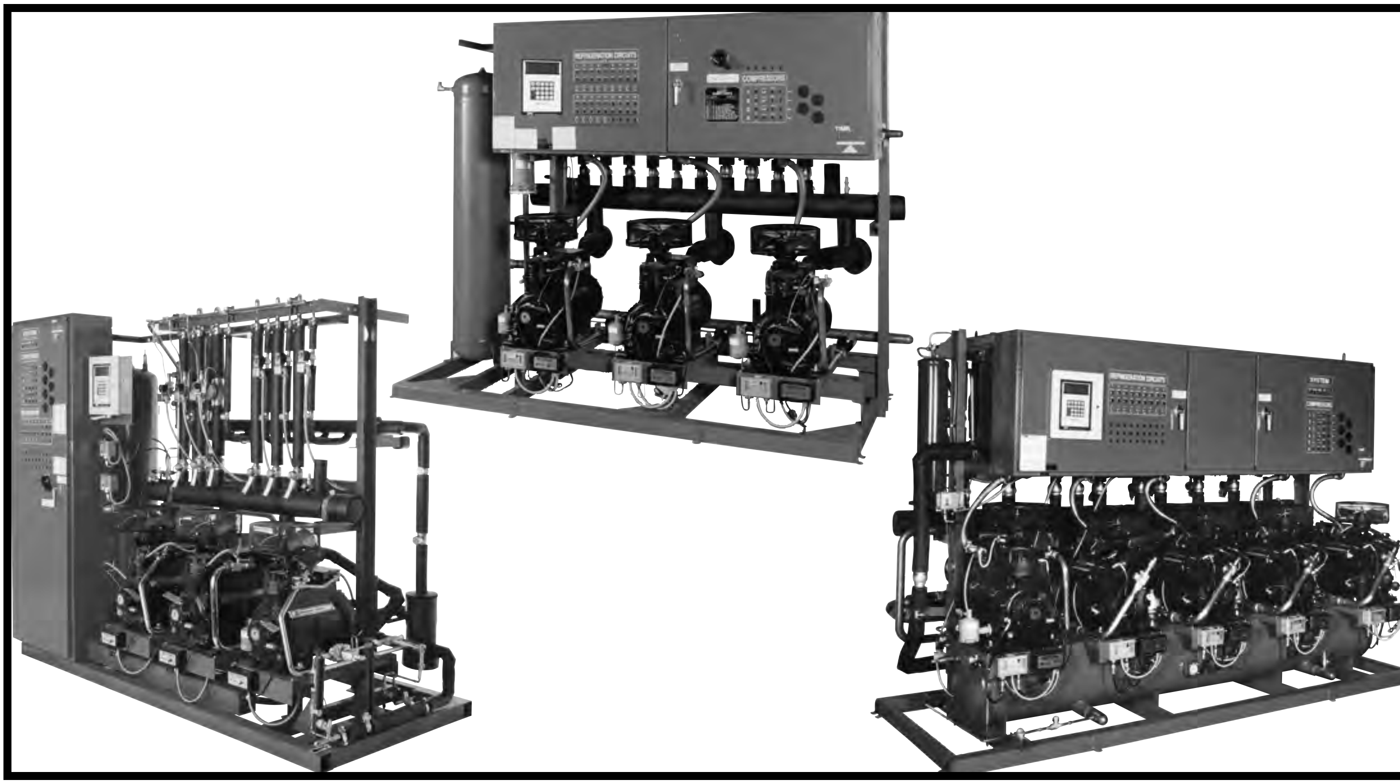
TYLER
REFRIGERATION

Carrier
A United Technologies Company

SYSTEMS

Installation & Service Manual



PARALLEL COMPRESSORS & ENVIROGUARD

PARALLEL COMPRESSOR SYSTEMS that Supply Specific Refrigeration Requirements for Case Line-ups in Stores.

Save these Instructions for Future Reference!!

These refrigerator systems conform to the Commercial Refrigeration Manufacturers Association Health and Sanitation standard CRS-S1-86.

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Tyler Refrigeration, Refrigerated Mechanical Systems * Yuma, Arizona 49120

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SECTION 1

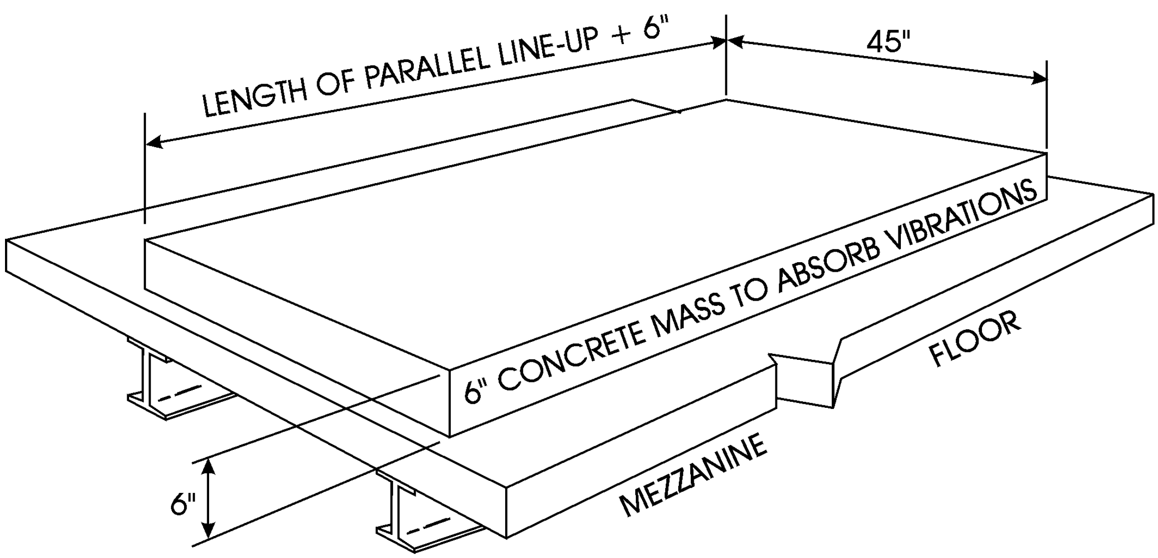
Planning for Mezzanine Machine Rooms

Many compressor rooms today are installed in mezzanine locations. With conventional systems, the units are typically spring mounted and spread over the expanse of the mezzanine area. With parallels, the total weight of the assembly may be as high as 7,900#, all concentrated in 54.3 sq. ft. or less. The industry typically uses solid mount compressor mountings for the purpose of simplifying piping to fixed manifolds. This poses no problem with ground level concrete pads - however, mezzanine construction frequently doesn't consider this. This can result in normal vibrations, harmonics and pulsations being amplified.

NOTE:

It is imperative that the mezzanine floor design provides an adequate mass to keep vibrations, harmonics and pulsations within normal ranges. The floor surface must be smooth and level.

Following These Guidelines:



Maximum Weight of Racks*

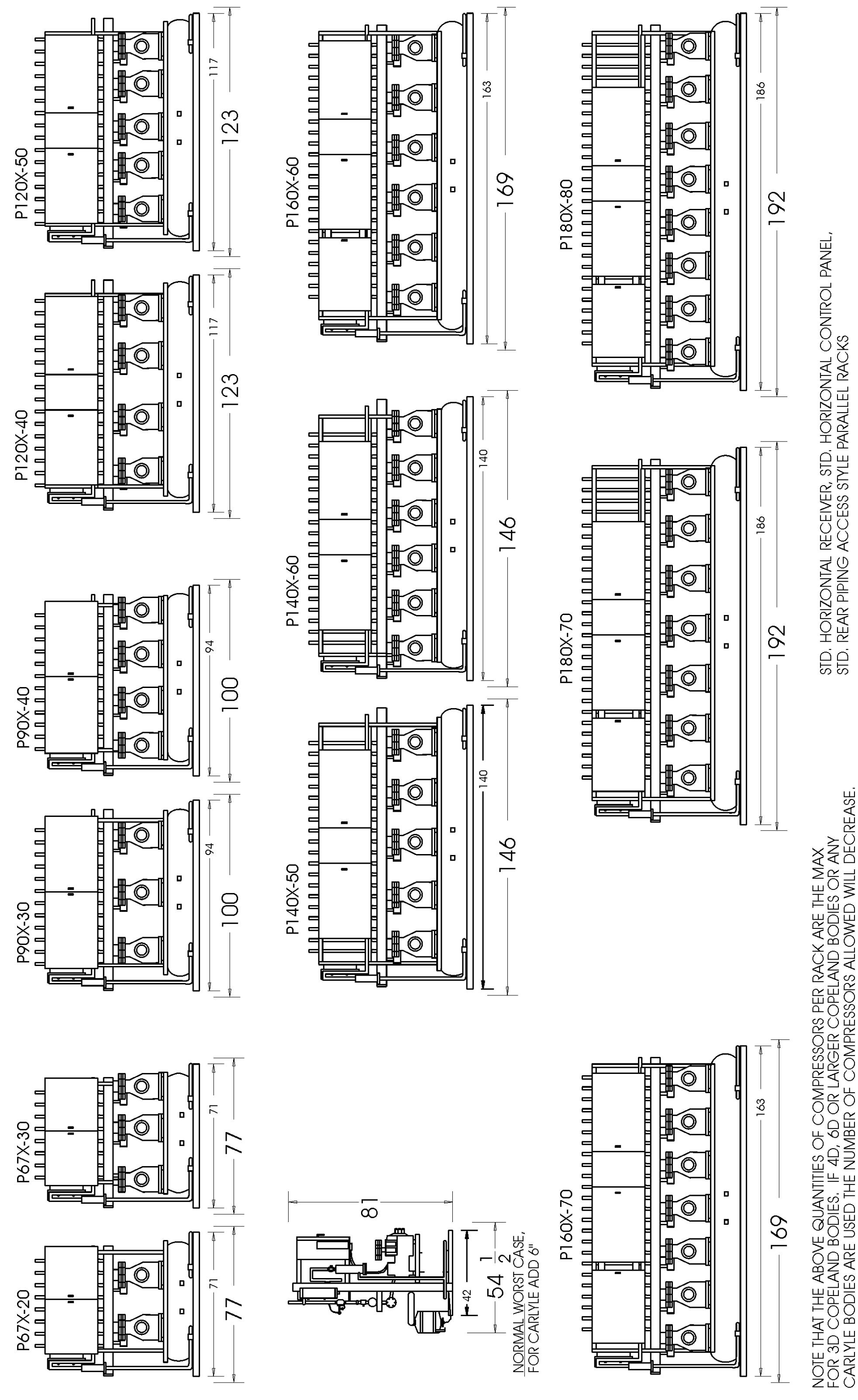
P67	P90	P120	P140	P160	P180
2 or 3 Compr.	3 or 4 Compr.	4 or 5 Compr.	5 or 6 Compr.	6 or 7 Compr.	7 or 8 Compr.
3,800#	4,400#	5,500#	6,100#	7,000#	7,900#
21 sq. ft.	27.5 sq. ft.	34 sq. ft.	41 sq.ft.	47.5 sq. ft.	54.3 sq. ft.

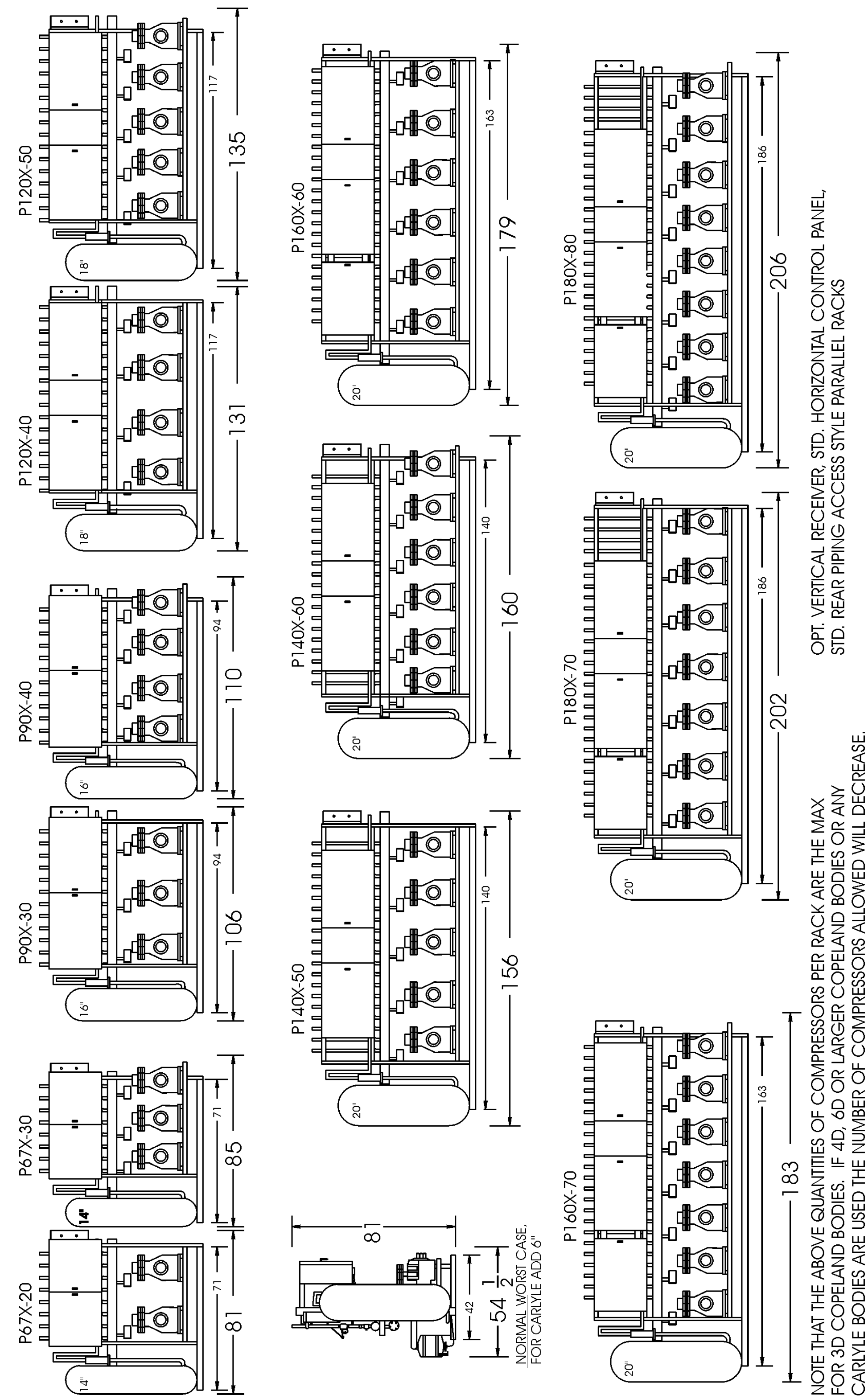
* Consult factory for all custom rack applications.

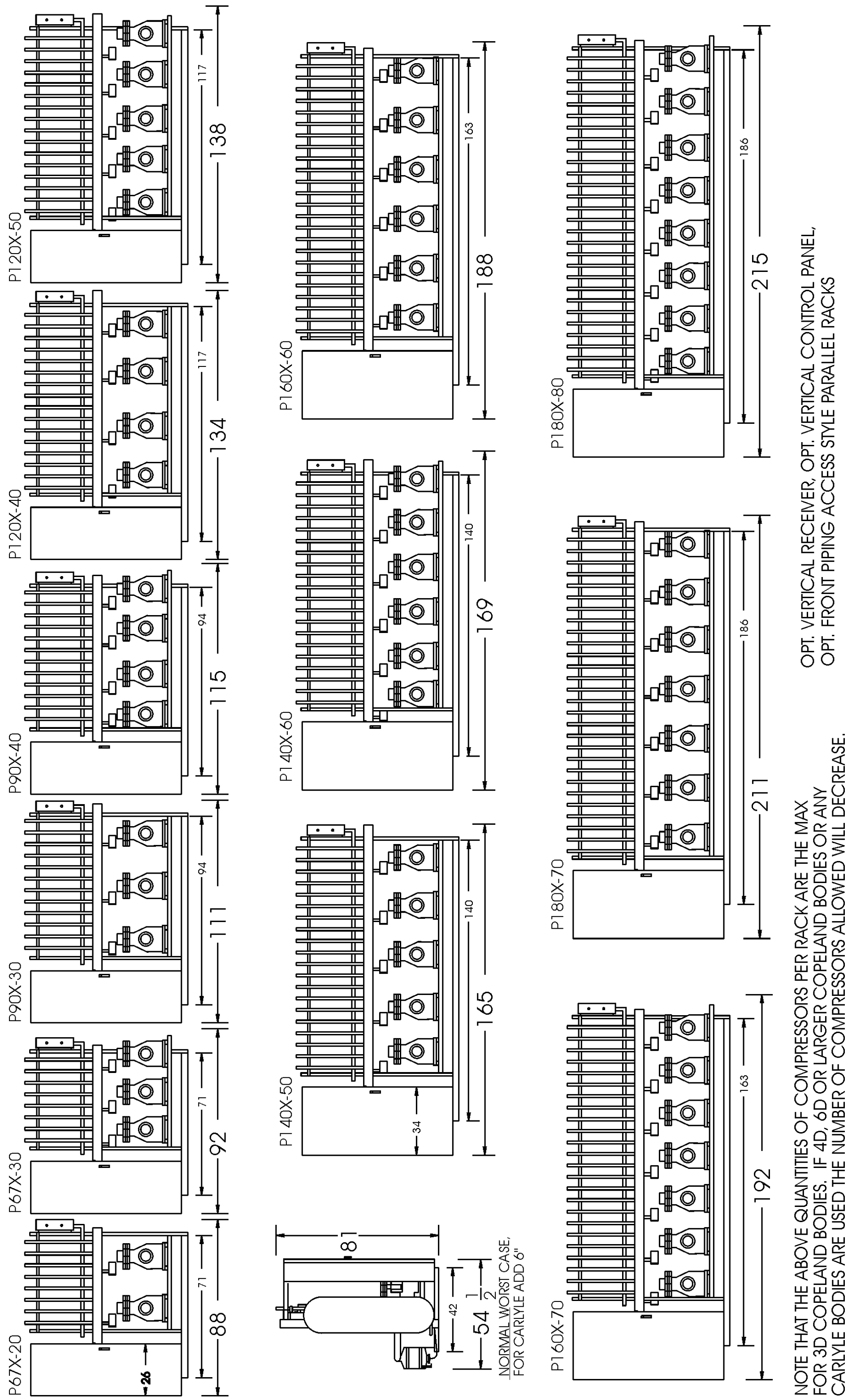
Machine Room Ventilation Requirements:

Remote Air: 100CFM/HP **Water Cooled:** 100 CFM/HP **Air Cooled:** 1,000 CFM/HP

Parallel Compressor Rack Dimensions




P67X-20
81
71
14"
P67X-30
85
71
14"
P90X-30
106
94
16"
P90X-40
110
94
16"
P120X-40
131
117
18"
P120X-50
135
117
18"
81
54 1/2
42
NORMAL WORST CASE, FOR CARLYLE ADD 6"
P140X-50
156
140
20"
P140X-60
160
140
20"
P160X-60
179
163
20"
P160X-70
183
163
20"
P180X-70
202
186
20"
P180X-80
206
186
20"
OPT. VERTICAL RECEIVER, STD. HORIZONTAL CONTROL PANEL,
STD. REAR PIPING ACCESS STYLE PARALLEL RACKS
NOTE THAT THE ABOVE QUANTITIES OF COMPRESSORS PER RACK ARE THE MAX
FOR 3D COPELAND BODIES. IF 4D, 6D OR LARGER COPELAND BODIES OR ANY
CARLYLE BODIES ARE USED THE NUMBER OF COMPRESSORS ALLOWED WILL DECREASE.


P67X-20
26
71
88
P67X-30
71
92
P90X-30
94
111
P90X-40
94
115
P120X-40
117
134
P120X-50
117
138
P140X-50
34
140
165
P140X-60
140
169
P160X-60
163
188
81
42
54 1/2
NORMAL WORST CASE,
FOR CARLYLE ADD 6"
P160X-70
163
192
P180X-70
186
211
P180X-80
186
215
NOTE THAT THE ABOVE QUANTITIES OF COMPRESSORS PER RACK ARE THE MAX
FOR 3D COPELAND BODIES. IF 4D, 6D OR LARGER COPELAND BODIES OR ANY
CARLYLE BODIES ARE USED THE NUMBER OF COMPRESSORS ALLOWED WILL DECREASE.
OPT. VERTICAL RECEIVER, OPT. VERTICAL CONTROL PANEL,
OPT. FRONT PIPING ACCESS STYLE PARALLEL RACKS

Parallel Compressor Rack ISOL Pad Mounting Drawings

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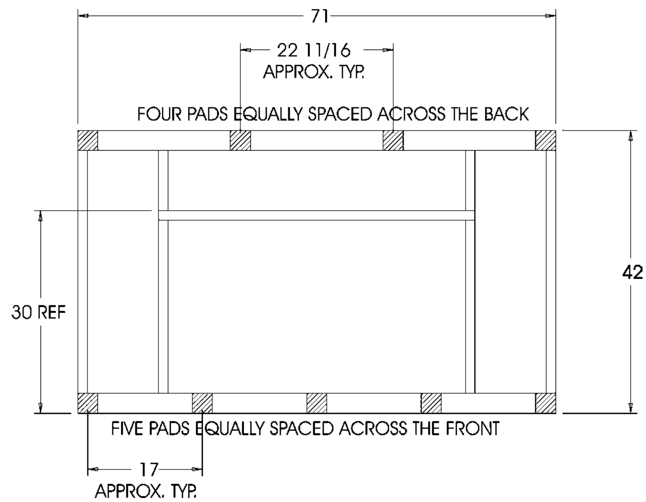

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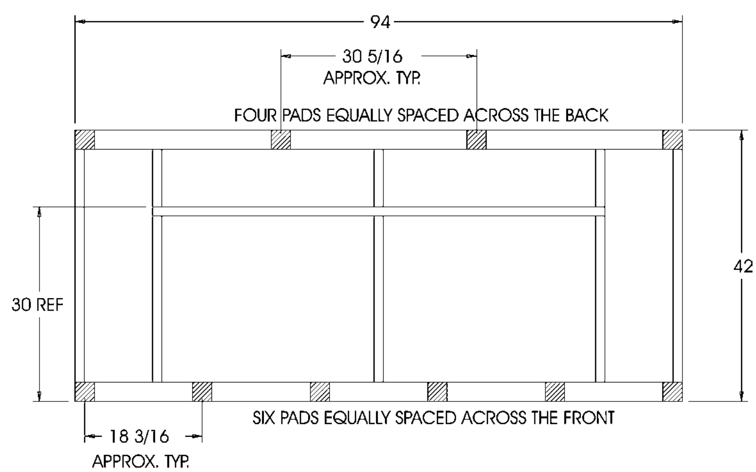

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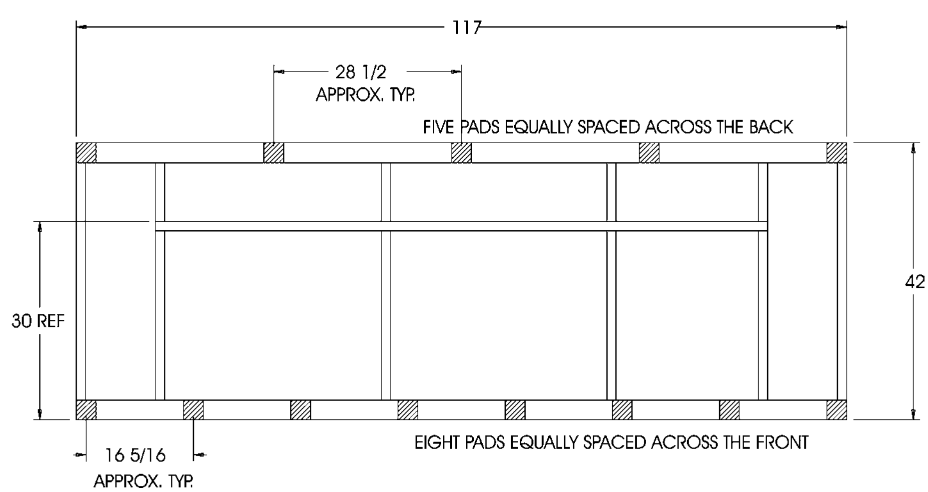

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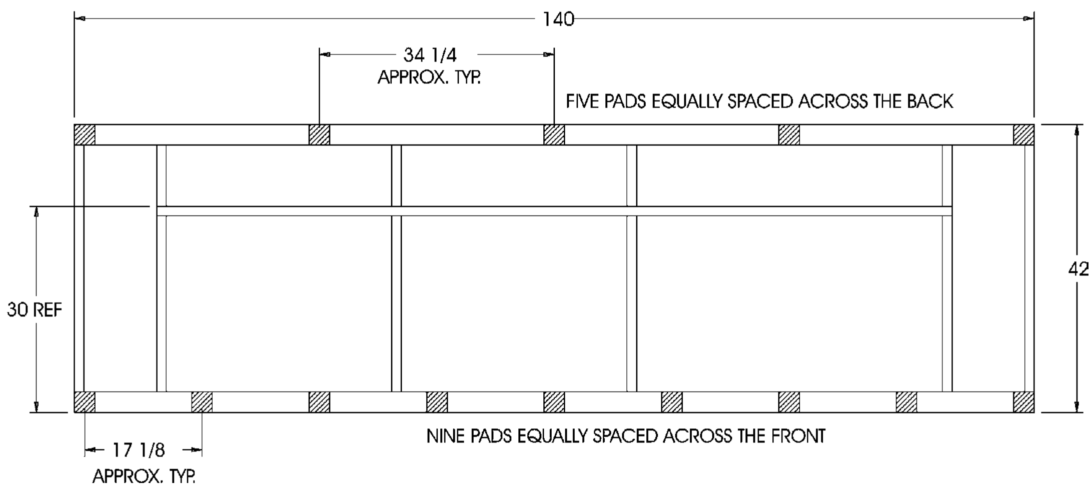

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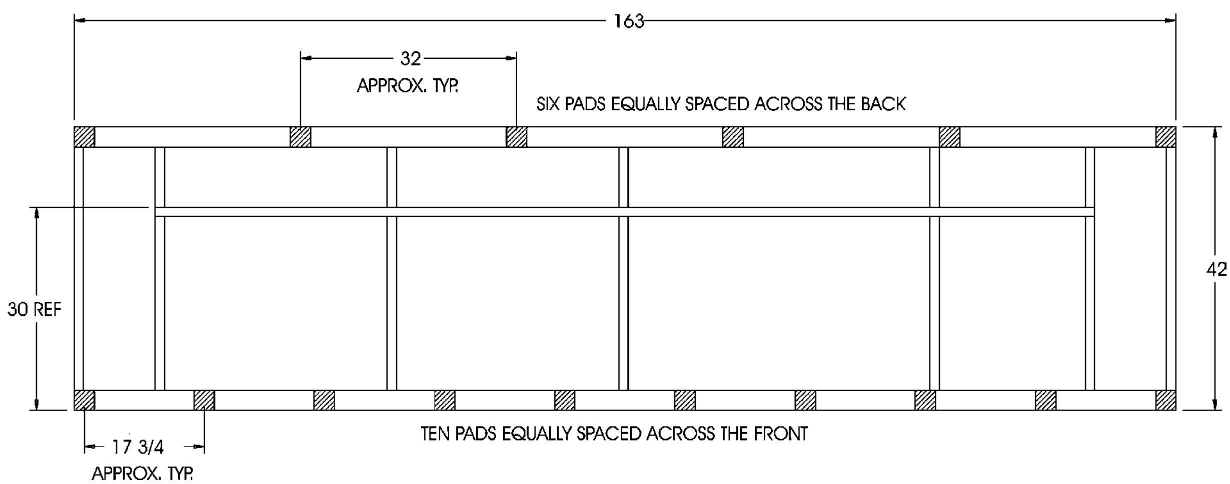

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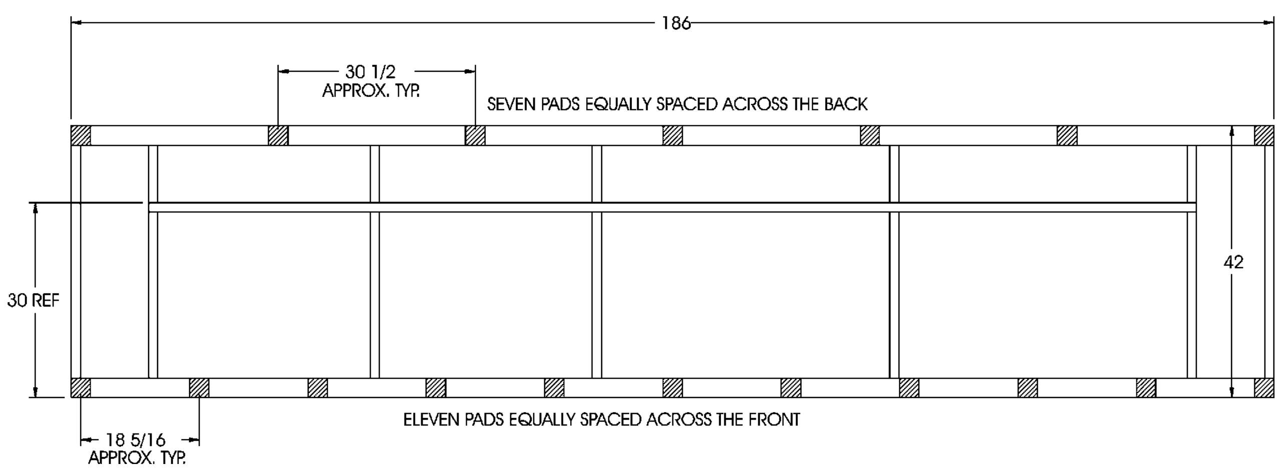

Parallel Compressor Rack ISOL Spring Mounting Drawings

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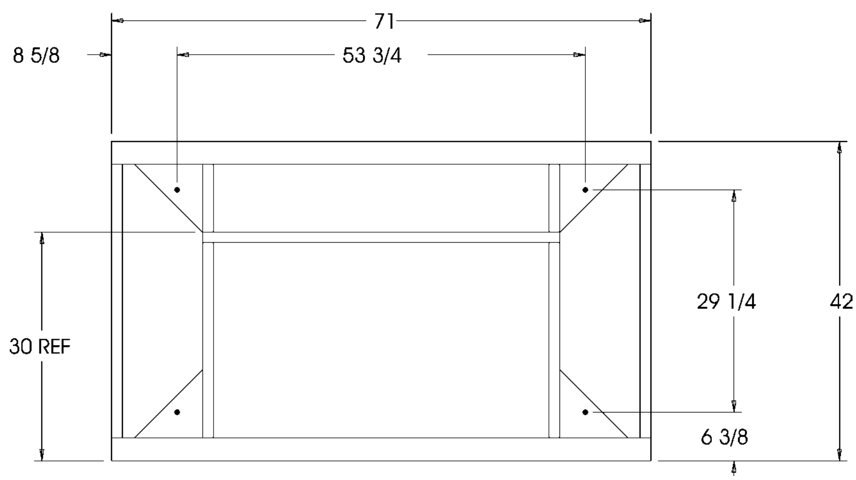

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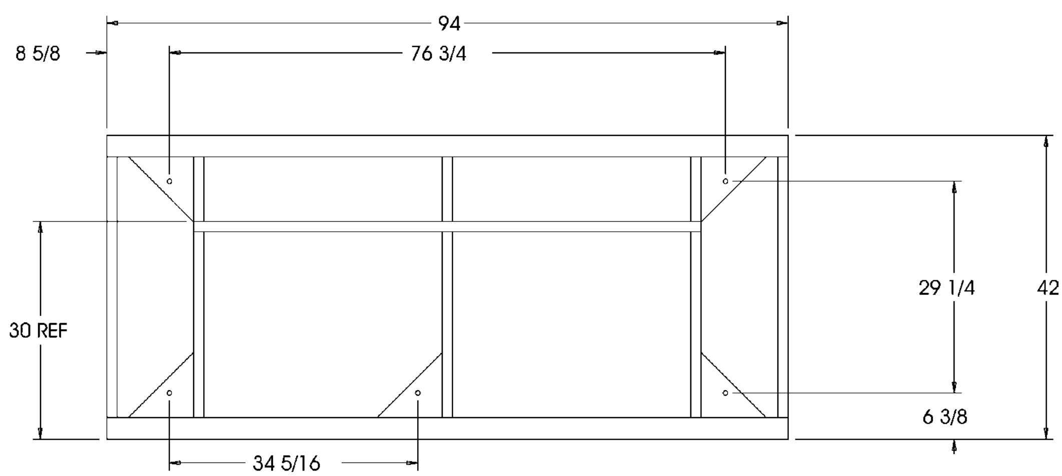

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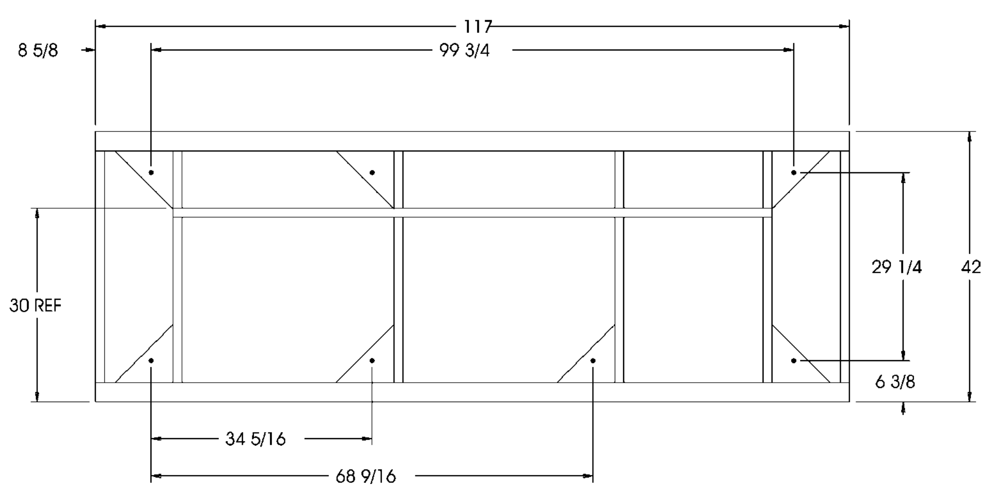

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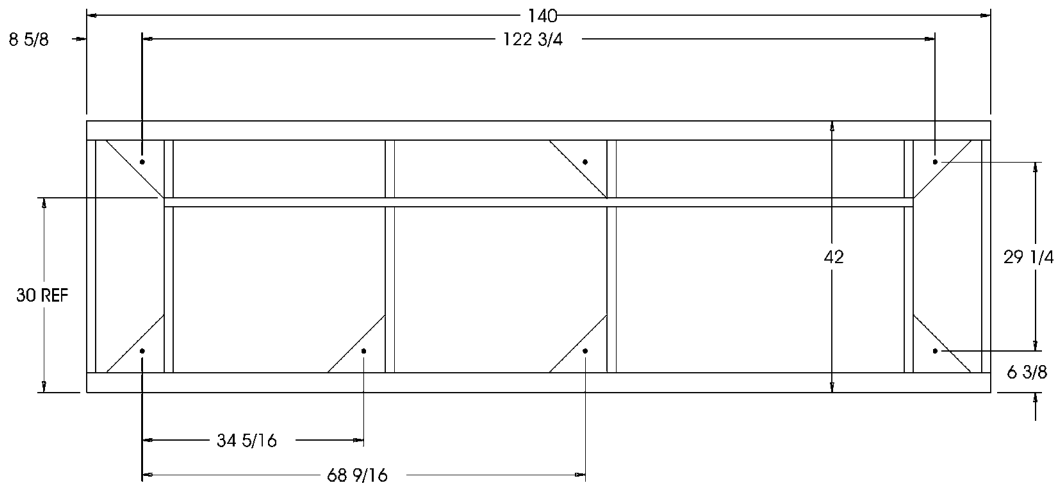

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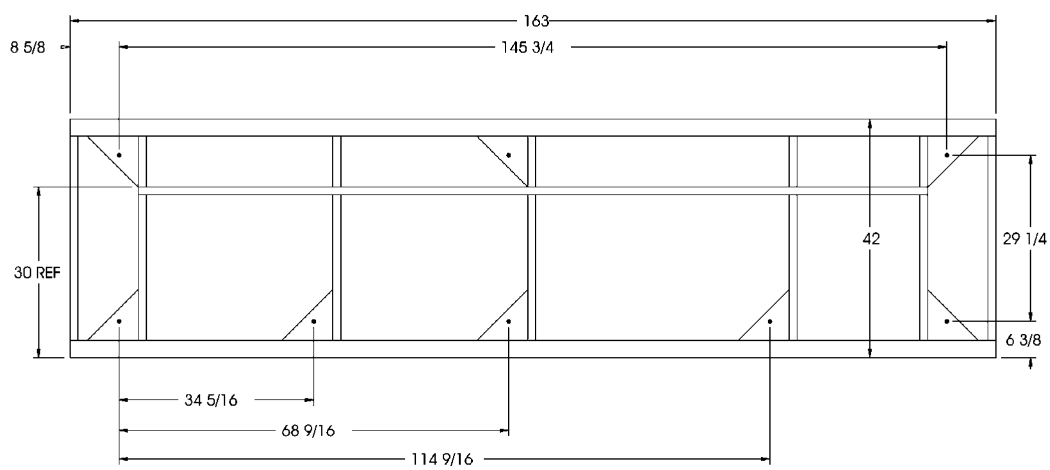

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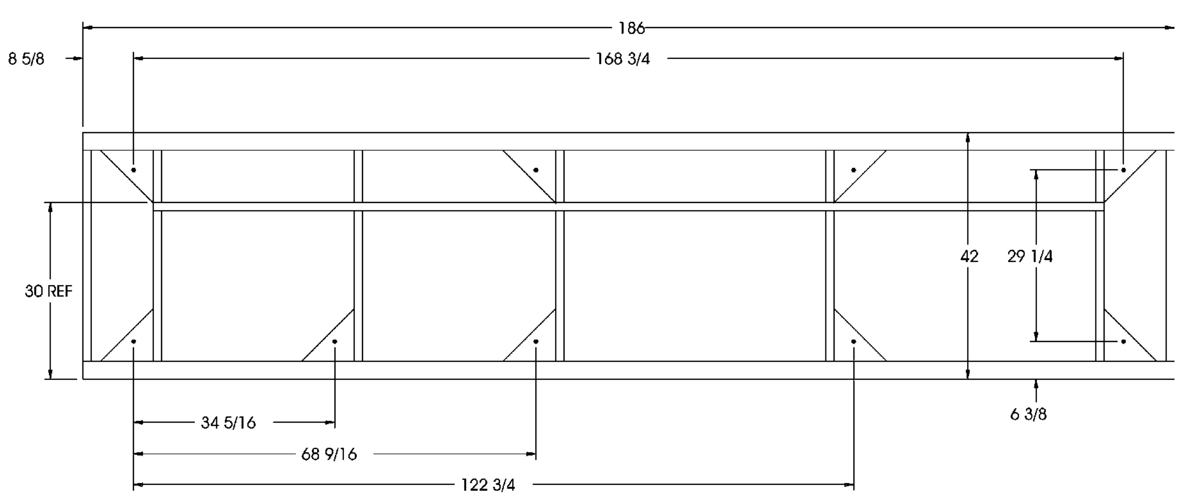

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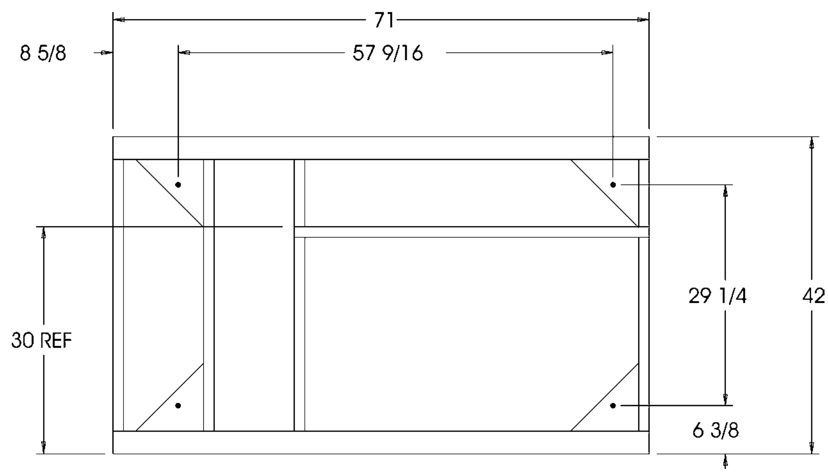
VRP/VFP67



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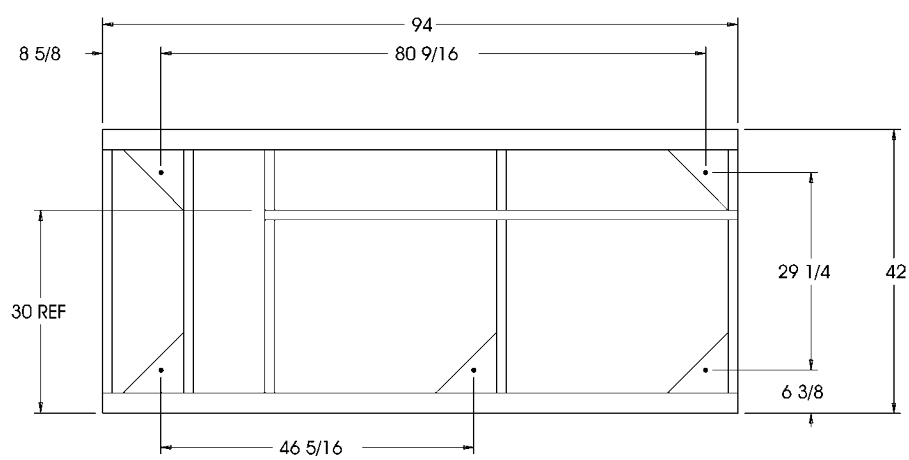

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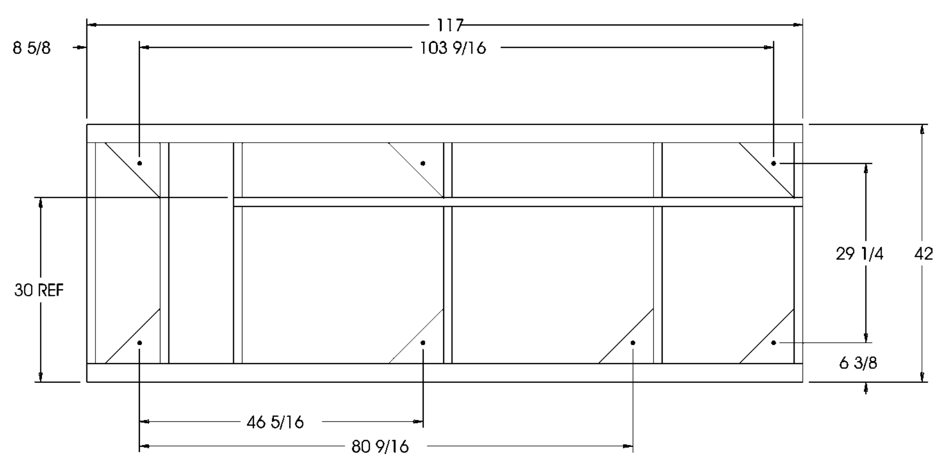

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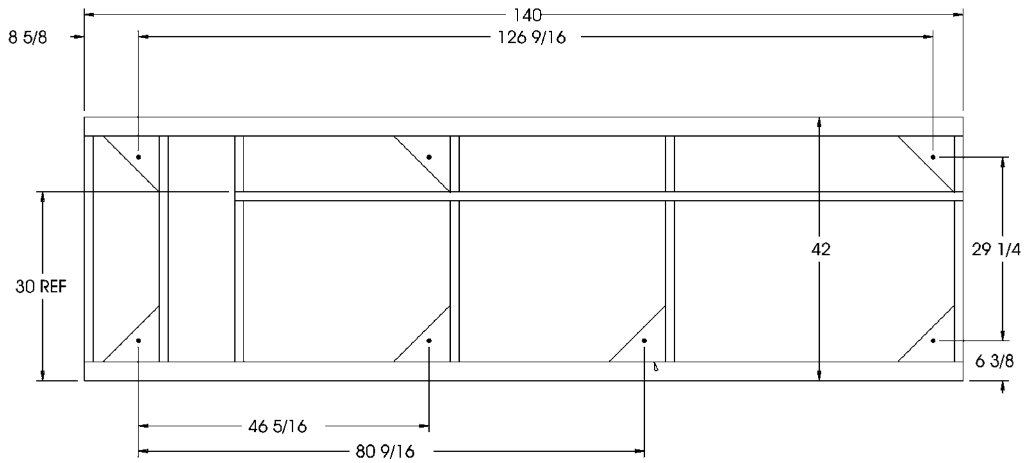

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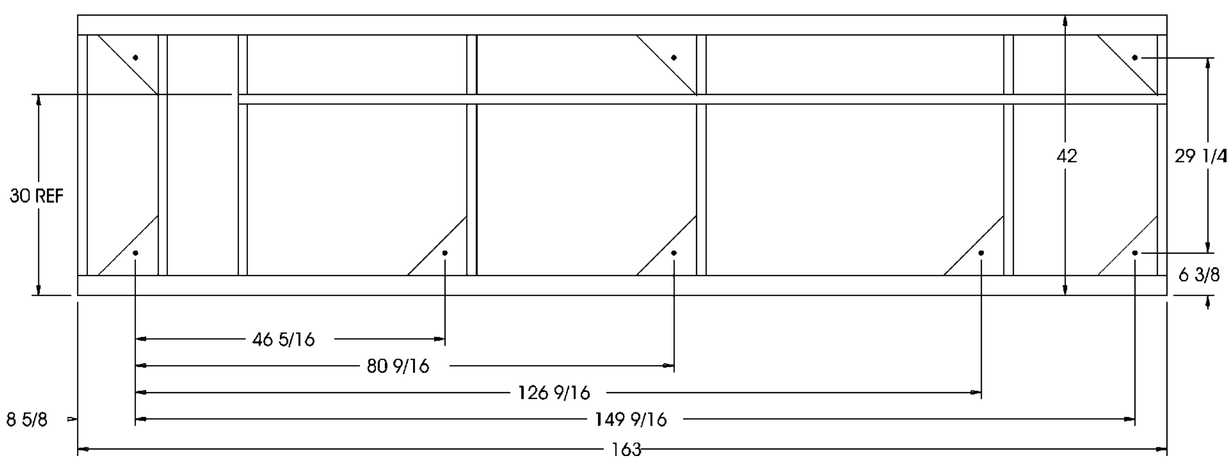

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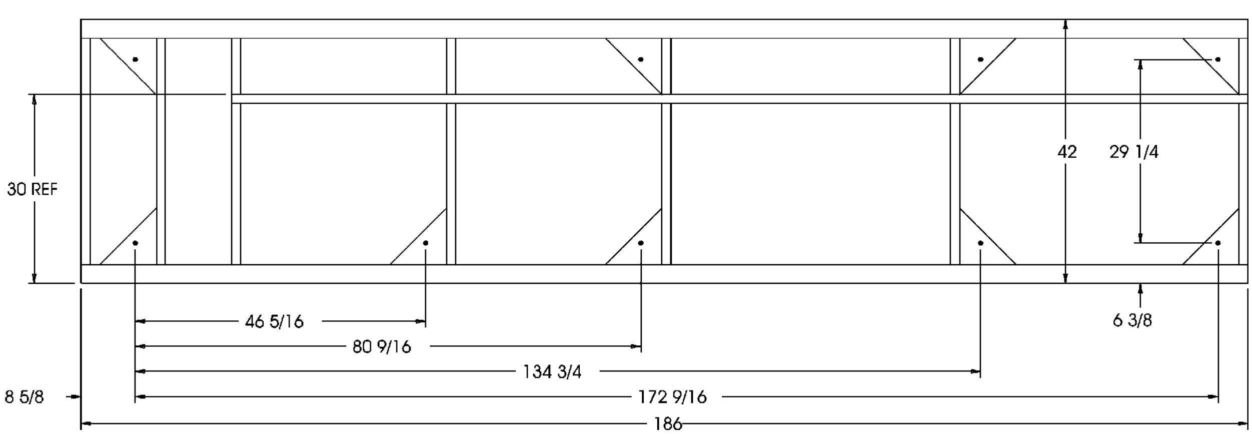


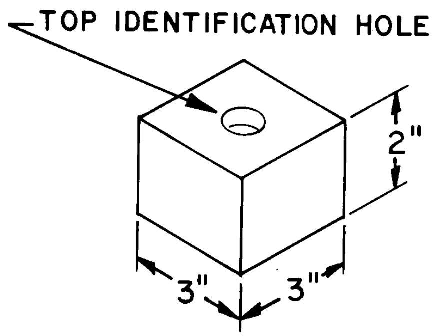
Setting Parallel Racks on Kinetic Absorption Pads

The kinetic absorption pads should be placed in the locations shown. The pads must be installed **PRIOR** to piping installation.

Installation

Install the pads with the identification holes up.

NOTE:
PADS WILL NOT LAST IF THEY ARE NOT PROPERLY INSTALLED!

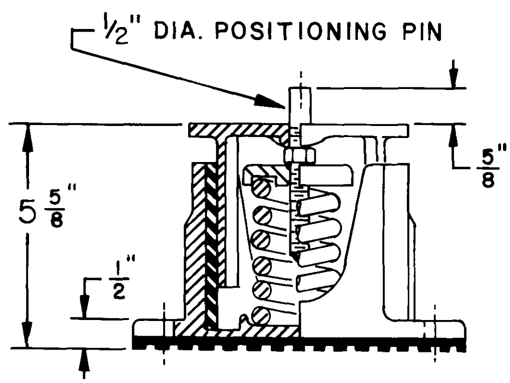


Optional Spring Mounting Pads for Parallel Racks

The optional spring mounts should be placed in the locations shown. The mounts must be installed PRIOR to piping installation.

Spring Installation: Install the spring mounts with the long side of the mount parallel with the rail of the compressor rack.

To Level Equipment: Adjust the height of the spring mountings by rotating the 1/2" adjusting bolt. Check to see that the clearance between the upper & lower spring assemblies is at least 1/4", bu not more than 1/2".



SECTION 2

Refrigeration Piping

Successful Installation of a Refrigeration System is Dependent Upon:

1. Good piping practices - with properly sized and installed lines as directed in this section.
2. Cleanliness of all refrigeration piping is of the utmost importance in the installation procedure.

CAUTION

The use of gaseous nitrogen or carbon dioxide flowing at low pressure through the lines while they are being welded is necessary to assure relative freedom from oxides and scale which can clog the small ports on pilot operated valves and other valves in this system.

Some Possible Consequences of Poor Piping:

- Increase oil requirements.
- Decreased operating efficiency and loss of capacity.
- Increased changes of fouling vital components.
- Failed compressors.

When **NC-2**, **NC-3** or **Enviroguard** is employed, ALL LIQUID LINES to and from the parallel rack (all the way from the compressor rack to the fixtures) **MUST BE INSULATED!** Allowing subcooled liquid to warm in the lines cancels the energy saving advantage of subcooling the liquid and may even cause liquid to “flash”. Flashing occurs when liquid converts to gas before reaching the expansion valve; this will cause erratic valve feed and subsequent loss of refrigeration.

ALL SUCTION LINES MUST BE INSULATED in order to assure cool suction gas to the compressor. Cool gas is necessary to aid in cooling the motor windings. (Head cooling fans help and sometimes are required by the compressor manufacturer).
Compressor motor failure can result if the suction gas from fixtures warms too much on its way to the compressor.

WITH GAS DEFROST, INSULATION ON THE SUCTION LINE helps maintain the temperature of the hot gas flowing to the cases during defrost.

Insulation on suction and liquid lines helps make the whole system more efficient.

Insulate - It pays!

The purpose of this section is to stress some of the more important aspects of piping, and areas in which difficulties are most likely to occur. This information is general, and cannot allow for all possible factors in a given installation which can accumulate to make it less than acceptable. Page 3-9 on pressure drop emphasizes the importance of properly designing the piping system.

Materials

Use only clean, dry sealed refrigeration grade copper tubing. Make copper to copper joints with phos-copper alloy or equal (15% min. silver content). Make joints of dissimilar metals of 45% silver solder. To prevent contamination of the line internally, limit the soldering paste or flux to the minimum required. Flux only the male portion of the connection, never the female.

CAUTION

- **Piping should be purged with dry nitrogen or carbon dioxide during the brazing process. This will prevent formation of copper oxide and scale inside the piping which can easily clog the small ports on pilot operated and other valves in the system.**
- **Pressure regulators and flow meter must be used with nitrogen or carbon dioxide.**

Service Valves

Field installed ball type service valves ARE RECOMMENDED TO FACILITATE SERVICING between the machine rack, the remote condenser, and the heat recovery coil.

NOTE

Use long radius elbows rather than short radius elbows. Less pressure drop and greater strength make the long elbows better for the system. This is particularly important on discharge hot gas lines for strength, and suction lines for reduced pressure drop. Avoid using 45 degree elbows.

Vibration Isolation & Piping Support

Piping must be properly supported to minimize line vibration. Vibration is transmitted to the piping by movement of the compressor and pressure pulsation's of the refrigerant as it is pushed through the piping.

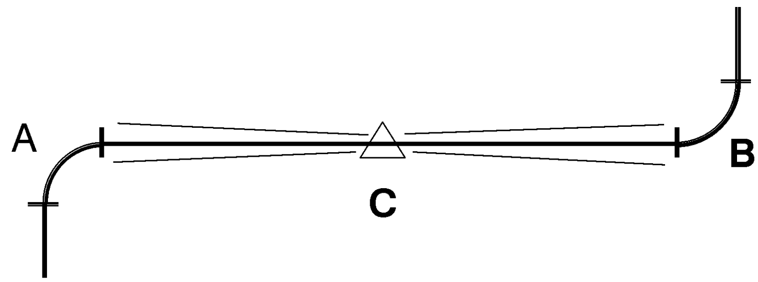
NOTE

Installer must follow applicable mechanical codes for pipe support and hanger installations.

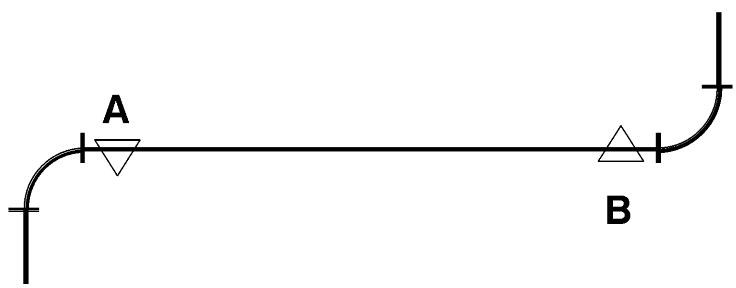
Insufficient and improper supporting of tubing can cause excessive line vibration resulting in:

- Excessive noise.
- Noise transmission to other parts of the building.
- Vibration transmission of floors, walls, etc.
- Vibration transmission back to compressor and other attached components.
- Decreased life of all attached components.
- Line breakage.

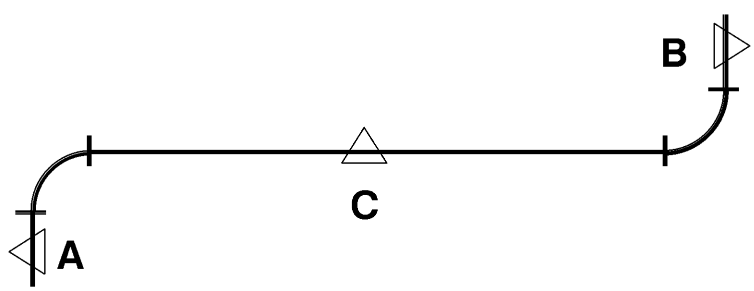
Guidelines for Good Piping



NOT GOOD:
Tubing will vibrate or rotate about point 'C'

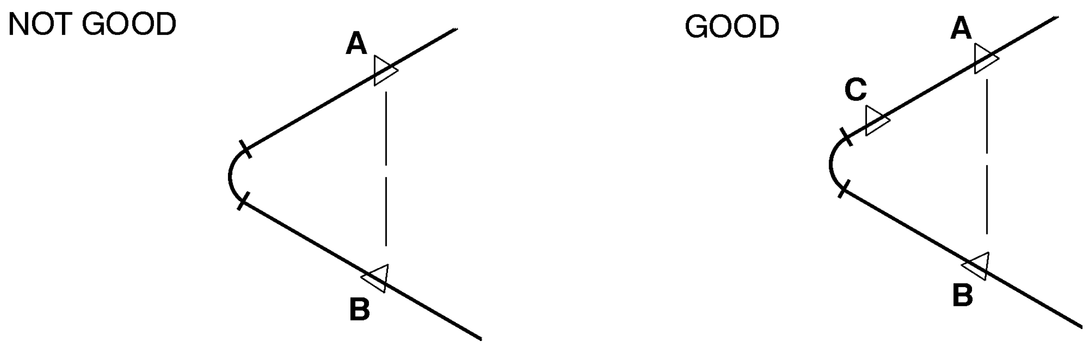


GOOD:
Long runs will require additional supports between 'A' and 'B'



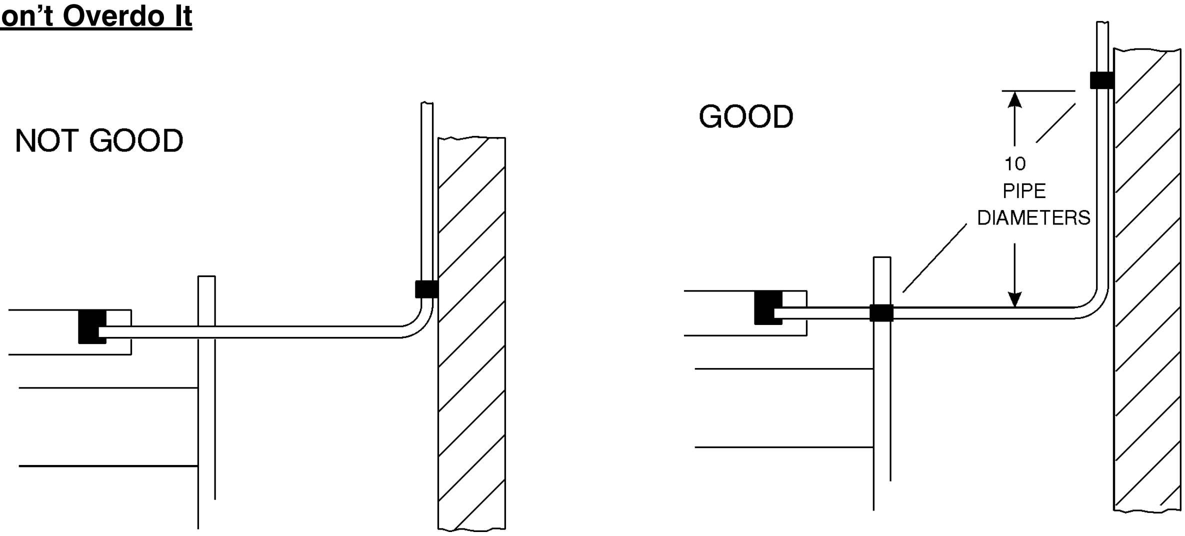
GOOD:
Support at 'C' may not be necessary for very short runs

1. A STRAIGHT RUN OF PIPING, must be supported at each end. Longer runs will require additional supports along the length; usually these are not more than 8' internals, depending on tubing size and situation. Clamps should be properly anchored and rubber grommets installed between the piping and clamp (Hydra-zorbs or equivalent) to prevent line chafing.



2. CORNERS MUST BE SUPPORTED and cannot be left free to pivot around the A-B axis as shown above.

Don't Overdo It



3. DON'T OVER SUPPORT PIPING when it is attached to the compressor rack. It must be free to float without stress.

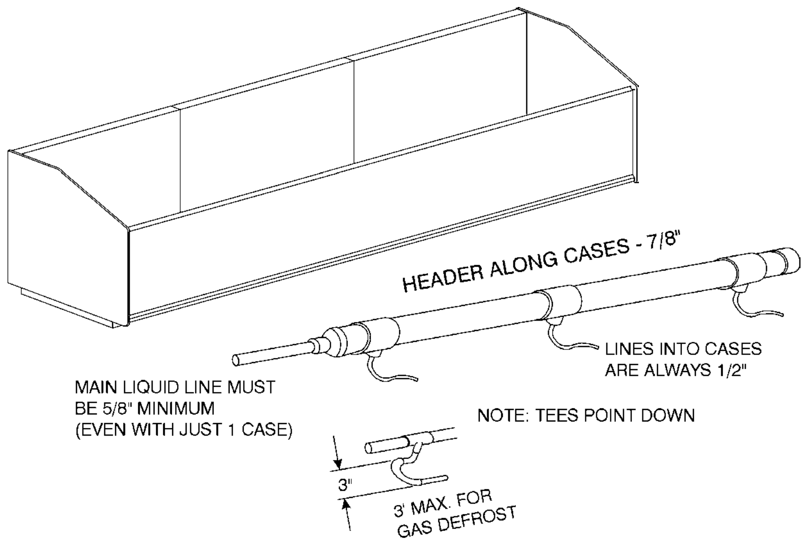
4. DON'T USE SHORT RADIUS ELBOWS: They can add excessive internal stress and pressure drops which can lead to failure.

5. CHECK ALL PIPING AFTER THE SYSTEM HAS BEEN PLACED IN OPERATION: Excessive vibration must be corrected as soon as possible. Extra supports are cheap when compared to the potential refrigerant loss caused from failed piping.

PROPER LINE SIZING IS THE RESPONSIBILITY OF THE INSTALLING CONTRACTOR! Application Department recommendations are listed on the System Summary Sheet furnished (if required) with the job. Also, refer to the line sizing charts in these instructions. *Horizontal suction lines should slope 1/2" per 10 foot of run toward the compressor to aid in good oil return!*

Gas Defrost Liquid Lines

Branch Lines



Liquid lines to the cases should be branched off the bottom of the header. This ensures a full column of liquid to the expansion valve. A branch line from the header to an individual case should not be over 3' long and must have 3" expansion loop incorporated.

Don't Cross Pipe Systems

Do not run suction or liquid lines through cases that are part of a separate system, especially if either has gas defrost.

NOTE

If there is no way to avoid this, insulate the piping for the portion that runs through the other cases.

Allow for Expansion

The temperature variations of refrigeration and defrost cycles cause piping to expand and contract. The expansion of piping must be taken into consideration, otherwise a piping failure will result. The following are typical expansion rates for copper tubing:

-40°F to -100°F = 2.5" per 100 feet of run (ultra low temp)

0°F to -40°F = 2" per 100 feet of run (low temp)

0°F to +40°F = 1.5" per 100 feet of run (medium temp)

+30°F to +50°F = 1" per 100 feet of run (high temp)

Expansion loops are designed to provide a definate amount of travel. Placing the loop in the middle of a piping run will allow for maximum pipe expansion with the minimal amount of stress on the loop. Don't us 45 degree elbows for loop construction because they will not allow the lines to flex. Refer to the charts on the next page for expansion loop lengths. Suction and liquid lines cannot be joined together of be allowed to touch. Pipe hangers must not restrict the expansion and contraction of piping. ***Insulation on suction and liquid lines makes the whole system more efficient! Insulate - It Pays!***

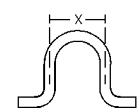
Expansion Loop Sizing

Chart #1 is to be used for A, B, and C type loops.

