Commercial Refrigeration is a science of vague assumptions, based upon debatable figures, taken from inconclusive experiments, performed with instruments of problematical accuracy by persons of doubtful reliability and questionable mentality

Energy & Store Development Conference

E+SD 2013

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THE VOICE OF FOOD RETAIL

Energy & Store
Development Conference

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Basic Refrigeration 101

Cooling by the removal of heat

The MOVEMENT of HEAT from a place where it is not wanted to a place where it is unobjectionable

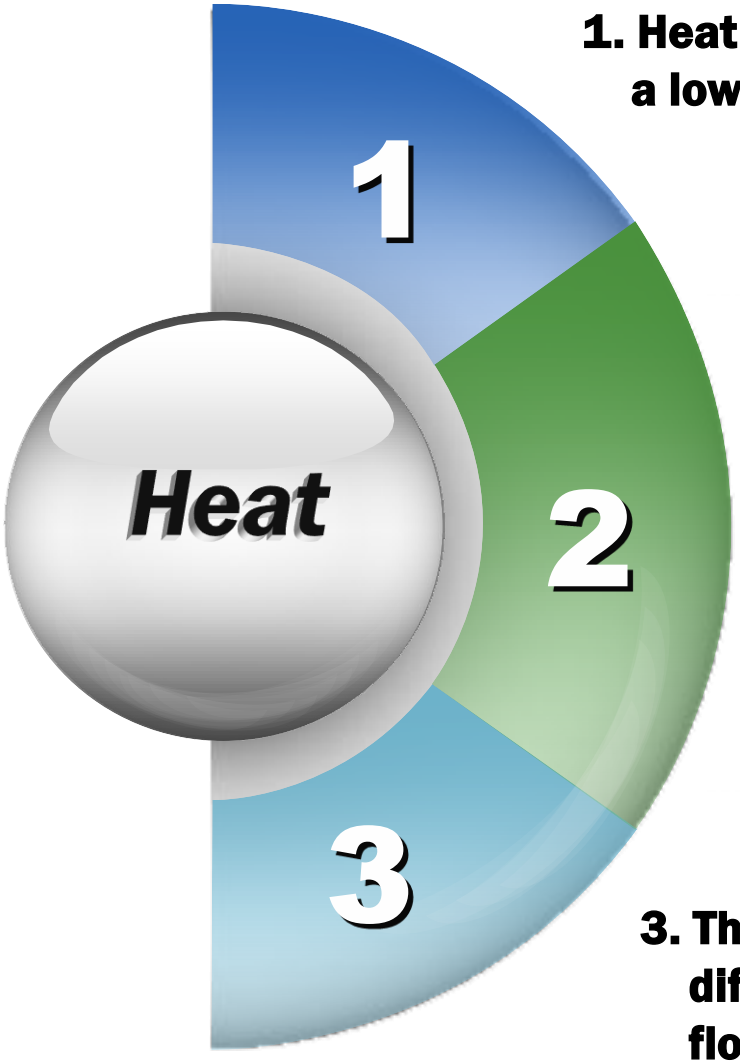
What is Refrigeration?

What is heat?	A form of energy
What is cold?	Absences of heat.
How does heat flow?	High heat to low heat
Does cold flow?	NO
How is heat measured?	British Thermal Unit (BTU)

British Thermal Unit (BTU)

Heat is a form of energy and is measured in BTU's.

A BTU is the quantity of heat required to raise the temperature, of one pound of water, one degree Fahrenheit.



1. Heat flows from high energy levels to a lower energy level.

2. Heat will not flow without a temperature difference

3. The greater the temperature difference, the faster the energy will flow.

Heat Flows Three Ways

Heat Flows in Three Ways

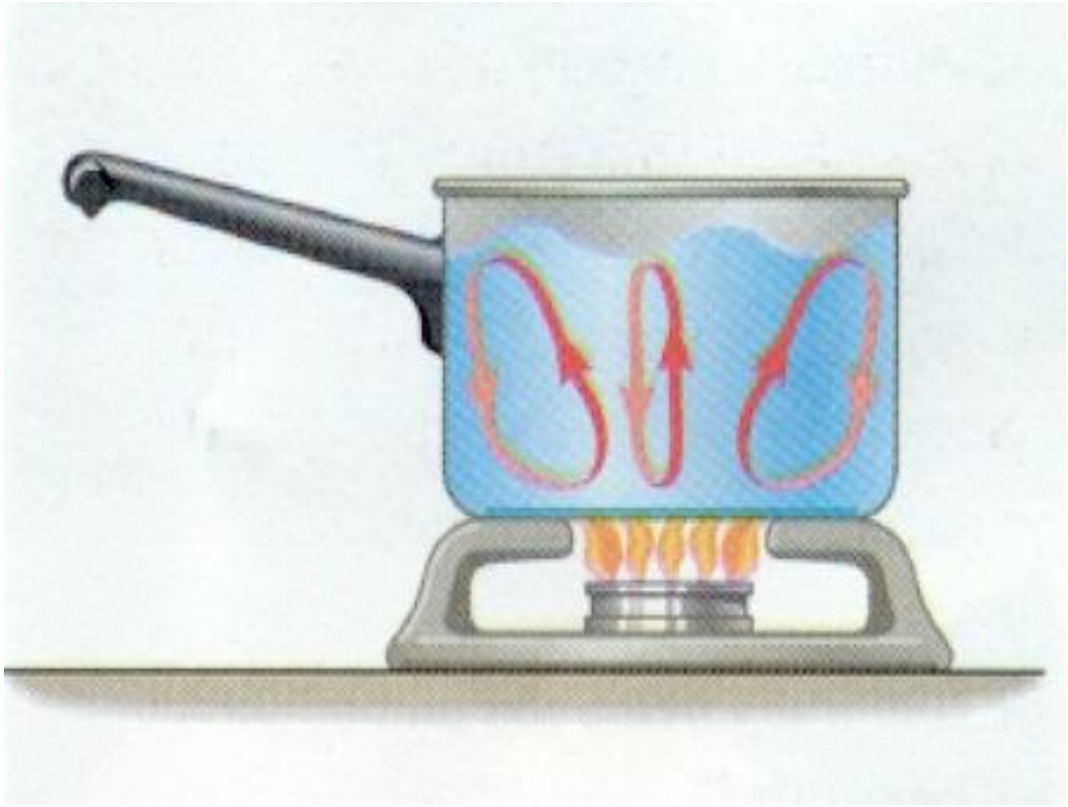
Conduction

- The transfer of heat from molecule to molecule through a substance is called conduction
- Movement of heat continues until a temperature balance is achieved throughout the entire material

Heat conducts through the pipe until it is heated evenly.

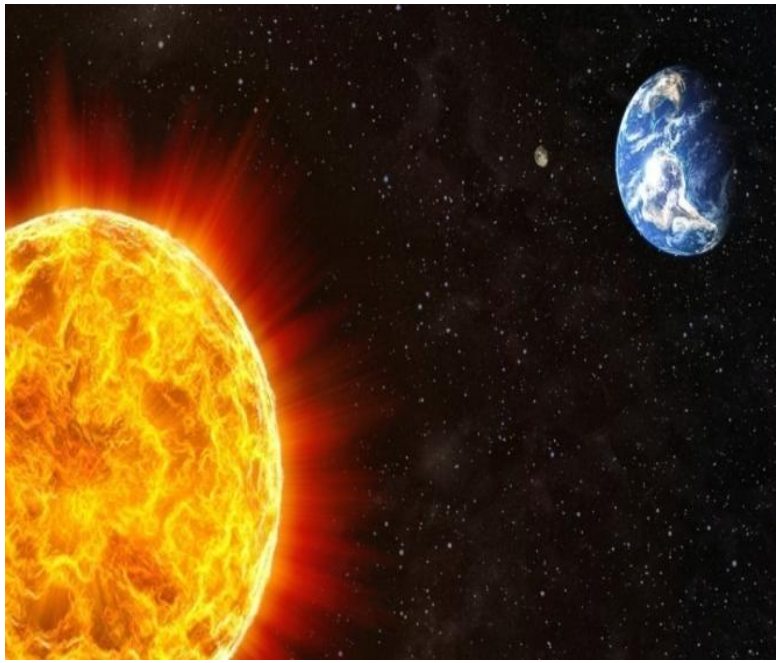
Convection

- The transfer of heat from one place to another by movement of molecules
- Portions of a substance are set in motion, forming currents
- Air in a refrigerator moves by convection (often aided by a fan)



Radiation

- Radiant heat is absorbed from a physically separated source without affecting the space in between
- When radiant heat is absorbed by a material, it is converted into sensible heat

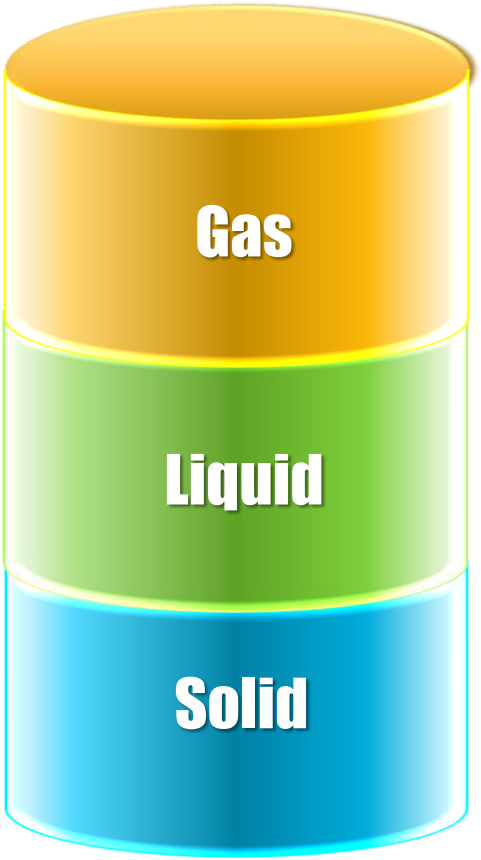


Specific Heat

The amount of heat (measured in BTU's) required to raise one pound of a substance one degree Fahrenheit.

