R-134a Retrofit Guidelines for Heavy Duty Vehicles

P R E P A R E D B Y

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REV. B

PROPRIETARY INFORMATION STATEMENT

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BACKGROUND

Over sixty years ago, Chlorofluorocarbons (CFCs) were developed. CFCs have many unique properties, they are low in toxicity, nonflammable, non corrosive and compatible with other materials. In addition, they offer the thermodynamic and physical properties that make them ideal for a variety of uses, such as refrigerants. Freon 12 or R-12 is a CFC.

However, the stability of CFCs and their chlorine content, has linked them to depletion of the earth's protective ozone layer. As a result, the international community in 1987 established a reduction and phase out schedule for the manufacturing of CFCs, known as the Montreal Protocol. This schedule has been accelerated twice since 1987. Currently, the U.S. Clean Air Act calls for the elimination of the production of CFCs as of January 1, 1996. As a result of this, Dupont, the world's largest producer of CFCs, has announced that it will cease production of CFC's January 1, 1995.

These events have brought our industry into the age of alternate refrigerants.

OVERVIEW

The purpose of this document is to establish a guideline for the upgrading of heavy duty vehicle R-12 a/c systems for use with the HFC 134a refrigerant. The recommendations and practices outlined in this document were developed specifically to address the unique needs of the heavy duty and off highway vehicle marketplace and may not be appropriate for automotive and other light vehicle applications. The challenge in developing this guideline, is the wide array of vehicles which could be candidates for retrofit.

The strategy employed in the development of this document is simple:

- Use the best available technology and Red Dot Engineering practices and expertise on R-12 systems, as the basis for the R-134a retrofit systems.
- Select and upgrade components and specifications which can be used in both R-12 and R-134a systems whenever possible to reduce the confusion, inventory, and opportunity for misapplication.
- Utilize as many of the O.E.M. R-134a system standards and components, to keep the vehicle as close to standard as possible.

This guideline is divided into two sections:

Component Standards - These guidelines are the recommendations of Red Dot Engineering regarding components for use in a heavy duty environment.

Recommended Practices - These guidelines are the preferred Red Dot practices for retrofitting.

No single procedure exists that can be applied to every retrofit opportunity. A successful retrofit will be based on choosing the appropriate options which will meet the expectations of the customer.

COMPONENT STANDARDS

Component attributes defined in this section are considered mandatory requirements for Red Dot Engineering use. In the real world, the decision will be based on the vehicle's system design, age, and cost to the customer. What components will be replaced in a retrofit will boil down to how much risk you and the customer are willing to take verses the retrofit cost..

COMPRESSOR

The compressor in a R-12 system was never designed for use in a R-134a system and the higher strain wear placed on it. The compressor should be replaced as part of the retrofit for maximum reliability as a general rule. Depending on the age and condition of the vehicle and the a/c system, and the type of compressor used, you may elect not to change the compressor. The reality of the situation is that all R-12 compressors will operate effectively for a period of time with R-134a. The length of service that can be expected depends on the compressor design, seal condition and wear to date. The traditional two cylinder reciprocating compressors have exhibited good service life, as have some rotary models. At Red Dot, our rule of thumb is if the basic compressor model is being offered in a R-134a version, then the basic R-12 design was capable of handling the increased demands of R-134a for a reasonable period of time. The gamble you and your customer take is the seal integrity and remaining wear life sufficient to provide enough service life to offset the cost of a new R-134a compressor?

When changing compressors, the selection of the compressor model and manufacturer will be based on the compressor originally provided by the vehicle manufacturer unless otherwise agreed upon by the vehicle manufacturer (see table at bottom of page).

COMPRESSOR IDENTIFICATION

The compressor shall have visible identification indicating compatibility with R-134a and identifying which lubricant is to be used.