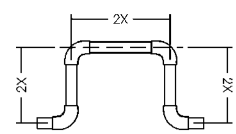
Chart #2 gives the total length of the expansion joint (L) along the outside surface.

Example: Given a 200 foot run of 1-3/8” medium temp piping; there will be a linear expansion of 3” to compensate for (medium temp 1-1/2” per 100 ft.). Pipe diameter has no affect on the amount of linear expansion but is needed for determining the size of the expansion loop. Find the 3” column at the top of Chart #1 and go down until it crosses the 1-3/8” row. The “X” dimension is 24”. If using type A loop it will be 24”, 48” for type B, and 72” for type C.

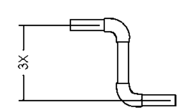
TUBE O.D.	‘X’ LENGTH - (in inches) FOR LINEAR EXPANSION									
	1/2”	1”	1-1/2”	2”	2-1/2”	3”	4”	5”	6”	7”
7/8”	8”	11”	13”	15”	17”	19”	22”	24”	27”	29”
1-1/8”	9”	12”	15”	17”	20”	21”	25”	28”	30”	33”
1-3/8”	10”	14”	17”	19”	22”	24”	27”	31”	34”	36”
1-5/8”	10”	15”	18”	21”	24”	26”	30”	33”	37”	39”
2-1/8”	12”	17”	21”	24”	27”	30”	34”	38”	42”	45”
2-5/8”	13”	19”	23”	27”	30”	33”	38”	42”	46”	50”
3-1/8”	15”	21”	25”	29”	33”	36”	41”	46”	51”	55”
4-1/8”	17”	24”	29”	34”	38”	41”	48”	53”	58”	63”
5-1/8”	19”	26”	32”	37”	42”	46”	53”	59”	65”	71”
6-1/8”	20”	29”	35”	41”	46”	50”	58”	65”	71”	77”



TYPE "A" LOOP

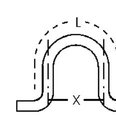


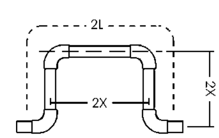
TYPE "B" LOOP

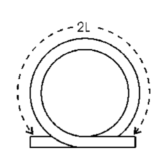


TYPE "C" LOOP

TUBE O.D.	‘L’ DEVELOPED LENGTH OF EXPANSION OFFSETS									
	1/2”	1”	1-1/2”	2”	2-1/2”	3”	4”	5”	6”	7”
7/8”	24”	34”	42”	49”	54”	60”	69”	77”	84”	91”
1-1/8”	28”	39”	48”	55”	62”	68”	78”	87”	96”	104”
1-3/8”	30”	43”	53”	61”	68“	75”	86”	97”	106”	114”
1-5/8”	33”	47”	58”	66”	74”	81”	94”	105”	115”	124”
2-1/8”	38”	54”	66”	76”	85”	93”	108”	120”	132”	142”
2-5/8”	42”	60”	73”	85”	95”	104”	120”	134”	147”	158”
3-1/8”	46”	65”	80”	92”	103”	113”	131”	146”	160”	173”
4-1/8”	53”	75”	92”	106”	119”	130”	150”	168”	184”	198”
5-1/8”	59”	84”	102”	118”	132”	147”	167”	187”	205”	224”
6-1/8”	65”	91”	112”	129”	145”	158”	183”	204”	224”	242”







SECTION 3

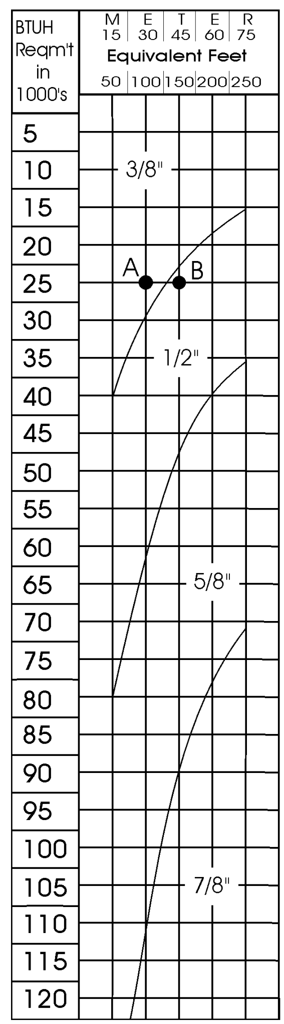
Using Line Sizing Charts

Basis

These line sizing charts are based on a suction pressure drop equivalent to 2°F change in saturation pressure and liquid line pressure drop of 5 psi. For R404A Low Temperature 1 psi; for R404A and R-22 Medium Temperature 2 psi is used. This is the maximum allowable pressure drop for the entire piping run regardless if it is 50’ or 250’. The advantage of the graphic representation of this information is to show just how close to full capacity a particular selection is. This is true for both the condensing unit capacities on the individual specification sheets or the separate suction line sizing charts. When the suction line graphs are arranged according to temperature, the relationship of temperature and line size become readily apparent. The lower the temperature, the larger the line required for the same heat load.

Equivalent Feet

Notice the phase “Equivalent Feet” (applies to meters as well). Fittings added to a refrigerant line induce an added pressure drop in the line. The added pressure drop is accounted for by adding extra length (see chart on page 3-6) to the piping run which will equal the same pressure drop produced by the fittings. In order to determine the equivalent footage, add the actual length of the piping run and the equivalent footage assigned for each particular fitting. Plot the intersection of the horizontal BTUH line with the vertical equivalent footage line. The area in which the plotted point falls is the recommended line size.



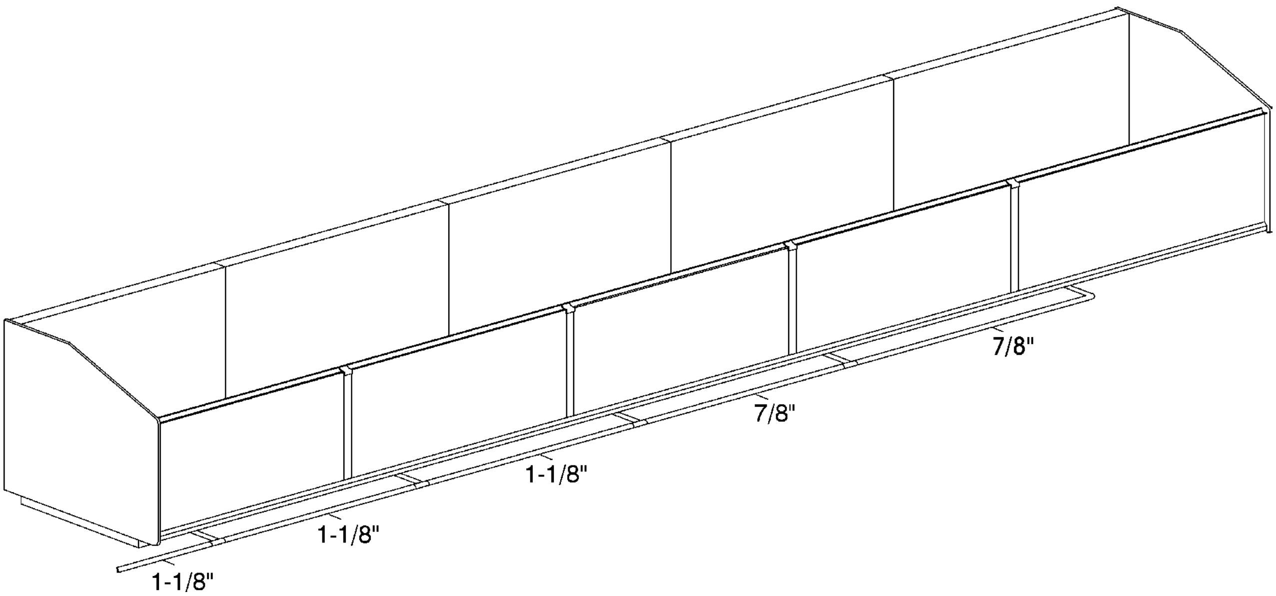
Liquid Line Sizing

Due to the lack of space, the case specific specification sheets do not show liquid or suction line sizing charts. They refer to a line sizing “BUFF” section in the back of the Specification Guide. Within this section, liquid and suction line sizing is explained. Liquid line sizing is based on a 5 pound pressure drop for the entire piping run, from 50’ to 250’.

Example: A 25,000 BTUH load will require a 3/8” line for 100 equivalent feet (Point A). At 150 equivalent feet, a 1/2” line would be required for the same load (Point B). *See chart shown on this page.*

Sizing Liquid & Suction Sub-Feed Lines Properly

Liquid & suction line lengths over 300 equivalent feet are discouraged by TYLER.
Contact Applications Engineering for recommendations exceeding 300 Equivalent Feet!



CASE-TO-CASE SUCTION LINE SUB-FEED BRANCH LINE SIZING													
FT	6	8	12	16	20	24	28	32	36	40	44	48	52	56
R404A	1/2”	7/8”	7/8”	7/8”	7/8”	1-1/8”	1-1/8”	1-1/8”	1-1/8”	1-1/8”	1-1/8”	1-1/8”	1-1/8”	1-1/8”

Suction Line Sizing

The line sizing charts on each specification sheet can be used to size the subfeed branch lines. When the line serves one case, select the size for that case length (6’, 8’ or 12’). This may be as small as 1/2” (example: service meat cases), or as large as 1-3/8” (example: multi-shelf ice cream cases). Select each succeeding step on the basis of the number of feet of case being served by that portion of the suction line.

Liquid Line Sizing

Use the Liquid Line size chart on page 3-5 to determine the appropriate size in the same manner as for suction lines.

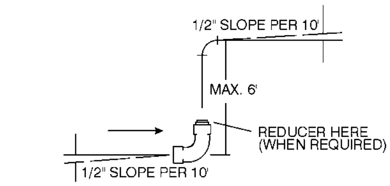
> **Exception** - In the case of gas defrost, follow the special instructions on page 2-5 making and sizing a liquid line manifold at the case.

NOTE

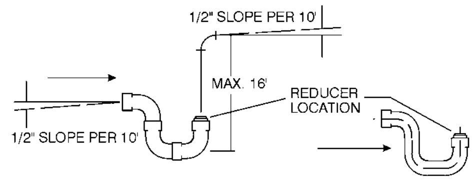
Low temp suction lines and all liquid lines must be insulated in all Nature’s Cooling and Enviroguard applications! Horizontal suction lines should slope 1/2” per 10’ toward the compressor to aid in good oil return.

Suction Line Riser Recommendations

1. Riser which can be installed without a trap.

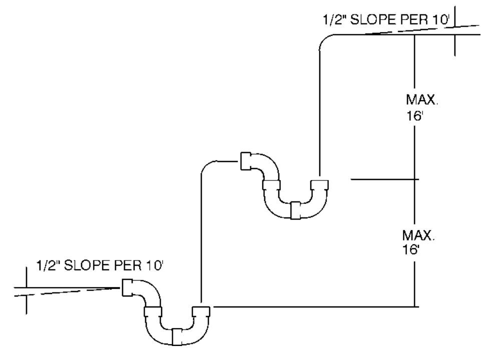


Suction line sizing is based on a design pressure drop which relates to the velocity of the gases moving through the line. Acceptable velocities for horizontal suction lines (with proper 1/2" slope per 10' run) range from 500' to more than 1,500' per minute. A properly sized line at the low range of its capacity will have a low velocity and one at full capacity will have velocities exceeding 1,500 fpm. A specified minimum velocity is required to keep oil moving along with the gas when the pipe is vertical. The charts on the next page show the size selection which will assure oil return ip a riser. This size may be the same as the horizontal suction line selection or it may be one size smaller. If the selection point on the chart is close to the dividing line between sizes, use the smaller size. The reducer fitting must be placed after the elbow. Long elbows can be used to make the trap or a P-trap can be used. **Do not use short elbows.**



2. Risers which require a P-trap.

Low Temp systems must be designed knowing that oil is more difficult to move as the temperature is lowered. The refrigerant gas also has a lower capacity to mix with the oil. A trap will allow oil to accumulate, reducing the cross section of the pipe and thereby increase the velocity of the gas. This increased velocity picks up the oil. The velocity chart is to be used to determine if the horizontal line size has sufficient velocity in the vertical position to carry the oil along. Generally, the riser will have to be reduced one size.



3. Riser requiring use of two traps

The use of two traps is necessary on long risers for the collection of oil during an off cycle. One trap would not be large enough to contain all of the oil coating a riser over 16', and could result in an oil slug delivered to the compressor system.

Supporting lines: Properly supporting the lines suspended from a wall or ceiling is very important. Line supports should isolate the line from contact with metal. When gas defrost is used, consideration should be given to rolling or sliding supports which allow free expansion and contraction. These supports would be used in conjunction with expansion loops described on page 2-6.

MAXIMUM RECOMMENDED SPACING BETWEEN SUPPORTS FOR COPPER TUBING			
Line Size / O.D In.	Max. Span / Ft.	Line Size / O.D. In.	Max. Span / Ft.
5/8	5	3-3/8	12
1-1/8	7	3-5/8	13
1-5/8	9	4-1/8	14
2-1/8	10	- - -	- - -

Vertical Riser Suction Line Size Charts

Proper line sizing is very important. When sizing for a suction line riser, use the proper chart. These charts are based on maintaining minimum velocities in the risers. This will assure that the oil mixed with the refrigerant will return to the compressor. Improper line sizing could cause less than optimum performance or pose the possibility of compressor damage due to oil failure.

NOTE

The line sizing information shown on each case Specification Sheet applies to horizontal runs only. DO NOT use this information for vertical runs. The liquid line sizing charts shown in the "BUFF" section of the Specification Guide, can be used for both horizontal and vertical runs. ***(When in doubt about oil return, due to a point being near a line, use the smaller size line.)***

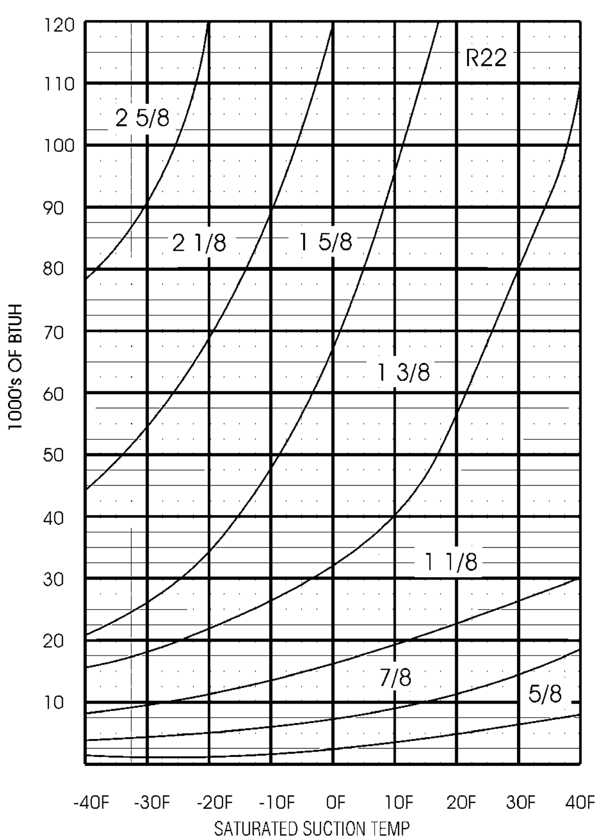
Any sizing of riser or any other suction line, or device, must be considered in view of the total system. The addition of any suction line pressure drop must not be ignored.

If suction P-traps are used, it is recommended that they be sized according to the horizontal line sizing chart.

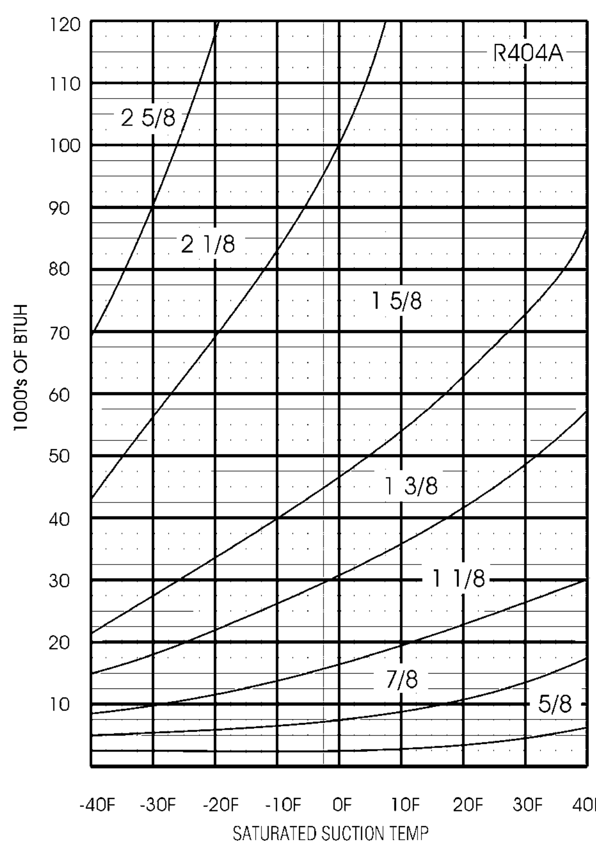
CAUTION

Do not arbitrarily reduce vertical risers without consulting these charts. Unnecessary vertical suction line reduction can cause excessive pressure drop, resulting in loss of system capacity.

R-22 Refrigerant



R404A Refrigerant



Line Sizing Guidelines

Minimum Horizontal Suction Velocity = one half of Minimum Riser Velocity

Maximum Pressure Drop

Medium Temp Application *Low Temp Application*

R-22 = 2.21 R404A = 2.46 R-22 = 1.15 R404A = 1.33

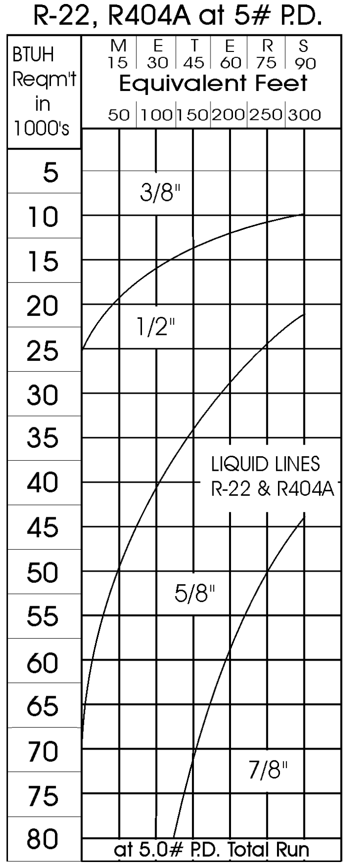
MINIMUM RISER VELOCITY				
	R-22 MT	R-22 LT	R404A MT	R404A LT
1/2”	560	850	440	660
5/8”	630	950	490	740
7/8”	750	1,130	590	890
1-1/8”	860	1,300	670	1,010
1-3/8”	960	1,440	750	1,120
1-5/8”	1,040	1,570	810	1,230
2-1/8”	1,200	1,810	930	1,410
2-5/8”	1,330	2,010	1,040	1,570

MINIMUM HORIZONTAL SUCTION VELOCITY				
	R-22 MT	R-22 LT	R404A MT	R404A LT
1/2”	280	425	220	330
5/8”	315	475	245	370
7/8”	375	565	295	445
1-1/8”	430	650	335	505
1-3/8”	480	720	375	560
1-5/8”	520	785	405	615
2-1/8”	600	905	465	705
2-5/8”	665	1,005	520	785

NOTE: Use R404A information for R-502 & R-507 refrigerants.

R-22 & R404A Liquid Line Sizing Chart

R-22, R404A at 5# P.D.



Using Suction Line Sizing Charts Correctly

Suction Line Sizing Charts

The Suction Line Sizing charts include R404A and R-22 suction temperatures, and lengths to 300 equivalent feet.* These charts are based on DuPont data and extensive field experience. The advantage of the graph presentation of information is to show just how close to full capacity a particular selection is. The suction line graphs are arranged according to temperature, and the relationship of temperature and line size becomes readily apparent. The lower the temperature, the larger the line for the same heat load.

* To determine the "Equivalent Feet" (or Meters), add the length of the pipe and the equivalent footage assigned for each particular fitting. See chart below.

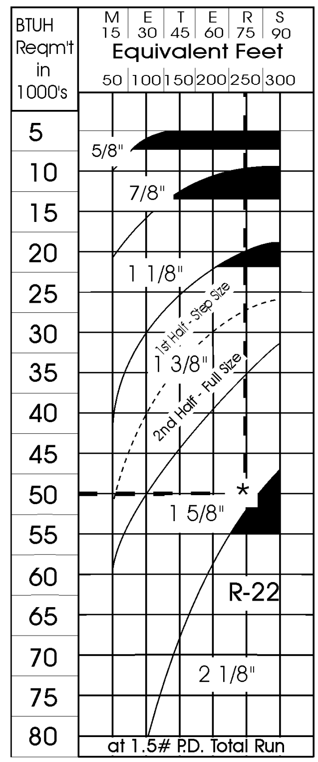
Find the Proper Chart

Find the proper chart based on refrigerant and suction temperature. Simply match BTUH load on the horizontal lines with equivalent feet on the vertical line. The point formed by the intersection will indicate the proper size unless it is a dark area. Selections falling in the dark areas of the charts show that the gas velocity is too slow to assure proper oil return, even with properly sloped lines. Reducing the line one size will increase velocity and pressure drop. Added pressure drop will require greater refrigeration capacity. Be sure the system can handle the added load. See the vertical riser charts for proper sizing of vertical suction lines on page 3-5.

Step Sizing

Step sizing is suggested for the selections falling in the first half of a size range. Pipe one size smaller (than the indicated run) can be used for 50' of the run closest to the cases, when the entire run is 100 equivalent feet or more. To show this principle, one size range on each suction chart has been bisected by dotted line to indicate the "1st Half-Step Size" and the "2nd Half-Full Size". The purpose of step sizing is to assure better oil return out of the evaporators.

10°F SUCTION TEMP



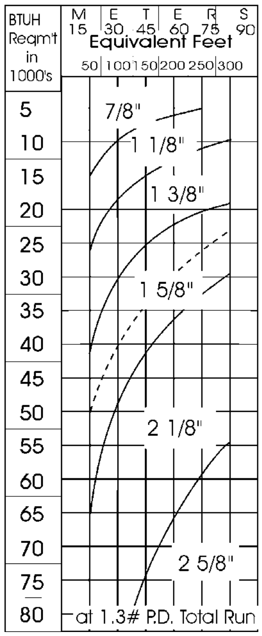
Dark Areas = Gas Velocities less than 750 FPM

Example: *Given a 50,000 BTUH load with R404A at 10°F Suction Temp and 150 Equivalent Feet of line, a 1-5/8" line is required. Since the selection point is in the 1st half of the range, 50 equivalent feet may be sized 1-3/8" (usually to the first 50' closet to the evaporators).* ***NOTE: Any 1-3/8" vertical riser height should be subtracted from the 50' step sizing.***

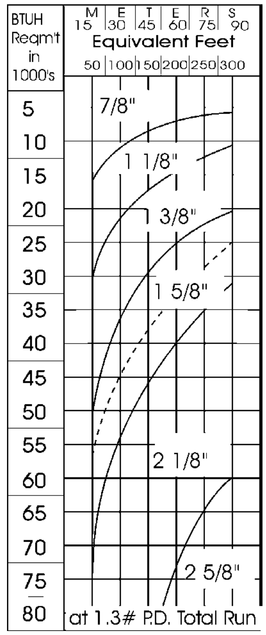
EQUIVALENT LENGTH OF PIPE FOR FITTINGS & VALVES (feet)						
Line Size O.D./In.	Globe Valve	Angle Valve	90° Elbow	45° Elbow	Tee, Sight Glass	T-Branch
1/2	9	5	0.9	0.4	0.6	2.0
5/8	12	6	1.0	0.5	0.8	2.5
7/8	15	8	1.5	0.7	1.0	3.5
1-1/8	22	12	1.8	0.9	1.5	4.5
1-3/8	35	17	2.8	1.4	2.0	7.0
2-1/8	45	22	3.9	1.8	3.0	10.0
2-5/8	51	26	4.6	2.2	3.5	12.0
3-1/8	65	34	5.5	2.7	4.5	15.0
3-5/8	80	40	6.5	3.0	5.0	17.0

R-22 Suction Line Sizing

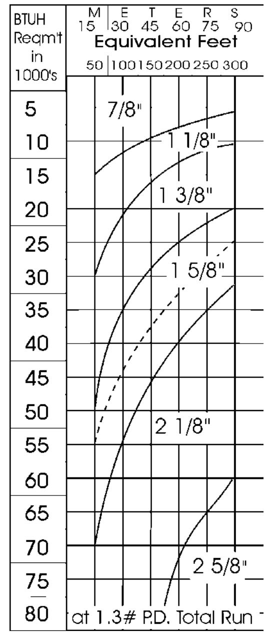
-35°F SUCTION TEMPERATURE



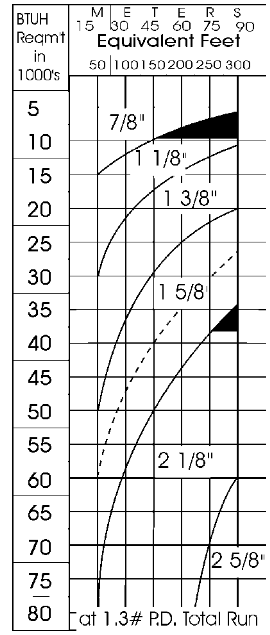
-25°F SUCTION TEMPERATURE



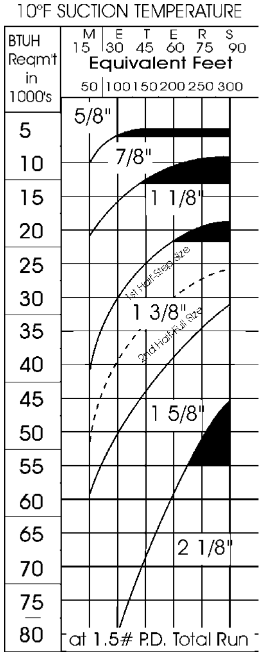
-20°F SUCTION TEMPERATURE



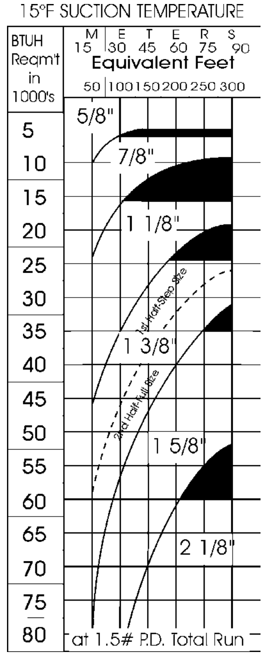
-15°F SUCTION TEMPERATURE



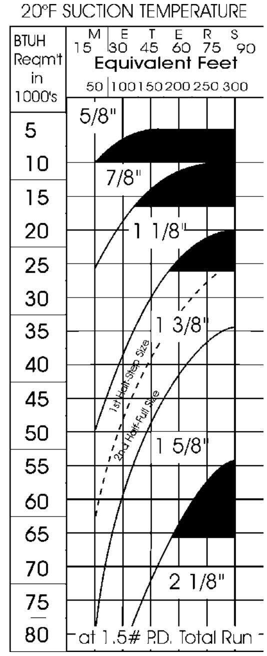
10°F SUCTION TEMPERATURE



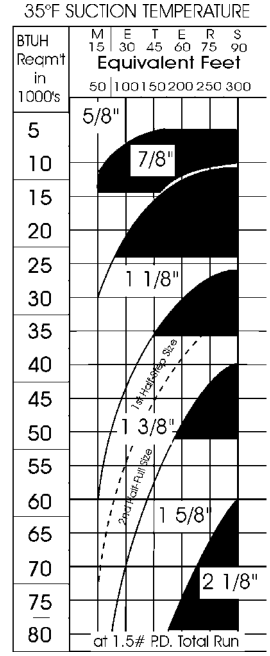
15°F SUCTION TEMPERATURE



20°F SUCTION TEMPERATURE



35°F SUCTION TEMPERATURE

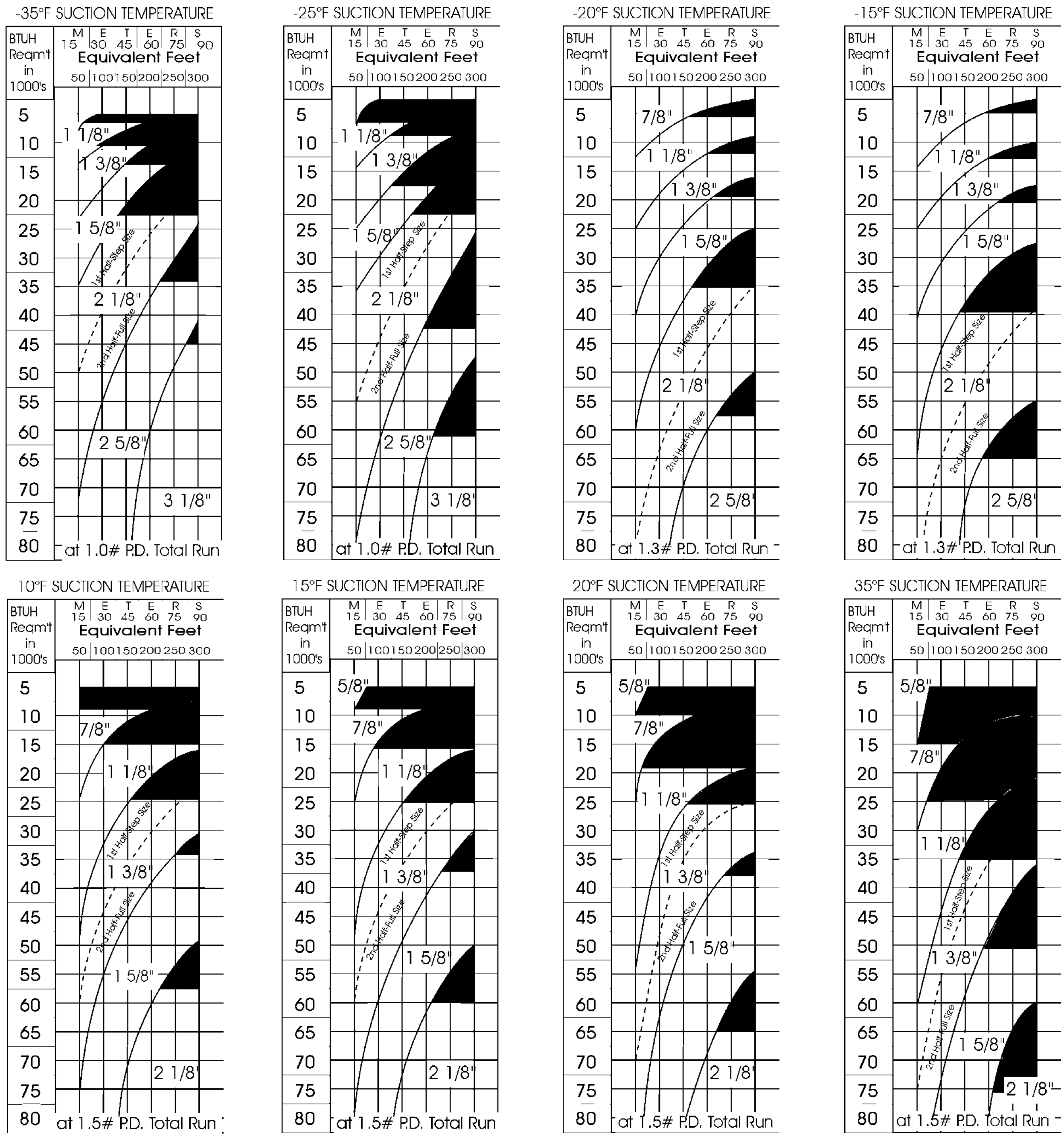


Step Sizing

Step sizing is suggested for selections in the 1st half of a size range. Pipe one size smaller can be used on the 50' closest to the cases, when the entire rune is 100' or more. Selections falling in the **BLACK AREAS** of the chart show that the gas velocity is below **750 fpm**, which is too slow to assure proper oil return. Reducing one size will assure good oil return by increasing velocity. Added pressure drop will require greater refrigeration capacity. Be sure the compressor selection is adequate.

All horizontal suction lines should be sloped 1/2" per 10' toward the compressor.
See vertical riser charts for proper vertical suction line sizing.

R404A Suction Line Sizing



Step Sizing

Step sizing is suggested for selections in the 1st half of a size range. Pipe one size smaller can be used on the 50' closest to the cases, when the entire rune is 100' or more. Selections falling in the **BLACK AREAS** of the chart show that the gas velocity is below **500 fpm**, which is too slow to assure proper oil return. Reducing one size will assure good oil return by increasing velocity. Added pressure drop will require greater refrigeration capacity. Be sure the compressor selection is adequate.

All horizontal suction lines should be sloped 1/2" per 10' toward the compressor. See vertical riser charts for proper vertical suction line sizing.

Pressure Concerns

Avoiding Excessive Pressure Drop

Pressure drop and resultant capacity losses are becoming more common with the increased use of EPR valves, suction line filters, accumulators, and suction manifolds on parallel systems. Each device stands on its own individual merit by contributing to case or system performance. But when all the resultant pressure drops are added, the end result is lower overall system performance. The symptoms may lead one to believe that the system is undersized, but a thorough check using a differential pressure gauge will very likely show where the real trouble lies.

Some Pressure Drop Built In

In general, most manufacturers rate their equipment by allowing for approximately two pounds pressure drop in the suction line between the evaporator to the compressor. Pressure drop built into the evaporator is usually considered by the designer and can frequently be larger than two pounds. This is to provide refrigerant velocities high enough to ensure good oil movement even in the coldest parts of the refrigeration system.

Avoiding Excessive Loss of Capacity

1. Size liquid and suction lines by accurately figuring the proper equivalent length.

   EQUIVALENT LENGTH = ACTUAL PIPING LENGTH + LENGTH EQUIVALENCE FOR FITTINGS AND COMPONENTS

   Use the equivalent length chart located on page 3-6 to determine the appropriate length for these fittings.

2. If possible, avoid high pressure drop components, such as various types of control valves, manifolds, tees, accumulators and filters. Of course, these devices are often used, hopefully after all the factors have been considered. The disadvantages must be outweighed by the advantages of combining systems, paralleling compressors, obtaining better case temperature control, protecting the compressors and/or safeguarding the system.

3. If suction line filters are to be used, size them properly. Use a properly sized filter that is the same as main line size or one size over the suction service valve, whichever is larger.

When Losses are Not Made Up

When pressure drop losses are not properly compensated for, an increase in case entering air temperature can be expected. This will be particularly noticeable when the condensing unit is operating at its design ambient condition (90°F or 100°F).

The following approximations can be made:

Low Temp Case: Each 10% increase (2# P.D.) raises entering air temp about 3°F.

Medium Temp Case: Each 10% increase raises entering air temp about 2°F.

SECTION 4

High Side Field Piping

Observe piping limits for best performance:

- Maximum 50 equivalent piping feet to Remote Condenser.
- Maximum 100 equivalent piping feet to Heat Recovery Coil.
- Maximum 200 equivalent piping feet total for entire circuit.
- Line size between Remote Condenser and Heat Recovery Coil must be the same size as the discharge line.

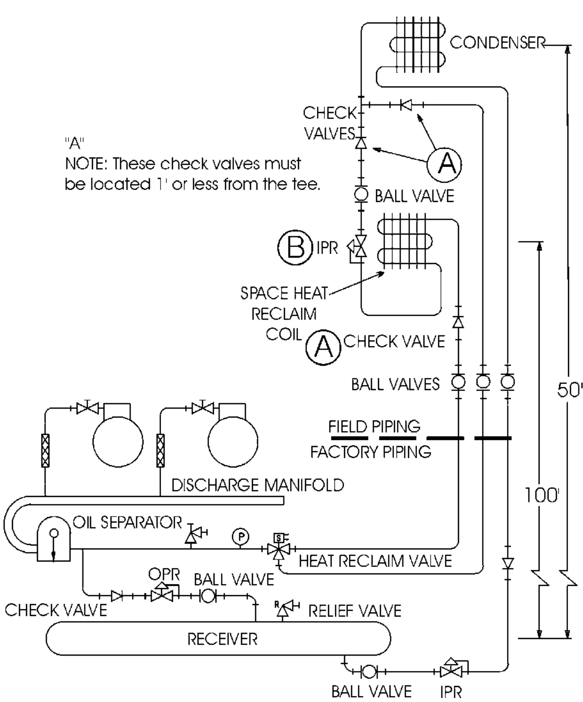
Installation Notice

Remote condensers must be mounted high enough in relation to the parallel rack so that the liquid drain on the condenser is at least 3 feet higher than the liquid return inlet on the receiver. Both applications ensure free draining. This drawing shows which items need to be installed as field piping. All items above the broken line are considered part of the field piping and are shipped loose. A detailed description on pages 17-1 & 17-2 gives a further explanation as to how the parts are employed.

All the components shown in the field piping diagram should be installed. If a heat recovery (HR) coil is used, 3 check valves (A) must be installed as shown in the diagram. One is placed in the normal flow piping to the condenser and the other two at the inlet and outlet of the HR coil. An optional IPR valve (B) for the HR coil will also be field installed on the coil, for NC-2 only. Isolation ball valves are recommended for the system and can be ordered as optional equipment.

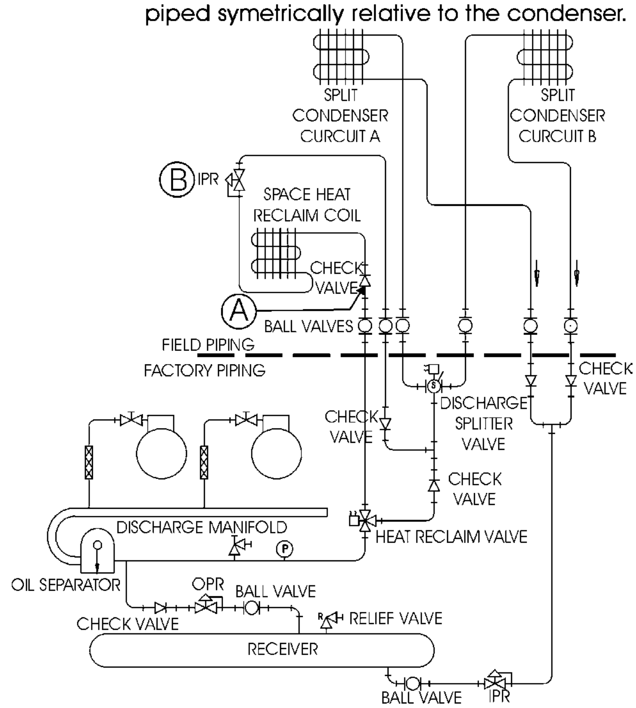
Schematics Are Representative Only

Typical Heat Reclaim Piping



Optional Split Condenser Piping

Both discharge and liquid return must be piped symetrically relative to the condenser.



Discharge to Remote Condenser & Heat Recovery Line Sizing

CAPACITY BTUH	R-22 EQUIVALENT LENGTH 50’	R-22 EQUIVALENT LENGTH 100’	R404A EQUIVALENT LENGTH 50’	R404A EQUIVALENT LENGTH 100’	CAPACITY BTUH	R-22 EQUIVALENT LENGTH 50’	R-22 EQUIVALENT LENGTH 100’	R404A EQUIVALENT LENGTH 50’	R404A EQUIVALENT LENGTH 100’
6,000	3/8	1/2	1/2	1/2	75,000	7/8	1-1/8	1-1/8	1-1/8
12,000	1/2	1/2	5/8	5/8	100,000	1-1/8	1-1/8	1-1/8	1-3/8
18,000	5/8	5/8	5/8	7/8	150,000	1-1/8	1-3/8	1-3/8	1-3/8
24,000	5/8	7/8	7/8	7/8	200,000	1-3/8	1-3/8	1-3/8	1-5/8
36,000	7/8	7/8	7/8	7/8	300,000	1-3/8	1-5/8	1-5/8	2-1/8
48,000	7/8	7/8	7/8	1-1/8	400,000	1-5/8	2-1/8	2-1/8	2-1/8
60,000	7/8	1-1/8	1-1/8	1-1/8	500,000	2-1/8	2-1/8	2-1/8	2-1/8

Recommended Liquid Line Sizing (Condenser to Receiver or Liquid Line Manifold)

CAPACITY BTUH	R-22 CONDENSER TO RECEIVER	R-22 RECEIVER TO EVAPORATOR 50’	R-22 RECEIVER TO EVAPORATOR 100’	R404A CONDENSER TO RECEIVER	R404A RECEIVER TO EVAPORATOR 50’	R404A RECEIVER TO EVAPORATOR 100’
6,000	3/8	1/4	3/8	3/8	1/4	3/8
12,000	1/2	3/8	3/8	1/2	3/8	1/2
18,000	1/2	3/8	3/8	5/8	1/2	1/2
24,000	5/8	3/8	1/2	5/8	1/2	5/8
36,000	5/8	1/2	1/2	7/8	1/2	5/8
48,000	7/8	1/2	5/8	7/8	5/8	5/8
60,000	7/8	1/2	5/8	7/8	5/8	7/8
75,000	7/8	1/2	5/8	7/8	5/8	7/8
100,000	7/8	5/8	7/8	1-1/8	7/8	7/8
150,000	1-1/8	7/8	7/8	1-3/8	7/8	7/8
200,000	1-1/8	7/8	7/8	1-3/8	1-1/8	1-1/8
300,000	1-3/8	1-1/8	1-1/8	1-5/8	1-3/8	1-3/8
400,000	1-5/8	1-1/8	1-1/8	2-1/8	1-3/8	1-3/8
500,000	1-5/8	1-1/8	1-3/8	2-1/8	1-3/8	1-3/8

SECTION 5

Electrical Supply Locations

Store Machine Room

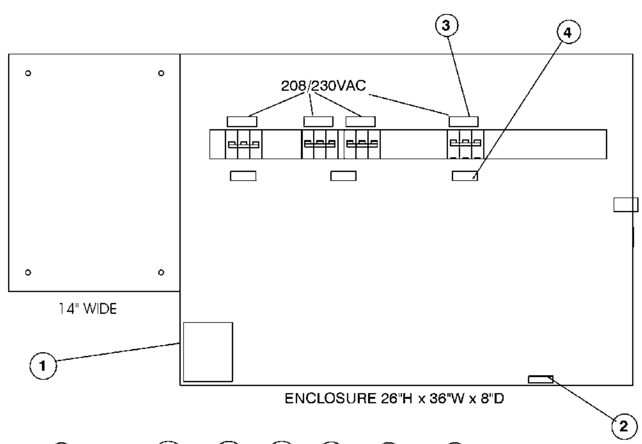
Parallel systems placed in a machine room have individual electrical knockouts on each unit. 7/8" pilot knockouts are located so any necessary holes for the conduit can be punched out safely. The TYLER Summary Sheet, included with each parallel unit, will give the load (in amps) for the unit. Each power supply must be sized accordingly to accommodate the load. Electrical specifications are also located on the name plate.

NOTE

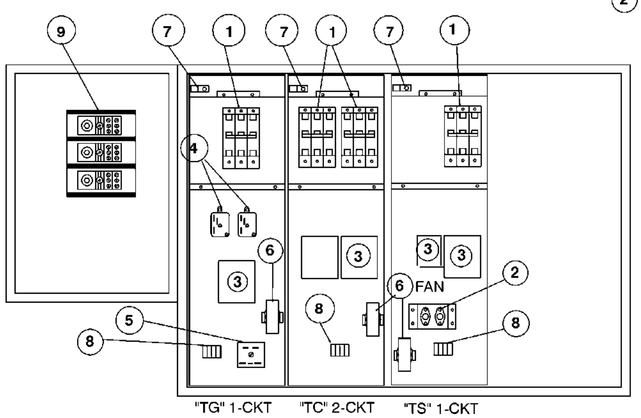
A single phase 208 volt power supply will be needed to power the compressor auxiliary circuit. The circuit breaker to the power supply is located in the control panel.

Remote Electric Defrost Panels - When Used

The panel(s) required for Electric Defrost are separate from the Parallels. Supply properly sized wire to the hookups in each panel. If the defrost panel is to be located in a TYLER Mechanical Center, the control wiring will be done in the factory. Control wiring in a store machine room must be done on site to connect the multi-circuit time clock(s,) or computer controller, to the Electrical Defrost breaker panel. Supply conductors must enter the panel via the electrical tap box knockouts. *(Refer to drawing on the following page.)*



1. LABEL NAMEPLATE
2. LABEL UL
3. LABEL 208/230V POWER
4. LABEL DEFROST CIRCUIT I.D.

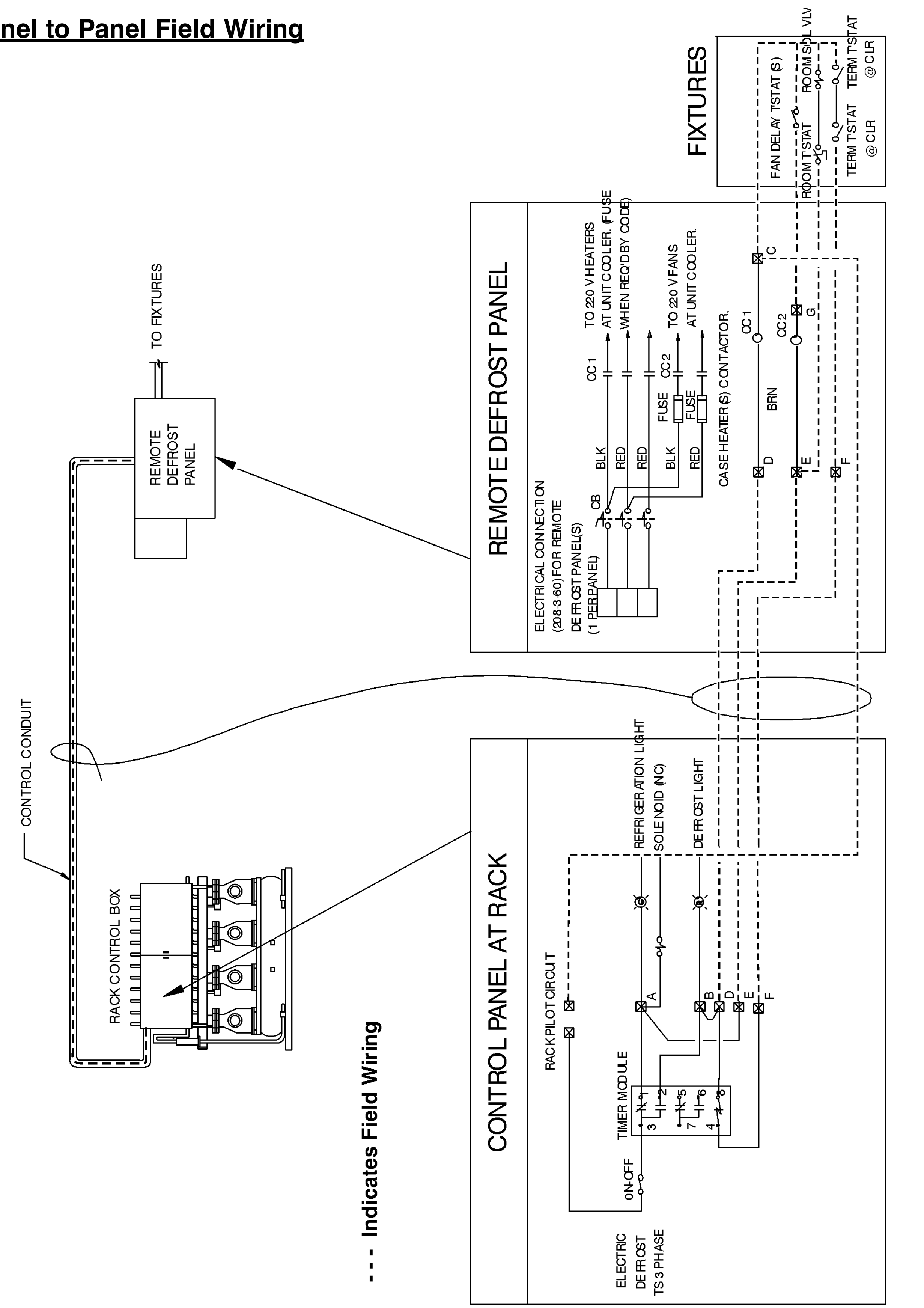


ITEM # DESCRIPTION

1. Defrost Circuit Breaker
2. Cooler Fan Fuses
3. Defrost/Cooler Fan Contactors
4. Current Sensing Relay (TG Defrost)
5. Time delay (On Make) Relay;1 Minute
6. Termination Relay (When Used)
7. Ground Lug
8. Control Circuit Terminal Blocks
9. Power Distribution Block

GENERAL REFERENCE ONLY

Panel to Panel Field Wiring



SECTION 6

System Charging Requirements

The heat of rejection must be known for the particular parallel system. It is the figure required for sizing the remote air condenser. If it is not known, it can be estimated by following the formula:

Medium Temp Systems: Heat of Rejection = Total BTUH Load X 1.35

Example: 200,000 BTUH X 1.35 = 270,000 (use the 285 column)

Low Temp Systems: Heat of Rejection = Total BTUH Load X 1.60

NOTE

****REMOTE CONDENSERS WITH 1/2" TUBES ARE LESS SUITABLE for parallels with Heat of Rejections in the higher ranges, especially with systems having gas defrost. The bottom line of the Receiver Charging Charts on page 6-2, provides add-on percentages which are to be used if the condenser has 1/2" tubes. If adding this percentage to the top line equals more than 100%, it has been marked "**" and indicates that the internal volume of the condenser is too large for the application.**

Heat of Rejection Table

(Use to select proper columns of receiver charge charts.)

BTU LOAD PER 1,000	MED TEMP x 1.35	LOW TEMP x 1.60	BTU LOAD PER 1,000	MED TEMP x 1.35	LOW TEMP x 1.60
75	101	120	250	338	400
100	135	160	300	405	480
125	169	200	350	473	560
150	225	240	400	540	640
200	270	320	500	675	800

Selecting and Using Refrigerant Charging Tables

Use the percentage shown in the charts on page 6-2 to estimate the system charge shown in the charts on page 6-3.

(All charts are based on systems with Heat Recovery.)

All commercial parallel refrigeration systems made by TYLER will make use of Nature's Cooling (NC) to a certain extent. With NC systems the receiver will be near full in the summer; as condensing temperatures drop, so will the receiver level. This drop in receiver level from lower ambient is caused by refrigerant backing up in the condenser. These must also be an extra amount of refrigerant available to handle gas defrosting at the lower ambient condition. Since the ambient temperature is the governing factor in how much refrigerant is required, the charging tables give range of conditions.

R-22 & R404A Receiver Charging Charts

Heat Rejected (1,000's BTUH)	Ambient	140	190	250	** 285	** 335
TWO-SOME with Electric Defrost	90°F	50%	60%	65%	72%	78%
	60°F	45%	50%	50%	60%	60%
	40°F	40%	40%	40%	58%	56%
	20°F	35%	35%	35%	50%	50%
	0°F	30%	30%	30%	45%	45%
	-15°F	25%	25%	25%	35%	38%
	-30°F	20%	20%	20%	30%	30%
(Add for 1/2" Cond.)		12%	20%	30%	30%	30%

Heat Rejected (1,000's BTUH)	Ambient	140	190	** 250	** 285	** 335
TWO-SOME with Gas Defrost	90°F	67%	75%	80%	87%	93%
	60°F	60%	65%	65%	75%	75%
	40°F	55%	55%	55%	71%	73%
	20°F	50%	50%	50%	65%	65%
	0°F	45%	45%	45%	60%	60%
	-15°F	40%	40%	40%	50%	53%
	-30°F	35%	35%	35%	45%	45%
(Add for 1/2" Cond.)		12%	20%	30%	30%	30%

Heat Rejected (1,000's BTUH)	Ambient	140	190	250	285	335	385	465
THREE-SOME with Electric Defrost	90°F	35%	40%	45%	52%	62%	70%	75%
	60°F	30%	32%	36%	40%	50%	57%	60%
	40°F	28%	30%	30%	35%	45%	50%	55%
	20°F	26%	28%	28%	32%	42%	45%	50%
	0°F	24%	26%	28%	30%	40%	42%	48%
	-15°F	22%	24%	24%	28%	32%	35%	38%
	-30°F	20%	20%	20%	26%	30%	32%	32%
(Add for 1/2" Cond.)		12%	20%	20%	25%	25%	25%	25%

Heat Rejected (1,000's BTUH)	Ambient	140	190	250	285	** 335	** 385	** 465
THREE-SOME with Gas Defrost	90°F	50%	55%	60%	67%	77%	85%	90%
	60°F	45%	47%	51%	55%	65%	72%	75%
	40°F	43%	45%	45%	50%	60%	65%	70%
	20°F	41%	43%	43%	47%	57%	60%	65%
	0°F	39%	41%	43%	45%	55%	57%	63%
	-15°F	37%	39%	39%	43%	47%	50%	53%
	-30°F	35%	35%	35%	41%	45%	47%	47%
(Add for 1/2" Cond.)		12%	20%	20%	25%	25%	25%	25%

Heat Rejected (1,000's BTUH)	Ambient	335	385	465	545	** 625	** 700	** 735
FOUR-SOME with Electric Defrost	90°F	50%	58%	68%	70%	75%	85%	88%
	60°F	45%	50%	50%	60%	60%	60%	65%
	40°F	40%	40%	40%	58%	58%	58%	63%
	20°F	35%	35%	35%	50%	50%	50%	58%
	0°F	30%	30%	30%	45%	45%	48%	50%
	-15°F	25%	25%	25%	38%	38%	38%	45%
	-30°F	20%	30%	20%	30%	30%	32%	35%
(Add for 1/2" Cond.)		12%	20%	25%	30%	30%	30%	30%

Heat Rejected (1,000's BTUH)	Ambient	335	385	** 465	** 545	** 625	** 700	** 735
FOUR-SOME with Gas Defrost	90°F	65%	73%	83%	85%	90%	100%	100%
	60°F	60%	65%	65%	75%	75%	75%	80%
	40°F	55%	55%	63%	63%	63%	63%	68%
	20°F	50%	50%	50%	65%	65%	65%	73%
	0°F	45%	45%	45%	60%	60%	63%	65%
	-15°F	40%	40%	53%	53%	53%	53%	60%
	-30°F	35%	35%	35%	45%	45%	47%	50%
(Add for 1/2" Cond.)		12%	20%	20%	25%	25%	25%	25%

** Indicates that a 1/2" Tube Condenser is not suitable.

Horizontal Receiver Capacity - Parallels (Pounds or Refrigerant @ 90°F.)

R-22						
MAX. COMP.	P67 3	P90 4	P120 5	P140 6	P160 7	P180 8
14" OD	60"	83"	106"	129"	152"	175"
100%*	340	478	615	751	889	1,026
90%	306	430	554	676	800	924
80%	272	382	492	601	711	821
70%	238	334	431	526	622	718
60%	204	287	369	451	533	616
50%	170	239	308	376	444	513
40%	136	191	246	301	356	411
30%	102	143	185	225	267	308
20%	68	96	123	150	178	205
10%	34	48	62	75	89	103

*100% ON GAUGE = 80% ACTUAL (for safety)

R404A						
MAX. COMP.	P67 3	P90 4	P120 5	P140 6	P160 7	P180 8
14" OD	60"	83"	106"	129"	152"	175"
100%*	296	415	535	654	774	893
90%	267	374	482	588	696	803
80%	237	3321	428	523	619	714
70%	207	291	375	458	542	625
60%	178	249	321	392	464	536
50%	148	208	268	327	387	446
40%	119	166	214	262	310	357
30%	89	125	161	196	232	268
20%	59	83	107	131	155	179
10%	30	42	54	65	77	89

*100% ON GAUGE = 80% ACTUAL (for safety)

NOTE

- **Receiver sizing is not intended for total system pumpdown. It is to allow for normal system variations. It will usually allow for one or more circuits to be pumped out for servicing.**
- **To obtain horizontal receiver capacities for different body sizes and/or vertical receiver applications, contact the Tyler Application Engineering department.**

SECTION 7

Start-Up Procedures

The start-up procedures consist of three steps; leak testing, evacuation and the charging start-up procedures. Follow these procedures to prevent any problems in the start-up of the unit.

Leak Testing Procedure

The success of all the subsequent (evacuation, charging and start-up) as well as successful operation of the system depends on a totally leak-free system.

CAUTION

Do not start any compressors before these procedures instruct you to do so. BEFORE STARTING, MAKE SURE THERE IS OIL IN THE COMPRESSOR. Serious compressor damage may result if all the steps are not followed properly. See page 8-5 for recommended oil usage.

1. The pilot circuitry ON-OFF switch, on the store power distribution panel, must be **OFF**.
2. Check that the compressor primary ON-OFF switches are all in the **OFF** position.
3. All the following valves must be **OPEN**:
   - Discharge Service Valves on the compressors
   - Suction Service Valves on the compressors
   - Liquid Return Valve on the receiver (from remote condenser)
   - Liquid Outlet Valve on the receiver
   - All field supplied Hand Shut Off Valves
   - All Liquid Line Manifold Valves
   - All Suction Line Manifold Valves
   - All Hot Gas Manifold Valves
   - All Oil Equalization System Valves
4. Remove the black power wire from the multi-circuit time clock motor in the defrost control panel. This will prevent the clock from advancing until the start-up procedures are complete.
5. Tighten all electrical connections in all panels prior to energizing the power.
6. Turn **ON** the pilot circuit breaker.
7. Turn **ON** the power at the store distribution panel and adjust the time clock modules so that all systems are **ON REFRIGERATION**. Flip the system ON-OFF toggle switches on the panel to **ON**. This opens all the branch circuit liquid line solenoid valves. **NOTE:** All compressor switches must remain **OFF** (See step 2 above.)
8. Connect the necessary charging lines to introduce refrigerant and dry nitrogen into the system use 3/8” or larger evacuating/charging lines for proper system evacuation.
9. Backseat the receiver liquid outlet valve and connect a charging line to the valve gauge port connection. Pressurize the system with approximately 50 psi with refrigerant and then build with nitrogen to 162 psi.

CAUTION

If pressure greater than 162 psi is used for testing, disconnect the low pressure computer transducers, control lines and seal the pressure port. This is done to avoid damaging the control’s bellows.

9. Using an electronic leak detector, carefully check the entire system for leaks. Special care should be taken to inspect all joints. Check the line pressure gauge at the nitrogen tank for pressure fluctuations. A sharp drop in pressure indicates a leaky system.
10. Allow the system to stand for 24 hours with the pressure on (Nitrogen tank off). If no pressure changes are observed, the system is tight. If leaks are found, isolate that particular portion of the system by closing off the hand valves. Let the leak depressurize the system at that point and repair the leak immediately.

NOTE

The use of nitrogen, or carbon dioxide, flowing at low pressure through the lines while they are being welded is necessary to assure relative freedom from the formation of oxides and scale. These can easily clog the small ports on the pilot operated and other valves in the system.

Evacuation Procedure

When the system is proven leak free, evacuate it using an efficient vacuum pump with clean or fresh oil and sufficient time to do a thorough job. Leave the system in a vacuum to aid in charging.

NOTE

Due to recommended piping of heat recovery coils, it is necessary to field supply a temporary by-pass between the line downstream of the inlet check valve on the heat recovery coil and the discharge line downstream of the IPR hold back valve. Failure to by-pass the IPR will result in the inability to evacuate the reclaim coil. The by-pass line must be removed after evacuation to assure proper operation of the system. **See piping schematics on page 4-1.**

Evacuation Method

1. Attach vacuum pump to the system to be evacuated.

NOTE

TYLER provides large servicing ports at:

- **Discharge line after the Oil Separator**
- **Liquid line prior to the Filter**
- **Suction Manifold**
- **Return Manifold**

2. Make sure the following valves are **OPEN**.
   - Discharge Service Valves on compressors
   - Suction Service Valves on the compressors
   - Liquid Return Valve on the receiver (from remote condenser)
   - Liquid Outlet Valve on the receiver
   - All field supplied Hand Shut Off Valves
   - All Liquid Line Manifold Valves
   - All Suction Line Manifold Valves
   - All Hot Gas Manifold Valves
3. Draw vacuum down to 500 microns with vacuum pump. (System must hold 500 microns.) **NOTE:** 500 microns is the standard representing the absence of moisture in the system.

4. The system is now ready for charging. *Remember that even the most careful evacuations and purging will not clean up a system that has been carelessly put together.*

NOTE

Moisture and air must be removed from the system in order to avoid any possibilities of compressor burnouts. Complete evacuation (draw vacuum down to 500 microns) is one of the best ways to ensure the system is clean.

Parallel Charging & Start-Up Procedure

Be sure to use the appropriate refrigerant designed for the system. Low and Medium temperature systems typically use either R404A or R-22 refrigerant, depending on the system design. For charging of the TYLER Commercial Refrigeration system use the high side charging method.

FOR ENVIROGUARD SYSTEM CHARGING, see pages 24-10 & 24-11.

Follow these precautions prior to, and during, the charging procedure:

1. Make sure all system filters are properly installed and clean before charging the system.
2. All charging lines must be cleaned and purged to ensure they are free of air and moisture.
3. The system must be tested for leaks and evacuated properly prior to charging it with refrigerant.
4. Remember to wear safety goggles when transferring and charging refrigerants.
5. **NEVER** allow liquid refrigerant to reach the compressors. The liquid is not compressible and will damage the compressors.
6. Be sure all temperature controls are set to the anticipated temperatures in each of the circuits.
7. Connect high and low side pressure gauges to common connection point or headers.
8. Make sure all fixtures are supplied with false loads prior to start-up.
9. INSURE PROPER OIL CHARGE BEFORE STARTING THE COMPRESSORS. (Use oil recommended by the manufacturer.)

NOTE

The manufacturer's information is tagged to the compressor.

Charging & Start-Up

1. Use the charging tables on pages 6-1 & 6-2 to determine the proper amount of refrigerant to charge into the system.
2. Attach a refrigerant tank with gauge and dehydrator to the 3/8" Schrader Valve next to the downstream regulator.
3. Fill the receiver with as much refrigerant as it will take (usually one tank).
4. Attach a refrigerant tank with gauge and dehydrator to the receiver outlet valve service port. (A 16 cubic inch drier should be used on a 145 pound cylinder.)
5. Close the receiver liquid outlet valve.
6. Slowly open the refrigerant tank valve and charge liquid refrigerant into the system. The vacuum should pull nearly all the refrigerant from a 145 pound tank.

7. Close the following valves:
   - All liquid line manifold valves.
   - All suction manifold valves.
8. Choose a branch circuit and open both the suction and liquid service isolation valves 1/4 turn.
9. Turn **ON** the condenser fan circuit.
10. Start one of the compressors. Check and record compressor amperage readings.
11. Open the receiver outlet.
12. Slowly open the suction and liquid isolation valves on the chosen circuit 1/4 turn at a time to activate the first branch circuit. Monitor activation of the first branch circuit during the opening of the liquid and suction service valve until there is assurance that the expansion valve sensing bulbs are controlling refrigerant flow through the cases.

