10 HVAC MYTHS – COMMON IN FLORIDA - 2021

(1)"**Square foot per ton"** can be used to determine what size air conditioning unit I need to condition my building. This of course is completely **false**, the only way to correctly size any hvac system is to perform complex math, also known as building heat load calculations. These calculations consume many design hours and include up to 5 hvac design manuals (ACCA Manuals J,D,S,T,ZR) that are prerequisite to energy code calculation, these hvac design manuals are performed within an intelligent CAD software program that data links all the design manuals to the hvac duct drawing using smart figures for the various duct system parts and building envelope components. Square foot per ton originated in the construction industry mid 1970's, before computer aided HVAC design, back when hvac designers were the only people to know that the architects listed square feet had nothing at all to do with what size the hvac system needed to be – we knew this because we performed the building heat load calculation math by hand – very time consuming. So the construction industry, especially the hvac trade, adopted the square feet per ton falsehood in lieu of performing the time consuming math that determines the correct size hvac unit for the building. Only after you perform the design manuals can you compute the buildings unique square feet per ton, no two buildings are the same, especially on an hourly basis for which a heat load calculation is based. Should you encounter anyone talking "square feet per ton" as a design practice, mention ACCA Manual J 8th edition (2016, v 2.5, code reference standard to 2023) room by room heat load calculations including adequate exposure diversity calculations, and ask that they perform all ACCA code required calculations. Florida surveys show that 60% of homes have oversized hvac equipment due to the construction industry guessing with the "square feet per ton" method. Thanks to modern computers we can now perform all 8 possible heat load calculations for any building (sun position is critical) and show that a home with exactly the same listed conditioned square feet will have 8 different heat load calculations – that's right the exact same model home may require different size air conditioners despite the homes square feet being the same – compass orientation alone proves this antique design practice "square feet per ton" false. Oh how nice it would be though if you could take a 3000 square foot home and divide it by some "magic" number, so simple (sq. ft. / magic number = required a/c tons), the reality is that each room of a building uses up to 40+ math formulas associated with just the Manual J heat load calculation – making equipment sizing much more complex than the simple "magic number" square feet per ton method.

(2)"Heat Load and Energy only" is all I need to get a permit. Spoken mostly by builders and hvac contractors, this is still **false** in Florida (2020, Dec.31), many jurisdictions now enforce the energy and mechanical codes fully. Keep in mind that code officials simply want paperwork and do not check to see if the 5 ACCA calculations are computed correctly. ACCA Manual J calculations will only be accurate if based on scaled duct drawing (Graphic Manual D drawn to scale including Manual T) and a fine tuned Manual S ensuring the equipment capacities are adjusted for the site location and based on the equipment expanded cooling performance data. Only a scaled duct drawing can provide a designer accurate exposure amounts to calculate the duct heat load amounts (a major part of the Manual J heat load) and only a scaled duct design based on Graphic Manual D, a CAD drawing tool that accounts for every duct section + every duct fittings pressure loss (for every main and branch duct for each duct mounting environment) can compute the duct systems most restrictive duct path and total pressure required for selection of the air handing equipment. This total duct pressure is used to determine the air handler's total cfm, the systems sensible heat ratio, and the equipment's heating and cooling capacity. Florida has many "design" services that guess on the duct heat loads (ASHRAE 152, by using the homes square feet to formulate a guessed amount of duct exposure in square feet) as well as the ducts total design pressures, in lieu of designing a code compliant Manual D duct system * that greatly effects the Manual J and S calculation results. According to the latest edition of Manual J 8th edition 2.5, section 23-8 Duct Loads "computer solution preferred", the preferred solution to compute duct heat loads is to use a computer software program that can account for every part of a duct system – prior to modern software, designers used simplified methods to produce an “estimated duct exposure amount” – also known as ASHRAE 152 (Manual J 6th and 7th editions). Recent comparative analysis generated from Graphic Manual D quantifies that any simplified duct heat load calculation is inaccurate and should only be used when the hvac contractor is developing budget pricing (prior to permitting) and not to be used for permit acquisition or installation. Professionals use intelligent HVAC CAD Graphic Manual D duct models that account for every piece of the duct system, capable of producing exact duct heat loads per duct section - no matter the installed environment of each duct, and also calculates the ducts total pressure – used to select the proper air handling equipment and to properly adjust the Manual S equipment selection. Should you encounter a “designer” that does just a “heat load and energy” only, ask for a complete scaled duct drawing based on the code required Manual D that includes every duct fitting and the associated pressures – “heat load and energy” is only a small part of the code required calculations that make a complete HVAC and Energy design – and would be inaccurate when based on a simplified duct gain rough estimate method like ASHRAE 152. The Florida energy code calculation software also contains input for the duct square foot amounts and the Manual S selected equipment capacities – data that is a result of the comprehensive graphic Manual D duct design – so this final calculation, the energy code calculation, is based on the 5 prerequisite ACCA design manuals including the scaled intelligent CAD duct drawing. “Heat Load and Energy only” is similar to “square feet per ton”, both unnecessary shortcuts resulting in inaccurate math results that will lead to improper equipment selection and duct sizing. I will say this myth helps to separate the professional comfort system designers who produce all ACCA math required for the best possible HVAC design from the “calc's only” designers who guess on many important sections of the ACCA HVAC design process. There really is no good reason to guess on the 5 ACCA design manuals when intelligent HVAC CAD is now commonplace, allowing a designer to produce up to 10 hvac system designs per day * including every HVAC design manual *all are data linked together and use no simplified calculations.

