



# Manchester

(Model 8330)  
Pellet Stove

## INSTALLATION INSTRUCTIONS



Please read this entire manual before installation and use of this pellet fuel burning room heater. Failure to follow these instructions could result in property damage, bodily injury, or even death.

CONTACT LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION  
INSPECTION REQUIREMENTS IN YOUR AREA.

SAVE THESE INSTRUCTIONS FOR FUTURE REFERENCE!



We recommend that our products be installed and serviced by professionals who are certified in the U.S. by NFI (National Fireplace Institute).

[www.nficertified.org](http://www.nficertified.org)



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# Introduction

Congratulations on your purchase of Hearthstone's Manchester pellet fired stove. The Manchester Pellet stove incorporates the latest in pellet burning technology providing you with clean, efficient heat for years to come. Your decision to purchase a Hearthstone Manchester Pellet stove reflects a choice to purchase a premium product and a technology which is carbon neutral, meaning that operation of this stove will not introduce any "new" CO<sub>2</sub> into our atmosphere and minimizes your carbon footprint.

Burning pellets produces essentially the same amount of CO<sub>2</sub> that the same amount of wood decomposing in the forest would produce. Purchase of this product illustrates forward thinking and the thoughtfulness to purchase an environmentally responsible product.

Pellet fuel is proven to provide the cleanest burn of any solid fuel, exhausting an average well below the United States EPA wood burning limit. Your Hearthstone Manchester Pellet stove is certified at 1.3g/hr of particulate emissions, well below the EPA standard of 7.5 g\hr, making your stove not only beautiful, but extremely clean burning and efficient as well. This is because the combustion air is closely monitored and modulated by our on-board computer, which optimizes the burn efficiency.





If you have any questions, comments or concerns please contact your local Hearthstone authorized dealer. They are certified industry professionals and should always be consulted on the installation and operation of your Hearthstone appliance for premium performance and trouble free operation and installation.

Hearthstone Quality Home Heating Products offers the best warranty in the industry. Satisfied customers are our top priority.

## Important Notes

### Please Read this Owner's Manual

Please read this manual in its entirety before installing your stove, thoroughly reading and understanding this manual will help you operate and maintain this pellet heater to ensure years of efficient, economical use. Please operate your stove in accordance with the instructions in this manual. For your safety and trouble free operation, observe a few simple safety precautions and perform some minimal maintenance. The unit will remain appealing while providing years of quality performance.

-  **WARNING: ENSURE ONLY A HEARTHSTONE DEALER OR AN NFI CERTIFIED PELLET SERVICE TECHNICIAN INSTALLS, AND REPAIRS THIS APPLIANCE. A QUALIFIED SERVICE TECHNICIAN MUST INSPECT THE APPLIANCE BEFORE USE, AND AT LEAST ANNUALLY.**
-  **WARNING: REGULAR CLEANING IS REQUIRED OR ASH BUILDUP IN THE FIRE BOX COULD IMPEDE OPERATION. IT IS IMPERATIVE THAT THE CONTROL COMPARTMENTS AND CIRCULATING AIR PASSAGES OF THE APPLIANCE ARE KEPT CLEAN AND FREE OF OBSTRUCTIONS. THIS IS NOT A SET AND FORGET APPLIANCE!**
-  **NEVER BURN PAPER, WOOD OR OTHER MATERIALS**
-  **CAUTION: DO NOT OPEN THE FRONT DOOR OR ASH PAN UNTIL THE STOVE HAS COOLED COMPLETELY.**

The Manchester Pellet is a pellet fuel burning heater certified and is designed to burn premium natural wood pellets only. Never burn any fuel not intended for use with this unit.

### Hot Surfaces

Certain exposed surfaces of the Manchester will reach high temperatures during normal operation. Clearances to combustibles must be maintained, as specified in the "Clearances to Combustibles" section of this manual.




-  **DUE TO HIGH TEMPERATURES, LOCATE THE APPLIANCE OUT OF TRAFFIC LANES AND AWAY FROM FURNITURE, DRAPERIES, CLOTHING AND FLAMMABLE MATERIALS. AS A GENERAL RULE, KEEP ALL COMBUSTIBLES 36 INCHES AWAY.**

Alert children and adults to the hazards of high surface temperatures and the need to stay away to avoid burns to skin or clothing ignition.

# Introduction

Ensure young children are carefully supervised when in the same room as the appliance. Do not place clothing or other flammable material on or near the appliance.

## Fire Hazard

-  **In the unlikely event of a soot, or creosote fire – leave the front door and ash drawer closed and shut the unit off (unplug the unit if the chimney fire does not go out immediately). Have the unit and venting inspected before further use.**
-  **Do not store or use gasoline or other flammable vapors or liquids in the vicinity of this appliance. Locate stove out of traffic and away from furniture, draperies, clothing, and flammable material.**
-  **Never use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter fluid, or similar liquids to start or ‘freshen up’ a fire in this heater. Keep all such liquids well away from the heater while it is in use.**

# Specifications

**Listed as:** Pellet-Fired Direct-Vent Fireplace Heater

**Model:** Manchester Pellet (8330)

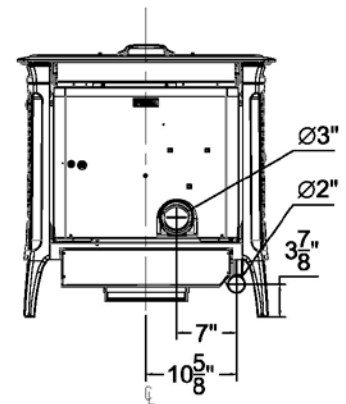
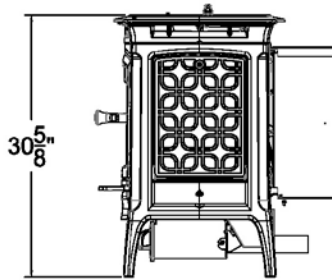
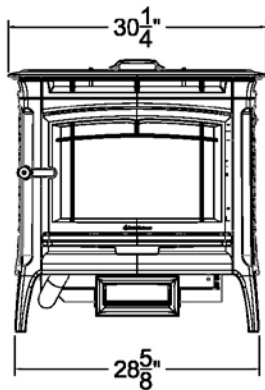
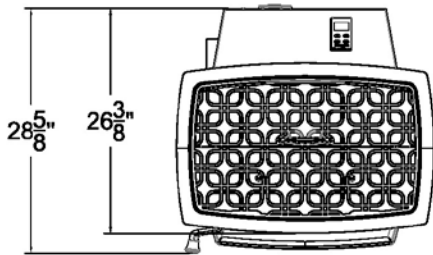
**Testing Agency:** OMNI-Test Laboratories, Inc.

**Tested to:**

- ASTM E 1509-04 Standard Specification for Room Heaters, Pellet Fuel-Burning Type
- ULC/ORD-C1482-M1990 Requirements for Space Heaters for Use with Particulate Solid Fuels
- ULC-S627-00 Space Heaters for Use with Solid Fuels

**Report No.:** 261-S-04b-2 Certified for US and Canada.

**Approved for Mobile Home Installation**



## Output Specifications

% max burn	lbs/hr	BTU's*	Hours of burn, 40lb
30	1.8	15,300	22.2
45	2.7	22,950	14.8
70	4.2	35,700	9.5
100	6.0	51,000	6.7

\*BTU measurements assume 8,500 btu/lb. Lower quality fuel will reduce heat output and overall performance.

# Specifications

## General Specifications

Stove Weight.....	350 lbs
Pellet Hopper Capacity.....	50 lbs*
Approximate Heating Ability (sq ft).....	up to 2000 sq ft
Burn Rate (lbs/hr).....	1.8 – 6.00 lbs/hr
Fuel.....	PFI certified premium or better Wood Pellets
<i>(Refer to Appendix A for more information about pellet fuel in general)</i>	
EPA Certified Particulate Emissions.....	1.3g/hr
<i>(EPA Standard – 7.5 g/hr)(Data from Omni-Test Laboratories, Inc. Report: 261-S-04-8.3)</i>	

## Electrical Specifications

Electrical Rating.....120 V.A.C. 60Hz, 4 Amps

*(A grounded surge protector is recommended to protect the circuit board. If the voltage entering your home is below 116 volts your stove may not work properly. Ensure that the polarity of the electrical receptacle that the stove is plugged into is correct.)*

Fuse replacement: 3.5 amp minimum to 4 amp maximum rating. Hearthstone PN 7000-185

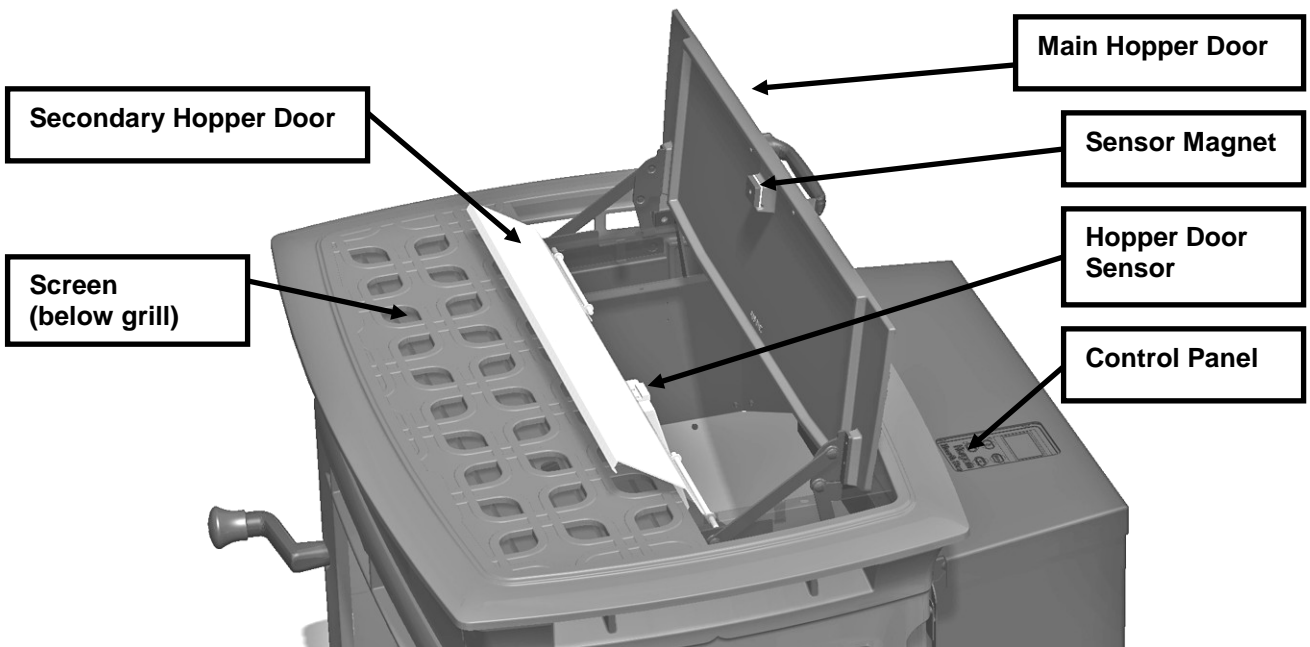
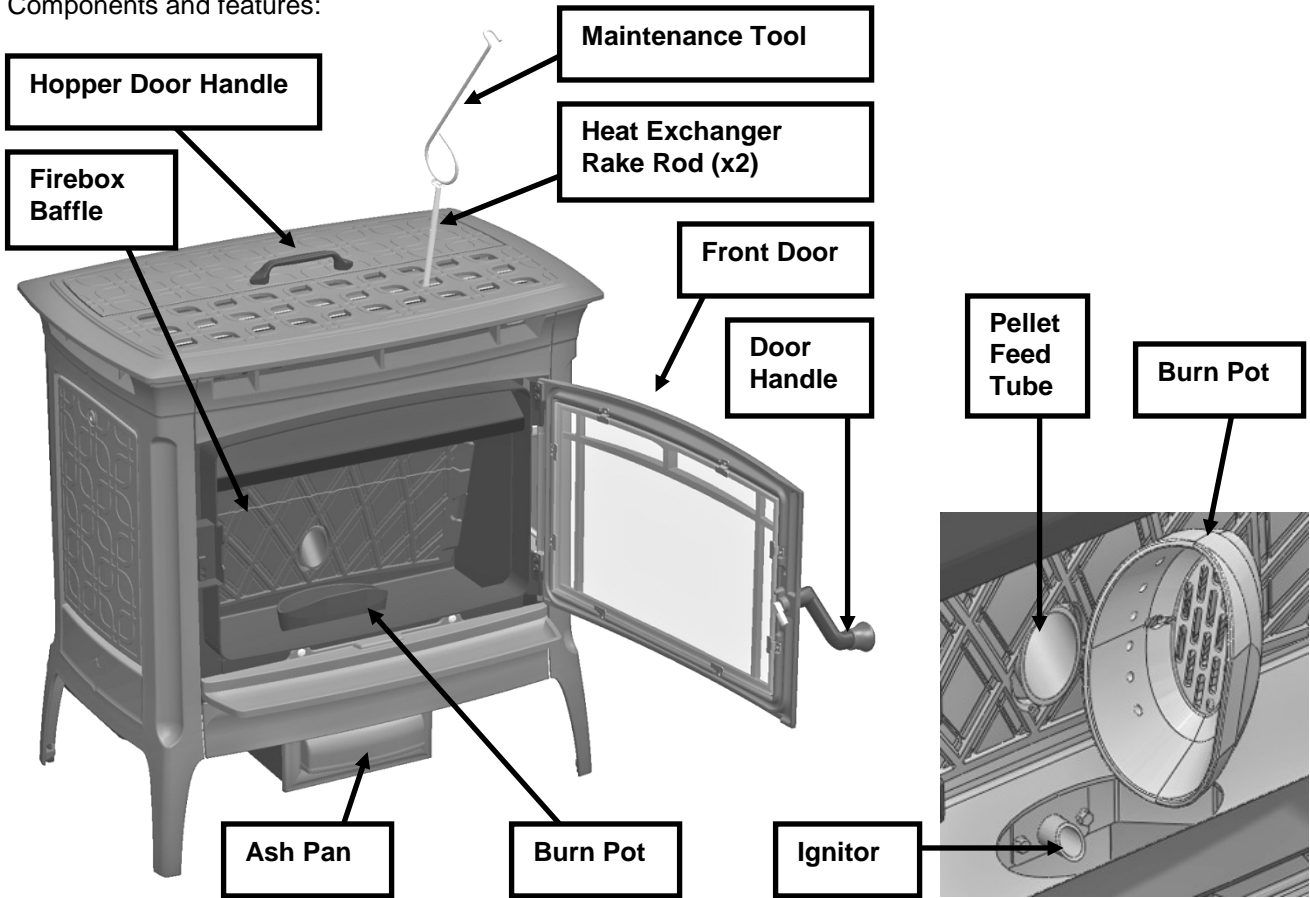
Watts used (startup) (approx).....	300 Watts
Watts used (max/high burn) (approx).....	160 Watts
Watts used (min/low burn) (approx).....	60 Watts

