

Single-Stage and Two-Stage AC/HP Models Using R-454B Refrigerant

Residential Piping and Long Line Guideline

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Safety Considerations

Only trained service technicians familiar with standard service instructions and training materials should attempt installation, service, and repair of these units. Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause death, personal injury, or property damage. Consult a qualified installer, service agency, or your distributor or branch for information or assistance. The qualified installer or agency must use factory--authorized kits or accessories when modifying this product. Refer to the individual instructions packaged with the kits or accessories when installing.

Follow all safety codes. Wear safety glasses, protective clothing, and work gloves. Use quenching cloth for brazing operations. Have a dry powder or CO₂ fire extinguisher available. Read these instructions thoroughly and follow all warnings or cautions included in literature and attached to the unit. Consult local building codes and National Electrical Code (NEC) for special requirements. In Canada, refer to current editions of the Canadian electrical code CSA 22.1.

Recognize safety information. This is the safety-alert symbol . When you see this symbol on the unit and in instructions or manuals, be alert to the potential for personal injury. Understand these signal words; DANGER, WARNING, and CAUTION. These words are used with the safety-alert symbol. DANGER identifies the most serious hazards which will result in severe personal injury or death. WARNING signifies hazards which could result in personal injury or death. CAUTION is used to identify unsafe practices which may result in minor personal injury or product and property damage. NOTE is used to highlight suggestions which will result in enhanced installation, reliability, or operation.

WARNING



FIRE HAZARD

Failure to follow this warning could result in personal injury or death.
Flammable Refrigerant Used.
To be repaired by trained service personnel ONLY.
Do not puncture refrigerant tubing.

WARNING

ELECTRICAL SHOCK HAZARD

Failure to follow this warning could result in personal injury or death.
All equipment should be installed in accordance with accepted practices and unit Installation Instructions, and in compliance with all national and local codes. Power should be turned off when servicing or repairing electrical components. Extreme caution should be observed when troubleshooting electrical components with power on. Observe all warning notices posted on equipment and in instructions or manuals.

! WARNING



EXPLOSION AND PERSONAL SAFETY HAZARD

Failure to follow this warning could result in personal injury, equipment damage or improper operation.

Refrigeration systems contain refrigerant under pressure. Use only service equipment and components rated for R-454B refrigerant. Extreme caution should be observed when handling refrigerants. Wear safety glasses and gloves to prevent personal injury. During normal system operations, some components are hot and can cause burns. Rotating fan blades can cause personal injury. Appropriate safety considerations are posted throughout this manual where potentially dangerous techniques are addressed.

Introduction

An application is considered Long Line, when the refrigerant level in the system requires the use of accessories to maintain acceptable refrigerant management for systems reliability. Accessory requirements depend on the system type, and are defined in this document. Defining a system as long line depends on the liquid line diameter, actual length of the tubing, and vertical separation between the indoor and outdoor units.

For Air Conditioner systems, the chart below shows when an application is considered Long Line:

**Table 1 – AC with R-454B Refrigerant Long Line Description in equivalent length ft (m)*
(Beyond these lengths, long line accessories are required)**

Liquid Line Size	Units On Same Level ft. (m)	Outdoor Below Indoor ft. (m)	Outdoor Above Indoor ft. (m)
1/4	No accessories needed within allowed lengths		
5/16	120 (36.6) total	50 (15.2) vertical or 120 (36.6) total	120 (36.6) total
3/8	80 (24.4) total	35 (10.7) vertical or 80 (24.4) total	80 (24.4) total

*.See page 3 for equivalent length definition

For Heat Pump systems, the chart below shows when an application is considered Long Line:

**Table 2 – HP with R-454B Refrigerant Long Line Description in equivalent length ft (m)*
(Beyond these lengths, long line accessories are required)**

Liquid Line Size	Units On Same Level ft. (m)	Outdoor Below Indoor ft. (m)	Outdoor Above Indoor ft. (m)
3/8	80 (24.4) total	80 (24.4) total	80 (24.4) total

*.See page 3 for equivalent length definition

NOTE: All long line applications must use a TXV indoor metering device.

