USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

Capt. Tim's Duct Design Mythbusters

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

The bitterness of poor quality is remembered long after the sweetness of low price is forgotten!

WHY CARE ABOUT THE DUCTS?

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

Human Comfort Zone

(After All, it's only Humans We're Experimenting With)

No. 1: Ducts designed per Manual D are self-balancing.

HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- Duct systems are not self-balancing. The closest thing to a self-balancing duct system would be one with an adequate return in every room that has a supply outlet. May not be practical or achievable in the real world.
- Installed ducts rarely perform like they do on paper; they must be adjusted individually after installation, using proper testing and balancing methods and accurate instruments.

No. 2: Sizing return grilles is easy; just use the 1 sq.ft. per ton or 100 sq.in. per ton rule of thumb.

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- According to major grille manufacturers, returns cannot be sized this way. When they are, the result is:
  - Poor airflow
  - High velocity through noisy grilles
  - Poor filter performance
  - Increased duct leakage
- Hart & Cooley says that a true rule of thumb to use is to plan for two cfm for each sq.in. of gross grille area.
- For example, a 20-in. x 25-in. grille has 500 square inches of gross area (500 x 2 cfm = 1,000 cfm). Using this approach, two 20-in. x 25-in. return grilles will be the right choice for a five-ton HVAC system in order to actually deliver 2,000 cfm back to the blower without causing the return to hemorrhage.
- Since the conventional wisdom of designing return grilles at 144 sq.in. per ton is so widely accepted, the average system return is undersized by 30% or more.

No. 3: A 20-in. X 20-in. filter grille is a good choice for a 4-ton unit.

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- This may be common practice, but it doesn't work well at all. Using the two cfm for each sq.in. rule: 20-in. X 20-in. equals 400 sq.in. gross area of grille, which means 800 cfm of recommended airflow.
- That's two tons of air, not four! Therefore, you'll need another 20-in. x 20-in. return.

No. 4: Seal the ducts and expect dramatic improvement in performance and comfort.

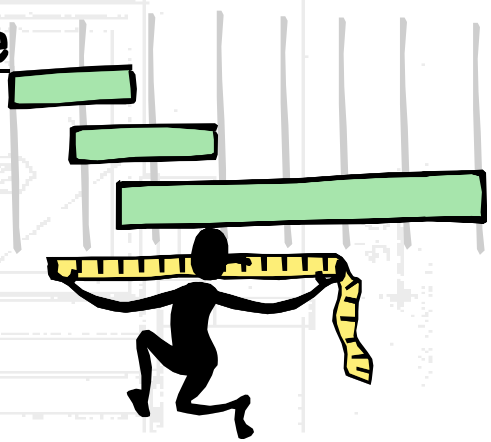
USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- Performance will only improve when ducts are first properly sized and then thoroughly sealed.
- Leaky ducts can cause zonal pressure imbalance in a home. Attic supply leaks can cause negative pressure in a home, which can increase unwanted infiltration, . If natural draft gas appliances are in the conditioned space, there is a danger of back drafting, which leads to carbon monoxide poisoning so we must seal the ducts.
- Undersized ducts when sealed can cause extremely high static pressure levels, which, in turn, may cause reduced evaporator supply air temperature. This can lead to compressor floodback and eventual mechanical failure. So, don't seal undersized ducts! Size them right, and then seal them tight.

No. 5: Using 0.1-in. wc friction rate on a ductulator will always give me the right size supply duct.

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

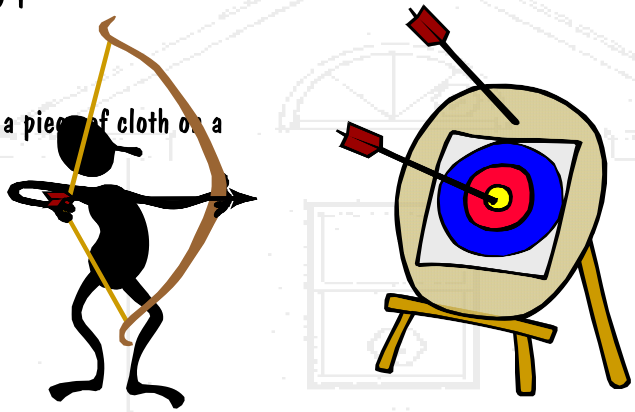
- More often than not in a residential application, this results in undersized supplies. We should use 0.1-in. wc as the maximum friction rate in residential supply duct design.
- These poorly-sized supply ducts cause uncomfortable zones, can't deliver the Btus, and make for noisy grilles.
- This is especially true with flex duct, which actually has its own special version of a duct slide rule. It's much better to use 0.06 for supplies and 0.05 for returns. This is simply because when supply duct airflow is actually and accurately measured in the field, it's been that 0.06 is a more realistic friction rate to ensure proper airflow.



