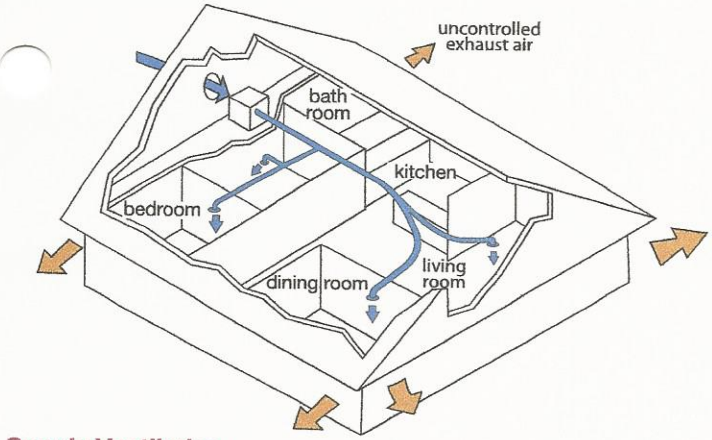
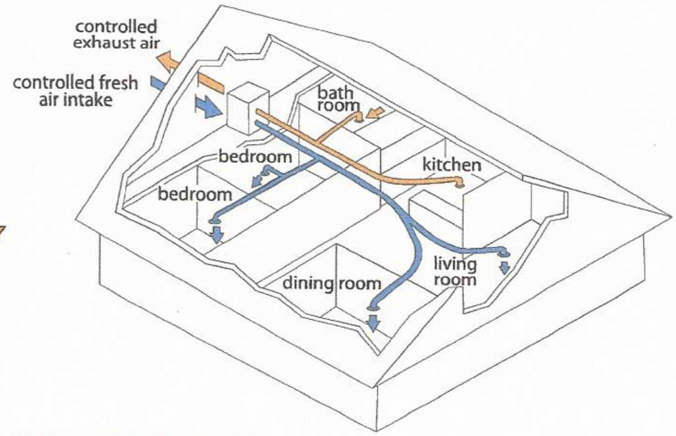



## Supply Ventilation

For the supply ventilation technique, the best way to bring air into the house under positive pressure is to run a small duct (usually 4 or 6 inches) from the return plenum of the air conditioner to a gable end or eave of the house. When the thermostat calls for cooling/heating, fresh air is drawn into the return plenum. It is then mixed with the large flow from inside the house, and is then filtered. Lastly, the cooled/heated and dehumidified air is warmed as it crosses the heat exchanger in winter and cooled in summer. If the air handler fan is used for ventilation, it is important to specify an electrically commutated blower motor (ECM). This is because they are so much more efficient than traditional motors, greatly reducing the cost of ventilation. Supply ventilation can also be provided through a stand alone combined dehumidifaction/ventilation system tapped into the supply plenum.




## Balanced Ventilation

Ventilation can occur using a balanced flow by introducing a HRV or an ERV. Both units pass the exiting and incoming air through a heat exchanger to moderate the temperature difference thus reducing the energy impact of the ventilation. The ERV, unlike an HRV, will also transfer some humidity from one air stream to the other. Manufacturers allow these systems to be ducted in several ways, including directly from the house to the outside or connected from the outside into the air ducts of the house. The system should always be ducted in a way approved by the manufacturer.

The table at the bottom of the page summarizes ventilation techniques and preferred methods.

| | HOUSE PRESSURE | PROS | CONS |
|---|---|---|---|
| **Exhaust** | Negative | • Simple Installation | • Uncontrolled Quality and Distribution of Fresh Outside Air<br>• No Energy Recovery |
| **Supply** | Positive | • Simple Installation<br>• Control and Distribution of Fresh Outside Air | • No Energy Recovery |
| **Balanced - HRV** | None | • Energy Recovery<br>• Lower Operating Cost<br>• Control and Distribution of Fresh Outside Air<br>• Control of Expelled Inside Air | |
| **Balanced - ERV** | None | • Energy Recovery<br>• Lower Operating Cost<br>• Humidity Control<br>• Control and Distribution of Fresh Outside Air<br>• Control of Expelled Inside Air | |

