ICE RINK
RETROFIT GUIDELINE

HCFC-22 (R-22) to Solstice® N40 (R-448A)
or Genetron Performax® LT (R-407F)

Honeywell

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PREFACE

R-22 is an HCFC refrigerant and as such is regulated in the United States under the Clean Air Act regulation. This includes a ban on production or import of R-22 as of Jan 1, 2020.

In Canada, the Canadian Environmental Protection Act (CEPA) also includes a ban on production or import of R-22 as of Jan 1, 2020.

As ice rink owners and operators work to comply with regulations, ensure refrigerant supply, and 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, capital cost, regulatory compliance, safety, maintenance, and cooling capacity.

Technicians may follow equipment manufacturers' recommendations and Honeywell's guidelines outlined in this publication to help retrofit existing R-22 ice rink systems to R-448A or R-407F.

SYSTEM CONFIGURATIONS

Ice rink refrigeration plants come in a variety of configurations.

Direct vs indirect systems:
In a direct system, the primary refrigerant flows under the rink ice slab. These type systems are not suitable for ammonia. These systems can have refrigerant charges up to 5,000 lbs.

In an indirect system, the primary refrigerant remains in the machine room. The primary refrigerant is used to chill a secondary fluid of either glycol or a salt brine solution. This solution is then pumped under the ice slab.

Refrigerant type:
The vast majority of existing refrigeration systems employ either HCFC R-22 or ammonia.

Heat exchanger:
For direct systems, the heat exchanger/evaporator is, in effect, the piping under the ice slab.

For indirect systems, the heat exchanger may be either flooded or direct expansion.

In flooded systems, the heat exchanger is basically a tank with the secondary solution running through pipes in the tank. The refrigerant in the heat exchanger is maintained as liquid refrigerant. The compressor(s) pull vapor refrigerant off the top of the tank. Flooded systems are typically not suitable to refrigerants with glide (zeotropes).

In direct expansion heat exchangers, the refrigerant runs through pipes and will fully evaporate in this piping. The secondary solution typically runs through the heat exchanger containing the primary refrigerant piping. Plate and frame heat exchangers are being more commonly used due to their smaller size and improved efficiency.

R-22 Retrofit Options

The options for retrofitting R-22 will depend upon the system configuration.

Option 1: Indirect system with direct expansion heat exchanger:
Honeywell's N40 (R-448A) and Genetron Performax LT (R-407F) have proven to be an excellent solution for replacing R-22 in this configuration. This retrofit guide concentrates on this system configuration.

Option 2: Indirect system with flooded heat exchanger:
Modern refrigerants with characteristics that are similar to R-22 exhibit glide in the evaporator. Due to this they are not recommended for flooded systems. For these systems, it is recommended to replace the flooded heat exchanger with a direct expansion heat exchanger. Honeywell's N40 (R-448A) and Genetron Performax LT (R-407F) are great choices to be used in the new evaporator.

Option 3: Direct system with R-22
Modern refrigerants with characteristics that are similar to R-22 exhibit glide. The glide would result in differing temperatures in the piping under the rink slab. Due to this they are not recommended for replacement of R-22 in direct ice rink systems.

It is possible that a refrigerant without glide and dissimilar to R-22 could be utilized. In this case a thorough design review of the compressor capacities, flow rates under the slab, and heat transfer would be required. Also, be sure to evaluate any oil cooling techniques for applicability. Contact Honeywell technical team for assistance.

SOLSTICE R-448A AND GENETRON R-407F

ASHRAE NUMBER, COMPONENTS AND ATTRIBUTES					
REFRIGERANT	TYPE	REPLACES	GWP	EER VS R-404A*	CAPACITY VS R-404A*
Solstice N40 (R-448A)	Solstice N40 (R-448A) HFO Blend R-32 R-125 R-1234yf R-134a R-1234ze	R-22 R-404A R-507 R-402A R-408A	1237	4% Better	2-6% Higher
Genetron Performax LT (R-407F)	HFC Blend R-32 R-125 R-134a		1674		

*+15°F suction temperature, +90°F condensing

RETROFIT PROCEDURES – INDIRECT SYSTEM WITH DIRECT EXPANSION EVAPORATOR

Although the information in this guide 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.

