

Comfort Strategies for Multi-Story Homes: A Quick Guide for Contractors

There are three strategies for delivering comfort and energy efficiency to multi-story homes:

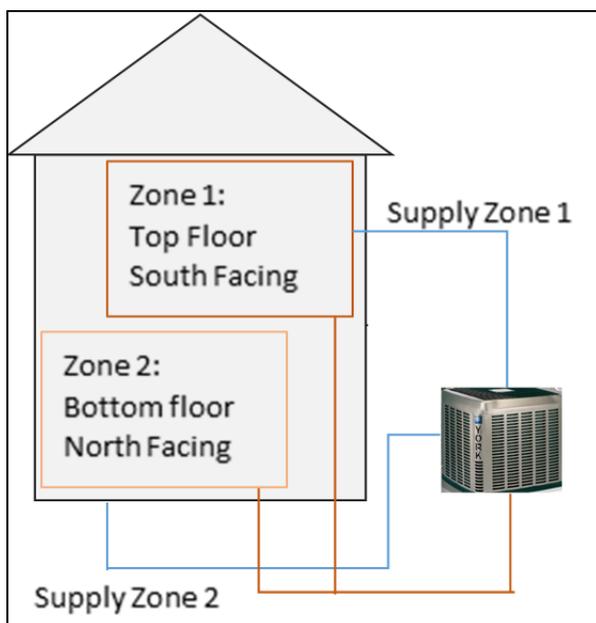
1. Zoning a single HVAC system
2. Adding a second HVAC system
3. Installing a ductless mini-split system

SMUD Home Performance Program offers rebates for mini-split system installations (\$250 rebate for each indoor head installed [maximum of four heads]) and new HVAC equipment including adding a second system.

Comfort and Multi-Story Homes

Houses over 2,000 square feet with two or more floors and high cooling loads in the summer or high heating loads in the winter are good candidates for an HVAC system upgrade.

In addition to seasonal impacts, in a typical two-story home the heating/cooling load commonly differs from floor to floor and room to room. For example, the top floor and south facing rooms of the house may require more cooling and less heating load than bottom floor and north facing rooms.



“Zoning has the capability of diverting more of the HVAC capacity to the area with the higher load,” according to the *Residential Zoned Ducted HVAC Systems CASE Report*.¹

¹ *Residential Zoned Ducted HVAC Systems*, Rick Chitwood, John Proctor, and Bruce Wilcox, September 2011.

Option 1: Zoning a Single HVAC System

Creating separate *zones* within an existing single HVAC system means the system can respond to different loads throughout the house. Known as a *dual-zone* or *multi-zone system*, zoning helps balance the airflow as loads change from winter to summer, morning to afternoon, day to night, and upstairs to downstairs and address a range of different heating/cooling needs, such as rooms with south- and west-facing windows, rooms with high or vaulted ceilings, and basements.

COMPONENTS OF A MULTI-ZONE HVAC SYSTEM.

Regardless of the equipment type, the components needed to zone a single HVAC system are:

- **Main HVAC system** with furnace, air conditioner, coil, and duct system. (Typically, you will be dealing with an existing HVAC system.)
- **Electronic zoning dampers:** One damper per zone; a typical zoned system will include 3 to 4 electronic dampers. Dampers should be installed near the plenum.
- **Smart zoning thermostats:** One thermostat for each zone; these thermostats usually come with a control board.
- **Zone control board and sensors**
- **Extra return air duct:** Not always needed, but generally recommended.

GOOD SYSTEM DESIGN IS IMPORTANT.

Zoning is a science. You cannot just add a damper and wing it. The contractor must use building-science techniques to design a system that will (1) support the required airflow, (2) protect the equipment, and (3) effectively address a variety of fan speed issues and technologies (for example, varying speed ranges, dipswitches, ramping profiles, and active control boards).

Zoning works best with thoughtful design and installation. Zoning is an effective way to increase comfort because a multi-zoned system keeps temperatures closer to the set point without overheating or overcooling areas with different loads.

BEST PRACTICES RESOURCES FOR EFFECTIVE DESIGN.

Zoning best practices are provided in the following two major resources. The *2013 California Building Code Residential Compliance Manual* recommends the following best practices to optimize airflow in multi-zoned systems:

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1. In every zonal control mode, the system should provide airflow through the return grilles that is equal to or greater (\geq) than 350 CFM per ton of nominal cooling capacity.
2. In every zonal control mode, the fan watt draw must be less than or equal to (\leq) 0.58 Watts per CFM.

The *ACCA Manual Zr: Residential Zoning Systems* provides industry vetted information on zoned system design for a home retrofit project. The *ACCA Manual Z* is available for purchase at the ACCA Website.

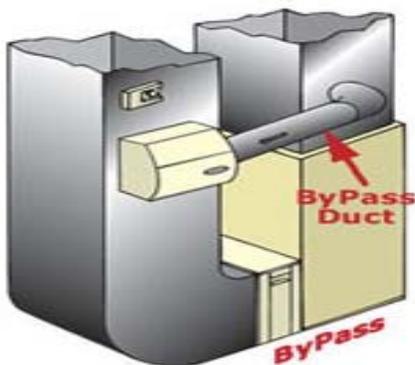
Equipment manufacturers provide training and certification on zoned system design.

Note: Once the system is operating at typical steady state, a HERS rater must measure and verify the system's refrigerant charge.²

BYPASS DUCT: A GOOD OR BAD IDEA?

Bypass ducts are short ducts placed between the supply plenum and the return air plenum in a zoned system to relieve pressure when not all zones are open. The efficacy of this strategy has become a point of controversy in the industry over recent years.

