CHAPTER 2
THEORY OF OPERATION

DESCRIPTION OF OPERATING CYCLES

POWER ON MODE

The ECO Xtreme has multiple operating modes, Power On, Recycle/Vacuum, Purge, and Charge modes. During the Power On Mode, the unit can be set via, the Hand Valves to; Charge, Recycle/Vacuum or Off. The service hoses connect to the vehicle, but for the purpose of the diagram, the low and high side valves are in the off position. Referring to FIGURE 2-1 POWER ON MODE, all Solenoids (normally closed) are closed, and the condenser fan is running.

The unit's hand valves must be in the Recycle mode to allow the unit to recover and recycle the refrigerant before the compressor is activated.

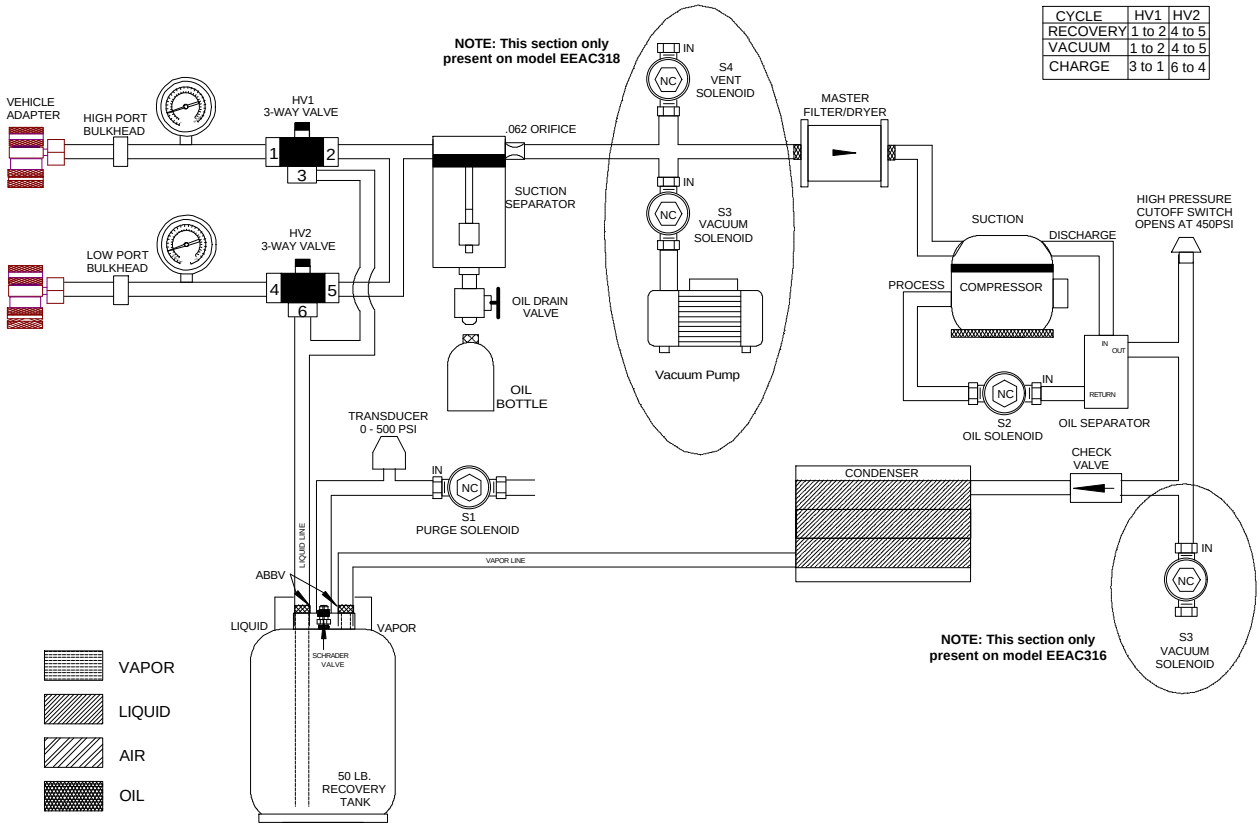

FIGURE 2-1 POWER ON MODE

RECYCLE MODE

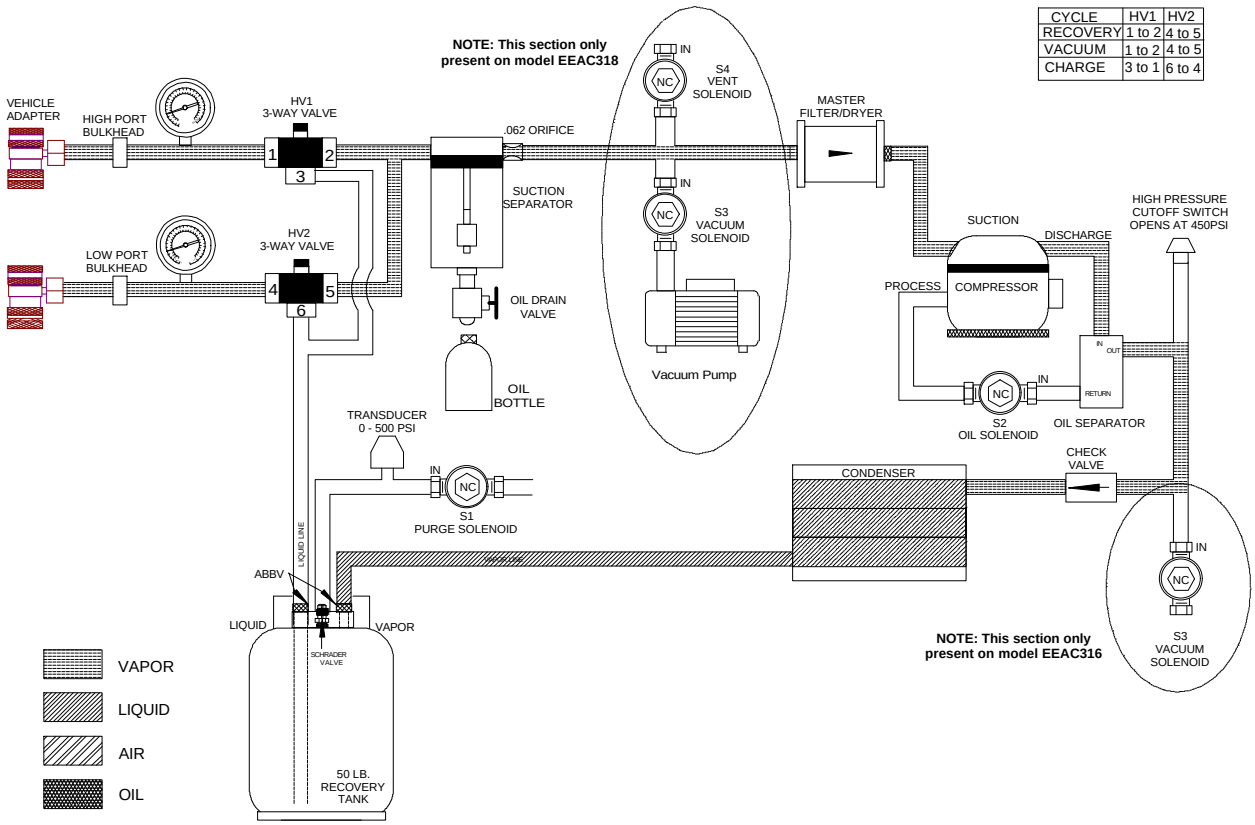

FIGURE 2-2 RECYCLE MODE

During the Recycle mode, the unit will pull all refrigerant from the vehicle, clean it, and store it in the recovery tank. To start the sequence, turn the unit's hand valves to the Recycle position. Program the unit to recycle. The Compressor starts, which takes between 5 to 10 seconds. Once the compressor starts, refrigerant will enter the Suction Separator assembly in a liquid or vapor state, but will exit in a vapor state. The refrigerant will pass through the Master Filter/Dryer to be dried/cleaned of all moisture and processed through the compressor.

Refrigerant then enters the oil separator to separate the oil that is used to lubricate the compressor. Refrigerant then exits the oil separator and flows through a check valve to allow the refrigerant to enter the condenser.

Refrigerant is then cooled using a fan and changed from a high-pressure vapor to a high-pressure liquid as it passes through the condenser. The final stage captures the refrigerant in the Recovery Tank. At the end of the Recover Mode, the gauge set will indicate approximately 15" of vacuum. The operator must turn the unit hand valves OFF. The operator should monitor the low side gauge for residual pressure buildup. Refer to Appendix C, Users Manual for more Information.