R-448A and R-407F are not "drop-in" replacements. R-448A and R-407F utilize synthetic lubricants. 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.

Step 1 – Site survey (see survey form in Appendix A)

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)
    - Many compressor manufactures models have been successfully retrofitted to R-448A and R-407F. Regardless of this it is important to contact compressor manufacturer to check on refrigerant compatibility and preferred oil. Contact Honeywell technical team if needed for assistance.
2. **System issues**
    - Walk the facility, machine room and condenser to identify any items that impact system operation. Some example areas to identify include failed condenser fans, failed sub coolers, degraded condensers, poor insulation, obsolete components, etc.

3. **Review expansion valves and relief valves**
    - In general, R-22 valves will have a close capacity in comparison to R-448A and R-407F.
    - Expansion valves should be adjusted for proper superheat during startup and commissioning.
    - A retrofit to electronic expansion valves is recommended but not required. These will increase the system stability and efficiency.
    - When retrofitting from R-22 to R-448A or R-407F the relief valve size may need to be increased. Please refer to manufactures literature for sizing guidelines
4. **Identify seals and O-rings for replacement**
    - Chlorine based refrigerants such as R-22 can result in elastomer seal failure when the chlorine-based refrigerant is removed.
    - Any component or valve with elastomeric seals should be retrofitted or replaced.
    - The direct expansion heat exchanger should be reviewed for elastomeric seals. If in doubt the seals should be replaced.
    - Seals on open drive compressors typically should be replaced.
    - Refer to Appendix C for more detail.
5. **Record baseline data**
    - Record baseline data to identify issues and as a reference for post-retrofit performance

    Refer to survey form in Appendix A for data to be recorded.
6. **Line sizes**
    - Lines sizes should be a good match. Review with service personnel to identify any line sets of questionable size. Refer to Honeywell bulletin 10 for recommended line sizes for R-448A.
7. **Test oil and refrigerant**
    - Test oil to identify any signs of serious system issues
8. **Forward completed survey form to the customer.**

Step 2 – Preparation

1. **Facility coordination**
    - It is recommended to meet with facility leader to discuss anticipated down time, facility hours and best time for retrofit.
2. **Order parts and refrigerant**
3. **Technician training**
    - Ensure that technicians are trained on setting superheat using dewpoint temperature with refrigerants with glide. Refer to Appendix B.
    - Refer to pressure-temperature chart in this document.
    - Ensure that technicians are trained on setting pressure valves based on average pressure when using refrigerants with glide. Refer to Appendix B.
    - 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 without elastomer seals, compressor changes, pilot lines, control adjustments, coil cleaning, etc.

5. **Recover excess refrigerant from receiver.**
   - This will reduce recovery time on the night of the retrofit. Weigh refrigerant for use in calculating R-448A charge.
6. **Change oil from mineral to POE.**
   - In most instances, the lubricant in use with R-22 is not suitable for use with R-448A or R-407F and a change to a synthetic lubricant is required. Honeywell recommends using a miscible lubricant approved by the compressor manufacturer.
   - A minimum of (1) full oil change is required
   - 95% of synthetic is preferred. Refer to compressor manufacturer for specific applications.
7. **Change suction and liquid filters and driers.**
8. **Upgrade controller with R-448A or R-407F pressure / temperature curves. Honeywell recommends using average pressures for control when using refrigerants with glide.**
9. **Leak check and repair.**

Step 3 – Retrofit

1. **Remind facility personnel the day prior to retrofit.**
2. **Recover existing refrigerant**
   - Use Green Chill guidelines at **www.epa.gov/GreenChill** to recover refrigerant.
3. **Record amount of refrigerant removed including refrigerant previously removed.**
4. **Break vacuum from recovery machine.**
5. **Replace seals, gaskets, and valves as needed.**
6. **Replace driers and filters.**
7. **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-condensables such as air.
   - Use a good electronic micron gauge to measure the vacuum. An accurate reading cannot be made with an analog refrigeration gauge.
   - Repair any leaks.
8. **Charge system with Solstice N40 refrigerant**
   - When working with R-448A and R-407F, it is important to remember that are blended refrigerants. It is essential that blended refrigerants be liquid-charged by removing only liquid from the cylinder. **Never vapor charge the system with vapor from a R-400 series refrigerant cylinder**. Vapor-charging may result in a change in the refrigerant composition and unpredictable system performance.
   - A throttling valve 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 into the suction line of the compressor.
   - Systems being charged with R-448A require approximately 8% lower charge than R-22

- 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.

