DIY Zoning: Home Owners Frequently Asked Questions

Table of contents

Questions

1. Temperature Zoning

1.1. What is a temperature zoning system?

A temperature zoning system is a system that allows to:

- Support a consistent temperature in a given part of a house, regardless of external conditions, such as sun, rain, snow, clouds, wind, phase of moon, or Philip Morris stock price;
- Support different temperatures in different parts of the house at different times as desired by the owner. In an essence, each zone will have its own climate.

  It is possible, for example, to have some rooms be cooler or warmer than others (individual preferences), and it is also possible to keep the same rooms at different temperature depending on, for example, whether the rooms are [supposed to be] occupied or not.

1.2. How do I know if I need a temperature zoning system or not?

If the answer to at least some of the following questions is "yes", then you probably need a temperature zoning system:

- Does your house have multiple levels?
- Does your house have levels that are completely or partially underground?
- Are some rooms in your house noticeably cooler (for heating) or hotter (for cooling) at certain season or time of day?
- Do some rooms in your house feel "stuffy"?
- Do you have rooms that are rarely used?
- Do you have family members that want it hotter or colder?
- Do you have a home office?
- Do you have a big TV and like to gather all the family to watch movies?

1.3. But why do I need it in the first place?

Because the heat distribution in the house is affected by many static and dynamic factors, including, but not limited to:

- Walls, ceilings, and windows insulation quality;
- Exposure (south exposure gives a room that is generally hotter, western exposure gives a room that is hot in the evening);
- Overcast (clouds in the sky make for less solar radiation absorbed by the walls and the roof);
- Wind & rain (wash the heat away);
- Humidity (FIXME: add a link to sensible vs. latent heat);
- Ductwork quality (for forced air systems) or piping quality (for steam or hot water heating systems) - insufficient supply or return will create "starved" zones;

1.4. But the HVAC contractor says that they can "balance" the house?

Sure, for the exact time of day, ambient temperature, weather and season at the moment when they do it. The house is fundamentally unbalanced - see the answer to the next question.

1.5. Why can the house be unbalanced?

Every house with a single thermostat is unbalanced by definition.

Let's consider how does the conventional single thermostat system works.

The thermostat reacts to the change of the temperature at the location it is installed. Most often, this is the living room, or a hallway somewhere in the middle of the house. Suppose we're in the cooling mode, and the temperature rises above the setpoint - this will make the thermostat do something that is called "call for cool" in HVAC jargon. The A/C will switch on, and the temperature will begin to fall. As soon as the temperature falls below the setpoint, the thermostat will command the A/C to stop (actually, it's a little bit more complicated - the temperature will rise a little bit above the setpoint, and fall little bit below setpoint to prevent constant starts and stops - it's called "hysteresis").

Now, how exactly did this process address the temperature in, say, bedroom upstairs?

It didn't.

Even though the cold air was being delivered to the bedroom upstairs, the temperature in it could have fallen just a little bit (for example, if you live in Arizona, the bedroom has a southern exposure, and it is a nice summer afternoon) before the temperature at the point where the thermostat is installed fell below the setpoint.

This effect aggravates as the ambient temperature gets close to the setpoint, because in this case the thermostat will be happy almost all the time, but the temperature in problem rooms

may drift as far as 10°F apart from the setpoint. The far rooms are starving.

And the opposite effect takes place when the ambient temperature is far away from the setpoint because it takes a lot of time for the A/C to satisfy the requirements in the place where the thermostat is installed. By the time it is happy, the far rooms are saturated.

1.6. Why can't the house be balanced?

There are some measures that can be taken in order to alleviate the problem, but none of them can eliminate it as long as there's a single temperature measurement point.

- "Balancing" dampers. The airflow to some rooms is restricted in order to provide more air to the rooms that don't get satisfactory conditioning. This increases the load on the A/C.
- Improving insulation in the rooms that don't get satisfactory conditioning. This costs a lot of money. Moreover, this may actually aggravate the problem instead of fixing it - for the case of insufficient cooling in a room with a lot of heat producing equipment, such as kitchen, home office, or a living room with a big TV.
- Running the fan constantly. This allows the air to be distributed uniformly, and the hot air influences the temperature at the point where the thermostat is installed, thus making it cycle more often. This costs money, too.

