SYSTEM ANALYZER

DATE: ______________________ CUSTOMER NAME: ___________________________

TECHNICIAN: ________________ ADDRESS: ___________________________

COMPANY: __________________ ___________________________

PHONE: ____________________ PHONE: ___________________________

REASON FOR SERVICE CALL:

- ❑ SCHEDULED MAINTENANCE
- ❑ LOW (NO) COOLING
- ❑ LOW (NO) HEATING
- ❑ RAPID ON-OFF CYCLE
- ❑ SYSTEM WON'T START
- ❑ NOISES - ODORS
- ❑ FAULTY THERMOSTAT
- ❑ OTHER ____

____

✸ BE SAFE…

Working on air conditioning, refrigeration or heating systems means working on components that are pressurized, rotating, or either thermally or electrically **HOT**. Be sure to disconnect all electrical power before working on system. Utilize all safety procedures shown is printed instructions. **Don't take chances**.

✸ RECORD SYSTEM DATA: REFRIGERANT __________ LBS. ___________ TYPE

TABLE 1 - Unit Nameplate Information

INDOOR SECTION	OUTDOOR SECTION	PISTON USED
MODEL NO. _______________ SERIAL NO. _______________ MODEL NO. _______________ VOLTAGE ____ V ____ ϕ phase ACTUAL L1-L2 __________ CURRENT _______________ ACTUAL L1 - __________	MODEL NO. _______________ SERIAL NO. _______________ VOLTAGE ____ V ____ ϕ CURRENT _______________ ACTUAL L1-L2 __________ L2-L3 __________ L1-L3 __________ L1 - __________ L2 - __________ L3 - __________	INDOOR PISTON SIZE _____________ TXV PART NUMBER _____________

Notes:

❋ **MAKE VISUAL PRE-START INSPECTION and obtain any LED fault codes (SYSTEM NOT RUNNING). RECORD AND CORRECT OBVIOUS DEFECTS. *CAUTION:* DISCONNECT MUST BE OPEN, LOCKED, AND TAGGED After codes are recorded.**

- ❑ Check equipment log (2 SP) (Fault code no. On PC board) # Flashes_____
- ❑ Thermostat – Properly configured __________
- ❑ Refrigerant piping – Liquid line size_______ Vapor Line Size_______ Linear Length__________
  Inverted Trap ______ Properly sized__________ Buried – Yes or NO
  If yes; How far? ____________
- ❑ Vapor line insulated - ______ Piping accessories – List_______________________
- ❑ Strainer – Installed – Not Installed ❑ Plugged – Yes or No
- ❑ Evaporator Coil – Dirty or Clean
- ❑ TXV – Power head – Vertical _____ Bulb – Cap-tube at 12:00_______ See Appendix "B"
- ❑ Air Filters – Dirty or Clean
- ❑ Supply plenum or duct work restricted _________ ❑ Diffusers Restricted – Yes or No
- ❑ Condenser Coil – Dirty or Clean
- ❑ Blower/Fans – Dirty or Clean
- ❑ Condenser Air restricted – Yes or No
- ❑ Condensate lines Trapped – Primary – Yes or No – Secondary – Yes or No – Level – Yes or No
- ❑ Compressor – Water tracks______ Visible Oil level________ Discoloration______
  Burns or Arcing_____________ Terminals ______________
- ❑ Visible Refrigerant leaks – Yes or No – If Yes, where? _______________
- ❑ Liquid filter drier – Installed or Not Installed – Where? ____________
- ❑ **Suction** filter drier – Installed or Not Installed
- ❑ Crankcase heater – installed or Not Installed – Working? _______ Voltage - _______ Amps - _____

⌖ START SYSTEM AND CHECK BASIC OPERATION

> ***CAUTION:*** **Before starting System:**
> **Be sure disconnects are open, locked and tagged. Then**
> ❑ Install pressure gauge manifold. ❑ Position electrical meter alligator clip on terminals. (Do not attach directly to compressor terminals.)

❑ **Start System**
Restore power.

❑ **Voltage**
Obtain and record voltage readings of each phase in Table 2. Imbalance should not Exceed 2 percent IF 3 Ø See Appendix "A"

❑ **Amperage**
Obtain and record amperage reading for Each phase. (Imbalance should not exceed 10 percent) See appendix "A"

❑ **Sounds**
Listen for abnormal sounds. Check for excessive vibration of compressor, piping, motors, and fans.

