TROUBLESHOOTING OF A GEOTHERMAL HEAT PUMP

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DIAGNOSTIC PERFORMANCE CHECK

When to use refrigerant gauges?

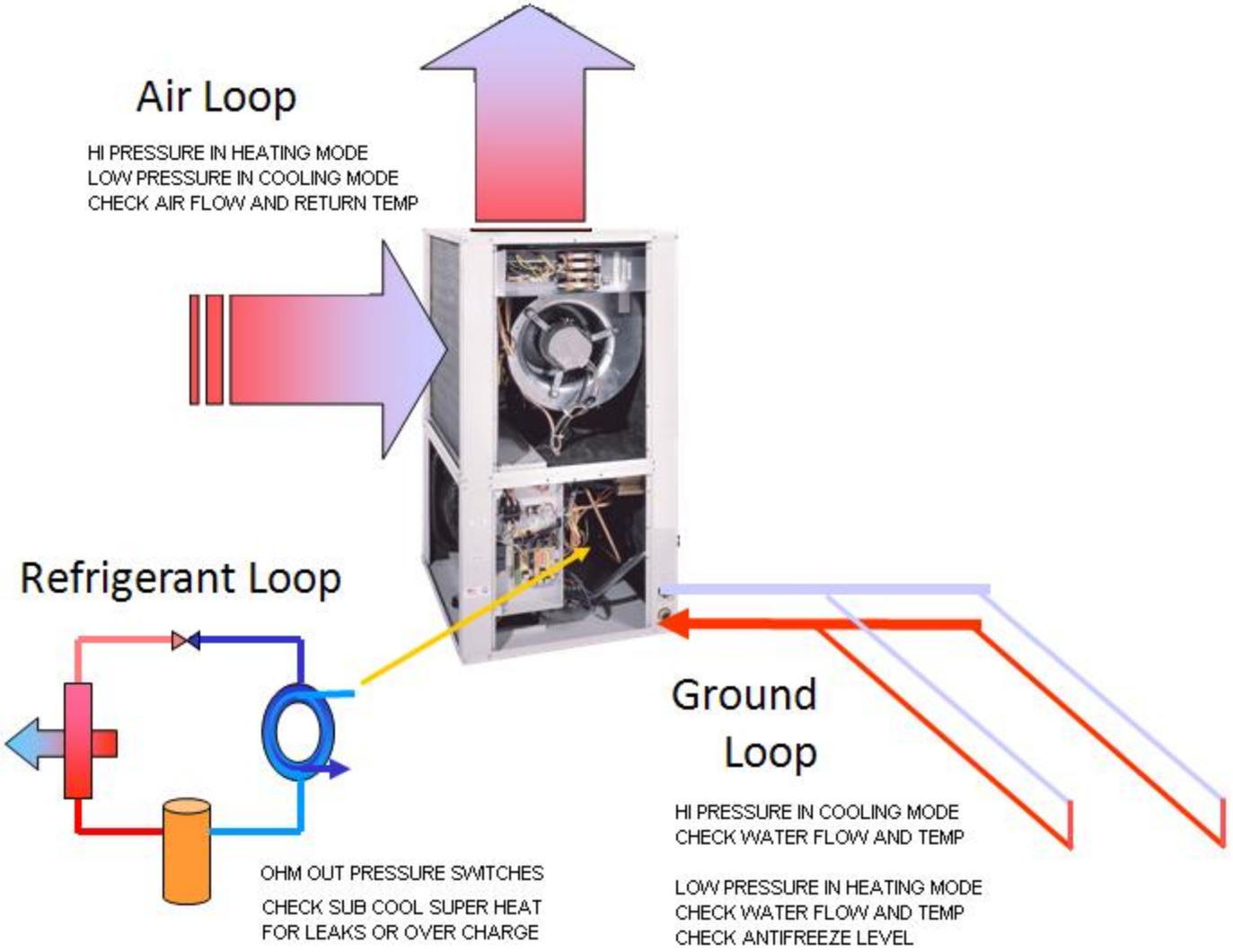
If water side performance check is out of range and external factors are ruled out.

Air flow, Water flow, and

Operating conditions.

Always check heat of extraction and rejection before installing gauges

HIGH AND LOW PRESSURE FAULTS



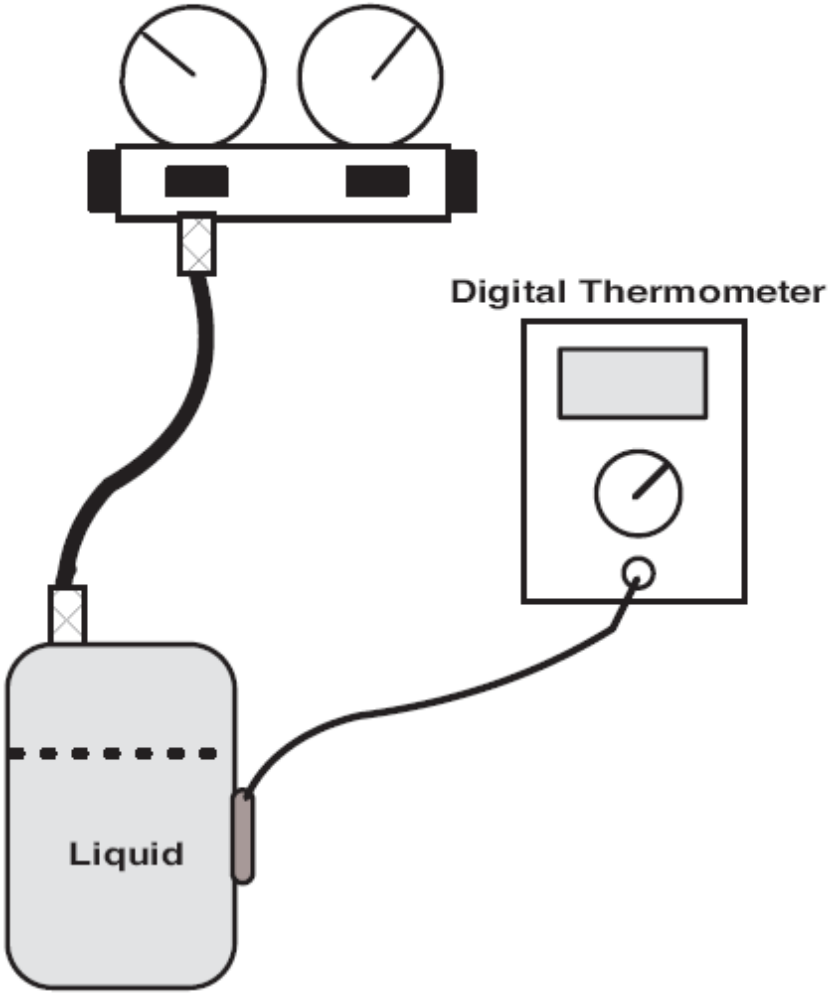
Refrigeration Troubleshooting

Figure 13: Calibrating Service Gauges

Note: Do this with two different temperature/pressure refrigerant samples for best gauge adjustment and accuracy.

