

CHIMNEY MAINTENANCE AND SAFETY

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Masonry Chimneys

- Normally site built of various materials such as brick, concrete blocks, stone, precast materials or some combination
- Masonry chimneys require a liner to meet modern codes and standards



Masonry Chimneys

Chimney walls must surround the flue liner.

The wall thickness varies with the material used.

Solid brick or concrete requires 4" nominal thickness.

Stone requires 12" thickness

Nominal dimensions are permitted to vary from actual by no more than 1/2."

Masonry Chimneys



- Terra Cotta flue tiles are made from an extruded clay product and baked for strength at about 1800 degrees Fahrenheit
- Tiles are stacked and should be secured with non-water soluble refractory cement. Airspace is required from the interior of the chimney wall, except for seismic areas.
- Shapes include square, rectangular, round and oval

Masonry Chimneys

If the flue liner in a chimney has softened, cracked, or otherwise deteriorated so that it no longer has the continued ability to contain the products of combustion (i.e., heat, moisture, creosote, and flue gases), the liner shall either be removed and replaced, repaired, or relined with a listed liner system or other approved material that will resist corrosion, softening or cracking from flue gases at temperatures appropriate to the class of chimney service.

NFPA 211 2019 14.9

Masonry Chimneys

Flue tiles may crack when subjected to a rapid temperature rise or fall (as a result of thermal shock).

Chimney fire temperatures can easily exceed 2,000° F.



Factory Built Wood Stove Chimneys

- Wood stoves manufacturers mandate a chimney tested to the UL103HT standard.
- These may be double wall or triple wall insulated pipe
- The inner wall will be stainless steel and the outer wall may be galvanized or stainless steel



Connector Pipe

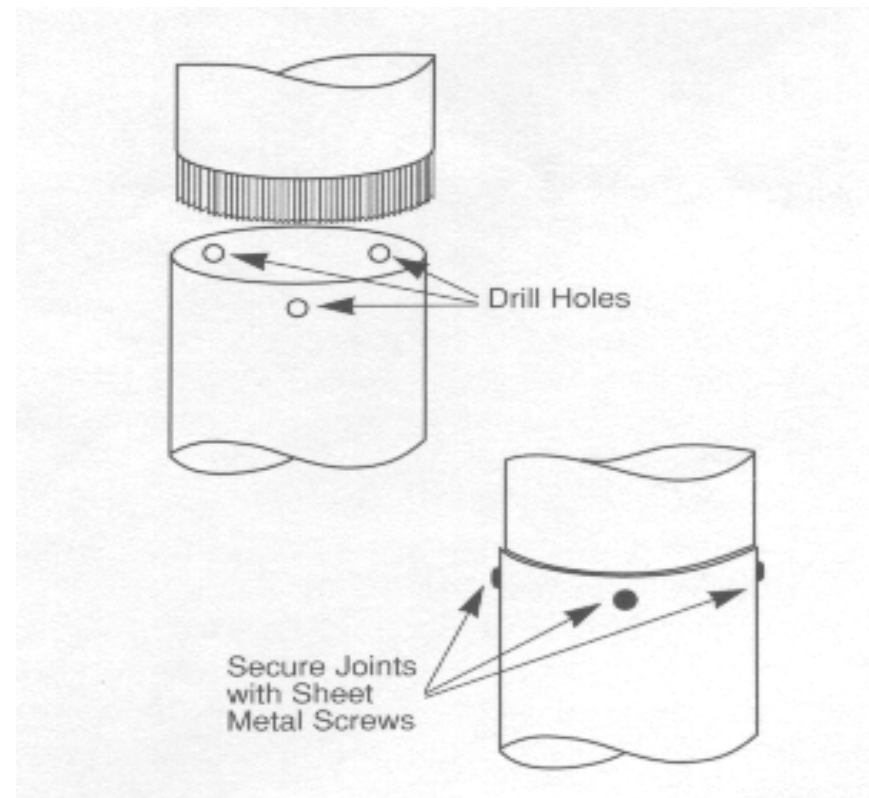


- Connector pipe is normally painted black or enameled
- It may be single or double wall. Single wall pipe is 24 gauge or thicker
- Single wall pipe will have a snap lock assembly or a welded seam

Connector Pipe

All stove pipe should be secured with at least three screws at each joint an equidistant apart. This prevents the pipe from shifting or disconnecting.

