The HVACR Training Authority

REFRIGERANT PIPING

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INTRODUCTION

In recent years, manufacturers of condensing units have more and more gone to motor-compressor units and direct-drive compressors, which means that the compressors are turning at motor speeds. These relatively high-speed compressors cannot operate without proper lubrication at all times. Even more than formerly, adequate oil return must be maintained.

Proper piping is conducive to long life and minimum repairs to the equipment, such as reduction of damage to compressors by broken valves, burned out bearings and scored cylinders by the lack of proper oil return; and damage to expansion valves due to wire drawing as a result of flash gases, to name only a few of the possible damages. After all, it is to the best interest of all to make the customer's equipment operate as efficiently and economically as possible.

The chief purpose of this discussion on refrigerant piping is to point out some of the precautions to be taken which affect the life and efficiency of refrigerating equipment, and to offer some helpful suggestions in piping design, selection and erection.

The author knows of nothing the user appreciates more, and which causes him to feel that he has received his money's worth, than NEATNESS. That is something he can see and understand. The only way fittings will fit properly is to install the piping runs plumb and level, except when otherwise necessary to pitch for proper drainage. The supporting of pipes is part of the job of neatness, and should be done as part of the permanent results as intended in the original engineered layout. The intervals or spacing of the supports will be governed by the type and size of pipe, but should be close enough to avoid any sagging between the supports.

In order to be able to properly select the valves, fittings and pipe for an installation, and the connection of the equipment for a given job, the location of each piece of the equipment with relation to each other component must be determined. These locations decide the design of the piping as well as the size and length, and they also determine the necessary valves and fittings. The first thing to do then is to make a layout. For small installations, the layout may even be mental; but there should be a thought-out plan before erection is started.

To simplify our discussion we shall divide it into four sub-topics, namely:

DISCHARGE OR HOT GAS LINES

LIQUID LINES

SUCTION LINES FOR R-12

SIZING REFRIGERANT PIPING

MISCELLANEOUS.

DISCHARGE OR HOT GAS LINES

The discharge or hot gas piping is as important as the other two lines. In many installations remote condensers are used, such as remote air-cooled condensers and evaporative condensers. Installations of these types present their problems, and should be piped to avoid excessive vibration, provide against the entrainment of oil, and for traps where necessary to protect the equipment.

The usual recommended maximum pressure drop for calculations of R-12 hot gas lines is 2 psig, and a minimum velocity of 1,500 fpm (feet per minute) in vertical, and 750 fpm in horizontal piping to maintain oil movement. These results can be obtained by referring to the manufacturers' charts on "pipe sizing".

Care should be taken when connecting condensing units in parallel, and each with its own receiver. The hot gas lines should be arranged so that the equalizer pipe between them is as short and as near the receivers as possible. (See Figure 66F01.) This equalizer should be at least the next size smaller pipe than the discharge piping. When connecting two or more compressors to one condenser, it is best to run a discharge line for each compressor directly into the condenser. If this method is not practical, each compressor discharge line should be connected to the main hot gas line in a "Y" or offset "T", as in Figure 66F02A and Figure 66F02B, but never bull-headed, as in Figure 66F02C.

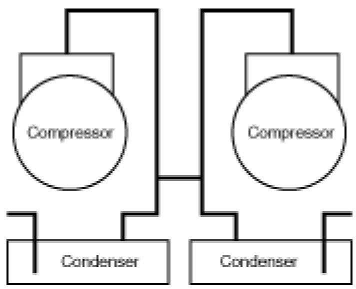


Figure 66F01 Paralleling Condensing Units

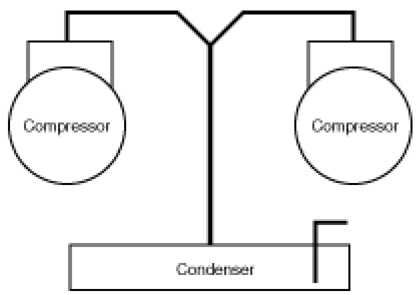


Figure 66F02A Y connection for paralleling the hot gas lines from two compressors to a condenser at a lower level (right).

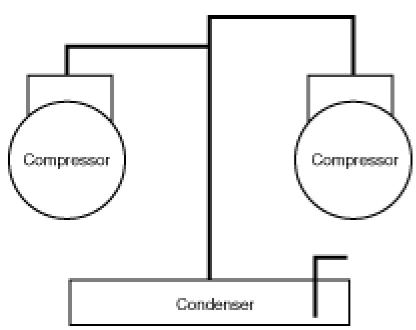


Figure 66F02B T or offset connection for paralleling the hot gas lines from two compressors to a condenser at a lower level (right).

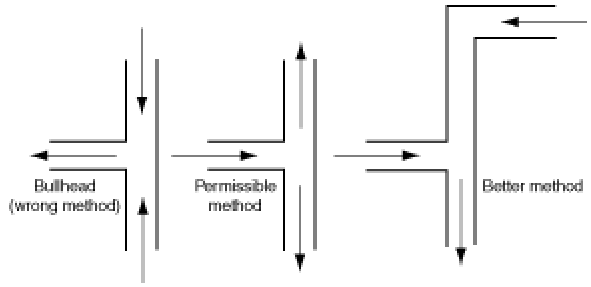
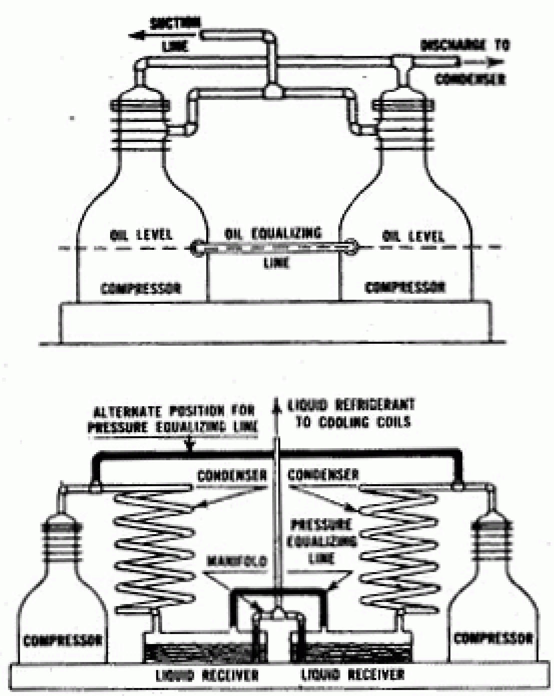


Figure 66F02C Bullhead (Wrong) and two permissible connections for paralleling two hot gas lines.

The opposing flow of refrigerant gases, as shown in the left diagram in Figure 66F02C, can set up a turbulence that may cause pulsation in the piping. If the rise to the main hot gas line is over 4 or 5 ft, the branch lines should connect to the main line above the center of the main line piping. Another suggested method for hot gas lines, when paralleling two compressors, is shown in Figure 66F03A.



Courtesy The Trane Company

Figure 66F03A

Another method of equalizing hot gas and receiver pressures and crankcase oil.

If the condenser is as much as 8 or 10 ft above the compressor, provisions should be made to trap the oil and refrigerant that might otherwise condense in the compressor heads when the compressors are stopped. (See Figure 66F03B and Figure 66F03C.) Using this method, oil and refrigerant will soon return to the system when the machine starts again, without damage to valve plates or heads. For each additional 30 ft rise, another trap should be provided, dividing the amount of pipe proportionately to each trap. These traps should be made as short as fittings will permit.

