RETROFIT GUIDE

Flooded and Direct Expansion Chillers

R-134a, R-12, R-401A and R-409A
system conversion to Solstice® R-513A

Honeywell

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PREFACE

As facility owners and operators work to comply with regulations, reduce their carbon footprint, ensure refrigerant supply and reduce energy usage, it can be beneficial to retrofit existing refrigeration equipment with a lowered GWP, more efficient refrigerant.

Technicians may follow equipment manufacturers' recommendations and Honeywell's guidelines outlined in this publication to help retrofit existing R-134a, R-12, R-401A, and R-409A chiller systems to R-513A.

R-12 is a refrigerant that was typically used for medium-temperature refrigeration and HVAC systems.

R-12 is a class I CFC refrigerant under the Clean Air Act, and as such it is regulated under the class I Ozone Depleting Substances (ODS) phase out within the Clean Air Act. This includes a ban on production or import of R-12 as of 1995.

R-401A and R-409A refrigerants that are employed as replacements for R-12 in chiller and refrigeration systems, contain Class II HCFC refrigerants and are regulated under the class II ODS phase out within the Clean Air Act. This includes a ban on production or import of applicable HCFCs as of 2020.

R-134a is a pure HFC refrigerant with similar characteristics to R-12 but with a lower GWP of 1300 as well as zero ozone depletion. R-134a is increasingly being replaced with R-513A due to concerns on the higher GWP of R-134 from an environmental aspect as well as supply concerns due to HFC quota regulations.

R-513A is a lower GWP refrigerant which is an excellent choice for replacement of R-134a, R-12, R-401A, and R-409A.

INTRODUCTION

The refrigerant and HVAC industry continues to move away from the use of ozone-depleting and high global warming potential (GWP) refrigerants. Contractors and technicians will play a key role in the transition to alternatives through retrofitting of legacy refrigerants with lower GWP refrigerants.

Honeywell has produced this guide to help contractors and technicians better understand the various technical and operational aspects of carrying out a refrigerant retrofit using R-513A.

Since systems can differ in condition and configuration, retrofit actions applied to one system may not necessarily result in the same level of success in another system. For this reason, Honeywell strongly recommends contacting the equipment manufacturer for detailed information on retrofitting the specific model under consideration. Also, review the Safety Data Sheet (SDS) for safety information on the specific refrigerant you choose.

Honeywell technical services is available to provide retrofit surveys, which can be at no cost for those companies needing help to get started with a retrofit program.

Please contact your Honeywell representative or technical help line for assistance..

REFRIGERANT COMPARISONS

Refrigerant comparisons appear in the chart below.

Refrigerant	Type	Replaces	Ozone Depletion Potential (ODP)	Global Warming Potential (GWP)***
REPLACEMENT REFRIGERANT				
Solstice® (R-513A)	HFO/HFC Blend R-1234yf R-134a	R-134a R-12 R-401A R-409A	0 .0	572
REFRIGERANTS TO BE RETROFITTED				
R-134a	Pure HFC	R-12 R-401A R-409A	0.0	1300
R-12	CFC R-12**	NA	1.0	10200
R-409A	HCFC/HFC Blend R-22* (HCFC) R-152a (HFC) R-124 (HCFC)	R-12	0 .037	1330
R-409A	HCFC Blend R-22* (HCFC) R-124 (HCFC) R-142b* (HCFC)	R-12	0 .048	1485

* Production and import ceased in 2020

** Production ceased 1995

*** AR5

APPLICATIONS

R-513A is suitable for replacement of refrigerants listed in the table above. The pressure and temperature characteristics are very similar. Refer to pressure-temperature charts in the appendix.

Typical uses for R-513A retrofits are chillers deployed for air conditioning on large corporate, educational and government campuses, ice rinks and industrial processes, to name just a few.

FLOODED SYSTEMS

R-513A is an azeotropic mixture and, as such, is suitable for use in flooded systems.

