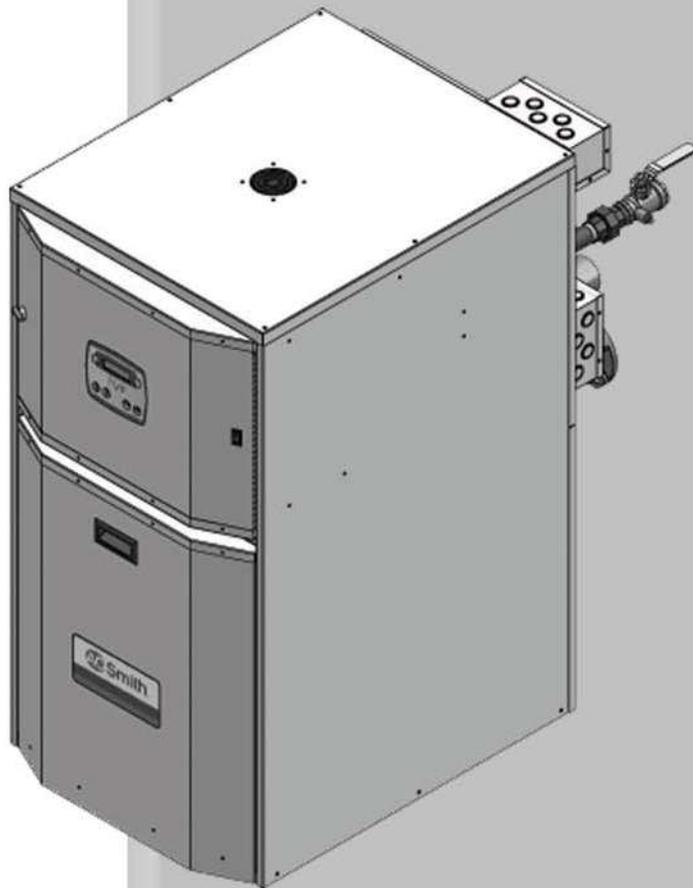




Installation & Operation Manual

Models: 500 - 2000
Up To 4:1 Turndown



**FREE CERTIFIED FACTORY
START-UP INCLUDED**

Required for warranty activation and
assuring maximum operating performance

CALL 800-527-1953 TO ARRANGE START-UP.



⚠ WARNING:

This manual supplies information for the installation, operation, and servicing of the appliance. It is strongly recommended that this manual and the VF Series Service Manual be reviewed completely before proceeding with an installation. 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

NOTICE

This is a gas appliance and should be installed by a licensed electrician and/or certified gas supplier. Service must be performed by a qualified service installer, service agency or the gas supplier.

⚠ WARNING

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

This appliance **MUST NOT** be installed in any location where gasoline or flammable vapors are likely to be present, unless the installation is such to eliminate the probable ignition of gasoline or flammable vapors.

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 neighbors 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.

Warranty –

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

Experience has shown that improper installation or system design, rather than faulty equipment, is the cause of most operating problems.

1. Excessive water hardness causing a lime/scale build-up in the copper tube is not the fault of the equipment and is not covered under the manufacturer's warranty (see *Water Treatment and Water Chemistry*).
2. Excessive pitting and erosion on the inside of the copper tube may be caused by too much water velocity through the tubes and is not covered by the manufacturer's warranty (see *Flow Rates and Temperature Rise for flow requirements*).

⚠ WARNING

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to this manual for assistance or additional information, consult a qualified installer, service agency or the gas supplier.

Checking equipment –

Upon receiving equipment, check for signs of shipping damage. Pay particular attention to parts accompanying the appliances which may show signs of being hit or otherwise being mishandled. Verify total number of pieces shown on packing slip with those actually received. In case there is damage or a shortage, immediately notify the carrier.

Do not use this appliance 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.

⚠ Owner warning –

The information contained in this manual is intended for use by qualified professional installers, service technicians, or gas suppliers. **Consult your local expert for proper installation or service procedures.**

NOTICE

Consult and follow all local Building and Fire Regulations and other Safety Codes that apply to this installation. Consult local gas utility company to authorize and inspect all gas and flue connections.

A gas appliance that draws combustion air from the equipment room where it is installed must have a supply of fresh air circulating around it during burner operation for proper gas combustion and proper venting.

⚠ WARNING

Should overheating occur or the gas supply fail to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the appliance.

Prevention of freezing –

Heat exchangers and headers damaged by freezing are not covered by warranty.

See *Section 7, Startup - Freeze Protection* for more information.

Please read before proceeding

⚠ WARNING

To minimize the possibility of serious personal injury, fire, or damage to your appliance, never violate the following safety rules:

1. Water heaters are heat producing appliances. To avoid damage or injury, do not store materials against the appliance or the vent-air intake system. Use proper care to avoid unnecessary contact (especially children) with the appliance and vent-air intake components.
2. Never cover your appliance, lean anything against it, store trash or debris near it, stand on it or in any way block the flow of fresh air to your appliance.
3. UNDER NO CIRCUMSTANCES must flammable materials such as gasoline or paint thinner be used or stored in the vicinity of this appliance, vent-air intake system or any location from which fumes could reach the appliance or vent-air intake system.

Codes –

The equipment shall be installed in accordance with those installation regulations in force in the local area where the installation is to be made. These shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made. In the absence of such requirements, the installation shall conform to the latest edition of the National Fuel Gas Code, ANSI Z223.1. All water heaters conform to the latest edition of the ASME Boiler and Pressure Vessel Code, Section IV. Where required by the authority having jurisdiction, the installation must comply with the Canadian Gas Association Code, CAN/CGA-B149.1 and/or B149.2 and/or local codes. This appliance meets the safe lighting performance criteria with the gas manifold and control assembly provided, as specified in the ANSI standards for gas water heaters, ANSI Z21.10.3.

Ratings



VF Series Water Heater Rating				Other Specifications			
Model Number <small>Note: Change "N" to "L" for L.P. gas models</small>	Input MBH (Note 3)		GPH at 100°F Rise (Note 1)	Appliance Water Content Gallons	Water Connections	Gas Connections	Air / Vent Sizes (Note 2)
	Min	Max					
VWH0500N	125	500	515	3.60	2.5"	1"	5" - 4"
VWH0750N	188	750	773	4.00	2.5"	1 1/4"	5" - 5"
VWH1000N	250	1000	1030	4.30	2.5"	1 1/4"	6" - 6"
VWH1500N	375	1500	1545	5.50	2.5"	1 1/2"	6" - 6"
VWH2000N	500	2000	2061	6.20	2.5"	1 1/2"	8" - 8"

NOTICE

Maximum allowed working pressure is located on the rating plate.

Notes:

- The ratings are based on standard test procedures prescribed by the United States Department of Energy.
- The VF Series requires special gas venting. Use only the vent materials and methods specified in the VF Series Installation and Operation Manual.
- The VF Series is equipped for operation up to 2000 feet, and including up to 4000 feet, with no field adjustments. The appliance output ratings up to 4000 feet shall be reduced by 4% for each 1000 feet above sea level. For operation above 4000 feet, consult the factory.

The VF Series - How it works...

1. Heat exchanger

The heat exchanger allows system water to flow through specially designed tubes for maximum heat transfer. The glass lined headers and copper finned tubing are encased in a jacket that contains the combustion process.

2. Heat exchanger access cover

The heat exchanger access cover is a stainless steel door which allows access for service, maintenance, and removal of the heat exchanger from inside the combustion chamber.

3. Blower

The blower pulls in air and gas through the venturi (see item 5) and injects the fuel/air mixture into the burner, where they burn inside the combustion chamber.

4. Gas valve

The gas valve allows the proper amount of gas to pass into the burner for combustion. The gas valve on the VF Series works under a negative pressure so gas should only be pulled through the valve when the blower is in operation.

5. Venturi

The venturi attaches to the inlet (or suction) side of the blower and generates the negative pressure needed by the gas valve.

6. Flue sensor (not shown)

The flue sensor is mounted in the exhaust collar of the unit and monitors the flue gas temperature. If the temperature in the stack exceeds the maximum temperature the unit will shut down to prevent a hazardous condition.

7. Outlet temperature sensor

This sensor monitors the outlet water temperature. If selected as the controlling sensor, the appliance will maintain set point by adjusting the firing rate of the unit according to this sensor.

8. Inlet temperature sensor

This sensor monitors inlet water temperature. If selected as the controlling sensor, the appliance will maintain set point by adjusting the firing rate of the unit according to this sensor.

9. Electronic display

The electronic display consists of 7 buttons and a dual line 32-character liquid crystal display used to monitor the operation of the heater as well as enter and view the programming of the main control board.

10. Burner (not shown)

The burner is made of a woven fabric over steel screen construction. The burner uses pre-mixed air and gas and provides a wide range of firing rates.

11. Water outlet (system supply)

The water outlet is a 2 1/2" pipe connection that supplies water to the system with connections for a flow switch (see #28) and a relief valve (see #25).

12. Water inlet (system return)

The water inlet is a 2 1/2" pipe connection that receives water from the system and delivers it to the heat exchanger.

13. Gas connection pipe

The gas pipe connection on this appliance is 1", 1 1/4", or 1 1/2" NPT. To deliver the correct amount of gas volume to the appliance it may be necessary to have a larger gas line reduced to 1 1/4" at the appliance. Please reference the National Fuel Gas Code charts for more details.

The control module is the main control for the appliance. This module contains the programming that operates the blower, gas valve, and pumps in addition to other programmable features.

15. Air intake

The air intake pipe allows fresh air to flow directly to the appliance. The air inlet is part of the filter box assembly where air filtration is accomplished with a standard filter.

16. Line voltage terminal strip

The line voltage terminal strip provides a location to connect all of the line voltage (120 VAC) contact points to the unit.

17. Low voltage connection board

The low voltage connection board provides a location to tie in all of the low voltage contacts to the appliance. This is where most of the external safety devices are connected to the unit such as the louver proving switch.

18. Condensate trap

The condensate trap is designed to prevent flue gases from escaping the appliance through the combustion chamber drain.

19. Access cover - front

The front access cover provides access to the gas train as well as the blower and other key components for service and maintenance.

20. Hot surface igniter (HSI)

The hot surface igniter is a device that is used to ignite the air/gas mixture as well as monitor the performance of the flame during operation. This device acts as a flame sense electrode.

21. Flame inspection window (sight glass) (not shown on Models 500 - 1000)

The flame inspection window is a quartz glass window that allows a visual inspection of the burner and flame during operation.

22. Gas shut off valve (downstream test cock)

The downstream test cock is provided in the gas train to ensure complete shut off of the gas to the burner in case of maintenance, inspection, or testing of the valve.

23. Manual reset high limit sensor

Device that monitors the outlet water temperature to ensure safe operation. If the temperature exceeds its setting (field adjustable), it will break the control circuit, shutting the appliance down.

24. Relief valve

The relief valve is a safety device that ensures the maximum pressure of the appliance is not exceeded. Water heaters operate on temperature and pressure and are shipped standard as 125 PSI and 210°F (98.9°C).

25. Power switch

The power switch is used to engage and disengage power to the appliance on the 120 VAC circuit.

26. Air pressure switch

The air pressure switch is a safety device which ensures proper blower operation. The air pressure switch is wired in series with the low voltage control circuit in such a way that if the fan does not engage or shuts down prematurely the device will break the control circuit and the unit will shut down.

27. 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.

The VF Series - How it works... *(continued)*

28. Drain port(s)

Location from which the heat exchanger can be drained.

29. Auto reset high limit switch

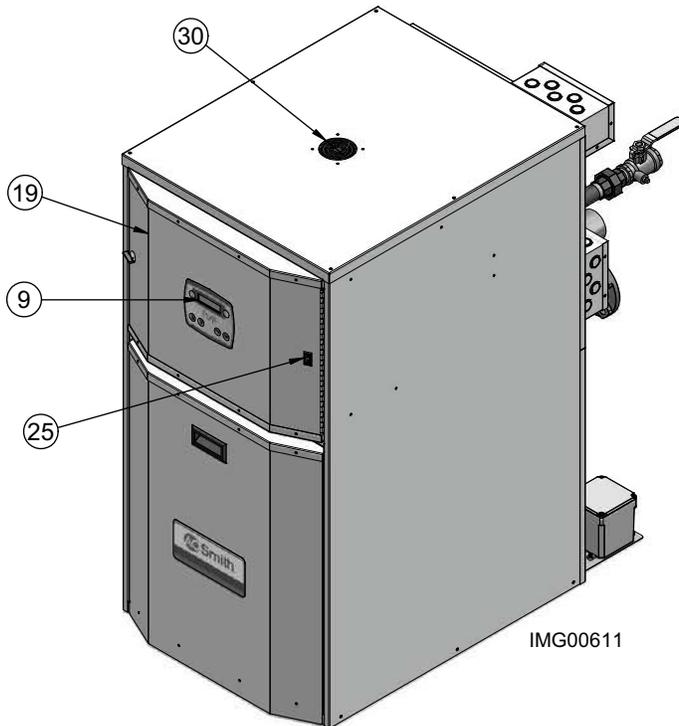
The auto reset high limit is fixed at 200°F (93°C) preventing the outlet water temperature from exceeding 210°F (98.9°C).

30. Ventilation fan

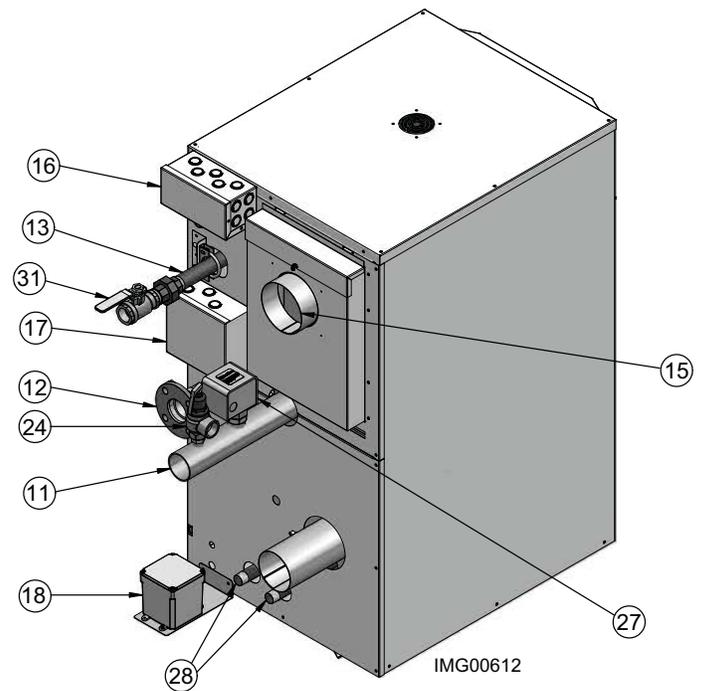
Provides air circulation around the controls inside the unit.

31. Manual shutoff valve

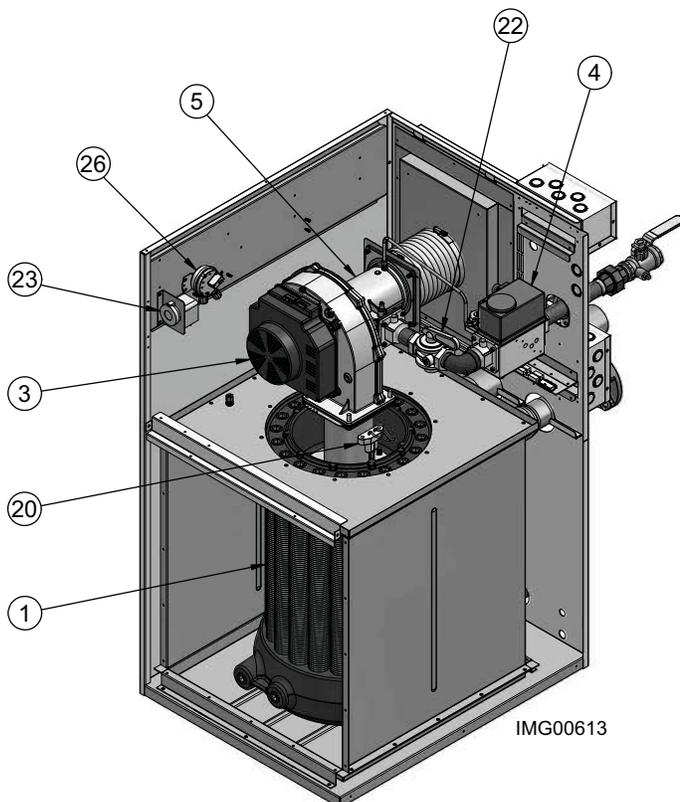
Manual valve used to isolate the unit from the gas supply.



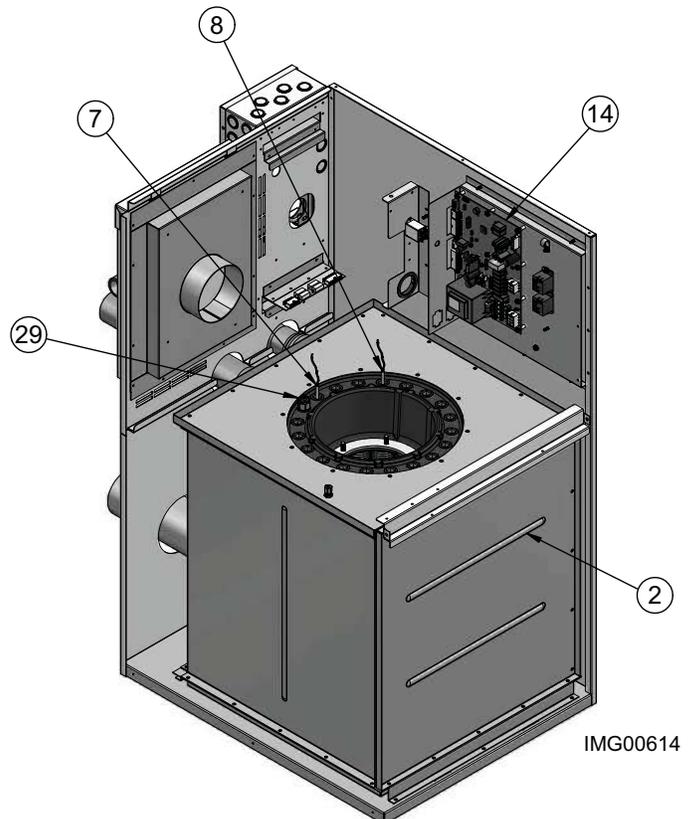
Models 500 - 1000 Front View



Models 500 - 1000 Rear View

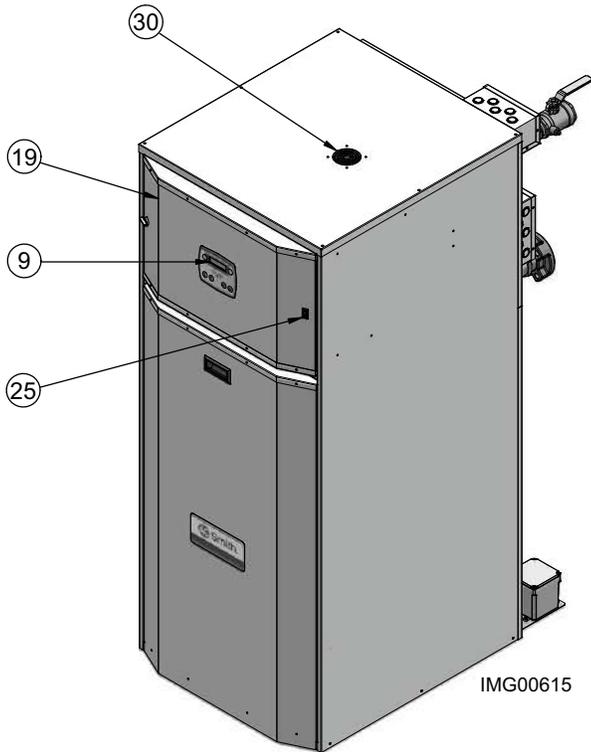


Models 500 - 1000 Right Side (inside unit)



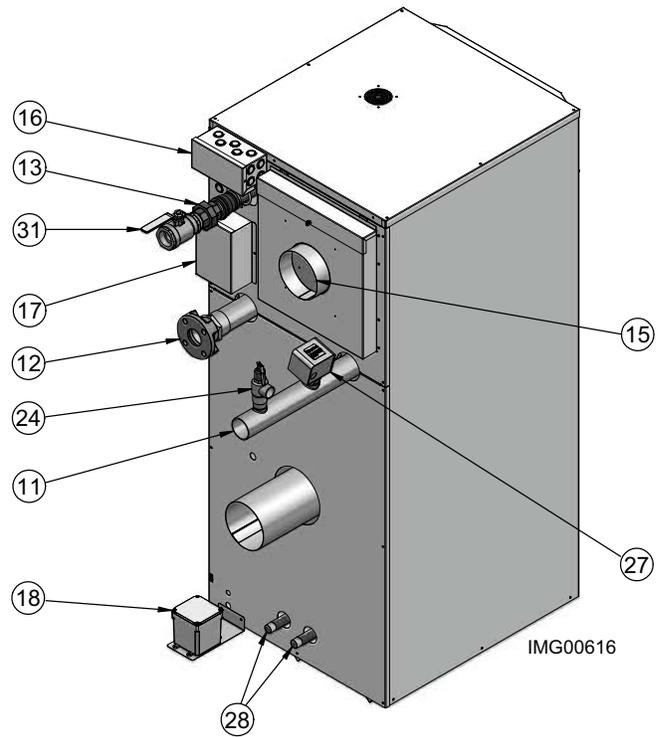
Models 500 - 1000 Left Side (inside unit)

The VF Series - How it works...



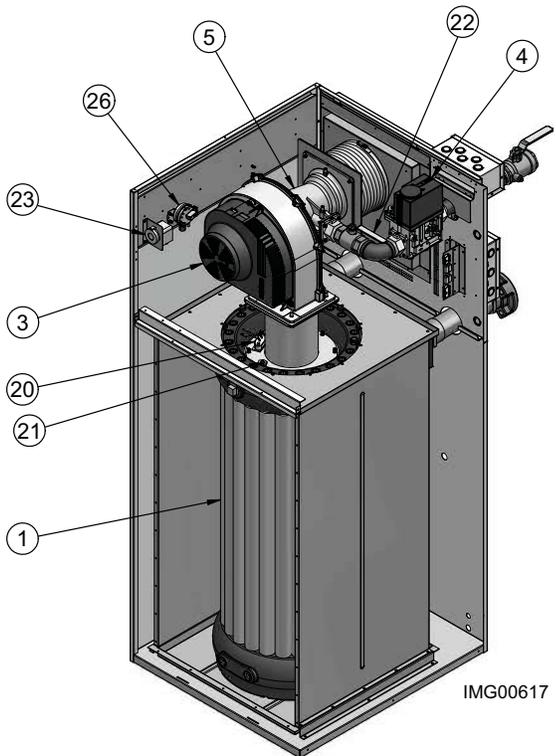
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Models 1500 - 2000 Front View



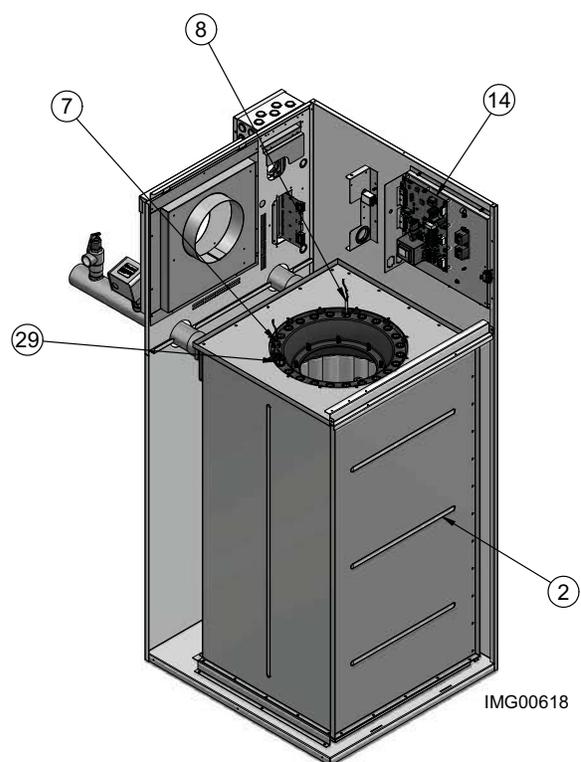
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Models 1500 - 2000 Rear View



IMG00617

Models 1500 - 2000 Right Side (inside unit)



IMG00618

Models 1500 - 2000 Left Side (inside unit)

1 Determine unit location

Location of unit

1. 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 unit. The pan must not restrict combustion airflow. Under no circumstances is the manufacturer to be held responsible for water damage in connection with this unit, or any of its components.
2. The appliance must be installed so that the ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, control replacement, etc.).
3. Appliances located in a residential garage and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit must be installed so that all burners and burner ignition devices have a minimum clearance of not less than 18" (46 cm) above the floor. The appliance must be located or protected so that it is not subject to physical damage by a moving vehicle.
4. **DO NOT** install this appliance in any location where gasoline or flammable vapors are likely to be present.
5. The appliance must be installed on a level floor. Combustible floor locations may be used. Maintain required clearances from combustible surfaces.
6. The appliance must not be installed on carpet.
7. The appliance must be installed indoors where it is protected from exposure to wind, rain, and weather.
8. This appliance may condense the products of combustion when operating at water temperatures below 140°F (60°C). Ensure that the appliance is located near an acceptable drain where condensate that may form in the venting system may be properly collected and disposed.
9. Access to rear of appliance **MUST** be maintained.

