What Builders Need to Know About HVAC System Design

Due to design and installation deficiencies, many HVAC systems do not achieve their advertised performance

By GLENN C. HOURAHAN, P.E.

The basic purpose of every HVAC system is to add or remove heat energy at a rate that matches heat losses or heat gains in the home. Designing HVAC systems can be a complicated process, but knowing what to look for can save time and money and provide homeowners with the performance they paid for.

To ensure that an HVAC system design is suited for its intended application, the builder should verify specific elements from the design documents and be aware of some basic red flags. Too many HVAC contractors continue to use 1950's rules-of-thumb that result in oversized HVAC equipment selections (often, by a factor of two) and undersized duct distribution systems (often, by a factor or two).

> Most homebuilders would recognize if a wall assembly or floor area were modeled twice as big as what is specified on the home's design plans...once they know where to look on the load calculation.

How many BTUs does a home need?

The first step in designing a home's HVAC system is making an accurate and correct load calculation. ACCA Manual J® determines a home's heat loss (winter) and heat gain (summer); losses and gains are reported in BTUs per hour. Fenestration (windows, glass doors, and skylights), opaque panels (ceilings, floors, walls), air infiltration (related to home tightness), mechanical ventilation/exhaust, internal heat gains (people, appliances, plants), and system components like ducts and blowers must all be factored into the load calculation.

Most homebuilders would recognize if a wall assembly or floor area were modeled twice as big as what is specified on the home's design plans ... once they know where to look on the load calculation. Purposefully misrepresenting wall and roof areas is fairly rare. However, to increase the load calculation to 'historical' rules-of-thumb values that some designers feel comfortable with (say, 500 or 600 square foot per ton of air-conditioning), these designers artificially increase the load by adding an excessive number of home occupants, inflating the concurrent appliance load, failing to take credit for glass shading (eave overhangs, internal blinds, etc.), and adding safety factors. Other common load-increasing approaches are unjustly increasing the outside design temperature for cooling load calculations and unjustly decreasing it for heating calculations. Just as common, inappropriate indoor design temperatures are used. Knowing the math behind a load calculation helps homebuilders to recognize when practitioners are fudging numbers to get bigger loads. In general, a new home being built to today's code requirements should have a cooling load that is between 900 – 1300 square feet of conditioned area per ton of equipment. Thereby, in many instances, a 2400 square foot home may only need a two ton system.

Selecting equipment for proper performance

The second step is to observe ACCA Manual S® procedures to select HVAC equipment for the specific home. The ACCA Manual J® total heating and cooling loads, along with the equipment manufacturer's expanded engineering data (adjusted for your local design conditions), will result in equipment selections that satisfy code requirements. Varying with equipment type, ACCA Manual S® prescribes how large the selected HVAC equipment can be (as compared to the ACCA Manual J® load).

Sizing the ducts so hhat the air goes where it needs to be

The next step is to size the duct distribution system per ACCA Manual D®'s duct sizing procedures. If the ducts are undersized, various rooms are not going to get enough air flow, and the little that they do get will be noisy. A duct design red flag is a designer that always uses the same value friction rate (say, exactly 0.10 IWC/100 ft) in all duct designs. Another is failing to account for the HVAC components (e.g., "A" coils, enhanced filters, dehumidifiers, registers/grilles, zoning dampers, etc.) that are in the airstream and decrease the amount of static pressure available to move the air down the ducts. Failing to account for these pressure drops will result in rooms at the end of a duct run not getting their proper share of air and distraught calls from uncomfortable occupants.

Resources to help

ACCA recognizes third-party software that helps designers to do their jobs (see www.acca.org/software). However, to assist your overall design review, consider having your HVAC designers use the Residential System Design Review Form (www.acca.org/codes) as the cover page to their design submission packages; the form contains the key J-S-D elements that you can easily verify. Additionally, with the HVAC system properly designed, it is critical that the contractor also properly installs the equipment. Free PDF downloads about the ANSI/ACCA 5 - 2015 HVAC Quality Installation Specification (www.acca.org/quality) and the ENERGY STAR® new homes program (www.acca.org/qa) can be found at the indicated URLS.

Glenn C. Hourahan *is a senior vice president at the Air Conditioning Contractors of America and directs technical activities in developing and updating design manuals, standards, contractor accreditation programs, and formulates ACCA's educational policy for an evolving workforce. For more information, visit www.acca.org.*