Refrigerant Changeover Guidelines
R-134a to R-513A or R-450A
for High and Medium Temperature Applications

Leading the Industry with Environmentally
Responsible Refrigerant Solutions

COPELAND™

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WARNING

Use only Emerson approved refrigerants and lubricants in the manner prescribed by Emerson. Other refrigerants and lubricants may, in some circumstances, be dangerous and could cause fires, explosions or electrical shorting.

Contact Emerson Application Engineering for more information.

The refrigerants referred to in this document are safe to use when handled properly. Any refrigerant can cause injury or even death when mishandled. Please review the guidelines carefully and consult the product safety data sheet provided by the refrigerant manufacturer.

This retrofit guideline is applicable to Copeland™ compressors in high or medium evaporation temperature applications, which have been approved for R-450A or R-513A.

USE OF R-513A REFRIGERANT

⚠WARNING

NOTE: Refrigerant migration of R-513A into the compressor crankcase could cause low oil viscosity, which could lead to compressor damage.

When using R-513A, it is critical to meet the following requirements:

- In order to assure that liquid refrigerant does not return to the compressor during the running cycle, attention must be given to maintaining proper superheat at the compressor suction inlet. Maintain adequate superheat settings with a minimum superheat of 20°F at the compressor.
- No liquid refrigerant migration into the compressor at any time, especially during standstill or during or after defrost.
- Pump down recommended.
- The use of a crankcase heater is recommended.
- Retrofit R-513A is only allowed for compressors which are approved for these refrigerants.

CONSIDERATIONS

1. R-450A or R-513A should not be mixed with any other refrigerant!

   Open flames in the presence of any fluorocarbon refrigerant can decompose the refrigerant and form hazardous acidic compounds. Use electronic leak detectors designed for use with R-450A and R-513A.

2. Do not work in high concentrations of refrigerant vapors. Always maintain adequate ventilation in the work area. After any leak, ventilate the area well before attempting to repair the equipment.

3. Polyolester lubricant in use with R-134a is also suitable for use with R-450A or R-513A. There is no need for a determined oil change, unless there are questions about the lubricant, or if tests indicate it is contaminated or has a high acid number. Approved lubricants for Copeland compressors are Emkarate RL32 3MAF and Mobil Arctic EAL 22CC.

4. In accordance with EN 378, R-450A and R-513A fall under the same refrigerant safety group A1 (no flame propagation, not toxic) as R-134a. Therefore, a field retrofit with the same system safety concept and safety components is generally possible.

5. The system capacity and efficiency can be somewhat different with R450A or R-513A from what they are with R-134a. For medium temperature conditions, R-450A shows approximately 87% capacity with similar efficiency compared to R-134a. One must check if the remaining system capacity would be sufficient. R-513A shows similar capacities and efficiencies compared to R-134a.

   In most multiple compressor racks, there should still be adequate capacity. However, it is recommended that system capacity verification be done using Copeland product selection software (PSS) or the comparison factors published by the refrigerant manufacturer.

Table 1:
Capacity, Efficiency and Characteristics Comparison

Refrigerant	Characteristics		Medium Temperature	
	GWP	Glide (°F)	Capacity **	Efficiency **
R-134a	1430	0.0	100%	100%
R-450A	605	1.44	87%	103%
R-513A	631	0.0	104%	99%

* GWP according to the 4th IPCC review

** Capacity and efficiency figures according to refrigerant manufacturers published comparison factors

6. In retrofitting an existing refrigeration system, material compatibility and the condition of the existing seals and gaskets must be taken into account. Heat set, compression set, and seal shrinkage can affect the condition of an existing seal or gasket. When the system is put under vacuum, the sealing device can be displaced, creating the potential for leakage. A general gasket change is usually not required, unless some specific gaskets show noticeable damages and need to be changed.

7. Special attention should be paid to the refrigerant characteristics of R-450A and R-513A in the liquid phase and to the relationship with the ester oil. Refrigerant migration into the compressor crankcase could cause low oil viscosity, which could lead to compressor damage.

