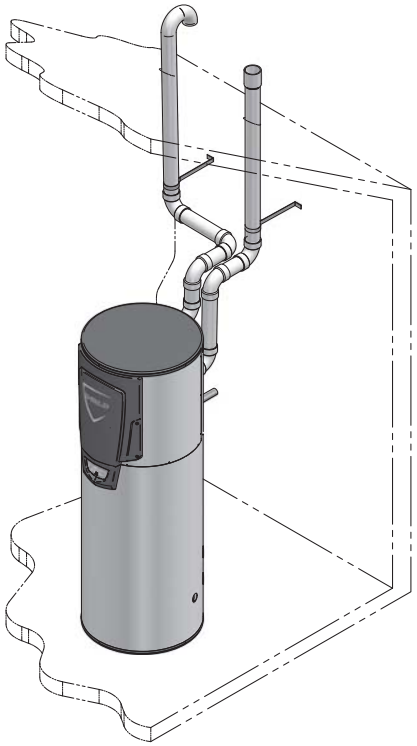


Figure 2-4 *PVC/CPVC Two-Pipe Vertical Termination - See page 29 for more details*

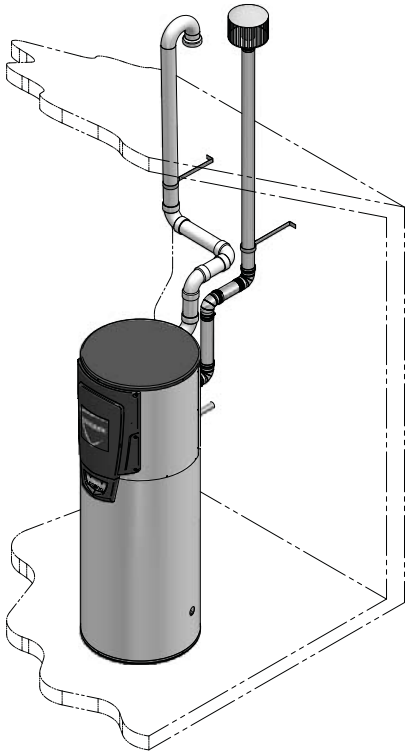


Figure 2-5 *Stainless Steel Two-Pipe Vertical Termination - See page 29 for more details*

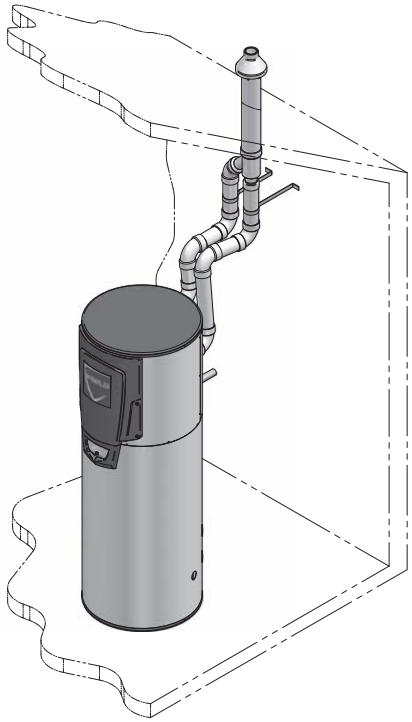


Figure 2-6 *PVC/CPVC Concentric Vertical Termination - See page 31 for more details*

Direct venting options - Vertical Vent, Sidewall Air

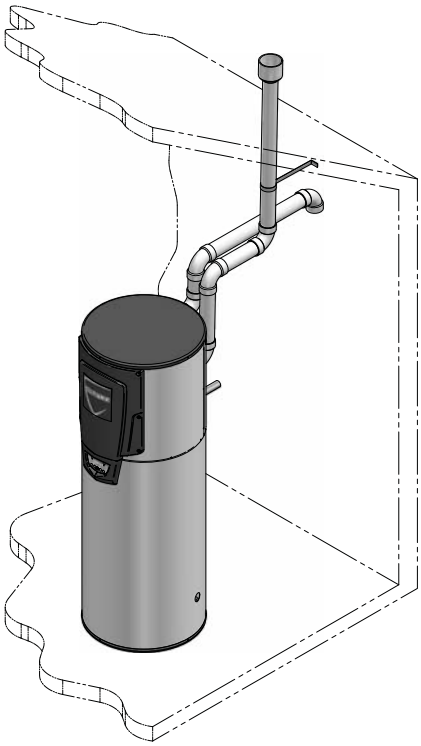


Figure 2-7 *PVC/CPVC Vertical Vent, Sidewall Air*

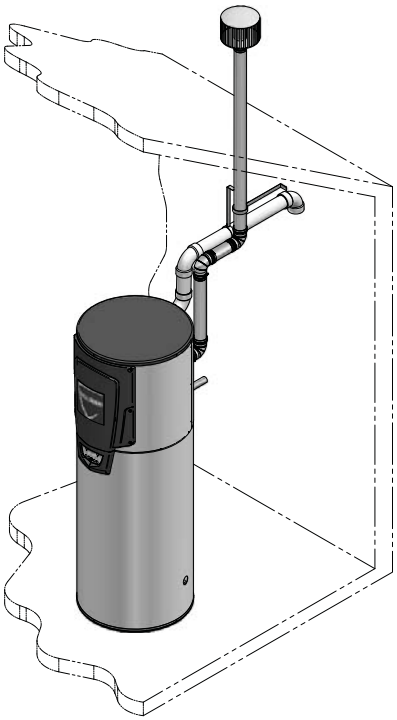


Figure 2-8 *Stainless Steel Vertical Vent, Sidewall Air*

2 General venting *(continued)*

Venting and combustion air

⚠ DANGER The Shield water heater 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 2A 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 material MUST BE used in a closet/alcove structure. Failure to follow this warning could result in fire, personal injury, or death.

NOTICE All 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 water heater (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 2B (pg. 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.

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.
4. The 3" Concentric Vent Kit available from Lochinvar (see Section 3 – *Sidewall Termination – Optional Concentric Vent*) and the 3" Concentric Vent Kit available from IPEX are both approved for use on the Shield Water Heater. Both kits are listed to the ULC-S636 standard for use in Canada.

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

Installing vent and air piping

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

1. Work from the water eater 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.

2 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.
   i. Wipe excess cement from the joint removing ring or beads as it will needlessly soften the pipe.

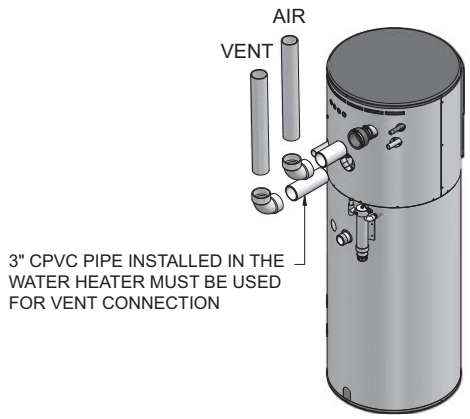
Table 2A *Vent Pipe and Fittings*

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 schedule 40	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-DWV	ANSI/ASTM D2665	
	CPVC schedule 40	ANSI/ASTM F441	
	AL29-4C	UL1738	ULC-S636
Pipe cement/primer	PVC	ANSI/ASTM D2564	IPEX System 636 Cements & Primers
	CPVC	ANSI/ASTM F493	
NOTICE: DO NOT USE CELLULAR (FOAM) CORE PIPE			
Approved Stainless Steel Vent Manufacturers			
Make			**Model**
ProTech Systems (Simpson Dura-Vent Co.)			FasNSeal Vent
Z-Flex (Nova Flex Group)			Z-Vent
Heat Fab (Selkirk Corporation)			Saf-T Vent

PVC/CPVC Air intake/vent connections

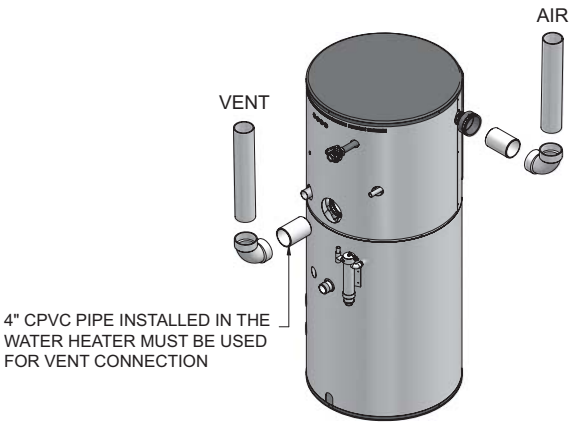
1. **Combustion Air Intake Connector** (FIG.'s 2-9 and 2-10) - Used to provide combustion air directly to the unit from outdoors. A fitting is provided on the unit for final connection. Combustion air piping must be supported per guidelines listed in the National Mechanical Code, Section 305, Table 305.4 or as local codes dictate.
2. **Vent Connector** (FIG.'s 2-9 and 2-10) - 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 2-9 *Near Water Heater Venting Models SNR150-100 - SNR200-100*



NOTE: CPVC VENT PIPE AND VENT FITTINGS MUST BE USED IN CLOSET AND ALCOVE INSTALLATIONS.

Figure 2-10 *Near Water Heater Venting Models SNA285-125 - SNA500-125*



NOTE: CPVC VENT PIPE AND VENT FITTINGS MUST BE USED IN CLOSET AND ALCOVE INSTALLATIONS.

2 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 2A.

⚠ WARNING Use only the materials, vent systems, and terminations listed in Table 2B. 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 2B for approved vent adapters. Discard CPVC starter piece.

2 General venting

Stainless steel air intake/vent connections

1. **Combustion Air Intake Connector** (FIG. 3-11) - 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. 3-11) - 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 Water Heater Stainless Steel Venting*

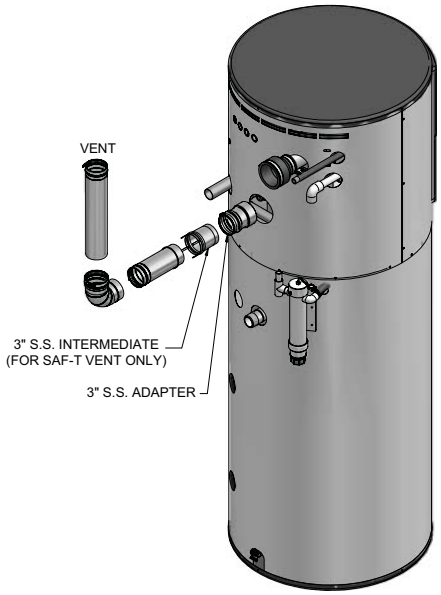


Table 2B *Approved Stainless Steel Terminations and Adapters*

Model	ProTech			Heat Fab				Z Flex		
	FasNSeal			Saf-T Vent				Z-Vent		
	Water Heater Adapter	Flue Termination	Intake Air Termination	Water Heater Adapter	Intermediate Adapter	Flue Termination	Intake Air Termination	Water Heater Adapter	Flue Termination	Intake Air Termination
SNR150 - SNR200	300715	FSBS3 FSRC3(R.C)	303889	KB80210	9353BUREZ-1*	9392 5300CI	9314TERM	2SVSLA03	2SVSTP03 2SVSRCX03	2SVSTEX0390
SNA285 - SNA500	F303759	FSBS4 FSRC4(R.C.)	FSAIH04 303888	KB285600	9454BUREZ-1*	9492 5400CI	9414TERM	2SVSLA04	2SVSTP04 2SVSRCX04	2SVSTEX0490

* = This adapter must be used in addition to the water heater 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.

The Shield water heater uses model specific combustion air intake and vent piping sizes as detailed in Table 2C below.

Table 2C *Air Intake/Vent Piping Sizes*

Model	Air Intake	Vent
SNR150-100 -- SNR200-100	3 inches	3 inches
SNA285-125 -- SNA500-125	4 inches	4 inches

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

Models SNA400-125 and SNA500-125 will de-rate 1.75% per 25 feet of vent when installed as direct vent or 0.75% per 25 feet of vent when drawing combustion air from the room.

Models SNR150-100 through SNA285-125 will de-rate up to 1% per 25 feet of vent pipe when installed as direct vent, but will not de-rate when drawing combustion air from the room.

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

Vent = 12 equivalent feet minimum / 100 equivalent feet maximum

Combustion Air (when used) = 12 equivalent feet minimum / 100 equivalent feet maximum

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

EXAMPLE: 20 feet of PVC pipe + (4) 90° elbows + (2) 45° elbows + (1) concentric vent kit (CVK3003) = 49 equivalent feet of piping.

2 General venting *(continued)*

Table 2D *Concentric Vent Kit Equivalent Vent Lengths*

Model	Kit Number	Equivalent Vent Length
SNR150-100 -- SNR200-100	CVK3003	3 feet
SNA285-125	CVK3007	3 feet
SNA400-125	CVK3007	5 feet
SNA500-125	CVK3007	30 feet

Removing from existing vent

Follow the instructions in Section 1, page 11 of this manual when removing a water heater 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 may use any of the vent/air piping methods covered in this manual. Do not attempt to install the Shield water heater 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 Shield water heater 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.

Air contamination

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

Please read the information given in Table 1A, page 10, listing contaminants and areas likely to contain them. If contaminating chemicals will be present near the location of the water heater combustion air inlet, have your installer pipe the water heater combustion air and vent to another location, per this manual.

⚠ WARNING If the water heater 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 10 before installing the water heater or air inlet piping.

If contaminants are found, you MUST:

- Remove contaminants permanently.

—OR—

- Relocate air inlet and vent terminations to other areas.

3 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 water heaters 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 3-1A *PVC/CPVC Sidewall Termination of Air and Vent*

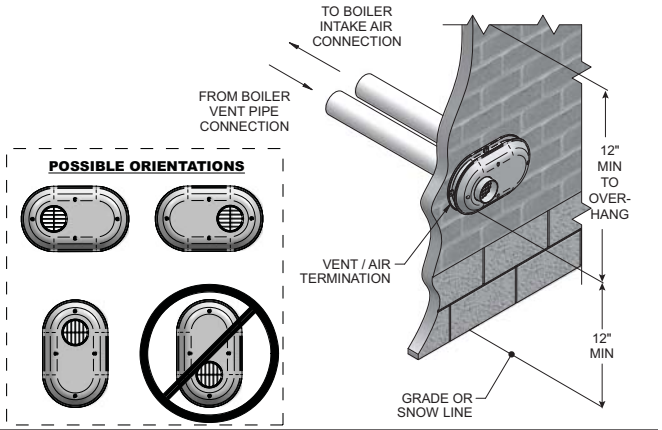


Table 3A *Sidewall Vent Kits*

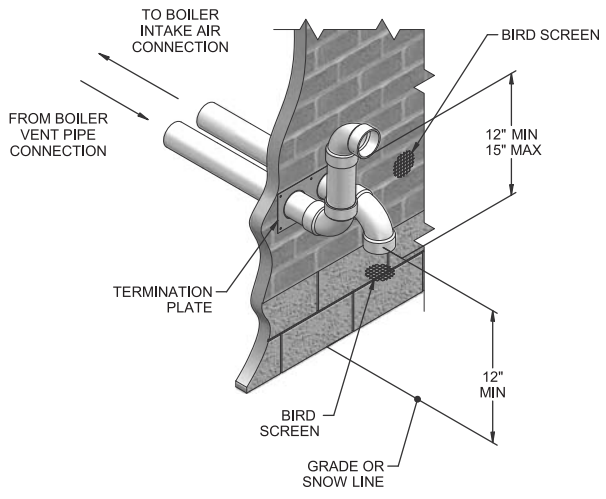
Model	Kit Number	Vent Size
SNR150-100 -- SNR200-100	KIT30045	3 inch vent
SNA285-125 -- SNA500-125	KIT30046	4 inch vent

If using the alternate sidewall termination:

3. The air piping must terminate in a down-turned elbow as shown in FIG. 3-1B. 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. 3-1B.

⚠ WARNING Do not exceed the maximum lengths of the outside vent piping shown in FIG. 3-1B. Excessive length exposed to the outside could cause freezing of condensate in the vent pipe, resulting in potential water heater shutdown.

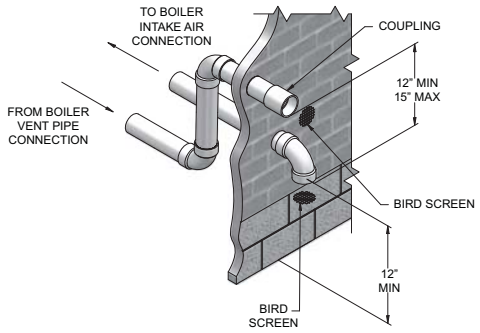
Figure 3-1B *Alternate PVC/CPVC Sidewall Termination of Air and Vent w/Field Supplied Fittings*



3 Sidewall direct venting *(continued)*

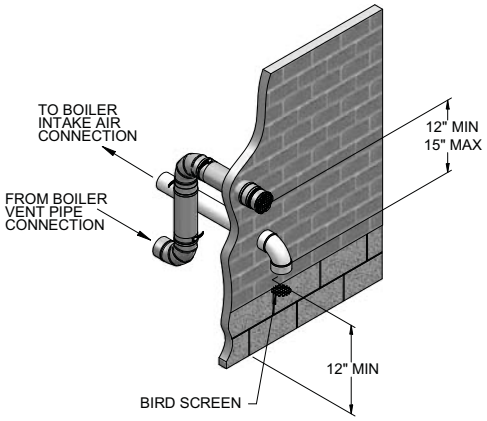
Vent/air termination – sidewall

Figure 3-1C *Alternate PVC/CPVC Venting Arrangement (if Space Allows) w/Field Supplied Fittings*



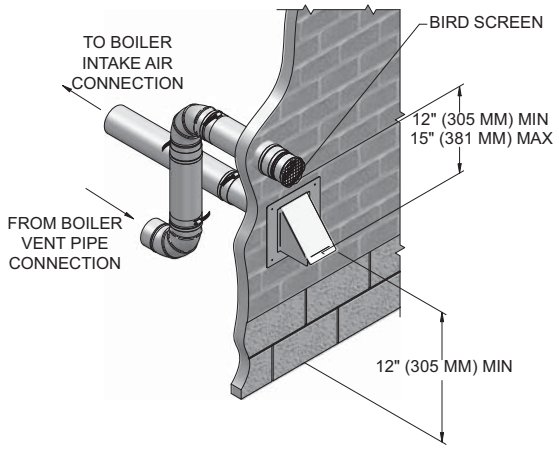
ALTERNATE VENTING ARRANGEMENT
(IF SPACE PERMITS)

Figure 3-1D *Alternate PVC/CPVC/SS Venting Arrangement - Typical Stainless Steel Sidewall Termination of Air and Vent w/Field Supplied Fittings, Utilizing 90° Elbow Intake*



MODELS SNR150-100 THRU SNA500-125

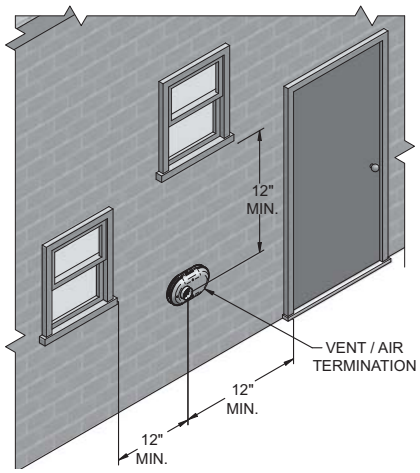
Figure 3-1E *Alternate SS Venting Arrangement - Typical Stainless Steel Sidewall Termination of Air and Vent w/Field Supplied Fittings, Utilizing FasNSeal's Hood Intake*



MODELS SNA285-125 THRU SNA500-125 WITH FASNSEAL ONLY

5. Maintain clearances as shown in FIG.'s 3-1A thru 3-3B, pages 22 and 24. Also maintain the following:
   a. Vent must terminate:
      - At least 6 feet from adjacent walls.
      - No closer than 12 inches below roof overhang.
      - At least 7 feet above any public walkway.
      - At least 3 feet above any forced air intake within 10 feet.
      - No closer than 12 inches below or horizontally from any door or window or any other gravity air inlet.
   b. Air inlet must terminate at least 12 inches above grade or snow line; at least 12 inches below the vent termination; and the vent pipe must not extend more than 24 inches vertically outside the building.
   c. Do not terminate closer than 4 feet horizontally from any electric meter, gas meter, regulator, relief valve, or other equipment. Never terminate above or below any of these within 4 feet 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 3-2A *Clearance to Gravity Air Inlets*



3 Sidewall direct venting

Figure 3-2B *Alternate Clearance to Gravity Air Inlets w/Field Supplied Fittings*

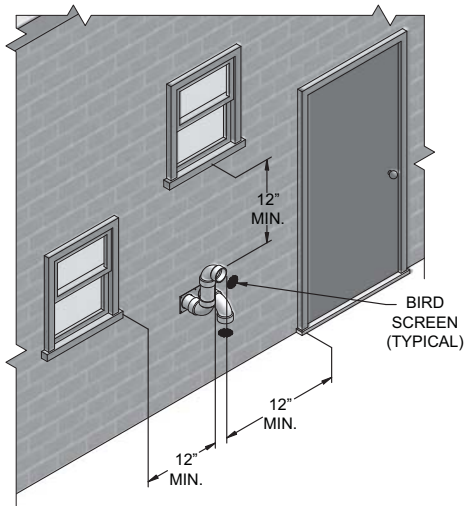


Figure 3-3A *Clearance to Forced Air Inlets*

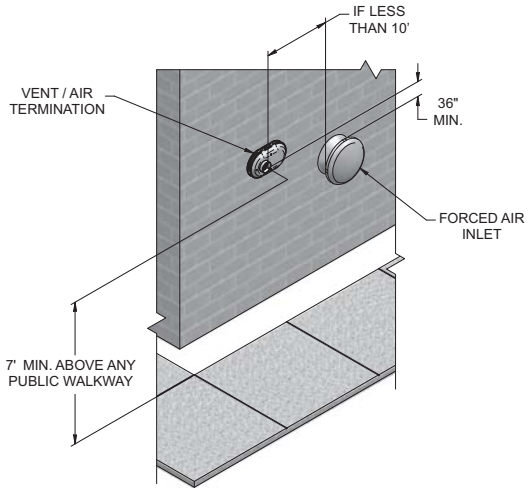
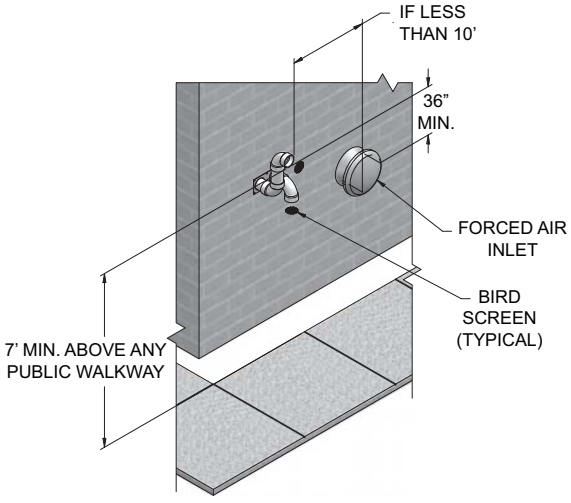


Figure 3-3B *Alternate Clearance to Forced Air Inlets w/Field Supplied Fittings*



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:

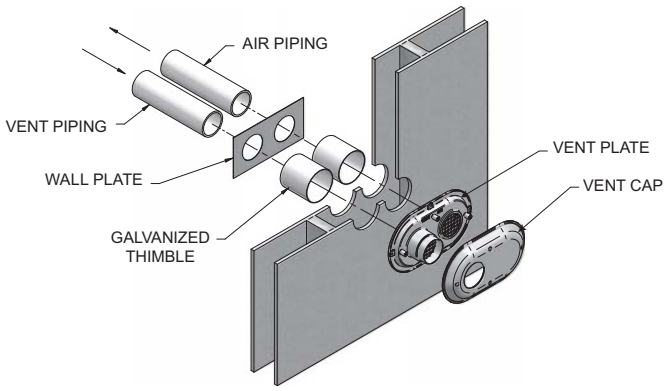
   a. Cut a hole for the air pipe. Size the air pipe hole as close as desired to the air pipe outside diameter.

   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:
      - 4½ inch hole for 3 inch vent pipe
      - 5½ inch hole for 4 inch 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 glue (cement/primer) listed in Table 2A 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. 3-4A). 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 3-4A *Sidewall Termination Assembly*

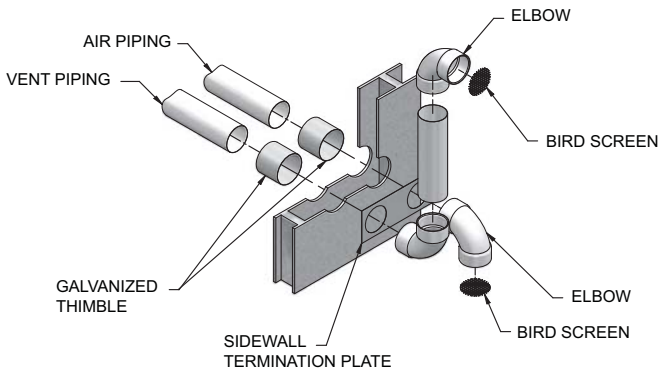


3 Sidewall direct venting *(continued)*

Prepare wall penetrations (Alternate - Field Supplied Option)

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:
      • 4½ inch hole for 3 inch vent pipe
      • 5½ inch hole for 4 inch vent pipe
   b. Insert a galvanized metal thimble in the vent pipe hole as shown in FIG. 3-4B.
3. Use a sidewall termination plate as a template for correct location of hole centers.
4. Follow all local codes for isolation of vent pipe when passing through floors or walls.
5. Seal exterior openings thoroughly with exterior caulk.

Figure 3-4B *Alternate Sidewall Termination Assembly w/Field Supplied Fittings*



Termination and fittings

1. The air termination coupling must be oriented at least 12 inches above grade or snow line as shown in FIG. 3-1A, page 22.
2. Maintain the required dimensions of the finished termination piping as shown in FIG. 3-1A, page 22.
3. If using the alternate sidewall termination do not extend exposed vent pipe outside of the building more than what is shown in this document. Condensate could freeze and block vent pipe.

Multiple vent/air terminations

1. When terminating multiple Shield water heaters terminate each vent/air connection as described in this manual (FIG. 3-5A).

⚠ 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.

2. Place wall penetrations to obtain minimum clearance of 12 inches between edge of air inlet and adjacent vent outlet, as shown in FIG. 3-5A for U.S. installations. For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
3. The air inlet of a Shield water heater is part of a direct vent connection. It is not classified as a forced air intake with regard to spacing from adjacent water heater vents.

Figure 3-5A *Multiple Vent Terminations (must also comply with* ***Figure 3-1A****)*

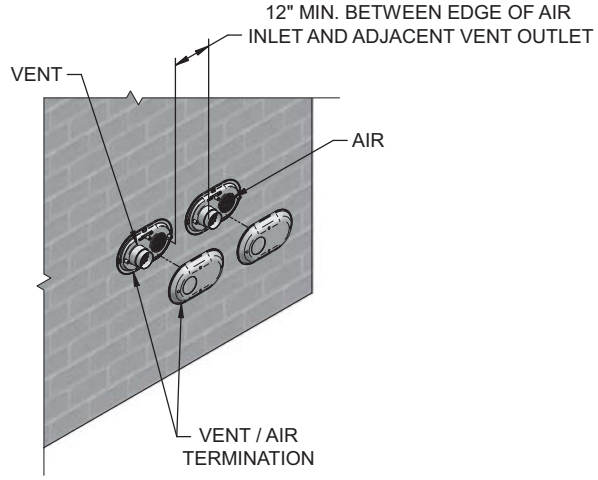
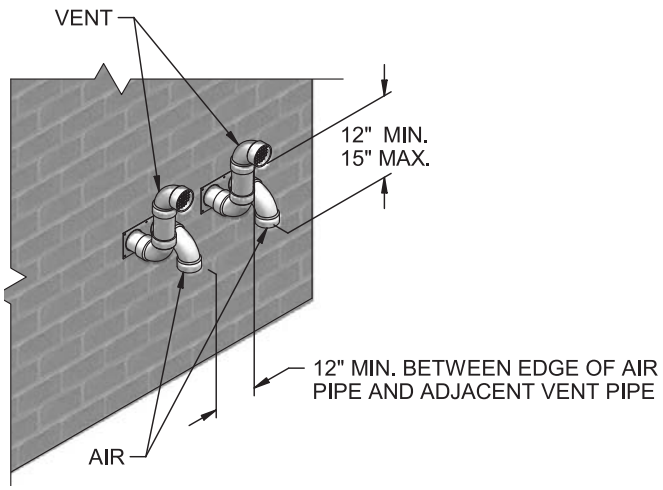


Figure 3-5B *Alternate Multiple Vent Terminations w/Field Supplied Fittings (must also comply with* ***Figure 3-1B****)*



3 Sidewall direct venting

Sidewall termination – optional concentric vent

Description and usage

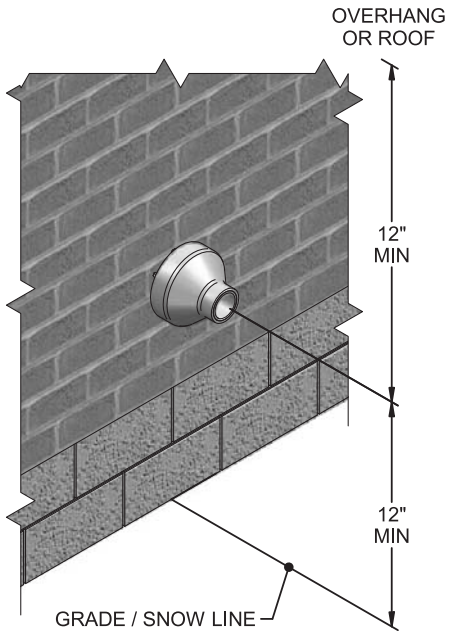
Lochinvar offers optional concentric combustion air and vent pipe termination kits (Factory Kit #CVK3003 for 3" diameter - Models SNR150-100 - SNR200-100 and #CVK3007 for 4" diameter - Models SNA285-125 - SNA500-125). Both combustion air and vent pipes must attach to the termination kit. The termination kits must terminate outside the structure and must be installed as shown in FIG. 3-6.

The required combustion vent pipe materials are listed in Table 2A, on page 18 of this manual.

Sidewall termination installation

1. Determine the best location for the termination kit (see FIG. 3-6).
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 3-6 *Concentric Sidewall Termination*



4. Cut one (1) hole (5 inch diameter for #CVK3003 installations or 7 inch 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.'s 3-7 and 3-8).
   b. Cement the rain cap to the smaller diameter kit pipe (FIG.'s 3-7 and 3-8).

Figure 3-7 *Kit Contents_CVK3003 - SNR150-100 -- SNR200-100*

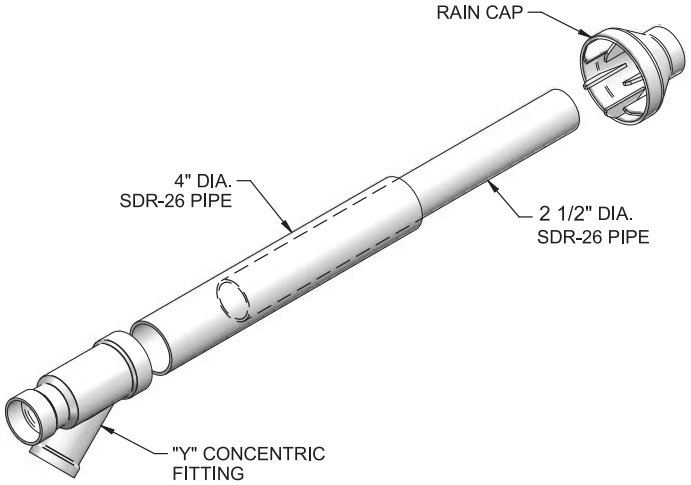
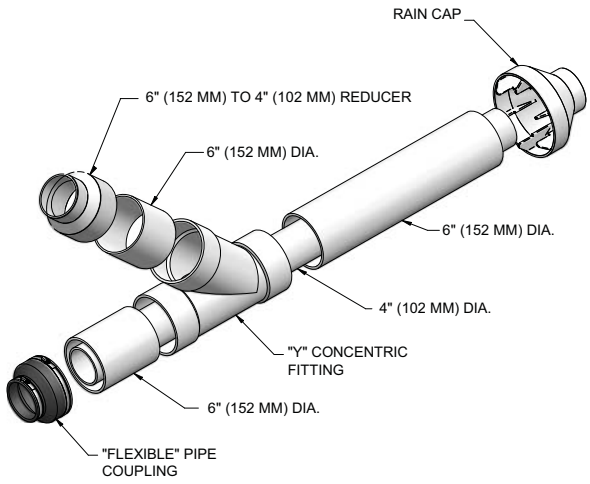


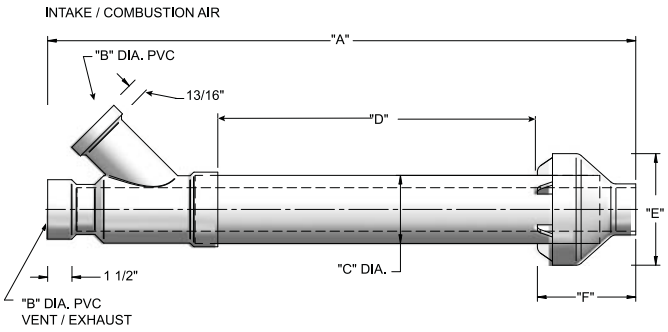
Figure 3-8 *Kit Contents_CVK3007 - SNA285-125 -- SNA500-125*



3 Sidewall direct venting *(continued)*

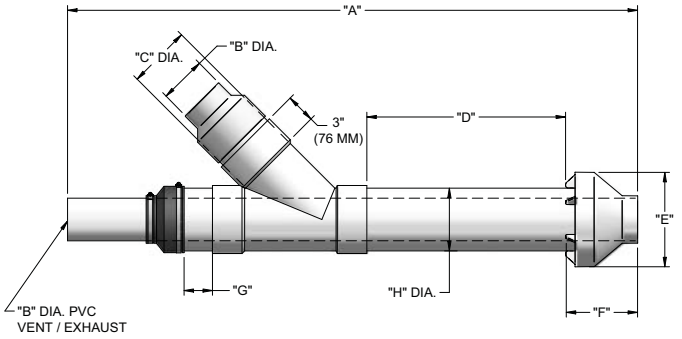
Sidewall termination – optional concentric vent

Figure 3-9 *Concentric Vent Dimensional Drawing - Models SNR150-100 -- SNR200-100 / CVK3003*



A	B	C	D*	E	F
38 7/8"	3"	4 1/2"	21 1/8"	7 3/8"	6 1/2"

Figure 3-10 *Concentric Vent Dimensional Drawing - Models SNA285-125 -- SNA500-125 / CVK3007*



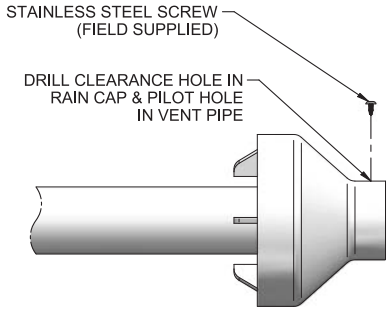
A	B	C	D	E	F	G	H
60"	4"	6"	21 1/8"	10"	7 5/8"	3"	6 5/8"

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. 3-11).

⚠ 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.

Figure 3-11 *Rain Cap to Vent Pipe Alternate Assembly*



6. Install the Y concentric fitting and pipe assembly through the structure's hole.

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

7. Install the rain cap and small diameter pipe assembly into the Y concentric fitting and large pipe assembly. Ensure small diameter pipe is bottomed and cemented in the Y concentric fitting for #CVK3003 installations and fastened tightly into the rubber adapter for #CVK3007 installations.

8. Secure the assembly to the structure as shown in FIG. 3-12 using field-supplied metal strapping or equivalent support material.

NOTICE Ensure termination location clearance dimensions are as shown in FIG. 3-6.

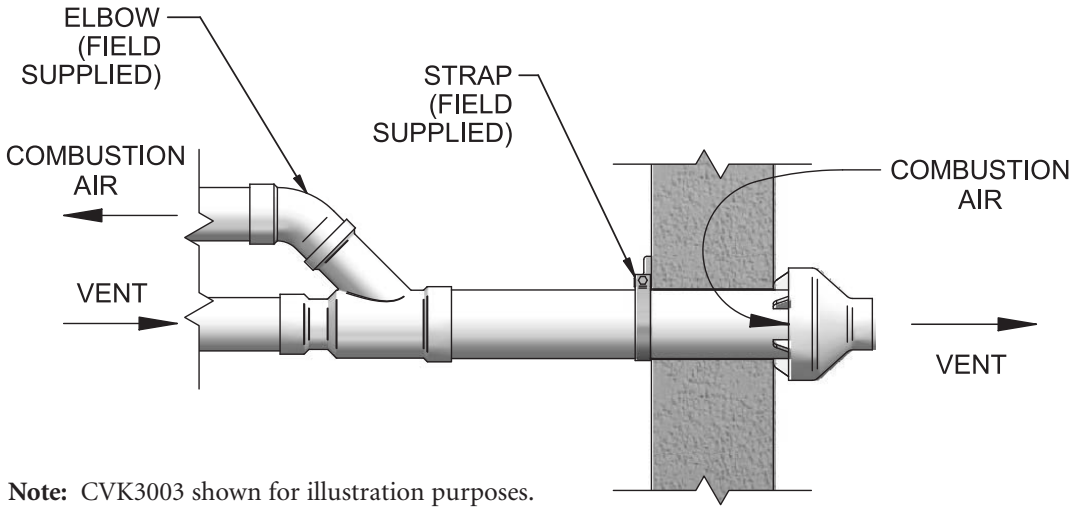
NOTICE If assembly needs to be extended to allow sidewall thickness requirement, the two (2) pipes supplied in the kit may be replaced by using the same diameter, field-supplied SDR-26 PVC (D2241) pipe for CVK3003 and standard schedule 40 PVC for CVK3007. Do not extend dimension D* more than 60 inches (see FIG.'s 3-9 and 3-10).

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

3 Sidewall direct venting

Sidewall termination – optional concentric vent

Figure 3-12 *Concentric Vent Sidewall Attachment*



Note: CVK3003 shown for illustration purposes.

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. 3-12 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. 3-13). 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. 3-13. The vent terminations must be at least 36 inches away from the first two (2) terminations. It is important that vent terminations be made as shown to avoid recirculation of flue gases. Dimension A in FIG. 3-13 represents the distance between pipes or rain shields, as touching or a 2 inch maximum separation.