Procedure:

1. Mount digital thermometer sensor at liquid portion of cylinder to read an accurate temperature.
2. Once the temperature is known, use the P/T chart to convert known refrigerant temperature to proper refrigerant pressure (PSI).
3. Adjust service gauge to match known pressure at that temperature.
4. This procedure needs to be repeated again, against another known temperature and pressure to verify gauge is properly calibrated.



R410A - R22

(°F)	PSIG		(°F)	PSIG		(°F)	PSIG		(°F)	PSIG		(°F)	PSIG	
	R410A	R22		R410A	R22		R410A	R22		R410A	R22		R410A	R22
-40	11.6	0.5	0	48.7	23.9	40	118.0	68.5	80	235.3	143.6	120	417.7	259.8
-39	12.2	0.9	1	49.9	24.8	41	120.3	69.9	81	239.0	145.9	121	423.2	263.4
-38	12.9	1.3	2	51.2	25.6	42	122.6	71.4	82	242.7	148.3	122	428.8	266.9
-37	13.5	1.7	3	52.5	26.4	43	125.0	72.9	83	246.5	150.7	123	434.5	270.5
-36	14.2	2.2	4	53.8	27.3	44	127.3	74.5	84	250.3	153.2	124	440.2	274.2
-35	14.9	2.6	5	55.2	28.2	45	129.7	76.0	85	254.1	155.6	125	445.9	277.9
-34	15.6	3.0	6	56.6	29.1	46	132.3	77.6	86	258.0	158.1	126	451.8	281.6
-33	16.3	3.5	7	58.0	30.0	47	134.6	79.1	87	262.0	160.6	127	457.6	285.3
-32	17.0	3.9	8	59.4	30.9	48	137.1	80.7	88	266.0	163.2	128	463.5	289.1
-31	17.8	4.4	9	60.9	31.8	49	139.6	82.4	89	270.0	165.8	129	469.5	292.9
-30	18.5	4.9	10	62.3	32.8	50	142.2	84.0	90	274.1	168.4	130	475.6	296.7
-29	19.3	5.4	11	63.8	33.7	51	144.8	85.7	91	278.2	171.0	131	481.6	300.6
-28	20.1	5.8	12	65.4	34.7	52	147.4	87.3	92	282.3	173.6	132	487.8	304.5
-27	20.9	6.4	13	66.9	35.7	53	150.1	89.1	93	286.5	176.3	133	494.0	308.5
-26	21.7	6.9	14	68.6	36.7	54	152.8	90.8	94	290.8	179.0	134	500.2	312.0
-25	22.5	7.4	15	70.0	37.7	55	155.6	92.5	95	295.1	181.7	135	506.5	316.0
-24	23.4	7.9	16	71.7	38.7	56	158.2	94.3	96	299.4	184.5	136	512.9	320.0
-23	24.2	8.5	17	73.3	39.8	57	161.0	96.1	97	303.8	187.3	137	519.3	324.0
-22	25.1	9.0	18	75.0	40.8	58	163.9	97.9	98	308.2	190.1	138	525.8	328.0
-21	26.0	9.6	19	76.6	41.9	59	166.7	99.7	99	312.7	193.0	139	532.4	333.0
-20	26.9	10.1	20	78.3	43.0	60	169.6	101.6	100	317.2	195.9	140	539.0	337.0
-19	27.8	10.7	21	80.1	44.1	61	172.6	103.5	101	321.8	198.8	141	545.6	341.0
-18	28.7	11.3	22	81.8	45.3	62	175.5	105.4	102	326.4	201.7	142	552.3	345.0
-17	29.7	11.9	23	83.6	46.4	63	178.5	107.3	103	331.0	204.7	143	559.1	350.0
-16	30.7	12.5	24	85.4	47.6	64	181.6	109.2	104	335.7	207.7	144	565.9	354.0
-15	31.7	13.2	25	87.3	48.7	65	184.3	111.2	105	340.5	210.7	145	572.8	358.0
-14	32.7	13.8	26	89.1	49.9	66	187.7	113.2	106	345.3	213.8	146	579.8	363.0
-13	33.7	14.4	27	91.0	51.1	67	190.9	115.2	107	350.1	216.8	147	586.8	367.0
-12	34.7	15.1	28	92.9	52.4	68	194.1	117.2	108	355.0	222.0	148	593.8	372.0
-11	35.8	15.8	29	94.9	53.6	69	197.3	119.3	109	360.0	223.1	149	601.0	376.0
-10	36.8	16.5	30	96.8	54.9	70	200.6	121.4	110	365.0	226.3	150	608.1	381.0
-9	37.9	17.2	31	98.8	56.2	71	203.9	123.5	111	370.0	229.5	151	615.4	386.0
-8	39.0	17.9	32	100.8	57.5	72	207.2	125.6	112	375.1	232.7	152	622.7	390.0
-7	40.2	18.6	33	102.9	58.8	73	210.6	127.8	113	380.2	236.0	153	630.1	395.0
-6	41.3	19.3	34	105.0	60.1	74	214.0	130.0	114	385.4	239.3	154	637.5	400.0
-5	52.4	20.0	35	107.1	61.5	75	217.4	132.2	115	390.7	242.7	155	645.0	405.0
-4	43.7	20.8	36	109.2	62.8	76	220.9	134.4	116	396.0	246.0	156	652.5	409.0
-3	44.9	21.6	37	111.4	64.2	77	224.4	136.7	117	401.3	249.4	157	660.2	414.0
-2	46.1	22.4	38	113.6	65.6	78	228.0	138.9	118	406.7	252.9	158	667.3	419.0
-1	47.3	23.1	39	115.8	67.0	79	231.6	141.3	119	412.2	256.3	159	675.6	424.0
11/16/05vcb												160	683.4	429.0