9. Adjust expansion valves

- Adjusting valves is a very important part of any retrofit. Properly adjusted valves will prevent compressor damage 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 °F to 6 °F superheat is recommended.

10. Adjust pressure controls

- All mechanical controls should be reviewed for adjustment. This includes safety controls, EPR valves, holdback valves, etc. Refer to Appendix B prior to making any set point adjustments.
- Adjusting pressures on R-448A and R-407F requires the use of an average of dew and bubble pressures as shown on Honeywell PT charts
- For condenser fan control, an average pressure should be used. Verify control system is using an average pressure. Refer to Appendix B prior to making any set point adjustments.

11. 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
RINK RETROFIT SURVEY

Rink Information

Ownership	
Address	
City	
Property #	
Survey Date	
Build Date	
In Attendance	

Upload site image here

RINK RETROFIT SURVEY

General Information

Outdoor Temp	
Outdoor Humidity	
Indoor Temp	
Indoor Humidity	
Existing Refrigerant	
Planned New Refrigerant	
Installing/Servicing Contractor	
Point of Contact, Phone, E-mail	

Additional Info

RINK RETROFIT SURVEY

Refrigeration System Information

Refrigeration System Manufacturer	
Compressor Types/Mfg	☐ Reciprocating ______ ☐ Screw ______ ☐ Semi Hermetic ______ ☐ Open Drive ______ ☐ Hermetic ______
Compressor Equipment Location	☐ Machine Room ☐ Roof ☐ Rink Level Ground ☐ Outside Ground Notes
Condenser Type/Location	☐ Air ☐ Water ☐ Evaporative Condenser Notes
Control Types	☐ Suction Pressure ☐ Temperature Across Chiller ☐ Ice Temperature ☐ Temperature Across Floor Piping Notes
Discharge Temperature Mitigation	☐ Head Cooling Fan ☐ Liquid Injection ☐ Y-1037 ☐ Demand Cooling ☐ Other Notes

RINK RETROFIT SURVEY

Refrigeration System Information

Refrigerant Feed Arrangement	☐ Flooded Notes ☐ Direct Expansion Evaluate any low-side vessels for liquid/vapor interface
Direct Expansion	☐ Thermal Expansion Valves ☐ Electronic Expansion Valves Valve Model and Manufacturer: ________________________
Flooded Type	☐ Mechanical Liquid Pumps (Overfeed Ratio?) ________ ☐ Pumper Drums ☐ Floats ☐ Feeding Heat Exchanger ☐ Feeding Floor Directly ________
Refrigerant Pumps/Manufacturer/Model	☐ Open Drive ________________ ☐ Magnetic Drive ________________ ☐ Capacity Control on Liquid Pumps? ________ ☐ Type of Control (On/off, dual pumps, variable speed) ________________________
Oil Management System	☐ Oil Separators ☐ Oil Filters ☐ Skimmer ☐ DX Oil Cooling ☐ Oil Reservoir ☐ Flash Tank Oil Cooling ☐ Liquid Injection Oil Cooling ☐ Injector ☐ Thermo-syphon Oil Cooling
Heat Recovery	☐ Subsoil ☐ Air ☐ Water ☐ Ice Skimmer Pit
Secondary Fluid	☐ Ethylene glycol _____% ☐ Brine-calcium chloride ☐ Propylene glycol _____% ☐ Other ________________

RINK RETROFIT SURVEY

Refrigeration System Information

Operating Conditions **Note Rink Status:** ☐ **Maintenance Run** ☐ **Building Ice**	Suction Pressure ________ psig Measured Suction Temp @ Compressor ________ °F Discharge Pressure ________ psig Measured Discharge Temp Leaving Compressor ________ °F Measured Liquid Pressure ________ psig Measured Liquid Temperature ________ °F
Chiller Configuration **Heat Exchanger**	☐ Shell in Tube (Refrigerant in Tubes) ☐ Shell in Tube (Refrigerant in Barrel) ☐ Plate Heat Exchanger (Brazed) ☐ Please heat exchanger (Bolt Up)

