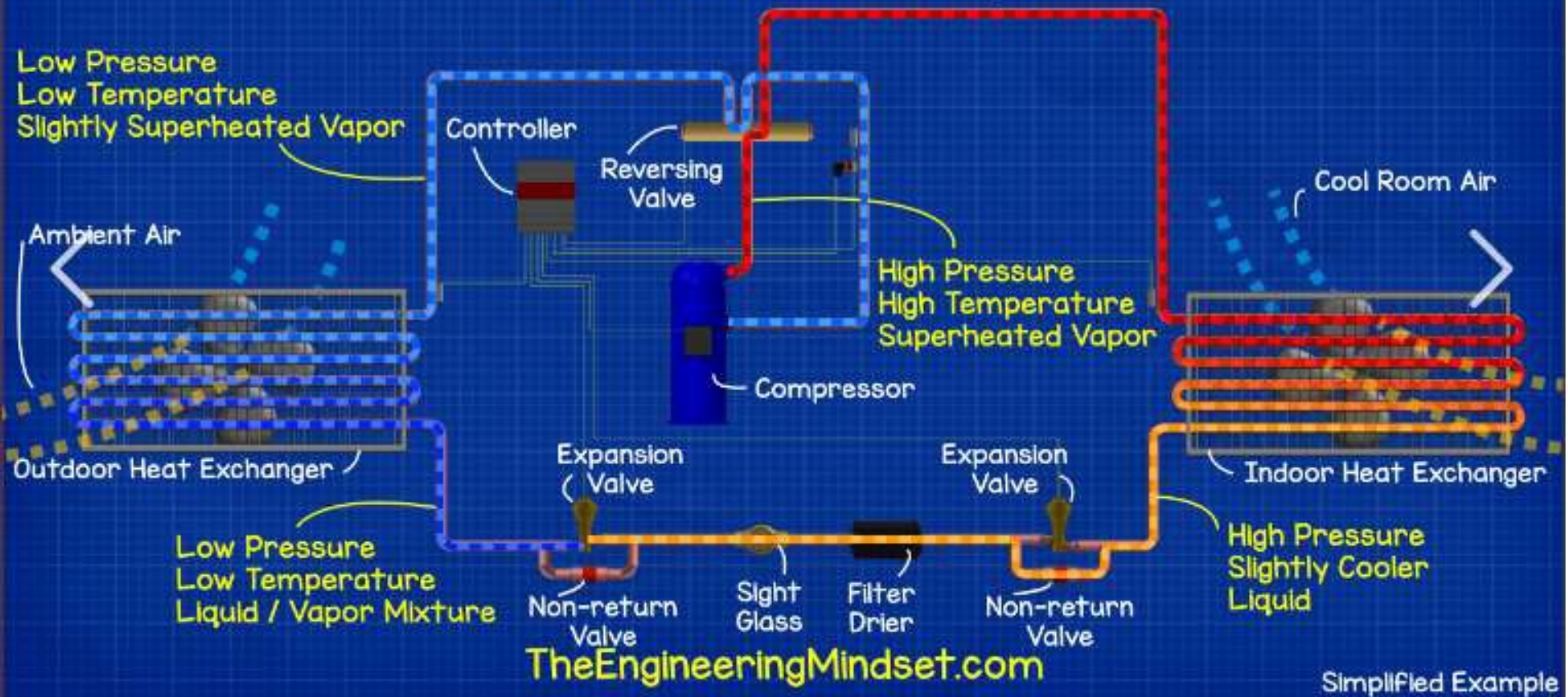
