



## Installation & Operation Manual

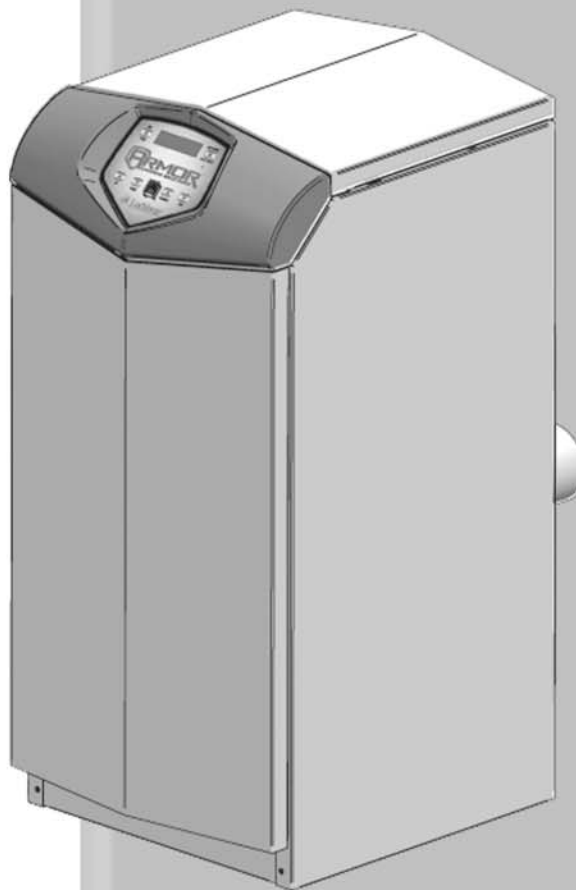
Models: 150 - 800

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

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

### -- WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a near by phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.
- Installation and service must be performed by a qualified installer, service agency, or the gas supplier.



**Lochinvar**<sup>®</sup>  
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, including this manual and the Armor Water Heater Service 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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## Hazard definitions

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

### **⚠ DANGER**

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

### **⚠ WARNING**

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

### **⚠ CAUTION**

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

### **CAUTION**

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

### **NOTICE**

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

## Please read before proceeding

### ⚠ WARNING

**Installer** – Read all instructions, including this manual and the Armor Water Heater Service 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.

### ⚠ WARNING

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

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

#### -- WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a near by phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.
- Installation and service must be performed by a qualified installer, service agency, or the gas supplier.

### When servicing 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.

### Water heater operation –

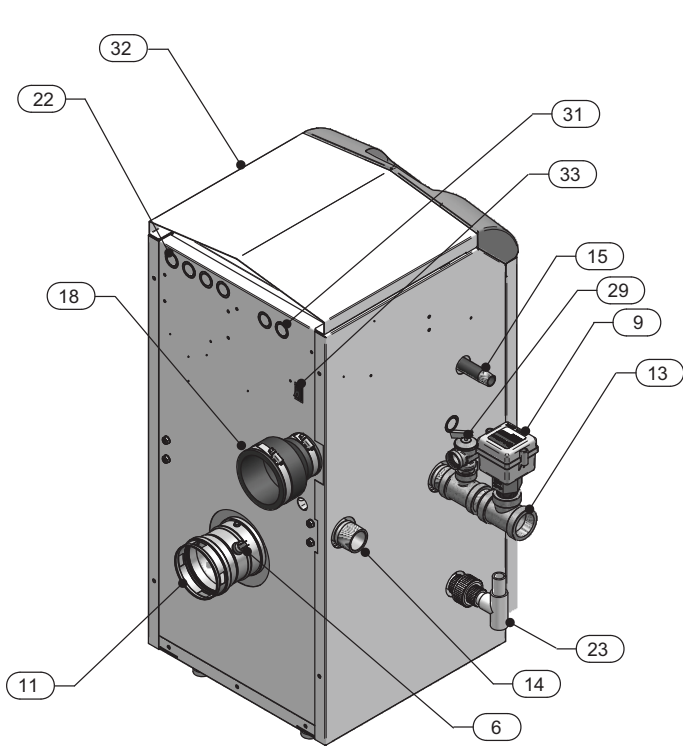
- Do not block flow of combustion or ventilation air to the water heater.
- Should overheating occur or gas supply fail to shut off, do not turn off or disconnect electrical supply to circulator. Instead, shut off the gas supply at a location external to the appliance.
- Do not use this water heater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

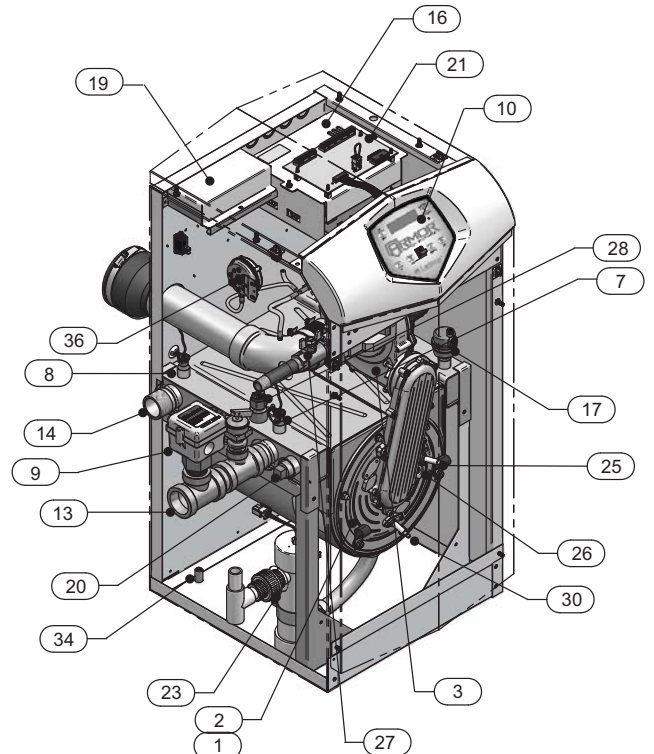
- 1. Stainless steel heat exchanger**  
Allows water to flow through specially designed coils for maximum heat transfer, while providing protection against flue gas corrosion. The coils are encased in a jacket that contains the combustion process.
- 2. Heat exchanger access cover**  
Allows access to the combustion side of the heat exchanger coils.
- 3. Blower**  
The blower pulls in air and gas through the venturi (item 5). Air and gas mix inside the blower and are pushed into the burner, where they burn inside the combustion chamber.
- 4. Gas valve**  
The gas valve senses the negative pressure created by the blower, allowing gas to flow only if the gas valve is powered and combustion air is flowing.
- 5. Venturi**  
The venturi controls air and gas flow into the burner.
- 6. Flue gas sensor**  
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.
- 7. Water heater outlet temperature sensor**  
This sensor monitors water heater outlet water temperature.
- 8. Water heater inlet temperature sensor**  
This sensor monitors return water temperature (system return). If selected as the controlling sensor, the control module adjusts the water heater firing rate so the inlet temperature is correct.
- 9. Flow Switch**  
The flow switch is a safety device that ensures flow through the heat exchanger during operation. This appliance is low mass and should never be operated without flow. The flow switch makes contact when flow is detected and allows the unit to operate. If flow is discontinued during operation for any reason the flow switch will break the control circuit and the unit will shut down.
- 10. Electronic display**  
The electronic display consists of 7 buttons and a dual line 32-character liquid crystal display.
- 11. Flue pipe adapter**  
Allows for the connection of the PVC vent pipe system to the water heater.
- 12. Burner (not shown)**  
Made with metal fiber and stainless steel construction, the burner uses pre-mixed air and gas and provides a wide range of firing rates.
- 13. Water outlet**  
NPT water connection that supplies hot water to the tank.
- 14. Water inlet**  
NPT water connection that returns water from the tank to the heat exchanger.
- 15. Gas connection pipe**  
Threaded pipe connection. This pipe should be connected to the incoming gas supply for the purpose of delivering gas to the water heater.
- 16. SMART Control Module**  
The SMART Control responds to internal and external signals and controls the blower, gas valve, and pumps to meet the demand.
- 17. Automatic air vent**  
Designed to remove trapped air from the heat exchanger coils.
- 18. Air intake adapter**  
Allows for the connection of the PVC air intake pipe to the water heater.
- 19. Line voltage junction box**  
The junction box contains the connection points for the line voltage power and the pump.
- 20. Water heater drain port**  
Location from which the heat exchanger can be drained.
- 21. Low voltage connection board**  
The connection board is used to connect external low voltage devices.
- 22. Low voltage wiring connections (knockouts)**  
Conduit connection points for the low voltage connection board.
- 23. Condensate drain connection**  
Connects the condensate drain line to a 1/2" PVC union.
- 24. Access cover - front (not shown)**  
Provides access to the gas train and the heat exchanger.
- 25. Ignition electrode**  
Provides direct spark for igniting the burner.
- 26. Flame inspection window**  
The quartz glass window provides a view of the burner surface and flame.
- 27. Gas shutoff valve**  
Manual valve used to isolate the gas valve from the gas supply.
- 28. 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.
- 29. Relief valve**  
Protects the heat exchanger from over pressure and temperature conditions. The relief valve is set at 150 PSI.
- 30. Flame sensor**  
Used by the control module to detect the presence of burner flame.
- 31. Line voltage wiring connections (knockouts)**  
Conduit connection points for the high voltage junction box.
- 32. Top panel**  
Removable panel to gain access to the internal components.
- 33. Power switch**  
Turns 120 VAC ON/OFF to the water heater.
- 34. Leveling legs**  
Used to allow the heat exchanger to be leveled. This is needed for the proper draining of the condensate from the combustion chamber.
- 35. Air shroud (500 Model Only)**  
The air shroud directs air and gas flow into the burner.
- 36. Air pressure switch**  
The air pressure switch detects blocked inlet or outlet conditions.
- 37. Pump relay (not shown)**  
The pump relay is used to control the circulation pump.

# The Armor Water Heater - How it works... (continued)

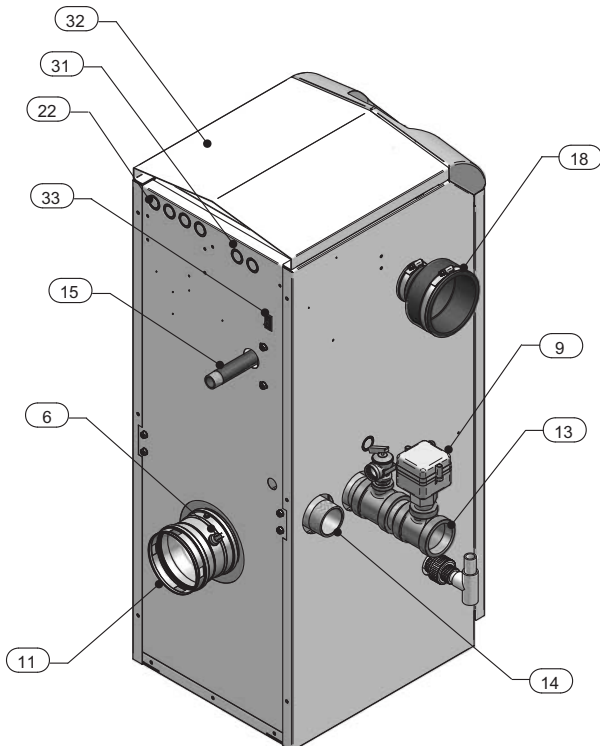
## Models 150 - 199



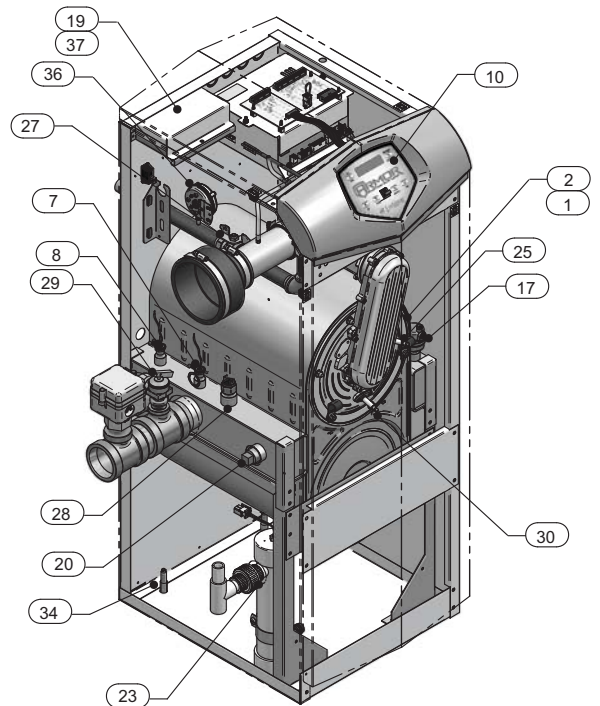
Rear View - Models 150 - 199



Left Side (inside unit) - Models 150 - 199



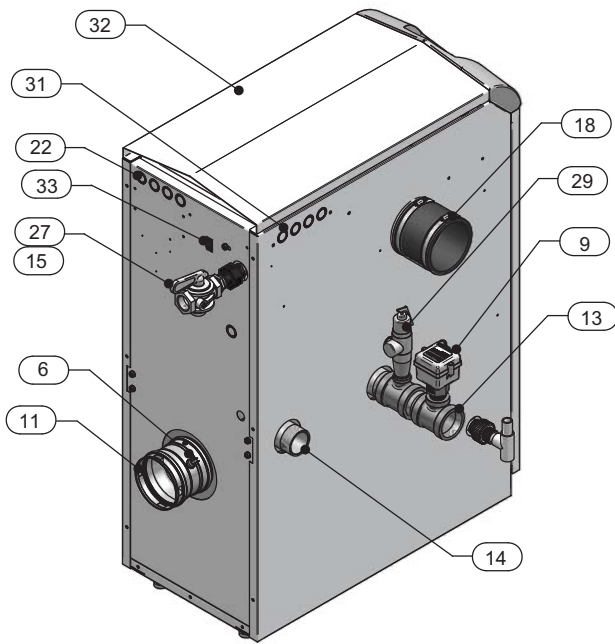
Rear View - Model 285



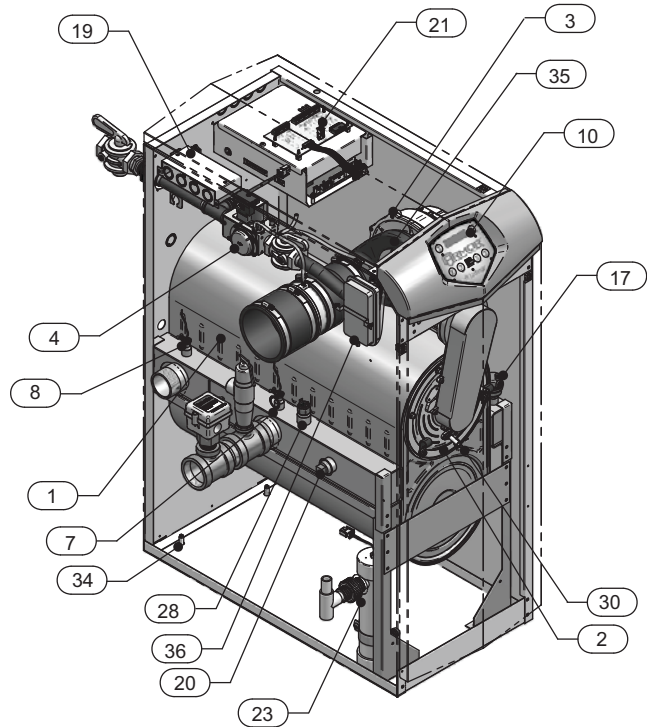
Left Side (inside unit) - Model 285

# The Armor Water Heater - How it works...

## Models 399 - 500

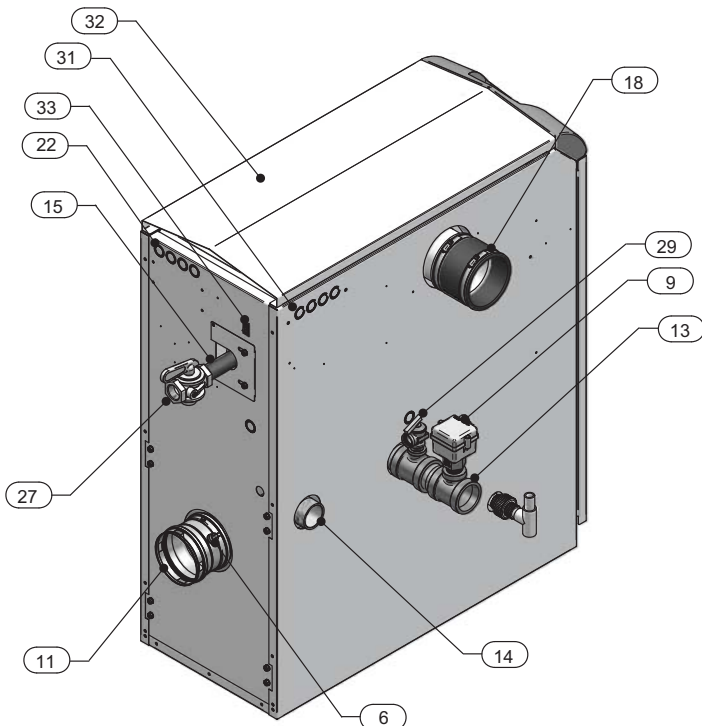


Rear View - Models 399 - 500

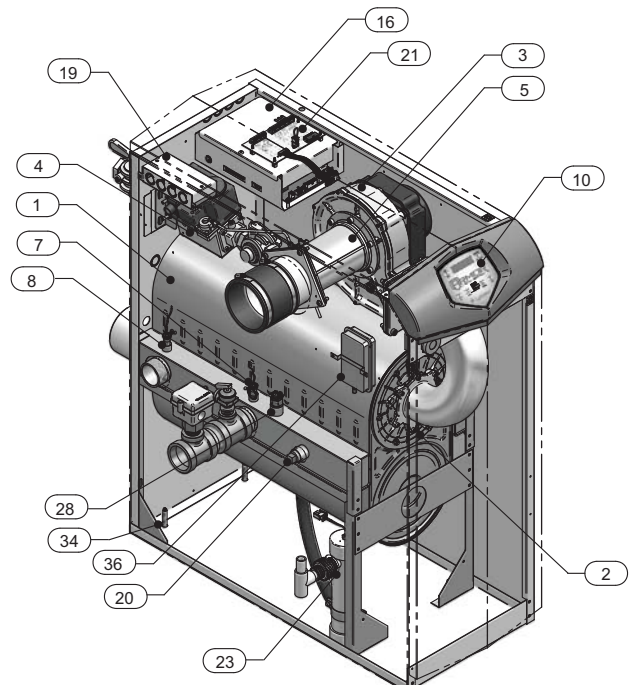


Left Side (inside unit) - Models 399 - 500

## Models 600 - 800



Rear View - Models 600 - 800



Left Side (inside unit) - Models 600 - 800

# Ratings



Model Number  Note: Change "N" to "L" for L.P. gas models.	CSA Input Modulation Btu/hr	Water Content Gallons	Water Connections	Gas Connections	Vent/Air Size
	(Note 2, 3)				(Note 1)
AWN150PM	30,000 - 150,000	1.3	1-1/4"	1/2"	3"/3"
AWN199PM	40,000 - 199,999	1.7	1-1/4"	1/2"	3"/3"
AWN285PM	57,000 - 285,000	2.4	2"	3/4"	4"/4"
AWN399PM	80,000 - 399,999	3.4	2"	1"	4"/4"
AWN500PM	100,000 - 500,000	4.2	2"	1"	4"/4"
AWN600PM	120,000 - 600,000	4.2	2"	1"	4"/4"
AWN700PM	140,000 - 700,000	5.0	2"	1"	6"/4"
AWN800PM	160,000 - 800,000	5.7	2"	1"	6"/4"

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

**Notes:**

1. Armor water heaters require special gas venting. Use only the vent materials and methods specified in the Armor Installation and Operation Manual.
2. Standard Armor 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 Armor 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.

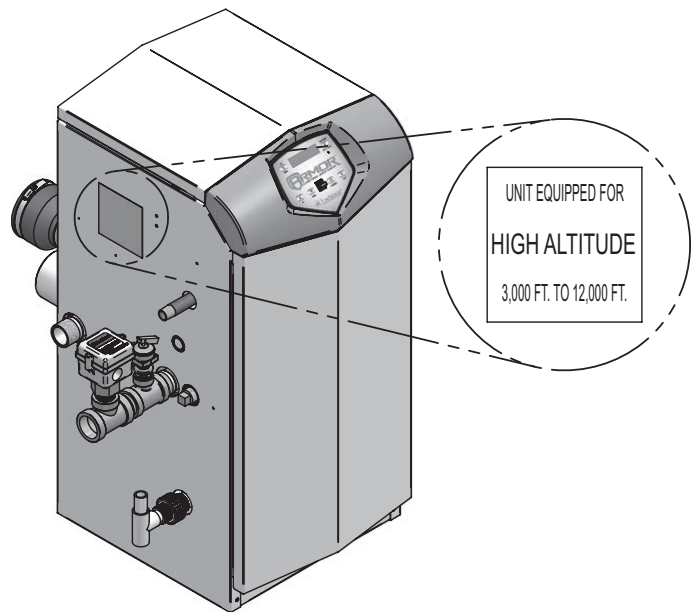


Figure A High Altitude Label Location

# 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 Armor 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. The pan must not restrict combustion air flow. Under no circumstances is the manufacturer to be held responsible for water damage in connection with this appliance, or any of its components.
3. Check area around the 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 Armor water heater must be installed so that gas control system components are protected from dripping or spraying water or rain during operation or service.
5. If a new water heater will replace an existing water heater, check for and correct system problems, such as:
  - System leaks causing oxygen corrosion or heat exchanger cracks from hard water deposits.

### ⚠ 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 starter CPVC pipe section provided with 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 86 cubic feet for AWN150 models, 106 cubic feet for AWN199 models, 120 cubic feet for AWN285 models, 165 cubic feet for AWN399 models, 191 cubic feet for AWN500 models, 223 cubic feet for AWN600 models, 247 cubic feet for AWN700 models and 278 cubic feet for AWN800 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 = 4 feet long, 5 feet wide, and 9 foot ceiling = 4 x 5 x 9 = 180 cubic feet.