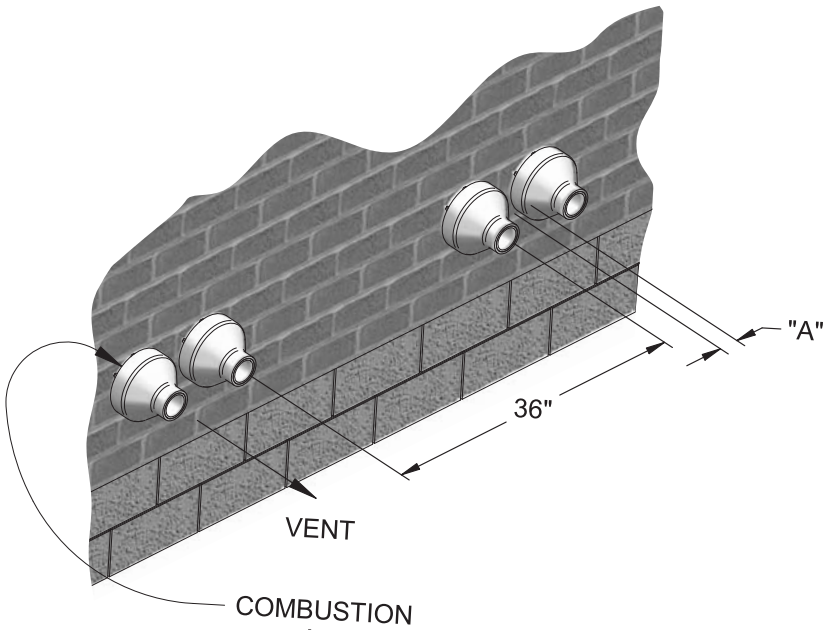


Figure 3-13 *Concentric Vent and Combustion Air Termination Dimension A as Touching or 2 inches Maximum Separation*

4 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 water heaters 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 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. 4-1A. 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. 4-1B 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 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 4-1A *Vertical Termination of Air and Vent*

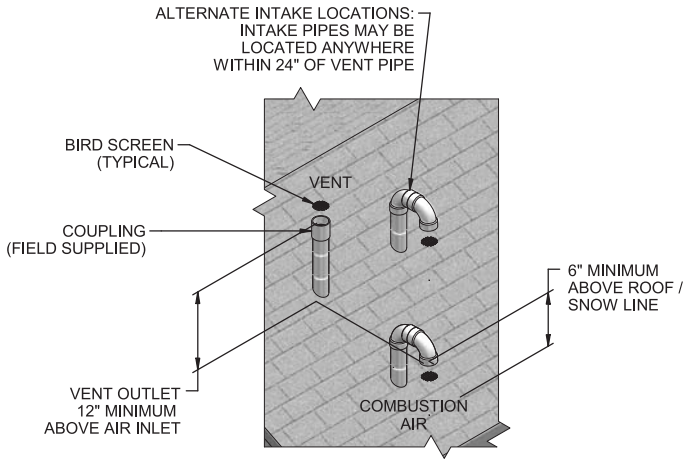
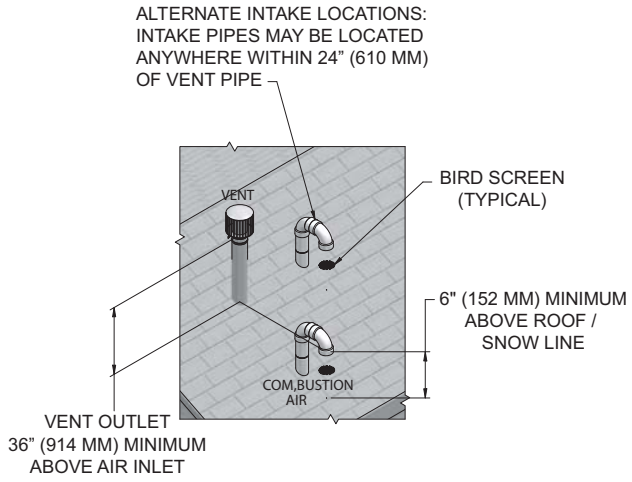


Figure 4-1B *Stainless Steel Vertical Termination of Air and Vent*



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.

4 Vertical direct venting

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:
      • 4½ inch hole for 3 inch vent pipe
      • 5½ inch hole for 4 inch vent pipe
   b. Insert a galvanized metal thimble in the vent pipe hole.
3. Space the air and vent holes to provide the minimum spacing shown in FIG. 4-1A, page 29.
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. 4-1A) 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. 4-1A. Locate the air inlet pipe no further than 2 feet 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. 4-1A. 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. 4-1B 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 apart and with the vent termination at least 1 foot above the air intake.
4. Maintain the required dimensions of the finished termination piping as shown in FIG. 4-1A.
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 Shield water heaters, terminate each vent/air connection as described in this manual (FIG. 4-2).

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

2. Place roof penetrations to obtain minimum clearance of 12 inches between edge of air intake elbow and adjacent vent pipe of another water heater for U.S. installations (see FIG. 4-2). For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
3. The air inlet of a Shield water heater is part of a direct vent connection. It is not classified as a forced air intake with regard to spacing from adjacent water heater vents.

Figure 4-2 *Vertical Terminations with Multiple Water Heaters*

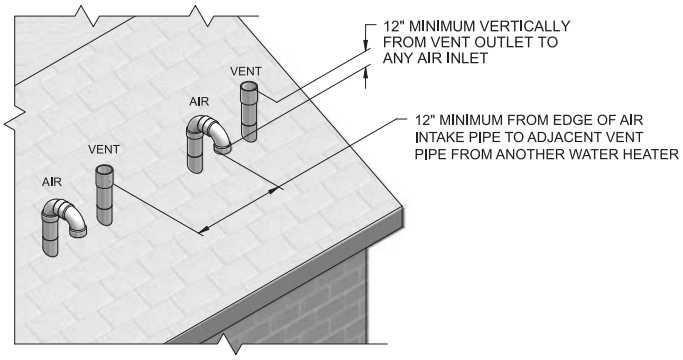
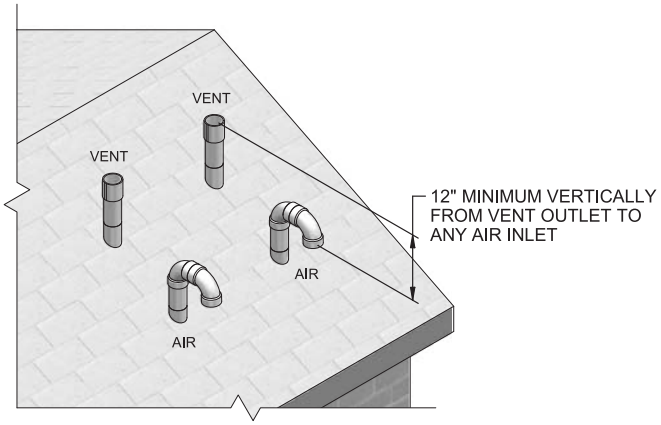


Figure 4-3 *Alternate Vertical Terminations with Multiple Water Heaters*



4 Vertical direct venting *(continued)*

Vertical termination – optional concentric vent

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. 4-4.

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

The required combustion air and vent pipe fittings are listed in Table 2A, on page 18 of this manual.

Vertical termination installation

1. See Section 4, Vertical Direct Venting - Determine Location (where applicable).

Figure 4-4 *Concentric Vertical Termination*

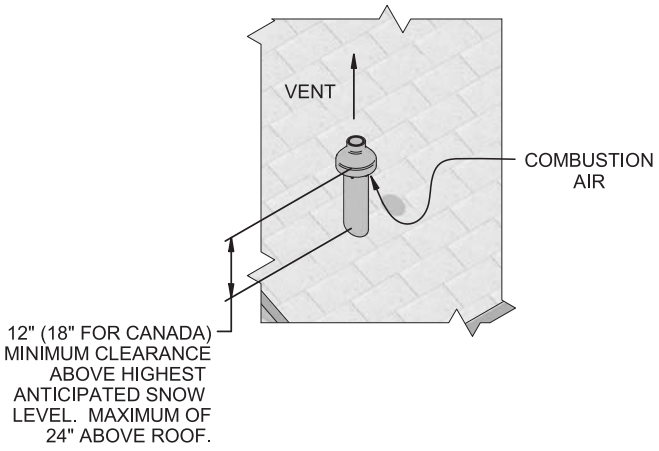


Figure 4-5 *Do Not Install U-Bent to Rain Cap*

2. Cut one (1) hole (5 inch diameter for #CVK3003 installations or 7 inch 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.'s 3-7 and 3-8, page 26).
   b. Cement rain cap to the smaller diameter kit pipe (see FIG.'s 3-7 and 3-8, page 26).
   c. Do not attach a U-Bent to the rain cap. Doing so could cause recirculation (see FIG. 4-5).

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. 3-11, page 27).

⚠ 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.

4 Vertical direct venting

Vertical termination – optional concentric vent

⚠ 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.

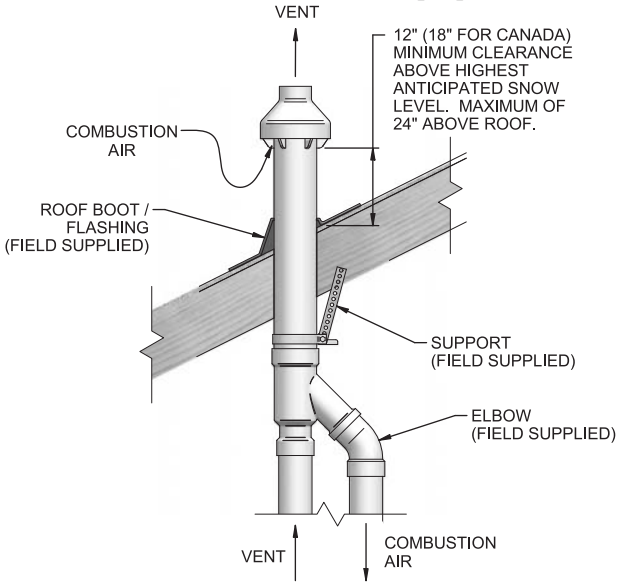
4. Install the Y concentric fitting pipe assembly up through the structure's hole and field supplied roof boot/flashing.

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. 4-6 using field supplied metal strapping or equivalent support material.

Figure 4-6 *Concentric Vent Roof Installation*

Note: CVK3003 shown for illustration purposes.



NOTICE Ensure termination height is above the roof surface or anticipated snow level (12 inches in U.S.A. or 18 inches in Canada) as shown in FIG. 4-4, page 31.

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 SDR-26 PVC (D2241) pipe for #CVK3003 and standard schedule 40 PVC for #CVK3007. Do not extend dimension D* more than 60 inches (see FIG.'s 3-9 and 3-10, page 27).

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 cemented and bottomed in the Y concentric fitting for #CVK3003 installations and fastened tightly into the rubber adapter for #CVK3007 installations.

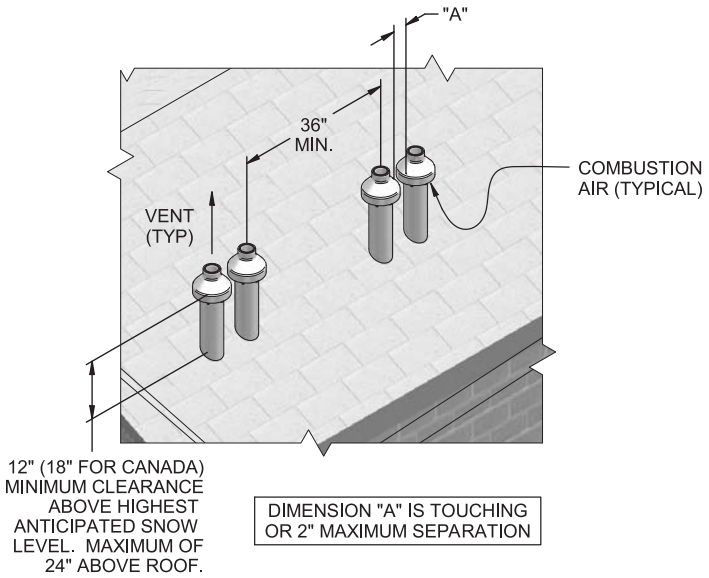
7. Cement the appliance combustion air and vent pipes to the concentric vent termination assembly. See FIG. 4-6 for proper pipe attachment.

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. 4-7). 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. 4-7. The vent terminations must be at least 36 inches away from the first two (2) terminations. It is important that vent terminations be made as shown to avoid recirculation of flue gases. Dimension A in FIG. 4-7 represents the distance between pipes or rain shields, as touching or a 2 inch maximum separation.

Figure 4-7 *Concentric Vent and Combustion Air Vertical Termination (Dimension A as Touching or 2 inches Maximum Separation)*



5 Conventional and sidewall venting

The Shield water heater may be installed with a single pipe carrying the flue products to the outside while using combustion air from the equipment room. The vent pipe may terminate either vertically (FIG. 5-1) above the roof line in a conventional vent manner or on a sidewall (FIG. 5-2).

Follow the requirements in the General Venting, Sidewall Direct Venting, and Vertical Direct Venting sections for vent material specifications, vent length requirements, and vent termination requirements.

Combustion and ventilation air must be supplied to the equipment room per the requirements on pages 12 - 14 of this manual for proper operation of the Shield water heater when utilizing the single pipe method.

Figure 5-1 *Vertical Venting w/Room Air*

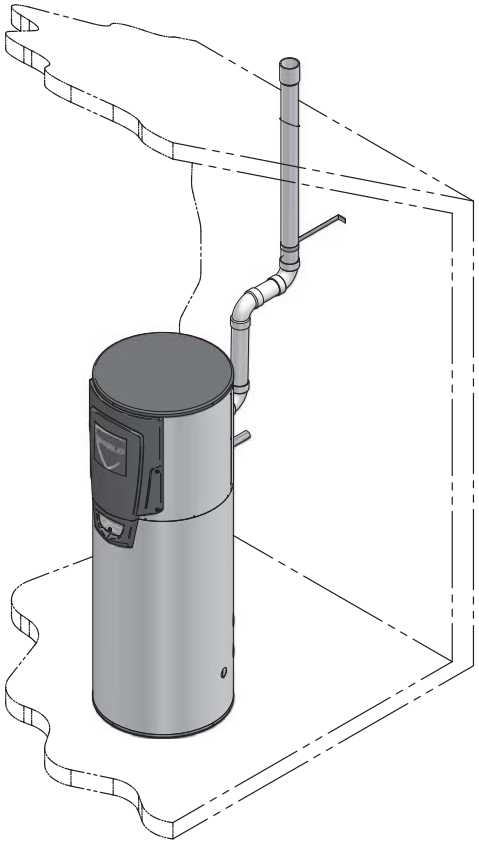
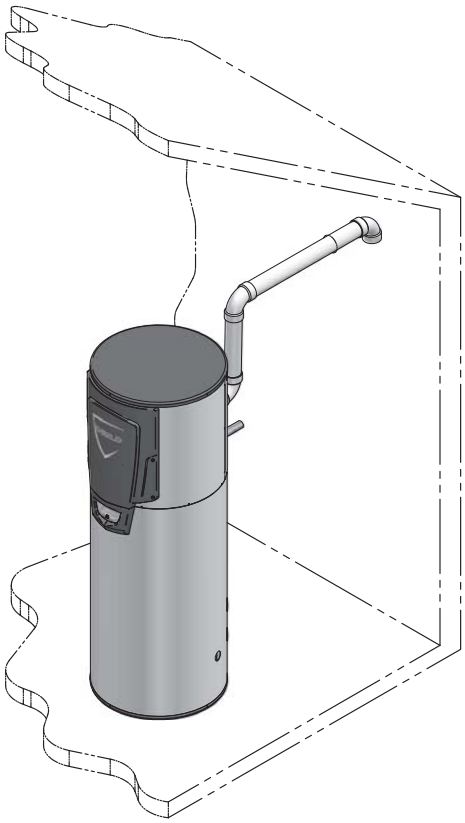


Figure 5-2 *Sidewall Venting w/Room Air*



6 System piping

System water piping methods

Observe a minimum of one inch clearance around all un-insulated hot water pipes when openings around the pipes are not protected by non-combustible materials.

⚠ WARNING Failure to install and maintain a new, listed temperature and pressure relief valve will release the manufacturer from any claim, which might result from excessive temperature and pressures.

Keep clear of the combination temperature and pressure relief valve discharge line outlet. The discharge may be hot enough to cause scald injury. The water is under pressure and may splash.

Hydrogen gas can be produced in an operating water heater that has not had water drawn from the tank for a long period of time (generally two weeks or more). HYDROGEN GAS IS EXTREMELY FLAMMABLE. To prevent the possibility of injury under these conditions, we recommend the hot water faucet to be open for several minutes at the kitchen sink before you use any electrical appliance, which is connected to the hot water system. If hydrogen is present, there will be an unusual sound such as air escaping through the pipes as hot water begins to flow. Do not smoke or have an open flame near the faucet at the time it is open.

General piping information

Basic steps are listed below along with illustrations on the following pages (FIG.'s 6-2 thru 6-4), which will guide you through the installation of the Shield water heater.

1. BEFORE PROCEEDING WITH THE INSTALLATION, CLOSE THE MAIN WATER SUPPLY VALVE. After shutting off the main water supply, open a faucet to relieve the water line pressure to prevent any water from leaking out of the pipes while making the water connections to the water heater. The COLD water inlet and HOT water outlet are identified on the water heater. Make the proper plumbing connections between the water heater and the plumbing system to the building. Install a shutoff valve in the cold water supply line.
2. If this water heater is installed in a closed water supply system, such as the one having a backflow preventer in the cold water supply, provisions must be made to control thermal expansion. DO NOT operate this water heater in a closed system without provisions for controlling thermal expansion. Warranties do not cover damages from thermal expansion such as pressure bulges and/or deformities. Your water supplier or local plumbing inspector should be contacted on how to control this situation.
3. After installation of the water lines, open the main water supply valve and fill the water heater. While the water heater is filling, open several hot water faucets to allow air to escape from the water system. When a steady stream of water flows through the faucets, close them and check all water connections for possible leaks.
4. Never operate the water heater without first being certain it is filled with water.

Scalding

This water heater can deliver scalding temperature water at any faucet in the system. Be careful whenever using hot water to avoid scalding injury. Certain appliances such as dishwashers and automatic clothes washers may require increased temperature water. By setting the thermostat on this water heater to obtain the increased temperature water required by these appliances, you may create the potential for scald injury. To protect against injury, you should install an ASSE approved mixing valve in the water system. This valve will reduce point of discharge temperature by mixing cold and hot water in branch supply lines. Such valves are available from the local plumbing supplier.

Figure 6-1 *Scald Warning*

Water temperatures over 125°F (52°C) can cause severe burns instantly or death from scalds.
Children, disabled, and elderly are at highest risk of being scalded.

See instruction manual before setting the thermostat at the water heater.

Feel water before bathing or showering.

Temperature limiting valves are available, consult local plumbing supplier.

6 System piping *(continued)*

The following chart (Table 6A) details the relationship of water temperature and time with regard to scald injury and may be used as a guide in determining the safest water temperature for your applications.

***Table 6A** Approximate Time / Temperature Scald Chart*

APPROXIMATE TIME / TEMPERATURE RELATIONSHIPS IN SCALDS	
120°F	More than 5 minutes
125°F	1 1/2 to 2 minutes
130°F	About 30 seconds
135°F	About 10 seconds
140°F	Less than 5 seconds
145°F	Less than 3 seconds
150°F	About 1 1/2 seconds
155°F	About 1 second

Water chemistry

NOTICE The Shield water heater is designed for heating potable water with a hardness of 5 to 25 grains per gallon and a total dissolved solids not exceeding 350 ppm.

The water must be treated if it is not between 5 to 25 grains per gallon or above 350 ppm of total dissolved solids. Hardness exceeding 25 grains or 350 ppm can cause non-warrantable premature failure of the heat exchanger. Water with a hardness of less than 5 grains per gallon will usually have a pH which can be aggressive and corrosive causing non-warrantable damage to the pump and associated piping. Corrosion due to water chemistry generally shows up first in the hot water system because heated water increases the rate of corrosive chemical reactions.

Piping components

Check valves:

Field supplied. Check valves are recommended for installation as shown in FIG.'s 6-2 thru 6-4.

Water heater 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 water heater.

Anti-scald mixing valve:

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

Unions:

Field supplied. Recommended for unit serviceability.

Temperature and pressure relief valve:

Factory supplied on water heaters. The temperature and pressure relief valve is sized to ASME specifications.

⚠ CAUTION No valves shall be placed between the relief valve, heat exchanger, or tank. The relief valve shall be piped to a suitable drain as close as possible to the heater with no reducing couplings or other restrictions. The piping must be sloping away from the heater at all times.

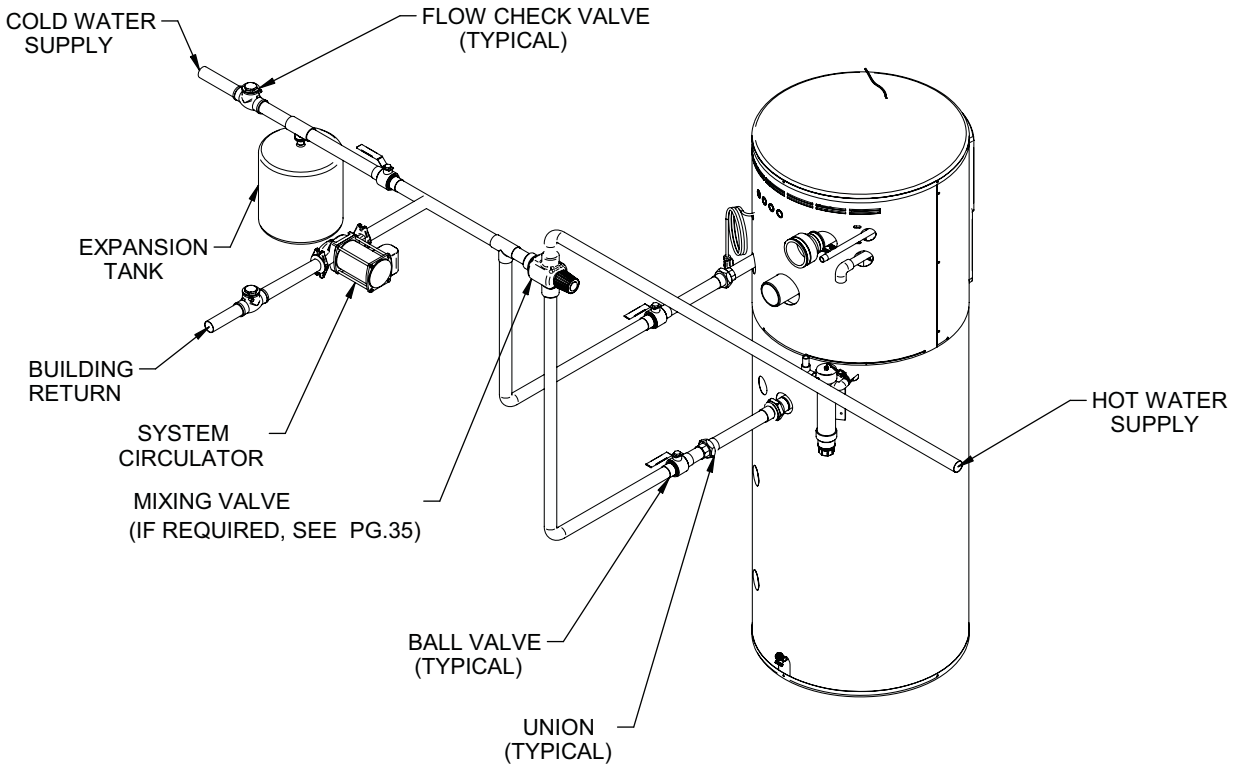
The heater is equipped with 3/4" CPVC (SDR11) pipe and elbow connections. If local codes prohibit the use of CPVC, the CPVC pipe, elbow, and 3/4" NPT adapter can be replaced with a copper equivalent.

See the *piping illustrations included in this section, FIG.'s 6-2 thru 6-4 for suggested guidelines in piping the Shield water heater.

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.

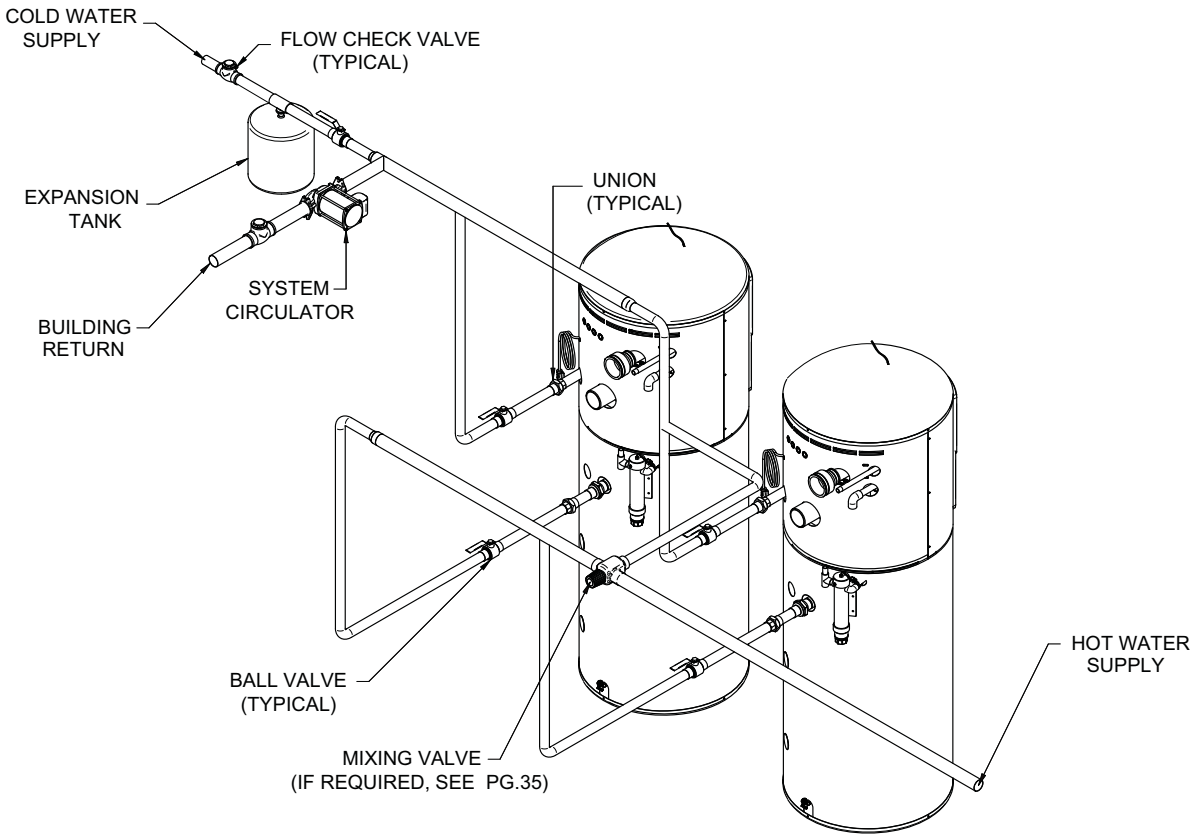
6 System piping

Figure 6-2 *Single Unit*



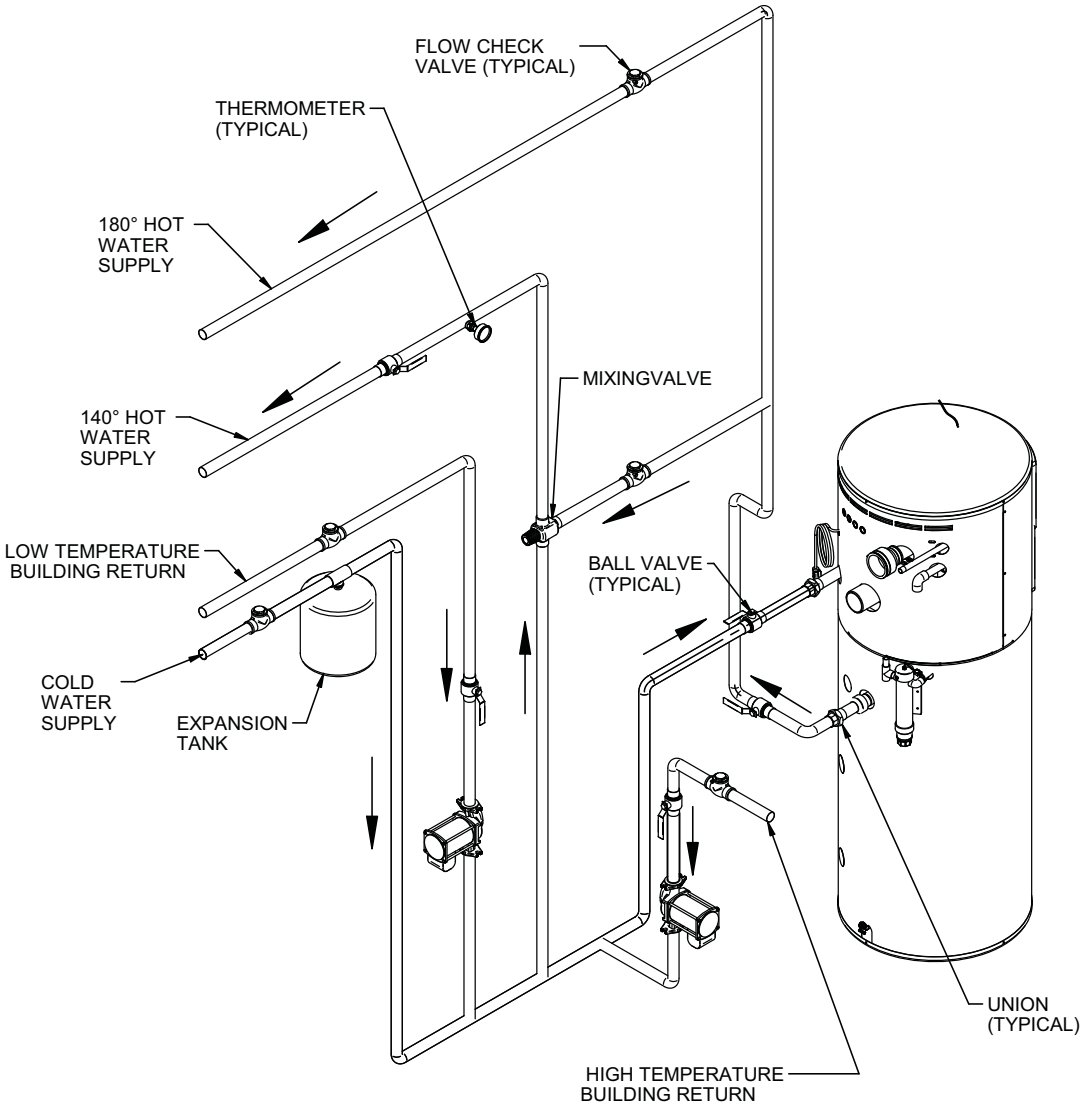
6 System piping *(continued)*

Figure 6-3 *Multiple Units*



6 System piping

Figure 6-4 *Two Temperature - Single Unit*



7 Gas connections

Connecting gas supply piping

1. Install ground joint union for servicing, when required.
2. On Models SNR150-100 -- SNA285-125 install a manual shutoff valve in the gas supply piping outside water heater jacket when required by local codes or utility requirements.
3. In Canada – When using manual main shutoff valves, it must be identified by the installer.

Figure 7-1 *Gas Supply Piping - Models SNR150-100 -- SNA285-125*

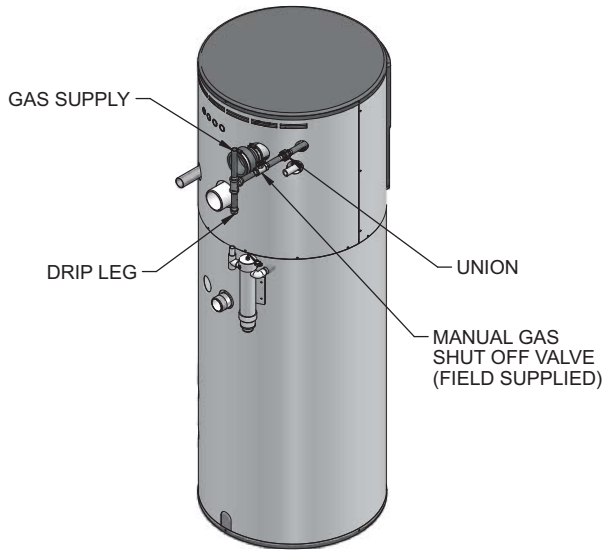
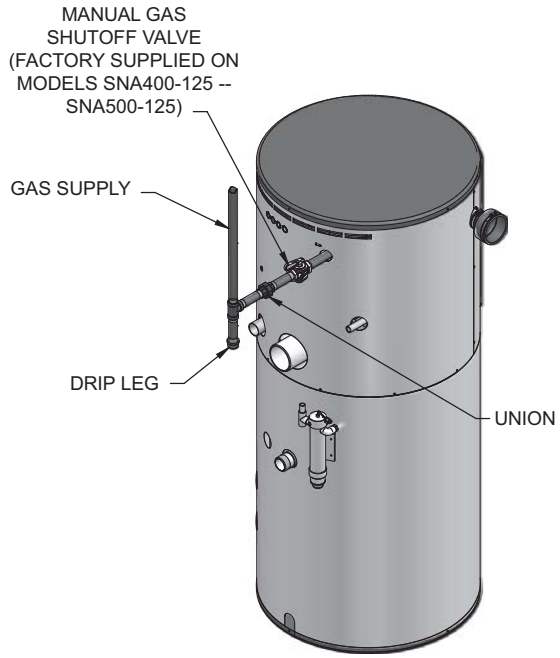


Figure 7-2 *Gas Supply Piping - Models SNA400-125 -- SNA500-125*



4. Support piping with hangers, not by the water heater 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 water heater or its accessories. Failure to comply could result in severe personal injury, death, or substantial property damage.

5. Purge all air from the gas supply piping.
6. Before placing the water heater in operation, check the water heater 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.

7. 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.

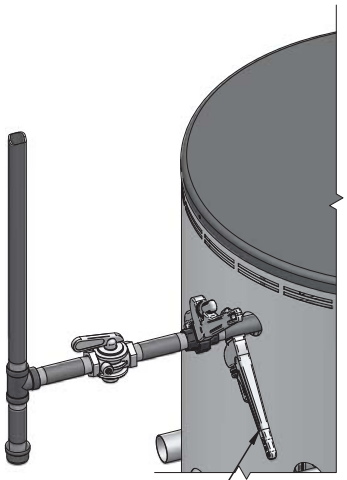
7 Gas connections

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

⚠ WARNING Shield water heaters are typically shipped ready to fire on natural gas. Check the water heater rating plate to determine which fuel the water heater is set for. In order to operate on LP gas contact the factory, 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.

⚠ WARNING Use two wrenches when tightening gas piping at water heater (FIG. 7-3), using one wrench to prevent the water heater gas line connection from turning. Failure to support the water heater gas connection pipe to prevent it from turning could damage gas line components.

Figure 7-3 *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.

⚠ WARNING Ensure that the high gas pressure regulator is at least 10 feet upstream of the appliance.

Natural gas:

Pipe sizing for natural gas

1. Refer to Table 7A for pipe length and diameter. Based on rated water heater 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 0.50 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. with no flow (lockup) or with water heater on.
   • Minimum 4 inches w.c. with gas flowing (verify during water heater startup).
2. Install 100% lockup gas pressure regulator in supply line if inlet pressure can exceed 14 inches w.c. at any time. Adjust lockup regulator for 14 inches w.c. maximum.

Propane gas:

⚠ WARNING Shield water heaters are typically shipped ready to fire on natural gas. Check water heater rating plate to determine which fuel the water heater is set for. In order to operate on LP gas contact the factory, 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. maximum pressure.
2. Pressure required at gas valve inlet pressure port:
   • Maximum 14 inches w.c. with no flow (lockup) or with water heater on.
   • Minimum 8 inches w.c. with gas flowing (verify during water heater startup).

7 Gas connections *(continued)*

Table 7A *Natural Gas Pipe Size Chart*

Nominal Iron Pipe Size (Inches)	Natural Gas Pipe Capacity Chart Length of Pipe in Straight Feet for 1/2 PSI													
	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

⚠ WARNING Shield water heaters are typically shipped ready to fire on natural gas. Check the water heater rating plate to determine which fuel the water heater is set for. In order to operate on LP gas contact the factory, 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 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 water heater 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. The gas valve is factory-set for the correct outlet pressure. This setting is suitable for natural gas and propane (when configured for LP), 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.

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., the meter, regulator, or gas line is undersized or in need of service. Perform the steps below when checking inlet gas supply:

1. Disconnect power from the appliance.
2. Shut off gas to the appliance.
3. Loosen the set screw one (1) full turn from inside the pressure tap on top of the gas valve. Place the tubing of the manometer over the tap once the set screw is loosened as shown in FIG.'s 7-4 thru 7-6.
4. Slowly turn on the gas supply at the field installed manual gas valve.
5. Reconnect power to the appliance.
6. Adjust the temperature set point on the control panel of the electronic control module to call for heat.
7. 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.
8. Ensure inlet pressure is within specified range. Minimum and maximum gas supply pressures are specified in this section of the manual.
9. If gas supply pressure is within normal range and no adjustments are needed, proceed on to Step 11.
10. 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.
11. Disconnect power from the appliance.
12. Shut off the gas to the appliance.
13. Remove the manometer from the pressure tap on top of the gas valve. Re-tighten the set screw inside the pressure tap.

⚠ 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. Reconnect gas to the appliance.
15. Reconnect power to the appliance.
16. Adjust the temperature set point on the control panel of the electronic control module to the desired water temperature so the appliance will call for heat.

7 Gas connections

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 7-4 *Inlet Gas Supply Check - Models SNR150/100 -- SNA285-125*

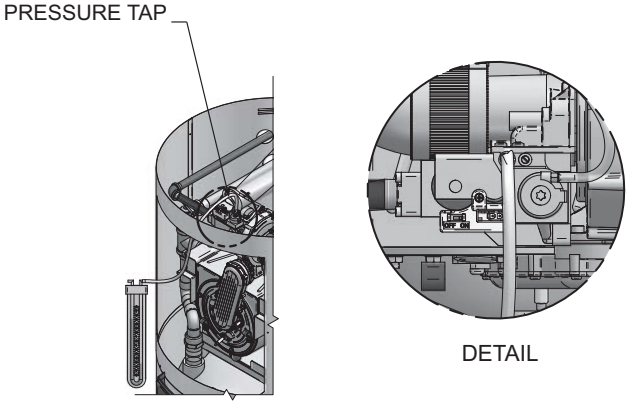


Figure 7-5 *Inlet Gas Supply Check - Model SNA400/125*

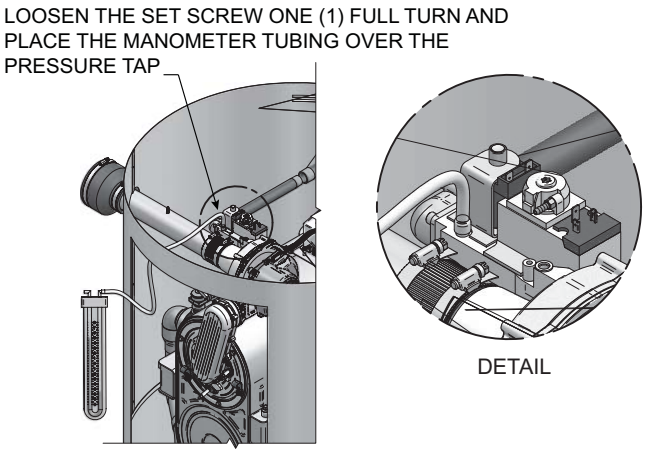
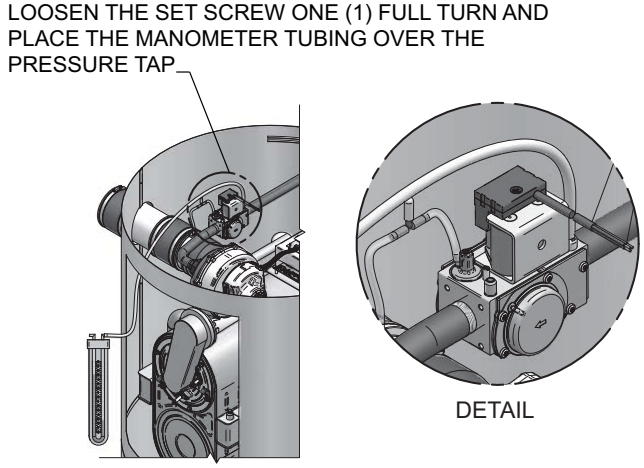


Figure 7-6 *Inlet Gas Supply Check - Model SNA500/125*



Gas pressure

The gas pressure must remain between 4 inches w.c. (natural), 8 inches w.c. (LP) minimum and 14 inches w.c. (natural and LP) maximum during stand-by (static) mode and while in operating (dynamic) mode. If an in-line regulator is used, it must be a minimum of 10 feet from the Shield water heater. 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. The gas valve is factory-set for the correct outlet pressure. This setting is suitable for natural gas and propane (when configured for LP), 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.

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 the water heater must be replaced, use only type 105°C wire or equivalent.