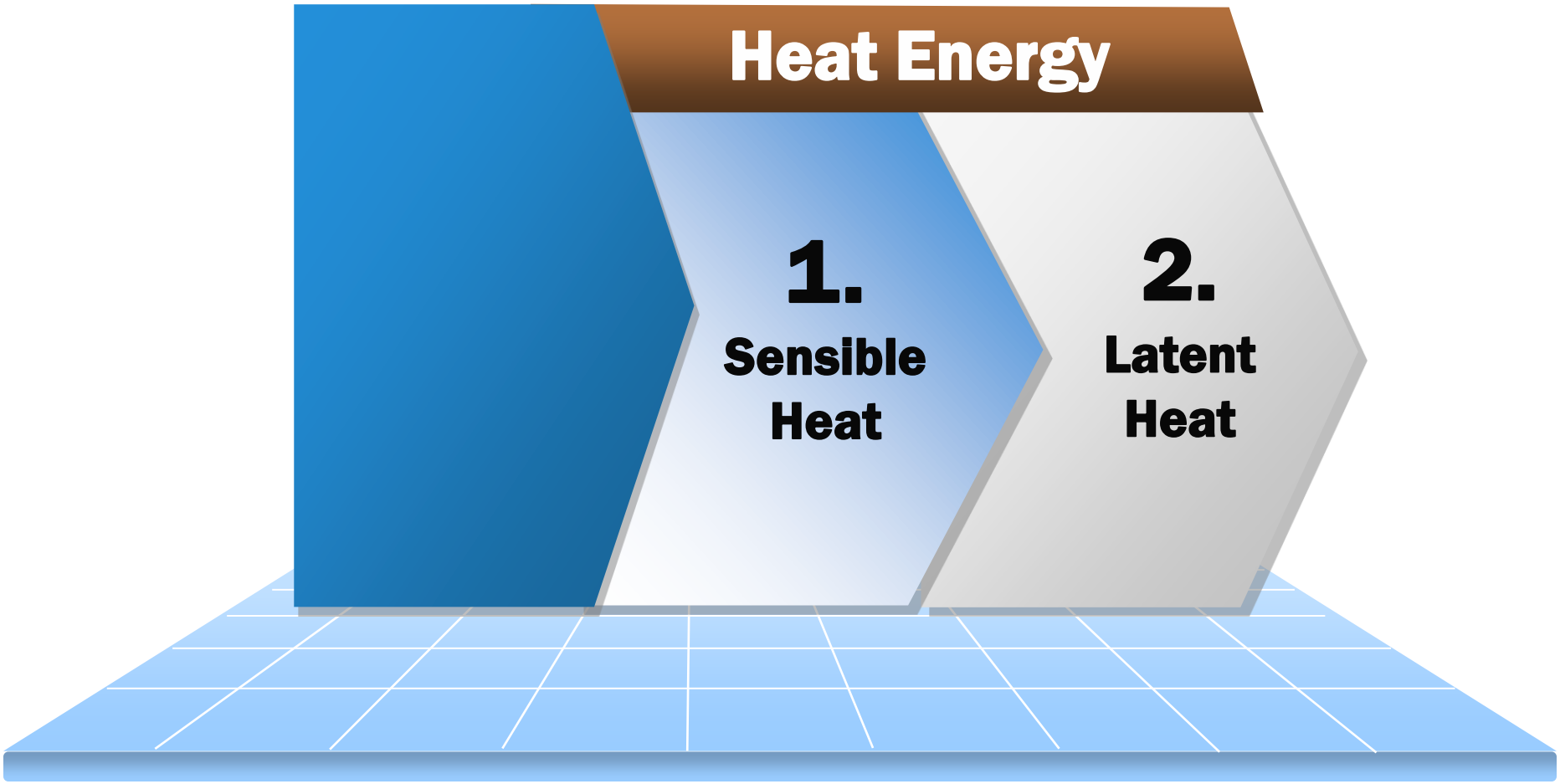
Substance	Specific Heat (BTU/LB/Deg F)	Temp Rise (Deg F) (From 1 BTU Addition)
Water (Liquid)	1.00	1.00
Apples	0.87	1.15
Beef, Ribs	0.67	1.49
Frog legs	0.88	1.13
Milk	0.90	1.11

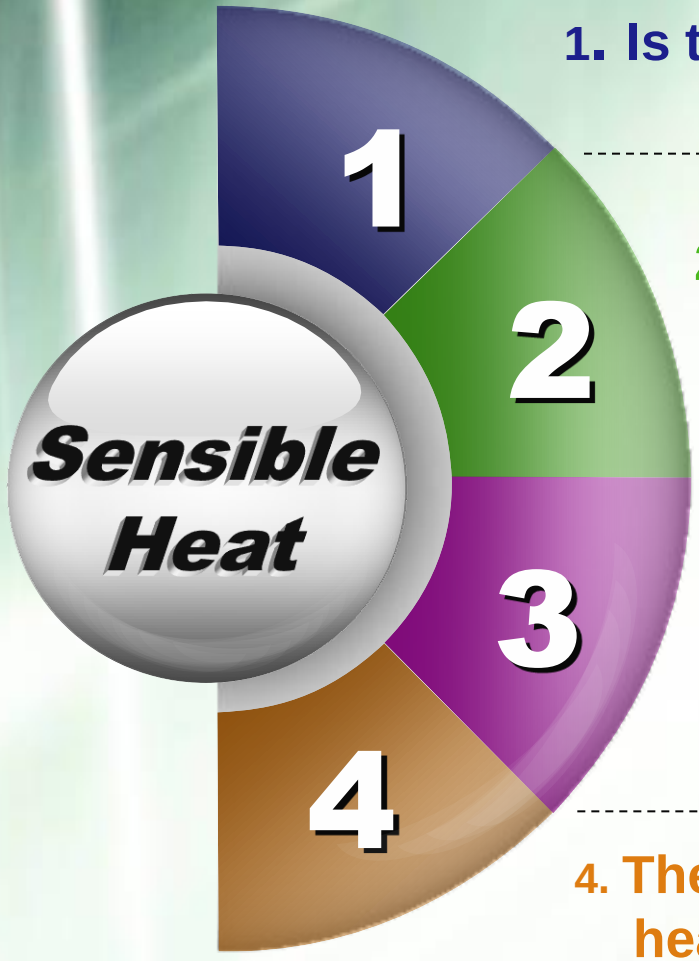
Physical State of a Substance



Adding heat energy in any of the three states will increase the temperature.

Changing the state of a substance will require a larger quantity of heat energy.


