

LONG LINE SET APPLICATION R-410A

TECHNICAL PUBLICATION
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Goodman Manufacturing Company, L.P.

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- Only allow qualified, experienced technicians to install or service this unit.
- Units must be installed in accordance with Regulations of the National Fire Protection Association and applicable local codes. Where local regulations are at a variance with instructions, installer should adhere to local codes.
- Before connecting tubing, read the outdoor unit installation manual. Pay particular attention to all safety precautions.

ATTENTION INSTALLING PERSONNEL

- As a professional installer you have an obligation to know the product better than the customer. This includes all safety precautions and related items.
- Prior to actual installation, thoroughly familiarize yourself with these guidelines.
- Pay special attention to all safety warnings posted on the equipment. Often during installation or repair it is possible to place yourself in a position which is more hazardous than when the unit is in operation.
- Remember, it is your responsibility to install the product safely and to know it well enough to be able to instruct a customer in its safe use.
- Safety is a matter of common sense...a matter of thinking before acting. Most dealers have a list of specific good safety practices...follow them.
- The precautions listed in this Technical Publication are intended as supplemental to existing Installation and Operation (IO) Manual practices. However, if there is a direct conflict between existing IO practices and the content of this manual, the precautions listed here take precedence.

This long line set application guideline applies to all AHRI listed R-410A air conditioner and heat pump split system matches of nominal capacity 18,000 to 60,000 Btuh. This guideline will cover installation requirements and additional accessories needed for split system installations where the line set exceeds 80 feet (24.4 m) in actual length. The long line sets can have three different configurations (1) Outdoor unit and Indoor unit are at the same level, (2) Outdoor unit is above the Indoor unit coil, (3) Outdoor unit is below the Indoor unit.

This guideline is meant to provide installation instructions based on most common long line set applications. Installation variables may affect the system operation.

*Contact Technical Services
for variations or applications outside those outlined in this document.*

SECTION 1. GENERAL REQUIREMENTS FOR ALL LONG LINE SET APPLICATIONS

1. Equivalent length must be used to determine acceptability of any long line set application. See Section 5 for equivalent length calculations.
2. **For any residential split system installed with a long line set, 3/8" liquid line size must be used.** Limiting the liquid line size to 3/8" is critical since an increased refrigerant charge level from having a larger liquid line could possibly shorten a compressor's life-span.
 - a. Exceptions for air conditioning (cooling only) applications, 1/4" liquid line may be used in:
 - i. 1.5 ton applications for up to 100 equivalent feet (30.5 equivalent meters) with maximum 40' (12.2 m) vertical lift
 - ii. 2.0 ton applications for up to 75 equivalent feet (22.9 equivalent meters) with maximum 20' (6.1 m) vertical lift
 - b. Exceptions for air conditioning (cooling only) applications, 5/16" liquid line may be used in:
 - i. 1.5 ton applications for up to 250 equivalent feet (76.2 equivalent meters) with maximum 60' (18.3 m) vertical lift
 - ii. 2.0 ton applications for up to 200 equivalent feet (61.0 equivalent meters) with maximum 40' (12.2 m) vertical lift
 - iii. 2.5 ton applications for up to 175 equivalent feet (53.3 equivalent meters) with maximum 30' (9.1 m) vertical lift
3. Most refrigerant tubing kits are supplied with 3/8" (9.5 mm) thick insulation on the suction line. For long line installations over 80 feet (24.4 m), if the line set passes through a high ambient temperature zone, 1/2" (12.7 mm) thick suction line insulation is required to reduce loss of capacity. The liquid line must be insulated if more than 50 feet (15.2 m) of liquid line will pass through an area that might reach temperatures of 30°F or higher than outdoor ambient. Never attach a liquid line to any uninsulated portion of the suction line.
4. A crankcase heater must be installed on *any* compressor (if crankcase heater is not already factory installed).
5. Hard start assist kit is required.
6. Use of a thermostatic expansion valve (TXV) is required in all long line set applications. Unit must be charged to 7 to 9 °F subcooling at the indoor unit.
7. Maximum equivalent length of line set is:
 - a. 250 feet (76.2 m) for single stage units with scroll or reciprocating compressors.
 - b. 150 feet (45.7 m) for single stage units with rotary compressors.
 - c. 150 feet (45.7 m) for two stage units.
8. Maximum linear length of line set is:
 - a. 200 feet (61.0 m) for single stage units with scroll or reciprocating compressors.
 - b. 150 feet (45.7 m) for single stage units with rotary compressors.
 - c. 150 feet (45.7 m) for two stage units.
9. **Low voltage wiring.** Verify low voltage wire gauge is adequate for the length used due to increased line set application.
10. **Vibration and Noise:** In long line applications, refrigerant tubing is highly prone to transmit noise and vibration to the adjoining structure. Use adequate vibration-isolating hardware when mounting line set to structural members. See Figures 1-1, 1-2 and 1-3 for example of proper mounting.

