



GUIDELINES FOR THE UTILIZATION OF

R-407A

R-448A

R-449A



Tecumseh

R-407A, R-448A, and R-449A are recognized as suitable alternative refrigerants for R-404A in Low and Medium temperature applications.

R-407A, R-448A, and R-449A are zeotropic blends of hydro fluorocarbon or HFC compounds, with some comprised of a different percentage of HFC and HFO compounds. They have no chlorine content, no ozone depletion potential, and a modest direct global warming potential.

R-407A, R-448A, and R-449A are **NOT** “drop-in” replacements for R-404A. There are differences that must be considered when handling, processing, and applying to new and existing equipment. These guidelines are offered to assist in understanding the differences.

R-407A, R-448A, and R-449A should only be used in Tecumseh hermetic compressors and condensing units approved for these refrigerants.

REFRIGERANT PROPERTIES

A) Pressure / Temperature Table of R-404A vs. R-407A, R-448A, and R-449A is shown in Figure 1.

Figure 1

Temperature		Pressure							
°F	°C	PSIG				KPa			
		R-404A	R-407A	R-448A	R-449A	R-404A	R-407A	R-448A	R-449A
-40	-40.0	4.3	-0.9	4.9	4.5	29.6	-6.2	33.8	31.3
-30	-34.0	9.6	3.2	10.4	9.9	66.1	22.0	71.6	68.4
-20	-28.0	16.0	8.4	17.0	16.4	110.2	57.9	117.1	113.2
-10	-23.0	23.6	14.8	24.9	24.2	162.6	102.0	171.4	166.7
0	-18.0	32.6	22.5	34.2	33.4	224.6	155.0	235.6	229.9
10	-12.2	43.1	31.6	45.1	44.1	297.0	217.7	310.7	303.8
20	-9.0	55.3	42.3	57.8	56.6	381.0	291.4	397.9	389.7
30	-1.0	69.3	54.8	72.3	70.9	477.5	377.6	498.4	488.7
40	4.4	85.3	69.3	89.0	87.4	587.7	477.5	613.3	602.0
50	10.0	103.6	86.0	108.0	106.1	713.8	592.5	744.0	730.8
60	15.6	124.2	105.2	129.4	127.2	855.7	724.8	891.7	876.5
70	21.1	147.4	126.9	153.5	151.0	1015.6	874.3	1057.7	1040.3
80	26.7	173.4	151.5	180.5	177.6	1194.7	1043.8	1243.4	1223.5
90	32.2	202.4	179.3	210.5	207.2	1394.5	1235.4	1450.1	1427.6
100	37.8	234.6	210.4	243.7	240.1	1616.4	1449.7	1679.3	1654.0
110	43.3	270.3	245.2	280.5	276.4	1862.4	1689.4	1932.4	1904.1
120	48.9	309.8	284.0	320.9	316.3	2134.5	1956.8	2211.0	2179.6
130	54.4	353.5	327.1	365.3	360.2	2435.6	2253.7	2516.6	2482.0
140	60.0	401.7	375.0	413.8	408.3	2767.7	2583.8	2850.9	2813.0
150	65.6	455.0	428.3	466.7	460.7	3135.0	2951.0	3215.5	3174.4

Black = Saturated Vapor
Black = Saturated Liquid

Green = (in Hg) Vacuum



REFRIGERANT PROPERTIES (Cont'd)

B) Data Comparing R-404A to R-407A, R-448A, and R-449A. See figure 2.

Figure 2

Refrigerant Comparison	R-404A	R-407A	R-448A	R-449A
ASHRAE Safety Designation	A1	A1	A1	A1
GWP	3922	2107	1273	1397
Approved Oil	POE	POE	POE	POE
Temperature Glide (°C / °F)	-1 / 2	-4 / 8	-13.8 / 7	-14 / 6.8
Boiling point at 1 bar (°C / °F)	-46.5 / -51.7	-38.9 / -38.0	-45.9 / -50.7	-46.0 / -50.7
Critical temperature (°C / °F)	72.1 / 161.8	82 / 179.6	83.6 / 182.6	81.5 / 178.7
Critical pressure (bar abs / PSIG)	37.3 / 541	45.2 / 654.8	45.5 / 660.9	44.1 / 640.3

1. R-407A, R-448A, and R-449A 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.

2. However, because R-407A, R-448A, and R-449A contain R-32 which is mildly flammable, they should not be mixed with air to check for system leaks. This type of mixture can become combustible. See Figure 3.