NOTE ***If the Recovery Tank becomes full at any time during the Recycle Mode, an LED will flash and an error message will be displayed.***

PURGE MODE

Since Tank Temperature is directly proportional to Tank Pressure, a Temperature probe held against the Recovery Tank is used to monitor tank temperature. The Temperature Sensor and Pressure Transducer are monitored before and after a Recovery. If needed, a Purge cycle is executed to release non-condensable (AIR) that may have been recovered along with the refrigerant. The unit monitors and releases non-condensable (AIR) until the pressure is correct (or proportional) to the current tank temperature.

Non-condensable gases are released through S1 solenoid, which has a 1/32 orifice to reduce flow and ensure refrigerant is not lost. This sequence will repeat until the proper pressure is established.

Special Consideration:
At any time during the Recover Mode, the unit may display High Pressure. If the High Pressure light illuminates, then either the red recover tank valve is turned off or the unit must be purged to release the non-condensable gas. Refer to the User's Manual in Appendix C for more information.

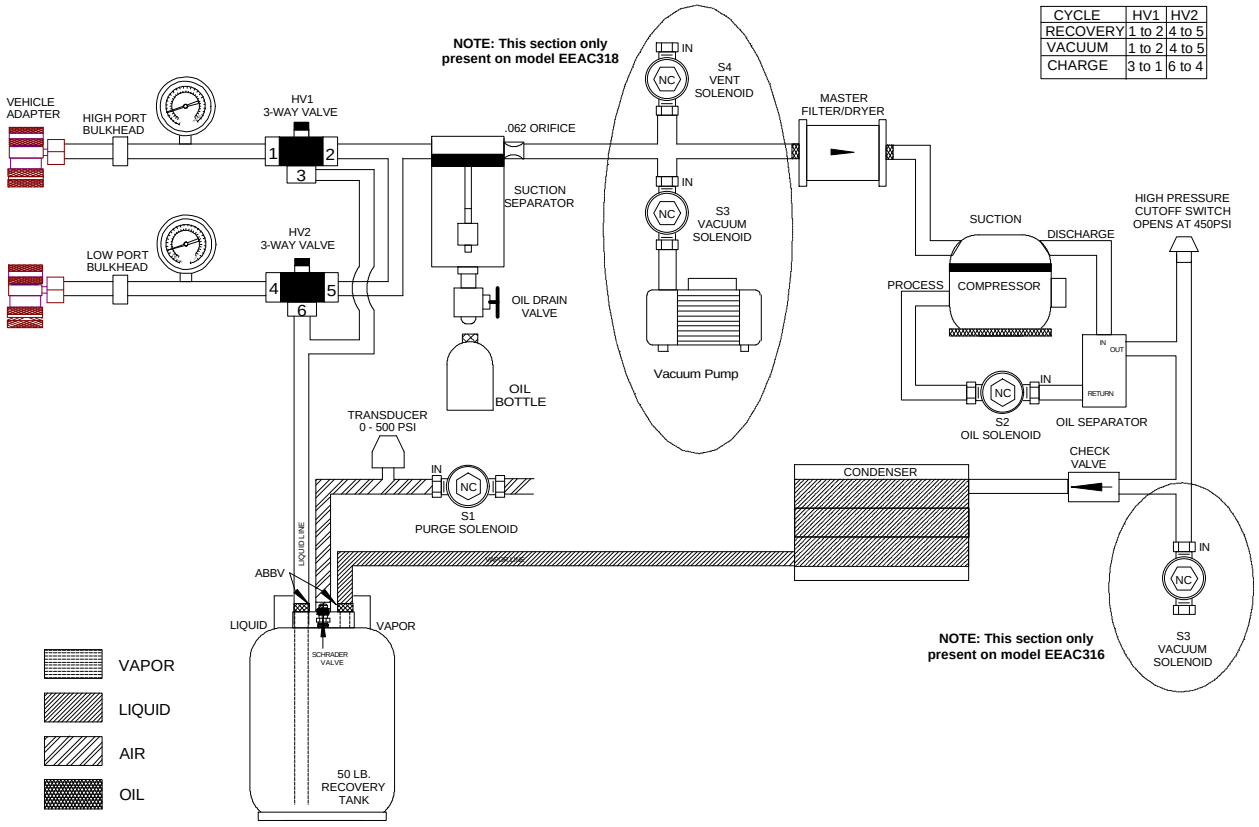

FIGURE 2-3 PURGE MODE

VACUUM MODE

The Vacuum Mode is initiated when the operator programs the unit to pull a vacuum from the vehicle using the ECO Xtreme. When the unit is set to Vacuum Mode and both hand valves are in the position. The unit will then turn the compressor ON (Vacuum Pump for the EEAC318). Once the compressor (pump) starts it will pull a deep vacuum from 25" Hg to 29" Hg. The pressure from the discharge side of the compressor is vented to atmosphere via S3 solenoid (in the EEAC318 solenoid S3 provides a path to the Vacuum Pump). During this process in the Model EEAC316, some oil from the compressor might escape, but is trapped in the bottom of the Compressor Oil Separator. At the end of the Vacuum cycle, the Oil Solenoid (S2) will open allowing the vacuum from the compressor to pull the oil back to the compressor.

Special Consideration:
In the Model EEAC318 the Vacuum Pump may require up to 60 seconds to restart if power is cycled quickly. Also, the Vacuum Pump will automatically shut down if it does not pull 15"Hg in 2.5 minutes. This is to prevent oil loss.

WARNING!

DURING A VACUUM MODE THE OUTPUT OF EITHER THE COMPRESSOR (EEAC316) OR THE VACUUM PUMP (EEAC318) IS VENTED TO ATMOSPHERE. PERFORMING A VACUUM ON A VEHICLE THAT HAS REFRIGERANT IN THE SYSTEM WILL VENT THAT REFRIGERANT TO ATMOSPHERE.

