NCFI POLYURETHANES — *POINT PAPER*

HVAC Systems in InsulStar® Homes

InsulStar spray-applied polyurethane insulation is very effective at sealing and insulating building envelope assemblies. Its ability to:

- Conform to odd shapes and cavities that eliminate voids and thermal bypasses;
- Expand in place to air seal construction cracks and crevasses; and
- Form a closed-cell insulating mass which retains its high R-value under a variety of climatic conditions

results in a tighter and more effective wall, floor or roof assembly than can be achieved with fibrous insulations. Tightening the exterior envelope with InsulStar insulation will substantially reduce the number one cause of moisture and mold problems: air infiltration. As moisture laden air leaks through an insulated wall or other building assembly, at some point, it is likely to be cooled to its dew point resulting in condensation. Condensation leads to conditions favorable to mold growth, wood rot, corrosion and reduced insulation effectiveness.

While InsulStar insulation offers distinct advantages and will result in significantly lower heating and cooling costs, certain factors relating to the design of HVAC systems (heating, ventilating and air conditioning) need to be considered.

If your HVAC contractor is unfamiliar with load calculations for high-performance InsulStar® homes, NCFI can recommend experienced designers.

Ventilation

Ventilation is needed in a home to supply fresh air, to expel odors and fumes, and to provide combustion air for burner-type appliances. Leaky homes typically provide this ventilation through natural infiltration. Because InsulStar insulated homes have very low natural infiltration rates, HVAC systems should be designed to provide adequate ventilation.

ASHRAE Standard 62.2 *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings* defines the minimum requirements for ventilating residential structures.

Many manufacturers offer reasonably priced energy recovery ventilators that can efficiently meet ventilation requirements.

Moisture & Mold

Four elements are needed for mold growth: mold spores, food source (mold loves cellulosic materials such as lumber and paper), favorable temperature and favorable humidity. The most reliable method to control mold is to control humidity. We can't eliminate mold food sources or mold spores. And mold and people love to live at the same temperatures. The only element we can control is humidity: mold wants relative humidity at 75 % or higher and people prefer it lower. Controlling humidity is the most effective way to control mold.

During the cooling season, the air conditioning system operates to cool and dehumidify a home's interior. Modern air conditioning systems are more effective at dehumidifying when they run for longer periods of time (fewer but longer cooling cycles). Short cooling cycles can result in cool interior surfaces that are at or near the dew point of the interior air. This condition will feel "clammy" and will offer ideal conditions for mold growth.

Sensible vs. Latent Heat

Sensible heat is the energy needed to change your home's temperature. Latent heat is the energy needed to vaporize water. As air conditioning systems work, they cool (remove sensible heat) and dehumidify (remove latent heat). The relative amounts of sensible and latent heat removed depend on the design and operation of the air conditioning equipment. Air conditioning equipment which is oversized will cycle on and off frequently: while effectively controlling room temperature (sensible heat) it will fail at controlling humidity (latent heat).

Avoid Oversizing

The temptation in air conditioning equipment selection is to oversize. However, oversizing an air conditioning system can result in multiple problems including:

- Reduced humidity removal
- Increased mold growth potential
- Large temperature differences between rooms
- Higher installed and operating costs
- Greater drafts and occupant discomfort.

An oversized air conditioning unit will tend to cycle on/off frequently: the unit will cool the air but will not run long enough to reduce the humidity.

HVAC equipment is rated for both sensible and latent loads; equipment must be matched to both these loads and not oversized. Properly sized HVAC equipment will avoid the above problems and lead to a healthier, more comfortable environment.

Load Calculation

The best way to avoid over- (or under-) sized HVAC equipment is to perform a load calculation. Don't rely on a contractor's "rule of thumb" or on a contractor's past experience. Remember: an InsulStar insulated house is much tighter than a fiberglass insulated house; your HVAC contractor may be unfamiliar designing units for high-performance InsulStar homes.

There are a number of excellent design tools and methodologies for calculating heating and cooling loads. *Manual J: Residential Load Calculation Manual*, published by the Air Conditioning Contractors of America (ACCA) is the standard for determining HVAC loads. Software versions of *Manual J* methodologies include Right-J (Wrightsoft Corporation,

www.wrightsoft.com); Rhvac (Elite Software, www.elitesoft.com); and various HVAC equipment manufacturer's versions. These programs also integrate ventilation needs into their calculations.

When performing load calculations for high-performance InsulStar homes, designers should consider the following:

- Model ductwork in conditioned space;
- Adjust the natural infiltration based on blower door testing or to the load calculation software's version of "tight";
- Adjust for lifestyle factors such as holiday parties, indoor plants and aquariums, and the number of occupants per bedroom.
- Insure both latent and sensible load components are accounted for in the load calculation.

> In general, it's more cost effective to reduce heating and cooling loads with high-performance insulation and windows than to increase equipment efficiency or capacity to meet a higher load.
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> — Bob Kingery, Energy Consultant

Non-Vented Attics

A major advantage of InsulStar spray polyurethane insulation is the capability of insulating the underside of the roof deck and create conditioned space in the attic. Conditioned attics allow for creating added living space and for routing ductwork.

However, most load calculation software do not accurately determine HVAC loads for non-vented attics and the rooms below. Two methods may be used to provide an improved load calculation:

1. Treat the attic as an additional room; calculate the attic load; and add a fraction of the attic load (based on the designer's experience) to the room(s) below.
2. Create a ceiling plane with a set temperature differential (such as 10º F) across it.

Balancing Loads and Equipment

HVAC equipment is typically balanced to provide a ratio of approximately 400 cfm of air flow per ton of cooling (12,000 Btu). In high-performance InsulStar homes, the load calculation often will require greater air flow per ton of cooling than the typical equipment ratios allow. Strategies to address this include:

1. Install a higher capacity air handling unit than the compressor unit (for example, mate a 2.5 ton air handler with a 1.5 ton compressor). Be sure to stay within the manufacturer's ARI match and that equipment selection meets latent load requirements.
2. Install a variable-speed air handler (low air velocity through the coil keeps the coil cooler and removes more humidity).
3. Install a two-speed compressor.
4. Install a thermidistat (controls both temperature and humidity; must be matched to equipment).
5. Install a stand-alone dehumidifier.
6. Install combinations of the above.

Other Considerations

Supplemental Dehumidification

In hot, humid climates, even properly sized air conditioning systems may need supplemental dehumidification, particularly in the spring and fall when temperatures are cooler but when humidity remains high.

Combustion Appliances

When installed within the building envelope, combustion appliances require their own air inlets and combustion gas outlets. These appliances are typically called "sealed combustion" or "two-pipe" units. Gravity vented and unvented combustion appliances should not be used within the thermal envelope of InsulStar homes.

Exhaust Venting

Provide adequate exhaust venting to the outside in kitchens and bathrooms to remove moisture at the source. Typically, kitchen ranges require 100 cfm to the exterior while bathrooms require 50 cfm to the exterior. Make sure the exhausts vent to the exterior rather than merely circulate or vent to attics or crawlspaces.

NCFI Polyurethanes Can Help

NCFI can recommend HVAC designers who are familiar with high-performance InsulStar homes. If you need help with load calculations or design concepts, let us know—we can help.

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