
Fireplace Makeup Air Strategies - Smith Residence

Outline

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Summary

The Smith residence is a Colonial style Manor House built with modern materials and airtight construction techniques. The main building has 10 open fireplaces. These can be considered as exhaust appliances. The fireplaces with the largest flue sizes will have the highest flows, on the order of 1500 cfm each.

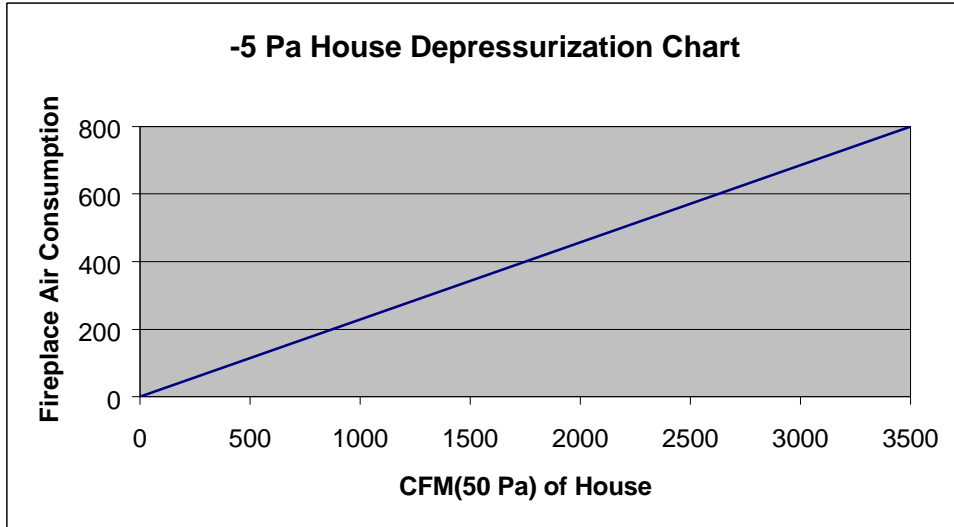
The building will not have the natural leakage (infiltration) of a historical building to provide makeup air to the fireplaces. Without makeup air, the exhaust flows from the fireplaces will depressurize the building. Testing has shown that a standard open fireplace will produce combustion products spillage (smoking) if the room pressure drops below -5 Pa (-0.00072 PSI or -0.20 inches H₂O). Therefore, makeup air is required.

Recommended Makeup Air Strategies

An accepted design guideline for the proper functioning of open fireplaces is that the average velocity of the air stream across the face should be 36 - 48 FPM to ensure smoke free operation. Using 36 FPM as a guideline, below is a summary of the required airflows for each fireplace:

	FP Opening/flue	CFM room air
Lower Level		
Manor Hse	5'8x5'/24x24	1020
1st Floor		
Manor Hse	5'8x5'/24x24	1020
	4'x3'4'/(3)16x16 (3)	1439
Kitchen	8'8x5'6'/(2)20x24	1715
Guest	3'x2'8'/16x16	288
	3'x2'8'/18x12	288
Cabana	4'x3'4'/16x16	480
	4'x3'4'/16x16	480
2nd Floor		
Manor Hse	4'x3'4'/16x16	480
	4'x3'4'/16x16	480
Kitchen	1'x1'4'/8x8	48
Guest	3'x2'8'/18x12	288

The required air flow for each fireplace equals infiltration plus makeup air. The chart below relates the airtightness of the house to the exhausts flow that will produce -5 Pa depressurization. CFM(50 Pa) is obtained from a blower door test.



Without a blower door test of the finished structure, infiltration is an unknown quantity. Assuming an airtight structure, the makeup air should therefore be sized equal to the required fireplace air flows.

Alternatively, the Canadian “R-2000 Makeup Air Guidelines” procedure can be used. It assumes that all rooms communicate. Without blower door test data, it assumes a “Normalized Leakage Area (NLA)” of 0.05 cm²/m² for ordinary airtight R-2000 construction. Next, the NLA is used to calculate an Equivalent Leakage Area (ELA) based on the total envelope area of the house.

If passive openings are used for makeup air, only 5 Pa of driving pressure is available from the fireplaces. The table below relates the duct size, length, and flow:

Duct dia inches	Duct length feet	CFM Flow At -5 Pa
4	20	15
12	20	828
12	60	478
19	20	2732
19	60	1577

A further complication from passive openings is that they can be adversely affected by wind. Therefore, a powered air supply, or air supplies, are required.

Air Outlet Locations

The flows required are too large to be introduced into the firebox directly, or through a grill in front of the firebox. This is due to the jetting action at the outlets, which will interfere with the normal gas flow in the fireplace and could cause smoke spillage. Therefore, a main design issue is the location of the makeup air outlets.

To prevent cold drafts, the makeup air should be preheated. With preheated makeup air, the location in the room is unimportant in terms of fireplace performance. The air outlet can be located wherever it makes the most sense aesthetically and practically.

Assumptions About Fireplace Usage

Each fireplace that is located in a room with a door should have its own makeup air supply, unless it can be assumed that the fireplace will only be operated with the room door open.

