# Design Assumptions for HVAC & Ventilation Design Note

The use of Icynene® in a building offers the opportunity for dramatic improvements in energy efficiency and comfort. By minimizing air leakage, Icynene® changes the way buildings fundamentally perform, and the demands on the HVAC system. In each structure, variations in climate, orientation, window areas, etc will determine the extent of the impact Icynene® can have on the overall building. Because each situation is different, it is impossible to use a rule-of-thumb to determine the specific heating and cooling loads. Instead, it is more important to understand how the use of Icynene® changes a building's performance and then use a standard HVAC design software package to calculate the loads.

## Increased Performance

There's no denying that installing Icynene® in a building can substantially reduce heating and cooling loads. This improved performance can be entirely attributed to the fact that Icynene® is both an air barrier and insulation material. Blower Door diagnostic air leakage test results for residential buildings insulated and air-sealed with Icynene® consistently test at less than 1.5 Air Changes per Hour (ACH) @ 50 Pa of pressure ($ACH_{50}$). When converted to leakage rates based on natural pressure, well-built houses insulated with Icynene® typically range from 0.05 ACH to 0.1 ACH at natural pressure ($ACH_{nat}$). Basing HVAC design for space conditioning on a design infiltration / exfiltration number of 0.1 $ACH_{nat}$ provides a conservative means to address field variability, and is therefore recommended. This compares very favorably to conventionally constructed residential buildings that often test at 5 to 7 $ACH_{50}$, or 0.6 – 0.7 $ACH_{nat}$.

In the interest of customer satisfaction and to ensure that desired interior design conditions can be met at all times, there is a natural tendency to add considerable extra heating and cooling capacity when selecting equipment. This common trend to oversize is understandable with typically constructed (leaky) buildings, due to the unpredictability of performance. However, oversizing equipment in predictably tight buildings leads to equipment short-cycling, resulting in elevated humidity levels, and therefore, added liability for the HVAC designer in the event that moisture/mold problems develop in the building.

## Mechanical Ventilation

Many new structures are excluded from requiring a dedicated mechanical ventilation system because the natural infiltration rates exceed the delivery volume of the mechanical ventilation system – it is assumed that the natural ventilation provides sufficient ventilation. However, natural ventilation is unreliable, and can often transport humidity into locations where moisture problems can result. Homes that are air-sealed and insulated with Icynene® do not rely on natural infiltration for ventilation. Instead, a mechanical ventilation system is required, in order to meet the code requirement for ventilation and to ensure the proper function of the home.

## HVAC in a Conditioned Attic or Crawlspace

In regions where standard construction practice involves the location of HVAC equipment in typically unconditioned spaces like attics or crawlspaces, the conversion to unvented attic or unvented crawlspace systems can lead to substantial reductions in energy consumption. Note that because most attics and crawlspaces can add a considerable amount to the volume of conditioned space, unvented attic or crawlspace systems can only reduce energy consumption in situations where duct losses to the outdoors are significant. Unvented attic and crawlspace systems should therefore not be used indiscriminately.

Depending on the jurisdiction, these assemblies can be referred to as conditioned space, indirectly conditioned space, or even buffered unconditioned space. In any case, the decision to locate HVAC and distribution systems in an unoccupied, indirectly conditioned space requires that special provisions be met. For attics, the HVAC and distribution system should be accommodated as follows:

1. The volume of the attic is added to the conditioned volume of the house.
2. Ducts and equipment should be specified as "within the conditioned envelope", with duct losses back into the conditioned space. The duct loss percentage should remain representative of the actual duct losses.
3. No supply or return terminals or registers are to be installed in the attic, as this area will not be directly conditioned.
4. Combustion appliances are to be sealed combustion units, and fitted with an outdoor air intake. Combustion units are to exhaust directly to the outdoors.
5. Vents originally intended to exhaust into the attic (plumbing stacks, dryer vents, etc) shall be continued through to the outdoors.

The decision to locate HVAC and distribution systems in an unoccupied, indirectly conditioned crawlspace should be accommodated as follows:

1. Ventilation is to be provided in accordance with the requirements of 2004 IRC Section R408.3.
2. The volume of the crawlspace is added to the conditioned volume of the house.
3. Ducts and equipment should be specified as "within the conditioned envelope", with duct losses back into the conditioned space. The duct loss percentage should remain representative of the actual duct losses.
4. Combustion appliances are to be sealed combustion units, and fitted with an outdoor air intake. Combustion units are to exhaust directly to the outdoors.
5. Vents originally intended to exhaust into the crawlspace shall be continued through to the outdoors

## Field Reliability

Today's buildings are far more vulnerable than those built even 50 years ago. Building practices have changed; it is now too expensive to build as we once did. As a result, small design errors can lead to condensation problems. A properly sized space conditioning system, coupled with a dedicated mechanical ventilation system, is required to controlling moisture issues and providing performance for the life of the building.

Proper design has to start with tried and proven concepts based on the results of years of comprehensive field experience. These design recommendations have been developed through the guidance of many of the US's top building science engineers, and based on years of field-testing. The net result is designs that can achieve an average of 30 to 50% reduction in space conditioning loads, and a similar reduction in energy costs.