Basic A/C and Heating Components

The A/C and Heating system in most homes is a combination of many components. These components when installed or linked together properly, can give our customers, when maintained, years of trouble free comfort.

If, on the other hand, the components are just hooked together with little regard to "Best Installation Practices", comfort may not be achieved, and the system itself may be the cause of problems that could make utilities high, or even make our customers sick.

With the units' complexity becoming greater, the installation, and maintenance of each product is becoming more critical by the day.

You may not need to work on a system during your career but being in the HVAC field will certainly draw questions from family, friends and customers alike. This Self Study will give you the basics of operation and should make it a little easier to answer some of the questions as well as give you a better understanding of the knowledge level needed to work in this industry.

We hope that you keep a copy of this Self Study program to use as reference as future needs arise.

HVAC for the Non Technical Employee

Our HVAC Roots

Dave Lennox built the first riveted heat exchanger.

In 1895 Ernest Bryant and Ezra Smith approached Dave Lennox in his machine shop in Marshalltown. The idea they brought was to build a heat exchanger from riveted steal, much more durable than the cast iron being used in existing systems. Dave reluctantly agreed, as his new tool business was just taking off. After completion the men couldn't pay for the project, Dave took over their patents, reworking their original design and proceeded to build the first Lennox Furnaces.

Willis Carrier invented Air conditioning as we know it today

In 1902 a printer from Brooklyn NY brought Willis Carriers first job in air conditioning to him. The printer was upset; his color reproductions were becoming ruined because of changing humidity. The birth of Air Conditioning was ultimately the birth of dehumidification.
It wasn't until 1906 that the inventor got a job to control temperature in a South Carolina cotton mill that the Air conditioners tonnage was increased to handle comfort cooling.

Lennox worked its way into the residential air conditioning market in 1952, and has grown to be a world leader in the HVAC business. Lennox has made great strides in building firsts like the Pulse furnace that produced efficiencies over 90% and 2 speed condensers that attained 15 SEER. These and the ever-changing products in our field have given us the opportunity to do things that could not have been possible without them. Lennox has become first again to achieve residential systems with SEER ratings over 20! Efficiency yes… but comfort is the key word for the future of HVAC.

Without comfort conditioning we could expect workers productivity to decline about 50% worldwide. Famous works of art would be lost forever. Scroll and documents could not be preserved. Not to mention mans inhumanity to man would increase. We just wouldn't be as nice as we should be.

What is a BTU?

The BTU is a British Thermal Unit or a measurement of heat.

- **A BTU is the amount of heat needed to raise one pound of water one degree Fahrenheit.**
- **A BTUH is the amount of heat needed to raise one pound of water one degree Fahrenheit in one hour.**
- **One BTU is equivalent to approximately one large kitchen match.**
- **There are 12,000 BTUH of heat removing capability per ton of Air conditioning.**
- **Ton the amount of Btus needed to melt 2000 pounds of ice over a 24-hour time period**
  1. **288,000 Btus per 24 hours**
  2. **12,000 Btus per hour**
- **A 3-ton air conditioner can remove approximately 36,000 kitchen matches worth of heat from a house in one hour. 3 tons X 12,000 BTUs per ton = 36,000 BTUH**
- **A 3-ton air conditioner does NOT weigh 6000 lbs!**

Physics of Air

- **Heat transfer is from warmer to cooler**

The most basic element of air conditioning is the premise that heat travels from warmer to cooler places. Heat does not necessarily rise, by can move in any direction from warmer to cooler, even down.

- **Moisture transfer is from wetter to drier.**

Moisture too can travel in any direction, although moist air is generally heavier and will fall.

Now with these truths known, think of the forces in and around your home with heat trying to get in, or out, and moisture (hidden heat) trying to get in, or out.
These forces are incredible, now add a windy day, this adds additional pressure to the walls and ceilings of our homes and it's a wonder we can heat or cool at all!

The air conditioner is a mechanical device that collects heat from an undesirable location and conveys it to a more desirable location, namely inside the house to outside the house.

The six elements of total comfort

There are six basic elements needed when "air conditioning" is being discussed. They are:

1. **Air Circulation**

How air is moved through the ductwork and through the house.

2. **Humidity**

Too much too little effects and solutions

3. **Even Temperature**

No large temperature swings throughout the home

4. **Fresh Air**

Ventilation, why bring in outside air?

5. **Filtration**

What is a good filter?

6. **Quiet**

Who wants a noisy A/C or heater?

All humans eat fast food quickly.

Components of an A/C system

There are 6 basic components of the Air conditioning system.

1. **The <u>Compressor</u> in the heart of the system. In the same way the heart pumps blood into the body, and it flows back to the heart through the veins. The compressor pumps the refrigerant through the outdoor coils, up the line set, through the evaporator and back to the compressor.**

   The heart is a liquid pump, pumping blood through the body.

   The compressor is a vapor pump; it does not pump liquid well.

   The compressor creates high pressure on the outlet and low pressure on the inlet.

   It compresses the gas… <u>Compressor</u>.

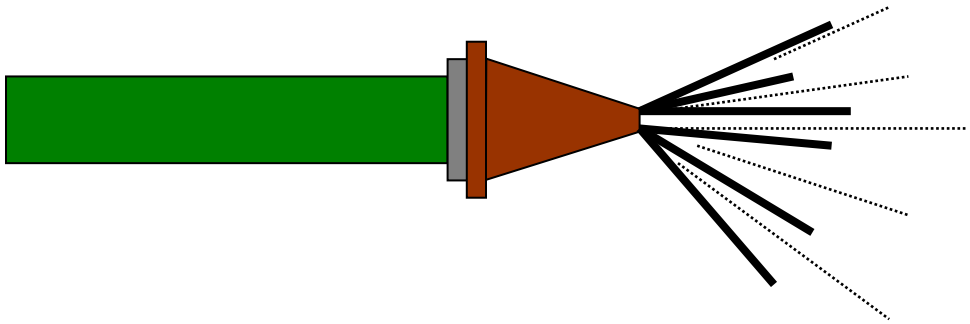
The two basic types found in residential are the <u>Reciprocating</u> and the <u>Scroll</u> compressors.

Te reciprocating compressor has many movable internal parts that can wear out or fail and were the main compressors used for the last 30 years in this market.

The scroll however has much fewer moving parts and greater efficiencies when being used in newer equipment. Scroll compressors appear to have less of a failure rate as well.

2. <u>The metering device</u> controls the flow of refrigerant.
There are two basic types of Metering Devices, the <u>Fixed and the TXV</u>. Both allow the refrigerant to flow from the small liquid line into the evaporator.
The <u>Fixed</u>-metering device has a very small hole in it that allows this flow, it is called an orifice.
When the liquid refrigerant flows through the orifice it is sprayed out on the other side similar to a water hose with a reducing fitting on it.

Fixed Metering Device



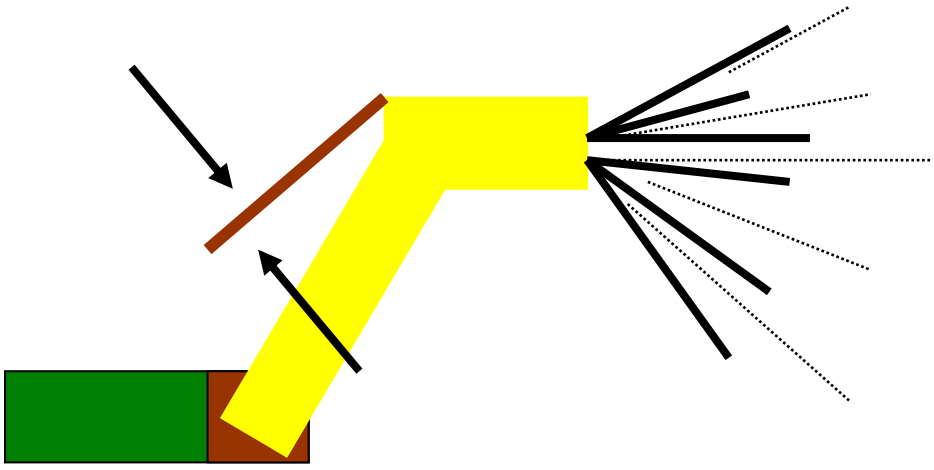
When using this hose and the sprayed water hits your skin, it starts to evaporate, allowing many BTUs of heat to be pulled from your body, absorbed into the water droplets and evaporated away.