### ⚠ 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.

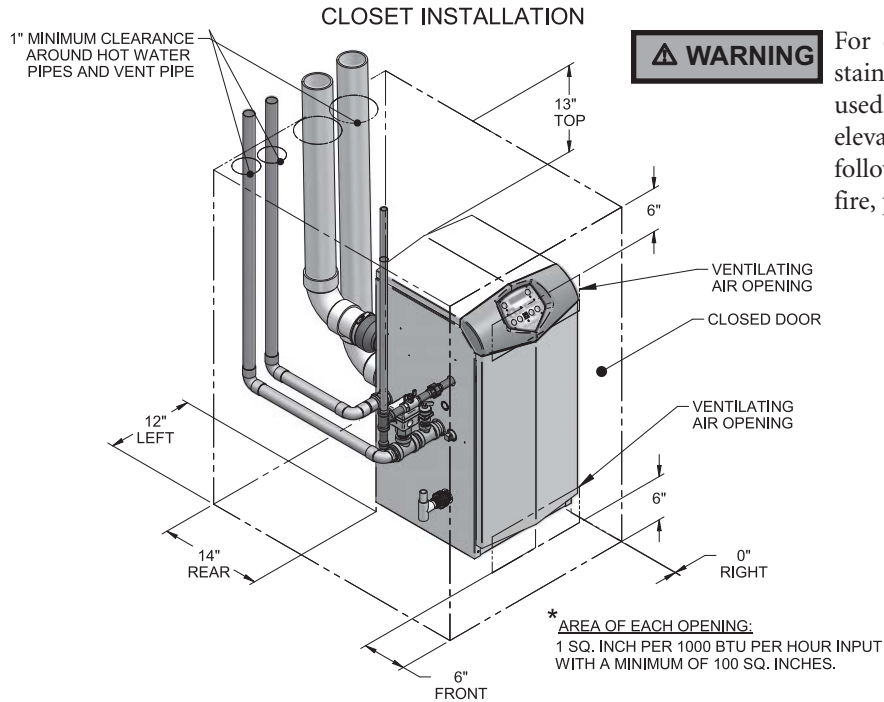
### Clearances for service access

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**



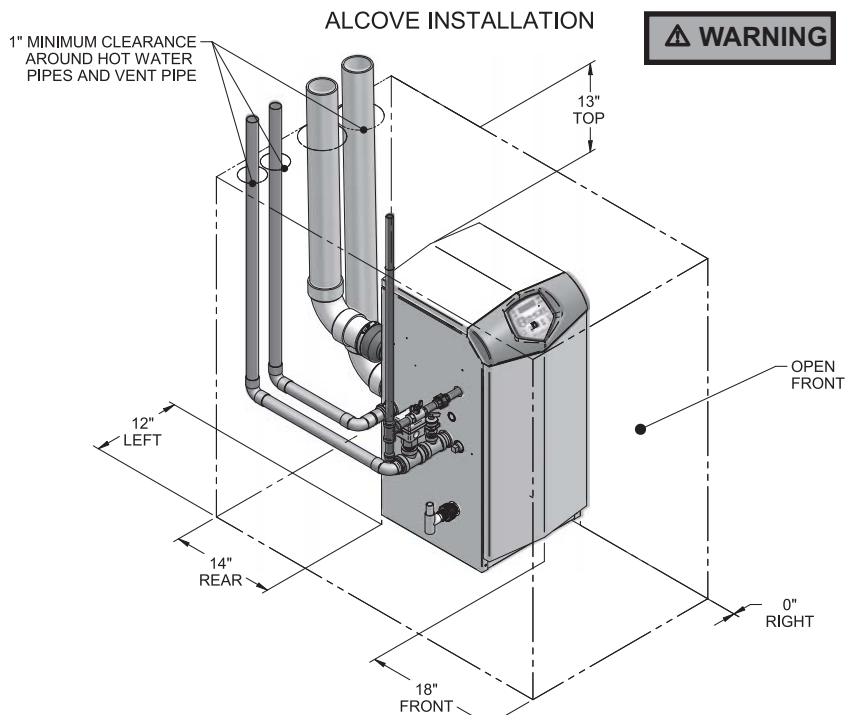
**⚠ WARNING**

For closet installations, CPVC or stainless steel 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:**

- FRONT - 24"
- TOP - 24"
- LEFT SIDE - 24"
- REAR - 24"

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



**⚠ WARNING**

For alcove installations, CPVC or stainless steel 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:**

- FRONT - 24"
- TOP - 24"
- LEFT SIDE - 24"
- REAR - 24"

# 1 Determine water heater location

## Provide air openings to room:

### Armor water heater alone in equipment room

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

### Armor water heater in same space with other gas or oil-fired appliances

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

#### **⚠ WARNING**

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

Do not install the water heater in an attic.

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

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

## Flooring and foundation

### Flooring

The Armor 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.

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

## Residential garage installation

### Precautions

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

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

## Vent and air piping

The Armor water heater requires a special vent system, designed for pressurized venting.

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

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

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

## Prevent combustion air contamination

Install air inlet piping for the Armor 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, page 11 for products and areas which may cause contaminated combustion air.

#### **⚠ WARNING**

You must pipe combustion air to the water heater air intake. Ensure that the combustion air will not contain any of the contaminants in Table 1A, page 11. Contaminated combustion air will damage the 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.

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

With stainless steel vent, seal and connect all pipe and components as specified by the vent manufacturer used; with PVC/CPVC vent, see the Installing Vent or Air Piping Section on page 18.

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

**Table 1A Corrosive Contaminants and Sources**

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

# 1 Determine water heater location

## When removing a water heater from existing common vent system:

### **⚠ DANGER**

Do not install the Armor 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.

## 2 Prepare water heater

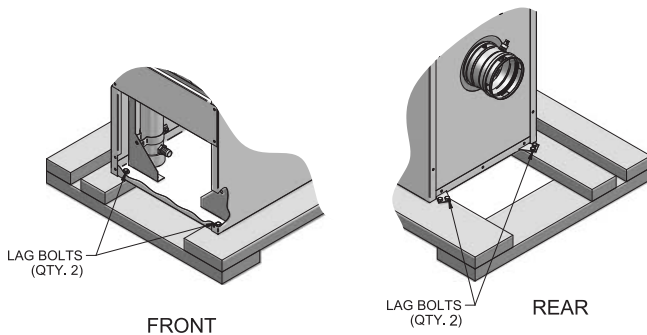
### Remove water heater from wood pallet

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

#### NOTICE

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

**Figure 2-1** Water heater Mounted on Shipping Pallet



### Gas conversions

#### ⚠ WARNING

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

For Models 150 - 399 you must install a propane orifice to operate the Armor water heater on propane gas. Verify when installing that the orifice size marking matches water heater size (Models 150 - 399, Table 2A).

The 500 - 800 Models do not require an orifice installation for propane operation, but they will require a valve adjustment.

**Table 2A** LP Conversion Table

LP Conversion Table	
Model	LP Orifice Stamping
150	150
199	210 / W150
285	285
399	8.0

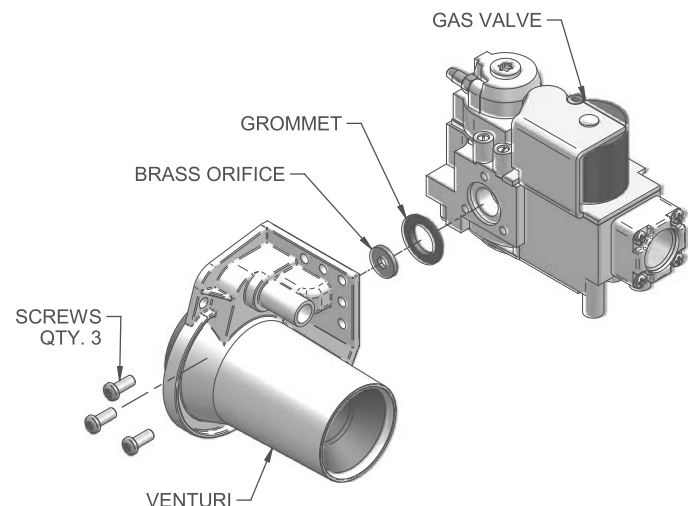
### Models 150 - 285

1. Remove the top and front access covers from the unit (no tools required for removal).
2. Remove the three screws securing the gas valve to the venturi (FIG. 2-2).
3. Locate the propane orifice disk from the conversion kit bag. Verify that the stamping on the orifice disk matches the water heater size (150 - 285) (see Table 2A above).  
Place the orifice into the black rubber grommet in the side of the gas valve and secure in the valve (FIG. 2-2).
4. Reposition the gas valve against the venturi and replace the screws (FIG. 2-2) securing the valve to the venturi.
5. After installation is complete, attach the propane conversion label (in the conversion kit bag) next to the water heater rating plate. Attach the LP caution label (in the conversion kit bag) to the left side of the unit in the lower left corner.
6. Replace the top and front access covers.

#### ⚠ WARNING

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

**Figure 2-2** Installing Propane Orifice - Models 150 - 285



## 2 Prepare water heater

### Model 399

1. Remove the top and front access covers from the unit (no tools required for removal).
2. Remove the three screws securing the venturi to the blower.  
**Note:** When separating the venturi from the blower, take care not to damage the O-ring inside the blower (FIG. 2-3).
3. Remove the four screws securing the gas valve to the venturi (FIG. 2-3).
4. Locate the propane orifice disk from the conversion kit bag. Verify that the stamping on the orifice disk matches the water heater size (see Table 2A on page 13).
5. Remove the existing orifice from the O-ring in the side of the gas valve and replace it with the orifice from the kit. Position and secure the orifice in the valve as shown in FIG. 2-3.
6. Reposition the gas valve against the venturi and replace the screws (FIG. 2-3) securing the valve to the venturi.
7. Inspect the O-ring inside the blower. Handle the O-ring with care, do not damage. Reposition the venturi against the blower and replace the screws securing the venturi to the blower (FIG. 2-3).
8. After installation is complete, attach the propane conversion label (in the conversion kit bag) next to the water heater rating plate. Attach the LP caution label (in the conversion kit bag) to the left side of the unit in the lower left corner.
9. Replace the top and front access covers.

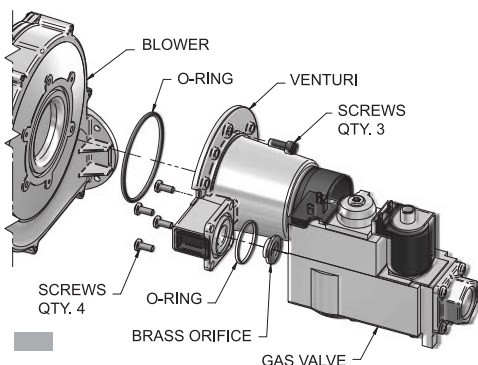
#### **⚠ WARNING**

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

#### **⚠ DANGER**

Armor 399: Inspect the O-ring when the blower is disassembled. The O-ring must be in good condition and must be installed. Failure to comply will cause a gas leak, resulting in severe personal injury or death.

**Figure 2-3** Installing Propane Orifice - Model 399



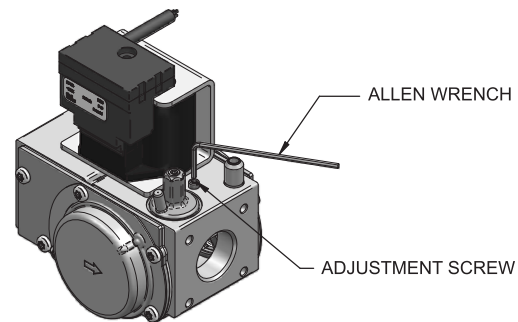
### Model 500

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

#### **⚠ WARNING**

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

**Figure 2-4** Gas Valve Adjustment - Model 500



## 2 Prepare water heater *(continued)*

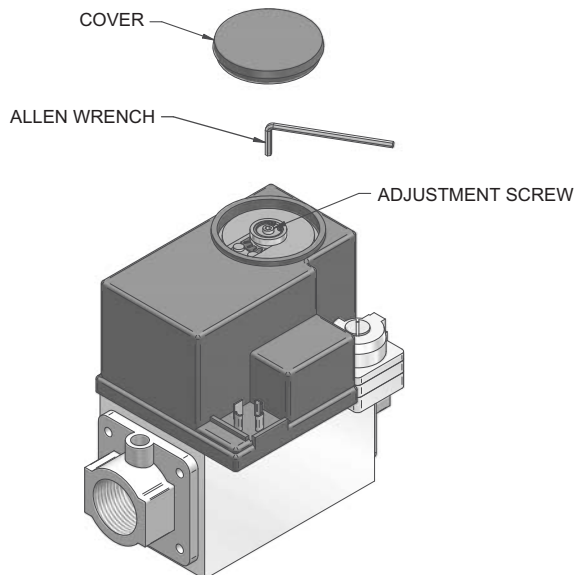
### Models 600 - 800

1. Remove the top access cover from the unit (no tools required for removal).
2. Remove the cover on top of the gas valve (FIG. 2-5).
3. Turn the adjustment screw on top of the gas valve clockwise one and three quarter (1 3/4) turns on the 600 Model, one and a half (1 1/2) turns on the 700 Model, and one turn on the 800 Model (see FIG. 2-5).
4. Use a combustion analyzer to verify CO<sub>2</sub> is within the range of 9.6 – 10.5%. If not, adjust the screw counterclockwise incrementally to raise CO<sub>2</sub> and clockwise to lower CO<sub>2</sub> (FIG. 2-5).
5. After adjustment is complete, attach the propane conversion label (in the conversion kit bag) next to the water heater rating plate. Attach the LP caution label (in the conversion kit bag) to the left side of the unit in the lower left corner.
6. Replace the gas valve cover along with the top access cover.

#### **⚠ WARNING**

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

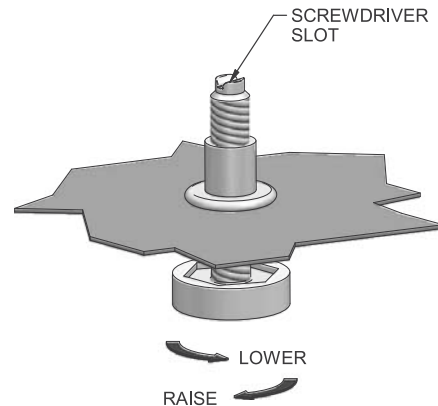
**Figure 2-5** Gas Valve Adjustment - Models 600 - 800



### Leveling the water heater

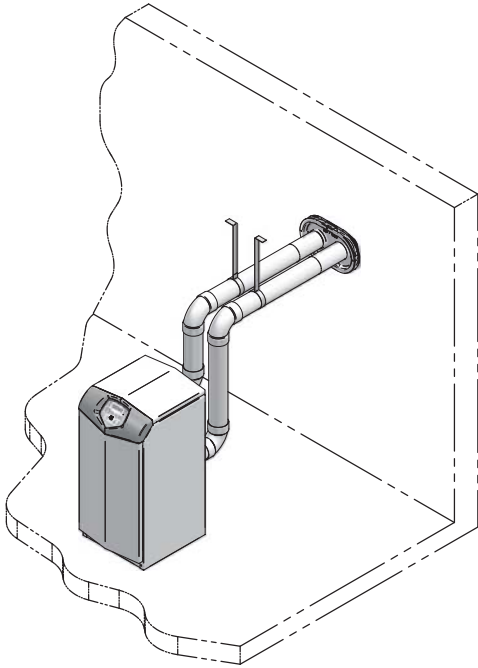
1. Set the water heater in place and check level.
  - a) Adjust legs if necessary to level the water heater, see FIG. 2-6 below.

**Figure 2-6** Leveling Legs on the Water Heater

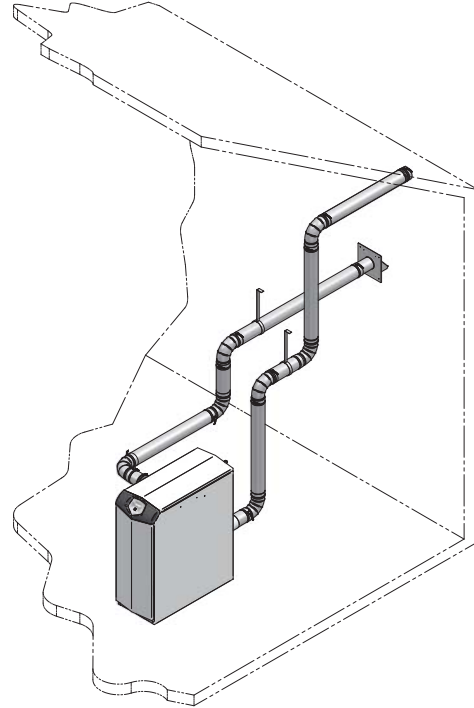


### 3 General venting

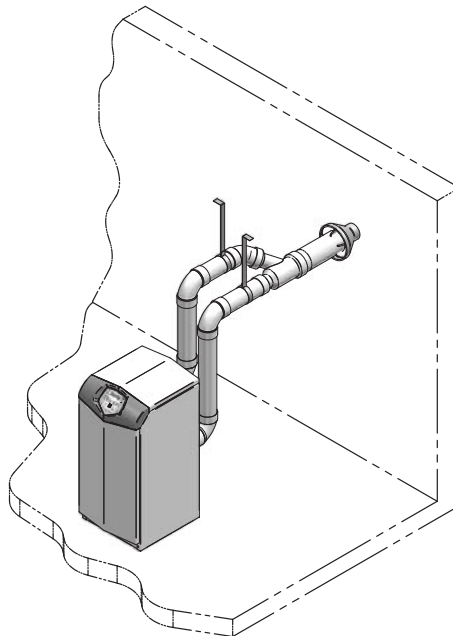
#### Direct venting options - Sidewall Vent



**Figure 3-1** PVC/CPVC Two-Pipe Sidewall Termination)  
- See page 25 for more details



**Figure 3-2** Stainless Steel Two-Pipe Sidewall Termination - See page 25 for more details

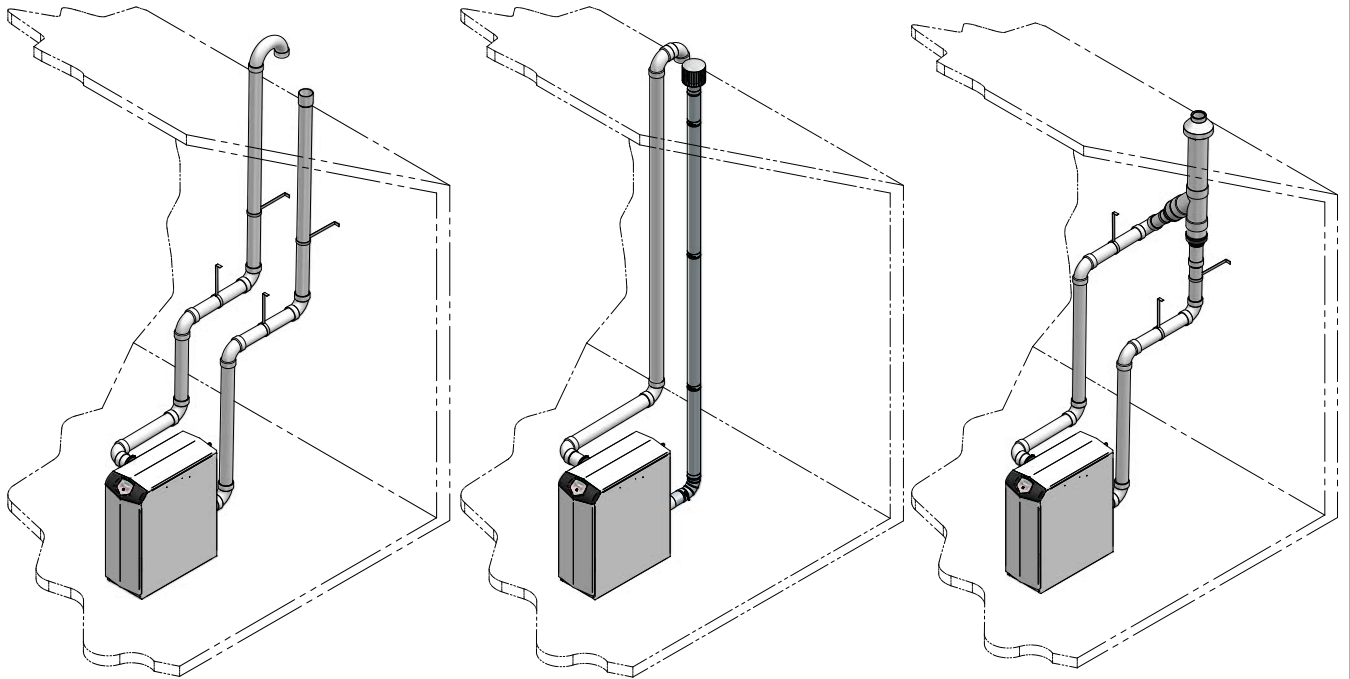


**Figure 3-3** PVC/CPVC Concentric Sidewall Termination  
(Models 150 - 600 Only) - See page 28 for more details



### 3 General venting (continued)

#### Direct venting options - Vertical Vent

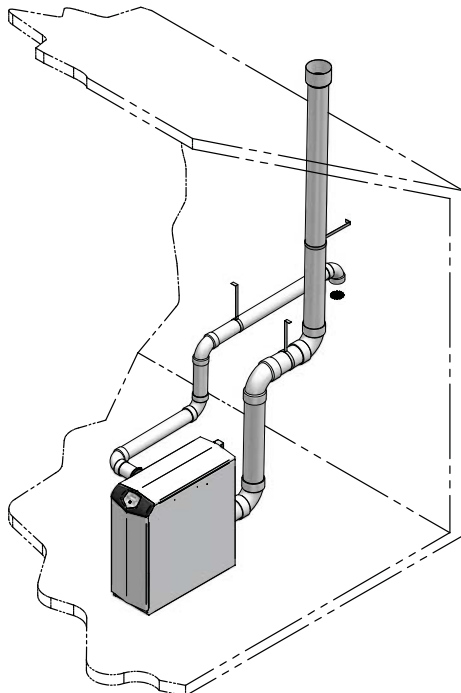


**Figure 3-4** PVC/CPVC Two-Pipe Vertical Termination - See page 31 for more details

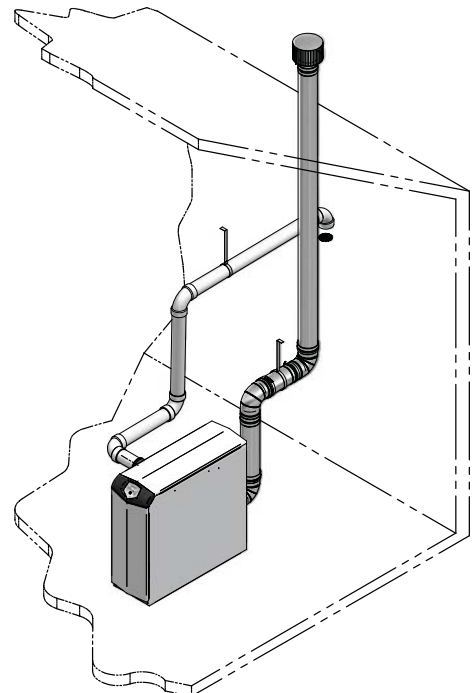
**Figure 3-5** Stainless Steel Two-Pipe Vertical Termination - See page 31 for more details

**Figure 3-6** PVC/CPVC Concentric Vertical Termination (Models 150 - 600 Only) - See page 33 for more details

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



**Figure 3-7** PVC/CPVC Vertical Vent, Sidewall Air



**Figure 3-8** Stainless Steel Vertical Vent, Sidewall Air

**NOTICE**

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

## 3 General venting

### Install vent and combustion air piping

#### ⚠ DANGER

The Armor 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 3A (pg. 19) for vent pipe, and fittings. Failure to comply could result in severe personal injury, death, or substantial property damage.

#### NOTICE

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

#### ⚠ WARNING

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

#### NOTICE

All PVC vent pipes must be glued, properly supported, and the exhaust must be pitched a minimum of a 1/4 inch per foot back to the 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 3B (pg. 21) 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 4 – *Sidewall Termination – Optional Concentric Vent*) and the 3" Concentric Vent Kit available from IPEX are both approved for use on the Armor 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 or air piping

#### NOTICE

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

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.