Heat Energy
1.
Sensible Heat
2.
Latent Heat

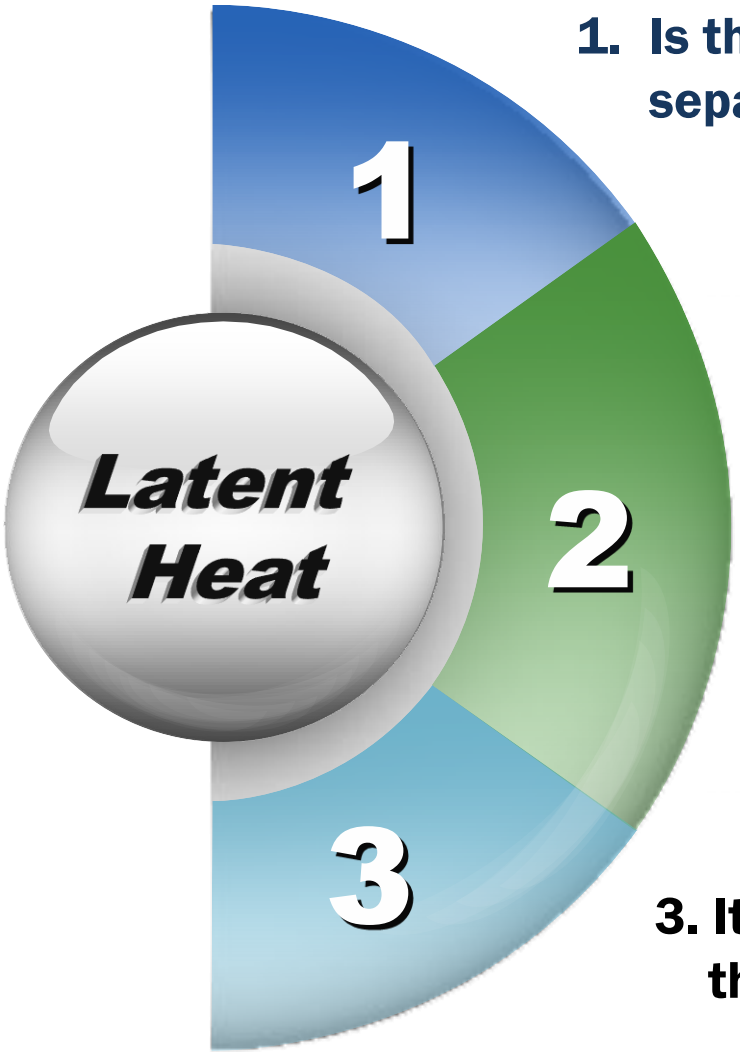


1. Is the energy of molecular motion

2. Causes a change in temperature, with No change in state.

3. Sensible heat causes an increase in molecular motion.

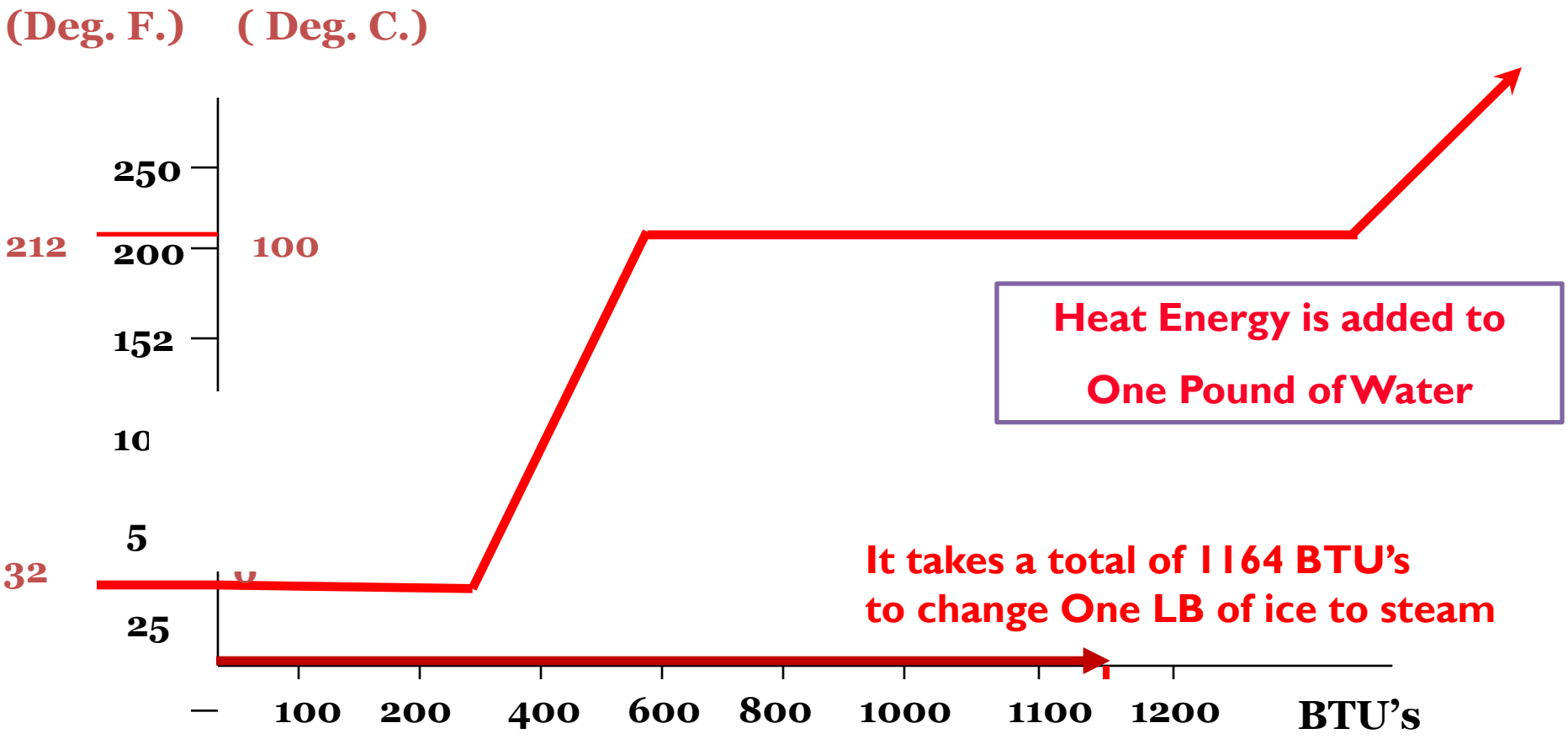
4. The addition or removal of sensible heat is measurable with a thermometer



1. Is the energy of molecular separation and arrangement.

2. Causes a change in state, while there is No Change In Temperature.

3. It can not be measured with a thermometer.


(Deg. F.)
(Deg. C.)
250
212
200
100
152
10
5
32
25
100
200
400
600
800
1000
1100
1200
BTU's
Heat Energy is added to
One Pound of Water
It takes a total of 1164 BTU's
to change One LB of ice to steam

Refrigeration

Mechanical refrigeration works by changing the state of the refrigerant.

The majority of heat is removed from the temperature controlled space as the refrigerant absorbs heat when it changes state from a liquid to a gas in the evaporator.

The majority of the absorbed heat is removed from the refrigeration system in the condenser as the refrigerant changes state from a gas back to a liquid.

Saturation Temperature

The temperature at which a substance will change state from a liquid to a vapor or a vapor to a liquid

Add Heat = Liquid to Vapor (Vaporization)

Remove Heat = Vapor to Liquid (Condensation)

Saturated Mixture

At a temperature equal to it's boiling point or condensing point, a substance can be both vapor and liquid.

Addition of Heat = Boiling

Removal Heat = Condensing

Sub-Cooled Liquid

At a temperature below it's boiling point, a substance is:

100% Liquid, no vapor present

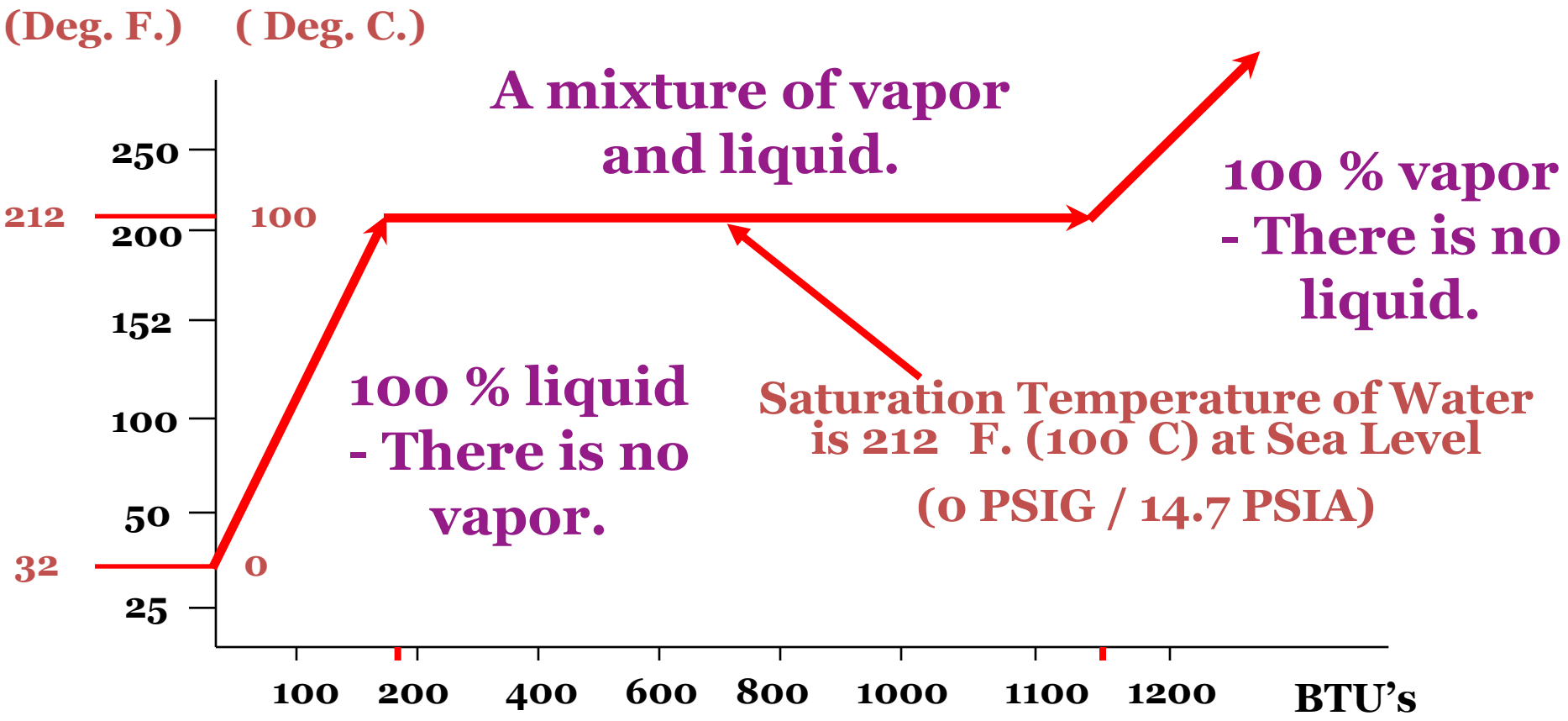
1lb. of water @ 200° F. What is the state of water?
- Sub-cooled liquid
- Sub-cooled by 12° F.

Super Heated Vapor

At a temperature above it's boiling point, a substance is:

100% vapor, no liquid present

1lb. Of water @ 220° F. What is the state of water?
- Super heated vapor (steam)
- Super heated by 8° F.


(Deg. F.)
(Deg. C.)
A mixture of vapor and liquid.
100 % vapor - There is no liquid.
100 % liquid - There is no vapor.
Saturation Temperature of Water is 212 F. (100 C) at Sea Level
(0 PSIG / 14.7 PSIA)
250
212
200
152
100
50
32
25
100
0
100
200
400
600
800
1000
1100
1200
BTU's

Pressure

Force Per Unit of Area

Pressure Movement

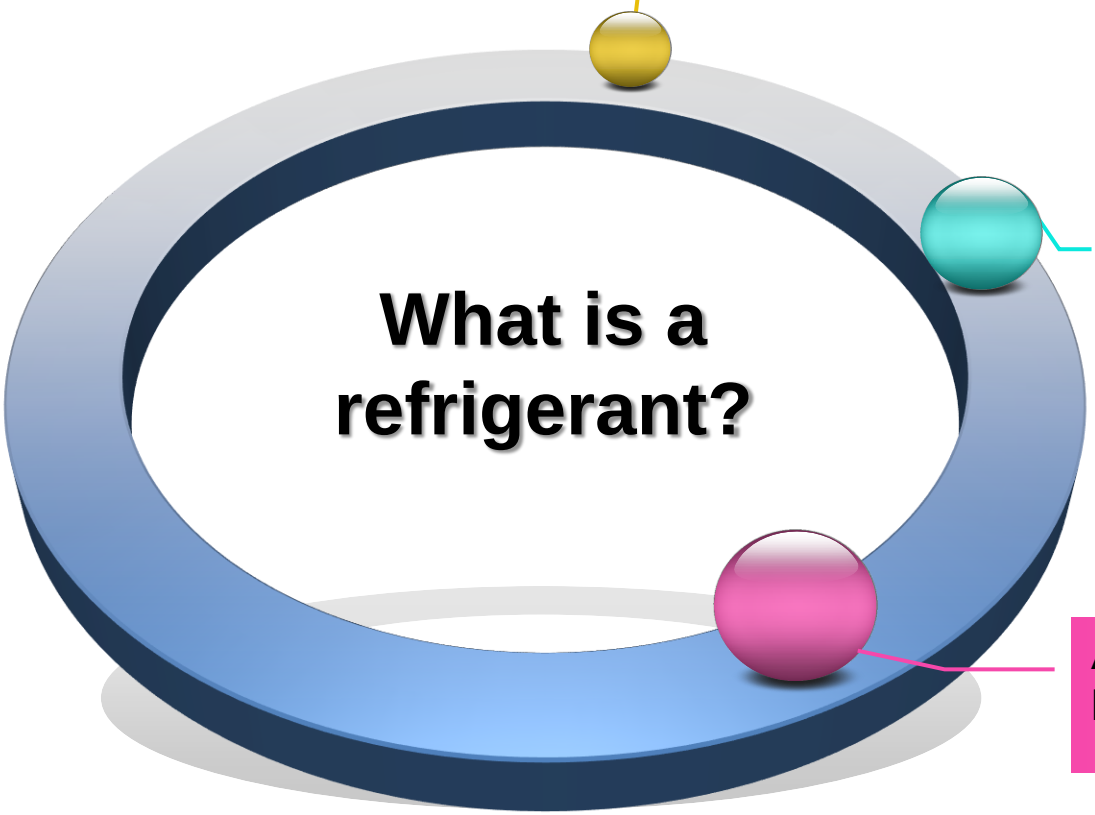
How does pressure flow?