(3)“**High ceilings result in a larger HVAC system”** is a common **false** belief in Florida. First we must clarify what “high ceilings” mean. The first type of high ceiling is the vaulted ceiling – this high ceiling type slopes up from the exterior wall top plate, up to the highest peak. This vaulted ceiling type adds interior volume and a slight amount of extra roof area exposure. To help with this myth, I constructed an intelligent CAD model home (2134 square foot single story). The homes cooling demand (aka: Manual J) with a simple flat 9.33’ ceiling height = 2.52 tons, I then vaulted EVERY room in the home, this home had a hip roof, so some of the interior vault ceilings are inverted hips (the total ceiling surface area increased a little) – but none of the exterior wall top plates changed height, so the glass envelope components overhang projection ratio’s remained the same, the peak vault ceiling height was 14 feet – this results in an average room height of 11.665’ that produces a new demand of 2.53! That’s right, simply vaulting ALL rooms in the home had almost no effect (.01 tons) on the total building demand, making “high ceilings required a larger HVAC unit” false for a simple vault. I then took the same energy model and raised the flat ceiling height from 9.33’ to 10’. Now this is a change in the exterior wall plate height, so it will also change the more critical glass shading once the overhang projection ratio is adjusted for the overhang now located higher up from the window, also some extra exterior wall area was added due to the higher plate height. This higher flat ceiling resulted in a new demand of 2.56 – again falsifying this myth. Thirdly I adjusted the same model home using a gable style roof – with a gable style roof the gable end walls will have a greater height, so the gable roof added some extra wall area and required some window overhang projection ratio changes, the demand result was 2.57 tons, again showing the myth false – it’s sure not true that “high ceilings result in larger HVAC units” – although each energy model’s demand did slightly increase as more exposure was added, the total demand increase due to high ceilings was not significant, and in each case the same size HVAC equipment had plenty of capacity to absorb the energy demand increase with the ceiling height changes. The only real effect high ceilings have in Florida is the hvac equipment’s ability to heat the home efficiently. Florida is cooling dominant, and every duct system is designed for cooling – the cool air is introduced high in the room (near the ceiling) for best room air mixture during the cooling season, but in the heating season the warmest air will rise to the higher vault ceiling area, so the HVAC system will operate longer to heat homes with high ceilings due to natural buoyancy of warm air that stratifies at the highest point.