It is important to realize that none of these measures will eliminate the problem. The difference between heat loss (through conditioning) and gain (through imperfect insulation) is changing depending on time of day, direction of the wind, whether there are clouds or not, if it is raining, how many people are in the particular room, is there any heat generating equipment, and so on and so forth.

Bottomline, it is not possible to balance the house without a zoning system.

1.7. Do zoning systems shorten the A/C lifespan?

Short answer: I don't give a damn.

Long answer, from personal standpoint: you know, if my house feels like hell, I don't really care if my A/C works for 30 years or 25, or 15, or even 10. I am not going to suffer just because there is a theoretical, no, cancel that, an alleged possibility that what I do is going to shorten the A/C life.

Long answer, from technical standpoint: not necessarily. Properly designed and implemented zoning system should not cause the A/C unit to run outside of design specifications. If the statement about shortening the A/C life was even remotely true, the zoning systems

manufacturers would have been out of business by now, buried under the pile of lawsuits filed against them by unhappy customers whose A/C units had died prematurely.

Very long answer, from technical standpoint: following is a list of factors that influence the lifespan of the HVAC unit, and a brief explanation of the way DZ handles them:

- Most critical: compressor lifespan will be drastically shortened if a phenomenon called slugging occurs.

  Using temperature sensors, DZ is able to detect the trend and take corrective actions to avoid this situation. A very detailed, albeit quite technical, explanation is available here.
- Restricted airflow is often pointed out to as the cause of HVAC unit premature failures. This is incorrect, in fact, the above effect (compressor slugging) **is** the root cause, whereas restricted airflow is just one of contributing factors. Restricted airflow can be a result of many conditions, including, but not limited to:
  - Dirty filter. Using pressure sensors, DZ is able to detect this situation and issue a notification to the user requiring to replace or clean the filter;
  - Dirty indoor coil. Same as above.
  - Too many dampers closed with no regard to airflow. First of all, DZ uses a balancing algorithm to maximize the open damper area, thus increasing the minimal damper opening. Then, again, using pressure sensors, DZ is able to detect this situation and take corrective actions to avoid restricting airflow too much.
- Compressor "short-cycling" is yet another behavior hurting the system longevity. Favorite metaphor to explain this is: compare highway and city driving.

  DZ uses a "zone resonance" algorithm to prolong a HVAC unit runtime to reduce number of cycles per time period, to reduce the energy consumption and prolong the lifespan of the unit.

In addition to these, a number of other technical solutions that positively influence the HVAC unit lifespan are used in DZ, but they fall beyond the scope of this discussion.

1.8. What are the general requirements for zoning?

To zone the house properly, not only the control side of the equation has to be considered, but also the operating conditions of the unit. Some of them are obvious, some of them are not. I will try to point out the issues without really getting into details, because a complete explanation takes a lot of time and effort and is not really required for the scope of the project. If you feel the explanation is inadequate, you are welcome to fix it.

Airflow

In order to achieve zoning, airflow generated by the unit has to be directed to different zones at different times. This is achieved by installing devices called "dampers", which can control the airflow by [partially] opening and closing. The airflow is usually measured in cubic feet per minute (CFM).

Warning:

If one (or few) zone is calling, all the airflow produced by air handler will be delivered to that one zoning, thereby requiring the duct to it to be able to sustain the airflow and static pressure.

Warning:

The higher is the airflow, the higher is wind noise. Flex ducts are more noisy than sheetmetal (unless sheetmetal resonates).

Static Pressure

Static pressure is the pressure that is created in the ductwork because of its resistance to airflow. This is kind of obvious. The more dampers are closed, the higher is the static pressure. The static pressure is usually measured in inches of water column (IWC) or water gauge (IWG).

Warning:

Important consideration: if the static pressure becomes too high, there's a risk of blowing up the ductwork or overloading the fan.

Consequence: static pressure has to be monitored. For details, see Excess Static Pressure Relief section of the Technical FAQ.

Temperature Drop

Temperature drop across the indoor coil depends on the capacity of the compressor (which we ignore for now) and the current airflow (the higher the airflow, the more heat the air carries away from the coil).

Warning:

Higher temperature drop allows to remove more moisture from the air, however, there's a limit to that. If it becomes too high, there's a risk of flooding the compressor and possibly damaging it.