### Important Note About Air Handlers

If a ventilation system that uses the HVAC air handler fan to provide the needed fresh air (as is the case in many supply ventilation strategies) is used, it is imperative to ensure that the air handler fan operates often enough to provide sufficient fresh air. During periods of mild weather, or at night in the summer, the air handler fan may not be called on to run for several hours, so the house would get no fresh air during these times. To address this, control units are now available that will ensure the house always gets the needed ventilation. If the air handler does not operate enough for sufficient ventilation, the monitors will call for the fan to operate and provide sufficient fresh air.

Typically, most homes need for the fan to run for between 10 and 20 minutes each hour to meet the home's ventilation needs. An example of this type of fan control unit is the *AirCycler*[2].

Regardless of technique, this exchange of air with the outside not only affects the temperature in the house, it also impacts the humidity in the house. Therefore, it's critical to include ventilation air in the ACCA Manual J, Eighth Edition (J8) HVAC sizing calculations.

### House Pressures

When providing mechanical ventilation, it's best to keep the pressures generated by the ventilation very small. Most standards recommend keeping any negative or positive pressures below +/- 3 Pascals or 0.012-inch water column with reference to the outside.

In heating dominated climates, a builder wants to keep the house under less than +3 Pascals to avoid forcing warm indoor air into the wall cavity where it could cause condensation. In all areas of the country, builders want to keep the house pressure with reference to the outside from exceeding -3 Pascals to avoid drawing combustion by-products into the house from open combustion furnace, fireplace and water heater flues or radon in from basements and crawlspaces. This should not be an issue in a tight home. The required ventilation airflow rates are so small and there should not be any open combination appliances.

The exception is when large exhaust fans, like big kitchen exhaust hoods are installed. These units require that one provide make up air. Hard wiring the big exhaust appliance to a fan that brings in sufficient air to offset the exhaust rate of the appliance will accomplish this.

## RIGHT SIZING HVAC EQUIPMENT

### Old "Rules of Thumb" No Longer Apply

In the beginning, the residential HVAC industry relied on "rules of thumb." The most commonly applied rule of thumb states that one ton of air conditioning equipment was needed for each 400 - 500 square feet of conditioned space. Homes like those in the 1950s and '60s with little or no insulation, leaky single pane windows, no air sealing package, ducts that lost one fourth of the conditioned air and other common attributes of older homes needed a ton of capacity for each 400 - 500 square feet of conditioned space in cooling-dominated climates. Similarly, each region had rules of thumb for heating requirements.

The home building industry has made significant strides in improving energy efficiency with higher R-values, improved windows and improved air tightness in both the envelope and the ducts. As a result, the sensible cooling and heating loads on a home are significantly less than when the rules of thumb were developed. SPF takes energy efficiency to the next level by allowing ducts and equipment in conditioned space and greatly reducing air infiltration. Given that air infiltration and duct leakage often contribute 40 percent or more of the heating and cooling load, SPF homes have greatly reduced sensible heating and cooling loads.

Today, most HVAC units are installed without the contractor performing a Manual J8 calculation. Most contractors just apply one of the rules of thumb. ACCA states that these typical industry practices result in the average system being between 150 - 200 percent oversized! With higher efficiency SPF homes, the old rules result in even greater over sizing.

Over sizing equipment will result in short cycling of the equipment and higher upfront cost for the builder and the homeowner. This reduces the efficiency of the units, leading to higher utility costs for the homeowner. Heating units and air conditioners start each cycle at a much lower efficiency than their stated efficiency rating. That is the efficiency they reach after running long enough to reach what is called "steady state efficiency." It takes at least 10 minutes for them to reach this efficiency level. When they short cycle, they are always operating at a much lower efficiency, so utility cost are higher than necessary. In addition, air conditioners that short cycle do not run long enough to perform dehumidication, which can lead to high indoor relative humidity and poor comfort.