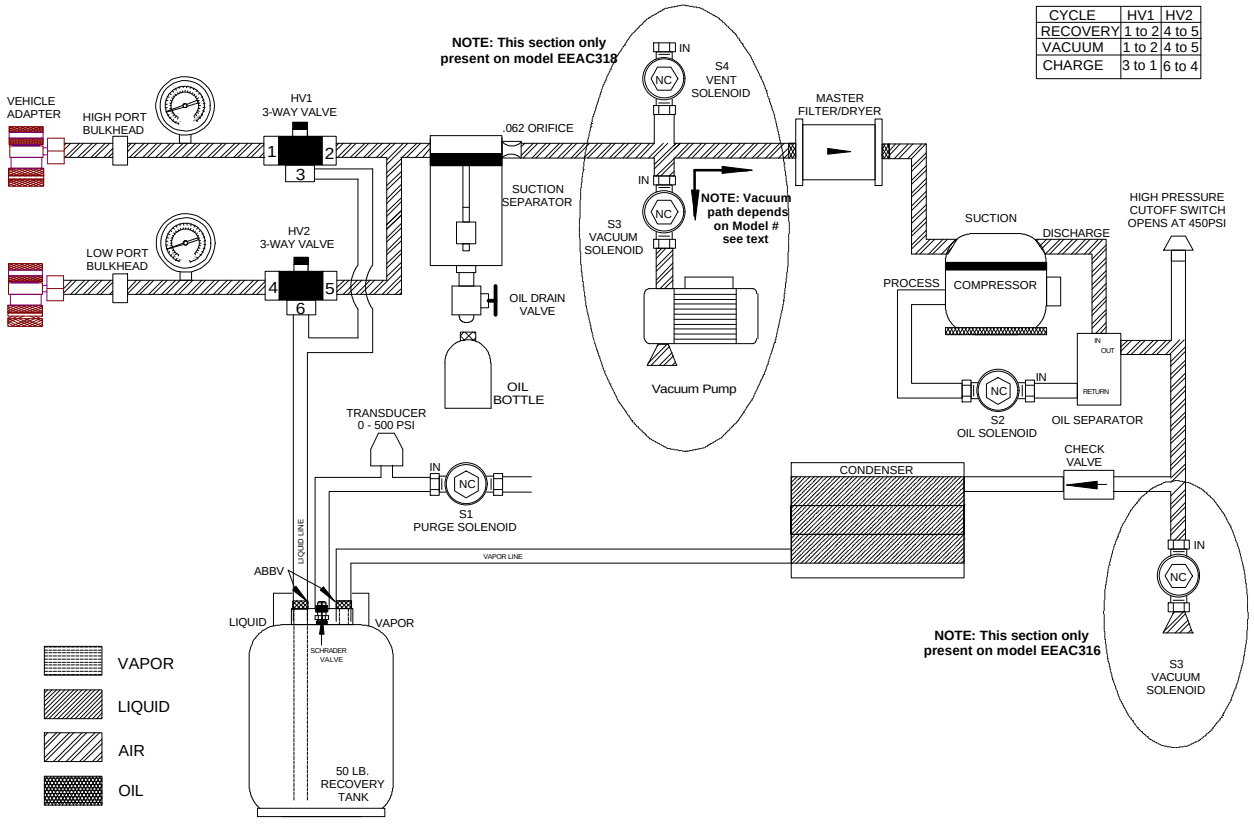

FIGURE 2-4 VACUUM MODE

CHARGE MODE

The Charge Mode is a manual operation. The operator would need to properly connect the ECO Xtreme to the vehicle and pull a vacuum before charging is performed. Be sure that the blue valve on the Recovery Tank is open during the charge mode. Liquid refrigerant flows from the liquid side of the Recovery Tank through the hand-valves and hoses, to the vehicle until the proper amount has charged. Then turn the unit's hand valves to off. Refer to FIGURE 2-5 CHARGE MODE

