RETROFIT GUIDE

Commercial Refrigeration Systems – Medium Temperature

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

Honeywell

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PREFACE

This guide is based on a retrofit of supermarket refrigeration systems but can be used as a general guidelines for any commercial refrigeration system retrofit.

As supermarket owners work to comply with regulations, as well as reduce their carbon footprint, existing refrigeration equipment may need to be either replaced or retrofitted with an alternative refrigerant. The selection of a retrofit refrigerant depends, in part, upon retrofit objectives that include factors such as efficiency, first cost, regulatory compliance and capacity.

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 refrigeration systems to R-513A.

R-12 is a refrigerant that was typically used for medium temperature refrigeration systems. R-12 is a class I CFC refrigerant under the Clean Air Act and as such 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-513A is an excellent choice for replacement of R-12, R-401A and R-409A.

INTRODUCTION

The commercial refrigeration industry continues to move away from the use of ozone-depleting and high global warming potential (GWP) refrigerants. Refrigeration contractors and technicians will play a key role in the transition to alternatives through retrofitting. Honeywell has produced this guide to help contractors and technicians better understand the various technical and operational aspects of carrying out retrofit procedures using R-513A.

Although the information can be helpful as a general guide, it should not be used as a substitute for the equipment manufacturer's specific recommendations. Also, retrofitting should be considered system specific.

Since systems can differ in condition and configuration, retrofit actions applied to one system will 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.

REFRIGERANT COMPARISONS

Refrigerant comparisons appear in the chart below.

Refrigerant	Type	Replaces	Ozone Depletion Potential (ODP)	Global Warming Potential (GWP)
ALTERNATIVE REFRIGERANTS				
Solstice® (R-513A)	HFO/HFC Blend R-1234yf R-134a	R-134a R-12 , R-401A R-409A	0 .0	572
RETROFITTED REFRIGERANTS				
R-12	CFC R-12**	NA	1 .0	10,200
R-401A (MP-39)	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 ceases in 2020
** Production ceased 1995

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 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.

The retrofit procedures listed here have been developed by Honeywell to address these issues and to help technicians perform successful retrofits utilizing positive-displacement (reciprocating, rotary, scroll or screw) compressors.

RETROFIT PROCEDURES - SUMMARY

A successful retrofit includes several steps to produce a low maintenance 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. Refer to individual retailer procedures to ensure adherence to product integrity and other protocols.

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 store 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. This is typically started as early in the evening as the store leadership will allow. The retrofit team will typically include a recovery crew, a construction crew for charging and adjustments, a controls expert, and a supervisor. Retrofitting a single parallel system can be done in one night. Fine tuning of superheat may continue into the operating hours on the next day.

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 discharge temperature mitigation devices (if any).
- If possible, locate refrigeration schedule to assess the load/capacity ratio. This will allow the capacity to be determined with the new refrigerant. See appendix A for detail.

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.

3. Review expansion valves and relief valves

- Any nonadjustable expansion valves should be identified. Replacement valves or adjustment kits should be on hand for these valves prior to the retrofit.
- 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
- 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. Refer to Appendix C for recommended seals and O-rings for replacement.

5. Record baseline data

- Record baseline data to identify issues and as a reference for post-retrofit performance.
- Refer to survey form at http://bit.ly/2qasBHi

6. Line sizes

- Review refrigerant line sizes, 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.

7. 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.

8. Forward completed survey form to the customer

Step 2 - Preparation

1. Store coordination

- It is recommended to meet with the store leader and department managers.
- Items to discuss include:
  - Retrofit dates and times.
  - Store hours.
  - Unloading of cases.
  - Opportunity for case cleaning.
  - Food safety (dry ice, keeping doors closed, etc).

2. Order parts and refrigerant

3. Technician training

- Ensure that technicians are trained on setting superheat .
- Refer to pressure-temperature chart in Appendix D 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, compressor changes, pilot lines, 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-450A or R-134a. A change to a synthetic lubricant is required. Honeywell recommends using a miscible lubricant approved by the compressor manufacturer.