Consequence: temperature drop across the coil has to be monitored.

Note:

Bottomline: you ***must*** have ductwork sufficient for zoning. In the worst case, it shouldn't have leaks, or otherwise you will aggravate the situation instead of remedying it.

2. HVAC

2.1. What is HVAC?

HVAC stands for **H**eating, **V**entilation & **A**ir **C**onditioning. Quite often the V part of HVAC gets overlooked, don't make this mistake.

HowStuffWorks provides a good starting point for understanding the basic facts about HVAC, it's actually quite fascinating.

2.2. What is a heat load?

This is a short name for "heat loss and gain calculation". This is something that every HVAC contractor should do at the very beginning of every job, but in reality there are very few that will even mention it to you, and if you even ask them about it, they will try to convince you that it is either very expensive or completely unnecessary because there's a "rule of thumb", or press you with their alleged experience and tell you how many thousands of people they have made happy.

This is all, forgive my French, bullshit.

It is neither complicated nor expensive. All it takes is the heat load software application that will cost you $49 if you get it from hvaccomputer.com, an hour of your time and the measuring tape, plus a little bit of information about your house that you are supposed to know before you start (like, what it's made of).

You'd probably be surprised - the calculated heat load value for your house may be well below your expectations, and quite often below the capacity of the unit you already have. If you don't feel comfortable with your current unit - the problem is somewhere else.

Warning:

Heat Load Calculation, or *Heat Loss and Heat Gain Calculation*, is a critical component of any HVAC related project. Insist on having one done, and if the contractor refuses to do so or keeps talking about "rule of thumb" or "square feet per ton", you're talking to a wrong contractor.

2.3. What about "rule of thumb"?

There is no "rule of thumb". This is what the contractors use to save some money, on your behalf.

Every house is different. Even the same floor plan will have different head load if it is

oriented in a different way, or insulated differently - for example, just replacing single pane windows and glass doors with tinted double pane may as well mean 1 ton difference in the heat load. That's several hundred dollars worth of equipment.

Warning:

There is ***NO*** rule of thumb.

2.4. Is bigger unit better?

No.

Proper is better.

If the unit is too small, you may be able to get away with it if you have a good zoning system - for example, if parts of your house are not occupied at all times. This is not the only justification for zoning, but zoning is outside of scope of this question - we'll get back to it later.

On the other side, if the unit is too big, you have automatically

- Paid unnecessary premium for something bigger than you need;
- Commited yourself to paying higher electrical bills because the bigger unit will "short cycle" (switch on and off more often), and the maximum energy is consumed at the startup (starting current may very well be ten times operating current);
- Condemned yourself to repair it more often, because the equipment doesn't like to be jerked (compare: highway vs. city driving);
- Created yourself a problem because the bigger unit will not be able to control the humidity properly. This will bite you in the back when you are paying your bills as well, because the way you feel is not just the temperature, it's humidity as well, and you will have to lower the thermostat to feel comfortable, which will cause the equipment to work longer.
- Forgotten about the "V" in HVAC - bigger unit will not provide sufficient air circulation because of short cycling, and the air in the house will feel "stale".

Hope you are convinced now.

Most frequently, the contractors will try to sell you a bigger unit than you really need. The reasons I can think of are:

- It is more expensive. They live on markup. The more expensive is the unit, the higher is the profit, even if the profit margin doesn't change.
- This is what they have in stock.
- They don't want to do the heat load calculation because this costs them money, however,

they are afraid that the unit will not be big enough to satisfy the load requirements. The inadequacy of a unit that is too big is much more difficult to identify than inadequacy of the unit that is too small.

- They fail to analyze the reason the customer requested a new unit in the first place. Quite often, the problems perceived to be related to a unit that is too small are in fact caused by inadequate ductwork, or improper balancing, or improper humidity control. Or such a simple thing as a dirty indoor coil.

2.5. What is a normal runtime for a HVAC unit?

Let's define runtime as time that passes from the moment the HVAC unit turns on to the moment it turns off during its normal cycle.

Short answer: 10-15 minutes and more.