HVAC BUZZWORDS

USA HERS
HOME ENERGY & INSPECTION SERVICES
FI Cert. 692 ~FL HI6371

- BTU = British Thermal Unit – energy to heat 1 pound of water from 39°F to 40°F
- 1 Ton = 12,000 BTUh
- Dry Bulb Temperature = air temperature
- Wet Bulb Temperature = "temperature of adiabatic saturation" psychrometer or a piece of cloth on a thermometer, temp it evaporates – less than dry bulb
- Dew Point = Temperature were air is saturated and condensation starts
- Relative Humidity = Amount of water vapor in the air
- CFM = Cubic Feet per Minute, air volume
- FPM = Feet Per Minute, air velocity
- Pascal Pa = Pressure (1 Pa = .000145 Psi) ~ 250 Pa = 1" wc
- Sensible Load = reduces the temperature
- Latent Load = reduces the moisture
- Sensible Heat Ratio (SHR) = ratio between the sensible and total load
- Grains for moisture = indicate amount of water vapor per pound of air
- Manual J = method for estimating the loads
- Manual D = method for designing & sizing the duct work from the Manual J
- Psychrometrics = the measurement of the heat and water vapor properties of air
- Enthalpy = a measure of the total energy of a thermodynamic system



No. 6: An 8-in. flex duct delivers 200 cfm.

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- According to the Air Diffusion Council and flex duct manufacturers themselves, an 8-in. flex duct will not deliver 200 cfm in typical field conditions.
- The 8-in. flex duct will only deliver 160 cfm up to 25 ft. of run. To get the same result past 25 ft., a 9-in. flex duct should be used.

No. 7: Installing a new air-handling unit is a "plug-and-play" process. Plug it in and out of the ducts comes 400 cfm per ton.

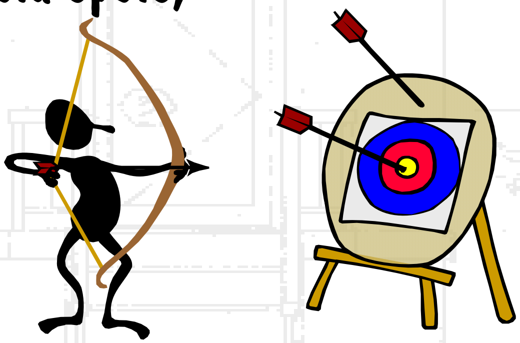
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- The typical manufacturer's fan-rated total external static pressure is 0.5-in. wc. In a well-designed system this is usually enough for proper airflow. This is not true if the ducts are undersized. That air-handler is trying, but if the static pressure is too high because the ducts are too small, cavitations will occur. Poof! There goes your 400 CFM per ton.
- A typical installation can be 28% low on airflow due to under sizing and other errors. That would mean air delivery is only 288 CFM per ton, well below the manufacturers' minimum requirement of 350. So, why aren't more coils freezing up? Probably because the undersized return leaks so badly due to improper installation practices, and the high static pressure difference (Delta P) inside and outside the duct make it so that the return air is reheated before it gets back to the coil.

No. 8: When it comes to location of supply outlets, anywhere will do.

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- The Coanda, or ceiling, effect helps that cold air "stick" to the ceiling much further that one would think. Understanding the properties and behavior of conditioned air will help maximize the performance of the HVAC system.
- Without a clear understanding of the performance of the specific grille regarding throw, spread, drop, and terminal velocity based on calculated airflow and velocity, we cannot properly locate a supply register. Improper location results in drafts, hot and cold spots, excessive noise, and ultimately, customer complaints.



No. 9: The typical run of supply duct is less than 25 ft. Our ductulator calculates the air flow for 100 ft. of duct, so we should have more than enough airflow.

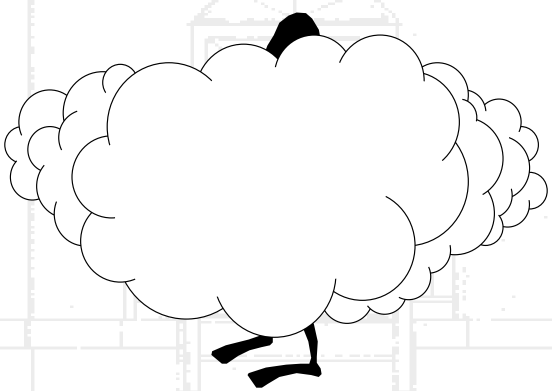
USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- When calculating the total effective length of a duct system, you need to take into account the supply run with the longest equivalent length and the longest equivalent length of the return side.
- When all the fittings, including the boot, elbows, grilles, and balancing damper are added together, it's not uncommon to have 350-ft. of total effective length.

No. 10: Return air ducts don't need turning vanes or any other "help" for proper airflow because the air is pulled instead of pushed in the return so it doesn't "wrinkle" around corners.

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- Due to the Coanda effect, the air will easily flow around the inside, or throat, of an elbow when it's rounded. The rounded heel has no measurable effect on equivalent length.