NOTE

Refrigeration circuits must be monitored during activation to protect the compressor from liquid slugging. Stop the compressor immediately if any abnormality is noted.

13. Monitor the oil level in the compressors. Add oil as required to maintain oil level at 1/4 to 1/3 full in the sightglass. If foaming occurs, run compressors intermittently until foaming settles. Before adding oil, check to see that the oil equalization system is operating properly. Oil should be added directly to the reservoir rather then individual compressors. *(See Section 8, Oil Equalization System for more detail.)*

NOTE

POE oils must be pumped into the system because of their high affinity to draw moisture.

14. Continue activation of the branch circuits, one at a time. Maintain no more that 50 psi charging pressure above the design suction pressure.

NOTE

In order to cut charging time, feed each circuit separately using refrigerant from a cylinder. Keep service valve closed to the manifold until the circuit is charged.

15. Adjust the EPR and TEV valve settings for their individual applications.
16. Continue activation of the refrigeration circuits until they are all on the line. Continue charging the circuits as necessary to maintain refrigerant level in the receiver. Check liquid line sightglass during charging, if bubbles are present it may indicate a low refrigerant charge. *(However, occasional bubbling may occur.)* The liquid level indication is a better charging indicator.
17. On electric defrost systems, check the defrost load amperage against the summary sheet.
18. Adjust the multi-circuit time clock settings for proper time termination and sequence of defrosting.
19. Check starters and heaters, contactor sizes and circuit breakers to ascertain correct selection and application.

20. Replace black power wire to the motor of the multi-circuit time clock, or reactivate the defrost control.
21. Check the ability of the compressor motors to start after shut down (in effect simulating a power failure). Use an ammeter to determine operation of a loaded start.
22. Record the motor amperage at normal operating pressures and temperatures.
23. Check the remote condenser and heat recovery coil for proper operation.
24. Check oil reservoir level, if oil level is below the bottom sightglass, add oil until level can be seen or is above the sightglass. Red beads should be visible in the center of the sightglass.
25. On gas defrost systems, check to ensure the system operates properly during defrost. Description of operation is on pages 12-1 & 12-2.
26. Due to the use of refrigerants such as R404A and R-507; systems now require oil which is hydroscopic, meaning it will very rapidly absorb moisture. In addition the combination of the HFC refrigerants and the POE oils act as very good solvents. This can break loose and circulate contaminants that before may not have been a problem. In order to deliver a clean uncontaminated system, proper start-up procedures should be followed. To help ensure a clean system, filter changes should become part of the start-up procedure. Filters should be changed as needed. *Example: Change drier filters at periodic intervals or 3 days, 3 weeks, and 3 months.* Watch the moisture indicator and observe the color and transparency of the oil. Another good indication is pressure drop across the filter and if it reaches 3 pounds or more, it should be replaced. *However, if proper evacuation procedures are followed, and dry uncontaminated oil is installed in the system after the evacuation, the 3 month filter change may not be needed.*

NOTE

The initial suction filters are shipped in place. A replacement set of suction filters are also shipped loose. These should be used to change the suction filters after initial startup (approx. 3 days). Liquid drier cores are also shipped loose for installation prior to startup, but after the system has been sealed.

Operational Check after Start-Up

When the system has been operating for at least 2 hours without any indication of problem, check the following items allowing the system to continue operations on automatic controls.

1. Check to see that all case fans are operating properly and rotating in the appropriate direction.
2. Check the setting of all thermostatic expansion valves for proper superheat.
3. Check the compressor operating parameters; head pressure, suction pressure, line voltage and compressor amperage. If any of the readings are not within the expected parameters (as noted on the nameplate and in this manual) determine the cause and correct.
4. Check the compressor oil level to ensure that it meets manufacturer's specifications.

SECTION 8

Oil Control System

The oil control system is made up of several devices working together to provide a constant supply of recirculated oil to the compressors.

Oil Separator

As hot discharge gas leaves the compressors, it must first travel through the oil separator. The oil separator's duty is to make the refrigeration system more efficient and to save energy. It does this by removing oil from the refrigerant vapors, which would otherwise travel throughout the system. Because oil is a lubricant, not a refrigerant, its presence in the refrigeration circuits will reduce the efficiency of the system.

Oil Separator Operation

An oil float (located in the bottom of the oil separator) opens or closes when a specific oil level is reached in the oil separator The float is attached to a needle valve which opens as the float rises to the upper limit of its travel. The needle valve is located in the line between the separator and the oil reservoir. When the valve opens, oil is forced to travel to the reservoir which is at a lower pressure.

During normal operation, the oil return line from the oil separator to the reservoir will be alternately hot and cool. This is caused by the oil float valve alternately opening and closing while returning oil to the reservoir. An oil return line at ambient temperature may suggest that the needle valve may be blocked by foreign matter or the oil strainer is plugged. If the oil return line is continually hot, the oil float valve may be leaking or being held open by foreign matter. In either case, the oil separator and/or the oil strainer should be cleaned.

Other problems may be indicated by a continually hot oil return line. It may mean that a compressor is pumping excessive oil or the separator is too small for the compressors. This can be checked visually by installing a sightglass in the oil return line. If the oil return line is cold, it means that there is condensation of liquid refrigerant in the oil separator.

Oil Reservoir

Oil trapped in the oil separator is piped directly to the oil reservoir. Oil movement from the oil separator to the reservoir is induced by having the reservoir at a lower pressure that the separator. The pressure of the oil in the reservoir is reduced through a vent line to the suction header. A 20 pound oil differential check valve is placed in this vent line to keep the pressure in the oil reservoir 20 pounds above the suction pressure. This is to ensure oil flow to the compressor oil level controls from the reservoir. The oil separator operates at the same pressure as the compressor discharge gas. The reservoir will be at 20 pounds above the suction pressure, and the compressor crankcase will operate at the suction pressure. These differences in pressure ensure positive flow of lubricating oil throughout the oil equalization system.

Oil Level Controls (Oil Float)

The oil level control will receive oil from the reservoir at 20 pounds above the suction pressure. The control will meter oil flow to the compressor, thus maintaining at least the minimum oil level required to operate safely. As the level of the oil is lowered in the compressor crankcase through operation, the float in the oil level control is lowered. When the float drops to a certain point a needle valve will open allowing oil to flow back into the compressor crankcase.

TYLER's default oil level controller is *Sporlan's OL-60XH*. The orifice in each is sized to maintain proper oil flow in the pressure differential range of 5 to 90 psi.

When a parallel system employs lower temperature satellite compressors, (which operate at a suction pressure more than 15 psi lower than the suction pressure of the main suction group) a regulating valve *Sporlan's ADRI-1 1/4-0/75 or Y-1236C* are used to step down the oil pressure feeding the oil level control(s) of the satellite(s). The outlet of the regulating valve is adjusted to maintain the same differential across the satellite's oil level control as that which is maintained across the oil level control on the main suction group. A minimum differential of 10 psi and a maximum of 30 psi are required. Because the suction pressure on the main suction group will rise with an increase in load or the end of a defrost period, it would be prudent to use a maximum pressure differential of 25 psi. (Refer to Figure 1.)

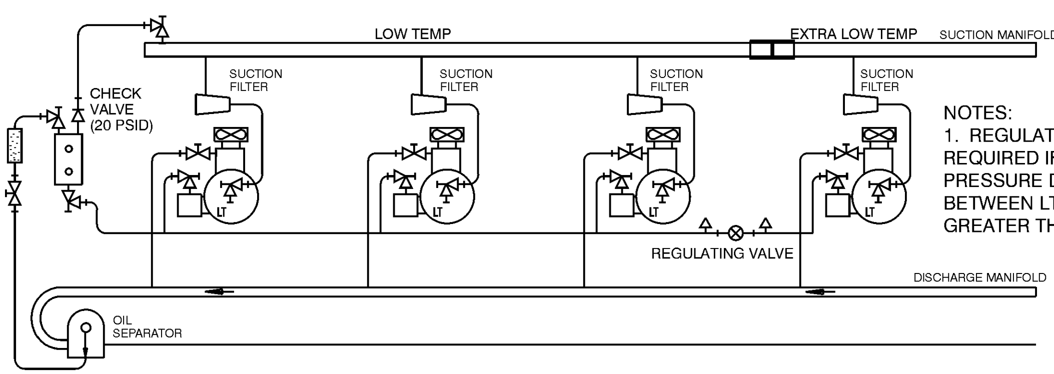


FIGURE 1

When a high temperature satellite is employed, the reservoir is still vented to the main suction manifold, but the check valve in the vent line must be sized to raise the oil feed pressure approximately 10 psi above the satellite suction pressure. That pressure is then stepped down with the regulating valve to approximately 20 psi above the suction pressure of the main. (Refer to Figure 2.)

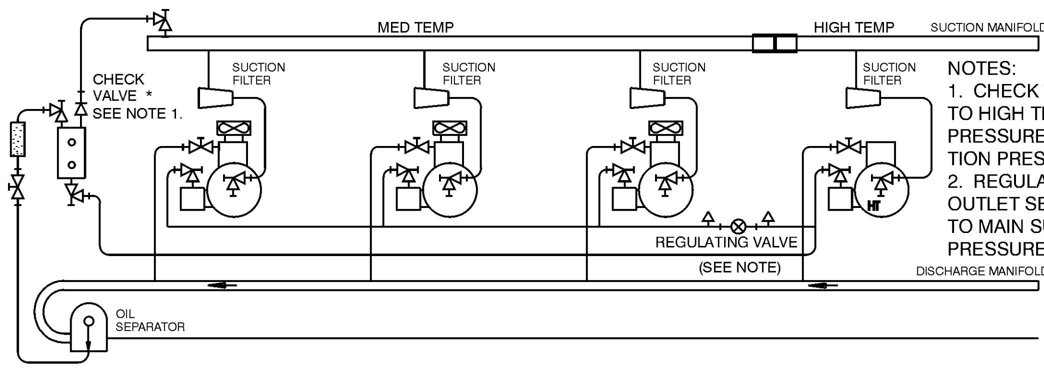


FIGURE 2

* If an ORI-6 is used here instead of a check valve(s), adjust valve to maintain reservoir pressure at 20 psi higher than suction pressure of high-temperature satellite.

The oil system for an internally compounded Carlyle system requires that the pressure differential across the oil level float control be approximately 20 psi. In addition the oil reservoir is vented to the interstage manifold. (See pages 22-4 & 22-6.)

Checking Oil Level

Oil level may be checked with the system either operating or idle. Some reservoirs are equipped with two sightglasses. Oil level should be maintained between the two sightglasses. Compressor oil level may be checked on the sightglass on each compressor crankcase. The level may be viewed on the oil level control, if it is equipped with a sightglass.

CAUTION

The level indicated on the oil level control sightglass may give a false indication of actual crankcase level. Use the sightglass on the compressor crankcase for an accurate oil level or to verify the oil level control sightglass reading. Improper compressor oil levels could cause damage to the compressor.

Oil Level Control Adjustment

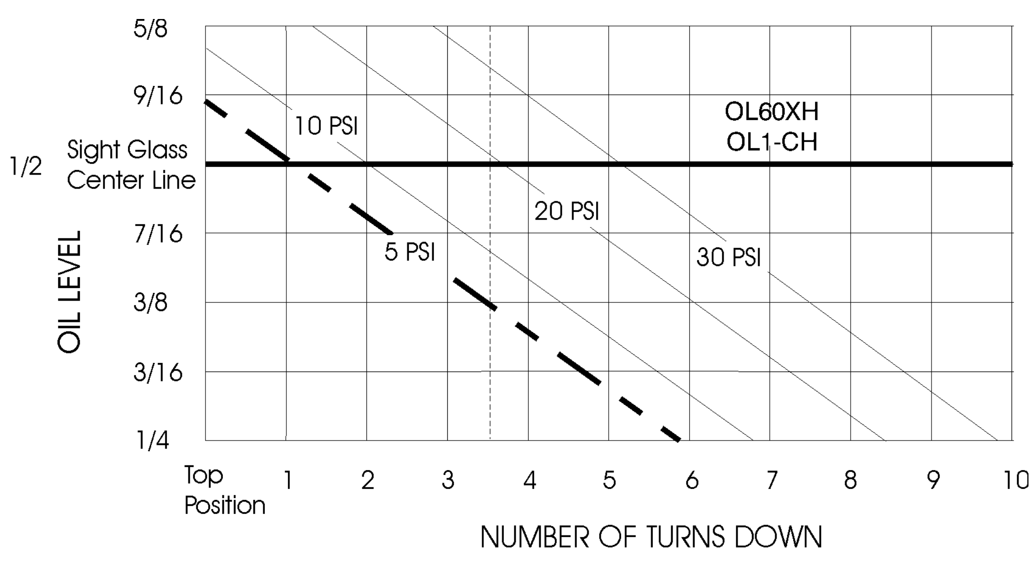
The oil level control may be adjusted to vary the oil in the compressor crankcase. To reset the oil level control, remove the seal cap on the top of the control. Turn the adjustment clockwise to lower and counterclockwise to raise the oil level. See chart below for the number of turns required.

CAUTION

When setting OL60XH & OL1-CH float controls, DO NOT adjust beyond 9 turns down from the top stop or control may be damaged. For all other float controls, refer to O.E.M. for setting instructions and requirements.

NOTE

The oil level control is factory set at 3-1/2 turns clockwise from the top stop.



Adding Oil

Oil may be added to the system in several ways. However, the following method is the preferred one. You will need a piece of flared tubing attached to an oil pump. Remember, the oil and oil transfer equipment must be clean and dry. The oil must be the proper viscosity for the compressor, the refrigerant, and the low side temperature.

The Preferred Method of Adding Oil

1. Attach tubing with oil pump to the middle opening of the gauge manifold.
2. Attach the high pressure hose of the gauge manifold to the discharge service fitting and the low pressure hose to the 1/4” flare connection at the top of the oil reservoir.
3. Front seat the flare valve at the top of the oil reservoir to receive oil from the oil separator.
4. Purge the tubing using gas from the high pressure side.
5. After purging the tubing, immerse the oil pump in a container filled with clean refrigerant oil.
6. Open the 1/4” flare connection on the top of the reservoir.
7. Slowly open the low pressure isolation valve on the gauge manifold and use the oil pump to deliver oil to the system reservoir from the container. It is important that some oil is left in the container so that the oil pump is always immersed. If not, air could be drawn into the system.
8. Shut the low pressure isolation valve on the gauge manifold when oil transfer is complete.
9. Open the flare valve at top of oil reservoir to receive oil from the separator.

NOTE:
Oil requirements vary by refrigerant used and compressor manufacturer.

The most widely used refrigerant oils are as follows:

Mineral Oil Applications

- Copeland compressors use Sunisco 3G or 3GS with a viscosity rating of 150 SUS.
- Carlyle compressors use Witco-Sunisco 3GS, Texaco-Capella WFI-32-150, or Chevron-Zerol 150 with a viscosity rating of 150 SUS.

Polyol Ester Oil Applications (HFC’s)

- Copeland MT/LT recommends - Mobil EAL Artic 22 CC, and ICU EMKARATE RL 32CF.
- Carlyle MT recommends - Mobil ARTIC EAL 68, Castrol SW68, Castrol E68, ICI EMKARATE RL 68H, Lubrizol 2916S, and CPI SOLEST 68.
- Carlyle LT recommends - Castrol SW68, Castrol E68, ICI EMKARATE RL 68H, Lubrizol 2916S, and CPI SOLEST 68.

Carlyle Screw Compressor Applications

- Carlyle MT recommends - Castrol SW100, CPI SOLEST BVA 120, ICI EMKARATE RL 100S, and Castrol E100.
- Carlyle LT recommends - CPI SOLEST BVA 120, Castrol E100, and ICI EMKARATE RL 100S.

NOTE
Castrol SW100 is not recommended for low temperature operations.

Bitzer/Copeland Screw Compressor Applications

- Bitzer/Copeland model SHM/L for MT/LT/HT HFC's recommends - CPI Solest 170.
- Bitzer/Copeland model SHM/L for MT/LT R22 recommends - CPI CP4214-150.
- Bitzer/Copeland model SHM/L for HT R22 recommends - CPI CP4214-320.

Removing Oil

Occasionally problems in line sizing or system operation may cause oil to be trapped in an evaporator or suction line, and large amounts of oil were added to compensate for this oil logging. When the problem has been solved and corrected, the excess oil will return to the compressor crankcase.

CAUTION

If this excess oil is not removed from the system, compressor damage will be the likely result.

To remove excess oil from the compressor via the oil fill plug:

1. With the compressor **OFF**, close the compressor suction valve and reduce the crankcase pressure to 1 to 2 psi.
2. Shut the discharge service valve.
3. Carefully loosen the fill plug, allowing any pressure to bleed off before fully removing the plug.
4. Remove the plug and insert a 1/4" O.D. copper tube into the plug hole. Use a tube of sufficient length to reach the bottom of the crankcase and the external end can be bent down below the level of the crankcase.
5. Wrap a clean rag tightly around the oil fill opening and crack the suction service valve to pressurize the crankcase to about 5 psi. Oil will be forced out of the drain line and will continue to drain due to the siphon effect on the oil (the residual refrigerant pressure will prevent any serious amount of moisture or foreign particles from entering the compressor.
6. After the desired amount of oil has been drained, remove the drain tube and reinstall the oil fill plug.
7. Open the compressor suction and discharge service valves.

SECTION 9

Pressure Regulator Settings

These settings are given as initial adjustment guidelines. The settings required for each individual system may vary.

"STANDARD" settings are given as comparisons and can be used for single compressor-remote condenser systems which may have the **IPR** and **OPR**. A single compressor system cannot take advantage of reduced cool weather loads and increased system capacity.

"NC" systems feature two, and up to eight compressors, with solid state or conventional pressure controls to cycle off needed compressors. **"NC-2"** is the same with an additional liquid bypass for maximizing natural liquid subcooling. **"NC-3"** includes mechanical subcooling.

IPR - Inlet (Upstream) Pressure Regulator

TYPE OF DEFROST	STANDARD	NO FLOATING HEAD		
	ELECTRIC OR GAS	ELECTRIC LOW	ELECTRIC MED	GAS DEFROST
R-22	195 PSIG	127 PSIG	175 PSIG	146 PSIG
R404A	230 PSIG	150 PSIG	189 PSIG	173 PSIG
R-507	235 PSIG	155 PSIG	192 PSIG	179 PSIG

NOTE

If the IPR valve has been replaced with an OLDR valve, the OLDR should be adjusted to a differential pressure equal to the IPR setting minus the OPR setting.

IPR - Inlet Pressure Regulator on Heat Recovery Coil

TYPE OF DEFROST	NC FLOATING HEAD		NC-2, NC-3 SYSTEMS	
	ELECTRIC	GAS DEFROST	ELECTRIC	GAS DEFROST
R-22	158 PSIG	158 PSIG	158 PSIG	158 PSIG
R404A	188 PSIG	188 PSIG	188 PSIG	188 PSIG
R-507	195 PSIG	195 PSIG	195 PSIG	195 PSIG

The IPR valve is shipped loose for installation downstream of the Heat Recovery Coil. This valve is used to raise system discharge pressure to get more heat out of the hot gases passing through the coil.

OPR - Outlet (Downstream) Pressure Regulator

TYPE OF DEFROST	STANDARD	NC FLOATING HEAD			NC-2, NC-3 SYSTEMS		
	ELECTRIC OR GAS	ELECTRIC LOW	ELECTRIC MED	GAS DEFROST	ELECTRIC LOW	ELECTRIC MED	GAS DEFROST
R-22	170 PSIG	102 PSIG	150	121 PSIG	102 PSIG	150	121 PSIG
R404A	205 PSIG	125 PSIG	164	148 PSIG	125 PSIG	164	148 PSIG
R-507	210 PSIG	130 PSIG	167	154 PSIG	130 PSIG	167	154 PSIG

The OPR valve supplies high side pressure to the receiver whenever the pressure falls below a set point.

DDPR Valve on Gas Defrost Systems (Optional)

The DDPR is a valve that maintains an adjustable pressure differential between its inlet and outlet pressures. This is accomplished in its normal, non-energized state. When the DDPR valve is energized, the valve opens and equalizes the inlet and outlet pressures. When all hot gas circuits in a system are in refrigeration mode, the valve should be energized.

NOTE

The minimum recommended differential pressure setting of the DDPR is 20 psi.

SECTION 10

OLDR Liquid Differential Regulator Valve

The OLDR valve has a solenoid bypass feature so the valve can either remain fully open or operate to maintain a differential. The OLDR valve fails to the open position.

In the differential mode, the pilot differential valve controls the valve by varying the pressure on top of the main piston. Inlet pressure enters the pilot assembly through an external tube connected to the inlet fitting. The outlet of the pilot differential valve is connected to the outlet fitting with an external tube. The valve will open only as far as necessary to maintain the pilot valve setting. The pilot valve modulates the piston from partially open to partially closed to maintain its setting. *(See Figure 1 on page 10-2.)*

In the fully open mode, the pilot port is closed. This stops the flow to the chamber above the main piston. The refrigerant above the main piston is bled to the outlet through an orifice in the pilot differential piston. The inlet pressure then moves the piston up and the valve opens. *(See Figure 3 on page 10-2.)*

Setting Procedure

The OLDR is set by turning the adjusting stem located under the cap on the pilot differential valve. Turning the stem clockwise increases the setting, counterclockwise decreases the setting. Adjustments must be made with the valve in its differential mode and no refrigerated cases in defrost, so that the head pressure is normal. Artificial low head pressure at the initiation of defrost can prevent a differential from occurring, thereby making it impossible to set the valve. *ALWAYS set the OLDR when no cases are in defrost*.

Once the pilot valve is set, it will modulate to maintain this differential setting during defrost. However, there are several system conditions that can cause the differential to change beyond the valve's control and still be acceptable:

1. When a defrost is initiated the head pressure may fall. It can take several minutes for the differential to be created while the head pressure returns to normal.
2. If there is a very low requirement for refrigeration, and therefore a low demand for liquid refrigerant, the differential may never build up enough to reach the valve setting.
3. As a gas defrost cycle progresses, condensing occurs in the evaporator in defrost at a slower rate. Therefore, there is more gas present in the evaporators, which results in a higher natural pressure drop. It is possible for this natural pressure drop to be higher than the differential valve's setting.

IMPORTANT

To verify valve operation, if no differential is occurring between the liquid header and the receiver during defrost, take all cases out of defrost and then put the valve in its differential mode and check its setting. If the valve is maintaining its set point with normal head pressures and no cases in defrost, then the valve is opening correctly and some other system condition such as outlined previously may be causing the problem.

OLDR Valve on Gas Defrost Systems

In order for the reverse flow to occur during gas defrost, the pressure of the gas defrost manifold must be greater than the pressure of the liquid header. The OLDR valve is used to create the differential required when a circuit goes into defrost. The valve is in the differential mode when energized. It uses an MKC-2 coil and fails in the full open position.

OLDR Valve Illustrations

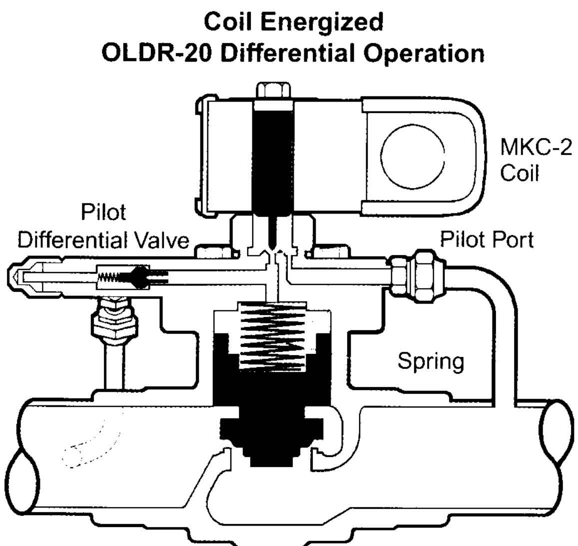


Figure 1

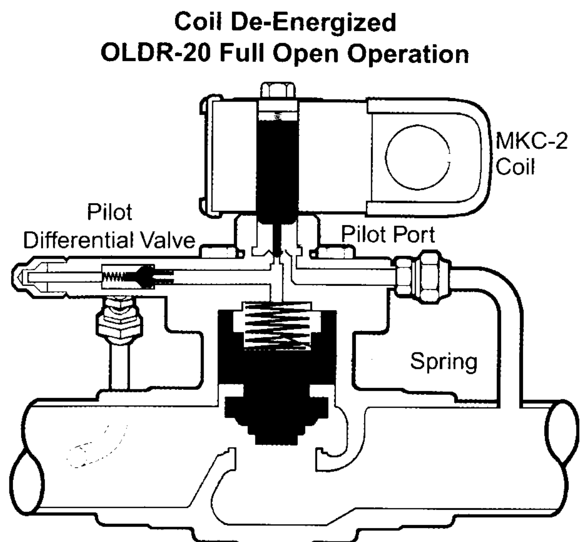


Figure 3

The following chart lists the differential pressure settings for the OLDR at various heights of net liquid lifts from the lowest fixture liquid line elevation to the condenser inlet manifold. Settings are presented and include the pressure drops for the liquid line, check valves and the defrost return solenoid valve.

Differential Pressure Settings for OLDR at Various Heights Chart

ELEVATION	PSID	ELEVATION	PSID
15	20	30	30
20	25	35	32
25	27	40	35

NOTE

The OLDR valve should be set at a minimum differential of 20 psi.

SECTION 11

Parallel Rack Pressure Control Settings (PSIG)

These settings are "*average*" and will have to be adjusted to suit the particular store and case line-ups. Use an accurate gauge to make settings.

Use pressure settings as backup with electronic rack control.

CUT IN / CUT OUT PRESSURE SETTINGS (PSIG)									
COMPRESSORS		**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
R-22 LOW	CUT IN	5	6	7	8	9	10	11	12
	CUT OUT	0	0	0	0	0	0	0	1
R-22 MED	CUT IN	31	32	33	34	35	36	37	38
	CUT OUT	21	22	23	24	25	26	27	28
R404A* LOW	CUT IN	9	10	11	12	13	14	15	16
	CUT OUT	0	0	1	2	3	4	5	6
R404A* MED	CUT IN	43	44	45	46	47	48	49	50
	CUT OUT	33	34	35	36	37	38	39	40

* also applies to R-507

Pressure Cycling Set Points for Condenser Fans

FANS OR PAIRS OF FANS	REFRIGERANTS			
	R404A / R-507		R-22	
	DEFROST TYPES & SETTINGS			
	HOT GAS ON / OFF	ELECTRIC ON / OFF	HOT GAS ON / OFF	ELECTRIC ON / OFF
6	240 / 220	200 / 180	210 / 190	170 / 150
5	230 / 210	190 / 170	200 / 180	160 / 140
4	220 / 200	180 / 160	190 / 170	150 / 130
3	210 / 190	170 / 150	180 / 160	140 / 120
2	200 / 180	160 / 140	170 / 150	130 / 110
1	190 / 170	150 / 130	160 / 140	120 / 100
0	<170	<130	<140	<100

- High Pressure CUT OUT 390-395 PSIG
- Pressure Relief Valve 450 PSIG

Remote Condenser Fan Settings

NOTE

Chart for ambient control usage only.

FANS OR PAIRS OF FANS	HEADER FAN 1	FAN 2	FAN 3	FAN 4	FAN 5
2	OFF @ 42°F				
3	OFF @ 42°F				
4	OFF @ 42°F	45 / 40°F			
5	OFF @ 42°F	45 / 40°F	59 / 53°F		
6	OFF @ 42°F	45 / 40°F	59 / 53°F	69 / 63°F	69 / 63°F
	DROP LEG TEMP	TEMPERATURE @ INLET			

Setting Suction Pressure Differential & Time Delay

The pressure differential is the suction pressure band that the compressor(s) will try to maintain. This band can be set from 1 to 10 pounds. TYLER recommends setting the differential at 4 pounds initially.

Time Delay Values

Time delay is the time period that the compressor will operate or remain idle after a specific pressure set point has been reached. This tends to minimize the amount of compressor cycling required to maintain a specific pressure differential. *"Minimum ON" time is the time the compressor runs after it reaches its target pressure. "Minimum OFF" time is the time the compressor waits to start.* TYLER recommends the following "Minimum ON" and "Minimum OFF" time settings:

"Minimum ON" time should be less than 15 seconds.

"Minimum OFF" time should be 2 minutes or less.

Of course these time and pressure differentials will vary depending on system characteristics of the loads being refrigerated and will have to be adjusted during the start-up period.

NOTE

Systems operating on electronic or computer controls, will operate the compressors in such a way as to achieve the ideal suction pressures. The systems still require setting pressure differentials and time delays as back-ups.

SECTION 12

Defrost Control Strategies

Temperature termination for all hot gas and electric defrost equipment is recommended with a termination sensing device at each fixture or coil. Frost build-up on coils varies depending on loading, traffic and ambient temperatures, consequently the required defrost time will also vary. If defrost termination is not sensed at each coil, there is a risk of other coils in the line-up not completely defrosting. This could cause icing, over-defrosting, and/or product quality problems.

Electric Defrost

On all TYLER cases (except the N6F(L) multi-shelf freezers) electric defrost termination can be done with the current sensing relay in our defrost panel. Therefore, no control wires are required between these cases and the compressor systems, helping reduce installation costs. Each case is independently terminated from the electric heat source by an inline klixon thermostat which opens-on-rise.

When the last heater shuts off, the lack of current deactivates the current relay and initiates refrigeration. This time-tested method assures each case gets defrosted but prevents over-defrosting by getting the refrigeration back on quickly. The N6F(L) multi-shelf freezer cases have defrost contactors located at the case and these have an auxiliary contact that closes when the termination thermostat de-energizes the contactor. These contacts are wired in series if more than one case and when all are closed, the clock solenoid is reset, again allowing each case to independently terminate based on its own needs.

When using an electronic controller with electric defrost, the controller will still initiate the defrost based on time. The sensors should still be placed in each case at the same location as our standard defrost termination thermostat. Multiple sensors on the same defrost circuit should be used so that all cases are satisfied before terminating heat and restarting refrigeration. The compromise is some danger of over-defrosting if some cases have less frost loads than other on the same circuit. The standard klixons must be kept in the circuit for U.L. requirements, but changed to 70°F termination to act as a safety and prevent cross controlling. In lieu of sensors, the standard defrost klixons may be monitored by the computer controller to terminate defrost.

Gas Defrost

When using a standard clock system with gas defrost, the clock will initiate the defrost based on time, and it will restart the refrigeration based on a fail safe time plus 5 minutes drain down time. Defrost termination by thermostats at the display fixture will only close the gas supply solenoid at the compressor rack. Termination thermostats at the display case (or evaporators in a walk-in cooler) should be connected in **parallel** and wired for open-on-rise. Once all thermostats are satisfied simultaneously, flow to the fixtures will cease. Once the fail safe/drain time has expired, the valves at the compressor rack will return to the refrigeration mode and pull down begins. All termination sensors should be mounted on the bypass check valves around the expansion valve. Fans are cycled off during the defrost except on horizontal type freezers

(dual temps will cycle in medium temp mode). An alternative using electronic controllers to control the gas valve from sensors that replace the original defrost limiting thermostats. The sensors are located at the same sensing points as the thermostats. For best results, these should be connected to cycle only the gas valve.

Refer to the electronic controller installation manual when using thermostats for termination instead of electronic sensors. Some controllers require a close-on-rise indication. If close-on-rise is used, wire the thermostats in series. Other controllers allow open-on-rise or close-on-rise indication. If open-on-rise is used, wire the thermostats in parallel.

Fan Control & Defrost Termination Temperatures

The following charts list specific fan control and defrost termination temperatures for electric, time off and gas defrost. Additional information or models not shown in the following charts should be obtained from the O.E.M.

These guidelines were established to help assure that electronic defrost controllers will not sacrifice proper equipment operation or cause costly problems. The best sensing points for termination vary with manufacturer and style of case. These locations should be adhered to per the manufacturer's recommendations.

Electric & Time Off Defrost Requirements Chart

CASE DATA				ELECTRIC DEFROST				TIME OFF	
MODEL	DISCH. AIR TEMP (°F)	EPR SETTINGS R-22	EPR SETTINGS R404A	DEF./ DAY	FAILSAFE TIME (MIN.)	TERM. TEMP (°F)	FAN CYCLE TEMPS.	DEF./ DAY	FAILSAFE TIME (MIN.)
NCSX, NCSGX	-25	3	8	1	36	50	---	---	---
NCNX, NCNGX, NCBX, NCEX	-25	3	8	1	36	50	---	---	---
NCJCX, NCJECX, NCJGCX, NCJGECX	-25	3	8	1	36	50	---	---	---
NTJCX, NTJGCX (DUAL TEMP)	-25/-15	3/7	8/14	1	36/60	50	---	---	---
NCWX	-25	3	8	1	46	50	---	---	---
NMF, NMFG	-15	7	14	1	60	50	---	---	---
NFX, NFSX, NFSGX	-15	7	14	1	60	50	---	---	---
NFNX, NFNGX, NFBX, NFBGX, NFEX, NFGEX	-15	7	14	1	60	50	---	---	---
NFJCX, NFJCGX, NFJECX, NFJGECX	-15	7	14	1	60	50	---	---	---
NFMJCX, NFMJGCX (DUAL TEMP)	-15/+22	7/37	14/50	1	36	50	---	---	---
NFWX, NFWGX, NFWEX	-15	7	14	1	46	50	---	---	---
N6F, N6FL	-10	10	17	2-3	40	55	---	---	---
P5FG, P5FGN (ANTHONY 101)	-8	19	27	1	46	60	40/20	---	---
(ELIMINAATOR)	-8	12	19	1	46	60	40/20	---	---
NFL	-5	13	21	1	46	50	---	---	---
P5FG, P5FGN (ANTHONY 101)	+1	18	26	1	46	60	40/20	---	---
(ELIMINAATOR)	+1	17	25.5	1	46	60	40/20	---	---

CASE DATA				ELECTRIC DEFROST				TIME OFF	
MODEL	DISCH. AIR TEMP (°F)	EPR SETTINGS R-22	EPR SETTINGS R404A	DEF./ DAY	FAILSAFE TIME (MIN.)	TERM. TEMP (°F)	FAN CYCLE TEMPS.	DEF./ DAY	FAILSAFE TIME (MIN.)
NFX, NFSX, NFSGX	+22	38	50	1	36	50	---	---	---
NFNX, NFNGX, NFBX, NFBGX, NFEX, NFGEX	+22	38	50	1	36	50	---	---	---
NFJCX, NFJGCX, NFJECX, NFJGECX	+22	38	50	1	36	50	---	---	---
NFWX, NFWGX, NFWEX	+22	38	50	1	36	50	---	---	---
N3MGE	+23	38	50	6	36	50	---	6	28
LPFMT (SELF-SERVE)	+23	38	50	---	---	---	---	4	40
LPFDT (SELF-SERVE)	+23	38	50		---	---	---	4	40
NNG (DELI)	+25	38	50	---	---	---	---	6	28
LPFDT (DOME)	+24	38	50	---	---	---	---	4	40
N6F, N6FL (MEAT)	+24	38	50	2	40	55	---	---	---
N2PSE (BULK)	+24	43	56	---	---	---	---	6	28
(MEAT/DELI)	+24	38	49	6	36	50	---	6	28
TNG (DELI)	+25	38	50	---	---	---	---	6	28
N3MG, N3HM, N3HMG	+27	38	50	6	36	50	---	6	22
N3HME, N3HMGE	+27	38	50	---	---	---	---	6	26
NSSD	+27	38	50	6	36	50	---	6	28
NMHP, NMGHP	+27.5	49	62	---	---	---	---	4	44
NM, NMG	+28	38	50	4	19	50	---	4	34
RCCG (RISER OPT. 2)	+28	35	46	---	---	---	---	4	30
RCCG (STD. RISER) (RISER OPT. 1)	+28	38	50	---	---	---	---	4	30
LPD	+28	38	50	---	---	---	---	4	30
TNG (CHEESE)	+28	43	56	---	---	---	---	6	28
NHMGHP	+28	49	62	---	---	---	---	4	44
N2MHP	+28	48	61	---	---	---	---	6	26
N3HMHP, N3HMGHP	+28	49	62	---	---	---	---	6	28
N4MHP, N4MGHP	+28	49	62	---	---	---	---	6	28
N5M, N5MG	+28	38	50	6	36	50	---	6	32
N6MHP	+28	48	61	---	---	---	---	6	26
N2PS (BULK)	+28	43	56	---	---	---	---	6	28
(MEAT DELI)	+28	38	49	6	36	50	---	6	28
NDRLHPA (SHELVING)	+28	37	49	---	---	---	---	4	45
NNG (CHEESE)	+28	43	56	---	---	---	---	6	28
LDSSI	+28.5	44	57	---	---	---	---	4	40
N5MHP, N5MGHP	+29	49	62	---	---	---	---	6	26
N3MGHP, N3MGHPE, N3MGHPEX	+29	49	62	---	---	---	---	4	32
LPFMT (DOME)	+29	38	50	---	---	---	---	4	40

CASE DATA				ELECTRIC DEFROST				TIME OFF	
MODEL	DISCH. AIR TEMP (°F)	EPR SETTINGS R-22	EPR SETTINGS R404A	DEF./ DAY	FAILSAFE TIME (MIN.)	TERM. TEMP (°F)	FAN CYCLE TEMPS.	DEF./ DAY	FAILSAFE TIME (MIN.)
TLD, TLD(2/4/6)(L/R)	+30	52	67	---	---	---	---	4	20
N2P (MEAT/DELI)	+30	38	49	6	36	50	---	6	28
NLD, NFD, NVD	+30	36	47	---	---	---	---	1	46
N6DHP(LR/MR)	+31	52	66	---	---	---	---	6	16
NHDHP(L/M) (SHELVING)	+31	52	66	---	---	---	---	6	24
(PEG BARS/MIXED)	+31	50	64	---	---	---	---	6	26
(PRODUCE INSERT)	+31	53	36	---	---	---	---	6	24
N6D(LR/MR)	+32	44	57	4	24	41	---	4	24
NHD(L/M)	+32	44	57	4	24	41	---	4	24
LD(48/54/60/72)	+32-35	41	53	---	---	---	---	6	20
N2P (BULK)	+33	43	56	---	---	---	---	6	28
N6D(L/M/H)	+33	44	57	4	24	41	---	4	24
NP (BULK)	+34	43	56	---	---	---	---	3-4	40
P5NG, P5NGN	+34	51	65	---	---	---	---	1	34
N6DN(L/M/H)	+34	44	57	6	18	41	---	6	18
N6DHP(L/M/H)A (ALL APPLICATIONS)	+34	52	66	---	---	---	---	4	18
N6DHPAC(L/M/H)A	+34.5	52	66	---	---	---	---	4	20
N5P (BULK)	+35	43	56	---	---	---	---	3	40
NPW, NPWE, NPWEE, NPE (BULK)	+35	43	56	---	---	---	---	1	60
N5D, N5DH, N5DL	+35	37	49	---	---	---	---	4	24
N5DSC	+35	---	---	---	---	---	---	6	28
N2PSSC	+35	---	---	---	---	---	---	4	18
NRPIE, NRPIEE	+35	43	56	---	---	---	---	1	60
NLBR	+36	51	65	---	---	---	---	6	20
FDESC	+37	---	---	---	---	---	---	6	25
N1P (BULK)	+38	43	56	---	---	---	---	3-4	40
N3PL, N3PH (BULK)	+38	43	56	---	---	---	---	3	40
N4P (BULK)	+38	43	56	---	---	---	---	3-4	40
N4PHP (BULK)	+39	60	75	---	---	---	---	2	10
N1PHP (BULK)	+42	60	75	---	---	---	---	2	10
NLM, NFM, MVM, NLF, NFF, NVF	---	36	47	---	---	---	---	1	110
TLM, TLF, TLM(2/4/6)(L/R)	---	37	49	---	---	---	---	2	70

Termination thermostats are open-on-rise. See case specific Installation & Service Manuals for proper locations.

Hot Gas Defrost Requirements Chart

CASE DATA				HOT GAS DEFROST			
MODEL	DISCHARGE AIR TEMP (°F)	EPR SETTINGS R-22	EPR SETTINGS R404A	DEFROSTS PER DAY	FAILSAFE TIME (MIN.)	TERM. TEMP (°F)	FAN CYCLE TEMPS.
NCSX, NCSGX	-25	3	8	1	25-30	55	----
NCNX, NCNGX, NCBX, NCEX	-25	3	8	1	25-30	55	----
NCJCX, NCJECX, NCJGCX, NCJGECX	-25	3	8	1	25-30	55	----
NTJCX, NTJGCX (DUAL TEMP)	-25/-15	3 7	8 14	1 2-3	25-30 20-25	55 55	---- ----
NCWX	-25	3	8	1	25-30	55	----
NMF, NMFG	-15	7	14	2	16-20	55	----
NFX, NFSX, NFSGX	-15	7	14	2-3	25-30	55	----
NFNX, NFNGX, NFBX, NFBGX, NFEX, NEGEX	-15	7	14	2-3	25-30	55	----
NFJCX, NFJGCX, NFJECX, NFGECX	-15	7	14	2-3	20-25	55	----
NFMJCX, NFMJGCX (DUAL TEMP)	-15/+22	7 37	14 50	2-3 2-3	20-25 16-20	55 55	---- 50/40
NFWX, NFWGX, NFWEX	-15	7	14	2-3	20-25	55	----
N6F, N6FL	-10	10	17	3-4	22-25	60	60/40*
P5FG, P5FGN (ANTHONY 101/)	-8	19	27	1	20-25	55	25/10
(ELIMINAATOR)	-8	12	19	1	20-25	55	25/10
NFL	-5	13	21	2	17-20	55	----
P5FG, P5FGN (101/E2 with HEAT)	+1	18	26	1	18-20	55	25/10
(ELIMINAATOR)	+1	17	25.5	1	18-20	55	25/10
NFX, NFSX, NFSGX,	+22	38	50	2-3	16-20	55	50/40
NFNX, NFNGX NFBX, NFBGX, NFEX, NFGEX	+22	38	50	2-3	16-20	55	50/40
NFJCX, NFJGCX NFJECX, NFJGECX	+22	38	50	2-3	16-20	55	50/40
NFWX, NFWGX, NFWEX	+22	38	50	2-3	16-20	55	50/40
N3MGE	+23	38	50	6	12-15	55	----
N6F, N6FL (MEAT)	+24	38	50	3-4	22-25	60	60/40*
N2PSE (MEAT/DELI)	+24	38	49	6	12-15	55	----
N3MG, N3HM, N3HMG	+27	38	50	6	12-15	55	50/40
NSSD	+27	38	50	6	12-15	55	50/40
NM, NMG	+28	38	50	4	12-15	55	50/40
N5MG	+28	38	50	6	12-15	55	50/40

***** Primary Fans Only**

CASE DATA				HOT GAS DEFROST			
MODEL	DISCHARGE AIR TEMP (°F)	EPR SETTINGS R-22	EPR SETTINGS R404A	DEFROSTS PER DAY	FAILSAFE TIME (MIN.)	TERM. TEMP (°F)	FAN CYCLE TEMPS.
N2PS (MEAT/DELI)	+28	38	49	6	12-15	55	----
N2P (MEAT/DELI)	+30	38	49	6	12-15	55	----
N6D(LR/MR)	+32	44	57	4	15	55	50/40
NHD(L/M)	+32	44	57	4	15	55	50/40
N6D(L/M/H)	+33	44	57	4	15	55	50/40
N6DN(L/M/H)	+34	44	57	6	15	55	50/40

- **Ice cream discharge air temperatures are -28, -25 & -8°F. Frozen food discharge air temperatures are -20, -15, -10, -5 & +1°F. All other discharge air temperatures are for medium temp applications.**
- **Most low temperature cases can be set up for dual temp application (frozen food / medium temp). Only the NTJCX & NTJGCX cases can be set up for split temp application (ice cream / frozen food).**
- **Termination thermostat bulbs are mounted on the bypass check valves around the expansion valves.**
- **Multiple cases, on a circuit using open-on-rise termination, should be connected in parallel so that all are satisfied before stopping the gas flow.**
- **An additional 5 minutes of drain down time should be allowed for after the failsafe time, or added to the failsafe time if not a separate function before the refrigeration comes on for electronic controllers only.**

SECTION 13

Gas Defrosting

Gas defrost is accomplished by diverting hot gas from the compressor discharge, down the suction line, and into an evaporator where it condenses to liquid refrigerant. This provides a very rapid means of defrost.

Gas defrost is available for cases operated by a parallel system. Gas defrost uses superheated compressor discharge gases to provide the heat source to melt the ice off of the evaporator coils. About 25% of the cases can be defrosted at a time, the other 75% of the cases are needed as a heat source for the defrosting cases.

Gas defrosts are initiated by a multi-circuit time clock or a computer controller. Both controls set the defrost initiation and duration times for all of the separate refrigeration circuits. It is necessary to program defrosts in the proper sequence. Care must be taken not to schedule more than one defrost at a time. No more than 25% of the rack system can be set to defrost at one time.

Gas Defrost Operating Principles

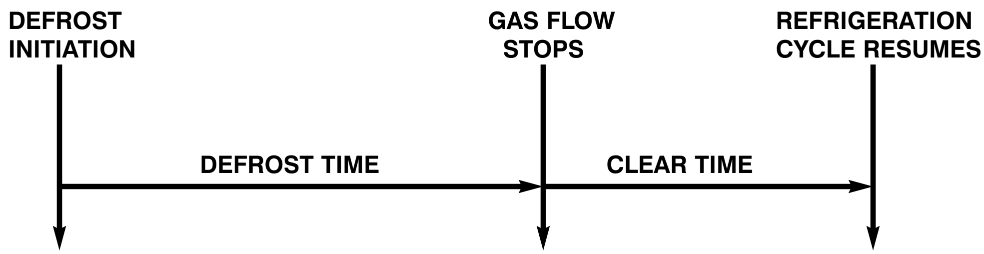
In a gas defrost system, hot refrigerant vapor is pumped directly through the evaporator tubing. The system uses a series of valves to supply superheated vapor from the compressor or saturated vapor from the receiver, through the suction line, to the evaporator(s) to be defrosted. This series of valves is explained in more detail on page 15-3.

At a pre-determined set time the time clock or computer controller will close a circuit's suction line valve to the compressor and open the hot gas supply valve to the circuit being defrosted. The hot vapor rushes to the evaporator, warming the coil. The hot vapor is condensed into liquid in the evaporator and then the liquid is returned to the liquid manifold via a bypass around the expansion valve. This liquid is, in turn, used as the refrigerant supply to other cases .

To make certain that the liquid flows from the evaporator of the defrosting fixture(s), a pressure differential is established between the compressor discharge pressure and the liquid header. When defrost is initiated, a DDPR valve throttles the normal hot vapor flow to the condenser. An OLDR valve adjusted for a minimum of 20 pounds of differential (located at the outlet to the receiver) is also placed on the line to drop the pressure in the liquid manifold and ensure flow from the defrosting evaporator to the liquid manifold. For proper adjustment, *see table on page 10-2.*

Gas Defrosting Programming

Gas defrosts are programmed to allow for a defrost period and a dripdown period or "clear time". This type of defrost operation allows the problem areas in the case to completely clear without subjecting the refrigerated product to excessive warm up. Temperature termination thermostats are used to sense when the refrigerant in the evaporator coil reaches a specific temperature.



When the termination temperature is reached (70°-75°F), the hot gas solenoid will close. If the coil cools and the termination time has not elapsed, then the hot gas flow will resume. This will continue until the allotted failsafe time on the time clock or computer controller has been reached.

The multi-circuit time clock or computer controller will initiate defrost by introducing hot gas flow to the fixtures. Defrost will continue until the temperature termination thermostats on all cases in the defrosting lineup close. When all the termination thermostats are satisfied, the hot gas solenoid will close.

> Refrigeration will not restart until the *entire time period* set on the defrost clock passes. This allows adequate clear time without overheating.

SECTION 14

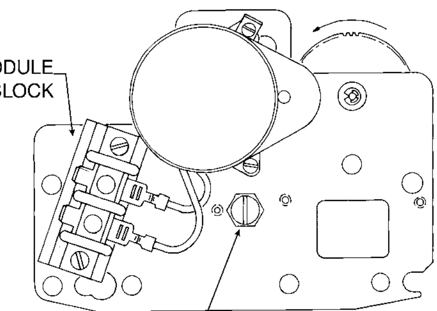
Multi-Circuit Time Clock Module

The multi-circuit time clock is a modular time clock with a frame, drive motor and individual program modules. The program modules clip into the frame and are held in place by a spring loaded latching lever.

Operation

When the time clock is to be set up for initial operation, the following must be done:

1. The number of defrosts for a specific circuit is set by inserting the black trippers into the 24-hour time dial (1 for each defrost).
2. Each of the 2-hour minute dials must be set for the length of the defrost period (failsafe).



MOTOR MODULE

As the 2-hour dial rotates, so do the 24-hour dials. The 2-hour dial makes a complete rotation every 2 hours. Defrosts will start when a tripper is reached on the 24-hour dial and will continue for the time period set on the 2-hour time dial.

Setting the Multi-Circuit Time Clock

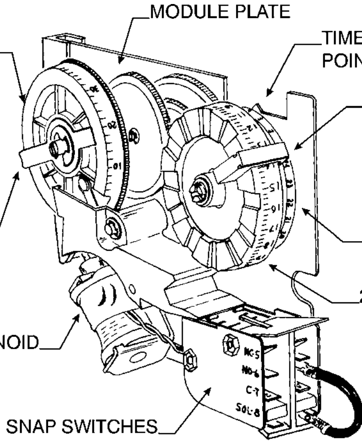
Setting the defrost times on the clock is a simple procedure. Follow these precautions:

PRECAUTIONS

- **Do not set the program timer with the circuit energized. De-energize the control circuit to prevent personnel injury or inadvertently tripping too many defrosts at one time.**
- **Do not use excessive force when turning the minute dial levers. Rotate the dial in a counter-clockwise direction.**

Setting

1. Insert black plastic trippers into the 24-hour time clock at the times of day the defrosts (indicated by the black numbers on the white dial) are to occur.
2. Set the failsafe time on the 2-hour clock by rotating the copper termination lever so the pointer indicates the desired time period.
3. Set clock to the correct time of day (indicated by the white numbers on the smaller black wheel to the left of each 24-hour module) using the black drive gear on the motor module.

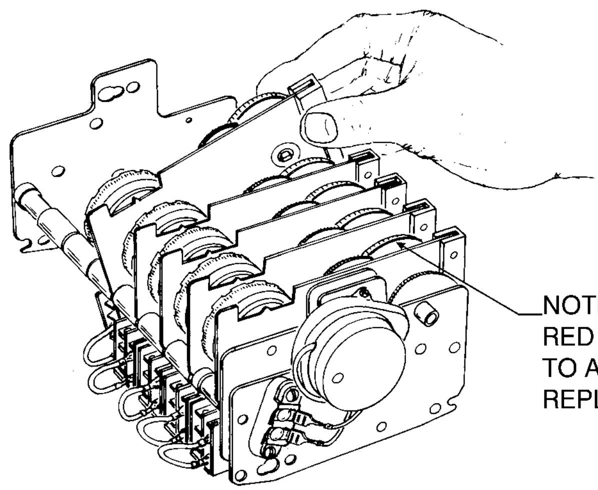


Multi-Circuit Time Clock Module Replacement

If a module needs to be replaced, be sure to use the right part. There are 4 different modules. The modules are designated with the letters A, B, D and E. Replace an A with an A; a B with a B; and so on.

These modules have been factory set. ***Do not try to change them!***

"A" Modules - Red Tab set at **75** minutes.
"B" Modules - Red Tab set at **45** minutes.
"D" Modules - Red Tab set at **15** minutes.
"E" Modules - Red Tab set at **105** minutes.



Removal and/or Installation and Alignment of Individual Program Modules

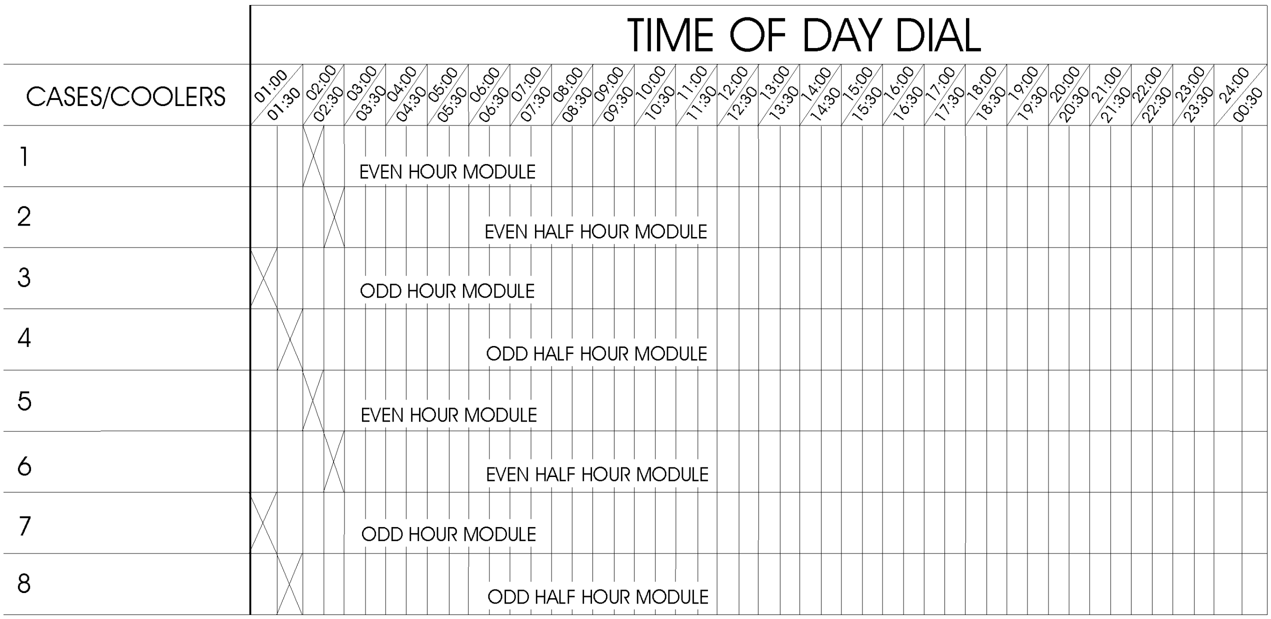
1. To remove a program module, rotate the black reduction gear on the motor module until the red tabs on **all** the 2-hour program dials come to the 12 o'clock position. Then pull out and up on the bottom of the module latching lever, disengage and point module up from frame to remove.
2. To re-install a program module, follow step 1 above, and rotate the trailing modules by hand until **all** red tabs are at 12 o'clock position. Check to be sure that the black numbers on all the 24-hour dial are in the same position as those on the modules already in the frame. Then fit the module cut out (located above the switches) into the slotted frame rod, align the tongue/groove on either side of the module, and snap the module down over the non-slotted frame rod. *Check to be sure* ***all*** *red tabs line up and* ***all*** *24-hour dial numbers line up.*

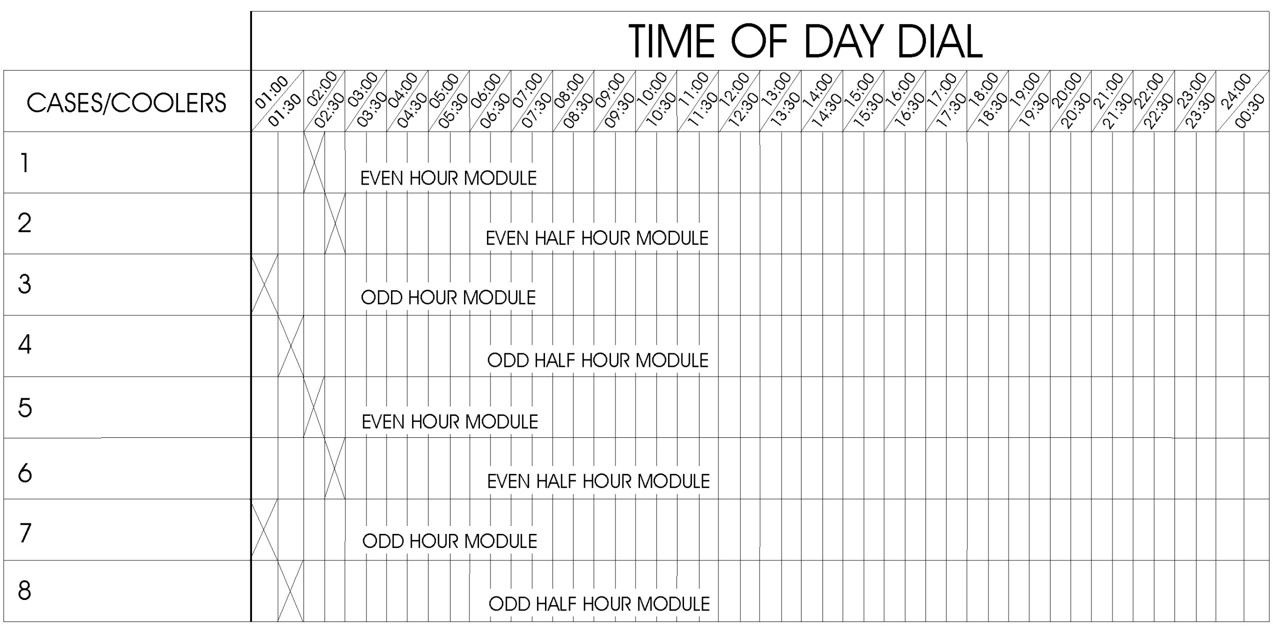
Removal and/or Installation of the Drive Module

1. To remove the drive module, rotate black reduction gear until tongue/groove with program module number 1 is parallel to the mounting surface.
2. Loosen hex nut fully.
3. Slide complete motor module parallel to the mounting surface and toward the 24-hour dials until the three locator studs clear their key slots, then remove the module.
4. To reinstall, reverse the above steps.

Program Charts for Multi-Circuit Timers

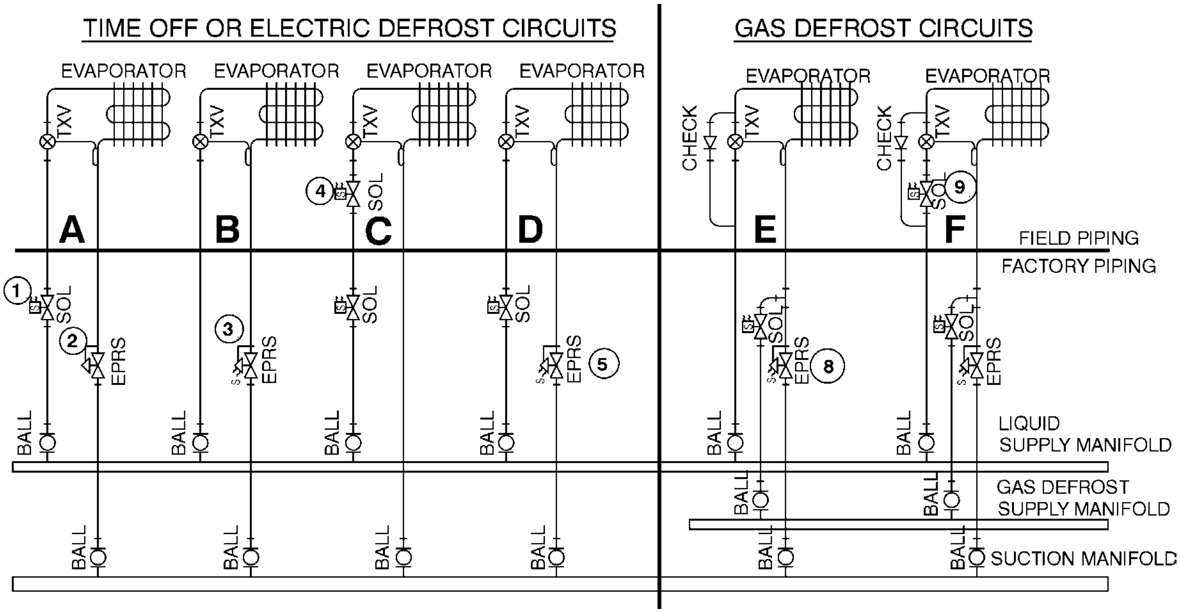
Below are program charts for the multi-circuit time clock. These charts may be used to design a defrost program for an entire parallel system.





SECTION 15

Refrigeration Circuits - Electric, Time Off or Gas Defrost



Time Off or Electric Defrost Circuits

The following component arrangements are associated with cases or unit cooler coils equipped with electric defrost heaters, air or timed off-cycle defrost. The purpose of these arrangements is to stop the flow of refrigerant through the evaporator while it is defrosting. Termination with electric defrost is by (TG) sensing relays (all cases except N6F & N6FL) or a termination pilot circuit. All termination methods use the failsafe feature of the multi-circuit time clock or a control relay in a computer controlled application.

A. Liquid flow can be interrupted by a factory mounted, normally closed, liquid line solenoid valve (1) controlled by the multi-circuit time clock or computer controller. An evaporator pressure regulator (EPR) (2) valve is factory installed on the suction stub of the compressor rack for temperature regulation (by pressure) of the entire lineup.

B. A variation of “A” omits the liquid line solenoid valve. Instead, the EPR (3) is equipped with a solenoid valve controlled by the multi-circuit clock or computer controller. When the solenoid valve is energized, it will force the EPR to shut (suction stop) and refrigerant flow in the lineup will cease.

C. When precise case temperature control is desired, each case is equipped with a liquid line solenoid valve (4) (normally closed) which is cycled by a thermostat. The thermostat will use a bulb to sense entering air temperature. No EPR valve is required. The control circuit for these multiple solenoids will be controlled by the multi-circuit clock or computer controller.

D. This lineup is a variation of “A”. The suction stop feature of an EPR (5) is employed for defrost in combination with a liquid line solenoid. This slows and eventually stops the feeding of refrigerant through the expansion valve while in defrost and is often used on medium temperature circuits.