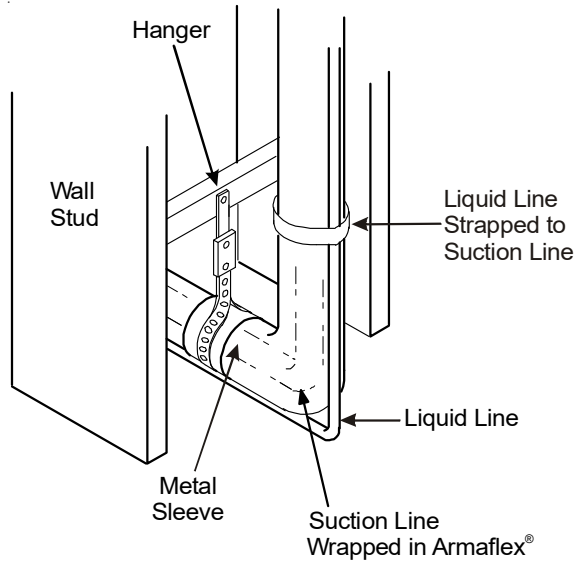


Figure 1-1.
Installation of Refrigerant Piping From Vertical to Horizontal

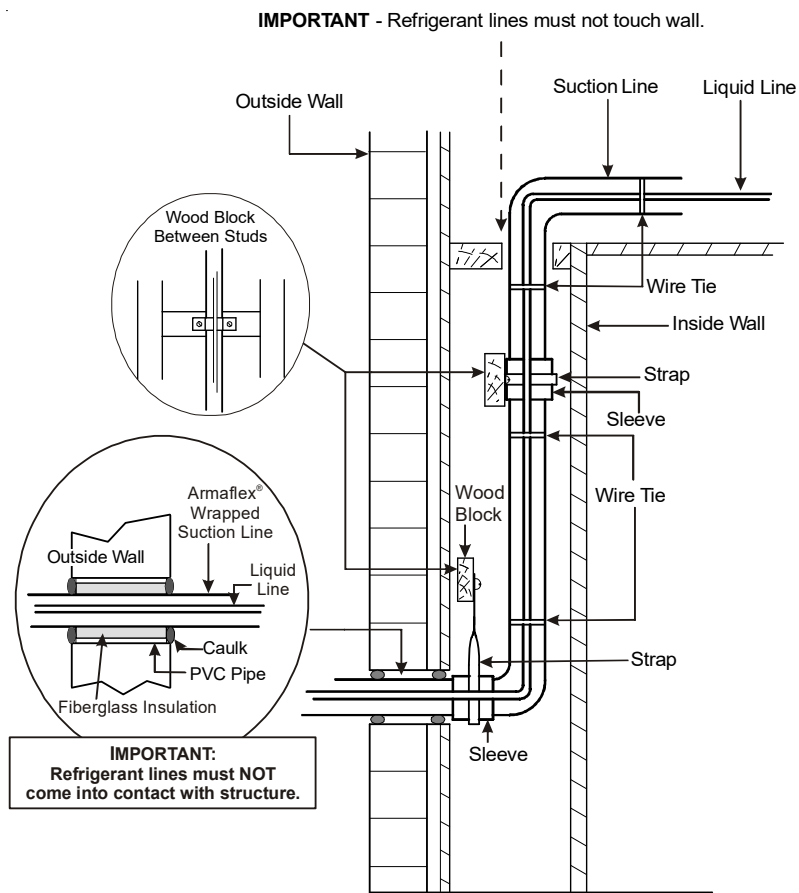


Figure 1-2. Installation of Refrigerant Piping (Vertical)

New construction shown

NOTE: If line set is installed on the exterior of an outside wall, similar installation practices are to be used.

Figure 1-3. Installation of Refrigerant Piping (Horizontal)

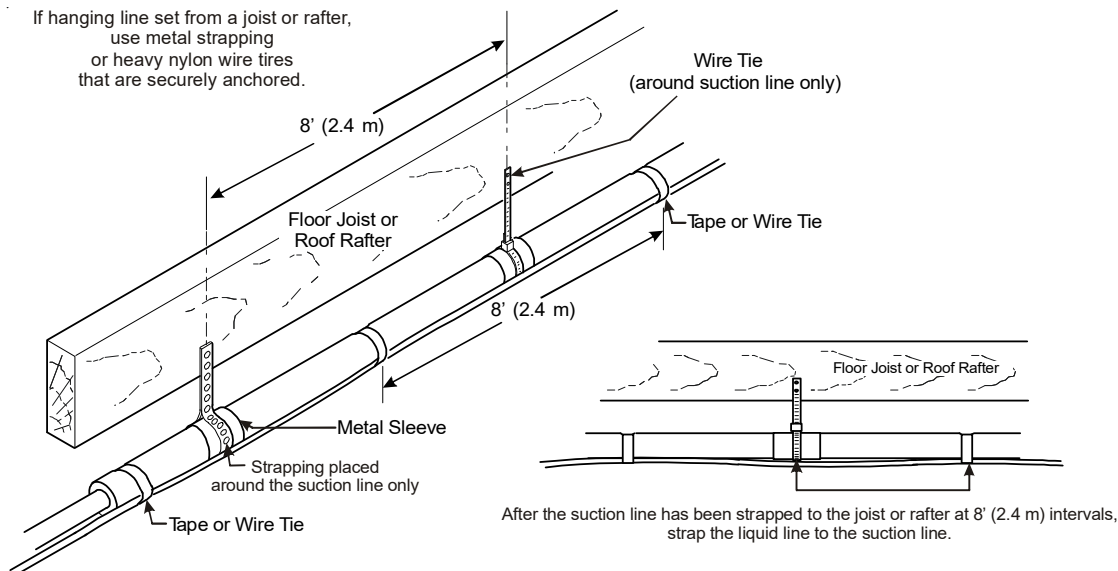


Figure 1-3. Installation of Refrigerant Piping (Horizontal)

11. **Heat Pump Application Only.** Liquid line solenoid must be installed less than 2 feet (61cm) from the outdoor unit following the solenoid supplier information for installation.
12. **Heat Pump Application Only.** Heating piston change (in the outdoor unit) is not required.
13. **Final Charge Adjustment.** All units must have refrigerant charge verified by proper adjustment of subcooling at the indoor unit after initial charge adjustment per Section 5. Proper adjustment means pressure and temperature of the liquid line at the indoor unit must be measured to calculate subcooling at the indoor unit. If subcooling at the indoor unit is less than 7°F, then additional refrigerant must be added until this subcooling level is achieved. If subcooling at the indoor unit is more than 9°F, then refrigerant must be removed until this subcooling level is achieved.