Figure 3

Composition	R-404A	R-407A	R-448A	R-449A
R-134a	4%	40%	21%	26%
R-125	44%	40%	26%	25%
R-143a	52%	0%	0%	0%
R-32	0%	20%	26%	24%
R-1234yf	0%	0%	7%	25%
R-1234ze	0%	0%	20%	0%

C) 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.



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D) Compatibility

R-407A, R-448A, and R-449A are compatible with all materials used in Tecumseh hermetic compressors and condensing units.

E) Refrigerant Glide

Blend refrigerants such as R-407A, R-448A, and R-449A boil and condense at varying temperatures for a given pressure. The range over which the temperature varies is referred to as “temperature glide”.

F) Bubble and Dew Point

For blend refrigerants, such as R-407A, R-448A, and R-449A use the “dew” (vapor) pressure to calculate superheat. To calculate subcooling use the “bubble” (liquid) pressure.

POLYOL ESTERS (POE's) and POLYVINYL ETHERS (PVE's)

A) Miscibility

1. Miscibility is the ability of the lubricant and the refrigerant to mix. This miscibility is a very important factor in providing proper heat transfer and in returning lubricant to the compressor in a refrigeration system over its range of operating temperatures.
2. R-407A, R-448A, and R-449A are ***not miscible*** with Mineral oils (MO), and Alkylbenzene (AB) oils
3. Polyol Ester (POE) as well as Polyvinyl Ether (PVE) oils ***are miscible*** with R-407A, R-448A, and R-449A.

B) Moisture

1. Polyol ester and polyvinyl ether oils are ***100 times*** more hygroscopic (ability to absorb moisture) than MO or AB 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 10 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 R-407A, (See System Cleanliness).

C) Compatibility

Extensive investigation and testing have been conducted by Tecumseh to determine that Polyol ester and Polyvinyl ether 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 or see (Policy Bulletin No. 105).

SYSTEM DESIGN

A) Compressor Selection

Only use Tecumseh compressors approved for use with R-407A, R-448A, and R-449A.

B) Expansion Valve Selection

Expansion valve manufacturers have designed products specifically for use with R-407A, R-448A, and R-449A. Consult the manufacturers for their recommendations.



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C) Capillary Tubes

Capillary tubes are not recommended when using R-407A, R-448A, and R-449A in low temperature applications. The higher operating temperatures can result in capillary tube plugging. Tecumseh recommends the use of thermostatic expansion valves.

D) Driers

Tecumseh requires that an appropriate drier be used on every R-407A, R-448A, and R-449A system. See the next section on system cleanliness for more information on driers.

SYSTEM CLEANLINESS

A) Driers

1. Synthetic lubricants (POE, PVE) are prone to hydrolyze with moisture resulting in the formation of acids. Tecumseh requires that an appropriate drier be used in every R-407A, R-448A, and R-449A application.
2. The types of driers which should be used are the molecular sieve or solid core types that are compatible with R-407A, R-448A, and R-449A. Loose fill driers are not recommended.
3. For specific drier selection, contact your drier supplier.

SYSTEM PROCESSING

A) Compatibility

1. Polyol ester and Polyvinyl ether oils are good solvents and have a tendency to wash system processing materials such as drawing components, rust inhibitors, and cleaning compounds from system surfaces. Care must be taken to remove such processing materials from all the system components.
2. Residual chlorinated materials **should** be considered system contamination and eliminated from all internal surfaces of the refrigeration system.

B) Evacuation

1. The evacuation levels for R-407A, R-448A, and R-449A systems should be the same as R-404A 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 time could take longer to achieve acceptable limits of system moisture and non-condensable. Tecumseh recommends a maximum of 2% non-condensable 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 and Polyvinyl ether oils vaporize much less than mineral oils at the same level of heat and vacuum. Therefore, if oil vaporization was not a problem with the R-404A system processing, it should not be a problem with the R-407A, R-448A, and R-449A system processing.

C) Leak Testing

Use normal service practices to check the system for leaks. Many leak detector manufacturers have detectors on the market designed for R-407A, R-448A, and R-449A. Consult these manufacturers for their recommendations on the appropriate equipment.



