GUIDELINES FOR THE UTILIZATION OF

R134a

R513A

GUIDELINES FOR THE UTILIZATION OF R134a AND R513A

For many years, R134a has emerged as the industry's major choice as an alternative refrigerant for R12. Due to the changing environmental landscape refrigerant manufacturers have introduced HFO blends with a much lower Global Warming Potential (GWP). To accommodate the industry R513A has been tested and approved by Tecumseh as a suitable replacement for R134a.

While R513A is a viable option for new and existing equipment, it is not a "drop-in" replacement for R12 or R134a. There are significant differences between R12, R134a, and R513A, which must be considered when handling, processing, applying, or retrofitting with these refrigerants. These guidelines are offered to help understand the differences.

NOTE: R134a can be charged in either the liquid or vapor state. R513A is an azeotrope and ***must*** be charged in the liquid phase. Any Tecumseh compressor with the letter "Y" as the refrigerant designation code in the model number can be used with either R134a or R513A.

REFRIGERANT PROPERTIES

A. Pressure/temperature table for R12, R134a, and R513A is shown in *Figure 1*.

Temperature		Pressure					
°F	°C	PSIG			KPa		
		R12	R134a	R513A	R12	R134a	R513A
-40	-40	-5.4	-7.3	-5.8	-37.2	-50.1	-39.9
-30	-34	-2.7	-4.8	-3.0	-18.7	-33.3	-20.8
-20	-28	0.5	-1.8	0.4	3.8	-12.4	2.7
-10	-23	4.5	1.9	4.5	30.8	13.3	31.3
0	-18	9.1	6.5	9.5	62.9	44.6	65.6
10	-12.2	14.6	11.9	15.5	100.6	82.3	106.5
20	-9	21.0	18.4	22.4	144.7	127.1	154.8
30	-1	28.4	26.1	30.6	195.7	179.9	211.2
40	4.4	36.9	35.0	40.1	254.4	241.6	276.6
50	10	46.6	45.4	51.0	321.3	313.3	351.9
60	15.6	57.6	57.4	63.5	397.3	395.8	438.1
70	21.1	70.1	71.1	77.7	483.1	490.3	536.0
80	26.7	84.0	86.7	93.8	579.3	597.7	646.8
90	32.2	99.6	104.3	111.9	686.7	719.3	771.4
100	37.8	116.9	124.2	132.1	806.1	856.1	910.9
110	43.3	136.1	146.4	154.7	938.4	1009.3	1066.4
120	48.9	157.3	171.2	179.7	1084.4	1180.2	1239.3
130	54.4	180.5	198.7	207.5	1244.8	1370.1	1430.5
140	60	206.0	229.2	238.1	1420.6	1580.5	1641.7
150	65.6	233.9	262.9	271.8	1612.8	1812.8	1874.3

Figure 1

B. R134a and R513A possess similar energy efficiency and capacity characteristics to R12.

C. *Figure 2* shows the comparison of some properties of R12, R134a, and R513A.

D. Water Solubility: Liquid R134a and R513A can absorb **much** more water than R12 therefore it would be less likely for a low temperature system to exhibit capillary tube blockage due to ice buildup. However, this does not reduce the need for a dry system. See Section B under (Lubricants).

E. Extensive investigation and testing have been conducted to determine that R134a, and R513A are compatible with all materials used in Tecumseh Products' hermetic compressors and condensing units.

Refrigerant Comparison	R12	R134a	R513A
Refrigerant Type	CFC	HFC	HFO-BLEND
ASHRAE Safety Designation	A1	A1	A1
GWP	10900	1430	573
Approved Oil	MINERAL/AB	POE	POE
Temperature Glide (K / °F)	0 / 0	0 / 0	0 / 0
Boiling point at 1 bar (°C / °F)	-45.2 / -49.5	-46.5 / -51.7	-47 / -52.6
Critical temperature (°C / °F)	80.7 / 177.3	72.1 / 161.8	74.9 / 166.8
Critical pressure (bar abs / PSIG)	318.4 / 605.2	37.3 / 541	40.0 / 580.2

Figure 2

R134a, and R513A are non-flammable. They have been assigned an A1 safety classification under ASHRAE 34 and EN 378 standards. A1 means that the substance is classified “non-dangerous” with the following nomenclature.

A = Low toxicity
1 = No flame propagation at 18°C / 64.4°F, 101300 Pa / 14.7 psi.

