Long Line Applications Guideline
R–22 Split Systems

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A. 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 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.

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

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. 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.

B. Definitions

This guideline covers all residential split system air conditioner and heat pump products using R–22 refrigerant. Long line and standard applications are defined as follows:

1. An application is “long line” when the equivalent length of the interconnecting tubing exceeds 80ft **or** the vertical separation between indoor and outdoor units exceeds 20ft .
2. An application is a “standard application” when the equivalent tubing length is 80 feet or less, **and** the vertical separation between units is 20ft or less.

Note: When an application exceeds either or both standard line set limits, some or all of the accessories shown in Table 1 are required depending on equipment and orientation.

C. Introduction

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 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 (See Table 1).

Another concern is proper lineset sizing and construction to control oil return to the compressor and minimize capacity losses. In residential applications, proper line sizing is critical to achieve adequate oil return. 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. This guideline has separate vapor line sizing charts for air conditioner and heat pump applications. Follow all line sizing recommendations in this Guideline to ensure adequate oil return and compressor lubrication.

The third concern is refrigerant metering. Elevation changes of more than 20 ft affect pressure drop in refrigerant lines. These effects must be considered when sizing orifice metering devices. Since all 13 SEER platform units require a TXV for cooling mode metering, this is only a concern for heat pump heating operation. Follow piston change recommendations in this guideline for proper heat pump heating operation (See Tables 5 & 6).

D. General Limitations

Tables 3 and 4 include the limits for long line applications. In general:

- Under 80 equivalent ft. and less than 20ft vertical separation is a standard application and does not require accessories.
- Maximum lineset *equivalent* length is 250 ft. Some applications have shorter limits – see Table 4.
- Maximum lineset *actual* length is 200 ft.
- Maximum vertical separation for outdoor unit ABOVE indoor unit is 200 ft.
- See Table 4 for maximum vertical separation and allowable total equivalent length when outdoor is unit on the same level or below indoor unit. (Also see Figures 2 and 3)
    - ○ When outdoor unit is below indoor unit, the maximum total equivalent length varies with the amount of vertical separation, and unit size.
    - ○ When units are on the same level, maximum equivalent length varies with unit size.
- Liquid line size for all applications is 3/8” od only.
- See Table 3 for allowable vapor line diameters.
- The maximum length of any buried section of lineset is 3 feet.

⚠ CAUTION

EQUIPMENT HAZARD

Failure to follow this caution may result in equipment damage.

See Table 1 “Long Line Accessory Requirements” for long line applications. Failure to use the required accessories may cause operating conditions detrimental to the proper operation and reliability of the equipment.

Table 1	Long Line Accessory Requirements					
Accessory	Outdoor Unit Above		Outdoor Unit Below		Equal Level	
	AC	HP	AC	HP	AC	HP
Liquid Line Solenoid (outdoor)	No	YES	No	YES	No	YES
TXV (indoor)	YES	YES	YES	YES	YES	YES
Crankcase Heater (factory installed on some models)	YES	YES	YES	YES	YES	YES
Start Capacitor & Relay	YES	YES	YES	YES	YES	YES
Piston Change (Heat Pump Outdoor)	n/a	YES (see Table 6)	n/a	YES (see Table 5)	n/a	No
Inverted Trap (Vapor Line)	No	No	YES (See Fig. 3)	YES (See Fig. 3)	No	No
Standard Trap(s) (Vapor Line)	YES	YES	No	No	No	No

E. Interconnecting Tubing

Choosing the proper tubing diameter is critical for reliable long line applications. **Liquid line diameters in all applications including long line must be 3/8". No other liquid line sizes are permitted**. See Table 3 for the allowable vapor tubing diameters. Pay particular attention that some vapor line sizes that are acceptable for air conditioners are NOT acceptable for heat pump applications.

Refrigerant tubing must be measured both in terms of actual length and equivalent length. Use actual length for limitations and refrigerant charge calculation (maximum actual length allowed is 200 ft). Equivalent length takes into account pressure losses from both tubing length and losses due to fittings such as elbows. 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 Figure 1 for equivalent lengths of commonly used fittings.

Calculate total equivalent length by adding linear length of the tubing required and the equivalent length of all elbows used. See Table 3 to determine capacity loss of the system due to equivalent length losses and subtract them from the published system capacity for the particular outdoor/indoor unit combination. System capacity data is found in the outdoor unit Product Specifications document.