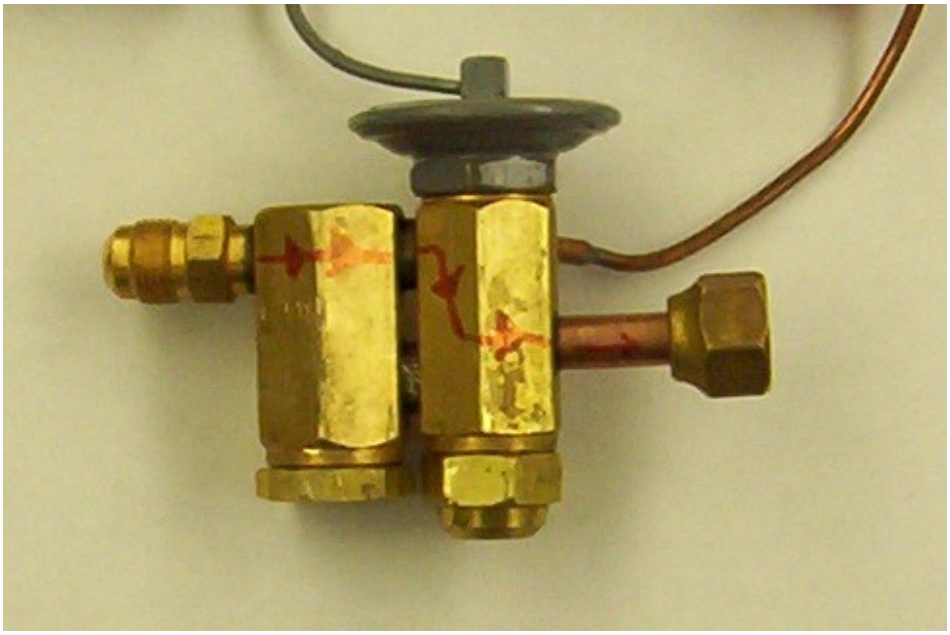
Now back in the evaporator…
When the refrigerant is allowed to flow through the metering device it goes from a high-pressure liquid to a low-pressure liquid, changing to vapor. As the refrigerant now enters the evaporator the <u>heat from the home evaporates</u> the refrigerant, and is absorbed <u>into</u> the refrigerant.

Once the refrigerant is evaporated it doesn't remove heat well, therefore, if we can supply refrigerant all through the evaporator coil and have it changing states (liquid to vapor) continually, we can have the evaporator working the very best it can.

That's where the TXV comes in. The TXV is a Thermal Expansion Valve, sometimes called a TEV (by those who can spell) the TXV opens and closes to allow more or less refrigerant into the coil to maximize the coils efficiency.

This is similar to a spray nozzle on the hose that regulates the amount of water, continually opening and closing to get just the right amount.



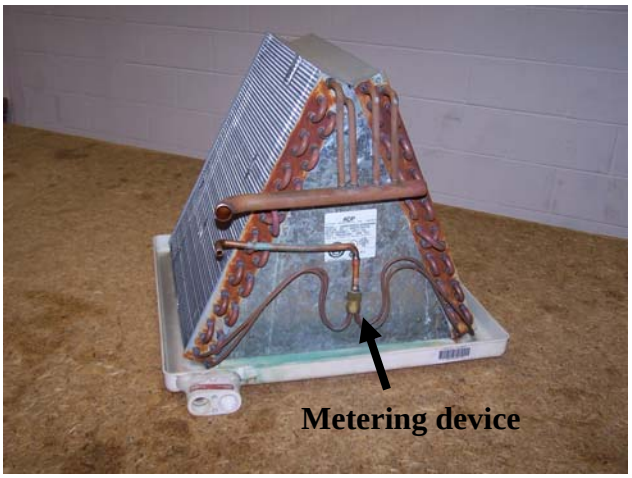


3. The <u>Evaporator coil</u> (which evaporates the refrigerant) is usually mounted on top of, next to, or below, the heater depending on the style of heater being used.

As refrigerant flows through the evaporator, the air from the blower warms the refrigerant causing it to evaporate. As the refrigerant evaporates, it picks up the heat from the house and moves it to the condenser (outdoor unit).
This action is similar to being misted with a bottle sprayer on a very hot day. As the water evaporates from your skin it removes heat from your skin causing you to cool off.

The evaporator serves another purpose also, it dehumidifies. Because the coil is cooled by the refrigerant to a low temperature, (usually around 35 to 45 degrees) the air that goes through the coil reaches dew point. (Like when you take a can of soda from the refrigerator and place it on a counter. The air on the outside of the cold can condenses on the can taking the moisture out of the air, dehumidifying the air)

Because we are now collecting water from the air, you must drain the water from the coil. Connecting a drain line to the bottom of the coil and running it to a location that can accept the possible 15 gallons a day of condensate will accomplish this.



4. Blower

The same way the compressor takes in vapor refrigerant in on one side and discharges it out on the other side we have a blower in the system to move air around.

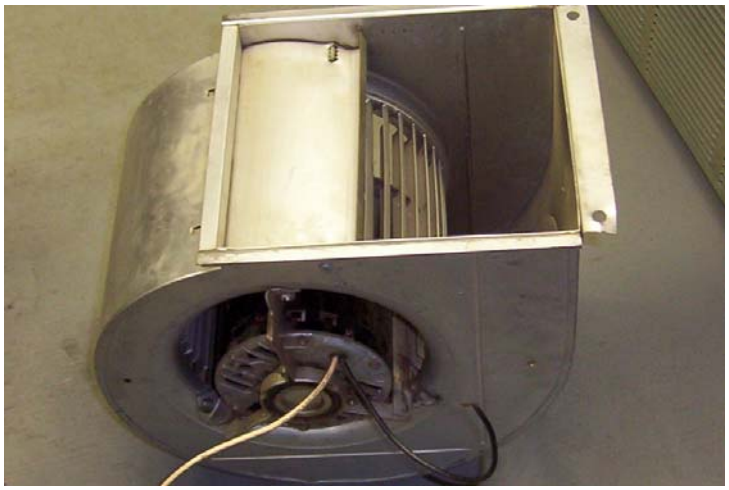
The blower is typically in the furnace or air handler system and is sized to move a specific amount of air per ton of air conditioning.

If it is not allowed to move the proper air through the house because the ducts are too small, or they are kinked, or maybe the filter is dirty, the blower acts similar to a heart with restricted arteries. Your blood pressure goes up because it cannot pump the proper amount of blood throughout your body. The pressure the blower has to blow against is also too high and it cannot move the proper air through the house.

If the system cannot move the proper amount of air, our customers are paying for air conditioning they are not using. If the evaporator doesn't have enough air, it cannot evaporate the entire amount of refrigerant. (This is Bad)

The compressor is now working harder and our customers are getting less cooling.

The proper airflow on all of our newer systems is getting more and more critical.



