ZONING

Forced-Air Heating Systems

Forced-air heating systems have a reputation for making some parts of the house too hot and others too cold. Even if the whole system is perfectly designed and installed, there are bound to be complaints. The right temperature for watching TV downstairs might be way too hot for sleeping upstairs.

by Gary Bailey

Until fairly recently, the luxury of having different thermostats for different parts of the house has been the domain of hot water heating systems — zoning forced air simply wasn't practical or cost effective. Today, advances in both electronics and furnace technology have made forced-air zoning a reality for new installations and upgrades alike.

How Zoning Works

The principle behind zoned forced air is simple. Motorized dampers installed in the ductwork are wired through thermostats in each zone to a control module (see Figure 1). When a zone calls for heat, the furnace fires as

Motorized dampers and electronic control systems make adding separate thermostats a snap

Zoned Forced-Air Installation

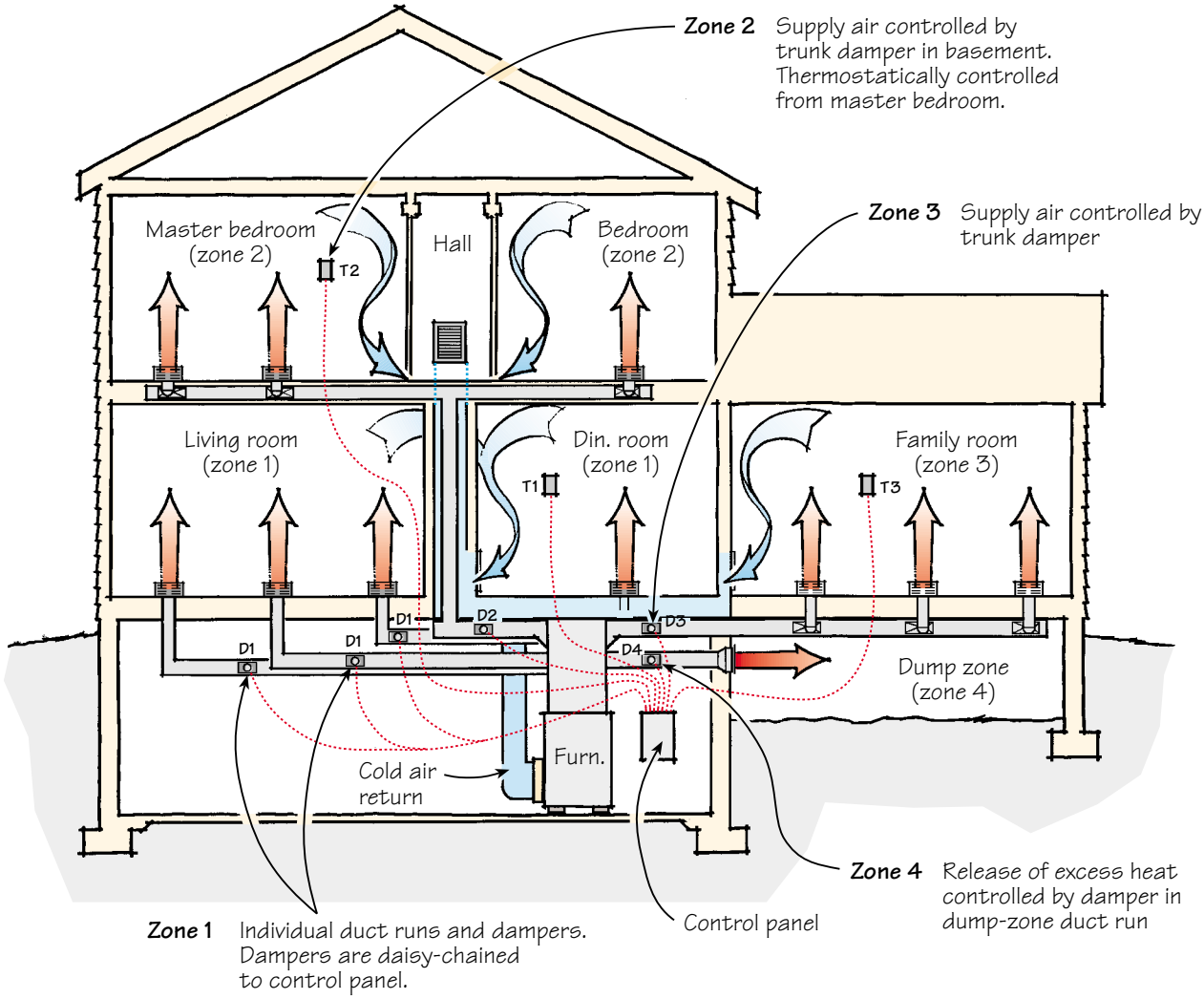

Figure 1. Typical residential forced-air systems may require three or four zones. Separate thermostats for each zone are wired through an electronic control panel, which modulates airflow by opening and closing motorized dampers in both the trunk and secondary supply ducts. A "dump zone" protects the furnace from overheating by drawing off excess heat when, for example, only one zone is calling for heat.