Flooded systems come in a variety of configurations but are normally characterized by the use of a low-pressure receiver and a flooded evaporator. The low-pressure receiver provides a location for the gas used by the compressors as well as the liquid refrigerant used in the evaporator. The gas is pulled off the receiver by the compressor and the liquid is piped to the evaporator. The liquid in the evaporator typically does not fully evaporate resulting in the term “flooded” evaporator.

An azeotropic mixture such as R-513A behaves as a pure fluid as it boils and condenses. This means that the temperature is constant during phase change. This also means that the refrigerant contained in the low-pressure receiver has the same composition in the liquid and gas phases. This characteristic of the azeotropic mixture is what allows R-513A to be a suitable application for flooded systems. Other refrigerants, such as those in the 400 series, are not azeotropes. These refrigerants can have the composition of the mixture change depending on whether the refrigerant is in the liquid or gas state within the low-pressure receiver. This can result in significant operational and capacity problems.

CAPACITY AND EFFICIENCY

A thermodynamic comparison of refrigerants shows R-513A has similar characteristics to legacy refrigerants. The chart below uses R-12 as a baseline since R-401A and R-409A systems are typically original R-12 systems.

With R-513A having a larger capacity than R-12 and R-134a, it is very likely to have adequate (even excess) capacity for any retrofit. While R-401A and R-409A have higher capacities than R-513A, these systems were likely originally R-12 and therefore do not require this additional capacity.

Refrigerant	GWP (AR5)	Capacity	Efficiency
R12	10200	100%	100%
R401A	1130	113%	101%
R409A	1485	114%	101%
R134a	1300	101%	99%
R513A	**572**	**106%**	**98%**

*Refrigerant comparisons | +20°F SST, +70°F SCT, +45°F RGT

R-513A IS NOT A DROP-IN REPLACEMENT

R-513A utilizes synthetic lubricants. The mineral oil typically contained in R-12, R-401A and R-409A systems will need to be changed. The elastomeric seals and O-rings in the R-12, R-401A and R-409A systems may also experience degradation due to the removal of chlorine contained in these refrigerants. Expansion valves will require adjustment and occasional modification or replacement.

For R-134a retrofits the seals and oil are generally acceptable as R-134a is an HFC with no chlorine, and the systems are normally already using POE oil. That being said, older systems that were originally R-12, R-401A, or R-409A should be carefully evaluated for seals and oil compatibility.

RETROFIT PROCEDURES - SUMMARY

A successful retrofit includes several steps to produce a reliable and efficient system. The steps outlined below have been developed through the experience of Honeywell's technical team, as well as many of our service company partners. This guide is only a recommendation based on field experience.

The first step is a site survey. A site survey is recommended to identify existing conditions that impact the retrofit as well as identifying system upgrades that can be done cost effectively during the retrofit. A refrigerant retrofit is an ideal time to increase the life cycle and efficiency of the refrigeration system. The survey also identifies components that may need to be replaced or added to match the new refrigerant and to reduce future leaks.

The second step includes activities to prepare for the retrofit. These are activities that can be done prior to the retrofit. Preparation also includes facility coordination and procurement of needed parts. This step shortens the down time during the retrofit as well as reducing overall risk.

The final step is the actual retrofit. The retrofit team will typically include a recovery crew, a construction crew for charging and adjustments, a controls expert and a supervisor. The time to retrofit a system varies greatly depending on the system size, application and up-time requirements. Retrofitting a single system can typically be done in nearly 8 hours. Fine tuning of controls and expansion valve superheat may continue for a time after the refrigerant is changed and the system is started up.

RETROFIT PROCEDURES - DETAILED

Step 1 - Site survey

1. Compressors

- Record manufacturer, model and serial numbers.
- Identify failed compressors, failed fans and any capillary control lines.

- Identify unique control devices that may need to be replaced such as discharge temperature mitigation, de-superheating valves, etc.
- Contact compressor manufacturer for compatibility with R-513A. User may also contact Honeywell for assistance.
- Crankcase heaters and suction accumulators are sometimes recommended by system and/or compressor manufacturer due to possible liquid migration of R-513A into the compressor crankcase. Contact the specific manufacturer for details.