Typical Operating Condition Chart

When checking need to know EWT

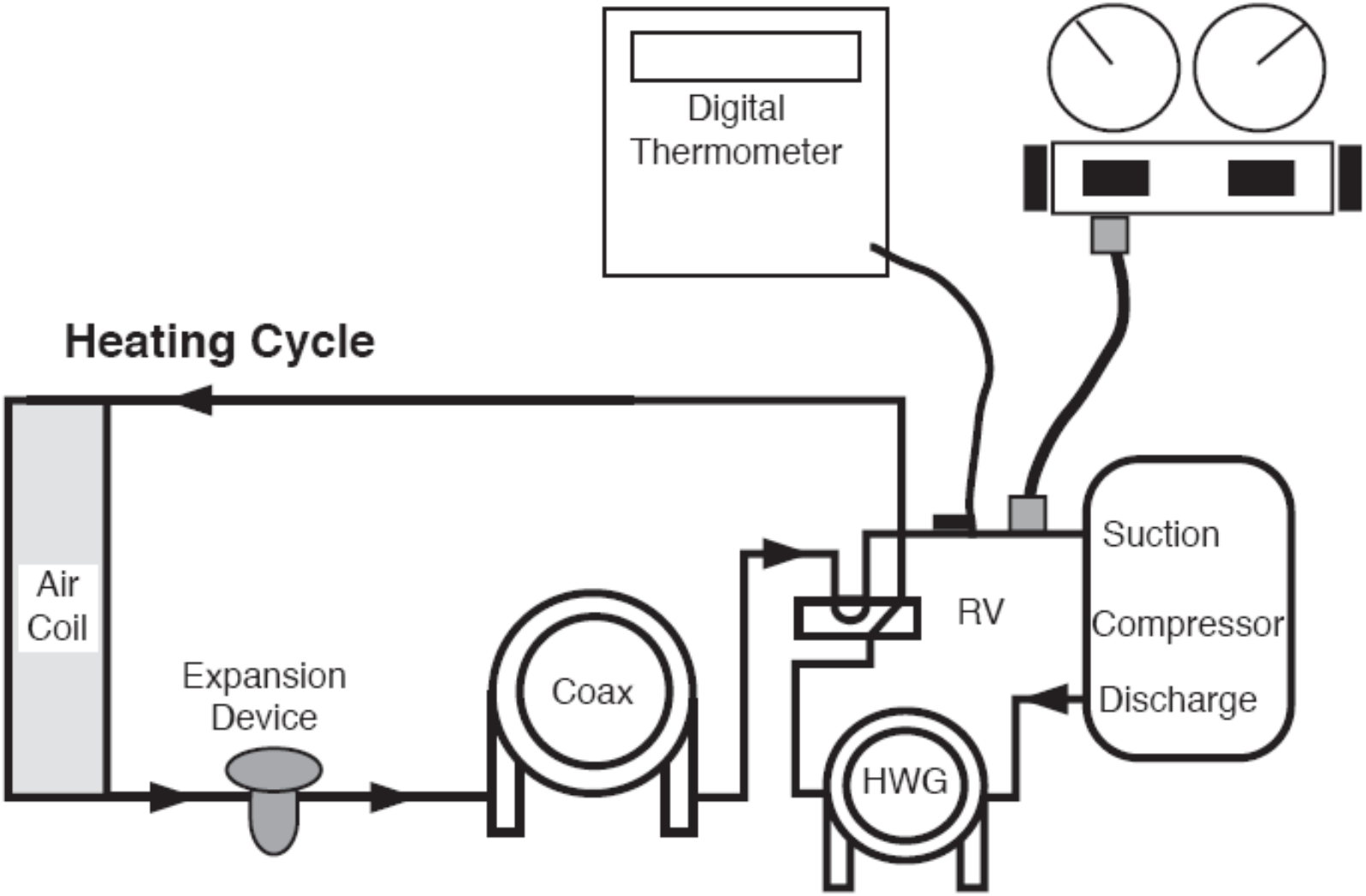
038		Full Load Cooling - without HWG active						Full Load Heating - without HWG active					
Entering Water Temp F	Water Flow GPM/ton	Suction Pressure PSIG	Discharge Pressure PSIG	Super-heat	Sub-cooling	Water Temp Rise F	Air Temp Drop F DB	Suction Pressure PSIG	Discharge Pressure PSIG	Super-heat	Sub-cooling	Water Temp Drop F	Air Temp Rise F DB
30	1.5	120-130	156-176	25-30	9-14	22.1-24.1	18-24	69-79	293-313	7-12	14-19	8.9-10.9	17-23
	2.25	119-129	148-168	25-30	8-13	16.8-18.8	19-25	73-83	297-317	7-12	14-19	6.7-8.7	18-24
	3	119-129	138-158	25-30	8-13	10.5-12.5	19-25	76-86	300-320	7-12	14-19	4.5-6.5	19-25
50	1.5	129-139	225-245	15-20	10-15	21.9-23.9	18-24	96-106	322-342	10-15	17-22	12.2-14.2	23-29
	2.25	128-138	211-231	15-20	9-14	16.1-18.1	19-25	100-110	326-346	10-15	17-22	9.3-11.3	24-30
	3	128-138	197-217	15-20	9-14	10.3-12.3	19-25	105-115	331-351	10-15	17-22	6.4-8.4	24-30
70	1.5	136-146	302-322	9-14	13-18	21.5-23.5	18-24	123-133	352-372	11-16	19-24	15-17	28-35
	2.25	135-145	283-303	9-14	12-17	15.8-17.8	19-25	129-139	358-378	11-16	19-24	11.6-13.6	29-36
	3	135-145	265-285	9-14	12-17	10-12	19-25	135-145	364-384	11-16	19-24	8.2-10.2	30-37
90	1.5	140-150	390-410	7-12	13-18	20.5-22.5	17-23	157-167	390-410	13-18	18-23	21-23	36-44
	2.25	140-150	369-389	8-13	8-13	14.9-16.9	17-23	169-179	399-419	13-18	16.5-21.5	15.5-17.5	37-45
	3	140-150	349-369	8-13	8-13	9.3-11.3	17-23	181-191	408-428	14-19	15-20	10.5-12.5	39-47
110	1.5	145-155	488-508	7-12	13-18	19-21	17-23						
	2.25	145-155	467-487	8-13	8-13	14-16	17-23						
	3	145-155	447-467	8-13	8-13	9-11	17-23						

Look in Installation, Operation & Maintenance Manual for unit operating chart for the unit your working on

