

# Why System Components Must be Properly Matched & Sized

## Tech to Tech Column October 07

*“Make daily deposits to your box of knowledge, soon it will have many reference cards.”--Randal S. Ripley*

What would you consider a heating or cooling system to be? In heating is it the furnace or in air conditioning the air handler, coil and condenser?

When referencing the word “system” in my office dictionary I found this interesting definition of the word “a number of bodily organs acting together to perform one of the main bodily functions such as the digestive system.”

Now, if we wrote this definition with a few changes, “a number of HVAC components (ductwork, furnace or air handler, line set, coils, condenser, etc.) acting together to perform one of the HVAC systems main functions such as heating or cooling the home or space” we would have a good explanation of what an HVAC system is.

There is a definite relationship between the individual components and how efficiently the system will operate. In fact, no matter how well you size or install every other component in the system, the system is the sum of all its parts and just like a chain will perform only as good as its weakest link allows.

If you undersize or oversize the ductwork, undersize the gas line, under or over size the furnace, or cooling components, etc., the system is not going to operate at its full capacity or provide the Human Comfort your customer is paying for.

This brings to mind another one of those sayings that would make me the wealthiest guy in the industry if I had a dollar for every time I have heard it, **“I’ll make it work.”** If you have an understanding of how the components relate to each other and how a “system”

operates, how can you make this statement?

It is true that you can make the system “work or operate” but at what level of efficiency, capacity or comfort? If you were paying for an HVAC system wouldn’t you expect the system to perform at the highest level of efficiency obtainable? After all isn’t that what you are paying for?

The best example of the problems that can result from mismatched components is the controversy created by the federally mandated raising of the minimum efficiency level from 10 to 13 SEER.

Bristol Compressors did a study on mismatched components where a 3 ton 13 SEER condenser was matched with a 3 ton 10 SEER evaporator coil on a heat pump system with a 95 degree outdoor temperature and 80 degree indoor temperature, the factory charge of 8 lbs, 7 oz and a fixed orifice metering device in the cooling mode.

The resultant SEER rating was 8.46 (not going to get you a utility rebate), the BTUH capacity rating was 22,208 (a loss of 38%) and a 54 degree superheat reading, can you say potential compressor failure, especially in a place where these hot days go on for weeks at a time.

The study went on to say that to increase the capacity to 29,823 BTUH (a loss of 18%); with a SEER rating of 8.92 and superheat of 14.68 the technician would have to increase the amount of refrigerant to 14 lbs, 14 oz.

If you add a TEV and reduce the charge to 10 lbs, 6 oz. the capacity goes

up to 31,266 BTUH (a loss of 13%) and a SEER rating of 11.85.

Every salesman and contractor should get a copy of this report and show it to their potential end user to see if they still want to take the cheap way out.

If you would like to read a complete analysis on the report see Brian Byrom's "When  $13 + 10 = 8$ " In the August edition of the RSES Journal ©.

Here are a few examples of how one component sized wrong and everything else being done correctly, can cause the system to operate at less than optimum performance.

**Leaking duct**—Say the return duct was leaking in an attic, the system could be pulling in 100+ degree air for the system to cool in the summer or below zero degree air in the winter.

The hot humid air coming into the return duct in the summer can cause the system to be undersized depending on the size of the leak but will definitely reduce its cooling & humidity removal capacity, increase the superheat and reduce the supply temperature to the space.

"It is not rocket science" (Sorry, I couldn't help myself) how pulling in potential ambient air of 20 degrees or less will affect your temperature rise. Just like a low return water temperature can potentially "shock a boiler" and stress the cast iron to the point of causing it to crack, a low ambient return air temperature can do the same to a furnace heat exchanger.

**Under sized gas line**—A 2 stage gas furnace could fire properly on low fire but not on high fire due to a lack of gas volume entering the unit.

This is most likely to occur when appliances are being added to an existing line and multiple appliances are operating at the same time.

**Under sized condenser, oversized evaporator coil**—an example of this is a 2 ton condenser matched with a 3 ton or larger evaporator coil. The condenser is not going to be able to pump enough refrigerant to properly feed the coil, regardless of the metering device, causing a high superheat, high coil temperature with little to no humidity removal, high supply temperature and insufficient cooling of the compressor windings.

**Undersized duct work**—improper airflow causing noise in the ductwork and at diffusers, freeze ups in A/C and high limit trips in heating.

**Undersized liquid line**—will cause a reduction in the volume of refrigerant fed to the evaporator potentially causing freeze ups, little to no humidity removal, high superheat and potential compressor damage from overheated windings and lower the operating efficiency.

**Under sized refrigerant suction line**—Hermetic compressors in residential air conditioning systems are cooled by the suction gases coming back from the evaporator. When less vapor volume is returned to the compressor it not only improperly cools the windings creating a potential burnout but it also lowers the amount of refrigerant the compressor is pumping, lowering the efficiency and capacity of the compressor and the system.

**In closing I would like to ask, do you still think you can make it work?**

If you want to rant at me, send short video clips of people doing dumb things or cell phone pics of installs that make you shake your head or anything else you think I would be interested in, my email address is

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