COMPRESSOR OIL

Unlike R-12 systems which universally use mineral oil, R-134a systems require the use of synthetic oils. While the predominate synthetic is Polyalkylene Glycol or P.A.G., there are over 12 variations being considered. The refrigeration oil to be used with R-134a shall be the oil specified by the compressor manufacturer. The same oil used by the O.E.M. vehicle manufacturer for new R-134a a/c system production should be the

Compressor Manufacturer	R-12 Model	Aftermarket Part No.	Red Dot Part No.	R-134a Model	Aftermarket Part No.	Red Dot Part No.	PAG Oil Charge
Alma Products	GM-A6	75R 8102	RD-5-5000-0	GM-A6	N/A	N/A	10 oz.
Blissfield	HGB-1000	75R 7100	RD-5-3691-0	HGB-1000	75R 7130	RD-5-7655-0	10 oz.
Climate Control	CCI-210	75R 7230	RD-5-6653-0	CCI-210	75R 7240	RD-5-7101-0	14 oz.
Sanden	SD-508	75R 8292	RD-5-5575-0	SD-508	75R 8382	RD-5-7088-0	10 /13 oz.*
Sanden	SD-510-HD	75R 8212	RD-5-5443-0	SD7H15	N/A	N/A	10 /13 oz.*
Sanden	SD-709	75R 8412	RD-5-6625-0	SD7H15	75R 8422	RD-5-7120-0	10 /13 oz.*
Zexel (Diesel Kiki)	15 CHS	75R 8512	RD-5-5876-0	15 CHS	75R 8612	RD-5-7145-0	10 /13 oz.*

*Red Dot estimates for single / dual evaporator systems Class 8 vehicles.

COMPRESSOR OIL TABLE

Compressor Manufacturer	Aftermarket Oil	Red Dot Part No.	Oil Part No.	Type
Alma Products	Ucon-488	N/A	N/A	PAG
Blissfield	ISO-46	N/A	N/A	Ester
Climate Control	Retro-Fix	79R 4590	RD-5-7102-0	PAG
Sanden	SP 20	79R 4580	RD-5-7103-0	PAG
Zexel (Diesel Kiki)	ZX100 PG (DH-PS)	79R 4585	RD-5-7166-0	PAG

first choice. This will minimize the number oil variations which the dealer, fleet, and service networks will have to stock. This also reduces the possibility of using the wrong oil, or cross-mixing of two oils.

COMPRESSOR MOUNTING

The existing vehicle mount will be used whenever possible. If a new design is required, the compressor mounting bracket shall be engine mounted and provide for good belt alignment, adequate belt adjustment, and provide durability and good service life. Slotted holes should be included in the mounting bracket to allow for alignment of the compressor clutch. Slotted holes are for compressor to mounting bracket only, not mounting bracket to engine. Fasteners with locking features (lock nuts, patch lock, etc.) and flat washers shall be used in mounting compressors and brackets.

COMPRESSOR DRIVE

The existing vehicle drive will be used whenever possible. If a new design is required, the compressor shall be belt driven through a clutch mounted to it. The drive arrangement shall allow for minimum belt wrap of:

- 120 Degrees for a Single V-Belt
- 80 Degrees for a Double V-Belt
- 80 Degrees for a V-Ribbed Belt

A new v-belt should be tensioned to 120 lbs., run in for 5 minutes and re-tensioned. The drive belt misalignment must not exceed 1/8 in./ft.

A v-ribbed belt should be run with an automatic tensioner developing 80 lbs. of belt tension.

COMPRESSOR CLUTCH

The existing vehicle clutch manufacturer, style, and size will be used whenever possible. If a new design is required, clutches shall employ double row or heavy duty equivalent bearings and internal dust covers when applicable. External dust covers are advisable for use in excessively high dirt/dust environments. The minimum voltage at the clutch coil shall be 11.5 volts for a 12 volt system to ensure proper clutch engagement. The measurement should be taken while the clutch is engaged and blower fan on high speed. The voltage should be maintained for a minimum of 5 minutes.