\*All void spaces in hopper filled.

^Dependent on energy efficiency of structure, fuel quality, user operation, and your installation.

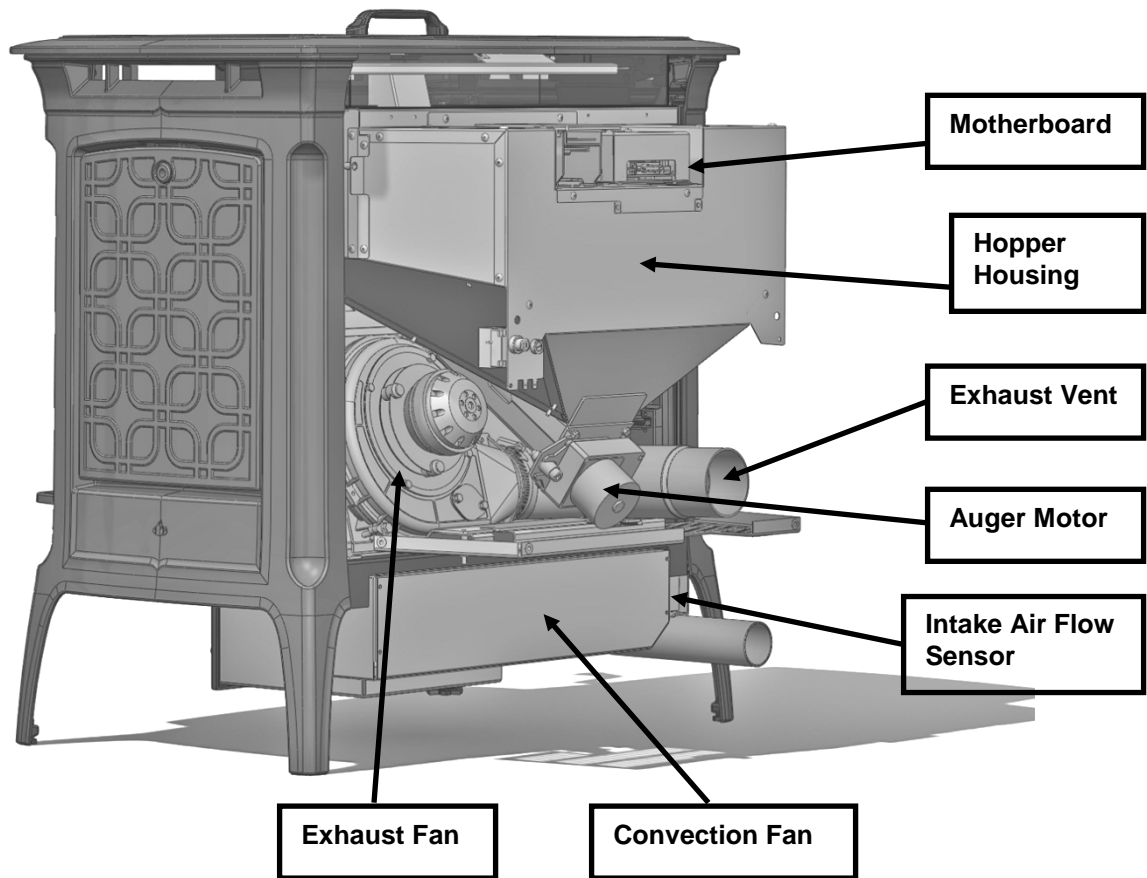
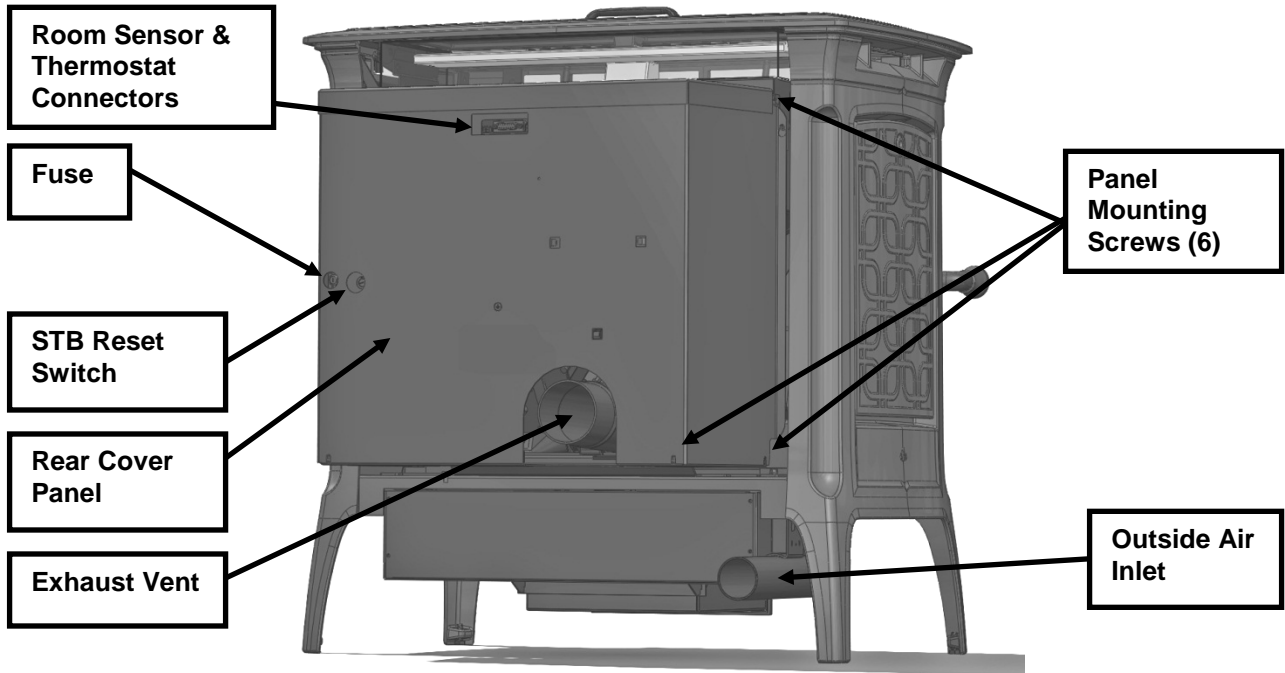
# Components

Components and features:





# Components



# Installation

## Packing list

- 1- Manchester Model 8330 Pellet Stove
- 1- Wired Room Sensor
- 1- Maintenance Tool
- 1- Owner's Manual
- 1- Warranty and Warranty Card

## Unpacking your Stove

Hearthstone packages your Manchester Pellet stove with the greatest care so that it ships safely. However, damage can still occur during transit and handling. When you receive your stove, immediately unpack and inspect it carefully, checking all parts for damage. Also, ensure all parts listed are included in the box. If any parts are damaged or missing, please contact your dealer immediately. We recommend that installation and repair of this Hearthstone pellet stove only by a qualified Hearthstone dealer. We recommend inspection of the stove and venting before use and at least annually by a qualified service person. Periodic cleaning is required throughout the heating season and at the end of each winter for the stove to work safely and efficiently.

- 🔥 Remove retaining clips from pallet; retain them if this is a mobile home installation (see page 12).

## Installation Preparation

- 🔥 Have a certified dealer install this heater. If you install the heater yourself, have your dealer review your installation plans. Adhere to all codes. Local codes take precedence if more stringent than federal codes.
- 🔥 Plan and sketch your installation, ensure all necessary requirements are met
- 🔥 Ensure you consider all structural framing members (studs, joists, rafters etc.) in your installation. Slight adjustments in placement consideration may significantly ease installation.
- 🔥 In order to avoid any odors associated with the initial burn, we suggest you burn the stove on high in an outdoor location for 30 minutes. This will allow paint to cure and any debris to burn off, greatly reducing or eliminating smells associated with stove break-in inside your home.
- 🔥 Ensure you consider access to the unit for cleaning and service when selecting an installation configuration.

## Hearth Requirements & Floor Protection

Ensure you protect combustible flooring (such as wood, carpet, vinyl) with a covering of any approved noncombustible material (metal, tile, stone, glass, etc.). The Manchester Pellet Stove does not require an R rated insulated hearth pad. Do not place combustible items under the stove. The floor protection must extend beyond the body of the stove at the minimum as follows:

1. **A** = 6" (152mm), **B** = 2" (51mm), **C** = Venting Mfg's Specifications (2" (51mm) min.).