❑ **Air Flow**
Check that all fans/motors are operational and moving proper amounts of air. See Appendix "A"

❑ **Shut system off if abnormal symptoms are noticed.**

⌖ MAKE SYSTEM OPERATIONAL CHECK

Allow system to stabilize for 30 minutes after startup. If system is in pull-down with extreme conditions it may not stabilize for several hours.

Measure, then record the following temperature and pressure readings in Table 4 on lines A thru T. Use system drawing below (Page 4) as reference for temperature/pressure reading points.

Determine possible system problem by comparing actual readings with typical readings found in Table 4. Apply them in the Quick System Analysis chart found on page 8 to further identify possible system problem.

☐ **SUPERHEAT**

Ⓐ Ⓑ Ⓒ

Compute the superheat by determining saturated suction temperature from Temperature-Pressure Chart on Page 5, and subtracting from actual suction line temperature.

☐ **SUBCOOLING**

Ⓓ Ⓔ Ⓖ

Compute sub cooling by subtracting liquid temperature entering TXV from saturated condensing temperature determined from Temperature-Pressure Chart on Page 5. Sub cooling is listed on unit rating plate.

Ⓗ **COMPRESSOR TEMPERATURES**

Measure temperature of hot gas discharge line near service valve. Temperatures exceeding 300° F cause oil and refrigerant to break down.

Ⓜ Record crankcase temperature. It should not exceed 125° F.

☐ **COMPRESSION RATIO**

Ⓟ Calculate the compression ratio by dividing absolute discharge pressure by absolute suction pressure.

Example: $\frac{260 \text{ psig} + 14.7 = 274.7}{70 \text{ psig} + 14.7 = 84.7} = 3.24 \text{ to } 1$

☐ **CAPACITY** (See Part 3)

Ⓠ Ⓡ Ⓣ

☐ Measure DB and WB temperatures entering and leaving evaporator, and DB temperatures entering and leaving condenser. Record values in Part 3.

☐ Use psychometric chart to determine evaporator ΔH (Btu/lb).

☐ For condensing unit capacity look up the condenser CFM in the presale literature. Subtract the heat of compression of 25-30% for reciprocating and 20-25% for scroll compressors.
Ex: BTUH = 1.10 X CFM X ΔT X .75