Recommended service clearances

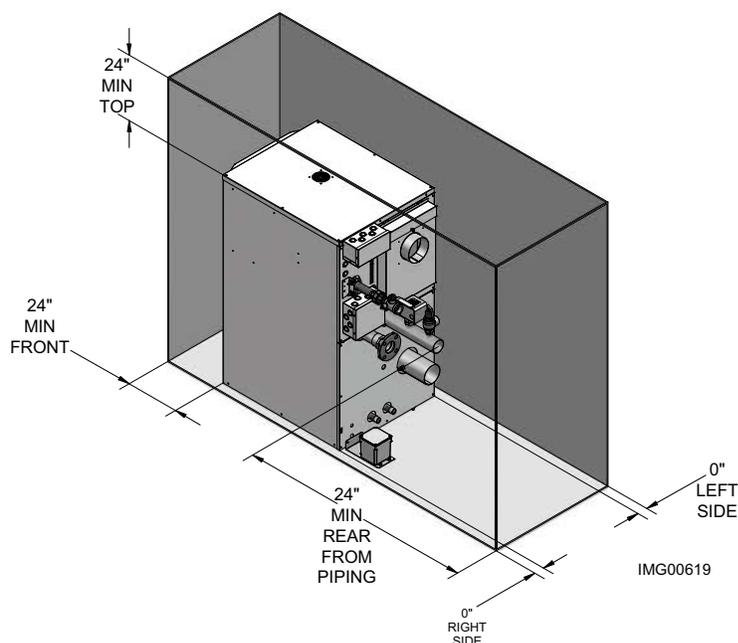


Figure 1-1_Recommended Service Clearances

Location	Clearances
Right Side	0"
Rear	6" (15cm) (Minimum 24" (0.61m) suggested for service to pump and components)
Left Side	0"
Front - Alcove*	(Minimum 24" (0.61m) suggested for service)
Top	6" (15cm) (Minimum 24" (0.61m) suggested for service)
Flue	2" (51mm)
Hot Water Pipes	1" (25.4mm)

*An Alcove is a closet without a door.

NOTICE

Clearances from combustible construction are noted on the appliance rating plate.

1 Determine unit location

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

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

Consult the *Venting* section of this manual for specific installation instructions for the appropriate type of venting system that you will be using. Direct Vent and Vent/Air venting systems require installation with **Category IV** flue pipe, sealed air inlet pipe, and air inlet caps, which must meet the manufacturer's specifications.

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

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

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

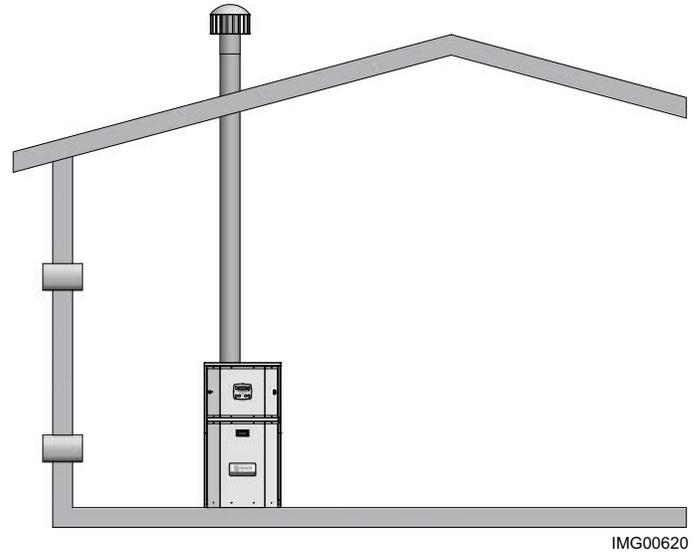


Figure 1-2_ Combustion Air Direct from Outside

1. If air is taken directly from outside the building with no duct, provide two permanent openings to the equipment room (see FIG. 1-2):
 - (a) Combustion air opening, with a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm² per kW). This opening must be located within 12" (30 cm) of the bottom of the enclosure.
 - (b) Ventilation air opening, with a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm² per kW). This opening must be located within 12" (30 cm) of the top of the enclosure.

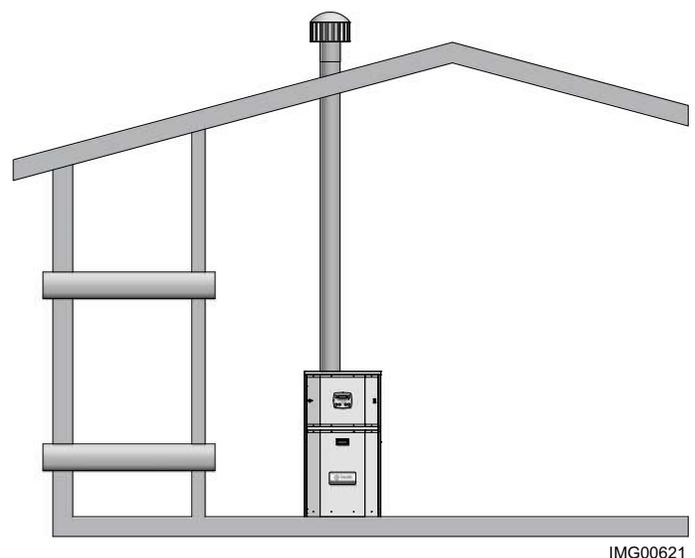


Figure 1-3_ Combustion Air Through Ducts

1 Determine unit location *(continued)*

2. If combustion and ventilation air is taken from the outdoors using a duct to deliver the air to the equipment room, each of the two openings should be sized based on a minimum free area of one square inch per 2000 Btu/hr (11 cm² per kW) of input (see FIG. 1-3).

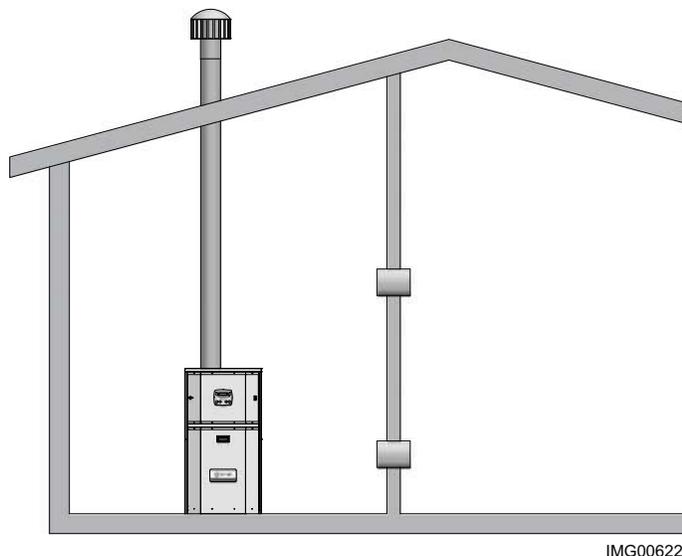


Figure 1-4_Combustion Air from Interior Space

3. If air is taken from another interior space, each of the two openings specified above should have a net free area of one square inch for each 1000 Btu/hr (22 cm² per kW) of input, but not less than 100 square inches (645 cm²) (see FIG. 1-4).

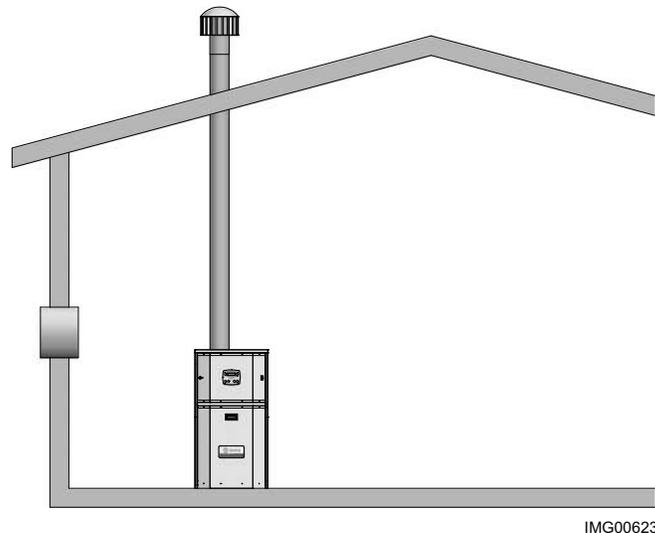


Figure 1-5_Combustion Air from Outside - Single Opening

4. If a single combustion air opening is provided to bring combustion air in directly from the outdoors, the opening must be sized based on a minimum free area of one square inch per 3000 Btu/hr (7 cm² per kW). This opening must be located within 12" (30 cm) of the top of the enclosure (see FIG. 1-5).

TABLE - 1B MINIMUM RECOMMENDED COMBUSTION AIR SUPPLY TO EQUIPMENT ROOM							
Model Number	*Outside Air from 2 Openings Directly from Outdoors		*Outside Air from 1 Opening Directly from Outdoors, in ²	Inside Air from 2 Ducts Delivered from Outdoors		Inside Air from 2 Ducts Delivered from Interior Space	
	Top Opening, in ²	Bottom Opening, in ²		Top Opening, in ²	Bottom Opening, in ²	Top Opening, in ²	Bottom Opening, in ²
500	125 (807 cm ²)	125 (807 cm ²)	167 (1077 cm ²)	250 (1613 cm ²)	250 (1613 cm ²)	500 (3226 cm ²)	500 (3226 cm ²)
750	188 (1213 cm ²)	188 (1213 cm ²)	250 (1613 cm ²)	375 (2420 cm ²)	375 (2420 cm ²)	750 (4839 cm ²)	750 (4839 cm ²)
1000	250 (1613 cm ²)	250 (1613 cm ²)	333 (2149 cm ²)	500 (3226 cm ²)	500 (3226 cm ²)	1000 (6452 cm ²)	1000 (6452 cm ²)
1500	375 (2420 cm ²)	375 (2420 cm ²)	500 (3226 cm ²)	750 (4839 cm ²)	750 (4839 cm ²)	1500 (9678 cm ²)	1500 (9678 cm ²)
2000	500 (3226 cm ²)	500 (3226 cm ²)	667 (4303 cm ²)	1000 (6452 cm ²)	1000 (6452 cm ²)	2000 (12904 cm ²)	2000 (12904 cm ²)

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

1 Determine unit location

Combustion air requirements are based on the latest edition of the National Fuel Gas Code, ANSI Z223.1; in Canada refer to the latest edition of CGA Standard CAN B149.1 or B149.2. Check all local code requirements for combustion air.

All dimensions based on net free area in square inches. Metal louvers or screens reduce the free area of a combustion air opening a minimum of approximately 25%. Check with louver manufacturers for exact net free area of louvers. Where two openings are provided, one must be within 12" (30cm) of the ceiling and one must be within 12" (30cm) of the floor of the equipment room. Each opening must have net free area as specified in the chart on page 11 (Table 1B). Single openings shall commence within 12" (30cm) of the ceiling.

CAUTION

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

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

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

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

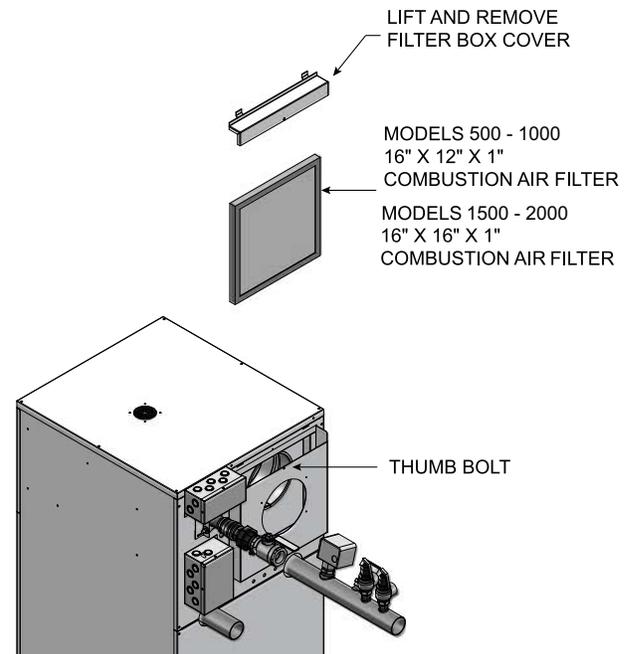


Figure 1-6_Filter Access

Combustion air filter

This unit has a standard air filter located at the combustion air inlet as shown above in FIG. 1-6. This air filter is provided to help ensure clean air is used for the combustion process. Check this filter every month and replace when it becomes dirty. The filter size on Models 500 -1000 is 16" x 12" x 1" (40.6cm x 30.5cm x 2.5cm) and for Models 1500 - 2000 it is 16" x 16" x 1" (40.6cm x 40.6cm x 2.5cm). You can find these commercially available filters at any home center or HVAC supply store. Follow the steps below when replacing the combustion air filter:

1. Locate the combustion air filter box mounted on the rear of the appliance.
2. Locate the flat thumb bolt at the top of the air filter box and turn it a 1/4 turn counterclockwise to align it with the slot in the air filter box.
3. Lift and remove the air filter box cover to gain access to the air filter.
4. Slide the air filter out the top of the air filter box.
5. Inspect the air filter for dirt and debris, replace if necessary.
6. Replace the air filter and the air filter box cover. Turn the thumb bolt clockwise a 1/4 turn to secure the air filter box cover to the air filter box.

NOTICE

During construction the air filter should be checked more frequently to ensure it does not become clogged with combustion dirt and debris.

CAUTION

Sustained operation of an appliance with a clogged burner may result in nuisance operational problems, bad combustion, and non-warrantable component failures.

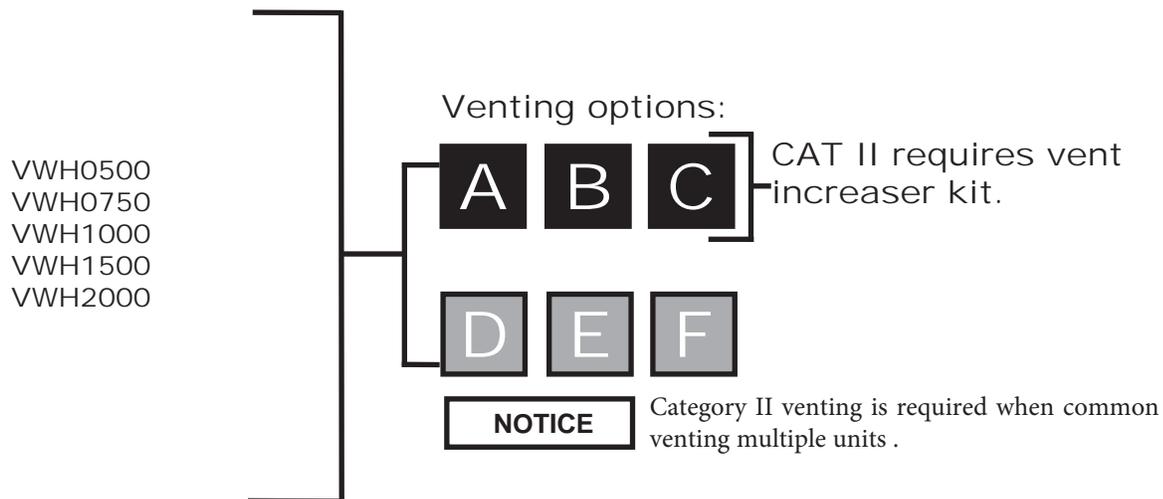
2 Venting

BEFORE YOU BEGIN

Identify your appliance's vent system:

This manual covers venting requirements for CAT II/IV models. Be sure to correctly identify the type of vent system your appliance requires before proceeding.

Category II/IV Models: See page 15



⚠ DANGER

Failure to use correct venting materials can result in loss of life from flue gas spillage into working or living space.

Venting Category Definitions: **(Reference National Fuel Gas Code ANSI Z223.1)**

CAT IV: Positive pressure condensing

An appliance that operates with a positive vent static pressure with a vent gas temperature that may cause excessive condensate production in the vent.

CAT II: Negative pressure condensing

An appliance that operates with a non-positive vent static pressure with a vent gas temperature that may cause excessive condensate production in the vent.

2 Venting

Vent Materials:

Category II/IV Vent Material Suppliers:

Category II/IV flue pipe materials and vent adapters (see FIG. 2-1) can be obtained from the following manufacturers:

Heat-Fab Inc., Saf-T CI Vent with AL29-4C stainless steel

Protech Systems Inc., Fas N Seal Vent with AL29-4C stainless steel

Flex-L International Inc., StaR 34 Vent with AL29-4C stainless steel

Metal-Fab Inc., Corr/Guard Vent with AL29-4C stainless steel

Z-Flex, Z-Vent with AL29-4C stainless steel

Or other listed Category IV vent systems suitable for a condensing, positive pressure, gas fired appliance.

A Category IV flue **MUST** have all vent joints and seams sealed gastight and have provisions for a drain to properly collect and dispose of condensate that may occur in the venting system.

Category IV Vent Adapter "Field Supplied"

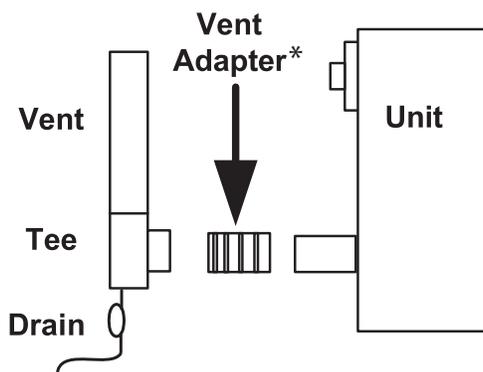


Figure 2-1_ Category IV Vent Adapter

TABLE - 2A FLUE ADAPTER SIZES	
MODEL	FLUE ADAPTER SIZE
VWH0500	4"
VWH0750	5"
VWH1000	6"
VWH1500	6"
VWH2000	8"

Category II In increaser Kit "Must be purchased from manufacturer"

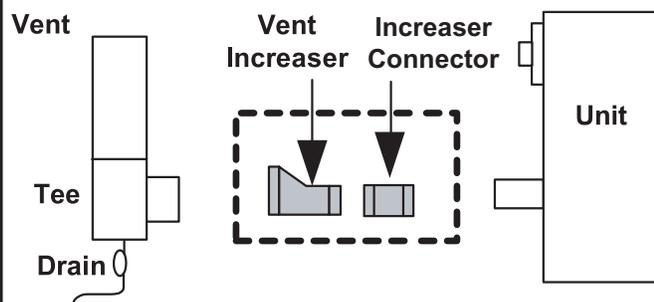


Figure 2-2_ Category IV to II Conversion Kit

TABLE - 2B CATEGORY IV TO CATEGORY II CONVERSION KITS		
MODEL	FLUE SIZE	KIT NUMBER
VWH0500	4" to 7"	100131418
VWH0750	5" to 9"	100131419
VWH1000	6" to 10"	100131420
VWH1500	6" to 8"	100131421
VWH2000	8" to 10"	100131422

***Note:** The manufacturer of the selected vent material can also provide a vent adapter to connect the vent material to the VF Series vent connection.

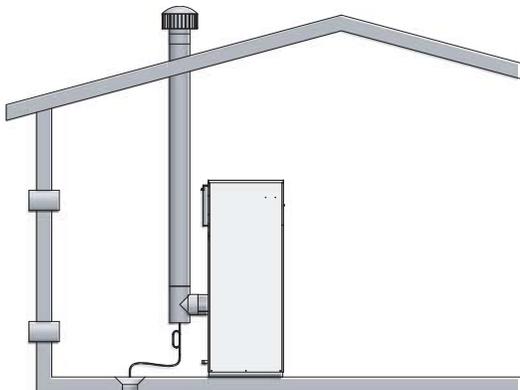
2 Venting *(continued)*

Condensing Vent Options: CAT II & IV

(CAT II vent options A, B, & C requires an adapter kit - see page 14)

A
**CAT II/
IV**

Vertical vent with combustion air from equipment room - see page 16.

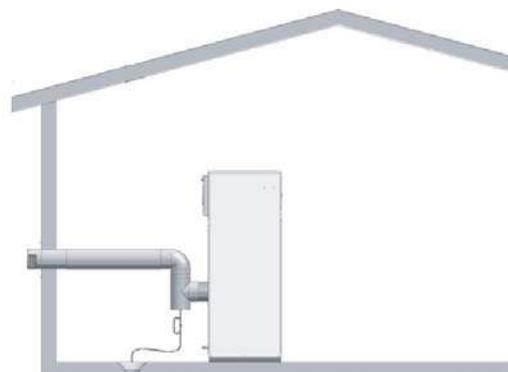


CAT II
requires an
adapter kit.

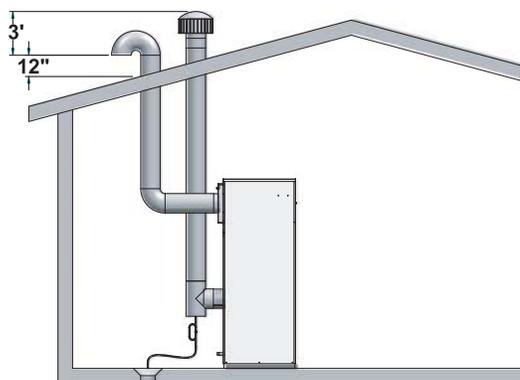
See page 14.

D
CAT IV

Sidewall termination with combustion air from equipment room - see page 17.


B
**CAT II/
IV**

Vertical Direct Vent installation with rooftop combustion air inlet - see page 16.

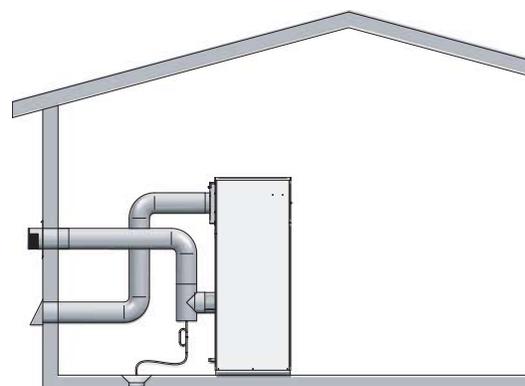


CAT II
requires an
adapter kit.

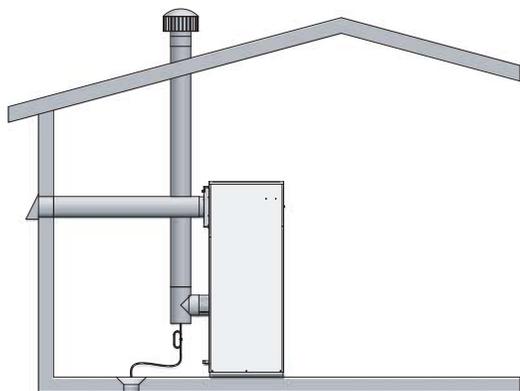
See page 14.

E
CAT IV

Horizontal Direct Vent installation with sidewall combustion air inlet - see page 18.


C
**CAT II/
IV**

Vertical Vent/Air installation with sidewall combustion air inlet - see page 17.

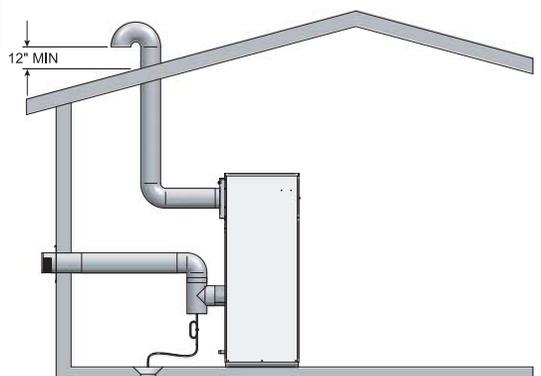


CAT II
requires an
adapter kit.

See page 14.

F
CAT IV

Horizontal Vent/Air installation with vertical combustion air inlet - see page 18.



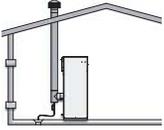
2 Venting

Condensing vent options: CAT II & IV

(CAT II vent options A, B, & C requires an adapter kit - see page 14)

A

CAT II/IV



CAT II requires an adapter kit.
See page 14.

Vertical vent with combustion air from equipment room - see page 15.

The flue outlet terminates on the rooftop.

The termination point for the flue products must follow the vertical vent termination clearance requirements on pages 24 and 25. These units can be identified by the Category IV as noted on the unit's rating plate.

The flue from this Category IV appliance must have all vent joints and seams sealed gastight. A Category IV vent system has specific vent material and installation requirements.

The flue products in the vent system may be cooled below their dew point and form condensate in the flue. The materials used for a Category IV vent must be resistant to any corrosive damage from flue gas condensate. The flue from a Category IV vent system must have a condensate drain with provisions to properly collect and dispose of any condensate that may occur in the venting system.

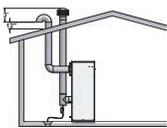
Follow all requirements in the *General Venting* and *Category IV General Venting* sections for proper installation and for venting flue products to the outdoors with a vertical termination (see pages 19 and 20).

TABLE - 2C
VENT TERMINATION SIZES

MODEL	CAT II VENT SIZE	CAT IV VENT SIZE	MODEL	CAT II VENT SIZE	CAT IV VENT SIZE
VWH0500	7"	4"	VWH1500	8"	6"
VWH0750	9"	5"	VWH2000	10"	8"
VWH1000	10"	6"	--	--	--

B

CAT II/IV



CAT II requires an adapter kit.
See page 14.

Vertical direct vent installation with rooftop combustion air inlet - see page 15.

The Vertical Direct Vent system is installed with a Category IV flue and a separate combustion air pipe to the outdoors. The flue outlet and combustion air intake must both terminate on the rooftop.

The termination point for the flue products must follow the vertical vent termination clearance requirements on pages 24 and 25. These units can be identified by the Category IV as noted on the unit's rating plate.

The optional Direct Vent system requires the installation of specific venting materials that are purchased locally.

Follow all requirements in the *General Venting* and *Category IV General Venting* sections for proper installation and for venting flue products to the outdoors with a vertical termination (see pages 19 and 20).

The Vertical Direct Vent system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance. Follow all requirements under the *Combustion Air Inlet* section on pages 22 and 23.