High To **Low**

What would happen if you take two refrigerant tanks, one with refrigerant and the other in a vacuum and connect a hose between them?

Refrigerant flows from the tank with refrigerant to the tank that is in a vacuum, until the pressures equalize.

What is a refrigerant?



A Medium to move heat

A substance that **absorbs heat by evaporating** at low temperatures and pressures.

And **gives up heat** by **condensing** at high temperatures and pressures

Pressure as it relates to Temperature

Temp. °F	REFRIGERANT					
	R-507 (AZ-50)	R-404A (HP-62)	R-410A (AZ-20)	R-22	R-744 (CO_2)	R-717 (NH_3)
104	256.2	250.6	337.1	207.7		210.9
105	259.9	254.2	341.9	210.8		214.4
106	263.5	257.8	346.7	213.8		217.9
107	267.2	261.4	351.5	216.9		221.5
108	271.0	265.1	356.5	220.0		225.1
109	274.8	268.8	361.4	223.2		228.8
110	278.6	272.5	366.4	226.4		232.5
111	282.4	276.3	371.5	229.6		236.2
112	286.3	280.1	376.6	232.8		240.0
113	290.3	284.0	381.8	236.1		243.9
114	294.2	287.9	387.0	239.4		247.7
115	298.3	291.8	392.3	242.8		251.6
116	302.3	295.8	397.6	246.1		255.6
117	306.4	299.8	403.0	249.5		259.6
118	310.5	303.8	408.4	253.0		263.7

Temp. °F	REFRIGERANT					
	R-507 (AZ-50)	R-404A (HP-62)	R-410A (AZ-20)	R-22	R-744 (CO_2)	R-717 (NH_3)
17	54.3	51.5	73.2	39.9	388.0	30.4
18	55.6	52.7	74.9	40.9	394.3	31.4
19	56.9	54.0	76.6	42.0	400.7	32.4
20	58.2	55.3	78.4	43.1	407.2	33.5
21	59.6	56.6	80.1	44.2	413.8	34.6
22	61.0	58.0	81.9	45.3	420.4	35.6
23	62.3	59.3	83.7	46.5	427.1	36.8
24	63.8	60.7	85.5	47.6	433.8	37.9
25	65.2	62.1	87.4	48.8	440.7	39.0
26	66.7	63.5	89.2	50.0	447.6	40.2
27	68.1	64.9	91.1	51.2	454.6	41.4
28	69.6	66.4	93.1	52.4	461.7	42.6
29	71.1	67.8	95.0	53.7	468.8	43.8
30	72.7	69.3	97.0	55.0	476.1	45.0
31	74.2	70.8	99.0	56.2	483.4	46.3