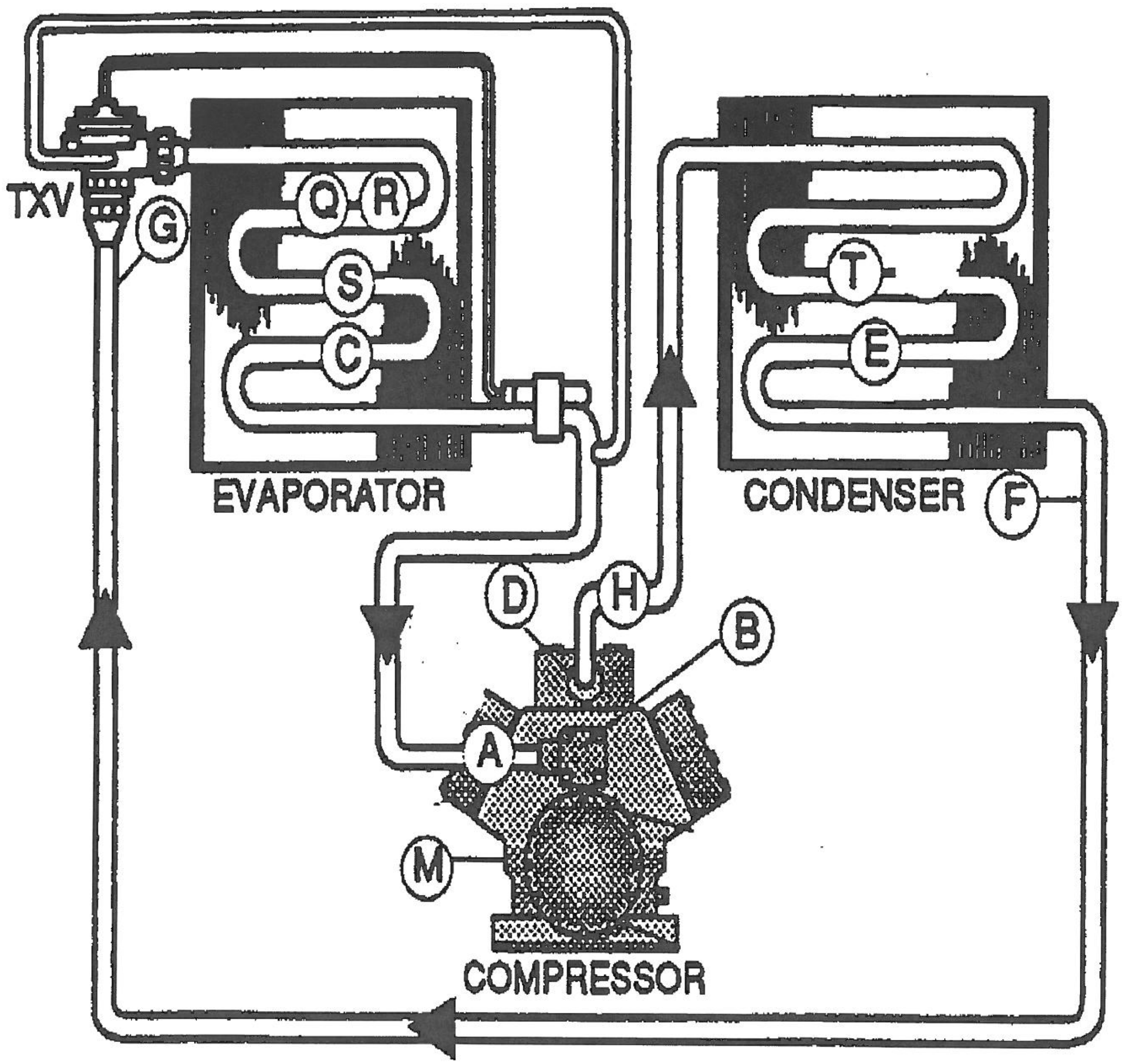
☐ Use formulas in Part 3 to calculate approximate evaporator and condenser capacities. Compare them to rated values.

Ⓢ Ⓣ - Capacity Quick Check

☐ Calculate temperature drop across evaporator and rise across condenser. Compare them to typical DB readings in Table 4.

✧ **PROCEED TO QUICK SYSTEM ANALYSIS CHART, PAGE 8, TO FURTHER IDENTIFY SYSTEM PROBLEM.**

⌑ ☐ **RECORD SYSTEM PROBLEM:**


TXV
G
Q
R
S
C
EVAPORATOR
T
E
CONDENSER
F
D
H
B
A
M
COMPRESSOR

PSIG	R-22	R-134A	R-410A	PSIG°	R-22	R-134A	R-410A
0	-41	-15	-60	78	46	75	20
2	-37	-10	-58	80	48	76	21
4	-32	-5	-54	85	51	79	24
6	-28	-1	-50	90	54	82	26
8	-24	3	-46	95	56	85	29
10	-20	7	-42	100	59	88	32
12	-17	10	-39	105	62	90	34
14	-14	13	-36	110	64	93	36
16	-11	16	-33	115	67	96	39
18	-8	19	-30	120	69	98	41
20	-5	22	-28	125	72	100	43
22	-3	25	-26	130	74	103	45
24	0	27	-24	135	76	105	47
26	2	30	-20	140	78	107	49
28	5	32	-18	145	81	109	51
30	7	35	-16	150	83	112	53
32	9	37	-14	160	87	116	57
34	11	39	-12	170	91	120	60
36	13	41	-10	180	94	123	64
38	15	43	-8	190	98	127	67
40	17	45	-6	200	101	131	70
42	19	47	-4	210	105	134	73
44	21	49	-3	220	108	137	76
46	23	51	-2	225	110	139	78
48	24	52	0	235	113	142	80
50	26	54	1	245	116	145	83
52	28	56	3	255	119	148	85
54	29	57	4	265	121	151	88
56	31	59	6	275	124	153	90
58	32	60	7	285	127	155	92
60	34	62	8	295	130	158	95
62	35	64	10	305	133	161	97
64	37	65	11	325	137	167	101
66	38	66	13	355	144	173	108
68	40	68	14	375	148	177	112
70	41	69	15	405	155	182	118
72	42	71	16	500	173	202	134
74	44	72	17	600	N/A	N/A	149
76	45	73	19	700	N/A	N/A	159

BEFORE PROCEEDING TO STEP 6, REVIEW TABLE 4 FOR "TYPICAL" OPERATING PRESSURES AND TEMPERATURES. THESE ARE FOR REFERENCE ONLY.