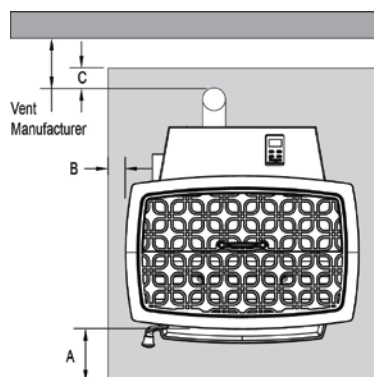


Figure 1 – Hearth with Vertical Venting

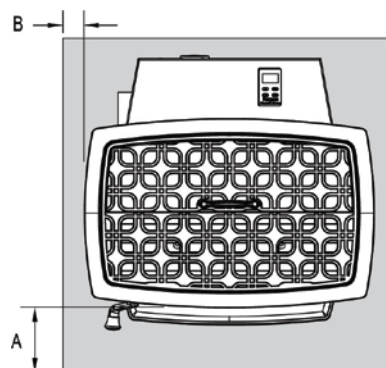


Figure 2 – Hearth with Horizontal Venting

# Installation

## Clearance to Combustibles

1. **D = 6" (152mm) minimum (16" (410mm) recommended to allow side door opening for service), E = 2" (51mm), F = 1" (25mm), G = 6" (152mm), H = 24" (610mm), I = 24" (610mm), and J = 2" (51mm).**

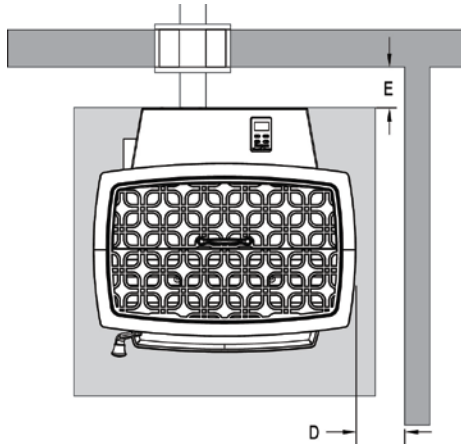


Figure 3 – Side and Rear Clearances

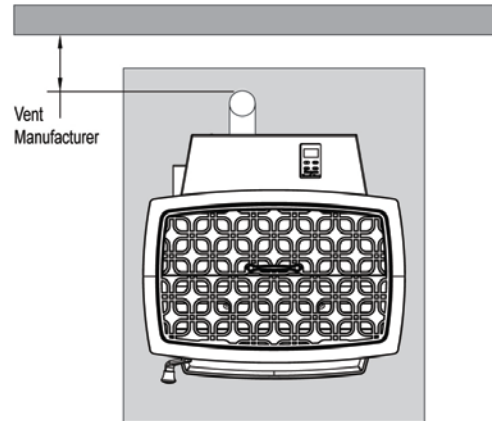


Figure 4 – Vertical Vent Clearance

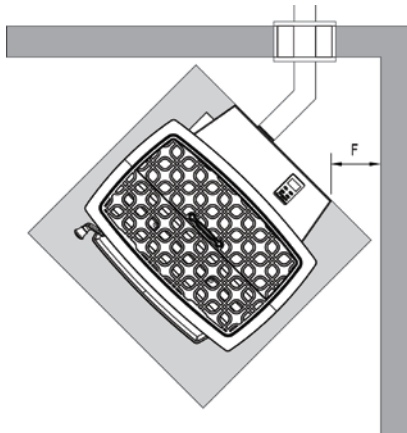


Figure 5 – Corner Clearances Horizontal Vent

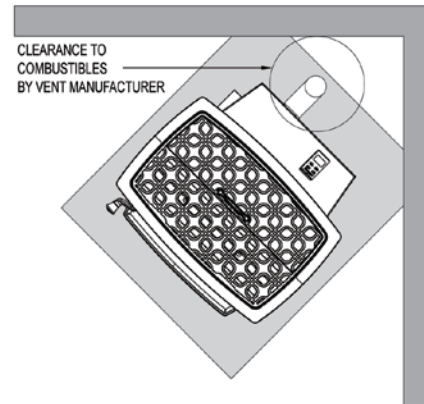


Figure 6 – Corner Clearance with Vertical Vent

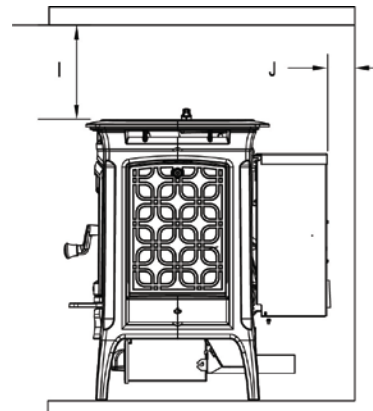
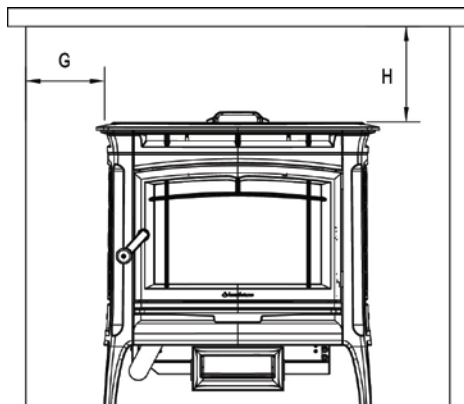


Figure 7 – Alcove Clearances

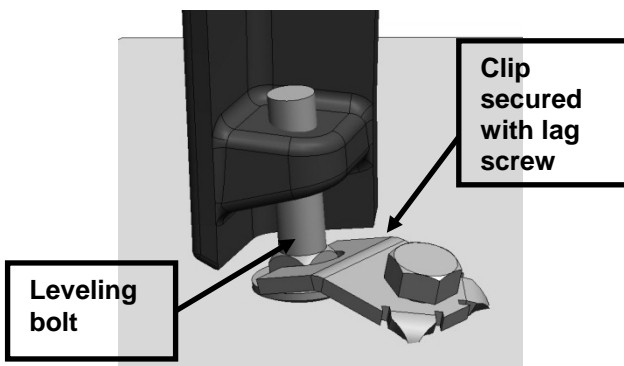
# Installation

## Manufactured & Mobile Home Installations

- 🔥 **WARNING: DO NOT INSTALL IN SLEEPING ROOM.**
- 🔥 **CAUTION: THE STRUCTURAL INTEGRITY OF THE MANUFACTURED HOME FLOOR, WALL, AND CEILING/ROOF MUST BE MAINTAINED.**
- 🔥 **Never use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter fluid, or similar liquids to start or 'freshen up' a fire in this heater. Keep all such liquids well away from the heater while it is in use.**

When installing this unit in a manufactured or mobile home, there are several **mandatory** requirements to follow:

1. You must bolt the stove to the floor. Accomplish this using the clips (PN 5532-012), and lag screws (5/16x1-3/4") used to attach the stove to the pallet for shipping. Ensure the lag bolt is long enough to penetrate the hearth pad, and securely fasten the stove to the floor of the structure.
3. The stove must be connected to a factory-built chimney conforming to CAN/ULC-S629, standard for 650° C Factory-Built Chimneys.



2. Venting installations must conform to all codes, and meet the specifications outlined in the Venting section of this manual beginning on page 15.
4. You must connect the stove to outside air. (See page 17). Using an outside air kit also requires attaching the stove to the structure as outlined in step 1.
5. You must ensure that the outside air inlet remains clear of any objects, leaves, icing, snow or other debris. Keep the inlet away from any exhaust fans. The inlet requires an adequate amount of ventilation. If the inlet becomes restricted during operation, the unit may starve for air, which may cause smoke spillage and an inability to maintain a proper fire. This smoke may set off smoke detectors in your home.
6. You must remove the venting when transporting the mobile home.
7. Use silicone to create an effective vapor barrier at the location where the chimney or other component penetrates to the exterior of the structure.

🔥 **Important: Use all specified components and methods for the installation. Do not use components that are not specified in this manual. Failure to use specified components and methods could void your warranty, and can cause malfunction or damage to the unit or structure.**

🔥 Do not modify the appliance to accomplish installation. Any modifications will void your warranty.

## Clearances to NFPA 211 Protected Surfaces

You can reduce the clearances to combustible surfaces by using any National Fire Protection Agency (NFPA) approved wall protection system (U.S. Only). Please refer to NFPA 211 for specifications and complete details. You can obtain this information directly from NFPA. In all instances, clearances may only be reduced by means approved by the regulatory authority.

### National Fire Protection Agency

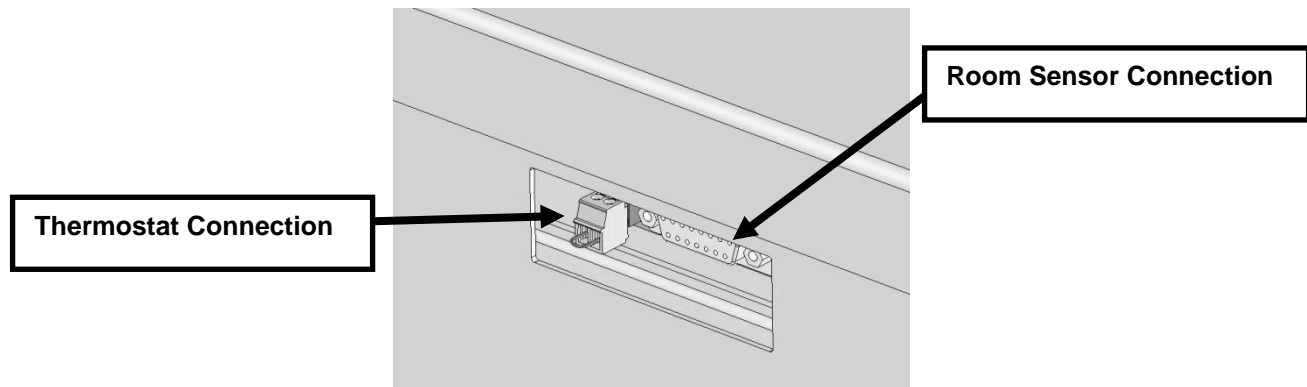
Batterymarch Park  
 Quincy, MA 02269  
 1-800-344-3555 or 1-617-770-3000  
[www.nfpa.org](http://www.nfpa.org)

# Installation

## Room Sensor Installation

We recommend you install your Manchester Pellet stove with the provided room sensor for optimum efficiency and comfort. The room sensor is a wired remote temperature probe for the stove's electronic control system. With the room sensor, the control system can efficiently regulate the stove's rate of burn to keep a more consistent room temperature and level of comfort. The room sensor gives you the option to use the Automatic and Programmable modes of operation (See Page **Error! Bookmark not defined.**).

1. Locate the room sensor as you would a regular thermostat. Do not install near the stove. Avoid other sources of heat such as sunny walls, and appliances such as televisions or refrigerators. Avoid placing near, or in unusually cool areas such as windows, entry areas, or on exterior walls.
2. Install the sensor's wiring carefully – if concealing the wiring, ensure it is properly secured and protected from future damage.
3. Once the room sensor and wiring are properly installed, connect the sensor's wiring to the 15 pin connector on the back of the unit.

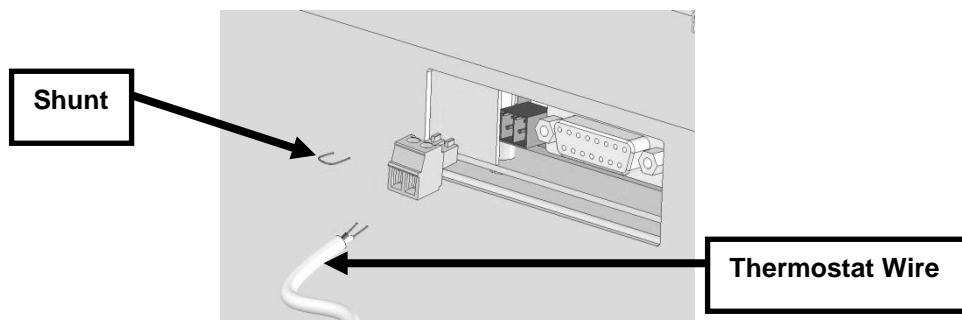


## Optional Thermostat Installation

You can purchase your own thermostat for use with the Manchester Pellet stove. Ensure the thermostat is properly located and the wiring properly installed to maximize the efficiency of the unit. Any UL approved millivolt thermostat will operate this stove. In Thermostat Mode, the thermostat will turn the stove on and off, but will not automatically vary the rate of burn. You must regulate the rate of burn manually.

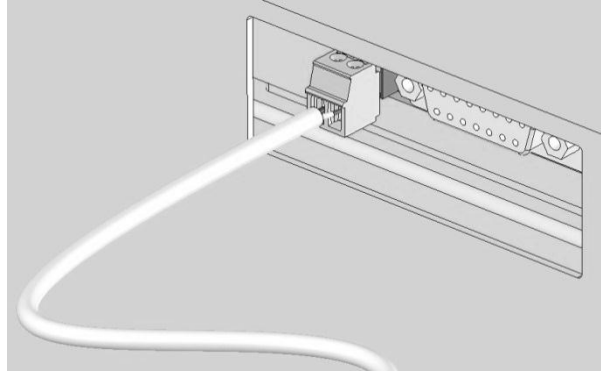
Due to the complexity of the startup / shutdown process it will take approximately 10 minutes for the pellet stove to respond to any signal from the thermostat. We recommend operating the stove only with the provided room sensor to minimize this start / stop cycle.