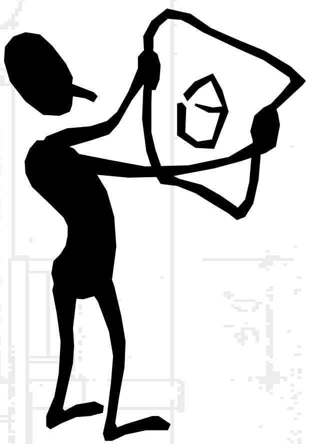
HVAC SYSTEM DESIGN

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

Importance of Design

- Undersized systems = discomfort
- Oversized systems = wear & tear on equipment, discomfort (cooling), unnecessary expense, higher initial cost
- Duct design can affect efficiency and system's ability to heat/cool evenly

The "RIGHT SIZED" equipment is critical for performance. 95% of problems related to over sizing, duct leakage, poor duct design



OBTAIN A GOOD SYSTEM DESIGN AND INSTALLATION

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

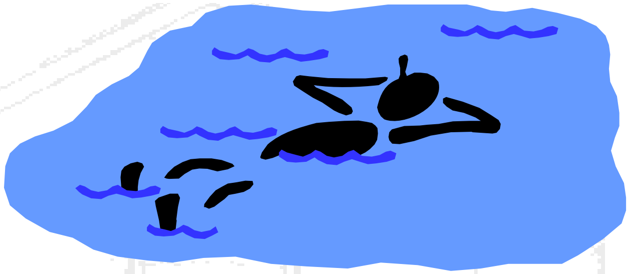
The HVAC equipment, duct layout, and ductwork are the "heart, veins & arteries" of the house.

- Find a contractor that will take the time to design and install it right
- Create specifications for contractors
- Ensure specifications are followed

Seek out "Best Value" – this is a "cost" avoidance issue -cheap doesn't work unless you want lots of call backs.

STEPS to a COMFORTABLE HOMEOWNER

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371



- Manual J8 – Load Analysis
- Manual D – Duct system design & sizing
- Manual S – Equipment selection
- Installation – duct sealing/insulation, thermostat location
- Commissioning – Compressor and AHU checks
- Ducts – verify CFM/FPM and balance system

OBJECTIVES OF MANUAL J8 LOAD CALCULATION

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

- To determine the proper sizing of HVAC equipment for a structure (Block Load)
- To determine the heating & cooling requirements for individual rooms (Room by Room load)
- Determine Proper Duct Design

Why Bother Sizing?

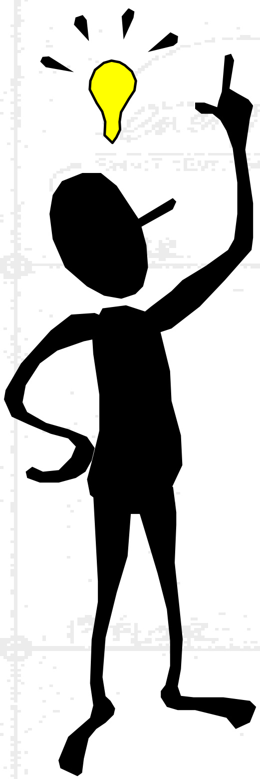
Obviously don't want one to small

Avoid Callbacks

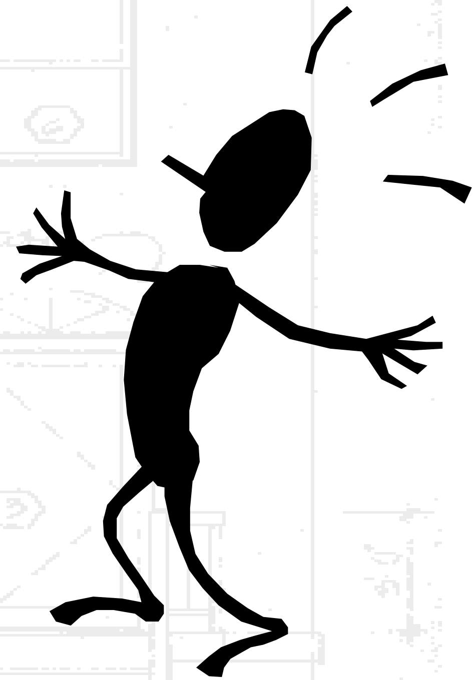
So just make it real big

HIGH PERFORMANCE HOUSES

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371



- So what is the cause for concern?
  - Improved thermal envelope leads to reduced heating and cooling loads which results in smaller HVAC equipment
  - Used to use 400 sqft / ton as an estimation of size
  - Now 600 and up to 1,200 sqft / ton
  - Reduced amount of airflow in the system
  - Standard to oversize ducts result in lower velocities
  - Lower velocities at diffusers reduce throw and mixing
  - Impact of duct leakage is amplified



SUMMARY

ENERGY EFFICIENCY PERFORMANCE ADVANTAGE

USA HERS
HOME ENERGY & INSPECTION SERVICES
Fl Cert. 692 ~FL HI6371

Unless you're prepared to break the laws of physics, energy efficiency delivers:

- *Lower Utility Costs*
- *More Comfort*
- *More Durability*
- *Improved Indoor Air Quality*
- *Environmental Protection*
- *Less call backs*
- *Happy Homeowner – more sales*