Refrigeration System Information

	System	Suction Group	Refrigerant	# of Compressors	Design Suction Pressure (°F)	Actual Suction Pressure (psig)/ SST (°F)	Suction Temp	Super-heat	Liquid Temp	Discharge Pressure (psig)/SST (°F)
1										
2										
3										
4										
5										
6										
7										

Notes

RINK RETROFIT SURVEY

Compressor Information

System/ Group	Com- pressor Number	Model Number	Serial Number	Year	Discharge Temp (°F)	Notes

Compressor Additional Notes

RINK RETROFIT SURVEY

System Notes

RINK RETROFIT SURVEY

Upgrade Possibilities & Recommendations

RINK RETROFIT SURVEY

Picture

Description

Picture

Description

RINK RETROFIT SURVEY

Picture

Description

Picture

Description

APPENDIX B
CONTROL SETTINGS

Control Settings with R-448A

- Superheat
- Liquid subcooling
- Evaporator Pressure Regulator (EPR)
- Condenser

Introduction

The proper setting of superheat, subcooling and pressures is critical to a well-performing system. During a retrofit it will be necessary to check and adjust mechanical control valves.

Superheat

Procedure:

1. Use a thermometer to determine the actual temperature at the evaporator coil outlet.
2. Use gauges to determine the pressure at the evaporator coil outlet.
3. Using this pressure, determine the dew temperature using the "dew" column of the PT chart.
4. Calculate superheat.

Superheat = actual temperature at evaporator coil outlet - dew temperature from PT chart.

Example: Determine the superheat on a system which uses Solstice N40 (R-448A) when the pressure at the Evaporator coil outlet reads 45 psig and the actual temperature at the coil outlet is 30°F.

1. Actual temperature at coil outlet = 30°F
2. Pressure = 45.0 psig
3. Find 45 psig in the pressure colum of the PT chart and read across to find the dew temperature at that pressure. In the following chart we see the dew temperature at 45 psig is 20°F.

Pressure (psig)	*Solstice N40 (R-448A)* Temperature °F		
	Avg	Bubble	Dew
35	6	1	11
40	11	6	16
45	15	10	20
50	19	14	24
55	23	18	28

4. Calculate superheat
   Superheat = 30°F – 20°F
   Superheat = 10°F

CONTROL SETTINGS

Subcooling at condenser outlet

Procedure:

1. Use gauges to determine the pressure at the outlet of the condenser
2. Using this pressure determine the bubble temperature using the “bubble” column of the PT chart.
3. Use a thermometer to get the actual temperature at the same point on the condenser outlet.
4. Calculate sub cooling.

Sub cooling = bubble temperature from PT chart - actual temperature at condenser coil outlet.

Example: Find the amount of subcooling on a system using Solstice N40 (R-448A) when the condenser outlet pressure is 195 psig and the condenser outlet temperature is 80°F.

1. Outlet pressure is 195 psig
2. Actual temperature of pipe is 80°F degrees
3. Find 195 psig in the pressure column of the PT chart and read across to find the bubble temperature at that pressure. In chart below we see the temperature at 195 psig is 85°F.

Pressure (psig)	Solstice N40 (R-448A) Temperature °F		
	Avg	Bubble	Dew
185	86	82	91
190	88	83	92
195	89	85	94
200	91	87	96
205	93	88	97

4. Calculate subcooling
   Subcooling = 85°F - 80°F
   Subcooling = 5°F

Note: The same procedure can be used to determine subcooling on the liquid line exiting a subcooler expansion valve inlet, etc.

Evaporator Pressure Regulator (EPR)

Procedure:

1. Determine desired suction temperature at the EPR valve based on design data for the fixture. This can be found on the refrigeration schedule or manufacturer specification sheet.
2. Use gauges to measure the pressure on the fixture side of the EPR valve.
3. Using this pressure find the average temperature column from the PT chart to determine the current setting of the EPR valve.
4. Adjust valve to match required fixture pressure. Some adjustment from the design set point will be necessary based on system pressure drop and other factors.

