KAIRAK™

UNRIVALED REFRIGERATION TECHNOLOGY

MULTI-RAK

MULTI-CIRCUITED REFRIGERATION SYSTEM

OWNER'S MANUAL

- INSTALLATION
- OPERATION
- MAINTENANCE

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MULTI-RAK
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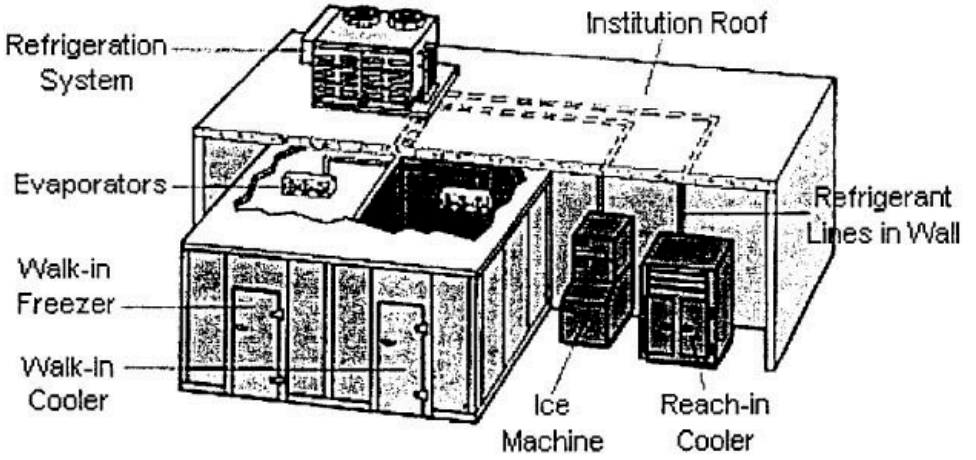


TYPICAL REMOTE REFRIGERATION SYSTEM

INTRODUCTION

DESCRIPTION OF MULTI-RAK (Figure 1)

The KaiRak remote air cooled Multi-Rak cooling system utilizes safe CFC's and offers tremendous operating efficiency by using multi-circuited condensers for 2-20 compressors and ice makers. This high operating efficiency is made through effective use of the condenser coil surface area. The condenser coils on our units are almost twice the size of conventional competitive designs. The large condenser coils provide the unit with summer design TD's (temperature difference between refrigerant condensing temperature and ambient air temperature) lower than traditional designs allow. Lower design TD's produce lower condensing temperatures which produce lower compression ratios and higher compressor capacities. Lower compression ratios and higher compressor capacity mean reduced kW/ton, thereby reducing operating cost. A 10 to 20 % reduction, in fact, depends on unit size and H.P. in contrast to single condensing units, Multi-Rak systems are easier to install, easier to service, and much less expensive to operate. Complete factory assembly eliminates on-sight construction costs of built-up systems by refrigeration technicians and electricians in the field. The Multi-Rak is designed primarily for institutional food service operations including hospitals, universities, schools, hotels, restaurants, coffee shops, and convenience stores.

Multi-Rak pulls fresh air over the compressor bodies to reduce their operating temperature. Compressor ventilation has become increasingly important because of regulations affecting the use of R-22 refrigerant, which has a higher discharge temperature. The systems are designed from 2-10 condenser fan motors. R-404A refrigerant is used for low temperature (0° to -30°F) applications and for high and medium temperature (20° to 50°) applications.

FEATURES OF MULTI-RAK

CONDENSING UNIT

A refrigeration condensing unit is a highly sophisticated apparatus. It is installed with the anticipation that it will provide many years of trouble-free operation with minimal maintenance. Usually the length of service life realized from a particular condensing unit is directly proportional to the care with which the original installation was performed.

Cleanliness is absolutely mandatory when installing a condensing unit. Utmost care has been taken at the factory to insure that the unit is free of all contamination. The factory-applied seals must not be removed until the unit is ready for installation. All tubing valves and fittings must be carefully inspected to insure cleanliness.

The correct electrical supply must be provided to the condensing unit control panel. The voltage at the motor-compressor terminals should be checked during start-up and unit operation under full load to insure a tolerance of plus or minus 10 percent of the nameplate rating.

The lubrication recommendations for the motor-compressor and fan motors (where applicable) must be carefully adhered to.

REFRIGERANT
R404A is used for the Walk-In Cooler, Walk-in Freezer, and undercounter refrigerated bases.

CONTROL PANEL
Each Multi-Rak system is provided with a pre-wired, control panel for single point connection with main disconnect.

Control panel is designed to assure efficient unit operation and provide a pre-selected sequence of operation during the refrigeration and defrost cycles. Each control panel is equipped with main disconnect, motor compressor breakers, contactors, fan motor capacitor, defrost time clock for freezer, and wiring diagram for service.

The control panel only requires 3 wires for power supply and 4 wires for defrost heaters and unit cooler fan motors in freezer. All system circuits are labels for easy identification.

ELECTRICAL DEFROST
An electrical defrost heater in the freezer is field-connected to the time clock in the control panel. Defrost is initiated by a time clock and stopped by a termination solenoid in the time clock connected to defrost limit thermostat in the freezer coil the time clock is set to fail safe termination period at 45 minutes. The freezer requires four defrosts per day starting at 12:00 a.m., 6:00 a.m., 12:00 p.m., and 6:00 p.m.

ELECTRICAL CHARACTERISTICS
Each Multi-Rak is equipped with 208-230 volts, 3 phase, 60 hertz power supply. 460-480 volts power supply available on request.

STANDARD COMPONENTS
Each Multi-Rak consists of two to twenty hermetic / glacier scroll compressors, multi-circuited condenser with heavy duty fan motors, oversized receivers, factory installed accessories, unit coolers with T-Stat, solenoid valve, TX valve and suction line P-Trap for freezer and cooler.

FACTORY INSTALLED ACCESSORIES
Drier, sight glass, head pressure control, dual pressure control, pre-wired control panel.

HEAD PRESSURE CONTROL VALVE
A head pressure control valve is provided when the ambient temperature is below 20°F. This provides stable head pressure in low ambient. The valve will maintain 180 lbs. PSIG in the receiver. This is accomplished by the modulation of the valve regulating flow from the condenser and the discharge line. It provides a minimum head pressure to insure refrigerant flow at the expansion valve. It also provides a minimum head pressure to assure refrigerant flow at the TXV and provide hot gas to the receivers for cold start situation.

U.L. APPROVAL
The "Multi-Rak" system is approved by Underwriters laboratories and displays the U.L. Label on the Control Panel, under condensing and compressor units (SGYU).

W.I. UNIT COOLERS

A. Freezer

A lower temperature electric defrost Lo-silhouette unit cooler for the freezer is provided with each Multi-Rak unit. The unit cooler draws air in through the coil and discharges it through the fans. For best results, the unit cooler should be located 18" from the back wall and blow towards the door. T-Stat, solenoid valve and TX valve are installed in the unit cooler at the factory. A suction line P-trap is also installed in the unit cooler for better oil return.

B. Cooler

A medium temperature Lo-silhouette unit cooler for the cooler is provided with each Multi-Rak unit. Air defrost is used for defrosting unit cooler. The unit coolers is provided with T-Stat, solenoid valve, TX valve and suction line P-Trap and is pre-piped and pre-wired for final connections.

The KaiRak "Multi-Rak" package refrigeration units are tested and assembled under strict quality assurance procedures. Each unit is tested and charged with nitrogen prior to shipment. Use caution and exercise safety at all times when preparing for final hook-up.

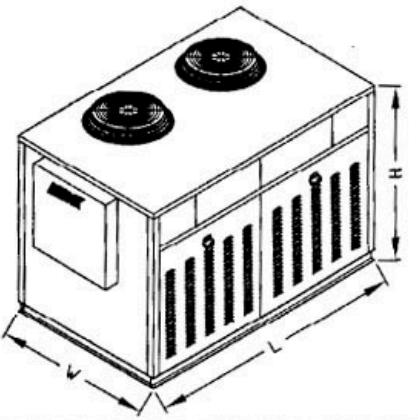
MULTI-RAK CONDENSING UNIT & COIL CAPACITY

CONDENSING UNIT CAPACITY								COIL CAPACITY		TOTAL SYSTEM						
HP	COMPRESSOR MODEL NO. (COPELAND)	CAPACITY MBH @ 95 F AMB	ELECTRICAL DATA (AMPS) VOLTS/PHASE/60 Hz		DIMENSIONS (INCHES)			COIL QTY	COIL MODEL NO.	RATING@1-PH, 60 Hz			LINE SIZE		TOTAL SYSTEM AMPS		SHIP WT.
										FAN MOTOR		DEFROST	SUCTION	LIQUID			
										RLA	VOLTS	HTR. RLA	O.D.	O.D.	208V 1PH	208V 3PH	
			208-230/1	208-230/3	L	W	H					208V/1PH					LBS
HERMETIC/SCROLL COMPRESSORS			**R-404A**		**MEDIUM TEMP.**			**WALK-IN COOLER**									
0.5	RS43C2E-CAV	5.9	5.4		10.75	6.63	11.25	1	ADT052	1.8	115		1/2	1/4	5.4		100
0.75	RS44C1E-CAV	8.3	7.7		10.75	6.63	11.25	1	ADT076	3.6	115		5/8	3/8	7.7		110
1	RS80C2E-TFD	10.8		6.4	10.75	6.63	11.25	1	ADT104	3.6	115		7/8	3/8		6.4	120
1.25	RS97C2E-TFC	12.2		7	10.75	6.63	11.25	1	ADT120	3.6	115		7/8	3/8		7	125
1.5	CS16K6E-TFD	13.5		7.5	10.28	9.09	13.31	1	ADT130	3.6	115		7/8	3/8		7.5	130
2	CS12K6E-TFD	16.9		7.5	10.28	9.09	13.31	1	ADT156	5.4	115		7/8	3/8		7.5	140
2.5	CS14K6E-TFD	18.3		9.1	10.28	9.09	13.44	1	ADT180	5.4	115		7/8	1/2		9.1	160
3	CS16K6E-TFD	22.7		10.4	10.28	9.09	13.81	1	ADT208	7.2	115		1 1/8	1/2		10.4	200
3.5	CS20K6E-TFD	27.3		11.4	10.28	9.09	14.06	1	ADT260	9	115		1 1/8	1/2		11.4	220
4	CS27K6E-TFD	35.8		15.6	9.44	9.28	15.06	1	ADT312	10.8	115		1 1/8	1/2		15.6	300
5	CS33K6E-TFD	39.9		20.7	9.44	9.28	15.31	1	ADT370	10.8	115		1 1/8	1/2		20.7	350
6	ZS45K4E-TFD	53.9		23.9	9.47	9.47	17.25	2	ADT260	18	115		1 3/8	5/8		23.9	400
7.5	ZS56K4E-TWC	65		30	12.63	13.89	21.23	2	ADT312	21.6	115		1 5/8	5/8		30	425
10	ZS75K4E-TWC	93.2		43.6	12.63	13.89	21.23	2	BMA450	24	115		2 1/8	7/8		43.6	500
15	ZS92K4E-TWC	113.4		52.9	12.63	13.89	21.54	2	BMA510	32	115		2 1/8	7/8		52.9	600
HERMETIC/SCROLL COMPRESSORS			**R-404A**		**LOW TEMP.**			**WALK-IN FREEZER**									
0.5	RS43C2E-CAV	1.4	5.4		10.75	6.63	11.25	1	TL21	1	115	9.6	1/2	1/4	6.4		100
0.75	RS64C1E-CAV	2.3	7.7		10.75	6.63	11.25	1	TL28	1.2	115	9.7	5/8	3/8	8.9		110
1	CS10K6E-TFD	2.3		7.5	10.28	9.09	13.31	1	LET035	1	208	3.9	5/8	3/8		8.5	120
1.25	CS12K6E-TFD	3.1		7.5	10.28	9.09	13.31	1	LET035	1	208	3.9	5/8	3/8		8.5	125
1.5	ZF06K4C-TFD	7.1		9.26	9.5	9.5	14.8	1	LET066	2	208	7.8	7/8	3/8		11.28	130
2	ZF09K4E-TFD	9		9.65	9.5	9.5	15.4	1	LET090	2	208	7.8	7/8	3/8		11.28	140
2.5	ZF09K4E-TFD	10.1		11.1	9.5	9.5	15.4	1	LET090	2	208	7.8	1 1/8	3/8		13.1	150
3	ZF13K4E-TFD	14		15	9.47	9.6	17.4	1	LET140	3	208	11.7	1 1/8	3/8		18	200
3.5	ZF15K4E-TFD	17.5		21.4	9.47	9.6	17.4	1	LET160	4	208	15.7	1 1/8	1/2		25.4	220
4	ZF18K4E-TFD	21.2		23.9	9.47	9.6	17.4	1	LET200	5	208	19.6	1 3/8	1/2		28.9	300
6	ZF24K4E-TWC	25.7		30	12.63	14.06	21.17	1	LET240	6	208	23.5	1 3/8	1/2		36	350
7.5	ZF33K4E-TWC	36.4		43.6	12.63	14.06	21.17	2	LET180	8	208	31.4	1 3/8	1/2		51.6	425
10	ZF40K4E-TWC	44.9		52.9	12.63	14.06	21.5	2	LET200	10	208	39.2	1 5/8	1/2		62.9	500
12	ZF48K4E-TWC	50.9		60	12.63	14.06	23.3	2	LET280	12	208	47	1 5/8	5/8		72	600
SEMI-HERMETIC COMPRESSORS			**R-404A**		**MEDIUM TEMP.**			**WALK-IN COOLER**									
0.5	HAGB-006E-CAV	4.3	4		12.75	8.94	10.47	1	ADT040	1.8	115		1/2	1/4	4		160
0.75	KANB-007E-CAV	6.5	5.4		14.38	9.5	10.44	1	ADT065	1.8	115		5/8	3/8	5.4		200
1	KARA-010E-TAC	9.3		4.3	14.38	9.5	10.44	1	ADT090	3.6	115		7/8	3/8		4.3	220
1.5	KAGA-016E-TAC	11.2		4.3	14.38	9.5	10.44	1	ADT104	3.6	115		7/8	3/8		4.3	250
2	ERCA-021E-TAC	19.5		8.8	16.69	12	12.91	1	ADT180	5.4	115		1 1/8	1/2		8.8	300
3	ERFA-031E-TAC	28.4		12.4	17.69	12	12.91	1	ADT260	9	115		1 1/8	1/2		12.4	400
4	NRB2-046E-TFC	38.9		21.8	20.19	13	15.34	1	ADT370	10.8	115		1 3/8	1/2		21.8	450
5	2DC3-050E-TFC	44		22.3	23.25	15.44	17.09	2	ADT208	14.4	115		1 3/8	5/8		22.3	550
5.5	2DD3-060C-TFC	53		22.3	23.25	15.44	17.09	2	ADT260	18	115		1 3/8	5/8		22.3	570
7.5	2DL3-075E-TFC	64.8		31.8	23.25	15.44	17.09	2	ADT312	21.6	115		1 5/8	5/8		31.8	650
7.5	2DA3-075E-TFC	74.8		32	23.25	15.44	17.09	2	ADT370	21.6	115		1 5/8	5/8		32	675
10	3DB3-100E-TFC	104.4		43.6	26.78	15.06	18.03	2	BMA510	32	115		2 1/8	7/8		43.6	900
12	3DF3-120E-TFC	129.3		48.2	26.78	15.06	18.03	2	BMA600	32	115		2 1/8	7/8		48.2	1000
15	3DS3-150E-TFC	143.1		59.6	26.03	15.06	18.03	2	BMA710	18	208		2 1/8	7/8		59.6	1200
20	4DA3-200E-TSK	151.9		66	25.41	20.19	17.66	2	BHA750	19.2	208		2 1/8	7/8		66	1500
25	4DH3-250E-TSK	193.9		82.2	26.28	20.5	17.81	2	BHA930	25.6	208		2 1/8	1 1/8		82.2	1800
30	4DJ3-300C-TSK	233.1		94	27.03	20.5	17.81	2	BHA1100	25.6	208		2 1/8	1 1/8		94	2000
35	6DH3-350E-TSK	293.8		107	30.19	22.44	17.97	2	BHA1400	27.6	208		2 5/8	1 1/8		107	2500
40	6DJ3-400E-TSK	343.6		142	30.19	22.44	20.81	2	BHA1610	39.6	208		2 5/8	1 3/8		142	3000
SEMI-HERMETIC COMPRESSORS			**R-404A**		**LOW TEMP.**			**WALK-IN FREEZER**									
0.5	KANB-005E-CAV	1.89	3.6		14.38	9.5	10.44	1	TL21	1	115	9.6	5/8	1/4	4.6		160
0.75	KANB-007E-CAV	3.1	5.6		14.38	9.5	10.44	1	TL35	1	208	7	7/8	3/8	5.6		200
1	KAJA-011E-TAC	4		4.6	14.38	9.5	10.44	1	LET040	1	208	3.9	7/8	3/8		5.6	220
1.5	KALA-016E-TAC	6.4		6.6	14.38	9.5	10.44	1	LET065	2	208	7.8	7/8	3/8		9.6	260
2	EAVA-021E-TAC	7.8		7.4	16.69	12	12.78	1	LET090	2	208	7.8	7/8	3/8		9.4	300
3	LAHA-032E-TAC	12.5		12.8	18.63	14	14.72	1	LET120	3	208	11.7	1 1/8	3/8		15.8	400
3.5	2DF3-030E-TFC	18		16.8	23.25	15.44	17.09	1	LET160	4	208	15.7	1 1/8	1/2		20.8	425
4	2DL3-040E-TFC	21.8		26.3	23.25	15.44	17.09	1	LET200	5	208	19.6	1 3/8	1/2		31.3	450
6	2DA3-060E-TFC	25.2		28.8	23.25	15.44	17.09	1	LET240	6	208	23.5	1 3/8	1/2		34.8	575
7.5	3DB3A075E-TFC	36.2		31.5	25.81	15.06	18.03	2	LET160	8	208	31.4	1 3/8	1/2		39.5	650
9	3DF3A090E-TFC	44.2		39	26.78	15.06	18.03	2	LET200	10	208	39.2	1 5/8	1/2		49	800
10	3DS3A100E-TFC	49.9		42	26.78	15.06	18.03	2	LET240	12	208	47	1 5/8	5/8		54	900
15	4DL3-150E-TSK	65.9		52.6	27.03	20.5	23	2	BME310	10.8	208	67.4	1 5/8	5/8		53.4	1200
22	4DT3-220E-TSK	81.8		66	27.94	20.5	23	2	BME390	10.8	208	67.4	2 1/8	5/8		76.8	1600
27	6DL3-270E-TSK	102.2		80.8	29.44	22.44	26	2	BME520	14.4	208	61@3ph	2 1/8	7/8		95.2	1900
30	6DT3-300E-TSK	114.4		95.6	29.44	22.44	28.84	2	BME520	14.4	208	61@3ph	2 1/8	7/8		110	2200