TABLE - 2D
AIR & VENT TERMINATION SIZES

MODEL	CAT II		CAT IV		MODEL	CAT II		CAT IV	
	AIR SIZE	VENT SIZE	AIR SIZE	VENT SIZE		AIR SIZE	VENT SIZE	AIR SIZE	VENT SIZE
VWH0500	5"	7"	5"	4"	VWH1500	6"	8"	6"	6"
VWH0750	5"	9"	5"	5"	VWH2000	8"	10"	8"	8"
VWH1000	6"	10"	6"	6"	--	--	--	--	--

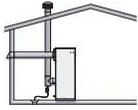
2 Venting *(continued)*

Condensing vent options: CAT II & IV

(CAT II vent options A, B, & C requires an adapter kit - see page 14)

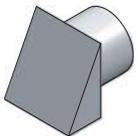


CAT II/IV



CAT II requires an adapter kit.

See page 14.



Air Inlet Cap

Vent/Air Vertical installation with sidewall combustion air inlet - see page 15.

The Vent/Air Vertical with a Sidewall Combustion Air Vent system terminates the flue at the rooftop and air inlet at the sidewall. The flue outlet and combustion air intake terminate in different pressure zones.

The optional Vent/Air vent system requires the installation of specific venting materials that are purchased locally.

The termination point for the flue products must follow the vertical vent termination clearance requirements on pages 24 and 25. These units can be identified by the Category IV as noted on the unit's rating plate.

Follow all requirements in the *General Venting* and *Category IV General Venting* sections for proper installation and for venting flue products to the outdoors with a vertical termination (see pages 19 and 20).

The Vent/Air Vertical system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance. Follow all requirements under the *Combustion Air Inlet* section on pages 22 and 23.

Sidewall combustion air inlet: The air inlet cap for the sidewall air inlet must be purchased from the appliance manufacturer.

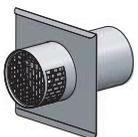
The part numbers for the required sidewall air inlet cap kit are listed by model. Each kit includes the special combustion air inlet cap for installation on an exterior sidewall. The sidewall air inlet cap supplied in the kit is sized to provide combustion air for a single appliance only.

TABLE - 2E
AIR INLET CAP TERMINATIONS

MODEL	CAT II		CAT IV		CAT IV KIT NUMBER	MODEL	CAT II		CAT IV		CAT IV KIT NUMBER
	AIR SIZE	VENT SIZE	AIR SIZE	VENT SIZE			AIR SIZE	VENT SIZE	AIR SIZE	VENT SIZE	
VWH0500	5"	7"	5"	4"	100131423	VWH1500	6"	8"	6"	6"	100131425
VWH0750	5"	9"	5"	5"	100131423	VWH2000	8"	10"	8"	8"	100131427
VWH1000	6"	10"	6"	6"	100131425	--	--	--	--	--	--



CAT IV



Vent Cap

Sidewall termination with combustion air from equipment room - see page 15.

The connection from the appliance flue outlet to the sidewall vent cap MUST be made with listed Category IV vent materials and accessories. The installer must supply suitable vent pipe material. The sidewall vent cap must be purchased from the appliance manufacturer.

The sidewall vent cap kit includes the wall penetration assembly and the discharge screen assembly. All required Category IV vent pipe and fittings must be purchased locally.

The termination point for the flue products must follow the sidewall vent termination clearance requirements on pages 25 and 26. These units can be identified by the Category IV as noted on the unit's rating plate.

Follow all requirements in the *General Venting* and *Category IV General Venting* sections for proper installation and for venting flue products to the outdoors with a sidewall termination (see pages 19 and 20).

TABLE - 2F
FLUE VENT TERMINATION SIZES

MODEL	CAT IV VENT SIZE	CAT IV KIT	MODEL	CAT IV VENT SIZE	CAT IV KIT
VWH0500	4"	100131428	VWH1500	6"	100131430
VWH0750	5"	100131429	VWH2000	8"	100131432
VWH1000	6"	100131430	--	--	--

2 Venting

Condensing vent options: CAT IV

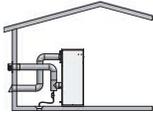


CAT IV

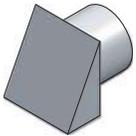
Horizontal direct vent installation with sidewall combustion air inlet - see page 15.

The horizontal direct vent system is installed with a Category IV flue and a separate combustion air pipe to the outdoors. The flue outlet and combustion air intake must both terminate on the same sidewall.

The connection from the appliance flue outlet to the sidewall vent cap MUST be made with listed Category IV vent materials and accessories. The installer must supply suitable vent pipe material. The horizontal direct vent must be purchased from the appliance manufacturer.



The termination point for the flue products must follow the sidewall vent termination clearance requirements on pages 25 - 28. These units can be identified by the Category IV as noted on the unit's rating plate.

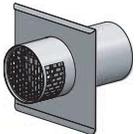


The horizontal direct vent kit includes the wall penetration assembly and the discharge screen assembly for the flue and a combustion air inlet cap. All required vent pipe and fittings must be purchased locally.

Follow all requirements in the *General Venting* and *Category IV General Venting* sections for proper installation and for venting flue products to the outdoors with a sidewall termination (see pages 19 and 20).

Air Inlet Cap

The horizontal direct vent system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance. Follow all requirements under the *Combustion Air Inlet* section on pages 22 and 23.



Vent Cap

TABLE - 2G SIDEWALL AIR AND VENT TERMINATION SIZES							
MODEL	CAT IV		CAT IV KIT	MODEL	CAT IV		CAT IV KIT
	AIR SIZE	VENT SIZE			AIR SIZE	VENT SIZE	
VWH0500	5"	4"	100131433	VWH1500	6"	6"	100131435
VWH0750	5"	5"	100131434	VWH2000	8"	8"	100131439
VWH1000	6"	6"	100131435	--	--	--	--

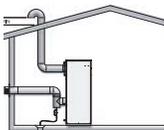


CAT IV

Horizontal vent/air installation with vertical or sidewall combustion air - page 15.

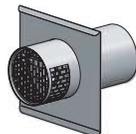
The Horizontal Vent/Air vent system terminates the flue at the sidewall and air inlet at either the rooftop or a sidewall opposite the vent termination. The flue outlet and combustion air intake terminate in different pressure zones.

The connection from the appliance flue outlet to the sidewall vent cap MUST be made with listed Category IV vent materials and accessories. The installer must supply suitable vent pipe material. The Horizontal Vent/Air vent cap must be purchased from the appliance manufacturer.



The termination point for the flue products must follow the sidewall vent termination clearance requirements on pages 25 - 28. These units can be identified by the Category IV as noted on the unit's rating plate.

The Horizontal Vent/Air vent system with a vertical air inlet requires a sidewall vent kit. The Horizontal Vent/Air vent system with a sidewall air inlet requires a horizontal direct vent kit. All required vent pipe and fittings must be purchased locally.



Vent Cap

Follow all requirements in the *General Venting* and *Category IV General Venting* sections for proper installation and for venting flue products to the outdoors with a sidewall termination (see pages 19 and 20).

The Horizontal Vent/Air vent system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance. Follow all requirements under the *Combustion Air Inlet* section on pages 21 and 22.

TABLE - 2H SIDEWALL VENT TERMINATION SIZES							
MODEL	CAT IV		CAT IV KIT	MODEL	CAT IV		CAT IV KIT
	AIR SIZE	VENT SIZE			AIR SIZE	VENT SIZE	
VWH0500	5"	4"	100131428	VWH1500	6"	6"	100131430
VWH0750	5"	5"	100131429	VWH2000	8"	8"	100131432
VWH1000	6"	6"	100131430	--	--	--	--

2 Venting *(continued)*

Common Venting CAT II:

Flues of multiple VF Series water heaters may be combined by incorporating a vent increaser to change the Category IV appliance to a Category II vent system which can be common vented using an engineered vent system. The increaser kit must be provided by the manufacturer and the combined engineered vent system must be designed to ensure that flue products will be properly exhausted from the building at all times. **Failure to use the correct vent increaser or a properly sized vent system may result in a hazardous condition where flue gases spill into an occupied living space.** Consult a vent designer to determine the diameter of the common vent pipe required for combined vent installation. It is recommended that all vent joints and seams are sealed gastight. This vent system has specific vent material and installation requirements. The negative draft in a conventional vent installation must be within the range of 0.02 to 0.08 inches w.c. to ensure proper operation. Make all draft readings while the unit is in stable operation (approximately 2 to 5 minutes).

CAT II & IV General venting information - Vent options: All Categories

Vent installation for connection to gas vents or chimneys must be in accordance with “Venting of Equipment”, of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment or applicable provisions of the local building codes.

All venting applications where combustion air is drawn from the equipment room must have adequate combustion and ventilation air supplied to the equipment room in accordance with the latest edition of CAN/CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment or applicable provisions of the local building codes.

The distance of the vent terminal from adjacent buildings, windows that open and building openings MUST comply with the minimum clearances stated in this manual and the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment.

The vent connection is made directly to the flue outlet opening on the rear of the unit. The connection from the appliance vent to the stack must be made as direct as possible with no reduction in diameter. A water heater shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel.

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

NOTICE

Examine the venting system at least once a year. Check all joints and vent pipe connections for tightness. Also check for corrosion or deterioration. Immediately correct any problems observed in the venting system.

CAT IV Specific venting information: Vent Options A, B, C, D, E, & F

A Category IV venting system operates with a positive pressure in the vent. This positive pressure is generated by the internal combustion air blower which operates the combustion process and also exhausts the flue products from the building. The Category IV flue from this appliance cannot be combined with the vent from any other appliance. **The Category IV flue from this appliance must be a dedicated stack, there is one exception however. The Category IV flues from multiple VF Series appliances may only be combined when using an engineered vent system incorporating an induced draft fan to ensure that flue products will be properly exhausted from the building at all times. Failure to use a properly sized induced draft fan on a combined Category IV vent installation may result in a hazardous condition where flue gases spill into an occupied living space.** Consult the induced draft fan manufacturer to size the induced draft fan and to determine the diameter of the common vent pipe required for a combined vent installation. The flue from this Category IV appliance must have all vent joints and seams sealed gastight. A Category IV vent system has specific vent material and installation requirements.

The flue products in the vent system may be cooled below their dew point and form condensate in the flue. The flue materials used for a Category IV vent must be resistant to any corrosive damage from flue gas condensate. The flue from a Category IV vent system must have a condensate drain with provisions to properly collect and dispose of any condensate that may occur in the venting system.

The connection from the appliance vent to the stack or vent termination outside the building must be made with listed Category IV vent material and must be as direct as possible. The Category IV vent and accessories such as firestop spacers, thimbles, caps, etc., must be installed in accordance with the vent manufacturer’s instructions. The vent connector and firestop must provide correct spacing to combustible surfaces and seal to the vent connector on the upper and lower sides of each floor or ceiling through which the vent connector passes.

Any vent materials specified must be listed by a nationally recognized test agency for use as a Category IV vent material.

The venting system must be planned so as to avoid possible contact with concealed plumbing or electrical wiring inside walls, floors, or ceilings. Locate the appliance as close as possible to a chimney or gas vent.

Horizontal portions of the venting system shall be supported to prevent sagging. Horizontal runs should slope upwards not less than a 1/4 inch per foot from the drain tee installed in the flue to the vertical portion of the flue or to the vent terminal on sidewall venting installations. This ensures proper removal of any condensate that may form in the flue. Follow the installation instructions from the vent material manufacturer.

2 Venting

CAT IV Specific venting information (*continued*): Vent options A, B, C, D, E, & F

Do not use an existing chimney as a raceway if another appliance or fireplace is vented through the chimney. The weight of the venting system must not rest on the unit. Adequate support of the venting system must be provided in compliance with local codes and other applicable codes. All connections should be secured and sealed per the vent manufacturer's specifications.

Vent connectors serving appliances vented by natural draft shall not be connected to any portion of the Category IV positive pressure vent system used by this appliance. Connection of a negative draft flue into the positive pressure stack from this appliance may cause flue products to be discharged into an occupied living space causing serious health injury.

When a Category IV vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

The flue may terminate either vertically at the rooftop or horizontally on a sidewall. Refer to the specific vent termination sections for information about recommended vent termination location and clearances.

Length of flue pipe

The installed length of the Category IV flue from the appliance to the point of termination, outside of the building, must not exceed a maximum of 50 equivalent feet (15.2m) in length. Subtract 5 feet (1.5m) of equivalent length for each 90° elbow installed in the vent. Subtract 2 1/2 feet (0.7m) of equivalent length for each 45° elbow installed in the vent.

CAT III/IV Drain Tee Requirements: Vent options A, B, C, D, E, & F

Drain tee installation

A drain tee must be installed in the Category II & IV vent pipe to collect and dispose of any condensate that may occur in the vent system. The drain tee should be installed at the point where the flue turns vertical for a rooftop termination or as one of the first fittings in a horizontal flue connector that will terminate on a sidewall. Ensure that horizontal portions of the vent are properly sloped to allow condensate to be evacuated at the drain tee. Plastic drain tubing, sized per the vent manufacturer's instructions, shall be provided as a drain line from the tee. The drain tubing must have a trap provided by a 10" (25.4cm) diameter circular trap loop in the drain tubing. Prime the trap loop by pouring a small quantity of water into the drain hose before assembly to the vent. Secure the trap loop in position with nylon wire ties. Use caution not to collapse or restrict the condensate neutralization system or a suitable drain for disposal of condensate that may occur in the Category IV vent system. Ensure that the drain from the condensate tee is not exposed to freezing temperatures. See Section 7, *Startup - Freeze Protection* for more information.

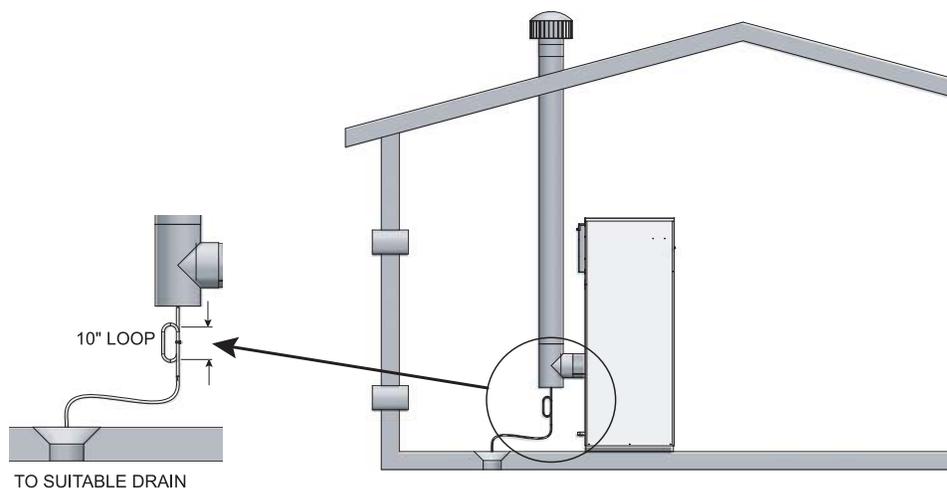


Figure 2-3_Drain Tee Installation

2 Venting *(continued)*

Vertical Air Inlet: Vent options B & F

Vertical combustion air inlet

The air inlet cap for the vertical rooftop air inlet is assembled from components purchased locally. The air inlet cap consists of two 90° elbows installed at the point of termination for the air inlet pipe. The first 90° elbow is installed on the rooftop at the highest vertical point of the air inlet pipe and turned horizontal, the second 90° elbow is installed on the horizontal outlet of the first elbow and turned down.

A 90° elbow and a 90° street elbow may be used to make this assembly. If a straight piece of pipe is used between the two elbows, it should not exceed 6 inches (152mm) in length. The termination elbow on the air inlet must be located a minimum of 12 inches (0.30m) above the roof or above normal levels of snow accumulation.

Location of a vertical air inlet cap

Incorrect installation and/or location of the air inlet cap can allow the discharge of flue products to be drawn into the combustion process on the heater. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems with the heater and possible spillage of flue products that can cause personal injury, death, or property damage.

The point of termination for the combustion air inlet cap **MUST** be at least 3 feet (0.91m) below the point of flue gas termination (vent cap) if it is located within a 10 foot (3.05m) radius of the flue outlet. Use care to ensure that the 90° elbow assembly is properly installed on the air inlet pipe.

The combustion air inlet cap must not be installed closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

The termination point of the combustion air inlet cap must be installed at least one foot (0.30m) above the rooftop and above normal snow levels.

The combustion air cap assembly used **MUST** adequately protect the combustion air inlet from wind and weather.

Combustion air supplied from outdoors must be free of contaminants (see *Combustion and Ventilation Air*, page 10). To prevent recirculation of flue products into the combustion air inlet, follow all instructions in this section.

The combustion air inlet caps for multiple appliance installations must maintain the minimum 3 foot (0.91m) clearance below the closest vertical flue outlet if within 10 feet (3.05m).

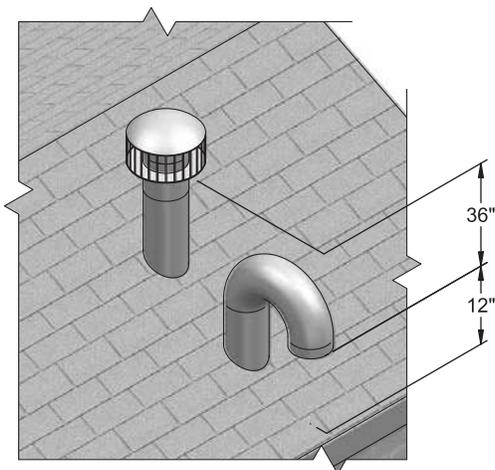


Figure 2-4_Vertical Air Inlet Clearances

2 Venting

Horizontal Air Inlet: Vent options C, E, & F

Sidewall combustion air inlet

The sidewall termination caps for both the flue products and combustion air must be purchased from the appliance manufacturer.

The part numbers for the required sidewall termination kit are listed under each designated table. Each kit includes both the special combustion air inlet cap and the sidewall flue cap for installation on an exterior sidewall. The sidewall air inlet cap supplied in the kit is sized to provide combustion air for a single appliance only.

Location of a sidewall air inlet cap

Incorrect installation and/or location of the air inlet cap can allow the discharge of flue products to be drawn into the combustion process on the heater. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems with the heater and possible spillage of flue products that can cause personal injury, death, or property damage.

The termination point of the sidewall air inlet must be installed a minimum of 12 inches (0.30m) above ground level and above normal levels of snow accumulation.

The point of termination for the sidewall combustion air inlet cap **MUST** be located a minimum of 3 feet (0.91m) horizontally and 12 inches (0.30m) below the point of flue gas termination (vent cap) if it is located within a 10 foot (3.05m) radius of the flue outlet.

The combustion air inlet caps for multiple appliance installations must maintain the same minimum clearance from the closest vent cap installed within a 10 foot radius of the point of flue gas termination as specified in single appliance installations.

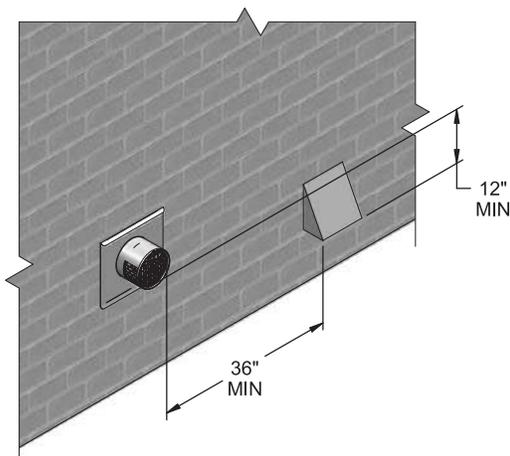


Figure 2-5 Horizontal Air Inlet Clearances

The combustion air inlet cap must not be installed closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

The combustion air cap assembly used **MUST** adequately protect the combustion air inlet from wind and weather.

Combustion air supplied from outdoors must be free of contaminants (see *Combustion and Ventilation Air*, page 10). To prevent recirculation of flue products into the combustion air inlet, follow all instructions in this section.

Multiple horizontal or vertical direct vent installations

The combustion air inlet caps for multiple appliance installations must maintain the same minimum clearance from the closest vent cap installed within a 10 foot radius of the point of flue gas termination as specified in single appliance installations. Multiple flue outlet caps may be installed side by side and multiple air inlet caps may be installed side by side, but the minimum clearance of a 3 feet (0.91m) horizontal radius and 12 inches (0.30m) below the closest flue outlet to the air inlet cap must be maintained. All clearance and installation requirements in this section and the applicable portions of the *Category IV General Venting* section must be maintained on multiple appliance installations.

2 Venting *(continued)*

Length of air inlet pipe for both vertical and horizontal - Vent options: All Categories

The maximum installed length of the air inlet pipe from the appliance to the air inlet cap is 50 equivalent feet (15.2m) in length. Subtract 5 feet (1.52m) of equivalent length for each 90° elbow installed in the air inlet pipe. Subtract 2 1/2 feet (0.7m) of equivalent length for each 45° elbow installed in the air inlet pipe.

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.

*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.

Combined combustion air inlet points - Category II & IV

The air inlet pipes from multiple appliances can be combined to a single common connection if the common air inlet pipe has a cross sectional area equal to or larger than the total area of all air inlet pipes connected to the common air inlet pipe. [Example: two 8" (20.3cm) air inlet pipes (50.3 in²(324.5cm²) area each) have a total area of 100.6 in² (645.2cm²) requires a 12 inch (30.5cm) (113.1in²area) (729.7cm²) common air inlet pipe.] The air inlet point for multiple water heater air inlets must be provided with an exterior opening which has a free area equal to or greater than the total area of all air inlet pipes connected to the common air inlet. This exterior opening for combustion air must connect directly to the outdoors. The total length of the combined air inlet pipe must not exceed a maximum of 50 equivalent feet (15.2m). You must deduct the restriction in area provided by any screens, grills, or louvers installed in the common air inlet point. These (screens, grills, or louvers) are common on the sidewall air inlet openings and some rooftop terminations. Screens, grills, or louvers installed in the common air inlet can reduce the free area of the opening from 25% to 75% based on the materials used.

2 Venting

Vertical Vent Termination Clearances - Venting options: A, B, & C

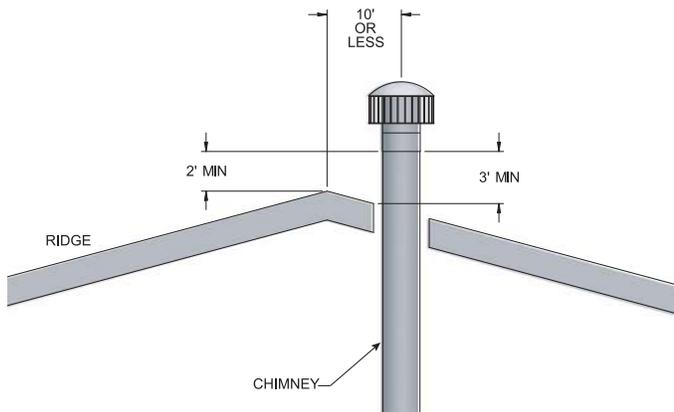


Figure 2-6_ Vent Termination from Peaked Roof - 10 ft. or Less From Ridge

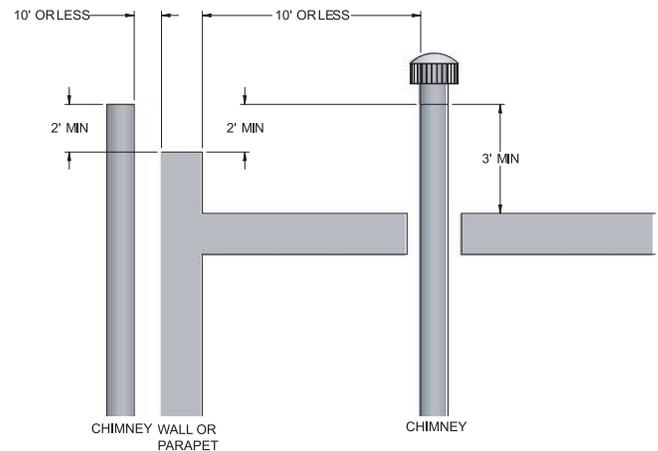


Figure 2-8_ Vent Termination from Flat Roof - 10 ft. or Less From Parapet Wall

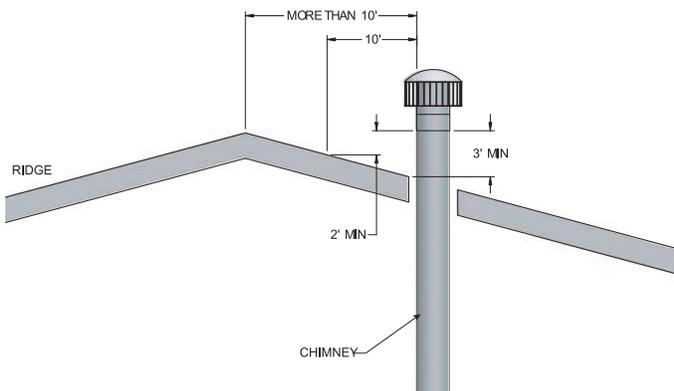


Figure 2-7_ Vent Termination from Peaked Roof - 10 ft. or More From Ridge

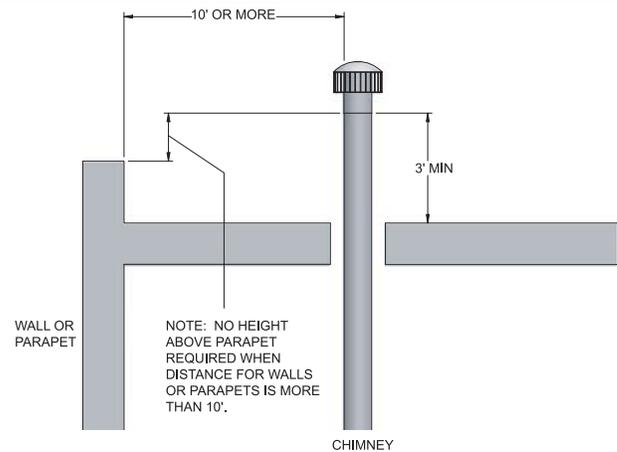


Figure 2-9_ Vent Termination from Flat Roof - 10 ft. or More From Parapet Wall

The vent terminal should be vertical and exhaust outside the building at least 2 feet (0.61m) above the highest point of the roof within a 10 foot (3.05m) radius of the termination.