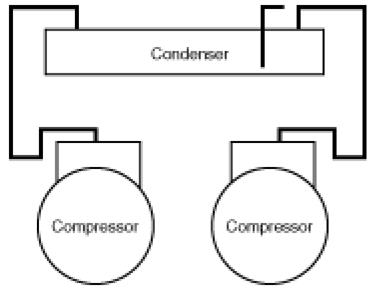


Figure 66F03C Separate hot gas lines from compressors to one condenser at a higher level, showing traps to prevent oil, and refrigerant from running back down into the compressor heads when the compressors stop.

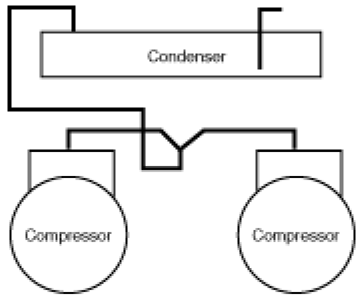


Figure 66F03C Similar connections to those in Figure 66F03B, except one hot gas line is used for both compressors. Note use of Y connections and trap.

If it is anticipated that the compressor temperature may be lower than the receiver temperature, and that the receiver is located above the compressor, a check valve should be installed in the discharge piping near the receiver (Figure 66F03D). This will prevent refrigerant evaporated out of the receiver from condensing in the compressor head, and causing serious damage when the compressor starts.

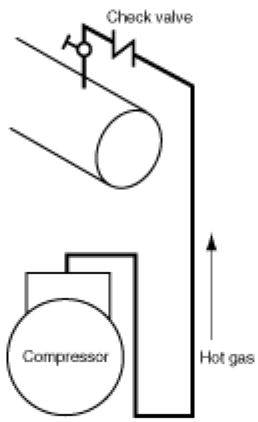


Figure 66F03DUse of check valve in hot gas line with condenser above the compressor if compressor is in cooler location than condenser.

EVAPORATIVE CONDENSER DISCHARGE LINES

Today we are becoming concerned with water-saving devices, and one of these is the evaporative condenser. As has been previously pointed out, the inlet and outlet piping of a multi-coil evaporative condenser should not be bull-head connected. The liquid outlet of an evaporative condenser should be piped downward from the condenser coil outlet and full size, before a reduction in pipe size is made. This will avoid trapping any refrigerant in the coils of the evaporative condenser (Figure 66F04A and Figure 66F04B).

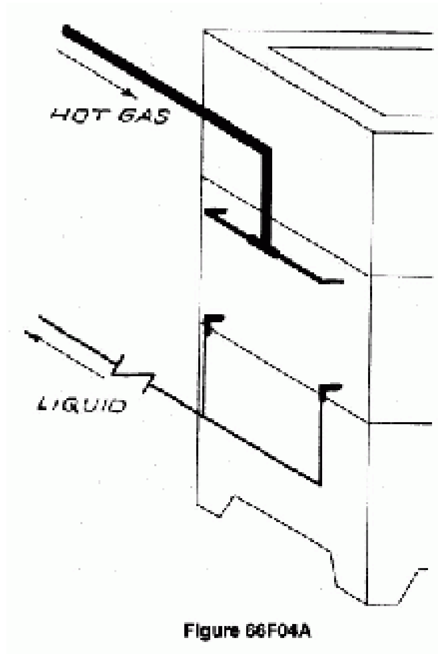


Figure 66F04A Bullhead tee connection (wrong) of hot gas line to two sections of evaporative condenser. T connection (right) of liquid lines. Note check valve in main liquid line to receiver.

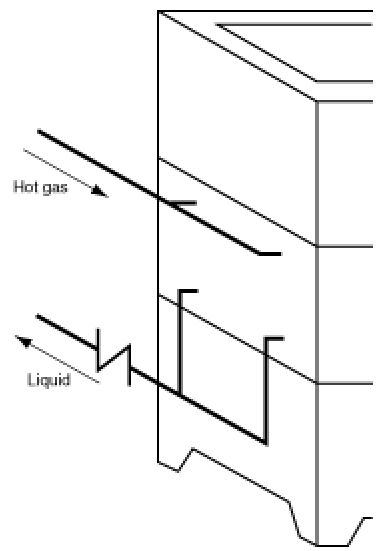


Figure 66F04B Correct hot gas and liquid lines for two section evaporative condenser.

Again, we have the temperature difference affecting the refrigerant in the discharge circuit. To avoid any difficulty, it is recommended that a check valve be installed at the inlet of the receiver, to prevent the refrigerant from recondensing out of the receiver back into the condenser coils, should the refrigerant temperature in the receiver exceed that in the evaporative condenser coils.

In cases of two or more evaporative condensers connected in parallel, the outlets should have a drop of at least 24” to provide a static head to insure the condensed refrigerant draining into the receiver.

Under certain weather conditions when the evaporative condenser is installed outside, and sometimes under what appears to be normal operating conditions, liquid refrigerant will have a tendency to hang up in the condenser coil, caused by gas binding in the receiver. This makes the system appear to be short of refrigerant, but after adding refrigerant and making another inspection, the system may be found to be over-charged. To help this condition, a control can be used to operate the fan motor or spray pump to maintain a pressure in the condenser sufficient to overcome the pressure to the receiver.

Another condition may be due to difference in levels, and may be corrected by repositioning the inlet and outlet of the condenser piping, as shown in Figure 66F05.

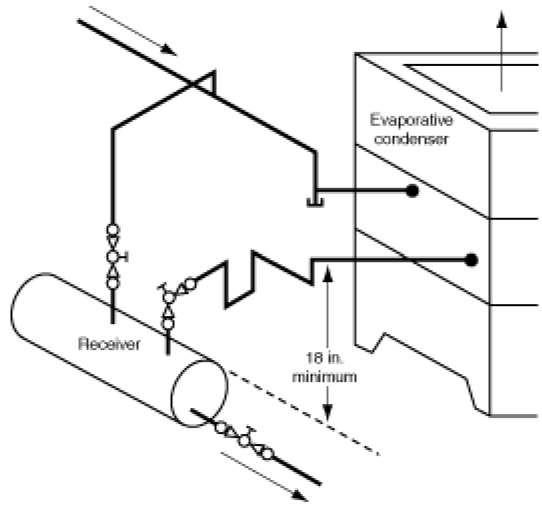


Figure 66F05 Evaporative condenser should be at higher level than its receiver. Note trap in liquid line and equalizer from top of receiver to hot gas line.

In some installations, it may be necessary to raise the evaporative condenser to obtain a minimum of 18” drop between the outlet of the condenser and the inlet to the receiver. Also, there must be a trap in this line at the lowest run to prevent gas from rising to the condenser coil. The small equalizer line from the receiver to the inlet piping of the condenser should have a valve for shutting off the receiver. The size of this pipe can be 3/8” up to 25 tons capacity, and 1/2” up to 60 tons.

When designing a system, the engineer needs to maintain a solid column of liquid refrigerant to the flow control device, such as a thermostatic expansion valve, low-side float valve or high-side float valve, and make sure that column will stay at a reasonable working temperature. Any flashing of liquid refrigerant in the liquid line affects the capacity of flow-control devices and of the evaporator. Also, it may cause damage to these controls, or may be noisy in operation.