CONDENSER

The current condenser must be evaluated for it's capacity and durability in the current design. In many cases, the condenser will need to be replaced. If possible, use the condenser being used by the O.E.M. for R-134a production.

SIZING - The condenser must have sufficient capacity to match the capability of the compressor, evaporator, and heat loading of the vehicle under all anticipated operating conditions. As a general rule, the condenser should have 20% more capacity than was required for an R-12 system (see pressure temperature chart on page 13 for actual operating differences).

MOUNTING - The condenser should be mounted in an unobstructed air stream and not touching the heat exchanger surfaces on other systems where the condenser is mounted in front of the vehicle radiator or charge air cooler.

The condenser should be mounted so that the condensed liquid exits at the bottom of

the condenser. Some condensers are attached to the vehicle using an isolation mounting system, these mounts serve two primary functions:

1) to suppress noise and vibration transmission from the A/C system to the vehicle.
2) to allow for thermal expansion differences between the condenser and the vehicle.

AUXILIARY FANS - Electric drive auxiliary fan assemblies may be added to enhance the performance of the existing or new condenser design.

HOSE MATERIAL

Nylon lined or barrier wall construction hose is a requirement for R-134a in a heavy duty application where extended vehicle operation is expected. Most equipment manufacturers have, for some time, been using this type of hose in their R-12 systems. There is a good chance you will not have to deal with replacing hoses as part of a retrofit, unless a major component such as the condenser is being changed. Depending on the new R-134a condenser mounting and/or fitting location, the condenser hoses may have to be replaced.

Some of the more common types of nylon/barrier hoses are:

Hose Manufacturer	R-134a Compatible Nylon Lined Hose
Aeroquip	FC-202
Aeroquip	FC-505
Dayco	XXXX
Goodyear	Galaxy 4816
Goodyear	Galaxy 4818
Goodyear	Galaxy 4824
Parker	P-80
Parker	P-90
Weatherhead	XXXX

Replacement hoses used in Red Dot retrofits are Goodyear Galaxy hose, unless otherwise specified by the vehicle manufacturer or vehicle fleet owner.

HOSE FITTINGS

ATCO, Steel construction, bead lock, is Red Dot's first choice for replacement hose assemblies using Goodyear Galaxy hose. ATCO, Aluminum construction, bead lock is the first alternative to steel. Both meet the new SAE J-2064 standard for integrity and leakage. If hose assemblies are to be made using hose material other than Goodyear Galaxy, the recommended hose manufacturer fitting shall be used. The bubble type crimp is considered the only acceptable crimp by Red Dot. Flat crimps do not provide the same level of crimp integrity and can damage the hose inner liner. Reusable fittings may be used only with Aeroquip FC-202 hose and only with the vehicle manufacturer or vehicle fleet owners' concurrence. Barbed-hose clamp fittings are not acceptable.

HOSES AND PIPING

The current vehicle hose routing and attachment scheme should be used whenever possible. Stainless steel solid tubing should be incorporated whenever the need for replacing solid lines is required.

O-RINGS

Only o-rings identified as R-134a compatible are to be used. Red Dot uses neoprene identified by the color Red, for all R-134a as well as R-12 applications. HNBR o-rings, typically green or light blue in color, are the first choice of most manufacturers for R-134a applications.

SYSTEM CHARGE PORTS

S.A.E. J639 compliant. Current R-12 Charge ports should be removed and replaced with R-134a Charge ports built into the compressor suction and discharge hose assemblies either on the fittings or in-line, depending on the service port accessibility. Retrofitting the R-12 charge ports is not acceptable, unless it can be clearly demonstrated that the ports do provide sufficient access to the larger R-134a service couplings, and the R-134a

service adapters cannot be easily removed, or reverse installed.

LOCATION - Charge ports should be easily accessible and located near the compressor or the sight glass with sufficient clearance to allow the attachment of the large R-134a quick connect service valves.