2. System issues

- Walk the store, machine room and roof to identify any items that impact system operation. Some example areas to identify include failed condenser fans, clogged evaporator coils, failed sub coolers, degraded condensers, poor insulation, obsolete components, etc.
- Some chiller manufacturer(s) specify replacement of the liquid level sensor when refrigerants are changed. This should be done as recommended by the system manufacturer.

3. Review expansion valves and relief valves

- In general, R-12, R-401A and R-409A valves will have a similar capacity (within 20%) when switching to R-513A. Expansion valve superheat will require some adjustment.
- As a precaution, ample supplies of power heads and valves should be on-hand during the retrofit.
- When retrofitting from R-401A, R-409A, or R-134a to R-513A the relief valve(s) size may need to be increased. Please refer to manufacture literature for sizing guidelines. When retrofitting from R-12 to R-513A the relief valve size will be acceptable assuming the valve was sized correctly for the existing equipment. Honeywell does recommend replacing the relief valves, in any case, to ensure they are in good working order.

4. Identify seals and O-rings for replacement

- Chlorine-based refrigerants, such as R-12, R-401A and R-409A, can result in elastomer seal failure when the chlorine-based refrigerant is removed. There are also common seals that should be replaced for a leak-free system.
- Heat set, compression set and shrinkage of seals are also common on older systems. As the system is pulled into vacuum and then re-pressurized these seals are likely to leak. Due to this, seals and O-rings should be replaced wherever possible.
- Existing R-134a systems will not have the same potential for seal degradation as the CFC/HCFC systems.

5. Record baseline data

- Record baseline data to identify issues and as a reference for post-retrofit performance.
- Review refrigerant line sizes and sloping, especially horizontal suction and riser lines. In general, line sizes will be acceptable if correctly sized in original installation. The Genetron Properties program is available as a free download and can be used to calculate line sizes.

6. Test oil and refrigerant

- Test oil to identify any signs of serious system issues.
- If recovered refrigerant is to be used at other stores, or otherwise re-used, it is recommended to test it for purity.

7. Forward completed survey form to the customer

Step 2 - Preparation

1. Facility coordination

- It is recommended to meet with the facility leader and relevant managers.
- Items to discuss include:
  - Retrofit dates and times.
  - Retrofit hours and production hours.
  - Care of any critical products.
  - Product and personnel safety during retrofit.

2. Order parts and refrigerant

3. Technician training

- Ensure that technicians are trained on setting superheat.
- Refer to pressure-temperature chart in Appendix C for setting superheat.
- Honeywell technical team is available to provide on-site or web-based training.

4. System changes

- Perform any activities identified in the survey that can be safely done before the retrofit. This includes any valves that can be isolated without a system pump down including compressor changes, pilot line upgrades, control adjustments, coil cleaning, etc.

5. **Change oil from mineral to POE**

- In most instances, the lubricant in use with R-12, R-401A and R-409A is not suitable for use with R-513A. A change to a synthetic lubricant is required. Honeywell recommends using a miscible lubricant approved by the compressor manufacturer.
- R-134a systems typically already have synthetic oil appropriate for R-513A.
- Usually (1) full oil change is required.

6. **Change suction and liquid filters and driers**
7. **Upgrade controller with R-513A pressure / temperature curves as applicable**
8. **Leak check and repair**

Step 3 - Retrofit

1. **Remind facility personnel the day prior to retrofit**
2. **Secure safety of product and personnel**
3. **Recover existing refrigerant**
4. **Record amount of refrigerant removed including refrigerant previously removed**
5. **Break vacuum from recovery machine**
6. **Replace seals, gaskets and valves as needed**
7. **Replace driers and filters**
8. **Evacuate system**

- Honeywell recommends evacuating the system to 500 microns from both sides of the system. Attempting to evacuate a system with the pump connected only to the low-side of the system will not adequately remove moisture and non-condensable elements such as air.
- Micron gauge should be placed as far away from the vacuum pump as possible to get an accurate vacuum reading.
- Remove all restrictions like valve cores, and using the shortest hoses possible will speed up the vacuum process.
- Use a good electronic micron gauge to measure the vacuum. An accurate reading cannot be made with an analog refrigeration gauge.
- Repair any leaks.