Four of the fireplaces on the first floor share a common air volume. If it is assumed that only one fireplace will be operated at a time, then a common makeup air supply for all four fireplace could be used, sized to the largest fireplace. If this assumption cannot be made, then each fireplace should have its own makeup air supply. Note that all four air supplies could have a common outlet, however.

Recommended Makeup Air Supply

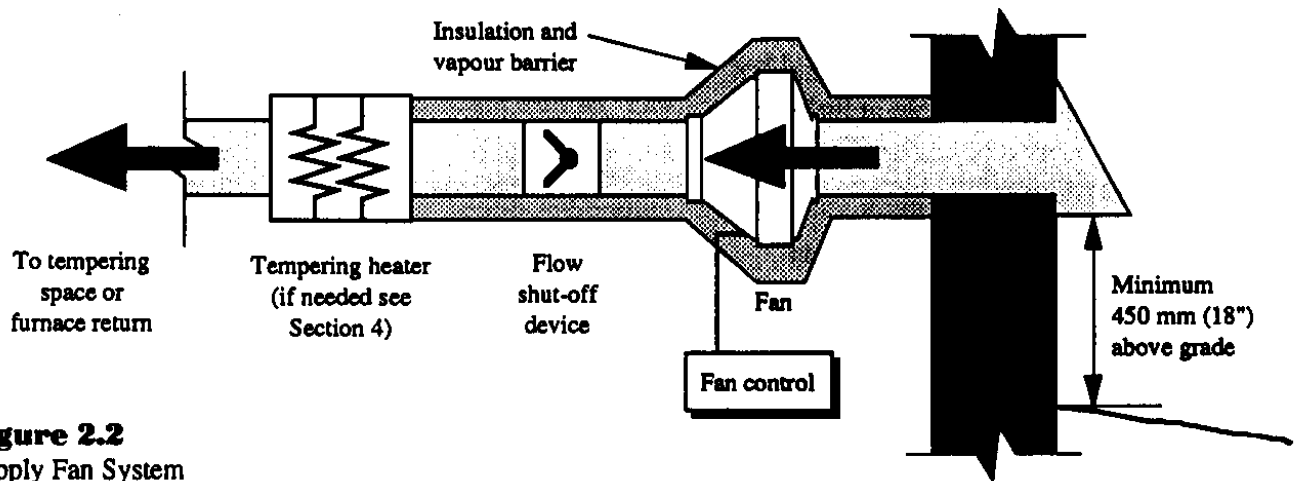


Figure 2.2
Supply Fan System

Controls

There should be a manual on/off switch at each fireplace for the makeup air.

Other Options

Attached is the Exhausto Application Manual. Exhausto is a Danish company that manufactures powered venting fans for fireplaces that sit at the top of the chimney.

Normally, this system is used to “fix” problem fireplaces. However, it should be recognized that this is done at the cost of additional depressurization of the building. This requires either makeup air or the absence of other combustion appliances, including furnaces unless they are of the sealed combustion type. In practical applications, it is recognized that most fireplaces are only used intermittently.

Other Considerations

The following information is needed:

- 1) Do all fireplaces need to be able to function with the room doors closed?
- 2) Will more than one fireplace be used at a time?
- 3) Is the worst case scenario that they will all be used at once?
- 4) Is it physically possible route the required diameter supply air ducts to each room?
- 5) What assumptions can be made about the tightness of the envelope?

The minimum strategy would be to assume that all rooms communicate, that only one or two of the largest fireplaces will be used at once, and that the building is of “ordinary R-2000” airtightness.

Post from Jim Buckley (Rumford.com) to MHA-Members Forum on April 7, 2021

[Jim Buckley](#)

Apr 7 [#9503](#)

The 1979 ASHRAE Handbook reports on empirical studies which show that modern masonry fireplaces require a minimum average face velocity of 0.2 feet/second in order to exhaust all the products of combustion. This was confirmed in our emission testing.

Converting this into an easy to remember rule of thumb we came up with the following:

Any fireplace needs at least one cubic foot per minute (CFM) of make-up air for every square inch of flue area.

For example a fireplace, with a 12"x12" flue at one cfm per square inch of cross-sectional flue area would, from TABLE R1003.14(2) in the International Residential Code (IRC), require 102 CFM. A four foot wide fireplace with a 16"x20" flue would require a minimum of 222 CFM makeup air.

While these fireplaces might actually require more air with a brisk fire, the greatest potential for spillage is when the fire is dying down and the draft and required makeup air volumes are reduced, so we think providing the minimum makeup air requirement to the flue size (one CFM per square inch of flue area) based on the ASHRAE formula is about right.

Getting it right is easy - just check with a stick of incense at a cracked open widow or door to see if the indoor air pressure is about the same as outdoor air pressure.

Controlling the amount of make-up air is the problem. There are commercial (complicated) systems that measure indoor air pressure and regulate the amount of make-up air needed to maintain a balanced system. In residential situations we recommend the make-up air be brought into the mechanical room. See <https://www.rumford.com/tech7.html> and regulate the amount of outside air needed with a rheostat located at each fireplace and connected to a variable speed makeup air system or a damper so the owner can increase the air when the fireplace is in use.

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