Example: Set the EPR valve on a circuit which uses

Solstice N40 (R-448A) when the pressure at the EPR reads 50 psig and the required fixture suction temperature is 15°F.

CONTROL SETTINGS

1. Desired fixture suction temperature is 15°F.
2. Pressure on the fixture side of valve is 50 psig.
3. Using the pressure column on the PT chart gives an average fixture temp of 19°F.

Pressure (psig)	Solstice N40 (R-448A) Temperature °F		
	Avg	Bubble	Dew
35	6	1	11
40	11	6	16
45	15	10	20
50	19	14	24
55	23	18	28

4. The EPR valve should be adjusted to a pressure of 45 psig to match the 15°F required by the fixture.

Pressure (psig)	Solstice N40 (R-448A) Temperature °F		
	Avg	Bubble	Dew
35	6	1	11
40	11	6	16
45	15	10	20
50	19	14	24
55	23	18	28

Condenser Pressure Control

There are three main methods of condenser fan / pressure control. These are

A: Condensing Pressure

B: Drop leg temperature

C: Temperature difference (TD)

A: Pressure control

The condensing pressure is sensed and compared to the setting. Fans are cycled to achieve this setting.

For refrigerants with glide, such as R-448A, the average temperature should be used.

Example: A common condenser pressure setting is 90°F saturated condensing pressure. Determine the corresponding pressure setting for R-448A.

1. On the PT chart find the pressure corresponding to an average temperature of 90°F.
2. This equals a 195 psig setting.
3. The mechanical or electronic fan control should be set to 195 psig.

CONTROL SETTINGS

Pressure (psig)	Solstice N40 (R-448A) Temperature °F		
	Avg	Bubble	Dew
185	86	82	91
190	88	83	92
195	90	85	94
200	91	87	96
205	93	88	97

B: Drop leg temperature control

The temperature of the condenser outlet piping is sensed and compared to the setting. Fans are cycled to achieve this setting.

For refrigerants with glide, the temperature of the refrigerant leaving the condenser is lower than the average value across the entire coil. Due to this the setting should be changed to reflect the average coil temperature.

Example: A common setting is to maintain a 90°F condenser outlet pipe temperature for refrigerants without glide. Determine the temperature setting for R-448A.

Refer to chart below:

1. Find the average temperature corresponding to the temperature setting.
2. Find the Bubble temperature in the same row on the PT chart.

Pressure (psig)	Solstice N40 (R-448A) Temperature °F		
	Avg	Bubble	Dew
185	86	82	91
190	88	83	92
195	90	85	94
200	91	87	96
205	93	88	97

The new setting will be the bubble temperature for the average pressure.

New setting = 85°F

C: Temperature Difference (TD) control

The condenser design and the outdoor ambient temperature are used to calculate the condenser pressure setting. This setting will change as the ambient changes.

Condenser setting

= current ambient + condenser design TD.

Example: For a condenser designed for 10 degree temperature difference on an 80 degree day.

CONTROL SETTINGS

1. Condenser setting = ambient + TD
   a. = 80ºF + 10ºF
   b. = 90ºF
2. Reading the average pressure corresponding to 90ºF gives a pressure setting of 195 psig.
3. The electronic fan control should be controlling to a value of 195 psig. Contact retailer for specific settings. Some retailers will lower the TD setting to achieve increased subcooling.

Pressure (psig)	Solstice N40 (R-448A) Temperature °F		
	Avg	Bubble	Dew
185	86	82	91
190	88	83	92
195	90	85	94
200	91	87	96
205	93	88	97

For mechanical controls simply convert fan cycling schedule from pressure to temperature (original gas). Find this temperature in the average column on the R-448A PT chart. Use the corresponding pressure at that average temperature.

Note for pressure and TD control methods

Some electronic controllers may use the bubble temperature (instead of average) for control. This will lead to a higher effective set point.

It is recommended to make set points as described in the examples above and monitor the system to see if it controls as expected.

If control performance is not correct it will be necessary to either adjust the set points or put offsets into the sensors to account for the difference between bubble and average temperatures.

Contact Honeywell technical team or the specific controller technical teams for assistance.

APPENDIX C
LEAK PREVENTION MEASURES

Introduction

During the retrofit from an HCFC to an HFO 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

Some ball valve manufacturers have an available retrofit cap 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.