IOM: A 39

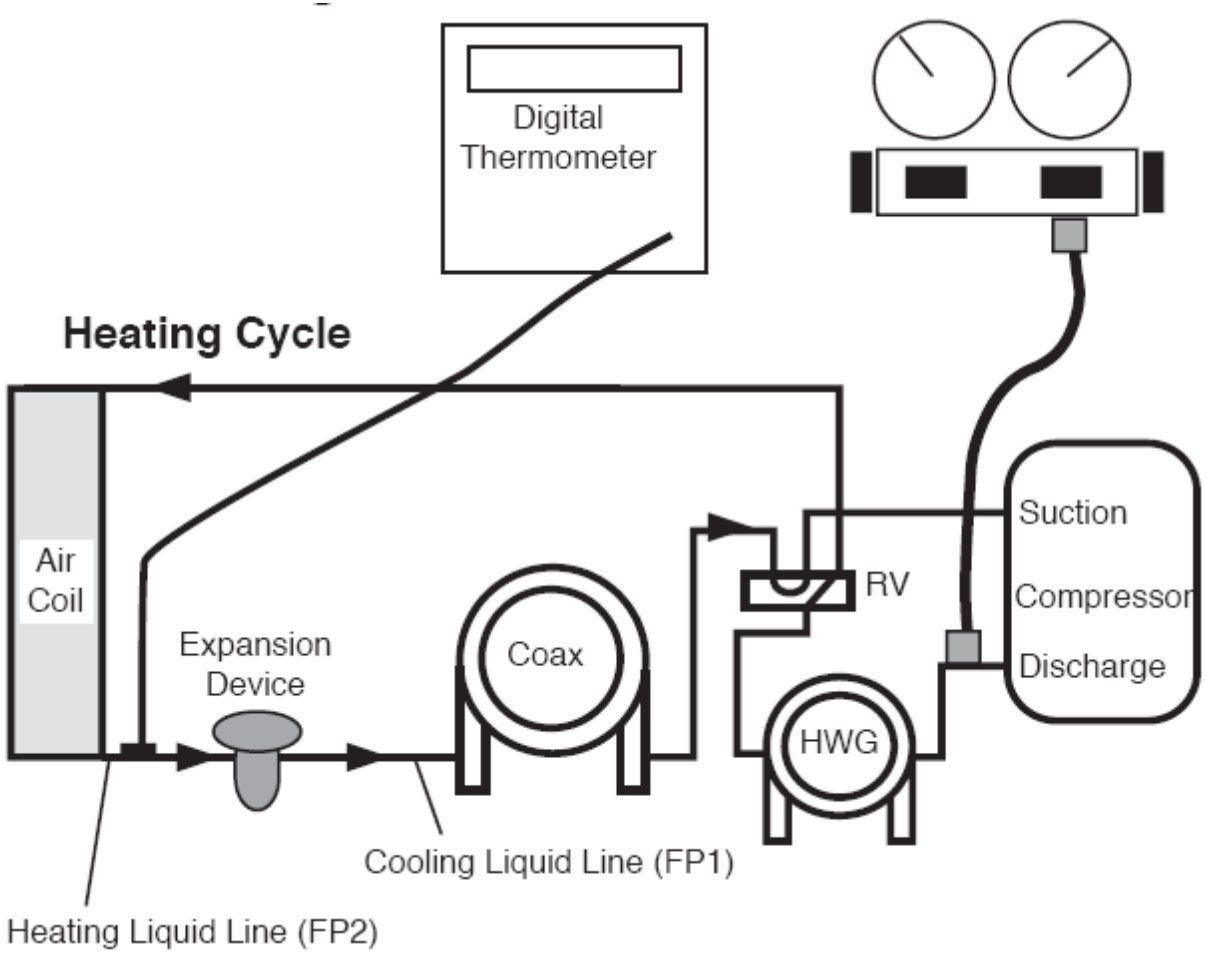
Measuring SuperHeat

Suction Line Temperature (-) minus Suction Saturation Temperature



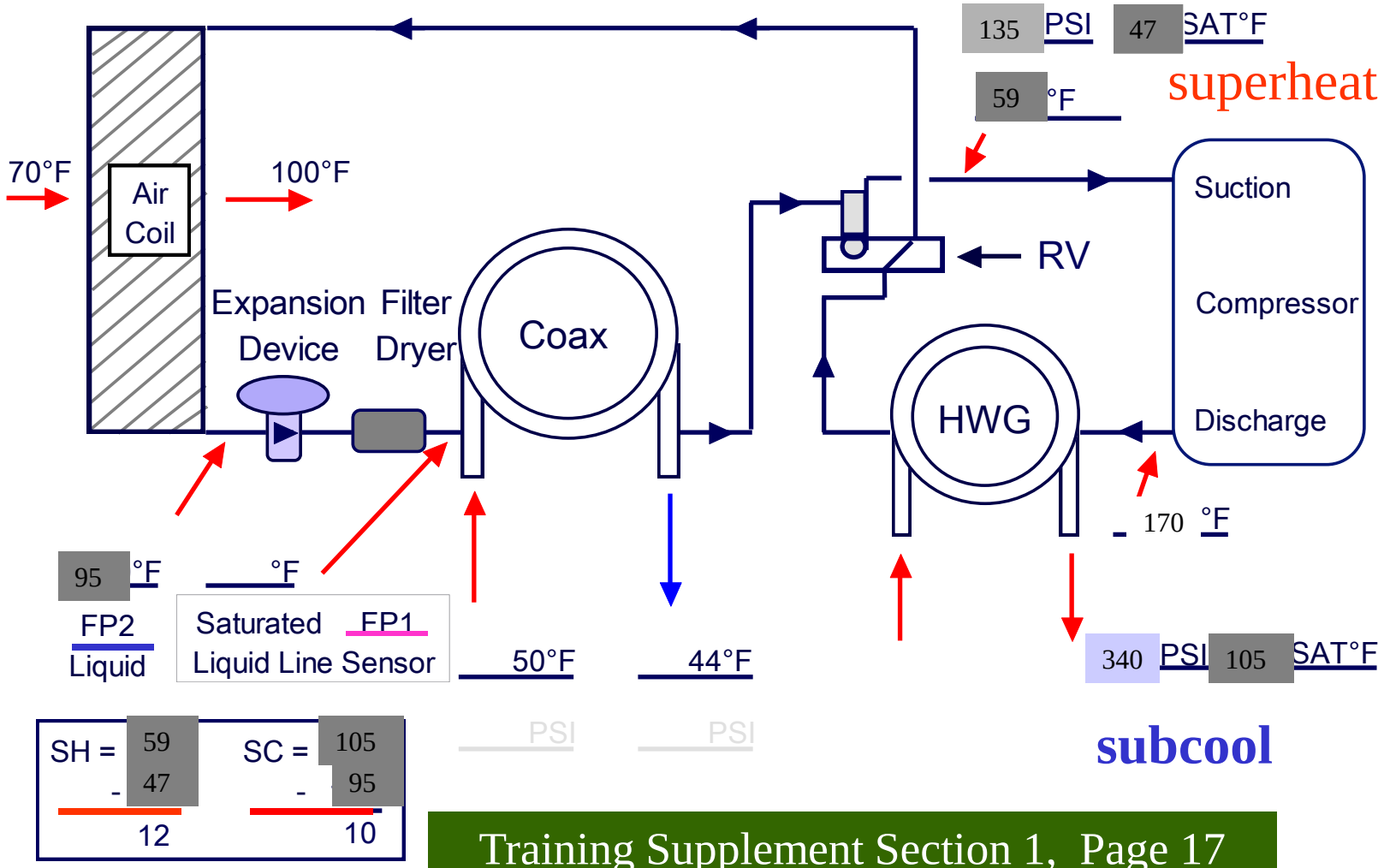
Measuring Subcooling

Subcooling = High Pressure Saturation Temperature (-) minus Liquid Line Temperature