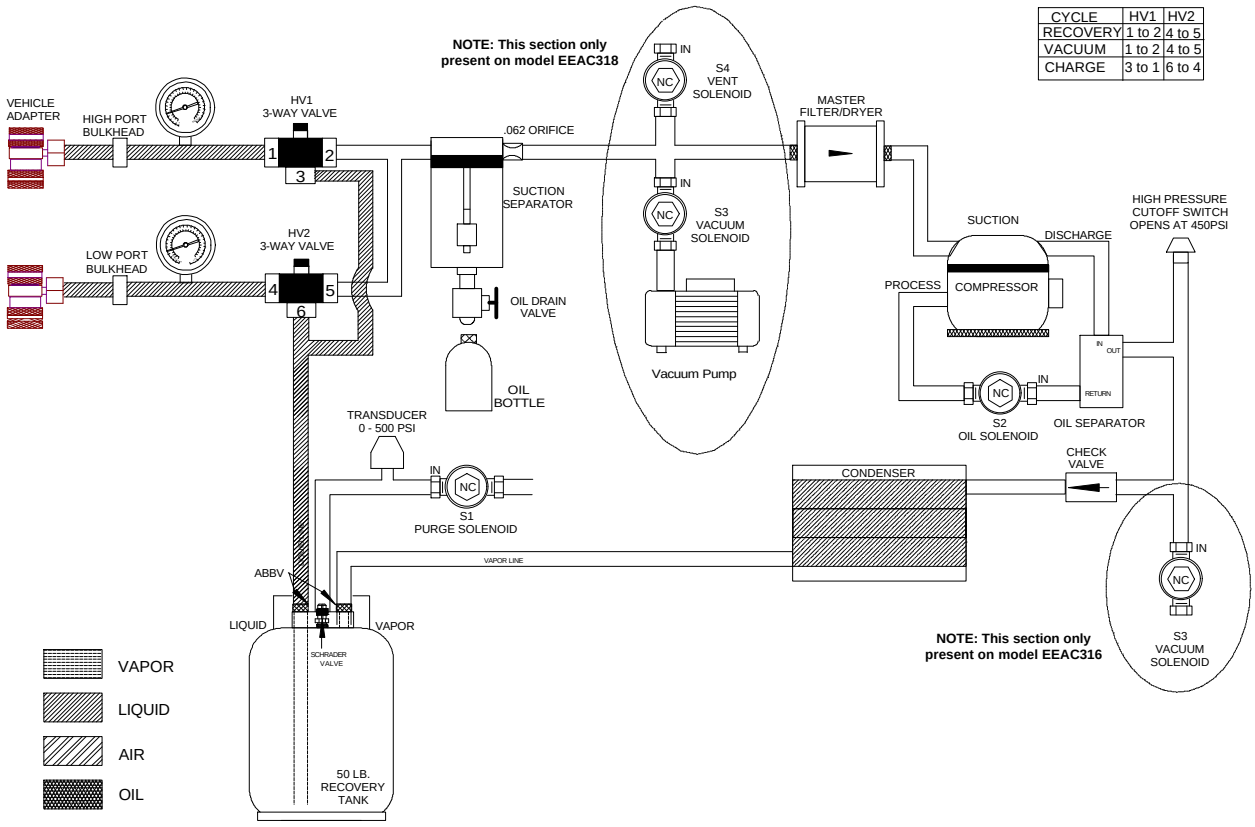

FIGURE 2-5 CHARGE MODE

Special Consideration:

During the charge mode, the unit may slow down or stop charging due to pressure equalization between the Recovery Tank and the vehicle (Slow Charge Condition). The customer needs to close the red (High) panel valve, start the vehicle and run the vehicle's AC system. The pressure in the vehicle on the low side will drop and the unit can continue to charge. The pressure in the Recovery Tank must be greater than the pressure in the vehicle to complete the charge cycle.