(4)“A larger HVAC system is required for my desired indoor temp of 70 degrees” is also heard a lot in Florida but **false**, so let’s test this myth with our intelligent CAD energy modeling program using that same 2134 square foot home. Florida energy codes set both the indoor and outdoor temperature set points used in the calculations, indoor temperature is 75 degrees for cooling season and the outdoor temperature will vary depending on the buildings site location – Florida has an outdoor temperature range from 89 to 93 degrees. Manual J 8th edition does mention that a home owner with a need for a lower indoor temp, say for health reasons, may base the homes heat load calculation on the occupants desired indoor temperature. Using the same model home with the highest heat load of 2.57 (based on the code set points of 91 degrees outdoor and 75 degrees indoor,Tampa) – keep in mind these design conditions are based on just one hour of time during peak design conditions and not based on record breaking outdoor conditions. Adjusting the energy model thermostat to an indoor set point of 70 degrees produces a new demand of 2.87, a demand that is still well within the selected 3 ton equipment capacity – and that’s at peak conditions, you could “freeze” the home at night during part load conditions when only 2.31 tons is required (due to the demand reduction associated with the solar radiation elimination). Further adjusting this homes energy model we locate the part load condition indoor set point that is achievable by the 3 ton equipment, it calculates to be lower than 65 degrees (this part load condition occurs for about 85% of the cooling season in Florida, 15% of the cooling season makes up the peak design conditions). Yes again, another fallacy – especially when you consider the part load conditions!

(5)“I just know my HVAC unit is too small, it takes forever to get the home cool again” is **false** if a home owner uses a programmable thermostat during peak weather conditions or has a standard thermostat that is set to “off” when the home is unoccupied. Programmable thermostats are energy savers when used properly, with the occupants away at work during most of the day the thermostat is programmed to maintain a higher indoor temperature suitable for a sleeping cat – they like 80 degrees. The thermostat’s set program will lower the indoor temperature before the occupants arrive home and keep that desired indoor temperature, energy savings come from the many hours the thermostat is programmed at the higher indoor set point temperature. This means that during about 15% of the year, the really hot sunny days with many consecutive hours of 91 degree or better temperatures, the thermostat program may need some adjusting to achieve the desired indoor temperature when you arrive home. The building’s interior material make up will thermally store the solar energy during the day, and because the 3 ton unit can only move 3 tons of heat in one hour, it may take several hours of equipment operation time to “catch up” with the hourly heat gain being added to the already stored energy in the building materials. The remedy is found while experimenting with the thermostats program until your program settings provide the perfect indoor temperature during this peak season, in some cases where your demand and capacity are closely matched – the thermostat program may be eliminated. Cooling equipment quickly neutralizes the excess heat once the sun sets. It’s recognized that this myth may be put to bed with understanding how the HVAC system neutralizes the demand on an hourly basis at a specific set of design conditions, so when I say my home requires a 3 ton, I mean that during one hour of time during the peak outdoor design conditions, 3 tons of energy must be removed from the indoors to keep the home comfortable. (In Tampa, there are 2,892 cooling hours, and 866 heating hours…so our 3 ton cooling and 2.35 ton heating model home has a yearly energy demand of 8,676 cooling tons and a yearly heating demand of 2,036 tons)

(6) “Ok to oversize variable capacity cooling equipment” beyond the heat load calculations demand is **false**. This phrase is a myth if the oversizing of the variable capacity equipment is very excessive and without good reason. The model home that so far has required the same 3 ton unit no matter what myth was thrown at it can be used here too. The demand for the home at the highest of 2.87 (70 degree thermostat set point) tons would have the most indoor comfort and energy savings when a 3 ton variable capacity cooling unit is selected. But we can't leave out the HVAC company salesperson, so our salesperson tells us that this variable capacity cooling equipment is also manufactured in two BIGGER models with a selection of 4 or 5 tons available! Bigger is better only if you're planning some guests over, and I mean a huge number of guests! With our home energy model set to peak outdoor conditions, the "bigger" 4 ton selection can provide a 70 degree indoor temperature with 30 occupants – and the "bigger" 5 ton would condition the home with 44 occupants. Both occupant scenarios are very unlikely for any home, but if you're planning that 4th of July cook out with all the relatives welcome, you can simply precool the home (this 3 ton can achieve 65 degrees indoor temperature the preceding night / morning). The energy model math results confirm that oversizing variable capacity equipment is a poor choice, resulting is a much higher installation cost for equipment capacity that would never be used. Using the code required Manual S equipment selection procedure ensures the variable capacity equipment is sized correctly, resulting in the best possible performance during both part and full load conditions - with the highest cooling stage capable of just neutralizing the worst case conditions.