9. **Charge system**

- Liquid charging adapter should be used to control the flow of refrigerant, if charging to the suction side, to ensure that the liquid is converted to vapor prior to entering the system.
- It is essential that blended refrigerants be charged using only liquid from the cylinder. With R-513A being an azeotrope, this is less important than 400-series refrigerants, but liquid charging is recommended as a best practice.
- **NOTE:** To prevent compressor damage, do not charge liquid directly into the suction line of the compressor.
- Systems being charged with R-513A require:
  - Approximately 21% lower charge than R-12.
  - Approximately 11% lower charge than R-409A.
  - Approximately 7% lower charge than R-401A.
  - Approximately 8% higher charge than R-134a.
- Allow conditions to stabilize - if the system is undercharged, add refrigerant in increments of 5 percent by weight of the original charge. Continue until desired operating conditions are achieved.

10. **Adjust expansion valves**

- Adjusting valves is a very important part of any retrofit. Properly adjusted valves will prevent compressor damage, ensure safe temperatures and result in an efficient system.
- Most valves will require some adjustment.
- In the absence of specific manufacturer recommendations, 6 to 8°F for medium temperature is recommended.

11. **Adjust pressure controls**

- All mechanical and electronic controls should be reviewed for adjustment. This includes safety controls, EPR valves, holdback valves, etc.
- R-513A does not have glide (it is an azeotropic mixture).

12. **Label Components and System**

- After retrofitting the system, label the system components to identify the refrigerant and specify the type of lubricant (by brand name) in the system. This will help ensure that the proper refrigerant and lubricant will be used to service the equipment in the future.
- Contact Honeywell wholesaler for labels, PT charts, etc.

APPENDIX A - REFRIGERANT OIL

Process

In most instances, the lubricant in use with R-12, R-401A and R-409A is not suitable for use with R-513A and a change to a synthetic lubricant is required. Honeywell recommends using a miscible lubricant approved by the compressor manufacturer. Differences among lubricants make it difficult to assume they are interchangeable. Check with the compressor manufacturer for the correct viscosity grade and brand for the compressor in the system being retrofitted.

If the lubricant is contaminated or an acid test indicates high levels of acidity, then a full lubricant change is warranted.

R-134a systems will typically already have synthetic oil.

Recommended process:

- Remove existing oil from compressor, reservoir and separator.
- Measure volume of lubricant removed. This volume will be used as a guide to determine the amount of new lubricant to add.
- Change lubricant filters if present.
- Add new lubricant. It is recommended that polyolester (POE) lubricant be pumped rather than poured to avoid pick-up of atmospheric moisture.
- Run for 24 hours ensuring all circuits are defrosted and that all coils such as heat reclaim and split condensers are engaged periodically.
- Test for percentage of mineral oil using oil refractometer. 95% synthetic is preferred.
- Repeat if needed.

Systems charged with POE lubricant should not be left open to the atmosphere for more than 10 to 15 minutes. This is due to the moisture-absorbing nature of POE oil.

Note that evacuation will not remove moisture from POE lubricant. A solid-core filter drier designed for moisture removal is the only effective means to remove moisture from POE lubricant.

APPENDIX B - LEAK PREVENTION MEASURES

During the retrofit from an HCFC or CFC to an HFO or HFC refrigerant, the elimination of chlorine from the refrigerant, as well as the solvent nature of the required synthetic oils, can contribute to system leaks.

These leaks are concentrated in component elastomeric O-rings and seals.

When retrofitting from an CFC or HCFC to an HFO refrigerant, the material compatibility and the condition of existing seals and gaskets should also be taken into account. Heat set, compression set, and seal shrinkage can all impact the condition of an existing seal or gasket. When the system is then put under vacuum, the sealing device can be displaced, creating the potential for leakage.

