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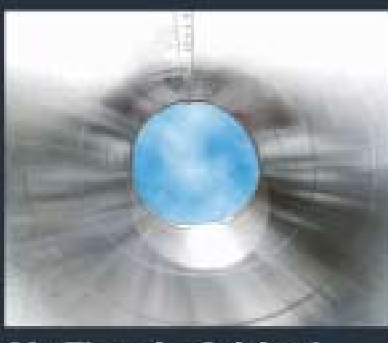
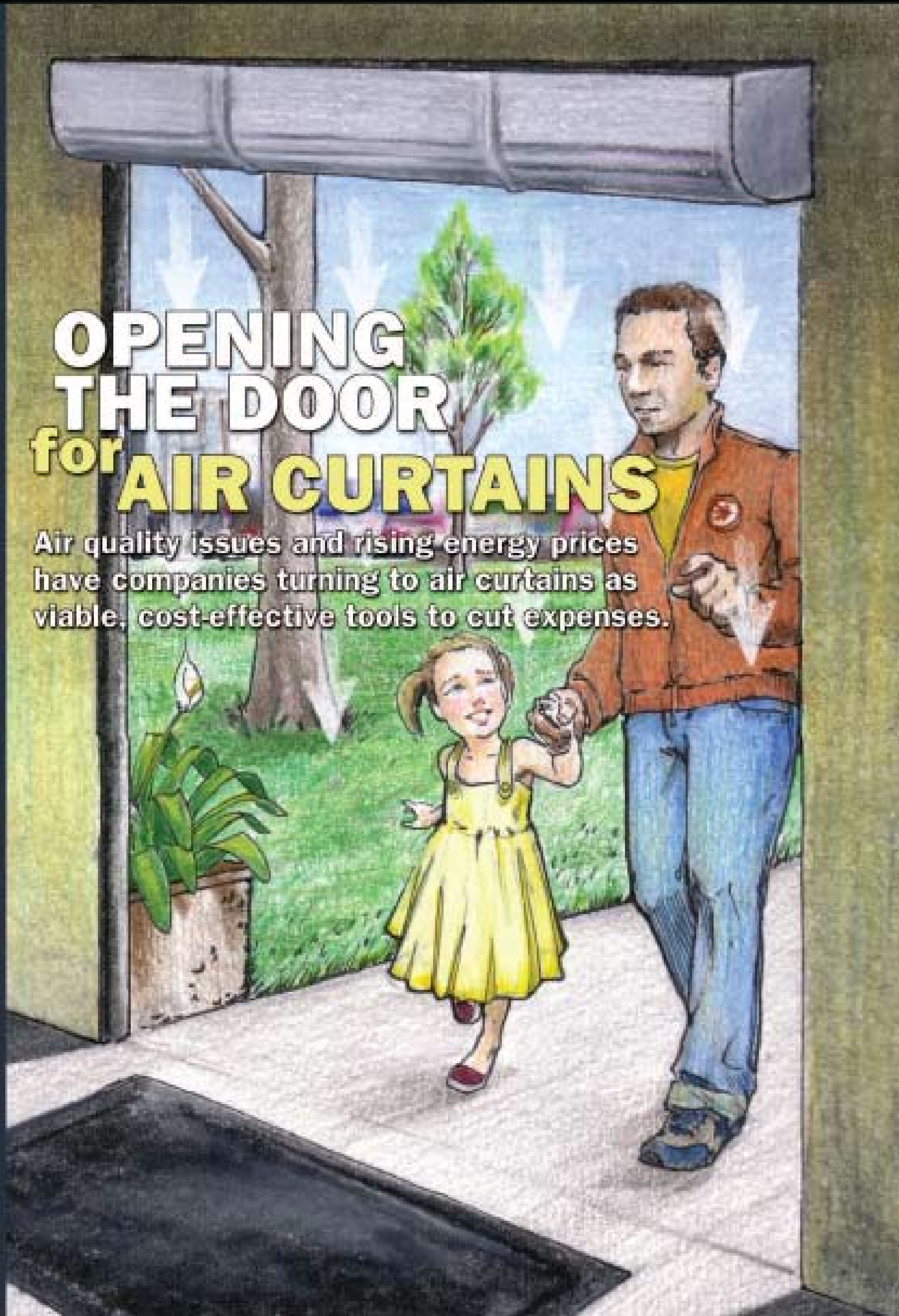
## HEATING, VENTILATION, AIR CONDITIONING AND REFRIGERATION









# OPENING THE DOOR for AIR CURTAINS

Air quality issues and rising energy prices have companies turning to air curtains as viable, cost-effective tools to cut expenses.