(7)"Oversizing my HVAC unit will save energy" has already been tested (D.O.E.) and proven **false**. The key component to belief in this myth is associated with equipment cycle duration; the thought here is that if my HVAC unit does not operate much it will not cost me much money. But here's the catch, much energy is required when the HVAC compressor first starts, so the highest amp draw occurs on each "start up" – oversized HVAC equipment will have very short operation cycles because they can quickly neutralize the homes demand – so the oversized HVAC equipment will "start up" many more times per hour when compared to properly sized HVAC equipment. Also because the HVAC equipment is of a greater size than what is required by the heat load calculation, it too will have a higher amp draw during the operation cycle, once you add the higher operation cycle amp draw to the many extra "start up" energy amp draws, your total energy usage can be as high as 27% more with the oversized HVAC equipment when compared to properly sized HVAC equipment. This myth not only costs you more in energy consumption, it also provides less indoor comfort. Indoor cooling coils take some time (10 minutes) to the reach dew point conditions required to phase change water vapor into liquid water (dehumidification). Low indoor moisture levels are critical to human comfort, so the control of indoor moisture can only be accomplished by HVAC cooling equipment that has extended operation cycles. Properly sized HVAC equipment will operate almost continuously during peak conditions, removing massive amounts of moisture, resulting in the best indoor air conditions by combining low indoor humidity levels with low energy consumption. Oversized HVAC equipment will not operate almost continuously during full or part load conditions, resulting in minimal moisture removal amounts, leaving the building with that "cold wet feel " for which no one feels comfortable, and the greater energy consumption is paid for in each electric bill. Bigger is not better when it comes to HVAC equipment sizing – this is why equipment is manufactured in many sizes.(.75,1,1.5,2,2.5,3,3.5,4,5 tons)

(8)"AHRI capacity ratings can be used in Florida" when selecting cooling or heating equipment is a **false** for sure. Now this one is a little confusing because our energy code requires energy raters to use AHRI ratings for the equipment efficiencies, also known as the "SEER" and "HSPF" (seasonal energy efficiency rating is used for the cooling cycle, and heating season performance factor is used for the heating cycle) for heat pump units. But our energy code prohibits the use of AHRI cooling and heating capacities because the capacities published by AHRI are based on a 95 degree outdoor temperature for cooling season and heating season has two temperature ranges for high and low (47/17). Because there is no design city in Florida that uses a 95 degree outdoor temp, the equipment's capacity will need some adjustment (aka Manual S) to match the actual site conditions that the equipment is installed. An example is Tampa, with only a 91 degree outdoor design temperature; we find that our heat pump has a greater cooling capacity than what AHRI lists @ 95 degrees. This is due to the lower outdoor temperature, our 3 ton cooling unit placed in the Tampa has a capacity of 3.093 tons instead of the 3.00 tons when tested at AHRI 95 degree outdoor design conditions. It's sure not a huge difference in this case, and Manual S equipment selection procedure shows this same 3 ton unit is correctly sized – this will be true throughout Florida because the AHRI design conditions are very closely matched to any Florida reference city design conditions. Manual S equipment selection procedures require more attention when the outdoor design temperatures are much greater than the AHRI test conditions of 95 degrees – like in Arizona where desert regions can use up to a 109 degree design temperature in the heat load calculations resulting in our 3 ton HVAC unit producing only 2.64 tons! Only Manual S equipment capacities can be used when selecting HVAC equipment.