It is recommended to replace the entire component, or the O-ring/seal, in the following areas.

- Schrader valves and caps
- Receiver level indicators and alarms
- Heat reclaim and condenser splitting valves
- Evaporator Pressure Regulators (EPRs)
- Solenoid valves
- Pilot hoses
- Ball valves

A retrofit cap is available with some ball valve manufacturers, that eliminates the need to replace the O-rings.

A retrofit is also a good time to replace valves that are beyond their life cycle. Some valves will not have replacement seals available and will need to be replaced.

APPENDIX C - COMPRESSORS

Several compressor manufacturers have compressors that are suitable for new installations of R-513A systems.

For existing systems many Copeland, Carlyle and Bitzer compressors are qualified for use by HFO-based refrigerants such as R-513A.

Older compressors may not be qualified for use by the manufacturer but are likely to operate at a satisfactory level.

When retrofitting, please contact the compressor manufacturer or Honeywell for applicability of specific makes and models of compressors.

Flooded systems commonly use centrifugal compressors. These compressors are typically closely matched to the refrigerant. Special care should be taken when retrofitting a system with centrifugal compressors.

APPENDIX D - PRESSURE – TEMPERATURE CHARTS

HONEYWELL PT CHARTS					
	R-513A	R-134a	R-401A	R-409A	R-12
Temperature (F)	Pressure (psig)	Pressure (psig)	Pressure (psig)	Pressure (psig)	Pressure (psig)
-15	2.4	0.0	5.1	6.3	2.4
-13	3.3	0.7	6.0	7.3	3.2
-11	4.1	1.5	7.0	8.3	4.0
-9	5.1	2.4	8.0	9.4	4.9
-7	6.0	3.2	9.0	10.5	5.8
-5	7.0	4.1	10.1	11.6	6.7
-3	8.0	5.0	11.2	12.8	7.6
-1	9.0	6.0	12.4	14.0	8.6
1	10.1	7.0	13.6	15.2	9.6
3	11.3	8.0	14.8	16.5	10.7
5	12.4	9.1	16.1	17.8	11.7
7	13.6	10.2	17.4	19.2	12.9
9	14.9	11.3	18.8	20.6	14.0
11	16.2	12.5	20.2	22.1	15.2
13	17.5	13.8	21.6	23.6	16.4
15	18.9	15.0	23.1	25.1	17.7
17	20.3	16.4	24.7	26.7	19.0
19	21.7	17.7	26.3	28.4	20.3
21	23.3	19.1	27.9	30.1	21.7
23	24.8	20.6	29.6	31.8	23.1
25	26.4	22.1	31.4	33.6	24.6
27	28.1	23.7	33.2	35.5	26.1
29	29.8	25.3	35.0	37.4	27.6
31	31.5	26.9	36.9	39.4	29.2
33	33.4	28.6	38.9	41.4	30.8
35	35.2	30.4	40.9	43.4	32.5
37	37.2	32.2	43.0	45.6	34.2
39	39.1	34.1	45.1	47.8	36.0
41	41.2	36.0	47.3	50.0	37.8
43	43.3	38.0	49.5	52.3	39.7
45	45.4	40.1	51.8	54.7	41.6
47	47.6	42.2	54.2	57.1	43.6
49	49.9	44.3	56.7	59.6	45.6
51	52.2	46.6	59.1	62.1	47.6
53	54.6	48.9	61.7	64.8	49.8
55	57.1	51.2	64.3	67.4	51.9
57	59.6	53.6	67.0	70.2	54.2