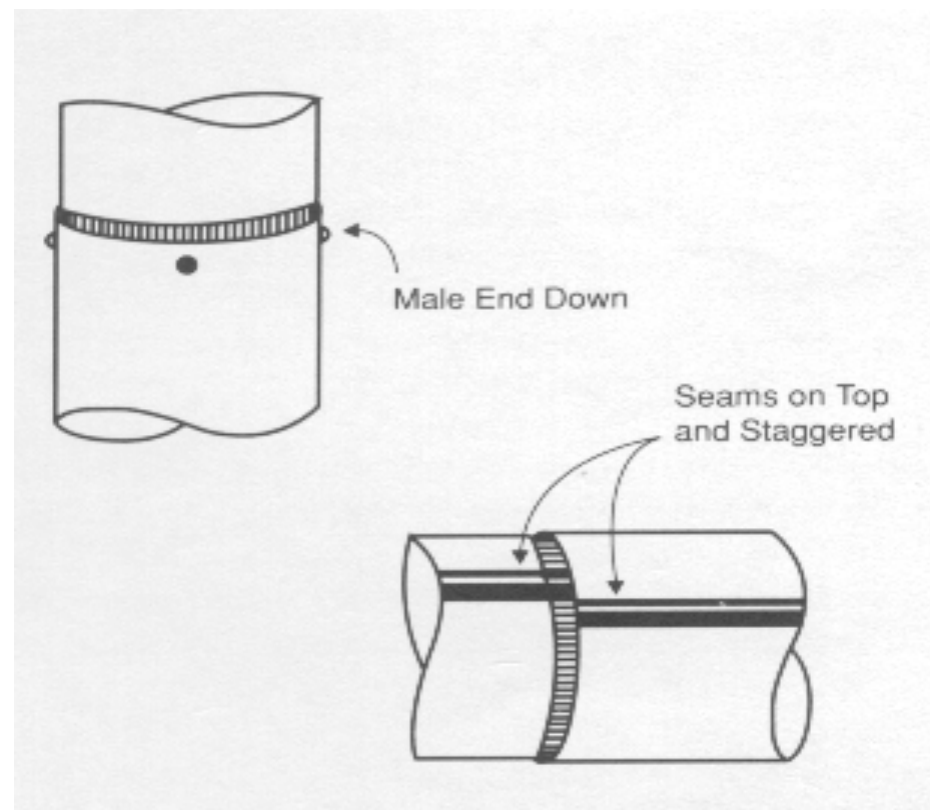
Connector pipes should extend through the flue tile and be flush with the inner wall of the flue tile



Connector Pipe

Connectors should be installed with the male end down (pointing toward appliance) of solid fuel appliances.

Horizontal connectors should be installed with pipe seams on top.



Connector Pipe

- Single wall pipe must be 18 inches from combustibles unless clearance reduction measures are in place.
- Double wall connector pipe is used to reduce clearances to combustibles typically, to 6 inches. Follow manufacturer instructions as the clearance requirements can vary.



Clearances

- Proper clearances between connector pipes and chimneys and combustibles are a key component of proper installations.
- There are two sources to determine proper combustibles
 - Codes and standards
 - Manufacturer's installation instructions

Clearances

- Manufacturer installation instructions
 - Clearances are determined by operating the appliance or chimney and measuring temperatures on surrounding surfaces.
 - Temperatures are measured in 40-200 places in a normal test depending on they type of testing being performed.
 - Wood burning appliances and vents must also pass a flash test at 2100 degrees which replicates a severe over fire situation for an appliance or chimney fire for a venting system

Clearances



- Manufacturer's clearance guidance is found in the installation instructions and on a data plate attached to the appliance

Clearances

- Combustibles are defined as materials likely to catch fire. Other than metal or masonry, construction materials are universally combustible
- Covering a combustible surface with masonry or metal does not render the combustible non combustible.
- Masonry materials in contact with combustibles will absorb heat and transfer heat to the combustible creating an area of high heat and low air movement

Clearances

- For a material to be considered non-combustible it must be made entirely of a non-combustible material. For example fire rated sheet rock is considered a combustible

Clearances

- Why are clearances important. One word
- **PYROLYSIS:** The decomposition of combustibles brought about by high heat

Clearances

- Ignition temperatures

- Wood

- Depending on species wood ignites at 400 to 480 degrees Fahrenheit.

