By Gord Cooke

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With recent changes to the CSA F280 Standard – *Determining the Required Capacity of Residential Space Heating and Cooling Appliances,* we are going to see the use of smaller furnaces and air conditioners in homes, and the rethinking of appliance sizing should also lead to a rethink of duct sizing as well.

RETHINKING duct design practices

Modern systems; modern challenges

Systems have changed, technology has changed, and consumer expectations have changed, all of which add up to challenges for HVAC technicians. Here are a few of the issues that make perfect comfort an elusive target:

- The need to size the system for both peak heating and peak cooling loads results in over-sized ductwork, for at least part of the year, for many spaces;
- Ever lighter-gauge ductwork is being used to save money, but this inevitably leads to more duct leakage as it bends and distorts;
- Higher expectations of consumers – our customers expect pinpoint control of comfort because advanced thermostats show a digital readout of temperature and humidity rather than the old wavering needle;
- More complicated design of buildings with far too many windows and the absence of interior walls forcing long routes for every upper floor duct.

The new metrics will take some getting used to, especially when it comes to applying load capacity data to the sizing and layout of a forced air distribution system in new homes, but F280 is not only for new homes. There will also be some interesting opportunities to assess and potentially modify duct work when replacing furnaces and air conditioners in existing buildings.

There are a number of things a technician can do in the field to assess and optimize systems, including duct sealing, checking pressures, and possibly even rethinking the duct layouts.

One of the best things that can be done for any duct system is to seal anything and everything you can, both in new construction and in retrofit. The leakiest fittings are usually the top and side take-offs from the main plenums, and the plenum fittings themselves. In a retrofit, it is often still possible to get at many of these.

Playing with assumptions

Be reminded that duct designs, even those done by professional, well-trained duct designers, are based on a number of assumptions, like minimal duct leakage, proper installation, and proper access to effective balancing dampers in each branch line, and minimal temperature loss between the appliance and each register.

Add those uncertainties to other variables and deviations, such as the standardization of duct components, fittings and diffusers, and it is not surprising that some designers and installers have come to use a one-size-fits-all approach.

If air sealing ducts doesn't become part of your standard scopes of work in the next three years, you are doing a disservice to the industry. All duct designs, but specifically equal friction methods that rely on significant adjustment of dampers, are really difficult to give the kind of control homeowners want unless ducts are sealed.

Beyond sealing, the system needs to be operating at design pressures. In a new system, measure the pressure off the top of the appliance and compare it to the original supply duct design pressure. In existing houses, compare the pressure to typical industry standards of 0.2 to 0.4" w.c.

In a retrofit, if you do this on the existing system, before any changes are made, nine times out of 10 you will find the actual pressure is far less than the design or industry standard. This can be an indication of being too conservative in the design and sizing of the duct system – and the need to think about downsizing on future jobs.

If the pressure is lower than the design, or lower than needed to force air out to the longest run, start dampening down the shortest runs and watch to see the pressure change. As it approaches the design pressure start measuring the airflow across the appliance and also at the registers in the longest run. Compare these to the design requirements. This will be an indication of just how successful you will be at solving comfort concerns in specific rooms in both new and retrofit work without having to make major duct changes.

The equivalent length of duct is determined by the actual length along the physical duct run, plus the "length" of each fitting – elbow, tee, transition and register – as found in industry duct design charts and tables for standard fittings.

It may help to think beyond simply making ducts smaller. Laying out ductwork in new builds to make the system "zoning ready" is a great place to start. With ECM fan motor technology in furnaces, it is quite easy to design a duct system that would accommodate two or three zone dampers without having to oversize return or supply plenums.

Sizing with the equal friction method

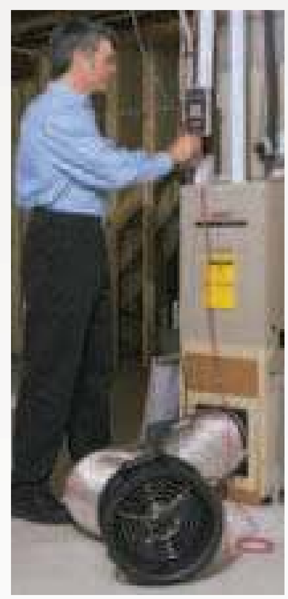
In the vast majority of houses in Canada, duct systems are designed, at least in theory, using the equal friction method. Even if simple rules of thumb are used to layout and size ductwork, the basis for those rules comes from duct design manuals and tables developed from the equal friction method.

The method starts by assigning or "guessing" at a constant pressure per unit length of ductwork – hence the name equal friction. The designer then calculates the airflow requirements to each room using the calculated peak heat loss and gain for the room, and the expected temperature difference created across the heating or cooling device.

The airflows of individual rooms are added together to determine the total flow required for the system.

Using industry tables or duct calculators, the required total airflow and the selected "equal friction," the duct sizes for the main duct and each section of the longest – or most restrictive – branch runs are determined. The pressure required for the longest run becomes the pressure required by the fan system in the air handler.

For example, a very common equal friction chosen in residential and small commercial systems is a pressure of 25 Pascal (0.1" water column) per 100 feet of duct.



If the longest or most restrictive run has an equivalent length of duct of 300 feet, then the pressure required in the system to deliver the required airflow to the longest run is 75 Pa or 0.3" W.C. This is often referred to as the root or index pressure for the system.

Designers would ensure that the furnace or air conditioner chosen would be capable of delivering the required total air flow at this longest-run pressure.

The size of duct for each of the shorter runs in the system is determined again using the required air flow for each run and the root pressure. It means that, in theory, the duct size for all other branches will be smaller than the ducts in the longest run.

Since ducts only come in specific incremental sizes, and installers don't want to carry too many different sizes and associated fittings, dampers are used to adjust the pressure in all the runs except the longest run.