TABLE 2 - Compressor Electrical Data

From Compressor Nameplate:	- Compressor Data - VOLTAGE	CURRENT	RESISTANCE CHECK
	C-R ____	C ____	C-R ____
	1ϕ C-S ____	S ____	C-S ____
Type: ____	R-S ____	R ____	R-S ____
Model No. ____	L1-L2 ____	L1- ____	L1-L2 ____
	3ϕ L1-L3 ____	L2- ____	L1-L3 ____
Serial No.____	L2-L3 ____	L3 ____	L2-L3 ____

Part 3: System Capacity

Indoors Coil (Evaporator)

Dry Bulb Temperature – Entering Coil - ______Leaving Coil________ΔT________
Wet Bulb Temperature – Entering Coil - ______Leaving Coil________ΔT________
Enthalpy- Entering Coil - ______Leaving Coil________Δh______Btu/lb

***Evaporator Capacity**
BTUH = 4.5 X CFM X Δh

4.5 X _____ X ______ = ________BTUH

*Due to varying field test conditions, a tolerance of 10% must be expected when comparing test data to actual performance.

Condenser Capacity

Dry Bulb Temperature – Entering the Coil - ____________
Dry Bulb Temperature – **Leaving the Coil - ____________

**Take the leaving air temperature in 4 different locations at the fan outlet and average them for the actual leaving air temperature.

BTUH = 1.10 X Condenser CFM X ΔT X Heat of Compression

1.10 X ______ X _______ X _______ = _______BTUH

Condenser CFM obtained form Product Data Catalog, Heat of Compression = .75 (Scroll) .80 (Recip.)
*Due to varying field test conditions, a tolerance of 10% must be expected when comparing test data to actual performance.