Example: A 4–ton system using 7/8 inch diameter line set has a total tubing length of 165ft. The tubing configuration uses four (4) standard 90˚ elbows and two (2) 90˚ long radius elbows. Checking Table 2, the total equivalent length is calculated as:

165ft straight tubing + (4 standard 90˚ elbows x 2 ft) + (2 long radius 90˚ elbows x 1.4ft) =

165ft + 8ft + 2.8 ft = 175.8 equivalent ft

Figure 1 **Tube Bend Losses**

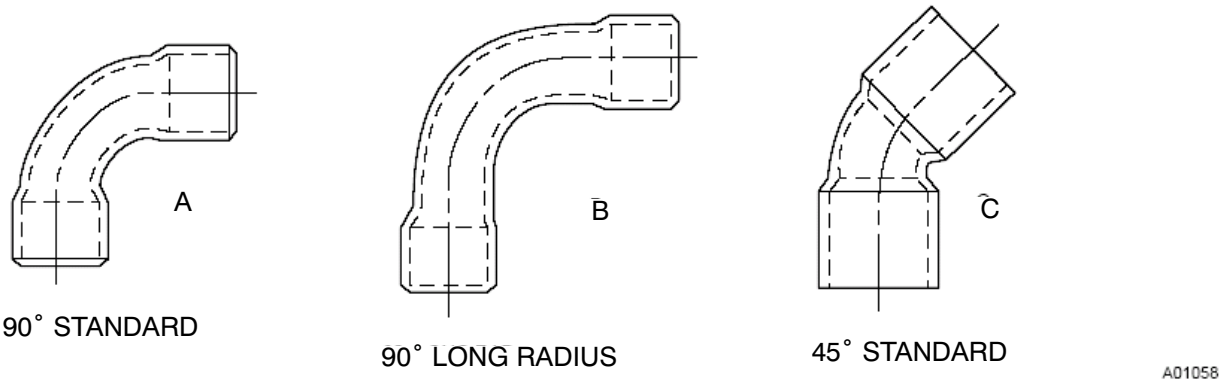


Table 2	Fitting Losses in Equivalent Feet		
TUBE SIZE OD (IN.)	FITTING – REFERENCE DIAGRAM IN FIGURE 1		
	90° STANDARD (A)	90° LONG RADIUS (B)	45° STANDARD (C)
1/2	1.2	0.8	0.6
5/8	1.6	1.0	0.8
3/4	1.8	1.2	0.9
7/8	2.0	1.4	1.0
1–1/8	2.6	1.7	1.3

F. Metering Device – Cooling

⚠ CAUTION

PRODUCT DAMAGE HAZARD

Failure to follow this caution may result in product damage.

Indoor coil and outdoor unit must be listed as a certified combination (match) in the ARI Unitary Directory of Certified Products.
Indoor coil must have R–22 specific, hard shut–off TXV refrigerant metering device.

In the new 13 SEER platform systems, all indoor units must use a hard shut–off TXV for metering in the cooling mode. This provides adequate refrigerant migration protection for all cooling applications.

G. Piston Sizing – Heat Pump Heating Mode

In the new 13 SEER platform systems, a piston (fixed orifice) is used for refrigerant metering in the heating mode. If the outdoor unit and the indoor unit are at the same elevation (equal level), no piston change is required. If there is any vertical separation between the outdoor unit and the indoor unit, a piston change is required.

When sizing the heating piston for installations where the outdoor unit is below the indoor unit, use Table 5. When outdoor unit is located above indoor unit, use Table 6.

Example: The factory supplied piston of a 3–ton heat pump is a number 57. A system is installed with 200 equivalent feet of lineset. Approximately 60 ft is horizontal and the outdoor unit is 140 feet above the indoor unit. Table 6 shows the piston change to be +6. The new piston size is 57 + 6 = 63. If 63 is not a standard size, round up to the next larger standard piston size.

Example: On the same heat pump, if the outdoor unit was located 49 feet below the indoor unit, Table 5 shows the piston change to be – 2. The new piston size is 57 – 2 = 55. If 55 is not a standard size, round down to the next available size.

H. Liquid Line Solenoid Valve – Heat Pump Heating Mode

Pistons do not provide off–cycle refrigerant migration protection in the heating mode. A liquid line solenoid is required for all long line heat pump applications, regardless of vertical separation between outdoor and indoor units. Bi–flow solenoid valves provide 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. The arrow shows the direction of flow control. The solenoid should be installed within 2 feet of the outdoor unit. The Liquid Line Solenoid Accessory part number is NASA001LS.

I. Charging Information

Use subcooling as the primary method for charging long line applications. Since the total system charge is increased for long line applications, it is necessary to calculate additional refrigerant charge.

For all long line applications, pressure drop and subcooling loss becomes a concern. In these applications, a **minimum of 10 degrees of subcooling** is required to ensure no refrigerant flashing occurs before the TXV metering device. Units should be charged to 10 degrees subcooling or the rating plate subcooling whichever is greater.