Long line applications are clearly defined in this Guideline, and must be treated differently from standard systems. A long line system requires special consideration for the following reasons:

- Additional refrigerant charge
- Refrigerant migration control
- Oil return concerns
- Capacity losses
- Metering device adjustments

Longer line sets require additional refrigerant charge that must be managed throughout the entire range of possible ambient conditions. Off-cycle refrigerant migration that results in excess refrigerant in the compressor at start up, or condensed liquid refrigerant in the suction line at start up must be avoided for compressor reliability. Follow all accessory requirements in this Guideline to control off-cycle refrigerant migration.

Another concern is proper line set sizing and construction to control oil return to the compressor, and minimize capacity losses. In residential applications, proper suction line sizing is critical to achieve adequate oil return, and maintain expected system performance. Oil return in heating mode is different from cooling mode thus, in some cases, heat pumps have additional line set limitations from air conditioning units. Follow all suction line sizing recommendations to ensure system performance and adequate oil return for compressor lubrication.

The third concern is refrigerant metering. Equivalent length and elevation changes affect pressure drop in refrigerant lines. These effects must be considered when sizing liquid lines and orifice-metering devices.

Proper heating piston sizing is a concern where heating piston metering devices are used. Follow piston change recommendations in this Guideline for proper equipment operation (see [Table 7](#) and [Table 9](#)).

The limiting factor when sizing liquid lines is pressure drop. Equivalent length and vertical separation both contribute to the pressure drop in a liquid line.

NOTE: When an application is “Long Line”, accessory requirements differ depending on product type. Requirements are listed in the individual product-type sections.

General Limitations

Liquid Lines

Liquid line diameters of 1/4” and 5/16” are allowed within published limitations with TXV device only. Using smaller liquid lines affects the maximum allowable equivalent length and when the application qualifies as long line. Elevation changes between the indoor and outdoor units also affect allowable equivalent lengths. (See [Table 5](#), [Table 6](#) and [Table 8](#) to properly size liquid lines.)

Suction Lines

Refer to individual Product Data Sheets for acceptable suction line diameters and related capacity effects.

Interconnecting Tubing and Fitting Losses

Choosing the proper tubing diameters is critical for reliable long line applications. For proper suction line sizing, see suction line sizing charts in individual unit Product Data Sheets. These charts show all acceptable suction line diameters and related performance data based on total equivalent length. See [Table 5](#), [Table 6](#) and [Table 8](#) for the allowable liquid tubing diameters for both single-stage and two-stage.

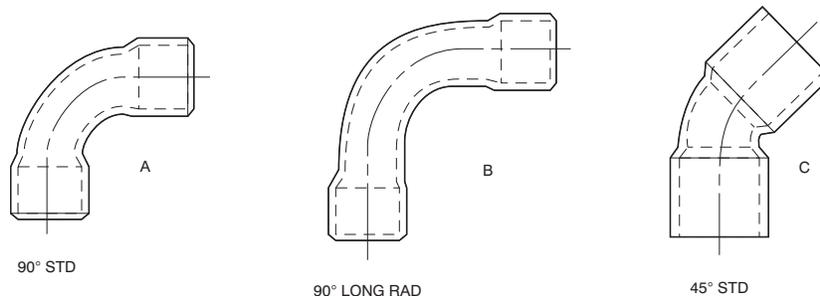
NOTE: Only 3/8” diameter liquid lines are allowed for variable-speed outdoor units.

Refrigerant tubing must be measured both in terms of actual length and equivalent length. Use actual length for refrigerant charge calculation. The maximum liquid line length will vary depending on diameter and elevation change between indoor and outdoor units. Equivalent length takes into account pressure losses from both tubing length and losses due to fittings and accessories, such as elbows, liquid line solenoid and filter drier. Losses from fittings are expressed in equivalent length, meaning the length of straight tubing that would have the same pressure loss as the fitting. See [Table 3](#) for equivalent lengths of commonly used fittings and accessories; maximum equivalent length allowed is up to 250 ft (76.2 m). See [Table 5](#), [Table 6](#) and [Table 8](#) for maximum total equivalent length.