always, but only the dampers attached to that zone open. The control module handles all the operation of dampers in response to the thermostats, and ensures that any excess heat gets pulled off the furnace after a zone's call for heat is satisfied.

The control module is key: How well it works and how flexible it is varies widely from one manufacturer to another. Electronic advances in the last few years have made some of these units very practical and reliable. Motorized dampers, on the other hand, haven't changed much for decades. There are dozens of brands, but only a handful of companies actually make them. You can mix and match as long as the motorized actuators use the same specs as the control module. We're Carrier dealers, so we prefer to stick with the integrated system Carrier has developed, called Comfort Zone.

Excess heat. In a hot water system, boilers are seldom damaged from overheating because the water acts as a buffer. Furnaces are trickier, however, especially when only one zone is calling for heat. If a furnace was designed to deliver air to 12 duct runs, but only two dampers are open in one zone that's calling for heat, the furnace would be at risk of damage from heat stress (see "Trouble-Free Forced-Air Heat," 12/98). The ideal way to cure this problem would be to use a multi-stage furnace, where the burner can fire at different rates, but that only makes sense if you're replacing the furnace.

Dump zone. When adding zoning to an existing system, the best way to get rid of excess heat is to create a separate "dump zone," which throws extra

Figure 2. Rectangular motorized dampers are placed near the furnace (left); round dampers for branch ducts are located as close to the trunk lines as possible (right).

heat into an unused part of the house — a basement workshop, for instance, or an upstairs storage room or insulated garage. If the furnace sits in an unfinished basement, there's no harm in dumping the heat directly to the surrounding air.

Bypass loops. Another way to get rid of excess heat with a Carrier multi-stage furnace is to use a bypass loop between the supply and return trunks. If the airflow falls below a certain level, the difference in pressure opens a simple barometric damper and sends air back to the furnace.

Many times, we have to combine bypass loops and dump zones to get an acceptable result. Neither of these methods is energy-efficient, but most clients are willing to waste a little heat to gain the comfort a zoned system provides.

Air conditioning. When ductwork is also used for central air conditioning, the airflow problems are magnified. During the summer, if a zone shuts down and reduces airflow, the AC unit could freeze solid. To combat this, the system we use employs sensors mounted in the cold air return that monitor the temperature of air coming back to the blower. When the air gets too cold, the sensors can be wired either to open cooling dump zones or cycle the air-conditioning unit on and off independently of the zone thermostats.

Humidifiers. In a zoned system, a central humidifier can pump out more moisture than is needed if only some of the zones are operating. Again, the solution lies in controls that will compensate and automatically turn the humidifier on and off as required by monitoring the humidity of air returning to the furnace, making sure it's never too high.

Planning the Job

When I get a call for zoned forced air, I start by meeting the clients at their home and sizing things up. I ask them about traffic patterns in the house, living arrangements, and any special needs they might have. While I'm there, I'm on the lookout for areas of the house that are too hot or too cold, and I take note of the general construction of each section of the house.

Once I get a feel for how the house should be divided into zones, I go one step further and carefully survey heat loss and gain, as well as the ductwork running to each proposed new zone. The perfect installation will have a cold air register in every room. That is seldom the case, so I look for adequate cold air returns in each zone, especially on the second floor, and add them as needed. Not having cold air registers on the second floor can result in air rushing down the stairs trying to find its way back to the furnace. This air movement can feel like a hurricane, and can undo the advantage of a zoned system by making it impossible to control airflow between zones. Luckily, unlike supply runs, which must be encased in ductwork, cold air returns can be built by boxing off joist or stud bays. I'll often cut in a register in the top riser of a stairway and use the stair carriage to get the air back to the basement, or find common passages in stacked closets and the like. Once the air is back to the basement, we pick it up in metal ductwork to carry it back to the furnace.