Past

Majority of New Systems

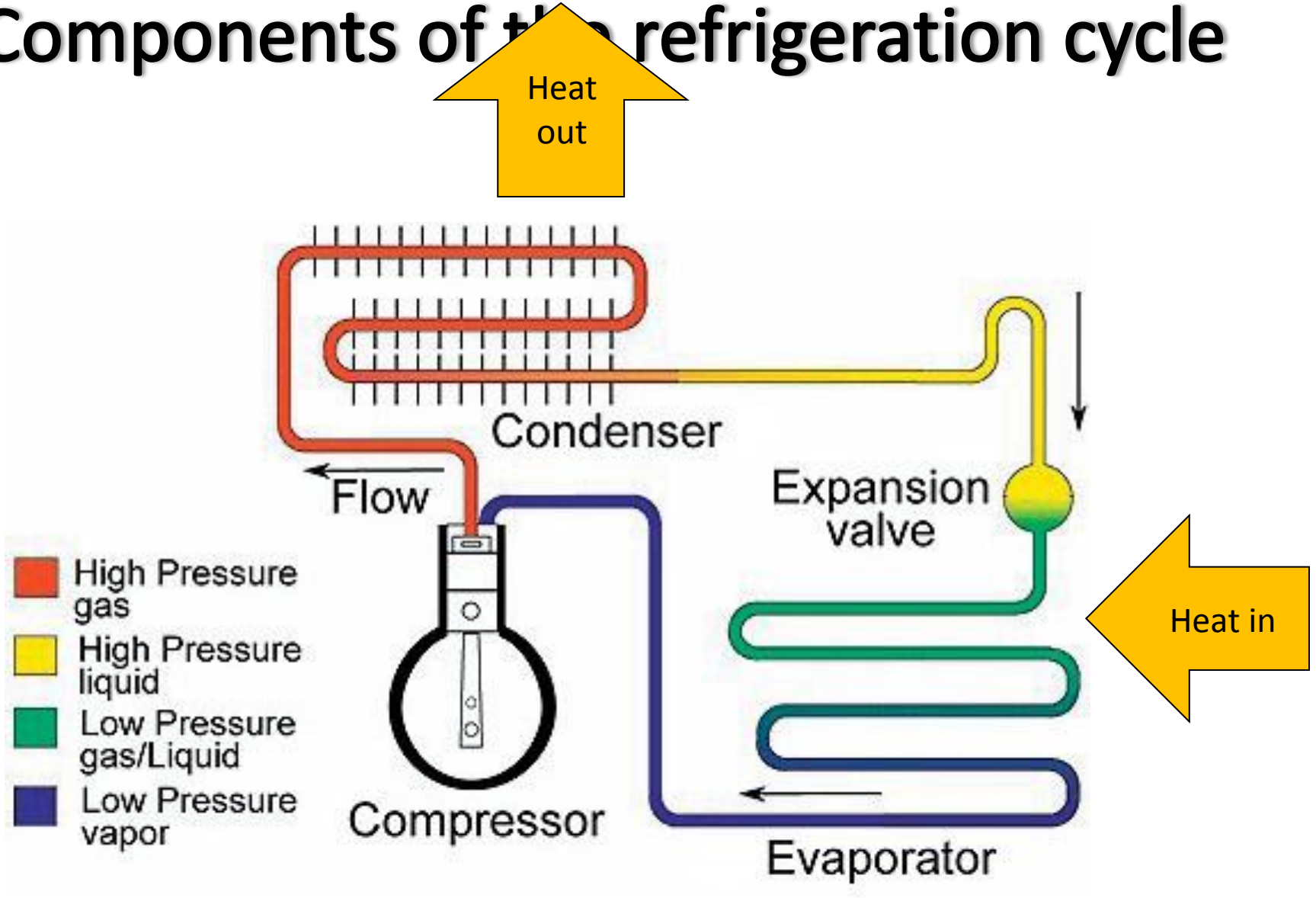
Other Retrofit Fluids

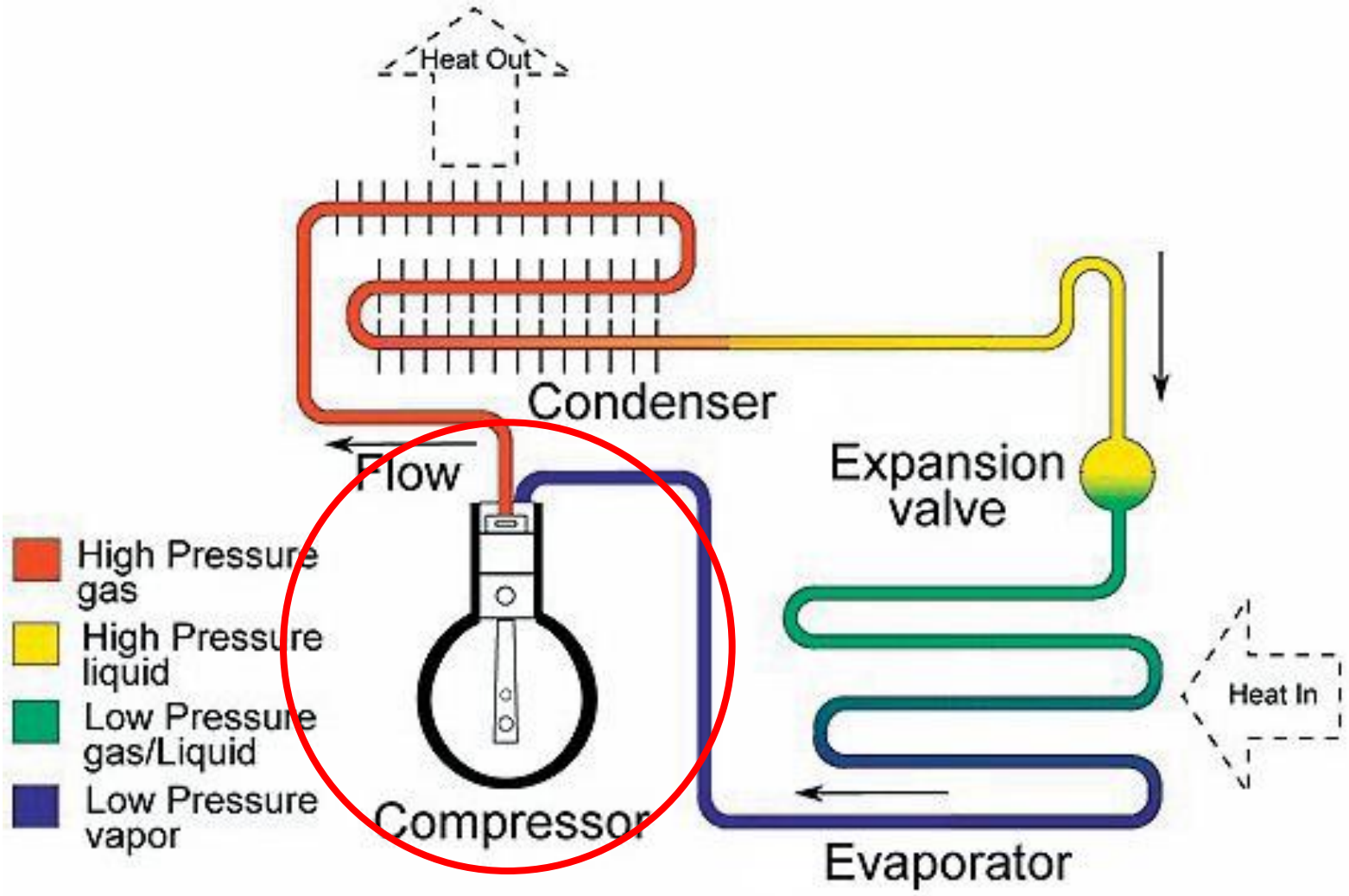
Higher Pressure

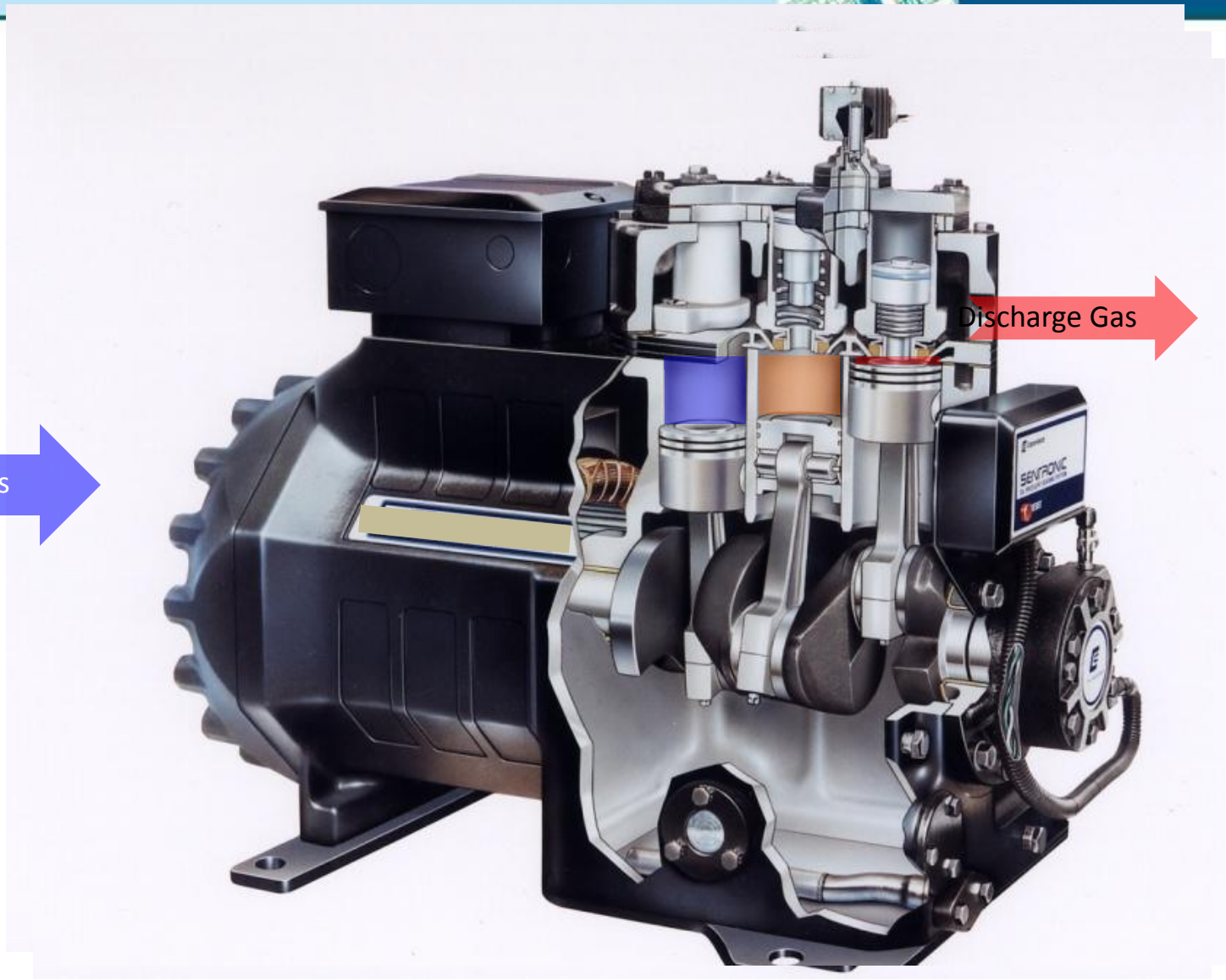
Natural Fluids

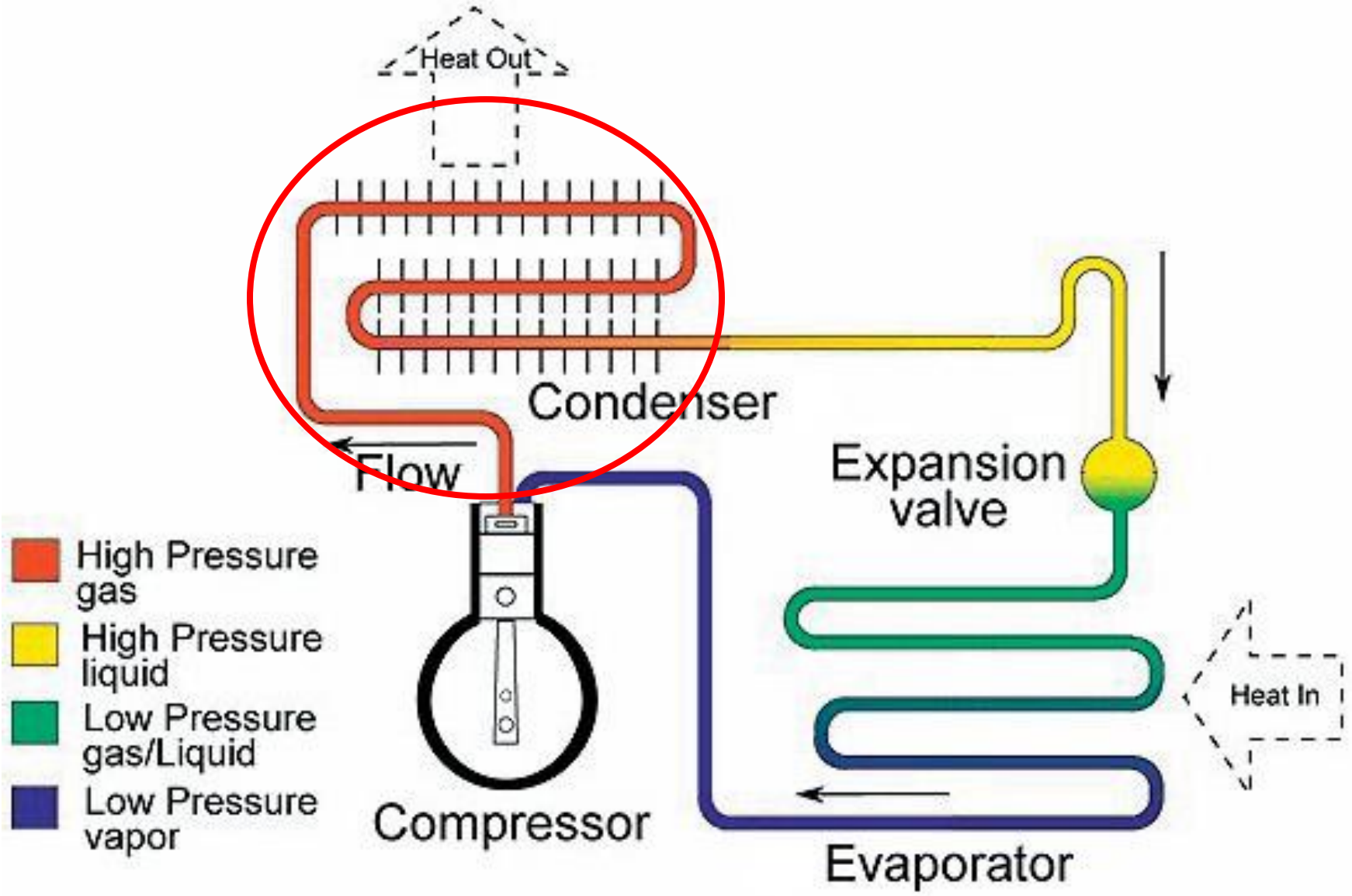
Refrigerant	Other Names/Components	ODP
R-22	Freon-22 (HCFC)	0.055
R-404A	R-125/143a/134a, HP-62	0
R-507	R-125/143a, AZ-50	0
R-407A	R-32/125/134a, Klea-60	0
R-407C / 407F	R-32/125/134a, Klea-66	0
R-422A	R-125/134a/600a, Isceon MO-70	0
R-422D	R-125/134a/600a, Isceon MO-29	0
R-410A	R-32/125, AZ-20, Puron	0
R-744	CO_2	0
R-717	Ammonia, NH3	0
R-290	Propane (HC)	0
R-600a	Isobutane (HC)	0
R-600	Butane (HC)	0

