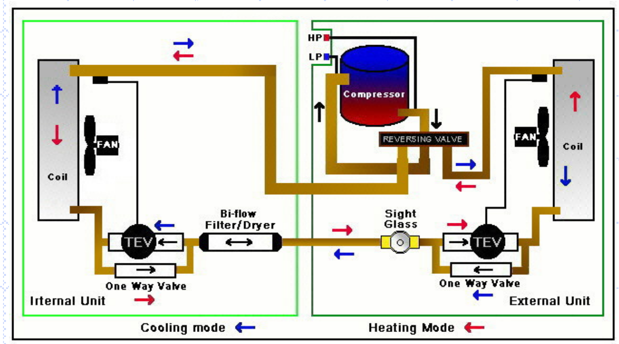
HVAC Systems
What the Rater Needs to Know in the Field



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This presentation used CASE* studies from the following

Building America
U.S. Department of Energy
Research Toward Zero Energy Homes
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The ENERGY CONSERVATORY
DIAGNOSTIC TOOLS TO MEASURE BUILDING PERFORMANCE

*CASE – Copy And Steal Everything

HVAC Systems - What the Rater Needs to Know in the Field

This session provides lessons learned from field inspections of HVAC systems that will help the rater better understand what to look for in assessing buildings. A checklist of items to look for related to the design and installation of systems will be provided so the rater can provide homeowners with an independent assessment of the HVAC system and guidance for improvement.

When a Heat Pump or Air Conditioning system is used in a Rating the HERS Index makes an assumption that the system is working to Manufacturer's specifications and therefore the intended energy benefits will be realized.

As the Rater Certifying the home, how can we be sure the system has been properly commissioned?

What does it take to commission a Heat Pump or Air Conditioner anyway?

Some Refrigeration Basics

Air Handler

Condenser

A Look at the Refrigeration Cycle

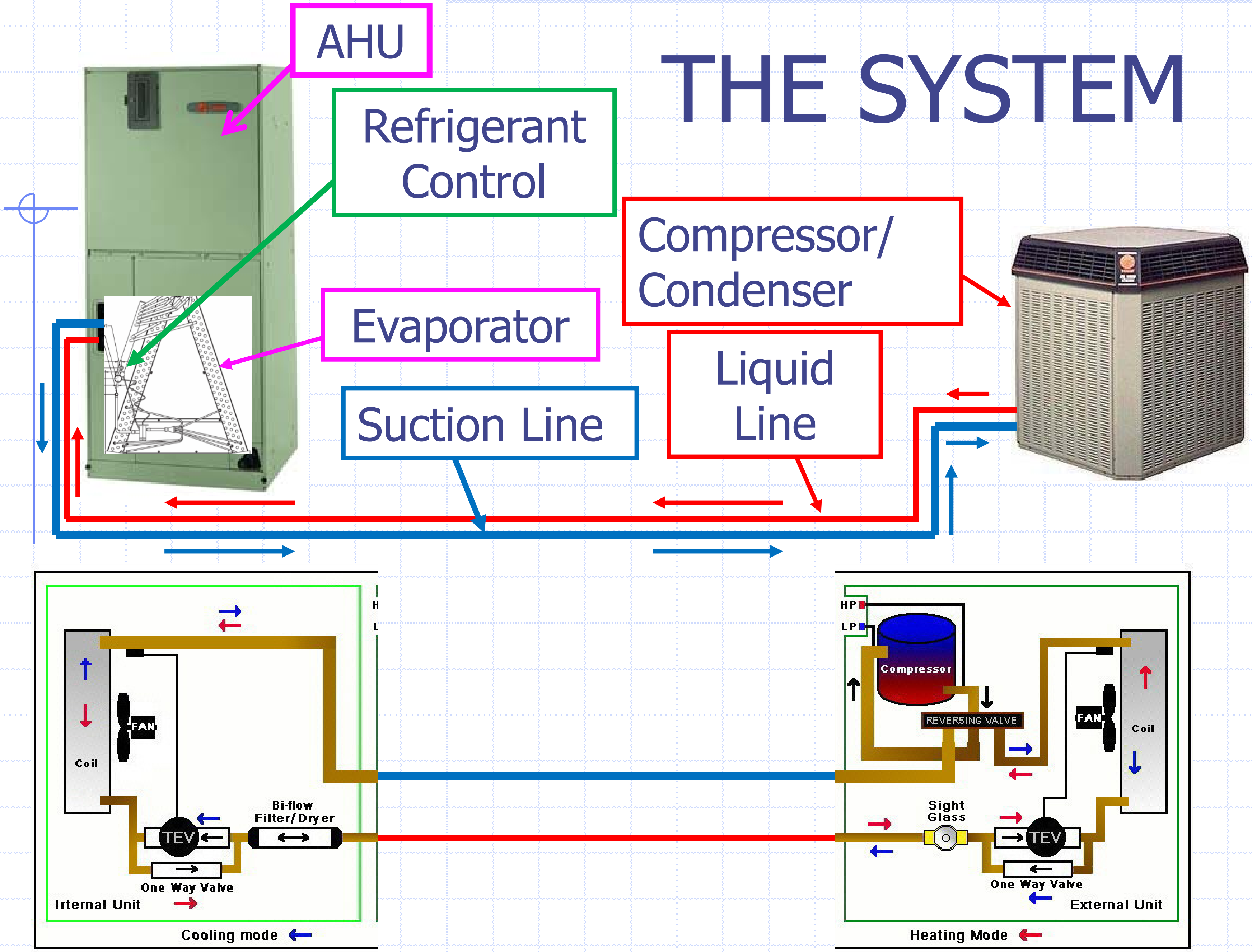
Inside the Condenser

1. Compressor (vapor pump)
2. Coil Guard
3. Control Panel
4. Condenser Coil
5. Refrigerant Connections
6. Reversing Valve

Inside the Air Handler

1. Blower & Motor
2. Control Panel
3. Evaporator Coil
4. Metering Device
5. Refrigerant Connections
6. Filter Access
7. Drain Connection

THE SYSTEM



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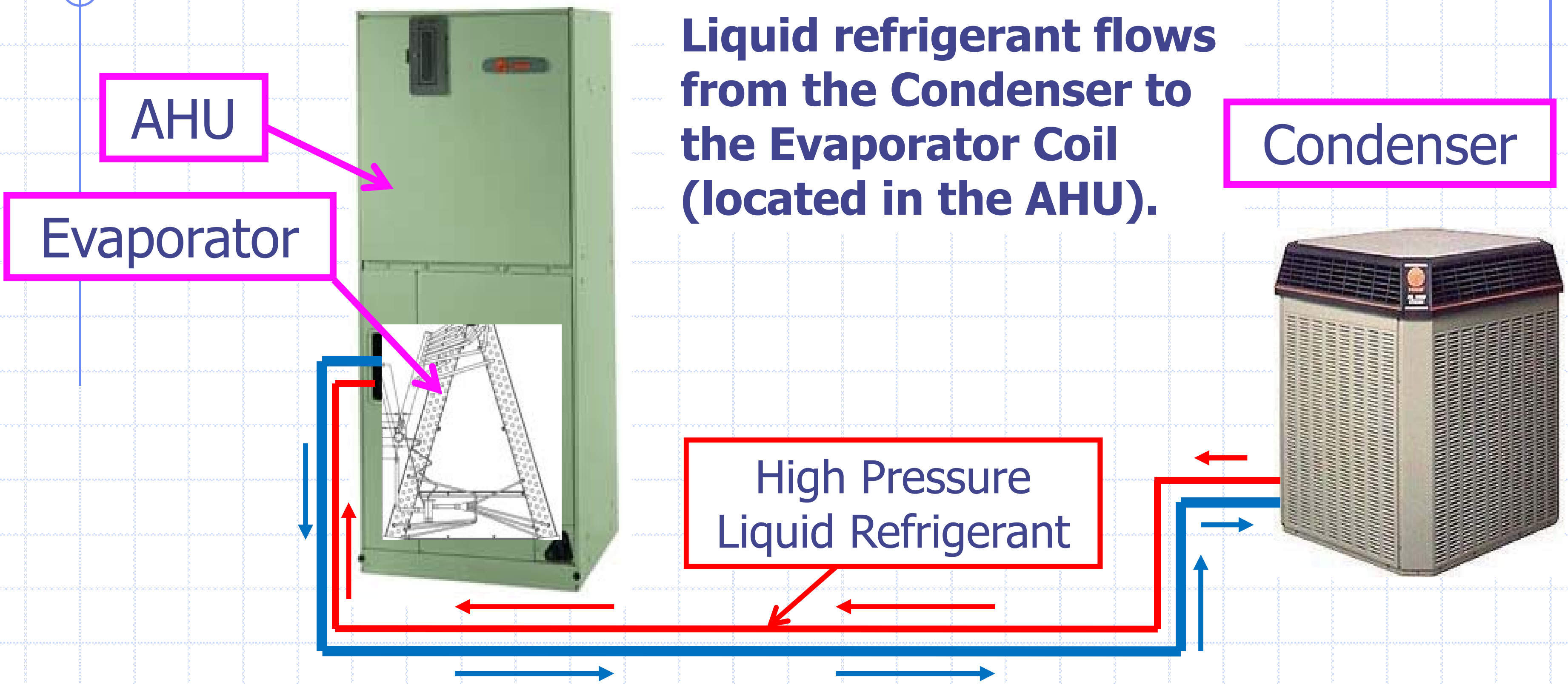
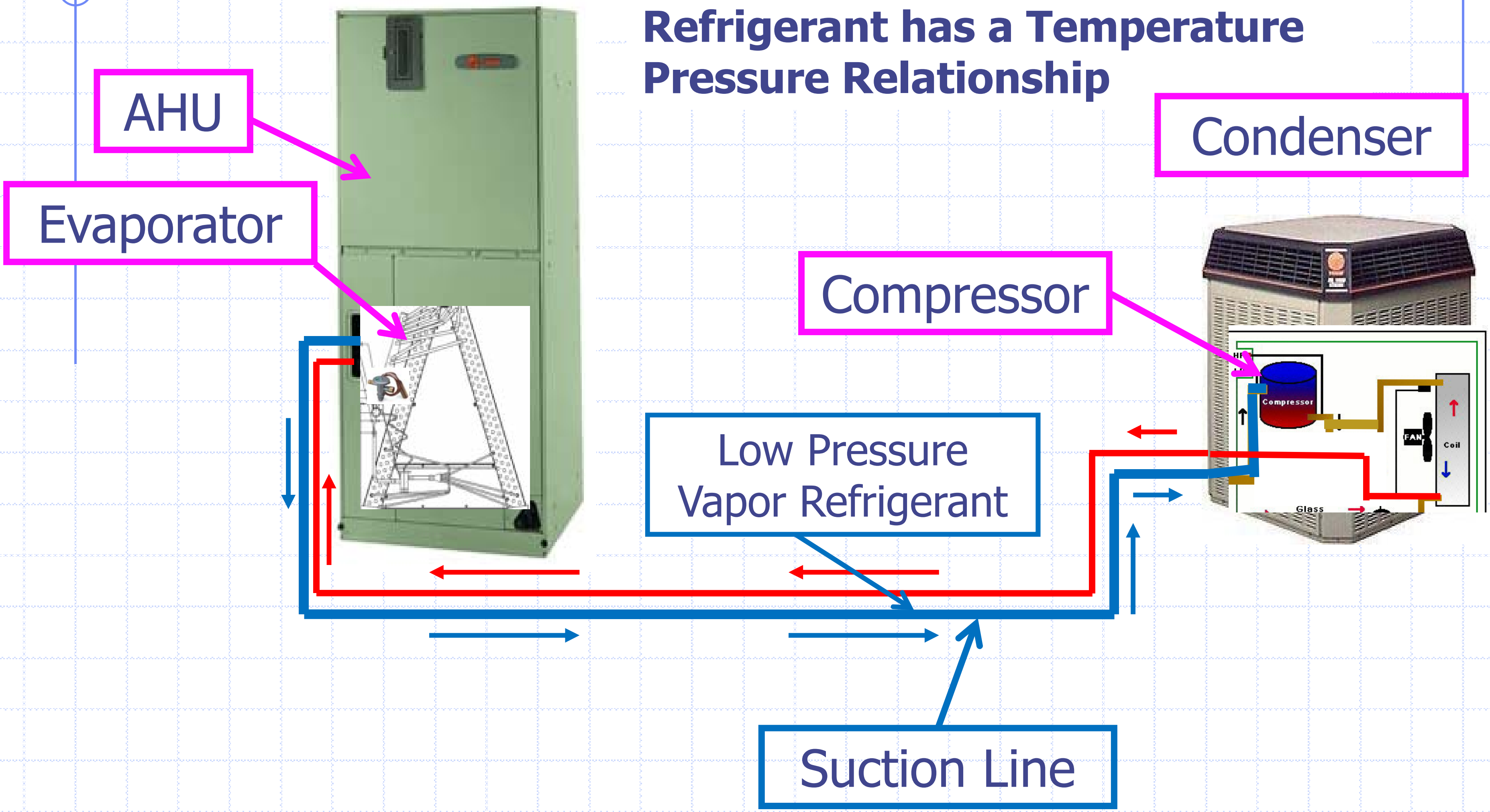
When the cooling system works properly-

Liquid refrigerant flows from the Condenser to the Evaporator Coil (located in the AHU).