Calculate total equivalent length by adding linear (both vertical and horizontal) length of the tubing required and the equivalent length of all elbows and accessories used. Total equivalent length is defined as the length of the line between the outdoor and indoor units plus the equivalent length of fittings and accessories.

Example: A 4-ton system using 7/8 in. diameter line set has a total tubing length of 165 ft. The tubing configuration uses four standard 90° elbows and two 90° long-radius elbows. Checking [Table 3](#), the total equivalent length is calculated as:

165 ft straight tubing + (four standard 90° elbows x 2 ft) + (two long-radius 90° elbows x 1.4 ft) = 165 ft. + 8 ft + 2.8 ft = 175.8 ft total equivalent length.



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Fig. 1 – Tube Bend Losses

Table 3 – Fitting Losses in Equivalent Feet

Tube Size O.D. (In.)	Fitting- Reference Diagram in Fig. 1		
	90° Std (A)	90° Long-Rad (B)	45° Std (C)
1/2	1.2	0.8	0.6
5/8	1.6	1.0	0.8
3/4	1.8	1.2	0.9
7/8	2.0	1.4	1.0
1-1/8	2.6	1.7	1.3
Liquid Line Solenoid	12		
Filter Drier	6		

Heat Pump Piston Sizing — 1 and 2-Stage

A fixed orifice is used for refrigerant metering in the heating mode in 1 and 2-stage heat pumps. This fixed expansion device must be changed from the factory-supplied accuratur based on indoor/outdoor vertical separation and system capacity. For horizontal applications up to 250 ft (76 m) total equivalent length, no heating piston change is necessary.

When sizing the heating piston for installations where the outdoor unit is below the indoor unit, use [Table 7](#). When outdoor unit is located above indoor unit, use [Table 9](#). A list of common piston sizes can be found on [Table 10](#).

Example: The factory supplied accuratur for a single-stage 3-ton heat pump is a number 57. A system is installed with 200 equivalent ft of line set. Approximately 60 ft (18.3 m) is horizontal and the outdoor unit is 140 ft (42.7 m) above the indoor unit. [Table 9](#) shows the accuratur piston change to be +6. The new piston size is 57 + 6 = 63. If a 63 is not produced, round up to the next larger available piston size.

On the same heat pump, if the outdoor unit was located 49 ft (14.9 m) below the indoor unit, [Table 7](#) shows the piston change to be -2. The new piston size is 57 - 2 = 55.

Liquid Line Solenoid — Long Line Heat Pump Heating

Since accurators do not provide off-cycle refrigerant migration protection in the heating mode, a liquid line solenoid is required for single-stage and two-stage heat pump long line applications. A bi-flow solenoid valve provides flow control protection only in the direction of the arrow molded into the valve. The arrow must point toward the outdoor unit for off-cycle refrigerant control in the heating mode (see Fig. 2). The arrow shows the direction of flow control. The solenoid should be installed within 2 ft. (609.6 mm) of the outdoor unit. See the Product Data of individual equipment for part numbers.

NOTE: Equivalent length of the liquid line solenoid should be added to the total equivalent length of the tubing.

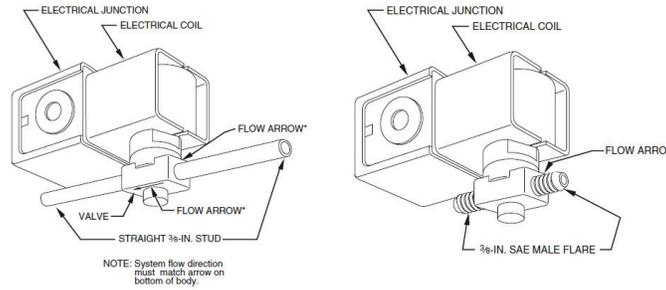


Fig. 2 – LSV - Flow control direction

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Charging Information

Use subcooling as the primary method for charging long line applications. Outdoor units are pre-charged for 15 ft (4.6 m) of 3/8 liquid line. When using different length diameter liquid lines, charge adjustments are required. See Table 4 for charge adjustments required. The charge adjustment will depend on the liquid line diameter used. See unit installation instructions for proper charging procedure.