NOTES:
1. Condensing unit capabilities are 95°F ambient. Cooler temp. is at 35°F with 29°F suctio gas temp. Freezer temp is at -10°F with -20°F suction gas temp.
2. Unit cooler and condensing units will have separte power supplies for walk-in cooler applications and a single power supply for walk-in freezer applications. The Unit Cooler is electrically connected to the condensing unit with a 4-wire color-coded defrost harness.
3. 1MBH = 1000 BTUs/Hour @ 208 volts, 3 Phase, 60hz Defrost heaters.

MULTI-RAK

MULTI-CIRCUITED REFRIGERATION SYSTEM

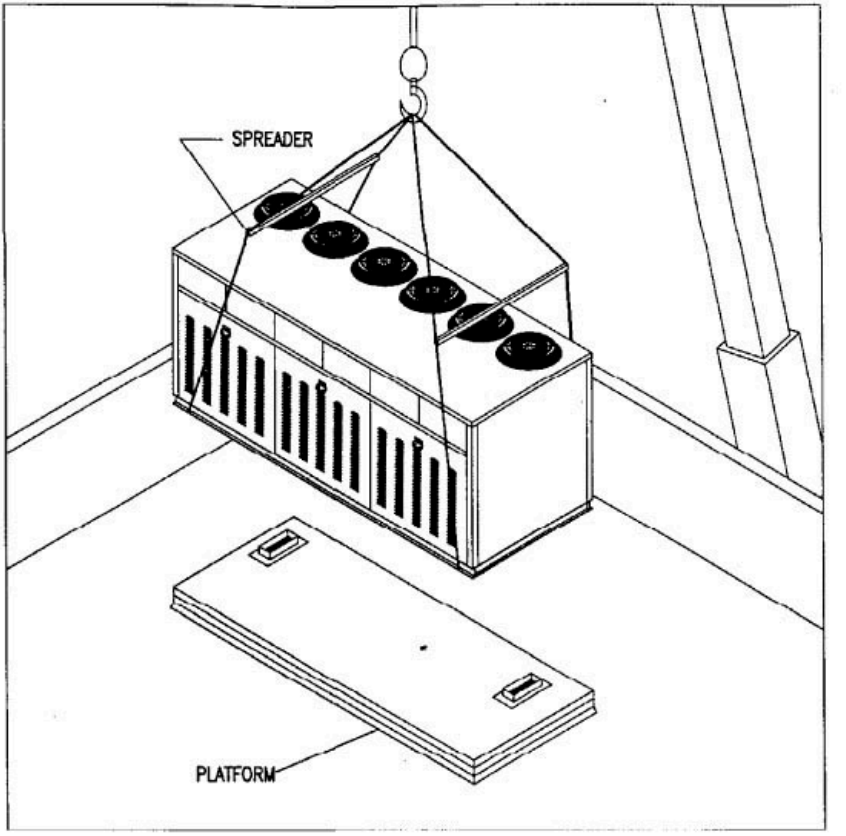


KAIRAK MODEL NUMBER	DIMENSION (IN.)		
	L	W	H
KMR-4	48	45	50
KMR-6	72	45	50
KMR-8	96	45	50
KMR-10	120	45	50
KMR-12	144	45	50
KMR-16	192	45	50
KMR-20	240	45	50

NOTES:

1. INSTALLATION CLEARANCE – 3 FEET ALL SIDES. REFRIGERATION LINES STUBBED AT RIGHT END OF RACK AND ELECTRICAL LINES STUBBED AT LEFT OF RACK.

FIGURE 1 - MULTI-RAK DIMENSIONAL DATA


SPREADER
PLATFORM

INSTALLATION

RECEIPT AND INSPECTION OF EQUIPMENT

Inspect the Multi-Rak refrigeration unit and all accessories shipped for any damage for shortages. Any damage or shortages should be reported immediately to the delivering carrier. Damaged material becomes the delivering carrier's responsibility and it should not be returned to the manufacturer without prior approval. Do not remove any shipping material until the unit is installed in its permanent location.

LIFTING INSTRUCTIONS (Figure 2)

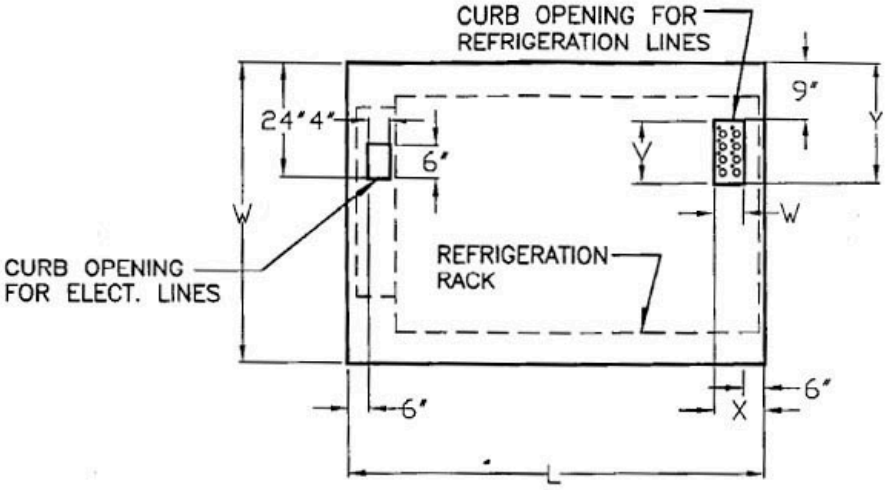
The Multi-Rak system is a heavy piece of machinery approximately 500 to 10,000 lbs. Careful consideration of lifting procedures should be made before the unit is lifted by any means. Particularly, any cables or any other load-bearing devices must not be allowed to press against piping, electrical conduit or the motor control panel. The only part of the unit designed to carry any of the lifting load is the base. Lifting loads should be distributed evenly around the base to avoid any twisting.

It is recommended that whenever the unit is lifted by a crane, the lifting space provided in the lower portion of the base frame be used as attachment points for the lifting cables as shown in Figure 2. The lifting cables should be prevented from contacting the unit by means of a spreader or similar device.

LOCATION AND VENTILATION

The Multi-Rak unit must be located in an area which allows easy access for installation and service of all electrical lines, refrigeration piping and any accessory equipment. The unit must be level to insure proper lubrication. A minimum of 3 feet clearance must be provided on all sides of the unit.

Equipment should be mounted on a smooth, hard, level surface. Mounting surface should be rigid, and provision should be made to prevent noise transmission (structural) to surrounding areas. Air cooled equipment should be installed under low structural overhangs which can cause condenser air recirculation or restriction. Adequate area (approx. 1 unit width) must be provided around equipment for unrestricted airflow and service. Two units side by side should have a minimum of 1 ½ unit width between them. Care should be taken to prevent air from other sources from entering condenser if this air is at an elevated temperature.



KAIRAK MODEL NUMBER	MULTI-RAK DIMENSIONS: MAXIMUM NUMBER OF COMPRESSORS SCROLL/ HERMETIC	MAXIMUM NUMBER OF COMPRESSORS SEMI-HERMETIC	ENCLOSURE WEIGHT (LBS.)	DIMENSIONS (INCHES) MULTI-RAK L	W	H	CONDENSER FAN MOTORS 208V, 1PH 60HZ QTY	AMPS	ROOF PLATFORM DIMENSIONS (INCHES) OVERALL PLATFORM L	W	H	CURB OPENING V	W	OPENING LOCATION X	Y
KMR-4	3	2	300	48	45	50	2	3.6	62	57	6	20	8	14	29
KMR-6	5	4	400	72	45	50	2	7.2	86	57	6	20	8	14	29
KMR-8	7	6	500	96	45	50	4	9.6	110	57	6	20	8	14	29
KMR-10	9	8	600	120	45	50	6	14.4	134	57	6	20	8	14	29
KMR-12	11	10	800	144	45	50	6	21.6	158	57	6	30	8	14	39
KMR-16	15	14	1400	192	45	50	8	19.2	206	57	6	30	8	14	39
KMR-20	18	16	1800	240	45	50	10	24	254	57	6	30	8	14	39

FIGURE 3 - PLATFORM DETAILS

INSTALLATION AREA (Figure 3)

Figure 3 illustrates the overall dimension and installation requirements.

ROOF PLATFORM REQUIREMENTS

The roof platform requirements are shown in Figure 3. The location and installation of all equipment should be in accordance with all local code requirements. The unit can usually be placed directly upon the roof platform, since each compressor is mounted on vibration isolation pads. For light roof construction, vibration isolation pads can be used underneath the supporting frame.

PITCH POCKET

A. 8" x 24" pitch pocket must be provided for refrigeration lines. After lines are installed backfill opening with hot pitch and make sure there are no leaks.
B. 4" x 6" pitch pocket must be provided for electrical lines. After lines are installed backfill opening with hot pitch and make sure there are no leaks.

ELECTRICAL (Figure 4A & 4B)

To insure operation of equipment and reduce the possibility of electrical power interruption, the following precautions must be observed:

1. All electrical work must be done in accordance with the National Electrical Code and existing local codes.
2. The power supply must be the same as that which appears on the data plate of the motors.
3. An adequate power supply must be provided.
4. Voltage fluctuations in excess of plus or minus 10 percent should be corrected.
5. 120 volts, 1 phase, 60 Hz. Power supply must be provided for walk-in cooler (Figure 4A).
6. All unit wiring terminals should be checked for tightness before power is applied to the equipment.
7. When wiring is completed, fan motors should be checked for proper rotation. All fan motors of multiple fan equipment have been factory wired to operate with same rotation. If rotation is found to be incorrect, reverse two of three leads on main incoming power.

Before starting a Multi-Rak unit, check that all breakers and motor protective devices are in place and that all wiring is secure. A wiring diagram for trouble-shooting the unit is included on the cover.