While flex ductwork (right) is inexpensive, its spiral wire-Helix construction has higher friction loss compared to sheet metal duct (above).

# Air Flow is HVACR System

Understanding the benefits—and drawbacks—of flex ductwork are critical to creating efficient HVAC systems.

**BY CHRIS VAN RITE**

All HVAC professionals know that air flow is absolutely a key component for proper HVAC system performance. The equipment's Seasonal Energy Efficiency Ratio (SEER) does not factor in resistance for the duct system. But ductwork that features poor air flow will cause the equipment to work harder and less efficiently.

However, a duct installation isn't necessarily a good duct system just because it passes inspection. Why? Because in many cities, building codes fail to address air flow, and a duct system with terrible air flow can pass code inspection as long as it is properly sealed and insulated. Code inspections set the benchmark for good and bad. Too many contractors assume they are installing a good duct system if they mimic their competitors and the job passes inspection; they could simply be building the lowest quality system capable of passing an inspection, rather than crafting one with the highest possible qualities.

Few people would argue that the quality of HVAC equipment found in new homes today is better than it was 30 years ago. But market pressures have forced contractors to cut costs, often at the expense of quality and performance, and the HVAC duct system is often one of the casualties. While technology and higher federal standards have brought about significant improvements in HVAC equipment, the quality of duct systems and overall system installation has declined.

The Consortium for Energy Efficiency (CEE) is a non-profit public-benefit group that actively promotes the use of energy-efficient products and services. According to research cited by CEE, most residential central-A/C systems are not installed properly. This not only increases energy use but also reduces comfort and contributes to peak demand for electricity. CEE noted three major problem areas, as well as the frequency with which they occur:

- Oversizing of equipment—47%;
- Inadequate air flow—70%; and
- Improper refrigerant charge—44%.

Correcting these problems could reduce air-conditioning peak demand by 14% in existing homes and 25%

Compressing or bending ductwork—as shown in these examples above and left—increases the turbulence and friction loss in HVAC systems, causing the system's equipment to work harder.

# Critical to Performance

in new construction. Proper installation and maintenance also could reduce air-conditioning energy bills by an average of 24% in existing homes and 35% in new construction.

## The true cost of flex

When it comes to flex duct, there are trade-offs between material cost and performance that must be kept in mind. Flex is inexpensive and easy to use, but its spiral wire-helix construction also means higher friction loss compared to sheet-metal duct or fiberglass duct board. Compression or bending—the very attributes that make flex duct so popular—cause the inner core of flex to change shape, which increases turbulence and friction loss.

It is no surprise that installers prefer flex. Its soft, flexible attributes make it easy to squeeze ductwork through tight places, kink it around corners and compress excessive lengths between fitting connections. Lower cost and ease of installation have made flex quite popular, particularly in the Southern and Western United States. Contractors and builders can install a flex-duct system just about anywhere with little or no accommodation for the home's frame or design. But while flex is a cost-effective solution for those involved in building/home construction, the end-result of using flex is often a duct system that reduces equipment efficiency and, over the life

Flex's soft, pliable nature makes it easy to place ductwork around tight corners. But installers must guard against overuse, or it will negatively impact the system's efficiency.

**Tests have consistently shown the benefits of installing sheet-metal duct work as a way to improve system efficiency using a combination of sheet-metal and flex ductwork allows for more installation options while allowing home owners to reduce energy costs.**

of the system, costs the actual homeowner thousands of dollars in higher utility bills.

Some states restrict the use of flex to 5 ft or less at the end of a sheet-metal duct run, which forces contractors and builders to work together to accommodate a proper duct system. But in states lacking flex installation restrictions, a disturbing trend has developed toward bad installations and an apparent disregard for air flow.

**Unfortunately, some contractors' remedy for poor air flow is to install oversized equipment rather than address the root problem.**

The Air Diffusion Council (ADC), an association of flexible air-duct manufacturers, publishes an installation guide titled, "Flexible Duct Performance & Installation Standards." The guide warns installers about the dangers of inappropriately installing flex, noting that: "The number of bends, the number or degrees in each bend and the amount of sag allowed between support joists will have serious effects on system performance due to the increased resistance each introduces. Install duct fully extended, do not install in the compressed state or use excess lengths. This will noticeably increase friction losses."