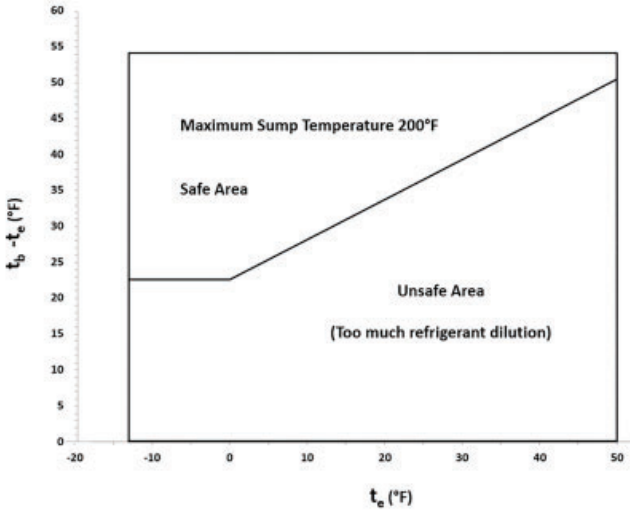
High priority should be given to the observation of the system for possible liquid refrigerant migration into the compressor. The system behavior should be checked at standard operation, during standstill and especially during or after defrost, or after reverse mode – for example, in heat pumps. All necessary precautions must be taken to prevent liquid refrigerant migration into the compressor, for example:

- The superheat settings of the expansion device should be adjusted for a minimum superheat of 20°F
- The installation of a crankcase heater is mandatory
- The system operation should work with a 'pump-down' scenario
- Use of suction accumulators, unless it has been qualified that an accumulator is not needed

8. Discharge temperatures of R-450A and R-513A are similar or marginally lower (1-5%) in comparison with R-134a. This could result in slightly larger operation envelopes. Please refer to the individual technical data, for example in the Copeland product selection software (PSS).
9. R-450A and R-513A have other density and mass flow than R-134a. It is recommended that pipe sizing be checked to determine that pressure drops and velocities would be acceptable with the new refrigerant. Checking pipe sizing will confirm that capacity and efficient oil return are not being negatively affected.
10. Both refrigerants R-450A and R-513A are blends of R-134a (HFC) and R-1234yf/ze (HFO). R-450A is a combination of 58% R-1234ze and 42% R-134a, and is a zeotropic blend with a temperature glide of 1.44°F. R-513A consists of 56% R-1234yf and 44% R-134a, and is an azeotropic blend.
11. For blend refrigerants like R-450A and R-513A, pressure/temperature data will include bubble and dew point data. To determine superheat, the dew temperature column in the temperature/pressure table has to be used. To determine subcooling, the bubble temperature column has to be used. The average condensing temperature is the mean of the dew and bubble temperatures at the condensing pressure. The average evaporating temperature is the mean of the temperature at the evaporator inlet and the dew temperature at the evaporating pressure.
12. It is essential that blend refrigerants like R-450A or R-513A be liquid charged removing only liquid from the filling cylinder. Vapor-charging may shift the refrigerant composition and could result in damage to the system. To prevent compressor damage, it is advocated not to charge liquid into the suction line.

    Due to other liquid density and weight of R-450A and R-513A, the refrigerant charge can be different from the initial charge for R-134a.
13. Compressor suction and discharge pressures for R-450A and R-513A differ from those for R-134a. It may be necessary to reset the pressure cut-outs to suit the different pressures of the replacement refrigerant. This procedure should be done carefully to avoid exceeding the recommended operating limits of the compressor. Pressure regulators may have to be reset. Contact the manufacturer for correct settings.
14. Systems that use a low-pressure controller to maintain space temperature may need to have the cut-in and cut-out points changed and adjusted.
15. Many refrigeration system controls, eg, supermarket control systems, rely on the pressure-temperature relationship of the refrigerant in use. When retrofitting from R-134a to R-450A or R-513A, the control settings have to be adjusted with the new refrigerant settings. Please refer to control system manufacturer for guidance.
16. R-450A and R-513A have other mass flow rates than R-134a (R-513A has higher and R-450A has lower mass flow rates in comparison with R-134a) but should normally stay within the usable range of a properly sized and installed R-134a expansion device. For R-450A installations, please check if the original expansion valve (or valve orifice) has the required capacity. If not, the expansion valve (or valve orifice) must be changed. For all R-450A and R-513A expansion devices, it is required to adjust the valve superheat settings. Use a PT-chart (dew point, saturated vapor values) for correct measurements and superheat adjustments. Consult the expansion valve manufacturer for correct selection and superheat settings.
17. For R-450A and R-513A refrigerants, Emerson recommends to use suction accumulators, unless it has been qualified that an accumulator is not needed. To determine if the accumulator can be removed, dedicated tests must be carried out to ensure that excessive liquid does not flood back to the compressor. All possible operating conditions, especially the conditions which could differ from the standard operation, like defrost, bypass, reverse operation, varying loads and so on, must be tested. Excessive flood back occurs when the sump temperature drops below the safe operation line shown in the following chart (next page):