In the Condensing Unit, the compressor Compresses and Pumps the Refrigerant.

Refrigerant has a Temperature Pressure Relationship



Refrigerant Temperature Pressure Chart

F	C	R-12	R-22	R-123	R-124	R-401 A	R-401 B	R-402 A	R-402 B	R-404 A	R-407 C	R-408 A	R-409 A	R-410 A	R-502	R-507	R-508 B	R-134 A	R-717
34	8.9	31.7	60.1	19.9	9.9	29.6	33.5	81.6	73.3	75.4	53.5	68.2	29.2	105	71.3	79.6	402	29.7	50.2
36	10	33.4	62.8	19.4	10.9	31.3	35.5	85	76.4	78.5	56.2	71.2	30.9	109	74.3	82.9	414	31.5	52.9
38	10	35.2	65.6	18.8	12	33.2	37.5	88.5	79.7	81.8	58.9	74.2	32.7	114	77.4	86.3	426	33.4	55.7
40	11.1	36.9	68.5	18.3	13.1	35	39.5	92.1	83	85.1	61.7	77.4	34.5	118	80.5	89.8	438	35.3	58.6
42	12.2	38.8	71.5	17.7	14.3	37	41.6	95.7	86.4	88.5	64.6	80.6	36.3	123	83.8	93.4	451	37.3	61.6
44	12.8	40.7	74.5	17.1	15.4	39	43.7	99.5	89.8	91.9	67.6	83.9	38.2	127	87	97	464	39.3	64.5
46	13.3	42.7	77.6	16.5	16.7	41	45.9	103.4	93.4	95.5	70.7	87.3	40.2	132	90.4	100.8	477	41.4	67.9
48	14.4	44.7	80.7	15.9	17.9	43.1	48.2	107.3	97.1	99.2	73.8	90.7	42.2	137	93.9	104.6	490	43.5	70.9
50	15.6	46.7	84	15.2	19.2	45.3	50.5	111.4	100.8	102.9	77.1	94.3	44.3	142	97.4	108.6	504	45.7	74.5
50	16.7					58	62	114	106		96	96	61						
52	17.8	48.8	87.3		20.5	60		120		109		99.4	63.6		101	112.6		47.7	77.7
54	18.3	51	90.8		21.9	62		124		113		103	66.2		104.8	116.7		50.1	81.5
55	18.9			13.4		64	69	125	116	114	106	105	67	156			539	51.5	
56	20	53.2	94.3		23.3	65		129		117		107.1	68.9		108.6	121		52.3	85
58	21.1	55.4	97.9		24.8	68		133		121		110	71.6		112.4	125.3		55	89
60	22.2	57.7	101.6	11.4	26.3	70	76	138	126	125	116	113.5	74.5	170	116.4	129.7		57.7	92.9
62	23.3	60.1	105.4		27.8	73		142		130		119.2	77.3		120.4	134.3		60.1	96.9
64	23.9	62.5	109.3		29.4	76		147		134		123.5	80.3		124.6	139		62.7	100.7
65	24.4			9.3		78	84	148	138	136	127	126	82	185				64.3	
66	25.6	65	113.2		31	79		152		139		127	83.3		128.8	143.7		65.5	105.3
68	26.7	67.6	117.3		32.7	82		157		144		132	86.4		133.2	148.6		68.3	109.3
70	27.8	70.2	121.4	6.9	34.4	85	92	160.4	150	148	139	135.1	89.5	200	137.6	153.6		71.2	114.1
72	28.9	72.9	125.7		36.2	89		168		153		141.5	92.8		142.2	158.7		74.2	118.7
74	29.4	75.6	130		38	92		173		158		146.2	96		146.8	163.9		77.2	123.4
75	30			4.3		94	101	174	162	160	151	149	98	217				79.8	
76	31.1	78.4	134.5		39.9	95		179		164		151	99.4		151.5	169.3		80.3	128.3
78	32.2	81.3	139		41.8	99		184		169		156	102.9		156.3	174.7		83.5	133.2
80	33.3	84.2	143.6	1.5	43.8	102	110	190	175	174	163	159.4	106.4	235	161.3	180.3		86.8	138.3
82	34.4	87.2	148.4		45.8	106		193.6		180		166.4	110		166.2	186		90.2	143.6
84	35	90.2	153.2		47.8	109		202		185		171	113.7		171.4	191.9		93.6	149
85	35.6			0.8		112	119	203	189	188	177	174	116	254				95.4	
86	36.7	93.3	158.2		50	113		208		191		177	117.4		176.6	197.8		97.1	154.5
88	37.8	96.5	163.2		52.1	117		214		197		182	121.2		181.9	203.9		100.7	160.1
90	38.9	99.8	168.4	2.4	54.3	121	130	220	204	203	191	186.4	125.1	274	187.4	210.2		104.5	165.9
92	40	103.1	173.7		56.6	125		227		209.9		194.2	129.1		192.9	216.6		108.2	171.9
94	40.6	106.5	179.1		59	129		234		215		200.1	133.2		198.6	223.1		112.1	178
95	41.1		182	4.2		132	140	235	220	218	206	203	137	295				114	
96	42.2	110	184.6		61.3	133		240		222		206.2	137.4		204.3	229.8		116.1	184.2
98	43.3	113.5	190.2		63.8	138		247		229		212.3	141.6		210.2	236.6		120.1	190.6
100	44.4	117.2	195.9	6.1	66.3	142	152	254	236	235	222	216.6	146	317	216.2	243.5		124.3	197.2

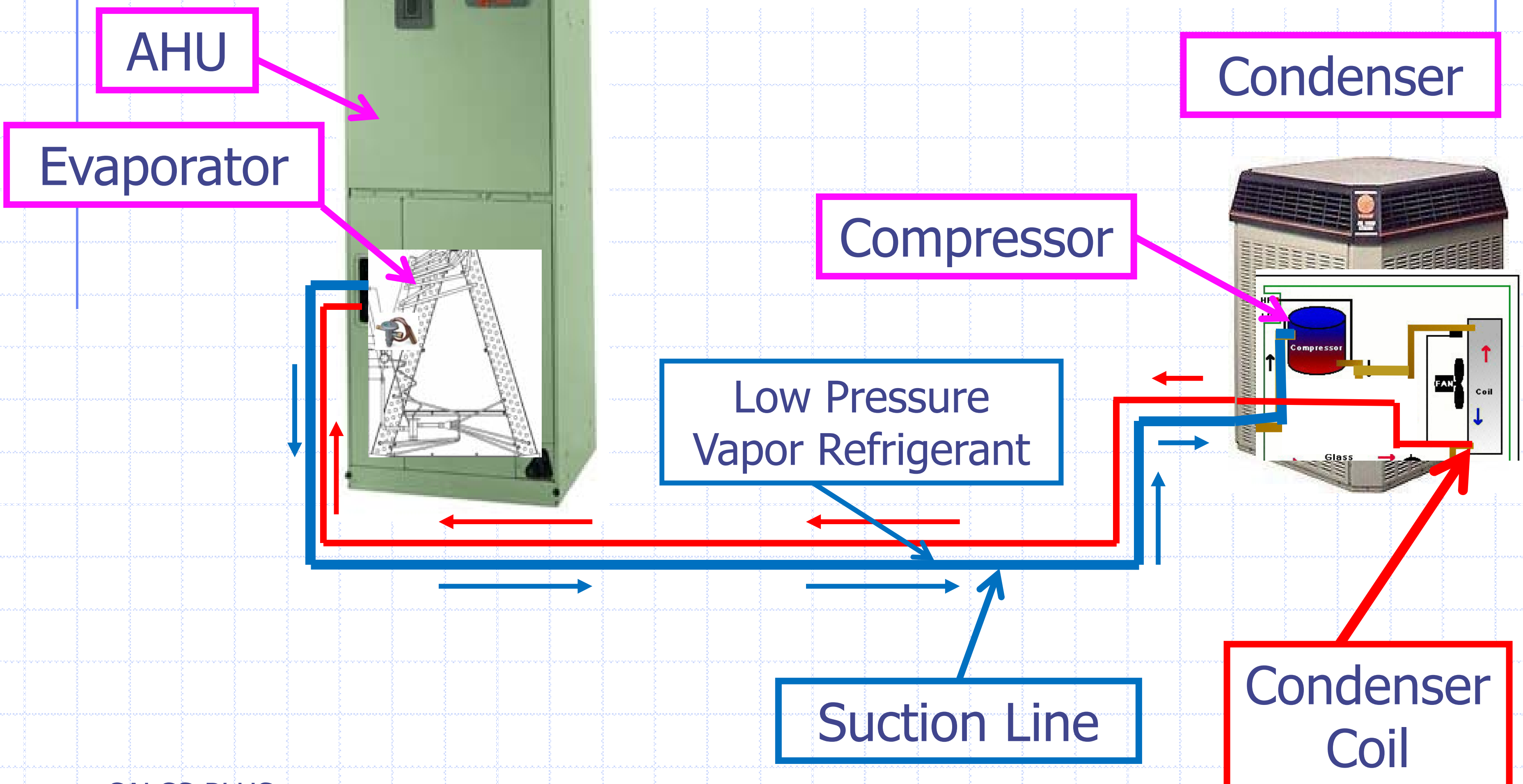
F	C	R-12	R-22	R-410 A
74	29.4	75.6	130	
75	30			217
76	31.1	78.4	134.5	
78	32.2	81.3	139	
80	33.3	84.2	143.6	235
82	34.4	87.2	148.4	
84	35	90.2	153.2	
85	35.6			254
86	36.7	93.3	158.2	
88	37.8	96.5	163.2	
90	38.9	99.8	168.4	274
92	40	103.1	173.7	
94	40.6	106.5	179.1	
95	41.1		182	295

When refrigerant is in it's vapor state there will be a direct pressure temperature relationship.
Pressure is measured using a set of Gauges.

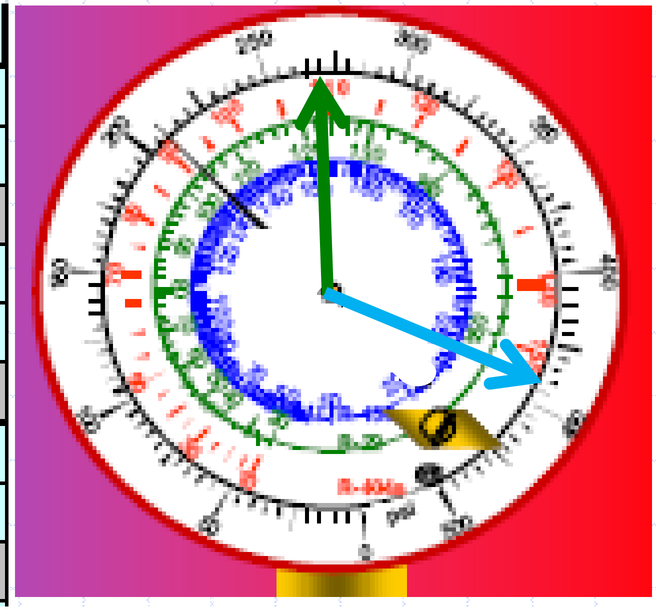
Compound Gauge: A gauge that reads pressures above atmospheric pressure in PSIG, and below atmospheric pressure in inches of Mercury column (“Hg) **(Usually Blue)**

Pressure Gauge: A gauge that reads pressures only above atmospheric pressure in PSIG. **(Usually Red)**

In the compressor, the refrigerant temperature and pressure increase as the vapor is compressed. The hot vapor exits the compressor enters the nearby condenser coil.