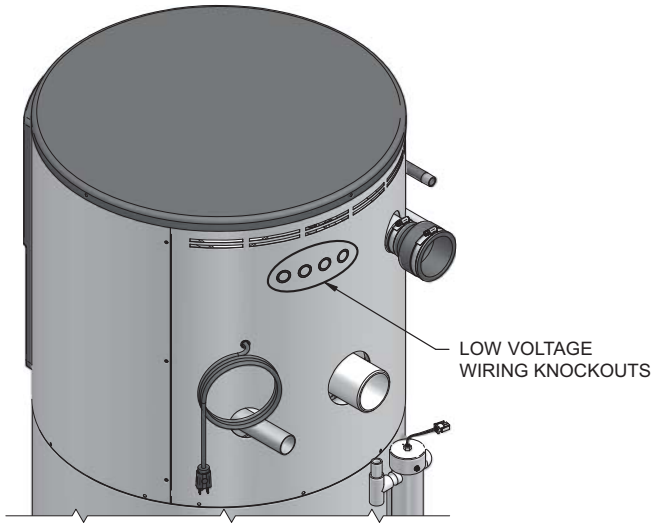
The water heater must be electrically grounded as required by National Electrical Code ANSI/NFPA 70 – latest edition.

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

Low voltage connections

1. Route all low voltage wires through the knockouts in the rear of the water heater, as shown in FIG. 8-1.
2. Connect low voltage wiring to low voltage connection board as shown in FIG. 8-3 on page 44 of this manual and the water heater wiring diagram.

Figure 8-1 *Routing Field Wiring*



Auxiliary device proving switch

1. When the operation of an external limit needs to be verified before the water heater fires, remove the jumper wire from terminals X & B and connect them to the contacts on the external limit (FIG. 8-3).

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.

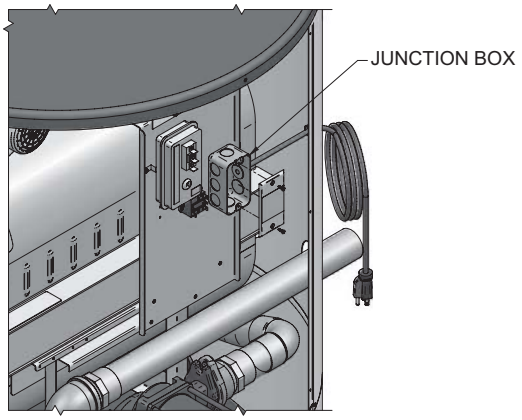
Power cord connection

This water heater is designed to operate with 120 VAC and 60 Hz power supply. If allowed by local codes, connect the power cord provided with the heater to a GFI protected outlet on a separate circuit and breaker. Ensure the circuit cannot be interrupted by a switch used to control lights or other appliances.

If local codes do not allow for the use of the power cord, remove the cord from the junction box found on the side of the control support bracket (FIG. 8-2) and attach conduit to the junction box. Route the wires out of the appliance to a GFI protected outlet on a separate circuit and breaker.

⚠ WARNING Use of an extension cord is NOT allowed. If a suitable electrical outlet is not within reach of the supplied power cord, a new receptacle must be installed or the power cord must be replaced with hard conduit as described above.

Figure 8-2 *Remove Power Cable*



Runtime contacts

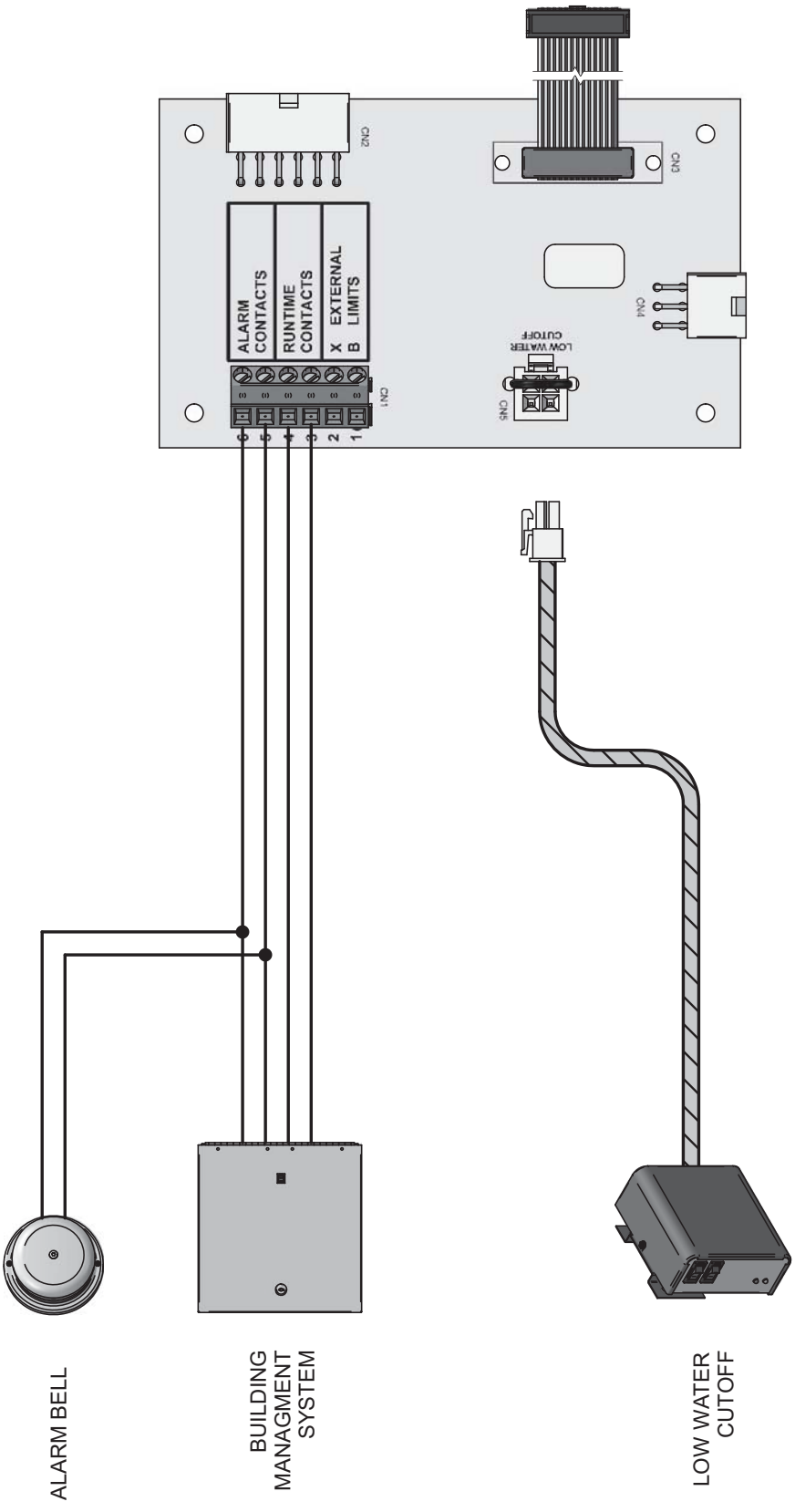
The electronic control closes a set of dry contacts whenever the burner is running. This is typically used by Building Management Systems to verify that the water heater is responding to a call for heat.

Alarm contacts

The electronic control closes another set of contacts whenever the water heater 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 water heater is down. Note that the alarm contacts will close momentarily after each call for heat.

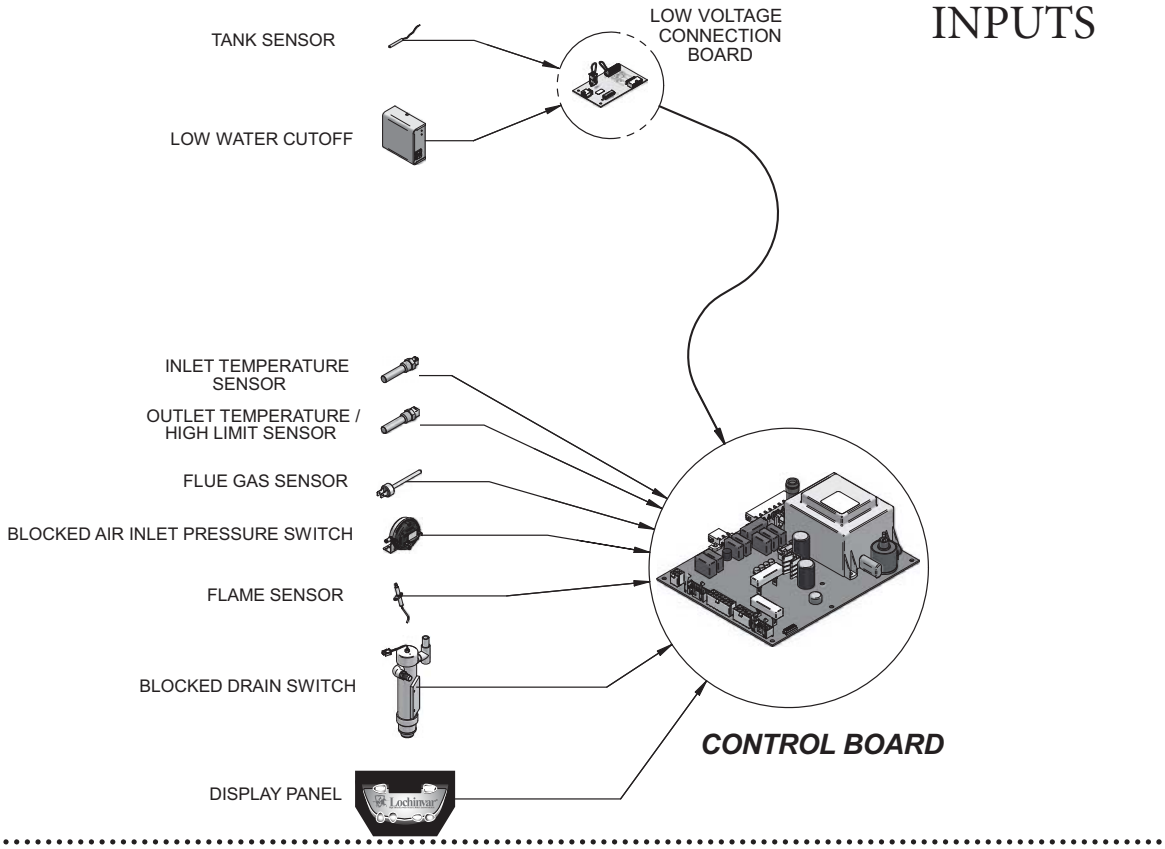
8 Field wiring

Figure 8-3 *Low Voltage Field Wiring Connections*



8 Field wiring *(continued)*

Figure 8-4 *Control Inputs/Outputs*



9 Condensate disposal

Condensate drain

1. This water heater is a high efficiency appliance that produces condensate.
2. Slope condensate tubing down and away from the water heater into a drain or condensate neutralizing filter. Condensate from the Shield water heater will be slightly acidic (typically with a pH from 3 to 5). Install a neutralizing filter if required by local codes.

   A Neutralizer Kit is available from the factory (KIT3087).
3. Leave the top of the 1/2 inch tee OPEN (FIG. 9-1). This is needed as a vacuum break.
4. Do not expose condensate line to freezing temperatures.

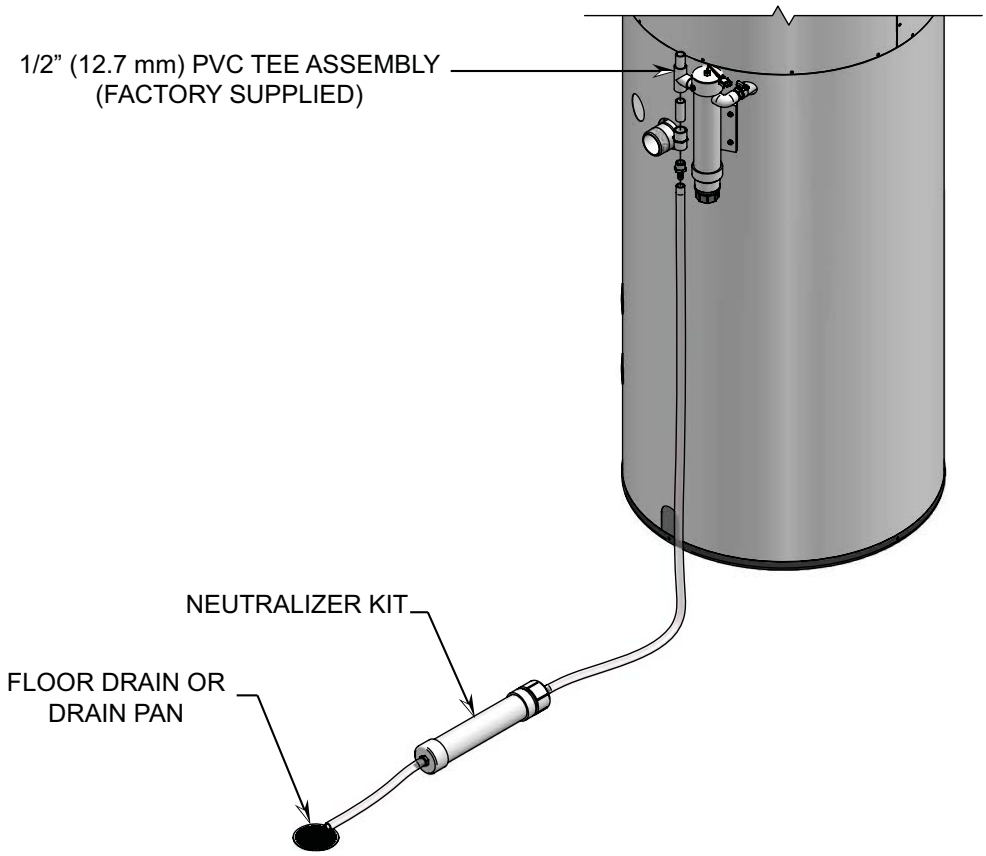
NOTICE Use materials approved by the authority having jurisdiction. In the absence of other authority, PVC and CPVC pipe must comply with ASTM D1785 or D2845. Cement and primer must comply with ASME D2564 or F493. For Canada use CSA or ULC certified PVC or CPVC pipe, fittings, and cement.

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.

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 water heater tee, resulting in potential water damage to property.

5. A condensate removal pump is required if the water heater is below the drain. When installing a condensate pump, select one approved for use with condensing water heaters and furnaces. The pump should have an overflow switch to prevent property damage from condensate spillage. The switch should be wired to the auxiliary device proving switch terminals on the low voltage connection board.

Figure 9-1 *Condensate Disposal*



10 Start-up

Chlorine concentration less than 200 ppm

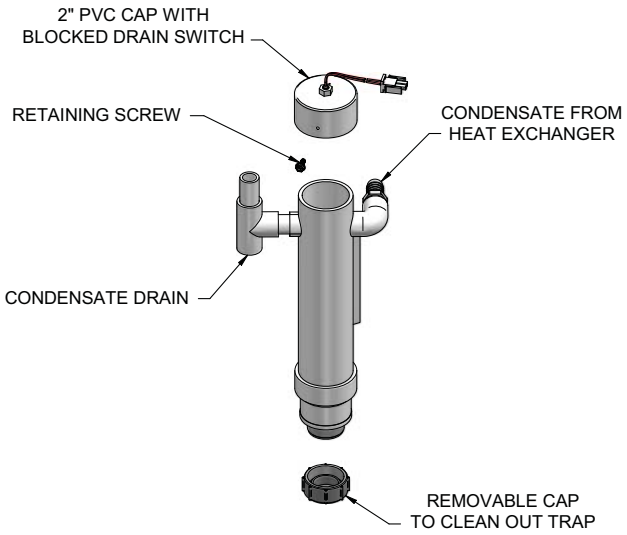
1. Do not fill the water heater or operate with water containing chlorine in excess of 200 ppm.
2. Filling with chlorinated fresh water should be acceptable since drinking water chlorine levels are much lower.
3. Do not use the water heater to directly heat swimming pool or spa water.
4. At initial fill and during water heater startup and testing, check system thoroughly for any leaks. Repair all leaks before proceeding further.

Check for gas leaks

⚠ WARNING Before starting the water heater, and during initial operation, smell near the floor and around the water heater for gas odorant or any unusual odor. Remove the top access panel and smell the interior of the water heater 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 (when configured for LP), 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 water heaters 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.

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 water heater operation to avoid flue gas emission from the condensate drain line. Failure to fill the trap could result in severe personal injury or death.

Final checks before starting the water heater

- ❑ Read this manual to familiarize yourself with electronic control module operation. Read pages 49 and 50 for proper steps to start the water heater.
- ❑ Verify the water heater and system are full of water and all system components are correctly set for operation.
- ❑ Verify the preparation procedures of Section 10, pages 47 and 48 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.

10 Start-up

Start the water heater

1. Read and follow the Operating instructions in FIG.'s 10-2 and 10-3, pages 49 and 50.

If water heater does not start correctly

1. Check for loose connections, blown fuse or service switch off.
2. Is external limit control (if used) open? Is water temperature above 200°F?
3. Is tank set point set below tank temperature?
4. Is gas turned on at meter and water heater?
5. Is incoming gas pressure less than 4 inches w.c.?

If none of the above corrects the problem, refer to the *Troubleshooting* section of this manual.

Check system and water heater

❑ Check water piping

1. Check system piping for leaks. If found, shut down the water heater and repair immediately. (See WARNINGS on pages 47 and 48 (startup) regarding failure to repair leaks.)
2. Check Delta T. Ensure Delta T is less than 25°F.
3. Vent any remaining air from the system using manual vents. Air in the system will interfere with circulation and cause hot water 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 water heater for gas odor following the procedure on page 39 of this manual *(Connecting Gas Supply Piping)*.

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

Check flame and combustion

1. Press the SHUTDOWN button on the display until **`HTR:Off`** appears in the display window.
2. Remove the screws securing the top panel to the unit. Remove the panel from the unit to gain access to the flue sensor.
3. Locate the flue sensor in the top of the vent connection. Remove the flue sensor and grommet from the unit. **Note:** Combustion measurements will be made at this point.
4. Press the SHUTDOWN button on the display until **`HTR:Standby`** appears in the display window.
5. Locate the pinhole button above the "r" in the Lochinvar logo 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 water heater into Service Mode. In Service Mode the water heater 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 water heater has modulated up to full fire, measure the combustion. The values should be in the range listed in Table 10A. 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 this manual for possible causes and corrective actions.

Table 10A *Flue Products Chart*

Natural Gas		Propane	
CO_2	O_2	CO_2	O_2
8.0% - 10%	3.0% - 6.5%	9.0% - 11%	4.1% - 6.9%

8. Once the combustion analysis is complete, press the SHUTDOWN button on the display board (FIG. 11-1) to take the water heater out of Service Mode. The water heater will go to shutdown and the display will show **`HTR:Off`**.
9. Replace the flue sensor and grommet into the vent connection.
10. Replace the top panel on the unit.
11. Place the Shield water heater back into normal operation.

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

10 Start-up *(continued)*

Figure 10-2 *Operating Instructions - Models SNR150-100 -- SNA285-125*

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.

WHAT TO DO IF YOU SMELL GAS

Do not try to light any appliance.

Do not touch any electric switch; do not use any phone in your building.

Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.

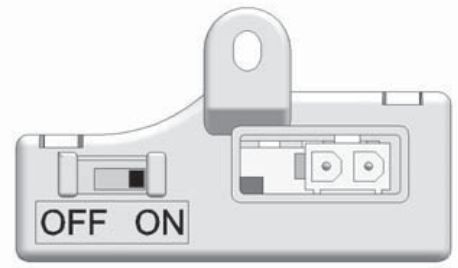
If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to move the gas control switch. Never use tools. If the switch will not move 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.

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 front door.
6. Move switch to the "OFF" position.
7. Wait five (5) minutes to clear out any gas. If you then smell gas, **STOP!** Follow "B" in the safety information above this label. If you don't smell gas, go to next step.
8. Move the switch to the "ON" position.
9. Install front door.
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 front door.
4. Move switch the "OFF" position.
5. Install front door.

LBL2339 REV B

10 Start-up

Figure 10-3 *Operating Instructions - Models SNA400-125 -- SNA500-125*

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.

WHAT TO DO IF YOU SMELL GAS

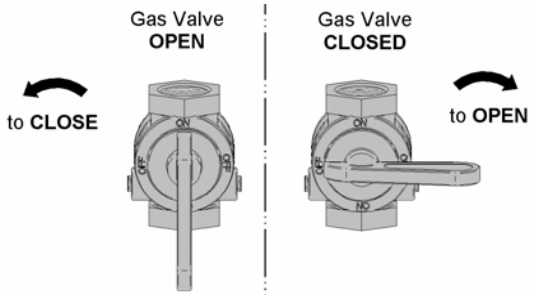
- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to turn the gas control knob. Never use tools. If the 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.

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 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 -

11 Operating information

General

How the water heater operates

The Shield water heater combines an advanced stainless steel heat exchanger, electronic control module, and tank that allows fully condensing operation. The blower pulls in air and pushes flue products out of the heat exchanger and flue piping. The control module regulates blower speed to control the water heater firing rate. The gas valve senses the amount of air flowing into the water heater and allows only the right amount of gas to flow. An internal pump circulates the water between the tank and heater and mixes the incoming water to provide maximum efficiency.

Temperature control

Modulation

The Shield water heater is capable of modulating its firing rate from a minimum of 20% to a maximum of 100%. The firing rate is dictated by the hot water draw and various other temperature limitations.

Night setback

The controller may be programmed to reduce the tank set point during a certain time each day. A start and stop time can be programmed for each day of the week.

Flame current support

To prevent nuisance shutdowns when the water heater is firing at minimum rates, the control will increase fan speed when the flame signal drops too low.

Protection features

Outlet temperature, flue temperature, and temperature rise limiting

The heat exchanger outlet temperature is monitored by the heat exchanger outlet temperature sensor. When the heat exchanger outlet temperature exceeds 190°F, the unit will reduce the fan speed. If the heat exchanger outlet water temperature exceeds 198°F 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 the control will reduce the maximum fan speed. If the flue temperature exceeds 240°F the control will shut the unit down. The unit will restart automatically once the flue temperature drops 25°F and the minimum off time has expired.

The control monitors the temperature difference between the heat exchanger inlet and the heat exchanger outlet sensors. If this difference exceeds 25°F the control will reduce the fan speed. If the temperature difference exceeds 30°F the control will shut the unit down. The unit will restart automatically once the temperature difference has dropped below 25°F and the minimum off time has expired.

Freeze protection

DO NOT install the water heater in a room likely to freeze.

The following integral feature of the electronic control module provides some protection for the water heater.

- The electronic control module provides freeze-up protection as follows when the water heater water temperature drops below 45°F:
- Below 45°F, the internal pump operates constantly.
- Below 37°F, the burner turns on.
- The burner and pump will turn off if water heater water temperature rises above 45°F.

⚠ CAUTION This feature of the electronic 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 water heater.

Monitor external limits

Connections are provided on the connection board for external limits. The electronic control module will shut off the burner and inhibit relighting whenever an external limit opens.

Runtime and alarm outputs

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

Error logging

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

11 Operating information

Water heater temperature regulation

Operating temperature (target)

The electronic control module senses water temperature in the tank and regulates water heater ignition and firing rate to achieve a target temperature. The target temperature can be set between 60°F and 185°F.

High limit operations

When the heat exchanger outlet temperature exceeds 203°F, high limit action occurs. The burner shuts down until the heat exchanger outlet water cools down, and requires manual reset of the control before operation will resume. To reset control, push the RESET key on the display.

Low water cutoff protection

1. The electronic control module uses sensing of both heat exchanger supply and return temperatures. If the flow rate is too low or either temperature too high, the control module modulates and shuts the burner down. This ensures water heater shutdown in the event of low water or low flow conditions in the heat exchanger.

Adjustable control parameters

To access the control parameters, press the MENU button on the display. When finished, press the MENU button again to return to the status display. Use the NEXT and PREVIOUS buttons to select the parameter you wish to change.

Date and time

The control uses an internal clock for the night setback feature and for logging of events. For these features to work correctly, the clock must be set when the water heater is first installed or anytime the water heater has been powered off for more than 30 days. The date and time are displayed as "MM:DD:YY W hh:mm". MM = month, DD = date, YY = year, W = day (1 = Monday, 2 = Tuesday, etc.), hh = hour (24 hour time; 2:00 PM = 14:00), mm = minutes.

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

Tank set point

When a HW call for heat becomes active, the control will use the tank set point to determine the firing rate of the water heater based on the actual water temperature. The temperature range of this parameter is 60°F to 185°F. The default value is 125°F.

Tank Differential

Once the tank set point is satisfied, the tank temperature must drop below the set point by this amount before the heater will fire again. The temperature range of this parameter is 3.6°F to 18°F. The default value is 6.3°F.

Temperature units (°F/°C)

The control can be configured to display temperature in either °C or °F. This setting can be changed by the user or the installer. The default is °F.

Night setback temperature

Once the internal clock has been set correctly, the night setback feature can be used to program a lower tank set point. The temperature range for this parameter is 32°F to 140°F. The feature is turned off with a setting of 32°F. The default value is 32°F.

Night setback times

If the night setback temperature is set to anything other than 32°F, the night setback feature becomes active. This will require start and stop times to be programmed for the days that reduced temperatures are required. Each day of the week (Sunday through Saturday) will have an ON and OFF time.

Night setback can be programmed to skip certain days of the week, and to remain active throughout certain days of the week. To skip a day, set the ON and OFF times for that day to any time before 12:00 (noon), and equal to each other. Night setback will become inactive at the OFF time on the previous day, and remain inactive until the ON time on the following day. To have night setback remain active throughout an entire day, set the ON and OFF times to any time after 12:00 (noon), and equal to each other. Night setback will become active at the ON time on the previous day, and remain active until the OFF time on the following day.

Saving parameters

To save parameters:

Press the ENTER/RESET button.

To keep parameter settings only for a current operating cycle:

Press the MENU/EXIT button 1 time to return to the status display.

11 Operating information *(continued)*

Sequence of operation

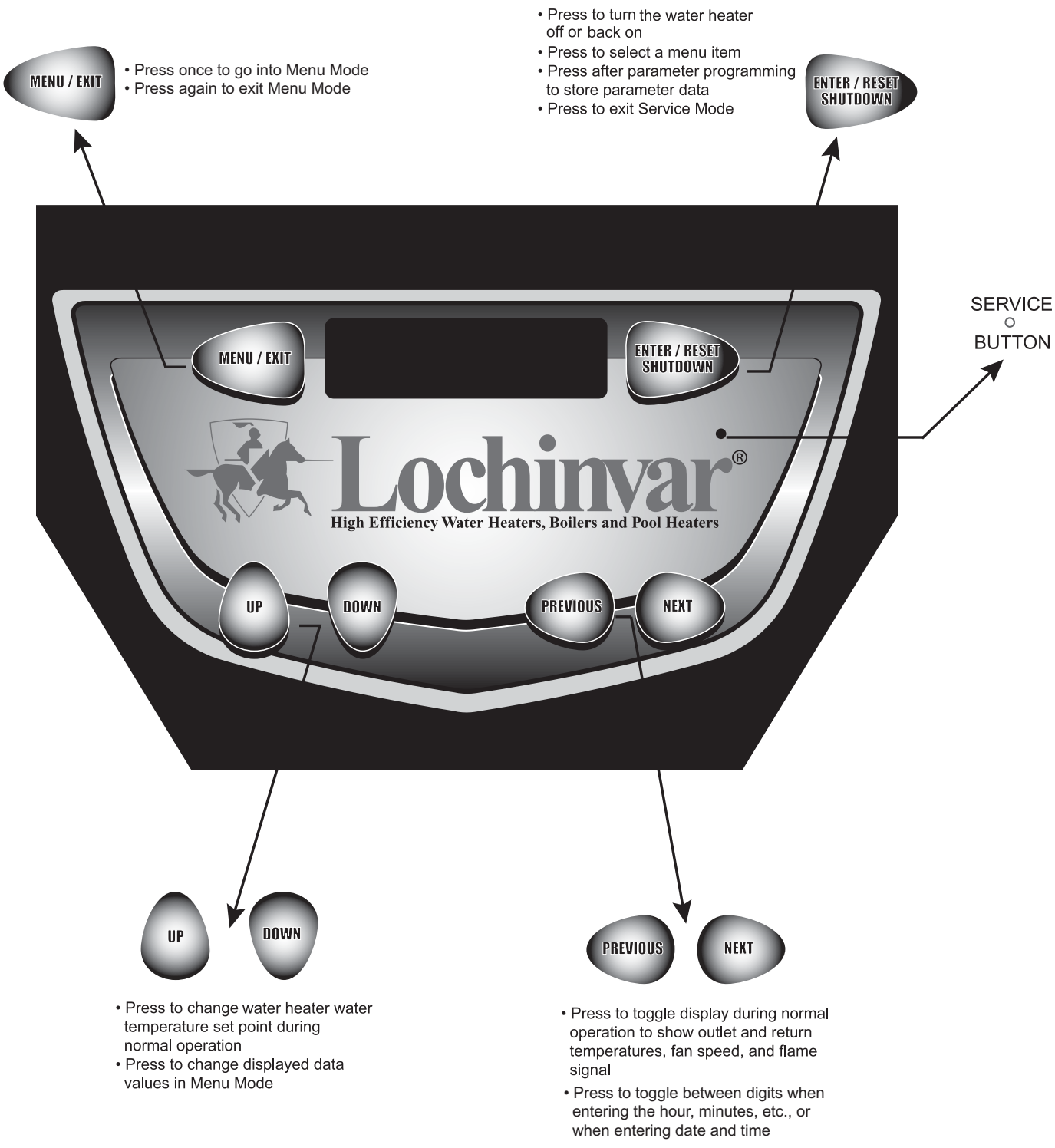
OPERATION	DISPLAY
1. When the tank temperature falls below the set point minus the differential, the control will start the burner.	HTR: Standby TANK: 123.8F(129)
2. The control connects 120 VAC to the blower. The blower does not run at this time. • The manual reset high limit must be closed before the control powers up the blower. • The control starts the internal pump. • If there is an external limit connected to the heater, it must be closed.	HTR: Standby TANK: 123.8F(129)
3. The control then starts a 10 second prepurge cycle.	HTR: PREPURGE TANK: 123.9F(129)
4. Once the prepurge cycle is complete, and the blocked drain switch and auto-reset high limit are closed, the control starts the 5 second trial for ignition by sending spark voltage to the spark electrode and opening the gas valve.	HTR: IGNITION TANK: 123.9F(129)
5. If the control does not detect flame by the end of the trial for ignition, the control performs a 10 second postpurge, another prepurge and tries to light the burner again. If the burner does not light after 4 trials, the control locks out for 1 hour and then tries another set of 4 trials.	HTR: POSTPURGE, PREPURGE TANK: 123.9F(129)
6. If the control detects a flame before the trial for ignition ends, it begins to modulate the burner in order to maintain the set point.	HTR: RUN 20% RATE TANK: 124.8F(129)
7. Once the tank temperature goes 3 - 4°F above the set point, the control will turn off the burner. The blower will remain on for the 10 second postpurge cycle. The internal pump will continue to run for its pump delay time, then turn off.	HTR: POSTPURGE TANK: 127.4F(129)
8. Burner off.	HTR: Standby TANK: 124.7F(129)

11 Operating information

Shield control module

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

Figure 11-1 *Control Panel*



11 Operating information *(continued)*

Status display screens

Status Display Screens		
By using the Previous/Next (◀, ▶) arrow keys on the electronic control module display panel, you can navigate through the five (5) display screens. Each screen will contain two (2) viewable items. The following is a description of the individual items and what they can display:		
Screen	**Display shows:**	**Description**
#1	**HTR: OFF**	The unit has been turned OFF by the Enter/Reset button on the electronic control module display panel.
	Standby	The unit has not received a call for heat.
	Prepurge	The unit has initiated a 10 second purge period on a call for heat.
	Ignition	The unit has begun a 5 second spark period to ignite the main burner.
	RUN*% Rate**	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.
	Service	The unit has been placed in a temporary mode that will allow the unit to fire at 100% of rate for the purpose of combustion analysis.
	TANK:*.*F**	The tank temperature is displayed.
	Open	The control does not detect the tank sensor.
	Shorted	The tank sensor wires or the sensor itself has become shorted.
Press the Next ▶ arrow key on the electronic control module display to access Screen #2.		
#2	**HEX IN: ***.*F**	The temperature at the inlet to the heat exchanger is displayed.
	Open	The control does not detect the heat exchanger inlet sensor.
	Shorted	The heat exchanger inlet sensor wires or the sensor itself has become shorted.
	HEX OUT: *.*F**	The temperature at the outlet of the heat exchanger is displayed.
	Open	The control does not detect the heat exchanger outlet sensor.
	Shorted	The heat exchanger outlet sensor wires or the sensor itself has become shorted.
Press the Next ▶ arrow key on the electronic control module display to access Screen #3.		

11 Operating information

Status Display Screens *(cont'd)*		
By using the Previous/Next (◀, ▶) arrow keys on the electronic control module display panel, you can navigate through the five (5) display screens. Each screen will contain two (2) viewable items. The following is a description of the individual items and what they can display:		
Screen	**Display shows:**	**Description**
#3	**RISE: ***.*F**	The control will display the temperature difference between the outlet and inlet of the heat exchanger.
	FLUE: *.*F**	The control will display the flue temperature.
	Open	The control does not detect the flue sensor.
	Shorted	The flue sensor wires or the sensor itself has become shorted.
Press the Next ▶ arrow key on the electronic control module display to access Screen #4.		
#4	**FAN SPD: ****RPM**	The control will display the actual fan motor RPM.
	FLAME SIG: **.*uA	The control will display the flame signal in dc microamps.
Press the Next ▶ arrow key on the electronic control module display to access Screen #5.		
#5	**FAULT 01 MM:DD:YY (fault)** **FAULT 01 hh:mm (fault)**	This screen allows the user to view the last 10 faults. The most recent fault is shown first. The top line of the display shows the fault number, and alternates between the date of the fault (MM:DD:YY) and the time (hh:mm). The bottom line shows cause of the fault. To view earlier faults, press the UP key. To review later faults, press the DOWN key.

12 Maintenance

Maintenance and annual startup

Table 12A *Service and Maintenance Schedules*

Service technician (see the following pages for instructions)	
ANNUAL START-UP	**General:** • Address reported problems • Inspect interior; clean and vacuum if necessary; • Clean condensate trap and fill with fresh water • Check for leaks (water, gas, flue, condensate) • Verify flue and air lines in good condition and sealed tight • Check system water pressure/system piping/expansion tank • Check control settings • Check ignition and flame sense electrodes (sand off any deposits; clean and reposition) • Check wiring and connections • Perform start-up checkout and performance verification per Section 10 in this manual. • Flame inspection (stable, uniform) • Flame signal (at least 10 microamps at high fire) • Clean the heat exchanger if flue temperature is more than 54°F above return water temperature. • Check anode rods. • Check Delta T (Temperature Rise) **If combustion or performance indicate need:** • Clean heat exchanger • Remove and clean burner using compressed air only • Clean the blower wheel

Owner maintenance	
Daily	• Check water heater area
Monthly	• Check vent piping • Check air piping • Check relief valve • Check condensate drain system • Check Delta T (Temperature Rise)
Every 6 months	• Check water heater piping (gas and water) for leaks • Operate relief valve

12 Maintenance

⚠ WARNING Follow the service and maintenance procedures given throughout this manual and in component literature shipped with the water heater. Failure to perform the service and maintenance could result in damage to the water heater 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 water heater should be inspected annually only by a qualified service technician. In addition, the maintenance and care of the water heater designated in Table 12A and explained on the following pages must be performed to assure maximum water heater efficiency and reliability. Failure to service and maintain the water heater and system could result in equipment failure.

⚠ WARNING Electrical shock hazard – Turn off power to the water heater before any service operation on the water heater 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 water heater area

1. Verify that water heater 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 water heater intake air vicinity, they must be removed. If they cannot be removed, reinstall the air and vent lines per this manual.

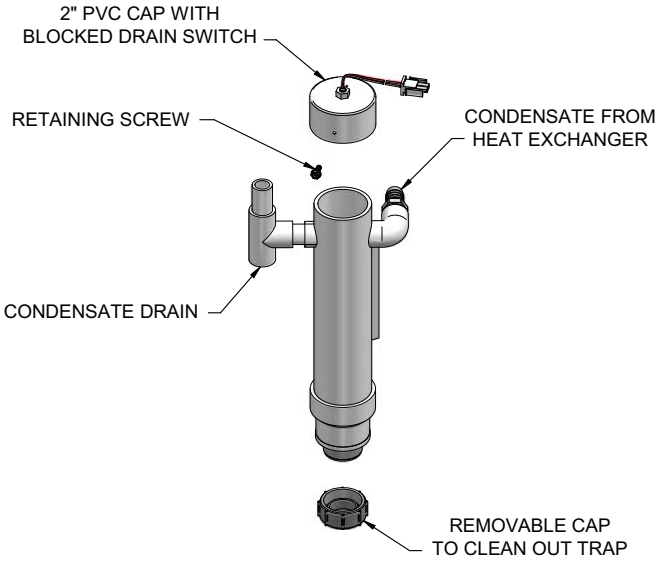
Inspect water heater interior

1. Remove the front access cover and inspect the interior of the water heater.

Clean condensate trap

1. Remove the clean out cap on the bottom of the trap. Let the condensate and any debris drain out.
2. Replace the clean out cap.
3. Fill with fresh water until the water begins to pour out of the drain.
4. Resume operation.

Figure 12-1 *Condensate Trap*



⚠ WARNING The condensate trap must be filled with water during all times of water heater 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 water heater leaks. Leaking water may 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 *(continued)*

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 water heater 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).

3. Watch the system pressure as the water heater 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 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 water expands due to temperature increase or contracts as the water cools. Tanks must be approved for potable water systems. See Section 6 - System Piping for suggested best location of expansion tanks.

Check water heater 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 - System 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 water heater 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 water heater 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

Inspect ignition and flame sense electrodes

1. Remove the ignition and flame sense electrodes from the water heater 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 water heater 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 water heater wiring

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

Check control settings

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

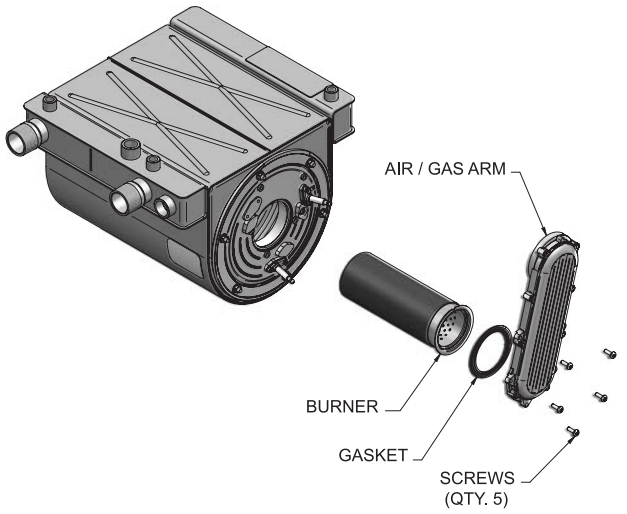
Perform start-up and checks

1. Start water heater 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 water heater and allow water heater 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. 12-2 below.
4. When replacing the burner, ensure gasket is in good condition and positioned correctly (FIG. 12-2).

Figure 12-2 *Burner Assembly*



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 for other procedures to deal with low flame signal.

Review with owner

1. Emphasize the need to perform the maintenance schedule specified in this manual.
2. Remind the owner of the need to call a licensed contractor should the water heater or system exhibit any unusual behavior.