- Usually (1) full oil change is required.
- Refer to Appendix A for oil change recommendations.

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 store personnel the day prior to retrofit

2. Secure food safety (dry ice, plastic sheeting, signs on coolers, etc.)

3. Recover existing refrigerant

- Use Green Chill guidelines at www.epa.gov/ greenchill to recover 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. Refer to Appendix D for recommendations

7. Replace expansion valves and add adjustment kits as determined in survey

8. Replace driers and filters

9. 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.

10. 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.
- **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.

11. Adjust expansion valves

- Adjusting valves is a very important part of any retrofit. Properly adjusted valves will prevent compressor damage, ensure safe food temperatures and result in an efficient system.
- Most valves will require some adjustment.
- Refer to step 1 item 3 for details on expansion valves.
- In the absence of specific manufacturer recommendations, a 4 to 6°F superheat for low temperature and 6 to 8°F for medium temperature is recommended.

12. Adjust pressure controls

- All mechanical 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).

13. 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 - COMPRESSORS

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.

Recommended process:

1. Remove existing oil from compressor, reservoir, and separator.
2. Measure volume of lubricant removed. This volume will be used as a guide to determine the amount of new lubricant to add.
3. Change lubricant filters if present.
4. Add new lubricant. It is recommended that polyolester (POE) lubricant be pumped rather than poured to avoid pickup of atmospheric moisture.
5. Run for 24 hours ensuring all circuits are defrosted and that all coils, such as heat reclaim and split condensers, are engaged periodically.
6. Test for percentage of mineral oil using oil refractometer. 95% synthetic is preferred.
7. 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.

Disclaimer: Some of the following information was obtained from manufacturers' information. Please refer to the manufacturer for updates to the information. In some cases it may be possible that the recommendations are quite conservative.

APPENDIX A - COMPRESSORS

Carlyle reciprocating compressors

As per **O6deaguide.pdf, Lit. No. 574-069 Rev B 6/04**, the following POE oils are approved for use on Carlyle O6D/E:

Manufacturer	Brand Name
Castrol ICI EMKARATE CPI	E68 RL68H SOLEST 68
Mobil Arctic† Castrol†	EAL 68 SW 68

Copeland reciprocating compressors

As per **Emerson 93-11**, Copeland recommends POE-32 for use with Solstice® 513A in refrigeration applications**. Visit the Emerson web site for the latest approved lubricants.

COMPRESSOR COMPATIBILITY

Copeland reciprocating compressors

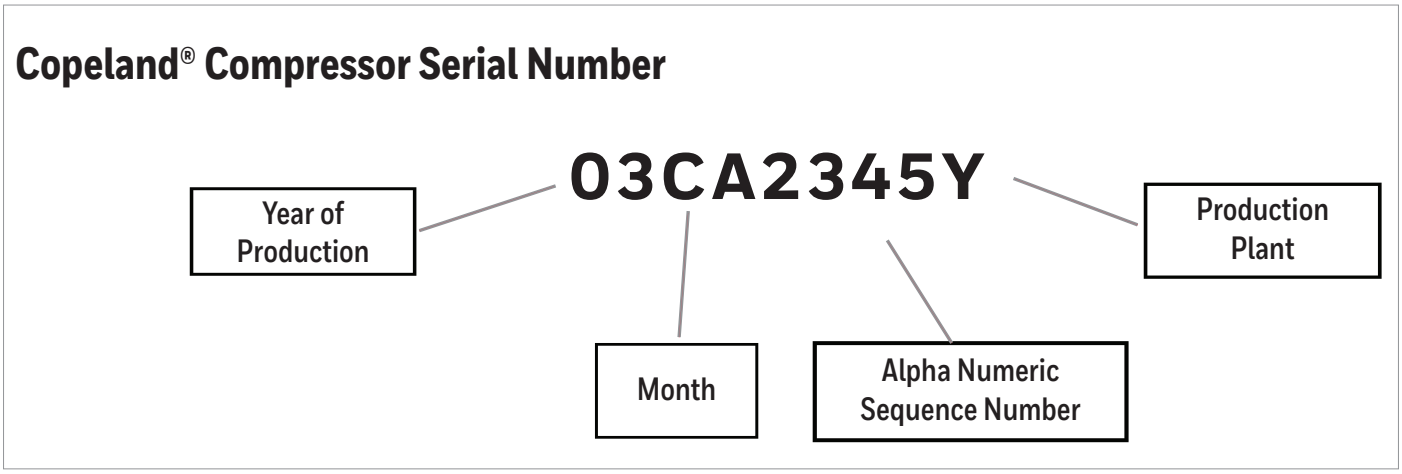
Older Copeland reciprocating compressors are recommended to be replaced with new models. This is because the older models were never qualified for use with HFO refrigerants and POE oil. These compressors can be identified by an "R" in the second letter in the model. For example, a 4RA3-1000-TSK compressor is not qualified for use with POE oil.