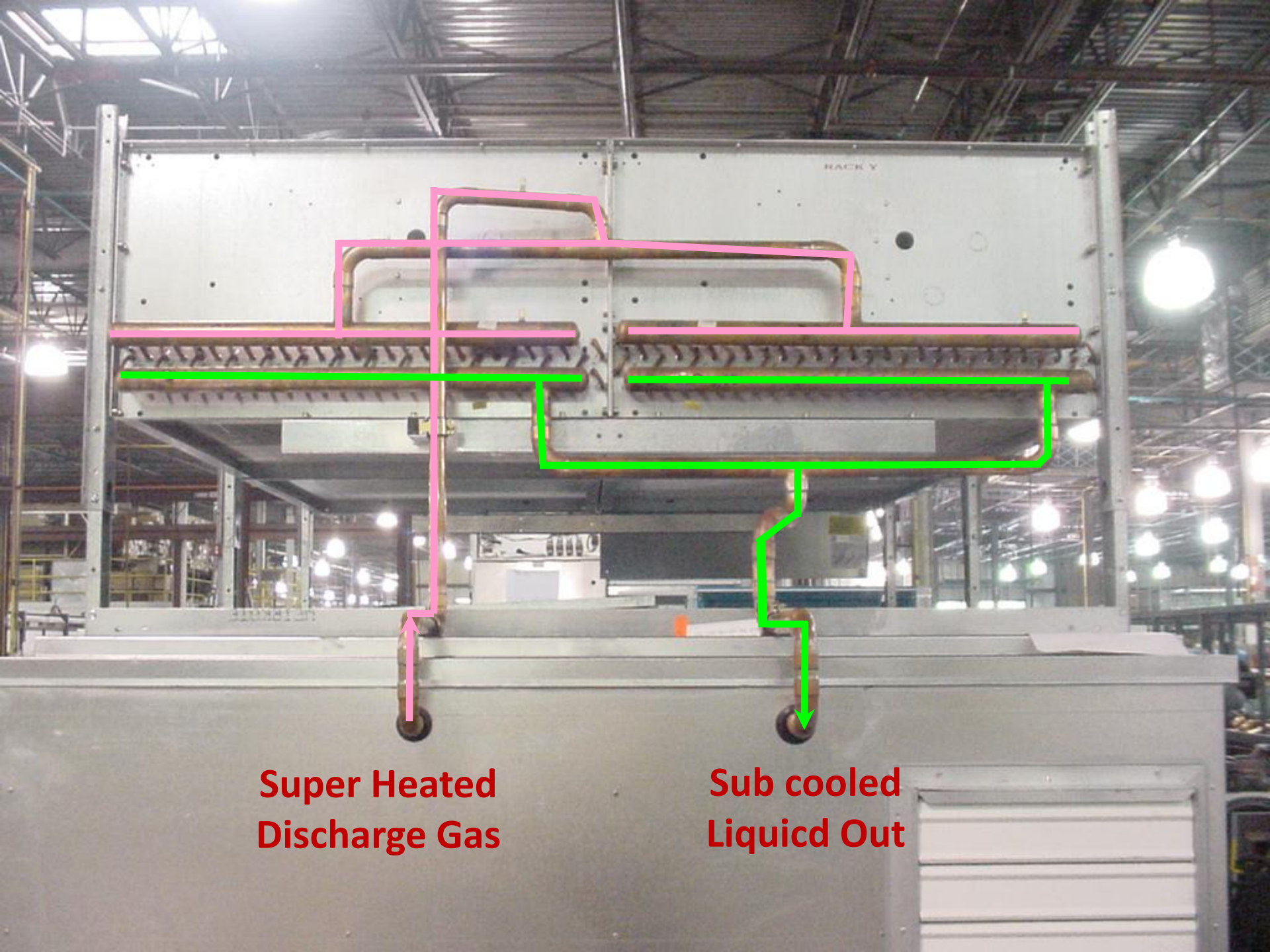
Components of the refrigeration cycle




Heat Out
Condenser
Flow
Expansion valve
High Pressure gas
High Pressure liquid
Low Pressure gas/Liquid
Low Pressure vapor
Compressor
Heat In
Evaporator


ction Gas
Discharge Gas


Heat Out
Condenser
Flow
Expansion valve
High Pressure gas
High Pressure liquid
Low Pressure gas/Liquid
Low Pressure vapor
Compressor
Heat In
Evaporator


Super Heated
Discharge Gas
Sub cooled
Liquicd Out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KRACK
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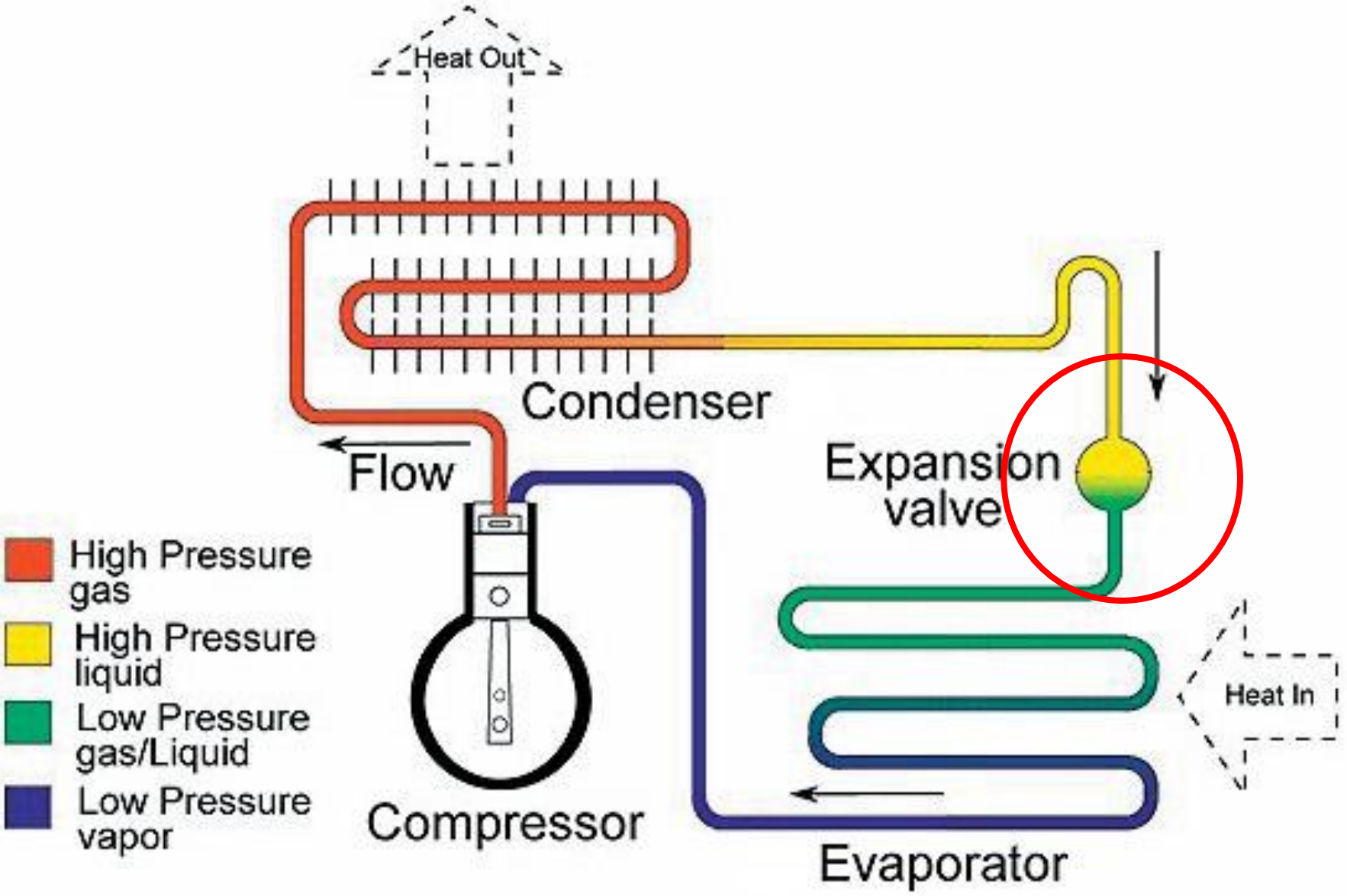
Heat Out
Condenser
Flow
Expansion valve
High Pressure gas
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Low Pressure gas/Liquid
Low Pressure vapor
Heat In
Compressor
Evaporator


AMERICAN WIRE & CABLE CO

Pressure as it relates to Temperature

Pressure Entering TXV

Temp. °F	REFRIGERANT					
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117	306.4	299.8	403.0	249.5		259.6
118	310.5	303.8	408.4	253.0		263.7