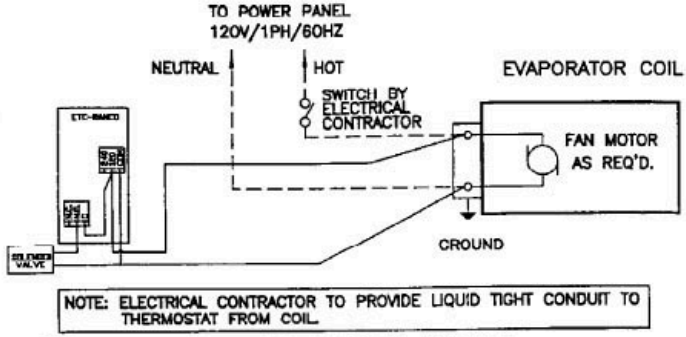


FIGURE 4A - WIRING DIAGRAM FOR WALK-IN COOLER

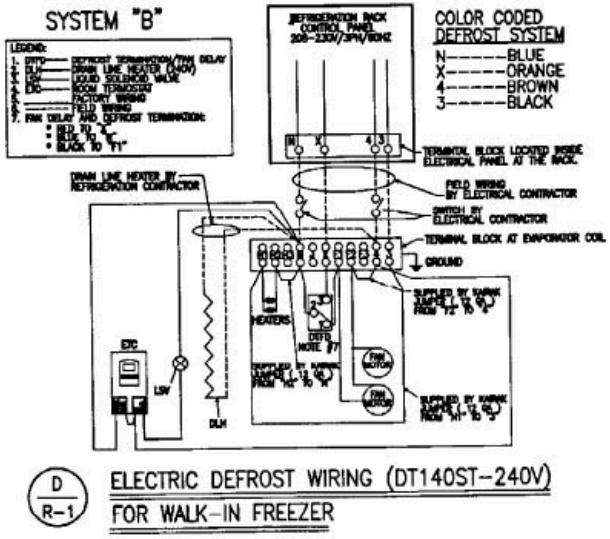


FIGURE 4B - WIRING DIAGRAM FOR WALK-IN FREEZER

REFRIGERATION (Figure 5)

1. Piping

Connect suction and liquid lines with the unit coolers and condensing unit on the roof. Leave access tubing in the attic space and backfill opening with hot pitch after installation so that there are no leaks.

Piping must be installed to prevent liquid refrigeration from entering the compressor, either during operation time or "off" time. All piping must be supported with hangers that can withstand the combined weight of tubing, insulation, valves, and fluid in the tubing.

2. Leak Testing

After all refrigeration lines are connected, the entire system must be leak tested, particular care should be given to those parts which will be inaccessible at a later date. **The use of an electric leak protector is highly recommended because of its greater sensitivity to small leaks.**

3. System Evacuation

With refrigerant piping completed and leak tested, equipment is ready to evacuate. Do not use compressor to evacuate system. A quality vacuum pump of 350 microns vacuum is necessary for adequate and dependable system vacuum. Moisture in a refrigeration system can cause corrosion, expansion valve freeze-up and oil sludge.

Attach vacuum pump to both high and low side of system through compressor service valves and evacuate to 350 microns (all service valves*, hand valves, and solenoids must be open during evacuation). It is suggested that vacuum pump be run for a period of time after vacuum has been reached.

*Service valves are back setting valves and must be mid-position to open to both sides of the system.

4. System Charging (Less Flooded Head Pressure Control)

With system wired, piped, and evacuated, unit is ready for refrigerant charging. All charging lines and manifolds must be evacuated prior to admitting refrigerant in to system to prevent contaminating system with noncondensibles.

Connect charging line to receiver outlet valve and admit "liquid" refrigerant into high side of system until flow stops due to pressure equalization between high side and drum pressure. Backseat outlet valve and disconnect charging line.

Connect charging line to compressor suction service valve and admit "vapor" into low side system.

Energize equipment and continue to admit vapor into low side of system until liquid line sight glass clears, indicating a fully charged system (it may be necessary to defeat low pressure control on initial start to prevent nuisance trip until low side pressure is above cut out point of control.

5. System Charging (With Flooded Head Pressure Control)
Initial charging is the same as outlined in item 4.

Do not adjust control valves. These are either factory preset or nonadjustable, depending on size.

Set unloaders (if supplied) to load compressors to 100% while charging. Add additional charge to bring total charge up to required charge as calculated in item 3. Additional charge to be added through low side (vapor) as outlined in item 4, fourth paragraph.

This is a continuation of "system charging" and must be performed before equipment can be left operating and unattended. This will involve checking and adjusting of all safety and operating controls (pressure and temperature controls have been set at the factory: however, it is still desirable to confirm that the settings are correct and controls function properly). Do not attempt to function safety controls without some means of stopping compressor in event of extreme high or low pressure conditions that could damage the equipment. If controls fail to function at set points, determine cause and correct. Jumping any safety control other than for testing purposes is dangerous to personnel and equipment, and nullifies equipment warranty.

Energize crankcase heaters and allow a minimum of 24 hours operation before a compressor start.

1. **High Pressure Control** – Connect a gauge to the compressor discharge service valve. Stop condenser airflow by stopping fans on air cooled equipment or restricting water flow on water cooled equipment. Control should open immediately when discharge pressure reaches control set point.
2. **Low Pressure (Pump-Down) Control** – Connect a gauge to the compressor suction service valve. Throttle receiver outlet valve to lower suction pressure at compressor. Compressor should pump-down and be energized when suction pressure reaches "cut-out" setting of control. Open receiver outlet valve and observe rise in pressure at compressor suction connection. Compressor should be energized when pressure reaches "cut-in" setting of control.
3. **Oil Pressure Control** – Copeland compressor-jumper between terminals T1 and T2 of the oil pressure safety control. Compressor should run approximately 120 seconds and cycle off. Remove jumper and reset control. Check operating oil pressure this is the differential between oil pump discharge pressure and suction pressure and should be a minimum of 10 psig. Also, after several hours running time, check oil level in compressor. Proper level is approximately ¼ level on oil sight glass.

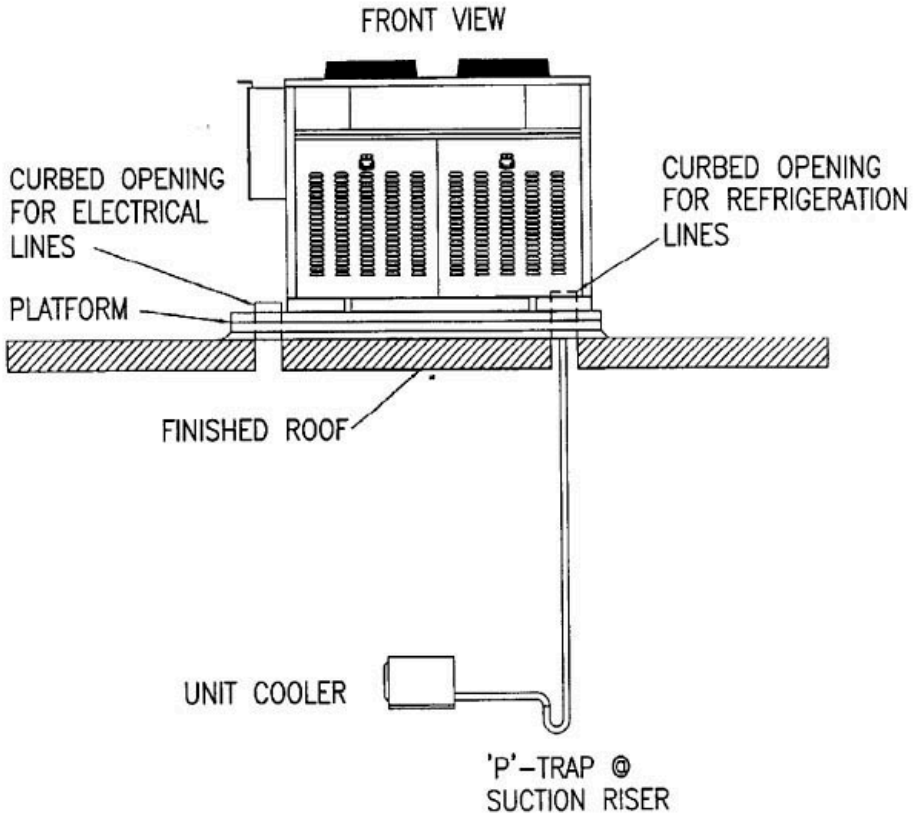


FIGURE 5 - PIPING DETAILS

4. **Temperature Control (Water Chillers)** – This is the main unit operating thermostat. As standard the control cycles both the compressor and the unloader(s) in response to return water temperature. The sensing bulb is located in a well on the return water nozzle. This control has been factory set to maintain desired leaving water temperature. The temperature control can be filed adjusted. To calculate the proper set point, add the specified leaving water temperature and the design temperature difference of return to supply (TD). Temperature control adjustment should be made as follows:

Example: Design conditions: 10°F TD, 55°F entering (return) water, 45°F leaving (supply) water and 5 psi water side pressure drop at rated flow.

Step 1: Check proper flow through cooler. Pressure gauges at the entering and leaving nozzles should be used. Adjust flow by balancing valves of throttling valves on discharge side of the cooler to corresponding pressure drop.

Step 2: The system water temperature should be at 60°F or above to simulate a pull down for proper start-up and check out.

Step 3: Adjust temperature control dial to 55°F. This will produce 45°F leaving temperature at designed flow rate.

Step 4: Observe the suction pressure as the return water temperature continues to fall and the compressor(s) and/or unloaders(s) are staged by the temperature control. The suction pressure at the compressor should not fall below approximately 58 psi during all stages of compressor/compressors operation.

The compressor(s) will eventually be staged off by the temperature control. When this occurs, the return water temperature must rise to the cut in set point of the temperature control (the dial setting) before the compressor(s) is staged on again.

Always consult equipment submittals for proper design conditions before adjusting the temperature control.

Possible causes of control failures and recommended corrective action:

Cause	Correction
A. Temperature setting too low	Readjust to proper setting. Check catalog or submittal data.
B. Cooler flow incorrect	Balance flow to catalog or submittal Requirements.
C. Low refrigerant charge	Recharge to correct operating level-clear sight glass.
D. Restricted liquid line	Check valve and drier.
E. Thermal expansion	Adjust superheat to approximately 8-12°F at the evaporator.

5. **Freezer Protection Control (Water Chillers) –** Control is a pressure sensing, manual reset safety control. It responds to suction pressure and prevents circuit operation should suction pressure fall below control set point for a period in excess of 120 seconds. Control is factory set and sealed at a pressure selected for the fluid being cooled or application requirements. For water systems, the control is at 54 psig. The fixed time delay (120 seconds allow circuit to stabilize on start-up and normal pump-down operation. Control is sealed at the factory. This seal must be intact to maintain warranty on compressor and/or cooler failures. Should readjustment be necessary, contact the factory authorization.
6. **Thermal Expansion Valve –** Adjust superheat setting to job requirements.
   How to determine superheat correctly.
   A) Measure the temperature of the suction line at the point the bulb is clamped.
   B) Obtain the suction pressure that exists in the suction line at the bulb location / by either of the following methods.
      1) If the valve is externally equalized, a gauge in the external equalizer line will indicate the desired pressure directly and accurately. OR
      2) Read the gauge pressure at the suction valve of the compressor. To the pressure add the estimated pressure drop through the suction line between bulb location and compressor suction valve.

      The sum of the gauge reading and the estimated pressure drop will equal the approximate suction line pressure at the bulb.

   C) Convert the pressure obtained in 6b(1) or 6b(2) to saturated evaporator temperature by using a temperature-pressure chart.
   D) Subtract the two temperature obtained in 6a and 6c, the difference is superheat.

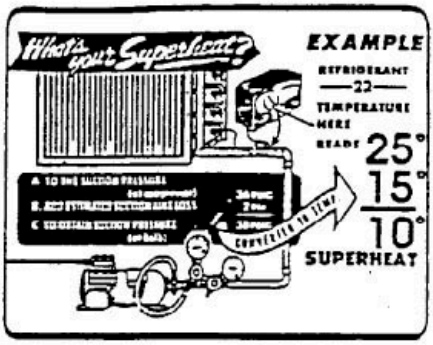


Figure 6

Figure A illustrates a typical example of superheat measurement on a refrigeration system using refrigerant 22. The temperature of the suction line at the bulb location is read at 25°F. The suction pressure at the compressor is 36 psig and the estimated line pressure drop is 2 psig...36 psig + 2 psig = 38 psig at the bulb, which is equivalent to a 15°F saturation temperature. 15°F subtracted from 25°F = 10°F superheat.

7. **Hot Gas Bypass (if supplied)** – Connect gauge to compressor suction service valve. Throttle receiver outlet valve to lower suction pressure at compressor. Hot gas regulator should begin to open as suction pressure approaches design suction pressure. This should be done before unit has pulled down to design condition.

START-UP PROCEDURE

After the installation has been completed, the following items should be covered before the system is placed in operation.

CONDENSING UNITS

1. Check electrical connections. Be sure they are all tight.
2. Observe the motor-compressor oil level before start-up. The oil level should be at or slightly above the center of the sight glass. Use only SUNISO 3g of 3GS compressor oil.
3. Insure that the rubber grommets are installed under the motor-compressor mounting nuts and that the motor compressor rides freely on its mounting vibration isolators.
4. Check the high and low pressure controls and all other safety controls. Adjust if necessary.
5. Check the Walk-In Cooler and Freezer thermostats for correct operation.
6. Suitable tags are provided to indicate the refrigerant used in the system.
7. The instruction manual, bulletins, tags, etc., attached to the unit should be placed inside the electrical panel for future reference.
8. Observe system pressures during initial operation. Do not add oil while the system is short of refrigerant unless the oil level is dangerously low.

***** CAUTION *****
DO NOT OVERCHAGE WITH OIL.

UNIT COOLER

Before Start-Up:

1. Make sure system is wired correctly.
2. Check to make sure all electrical terminals are tight.
3. Make sure fan sets screws are tight.
4. Make sure unit is mounted securely using all the hangers and is level as possible.
5. Make sure the drain connection is tightened to the drain line securely.
6. Pour water into the drain pan to check for complete drainage of drain pan and drain line.

After Start-Up:

1. On initial start-up freezer unit cooler, the fans will not start until the coil temperature reaches about twenty-five degrees Fahrenheit.
2. Check the expansion valve superheat setting. It is important that the valve is set properly for efficient operating and even frost formation.
3. Make sure the drain line heater is working properly.
4. Heavy moisture loads are usually encountered when starting a system for the first time. This will cause a rapid frost build-up be watched and that the unit be defrosted manually as required.
5. Observe the system as it goes through the first defrost cycle make sure that the timer, defrost heaters, termination thermostat and other system component function properly.