Handling ceramic fiber materials

REMOVAL OF COMBUSTION CHAMBER LINING

⚠ WARNING The combustion chamber door insulation in this product contains ceramic fiber material. Ceramic fibers can be converted to cristobalite in very high temperature applications. The International Agency for Research on Cancer (IARC) has concluded, "Crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group 1).":

12 Maintenance *(continued)*

- Avoid breathing dust and contact with skin and eyes.
  - Use NIOSH certified dust respirator (N95). This type of respirator is based on the OSHA requirements for cristobalite at the time this document was written. Other types of respirators may be needed depending on the job site conditions. Current NIOSH recommendations can be found on the NIOSH website at http://www.cdc.gov/niosh/homepage.html. NIOSH approved respirators, manufacturers, and phone numbers are also listed on this website.
  - Wear long-sleeved, loose fitting clothing, gloves, and eye protection.
- Apply enough water to the combustion chamber lining to prevent airborne dust.
- Remove the combustion chamber lining from the water heater and place it in a plastic bag for disposal.
- Wash potentially contaminated clothes separately from other clothing. Rinse clothes washer thoroughly.

NIOSH stated First Aid.

- Eye: Irrigate immediately.
- Breathing: Fresh air.

Cleaning heat exchanger

1. Shut down water heater:
   - Follow the "To Turn Off Gas to Appliance" instructions for the water heater on pages 49 and 50.
   - Do not drain the water heater unless it will be exposed to freezing temperatures.
2. Allow time for the water heater to cool to room temperature if it has been firing.
3. Remove the blower assembly (gas air/arm) from the heat exchanger access cover. Set bolts aside.
4. Remove the nuts securing the heat exchanger access cover to the heat exchanger and set aside.
5. Remove the heat exchanger access cover, cover gasket(s) and chamber insulation assembly.

⚠ WARNING The water heater contains ceramic fiber materials. Use care when handling these materials per instructions listed on this page. Failure to comply could result in severe personal injury.

6. Use a vacuum cleaner to remove any accumulation on the water heater heating surfaces. Do not use any solvent.
7. Finish cleaning using a clean cloth dampened with warm water.
8. Install access cover gasket, chamber insulation assembly and cover.
9. Secure nuts on the studs. DO NOT overtighten.
10. Re-install the blower assembly (gas air/arm) using the bolts set aside in Step 3.
11. Close isolation valves on piping to isolate water heater from system. Attach a hose to the water heater drain and flush water heater thoroughly with clean water by using purging valves to allow water to flow through the water make-up line to the water heater.
12. When the water heater has been flushed, restore water heater to operation.
13. Perform start-up and check-out procedures listed in Section 10 - Start-up.

Oiled bearing circulators

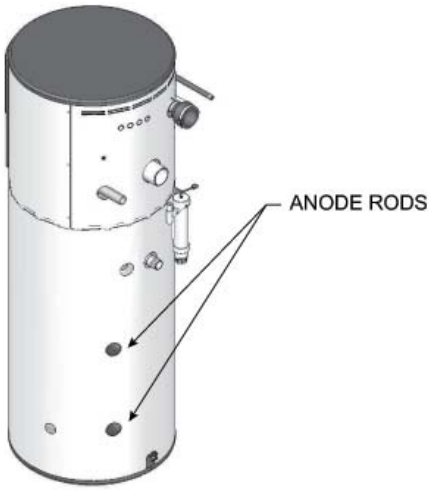
1. The circulator shipped with the Shield water heater is water-lubricated. No oiling is required.
2. Check other circulators in the system. Oil any circulators requiring oil, following circulator manufacturer's instructions. Over-oiling will damage the circulator.

Magnesium anode rod inspection

Glass lined storage tanks have a magnesium anode(s) (FIG. 12-3) to provide cathodical protection of the lining and minimize corrosion. Aggressive water conditions in some areas of the country may accelerate the deterioration of the anode(s). The anode(s) should be periodically removed and inspected to determine if replacement is necessary.

The heater must be valved off from the system and fully drained to remove an anode for inspection. Anodes are supplied in threaded fittings on the side of the tank. Adequate service clearance is required to allow removal of an anode. The anode(s) should be replaced when more than six inches of the core wire is exposed at either end of the rod.

Figure 12-3 *Anode Location*



NOTICE Anode rods showing excessive decomposition may indicate electrolysis. An earth ground should be attached to the vessel to divert stray current and prevent tank damage.

Check Delta T

1. Ensure Delta T is less than 25°F.

13 Troubleshooting

⚠ WARNING Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Always disconnect power to the water heater before servicing. Failure to comply could result in severe personal injury, death, or substantial property damage.

⚠ WARNING Never jumper (bypass) any device except for momentary testing as outlined in the Troubleshooting chart. Severe personal injury, death, or substantial property damage can result.

Before troubleshooting:

1. Have the following items:
   a. Voltmeter that can check 120 VAC, 24 VAC, and 12 VDC.
   b. Continuity checker.
   c. Contact thermometer.

2. Check for 120 VAC (minimum 102 VAC to maximum 132 VAC) to water heater.

3. Make sure the tank is calling for heat.

4. Make sure all external limit controls are installed and operating.

Check the following:

1. Wire connectors to control module and connection board are securely plugged in.

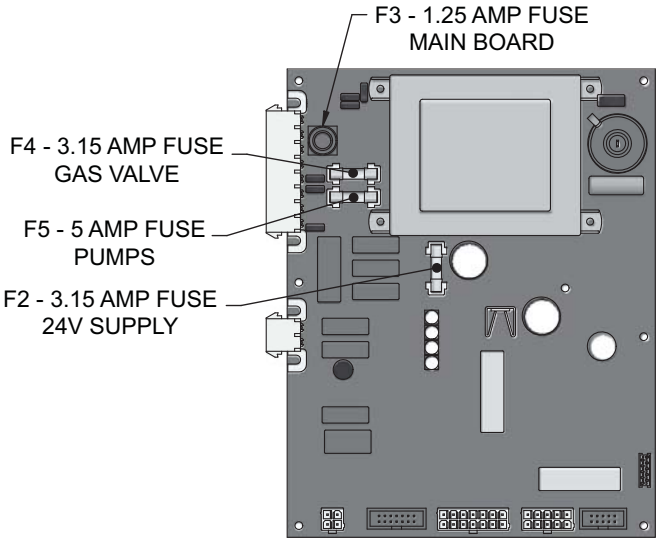
2. Gas pressures:
   • Maximum: 14 inches w.c. (natural and LP) with no flow (lockup) or with water heater on
   • Minimum: 4 inches w.c. (natural), 8 inches w.c. (LP) with gas flowing (verify during water heater startup)

Check control module fuses

NOTICE ALWAYS check control module fuses before replacing control module or any major components (blower, etc.). If one of these fuses is blown, it can prevent the control module or other components from operating.

1. Turn OFF power to the water heater at the external disconnect switch.
2. Remove top access cover.
3. Remove the control module cover.
4. Inspect fuses F2, F3, F4, and F5, see FIG. 13-1 below.

Figure 13-1 *Control Module Fuses*



5. The water heater is shipped with three (3) spare fuses in a plastic bag attached to the control module cover.
6. If necessary, replace open fuse (F3 is 1.25 amps, F2 and F4 are 3.15 amps, and F5 is 5 amps).

Note: Fuses F2 - F5 are all slow blow fuses.

⚠ WARNING Do not jumper fuse or replace with any fuse except as specified. Failure to comply could result in severe personal injury, death, or substantial property damage.

7. Install control module cover and top access cover after fuse inspection.
8. Restore power to the water heater at the external disconnect switch and verify water heater operation (Section 10 - Start-up) after completing water heater service.

13 Troubleshooting *(continued)*

Table 13A *Troubleshooting Chart - No Display*

FAULT	CAUSE	CORRECTIVE ACTION
No Display	- No 120 VAC supplied to unit.	• Check external line switch, fuse, or breaker. • Check wiring harness connection between display board and main control board. Connect harness at both points.
	- Bad display board.	• Replace board.
	- Bad main control board.	• Replace the main control board.
	- Blown fuse.	• Replace fuse F3 on the main control board, see page 62 of this manual.
No Burner Operation	- Tank temperature set point satisfied.	• Review temperature setting.
	- Unit locked out on fault.	• Consult display for specific fault. Refer to fault descriptions on page 66 of this manual for corrective actions.
Unit Does Not Modulate Above 50%	- Flue sensor open.	• Verify that the flue sensor is located in the flue outlet.
		• Check wiring connections at the flue sensor.
		• Check the resistance of the flue sensor and compare to Table 13C on page 64 of this manual.

13 Troubleshooting

Checking temperature sensors

The water heater temperature sensors (inlet water, outlet water, tank water, and flue) are all resistance type devices. The following tables show the correct values for the sensors at various temperatures. Use an ohmmeter to read the resistance of the sensor at a known temperature. If the resistance of the sensor does not closely match its corresponding table, replace the sensor.

Table 13B - *Inlet/Outlet Tank Sensor Resistance vs. Temperature*

Temperature °F	Resistance Ω	Temperature °F	Resistance Ω
50	18,780	158	1,990
68	12,263	176	1,458
86	8,194	194	1,084
104	5,592	212	817
122	3,893	--	--
140	2,760	--	--

Table 13C - *Flue Temperature Sensor Resistance vs. Temperature*

Temperature °F	Resistance Ω	Temperature °F	Resistance Ω
68	14,773	176	1,707
86	9,804	194	1,266
104	6,652	212	952
122	4,607	230	726
140	3,252	248	560
158	2,337	--	--

13 Troubleshooting *(continued)*

Table 13D *Troubleshooting Chart - Noisy System*

FAULT	CAUSE	CORRECTIVE ACTION
Noisy Operation	- Supply gas problem. Natural gas pressures should be between 4 inches w.c. and 14 inches w.c. LP gas pressures should be between 8 inches w.c. and 14 inches w.c.	• Refer to Section 7 - Gas Connections for detailed information concerning the gas supply.
	- Gas/air mixture problem.	• Refer to the Gas Valve Adjustment Procedure on page 73 of this manual for the proper gas valve setting. Verify that the vent/air intake lengths do not exceed the maximum listed in the General Venting section.
	- Dirty/damaged burner.	• Refer to page 60 in this manual for the burner removal and inspection procedure. Clean or replace the burner as necessary.
	- Low water flow through the heat exchanger.	• Refer to Section 6 - System Piping for minimum flow rates.
	- Air in the piping system.	• Properly purge all air from the piping system.
No Pump Operation	- Blown fuse.	• Replace fuse F5 on the control board, see page 62 of this manual.
	- Faulty pump.	• Replace pump.
	- Faulty pump relay.	• Replace pump relay.
	- Internal fault on control board.	• Replace main control board.
Relief Valve Opening	- System pressure exceeds relief valve setting.	• Lower the system pressure below the 150 PSI rating of the supplied relief valve.

13 Troubleshooting

Table 13E *Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

FAULT	DESCRIPTION	CORRECTIVE ACTION
Flame Sequence (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The flame detector circuit is seeing a flame signal while no flame is present.	• Check supply voltage for proper polarity. • Check external wiring for voltage feedback. • Check the flame rod and make sure it is clean. • Check the internal wiring for bad connections. • Replace main control board.
No Flame Ign (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The unit has failed to prove main burner ignition after four (4) attempts.	• Inspect spark electrode and associated wiring for damage and connection. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Check for proper electrical grounding of the unit. • Check incoming supply gas pressure. Natural gas pressures should be between 4 - 14 inches w.c. and LP gas pressures should be between 8 - 14 inches w.c. Refer to Section 7 - Gas Connections for detailed information concerning the gas supply. • Verify that the plastic hose from the gas valve to the air inlet is connected and is not damaged. • Verify that the vent/air intake pipes are correctly installed and that there are no obstructions. • Check for 24 VAC to the gas valve at the 2-pin connection on the side of the main control board during the ignition attempt. If no voltage is present, replace the main control board. • If 24 VAC is present at the main control board, check the wiring between the main control board and the gas valve. Replace the wiring if necessary. Do not disconnect the wiring from the gas valve and attempt to measure voltage at that point. The main control board can detect if the gas valve is not connected and will display the GV / Relay Fail fault. • If 24 VAC is present, check the outlet of the valve to ensure the valve is flowing gas. With a manometer connected to the outlet tap of the gas valve, when the unit is in the prepurge period, there should be a negative pressure present. When the valve is energized a change in pressure should occur. If the pressure change does not occur, the gas valve is not opening. Replace the gas valve. • Inspect flame sensor and associated wiring. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Inspect the burner. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Replace the main control board.

13 Troubleshooting *(continued)*

***Table 13E** (continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

FAULT	DESCRIPTION	CORRECTIVE ACTION
No Flame Running (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The unit was running and lost the flame signal. This condition occurred four (4) straight times.	• Inspect spark electrode and associated wiring for damage and connection. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Check for proper electrical grounding of unit. • Check incoming supply gas pressure. Natural gas pressures should be between 4 - 14 inches w.c. and LP gas pressures should be between 8 - 14 inches w.c. Refer to Section 7 - Gas Connections for detailed information concerning the gas supply. • Verify that the plastic hose from the gas valve to the air inlet is connected and is not damaged. • Verify that the vent/air intake pipes are installed correctly and there are no obstructions. • Check for 24 VAC to the gas valve at the 2-pin connection on the side of the main control board during the ignition attempt. If no voltage is present, replace the main control board. • If 24 VAC is present at the main control board, check the wiring between the main control board and the gas valve. Replace the wiring if necessary. Do not disconnect the wiring from the gas valve and attempt to measure voltage at that point. The main control board can detect if the gas valve is not connected and will display the GV / Relay Fail fault. • If 24 VAC is present, check the outlet of the valve to ensure the valve is flowing gas. With a manometer connected to the outlet tap of the gas valve, when the unit is in the prepurge period, there should be a negative pressure present. When the valve is energized a change in pressure should occur. If the pressure change does not occur, the gas valve is not opening. Replace the gas valve. • Inspect flame sensor and associated wiring. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Inspect the burner. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Replace the main control board.
GV/Relay Fail (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The main control board did not detect the gas valve.	• Ensure gas valve switch is ON (Models SNR150-100 and SNA285-125). • Check wiring harness connection at the gas valve and at the main control board. • Replace the gas valve wire harness. • Replace the gas valve. • Replace the main control board.

13 Troubleshooting

Table 13E *(continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

FAULT	DESCRIPTION	CORRECTIVE ACTION
Manual Reset High Limit (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The outlet water temperature has exceeded the fixed setting of the manual reset high limit.	• Verify that the system is full of water and that all air has been properly purged from the system. • Verify that the water heater is piped properly into the heating system. Refer to Section 6 - System Piping for the proper piping methods for the Shield water heater. • Check 120 VAC to water heater pump motor on a call for heat. If voltage is not present, check wiring back to the main control board. • Replace the main control board if necessary. • If 120 VAC is present on a call for heat and the water heater pump is not operating, replace the pump. • Check resistance of water sensors and compare to Table 13B on page 64 of this manual. Replace sensor if necessary.
Fan Low OR Fan Speed Low (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The actual fan RPM is 30% lower than what is being called for.	• Vent/air intake lengths exceed the maximum allowed lengths. Refer to Section 2 - General Venting for proper lengths. • Check for obstruction or blockage in the vent/air intake pipes or at terminations. • Check the wiring connections at the fan and at the main control board. • Replace the fan. • Replace the main control board.
	Blown fuse.	• Replace fuse F4 on the control board, see page 62 of this manual.
APS Open (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	Air pressure switch contacts are open.	• Check the wiring connections to switch. Wires should be connected to the common and normally closed terminals. • Air intake lengths exceed the maximum allowed lengths. Refer to Section 2 - General Venting for proper lengths. • Check for obstruction or blockage in the air intake pipes or at terminations. • Check reference hoses connected to the air pressure switch for blockage or obstruction. • Inspect the burner. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Inspect the heat exchanger. Reference page 61 of this manual for removal and cleaning procedures. Replace if necessary. • Faulty air pressure switch. Replace switch.

13 Troubleshooting *(continued)*

***Table 13E** (continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

FAULT	DESCRIPTION	CORRECTIVE ACTION
Fan High OR Fan Speed High (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The actual fan RPM is 30% higher than what is being called for.	• Vent/air intake lengths exceed the maximum allowed lengths. Refer to Section 2 - General Venting for proper lengths. • Check for obstruction or blockage in the vent/air intake pipes or at terminations. • Check the wiring connections at the fan and at the main control board. • Replace the fan. • Replace the main control board.
Sensor Open (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	Either the heat exchanger inlet water, heat exchanger outlet water or tank temperature sensor has been disconnected. S1 = Outlet Sensor S2 = Inlet Sensor	• Check the sensors and their associated wiring. Repair or replace the sensor or wiring if damaged. • Measure the resistance of the sensors and compare the resistance to the tables on page 64 of this manual. • Replace the sensor if necessary.
Sensor Shorted (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	Either the heat exchanger inlet water heat exchanger outlet water or tank temperature sensor has been shorted. S1 = Outlet Sensor S2 = Inlet Sensor	• Check the sensors and their associated wiring. Repair or replace the sensor or wiring if damaged. • Measure the resistance of the sensors and compare the resistance to the tables on page 64 of this manual. • Replace the sensor if necessary.
External Limit Switch (will retry after 5 minutes. RESET may be pressed after condition is corrected.)	An optional remote limit switch is not making.	• Check function of remote devices. • Check for loose or misplaced jumper if external limit switch is not installed.
Temp O/Shoot	The flue temperature has exceeded the set parameters for the water heater.	• Inspect the heat exchanger. Reference page 61 of this manual for the procedure on how to clean the flue side of the heat exchanger. • Inspect the flue sensor and associated wiring. Measure the resistance of the flue sensor and compare to Table 13C on page 64 of this manual. Replace the sensor if necessary. • Verify that the vent/air intake pipes are properly installed and that there are no obstructions. • Replace the main control board.
	Scaling has reduced water flow.	• Deliming may be required.

13 Troubleshooting

Table 13E *(continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

FAULT	DESCRIPTION	CORRECTIVE ACTION
Temp O/Shoot (continued)	The temperature rise across the heat exchanger has exceeded the set parameters for the water heater.	• Verify that the system is full of water and that all air has been properly purged from the system. • Verify that the water heater is piped properly into the heating system. Refer to Section 6 - System Piping for the proper piping methods for the Shield water heater. • Check for 120 VAC to the water heater pump motor on a call for heat. If voltage is not present, check the wiring back to the main control board. Replace the main control board if necessary. • If 120 VAC is present on a call for heat and the water heater pump is not operating, replace the pump. • Verify that the water heater pump is set to the proper speed or that the pump is the proper size. Reference Section 6 - System Piping for water heater pump specifications.
	Heat exchanger outlet water temperature has exceeded the maximum outlet water temperature.	• Verify that the system is full of water and that all air has been properly purged from the system. • Verify that the water heater is piped properly into the heating system. Refer to Section 6 - System Piping for the proper piping methods for the Shield water heater. • Check for 120 VAC to the water heater pump motor on a call for heat. If voltage is not present, check wiring back to the main control board. Replace the main control board if necessary. • If 120 VAC is present on a call for heat and the water heater pump is not operating, replace the pump. • Replace the main control board.
Parameters Progr (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	After downloading parameters from a laptop, the main control board must be reset.	• Press the ENTER/RESET button on the display panel.
Blocked Drain SW (will retry after 5 minutes. RESET may be pressed after condition is corrected.)	The blocked drain switch has detected excessive condensate build up inside the unit.	• Check condensate tube from unit to floor drain for proper installation and obstructions. • Inspect condensate trap for blockage. Clean if necessary. • Check for loose wiring connection at wire harness plug. • Bad blocked drain switch. Replace switch.

13 Troubleshooting *(continued)*

***Table 13E** (continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

FAULT	DESCRIPTION	CORRECTIVE ACTION
Service Blk	While the unit is in Service Mode, the outlet temperature has exceeded 185°F.	• Establish a draw to remove HW heat from the water heater. • Verify that the system is full of water and that all air has been properly purged from the system. • Verify that the water heater is piped properly into the heating system. Refer to Section 6 - System Piping for the proper piping methods for the Shield water heater. • Check 120 VAC to the water heater pump motor on a call for heat. If voltage is not present, check the wiring back to the main control board. Replace the main control board if necessary. • If 120 VAC is present on a call for heat and the water heater pump is not operating, replace the pump. • Verify that the water heater pump is set to the proper speed or that the water heater pump is the proper size. Reference Section 6 - System Piping for water heater pump specifications.
Low 24 VAC	120 VAC input to the main control board has dropped below 80 VAC.	• Check 120 VAC supply to the transformer. • Check wiring connections at the low voltage terminal strip. • Check the wire size/length to remote devices. • Replace the transformer.
Watch Dog Error	The main control board has detected an internal fault.	• Replace the main control board.
Write EEProm	The main control board has detected an internal fault.	• Replace the main control board.
CRC Parameters	The main control board has detected an internal fault.	• Replace the main control board.

13 Troubleshooting

Combustion Analysis Procedure

1. Press the SHUTDOWN button on the display until **HTR:Off** appears in the display window.
2. Remove the screws securing the top panel to the unit. Remove the panel from the unit to gain access to the flue sensor.
3. Locate the flue sensor in the top of the vent connection. Remove the flue sensor and grommet from the unit. **Note:** Combustion measurements will be made at this point.
4. Press the SHUTDOWN button on the display until **HTR:Standby** appears in the display window.
5. Locate the pinhole button above the "r" in the Lochinvar logo 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 water heater into Service Mode. In Service Mode the water heater 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 water heater has modulated up to full fire, measure the combustion. The values should be in the range listed in Table 13G. 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 chart below for possible causes and corrective actions.

***Table 13G** Flue Products*

Natural Gas		Propane	
CO_2	O_2	CO_2	O_2
8.0% - 10%	3.0% - 6.5%	9.0% - 11%	4.1% - 6.9%

8. Once the combustion analysis is complete, press the SHUTDOWN button on the display board (FIG. 11-1) to take the water heater out of Service Mode. The water heater will go to shutdown and the display will show **HTR:Off**.
9. Replace the flue sensor and grommet into the vent connection.
10. Replace the top panel on the unit.
11. Place the Shield water heater back into normal operation.

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

***Table 13F** Troubleshooting Chart - Combustion Levels*

POSSIBLE CAUSE	CORRECTIVE ACTION
Vent/Air Intake Length or Obstruction	• Refer to Section 2 - General Venting for the proper venting and air intake methods for the Shield water heater. • Check for obstructions at the vent/air intake terminals.
Gas Supply Pressure	• Refer to Section 7 - Gas Connections for the proper gas supply for the Shield water heater.
Dirty/Damaged Burner	• Refer to page 60 of this manual for burner removal and cleaning procedures. • Replace burner if necessary.
Gas Valve Adjustment	• Refer to page 73 of this manual for the gas valve adjustment procedure.

13 Troubleshooting *(continued)*

Gas valve adjustment procedure

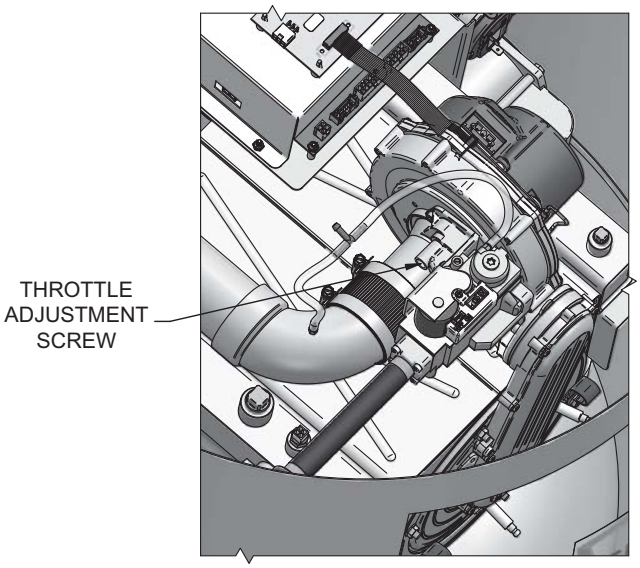
If adjustment of the gas valve is deemed necessary, use the following procedures: (**Note:** The procedures below are model specific.)

Models SNR150-100 -- SNA285-125

Locate the throttle adjustment screw on the side of the venturi valve (FIG. 13-2). Using a screwdriver, turn the screw a 1/4 turn **clockwise** to decrease CO_2 levels or a 1/4 turn **counterclockwise** to increase CO_2 levels. After performing one adjustment on the valve, follow the Combustion Analysis Procedure on page 72 of this manual to measure the combustion.

If combustion is still not within the specified range, repeat the procedure. This procedure SHOULD NOT be performed more than four (4) times. If after four (4) adjustments and the combustion is still not within the specified range, revisit the possible causes in Table 13F on page 72 or replace the gas valve.

Figure 13-2 *Gas Valve Adjustment: Models SNR150-100 -- SNA285-125*

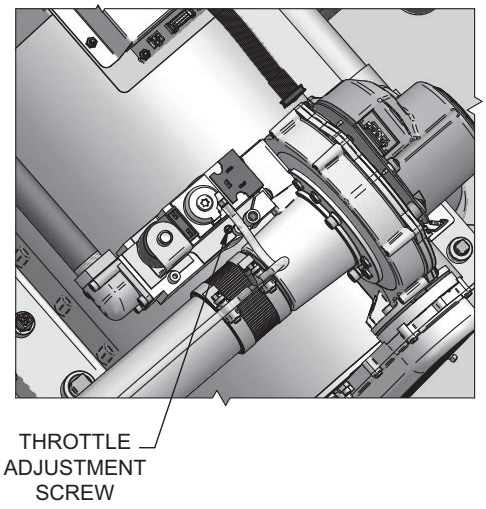


Model SNA400-125

Locate the throttle adjustment screw on the top of the gas valve, see FIG. 13-3. Using a screwdriver, turn the screw 1/8 turn **counterclockwise** to increase CO_2 levels or 1/8 turn **clockwise** to decrease CO_2 levels. After one adjustment on the valve, follow the Combustion Analysis Procedure on page 72 of this manual to measure the combustion.

If combustion is still not within the specified range, repeat the procedure. This procedure SHOULD NOT be performed more than four (4) times. If after four (4) adjustments and the combustion is still not within the specified range, revisit the possible causes in Table 13F on page 72 or replace the gas valve.

Figure 13-3 *Gas Valve Adjustment: Model SNA400-125*

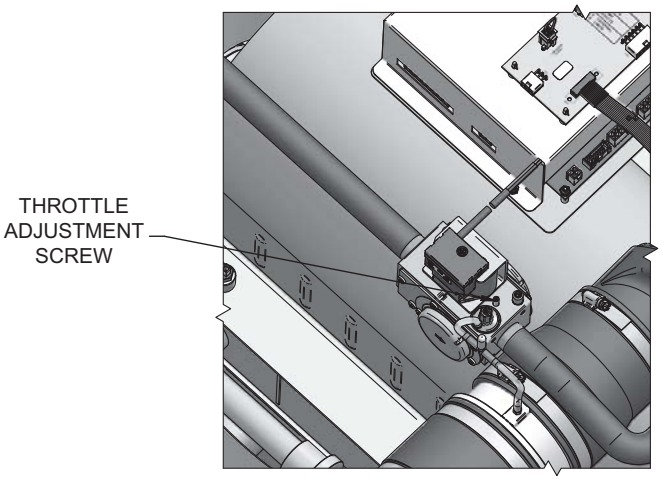


Model SNA500-125

Locate the throttle adjustment screw on top of the gas valve, see FIG. 13-4. Using a screwdriver, turn the screw a 1/4 turn **counterclockwise** to increase CO_2 levels or a 1/4 turn **clockwise** to decrease CO_2 levels. After one adjustment on the valve, follow the Combustion Analysis Procedure on page 72 of this manual to measure the combustion.

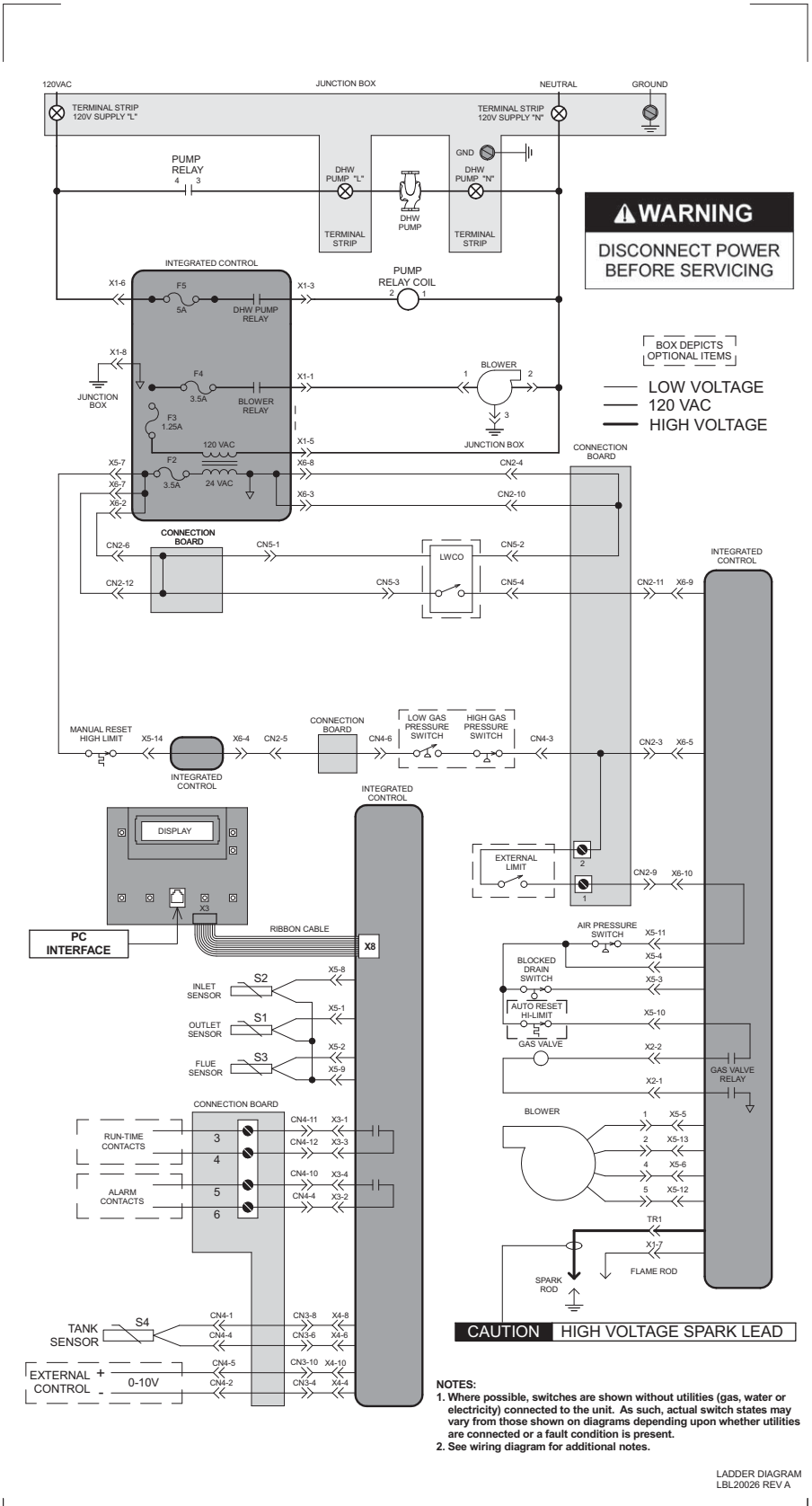
If combustion is still not within the specified range, repeat the procedure. This procedure SHOULD NOT be performed more than four (4) times. If after four (4) adjustments and the combustion is still not within the specified range, revisit the possible causes in Table 13F on page 72 or replace the gas valve.

Figure 13-4 *Gas Valve Adjustment: Model SNA500-125*



14 Diagrams

Figure 14-1 *Ladder Diagram*



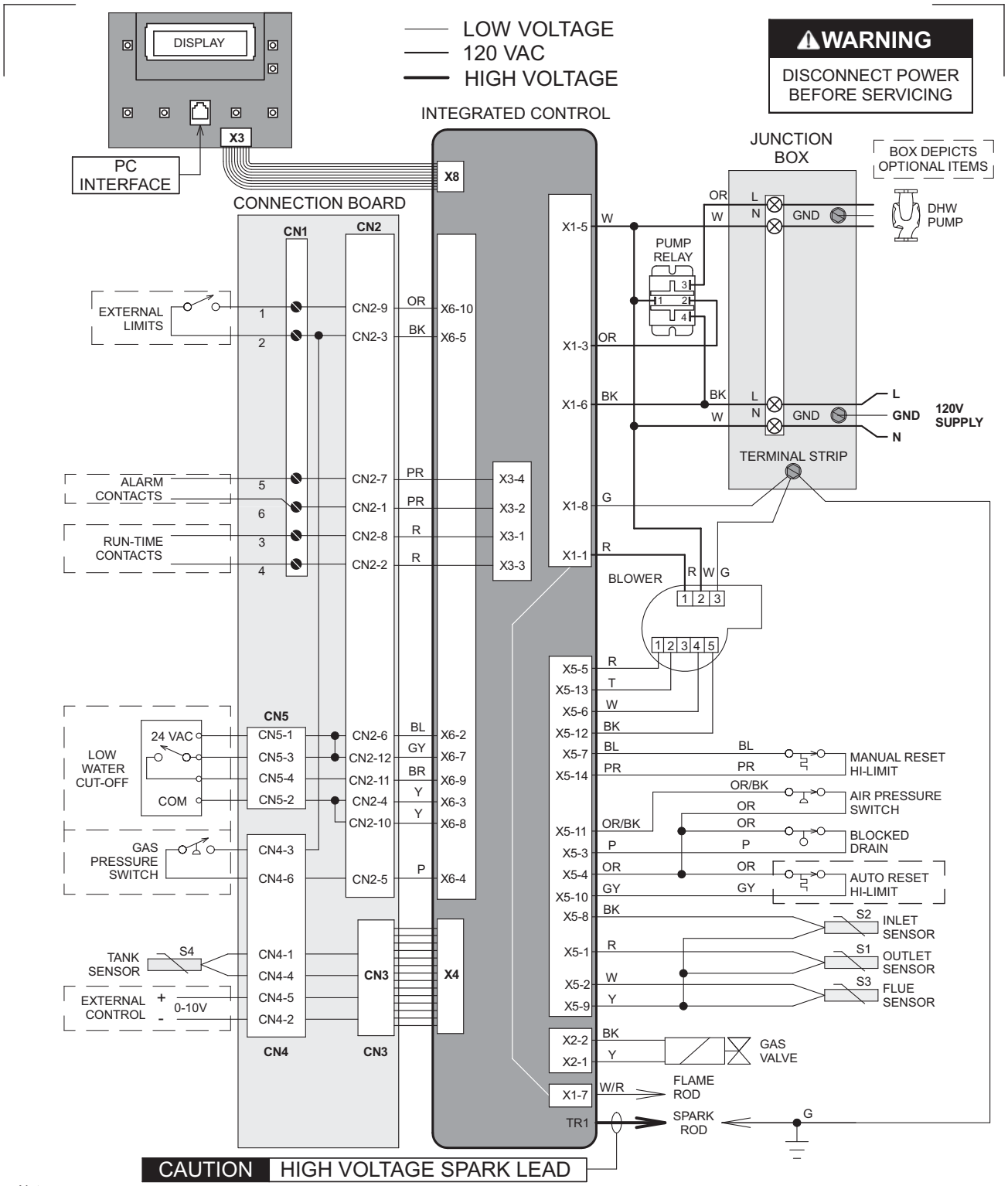
NOTES:

1. **Where possible, switches are shown without utilities (gas, water or electricity) connected to the unit. As such, actual switch states may vary from those shown on diagrams depending upon whether utilities are connected or a fault condition is present.**
2. **See wiring diagram for additional notes.**

LADDER DIAGRAM
LBL20026 REV A

14 Diagrams *(continued)*

***Figure 14-2** 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
LBL20025 REV A

Revision Notes: *Revision A (ECO #C02299) initial release.*

Revision B (ECO #C02870) reflects the addition of a mixing valve to the piping diagrams (FIG.'s 6-2 and 6-3, pgs. 32 - 34).

Revision C (ECO #C02738) reflects edits made to the Gas Valve Adjustment Procedure for Model SNA400-125 on page 69.

Revision D (ECO #C03223) reflects edits made to the high altitude section on page 7.

Revision E (ECO #C03735) reflects the addition of stainless steel venting, hydro changes and the addition of the Anode Rod(s) section.

Revision F (ECO #C03974) reflects Delta T updates and additions.

SWH-I-S Rev F
6/09

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2 General venting

PVC/CPVC

This product has been approved for use with the PVC/CPVC vent materials listed in Table 2D.

Installing vent and air piping

⚠ WARNING The vent connection to the appliance must be made with the starter CPVC pipe section provided with the 286-501 models (starter piece is factory installed on the 126-201 models) if PVC/CPVC vent is to be used. 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 Table 2D to make the vent connections. Failure to follow this warning could result in fire, personal injury, or death.

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

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 water heater (to allow drainage of condensate).

⚠ 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.

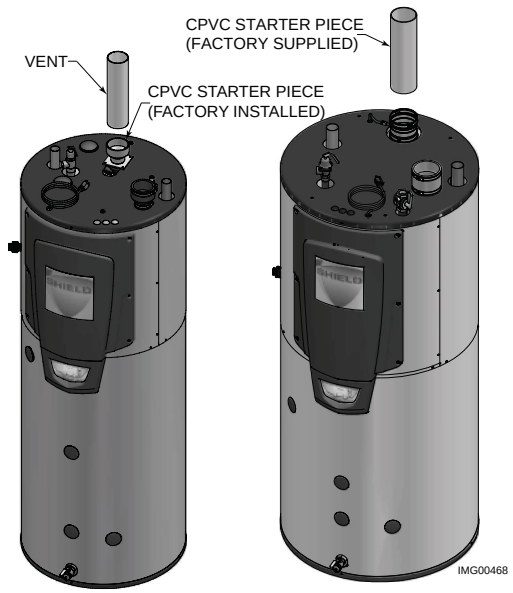
1. Work from the water heater to vent or air termination. Do not exceed the lengths given in this manual for the air or vent piping.
2. Cut pipe to the required lengths and deburr the inside and outside of the pipe ends.
3. Chamfer outside of each pipe end to ensure even cement distribution when joining.
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.
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 and to the pipe end to approximately 1/2" beyond the socket depth.
   c. Apply a second primer coat to the fitting socket.
   d. While primer is still wet, apply an even coat of approved cement to the pipe equal to the depth of the fitting socket along with an even coat of approved cement to the fitting socket.
   e. Apply a second coat of cement to the pipe.
   f. 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.
   g. Wipe excess cement from the joint removing ring or beads as it will needlessly soften the pipe.

Table 2D *PVC/CPVC Vent Pipe, and Fittings*

Approved PVC/CPVC Vent Pipe and Fittings		
Item	**Material**	**Standard**
Vent pipe	PVC Schedule 40, 80	ANSI/ASTM D1785
	PVC - DWV	ANSI/ASTM D2665
	CPVC Schedule 40, 80	ANSI/ASTM F441
Vent fittings	PVC Schedule 40	ANSI/ASTM D2466
	PVC Schedule 80	ANSI/ASTM D2467
	CPVC Schedule 80	ANSI/ASTM F439
	PVC - DWV	ANSI/ASTM D2665
Pipe Cement / Primer	PVC	ANSI/ASTM D2564
	CPVC	ANSI/ASTM F493
NOTICE: DO NOT USE CELLULAR (FOAM) CORE PIPE		

NOTE: In Canada, CPVC and PVC vent pipe, ttings and cement/ primer must be ULC-S636 certi ed.

Figure 2-7 *Near Water Heater PVC/CPVC Venting*



MODELS: 126-065 - 201-100 MODELS: 286-125 - 501-125

2 General venting *(continued)*

Polypropylene

This product has been approved for use with polypropylene vent with the manufacturers listed in Table 2E.

All terminations must comply with listed options in this manual and be a single-wall vent offering.

For support and special connections required, see the manufacturer's instructions. All vent is to conform to standard diameter and equivalent length requirements established.