NOTE ***Never try to install a heater blanket on a Recovery Tank.***

TEMPERATURE SENSOR

(Refer to Drawing 1-1 in Chapter 1)
The temperature sensor monitors the temperature of the refrigerant in the Recovery Tank. The Chart below will help you check out the temperature sensor by giving you temperature probe resistance and voltage for specific temperatures. The output voltage of the temperature probe changes with temperature, but is not linear. The chart below shows the resistance of the probe vs. temperature and output voltage when plugged into the board.

ºC	ºF	Probe Resistance +/- 2%	Voltage across Probe +/- 2%	ºC	ºF	Probe Resistance +/- 2%	Voltage across Probe +/- 2%
0	32	32657	1.9139	35	95	6532	0.9878
1	34	31036	1.8908	36	97	6268	0.9632
2	36	29505	1.8672	37	99	6016	0.9391
3	37	28058	1.8431	38	100	5776	0.9153
4	39	26690	1.8186	39	102	5546	0.8919
5	41	25396	1.7937	40	104	5327	0.8689
6	43	24174	1.7684	41	106	5117	0.8462
7	45	23018	1.7428	42	108	4918	0.8242
8	46	21922	1.7168	43	109	4726	0.8023
9	48	20886	1.6906	44	111	4543	0.7810
10	50	19904	1.6640	45	113	4369	0.7601
11	52	18974	1.6372	46	115	4201	0.7396
12	54	18093	1.6101	47	117	4041	0.7195
13	55	17258	1.5828	48	118	3889	0.7000
14	57	16465	1.5554	49	120	3742	0.6808
15	59	15715	1.5278	50	122	3602	0.6620
16	61	15003	1.5001	51	124	3467	0.6436
17	63	14327	1.4723	52	126	3340	0.6259
18	64	13684	1.4444	53	127	3217	0.6085
19	66	13074	1.4165	54	129	3099	0.5915
20	68	12495	1.3886	55	131	2986	0.5748
21	70	11944	1.3607	56	133	2878	0.5587
22	72	11421	1.3329	57	135	2774	0.5429
23	73	10923	1.3051	58	136	2675	0.5276
24	75	10451	1.2776	59	138	2580	0.5127
25	77	10000	1.2500	60	140	2488	0.4981
26	79	9573	1.2227	61	142	2400	0.4839
27	81	9166	1.1956	62	144	2316	0.4701
28	82	8778	1.1687	63	145	2235	0.4567
29	84	8409	1.1420	64	147	2157	0.4436
30	86	8057	1.1155	65	149	2083	0.4310
31	88	7722	1.0893	66	151	2011	0.4186
32	90	7403	1.0635	67	153	1941	0.4064
33	91	7099	1.0379	68	154	1876	0.3949
34	93	6809	1.0127	69	156	1813	0.3837
				70	158	1752	0.3727

Table 1, Temperature Probe function

TEMPERATURE / PRESSURE CHART (REFERENCE)

54°F = 50.05PSI	70°F = 71.10PSI	84°F = 93.50PSI |	98°F = 120.02PSI
57°F = 53.68PSI	72°F = 74.10PSI	86°F = 97.02PSI |	100°F = 124.10PSI
60°F = 57.40PSI	74°F = 77.10PSI	88°F = 100.66PSI	104°F = 132.74PSI
62°F = 60.04PSI	76°F = 80.22PSI	90°F = 104.30PSI	108°F = 141.74PSI
64°F = 62.68PSI	78°F = 83.46PSI	92°F = 108.14PSI	112°F = 151.14PSI
66°F = 65.42PSI	80°F = 86.70PSI	94°F = 111.98PSI	116°F = 160.94PSI
68°F = 68.26PSI	82°F = 90.10PSI	96°F = 115.94PSI	120°F = 171.10PSI

Table 2, R-134a Temperature / Pressure Chart

COMPONENT OPERATION

SOLENOID

The Solenoids are normally closed allowing flow only when power is supplied across the coil. One terminal on the solenoid is wired to neutral while the other is connected to a driver, delivering 115VAC hot. (Refer to Chapter 1 AC/DC Distribution.)

