

Residential Mechanical Equipment Loads and Sizing

Mechanical systems in residential construction are commonly oversized, which increases installation costs, wastes energy, and reduces comfort and moisture control. Properly sized equipment will cost less, last longer, provide greater comfort, reduce humidity, and save homeowners money. Yet builders and code officials are sometimes uncertain as to how to evaluate equipment sizing calculations to make sure they meet the intent of the code.

Manual J and Manual S

Residential equipment sizing procedures are found in the Air Conditioning Contractors of America (ACCA) Manual J¹ and Manual S² documents. Manual J is used to calculate heating and cooling loads, which are an estimate of the amount of energy required to keep a building at comfortable conditions during the coldest and hottest days of the year for any given climate and building design. Computer software programs are available to simplify the load calculations specified in Manual J. Once the heating and cooling loads are determined, Manual S can be used to select appropriate equipment that is capable of meeting the building loads. The intent of these procedures is to select heating and cooling equipment that is properly sized—not too small and not too large. Sizing equipment right will provide the best combination of comfort, energy efficiency, and low cost.

The code requirements pertaining to residential equipment sizing in the 2006 International Energy Conservation Code (IECC) are slightly



different than in the 2009 and 2012 IECC. The 2006 and 2009 IECC reference Section M1401.3 of the International Residential Code (IRC), but the 2012 IECC references Manual J and Manual S directly.

The 2006 IRC does not specifically require that equipment be sized according to Manual S, but that it be sized according to building loads calculated using Manual J. This means that jurisdictions enforcing the 2006 IECC requirements may only be asking for documentation that verifies loads were calculated according to Manual J. The 2009 IRC requires sizing in accordance with both Manual J and Manual S.

A recent code compliance evaluation study based on compliance with the 2006 IECC was conducted

¹ Air Conditioning Contractors of America Manual J Residential Load Calculation (www.acca.org/store/product.php?pid=172)

² Air Conditioning Contractors of America Manual S Residential Equipment Selection (www.acca.org/store/product.php?pid=154)

in Utah. The study found that while ACCA Manual J was being required in most jurisdictions and code officials had been taught how to read it, most of the jurisdictions were unsure how to actually look at the loads created for the house to determine if the equipment that was being proposed or installed actually met or exceeded the loads. The study concluded that all jurisdictions could benefit from additional Manual J training that focused more on how to verify if the equipment chosen actually matched the loads calculated.

The 2009 IRC, referenced in the 2009 IECC, corrected this problem by requiring that equipment be sized in accordance with Manual S based on the loads calculated according to Manual J. This removed the burden on the code official of interpreting correctly sized equipment based on the building loads.

Calculation Errors

Even when Manual J and Manual S calculations are submitted to the building department, enforcement staff should still check the documentation to verify that the calculations were correctly done, and later that the building was constructed as documented.

In a recent article in ECOHOME 2011 titled “10 Common Failures in LEED for Homes Project³,” green rater Andrea Foss lists common errors she finds on Manual J submissions, including:

- Use of default values instead of values reflecting the actual design
- Use of the incorrect city
- Failure to specify the home’s infiltration rate as “tight”
- Inaccurate insulation values for the walls and windows

Third-party evaluators involved in recent code compliance evaluations observed that values submitted with code compliance documentation (such as REScheckSM) did not match corresponding values used in loads calculations. Conflicting values can be found on the submitted plans, the compliance reports, and/or on the Manual J calculations. For example, both REScheck and Manual J software require exterior wall areas and R-values, window areas and

their corresponding U-factors and solar heat gain coefficient values. Correlating values across these documents can reveal calculation errors and discrepancies. Training to understand what should be looked for is often needed for code officials trying to validate these documents. Some existing resources may help, such as the Submittal Checklist for Residential HVAC New Construction or Replacement⁴, developed by Pima County Development Services. This document identifies key values to compare across REScheck compliance reports and several commonly used software products that implement the Manual J calculations.

Documentation Matching As-Built

Once documentation is verified to be accurate and consistent, the code official must verify the building was constructed as designed. State compliance study reports concluded that even when calculations were provided, the equipment actually installed was often substantially greater than what was specified from the loads and/or sizing calculations. In many instances, ‘paper’ compliance varied from what was observed on-site.

Further Resources

Designing Forced-Air HVAC Systems (http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/forced_air_hvac_guide.pdf)

Right-size Heating and Cooling Equipment (http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/31318.pdf)

³ 10 Common Failures in LEED for Homes Project (www.builderonline.com/leed/10-common-failures-in-leed-for-homes-projects.aspx)

⁴ Submittal Checklist for Residential HVAC New Construction or Replacement (www.pimaxpress.com/Documents/Building/Manual%20%20Submittal%20Requirements.pdf)