Figure 1
Dilution chart for transient operation (tb = bottom shell temp.; te = Evaporating dew temp.)



18. Filter-driers must be changed at the time of conversion. They should have an equilibrium point of dryness (EPD) of 50 ppm or lower.
    - Solid core driers such as Emerson ADK are compatible with R-450A or R-513A.
    - Compacted bead type driers Alco FDB and filter drier shell types Alco ADK Plus and Alco FDS Quick Cap are also compatible.
    - Loose fill type driers are not recommended and should be replaced with the types referenced above.

CHANGEOVER PROCEDURE

Before starting the changeover, at least the following items should be readily available:

- Safety glasses
- Gloves
- Refrigerant service gauges
- Electronic thermometer
- Vacuum pump capable of pulling 250 microns
- Electronic leak detector, suitable for R450A or R513A
- Refrigerant recovery unit including refrigerant cylinder
- Proper container for removed lubricant
- Replacement liquid line filter-drier(s)
- Crankcase heater, if not installed
- Refrigerant accumulator, if needed
- New POE lubricant, if needed
- R450A/R513A pressure temperature chart
- R450A/R513A refrigerant

1. The system should be thoroughly leak tested with the R-134a refrigerant still in the system. All leaks should be repaired before the R-450A or R-513A refrigerant is added.
2. Check the system for possible liquid refrigerant migration into the compressor. Observe the system behavior in standard operation, during standstill and especially during or after defrost, or after reverse mode. Take all necessary precautions to prevent liquid refrigerant migration into the compressor.
3. Check if a crankcase heater is installed and if the on/off settings are appropriate. Ideally, the crankcase heater is always switched on during all compressor off periods. Otherwise the crankcase heater must be turned on 12 hours before each compressor start after longer standstill periods.
4. To determine if an accumulator is needed, dedicated tests during different operating conditions must be carried out.
5. Record baseline data on original R-134a system performance with the system operating under stable conditions. The following data should be recorded as a minimum with R-134a still in the system: compressor inlet and outlet pressures and temperatures, outdoor temperature and liquid temperature, preferably near the expansion valve inlet. This will enable superheat, subcooling and pressure ratio to be determined and provide the base data for comparison when the system is put back into operation with the R-450A or R-513A.
6. Disconnect electrical power to the system.
7. Properly remove the R-134a from the system. The refrigerant charge should be isolated from the system by pumping it down into the receiver enabling the bulk of the charge to be quickly transferred to the recovery cylinder. In all cases, the refrigerant must be removed from the system using a recovery machine capable of meeting or exceeding the required levels of evacuation. The charge must be collected in a recovery cylinder. Do not vent the refrigerant. Measure and note the amount removed. Knowing the recommended R-134a refrigerant charge size for the system is helpful. In all cases, weigh the entire amount of removed refrigerant. This amount can be used as a guide for the internal quantity of the R-450A or R-513A refrigerant to be charged to the system.
8. Replace the liquid line filter-drier with one that is compatible with R-450A or R-513A.
9. Install a crankcase heater, if not present yet.
10. Install a liquid accumulator in the suction line, if needed.
11. If the polyolester oil is contaminated or an acid test indicates high levels of acidity, then a lubricant

change is required. If affected, drain the existing lubricant from the compressors, separators and oil reservoirs. Measure the amount (volume) of lubricant removed. Change lubricant filters if present. Recharge the system with polyolester lubricant, use the same amount (volume) as was removed.

12. Check if the existing expansion devices (or valve orifices) would have enough capacity when operated with R-450A or R-513A. If needed, change the expansion device or valve orifice. In any case, it is required to adjust the expansion valve in order to reset the superheat settings for R-450A or R-513A. Maintain adequate superheat settings of minimum 20°F. Consult the valve manufacturer for guidance and recommendations.