F	C	R-12	R-22	R-410 A
112	51.1	140.5	232.8	
114	51.7	144.7	239.4	
115	52.2			390
116	53.3	148.8	246.1	
118	54.4	153.2	252.9	
120	55.6	157.7	259.9	417
122	56.7	162.2	267	
124	57.2	166.7	274.3	
125	57.8			445
126	58.9	171.4	281.6	
128	60	176.2	289.1	
130	61.1	181	296.8	
132	62.2	185.9	304.6	
134	62.8	191	312.5	

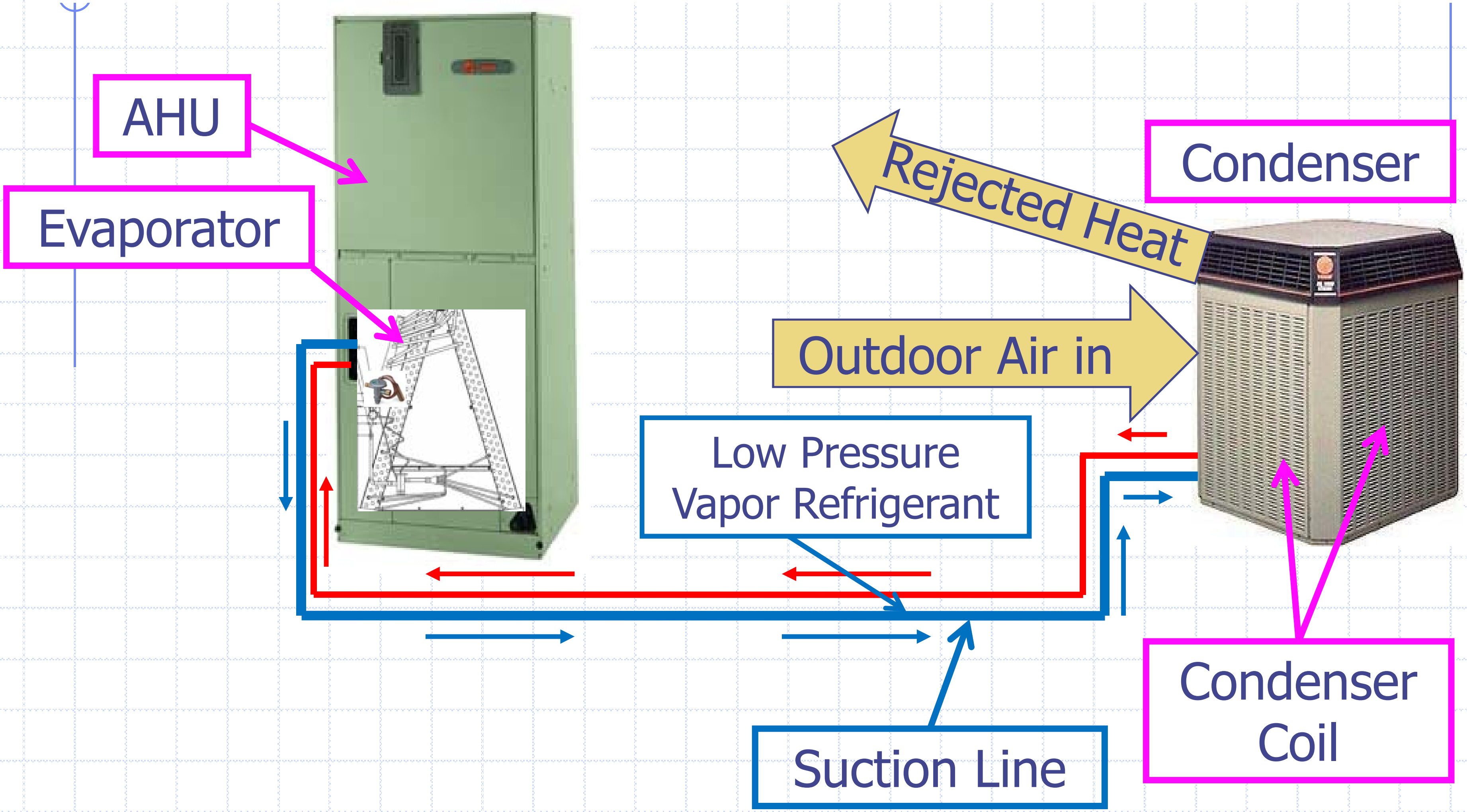


The temperature of the refrigerant leaving the compressor is typically between 30 and 20° warmer than the outdoor temperature.

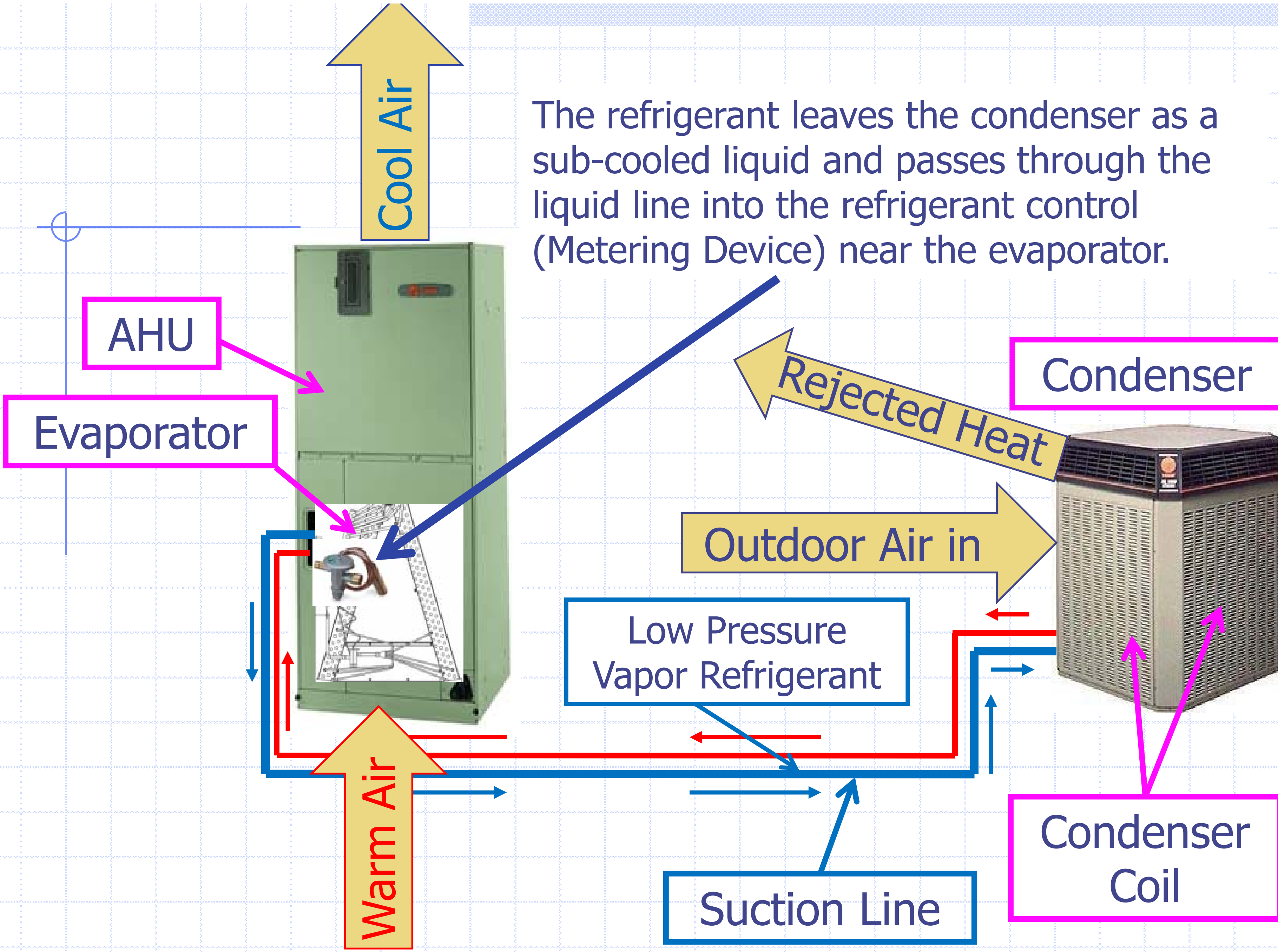
30° warmer for standard efficiency units and as low as 20° for ultra high efficiency equipment.

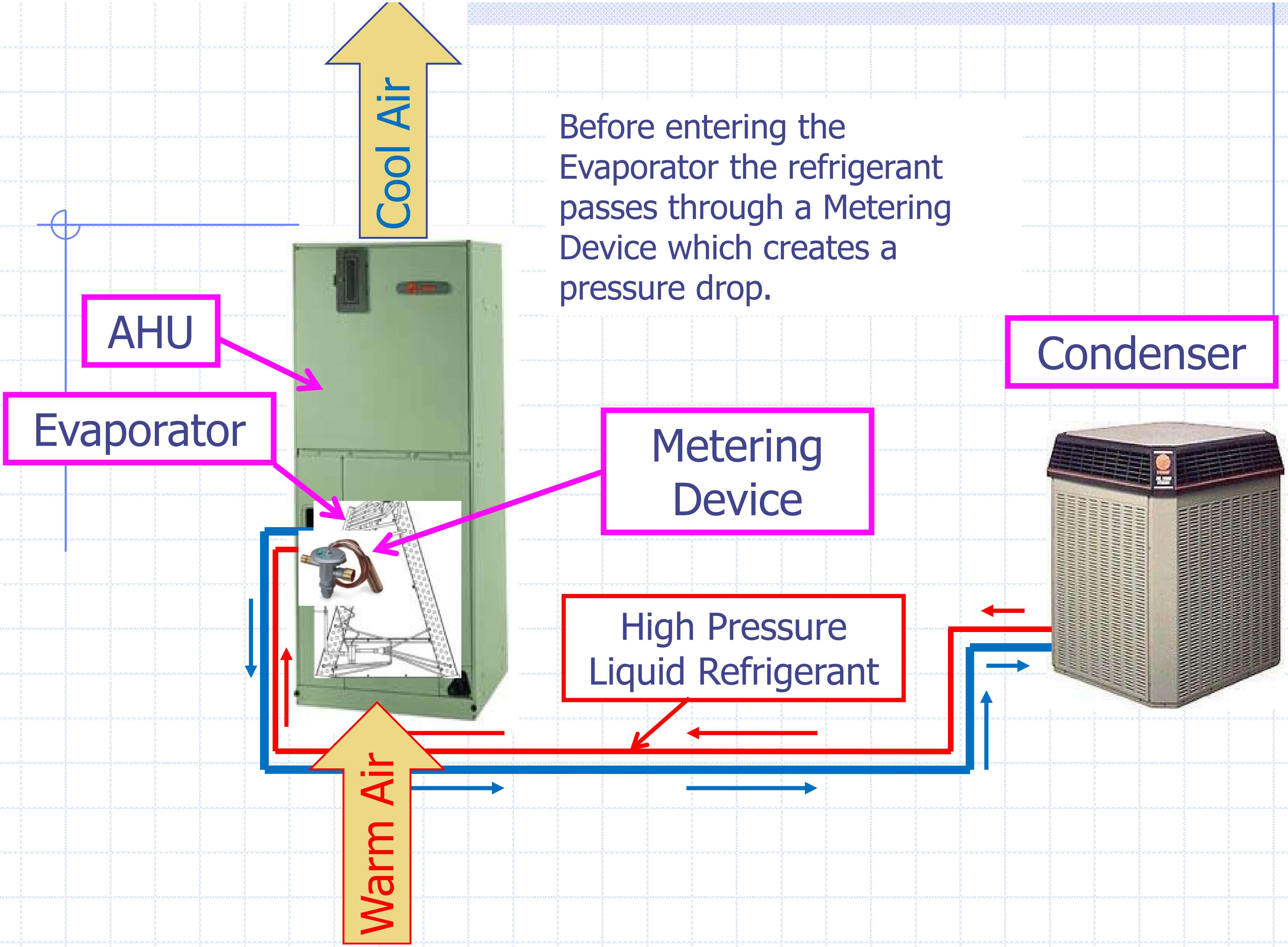
If the outdoor temperature was 94° the vapor pressure would be (94 + 30= 124°) 274.3 PSIG for R-22 and 443 PSIG for R-410-A

Cooler outdoor air is moved across the condenser coil removing heat, condensing the high-temperature, high-pressure refrigerant vapor into a liquid as heat is rejected; the liquid refrigerant is then sub-cooled 6 to 8° below the pressure temperature relationship.