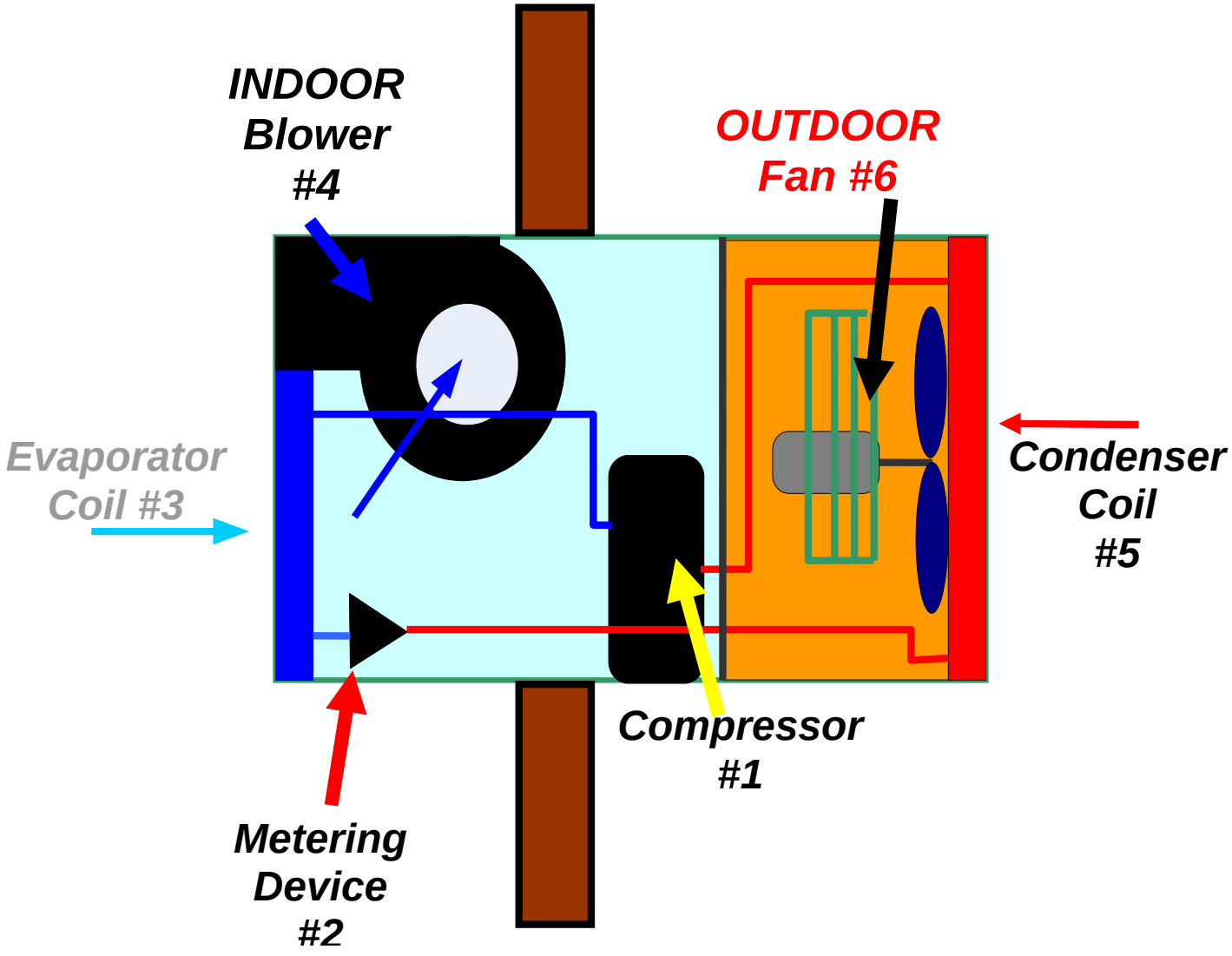
Typically in the past the industry used blowers that had 1 – 4 speeds to adjust the proper airflow to the home.

Newer systems now have Variable drive blowers that can be adjusted to give multiple speeds and better control of desired airflow than ever before. These new blowers coupled with immerging technologies will give our customers benefits we could not offer before with conventional blowers.

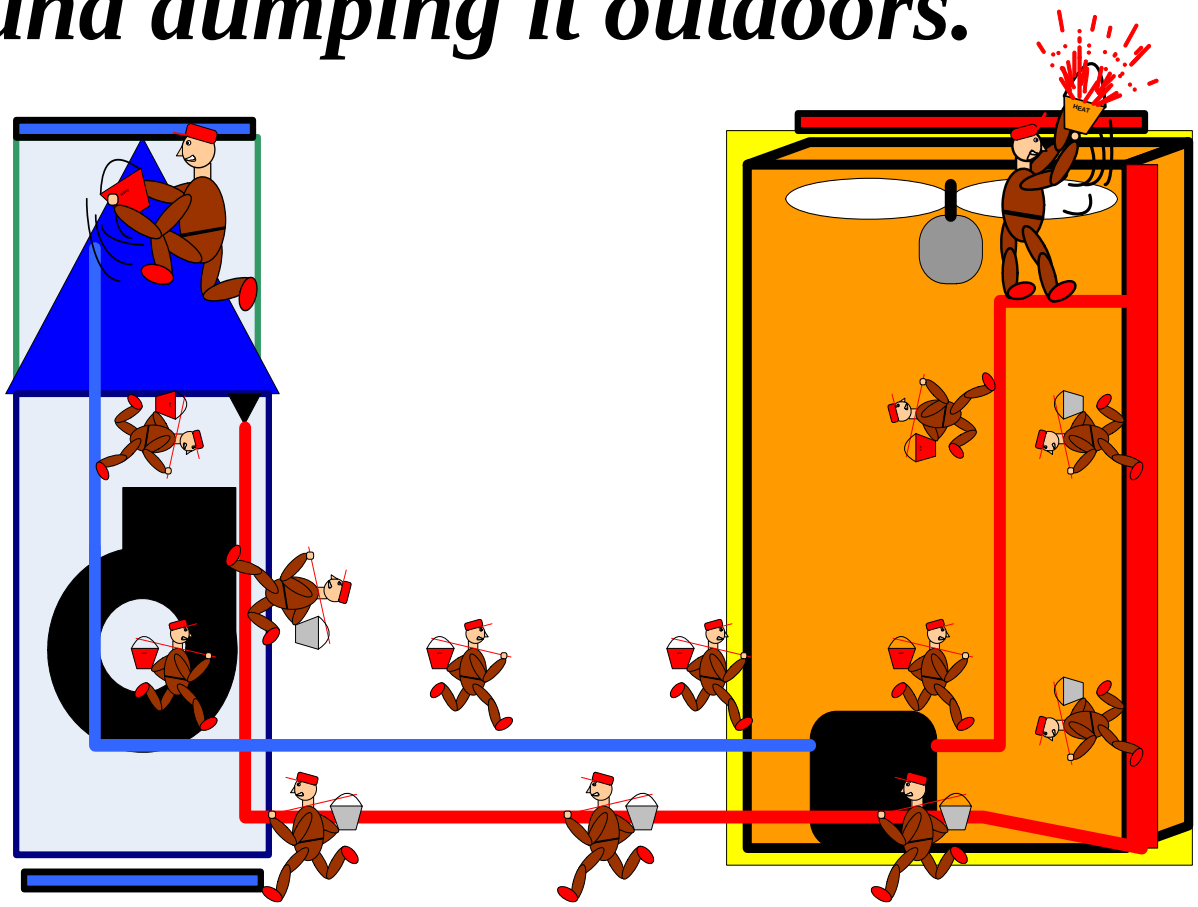
5. **The compressor now runs the refrigerant through the outdoor coil or <u>Condenser coil</u> where the condenser fan can cool the refrigerant off much like the radiator in your car cools the antifreeze in your engine. As the refrigerant is cooled, within the condenser, the vapor refrigerant gives up its heat and condenses back into a liquid. Thus the name Condenser coils.**

6. **The <u>Condenser fan motor</u> pulls air from outside, across the condenser coil that is rejecting the heat absorbed by the refrigerant, it then exhausts it away from the unit.**
Newer units have blades that taper off on the backside of the blade to help reduce blade noise.

A simple window air conditioner will also contain the same 6 components. A window unit is a unit with all the components in one package therefore it can be considered a type of package unit.



Refrigerant Running through the system Picking up heat indoors and dumping it outdoors.



Lineset (Copper Refrigerant Lines)

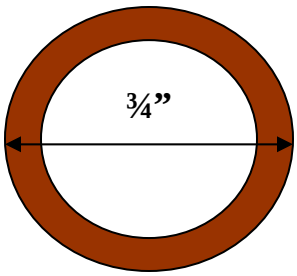
The Lineset carries refrigerant between the evaporator and condenser on a split system unit. This sounds easy enough but there are specifics that need to be followed here also. The line sizes, and length, recommendations need to be followed from the installation instruction manual shipped with every unit.

- **If the line is too large the refrigerant will not move fast enough to carry the oil throughout the system.**
- **If it is too small it will not carry enough refrigerant to do the job the unit is designed to do.**
- **If it is too long the compressor may not pump enough to get the refrigerant easily around the system causing loss in efficiency and capacity.**
- **If it is run too high or buried underground oil may become trapped, not making it through the system, and could cause compressor failure.**

The suction line is insulated with insulation tube to help prevent picking up additional heat going back to the compressor.