RECEIVER DRIER

Steel construction, 15 cubic inches of XH-7 or XH-9 desiccant, spring loaded, and large sight glass unless separate moisture indicator is used, are the preferred Red Dot design. If the production R-134a system receiver drier can be used for the retrofit, it should be considered as the first choice.

IDENTIFICATION - The receiver drier shall have visible identification indicating compatibility with R-134a.

MOUNTING - The existing vehicle mounting will be used whenever possible. If a new design is required, the receiver drier shall be mounted in an upright position on the vehicle, in a location that protects the device from vibration and heat. The cab firewall is the preferred location.

SIGHT GLASSES, PRESSURE RELIEF VALVES AND MOISTURE INDICATORS - The existing location of Sight glasses, pressure relief valves and moisture indicators will be used whenever possible. A larger sight glass such as those provided by a remote mounted moisture indicator is preferred for R-134a system charging.

EXPANSION VALVE

A R-134a version from the same manufacturer of the original equipment should be used. The same style, physical dimensions, R-134a charge head, super heat setting and adjusted orifice size should be the criteria for the retrofit valve. If a 134 version is not available, the existing R-12 expansion valve will work acceptably.

SYSTEM PROTECTION

Unless otherwise stated by the vehicle manufacturer, the current system protection scheme will be considered adequate for R-134a operation. Slight setting adjustments on the high pressure cutout and the condenser fan engagement may be required, depending on the condenser capacity.

HIGH SIDE HIGH PRESSURE SWITCH

The pressure switch is installed on the high pressure side of the system, to shut the A/C clutch off in the event of excessive refrigerant pressure. The existing vehicle switch should be used whenever possible. If a new design is required, the following design attributes apply:

SETTINGS - The pressure settings shall comply with the recommendations of the compressor manufacturer and should not exceed 400 psig at the compressor discharge. Switch dead bands should be 80 to 120 psig. Consideration must be given as to the pressure drop from the compressor discharge to the actual switch location when determining actual setting values.

MOUNTING - The switch should be located on the sight glass - moisture indicator assembly, receiver drier or expansion valve inlet.

CONNECTIONS - The electrical terminals should match the existing switch and be protected by a boot, connector, or sealant material to prevent corrosion.

NOTE: This switch function may be contained in a multi-function pressure switch such as the Trinary or Binary switches.

HIGH SIDE LOW PRESSURE SWITCH

The function of the switch is to disengage the compressor clutch in the event of refrigerant loss. The switch should be located near the receiver drier or the expansion valve. The existing vehicle switch should be used whenever possible. If a new design is required, the following design attributes apply:

SETTINGS - The pressure settings shall comply with the recommendations of the compressor manufacturer. A typical value is 30 psig.

MOUNTING - The switch should be located on the sight glass - moisture indicator assembly, receiver drier or expansion valve inlet.

CONNECTIONS - The electrical terminals should match the existing vehicle and be protected by a boot, connector, or sealant material to prevent corrosion.

NOTE: This switch function may be contained in a multi-function pressure switch such as the Trinary or Binary switches.

LOW SIDE LOW PRESSURE SWITCH

The function of the switch is to disengage the compressor clutch in the event of partial refrigerant loss or a circuit restriction. Currently, very few R-12 systems employ this switch. Those that do, the existing vehicle switch should be used whenever possible. If a new design is required, the following design attributes apply:

SETTINGS - The pressure settings shall comply with the recommendations of the compressor manufacturer. A typical setting would be 8 psig. Consideration must be given as to the pressure drop from the compressor inlet to the actual switch location when determining actual setting values.

MOUNTING - The switch should be located on the compressor suction line.

CONNECTIONS - The electrical terminals

should be protected by a boot, connector, or sealant material to prevent corrosion.