PRESSURE TEMPERATURE CHARTS

Solstice N40 (R-448A)

SOLSTICE N40 (R-448A)							
PRESSURE BASED PT CHART							
Pressure (psig)	Temperature °F			Pressure (psig)	Temperature °F		
	Avg	Bubble	Dew		Avg	Bubble	Dew
0.0	-45.5	-51.0	-39.9	155.0	75.3	70.6	80.0
5.0	-34.3	-39.8	-28.8	160.0	77.2	72.5	81.8
10.0	-25.2	-30.6	-19.7	165.0	79.0	74.4	83.7
15.0	-17.4	-22.8	-12.0	170.0	80.9	76.3	85.5
20.0	-10.6	-16.0	-5.2	175.0	82.6	78.1	87.2
25.0	-4.5	-9.9	0.8	180.0	84.4	79.8	89.0
30.0	1.0	-4.3	6.3	185.0	86.1	81.6	90.7
35.0	6.1	0.8	11.4	190.0	87.8	83.3	92.3
40.0	10.8	5.5	16.0	195.0	89.5	85.0	94.0
45.0	15.1	9.9	20.4	200.0	91.1	86.6	95.6
50.0	19.2	14.1	24.4	205.0	92.7	88.3	97.1
55.0	23.1	17.9	28.3	210.0	94.3	89.9	98.7
60.0	26.8	21.6	31.9	215.0	95.8	91.4	100.2
65.0	30.3	25.1	35.4	220.0	97.3	93.0	101.7
70.0	33.6	28.5	38.7	225.0	98.8	94.5	103.2
75.0	36.8	31.7	41.8	230.0	100.3	96.0	104.6
80.0	39.8	34.8	44.8	235.0	101.8	97.5	106.1
85.0	42.7	37.7	47.7	240.0	103.2	98.9	107.5
90.0	45.5	40.6	50.5	245.0	104.6	100.4	108.9
95.0	48.3	43.3	53.2	250.0	106.0	101.8	110.2
100.0	50.9	45.9	55.8	255.0	107.4	103.2	111.6
105.0	53.4	48.5	58.4	260.0	108.7	104.6	112.9
110.0	55.9	51.0	60.8	265.0	110.1	105.9	114.2
115.0	58.3	53.4	63.2	270.0	111.4	107.3	115.5
120.0	60.6	55.8	65.5	275.0	112.7	108.6	116.8
125.0	62.9	58.0	67.7	280.0	113.9	109.9	118.0
130.0	65.1	60.3	69.9	285.0	115.2	111.2	119.2
135.0	67.2	62.4	72.0	290.0	116.5	112.4	120.5
140.0	69.3	64.5	74.0	295.0	117.7	113.7	121.7
145.0	71.3	66.6	76.1	300.0	118.9	115.0	122.9
150.0	73.3	68.6	78.0	305.0	120.1	116.2	124.0

SOLSTICE N40 (R-448A)			
PRESSURE BASED PT CHART			
Pressure (psig)	Temperature		
	°F		
	Avg	Bubble	Dew
310.0	121.3	117.4	125.2
315.0	122.5	118.6	126.4
320.0	123.6	119.8	127.5
325.0	124.8	121.0	128.6
330.0	125.9	122.1	129.7
335.0	127.0	123.3	130.8
340.0	128.2	124.4	131.9
345.0	129.3	125.5	133.0
350.0	130.3	126.7	134.0
355.0	131.4	127.8	135.1
360.0	132.5	128.9	136.1
365.0	133.5	129.9	137.1
370.0	134.6	131.0	138.1
375.0	135.6	132.1	139.1
380.0	136.6	133.1	140.1
385.0	137.7	134.2	141.1
390.0	138.7	135.2	142.1
395.0	139.6	136.2	143.1
400.0	140.6	137.3	144.0
405.0	141.6	138.3	145.0
410.0	142.6	139.3	145.9
415.0	143.5	140.2	146.8
420.0	144.5	141.2	147.7
425.0	145.4	142.2	148.6
430.0	146.3	143.2	149.5
435.0	147.3	144.1	150.4
440.0	148.2	145.1	151.3
445.0	149.1	146.0	152.2
450.0	150.0	146.9	153.0
455.0	150.9	147.9	153.9