Suction and liquid line with liquid line drier

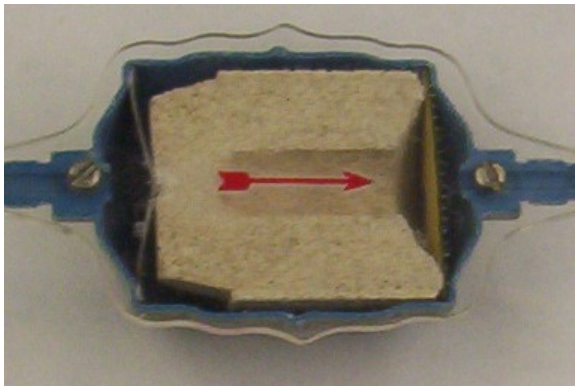
- **Refrigerant lines are sized according to the outside diameter OD of the pipe. For example 7/8", ¾"etc.**

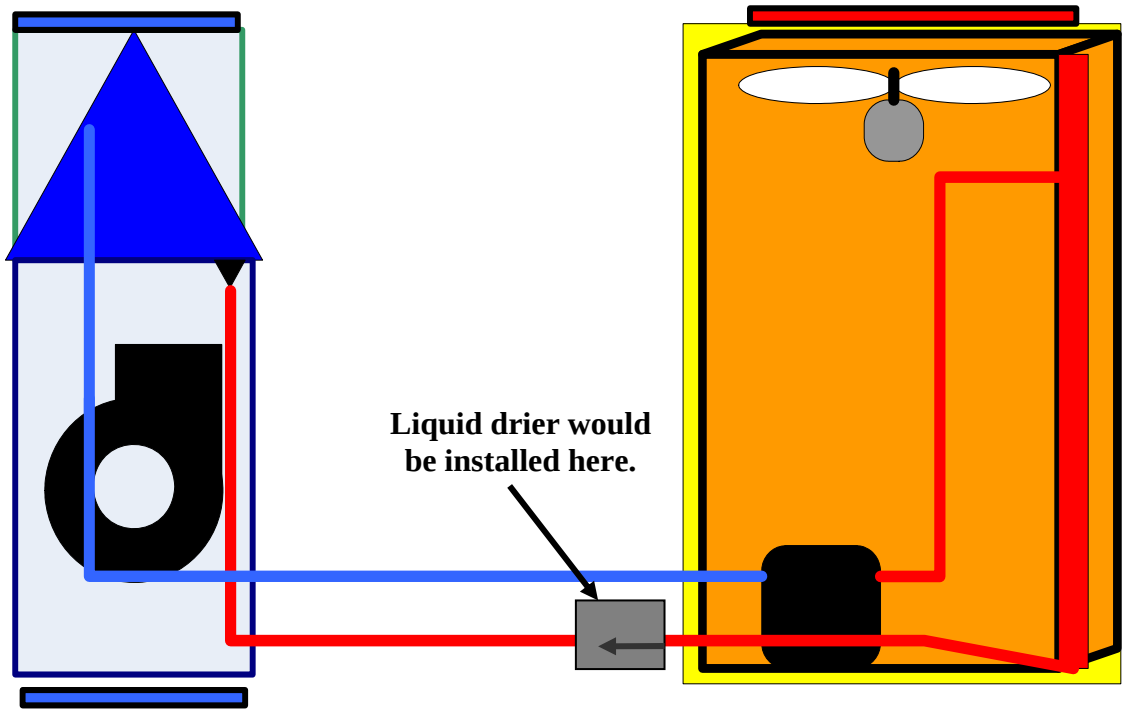


Driers

Driers are installed in some units from the factory to help keep the refrigerant dry while it circulates through the system. If moisture gets into the system, and is heated, it will combine with the refrigerant and become Hydrochloric or Hydrofluoric acid, both of which will eat the windings of the compressor and burn it up.
Driers come in two basic forms and are installed in the Lineset.

- **The Liquid line drier is installed in the liquid line and removes moisture. It should be replaced whenever the unit refrigerant system is opened.**
- **The Suction Line drier is installed in the suction line and removes trash and moisture. It is normally only installed when a system has had a burn out or has abnormal amounts of trash in it. This is a concern when existing line sets are used with new components.**

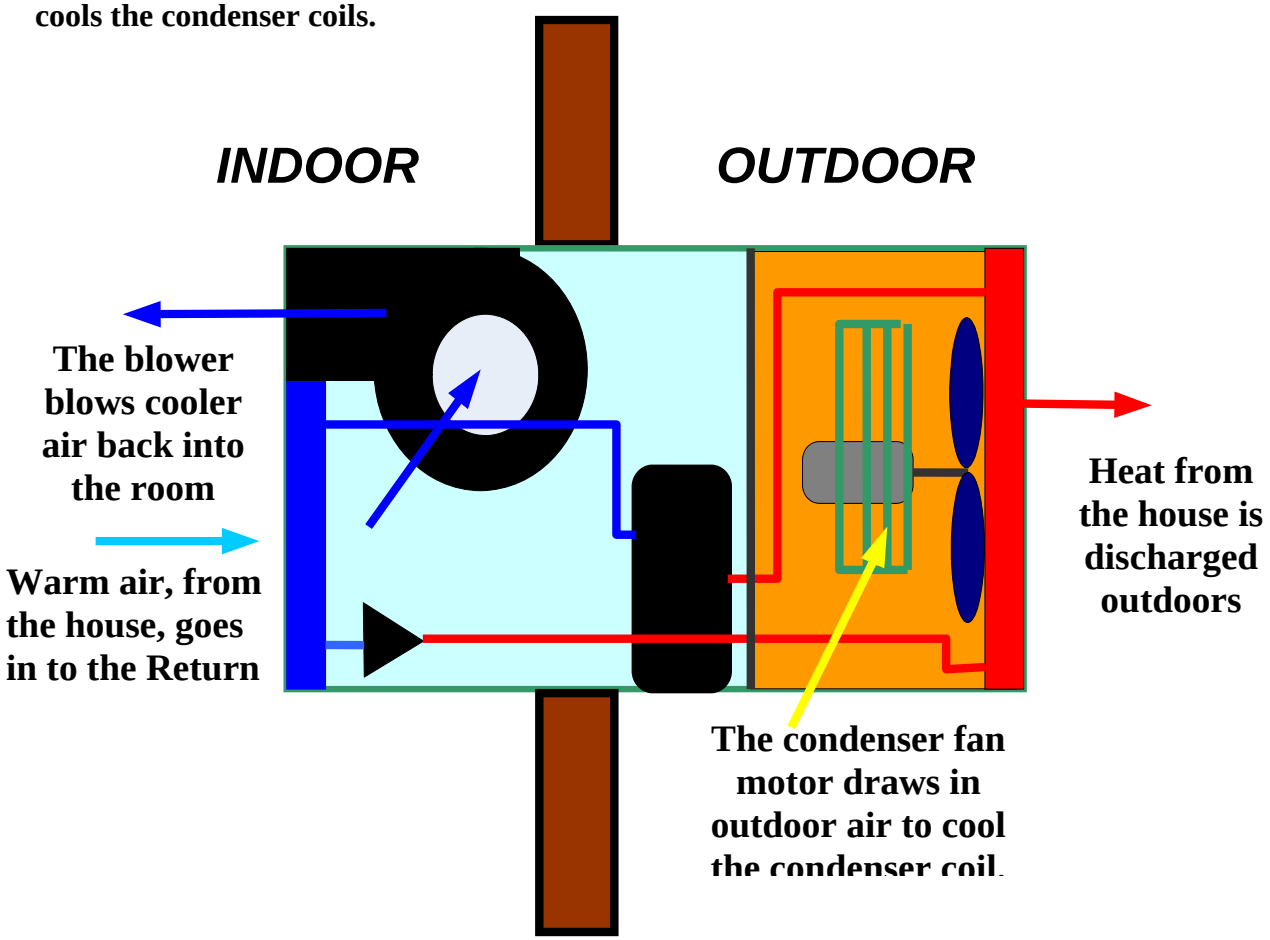




Airflow

Most of us have felt the cool air blowing from an air conditioner inside the home.
With a window unit or a hotel type unit it is easy to understand that the cool air blows out on one side, and hotter air, is blown out the other.

Remember the refrigerant flowing through the evaporator coil, cools the air, and then that heat is dumped outside when the condenser fan motor cools the condenser coils.



The blower picks up heat from the home and the evaporator absorbs it into the refrigerant.
The condenser fan discharges this same heat from the condenser coil to a more desirable location.