FAN OVERRIDE SWITCH

The switch is installed in the high side of the system on any vehicle that uses an on-off engine cooling fan to provide auxiliary air flow across the a/c condenser. The function of the switch is to ensure air flow across the condenser above a predetermined a/c system pressure. The switch may also be used to control electric drive fans on remote mounted condensers. The existing vehicle switch should be used whenever possible. If a new design is required, the following design attributes apply:

SETTINGS - The pressure settings shall comply with the recommendations of the compressor manufacturer and the performance characteristics of the condenser. A typical setting would 250 psig fan on, with fan off 40 to 60 psig lower. Consideration must be given as to the pressure drop from the compressor discharge to the actual switch location when determining actual setting values.

MOUNTING - The switch should be located on the sight glass - moisture indicator assembly, receiver drier or expansion valve inlet.

CONNECTIONS - The electrical terminals should be protected by a boot, connector, or sealant material to prevent corrosion.

NOTE: This switch function may be contained in a multi-function pressure switch such as the Trinary or Binary switches.

R-134a RETROFITS RECOMMENDED PRACTICES

These guidelines are the preferred methods to be followed but are not mandatory.

GENERAL GUIDELINES:

1. As long as R-12 is available it should be your first service option.
2. If retrofitting is required, use a O.E.M. authorized retrofit kit or procedure. Remember, anything will work for a short period of time, our goal is long term reliability. The auto industry is developing low cost "dirty changeovers" to service older cars. There is a big difference in the operational life in a four or five year car than a heavy duty vehicle.
3. When considering a retrofit, know the history of the vehicle. Does the a/c system work well as an R-12 system? Can the system tolerate a 20 to 25 psi head pressure increase? Or are you going to have problems with the system pressure protection switches? What type of climate is the vehicle going to operate in? Is this the best decision for the customer?
4. There is no substitute for using the proper components, use only what is offered from the O.E.M. or the vehicle specific retrofit kit.
5. Comply with SAE recommended practices J-1660 and J-1661.

KEY COMPONENT SUMMARY

COMPRESSOR - Note the type, condition and age of the compressor. Use your own judgment or let the customer make the call on whether or not to replace it.

CONDENSER - When R-134a is used in an R-12 system, operating pressures generally run about 20 psi higher (see pressure temperature chart on page 13 for actual operating differences). If this is acceptable, the existing condenser can be used. If operating pressures are already marginal, as in some existing systems, a larger condenser should be added. Try to follow the O.E.M. guidelines, if known.

RECEIVER DRIER - Always replace the receiver drier. Many new receiver driers are being built with XH-7 or XH-9 desiccant which are compatible with both R-12 and R-134a. But, a drier that has been in service will have collected moisture, contaminants, and lubricant. It is good insurance to start with a clean component. R-134a is more sensitive to the presence of free moisture. A receiver drier with more desiccant (such as 15 cubic inches in place of 12 cubic inches) is a great idea.

EXPANSION VALVE - Beginning in 1993, many expansion valves were being charged with R-134a. These valves work equally well with R-12 and R-134a. Even a TXV charged with R-12 will work fairly well with R-134a. If the valve is clean and functioning, it can be reused with little risk.

EVAPORATOR - The evaporator coil does not require replacement. It should be removed and drained of lubricant whenever possible.

HOSES - R-134a will permeate through rubber hose much faster than R-12. A nylon barrier hose is much better for either refrigerant but essential with R-134a. Non-barrier hoses in an R-12 system can develop a natural barrier through the absorption of mineral oil into the hose material over time making complete hose replacement not a requirement. Nylon barrier hose is the only alternative for any new hose assemblies.

Hose replacement is costly but the customer should be advised of the risk of possible replacement at a later date.

SEALS AND O-RINGS - Certain seals and o-rings in older systems are not compatible with R-134a and their lubricants. The best bet is to change o-rings with a known material such as neoprene or HNBR. Since changing every seal isn't always practical, if after visual inspection, the connection looks good, and will not be disturbed during the retrofit process, then don't replace it.

SERVICE PORTS - The R-12 service ports, most often Schrader type fittings, must be removed or converted to R-134a service ports.