For all long line applications, pressure drop and subcooling loss become a concern. In these applications, a minimum of 10°F (5.6°C) of subcooling is required for all liquid line diameters to ensure no refrigerant flashing occurs before the TXV metering device. Systems should be charged to 10°F subcooling or the rating plate subcooling, whichever is greater. Ensure the indoor and outdoor conditions are within allowable limits to charge by subcooling - indoor between 70°F and 80°F (21.1°C and 26.7°C), outdoor between 70°F and 100°F (21.1°C and 37.8°C). If outside these limits, weigh in charge.

The amount of factory-charge can be found on the unit rating plate or in the Product Data literature.

Table 4 – Refrigerant Charge Adjustments

Liquid Line Diameter (in.)	R-454B Charge (oz/ft)
3/8	0.60 (Factory charge for lineset = 9 oz)
5/16	0.40
1/4	0.27

Units are factory-charged for 15 ft (4.6 m) of 3/8” lineset. Factory charge for 3/8 lineset is 9 oz. When using other length or diameter liquid lines, charge adjustments are required per chart above.

Charging Formula:

$[(\text{Lineset oz/ft} \times \text{total length}) - (\text{factory charge for lineset})] = \text{charge adjustment}$

Example 1: System has 15 ft of line set using existing 1/4” liquid line. What charge adjustment is required?

Formula: $(.27 \text{ oz/ft} \times 15\text{ft}) - (9 \text{ oz}) = (-4.95) \text{ oz.}$

Net result is to remove 4.95 oz of refrigerant from the system

Example 2: System has 45 ft of existing 5/16” liquid line. What is the charge adjustment?

Formula: $(.40 \text{ oz/ft.} \times 45\text{ft}) - (9 \text{ oz.}) = 9 \text{ oz.}$

Net result is to add 9 oz of refrigerant to the system

NOTE: Conditions must be favorable for charging by subcooling method. Indoor temperature must be 70°F to 80°F (21.1°C to 26.7°C), and outdoor temperature must be 70°F to 100°F (21.1°C to 37.8°C). If outside these conditions, adjust charge for long line sets by weigh-in method.

Vapor Line Sizing And Cooling Capacity Loss

Acceptable vapor line diameters provide adequate oil return to the compressor while avoiding excessive capacity loss. Charts with acceptable suction line diameters and capacity losses are shown in the Product Data for each individual model number. Please refer to the Product Data sheets for this information.

APPLICATIONS

1 and 2-stage Long Line Applications - Units on Equal Level

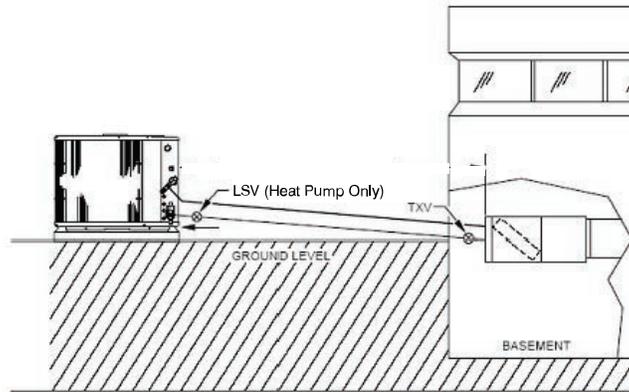


Fig. 3 – Equal-Level Outdoor/Indoor Unit

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- A hard start kit (capacitor and relay) is required on 1-stage units
- A crankcase heater must be installed on compressor if not factory-supplied
- Vapor line should slope toward indoor unit
- Heat pump only – Bi-flow liquid line solenoid must be installed within 2 ft (0.61 m) of outdoor unit with arrow pointing towards outdoor unit.
- Heat Pump Only – no heating piston adjustment required.
- See Product Data for specific unit for accessory part numbers.