NOTE ***ALL SOLENOIDS ARE MARKED WITH AN ARROW, A DOT OR THE WORD "IN" STAMPED ON THE BODY INDICATING DIRECTION OF FLOW.***

- **OIL SOLENOID:** Normally Closed, closed in Recycle or Vacuum mode to prevent flow from the Oil Separator outlet to the Compressor inlet. Opens to allow oil to return to the compressor

COMPRESSOR

The ECO Xtreme uses a rotary vane type Compressor. This Compressor, in model EEAC316, performs two functions; one as a vacuum pump and the other as a Pressure Compressor. In the Vacuum mode, the Compressor pulls a deep vacuum which removes moisture and non-condensable from the vehicle refrigerant system. In the Recycle Mode the Compressor pulls low pressure refrigerant gas from the Oil Separator and compresses it, sending it on to the condenser as a high pressure, high temperature vapor. During this process, it is normal for a small amount of compressor oil to mix with the refrigerant leaving the Compressor. The oil reservoir will separate and capture this oil and return it to the Compressor. The Compressor is protected by routing 115VAC through a Klixon thermal overload device (circuit breaker) located under the plastic cap of the Compressor.

NOTE ***IT IS RECOMMENDED TO CHANGE OIL EVERY 3 MONTHS.***

OIL SEPARATOR

The oil separator is located next to the Compressor. During normal operation a small amount of oil will leave the Compressor through the discharge port. This oil is captured in the oil separator. Once the operation is completed and the operator turns off the unit. The oil will be drawn back to the compressor via the oil return line. This assures that the Compressor will always have a sufficient quantity of oil for proper operation.

VACUUM PUMP

NOTE ***ONLY UNIT MODEL EEAC318 HAS A SEPARATE VACUUM PUMP. MODEL EEAC316 USES THE COMPRESSOR AS BOTH A COMPRESSOR AND A VACUUM PUMP.***

The Vacuum Pump is used to pull a very low vacuum on a vehicle. The Vacuum Pump used in the unit, model EEAC318, is a self contained vender item that we do not service (other than normal oil maintenance, see Chapter 3). If it fails, replace it. The Vacuum Pump is feed 115 VAC from the Control Board, via connectors J29 and 30, when a Vacuum Mode is initiated.

RECOVERY TANK

The Recovery Tank stores up to 80% of recycled, filtered, and dried refrigerant. It has two manual hand valves, and a purge fitting located on top of the tank. During the Recycle mode the refrigerant enters the tank through the valve marked "VAPOR" (RED). In the charge (Dispense Refrigerant) mode, the refrigerant exits through the valve marked "LIQUID" (BLUE). This port has a tube, which reaches the bottom of the recovery tank. When using the recycle unit, open both valves on the recovery tank for proper operation. During the auto purge mode, the non-condensable gas (AIR) exits through the yellow hose via the purge fitting. This process will release the non-condensable gas out of the purge valve on the front panel of the unit. For more information, refer to PURGE MODE on page 2-3.

LOAD CELL

The Load Cell is the device that weighs the amount of the refrigerant in the tank. The load cell is made of four strain gauge resistors connected in a whetstone bridge configuration. The design of the Controller Board only uses the Signal+ to read the amount on the scale. This voltage can be read on the A/D (U6 pin 3) to determine the amount on the scale. Example: Every 1 oz. divided by (/) 229.807.
To determine the voltage reading with a certain amount on the scale, the math would follow:
(40 lbs. x 16) + (0 oz.) / 229.807 = 2.78VDC.
To determine the amount reading with voltage, then the math would follow:
(2.09VDC x 229.807) / 16 = 30lbs. 0 oz.

CUTOFF SWITCHES

There is one Cutoff Switch used in this unit, which is the High Pressure cutoff switch. This switch works the same way as a snap switch. When the pressure reaches 450 psi, the switch snaps open. When the pressure decreases to 375 psi, the switch then snaps closed.

SWITCH	DEACTUATION	ACTUATION
HIGH	375 psi	450 psi

SUCTION SEPARATOR

The Suction Separator assembly is located in the front of the unit. Oil removed from the vehicle's A/C system is separated from the refrigerant and is accumulated in the separator bowl. The purpose of the Suction Separator is to remove contaminants from the refrigerant being recovered. Refrigerant can enter the Suction Separator as a vapor or liquid. Any liquid entering must vaporize in order to exit through the outlet port at the top of the assembly. Once the refrigerant has changed from a liquid to a vapor state, the compressor will draw out the vapor.
The remaining oil (if any) will need to be purged out via the oil drain valve. The amount of oil removed will be the amount of oil that should be added back to the vehicle. Refer to Appendix C Users Manual for more information.