13. Evacuate the system to 250 microns. A vacuum decay test is suggested to assure the system is dry and leak free. Apply normal service practices to reconnect and evacuate the system. To remove air and other non-condensables, it is recommended to evacuate the system from both sides. Attempting to evacuate a system with the pump connected only to the low-side of the system will not adequately remove moisture and non-condensables such as air.

    Use a good electronic gauge to measure the vacuum. An accurate reading cannot be made with a refrigeration gauge.

14. Check the system for leaks applying normal service practices.

15. Recharge the system with R-450A or R-513A to the high side of the system. Remove only liquid from the charging cylinder. The first charge should be approximately 85% of the R-134a charge by weight. Record the amount of refrigerant charged.

16. Check system operation and operating controls. Update control settings for the operation with R-450A or R-513A. Start the system and allow conditions to stabilize. The discharge pressure of R-450A or R-513A can be different from that of R-404A and condenser fan and ambient controls may require adjustment.

17. Add the 'pump-down' function to the system operation.

18. Adjust the refrigerant charge.

19. Operate the system. Record the data and compare to the data recorded at step 4.

20. Properly label the components. Tag the compressor with the refrigerant (R-450A or R-513A) and the lubricant used.

Caution: These guidelines are intended for use with R-450A or R-513A only. Other refrigerants may not be compatible with the materials used in Copeland compressors or the lubricants recommended in this technical information.

The information contained herein is based on technical data and tests which are believed to be reliable and is intended for use by persons having technical skill, at their own discretion and risk. Since conditions of use are beyond the control of Emerson, no liability can be assumed for results obtained or damages incurred through the application of the information presented.

ADDENDUM

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⚠ CAUTION

POE must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE, including without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).

WARNING: Use only Emerson approved refrigerants and lubricants in the manner prescribed by Emerson. In some circumstances, other refrigerants and lubricants may be dangerous and could cause fires, explosions or electrical shorting. Contact Emerson, Sidney, Ohio for more information.

The information contained herein is based on technical data and tests which we believe to be reliable and is intended for use by persons having technical skill, at their own discretion and risk. Since conditions of use are beyond the control of Emerson Climate Technologies, Inc., we can assume no liability for results obtained or damages incurred through the application of the data presented.

Saturation Temperature (F°)	R-134a	R-450A		R-513A	
	Pressure	Liquid Pressure	Vapor Pressure	Liquid Pressure	Vapor Pressure
-40	14.80	16.56	16.97	11.63	11.77
-38	13.90	15.76	16.19	10.60	10.74
-36	12.95	14.93	15.37	9.52	9.66
-34	11.96	14.05	14.52	8.40	8.54
-32	10.92	13.13	13.63	7.22	7.36
-30	9.84	12.17	12.69	6.00	6.14
-28	8.71	11.17	11.71	4.72	4.86
-26	7.53	10.12	10.69	3.39	3.53
-24	6.29	9.03	9.63	2.01	2.15
-22	5.00	7.89	8.51	0.56	0.70
-20	3.66	6.70	7.35	0.46	0.39
-18	2.26	5.46	6.14	1.23	1.16
-16	0.80	4.17	4.88	2.02	1.96
-14	0.35	2.82	3.57	2.85	2.78
-12	1.13	1.42	2.20	3.71	3.64
-10	1.94	0.02	0.77	4.60	4.54
-8	2.78	0.76	0.35	5.53	5.46
-6	3.65	1.53	1.10	6.48	6.42
-4	4.56	2.34	1.89	7.48	7.42
-2	5.50	3.17	2.71	8.51	8.45
0	6.48	4.04	3.55	9.58	9.52
2	7.49	4.94	4.43	10.68	10.63
4	8.54	5.87	5.35	11.83	11.77
6	9.63	6.84	6.29	13.01	12.96
8	10.76	7.84	7.27	14.24	14.18
10	11.93	8.88	8.29	15.50	15.45
12	13.14	9.95	9.34	16.81	16.76
14	14.40	11.07	10.43	18.17	18.12
16	15.70	12.22	11.56	19.56	19.51
18	17.04	13.41	12.73	21.00	20.96
20	18.43	14.64	13.93	22.49	22.45
22	19.86	15.91	15.18	24.03	23.98
24	21.35	17.23	16.47	25.61	25.57
26	22.88	18.58	17.80	27.24	27.21
28	24.46	19.99	19.18	28.93	28.89
30	26.09	21.43	20.60	30.66	30.63
32	27.77	22.93	22.06	32.45	32.42
34	29.51	24.47	23.58	34.29	34.26
Red (in of Hg) = Vacuum			Black (psig) = Pressure		