Compressor replacement should occur prior to any change to synthetic oil.

Newer model Discus compressors are approved for use with POE oil and R-513A.

The compatible models are:

- 2D all
- 3D manufactured after 1999
- 4D and 6D manufactured after April 2003



3D compressor Moduload systems should be checked for applicability. Retrofit kits are available.

Blocked suction capacity control on 4D and 6D compressors is compatible with POE oil and R-450A or R-134a.

Refer to Emerson application engineering bulletin **CC7.26.5/0117E** for information on recommended crankcase heaters, suction accumulators, etc.

Carlyle reciprocating compressors

Carlyle began using a higher flow oil pump in June 1994. This pump is recommended in order to prevent oil failures when using synthetic oils. It is recommended that compressors with serial numbers beginning with 0694 or older be retrofitted with the high-flow oil pump.

Compressor Serial Number Significance

ALL NEW COMPRESSORS

Example: S/N 3695J00123

36 95 J 00123

- 00123 — Numerical Sequence
- J — Plant location: J = Syracuse, U = Atlanta
- 95 — Year of Manufacture: 93, 94, 95, etc.
- 36 — Week of Manufacture: 01 thru 52 Begin Jan.1st

ALL SERVICE COMPRESSORS

Example: S/N 3602UD0123

36 02 U D 0123

- 0123 — Numerical Sequence
- D — Compressor Type: D, E
- U — Plant location: M = Atlanta, P = Phoenix, U = Atlanta (after 4/2001)
- 02 — Year or Manufacture: 93, 94, 95, etc.
- 36 — Week of Manufacture: 01 thru 52. Begin Jan. 1st

NEW AND SERVICE REPLACEMENT COMPRESSORS BUILT BETWEEN NOV. 1968 - OCT. 1978

Example: S/N A2J0001

A 2 J* 0001

- 0001 — Numerical Sequence
- J — Plant location: J = Syracuse
- 2 — Year of Manufacture: 9= 69, 0 = 70, 1 = 71. etc.
- A — Month of Manufacture: A=Jan, B=Feb, etc.; skipl; M=Dec

**An "x", "A" or "P" in this location indicates service compressor.*

As per **O6deaguide.pdf, Lit. No. 574-069 Rev B 6/04,** Carlyle serial number/date reference Per 06D/E Pocket Service Guide, page 8, literature number 020-611 at www.carlylecompressor.com

Carlyle screw compressors

Carlyle 74mm screw compressors have a low risk of a compressor seal refrigeration leak during retrofits.

DISCHARGE TEMPERATURE MITIGATION

With R-513A running in medium temperature systems there will be no need for discharge temperature mitigation.

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.

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

APPENDIX B – REFRIGERANT LINE SIZING

INTRODUCTION

Refrigerant line sizes in a typical supermarket system consist of the compressor discharge, condenser return and individual circuit liquid and suction lines.

The correct line sizes help to ensure a properly running system. Prior to a retrofit it is recommended to review horizontal and vertical suction line sizes.

