# Research & Development Highlights

93-206 Technical Series

## Testing of Fresh Air Mixing Devices

## Introduction

When fresh air is introduced into the return air ducts of forced-air furnaces, it may pool and hit the heat exchanger of the furnace in a localized cold flow. This in turn can initiate local corrosion and stress cracking of the heat exchanger. A few instances have also been reported of cold air coming out of supply registers, when the heat is off but the furnace fan is running. There are many possible causes for all of these problems, but ducting was thought to be too badly built to allow such problems to occur in houses. Since the 1995 National Building Code is to require either a long run of ducting or a mixing device to reduce the possibility of such problems, a test project was undertaken to develop mixing devices of adequate performance.

**Research Program**

In the absence of a local test house with a sufficiently well-designed and built forced-air duct to create the pooling problem, a laboratory duct set-up was constructed, to study both streamline flow and mixing device performance. Conditions of cold-stream flow were produced; then the flow was mixed by means of several devices of varying complexity. Very accurate temperature profiles were measured, and the flow was visualized with smoke.

**Findings**

Ducting with sharp corners and leaky connections will not support streamline flow. When ducts are built to HRAI guidelines, however, for reduced pressure drop and flow noise reduction, a cold steam can be created and its dispersion delayed. Although some care must be taken to introduce the cold air and avoid mixing, unmixed flow can and does happen.

Several mixing devices were built, and located in different parts of the duct to determine temperature mixing distances and patterns.

Most worked well enough to be located within a few metres of the furnace inlet, and yet introduce small temperature distortions in the flow field.

The simplest workable device was a flush intake just downstream of the horizontal to vertical corner, where a separation vortex would be expected to occur. It was the second best device tested, and the least expensive. Locating the flush inlet on the outside of the corner produced much poorer results - the worst of the lot.

A simple taper cut-off, at either 45 degrees or 60 degrees, produced reasonable mixing. The short (45 degree) cylindrical section worked best at the inside corner, where the flush intake worked best. Interestingly and unexpectedly, the taper cut-off did not work as well as a flush intake. The long taper cut-off worked best on the outside corner, but at a higher pressure drop. There it had a reasonable mixing effect, but not a great one.

The most complex mixing cone, distorted to form a series of slots across the diagonals of the duct, was by far the best mixing device. This was not a surprise, since a similar technology is used in jet engines, for mixing of fuel and air. The pressure drop was high, but not unreasonably so. it would cost about $100 installed, but could be located very close to the furnace and create almost perfect mixing.

**implications for the housing Industry**

Introducing cold air into energy-efficient ducting might lead to cold-air pooling, -and then to corrosion or cracking problems in furnace heat exchangers. it might also lead to comfort problems near some supply registers if the furnace fan were run continuously for better indoor air distribution and quality. Several mixing devices can eliminate this effect. One is so good that it could reasonably be used in the supply ducting, and not result in cold draft problems in nearby registers.

The costs of these devices vary from almost zero to about $100 installed, given the requirement to make any connection to the forced-air ducting.

There is an irony here: Some ducting has been so badly built, with such high levels of mixing and high pressure drops, that no cold-streaming or pooling was evident. When more efficient ducting is used as in the Prairies (to reduce pressure drops and operating costs), mixing can be much less reliable, and a mixing device may be required to avoid the problems inherent in cold streamlined flow.

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*Research Report: Testing of Fresh Air Mixing Devices (1993)*
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*A full report on this research project is available from the Canadian Housing Information Centre at the address below.*

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