(9)“Total R Values can be used in the Energy Calculations” is **false** but commonly observed in both heat load and energy code calculations, this myth is commonplace for persons with little building science knowledge , and easily clarified with education. The current Florida energy calculation procedure allows only the ASTM tested, rated, and stamped thermal layer material item to be listed as the envelope components total “R” (resistance) value. In cases where an energy code calculations is performed on a really old building (constructed prior to 1975) where an existing re-used envelope component, say like a concrete block wall that has no thermal layer, the energy code will allow the average weighted sum of all the component layers.(so this old uninsulated block wall has R values associated with two air films, two air spaces, the concrete block itself, the furring strips, and the indoor plaster walls resulting in an average weighted block wall R value of 3). Heat load calculations also require that all material and air (both films and spaces) layers to be accounted for so long as the total envelope component R value calculation uses the weighted average method, accounting for : furring width, between furring width, framing percentage, air film, air spaces, emittance of each surface, heat flow direction, and of course the thermal resistance for each material that makes up the envelope component. Designers use a U factor calculator to build each envelope component layer by layer, the calculator also accounts for thermal bridging if applicable. Upon observing many modern home energy code forms, I commonly see where “designers” assemble envelope components without performing the weighted values calculation, the most common is the core fill concrete block wall. This insulation type in installed into the concrete block cells, has a rated R value of 13, but remember this insulating method does not even meet the definition of an envelope component because the insulation is not continuous, about 37% of the exterior concrete block wall is poured solid (based on a modern home with 20% glass to floor area) and cannot be insulated in the solid concrete cells, and therefore does not comply with the energy code definition of a legal building envelope component. This wall with only the hollow cells insulated has a weighted average R values of only 5.97 due to the thermal bridge that occurs at the poured concrete wall area – despite the R 13 rating of the insulation itself. I see many energy forms showing this R-13 when the walls “R” values are truly only 5.97. The remedy for this wall style is to add a continuous R-4 Insulation (paper and aluminum foil) inside the block wall and in contact with the primary air barrier (wall board). The energy codes definition of an envelope component is met once the R-4 continuous insulation is added, giving this wall an average weighted R value of 9.8. So It’s not a simple task of adding the two thermal layer R values together , thermal bridging must be considered because there’s a considerable difference in energy transfer just in this one block wall example, simply adding the thermal layers together, R13 + R4 = R-17 would be a mistake when compared to the actual weighted average R value calculation of 9.8. So for this myth that’s not really a myth when education is injected into the mix, when calculating heat loads be sure to take credit for all layers of the envelope component, but when calculating a modern energy calculation (post 1975) it’s not legal to add in any R value that is not the thermal layer, with its ASTM “R” value stamp.

(10)“I want to use a gas furnace for heating in Florida” sounds funny and can be **false**? No, it’s not mythical with respect to true or false at all, it's just plain silly to over engineer HVAC heating equipment, with only one consideration that could make it sensible to use a gas furnace in Florida. Nowhere in Florida is gas furnace equipment really needed, especially if the home has a modern building envelope (post 1975). Manual J 8th edition calculates the heating season demand, or the amount of heat that needs to be added to the interior of the home for winter time comfort. Manual S is then used to select the proper equipment type and equipment size. To date I have not seen any Florida heat load calculation that produce results that in turn would lead to the decision to install gas furnace equipment in any building because the demand is so low and the gas furnace equipment (even the lowest capacity manufactured) would be far too large to accomplish the task. There are a few old uninsulated buildings in the panhandle area of Florida that could actually produce a heat load calculation that would warrant the use of a gas furnace – and so long as the heating season heat load calculation closely matches the gas furnace's highest stage of heating capacity. Back to our energy model home with the highest peaked ceilings, but this time let's look at how much heat must be added to this home to keep us a nice toasty 70 degrees indoors while the few cold fronts pass by each year. Our energy model home requires that 28,207 btuh be added inside this home during the peak coldest outdoor weather, that's equivalent to 2.35 tons of heat, our 3 ton heat pump selected produces 34,000 btuh of heat – way more than we need, but because this home is located in a cooling dominant region, the heat pump equipment size is selected for the cooling demand. So already our heating system is oversized, so much so that this 3 ton heat pump has a heating capacity capable of heating the homes interior all the way up to 79 degrees during the peak outdoor conditions – this is why a heat pump is the recommended equipment type for north and central Florida, while electric resistance heat is acceptable for south Florida. So what about the gas furnace – I am a Yankee from New York, can I have my gas furnace please? The very smallest gas furnace equipment available in this 3 ton range produces a whopping 48,000 btuh of heat, nearly twice the amount of heat needed to heat this home and having the capability to heat the interior of the home to 96 degrees while its freezing outdoors! Similar to oversizing a cooling system, oversizing this heating system means you installed a whole lot of heat capacity that will never be used. The comfort penalty paid is due to the short cycling again, the gas equipment will operate just a few minutes to heat the air (thermostat will trigger off quickly) and then cycle off long before much of the heat is absorbed into the building materials and furnishings where the occupants can feel it, resulting in a home that feels cold and drafty. The goal again of Manual S equipment selection is to be sure you select heating equipment capacities that closely match your demand (heat load calculations). Although this request "I want a gas furnace in Florida" is shattered mathematically by both the Manual J and Manual S design procedures, this practice of installing gas furnaces in Florida will live on as long as the gas companies offer rebates to home owners or builders who know little about HVAC design or selecting heating equipment capacities that make sense (just enough capacity to do the job). Bigger is not better when selecting the heating equipment, Manual S recommends no more than 15% oversizing for heating or cooling equipment capacities – also this gas equipment type adds in the unnecessary dangers of pressurized explosive gas, introduction of moisture contained in the gas, open flames (heat exchanger), combustion air requirements, gas flue back drafting, and interior building pressure indifferences - all added into a Florida home that could easily be heated with the much safer electric heat pump that better matches the building demand.