The vertical termination must be a minimum of 3 feet (0.91m) above the point of exit.

A vertical termination less than 10 feet (3.05m) from a parapet wall must be a minimum of 2 feet (0.61m) higher than the parapet wall.

The vent cap should have a minimum clearance of 4 feet (1.22m) horizontally from and in no case above or below, unless a 4 foot (1.22m) horizontal distance is maintained from electric meters, gas meters, regulators, and relief equipment.

The venting system shall terminate at least 3 feet (0.9m) above any forced air inlet within 10 feet (3.05m).

The venting system shall terminate at least 4 feet (1.2m) below, 4 feet (1.2m) horizontally from, or 1 foot (30cm) above any door, window, or gravity air inlet into any building.

Do not terminate the vent in a window well, stairwell, alcove, courtyard, or other recessed area. The vent cannot terminate below grade. The bottom of the vent terminal shall be located at least 12 inches (30cm) above the roof or above normal snow levels.

To avoid a blocked flue condition, keep the vent cap clear of snow, ice, leaves, debris, etc.

2 Venting *(continued)*

Vertical Vent Termination Clearances - Venting options: A, B, & C

Flue gases from this appliance may contain large amounts of water vapor that will form a white plume in winter. Plume could obstruct window view.

Flue gas condensate can freeze on exterior surfaces or on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition. Flue gas condensate can cause discoloration of exterior building surfaces. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

The manufacturer shall NOT be held liable for any personal injury or property damage due to ice formation or dislodging of ice from the vent system or vent termination.

Masonry chimney installations

A standard masonry chimney must NOT be used to vent the products of combustion from the flue of a Category IV, positive pressure appliance. If a masonry chimney is to be used, the chimney MUST use a sealed, metallic, corrosion resistant liner system to vent flue products from this high efficiency appliance. Sealed, metallic, corrosion resistant liner systems (single-wall, double-wall, flexible or rigid metallic lines) must be rated for use with a high efficiency, Category IV, positive pressure vent system. Corrosion resistant chimney liner systems are typically made from a high grade of corrosion resistant stainless steel such as AL29-4C. The corrosion resistant liner must be properly sized and fully sealed throughout the entire length if the flue is contained within the masonry chimney. Both the top and the bottom of the masonry chimney must be capped and sealed to provide a dead air space around the sealed corrosion resistant metallic liner. Consult with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion resistant liner system.

CAUTION

Venting of a high efficiency Category IV appliance into a masonry chimney without a sealed stainless steel liner can result in operational and safety problems. Any breaks, leaks, or damage to the masonry flue/tile will allow spillage of the positive pressure flue products from the chimney. These flue products can easily escape into an occupied living space causing a health hazard. If there is any doubt about the condition of a masonry chimney, or its acceptability for use after insertion of a corrosion resistant liner system, consult with local code officials.

Location of a sidewall vent termination - Venting options: D, E, & F

The vent cap shall terminate at least 3 feet (0.91m) above any forced air inlet within 10 feet (3.05m).

The vent shall terminate at least 4 feet (1.22m) below, 4 feet (1.22m) horizontally from or 1 foot (0.30m) above and 2 feet (0.60m) horizontally from any door, window, or gravity air inlet to the building.

The sidewall vent termination must be at least 8 feet (2.4m) horizontally from any combustion air intake located above the sidewall termination cap.

Do not terminate the vent in a window well, stairwell, alcove, courtyard, or other recessed area. The vent cap cannot terminate below grade.

The vent shall not terminate directly above a public walkway due to the normal formation of water vapor in the combustion process. Horizontal terminations must not be located over areas of pedestrian or vehicular traffic.

The vent system shall terminate at least 1 foot (0.30m) above grade, above normal snow levels and at least 7 feet (2.13m) above grade when located adjacent to public walkways.

The vent terminal shall not be installed closer than 3 feet (0.91m) from an inside corner of an L-shaped structure.

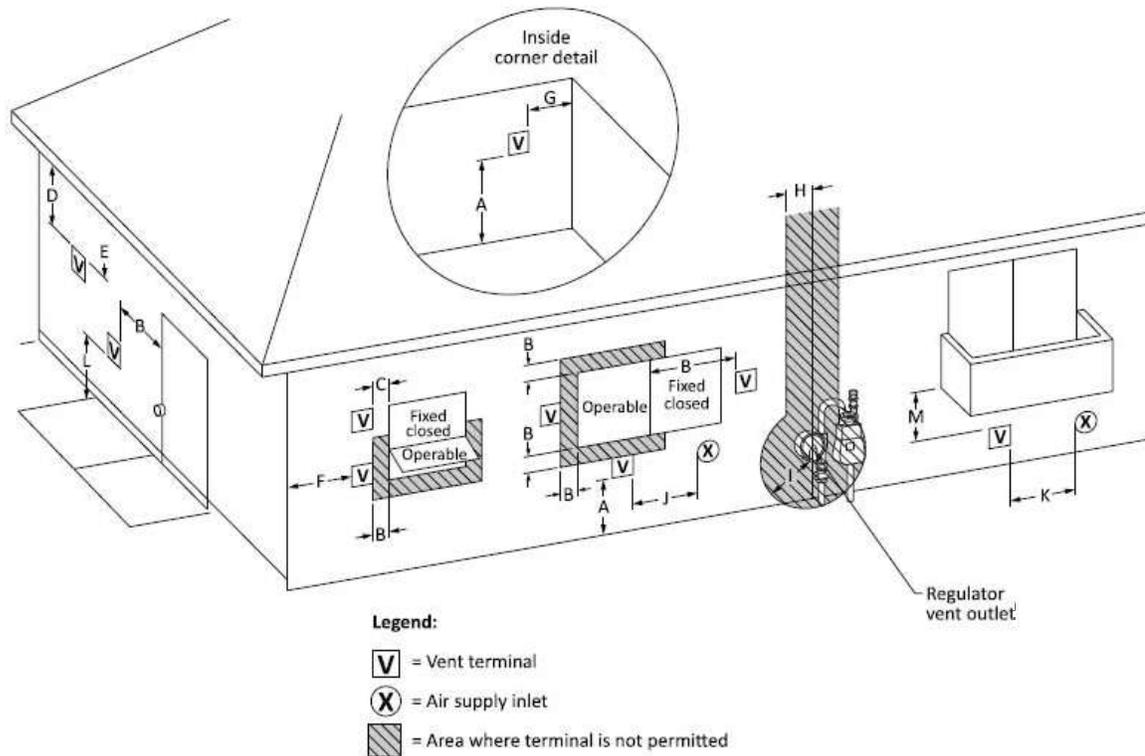
The vent cap should have a minimum clearance of 4 feet (1.22m) horizontally from and in no case above or below, unless a 4 foot (1.22m) horizontal distance is maintained from electric meters, gas meters, regulators, and relief equipment.

Flue gas condensate can freeze on exterior walls or on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition. Some discoloration to exterior building surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

The sidewall vent system MUST use the sidewall vent cap kit provided by the appliance manufacturer for installation on a sidewall termination.

The sidewall vent cap MUST be purchased as a kit from the appliance manufacturer to ensure proper operation. Locally purchased or fabricated sidewall vent caps should not be used.

2 Venting

Figure 2-10A Direct Vent Terminal Clearances

Table 21 Direct Vent Terminal Clearances

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

2 Venting *(continued)*

Table 2I Direct Vent Terminal Clearances *(continued)*

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

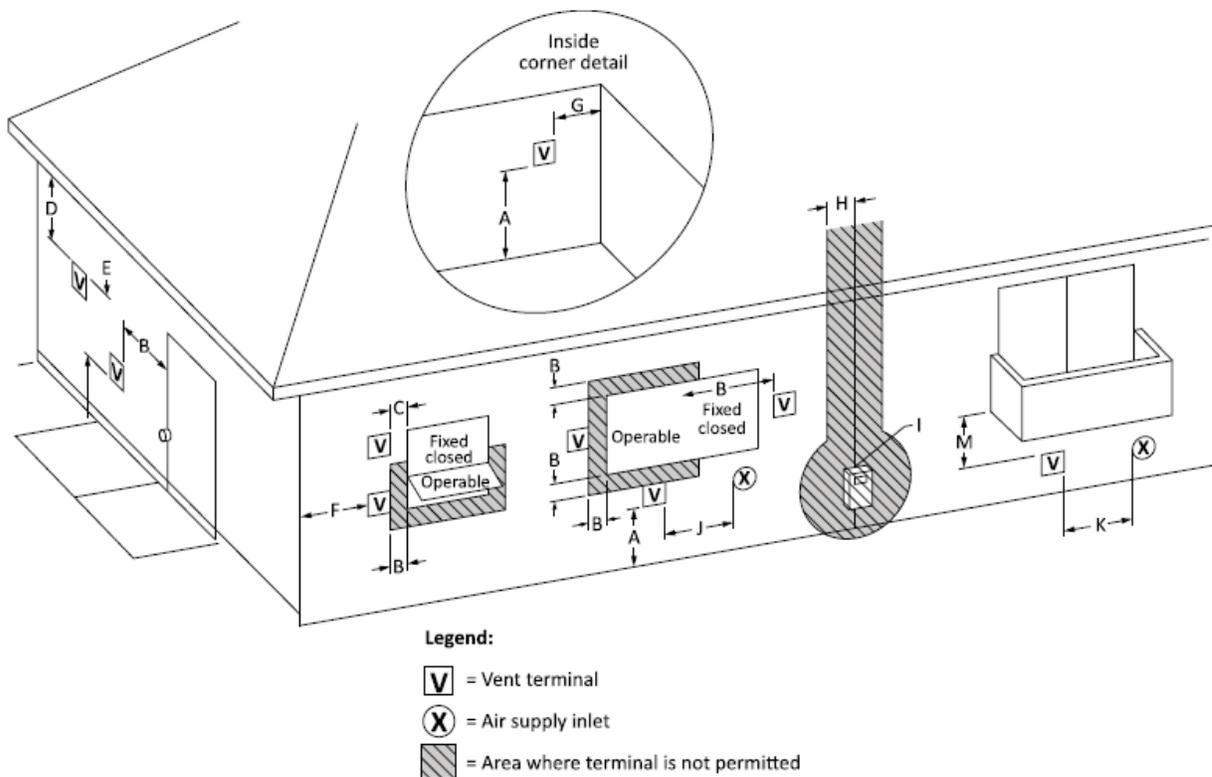
* Clearance in accordance with local installation codes and the requirements of the gas supplier.

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

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

NOTES:

- 1) In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code
- 2) In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code

Figure 2-10B Other than Direct Vent Terminal Clearances


2 Venting

Table 2J Other than Direct Vent Terminal Clearances

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

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

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

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

NOTES:

- 1) In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code
- 2) In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code

3 Gas connections

Gas supply

Verify that the appliance is supplied with the type of gas specified on the rating plate. This appliance is configured for operation up to 4000 feet altitude. Consult factory for installations above 4000 feet elevation.

Inlet gas pressure: Measured at the inlet pressure tap on the appliance gas manifold. The pressure tap is located upstream of the redundant gas valve and downstream of the field installed gas cock.

**TABLE 3A
INLET GAS PRESSURE**

MODEL	NATURAL		LP	
	Max. w.c.	Min. w.c.	Max. w.c.	Min. w.c.
500 -1000	14.0	4.0	13.0	11.0
1500 - 2000	14.0	4.0	14.0	8.0

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

Gas pressure test

1. 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).
2. 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).
3. The appliance and its gas connection must be leak tested before placing it in operation.

Checking manifold gas pressure

Reference the VF Series Service Manual for information regarding manifold gas pressure.

Gas connection

Safe operation of the appliance requires properly sized gas supply piping. See gas line sizing data:

1. Gas pipe size may be larger than appliance connection.
2. Installation of a union at the appliance gas line connection is required for ease of service and removal of the gas train.
3. If an additional manual shutoff valve is required by local codes, install the valve on the outside at the gas supply to the appliance as shown in FIG. 3-1.
4. A sediment trap (drip leg) **MUST** be provided in the inlet of the gas connection to the appliance, see FIG. 3-1.
5. Optional gas controls may require routing of bleeds and vents to the atmosphere, outside the building when required by local codes.

**TABLE - 3B
FITTINGS TO EQUIVALENT STRAIGHT PIPE**

Diameter Pipe (inches)	1 1/2	2	3	4	5
Equivalent length of Straight Pipe (feet)	4	5	10	14	20

NOTICE

If an inline high gas pressure regulator is used, it **MUST BE** of the lockup type and be located a minimum of 10 feet from the appliance. Failure to do so may result in insufficient gas volume supplied to the appliance.

3 Gas connections

**TABLE - 3C
GAS PIPING SIZE CHART**

Nominal Iron Pipe Size Inches	Length of Pipe in Straight Feet														Maximum Capacity of Pipe in Thousands of Btu/hr per hour for gas pressures of 14 Inches Water Column (0.5 PSIG) or less and a pressure drop of 0.5 Inch Water Column (Based on NAT GAS, 1025 Btu/hr per Cubic Foot of Gas and 0.60 Specific Gravity)
	10	20	30	40	50	60	70	80	90	100	125	150	175	200	
3/4	369	256	205	174	155	141	128	121	113	106	95	86	79	74	
1	697	477	384	328	292	267	246	256	210	200	179	164	149	138	
1 1/4	1,400	974	789	677	595	543	502	472	441	410	369	333	308	287	
1 1/2	2,150	1,500	1,210	1,020	923	830	769	707	666	636	564	513	472	441	
2	4,100	2,820	2,260	1,950	1,720	1,560	1,440	1,330	1,250	1,180	1,100	974	871	820	
2 1/2	6,460	4,460	3,610	3,100	2,720	2,460	2,310	2,100	2,000	1,900	1,700	1,540	1,400	1,300	
3	11,200	7,900	6,400	5,400	4,870	4,410	4,000	3,800	3,540	3,300	3,000	2,720	2,500	2,340	
4	23,500	16,100	13,100	11,100	10,000	9,000	8,300	7,690	7,380	6,870	6,150	5,640	5,130	4,720	

Gas piping

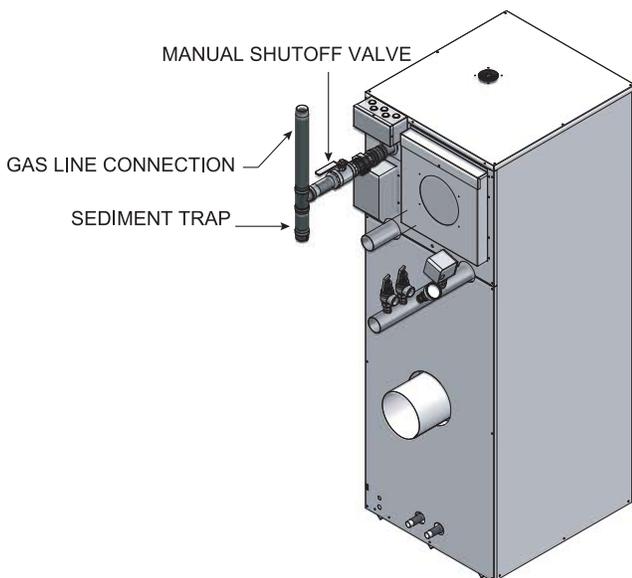


Figure 3-1 Gas Line Connection with Sediment Trap (Drip Leg) and Manual Main Gas Shutoff Valve

All gas connections must be made with pipe joint compound resistant to the action of liquefied petroleum and natural gas. All piping must comply with local codes and ordinances. Tubing installations must comply with approved standards and practices.

Install piping to control

1. The gas line should be a separate line direct from the meter unless the existing gas line is of sufficient capacity. Verify pipe size with your gas supplier.
2. Use new, properly threaded black iron pipe free from chips. If tubing is used, make sure the ends are square, deburred and clean. All tubing bends must be smooth and without deformation. Avoid flexible gas connections. Internal diameter of flexible gas lines may not provide appliance with proper volume of gas.
3. Run pipe or tubing to the unit's gas inlet. If tubing is used, obtain a tube to pipe coupling in order to connect the tubing to the unit's gas inlet.
4. Install a sediment trap in the supply line to the unit's gas inlet (see FIG. 3-1).
5. Remove seal over gas inlet to the appliance.
6. Apply a moderate amount of good quality pipe compound (DO NOT use Teflon tape) to pipe only, leaving two end threads bare.
7. Connect gas pipe to inlet of appliance. Use a wrench to support the gas manifold on the appliance.
8. For LP gas, consult your LP gas supplier for expert installation.

3 Gas connections *(continued)*

Checking gas supply pressure

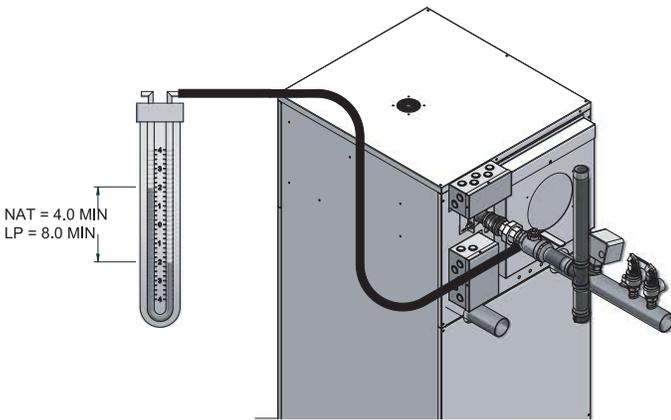


Figure 3-2 Gas Supply Pressure Measurement

- Turn the main power switch to the “OFF” position.
- Shut off the gas supply at the manual gas cock in the gas piping to the appliance. If fuel supply is LP gas, shut off gas supply at the tank.
- Remove the 1/8" hex plug from the gas pressure test port located on the manual shutoff valve at the rear of the appliance. Install a fitting in the inlet pressure tapping suitable to connect to a manometer or magnahelic gauge. Range of scale should be 14 inches water column or greater to check inlet pressure.
- Turn on gas supply at the field installed manual gas cock, turn on LP gas at tank if required.
- Turn the power switch to the “ON” position.
- Adjust the temperature set point on the display to call for heat.
- Observe the gas supply pressure as the burner fires at 100% of rated input. Percent of burner input will be shown on the display of the control module.
- Ensure inlet pressure is within specified range. Minimum and maximum gas supply pressures are specified in the *Gas Supply* section of this manual.
- If gas pressure is out of range, contact the gas utility, gas supplier, qualified installer or service agency to determine necessary steps to provide proper gas pressure to the control.
- If gas supply pressure is within normal range, proceed to remove gas manometer and replace pressure tap fittings in the gas piping to the appliance.
- Turn the power switch to the “OFF” position.
- Shut off gas supply at the manual gas cock in the gas piping to the appliance. If fuel supply is LP gas, shut off gas supply at the tank.
- Remove the manometer and related fittings from the gas pressure test port at the inlet gas supply connection to the appliance. Replace the 1/8" plug in the gas pressure test port and tighten.
- Turn on the gas supply at the manual valve, turn on LP gas at the tank if required.
- Turn the power switch to the “ON” position.
- Adjust the temperature set point on the display of the control module to the desired water temperature so the appliance will call for heat.
- Check burner performance by cycling the system while you observe burner response. The burner should ignite promptly. Flame pattern should be stable, see “*Maintenance - Normal Flame Pattern*” in the VF Series Service Manual. Turn system off and allow burner to cool, then cycle burner again to ensure proper ignition and flame characteristics.

NOTICE

If a pressure drop of more than 2" w.c. occurs between Standby (Static) Mode and Operating (Dynamic) Mode, a gas volume problem exists. Contact the gas utility, gas supplier, qualified installer, or service agency to determine the necessary steps to provide the proper gas volume to the appliance.

High and low gas pressure switches

- Manual reset high and low gas pressure switches are supplied to meet Factory Mutual, GE GAP, and CSD-1 requirements.
- In the Commonwealth of Massachusetts, gas appliances over 1,000,000 BTU must be equipped with manual reset high and low gas pressure switches when required to meet the Massachusetts requirements.

NOTE: Massachusetts code requires a pressure regulator to be installed upstream of the low gas pressure switch. A.O. Smith requires any inline regulator used **MUST BE** of the lockup type and be located a minimum of 10 feet from the appliance. Failure to do so may result in insufficient gas volume supplied to the appliance. Massachusetts also requires a shutoff valve be installed ahead of the regulator for replacement or service. When required, both regulator and shutoff valve are to be “field provided”.

- Figures 3-3A and 3-3B on page 32 show piping connections for high and low gas pressure switches for respective VF Series models.

3 Gas connections

High and low gas pressure switches (continued)

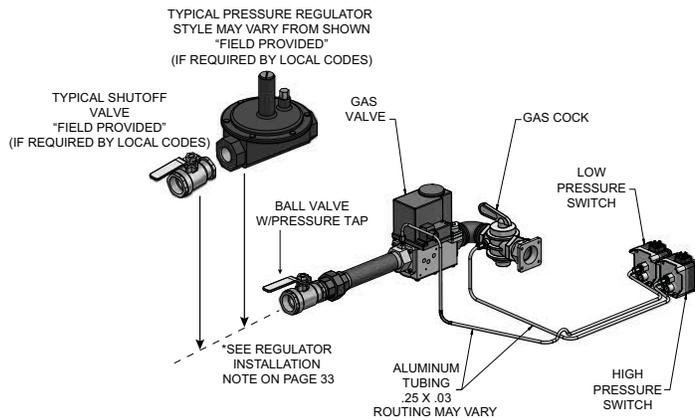


Figure 3-3A_VF 500 - 1000 High & Low Gas Pressure Switches

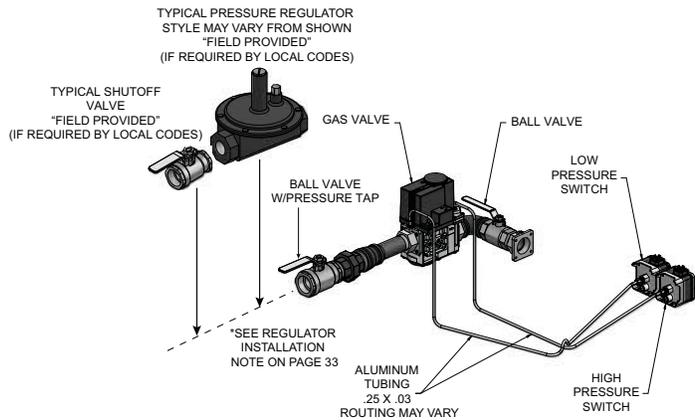


Figure 3-3B_VF 1500 - 2000 High & Low Gas Pressure Switches

NOTICE

The gas train and controls assembly provided on this unit have been tested under the applicable American National Standard to meet minimum safety and performance criteria such as safe lighting, combustion, and safety shutdown operation.

VF Series gas train

The ratio gas valve on this appliance uses line (120 VAC) voltage for operation. The valve contains the safety shutoff and operating valves required on water heaters. The ratio valve uses the negative pressure signal generated by the venturi to modulate the amount of gas, so that the proper mixture of air and gas is delivered to the burner throughout the full range of burner operation. The ratio gas valve does not require installation of a vent line - see the *Venting of Gas Train Components* section below.

There are no serviceable parts on the combination gas valve.

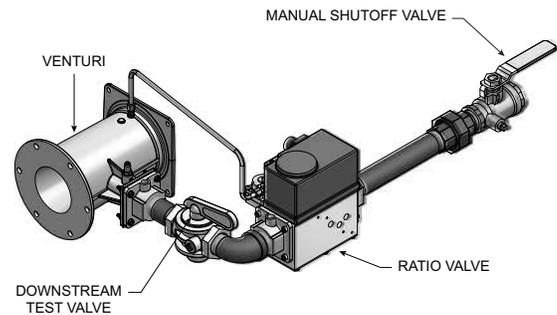


Figure 3-4_Gas Train Assembly VF 1500 - 2000

Venting of gas train components - and optional gas train components

Local codes may require the routing component bleeds and vents to the atmosphere outside the building. Components (valves, pressure switches) having vents which would require external vent lines are provided with threaded vent line connections. These vent line connection points may be accessed by removing the top jacket panels. Proper routing of vent lines to the atmosphere from the factory supplied termination points is the responsibility of the installing contractor.

4 Water connections

Inlet and outlet connections

For ease of service, install unions on the inlet and outlet of the appliance. The connection to the appliance marked “Water Inlet” on the header should be used for return from the system. The connection on the header marked “Hot Water Outlet” is to be connected to the supply side of the system. Minimum water pipe connections to this appliance are 2 1/2 inches (63.5mm) pipe. See the piping requirements in the water heater section of this manual for multiple appliance installations.

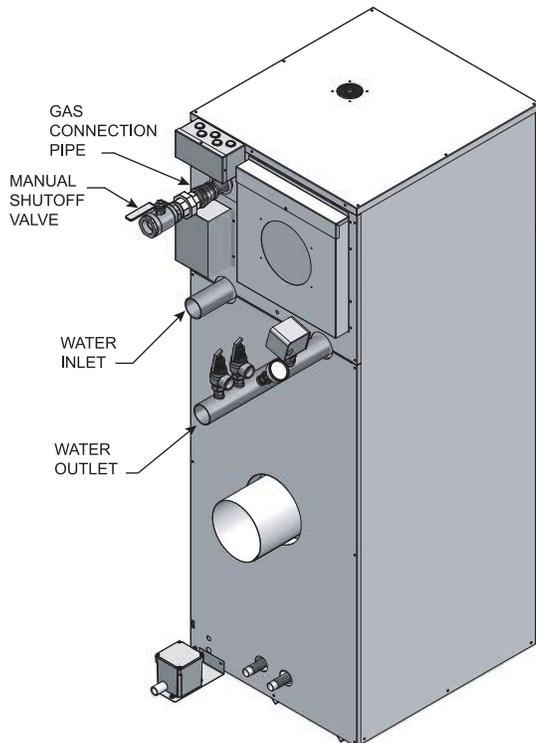


Figure 4-1_Water Connections

Initial set-up of maximum water flow

On initial start-up of the VF water heater, the maximum water flow to the heat exchanger must be checked and manually limited with a valve or bypass before normal operation begins.