Composition	R12	R134a	R513A
R134a	0%	100%	44%
R1234yf	0%	0%	56%

Figure 3

F. Chemical Stability

When decomposed, refrigerants generate fluoride ions and organic acids, causing POE oil degradation (PVE is less a concern), leading to corrosion of expansion valves, capillary tube plugging, and compressor bearing wear.

G. Refrigerant Glide

Blend refrigerants such as R513A boil and condense at varying temperatures for a given pressure. The range over which the temperature varies is referred to as “temperature glide”.

LUBRICANTS - POLYOL ESTERS (POE's)

A. Miscibility

1. Miscibility is the ability of the lubricant and the refrigerant to mix. This miscibility is a very important factor in the returning of the lubricant to the compressor in a refrigeration system over its range of operating temperatures.
2. R134a / R513A and mineral oils are **not miscible.**
3. Polyol ester oils and R134a / R513A **are miscible.**

B. Moisture

1. Polyol ester oils, while not as hygroscopic (ability to absorb moisture) as earlier considered PAG's (polyalkylene glycols), are **100 times** more hygroscopic than mineral oils. This moisture is difficult to remove even with heat and vacuum.
2. **Utmost care must be taken to prevent moisture from getting into the refrigeration system.** Do not leave the compressor or system open to the atmosphere for longer than 15 minutes maximum. The preferred method of assembly would be to remove system component plugs and caps just prior to brazing. The maximum system moisture content after completing system processing should be 80 PPM.

   After running the system with the appropriate drier installed, the system moisture level should be 10 PPM or less. These levels are based on measuring moisture in liquid refrigerant samples taken from the system.
3. **Always** use an appropriate drier in the system when using R134a and R513A. (See section on DRIERS.)

C. Compatibility

1. Extensive investigation and testing have been conducted by Tecumseh Products Company to determine that the polyol ester lubricants **approved by Tecumseh** are compatible with all materials used in Tecumseh hermetic compressors. Contact your Tecumseh sales representative for the latest list of approved oils. (Policy Bulletin No. 105.)
2. All polyol ester oils approved by Tecumseh Products are compatible with each other.
3. While polyol ester oils are compatible with mineral oils, they should not be indiscriminately mixed with mineral oils in R134a and R513A refrigerant systems. This practice could result in the inability of the oil to return to the compressor and/or reduce heat transfer performance in the evaporator. However, small amounts, up to 5% of mineral oil are acceptable in field retrofit situations (1% or less is preferred)

SYSTEM DESIGN

A. Compressor selection: Tecumseh is continuing to design R134a and R513A compressors with the compatibility of oil, refrigerant and materials in mind. These compressors will have the letter **"Y"** as the refrigerant designator, e.g. **AE4440Y-AA1A.** It will be necessary to test each compressor selection in the applications to determine its suitability, since system operating conditions vary greatly from one application to another.

B. Capillary tube selection: **In general**, Capillary tubes selected for R12 and R134a applications should be adequate for a preliminary selection for R513A. As with any capillary tube selection, system testing is necessary to determine the proper final selection.

C. Expansion valve selection: The expansion valve manufacturers have designed product specifically for use with R134a and R513A. Consult them for their recommendations.

D. Driers: Tecumseh requires that an appropriate drier be used on every R134a and R513A system. See section on DRIERS.

E. Return gas/discharge temperatures: The theoretical discharge temperature for R12 is **slightly** lower than that of R134a and R513A at similar conditions. Therefore, existing compressor guidelines regarding return gas and discharge temperatures for R12 should apply to R134a and R513A compressors as well. In general, keeping the return gas cool without flooding liquid refrigerant back to the compressor is beneficial in limiting compressor discharge and motor temperatures to acceptable levels.

F. Refrigerant quantity: The refrigerant quantity will depend on the system components. **In general,** based on limited application data, 5% to 20% less R134a will be needed compared to R12 and 3% to 5% less R513A compared to R134a.

DRIERS

A. The polyol ester oils, which are used with R134a and R513A, are prone to hydrolyze with moisture, resulting in the formation of acids. Therefore, Tecumseh requires that an appropriate drier be used in every R134a / R513A application.

B. The types of driers, which should be used, are the molecular sieve types, which are presently compatible with R134a and R513A. The XH-6 **(bonded core),** XH-7 and XH-9 types are recommended. The XH-6 (loose fill) type is not recommended due to its somewhat higher attrition rate.