OPERATIONAL CHECK-OUT

Only after the system has operated for at least two hours at normal operating conditions without and indications of malfunctions should it be allowed to operate overnight on automatic controls. A thorough recheck of the entire system operation should be made as follows:

1. Check the motor-compressor head and suction pressure. If the pressures are not within the system design limits, determine why and take corrective action.
2. Check the liquid line sight glass and expansion valve operation. If there are indications that more refrigerant is required, leak test all connections and system components and repair any leak before adding refrigerant.
3. Observe the oil level in the motor-compressor crankcase sight glass and add oil as necessary to bring the level to the center of the sight glass.
4. Thermostatic expansion valves must be checked for proper superheat settings. Feeler bulbs must be positive thermal contact with the suction line. Valves with high superheat settings produce little refrigeration and poor oil return. Too little superheat causes low refrigeration capacity and promotes liquid slugging and compressor bearing washout. Liquid refrigerant must be prevented from reaching the crankcase. If proper controls cannot be achieved with the system in normal operation, a suction accumulator must be installed in the suction line just ahead of the motor-compressor to prevent liquid refrigerant from reaching the motor-compressor.
5. Using suitable instruments, carefully check line voltage and amperage at the compressor terminals. Voltage must be plus or minus 10 percent of that indicated on the compressor nameplate rating. If amperage draw is excessive, immediately determine the cause and take corrective action. On three phase motor-compressor, check to see that a balanced load is drawn by each phase.
6. Check fan motor on air-cooled condensers and in walk-in evaporator coils for correct rotation. Fan motor mounts should be carefully checked for tightness and proper alignment.
7. High pressure controls on condensing unit should be set to cut out as follow:

R-12	R-22 & R-404
225 psig	350 psig

   The cut-out point of these controls should be checked by stopping the condenser fan and simultaneously monitoring the head pressures with an accurate gauge.
8. Re-check all safety controls and operating controls for proper operation and adjust if necessary.

9. Check the defrost time clock for initiation, termination and length of defrost period as described below.

The standard defrost timer furnished by KaiRak provides frequency controls including a fail-safe feature that automatically terminates defrost after a set time if the termination thermostat fails to function properly. The standard timer is furnished with a 240 volt clock motor and has a contact rating of 40 amps at 240 volts. Figure 6 shows the time dial.

A. To set the number of defrost every 24 hours, screw a pin into the outer dial at each desired time of defrost.
B. To set the time of day, grasp the center knob and rotate counterclockwise until the correct time of day on the outer dial is lined up with the pointed. Do not attempt to set the timer by grasping and turning the outer dial.
C. To set the fail-safe time, push down the pointer on the inner dial and adjust it to the desired time in minutes.

The time should initially be set for 4 defrost cycles per day. However, each installation should be checked so the system operated efficiently with a minimum number of defrost cycles. The fail-safe efficiently with a minimum number of defrost cycles. The fail-safe setting should not normally exceed 45 minutes because of danger of overheating the unit if the defrost cycle is prolonged too long.

Figure 7. Timer Dial

10. Dual pressure controls settings on the condensing unit should be set to cut in and out as follows:

	High	Low	
Fixture Description	Cut Out psig	In psig	Out psig
Walk-In Freezer	350	26	15
Walk-In Cooler	225	28	17

SHUT DOWN

Equipment which will not be required to operate for a period of time should be secured by storing refrigerant charge in the receiver or condenser.

1. Front seal the receiver outlet valve. Set thermostat at a setting below system temperature to insure that liquid line solenoid is energized. Defeat the low pressure control and allow unit to pump down to a suction pressure of approximately 5 psig. It may be necessary to repeat pump-down as some refrigerant will remain in oil and will slowly boil off. When suction pressure holds at 5 psig, front seal suction service valve. Lock disconnect in position.
2. On units with water-cooled condensers, special precautions must be taken to completely drain the vessels to prevent freezing if ambient should be below 32°F.
3. Inspect system for possible worn of faulty components and repair if required.

SYSTEM RESTART AFTER SHUT DOWN

1. Thorough leak test should be performed.
2. Coil(s) should be checked for dirt accumulation or obstruction and cleaned if necessary.
3. Energize crankcase heaters and allow a minimum of 24 hours operation before a compressor restart.
4. Install gauges, start system and check for correct refrigerant charge, and proper system operation and balance.

MAINTENANCE

AIR-COOLED CONDENSER

Air-cooled condenser should be cleaned with a brush and vacuum cleaner every four to six months to remove all accumulations of dust, leaves and other debris. Where air-cooled condenser must operate in usually dusty locations, cleaning should be scheduled as often as conditions dictate.

WARNING

BE SURE THAT THE MAIN DISCONNECT SWITCH IN THE OFF POSITION BEFORE ANY CLEANING OF THE CONDENSERS IS ATTEMPTED.

ELECTRICAL AND PIPING CONNECTIONS

All electrical connections should be periodically checked to be sure they are tight. Loose connections contribute to low voltage conditions which can cause motor failure.

Refrigerant connections should be inspected to insure that they have not loosened. Whenever it is necessary to add refrigerant, a careful leak check of all refrigerant connections should be made.

CRANKCASE LUBRICATION

As indicated under the operational check-out procedures, the oil level in the motor-compressor crankcase should be at the center of the sight glass at all times. If the oil level is low, more oil should be added to bring the level up to the center of the sight glass and cause of oil migration corrected. Check the expansion valve adjustment and the size of risers and traps.

The quality of the compressor oil can, however, be checked rather easily by using an oil sample. Visual examination of the compressor oil can disclose the condition of the system. Acid test is highly recommended to measure the extent of contamination in a system. Dirty, discolored oil properly indicates one of the following:

1. Contaminations such as moisture, air, etc., trapped in the system.
2. Excessive pressure drop of improper control settings allows motor-compressors to operate at a dangerously low suction pressure. This may cause motor compressor overheating and oil discoloration.

If this situation occurs and oil discoloration is not too dark, the installation of a new liquid line filter-drier may be enough to remove contamination and clear the oil. If the discoloration is severe, the oil should be replaced and a new liquid filter-drier installed as many times as necessary to eliminate the contamination. After the oil is replaced, the system controls be readjusted.

UNIT COOLER

Unit cooler should be checked at least once a month for proper defrosting to maintain amount and pattern of frosting. It is dependent on the temperature of the room, the type of product being stored, how often new product is brought into the room and the percentage of time the door to the room is open. Also, if the coil is not defrosting completely, check for faulty defrost heaters.

Under normal usage, maintenance should cover the following items at least once every six months.

1. Tighten all electrical connections.
2. Tighten fan set screws.
3. Clean the coil surface.
4. Check the operation of the control system.
5. Clean the drain pan and check for proper drainage.
6. Check the drain line heaters.

HEATER REPLACEMENT IN LOW TEMP UNIT COOLER

1. Make sure the electrical power to the heaters is turned off.
2. Disconnect heater leads on both ends of the heater to be removed.
3. Remove the sheet metal screws holding the heater retainer to the heater plate on the electrical connection end of the unit.
4. Pull the heater(s) to be replaced out of the tube holes in the coil. It is necessary to lower the drain pan to remove the bottom heater.
5. Replacement coil heaters are received coiled in a two foot diameter. Before inserting the heater in the coil, uncoil about one foot of the straight end to make it easier to insert the heater into the tube hole.
6. Insert the end of the heater into the tube hole and uncoil it while pushing it through coil.
7. Attach tube clamp and retaining bracket to new heater just before rubber boot. Push heater in until bracket meets the header plate. Fasten bracket to the header plate to prevent heater "creep".
8. Reconnect the heater leads as shown on the wiring diagram.

SERVICE DIAGNOSIS - CONDENSING UNITS

SYMPTOM	CAUSE	REMEDY
A Compressor does not run	1 Motor line open.	1 Close start or disconnect switch.
	2 Fuse blown.	2 Replace fuse.
	3 Tripped overload.	3 See part C.
	4 Control contacts dirty or jammed in open position	4 Repair or replace.
	5 Piston seized.	5 Remove motor compressor head. Look for broken valve and jammed parts.
	6 Frozen compressor or motor bearings.	6 Repair or replace.
	7 Control in off position because of cold location.	7 Use thermostatic control or move control to warmer location.
	8 Defective starting component (single phase compressor only).	8 Locate and replace.
B Unit short cycles.	1 Control differential set too closely.	1 Widen differential.
	2 Discharge valve leaking.	2 Correct condition.
	3 Motor-compressor overload	3 Check for high head pressure, tight bearings, seized, pistons, clogged air cooled condenser.
	4 Refrigerant shortage.	4 Repair leak and recharge.
	5 Refrigerant overcharge.	5 Purge.
	6 Cycling on high pressure.	6 Check water supply, dirty condenser or defective fan.
C Compressor will not start - hums intermittently (cycling on overload).	1 Improperly wired.	1 Check wiring against diagram.
	2 Low line voltage.	2 Check main line voltage and determine location of voltage and drops.
	3 Relay contacts not closing.	3 Check by operating manually. Replace relay if defective.
	4 Open circuit in starting winding.	4 Check stator leads. If leads are OK, replace stator.
	5 Stator winding grounded.	5 Check stator leads. If leads are OK, replace stator.

C (Continued) Compressor will not start - hums intermittently (cycling on overhead).	6	High discharge pressure.	6 Eliminate cause of excessive pressure. Make sure discharge shut-off valve is open.
	7	Tight compressor.	7 Check oil level; correct binding.
D Unit operates long or continuously.	1	Refrigerant shortage.	1 Repair leak and recharge.
	2	Control contacts sticking closed position.	2 Clean points or replace control
	3	Dirty condenser.	3 Clean condenser.
	4	Air in system.	4 Purge.
	5	Compressor inefficient.	5 Check valves and piston.
	6	Improper wiring.	6 Check wiring and correct it if necessary.
E Fixture temperature too high.	1	Refrigerant shortage.	1 Repair leak and recharge.
	2	Control set too high	2 Reset control.
	3	Control wiring loose.	3 Check wiring to control.
	4	Expansion valve or strainer plugged.	4 Clean or replace.
	5	Compressor inefficient.	5 Check valves and pistons.
	6	Expansion valve set too high.	6 Lower settings.
	7	Iced or dirty coil.	7 Defrost or clean
	8	Unit too small.	8 Add unit or replace.
	9	Clogged or small gas lines.	9 Clear clogging or increase line size.
	10	Oil logged system.	10 Remove excess oil, check refrigerant. Charge.
F Head pressure too high.	1	Refrigerant overcharge.	1 Purge
	2	Air in system.	2 Purge
	3	Dirty air-cooled condenser.	3 Clean area around air-cooled condenser and inspect for airborne dirt source.
	4	Insufficient water supply.	4 Check water valves and inspect cooler.
	5	Recirculating cooling air.	5 Seal off unit from other machines and provide intake isolated from air outlet.
	6	High side restriction.	6 Remove blockage.
	7	Head pressure control valve set wrong.	7 Readjust.

G Head pressure too low.	1 Refrigerant shortage.	1 Repair leak and recharge.
	2 Compressor suction or discharge valves inefficient.	2 Clean or replace leaky valve plates.
	3 Cold ambient or cold water.	3 No remedy, as efficiency is generally increased. However, if condensing temperature is below 85°F expansion valve will not be able to feed properly and some form of head pressure control must be provide.
	4 Head pressure control valve set wrong or no head pressure valve installed.	4 Readjust or install a head pressure control valve.
H Noisy Unit	1 Insufficient compressor oil.	1 Repair leak and recharge.
	2 Tubing rattle.	2 Bend tubes away from contact.
	3 Mounting loose.	3 Tighten.
	4 Oil slugging or refrigerant flood back.	4 Adjust oil level or refrigerant change. Check expansion valve for leak or oversized orifice.
	5 Unbalanced fan or defective fan motor.	5 Replace bent or broken fan blades. Check motor bearings.
I Compressor loses oil.	1 Short of refrigerant.	1 Repair leak and recharge.
	2 Gas-oil ratio low.	2 Add 1 pt. Oil for each 10lbs. Of refrigerant added to factory charge.
	3 Plugged expansion valve or strainer.	3 Clean or replace.
	4 Oil trapping in lines.	4 Drain tubing toward compressor.
	5 Short cycling.	5 Refer to Part B.
	6 Superheat too high at compressor suction.	6 Change location of expansion valve bulb or adjust valve to return wet gas to compressor.
J Frosted or sweating suction line.	1 Expansion valve admitting excess refrigerant.	1 Adjust expansion valve.

K	Hot liquid line.	1 Shortage or refrigerant.	1 Repair leak and recharge.
		2 Expansion valve open too wide.	2 Adjust expansion valve.
L	Frosted liquid line.	1 Receiver shut-off valve partially closed or restricted.	1 Open valve or remove.
		2 Clogged dehydrator or restricted.	2 Replace clogged part.
M	Unit on vacuum	1 Ice plugging expansion.	1 Apply hot wet cloth to expansion valve. If suction pressure now increase, there is moisture in the system and a dryer should be installed in the line.
		2 Plugged expansion valve.	2 Clean strainer or replace expansion valve.
N	Compressor will not unload or load up.	1 Defective capacity control.	1 Replace.
		2 Unloader mechanism defective.	2 Replace.
		3 Faulty thermostat stage or broken capillary tube.	3 Replace.
		4 Stages not set for application.	4 Replace.
O	Compressor loading - unloading intervals too short.	1 Erratic water thermostat.	1 Replace.
		2 Insufficient water flow.	2 Adjust gpm
P	Little or no oil pressure.	1 Clogged suction oil strainer.	1 Clean
		2 Excessive liquid in crankcase.	2 Check crankcase heater. Reset expansion valve for higher superheat. Check liquid line solenoid valve operation.
		3 Oil pressure gauge defective.	3 Repair or replace. Keep valve closed except when taking reading.
		4 Low oil pressure safety switch defective.	4 Replace.
		5 Worn oil pump.	5 Replace.
		6 Oil pump reversing gear stuck in wrong position.	6 Reverse direction of compressor rotation.
		7 Worn bearing.	7 Replace compressor.