Properly Charged

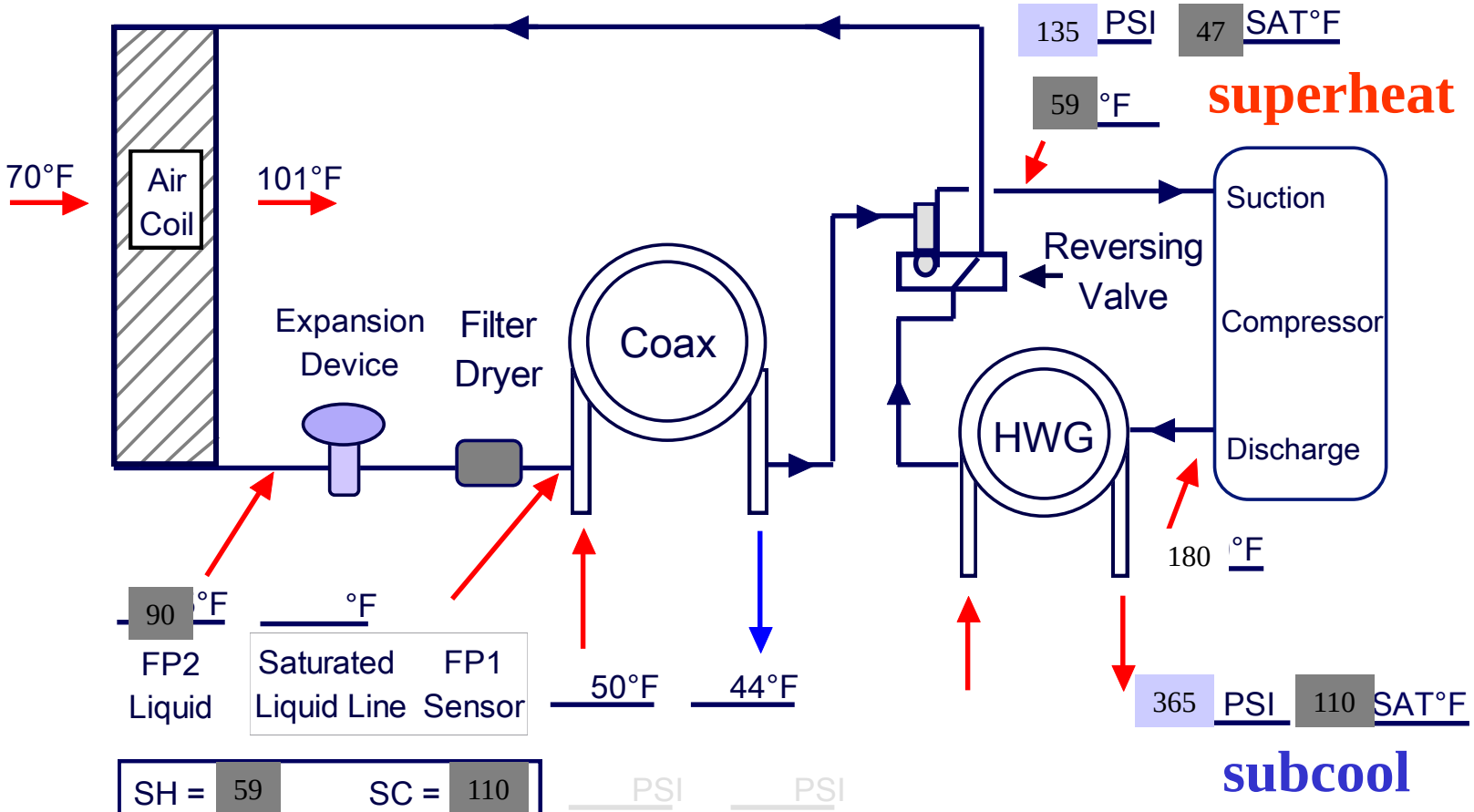
TXV System – Heating Cycle



12/22/05Rev2vcb

Over Charged

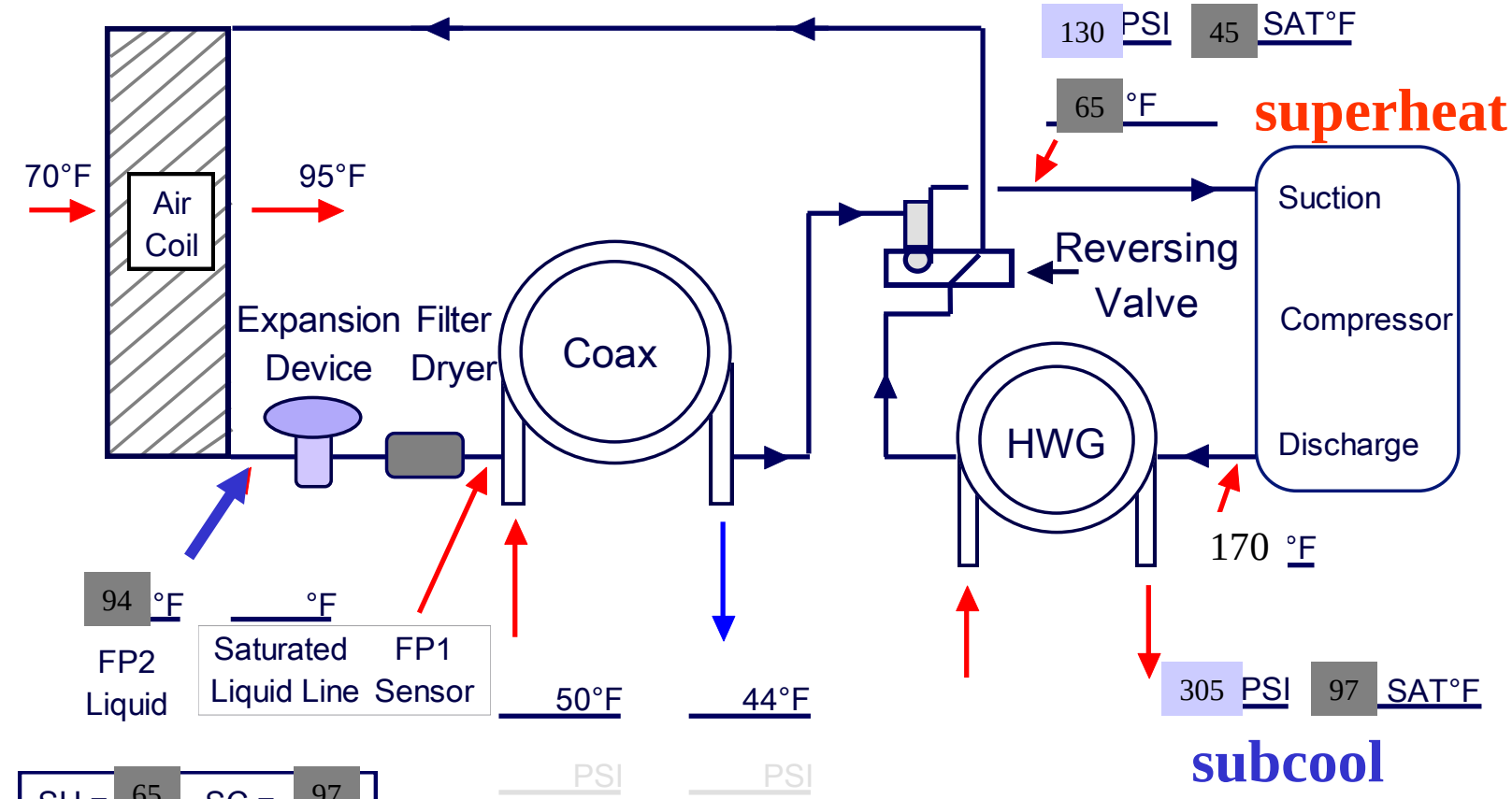
TXV System – Heating Mode



Note SH
Is the same

Under Charged

TXV System – Heating Mode



12/23/05Rev2vcb

Thermostatic Expansion Valve (TXV)

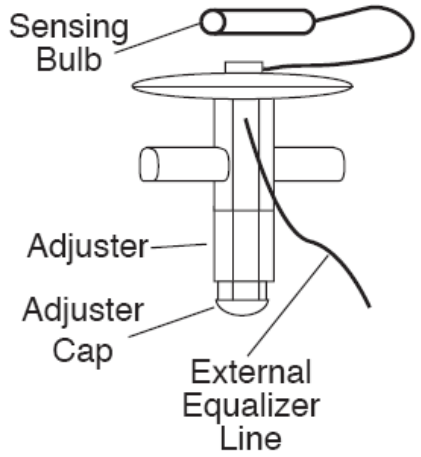
What Are Thermostatic Expansion Valves

Thermostatic expansion valves are in essence a mechanical variable orifice. The valve measures superheat and adjusts refrigerant flow to allow a specified superheat at the compressor. The valve uses the following to measure superheat:

- Bulb pressure (to estimate suction line temperature)
- Suction line pressure
- Spring pressure (as superheat adjustment)

Figure 6 shows a cross section of a thermostatic expansion valve for reference.

Figure 14: Adjusting TXVs



Thermostatic Expansion Valve (TXV) Troubleshooting

Overcharged System
- High subcooling
- Superheat will be maintained by expansion valve at valve setting
- Basically no change in capacity

Undercharged System
- Low subcooling
- High superheat
- Lower capacity

TXV Stuck Closed (or Restriction)
- High superheat
- High subcooling

TXV Stuck Open
- Low superheat
- Low subcooling

REFRIGERATION GUIDE

TROUBLESHOOTING	HEAD PRESSURE	SUCTION PRESSURE	COMP AMP DRAW	SUPER HEAT	SUB COOLING	AIR DELTA T	WATER DELTA T
LOW AIR FLOW HEATING	HIGH	HIGH	HIGH	HIGH/NORMAL	LOW	HIGH	LOW
LOW WATER FLOW HEATING	LOW/NORMAL	LOW/NORMAL	LOW	LOW	HIGH	LOW	HIGH
LOW EAT HEATING	LOW	LOW	LOW	NORMAL	HIGH	NORMAL	HIGH/NORMAL
HIGH EAT HEATING	HIGH	HIGH	HIGH	NORMAL/HIGH	NORMAL/LOW	LOW	NORMAL
HIGH AIR FLOW HEATING	LOW	LOW	LOW	LOW	HIGH	LOW	LOW