**Table 5 – Maximum Total Equivalent Length
Units on Equal Level**

Nominal Tonnage	System Type	Liquid Line Diameter (in.) w/ TXV	Maximum Total Equivalent Length* (ft.) : Units on equal level
1.5	AC Only	1/4	150
	AC Only	5/16	250
	AC/HP	3/8	250
2	AC Only	1/4	75
	AC Only	5/16	250
	AC/HP	3/8	250
2.5	AC Only	1/4	30
	AC Only	5/16	175
	AC/HP	3/8	250
3	AC Only	5/16	175
	AC/HP	3/8	250
3.5	AC Only	5/16	125
	AC/HP	3/8	250*
4	AC/HP	3/8	250*
5	AC/HP	3/8	250*

*.Total equivalent length accounts for losses due to elbows or fitting.

1 and 2-stage Long Line Applications - Outdoor Unit Below Indoor Unit

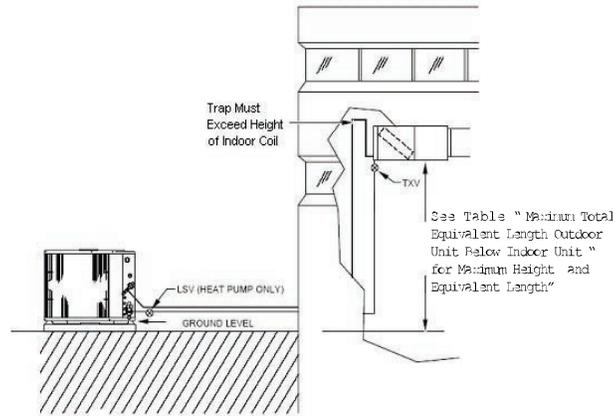


Fig. 4 – Outdoor Unit Below Indoor Unit

- Maximum total equivalent length and lift per [Table 6](#) below
- A hard start kit (capacitor and relay) is required on 1-stage units
- A crankcase heater must be installed on compressor if not factory-supplied
- Heat pump only – Bi-flow liquid line solenoid must be installed within 2 ft (0.61 m) of outdoor unit with arrow pointing towards outdoor unit.
- Heat Pump Only – outdoor piston adjustment required per [Table 7](#) below
- An inverted vapor-line trap must be installed at indoor unit. The top peak of trap must be greater than height of indoor coil.
- Unit must be charged to 10 deg subcooling or nameplate subcooling, whichever is greater.
- See Product Data of specific unit for accessory part numbers.

Table 6 – Maximum Total Equivalent Length† Outdoor Unit BELOW Indoor Unit

Nominal Tonnage	System Type	Liquid Line Diameter (in.) w/ TXV	Maximum Total Equivalent Length† (ft.): Outdoor unit BELOW Indoor Vertical Separation ft (m)								
			0-5 (0-1.5)	6-10 (1.8-3.0)	11-20 (3.4-6.1)	21-30 (6.4-9.1)	31-40 (9.4-12.2)	41-50 (12.5-15.2)	51-60 (15.5-18.3)	61-70 (18.6-21.3)	71-80 (21.6-24.4)
1.5	AC Only	1/4	150	150	125	100	100	75	--	--	--
	AC Only	5/16	250	250	250	250	250	250	250	225	150
	AC/HP	3/8	250	250	250	250	250	250	250	250	250
2	AC Only	1/4	75	75	75	50	50	--	--	--	--
	AC Only	5/16	250	250	250	250	250	225	175	125	100
	AC/HP	3/8	250	250	250	250	250	250	250	250	250
2.5	AC Only	1/4	30	--	--	--	--	--	--	--	--
	AC Only	5/16	175	225	200	175	125	100	75	--	--
	AC/HP	3/8	250	250	250	250	250	250	250	250	250
3	AC Only	5/16	175	150	150	100	100	100	75	--	--
	AC/HP	3/8	250	250	250	250	250	250	250	250	250
3.5	AC Only	5/16	125	100	100	75	75	50	--	--	--
	AC/HP	3/8	250	250	250	250	250	250	250	250	150
4	AC/HP	3/8	250	250	250	250	250	250	230	160	--
5	AC/HP	3/8	250	250	250	225	190	150	110	--	--

† Total equivalent length accounts for losses due to elbows or fitting. See the [Table 3](#) for details.