If the evaporator is located above the receiver, there are three important precautions that should apply:

a. The liquid refrigerant should be delivered to the evaporator without flashing due to heating of liquid from surrounding air, or to drop in pressure due to friction in the piping or to static head.

b. The expansion valve or other flow control devices should be selected according to the manufacturers’ rating for the capacity required after pressure drop due to friction and static head have been considered.

c. The liquid refrigerant should reach the flow control device sub-cooled at least 1°F below the exit temperature at the receiver.

The limits in height to which liquid refrigerant can be piped without flash gas differ among engineers, but a maximum rise of 15 ft for R-12 is usually recommended. The controlling factor is the static head of the refrigerant at a given temperature. For R-12 at 97°F, this is .55 psi per ft of rise, and .57 psi per ft of rise at 70°F. For R-22 at 97°F, it is .50 psi per foot of rise, and .52 psi per foot of rise at 70°F, so the maximum rise may be a foot or so more than for R-12.

Several steps can be taken to reduce flash gas in lifts higher than that mentioned above:

1. Increase liquid pipe size one size over the calculated size, to reduce pressure drop due to pipe friction.

2. Increase shut-off valves, strainers, solenoid valves and dryers to match above piping. These measures (1 and 2) will not reduce pressure drop due to static head.

3. If, due to excessive static head, the above recommendations cannot be used a heat exchanger installed between the suction and liquid line in (Figure 66F06A) to sub-cool the liquid will accomplish satisfactory results. It is important that the heat exchanger be installed in a position that will not allow oil to be trapped in the suction side of it, which in turn reduces the oil level in the compressor.

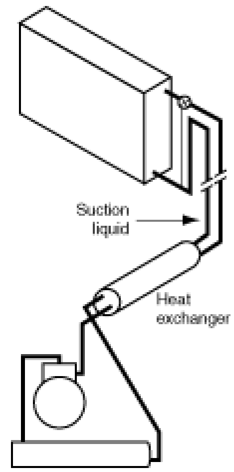


Figure 66F06A Use of heat exchanger in liquid and suction line to sub-cool the liquid in case of excessive static head.

4. Another alternative is to locate the receiver on the same floor level and near the evaporator. This method will be more applicable when a receiver is used with a shell and tube condenser-receiver or other type condenser.

The following are precautions to be followed in liquid line piping that will improve the service of the equipment:

- Never locate a stop valve directly below a"Y" type strainer in a vertical pipe see left drawing (Figure 66F06B), as balls of solder, scale and foreign particles will drop into the valve when the flow of refrigerant ceases, causing damage to the valve disc and seat, as the valve is turned to the closed position. Figure 66F06C and Figure 66F06D show suggested installations of stop valves and strainers in the liquid line. The use of an angle strainer usually eliminates one fitting.

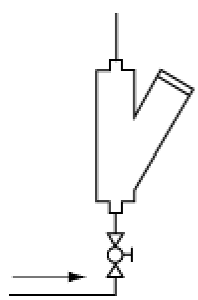


Figure 66F06B Stop valve directly beow strainer in vertical liquid line (Wrong).

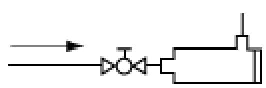


Figure 66F06C Stop valve ahead of angle strainer in horizontal liquid line (Right).

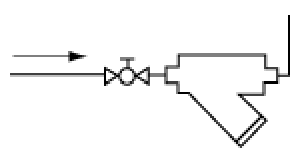


Figure 66F06D Stop valve ahead of Y strainer in horizontal liquid line (Right).

- Dryers should be installed in a vertical position and the liquid fed upward. The large volume of the drier causes a reduced velocity of the liquid. If the drier is placed in a horizontal position, oil may tend to separate out and fill that portion below the outlet, thus reducing the capacity of the drier. According to recent research, a good cleanable strainer should be installed in the liquid line between the receiver and drier, to save the drier from becoming contaminated with the foreign substances that may be in the refrigerating system. This procedure will improve and increase the effectiveness of the drier.

- If the liquid line is run through an area with an ambient temperature above the design refrigerant temperature, then the line should be insulated the required thickness to protect it from outside heat gain.

SUCTION LINES

The design and sizing of suction piping requires very careful consideration for the successful and efficient operation of each part of the equipment, since the suction line plays a most important part in the rapid return of oil to the compressor. If this one thing is accomplished without abnormal pressure drop due to friction and without slugging, long compressor life will result.

The paralleling of compressors and evaporators present many difficult problems. There are important designs to be practiced in paralleling either, and they are **NOT** the same.

For installations of the evaporator or evaporators above the condensing unit, the suction line should be trapped by running the piping upward from the coil outlet trap, and as near the coil as possible, and to the height of the coil, to prevent the condensed vapors remaining in the coil from draining directly into the compressor.

Many times, the importance of proper piping design when inter-connecting evaporators is overlooked, and consequently the expansion valve is condemned. To further explain the principle involved, Figure 66F07 compares a dribbling coffee cup to the suction line. As the coffee is slowly poured, it will follow the outside of the cup to the lowest point. Now refer to the suction line branches in this same picture. The shaded area represents small quantities of semi-vapor and liquid refrigerant. As this mixture flows from the top coil toward the lower coil, it tends to flow into the tee branch, following the wall of the tubing and spreading out as shown in cross section A-A, thus causing an effective temperature change of the TEV bulb, and in turn affecting the proper functioning of the valve itself.

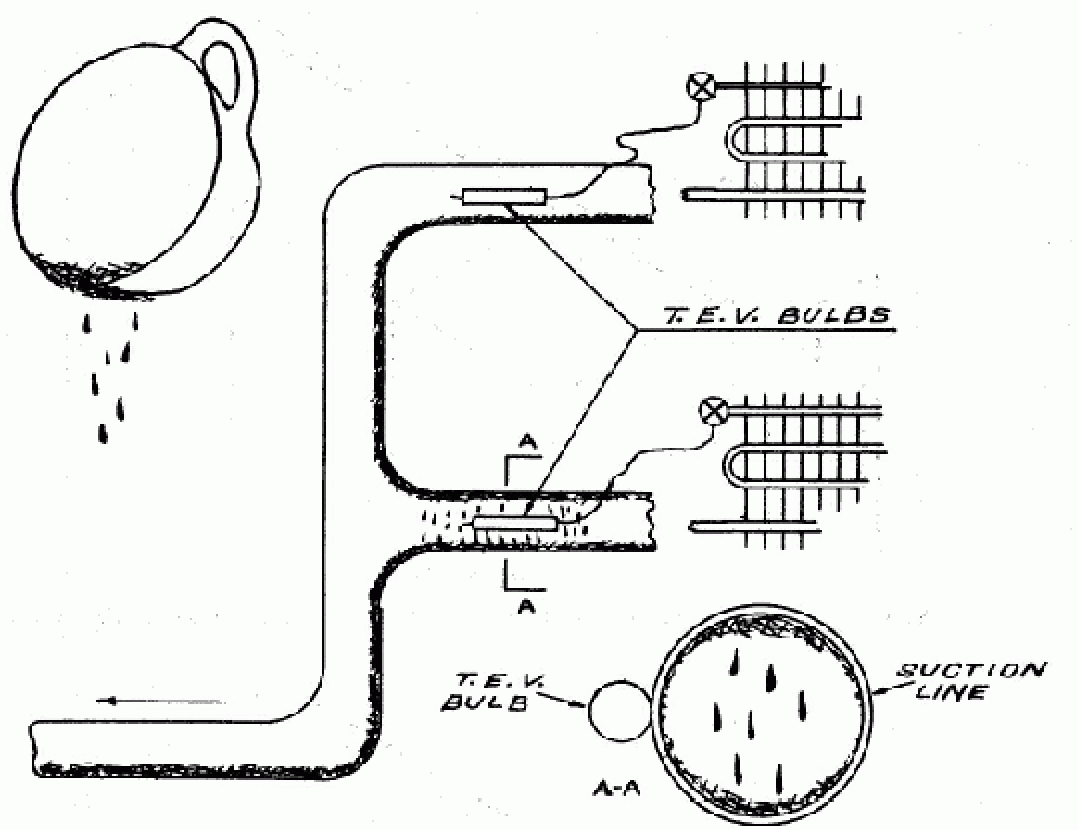


Figure 66F07

Comparison of coffee dribbling from cup, and liquid following inside tube of suction line of lower evaporator. Locate T.E.V. bulbs on side, rather than top or bottom of suction line.