- Wood that has been pyrolyzed will ignite at a lower temperature

- Pyrolyzed wood can ignite as low as 200 degrees Fahrenheit

Clearances

- Temperatures in excess of 212 degrees Fahrenheit start pyrolysis
 - Chemical bonds break down
 - Weight loss occurs in the wood
 - Water vapor driven off
 - Char starts to form

Clearances

- Cheating just a little on clearances will cause problems, the temperatures allowed in testing approach the point where pyrolysis occurs. There is no fudge factor built in
- Clearance reduction methods for unlisted appliances and connectors are listed in NFPA 211, unlisted appliances with clearance reduction in place can not be less than 12 inches from a combustible and single wall connector can not be closer than 6 inches to a wall with clearance reduction in place

Clearances

- This is an example of what can happen when combustible framing is placed in contact with a masonry chimney



Clearances



- Here is an example of a framing member that was hidden behind a brick wall
- The pyrolysis is due to inadequate clearances to the connector pipe

Clearances

- In this instance wood was placed directly under tile to create a stove board. Pyrolysis was the result



Draft

Draft can be defined as the measure of force which causes gases to move up and out of the chimney and air to be drawn into appliance.

Two major factors influence draft:

1. The difference between the average flue gas temperature and the temperature of the outside air.
2. The height of the chimney.

Temperature Difference

- Warmer flue gases have greater buoyancy than cooler gases
- Warmer, less dense gases rise and are replaced by cooler, heavier gases
- These rising gases create a vacuum at the appliance and combustion air is drawn into the combustion chamber

Temperature Difference

- The greater the temperature difference between the gases inside the flue and the air outside the chimney, the greater the draft will be and air will be drawn more forcefully into the system.

Chimney Height

Taller chimneys contain a taller column of warm, rising gas which increases draft.

The height is the critical factor, not the volume or movement of the gases.

Measuring Draft

Chimney draft is measured in inches of water column.

Good draft would be represented by a negative number because the pressure in the chimney is less than the surrounding atmosphere.

Lower negative numbers represent greater draft.

Measuring Draft

- Older technology utilized U-tube manometers or analog manometers to measure draft
- Technicians now use digital manometers to measure draft



Flow Capacity

Flow is the volume of flue gases which actually move through the venting system as a result of draft.

Three factors which influence flow capacity are:

1. Draft
2. Amount of resistance to flow
3. Size of venting passageways

Resistance to Flow

Friction always exists between moving gases and the flue walls.

Variables affecting friction – or resistance to flow – include:

- Bends & turns in venting system

- Changes in size or shape

- Surface irregularities (mortar protrusions, etc.)

- Appliance air inlet settings



Wood

- Wood burning appliances have the potential for very high flue temperatures and creosote build-up
- Operator burning habits have more influence on appliance performance and creosote build up than wood type.