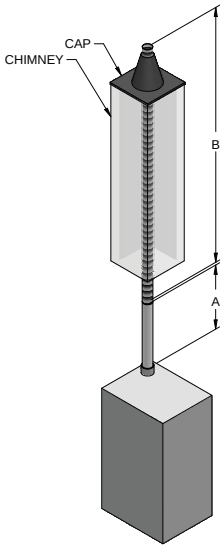
When determining equivalent combustion air and vent length for polypropylene single-wall piping:

- 1 foot of Duravent 4 inch single-wall pipe is equivalent to 1.6 feet of piping

Flexible polypropylene

For use of flex pipe, it is recommended to have the vent material in 32°F or higher ambient space before bending at installation. No bends should be made to greater than 45° and ONLY installed in vertical or near vertical installations (FIG. 2-8).

Figure 2-8 *Near Boiler Flexible Polypropylene Venting*



Duravent 3"

"A" DIM	"B" DIM	
3" RIGID	3" FLEX	4" FLEX
10 FT	60 FT	90 FT
20 FT	53 FT	80 FT
30 FT	47 FT	70 FT
40 FT	40 FT	60 FT
50 FT	33 FT	50 FT
60 FT	27 FT	40 FT
70 FT	20 FT	30 FT
80 FT	13 FT	20 FT
90 FT	7 FT	10 FT

Duravent 4"

"A" DIM	"B" DIM	
4" RIGID	4" FLEX	5" FLEX
10 FT	30 FT	90 FT
20 FT	27 FT	80 FT
30 FT	23 FT	70 FT
40 FT	20 FT	60 FT
50 FT	17 FT	50 FT
60 FT	13 FT	40 FT
70 FT	10 FT	30 FT
80 FT	7 FT	20 FT
90 FT	3 FT	10 FT

Centrotherm 3"

"A" DIM	"B" DIM	
3" RIGID	3" FLEX	4" FLEX
10 FT	45 FT	90 FT
20 FT	40 FT	80 FT
30 FT	35 FT	70 FT
40 FT	30 FT	60 FT
50 FT	25 FT	50 FT
60 FT	20 FT	40 FT
70 FT	15 FT	30 FT
80 FT	10 FT	20 FT
90 FT	5 FT	10 FT

Centrotherm 4"

"A" DIM	"B" DIM
4" RIGID	4" FLEX
10 FT	33 FT
20 FT	29 FT
30 FT	26 FT
40 FT	22 FT
50 FT	18 FT
60 FT	15 FT
70 FT	11 FT
80 FT	7 FT
90 FT	4 FT

*NOTES: 1) FLEX PIPE MAY ONLY BE RUN IN A VERTICAL ORIENTATION
2) ALL VENT LENGTHS REPRESENTED IN ABOVE CHARTS ARE EQUIVALENT LENGTHS.
3) SECTION A IS EQUIVALENT FEET OF RIGID PIPE, WHICH MAY INCLUDE 45 AND 90° ELBOWS. PLEASE SEE SIZING SECTION FOR DETERMINING EQUIVALENT FEET.

IMG00840

NOTICE The installer must use a specific vent starter adapter at the flue collar connection. The adapter is supplied by the vent manufacturer to adapt to its vent system. See Table 2F for approved vent adapters. Discard CPVC starter piece.

NOTICE All vent connections MUST be secured by the vent manufacturer's joint connector (FIG. 2-9).

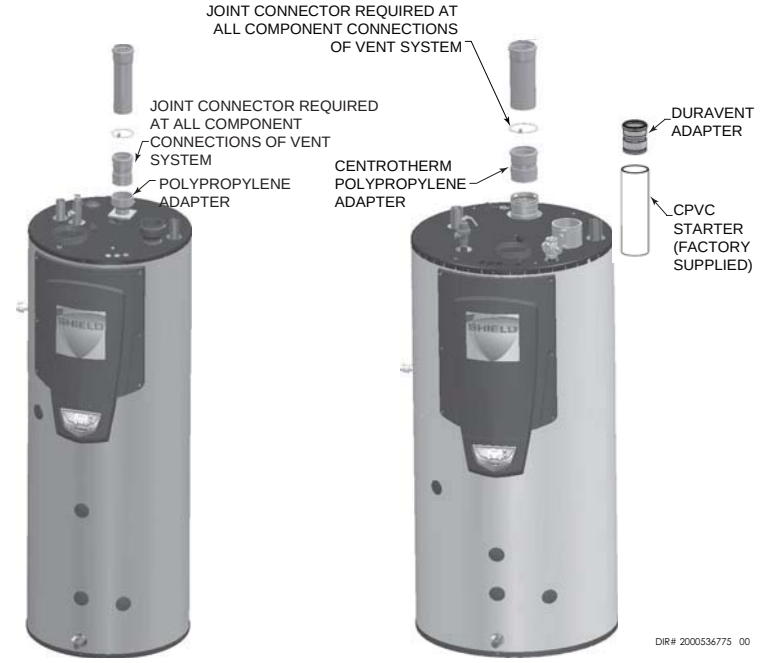
⚠ WARNING Insulation should not be used on polypropylene venting materials. The use of insulation will cause increased vent wall temperatures, which could result in vent pipe failure.

⚠ WARNING Use only the adapters and vent system listed in Tables 2E and 2F. DO NOT mix vent systems of different types or manufacturers. 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. For Canadian installation, polypropylene vent must be listed as a ULC-S636 approved system.

NOTICE Installation of a polypropylene vent system should adhere to the vent manufacturer's installation instructions supplied with the vent system.

Figure 2-9 *Near Water Heater Polypropylene Venting*



MODELS: 126-065 - 201-100

MODELS: 286-125 - 501-125

Table 2E *Polypropylene Vent Pipe and Fittings*

Approved Polypropylene Vent Manufacturers	
Make	**Model**
Centrotherm Eco Systems	InnoFlue SW/Flex
Duravent (M & G Group)	PolyPro Single-Wall / PolyPro Flex

Table 2F *Approved PolypropyleneTerminations*

Model	Centrotherm InnoFlue SW				Duravent Polypro		
	Polypropylene Adapter	Joint Connector	Sidewall Retaining Bracket*	Sidewall Adapter*	Polypropylene Adapter	Joint Connector	Sidewall Kit*
126-065 -- 201-100	ISAAL0303	IANS03	IATP0303	ISTAGL0303	3PPS-ADL	3PPS-LB	3PPS-HLK
286-125 -- 501-125	ISAAL0404	IANS04	IATP0404	ISTAGL0404	4PPS-AD-M	4PPS-LB	4PPS-HLK

* These parts are only needed if the sidewall termination assembly is used (see FIG. 3-4B on page 28).

2 General venting

Stainless steel vent

This product has been approved for use with stainless steel using the manufacturers listed in Table 2G. This unit requires Category IV venting.

⚠ WARNING Use only the materials, vent systems, and terminations listed in Tables 2G and 2H. DO NOT mix vent systems of different types or manufacturers. Failure to comply could result in severe personal injury, death, or substantial property damage.

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 2H for approved vent adapters. Discard CPVC starter piece.

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.

Figure 2-10 *Near Water Heater Stainless Steel Venting*

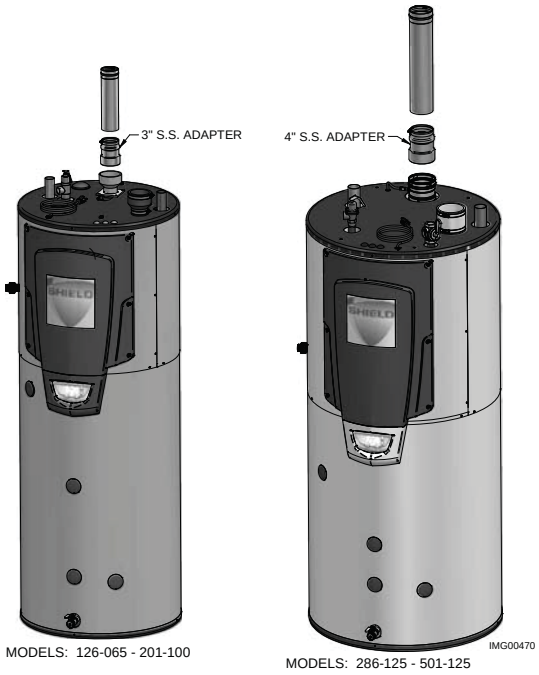


Table 2G *Stainless Steel Vent Pipe and Fittings*

Approved Stainless Steel Vent Manufacturers	
Make	**Model**
Dura Vent (M & G Group)	FasNSeal Vent / FasNSeal Flex* Vent
Z-Flex (Nova Flex Group)	Z-Vent
Heat Fab (Selkirk Corporation)	Saf-T Vent
Metal Fab	Corr/Guard
Security Chimney	Secure Seal

*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.

Table 2H *Approved Stainless Steel (S.S.) Terminations and Adapters*

Model	ProTech			Heat Fab			Z Flex		
	FasNSeal			Saf-T Vent			Z-Vent		
	S.S. Adapter	Flue Termination	Intake Air Termination	S.S. Adapter	Flue Termination	Intake Air Termination	S.S. Adapter	Flue Termination	Intake Air Termination
126-065 -- 201-125	300715	FSBS3 FSRC3(R.C)	303889	9301PVC	9392 5300CI	9314TERM	2SVSLA03	2SVSTP03 2SVSRCX03	2SVSTEX0390
286-125 -- 501-125	F303759	FSBS4 FSRC4(R.C.)	FSAIH04 303888	9401PVC	9492 5400CI	9414TERM	2SVSLA04	2SVSTP04 2SVSRCX04	2SVSTEX0490
Metal Fab				**Security Chimney**					
Corr/Guard				Secure Seal					
126-065 -- 201-125	3CGIA	3CGSWHT 3CGSWC	3CGSW90LT	--	--	--			
286-125 -- 501-125	4CGIA	4CGSWHT 4CGSWC	4CGSW90LT	SS4PVCU	SS4STU SS4RCBU	SS4ST90AU			

3 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.

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 17 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.
   h. Do not locate the terminations over public walkways.
   i. Do not locate the terminations near soffit vents, crawl space vents, or other areas where condensate or vapor could create a nuisance, hazard, or cause property damage.
   j. Do not locate the terminations where condensate vapor could cause damage or could be detrimental to the operation of regulators, relief valves, or other equipment.

Figure 3-1A *PVC/CPVC/Polypropylene Sidewall Termination of Air and Vent*

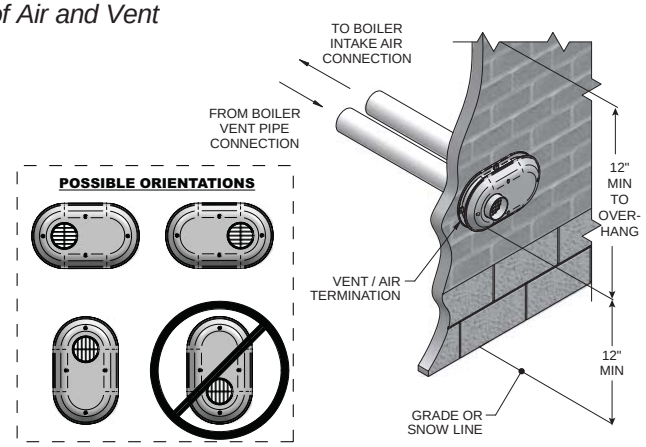


Table 3A *Sidewall Vent Kits*

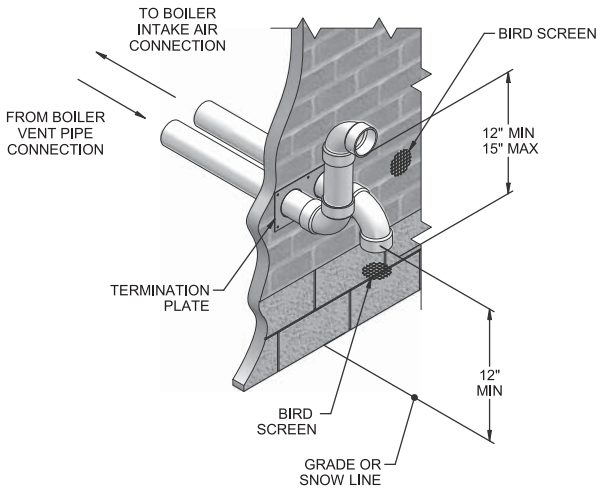
Model	Kit Number	Vent Size
126-065 -- 201-100	100157610	3 inch vent
286-125 -- 501-125	100157611	4 inch vent

If using the alternate sidewall termination:

3. The air piping must terminate in a down-turned elbow as shown in FIG. 3-1B. 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. 3-1B.

⚠ WARNING Do not exceed the maximum lengths of the outside vent piping shown in FIG. 3-1B. Excessive length exposed to the outside could cause freezing of condensate in the vent pipe, resulting in potential water heater shutdown.

Figure 3-1B *Alternate PVC/CPVC/Polypropylene Sidewall Termination of Air and Vent w/Field Supplied Fittings*



3 Sidewall direct venting

Vent/air termination – sidewall

Figure 3-1C *Alternate PVC/CPVC/SS/ Polypropylene Venting Arrangement (if Space Allows) w/Field Supplied Fittings*

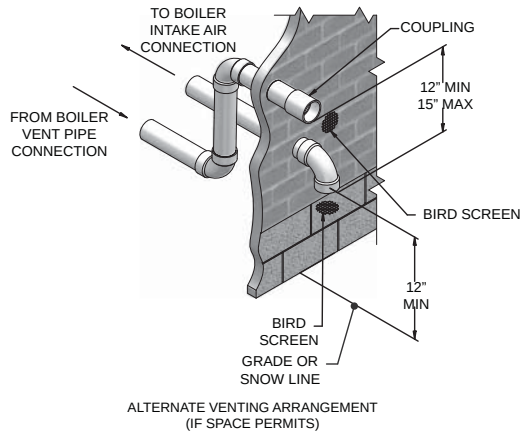
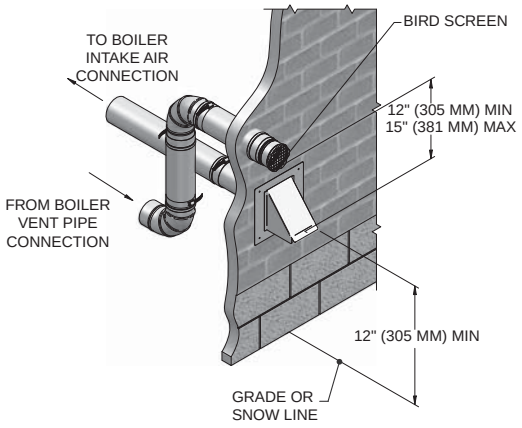


Figure 3-1D *Alternate SS Venting Arrangement - Typical Stainless Steel Sidewall Termination of Air and Vent w/Field Supplied Fittings, Utilizing a Hood Intake*



5. Maintain clearances as shown in FIG.'s 3-1A thru 3-3B, pages 23 - 27. Also maintain the following:
   a. Vent must terminate:
      • At least 6 feet from adjacent walls.
      • No closer than 12 inches below roof overhang.
   b. Air inlet must terminate at least 12 inches above grade or snow line; at least 12 inches below the vent termination; and the vent pipe must not extend more than 24 inches vertically outside the building as shown in FIG. 3-1B. Condensate could freeze and block vent pipe.
   c. Do not terminate closer than 4 feet horizontally from any electric meter, gas meter, regulator, relief valve, or other equipment. Never terminate above or below any of these within 4 feet 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 3-2A *Clearance to Gravity Air Inlets*

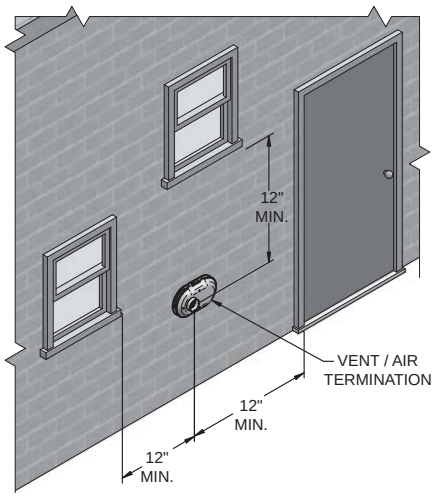
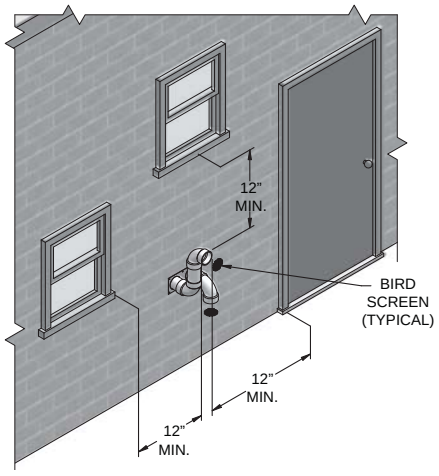


Figure 3-2B *Alternate Clearance to Gravity Air Inlets w/ Field Supplied Fittings*



3 Sidewall direct venting *(continued)*

Figure 3-3A *Direct Vent Terminal Clearances*

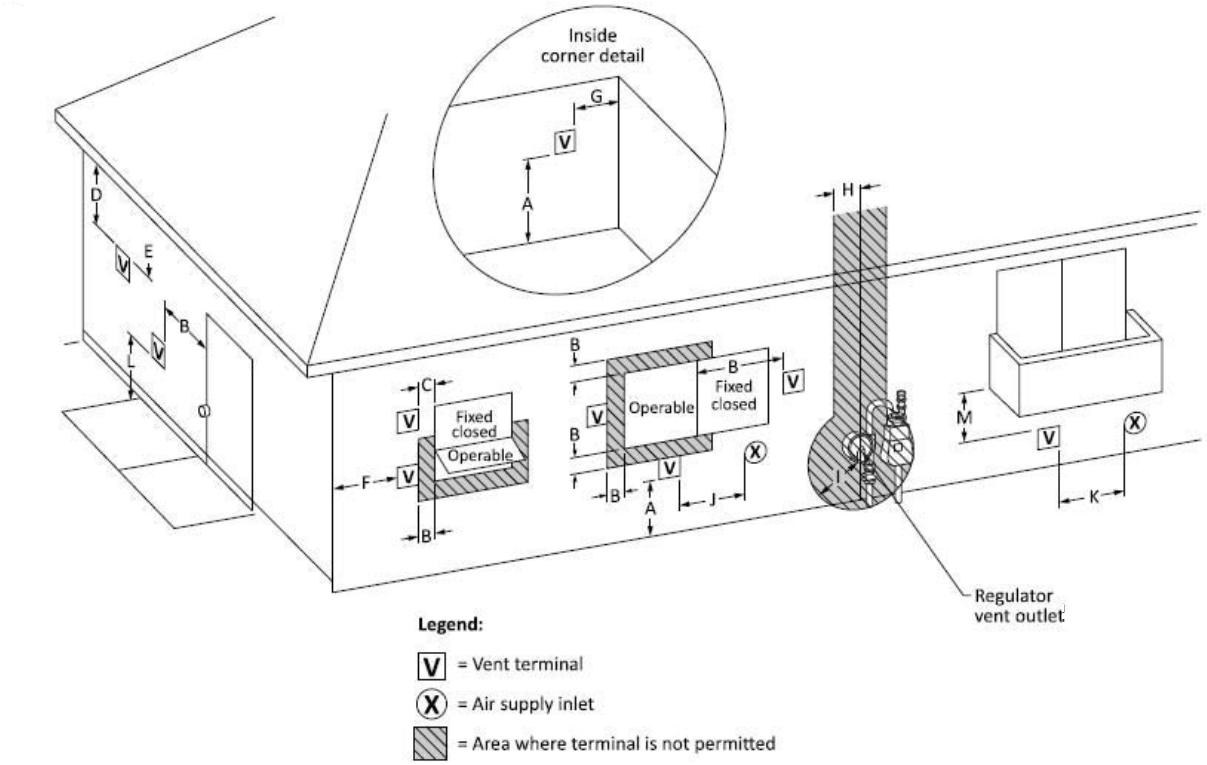


Table 3B *Direct Vent Terminal Clearances*

		Canadian Installations[1]	US Installations[2]
A =	Clearance above grade, veranda, porch, deck, or balcony	12 in (30 cm)	12 in (30 cm)
B =	Clearance to window or door that may be opened	6 in (15 cm) for appliances ≤ 10,000 Btuh (3 kW), 12 in (30 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36 in (91 cm) for appliances > 100,000 Btuh (30 kW)	6 in (15 cm) for appliances ≤ 10,000 Btuh (3 kW), 9 in (23 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 50,000 Btuh (15 kW), 12 in (30 cm) for appliances > 50,000 Btuh (15 kW)
C =	Clearance to permanently closed window	*	*
D =	Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 ft (61 cm) from the center line of the terminal.	*	*
E =	Clearance to unventilated soffit	*	*
F =	Clearance to outside corner	*	*
G =	Clearance to inside corner	*	*
H =	Clearance to each side of center line extended above meter / regulator assembly	*	*
I =	Clearance to service regulator vent outlet	Above a regulator within 3 ft (91 cm) horizontally of the vertical center line of the regulator vent outlet to a maximum vertical distance of 15 ft (4.5 m)	*

3 Sidewall direct venting

***Table 3B** Direct Vent Terminal Clearances (continued)*

J =	Clearance to nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	6 in (15 cm) for appliances ≤ 10,000 Btuh (3kW), 12 in (30 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36 in (91 cm) for appliances > 100,000 Btuh (30 kW)	6 in (15 cm) for appliances ≤ 10,000 Btuh (3kW), 9 in (23 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 50,000 Btuh (15 kW), 12 in (30 cm) for appliances > 50,000 Btuh (15 kW)
K =	Clearance to a mechanical air supply inlet	6 ft (1.83 m)	3 ft (91 cm) above if within 10 ft (3 m) horizontally
L =	Clearance above paved sidewalk or paved driveway located on public property	7 ft (2.13 m)†	*
M =	Clearance under veranda, porch, deck, or balcony	12 in (30 cm)‡	*

* Clearance in accordance with local installation codes and the requirements of the gas supplier.

† A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.

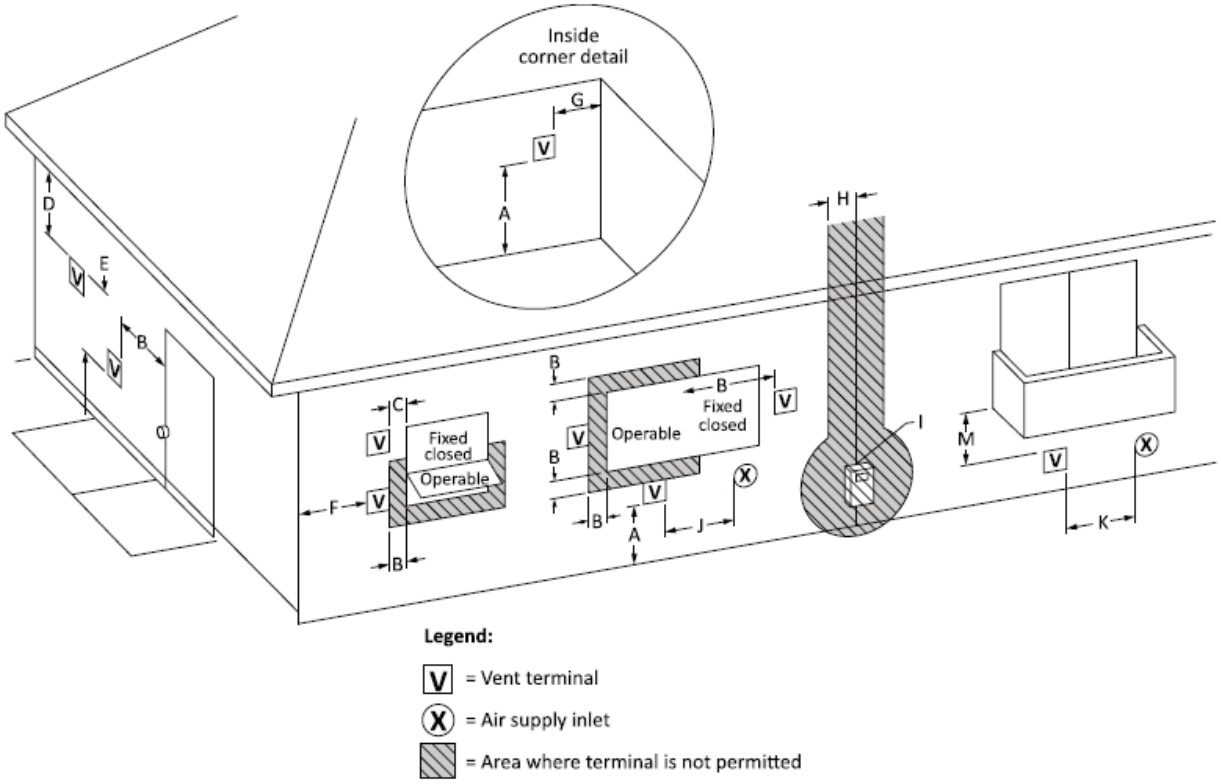
‡ Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath he oor.

NOTES:

1) In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code

2) In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code

***Figure 3-3B** Other than Direct Vent Terminal Clearances*



3 Sidewall direct venting *(continued)*

Table 3C *Other than Direct Vent Terminal Clearances*

		Canadian Installations[1]	US Installations[2]
A =	Clearance above grade, veranda, porch, deck, or balcony	12 in (30 cm)	12 in (30 cm)
B =	Clearance to window or door that may be opened	6 in (15 cm) for appliances ≤ 10,000 Btuh (3 kW), 12 in (30 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36 in (91 cm) for appliances > 100,000 Btuh (30 kW)	4 ft (1.2 m) below or to side of opening; 1 ft (300 mm) above opening
C =	Clearance to permanently closed window	*	*
D =	Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 ft (61 cm) from the center line of the terminal.	*	*
E =	Clearance to unventilated soffit	*	*
F =	Clearance to outside corner	*	*
G =	Clearance to inside corner	*	*
H =	Clearance to each side of center line extended above meter / regulator assembly	*	*
I =	Clearance to service regulator vent outlet	Above a regulator within 3 ft (91 cm) horizontally of the vertical center line of the regulator vent outlet to a maximum vertical distance of 15 ft (4.5 m)	*
J =	Clearance to nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	6 in (15 cm) for appliances ≤ 10,000 Btuh (3kW), 12 in (30 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36 in (91 cm) for appliances > 100,000 Btuh (30 kW)	4 ft (1.2 m) below or to side of opening; 1 ft (300 mm) above opening
K =	Clearance to a mechanical air supply inlet	6 ft (1.83 m)	3 ft (91 cm) above if within 10 ft (3 m) horizontally
L =	Clearance above paved sidewalk or paved driveway located on public property	7 ft (2.13 m)†	7 ft (2.13 m)
M =	Clearance under veranda, porch, deck, or balcony	12 in (30 cm)‡	*

* Clearance in accordance with local installation codes and the requirements of the gas supplier.

† A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.

‡ Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath he oor.

NOTES:

1) In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code

2) In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code

3 Sidewall direct venting

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:
      - 4½ inch hole for 3 inch vent pipe
      - 5½ inch hole for 4 inch vent pipe

   Drill 3/16" diameter holes for inserting the plastic anchors into the wall.
2. For Polypropylene Only: Install the vent and air intake sidewall adapters from Table 2F on page 21 into the vent plate. Slide the sidewall retaining bracket down the sidewall adapters flush to the vent plate (FIG. 3-4B).
3. For PVC/CPVC Only: Install the vent and air intake piping through the wall into the vent plate openings. Use RTV silicone sealant to seal the air pipe. Use the cement/primer listed in Table 2D on page 20 to seal the vent pipe.
4. Mount and secure the vent plate to the wall, using stainless steel screws.
5. Seal all gaps between the pipes and wall. Seal around the plate to the wall assuring no air gaps.
6. Assemble the vent cap to the vent plate (see FIG.'s 3-4A and 3-4B). Insert the stainless steel screws into the vent cap screw hole openings and securely attach the vent cap to the vent plate.
7. Seal all wall cavities.
8. PVC/CPVC terminations are designed to accommodate any wall thickness of standard constructions per the directions found in this manual.
9. Stainless steel terminations are designed to penetrate walls with a thickness up to 9.25 inches of standard construction.

Figure 3-4A *PVC/CPVC Sidewall Termination Assembly*

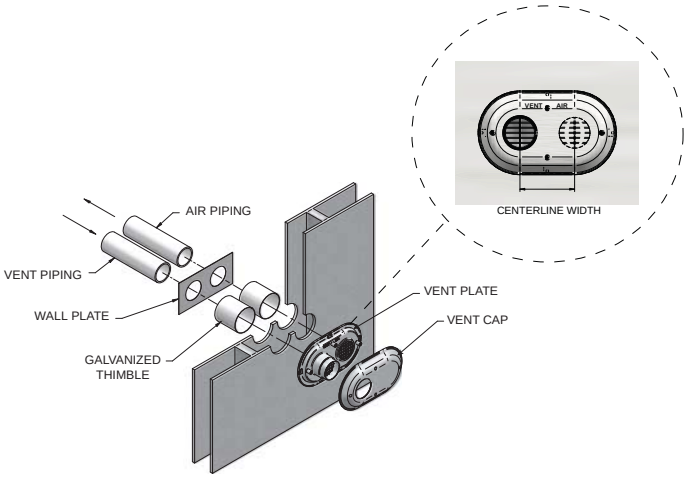
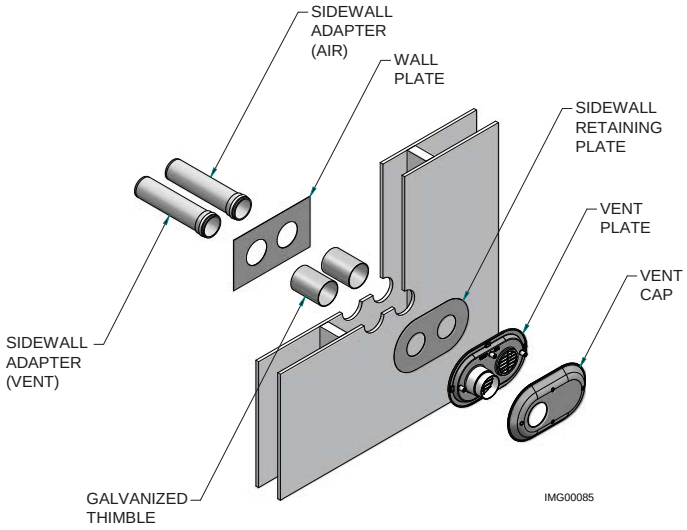


Table 3D *Sidewall Vent Centerline Dimensions*

Model	Air	Vent	Centerline Width
126-065 -- 201-100	3"	3"	5 5/8"
286-125 -- 501-125	4"	4"	5 5/8"

Figure 3-4B *Polypropylene Sidewall Termination Assembly*

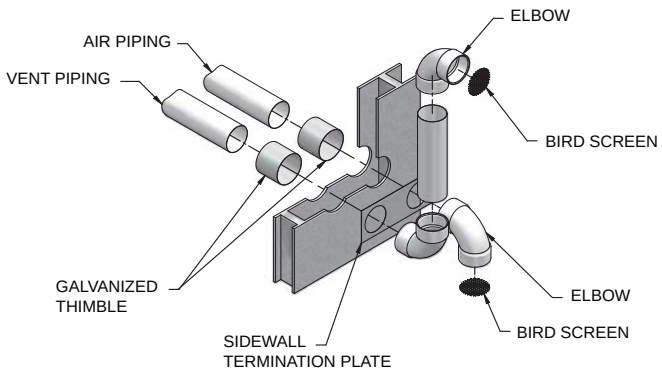


3 Sidewall direct venting *(continued)*

Prepare wall penetrations (Alternate - Field Supplied Option)

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:
      • 4½ inch hole for 3 inch vent pipe
      • 5½ inch hole for 4 inch vent pipe
   b. Insert a galvanized metal thimble in the vent pipe hole as shown in FIG. 3-4C.
3. Use a sidewall termination plate as a template for correct location of hole centers.
4. Follow all local codes for isolation of vent pipe when passing through floors or walls.
5. Seal exterior openings thoroughly with exterior caulk.

Figure 3-4C *Alternate Sidewall Termination Assembly w/Field Supplied Fittings*



Multiple vent/air terminations

1. When terminating multiple Shield water heaters terminate each vent/air connection as described in this manual (FIG. 3-5A).

⚠ 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.

2. Place wall penetrations to obtain minimum clearance of 12 inches between edge of air inlet and adjacent vent outlet, as shown in FIG. 3-5A for U.S. installations. For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
3. The air inlet of a Shield water heater is part of a direct vent connection. It is not classified as a forced air intake with regard to spacing from adjacent water heater vents.

Figure 3-5A *Multiple Vent Terminations (must also comply with* ***Figure 3-1A****)*

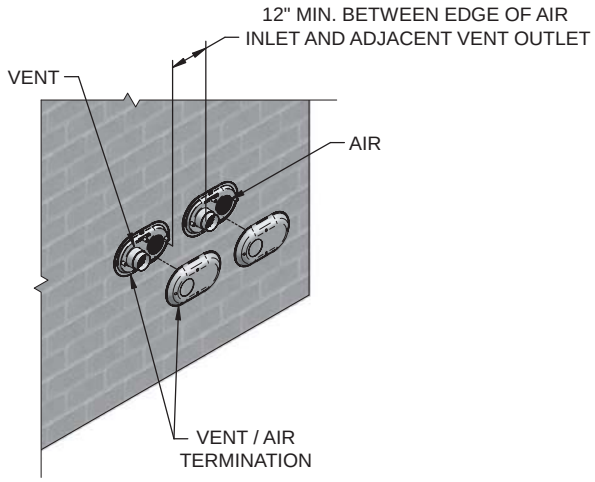
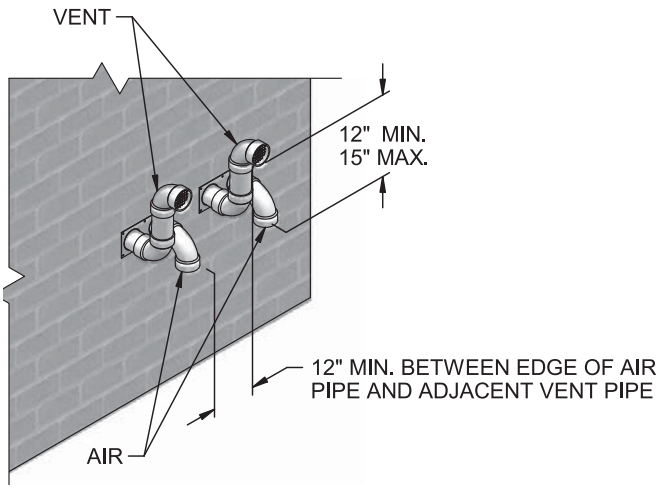


Figure 3-5B *Alternate Multiple Vent Terminations w/Field Supplied Fittings (must also comply with* ***Figure 3-1B****)*



3 Sidewall direct venting

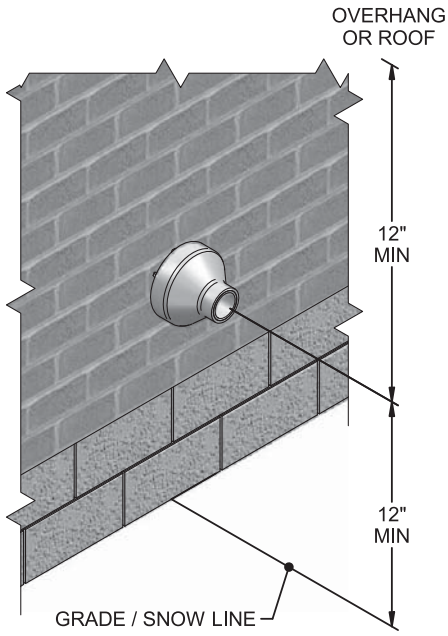
Sidewall termination – optional concentric vent

Description and usage

Lochinvar offers optional concentric combustion air and vent pipe termination kits (Factory Kit #100140480 for 3" diameter - Models 126-065 - 201-100 and #100140484 for 4" diameter - Models 286-125 - 501-125). Both combustion air and vent pipes must attach to the termination kit. The termination kits must terminate outside the structure and must be installed as shown in FIG. 3-6.

The required combustion vent pipe materials are listed in Table 2D, on page 20 of this manual.

Figure 3-6 *Concentric Sidewall Termination*



Sidewall termination installation

1. Determine the best location for the termination kit (see FIG. 4-6).

2. Reference the *Determine Location Section* on page 23 of this manual for general termination considerations.

3. Cut one (1) hole (5 inch diameter for #100140480 installations or 7 inch diameter for #100140484 installations) into the structure to install the termination kit.

4. 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.'s 3-7 and 3-8).
   b. Cement the rain cap to the smaller diameter kit pipe (FIG.'s 3-7 and 3-8).

Figure 3-7 *Kit Contents_100140480 - 126-065 -- 201-100*

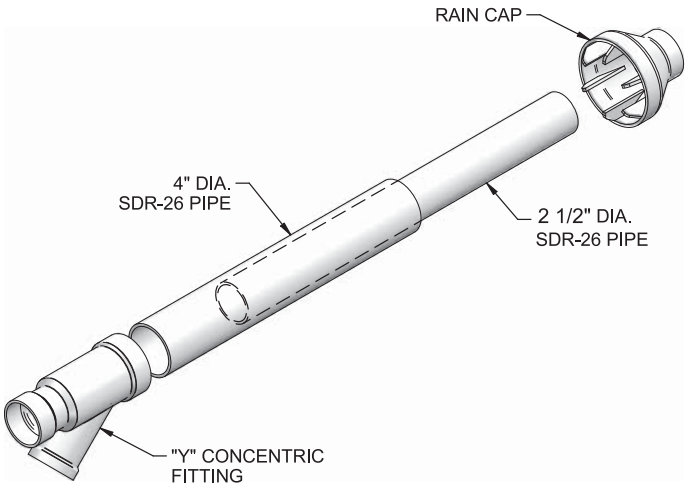
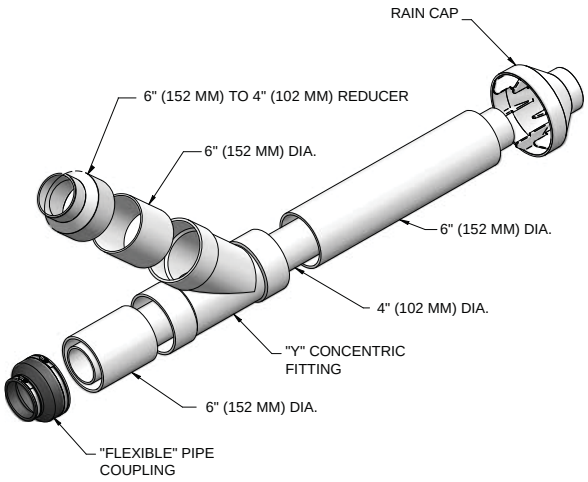


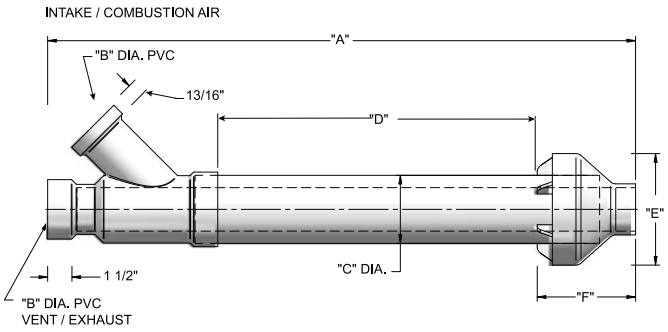
Figure 3-8 *Kit Contents_100140484 - 286-125 -- 501-125*



3 Sidewall direct venting *(continued)*

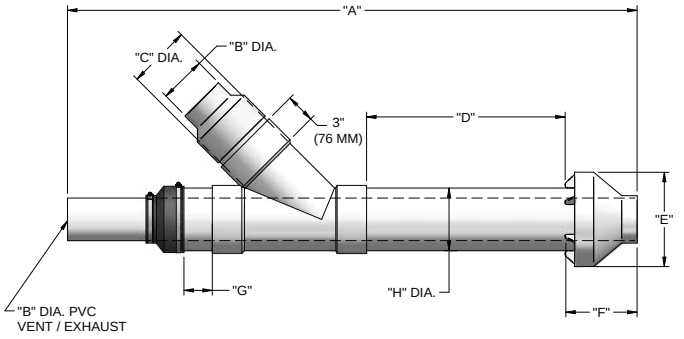
Sidewall termination – optional concentric vent

Figure 3-9 *Concentric Vent Dimensional Drawing - Models 126-065 -- 201-100 / 100140480*



A	B	C	D*	E	F
38 7/8"	3"	4 1/2"	21 1/8"	7 3/8"	6 1/2"

Figure 3-10 *Concentric Vent Dimensional Drawing - Models 286-125 -- 501-125 / 100140484*



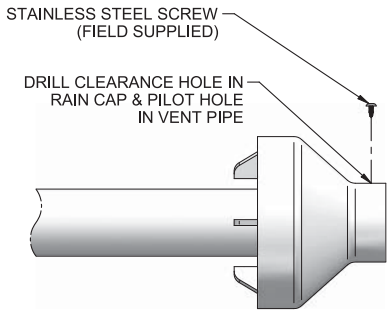
A	B	C	D	E	F	G	H
60"	4"	6"	21 1/8"	10"	7 5/8"	3"	6 5/8"

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. 3-11).