-- = outside acceptable range

Table 7 – R-454B Refrigerant Heat Pump Outdoor Piston Change – Outdoor Unit BELOW Indoor Unit

Nominal Tonnage	Vertical Separation (ft.) - Outdoor Below Indoor Unit						
	0-19 (0-5.8)	20-29 (6.1-8.8)	30-39 (9.1-11.9)	40-49 (12.2-14.9)	50-59 (15.2-18.0)	60-69 (18.3-21.0)	70-80 (21.3-24.4)
1.5	0	-1	-1	-2	-2	-2	-2
2	0	-1	-1	-2	-2	-3	-3
2.5	0	-1	-1	-2	-2	-3	-3
3	0	-1	-2	-2	-2	-3	-3
3.5	0	-1	-2	-2	-3	-3	-4
4	0	-1	-2	-2	-3	-3	--
5	0	-1	-2	-3	-3	--	--

NOTE: (--) Indicates vertical separation exceeds allowable limits.

Example 1: On a 4 ton system the outdoor unit is 60 ft (18.3 m) below the indoor unit. This is acceptable only if the total equivalent length is 230 ft (70.1 m) or less. The heating piston must be re-sized -3.

Example 2: On a 3-ton system the outdoor unit is 80 ft (24.4 m) below the indoor unit. This is acceptable up to 250 ft (76.2 m) total equivalent length. The heating piston must be re-sized -3.

1 and 2-stage Long Line Applications - Outdoor Unit Above Indoor Unit

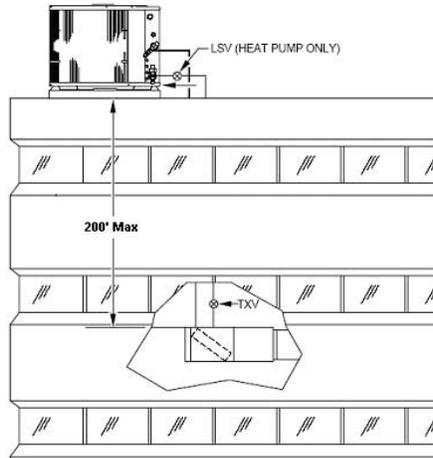


Fig. 5 – Outdoor Unit Above Indoor Unit

- Maximum lengths and separation per Table 8 below
- A crankcase heater must be installed on compressor if not factory-supplied.
- A hard start kit (start capacitor and relay) required for 1-stage units.
- Heat pump only – Heating piston must be changed as shown in Table 9.
- Heat pump only – Bi-flow liquid line solenoid must be installed within 2 ft (0.61 m) of outdoor unit with arrow pointing towards outdoor unit.
- Vapor line traps are not required.
- See Product Data of specific unit for accessory part numbers.

