esidential Ventilation Issues
by Dara Bowser & Bob Allison

Minimum Return Air Temperature in Warm Air Systems....WHY?

In a previous article, we reviewed the rules concerning minimum return air temperatures in forced air systems. Since writing the article, several inquiries have been received asking WHY? That is...Why is there a lower limit of 15.5 C (60 F) for return air temperature?

There are in fact several answers to this question, as follows:

a) Comfort - the HRAI Residential Ventilation Manual recommends that floor supply diffusors not be designed for delivered air temperatures of less than 17 C. It is commonly accepted that when the furnace return air temperature is at 15.5 C, then 7 C at the diffusor will usually be maintained by a combination of motor heat from the blower and heat gain from the space, via the ducts.

b) Condensation on Ductwork and Furnace Cabinet. The limit of mixed return air temperature is calculated using a formula which assumes that the return air is perfectly mixed. In practice, return air is not perfectly mixed and the return air stream close to the point of attachment of the outside air duct is likely to be somewhat cooler. For example, 14 C would not be unexpected. In fact 14 C would begin to attract condensation on the duct surface if the basement air conditions were 21 C and 45% R.H. It is not common that indoor conditions in a home would reach these levels during the middle of the winter, but some houses do have higher levels of winter-time indoor humidity than this.

c) Premature Heat Exchanger, Chimney and Chimney-Connector Failure. Whenever a combustion burner ignites in a furnace, condensation of flue-gas products can occur on the inside of the heat exchanger, in the chimney and the chimney-connector. During operation, these components heat up and eventually dry out.

If the furnace blower motor runs continuously and the return air temperature is below 15.5 C, the heat exchanger will be colder than normal when the flame lights up. This means cooler flue-gas temperatures during the start-up phase and **longer wet-times for all of the components**. Long wet-times lead to premature failure of these components. For furnace manufacturers who warrant their heat exchangers for 20 years or more, increased wet-times spell lost money and reputation. More importantly for regulatory authorities, premature failure of chimneys and chimney connectors is a health and life-safety issue.

A note about Continuous Blower use:
The OBC section 9.32 requires that a labeled switch be provided which is capable of turning on the recirculation system blower if the forced-warm air system is to be relied upon to provide ventilation distribution. (See OBV sub-section 9.32.3.6). This, the OBV requires that the heating system blower be capable of being operated continuously, independently from the heating cycle.

The problems listed here are normally only of concern when the furnace blower is operated continuously and are not a concern where the furnace blower operates only when the burner is on, i.e. the traditional "heating only" cycle of a forced warm-air system.

d) Mid-efficiency Furnaces are More Critical. All new gas furnaces in Ontario must have an efficiency (AFUE) rating of at least 78%. Efficiency in these "mid-efficiency " furnaces is achieved by a variety of methods including elimination of the standing pilot, control of excess air using a blower or damper control, increased airflow (lower air-temperature rise) and increased heat-exchanger surface area. The overall result is lower flue-gas temperatures.

e) Chimney Icing. The conditions that lead to condensation can in certain cases, result in icing in the chimney during extremely cold weather, thereby restricting the chimney area. Low flue-gas temperatures can contribute to this problem. Low return air temperatures contribute to low flue-gas temperatures.

f) "Fan Assisted" Furnaces and Chimneys. Some mid-efficiency "fan-assisted" furnaces have small fans which assist in bringing the flue-gases through the heat exchanger and are connected to chimneys. These chimneys may be masonry chimneys equipped with a liner, or "B-vent" manufactured chimneys. It is important to recognize that it makes no difference if the furnace is equipped with a fan or not. If it is connected to a chimney, the problems associated with low return air temperature apply!

g) Negative Pressure is Also an Issue. Chimneys depend on their temperature to produce draft or lift. A chimney depends on a positive flow of air up the chimney before the equipment starts, or there is no guarantee that the chimney will not downdraft. If the temperature at the base of the chimney is too cold, very little lift will be generated, and the time just prior to start-up, (when the chimney is coolest), is the most critical. In some situations the chimney-draft during the off-cycle will be insufficient to overcome even the -5 Pa depressurization which is allowed by CSA F326, and which is the maximum depressurization considered by the Ontario Gas Utilization Code (OGUC) for furnaces connected to chimneys.

h) The House is a System. As with many other issues, actual problems will depend on a combination of circumstances. Some of the contributing factors are:

- low return air temperature
- mid-efficiency furnaces
- short furnace cycle-times (which may be due to over-size)
- improper chimney connector design (usually too long)
- over-sized or under-sized chimneys (use of OGUC is a must)
- house depressurization due to exhausting appliances

How all of these factors interact in the field is not known, particularly as the type of home we build is changing faster than the amount of time required to gather life-cycle information on the problem components (10 to 20). We do know, however, that the lowest return air temperature that a furnace is tested in the lab is 15.5 C and the lowest negative pressure that a conventional chimney is designed to counteract is -5 Pa. The codes, therefore, do not accept design return air temperatures lower than 15.5 C. Neither do the codes accept negative pressures of more than -5 Pa whenever chimneys are used.

Note: The subject of combustion back-spillage is only discussed here to the extent that it may be influenced by low return air temperatures. Combustion back-spillage may occur due to factors which do not involve low return-air temperatures. A full discussion of combustion back-spillage would involve many issues, some of which are not mentioned here.

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CHAPTER GOES TO QUEBEC CITY

Thirty-four Golden Triangle chapter members were recently the guests of Trus Joist MacMillan Ltd. on a trip to Quebec City.

The two day program included seminars on product design, installation procedures, a tour of the Nordel Plant and an evening complete with super wing and wining and free time to explore "Old Quebec".

All in all, it was an excellent tour and many thanks to our gracious host Tony Caravagio and company for a job well done.