Inspecting the existing ductwork is important because, while the duct system taken as a whole may be fine, often it will have deficiencies in one area of the house or another. For example, the upstairs may be too hot even though it doesn't have

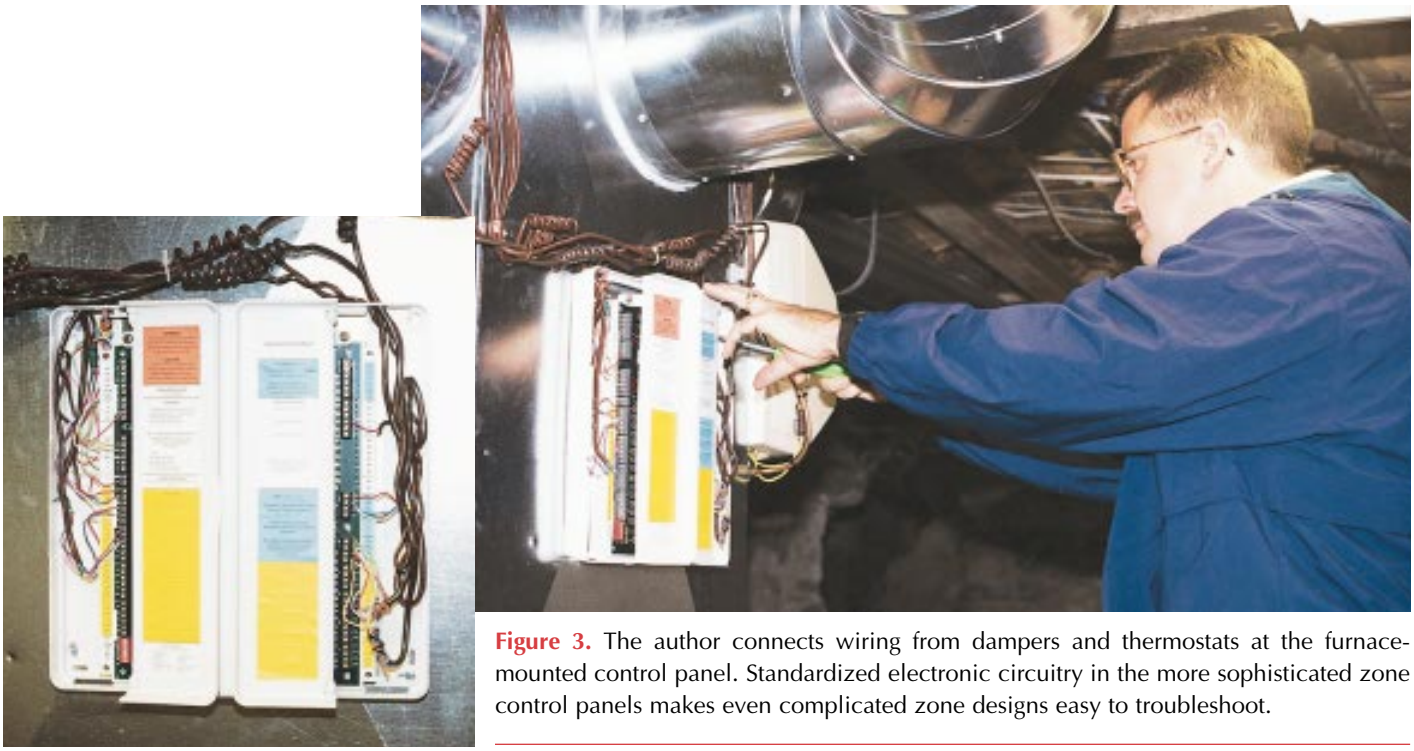

Figure 3. The author connects wiring from dampers and thermostats at the furnace-mounted control panel. Standardized electronic circuitry in the more sophisticated zone control panels makes even complicated zone designs easy to troubleshoot.

a lot of registers. Without proper ductwork, zoning will not perform as advertised. The ductwork doesn't have to be perfect, but we like to make whatever corrections we can.

If we decide a job is going to have four zones, it means I have to do four load calculations and duct surveys. Then I come up with an individual plan of attack for each zone, plus the dump zone.

Divide and Conquer

There is no hard and fast rule for defining zones. In general, I first split the house up into public (living) and private (bedroom) areas. I further subdivide the spaces based on how they're used. If the bedrooms are all on the same floor, for example, I'll often make them a single zone; but if there's a large master suite, it gets a separate zone. On the other hand, a basement family room might require only a little bit of heat, but the zone might be active nine months out of the year to keep the room at 70˚F year round.