SECTION 2. OUTDOOR UNIT AND INDOOR UNIT ARE AT THE SAME ELEVATION

Accessory	Air Conditioner (AC)	Heat Pump (HP)
Crankcase Heater (40 watts minimum)	Yes	Yes
Hard Start Assist	Yes (See manual for each product)	Yes (See manual for each product)
TXV (Indoor)	Yes	Yes
Liquid Line Solenoid at Outdoor (Kit # LSK02*)	No	Yes *See Note 6
Inverted Refrigerant Trap at Indoor	No	No
Oil Trap at Indoor	No	No

1. In a completely horizontal installation with a long line set where the indoor unit is at the same altitude as (or slightly below) the outdoor unit, the line set should be sloped continuously towards the indoor unit. This helps reduce refrigerant migration to the outdoor unit during a system's off-cycle.
2. The maximum elevation (vertical) difference for this section to be applicable is 10 feet (3.0 m) separation between outdoor unit and indoor unit. If outdoor unit is more than 10 feet (3.0 m) above indoor unit use Section 3. If outdoor unit is more than 10 feet (3.0 m) below indoor unit use Section 4.
3. Inverted suction loop is not required at either unit.

4. An accumulator is not required for air conditioners (accumulators are factory installed on heat pumps).
5. An oil trap at the indoor unit is not required.
6. Liquid Line Solenoid not required if non-bleed TXV is used on the outdoor unit.

SECTION 3. OUTDOOR UNIT IS ABOVE THE INDOOR UNIT

Accessory	Air Conditioner (AC)	Heat Pump (HP)
Crankcase Heater (40 watts minimum)	Yes	Yes
Hard Start Assist	Yes (See manual for each product)	Yes (See manual for each product)
TXV (Indoor)	Yes	Yes
Liquid Line Solenoid at Outdoor (Kit # LSK02*)	No	Yes *See Note 5
Inverted Refrigerant Trap at Indoor	No	No
Oil Trap at Indoor	Yes**	Yes**

**An oil trap at the indoor unit is required if the elevation difference exceeds 80' (24.4 m). The trap can be constructed of standard refrigerant fitting (See Figure 3-1.)

1. Suction line must be sloped continuously towards the indoor unit.
2. The maximum elevation (vertical) difference between the outdoor unit and indoor unit is:
 - a. not restricted in this configuration for single stage air conditioning units (must adhere to maximum equivalent length).
 - b. 80 feet (24.4m) for single stage heat pump units. Exception: 200ft (61 m) vertical separation allowed for 14 SEER Long Line Set models and 16 SEER single stage HP models.
 - c. 25 feet (7.6 m) for two stage units.
3. Inverted suction loop is not required at either unit.
4. An accumulator is not required for air conditioners (accumulators are factory installed on heat pumps).
5. Liquid Line Solenoid not required if non-bleed TXV is used on the outdoor unit.

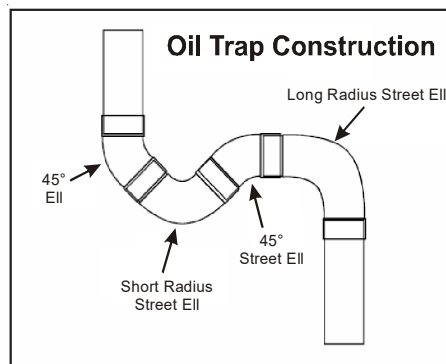
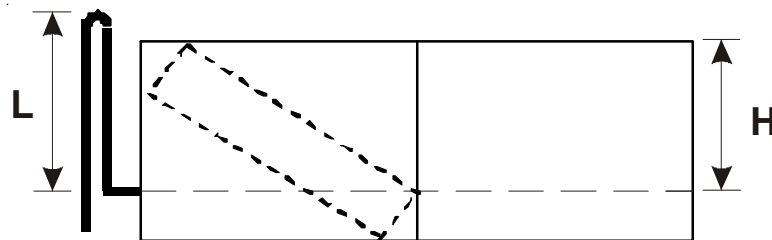