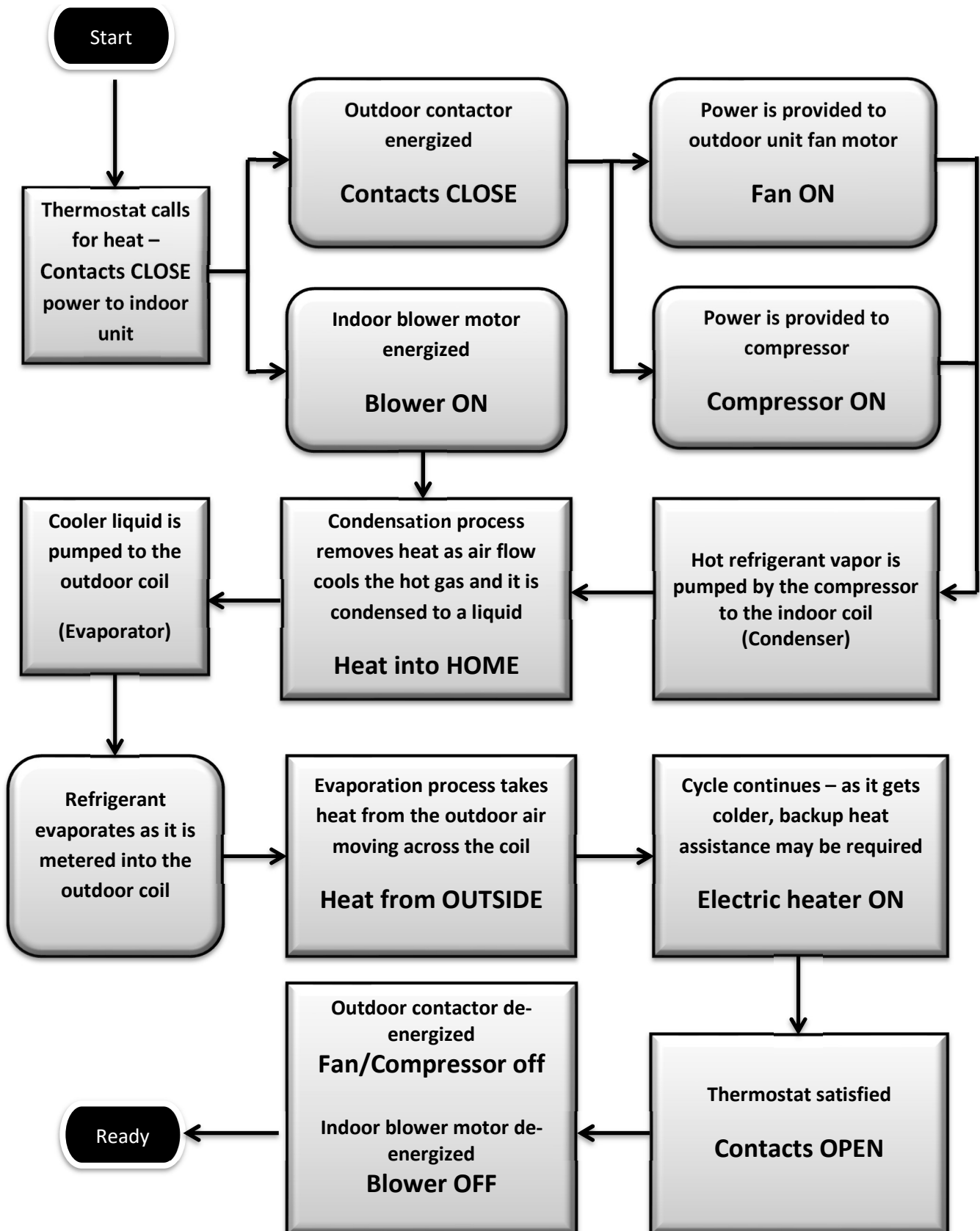


