

The “ICF Effect” on HVAC Design

Insulating Concrete Form (ICF) construction is a well-known solution for energy savings, thanks to the unique combination of the “ICF Effect:”

- continuous insulation,
- reduced air infiltration,
- thermal mass moderation.

Walls built with ICFs can significantly reduce heating and cooling loads and affect HVAC equipment sizing. With ICF houses, the traditional HVAC sizing rule of thumb doesn’t work well, because it is based on assumptions of standard heating loads per square foot. ICFs fall outside of the norm. HVAC systems should be sized for the house specifics, taking the “ICF Effect” into account. A “rightsized” system can deliver comfort through clean indoor air quality and stable interior temperatures. Matching the HVAC equipment to meet the design load also optimizes energy efficiency and helps maintain comfortable humidity levels.

“Rightsizing” HVAC equipment for ICF walls helps deliver comfort, efficiency and moisture control.

CODE COMPLIANCE

The most widely adopted energy code in the US, the International Energy Conservation Code (IECC), recognizes the impact of air infiltration, thermal mass and continuous insulation. For commercial construction, the IECC requires compliance with ASHRAE/IESNA Standard 90.1, Energy for Buildings Except for Low-Rise Residential Buildings.¹ In this standard, the American Society for Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has incorporated tables which offer credits for thermal mass.²

For residential construction, the IECC recognizes the contribution of thermal mass by reducing the R-

value requirements for insulation.³ The Code further stipulates that 50% of this insulation must be installed on the exterior of the mass wall. Most ICFs meet the high R-values required in the coldest climate zones, while exceeding the Code in other zones.

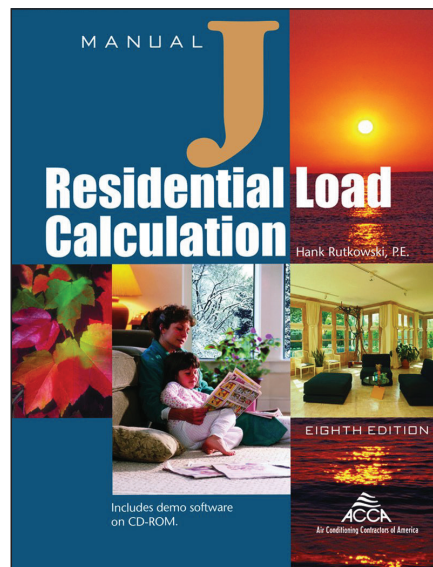
RESCHECK/ COMCHECK

Jurisdictions who adopt the IECC also generally allow for the use of the U.S. Department of Energy (DOE) software, ResCheck and ComCheck, to determine code compliance. This widely used freeware calculates an overall U-factor for the building envelope, and allows for an exchange of enhanced energy efficiency in one component against decreased energy efficiencies in another.

While helpful in achieving code compliance, this method may affect occupancy comfort. For example, while the ICF R-values may be considerably higher than required by the prescriptive method in some climate zones, a trade-off of a low Rvalue insulation in the ceiling would not be desirable. The heat gain from the attic would greatly affect the overall comfort level in the home.

The residential calculator, ResCheck, specifically lists ICFs as one of the wall types choices. The user must enter the total R-value of the continuous insulation of the ICF. This number is unique to each ICF brand, depending on the thickness of the foam. With ComCheck, the commercial calculator, the closest option to an ICF is a solid concrete wall, with a choice of wall widths, concrete density and furring details.

While the ResCheck/ Comcheck software does not capture the full impact of the ICF Effect, it does offer some opportunities to address two of the factors: continuous insulation and thermal mass. The third factor: air infiltration, is best addressed by the ACCA Manual J calculations for sizing residential HVAC system.



ACCA HVAC Sizing

HVAC SIZING SOFTWARE – RESIDENTIAL

The IECC requires a mandatory equipment sizing using the Air Conditioning Contractors of America (ACCA) Manual J procedure.⁴ ACCA also recognizes several third-party software providers as producers of computer programs that are compatible with ACCA's Eighth Edition of Manual J.⁵ This most recent edition (MJ8) now allows input for values of air infiltration.

Manual J8 offers several options to capture the airtight nature of the ICF wall. On the Worksheet E (Infiltration), Step 2 - Option 1, ACH Values allows for the choice of a "TIGHT" Construction type, based on a wall of .005 Leakage Area ELA4 (Sqin/SqFt), or ACH Heating of .20 to .40, and ACH Cooling of .10 to .20.

Option 2 is the Component Leakage Area Method, which allows for a wall component entry of .00 in²/ft² leakage. The final Option 3 is the Blower Door Method. This diagnostic tool is routinely used by energy modelers to determine an accurate assessment of air infiltration. While this last method is the most accurate, it requires the additional procedure of the Blower Door Test.

Manual J8 is more limited in its ability to account for thermal lag due to the concrete, but it does allow for daily range input of high, medium, or low.

Rightsizing heating and cooling equipment is important to deliver comfort, efficiency and reliability over the entire range of the operating conditions. According to the ACCA Manual, "research studies and the experience of knowledgeable system designers indicate that aggressive use of Manual J procedures provides an adequate factor of safety."

THERMAL MASS SIZING SOFTWARE

In response to the need for more accurate HVAC sizing, the Department of Housing and Urban Development (HUD) and the Portland Cement Association (PCA) sponsored the development of an HVAC sizing tool specifically designed to capture the effect of thermal mass in concrete walls.⁶ The resulting sizing program, based on the DOE2.1E software engine, takes an approach more common to energy modeling rather than the traditional HVAC load sizing methodology. To fully account for the thermal mass imparted by concrete walls, this program utilizes

hourly weather data for a full typical year. This captures the thermal lag, which will have the effect of moderating and delaying the peak temperatures.



Thermal Mass HVAC sizing Developed by HUD and the Portland Cement Association

INDOOR AIR QUALITY

For greatest effectiveness, the HVAC system should be right-sized for all criteria of the design load. This includes the proper sizing of the air handling equipment for the square footage of the house, in order to keep the conditioned air properly circulating.

Rightsizing is also important for the control of humidity. Oversized equipment can cause shortcycling. This limited run time can adversely affect the air quality and reduce the amount of dehumidification. Excessive humidity

in a house causes problems with wood swelling, and can eventually lead to issues with mold and mildew.

Building science supports the approach of "build tight, ventilate right." The airtight construction of ICFs may call for a supplemental ventilation system and sealed combustion appliances and fireplaces. Replacement air for the kitchen and bathroom exhaust fans can be introduced into the return side of the HVAC system, and can be conditioned, filtered and humidity controlled.

ICF construction offers a unique combination of thermal qualities which can greatly improve the energy efficiency of a house. When the ICF Effect is taken into consideration in the design of the HVAC system, ICF houses can provide overall thermal comfort and clean indoor air quality.

SOURCES

1. IECC, 2006 Commercial Energy Efficiency, Table 501.2 Application, 502.2.3 and Table 502.2 Above-grade walls minimum (R-value) and definition of mass.
2. ASHRAE Standard 90.1, Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings
3. IECC, 2006 TABLE 402.1.1 Insulation And Fenestration Requirements By Component and 402.2.3 Mass Walls
4. IECC 403.6 with reference to IRC 2006 M1401.3
5. Manual J Residential Load Calculations, 8th Edition, ISBN#1 - 892765-28-4, Hank Rutkowski, P.E., ACCA
6. HVAC Sizing Methodology for ICF Homes, HUD, Feb 2004 www.concretehomes.org, HVAC Sizing CD, Version 3.0

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