SUCTION LINE DESIGN FOR MULTIPLE EVAPORATORS

The suction piping layout shown in Figure 66F08A and Figure 66F08B might lead to three coils in adjoining walk-in or reach-in refrigerators. Suppose there are three walk-ins in Figure 66F08A, each with identical blower coils, each controlled by a thermostat and a liquid line solenoid valve. If the suction piping were installed in the manner shown, it would interfere with the proper operation of the TEV's. For instance, assume that the left end cooler were requiring refrigeration, the condensing unit is running, and the solenoids were open on either or both of the coolers. It would be possible for the cold suction vapors to drain into the left and coil and suction line and effect the operation of the TEV on this left end coil, since a trap has been installed in the main suction piping preventing free drainage and return of the suction vapors and oil.

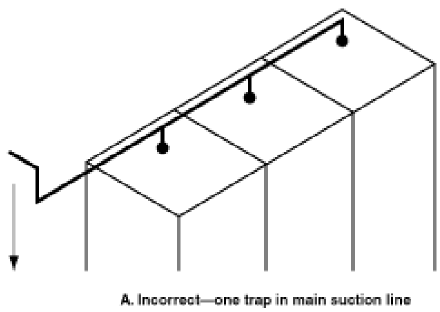


Figure 66F08A Suction line from three adjacent refrigerators with trap in main line (Wrong).

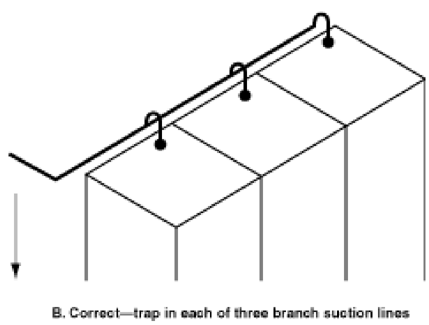


Figure 66F08B Same refrigerators as in Figure 66F08A, but with trap in each of the three branch suction lines (Right).

The solution to this problem is shown in Figure 66F08B. Here the trap in the main suction line has been removed, and the branch suction lines from each blower coil have been connected into the top of the main suction line, thus preventing the draining of refrigerant from one coil into another.

Notice how the piping from the unit in Figure 66F09A has been rearranged in Figure 66F09B with the same number of fittings, to prevent suction vapors from the upper coil draining into the lower one.

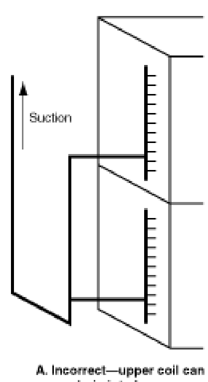


Figure 66F09A Upper coil of two evaporators in parallel can drain into lower coil (Wrong).

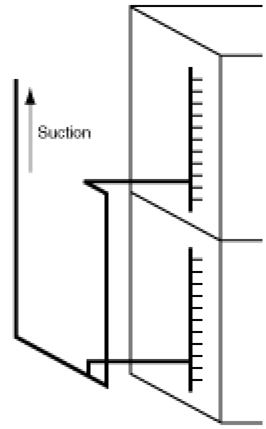


Figure 66F09BSuction piping of Figure 66F09A rearraged to provide trap (Right).

When evaporators are stacked in banks, one on top of the other, precautions should be taken to pipe them so that the draining vapors from the upper coil do not have a chance to affect the control of the coil or coils below. Figure 66F10A is a diagram of the wrong method, while Figure 66F10B shows the right method of piping such an installation.

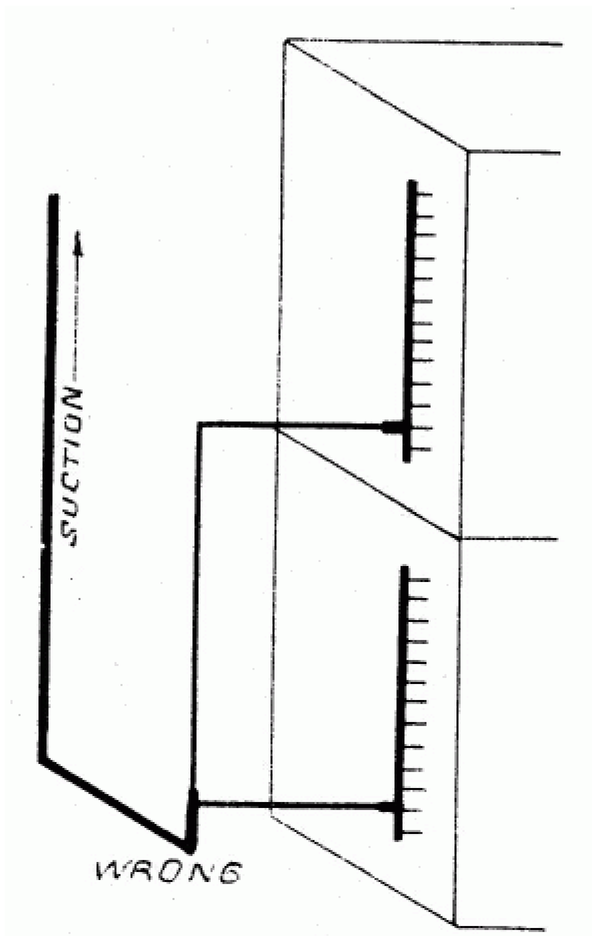


Figure 66F10A

Two air-conditioning coils stacked in a vertical bank. Upper coil can drain into lower (Wrong).

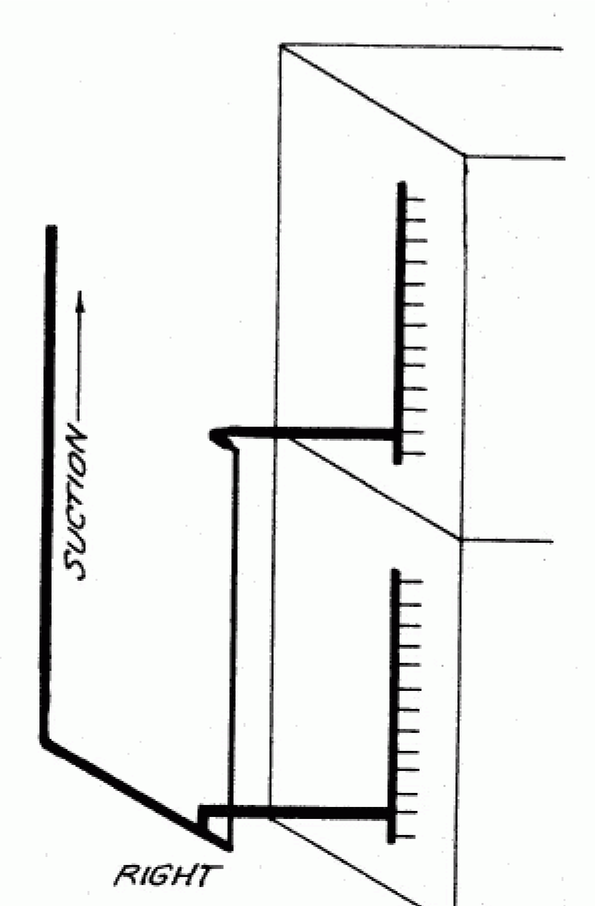


Figure 66F10B

Piping of Figure 66F10A rearranged to provide trap (Right).