### 3 General venting *(continued)*

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

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

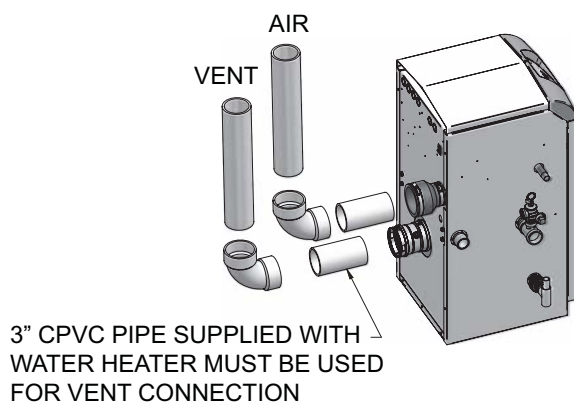
All vent pipe materials and fittings must comply with the following:			
Item	Material	Standards for installation in:	
		United States	Canada
Vent pipe and fittings	PVC schedule 40	ANSI/ASTM D1785	CPVC and PVC venting must be ULC-S636 Certified. IPEX is an approved manufacturer in Canada supplying vent material listed to ULC-S636.
	PVC-DWV	ANSI/ASTM D2665	
	CPVC schedule 40/80	ANSI/ASTM F441	
	AL29-4C	UL1738	
Pipe cement/primer	PVC	ANSI/ASTM D2564	IPEX System 636 Cements & Primers
	CPVC	ANSI/ASTM F493	
<b>NOTICE: DO NOT USE CELLULAR (FOAM) CORE PIPE</b>			
<b>Approved Stainless Steel Vent Manufacturers</b>			
<b>Make</b>		<b>Model</b>	
ProTech Systems (Simpson Dura-Vent Co.)		FasNSeal Vent / FasNSeal Flex* Vent	
Z-Flex (Nova Flex Group)		Z-Vent	
Heat Fab (Selkirk Corporation)		Saf-T Vent	

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

#### PVC/CPVC Air intake/vent connections

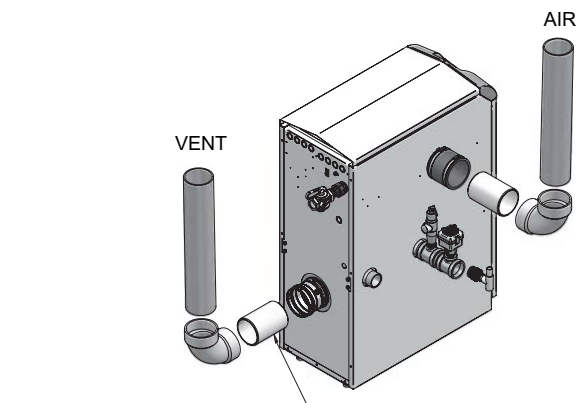
1. **Combustion Air Intake Connector** (FIG.'s 3-9 thru 3-11) - Used to provide combustion air directly to the unit from outdoors. A fitting is provided on the unit for final connection. Combustion air piping must be supported per guidelines listed in the National Mechanical Code, Section 305, Table 305.4 or as local codes dictate.
2. **Vent Connector** (FIG.'s 3-9 thru 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 3-9 Near Water Heater PVC/CPVC Venting Models 150 - 199**



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

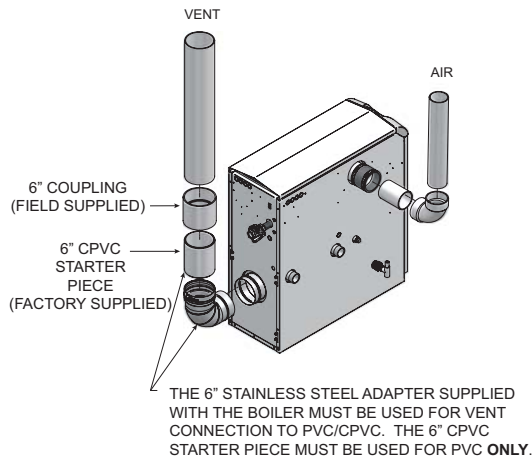
**Figure 3-10 Near Water Heater PVC/CPVC Venting Models 285 - 600**



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

### 3 General venting

**Figure 3-11** Near Water Heater PVC/CPVC Venting Models 700 - 800



#### Air inlet pipe materials:

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

- PVC, CPVC or ABS
- Dryer Vent or Sealed Flexible Duct (not recommended for rooftop air inlet)
- Galvanized steel vent pipe with joints and seams sealed as specified in this section.
- Type "B" double-wall vent with joints and seams sealed as specified in this section.

AL29-4C, stainless steel material to be sealed to specification of its manufacturer.

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

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

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

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

- a. Seal all joints and seams of the air inlet pipe using either Aluminum Foil Duct Tape meeting UL Standard 723 or 181A-P or a high quality UL Listed silicone sealant such as those manufactured by Dow Corning or General Electric.
- b. Do not install seams of vent pipe on the bottom of horizontal runs.

- c. Secure all joints with a minimum of three sheet metal screws or pop rivets. Apply Aluminum Foil Duct Tape or silicone sealant to all screws or rivets installed in the vent pipe.
- d. Ensure that the air inlet pipes are properly supported.

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

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

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

#### Stainless steel vent

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

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

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

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

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

### 3 General venting *(continued)*

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

Model	ProTech			Heat Fab				Z Flex		
	FasNSeal			Saf-T Vent				Z-Vent		
	Adapter	Flue Termination	Intake Air Termination	Adapter	Intermediate Adapter	Flue Termination	Intake Air Termination	Adapter	Flue Termination	Intake Air Termination
150 - 199	300715	FSBS3 FSRC3(R.C)	303889	KB80210	9353BUREZ-1*	9392 5300CI	9314TERM	2SVSLA03	2SVSTP03 2SVSRCX03	2SVSTEX0390
285-600	F303759	FSBS4 FSRC4(R.C)	FSAIH04 303888	KB285600	9454BUREZ-1*	9492 5400CI	9414TERM	2SVSLA04	2SVSTP04 2SVSRCX04	2SVSTEX0490
700-800	F303759 (Intake Only)	FSBS6	FSAIH04 303888							

\* = This adapter must be used in addition to the water heater adapter for Saf-T vent pipe as shown in FIG. 3-12, unless approved vent other than standard diameter is used. Consult a Heat Fab representative for questions.

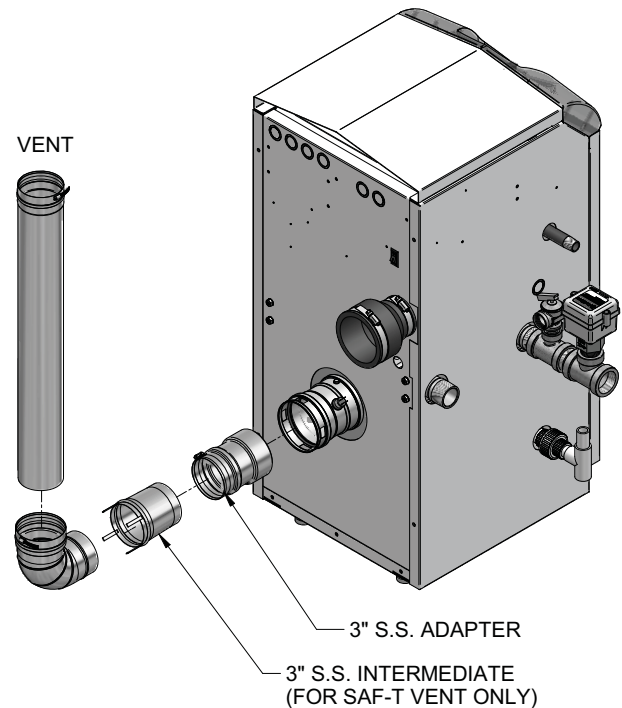
**Table 3C** Stainless Steel Vent Termination Kit(s)

Model	Kit Number
700 - 800	KIT3137

#### Stainless steel air intake/vent connections

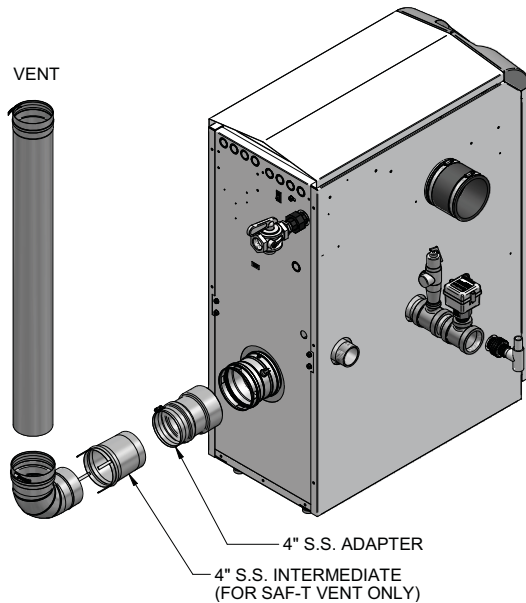
- Combustion Air Intake Connector** (FIG.'s 3-12 thru 3-14) - Used to provide combustion air directly to the unit from outdoors. A fitting is provided on the unit for final connection. Combustion air piping must be supported per guidelines listed in the National Mechanical Code, Section 305, Table 305.4 or as local codes dictate.
- Vent Connector** (FIG.'s 3-12 thru 3-14) - 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 3-12** Near Water Heater Stainless Steel Venting Models 150 - 199

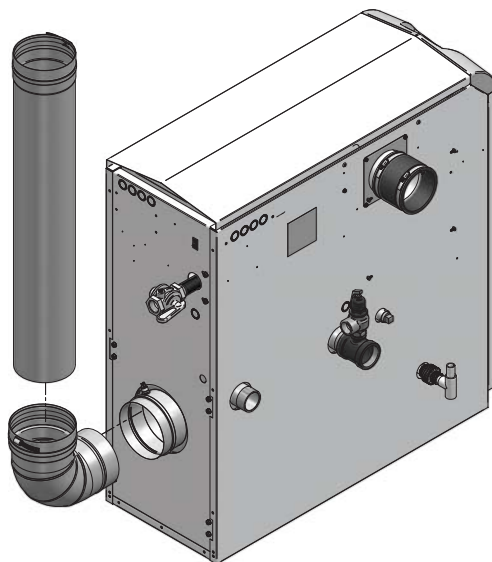


### 3 General venting

**Figure 3-13** Near Water Heater Stainless Steel Venting Models 285 - 600



**Figure 3-14** Near Water Heater Stainless Steel Venting Models 700 - 800



The Armor water heater uses model specific combustion air intake and vent piping sizes as detailed in Table 3D below.

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

Model	Air Intake	Vent
150 - 199	3 inches	3 inches
285 - 600	4 inches	4 inches
700 - 800	4 inches	6 inches

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

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

**Combustion Air** = 12 equivalent feet minimum / 100 equivalent feet maximum

**Vent** = 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.

**NOTICE** The appliance output rating will reduce by up to 1.5% for each 25 feet of vent length.

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

Model	Kit Number	Equivalent Vent Length
150 - 199	CVK3003	3 feet
285	CVK3007	3 feet
399	CVK3007	5 feet
500 - 600	CVK3007	30 feet

#### Removing from existing vent

Follow the instructions in Section 1, page 12 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 must also install air piping from outside to the water heater air intake adapter. The resultant installation is direct vent (sealed combustion).

You may use any of the vent/air piping methods covered in this manual. Do not attempt to install the Armor 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.

### 3 General venting *(continued)*

#### Vent, air piping and termination:

The Armor 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.

#### Optional room air

##### NOTICE

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

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

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

##### ⚠ WARNING

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

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

Model	Kit Number	Description
150 - 199	KIT30052	Room Air Kit
285 - 800	KIT30053	Room Air Kit
399 - 800	KIT30054	Room Air Filter Kit

#### 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 11, 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 11 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.

# 4 Sidewall direct venting

## Vent/air termination – sidewall

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

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

**⚠ WARNING** Do not connect any other appliance to the vent pipe or multiple 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

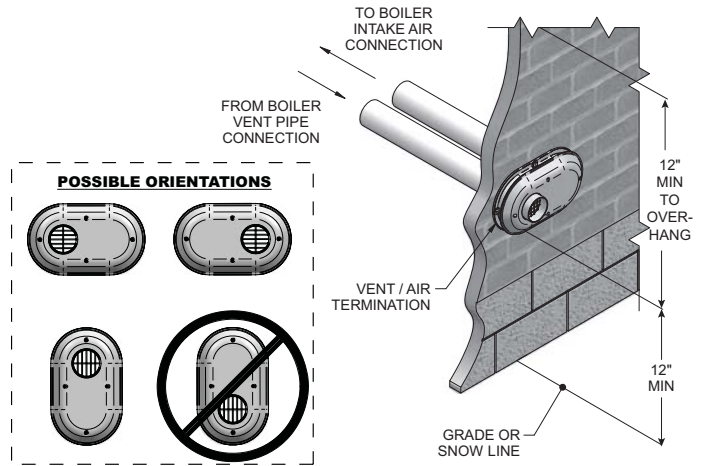
Locate the vent/air terminations using the following guidelines:

- The total length of piping for vent or air must not exceed the limits given in the General Venting Section on page 22 of this manual.
- You must consider the surroundings when terminating the vent and air:
  - Position the vent termination where vapors will not damage nearby shrubs, plants or air conditioning equipment or be objectionable.
  - The flue products will form a noticeable plume as they condense in cold air. Avoid areas where the plume could obstruct window views.
  - Prevailing winds could cause freezing of condensate and water/ice buildup where flue products impinge on building surfaces or plants.
  - Avoid possibility of accidental contact of flue products with people or pets.
  - 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.

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

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



**Table 4A Sidewall Vent Kits**

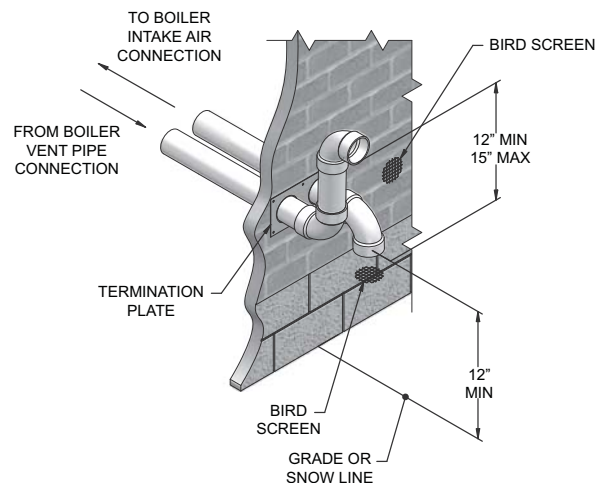
Model	Kit Number	Vent Size
150 - 199	KIT30045	3 inch vent
285 - 600	KIT30046	4 inch vent
700 - 800	KIT30048	6 inch vent

### If using the alternate sidewall termination:

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

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

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

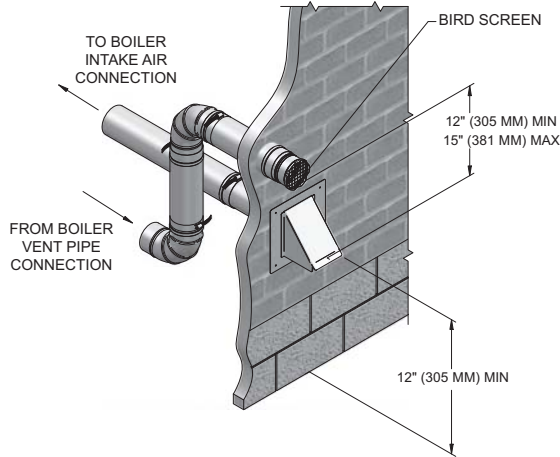




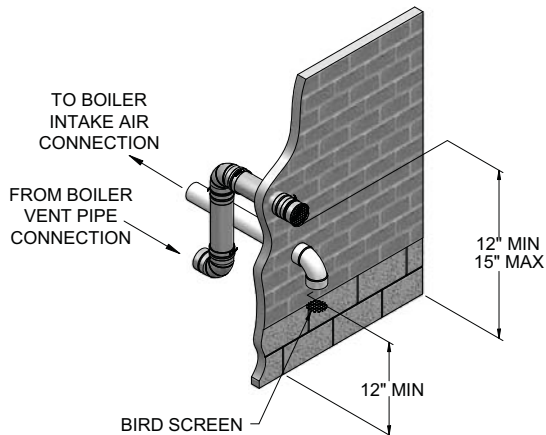
## 4 Sidewall direct venting *(continued)*

### Vent/air termination – sidewall

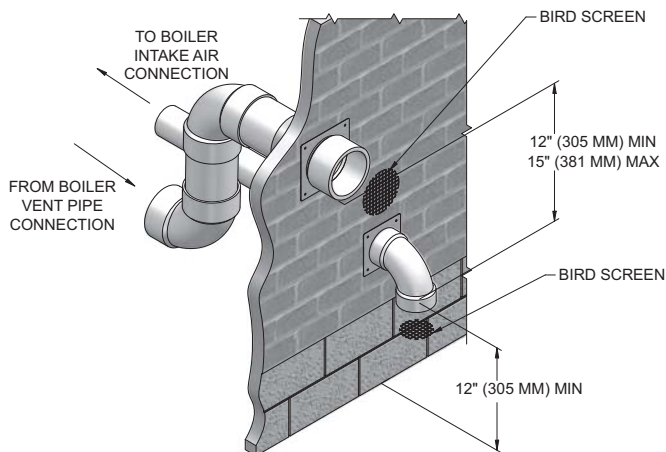
**Figure 4-1C** Alternate Stainless Steel Vent Termination - Typical Stainless Steel Sidewall Termination of Air and Vent Models 285 - 600 w/Field Supplied Fittings, Utilizing FasNSeal's Hood Intake. Available Through FasNSeal Only



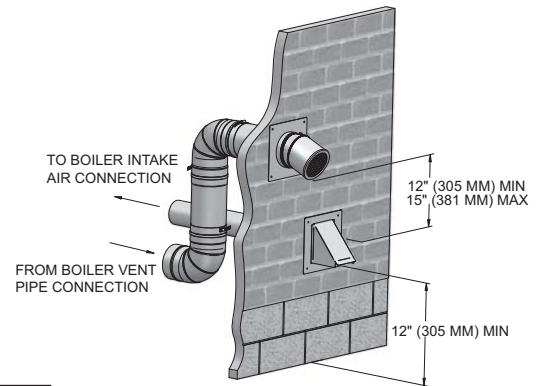
**Figure 4-1D** Alternate PVC/CPVC/SS Vent Termination - Typical Stainless Steel Sidewall Termination of Air and Vent Models 150 - 600 w/Field Supplied Fittings, Utilizing 90° Elbow Intake



**Figure 4-2A** Alternate PVC/CPVC Sidewall Termination Models 150 - 800 w/Field Supplied Fittings



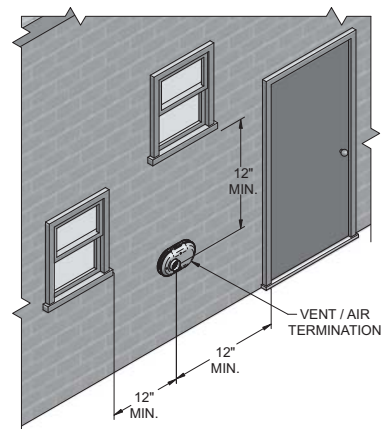
**Figure 4-2B** Alternate Stainless Steel Sidewall Termination Models 700 - 800 w/Field Supplied Fittings



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

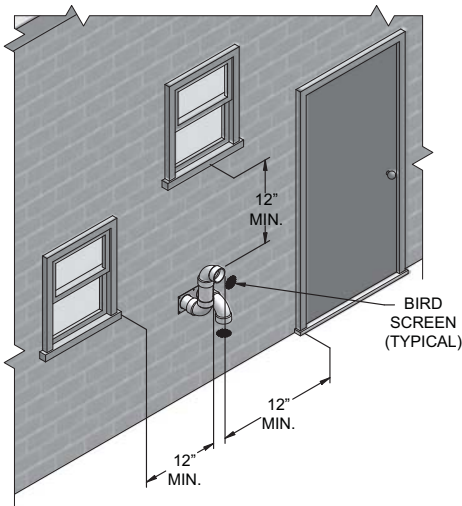
5. Maintain clearances as shown in FIG.'s 4-1A thru 4-3B, pages 24 thru 26. Also maintain the following:
  - a. Vent must terminate:
    - At least 6 feet from adjacent walls.
    - No closer than 12 inches below roof overhang.
    - At least 7 feet above any public walkway.
    - At least 3 feet above 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 as shown in FIG. 4-1B.
  - 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 4-3A** Clearance to Gravity Air Inlets

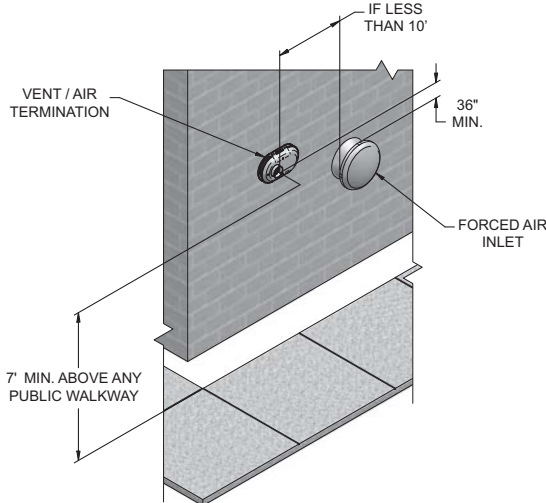


## 4 Sidewall direct venting

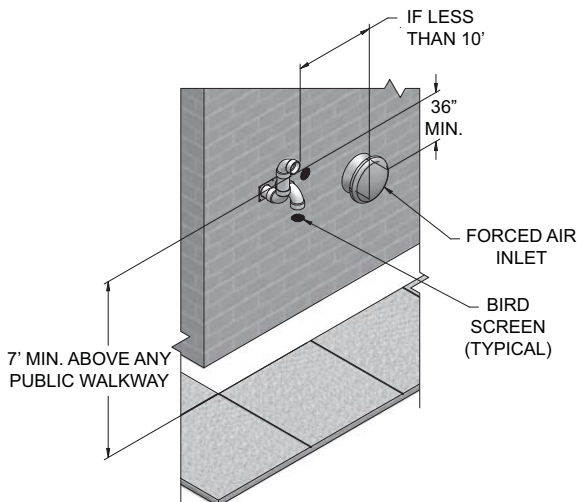
**Figure 4-3B** Alternate Clearance to Gravity Air Inlets w/Field Supplied Fittings



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



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



### Prepare wall penetrations

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

Air pipe penetration:

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

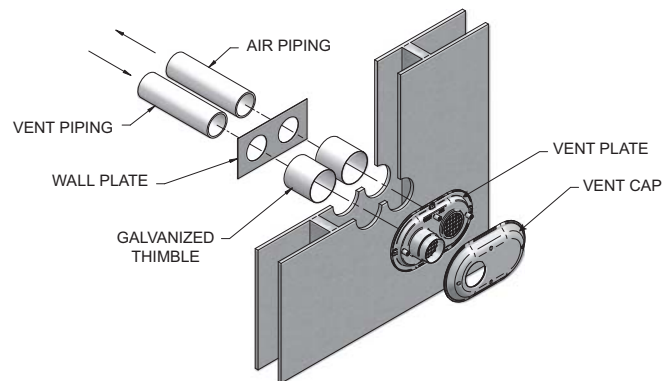
Vent pipe penetration:

- Cut a hole for the vent pipe. For either combustible or noncombustible construction, size the vent pipe hole with at least a 1/2 inch clearance around the vent pipe outer diameter:
  - 4½ inch hole for 3 inch vent pipe
  - 5½ inch hole for 4 inch vent pipe
  - 7½ inch hole (191 mm) hole for 6 inch (152 mm) vent pipe

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

- Install the vent and air intake piping through the wall into the vent plate openings. Seal all gaps between the pipes and wall. Use RTV silicone sealant to seal the air pipe. Use the cement/primer listed in Table 3A on page 19 to seal the vent pipe.
- Mount and secure the vent plate to the wall using stainless steel screws. Seal around the plate to the wall assuring no air gaps.
- Assemble the vent cap to the vent plate (see FIG. 4-4A). Insert the stainless steel screws into the vent cap screw hole openings and securely attach the vent cap to the vent plate.
- Seal all wall cavities.