1. Locate the thermostat connection (see image above), and remove the connector from the stove.
2. Use a small flat tip screwdriver – loosen the screws and remove the shunt.
  - 🔥 **Note:** do not connect the Room Sensor if using a thermostat.



## Installation

3. Remove a small length of the cover from the thermostat wire. Strip approximately  $\frac{1}{4}$  inch insulation off the wires. Insert one wire on each side of the connector – tighten the screws.
4. Insert the connector into the connection port.



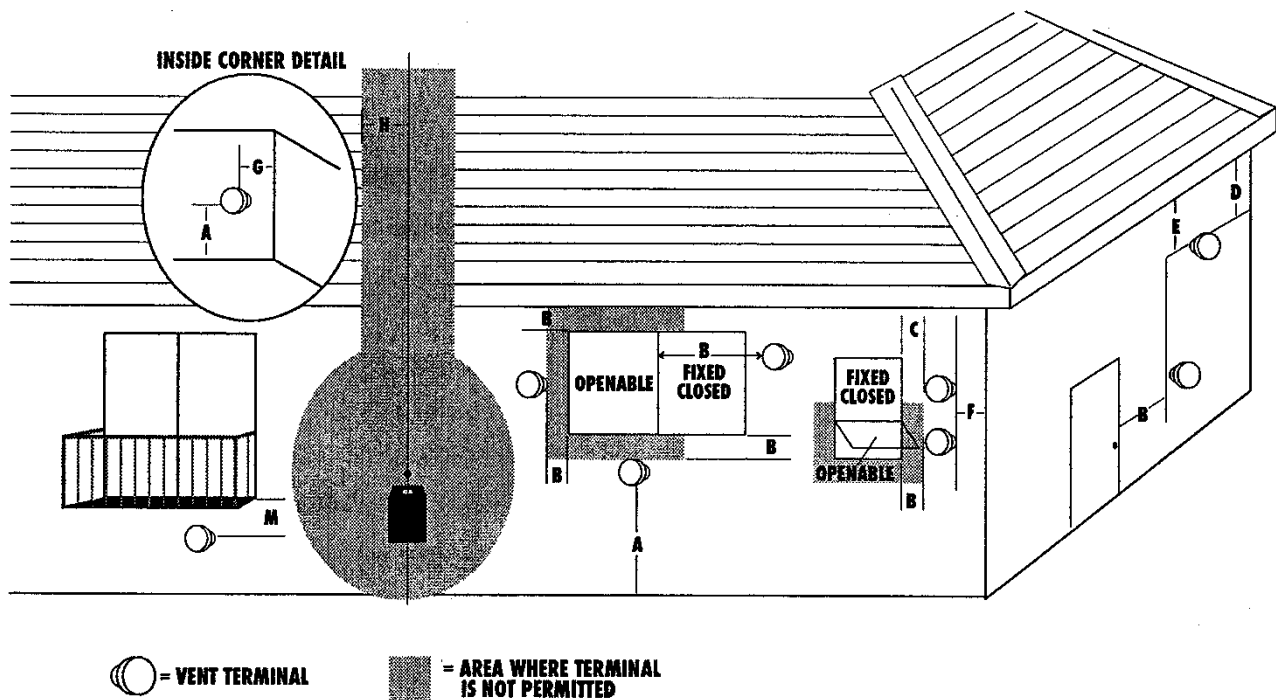
5. Room Sensor extension - acceptable wire size is 20 – 18 AWG (.75mm to 1mm). Maximum recommended length is 50 feet.
6. Connect the stove to a grounded 120 volt receptacle, and set the stove to Thermostat Mode (See Page **Error! Bookmark not defined.**).

# Venting

**Note:** Only 3" or 4" L or PL venting is approved for use on this stove.

- 🔥 DO NOT INSTALL A FLUE DAMPER IN THE EXHAUST VENTING SYSTEM OF THIS UNIT.
- 🔥 DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE.
- 🔥 INSTALL VENTING AT CLEARANCES SPECIFIED BY THE VENT MANUFACTURER.
- 🔥 A CHIMNEY CONNECTOR SHALL NOT PASS THROUGH AN ATTIC OR ROOF SPACE, CLOSET OR SIMILAR CONCEALED SPACE, A FLOOR, OR A CEILING.
- 🔥 CAUTION: DO NOT CONNECT TO ANY AIR DISTRIBUTION DUCT OR SYSTEM.
- 🔥 WHERE PASSAGE THROUGH A WALL OR PARTITION OF COMBUSTIBLE CONSTRUCTION IS REQUIRED, THE INSTALLATION SHALL CONFORM TO CAN/CSA-B365, INSTALLATION CODE FOR SOLID FUEL BURNING APPLIANCES AND EQUIPMENT.
- 🔥 ENSURE YOUR INSTALLATION PROVIDES SUFFICIENT COMBUSTION AIR FOR THIS UNIT. DO NOT RELY ON ROOM AIR FOR COMBUSTION – USE OF AN OUTSIDE AIR KIT RECOMMENDED.

## Exterior venting requirements



**A-** The clearance above grade must be a minimum of 18" (46cm). When venting terminates above a paved sidewalk or driveway on public land, termination must be at least 7 feet (213.4cm) above grade.

**B\***- The clearance to a window or door that can be opened must be a minimum of 48" (122cm) to the side and 48" (122cm) below the window/door, and 12" (30.5cm) above the window/door.

**C-** A 12" (30.5cm) clearance to a permanently closed window is recommended to prevent condensation on the window.

**D-** The vertical clearance to a ventilated soffit must be a minimum of 12" (30.5cm)

**E-** The clearance to an unventilated soffit must be a minimum of 12" (30.5cm)

**F-** The clearance to an outside corner is 11" (28cm)

**G-** The clearance to an inside corner is 12" (30.5cm)

**H-** A vent must not be installed within 2 feet (61cm) above a gas meter/regulator assembly when measured from the horizontal centerline of the regulator

**M-** The clearance under a veranda, porch, deck or balcony must be a minimum or 12" (30.5cm)

\* The horizontal clearance to a door or window may be reduced to 12" if outside combustion air is used (see figure 8).

# Venting

 **Warning: Ensure your venting system (chimney connector, and chimney) are in good condition and kept clean.**

The minimum horizontal clearance to vegetation and other exterior combustibles such as mulch is 36" as measured from the center of the outlet or termination cap. This 36" radius continues to grade up to a minimum of 7 feet below the outlet.

The longer the vent pipe and more elbows used in the system, the greater the flow resistance. Therefore, we recommend using as few elbows as possible, and 15 feet or less, of vertical vent pipe. The maximum horizontal run should not exceed 10 feet. If more than 15 feet of pipe, or two 90° elbows are required, vent pipe size should increase to 4", as larger piping offers less flow resistance. Maximum recommended vertical vent for 4 inch pipe is 30 feet.


Please note that pellets are a wood product and soot may occur during startup while the firebox approaches sufficient temperature to sustain complete combustion of fuel.

**Soot and Flyash: Formation and Need for Removal-** The products of combustion will contain small particles of flyash. The flyash will collect in the exhaust venting system and restrict the flow of the flue gases. Incomplete combustion, such as occurs during startup, shutdown, or incorrect operation of the room heater will lead to some soot formation which will collect in the exhaust venting system. The exhaust venting system should be inspected at least once every year to determine if cleaning is necessary. To reduce the risk of a chimney fire, remove any soot or flyash if an accumulation of 1/8" (3mm) or more is found.

Please follow venting manufacturer's recommendations and required installation procedures. All joints for connector pipe shall be required to be fastened with at least three screws. If vented horizontally, joints shall be made gastight with at least three screws and high temperature silicone.

Before considering your installation to be complete, perform a leak test on your venting. Leaks are easiest to see during startup. Look for leaks at the vent pipe joints. Use of an incense stick is recommended to find leaks.

Though unlikely with pellet burning appliances, incomplete combustion of biofuels can produce Carbon Monoxide (CO) which is a colorless, odorless gas. Exposure to high concentrations of Carbon Monoxide can result in injury or death. Install a CO detector (recommended), and keep your appliance and venting maintained according to the instructions in this manual.

 **Important: Use all specified components and methods for the installation. Do not use components that are not specified in this manual. Failure to use specified components and methods could void your warranty, and can cause malfunction or damage to the unit or structure.**

 Do not modify the appliance to accomplish installation. Any modifications will void your warranty.

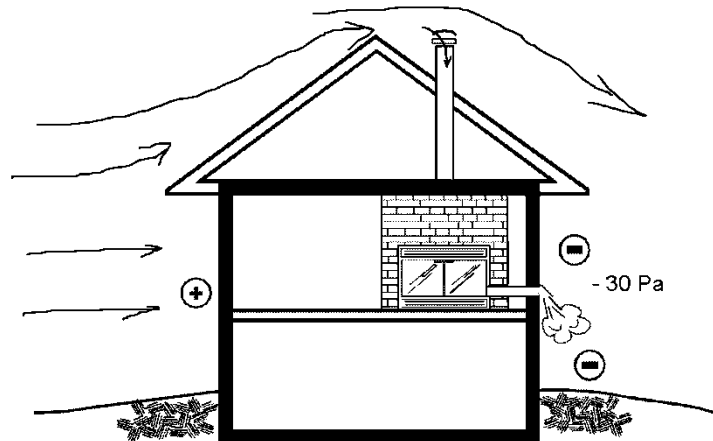


# Venting

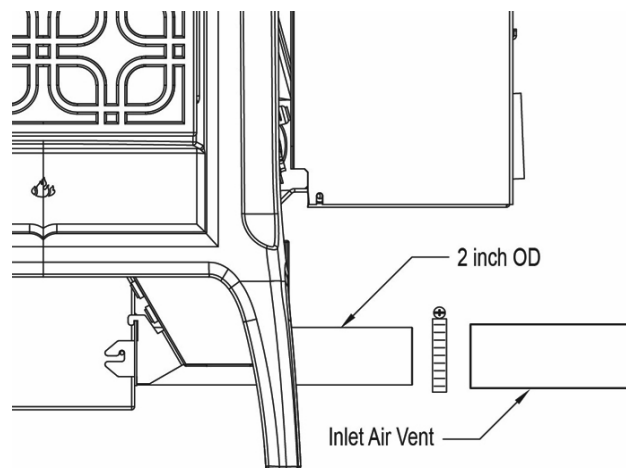
## Outside Air

### 🔥 WARNING: CONNECT THE STOVE TO OUTSIDE AIR WHEN REQUIRED!

We recommend you connect your Manchester Pellet Stove to an outside air source to achieve the most efficient and productive operation. If using an existing masonry chimney for exhaust venting and using outside air feature, ensure make-up air draws from the side of the building most likely to experience direct wind pressure (upwind side). You can use a coaxial venting configuration (direct vent) if environmental negative pressure is a problem in your installation (see illustration below). This situation become less likely the closer the make-up and exhaust air piping are to each other.



Never draw outside air from an enclosed space (garage, unventilated crawl space, etc), as this would create a negative pressure situation and potentially starve your appliance of combustion air, creating more soot and reducing performance efficiency.