References / Florida building code required = Manual J 8thedition v2.5 is the reference standard + Manual S required:R403.6 or ACCA183 commercial heat load CLTD:FECC403.2.2 /Manual D required:FECC403.2.7.5+FMC603.2/building envelope component materials required prior to permit acquistion:FECC103.2+FECR103.2/ HVAC drawings and required drawing Information: FBC101.4.2+ FBC101.4.6 +FBC105.3.1.2+FBC107.3.5/AHRI capacity data cannot be used:FECCR403.6.1.1

References / HVAC Manuals J,D,S,T,ZR required = special thanks to Hank Rutkowski P.E. the genius author of the Manual J 8th edition load calculation procedure (first printing, April 2002 / current v2.5 2016))// Introduction: how hvac works, 8th edition is room by room calculations, continuous equipment operation is normal at design conditions, 7-10 minutes to reach dew point conditions at the cooling coil, part load and full load description, sensible heat ratio of building and sensible heat ratio at equipment differences ,no benefit to oversizing equipment, "An HVAC design involves much more than a heat load estimate – producing a heat load estimate is not equivalent to designing a comfort system"/ Section one: cooling and heating loads room by room, peak heat load and average heat load procedure, adequate exposure diversity and thermal zone grouping, thermal zoning and zone control per level minimum, evaluating zoning requirements/ Section five: indoor design conditions authority (DOE) determined by Manual J (indoor temperature was previously decided by the home owner) with a warning about oversizing equipment for unlikely scenarios like "I like it cold at night = bigger hvac equipment", educating home owners about the disadvantages of oversized equipment, solar heat load reduction at night/ Section ten: Manual D software is available for both modeling new and existing hvac systems, default duct heat load (ASHRAE 152) should only be used for rough estimates (usually resulting in much higher values than using graphic Manual D), computer method for Manual D graphic is required for permit documents and installation, CAD HVAC design tools that tie together all 5 of the HVAC designs manuals produces the most accurate results/ Survey section appendix one: thermal zone identification, north arrow super critical, indoor design conditions, building envelope component make up/ Fenestration appendix 4: solar heat gain is the major heat load, thermal storage absorption at peak conditions extends the cooling cycle, cooling dominate climates and low e coatings / Appendix section seven: duct system efficiency and the environment that surrounds the duct, whimsical guidelines and unreliable rules of thumb (ducts not based on graphic manual D)/ Table 1A: climatic conditions for USA.

Home Energy Modeling for this study courtesy of ⇨ HVAC Designs Inc. ⇨ “Precise, Calculating, and Cool”