Following the recommendations of cold plate manufacturers, cold plates should be piped so the refrigerant enters the bottom opening, and with a maximum of 75 sq ft of surface in any one circuit. As in the case of other suction piping, the return or suction pipe from each plate or bank of plates fed by one TEV should be connected into the top or at a 45° angle downward to the main suction line, as illustrated in Figure 66F10C and 66F10D. This is to maintain proper refrigerant control, as previously explained.

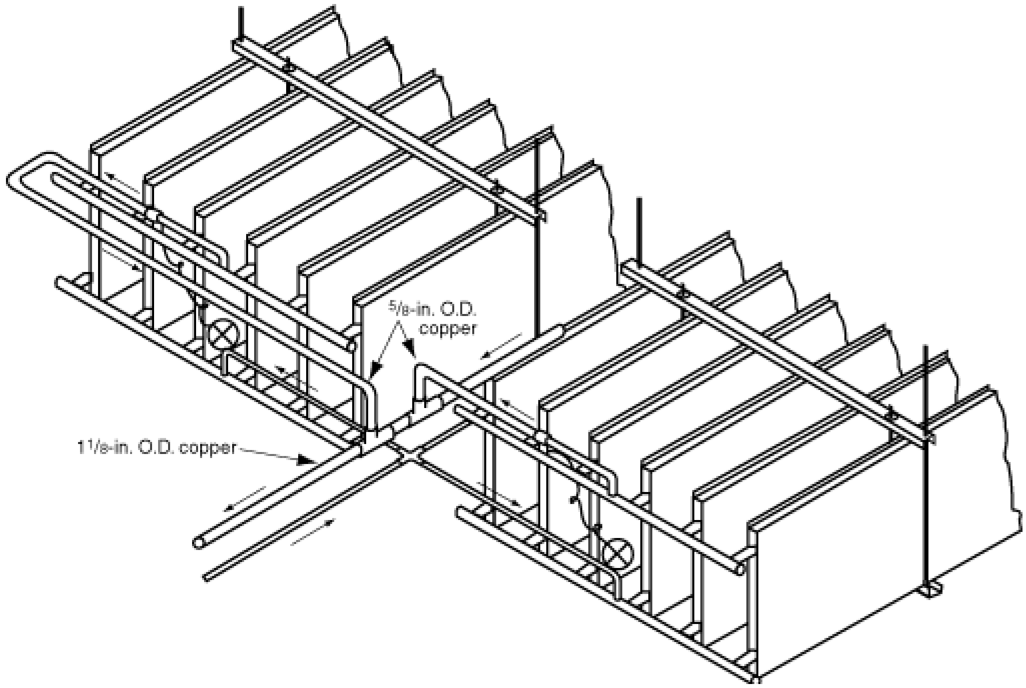


Figure 66F10C Piping layout for two parallel banks of vertical overhead plate coils.

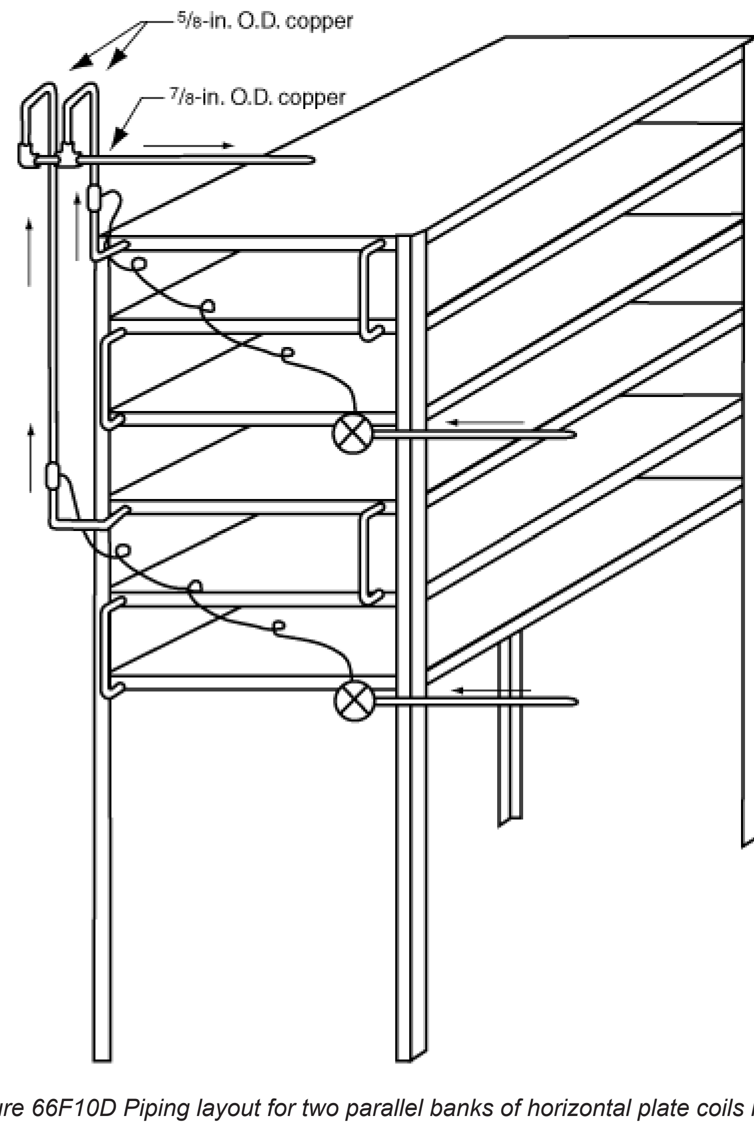


Figure 66F10D Piping layout for two parallel banks of horizontal plate coils in rack.

Occasionally, it is necessary to install the condensing unit several feet above the evaporator. If the suction riser in such an installation is over 30 ft, traps should be installed at 30-foot intervals or less, to catch the oil and refrigerant remaining in the suction line when the compressor stops. When the compressor starts again, the oil and refrigerant will gradually return to the compressor, pushed by the velocity of the vapors through the open portion of the trap. Otherwise, this oil and refrigerant might come back to the compressor as a "slug" and damage it.

Along with high-speed compressors has come suction capacity controls and cylinder unloaders. These devises have brought about the problems of maintaining riser velocity and suction lift, which will provide continuous oil return to compressors. During the running cycle the reduction of capacity may be as much as 25%, thus reducing the velocity of the suction gas which will be below the required velocity to entrain and return sufficient oil to the compressor.