Long answer: Generally, the longer the unit works, the better. Part of the reason is that at the beginning of the cycle the unit is just "warming up", and the temperature difference between the coil and indoor air is insufficient for efficient heat transfer. The coil gets to normal operating temperature in at least 5-10 minutes (FIXME: include graphs), and only then the unit approaches its design efficiency.

It is not unusual for the unit to run 30 to 60 minutes and longer - this fact alone does *not* mean the unit is undersized.

2.6. What about the filter?

Warning:

Changing, or cleaning, the air filter in your HVAC system is a critical maintenance procedure.

This is what happens when you don't do it often enough:

- You are breathing dust now. Hope you don't have allergies.
- Your unit is breathing dust now. You can cough to help your lungs to get rid of the dust, your unit can't.
- The restricted airflow causes the unit to have a higher temperature drop across the indoor coil, which may cause the refrigerant not to be completely evaporated, which will cause the liquid refrigerant to reach the compressor, and the compressors are not designed to compress liquid, they are designed to compress gas. There are some compressors that are able to withstand such an abuse, but not all of them. The ones that are not, will die. You will pay dearly for that.
- Even if it doesn't get this bad, the dirt will invariably accumulate on the indoor coil.

Some units are notorious for a high price that you have to pay to clean the indoor coil.

For example, Goettl (the site seems to be down quite often) units are designed in such a way that it is not possible to get to the indoor coil without dissassembling the ductwork. Some contractors just cut the holes in the ductwork, clean the coil, and patch the holes back. Disgusting design.

2.7. What is "multistage"?

The units referred to as "multistage" have two or more possible values for the compressor output. It may be a single compressor operating at different speeds, or it may be more than one compressor with any combination of them working at any given time.

The point of doing so is to provide heating or cooling capacity adequate to the demand and thus conserve the energy and optimize the unit operation.

2.8. What is a "variable speed fan"?

To be exact, there are two different kinds of fans: multi-speed and variable speed.

Multi-speed fan can be thought of as a single speed fan able to operate at different speeds and thus producing different airflow.

Variable speed fan is a more complicated animal: as a multi-speed fan, it will have more than one possible operating speed, but unlike multi-speed fan, the variable speed fan will take active measures to keep the airflow at the specified level. So, while multi-speed is just multi-speed, variable speed is multi-capacity.

Variable speed fans are known to be able to deliver much higher static pressure than other kinds, and a lot of HVAC contractors think they are a blessing. However, variable speed fans appear only in relatively expensive units.

2.9. Multistage & Variable Speed?

A combination of a multistage compressor and variable speed fan is the way to go to achieve the best comfort and energy savings. Here's where they shine:

- Harsh climates, where the periods of extreme cooling demand exist along with the periods when the cooling is barely required. This is true on both day-by-day and seasonal basis. Example: Southwestern US.
- Humid climates, where the need for dehumidification is no less than need for cooling. Example: Southeast US.

It should be noted, though, that they are expensive, but then again, you get what you paid for. Just make sure your contractor has experience in dealing with such systems.

Note:

Historical note: once upon a time, there was a Trane XV1500 which was truly infinitely multistage, infinitely variable speed fan unit. Its fate is similar to the one of Betamax.

Note:

Update on that: according to inside information, infinitely multistage and infinitely variable systems are quietly planning a loud comeback. Expected to happen around 2005.

2.10. What is "compressor slugging"?

Compressor slugging is a phenomenon when some amount of refrigerant doesn't evaporate and reaches the compressor in a liquid form. Liquids are not compressable, and if the compressor design doesn't take this into account, the compressor will invariably be damaged.

A particular design of a compressor called a "scroll" compressor is not affected by liquids entering its internals (which doesn't mean the efficiency doesn't suffer, though).

3. HVAC devices you may not know about

3.1. What is an economizer?

An *economizer* is a device that allows to shorten HVAC unit run time and thus reduce energy costs when the outdoor air temperature (more correctly, heat) is practical to use.

For example, imagine a situation (happens quite often in climates with sharp day/night contrast) when the outdoor air temperature is already low, and the indoor air is still hot. In this case, it would make perfect sense to pump outside air in and dump indoor air out, rather than run the air conditioner.

Reverse situation: imagine an old brick or stone house, which is still cold in the spring, when the outdoor air is already warm enough to be used.