HIGH WATER FLOW HEATING	NORMAL	LOW	NORMAL	HIGH	NORMAL	NORMAL	LOW
SCALED COAXIAL HEATING	LOW	LOW	LOW	NORMAL/LOW	HIGH	LOW	LOW
LOW AIR FLOW COOLING	LOW	LOW	LOW	LOW/NORMAL	HIGH	HIGH	LOW
LOW WATER FLOW COOLING	HIGH	HIGH	HIGH	HIGH	LOW	LOW	HIGH
LOW EAT COOLING	LOW	LOW	LOW	NORMAL/LOW	HIGH	LOW	LOW
HIGH AIR FLOW COOLING	LOW	HIGH	NORMAL	HIGH	LOW	LOW	NORMAL
HIGH WATER FLOW COOLING	LOW	LOW	LOW	LOW	HIGH	NORMAL	LOW
HIGH EAT COOLING	HIGH	HIGH	HIGH	HIGH	LOW	LOW	HIGH
SCALED COAXIAL COOLING	HIGH	HIGH	HIGH	NORMAL/LOW	LOW	LOW	LOW
UNDER CHARGED	LOW	LOW	LOW	HIGH	LOW	LOW	LOW
OVER CHARGED	HIGH	HIGH	HIGH	NORMAL	HIGH	NORMAL/LOW	NORMAL
RESTRICTED TXV	HIGH	LOW	NORMAL/LOW	HIGH	HIGH	LOW	LOW
TXV BULB LOSS OF CHARGE	HIGH	LOW	LOW	HIGH	HIGH	LOW	LOW
TXV STUCK OPEN	LOW	HIGH	NORMAL/HIGH	LOW	LOW	LOW	LOW
COMPRESSOR VALVES	LOW	HIGH	LOW	HIGH	NORMAL/HIGH	LOW	LOW

LEAK DETECTION

- A single leak detection method that locates every leak in every possible situation simply does not exist.

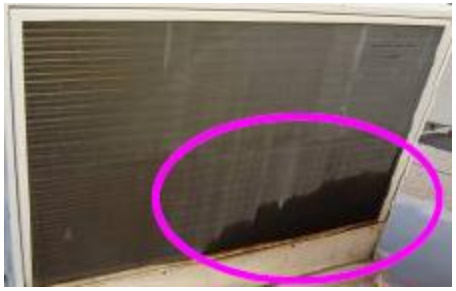
- A leak of 1kg of refrigerant causes approximately the same environmental damage as driving a van 10,000 miles

LEAK DETECTION

Visual inspection

Technician looks and feels for signs of dirt and oil

Look around valve caps and vibrating parts



LEAK DETECTION

Ultrasonic leak detectors

Relatively new to industry it amplifies noise

Detector will allow technician to hear minute sounds indicating a small leak

Refrigerant sniffers

Good for most leaks if used and maintained correctly

LEAK DETECTION

Dye

Can be messy but effective Dye travels with oil so it can take time to find

Quality high-intensity inspection lamps cause fluorescent dye to glow brighter.