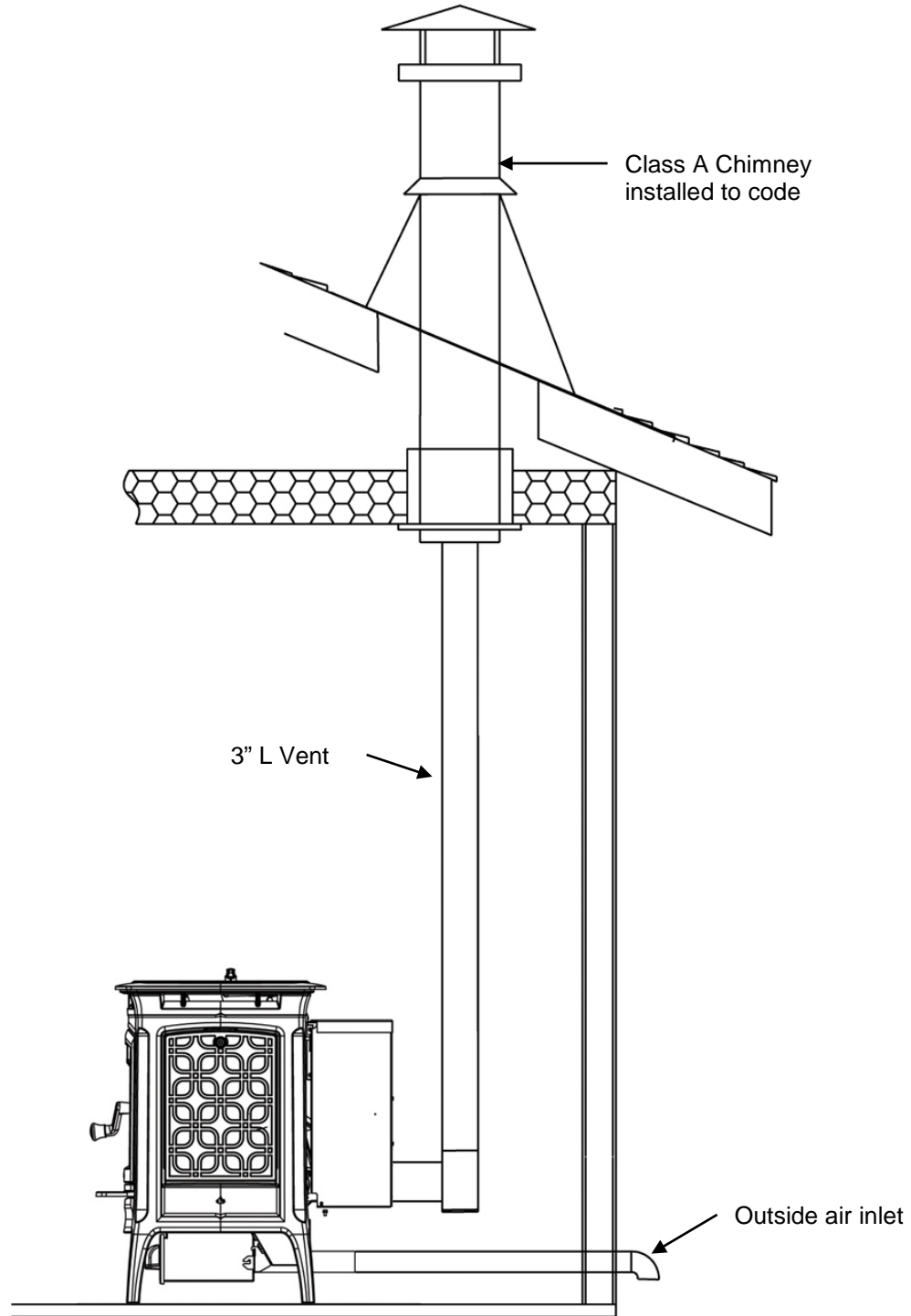
**Figure 8 – Outside Air Attachment**

- 🔥 2 inch diameter supply pipe for outside air must not be longer than 6 feet. Increase diameter of vent pipe to 3 or 4 inches if exceeding 6 feet in length.
- 🔥 Use a metal hose clamp or equivalent to secure supply air pipe to stove.
- 🔥 Using an outside air kit requires attachment of the stove to the structure (Mobile home only) as outlined in step 1 on page 12.



# Venting

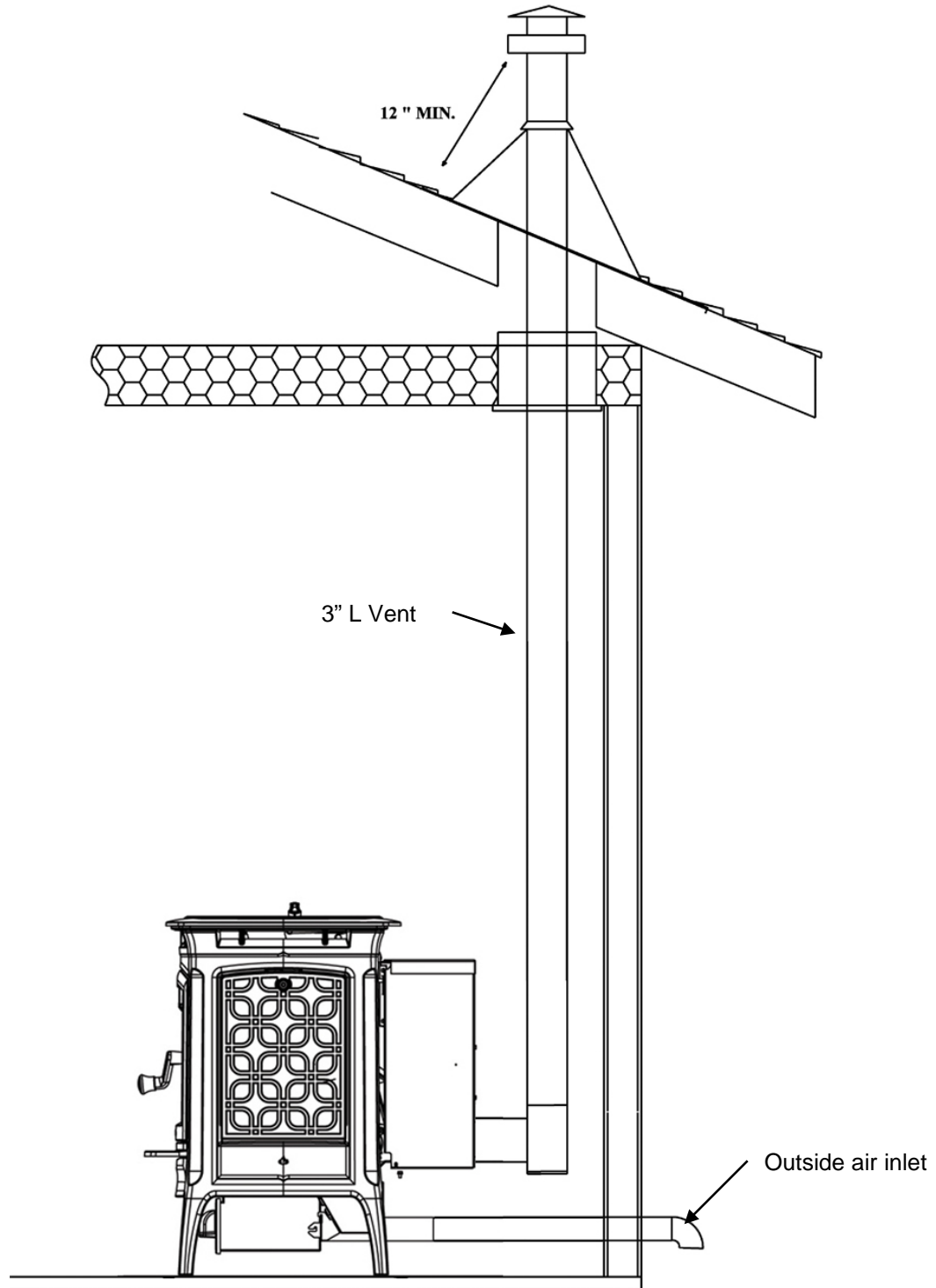
## INSTALLATION EXAMPLE: CLASS A CHIMNEY



- 🔥 Use this installation when the pellet stove replaces an existing wood stove with a Class "A" chimney.
- 🔥 Use 4" L vent if over 15' of vertical L venting is installed

# Venting

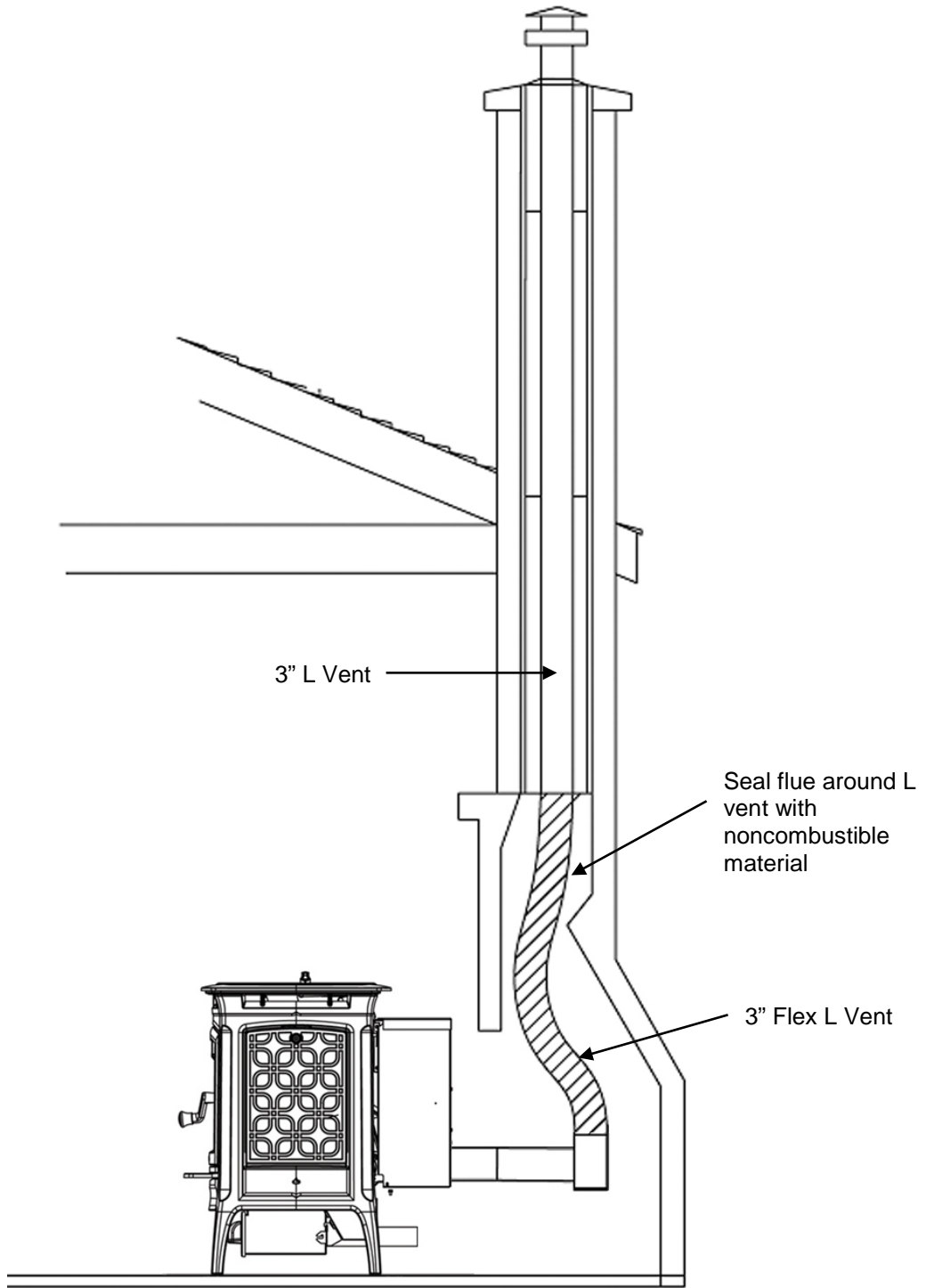
## INSTALLATION EXAMPLE: VERTICAL L VENT THROUGH THE CEILING AND ROOF



- 🔥 Use this vent configuration on new installations where there are limitations to venting out the side wall.
- 🔥 Use 4" L vent if installing over 15' of vertical L venting.