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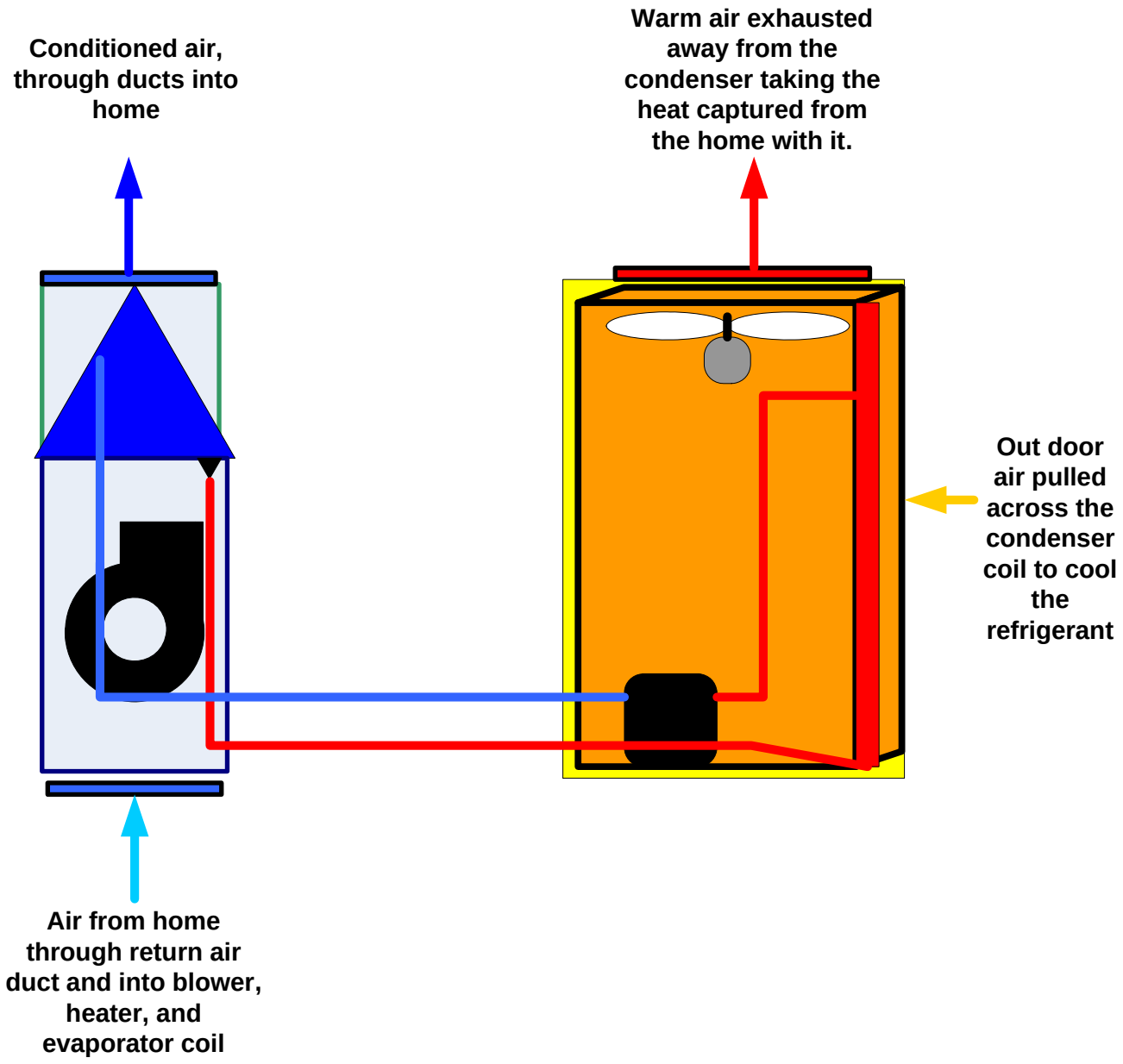
Airflow works the same way on a split system, or a system that is separated, and connected by copper lines. The blower takes air in at the return air grill, it moves it across the evaporator where the air gives up its heat to the refrigerant and then the cooler air is divided up into the rooms via the ductwork. Outside at the condenser, air is drawn in across the condenser coil by the condenser fan motor and delivers it up and away from the unit to a more desirable location.



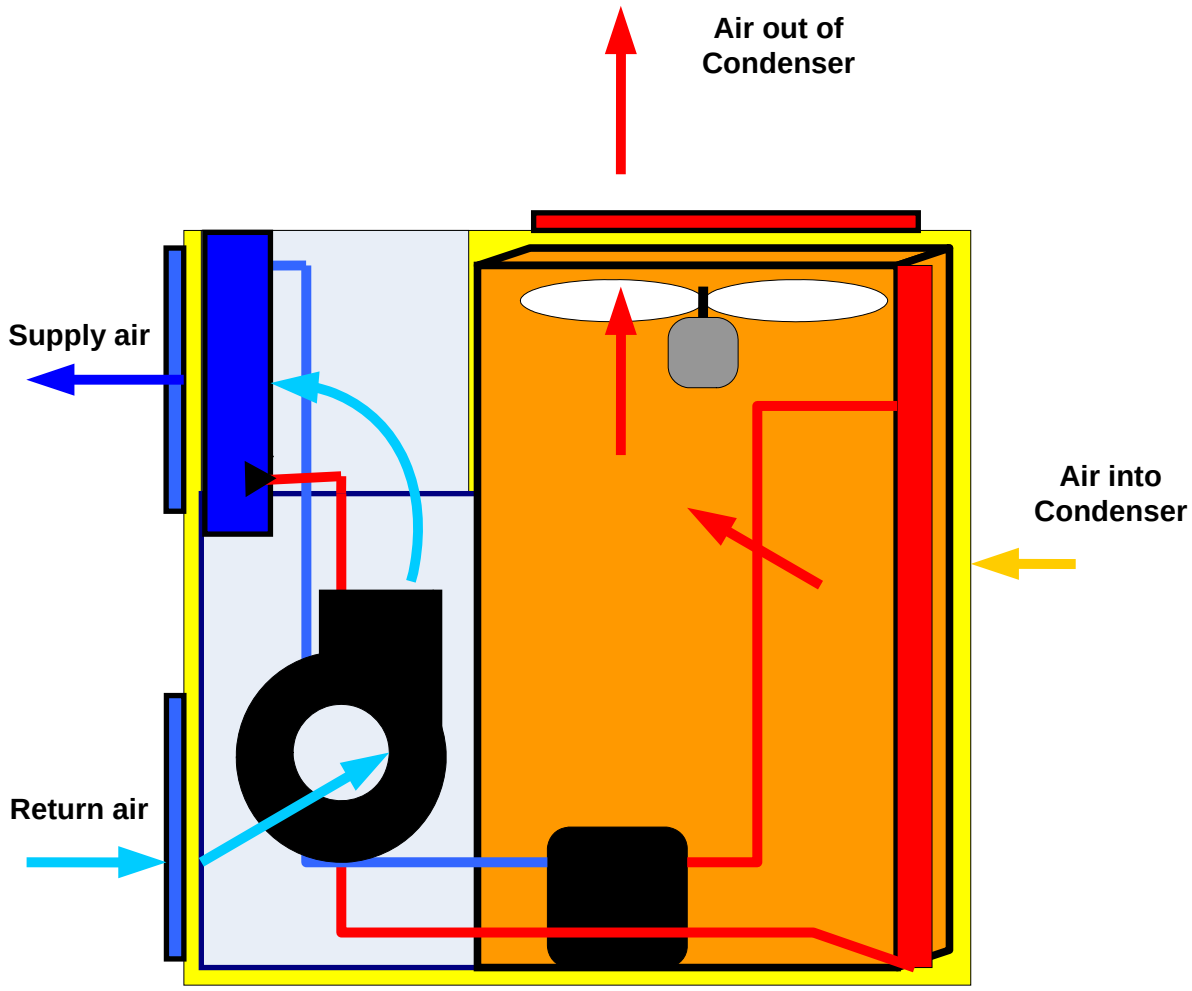
Package Systems

The package system has all of its components in one place. Examples of a package system could be a window unit, hotel style through the wall unit, or even a unit that sits outside on the ground with ductwork piped into the home or on a roof with ductwork piped into the attic.

As the name implies, a package unit is an A/C and possibly heating system with all the components packed into a single package. A package unit can be found on Manufactured housing, Commercial buildings, or on Residential buildings. They tie into the duct system a couple of ways, either through the roof, or through the wall.

Package systems are available in, heating only, cooling only, cooling and electric heat, cooling and heat pump, cooling and gas heat and also, cooling and oil applications.