The correct design of these line sizes ensures that:

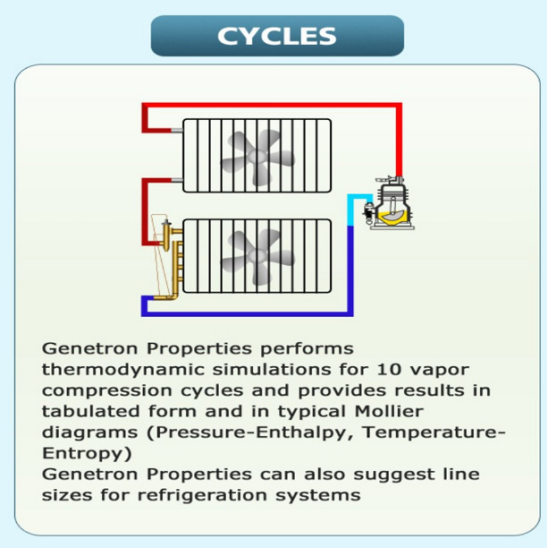
1. The suction line size is **large enough** to result in a **pressure drop** that is compatible with the design. Designers will normally account for a suction line pressure drop. (The design pressure drop can be determined by a review of the refrigeration schedule; contact Honeywell technical services for assistance).
2. The line size is **small enough** to result in **refrigerant velocity** sufficient to ensure oil is returned to the compressor. This is especially important on vertical risers.

SUCTION LINE SIZES

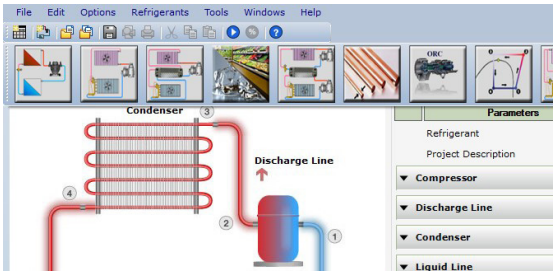
ASHRAE recommends horizontal suction line refrigerant velocities greater than 500 ft/min for horizontal lines and greater than 900ft/min for vertical risers. A vertical suction riser should maintain a minimum of 900 fpm at the lowest load condition expected for the system.

Pipe size calculation:
The **Genetron® Properties** program is available as a free download and can be used to calculate line sizes.

Step 1: Determine circuit design temperatures and refrigeration load.
Step 2: Determine existing line sizes.
Step 3: Choose Cycles in the Genetron software.



Step 4: Select line sizing



Step 5: Calculate the drop in saturation temperature and velocity for the horizontal lines and risers.

Note: When calculating riser temperature rise, enter a main line length of zero. Contact Honeywell technical support with any questions.

APPENDIX C - LEAK PREVENTION MEASURES

INTRODUCTION

During the retrofit from an HCFC 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 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:

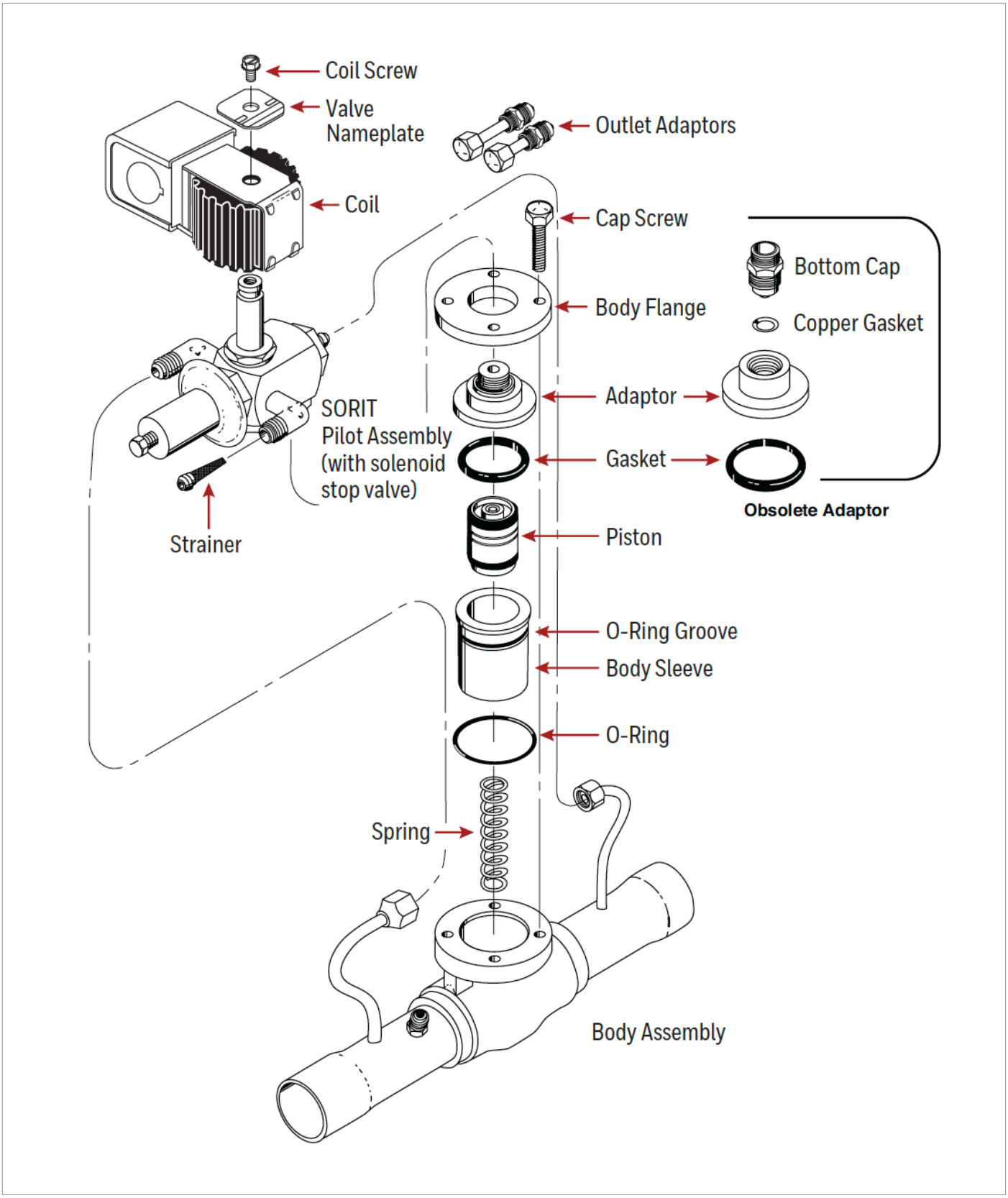
- Schrader valves and caps
- Receiver level indicators and alarms
- Heat reclaim and condenser splitting valves
- Evaporator Pressure Regulators (EPRs)
- Solenoid valves
- Pilot hoses
- Ball valves