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



**Table 4B** Sidewall Vent Centerline Dimensions

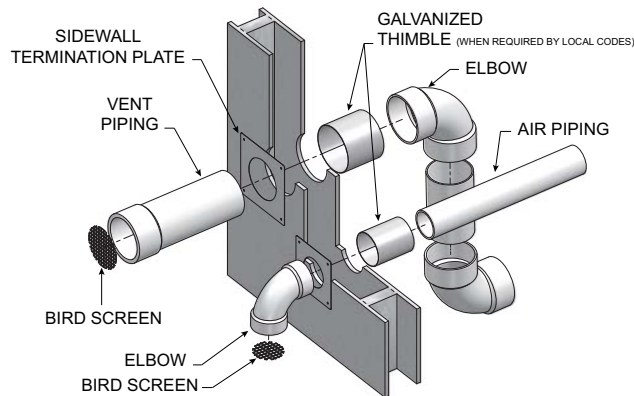
Model	Air	Vent	Centerline Width
150 - 199	3"	3"	5 5/8"
285 - 600	4"	4"	5 5/8"
700 - 800	4"	6"	7 3/4"

## 4 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
    - 7½ inch hole (191 mm) hole for 6 inch (152 mm) vent pipe
  - b. Insert a galvanized metal thimble in the vent pipe hole as shown in FIG. 4-4B.
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 4-5B** A Typical Sidewall Termination Assembly - Models 150 - 800 PVC/CPVC or Stainless Steel



### Termination and fittings

1. Prepare the vent termination elbow and the air termination elbow (FIG. 4-5B) by inserting bird screens. Bird screens can be obtained locally.
2. When completed, the air termination coupling must be oriented at least 12 inches (305 mm) below the vent termination and at least 12 inches (305 mm) above grade or snow line as shown in FIG. 4-1A, page 24.
3. Maintain the required dimensions of the finished termination piping as shown in FIG. 4-1A, page 24.
4. Do not extend exposed vent pipe outside of building more than shown in this document. Condensate could freeze and block vent pipe.
5. PVC/CPVC terminations are designed to accommodate any wall thickness of standard constructions per the directions found in this manual.
6. Stainless steel terminations are designed to penetrate walls with a thickness up to 9.25 inches of standard construction.

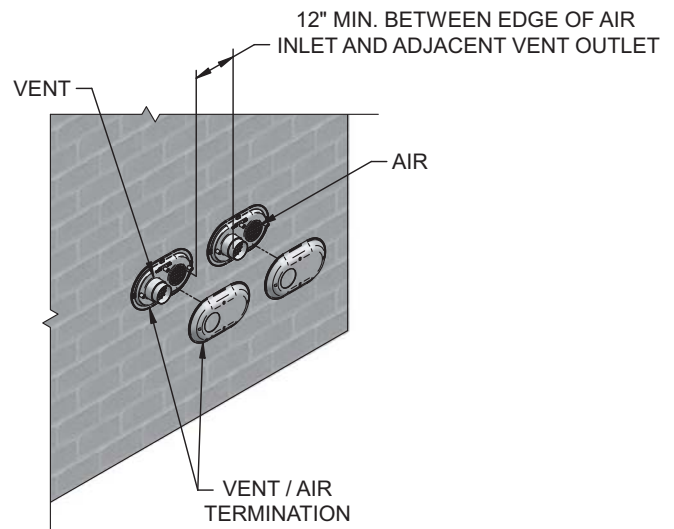
### Multiple vent/air terminations

1. When terminating multiple Armor water heaters terminate each vent/air connection as described in this manual (FIG. 4-5A).

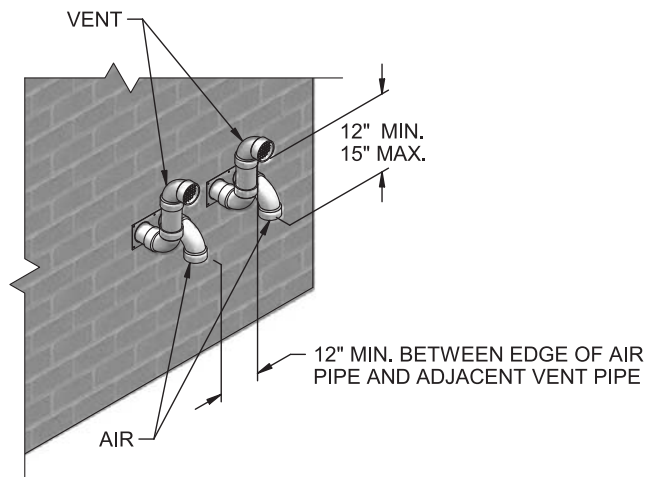
**⚠ WARNING** All vent pipes and air inlets must terminate at the same height to avoid possibility of severe personal injury, death, or substantial property damage.

2. Place wall penetrations to obtain minimum clearance of 12 inches between edge of air inlet and adjacent vent outlet, as shown in FIG. 4-5A for U.S. installations. For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
3. The air inlet of a Armor 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 4-5A** Multiple Vent Terminations (must also comply with Figure 4-1A)



**Figure 4-5B** Alternate Multiple Vent Terminations w/Field Supplied Fittings (must also comply with Figure 4-1B)



# 4 Sidewall direct venting

## Sidewall termination – optional concentric vent: Models 150 - 600

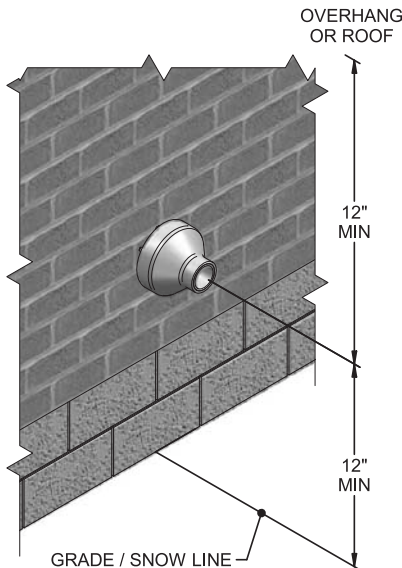
### Description and usage

Lochinvar offers optional concentric combustion air and vent pipe termination kits (Factory Kit #CVK3003 for 3" diameter - Models 150 - 199 and #CVK3007 for 4" diameter - Models 285 - 600). 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 below in FIG. 4-6.

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

The required combustion vent pipe materials are listed in Table 3A, on page 19 of this manual.

**Figure 4-6 Concentric Sidewall Termination**

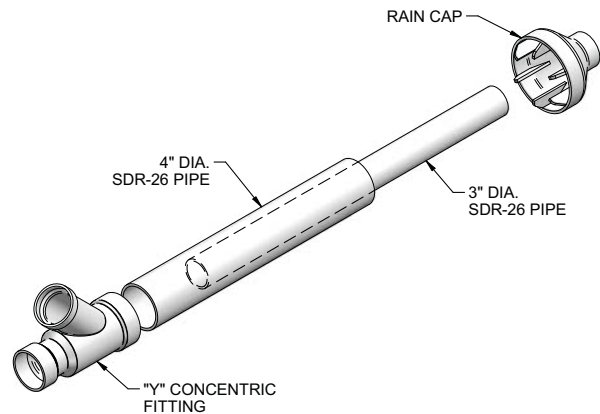


### Sidewall termination installation

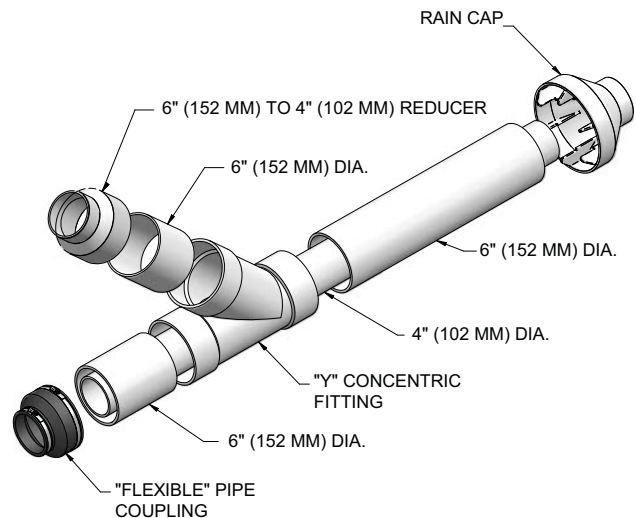
1. Determine the best location for the termination kit (see FIG. 4-6).
2. The total length of piping for vent or air must not exceed the limits given in the General Venting Section on page 22 of this manual.
3. You must consider the surroundings when terminating the vent and air:
  - a. Position the vent termination where vapors will not damage nearby shrubs, plants or air conditioning equipment or be objectionable.
  - b. The flue products will form a noticeable plume as they condense in cold air. Avoid areas where the plume could obstruct window views.

- c. Prevailing winds could cause freezing of condensate and water/ice buildup where flue products impinge on building surfaces or plants.
- d. Avoid possibility of accidental contact of flue products with people or pets.
- f. Do not terminate above any door or window. Condensate can freeze, causing ice formations.
- g. Locate or guard vent to prevent condensate damage to exterior finishes.

**Figure 4-7 Kit Contents\_CVK3003 - Models 150 - 199**



**Figure 4-8 Kit Contents\_CVK3007 - Models 285 - 600**

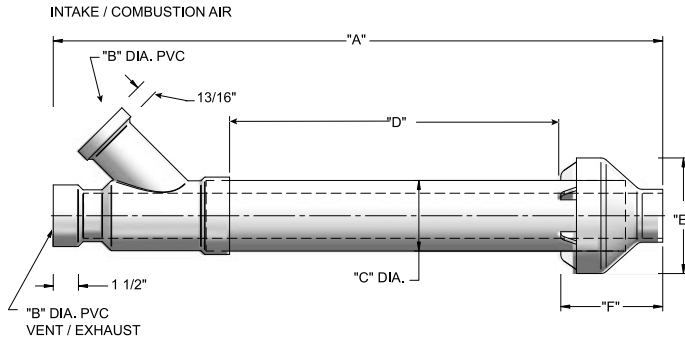


4. Cut one (1) hole (5 inch diameter for #CVK3003 installations or 7 inch diameter for #CVK3007 installations) into the structure to install the termination kit.
5. Partially assemble the concentric vent termination kit. Clean and cement using the procedures found in these instructions.
  - a. Cement the Y concentric fitting to the larger kit pipe (FIG's 4-7 and 4-8).
  - b. Cement the rain cap to the smaller diameter kit pipe (FIG's 4-7 and 4-8).

# 4 Sidewall direct venting *(continued)*

## Sidewall termination – optional concentric vent: Models 150 - 600

**Figure 4-9 Concentric Vent Dimensional Drawing - Models 150 - 199**



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

**NOTICE**

Instead of cementing the smaller pipe to the rain cap, a field-supplied stainless steel screw may be used to secure the two (2) components together when field disassembly is desired for cleaning (see FIG. 4-11).

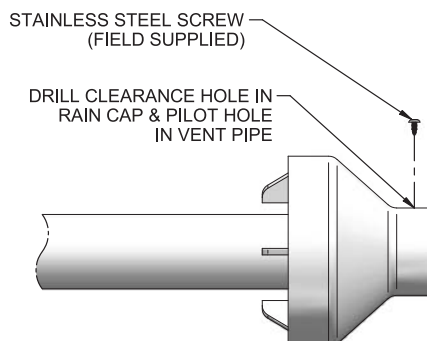
**WARNING**

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.

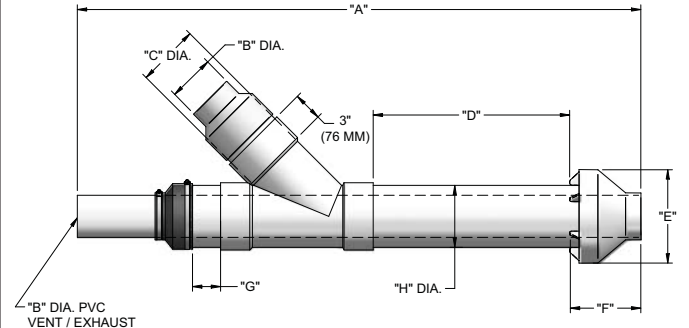
**WARNING**

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 4-11 Rain Cap to Vent Pipe Alternate Assembly**



**Figure 4-10 Concentric Vent Dimensional Drawing - Models 285 - 500**



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

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. 4-12 using field-supplied metal strapping or equivalent support material.

**NOTICE**

Ensure termination location clearance dimensions are as shown in FIG. 4-6.

**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 4-9 and 4-10).

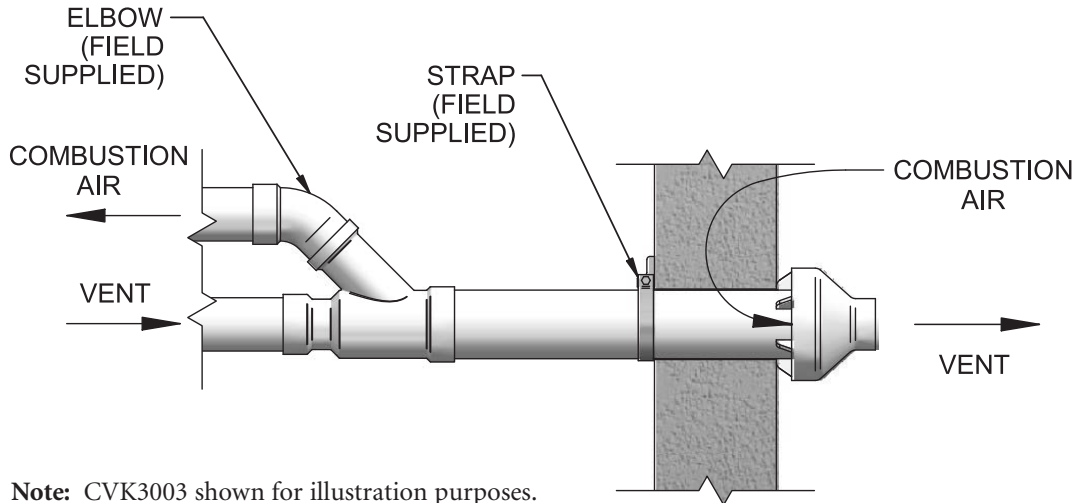
**NOTICE**

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

## 4 Sidewall direct venting

### Sidewall termination – optional concentric vent: Models 150 - 600

Figure 4-12 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. 4-12 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. 4-13). 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. 4-13. The next two (2) 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. 4-13 represents the distance between pipes or rain shields, as touching or a 2 inch maximum separation.

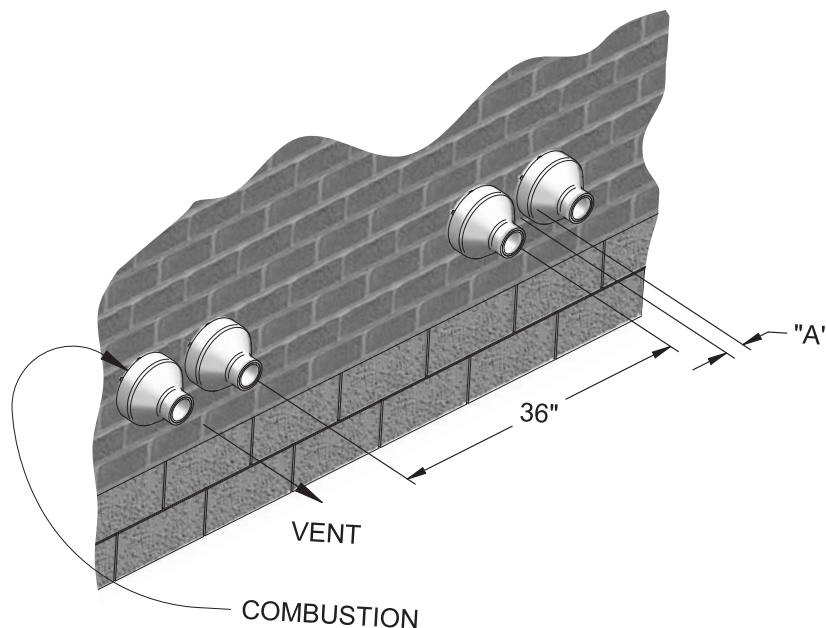


Figure 4-13 Concentric Vent and Combustion Air Termination Dimension A as Touching or 2 inches Maximum Separation

# 5 Vertical direct venting

## Vent/air termination – vertical

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

**⚠ WARNING** Do not connect any other appliance to the vent pipe or multiple 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.

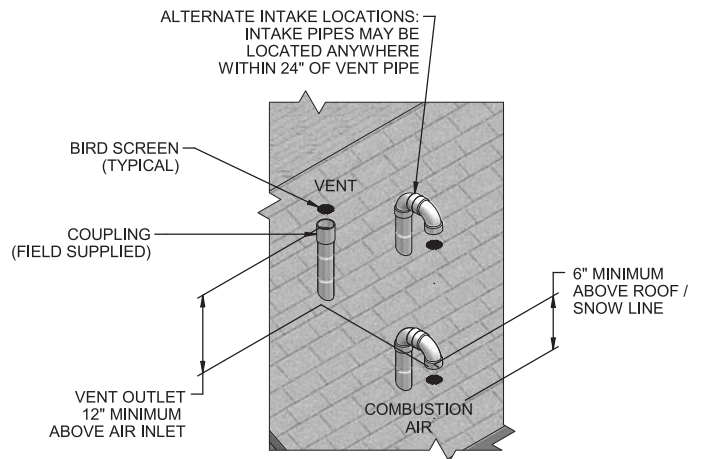
### Determine location

Locate the vent/air terminations using the following guidelines:

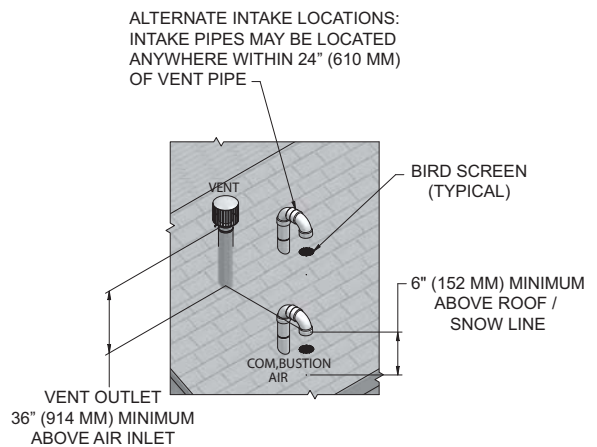
1. The total length of piping for vent or air must not exceed the limits given in the General Venting Section on page 22 of this manual.
2. The vent must terminate at least 3 feet above the highest place in which the vent penetrates the roof and at least 2 feet above any part of a building within 10 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. 5-1A. The top of the coupling must be at least 1 foot above the air intake. When the vent termination uses a rain cap as illustrated in FIG. 5-1B maintain at least 36" (914 mm) above the air inlet. The air inlet pipe and vent pipe can be located in any desired position on the roof, but must always be no further than 2 feet apart and with the vent termination at least 1 foot above the air intake.

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

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



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



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

## 5 Vertical direct venting

### 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
    - 7½ inch hole for 6 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. 5-1A, page 31.
4. Follow all local codes for isolation of vent pipe when passing through floors, ceilings, and roofs.
5. Provide flashing and sealing boots sized for the vent pipe and air pipe.

#### Termination and fittings

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

#### Multiple vent/air terminations

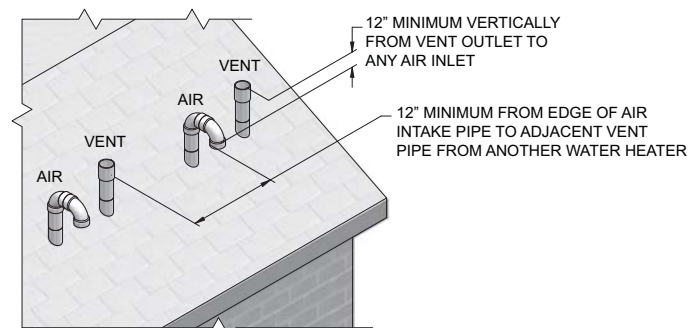
1. When terminating multiple Armor water heaters, terminate each vent/air connection as described in this manual (FIG. 5-2).

#### **WARNING**

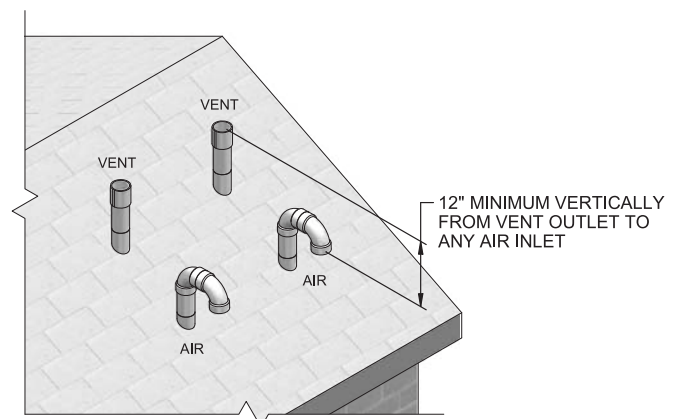
Terminate all vent pipes at the same height and all air pipes at the same height to avoid possibility of severe personal injury, death, or substantial property damage.

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. 5-2). For Canadian installations, provide clearances required by CSA B149.1 Installation Code.
3. The air inlet of an Armor 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 5-2 Vertical Terminations with Multiple Water Heaters**



**Figure 5-3 Alternate Vertical Terminations with Multiple Water Heaters**





## 5 Vertical direct venting *(continued)*

### Vertical termination – optional concentric vent: Models 150 - 600

#### Description and usage

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

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

The required combustion vent pipe and fittings are listed in Table 3A, on page 19 of this manual.

#### Vertical termination installation

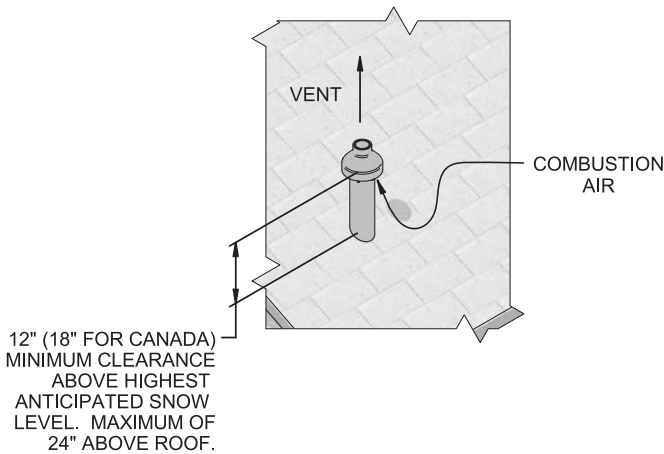
1. See Section 5, Vertical Direct Venting - Determine Location (where applicable).

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 4-7 and 4-8, page 28).
  - b. Cement rain cap to the smaller diameter kit pipe (see FIG.'s 4-7 and 4-8, page 28).
  - c. Do not attach a U-Bent to the rain cap. Doing so could cause recirculation (see FIG. 5-5).

**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. 4-11, page 29).

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

**Figure 5-4** Concentric Vertical Termination



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



## 5 Vertical direct venting

### Vertical termination – optional concentric vent: Models 150 - 600

#### ⚠ WARNING

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

- Install the Y concentric fitting 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.

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

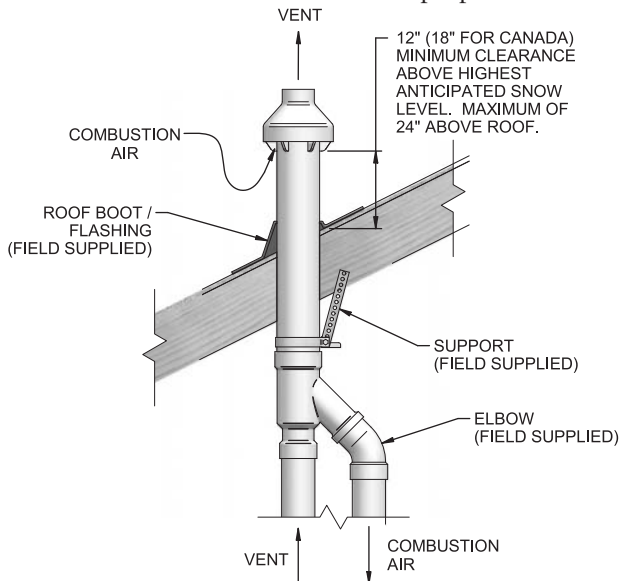
#### CAUTION

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

- 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.
- Cement the appliance combustion air and vent pipes to the concentric vent termination assembly. See FIG. 5-6 for proper pipe attachment.
- Operate the appliance through one (1) heat cycle to ensure combustion air and vent pipes are properly connected to the concentric vent termination connections.