The package unit's airflow is just like the previous systems. Giving up its heat to the evaporator coil and cooling the refrigerant in the condenser.



Ductwork

The duct system is the conduit for moving air throughout the house. Installers will spend more time on this aspect of the job than any other area, yet it is the area done inadequately most often.
Good ductwork rules;

- **Install once for a lifetime. Strapping and supporting ducts will keep customers as well as other trades from disrupting the ducts.**

- **The straighter the better. If the ducts are all crooked throughout the duct system chances are the blower has to work very hard to move air through. It is much easier to get air flowing in a straight line as opposed to having it continually change direction.**

- **If it leaks air it's not good enough. If it is installed to never fall apart the chance of leaking air will be kept to a minimum keeping utilities down and enhancing Indoor Air Quality.**

The three most common types of ducting are:

1. **Metal ducts**
2. **Ductboard**
3. **Flexible ducts**

Duct types are not necessarily good or bad but installation practices are. Taking the time to learn about proper design and installation practices will go a long way to it becoming a good or bad system.

Duct cleaning

If cleaning is necessary there are two basic methods.

- **Rotating brush with a vacuum connected to it.**
- **Negative pressure system that uses brushes, whips, or airflow to move the dust toward a remote vacuum system. (Sometimes in the home or mounted on a truck outside.)**

Neither system is effective unless a visual inspection of the ENTIRE duct system is accomplished. This can be done with inspection holes or cameras.

Ducts should ideally never have to be cleaned. Having said that we don't live in an ideal world. We should note however that if ductwork is installed well, maintenance is properly performed, and filtration taken care of regularly the chances of ever having to clean ductwork in a residential system is minimal.

Our thinking as an industry must change however if we plan to accomplish this. Installing filters at the return grills will keep the return ductwork cleaner. Sealing the ductwork will help to prevent dust being sucked into the system. Properly sizing filters to have the proper speed of the air crossing it will help the filter do the job it is designed to do.

Heat pump

Now remember we said: "An air conditioner is a mechanical device that collects heat from an undesirable location and conveys it to a more desirable location namely inside the house to outside the house."

A heat pump works just like an A/C in the cooling mode but in the heating mode, causes the refrigerant to flow backwards. It takes the heat from outside, absorbs it into the refrigerant, and then releases it from the refrigerant to the indoor air. (Turn a window unit around into a window backwards)

Heat from outside? Think about this.
Your ice cream is cold when you bring it home but your freezer still takes more heat from it, making it colder.
Where does that heat go?
To the Back or bottom of freezer, the condenser coil.

By reversing the flow of refrigerant the two coils, evaporator and condenser, are reversed. The refrigerant now flows from the compressor to the indoor coil first, where the refrigerant condenses and then flows to the outdoor coil where it evaporates.

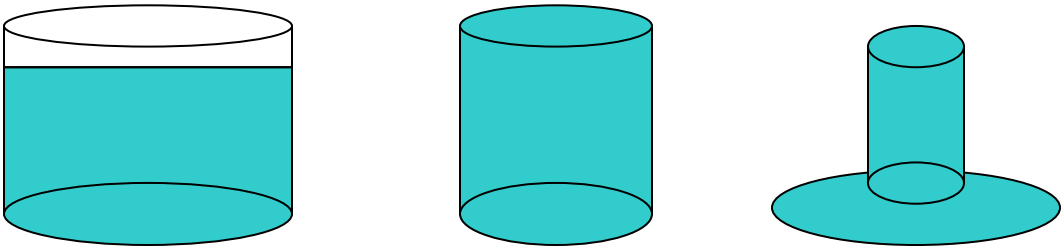
Refrigerant 22 boils at –40F so it can pick up heat from the outdoors even if it is really cold outside.

Because the evaporator coil is now working outdoors, the chance for it to ice up is good. Therefore the system must go through a defrost cycle. To make the system defrost the unit has the refrigerant flow just as it did in cooling. The outdoor fan cycles off and now the refrigerant warms the outdoor coil until the ice melts and it shifts back into the heating mode.

A heat pump when compared to electric heat is approximately 3 times more efficient to operate (3 COP, Coefficient of Performance). When compared to gas heat they are close to the same. Local gas and electric prices dictate the efficiency of each.

Humidity

Humidity is measured in Percentage of Relative Humidity (%RH) or the amount of moisture in the air compared to how much moisture the air can hold at any given temp.



If you had a 100 gallon container, and filled it ¾ full with water, it would be similar to a 100 degree day at 75% RH. The amount of water in the air, (container) compared to how much it can hold.

If you then reduced the container size, (lowered the temperature) to a 75-gallon, (75 degree day) and placed the same amount of moisture in that container. It would now change to a 75 degree day at 100% RH; this air is now completely saturated with water.

If you lower the temperature any more, the container (air) will not be able to hold it, and it will condense on objects.

The higher the humidity, usually the more uncomfortable you are in the cooling season, but it can make us feel warmer in the heating season as well. Remember moisture that is in the air is a form of heat (Latent Heat). Therefore, it must be controlled for us to feel comfortable.

If the Relative Humidity is too high, we can have moisture problems. Fungus can grow, dust mites thrive, and a host of other undesirable conditions can occur.

If the Relative Humidity is too low, we lessen those effects but now we can have static electricity, skin disorders, nose bleeds etc. another group of issues we must consider.

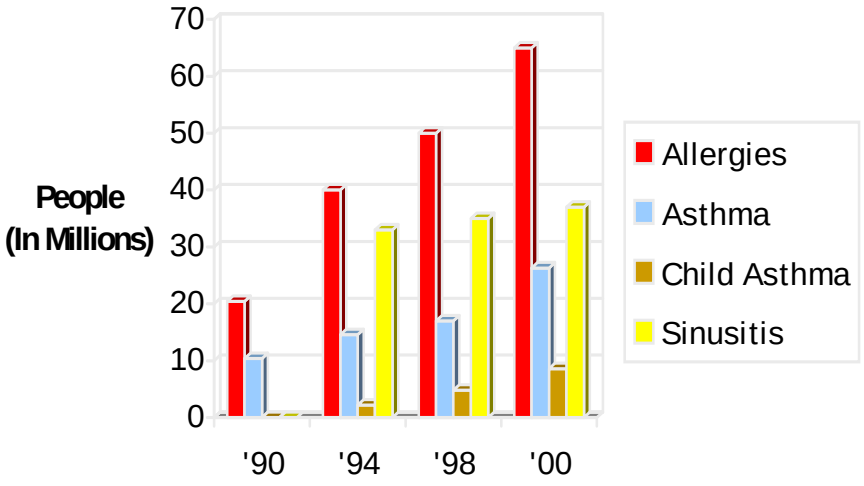
Lennox has chosen 25-50% as being the optimum range for Relative Humidity to handle both the comfort level and the IAQ issues.
There are however, some conditions, when we must deviate from these parameters, as not to create other problems in the residence.

Filters

Particulate is a fancy name for dust. It is basically anything that can become airborne, that we can breathe in our home. We breathe in dust every day, and our bodies have its own filtering system. The hairs in our noses, and the mucus membrane, help filter out this dust, and keep our lungs clear.

The first problem occurs when the dust becomes so small that our bodies can't do an adequate job of filtering it out.

The second problem is, the air in our homes contain tremendous amounts of this very fine dust that can pose respiratory problems in adults, but more often, in children.



The graph above shows the incidence of health problems that can be aggravated by airborne particulates. By reducing the airborne particulates in the home, we can help to reduce the incidence of these health concerns.

It is not just dust, its what is *in* the dust that can be a problem, viruses, pollen, mold spores, lead paint dust, pet dander and a group of other potentially harmful items, all going in and out of our air conditioner, and in and out of our bodies.

It is our job once again to solve all the problems associated with dust. We do this with filtration, and or filters.

Filters

To do our jobs correctly we must be able to identify what is a good or poor filter. Until recently this was a very difficult thing to do.

Filtration Ratings in a nutshell

- **ASHRAE Standard 52.1-1992**

If a filter captured 90% of the large dust, over a given time, it was given a 90% Arrestance Efficiency.

If a filter captured 30% of the fine dust, over a given time, it was given a 30% Dust Spot Efficiency.

By testing this way, you can only tell how good the filter is over the life of the filter (average) not how well it will do with a particular size dust when the filter is brand new or least efficient.