Performing strict Manual J8 loads gives builders credit for much-improved envelopes they are delivering. Ideal equipment operation is then accomplished by following the ACCA Manual S for equipment selection (now required by IECC 2009); never over sizing by more than 15 percent over the calculated actual BTU load and being willing to reduce the tonnage of the equipment to closely match the now reduced sensible load.

## HUMIDITY AND MOISTURE RELATED ISSUES

This increase in air tightness also changes the moisture dynamics in the home in several ways. First, the moisture generated in the house, stays in the house. Second, the sensible or temperature load on the house goes down significantly, while the latent or humidity load remains the same. Therefore, if adjustments are not made – the air conditioner is oversized, it short cycles and the inside humidity goes up.

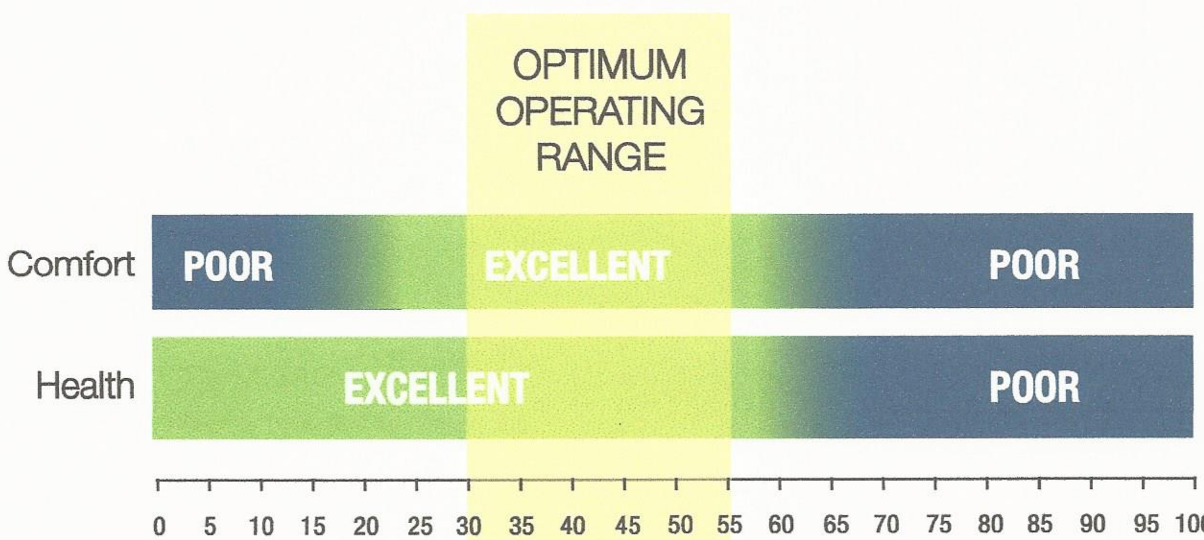
Moisture control is critical to both human comfort and to our health. ASHRAE studies have shown that most people are comfortable when the relative humidity is between 30 - 60 percent. When the indoor humidity exceeds 60 percent, owners will try to address this discomfort by lowering the temperature to find comfort. This just increases the electric bills and can lead to condensation on supply grilles and the growth of mold. When the indoor relative humidity is allowed to exceed 55 percent, dust mites begin to flourish. Dust mites are a primary cause of asthma attacks and one of the most common allergens present in our environment. Similarly, growth and activity of mold and various bacteria increase at higher humidity levels.

The chart below shows the relationship between indoor relative humidity, comfort and the growth and activity of various organisms that contribute to unhealthy indoor air quality.

There is a reference to an "Optimum Operating Range" between 30 - 55 percent indoor relative humidity. In this range, most people are comfortable, and the home experiences low levels of activity by the organisms that are detrimental to healthy indoor air quality.

Higher relative humidity levels also increase the risk of condensation, which can lead to mold and rot. Moisture can condense on relatively warm surfaces in a high relative humidity environment. Keeping humidity levels under control will reduce this risk.