R-134A REFRIGERANT AND LUBRICANT OIL HANDLING PRACTICES

1. Always wear protective goggles and gloves when working with R-134a refrigerant, lubricant oil or a/c system. Avoid contact with skin and eyes.
2. Take the necessary precautions when servicing an a/c system while under pressure, and avoid releasing refrigerant into the atmosphere.
3. If accidental release occurs, evacuate the area, avoid breathing refrigerant/lubricant vapor or mist. Vapors may concentrate near the floor or low spots and displace the oxygen available for breathing, causing suffocation. Ventilate the work are before resuming service. Use auxiliary ventilation at floor level, if necessary, to move vapors.
4. Use only approved recycle/recovery equipment meeting SAE/UL Standards.
5. Never use compressed air or oxygen to purge or leak test any R-134a refrigerant container, component or system. R-134a in the presence of air or oxygen and pressurized is *combustible*. R-134a may be safely pressurized with dry nitrogen.
6. When charging use or a calibrated charging machine or weight scale for proper charge determination.
7. Use only an approved heating device for dispensing R-134a. Do not heat or store refrigerant containers or recycling/recovery equipment at temperatures above 125 Deg. F. (52 Deg. C).
8. Never mix refrigerants or lubricants.
9. R-134a lubricants pickup moisture quickly. Keep the lubricant container capped. Do not expose the lubricant to air for any length of time.
10. When removing or installing a/c system components, cap all fittings to minimize moisture absorption.
11. Always review and have available the material safety data sheet (MSDS) provided by the manufacturer of the refrigerant or lubricant. It contains the safe and proper handling information for the product as well as the instructions for emergency situations.

GENERAL RETROFIT PROCEDURE

STEP 1
INSPECT AND SURVEY THE SYSTEM

- Discuss vehicle history with the customer.
- Conduct a visual inspection of the system, noting any signs of wear or leaks.
- Confirm the system is charged with R-12.
- Survey the system and determine what components need changing. If a kit is available from the original manufacturer your job is made easier. If not, review each component and make a judgment call.

STEP 2
PERFORMANCE CHECK THE SYSTEM

- Attach a R-12 manifold gauge set to confirm the presence of refrigerant. If there is positive pressure continue, if not, go to step 3.
- Energize a/c unit, set the fan speed to low, if a dual system, also energize the auxiliary a/c unit and set it's fan speed to low.
- Allow the system to run for several minutes, note the a/c outlet temperature, high and low pressure readings, and sight glass. If the system is fully charged and operating normally proceed to step 4.

STEP 3
LEAK-CHECK THE SYSTEM

- Visually inspect the system for signs of leakage.
- If a partial charge exists, check possible leak points with an R-12 leak detector.
- Repair any obvious problems.
- Recharge and confirm system is operating normally.

STEP 4
RECOVER THE R-12 REFRIGERANT

- Run the system for at least ten minutes, to get as much oil into the compressor.
- Using your R-12 recovery/recycle equipment, remove the R-12.

STEP 5
REMOVE THE REFRIGERANT OIL

- Remove the compressor and drain oil if compressor is to be reused.
- Flush the system with R-12, if possible, then recover the R-12.
- If flushing is not possible, removing the evaporator or evaporators and draining can be effective for removing oil.
- Allow any residual oil to drain from the hoses.

STEP 6
REPLACE THE RECEIVER-DRIER

- Remove the R-12 receiver-drier and discard.
- Allow any residual oil to drain from the hoses.
- Replace o-rings with R-134a compatible o-rings.
- Install R-134a compatible receiver-drier.

STEP 7
INSTALL THE REMAINING *NEW* R-134A COMPONENTS

- Install new TXV if required.
- Replace any disturbed o-rings with R-134a compatible o-rings.
- Install new compressor.

  If using the existing compressor:
  - Thoroughly drain the existing oil.

- Add the manufacturer's specified refrigerant oil, in the amount specified.
- Manually turn the compressor shaft two or three times to prevent any liquid compression.
- Clean the compressor drain plug.
- Replace the drain plug o-ring with a R-134a compatible o-ring.
- Install drain plug.