**Figure 5-6 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. 5-4, page 33.

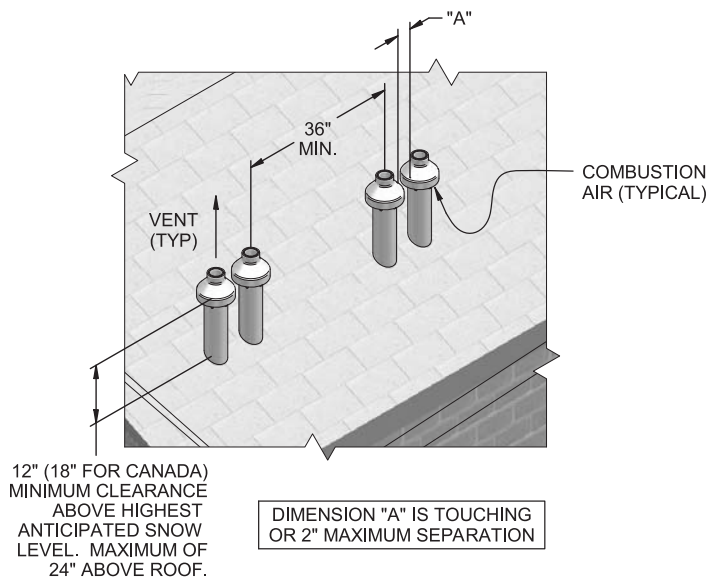
#### NOTICE

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 4-9 and 4-10, page 29).

### Multiventing vertical terminations

When two (2) or more direct vent appliances are vented near each other, each appliance must be individually vented (see FIG. 5-7). NEVER common vent or breach vent this appliance. When two (2) or more direct vent appliances are vented near each other, two (2) vent terminations may be installed as shown in FIG. 5-7. The next two (2) 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. 5-7 represents the distance between pipes or rain shields, as touching or a 2 inch maximum separation.

**Figure 5-7 Concentric Vent and Combustion Air Vertical Termination (Dimension A as Touching or 2 inches Maximum Separation)**

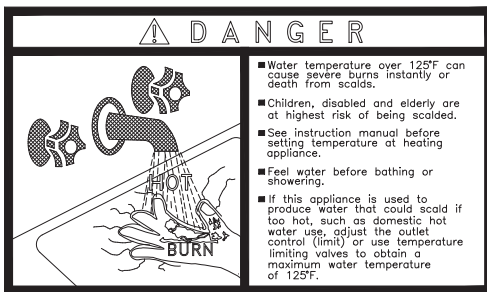


# 6 System piping

## 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 a 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 6-3 Scald Warning Label Located on the Appliance



The following chart (Table 6B) 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 6B 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**

Water temperature rise and maximum flow data is based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 ppm.

The required temperature rise and the standard circulating pump are sized based on the heating of potable water with a hardness of 5 to 25 grains per gallon and a total dissolved solids not exceeding 350 ppm. Consult the manufacturer when heating potable water exceeding these specifications.

Heating of high hardness and/or high total dissolved solids water may require a larger circulating pump, and a revised temperature rise specification based on the water chemistry of the water to be heated.

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

### Water heater system piping:

Water heater system piping MUST be sized per the pipe requirements listed in Table 6C. Reducing the pipe size can restrict the flow rate through the water heater, causing inadvertent high limit shutdowns and poor system performance.

### Check valves:

Field supplied. Check valves are recommended for installation as shown in FIG.'s 6-4 thru 6-8.

### 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. Storage tanks may require additional valves depending on local codes.

### Tank sensor:

Lochinvar supplies a tank sensor. The tank sensor must be installed in the tapping provided in the lower 25% of the storage tank to achieve proper operation. As shipped from the factory, the tank sensor is in the literature package shipped with the unit. Placing the sensor in the tapping provided on the storage tank will improve temperature response and prevent short cycles of operation.

Table 6C Water Heater Pump Applications / Recommended Temperature Rise

Water Heater Pump Applications						
Model	*Pipe Size	Armstrong	Grundfos	Flow Rate (GPM)	Loss (FT/HD)	Temp. Rise
150	1-1/4"	E8	--	16	16.6	18°F
199	1-1/4"	E8	--	21	11.8	18°F
285	2"	E17	--	30	17.1	18°F
399	2"	E24	--	39	21	18°F
500	2"	E22	--	53	26	18°F
600	2"	E22	--	53	26	22°F
700	2"	--	TP 40-160	63	32	22°F
800	2"	--	TP 40-160	67	31	24°F

**NOTICE**

Pump sizing and flow requirements are based on 45 feet of piping, 4 - 90° elbows, and 2 - fully ported ball valves.

# 6 System piping

## System water piping methods

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

### General piping information

Basic steps are listed below along with illustrations on the following pages (FIG.'s 6-4 thru 6-8), which will guide you through the installation of the Armor water heater.

1. Connect the cold water supply to the inlet side of the water heater, make sure to install with pipe sealant compound.
2. Connect the hot water supply to the outlet side of the water heater, make sure to install with pipe sealant compound.
3. Install a backflow preventer on the cold feed make-up water line.
4. Install the factory supplied pump as shown in FIG.'s 6-4 thru 6-8.
5. Install an expansion tank on the system supply. Consult the tank manufacturer's instruction for specific information relating to tank installation. Size the expansion tank for the required system volume and capacity.
6. Install a drain valve at the lowest point of the system.
7. This appliance is supplied with a relief valve sized in accordance with ASME Boiler and Pressure Vessel Code, Section IV ("Heating Boilers"). Pipe the discharge of the safety relief valve to a suitable drain to prevent injury in the event of pressure relief. Pipe the discharge to a drain. Provide piping that is the same size as the safety relief valve outlet. Never block the outlet of the safety relief valve.

**⚠ WARNING**

The relief valve, tee and other necessary fittings are shipped in the install kit with the water heater and are to be field installed.

See the \*piping illustrations included in this section, FIG.'s 6-4 thru 6-8 for suggested guidelines in piping the Armor 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.

### Flow switch and relief valve installation

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

1. Install the tee with the 3/4 inch fitting positioned vertically and on the top as shown in FIG. 6-1.
2. Install the relief valve into the 3/4 inch fitting of the tee installed in Step 1 (FIG. 6-1).
3. Install the close nipple on the downstream side of the temperature and pressure relief valve tee (FIG. 6-1).
4. Install the tee with the 1 inch fitting positioned vertically and on the top (FIG. 6-1).
5. Attach the paddle to the flow switch per the manufacturer's instructions. Reference Table 6A to select the correct paddle for the pipe size used (consult the manufacturer's instructions for a detailed explanation).

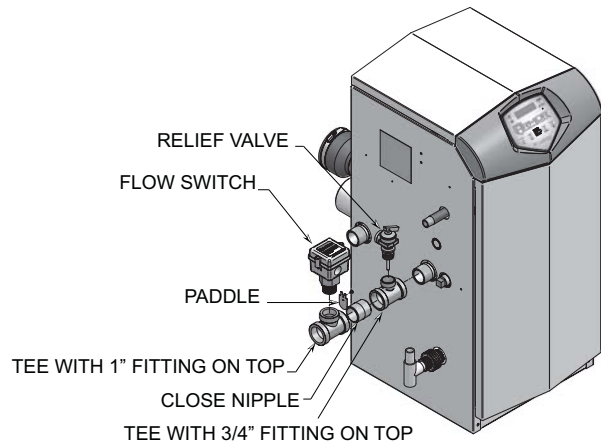
**For Example:** If using a 1 1/4 inch pipe size (Models AWN150 - AWN199) select paddle #1.

6. Install the assembled flow switch into the 1 inch fitting of the tee installed in Step 4 (see FIG. 6-1).

**NOTICE**

Be sure to install flow switch so that the arrow on the flow switch is pointing in the direction of the flow (see FIG. 6-2).

Figure 6-1 Flow Switch and Relief Valve Installation



### Flow switch adjustment

Refer to Table 6A for the proper setting of the sensitivity screw. For reference, the position of the screw prior to setting should be turned clockwise with a Phillips driver until it stops (FIG. 6-2). Proceed to turn the screw counterclockwise the amount of turns listed in Table 6A based on the model.

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

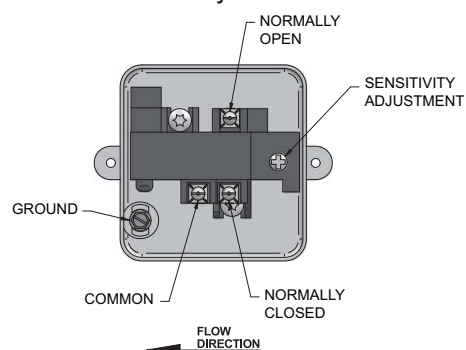
Table 6A Paddle Size / Sensitivity Screw Adjustment

MODEL	PADDLE SIZE	SENSITIVITY SCREW ADJUSTMENT
<b>Note: Paddles are included with the flow switch.</b>		
150	#1	9 turns
199	#1	6 turns
285	#3	8¾ turns
399	#1	8 turns
500	#1	7½ turns
600	#1	7 turns
700	#1	6½ turns
800	#1	5½ turns

**NOTICE**

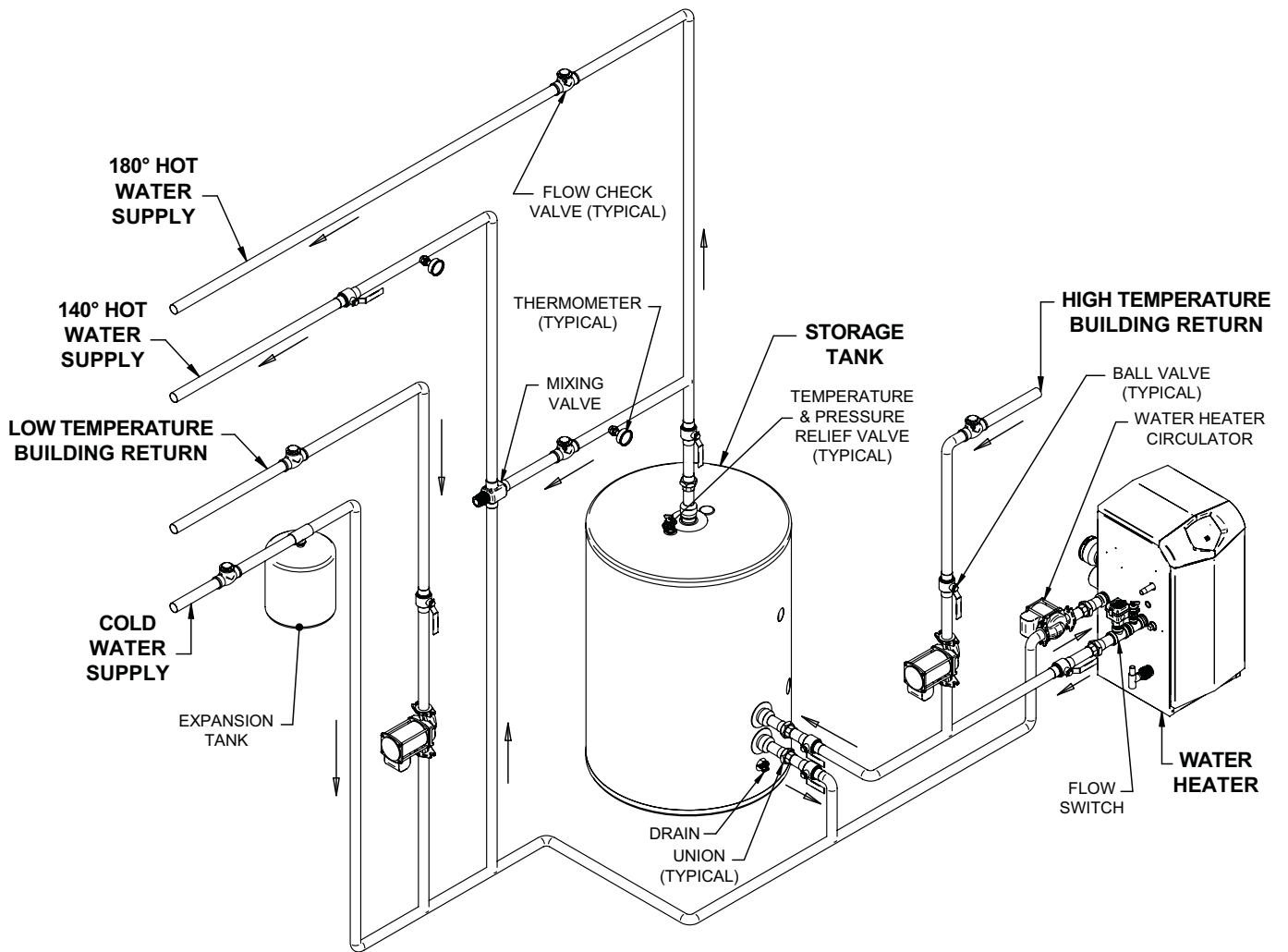
Turn the sensitivity screw clockwise to increase the flow rate required to activate the switch. Turn the sensitivity screw counterclockwise to decrease the flow rate required to activate the switch.

Figure 6-2 Flow Switch Adjustment



## 6 System piping *(continued)*

Figure 6-4 Single Heater - Single Tank (2 Temperature)



**CAUTION**

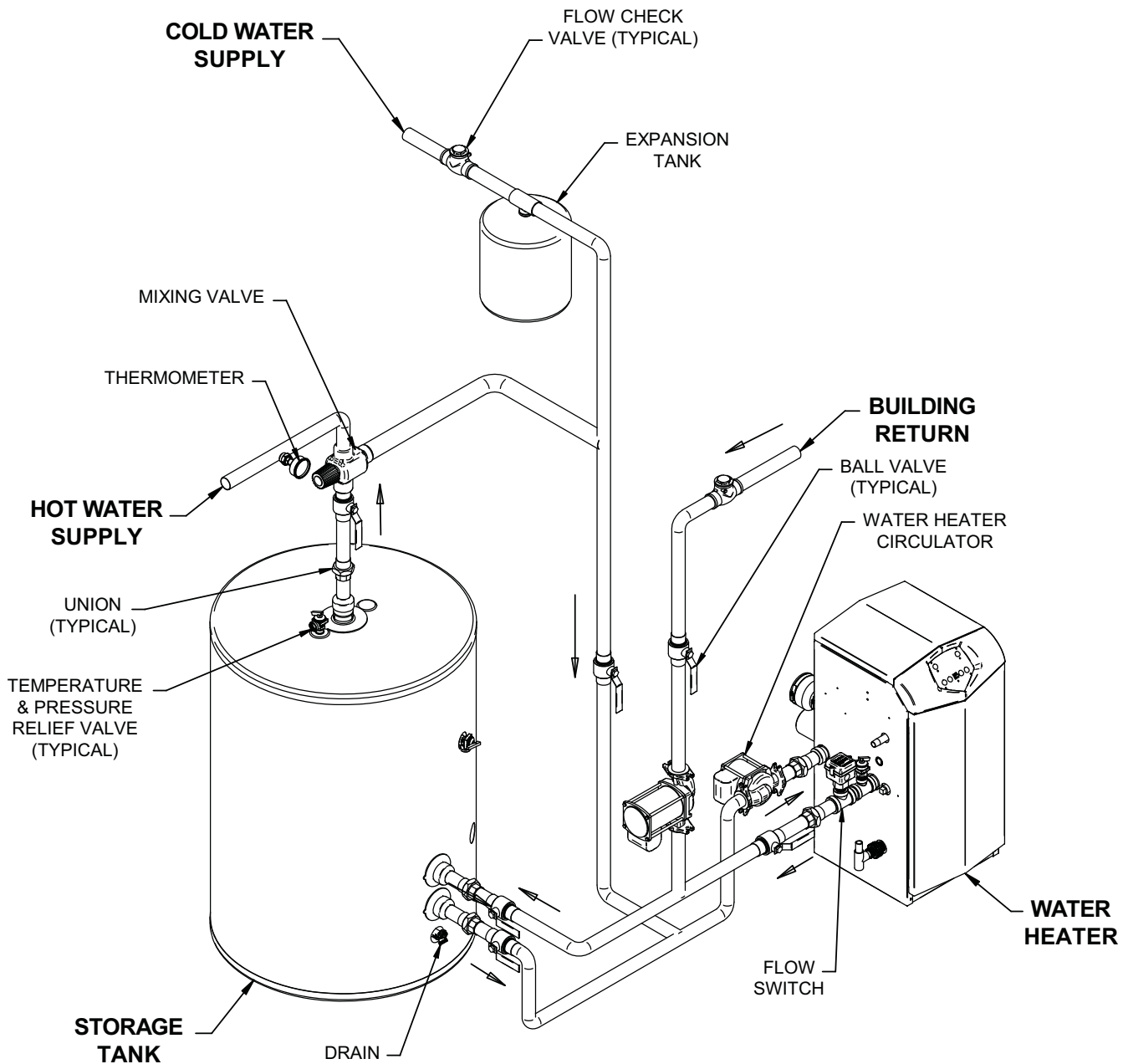
The piping will not support the weight of the water heater circulator pump. Do not attempt to support the weight of the water heater circulator pump with the piping or its accessories. Refer to the pump manufacturer's installation instructions. Failure to comply could result in severe personal injury, death, or substantial property damage.

**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 6-5 Single Heater - Single Tank

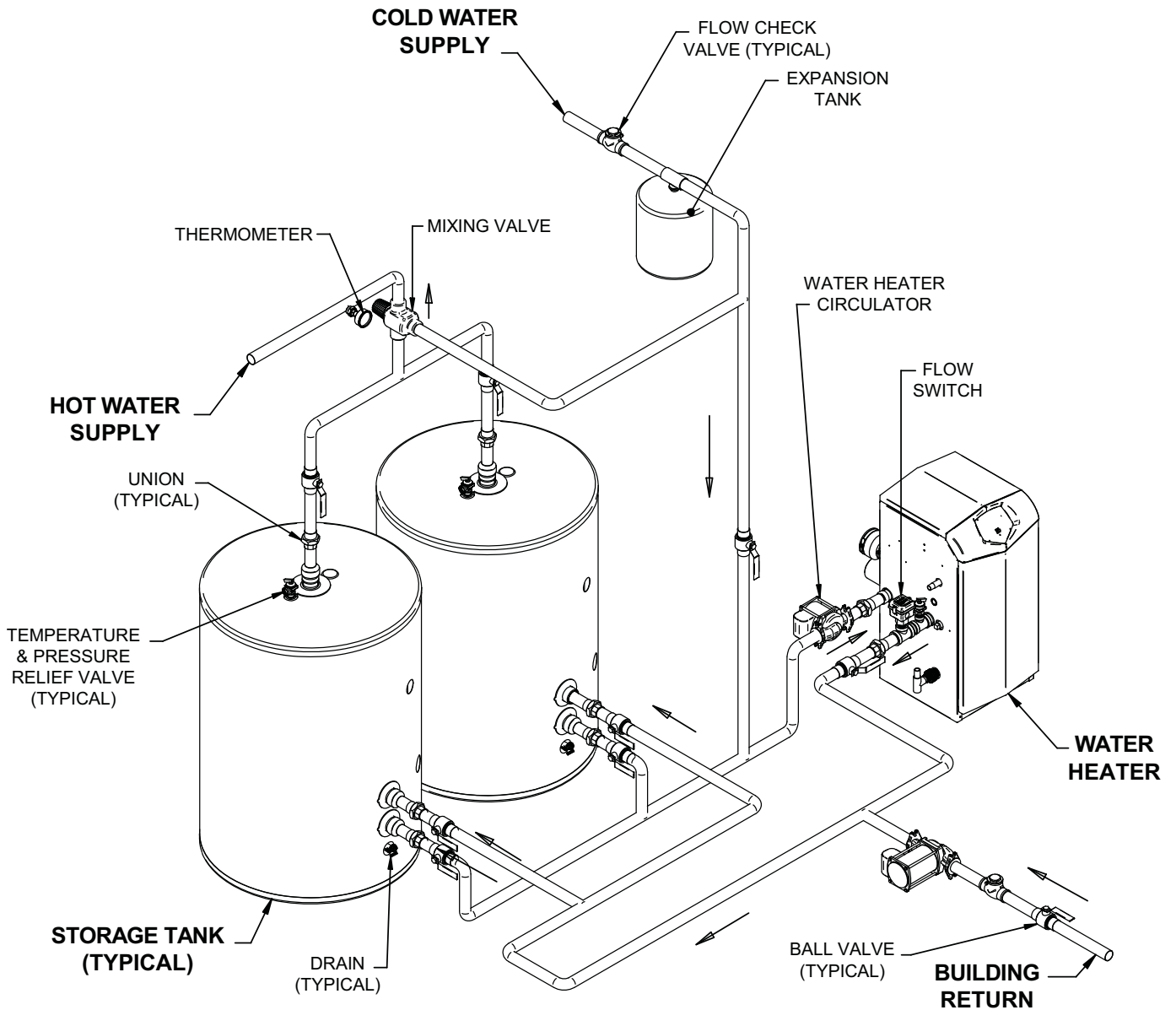


**CAUTION** The piping will not support the weight of the water heater circulator pump. Do not attempt to support the weight of the water heater circulator pump with the piping or its accessories. Refer to the pump manufacturer's installation instructions. Failure to comply could result in severe personal injury, death, or substantial property damage.

**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 *(continued)*

Figure 6-6 Single Heater - Double Tank



**CAUTION**

The piping will not support the weight of the water heater circulator pump. Do not attempt to support the weight of the water heater circulator pump with the piping or its accessories. Refer to the pump manufacturer's installation instructions. Failure to comply could result in severe personal injury, death, or substantial property damage.