## Higher friction loss, less air flow

In simple terms, when less air is delivered, the system has to run longer to achieve the desired comfort level. Air flow problems have plagued the HVAC industry for years. Unfortunately, some contractors' remedy for poor air flow is to install oversized equipment rather than address the root problem. Design tools—such as the friction-loss tables in the Air Conditioning Contractors of America's (ACCA) "Manual D" and ductulators—are used to size ducts so they deliver the desired amount of air. However, these design tools assume certain installation standards, some of which date back to the 1950s. Because the quality of modern duct installations has declined, the design tools don't always correlate with installed duct performance.

In 2002, a comprehensive review of air flow in an HVAC duct was commissioned by the Air Distribution Institute in cooperation with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and other funding partners. The Energy Systems Laboratory (ESL) at Texas A&M University undertook this research to verify the accuracy of the "Manual D" friction-loss tables and assess whether the test methods used to gather friction-loss data was appropriately related to modern installation practices.

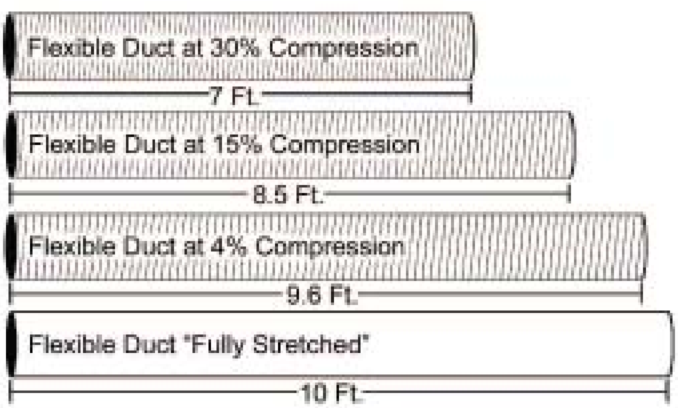
The ESL research concluded that when following test protocols prescribed by ASHRAE, the "Manual D" friction-loss tables—and therefore the ductulators that correlate with "Manual D"—were accurate for both round metal duct and flex. However, when flex was tested under the "as built" conditions seen in modern installations, friction losses increased as much as 10 times more than predicted by "Manual D." A similar study conducted by Lawrence Berkeley National Laboratory found very similar results.

The prescribed method for testing air flow in flexible duct work requires that it is stretched tight and released on a flat surface. This results in the flex resting at approximately a 4% straight line compression. Air is then forced through the test duct section and sensors record pressure loss. The problem is that flex is rarely installed in a straight line and stretched as in the prescribed test method.

One common mistake installers make is not cutting off excess lengths of flex duct before making connections. This practice compresses the installed flex into a shorter length, much like an accordion. The amount of compression in flex duct is described as a percentage of the stretched length. For example, if a piece of flex measures 10 ft when fully stretched, but is 7-ft long when installed, it results in a 30% compression. Figure 1 depicts flex at various rates of compression and shows there is little difference in appearance between fully stretched flex and compressed flex.

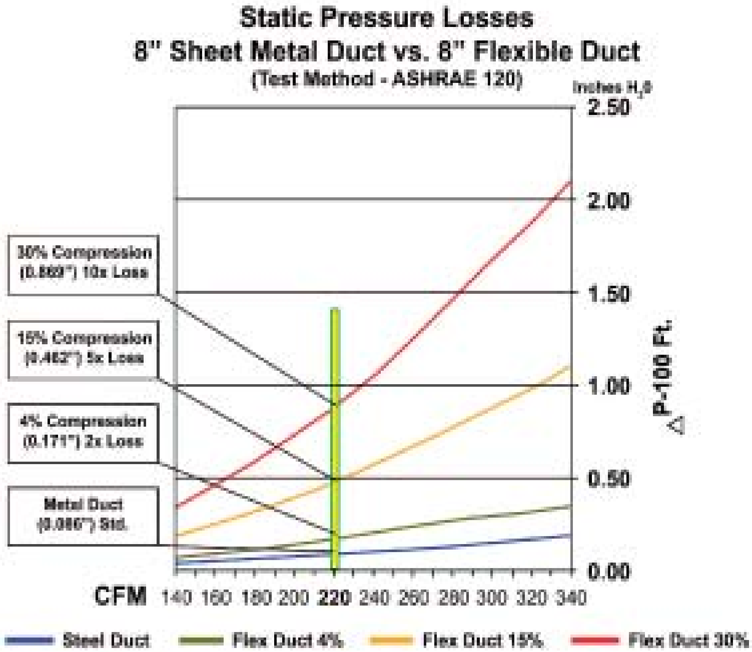
ESL researchers investigated the affects of straight line compression in flex duct and found that even small amounts of compression dramatically increase friction loss. In Figure 2, the chart shows the incremental increase in static pressure losses as compression rises. It has long been an accepted practice to up-size by one diameter when using flex instead of metal duct. ESL research found that when installed at as little as a 15% straight line compression, a 10-in. diameter flex duct is required to equal an 8-in. diameter metal duct.