LEAK DETECTION

Isolation method

This is time consuming method but sometimes its your only choice

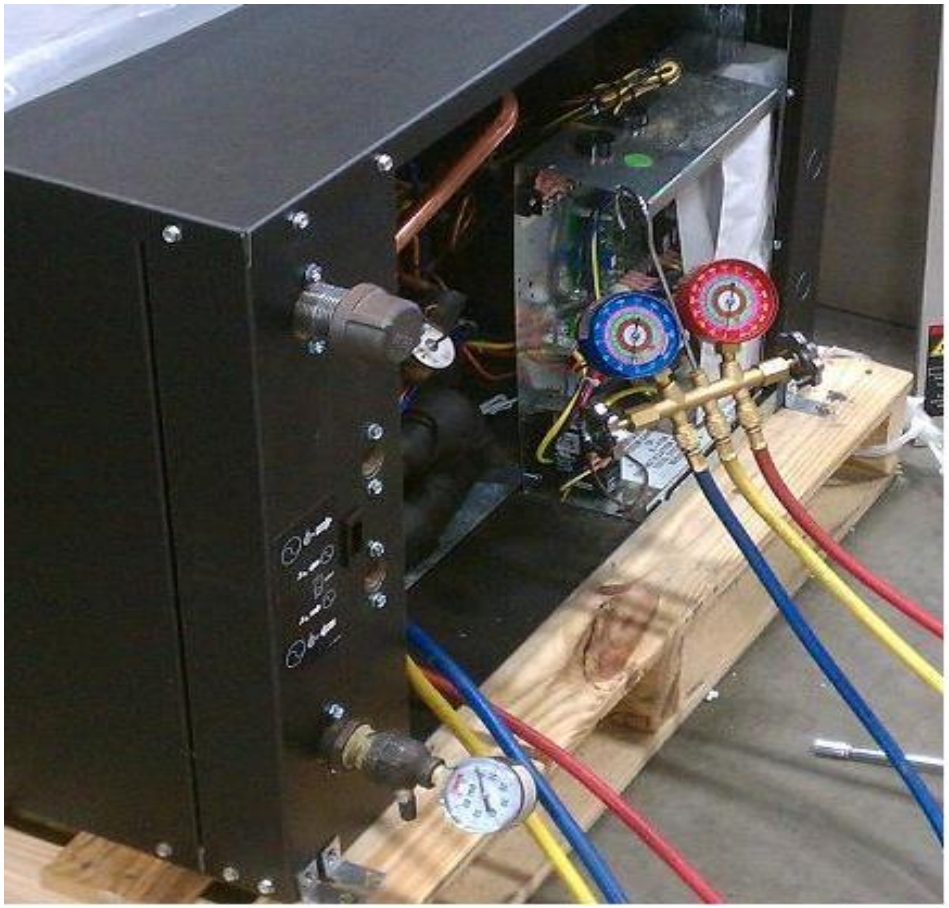
This is done by isolating a suspected part of the system and pressurizing only that part

Easiest done on split systems

LEAK DETECTION

Water coil leaks

Pressurize refrigerant side with nitrogen. If refrigerant side goes down and gauge on water coil goes up leak is into water coil



CAPACITOR FAILURE

Ohm out capacitor if you don't have a microfarad tester.

Ohm meter should swing to 0 ohms and swing back to infinity every time that you reverse the ohms meter test leads

CAPACITOR FAILURE

Most likely cause is high amp draw

Check incoming voltage

Low volts = high amps

On Water to Air Geo check water flow and temp in cooling mode

In heating mode make sure air filter and coil are clean

Check ducts and vents for restriction

CAPACITOR FAILURE

On Water to Water geo's check source side flow and temp in cooling mode

Check load side flow and temp in heating mode

If higher heating temps are needed use outdoor reset

HIGH ELECTRIC BILLS

Geo over sold can't meet expectations

Under sized package units with large plenum heaters don't always meet expectations

On pay back programs try to size for single digit temperatures

On retrofit applications with smaller duct consider splits with fossil fuel back up

HIGH ELECTRIC BILLS

Water to water geo's have a lower COP with higher water temps. Try to design systems using lowest water temps possible. If higher temps are needed use outdoor reset