Gas Defrost Piping Arrangements

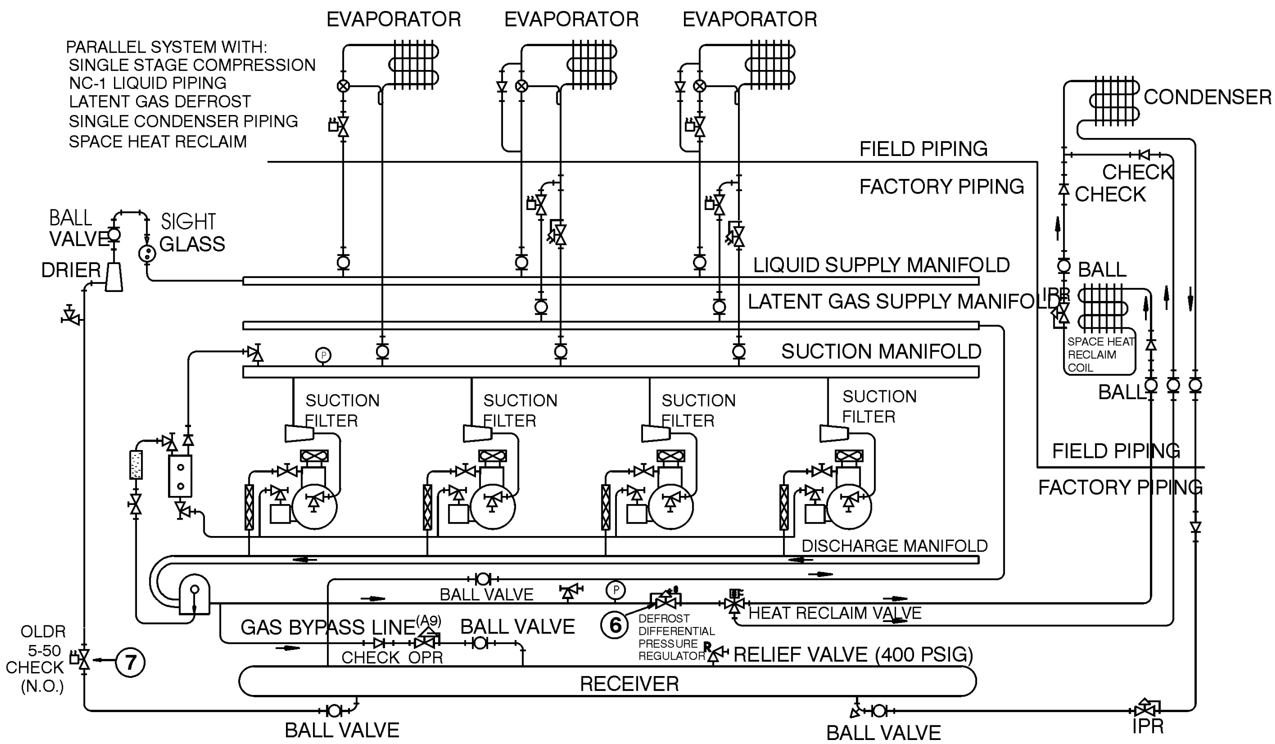
E. (SORIT, BEPRS) - This type of EPR valve (8) is a minimum pressure drop valve which uses the system's high pressure to operate the valve. With regards to Sporlan's SORIT, the initial S stands for the solenoid stop, ORI stands for "Open-on-Rise of Inlet Pressure", and the "T" is the schrader access valve used in adjusting the valve (8). The SORIT's suction stop solenoid is controlled by the time clock or computer controller and closes the valve during defrost.

F. An optional variation of "E" adds a liquid solenoid (9) just upstream of the expansion valve. The solenoid can be used for temperature control in conjunction with the EPR.

On all of these arrangements, the hot gas line is equipped with a solenoid valve. At the beginning of defrost, the valve is opened, allowing hot gas to flow to the evaporator coil. A termination thermostat operating a pilot circuit shuts off the gas flow when termination temperature has been reached in the fixture.

The EPR valve does not open again until a drip down or drain down time has been allowed. A 10 to 26 minute time period allows the evaporator coil and drain pan to clear. The entire time period set on the multi-circuit time clock or computer controller is called the "Failsafe" time period; it includes both the defrost and the drip down time. However, if at any time during this drip down period a fixture's temperature drops 10°F or more, the defrost will be reinitiated. Although this is true for all cases, it is most prevalent in the N6F(L), NFJGCX, P5FG and P5FGN cases. It will continue until either temperature termination or Failsafe time from the initial defrost termination passes.

Refrigeration Circuits Piping Diagram



Gas Defrost Circuits

Hot gas from the receiver is used to defrost cases by reversing the flow through the evaporator coil. This flow reversal must be done by devices added to the parallel rack piping, including the hot gas manifold which is run parallel to the suction and liquid manifolds.

System pressure must be directed to the portion of the system that is in defrost. This is accomplished using an electrically operated DDPR valve (6) in the discharge line. The system pressure pushes hot gas through the suction line, where it condenses into liquid in the frost laden evaporator coil. Movement of the condensed hot gas liquid into the liquid manifold is induced by creating a 20 pound drop in the liquid pressure. This is done with the normally open OLDR valve (7). When a part of the system goes into defrost, the OLDR valve (7) is energized and modulates to a partially closed position, creating the pressure drop required.

This valve arrangement provides the necessary pressure difference to ensure a reverse flow through the specific branch circuit. The OLDR valve (7) and the DDPR valve (6) operate together during any defrost cycle. When the defrost is terminated the DDPR valve (6) and the OLDR valve (7) are returned to the open position allowing normal system operation to resume. This valve arrangement provides both system stability and the necessary difference in liquid pressures to ensure flow of the condensed hot gas liquid from the defrosting fixture.

SECTION 16

Receiver Gas Defrost

Receiver gas defrost is accomplished by using the relatively cool gas from the top of the receiver. The cool gas is discharged down the suction line to the evaporator, where it begins to condense, giving up latent heat in melting the accumulated frost from the evaporator. The defrost gas, being at a relatively cool temperature at the start of defrost, reduces thermal stress on the piping, thereby reducing the possibility of line breakage and loss of refrigerant. The gas volume in the receiver is constantly being supplied from the compressor discharge line which maintains gas flow throughout the defrost cycle.

Receiver gas defrost is available for case lineups operated by a parallel compressor system. Defrost is accomplished by using the cool saturated gas from the receiver at elevated pressures. The compressor discharge gas is injected into the receiver. As the discharge gas passes over the liquid in the receiver, it is desuperheated. This provides a positive pressure, which helps maintain the flow of liquid to the refrigerated fixtures during defrost. About 25% of the total load can be defrosted at one time, and the remaining 75% of the load is needed as a heat source for the defrosting cases.

Receiver gas defrost is initiated by either a mechanical or electronic multi-circuit time clock or computer controller. These devices provide the proper sequence of defrosts. Only one circuit is to be defrosted at a time, if this is not adhered to, the entire system may operate improperly.

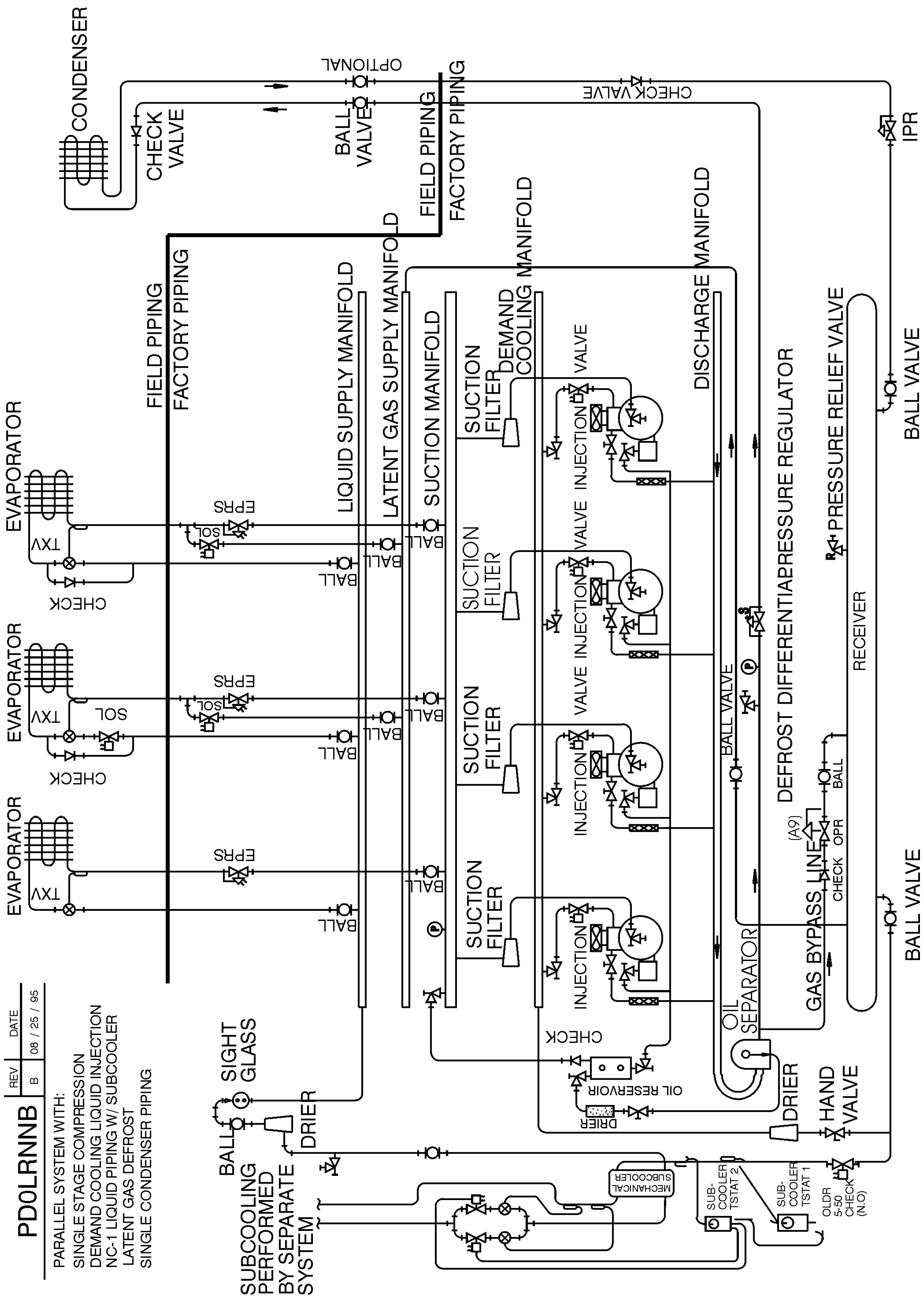
Systems having a DDPR valve in the discharge line are to be set for a 20 psid differential across the valve. This valve is necessary in cold ambient areas, below 30°F, because it ensures adequate gas flow during defrost to the defrosting fixtures.

Control Strategy (NC-1 Latent Heat / Receiver Gas Defrost)

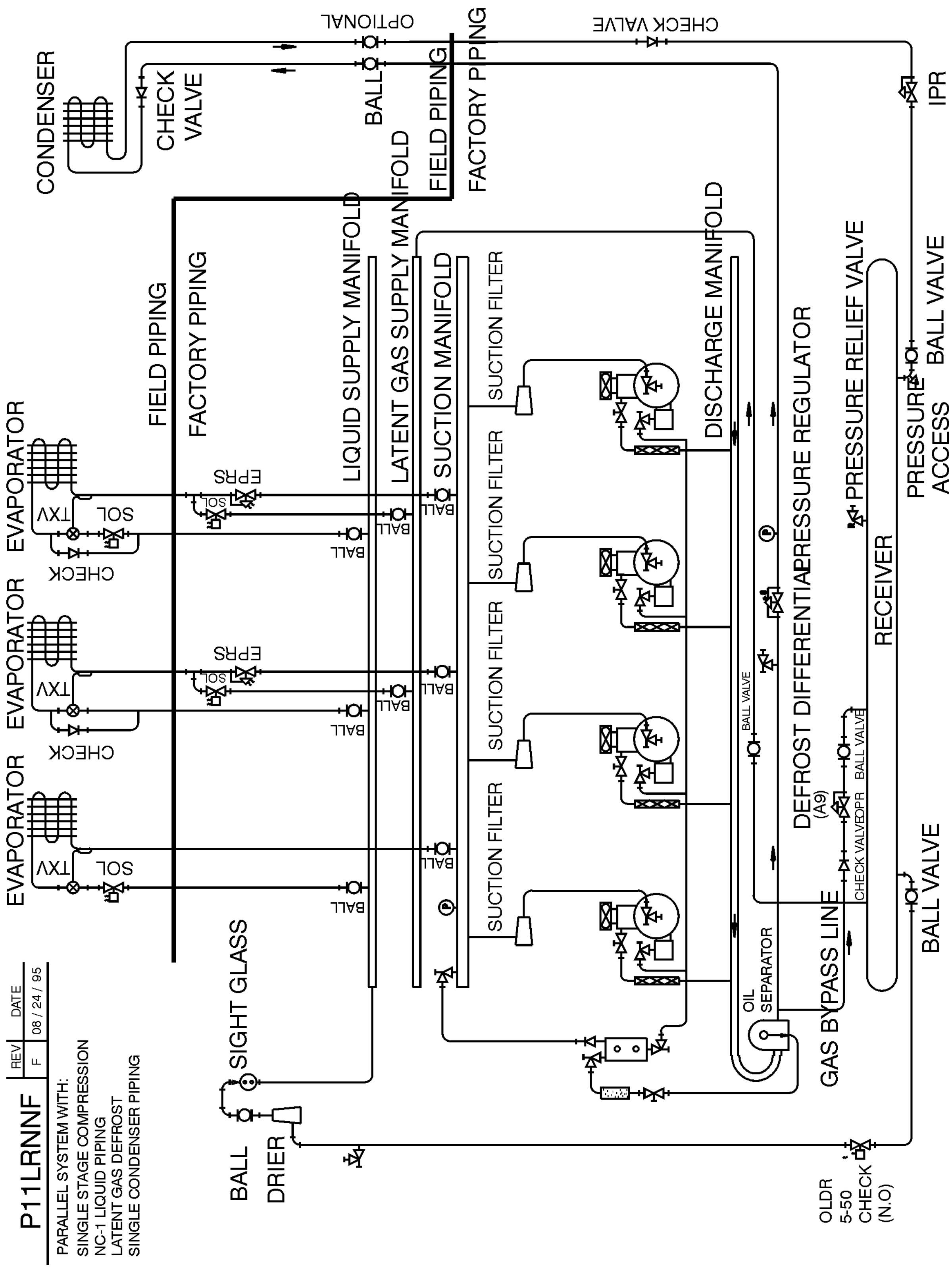
1. Remote Condenser Fans are controlled by a pressure control, set for the minimum target pressure corresponding to 88°-89°F saturation temperature. This ensures adequate defrost during cold ambient temperatures.
2. Outlet Pressure Regulator (OPR) Valve is set for the target pressure corresponding to 86°-87°F saturation temperature.
3. Inlet Pressure Regulator (IPR) Valve is set for the target pressure corresponding to 94°-95°F saturation temperature.
4. The OLDR Liquid Solenoid Valve is energized during defrost to create a pressure differential. Refer to table on page 10-2 for proper adjustment.

Piping Diagram

for Parallel System with Demand Cooling, Mechanical Subcooling & Latent Gas Defrost



Piping Diagram **for Parallel System with Latent Gas Defrost**



SECTION 17

Parallel System with NC-2 & Heat Recovery

TYLER Refrigeration manufactures multi-compressor parallel systems with two or more compressors. They can be of various size and capacity and operate at different suction temperatures. All compressor units are electrically powered and use electro-mechanical switches or electronics to control their operation. The compressor control panel contains all the necessary controls to operate the compressors properly. The systems are designed to be used with remote condensers and optional heat recovery coils.

The systems utilize either a horizontal or vertical receiver tank. Compressor horsepower sizes may be mixed for flexibility in capacity control. Each system is individually designed for the specific needs of a given application. It is unlikely that any two parallel system assemblies will be exactly alike.

- A typical installation will usually consist of more than one parallel system.
- A typical installation may use R-22 or R404A refrigerants.

Separate loads will be connected to the parallel rack at the liquid and suction line manifolds. Temperature control at each individual circuit will be provided by an evaporator pressure regulator (EPR) valve in the suction lines or by thermostats with liquid or suction line solenoid valves.

Typical Piping & Devices - All Systems

See page 17-3 for "Piping Diagram for Parallel System with NC-2 & Heat Recovery".

All liquid refrigerant flowing out to the case and cooler circuits must pass through a replaceable core filter drier (1). This filter and the filters in the suction line of each compressor are important in keeping installation debris from damaging the components in the system.

- The drier element absorbs and holds moisture, acids, sludge and varnish which may be in the system.

A moisture indicating sight glass (2) tells when the drier needs to be changed; it also shows flow through the liquid line. A liquid level gauge on the receiver determines the system charge. Factory piping includes three ball shutoff valves (3) to aid in servicing. There are also service valves at each station on the liquid manifold (4) and suction manifold (5).

- Additional ball valves (6) are recommended and optionally supplied for field installation at the points shown. This makes the completed system fully serviceable at any point with a minimum of refrigerant loss.

Each compressor has a replaceable core suction line filter (7). A schrader valve is on the filter body; one can also be installed on the suction service valve of the compressor to make a pressure drop check of the filter's condition possible.

Discharge gas from the compressors is piped through an oil separator (8). Refrigeration oil is removed from the hot gas and oil mixture to be sent back to the oil float system. This lubricates the compressors and minimizes the amount of oil getting in the evaporators. Oil from the separator is piped into an oil reservoir and distributed to the oil level controls on each compressor.

- Most parallels are equipped for heat recovery (HR) so that heat may be reclaimed and put back into the building. A diverting valve (9) redirects hot gas to the HR coil (10) when heat is demanded by the Environmental Control Panel thermostat.

The Heat Recovery (HR) coil is optionally equipped with an inlet Pressure Regulator (IPR) on systems with Nature's Cooling (NC-2 or NC-3). The IPR valve is standard on NC-2 systems. The valve raises the system pressure during heat recovery to get more heat out of the discharge gas.

In most other systems, liquid from the remote condenser returns directly to the receiver. Natural subcooling is diminished since the liquid mixes in the receiver and warms, to some extent, in the machine room. NC-2 preserves the naturally cooled liquid's temperature by bypassing the receiver when advantageous to do so. The bypass line is operated by a liquid temperature sensing thermostat (11). When liquid returning from the remote condenser rises to 70°F, the valve closes. The liquid then flows directly into the receiver.

When outside temperature drops the condenser fans begin shutting off because they are set on a temperature sensing thermostat. When the temperatures fall, pressure in the system also drops. However, the pressure inside the receiver is allowed to fall only so far; the minimum allowable pressure is the point where system performance will be hurt. The receiver pressure is kept from falling below this minimum point by an Outlet Pressure Regulator (OPR) valve (12) located in a gas bypass line run from the compressor discharge to the receiver. As temperatures / pressures drop the OPR valve opens, allowing gas from the compressor discharge to maintain the pressure in the receiver. This also causes liquid to start backing up in the condenser because the receiver will be at a higher pressure than the condenser. During low ambient periods, the system pressure will be maintained at the setpoint of the OPR valve.

- The OPR is also known as a downstream pressure regulator.

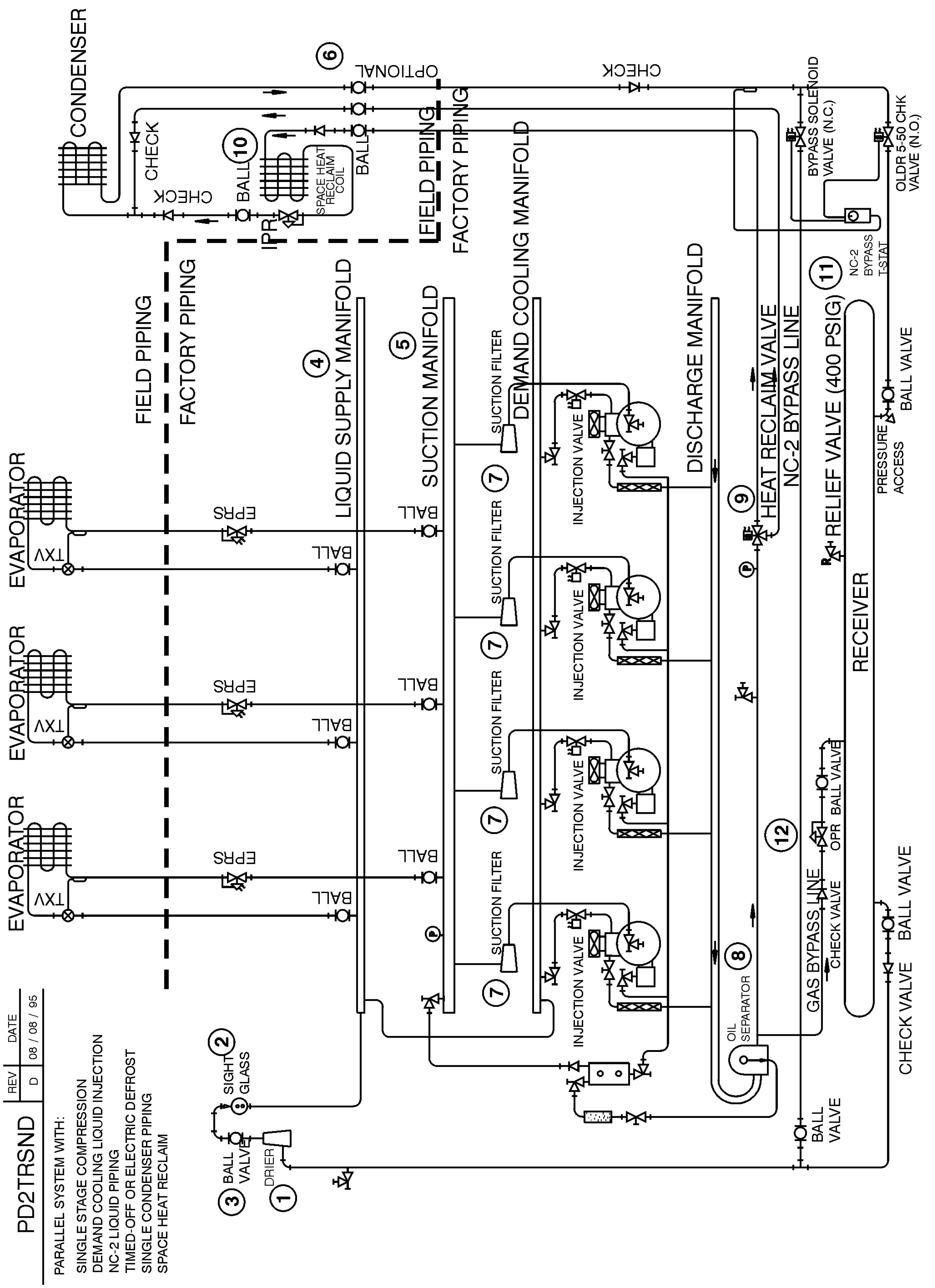
NC-2

This system operates with the receiver continuously at the same head pressure as the condenser. ***Refer to "Pressure Regulator Settings" on pages 9-1 & 9-2 for proper pressure settings.*** Its design raises system efficiency by maximizing the amount of natural liquid subcooling while allowing the compressors to operate at the lowest possible compression ratios. Simplicity is attained by reducing the number of valves in the system. NC-2 functions with a normally open solenoid valve located in the liquid return line between the condenser and the receiver. With this valve open, there is direct and unconstrained liquid flow from the condenser to the receiver (head pressures are allowed to "float"). The only time the solenoid valve will close is during NC-2 operation or for gas defrost (if used). During NC-2 operation (when the temperature of the liquid returning from the condenser is less than 70°F) flow will completely bypass the receiver.

NOTE

Use of split condenser piping may reduce the effectiveness of NC-2.

Piping Diagram for Parallel System with NC-2 & Heat Recovery



Parallel System with Heat Recovery & Companion

In the medium temperature range, the typical refrigeration (case) load operates at 20°F suction temperature. Lowering the pressure to accommodate a few meat or deli operating at 10°-15°F would penalize the whole system. Because the lower the suction pressure at which a compressor is operated, the less efficient it is. The entire system would have to operate at this lower suction pressure. By adding a companion,one or more compressors operate at this lower efficiency rate, while the other compressor(s) run at peak efficiency.

A companion compressor's suction line runs directly to the meat or deli cases. A 2 pound check valve connection to the suction manifold allows the adjacent parallels to help pull down the meat/deli cases temperature immediately after defrost. If there were sufficient meat/deli cases to warrant it, the boosters could be on a separate parallel system.

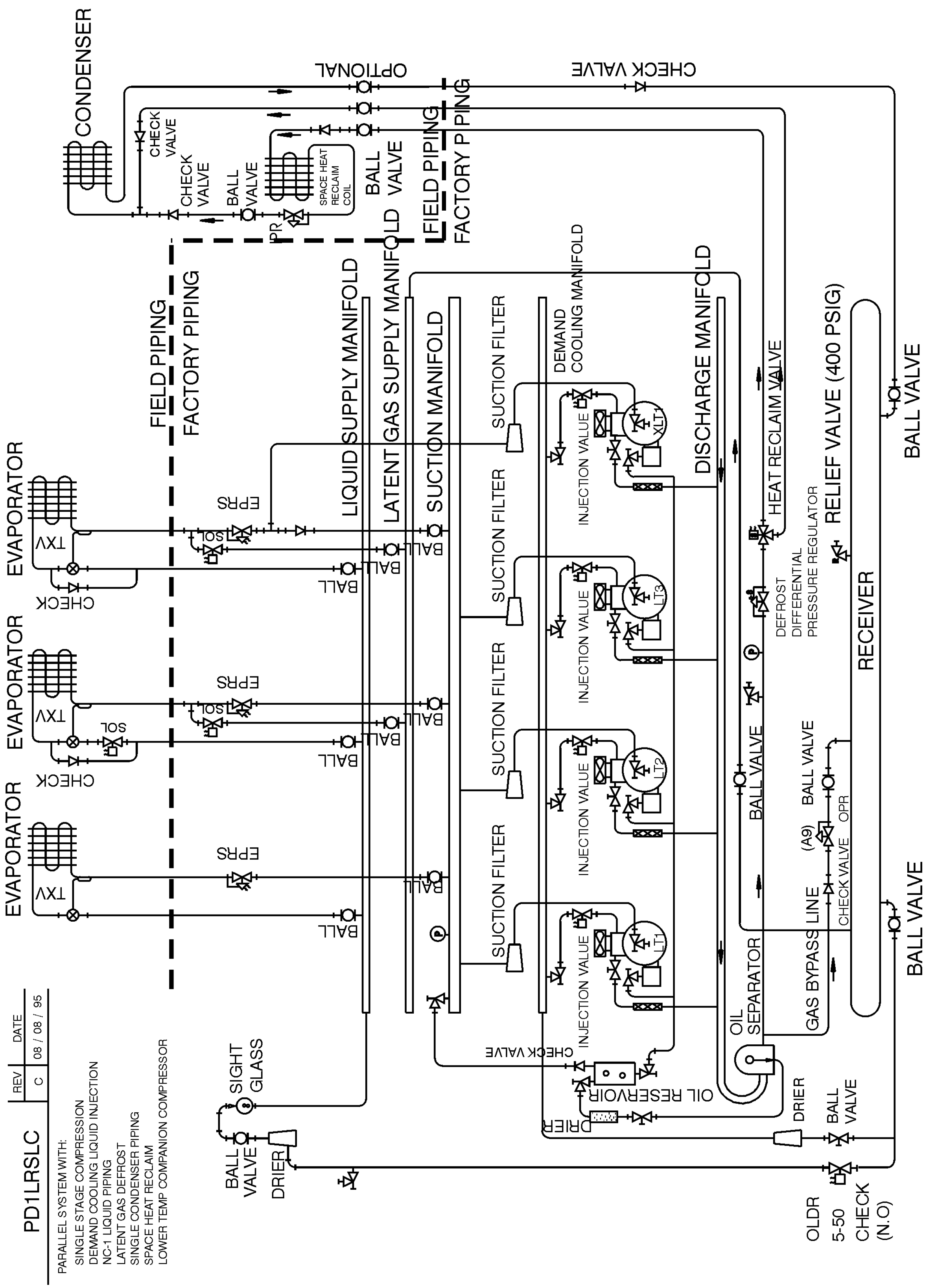
Ice cream case companion compressors on low temp systems work similarly. The normal low temp frozen food cases are at -20° to -25°F while the companion operates the ice cream cases at -35°F. The parallel compressors on the frozen food system assist the booster in rapid temperature pulldown after defrost through the 2 pound check valve connection.

Companion Compressor Protection

All companion compressors are equipped with a 2 minute delay to protect against short cycling. When a companion compressor is applied to a gas defrost system, an additional time-delay relay is used to lock the compressor out after a defrost for a few additional minutes. This allows the companion suction line to cool preventing possible liquid slugging and/or thermal cutout because of high suction line temperature.

See page 17-5 for "Piping Diagram for Parallel System with Heat Recovery & Companion".

Piping Diagram for Parallel System with Heat Recovery & Companion



Parallel System with Mechanical Subcooling

Mechanical subcooling makes the entire system more efficient and allows closer sizing of compressor to cases in the sunbelt states. It also provides a capacity reserve for hot weather protection.

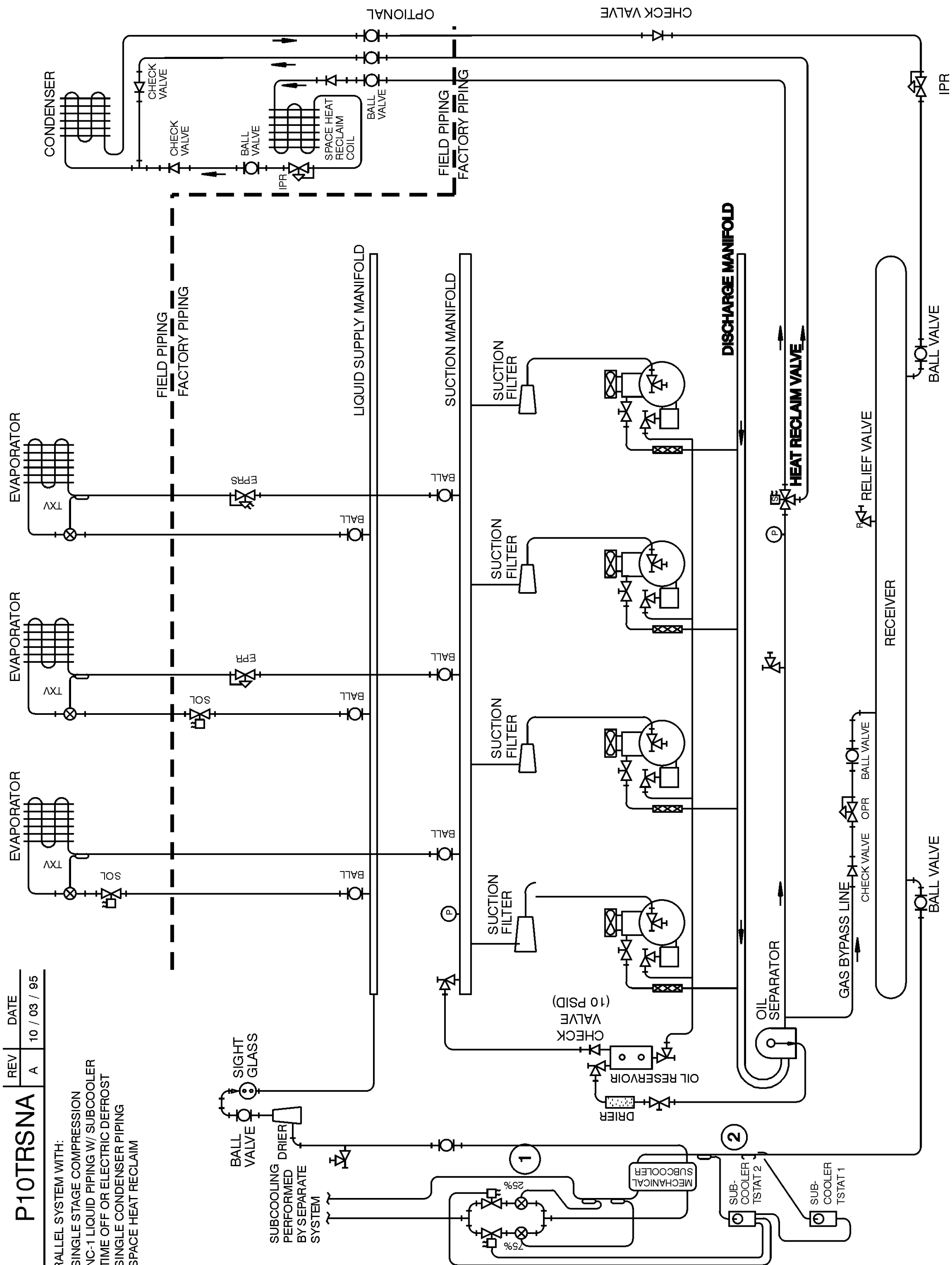
The subcooler compressor operates at a high efficiency suction temperature of approximately 40°F. Subcooler liquid supply is usually from a separate system.

The liquid line feed to the expansion side of the subcooler is controlled by two paralleled, normally closed, solenoid valves upstream of two expansion valves (1). The solenoid valves are sized at 75% and 25% of the total subcooling load. The solenoid valves are thermostatically controlled (2). While the liquid inlet temperature is above 70°F, the 75% solenoid is energized. If the temperature falls below 70°F, the 25% solenoid is energized.

The settings for the 25% thermostat are 55°F ON and 40°F OFF. The subcooler compressor is controlled and protected by its own pressure control. When liquid return temperature is above 55°F, the subcooler will cycle ON and OFF between 55°F and 40°F.

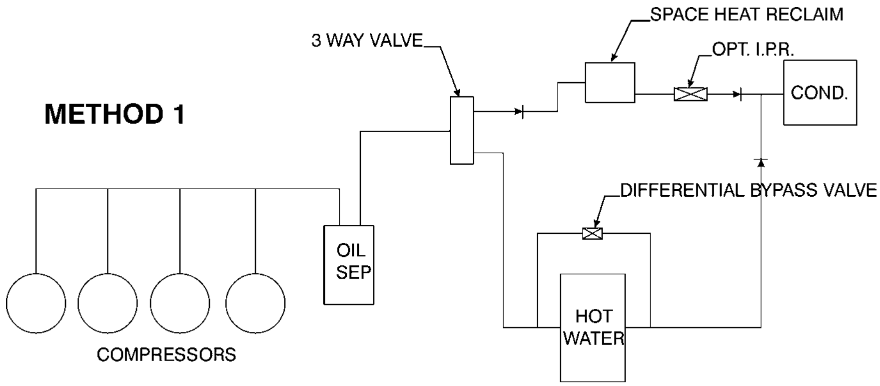
See page 17-7 for "Piping Diagram for NC-1 & Mechanical Subcooling".

Piping Diagram for Parallel System with NC-1 & Mechanical Subcooling



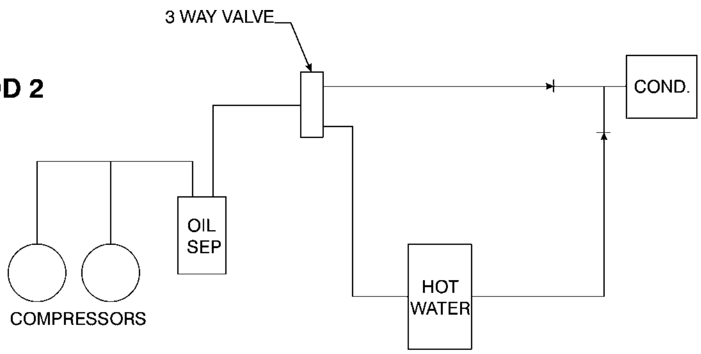
Hot Water Piping Methods

METHOD 1



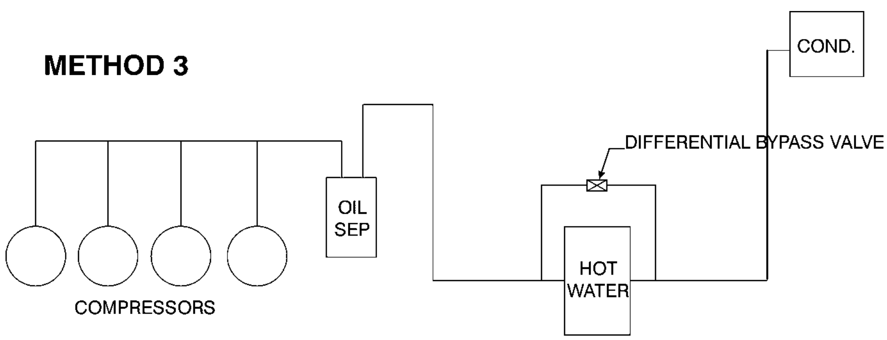
FULL PARALLEL ON HOT WATER OR SPACE HEAT RECLAIM

METHOD 2



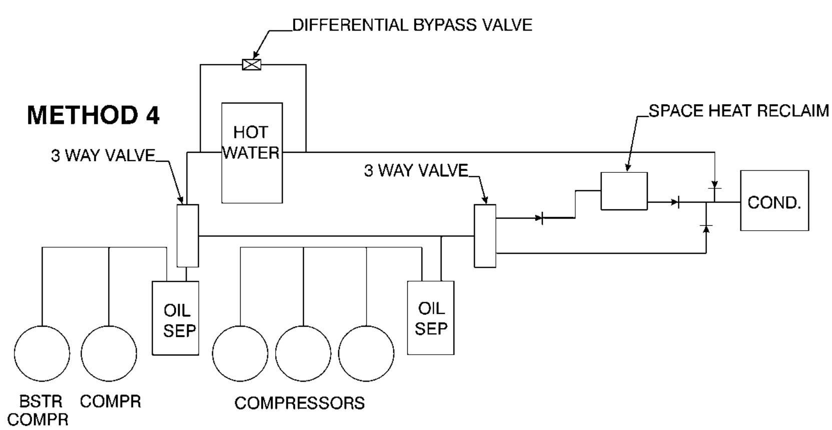
FULL PARALLEL ON HOT WATER RECLAIM (W/3 WAY VALVE)

METHOD 3



FULL PARALLEL ON HOT WATER RECLAIM (W/BYPASS VALVE

METHOD 4

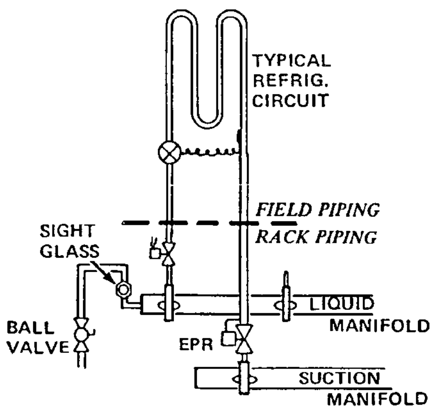


SATELLITE COMPRESSOR(S) >10 HP ON HOT WATER
RECLAIM W/MAIN PARALLEL ON SPACE HEAT RECLAIM

SECTION 18

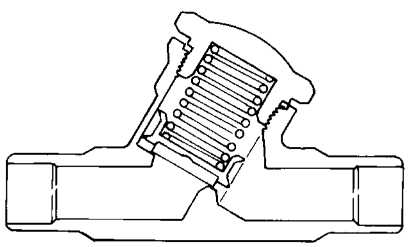
Component Description & Definitions

Refrigeration Branch Circuit



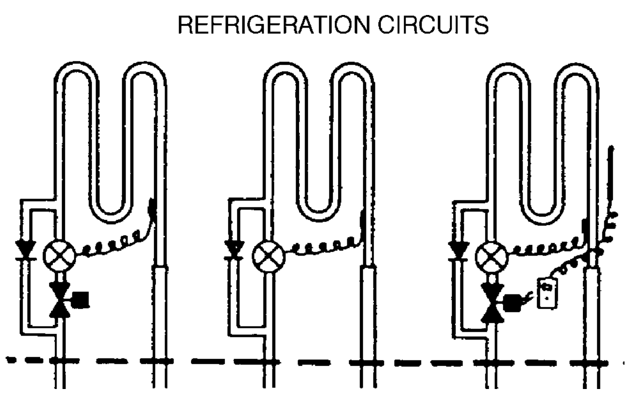
A Refrigeration Branch Circuit is a lineup or group of cases and/or coolers connected to a common liquid line solenoid and common suction line. The suction line may or may not be equipped with an EPR valve.

Check Valve (Symbol = ⧏)



Parallel systems employ a number of spring loaded check valves of various sizes. They allow gases or liquid flow in only one direction. Three different spring loadings are used.

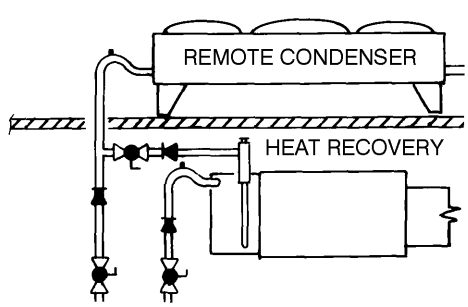
Check Valve Locations



"Normal" Check Valves - The spring above the valve disc assures positive return and seating.

Applications:

1. In cases around the expansion valves and liquid line solenoid valves to provide reverse flow of liquid during gas defrost.
2. At the inlet and outlet of the heat recovery coil. Three are provided with the unit for field installation.



OLDR Liquid Differential Regulator Valve

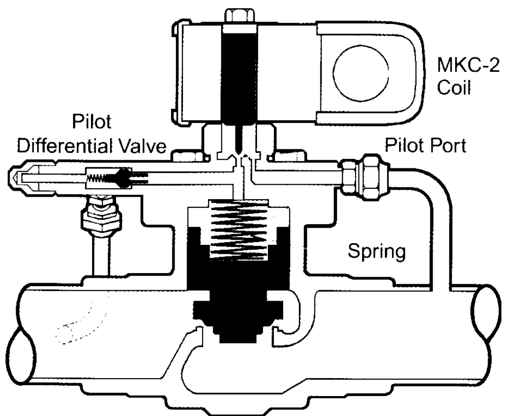
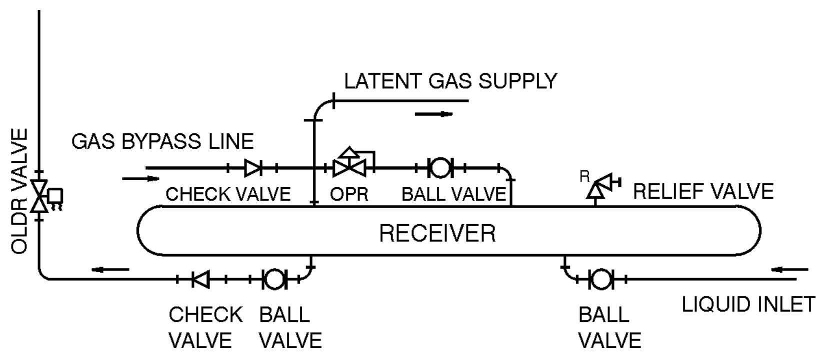
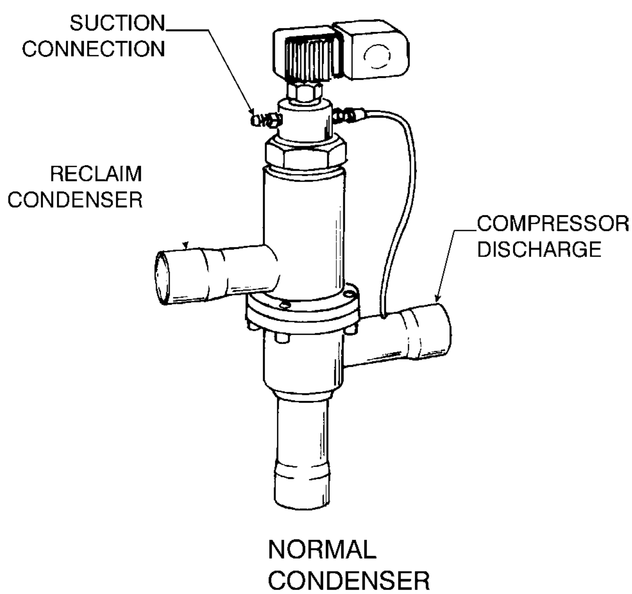


Figure 1

The OLDR Valve is used at the outlet of the receiver to provide a pressure difference between the gas manifold and liquid line manifold. This assures liquid refrigerant movement from case coils while on defrost. Any lack of liquid refrigerant for circuits not in defrost is made up using liquid in the receiver.



Heat Recovery Valve

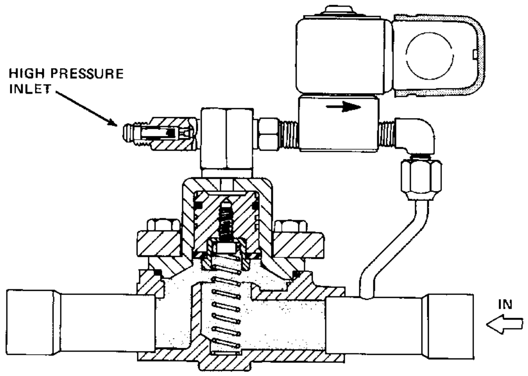


This 3-way valve is used for heat reclaim, thereby eliminating the need for an N.O. solenoid.

In the de-energized position, the discharge gas is routed through the outside condenser and the gas in the heat recovery coil is isolated using check valves. The gas in the line between the diverting valve and the check valve upstream of the heat recovery coil is fed back through the valve and into the suction side of the system.

In the energized position, discharge gas is fed through the valve and into the heat reclaim coil and then into the remote condenser. The line to the suction side of the system is automatically closed through the valve.

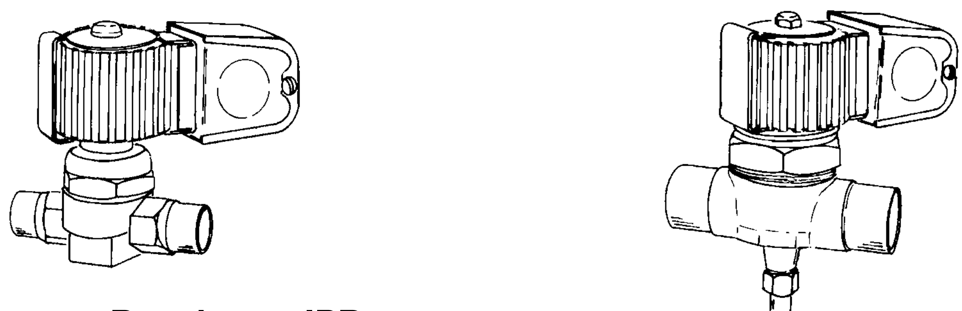
Suction Stop Valve



This normally open valve is operated from the multi-circuit time clock or computer controller. During the refrigeration cycle the valve is de-energized and remains open. The valve makes use of the system's low pressure to hold itself open by porting the top of the piston to suction manifold. When defrost is initiated, the solenoid valve is energized, directing system high pressure to the top of the piston, closing the valve.

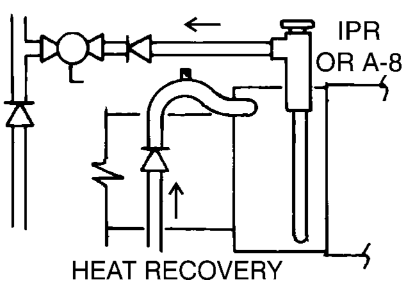
Liquid Line Solenoid

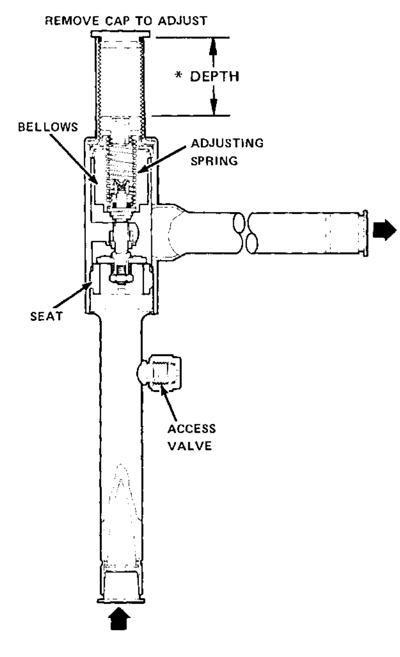
A normally closed valve in the de-energized position, must be energized to open during the refrigeration cycle. It may be used for circuits on electric or timed off defrost, or can be used with thermostats.



Inlet Pressure Regulator - IPR

The heat recovery (HR) coil is optionally equipped with an inlet pressure regulator (IPR) on systems which employ Nature's Cooling (NC-2). The IPR valve is standard on NC-2 systems. The valve raises the system pressure during HR to get more heat out of the coil.





As shown, the outlet pressure from the heat recover coil is exerted on the underside of the bellows and the top of the seat disc at the same time. Since the effective area of the bellows and the disc are the same, the two pressures cancel out. The force of the incoming pressure alone will work against the spring pressure to operate the valve.

See page 9-1 for pressure setting requirements.

ORIT & IPR or A-8 Pressure Settings

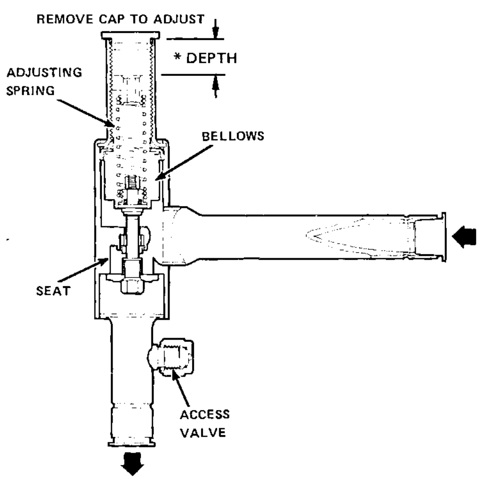
PRESSURE SETTING (PSIG)	ORIT-10 SPOR X62	IPR-10 GR5172	IPR-10 GR5171	IPR-6 GR5170	A-8
	DEPTH	DEPTH	DEPTH	DEPTH	SEE SECTION 9-1
135	1/2”	19/32”	19/32”	1/2”	-----
185	11/16”	47/64”	47/64”	5/8”	-----
200	3/4”	51/64”	51/64”	21/32”	-----

Changes per turn: ORIT-10 = 17 psig IPR-10 = 14 psig IPR-6 = 24 psig A-8 = N/A
(See Section 9-1)

Adjusting IPR and OPR Valves

The factory setting must be adjusted to recommended settings soon after starting the system. The valve can be adjusted by installing a pressure gauge on the Schrader valve and turning the adjusting screw IN to raise the pressure. An allen wrench is required for the adjustment screw. ***Remember: The system must be in defrost to provide flow through the valve.***

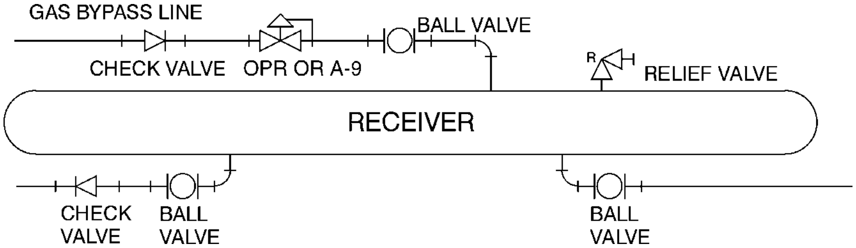
Outlet Pressure Regulator - OPR



This valve is designed to be sensitive only to its outlet pressure. The inlet pressure is exerted on the underside of the bellows and on the top of the seat disc. Since the effective area of the bellows is equal to the area of the port, the inlet pressure cancels out and does not affect valve operation. The valve outlet pressure acting on the bottom of the disc exerts a force in the closing direction. This force is opposed by the adjustable spring force. Thus, by increasing the spring force the valve setting (pressure at which the valve will close) is increased.

As long as the valve outlet pressure is greater than the valve pressure setting, the valve will remain closed. As the outlet pressure is reduced, the valve will open and pass refrigerant vapor into the receiver. Further reduction in outlet pressure will allow the valve to open to its rated position where the rated pressure drop will exist across the valve port. An increase in the outlet pressure will cause the valve to throttle until the pressure setting is reduced.

The valve supplied with R404A systems has a range from 80 to 200 psi.
See page 9-1 for pressure setting requirements.

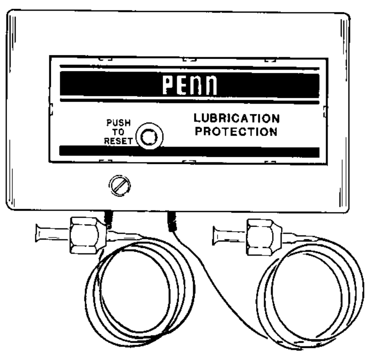


CROT & OPR Pressure Settings

PRESSURE SETTING (PSIG)	CROT 6X72 DEPTH	OPR-6 GR5168 DEPTH	OPR-6 GR5169 DEPTH	A-9 SEE SECTION 9-1
70	9/16”	49/64”	----	-----
90	5/8”	7/8”	----	-----
100	11/16”	29/32”	17/64”	-----
115	3/4”	31/32”	5/16”	-----
155	----	----	13/32”	-----

Changes per turn:	6X72 CROT = 27 psig	OPR-6 (50-130) = 15.5 psig	OPR-6 (80-200) = 24 psig	A-9 N/A (See Section 9-1)

PENN Oil Pressure Safety Switch

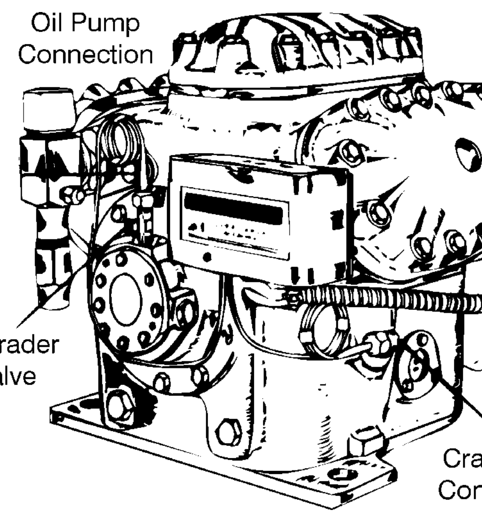


All Copeland and Carlyle compressors, 5 HP and above, are equipped with “Lubrication Protection” - a PENN term. The control is completely non-adjustable and set to Copeland & Carlyle specification.

The P45 control measures the net oil pressure available to circulate oil through the lubrication system. (Net oil pressure is the difference between the oil gauge pressure and the refrigerant pressure in the crankcase.)

When the compressor is started, the time delay heater is energized. If the net oil pressure does not build up to the “heater off or cut-out” value, within the required time limit, the time delay trips to stop the compressor.

If the net oil pressure rises to the “heater off or cut-out” value within the required time after the compressor starts, the time delay heater is automatically de-energized and the compressor continues to operate normally.



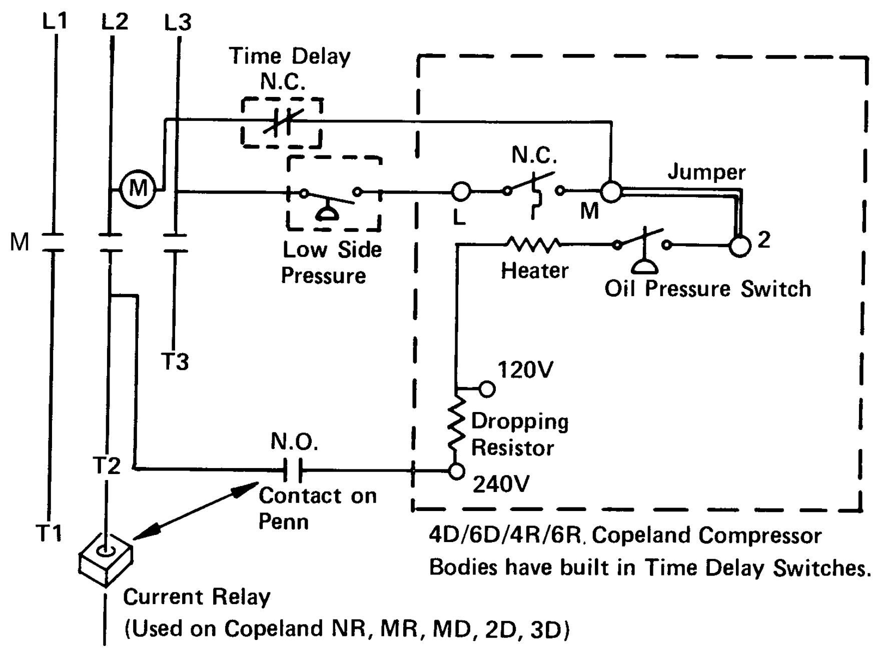
If the net oil pressure drops below the “heater on or cut-in” value during the running cycle, the time delay is energized. If the net oil pressure does not return to the “heater off or cut-out” value within the time delay period, the compressor will be shut down.

Mechanical Oil Pressure Safety Switch P45

COPELAND COMPRESSORS - 120 SECONDS TIME DELAY	
CUT IN 12 to 14 psig	CUT OUT 7 to 9 psig
SENTRONIC CONTROLS* - 120 SECONDS TIME DELAY	
CUT IN 12 to 14 psig	CUT OUT 7 to 9 psig
CARLYLE COMPRESSORS - 120 SECONDS TIME DELAY	
CUT IN 8 to 11 psig	CUT OUT 4 to 8 psig

** Sentronic - Copeland Only*

Oil Pressure Failure Switch Wiring



L1, L2, L3 — Power Supply Connections
T1, T2, T3 — Compressor Motor Connections

SECTION 19

Optional Sentronic & Sentronic+™ Electronic Oil Pressure Control

NOTE

Information in this section is based on Copeland Application Engineering Bulletin AE-1275-R8.

The optional Sentronics oil pressure safety control utilizes an electronic pressure sensor and module to precisely measure oil pump differential pressure. The main advantage of the Sentronic control is to eliminate traditional capillary tubes to measure oil pressure. A secondary advantage is the use of an electronic clock in the two minute time out circuit. Because of these two advantages, the Sentronic control will improve the overall reliability of the refrigeration system.

The Sentronic control has been specifically designed for the 3D, however most Copeland compressors have oil pump designs that can utilize this control. Sentronic can replace existing capillary tube controls in the field, and retrofit older Copeland compressors with compatible oil pump designs.

As in the past, all new and replacement Copelamatic motor compressors equipped with oil pumps require the use of an approved safety control. Failure to use an oil pressure safety control will be considered a misuse of the compressor.

To meet Copeland specifications, an oil pressure safety control must maintain its pressure setting and time delay calibration within close limits over the widest variation in operating conditions. This control must successfully pass a life test with a minimum 200,000 cycles. Controls must be of the nonadjustable, manual reset type with a 120 second nominal time delay at rated voltage. They must have a cut-out pressure of 9 psid $\pm$ 2 psid, with a maximum cut-in pressure of 14 psid.

Basic Operation

The Sentronic oil pressure sensor mounts directly into the oil pump. The sensor measures oil pump differential pressure, i.e., the difference between oil pump outlet pressure and crankcase pressure. The oil control sensor will then send an operating signal to the oil control module.

Should the oil pressure fall below 9 psid $\pm$2 psid for a period of two minutes, the module will open the control circuit and shut the compressor down. The two minute time delay serves to avoid shutdown during short fluctuation in oil pressure on start up.

Oil pressure can be approximately measured in the field. Oil pumps will still be furnished with a Schrader valve for the discharge high pressure port. To measure oil pressure, subtract crankcase pressure from discharge oil pressure.

If the oil pressure switch trips, it is a warning that the system has been without proper lubrication for a period of two minutes. Repeated trips of the oil pressure safety control are a clear indication that something in the system requires immediate remedial action. On a well designed system, there should be no trips of the oil pressure safety control. *Repeated trips should never be accepted as a normal part of the system operation.*

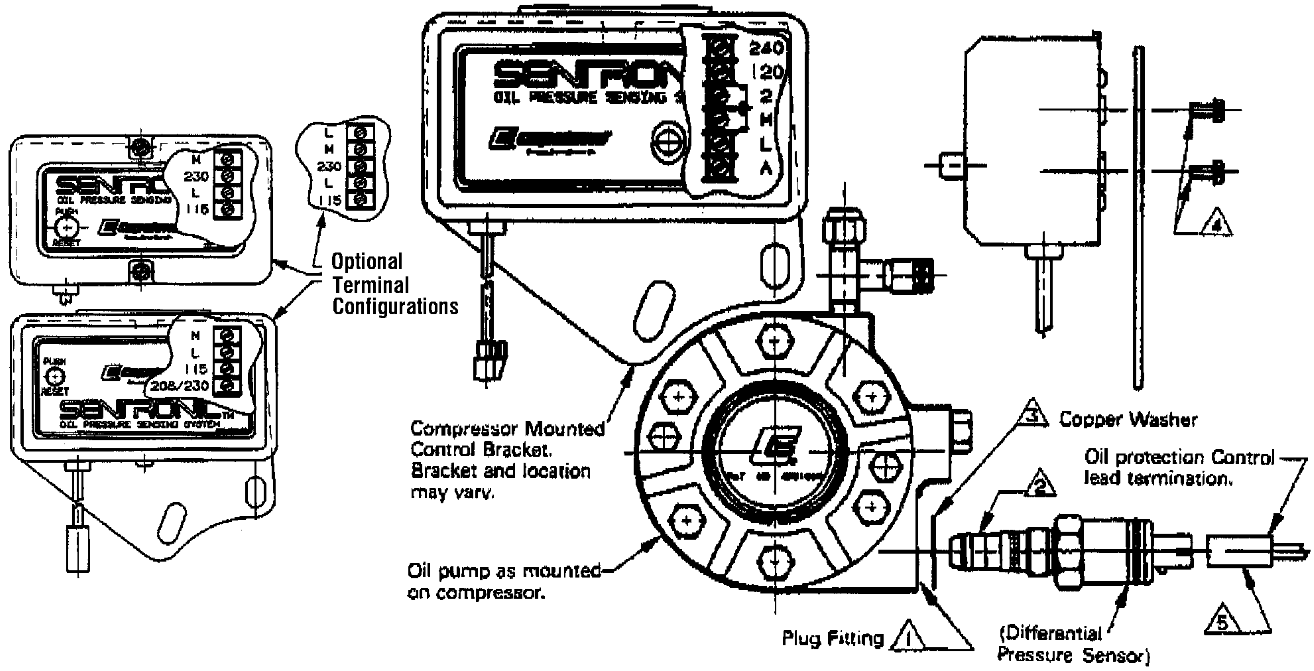
Once the oil pressure control has tripped, it must be manually reset to restore the system to operation. If the compressor net oil pressure falls below the cut-out setting of the control during operation and does not re-establish sufficient pressure **within 120 seconds**, the time delay circuit will open the L-M contacts and stop compressor operation.

IMPORTANT

If a power interruption occurs after an oil pressure safety trip, wait two minutes after the power is restored before resetting.

Installing Sentronic

All OEM Copeland compressors with oil pumps, shipped after September, 1986, have a plug fitting in the oil pump housing for mounting the sensor. The current oil pump is designed to accept either the Sentronic sensor or a capillary tube for the traditional mechanical oil pressure control.



To Install the Sensor

1. Remove the plug fitting from the oil pump housing.
2. Discard the copper washer from under the head of the plug fitting.
3. Install a new o-ring into the groove on the sensor. Use refrigeration oil to pre-lube the o-ring before installation. **NOTE: Use care not to cut the o-ring.**
4. Install a new copper washer under the hex flange of the sensor.
5. Screw the sensor into the oil pump housing, where the plug fitting was removed..
6. Torque the sensor to 60-65 ft-lb.

CAUTION

Do not over-torque the sensor during installation. Over-torquing could damage

To Install the Module

1. When using the bracket above the oil pump, use two 10-32 pan head screws with washers. The maximum screw length is .265 plus bracket thickness.

CAUTION

Do not use mounting screws that are too long. Screws over .265 is length could damage the circuit board.

2. Plug the cable from the module into the end of the sensor. *Care should be taken not to wrap the cable around a current carrying conductor.*
3. Hi-Potting: Copeland hi-pots the module as part of final processing. If additional hi-potting is required, it is recommended it be limited to one time only.

CAUTION

Excessive hi-potting can cause damage to the Sentronic module.

Electrostatic Painting

Static electricity discharges from electrostatic painting can damage the Sentronic module. It is recommended that the module not be mounted until such painting is complete.