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

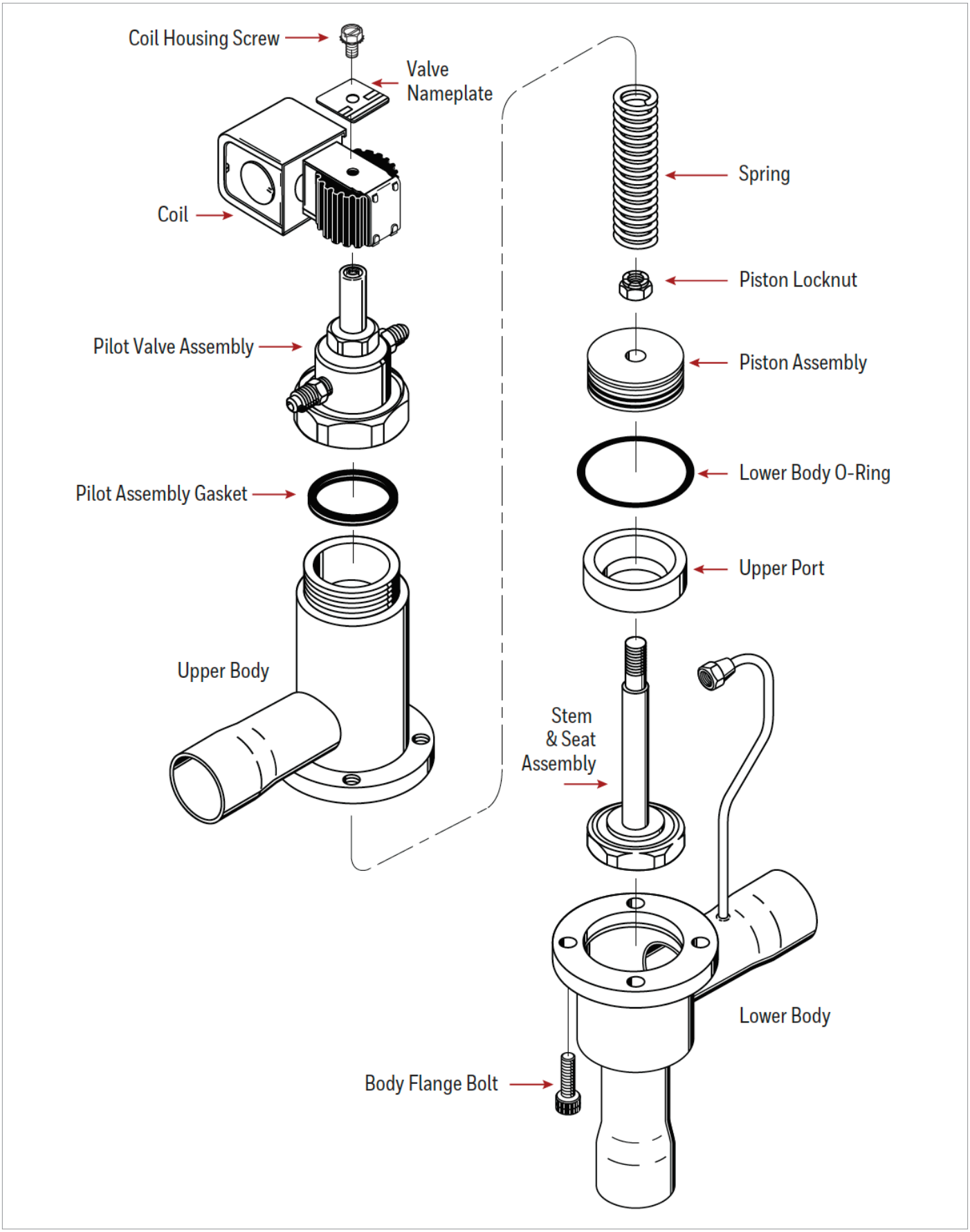
A retrofit is also a good time to replace valves that are beyond their life-cycle. Some valves will not have replacement seals available and will need to be replaced.