Most high-speed compressors have some type of oil pump, or are designed to provide forced lubrication to the bearings. At these motor speeds all bearings must have full lubrication at all times. A matter of minutes without sufficient oil and the bearings will become damaged.

To provide for oil return during the reduced capacity period, where the main suction line or compressor are above the evaporator, a two-pipe or double riser can be used (Figure 66F11). The two pipes should be sized with a combined capacity for full compressor load to maintain a velocity of 1,500 fpm, and the smaller pipe selected with a capacity to maintain the required velocity with the compressor operating at it's minimum capacity.

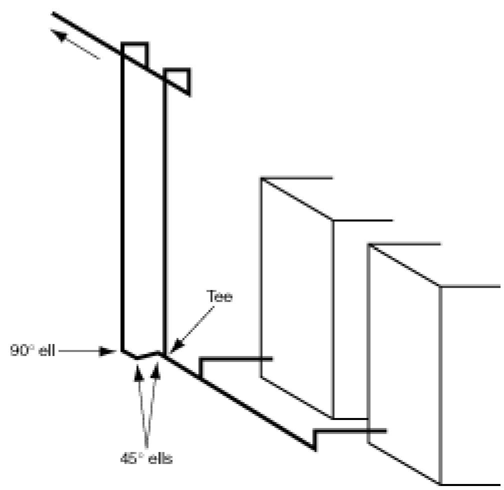


Figure 66F11Two vertical parallel sections of a suction line from two evaporators in multiple operated by condensing unit at higher level and provided with capacity reduction as load decreases.

This two-pipe riser is made by installing a tee in the suction line below the level of the outlet of the coil or coils, with the branch opening pointing upward. DO NOT reduce the run of the tee. This would make a trap in the wrong place. It would be necessary to reduce or use a tee with branch size of the selected small pipe size. On the down stream side of the tee make a trap as short as fittings will permit. When using solder fittings, this can be done with two 45° street ells and one 90° street ell. (See Figure 66F11.) If a reduction is necessary to accommodate the larger pipe, put the reducer immediately after the trap. Both riser pipes are run high enough so that they enter the main suction line in the top or on a 45° angle downward.

This design prevents any refrigerant from draining back, once it has reached the main suction line. From the point where these two pipes enter the main suction line, the suction piping should be pitched or sloped at least 1" for every 20 ft, toward the compressor. This latter recommendation is good practice in piping all suction lines.

Now that we have installed a two-pipe riser in the suction line, how does it function? As suction vapor volume is reduced, so is the velocity in a certain size suction pipe. Since the compressor capacity reduction is controlled by suction pressure, oil in the suction gas, with its reduced velocity, will separate out in the trap and seal it, causing the refrigerant vapors to pass up the small pipe. Then, as the suction pressure builds up, creating sufficient pressure difference on each side of the trap, the trap seal will be broken and the vapors passing over the oil will gradually pick up all the oil in the trap and return it to the compressor.

For systems with controlled suction capacity and a short suction line to just above the evaporator, minimum velocity for proper oil return can be maintained by reducing the riser to a size equal to the size pipe required for minimum velocity at the lowest capacity of the compressor. In making the turn at the top of this riser, use an elbow the same size as the riser; then increase the piping to the full suction line size.

SIZING REFRIGERANT PIPING

Pressure drop in refrigerant piping has been mentioned previously, but needs to be considered again in planning for the erection of the piping. Referring to Table 66T12A, a 1-1/8" × 90° wrought elbow equals 1.85 ft of the same size pipe, and for a 45° wrought elbow, the equivalent is 1 ft. of pipe or nearly 50 % less pressure-drop through a 45° elbow than for a 90° elbow. In making short offsets, minimize pressure drop by using a 90° and a 45° elbow or two 45° elbows rather than two 90° elbows.

Table 66T12A Equivalent resistance of copper fittings and valves in feet of copper tubing of same size. Length in Feet of Pipe to be Added to Actual Length of Run Owing to Fittings.

Copper pipe size (O.D. in.)	90° elbow Wrought	90° elbow Cast	45° elbow	Tee	Gate valve	Globe valve	Angle valve
1/2	0.8	1.3	0.4	2.5	0.26	7.0	4.0
3/4	1.0	1.5	0.6	2.5	0.3	12.0	6.5
7/8	1.45	1.8	0.8	3.6	0.36	17.2	9.5
1-1/8	1.85	2.2	1.0	4.6	0.48	22.5	12.0
1-3/8	2.4	2.9	1.3	6.4	0.65	32.0	16.0
1-5/8	2.9	3.5	1.6	7.2	0.72	36.0	19.5
2-1/8	3.6	4.2	2.0	9.6	0.96	48.0	22.5
2-5/8	4.5	5.1	2.4	11.2	1.1	56.0	28.0
3-1/8	1.0	6.5	2.9	12.8	1.4	72.0	32.0
3-5/8	1.0	7.6	3.4	16.0	1.6	80.0	40.0
4-1/8	1.0	9.6	4.0	18.6	1.7	100.0	48.0

It is economical to use angle valves instead of straight-through globe valves. The saving in this practice can be seen in a study of the pressure drop through these valves in this same chart. It will be noted that angle valves have about 1/2 the pressure drop as that of globe valves. In many cases an angle valve can be used to make a turn instead of an elbow, thus conserving one fitting and reducing the leak potential at least by two.

The foregone information and a mental or drawn plan of installation are necessary before any attempt can be made to select the pipe size. For example, in Figure 66F16 you see a proposed air conditioning installation. The condensing unit is 15 hp selected for R-12 at 40°F suction temperature and 100°F condensing temperature, hence the load will be about 15 tons or 180,000 Btu/per hr. To temporarily select the suction piping for 2 psig pressure drop, 100°F condensing and 40°F suction temperatures, refer to the chart, (Figure 66F17), pressure drops in refrigerant lines for R-12. It is found that it is near 2-1/8" pipe.

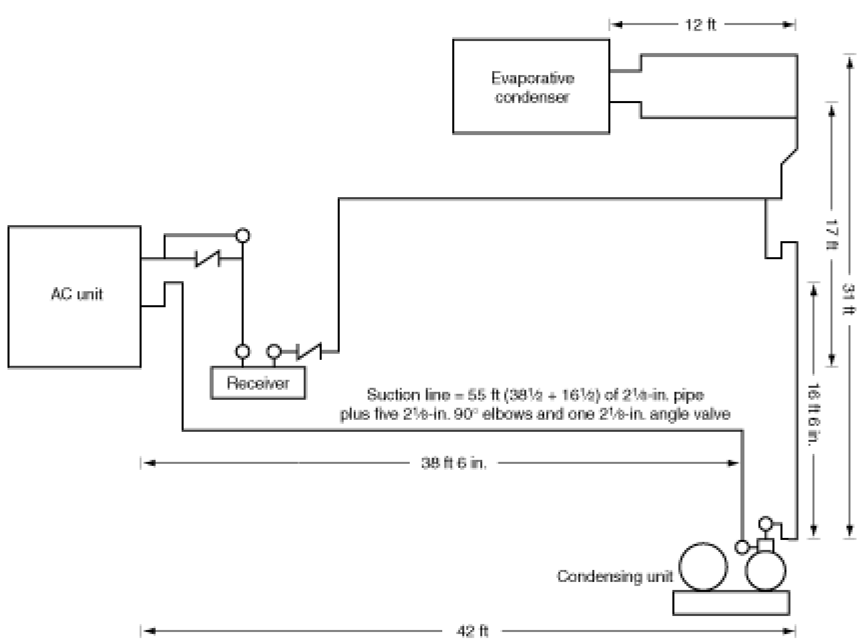


Figure 66F16 Typical 15 HP air-conditioning installation with dimensioned piping layout.