Minimum water temperatures

A minimum return water temperature of 140°F (60°C) has been established to control condensate formation based on the Btu/hr output at rated burner input. Maintaining inlet water temperatures to the appliance equal to or higher than the specified minimum temperature ensures proper operation of the appliance and prevents condensate formation on the heat exchanger. An appliance allowed to sustain operation at water temperatures lower than the specified minimum temperature may not provide enough heat from the burner to maintain water temperature in the heat exchanger above the 140°F (60°C) dew point of flue products. Operation of the appliance at a temperature below the specified minimum set point will result in non-warrantable operational problems from the condensate formation on the primary heat exchanger (see the *Low Temperature Bypass Requirements* section on page 35 of this manual).

⚠ CAUTION

An appliance allowed to operate at return temperatures below the specified minimum setting may experience problems with the operating controls, safety switches, obstruction of the flue gas passages on the heat exchanger, incomplete combustion and possible flue gas spillage. Sustained operation at lower than specified water temperatures may cause hazardous conditions that may result in personal injury or non-warrantable damage to the appliance.

Water flow switch

A water flow switch is factory installed in the outlet piping on all water heaters. The flow switch must prove water flow before a trial for ignition can begin. The flow switch requires a minimum flow of 26 GPM to make the flow switch and start burner operation. A water flow switch meets most code requirements for a low water cutoff device on water heaters requiring forced circulation for operation. A fault message, **Flow Sw/LWCO** will be indicated in the Operator Interface on a low water flow condition as sensed by the flow switch.

4 Water connections

Low water cutoff

If this water heater is installed above radiation level, a low water cutoff device must be installed at the time of installation. An electronic low water cutoff is available as a factory supplied option on all models. The low water cutoff should be inspected every 6 months. A fault message, **Flow Sw/LWCO** will be indicated in the Operator Interface on a low water condition as sensed by the low water cutoff.

Relief valve

This unit is supplied with a safety relief valve(s) sized in accordance with ASME Boiler and Pressure Vessel Code, Section IV (“Rules of Construction of Heating Boilers”). The relief valve(s) is installed in the vertical position and mounted in the hot water outlet. No valve is to be placed between the relief valve and the unit. To prevent water damage, the discharge from the relief valve shall be piped to a suitable floor drain for disposal when relief occurs. No reducing couplings or other restrictions shall be installed in the discharge line. The discharge line shall allow complete drainage of the valve and line. Relief valves should be manually operated at least once a year.

CAUTION Avoid contact with hot discharge water.

Water heater installations

Piping of the water heater system

The drawings in this section show typical water heater piping installations, see FIG.’s 9-1 through 9-4. Before beginning the installation, consult local codes for specific plumbing requirements. The installation should provide unions and valves at the inlet and outlet of the appliance so it can be isolated for service. An air separation device must be supplied in the installation piping to eliminate trapped air in the system. Locate a system air vent at the highest point in the system. The system must also have a properly sized expansion tank installed. Typically, an air charged diaphragm-type expansion tank is used. The expansion tank must be installed close to the appliance and on the suction side of the system pump to ensure proper operation.

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.

CAUTION

The water heater system should not be operated at less than 12 PSIG.

Hot water piping must be supported by suitable hangers or floor stands, **NOT** by the water heater. Copper pipe systems will be subject to considerable expansion and contraction. Rigid pipe hangers could allow the pipe to slide in the hanger resulting in noise transmitted into the system. Padding is recommended on rigid hangers installed with a copper system. The pressure relief valve must be piped to a suitable floor drain. See the *Relief Valve* section on this page.

Water connections

All water heaters have 2 1/2 inch copper pipe inlet and outlet connections. Installed piping to and from the appliance must be a minimum of 2 1/2 inch diameter.

CAUTION

Field installed reducing bushings must not be used.

Any reduction in pipe size may decrease flow resulting in high water temperatures, water heater noise, flashing to steam, and non-warrantable heat exchanger damage.

It is important to guarantee that adequate flow is provided to properly dissipate heat from the water heater and also ensure that flow through the water heater does not exceed the maximum recommended flow rate of 75 GPM for Models 500 - 1000 and 90 GPM for Models 1500 - 2000 for a water heater equipped with a copper heat exchanger.

Water heater circulator requirements

This is a low mass, high efficiency hot water heater which must have adequate flow for quiet, efficient operation. Pump selection is critical to achieve proper operation. A pump should be selected to achieve proper system design water temperature rise. Pipe diameter and length are critical to ensure proper flow through the water heater. A Temperature Rise Chart (Table 4D on page 36) is provided to assist in proper pump selection. This table provides GPM and water heater head-loss at various temperature rises for each model based on Btu/hr input. Temperature rise is the difference in water heater inlet temperature and water heater outlet temperature while the water heater is firing at full rate.

Example: The water heater inlet temperature is 160°F (71.1°C) and the water heater outlet temperature is 180°F (82.2°C). This means that there is a 20°F (11.1°C) temperature rise across the water heater. The water heater temperature rise is visible in the Operator Interface on the water heater’s front control panel.

4 Water connections *(continued)*

Circulator pump specifications

1. Maximum operating pressure for the pump must exceed system operating pressure.
2. Maximum water temperature should not exceed the nameplate rating.
3. A properly sized expansion tank must be installed (reference Section 9 - *Domestic Water Heaters*).

Intermittent pump operation

An intermittent pump operation feature is provided. The water heater's circulating pump will cycle on at each call for heat, before the burner fires. The pump will continue to operate while the burner is firing. The pump will run for a minimum 30 second period after the temperature set point is satisfied. This timing is selectable from the Operator Interface. This timing will remove any of the residual heat from the combustion chamber before turning the pump off. See the wiring diagram in *Section 11* of this manual.

Pump Maintenance: Inspect the pump every six (6) months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by the pump manufacturer.

⚠ CAUTION

At no time should the system pressure be less than 12 PSIG.

Low system water volume

System run time is very important to the overall operating efficiency of the water heater. Short cycling of the water heater creates problems with condensation in the vent stack, condensation on the heat exchanger, system temperature spikes, and mechanical component failures. To prevent short cycling of the water heater, it is important to limit the water heater cycles to six or fewer per hour.

Minimum water heater inlet temperatures

Inlet water temperatures below the specified minimum of 140°F (60°C) can excessively cool the products of combustion resulting in condensation on the heat exchanger. Condensation on the heat exchanger can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the related components. See the *Low Temperature Bypass Requirements* section for water heater system applications below the minimum specified temperature.

Low temperature bypass requirements

To prevent condensation problems, a water heater **MUST NOT** be operated (other than for brief periods during initial system startup) with an inlet water temperature of less than 140°F (60°C). If normal system return temperatures are less than the required 140°F (60°C) water heater inlet requirement, a method of low return water temperature protection **MUST BE** provided to protect the water heater.

⚠ CAUTION

A water heater allowed to operate at set point temperatures below the specified minimum settings may experience operational problems with the operating controls and safety switches, obstruction of the flue gas passages on the heat exchanger, incomplete combustion and possible flue gas spillage. Operation at lower than specified water temperatures may cause hazardous conditions that result in non-warrantable damage to the appliance.

TABLE - 4A
MAXIMUM FLOW FOR HEATING WATER HEATER
The maximum flow rate through the water heater with a copper heat exchanger must not exceed the following:

Model	Maximum Flow
500 - 1000	75 GPM
1500 - 2000	90 GPM

If higher flow rates are required through the water heater, an optional Cupro-Nickel heat exchanger is available. Consult the factory for specific application requirements.

4 Water connections

TABLE - 4B

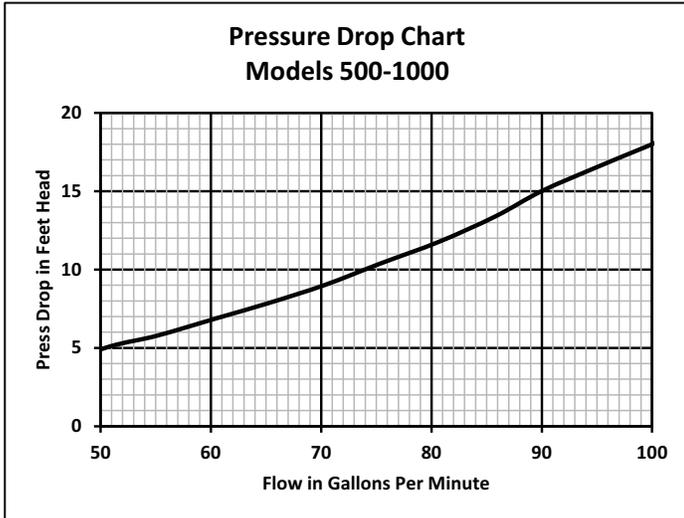


TABLE - 4C

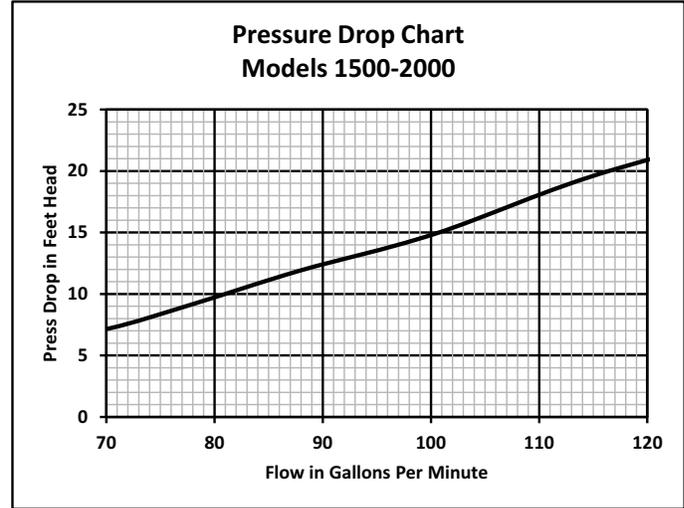


TABLE - 4D
ACCEPTABLE TEMPERATURE RISE

Model	Min Δ °F	Max Δ °F
500	11	18
750	17	25
1000	23	30
1500	28	35
2000	38	41

Water heater requirements

The installer must ensure that the water heater is supplied with adequate flow without excessive temperature rise. Flow rates exceeding the maximum recommended flow will result in erosion of the water heater tubes.

Typical water heating installations

General plumbing rules:

1. Check all local codes.
2. For serviceability of water heater, always install unions.
3. Always pipe pressure relief valve to an open drain.
4. Locate system air vents at highest point of system.
5. Expansion tank must be installed near the water heater and on the suction side of the system pump.
6. Support all water piping.

5 Electrical connections

Water heater operating control module

The operating temperature control for the appliance is the control module. It is located on the inside of the control panel, behind the front access door. Access to adjust the temperature set point and other user adjustable points is made through the Operator Interface located on the right front access door. The outlet sensor is placed in a bulbwell installed in the outlet side of the heat exchanger top header. The inlet sensor is located in a bulbwell on the inlet side of the heat exchanger top header.

The operating sensor, inlet or outlet, is selectable from the screen in the Operator Interface.

The exact temperature set point is based on your system's requirements. Set the control set point(s) to the desired operating water temperature.

The maximum temperature set point for a water heater is 190°F (88°C). The auto reset high limit is fixed at 200°F (93°C), and the adjustable manual reset high limit has a maximum setting of 210°F (98.9°C).

A 120 VAC, 15 Amp, 1 ph, 60 Hz circuit is required for operation of the appliance controls.

The appliance, when installed, must be electrically grounded in accordance with the requirements of the authority having jurisdiction or in the absence of such requirements, with the latest edition of the National Electrical Code ANSI/NFPA No. 70. When the unit is installed in Canada, it must conform to the CAE C22.1, Canadian Electrical Code, Part I and/or local Electrical Codes. Multiple units connected in a Cascade must be grounded to the same ground connection.

1. All wiring between the appliance and field installed devices shall be made with type T wire [63°F (35°C) rise].
2. All line voltage wire exterior to the appliance must be enclosed in approved conduit or approved metal clad cable.
3. The circulating pump must run continuously when the appliance is being fired.
4. To avoid serious damage, DO NOT energize the appliance until the system is full of water. Ensure that all air is removed from the heat exchanger and piping before beginning initial operation. Serious damage may result if the appliance is operated without proper flow.
5. Provide the appliance with proper overload protection.

⚠ 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.

**TABLE - 5A
AMP DRAW DATA**

Model	Blower & Controls	Pump FLA*	Approximate Total Amps @ 120 VAC
500	6.7	8.8	15.5
750	6.7	8.8	15.5
1000	6.7	8.8	15.5
1500	6.5	8.8	15.3
2000	6.5	8.8	15.3
*Standard Pump Supplied with Water Heaters Only			

NOTICE

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

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

Appliance 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, 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. 5-1.
2. Provide and install a fused disconnect or service switch (15 AMP recommended) as required by the code (see FIG. 5-1).
3. To activate a system pump, wire as shown in FIG. 5-1. If the motor is larger than 1 HP, you must install a contactor.
4. When connecting power to units which are to be cascaded, each unit must be connected to the same ground connection.

5 Electrical connections

EMS or remote thermostat connection

An EMS, remote thermostat or other remote temperature control may be connected to the water heater (see FIG. 5-3). Follow the manufacturer's instructions supplied with the remote temperature control for proper installation and adjustment. Connection of a set of dry switching contacts or a remote on/off thermostat to the low voltage connection board will allow the unit to be switched on and off by making or breaking a 24 VAC control circuit.

Ensure that all wiring used to connect the switching contacts of the remote temperature controller to the connection board are a minimum of 18 gauge and have a maximum installed length of 300 feet (91.4m). Set the control to a set point temperature slightly higher than the setting of the remote temperature control. This will ensure that the remote temperature controller functions as the operating control for the heater.

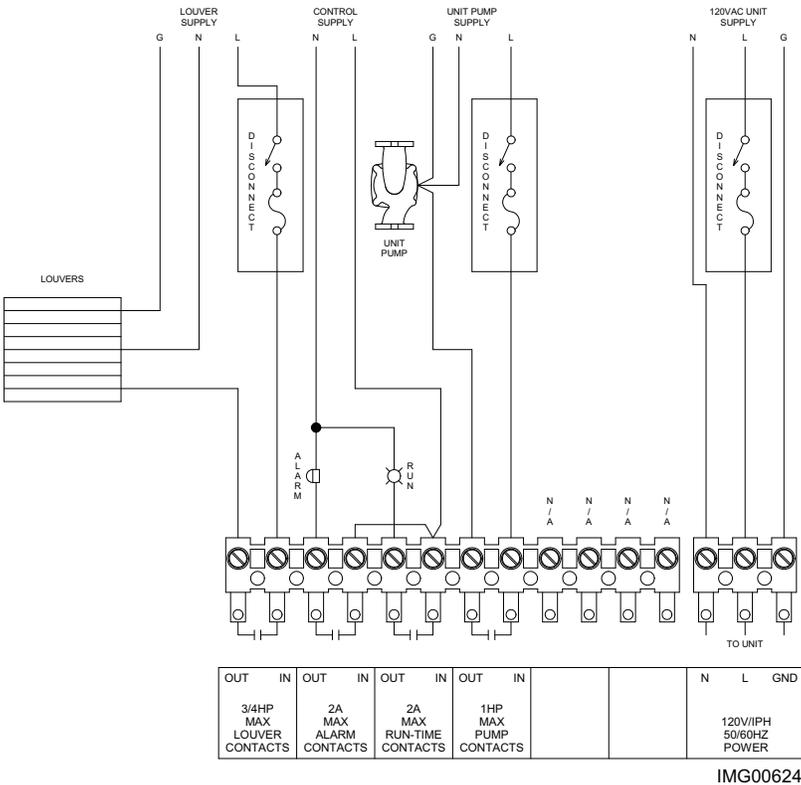


Figure 5-1_Line Voltage Field Wiring Connections

Low voltage connections

1. Route all low voltage wires through the knockouts in the rear of the heater, as shown in FIG. 5-2.
2. Connect low voltage wiring to the low voltage connection board as shown in FIG. 5-4 on page 40 of this manual and the heater wiring diagram.

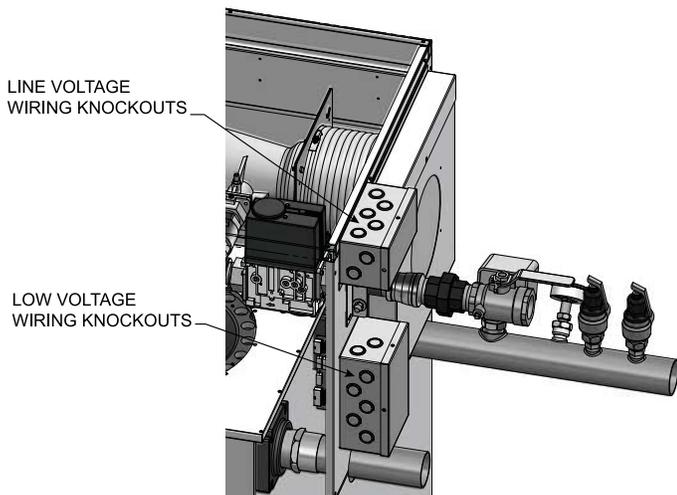


Figure 5-2_Routing Field Wiring

REMOTE ON/OFF WIRE CONNECTION

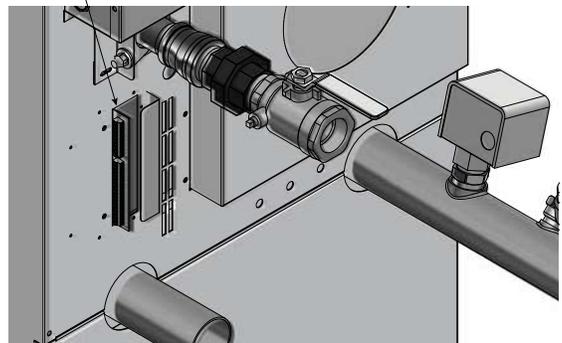


Figure 5-3_Remote ON/OFF Wire Connection

5 Electrical connections *(continued)*

Louver proving switch

1. When the operation of a louver proving switch 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. 5-4).

Water heater Management System (BMS)

1. An external control may be connected to control either the firing rate or the set point of the appliance. Connect the 0 - 10 VDC terminals to the 0 - 10 VDC output of the external control. The control can be programmed to use the enable output of the Boiler Management System, or use the voltage signal to enable the heater. Connect the enable terminals to the enable output of the BMS, when used.
2. Make sure the ground terminal is connected to the ground output terminal of the external control, and the 0 - 10 VDC terminal is connected to the 0 - 10 VDC terminal of the external control.

Runtime contacts

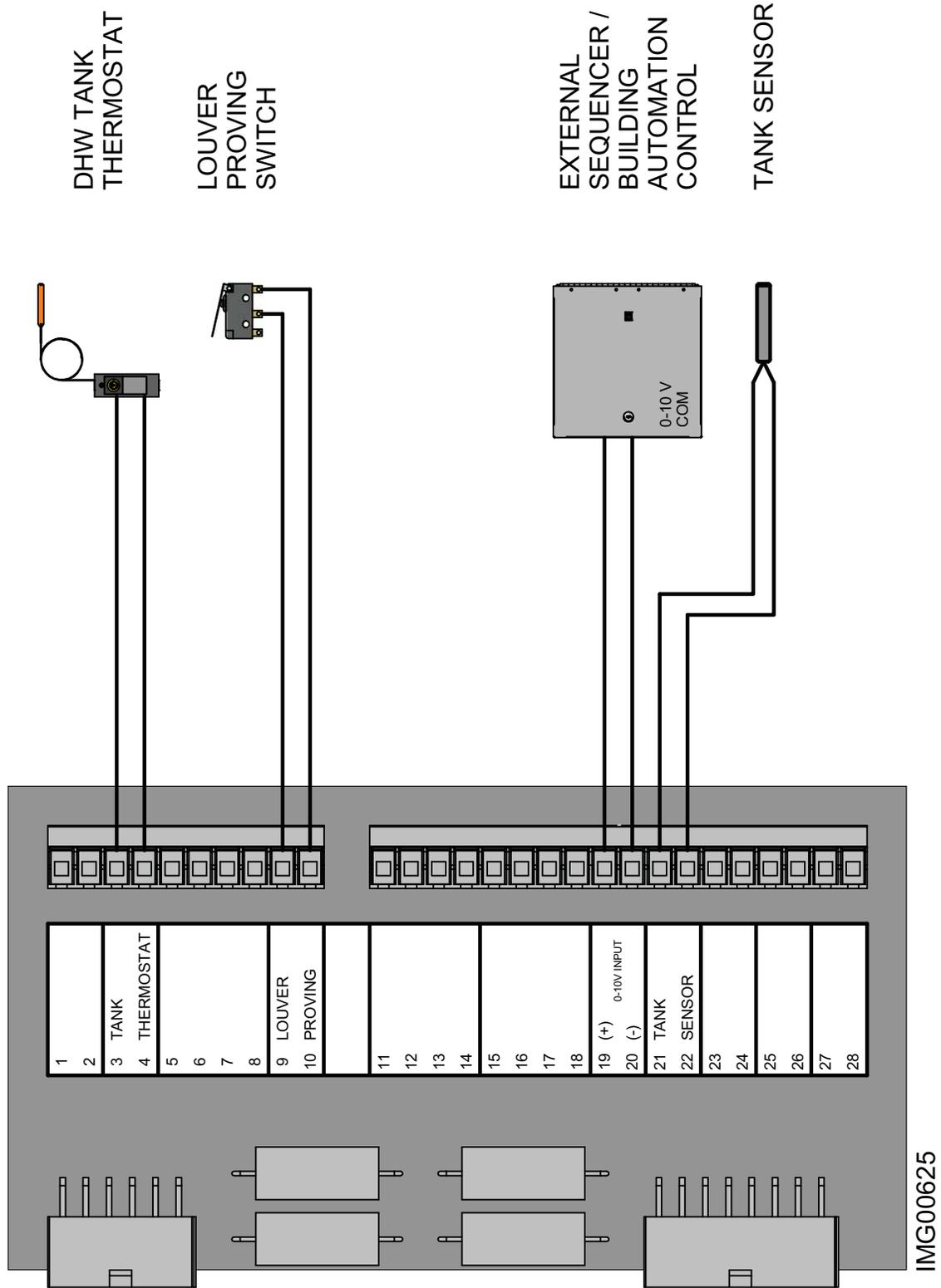
The control closes a set of dry contacts whenever the burner is running. This is typically used by Building Management Systems to verify that the water heater is responding to a call for heat.

Alarm contacts

The control closes another set of contacts whenever the 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.

5 Electrical connections

Figure 5-4_Low Voltage Field Wiring Connections



6 Condensate disposal

Condensate trap installation

1. Locate the condensate trap kit shipped loose with the appliance. The kit includes a sheet metal mounting base, two (2) nuts and the condensate trap.
2. Install the condensate trap mounting base on the rear of the appliance in the lower left-hand corner as depicted in FIG. 6-1. Use the pre-drilled holes on the appliance to secure the mounting base to the appliance.
3. Secure the condensate trap to the base using the two (2) nuts supplied with the kit. The trap should be oriented so that the barb connections are pointing toward the appliance (FIG. 6-1).
4. Use a level to ensure that the condensate trap is level on its base. Failure to keep the condensate trap level can result in the spillage of flue products from the condensate trap.
5. Locate the two hoses exiting the back of the appliance. Attach the larger hose on the appliance to the lower barb connection on the condensate trap. Secure the hose to the barb with a field supplied hose clamp (FIG. 6-1).
6. Attach the smaller hose on the unit to the upper barb connection on the condensate trap. Secure the hose to the barb connection with a field supplied hose clamp (FIG. 6-1).
7. Route the 3-pin wiring harness from the condensate trap to the matching connector on the lower back of the appliance as shown in FIG. 6-1. This is the blocked drain safety switch. This switch will shut the appliance off if the condensate trap becomes too full of liquid.
8. Remove the four (4) screws securing the top cover to the condensate trap and remove the cover (FIG. 6-1).
9. Locate the plastic ball inside the float tube. Verify there is nothing under the ball causing it to not seat properly (FIG. 6-1).
10. Fill with fresh water until the water begins to pour out of the drain.
11. Replace the cover.
12. Replace the four (4) screws removed in Step 8.
13. A 1/2" pipe connection is supplied on the condensate trap. Connect a suitable pipe or tube to this connection (see FIG. 6-1).

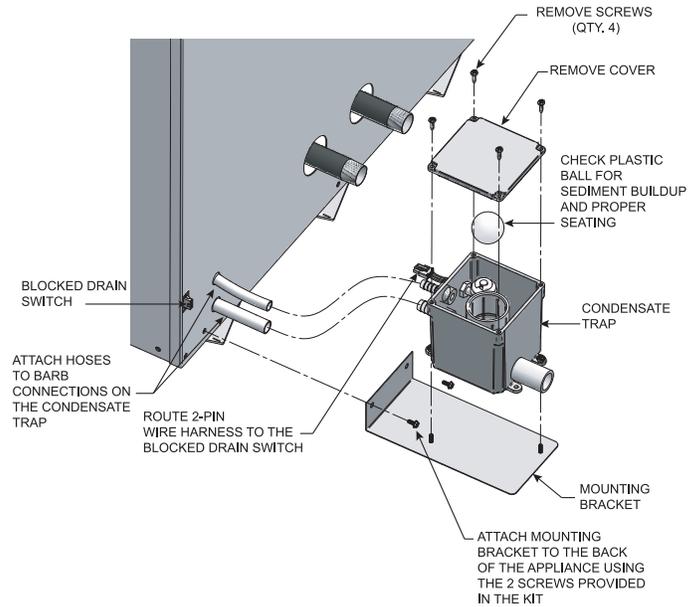


Figure 6-1 Install Condensate Trap



WARNING

Use a level to ensure that the condensate trap is level on its base. Failure to keep the condensate trap level can result in the spillage of flue products from the condensate trap.