**Optimum relative humidity effects on comfort and health**



### Equipment Sizing and Selection:

There are several methods that contribute to controlling humidity in tight, SPF homes:

- Right sized air conditioner
- Evaporator coil selection
- Variable speed blower (ECM) units with a humidistat
- Stand-alone dehumidifier (hot humid climates)

Using the traditional rules of thumb for sizing will result in oversized equipment and short cycling in tight, SPF homes. Why is it important to ensure short cycling does not occur? Most evaporator coils today don't begin to remove moisture from the indoor air until eight or nine minutes into the cooling cycle. Over sizing the system results in short cycling because the unit can lower the house temperature so quickly that the system never runs long enough to get into the mode where it performs good moisture removal. Right sizing the equipment to ensure efficient and adequate run times will improve the humidity control of the air conditioning system.

Another necessary adjustment is to select evaporator coils (the indoor component of an air conditioner) with a good sensible heat ratio (SHR). SHR is the ratio of air cooling to humidity removal that a coil does. Many contactors select the coil that gives them the highest seasonal energy efficiency ratio (SEER) rating. This is usually a coil that has a lower latent capacity than other coils that could be matched to the selected condenser using AHRI certified equipment, so it does less dehumidification. This is all right if one lives in an arid or desert climate. For everyone else, a good number to aim at is an SHR of 0.75 or less. This means that at-design conditions, the coil will expend 75 percent of its energy cooling air and 25 percent of its capacity in de-humidification. This is particularly critical in humid climates.

It is also wise to use electronically commutated motors (ECM) or variable speed blowers paired with a thermostat/humidistat combination controller often called a "thermidistat." This combination of a variable speed blower with an advanced control unit can greatly improve indoor humidity control. Thermidistats sense and operate to control indoor relative humidity as well as temperature. When the indoor relative humidity exceeds the level set by the owner, say 50 percent, the compressor comes on, and the fan operates at a slower speed than it does in normal cooling mode. This moves a smaller amount of air over the coil, so the air gets colder before leaving the coil and this increases the amount of moisture removed. The unit will run in this mode until the humidity level is reduced and then if necessary, it will ramp up to high speed to meet the temperature setting. In many climates these adjustments will be sufficient, but not necessarily in the more extreme climates.

Since the system is also cooling the house as it dehumidifies, it can overcool the home. Most systems have an override that cuts the air conditioner off if the house temperature drops to more than three degrees below the thermostat set point. In very humid climates, the dehumidification cycle can be ended by this override before the humidity level is reduced to the desired level, leaving the house uncomfortable.

In especially humid climates, it is a good idea to install a separate, stand-alone dehumidifier to address the latent load in the mild "shoulder" months and at night, when the sensible temperature load limits the run time of the air conditioner. A good option in these cases is the installation of a unit that combines the ability to ventilate the house, with high efficiency filtration and very efficient humidity control that is not dependent on air conditioner run time. Since these units are designed to remove moisture, they are optimized for this job. Many units will remove each pint of water for one-third of the energy that an air conditioner would take to remove the same amount of water, thus making them energy efficient options. Several studies have researched the pros and cons of several humidity control options in a hot and humid climate[3].

## USE OF MANUAL J

Before desktop computers, it took three or four hours with a pencil and eraser of doing hundreds of multiplication, addition and subtraction problems by hand and looking up dozens of heat transfer multipliers for many materials in a myriad of tables to do a Manual J calculation. The investment of time for the contractor was too great, so rules of thumb were used. With today's software, one can perform a Manual J calculation in less than an hour.

### Envelope Efficiency Problems Contractors Didn't Know They Had

Even when contractors installed equipment to a strict Manual J, they often got call backs because the units appeared to be undersized. The reason was that the performance of the home was often less than the input values into the software. Insulation did not perform to its stated R-value because of improper installation and air movement and convection through the material. Duct leakage was found to be a major load that was not accurately taken into account in older versions of Manual J. Chases, knee walls and open flooring systems were often left essentially uninsulated, although they were rarely accounted for in that way.