Oversized HVAC Cooling Equipment - 2021

Recent energy code changes require all phases of HVAC work to include engineering for proper sizing of HVAC equipment. The practice of installing HVAC equipment based on one's "experience" or simply using the existing HVAC equipment size (equipment change outs) as the criteria for the size of replacement HVAC equipment is now abolished by the Energy codes and the ACCA hvac design manual S. An exact change out of the existing HVAC equipment should be verified by calculations because the existing HVAC equipment will most likely be grossly oversized. Our codes require a heat load demand (Manual J or Manual N) mathematical calculation to determine the correct size HVAC system(s) for all buildings, our code does not allow HVAC equipment that is too small (not even 1 btuh short is allowed) or too large (not greater than 15% of the calculated heat load or closest available equipment size).

The heat load demand calculations required are both time consuming and complicated, as each building envelope component heat transfer will vary per component type and building compass orientation. A typical single HVAC system heat load demand calculation can consume about 4 hours of time (manual J 8th edition in linked to Manual's D,S,T). The reason for this code update is obvious, many Florida buildings either never had a heat load demand calculations performed – or many buildings have had major envelope component changes like new energy efficient windows or increased insulation. The typical older Florida home that has had one or two HVAC equipment replacements that are most likely oversized because each time equipment is replaced the typical HVAC contractor increases the existing size by ½ ton, so if the home has had a few equipment replacements over time – the building most likely has grossly oversized HVAC equipment installed. Also, many older homes have had windows upgraded, vented attics converted to unvented attics, additional insulation added, or any other change that would affect the buildings heat load demand calculations. A common example is a home upgraded with modern low e windows and an unvented attic may have reduced the required a/c cooling tons by 25%. A majority of HVAC contractors use a "square feet per ton guess" as a short cut to select HVAC equipment size, this "square foot per ton guess" too was abolished by the energy codes in 2001, as the practice of guessing is forbidden and absurd. 25 years ago, most homes used minimum insulation and single pane clear glass, usually about 18% GFA (glass to floor area) – resulting in calculations that ranged in the 400 to 500 square feet per ton, but today's homes are using greater insulation R values and double pane low e windows – resulting in heat load demand calculations 600 to 1000 square feet per ton and can go all the way to 1300 square feet per ton if using the best building materials like ICF walls, low GFA, , , low e triple pane windows, and tight building envelope construction practices.

Oversized HVAC cooling equipment in a space can cause high indoor humidity levels because the HVAC equipment is controlled by a thermostat – thermostats only measures and react to sensible heat; thermostats do not monitor or control latent heat (moisture). With oversized HVAC cooling equipment, the operation duration of the cooling equipment cycle is too short; this short cycle is due to the oversized equipment's sensible heat removal ability that quickly neutralizes the sensible demand resulting in a quickly cooled building. Properly sized HVAC cooling equipment will operate continuously during design conditions, so when the outdoor temperature is 93 degrees – the HVAC system should operate nearly continuously to ensure the indoor space conditions will be met (both temperature and humidity). If you have an HVAC cooling system that does not operate nearly continuous during design conditions – the equipment is too large (oversized). Part load conditions (when it's not 93 degrees outside) exist for most of the year (85%), so correctly sized equipment will cycle a few times per hour because the demand is lower than the equipment's ability. Because most HVAC equipment is single speed (one stage of capacity), the cooling demand (load calculation) and equipment ability (equipment size selected) only match during the peak design conditions – for most of the year the single capacity equipment is oversized. For moisture control, operation times are critical because the typical HVAC cooling coil requires about 7-10 minutes of operation time to reach dew point at the cooling coil, so no moisture is removed from the building until dew point is reached at the air handler indoor coil (about 55 degrees or lower). The typical building in our region requires at least 30 minutes of operation time at dew point temperature in order to meet the latent heat load demand (moisture). So, we must add the 30 minutes required to meet the latent heat load demand to the 10 minutes required for the indoor coil to reach the dew point for a total minimum operation time of 40 minutes – this would best represent a typical peak design condition hour in our region. If your equipment is oversized by more than the 15% allowed by code, it will struggle to keep a desired humidity level in the building even during design conditions.

It's not the heat, it's the humidity – our bodies rely on the natural evaporative cooling process of the skin to maintain our body temperature in the comfort range – so if our indoor environment has a high humidity level, the people may feel uncomfortable because the skin will be unable to effectively transfer latent heat (sweat) into the surrounding air. Oversized HVAC equipment will not only struggle to control the humidity levels, it has the extra power (oversized) to create an indoor environment that is very cool and very moist (overcooling), resulting in water damage to the building envelope components that could possibly result in negative health for the occupants. A home owner with no knowledge of "overcooling" will most likely set the thermostat to a lower temperature because the people feel uncomfortable due to the high moisture content; this of course is huge mistake. Homes have a moisture balance point of about 78 degrees; this is nearly equal to the expected worst case dew point that occurs outdoors at the worst-case month like August. As the building owner drives the indoor temperature below 78 degrees, the indoor relative humidity levels will increase dramatically – causing a cold and moist indoor environment. As the high moisture content within the building air come in contact with colder interior surfaces – the harmless water vapor may condense into harmful liquid water. The only way to maintain a buildings humidity level year round is with a dedicated ventilating dehumidification system, controlled by a humidistat or dew point sensor. These dedicated ventilating dehumidifiers remove moisture without lowering the indoor temperature, so the indoor humidity levels drop with little change to the indoor temperature. Typical central HVAC cooling equipment combines the heat and moisture removal processes but only controls the sensible heat. This typical central cooling equipment alone will not be able to control humidity levels year round because the two processes (sensible heat and latent heat removal) are not decoupled and controlled independently. So even if the HVAC system is properly sized (this includes variable capacity cooling equipment too), it's unlikely able to control the humidity levels during part load conditions - and if the equipment is oversized – its very likely to cause comfort and possible building problems like mold and rot especially if the building is overcooled past the interior dew point temperature.