House construction also affects zoning. For example, a living room with a lot of south-facing glass might require a lot of heat, but only after the sun goes down; during the day, it could actually overheat, even in winter.

Limitations. The Comfort Zone system we use is more forgiving than most, but there are still limitations to how much splitting up we'll be able to do. The largest control panel available allows for eight zones, but with that many zones chances are good a high percentage of them will not be calling for heat at the same time. Unless you want to dump a lot of heat every time the furnace fires, three or four zones is a more realistic target.

With any system, each zone must be able to carry about 60% of the output of the furnace; otherwise, the dump zone must be brought on line. For example, if I'm using a furnace that produces 72,000 Btus, each zone should be able to handle about 43,000 Btus (72,000 x .6). Now, say I want to supply a single zone for three upstairs bedrooms using a 6-inch round pipe to supply each room. At 100 cubic feet per minute (cfm) per duct, the total airflow is 300 cfm, which translates into 22,000 Btus. Following the 60% rule, this leaves an excess of 21,000 Btus. Unless the excess heat is taken up by a second zone calling for heat, it will have to be shunted to a dump zone. That's why putting a single small room on a separate zone is too wasteful to be practical. It's also an example of how a two-stage furnace comes in handy. If the heating plant in this example were a high-low unit, on the low setting no heat would need to be dumped.

Installing the System

We place trunk dampers close to the furnace, and branch dampers close to where the runs come off the trunk (Figure 2). An installer can pull the ductwork apart and set a motorized damper in just a few minutes. We run thermostat wire from each damper back to the control panel, which is typically mounted close to the furnace. Setting the dampers for most single-family systems can be

done in less than a day, if there are no ductwork modifications.

Thermostats. The most common residential thermostat we use looks like a typical programmable unit and is wired back to the control panel. More sophisticated types of thermostats are accessible only through the panel, but these are intended for use in office buildings, where you don't want people to change settings. Sensors are also available that monitor air temperature in the ducts instead of the room. These are used in buildings like warehouses, for example, where you don't want to mount the thermostat on the wall.

Zone controls. In the old days, zoning forced air required a separate trunk for every zone, each with its own large motorized damper. Controls were primitive, usually rigged on site out of wires and relays. Not only were these systems unreliable, but the only guy who knew how to service them was the guy who built them. We've walked into jobs where inventor types had built their own zoning with off-the-shelf parts, but even my top technicians couldn't figure out what they'd done.

The single biggest advantage of the new computerized control modules is that they standardize every job and are very simple to troubleshoot (Figure 3). The control modules let us choose between a single large damper controlling an entire trunk, individual dampers in each run, or any combination.

If the zone equipment is hooked up to a high-end furnace from the same manufacturer, as with the Comfort Zone, the electronics in the furnace also come into play (Figure 4). We can control the burners and staging as well as central AC, air cleaners, and humidity using the same electronics.

Figure 4. When combined with compatible zone controls, the electronic controls on high-end furnaces can also handle air conditioning, humidifiers, and air cleaners.

Cost. A typical three- or four-zone system will run between $1,200 and $2,000, installed, and depending on ductwork modifications, will take two or three days to complete. The Carrier products we use are available to specialty trades only, but contractors who want to tackle the job themselves could look into one of the other brands on the market (see Sources of Supply).

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Sources of Supply

Carrier Corporation
P.O. Box 4808
Syracuse, NY 13221
800/227-7437
www.carrier.com
Comfort Zone System

Enerzone Systems Corp.
4103 Pecan Orchard Drive
Parker, TX 75002
972/424-9808
www.enerzone.com
motorized and air-operated dampers and control panels

Research Products Corporation
P.O. Box 1467
Madison, WI 53701
800/545-2219
www.resprod.com/pt.html
PerfectTemp zone control system
Aprilaire automatic humidifiers

EWC Corporation
385 Highway 33
Englishtown, NJ 07726
800/446-3110
www.ewccontrols.com
Ultra-Zone system — dampers and controls

Honeywell
Honeywell Plaza
Minneapolis, MN 55440
800/328-5111
www.honeywell.com
PerfectClimate zone control system

TrolATemp
55-57 Bushes Lane
Elmwood Park, NJ 07407-3204
800/828-8367
www.trolatemp.com
Zone control panels and automated dampers