Table 8 – Maximum Total Equivalent Length Outdoor Unit ABOVE Indoor Unit

Nominal Tonnage	System Type	Liquid Line Diameter (in.) w/TXV	Vertical Separation (ft.) Outdoor unit ABOVE indoor unit							
			25 (7.6)	26-50 (7.9-15.2)	51-75 (15.5-22.9)	76-100 (23.2-30.5)	101-125 (30.8-38.1)	126-150 (38.4-45.7)	151-175 (46.0-53.3)	176-200 (53.6-61.0)
1.5	AC Only	1/4	175	250	250	250	250	250	250	250
	AC Only	5/16	250	250	250	250	250	250	250	250
	AC/HP	3/8	250	250	250	250	250	250	250	250
2	AC Only	1/4	100	125	175	200	225	250	250	250
	AC Only	5/16	250*	250	250	250	250	250	250	250
	AC/HP	3/8	250	250	250	250	250	250	250	250
2.5	AC Only	1/4	30	--	--	--	--	--	--	--
	AC Only	5/16	250	250	250	250	250	250	250	250
	AC/HP	3/8	250	250	250	250	250	250	250	250
3	AC Only	5/16	225	250	250	250	250	250	250	250
	AC/HP	3/8	250	250	250	250	250	250	250	250
3.5	AC Only	5/16	175	200	250	250	250	250	250	250
	AC/HP	3/8	250	250	250	250	250	250	250	250
4	AC/HP	3/8	250	250	250	250	250	250	250	250
5	AC/HP	3/8	250	250	250	250	250	250	250	250

Table 9 – Heat Pump Outdoor Piston Change - Outdoor Unit ABOVE Indoor Unit

Nominal Tonnage	Vertical Separation (ft.) - Outdoor Above Indoor Unit								
	20-25 (6.1-7.6)	26-50 (7.9-15.2)	51-75 (15.5-22.9)	76-100 (23.2-30.5)	101-125 (30.8-38.1)	126-150 (38.4-45.7)	151-175 (46.0-53.3)	176-200 (53.6-61.0)	
1.5	+1	+1	+2	+3	+3	+4	+5	+6	
2	+1	+1	+2	+3	+4	+5	+6	+7	
2.5	+1	+2	+2	+4	+5	+6	+8	+9	
3	+1	+2	+2	+4	+5	+6	+8	+9	
3.5	+1	+2	+3	+4	+5	+7	+8	+10	
4	+1	+2	+3	+4	+5	+7	+9	+10	
5	+1	+2	+3	+5	+6	+8	+10	+12	

Table 10 – Common Accurator Piston Sizes
(Part numbers are all EA52PHxxx. The last 3 digits represent size)

EA52PH032	063	093
035	065	096
037	067	098
038	068	101
040	070	104
042	073	106
043	076	109
046	078	110
049	080	113
052	082	116
055	084	120
057	086	125
059	088	128
061	090	

Air Conditioners and Heat Pumps with R-454B Refrigerant — Quick Reference Guide

- Be sure that servicing equipment and replacement components are designed to operate with R-454B refrigerant
- Recovery cylinder service pressure rating must be 400 psig, DOT 4BA400 or DOT 4BW400.
- R-454B refrigerant systems should be charged with liquid refrigerant. Use a commercial type metering device in the manifold hose when charging into suction line with compressor operating
- Leak detectors should be designed to detect R-454B refrigerant.
- R-454B refrigerant is compatible with POE and PVE oils only.
- Vacuum pumps will not remove moisture from oil.
- Do not use liquid-line filter driers with rated working pressures less than 600 psig.
- Do not leave R-454B suction line filter driers in line longer than 72 hours.
- Do not install a suction-line filter drier in liquid line.
- POE and PVE oils absorb moisture rapidly. Do not expose oil to atmosphere.
- POE and PVE oils may cause damage to certain plastics and roofing materials.
- Wrap all filter driers and service valves with wet cloth when brazing.
- A factory approved liquid-line filter drier is required on every unit.
- Do NOT use R-410A TXV. TXVs are not cross compatible between R-410A and R-454B.
- Do NOT convert a coil with a piston or R-410A metering device. Coils must come from the factory with an R-454B TXV and an A2L dissipation board already installed.
- Never open system to atmosphere while it is under a vacuum.
- When system must be opened for service, recover refrigerant, evacuate then break vacuum with dry nitrogen and replace filter driers. Evacuate to 500 microns prior to recharging.
- Do not vent R-454B refrigerant into the atmosphere.
- Do not use capillary tube coils.
- Observe all **warnings, cautions, and bold text**.
- All indoor coils must be installed with a hard shutoff R-454B TXV metering device in long line applications.