Sentronic Troubleshooting

Checking the Sensor

Unplug the sensor and start the compressor. Simultaneously measure the oil pump differential pressure. Monitor the two terminals, at the back of the sensor, with an ohmmeter or continuity measuring set. If the differential pressure is below 7-9 psid, the sensor circuit should be open (infinite resistance or no continuity). If the pressure is above 12-14 psid, the sensor circuit should be closed.

Checking the Module

Shut off the compressor. Unplug the sensor. Verify the module is powered (230 volts [or 115] across the 230 volt terminal and L on the control). Start the compressor with the sensor unplugged. **After 120 seconds plus an additional 15 seconds**, the contact between the L-M terminals should open and shut off the compressor. If not, the timing circuit is defective and the module must be replaced. With the module off on oil pressure, press the reset. If there is power to the module, the contactor should close and start the compressor.

Electrical Connection Instructions

CAUTION

Damage to the Sentronic module will result if the “M” terminal of the Sentronic is connected to ground or directly to line voltage!

NOTE

When changing components or making any kind of electrical alterations to any installation, existing or new, all ground connections must be specifically checked to make sure they are secure. If there is any doubt about component or system grounding, the local electrical inspector should be consulted.

The electrical connection diagrams included in this section are intended to represent the most common Sentronic application control circuits. The system manufacturer should be consulted when more complex circuits are encountered.

Standard Control Circuits

Current Sentronic

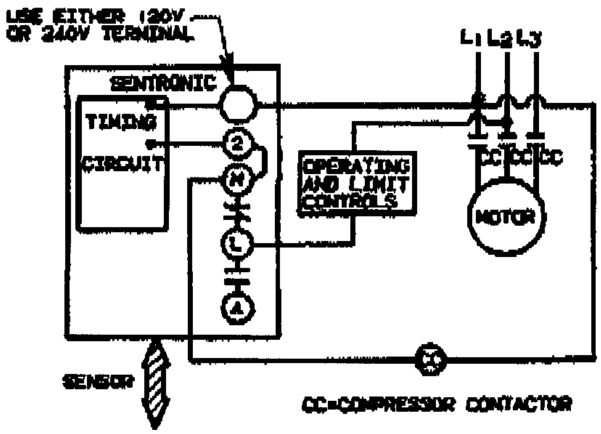


DIAGRAM 3A

Previous Sentronic

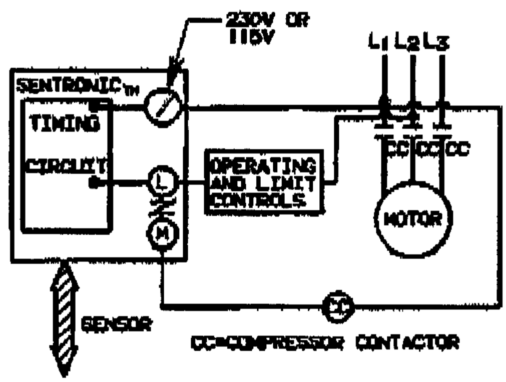


DIAGRAM 3B

Both Diagrams 3A (new Sentronic) and 3B (previous Sentronic) show typical wiring connections and the similarity of Sentronic and Sentronic oil pressure switches used on three-phase motor compressors.

Sentronics are energized when they are connected to a voltage source. In both diagrams 3A and 3B, if the compressor controlling and overload devices are closed, the compressor starts and at the same time, a circuit is made from one side of the power to incoming lines to the "L" terminal. The "L" terminal is one side of the "L-M" N.C. contact of the Sentronic module. The "M" side of the N.C. contact is usually connected to the compressor contac tor coil. The circuit for the electronic module power is completed by the connection of the 230/240 (or 115/120) volt terminal to the other side of the incoming power line.

The electronic two minute timing circuit operates whenever voltage is applied to a Sentronic, and it has not tripped. The timing will be iterrupted when oil pressure rises above 12-14 psid and closes the Sentronic sensor. Should oil pressure not build up suffi ciently for 120 seconds, the electronic delay will time out, open its L-M contact, break the control circuit, and de-energize the compressor contactor to stop compressor operation.

While the compressor is running, if the compressor net oil pressure falls below the cut-out setting of the sensor while operating, and does not re-establish sufficient pressure within an acceptable time, the time delay circuit will open the L-M contacts, stopping compressor operation. Once the oil pressure switch has tripped, it must be **manually reset** to restore the system to operation.

IMPORTANT

If a power interruption occurs after an oil pressure safety trip, wait two minutes before resetting after power is restored.

Control with Alarm

Current Sentronic

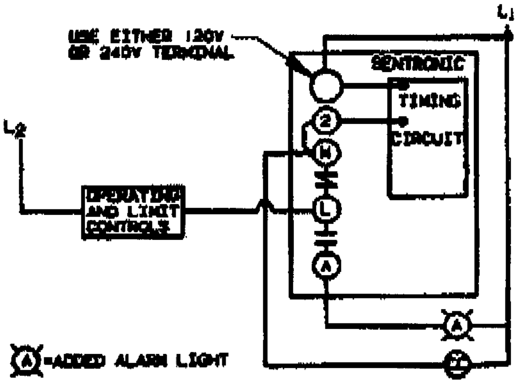


DIAGRAM 4A

Previous Sentronic

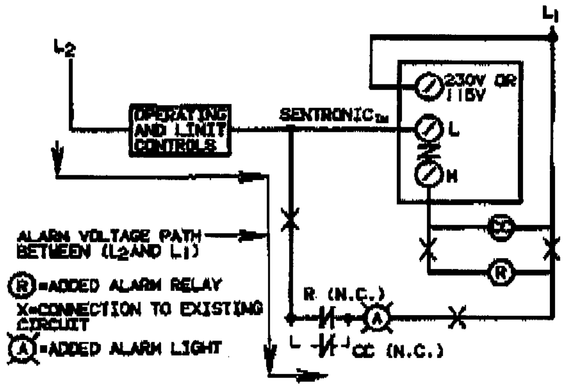


DIAGRAM 4B

Diagrams 4A (new Sentronic) and 4B (previous Sentronic) use an added alarm circuit. To contrast the 4 and 5 terminal Sentronic with the new Sentronic. The new Sentronic does not require an extra relay or auxiliary contact for an alarm circuit.

Using Current Sensing Relay to Prevent Nuisance Tripping of Pressure Control

On motor compressors equipped with internal inherent protection and oil pressure safety controls, it is possible for a trip of the oil pressure safety control to occur if the protector should open due to motor overheating or a temporary overload on the motor. In such an event, the control and contactor would still be closed, although the compressor motor would not be operating. The two minute timing circuit would be activated due to a lack of oil pressure, and after the 120 second time delay, the oil pressure safety control could trip. Even though the compressor motor had cooled sufficiently for the internal inherent protector to automatically reset, the compressor could not be started until the oil pressure safety control was manually reset.

Normally this is not a problem since the compressor, if properly applied, will seldom ever trip due to an internal inherent protector. If this does happen, the fact that the protector trip has occurred indicates that the system operation should be reviewed. However, on frozen food or other critical temperature applications, where a product loss may occur due to a compressor shutdown over night or weekend, it may be desirable to prevent the possible nuisance trip by means of a current sensing relay.

The PENN R10A current sensing relay has been developed for this purpose. It is mounted on the load side of the contactor. The relay senses by induction, the full operating current of one phase of the motor. It closes on a rise in load current above 14 amps and opens if the load current falls below 4 amps.

Current Sentronic

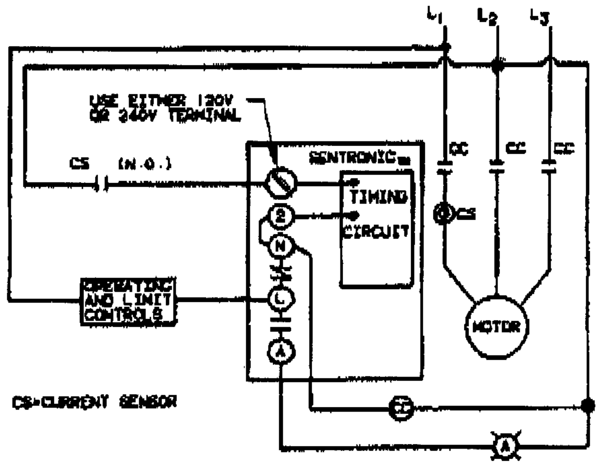


DIAGRAM 5A

Previous Sentronic

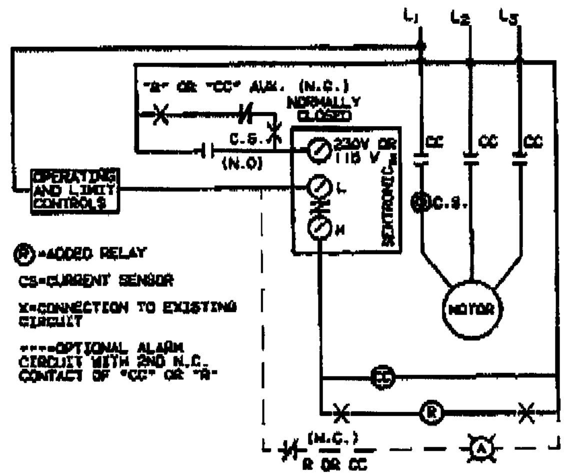


DIAGRAM 5B

Both Diagrams 5A and 5B use a current relay (C.S.). When the current relay is not energized by motor current, its Normally Open (N.O.) contact opens the circuit that powers the Sentronic to avoid a nuisance trip.

Diagram 5B shows the circuit used with the older model Sentronic. An external control relay, “R”, is required to maintain power to the module in the event of an oil pressure safety trip since the module requires power to reset. When the module is tripped on low oil pressure, relay “R” is not energized, and the relay “R” Normally Closed (N.C.) contact provides a voltage path to the module.

The circuit of Diagram 5A uses the new Sentronic. The current relay operates in the same manner as in Diagram 5B, but the oil pressure switch requires no power to reset, so it needs no external relay to provide a reset power path.

NOTE

On some 550 volt motor-compressors, it may be necessary to loop the current carrying wire so that it passes through the current sensing relay twice in order to increase the metered amperage to close the relay contacts.

Using a Separate Control Voltage with the New Sentronic:

Diagram 6 shows how the current Sentronic might be used with a voltage on its S.P.D.T. contact that is different from the voltage that supplies its power. Any A.C. voltage up to and including 240V might be used.

To use the Sentronic contact (S.P.D.T.) for a separate voltage, remove the jumper between terminals “2” and “M”. In this diagram, the separate control voltage is supplied by “LL1” and “LL2”. The separate voltage powers the compressor contactor (CC), by means of a

The Current Sentronic

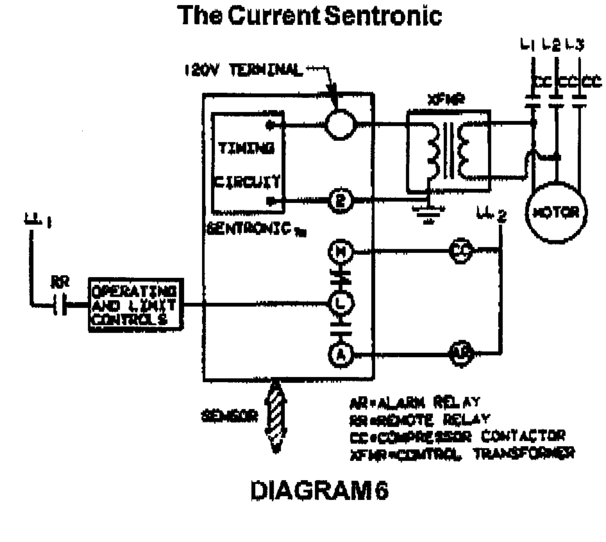


DIAGRAM 6

Remote Relay. When the Remote Relay is energized, requesting the compressor to run, its contact, (RR), closes to deliver “LL1” voltage energizes the compressors contactor coil (CC). When the compressor contactor closes, it provides the power, through a control circuit transformer (XFMR), to energize the Sentronic. If the Sentronic trips, its contact (“L” to “M”) in the “LL1-LL2” control circuit opens to de-energize the compressor contactor and stop the compressor. The Sentronic contact “L” to “A”) closes to energize an Alarm Relay (AR).

Field Retrofit Considerations

Sentronic can be used to replace conventional capillary tube style oil pressure controls in the field. Before retrofitting, determine if the existing oil pump is equipped with the plug fitting for mounting the sensor. Order appropriate kit from TYLER Refrigeration.

NOTES

- **Slight wiring differences exist from one manufacturer’s unit to another.**
- ***If wiring modifications are unclear, consult a certified electrician!***
- **No wiring modifications are required with solid state motor protection.**

Sentronic & Sentronic+™ Specifications

	Sentronic	**Sentronic+™**
CUT-OUT	9 psid ± 2 psid	9 psid ± 2 psid
CUT-IN	12-14 psid	12-14 psid
TIME DELAY	120 sec. ± 15 sec.	120 sec. ± 15 sec.
MAX. CONTROL	720 VA; 120 / 240 V	500 VA; 120 / 240 V
CIRCUIT VOLTS/AMPS	120 Volt, 6.0 Amps 230 Volt, 3.8 Amps	120 Volt, 4.2 Amps 230 Volt, 2.2 Amps
SENSOR TORQUE	60 - 65 ft/lb	60 - 65 ft/lb

The sensor and module are provided as a set. If a sensor or module is defective, order the Sentronic kit from TYLER Refrigeration.

Electrical Bench Checkout Procedure

The following instructions describes how the Sentronic may be easily bench-checked using only a voltmeter and a 120VAC electrical extension cord.

CAUTIONS

- **Damage to the Sentronic module may result if the "M" terminal of the Sentronic is connected to ground or directly to a voltage line!**
- **This test is conducted with 120VAC. A shock will result if the Sentronic terminals are touched when the Sentronic module is energized.**
- **Use care whenever working with any voltage! Make sure your electrical outlet is grounded, the electrical extension cord used has a ground wire, and the ground wire is connected to the grounding screw of the Sentronic.**

1. Apply 120VAC power to the Sentronic module terminals marked "120" and "L". The Sentronic should have a jumper in place between terminals "M" and "2".
2. Wait two minutes, then push the Sentronic reset button to reset the module and start the timing circuit.
3. With a voltmeter, measure line voltage (120VAC) between the "M" terminal and the "120" terminal. It should be the same as the electrical outlet voltage - About 120VAC.
4. Since there is no connection made to the pressure sensor, the module sees this as a no-oil pressure condition. After two minutes (± 15 seconds - dependent on 50 or 60 cycle frequency) the Sentronic internal timer will "time-out". The module will trip; the circuit between "L" and "M" will open, and it will no longer pass current to the load.
5. With the voltmeter connected to terminals "M" and "120", the voltage should now read zero volts because the circuit between "L" and "M" has been opened through the action of the electronic circuit.
6. Reset the Sentronic, then remove voltage from terminals "120" and "L". With a small piece of wire, jumper the female sensor connections at the end of the black sensor cord attached to the module. Reapply power to terminals "120" and "L" and wait two minutes. The module should not "time-out" after two minutes because jumpering the sensor connections makes the timing circuit "see" good oil pressure. The jumper imitates the action of a small pressure switch located in the sensor. This switch opens on low oil pressure and closes on good oil pressure.
7. Measure between the "120" terminal and the "M" terminal with the voltmeter. The |meter should read full line voltage showing that the circuit has not opened.
8. To check if the module will operate on 208/240 volts as well as on 120 volts, change the scale of the voltmeter (if necessary), to read up to 250VAC. Without removing power, measure the voltage between the "M" terminal and the "240" terminal. You should read nearly twice the voltag as that read between the "M" terminal and the "120" terminal. This is because Sentronic has a small control transformer connected so that it can accept either 120V or 208/240V. It's self-transforming action actually enables it to step up its own voltage. By making this voltage chack, the transformer is being checked.
9. If the module successfully passes the above test sequence it is fully functional. If the module fail;s any of the above steps, it is faulty and should be replaced.

SECTION 20

Maintenance & Troubleshooting

Maintenance

Compressors

Lubrication: Check oil level in the compressor crankcase sightglass on a regular interval (after initial run, **check at least monthly**). If the level is low, add according to instructions in this manual and the cause of oil migration corrected. If the system has a suction filter, check for pressure drop across the filter. A plugged suction filter can lead to high oil levels.

Dirty or Discolored Oil Indicates One of the Following:

1. Contaminants in the oil such as air, moisture and acids.
2. Operating the compressor in a vacuum. This will cause a lack of suction cooling and in turn overheats and discolors the oil.
3. Improper air flow on air cooled compressors can cause the oil to overheat.
4. If the oil appears contaminated, the liquid line filter should be changed.

The first time the oil becomes discolored, a new liquid line filter is usually enough to remedy the problem. Any following oil discoloration will require the oil to be changed.

Mountings

Check all compressor mountings for tightness. Vibration may cause the mountings to loosen, placing unnecessary stress on the compressor piping.
(Check mountings every 6 months.)

Line Connection

Check and tighten all compressor lines and service connections, (including access fittings such as schrader valves).
(Check line and valve connections every 6 months.)

Electrical

Turn off all power to rack before checking or tightening any wire connections.
Check all electrical connections to see that they are tight. Loose connections can cause several problems; including low voltage conditions and line arcing.
(Check electrical connections every 6 months.)

Refrigerant Piping

Refrigerant piping and fittings should be checked for tightness and leak integrity on a **regular basis**. Any time a refrigerant charge is required for a system, a careful leak check should be made of the system. Refer to EPA and local requirements for expected leakage and repair documentation process.

Troubleshooting

SYMPTOMS	POSSIBLE CAUSES
A. Compressor hums, but will not start.	
	1. Improperly wired.
	2. Low line voltage.
	3. Defective run or start capacitor.
	4. Defective start relay.
	5. Short or grounded motor windings.
B. Compressor will not run and will not try to start (no hum).	
	1. Power circuit open due to blown fuse, tripped circuit breaker, or open disconnect.
	2. Compressor motor protection open.
	3. Open thermostat or temperature control.
	4. Burned motor windings - open circuit.
C. Compressor starts but trips on overload.	
	1. Low line voltage trips on overload.
	2. Improperly wired.
	3. Defective run or start capacitor. 4. Defective start relay.
	5. Excessive suction or discharge pressure.
	6. Tight bearings or mechanical damage in the compressor.
	7. Defective overload protector.
	8. Shorted or grounded motor windings.
D. Unit short cycles.	
	1. Control differential set too low.
	2. Shortage of system refrigerant.
	3. Discharge pressure too high.
	4. Discharge valve plate leaking.

SYMPTOMS	POSSIBLE CAUSES
E. Head pressure too high.	
	1. Dirty condenser.
	2. Refrigerant overcharged.
	3. Air in the system.
	4. Malfunction of the condenser fan (air cooled).
	5. Restricted water flow (water cooled).
	6. Excessive air temperature entering the condenser.
	7. Restriction in the discharge line.
F. Head pressure too low.	
	1. Low ambient temperature (air cooled).
	2. Low refrigerant charge.
	3. Damaged valves or rods in the compressor.
	4. Improper setting of the receiver OPR valve (Headmaster).
	5. Electronic controls improperly set.
G. Refrigerated space temperature too high.	
	1. Poor air movement. Fan motor out.
	2. Iced or dirty evaporator coil.
	3. Low refrigerant charge.
	4. Clogged strainer, drier or expansion valve.
	5. Improperly adjusted expansion valve.
	6. Compressor malfunction. (See F-3 above.)

SYMPTOMS	POSSIBLE CAUSES
H. Loss of oil pressure.	
	1. Loss of oil from compressor due to: a) Oil trapping in system. b) Compressor short cycling. c) Insufficient oil in system. d) Operation at too low of suction pressure.
	2. Excessive liquid refrigerant returning to the compressor.
	3. Malfunctioning oil pump.
	4. Restriction on the oil pump inlet screen.
	5. Restriction in sensor (electronic control).

SECTION 21

R-22 Low Temperature Demand Cooling

The Copeland Demand Cooling System *(Figure 1)* uses electronics to counteract the occasionally high internal compressor discharge temperatures created by the R-22 refrigerant in low temperature applications. Demand cooling diverts refrigerant to the compressor. *(See Figure 2 on page 21-3.)* The demand cooling module uses the signal of a discharge head temperature sensor to monitor discharge gas temperature. If a critical temperature is reached, the module energizes an injection valve which meters a controlled amount of saturated refrigerant into the compressor suction cavity to cool the suction gas. If the discharge temperature rises above a preset maximum level, the module will turn the compressor off and activate its alarm contact. This shut down will require a manual reset.
See Control Setting chart at the bottom of this page.

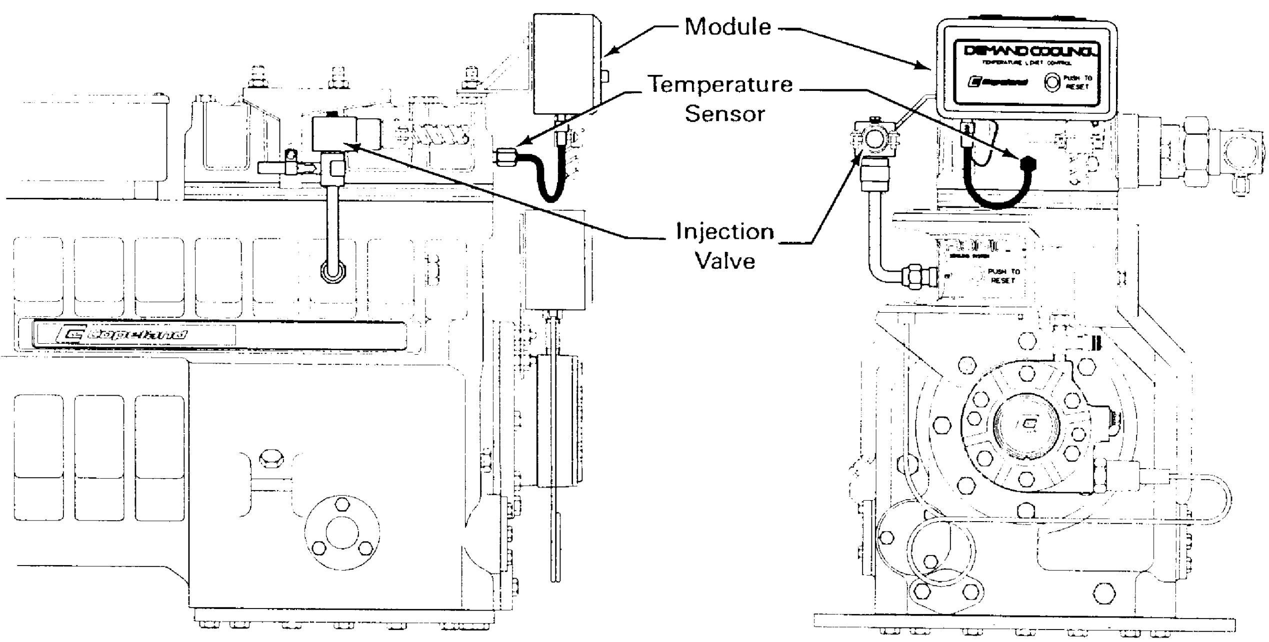


FIGURE 1 DEMAND COOLING SYSTEM COMPONENTS (REPRINTED FROM COPELAND ENGINEERING BULLETIN AE-1287)

CONTROL SETTINGS	
Cut-In Temperature	292°F (non-adjustable)
Cut-Out Temperature	282°F (non-adjustable)
Trip Temperature	310°F (non-adjustable)

TYLER Part Number for Demand Cooling Kits**	
BODY	PART NO.
2D	5930211
3D	5930212
4D	5931213
6D	5930214

**Demand Cooling Kits include: Demand Cooling Module (w/ 2 mounting screws), Temperature Sensor (w/ 3 ft. of shielding cable), Injection Valve and Solenoid (w/ mounting hardware), and an Installation/Troubleshooting Guide.

TYLER Part Number / Demand Cooling Components	
DESCRIPTION	PART NO.
Electronic Control Module	5930500
Temperature Sensor (w/3' cable)	5930501
Temperature Sensor (w/ 10' cable)	5930502
208/240V Injection Valve Solenoid Coil	5930503

TYLER Part Number / Demand Cooling Injection Valves (Less Solenoid)			
MODEL	120V 1Ph 60Hz	208/240V 1Ph 60Hz	220/240V 1Ph 50Hz
2D	5930504	5930504	5930504
3D	5930505	5930505	5930506
4D	5930507	5930507	5930505
6D	5930508	5930508	5930509

System Information

The correct injection valve **must be used** for each compressor body style. In order to provide the necessary cooling, when required, the orifices in the injection valve have been carefully matched to each body style. These orifices are large enough to provide the cooling, but will prevent large amounts of liquid from being injected. This helps prevent excessive system pressure fluctuation during injection valve cycling. Normally, pressure fluctuations should not exceed 1 to 2 psi.

- Demand cooling is designed to work on all Copeland Discuss compressors equipped with injection ports.
- **The system must be clean!** The refrigerant injection line feeding the injection solenoid valve **must tie in after the liquid line filter drier**.
- The liquid refrigerant supply line **must be a minimum of 3/8" and routed** so it will not interfere with compressor maintenance.
- The liquid refrigerant supply line to the injection valve **must be supported** so that it does not place stress on the injection valve and injection valve tubing, or permit excessive vibration.
- A head fan **must be used** to help lower compressor discharge temperatures.
- Return gas temperatures **must not exceed 65°F**.
- Suction lines **should be well insulated** to reduce suction line heat gain.

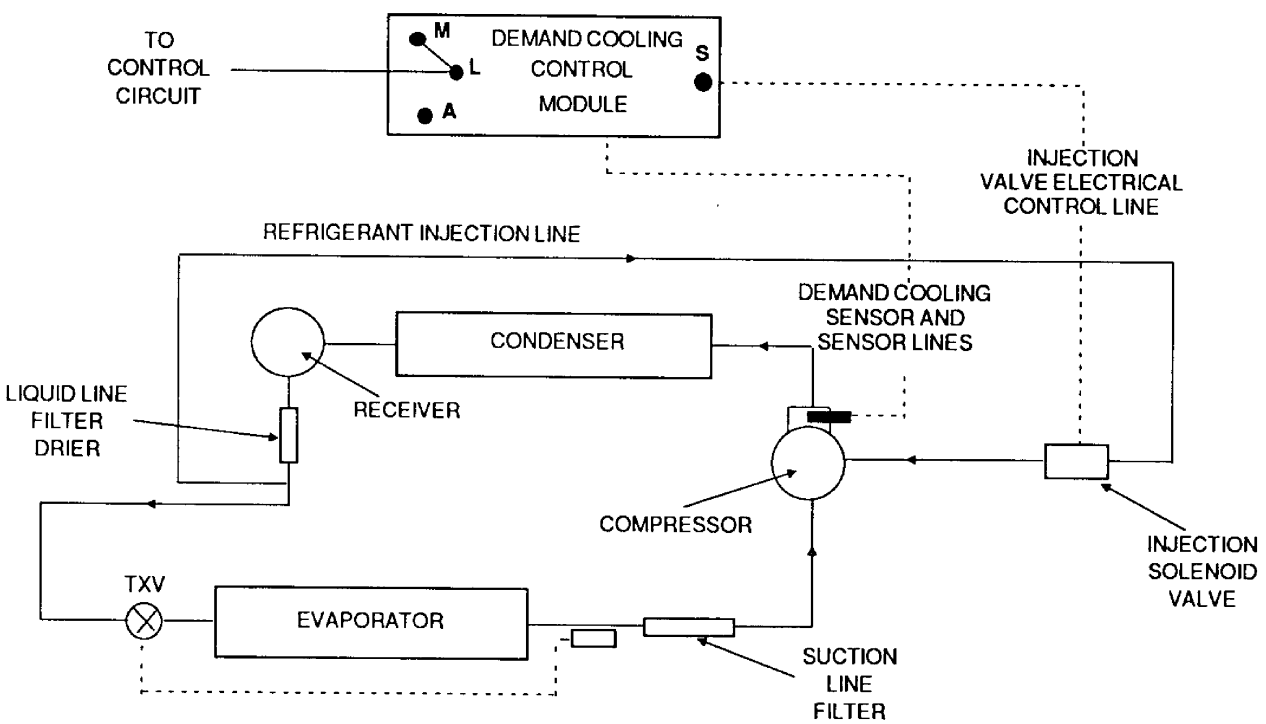
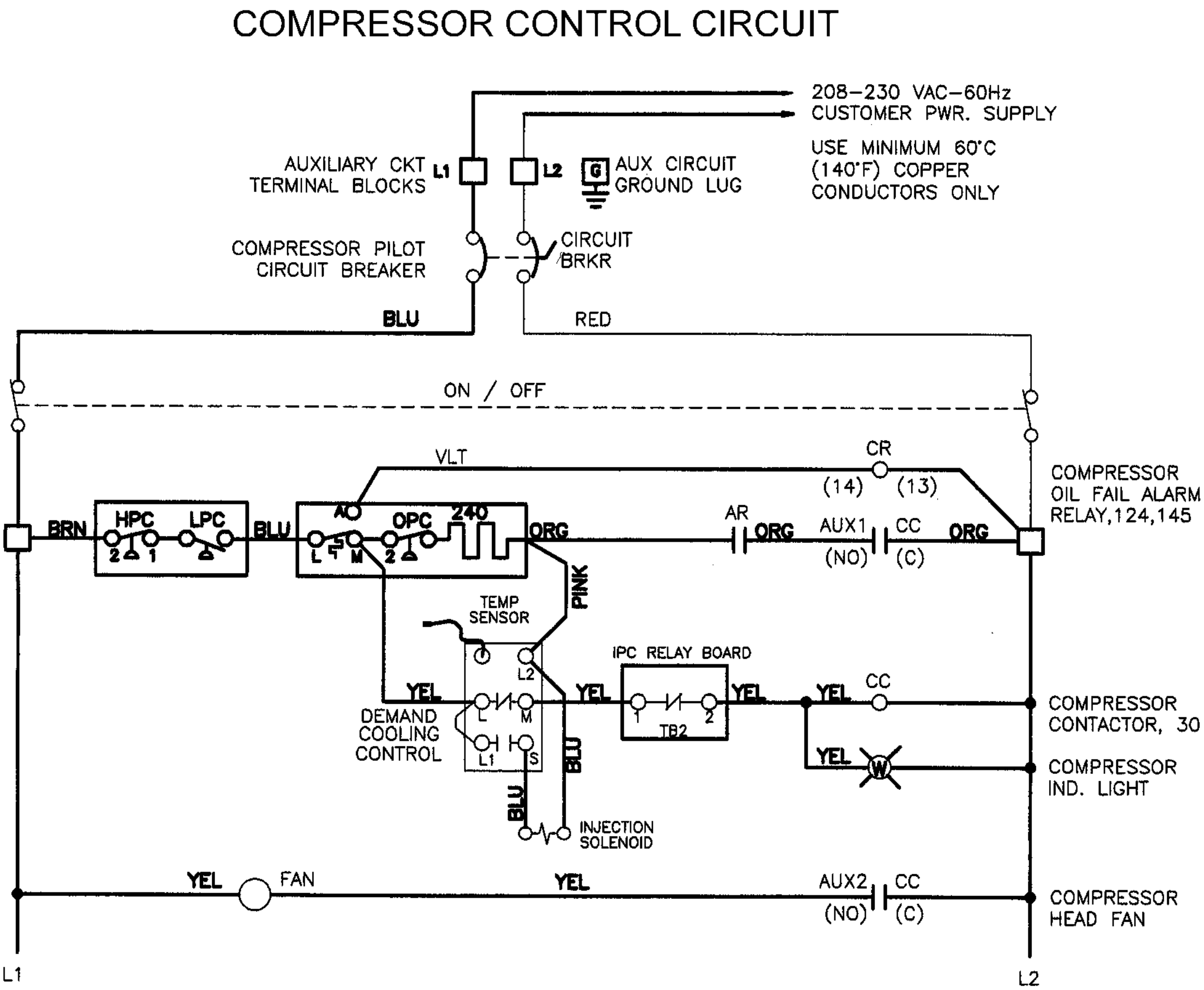
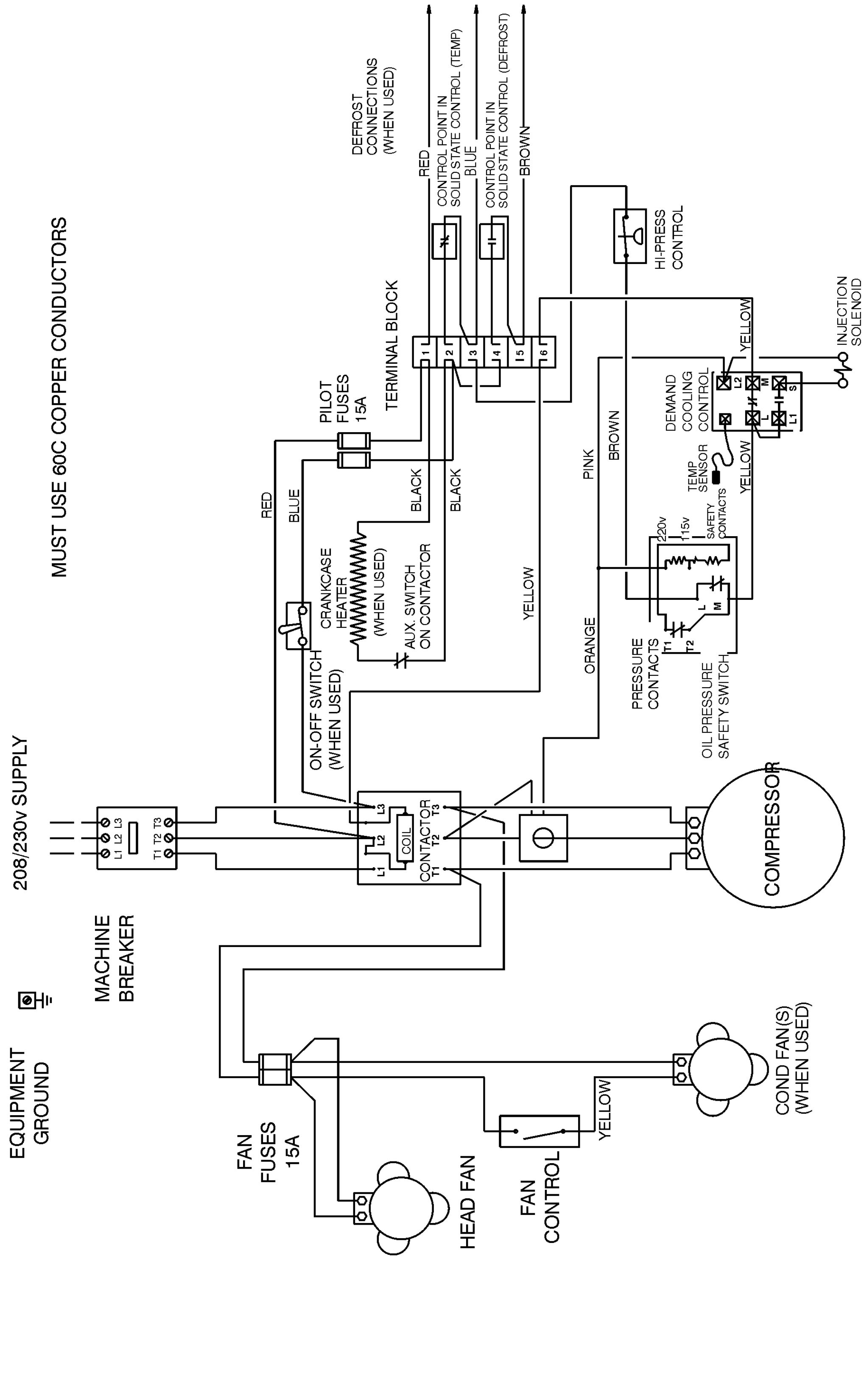


FIGURE 2 DEMAND COOLING SYSTEM DIAGRAM (REPRINTED FROM COPELAND ENGINEERING BULLETIN AE-1287)

Typical Parallel Wiring Application

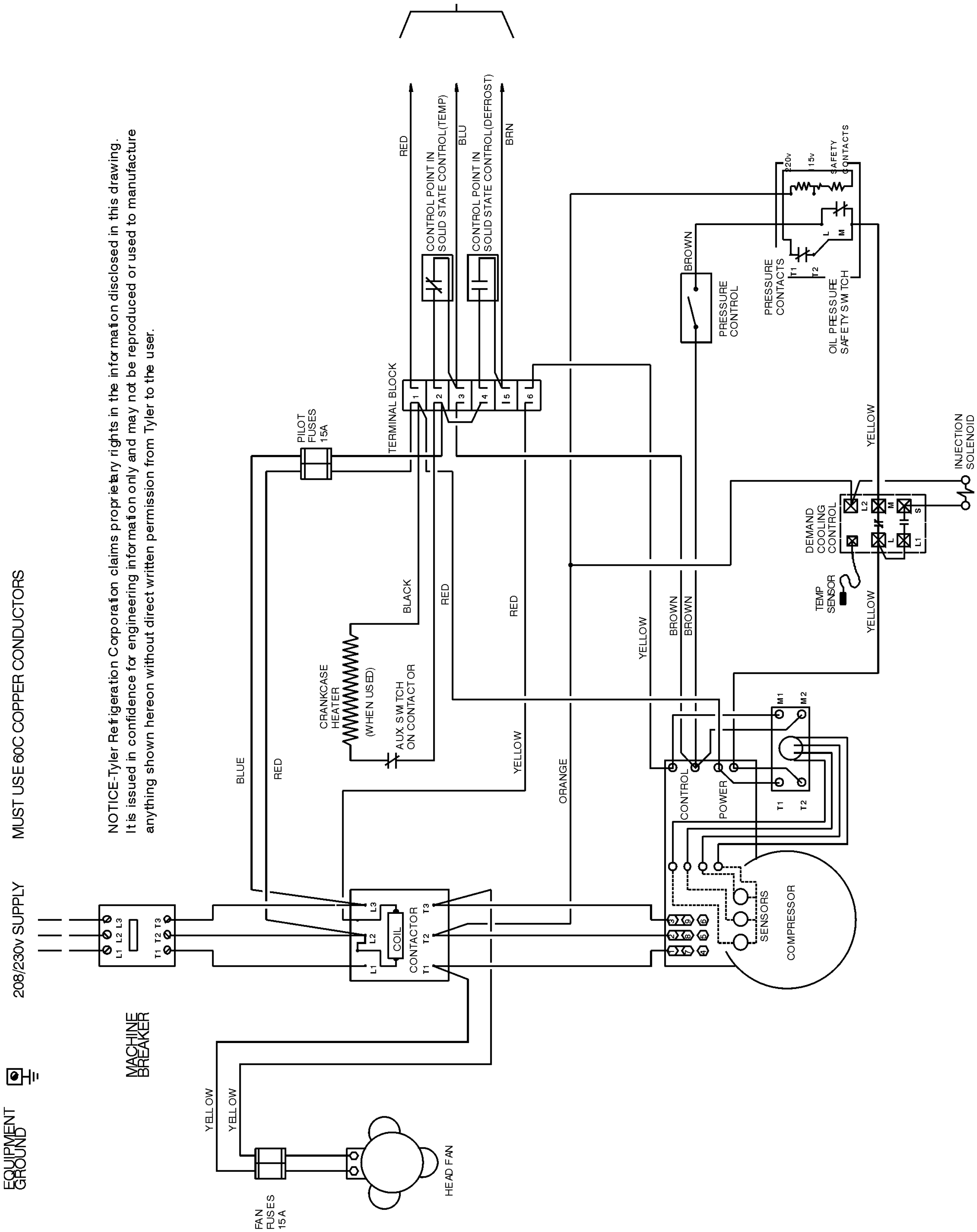


Typical Single Unit Compressor Wiring TFC/TFD



NOTICE-Tyler Refrigeration Corporation claims proprietary rights in the information disclosed in this drawing. It is issued in confidence for engineering information only and may not be reproduced or used to manufacture anything shown hereon without direct written permission from Tyler to the user.

Typical Single Unit Compressor Wiring TSK



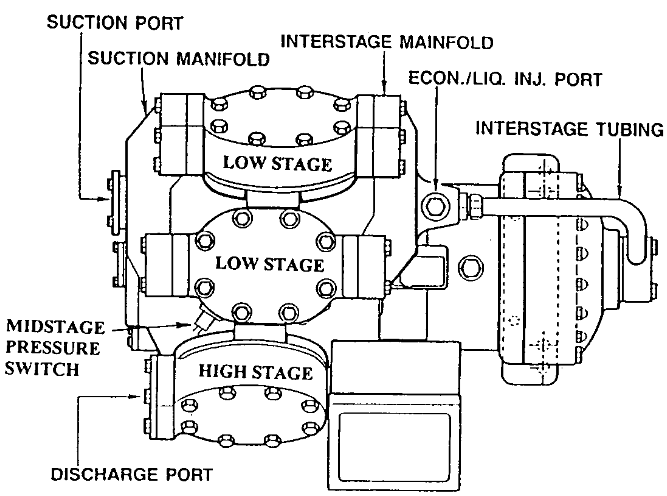
SECTION 22

Carlyle Compound Cooling

Why Compound Cooling

In low temperature applications, single-stage compression of R-22 may cause overheating at high compression ratios. Single-stage compression also results in lower Energy Efficiency Ratios (EERs) than R-502, thus resulting in higher power usage. To compensate for higher discharge temperatures in single-stage R-22, the injection of liquid refrigerant must be used in many operating conditions. Liquid injection may result in lower EERs and is a potential reliability risk to the compressor.

How Compound Cooling Works



06E COMPOUND COOLING™ COMPRESSOR

A variation of the two-stage booster system, the internally compounded compressor has both the high and low stages built into one compressor body. In this arrangement, compression is accomplished in two stages, safely and economically. All nine Compound Cooling models have six cylinders. Four cylinders (acting as the low stage) “boost” the suction pressure from the refrigeration load to the intermediate pressure.

The remaining two cylinders (acting as the high stage) complete the compression on to normal condensing temperatures. The result is lower internal losses and a compressor that delivers more capacity in the same displacement. The lower losses also increase operating efficiencies.

Suction Pressure Range

Compound Cooling Compressors (C3) are specifically designed for today’s low temperature R-22 applications. These applications are designed for operation in the -40°F to -10°F SST (Saturated Suction Temperature) range.

Intermediate Pressure Range

The intermediate pressure may be obtained from the table on page 22-5. The intermediate pressure of the C3 compressors will vary based on suction and discharge pressure. The amount of interstage flow due to subcooling and desuperheating will also vary the intermediate pressure. When subcooling and desuperheating are employed, the approximate intermediate pressure (AIP) may be calculated by taking the square root of the product of the suction and the discharge pressure ±10 psi.

NOTE

If an economizer (Figure 1) is not used, the intermediate pressure may be up to 30 psi lower that the AIP.

Discharge Pressure Range

C3 compressors are designed to operate at discharge pressures ranging from 70° to 130°F SCT (Saturated Condensing Temperature).

Economizer

Two-stage systems have the inherent benefit of being able to utilize interstage subcooling and desuperheating through the use of a heat exchanger. Figure 1 is a diagram of an economizer cycle. Liquid at the saturated condensing temperature (SCT) passes through a heat exchanger on the way to the evaporator. The liquid is subcooled.

A tap off the main liquid line is directly expanded across the subcooler pressure to interstage pressure. The subcooling is done at interstage pressure where the refrigerant can be compressed more efficiently. This increases the compressor capacity and energy efficiency ratio (EER).

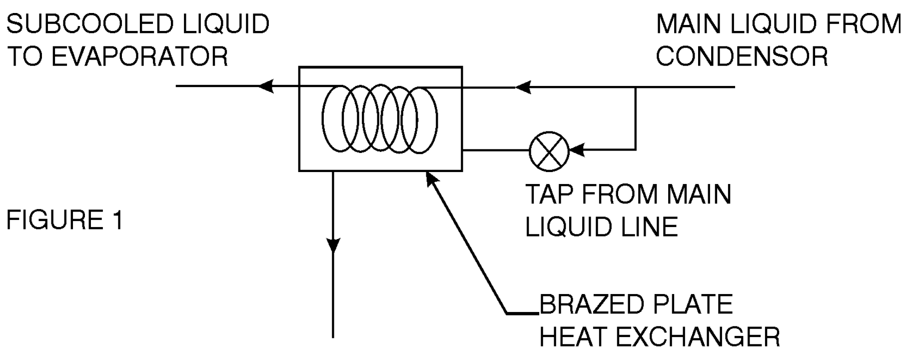


FIGURE 1

TO COMPRESSOR INTERSTAGE (ECONOMIZER CONNECTION)

Desuperheating Expansion Valve

A desuperheating expansion valve is used to limit the discharge temperature to a maximum of 220°F to 230°F leaving each compressor. This valve only operates when the economized flow alone cannot prevent this maximum temperature.

Start-Up

Initial start-up of the compressors should be done with the economizer and desuperheating valve OFF. After a few minutes of run time, the subcooler and desuperheating expansion valves should be allowed to operate. After initial start-up the economizer and desuperheating valve do not have to be valved OFF.

Oil

Check for these proper oil levels at compressor sightglasses before start-up and after 15-20 minutes of operation.

Small compressors are (16-37 CFM) 1/2 to 2/3 SG. Large compressors are (50-99 CFM) 1/8 to 3/8 SG.

Approved Oils (R-22):

Totaline 150
IGU Petroleum Ind Cryol-150
Witco . . . . Suniso 3GS

General Notes

1. Unloaders not allowed.
2. All compound cooling compressors are equipped with a discharge temperature sensor (open 295°F, close 235°F) for over temperature protection.
3. The large body compressors (50-99 CFM) require calibrated circuit breakers for over current protection (same as 06E).
4. Low pressure access ports are located on the low pressure side of the low stage cylinder heads. (Compressor crankcase is at interstage pressure.)
5. Do not run motor barrel equalizing tubing between compressors for oil level equalization.

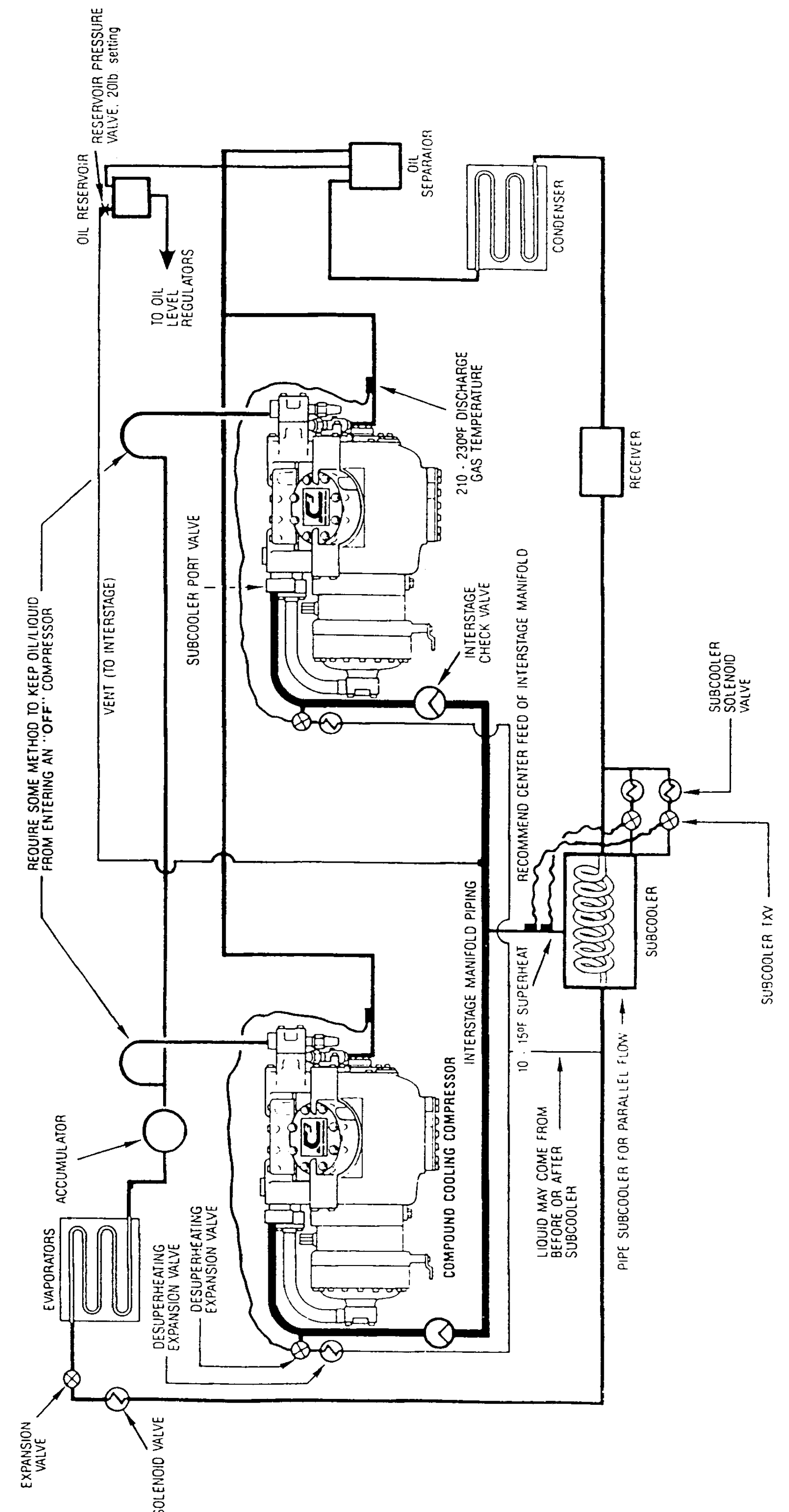
Multiple Compressor Systems

Multiple compressor systems may also be controlled through the use of mechanical expansion valves. Mechanical desuperheating expansion valves should be set to maintain approximately 220°F to 230°F discharge temperature with the bulb set 6” from the discharge service valve of each compressor. The bulb must be well insulated. ***(See Compressor System Diagram on page 22-4.)***

The use of floating head pressures in systems controlled by a mechanical TXV will result in varying liquid temperatures leaving the economizer due to varying interstage pressures.

A solenoid valve located before the economizer and desuperheating expansion valves is required (except on application using electronic valves that have a positive shutoff). The economizer solenoid must be interlocked with the rack to close anytime all compressors are OFF. The desuperheating solenoids must be interlocked with each individual compressor to close when the compressor is OFF.

Compressor System Diagram



R-22 Approximate Interstage Pressure (psig) ± 10 psi with a Subcooler

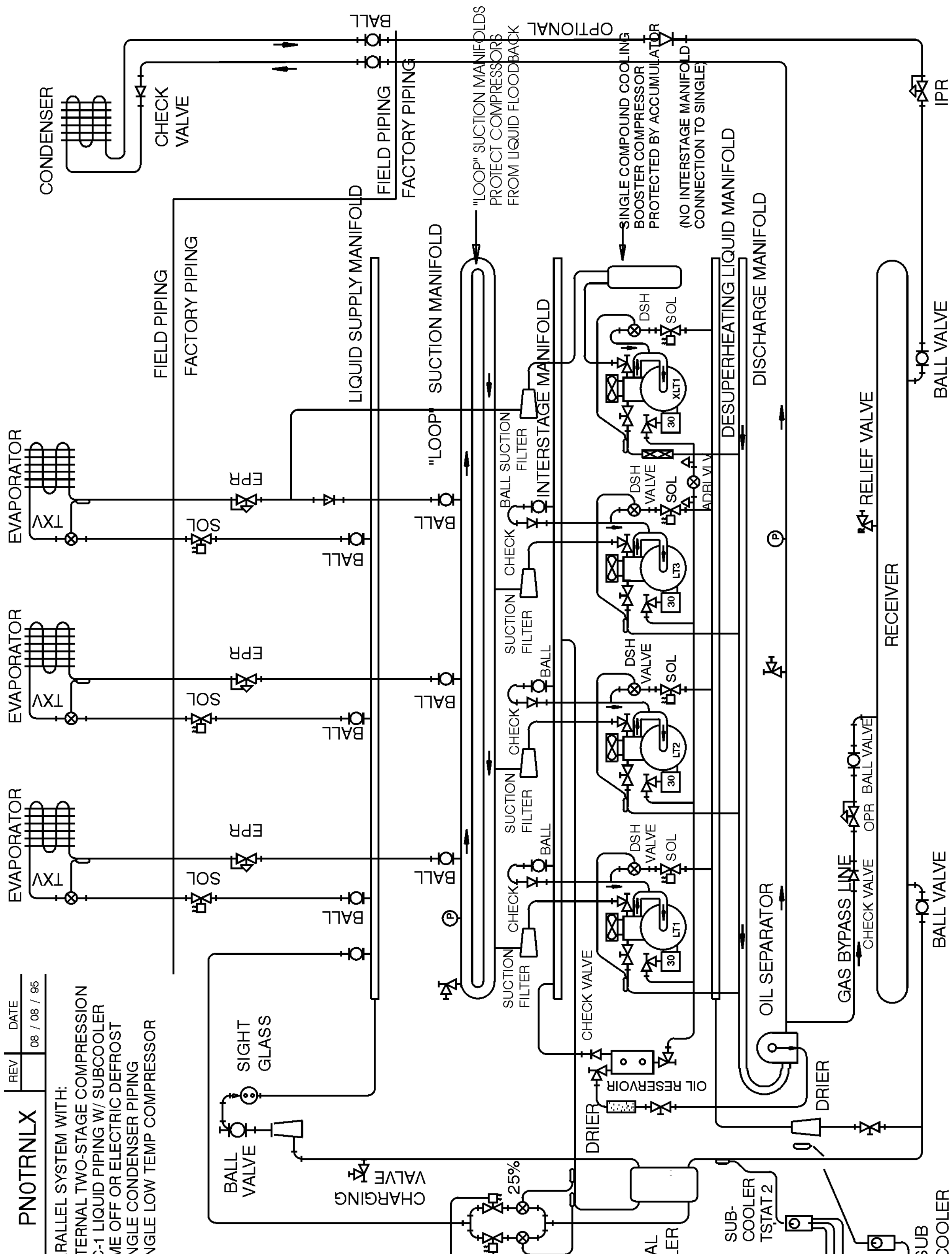
SATURATED SUCTION TEMP. (°F)	SUCTION PRESSURE (PSIG)	SATURATED CONDENSING TEMPERATURE (°F)							
		60	70	80	90	100	110	120	130
		CONDENSING PRESSURE (PSIG)							
		101.6	121.4	143.6	168.4	195.9	226.4	259.9	296.8
-60	11.9*	3	5	6	8	10	11	13	15
-55	9.2*	11	13	15	17	19	22	24	27
-50	6.1*	17	20	22	25	28	31	34	37
-45	2.7*	23	26	29	32	35	39	43	46
-40	0.5	27	31	34	38	42	46	50	54
-35	2.6	30	34	38	42	46	50	54	59
-30	4.9	33	37	41	45	50	54	59	63
-25	7.4	36	40	44	49	54	58	63	68
-20	10.1	39	43	48	53	58	63	68	73
-15	13.2	42	47	52	57	62	67	73	79
-10	16.5	46	50	56	61	66	72	78	84

*** Indicates Vacuum**

NOTE

If using alternate refrigerants such as R-507, R-125 or R-404A, use the given formula and appropriate PT charts to calculate the interstage pressures.

Piping Diagram for Parallel System with Two-Stage Compressors

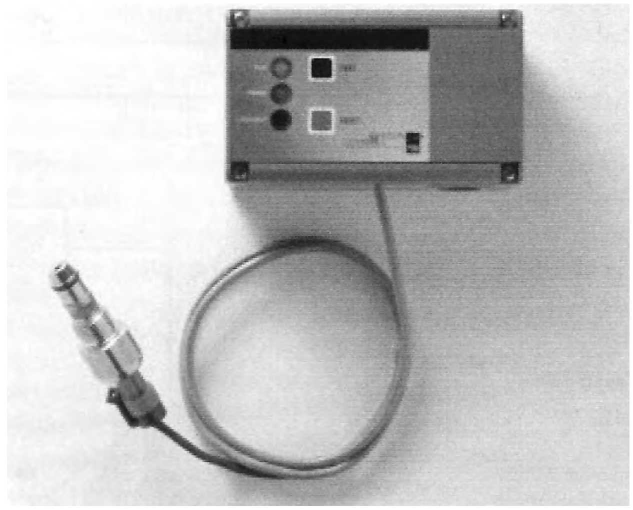


SECTION 23

Optional Johnson Controls Electronic Oil Pressure Control

The Electronic Lube Oil Control is designed for use on refrigerated compressors equipped with either a bearing head or oil pump that accepts a single-point differential pressure transducer. The control senses net lube oil pressure and de-energizes the compressor if pressure falls below a setpoint. The control has a front-mount LED display to indicate the status of the lubrication system. An anti-short-cycling delay is available, as well as a choice of an accumulative or nonaccumulative timer as required by the compressor manufacturers.

P545, P445 and P345 Series Models



NOTE

These are general installation and service instructions. Consult the Johnson Controls website for specific information on individual control models and sensors.

FEATURES AND BENEFITS	
Single-Pole Double-Throw (SPDT) Relay Contacts for Liquid Line Solenoid and Alarm Applications	Allows liquid line solenoid to be closed if the control shuts off the compressor due to low oil pressure (minimizes refrigerant migration); provides alarm indication, including circuits that use neon lights.
Relay Contact Output for Compressor	Provides reliable, long lasting operation.
Built-In Test Circuit	Verifies proper control operation quickly without additional tools or equipment.
Improved Noise Immunity	Exceeds immunity requirements of UL 991 for transient overvoltage: IEC 61000-4-3 for radiated Radio Frequency (RF) and IEC 61000-4-6 for RF-induced conducted disturbances.
Selection of Anti-short Cycle Time Delay	Allows choice of anti-short-cycle strategy for a wide range of equipment requirements; possible elimination of external short-cycle timer.
User-Friendly Display Panel	Displays the status of the compressor lubrication system continuously.
Backwards Compatibility	Allows easy replacement of existing electronic lube oil controls.

Installation

IMPORTANT WARNING

These Johnson Controls are designed for use only as operating controls. Where an operating control failure would result in personal injury or loss of property, it is the responsibility of the installer to add devices (safety or limit controls) or systems (alarm or supervisory systems) that protect against, and/or warn of control failure.

NOTE

The control is not position sensitive. When direct mounting to a compressor is required, a mounting bracket is available.

1. If panel mounting, use the mounting slots on the back of the control case. If mounting the control on a compressor, use the two threaded holes on the back of the control case. Use only the mounting screws provided. Damage to internal components may occur if other screws are used.

NOTE

When modifying an existing refrigeration compressor to accept the sensor, follow the procedures recommended by the original equipment manufacturer.

2. Use the following procedure to install the sensor:
   a. Wipe and dry all mating surfaces before mounting the sensor.
   b. Fit the fiber washer over the sensor nozzle. *(See Figure 3.)* Wet the switch nozzle and gasket with oil.
   c. Install the sensor in the lube oil sensor port according to the compressor manufacturer's instructions.
   d. Hand tighten until surfaces of fiber washer and compressor housing meet.
   e. Tighten until sealed.

CAUTION

Do not apply more than 25 ft-lb of torque to the fiber washer. Torque over 25 ft-lb may cause seal failure. As a general guideline, 1/8 turn equals approximately 40 ft-lb, and 1/16 turn equals approximately 5 ft-lb.

3. Use the following procedure to connect the cable to the sensor or switch. *(See Figure 3.)* Sensor or switch may vary from illustrated types.
   a. Roll the lip of the rubber boot back over itself on the sensor cable connector.
   b. Insert the cable connector into the sensor or switch connector until it snap locks.
   c. Roll the lip of the boot over the edge of the sensor housing.

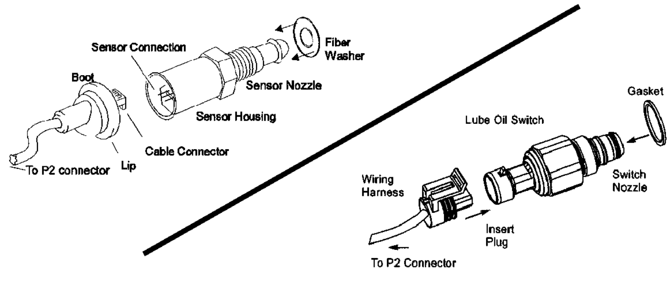


Figure 3: Sensor / Switch Installation

Setting the Anti-Short-Cycling Timer

To change the anti-short-cycling delay timer from the factory-set 100 second position, move the jumper into the desired position. (See Figure 4, Insert B.)

NOTE

If the jumper is completely removed, the control will operate at the default delay of 100 seconds.

R310AD or R10A Relay Connection

To connect a Wide Range Current Sensing Relay, cut and discard resistor R38/R39. Connect the relay to the two male blade terminals, FT1 and FT2. (See Figure 4, Insert A.)

IMPORTANT

The relay will not work when the control's anti-short-cycling delay timer is set at 0 seconds. Set the timer to 35, 65, or 100 seconds.

Wiring

WARNING

To avoid possible electrical shock or damage to equipment, disconnect power supply before wiring any connections.

Make all wiring connections using copper conductors only. All wiring must be installed to conform to the National Electric Code and local regulations.