Figure 3-1. Oil Trap

SECTION 4. OUTDOOR UNIT IS BELOW THE INDOOR UNIT

Accessory	Air Conditioner (AC)	Heat Pump (HP)
Crankcase Heater (40 watts minimum)	Yes	Yes
Hard Start Assist	Yes (See manual for each product)	Yes (See manual for each product)
TXV (Indoor)	Yes	Yes
Liquid Line Solenoid at Outdoor (Kit # LSK02*)	Yes	Yes *See Note 5
Inverted Refrigerant Trap at Indoor	Yes	Yes
Oil Trap at Indoor	No	No

- The maximum elevation (vertical) difference between the outdoor unit and the indoor unit is 80 feet (24.4 m).
- Suction line must be installed in a manner to prevent liquid migration to the outdoor unit from the indoor unit (see following note 3).
- An inverted suction line trap must be installed on the suction line just before the inlet to the indoor unit (see Figure 4-1). The top of the inverted loop must be slightly above the top of the indoor unit coil and can be created simply by brazing two 90° long radius elbows together if a bending tool is unavailable. Properly support and secure the inverted loop to the nearest point on the indoor unit or adjacent structure.
- Line sets over 79 feet require an accumulator to be added (external to the outdoor unit, within 2 linear feet (61 linear centimeters) of the outdoor unit) for air conditioning installations. See Table 4-1 for accumulator selection. Adapter fittings at the accumulator connection may be required. Do NOT install an accumulator in the suction line set in heat pump applications.
- Liquid Line Solenoid not required if non-bleed TXV is used on the outdoor unit.



L = Length of trap must be more than Indoor Unit Height (H)

Figure 4-1. Indoor Unit with Inverted Suction

Total System Refrigerant Charge			Goodman Accumulator			
			Preferred		Minimum	
oz.	lb.	kg.	Part Number	Connection	Part Number	Connection
112	7	3.2	0151R00004P	3/4"	0151R00004P	3/4"
144	9	4.1	B1226206	3/4"	0151R00004P	3/4"
176	11	5.0	B1226207	7/8"	B1226206	3/4"
208	13	5.9	0151L00008	7/8"	B1226206	3/4"
240	15	6.8	0151L00009	7/8"	B1226207	7/8"
288	18	8.2	0151L00001	1 1/8"	0151L00008	7/8"
352	22	10.0	0151L00010	7/8"	0151L00001	1 1/8"
480	30	13.6	0151L00010	7/8"	0151L00010	7/8"

Table 4-1. Accumulator Size

SECTION 5. CALCULATIONS - TUBING EQUIVALENT LENGTH, TUBE SIZE AND REFRIGERANT

- In long line applications the “equivalent line length” is the sum of the straight length portions of the suction line plus losses (in equivalent length) from 45 and 90 degree bends. Add the total straight (lineal) length of tubing to the equivalent length of elbows and bends to get total equivalent length.

$$\text{Equivalent length} = \text{Length}_{\text{Horizontal}} + \text{Length}_{\text{Vertical}} + \text{Losses from bends (see Table 5-1)}$$

- Table 5-1 lists the equivalent length gained from adding bends to the suction line. Properly size the suction line to minimize capacity loss.

Type of Elbow Fitting	Inside Diameter (in)		
	3/4	7/8	1 1/8
90° short radius	1.7	2	2.3
90° long radius	1.5	1.7	1.6
45°	0.7	0.8	1

Table 5-1. Losses from suction line elbows (equivalent length, ft.)

Type of Elbow Fitting	Inside Diameter (in)		
	3/4	7/8	1 1/8
90° short radius	0.5	0.6	0.7
90° long radius	0.5	0.5	0.5
45°	0.2	0.2	0.3

Table 5-2. Losses from suction line elbows (equivalent length, m)

Table 5-1. Losses from suction line elbows (equivalent length, ft.)