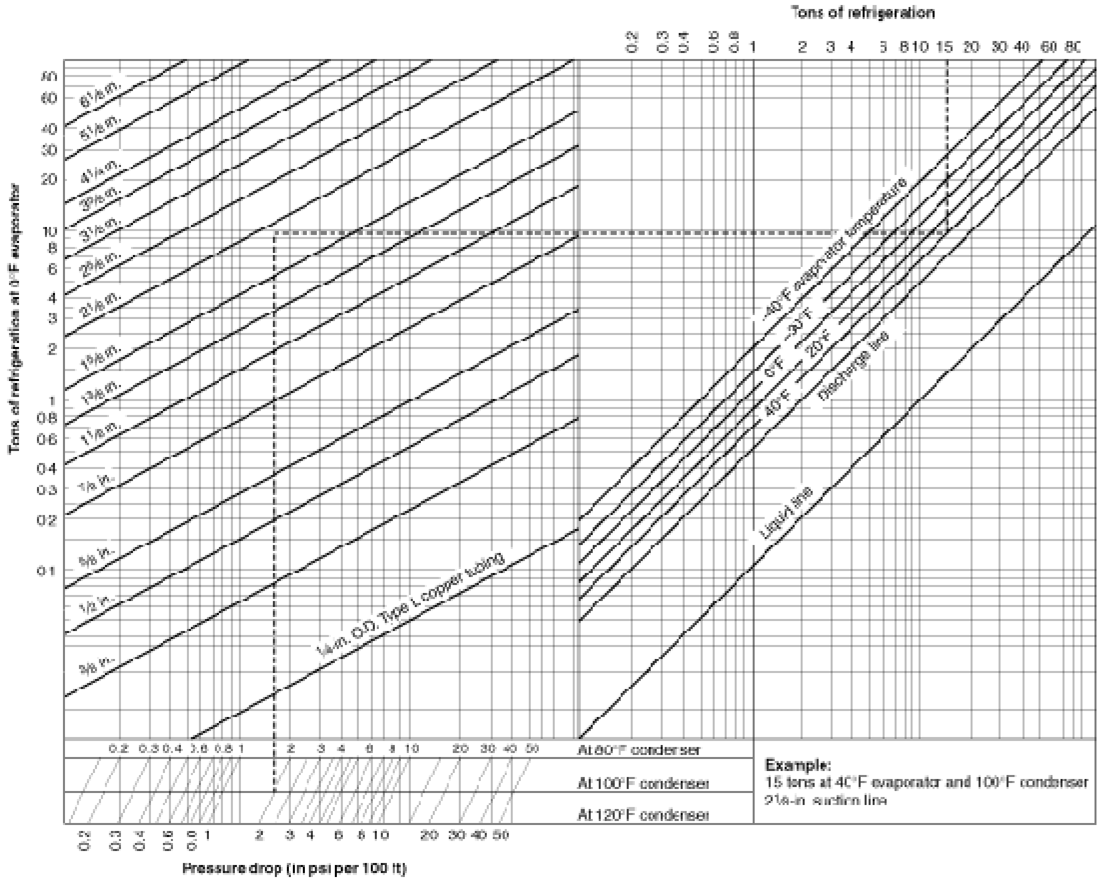


Figure 66F17 Pressure Drops in Refrigerant Lines Freon 12. Figured for type L copper tubing. For iron pipe subtract 1/8" from copper tubing size to find nominal iron pipe size. Multiply copper pressure by 16.

In order to be within the limitations, make a calculation including the fittings and valves, thus:

Suction Piping:	Horizontal	38.5 Feet
	Vertical	16.5 Feet
	TOTAL	55.0 Feet
Six 2-1/8" Elbows, each 3.6 ft		21.6 Feet
	GRAND TOTAL	76.6 Feet

To use the chart in Figure 66F17, follow these instructions:

In the upper right-hand corner you will find no indication for 15 tons, but you can select a spot half-way between 10 and 20 tons. Imagine a vertical line there, and follow it down until it intersects with the slanting 40° Evaporator Temperature line. From this intersection, run a horizontal line toward the left edge of the chart.

Next, we have assumed a 100° condensing temperature and have allowed a maximum pressure drop in the suction line of 2 psig; so, at the bottom of the chart, find the point where the horizontal 100° condenser line intersects the diagonal pressure-drop line marked "2." From this intersection, run a line upward until it intersects the horizontal line you drew toward the left of the chart from the 15 tons and 40° evaporator intersection.

Where these two lines meet is the size of suction tubing to use (indicated by another set of slanting diagonals, with pipe sizes on them). However, the intersection does not fall exactly on any size, but is just below the diagonal line for 2-1/8" tube size, and much above the diagonal line for the 1-5/8" tube size.

Since the selected pipe is under the 100 ft in length, as noted in the chart, by using 2-1/8" suction line for this installation, proper oil return with a minimum pressure drop can be expected.

Liquid and hot gas piping can be selected in the same manner as the suction piping, except with maximum allowable pressure-drop being in the 5 to 7 psig range.

Table 66T12A, Table 66T12B, Table 66T13, Table 66T14A, Table 66T14B, and Table 66T15 are for the selection of refrigerant liquid and suction piping for open self-service refrigerated store fixtures, and for other refrigerated fixtures having the same Btu/hr load and held at approximately the same temperatures.

Equivalent resistance of iron fittings
and valves in feet of iron pipe of same size.
Length in Feet of Pipe to be Added to Actual Length of Run Owing to Fittings.

Iron Pipe Size Nom.	Standard Elbow	Side Outlet Tee	Gate	Valve Globe	Angle
1/2	1.3	3	.3	14	7
3/4	1.8	4	.4	18	10
1	2.2	5	.5	23	12
1 1/4	3	6	.6	29	15
1 1/2	3.5	7	.8	34	18
2	4.3	8	1	46	22
2 1/2	5	11	1.1	54	27
3	6.5	13	1.4	66	34
3 1/2	8	15	1.6	80	40
4	9	18	1.9	92	45

Courtesy of ASH&VE Guide

Table 66T12B

Table 66T14A R-12 Piping Requirements for Self-Service Dairy & Delicatessen Cases and for other refrigerated fixtures having the same BTU/hr load and held at approximatly the same temperatures.

Overall case length**	Condensing unit, hp		Refrigerant line sizes					
	Air-cooled (or air and water)	Water-cooled	First case*		Second case		Third case	
			Liquid	Suction	Liquid	Suction	Liquid	Suction
6 ft 3 in.	3/4	3/4	3/8	5/8				
12 ft 3 in.	1-1/2	1-1/2	3/8	5/8	3/8	7/8		
18 ft 4 in.	3	2	3/8	5/8	3/8	7/8	3/8	7/8
24 ft 5 in.		3	3/8	5/8	3/8	7/8	3/8	7/8
30 ft 5 in.		5	3/8	5/8	3/8	7/8	3/8	7/8
36 ft 6 in.		5	3/8	5/8	3/8	7/8	3/8	7/8

Overall case length	Condensing unit, hp		Refrigerant line sizes					
	Air-cooled (or air and water)	Watercooled	Fourth case		Fifth case		Sixth case	
			Liquid	Suction	Liquid	Suction	Liquid	Suction
6 ft 3 in.	3/4	3/4						
12 ft 3 in.	1-1/2	1-1/2						
18 ft 4 in.	3	2						
24 ft 5 in.		3	1/2	1 1/8				
30 ft 5 in.		5	1/2	1 1/8	1/2	1 1/8		
36 ft 6 in.		5	1/2	1 1/8	1/2	1 1/8	1/2	1 3/8

* 1st case is farthest one from condensing unit.