PRESSURE TRANSDUCER

(Refer to Drawing 1-1 in Chapter 1)
There is only one transducer used in this unit, to monitor the pressure in the recovery tank. The Purge Transducer is rated at 0 to 500 psia. The transducer outputs a voltage proportional to amount of the pressure sensed. Output voltage is 0.0 to 4.0 volts full scale, and with a 0.5 ± 0.1 volt zero offset.
Example: Every 1 psi equals 8mv plus the 0.5 volt zero offset. At 250 psia, the output voltage is 2.5 ± 0.1 volt. Note, this transducer measures absolute pressure (PSIA) instead of gauge pressure (PSIG) and is not interchangeable with older ones.

MASTER FILTER/DRIER

When vapor refrigerant passes through the Master Filter/Dryer, it is dried/cleaned of all moisture. The master filter/drier is the only component that removes moisture from refrigerant. The master filter/drier should be changed when the filter counter (Timer) has reached (or counts down to) 0 pounds 0 ounces since the last master filter/drier change. The maximum amount of time for a new filter dryer is 95 pounds. For more information on tracking, refer to Appendix C Users Manual. This filter is designed to remove moisture from R-134a refrigerants.

NOTE ***The unit is only designed to recover R134a refrigerant.***

TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Unit displays Tank Full.	Is the gross weight greater than 70 pounds? (50lb tank = 26.5lb) **YES–>**Tank is Full. Install an empty tank. Perform Scale calibration, Chapter 3. If unit will not calibrate Replace Controller Board, or replace Load Cell.
II. Unit displays High Pressure.	Verify the unit has been purged properly and Pressure Transducer has Been Calibrated. Be sure RED hand valve on tank is open and unit hand valve is set to recycle during Recycle Mode. Disconnect RED hose from tank and bleed off pressure. Does High Pressure Switch read shorted with an Ohm Meter? **NO–>** Replace High Pressure Switch. Reconnect the RED hose to recovery tank. Perform the purge sequence.
III. Unit will not charge liquid or charges slowly.	Is the BLUE hand valve at the Recovery Tank, Service Hoses and Front Panel valves open? **NO–>** Open the hand valves. Check to see that the Schrader core depressors in the service hoses are opening Schrader cores on the vehicle A/C system. Listen for pressure release when connecting to vehicle. • Repair or replace as needed. Does unit charge? **YES–>**End Troubleshooting. Try charging hoses, if Ok check vehicle adapters at car. **NO–>** Restriction in hose. Repair as needed. Turn off high side valve on gauge set and start vehicle up, run vehicle compressor. This is normal due to a slow charge condition.

COMPLAINT	CORRECTIVE ACTION
IV. No Vacuum or vacuum is weak, or less then 25 inches. **(Model EEAC316 only)**	Check for debris in the Oil return solenoid? **NO–>** Refer to Chapter 1 AC/DC. Disconnect the suction side of the compressor. Connect a gauge set yellow hose to the compressor. Open inline hand valve on yellow hose, and open low side valve on gauge set. Set the unit up for a Vacuum operation. Does the gauge set read 25" to 29"? **NO–>** Disconnect oil return tube from compressor and block off compressor side. Does the gauge set read 25" to 29"? **NO–>** Replace Compressor. **YES–>**Clean or replace Oil Solenoid. Disconnect yellow hose from compressor and reconnect compressor to the input side of the master filter/dryer.
V. No vacuum or vacuum is weak, or less then 25 inches. **(Model EEAC318 only)**	Does Vacuum Pump Start? **NO–>** Refer to Chapter 1 AC/DC. **YES–>**Disconnect the suction side of the Vacuum Pump. Connect a gauge set yellow hose to the compressor. Open inline hand valve on yellow hose, and open low side valve on gauge set. Set up a vacuum operation. Does the gauge set read 25" to 29"? **YES–>**Check for leaking solenoids (S4 or S3), leaking hand valves or leaking hoses / fittings. **NO–>** Check oil level in Vacuum Pump – replace Vacuum Pump.

TROUBLESHOOTING COMPLETE