Enthalpy Chart

Wet-Bulb	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Wet-Bulb
35	13.01	13.05	13.09	13.14	13.18	13.22	13.27	13.31	13.35	13.40	35
36	13.44	13.48	13.53	13.57	13.61	13.66	13.70	13.74	13.79	13.83	36
37	13.87	13.92	13.96	14.01	14.05	14.10	14.14	14.19	14.23	14.28	37
38	14.32	14.36	14.41	14.45	14.50	14.54	14.59	14.64	14.68	14.73	38
39	14.77	14.82	14.86	14.91	14.96	15.00	15.05	15.09	15.14	15.18	39
40	15.23	15.28	15.32	15.37	15.42	15.47	15.51	15.56	15.61	15.65	40
41	15.70	15.75	15.80	15.84	15.89	15.94	15.99	16.04	16.08	16.13	41
42	16.17	16.22	16.27	16.32	16.37	16.42	16.46	16.51	16.56	16.61	42
43	16.66	16.71	16.76	16.80	16.85	16.90	16.95	17.00	17.05	17.10	43
44	17.15	17.20	17.25	17.30	17.35	17.40	17.45	17.50	17.55	17.60	44
45	17.65	17.70	17.75	17.80	17.85	17.91	17.96	18.01	18.06	18.11	45
46	18.16	18.21	18.26	18.32	18.37	18.42	18.47	18.52	18.58	18.63	46
47	18.68	18.73	18.79	18.84	18.89	18.95	19.00	19.05	19.10	19.16	47
48	19.21	19.26	19.32	19.37	19.43	19.48	19.53	19.59	19.64	19.70	48
49	19.75	19.81	19.86	19.92	19.97	20.03	20.08	20.14	20.19	20.25	49
50	20.30	20.36	20.41	20.47	20.53	20.58	20.64	20.69	20.75	20.81	50
51	20.86	20.92	20.98	21.03	21.09	21.15	21.21	21.26	21.32	21.38	51
52	21.44	21.49	21.55	21.61	21.67	21.73	21.78	21.84	21.90	21.96	52
53	22.02	22.08	22.14	22.20	22.26	22.32	22.38	22.44	22.50	22.56	53
54	22.62	22.68	22.74	22.80	22.86	22.92	22.98	23.04	23.10	23.16	54
55	23.22	23.28	23.34	23.41	23.47	23.53	23.59	23.65	23.72	23.78	55
56	23.84	23.90	23.97	24.03	24.10	24.16	24.22	24.29	24.35	24.42	56
57	24.48	24.54	24.61	24.67	24.74	24.80	24.86	24.93	24.99	25.06	57
58	25.12	25.19	25.25	25.32	25.38	25.45	25.52	25.58	25.65	25.71	58
59	25.78	25.85	25.92	25.98	26.05	26.12	26.19	26.26	26.32	26.39	59
60	26.46	26.53	26.60	26.67	26.74	26.81	26.87	26.94	27.01	27.08	60
61	27.15	27.22	27.29	27.36	27.43	27.50	27.57	27.64	27.70	27.78	61
62	27.85	27.92	27.99	28.07	28.14	28.21	28.28	28.35	28.43	28.50	62
63	28.57	28.64	28.72	28.79	28.87	28.94	29.01	29.09	29.16	29.24	63
64	29.31	29.39	29.46	29.54	29.61	29.62	29.76	29.83	29.91	29.98	64
65	30.06	30.14	30.21	30.29	30.37	30.45	30.52	30.60	30.68	30.75	65
66	30.83	30.91	30.99	31.07	31.15	31.23	31.30	31.38	31.46	31.54	66
67	31.62	31.70	31.78	31.86	31.94	32.02	32.10	32.18	32.26	32.34	67
68	32.42	32.50	32.59	32.67	32.75	32.84	32.92	33.00	33.08	33.17	68
69	33.25	33.33	33.42	33.50	33.59	33.67	33.75	33.84	33.92	34.01	69
70	34.09	34.18	34.26	34.35	34.43	34.52	34.61	34.69	34.78	34.86	70
71	34.95	35.04	35.13	35.21	35.30	35.39	35.48	35.57	35.65	35.74	71
72	35.83	35.92	36.01	36.10	36.19	36.28	36.38	36.47	36.56	36.65	72
73	36.74	36.83	36.92	37.02	37.11	37.20	37.29	37.38	37.48	37.57	73
74	37.66	37.76	37.85	37.95	38.04	38.14	38.23	38.33	38.42	38.51	74
75	38.61	38.71	38.80	38.90	39.00	39.09	39.19	39.28	39.38	39.47	75
76	39.57	39.67	39.77	39.87	39.97	40.07	40.17	40.27	40.37	40.47	76
77	40.57	40.67	40.77	40.87	40.97	41.08	41.18	41.28	41.38	41.48	77
78	41.58	41.68	41.79	41.89	42.00	42.10	42.20	42.31	42.41	42.52	78
79	42.62	42.73	42.83	42.94	43.05	43.16	43.26	43.37	43.48	43.58	79
80	43.69	43.80	43.91	44.02	44.13	44.24	44.34	44.45	44.56	44.67	80

Table 4 – Typical operating pressures and temperatures
(Caution: Check Manufacturer Recommendations)