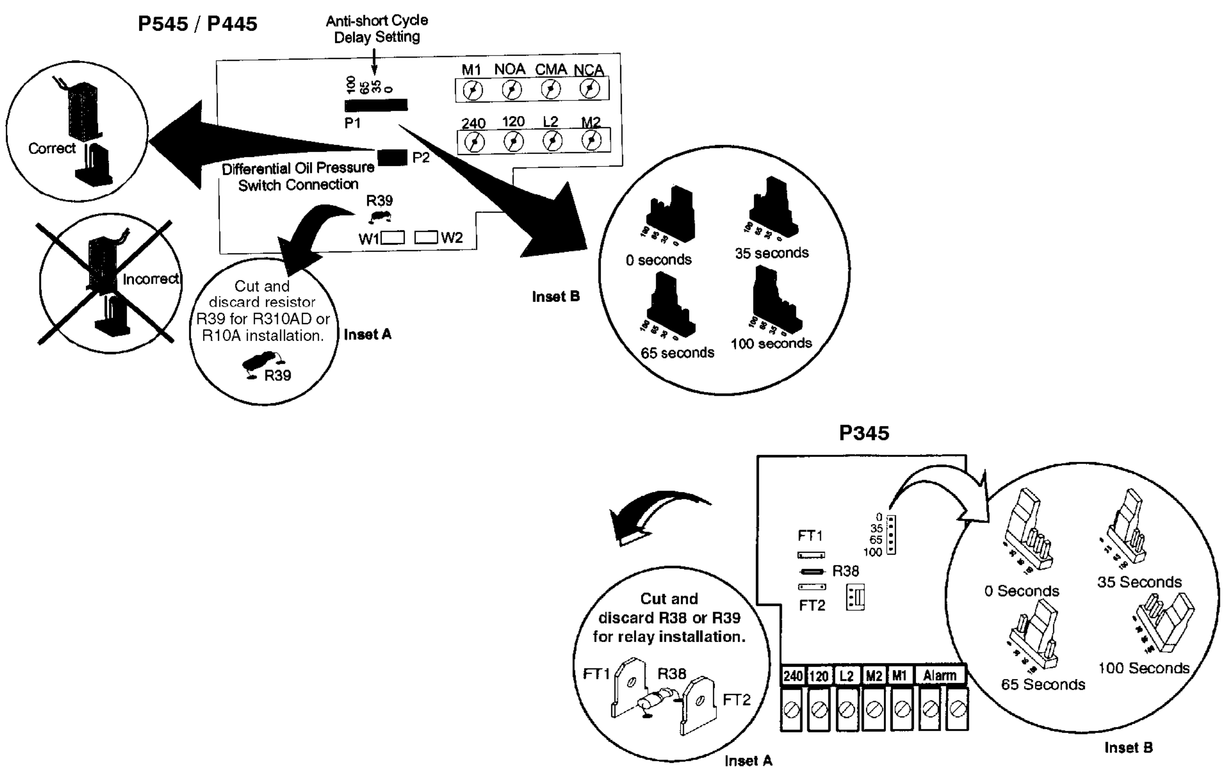


Figure 4: Terminal Designations

Wiring Diagrams

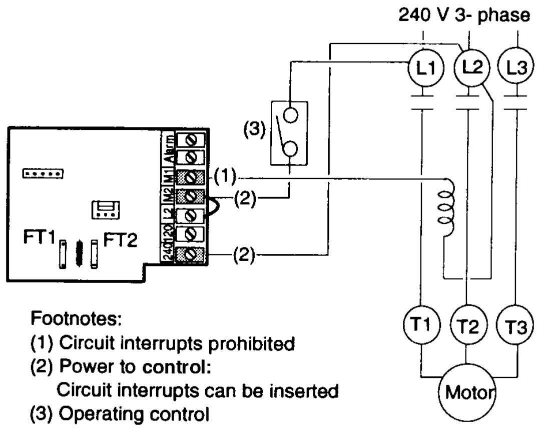


Figure 5: Typical 3-wire Application

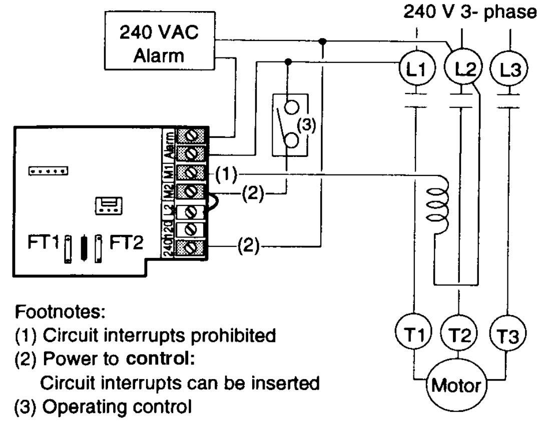


Figure 6: Control and an Alarm Circuit Powered by the Same Voltage Supply as the Compressor Motor

Checkout Procedures (LEDs Operating Status)

Green LED only: The compressor contactor is energized, and the system's net oil pressure is at or above the opening point of the P400 switch or the setpoint (factory-set) of the P400 sensor.

Green and Yellow LEDs: The green LED signals that the compressor contactor is energized while the yellow LED signals that the lube oil pressure is below the switch opening point or sensor setpoint. The timing circuit is active.

NOTE

The P345 models are available with either accumulative or nonaccumulative lube oil pressure time delays. Both timers start when the net oil pressure drops below the setpoint. If pressure does not rise above the setpoint before the end of the timer's cycle, the P345 will lockout the compressor contactor.

Accumulative Timing: (Copeland Models) If the pressure returns to the setpoint value or higher before the time delay is complete, the timer will stop and run back down towards 0 at one-half of its forward rate. If low pressure is detected before the timer reaches 0, the timer will again run forward at its normal rate, without resetting at 0. The timer will automatically reset at 0 seconds if power is removed from the P345.

Nonaccumulative Timing: (Carlyle Model) Each time the pressure reaches the setpoint, the timer stops and resets to 0 seconds.

Yellow LED: Power to the control has been interrupted and restored before the anti-short cycle delay has elapsed. The compressor contactor remains de-energized until the anti-short cycle delay is complete, and then restarts automatically.

Red LED: The control has de-energized the compressor contactor (lock condition), because of a lube oil pressure problem at the compressor.

Electrical Checkout Procedure

Use the following procedure to test for correct operation during initial installation and maintenance operations:

WARNING

To avoid possible electrical shock or damage to equipment, disconnect power supply before wiring any connections.

1. De-energize the supply voltage to the control and the compressor circuit.
2. Disconnect wire leads between the contactor and compressor motor ("T" or "W" terminals) to stop the compressor from running during this part of the test. *(See wiring diagrams, Figures 5 & 6.)*

NOTE

On systems using a current sensing relay (R310AD or R10A), remove relay connections to control terminals (W1 and W2) or (FT1 and FT2), and connect a jumper between these two terminals.

3. Re-energize the supply voltage to the control. Check that all the operating and limit controls are closed This ensures that power is being supplied to the control.
4. The compressor contactor circuit will immediately be energized and the yellow & green LEDs will be ON. The green LED indicates that the compressor contactor is energized. The yellow LED indicates that the oil pressure differential is low and the timing circuit is energized.
5. When the factory set low pressure time delay elapses, the control de-energizes (locks out) the contactor. The red LED will illuminate while the yellow & green LEDs will turn OFF. If an alarm is installed, the control's alarm contacts will close and the liquid line solenoid contacts will open.
6. Press RESET. The red LED will turn OFF and the green & yellow LEDs will turn ON. The contactor is now energized.

NOTE

The control will remain locked until the RESET button is pressed, even if power is removed from the control. The control cannot be reset without power.

7. De-energize the supply voltage. Reconnect the compressor leads to the contactor, or reset the disconnect. If an R310AD switch is used, reconnect the compressor leads to the contactor. If a R10A Series Relay is used, remove the jumper and reconnect the relay leads to the control. *See Figure 4*.
8. Re-energize the supply voltage. If the operating and limit controls are closed and power has been removed for longer than the anti-short cycle delay, the compressor will start and both the green & yellow LEDs will be ON. The yellow LED will turn OFF when the lube oil pressure level reaches the switch opening point or sensor setpoint, generally within seconds of starting the compressor.

Operational Control Test

Use this test to check that the control is operating correctly. This test simulates a low oil pressure condition and initiates an immediate lockout of the compressor with the P545 control, or an abbreviated (8 second) timing cycle followed by a lockout of the compressor with the P445/P345 control.

1. With power to the control, adequate oil pressure, and the contactor energized (only the green LED is ON), press and hold the TEST button down.
2. On the P545 control, the red LED lights up and the control de-energizes (locks out) the compressor contactor.

   On the P445 and P345 controls, the yellow LED (low pressure warning stage) will be ON for approximately 8 seconds before the red LED (lockout stage) comes ON, and the control de-energizes (locks out) the compressor contactor.

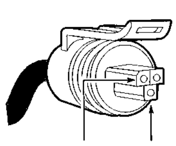
   If any of the systems are equipped with an alarm, the relay circuit will energize (close) and the alarm will sound.
3. Wait 100 seconds and press the RESET button to energize the contactor and restart the motor.

NOTE

The control cannot be reset without power.

Troubleshooting

Table 1: Troubleshooting Chart for Systems Not Using a R10A Sensing Relay

LED Status	Troubleshooting Procedure
No LEDs ON	Check the power source.
Red LED ON	Use these steps to resolve the problem: 1. Connect pressure gauges at the oil pump and at the crankcase.
	2. Press RESET on the control.
	P545 A. If the green & yellow LEDs are ON but the compressor remains OFF, inspect the wiring and check for an overheated motor. If the compressor motor is overheated, determine the cause and correct the problem. (An R310AD current sensing switch may be installed along with the control to provide a controlled shutdown caused by thermal overload.)
	B. If both the green & yellow LEDs are ON for the duration of the time delay and the system shuts down., observe the crankcase and oil pump pressure gauges.
	• If the system does not reach sufficient oil pressure by the end of the time delay, check the compressor and system for problems.
 WHA-P400-xxx Wiring Harness Plug	• If the system does reach sufficient pressure: - Disconnect the wiring harness at the P400 switch. - Use a single piece of 22-gauge wire as a jumper between the common and signal terminals of the wiring harness. - Press RESET. - If the green LED come ON and the yellow LED turns OFF, replace the P400 switch. Otherwise, replace the control.

LED Status	Troubleshooting Procedure
Red LED ON (cont.)	P445/P345 A. If the green & yellow LEDs are ON, but the compressor remains OFF, check the wiring.
	B. If the system immediately shuts down, the compressor may be overheated or the pressure sensor or sensor cable may be bad.
	• Check compressor temperature; if the compressor is overheated, an R10A relay can be installed with the control to provide controlled shutdown based on thermal overload. Determine the cause of overheating and correct.
	• Unplug the sensor cable from the sensor and press RESET; if the system restarts correctly with the sensor unplugged, replace the sensor.
	• If the system does not restart with the sensor unplugged, unplug the sensor cable from the control circuit board and press RESET; if the system restarts correctly, replace the sensor cable.
	C. If the green & yellow LEDs are ON for the duration of the time delay and the system shuts down, observe the crankcase and oil pump pressure gauges:
	• If the system does not reach sufficient oil pressure by the end of the time delay, check the compressor and system for problems.
	• If the system does reach sufficient oil pressure, disconnect the sensor cable at the sensor, connect a voltmeter to the left and center pins of the sensor cable via two short pieces of 22-gauge wire (See Figure 7). Press the RESET button. - If the voltage between these terminals is not approximately 5V (between 4.75 and 5.35V), test the sensor cable for continuity. Replace the cable and repeat this step if the cable is faulty. - If the cable is OK and the voltage is still insufficient, replace the control. - If the control and cable are OK, remove the voltmeter and use a single piece of 22-gauge wire between the center and right pins of the sensor cable (See Figure 7). Press the RESET button. If the green LED comes ON and the yellow LED goes OFF, replace the sensor. Otherwise, replace the control.
Dim and flickering Yellow LED	1. Check the power source.
	2. Confirm that the compressor is operating at sufficient pressure, without excessive pressure fluctuations.
	3. Check the wiring harness for loose connections.
	4. If the oil pressure is sufficient, the cable connections are good, and the yellow LED still flickers, replace the switch or sensor.
Control does not lock out compressor when lube oil pressure is low	P545 1. Press the TEST button. If the control does not lock out is 8 seconds, replace the control. If control locks out properly, go to Step 2.
	2. Disconnect the wiring harness from the control. Press the RESET button.
	3. If the compressor starts and runs through the time delay (yellow & green LEDs ON) and then locks out, check the wiring harness for shorted condition. If the wiring harness test OK, replace the P400 switch.
	P445/P345 1. Check sensor cable at circuit board for proper installation.
	2. Follow the procedure described Figure 7 for troubleshooting the control and sensor.

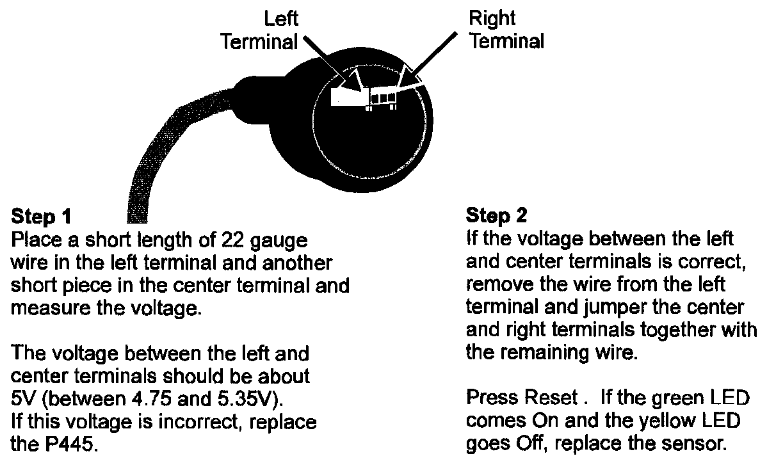


Figure 7: Troubleshooting Using the Cable Terminals

Table 2: Troubleshooting Chart for Systems Using a R310AD Switch or R10A Sensing Relay

Problem	Possible Solution
Control does not respond to R301AD Switch or R10A Relay. Control de-energizes (locks out) compressor after compressor shut down. Red LED is ON.	Make sure that the anti-short cycle delay is **not** at o seconds.
Control does not respond to R310AD Switch or R10A Relay. The Green LED is ON for approx. 4 seconds, followed by the Yellow LED turning ON for the duration of the selected anti-short cycle time delay. This process repeats indefinitely.	1. Check that resistor R39 has been cut and discarded.
	2. Check the R310AD switch or R10A relay; replace the switch or relay if necessary.
Contactor energizes for 3 or 4 seconds. It remains OFF for the duration of the anti-short cycle time delay, and then repeats. (Compressor is unable to start during the 3 to 4 second period.)	Insufficient current to the R310AD switch or R10A current sensing relay, is the most likely cause of this problem. (Normal control operation for when there is no current.)
	1. Check compressor for internal overloads.
	2. Check the compressor wiring.
	3. Check the compressor’s contactors.
	4. Check the compressor for general failure.

SECTION 24

Enviroguard

***ENVIROGUARD** is a patented refrigerant control system in which the amount of liquid refrigerant being used in the system is controlled by a system pressure regulator (SPR).*

The refrigerant system charge is reduced by taking the receiver out of the refrigerant circuit and allowing liquid refrigerant to return directly to the liquid manifold which feeds the branch refrigeration circuits. With the receiver out of the refrigerant circuit, a minimum receiver charge is no longer required as with conventional system designs. The receiver is only used as a storage vessel to store the condenser charge variations between summer and winter operation.

The system pressure regulator (SPR) is controlled by a pilot pressure from a remote mounted ambient air or water temperature sensor connected to the SPR by a pilot line.

The remote mounted ambient air sensor is located under the air-cooled condenser to sense the ambient air temperature entering the condenser. For evaporative condenser applications, the water temperature sensor is located in the sump.

When the ambient air or water temperature rises or falls, the pressure inside the sensor and pilot line also rises or falls. This exerts a corresponding higher or lower pressure on the pilot of the SPR.

The SPR setting is adjusted to achieve a differential of approximately 45 psig for R-22 low temperature air-cooled applications and approximately 61 psig for R-22 medium temperature air-cooled applications. Refer to pages 24-11 through 24-15 to determine the actual differential pressure setting to be used for the system being installed.

Since the SPR pilot pressure is equivalent to the saturated refrigerant pressure at the ambient temperature, the pressure at which the SPR begins to bypass refrigerant into the receiver on a R-22 low temperature system is the sum of the saturated refrigerant pressure corresponding to the actual ambient air temperature plus the approximate differential pressure setting of either 45 or 61 psig.

Whenever the ambient air temperature drops, the pressure setting at which the SPR bypasses liquid refrigerant to the receiver also drops relative to the ambient air temperature.

Anytime the condensing pressure rises 45 or 61 psig above the corresponding ambient air sensor pressure, the SPR begins to bypass refrigerant into the receiver.

Condensing pressure changes occur at the same time relative to changes in the ambient temperature so liquid feed is always constant.

If a condenser should become fouled or damaged, an elevated condensing pressure will occur resulting in in refrigerant being bypassed into the receiver. Eventually branch circuit evaporator temperatures, will rise because refrigerant is being bypassed out of the working part of the system into the receiver simulating a refrigerant starved system.

Normally condenser fans will be running most of the time, but should be controlled by an electronic pressure controller for optimum performance. During this period condenser fans are not cycled to achieve the benefit of reduced condensing pressure variations and to achieve maximum liquid subcooling. The reduced condensing pressure variation and liquid subcooling lead to improved expansion valve operation. Allowing condenser fans to cycle will increase condensing pressure variation and result in erratic expansion valve operation.

If a refrigerant leak should occur in the system, it will be noticed earlier by way of higher evaporator temperatures. Overall, less refrigerant will be lost to the atmosphere than with conventional system designs before a problem is detected.

Whenever any or all of the compressors are running, a bleed circuit opens to bleed refrigerant from the receiver back into the system for use.

This patented design allows the refrigerant working charge in the system to seek its own level of equilibrium relative to the ambient temperatures.

During typical system operation, when the ambient air temperature is above approximately 70°F, part of the refrigerant charge normally flooding the condenser will be stored in the receiver. This is because more condenser surface is required to reject the total heat of rejection at the higher ambient air temperatures.

Whenever the ambient air temperature is below approximately 70°F, the receiver will be empty because refrigerant will be flooding the condenser. This is because less condenser surface is required during winter operation because of the lower ambient air temperatures.

Application Guidelines

The following application guidelines MUST be followed regarding the application and use of ENVIROGUARD on customer systems.

1. Space or hot water reclaim may be used with Enviroguard however, the amount of space heating is very limited with condenser fan controls set to maximize energy savings. The resetting of these controls to increase heat recovery, or the addition of holdback valves, will also increase compressor operating costs in cool weather
2. For air-cooled applications, only remote air-cooled condensers furnished by TYLER will be supplied.
3. The condenser drain line should be sized appropriately based on previously established design guidelines.
4. All liquid refrigerant lines located inside the building, including the condenser drain line, MUST be insulated to preserve subcooled liquid temperatures and prevent condensation from forming.
5. For lineups greater that three cases, some type of suction stop device is required. *The exception to this is no more than 24' per circuit of multi-shelf freezers.*
6. Receiver liquid level alarms WILL NOT BE AVAILABLE, but receiver liquid level indicators will still be installed as standard equipment.
7. Parallel unit compressor suction pressure should be controlled using floating suction pressure to achieve optimum temperature control. This consists of floating the suction pressure higher by referencing the case temperature sensor(s).

8. Existing system retrofits WILL NOT be sold or installed at this time until approved by TYLER.
9. An electronic air temperature sensor at SPR air sensor is beneficial for setting and checking the SPR valve.
10. Evaporative condensers may be used with Enviroguard.

NOTE

The same benefits will not be realized as those realized when using air-cooled condensers, especially in colder climates.

The primary benefit from using Enviroguard with an evaporative condenser may be some small additional refrigerant charge reduction over and above only using the evaporative condenser without Enviroguard. An evaporative condenser does not rely on flooding the condenser in cool weather to reduce condenser surface as compared to an air-cooled condenser.

Extremely low subcooled liquid temperatures would not be obtained unless an additional air-cooled coil or subcooler is added. This is because of the lower temperature limit of the water in the evaporative condenser sump.

Fixture Temperature Control

Suction stop EPR's are recommended for fixture and/or circuit temperature control.

NOTE

Liquid line solenoids and pump down can be used on a LIMITED basis.

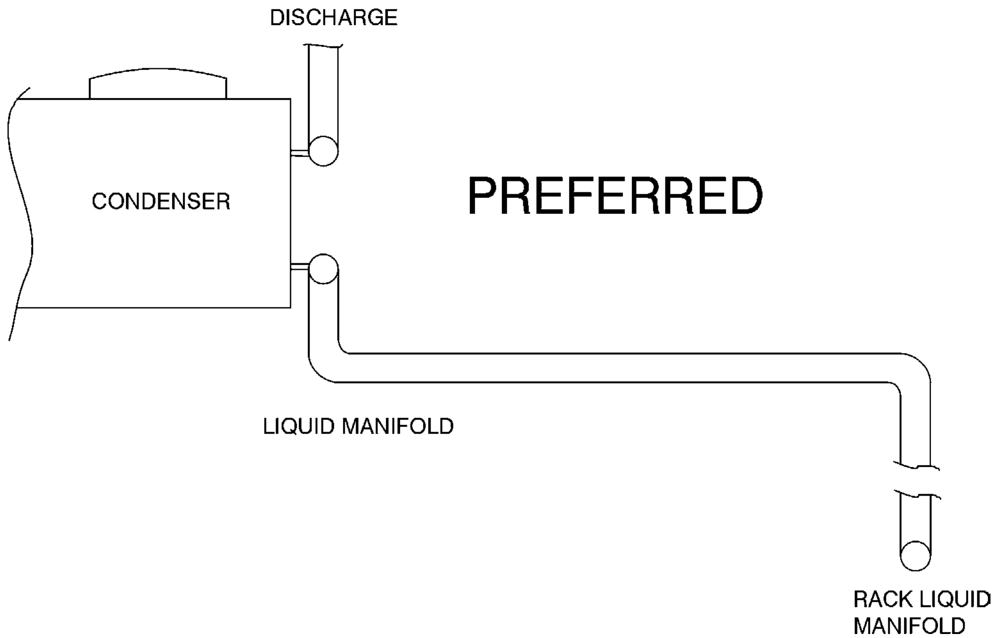
Condenser Locations

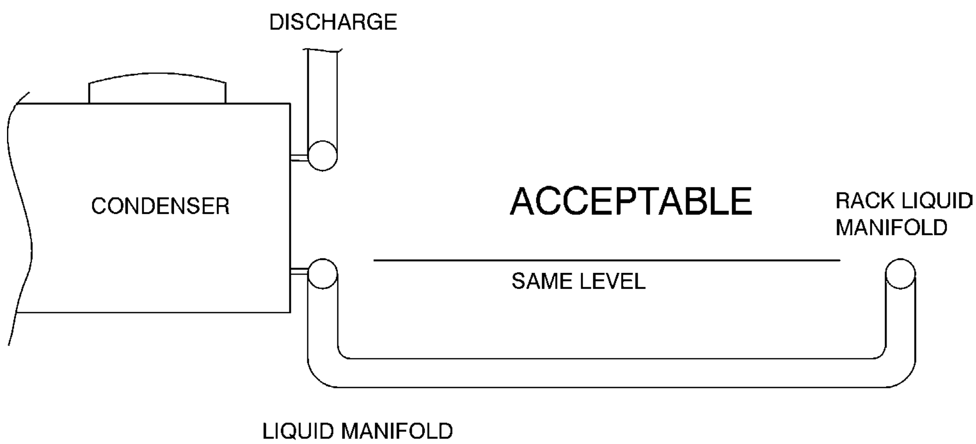
The IDEAL location of the condenser is any level ABOVE the liquid supply manifold on the compressor unit. The condenser liquid manifold and compressor unit liquid supply manifold can be at the same horizontal level. A direct horizontal condensate line from the condenser outlet to the compressor unit liquid line manifold is to be avoided, when both are at the same level. The line should be routed from the condenser manifold outlet to a level below the condenser, then be routed horizontally towards the compressor unit location. *(See the Preferred Condenser Piping on the next page.)*

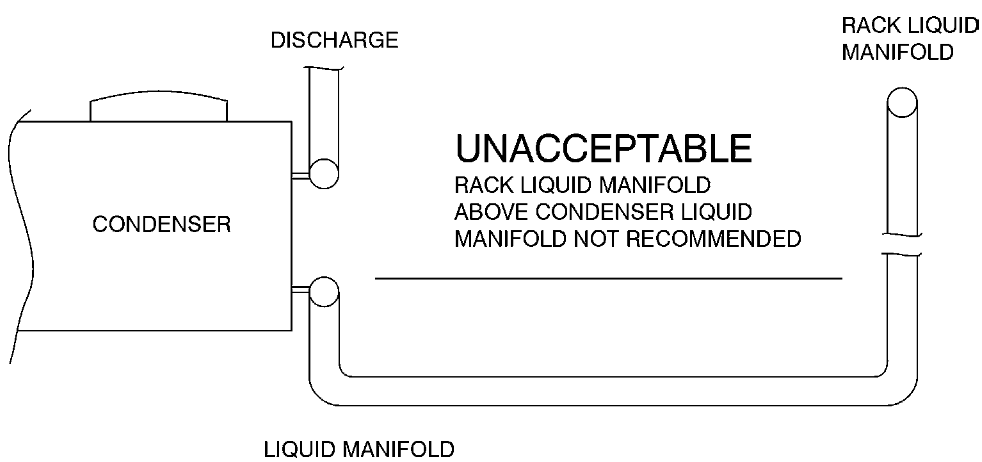
Condensate lines routed over or above the condenser to the compressor unit are NOT recommended. The horizontal portion of the condenser condensate line should be sloped toward the compressor unit at 1/2" per 10' of horizontal run.

See page 4-1 to reference "High Side Field Piping" information.

Condenser Piping Diagrams







Condenser Fan Control

Normally condenser fans will be running most of the time, but should be controlled by an electronic pressure controller for optimum performance.

The recommended control method would be to use a pressure transducer input to an electronic compressor controller having a condenser fan control feature.

Temperature control of condenser fans is not acceptable because it does not sense a sudden discharge pressure rise at low ambient. This sudden pressure rise could create a starved liquid refrigerant condition to the system. In this condition the liquid from the condenser would be dumped into the receiver through the SPR during the high pressure surge.

Upon reduction of the discharge pressure there would be insufficient liquid to maintain flow and discharge pressure at normal conditions until the refrigerant transferred back into the system. The discharge pressure surge could be caused by compressor cycling, defrost termination, etc.

Dropleg Pressure Transducer

The transducer is located on the condenser liquid dropleg. The DDPR and condenser fan control settings are listed in the tables on page 24-24.

Mechanical Liquid Subcooling

Mechanical subcoolers may be used with Enviroguard in areas which have warmer climates to obtain subcooled liquid when actual condenser liquid temperatures are higher than 55°F.

Temperature control of the subcooler is achieved with two thermostats. The thermostat sensing bulbs are located on the main liquid line entering the subcooler and on the condenser liquid line dropleg. The thermostats control the liquid solenoid valves feeding refrigerant to the subcooling expansion valves.

An optional EPR may be mounted in the suction line leaving the subcooler, when the subcooler is supported by another rack system experiencing large suction pressure changes. This enables the subcooler to maintain more stable liquid temperatures to the fixtures.

See pages 17-6 and 24-25.

System Components

Figure 1 shows the piping and components used in this system design. (*See page 24-9.)*

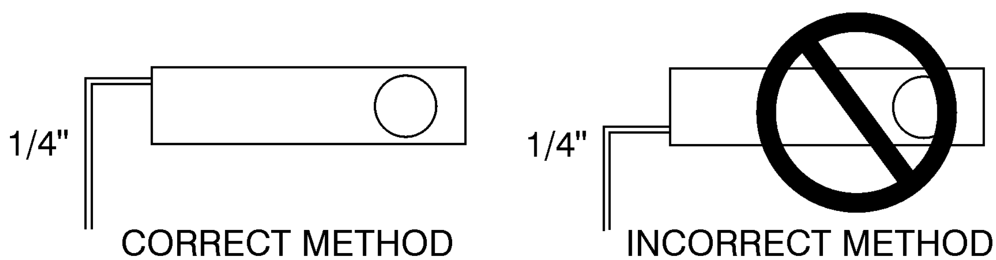
A. System Pressure Regulator (SPR)

The system pressure regulator (SPR) is the primary system component which needs adjusting compared to setting regulators on conventional refrigeration systems.

B. Ambient Air Sensor

The sensor consists of 12 inches of 1-3/8" O.D. tubing with a sightglass mounted on the side for charging the sensor. The pilot line between the remote sensor and the SPR should be 1/8" or 1/4" O.D. copper tubing. (DO NOT USE COPPER TUBING LARGER THAN 1/4" O.D.) The pilot line to the SPR valve, MUST BE INSULATED when running through spaces where the temperature differs from the ambient air or water temperatures.

The ambient air sensor is mounted under the remote air-cooled condenser in the entering air stream of the fans. These fans will always remain running. The sensor is position sensitive and should be mounted with the pilot line at the top as shown below.



If an evaporative condenser is used, the sensor should be mounted in the evaporative condenser sump. The sensor should be halfway submerged in the sump water with the pilot line connection pointing downward. *(Refer to page 24-28.)*

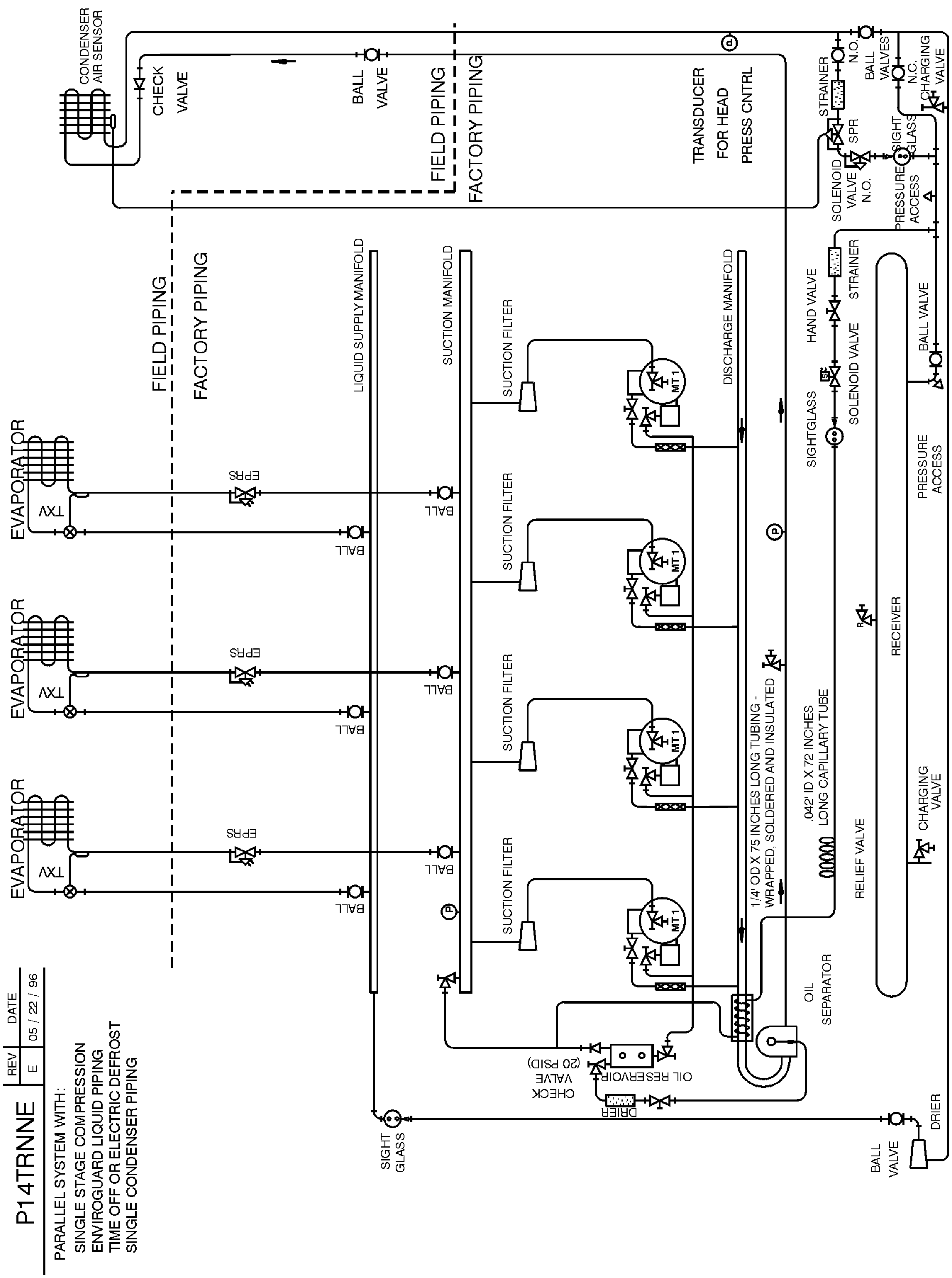
C. Refrigerant Bleed Circuit

The refrigerant bleed circuit consists of the following component parts:

1. Hand Valve
2. Strainer
3. Solenoid Valve (Normally Closed)
4. Sightglass
5. Capillary Tube
6. 1/4" O.D. Heat Exchanger
7. 1/4" O.D. Copper Tube

Whenever any compressor is running, the 1/4" solenoid valve is energized to allow liquid refrigerant to be drained from the receiver and metered back into the suction manifold. The heat transfer between the 1/4" O.D. tubing and the discharge header ensures that no liquid refrigerant is injected directly into the suction header. This would cause liquid floodback and possible compressor failure.

Piping & Components Diagram - Basic Enviroguard System



Installing the System

A. Installing System Piping

1. Install system components consistent with good refrigeration piping practices.
2. Ensure that the refrigeration piping is clean and free of debris and copper oxidation. Purge copper lines with an inert gas such as nitrogen while brazing. *See Section 2, pages 2-1 through 2-6.*
3. Evacuate the system properly in preparation to charge the system with refrigerant. *See Section 7, page 7-1 & 7-2.*

B. Installing the Ambient Air Sensor

1. Install the ambient air sensor in a HORIZONTAL position under the air-cooled condenser. It should be mounted under the fan or set of fans. These fans will always remain running. This is typically located at the header end of the condenser.

NOTE

DO NOT allow the ambient air sensor to contact the condenser fins or tubing. The ambient air sensor should be mounted far enough under the condenser so that sunlight does not shine directly on it.

2. Connect a 1/8" or 1/4" O.D. copper line from the ambient air sensor to the pressure pilot on the SPR. The SPR is located on the compressor rack return liquid line.

NOTES

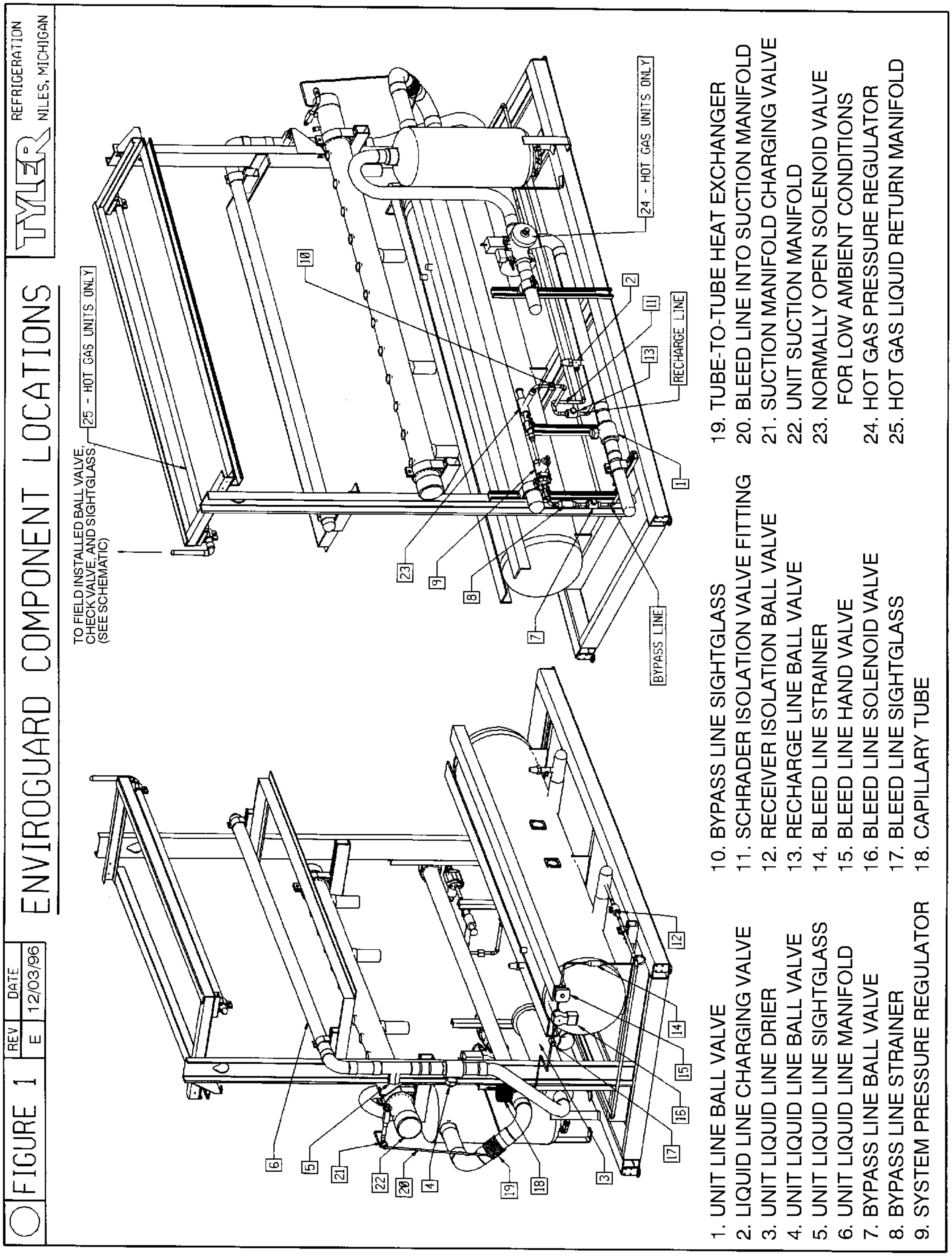
- **Do not use copper tubing larger than 1/4" O.D.**
- **Do not run this line adjacent to a discharge line.**

3. It is recommended to have a temperature sensor located at the SPR air sensor for the purpose of setting the SPR.
4. Evacuate and charge the ambient air sensor and copper capillary line assembly with the same refrigerant type being used in the refrigeration system. It should be charged to approximately a 1/2 to 3/4 level. This can be viewed in the sightglass located on the side of the ambient air sensor.

NOTE

Evacuate and charge sensor only with new unused refrigerant. DO NOT use refrigerant that may be contaminated with oil.

Enviroguard Component Locations



Charging the System

Refer to Figure 1 on page 24-9 for system component locations on the parallel compressor unit relative to Enviroguard system start-up. The following procedures should be used for charging Enviroguard systems:

1. After evacuating the system, leave charging hoses attached to the liquid charging port (#2) on the main liquid line.
2. Close the 1/2" liquid line ball valve (#1) located on the inlet side of the unit liquid line drier (#3) to prepare for charging.
3. Close the 1/2" liquid line ball valve (#7) to the inlet of the SPR (#9).
4. Close the 1/2" liquid line ball valve (#13) bypassing the SPR (#9).
5. Remove the cap from the SPR (#9) and turn the square adjusting stem at least 4 turns clockwise to increase the spring tension which increases the pressure setting of the SPR.
6. Open the liquid line and suction line ball valves on ONE branch refrigeration circuit.
7. Ensure that all condenser fans are turned ON and running.
8. Begin charging the refrigeration system with liquid refrigerant into the liquid line charging valve (#2) downstream of the main liquid line ball valve (#1) located on the inlet side of the unit liquid drier (#3).
9. Start one compressor.
10. Continue to open other branch circuit liquid line and suction line shutoff valves one branch circuit at a time while continuing to charge the system with refrigerant.
11. Turn ON additional compressors to balance the compressor capacity to the increasing refrigeration load.
12. Monitor discharge pressure at the discharge service valve on any running compressor.
13. Continue charging liquid refrigerant into the system while monitoring the discharge pressure. When it begins to rise rapidly, discontinue charging liquid refrigerant through the liquid line charging valve (#2).
14. Open the main liquid line ball valve (#1) on the inlet side of the unit liquid drier (#3) and check the condition of the sightglass (#5). If bubbles exist, finish charging with vapor refrigerant through the suction charging valve (#21) until the sightglass (#5) clears and a solid column of liquid is observed in the sightglass.
15. An alternate method to charging the system with vapor refrigerant through the suction charging valve is to charge liquid refrigerant directly into the liquid line of a branch circuit. Before charging, isolate the circuit from the unit liquid manifold by closing the liquid line ball valve on that branch circuit.
16. Attach an accurate thermocouple to the unit liquid line near the main liquid line ball valve (#1) located on the inlet side of the liquid drier (#3).
17. Attach a pressure gauge set to the Schrader access fitting on the unit liquid drier (#3).

18. Continue charging until the liquid temperature measured with the thermocouple is within 2° to 3°F of the actual ambient air temperature and the liquid pressure reaches the corresponding pressure for actual ambient air temperatures up to 60° to 70°F.

Charging in ambient air temperatures above 60° to 70°F will require adding additional refrigerant after this condition is reached. See chart below for approximate guidelines for receiver charges when ambient air temperatures are above 70°F.

Ambient (°F)	Receiver Charge (% of full charge)
75 - 80	10
80 - 85	15
85 - 90	20
90 - 95	25

Setting the SPR

The following procedure should be followed in determining the setting of the SPR. *Example worksheets for R-22 low and medium temperature systems are shown on page 24-14.*

1. Determine the condenser outdoor design ambient air temperature.
2. Determine the design condenser temperature difference (TD). TYLER generally recommends using a 10°F to 15°F TD for low temperature air-cooled applications.

   The design condenser TD can be determined from the TYLER Summary Sheet as the difference between the condensing temperature and the design ambient air temperature.
3. List a 5°F TD safety to the design condenser TD to compensate for any condenser fouling that may occur. (i.e.: bent fins, loss of condenser fans, dust, etc.)
4. Determine the adjusted condensing temperature by adding the condenser TD and the 5°F TD safety to the design ambient air temperature.
5. Determine the corresponding saturated refrigerant pressure equal to the adjusted air temperature.
6. Determine the corresponding saturated refrigerant pressure equal to the design ambient air temperature.
7. Determine the SPR target differential pressure by subtracting the corresponding saturated refrigerant pressure equal to the design ambient air temperature from the corresponding saturated refrigerant pressure equal to the adjusted condensing temperature.
8. Determine the actual ambient air temperature at the time of system start-up. Ambient air temperature sensor as an input to electronic rack controller can be referenced.
9. Determine the corresponding saturated refrigerant pressure equal to the actual ambient air temperature at the time of setting the SPR.
10. List the target SPR differential pressure as determined in step 7.

11. Determine the target SPR bypass pressure by adding the corresponding saturated refrigerant pressure equal to the actual ambient air temperature and the target SPR differential pressure.

This pressure is the actual pressure at which refrigerant should be observed in the sightglass on the outlet line after the SPR during SPR adjustment.

This procedure can be used with other refrigerant types to determine the differential pressure setting required for proper system operation. Differential settings will vary depending on the type of refrigerant being used.

Setting the SPR on Enviroguard

1. Determine the offset setting. *(Refer to charts on pages 24-17 thru 24-22.)*
   Example: Low temp R404A / 100°F Design, 55 psig.
2. Measure the ambient air entering the condenser.
   Example: 60°F.
3. Determine what pressure the refrigerant would be at that temperature.
   Example: R404A at 60°F = 125 psig.
4. Add the offset setting to the ambient converted to the pressure.
   Example: 55 psig + 125 psig = 180 psig.
5. At 60°F ambient, refrigerant should bypass through the SPR at 180 psig.
6. Set the condenser fans on the controller to cycle OFF at 175 psig with a 20 psig differential.
7. Install a gauge in the liquid return line and open the hand valve upstream of the SPR.
8. Check to make sure the Normally Open solenoid valve is configured to be de-energized (open).
9. Adjust the SPR so that it opens at 180 psig and above and closes at 179 psig and below.

NOTE

Observe the sightglass to determine when the SPR opens and closes.

10. Reset the fan control as follows:

    85 psig for electric defrost *(Refer to chart on page 24-24.)*
    114 psig for gas defrost *(Refer to chart on page 24-24.)*
    Fan staging differential = 5 psig
    On/Off delays = 20 to 30 seconds

    Rapid recovery 5 psig above the highest setting, 10 seconds above the last stage.

    (See examples on next page.)

Examples:

a) Condenser Fan Control *(Example #1: R404A Hot Gas)*	
Condenser Fan - Lowest Stage	114 psig
Second Stage	119 psig
Fourth Stage	124 psig
Fifth Stage	134 psig
Rapid Recovery	139 psig

b) Controllers without Capability to Set Differential Between Stages *(Example #2: R404A Hot Gas)*	
Set Point Lowest Stage	114 psig
Count Stages: (stages) x (5)	= Differential
Four Stages: (4) x (5)	= 20 Differential
Rapid Recovery Setting would be 5 psig above highest setting	114+20+5 = 139

11. The Normally Open solenoid valve should be configured to be energized (closed) when the head pressure falls to 5 psig above the cut-out pressure of the lowest condenser fan setting.

Listed below for reference is a Temperature - Pressure Chart for R-22, R404A, R-502, R-507, R401A and R-402A refrigerants.

TEMPERATURE - PRESSURE CHART

(Black Figures) = Vacuum Black Figures = Vapor (psig) **Bold Figures = Liquid**

TEMP. °F	R-22	R-404A	R-502	R-507	R-401A	R-402A	TEMP. °C
-60	(-12.0)	(-3.5)	(-7.2)	N/A	N/A	N/A	-51.1
-55	(-9.2)	(-1.8)	(-3.9)	N/A	N/A	N/A	-48.3
-50	(-6.2)	0	0.2	0.9	18.5	1.2	-45.0
-45	(-2.7)	2.1	1.9	3.1	16.5	3.4	-42.7
-40	0.5	5.5	4.1	5.5	14.5	5.9	-40.0
-35	2.6	8.1	6.5	8.2	12.0	8.6	-37.2
-30	4.9	10.8	9.2	11.1	9.0	11.6	-34.4
-28	5.9	12.0	10.3	12.4	8.3	12.8	-33.3
-26	6.9	13.2	11.5	13.7	7.0	14.1	-32.2
-24	7.9	14.5	12.7	15.0	6.0	15.5	-31.1
-22	9.0	15.8	14.0	16.4	4.5	16.9	-30.0
-20	10.1	17.1	15.3	17.8	3.5	18.4	-28.9
-18	11.3	18.5	16.7	19.3	2.0	19.9	-27.8
-16	12.5	20.0	18.1	20.9	0.5	21.5	-26.7
-14	13.8	21.5	19.5	22.5	0.4	23.1	-25.6
-12	15.1	23.0	21.0	24.1	1.4	24.8	-24.4
-10	16.5	24.6	22.6	25.8	2.2	26.5	-23.3
-8	17.9	26.3	24.2	27.6	3.1	28.3	-22.2
-6	19.3	28.0	25.8	29.4	3.9	30.2	-21.1
-4	20.8	29.8	27.5	31.3	4.8	32.1	-20.0
-2	22.4	31.6	29.3	33.2	5.7	34.1	-18.9
0	24.0	33.5	31.1	35.2	6.7	36.1	-17.8
2	25.6	34.8	32.9	37.3	8.0	38.1	-16.7
4	27.3	37.1	34.9	39.4	8.8	40.4	-15.6
6	29.1	39.4	36.9	41.6	9.9	42.6	-14.4
8	30.9	41.6	38.9	43.8	11.0	44.9	-13.3
10	32.8	43.7	41.0	46.2	12.2	47.3	-12.2
12	34.7	46.0	43.2	48.5	13.4	49.7	-11.1
14	36.7	48.3	45.4	51.0	14.6	52.2	-10.0
16	38.7	50.7	47.7	53.5	15.9	50.7	-8.9
18	40.9	53.1	50.0	56.1	17.2	57.5	-7.8
20	43.0	55.6	52.5	58.8	18.6	60.2	-6.7
22	45.3	58.2	54.9	61.5	20.0	63.0	-5.6
24	47.6	60.9	57.5	64.3	21.5	65.9	-4.4
26	49.9	63.6	60.1	67.2	23.0	68.9	-3.3
28	52.4	66.5	62.8	70.2	24.6	72.0	-2.2
30	54.9	69.4	65.6	73.3	26.2	75.1	-1.1
32	57.5	72.3	68.4	76.4	27.9	78.3	0
34	60.1	75.4	71.3	79.6	29.6	81.6	1.1
36	62.8	78.4	74.3	82.9	31.3	85.0	2.2
38	65.6	81.8	77.4	86.3	33.2	88.5	3.3
40	68.5	85.1	80.5	89.8	35.0	92.1	4.4
42	71.5	88.5	83.8	93.4	37.0	95.7	5.6
44	74.5	91.9	87.0	97.0	39.0	99.5	6.7
46	77.6	95.5	90.4	100.8	41.0	103.4	7.8
48	80.7	99.2	93.9	104.6	43.1	107.3	8.9

TEMP. °F	R-22	R-404A	R-502	R-507	R-401A	R-402A	TEMP. °C
50	84.0	102.9	97.4	108.6	45.3	102.9	10.0
52	87.3	**109.0**	101.0	112.6	**60.0**	**120.0**	11.1
54	90.8	**113.0**	104.8	116.7	**62.0**	**124.0**	12.2
56	94.3	**117.0**	108.6	121.0	**65.0**	**129.0**	13.3
58	97.9	**121.0**	112.4	125.3	**68.0**	**133.0**	14.4
60	101.6	**125.0**	116.4	129.7	**70.0**	**138.0**	15.6
62	105.4	**130.0**	120.4	134.3	**73.0**	**142.0**	16.7
64	109.3	**134.0**	124.6	139.0	**76.0**	**147.0**	17.8
66	113.2	**139.0**	128.8	143.7	**79.0**	**152.0**	18.9
68	117.3	**144.0**	133.2	148.6	**82.0**	**157.0**	20.0
70	121.4	**148.0**	137.6	153.6	**85.0**	**160.0**	21.1
72	125.7	**153.0**	142.2	158.7	**89.0**	**168.0**	22.2
74	130.0	**158.0**	146.8	163.9	**92.0**	**173.0**	23.3
76	134.5	**164.0**	151.5	169.3	**95.0**	**179.0**	24.4
78	139.0	**169.0**	156.3	174.7	**99.0**	**184.0**	25.6
80	143.6	**174.0**	161.2	180.3	**102.0**	**190.0**	26.7
82	148.4	**180.0**	166.2	186.0	**106.0**	**193.0**	27.8
84	153.2	**185.0**	171.4	191.9	**109.0**	**202.0**	28.9
86	158.2	**191.0**	176.6	197.8	**113.0**	**208.0**	30.0
88	163.2	**197.0**	181.9	203.9	**117.0**	**214.0**	31.1
90	168.4	**203.0**	187.4	210.2	**121.0**	**220.0**	32.2
92	173.7	**209.9**	192.9	216.6	**125.0**	**227.0**	33.3
94	179.1	**215.0**	198.6	223.1	**129.0**	**234.0**	34.4
96	184.6	**222.0**	204.3	229.8	**133.0**	**240.0**	35.6
98	190.2	**229.0**	210.2	236.6	**138.0**	**247.0**	36.7
100	195.9	**235.0**	216.2	243.5	**142.0**	**254.0**	37.8
102	201.8	**242.0**	222.3	250.6	**146.0**	**261.0**	38.9
104	207.7	**249.0**	228.5	257.9	**151.0**	**269.0**	40.0
106	213.8	**256.0**	234.9	265.3	**156.0**	**276.0**	41.1
108	220.0	**264.0**	241.3	272.9	**160.0**	**284.0**	42.2
110	226.4	**271.0**	247.9	280.6	**165.0**	**292.0**	43.3
112	232.8	**279.0**	254.6	288.6	**170.0**	**299.0**	44.4
114	239.4	**286.0**	261.5	296.6	**175.0**	**307.0**	45.6
116	246.1	**294.0**	268.4	304.9	**180.0**	**316.0**	46.7
118	252.9	**302.0**	275.5	313.3	**185.0**	**324.0**	47.8
120	259.9	**311.0**	282.7	321.9	**191.0**	**332.0**	48.9
122	267.0	**319.0**	290.1	330.7	**196.0**	**341.0**	50.0
124	274.3	**328.0**	297.6	339.7	**202.0**	**350.0**	51.1
126	281.6	**336.0**	305.2	348.9	**207.0**	**359.0**	52.2
128	289.1	**345.0**	312.9	358.2	**213.0**	**368.0**	53.3
130	296.8	**354.0**	320.8	367.8	**219.0**	**377.0**	54.4
135	316.6	**378.0**	341.3	392.6	**234.0**	**400.0**	57.2
140	337.3	**402.0**	362.6	418.7	**250.0**	**426.0**	60.0
145	358.9	**428.5**	385.0	446.3	**266.0**	**452.5**	62.8
150	381.5	**449.0**	408.4	475.3	**283.0**	**479.0**	65.6

Sample Worksheet for R-22 Low Temp System Application

A	Design ambient air temperature	95°F
B	Design condenser TD	10°F
C	TD safety factor	5°F
D	Adjusted condensing temperature	110°F
E	Corresponding saturated refrigerant pressure equal to the condensing temperature	227 psig
F	Corresponding saturated refrigerant pressure equal to the ambient air temperature	182 psig
G	Target SPR differential	45 psig
H	Actual ambient air temperature at time of system start-up	60°F
I	Corresponding saturated refrigerant pressure equal to the ambient air temperature	102 psig
J	Target SPR differential pressure	45 psig
K	Target SPR bypass pressure	147 psig

In this low temperature example, the actual pressure at which the SPR will be set to bypass refrigerant to the receiver is 147 psig with the ambient air temperature measured at 60°F.

Sample Worksheet for R-22 Medium Temp System Application

A	Design ambient air temperature	95°F
B	Design condenser TD	15°F
C	TD safety factor	5°F
D	Adjusted condensing temperature	115°F
E	Corresponding saturated refrigerant pressure equal to the condensing temperature	243 psig
F	Corresponding saturated refrigerant pressure equal to the ambient air temperature	182 psig
G	Target SPR differential	61 psig
H	Actual ambient air temperature at time of system start-up	60°F
I	Corresponding saturated refrigerant pressure equal to the ambient air temperature	102 psig
J	Target SPR differential pressure	61 psig
K	Target SPR bypass pressure	163 psig

In this low temperature example, the actual pressure at which the SPR will be set to bypass refrigerant to the receiver is 163 psig with the ambient air temperature measured at 60°F.

Blank Worksheet for System Start-Up

A	Design ambient air temperature	
B	Design condenser TD	
C	TD safety factor	______
D	Adjusted condensing temperature	
E	Corresponding saturated refrigerant pressure equal to the condensing temperature	
F	Corresponding saturated refrigerant pressure equal to the ambient air temperature	______
G	Target SPR differential	
H	Actual ambient air temperature at time of system start-up	
I	Corresponding saturated refrigerant pressure equal to the ambient air temperature	
J	Target SPR differential pressure	______
K	Target SPR bypass pressure	

After determining the actual SPR bypass pressure, follow the procedures listed on the following pages to adjust the SPR.

IMPORTANT NOTE

The pressure at which the SPR will be set to bypass refrigerant into the receiver depends on the actual measured ambient air temperature taken at the time the SPR adjustment is performed. This is determined from the information on this worksheet.

Adjusting the SPR

The following procedure must be followed for each installation at the time of system start-up to properly adjust the SPR. *The item numbers in this procedure correspond with the Figure 1 drawing on page 24-9.*

1. Open the 1/2” ball valve (#7) located on the 1/2” bypass (inlet) line to the SPR (#9).
2. Compare the liquid line pressure to the target SPR bypass pressure. The liquid line pressure should be some value less than the target SPR bypass pressure. *See pages 24-14 & 24-15.*
3. If the liquid line pressure is greater than the initial SPR bypass pressure and vaporizing liquid refrigerant is being observed in the sightglass on the outlet line of the SPR, immediately turn the SPR square adjusting stem 4 turns clockwise. This will raise the actual SPR pressure.
4. If the liquid line pressure is less than the initial SPR bypass pressure, turn OFF condenser fans until the liquid line pressure rises equal to or 5 psig greater than the target SPR bypass pressure.
5. Turn the SPR (#9) square adjusting stem counter-clockwise to lower the actual SPR bypass pressure. Keep adjusting until vaporizing liquid refrigerant is seen in the sightglass (#10) in the outlet line downstream of the SPR. Continue to observe the liquid line pressure. It should decrease to the target SPR bypass pressure. At this point the SPR (#9) is set for proper operation.
6. To verify that the SPR (#9) has been properly set, turn all condenser fans ON again. This will lower the condensing (liquid line) pressure. (The condensing fans were turned OFF to allow adjustment of the SPR.)
7. After the condensing pressure has dropped well below the target SPR bypass pressure (30 psig), turn OFF the condenser fans another time to raise the condensing pressure.
8. Again, observe the sightglass (#10) downstream of the SPR (#9) while monitoring the liquid line pressure. This determines the actual liquid line pressure at which the SPR (#9) begins to bypass refrigerant into the receiver. Again, the actual bypass pressure will be indicated by seeing vaporizing refrigerant in the sightglass (#10).
9. If the SPR (#9) is still not set at the correct bypass pressure, repeat steps 5 through 8 until the correct SPR bypass pressure setting is obtained. Turn the SPR square adjusting stem clockwise to raise the bypass pressure or counter-clockwise to lower the bypass pressure.
10. Replace the seal cap on the SPR (#9) and turn ON all the condenser fans to put then back into the automatic control circuit.
11. Leak test the seal cap on the SPR (#9) to ensure that the cap has been installed tightly.
12. The system is now set for proper operation.