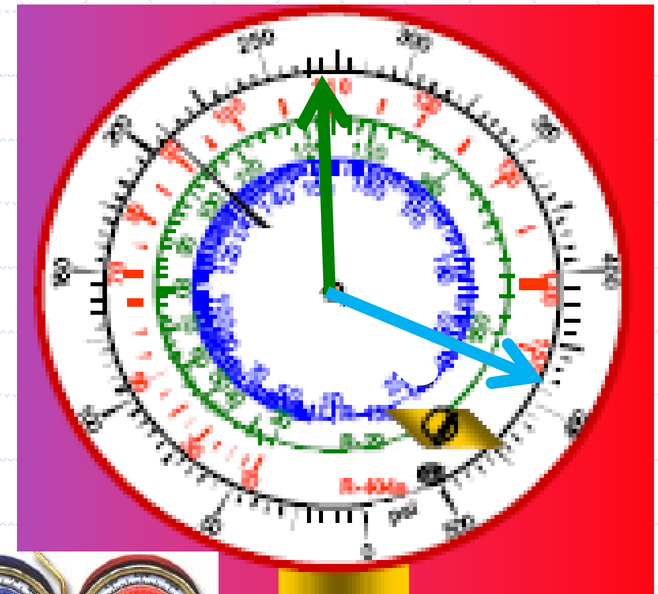
The refrigerant leaves the condenser as a sub-cooled liquid and passes through the liquid line into the refrigerant control (Metering Device) near the evaporator.



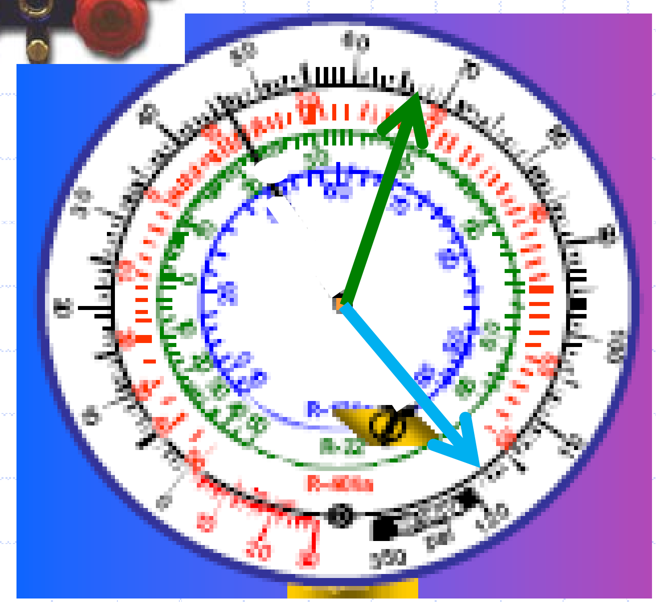


Before entering the Evaporator the refrigerant passes through a Metering Device which creates a pressure drop.

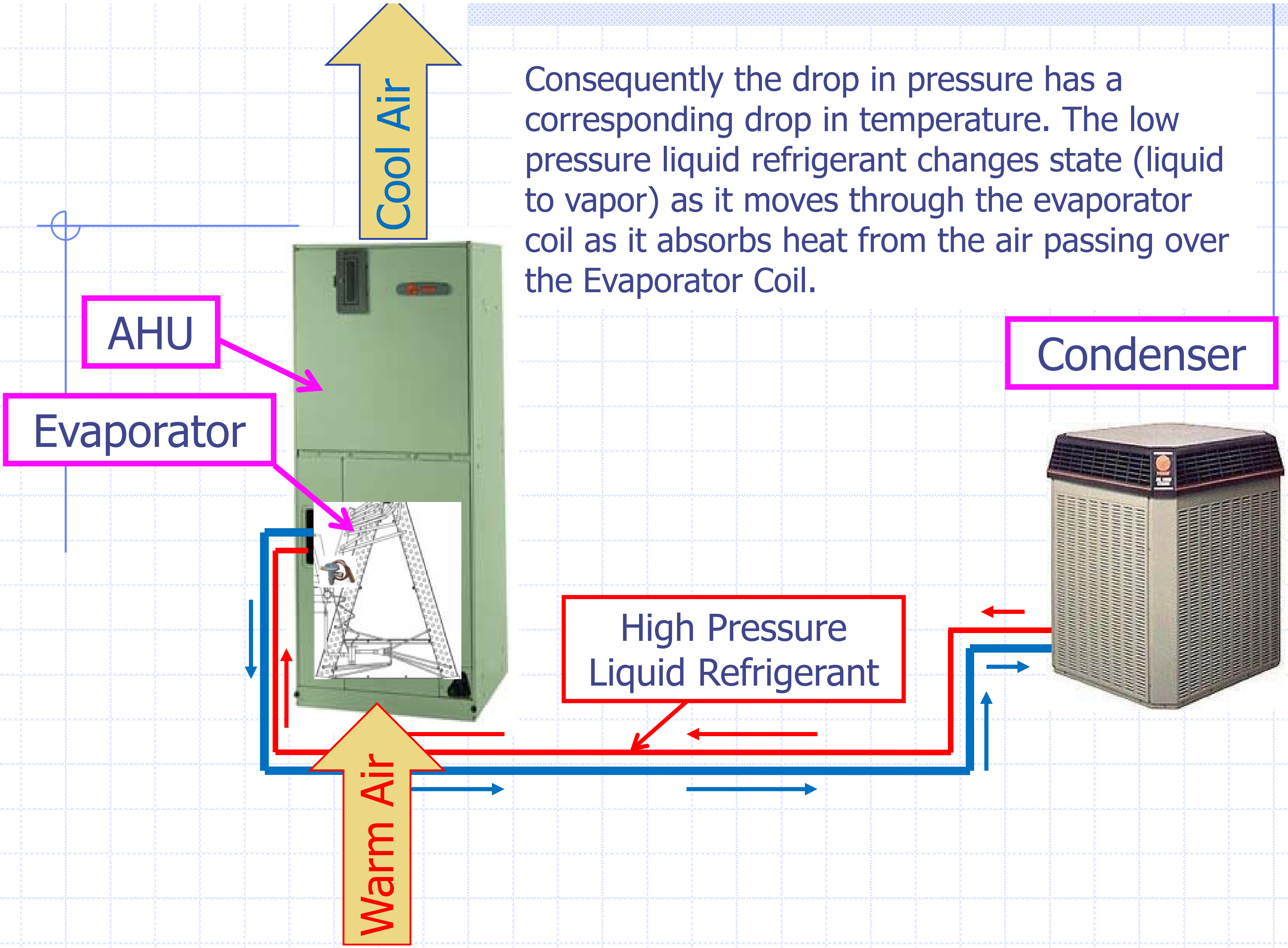
F	C	R-12	R-22	R-410 A
112	51.1	140.5	232.8	
114	51.7	144.7	239.4	
115	52.2			390
116	53.3	148.8	246.1	
118	54.4	153.2	252.9	
120	55.6	157.7	259.9	417
122	56.7	162.2	267	
124	57.2	166.7	274.3	
125	57.8			445



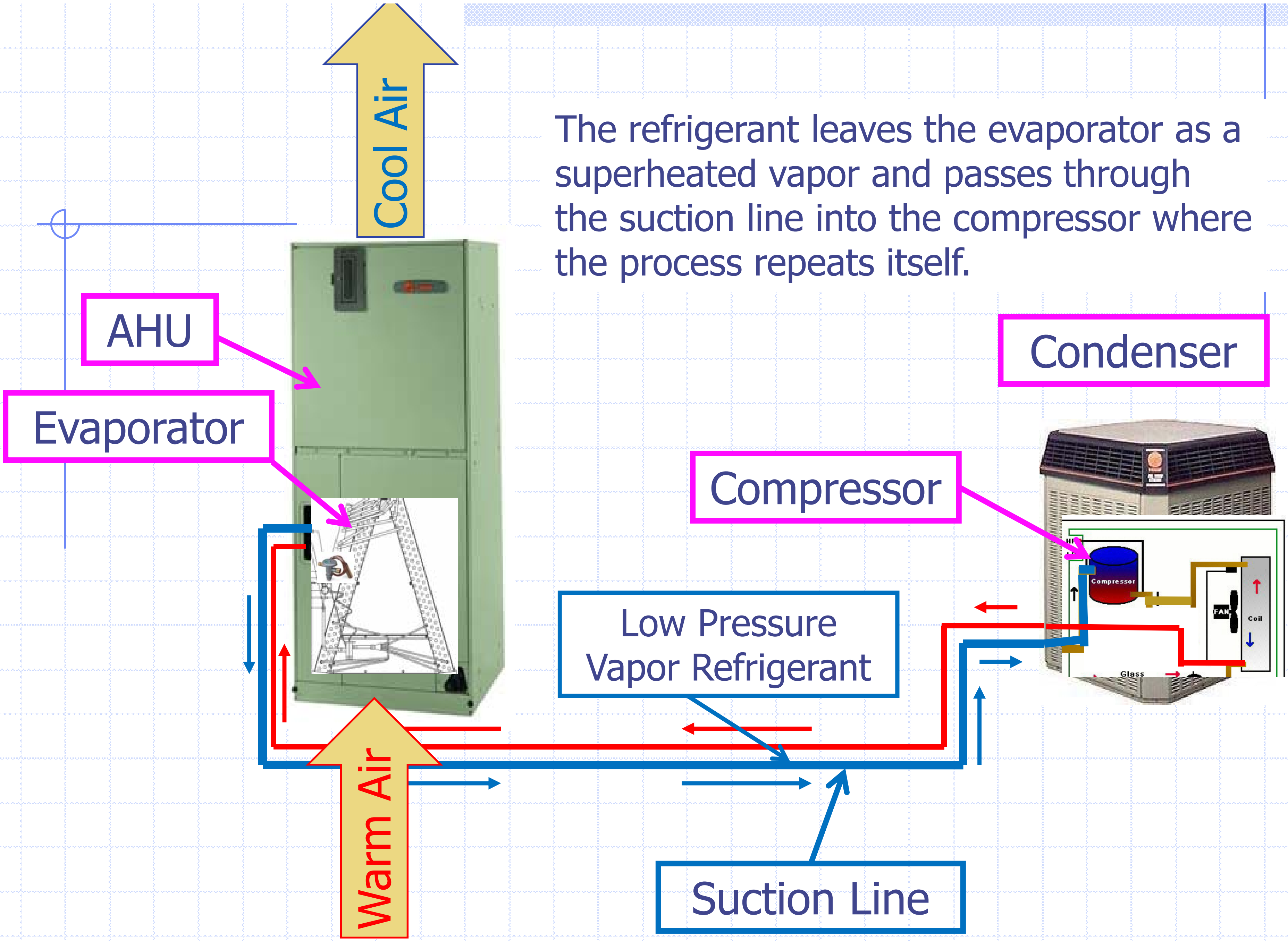
F	C	R-12	R-22	R-410 A
34	8.9	31.7	60.1	105
36	10	33.4	62.8	109
38	10	35.2	65.6	114
40	11.1	36.9	68.5	118
42	12.2	38.8	71.5	123
44	12.8	40.7	74.5	127
46	13.3	42.7	77.6	132
48	14.4	44.7	80.7	137



Consequently the drop in pressure has a corresponding drop in temperature. The low pressure liquid refrigerant changes state (liquid to vapor) as it moves through the evaporator coil as it absorbs heat from the air passing over the Evaporator Coil.