Tecumseh

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D) Refrigerant Charging

1. R-407A, R-448A, and R-449A are zeotropic refrigerants and must be charged in the liquid state into the liquid line or receiver. Vapor charging can change the refrigerant composition which will change system performance and could result in damage to the system.
2. 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 reliability.
3. Break the system vacuum by charging R-407A, R-448A, and R-449A as a “*liquid refrigerant*” into the liquid line or receiver. **CAUTION: Never start the compressor while it is under a deep vacuum.**

E) Pressure Controls

It may be necessary to adjust the pressure cutouts for low and high pressure controls. This is very important as the controls must be adjusted so the system operating pressures do not exceed the compressors operating window. See Compressor Reliability for approved operating limits.

F) Line Sizing

Due to the difference in density and mass flow when compared to R-404A the refrigerant line size should be checked when using R-407A, R-448A, and R-449A. This will confirm there are no negative effects on system capacity and oil return.

COMPRESSOR RELIABILITY

A) Discharge Line Temperature

1. Laboratory testing has proven that R-407A, R-448A, and R-449A have a higher discharge temperature compared to R-404A especially at low evaporating temperatures. Because of this, certain precautions must be followed to maintain compressor reliability.
2. Tecumseh **requires** that discharge gas temperatures are maintained below 120°C (248°F).
3. If discharge temperatures cannot be maintained within acceptable limits a TREV (temperature responsive expansion valve) will be required to keep return gas temperatures down.
4. A discharge thermostat is also recommended to protect the compressor from high discharge temperatures.

B) Return Gas Temperatures / Superheat

See Compressor Operating Window pages 7-9 for limits.

C) Compressor Cooling

For any application using R-407A, R-448A, and R-449A we highly recommend sufficient compressor fan cooling especially at low evaporating temperatures.

D) Sound Blankets

Do not insulate the compressor with a sound blanket or other means as it will result in elevated discharge temperatures.



E) Liquid Vapor Heat Exchange

Do not apply liquid / vapor heat exchangers (also known as desuperheaters) as it will result in elevated discharge temperatures.

F) Performance Comparison

Reference Figures 4 and 5 below for an estimated compressor capacity and efficiency comparison to R-404A. The information is based on calorimeter data at AHRI (LBP/MBP) rating points. The results may vary depending on the compressor platform.

Figure 4

Capacity Relative to R-404A		
Refrigerant	Evaporator Temperature	
	Low	Medium
R-407A	90%	104%
R-448A	96%	106%
R-449A	96%	106%

Figure 5

COP Relative to R-404A		
Refrigerant	Evaporator Temperature	
	Low	Medium
R-407A	102%	112%
R-448A	104%	108%
R-449A	104%	108%

