Residential Ventilation Issues
by Dara Bowser & Bob Allison

Outside Air Connections to Warm Air Systems... What are the Rules?
(Part 1)

Outside air connections to the return air duct of forced warm air heating systems have been installed for a number of years in Ontario. They have traditionally been used to increase the overall air-change rate in houses during the winter. Some of these arrangements have also been claimed to relieve problems of combustion due to depressurization.

When considering the application of rules to such a connection, the first question which must be answered is whether or not the connection is part of the ventilation system design. If the outdoor air connection is not part of the ventilation system design, (this often occurs when the ventilation system is designed according to Section 9.32 and non-spillage susceptible combustion equipment is used.), the rules which apply are those which arise out of clause 6.2.1.1. for the design of the forced air system itself and those found in section 9.32 concerning intake location.

If, on the other hand, the outside air connection is required by the ventilation system design, several additional rules will apply.

Minimum Return Air Temperature:

OBC article 9.33.1.1. requires that the design, installation and modification of a heating, and/or air-conditioning system conform to the rules of Part 6. Subsection 6.2.1. and specifically sentence 6.2.1.1. (1) require that any HVAC system be designed, constructed and installed according to good engineering practice as described in the *ASHRAE Handbooks* and/or the *HRAI Digest* gives rules for the design of outside air connections in the Air System Design Manual section of the Digest as follows:

1) The *"Mixed Air Temperature"* (MAT) of the forced air system should not be less than 60°F (15.5°C) at all times (including "Blower only" modes) and in no event should the delivered air temperature be less than 65°F when using floor supply outlets.

2) The Mixed Air Temperature (MAT) is calculated using the formula:

$MAT = T_1 - [(T_1-T_2) * V_2/(V_1+V_2)]$ where:

MAT = mixed air temperature

T_1 = temperature of building air (usually 20°C [68°F])

T_2 = temperature of outside air mixed to return air (see notes)

V_1 = flowrate of building air

V_2 = flowrate of outside air

Note 1: T_2 is the delivered air temperature of any device which supplies the outside air. An HRV for example would pre-heat the incoming air so the pre-heated air temperature would be used. If no device is used to supply outdoor air, then the temperature used is the outside air temperature.

Note 2: The *2-1/2% January Design Temperature* is normally used for these calculations. (OBC Table 2.5.1.A.)

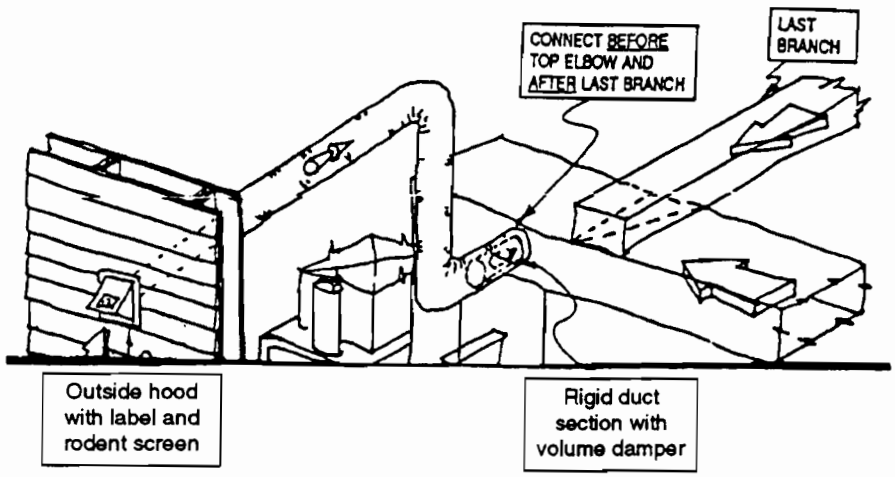
Note 3: A "mixing pot" type of pre-heater which uses air from the supply of the furnace to mix with outside air is not considering as having an effect because any air volume taken from the supply side will be at the T_1 temperature when the furnace blower only is operating. Air obtained from the supply is considered part of the building return air. (V_1).

When applying this formula to conventional warm air systems, designers will quickly find that handling the entire *Total Ventilation Capacity* (TVC) with such a connection is not possible without preheating. The *Principal Ventilation Capacity* (PVC) however, can often be mixed directly into the return airstream without exceeding the critical 60°F limit if the dwelling unit is located in Southern Ontario. In more northern locals, the PVC flowrate added directly to the return airflow will often require pre-heating.

Location of Connection:

The illustration shows the current recommendation for intake connection location, as found in the **HRAI Residential Ventilation Manual.** This recommendation is

in the process of review based on recent tests carried out by CMHC on the effects of connection location on return air mixing. The CMHC research suggests that a connection at the top of the drop duct may provide adequate mixing of outdoor air with return air before it reaches the furnace.



Mixing with the entire return air volume is important. Condensation on return ducts due to excessively cold temperatures has been reported where the outside air connection was to a return air plenum which carried only 1/2 of the total return air-flow.

Duct Size:

The outdoor intake duct should be sized as a return air branch duct as part of the overall design of the warm air system. Such a design will account for the airflow capacity on heating or air-conditioning speed (at the discretion of the designer) and actual intake airflow rates will be lower at lower fan speeds.

If the warm air duct system is not designed, then the outdoor air intake connection is well and truly a "shot in the dark" because system design conditions (such as return air static pressure) are not known. Too much air entry can result in discomfort, high energy costs, condensation on the ductwork and pre-mature failure of the furnace heat exchanger.

Insulation:

Outdoor air intake ducts should be insulated to at least RSI 0.5 (1" of fibreglass) to prevent condensation. The vapour barrier should be on the outside.

Intake Configuration:

The intake terminal on the outside of the house is subject to the same rules for height, clearances, screens, etc. that would apply to an HRV air intake. (OBC article 9.32.3.12)

Air Intake Required by Ventilation System Design:

This situation will only occur when the ventilation system is being designed according to Part 6 of the OBC. The rules for these types of intake are in addition to the rules previously described in this article. Due to space limitations, this topic will be covered in Part 2 of this article.

The topic of this article is covered in detail in the 2-day HRAI workshop: **"Residential Ventilation System Design".** (Building Officials should note that the 2-day OBOA *Residential Ventilation Workshop* is a prerequisite for the HRAI course.

The Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI) is a not-for-profit national trade association serving the HVACR industry and the public interest. HRAI provides a wide range of informational and educational opportunities for building officials. Just as contractors, building owners, and building managers need to keep up to date in our every-changing HVACR industry, building officials also need to know the "facts" and need to keep current. HRAI continues to work closely with OBOA and salutes the various municipalities across Canada who have joined the association as associate members. HRAI, through its national network of chapters, provides a means for building officials, contractors, wholesalers, manufacturers and consultants to work together.

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HRAI is pleased to provide the support for the timely and ongoing information in this column for OBOA members.

*Dana Bowser is an HRAI Ventilation Instructor.
*Bob Allison is the Deputy Chief Building Official of the Regional Municipality of Haldimand-Norfolk.

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