Pressure Leaving TXV

Temp. °F	REFRIGERANT					
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22	61.0	58.0	81.9	45.3	420.4	35.6
23	62.3	59.3	83.7	46.5	427.1	36.8
24	63.8	60.7	85.5	47.6	433.8	37.9
25	65.2	62.1	87.4	48.8	440.7	39.0
26	66.7	63.5	89.2	50.0	447.6	40.2
27	68.1	64.9	91.1	51.2	454.6	41.4
28	69.6	66.4	93.1	52.4	461.7	42.6
29	71.1	67.8	95.0	53.7	468.8	43.8
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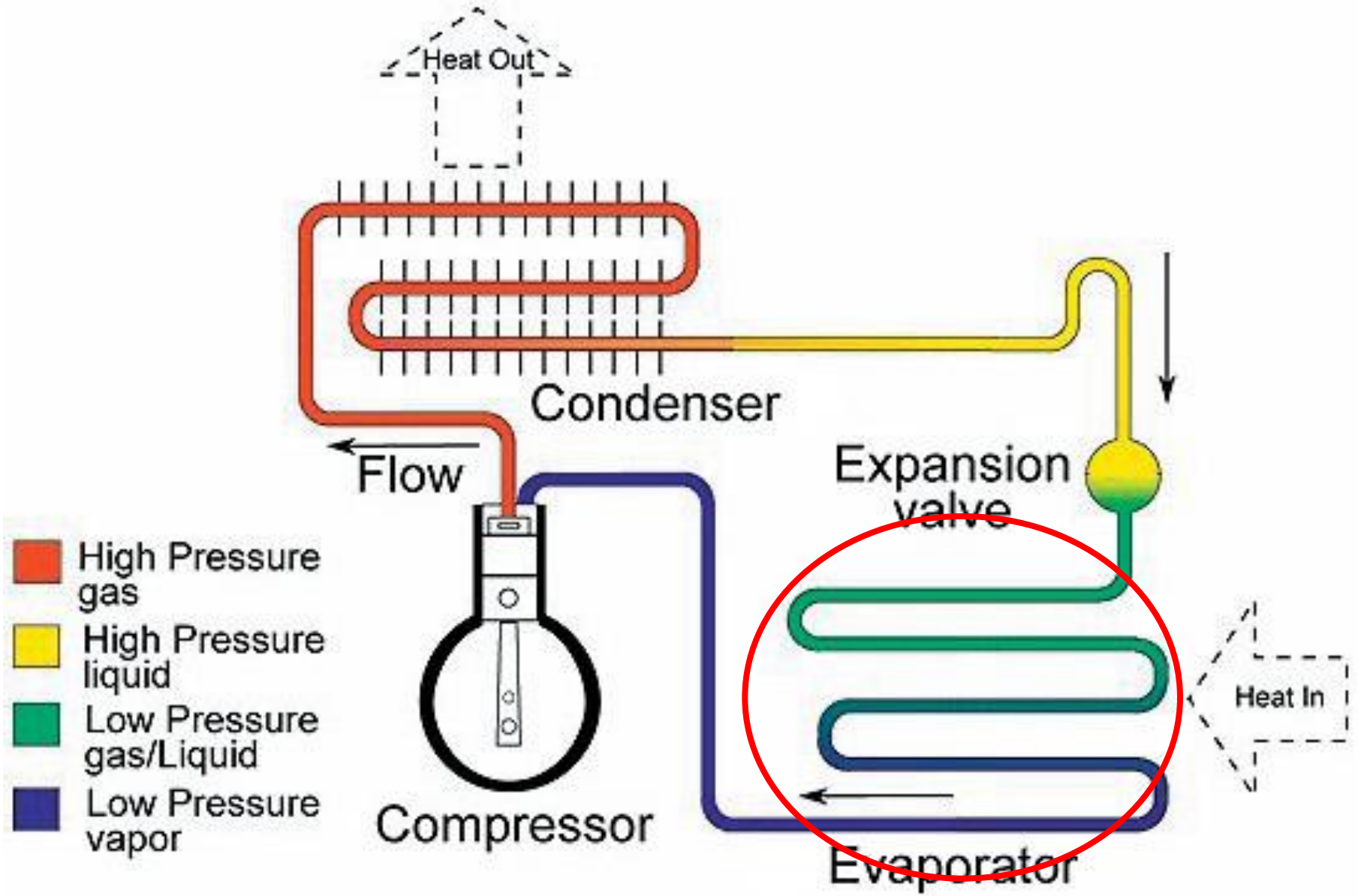
Heat Out
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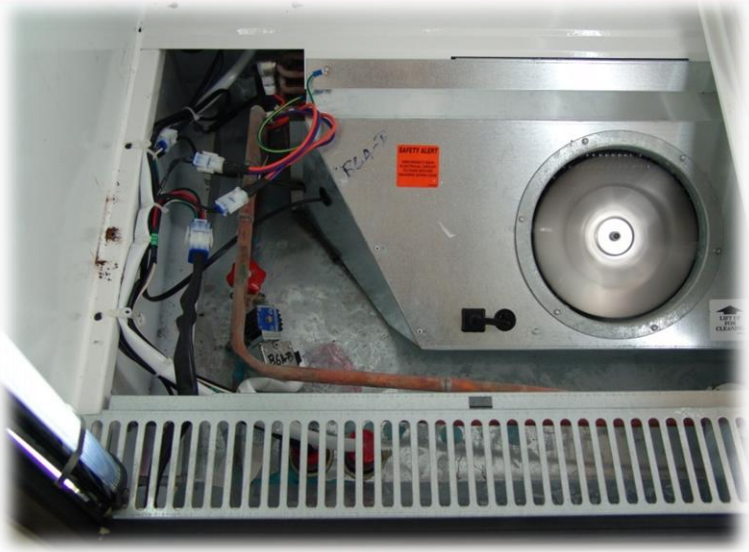
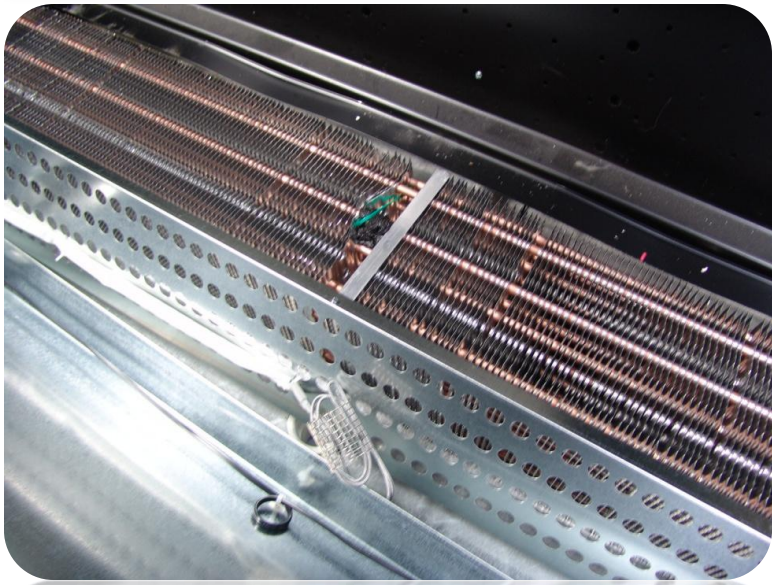
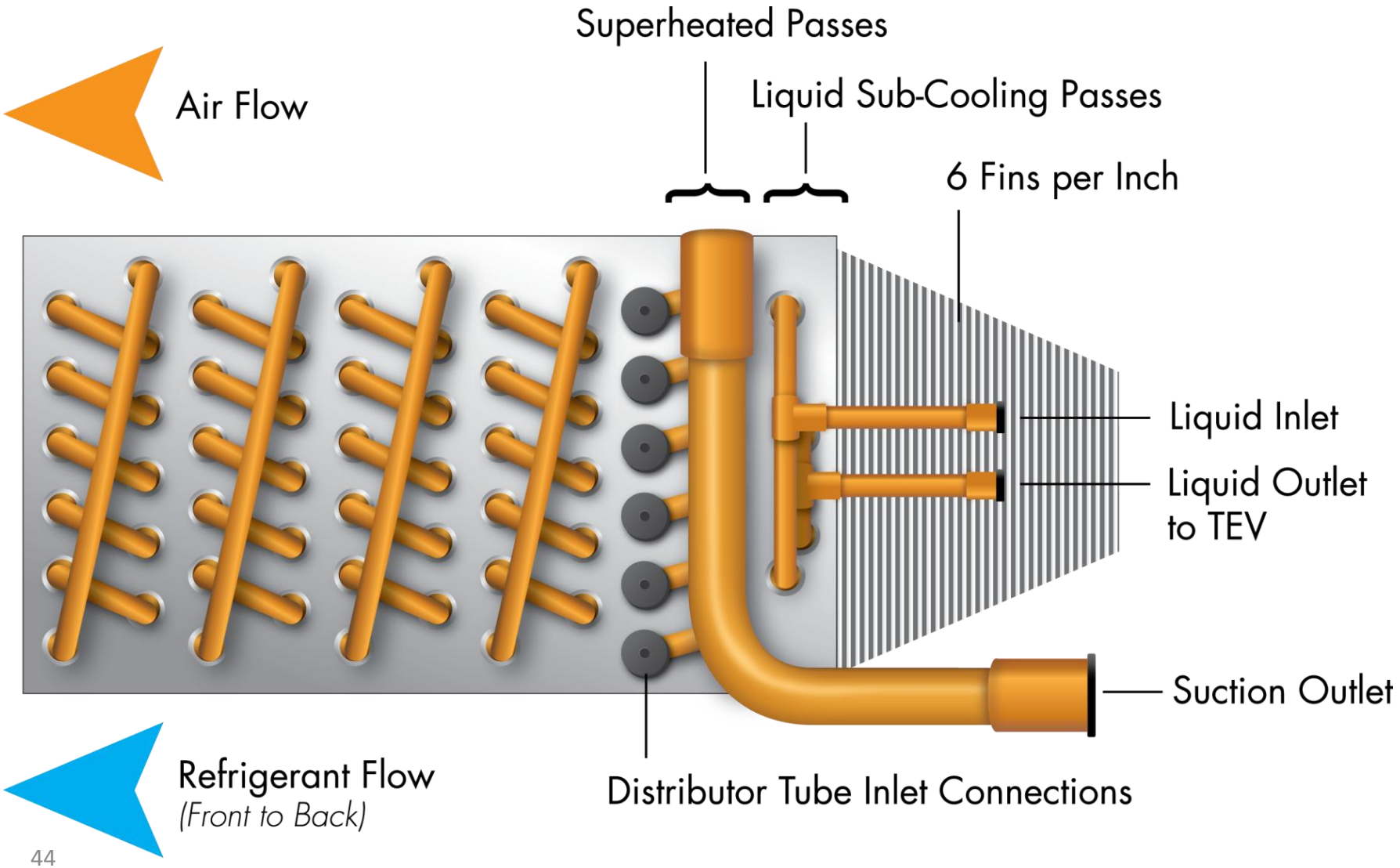
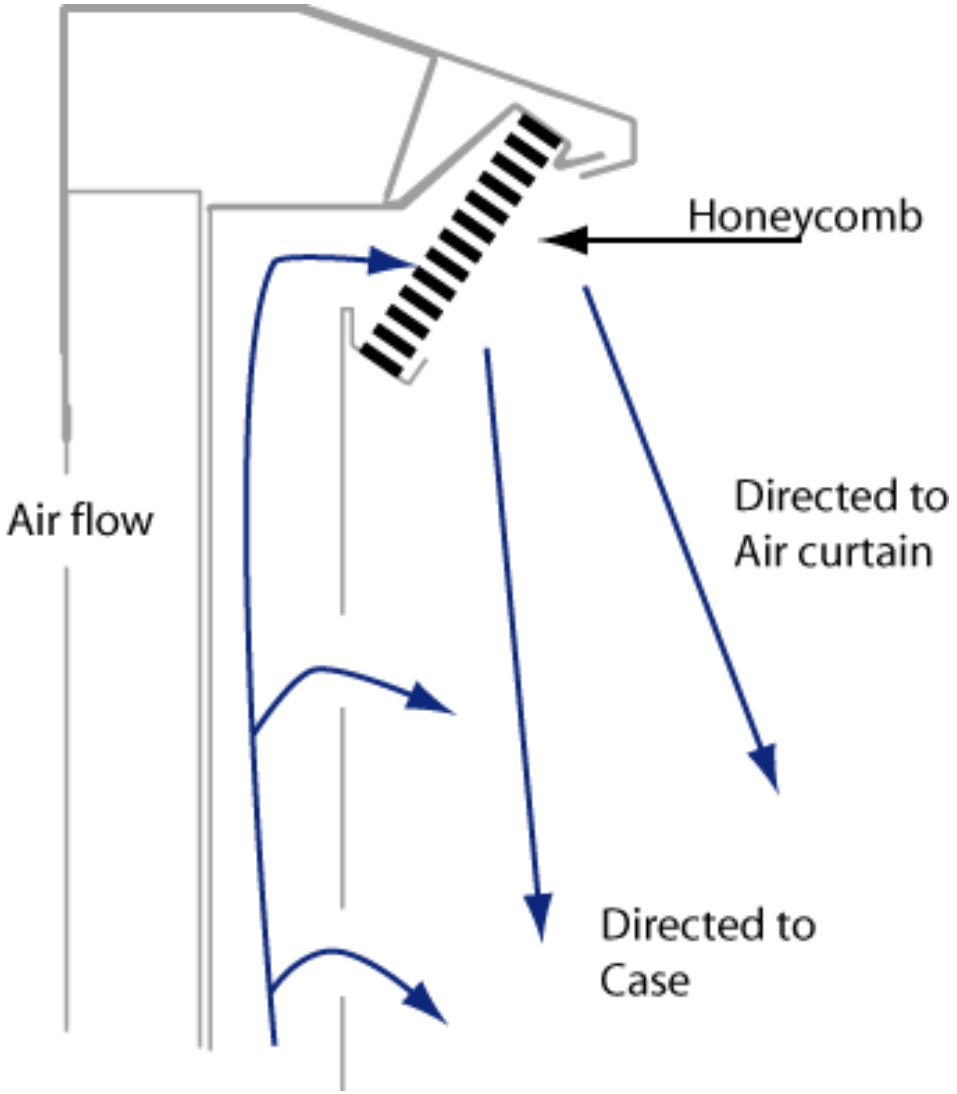
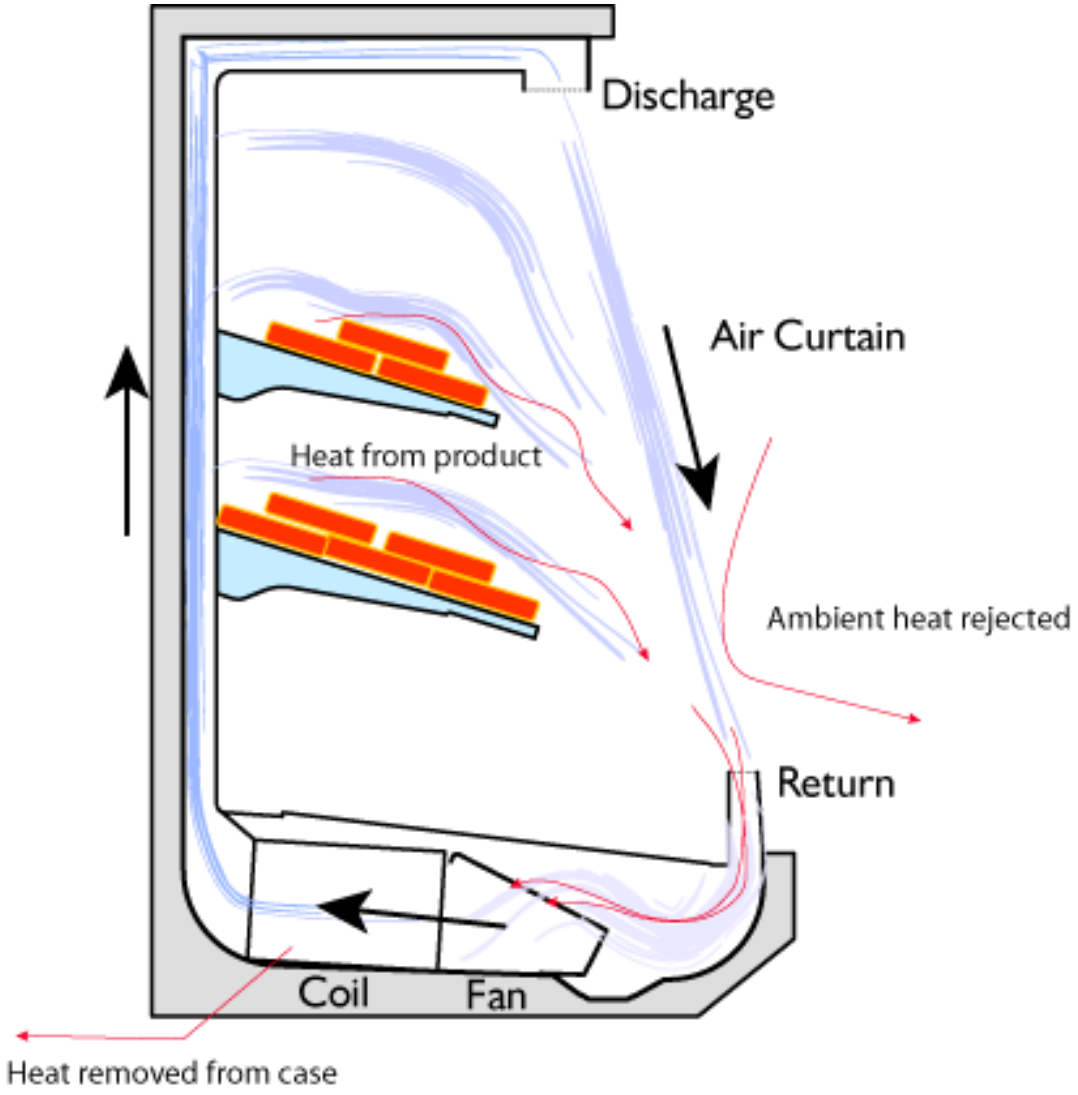
Heat In
Evaporator