Outdoor units are pre–charged at the factory for 15 feet of line set and a matched indoor coil. For line lengths greater than 15 feet, add 0.6 oz. of refrigerant per foot of additional line length. The amount of factory charge can be found on the unit rating plate and in the outdoor unit Product Specifications document. Long–line applications do not require additional oil charge.

J. Tubing Sizing, Configurations, and Cooling Capacity Losses

⚠ CAUTION

COMPONENT FAILURE HAZARD

Failure to follow this caution may result in unit component failure.

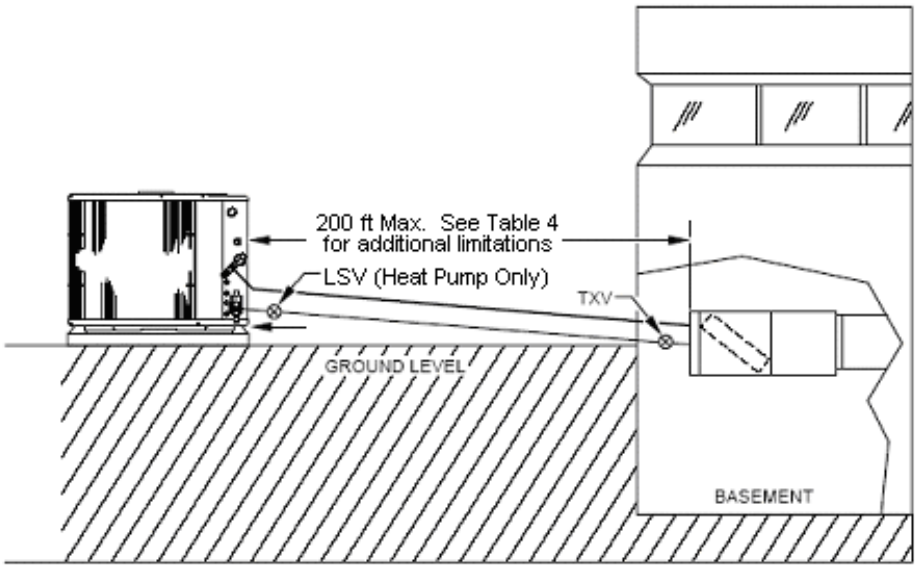
For proper oil return and minimizing capacity losses, only use vapor line sizes listed in Table 3.

Table 3		R–22 Cooling Capacity Loss for Various Line Lengths & Tube Diameters											
Model Size	Liquid Line (in.)	Acceptable Vapor Line Sizes (in.)	Cooling Capacity Loss (%) at Total Equivalent Line Length (ft.)										
			Standard Application			Long Line Application (Requires Accessories) *							
			25’	50’	80’	81’	100’	125’	150’	175’	200’	225’	250’
18	⅜	⅝	0	1	1	1	2	3	3	4	5	5	6
		¾	0	0	0	0	0	1	1	1	1	2	2
24		⅝	0	1	3	3	3	5	6	7	8	9	10
		¾	0	0	0	0	1	1	1	2	2	3	3
30		¾	0	1	1	1	2	3	3	4	5	5	6
		⅞	0	0	0	0	1	1	1	2	2	2	3
36		¾	0	1	2	2	3	4	5	6	7	8	9
		⅞	0	0	1	1	1	2	2	3	3	4	4
42		¾	1	2	3	3	4	5	7	8	9	10	11
		⅞	0	1	1	1	2	2	3	4	4	5	5
48		¾	1	2	4	4	5	7	8	10	11	13	14
		⅞	0	1	2	2	2	3	4	5	5	6	7
		1⅛	0	0	0	0	0	0	1	1	1	1	1
60		⅞	1	2	3	3	4	5	7	8	9	10	11
		1⅛	0	0	1	1	1	1	2	2	2	3	3

***** Applications are considered “Long Line” if the total equivalent tubing length exceeds 80 feet or there is more than 20 foot vertical separation between indoor and outdoor units). These applications require additional accessories and system modifications for reliable system operation. Refer to Table 1.