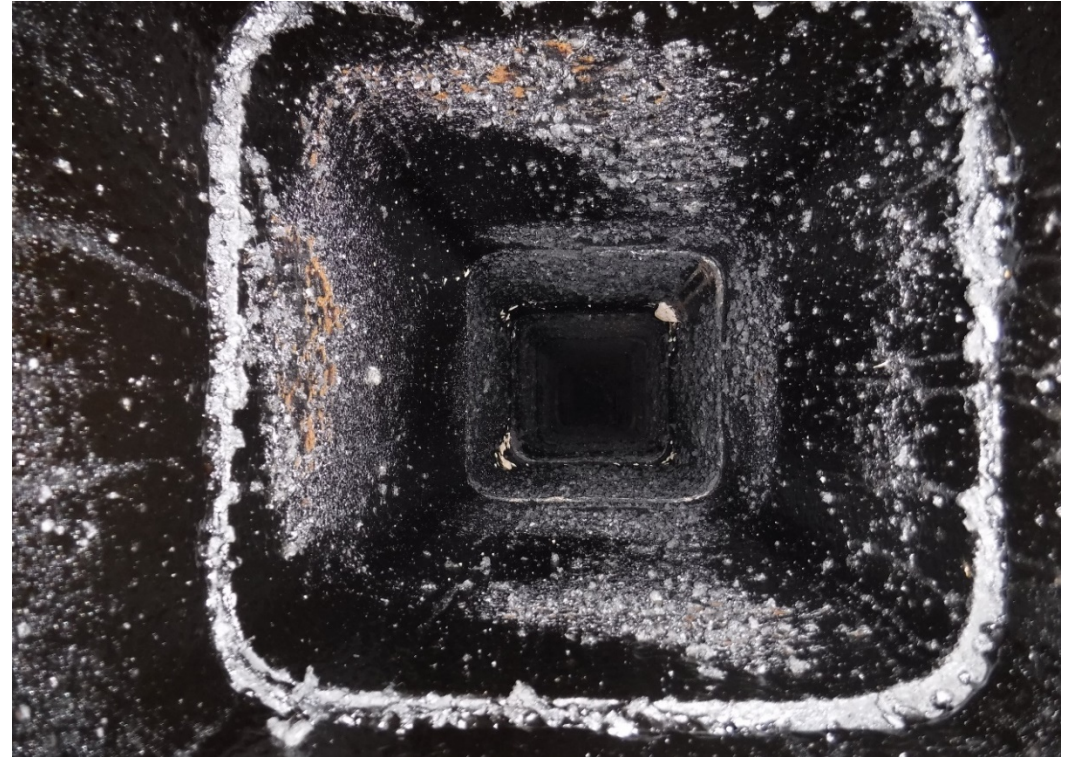
Wood

- Ideally wood should have a moisture content between 15 and 25 percent
- An important diagnostic tool is a moisture meter.



Wood

- Heat used to dry wet wood wastes BTUs that could be available for heating.
- Wet wood causes a cooler fire and cooler flue gases which promote creosote formation



Wood



- Flue gas thermometers are critical to maintaining efficient burning and reducing creosote formation.
- Proper flue sizing and operation of the appliance are also important to reducing creosote formation

Troubleshooting

- A chimney must perform three functions
 - Safely exhaust the products of combustion to the outside
 - Protect surrounding combustibles from the heat of exhaust gases
 - Draw oxygen into the appliance to sustain combustion

Troubleshooting

- When troubleshooting follow a basic three step process
 - Gather information on the symptoms of the problem
 - Make a tentative diagnosis and test if possible
 - Specify effective solutions or refer the home owner to an expert to provide solutions

Troubleshooting

- Start gathering information Some questions that may need to be answered:
 - Is the problem intermittent or constant?
 - When does the problem occur?
 - Is the problem worsening or does the severity vary?
 - Are there any consistent circumstances that are related to the problem?
 - What solutions have been attempted thus far?

Troubleshooting

- If it can be done without undue risk light the appliance and replicate the problem, make a diagnosis and attempt a trial solution
- Try one solution at a time
- Try cheapest and easiest solutions first
- Be aware multiple problems may exist on any system

Troubleshooting

- Draft is an important element of chimney performance
- Draft is expressed in negative numbers as it is a suction
- Draft must be sufficient to overcome negative pressure in the home



Troubleshooting

- Troubleshooting wood and coal appliances can be challenging as several factors may be in play that add up to a problem. Some things to investigate:
 - Chimney height
 - Vent design
 - Negative pressure in the home
 - Fuel choices
 - Burning habits
 - Wind
- Remember the house will function as a system

Troubleshooting



- Quality of firewood is often a primary issue with wood burning appliances
- A moisture meter is an important tool to determine wood moisture content. It is necessary to split the wood to obtain an accurate reading
- Wood should be between 15 and 25 percent moisture content

Troubleshooting

- Check the homeowners wood storage
- Wood should be split and under a cover but open on the sides for air flow
- The EPA has a good website with materials related to proper wood cutting and storage, **epa.gov/burnwise**



Wood

- All wood contains the same number of BTUs per pound.
- A cord of hardwood will weigh considerably more than a cord of softwood and will contain more BTUs per given volume
- Wood stove operators can easily manage heat output by using different types and amounts of wood for the desired result