- **ASHRAE Standard 52.2-1999.**

Filter testing under this new method uses specific particles of 0.3 to 10 microns. This standard is specifically designed to test "High Efficient Filters" for discriminating homeowners, labs, hospitals etc.

The filter is tested with test dust from 0.3 to 10 microns to see how well it removes dust at each different stage of loading. This gives a clearer picture, at each stage, how well a filter is doing, rather than an average, as was the case in the older standards.

The resulting efficiencies to the test are now given a number from 1-16 called the Minimum Efficiency Reporting Value (MERV). This number tells the user, under the least efficient conditions (usually brand new), how well this filter will work.

Typical Ratings for Various Filters

For the sake of example, these are some typical MERV ratings, and how they correspond to the Dust Spot efficiencies of past Standards.

MERV	Type of filter	Average Dust Spot
MERV 1-4	Fiberglass, Disposable Panel, Washable metal/synthetic, Self charging (Passive)	20%
MERV 5-8	Pleated, Media panel, Cube	20-35%
MERV 9-12	Extended pleated	40-75%
MERV 13-16	Electronics	80-99%
	HEPA	99.9%

The stand-alone versions do not do a good enough job for the whole house to be recommended by Lennox.

Use a MERV 8 as target minimum for recommendations.

HEPA bypass is a very good way of removing dust in all sizes from the environment. Being in the MERV 17-20 range, this style of filter uses a bypass around the units' air handler to remove dust from the air. Utilizing its own blower, it can overcome the resistances that a typical residential blower cannot.

Ventilation

The V in HVAC is one of the most overlooked areas in our industry. As homes get tighter, and the products we use in our homes become more toxic, we have begun to build an Indoor Air Quality nightmare.

It is estimated by the EPA that the air inside the home is 40 to 100 times more polluted than outdoor air.

Inside today's tighter homes, both moisture and pollutants are being formed. The moisture comes from cooking; washing clothes and dishes, showers, and even our breathing contributes.

Other pollutants can include the very materials from which the home is constructed; insulation, plywood, particleboard, foam sealants, caulk, paints, carpets and glues. All of these products when exposed to higher temperatures or humidity will off-gas at higher rates. Off gassing is when these products let off VOCs (Volatile Organic Compounds) into the air we breathe.

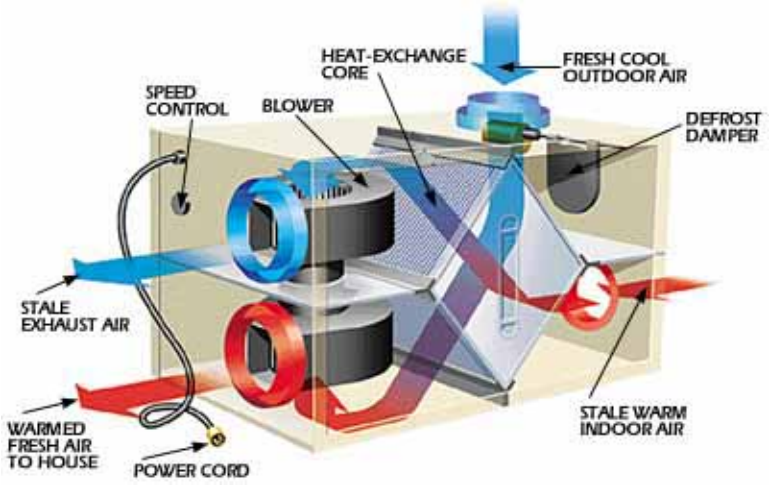
The recommended methods for controlling these VOCs are to:

1. **Remove products from the living space.**
2. **Ventilate.**

Because we don't want to bring in extreme temperature air, we can use an HRV, *Heat recovery Ventilator* or an ERV, *Energy Recovery Ventilator*. They temper the incoming air by running it side by side, with the exhaust air, through a heat exchanger core.

HRV is typically used in northern climates

ERV is typically used in southern climates where we must dehumidify the fresh air.



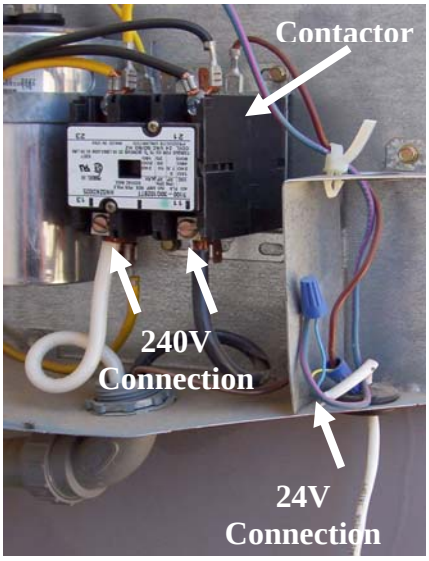
Wiring

In order for the blower to blow, the compressor to compress, and the thermostat to turn the units on and off, we must have electricity.
One of the key components in an electrical circuit is the path, the wiring.

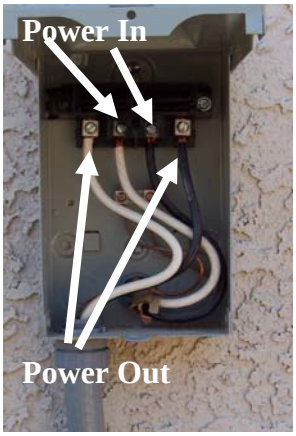
The International Electrical Code will determine the size and wire type to be used on any installation.

There are basically 3 voltages we work with.

- **The first is the control voltage (low voltage) or 24 volts. The installer runs this from the thermostat to the heater and another set of wires run from the heater to the condenser. This voltage operates switches in the heater to turn on the blower or the heat relay. It also operates the contactor in the condenser that will control the compressor and condenser fan motor.**



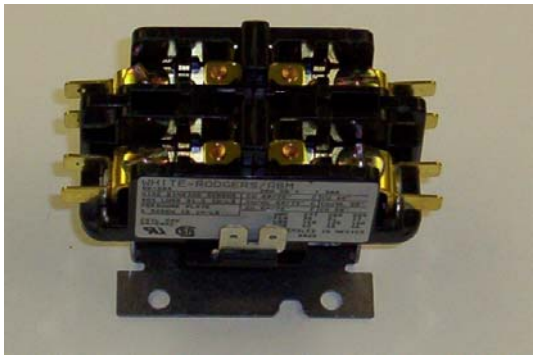
- **The second is 120 volts (you may also hear it called 110 or 115) this is usually the operating voltage for the motor on a gas or oil furnace.**



- **The third is 240 (or 210, 220, 230) volts. This is the voltage supplied by the installer to the condenser (outdoor unit) to run the compressor and the condenser fan motor. This voltage is also run to the heater section if the heater is a heat pump or an electric heater.**

Contactor

The contactor is a mechanical switch that closes and opens, on a signal from the thermostat, to send high voltage power to the compressor and condenser fan motor.



Thermostat

The thermostat (Stat) is the brain of the entire system. It turns everything on and off; it is the one part of the system your customer may look at on an every day basis.
Newer thermostats are now giving more and more information about the comfort levels in a home.

Thermostats come in programmable and Nonprogrammable types. Both types are becoming more accurate because digital inputs and outputs have narrowed the on / off settings to be approximately 1 degree + or -.

Programmable stats have the ability to "setback" while you are at work and then move back to the desired setting before you arrive home in the evening. They typically come in a 5 /2 day program or a 7day program.

Drains

There are primary drains and secondary drains. Or said differently, a drain that takes the water out and a drain that is a back up or safety.

Drains are typically run with ¾" PVC pipe "Down, Straight and Secure" are the key words here.

There are three primary drains that could be run.

- **One is from the 90% condensing gas furnace.**
- **One from the A/C evaporator coil.**
- **One from a humidifier.**

If the evaporator or furnace is installed over a conditioned space, an auxiliary pan and secondary drain should be run as well.