# Venting

## INSTALLATION EXAMPLE: EXISTING MASONRY FIREPLACE CHIMNEY

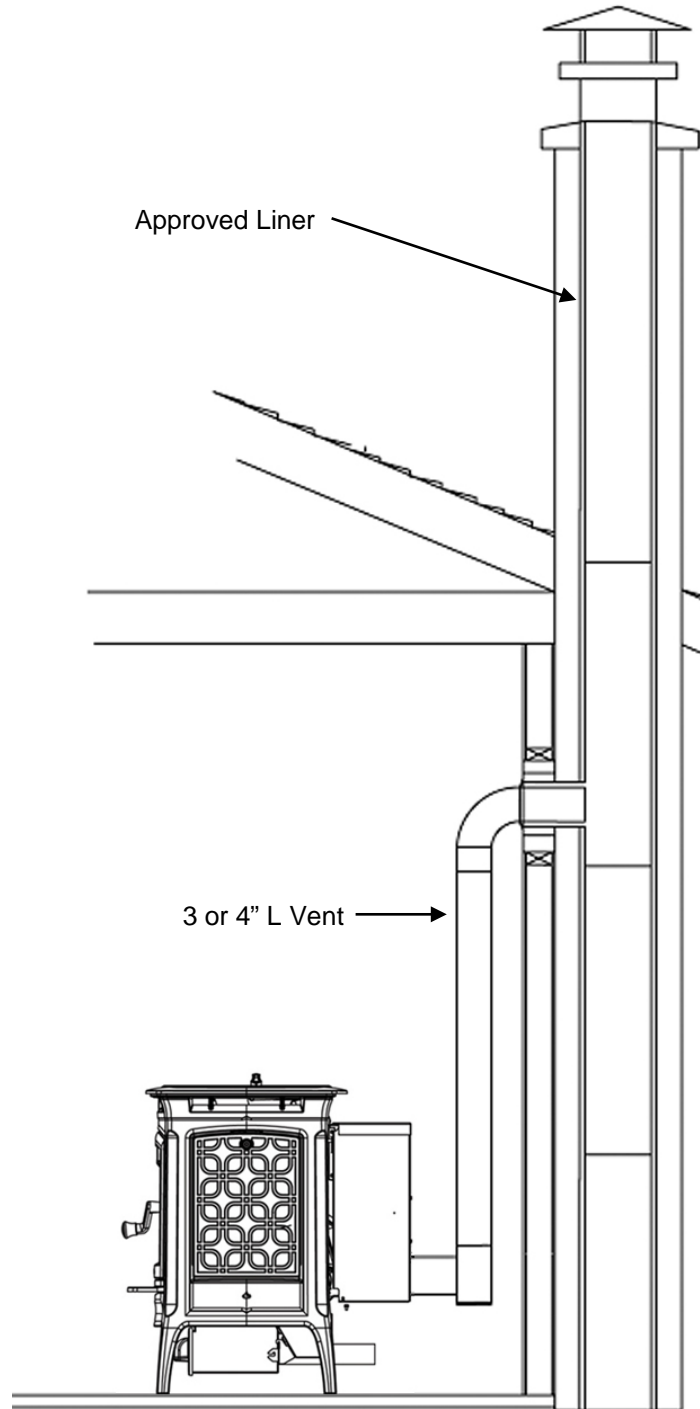


- 🔥 Typical installation for use with an existing Masonry Fireplace Chimney.
- 🔥 Use 4" L vent if installing over 15' of vertical L venting.



# Venting

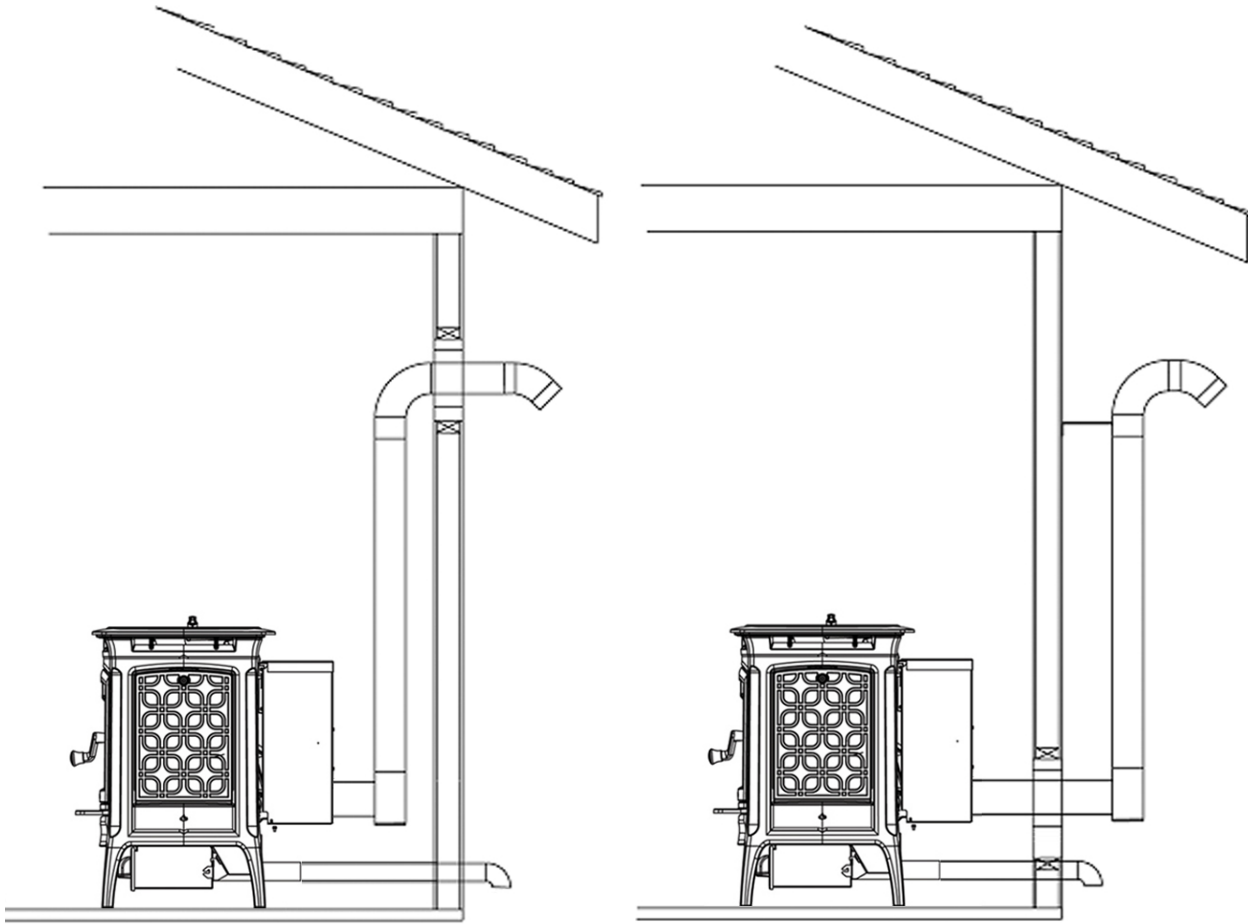
## INSTALLATION EXAMPLE: EXISTING MASONRY CHIMNEY



- 🔥 Installed into an existing masonry chimney with no L Vent liner (chimney must have other approved liner in good condition, and a working clean-out).
- 🔥 3" or 4" L vent is acceptable.

# Venting

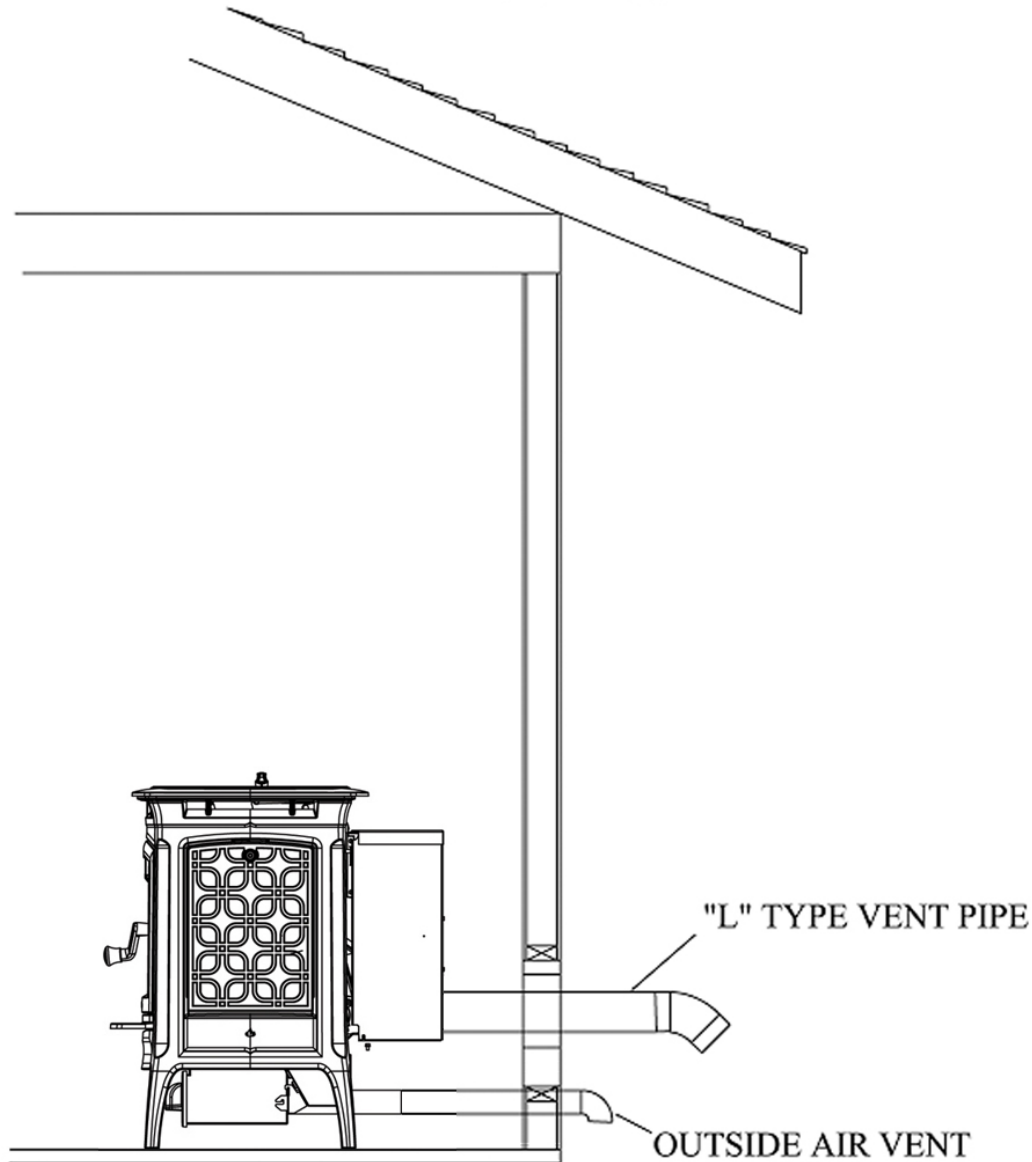
## INSTALLATION EXAMPLE: VENTING WITH VERTICAL RISE



Use these configurations to minimize the chance of smoke spillage in the room during a power outage. This vent configuration will generate its own draft. There must not be any combustible material within 36" of the outlet and the termination must be at least 18" above ground level.