EXAMPLE: 3/4” suction line using 3/4” elbows

$$150 \text{ feet of straight tubing} + (\text{four short radius elbows} \times 1.7) + (\text{2 long radius elbows} \times 1.5) = 150 + 3.4 + 3 = 156.4 \text{ equivalent feet}$$

- Table 5-2 lists multiplier values to recalculate system cooling capacity as a function of a system’s equivalent line length (as calculated from the suction line) and the selected suction tube size.

NOTE: Select the proper suction tube size based on equivalent length of the suction line (see Tables 5-1 and 5-2) and recalculated system capacity.

Unit (Btu)	Suction Dia. (in)	Capacity Multiplier for Given Length (ft) ¹									
		25	50	75	100	125	150	175	200	225	250
18000	1/2	0.99	0.97	0.96	0.94	0.94	0.93	0.93	0.92	0.91	0.89
	5/8	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97
	3/4	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
24000	5/8	0.99	0.99	0.98	0.98	0.97	0.97	0.97	0.96	0.95	0.95
	3/4	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.97
	7/8 ²	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
30000	5/8	0.99	0.99	0.98	0.97	0.96	0.96	0.96	0.94	0.93	0.92
	3/4	1.00	1.00	0.99	0.99	0.99	0.98	0.88	0.98	0.98	0.97
	7/8	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99
36000	5/8	0.99	0.98	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.88
	3/4	1.00	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96
	7/8 ³	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98
42000	3/4	1.00	0.99	0.99	0.98	0.97	0.97	0.96	0.96	0.95	0.94
	7/8	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97
	1 1/8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
48000	3/4	0.99	0.99	0.98	0.97	0.96	0.96	0.95	0.95	0.94	0.93
	7/8	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97
	1 1/8 ⁴	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
60000	3/4	0.99	0.98	0.97	0.96	0.94	0.93	0.93	0.91	0.90	0.89
	7/8	1.00	0.99	0.98	0.98	0.97	0.97	0.96	0.94	0.95	0.95
	1 1/8 ⁴	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99

Table 5-3. Capacity Multipliers (feet)

¹ Equivalent length is to be used for capacity multiplier reduction.

² 7/8" suction line is not approved for 2-ton two stage heat pump applications.

³ 7/8" suction line is not approved for 3-ton two stage heat pump applications over 80 feet.

⁴ 1-1/8 suction line is not approved for 4-ton and 5-ton two stage heat pump applications over 80 feet.

Unit (Btu)	Suction Dia. (in)	Capacity Multiplier for Given Length (m) ¹									
		7.6	15.2	22.9	30.5	38.1	45.7	53.3	61.0	68.6	76.2
18000	1/2	0.99	0.97	0.96	0.94	0.94	0.93	0.93	0.92	0.91	0.89
	5/8	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97
	3/4	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
24000	5/8	0.99	0.99	0.98	0.98	0.97	0.97	0.97	0.96	0.95	0.95
	3/4	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.97
	7/8 ²	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
30000	5/8	0.99	0.99	0.98	0.97	0.96	0.96	0.96	0.94	0.93	0.92
	3/4	1.00	1.00	0.99	0.99	0.99	0.98	0.88	0.98	0.98	0.97
	7/8	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99
36000	5/8	0.99	0.98	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.88
	3/4	1.00	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96
	7/8 ³	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98
42000	3/4	1.00	0.99	0.99	0.98	0.97	0.97	0.96	0.96	0.95	0.94
	7/8	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97
	1 1/8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
48000	3/4	0.99	0.99	0.98	0.97	0.96	0.96	0.95	0.95	0.94	0.93
	7/8	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97
	1 1/8 ⁴	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
60000	3/4	0.99	0.98	0.97	0.96	0.94	0.93	0.93	0.91	0.90	0.89
	7/8	1.00	0.99	0.98	0.98	0.97	0.97	0.96	0.94	0.95	0.95
	1 1/8 ⁴	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99

Table 5-4. Capacity Multipliers (meters)

4. **Refrigerant Quantity Adjustment.** All residential R-410A outdoor units are factory charged for 15 feet (4.6 m) of line set.