Wood



- Flue gas thermometers are critical to maintaining efficient burning and reducing creosote formation.
- Proper flue sizing and operation of the appliance are also important to reducing creosote formation

Troubleshooting

- Wind may cause smoke and flue gases to be forced from the chimney into the home
- Wind induced issues are typically sporadic and occur under specific circumstances
- The issue may be caused by high pressure at the termination or wind blowing down the flue

Troubleshooting

- Barriers downwind from the chimney may cause wind to “pile up” and create a high pressure zone at the top of the chimney
- Barriers upwind may create turbulence which blows down the chimney
- Raising the chimney height may put it above the problem area
- Specially designed chimney caps are available to combat wind problems



Troubleshooting

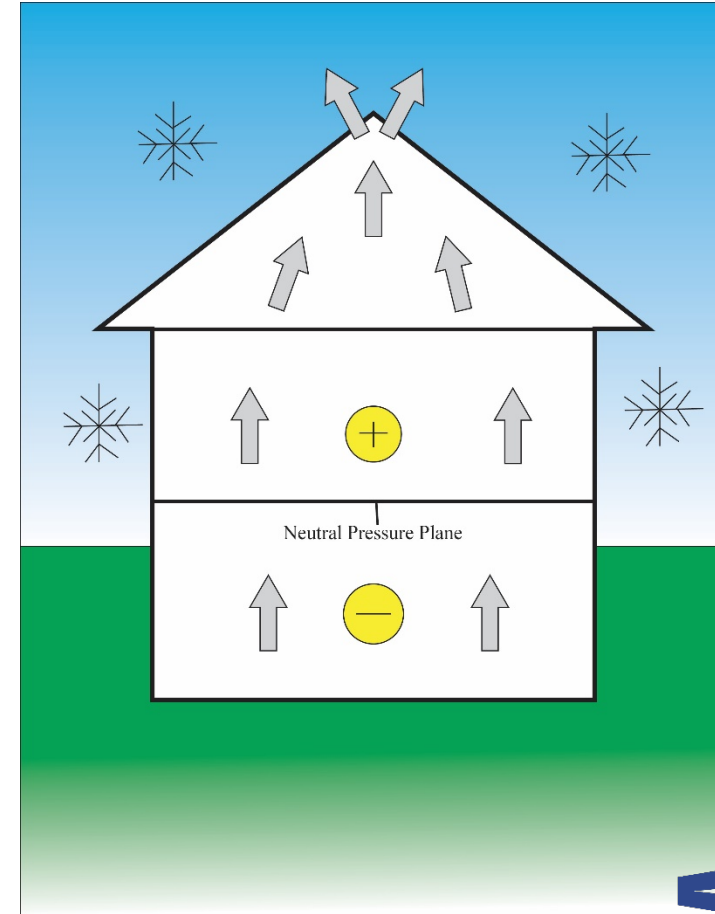
- Negative pressure in homes is an ever increasing issue
- Negative pressure has two basic causes in a home
 - Mechanical systems that exhaust air from the home
 - Stack effect

Troubleshooting

- As homes are sealed tighter to aid in energy efficiency, it becomes more difficult for natural draft appliances to function
- Exhaust devices such as clothes dryers, attic fans, kitchen range hoods and central vacuum systems all exhaust air from the home. When a home is tight often the easiest way for replacement air to enter the home is down the flue
- Natural draft appliances will lose when competing with mechanical systems

Troubleshooting

- Stack effect is caused when heated air rises and leaves the home
- The home functions as a chimney and the taller the home the greater the stack effect
- Pressure will change throughout levels in the home