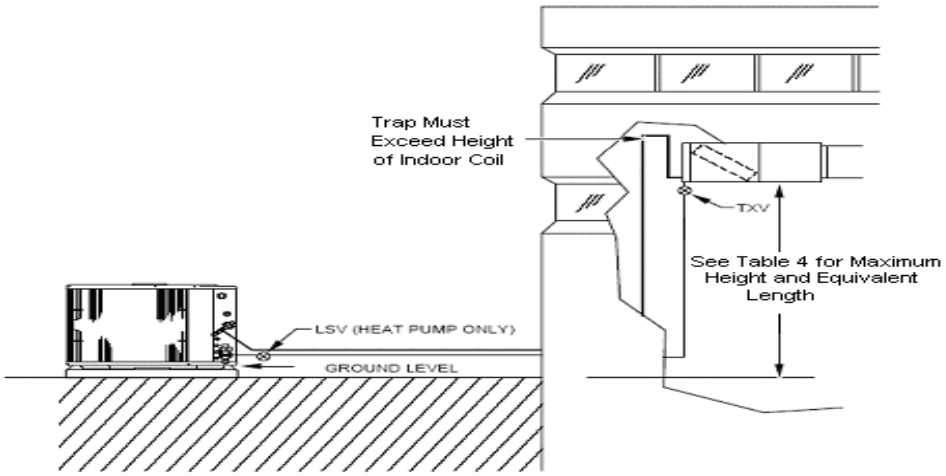
Applications in shaded area may have height restrictions that limit allowable total equivalent length when outdoor unit is below indoor unit. Refer to Table 4.

Figure 2	Long Line R–22 Equal Level Applications



- Unit must be charged to 10 degrees subcooling or nameplate subcooling, whichever is greater.
- Hard shutoff TXV must be installed at indoor unit.
- Hard Start Kit (start capacitor and relay) must be installed on outdoor unit.
- Crankcase heater must be installed on compressor.
- Vapor line should slope towards indoor unit.
- Maximum actual liquid line length is 200 ft.
- Vertical separation must be less than 20 feet .
- Heat Pump Only – Bi–flow liquid line solenoid must be installed within 2 ft of outdoor unit with arrow pointing towards outdoor unit.
- Heat Pump Only – Outdoor piston adjustment not required.

Figure 3	Long Line R–22 Outdoor Unit Below Indoor Unit



- Unit must be charged to 10 degrees subcooling or nameplate subcooling, whichever is greater.
- Hard shut–off TXV must be installed at indoor unit.
- Crankcase heater must be installed on compressor.
- Hard start kit (start capacitor and relay) must be installed in outdoor unit.
- Heat Pump Only – Heating piston must be changed as shown in Table 5.
- Heat Pump Only – Bi–flow liquid line solenoid must be installed within 2 ft of outdoor unit with arrow pointing towards outdoor unit.
- An inverted vapor–line trap must be installed at indoor unit. The top peak of trap must be greater than height of indoor coil.

Table 4	R–22 Maximum Equivalent Length (feet) – Outdoor Unit Level With or Below Indoor Unit						
Model Size	Vertical Separation (feet)						
	0	1 – 10	11 – 20	21 – 30	31 – 40	41 – 50	51 – 60
18 (1½ ton)	250	250	250	250	250	250	250
24 (2 ton)	250	250	250	250	250	250	60
30 (2½ ton)	250	250	250	250	250	--	--
36 (3 ton)	250	250	250	250	150	--	--
42 (3½ ton)	250	250	247	170	70	--	--
48 (4 ton)	250	230	175	110	40	--	--
60 (5 ton)	170	130	100	60	--	--	--

(--) Dashes indicate vertical separation exceeds allowable limits.

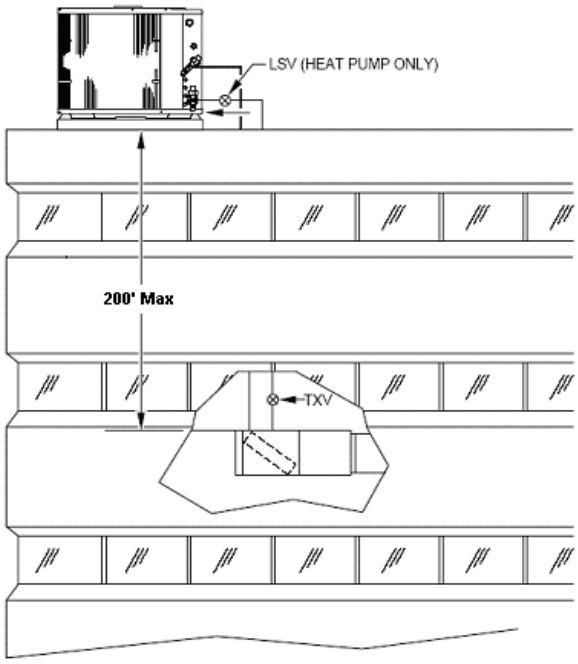
Table 5	R–22 Heat Pump Outdoor Piston Change – Outdoor Unit Below Indoor Unit				
Model Size	Vertical Separation (feet)				
	0 – 20	21 – 30	31 – 40	41 – 50	51 – 60
18 (1½ ton)	0	– 2	– 2	– 3	– 3
24 (2 ton)	0	– 2	– 3	– 3	– 4
30 (2½ ton)	0	– 2	– 3	--	--
36 (3 ton)	0	– 2	– 3	--	--
42 (3½ ton)	0	– 3	– 3	--	--
48 (4 ton)	0	– 3	– 4	--	--
60 (5 ton)	0	– 3	--	--	--

(--) Dashes indicate vertical separation exceeds allowable limits.