SPR Bleed Pressure at Various Ambients at Condenser Design

Low Temp with R507

Design Ambient (°F)		90	95	100	105	110
Condenser TD (°F)		15	15	15	15	15
SPR Offset (psig)		50	52.5	56	58	61.5
Ambient (°F)	Sat. Pres. (psig)	SPR Bleed Pressure (psig)				
135	382.5	432.5	435	438.5	440.5	444
130	358.5	408.5	411	414.5	416.5	420
125	336	389	388.5	392	394	397.5
120	314.5	364.5	367	370.5	372.5	376
115	294	344	346.5	350	352	355.5
110	274.5	324.5	327	330.5	332.5	336
105	256	306	308.5	312	314	317.5
100	238.5	288.5	291	294.5	296.5	300
95	222	272	274.5	278	280	283.5
90	206	256	258.5	262	264	267.5
85	191	241	243.5	247	249	252.5
80	177	227	229.5	233	235	238.5
75	164	214	216.5	220	222	225.5
70	151	201	203.5	207	209	212.5
65	139	189	191.5	195	197	200.5
60	127.5	177.5	180	183.5	185.5	189
55	117	167	169.5	173	175	178.5
50	107	157	159.5	163	165	168.5
45	97	147	149.5	153	155	158.5
40	88	138	140.5	144	146	149.5
35	80	130	132.5	136	138	141.5
30	72	122	124.5	128	130	133.5
25	64.5	114.5	117	120.5	122.5	126
20	58	108	110.5	114	116	119.5
15	51	101	103.5	107	109	112.5
10	45	95	97.5	101	103	106.5
5	39.5	89.5	92	95.5	97.5	101
0	34	84	86.5	90	92	95.5
-5	29.5	79.5	82	85.5	87.5	91
-10	25	75	77.5	81	83	86.5
-15	21	71	73.5	77	79	82.5
-20	17	67	69.5	73	75	78.5
-25	13.5	63.5	66	69.5	71.5	75
-30	10	60	62.5	66	68	71.5
-35	7.5	57.5	60	63.5	65.5	69
-40	5	55	57.5	61	63	66.5

Table includes condenser + TD 5°F safety

Low Temp with R404A

Design Ambient (°F)		90	95	100	105	110
Condenser TD (°F)		15	15	15	15	15
SPR Offset (psig)		49.4	52	54.7	57.4	60.2
Ambient (°F)	Sat. Pres. (psig)	SPR Bleed Pressure (psig)				
140	400.9	450.3	452.9	455.6	458.3	461.1
135	376.7	426.1	428.7	431.4	343.1	436.9
130	353.6	403	405.6	408.3	411	413.8
125	331.6	381	383.6	386.3	389	391.8
120	310.5	359.9	362.5	365.2	367.9	370.7
115	290.5	339.9	342.5	345.2	347.9	350.7
110	271.4	320.8	323.4	326.1	328.8	331.6
105	253.2	302.6	305.2	307.9	310.6	313.4
100	235.8	285.2	287.8	290.5	293.2	296
95	219.4	268.8	271.4	274.1	276.8	279.6
90	203.7	253.1	255.7	258.4	261.1	263.9
85	188.9	238.3	240.9	243.6	246.3	249.1
80	174.8	224.2	226.8	229.5	232.2	235
75	161.4	210.8	213.4	216.1	218.8	221.6
70	148.8	198.2	200.8	203.5	206.2	209
65	136.9	186.3	188.9	191.6	194.3	197.1
60	125.6	175	177.6	180.3	183	185.8
55	115	164.4	167	169.7	172.4	175.2
50	105	154.4	257	159.7	162.4	165.2
45	95.6	145	147.6	150.3	153	155.8
40	86.7	136.1	138.7	141.4	144.1	146.9
35	78.4	127.8	130.4	133.1	135.8	138.6
30	70.6	120	122.6	125.3	128	130.8
25	63.4	112.8	115.4	118.1	120.8	123.6
20	56.6	106	108.6	111.3	114	116.8
15	50.2	99.6	102.2	104.9	107.6	110.4
10	44.3	93.7	96.3	99	101.7	104.5
5	38.8	88.2	90.8	93.5	96.2	99
0	33.8	83.2	85.8	88.5	91.2	94
-5	29.1	78.5	81.1	83.8	86.5	89.3
-10	24.7	74.1	76.7	79.4	82.1	84.9
-15	20.7	70.1	72.7	75.4	78.1	80.9
-20	17	66.4	69	71.7	74.4	77.2
-25	13.6	63	65.6	68.3	71	73.8
-30	10.5	59.9	62.5	65.2	67.9	70.7
-35	7.7	57.1	59.7	62.4	65.1	67.9
-40	5.1	54.5	57.1	59.8	62.5	65.3

Table includes condenser + TD 5°F safety

Low Temp with R-22

Design Ambient (°F)		90	95	100	105	110
Condenser TD (°F)		15	15	15	15	15
SPR Offset (psig)		42.3	44.5	46.8	49.1	51.6
Ambient (°F)	Sat. Pres. (psig)	SPR Bleed Pressure (psig)				
140	337.5	379.8	382	384.3	386.6	389.1
135	316.5	358.8	361	363.3	365.6	368.1
130	296.7	339	341.2	343.5	345.8	348.3
125	277.9	320.2	322.4	324.7	327	329.5
120	259.8	302.1	304.3	306.6	308.9	311.4
115	242.7	285	287.2	289.5	291.8	294.3
110	226.3	268.6	270.8	273.1	275.4	277.9
105	210.7	253	255.2	257.5	259.8	262.3
100	195.9	238.2	240.4	242.7	245	247.5
95	181.7	224	226.2	228.5	230.8	233.3
90	168.3	210.6	212.8	215.1	217.4	219.9
85	155.6	197.9	200.1	202.4	204.7	207.2
80	143.6	185.9	188.1	190.4	192.7	195.2
75	132.2	174.5	176.7	179	181.3	183.8
70	121.4	163.7	165.9	168.2	170.5	173
65	111.2	153.5	155.7	158	160.3	162.8
60	101.6	143.9	146.1	148.4	150.7	153.2
55	92.5	134.8	137	139.3	141.6	144.1
50	84	126.3	128.5	130.8	133.1	135.6
45	76	118.3	120.5	122.8	125.1	127.6
40	68.5	110.8	113	115.3	117.6	120.1
35	61.4	103.7	105.9	108.2	110.5	113
30	54.9	97.2	99.4	101.7	104	106.5
25	48.7	91	93.2	95.5	97.8	100.3
20	43	85.3	87.5	89.8	92.1	94.6
15	37.7	80	82.2	84.5	86.8	89.3
10	32.7	75	77.2	79.5	81.8	84.3
5	28.2	70.5	72.7	75	77.3	79.8
0	23.9	66.2	68.4	70.7	73	75.5
-5	20	62.3	64.5	66.8	69.1	71.6
-10	16.5	58.8	61	63.3	65.6	68.1
-15	13.2	55.5	57.7	60	62.3	64.8
-20	10.1	52.4	54.6	56.9	59.2	61.7
-25	7.4	49.7	51.9	54.2	56.5	59
-30	4.9	47.2	49.4	51.7	54	56.5
-35	2.6	44.9	47.1	49.4	51.7	54.2
-40	0.5	42.8	45	47.3	49.6	52.1

Table includes condenser + TD 5°F safety

Medium Temp with R-507

Design Ambient (°F)		90	95	100	105	110
Condenser TD (°F)		20	20	20	20	20
SPR Offset (psig)		68.5	72	76	80	84
Ambient (°F)	Sat. Pres. (psig)	SPR Bleed Pressure (psig)				
135	382.5	451	454.5	458.5	462.5	466.5
130	358.5	427	430.5	434.5	438.5	442.5
125	336	404.5	408	412	416	420
120	314.5	383	386.5	390.5	394.5	398.5
115	294	362.5	366	370	374	378
110	274.5	343	346.5	350.5	354.5	358.5
105	256	324.5	328	332	336	340
100	238.5	307	310.5	314.5	318.5	322.5
95	222	290.5	294	298	302	306
90	206	274.5	278	282	286	290
85	191	259.5	263	267	271	275
80	177	245.5	249	253	257	261
75	164	232.5	236	240	244	248
70	151	219.5	223	227	231	235
65	139	207.5	211	215	219	223
60	127.5	196	199.5	203.5	207.5	211.5
55	117	185.5	189	193	197	201
50	107	175.5	179	183	187	191
45	97	165.5	169	173	177	181
40	88	156.5	160	164	168	172
35	80	148.5	152	156	160	164
30	72	140.5	144	148	152	156
25	64.5	133	136.5	140.5	144.5	148.5
20	58	126.5	130	134	138	142
15	51	119.5	123	127	131	135
10	45	113.5	117	121	125	129
5	39.5	108	111.5	115.5	119.5	123.5
0	34	102.5	106	110	114	118
-5	29.5	98	101.5	105.5	109.5	113.5
-10	25	93.5	97	101	105	109
-15	21	89.5	92	97	101	105
-20	17	85.5	89	93	97	101
-25	13.5	82	85.5	89.5	93.5	97.5
-30	10	78.5	82	86	90	94
-35	7.5	76	79.5	83.5	87.5	91.5
-40	5	73.5	77	81	85	89

Table includes condenser + TD 5°F safety

Medium Temp with R404A

Design Ambient (°F)		90	95	100	105	110
Condenser TD (°F)		20	20	20	20	20
SPR Offset (psig)		67.6	71.1	74.7	78.4	82.3
Ambient (°F)	Sat. Pres. (psig)	SPR Bleed Pressure (psig)				
140	400.9	468.5	472	475.6	479.3	483.2
135	367.7	444.3	447.8	451.4	455.1	459
130	353.6	421.2	424.7	428.3	432	435.9
125	331.6	399.2	402.7	406.3	410	413.9
120	310.5	378.1	381.6	385.2	388.9	392.8
115	290.5	358.1	361.6	365.2	368.9	372.8
110	271.4	339	342.5	346.1	349.8	353.7
105	253.2	320.8	324.3	327.9	331.6	335.5
100	235.8	303.9	306.9	310.5	314.2	318.1
95	219.4	287	290.5	294.1	297.8	301.7
90	203.7	271.3	274.8	278.4	282.1	286
85	188.9	256.5	260	163.6	267.3	271.2
80	174.8	242.4	245.9	249.5	235.2	257.1
75	161.4	229	232.5	236.1	239.8	243.7
70	148.8	216.4	219.9	223.5	227.2	231.1
65	136.9	204.5	208	211.6	215.3	219.2
60	125.6	193.2	196.7	200.3	204	207.9
55	115	182.6	186.1	189.7	193.4	197.3
50	105	172.6	176.1	179.7	183.4	187.3
45	95.6	163.2	133.7	170.3	174	177.9
40	86.7	154.3	157.8	161.4	165.1	169
35	78.4	146	149.5	153.1	156.8	160.7
30	70.6	138.2	141.7	145.3	149	152.9
25	63.4	131	134.5	138.1	141.8	145.7
20	56.6	124.2	127.7	131.3	135	138.9
15	50.2	117.8	121.9	124.6	128.6	132.5
10	44.3	111.9	115.4	119	122.7	126.6
5	38.8	106.4	109.9	113.5	117.2	121.1
0	33.8	101.4	104.9	108.5	112.2	116.1
-5	29.1	96.7	100.2	103.8	107.5	111.4
-10	24.7	92.3	95.8	99.4	103.1	107
-15	20.7	88.3	91.8	95.4	99.1	103
-20	17	84.6	88.1	91.7	95.4	99.3
-25	13.6	81.2	84.7	88.3	92	95.9
-30	10.5	78.1	81.6	85.2	88.9	92.8
-35	7.7	75.3	78.8	82.4	86.1	90
-40	5.1	72.7	76.2	79.8	83.5	87.4

Table includes condenser + TD 5°F safety

TYLER REFRIGERATION

Medium Temp with R-22

Design Ambient (°F)		90	95	100	105	110
Condenser TD (°F)		20	20	20	20	20
SPR Offset (psig)		57.9	60.9	64	67.2	70.4
Ambient (°F)	Sat. Pres. (psig)	SPR Bleed Pressure (psig)				
140	337.2	395.1	398.1	401.2	404.4	407.6
135	316.5	374.4	377.4	380.5	383.7	386.9
130	296.7	354.6	357.6	360.7	363.9	367.1
125	277.9	335.8	338.8	341.9	345.1	348.3
120	259.8	317.7	320.7	323.8	327	330.2
115	242.7	300.6	303.6	306.7	309.9	313.1
110	226.3	284.2	287.2	290.3	293.5	296.7
105	210.7	268.6	271.6	274.7	277.9	281.1
100	195.9	253.8	256.8	259.9	263.1	266.3
95	181.7	239.6	242.6	245.7	248.9	252.1
90	168.3	226.2	229.2	232.3	235.5	238.7
85	155.6	213.5	216.5	219.6	222.8	226
80	143.6	201.5	204.5	207.6	210.8	214
75	132.2	190.1	193.1	196.2	199.4	202.6
70	121.4	179.3	182.3	185.4	188.6	191.8
65	111.2	169.1	172.1	175.2	178.4	181.6
60	101.6	159.5	162.5	165.6	168.8	172
55	92.5	150.4	153.4	156.5	159.7	162.9
50	84	141.9	144.9	148	151.2	154.4
45	76	133.9	136.9	140	143.2	146.4
40	68.5	126.4	129.4	132.5	135.7	138.9
35	61.4	119.3	122.3	125.4	128.6	131.8
30	54.9	112.8	115.8	118.9	122.1	125.3
25	48.7	106.6	109.6	112.7	115.9	119.1
20	43	100.9	103.9	107	110.2	113.4
15	37.7	95.6	98.6	101.7	104.9	108.1
10	32.7	90.6	93.6	96.7	99.9	103.1
5	28.2	86.1	89.1	92.2	95.4	98.6
0	23.9	81.8	84.8	87.9	91.1	94.3
-5	20	77.9	80.9	84	87.2	90.4
-10	16.5	74.4	77.4	80.5	83.7	86.9
-15	13.2	71.1	74.1	77.2	80.4	83.6
-20	10.1	68	71	74.1	77.3	80.5
-25	7.4	65.3	68.3	71.4	74.6	77.8
-30	4.9	62.8	65.8	68.9	72.1	75.3
-35	2.6	60.5	63.5	66.6	69.8	73
-40	0.5	58.4	61.4	64.5	67.7	70.9

Table includes condenser + TD 5°F safety

Setting the Normally Open Solenoid for Enviroguard

1. The Normally Open solenoid valve should be configured to be energized (closed) when the head pressure falls to 5 psig above the cut-out pressure of the lowest condenser fan setting.
2. The Normally Open solenoid valve should be configured to be de-energized (opened) at 10 psig above the lowest fan setting.

Adjusting the Branch Circuit Expansion Valve

The expansion valve in the branch refrigeration circuits should be adjusted after the refrigeration system has been running for several days and has reached steady operating conditions. *(Reference Case Manufacturers Manual for proper Valve Adjustments.)*

Condenser Fan Settings

1. Condenser fans are cycled by an electronic compressor and condenser control unit. The preferred method uses a dropleg pressure transducer mounted on the condenser side of any pressure regulating valves. The first fan (or set of fans) should run continuously in areas having ambients above 20°F. In areas ambients can go below 20°F, ALL condenser fans (or sets of fans) can be cycled on the electronic control.
2. Fan staging differential = 5 psig with ON/OFF delays = 20 to 30 seconds.
3. Rapid recovery feature = 5 psig above the last stage with 5 to 10 seconds delay on.
4. If conventional pressure controls are used, set the last stage per chart with a minimal differential (approximately 7 psig) and stage other fans above this point.
5. When EPRs are involved in controlling temperatures of the fixture evaporators, condenser fans should be set to limit condensing pressure to 35 psig above the warmest evaporator pressure setting of the EPRs.
6. When Heat Recovery is used, DO NOT apply an IPR on the outlet of the coil. If an IPR is installed to a heat recovery coil, it becomes a division point between the compressor discharge and the condenser liquid. During colder ambients no liquid flow will take place to maintain refrigeration. All liquid will stack in the cold condenser.
7. A Normally Open solenoid valve located downstream of the SPR is a low limit for the system head pressure. This Normally Open solenoid valve must be configured to be energized (closed) at 10 psig higher than the lowest condenser fan setting.
8. To increase the amount of heat available for heat recovery, raise the condenser fan pressure control setting to 75°F saturated condensing temperature and the Normally Open solenoid valve control at 30 psig above the fan pressure setting.

Enviroguard Settings

CONDENSER DESIGN (10°F)(6.3°C) TD Low Temp (15°F)(8°C) TD Med Temp			
CONDENSER FAN SETTINGS			
Electric Defrost	R-22	R404A	R-507
Low Temp (psig)	69	85	90
Med Temp (psig)	102	125	130
Hot Gas Defrost	R-22	R404A	R-507
Low Temp (psig)	93	114	120
Med Temp (psig)	102	125	130

NOTE

The Normally Open solenoid valve must be programmed to be energized (closed) at 5 psig higher then the lowest setting of the condenser fans.

Differential Pressure Settings for DDPR at Various Riser Heights

RISER HEIGHTS (ft)	DDPR SETTINGS (psid)
0	20
15	28
20	30
25	33
30	35
35	38
40	40

The minimum allowable differential pressure setting of the DDPR is 20 psid.

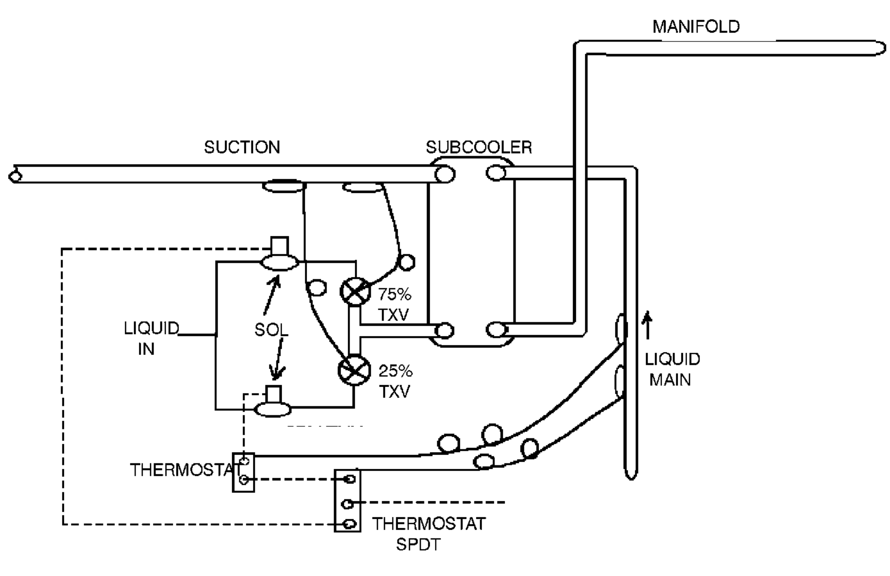
Setting the DDPR for Enviroguard

1. Install gauges both upstream and downstream of the DDPR.
2. Close the hot gas hand valve to station #1.
3. Initiate defrost station #1.
4. Adjust DDPR to proper setting. (DDPR setting = 20 psig plus 1/2 the riser height.)

   Example: *If the riser height between the case level and the condenser inlet is 24', the setting for the DDPR would be 20+12 = 32psig.*
5. Remove the gauges.
6. Cycle the defrost OFF.
7. Open the hot gas hand valve to station #1.

Mechanical Liquid Subcooling

1. When subcoolers are operated with two expansion valves, one is rated at 25% of the load and the other at 75% of the load. Two thermostats are necessary to control the respective valves. The one designated thermostat in the 25% TXV solenoid circuit is set to operate at 55°F cut-in and 50°F cut-out. This thermostat is wired to the close-on-rise temperature switch function. The one designated thermostat in the 75% TXV solenoid circuit is set to operate at 80°F cut-in and 75°F cut-out. This double-throw switch is wired to the close-on-rise temperature for the 75% TXV circuit and to the close-on-rise temperature for the 25% TXV circuit switch functions. The sensing bulbs of both thermostats are mounted on the main liquid line entering the subcooler or the condenser liquid dropleg.
2. For systems equipped with an EPR on the suction outlet of the subcooler, the EPR should be set at a pressure corresponding to a 30°F saturated evaporating temperature for the refrigerant type being used.
3. The typical subcooler leaving target liquid temperature is 40°F.
4. Subcooler expansion valves should be set to achieve a superheat of 10°F.



Servicing the System

Servicing the entire system requires a total shutdown of the unit. Following the procedures below will provide the shutdown instructions. *Refer to Figure 1 on page 24-9 to locate the components that are referred to in these procedures.*

1. Close the main liquid line ball valve (#1) before the unit liquid drier (#3) and hand valve (#15).
2. The system will be pumped down when all compressors cycle OFF on the backup low pressure controls and the system suction pressure is 1 psig or less.
3 The system is now shutdown and ready for servicing.

To restart the system after servicing, follow this set of procedures. *Figure 1 on page 24-9 shows the locations of the components that are referred to in these procedures.*

1. Open the ball valve (#13) on the recharge line to allow the liquid refrigerant to flow from the receiver into the unit liquid manifold (#6).
2. Open the hand valve (#15) on the bleed line assembly.
3. Continue to observe the system head pressure until it reaches the design condition or higher. This is also indicated when no bubbles are observed in the unit liquid line sightglass (#5).
4. Close the ball valve (#13) in the recharge line and open the main liquid line ball valve (#1) on the inlet side of the unit liquid drier (#3).
5. The system is now ready for normal operation.

To service a separate branch circuit without shutting down the entire system, follow this set of procedures.

1. Close the branch circuit liquid line ball valve while monitoring the suction pressure in the branch circuit.
2. When the suction pressure in the branch circuit reaches the same suction pressure as the parallel compressor unit or 0 psig, close the branch circuit suction line ball valve.
3. In servicing the branch circuit, ensure that proper procedures are followed in recovering refrigerant.
4. After servicing the branch circuit ensure that the branch circuit has been proper evacuated before putting it back into service.
5. To place the branch circuit back into service, open the branch circuit liquid line and suction line ball valve.

Evaporative Condenser Settings

SPR Settings

1. Determine the design ambient wet bulb temperature.
2. Determine the design ambient wet bulb temperature to refrigerant condensing temperature difference. Typical condensing temperatures for low temp systems are 90° to 95 °F with a 20° TD. Condensing temperatures for medium temp systems are 95° to 100°F with a 25° TD. Refer to manufacturers recommended guidelines.
3. The following examples are for low & medium temp systems using R-22 refrigerant. These example charts will determine the SPR differential setting:

Low Temp System Example Chart

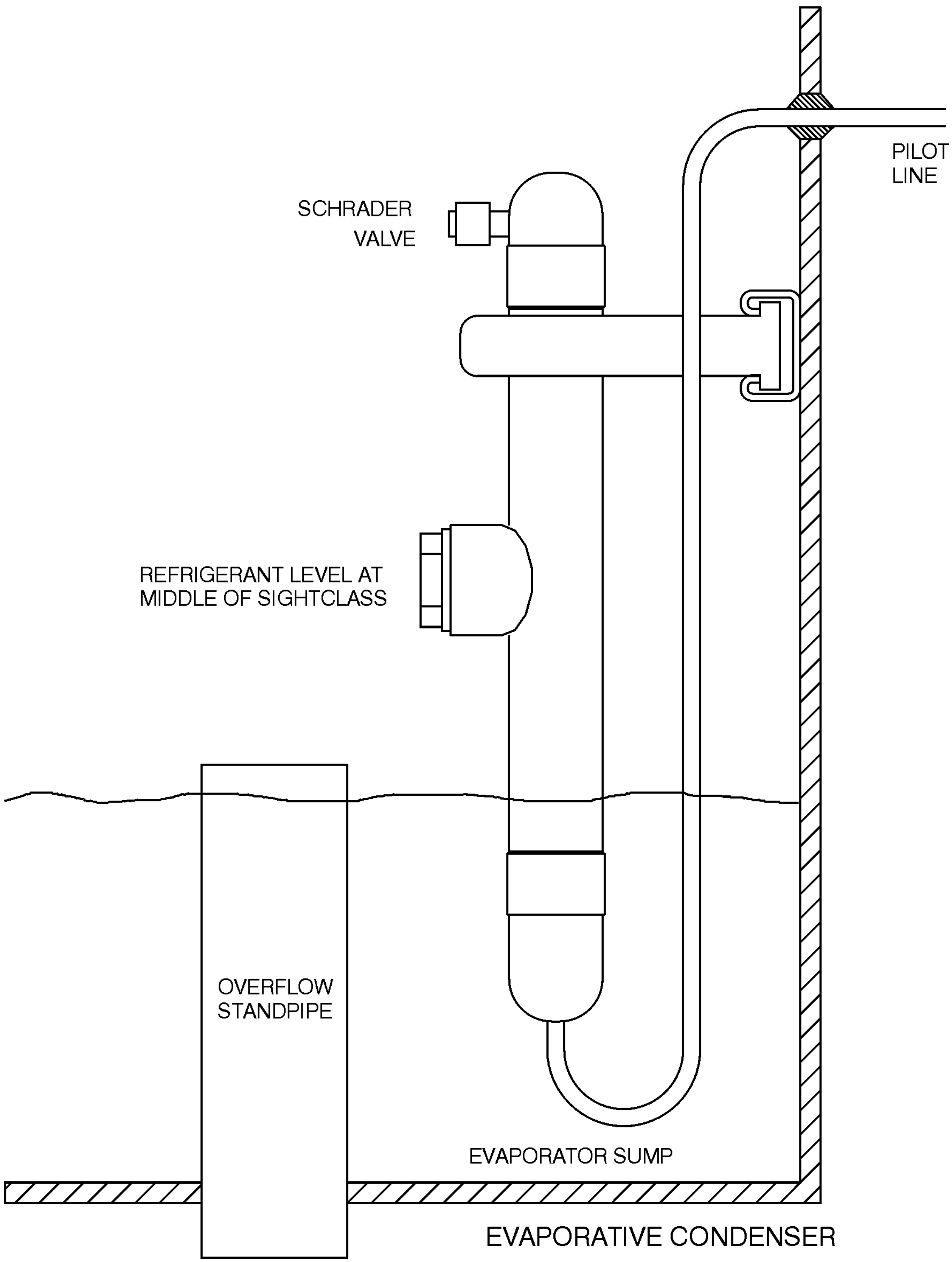
A	Design wet bulb temperature for area	75°F
B	Temperature difference (TD) for wet bulb to refrigerant	20°F
C	Saturated condensing temperature	95°F
D	Corresponding saturation pressure at condensing temperature	182 psig
G	Corresponding saturation pressure at wet bulb temperature	132 psig
H	Required SPR differential setting	50 psig

Medium Temp System Example Chart

A	Design wet bulb temperature for area	75°F
B	Temperature difference (TD) for wet bulb to refrigerant	25°F
C	Saturated condensing temperature	100°F
D	Corresponding saturation pressure at condensing temperature	198 psig
G	Corresponding saturation pressure at wet bulb temperature	132 psig
H	Required SPR differential setting	66 psig

All Evaporative Condenser controls are set according to manufacturers guidelines. (i.e.: two stage fan control, damper controls, etc.)

Evaporative Condenser Sensing Bulb



Gas Defrost Application

Hot Gas Defrost of a Branch Circuit

Upon defrost initiation by the defrost time clock the following actions occur:

1. The suction stop solenoid valve or EPR closes. The branch circuit gas solenoid valve opens. The defrost differential pressure regulator (DDPR) is de-energized into the differential pressure regulating mode.
2. The discharge pressure drops as hot discharge gas begins to flow through the hot gas supply manifold to the evaporators.
3. The frost on the evaporators absorbs heat energy from the hot gas which is increasing in pressure. The liquid begins to flow backwards through the liquid line around the expansion valve. It then goes through the bypass check valve and branch circuit liquid line return check valve to the hot gas return manifold.

   The liquid continues to flow into the discharge line to the condenser increasing the available condenser liquid supply. Another check valve on the branch circuit liquid line prevents the liquid from entering the main liquid supply manifold.
4. Defrost pressure continues to rise until a differential pressure is established across the DDPR. When the differential setting of the DDPR is reached, part of the hot gas is bypassed through the DDPR into the heat recovery coil or condenser while maintaining defrost pressure to the evaporators.

Halfway through the defrost period:

1. The defrost pressure (and saturated temperature) continues to rise as the liquid returns from the evaporators. This is a two-phase mixture of liquid and vapor as the frost is melted off the evaporators.
2. This two-phase mixture of liquid and vapor flows through the liquid line into the discharge line to the condenser. The returning liquid increases the liquid supply in the condenser and any vapor returning from the evaporators is also condensed to liquid in the condenser. This increases the liquid supply for the branch circuits in refrigeration.

   The returning liquid, condenser and main liquid supply circuit is at a pressure corresponding to the defrost discharge pressure minus the DDPR differential pressure setting.

About three quarters of the way through the defrost period:

The defrost pressure (and corresponding saturated temperature) continues to rise as all frost is melted from the evaporators.

The fixture discharge air temperature begins to rise until the termination temperature is reached. The branch circuit hot gas solenoid valve is then closed. The hot gas solenoid valve may cycle open and closed several times before the defrost is terminated completely. A drip down or drain period delay is designed into the system to allow condensate to drain from the fixture before resuming refrigeration.

At the end of defrost when the defrost clock has timed out:

1. After termination of defrost based on time, the branch circuit hot gas solenoid valve closes. The suction stop solenoid valve or EPR opens after the drip down delay and the DDPR returns to the Normally Open mode.
2. Refrigeration is reestablished in the defrosted branch circuit, and all refrigerant flows resume to the normal directions.

Application Guidelines

(See Section 13 "Gas Defrosting" for additional information.)

1. Defrost Differential Pressure Regulator Valve (DDPR) for Hot Gas Defrost

   The DDPR is located in the discharge line downstream of the takeoff tee to the hot gas supply manifold. Its purpose is to develop a pressure differential between the hot gas supply manifold and the hot gas return manifold. This ensures effective defrosting and good liquid return from the evaporators being defrosted.

2. Hot Gas Return Manifold for Gas Defrost (When Used)

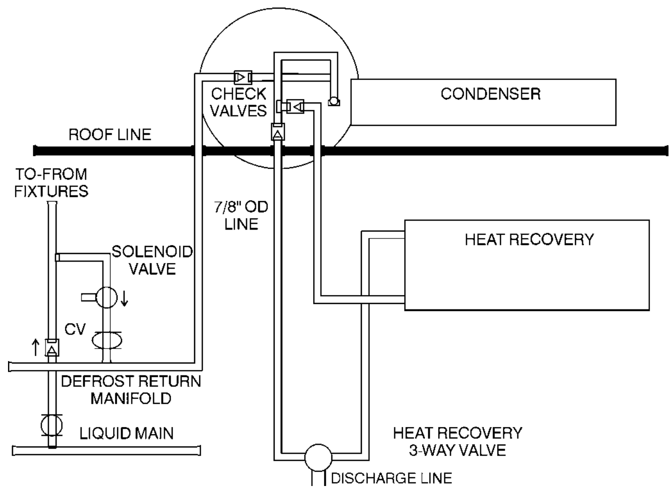
   An important area is the field piping of the 7/8" OD gas return line to the condenser. This line must be field piped from the defrost return manifold and tapped into the discharge line at the condenser. This can be just before, but preferably after the inverted trap into the condenser manifold. A 7/8" OD check valve must be installed near the tap in. However, a discharge line check valve must be installed within 4" upstream of the tap in. This will ensure defrost return liquid will enter condenser and maintain liquid integrity to circuits in refrigeration. This also prevents storage of defrost return liquid in excessive long discharge line during defrost. Where systems utilize a heat recovery circuit, the return line must be tapped in downstream of the main discharge line check valve. The check valve needs to be installed within 2' of the tap in.

   The hot gas return manifold outlet piping shall be piped into the horizontal discharge line leading to the condenser from the top side or side of the discharge line. Piping into the bottom of the discharge line creates a holding well for oil and liquid refrigerant during the refrigeration cycle. A vertical discharge line is no problem with the exception of the location of the discharge line check valve.

   If using heat recovery, the hot gas return manifold outlet piping should not be piped into the heat recovery coil. This could cause a shortage of liquid refrigerant for fixtures in refrigeration while one branch circuit is being defrosted.

3. Check Valves for Gas Defrost

   Check valves installed in the discharge line and heat recovery return line should be located as close as possible to each other and within 4' of the hot gas return tap in as described on page 24-30. This reduces the potential for excessive liquid storage in long discharge lines and associated piping causing unbalance to occur in the condenser liquid supply during a defrost cycle. This applies to both horizontal and vertical discharge lines.



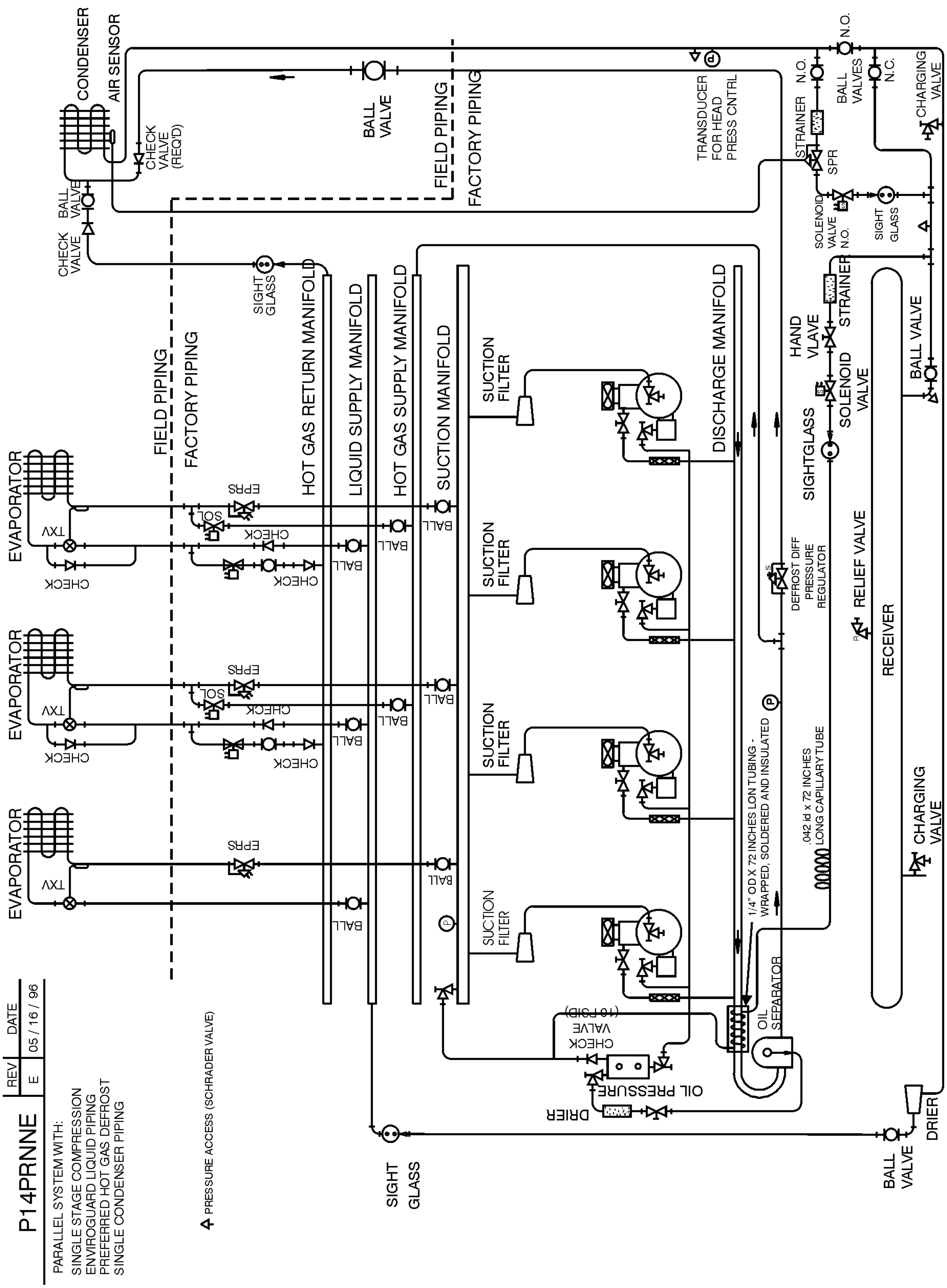
   One check valve is mounted in the liquid line leaving the main liquid supply manifold. Its purpose is to allow liquid flow during refrigeration and block liquid flow to the main liquid supply manifold during a gas defrost.

   A Normally Closed solenoid valve is located in the line connecting the main branch circuit liquid line to hot gas return manifold. Its purpose is to allow flow from the branch circuit liquid line to the hot gas return manifold during defrost. This assures refrigeration of all circuits during defrost regardless of field routing of the branch liquid lines.

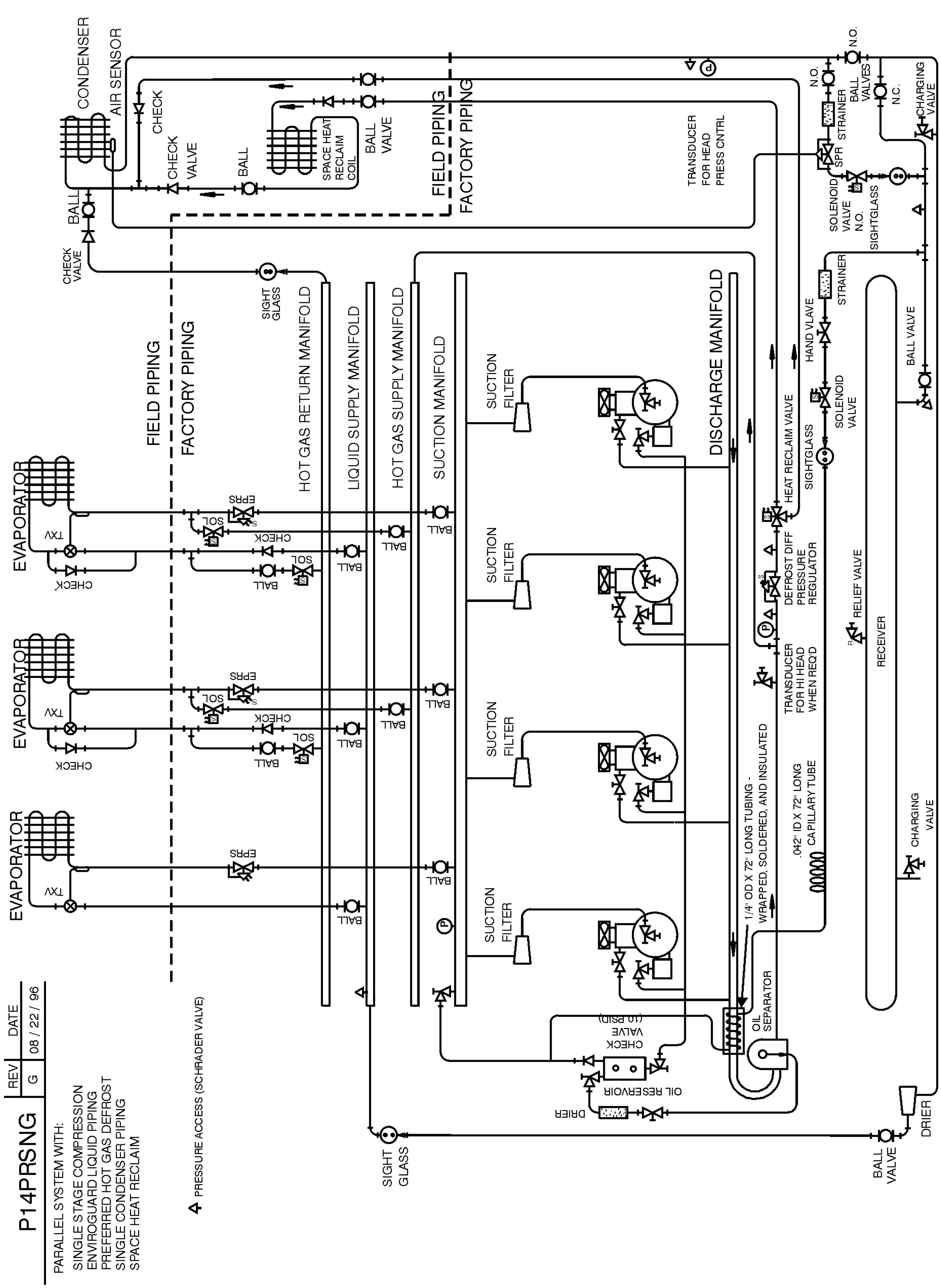
System Components with Gas Defrost

1. Defrost Differential Pressure Regulator (DDPR)
   - Refrigeration Specialties
2. Hot Gas Return Manifold and Return Lines
   A) Manifold, 1-1/8" OD
   B) Ball Shutoff Valve 7/8" OD, if used (field installed)
   C) Sightglass (field installed)
   D) 7/8" OD Check Valve (field installed)
3. Branch Circuit Liquid Line Components
   A) Watsco "bullet type" Check Valves, 5/8" OD
   B) Ball Shutoff Valves, 5/8" OD
   C) Two valves each are required per branch circuit.
   D) Normally Closed 5/8" Solenoid Valve

Piping Diagram for Enviroguard with Gas Defrost



Piping Diagram for Enviroguard with Gas Defrost & Space Heat Recovery



Gas Defrost Control Settings

1. Defrost

   A) Defrost frequency and duration should be set per fixture requirements recommended by manufacturer. Normally no compensations to defrost frequency or duration need to be made.

   B) For **Gas Defrost**, minimum defrosting discharge pressure is to be maintained at a minimum refrigerant saturation pressure corresponding to 55°F for any refrigerant type used.

2. Defrost Differential Pressure Regulator Valve (DDPR) for Gas Defrost

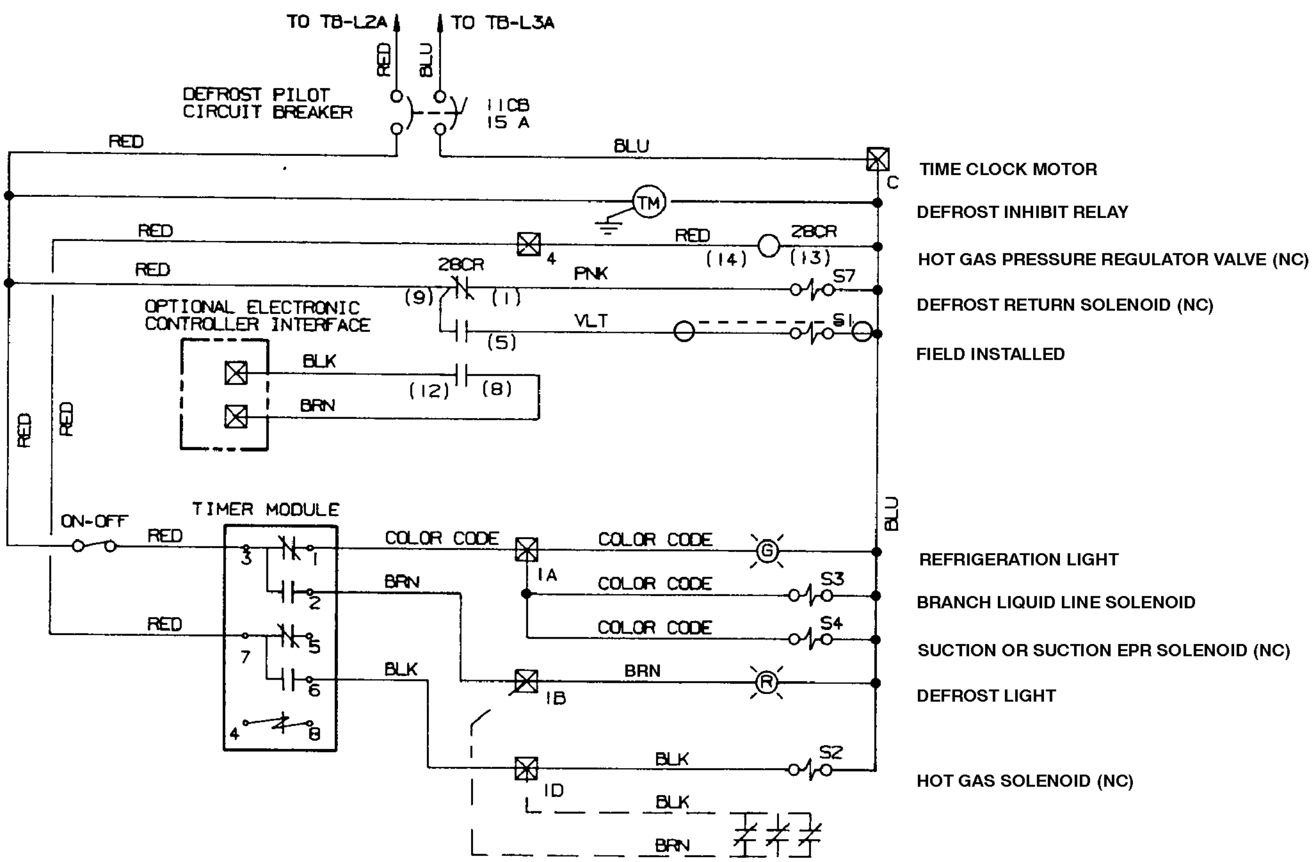
   The table on page 24-26 lists the differential pressure settings for the DDPR for various heights of net liquid lifts from the lowest fixture liquid line elevation to the condenser inlet manifold. Settings are presented and include the pressure drops for the liquid line, the check valve, and the defrost return solenoid valve.

3. Condenser & Normally Open Solenoid Settings

   A Normally Open solenoid valve is located in the SPR bypass line downstream of the SPR. The Normally Open solenoid valve function is to provide a low limit for the system operating pressures to prevent excessive refrigerant bleedoff. *(See page 24-23.)*

Wiring for Defrost Return Solenoid (Field Installed)

Gas Defrost with Suction Stop



Troubleshooting Enviroguard Problems

PROBLEM	PROBABLE CAUSE	CORRECTION
Liquid flashing in sightglass.	Lack of refrigerant.	Add refrigerant.
	Restricted drier.	Change drier.
	Condensing pressure too low.	Increase condensing pressure.
	Excessive liquid in receiver.	Transfer refrigerant to system.
High discharge pressure.	Condenser fan failure.	Check motor, fuses and control.
	Evap. condenser pump failure.	Check motor, fuses and control.
	Receiver overcharged.	Check SPR circuit for closed off valves.
	Dirty or plugged condenser.	Clean condenser.
Receiver full of liquid.	System overcharge.	Reduce refrigerant charge.
	Misadjusted SPR valve.	Check setting of SPR.
	SPR air sensor lost charge.	Recharge sensor.
	Condenser fan failed.	Check and replace motor, fuses, control, wires, etc.
	Condenser dirty & plugged.	Clean debris out of condenser.
	Bleed circuit restricted.	Check strainer & solenoid valve.
	SPR valve leaking.	Check for chips and debris in valve seat.
Condensate liquid dropleg too warm.	Refrigerant undercharged.	Add refrigerant to system.
	Condenser fan failure.	Check motors, fuses, wires, controls, etc.
	Dirty or plugged condenser.	Clean condenser.
Floodback to compressors.	Expansion valves not set for proper superheat.	Check superheat and readjust TXVs.
	Incomplete defrost.	Check termination and duration.
	Loss of evaporator fans.	Check evaporator fans.
	Clogged evaporator fins.	Clean evaporator.
Gas defrost not clearing fixtures.	DDPR valve not set to correct differential for elevation.	Check and reset DDPR valve to proper value for elevation.
	Defrost duration is too short.	Check and reset duration of defrost.
	Defrost termination temperature set too low.	Check and reset termination temperature higher.

SECTION 25

Enviroguard II

***ENVIROGUARD II** is a patented refrigerant control system in which the amount of liquid refrigerant being used in the system is controlled by an electronic I/O board. The algorithm receives input from the ambient temperature, liquid dropleg temperature and pressure to control the condenser fans (system head pressure) and the solenoid valve operation.*

Enviroguard II systems have been superceded by Enviroguard III systems. Enviroguard II system are no longer being built. Most Enviroguard II systems have been retrofitted in the field into Enviroguard III systems.

All questions concerning Enviroguard II systems should be referred to the CARRIER-TYLER Service Department.

Phone: (800) 992-3744, ext. 428 or 747

SECTION 26

Enviroguard III

***ENVIROGUARD III** is a patented refrigerant control system that utilizes floating head technology (Nature's Cooling). The amount of liquid refrigerant being used in the system is controlled by a selection of various electronic controller systems. These controllers include Comtrol MCS-4000, CPC's RMCC, CPC's Einstein 1 & 2, Danfoss AKC-55 and Micro-Thermo. Any of these controllers work with Enviroguard III to provide Nature's Cooling with lower compressor runtimes that lower operational and maintenance cost.*

Theory of Operation

Enviroguard was developed by TYLER to expand on floating head technology (Nature's Cooling). The concept of which is to take advantage of lower ambient operating conditions and thereby lower system liquid temperatures below actual condensing temperature. This process is called **Subcooling**. The net effect is lower compressor runtimes which result in lower operational and maintenance cost.

Subcooling Defined

Subcooling is defined as the point at which liquid is cooled below it's condensing temperature.

Example: Refrigerant R404A	
Condensing Pressure (psig)	203
Converted to Condensing Temperature (° F)	90
Actual Temperature of Liquid at Outlet of Condenser (° F)	85
Acquired Subcoling (° F)	5

Nature's Cooling Concept

Example:
At 100° F condensing and 0° F subcooling, 47% of the refrigerant's BTU capacity is lost through the TXV on an evaporator operating at a -25° F SST. This only leaves 53% of the systems total capacity to address the evaporator load.

The same system at 100° F condensing and 50° F subcooling loses only 27% of it's total capacity through the TXV with 73% available for the evaporator load. Less of the refrigerant's total capacity is being used to cool itself to the operating temperature of -25° F SST, thereby leaving more for net refrigeration. With this scenario less of the evaporator coil is actually being used with no ill effects to the product integrity.

Enviroguard and TXV Operation

When a TXV has been applied to the evaporative load, there are 4 variables that can affect it's operation in regards to the capacity.

1. Evaporator Temperature
2. Head Pressure
3. Temperature of Liquid Refrigerant Entering the TXV
4. A Change in Evaporative Load

IMPORTANT

TXV operation is NOT compromised with Enviroguard because the lower operating head pressures are offset by the resulting drop in liquid temperature that is entering the valve.

Enhanced Nature's Cooling Concept

With Nature's Cooling and Enviroguard we have the ability to keep condensing temperature within 4° F of ambient on a properly charged system. In other words, the condensing temperatures vary or float with the actual ambient operating temperatures.

Effects and Facts to Consider

EFFECT CHART	
Effects:	**Benefits:**
Increased Compressor Capacity.	For each 10° F drop in condensing temperature, there is a 6% rise in compressor capacity.
Reduced Power Consumption (BTU/Watt-Hr).	For each 10° F drop in condensing temperature, there is an 8% drop in power consumption.
Lower Maintenance Cost.	Extended compressor life due to overall runtime.

Facts to Consider

- The Enviroguard system is piped with the **liquid header** and the **receiver** in parallel of each other
- The liquid header begins at the outlet of the condenser.
- At or below approximately 70° F ambient temperature, there should be NO liquid present in the receiver.
- The system charge is balanced through a bleed solenoid and tubing located between the bottom of the receiver and the suction manifold. Under normal operating conditions this process is constant as long as one compressor is running.
- Enviroguard's control strategy targets net subcooling for EG valve operation.
- Enviroguard provides control strategy that prevents elevated condenser operation.

Enviroguard and Heat Reclaim

Space or hot water reclaim may be used with Enviroguard, however, the value of space heating is very limited with the condenser fan controls set to maximize the energy savings. The resetting of these controls to increase heat recovery, or the addition of holdback valves, will also increase the compressor operating cost in cool weather.

Enviroguard and Hot Gas Defrost

A discharge differential pressure regulating valve (DDPR) is used on Enviroguard systems with hot gas defrost. The DDPR should be field adjusted to maintain a differential of 20 psig plus one-half the riser height.

Example:
If the riser height between the case level and the condenser inlet is 24 feet, the setting for the DDPR would be 20+12 = 32 psig.

Important to Know!

- The condenser dropleg temperature and the outdoor temperature should be within 2 to 4° F of each other, under normal operating conditions and a proper refrigerant charge.
- Head pressures run considerably lower than fixed head systems. In fact, an R404A system with electric defrost has a condenser pressure set point of 85 psig.
- 60° F is the target condensing temperature for medium-temp systems. 40° F is the target condensing temperature for low-temp systems with electric defrost. Low-temp systems with hot gas defrost have a 55° F condensing temperature set point.
- For multi-temp systems, use the 60° F medium-temp target condensing temperature setting.

Inputs

Enviroguard uses three inputs.

1. Dropleg Pressure Transducer (See page 26-5.)
2. Dropleg Temperature Sensor (See page 26-5.)
3. Ambient Air Temperature Sensor *(field installed by contractor)* (See page 26-10.)

The controller will process the information from these three inputs to perform the Enviroguard function.

NOTE

Prior to system start-up, the information from all three of these inputs SHOULD BE CHECKED for accuracy.

SPR Operation

1. The SPR solenoid will not operate until all of the condenser fan outputs are ON. This will allow the system to take advantage of the additional subcooling during the lower ambient temperature conditions. It also disables the SPR override until all the fans are ON in the lower ambient conditions.

2. The receiver vent solenoid may be wired to the same output point as the SPR solenoid, or wired to a separate output point (controller dependent). The receiver vent solenoid will delay 5 minutes behind the SPR solenoid when turning ON, but will not delay when cycling OFF. The time delay function is handled with a solid state timer, or controller programming (controller dependent). This solenoid is used to lower the receiver pressure, if all of the condenser fans are ON and the subcooling set point is achieved. If after 5 minutes the SPR is still energized, the solenoid will energize allowing the receiver to vent to the suction header. This allows the liquid in the receiver to boil off which lowers the receiver pressure and allows the refrigerant to flow from the condenser to the receiver.

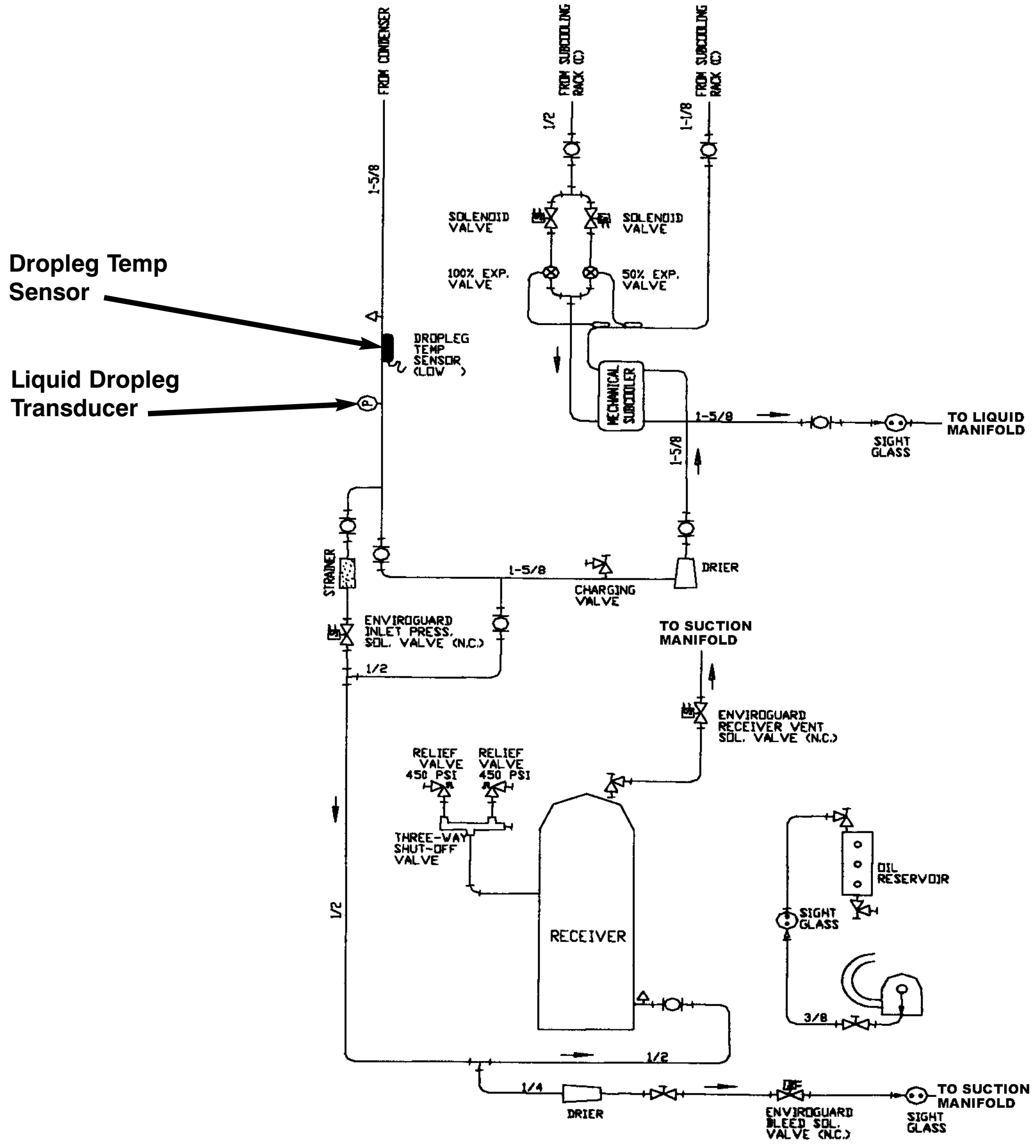
   An alternative method to sharing a common output point with the SPR solenoid, is to wire the receiver vent solenoid to a dedicated output control point with a preprogrammed time delay. The three output points are as follows:

   - **Bleed Out Solenoid** (Liquid from the Receiver to the System)
   - **SPR Solenoid** (Liquid from the System to the Receiver)
   - **Receiver Vent Solenoid** (Vapor from top of the Receiver to Suction)

3. The Receiver Bleed Solenoid is controlled by auxiliary contacts that are mounted on the compressor contactors, or a computer digital input point (DI), monitoring compressor run status. These compressor contactors are for the suction group it is piped to on the suction header. This solenoid is active if any compressors on that suction group are running. If there is liquid in the receiver, the liquid will be allowed to pass through a cap tube then through a 1/4” OD line wrapped around the discharge line. This vaporizes the liquid before it vent to the suction header.

Liquid Return and Enviroguard Piping

(See piping diagram below and photos on pages 26-6 & 26-7.)



Subcooling is Calculated by:

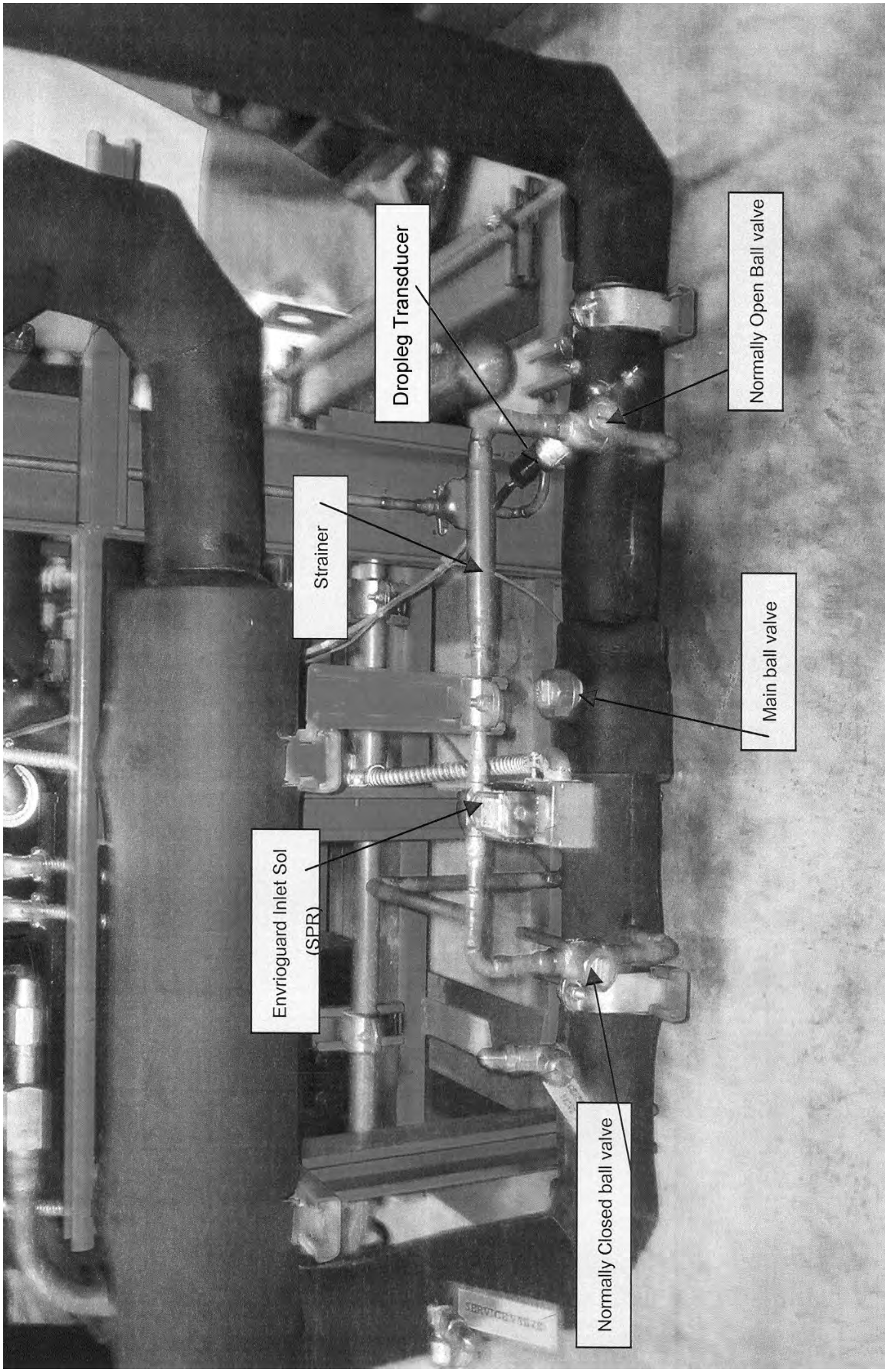
The dropleg pressure covered to the temperature, then compare that temperature to the actual dropleg temperature.

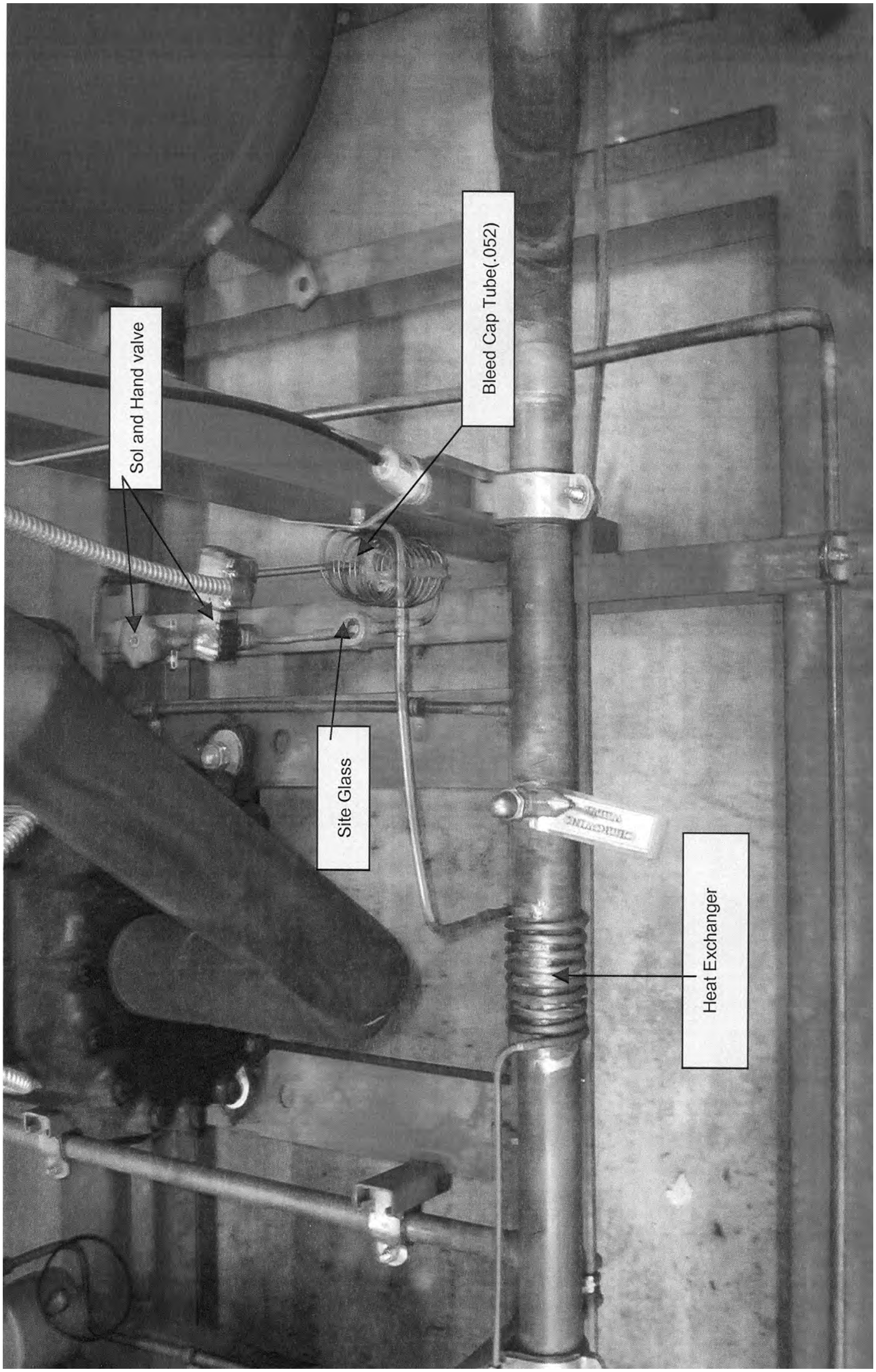
Example:
150# = 70° F saturated liquid temperature.

Correction for the condenser height above the rack equals1/2# for every foot of rise (Static Pressure).

Condenser elevation is 20'. Corrected reading of 140# or 66° F saturated temperature.

Actual dropleg temperature of 56° F = 10° F of subcooling.


Dropleg Transducer
Normally Open Ball valve
Strainer
Main ball valve
Envrioguard Inlet Sol
(SPR)
Normally Closed ball valve


Sol and Hand valve
Bleed Cap Tube(.052)
Site Glass
Heat Exchanger

Failsafe for Enviroguard III

Control outputs are wired so the SPR valve fails to the closed position. The contacts are set for inverted operation. This failsafe activates under the following conditions:

1. The outputs will be de-energized if there is a controller and/or communication failure.
2. If any of the three sensors (Dropleg Pressure Transducer, Dropleg Temperature Sensor, or Ambient Air Temperature Sensor) fail.

Guidelines for Enviroguard III

1. All liquid lines MUST BE INSULATED! This includes the condenser liquid return line from the machine room roof to the rack.
2. If heat recovery is used, an additional check valve is needed at the inlet to the heat recovery coil. This prevents refrigerant from pumping out of the recovery coil during the OFF cycle and unnecessary shifts of refrigerant to the receiver.
3. One ambient temperature sensor may be required for each Enviroguard system (controller dependent). Each sensor should be mounted under the header end of the condenser. The mounting locations should be away from metal surfaces that could affect the temperature readings.
4. Suction stop EPR's are recommended for circuit temperature control.

NOTE

Liquid line solenoids and pump down can be used on a LIMITED basis.

5. Prior to TXV adjustment, set condensing temperature to 90° F. Refrigerant type will dictate the corresponding pressure. When valves are set, use Enviroguard guidelines to set condensing pressure for normal operation. *(See page 26-19.)*
6. Prior to normal operation, insure that the Enviroguard ball valves are in their proper positions. *(See page 26-10.)*

   Example: *N/O open and N/C closed*

Condenser Set Points

CONDENSER SET POINTS			
Refrigerant Type	**Medium Temp (60° F)**	**Low Temp - Hot Gas (55° F)**	**Low Temp (40° F)**
R404A	125.0	115.0	85.1
R-507	129.7	118.8	89.8
R-22	101.6	92.6	68.5

Recommended Charging Procedure

Ambient air temperature is above 70°F:

The system should be charged to 20 - 25% of the receiver level.

Ambient air temperature is below 70°F:

1. Make sure the condenser set point is set to a pressure whose saturated temperature is at least 35°F above the ambient air temperature.
2. Close off the SPR line.
3. Add charge until the subcooling sensor control point achieves an average of 30°F of subcooling.

NOTE

Southern climates may use 25°F for low temperature systems.

4. When checking your subcooling value, you must deduct one-half of the condenser elevation from the pressure reading. *Example: If you have a 20 foot condenser elevation you would deduct 10 pounds from the pressure reading.* The condenser elevation deducts the static pressure of the column of liquid 1/2 pound per foot of rise. The calculated pressure is the pressure at the outlet of the condenser.