P	(Continued) Little or no oil pressure.	8 Low oil level. 9 Loose fitting on oil lines. 10 Pump housing gasket leaks. 11 Flooding of refrigerant into crankcase.	8 Add oil. 9 Check and tighten system. 10 Replace gasket. 11 Adjust thermal expansion valve.
Q	Motor overload relays or circuit breaker open.	1 Low voltage during high load conditions. 2 Defective or grounded wiring in motor or power circuits. 3 Loose power wiring. 4 High condensing temperature. 5 Power line fault causing unbalanced voltage. 6 High ambient temperature around the overload relay. 7 Failure of second starter to pull in on part winding system.	1 Check supply voltage for excessive line drop. 2 Replace compressor motor. 3 Check all connection and tighten. 4 See corrective steps for high discharge pressure. 5 Check supply voltage. Notify power company. Do not start until fault is corrected. 6 Provide ventilation to reduce heat. 7 Repair or replace starter or time delay mechanism.
R	Compressor thermal protector switch open.	1 Operating beyond design conditions. 2 Discharge valve partially shut. 3 Blown valve gasket.	1 Add facilities so that conditions are within allowance limits. 2 Open valve. 3 Replace gasket.
S	Freeze protection opens.	1 Thermostat set too low. 2 Low water flow. 3 Low suction pressure.	1 Reset to 40°F or above. 2 Adjust gpm. 3 See "Low Suction Pressure."

TEMPERATURE PRESSURE CHART

Temp °F	R-22 Vapor Pressure	R-123 Vapor Pressure	R-134a Vapor Pressure	R-408A (FX-10) Liquid Pressure	R-404A (FX-70) Liquid Pressure	R-409A (FX-56) Liquid Pressure	R-409A (FX-56) Vapor Pressure	R-407C Liquid Pressure	R-407C Vapor Pressure	R-410A Liquid Pressure
-50	6.2	29.2	18.7	1.6	0.6	12.4	17.2	2.9	11.4	3.5
-45	2.7	29.0	16.9	1.1	2.7	9.7	15.2	0.4	8.5	8.5
-40	0.5	28.9	14.8	3.3	5.0	6.8	13.1	2.5	5.2	11.6
-35	2.6	28.7	12.5	5.6	7.6	3.5	10.7	4.8	1.5	14 9
-30	4.9	28.4	9.8	8.2	10.4	0.0	8.1	7.3	1.3	18.5
-25	7.4	28.1	6.9	11.0	13.4	2.0	5.1	10.1	3.6	22.5
-20	10.1	27.8	3.7	14.1	16.8	4.1	1.9	13.1	6.1	26 9
-15	13.2	27.4	0.1	17.5	20.5	6.5	0.8	16.5	8.8	31.7
-10	16.5	27.0	1.9	21.2	24.5	9.0	2.8	20.1	11.9	36.8
-5	20.0	26.5	4.1	25.2	28.8	11.8	4.9	24.0	15.2	42.5
0	23.9	25.9	6.5	29.5	33.5	14.8	7.2	28.3	18.9	48.6
5	28.2	25.3	9.1	34.2	38.6	18.1	9.7	33.0	22.9	55.2
10	32.8	24.6	11.9	39.3	44.0	21.7	12.5	38.0	27.3	62.3
15	37.7	23.7	15.0	44.8	49.9	25.5	15.4	43.5	32.0	70.0
20	43.0	22.8	18.4	50.7	56.2	29.6	18.7	49.3	37.2	78.3
25	48.7	21.8	22.1	57.0	63.0	34.0	22.2	55.7	42.7	87.3
30	54.9	20.7	26.0	63.7	70.3	38.7	26.0	62.5	48.7	96.8
35	61.5	19.5	30.3	71.0	78.1	43.8	30.1	69.8	55.2	107.0
40	68.5	18.1	35.0	78.7	86.4	49.2	34.5	77.6	62.1	118.0
45	76.0	16.6	40.0	87.0	95.2	54.9	39.2	86.0	69.5	129.7
50	84.0	15.0	45.4	95.8	104.7	61.0	44.3	94.9	77.5	142.2
55	92.5	13.1	51.1	105.1	114.7	67.6	49.8	104.5	86.0	155.5
60	101.6	11.2	57.3	115.1	125.3	74.5	55.6	114.6	95.1	169.6
65	111.2	9.0	63.9	125.6	136.6	81.8	61.9	125.4	104.8	184.6
70	121.4	6.6	71.0	136.8	148.6	89.5	68.6	136.9	115.2	200.6
75	132.2	4.0	78.6	148.7	161.2	97.7	75.8	149.1	126.2	217.4
80	143.6	1.2	86.6	161.2	174.6	106.4	83.4	162.1	137.8	235.3
85	155.7	0.9	95.1	174.4	188.8	115.5	91.5	175.8	150.2	254.1
90	168.4	2.5	104.2	188.4	203.7	125.2	100.2	190.2	163.4	274.1
95	181.8	4.2	113.8	203.1	219.4	135.3	109.4	205.5	177.4	295.1
100	195.9	6.1	124.1	218.7	235.9	146.0	119.2	221.6	192.1	317.2
105	210.7	8.1	134.9	235.4	253.4	157.2	129.6	238.5	207.8	340.5
110	226.3	10.3	146.3	252.1	271.7	169.0	140.6	256.4	224.4	365.0
115	242.7	12.6	158.4	270.2	290.9	181.4	152.3	275.1	241.9	390.7
120	259.9	15.1	171.1	289.1	311.1	194.4	164.7	294.7	260.5	417.7
125	277.9	17.7	184.5	308.9	332.3	208.0	177.8	315.2	280.1	445.9
130	296.8	20.6	198.7	329.7	354.5	222.3	191.6	336.7	300.9	475.6
135	316.5	23.6	213.6	351.5	377.8	237.2	206.3	359.2	322.9	506.5
140	337.2	26.8	229.3	374.3	402.2	252.9	221.8	382.6	346.2	539.0
145	358.8	30.2	245.7	398.1	427.7	269.3	238.2	407.0	370.8	572.8
150	381.5	33.8	263.0	423.0	454.4	286.4	255.5	432.4	396.9	608.1

LINE SIZING FOR REFRIGERATION SYSTEMS

The following Tables 1 through 6B indicate liquid lines and suction lines for all condensing units for R22, R404A, R134A, and R507.

When determining the refrigerant line length, be sure to add an allowance for fittings. See Table 2 below. Total equivalent length of refrigerant lines is the sum of the actual linear footage and the allowance for fittings.

Table 1. Pressure loss of liquid Refrigerants in Liquid Line Risers (Expressed in Pressure Drop, PSIG, and Subcooling Loss, °F).

	Liquid Line Rise in Feet																	
	10'		15'		20'		25'		30'		40'		50'		75'		100'	
Refrigerant	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F
R22	4.8	1.6	7.3	2.3	9.7	3.1	12.1	3.8	14.5	4.7	19.4	6.2	24.2	8.0	36.3	12.1	48.4	16.5
R134a	4.9	2.0	7.4	2.9	9.8	4.1	12.3	5.2	14.7	6.3	19.7	8.8	24.6	11.0	36.8	17.0	49.1	23.7
R507, R404A	4.1	1.1	6.1	1.6	8.2	2.1	10.2	2.7	12.2	3.3	16.3	4.1	20.4	5.6	30.6	8.3	40.8	11.8

Based on 110°F liquid temperature at bottom of riser.

Table 2. Equivalent Feet of Pipe Due to Valve and Fitting Friction

Copper Tuber, O.D., Type "L"	1/2	5/8	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8	3 1/8	3 5/8	4 1/8	5 1/8	6 1/8
Globe Valve (Open)	14	16	22	28	36	42	57	69	83	99	118	138	168
Angle Valve (Open)	7	9	12	15	18	21	28	34	42	49	57	70	83
90° Turn Through Tee	3	4	5	6	8	9	12	14	17	20	22	28	34
Tee (Straight Through) or Sweep Below	.75	1	1.5	2	2.5	3	3.5	4	5	6	7	9	11
90° Elbow or Reducing Tee (Straight Through	1	2	2	3	4	4	5	7	8	10	12	14	16

Table 3. Weight of Refrigerants in Copper Lines During Operation (Pounds per 100 lineal feet of type "L" tubing).

Line Size O.D. in Inches	Refrigerant	Liquid Line	Hot Gas Line	Suction Line at Suction Temperature				
				-40°F	-20°F	0°F	+20°F	+40°F
3/8	134a	4.0	.15	.01	.01	.02	.04	.06
	22	3.9	.22	.02	.03	.04	.06	.08
	R507, 404A	3.4	.31	.03	.04	.06	.09	.13
1/2	134a	7.4	.30	.01	.03	.04	.07	.11
	22	7.4	.41	.03	.05	.07	.11	.15
	R507, 404A	6.4	.58	.04	.07	.13	.16	.24
5/8	134a	11.9	.47	.02	.05	.07	.12	.17
	22	11.8	.65	.05	.08	.12	.17	.25
	R507, 404A	10.3	.93	.07	.11	.17	.25	.35
7/8	134a	24.7	.90	.05	.10	.15	.24	.36
	22	24.4	1.35	.10	.16	.24	.36	.51
	R507, 404A	21.2	1.92	.15	.23	.37	.51	.72
1 1/8	134a	42.2	1.70	.08	.17	.26	.41	.60
	22	41.6	2.30	.17	.28	.42	.61	.87
	R507, 404A	36.1	3.27	.26	.39	.63	.86	1.24
1 3/8	134a	64.2	2.57	.14	.26	.40	.61	1.91
	22	63.5	3.50	.27	.42	.64	.93	1.33
	R507, 404A	55.0	4.98	.40	.58	.95	1.32	1.87
1 5/8	134a	90.9	3.65	.20	.37	.57	.87	1.30
	22	90.0	4.96	.37	.59	.90	1.33	1.88
	R507, 404A	78.0	7.07	.56	.82	1.35	1.86	2.64
2 1/8	134a	158	6.34	.34	.64	.98	1.51	2.24
	22	156	8.61	.65	1.03	1.57	2.30	3.26
	R507, 404A	134	12.25	.98	1.43	2.35	3.23	4.58
2 5/8	134a	244	9.78	.52	.99	1.51	2.32	3.47
	22	241	13.70	1.01	1.59	2.42	3.54	5.03
	R507, 404A	209	18.92	1.51	2.21	3.62	5.00	7.07
3 1/8	134a	348	13.97	.75	1.41	2.16	3.31	4.96
	22	344	18.95	1.44	2.28	3.45	5.05	7.18
	R507, 404A	298	27.05	2.16	3.15	5.17	7.14	9.95
3 5/8	134a	471	18.90	.99	1.91	2.92	4.48	6.69
	22	465	25.60	1.94	3.08	4.67	6.83	9.74
	R507, 404A	403	36.50	2.92	4.25	6.97	19.65	13.67
4 1/8	134a	612	24.56	1.29	2.49	3.81	5.84	8.75
	22	605	33.40	2.53	4.01	6.08	8.90	12.70
	R507, 404A	526	47.57	3.80	5.55	9.09	12.58	17.80

Table 4. Recommended Remote Condenser Line Sizes

Net Evaporator Capacity	Total Equiv. Length	R-134a		R-22		R507 & R-404A	
		Discharge Line (O.D.)	Liquid Line Cond. to Receiver (O.D.)	Discharge Line (O.D.)	Liquid Line Cond. to Receiver (O.D.)	Discharge Line (O.D.)	Liquid Line Cond. to Receiver (O.D.)
3,000	50	3/8	3/8	3/8	3/8	3/8	3/8
	100	3/8	3/8	3/8	3/8	3/8	3/8
6,000	50	1/2	3/8	3/8	3/8	1/2	3/8
	100	1/2	3/8	1/2	3/8	1/2	3/8
9,000	50	1/2	3/8	1/2	3/8	1/2	3/8
	100	5/8	3/8	1/2	3/8	1/2	3/8
12,000	50	5/8	3/8	1/2	3/8	1/2	3/8
	100	5/8	1/2	5/8	3/8	5/8	1/2
18,000	50	5/8	1/2	5/8	3/8	5/8	1/2
	100	7/8	1/2	5/8	3/8	7/8	1/2
24,000	50	7/8	1/2	5/8	3/8	5/8	1/2
	100	7/8	1/2	7/8	1/2	7/8	5/8
36,000	50	7/8	1/2	7/8	1/2	7/8	5/8
	100	1 1/8	5/8	7/8	5/8	7/8	7/8
48,000	50	7/8	5/8	7/8	5/8	7/8	5/8
	100	1 1/8	7/8	7/8	7/8	1 1/8	7/8
60,000	50	1 1/8	5/8	7/8	5/8	7/8	7/8
	100	1 1/8	7/8	1 1/8	7/8	1 1/8	7/8
72,000	50	1 1/8	7/8	7/8	7/8	1 1/8	7/8
	100	1 3/8	7/8	1 1/8	7/8	1 1/8	1 1/8
90,000	50	1 1/8	7/8	1 1/8	7/8	1 1/8	7/8
	100	1 3/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8
120,000	50	1 3/8	7/8	1 1/8	7/8	1 1/8	1 1/8
	100	1 5/8	1 1/8	1 3/8	1 1/8	1 3/8	1 3/8
180,000	50	1 5/8	1 1/8	1 3/8	1 1/8	1 3/8	1 3/8
	100	1 5/8	1 3/8	1 5/8	1 3/8	1 5/8	1 5/8
240,000	50	1 5/8	1 3/8	1 3/8	1 3/8	1 5/8	1 3/8
	100	2 1/8	1 5/8	1 5/8	1 3/8	2 1/8	1 5/8
300,000	50	2 1/8	1 3/8	1 5/8	1 3/8	1 5/8	1 5/8
	100	2 1/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8
360,000	50	2 1/8	1 5/8	1 5/8	1 5/8	2 1/8	1 5/8
	100	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8
480,000	50	2 1/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8
	100	2 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8
600,000	50	2 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8
	100	2 5/8	2 5/8	2 5/8	2 5/8	2 5/8	2 5/8
720,000	50	2 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8
	100	3 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8
840,000	50	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8
	100	3 1/8	3 1/8	2 5/8	2 5/8	2 5/8	3 1/8
960,000	50	2 5/8	2 5/8	2 5/8	2 5/8	2 5/8	2 5/8
	100	3 1/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
1,080,000	50	3 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8
	100	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 5/8
1,200,000	50	3 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8
	100	3 5/8	3 5/8	3 1/8	3 1/8	3 5/8	4 1/8
1,440,000	50	3 1/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
	100	3 5/8	3 5/8	3 1/8	3 5/8	3 5/8	4 1/8
1,680,000	50	3 5/8	3 1/8	3 1/8	3 1/8	3 1/8	3 5/8
	100	4 1/8	4 1/8	3 5/8	3 5/8	3 5/8	4 1/8