How Heat Pumps Work

Air to Air Heat Pumps



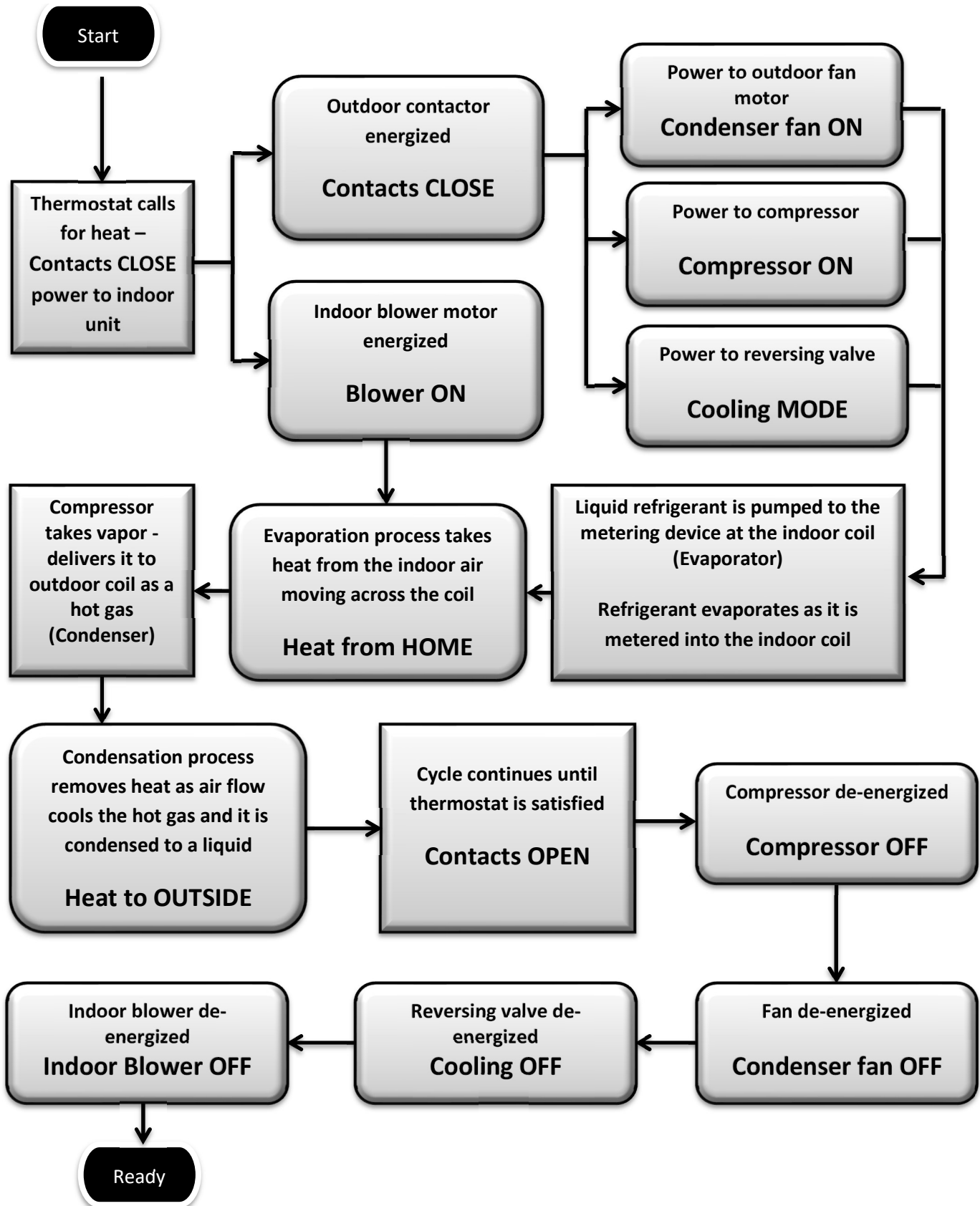
Sequence of operation for a typical electric heat pump (Heating Mode)



Sequence of operation for a typical air-source electric heat pump: (Heating Mode)

- Thermostat calls for heat – contacts close which provides control voltage to the indoor unit
- The indoor blower is energized at the same time there is a signal sent to the outdoor unit
- The outdoor fan and compressor both energize and start to operate
- Refrigerant from the outdoor coil is pumped to the indoor coil as a hot gas (discharge side of the compressor) – this refrigerant is in a high pressure, high temperature state
- The operation of the indoor blower uses air to remove the heat from the hot gas and condenses it to a liquid in the indoor coil (condenser) – heat is added from the refrigerant to the house
- The high pressure, medium temperature liquid is then pumped to a metering device at the outdoor coil
- The liquid passes through a metering device which allows the liquid/vapor refrigerant to pass into the low pressure outdoor coil (suction side of the compressor)
- The refrigerant now evaporates to a gas in the outdoor coil – (evaporator) the low pressure coil along with the heat taken from the outdoor air moving across the coil allows the refrigerant to evaporate - heat is removed from the outdoor air to be delivered by the refrigerant to the house
- The low pressure, low temperature gas is sucked into the compressor where it is discharged to the indoor coil again as a high pressure, high temperature vapor
- The cycle continues until the thermostat is satisfied
- If the heat pump cannot keep up due to low outdoor temperatures, back up resistance heat may be required to supplement the heat pump – heaters are operated as long as there is a need
- Occasionally, an air source heat pump will need to go into “Defrost” mode to remove ice/frost buildup on the outdoor coil – this is performed by the system going into cooling mode where the outdoor coil now becomes the condenser – the heat from the coil will remove the ice
- If there is a problem with the heat pump, the thermostat will have an “emergency heat” setting which will not allow the heat pump to operate and will bring on the back-up resistance heat as the primary heater

Sequence of operation for a typical electric heat pump (Cooling Mode)



Sequence of operation for a typical air-source electric heat pump: (Cooling Mode)