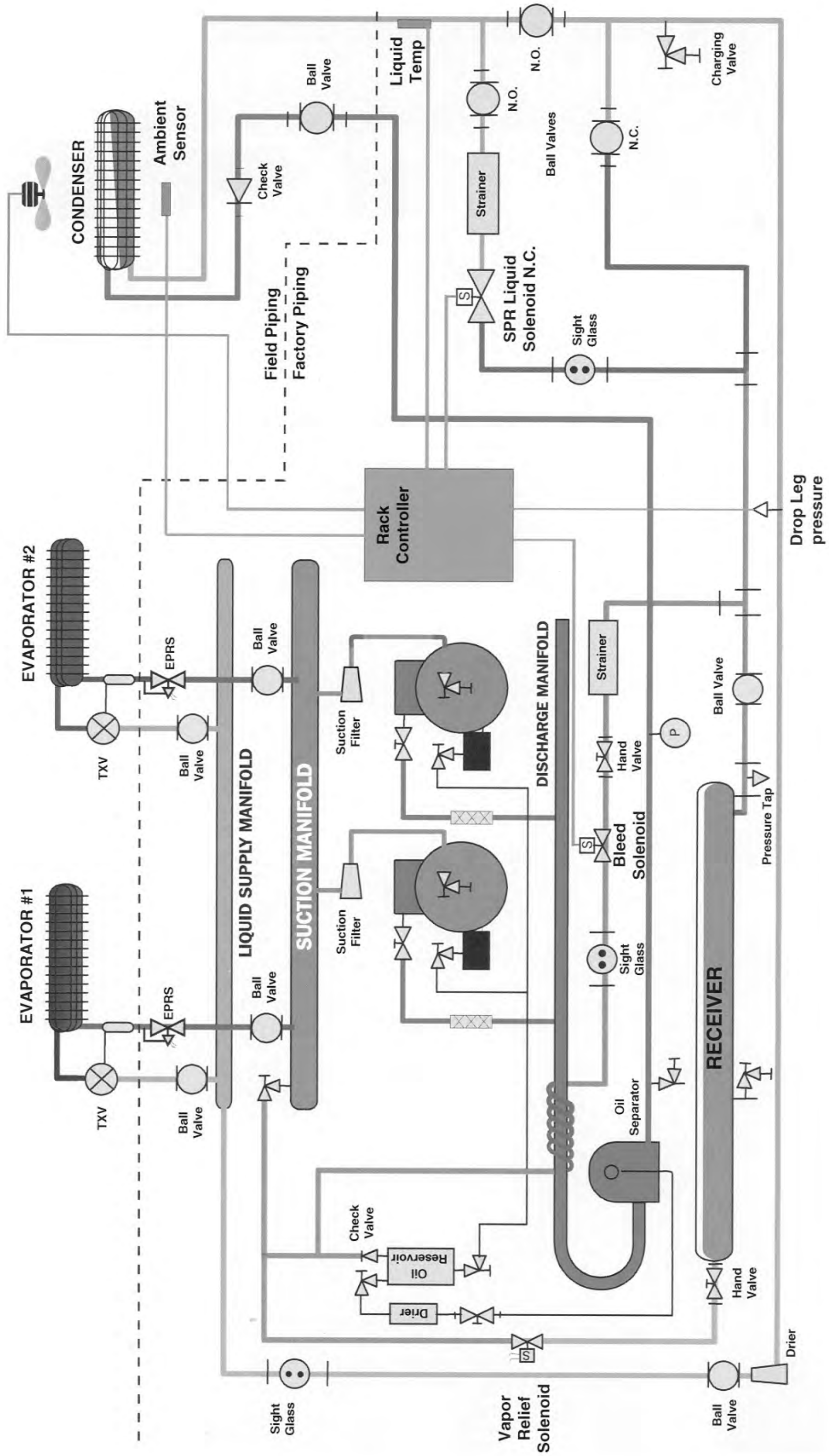
Enviroguard III Piping Diagrams, Evaporator #2 Defrosting

The following four typical piping diagrams for Enviroguard III systems with Electric or Time Off Defrost and Hot Gas Defrost for Summer and Winter Operation are shown on pages 26-10 through 26-13.

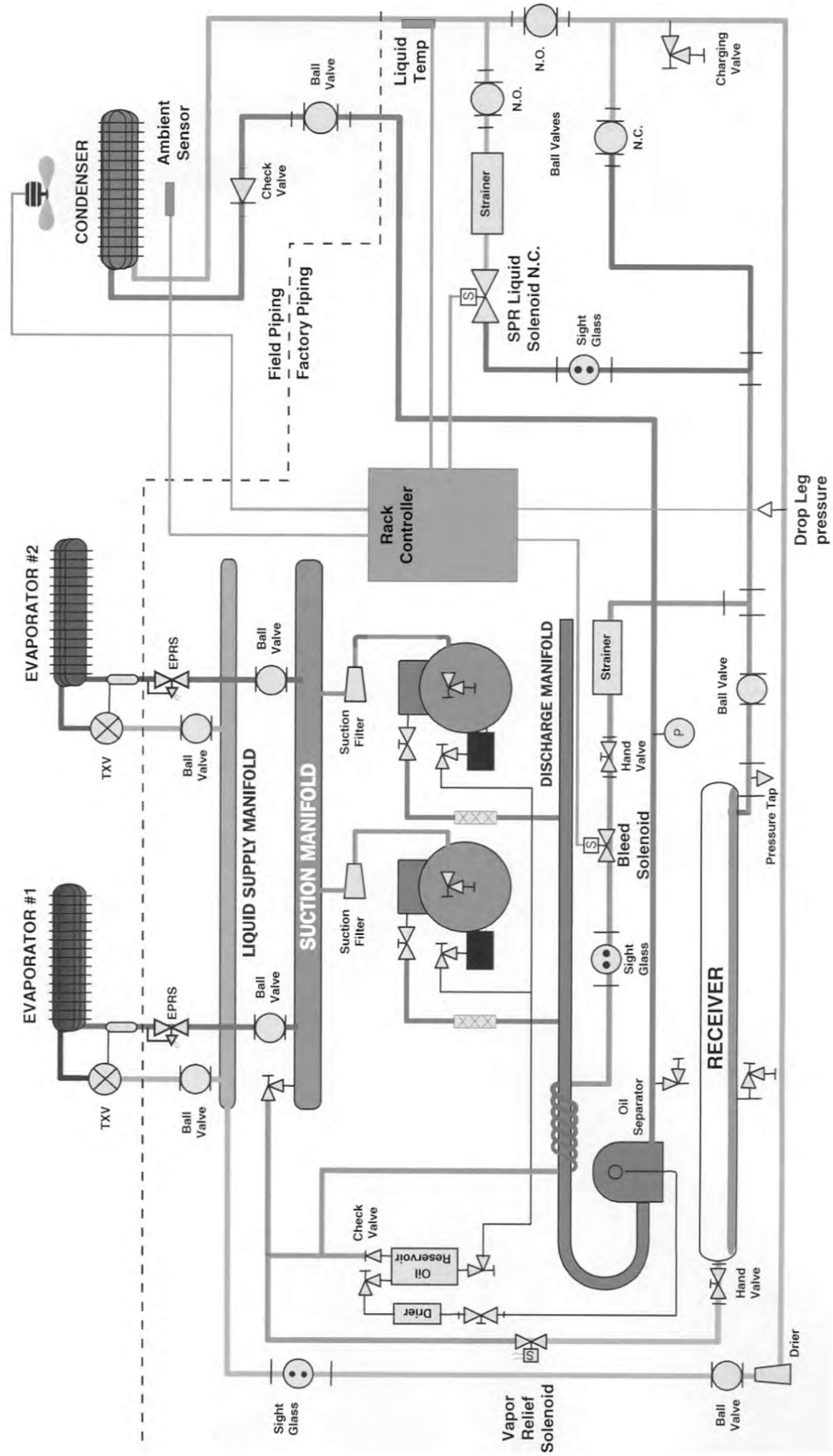
NOTE

Enviroguard piping can vary based on system options and or customer requirements.

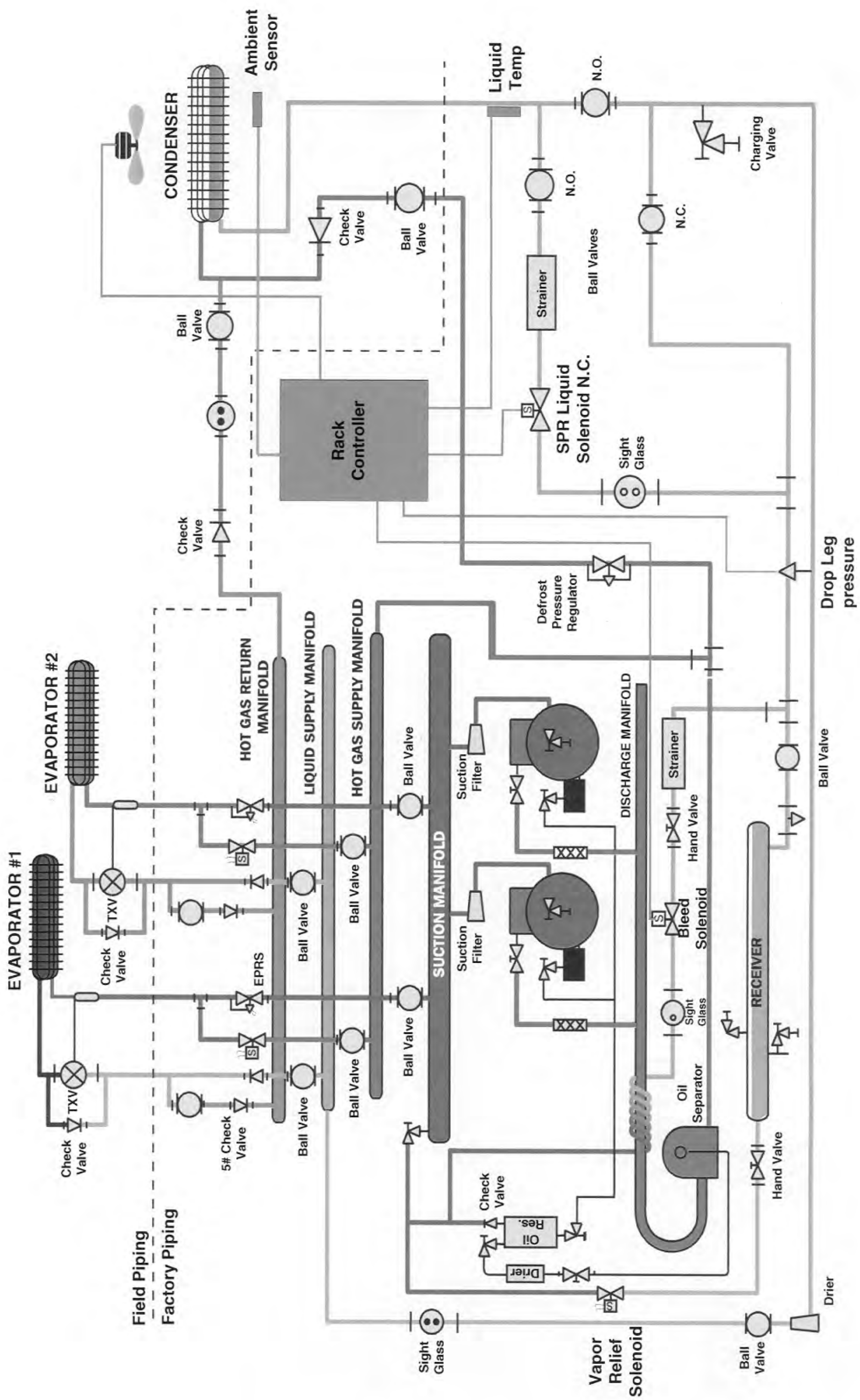
Enviroguard III Piping Diagram for Electric or Time Off Defrost Summer Operation



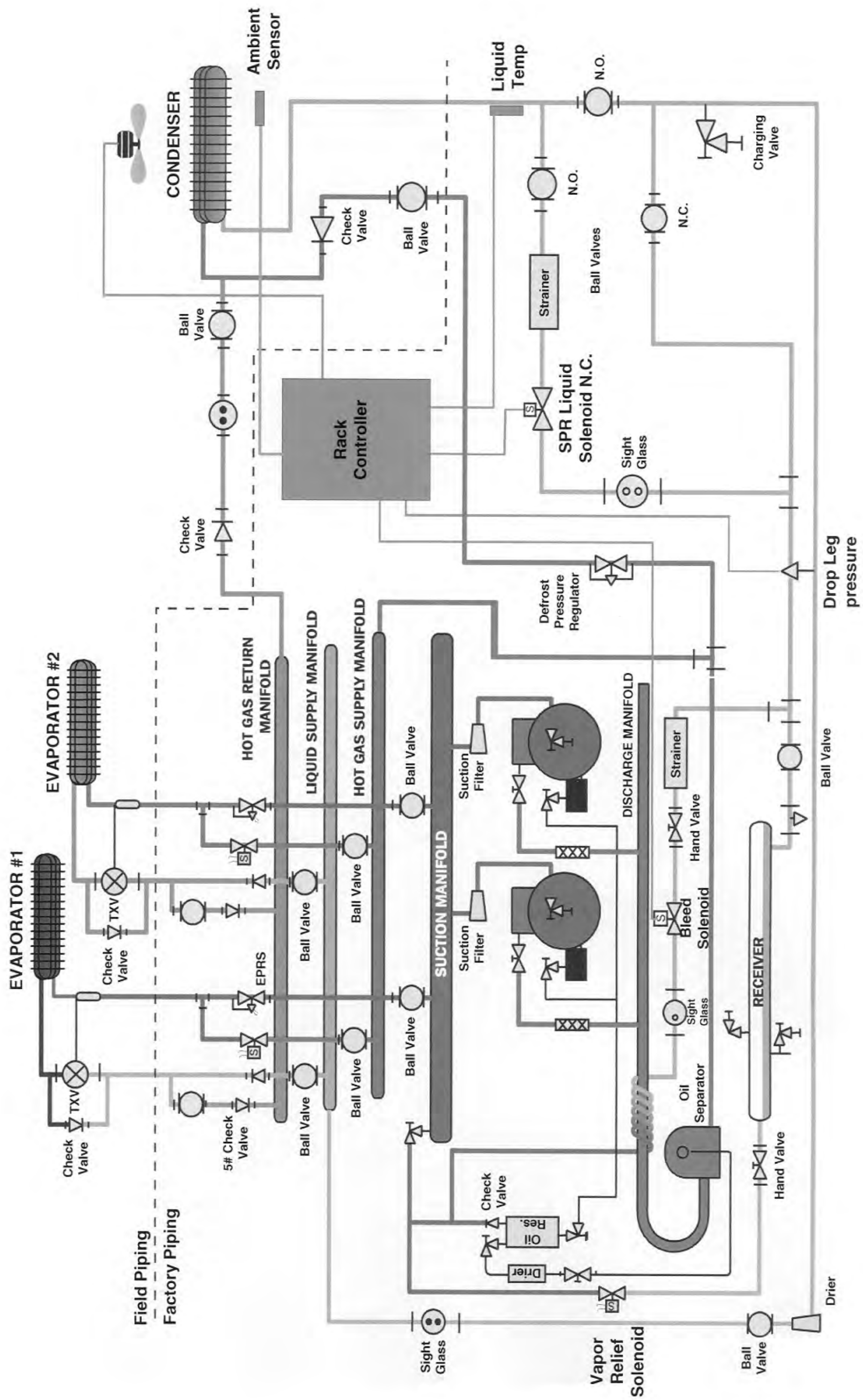
Enviroguard III Piping Diagram for Electric or Time Off Defrost
Winter Operation



**Enviroguard III Piping Diagram for Hot Gas Defrost
Summer Operation**



Enviroguard III Piping Diagram for Hot Gas Defrost
Winter Operation



Enviroguard III Control Set-Ups

Enviroguard III systems are designed to be versatile and adaptable. These systems can be controlled by a variety of controller systems supplied by the leading electronic controller system manufacturers. The most widely used electronic controllers for Medium Temp applications are:

Comtrol MCS-4000 Controller

CPC's RMCC Controller

CPC's Einstein 2 Controller

Danfoss AKC-55 Controller

Micro-Thermo Controller

All of these controllers can be used with the Enviroguard III system. The following pages describe the set-up of the Enviroguard III system using each one of these controllers.

Enviroguard III Control Set-Up for Comtrol MCS-4000 Controller

Comtrol Enviroguard III Operation

The Comtrol EG III, when selected as the control method, will setup three Inputs data readings and two Outputs data readings in the electronic controller. These five data readings are the base operating information needed to properly run the system.

INPUT 1 - Ambient Air Temperature

INPUT 2 - Condenser Outlet Liquid Temperature

INPUT 3 - Dropleg Pressure

OUTPUT 1 - SPR Solenoid Valve Setting

OUTPUT 2 - Receiver Vent Solenoid Valve Setting

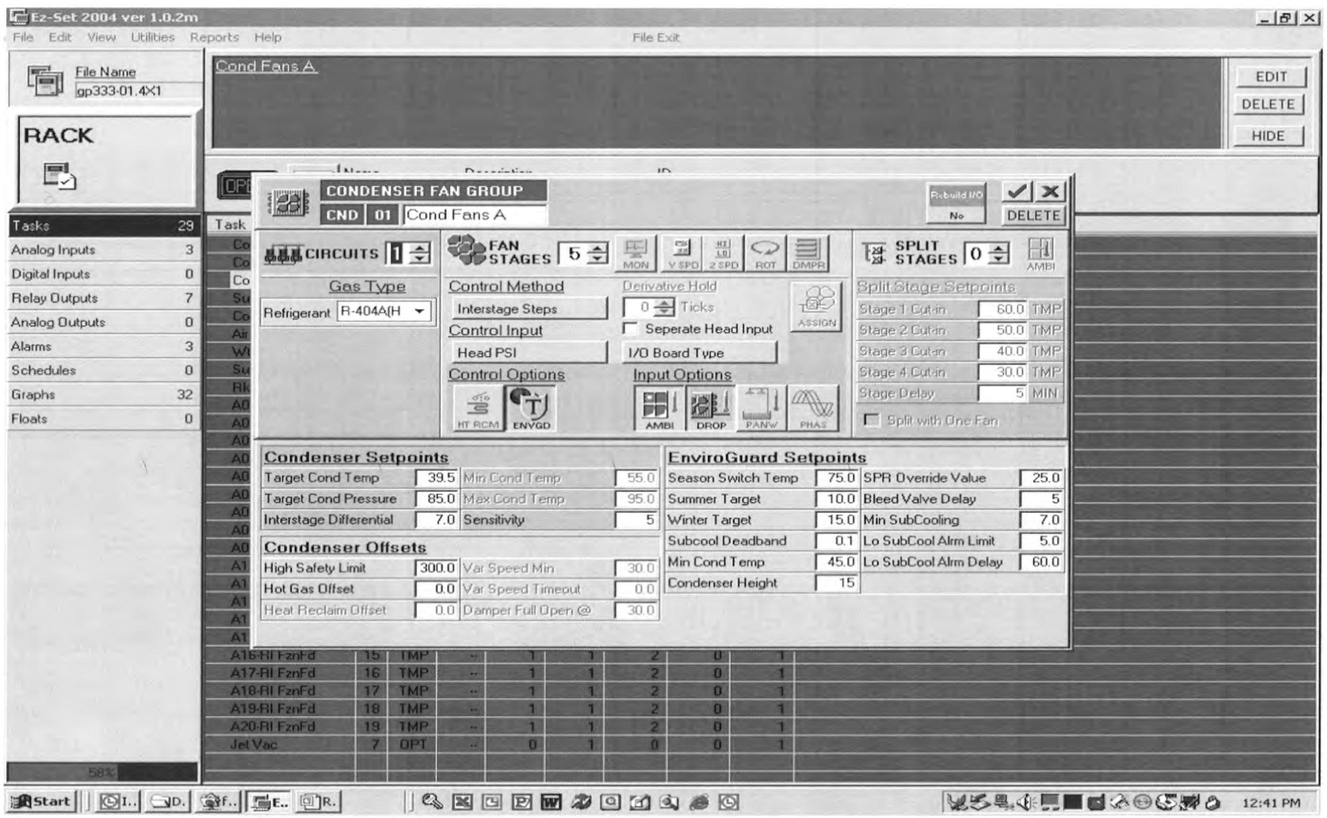
Comtrol Cond Fan Set-Up Screen and Procedure

When setting up the Comtrol EGIII, the following are selections to be made for Enviroguard III set-up. *The Cond Fans set-up screen is shown on page 26-15.*

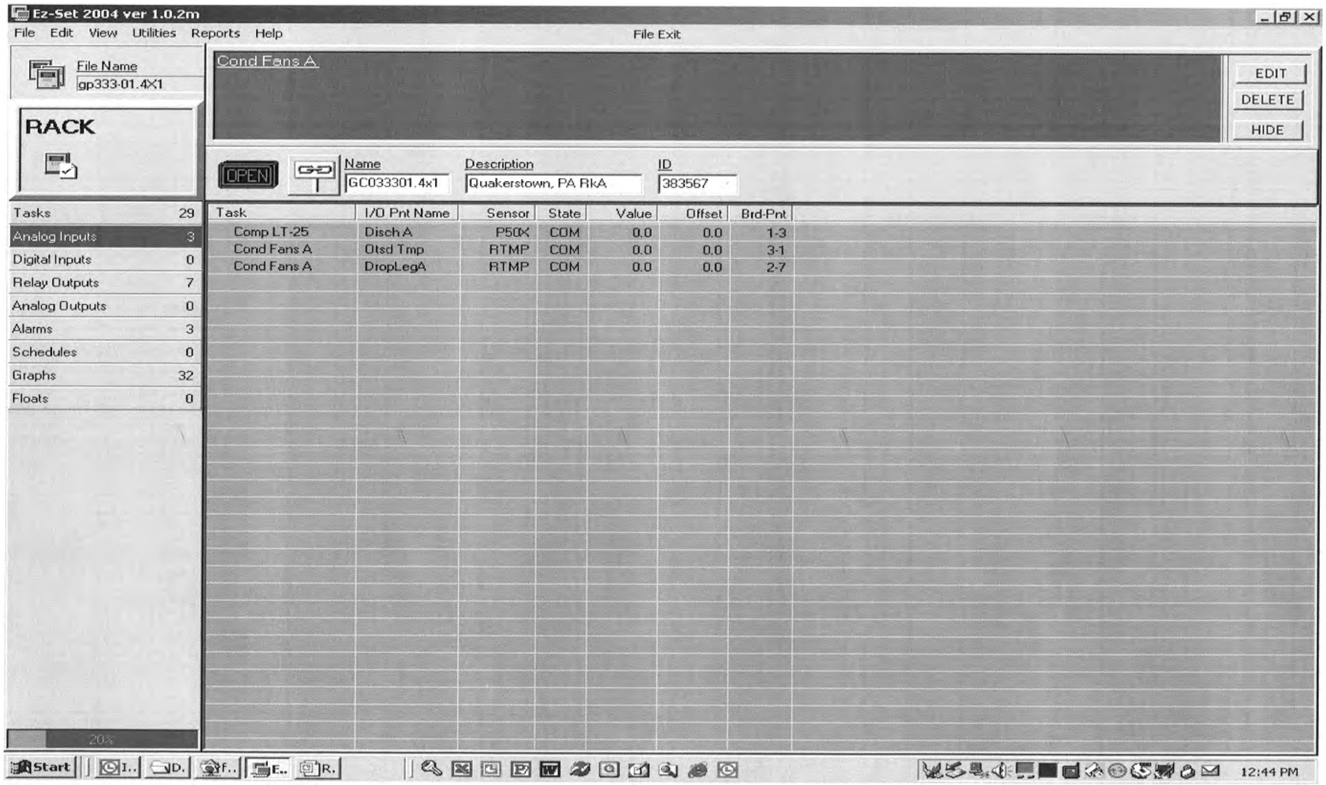
1. Season Switch Temperature - This is the ambient air temperature that the controller will switch to the lower subcooling target temperature. (85°F Ambient)
2. Target Summer Subcooling - This is the lower of the two subcooling set points used when above the season switch temperature setpoint. (10 °F Subcooling)
3. Target Winter Subcooling - This is the setpoint used when below the season switch temperature. (15°F Subcooling)
4. Subcooling control dead-band. (0.1°F)
5. Minimum Condensing Temperatures in the Enviroguard set-up. 45°F for Low Temp with electric or time off defrost, 60°F for Low Temp with hot gas defrost, 65°F for Medium Temp systems.

7. Condenser Height above the rack. This is the height of the liquid return line from the liquid transducer to the condenser outlet.
8. SPR Override (25°F) - This will operate the SPR output if the saturated condensing temperature is 25°F above the ambient air temperature and the minimum subcooling is met.
9. Minimum Subcooling (7°F)
10. Bleed Valve Time Delay (Receiver Vent Solenoid 5 minute delay)
11. Low Subcooling Alarm Limit (5°F) - Alarm activates when the setpoint continuously for the time specified.
12. Low Subcooling Alarm Delay (60 minutes)

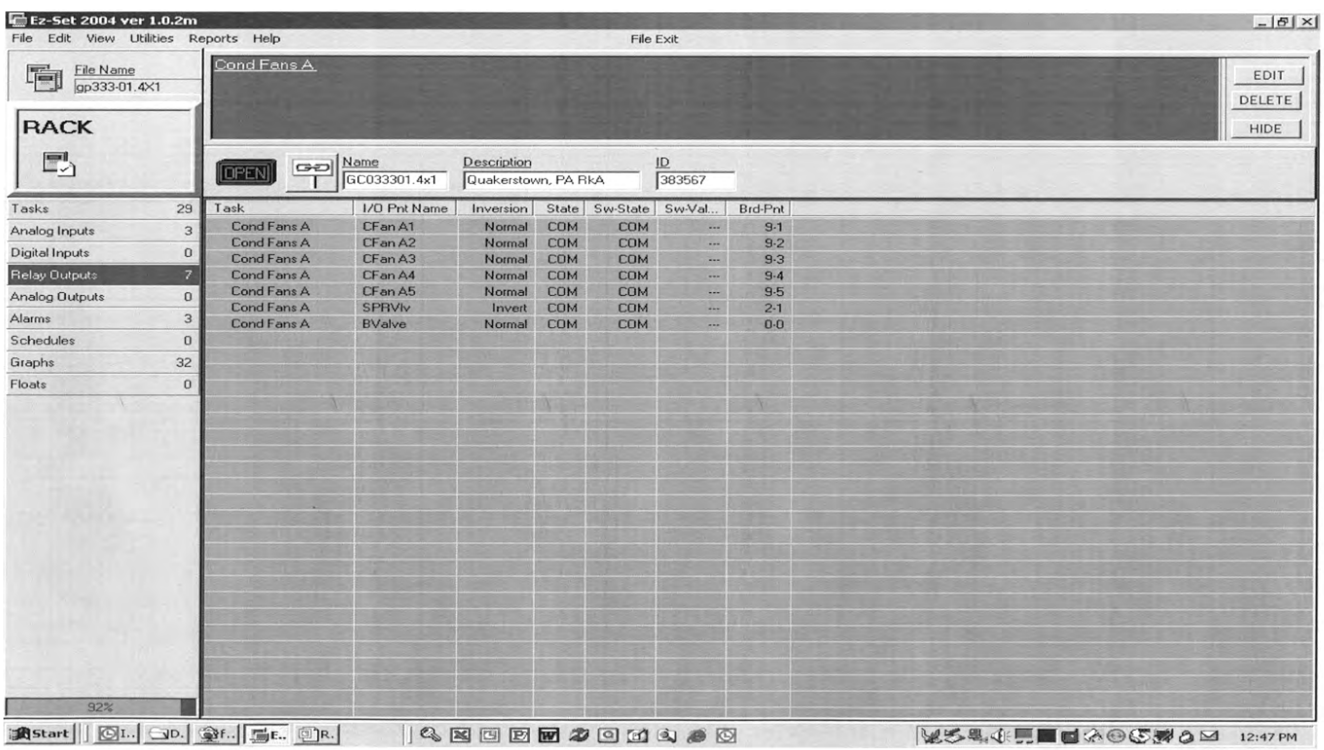
Condenser Fan Group Set-Up Screen



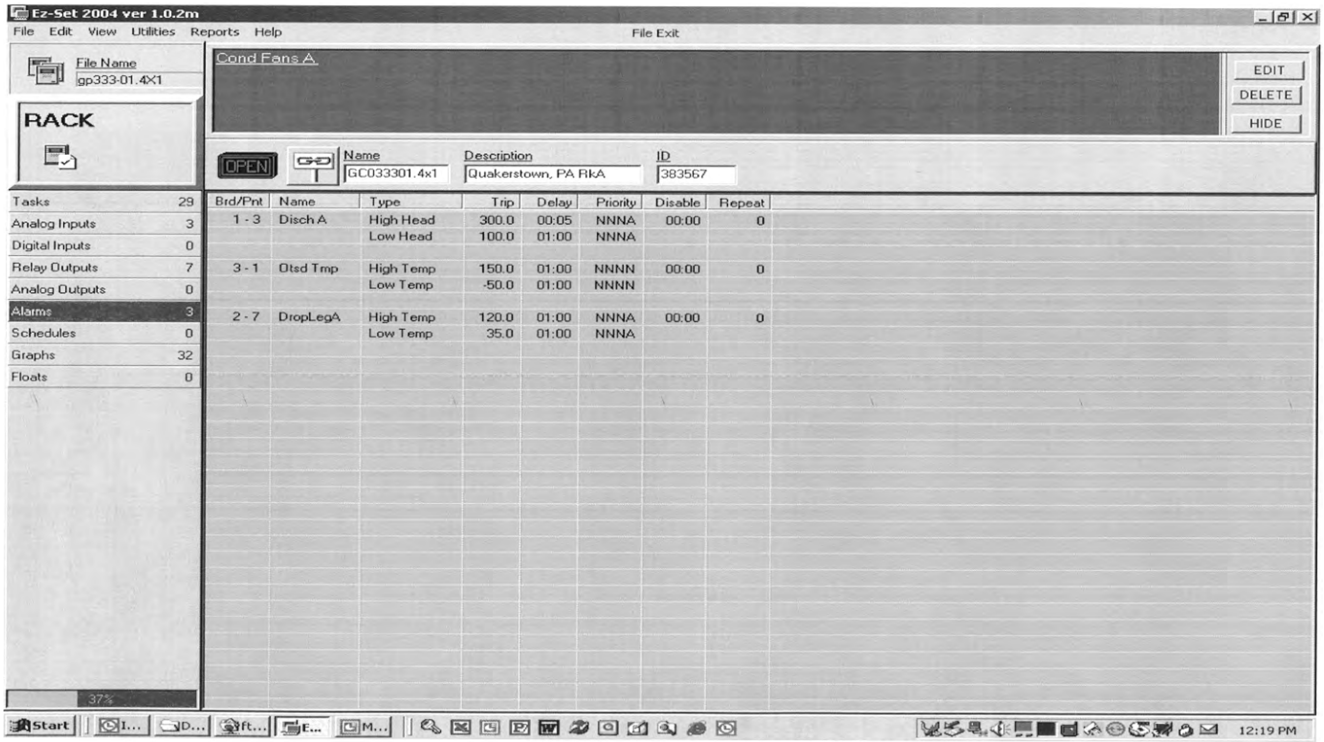
Comtrol Analog Set-Up Screen



Comtrol Output Relay Set-Up Screen



Comtrol Alarm Setpoints Screen



Enviroguard III Control Set-Up for CPC's RMCC Controller

RMCC Controller Set-Up

The SPR solenoid is controlled by the liquid subcooling at the condenser. The valve will be opened when 7°F or more of subcooling is achieved, only when all the condenser fans are running. Subcooling is the differential between the saturated condensing temperature and the condenser outlet liquid temperature. Sensor control logic is used for the SPR operation. The required controller screens are listed below in bold face.

Sensor Set-Up

Sensor #1: (Sensor point to the monitor liquid temperature.)

Name:	COND LIQ TEMP
Type:	Temp

Sensor #2: (Sensor point to the control liquid subcooling; monitoring pressure sensor input as a saturated temperature.)

Name:	SUBCOOLING
Type:	5 Pres 2 Temp
Refrigerant Type:	(Specify)
Pre Input Offset:	0.0

Sensor Setpoints for Subcooling

Sensor #2: (Setpoint to target 7°F of subcooling.)

Using Diff of	**(Sensor #2)**	**Sensor #1)**
CUT ON:	7.0	
CUT OUT:	**6.9**	
ON Delay:	0 sec	
OFF Delay:	0 sec	
Min time ON:	0 min	

Offset: (Field set-up. Use a negative offset that is 1/2 the vertical distance in feet from the rack bottom to the condenser.) *Example: If the vertical distance is 15 feet, the offset is -7.5.*

Condenser Set-Up:

Control Strategy:	AIR COOLED
Control Source:	OUTLET
Control Type:	**PRESSURE**
Condenser Fan Type:	SINGLE SPEED

Condenser Pressure Inputs Set-Up:

Input Pres Offset:	0.0
Outlet Pres Offset:	(Field set-up as explained above.)

Condenser Pressure Delays Set-Up:

Fan Minimum ON Time:	0 min
Fan Minimum OFF Time:	0 min

Condenser Single Speed Fan Set-Up:

Fan ON Delay:	5 sec
Fan OFF Delay:	5 sec
Fast Rec Fan ON Delay:	1 sec
Fast Rec Fan OFF Delay:	1 sec
Equalize Runtimes:	NO

Condenser Setpoints:

Condenser Setpoints: *(Use the following table.)*

Refrigerant Type	Medium Temp, Time Off (60°F)	Low Temp, Hot Gas (45°F)	Low Temp, Electric / Time Off (40°F)
R404A	125.0	93.7	85.1
R-507	129.7	98.9	89.8
R-22	101.6	76.0	68.5

Throttle Range:	60
Fast Recovery Setpoint:	300
Low Pressure Cutoff:	NONE

Input/Output (Board-Point) Definitions:

Inputs:	Sensor #1:	Condenser Output Temperature
	Sensor #2:	Liquid Dropleg Pressure
Outputs:	Sensor #2:	
	SPR Valve Control:	ON to open
	Regular Condenser Fans:	Fan control
	Extra* Condenser Fan Stage:	SPR valve control: ON to enable

***NOTES:**

- **This is only required when the condenser control RO board is located at the condenser.** ***(See "CASE 2" wiring on page 26-21.)***
- **This extra condenser fan stage must be programmed at the last condenser fan and must not be forced either ON or OFF during normal operations.**
- **The RO point for this extra fan stage is located at the rack, while the RO points for the regular fans are located at the condenser.**

Recommended Charging Procedure

Ambient air temperature above 70°F:

Charge the system to a 20% receiver level.

Ambient air temperature below 70°F:

- Make sure the condenser setpoint is set to a pressure whose saturated temperature is at least 35°F above the ambient air temperature.
- Close off the SPR line.
- Add charge until the Subcooling Sensor Control point achieves an average of 30.

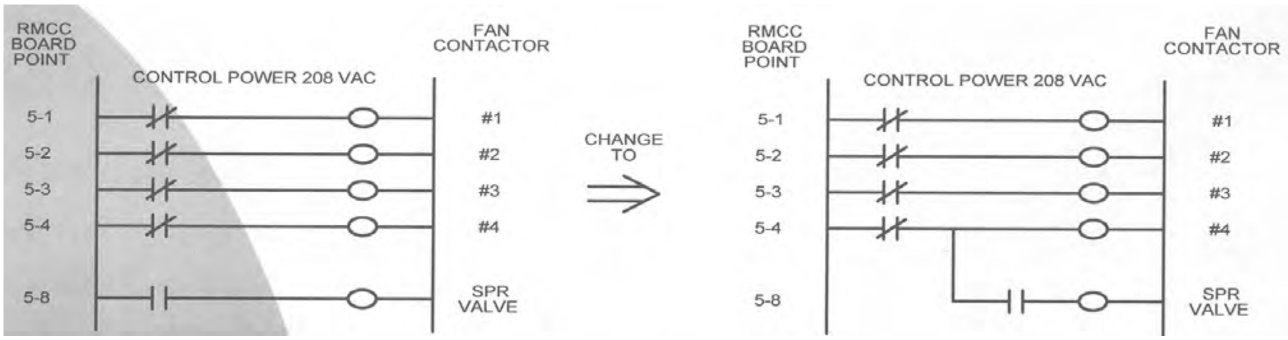
NOTE

Southern climates may use 25 for low temp systems.

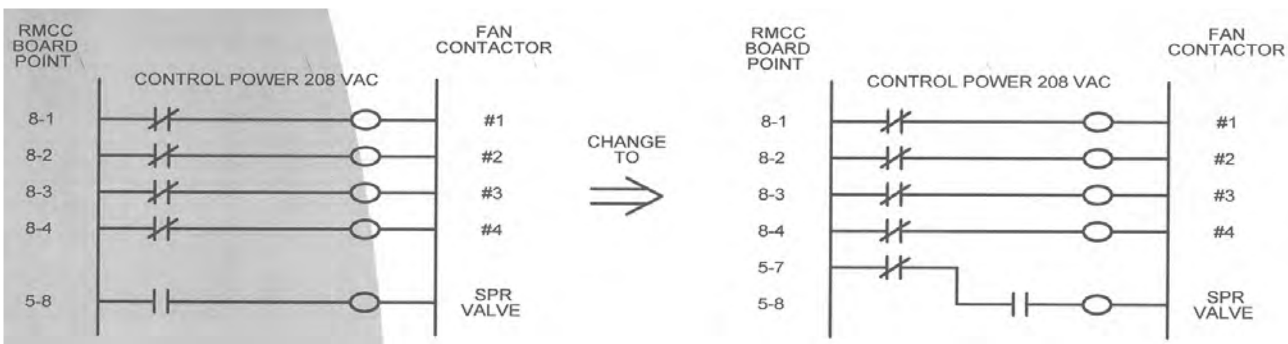
SPR Solenoid Valve Wiring

Use the RO point for the last fan to break the circuit for the SPR control. SPR valve will only open when all fans are running. In the following cases, RO board 5 is located at the rack and board 8 is located at the condenser. In the case where there is a control board at the condenser, RO points 5-7 are added as an extra condenser fan stage and must be programmed as the 5th (last) fan.

CASE 1 - Condenser Control with RO Board at Rack



CASE 2 - Condenser Control with RO Board at Condenser



Enviroguard III Control Set-Up for CPC's Einstein 1 Controller

Analog Input Set-Up

Make sure the board:point for the pressure input is set to:

Type: 500 lb Eclipse

Sensor Offset: -1/2 the condenser height above the rack.

Make sure the board:point for the dropleg sensor is set up to:

Type: Temperature

Add the Controls (If they are not already added)

The following four controls can be added to the electronic control set-up: Condenser Control, Conversion Cell, Analog Sensor Control, and Digital Combiner.

Condenser Control Set-Up

General: Set "Control Type:" for "Pressure".

Enter the number of fan stages.

Setpoint: Enter a pressure setpoint whose saturated temperature is 40°F for low temp, 45°F for low temp with hot gas, or 60°F for medium temp.

Minimum ON and Min OFF times must be 0:00:00.

Inputs: Assign the PRES CTRL IN board:point location.

Fan Outs: Assign board:point location for each fan.

Conversion Cell Set-Up

General: Name it "Sat Temp".

Choose "press to temp" conversion

Choose the proper refrigerant.

Set update rate to 0:00:01. (Display must be in FULL options to change it. (F8, Q))

Inputs: Set its pressure input board:point location.

Analog Sensor Control Set-Up

General: Name it "Subcool".

Give it 2 inputs.

Choose "DF" for "Engr Units".

Choose "In1-In2-In3" for "Comb Type".

Set update rate to 0:00:02. (Display must be in FULL options to change it. (F8, Q))

Inputs: Assign "Sat Temp" to "Input 1".

Assign dropleg temp sensor board:point location to "Input 2".

Setpoint: Set "CUTIN" to 15.0 and "CUTOUT" to 14.9.

Digital Combiner Set-Up

General: Name it "SPR".

Give it 2 Inputs.

Choose "On-Off" for "Engr Units".

Choose "And" for "Comb Type".

Inputs: Assign "Subcool": "Command Out" to "Dig Input 1".

Assign "Condenser 01": (the last Fan out on the condenser) to "Dig Input 2".

Outputs: Assign the board:point location for OUTPUT to be the SPR Relay.

Analog Inputs Set-Up Chart

Key Entry	Description
"F8", "Y", "6", "1"	Go to the Input summary screen.
Scroll to the Pressure Sensor board:point, "F7".	Choose the pressure sensor input and select:
("1" if not already defined), Scroll down to "G".	Sensor Type: "Eclipse-500LB".
Scroll down four times, (-1/2 the condenser elevation in feet).	Sensor Offset: (-1/2 the condenser elevation in feet)
"F10", Scroll to the dropleg sensor board:point, "F7".	Choose the dropleg sensor input and select.
("1" if not already defined), Scroll down to "T".	Sensor Type: "Temperature"
"F10", "F9"	Go to the Home Screen.

Add Controls Chart

Key Entry	Description
"F8", "Z", "1", Scroll down to "1", "Enter", "Y"	Add the Condenser Control.
"F7", "97", "Enter", Scroll down to "1", "Enter", "Y"	Add one Conversion Cell.
"F7", "96", "Enter". Scroll down to "1", "Enter", "Y"	Add one Analog Sensor.
"F7", "66", "Enter", Scroll down to "1", "Enter", "Y"	Add one Digital Combiner.
"F10", "F9"	Go to Home Screen.

Condenser Set-Up Chart

Key Entry	Description
"F2", "F8", "B"	Got to condenser controls and choose Set-up.
Scroll down three times to "P".	Choose Control Type: "Pressure"
Scroll down twice to (number of fan stages).	Enter the number of fan stages.
"F2:, (Pressure Setpoint)	Tab to setpoints and set-up":
Scroll down twice	PRESS CTRL STPT: (Recommended minimum)
"0:00:00", Scroll down, "0:00:00"	Fan Min On: 0:00:00 Fan Min Off: 0:00:00
"F2", (board), Scroll right, (point)	Tab to Inputs: PRES CTRL IN: (Pressure: board:point)
"F2", (board), Scroll right, (point)	Tab to Fan Outs and set-up output board:point.
"F9"	Return to Home Screen.

Conversion Cell Set-Up Chart

Key Entry	Description
“F5”, “N”, “F8”, “B”	Go to Conversion Cell Status, then choose Set-up.
“Del”, “Sat Temp”	Delete default name, Type in “Sat Temp”.
Scroll down to “P”	Choose “Press to Temp”
Scroll down to “F7”, (choose ref.), “Enter”	Choose proper refrigerant.
“F8”, “Q”, Scroll down twice, “0:00:01”	Set Options to FULL, Set Update Rate to 1 second.
“F2”, “F3”, “1”, “1”, (board), Scroll right, (point)	Tab to Inputs: Reformat to board:point: and assign the pressure board:point.
“F9”	Return to Home Screen.

Analog Sensor Control Set-Up Chart

Key Entry	Description
“F4”, “F8”, “B”	Go to Sensor, then choose Set-up.
“Del”, “Subcool”	Delete default name, Type in “Subcool”.
Scroll down to “2”	Give it 2 inputs.
Scroll down to “1”	Use “DF” for units.
Scroll down to “6”	Choose “In1-In2-In3” for Comb Method.
Scroll down twice, “0:00:02”	Set Update Rate to 0:00:02.
“F2”, F3”, “1”, “2”	Tab to Inputs, Choose “Controller:” “Application:” Property format for Input 1.
Scroll right to “F7”, Scroll to “Sat Temp”, “Enter”	For “Application”: Choose “Sat Temp”
Scroll right to “F7”, Scroll to “Temp Out”, “Enter”	For “Output”: Choose “Temp Out”
Scroll down, (board), Scroll right, (point)	INPUT2: (board:point for the dropleg sensor)
“F2”, “15.0”, Scroll down, “14.9”	Tab to Setpoints and enter 15.0 for cut-in and 14.9 for cut-out.
“F9”	Return to Home Screen.

Digital Combiner Set-Up Chart

Key Entry	Description
"F5", "P", "F8", "B"	Go to Digital Combiners, then choose Set-up.
"Del", "SPR"	Delete default name, Type in "SPR".
Scroll down to "2"	Give it 2 inputs.
Scroll down, "F7", "128", "Enter"	Use "On-Off" for units.
Scroll down to "0"	Choose "And" for Comb Method.
"F2", F3", "1", "2", Scroll right, "F7", (Choose "Subcool"), "Enter", Scroll right, "F7", (Choose "Command Out"), "Enter"	Tab to "Comb Ins". Set Digital Input 1 format to "Controller Application: Output". Choose "Subcool: Command Out" for Digital Input 1.
Scroll down, "F3", "1", "2", Scroll right, "F7", (Choose "Condenser 01), "Enter", Scroll right, "F7", (Choose last Fan Out), "Enter"	Set "Digital Input 2" format to :Controller Application: Output". Choose the last condenser fan output for Digital Input 2.
"F2", (board), Scroll right, (point)	Tab to "Outputs" and assign the proper board:point for the SPR.
"F9"	Return to Home Screen.

Recommended Charging Procedures

Ambient air temperature above 70°F:

Charging the system should be to a 20% receiver level.

Ambient air temperature below 70°F:

- Make sure the condenser setpoint is set to a pressure whose saturated temperature is at least 35°F above the ambient air temperature.
- Close off the SPR line.
- Add charge until the SUBCOOLING Sensor Control point achieves an average of 30°F.

NOTE

Southern climates may use 25°F for low temp systems.

Condenser Setpoints:

Refrigerant Type	Medium Temp, Time Off (60°F)	Low Temp, Hot Gas (45°F)	Low Temp, Electric / Time Off (40°F)
R404A	125.0	93.7	85.1
R-507	129.7	98.9	89.8
R-22	101.6	76.0	68.5

Enviroguard III Control Set-Up for CPC's Einstein 2 Controller

The following information applies to programming software packages RX-300 and RX-400, from the controller keypad. The same information may be entered using the UltraSite© software available through Emerson/CPC. In each method there are additional values in each screen that apply to the refrigeration design, which may not be addressed in this section. Refer to the pre-programming information supplied with the rack, or the standard E2 installation manual for information regarding additional programming values.

The standard Einstein key pad uses the following icon keys:

"?" = Help key

"Bell symbol" = Advisory log

"House symbol" = Home key

"Staircase with arrow symbol" = Back to previous key

The Menu key can be used to go to any input screen where values or programming have been established. If you follow these steps, the system will warn you of overwriting or editing any existing programming. Check the Menu for existing programming.

Enviroguard Condenser Set-Up Procedure

Using the Log In/Out key, log into the E-2 with your Username <Enter> and Password <Enter>.

Press <ALT-F> to toggle on full options. "**FULL**" should be indicated at the top of the screen.

Press <F2> to access the "**Condenser Status**" screen, then press <F5> to access the "**SETUP**" screen.

Press <F2> for "**NEXT TAB**", until you access the "**C1: General**" tab.
Scroll down to "**Control Type**" (approx. 3 lines) to verify that it is set to "**PRESSURE**". If not, press <F4> for "**LOOKUP**" to bring up the "**Option List Selection**". Scroll up or down to "**PRESSURE**", then <enter> to return to the "**SETUP**" screen.

Press <F2> for "**NEXT TAB**", until you access the "**C2: Setpoints**" tab.
Adjust the "**Pres Ctrl Stpt**" (pressure control setpoint), to a saturated pressure corressponding with the system refrigerant, and following temperatures:

+40°F for low temperature applications using electric defrost.
+45°F for low temperature applications using hot gas defrost.
+60°F for all medium temperature applications.
<Enter or Scroll Down>

Scroll to "**Fan min ON**", set this value to 0:00:00. <Enter or Scroll Down>

Scroll to "**Fan min OFF**", set this value to 0:00:00.

Press <F2> for “**NEXT TAB**”, until you access the “**C3: Inputs**” tab.
Enter the “**PRES CTRL IN**” number value for the condenser drop leg pressure input board <Enter or Arrow over> and the input point location <Enter or Arrow over>.

NOTE: If the input board and point have not yet been defined, the system will alert you to define them now in the “**Sensor Selection**” screen. Following are the definitions:

Press <Enter>, this takes you to the “**Sensor Selection**” screen.
Scroll to “**Sensor Type**”, press <F4> for “**LOOKUP**”. Scroll to select “**5v-500psi**”, <Enter> or <F1>.

After defining the sensor, return to the condenser setup “Inputs” tab, press <Home>, then <F2> for the “**CONDENSER**”, <F5> for “**SETUP**”, and <F2> to the “**Inputs**” tab.

Arrow down to select “**DISH TRIP IN**”, enter the same board and point locations. If you receive an error message that the format is incorrect, change the I/O format by the following method:

Make sure the cursor is on the “**DISH TRIP IN**” line.

Press <F3> to enter the Edit mode.

Scroll to “**Alternate I/O Formats**”, <Enter>.

Select the number that corresponds with “**Board: Point**”. This will bring you to the screen where you can modify the “**DISH TRIP IN**”.

Add a Conversion Cell for Enviroguard III

Access the “**MAIN MENU**” screen by pressing the menu key.

Scroll to, or press the item number that corresponds to “**Add/Delete Applications**”, then <Enter>.

Scroll to, or press the item number that corresponds to “**Add Application**”, then <Enter>.

At the “**Add Application**” screen, select the “**Type**” line and press <F4> “**LOOKUP**”, to access the list of available applications.

Scroll to, or press the item nuber that corresponds to “**Conversion Cell**”, then <Enter>.

Scroll to “**How Many?**”, input <1>, then <Enter>.

A dialog box will ask if you wish to edit the new application, press <Y> for Yes to enter the conversion “**SETUP**” screen.

Scroll to the “**Name**” line and enter the name as <SAT TEMP>, then scroll down to “**Conversion Type**”, this should be set to “**Press to Temp**”.
If not, press <F4> “**LOOKUP**”, select “**Press to Temp**”, then<Enter>.

Scroll down to “**Refrig Type**”, press <F4> “**LOOKUP**”, select the system refrigerant, then<Enter>.

Scroll down to “**Use Abs Press**”, this should be set to “**No**”. If not, press <N>.

Scroll down to “**Update Rate**”, this should be set to “**0:00:01**”. If not, enter this value now.

Press <F2> “**NEXT TAB**” to “**C2: Inputs**”. Select the “**PRESSURE IN**” line and enter the board and point location to be converted. This is the information for the condenser pressure input point.

Press the Home key <house symbol>, then <Y> when asked to save changes.

<u>Add Anolog Sensor Control for Enviroguard III</u>

Access the “**MAIN MENU**” screen by pressing the menu key.

Scroll to, or press the item number that corresponds to “**Add/Delete Applications**”, then <Enter>.

Scroll to, or press the item number that corresponds to “**Add Application**”, then <Enter>.

At the “**Add Application**” screen, select the “**Type**” line and press <F4> “**LOOKUP**”, to access the list of available applications.

Scroll to, or press the item nuber that corresponds to “**Analog Sensor Ctrl**”, then <Enter>.

Scroll to “**How Many?**”, input <1>, then <Enter>.

A dialog box will ask if you wish to edit the new application, press <Y> for Yes to enter the conversion “**SETUP**” screen.

Scroll to the “**Name**” line and enter the name as <Subcool/Env3>, then scroll to “**Num Inputs**” line and enter the number <2>.

Scroll to “**Eng Units**” line and press <F4> “**LOOKUP**”, to access the list of available descriptions. Scroll to or press the item number that corresponds to ”**DF**”, degrees Fahrenheit, then <Enter>.

Scroll down to “**Comb Method**” line and press <F4> for “**LOOKUP**”, to access the list of avaialble descriptions. Scroll to, or press the item number that corresponds to “**1-in2-in3**”, then <Enter>.

Scroll down to “**Update Rate**”, this should be set to “**0:00:02**”. If not, enter this value now.

Press <F2> “**NEXT TAB**” to “**C2: Inputs**”. You are now ready to define the control analog inputs.

Analog Input Setup

At the “**INPUT**” line press <F3> “**Edit**”, then select “**Alternate I/O Formats**” and <Enter>.

> Enter the number that corresponds to “**Controller: Application: Property**” with the cursor in the “**Controller**” field for “**INPUT1**”, press <F4> for “**LOOKUP**”. Scroll down to find this controller’s name, then press <F1> “**Select**”.
>
> Scroll the cursor to the “**Application**” field for “**INPUT1**”, press <F4> for “**LOOKUP**”. Scroll or page down to find the “**Conversion Cell**” that was set up prior, named “**SAT TEMP**”. Press <F1> “**Select**”.

Back at the “**SETUP**” screen, scroll down to “**INPUT2**” line, press <F3> “**Edit**”, then select “**Alternate I/O Formats**” and <Enter>.

> Enter the number that corresponds to “**Board: Point**”. At the input fields for “**INPUT2**”, enter the corresponding board number and input number for the drop leg temperature sensor.

Press <F2> “**NEXT TAB**”, for “**C4: Setpoint**” to define the inputs.

> Scroll to “**Cut In**” value field and enter <15.0>.
>
> Scroll to “**Cut Out**” value field and enter <14.9>.
>
> Both “**Delay**” fields should be set at “**00:00:00**”.

Press the Home key <house symbol>, then <Y> when asked to save changes.

<u>**Add Digital Combiner for Enviroguard III on RX-300 & RX-400**</u>

NOTE

Before you begin programming this section, use the Home key to view the Home screen and note the number of fan control points used for the Condenser. This will be located in the bottom left section of the screen, and the fan points will be labeled F1, F2, F3, etc..

A digital combiner falls under the category of "**Configured Application**", you can view this after it has been defined from the "**MAIN MENU**" screen.

Access the "**MAIN MENU**" screen by pressing the menu key.

Scroll to or press the item number that corresponds to "**Add/Deleate Applications**", then <Enter>.

Scroll to or press the item number that corresponds to "**Add Application**", then <Enter>. Scroll the curor to the "**Type**" line and press <F4> "**LOOKUP**", to access the list of available applications.

Scroll to or press the item number that corresponds to "**Digital Combiner**", then <Enter>.

Scroll to "**How many?**", input <1>, then <Enter>.

A dialog box will ask if you wish to edit the new application, press <Y> for Yes to enter the digital combiner "**SETUP**" screen.

Scroll to the "**Name**" line and press the "**Del**" key to remove any existing text. Enter the name as <SPR>.

Scroll to "**Num Inputs**" line and enter the number <2>.

Scroll to "**Eng Units**" line and press <F4> "**LOOKUP**", to access the list of available descriptions. Scroll to or press the item number that corresponds to"**ON-OFF**" line, then <Enter.

Scroll down to "**Comb Method**" line and press <F4> for "**LOOKUP**", to access the list of avaialble descriptions. Scroll to, or press the item number that corresponds to "**And**", then <Enter>.

Following the same procedure, scroll down to "**Alt Comb Method**" and set its value to "**AND**".

Press <F2> "**NEXT TAB**" to "**C2: Comb Ins**". You are now ready to define the combiner digital inputs.

Digital Input Setup

At the "**DIG INPUT1**" line press <F3> "**Edit**", then select "**Alternate I/O Formats**" and <Enter>.

Enter the number that corresponds to "**Controller: Application: Property**" with the cursor in the "**Controller**" field for "**DIG INPUT1**", press <F4> for "**LOOKUP**". Scroll down to find this controller's name, then press <F1> "**Select**".

Scroll the cursor to the "**Application**" field for "**DIG INPUT1**", then press <F4> for "**LOOKUP**". Scroll or page down to find the "**Anolog Sensor Ctrl**" that was set up prior, named "**SUBCOOL/ENV3**". Press <F1> for "**Select**".

Scroll the cursor to the "**Output**" field for "**DIG INPUT1**", then press <F4> for "**LOOKUP**". Scroll down to "**COMMAND OUT**", then press <F1> for "**Select**".

Back at the "**SETUP**" screen, scroll down to "**DIG INPUT2**" line, press <F3> "**Edit**", then select "**Alternate I/O Formats**" and <Enter>.

Enter the number that corresponds to "**Controller: Application: Property**" with the cursor in the "**Controller**" field for "**DIG INPUT2**", press <F4> for "**LOOKUP**". Scroll down to find this controller's name, then press <F1> "**Select**".

Scroll the cursor to the "**Application**" field for "**DIG INPUT2**", then press <F4> for "**LOOKUP**". Scroll or page down to find the "**Condenser Control**" named "**Condenser**". Press <F1> for "**Select**".

Scroll the cursor to the "**Output**" field for "**DIG INPUT2**", then press <F4> for "**LOOKUP**". Scroll down to the description of the last fan control used for this system.

EXAMPLE

A condenser system with 4 stages of fan control, you would scroll down to "**FAN OUT4**", then press <F1> "**Select**". A system with 1 point of fan control would use "**FAN OUT1**". A quick way to determine this information is at the home screen, as noted at the beginning of this procedure.

Press <F2> "**NEXT TAB**", for "**C4: Outputs**" to define the outputs.

At the "**OUTPUT**" line, press <F3> "**Edit**", scroll to the selection "**Alternate I/O Formats**", then <Enter>.

Enter the number that corresponds to "**Board: Point**". This is the "**Board**" and output "**Point**" number that relates to the SPR solenoid valve, or relay.

Press the Home key <house symbol>, then <Y> when asked to save changes.

Recommended Charging Procedures

Ambient air temperature above 70°F:

Charging the system should be to a 20% receiver level.

Ambient air temperature below 70°F:

- Make sure the condenser setpoint is set to a pressure whose saturated temperature is at least 35°F above the ambient air temperature.
- Close off the SPR line.
- Add charge until the SUBCOOLING Sensor Control point achieves an average of 30°F.

NOTE
Southern climates may use 25°F for low temp systems.

Condenser Setpoints:

Refrigerant Type	Medium Temp, Time Off (60°F)	Low Temp, Hot Gas (45°F)	Low Temp, Electric / Time Off (40°F)
R404A	125.0	93.7	85.1
R-507	129.7	98.9	89.8
R-22	101.6	76.0	68.5

Enviroguard III Control Set-Up for Danfoss AKC-55 Controller

Screen #1: Condenser Configuration

To get this screen: Select “Condenser” under “Rack Configuration”.

Control Sensor: Pressure.

NOTE

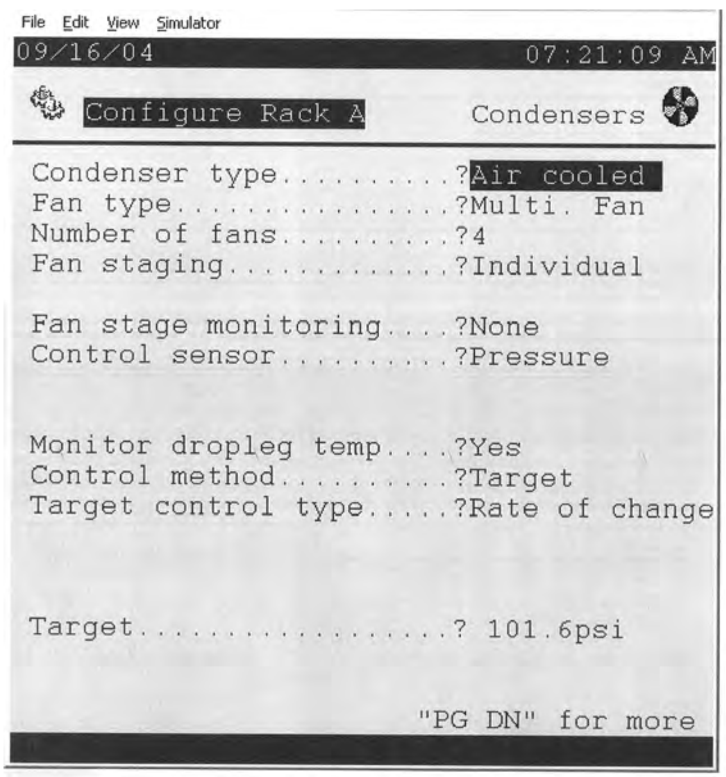
Use the dropleg pressure transducer although AKC-55 labels it as discharge pressure.

Target: Use the saturated pressure at the following temperatures:

40°F - Low temperature racks without gas defrost.

55°F - Low temperature racks with gas defrost.

60°F - Medium temperature racks.



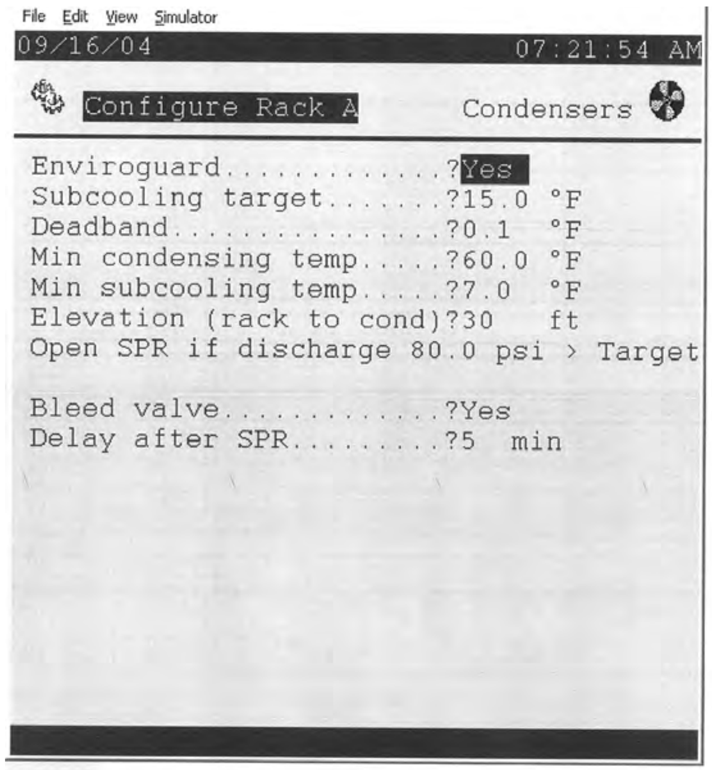
Screen #2: Enviroguard Configuration

To get to this screen: "Page Down" from Screen #1.

Select "Yes" to activate the Enviroguard Condenser Control Option.

Min condenser temp: Use the same temperatures that were used in the previous screen.

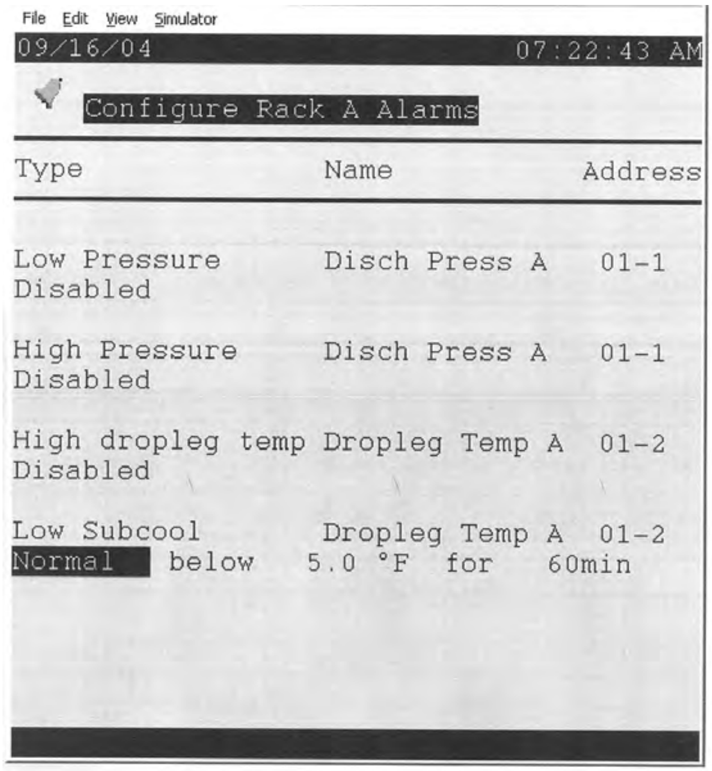
Elevation: Change it according to the actual installation.



Screen #3: Low Subcooling Alarm Setup

To get to this screen: “Select “Alarm” under “Rack Configuration”.

Define the Alarm condition as shown below.



Screen #4: Condenser Status

To get to this screen: "Select "Condenser" under "Refrigeration".

This screen shows the Subcooling Value, the SPR Status as well as the other condenser parameters.