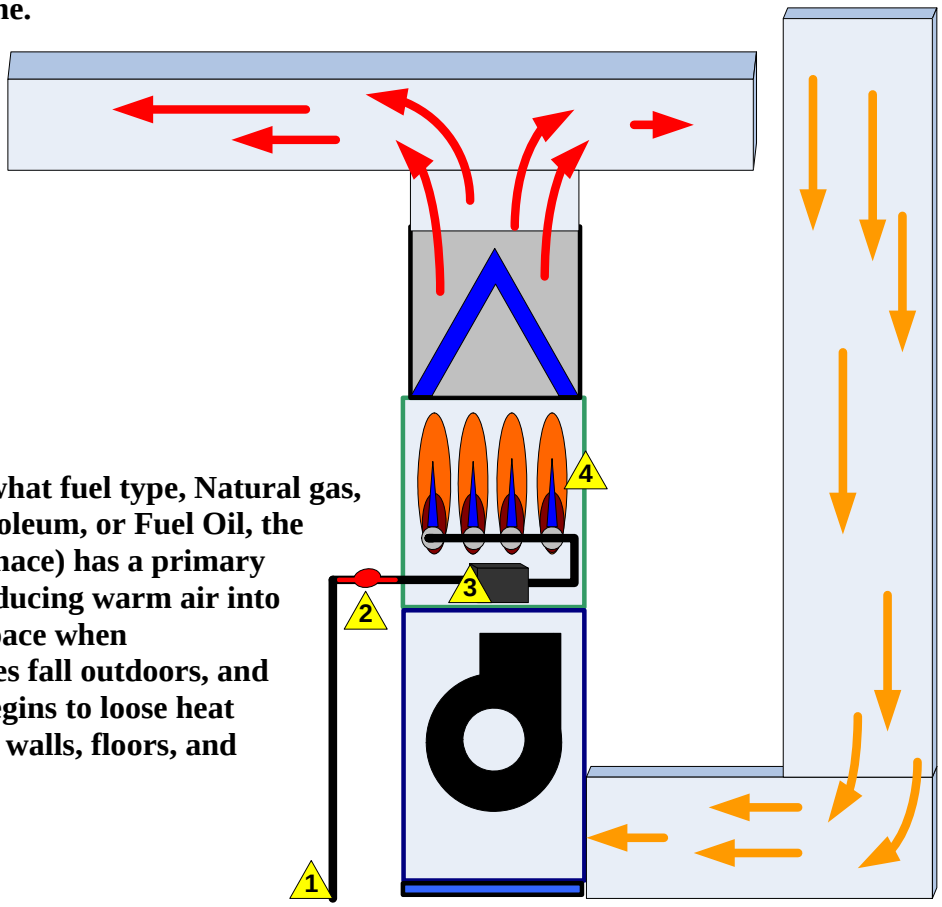
Heater (Electric, Gas, and Oil)

Electric heat

The simplest form of electric heat could be thought of as a common hair dryer. The blower blows air across an electric coil that is heated up to a glowing red. You may find hair dryers consume 1500 watts of electricity, (that's 15 light bulbs at 100 watts each) while a common electric heater would consume 20,000 watts of electricity (200 light bulbs at 100 watts each).

Gas and Oil

Gas and Oil furnaces take fossil fuel and ignite it to heat the home. Fuel is brought in to the furnace through the fuel line (#1). The fuel then passes the gas cock (#2), which is a manual shut off valve before the furnace. The gas then flows through the gas valve (#3) that is operated by the thermostat. The fuel is now ignited by a number of different ways to initiate combustion (#4). With the fuel burning in a chamber, the chamber gets very hot. The blower is now turned on, and the air from the home is moved around the chamber, heating the air. The warm air is now blown into the home.



No matter what fuel type, Natural gas, Liquid Petroleum, or Fuel Oil, the Heater (furnace) has a primary job of introducing warm air into the living space when temperatures fall outdoors, and the home begins to loose heat through the walls, floors, and ceilings.

Types of Ignition

To get the fuels to burn, there is a need to ignite it; this industry has three principal types of ignition.

- **Standing pilot. The standing pilot is a very familiar form of ignition. It consists of a pilot light that burns, and when the main burner turns on, ignites the fuel for the burner to burn. This was used in heating for many years, and is still used on water heaters, but is being replaced with more efficient means of ignition.**

- **Electronic ignition. Electronic ignition uses an electrical spark to ignite the fuel for the burners. This means of ignition does not require the burning of fuel for a pilot light because it lights the burners directly. Electronic ignition or sometimes-called, spark ignition, is used on some gas stoves, Bar B Que grills, and still used on some brands of gas furnaces. Oil furnaces use electronic ignition almost exclusively.**

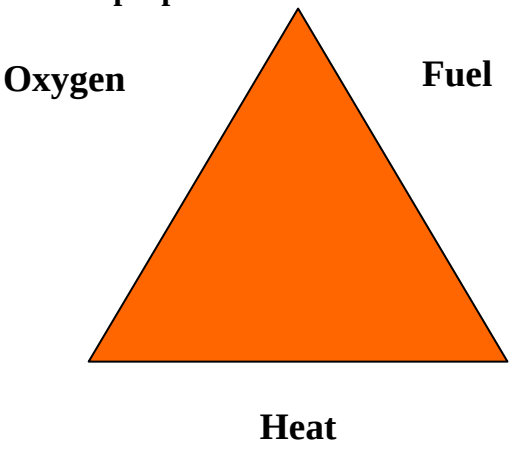
- **Hot surface ignition, or HSI has become the predominant form of ignition. Basically the manufacturers uses electricity to heat up a surface until it becomes hot enough to light the burners. A very basic form of this type is the automobile cigarette lighter, (remember those) it uses an electrical current to make the coil glow red hot to be used as an ignition surface. Today in heating, many different types of surfaces have been tried, and are being improved upon.**

Fuel burning heaters

When dealing with fossil fuels, proper combustion is needed to insure the furnace is safe to operate.

There are three things needed for proper combustion.

- **Fuel**
- **Oxygen**
- **Heat**



If any of these three is supplied in a quantity of too much, or too little, the result is incomplete combustion.
Incomplete combustion has a serious byproduct called Carbon Monoxide.

Depending on your area you can expect to see the heater mounted in a variety of locations.

Horizontal: in either the attic, or crawlspace.

Up flow: in a closet, basement, mechanical room, garage, or attic

Down flow (Counter flow): in a closet, or mechanical room.

Package unit: on the roof, or side of the home.

If you are burning a fossil fuel, (oil, or gas) for heating purposes, you will be required to hook up a vent system (vent pipe) that will exhaust the gasses that contain products of combustion out of the house. These products include carbon dioxide, nitrogen and water vapor.

Think of this vent system like the exhaust system on a car.

Vent piping

The venting of fuel burning appliances is necessary for the same reason we need the exhaust pipe to extend past the back of the car. If the exhaust gasses are mixed in the house, or in the basement, they could enter the home, and many problems could occur, with carbon monoxide poisoning being only one of them.

The three most common venting types will be:

- **Single wall metal pipe used as a connector, or a starter piece.**
- **Double wall Type B vent pipe used for 80% efficient, and less units.**
- **Schedule 40 PVC, is used on 90% efficient, positive pressure venting, and combustion air.**

The type of vent pipe is the easiest way to tell at a glance if a furnace is an 80% and less or a 90% and greater.

An 80% heater has metal Type B vent while the 90% has plastic PVC vent.

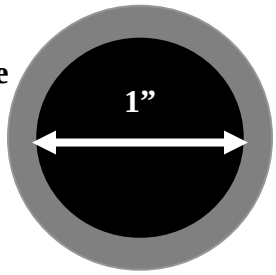
Fuel Piping

Fuel piping is needed when a furnace uses a fossil fuel like oil, natural gas, or propane. The installer must run the fuel line from the fuel supply, to the furnace. Guidelines have been established by the NFGC National Fuel Gas Code on how this should be done, how large or small, how long or how to support.

There are several materials that can be used for the purpose of fuel piping with the most common being;

- **Black iron**
- **Galvanized steel**
- **Copper pipe**
- **Trac pipe**
- **Flex connectors**

- **Black iron and galvanized pipe are identified by their inside diameter ID. For example ¾" or 1" pipe.**



Conclusion

You have been enlightened today in many areas of the HVAC industry. The components we have discussed have gone well beyond the perception that this industry is just heating and cooling.

The definition of air conditioning itself tells us this.

Air conditioning
The process by which comfort conditions are maintained within a structure including but not limited to humidity control, particulate level, temperature level, ventilation, air speed, air volume, and noise levels.

As equipment becomes more sophisticated the ability to zero in on our customers wants and needs in every room of their home becomes greater.

We at HVAC Learning Solutions hope you have enjoyed this presentation and also hope you might keep it as a companion guide for future reference.