EXAMPLE VALVES WITH GASKET AND O-RING LOCATIONS

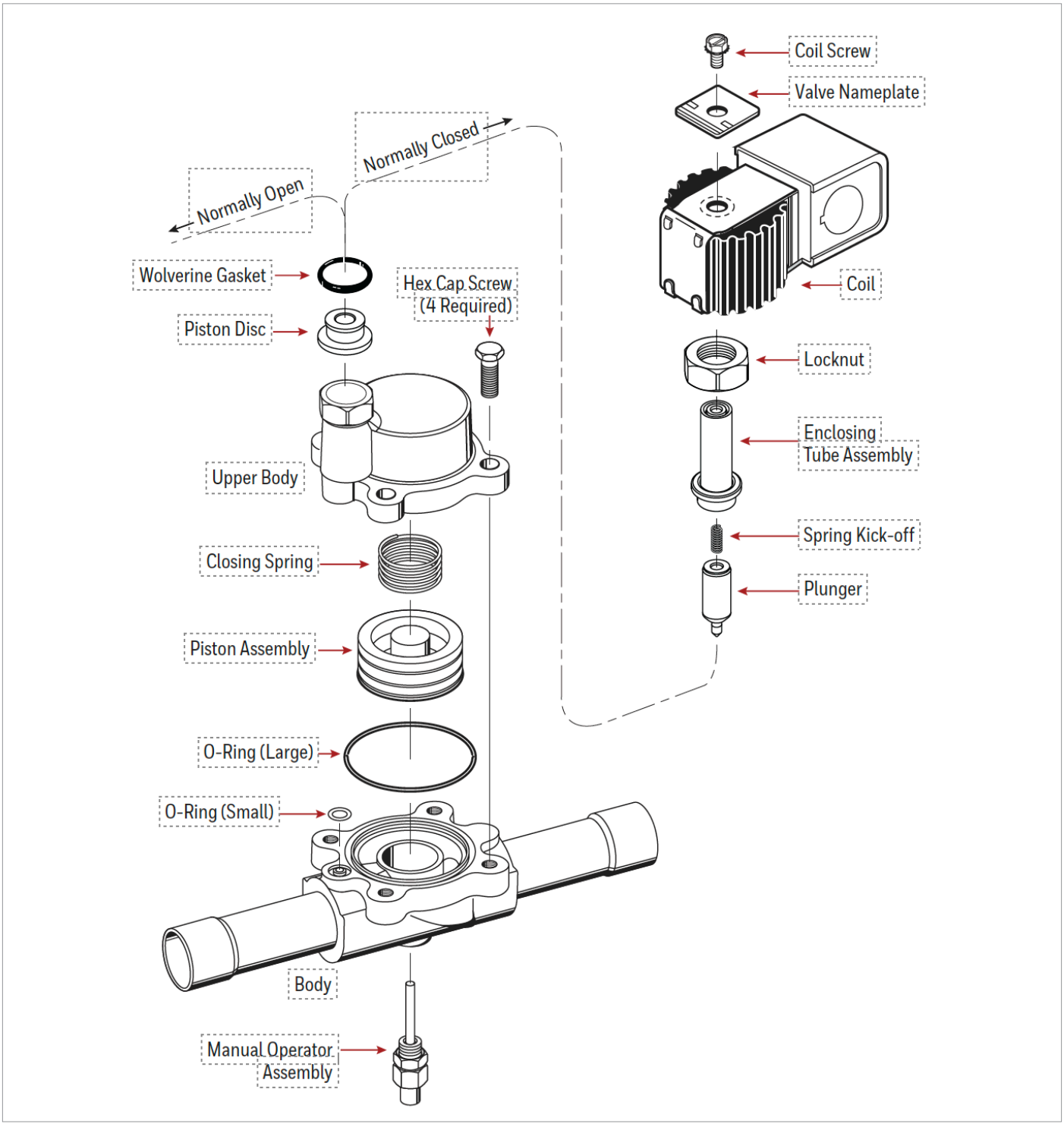
Evaporator Pressure Regulator



Heat Reclaim Valve



Solenoid Valve



APPENDIX D - PRESSURE/TEMPERATURE CHART

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)
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
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

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)
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

Genetron 134a

Pressure (psig)	Temperature (°F)
0.0	-14.9
5.0	-3.1
10.0	6.7
15.0	14.9
20.0	22.2
22.0	24.9
24.0	27.4
26.0	29.9
28.0	32.3
30.0	34.6
32.0	36.8
34.0	38.9
36.0	41.0
38.0	43.0
40.0	45.0
42.0	46.9
44.0	48.7
46.0	50.5
48.0	52.3
50.0	54.0
55.0	58.1
60.0	62.0
70.0	69.2
80.0	75.9
90.0	82.0
100.0	87.7
105.0	90.4
110.0	93.0

Pressure (psig)	Temperature (°F)
115.0	95.5
120.0	98.0
125.0	100.4
130.0	102.7
135.0	105.0
140.0	107.2
145.0	109.4
150.0	111.5
155.0	113.6
160.0	115.6
165.0	117.6
170.0	119.6
175.0	121.5
180.0	123.3
185.0	125.2
190.0	127.0
195.0	128.7
200.0	130.4
205.0	132.1
210.0	133.8
215.0	135.5
220.0	137.1
230.0	140.2
240.0	143.3
250.0	146.3
260.0	149.2
270.0	152.0
280.0	154.7

For more information visit
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THE FUTURE IS WHAT WE MAKE IT

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