COMPRESSOR OPERATING WINDOW

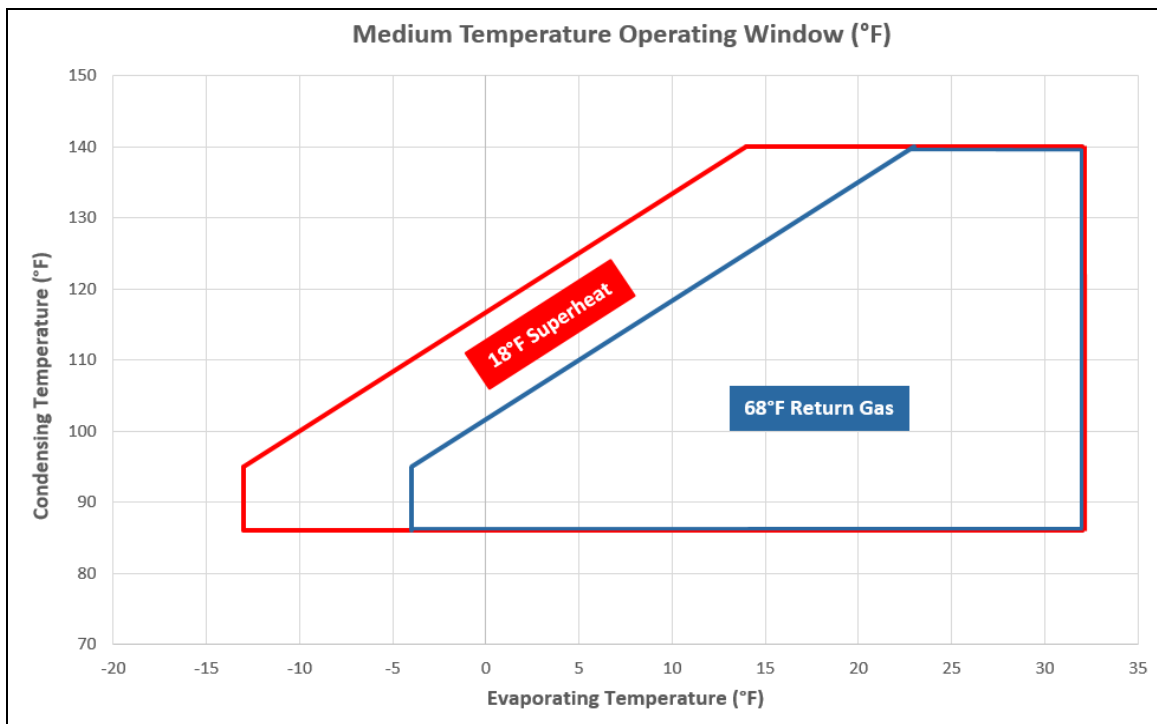
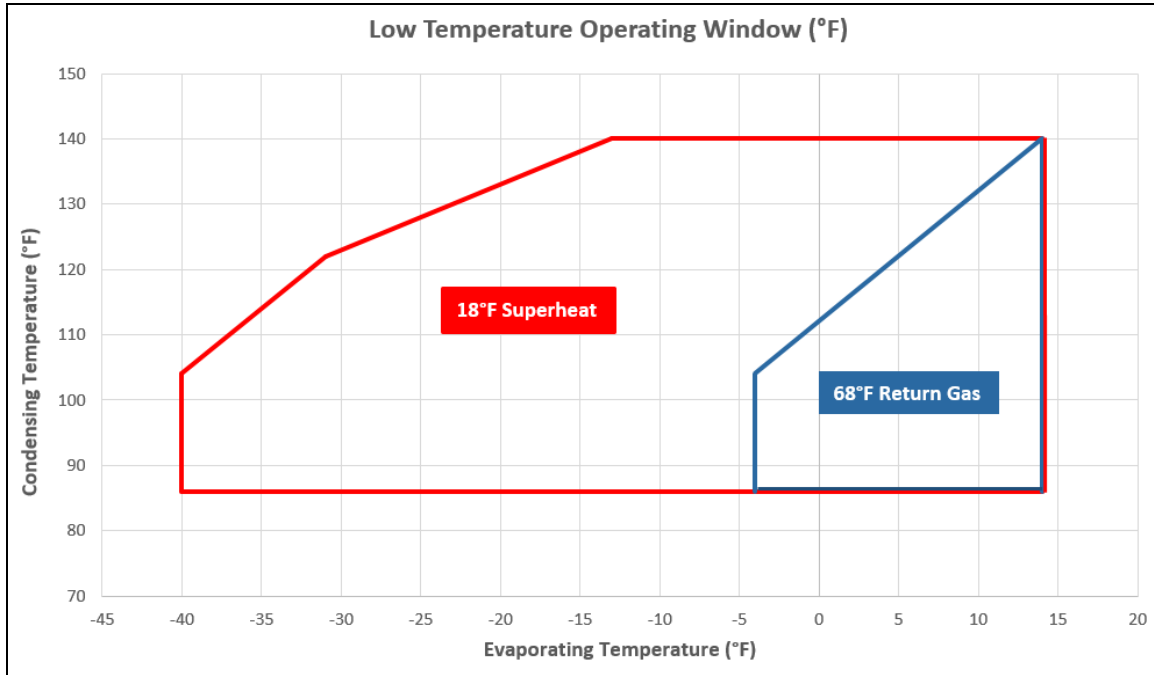
A) Return Gas Temperatures / Superheat

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. ***In general terms, limiting superheat to a maximum temperature of 10K (18°F), the operating window is fully or mostly usable with R-407A, R-448A, and R-449A.***

Note: For additional information on Compressor Operating Limits Reference Policy Bulletin 130



R-407A, R-448A, R-449A Application Boundaries °F





R-407A, R-448A, R-449A Application Boundaries °C