Failure to follow this warning could result in product damage or improper operation, personal injury, or death.



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.

14. Slope the condensate line down and away from the appliance into a drain or condensate neutralizing filter. Do not expose the condensate line to freezing temperatures.



NOTICE

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, the blocked drain safety switch will prevent the appliance from firing.

7 Start-up

Check/control water chemistry

⚠ CAUTION

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

Filling hot water heater

1. Close the system's drain valve by turning the handle clockwise.
2. Open a nearby hot water faucet to permit the air to escape.
3. Fully open the cold water inlet pipe valve allowing the water heater and piping to be filled.
4. Close the hot water faucet as water starts to flow.
5. The water heater is ready for operation.

⚠ WARNING

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

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 front 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

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 four (4) screws securing the top cover to the condensate trap and remove the cover (FIG. 7-1).
2. Locate the plastic ball inside the float tube. Verify there is nothing under the ball causing it to not seat properly.
3. Fill with fresh water until the water begins to pour out of the drain.
4. Replace the cover.
5. Replace the four (4) screws removed in Step 1.

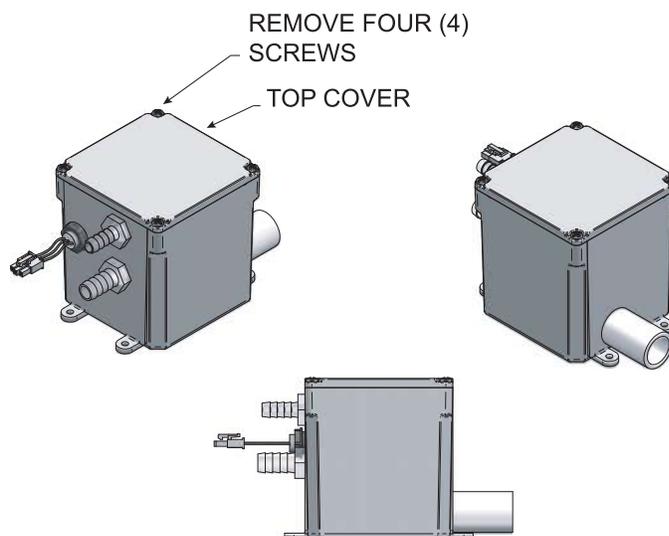


Figure 7-1_Condensate Trap

⚠ WARNING

The condensate trap (FIG. 7-1) 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.

Check vent and air piping

1. 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.

7 Start-up *(continued)*

Placing the water heater in operation

Water heater operational checks

- Turn the water heater main power switch to the "ON" position.
- Verify operation of the control module and Operator Interface.
- Program the adjustable points from the Operator Interface.
- Push the reset for the low water cutoff (if equipped).
- Ensure that maximum flow to the water heater does not exceed 75 GPM on Models 500 - 1000 and 90 GPM on Models 1500- 2000. Verify by checking temperature rise while burner is firing at 100% of rated input.
- Install a manometer on the gas supply to the water heater and verify minimum gas supply pressure as the burner fires at 100% of rated input.
- Verify operation of safeties as necessary (low water cutoff, high limit, gas pressure, etc.,).
- Verify that all adjustable points in the Operator Interface are set as required.

Water heater operation

- Water heater should begin the start-up process for the sequence of operation.
- The water heater will ignite at the proper ignition speed and will then modulate to meet the system demand.
- Ensure that inlet water temperature does not fall below the specified minimum for the water heater.
- Based on system demand, water heaters may run for an extended period of time at a reduced rate of input to maximize efficiency.
- As system demand is satisfied, the burner will cycle off and the combustion air blower will run for a post purge operation before the water heater shuts down.

Start the water heater

- Read and follow the Operating instructions in FIG. 7-2, on page 44.

If water heater does not start correctly

- Check for loose connections, blown fuse or service switch off?
- Is external limit control (if used) open? Is water temperature above 200°F (93.3°C)?
- Is thermostat set below tank temperature?
- Is gas turned on at meter or water heater?
- Is incoming gas pressure less than 4 inches water column?

If none of the above corrects the problem, refer to the *Troubleshooting* section of the VF Series Service Manual.

WARNING

The venting system must be installed so that it will prevent flue gas spillage and carbon monoxide emissions, which will result in severe personal injury or death.

Set clock

The 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 appliance is installed, and anytime the appliance has been powered off for more than one month. Use the following procedure to set the clock:

- Press and hold the SETUP/RETURN button (FIG. 8-1) for at least 5 seconds.
- The display changes to ready "ENTER MENU CODE", with four (4) zeros below it.
- Change the zeros to match the user code (factory set at "0704"). Use the (+) and (-) buttons to increment or decrement the flashing digit, and the FORWARD and BACK buttons to select which digit flashes.
- Press the SAVE/CLEAR button.
- The display changes to read USER CODE for a few seconds, then displays a menu.
- Press the SAVE/CLEAR button.
- Press the (+) button twice to display "A3 DATE AND TIME".
- Press the SAVE/CLEAR button once.
- 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.,)

YY: year

MM: month

DD: date

NOTICE

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

Use the (+) and (-) buttons to increment or decrement the flashing number, and the FORWARD and BACK buttons to select which number flashes.

- Press the SAVE/CLEAR button to save the setting.
- Press the SETUP/RETURN button twice to exit the Programming Mode.

7 Start-up

Figure 7-2_Operating Instructions

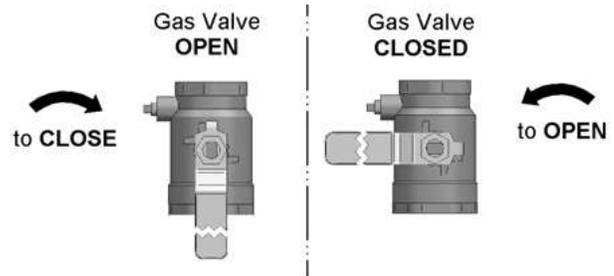
FOR YOUR SAFETY READ BEFORE OPERATING

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

- A. This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
- B. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.
- 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

- STOP!** Read the safety information above on this label.
- Set the thermostat to lowest setting.
- Turn off all electric power to the appliance.
- This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
- Turn gas shutoff valve located on rear of unit clockwise to close valve. Handle will be perpendicular to pipe. Do not force.
- 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.
- Turn gas shutoff valve counterclockwise to open valve. Handle will be parallel to pipe.
- Turn on all electric power to appliance.
- Set thermostat to desired setting.
- 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

- Set the thermostat to lowest setting.
- Turn off all electric power to the appliance if service is to be performed.
- Turn gas shutoff valve located on rear of unit clockwise to close valve. Handle will be perpendicular to pipe. Do not force.
- Install top cover.

LBL2740 REV A

8 Operating information

General

How the appliance operates

The VF Series uses a copper finned tube heat exchanger to transfer heat from the flue products to the water. An electronic control module monitors various inputs to initiate a call for heat. The blower provides both primary and secondary air to the burner and forces the flue products out of the combustion chamber and into the vent system. The control module regulates the blower speed to control the firing rate of the unit. The modulating gas valve monitors the amount of combustion air being pulled into the blower and regulates the amount of gas supplied, which then mixes with the combustion air and is supplied to the burner.

NOTICE

If an inline high gas pressure regulator is used, it **MUST BE** of the lockup type and be located a minimum of 10 feet from the appliance. Failure to do so may result in insufficient gas volume supplied to the appliance.

NOTICE

If a pressure drop of more than 2" water column occurs between Standby (static) Mode and Operating (dynamic) Mode, a gas volume problem exists. Contact the gas utility, gas supplier, qualified installer, or service agency to determine the necessary steps to provide the proper gas volume to the appliance.

How the control module operates

The control module receives input from appliance sensors and external devices. The control module activates and controls the blower and gas valve to regulate heat input and switches the system pumps on and off as needed. The user programs the module to meet system needs by adjusting control parameters. These parameters set operating temperatures and appliance operating modes. Water heater operation can be based on a tank sensor or a tank thermostat.

Control inputs and outputs

Tank thermostat (field provided)

This input tells the water heater to provide water for heating a domestic hot water tank (see FIG. 5-4 on page 40 of this manual).

0 - 10V input (set point or power)

The VF Series 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.

Temperature control

Modulation

The VF Series is capable of modulating its firing rate from a minimum of 25% to a maximum of 100%. The firing rate is dictated by the call for heat (i.e., domestic hot water), the heating load, ramp delay (if enabled), and various other temperature limitations.

Gradient limiting

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

Night setback

The controller may be programmed to reduce the tank (water heaters) set points 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 (85°C), the unit will reduce the fan speed. If the outlet water temperature exceeds 195° (90.6°C) the control will shut the unit down until it cools off.

The control module monitors the flue temperature by a sensor located in the flue exhaust. If the flue temperature exceeds 400°F (204°C) the control will reduce the maximum fan speed. If the flue temperature exceeds 450°F (232°C) the control will shut the unit down. The unit will restart automatically once the flue temperature drops 100°F (56°C) and the minimum off time has expired.

The control monitors the temperature difference between the inlet and the outlet sensor. If this difference exceeds 55°F (31°C) the control will reduce the fan speed. If the temperature difference exceeds 65°F (36°C) the control will shut the unit down. The unit will restart automatically once the temperature difference has dropped 10°F (6°C) and the minimum off time has expired.

8 Operating information

Freeze protection

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

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

- The control module provides freeze-up protection as follows when the appliance water temperature drops below 45°F (7.2°C):
- Below 45°F (7.2°C), the appliance and system pumps operate constantly.
- Below 37°F (2.7°C), the appliance turns on.
- Appliance and pumps turn off if appliance water temperature rises above 45°F (7.2°C).

CAUTION

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

High limit operations

When outlet temperature exceeds 200°F (93°C), high limit action occurs. The appliance shuts down until the outlet water cools down and the RESET button on the Operator Interface is pressed.

Low water cutoff protection

1. The control module uses temperature sensing of both inlet and outlet areas of the heat exchanger. If the flow rate is too low or the outlet temperature too high, the control module modulates and shuts the appliance down. This along with the flow switch, ensures appliance shutdown in the event of low water or low flow conditions.
2. Some codes and jurisdiction may accept these integral features of the control in lieu of requiring an additional limit control or low water cutoff. Consult local jurisdiction to determine. Contact manufacturer for low water cutoff kit availability.

Monitor external limits

Connections are provided on the connection board for external limits such as a louver proving switch. The will shut off the burner and inhibit relighting whenever any of these external limits open.

Run-time and alarm outputs

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

Run-time and cycle counting

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

The control uses four (4) ignition counters to monitor the amount of appliance 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 control module senses water temperature and regulates appliance firing and firing rate to achieve a target temperature. The target temperature can be set between 60°F (16°C) and 190°F (88°C).

8 Operating information *(continued)*

Sequence of operation

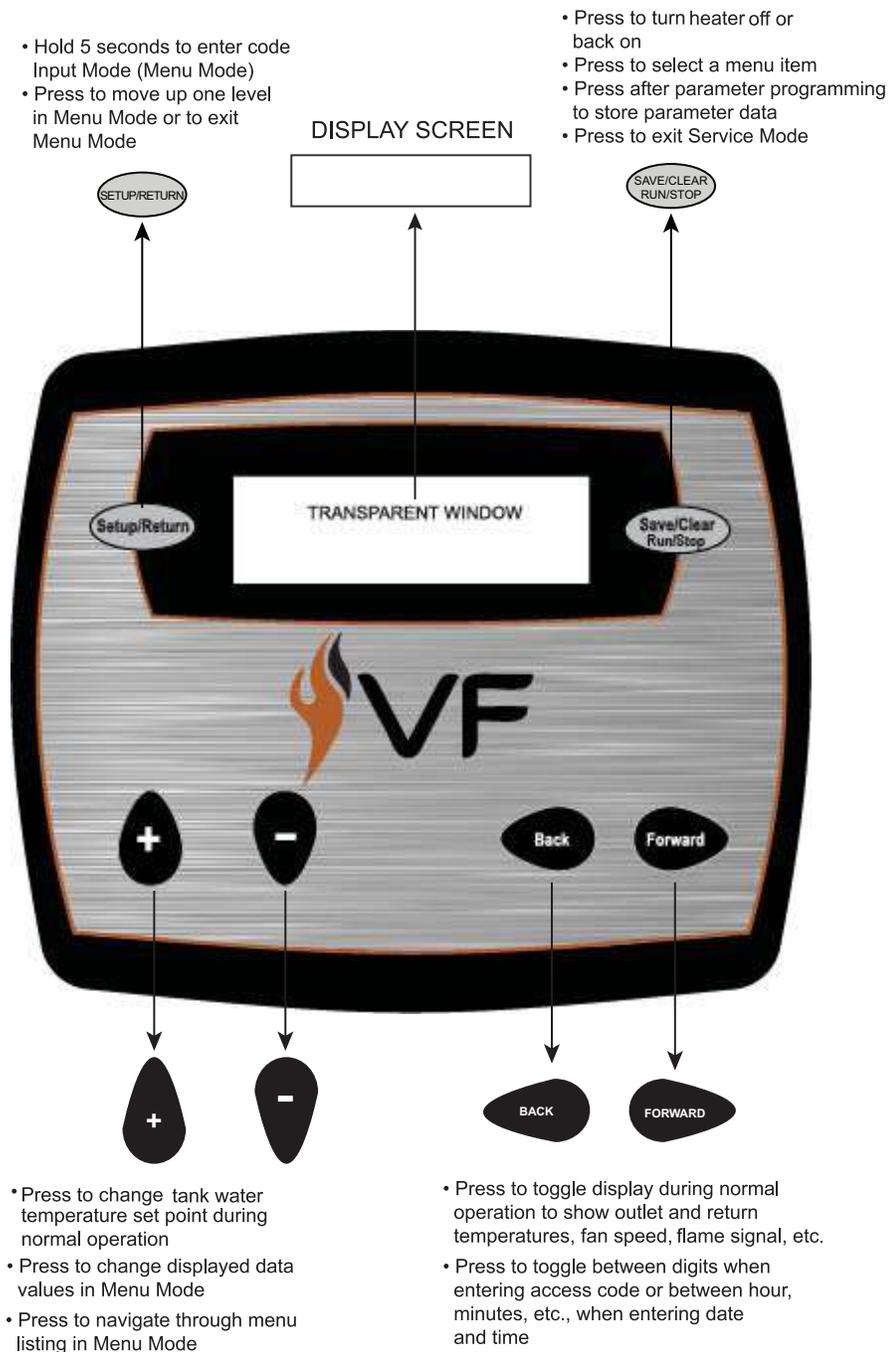
OPERATION	DISPLAY
1. The manual reset high limit must be closed before any action will take place.	HTR: Standby OUT: 123.8F(129)
2. Upon a call for heat the control turns on the appropriate pumps. The flow switch and low water cutoff (if equipped) must close.	HTR: Standby OUT: 123.8F(129)
3. <ul style="list-style-type: none"> • If the unit is equipped with a proof of closure valve, the proof of closure switch must be closed. The proof of closure valve is then energized. The gas pressure switch(es) (if equipped) must close. • If the contact for the louvers is closed, the louver proving, blocked drain switch, and auto reset high limit (water heater only) inputs must close. • If the air pressure switch is open, the prepurge cycle then begins by starting the combustion blower. Once started, the air pressure switch must close. 	HTR: Standby OUT: 123.8F(129)
4. After prepurge, the blower slows down and the hot surface igniter (HSI) is energized.	HTR: PREPURGE OUT: 123.9F(129)
5. Once the HSI is hot, the trial for ignition begins with the opening of the gas valve.	HTR: IGNITION OUT: 123.9F(129)
6. If the control does not sense flame, it will lock out.	HTR: POSTPURGE, LOCKOUT OUT: 123.9F(129)
7. If the control senses flame at the end of the trial for ignition period, it will fire the burner to maintain the set point. The firing rate will modulate as required to hold the actual temperature at the set point.	HTR: SH 20% RATE OUT: 124.8F(129)
8. Once both calls for heat are satisfied, the control will turn off the burner. The blower will remain on for the postpurge cycle. The pump will continue to run for its respective pump delay times and then turn off.	HTR: POSTPURGE OUT: 127.4F(129)
9. System pump continues its delay if longer.	HTR: Standby OUT: 124.7F(129)
10. Pump off.	HTR: Standby OUT: 122.9F(129)

8 Operating information

SMART SYSTEM™ VF Series control module

Use the control panel (FIG. 8-1) to set temperatures, operating conditions, and monitor appliance operation.

Figure 8-1_Control Panel - Operator Interface



Access modes

User

The user can adjust the space heating target temperature and the tank target temperature (if a tank sensor is used) by using the (+) and (-) buttons (FIG. 8-1) 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:

- Appliance 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 VF Series Service Manual.

Saving parameters (*reference the Parameter Table in the VF Series Service Manual*)

To save parameters and exit programming:
Press the SAVE/CLEAR button, then the SETUP/RETURN button 3 times.

To keep parameter settings only for a current operating cycle:

Press the SETUP/RETURN button 3 times after making all desired parameter changes.

To enter a parameter and continue programming:

Press the SETUP/RETURN button 1 time to return to the parameter listings; press again to return to the menu listings. Remember to press the SAVE/CLEAR button when finished programming in order to save the changes made.

See the VF Series Service Manual for a detailed description of parameters and access modes.

8 Operating information *(continued)*

Status display screens

Status Display Screens		
By using the Back/Forward (◀, ▶) arrow keys on the display panel, you can navigate through the nine (9) display screens. Each screen will contain two (2) viewable items. The following is a description of the individual items and what they can display:		
Screen	Display shows:	Description
#1	HTR: OFF	The unit has been turned OFF by the Enter/Reset button on the display panel.
	Standby	The unit has not received a call for heat from a remote thermostat.
	Set Point Met	The unit has met the water temperature set point, but is still receiving a call for heat from either a remote thermostat or a BMS.
	Prepurge	The unit has initiated the prepurge and HSI warm-up periods on a call for heat.
	Ignition	The unit has begun a trial for ignition.
	DHW***% 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 postpurge period 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 for the purpose of combustion analysis.
	OUT: ***F(***)	When the outlet sensor has been selected as the control sensor (default), the control will display the outlet temperature as well as the set point in parenthesis.
	***F	If the outlet sensor has not been selected as the control sensor or a system supply sensor is connected, only the outlet temperature will be displayed.
	Open	The control does not detect the outlet sensor.
	Shorted	The outlet sensor wires or the sensor itself has become shorted.
Press the Forward ▶ arrow key on the display to access Screen #2.		
#2	IN: ***F	If the inlet sensor has not been selected as the control sensor or a system return sensor is installed, only the inlet temperature will be displayed.
	F ()	When the inlet sensor has been selected as the control sensor, 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.

8 Operating information

Status Display Screens *(cont'd)*

By using the Back/Forward (◀, ▶) arrow keys on the display panel, you can navigate through the nine (9) 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
Press the Forward ▶ arrow key on the display to access Screen #3.		
#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 grounded.
	TANK: ***F	The control will display the temperature.
	Open	The control does not detect the auxiliary sensor.
	Shorted	The auxiliary sensor wires or the sensor itself has become grounded.
Press the Forward ▶ arrow key on the 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 Forward ▶ arrow key on the display to access Screen #5.		
#5	DHW CFH: OFF	The control has not received a call for heat from a tank sensor or tank thermostat.
	ON	The control has received a call for heat from a tank sensor or tank thermostat.
Press the Forward ▶ arrow key on the display to access Screen #6.		
#6	DHW PUMP: OFF	The control has not received a DHW call for heat and has not powered the DHW pump.
	ON	The control has received a DHW call for heat and has powered the DHW pump.
	Delay	The DHW call for heat has been satisfied and the DHW pump is running for a fixed time to remove any residual heat.
	0-10V IN: **.VDC	The control will display a 0-10 VDC signal received from a Building Management System (BMS) connected to the unit.
Press the Forward ▶ arrow key on the display to roll back to Screen #1. At any point if you wish to access an earlier screen, press the Back ◀ arrow key on the display.		

9 Domestic water heaters

This section applies only to those appliances used to supply domestic hot water, installed with a storage tank(s). A circulating pump **MUST** be installed in the piping assembly to the storage tank and valves used to control water velocity through the appliance. Proper water velocity is important for correct operation of your water heater.

This section contains specific instructions for those appliances used to supply domestic hot water. All warnings, cautions, notes and instructions in the general installation and operation sections apply to these instructions. Water heaters are designed for installation with a storage tank. The operation of the circulating pump, proper sizing of the piping between the tank and heater and the control of water velocity, as explained in this section, are important for correct operation of your water heater.

NOTICE

To ensure proper velocity through the heat exchanger, it is necessary to regulate the temperature rise across the heat exchanger from inlet to outlet. This must be done on initial installation and periodically rechecked. With the correct temperature rise across the heat exchanger when the water heater is firing at 100% of rated input, you may be assured of the proper velocity in the tubes. This will yield long life and economical operation from your water heater.

Excessive lime/scale build-up in the heat exchanger tubes is a result of restricted flow and too little velocity in the tubes. Excessive pitting or erosion in the tube is caused by high water flow and too much velocity through the tubes. Care should be taken to measure temperature rise and maintain velocity as follows:

Initial set-up of maximum water flow

On initial start-up of the VF water heater the maximum water flow through the heat exchanger must be manually set before normal operation begins.

TABLE 9A
MAXIMUM WATER FLOW

⚠ CAUTION: The maximum flow rate through a VF water heater with a copper heat exchanger must be set to provide and not exceed the following flow:

Model	Maximum Flow
500 - 1000	75 GPM
1500 - 2000	90 GPM

If higher flow rates are required through the water heater, an optional Cupro Nickel heat exchanger is available. Consult the factory for specific application requirements.

The heat exchanger is capable of operating within the design flow rates required for the water heater, storage tank(s), and connecting piping. Erosion of the finned copper tubes may occur if the flow rate exceeds the maximum allowable flow rate through the water heater. The maximum flow rate through the water heater must be adjusted. Maximum flow on Models 500 - 1000 is 75 GPM and 90 GPM on Models 1500 - 2000. Flow rate can be determined by measuring the temperature rise through the water heater when it is firing at full rate input.

TABLE - 9B
TEMPERATURE RISE AT FULL RATE FIRE
75 AND 90 GPM FLOW

Model	Temperature Rise
500	11°F (6.1°C) @ 75 GPM
750	17°F (9.4°C) @ 75 GPM
1000	23°F (12.8°C) @ 75 GPM
1500	28°F (15.6°C) @ 90 GPM
2000	38°F (21.1°C) @ 90 GPM

1. The pump must run continuously when the burner is firing.
2. With the pump running and the burner in the water heater in the off cycle, the inlet water temperature and outlet water temperature readings on the Operator Interface should read approximately the same temperatures. Water Temperature Rise on the Operator Interface should read near zero.
3. Turn the water heater on and allow time for the temperature to stabilize. The Service Mode can be used to force the water heater to run at full fire. See the VF Series Service Manual for a detailed explanation of the Service Mode. Check the water temperature rise in the Operator Interface when the burner is firing at 100% of rated input.
4. Compare the water temperature rise in the Operator Interface with the required temperature rise. Should adjustment be needed, proceed as follows.

9 Domestic water heaters

If the temperature rise is too high, the water velocity is too low, adjust as follows:

1. Check for restrictions in the outlet of the water heater.
2. Be sure all valves are open between the water heater and the storage tank. Ensure that all ball valves are fully ported.
3. Check the pump to be sure it is running properly and that the pump motor is running in the proper direction.
4. Check diameter and length of the piping between the storage tank and water heater against the head capacity of the circulating pump.
5. Be sure the pipes between the water heater and storage tank are not less than 2 1/2 inch (63.5mm) diameter. To increase flow and decrease temperature rise, increase the piping to 3 inch (76.2mm) diameter to decrease head loss in the piping to the storage tank.
6. Common manifold piping for multiple unit installations will require larger minimum pipe sizes and tank circulating tapings to ensure proper flow.

If the temperature rise is too low, the water velocity is too high, adjust as follows:

1. Temperature rise can be increased by slowly closing the field-installed ball valve in the outlet piping from the water heater to the storage tank to achieve the proper temperature rise.
2. Sustained high water velocity and low temperature rise may result in pitting or erosion of the copper tubes in the heat exchanger. This is a non-warrantable failure. Temperature rise must be properly adjusted to achieve the specified flow rate.
3. Once temperature rise has been properly set, return to normal operation.

⚠ CAUTION

Temperature rise cannot be adjusted when the burner is firing at less than 100% of rated input.

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, an optional Cupro Nickel heat exchanger 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 heater, 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.