C. Solid core driers if made with bauxite would have the tendency to absorb both polyol ester oil and moisture. The ester could hydrolyze and form acidic materials. If the drier were to be overloaded due to excessive moisture in the system, it could release the acidic materials back into the system. Clearly this would **not** be healthy for the compressor. **For this reason, Tecumseh does not recommend the use of solid core driers made with bauxite for systems containing polyol ester oils.**

D. For specific drier selection, contact your drier supplier.

SYSTEM PROCESSING

A. Compatibility

1. Polyol ester oils are good solvents and have a tendency to wash system processing materials such as drawing components, rust inhibitors and cleaning compounds from system sur- faces. Care must be taken to remove such processing materials from all the system components.

2. Residual chlorinated materials **should** be considered as system contamination and eliminated from all internal surfaces of the refrigeration system.

B. Evacuation

1. The evacuation levels for R134a and R513A systems should be the same as for R12 systems (minimum of 200 microns at the system and pulled from both the low and high-pressure sides of the system. If care is not taken to prevent moisture from entering the system components prior to assembly, evacuation could be expected to take longer to achieve acceptable limits of system moisture and non-condensibles. Tecumseh recommends a maximum of 2% non-condensibles and 80 PPM moisture. The completed system should have a moisture level of 10 PPM or less after running with an appropriate drier installed. These levels are based on measuring moisture in liquid refrigerant samples taken from the system.

2. Polyol ester oils vaporize much less than mineral oils for the same level of heat and vacuum. Therefore, if oil vaporization was not a problem with the R12 system processing, it should not be a problem with the R134a and R513A system processing.

C. Leak Testing

1. Use equipment, which is designed for R134a and R513A leak detection or approved for use with R134a/R513A by the manufacturer. Many leak detector manufacturers have R134a and R513A detectors on the market, consult these manufacturers for their recommendations on their equipment.

2. **CAUTION:** ***Do not*** attempt to use R134a or R513A as a mixture with air to pressure test for leaks.

D. Refrigerant Charging

1. In general, refrigerant charging equipment such as charging boards, valves, and hoses, which are compatible with HFC refrigerants, should be compatible with R513A. Some equipment may need to be recalibrated for use with R513A. Converted R12 equipment should be clean of all residual R12. Pulling a deep vacuum (25 to 50 microns) and repeated flushing with R134a/R513A should be sufficient. Consult your equipment and component manufacturer for specific recommendations for converting R12 equipment for use with R134a/R513A.

2. R134a can be charged in either the liquid or vapor state, R513A on the other hand must be charged in a liquid state. When refrigerant charging is done in the liquid state, it should be done into the liquid line or receiver. Liquid charging can be done into the suction line while the compressor is running if the refrigerant is SLOWLY metered through a liquid charge adaptor or similar devise. (The preferred method of charging any refrigerant is to charge liquid into the liquid line or receiver.)”

RETROFITTING

The ideal situation regarding the use of R134a and R513A would be that it be limited to new equipment only. In this way, the system components would all be selected and tested by a system designer with the necessary concerns regarding R134a and R513A and polyol ester oils in mind. However, in the real world of today with millions of existing R12 systems in the field, this would not be possible.

Therefore, we offer some **general** guidelines to those who must retrofit existing R12 units in the field with R134a or R513A. Specific procedures can only be determined after an in-depth evaluation of the existing equipment. Contact the equipment OEM for specific details.

A. Replacing an R12 compressor with an R134a/R513A ("Y") compressor: Use generally accepted system changeout procedures, taking special effort not to leave the system or the R134a/R513A compressor open to the atmosphere for more than a few minutes (15 minutes maximum).

1. Recover the R12 refrigerant in the system using proper recovery equipment. Take special effort to remove any residual mineral oil left in the system. The remaining mineral oil should be 5% or less.
2. Refit the system with the proper capillary tube, expansion valve, or other appropriate expansion device.
3. Install a drier suitable for R134a/R513A of suitable size for the system being retrofitted.
4. Install the proper Tecumseh R134a/R513A ("Y") compressor containing polyol ester oil. ***Be sure to use the correct electrical components: they could differ from those used with the R12 compressor.***
5. Evacuate the system thoroughly. Break the system vacuum with R134a (liquid), or R513A (liquid) into the liquid line.
6. Charge the system using industry acceptable charging methods with the proper amount of R134a or R513A.
7. Check the system for proper operation.
8. After retrofitting an R12 system with R134a or R513A, always identify the system as being charged with that refrigerant and containing a polyol ester oil. Indicate on the unit the amount of refrigerant used.
9. Tecumseh compressors, which have refrigerant designation codes other than “Y”, are **NOT** approved for use with R134a and R513A.