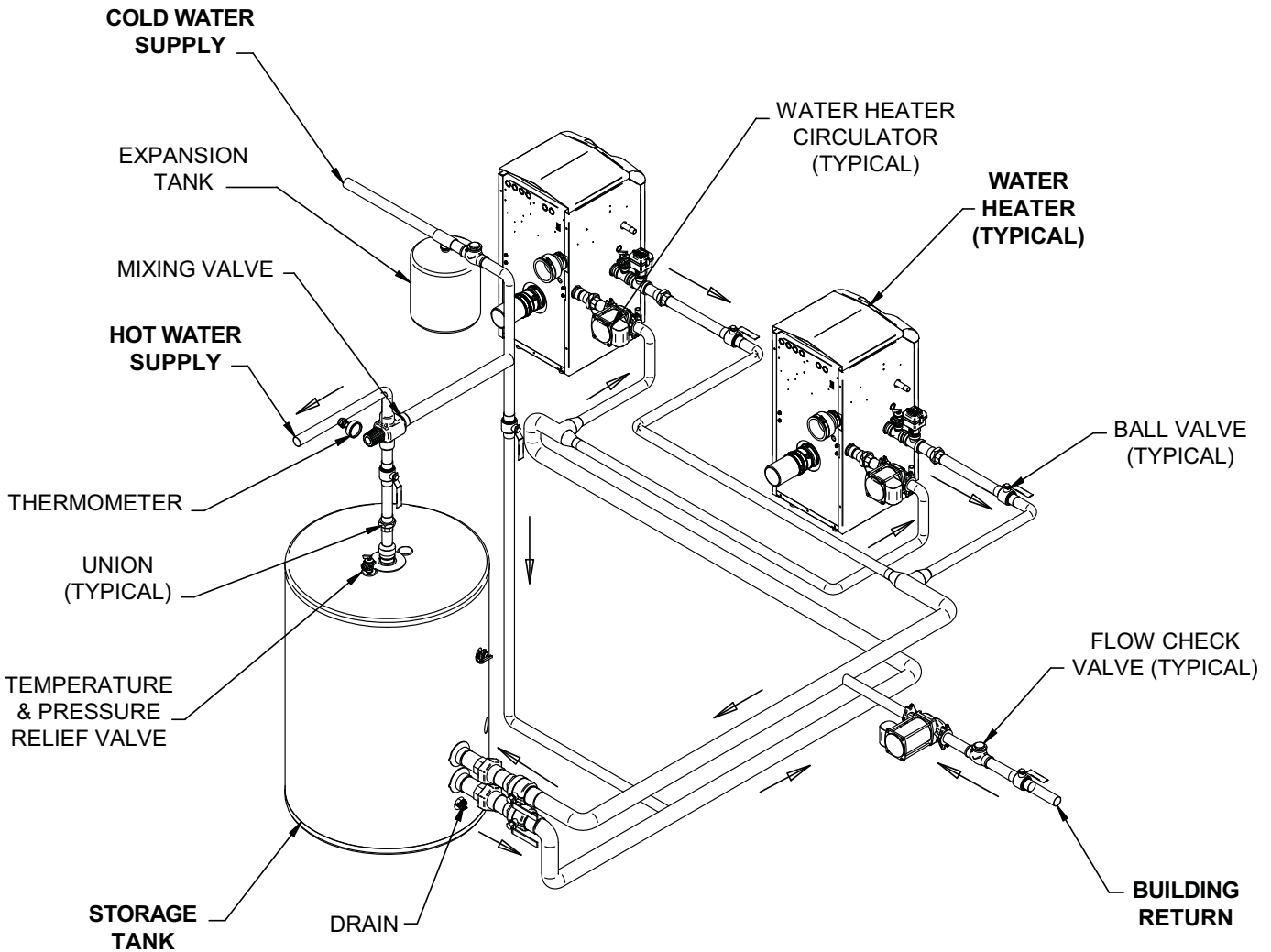
**NOTICE**

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 6-7 Double Heater - Single Tank

Model	Number of Units						
	2	3	4	5	6	7	8
	Required Pipe Sizes in NPT						
150	1 1/2"	2"	2"	2"	2 1/2"	3"	3"
199	1 1/2"	2"	2 1/2"	2 1/2"	3"	3"	4"
285	2"	2 1/2"	2 1/2"	3"	3"	4"	4"
399	2 1/2"	3"	3 1/2"	4"	4"	5"	5"
500	3"	3 1/2"	4"	5"	5"	5"	6"
600	3"	3 1/2"	4"	5"	5"	5"	6"
700	3"	4"	5"	5"	6"	6"	6"
800	3"	4"	5"	6"	6"	6"	6"



**CAUTION** The piping will not support the weight of the water heater circulator pump. Do not attempt to support the weight of the water heater circulator pump with the piping or its accessories. Refer to the pump manufacturer’s installation instructions. Failure to comply could result in severe personal injury, death, or substantial property damage.

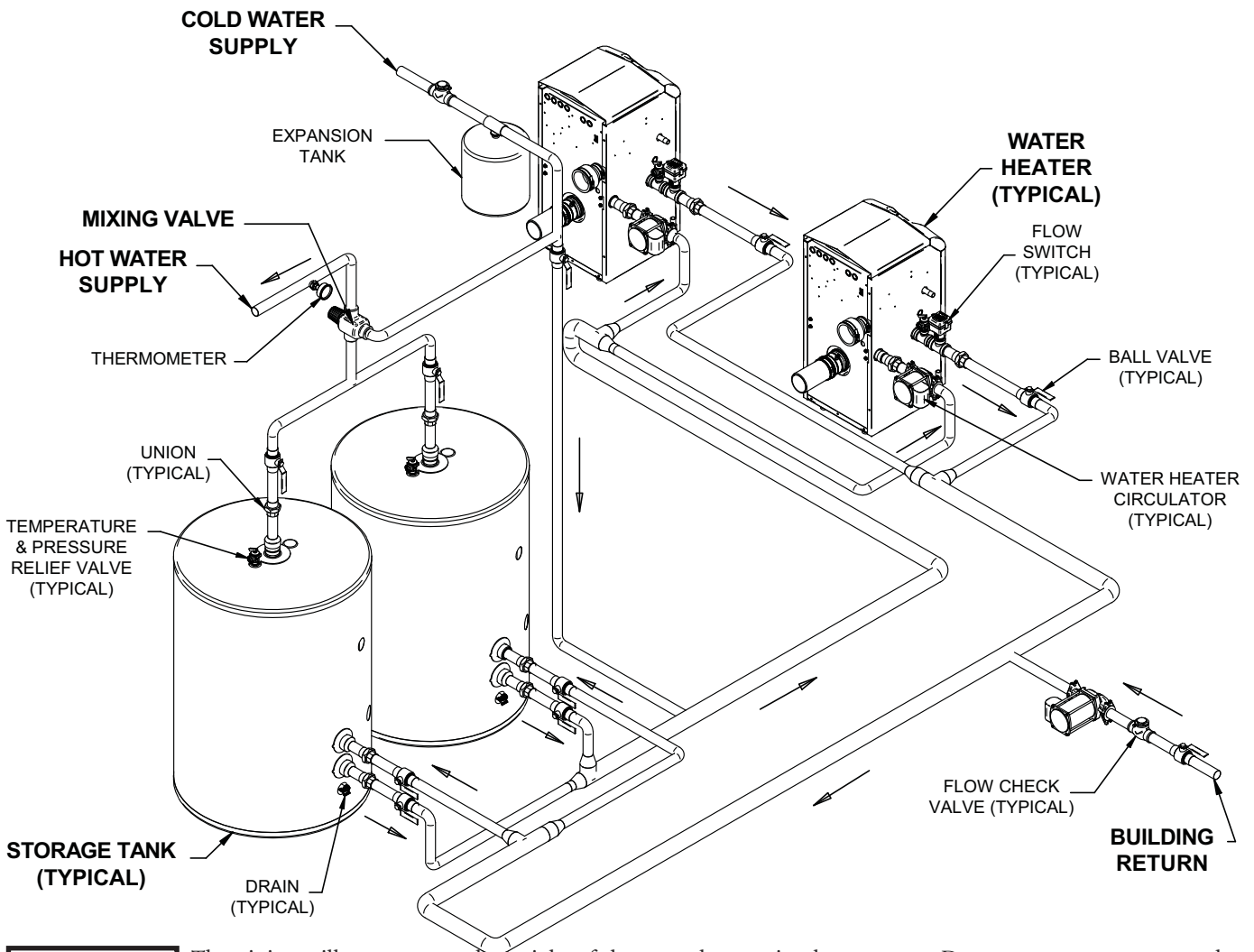
**NOTICE** Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.



# 6 System piping *(continued)*

Figure 6-8 Double Heater - Double Tank

Model	Number of Units						
	2	3	4	5	6	7	8
	Required Pipe Sizes in NPT						
150	1 1/2"	2"	2"	2"	2 1/2"	3"	3"
199	1 1/2"	2"	2 1/2"	2 1/2"	3"	3"	4"
285	2"	2 1/2"	2 1/2"	3"	3"	4"	4"
399	2 1/2"	3"	3 1/2"	4"	4"	5"	5"
500	3"	3 1/2"	4"	5"	5"	5"	6"
600	3"	3 1/2"	4"	5"	5"	5"	6"
700	3"	4"	5"	5"	6"	6"	6"
800	3"	4"	5"	6"	6"	6"	6"



**CAUTION** The piping will not support the weight of the water heater circulator pump. Do not attempt to support the weight of the water heater circulator pump with the piping or its accessories. Refer to the pump manufacturer's installation instructions. Failure to comply could result in severe personal injury, death, or substantial property damage.

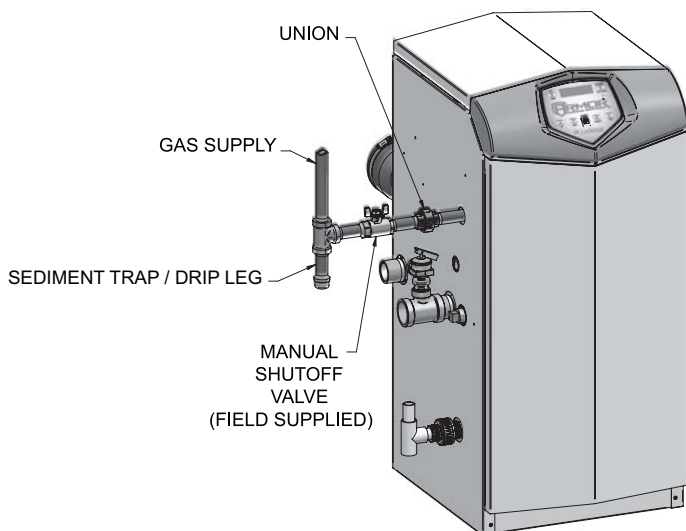
**NOTICE** Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

# 7 Gas connections

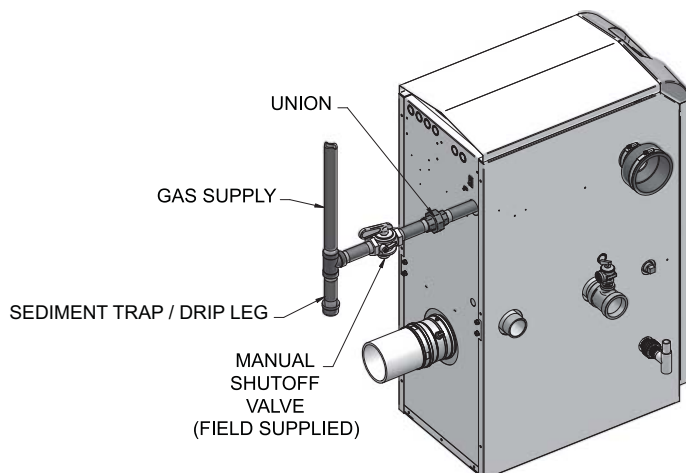
## Connecting gas supply piping

1. Remove the top access panel and refer to FIG.'s 7-1 thru 7-4 to pipe gas to the water heater.
  - a. Install ground joint union for servicing, when required.
  - b. On Models 150 - 399 install a manual shutoff valve in the gas supply piping outside water heater jacket when required by local codes or utility requirements.
  - c. In Canada – When using manual main shutoff valves, it must be identified by the installer.
2. Install sediment trap / drip leg.

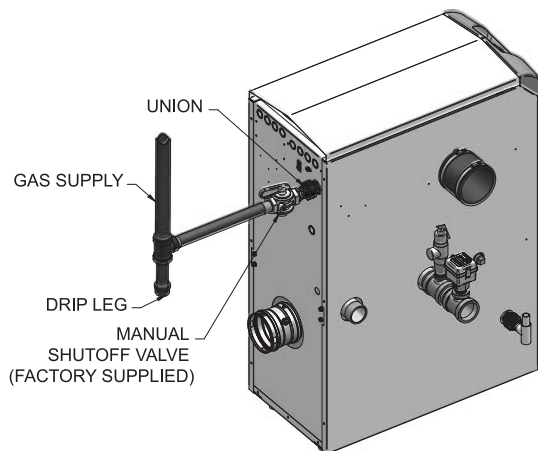
**Figure 7-1 Gas Supply Piping - Models 150 - 199**



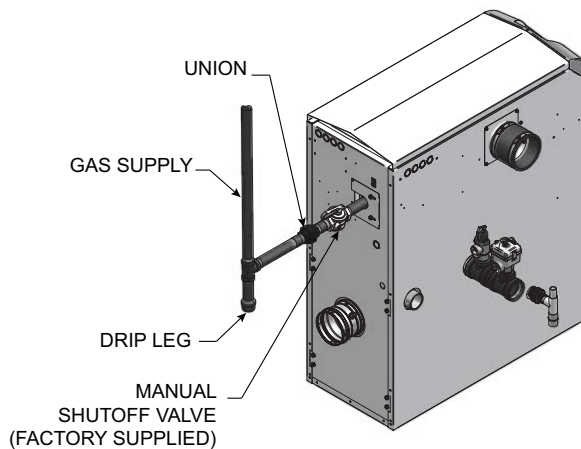
**Figure 7-2 Gas Supply Piping - Models 285 - 399**



**Figure 7-3 Gas Supply Piping - Model 500**



**Figure 7-4 Gas Supply Piping - Models 600 - 800**



3. 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.

4. Purge all air from the gas supply piping.
5. 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.

## 7 Gas connections *(continued)*

**⚠ 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.

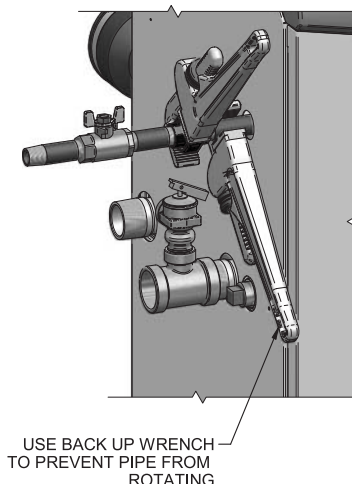
- Use pipe sealing compound compatible with propane gases. Apply sparingly only to male threads of the pipe joints so that pipe dope does not block gas flow.

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

**⚠ WARNING** Armor 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. If set to natural gas, it may be converted to LP by installing an orifice or by making a gas valve adjustment (see pages 13 thru 15). In order to operate on LP gas, an orifice **MUST BE** installed or a gas valve adjustment **MUST BE** made. Failure to comply could result in severe personal injury, death, or substantial property damage.

**⚠ WARNING** Use two wrenches when tightening gas piping at water heater (FIG. 7-5), 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 7-5 Inlet Pipe with Backup Wrench**



**NOTICE**

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

### Natural gas:

#### Pipe sizing for natural gas

- 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).
  - 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.
  - For additional gas pipe sizing information, refer to ANSI Z223.1 (or B149.1 for Canadian installations).

#### Natural gas supply pressure requirements

- 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).
- 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** Armor 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. If set to natural gas, it may be converted to LP by installing an orifice or by making a gas valve adjustment (see pages 13 thru 15). In order to operate on LP gas, an orifice **MUST BE** installed or a gas valve adjustment **MUST BE** made. Failure to comply could result in severe personal injury, death, or substantial property damage.

#### Pipe sizing for propane gas

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

#### Propane Supply Pressure Requirements

- Adjust propane supply regulator provided by the gas supplier for 14 inches w.c. maximum pressure.
- 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).

**⚠ WARNING** Ensure that the high gas pressure regulator is at least 6 - 10 feet upstream of the appliance.

# 7 Gas connections

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

Nominal Iron Pipe Size (Inches)	Single Unit 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**

Armor 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. If set to natural gas, it may be converted to LP by installing an orifice or by making a gas valve adjustment (see pages 13 thru 15). In order to operate on LP gas, an orifice **MUST BE** installed or a gas valve adjustment **MUST BE** made. Failure to comply could result in severe personal injury, death, or substantial property damage.

## Check 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, 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. Turn the main power switch to the "OFF" position.
2. Shut off gas supply at the manual gas valve in the gas piping to the appliance.
3. On Models 150 - 500 loosen the set screw one (1) full turn from inside the pressure tap on top of the gas valve. On Models 600 - 800 remove the 1/8" (3 mm) pipe plug on the inlet flange to the valve and install a suitable 1/8" (3 mm) fitting (field supplied) for the manometer tubing. Place the tubing of the manometer over the tap once the set screw is loosened or the 1/8" (3 mm) fitting is installed (depending on model) as shown in FIG.'s 7-6 thru 7-9 on page 45.
4. Slowly turn on the gas supply at the field installed manual gas valve.

5. Turn the power switch to the "ON" position.
6. Adjust the temperature set point on the control panel of the SMART SYSTEM 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. Turn the power switch to the "OFF" position.
12. Shut off the gas supply at the manual gas valve in the gas piping to the appliance.
13. Remove the manometer from the pressure tap on top of the gas valve. On Models 150 - 500 re-tighten the set screw inside the pressure tap. On Models 600 - 800 remove the 1/8" (3 mm) field supplied fitting and reinstall the pipe plug removed in Step 3.

**⚠ WARNING**

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

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

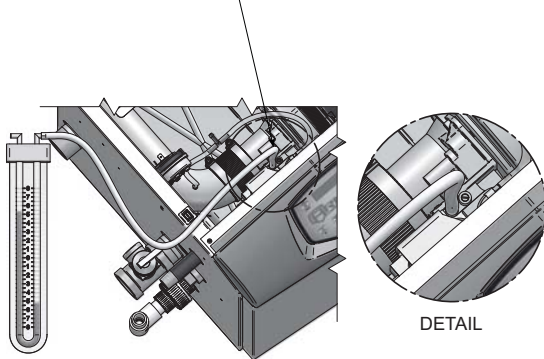
14. Turn on the gas supply at the manual gas valve.
15. Turn the power switch to the "ON" position.
16. Adjust the temperature set point on the control panel of the SMART SYSTEM control module to the desired water temperature so the appliance will call for heat.

# 7 Gas connections *(continued)*

- 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.

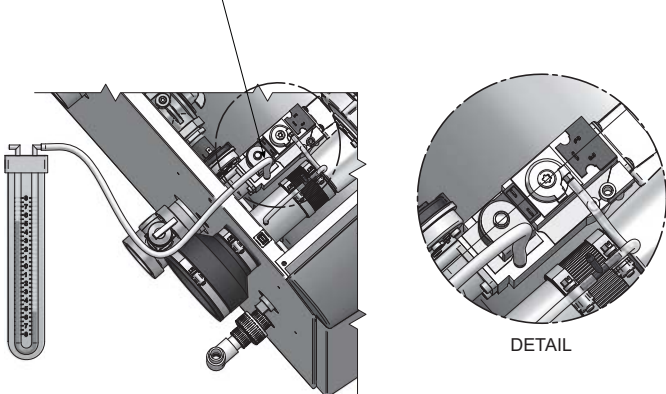
**Figure 7-6 Inlet Gas Supply Check - Models 150 - 285**

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



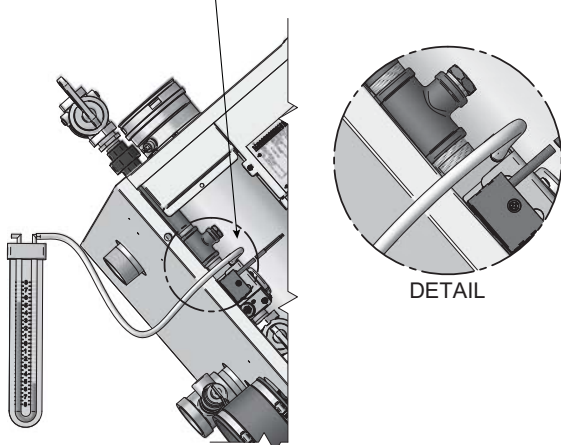
**Figure 7-7 Inlet Gas Supply Check - Model 399**

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



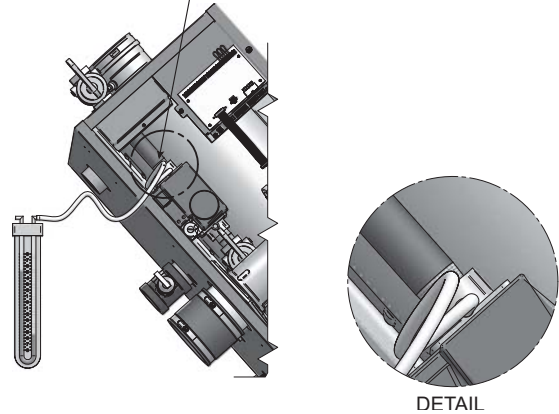
**Figure 7-8 Inlet Gas Supply Check - Model 500**

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



**Figure 7-9 Inlet Gas Supply Check - Models 600 - 800**

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



## Gas pressure

The gas pressure must remain between 4 inches w.c. (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 Armor 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, 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.

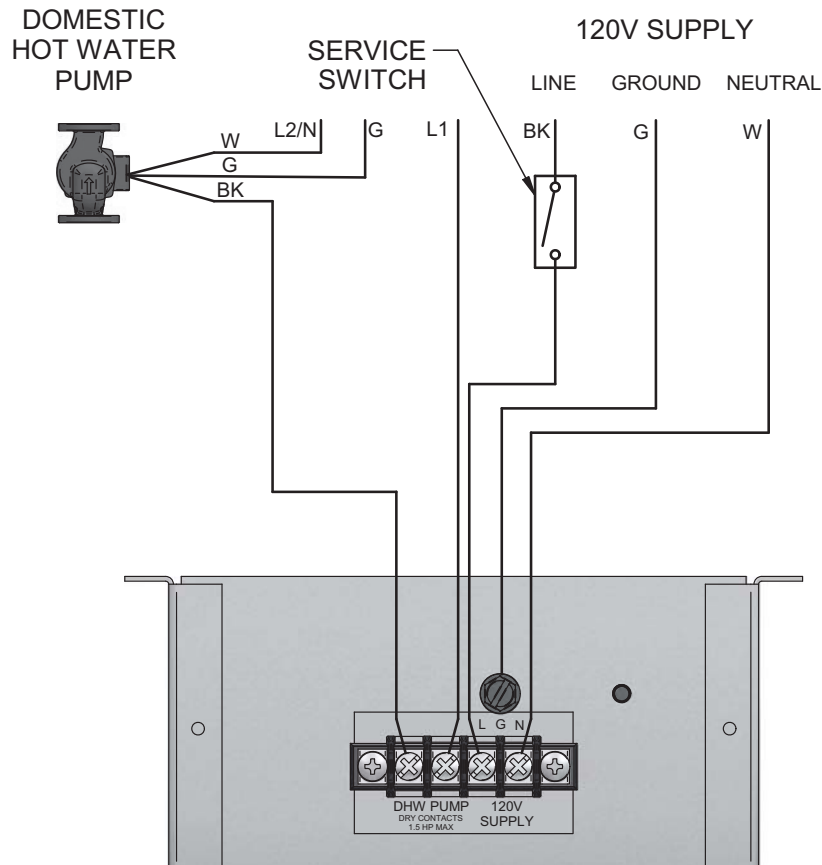
### Installation must comply with:

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

### Line voltage connections

1. Connect 120 VAC power wiring to the line voltage terminal strip in the junction box, as shown in FIG. 8-1.
2. Provide and install a fused disconnect or service switch (15 amp recommended) as required by the code (see FIG. 8-1).
3. The DHW (water heater) pump is shipped loose on all Armor models. Wire the water heater pump as shown in FIG. 8-1.
4. Dry contacts are sized for 1.5 hp/120V, 3 hp/240V or 25 amps.

Figure 8-1 Line Voltage Field Wiring Connections

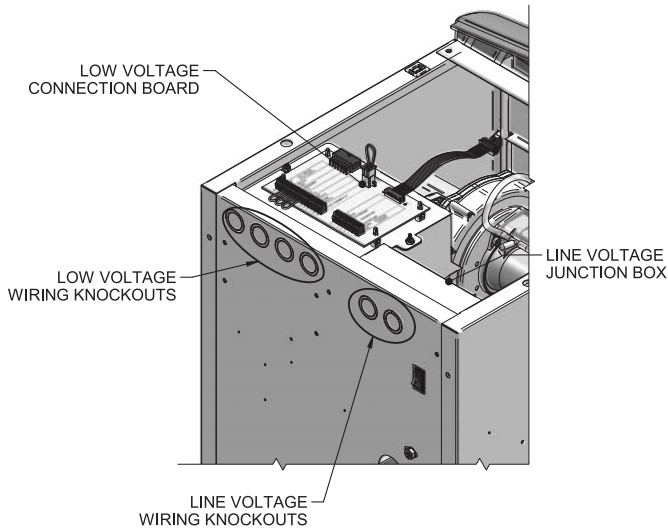


## 8 Field wiring *(continued)*

### Low voltage connections

1. Route all low voltage wires through the knockouts in the rear of the water heater, as shown in FIG. 8-2.
2. Connect low voltage wiring to low voltage connection board as shown in FIG. 8-3 on page 49 of this manual and the water heater wiring diagram.