⚠ 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.

Figure 3-11 *Rain Cap to Vent Pipe Alternate Assembly*



6. Install the Y concentric fitting and pipe assembly through the structure's hole.

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

7. Install the rain cap and small diameter pipe assembly into the Y concentric fitting and large pipe assembly. Ensure small diameter pipe is bottomed and cemented in the Y concentric fitting for #100140480 installations and fastened tightly into the rubber adapter for #100140484 installations.

8. Secure the assembly to the structure as shown in FIG. 3-12 using field-supplied metal strapping or equivalent support material.

NOTICE Ensure termination location clearance dimensions are as shown in FIG. 3-6.

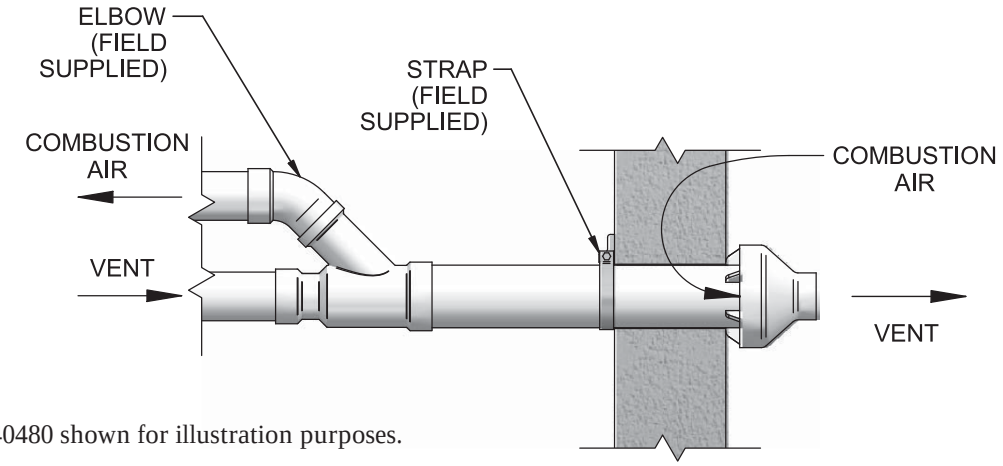
NOTICE If assembly needs to be extended to allow sidewall thickness requirement, the two (2) pipes supplied in the kit may be replaced by using the same diameter, field-supplied SDR-26 PVC (D2241) pipe for 100140480 and standard schedule 40 PVC for 100140484. Do not extend dimension D* more than 60 inches (see FIG.'s 3-9 and 3-10).

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

3 Sidewall direct venting

Sidewall termination – optional concentric vent

Figure 3-12 *Concentric Vent Sidewall Attachment*



Note: 100140480 shown for illustration purposes.

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. 3-12 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. 3-13). 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. 3-13. It is important that vent terminations be made as shown to avoid recirculation of flue gases.

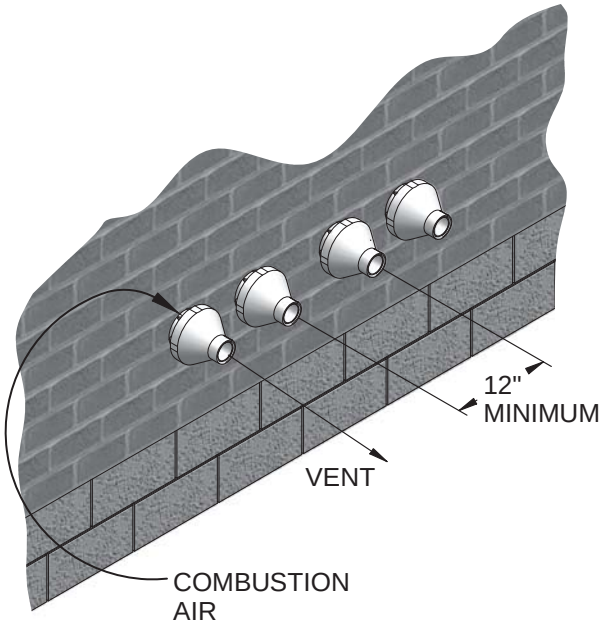


Figure 3-13 *Concentric Vent and Combustion Air Termination*

4 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.

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 17 of this manual.
2. Prepare the vent termination and the air termination elbow (FIG. 4-1A) by inserting bird screens. Bird screens should be obtained locally.
3. 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.
4. The air piping must terminate in a down-turned 180° return pipe no further than 2 feet from the center of the vent pipe. This placement avoids recirculation of flue products into the combustion air stream.
5. The vent piping must terminate in an up-turned coupling as shown in FIG. 4-1A. 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. 4-1B 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 for PVC and 3 feet for stainless steel, above the air intake.
6. Maintain the required dimensions of the finished termination piping as shown in FIG. 4-1A.
7. Do not extend exposed vent pipe outside of building more than shown in this document. Condensate could freeze and block vent pipe.

⚠ 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 4-1A *Vertical Termination of Air and Vent*

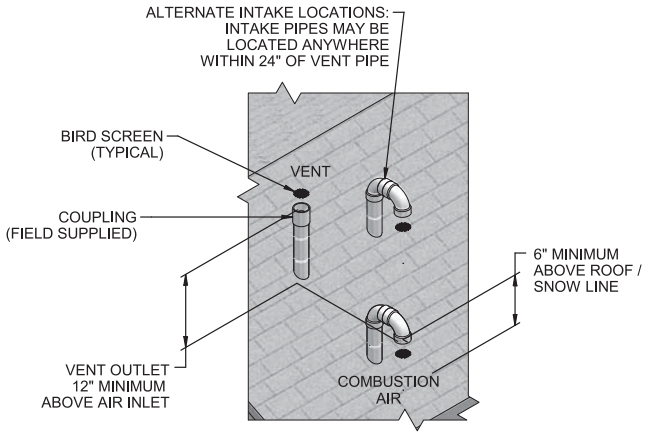
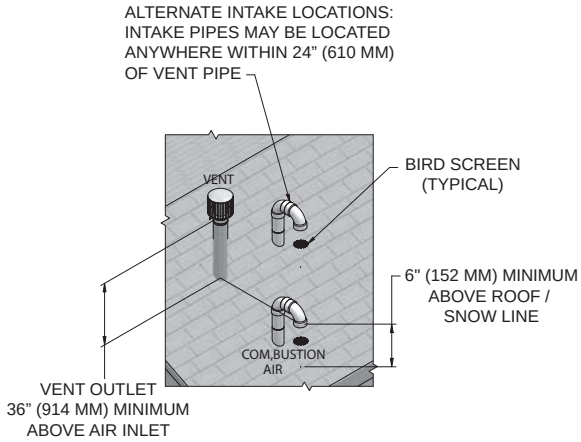


Figure 4-1B *Stainless Steel Vertical Termination of Air and Vent*



8. 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.

4 Vertical direct venting

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:
      • 4½ inch hole for 3 inch vent pipe
      • 5½ inch hole for 4 inch vent pipe
   b. Insert a galvanized metal thimble in the vent pipe hole.
3. Space the air and vent holes to provide the minimum spacing shown in FIG. 4-1A, page 33.
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.

Multiple vent/air terminations

1. When terminating multiple Shield water heaters, terminate each vent/air connection as described in this manual (FIG. 4-2).

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

2. Place roof penetrations to obtain minimum clearance of 12 inches between edge of air intake elbow and adjacent vent pipe of another water heater for U.S. installations (see FIG. 4-2). For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
3. The air inlet of a Shield water heater is part of a direct vent connection. It is not classified as a forced air intake with regard to spacing from adjacent water heater vents.

Figure 4-2 *Vertical Terminations with Multiple Water Heaters*

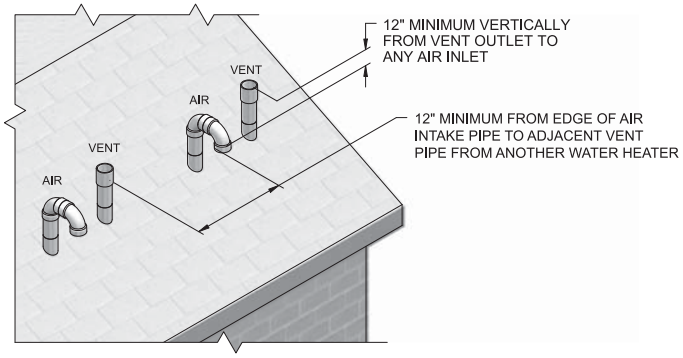
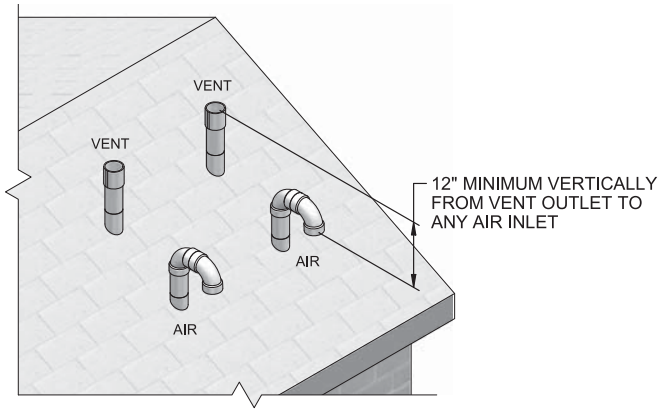


Figure 4-3 *Alternate Vertical Terminations with Multiple Water Heaters*



4 Vertical direct venting *(continued)*

Vertical termination – optional concentric vent

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. 4-4.

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

The required combustion air and vent pipe fittings are listed in Table 2D, on page 20 of this manual.

Vertical termination installation

1. See Section 4, Vertical Direct Venting - Determine Location (where applicable).
2. Cut one (1) hole (5 inch diameter for #100140480 installations or 7 inch diameter for #100140484 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.'s 3-7 and 3-8, page 30).
   b. Cement rain cap to the smaller diameter kit pipe (see FIG.'s 3-7 and 3-8, page 30).
   c. Do not attach a U-Bent to the rain cap. Doing so could cause recirculation (see FIG. 4-5).

Figure 4-4 *Concentric Vertical Termination*

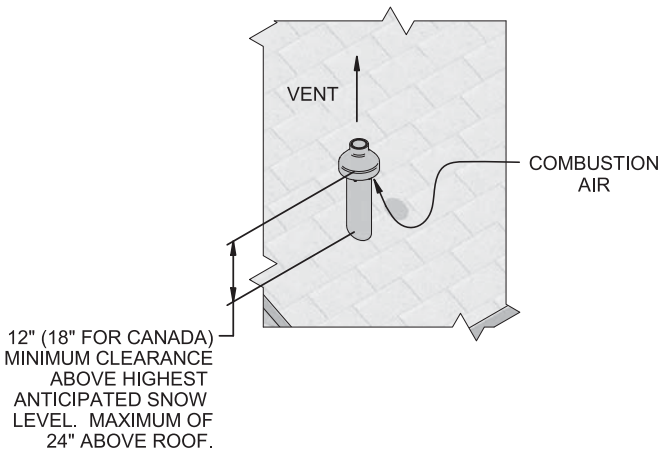


Figure 4-5 *Do Not Install U-Bent to Rain Cap*

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. 3-11, page 31).

⚠ 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.

4 Vertical direct venting

Vertical termination – optional concentric vent

⚠ 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.

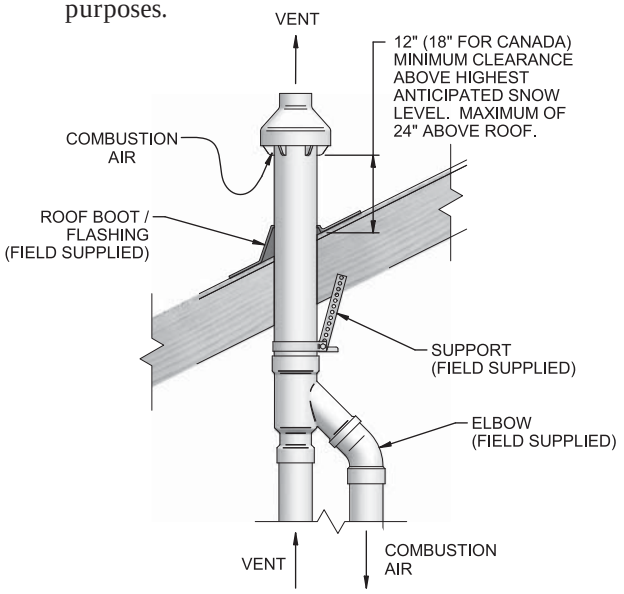
4. Install the Y concentric fitting pipe assembly up through the structure's hole and field supplied roof boot/flashing.

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. 4-6 using field supplied metal strapping or equivalent support material.

Figure 4-6 *Concentric Vent Roof Installation*

Note: 100140480 shown for illustration purposes.



NOTICE Ensure termination height is above the roof surface or anticipated snow level (12 inches in U.S.A. or 18 inches in Canada) as shown in FIG. 4-4, page 35.

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 SDR-26 PVC (D2241) pipe for #100140480 and standard schedule 40 PVC for #100140484. Do not extend dimension D* more than 60 inches (see FIG.'s 3-9 and 3-10, page 31).

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 cemented and bottomed in the Y concentric fitting for #100140480 installations and fastened tightly into the rubber adapter for #100140484 installations.

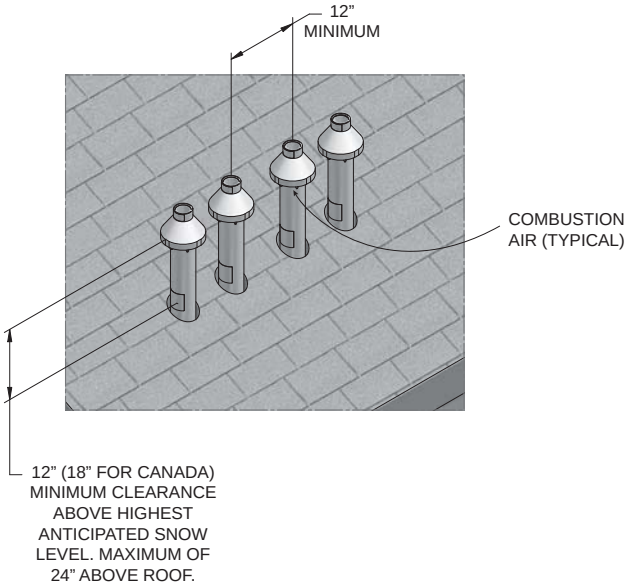
7. Cement the appliance combustion air and vent pipes to the concentric vent termination assembly. See FIG. 4-6 for proper pipe attachment.

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. 4-7). 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. 4-7. It is important that vent terminations be made as shown to avoid recirculation of flue gases.

Figure 4-7 *Concentric Vent and Combustion Air Vertical Termination*



5 System piping

System water piping methods

Observe a minimum of one inch clearance around all un-insulated hot water pipes when openings around the pipes are not protected by non-combustible materials.

⚠ WARNING Failure to install and maintain a new, listed temperature and pressure relief valve will release the manufacturer from any claim, which might result from excessive temperature and pressures.

Keep clear of the combination temperature and pressure relief valve discharge line outlet. The discharge may be hot enough to cause scald injury. The water is under pressure and may splash.

Hydrogen gas can be produced in an operating water heater that has not had water drawn from the tank for a long period of time (generally two weeks or more). HYDROGEN GAS IS EXTREMELY FLAMMABLE. To prevent the possibility of injury under these conditions, we recommend the hot water faucet to be open for several minutes at the kitchen sink before you use any electrical appliance, which is connected to the hot water system. If hydrogen is present, there will be an unusual sound such as air escaping through the pipes as hot water begins to flow. Do not smoke or have an open flame near the faucet at the time it is open.

General piping information

Basic steps are listed below along with illustrations on the following pages (FIG.'s 5-2 thru 5-4), which will guide you through the installation of the Shield water heater.

1. BEFORE PROCEEDING WITH THE INSTALLATION, CLOSE THE MAIN WATER SUPPLY VALVE. After shutting off the main water supply, open a faucet to relieve the water line pressure to prevent any water from leaking out of the pipes while making the water connections to the water heater. The COLD water inlet and HOT water outlet are identified on the water heater. Make the proper plumbing connections between the water heater and the plumbing system to the building. Install a shutoff valve in the cold water supply line.
2. If this water heater is installed in a closed water supply system, such as the one having a backflow preventer in the cold water supply, provisions must be made to control thermal expansion. DO NOT operate this water heater in a closed system without provisions for controlling thermal expansion. Warranties do not cover damages from thermal expansion such as pressure bulges and/or deformities. Your water supplier or local plumbing inspector should be contacted on how to control this situation.
3. After installation of the water lines, open the main water supply valve and fill the water heater. While the water heater is filling, open several hot water faucets to allow air to escape from the water system. When a steady stream of water flows through the faucets, close them and check all water connections for possible leaks.
4. Never operate the water heater without first being certain it is filled with water.

Scalding

This water heater can deliver scalding temperature water at any faucet in the system. Be careful whenever using hot water to avoid scalding injury. Certain appliances such as dishwashers and automatic clothes washers may require increased temperature water. By setting the thermostat on this water heater to obtain the increased temperature water required by these appliances, you may create the potential for scald injury. To protect against injury, you should install an ASSE approved mixing valve in the water system. This valve will reduce point of discharge temperature by mixing cold and hot water in branch supply lines. Such valves are available from the local plumbing supplier.

Figure 5-1 *Scald Warning*

Water temperatures over 125°F (52°C) can cause severe burns instantly or death from scalds.
Children, disabled, and elderly are at highest risk of being scalded.

See instruction manual before setting the thermostat at the water heater.

Feel water before bathing or showering.

Temperature limiting valves are available, consult local plumbing supplier.

5 System piping

The following chart (Table 5A) details the relationship of water temperature and time with regard to scald injury and may be used as a guide in determining the safest water temperature for your applications.

Table 5A *Approximate Time / Temperature Scald Chart*

APPROXIMATE TIME / TEMPERATURE RELATIONSHIPS IN SCALDS	
120°F	More than 5 minutes
125°F	1 1/2 to 2 minutes
130°F	About 30 seconds
135°F	About 10 seconds
140°F	Less than 5 seconds
145°F	Less than 3 seconds
150°F	About 1 1/2 seconds
155°F	About 1 second

Water chemistry

NOTICE The Shield water heater is designed for heating potable water with a hardness of 5 to 20 grains per gallon and a total dissolved solids not exceeding 350 ppm.

The water must be treated if it is not between 5 to 25 grains per gallon or above 350 ppm of total dissolved solids. Hardness exceeding 25 grains or 350 ppm can cause non-warrantable premature failure of the heat exchanger. Water with a hardness of less than 5 grains per gallon will usually have a pH which can be aggressive and corrosive causing non-warrantable damage to the pump and associated piping. Corrosion due to water chemistry generally shows up first in the hot water system because heated water increases the rate of corrosive chemical reactions.

Piping components

Check valves:

Field supplied. Check valves are recommended for installation as shown in FIG.'s 5-2 thru 5-4.

Water heater 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 water heater.

Anti-scald mixing valve:

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

Unions:

Field supplied. Recommended for unit serviceability.

Temperature and pressure relief valve:

Factory supplied on water heaters. The temperature and pressure relief valve is sized to ASME specifications.

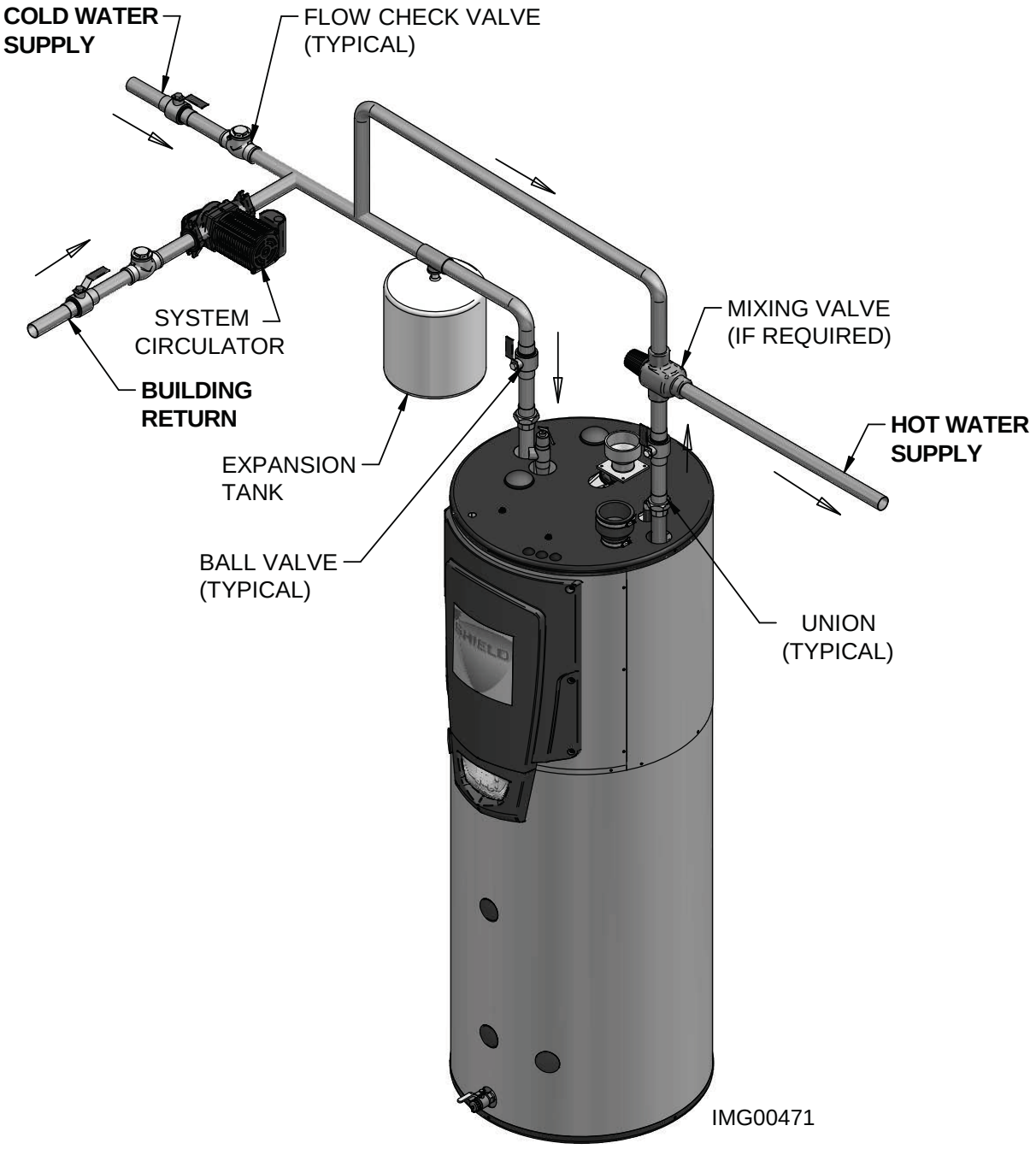
⚠ CAUTION No valves shall be placed between the relief valve, heat exchanger, or tank. The relief valve shall be piped to a suitable drain as close as possible to the heater with no reducing couplings or other restrictions. The piping must be sloping away from the heater at all times.

See the * piping illustrations included in this section, FIG.'s 5-2 thru 5-4 for suggested guidelines in piping the Shield water heater.

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.

5 System piping *(continued)*

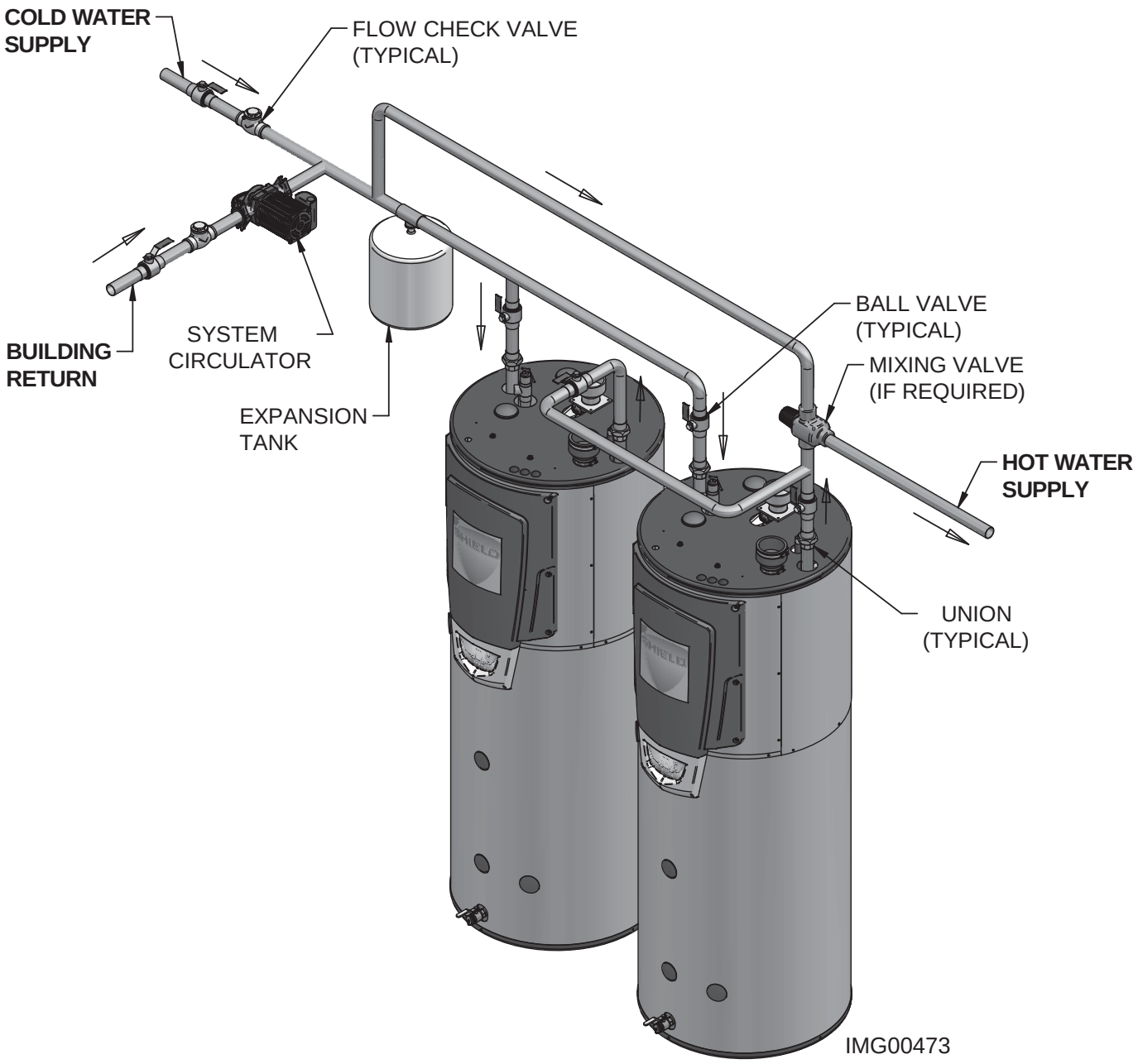
Figure 5-2 *Single Unit*



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.

5 System piping

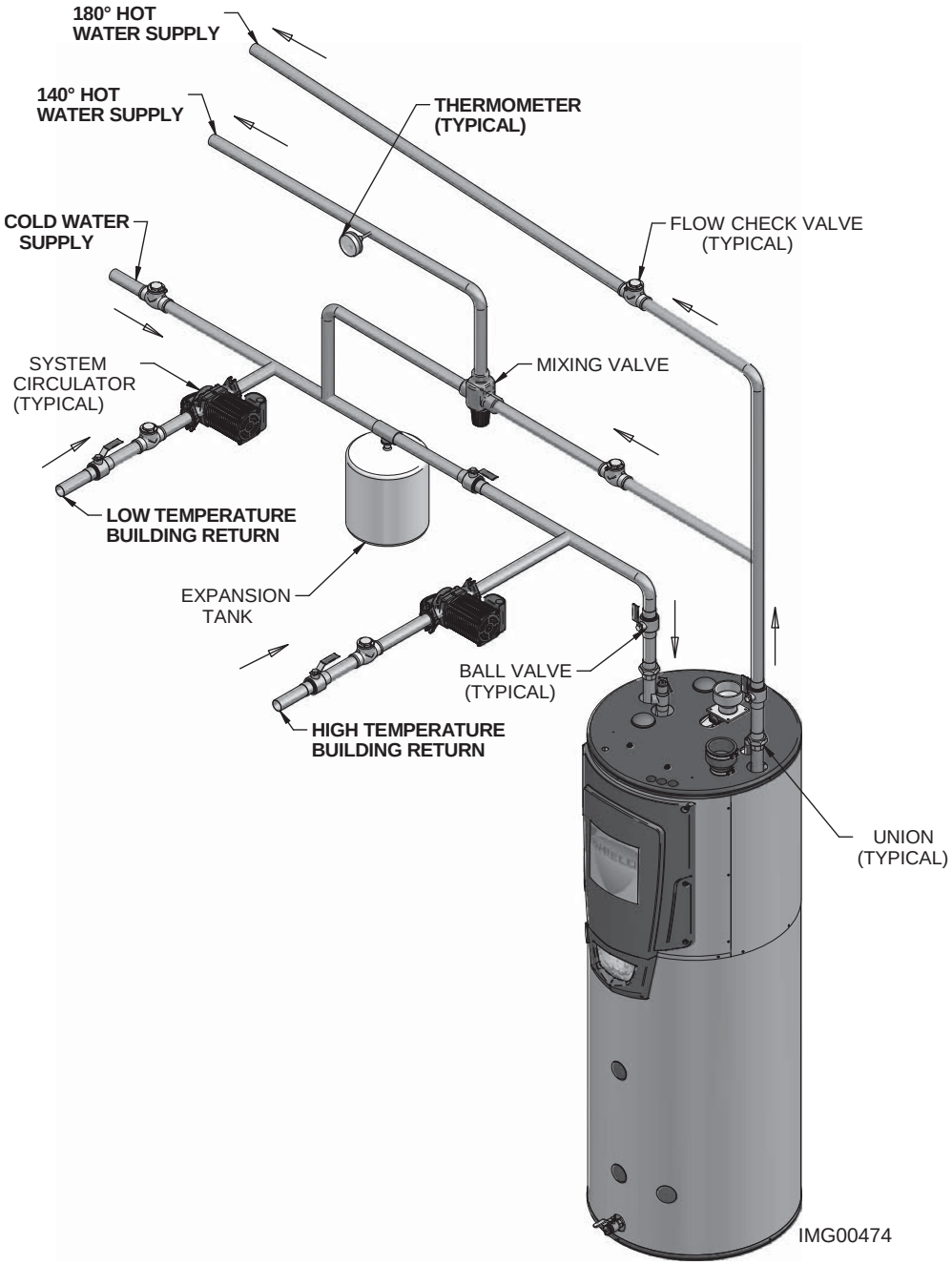
Figure 5-3 *Multiple Units*



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.

5 System piping *(continued)*

Figure 5-4 *Two Temperature - Single Unit*



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 Gas connections

Connecting gas supply piping

1. Install ground joint union for servicing, when required.

2. On Models 126-065 -- 286-125 install a manual shutoff valve in the gas supply piping outside water heater jacket when required by local codes or utility requirements.

3. In Canada – When using manual main shutoff valves, it must be identified by the installer.

Figure 6-1 *Gas Supply Piping - Models 126-065 -- 286-125*

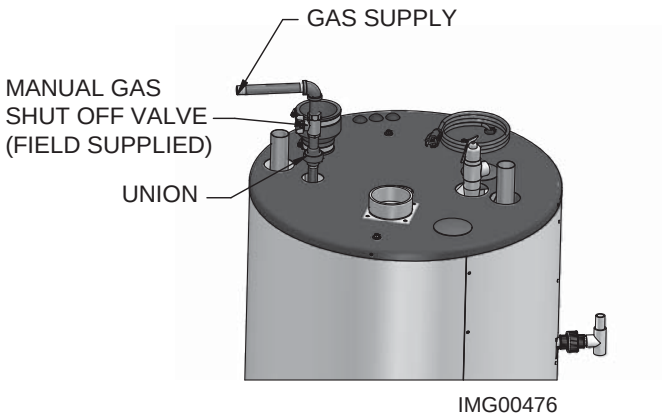
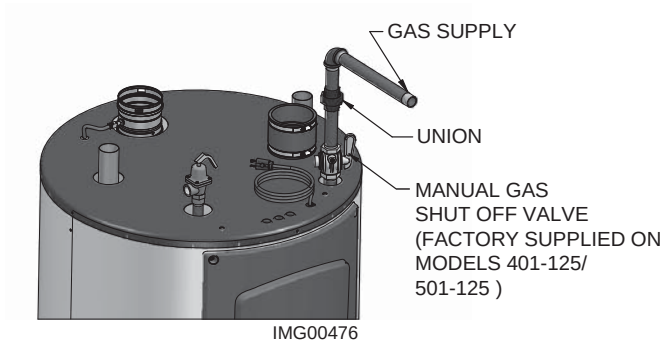


Figure 6-2 *Gas Supply Piping - Models 401-125 -- 501-125*



4. Support piping with hangers, not by the water heater 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 water heater or its accessories. Failure to comply could result in severe personal injury, death, or substantial property damage.

5. Purge all air from the gas supply piping.

6. Before placing the water heater in operation, check the water heater 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.

7. 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.

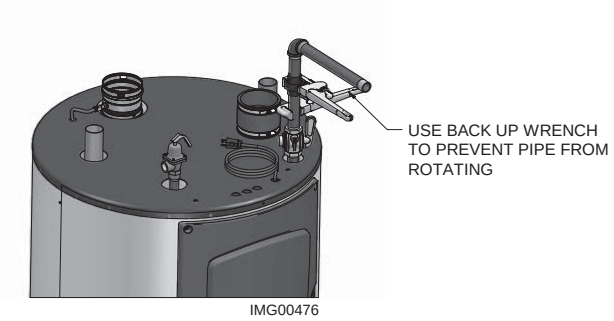
6 Gas connections *(continued)*

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

⚠ WARNING Shield water heaters are typically shipped ready to fire on natural gas. Check the water heater rating plate to determine which fuel the water heater is set for. In order to operate on LP gas contact the factory, 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.

⚠ WARNING Use two wrenches when tightening gas piping at water heater (FIG. 6-3), using one wrench to prevent the water heater gas line connection from turning. Failure to support the water heater gas connection pipe to prevent it from turning could damage gas line components.

Figure 6-3 *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.

⚠ WARNING Ensure that the high gas pressure regulator is at least 10 feet upstream of the appliance.

Natural gas:

Pipe sizing for natural gas

1. Refer to Table 6A for pipe length and diameter. Based on rated water heater input (divide by 1,000 to obtain cubic feet per hour).
   a. Table 6A is only for natural gas with specific gravity 0.60 inches, with a pressure drop through the gas piping of 0.30 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. with no flow (lockup) or with water heater on.
   • Minimum 4 inches w.c. with gas flowing (verify during water heater startup).

2. Install 100% lockup gas pressure regulator in supply line if inlet pressure can exceed 14 inches w.c. at any time. Adjust lockup regulator for 14 inches w.c. maximum.

Propane gas:

⚠ WARNING Shield water heaters are typically shipped ready to fire on natural gas. Check water heater rating plate to determine which fuel the water heater is set for. In order to operate on LP gas contact the factory, 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. maximum pressure.

2. Pressure required at gas valve inlet pressure port:
   • Maximum 14 inches w.c. with no flow (lockup) or with water heater on.
   • Minimum 8 inches w.c. with gas flowing (verify during water heater startup).

6 Gas connections

Table 6A *Natural Gas Pipe Size Chart*

Capacity of Schedule 40 Metallic Pipe in Cubic Feet of Natural Gas Per Hour (based on .60 specific gravity, 0.30" w.c. pressure drop)														
Pipe Size (Inches)	Length of Pipe in Straight Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/2	131	90	72	62	55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/4	273	188	151	129	114	104	95	89	83	79	70	63	58	N/A
1	514	353	284	243	215	195	179	167	157	148	131	119	109	102
1 1/4	1,060	726	583	499	442	400	368	343	322	304	269	244	224	209
1 1/2	1,580	1,090	873	747	662	600	552	514	482	455	403	366	336	313
2	3,050	2,090	1,680	1,440	1,280	1,160	1,060	989	928	877	777	704	648	602
2 1/2	4,860	3,340	2,680	2,290	2,030	1,840	1,690	1,580	1,480	1,400	1,240	1,120	1,030	960
3	8,580	5,900	4,740	4,050	3,590	3,260	3,000	2,790	2,610	2,470	2,190	1,980	1,820	1,700
4	17,500	12,000	9,660	8,270	7,330	6,640	6,110	5,680	5,330	5,040	4,460	4,050	3,720	3,460

⚠ WARNING Shield water heaters are typically shipped ready to fire on natural gas. Check the water heater rating plate to determine which fuel the water heater is set for. In order to operate on LP gas contact the factory, 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 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 water heater to fire at full rate. Consult with local codes for proper installation or service procedures.

⚠ WARNING DO NOT 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 (when configured for LP), requiring no field adjustment. Attempting to 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., the meter, regulator, or gas line is undersized or in need of service. Perform the steps below when checking inlet gas supply:

1. Disconnect power from the appliance.
2. Shut off gas to the appliance.
3. Loosen the set screw one (1) full turn from inside the pressure tap on top of the gas valve. Place the tubing of the manometer over the tap once the set screw is loosened as shown in FIG.'s 6-4 thru 6-6.
4. Slowly turn on the gas supply at the field installed manual gas valve.
5. Reconnect power to the appliance.
6. Adjust the temperature set point on the control panel of the electronic control module to call for heat.
7. 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.
8. Ensure inlet pressure is within specified range. Minimum and maximum gas supply pressures are specified in this section of the manual.
9. If gas supply pressure is within normal range and no adjustments are needed, proceed on to Step 11.
10. 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.
11. Disconnect power from the appliance.
12. Shut off the gas to the appliance.
13. Remove the manometer from the pressure tap on top of the gas valve. Re-tighten the set screw inside the pressure tap.

⚠ 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. Reconnect gas to the appliance.
15. Reconnect power to the appliance.
16. Adjust the temperature set point on the control panel of the electronic control module to the desired water temperature so the appliance will call for heat.