HIGH ELECTRIC BILLS

Loop pumps over sized and on 24/7

Unit low on charge capacity down run time up

Use of set back thermostats

Thermostat algorithm set up incorrectly

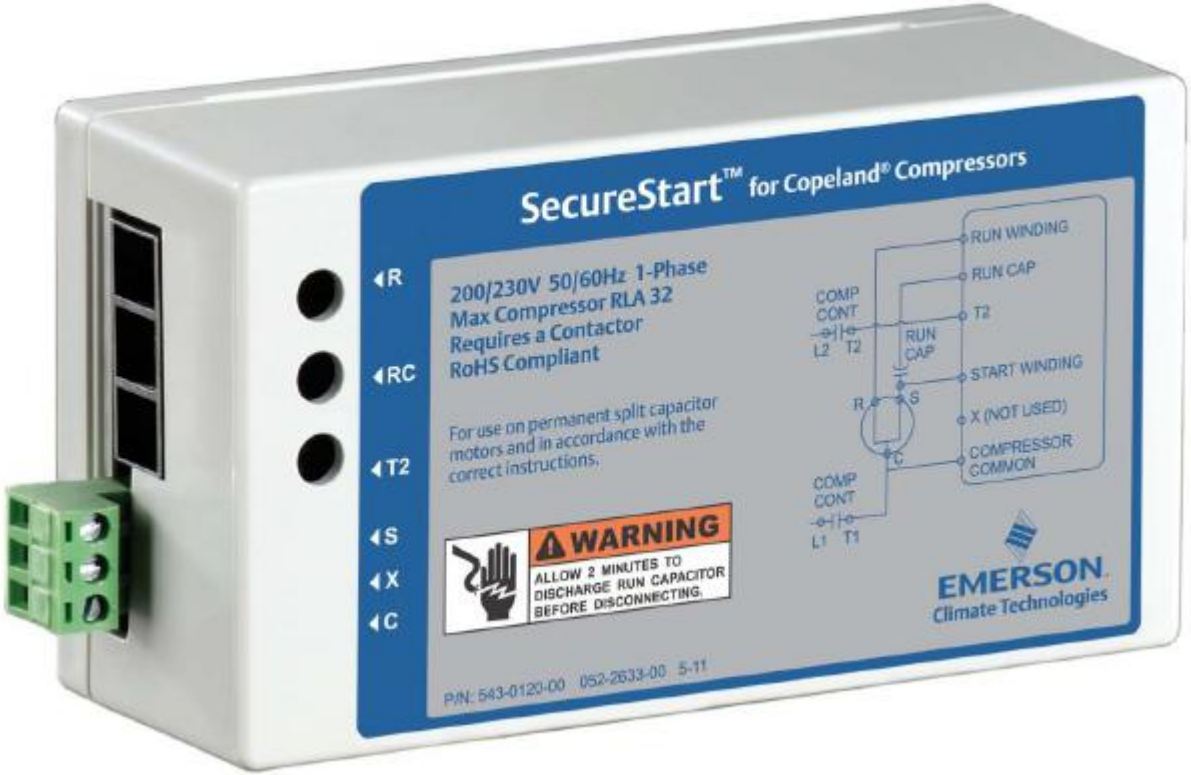
HIGH ELECTRIC BILLS

Homeowner can't comprehend geo's cost versus the total electric bill

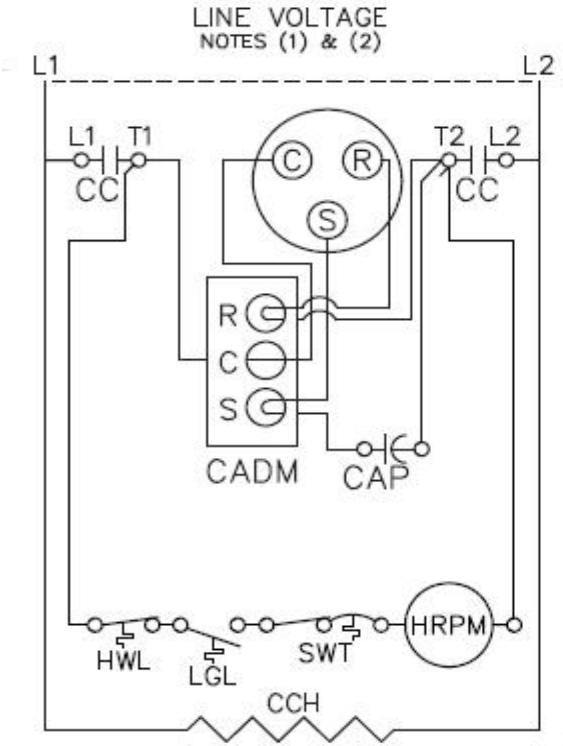
Isolate geo from the rest of the house load

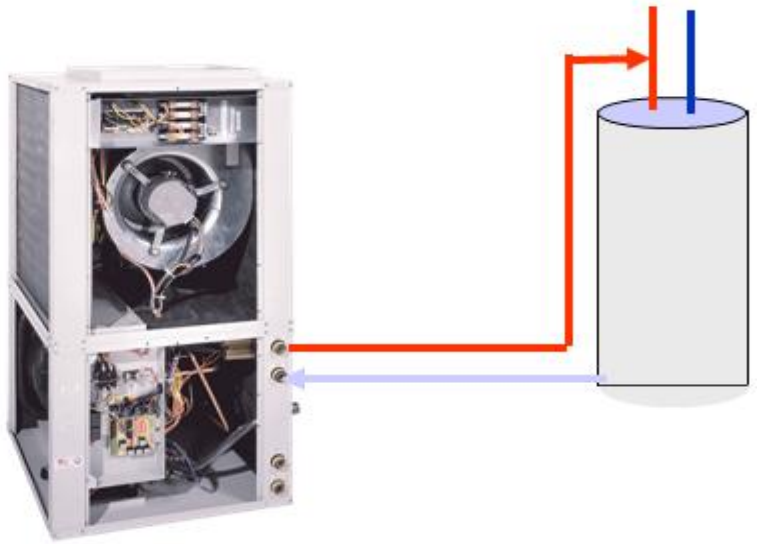
LIGHT DIMMING

Installing soft start kit generally resolves issue



NO HOT WATER





Domestic Hot Water Loop

EWT °F	GPM	WPD		Cooling - EAT 80/67°F							Heating - EAT 70°F					
		PSI	FT	Airflow CFM	TC	SC	kW	HR	EER	HWC*	HC	kW	HE	LAT	COP	HWC*
20	12.00	4.8	11.1	Operation not recommended							31.8	2.89	22.2	91.0	3.22	3.8
	12.00	4.8	11.1								32.3	2.80	22.8	88.1	3.38	3.3
30	6.00	1.3	3.0	1400	55.8	35.9	2.23	62.5	25.0	-	34.7	3.00	24.7	92.9	3.39	4.0
	6.00	1.3	3.0	1650	56.8	38.6	2.36	64.8	24.1	-	35.2	2.91	25.4	89.8	3.55	3.5
	9.00	2.7	6.2	1400	56.2	36.0	2.11	62.5	26.6	-	36.3	3.04	26.1	94.0	3.50	3.9
	9.00	2.7	6.2	1650	57.2	38.7	2.23	64.8	25.7	-	36.8	2.95	26.8	90.7	3.66	3.4
	12.00	4.6	10.6	1400	56.6	36.0	2.03	62.6	27.9	-	37.2	3.07	26.9	94.6	3.55	3.9
	12.00	4.6	10.6	1650	57.6	38.7	2.15	64.9	26.8	-	37.7	2.97	27.6	91.2	3.72	3.3
40	6.00	1.1	2.5	1400	55.5	37.2	2.43	63.0	22.8	-	39.8	3.17	29.2	96.3	3.68	4.1
	6.00	1.1	2.5	1650	56.5	40.0	2.57	65.3	22.0	-	40.4	3.07	30.0	92.7	3.86	3.6
	9.00	2.6	6.0	1400	56.1	37.2	2.30	63.0	24.4	-	41.8	3.22	31.0	97.6	3.80	4.0
	9.00	2.6	6.0	1650	57.1	40.0	2.43	65.3	23.5	-	42.4	3.12	31.8	93.8	3.98	3.5
	12.00	4.4	10.2	1400	56.3	37.3	2.23	63.0	25.2	-	42.9	3.25	32.0	98.4	3.87	4.0
	12.00	4.4	10.2	1650	57.3	40.1	2.36	65.3	24.3	-	43.5	3.15	32.8	94.4	4.05	3.4
50	6.00	1.1	2.5	1400	54.2	37.8	2.63	62.4	20.6	1.9	45.1	3.33	33.9	99.8	3.97	4.3
	6.00	1.1	2.5	1650	55.2	40.6	2.78	64.7	19.9	2.0	45.8	3.23	34.8	95.7	4.16	3.7
	9.00	2.5	5.8	1400	55.3	37.9	2.49	63.0	22.2	1.7	47.5	3.40	36.0	101.4	4.09	4.2
	9.00	2.5	5.8	1650	56.3	40.8	2.63	65.3	21.4	1.7	48.2	3.29	37.0	97.0	4.29	3.7
	12.00	4.2	9.7	1400	55.7	37.9	2.42	63.1	23.0	1.4	48.9	3.44	37.3	102.3	4.17	4.2
	12.00	4.2	9.7	1650	56.7	40.8	2.56	65.4	22.1	1.4	49.6	3.33	38.3	97.8	4.37	3.6

Thank you for attending!