3.2. What is an HRV?

An HRV (stands for **H**eat **R**ecovery **V**entilator) is a device that serves a purpose opposite of that of economizer: it allows to dump the stale indoor air and accept fresh outdoor air without losing as much energy as you would if you just opened a window. This is important in tight

new houses to prevent indoor pollutants from reaching unhealthy levels.

Basically, an HRV is a fan with a heat exchanger: for cooling, the hot outdoor air will pass its energy to the air leaving the house, for heating, the hot indoor air will pass its energy to cold outdoor air entering the house.

HRVs only move the heat associated with air temperature difference. See the ERV section for more on this.

3.3. What is an ERV?

An ERV (stands for **E**nergy **R**ecovery **V**entilator) is a device that does a similar job to an HRV, but handles both the heat from air temperature and moisture in the air (known as sensible and latent heat.) Because it exchanges both, they are usually more efficient and do not have condensation problems that can occur in a HRV. There are two types of ERVs, linear exchangers similar to HRVs and rotary wheel type systems where media moves between the air moving in and moving out to transfer the heat and moisture.

Note:

Thanks to Jerry Scharf for his contribution to HRV and complete ERV section.

4. DIY Zoning

4.1. What DZ can offer that commercial systems don't?

Short answer: vendor independence, long life and unlimited flexibility.

Long answer: see, every vendor wants to lock you in into using their products only. Don't you find funny that Gillette recommends using only Gillette shaving cream with their razors, Zippo warns against using lighter fluids other than those manufactured by Zippo, and so on and so forth?

This is called a **vendor lock-in**.

Likewise, with HVAC systems that are any good at all, vendors will go all the way to ensure that you won't be able to use, to give a specific example, Carrier Infinity Control (providing the features like those of DZ) with any non-Carrier equipment. But if you've done your homework, you know that Carrier HVAC units are not the best. And you also know that the equipment Infinity works with costs way, way more than you'd want to invest into it. And you also know that it obsoletes not quite old Carrier Thermidistat as well.

This is called a **planned obsolescence**.

Didn't you notice that it your car starts falling apart right after the manufacturer warranty period ends, and suddently becomes very expensive to repair?

DZ, on the other hand, is free of it. Take a look around - it offers unsurpassed interoperability with any device specifications for which are open. And it is guaranteed to stay this way by the virtue of the way it is licensed - GPL makes sure the project is available even if I die tomorrow. It cannot be taken away from you. You are free to extend and modify it in any way you see fit.

4.2. How expensive is DZ?

DZ is free as in speech, and free as in beer. The only thing that you pay for it is your time.

4.3. How can I install DZ in my house?

Right now, the only way to do it is to do it yourself. This is not a task for everybody, you have to comply to a rather longish list of prerequisites. However, commercial support is planned, but don't hold your breath.

4.4. Who will fix it if it breaks?

If you were able to install it in the first place (see previous question), you will definitely have no problems fixing it.

There are several definitions to the word "breaks".

- *One of the pieces breaks:* The components used are stock and inexpensive, there's nothing complicated about them. The whole system is self-diagnosing, and very verbose in doing so. If a component breaks, the system will most probably tell you about that right away, if the component is smart enough to report the failure or stop responding. If it is not, the system will figure out the failure cause indirectly, and will tell you to check a specific component and make sure it's OK.
- *There's a software bug:* The reported bugs are fixed with high priority - usually a few hours.
- *HVAC system controlled by DZ breaks:* It is unlikely that DZ was at fault. There's nothing we can do: there is a big red disclaimer in many places around this site.

Note:

In 8 years and counting (since 2001), there were no reported cases of DZ causing hardware failures.

4.5. Can I alleviate effects of it breaking?

Yes, there *is* a low-tech solution to back up your HVAC system in case DZ breaks.

It is up to you to decide whether it is sufficient or not (if you have a $60,000 Steinway in your hall you'd probably want to spend a reasonable amount of money to protect it, so you don't find it all dried and cracked up after you return from a summer vacation to your Arizona home).

In a very simplistic case, you can't be concerned about both temperature extremes at the same time, so you either protect yourself from extreme heat or extreme cold. In both cases, you install a simplest possible mechanical thermostat that overrides DZ (usually in parallel) and switches on the heater/furnace, or the air conditioner, when the preset temperature is reached.