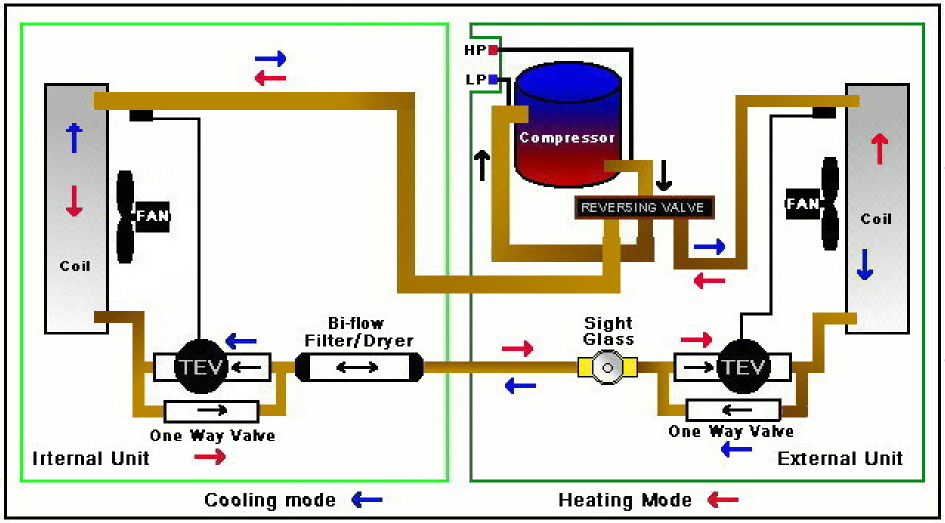


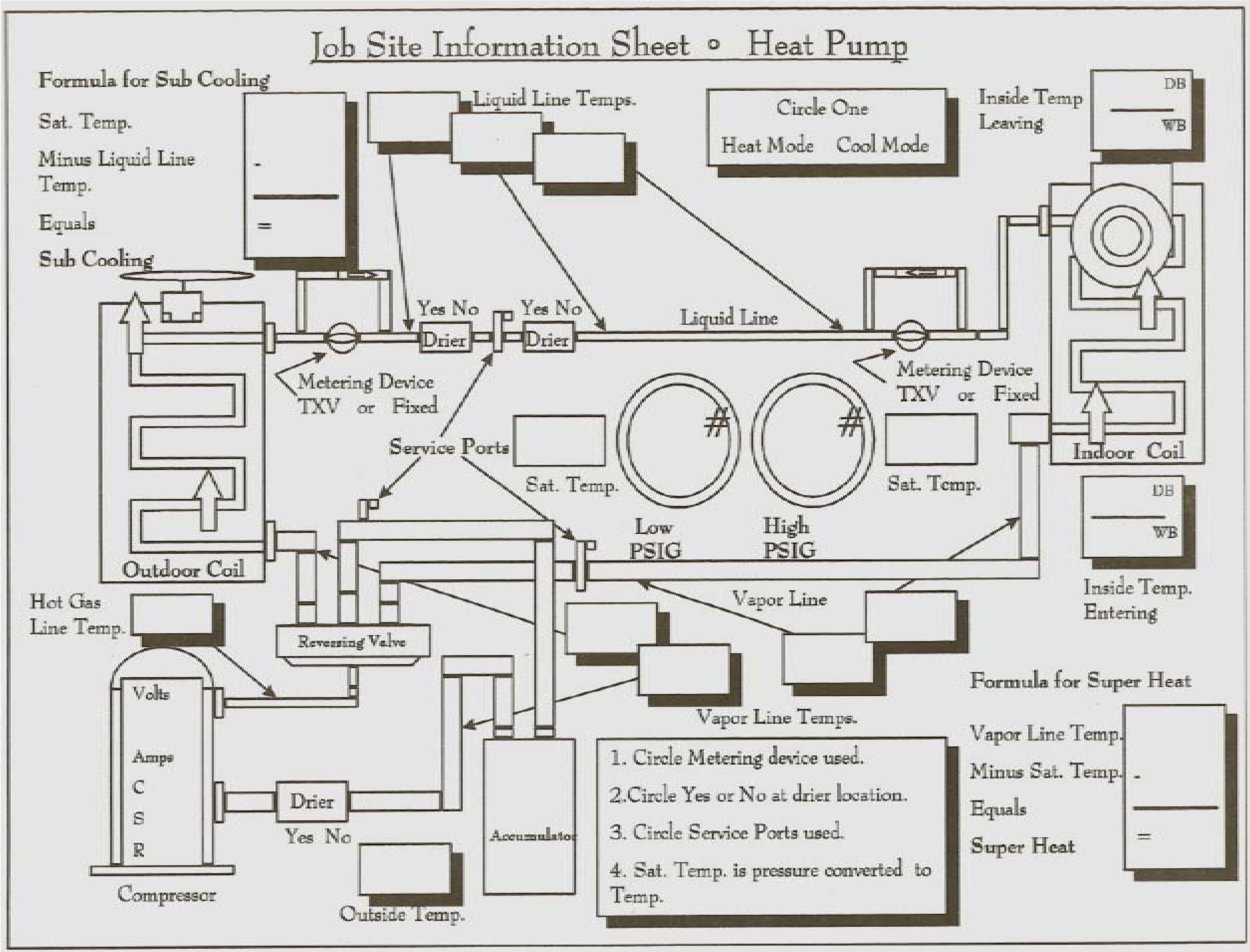
The refrigerant leaves the evaporator as a superheated vapor and passes through the suction line into the compressor where the process repeats itself.



For System Commissioning the Measurements that should be Taken Are:

- Suction pressure
- Discharge pressure
- Saturation temperature
- Condensing temperature
- Superheat
- Sub cooling
- Compressor Running Load Amps
- Airflow in CFM at Evaporator
- Outdoor dry bulb
- Return air dry bulb
- Return air wet bulb
- Supply air dry bulb
- Supply air wet bulb




Job Site Information Sheet ∘ Heat Pump
Formula for Sub Cooling
Sat. Temp.
Minus Liquid Line Temp.
Equals
Sub Cooling
-
=
Liquid Line Temps.
Circle One
Heat Mode Cool Mode
Inside Temp Leaving
DB
WB
Yes No
Drier
Yes No
Drier
Liquid Line
Metering Device
TXV or Fixed
Metering Device
TXV or Fixed
Service Ports
Sat. Temp.
#
#
Sat. Temp.
Low PSIG
High PSIG
Indoor Coil
DB
WB
Inside Temp. Entering
Outdoor Coil
Hot Gas Line Temp.
Reversing Valve
Vapor Line
Vapor Line Temps.
Formula for Super Heat
Vapor Line Temp.
Minus Sat. Temp.
Equals
Super Heat
-
=
Volts
Amps
C
S
R
Compressor
Drier
Yes No
Accumulator
Outside Temp.
1. Circle Metering device used.
2.Circle Yes or No at drier location.
3. Circle Service Ports used.
4. Sat. Temp. is pressure converted to Temp.

Some Important Points

In any Heat Pump or Air Conditioning system there are only two components that can be changed or adjusted to decrease or increase the capacity and efficiency of the System!

1. Airflow
2. Refrigerant charge

The efficiency of any system can never be higher than manufacturers performance tables;

However, the efficiency can be far less!!!!!!

You must have an EPA card to open any refrigeration system. This Includes putting gauges on the system!

So

How does a rater tell if the system is operating to manufacturers performance specifications?

Temperature difference across the evaporator coil?

What should the temperature difference across the evaporator coil be?

Temperature Difference Across a DX Coil

The Temperature difference across the evaporator coil is determined by the condition of the entry air.

However, Temperature Difference across the coil doesn't give BTUH output.

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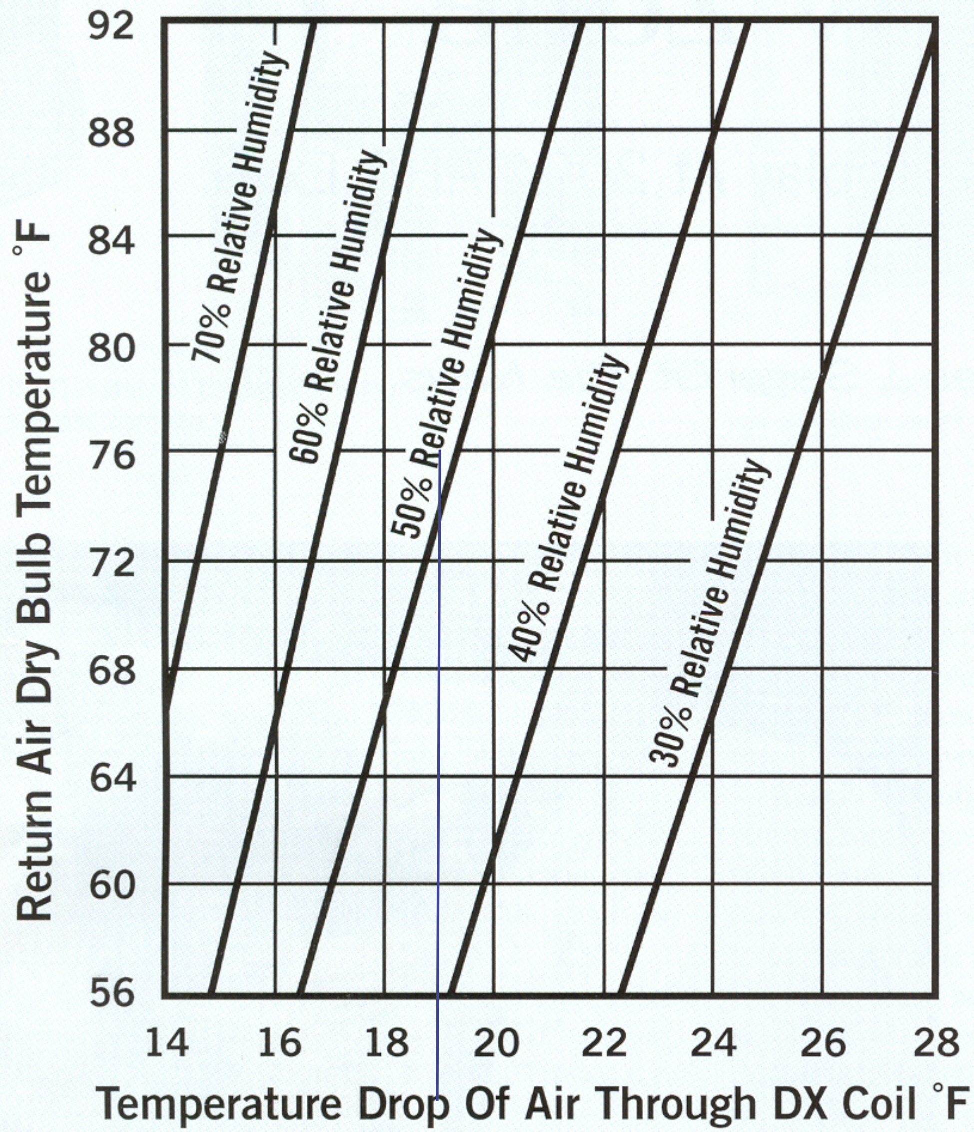


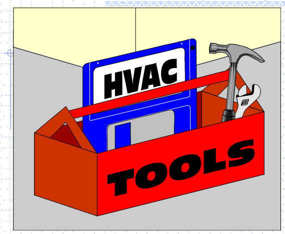
Figure 1. The temperature difference or drop across A/C coils as a function of return air dry-bulb temperature and relative humidity.

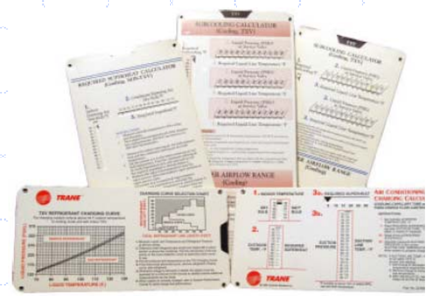
Gauges are Not Needed to Check System Performance

There is no reason to put gauges on a sealed system after the initial installation and commissioning unless a problem with the mechanical refrigeration circuit is suspected.

If you do not know how the system was designed to operate, there is no need to hook up gauges. The information that you will get will have no more value than the line temperature alone.

The refrigerant charge can be checked very accurately without gauges using equipment we already have in our toolbox and with manufacturers performance data and charging charts.





The capacity in BTUH can be calculated determining if the unit is working at or near capacity with a Psychrometric chart, a digital thermometer, a digital humidity stick, and an airflow measuring devise that will accurately measure airflow across the coil.

At design conditions almost all <u>standard</u> efficiency air conditioners operate with a 40° F evaporator coil temperature and at 125° F condensing coil temperature.

High efficiency and ultra high efficiency air conditioners operate with a 45° F evaporator coil temperature and at ?° F condensing coil temperature.

Temperature drop across a coil will vary with the latent load (humidity). The higher the humidity, the more cooling energy goes to converting water vapor (humidity) to water. The drop can fall within a range of 16° to 24° degrees with ease.

To further understand checking the charge without gauges let's work from design conditions. If indoor design conditions are 75°F the coil temperature should be 40°F. The design temperature difference is 35° F (75 – 40 = 35).