**Figure 8-2 Routing Field Wiring (Models 150 - 285)**



### Thermostat

If a tank thermostat is used, connect it to the tank thermostat terminals on the low voltage connection board (see FIG. 8-3 on page 49).

### Tank sensor

If a tank sensor is used, connect it to the tank sensor terminals on the low voltage connection board (see FIG. 8-3 on page 49). If using a tank sensor you **MUST** use the sensor provided with the water heater.

### Auxiliary device relay

1. If an auxiliary device needs to operate when the water heater fires, it can be controlled by this output. Connect these terminals to a 24 VAC relay coil, which is wired to operate the auxiliary device (FIG. 8-3).

### Auxiliary device proving switch

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

### High gas pressure switch

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

### Low gas pressure switch

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

#### NOTICE

See *Section 7 - Gas Connections* for a detailed explanation regarding high and low gas pressure switch operation.

### Flow switch

1. A flow switch is used to guarantee flow through the water heater before allowing it to fire. The flow switch must be installed in line with the water heater.
2. Connect these terminals to the normally open contacts on the flow switch (FIG. 8-3).

### Water heater Building Management System (BMS)

1. An external control may be connected to control either the firing rate or the set point of the water heater. Connect the tank thermostat terminals to the enable output of the external control and connect the 0 - 10 VDC terminals to the 0 - 10 VDC output of the external control.
2. Make sure the ground terminal is connected to the ground output terminal of the external control, and the 0 - 10 VDC terminal is connected to the 0 - 10 VDC terminal of the external control.

## 8 Field wiring

### Runtime contacts

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

### Alarm contacts

The SMART SYSTEM 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.

### Wiring of the cascade

When wiring the water heaters for Cascade operation, select one water heater as the Leader water heater. The remaining water heaters will be designated as Members. See page 56 “Configuration of the Cascade” for a detailed explanation of this procedure.

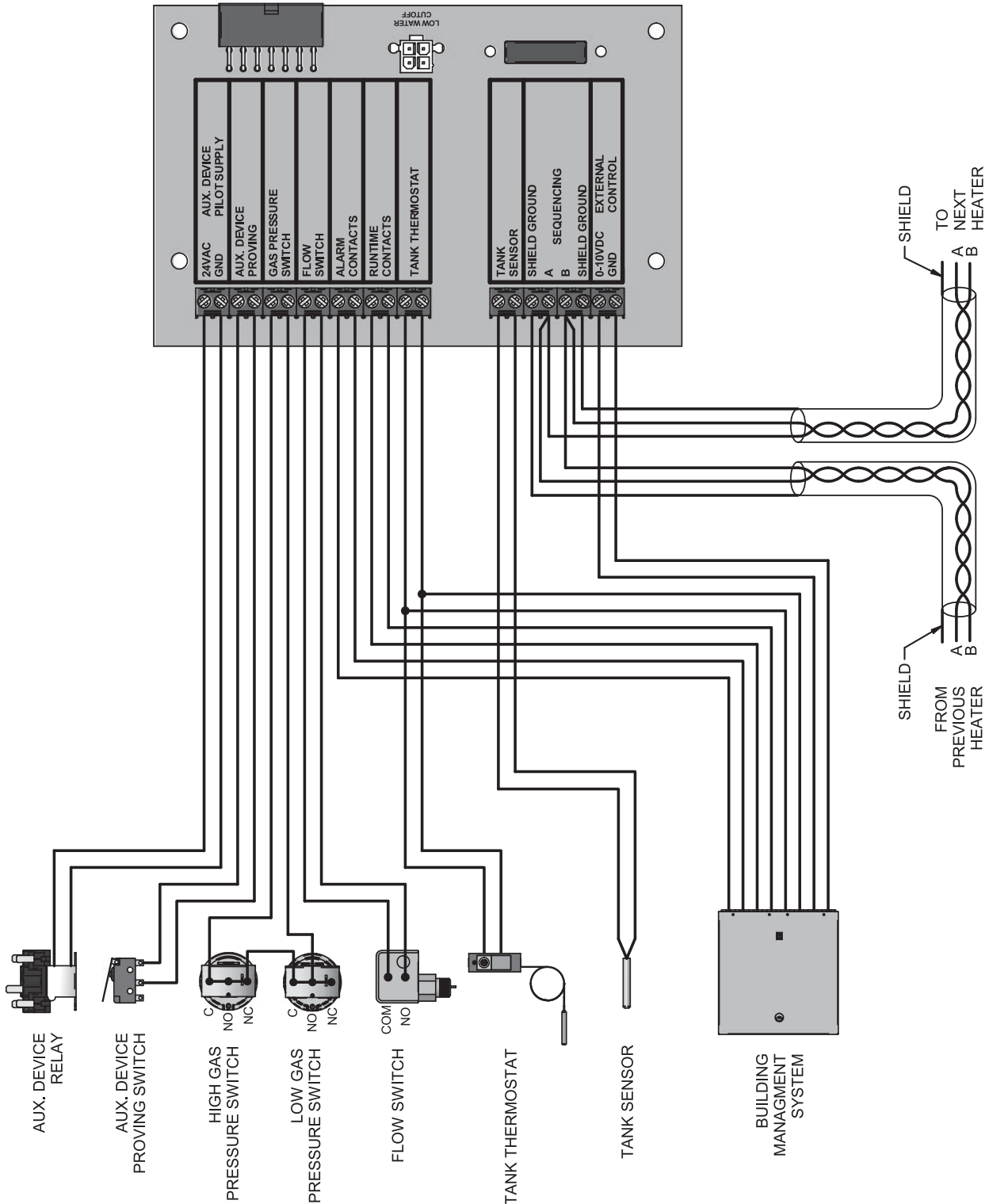
Connect the tank sensor to the Leader water heater. For the Cascade system to work properly the tank sensor must be installed. The tank sensor should be wired to the low voltage connection board at the terminals marked for the tank sensor (see FIG. 8-3). The Leader control will use the water temperature at the tank sensor to control the operation of the Cascade.

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



# 8 Field wiring (continued)

Figure 8-3 Low Voltage Field Wiring Connections



## 9 Condensate disposal

### Condensate drain

1. This water heater is a high efficiency appliance that produces condensate.
2. The side of the water heater has a 1/2 inch PVC union for connection of a 1/2 inch PVC pipe (FIG. 9-1).
3. Slope condensate tubing down and away from the water heater into a drain or condensate neutralizing filter. Condensate from the Armor 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 (FIG. 9-1) is available from the factory (KIT3087 for Models 150 - 500 and KIT3046 for Models 600 - 800).

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

#### NOTICE

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

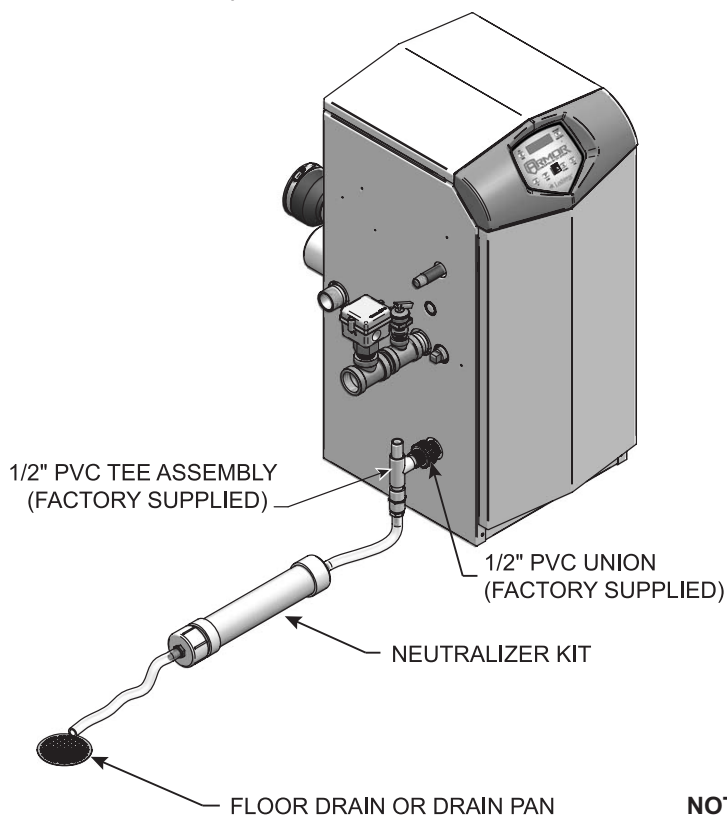
#### NOTICE

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

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.

8. 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



**NOTE:** KIT3087 shown for illustration purposes.

# 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, requiring no field adjustment. Attempting to alter or measure the gas valve outlet pressure could result in damage to the valve, causing potential severe personal injury, death, or substantial property damage.

## ⚠ WARNING

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.

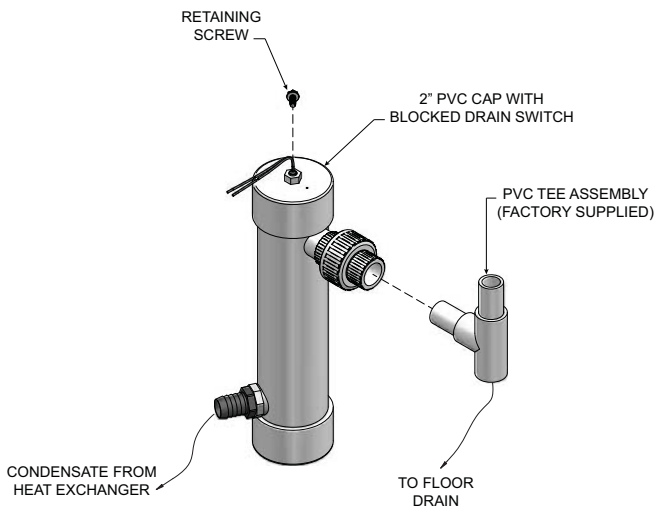
### Fill condensate trap with water

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.

Figure 10-1 Condensate Trap



# 10 Start-up

## Final checks before starting the water heater

- ❑ Read the Armor Water Heater Service Manual to familiarize yourself with SMART SYSTEM control module operation. Read this manual, pages 53 and 54 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 51 and 52 have been completed.
- ❑ Fill the vent condensate trap with water (removing the retaining screw in order to remove the 2 inch PVC cap with the switch located at the top of the trap). Replace the cap. Press the cap onto the trap until the cap makes contact with the drain. Replace the retaining screw.
- ❑ Verify electrical connections are correct and securely attached.
- ❑ Inspect vent piping and air piping for signs of deterioration from corrosion, physical damage or sagging. Verify air piping and vent piping are intact and correctly installed per this manual.

## Start the water heater

1. Read and follow the Operating instructions in FIG.'s 10-2 and 10-3, pages 53 and 54.

## 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 heater water temperature above 200°F?
3. Is tank thermostat or tank set point set below room temperature?
4. Is gas turned on at meter or 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 the Armor Water Heater Service 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 51 and 52 (startup) regarding failure to repair leaks.)
2. Check Delta T. Reference Section 6 - *System Piping* on page 35 for more information regarding Delta T.
3. Vent any remaining air from the system using manual vents. Air in the system will interfere with circulation and cause heat distribution problems and noise.

### ❑ Check vent piping and air piping

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

#### **⚠ WARNING**

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

### ❑ Check gas piping

1. Check around the 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.

### ❑ Propane water heaters – verify conversion

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

#### **⚠ WARNING**

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

#### **⚠ WARNING**

Armor 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. If set to natural gas, it may be converted to LP by installing an orifice or by making a gas valve adjustment (see pages 13 thru 15). In order to operate on LP gas, an orifice **MUST BE** installed or a gas valve adjustment **MUST BE** made. Failure to comply could result in severe personal injury, death, or substantial property damage.

## Check flame and combustion

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

# 10 Start-up *(continued)*

Figure 10-2 Operating Instructions - Models 150 - 285

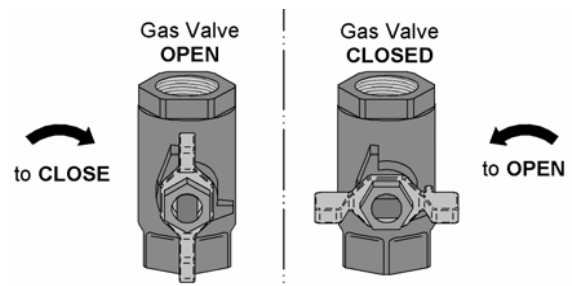
## FOR YOUR SAFETY READ BEFORE OPERATING

**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 clockwise to close valve. 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 counterclockwise to open valve. 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 clockwise to close valve. Handle will be perpendicular to pipe. Do not force
5. Install top cover.

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# 10 Start-up

Figure 10-3 Operating Instructions - Models 399 - 800

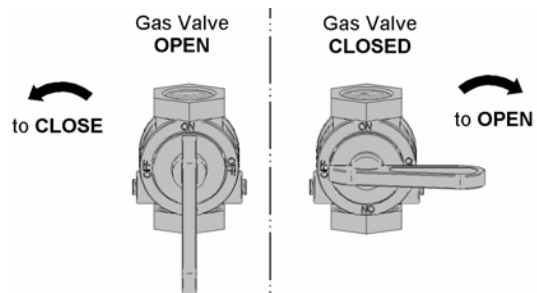
## FOR YOUR SAFETY READ BEFORE OPERATING

**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 Start-up *(continued)*

## Check flame and combustion *(continued)*

4. Place the water heater into the active position by pressing the SHUTDOWN button on the display board (FIG. 11-1, page 61) until **WHR: Standby** appears in the display window.
5. Locate the pinhole button above the “R” in the Armor 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 below. The CO levels should be less than 150 ppm for a properly installed unit.

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

**Table 10A Flue Products Chart**

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

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

### **WARNING**

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

## Set water heater operation

### Set tank set point temperature

If the tank sensor is connected the UP and DOWN keys may be used during normal operation to adjust the tank set point temperature. Once the desired temperature is displayed, press the ENTER/RESET key to save the new setting. If the ENTER/RESET key is not pressed, the new setting will be used for the current heating cycle only. The old setting will become active after the current heating cycle ends.

If a tank thermostat is used, set the water heater set point above the setting of the tank thermostat by pressing the MENU key for at least 5 seconds (see the Armor Service Manual for a detailed explanation of this procedure). The SMART SYSTEM control will use this set point to modulate the burner based on the inlet temperature into the water heater. If a tank sensor is used, set the water heater set point to the desired tank temperature.

### Verify WHR circulator mode

When the tank thermostat or tank sensor calls for heat, the SMART SYSTEM control will turn on the water heater pump. When the DHW call for heat ends, the water heater pump will continue to run for a period of time. This pump delay is set at the factory to 30 seconds. If a shorter or longer delay is desired, the appropriate parameter in the control must be changed. See the Armor Water Heater Service Manual for a detailed explanation of this procedure.

# 10 Start-up

## Set clock

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

1. Press and hold the MENU key for at least 5 seconds.
2. The display changes to ready "ENTER MENU CODE", with four (4) zeros below it.
3. Change the zeros to match the user code (factory set at "0704"). Use the UP and DOWN keys to increment or decrement the flashing digit, and the NEXT and PREVIOUS keys to select which digit flashes.
4. Press the ENTER key.
5. The display changes to read USER CODE for a few seconds, then displays a menu.
6. Press the ENTER key.
7. Press the UP key twice to display "A3 DATE AND TIME".
8. Press the ENTER key once.
9. The date and time are displayed as "YY:MM:DD W hh:mm", where:  
 mm: minutes  
 hh: hour (24 hour time; e.g., 2:00 PM = 14:00)  
 W: day of the week (1 = Sunday, 2 = Monday, 3 = Tuesday, etc.,)  
 DD: date  
 MM: month  
 YY: year

Use the UP and DOWN keys to increment or decrement the flashing number, and the NEXT and PREVIOUS keys to select which number flashes.

10. Press the ENTER key to save the setting.
11. Press the MENU key twice to exit the Programming Mode.

### NOTICE

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

## Configuration of the cascade

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

Input the Installer code as described in the Armor Water Heater Service Manual. Once the control parameters have been accessed, use the DOWN arrow key to select the H Control Mode parameters. Press the ENTER key to access these parameters. Use the UP arrow key to access parameter H2 SH Source. Press the ENTER key to access this parameter. Use the DOWN arrow key to select Cascade. Press the ENTER key to program this into the control.

Press the UP arrow key to select the parameter H3 WHR Address. Press the ENTER key to access this parameter. Each unit in the Cascade system must be programmed with its own address. The water heater designated as the Leader will have an address of 0. The remaining water heaters in the Cascade will be Members and have addresses from 1 - 7. Use the UP and DOWN arrow keys to select the appropriate address. Press the ENTER key to program this into the control.

Press the MENU key twice to exit the control parameters. Repeat this procedure for all water heaters in the Cascade, designating the Leader control and the Member controls.



# 11 Operating information

## General

### How the water heater operates

The Armor water heater uses an advanced stainless steel heat exchanger and electronic control module that allows fully condensing operation. The blower pulls in air and pushes flue products out of the water heater through 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.

### Control inputs and outputs

#### Tank thermostat / tank sensor

Either of these inputs will tell the water heater to provide heat to the water tank. If a tank sensor is connected, the SMART SYSTEM control will ignore the tank thermostat.

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

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

### Temperature control

#### Modulation

The Armor 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 outlet temperature is monitored by the water heater outlet temperature sensor. When the outlet temperature exceeds 185°F, the unit will reduce the fan speed. If the outlet water temperature exceeds 195°F 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 inlet and the outlet sensor. On Models 150 - 500 if this difference is between 25 - 30°F the control will reduce the fan speed. If the temperature difference exceeds 30°F the control will shut the unit down.

On Models 600 - 800 if the temperature difference is between 30 - 35°F the control will reduce the fan speed. If the temperature difference exceeds 35°F the control will shut the unit down.

The unit will restart automatically once the temperature difference has dropped below 25°F (Models 150 - 500) or 30°F (Models 600 - 800) 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 SMART SYSTEM control module provides some protection for the water heater.

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

#### **⚠ CAUTION**

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

# 11 Operating information

## Monitor external limits

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

## 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.

## Runtime and cycle counting

The control uses two timers to monitor the total hours of burner operation. One timer monitors the time the water heater is firing under 50% of rate. The other timer monitors the time the water heater is firing over 50% rate.

The control uses four (4) ignition counters to monitor the amount of water heater cycles. The first counter counts all ignitions of the control. The second counter counts only ignition attempts that have failed. The third and fourth counters are the same as the first and second respectively, but can be reset by the installer.

## Service reminder

The control can be programmed for service reminder notification. This notification will become active when either a set time frame has expired, or a set amount of running hours or cycles has expired (all adjustable by the installer). The display will alternate the standard text on the display screen with Service Due every 5 seconds. The service reminder notification can be reset by the installer.

## Error logging

The control will hold in memory the last 10 error codes as well as the last 10 turn-off functions. The date and time of the occurrence will be recorded as well. Only the 10 most current occurrences will be held in memory.

## Water heater temperature regulation

### Operating temperature (target)

The SMART SYSTEM control module senses water temperature and regulates water heater firing and firing rate to achieve a target temperature. The target temperature can be set between 60°F and 185°F.

## High limit operations

When outlet temperature exceeds 200°F, high limit action occurs. The water heater shuts down until the 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 SMART SYSTEM control module uses temperature sensing of both supply and return areas of the heat exchanger. If the flow rate is too low or either temperature too high, the control module modulates and shuts the water heater down. This ensures water heater shutdown in the event of low water or low flow conditions.
2. A flow switch is factory supplied to provide low flow protection.

## Cascade

When multiple water heaters are installed, they can be wired together in a cascade sequence. A maximum of eight water heaters can be controlled from a single control. In this application one water heater would be designated as the Leader control and all others would be designated as Member controls.

Once the Leader water heater receives a call for heat from a tank sensor, BMS or tank thermostat, the control will determine what the set point will be. A fixed temperature set point can be programmed into the control. See page 57 of this manual to program the set point.

If the water temperature at the tank or inlet sensor is less than the set point - differential, then the control will initiate a call for heat on the Cascade (see the Armor Water Heater Service Manual for an explanation of the differential). The Leader will energize the lead water heater on the Cascade. For a new startup this will be the Leader water heater.

The water heater will fire at its ignition speed and will then modulate its firing rate to maintain the set point. If the first water heater reaches 100% of its firing rate, the Leader will calculate at what point the second water heater could fire at 20% of its firing rate. At this point, the Leader will fire the second water heater on the Cascade. For a new startup, this would be the first Member water heater. The water heater will fire at its ignition speed and will then modulate its firing rate to maintain the set point.

# 11 Operating information *(continued)*

If the set point still cannot be met, the Leader will continue firing more Members until either the heat demand is met or all water heaters on the Cascade are firing. As the heat demand decreases, the last water heater on will modulate down to 20% of its firing rate. Once the demand for that water heater is zero it will shut down. As the heat demand decreases further, the second to last water heater will modulate down and shut off. This will continue until the demand is satisfied and all water heaters are shut off.

## Sequence of the cascade

To equalize the runtime of all water heaters on the Cascade, the firing sequence will automatically be changed at set intervals.

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

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

## Night Setback operation with cascade

Night Setback operation of the water heaters within the Cascade is available. Programming of the Night Setback will be done through the Leader water heater. Refer to the Armor Water Heater Service manual for information regarding Night Setback.

## Access modes

### User

The user can adjust water tank target temperature by using the UP and DOWN buttons (FIG. 11-1) at any time during normal operation. By entering the USER code (0704), the user can also change temperature units, time and date, and night setback settings. In User Mode, the following parameters can be viewed but not changed:

- Water heater model number
- Software version
- Total operating hours
- Total cycles

### Installer

Most parameters are available only to the installer, accessible only by entering the installer access code, see the Armor Water Heater Service Manual.

**Saving parameters** *(reference the Parameter Table in the Armor Water Heater Service Manual)*

**To save parameters and exit programming:**

Press the ENTER/RESET button.

**To keep parameter settings only for a current operating cycle:**

Press the MENU/EXIT button 3 times after making all desired parameter changes.

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

Press the MENU/EXIT button 1 time to return to the parameter listings; press again to return to the menu listings. Remember to press the ENTER/RESET button when finished programming in order to save the changes made.

See the Armor Water Heater Service Manual for a detailed description of parameters and access modes.