- Thermostat calls for cooling – contacts close which provides control voltage to the indoor unit
- The indoor blower is energized at the same time there is a signal sent to the outdoor unit
- The outdoor fan and compressor both energize and start to operate
- Liquid refrigerant from the outdoor coil is pumped to the indoor coil metering device - this refrigerant is in a high pressure, medium temperature state
- The liquid passes through a metering device which allows the liquid/vapor refrigerant to pass into the low pressure indoor coil (suction side of the compressor)
- The refrigerant now evaporates to a gas state in the indoor coil – (evaporator) – the low pressure coil along with the heat taken from the indoor air moving across the coil allows the refrigerant to evaporate - heat is removed from the indoor air to the refrigerant where it will be delivered to the outside
- The low pressure, low temperature gas now is sucked into the compressor where it is discharged to the outdoor coil as a high pressure, high temperature vapor (discharge side of the compressor)
- The operation of the outdoor blower uses outdoor air to remove the heat from the hot gas and condenses it to a liquid in the outdoor coil (condenser) – heat is delivered from the refrigerant to the outside
- The high pressure, medium temperature liquid is again pumped to the metering device at the indoor coil
- The cycle continues until the thermostat is satisfied

Heat Pump Sequence of Operation

Cooling Mode

1. The thermostat calls for cooling.
2. This sends a 24-volt signal through the "Y" terminal to the compressor contactor in the outdoor unit. The compressor and outdoor fan start.
3. At the same time a 24-volt signal flows through the "G" terminal to the indoor blower relay. The indoor blower starts.
4. The cooling system is now in operation.
5. The thermostat satisfies and ends the call for cooling.
6. This ends the 24-volt signal to the compressor contactor and the outdoor unit stops.
7. This ends the 24-volt signal to the indoor blower relay and the indoor blower stops.
8. The system is now off.

Heating Mode

1. Setting the thermostat to the heat mode automatically powers the reversing valve solenoid.
2. The thermostat calls for first stage heat.
3. This sends a 24-volt signal through the "Y" terminal to the compressor contactor in the outdoor unit. The compressor and outdoor fan start.
4. At the same time a 24-volt signal flows through the "G" terminal to the indoor blower relay. The indoor blower starts.
5. The heating system is now in operation.
6. If first stage heating is not enough to heat the building, the second stage thermostat bulb makes a call for more heat.
7. A 24-volt signal flows through the "W2" terminal to the heating relay in the indoor air handler.
8. This sequencing relay cycles on electric elements to add more heat to the indoor air stream.
9. As the building warms, the second stage call for heat ends.
10. This breaks the 24-volt signal to the "W2" terminal and de-energizes the heating relay.
11. The electric heat element(s) cycle off.
12. The first stage thermostat call satisfies and ends the call for heat.
13. This ends the 24-volt signal to the compressor contactor and the outdoor unit stops.
14. This ends the 24-volt signal to the indoor blower relay and it stops.
15. The system is now off. The reversing valve pilot solenoid stays energized as long as the thermostat is set for heating.

Defrost

Electrical: A defrost control must recognize when there is a layer of ice on the outdoor coil and when that ice must be removed. There are several different types of defrost controls. While they vary in the methods used to recognize when defrost is necessary, they all take the same action. These controls also must determine when the ice is gone and terminate defrost.

1. The defrost control initiates a defrost cycle when ice builds up on the outdoor coil.
2. The control energizes the on-board defrost relay with 24 volts.
3. The defrost relay contacts open to de-energize the reversing valve.
4. The defrost relay contacts break power to the outdoor fan.
5. The defrost relay powers the heat relay to bring on the indoor electric heat.
6. After the ice is defrosted, the defrost control terminates the defrost cycle by de-energizing the defrost relay.
7. The defrost relay contacts close sending 24 volt power to the reversing valve and the valve returns to the heating position.
8. The defrost relay contacts close sending power to the outdoor fan.
9. The defrost relay contacts open breaking 24 volt power to the indoor heating relay.
10. The heat pump is now in the normal heating mode.

Emergency Heat

Mechanical: The emergency heat setting on the heat pump thermostat is manually selected by the equipment owner. This is usually in response to a malfunction in the outdoor unit. Doing so locks out the outdoor unit. The indoor auxiliary heating system must provide the heat required. Setting the thermostat to the heat position allows the outdoor unit to operate. Due to the expense of electric resistance heating compared to the efficiency of the heat pump, repairs should be made as soon as possible.

1. Manually select the emergency heat position on the thermostat subbase.
2. The outdoor unit stops all operation.
3. On a call for heat, the indoor unit becomes the sole heat source.