** Overall dimensions are the total length of case to the nearest inch.

Recommendation based on designed 20°F evaporator and 28°F. shelf temperature when operating in a 90°F store.

Table 66T14B R-12 Piping Requirements for Refrigerated Vegetables Display Cases and for other refrigerated fixtures having the same BTU/hr load and held at approximatly the same temperatures.

Number of cases	Condensing unit, hp Air-cooled (or air and water)	Condensing unit, hp Water-cooled	Refrigerant line sizes First case* Liquid	First case* Suction	Second case Liquid	Second case Suction	Third case Liquid	Third case Suction	Fourth case Liquid	Fourth case Suction
1 (8 ft)	3/4	3/4	1/4	5/8						
1 (11 ft)	1	3/4	3/8	5/8						
2 (8 ft)	1-1/2	1	3/8	5/8	3/8	7/8				
1 (8 ft)										
1 (11 ft)	2	1-1/2	3/8	5/8	3/8	7/8				
2 (11 ft)	2	1-1/2	3/8	5/8	3/8	7/8				
1 (8 ft)										
2 (11 ft)	3	2	3/8	5/8	3/8	7/8	1/2	1 1/8		
3 (11 ft)	3	3	3/8	5/8	3/8	7/8	1/2	1 1/8		
1 (8 ft)										
3 (11 ft)		3	3/8	5/8	3/8	7/8	1/2	1 1/8	1/2	1 1/8
4 (11 ft)		3	3/8	5/8	3/8	7/8	1/2	1 1/8	1/2	1 1/8

* 1st case is farthest one from condensing unit.

Recommendation based on designed 20°F evaporator and 38°F shelf temperature when operating in a 90°F store temperature.

Table 66T15 R-22 Piping Requirements for Frozen Food Self-Service Display Cases and for other refrigerated fixtures having the same BTU/hr load and held at approximatly the same temperatures.

Number of cases	Condensing unit, hp Water-cooled	Refrigerant line sizes First case* Liquid	First case* Suction	Second case Liquid	Second case Suction	Third case Liquid	Third case Suction
1 (8 ft)	2	3/8	5/8				
1 (11 ft)	2	3/8	5/8				
1 (8 ft)							
1 (11 ft)	5	3/8	5/8	1/2	7/8		
2 (8 ft)	3	3/8	5/8	1/2	7/8		
2 (11 ft)	5	3/8	5/8	1/2	7/8		
3 (8 ft)	5	3/8	5/8	1/2	7/8	5/8	7/8
3 (11 ft)	7.5	3/8	5/8	1/2	7/8	5/8	1 1/8

* First case is farthest case from condensing unit. Liquid-line sizes shown do not have to be increased for runs up to 250 ft. Important: If there is a rise in the suction line of 5 ft or more anywhere in the run, reduce the suction piping to next smaller size for the rise only, then continue the run with recommended size. Exception: Suction lines should never be reduced below 5/8 in.

Insulate liquid lines and suction lines together for 30 ft toward the condensing unit after the nearest case. If the run is less than 30 ft, insulate between the nearest case and the condensing unit.

These recommendations are based on field experience of the manufacturer and are practical data. These requirements are suitable under normal conditions, and at 90°F store temperature.

For the refrigerant lines in excess of 50 ft from the nearest refrigerator to the condensing unit, follow the recommended pipe size for the first 50 ft from the refrigerator, then increase to next larger size for the balance of the run to the condensing unit.

These charts are offered as a help in diagnosing service problems on these types and sizes of equipment. For selection of proper pipe sizes on initial installation refer to the data provided by the manufacturer whose equipment is being installed.

Figure 66F19A shows the suggested piping of oil and crankcase gas pressure-equalizing lines for parallel-connected compressors. It is important that the oil equalizing line be connected to the compressor body at the minimum oil level line, so that a slight difference in crankcase pressure will not force the oil below a minimum operating level in the crankcase. The gas equalizing line should be pitched from the center toward each compressor or supported rigidly enough to prevent sags or traps which might fill with oil and restrict the passage of gas. These lines should be of ample size to allow free equalizing of the oil level. If the manufacturer has provided taps in the compressor for these lines, use the same size pipe as the compressor openings provided by him. One valve in each line, and a means of disconnecting at each compressor, should be provided for the removal of either compressor without taking the other out of service.

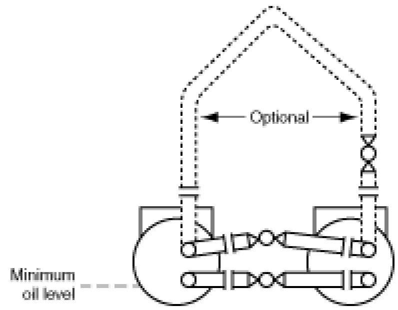


Figure 66F19A Oil and Gas equalizing lines between compressors in parallel.

NEVER connect the oil return pipe from an oil separator into the compressor below the oil level in the crankcase, because in case of failure of the oil separator float or leak through of liquid refrigerant, it may agitate the oil in the crankcase enough to cause foaming, and consequently reduce the oil pump's ability to supply enough oil, resulting in insufficient lubrication and compressor damage. Installers should refrain from connecting oil return piping from oil separators to the suction service valve port. In cases of closed crankcases, the oil may not get into the crankcases quick enough, and the bearings are again subject to damage.

On the larger systems of 3 hp and over, it is quite convenient to the service engineer to install a 1/4" flare angle valve in a tee in the liquid line between the stop or receiver valve and the strainer. This valve provides an easy means of adding or removing refrigerant.

It is often desirable to install a sight glass in the liquid line piped with the larger sizes of copper tube or iron pipe. In the case of copper pipe, a 3/8" sight glass can be installed by drilling two 3/8" holes about 12" apart and in line with the length of the pipe. Next, silver braze two short lengths of 3/8" soft copper tubing, with one end cut on 45° angle and the angle end extending about 1/2"into the two drilled holes. Then flare and bend to install a stock 3/8" flare-connection sight glass. For iron pipe, cut or drill two holes as above, that will receive 1/4" long steel coupling. These should be cut at a 45° angle, as in the case of the tubing, and inserted in the same manner, similar to the method shown in Figure 66F19B.

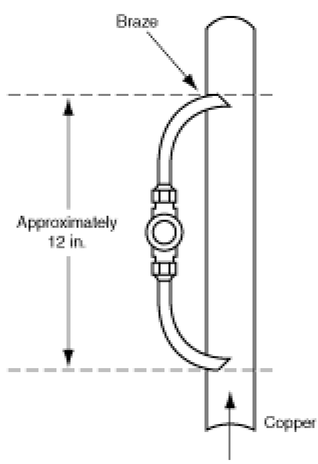


Figure 66F19B Sight glass connections for large copper tube and steel pipe lines.

As the installer, keep in mind that you may be called on the report service or remove some part of the equipment you are installing, so for your own protection, arrange the components in serviceable and work-man-like locations.