Table 5A. Recommended Line Sizes for R-22 *

SYSTEM CAPACITY	SUCTION LINE SIZE																				
	SUCTION TEMPERATURE																				
	+40°F Equivalent Lengths						+20°F Equivalent Lengths						+10°F Equivalent Lengths						0°F Equivalent		
BTU/H	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2	3/8	3/8	3/8
3,000	3/8	3/8	3/8	1/2	1/2	1/2	3/8	1/2	1/2	1/2	5/8	5/8	3/8	1/2	1/2	1/2	5/8	5/8	1/2	1/2	1/2
4,000	3/8	3/8	1/2	1/2	1/2	1/2	3/8	1/2	1/2	1/2	5/8	5/8	1/2	1/2	1/2	5/8	5/8	5/8	1/2	1/2	5/8
6,000	1/2	1/2	1/2	5/8	5/8	5/8	1/2	1/2	5/8	5/8	5/8	5/8	1/2	5/8	5/8	5/8	7/8	7/8	5/8	5/8	5/8
9,000	1/2	5/8	5/8	5/8	7/8	7/8	1/2	5/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	7/8	7/8	5/8	7/8	7/8
12,000	5/8	5/8	5/8	7/8	7/8	7/8	5/8	5/8	7/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	5/8	7/8	7/8
15,000	5/8	5/8	7/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	7/8
18,000	5/8	7/8	7/8	7/8	7/8	1 1/8	5/8	7/8	7/8	7/8	7/8	1 1/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	1 1/8
24,000	5/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8
30,000	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8
36,000	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8
42,000	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8
48,000	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	1 3/8	1 3/8
54,000	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8
60,000	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8
66,000	7/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 5/8
72,000	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 3/8	1 5/8
78,000	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8
84,000	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	1 3/8	1 5/8	1 5/8
90,000	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	1 3/8	1 5/8	1 5/8
120,000	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	1 5/8	1 5/8	2 1/8
150,000	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	1 5/8	1 5/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 1/8
180,000	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	1 3/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	1 5/8	2 1/8	2 1/8
210,000	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 1/8	2 1/8
240,000	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8
300,000	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	2 5/8
360,000	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 1/8	2 5/8	2 5/8
480,000	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 1/8	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	2 5/8	2 5/8	3 1/8
600,000	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 1/8	2 5/8	3 1/8	3 1/8	3 1/8	3 5/8	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	3 5/8	2 5/8	3 1/8	3 1/8

* NOTES:

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return.
   All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2°F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 5B. Recommended Line Sizes for R-22 (continued) *

SUCTION LINE SIZE															LIQUID LINE SIZE						SYSTEM CAPACITY
SUCTION TEMPERATURE															Receiver to Expansion Valve						
0°F			-10°F						-20°F						Equivalent Lengths						
Lengths			Equivalent Lengths						Equivalent Lengths												
100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	BTUH
3/8	1/2	1/2	**3/8**	3/8	3/8	3/8	1/2	1/2	3/8	3/8	3/8	**1/2**	1/2	1/2	3/8	3/8	3/8	3/8	3/8	3/8	1,000
5/8	5/8	5/8	**1/2**	1/2	1/2	5/8	5/8	5/8	**1/2**	1/2	5/8	5/8	5/8	7/8	3/8	3/8	3/8	3/8	3/8	3/8	3,000
5/8	5/8	7/8	1/2	1/2	**5/8**	5/8	5/8	7/8	1/2	**5/8**	5/8	5/8	7/8	7/8	3/8	3/8	3/8	3/8	3/8	3/8	4,000
5/8	7/8	7/8	1/2	**5/8**	5/8	7/8	7/8	7/8	5/8	5/8	**7/8**	7/8	7/8	7/8	3/8	3/8	3/8	3/8	3/8	3/8	6,000
7/8	7/8	7/8	5/8	**7/8**	7/8	7/8	7/8	7/8	5/8	**7/8**	7/8	7/8	1 1/8	1 1/8	3/8	3/8	3/8	3/8	3/8	3/8	9,000
7/8	7/8	1 1/8	**7/8**	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	7/8	**1 1/8**	1 1/8	1 1/8	3/8	3/8	3/8	3/8	3/8	3/8	12,000
7/8	1 1/8	**1 1/8**	7/8	7/8	7/8	**1 1/8**	1 1/8	1 1/8	7/8	7/8	**1 1/8**	1 1/8	1 1/8	1 1/8	3/8	3/8	3/8	3/8	3/8	1/2	15,000
1 1/8	1 1/8	1 1/8	7/8	7/8	**1 1/8**	1 1/8	1 1/8	1 1/8	7/8	**1 1/8**	1 1/8	1 1/8	1 1/8	1 3/8	3/8	3/8	3/8	3/8	1/2	1/2	18,000
1 1/8	1 1/8	**1 3/8**	7/8	1 1/8	1 1/8	1 1/8	**1 3/8**	1 3/8	7/8	1 1/8	1 1/8	**1 3/8**	1 3/8	1 3/8	3/8	3/8	1/2	1/2	1/2	1/2	24,000
1 1/8	**1 3/8**	1 3/8	7/8	1 1/8	1 1/8	**1 3/8**	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	3/8	3/8	1/2	1/2	1/2	1/2	30,000
1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	3/8	1/2	1/2	1/2	1/2	1/2	36,000
1 3/8	1 3/8	**1 5/8**	1 1/8	1 1/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1 1/8	*1 3/8	1 3/8	**1 5/8**	1 5/8	1 5/8	3/8	1/2	1/2	1/2	1/2	5/8	42,000
1 3/8	**1 5/8**	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1 1/8	1 3/8	1 3/8	**1 5/8**	1 5/8	2 1/8	1/2	1/2	1/2	1/2	1/2	5/8	48,000
1 3/8	**1 5/8**	1 5/8	1 1/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1 5/8	1 3/8	1 3/8	**1 5/8**	1 5/8	2 1/8	2 1/8	1/2	1/2	1/2	1/2	5/8	5/8	54,000
1 5/8	1 5/8	2 1/8	1 1/8	1 3/8	1 3/8	**1 5/8**	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8	1 5/8	**2 1/8**	2 1/8	1/2	1/2	1/2	5/8	5/8	5/8	60,000
1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	**2 1/8**	1 3/8	1 5/8	1 5/8	1 5/8	**2 1/8**	2 1/8	1/2	1/2	5/8	5/8	5/8	5/8	66,000
1 5/8	**2 1/8**	2 1/8	1 3/8	1 3/8	1 5/8	1 5/8	**2 1/8**	2 1/8	1 3/8	1 5/8	1 5/8	**2 1/8**	2 1/8	2 1/8	1/2	1/2	5/8	5/8	5/8	5/8	72,000
1 5/8	**2 1/8**	2 1/8	1 3/8	1 5/8	1 5/8	1 5/8	**2 1/8**	2 1/8	1 3/8	1 5/8	1 5/8	**2 1/8**	2 1/8	2 1/8	1/2	1/2	5/8	5/8	5/8	7/8	78,000
1 5/8	**2 1/8**	2 1/8	1 3/8	1 5/8	1 5/8	**2 1/8**	2 1/8	2 1/8	1 3/8	1 5/8	**2 1/8**	2 1/8	2 1/8	2 1/8	1/2	5/8	5/8	5/8	5/8	7/8	84,000
2 1/8	2 1/8	2 1/8	1 3/8	1 5/8	1 5/8	**2 1/8**	2 1/8	2 1/8	1 3/8	1 5/8	**2 1/8**	2 1/8	2 1/8	2 1/8	1/2	5/8	5/8	5/8	7/8	7/8	90,000
2 1/8	2 1/8	2 1/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	**2 5/8**	1 5/8	2 1/8	2 1/8	2 1/8	**2 5/8**	2 5/8	5/8	5/8	5/8	7/8	7/8	7/8	120,000
2 1/8	**2 5/8**	2 5/8	1 5/8	2 1/8	2 1/8	2 1/8	**2 5/8**	2 5/8	2 1/8	2 1/8	2 1/8	**2 5/8**	2 5/8	2 5/8	5/8	7/8	7/8	7/8	7/8	7/8	150,000
2 1/8	**2 5/8**	2 5/8	1 5/8	2 1/8	2 1/8	**2 5/8**	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	**3 1/8**	5/8	7/8	7/8	7/8	7/8	1 1/8	180,000
2 5/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	**2 5/8**	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	2 5/8	**3 1/8**	3 1/8	7/8	7/8	7/8	7/8	7/8	1 1/8	210,000
2 5/8	2 5/8	**3 1/8**	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	**3 1/8**	2 1/8	2 5/8	2 5/8	2 5/8	**3 1/8**	3 1/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	240,000
2 5/8	**3 1/8**	3 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	**3 1/8**	2 1/8	2 5/8	3 1/8	3 1/8	3 1/8	**3 5/8**	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	300,000
3 1/8	3 1/8	3 1/8	2 1/8	2 5/8	2 5/8	3 1/8	3 1/8	**3 5/8**	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	3 5/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	360,000
3 1/8	**3 5/8**	3 5/8	2 5/8	3 1/8	3 1/8	3 1/8	**3 5/8**	3 5/8	2 5/8	3 1/8	3 5/8	3 5/8	3 5/8	**4 1/8**	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	480,000
3 5/8	3 5/8	**4 1/8**	2 5/8	3 1/8	3 1/8	**3 5/8**	3 5/8	4 1/8	3 1/8	3 1/8	3 5/8	3 5/8	**4 1/8**	4 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	600,000

* NOTES:

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return.
   All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2°F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 6A. Recommended Line Sizes for R-404A and R507 *

SYSTEM CAPACITY BTU/H	SUCTION LINE SIZE																				
	SUCTION TEMPERATURE																				
	+20°F Equivalent Lengths						+10°F Equivalent Lengths						-10°F Equivalent Lengths						-20°F Equivalent		
	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2	3/8	3/8	3/8	1/2	1/2	1/2	3/8	3/8	1/2
3,000	3/8	3/8	1/2	1/2	1/2	5/8	3/8	1/2	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	5/8	7/8	1/2	1/2	5/8
4,000	3/8	1/2	1/2	1/2	5/8	5/8	1/2	1/2	1/2	5/8	5/8	7/8	1/2	5/8	5/8	5/8	7/8	7/8	1/2	5/8	5/8
6,000	1/2	1/2	5/8	5/8	7/8	7/8	1/2	1/2	5/8	5/8	7/8	7/8	1/2	5/8	5/8	7/8	7/8	7/8	5/8	5/8	7/8
9,000	5/8	5/8	7/8	7/8	7/8	7/8	5/8	5/8	7/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	1 1/8	5/8	7/8	7/8
12,000	5/8	7/8	7/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	1 1/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	7/8
15,000	5/8	7/8	7/8	7/8	7/8	1 1/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	7/8	7/8	1 1/8
18,000	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8
24,000	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8
30,000	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8
36,000	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	1 1/8	1 3/8
42,000	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8
48,000	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8
54,000	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 3/8	1 5/8
60,000	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8
66,000	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8
72,000	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8
78,000	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	1 5/8	1 5/8	1 5/8
84,000	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	1 5/8	1 5/8
90,000	1 3/8	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	2 5/8	1 5/8	1 5/8	2 1/8
120,000	1 3/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	1 3/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	1 5/8	2 1/8	2 1/8
150,000	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 1/8	2 1/8	2 1/8
180,000	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	2 1/8	2 1/8	2 5/8
210,000	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	3 1/8	3 1/8	2 1/8	2 5/8	2 5/8
240,000	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 1/8	2 5/8	2 5/8
300,000	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	2 5/8	2 5/8	2 5/8
360,000	2 1/8	2 1/8	2 5/8	2 5/8	3 1/8	3 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	3 5/8	2 5/8	2 5/8	3 1/8
480,000	2 1/8	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	2 5/8	2 5/8	2 5/8	2 5/8	3 5/8	3 5/8	2 5/8	3 1/8	3 1/8	3 5/8	3 5/8	4 1/8	2 5/8	3 1/8	3 1/8
600,000	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	3 5/8	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	3 5/8	3 1/8	3 1/8	3 1/8	3 5/8	4 1/8	4 1/8	3 1/8	3 1/8	3 1/8

* NOTES:

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return.
   All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2°F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 6B. Recommended Line Sizes for R-404A and R507 (continued) *