Saturation Temperature (F°)	R-134a	R-450A		R-513A	
	Pressure	Liquid Pressure	Vapor Pressure	Liquid Pressure	Vapor Pressure
36	31.30	26.05	25.14	36.18	36.15
38	33.14	27.69	26.74	38.13	38.11
40	35.05	29.38	28.40	40.14	40.11
42	37.00	31.12	30.11	42.20	42.18
44	39.02	32.91	31.87	44.33	44.30
46	41.10	34.75	33.68	46.51	46.49
48	43.24	36.65	35.54	48.75	48.73
50	45.44	38.60	37.46	51.06	51.04
52	47.70	40.61	39.44	53.42	53.41
54	50.03	42.67	41.47	55.86	55.84
56	52.42	44.80	43.56	58.35	58.34
58	54.88	46.98	45.71	60.92	60.90
60	57.41	49.22	47.91	63.55	63.54
62	60.01	51.53	50.18	66.24	66.24
64	62.67	53.90	52.51	69.01	69.01
66	65.41	56.33	54.91	71.85	71.85
68	68.22	58.82	57.36	74.76	74.76
70	71.11	61.38	59.89	77.75	77.74
72	74.07	64.01	62.48	80.81	80.80
74	77.11	66.71	65.13	83.94	83.94
76	80.22	69.47	67.86	87.15	87.15
78	83.42	72.31	70.65	90.44	90.44
80	86.69	75.21	73.52	93.81	93.81
82	90.05	78.19	76.46	97.26	97.26
84	93.49	81.25	79.47	100.79	100.79
86	97.01	84.37	82.56	104.40	104.40
88	100.62	87.58	85.72	108.10	108.10
90	104.32	90.86	88.96	111.88	111.88
92	108.10	94.22	92.27	115.75	115.75
94	111.98	97.66	95.67	119.70	119.70
96	115.94	101.18	99.15	123.75	123.75
98	120.00	104.78	102.71	127.89	127.88
100	124.16	108.46	106.35	132.12	132.11
102	128.40	112.23	110.07	136.44	136.43
104	132.75	116.09	113.89	140.85	140.85
106	137.19	120.03	117.78	145.37	145.36
108	141.73	124.06	121.77	149.98	149.97
Red (in of Hg) = Vacuum			Black (psig) = Pressure		

Saturation Temperature (F°)	R-134a	R-450A		R-513A	
	Pressure	Liquid Pressure	Vapor Pressure	Liquid Pressure	Vapor Pressure
110	146.38	128.19	125.85	154.68	154.67
112	151.12	132.40	130.02	159.49	159.48
114	155.98	136.70	134.28	164.40	164.39
116	160.93	141.10	138.63	169.42	169.40
118	165.99	145.59	143.08	174.53	174.51
120	171.17	150.18	147.62	179.76	179.74
122	176.45	154.87	152.26	185.09	185.06
124	181.84	159.65	157.00	190.53	190.50
126	187.35	164.54	161.85	196.08	196.05
128	192.98	169.53	166.79	201.74	201.71
130	198.72	174.62	171.84	207.52	207.48
132	204.57	179.81	176.99	213.41	213.37
134	210.55	185.11	182.25	219.42	219.38
136	216.65	190.52	187.62	225.55	225.50
138	222.88	196.04	193.09	231.80	231.75
140	229.23	201.67	198.68	238.17	238.11
142	235.70	207.41	204.38	244.67	244.60
144	242.31	213.27	210.20	251.29	251.22
146	249.04	219.23	216.13	258.04	257.96
148	255.91	225.32	222.18	264.91	264.84
150	262.92	231.53	228.34	271.92	271.84
Red (in of Hg) = Vacuum			Black (psig) = Pressure		

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