- Clean and install new compressor port seals.
- Add any additional refrigerant oil which may be required beyond the capacity of the compressor in the suction line of the compressor.
- Re-attach compressor hoses.
  NOTE: Coat seals and o-rings lightly with R-134a lubricant to insure proper sealing. *Mineral oil is an acceptable alternative for coating seals and o-rings, if concerns over safe handling of R-134a lubricants exist.*

STEP 8
INSTALL R-134A SERVICE PORTS

- Disable or remove R-12 service ports.
- Permanently install R-134a quick connect service ports.

STEP 9
DRAW EXTENDED DEEP VACUUM

- Attach R-134a Service manifold.
- Attach vacuum pump. The pump must be capable of a vacuum of 29.2 in. Hg. minimum at sea level (subtract one inch for every 1,000 foot increase in altitude).
- Evacuate for a minimum of 45 minutes for a single evaporator system, or 60 minutes for a dual or long hose systems.

STEP 10
CHARGE WITH R-134A

- Remove the vacuum pump.
- Attach the R-134a charging equipment.
- Charge to the recommended charge level, if known. Otherwise, charge to 90% of recommended R-12 charge.

STEP 11
PERFORMANCE TEST

- Energize a/c unit, set the fan speed to low, if a dual system, also energize the auxiliary a/c unit and set it's fan speed to low.
- Allow the system to run for several minutes, note the a/c outlet temperature, high and low pressure readings, and sight glass.
- If operating normally, shut the vehicle off.
- Remove R-134a service equipment.
- Replace service port caps.

STEP 12
FINAL LEAK CHECK THE SYSTEM

- Perform a leak check with a R-134a leak detector. (per SAE J-1628)

STEP 13
LABEL RETROFITTED SYSTEM

- Replace R-12 compressor label, if necessary.
- Replace the original system's label with one showing the retrofit to R-134a. Include the amount of refrigerant, and the amount and type of lubricant that was added per SAE J-1660.
- Remove all reference to the previous refrigerant, including noting the vehicle's glove box and or owner's manual.

PRESSURE TEMPERATURE CHART

Degrees Fahrenheit	Degrees Celsius	R-134a	R-12
-30	-34.4	**9.8*	**5.5*
-25	-31.7	**6.9*	**2.3*
-20	-28.9	**3.7*	0.6
-15	-26.1	0.0	2.4
-10	-23.3	1.9	4.5
-5	20.6	4.1	6.7
0	-17.8	6.5	9.2
5	-15.0	9.1	11.8
10	-12.2	12.0	14.6
15	-9.4	15.0	17.7
20	-6.7	18.4	21.0
25	-3.9	22.1	24.6
30	-1.1	26.1	28.5
35	1.7	30.4	32.6
40	4.4	35.0	37.0
45	7.2	40.0	41.7
50	10.0	45.3	46.7
55	12.8	51.1	52.0
60	15.6	57.3	57.7
65	18.3	63.9	63.8
70	21.1	70.9	70.2
75	23.9	78.4	77.0
80	26.7	86.4	84.2
85	29.4	94.9	91.8
90	32.2	103.9	99.8
95	35.0	113.5	108.3
100	37.8	123.6	117.2
105	40.6	134.3	126.6
110	43.3	145.6	136.4
115	46.1	157.6	146.8
120	48.9	170.3	157.7
125	51.7	183.6	169.1
130	54.4	197.6	181.0
135	57.2	212.4	193.5
140	60.0	227.9	206.6
145	62.8	244.3	220.3
150	65.6	261.4	234.6
155	68.3	279.5	249.5
160	71.1	298.4	265.1
165	73.9	318.3	281.4
170	76.7	342.0	298.3
180	82.2	385.9	334.3

All pressure values (except as noted) are PSIG
* Denotes values in - inches Hg. Vacuum