SUCTION LINE SIZE															LIQUID LINE SIZE						SYSTEM CAPACITY
SUCTION TEMPERATURE															Receiver to Expansion Valve						
-20°F Lengths			-30°F Equivalent Lengths						-40°F Equivalent Lengths						Equivalent Lengths						
100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	25'	50'	75'	100'	150'	200'	BTU/H
1/2	1/2	1/2	3/8	3/8	**1/2**	1/2	1/2	5/8	3/8	**1/2**	1/2	1/2	5/8	5/8	3/8	3/8	3/8	3/8	3/8	3/8	1,000
5/8	7/8	7/8	**1/2**	1/2	5/8	5/8	7/8	7/8	1/2	1/2	**5/8**	5/8	7/8	7/8	3/8	3/8	3/8	3/8	3/8	3/8	3,000
7/8	7/8	7/8	**5/8**	5/8	5/8	7/8	7/8	7/8	1/2	**5/8**	5/8	7/8	7/8	7/8	3/8	3/8	3/8	3/8	3/8	3/8	4,000
7/8	7/8	7/8	**5/8**	5/8	7/8	7/8	7/8	7/8	5/8	5/8	**7/8**	7/8	7/8	1 1/8	3/8	3/8	3/8	3/8	3/8	3/8	6,000
7/8	1 1/8	1 1/8	5/8	**7/8**	7/8	7/8	1 1/8	1 1/8	5/8	**7/8**	7/8	7/8	1 1/8	1 1/8	3/8	3/8	3/8	3/8	3/8	3/8	9,000
1 1/8	1 1/8	1 1/8	7/8	7/8	7/8	**1 1/8**	1 1/8	1 1/8	7/8	7/8	7/8	**1 1/8**	1 1/8	1 1/8	3/8	3/8	3/8	3/8	3/8	1/2	12,000
1 1/8	1 1/8	1 3/8	7/8	7/8	**1 1/8**	1 1/8	1 1/8	1 3/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	3/8	3/8	3/8	3/8	1/2	1/2	15,000
1 1/8	1 3/8	1 3/8	7/8	**1 1/8**	1 1/8	1 1/8	1 3/8	1 3/8	7/8	1 1/8	1 1/8	**1 1/8**	1 3/8	1 3/8	3/8	3/8	3/8	1/2	1/2	1/2	18,000
1 3/8	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	**1 3/8**	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	**1 3/8**	1 3/8	1 3/8	3/8	3/8	1/2	1/2	1/2	1/2	24,000
1 3/8	1 3/8	1 5/8	1 1/8	1 1/8	**1 3/8**	1 3/8	1 3/8	1 5/8	1 1/8	1 1/8	**1 3/8**	1 3/8	1 3/8	1 5/8	3/8	1/2	1/2	1/2	1/2	1/2	30,000
1 3/8	1 3/8	1 5/8	1 1/8	**1 3/8**	1 3/8	1 3/8	1 3/8	1 5/8	1 1/8	**1 3/8**	1 3/8	1 3/8	1 5/8	1 5/8	1/2	1/2	1/2	1/2	1/2	5/8	36,000
1 5/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1/2	1/2	1/2	1/2	5/8	5/8	42,000
1 5/8	1 5/8	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1/2	1/2	1/2	5/8	5/8	5/8	48,000
1 5/8	1 5/8	1 5/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	2 1/8	1 3/8	1 3/8	1 3/8	**1 5/8**	1 5/8	2 1/8	1/2	1/2	1/2	5/8	5/8	5/8	54,000
1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1 5/8	2 1/8	1 3/8	1 3/8	**1 5/8**	1 5/8	1 5/8	2 1/8	1/2	1/2	5/8	5/8	5/8	5/8	60,000
1 5/8	1 5/8	2 1/8	1 3/8	**1 5/8**	1 5/8	1 5/8	1 5/8	2 1/8	1 3/8	**1 5/8**	1 5/8	1 5/8	1 5/8	2 1/8	1/2	1/2	5/8	5/8	5/8	5/8	66,000
1 5/8	1 5/8	2 1/8	1 3/8	**1 5/8**	1 5/8	1 5/8	1 5/8	2 1/8	1 3/8	**1 5/8**	1 5/8	1 5/8	1 5/8	2 1/8	1/2	5/8	5/8	5/8	5/8	5/8	72,000
1 5/8	2 1/8	2 1/8	1 5/8	**1 5/8**	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	1 5/8	1 5/8	1 5/8	**2 1/8**	2 1/8	5/8	5/8	5/8	5/8	5/8	7/8	78,000
2 1/8	2 1/8	2 1/8	1 5/8	1 5/8	1 5/8	**2 1/8**	2 1/8	2 1/8	1 5/8	1 5/8	1 5/8	**2 1/8**	2 1/8	2 1/8	5/8	5/8	5/8	5/8	7/8	7/8	84,000
2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	**2 1/8**	2 1/8	2 1/8	2 5/8	1 5/8	1 5/8	**2 1/8**	2 1/8	2 1/8	2 5/8	5/8	5/8	5/8	7/8	7/8	7/8	90,000
2 1/8	2 5/8	2 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	5/8	5/8	7/8	7/8	7/8	7/8	120,000
2 5/8	2 5/8	2 5/8	**2 1/8**	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 1/8	2 1/8	2 5/8	**2 5/8**	2 5/8	2 5/8	5/8	7/8	7/8	7/8	7/8	1 1/8	150,000
2 5/8	2 5/8	3 1/8	2 1/8	2 1/8	**2 5/8**	2 5/8	2 5/8	3 1/8	2 1/8	2 1/8	**2 5/8**	2 5/8	2 5/8	3 1/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	180,000
2 5/8	3 1/8	3 1/8	2 1/8	**2 5/8**	2 5/8	2 5/8	3 1/8	3 1/8	2 1/8	2 5/8	2 5/8	2 5/8	**3 1/8**	3 1/8	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	210,000
2 5/8	3 1/8	3 1/8	2 5/8	2 5/8	**2 5/8**	3 1/8	3 1/8	3 5/8	2 5/8	2 5/8	2 5/8	**3 1/8**	3 1/8	3 5/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	240,000
3 1/8	3 5/8	3 5/8	2 5/8	2 5/8	**3 1/8**	3 1/8	3 5/8	4 1/8	2 5/8	2 5/8	**3 1/8**	3 5/8	3 5/8	4 1/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	300,000
3 5/8	3 5/8	4 1/8	2 5/8	3 1/8	3 1/8	**3 5/8**	3 5/8	4 1/8	2 5/8	3 1/8	**3 5/8**	3 5/8	4 1/8	4 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8	360,000
3 5/8	3 5/8	4 1/8	3 1/8	**3 5/8**	3 5/8	4 1/8	4 1/8	4 1/8	3 1/8	3 5/8	3 5/8	**4 1/8**	4 1/8	4 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	480,000
3 5/8	3 5/8	**4 1/8**	3 1/8	3 5/8	3 5/8	**4 1/8**	4 1/8	5 1/8	3 1/8	3 5/8	3 5/8	**4 1/8**	4 1/8	5 1/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	600,000

* NOTES:

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return.
   All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2°F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Diagram 1. **Typical Wiring Diagram for Multiple Evaporators with Heater Limit Defrost and Evaporator Fan Contactors.**

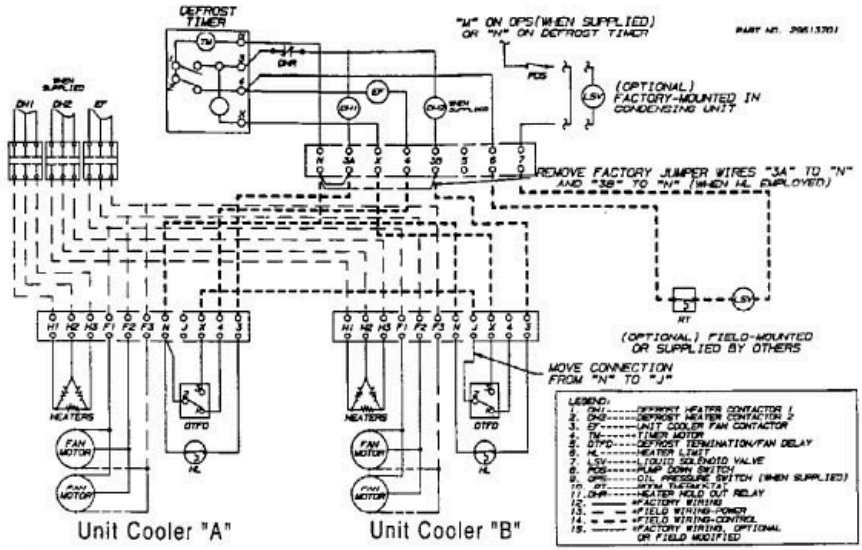


Diagram 2. **Typical Wiring Diagram for Multiple Evaporators with Evaporator Fan Contactors but without Heater Limit Defrost.**

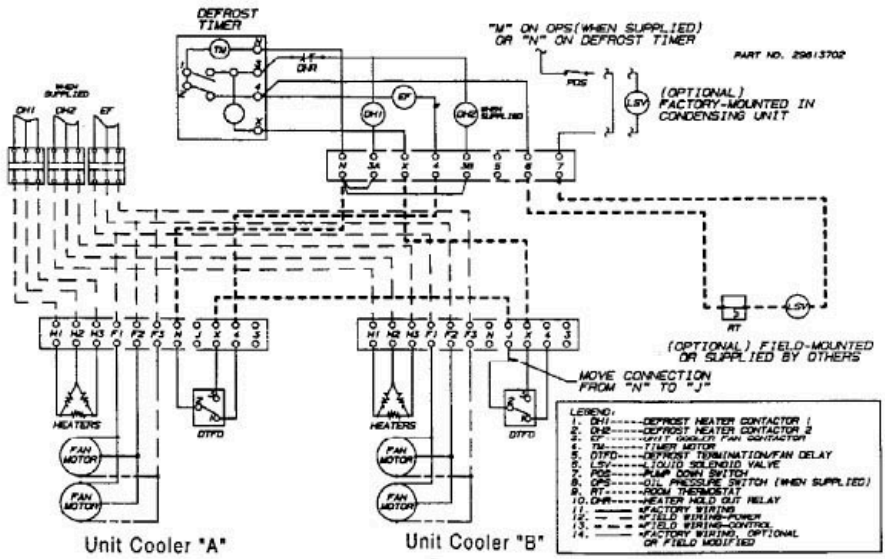


Diagram 3. Typical Wiring Diagram for Single Evaporator / Single Phase Defrost and Evaporator Fan Contactors.

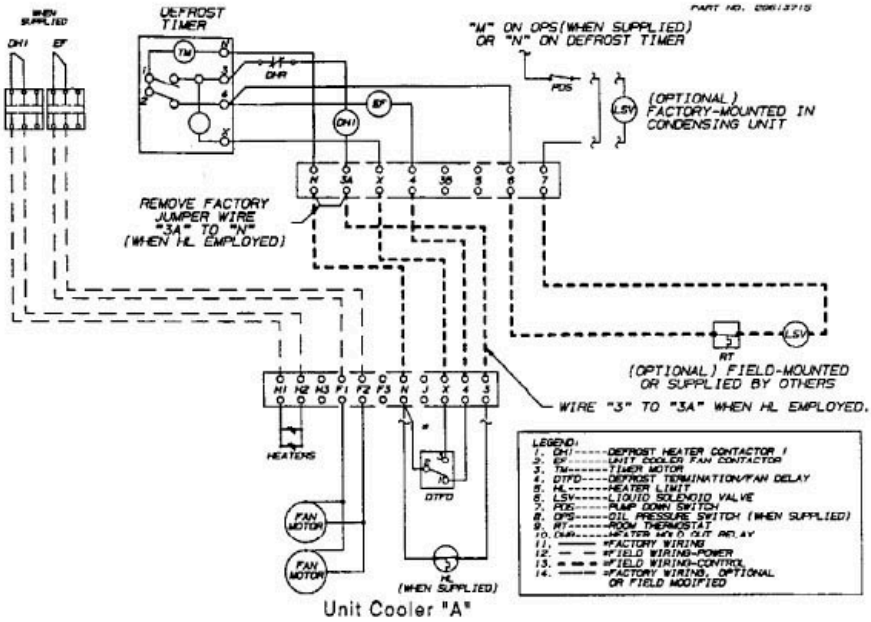


Diagram 4. Typical Wiring Diagram for Single Evaporator Defrost and Evaporator Fan Contactors.

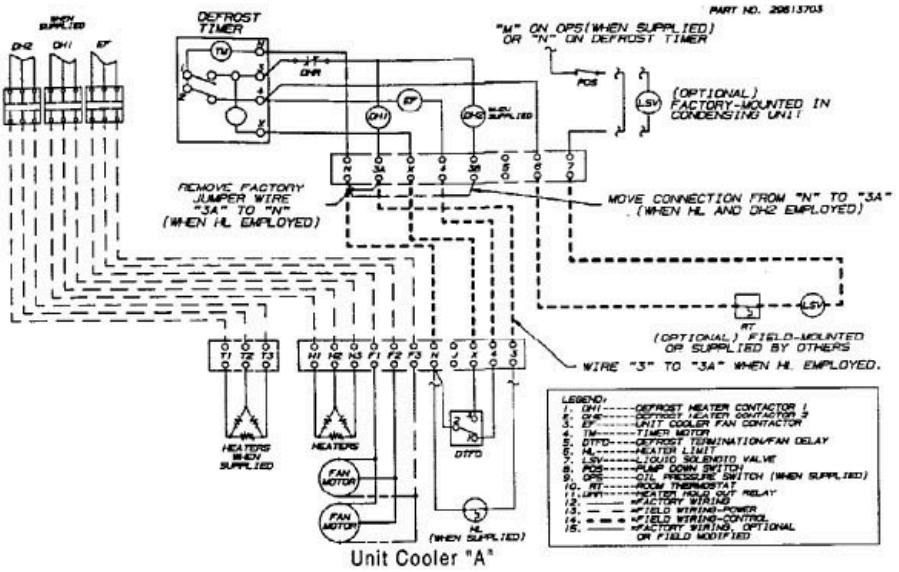


Diagram 5. Typical Wiring Diagram for Multiple Evaporators with Defrost Timer Only.

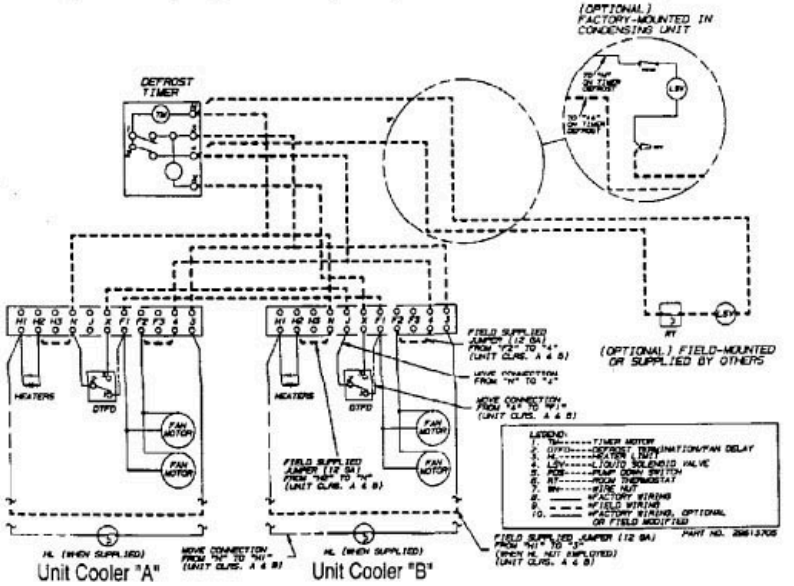


Diagram 6. Typical Wiring Diagram for Single Evaporator with Defrost Timer Only.