For standard efficiency systems this <u>temperature difference</u> will stay the same under all load conditions at the rated CFM. High efficiency equipment will be 30° difference.

Three Part Process

Collect the Data
Do the Math
Compare the Results

Collect the Data

Measured Air Handler CFM	____________
Return DB DBr	____________
Return WB or RH	____________
Supply DB DBs	____________
Supply WB or RH	____________
Suction Line Temperature SLT	____________

Do the Math

ΔDB across the Evaporator Coil	____________
Grains/Lb Difference ΔGR	____________
CFM x 1.1 x ΔDB = BTU/H Sensible	____________
CFM x .68 x ΔGR = BTU/H Latent	____________
Evaporator Coil Temp ECT=(DBr – 35)	____________
Super Heat = SLT-ECT	____________
Entering Air WB Temperature	____________

Measured Air Handler CFM

Prior to testing any system, make sure the filters, condenser coil, evaporator coil, and blower are clean.

Verify the system airflow is within the desired range required by the manufacture.

If the airflow is not set correctly, the system cannot operate as designed!

Airflow Measurement Methods

Pressure drop across the dry evaporator coil method
Total external static pressure method
The temperature rise method (Sensible heat formula)
Consult Manufacturer's Airflow Performance Chart

Manufacturer's Airflow Performance Chart

AIRFLOW PERFORMANCE 2TEE3F37A, 4TEE3F37B WITH WET COIL, FILTER, NO HEATER												
OUTDOOR UNIT SIZE (TONS)	Speed Settings	AIRFLOW SETTING	DIP SWITCH SETTING				Airflow Power	EXTERNAL STATIC PRESSURE				
			SW 1	SW 2	SW 3	SW 4		0.1	0.3	0.5	0.7	0.9
2	Low	350 CFM/ton	ON	ON	OFF	ON	CFM Watts	700 90	700 115	700 155	700 190	660 220
	Normal	400 CFM/ton	ON	ON	OFF	OFF	CFM Watts	800 110	800 140	800 180	770 230	750 260
	High	450 CFM/ton	ON	ON	ON	OFF	CFM Watts	900 130	900 165	900 220	900 265	900 310
2.5	Low	350 CFM/ton	OFF	ON	OFF	ON	CFM Watts	880 130	880 165	880 215	880 265	880 305
	Normal	400 CFM/ton	OFF	ON	OFF	OFF	CFM Watts	1000 165	1000 215	1000 270	1000 315	880 325
	High	450 CFM/ton	OFF	ON	ON	OFF	CFM Watts	1125 225	1125 285	1125 330	1100 380	900 340
3	Low	350 CFM/ton	ON	OFF	OFF	ON	CFM Watts	1040 170	1040 230	1040 280	1040 330	1000 325
	Normal	400 CFM/ton	ON	OFF	OFF	OFF	CFM Watts	1160 240	1160 300	1160 350	1100 385	870 335
	High	450 CFM/ton	ON	OFF	ON	OFF	CFM Watts	1300 325	1300 365	1260 425	1140 410	950 330
3.5	Low	350 CFM/ton	OFF	OFF	OFF	ON	CFM Watts	1225 295	1225 330	1200 385	1070 390	890 340
	Normal **	400 CFM/ton	OFF	OFF	OFF	OFF	CFM Watts	1350 365	1350 420	1280 455	1140 415	940 365
	High	450 CFM/ton	OFF	OFF	ON	OFF	CFM Watts	1400 405	1400 475	1300 460	1150 430	940 375

NOTES:
1. ** Factory Setting
2. At continuous fan setting: Airflow values are approximately 50% of the listed values.

Manufacturer's Airflow Performance Chart

	AIRFLOW PERFORMANCE TWE030CA40D					
	EXTERNAL STATIC PRESSURE (INCHES OF WATER)					
	Upflow & Downflow (See Notes)			Horizontal: No Filter (See Notes)		
	220 Volts			220 Volts		
CFM	HI	MED	LO	HI	MED	LO
600			0.72			0.71
650			0.62			0.31
700		0.86	0.51		0.84	0.50
750		0.75	0.40		0.72	0.39
800	0.89	0.65	0.29	0.87	0.62	0.28
850	0.81	0.54	0.18	0.79	0.51	0.17
900	0.72	0.43	0.06	0.69	0.40	0.08
950	0.63	0.32	0.00	0.61	0.30	
1000	0.53	0.21		0.51	0.17	
1050	0.42	0.10		0.40	0.02	
1100	0.31	0.00		0.31		
1150	0.20			0.22		
1200	0.08			0.10		

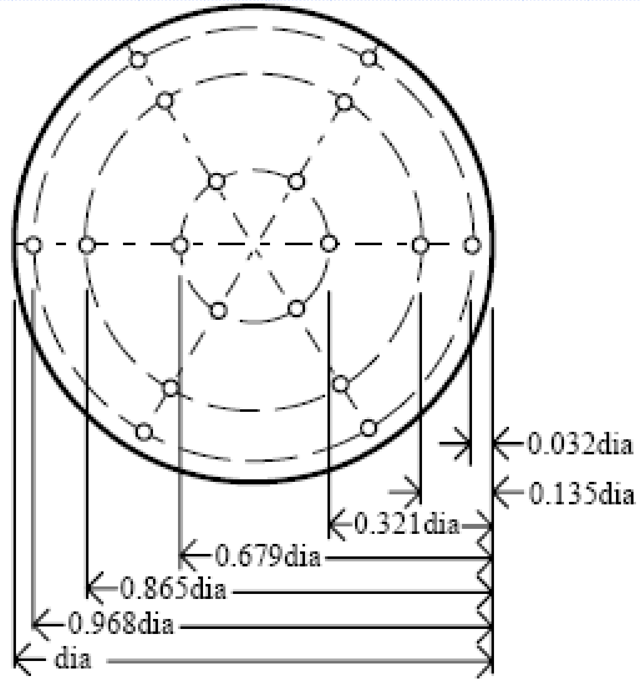
NOTES:
1. With wet coil; filter in place; no heater installed.
2. Tray is in place for all positions.
3. Baffles are in place for downflow.
4. VERTICAL: With filter. Subtract 0.06" for downflow.
5. HORIZONTAL: As shipped, but without filter.
   Subtract 0.05" for horizontal left.

Airflow
The Down and Dirty

Airflow should be about 400 CFM per ton.
The numbers on the manufacturer's tag (usually) indicates the BTUH rating and can be converted to CFM.
However nothing replaces Manufacturers Performance Data.

012 (12,000 Btuh) = 400 CFM
018 (18,000 Btuh) = 600 CFM
024 (24,000 Btuh) = 800 CFM
030 (30,000 Btuh) = 1000 CFM
036 (36,000 Btuh) = 1200 CFM
042 (42,000 Btuh) = 1400 CFM
048 (48,000 Btuh) = 1600 CFM
060 (60,000 Btuh) = 2000 CFM ????????

Flow Plate



Traverse the Duct

Rotating Vane Anemometer

Hot Wire Anemometer

Measure the:

Return DB (DBr)
Return WB or RH
Supply DB (DBs)
Supply WB or RH

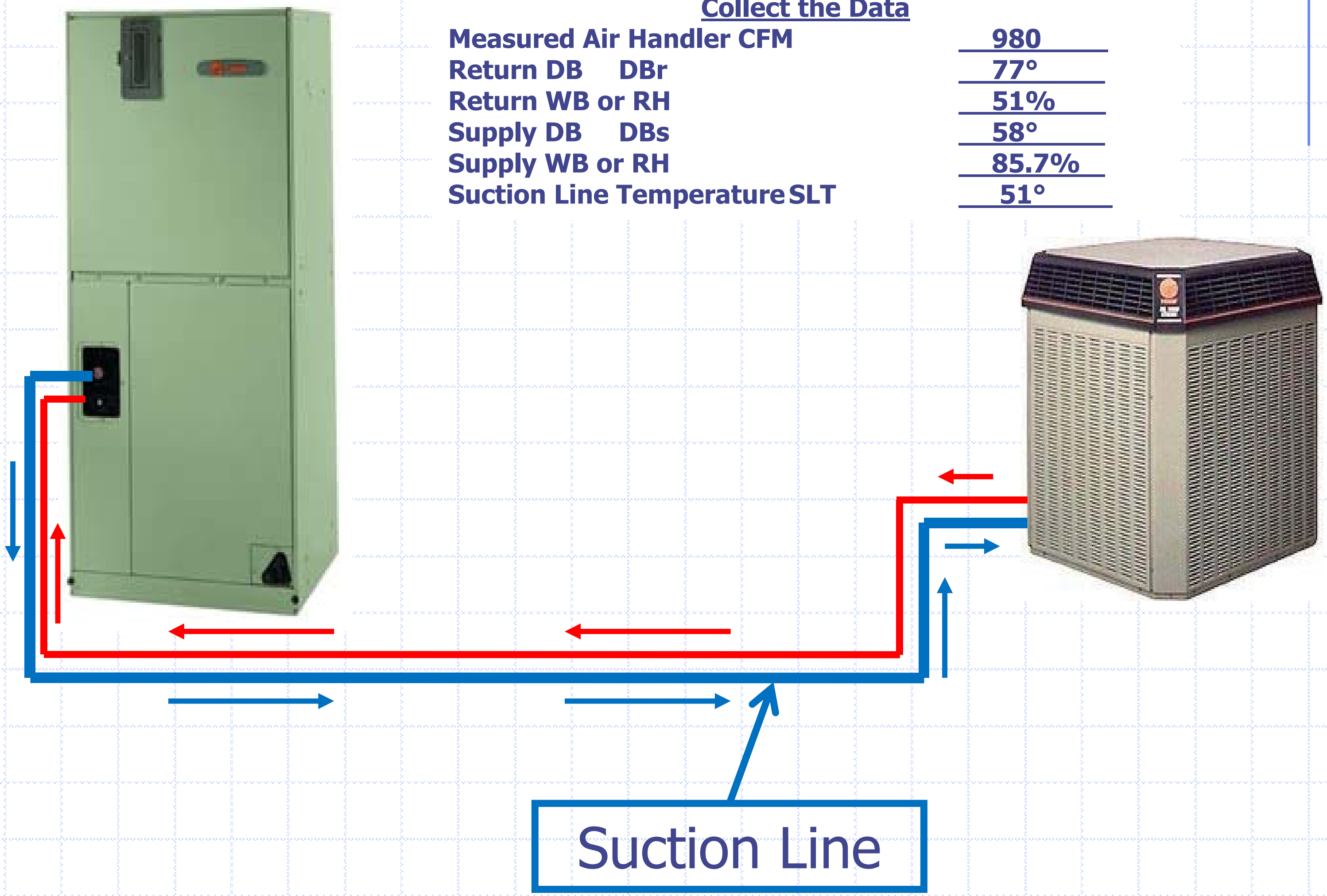
Collect the Data

Measured Air Handler CFM	980
Return DB DBr	77°
Return WB or RH	51%
Supply DB DBs	58°
Supply WB or RH	85.7%
Suction Line Temperature SLT	

Suction Line Temperature SLT

Collect the Data

Measured Air Handler CFM	**980**
Return DB DBr	**77°**
Return WB or RH	**51%**
Supply DB DBs	**58°**
Supply WB or RH	**85.7%**
Suction Line Temperature SLT	**51°**



Do the Math

Collect the Data

Measured Air Handler CFM	**980**
Return DB DBr	**77°**
Return WB or RH	**51%**
Supply DB DBs	**58°**
Supply WB or RH	**85.7%**
Suction Line Temperature SLT	**51°**