To calculate the initial amount of extra refrigerant (in ounces):

- Subtract 15 feet (4.6 m) from the total linear (not equivalent) length of actual line set
- Multiply that value by 0.6 (oz. per foot) or 17.0 (g per meter) of R-410A refrigerant
- This will be the initial amount of R-410A refrigerant that must be added prior to final charge adjustment.

All systems must have final charge adjustment performed as required in Section 1. In most residential applications a minimal amount of additional refrigerant will be needed to account for the volume in the suction line. For some applications using 1 1/8" suction line and/or over 150 feet of lineal length (45.7 m), approximately 3 pounds (1.4 kg) of additional refrigerant may be needed to account for the suction line. For a more precise calculation of refrigerant needs use Table 5-3. The additional refrigerant for given line lengths can be found in Table 5-4.

$$R_A \text{ (oz.)} = (L_A - 15) \text{ ft.} \times 0.6 \text{ oz./ft.}$$

$$R_A \text{ (g)} = (L_A - 4.6) \text{ m.} \times 55.8 \text{ g/m.}$$

Where:

R_A = Initial additional refrigerant needed

L_A = Actual lineal line set length

Line set sizes	Additional Refrigerant (oz. per lineal foot)	Additional Refrigerant (g. per lineal meter)
3/8" liquid only	0.60	55.8
3/8" liquid and 5/8" suction	0.63	58.6
3/8" liquid and 3/4" suction	0.67	62.3
3/8" liquid and 7/8" suction	0.74	68.8
3/8" liquid and 1 1/8" suction	0.78	72.5

Table 5-5 Additional Refrigerant Per Unit Length.

	Additional lineal line length over 15 feet						
	25	50	75	100	125	150	175
	Initial refrigerant addition (oz.)						
3/8" liquid line only	15	30	45	60	75	90	105
3/8" liquid line & 5/8" suction line	16	32	47	63	79	95	110
3/8" liquid line & 3/4" suction line	17	34	50	67	84	101	117
3/8" liquid line & 7/8" suction line	18	35	53	70	88	105	123
3/8" liquid line & 1-1/8" suction line	20	39	59	78	98	117	137

Table 5-6 Initial Refrigerant for Given Line Length (feet)

	Additional lineal length over 4.6 meters						
	7.6	15.2	22.9	30.5	38.1	45.7	53.3
	Initial refrigerant addition (kg)						
3/8" liquid line only	0.4	0.9	1.3	1.7	2.1	2.6	3
3/8" liquid line & 5/8" suction line	0.5	0.9	1.3	1.8	2.2	2.7	3.1
3/8" liquid line & 3/4" suction line	0.5	1	1.4	1.9	2.4	2.9	3.3
3/8" liquid line & 7/8" suction line	0.5	1	1.5	2	2.5	3	3.5
3/8" liquid line & 1-1/8" suction line	0.6	1.1	1.7	2.2	2.8	3.3	3.9

Table 5-7 Initial Refrigerant for Given Line Length (meters)

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NOTE: SPECIFICATIONS AND PERFORMANCE DATA LISTED HEREIN ARE SUBJECT TO CHANGE WITHOUT NOTICE

Quality Makes the Difference!

All of our systems are designed and manufactured with the same high quality standards regardless of size or efficiency. We have designed these units to significantly reduce the most frequent causes of product failure. They are simple to service and forgiving to operate. We use quality materials and components. Finally, every unit is run tested before it leaves the factory.

That's why we know. . . **There's No Better Quality.**

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