Genetron Performax LT (R-407F)

GENETRON PERFORMAX LT (R-407F)							
PRESSURE BASED PT CHART							
Pressure (psig)	Temperature °F			Pressure (psig)	Temperature °F		
	Avg	Bubble	Dew		Avg	Bubble	Dew
0.0	-45.2	-50.9	-39.4	46.0	15.5	10.4	20.7
1.0	-42.7	-48.5	-37.0	49.0	18.0	12.8	23.1
2.0	-40.4	-46.1	-34.7	52.0	20.3	15.2	25.5
3.0	-38.2	-43.9	-32.5	55.0	22.6	17.5	27.7
4.0	-36.1	-41.8	-30.5	59.0	25.5	20.4	30.6
5.0	-34.1	-39.8	-28.5	63.0	28.3	23.2	33.3
6.0	-32.2	-37.8	-26.5	67.0	31.0	25.9	36.0
7.0	-30.3	-36.0	-24.7	83.0	40.8	35.9	45.7
8.0	-28.5	-34.1	-22.9	101.0	50.5	45.7	55.3
9.0	-26.8	-32.4	-21.2	121.0	60.0	55.3	64.7
10.0	-25.1	-30.7	-19.5	142.0	68.9	64.3	73.4
11.0	-23.5	-29.1	-17.9	154.0	73.6	69.1	78.1
12.0	-21.9	-27.5	-16.4	167.0	78.4	74.0	82.8
13.0	-20.4	-25.9	-14.8	181.0	83.3	78.9	87.6
14.0	-18.9	-24.4	-13.4	196.0	88.3	84.0	92.5
16.0	-16.0	-21.5	-10.5	212.0	93.3	89.1	97.5
18.0	-13.3	-18.8	-7.8	229.0	98.3	94.2	102.4
20.0	-10.7	-16.2	-5.3	246.0	103.1	99.1	107.1
22.0	-8.2	-13.7	-2.8	264.0	107.9	104.0	111.8
24.0	-5.8	-11.3	-0.4	284.0	113.0	109.2	116.8
26.0	-3.6	-8.9	1.8	304.0	117.8	114.1	121.5
28.0	-1.4	-6.7	4.0	325.0	122.7	119.1	126.3
29.0	-0.3	-5.6	5.1	348.0	127.7	124.2	131.2
31.0	1.8	-3.5	7.1	349.0	127.9	124.5	131.4
34.0	4.8	-0.5	10.1	372.0	132.7	129.4	136.0
37.0	7.7	2.4	12.9	397.0	137.7	134.5	140.9
40.0	10.4	5.2	15.7	423.0	142.6	139.5	145.6
43.0	13.0	7.8	18.2	450.0	147.5	144.6	150.3

Genetron R-22

GENETRON (R-22)			
PRESSURE BASED PT CHART			
Pressure (psig)	Temperature ºF	Pressure (psig)	Temperature ºF
0.0	-41.5	210.0	104.8
10.0	-20.4	215.0	106.4
20.0	-5.2	220.0	108.0
30.0	6.9	225.0	109.6
40.0	17.1	230.0	111.1
45.0	21.7	235.0	112.7
50.0	26.0	240.0	114.2
55.0	30.0	245.0	115.7
60.0	33.9	250.0	117.1
65.0	37.5	255.0	118.6
70.0	41.0	260.0	120.0
75.0	44.3	265.0	121.4
80.0	47.5	270.0	122.8
85.0	50.6	275.0	124.2
90.0	53.5	280.0	125.5
95.0	56.4	285.0	126.9
100.0	59.1	290.0	128.2
105.0	61.8	295.0	129.5
110.0	64.4	300.0	130.8
120.0	69.3	305.0	132.1
130.0	74.0	310.0	133.3
140.0	78.4	315.0	134.6
150.0	82.7	320.0	135.8
160.0	86.7	325.0	137.0
170.0	90.6	330.0	138.2
180.0	94.3	335.0	139.4
185.0	96.2	345.0	141.8
190.0	97.9	355.0	144.1
195.0	99.7	365.0	146.3
200.0	101.4	375.0	148.6
205.0	103.1	385.0	150.7

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