DBr – DBs = ΔDB or ΔT

Lets say the entering air is 77°F

The leaving air is 58°F

ΔDB across the Evaporator Coil **19°**

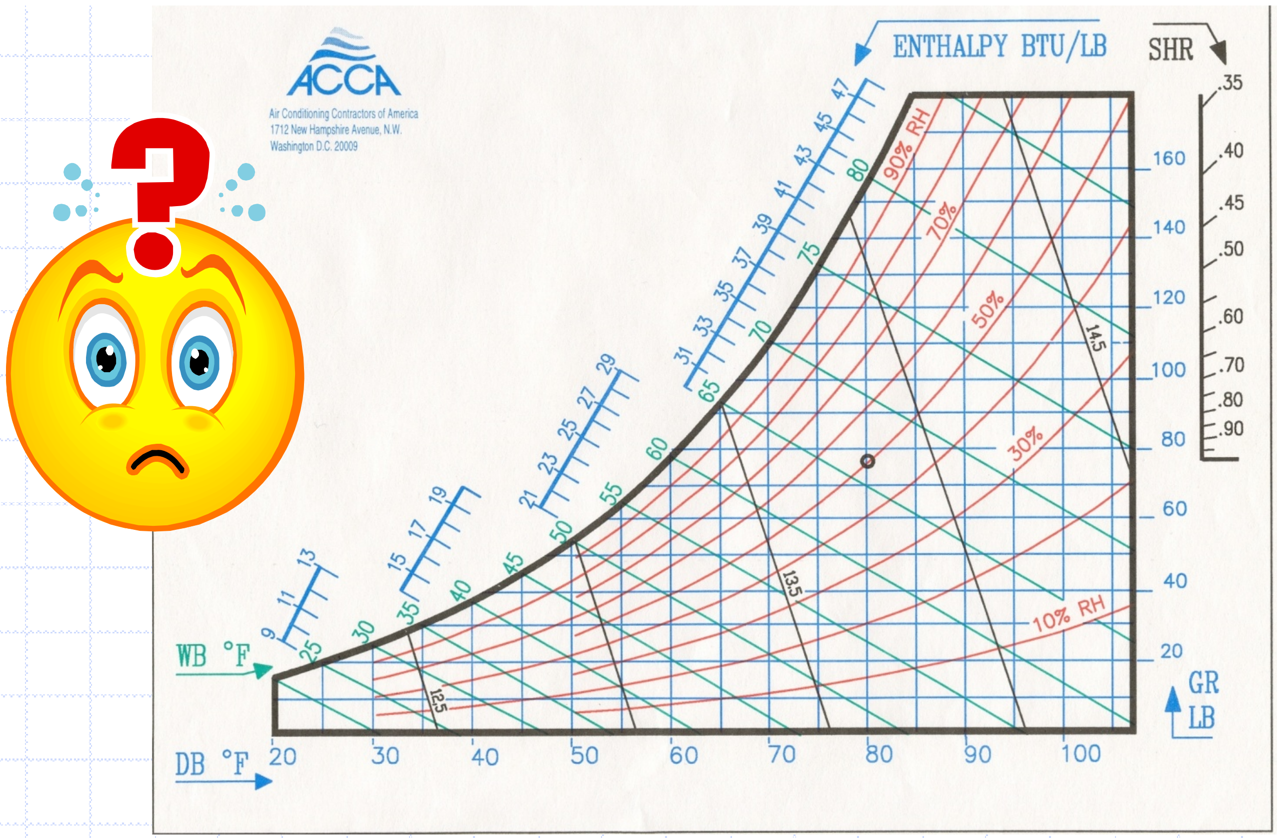
Pretty Simple, Right!

ΔDB across the Evaporator Coil	**19°**
Grains/Lb Difference ΔGR	
CFM x 1.1 x ΔDB = BTU/H Sensible	
CFM x .68 x ΔGR = BTU/H Latent	
Evaporator Coil Temp ECT=(DBr – 35)	
Super Heat = SLT-ECT	
Entering Air WB Temperature	

Do the Math

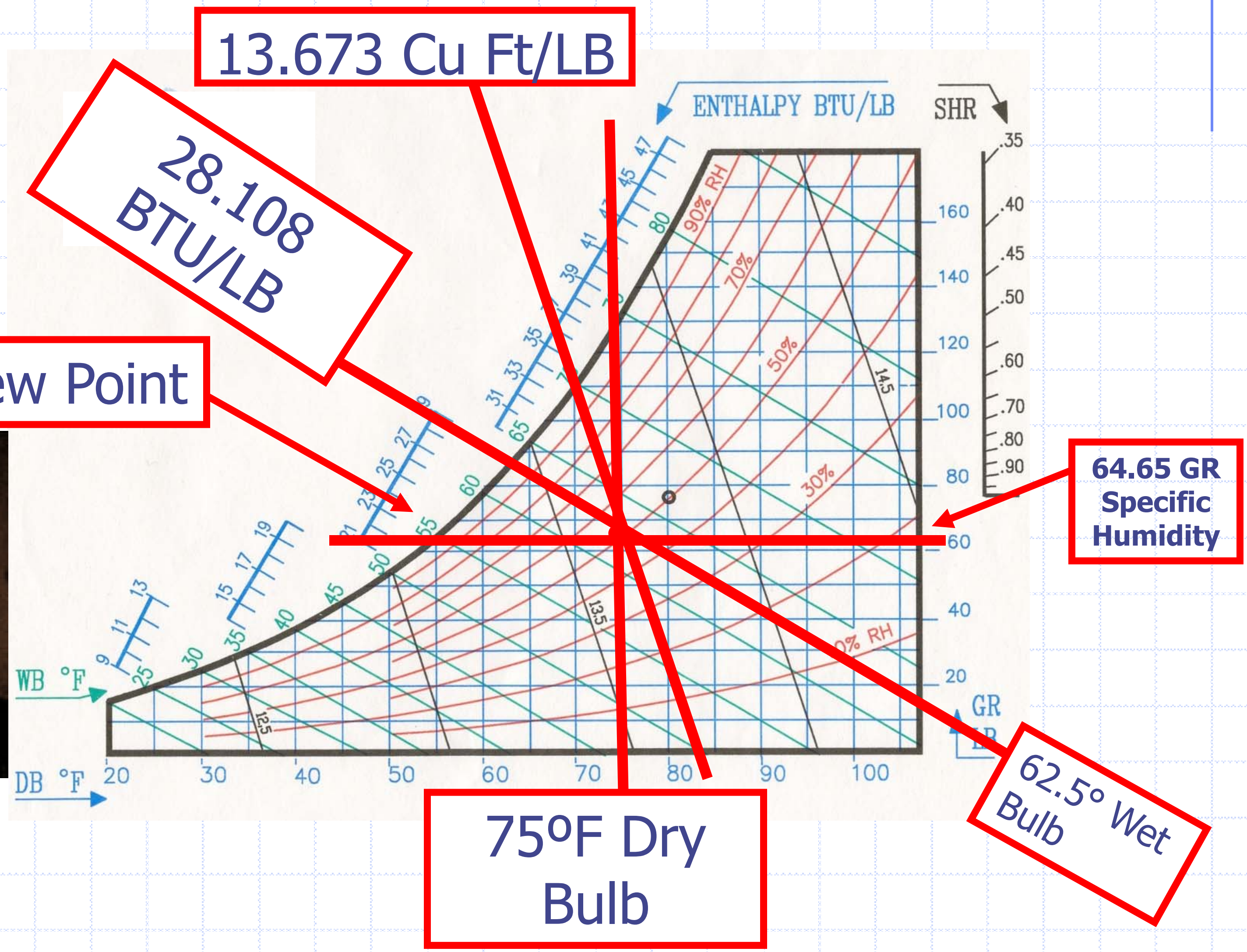
- **Grains/Lb Difference ΔGR** ___________

Holy Sh _ _! I have to do Psychrometrics ?????

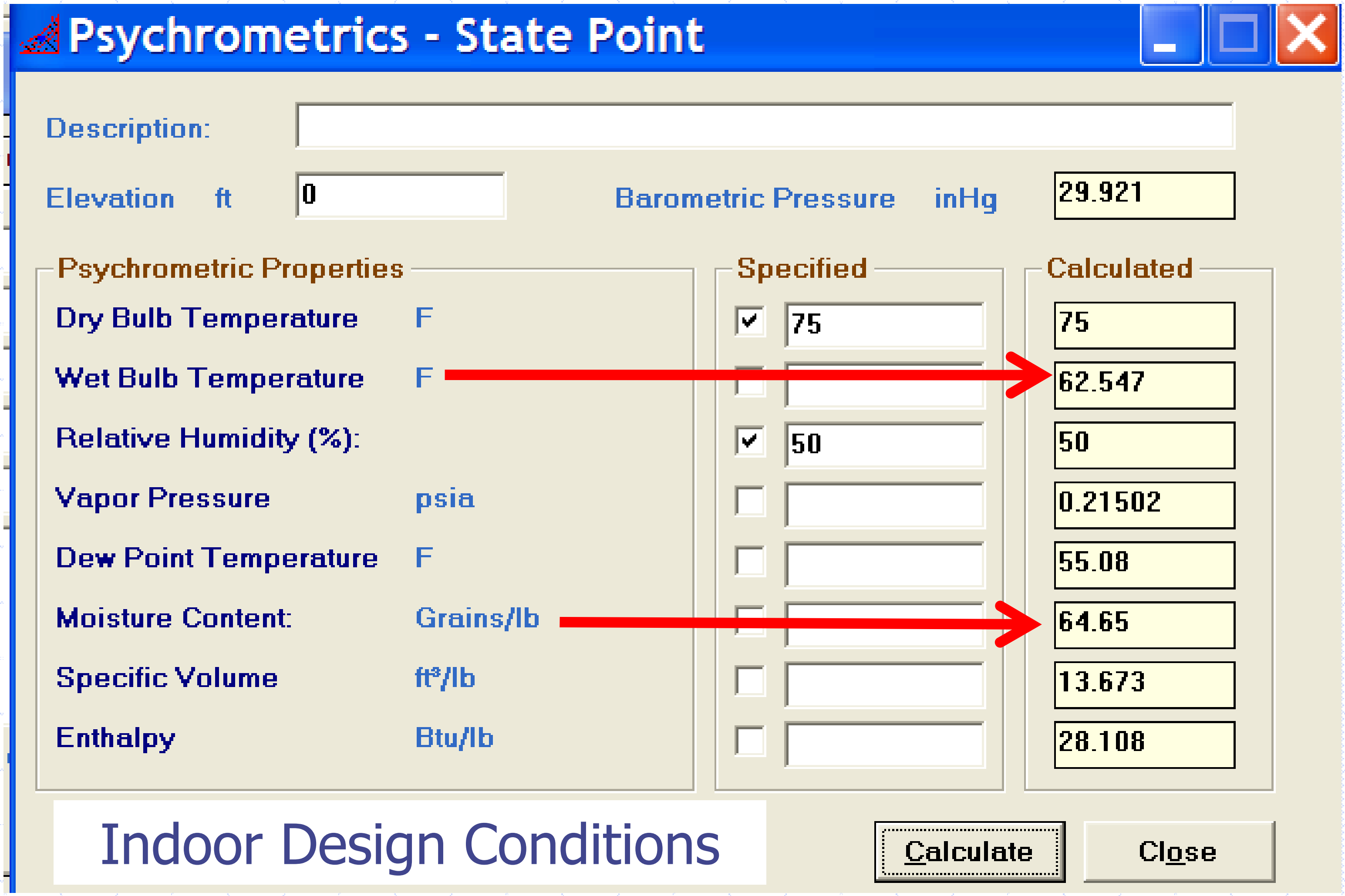


Designed indoor conditions of 75ºF @ 50% RH looks something like this.