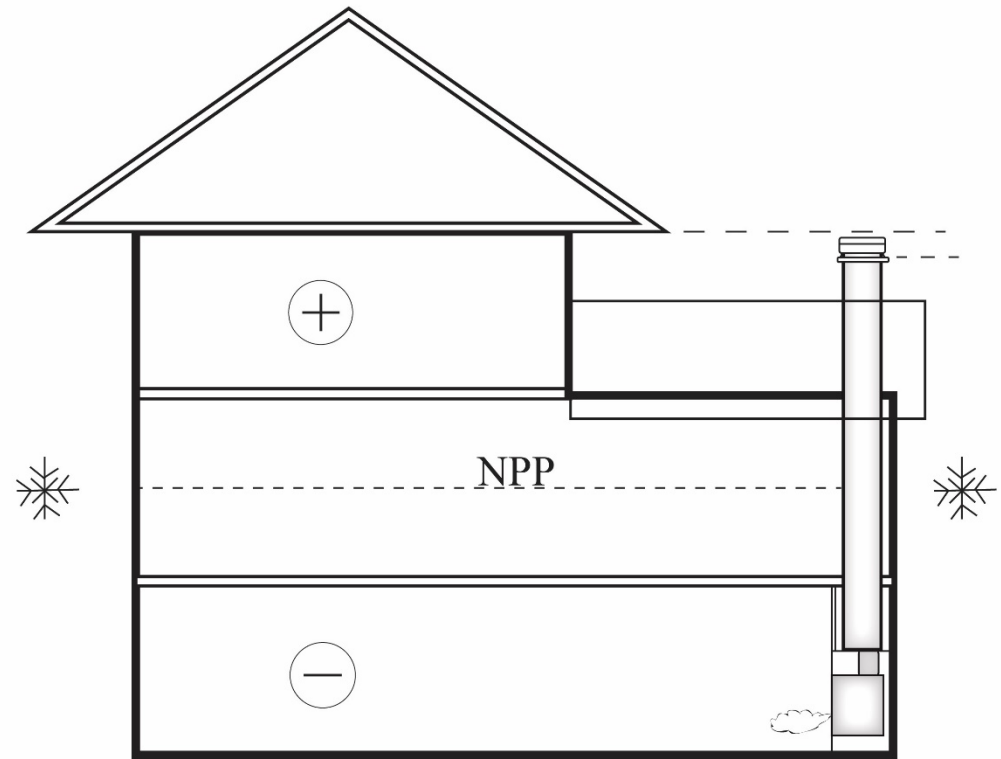


Troubleshooting

- External chimneys are more prone to issues as they cool, internal chimneys being warmer are more resistant to problems
- Stack effect can not be eliminated but it's effects can be minimized or eliminated by sealing leaks at upper levels
- Other appliances operating in the home may overpower an appliance at a lower level causing spillage or back drafting

Troubleshooting

- Raising the chimney to a height above the building envelope will often allow the appliance to vent
- Chimneys should be a minimum of 24 inches taller than anything within 10 feet and a minimum of 36 inches taller than the roof penetration
- Leaky duct work may affect pressure levels in the home in a way unrelated to stack effect
- Operating exhaust fans will exacerbate pressure issues



Troubleshooting

- Air leaks in the flue, such as missing mortar joints, allows air to enter inhibiting draft and cooling flue gases



Troubleshooting

- Wood stoves and inserts that meet EPA guidelines are sensitive to insufficient draft and low flue gas temperatures due to their clean burning design and sometimes intricate smoke flow patterns.
- As a general rule of thumb 15 feet is the minimum vertical chimney height for proper operation though some require more height
- Connector pipes should be as straight and short as possible

Troubleshooting

- Inadequate flue temperatures are caused by:
 - Wet wood, a large amount of BTUs are devoted to drying the wood to burn
 - Oversized flues allowing slowing of gases and cooling
 - Long runs of connector pipe
 - Operator error choking the air supply off
 - Uninsulated liners
 - Offsets in the flue slowing flue gases
 - Stove design extracting a high percentage of the heat which is good for heating the home but delivers lower flue temperatures

Troubleshooting

- Complaints of low heat output can be caused by several things
 - Newer EPA stoves operate differently than older models and produce the same heat with less wood
 - Moisture content of the wood
 - Improper setting of the air control
 - Too little or too much draft
 - Published brochures listing the area an appliance will heat can be misleading. Several factors influence the area heated
 - Regional climate differences
 - Ceiling heights and volume of windows
 - Insulation levels
 - Consumer expectations

Troubleshooting

- Several factors can make a fire difficult to start
 - Using insufficient kindling to warm the flue and establish draft
 - Failure to open the air controls sufficiently
 - Primary air channels are blocked or plugged
 - Moist or rotted wood
 - Cold chimneys outside the building envelope that are difficult to warm
 - Improper chimney design

QUESTIONS?

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