# Venting

## INSTALLATION EXAMPLE: HORIZONTAL VENTING

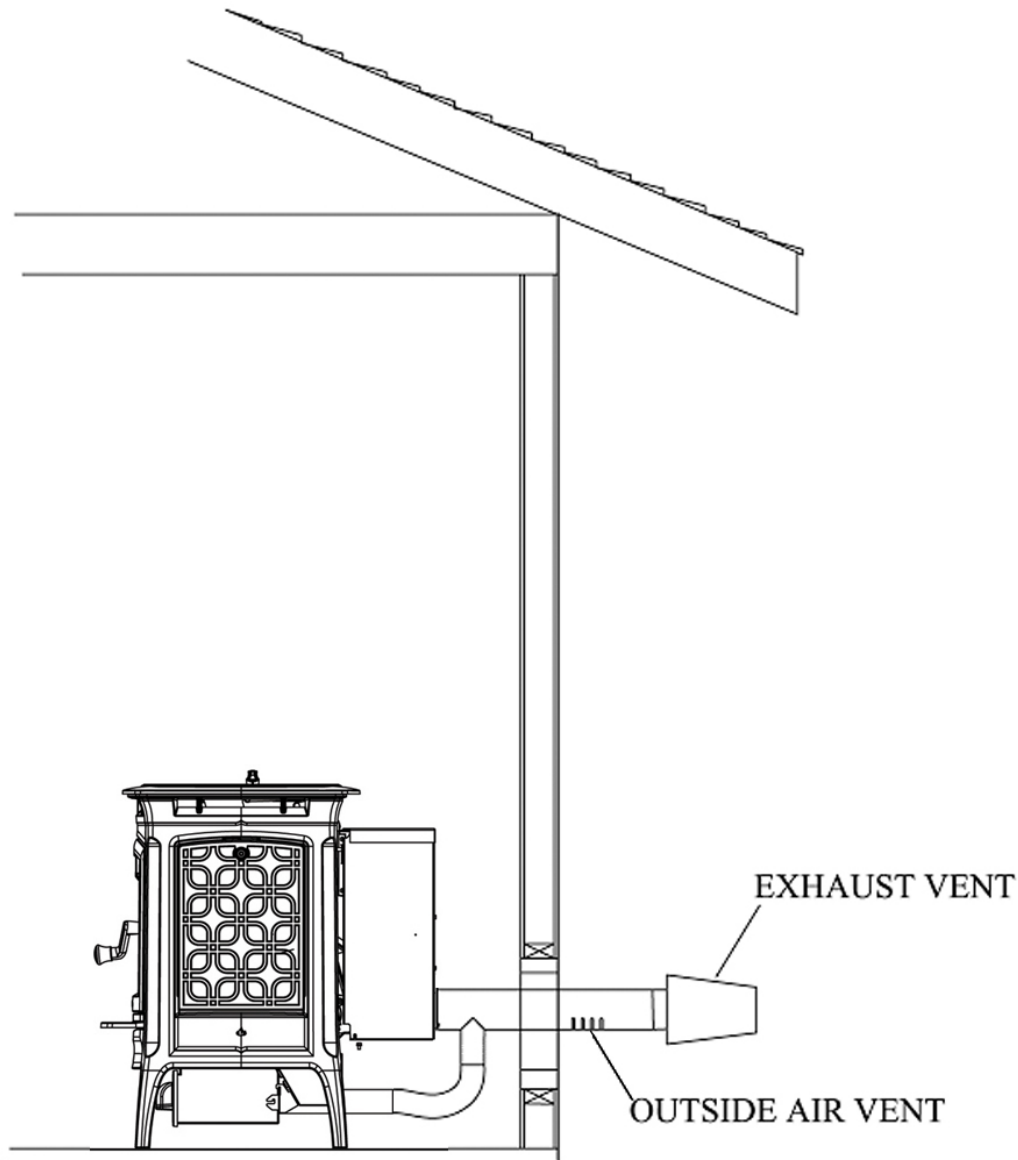


- 🔥 Use of this method is acceptable as long as there is no combustible material within 36" of the termination, and the termination is at least 18" above grade.
- 🔥 There may be smoke spillage into the room if there is a power outage. The outside air vent is recommended to reduce this chance.
- 🔥 **NOTE:** As your Manchester pellet stove is power vented, you can install it (with consideration to exterior clearances) with this horizontal only exit configuration. However, we recommend a vertical rise of 5 feet minimum in case of a power outage when some smoke may back up into your heated space. Without any natural draft, the stove will smoke in this situation. However, the smoke will stop within 10 minutes.

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# Residential Pellet Fuel Information

(Excerpt from "Pellet Hearth Systems Reference Manual Second Addition" December 2008)

In much of the world, the concept of home is linked directly to the ability to maintain a heated environment in winter months. With the energy crisis of the 1970's came the first notice that the source of that heat and comfort had to be scrutinized. The realization of limitations and eventual shortages for finite, irreplaceable, fossil fuels spurred a new interest in renewable, and therefore sustainable, alternative fuel sources.

Almost simultaneously, the issue of waste surfaced. The habits of our throwaway society not only resulted in costly waste of valuable energy resources, but also in a crisis in disposal space and methods. The development of residential pellet fuel responds to both the call for renewable biomass sources of home heating fuels and waste stream reduction.



NORTH AMERICAN PELLET MILLS

## 1. PELLET PRODUCTION

As forest products companies produce lumber, plywood, and other goods, they create wood and bark residues that contain energy. In the form of sawdust, bark, and chips, these residues are bulky and vary greatly in moisture content. The process of pelletizing reduces their bulk by compression and increases their combustion manageability by controlling consistency. Originally produced for industrial and institutional use, pellets entered the residential fuel market with the introduction of the first home pellet appliances in the mid-1980's.

### 1.1 RAW MATERIALS

Although a wide variety of materials, including sawdust and wood scraps from hard and soft woods, shells and nut hulls, agricultural by-products, paper, and cardboard, is pelletized for use as fuel, residential pellets are primarily wood-based residues. Corn, because of its natural similarity to pellets, is used in some specially designed residential appliances. Because corn combustion differs from wood pellet combustion, corn should not be burned alone or mixed with wood pellets unless the appliance is specifically designed for corn combustion.

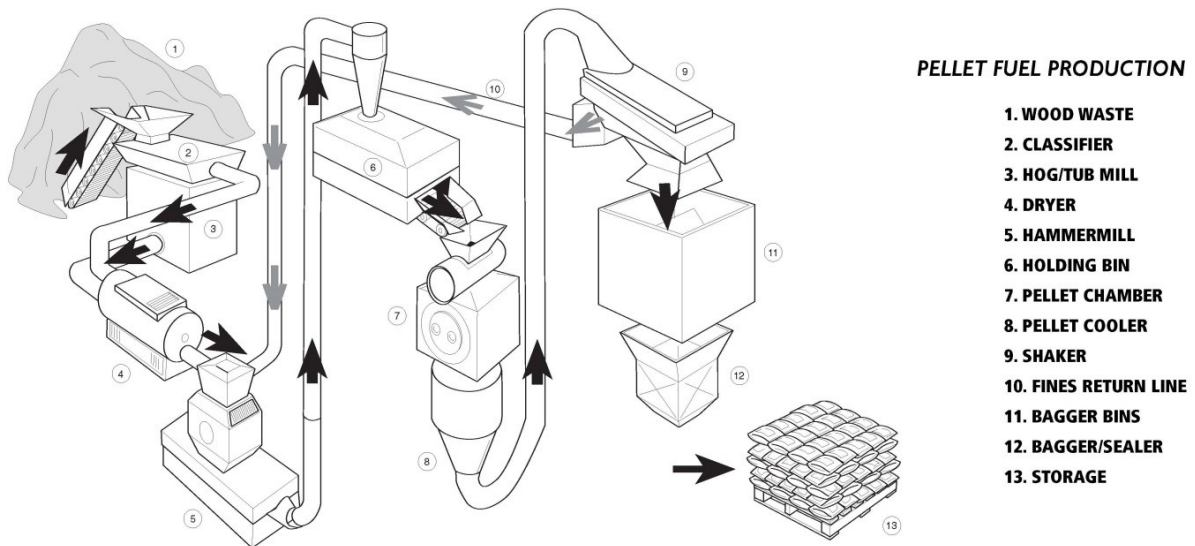
Because ash content and other factors presently limit or prevent the practical use of other agricultural and paper products in most residential appliances. Increasing competition for forest industry by-products and reduction in logging in some areas are a growing concern of pellet manufacturers. Pellet appliance design, however, is responding to fuel manufacturers' predictions of future shortages of premium grade fuel with research and development aimed at greater ash tolerance.

The amount of residues available from processing logs varies depending on factors such as log size, timber species, lumber dimensions, moisture content, and processing machinery. Typically, 5 to 10% of the original material is available for pellet fuel conversion. The raw materials may be received at the pellet processing plant as residues from kiln dried lumber or as residues from freshly processed (green) wood in which the weight of moisture may exceed the dry material weight. Heating, or caloric, value of finished pellets ranges from 7,000 to over 9,000 Btu (British thermal units) per pound (at 5% moisture), with resinous species (such as pines and fir) having slightly higher gross caloric values than non-resinous species (hardwoods) and bark. Average Btu content of pellets as received by the consumer is 8,300 Btu per pound at 5% moisture.

Softwoods, hardwoods, and blends of different species are used as raw materials and known as feed stock. Where hardwoods are generally the preferred species for cordwood appliances because of their higher Btu content and lower emissions, pellets from softwoods generally have slightly higher caloric value and lower ash content than pellets produced from hardwoods, particularly hardwoods containing bark. Resins in softwoods that are more difficult to burn in a cordwood appliance are not a problem in pellet appliances, which regulate the air for combustion and provide precise, gradual fuel feed in small amounts.

Raw material particle size ranges from fine sawdust to large chips that must be ground to uniform size. Careful handling of raw materials before the pelletizing process is important in reducing unwanted foreign materials.

## 1.2 MANUFACTURING PROCESS



The production of pellet fuel begins with the raw materials, or feed stock. Contaminants must be removed by using magnets to remove iron and classifiers to remove stones and non-magnetic metals. Classifiers, also known as scalpers, are devices which employ air flow to move and separate the lighter wood particles from heavier unwanted materials. Storage facilities and methods for managing feed stock materials are determined by the moisture content of the materials; dry materials must be protected from the elements, and green materials must be processed in timely fashion to prevent microbiological deterioration. After storage, feed stock is pulverized and screened into small uniform pieces by hammer mills and grinders and conveyed to holding bins or silos. A cyclone process of swirling air collects the lighter fines, or dust, for use as dryer fuel.

In the case of green materials, the next step is the drying process. The most commonly used type of dryer is the rotary dryer, a large revolving drum (some more than 10 feet in diameter and 40 feet long) which continually lifts and tumbles the material through a hot gas stream. The drying process is regulated by a variable rate feed screw and by control instruments which measure and match heat input to demand. Uniform moisture is also achieved by the larger, wetter, heavier particles moving more slowly through the drum than finer, drier, lighter particles. Dryers are often fired by using a portion (about 8 to 10%) of the feed stock, mainly the fines, or smallest particles (also known as wood flour). The drying process generally reduces incoming moisture content (wet basis, see following) of 40-45% to 6-10%.

## MOISTURE CONTENT

Fuel moisture content has a dramatic effect on efficiency: wood at 50% moisture has a heating value of 4,000 Btu/lb., at 20% the heating value is 6,200 Btu/lb., and oven dry wood delivers up to 8,600 Btu/lb. One of the advantages of pellet fuel is its high Btu content (about 8,000 Btu/lb.) and consistently low moisture content, usually between 6-10%, calculated on the wet basis.

Because there are two methods for determining wood moisture content (M.C.), the wet basis and the dry basis, the concept can be confusing. The pellet fuel industry universally uses the wet basis when describing residential pellet feedstock and fuel. The dry basis is used primarily in labs and technical situations. The following M.C. calculations demonstrate the difference in the two methods.

In the dry basis, the wood is weighed wet, then dried to an oven dried condition. The oven-dried weight is subtracted from the wet wood weight to determine the weight of the lost water. Moisture content is then calculated by dividing the weight of the water by the weight of the oven dry wood. In the wet basis, the weight of the water is divided by the weight of the wet wood.

**Example:** A quantity of wood weighs 10 pounds. It is dried to oven-dry condition, and then it weighs 8 pounds. What is its wet basis M.C.?

Weight of the wet wood (10 lbs.) - weight of the oven dried wood (8 lbs.) = weight of the water (2 lbs.)

$$\frac{\text{Weight of water} \quad (2)}{\text{Weight of wet wood} \quad (10)} = .20 \text{ M.C. (Wet Basis)}$$

The dry basis used in labs follows the same procedure but divides the weight of the water by the weight of the dried wood.

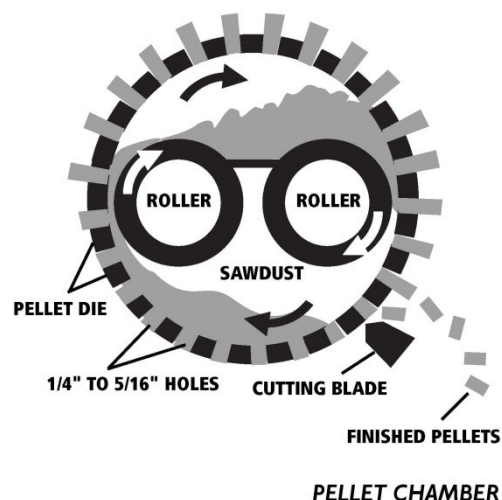
Weight of wet wood minus weight of dried wood = weight of water

10 - 8 = 2 (pounds of water).

$$\frac{\text{Weight of water} \quad (2)}{\text{Weight of dried wood} \quad (8)} = .25 \text{ M.C. (Dry Basis)}$$

The dry basis moisture content is thus 25%, while the wet basis moisture content of this same quantity of wood is 20%. Customers are more likely to understand and relate to wet basis percentages since dry basis figures can exceed 100%. Pellet industry standards use the wet basis.