Willis Carrier



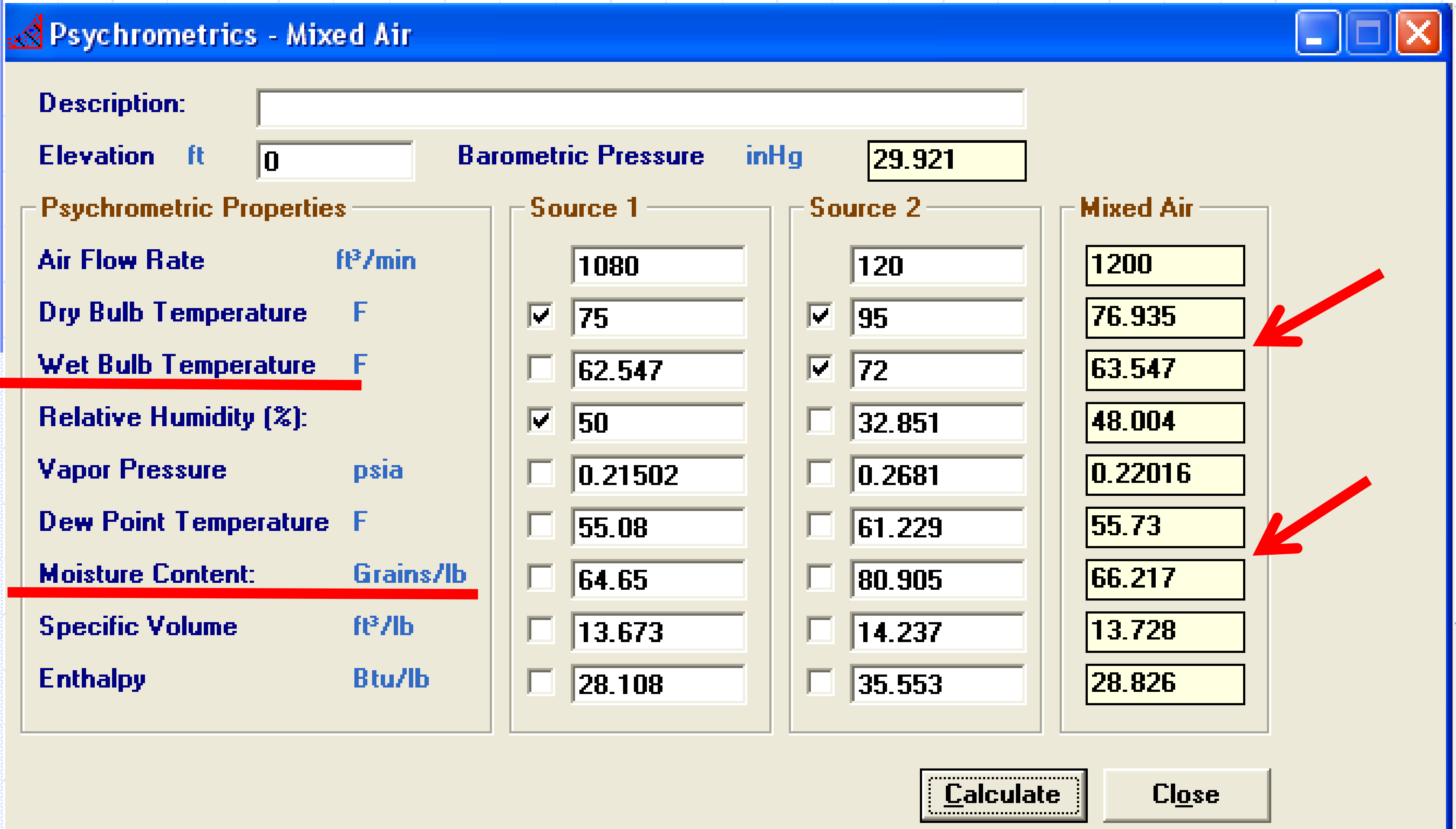
Get a Computer Program!

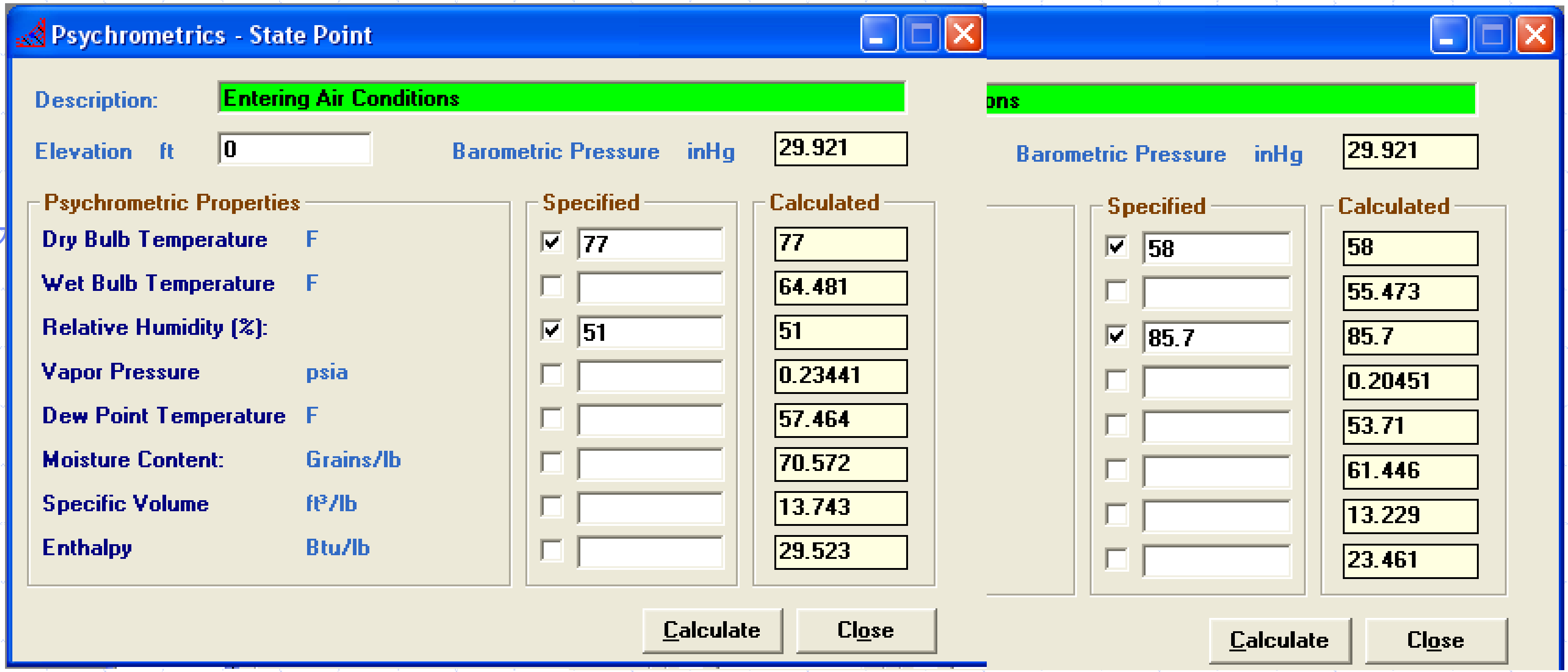


Indoor Design Conditions

CALCS-PLUS

Mixed Air Properties





Collect the Data

Measured Air Handler CFM	**980**
Return DB DBr	**77°**
Return WB or RH	**51%**
Supply DB DBs	**58°**
Supply WB or RH	**85.7%**
Suction Line Temperature SLT	**51°**

ΔDB across the Evaporator Coil	**19°**
Grains/Lb Difference ΔGR	**9.11**
CFM x 1.1 x ΔDB = BTU/H Sensible	
CFM x .68 x ΔGR = BTU/H Latent	
Evaporator Coil Temp ECT=(DBr – 35)	
Super Heat = SLT-ECT	
Entering Air WB Temperature	**64.5°**

CALCS-PLUS

Do the Math

ΔDB x CFM x 1.1 = BTU/H Sensible ____________
ΔGR x CFM x .68 = BTU/H Latent ____________

ΔDB across the Evaporator Coil	19°
Grains/Lb Difference ΔGR	9.11
CFM x 1.1 x ΔDB = BTU/H Sensible	20,482
CFM x .68 x ΔGR = BTU/H Latent	6,070
Evaporator Coil Temp ECT=(DBr – 35)	
Super Heat = SLT-ECT	
Entering Air WB Temperature	64.5°

980 x 1.1 x 19 = 20,482 BTU/H
980 x .68 x 9.11 = 6,070 BYU/H
Net Output 26,552 BTU/H

CALCS-PLUS
CALCS-PLUS

Do the Math

Evaporator Coil Temp ECT=(DBr – 35)

ΔDB across the Evaporator Coil	19°
Grains/Lb Difference ΔGR	9.11
CFM x 1.1 x ΔDB = BTU/H Sensible	20,482
CFM x .68 x ΔGR = BTU/H Latent	6,070
Evaporator Coil Temp ECT=(DBr – 35)	42°
Super Heat = SLT-ECT	51°
Entering Air WB Temperature	64.5°

Entering Dry Bulb (77) – 35° = 42

CALCS-PLUS

Compare the RESULTS

Collect the Data

Measured Air Handler CFM	**980**
Return DB DBr	**77°**
Return WB or RH	**51%**
Supply DB DBs	**58°**
Supply WB or RH	**85.7%**
Suction Line Temperature SLT	**51°**

ΔDB across the Evaporator Coil	**19°**
Grains/Lb Difference ΔGR	**9.11**
CFM x 1.1 x ΔDB = BTU/H Sensible	**20,482**
CFM x .68 x ΔGR = BTU/H Latent	**6,070**
Evaporator Coil Temp ECT=(DBr – 35)	**42°**
Super Heat = SLT-ECT	**51°**
Entering Air WB Temperature	**64.5°**

With System Performance Ratings

CALCS-PLUS

System Performance Rating ARI

The Air Conditioning and Refrigeration Institute (ARI, www.ari.org) defines the standards for air-conditioning design.

All equipment in the ARI directory is rated under the same conditions.

ARI testing Standards:

95° F Outdoor temperature

80° F Indoor temperature

50% Relative humidity

Outdoor Model	Indoor Model
2TTR3030A1	TWE031E13

Airflow = 1000

Values At ARI Rating Conditions

Total Net Capacity	=	27800	Btuh
Airflow	=	1020	CFM
Compressor Power	=	1970	watts
Indoor Fan Power	=	236	watts
Outdoor Fan Power	=	150	watts
S.E.E.R	=	14.00	

System Performance Rating Manual J Design

TRANE RS

PERFORMANCE DATA COOLING

February 10, 2007

-- U.S. (ENGLISH) --

(Capacities are net in btuh/1000 - indoor fan heat deducted)

Outdoor Model
2TTR3030A1

Indoor Model
TWE031E13

Airflow = 1000

Values At ARI Rating Conditions

Total Net Capacity	=	27800	Btuh
Airflow	=	1020	CFM
Compressor Power	=	1970	watts
Indoor Fan Power	=	236	watts
Outdoor Fan Power	=	150	watts
S.E.E.R	=	14.00	

Correction Factors - Other Airflows

Airflow	875	1125
Total Capacity	0.98	1.02
Sensible Capacity	0.94	1.06
Compressor Kw	0.99	1.01

Rated with 25 feet of 3/4 suction and 5/16 liquid lines.

	O.D.	I.D.	TOTAL	--SENSIBLE CAPACITY--				SYSTEM
	D.B	W.B.	CAP	72	75	78	80	KW
	85	59	26.0	21.3	23.9	26.0	26.0	2.11
	85	63	27.1	17.3	20.0	22.6	24.3	2.12
	85	67	29.2	15.4	15.4	18.9	20.7	2.16
	95	59	24.7	20.7	23.4	24.7	24.7	2.30
	95	63	25.7	16.7	19.4	22.0	23.8	2.31
	95	67	27.7	13.1	15.8	18.4	20.1	2.35
	105	63	24.3	16.2	18.8	21.4	23.2	2.51
	105	67	26.2	12.6	15.2	17.8	19.6	2.55
	105	71	28.3	8.9	11.6	14.2	15.9	2.57
	115	63	23.0	15.7	18.3	20.9	22.7	2.70
	115	67	24.7	12.0	14.7	17.3	19.0	2.75
	115	71	26.7	8.4	11.0	13.6	15.4	2.77
***	95	63	25.7	I.D.D.B =	75		19.4	2.31

Manual J Design Conditions:

95° F Outdoor temperature

75° F Indoor temperature

50% Relative humidity

O.D.	I.D.	TOTAL	--SENSIBLE CAPACITY--				SYSTEM
D.B	W.B.	CAP	72	75	78	80	KW
95	59	24.7	20.7	23.4	24.7	24.7	2.30
95	63	25.7	16.7	19.4	22.0	23.8	2.31
95	67	27.7	13.1	15.8	18.4	20.1	2.35

Collected Data

Measured Air Handler CFM		980
Return DB	DBr	77°
Return WB or RH		51%
Supply DB	DBs	58°
Supply WB or RH		85.7%
Suction Line Temperature	SLT	51°

ΔDB across the Evaporator Coil		19°
Grains/Lb Difference	ΔGR	9.11
CFM x 1.1 x ΔDB = BTU/H Sensible		20,482
CFM x .68 x ΔGR = BTU/H Latent		6,070
Evaporator Coil Temp ECT=(DBr – 35)		42°
Super Heat = SLT-ECT		51°
Entering Air WB Temperature		64.5°

O.D.	I.D.	TOTAL	--SENSIBLE CAPACITY--				SYSTEM
D.B	W.B.	CAP	72	75	78	80	KW
95	59	24.7	20.7	23.4	24.7	24.7	2.30
95	63	25.7	16.7	19.4	22.0	23.8	2.31
95	67	27.7	13.1	15.8	18.4	20.1	2.35

Thank You

Questions?