9 Domestic water heaters *(continued)*

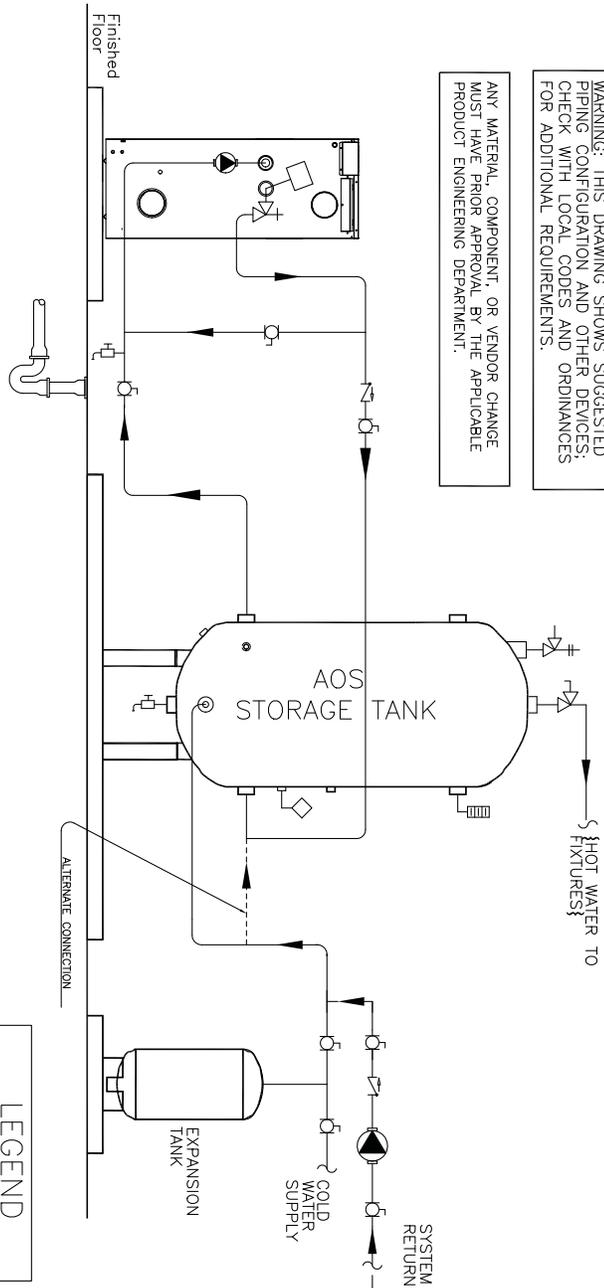
Figure 9-1_ Typical Water Heater Piping with Storage Tank

COMMON MANIFOLD SIZE (Min.) Models: 500 - 1000		
Number of Units	GPM	Diameter (in.)
1	75	2 1/2

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES. CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT, OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.

COMMON MANIFOLD SIZE (Min.) Models: 1500 - 2000		
Number of Units	GPM	Diameter (in.)
1	90	2 1/2



- NOTES:
1. PREFERRED PIPING LAYOUT.
 2. THE TEMPERATURE AND PRESSURE RELIEF VALVE SETTING SHALL NOT EXCEED PRESSURE RATING OF ANY COMPONENT IN THE SYSTEM.
 3. SERVICE VALVES ARE SHOWN FOR SERVICING WATER HEATER. HOWEVER, LOCAL CODES SHALL GOVERN THEIR USAGE.
 4. MAXIMUM PIPING LENGTH BETWEEN TANK AND WATER HEATER SHOULD NOT EXCEED A TOTAL OF 50 EQUIVALENT FEET CONSTRUCTED OF 2-1/2 INCH PIPE SIZE OR LARGER.
- REFERENCE DRAWING AO 41.0 (V)

LEGEND	
	TEMPERATURE & PRESSURE RELIEF VALVE
	PRESSURE RELIEF VALVE
	CIRCULATING PUMP
	TEMPERATURE CONTROL PROBE
	DRAIN
	BALL VALVE
	CHECK VALVE
	TEMPERATURE GAGE
	WATER FLOW SWITCH

AO5D61246

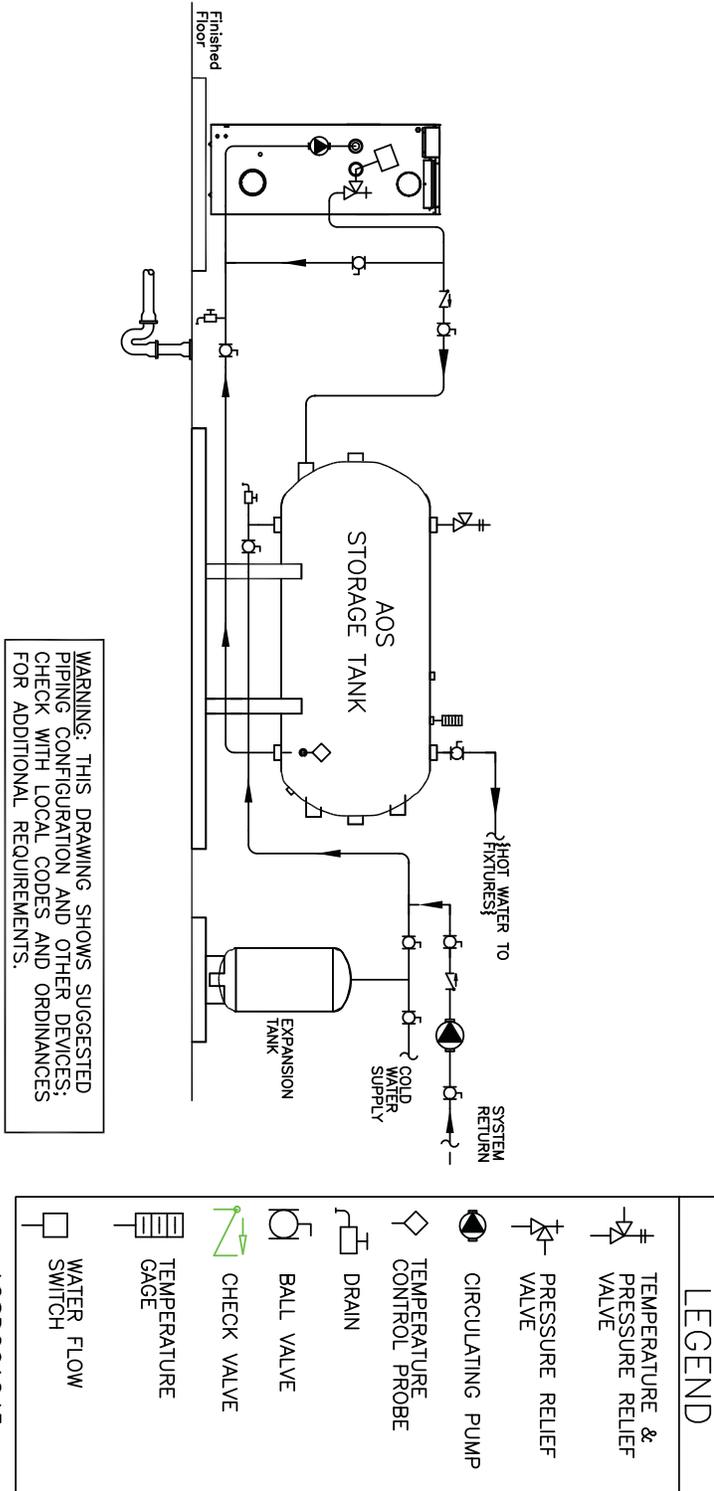
NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

9 Domestic water heaters

Figure 9-2 Single Water Heater Piping with Two Storage Tanks

COMMON MANIFOLD SIZE (Min.)		
Models: 500 - 1000		
Number of Units	GPM	Diameter (in.)
1	75	2 1/2

COMMON MANIFOLD SIZE (Min.)		
Models: 1500 - 2000		
Number of Units	GPM	Diameter (in.)
1	90	2 1/2


NOTES:

- PREFERRED PIPING LAYOUT.
- THE TEMPERATURE AND PRESSURE RELIEF VALVE SETTING SHALL NOT EXCEED PRESSURE RATING OF ANY COMPONENT IN THE SYSTEM.
- SERVICE VALVES ARE SHOWN FOR SERVICING WATER HEATER. HOWEVER, LOCAL CODES SHALL GOVERN THEIR USAGE.
- MAXIMUM PIPING LENGTH BETWEEN TANK AND WATER HEATER SHOULD NOT EXCEED A TOTAL OF 50 EQUIVALENT FEET CONSTRUCTED OF 2-1/2 INCH PIPE SIZE OR LARGER.

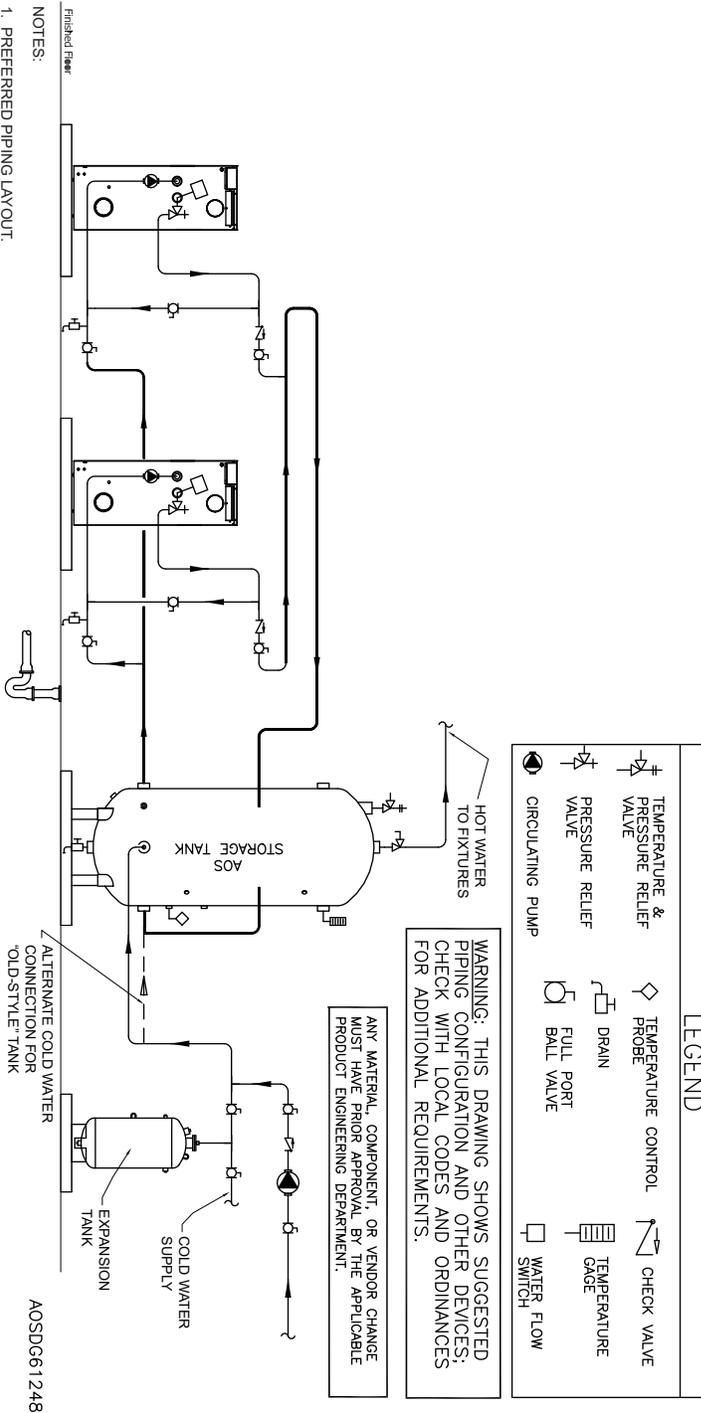
NOTICE

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.

9 Domestic water heaters *(continued)*

Figure 9-3 Multiple Water Heater Piping with a Single Storage Tank

- NOTES:
1. PREFERRED PIPING LAYOUT.
 2. THE TEMPERATURE AND PRESSURE RELIEF VALVE SETTING SHALL NOT EXCEED PRESSURE RATING OF ANY COMPONENT IN THE SYSTEM.
 3. SERVICE VALVES ARE SHOWN FOR SERVICING WATER HEATER. HOWEVER, LOCAL CODES SHALL GOVERN THEIR USAGE.
 4. A.O. SMITH PIPING METHOD IS BASED ON 50 EQUIVALENT FEET OF PIPING. WATER HEATER PLACEMENT SHALL BE AS CLOSE AS PRACTICAL TO THE STORAGE TANK. APPLICATIONS IN EXCESS OF THESE RECOMMENDATIONS SHALL REQUIRE A LICENSED ENGINEER FOR DESIGN ASSISTANCE.
 5. TEMPERATURE CONTROL PROBE (QUAD THERMISTOR PROBE, P/N 9006905005 MUST BE INSTALLED ONTO THE TANK, AND CONNECTED TO EACH WATER HEATER.
REF.: A041.2(V)



COMMON MANIFOLD SIZE (Min.) Models: 500 - 1000		
Number of Units	GPM	Diameter (in.)
2	150	3 1/2
3	225	4
4	300	5
5	375	6
6	450	6
7	525	6
8	600	8

COMMON MANIFOLD SIZE (Min.) Models: 1500 - 2000		
Number of Units	GPM	Diameter (in.)
2	180	4
3	270	5
4	360	6
5	450	6
6	540	6
7	630	8
8	720	8

NOTICE

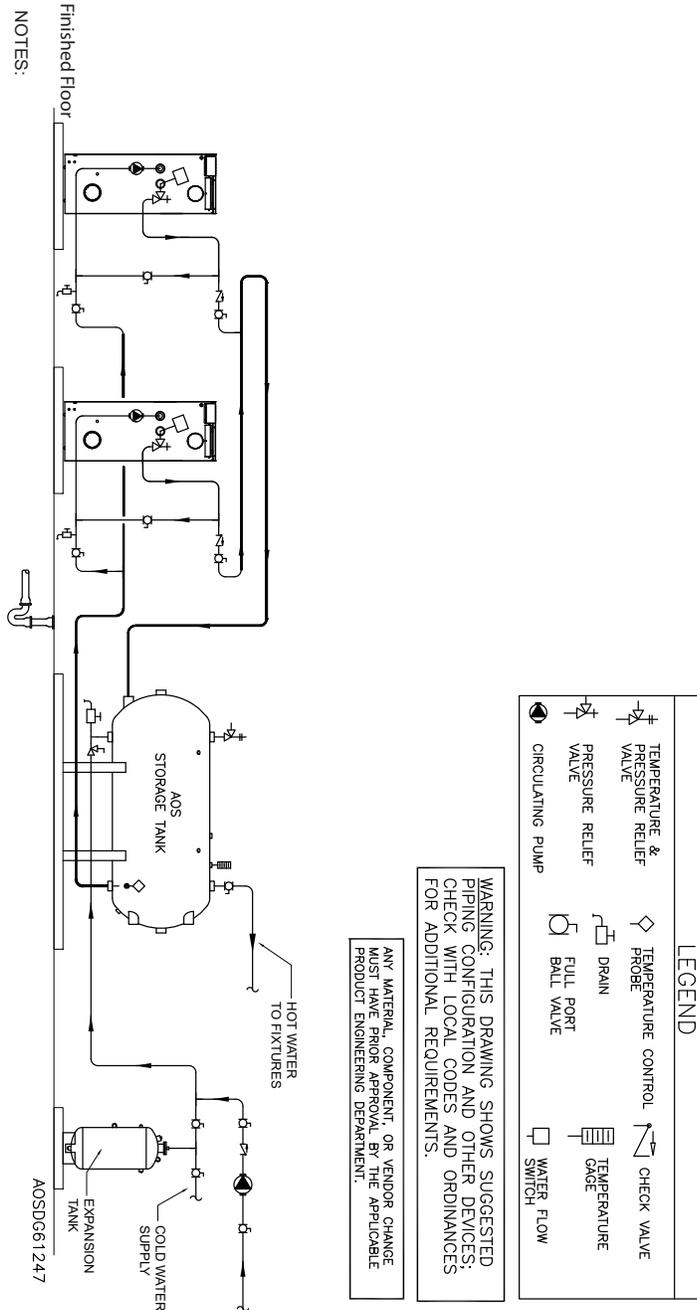
Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

9 Domestic water heaters

Figure 9-4 Multiple Water Heater Piping with Multiple Storage Tanks

COMMON MANIFOLD SIZE (Min.) Models: 500 - 1000		
Number of Units	GPM	Diameter (in.)
2	150	3 1/2
3	225	4
4	300	5
5	375	6
6	450	6
7	525	6
8	600	8

COMMON MANIFOLD SIZE (Min.) Models: 1500 - 2000		
Number of Units	GPM	Diameter (in.)
2	180	4
3	270	5
4	360	6
5	450	6
6	540	6
7	630	8
8	720	8



- REF. NO.: AO 41.3(H)

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.

9 Domestic water heaters *(continued)*

TABLE 9C

**COMMON WATER MANIFOLD SIZE FOR
MULTIPLE WATER HEATER INSTALLATIONS**

Pipe sizing chart provides minimum pipe size for common manifold piping to ensure adequate flow.		
Number of Water Heaters	Common Manifold Size (Min.) Models	
	500 - 1000	1500 - 2000
1	2 1/2"	2 1/2"
2	3 1/2"	4"
3	4"	5"
4	5"	6"
5	6"	6"
6	6"	6"
7	6"	8"
8	8"	8"

Pump operation

1. The water heater must have a properly sized circulating pump. This pump is sized to circulate water between the heater and the storage tank only.
2. The pump is sized to the heater input and water chemistry specifications noted in the *Water Chemistry* section on page 52.
3. The diameter and length of the piping installed between the storage tank(s) and water heater must be properly sized based on the capacity of the circulating pump.
4. The pump must run continuously when the water heater is energized. This is the standard operating system for a water heater.

An intermittent pump control function with an all bronze pump is installed as standard equipment on all water heater systems. The pump will operate only while there is a "Call for Heat" and for a timed period after the water temperature set point is satisfied to remove any residual heat from the combustion chamber.

5. Lubricate pump to manufacturer's recommendations. Pump damage due to inadequate lubrication is non-warrantable.

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.

The standard circulating pump on this water heater is sized based on installation of a single storage tank and heater in close proximity. If the number of fittings and straight pipe exceeds the specified maximum equivalent number of straight feet for a specified diameter of pipe, non-warrantable operational problems may be experienced.

500,000 - 1,000,000 Btu/hr Models
1/2 HP, 120 VAC, 9.8 Amps

1,500,000 - 2,000,000 Btu/hr Models
3/4 HP, 120 VAC, 8.8 Amp

The standard pump selection is based on the following pipe and fittings from the water heater to the storage tank:

6 - 90° elbows 2 - ball valves
2 - unions 1 - cold water tee

Not more than 45 feet of straight pipe.

For every elbow and tee in excess of those shown above, DEDUCT 6.5 FEET from the maximum allowable straight pipe in the heater to tank circulating loop.

TABLE 9D

MINIMUM PUMP PERFORMANCE

Based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 ppm. See *Water Chemistry* section on page 52 .

Model	GPM	Ft. Hd.
500 - 1000	75	15
1500 - 2000	90	15

When installing multiple water heaters and/or multiple storage tanks, the diameter of the inter-connecting pipe and all fittings must be increased. An increase in pipe diameter will decrease head loss in the system piping and ensure proper flow. Proper pipe size between the heater and storage tank **MUST** be maintained to ensure that the standard pump supplied on the water heater will maintain desired flow.

Heat exchanger

On all models, header inspection plugs in the heat exchanger can be removed for field inspection and cleaning of copper tubes. The heat exchanger may be removed from the unit.

9 Domestic water heaters

Thermostat adjustment procedure

1. Press the (+) or (-) button to view the set point setting.
2. Press either the (+) or (-) button to increase or decrease the displayed set point value.
3. Press the SAVE/CLEAR button to permanently store the new set point into the control module's memory.

Failure to press the SAVE/CLEAR key after changing the display value will result in the set point reverting back to its previous value after the current heat demand ends.

The control may be adjusted any time regardless of call for heat status. When pressing the (+) or (-) key to enter any new set points, the control module will immediately begin controlling based on the new set point.

Minimum water temperatures (domestic hot water use)

Domestic water temperatures:

This high efficiency water heater should be operated at a temperature setting high enough to prevent condensing of the products of combustion on the unit's heat exchanger or in the attached venting system. Use extreme caution when storing water at elevated temperatures. A water temperature setting maintained above the dew point of the products of gas combustion should prevent condensate formation and ensure proper performance of the venting system. The manufacturer recommends the use of a properly sized thermostatic mixing valve to supply domestic hot water at temperatures less than 140°F (60°C). Storing the water at a higher temperature and thermostatically mixing the water will increase the available quantity of mixed hot water, greatly reducing the possibility of condensate formation on the heat exchanger or in the venting system and help prevent the growth of water borne bacteria.

NOTICE

Adequate care **MUST** be taken to prevent a potential scald injury when storing water at elevated temperatures for domestic use.

Inlet water temperatures below the specified minimum recommendations can excessively cool the products of combustion resulting in condensation on the heat exchanger. Condensation on the heat exchanger can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the related components.

CAUTION

An appliance allowed to operate at return temperatures below the specified minimum setting may experience problems with the operating controls, safety switches, obstruction of the flue gas passages on the heat exchanger, incomplete combustion, and possible flue gas spillage. Sustained operation at lower than specified water temperatures may cause hazardous conditions that may result in personal injury or non-warrantable damage to the appliance.

The maximum temperature set point that can be programmed into the control module from the Operator Interface for water heater operation is 190°F (88°C). The control is factory pre-set at approximately 120°F (49°C). Facilities with small children or invalids may require 120°F (49°C) or a lower temperature setting to reduce risk of scald injury. Some states may require a lower temperature setting. Check with your gas supplier for local requirements governing the temperature setting. Remember, no water heating system will provide exact temperature at all times. Allow a few days of operation at this setting to determine the correct temperature setting consistent with your needs.

NOTICE

1. This water heater, when set at the lower temperature setting, is not capable of producing hot water of sufficient temperature for sanitizing purposes.
2. Higher stored water temperature increases the ability of the water heater to supply desired quantities of hot water, however remember --

CAUTION

Hotter water increases the risk of scald injury.

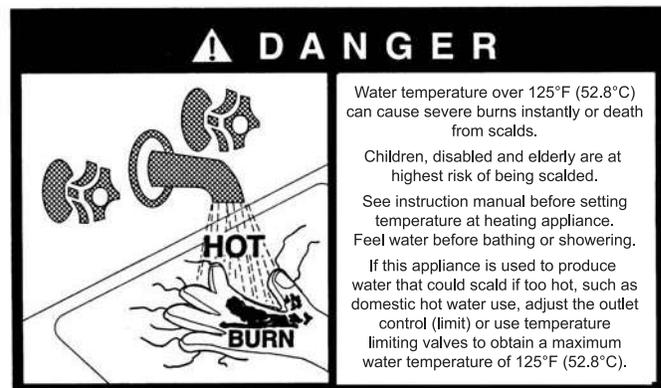


Figure 9-5_Danger Warning

9 Domestic water heaters *(continued)*

The following chart (Table 9E) 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.

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

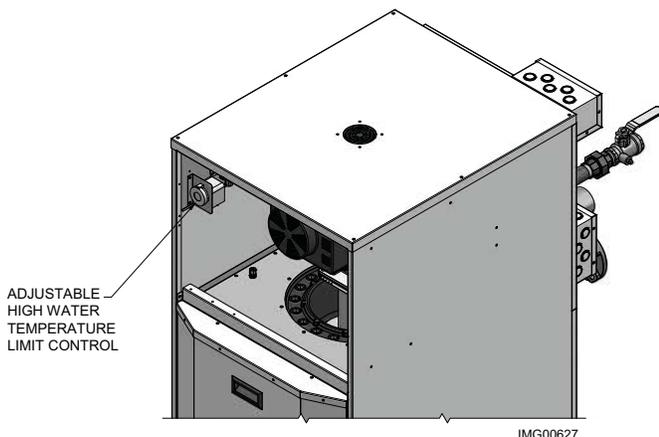
CAUTION Setting the temperature selector to higher settings provides hotter water, which increases the risk of scald injury.

Location of Cold Water Supply Piping Connections

Incorrect piping of the cold water supply to the system may result in excessive low temperature operation causing condensate formation on the primary heat exchanger and operational problems. The cold water supply piping must be installed in the discharge piping from the heater to the storage tank. This allows the cold water to be tempered in the storage tank before entering the heater. See typical installation drawings provided in this manual for correct piping (FIG.'s 9-1 thru 9-4). Higher water temperatures reduce the volume of condensate formed.

WARNING Should overheating occur or the gas supply fail to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the appliance.

Adjustable high water temperature limit control



A high limit control is located on the inside of the left front panel, as shown in FIG. 9-6. The setting of this control knob limits maximum discharge water temperature. The water heater temperature limit control is adjustable up to a maximum setting of 210°F (99°C). This water heater also includes a fixed high water temperature limit control set to 200° (93.3°C). The RESET key on the display must be pushed whenever water temperature has exceeded the set point of the limit. The temperature of the water in the heat exchanger must drop a minimum of 15°F (8.3°C) below the setting of the high limit control before the reset function can be activated. A high limit message will be shown in the Operator Interface when water temperature exceeds the high water temperature limit control set point.

NOTICE

The high limit control will not reset until the water temperature has dropped below the set point of the high limit.

Optional relief valve

This water heater is normally supplied with a temperature and pressure relief valve sized in accordance with applicable codes. Units may be supplied with an optional pressure only relief valve. When a water heater is equipped with this optional relief valve and is piped to a separate storage vessel, the storage vessel must have a properly installed temperature and pressure relief valve which complies with local codes.

Thermal expansion

A relief valve that discharges periodically may be due to thermal expansion in a closed system. A water heater installed in a closed system, such as one with a backflow preventer or check valve installed in the cold water supply, shall be provided with means to control expansion. Contact the water supplier or local plumbing inspector on how to correct this situation. Do not plug or cap the relief valve discharge.

Cathodic protection

Hydrogen gas can be produced in a hot water system that has not been used for a long period of time (generally two weeks or more). Hydrogen gas is extremely flammable. To prevent the possibility of injury under these conditions, we recommend the hot water faucet be open for several minutes at the kitchen sink before you use any electrical appliance which is connected to the hot water system. If hydrogen is present, there will be an unusual sound such as air escaping through the pipe as the hot water begins to flow. There should be no smoking or open flames near the faucet at the time it is open.