The dried materials are conveyed to the conditioning chamber where steam may be added to lubricate the materials and to help soften the natural lignens that act as a bonding agent to hold the pellets together. The materials (feedstock) go next to the pelleting chamber where they are extruded, or pressed, through thousands of 1/4 to 5/16" diameter holes in a steel die 1.5 to 3.5 inches thick. This extrusion process heats the newly formed pellets to temperatures approaching 250° F. The hot, still soft pellets are conveyed to a cooler to achieve room temperatures and hardening. Dust and loose fines are shaken off and recycled as the pellets proceed to be bagged.



## 2. FUEL STANDARDS

The importance of consistent fuel and quality controls became apparent in the early years of residential pellet appliances. Fuel characteristics are crucial factors in appliance performance and maintenance. The Fiber Fuels Institute (FFI) and the Association of Pellet Fuel Industries (APFI) adopted national standards recognizing acceptable criteria for these characteristics in 1991. FFI and APFI have now merged into one association, the Pellet Fuel Institute (PFI). Voluntary fuel quality certification is the responsibility of the pellet manufacturer. Not all pellet fuels carry the voluntary PFI guaranteed analysis, even though some packaging may be marked "Premium." End users may have to rely on experienced retailers in choosing appropriate fuel.

### 2.1 CRITERIA

PFI standards establish two grades of fuel, Premium and Standard. The following chart indicates that the only difference between the two grades is inorganic ash content. Table 1 outlines the fuel grade standards. However, each of the six criteria is important, because understanding them clarifies appliance performance and maintenance.

**TABLE I. PFI PELLETT FUEL STANDARDS**

<i>Criteria</i>	<i>Premium Grade</i>	<i>Standard Grade</i>
<i>1. Bulk density/cu. ft.</i>	<i>Not less than 40 lbs.</i>	<i>Not less than 40 lbs.</i>
<i>2. Dimensions</i>	<i>Diameter 1/4-5/16"</i>	<i>Diameter 1/4-5/16"</i>
<i>3. Fines</i>	<i>Not more than .5% by weight shall pass 1/8" screen</i>	<i>Not more than .5% by weight shall pass 1/8" screen</i>
<i>4. Sodium (salts)</i>	<i>Less than 300 parts per million</i>	<i>Less than 300 parts per million</i>
<i>5. Inorganic ash</i>	<i>Less than 1%</i>	<i>Less than 3%</i>
<i>6. Length</i>	<i>Maximum 1 1/2"</i>	<i>Maximum 1 1/2"</i>

Understanding the rationale for each of the criteria begins the process of understanding appliance performance and maintenance.

#### 2.1.1 DENSITY

The density, or weight per cubic foot, reflects the amount of solid material packed into the pellet and therefore has a relationship to the heat content of the fuel. In the same number of auger turns, higher density fuel delivers more Btu content than a low density fuel. Additionally, lower density fuel burns faster and may affect low burn settings. Wide variations can require appliance adjustment, particularly in the case of excessively low density fuel which could cause the fire to go out. Density is also important as a gauge that adequate pressure and bonding have produced hard pellets that can withstand shipping and handling.

#### 2.1.2 DIMENSIONS

Pellet diameter is another factor that affects stove performance. The 1/4-5/16 inch standard reflects the common die size for residential fuel in the Americas. Industrial pellets can range as large as 1/2" in diameter and are unacceptable in residential appliances. The most common size for residential appliances is 1/4"; in fact, some appliance manufacturers report problems with some varieties of 5/16" pellets. Apparently, unusually hard pellets of this size may not cut easily when caught between parts of the feeding mechanism and may cause feeding jams. It is therefore important to

know whether an appliance manufacturer specifies the size of pellets to be used in a specific appliance.

### **2.1.3 FINES**

Fines are the smallest, dust-like particles produced in the pelleting process. They also occur in breakdown during shipping and handling. The production standard is intended to assure hard pellets that withstand handling. Excessive fines represent loss of usable fuel and cause performance and maintenance problems. They are also a source of irritation for appliance owners when the dust escapes into the home during pouring from the bag into the hopper. The fines are less likely to burn because they are easily blown away from the flame by combustion air. Fines cause performance problems, including loss of fuel feeding if they build up on the sides of the hopper and reduce the opening size to the fuel delivery system. Additionally, fines can increase the need for maintenance by filling ash traps prematurely and by jamming augers.

### **2.1.4 SODIUM**

The presence of excessive salt, specifically water soluble inorganic sodium, can cause severe damage from corrosion in appliances and venting systems. The sources of salt contamination include logs that have been floated in salt water, plywood, and particleboard. Manufacturers now test to ASTM E776, standard for sodium extraction. Additionally, the presence of trace amounts of alkaline salts can increase clinkering, due to a reduced ash melting point for silica.

### **2.1.5 INORGANIC ASH**

Ash is the term for the various noncombustible minerals that remain after combustion. Ash content is the basis for determining fuel grade since all other criteria are identical for both premium and standard grade. Later discussion of appliance design and maintenance requirements will indicate clearly how crucial this fuel characteristic is. On one hand, fused ash, or clinkers (see discussion under 3.1.1 Combustion below), can block combustion air inlets and affect performance adversely. On the other, fly ash that is blown from the fire chamber can accumulate on heat exchangers and in the venting system with problematic results. Simply put, ash content is the main factor determining the frequency of appliance maintenance. In some appliances, that frequency can make the use of higher ash fuels impractical. Predictions of premium quality low ash fuel shortages are consequently a growing concern that appliance manufacturers are addressing in appliance design.

Appliance sensitivity to ash content varies with design, venting system design, and recommended maintenance frequency. Even within the allowed 1% ash content of premium grade pellets, there are noticeable performance variations in some appliances. Changing from a .25% ash content fuel to a .75% ash content fuel can cause troublesome performance and maintenance in some appliances. Manufacturer's fuel recommendations and individual ongoing experience with locally used fuels are important for appliance adjustment and customer satisfaction. Some biomass and corn burning appliances have been introduced to deal with the 1-3% ash produced from these fuels. A fuel stirring/aeration device may be incorporated to mix the ash with the fuel and to increase fuel efficiency.

### **2.1.6 LENGTH**

Excessively long pellets can cause bridging, the condition of pellets getting stuck across the fuel delivery entrance of the hopper. The effect is that of a log jam, with fuel unable to feed past the blockage. Long pellets may also cause auger jams. Finally, long pellets deliver inconsistent amounts of fuel. Dramatic variations in fuel feed rates in turn causes performance problems since combustion air settings deliver a volume of air based on expectations of consistent amounts of fuel. PFI standards call for maximum pellet length of 1 1/2 inches. In spite of this standard, some appliances will bridge with this length pellet and can be difficult to diagnose. The appliance manufacturer should be consulted regarding their recommendations for maximum pellet length.

## 2.2 LABELING

PFI Fuel Standards recommend that manufacturers identify their product with a guaranteed analysis and parameters included in the label (example below).

<b>GUARANTEED ANALYSIS</b>	
<i>Grade:</i>	xxx
<i>Type of Material:</i>	xxx
<i>Ash:</i>	x%
<i>Fines:</i>	x%
<i>Chlorides:</i>	x ppm

## 3. EFFECTS ON PERFORMANCE AND MAINTENANCE

When compared to cordwood on a one to one basis, pellets offer some distinct advantages. Pellets are more consistent and predictable in moisture and BTU content. They are more compact, so they require less storage space. They are cleaner, easier to handle, and they burn cleaner. However, these characteristics have to be put into the perspective of the appliances they burn in to have real meaning. Pellet fuels narrow the wide variables of cordwood fuels, but pellet appliances, as mechanical, electrical based systems, also have a narrower range of fuel tolerance than wood stoves. Understanding the effects of fuel characteristics in pellet appliances is essential for optimum performance, adequate maintenance, and overall customer satisfaction.

### 3.1 PERFORMANCE

As will be discussed later, different appliance designs have different fuel requirements and tolerances. For now, we can look broadly at some effects of using unsuitable or impure fuel.

#### 3.1.1 COMBUSTION

A direct effect of fuel quality on combustion that is not included in the PFI Standards is silica content. Silica is essentially sand or dirt that is naturally in the bark of the tree or that enters the feed stock in the handling process. In the combustion process, silica is heated to fusion temperatures, melts, and solidifies as it is cooled. The result is clinkers, solid chunks of lava like material. The effect on combustion occurs if the clinkers stay in the grate area and block incoming combustion air.

Analysis of silica content is impractical because of the variations in growing conditions and because of the significant effect on fusion temperatures of small amounts of trace elements. The normal melting point of silica, 2,700° F., is reduced to 1,500° F. in the presence of minute amounts (1/4%) of alkaline salts (sodium chloride or potassium chloride). This reduction in the melting point promotes ash fusion at lower temperatures and increases clinkering. Combustion temperatures in the burn pot/grate area vary widely with appliance design, so fuel with silica may cause clinkering problems in a stove with high combustion chamber temperatures and not in another appliance that operates with lower temperatures.

Ash content has indirect effects on combustion. Excessive ash content, if not maintained properly, can restrict or block burn pot air holes and/or the venting system and result in poor combustion due to inadequate combustion air.

Improper pellet density can also have a direct effect on combustion by causing an abnormal feed rate. Low density pellets may feed too little combustible fuel and may cause the fire to go out, while excessively high density pellets can be difficult to start in automatic ignition appliances or they can

overfeed the stove, causing high temperatures or smothering the fire. Most appliances now have simple adjustment mechanisms to overcome these difficulties. Proper adjustment of fuel to air settings for the particular fuel must be made for maximum performance as the appliance owner changes the fuel source to one with different density.

Bridging and blockage or auger jamming caused by unsuitable pellet diameter or length, or by excessive fines, indirectly affects combustion by depriving the combustion chamber of fuel.

### **3.1.2 HEAT TRANSFER**

Fly ash gradually builds up on heat exchanger tubes or fins. The coating of ash acts as an insulator and prevents proper transfer of heat to the convection air passing through the tubes into the home. The frequency of cleaning heat exchangers is determined in large part by the ash content of the fuel.






### **3.1.3 MECHANICS**

High ash and fines content can build up on impellers and affect blower motor durability. Jamming from excessive fines or improper pellet size can affect auger durability.

## **3.2 MAINTENANCE**

Using a fuel that is not suited for a particular appliance increases the frequency of maintenance. Clinkers from high silica content fuel (or from lowered ash fusion temperatures brought about by the presence of alkaline salts) must be removed before they block combustion air, affect performance, or cause other maintenance needs. High ash and/or fines in fuel necessitate more frequent cleaning of the burn pot/grate, ash storage areas, heat exchangers and venting system. The systems and components of pellet appliances are interdependent and sensitive to proper maintenance. Simple maintenance tasks, left unattended, can become a need for total system maintenance as well as a source of owner frustration. The frequency of component replacement is also increased by the lack of regular, properly performed maintenance.

## **4. SUMMARY**

-  Residential pellet fuel is recovered biomass products processed to be of uniform size, density, moisture content, and ash content.
-  Feed stock is separated from unwanted contaminants, pulverized into small pieces, dried, compressed, cooled, and bagged in the pellet manufacturing process.
-  PFI standards for density, dimensions, fines, sodium and ash are voluntarily complied with by pellet manufacturers. Recommended labeling includes an analysis of these factors.
-  Ash content, the primary maintenance factor, is the only difference in composition between standard (up to 3%) and premium (less than 1%) grades of fuel in PFI standards.
-  The fuel quality standards include characteristics that affect performance, maintenance, durability, and customer satisfaction. Another factor not included in the standards is silica content, the primary cause of clinkering.