# 11 Operating information

## Sequence of operation

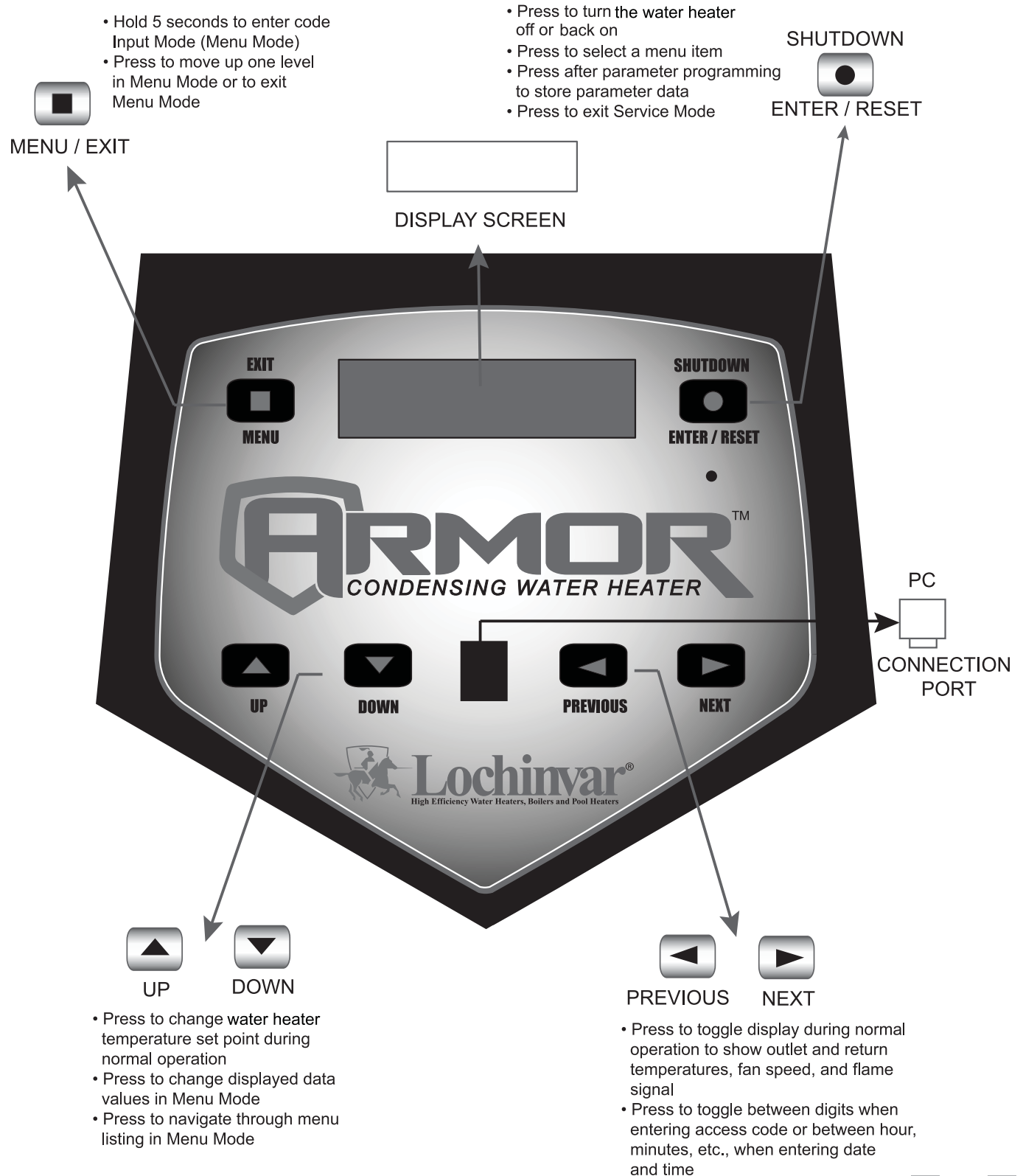
OPERATION	DISPLAY
1. Upon a call for heat, the control turns on the water heater pump.	WHR : Standby OUT : 123.8F (129)
2. The control connects 120 VAC to the blower. The blower does not run at this time. <ul style="list-style-type: none"> <li>• The flow switch must close before the control powers up the blower.</li> <li>• The manual reset high limit must be closed before the control powers up the blower.</li> <li>• If the unit is equipped with a solenoid valve and/or a vent valve, they will be energized along with the blower.</li> <li>• If the unit is equipped with a gas pressure switch, it must close at this time.</li> <li>• If there is an auxiliary device connected to the unit, the unit will then provide 24 VAC to its enable relay. If the auxiliary device has a proving switch, it must close before the sequence continues.</li> </ul>	WHR : Standby OUT : 123.8F (129)
3. The control then starts a 10 second prepurge cycle.	WHR : PREPURGE OUT : 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.	WHR : IGNITION OUT : 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 on Models 150 - 399, the control locks out for 1 hour and then tries another set of 4 trials.  If the burner does not light after 1 retry on Models 500 - 800 the control will lock out.	WHR : POSTPURGE , PREPURGE OUT : 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.	WHR : RUN 20% RATE OUT : 124.8F (129)
7. Once the call for heat is satisfied, the control will turn off the burner. The blower will remain on for the 10 second postpurge cycle. The water heater pump will continue to run for its respective pump delay time, then turn off.	WHR : POSTPURGE OUT : 127.4F (129)
8. Water heater pump off.	WHR : Standby OUT : 124.7F (129)

# 11 Operating information *(continued)*

## SMART SYSTEM™ Armor water heater 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

## Status display screens

Status Display Screens		
By using the Previous/Next (◀, ▶) arrow keys on the SMART SYSTEM display panel, you can navigate through the six (6) 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	WHR: OFF	The unit has been turned OFF by the Enter/Reset button on the SMART SYSTEM display panel.
	Standby	The unit has not received a call for heat from a tank thermostat nor has it received a call for heat from a tank sensor.
	Set Point Met	The unit has met the water temperature set point, but is still receiving a call for heat from either a tank sensor or a tank thermostat.
	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.
	OUT:***.°F	The outlet temperature is displayed.
	Open	The control does not detect the outlet sensor.
	Shorted	The outlet sensor wires or the sensor itself has become shorted.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #2.		
#2	IN: ***.°F	If a tank sensor is installed, only the inlet temperature will be displayed.
	***.°F (***)	When a tank thermostat is installed, the control will display the inlet temperature as well as the set point in parenthesis.
	Open	The control does not detect the inlet sensor.
	Shorted	The inlet sensor wires or the sensor itself has become shorted.
	RISE: ***.°F	The difference between the inlet temperature and the outlet temperature.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #3.		

# 11 Operating information *(continued)*

Status Display Screens <i>(cont'd)</i>		
By using the Previous/Next (◀, ▶) arrow keys on the SMART SYSTEM display panel, you can navigate through the six (6) 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	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.
	TANK: ***.°F (***)	The control will display the tank temperature, if used, the set point appears in parenthesis.
	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 SMART SYSTEM 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 SMART SYSTEM display to access Screen #5.		
#5	WHR CFH: OFF	The control has not received a call for heat from a tank thermostat or tank sensor.
	ON	The control has received a call for heat from a tank thermostat or tank sensor.
	WHR PUMP: OFF	The control has not received a DHW call for heat and has not powered the water heater pump.
	ON	The control has received a DHW call for heat and has powered the water heater pump.
	Delay	The DHW call for heat has been satisfied and the water heater pump is running for a fixed time to remove any residual heat.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #6.		
#6	Not Used: N/A	Not used.
	0-10V IN: **.*Vdc	The control will display a 0-10 VDC signal received from a Building Management System (BMS) connected to the unit.

# 11 Operating information

## Status Display Screens (cont'd)

### Operation of the cascade

The water heater designated as the Leader will have two additional display screens that can be viewed. These screens will provide information regarding the operation of the Cascade. Each screen will contain two viewable items. The following is a description of the individual items and what they can display:

Screen	Display shows:	Description
#7	Cas: Off	The Leader control has been turned off by the <b>Enter/Reset</b> button on the Smart System display.
	Cas: Standby	The Leader water heater has not received a call for heat from a remote thermostat.
	Cas: 127.4F (130)	The Cascade is now active. The tank temperature will be displayed. The Cascade set point will be displayed in parenthesis.
	Cas: Setpoint Met	The Cascade has met the water temperature set point, but is still receiving a call for heat from a tank sensor.
	Cas: No Members	The Leader control could not detect any Member controls to participate in the Cascade.
	PMP: Off	The Leader control has not received a call for heat from a tank sensor and has not powered the water heater pump.
	PMP: On	The Leader control has received a call for heat from a remote thermostat and has powered the water heater pump.
	PMP: Delay	The tank call for heat has been satisfied and the water heater pump is running for a fixed time to remove any residual heat.

Press the Next ► arrow key on the SMART SYSTEM display to access Screen #8.

#8	Cas Pow: ***% ***%	The first percentage shows the firing rate that is being sent to the last water heater called on. The second percentage shows the total power available to the Cascade.
	<b>Present:</b> 01234567 Example: <b>Present:</b> 23----01	Shows the number of water heaters connected to the Cascade. The Leader is designated as 0. Members will be designated 1 - 7. If a “-“ is used in place of a number, that water heater is either not connected, or in a lockout mode and not available for the Cascade. If the number is flashing, then that water heater is providing heat to the Cascade. As the lead water heater is changed from day to day, that water heater’s address will be shown first in the string of numbers. In the example, water heaters 0 - 3 are present and water heater 2 is the lead water heater.

Press the Next ► arrow key on the SMART SYSTEM display to roll back to Screen #1. At any point if you wish to access an earlier screen, press the Previous ◀ arrow key on the SMART SYSTEM display.



# 12 Maintenance

## Maintenance and annual startup

Table 12A Service and Maintenance Schedules

<b>Service technician</b> (see the following pages for instructions)		<b>Owner maintenance</b>	
<b>ANNUAL START-UP</b>	<b>General:</b>		
	<ul style="list-style-type: none"> <li>• Address reported problems</li> <li>• Inspect interior; clean and vacuum if necessary;</li> <li>• Clean condensate trap and fill with fresh water</li> <li>• Check for leaks (water, gas, flue, condensate)</li> <li>• Verify flue and air lines in good condition and sealed tight</li> <li>• Check system water pressure/system piping/expansion tank</li> <li>• Check control settings</li> <li>• Check ignition and flame sense electrodes (sand off any deposits; clean and reposition)</li> <li>• Check wiring and connections</li> <li>• Perform start-up checkout and performance verification per Section 10 of this manual.</li> <li>• Flame inspection (stable, uniform)</li> <li>• Flame signal (at least 10 microamps at high fire)</li> <li>• Clean the heat exchanger if flue temperature is more than 54°F above return water temperature.</li> <li>• Check Delta T (Temperature Rise)</li> </ul>	<b>Daily</b>	<ul style="list-style-type: none"> <li>• Check water heater area</li> <li>• Check pressure/temperature gauge</li> </ul>
	<b>If combustion or performance indicate need:</b>		<b>Monthly</b>
<ul style="list-style-type: none"> <li>• Clean heat exchanger</li> <li>• Remove and clean burner using compressed air only</li> <li>• Clean the blower wheel</li> </ul>		<b>Every 6 months</b>	<ul style="list-style-type: none"> <li>• Check water heater piping (gas and water) for leaks</li> <li>• Operate relief valve</li> </ul>

# 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 - Determine Water Heater Location. 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 and the Armor Water Heater Service Manual.

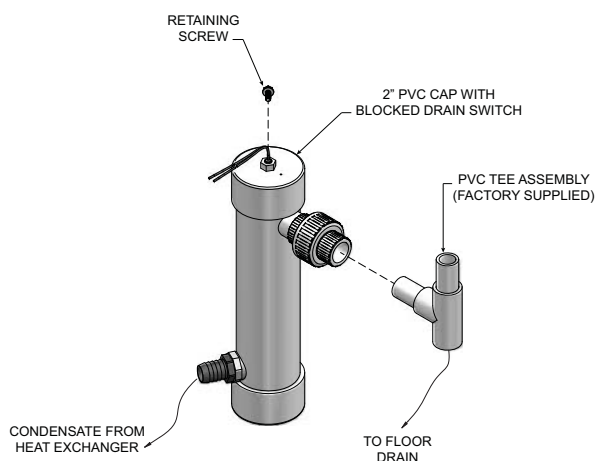
## Inspect water heater interior

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

**Figure 12-1** Condensate Trap



**⚠ WARNING** The condensate trap must be filled with water during all times of 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.

# 12 Maintenance *(continued)*

**⚠ 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 heating system water expands due to temperature increase or contracts as the water cools. Tanks may be open, closed or diaphragm or bladder type. See Section 6 - System Piping for suggested best location of expansion tanks and air eliminators.

## 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.

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

# 12 Maintenance

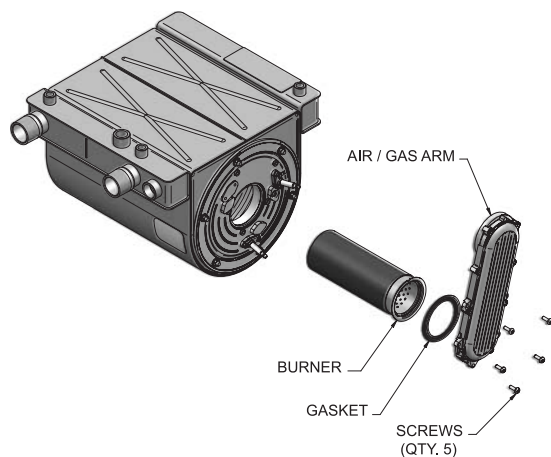
## Perform start-up and checks

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 in the Armor Service Manual 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.
3. Remind the owner to follow the proper shutdown procedure and to schedule an annual start-up.

## Cleaning heat exchanger

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

1. Shut down water heater:
  - Follow the “To Turn Off Gas to Appliance” instructions for the water heater in Section 10 - 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.
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 the Service Manual. Failure to comply could result in severe personal injury.

5. Remove the condensate hose from the heat exchanger end. Connect a field supplied 3/4" diameter hose to a drain pan. Using field supplied means, cover the refractory in the back of the combustion chamber of the heat exchanger.
6. Use a vacuum cleaner to remove any accumulation on the 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 10 - Startup on pages 52 and 55 of this manual.
13. Replace the access cover and restore water heater to operation.

# 12 Maintenance *(continued)*

**Table 12B** Heat Exchanger Cleaning Kits

Model	Kit Number	Part Number	Component Description
150 - 399	KIT30063	CTN20005	Rear Refractory Cover
		MSC20083*	Nylon 4" Wheel Brush*
		MSC20084	3mm Allen Wrench
		MSC20086	1/4" x 24" Drill Extension
500 - 800	KIT30064	CTN20005	Rear Refractory Cover
		MSC20083*	Nylon 4" Wheel Brush*
		MSC20085	1/4" x 12" Drill Extension
		MSC20086	1/4" x 24" Drill Extension

**⚠ CAUTION**

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

## Check Delta T

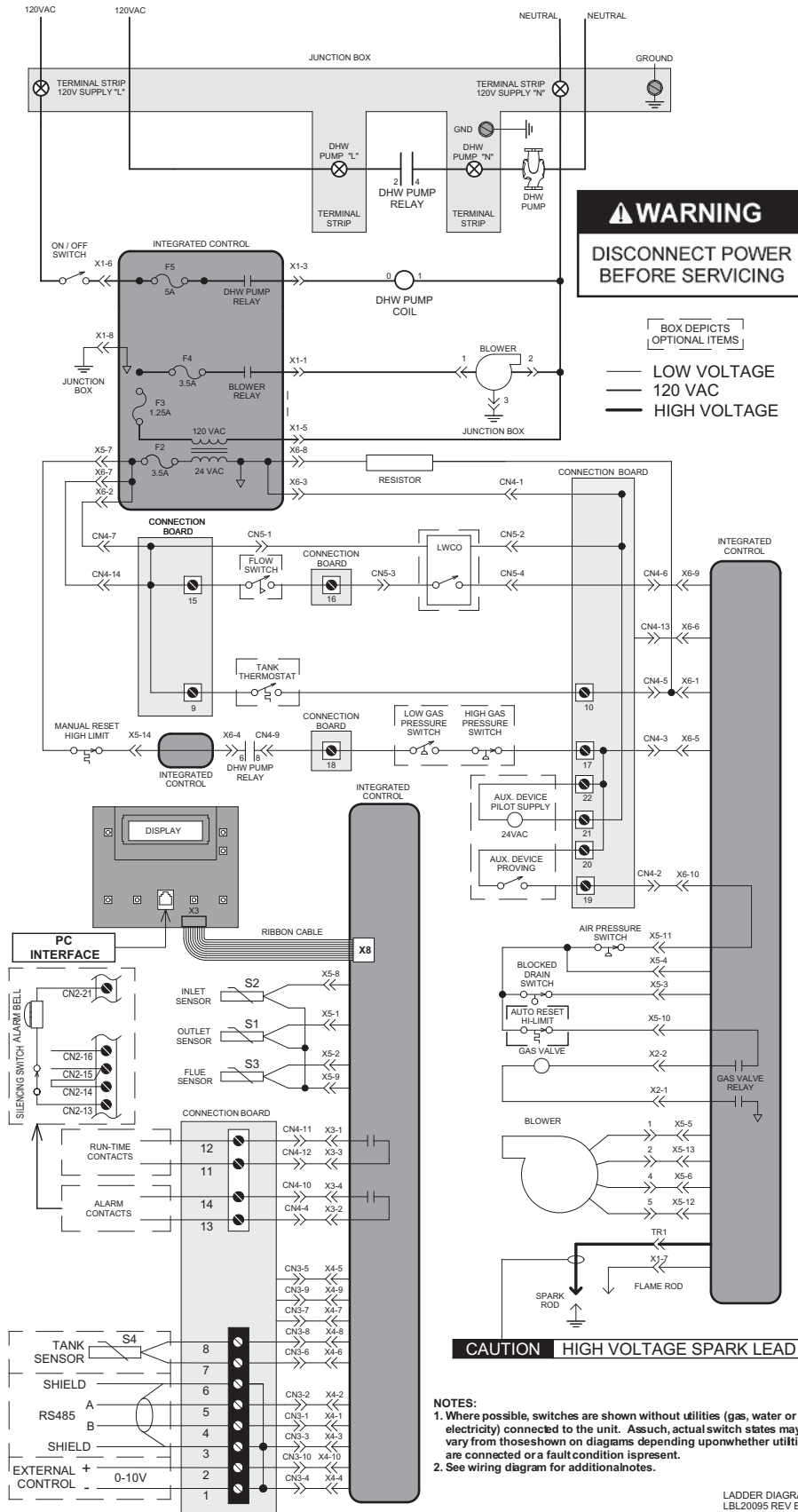
1. Check Delta T. Reference Section 6 - *System Piping* on page 35 for more information regarding Delta T.

## Oiled bearing circulators

1. The circulator shipped with the Armor 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.

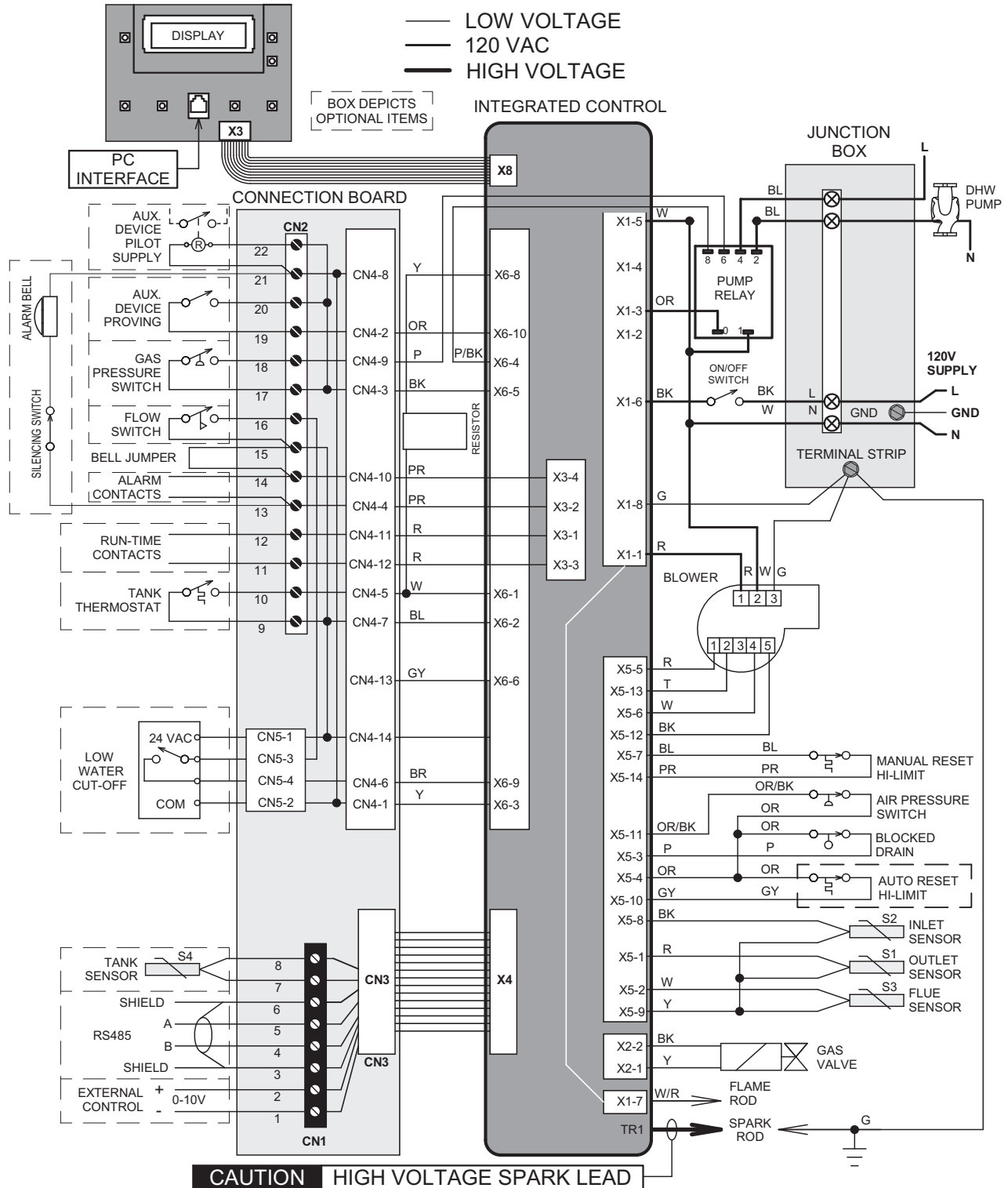
# 13 Diagrams

Figure 13-1 Ladder Diagram



# 13 Diagrams *(continued)*

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.

**Revision Notes:** *Revision B (AW-I&O-Rev B) reflects the addition of the Dungs information to the manual.*

*Revision C (AW-I&O-Rev C) reflects changes made to pages 30 and 31 (piping diagrams).*

*Revision D (AW-I&O-Rev D) reflects changes made to Model 199 orifice.*

*Revision E (AW-I&O-Rev E) reflects an additional LP warning on page 13.*

*Revision F (ECO #C02407) reflects the addition of air inlet pipe materials, air inlet, air pressure switch, flow switch, relief valve, high altitude, new vent termination, Maintenance Section along with updates made to the ladder and wiring diagrams.*

*Revision G (ECO #C02545) reflects the addition of references to the safety shutoff testing and instructions, sediment trap, periodic cleaning of screens in vent terminations, wall thickness for direct vent terminations, removal of B149.2 references, approval of the 3" concentric vent kit for ULC-S636, the addition of the Scald Warning Label and sidewall vent termination kit number correction.*

*Revision H (ECO #C02870) reflects the addition of a mixing valve to the piping diagrams (FIG.'s 6-4 thru 6-8, pgs. 30 - 34).*

*Revision I (ECO #C02738) reflects edits made to the LP Conversion Table for the new orifice on the 399 model (page 12) along with edits made to Table 6C on page 29.*

*Revision J (ECO #C03223) reflects edits made to the high altitude section on page 7 and updates made to the condensate trap image on pages 44 and 59.*

*Revision K (ECO #C04150) reflects the addition of Models 600 - 800 along with venting updates.*

*Revision L (ECO #C05457) update the vent table to reflect Schedule 80 as acceptable CPVC material (R02799), add flex-smooth wall to the FasNSeal material (ECR #R02845), update the HEX cleaning procedure to reflect the new HEX cleaning kit (R02634), add stainless steel as acceptable material in a closet or alcove installation (R02900).*