6 Gas connections *(continued)*

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 6-4 *Inlet Gas Supply Check - Models 126-065 -- 286-125*

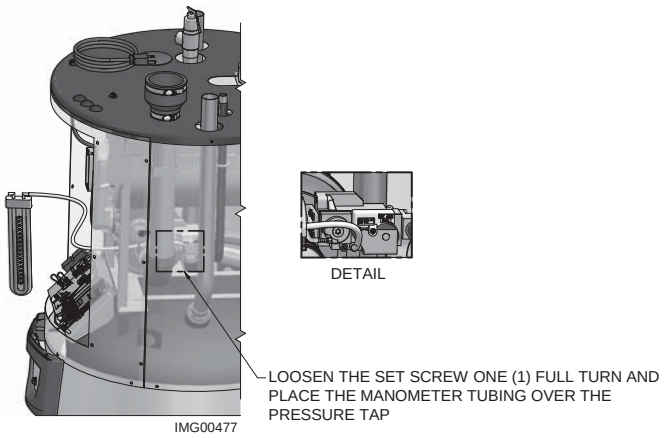


Figure 6-5 *Inlet Gas Supply Check - Model 401-125*

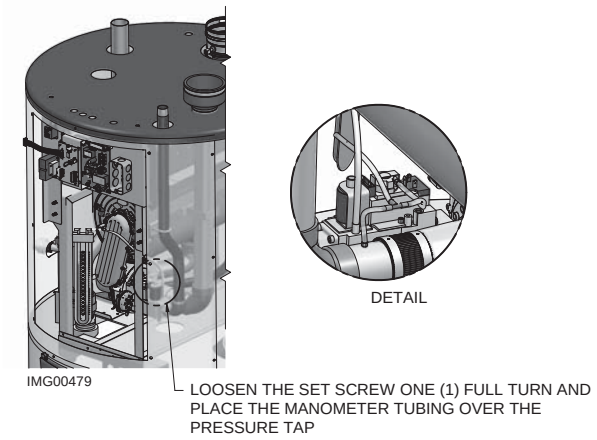
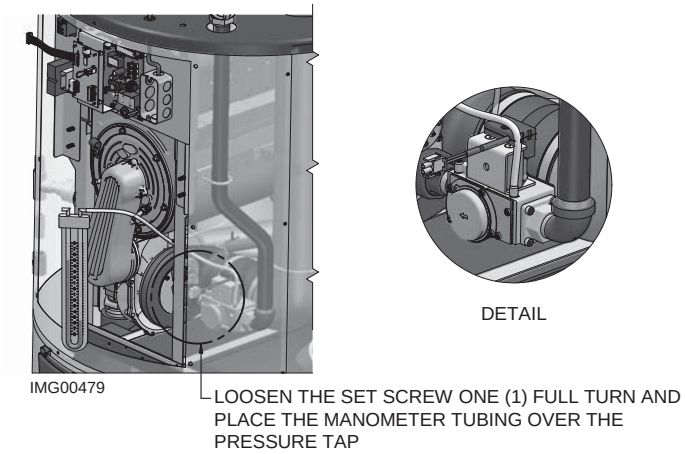


Figure 6-6 *Inlet Gas Supply Check - Model 501-125*



Gas pressure

The gas pressure must remain between 4 inches w.c. (natural), 8 inches w.c. (LP) minimum and 14 inches w.c. (natural and LP) maximum during stand-by (static) mode and while in operating (dynamic) mode. If an in-line regulator is used, it must be a minimum of 10 feet from the Shield water heater. 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 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 (when configured for LP), requiring no field adjustment. Attempting to measure the gas valve outlet pressure could result in damage to the valve, causing potential severe personal injury, death, or substantial property damage.

7 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 the water heater must be replaced, use only type 105°C wire or equivalent.

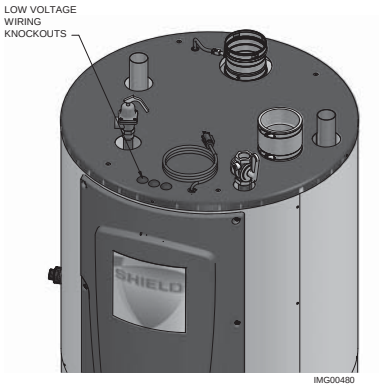
The water heater must be electrically grounded as required by National Electrical Code ANSI/NFPA 70 – latest edition.

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

Low voltage connections

1. Route all low voltage wires through the knockouts in the top of the water heater, as shown in FIG. 7-1.
2. Connect low voltage wiring to low voltage connection board as shown in FIG. 7-3 on page 47 of this manual and the water heater wiring diagram.

Figure 7-1 *Routing Field Wiring*



Enable switch

An external switch or contact may be used to enable/disable the water heater. To connect the enable switch, remove the jumper wire from across the ENABLE terminals on the low voltage connection board and connect the wires from the switch in its place. Note that the freeze protection feature will still fire the heater even though the enable input is open.

Louver relay output / louver proving switch input

When installed using the optional room air configuration, the heater is able to control powered louvers used to allow outside air into the room. Connect the 24VAC control relay coil to the LOUVER RELAY output on the low voltage connection board. Remove the jumper wire from the LOUVER PROVING SWITCH terminals on the low voltage connection board and connect the louver proving switch wires in its place.

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.

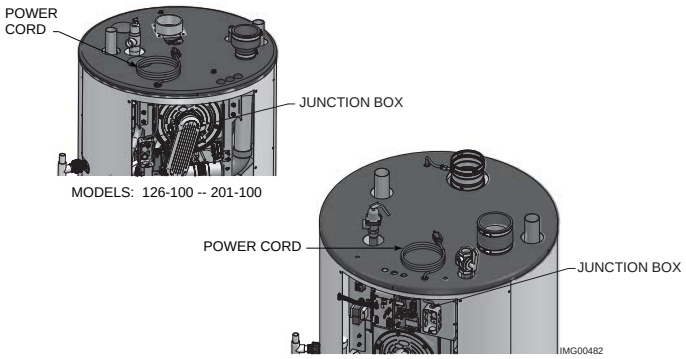
Power cord connection

This water heater is designed to operate with 120 VAC and 60 Hz power supply. If allowed by local codes, connect the power cord provided with the heater to a GFI protected outlet on a separate circuit and breaker (15 amp recommended). Ensure the circuit cannot be interrupted by a switch used to control lights or other appliances.

If local codes do not allow for the use of the power cord, remove the cord from the junction box found on the side of the control support bracket (FIG. 7-2) and attach conduit to the junction box. Route the wires out of the appliance to a GFI protected outlet on a separate circuit and breaker (15 amp recommended).

⚠ WARNING Use of an extension cord is NOT allowed. If a suitable electrical outlet is not within reach of the supplied power cord, a new receptacle must be installed or the power cord must be replaced with hard conduit as described above.

Figure 7-2 *Remove Power Cord*



Runtime contacts

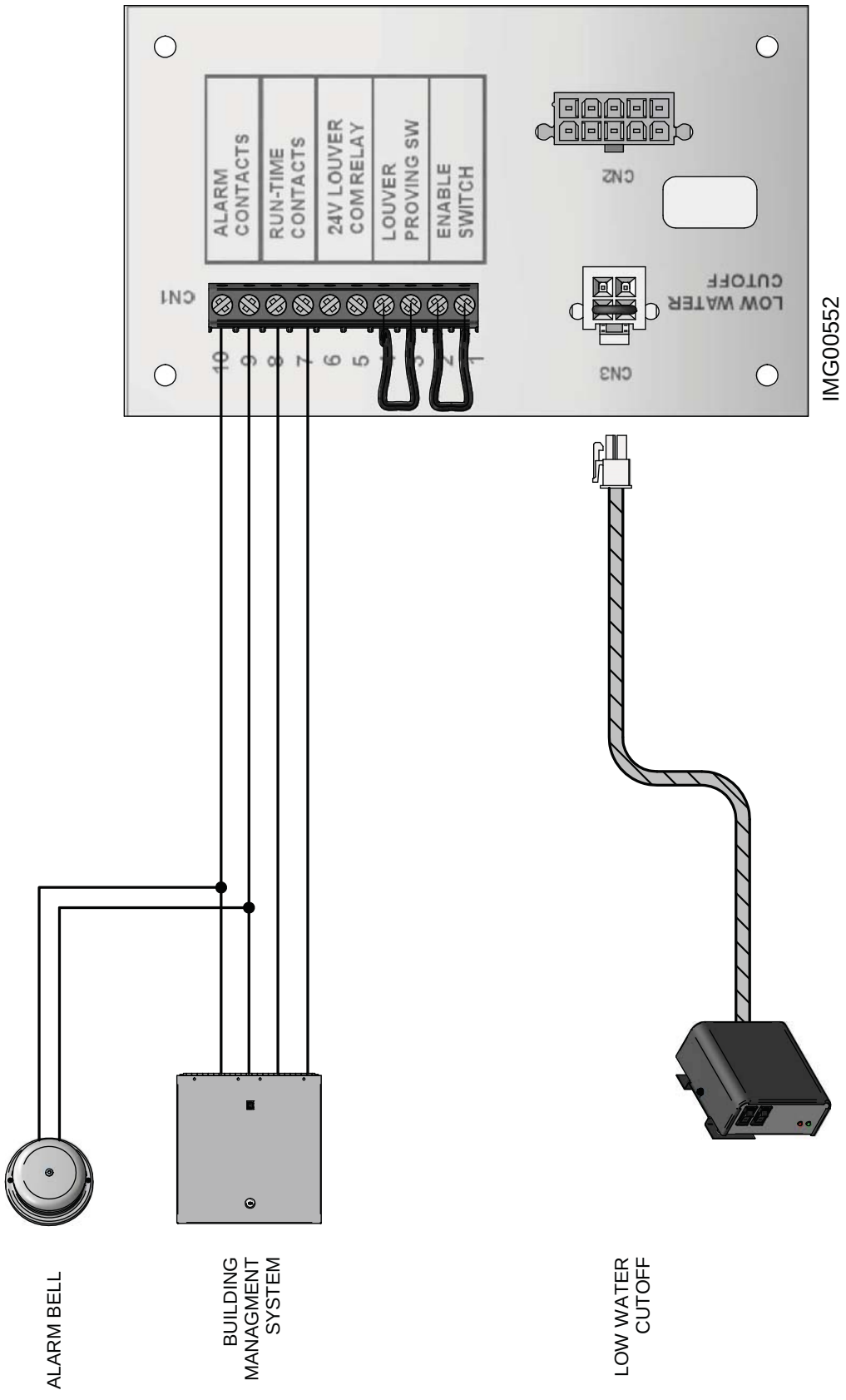
The electronic control closes a set of dry contacts whenever the burner is running. This is typically used by Building Management Systems to verify that the water heater is responding to a call for heat.

Alarm contacts

The electronic control closes another set of contacts whenever the water heater 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 water heater is down. Note that the alarm contacts will close momentarily after each call for heat.

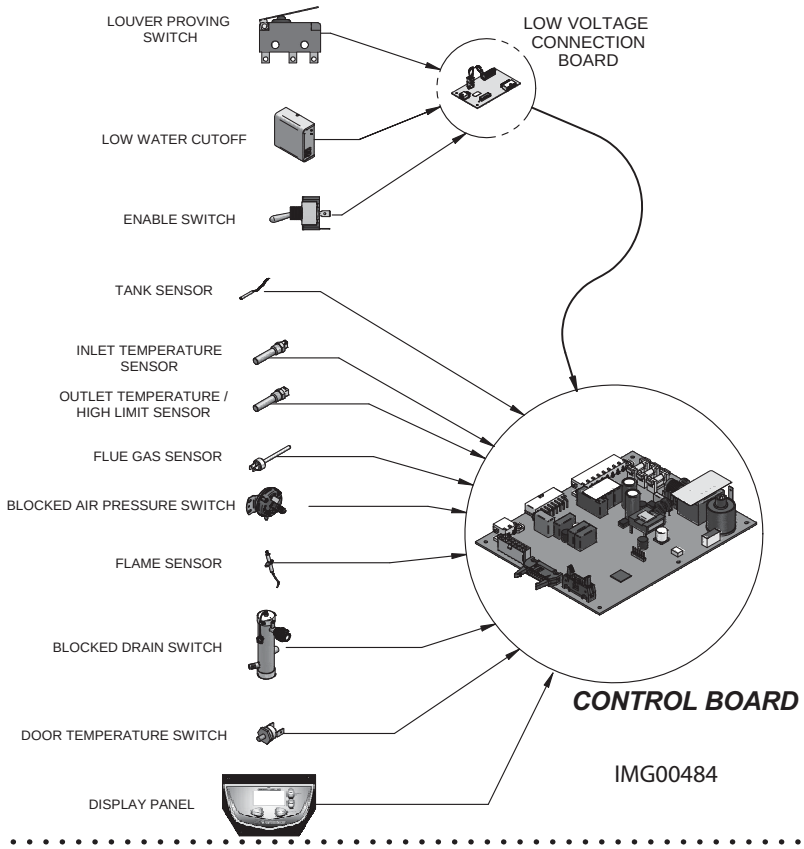
7 Field wiring *(continued)*

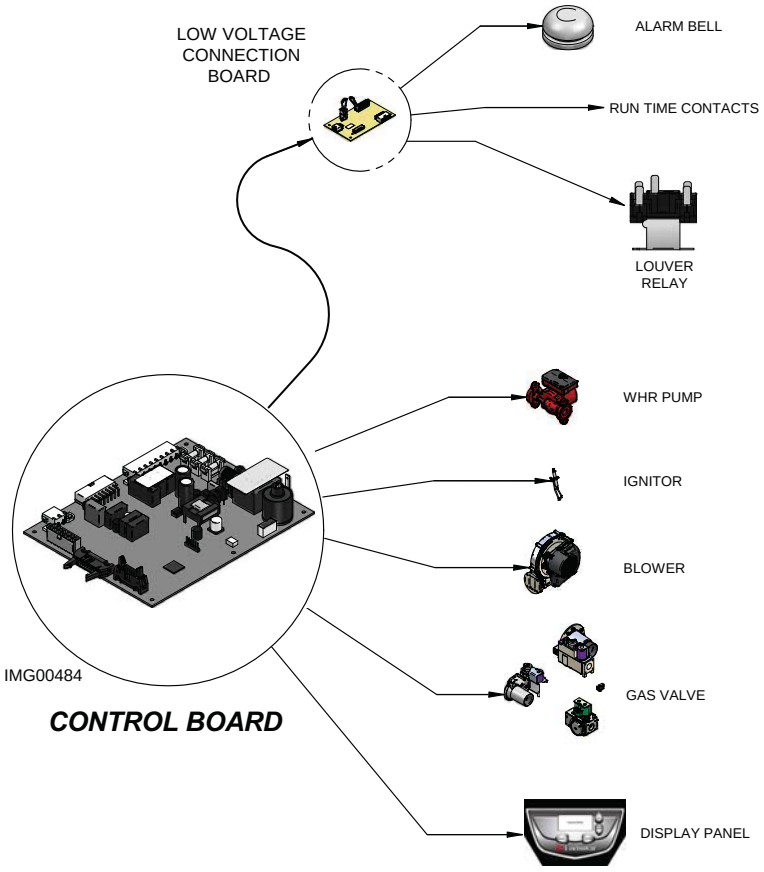
Figure 7-3 *Low Voltage Field Wiring Connections*



7 Field wiring

Figure 7-4 *Control Inputs/Outputs*





8 Condensate disposal

Condensate drain

1. This water heater is a high efficiency appliance that produces condensate.
2. Slope condensate tubing down and away from the water heater into a drain or condensate neutralizing filter. Condensate from the Shield water heater will be slightly acidic (typically with a pH from 3 to 5). Install a neutralizing filter if required by local codes.

   A Neutralizer Kit is available from the factory (100157721).

Note: The Neutralizer Kit MUST BE installed horizontally.

3. Do not expose condensate line to freezing temperatures.

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.

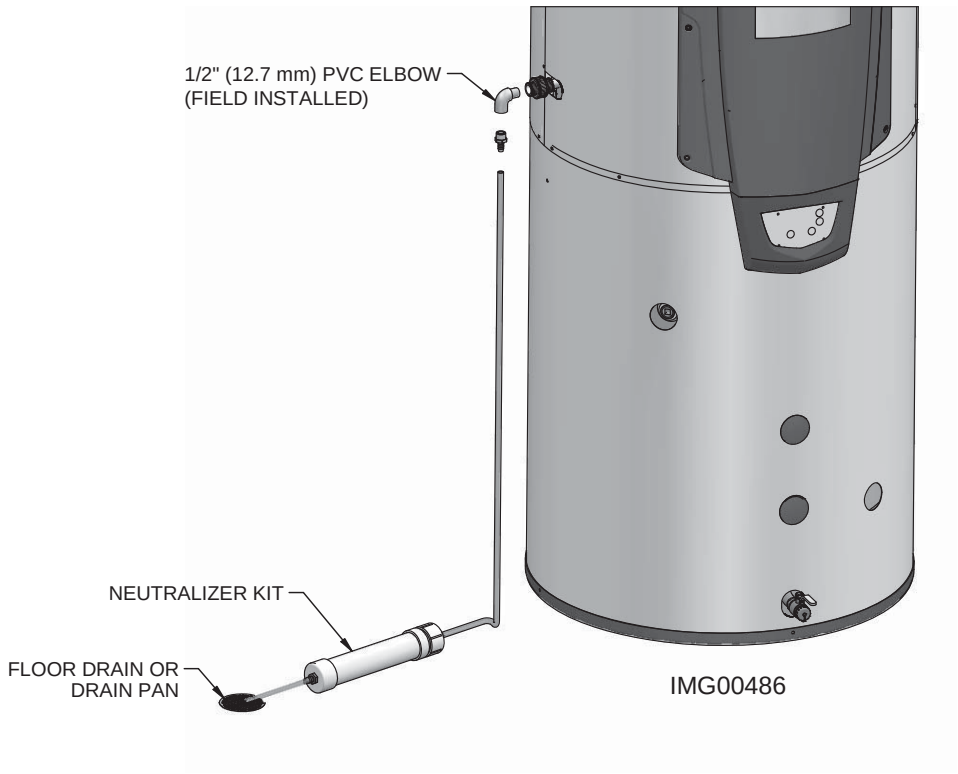
NOTICE

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.

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 water heater condensate trap, resulting in potential water damage to property.

4. A condensate removal pump is required if the water heater is below the drain. When installing a condensate pump, select one approved for use with condensing water heaters and furnaces. The pump should have an overflow switch to prevent property damage from condensate spillage. The switch should be wired to the auxiliary device proving switch terminals on the low voltage connection board.

Figure 8-1 *Condensate Disposal*



9 Start-up

Chlorine concentration less than 200 ppm

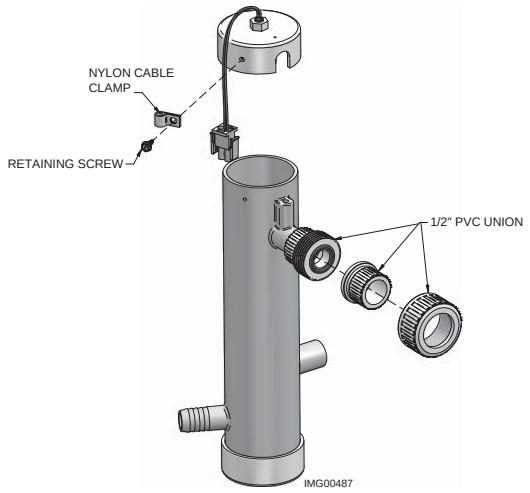
1. Do not fill the water heater or operate with water containing chlorine in excess of 200 ppm.
2. Filling with chlorinated fresh water should be acceptable since drinking water chlorine levels are much lower.
3. Do not use the water heater to directly heat swimming pool or spa water.
4. At initial fill and during water heater startup and testing, check system thoroughly for any leaks. Repair all leaks before proceeding further.

Check for gas leaks

⚠ WARNING Before starting the water heater, and during initial operation, smell near the floor and around the water heater for gas odorant or any unusual odor. Remove the top access panel and smell the interior of the water heater 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 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 (when configured for LP), requiring no field adjustment. Attempting to measure the gas valve outlet pressure could result in damage to the valve, causing potential severe personal injury, death, or substantial property damage.

Figure 9-1 *Condensate Trap*



⚠ WARNING Propane water heaters 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.

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. 9-1).
2. Remove the 2 inch PVC cap with the switch located at the top of the trap (FIG. 9-1).
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. 9-1) must be filled with water during all times of water heater operation to avoid flue gas emission from the condensate drain line. Failure to fill the trap could result in severe personal injury or death.

Final checks before starting the water heater

- ❑ Read this manual to familiarize yourself with electronic control module operation. Read pages 52 and 53 for proper steps to start the water heater.
- ❑ Verify the water heater and system are full of water and all system components are correctly set for operation.
- ❑ Verify the preparation procedures of Section 9, pages 50 and 51 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.

9 Start-up *(continued)*

Start the water heater

1. Read and follow the Operating instructions in FIG.'s 9-2 and 9-3, pages 52 and 53.

If water heater does not start correctly

1. Check for loose connections, blown fuse or service switch off.
2. Is external limit control (if used) open? Is water temperature above 200°F?
3. Is tank set point set below tank temperature?
4. Is gas turned on at meter and water heater?
5. Is incoming gas pressure less than 4 inches w.c.?

If none of the above corrects the problem, refer to the *Troubleshooting* section of this manual.

Check system and water heater

❑ Check water piping

1. Check system piping for leaks. If found, shut down the water heater and repair immediately.
2. Check Delta T. Ensure Delta T is less than 25°F, if not, reference *Section 12 - Troubleshooting.*
3. Vent any remaining air from the system using manual vents. Air in the system will interfere with circulation and cause hot water 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 water heater for gas odor following the procedure on page 42 of this manual *(Connecting Gas Supply Piping).*

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

Check flame and combustion

1. Shut the water heater down by pressing the UP button for five (5) seconds.
2. Locate the flue sensor in the vent connection. Remove the flue sensor and grommet from the unit. **Note:** Combustion measurements will be made at this point.
3. Place the water heater in active position by pressing the UP button for five (5) seconds.
4. Press ENTER plus the UP button for five (5) seconds to enter Service Mode.
5. Insert the probe from a combustion analyzer into the hole left by the removal of the flue temperature sensor.
6. Once the water heater has modulated up to full fire, measure the combustion. The values should be in the range listed in Table 9A. 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 this manual for possible causes and corrective actions.
7. Once the combustion analysis is complete, exit Service Mode.

Table 9A *Flue Products Chart*

Natural Gas		Propane	
CO_2	O_2	CO_2	O_2
8.0% - 10%	3.0% - 6.5%	9.0% - 11%	4.1% - 6.9%

8. Replace the flue sensor and grommet into the vent connection.
9. Place the Shield water heater back into normal operation.

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

9 Start-up

Figure 9-2 *Operating Instructions - Models 126-065 -- 286-125*

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.

WHAT TO DO IF YOU SMELL GAS

Do not try to light any appliance.

Do not touch any electric switch; do not use any phone in your building.

Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.

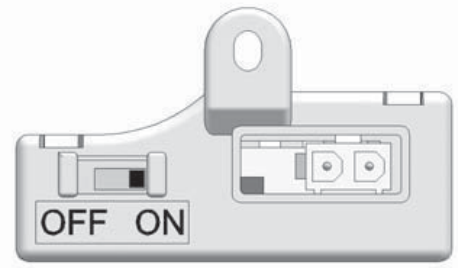
If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to move the gas control switch. Never use tools. If the switch will not move 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.

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 front door.
6. Move switch to the "OFF" position.
7. Wait five (5) minutes to clear out any gas. If you then smell gas, **STOP!** Follow "B" in the safety information above this label. If you don't smell gas, go to next step.
8. Move the switch to the "ON" position.
9. Install front door.
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 front door.
4. Move switch the "OFF" position.
5. Install front door.

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9 Start-up *(continued)*

Figure 9-3 *Operating Instructions - Models 401-125 -- 501-125*

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.

WHAT TO DO IF YOU SMELL GAS

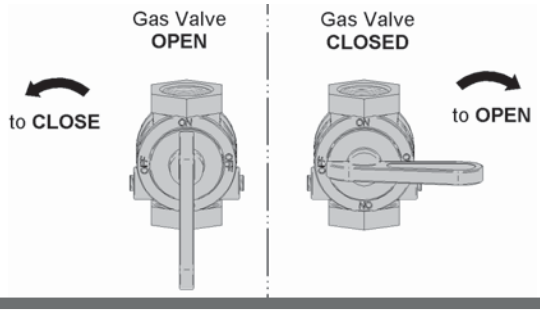
- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to turn the gas control knob. Never use tools. If the 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.

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 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.

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10 Operating information

General

How the water heater operates

The Shield water heater combines an advanced stainless steel heat exchanger, electronic control module, and tank that allows fully condensing operation. The blower pulls in air and pushes flue products out of the heat exchanger and flue piping. The control module regulates blower speed to control the water heater firing rate. The gas valve senses the amount of air flowing into the water heater and allows only the right amount of gas to flow. An internal pump circulates the water between the tank and heater and mixes the incoming water to provide maximum efficiency.

Temperature control

Modulation

The Shield water heater is capable of modulating its firing rate from a minimum of 20% to a maximum of 100%. The firing rate is dictated by the hot water draw and various other temperature limitations.

Night setback

The controller may be programmed to reduce the tank set point during a certain time each day. There are seven (7) start and seven (7) stop triggers.

Flame current support

To prevent nuisance shutdowns when the water heater is firing at minimum rates, the control will increase fan speed when the flame signal drops too low.

Protection features

Outlet temperature, flue temperature, and temperature rise limiting

The heat exchanger outlet temperature is monitored by the heat exchanger outlet temperature sensor. When the heat exchanger outlet temperature exceeds 190°F, the unit will reduce the fan speed. If the heat exchanger outlet water temperature exceeds 198°F 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 the control will reduce the maximum fan speed. If the flue temperature exceeds 225°F (107°C) the control will shut the unit down. The unit will restart automatically once the flue temperature drops 10°F (6°C) and the minimum off time has expired.

The control monitors the temperature difference between the heat exchanger inlet and the heat exchanger outlet sensors. If this difference exceeds 25°F the control will reduce the fan speed. If the temperature difference exceeds 30°F the control will shut the unit down. The unit will restart automatically once the temperature difference has dropped below 25°F and the minimum off time has expired.

Freeze protection

DO NOT install the water heater in a room likely to freeze.

The following integral feature of the electronic control module provides some protection for the water heater.

- The electronic control module provides freeze-up protection as follows when the water heater water temperature drops below 45°F:
- Below 45°F, the internal pump operates constantly.
- Below 37°F, the burner turns on.
- The burner and pump will turn off if water heater water temperature rises above 45°F.

⚠ CAUTION This feature of the electronic 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 water heater.

Runtime and alarm outputs

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

Error logging

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

10 Operating information *(continued)*

Water heater temperature regulation

Operating temperature (target)

The electronic control module senses water temperature in the tank and regulates water heater ignition and firing rate to achieve a target temperature. The target temperature can be set between 60°F and 185°F.

High limit operations

The Shield water heater is equipped with a fixed automatic reset high limit and an adjustable manual reset high limit. The automatic reset high limit has a 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 water heater 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. Connect the water heater to 120V power.
2. Note the outlet temperature shown on the display.
3. Press and hold the ENTER and DOWN keys until “P01” appears in the lower digits on the display.
4. Press and hold the DOWN key until the set point shown in the upper digits is less than the outlet temperature (or it reaches its minimum setting, whichever is higher).
5. Press the ENTER key four (4) times. The word “SET” will appear on the display.
6. Once the outlet temperature reaches the new Manual Reset High Limit setting, the control will lock out, run the blower and DHW pump, and display “E15” in the lower digits on the display. It may be necessary to activate Service Mode to bring the outlet temperature above the Manual Reset High Limit set point. Press and hold the ENTER and UP keys for 5 seconds to activate Service Mode.
7. Press the ENTER and DOWN keys again until ‘P01” appears in the lower digits.
8. Press and hold the UP key to readjust the set point to the desired setting.
9. Press the ENTER key four (4) times. The word “SET” will appear on the display.
10. Press the RESET key to clear the Manual Reset High Limit.
11. If Service Mode was activated, press ENTER for 5 seconds to deactivate Service Mode.

Adjustable control parameters

Date and time

The control uses an internal clock for the night setback feature and for logging of events. For these features to work correctly, the clock must be set when the water heater is first installed or anytime the water heater has been powered off for more than 15 minutes. Note that hours are displayed as 24 hour time (2:00PM = 14:00). Days are displayed as a number (Monday = 1, Tuesday = 2, ..., Sunday = 7).

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

User adjustable parameters

To access the User Adjustable Parameter Menu, press and hold the ENTER button for five (5) seconds. Once pressed, the temperature unit’s adjustment will be shown. Press the ENTER button to cycle to other adjustment values. Once you have cycled through all of the values, the new values will be saved.

Table 10A *User Adjustable Parameters*

Code	Description
u01	Temperature Units (°C/°F)
u02	Hot Water Set Point
u03	Year
u04	Month
u05	Day
u06	Hour
u07	Minute

Installer settings

Set the Hot Water (HW) Temperature as follows:

1. Press and hold the ENTER button for five (5) seconds.
2. Press ENTER again and the u02 Screen should appear.
3. Press the UP and DOWN buttons to set the temperature.
4. Once you have successfully set the temperature, press the ENTER button seven (7) times to save your data.

10 Operating information

Table 10B *Temperature Parameter Settings*

Code	Description	Factory Default	Min	Max
p01	Manual Reset High Limit Set Point	210	32	210
p02	Night Setback Set Point	0	0	90
p03	Maximum Tank Set Point	125	32	190
p04	HW Pump Delay	0:30	0:00	0:40:00
--	HW Temp	125	60	185

Installer adjustable parameters

To access the Installer Adjustable Parameter Menu, press and hold the ENTER and DOWN buttons simultaneously for five (5) seconds. Once pressed, the temperature unit's adjustment will be shown. Press the OK button to cycle to other adjustment values. Once you have cycled through all of the values, the new values will be saved.

Table 10C *Installer Adjustable Parameters*

Code	Description
p01	Manual Reset High Limit
p02	Night Setback Offset
p03	Maximum Tank Set Point
p04	Pump Delay Time

Night setback

Access the Night Setback Menu by pressing the UP and DOWN buttons simultaneously for five (5) seconds.

This feature allows the user to lower the tank set point at certain times each week. The Night Setback Offset (see *Installer Adjustable Parameters*, this page) determines how much the set point is lowered. The times at which the set point is lowered are controlled by seven (7) start triggers and seven (7) stop triggers. Each trigger can be set to any time on any day. When the internal clock (see *User Adjustable Parameters*, page 55) reaches a start trigger, Night Setback will begin. When the internal clock reaches a stop trigger, Night Setback will end. When a start trigger and a stop trigger are programmed to the same day and time, the stop trigger will have priority, so Night Setback will not become active. (The default settings are all set to the same day and time.) Use the following procedure to adjust the triggers:

1. Press the UP and DOWN buttons simultaneously for five (5) seconds.
2. The top digits on the display will show the trigger type. To change from ON to OFF, or back, press the UP or DOWN button, then press the ENTER button.
3. The trigger number will then appear. Press the UP or DOWN buttons to change the trigger number you are programming, then press the ENTER button.
4. The day of the week (1 - 7) for that trigger will then appear in the lower digits on the display (1 = Monday, 2 = Tuesday, etc.,). Press the UP or DOWN buttons to change the day of the week, then press the ENTER button.
5. The time for that trigger then appears in a 24 hour format (for example, 2:00 PM = 1400), with the hours digits flashing. Use the UP and DOWN buttons to adjust the hours, then press the ENTER button.
6. The minutes digits will then start flashing. Press the UP and DOWN buttons to adjust the minutes. If you are finished programming all of the triggers, press and hold the ENTER key for 5 seconds. Otherwise, press the ENTER button once. The bottom digits will clear and the top digits will show ON or OFF again. Go back to Step 2 of this procedure.

Low water cutoff protection

The electronic control module uses sensing of both heat exchanger supply and return temperatures. If the flow rate is too low or either temperature too high, the control module modulates and shuts the burner down. This ensures water heater shutdown in the event of low water or low flow conditions in the heat exchanger.

To turn the heater ON/OFF

To turn the heater ON, press the UP button and hold it for five (5) seconds. To turn the heater OFF, press the UP button and hold again for five (5) seconds.

Service mode

To control the modulation of the heater for troubleshooting procedures, the Service Mode can be accessed by pressing the ENTER and UP buttons simultaneously, holding them for five (5) seconds. Once in the Service Mode, the UP and DOWN buttons control the speed of the blower. To toggle between the maximum and minimum speeds, press the ENTER button momentarily. When ready to return to the normal state, press the ENTER button for five (5) seconds. The control will also leave Service Mode in the event of a lockout.

Error logging

To access the error log, press the DOWN button for five (5) seconds. The error codes will be displayed beginning with the most recent. The top number indicating the error number starting with "1" being the most recent. The bottom of the display will show the following information in two (2) second intervals:

1. Error Code
2. Hour and Minute of the Error
3. Date of the Error
4. Year of the Error

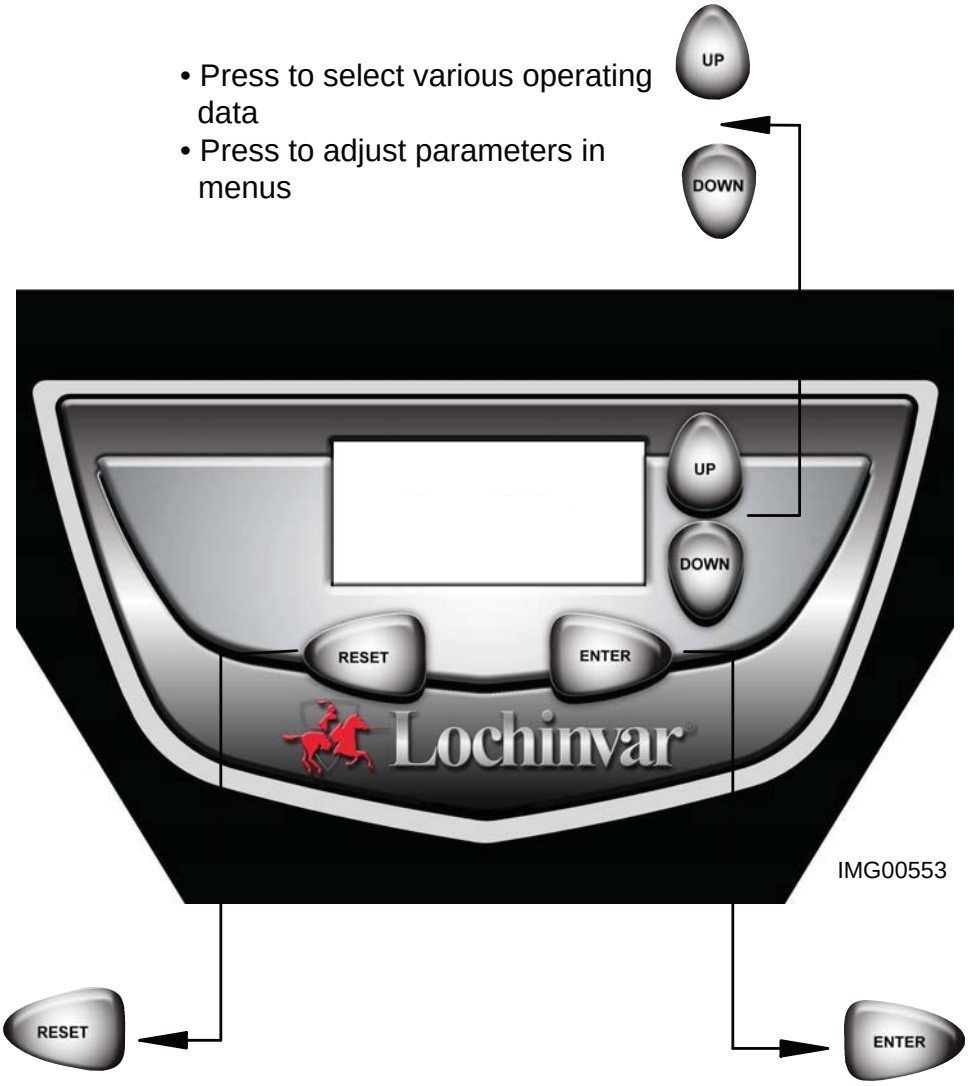
To view the next error press the UP button. To pause the information on the screen, press and hold the ENTER button, when released it will skip to the next value. To leave the Error Log Menu press and hold the DOWN button for five (5) seconds.

10 Operating information *(continued)*

Shield control module

Use the control panel (FIG. 10-1) to set temperatures, operating conditions, and monitor water heater operation.

Figure 10-1 *Control Panel*



11 Maintenance

Maintenance and annual startup

Table 11A *Service and Maintenance Schedules*

Service technician (see the following pages for instructions)		Owner maintenance	
ANNUAL START-UP	**General:** • Address reported problems • Inspect interior; clean and vacuum if necessary; • Clean condensate trap and fill with fresh water • Check for leaks (water, gas, flue, condensate) • Verify flue and air lines in good condition and sealed tight • Check system water pressure/system piping/expansion tank • Check control settings • Check ignition and flame sense electrodes (sand off any deposits; clean and reposition) • Check wiring and connections • Perform start-up checkout and performance verification per Section 9 in this manual. • Flame inspection (stable, uniform) • Flame signal (at least 10 microamps at high fire) • Clean the heat exchanger if flue temperature is more than 54°F above return water temperature. • Check anode rods. • Check Delta T (Temperature Rise) **If combustion or performance indicate need:** • Clean heat exchanger • Remove and clean burner using compressed air only • Clean the blower wheel	**Daily**	• Check water heater area
		Monthly	• Check vent piping • Check air piping • Check relief valve • Check condensate drain system • Check Delta T (Temperature Rise)
		Every 6 months	• Check water heater piping (gas and water) for leaks • Operate relief valve

11 Maintenance *(continued)*

⚠ WARNING Follow the service and maintenance procedures given throughout this manual and in component literature shipped with the water heater. Failure to perform the service and maintenance could result in damage to the water heater 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 water heater should be inspected annually only by a qualified service technician. In addition, the maintenance and care of the water heater designated in Table 11A and explained on the following pages must be performed to assure maximum water heater efficiency and reliability. Failure to service and maintain the water heater and system could result in equipment failure.

⚠ WARNING Electrical shock hazard – Turn off power to the water heater before any service operation on the water heater 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 water heater area

1. Verify that water heater 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 water heater intake air vicinity, they must be removed. If they cannot be removed, reinstall the air and vent lines per this manual.

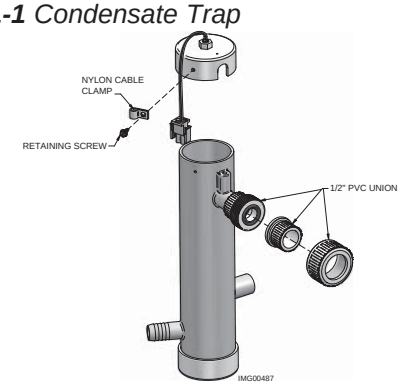
Inspect water heater interior

1. Remove the pump access panel and inspect the interior of the water heater.
2. Vacuum any sediment from inside the water heater 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. 11-1).
3. Remove the 2 inch PVC cap with the switch located at the top of the trap (FIG. 11-1).
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 11-1 *Condensate Trap*



⚠ WARNING The condensate trap must be filled with water during all times of water heater 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 water heater leaks. Leaking water may 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.

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 water heater 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).
3. Watch the system pressure as the water heater 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 push valve to flush vent. Replace caps. Make sure vents do not leak. Replace any leaking vents.

11 Maintenance

Check expansion tank

1. Expansion tanks provide space for water to move in and out as the water expands due to temperature increase or contracts as the water cools. Tanks must be approved for potable water systems. See Section 5 - System Piping for suggested best location of expansion tanks.

Check water heater 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 5 - System 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 water heater 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 water heater until a new relief valve has been installed.

2. After following the 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.

Inspect ignition and flame sense electrodes

1. Remove the ignition and flame sense electrodes from the water heater 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 water heater 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 water heater wiring

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

Check control settings

1. Set the control module display to Parameter Mode and check all settings. Adjust settings if necessary. See Section 10 of this manual for adjustment procedures.
2. Check settings of external limit controls (if any) and adjust if necessary.