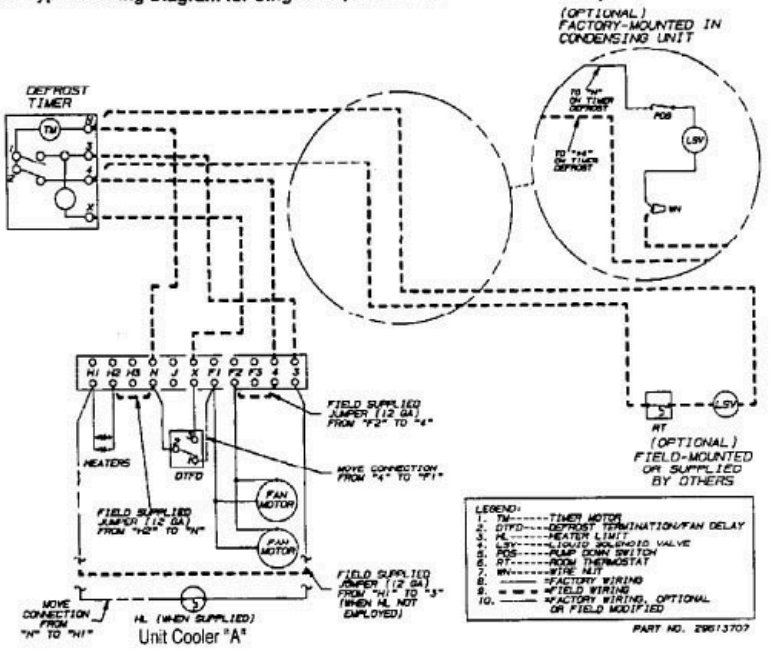


Diagram 7. Typical Wiring Diagram for Multiple Evaporators Defrost and Evaporator Fan Contactors with Unit Cooler Holdout Relay.

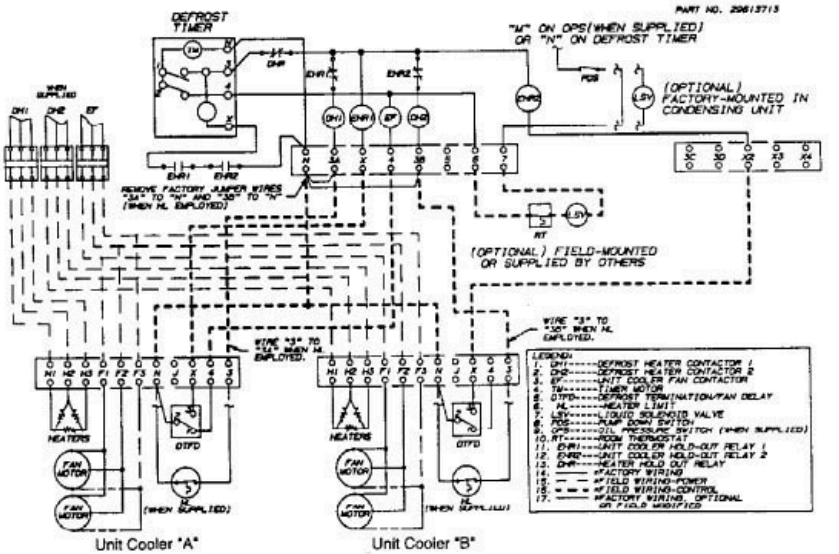


Diagram 8. **Typical Wiring Diagram for Single Evaporator with and without Defrost Timer.**

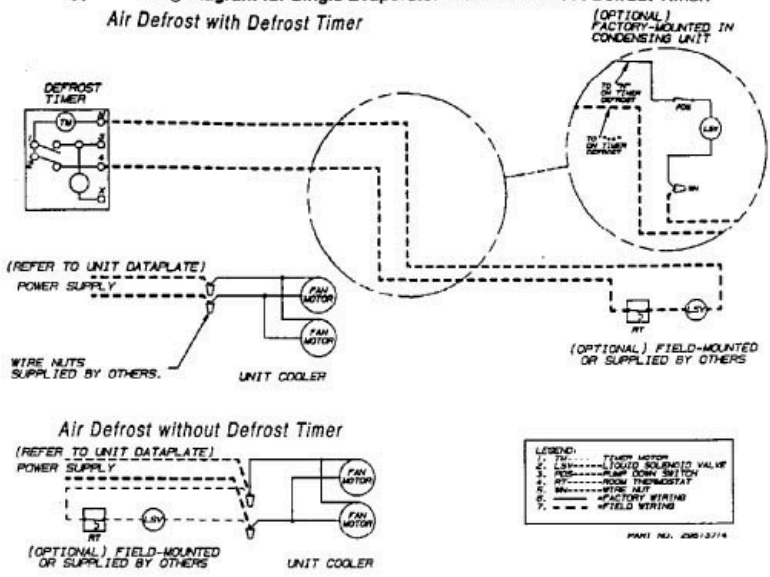


Diagram 9. **Typical Wiring Diagram for Defrost Contactor with Evaporator Holdout Relay with Heater Limit.**

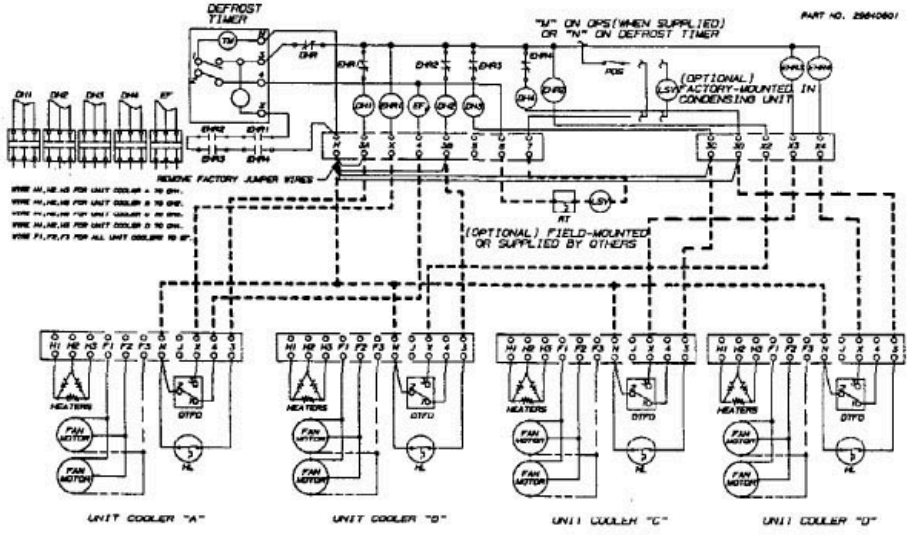


Diagram 10. Typical Wiring Diagram for Defrost Contactor with Evaporator Holdout Relay without Heater Limit.

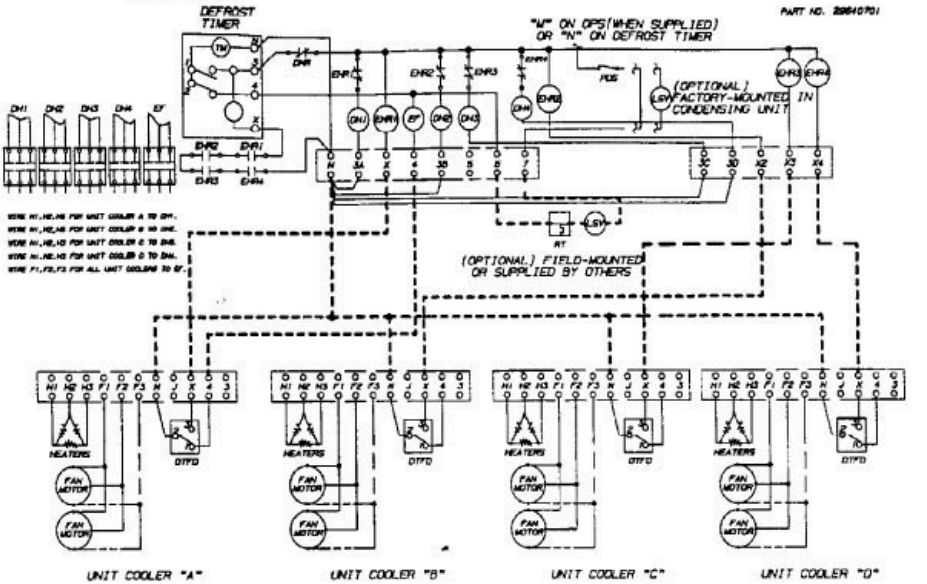
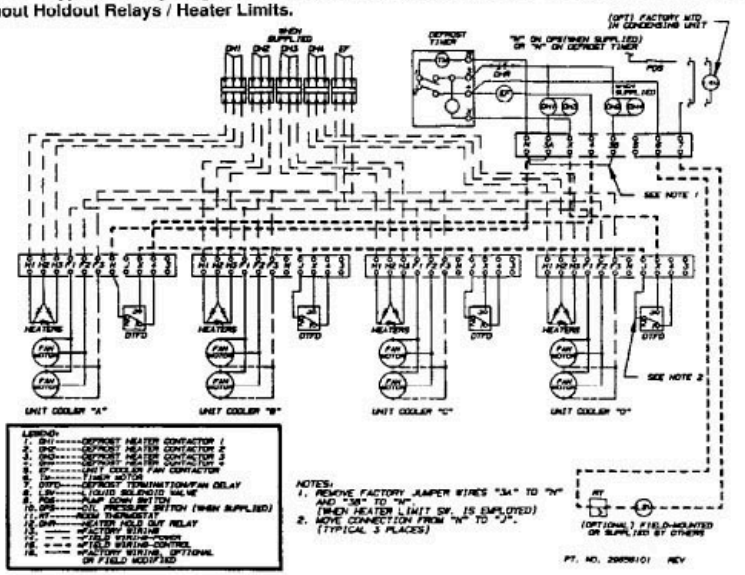


Diagram 11. Typical Wiring Diagram for Multiple Evaporators with Defrost Switches Connected in Series and without Holdout Relays / Heater Limits.



WARRANTIES

Kairak's warranty coverage warrants that Kairak-branded products are free of defects in materials and factory workmanship. The following applies to all Kairak Model and Serial numbers.

Kairak's warranty is extended only to the original purchaser and shall not apply to any failures resulting from damage in transit, improper installation, alteration, normal wear, misuse, abuse, improper voltage, accident or negligence. The warranty excludes; T-stat adjustments, time clock adjustments, gaskets, cutting boards, filters, clogged drains, ice build-up with no mechanical failures, and the loss of contamination of food due to mechanical or electrical failure. Warranty does not apply outside the United States.

In order to be covered under this warranty, prior authorization to perform the necessary and appropriate service must be obtained from the factory. Model and Serial number must be provided at the time of service request. Kairak does not assume responsibility for any expenses, including labor, parts or travel expenses incurred without such prior authorization. Kairak shall not be liable, whether in contract or in tort or under any other legal theory for loss of use, revenue or profit, substitute use or performance, incidental, indirect or special and/or consequential damages, loss of refrigerant or for any other loss or cost of similar type. Such related charges will be back charged to the responsible party. The decision of the Kairak Service and Warranty, as to whether a defect is within the terms of this warranty shall be final.

Failure to object or provision contained in a customer's purchase order or other communication shall not be deemed as a waiver of terms or conditions of their warranty, nor shall it be considered acceptance of such provisions. This warranty supersedes and is in lieu of all other warranties, expressed or implied and of other obligations of liabilities, on the part of Kairak.

In case of freight damage, do not refuse shipment, but call agent's attention to its condition, making careful note of the details on freight bill before freight charges are paid. File claim for damages with freight agent immediately.

BLU FIXTURES manufactured by Kairak hold a 3-year parts and labor warranty. Kairak holds a 5-year compressor warranty, with a one-time compressor only replacement after the first year. Kairak will warranty the labor to replace the compressor for the first three years, 30 days from the ship date. After the first three years, labor, tax, shipping and miscellaneous parts will not be included. Please contact our warranty department for compressor replacement procedures during the warranty period. BLU remote Fixtures are designed to operate with Kairak remote systems only. Violation of these terms will void all warranty.

REFRIGERANT FIXTURES manufactured by Kairak hold a 1-year parts and labor warranty. Kairak holds a 5-year compressor warranty, with a one-time compressor only replacement after the first year. Kairak will warranty the labor to replace the compressor for the first year, 30 days from the ship date. After the first year, labor, tax, shipping and miscellaneous parts will not be included. Please contact our warranty department for compressor replacement procedures during the warranty period.

REMOTE SYSTEMS manufactured by Kairak hold a 1-year parts and 90-day labor warranty on the remote system, with an option to purchase 1-year labor warranty at the time of purchase order receipt. This warranty does not apply to motors, switches, controls, accessories or parts manufactured by others and purchased by Kairak, unless the manufacturer warranties the same to Kairak. Kairak holds a 5-year compressor warranty, with a one-time compressor only replacement after the first year. Kairak will warranty the labor to replace the compressor for the first year, 30 days from the ship date. After the first year, labor, tax, shipping and miscellaneous parts will not be included. Please contact our warranty department for compressor replacement procedures during the warranty period.

TO REQUEST AUTHORIZED SERVICE, CALL THE KAIRAK SERVICE AND WARRANTY HOTLINE: (800) 833-1106. After-hour requests must be urgent in nature and documented with Kairak's after-hours service line prior to service being performed. Kairak is responsible for straight time only, unless otherwise approved by the warranty department.

SERVICE RECORD

A permanent data sheet should be prepared on each installation, with a copy for the owner and the original for the installing contractor's files. If another firm is to handle service and maintenance, additional copies should be prepared as necessary.

System Reference Data

The following information should be filled out and signed by Refrigeration Installation Contractor.

Date System Installed: _____

Installer and Address: _____

_____

_____

Condensing Unit Unit Model#: _____

Unit Serial #: _____

Compressor Model #: _____ Compressor Model #: _____

Compressor Serial #: _____ Compressor Serial #: _____

Electrical _____ Volts _____ Phase _____

Voltage at Compressor L1_____ L2 _____ L3 _____

Amperage at Compressor L1_____ L2 _____ L3 _____

Evaporator(s) Quantity _____

Evaporator Model #: _____ Evaporator Model #: _____

Evaporator Serial #: _____ Evaporator Serial #: _____

Electrical _____ Volts _____ Phase _____

Expansion Valve Manufacturer/Model _____ _____

Ambient at Start-Up _____ °F

Design Box Temperature _____ °F _____ °F

Operating Box Temperature _____ °F _____ °F

Thermostat Setting _____ °F _____ °F

Defrost Setting _____ / day _____ minutes fail-safe _____/day _____minutes fail-safe

Compressor Discharge Pressure _____ PSIG _____ PSIG

Compressor Suction Pressure _____ PSIG _____ PSIG

Suction Line Temperature @ Comp. _____ °F _____ °F

Discharge Line Temperature @ Comp. _____ °F _____ °F

Superheat at Compressor _____ °F _____ °F

Suction Line Temperature @ Evaporator _____ °F _____ °F

Superheat at Evaporator _____ °F _____ °F

Evacuation: # times _____ Final Micron_____ # Times _____ Final Micron_____

Evaporator Drain Line Trapped Outside of Box: yes ☐ no ☐