HONEYWELL PT CHARTS					
	R-513A	R-134a	R-401A	R-409A	R-12
Temperature (F)	Pressure (psig)	Pressure (psig)	Pressure (psig)	Pressure (psig)	Pressure (psig)
59	62.2	56.1	69.8	73.0	56.5
61	64.9	58.7	72.6	75.9	58.8
63	67.6	61.3	75.5	78.9	61.2
65	70.4	64.0	78.5	81.9	63.7
67	73.3	66.8	81.6	85.0	66.2
69	76.2	69.7	84.7	88.2	68.8
71	79.3	72.6	87.9	91.4	71.4
73	82.4	75.6	91.2	94.8	74.1
75	85.5	78.7	94.5	98.2	76.8
77	88.8	81.8	97.9	101.6	79.7
79	92.1	85.0	101.4	105.2	82.5
81	95.5	88.4	105.0	108.8	85.5
83	99.0	91.8	108.7	112.6	88.5
85	102.6	95.2	112.4	116.4	91.6
87	106.2	98.8	116.3	120.2	94.7
89	110.0	102.5	120.2	124.2	98.0
91	113.8	106.2	124.2	128.2	101.3
93	117.7	110.0	128.3	132.4	104.6
95	121.7	113.9	132.5	136.6	108.0
97	125.8	118.0	136.7	140.9	111.5
99	130.0	122.1	141.1	145.3	115.1
101	134.3	126.3	145.6	149.8	118.8
103	138.6	130.6	150.1	154.4	122.5
105	143.1	135.0	154.8	159.1	126.3
107	147.7	139.5	159.5	163.8	130.2
109	152.3	144.0	164.3	168.7	134.1
111	157.1	148.7	169.3	173.7	138.1
113	161.9	153.5	174.3	178.7	142.2
115	166.9	158.4	179.4	183.9	146.4
117	172.0	163.4	184.6	189.1	150.7
119	177.1	168.6	190.0	194.5	155.1
121	182.4	173.8	195.4	199.9	159.5
123	187.8	179.1	201.0	205.5	164.0
125	193.3	184.6	206.6	211.1	168.6
127	198.9	190.1	212.4	216.9	173.3
129	204.6	195.8	218.2	222.8	178.1
131	210.5	201.6	224.2	228.7	183.0
133	216.4	207.5	230.3	234.8	188.0
135	222.5	213.6	236.5	241.0	193.0
137	228.7	219.7	242.8	247.3	198.2

HONEYWELL PT CHARTS					
	R-513A	R-134a	R-401A	R-409A	R-12
Temperature (F)	Pressure (psig)	Pressure (psig)	Pressure (psig)	Pressure (psig)	Pressure (psig)
139	235.0	226.0	249.3	253.7	203.4
141	241.4	232.4	255.8	260.3	208.7
143	248.0	239.0	262.5	266.9	214.1
145	254.6	245.7	269.3	273.7	219.7
147	261.5	252.5	276.2	280.5	225.3
149	268.4	259.4	283.2	287.5	231.0
151	275.5	266.5	290.4	294.7	236.8
153	282.7	273.7	297.7	301.9	242.8
155	290.0	281.0	305.1	309.2	248.8
157	297.5	288.5	312.6	316.7	254.9
159	305.1	296.2	320.3	324.3	261.1
161	312.9	303.9	328.1	332.0	267.5
163	320.8	311.9	336.0	339.9	273.9
165	328.9	320.0	344.1	347.9	280.5
167	337.1	328.2	352.3	356.0	287.1
169	345.5	336.6	360.6	364.2	293.9
171	354.0	345.1	369.1	372.6	300.8
173	362.7	353.8	377.8	381.1	307.8
175	371.5	362.7	386.5	389.8	314.9
177	380.5	371.8	395.4	398.5	322.2
179	389.7	381.0	404.5	407.4	329.5
181	399.0	390.4	413.7	416.5	337.0
183	408.6	399.9	423.1	425.7	344.6
185	418.3	409.7	432.6	435.0	352.3
187	428.2	419.6	442.2	444.5	360.1
189	438.3	429.7	452.0	454.1	368.1
191	448.6	440.0	462.0	463.9	376.2
193	459.1	450.5	472.1	473.8	384.5
195	469.8	461.2	482.4	483.8	392.8
197	480.8	472.1	492.9	494.0	401.3
199	492.0	483.2	503.5	504.4	410.0
201	503.5	494.6	514.3	514.9	418.8

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