Figure 9-6 Adjustable High Water Temperature Limit Control

10 Maintenance

Maintenance and annual startup

Table 10A_Service and Maintenance Schedules

Service technician (see the following pages for instructions)		Owner maintenance (see the VF Series User's Information Manual for instructions)		
ANNUAL START-UP	<p>General:</p> <ul style="list-style-type: none"> • Address reported problems • Inspect interior; clean and vacuum if necessary; • Inspect condensate system and flush with fresh water • Check for leaks (water, gas, flue, condensate) • Examine venting system • Check system water pressure/system piping/expansion tank • Check control settings • Check igniter • Check wiring and connections • Check flue gas passageways • Flame inspection (stable, uniform) • Inspect and clean the burner • Perform start-up checkout and performance verification per <i>Section 7 - Start-up</i>. <p>If combustion or performance indicate need:</p> <ul style="list-style-type: none"> • Clean heat exchanger • Remove and clean burner using compressed air only • Clean the blower wheel 		<ul style="list-style-type: none"> • Check appliance area • Check pressure/temperature gauge 	
		Daily		
		Monthly	<ul style="list-style-type: none"> • Check vent piping • Check air piping • Check relief valve • Check condensate drain system 	
		Periodically	<ul style="list-style-type: none"> • Test low water cutoff (if used) • Reset button (low water cutoff) 	
	Every 6 months	<ul style="list-style-type: none"> • Check appliance piping (gas and water) for leaks • Operate relief valve 		

10 Maintenance *(continued)*

⚠ WARNING

Follow the service and maintenance procedures given throughout this manual and in component literature shipped with the appliance. Failure to perform the service and maintenance could result in damage to the appliance 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 appliance should be inspected annually only by a qualified service technician. In addition, the maintenance and care of the appliance designated in Table 10A and explained on the following pages must be performed to assure maximum appliance efficiency and reliability. Failure to service and maintain the appliance and system could result in equipment failure.

⚠ WARNING

Electrical shock hazard – Turn off power to the appliance before any service operation on the appliance 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 appliance area

1. Verify that appliance area is free of any combustible materials, gasoline and other flammable vapors and liquids.

Inspect appliance interior

1. Remove the outer access panels and inspect the interior of the appliance.
2. Vacuum any sediment from inside the appliance and components. Remove any obstructions.

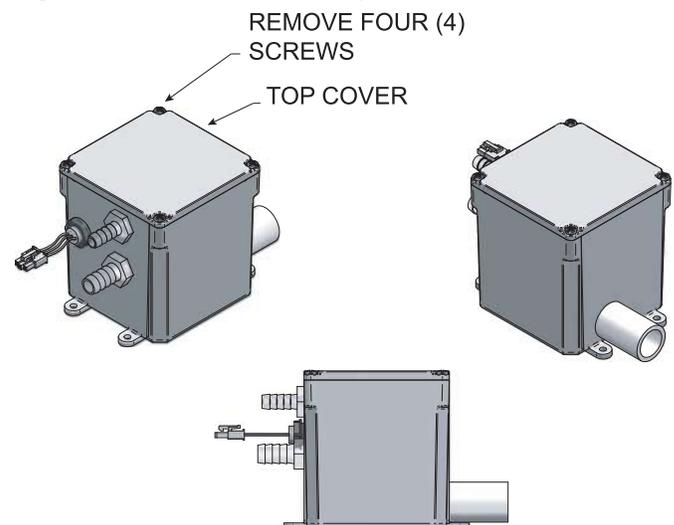
Inspect condensate system

1. Inspect the condensate drain line, condensate PVC fittings, and condensate trap on an annual basis.

Flush condensate trap with water

1. Remove the four (4) screws securing the top cover to the condensate trap and remove the cover (reference FIG. 10-1).
2. Locate the plastic ball inside the float tube. Verify there is nothing under the ball causing it to not seat properly.
3. If necessary, flush with fresh water until the water begins to pour out of the drain.
4. Replace the top cover on the condensate trap.
5. Replace the four (4) screws removed in Step 1.

Figure 10-1_Condensate Trap



Check all piping for leaks

⚠ WARNING

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

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

10 Maintenance

Flue vent system and air piping

1. Check for gastight seal at every connection, seam of air piping, and vent piping periodically inspected by a qualified service agency.

⚠ 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 water system

1. Verify all system components are correctly installed and operational.
2. 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.
3. Inspect automatic air vents and air separators. Remove air vent caps and briefly press push valve to flush vent. Replace caps. Make sure vents do not leak. Replace any leaking vents.

Check expansion tank

1. Expansion tanks provide space for water to move in and out as the heating system water expands due to temperature increase or contracts as the water cools. Tanks may be open, closed, diaphragm or bladder type. See *Section 4 - Water Connections* for suggested best location of expansion tanks and air eliminators.

Check 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 4 - Water Connections* 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 appliance 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.

10 Maintenance *(continued)*

Inspect/replace hot surface igniter

1. Turn off main electrical power to the appliance.
2. Turn off main manual gas shutoff to the appliance.
3. Carefully pull back the insulation flaps to expose the burner mounting flange.
4. Locate the hot surface igniter. Disconnect the two power leads to the hot surface igniter.
5. Loosen and remove the two wing nuts that mount the igniter.
6. Lift the igniter vertically out of the burner mounting flange. Use care, do not hit or break the silicon carbide igniter. Do not contaminate the igniter by handling with oily or dirty hands.
7. Check the replacement igniter for cracks or damage before installing.
8. Ensure that the fiber gasket used to seal the base of the igniter to the burner flange is reinstalled to seal the base of the replacement igniter.
9. Carefully insert the igniter into the mounting point on the burner flange and position on the mounting studs.
10. Reinstall the two wing nuts and tighten by hand only. Over tightening the wing nuts may break the ceramic mounting flange.
11. Ensure that the igniter gasket is properly installed and seals the point of contact between the igniter and burner mounting flange.
12. Reconnect the power leads to the igniter.
13. Replace the insulation blanket flaps.
14. Turn on main gas supply and main power.
15. Test fire the appliance to ensure proper operation.

Check all wiring

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

Check control settings

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

Perform start-up and checks

1. Start appliance and perform checks and tests specified in *Section 7 - Start-up*.
2. Verify cold fill pressure is correct and that operating pressure does not go too high.

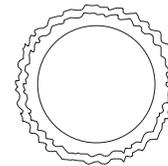
Check burner flame

Visually check main burner flames at each start-up after long shutdown periods or at least every six months. A burner viewport is located on the burner mounting flange.

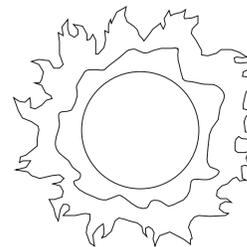


WARNING The area around the burner viewport is hot and direct contact could result in burns.

Figure 10-2 *Flame Pattern Illustration*



NORMAL BURNER FLAME



ABNORMAL BURNER FLAME

Normal Flame: A normal flame at 100% of burner input is blue, with slight yellow tips, a well defined flame and no flame lifting.

Yellow Tip: Yellow tipping can be caused by blockage or partial obstruction of air flow to the burner.

Yellow Flames: Yellow flames can be caused by blockage of primary air flow to the burner or excessive gas input. This condition **MUST** be corrected immediately.

Lifting Flames: Lifting flames can be caused by over firing the burner, excessive primary air or high draft.

If improper flame is observed, examine the venting system, ensure proper gas supply and adequate supply of combustion and ventilation air.

10 Maintenance

Check flue gas passageways

Any sign of soot around the inner jacket, outer jacket, flue pipe connections, burner or in the areas between the fins on the copper heat exchanger indicates a need for cleaning. The following cleaning procedure must only be performed by a qualified serviceman or installer. Proper service is required to maintain safe operation. Properly installed and adjusted units seldom need flue cleaning.

NOTICE

All gaskets/sealants on disassembled components or jacket panels must be replaced with new gaskets/sealants on reassembly. Gasket and sealant kits are available from your distributor.

CAUTION

When a Category IV vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

Inspect and clean burner

The burner should be removed for inspection and cleaned on an annual basis. An appliance installed in a dust or dirt contaminated environment may require cleaning of the burner on a 3 to 6 month schedule or more often, based on severity of the contamination. The fan assisted combustion process may force airborne dust and dirt contaminants, contained in the combustion air, into the burner. With sustained operation, non-combustible contaminants may reduce burner port area, reduce burner input or cause non-warrantable damage to the burner.

Use extreme care when operating an appliance for temporary heat during new construction. Airborne contaminants such as dust, dirt, concrete dust or drywall dust can be drawn into the burner with the combustion air and block the burner port area. An external combustion air filter is provided with the appliance. This filter helps ensure clean air is used for the combustion process. Check this filter every month and replace when it becomes dirty. The burner of an appliance used for temporary heat without a combustion air filter installed will probably require a thorough cleaning before the unit is placed into normal service.

Access to the burner will require the following steps:

1. Turn off main electrical power to the appliance.
2. Turn off main manual gas shutoff to the appliance.
3. Remove the front outer control panel covers. Slide out the inner control panel to increase service clearances and carefully remove the multi-pin wiring connectors on the back of the control panel. Remove the screws along the front and rear edge of the top outer jacket panel to remove top. Remove the control panel to allow access to the components in the top of the appliance.
4. Remove the sensing tubes from the low air pressure switch to the combustion air blower.
5. Disconnect the wiring connections on the top of the combustion air blower.
6. Remove the six (6) hex head bolts attaching the gas/air venturi to the inlet of the combustion air blower.
7. Remove the four (4) nuts holding the combustion air blower to the top of the burner and remove the combustion air blower assembly.
8. Use care when removing the combustion air blower assembly to prevent damage to the venturi and burner gaskets.
9. Disconnect the power wires to the hot surface igniter.
10. Remove the hot surface igniter. The hot surface igniter is fragile. Use care to prevent impact damage to the silicone carbide igniter surface when removing the igniter.
11. Remove the eight (8) nuts holding the burner to the heat exchanger.
12. The burner can now be lifted vertically out of the heat exchanger chamber.
13. Use care when removing the burner to prevent damage to the woven burner port surface or gaskets on removal.
14. Remove any visible dust or dirt blockage from the surface of the burner with a vacuum. Compressed air may also be blown across the burner surface to clean the "pores" of the woven burner port material.
15. Reassemble in reverse order.

10 Maintenance *(continued)*

Inspect and clean the heat exchanger

1. Turn off all power to the appliance.
 2. Turn off main gas to appliance.
 3. Remove the front outer jacket panel.
 4. Remove the inner jacket panel (see FIG. 10-3).
 5. Check the heat exchanger surface for soot. If soot is present, the heat exchanger must be cleaned and the problem corrected.
 6. Remove the burner as described in the *Inspect and Clean Burner* section of the VF Series Service Manual.
 7. Check the “V” baffles on the heat exchanger. Remove and clean if necessary.
 8. Remove soot from the heat exchanger with a stiff bristle brush. Use a vacuum to remove loose soot from surfaces and inner chamber.
 9. The heat exchanger can be removed by disconnecting all water piping to the heat exchanger, removing the screws holding the heat exchanger to the top of the inner jacket and sliding the heat exchanger towards the front of the appliance. Once the heat exchanger is removed, a garden hose can be used to wash the tubes to ensure that all soot is removed from the heat exchanger surfaces. *Note: Do not wet the insulation blankets on the inside of the outer jacket panels.*
 10. Ensure that any soot present on the burner is removed. See *Inspect and Clean Burner* section of the VF Series Service Manual.
 11. Carefully reinstall the heat exchanger and “V” baffles if removed from the appliance.
 12. Reinstall the inner jacket panel, burner, manifolds, wires, and hoses. Use new gasket material to ensure a proper air seal.
 13. Reassemble all gas and water piping. Test for gas leaks.
- NOTICE** Upon completion of any testing on the gas system, leak test all gas connections with a soap and water solution while main burners are operating. Do not spray soap and water solution on the control module housing. The use of an excessive amount of soap and water solution can damage the control. Immediately repair any leak found in the gas train or related components. Do not operate an appliance with a leak in the gas train, valves, or related piping.
14. Reassemble outer jacket panels.
 15. Cycle unit and check for proper operation.

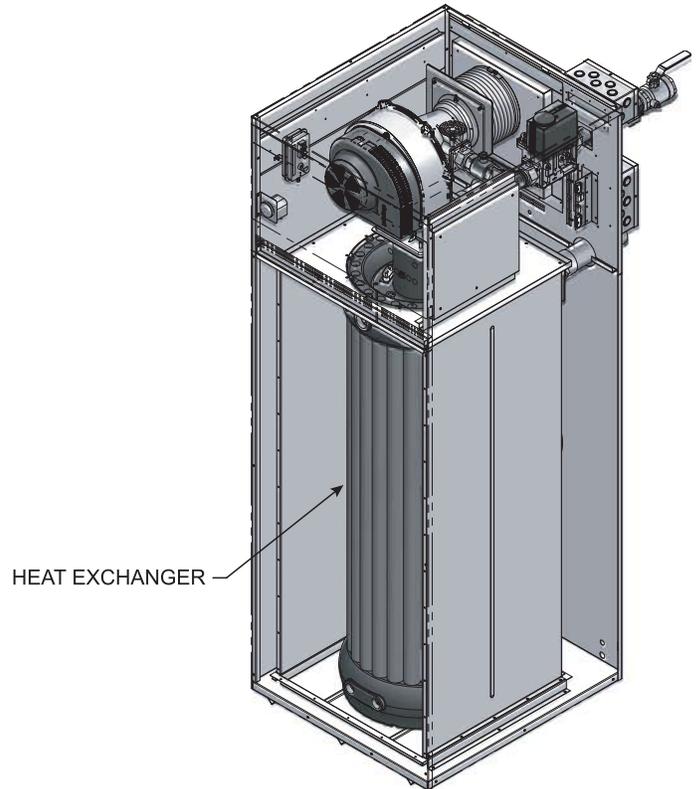


Figure 10-3 Location of the Heat Exchanger Inside Jacket

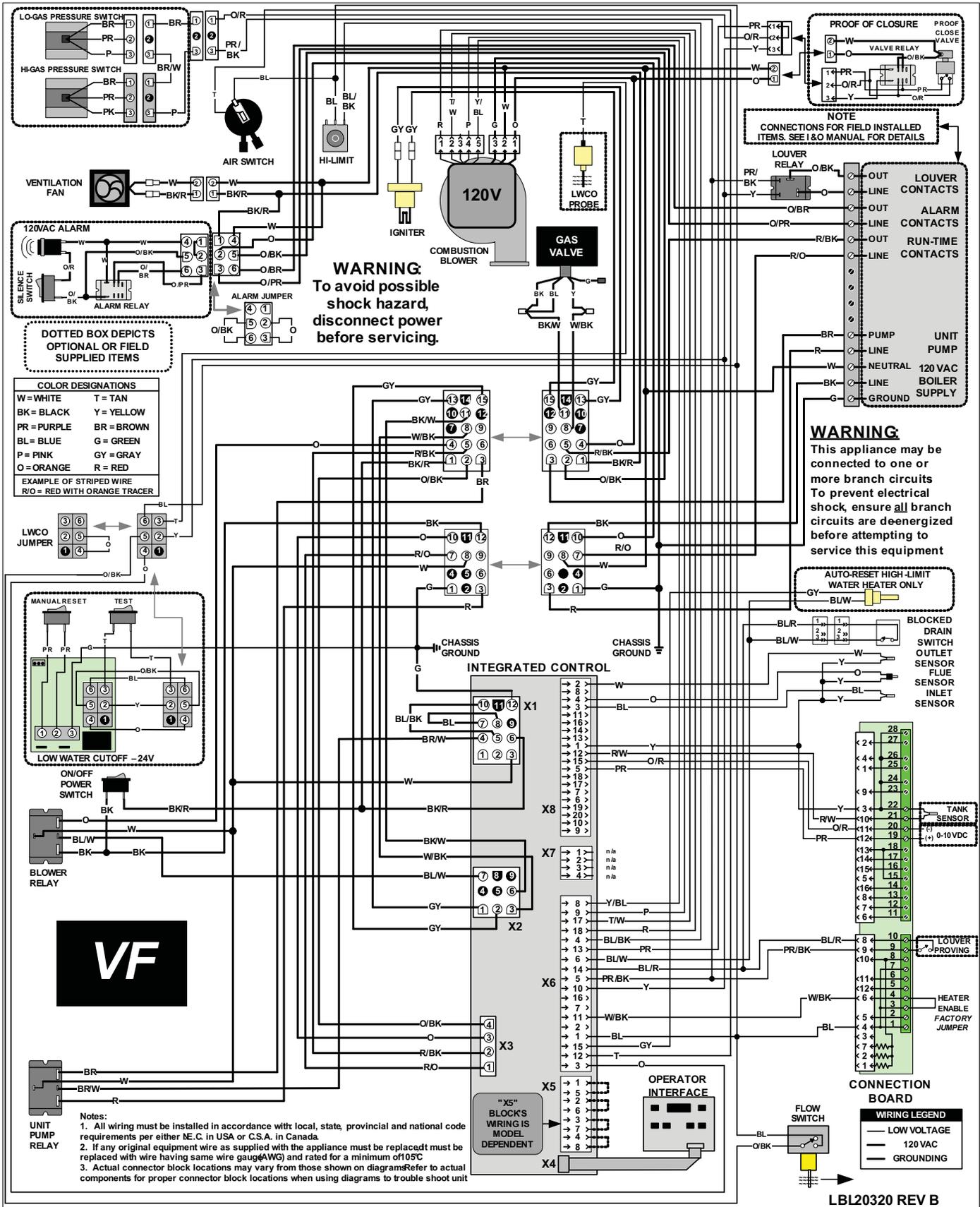
Review with owner

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

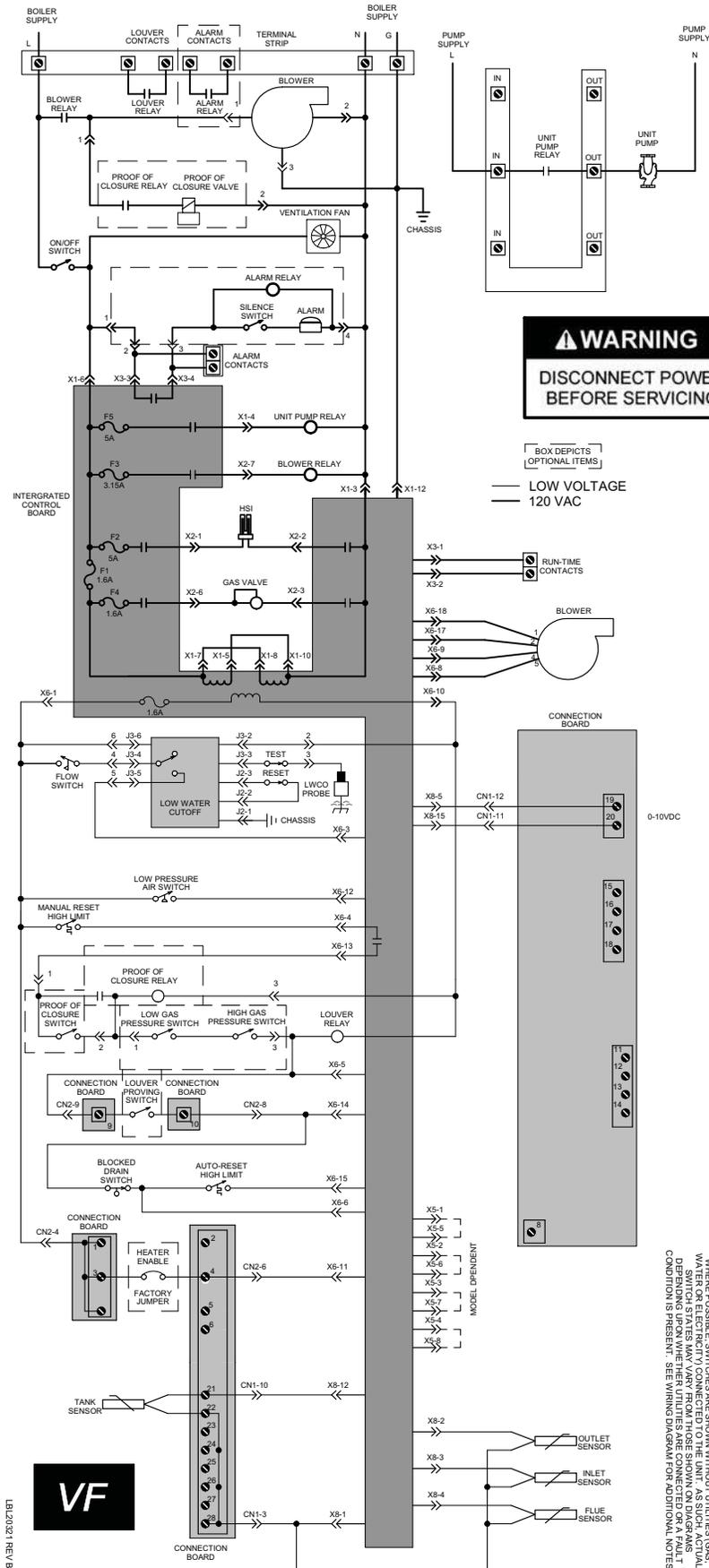
Oiled bearing circulators

Inspect the pump every six (6) months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by the pump manufacturer.

11 Connection diagram



12 Ladder diagram



Notes

Notes

Notes

13 Warranty

LIMITED WARRANTY

A. O. Smith Corporation, the warrantor, extends the following LIMITED WARRANTY to the owner of this hot water supply boiler:

1. If within FIVE years after initial installation of the hot water supply boiler, a heat exchanger or gas burner shall prove upon examination by the warrantor to be defective in material or workmanship, the warrantor, at his option will exchange or repair such part or portion.
 - a. This warranty is extended to the owner for all other parts or portion during the FIRST year following initial installation of this hot water supply boiler.
 - b. The warranty on the repair or replacement of the part or portion will be limited to the unexpired term of the original warranty.

2. CONDITIONS AND EXCEPTIONS

This warranty shall apply only when the hot water supply boiler is installed in accordance with local plumbing and building codes, ordinances and regulations, the printed instructions provided with it and good industry practices. In addition, a pressure relief valve, certified by C.S.A. and approved by the American Society of Mechanical Engineers, must have been installed and fresh water used for filling and make-up purposes.

- a. This warranty shall apply only when the hot water supply boiler is used:
 - (1) with inlet water temperature 140°F (60°C) and above and outlet water temperatures not exceeding the maximum setting of its operative and/or high limit control;
 - (2) at water pressure not exceeding the working pressure shown on the hot water supply boiler;
 - (3) when filled with water, free to circulate at all times and with the heat exchanger free of damaging scale deposits;
 - (4) in a non-corrosive and non-contaminated atmosphere;
 - (5) in the United States, its territories or possessions, and Canada;
 - (6) at a water velocity flow rate not exceeding or below the hot water supply boiler's designed rates;
- b. Any accident to the hot water supply boiler, any misuse, abuse (including freezing) or alteration of it, any operation of it in a modified form, or any attempt to repair leaks in the heat exchanger will void this warranty.

3. SERVICE AND REPAIR EXPENSE

Under this limited warranty the warrantor will provide only a replacement part. The owner is responsible for all other costs. Such costs may include but are not limited to:

- a. Labor charges for service, removal, repair, or reinstallation of the component part;
- b. Shipping, delivery, handling, and administrative charges for forwarding the replacement part from the nearest distributor and returning the claimed defective part to such distributor.
- c. All cost necessary or incidental for any material and/or permits required for installation of the replacement.

4. LIMITATIONS ON IMPLIED WARRANTIES

Implied warranties, including any warranty of merchantability imposed on the sale of this hot water supply boiler under state or provincial law are limited to one (1) year duration for the hot water supply boiler or any of its parts. Some states and provinces do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

5. CLAIM PROCEDURE

Any claim under this warranty should be initiated with the dealer who sold the hot water supply boiler, or with any other dealer handling the warrantor's products. If this is not practicable, the owner should contact:

U.S. Customers
 A. O. Smith Corporation
 500 Tennessee Waltz Parkway
 Ashland City, TN
 Telephone: 800 527-1953

Canadian Customers
 A. O. Smith Enterprises Ltd.
 P. O. Box, 310 - 768 Erie Street
 Stratford, Ontario N5A 6T3
 Telephone: 800-265-8520

- a. The warrantor will only honor replacement with identical or similar parts thereof which are manufactured or distributed by the warrantor.
- b. Dealer replacements are made subject to in-warranty validation by warrantor.

6. DISCLAIMERS

NO OTHER EXPRESS WARRANTY HAS BEEN OR WILL BE MADE ON BEHALF OF THE WARRANTOR WITH RESPECT TO THE MERCHANTABILITY OF THE HOT WATER SUPPLY BOILER OR THE INSTALLATION, OPERATION, REPAIR OR REPLACEMENT OF THE HOT WATER SUPPLY BOILER. THE WARRANTOR SHALL NOT BE RESPONSIBLE FOR WATER DAMAGE, LOSS OF USE OF THE UNIT, INCONVENIENCE, LOSS OR DAMAGE TO PERSONAL PROPERTY, OR OTHER CONSEQUENTIAL DAMAGE. THE WARRANTOR SHALL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR DAMAGE TO ANY PERSONS OR PROPERTY, WHETHER DIRECT OR INDIRECT, AND WHETHER ARISING IN CONTRACT OR TORT.

- a. Some states and provinces do not allow the exclusion or limitation of the incidental or consequential damage, so the above limitations or exclusions may not apply to you.
- b. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state or province to province.

Fill in the following for your own reference. Keep it. Registration is not a condition of warranty. The model and serial number are found on the hot water supply boiler's rating plate.

Owner _____

Installation Address _____

City and State _____ Zip Code _____

Date Installed _____ Model No. _____ Serial No. _____

Dealer's Name _____ Phone No. _____

Dealer's Address _____

FILL IN WARRANTY AND KEEP FOR FUTURE REFERENCE



Revision Notes: Revision A (ECO #C12846) initial release.

Revision B (ECO #C14970) reflects wiring and ladder diagram updates.

Revision C (Change # 500001030) reflects the update of Table 4-D on page 34 as well as the addition of the factory startup logo on the manual cover.

Revision D (PCP# 3000006581 / CN# 500006679) reflects the addition of new clearance information on pages 26-28. SAP material numbers have been updated.

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