B. Refrigerant Change Out Only (Existing R134a System to R513A):

1. Establish baseline performance with R134a.
2. Disconnect power.
3. Recover R134a refrigerant from the system using proper recovery equipment. Weigh and record the amount.

4. Replace liquid line filter drier with a drier that is compatible with the replacement refrigerant.

5. R513A has similar mass flow rates to R134a so, TXV settings may be retained with minor adjustments.

6. Leak test using nitrogen (refer to Tecumseh's Service Handbook for proper leak test procedure). When pressure testing confirms that the system is free of leaks, evacuate the system thoroughly. Air, moisture and non-condensables must be removed to ensure long term compressor reliability. Evacuate to a minimum of 500 microns. Always use a vacuum gauge to measure vacuum levels.

7. Recharge with R513A refrigerant in the liquid state to 85% of the original R134a name plate charge or weighed amount. Depending on the application and system design, refrigerant charge may vary. Generally, the system will use less than that used with R134a.

8. Label Equipment indicating charged with R513A.

C. Performance Comparison

Reference Figures 4 and 5 below for an estimated compressor capacity and efficiency comparison to R404A. The information is based on calorimeter data at AHRI (LBP/MBP) rating points. The results may vary depending on the compressor platform.

Capacity Relative to R-134a		
Refrigerant	**Evaporator Temperature**	
	Low	**Medium**
R-513A	99%	100%

Figure 4

COP Relative to R-134a		
Refrigerant	**Evaporator Temperature**	
	Low	**Medium**
R-513A	104%	102%

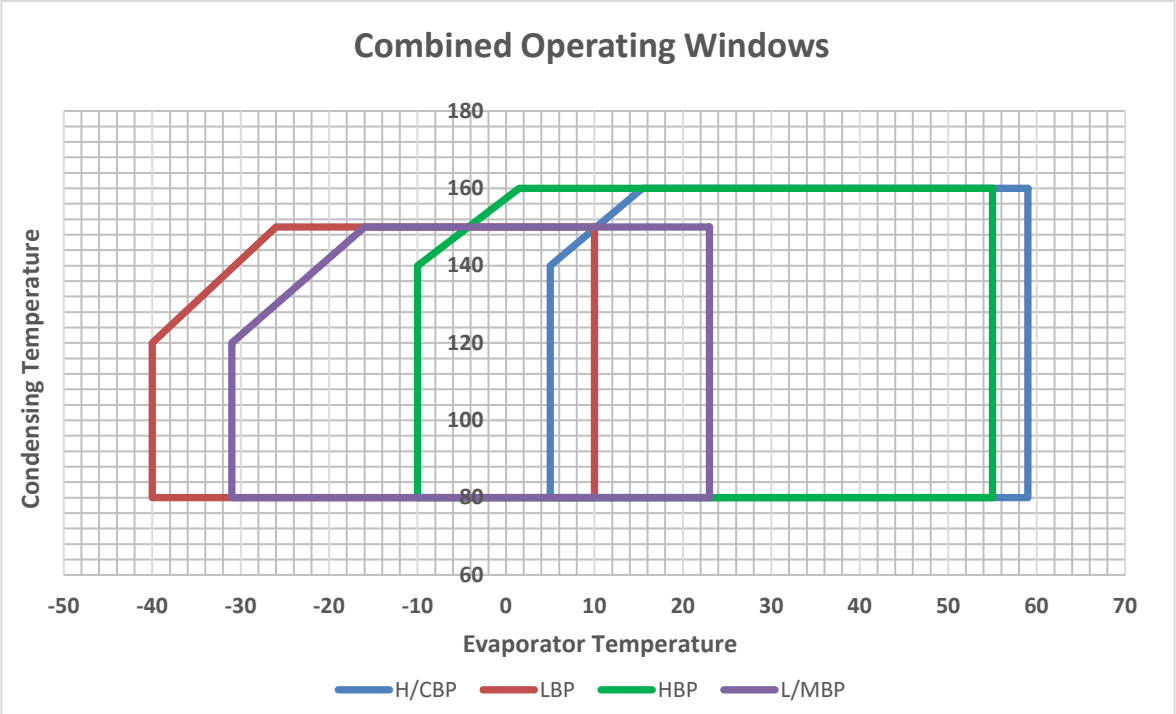
Figure 5

COMPRESSOR OPERATING WINDOW

A. Application Boundaries

The operating windows shown on pages 8-9 are provided as guidelines only and need to be adjusted based on the specific compressor applied and the overall design of the refrigeration system

R134a / R513A APPLICATION BOUNDARIES (°F)



R134a / R513A APPLICATION BOUNDARIES (°C)