MEASUREMENTS (OUTDOOR AIR TEMPERATURE 85-95°F)	R-22	R-134A	R-410A	Actual System Readings
(A) Suction Line Temperature °F	51 - 53	51 - 53	62 - 66	
(B) Suction Pressure psig	68 - 72	37 -41	136 - 142	
(C) Sat Suction Temperature °F (Superheat: TXV Line A-C) (°F) (Superheat: Non-TXV Line A-C) (°F) Note: Non-TXV use Superheat Charging Chart	41 (10-12) (5 –45)	41 - 46 (10-12)	48 - 51 (10-14) (5 – 45)	
(D) Discharge Pressure psig	260	168	380	
(E) Sat Cond. Temperature °F	120	118	113	
(F) Liquid Temp Leaving Condenser °F	112	103	104	
(G) Liquid Temp Entering TXV °F (Sub-cooling: Line E-G) (°F) Note: Does not apply to Non-TXV	110 See rating plate	101 See rating plate	102 See rating plate	
(H) Hot Gas Discharge Line Temp °F	180 - 200	134 - 150	161 - 165	
(M) Crankcase Temp °F	90 - 135	100 - 125	100 - 108	
(P) Compression Ratio	2:1 to 4:1	3:1 to 4:1	2:1 to 3:1	
(Q) Air Entering Evaporator WB°F / DB°F	61 to 66 / 72 to 80	61 to 66 / 72 to 80	61 to 66 / 72 to 80	
(R) Air Leaving Evaporator WB°F/DB°F	54 to 60 53 to 59	54 to 60 53 to 59	54 to 60 53 to 59	
(S) Air Temp Drop Across Evaporator DB°F	16 to 20	16 to 20	16 to 20	
(T) Outdoor Air Temp Rise Across Condenser (DB) Hi Effic	15 to 20	15 to 20	15 to 20	
(T) Outdoor Air Temp Rise Across Condenser (DB) STD	20 to 30	20 to 30	20 to 30	

NOTES:

QUICK SYSTEM ANALYSIS

SYSTEM PROBLEM	OPERATING TRENDS (LOW-NORMAL-HIGH														
	SUCTION PRESSURE			DISCHARGE PRESSURE			SUPERHEAT			SUBCOOLING			AMPERES		
	L	N	H	L	N	H	L	N	H	L	N	H	L	N	H
Overcharge			●			●	●					●			●
Condenser (Air) Restricted			●			●	●			●					●
Non-Condensibles in System			●			●	●			●					●
High Evaporator Load			●			●		●			●				●
Loose TXV Feeler Bulb - Oversized TXV - Leaking TXV Seat - Wrong Equalizer Connection - Uninsulated Feeler Bulb			●			●	●			●					●
Undercharge	●			●					●	●			●		
Liquid Line Restriction	●			●					●			●	●		
Low Outdoor Ambient	●			●					●			●	●		
Suction Line Restriction	●			●					●			●	●		
Evaporator Air (Cooler Liquid) Restricted	●			●			●					●	●		
Undersized TXV - Leaking Feeler Bulb - No External Equalizer	●			●					●			●	●		
Inefficient Compressor			●	●					●			●	●		
ACTUAL SYSTEM OPERATION (▤)															

INSTRUCTIONS: Compare actual system operating condition (Step 6) with Typical Readings in Table 4. Record actual system readings in Analysis Chart above by inserting a • under Low-Normal-High columns. Read upward and left to determine possible system problem

NOTES:

Appendix "A"

Voltage Imbalance

Take a voltage reading between L1 to L2 and L1 to L3, and L2 to L3. Average these readings. Subtract the average from the 3 voltages readings to obtain the maximum deviation. Divide the average from the maximum deviation then multiply by 100 to get Voltage imbalance

Example: L1 – L2 = 248, L1 – L3 = 253, L2 – L3 = 246
747 ÷ 3 = 249 average
249 – 248 = 1
253 – 249 = 4
249 – 246 = 3
(4 ÷ 249) X 100 = 1.6% Voltage imbalance

Current Imbalance

Take the amperages from L1, L2, and L3. Average these readings. Subtract The average from the 3 amperages to obtain the maximum deviation. Divide the average from the maximum deviation them multiply by 100 to get current imbalance.

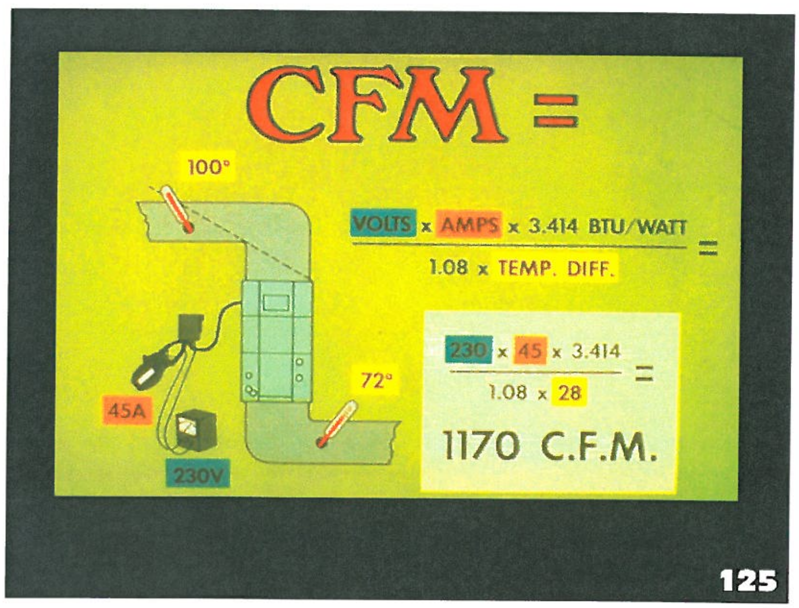
Example:
L1 = 78
L2 = 76
L3 = 71
225 ÷ 3 = 75
L1 78 – 75 = 3
L2 76 – 75 = 1
L3 75 – 71 = 4
(4 ÷ 75) x 100 = 5.3%