Perform start-up and checks

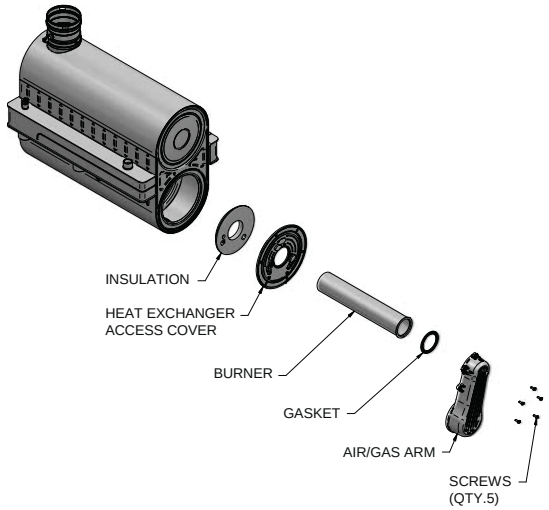
1. Start water heater and perform checks and tests specified in Section 9 - Start-up.
2. Verify cold fill pressure is correct and that operating pressure does not go too high.

11 Maintenance *(continued)*

Check burner flame

1. Inspect flame through observation window.
2. If the flame is unsatisfactory at either high fire or low fire, turn off water heater and allow water heater 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. 11-2 below.
4. When replacing the burner, ensure gasket is in good condition and positioned correctly (FIG. 11-2).

Figure 11-2 *Burner Assembly*



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 12 - Troubleshooting for other procedures to deal with low flame signal.

Review with owner

1. Emphasize the need to perform the maintenance schedule specified in this manual.
2. Remind the owner of the need to call a licensed contractor should the water heater or system exhibit any unusual behavior.

Handling ceramic fiber materials

REMOVAL OF COMBUSTION CHAMBER LINING

⚠ WARNING The combustion chamber insulation in this appliance contains ceramic fiber material. Ceramic fibers can be converted to cristobalite in very high temperature applications. The International Agency for Research on Cancer (IARC) has concluded, “Crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group 1).” Normal operating temperatures in this appliance are below the level to convert ceramic fibers to cristobalite. Abnormal operating conditions would have to be created to convert the ceramic fibers in this appliance to cristobalite.

The ceramic fiber material used in this appliance is an irritant; when handling or replacing the ceramic materials it is advisable that the installer follow these safety guidelines.

- Avoid breathing dust and contact with skin and eyes.
  - Use NIOSH certified dust respirator (N95). This type of respirator is based on the OSHA requirements for cristobalite at the time this document was written. Other types of respirators may be needed depending on the job site conditions. Current NIOSH recommendations can be found on the NIOSH website at http://www.cdc.gov/niosh/homepage.html. NIOSH approved respirators, manufacturers, and phone numbers are also listed on this website.
  - Wear long-sleeved, loose fitting clothing, gloves, and eye protection.
- Apply enough water to the combustion chamber lining to prevent airborne dust.
- Remove the combustion chamber lining from the appliance and place it in a plastic bag for disposal.
- Wash potentially contaminated clothes separately from other clothing. Rinse clothes washer thoroughly.

NIOSH stated First Aid.

- Eye: Irrigate immediately.
- Breathing: Fresh air.

Cleaning heat exchanger

For recommended materials; including brush, appropriate extension(s), refractory cover, and detailed instructions see Table 11B - Heat Exchanger Cleaning Kits on page 62.

1. Shut down water heater:
   - Follow the “To Turn Off Gas to Appliance” instructions for the water heater in Section 9 - Startup.
   - Do not drain the water heater unless it will be exposed to freezing temperatures. If using freeze prevention fluid in system, do not drain.
2. Allow time for the water heater to cool to room temperature if it has been firing.

11 Maintenance

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 water heater contains ceramic fiber materials. Use care when handling these materials per instructions in this manual. Failure to comply could result in severe personal injury.

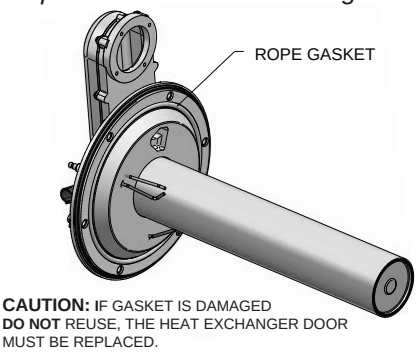
5. Remove the condensate hose from the heat exchanger end. Connect a field supplied 3/4" diameter hose to a drain pan. Using field supplied means, cover the refractory in the back of the combustion chamber of the heat exchanger.
6. Use a vacuum cleaner to remove any accumulation on the water heater heating 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 water heater from system. Attach a hose to the water heater drain and flush water heater thoroughly with clean water by using purging valves to allow water to flow through the water make-up line to the water heater.
12. Perform start-up and check-out procedures in the Check Flame and Combustion - Section 9 - Startup on page 51 of this manual.
13. Replace the access cover and restore water heater to operation.

Table 11B *Heat Exchanger Cleaning Kits*

Model	Kit Number	Part Number	Component Description
126-065 -- 201-100 286-125 -- 401-125	100157627	100140243	Rear Refractory Cover
		100162565*	Nylon 4" Wheel Brush*
		100162566	3mm Allen Wrench
		100162568	1/4" x 24" Drill Extension
501-125	100157628	100140243	Rear Refractory Cover
		100162565*	Nylon 4" Wheel Brush*
		100162567	1/4" x 12" Drill Extension
		100162568	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 11-3 *Rope Gasket - Heat Exchanger Door*



NOTICE Rope gasket is intended for sealing combustion (FIG. 11-3). If damaged DO NOT reuse, the heat exchanger door must be replaced. Consult factory for replacement heat exchanger door (kit 100173749).

Oiled bearing circulators

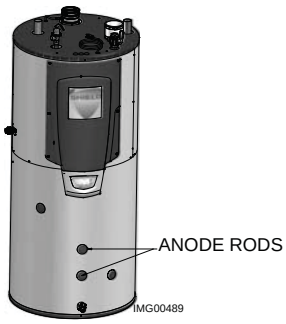
1. The circulator shipped with the Shield water heater is water-lubricated. No oiling is required.
2. Check other circulators in the system. Oil any circulators requiring oil, following circulator manufacturer's instructions. Over-oiling will damage the circulator.

Magnesium anode rod inspection

Glass lined storage tanks have a magnesium anode(s) (FIG. 11-4) to provide cathodical protection of the lining and minimize corrosion. Aggressive water conditions in some areas of the country may accelerate the deterioration of the anode(s). The anode(s) should be periodically removed and inspected to determine if replacement is necessary.

The heater must be valved off from the system and fully drained to remove an anode for inspection. Anodes are supplied in threaded fittings on the side of the tank. Adequate service clearance is required to allow removal of an anode. The anode(s) should be replaced when more than six inches of the core wire is exposed at either end of the rod.

Figure 11-4 *Anode Location*



NOTICE Anode rods showing excessive decomposition may indicate electrolysis. An earth ground should be attached to the vessel to divert stray current and prevent tank damage.

12 Troubleshooting

⚠ WARNING Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Always disconnect power to the water heater before servicing. Failure to comply could result in severe personal injury, death, or substantial property damage.

⚠ WARNING Never jumper (bypass) any device except for momentary testing as outlined in the Troubleshooting chart. Severe personal injury, death, or substantial property damage can result.

Before troubleshooting:

1. Have the following items:
   a. Voltmeter that can check 120 VAC, 24 VAC, and 12 VDC.
   b. Continuity checker.
   c. Contact thermometer.

2. Check for 120 VAC (minimum 102 VAC to maximum 132 VAC) to water heater.

3. Make sure the tank is calling for heat.

4. Make sure all external limit controls are installed and operating.

Check the following:

1. Wire connectors to control module and connection board are securely plugged in.

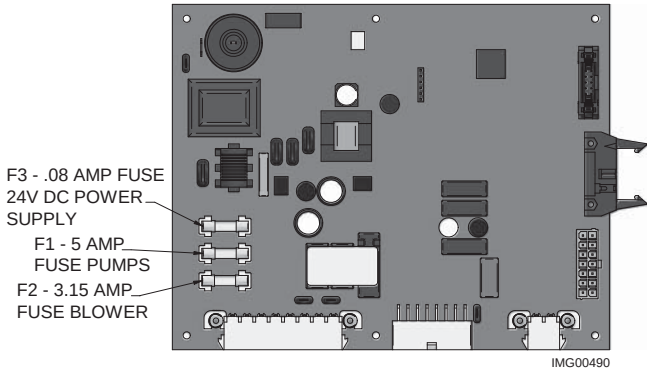
2. Gas pressures:
   - Maximum: 14 inches w.c. (natural and LP) with no flow (lockup) or with water heater on
   - Minimum: 4 inches w.c. (natural), 8 inches w.c. (LP) with gas flowing (verify during water heater startup)

Check control module fuses

NOTICE ALWAYS check control module fuses before replacing control module or any major components (blower, etc.). If one of these fuses is blown, it can prevent the control module or other components from operating.

1. Turn OFF power to the water heater at the external disconnect switch.
2. Remove front access cover.
3. Remove the control module cover.
4. Inspect fuses F2, F3, F4, and F5, see FIG. 12-1 below.

Figure 12-1 *Control Module Fuses*



5. The water heater is shipped with three (3) spare fuses in a plastic bag attached to the control module cover.

6. If necessary, replace open fuse (F3 is 1.25 amps, F2 and F4 are 3.15 amps, and F5 is 5 amps).

Note: Fuses F2 - F5 are all slow blow fuses.

⚠ WARNING Do not jumper fuse or replace with any fuse except as specified. Failure to comply could result in severe personal injury, death, or substantial property damage.

7. Install control module cover and front access cover after fuse inspection.

8. Restore power to the water heater at the external disconnect switch and verify water heater operation (Section 9 - Start-up) after completing water heater service.

12 Troubleshooting

Table 12A *Troubleshooting Chart - No Display*

FAULT	CAUSE	CORRECTIVE ACTION
No Display	- No 120 VAC supplied to unit.	• Check external line switch, fuse, or breaker. • Check wiring harness connection between display board and main control board. Connect harness at both points.
	- Bad display board.	• Replace board.
	- Bad main control board.	• Replace the main control board.
	- Blown fuse.	• Replace fuse F3 on the main control board, see page 63 of this manual.
No Burner Operation	- Tank temperature set point satisfied.	• Review temperature setting.
	- Unit locked out on fault.	• Consult display for specific fault. Refer to fault descriptions on page 67 of this manual for corrective actions.
Unit Does Not Modulate Above 50%	- Flue sensor open.	• Verify that the flue sensor is located in the flue outlet.
		• Check wiring connections at the flue sensor.
		• Check the resistance of the flue sensor and compare to Table 12C on page 65 of this manual.

12 Troubleshooting *(continued)*

Checking temperature sensors

The water heater temperature sensors (inlet water, outlet water, tank water, and flue) are all resistance type devices. The following tables show the correct values for the sensors at various temperatures. Use an ohmmeter to read the resistance of the sensor at a known temperature. If the resistance of the sensor does not closely match its corresponding table, replace the sensor.

Table 12B - *Inlet/Outlet Tank Sensor Resistance vs. Temperature*

Temperature °F	Resistance Ω	Temperature °F	Resistance Ω
50	18,780	158	1,990
68	12,263	176	1,458
86	8,194	194	1,084
104	5,592	212	817
122	3,893	--	--
140	2,760	--	--

Table 12C - *Flue Temperature Sensor Resistance vs. Temperature*

Temperature °F	Resistance Ω	Temperature °F	Resistance Ω
68	14,773	176	1,707
86	9,804	194	1,266
104	6,652	212	952
122	4,607	230	726
140	3,252	248	560
158	2,337	--	--

12 Troubleshooting

Table 12D *Troubleshooting Chart - Noisy System*

FAULT	CAUSE	CORRECTIVE ACTION
Noisy Operation	- Supply gas problem. Natural gas pressures should be between 4 inches w.c. and 14 inches w.c. LP gas pressures should be between 8 inches w.c. and 14 inches w.c.	• Refer to Section 6 - Gas Connections for detailed information concerning the gas supply.
	- Gas/air mixture problem.	• Refer to the Gas Valve Adjustment Procedure on page 74 of this manual for the proper gas valve setting. Verify that the vent/air intake lengths do not exceed the maximum listed in the General Venting section.
	- Dirty/damaged burner.	• Refer to page 62 in this manual for the burner removal and inspection procedure. Clean or replace the burner as necessary.
	- Low water flow through the heat exchanger.	• Very pump operation.
	- Air in the piping system.	• Properly purge all air from the piping system.
No Pump Operation	- Blown fuse.	• Replace fuse F5 on the control board, see page 63 of this manual.
	- Faulty pump.	• Replace pump.
	- Faulty pump relay.	• Replace pump relay.
	- Internal fault on control board.	• Replace main control board.
Relief Valve Opening	- System pressure exceeds relief valve setting.	• Lower the system pressure below the 150 PSI rating of the supplied relief valve.

12 Troubleshooting *(continued)*

Table 12E *Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

ERROR CODE	DESCRIPTION	CORRECTIVE ACTION
E00	Invalid lockout code.	• Reset control module. • Switch power OFF and ON. • Replace control module.
E01	The control module has detected parameter settings that are corrupted.	• Replace control module.
E02 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The actual fan RPM is more than 30% above or below the fan speed RPM target.	• Vent/air intake lengths exceed the maximum allowed lengths. Refer to Section 2 - General Venting for proper lengths. • Check for obstruction or blockage in the vent/air intake pipes or at terminations. • Check the wiring connections at the fan and at the main control board. • Replace the fan. • Replace the main control board.
	Blown fuse.	• Replace fuse F2 on the control board, see page 63 of this manual.
E04 (will require a manual reset once condition has been corrected. Press the RESET button on the display to reset.)	Either the optional flow switch or the optional low water cutoff is not making.	• Check pump operation on a call for heat. • Check for closed valves or obstructions in the piping. • Verify system is full of water and all air has been purged from the system. • Check for loose or misplaced jumpers if flow switch or LWCO is not installed.
	Blown fuse.	• Replace fuse F3 on the control board, see page 63 of this manual.
E05 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The flame detector circuit is seeing a flame signal when the gas valve is closed.	• Verify flame is not present. If present, turn off gas supply and replace gas valve. • Check supply voltage for proper polarity. • Check external wiring for voltage feedback. • Check the flame rod and make sure it is clean. • Check the internal wiring for bad connections. • Replace main control board.

12 Troubleshooting

***Table 12E** (continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

ERROR CODE	DESCRIPTION	CORRECTIVE ACTION
E06	The outlet water temperature has exceeded the setting of the automatic reset high limit.	• Adjust the set point of the auto reset limit to a higher setting up to a maximum of 200°F. Reference Section 10 - Operating Information for adjusting procedures. • Verify that the system is full of water and that all air has been properly purged from the system. • Verify that the boiler is piped properly into the heating system. Refer to Section 5 - System Piping for the proper piping methods for the Shield water heater. • Check 120 vac to boiler pump motor on a call for heat. If voltage is not present, check wiring back to the main control board. • Replace the main control board if necessary. • If 120 vac is present on a call for heat and the pump is not operating, replace the pump. • If operating on something other than an outlet sensor, check temperature setting of the main control board. • If the optional manual reset high limit has tripped, check setting of the device. • Check resistance of water sensors and compare to Table 12B on page 65 of this manual. Replace sensor if necessary.
E07 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	Either the air pressure switch, the O-temp heat exchanger switch, or the burner door temperature switch has opened. **⚠ WARNING** If the burner door temperature switch trips, the burner door and the burner door temperature switch will be extremely HOT. Allow the unit to cool before touching. Failure to follow this warning could result in severe personal injury, death, or substantial property damage.	**AIR PRESSURE SWITCH** • Check the wiring connections to switch. Wires should be connected to the common and normally closed terminals. • Air intake lengths exceed the maximum allowed lengths. Refer to Section 2 - General Venting for proper lengths. • Check for obstruction or blockage in the air intake pipes or at terminations. • Check reference hoses connected to the air pressure switch for blockage or obstruction. • Inspect the burner. Reference page 61 of this manual for removal and cleaning procedures. Replace if necessary. • Inspect the heat exchanger. Reference page 61 of this manual for removal and cleaning procedures. • Faulty air pressure switch. Replace switch. **O-TEMP HEX SWITCH (Applies to the 286 Model Only):** • Check the wiring connections to the fuse on the heat exchanger. • Check continuity across the thermal fuse. If open, replace heat exchanger. **BURNER DOOR TEMPERATURE SWITCH (Applies to the 286-125 -- 501-125 Models Only):** • The underlying cause of the fault must be identified and resolved by a qualified service technician before resetting the burner door temperature switch. • Check continuity across two contacts. Wires should be connected at both poles of the normally closed switch. • Faulty burner door temperature switch. Replace burner door temperature switch.

12 Troubleshooting *(continued)*

Table 12E *(continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

ERROR CODE	DESCRIPTION	CORRECTIVE ACTION
E08	Louver proving switch open.	• Check wiring to louver proving switch. • Check louver proving switch.
E09	The blocked drain switch has detected excessive condensate build up inside the unit.	• Check condensate tube from unit to floor drain for proper installation and obstructions. • Inspect condensate trap for blockage. Clean if necessary. • Check for loose wiring connection at wire harness plug. • Bad blocked drain switch. Replace switch.
E11 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The unit has lost flame signal four (4) times during a call for heat.	• Inspect spark electrode and associated wiring for damage and connection. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Check for proper electrical grounding of the unit. • Check incoming supply gas pressure. Natural gas pressures should be between 4 - 14 inches w.c. and LP gas pressures should be between 8 - 14 inches w.c. Refer to Section 6 - Gas Connections for detailed information concerning the gas supply. • Verify that the plastic hose from the gas valve to the air inlet is connected and is not damaged. • Verify that the vent/air intake pipes are correctly installed and that there are no obstructions. • Check for 24 vac to the gas valve at the 2-pin connection on the side of the main control board during the ignition attempt. If no voltage is present, replace the main control board. • If 24 vac is present at the main control board, check the wiring between the main control board and the gas valve. Replace the wiring if necessary. Do not disconnect the wiring from the gas valve and attempt to measure voltage at that point. The main control board can detect if the gas valve is not connected and will display the Gas Valve or Gas Valve Fail fault. • If 24 vac is present, check the outlet of the valve to ensure the valve is flowing gas. With a manometer connected to the outlet tap of the gas valve, when the unit is in the prepurge period, there should be a negative pressure present. When the valve is energized a change in pressure should occur. If the pressure change does not occur, the gas valve is not opening. Replace the gas valve. • Inspect flame sensor and associated wiring. Reference page 60 of this manual for removal and cleaning procedures. Replace if necessary. • Inspect and clean the heat exchanger as necessary. Reference page 61 of this manual for cleaning procedures. • Inspect the burner. Reference page 61 of this manual for removal and cleaning procedures. Replace if necessary. • Replace the main control board.
E12 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The unit has failed to prove main burner ignition after four (4) attempts.	
n05	The fan speed is being increased due to the flame current going below 5 microamps.	

12 Troubleshooting

Table 12E *(continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

ERROR CODE	DESCRIPTION	CORRECTIVE ACTION
E13	The flue temperature has exceeded 250°F.	• Inspect the heat exchanger. Reference page 61 of this manual for the procedure on how to clean the flue side of the heat exchanger. • Inspect the flue sensor and associated wiring. Measure the resistance of the flue sensor and compare to Table 12C on page 65 of this manual. Replace the sensor if necessary. • Verify that the vent/air intake pipes are properly installed and that there are no obstructions. • Replace the main control board.
b05	The flue temperature has exceeded 240°F.	
n04	The fan speed is being limited due to the flue temperature exceeding 215°F.	
E15 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The outlet water temperature has exceeded the 210°F manual reset high limit (MRHL) setting.	• Verify that the system is full of water and that all air has been properly purged from the system. • Verify that the boiler is piped properly into the heating system. Refer to Section 5 - System Piping for the proper piping methods for the Shield water heater. • Check 120 vac to pump motor on a call for heat. If voltage is not present, check wiring back to the main control board. • Replace the main control board if necessary. • If 120 vac is present on a call for heat and the boiler pump is not operating, replace the pump. • If operating on something other than an outlet sensor, check temperature setting of the main control board. • Check resistance of water sensors and compare to Table 12B on page 65 of this manual. Replace sensor if necessary.
b03	The outlet water temperature has exceeded 195°F.	
n02	The fan speed is being limited due to the outlet temperature exceeding 185°F.	
E18 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The control module reads an excessive temperature difference between the two outlet sensors.	• Check wiring to sensor. Make sure wiring is connected and not damaged. Reconnect / repair wiring if necessary. • Measure the resistance of the sensor and compare to the resistance in Table 12B on page 65 of this manual. Replace sensor if necessary. • Replace control module.
E19 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	One or both of the flue sensors is open or shorted.	• Inspect the flue sensor and associated wiring. Measure the resistance of the flue sensor and compare to Table 12C on page 65 of this manual. Replace the sensor if necessary. • Replace the main control board.

12 Troubleshooting *(continued)*

***Table 12E** (continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

ERROR CODE	DESCRIPTION	CORRECTIVE ACTION
E21 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	One or both of the outlet sensors has opened or shorted.	• Check the sensor and its associated wiring. Repair or replace the sensor or wiring if damaged. • Measure the resistances of the sensors and compare the resistances to the tables on page 65. Replace if necessary.
E22 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The inlet sensor is open.	• Check the sensor and its associated wiring. Repair or replace the sensor or wiring if damaged.
E23 (will require a manual reset once the condition has been corrected. Press the RESET button on the display to reset.)	The inlet sensor is shorted.	
b01	The temperature has reached the set point + 4°F.	• None
b02	The main control board has received a call for heat too quickly after the previous call for heat has ended.	• The control board will release the call for heat after 60 seconds. • The control board will release the call for heat if the outlet temperature drops 10°F.
b04	The temperature rise across the heat exchanger has exceeded 30°F.	• Verify that the system is full of water and that all air has been properly purged from the system. • Check for 120 vac to the pump motor on a call for heat. If voltage is not present, check the wiring on the pump relay back to the main control board. Replace the main control board if necessary. • If 120 vac is present on a call for heat and the pump is not operating, replace the pump. • Scale accumulation in the heat exchanger. Verify that the water chemistry meets the requirements listed in Section 5 - System Piping.
n03	The fan speed is being limited due to the temperature rise across the heat exchanger exceeding 25°F.	

12 Troubleshooting

Table 12E *(continued from previous page) Troubleshooting Chart - Fault Messages Displayed on Water Heater Interface*

ERROR CODE	DESCRIPTION	CORRECTIVE ACTION
b06	120 vac input to the main control board has dropped below 80 vac.	• Check 120 vac supply to the transformer. • Check wiring connections at the low voltage terminal strip. • Check the wire size/length to remote devices. • Replace the transformer. • Check 24V.
n01	The flue temperature did not change after the burner started firing.	• Verify that the flue sensor is installed. • Check the sensor and its associated wiring. Repair or replace the sensor or wiring if damaged.
n06	Tank sensor is not connected.	• Check the tank sensor and its associated wiring. Repair or replace as needed.
n07	The inlet sensor has been disconnected.	• Check the sensors and their associated wiring. Repair or replace the sensor or wiring if damaged. • Measure the resistance of the sensors and compare the resistance to the tables on page 65 of this manual. • Replace the sensor if necessary.
n08	The inlet sensor has been shorted.	• Check the sensors and their associated wiring. Repair or replace the sensor or wiring if damaged. • Measure the resistance of the sensors and compare the resistance to the tables on page 65 of this manual. • Replace the sensor if necessary.

12 Troubleshooting *(continued)*

Combustion Analysis Procedure

1. Shut the water heater down by pressing the UP button for five (5) seconds.
2. Locate the flue sensor in the vent connection. Remove the flue sensor and grommet from the unit. **Note:** Combustion measurements will be made at this point.
3. Place the water heater in active position by pressing the UP button for five (5) seconds.
4. Press ENTER plus the UP button for five (5) seconds to enter Service Mode.
5. Insert the probe from a combustion analyzer into the hole left by the removal of the flue temperature sensor.
6. Once the water heater has modulated up to full fire, measure the combustion. The values should be in the range listed in Table 12F. 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 this manual for possible causes and corrective actions.
7. Once the combustion analysis is complete, exit Service Mode.
8. Replace the flue sensor and grommet into the vent connection.
9. Place the Shield water heater back into normal operation.

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

Table 12F *Flue Products*

Natural Gas		Propane	
CO_2	O_2	CO_2	O_2
8.0% - 10%	3.0% - 6.5%	9.0% - 11%	4.1% - 6.9%

Table 12G *Troubleshooting Chart - Combustion Levels*

POSSIBLE CAUSE	CORRECTIVE ACTION
Vent/Air Intake Length or Obstruction	• Refer to Section 2 - General Venting for the proper venting and air intake methods for the Shield water heater. • Check for obstructions at the vent/air intake terminals.
Gas Supply Pressure	• Refer to Section 7 - Gas Connections for the proper gas supply for the Shield water heater.
Dirty/Damaged Burner	• Refer to page 61 of this manual for burner removal and cleaning procedures. • Replace burner if necessary.
Gas Valve Adjustment	• Refer to page 74 of this manual for the gas valve adjustment procedure.

12 Troubleshooting

Gas valve adjustment procedure

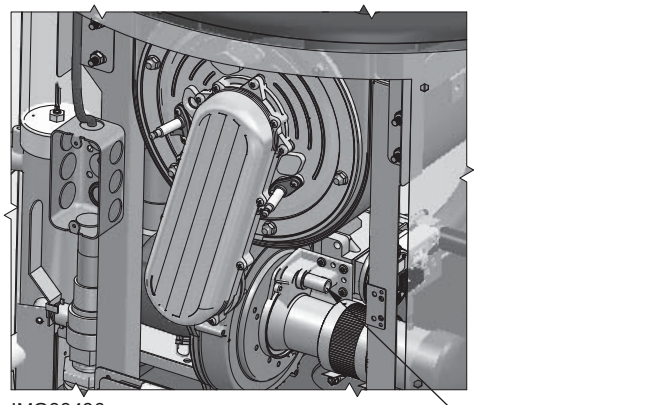
If adjustment of the gas valve is deemed necessary, use the following procedures: (**Note:** The procedures below are model specific.)

Models 126-065 -- 286-125

Locate the throttle adjustment screw on the side of the venturi valve (FIG. 12-2). Using a screwdriver, turn the screw a 1/4 turn **clockwise** to decrease CO_2 levels or a 1/4 turn **counterclockwise** to increase CO_2 levels. After performing one adjustment on the valve, follow the Combustion Analysis Procedure on page 73 of this manual to measure the combustion.

If combustion is still not within the specified range, repeat the procedure. This procedure SHOULD NOT be performed more than four (4) times. If after four (4) adjustments and the combustion is still not within the specified range, revisit the possible causes in Table 12G on page 73 or replace the gas valve.

Figure 12-2 *Gas Valve Adjustment: Models 126-065 -- 286-125*

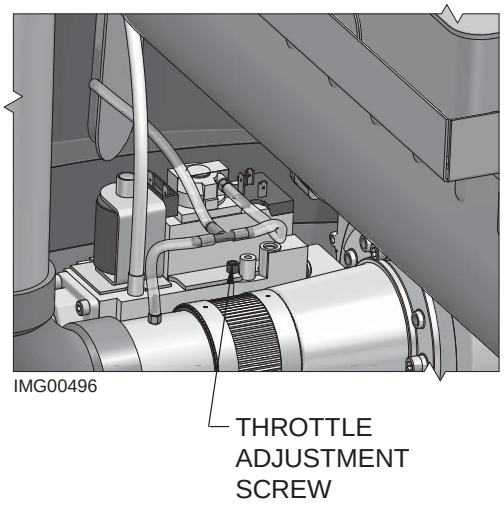


Model 401-125

Locate the throttle adjustment screw on the top of the gas valve, see FIG. 12-3. Using a screwdriver, turn the screw 1/8 turn **counterclockwise** to increase CO_2 levels or 1/8 turn **clockwise** to decrease CO_2 levels. After one adjustment on the valve, follow the Combustion Analysis Procedure on page 73 of this manual to measure the combustion.

If combustion is still not within the specified range, repeat the procedure. This procedure SHOULD NOT be performed more than four (4) times. If after four (4) adjustments and the combustion is still not within the specified range, revisit the possible causes in Table 12G on page 73 or replace the gas valve.

Figure 12-3 *Gas Valve Adjustment: Model 401-125*

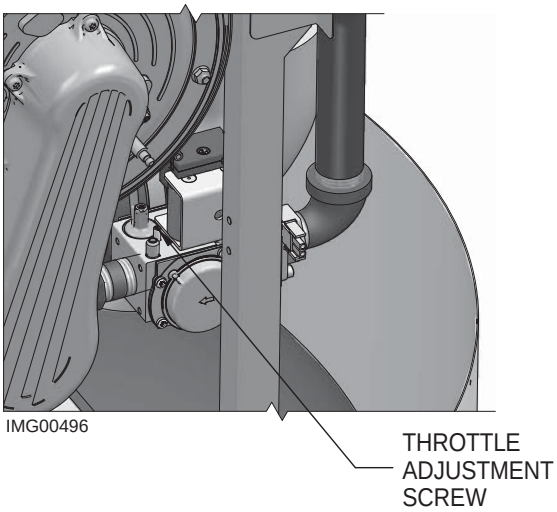


Model 501-125

Locate the throttle adjustment screw on top of the gas valve, see FIG. 12-4. Using a screwdriver, turn the screw a 1/4 turn **counterclockwise** to increase CO_2 levels or a 1/4 turn **clockwise** to decrease CO_2 levels. After one adjustment on the valve, follow the Combustion Analysis Procedure on page 73 of this manual to measure the combustion.

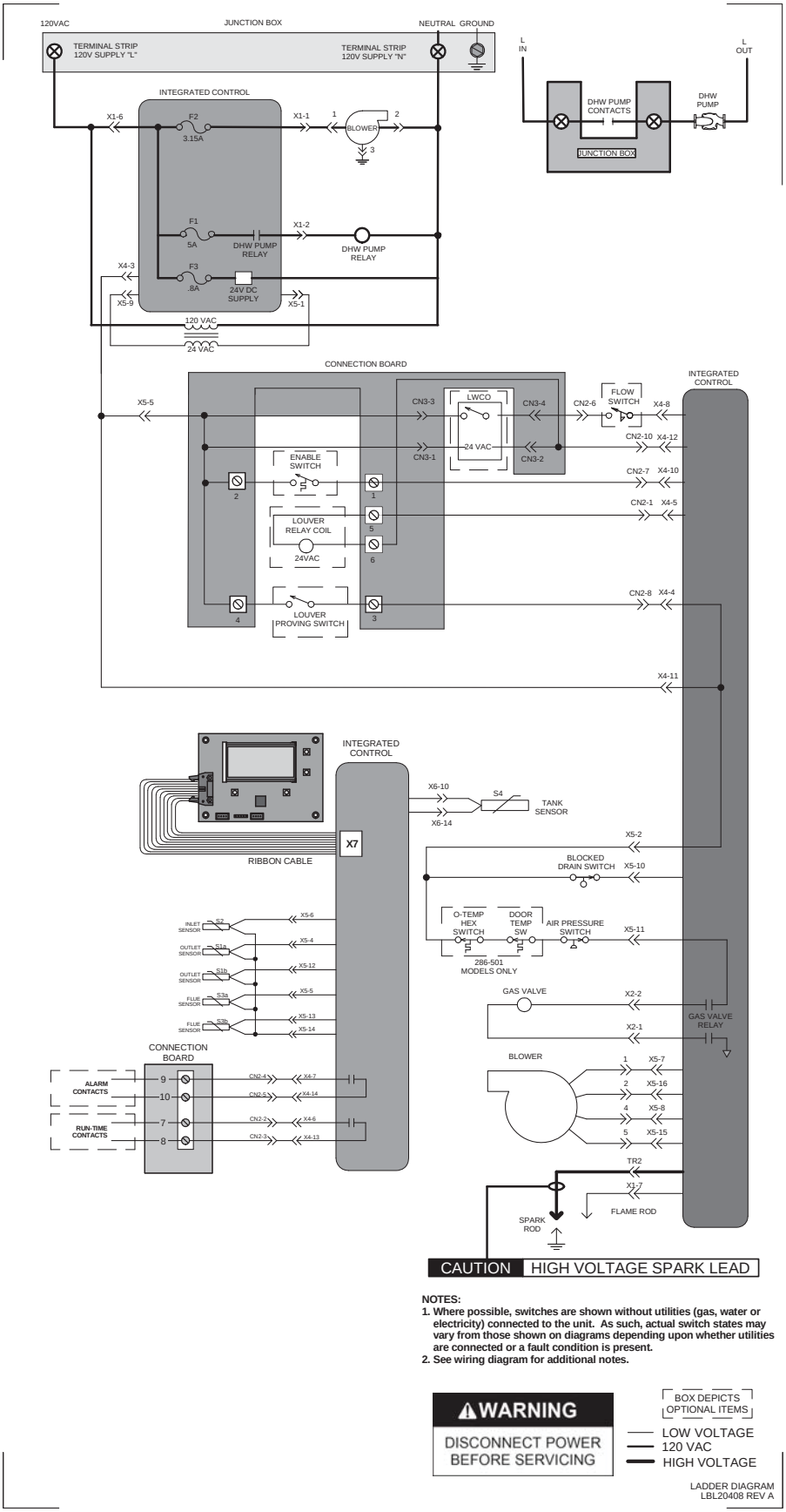
If combustion is still not within the specified range, repeat the procedure. This procedure SHOULD NOT be performed more than four (4) times. If after four (4) adjustments and the combustion is still not within the specified range, revisit the possible causes in Table 12G on page 73 or replace the gas valve.

Figure 12-4 *Gas Valve Adjustment: Model 501-125*



13 Diagrams

Figure 13-1 *Ladder Diagram*



NOTES:

1. **Where possible, switches are shown without utilities (gas, water or electricity) connected to the unit. As such, actual switch states may vary from those shown on diagrams depending upon whether utilities are connected or a fault condition is present.**
2. **See wiring diagram for additional notes.**

⚠WARNING

DISCONNECT POWER BEFORE SERVICING

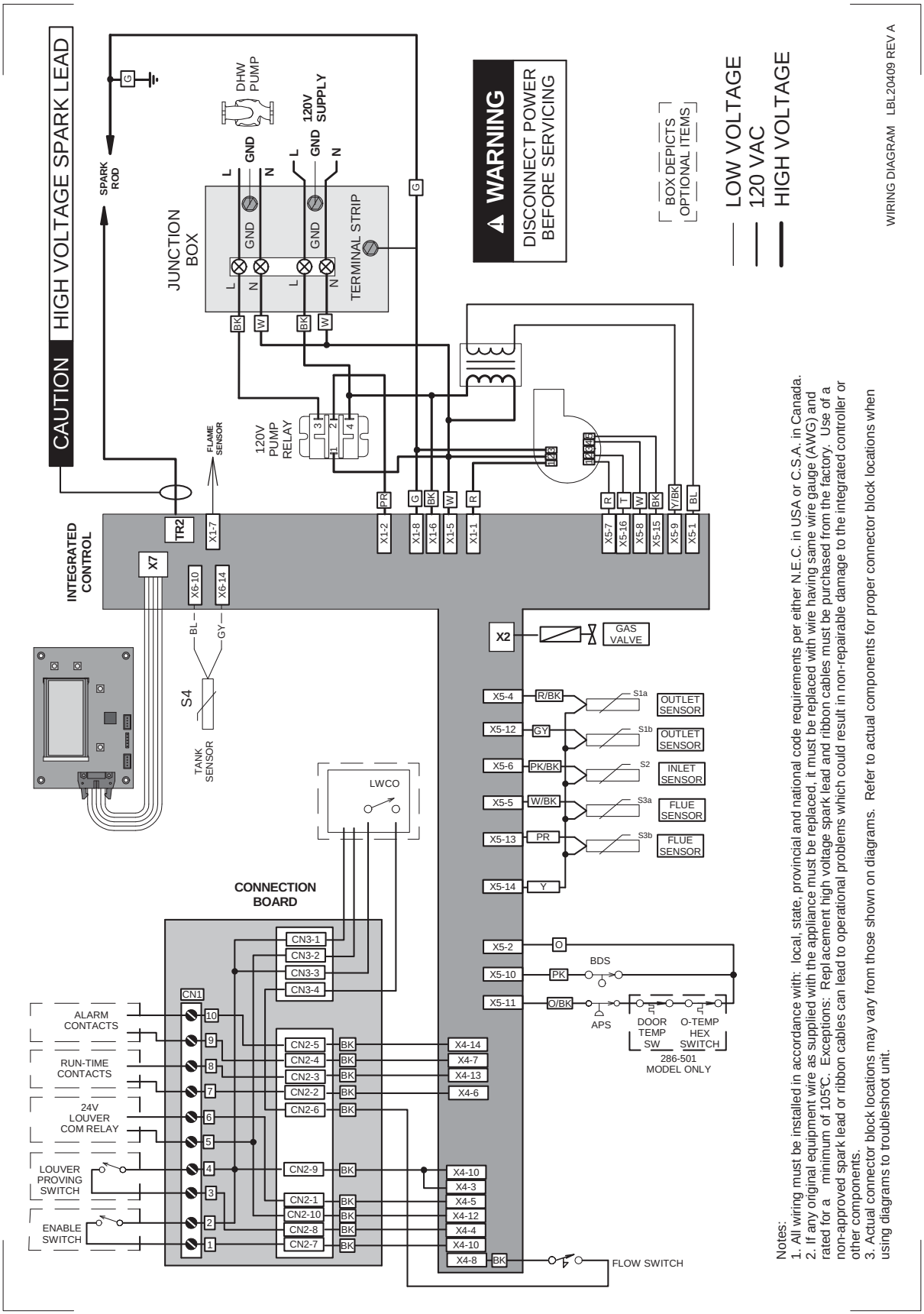
BOX DEPICTS OPTIONAL ITEMS

LOW VOLTAGE
120 VAC
HIGH VOLTAGE

LADDER DIAGRAM
LBL20408 REV A

13 Diagrams

Figure 13-2 *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.

Notes

Notes

Notes

Revision Notes: *Revision A (ECO #C12258) initial release.*

Revision B (ECO #C12665) reflects the addition of the CSA Low Lead Content logo.

Revision C (ECO #C11814) reflects the addition of Metal Fab and Security Chimney to the manual.

Revision D (ECO #C13833) reflects the removal of the page number reference on page 15, the addition of the corrosive contaminant warning on page 3 (R06313), changes made to Table 6A - Gas Piping Chart on page 41 (R6621), the addition of the Temperature Parameter Setting Table and HW Temperature Setting instructions on pages 52 and 53 (R6658), edits made to the callouts on page 5 (R06493), along with updating the flex piping information (R06464) on page 21.

Revision E (ECO #C14411) reflects a note that the SNA286-125 model can be vented using 3" diameter pipe up to a maximum of 60 equivalent feet, pages 7 and 17, along with changing out LBL20026 and LBL20025 (R6979).

Revision F (ECO #C14713) reflects high altitude updates.

Revision G (ECO #C14988) reflects the correction of FIG. 2-2 on page 15.

Revision H (ECO #C15251) reflects the addition of the burner door temperature switch updates (R6322).

Revision I (ECO C16918) reflects the update of ratings information on page 7 (R07744), FIG. 3-13 description on page 29 (R07478), water chemistry information on page 35 (R07142), and water column information on page 40.

Revision K (Change #500000930) reflects edits made to FIG 4-7 on page 33.

Revision L (PCP# 3000001537 / CN# 500001784) reflects the addition of a note that the starter is factory installed on the 126-201 models under General Venting on page 20.

Revision M (PCP# 3000000426 / CN# 500000623) reflects the addition of combustion clearance dimensions in FIG.'s 1-1 and 1-2 on page 9.

Revision N (PCP# 3000004287 / CN# 500004864) reflects a change to the numbers of the Polypropylene Adapters in Table 2F on page 21. Figure 2-9 has also been updated.

Revision P (PCP# 3000005143 / CN# 500006666) reflects the addition of new venting category information on pages 25 through 27.

Revision R (PCP# 3000004438 / CN# 500005574) reflects an update to the flue temperatures on page 54.

Revision T (PCP# 3000006133 / CN# 500007549) reflects the addition of a PVC-DWV vent fitting in Table 2D on page 20.

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