A 2011 study³ noted that mixing in bypass air lowers the return air temperature entering the cooling coil, which significantly lowers the EER. "Bypass ducts cause a lower cooling coil temperature. The lower evaporator temperature lowers the total and sensible capacity of the air conditioner."



Source: Electronic Air Cleaner, http://electronicaircleaners.com/images/honeywell/humidifier_bypass.jpg

For more information, clicking [here](#) to watch a video by John Proctor about bypass ducts.

² If the start-up is in the summer and the indoor temps are at 85°F when the refrigerant charge is measured, it may need to be adjusted when the indoor temperature is at the design 75°F.)

³ *Residential Zoned Ducted HVAC Systems*, Rick Chitwood, John Proctor, and Bruce Wilcox, September 2011.

ARE THERE ALTERNATIVES TO THE BYPASS DUCT?

John Proctor (Proctor Engineering Group) and Rick Chitwood (Chitwood Energy Management) offer several alternatives to bypass ducts,⁴ including:

- Bonus supply branches that take the same CFM/ton as the zone supply branches
- Oversizing all ducts. However, when all zones are open at the same time on a system with oversized ducts, air velocity reduction can cause conditioned air to stratify and not mix well with room air.
- Have 3 zones and always have 2 open
- Install variable airflow/variable capacity air conditioners or separate HVAC systems for each zone
- Use Barometric Zone Dampers (BZD), which costs less and take less time and space to install than a bypass duct. However, a BZD can leak into unintended zones.



Source: Jackson Systems: <http://www.jacksonsystems.com/products/barometric-zone-dampers.html>

WILL A MULTI-ZONE HVAC SYSTEM SAVE MONEY?

It depends. If the contractor correctly configures the HVAC zones overall energy consumption can drop by up to 29 percent in older, poorly insulated, poorly air-sealed houses, especially those located in cold climates. In newer homes with good insulation and air sealing, energy savings from zoning will likely be less than older homes, but the occupants will still benefit from comfortable temperatures throughout the home. Because a non-zoned single HVAC system typically under serves a portion of the home, installing a multi-zone system may use more energy to deliver comfortable air temperatures in all rooms of the house.

DOES ZONING DUCTWORK INCREASE INSTALLATION COSTS?

Yes, installing zones on an existing single HVAC system can cost up to \$2,000. However, zoning a single HVAC system is often less expensive than installing multiple HVAC systems. In addition, zoning an existing system can allow longer equipment service life.

⁴ *Residential Zoned Ducted HVAC Systems*, Rick Chitwood, John Proctor, and Bruce Wilcox, September 2011.

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Option 2: Second HVAC System

Another option is to install a *dual-unit system* consisting of two separate single-zone HVAC systems in which each system heats and cools a specific area of the home, such as the first or second floor, or main house and new addition.

COMPONENTS OF A DUAL-UNIT HVAC SYSTEM.

In a dual-unit design, each HVAC system serves a separate area of the house with its own thermostat. This method is typically used in new construction or when building an addition to an existing home.

BENEFITS OF A DUAL-UNIT HVAC SYSTEM.

The benefits of a dual-unit system include:

- Having a **“back up” system** in place should one of the units be out of working order for a period of time.
- With strategic placement of the HVAC units, the **shorter ductwork can reduce airflow losses** caused by friction.
- **Smaller HVAC units** can be installed because each system is serving only a portion of the total house square footage.

SMUD Home Performance Program offers rebates for the installation of a new energy efficiency HVAC system.

Option 3: Ductless Mini-Split System

A mini-split heat pump is a type of HVAC system that consists of an outdoor unit and one or more wall- or ceiling-mounted indoor units.



The outdoor unit of a mini-split heat pump can be mounted to the wall (above) or placed on the ground. (Source: *Gary Cziko*)

The outdoor unit includes a compressor/ condenser that compresses and expands refrigerant fluid.



The indoor unit of a mini-split system is low-profile and operates without ducts. (Source: www.energystar.gov)

The indoor unit includes an air handler that blows heated or cooled air into the house.

BENEFITS OF A DUCTLESS MINI-SPLIT SYSTEM.

The main difference between a mini-split system and a conventional HVAC is that the mini-split system does not use ducts to distribute conditioned air throughout the home. Instead, the mini-split indoor unit blows heated or cooled air directly into the room, eliminating the need for ducts.

With conventional heating and cooling systems, generally one thermostat controls the temperature of the entire home. With mini-split systems, the homeowner can control the temperature of each zone or room in your home. Rather than heating and cooling the entire home, the homeowner can condition the air in only the occupied rooms of the home.

In houses with traditional forced-air heating and cooling systems, ducts distribute conditioned air throughout the house. In California, about 30 percent of the air that moves through the duct system is lost through leaks and holes in the ducts and poor connections between the ducts and the heating/cooling equipment. Installing a mini-split system can eliminate those duct losses and the costs associated with them, as well as increase your comfort.

While some mini-splits provide only cooling, the SMUD Home Performance Program currently requires that rebated mini-splits include a heating component.⁵ The SMUD Home Performance Program provides rebates for mini-split systems with a minimum 15 SEER and 8.5 HSPF.

SMUD Home Performance Program offers a \$250 rebate for each indoor head installed (maximum of four heads).

FOR MORE INFORMATION

For more information about energy efficiency incentives available through SMUD, visit: <http://hpp.smud.org/> or email Jim Mills at: james.mills@smud.org

For more information about zoning HVAC system: <http://www.energyvanguard.com/> <http://www.energy.ca.gov/>

⁵ The heating efficiency of a mini-pump heat pump is measured in Heating Seasonable Performance Factor (HSPF). For SEER, EER, and HSPF, higher numbers indicate greater efficiency.