Example 1: A 3–ton heat pump is to be installed 40 ft below the fan coil. From Table 4, this is acceptable only if the total equivalent length is 148 ft or less. From Table 5, the heating piston must be re–sized –3.

Example 2: A 5–ton air conditioner is to be installed on the same level as the coil. From Table 4, this is acceptable up to 175 total equivalent length.

Figure 4	Long Line R–22 Outdoor Unit Above Indoor Unit



- Unit must be charged to 10 degrees subcooling or nameplate subcooling, whichever is greater.
- Hard shut–off TXV must be installed at indoor unit.
- Crankcase heater must be installed on compressor.
- Hard Start Kit (start capacitor and relay) must be installed in outdoor unit.
- Heat Pump Only – Heating piston must be changed as shown in Table 6.
- Maximum actual liquid line length is 200 ft.
- Heat Pump Only – Bi–flow liquid line solenoid must be installed within 2 ft of outdoor unit with arrow pointing towards outdoor unit.

Table 6	R–22 Heat Pump Outdoor Piston Change – Outdoor Unit Above Indoor Unit							
Model Size	Vertical Separation (feet)							
	20 – 25	26 – 50	51 – 75	76 – 100	101 – 125	126 – 150	151 – 175	176 – 200
18 (1½ ton)	+ 1	+ 1	+ 2	+ 3	+ 3	+ 4	+ 5	+ 6
24 (2 ton)	+ 1	+ 1	+ 2	+ 3	+ 4	+ 5	+ 6	+ 7
30 (2½ ton)	+ 1	+ 2	+ 2	+ 4	+ 5	+ 6	+ 8	+ 9
36 (3 ton)	+ 1	+ 2	+ 2	+ 4	+ 5	+ 6	+ 8	+ 9
42 (3½ ton)	+ 1	+ 2	+ 2	+ 4	+ 5	+ 7	+ 8	+ 10
48 (4 ton)	+ 1	+ 2	+ 3	+ 4	+ 5	+ 7	+ 9	+ 10
60 (5 ton)	+ 1	+ 2	+ 3	+ 5	+ 6	+ 8	+ 10	+ 12

Table 7	Standard Pistons Available through FAST
Size	FAST Part Number
.040	1173990
.042	1173634
.046	1173650
.049	1173868
.052	1174060
.055	1173655
.057	1173658
.059	1173871
.061	1173663
.063	1174003
.065	1173873
.067	1173867
.070	1173869
.073	1174017
.076	1173673
.078	1174094
.082	1173870
.086	1173872
.104	1173532

K. General Requirements (Check list)

All Applications

- Hard shutoff TXV must be installed at indoor unit.
- Hard Start Kit (start capacitor and relay) must be installed on outdoor unit.
- Crankcase heater must be installed on compressor.
- Use only 3/8 inch od Liquid Line.
- Use only Vapor Line sizes listed in Table 3.
- Add 0.6 oz. of refrigerant per ft of actual line length beyond 15 ft.
- Charge system to 10 degrees subcooling or rating plate subcooling, whichever is greater.

Heat Pumps Only

- Bi–flow liquid line solenoid must be installed within 2 ft of outdoor unit with arrow pointing towards outdoor unit.

Equal–level Outdoor/Indoor unit

- Vertical separation between outdoor unit and Indoor unit must be less than 20 feet .
- Vapor line should slope towards indoor unit.
- Heat Pumps Only – No outdoor piston adjustment required.

Outdoor unit BELOW indoor unit

- Outdoor unit greater than 20 feet below indoor unit.
- An inverted vapor–line trap must be installed at indoor unit. The top peak of trap must be greater than height of indoor coil, see Figure 3.
- Vertical separation and line set equivalent length must not exceed Table 4 requirements.
- Heat Pumps Only – adjust outdoor piston per Table 5.

Outdoor unit ABOVE indoor unit

- Outdoor unit greater than 20 feet above indoor unit.
- Charge system to 10 degrees subcooling or rating plate subcooling whichever is greater.
- Heat Pumps Only – adjust outdoor piston per Table 6.