Appendix "A" cont.

Airflow Checks; There are several ways to check airflow. In order to properly check capacity you must know the CFM of the system you are working on. The following are some of the ways to check airflow.

1. Air-hood – measure all supply air grills.
2. External Static – measure the external static of the air-handling unit and obtain the CFM for the Product Data Catalog. Use plenum not in the package unit panel.
3. Temperature Rise – measure the temperature rise of the air-handler system in the cooling airflow setting. Electric heat example: obtain the voltage and amperage with all the heat strips on and the blower set up on the cooling airflow speed. Take the temperature rise (out of site of the heating source). Multiply the Voltage by the amperage to obtain the Watts (Ohms Law). Multiply by 3.414 BTU's/Watt. Multiply 1.10 by Temperature Rise. Divide the temperature by the BTU's to obtain the CFM.

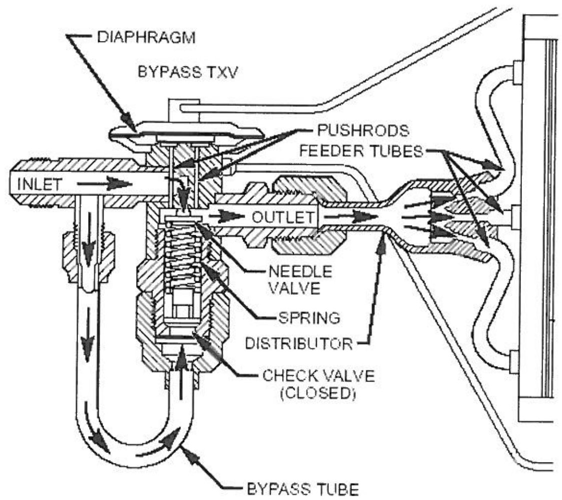
Example:



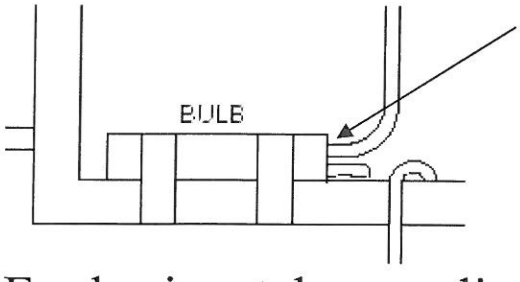
Appendix "B"

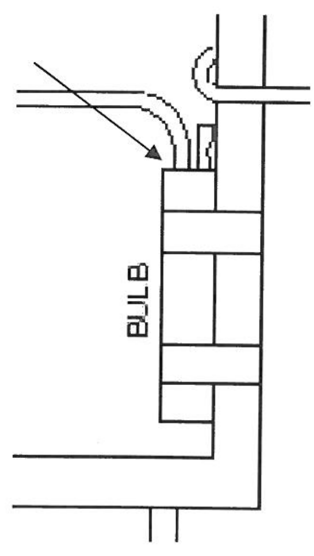
TXV and TXV Bulb positions.

The TXV should be mounted with the Diaphragm in the "UP" position.



The TXV Bulb should be mounted so that the capillary tube to the diaphragm is in the 12:00 position on the vapor line.





For horizontal vapor lines;
7/8" or smaller locate the bulb at 10:00 or 2:00
1 1/8" or larger locate the bulb at 8:00 or 4:00