Compression is just one installation variable that increases friction loss in flex. Besides excessive bending and crimping, installers often find it easier to simply use the piece they have rather than take the most direct route and cut off the excess. This is both a waste of material and needlessly adds additional length and friction loss to the duct system.




## FIGURE 1

**While compression can result in poor air flow, this illustration shows that there is almost no difference between fully-stretched and compressed flex ductwork.**




## FIGURE 2

**This chart illustrates the corresponding increase in static pressure loss as compression rises.**

## The push for performance and better IAQ

Many contractors and builders do not realize the impact of using a less-efficient duct material and then installing it poorly. Until code bodies, energy-savings programs and state and local amendments address the problem and restrict the use of flex duct, these problems will likely continue. However, change and improvements are starting to occur in these areas.

For example, the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) have launched a joint program called Energy Star. As part of its Energy Star Homes Technical Standards, the governing bodies make the following recommendations:

- Avoid flex duct whenever possible;
- Flexible duct that runs longer than 5 ft can severely restrict air flow; and
- Keep flexible ductwork as short and straight as possible.

ASHRAE also recently published the standard, "Advanced Energy Design Guide for Small Office Buildings." The stated goal in this publication is to help engineers achieve a 30% energy savings over the specifications noted in ASHRAE 90.1 from 1999. The design guide recommends that flexible ductwork should be limited to connections between duct branch and diffusers and limited to 5 ft or less.

Of the three major types of duct material, sheet-metal duct still provides the most durable, efficient and clean-air distribution system. Installing sheet-metal duct in a straight line, in addition to providing superior air flow, is the easiest installation method. Therefore, installers tend to limit the number of turns and plan them so each run can go as far as possible before changing directions. The result is a galvanized metal-duct system with few turns, which limits friction loss and increases efficiency.

**"Hybrid" duct systems maximize the efficiency of metal duct while using the convenience of flex to make the final connection to the register box and minimize HVAC system noise.**

Zinc in the galvanized coating of sheet-metal duct actually kills mold and gives excellent protection against all types of organic growth; an added benefit that has been discovered in recent years. And while duct systems require cleaning occasionally, it is much easier to maintain the hard, smooth surface of sheet metal than non-metallic duct materials. *(Editor's Note: For more information on how to clean ductwork, refer to the February 2008* RSES Journal *feature article, "The Inside Dirt on Duct Cleaning.")*

## Hybrid duct systems

Because sheet-metal duct is hard and smooth, it conducts air very efficiently. Unfortunately, it also does the same thing with sound. Conversely, while flex duct's rough surface isn't the most efficient way to move air, it does have superior sound-attenuating qualities.

As in states where the use of flex duct is restricted, many contractors have found a way to get the best of both worlds by running a predominantly metal duct system and installing short, 3- to 5-ft lengths of flex at the end of the duct run. These "hybrid" duct systems maximize the efficiency of metal duct while using the convenience of flex to make the final connection to the register box and minimize HVAC system noise. Until recently, the new-construction trends for HVAC ductwork has been variations that were faster, cheaper and easier.

These inexpensive products also lend themselves to using lower-paid, lower-skilled labor, which also has contributed to a host of installation-related problems. But rising energy costs and a growing awareness of indoor air quality have more homeowners insisting on a clean, comfortable and healthy living space with affordable utility bills. Upgrading to a sheet-metal or hybrid duct system is an excellent way to fulfill these requirements.

Regardless of the materials that are used, proper duct sizing and installation are critical to system performance and, therefore, energy efficiency. As the demand for more energy-efficient homes increases, today's HVAC contractor, who offers higher levels of products and services, will have a growing number of excellent opportunities to generate higher profits and greater confidence from the consumer.◆

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