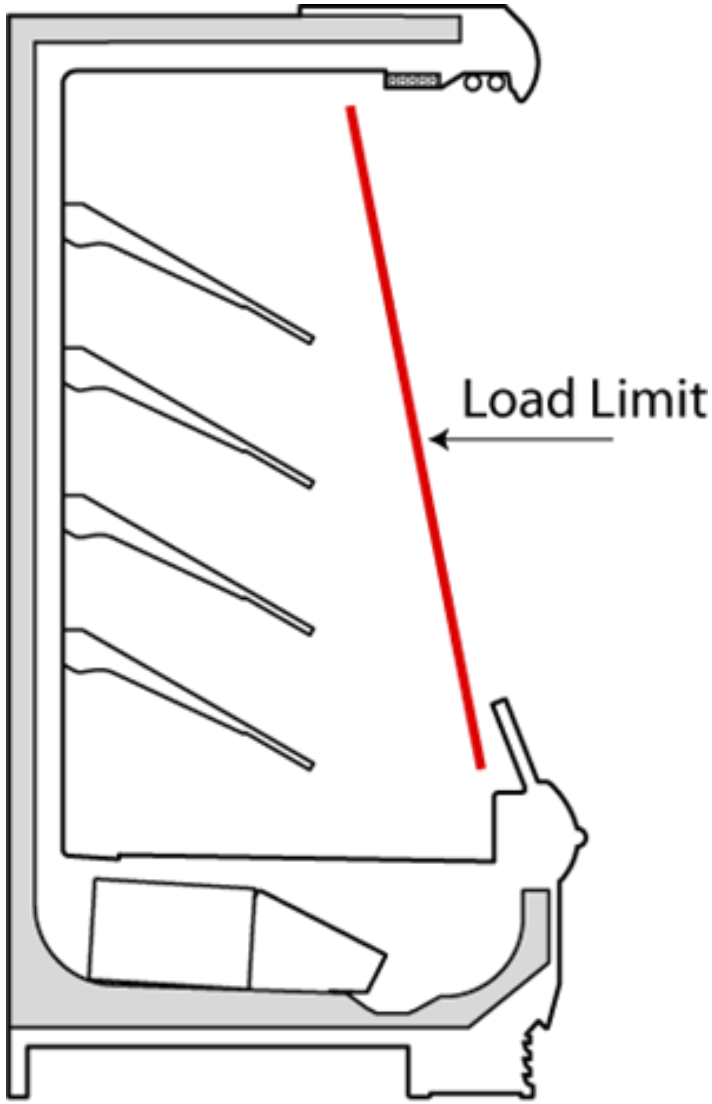


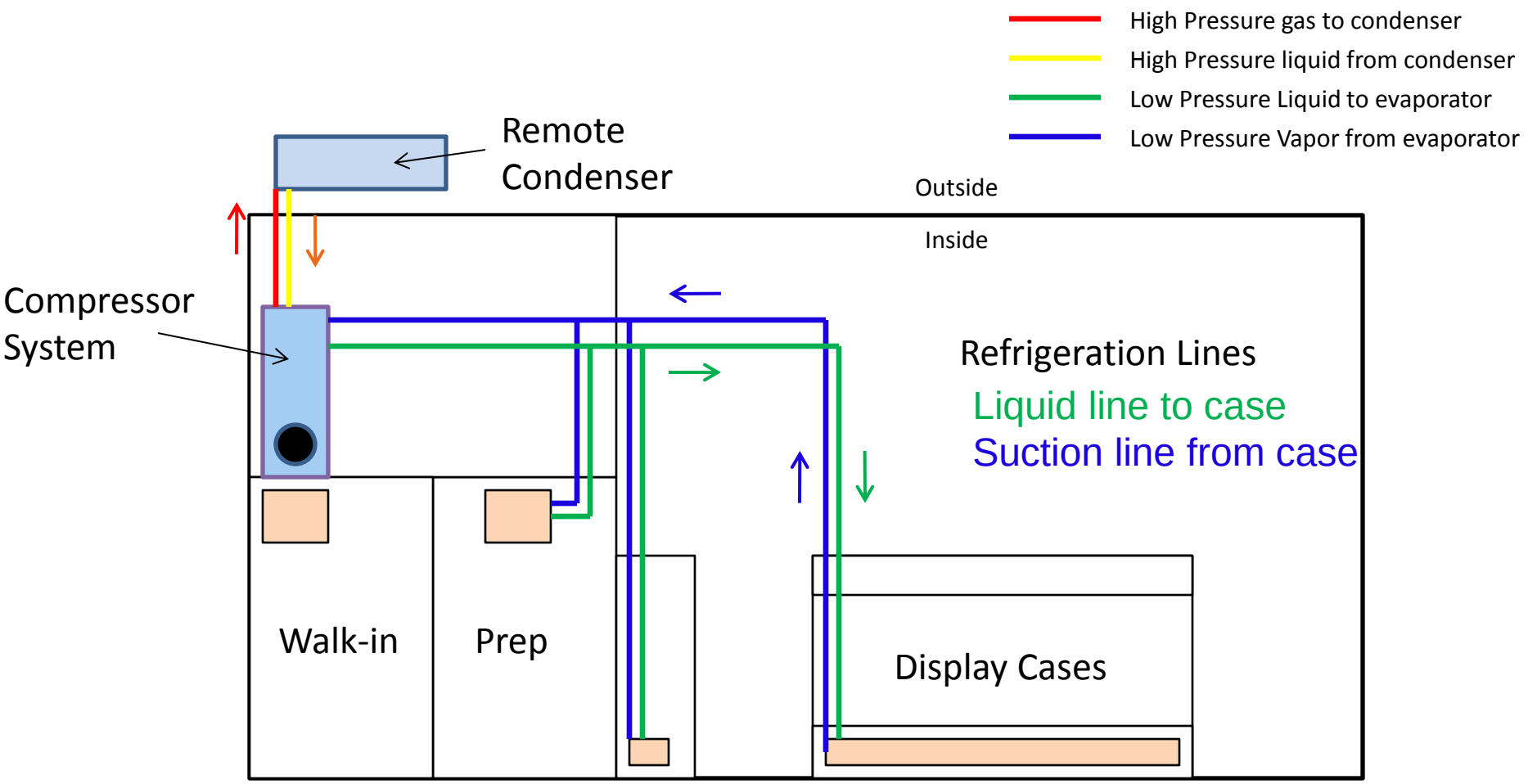



Air Flow
Superheated Passes
Liquid Sub-Cooling Passes
6 Fins per Inch
Liquid Inlet
Liquid Outlet to TEV
Suction Outlet
Refrigerant Flow
(Front to Back)
Distributor Tube Inlet Connections


Honeycomb
Air flow
Directed to
Air curtain
Directed to
Case


Discharge
Air Curtain
Heat from product
Ambient heat rejected
Return
Coil
Fan
Heat removed from case


Load Limit



How the components tie together

Questions