HUSSMAN
Limited Warranty

This warranty is made to the original user at the original installation site and is not transferable.

Hussmann merchandisers are warranted to be free from defect in material and workmanship under normal use and service for a period of one (1) year from the date of original installation (not to exceed fifteen (15) months from the date of shipment for the factory). **Hussmann Impact Modular Coils are warranted for a total of five (5) years based upon the above criteria.** Hussmann's obligation under this warranty shall be limited to repairing or exchanging any part or parts, without charge F.O.B. factory or nearest authorized parts depot within said period and which is proven to the satisfaction of the original manufacturing plant warranty group to be thus defective.

Hussmann covers the entire case or refrigeration product and all its components (except for lamps, driers, fuses, and other maintenance type replacement parts) for the one (1) year warranty period.

Additionally, Hussmann warrants for a total period of three (3) years all sealed, multi-glass assemblies except those used in sliding doors on closed meat display cases. If within three (3) years from the date of installation (not to exceed thirty-nine (39) months from the date of shipment from factory), it shall be proven to the satisfaction of the originating factory warranty group that there is impaired visibility through the multi-glass assemblies thereof caused by moisture between the glasses, the multi-glass assembly will be replaced free of charge, F.O.B. factory. This additional warranty excludes accident, misuse, or glass breakage.

On Hussmann manufactured self-contained display cases, Hussmann agrees to repair or exchange, at its option, the original motor/compressor unit only with a motor/compressor of like or of similar design and capacity if it is shown to the satisfaction of Hussmann that the motor/compressor is inoperative due to defects in factory workmanship or material under normal use and service as outlined in Hussmann's "Installation Instructions" which are shipped inside new Hussmann equipment. Hussmann's sole obligation under this warranty shall be limited to a period not to exceed five years from date of factory shipment.

On Hussmann refrigeration systems, an additional (4) year extended warranty for the motor/compressor assembly is available, but must be purchased prior to shipment to be in effect. Hussmann reserves the right to inspect the job site, installation and reason for failure.

The motor/compressor warranties listed above do not include replacement or repair of controls, relays, capacitors, overload protectors, valve plates, oil pumps, gaskets or any external part on the motor/compressor replaceable in the field, or any other part of the refrigeration system or self-contained display case.

THE WARRANTIES TO REPAIR OR REPLACE ABOVE RECITED ARE THE ONLY WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, MADE BY HUSSMANN WITH RESPECT TO THE ABOVE MENTIONED EQUIPMENT, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS, AND HUSSMANN NEITHER ASSUMES NOR AUTHORIZES ANY PERSON TO ASSUME FOR IT, ANY OTHER OBLIGATION OR LIABILITY IN CONNECTION WITH THE SALE OF SAID EQUIPMENT OR ANY PART THEREOF.

THIS WARRANTY SHALL NOT APPLY TO LOSS OF FOOD OR CONTENTS OF THE EQUIPMENT DUE TO FAILURE FOR ANY REASON. HUSSMANN SHALL NOT BE LIABLE:

- For payment of labor for any removal or installation of warranted parts;
- For any repair or replacements made without the written consent of Hussmann, or when the equipment is installed or operated in a manner contrary to the printed instructions covering installation and service which accompanied such equipment;
- For any damages, delays, or losses, direct or consequential which may arise in connection with such equipment or part thereof;
- For damages caused by fire, flood, strikes, acts of God or circumstances beyond its control;
- When the equipment is subject to negligence, abuse, misuse or when the serial number of the equipment has been removed, defaced, or altered;
- When the equipment is operated on low or improper voltages;
- When the equipment is put to a use other than normally recommended by Hussman (i.e. deli case used for fresh meat);
- When operation of this equipment is impaired due to improper drain installation;
- For payment of refrigerant loss for any reason;
- For costs related to shipping or handling of replacement parts.

Hussmann Corporation, Corporate Headquarters: Bridgeton, Missouri, U.S.A. 63044 August 1, 1998

HUSSMANN®

WARRANTY CLAIMS ADMINISTRATION POLICY

When it is found that an error has been made in a shipment, or defects in workmanship are discovered during the installation and startup of equipment, Hussmann Atlanta/Custom Systems realizes that consideration should be given to relieve our customer of those costs to which he has been subjected through no fault of his own.

The objective of the labor cost policy is to reimburse customers or contractors, for field cost of a severe nature directly incurred due to replacement of in-warranty parts.

Hussmann Atlanta/Custom Systems also recognizes that failure of operation components can occur due to hidden defects, ever though there had been no error with respect to the type or model of the equipment shipped.

DEFINITIONS

1. Labor is defined as the work performed directly attributable to the replacement of in-warranty parts at a specific store on a single call.

2. Labor cost is defined as direct labor.

3. On new store installations, startup is defined as the store opening. With regard to remodels the date of installation will be considered startup.

COST EXCLUDED FROM THIS POLICY

1. Cost to and from the job site, such as labor for travel, mileage, truck charges or labor for the procurement or return of a replacement part or parts.

2. Any normal service cost that may be incurred at the store during the call at which the in-warranty items are corrected.

3. Preliminary calls or call backs associated with in-warranty replacement.

4. Sub-contractor's invoices will not be considered separately.

5. No meals or lodging will be considered.

6. No refrigerant loss will be considered.

Re-issued 08-28-94

WARRANTY CLAIMS ADMINISTRATION POLICY

7. For any damages, delays, losses, direct or consequential, caused by defects, nor for damages caused by short or reduced supply of material, fire, flood, strikes, acts of God or circumstances beyond its control.

8. When the failure or defect of any part or parts is incident to ordinary wear, accident, abuse or misuse, or when the serial number of the equipment has been removed, defaced, altered or tampered with.

9. When equipment is operated on low or improper voltages, or put to use other than normally recommended by Hussmann.

Re-issued 08-28-94

HUSSMANN®

WARRANTY PART RETURN PROCEDURE

On those parts found to be defective within the parameters of our warrantee, the following procedure shall apply:

1. The salesman or field engineer shall inspect the component and report the problem to Hussmann Atlanta Customer Service Coordinator for consideration of responsibility.

2. The salesman or field engineer shall report the following information to Hussmann Atlanta Customer Service Coordinator.

   a) Serial number of unit in question
   b) Customer name and address
   c) Installation date
   d) Problem or complaint
   e) Complete part number

3. If Hussmann Atlanta determines the responsibility is that of Hussmann Atlanta, a RMA# will be issued to the salesman or field engineer. This number is to be used in all related correspondence.

4. A purchase order will be required when ordering parts.

5. When returning parts, the warranty tag (which includes the RMA#) must be completed in full and attached to the part. Please give a detailed description of the part defect and/or failure (please do not use defective as the reason.) The RMA# must appear outside the box.

6. If the parts are improperly returned, shipment acceptance will be denied and parts returned to sender. No credits will be issued against these parts.

7. Please be aware that Hussmann Atlanta/Customs Systems' policy is to invoice for all warranty parts that are not returned within forty-five (45) days. All parts will be billed against the purchase order # issued if not returned within the guidelines stated herein.

Re-issued 08-28-94

REPAIR AUTHORIZATION PROCEDURE

On those item found to be defective in workmanship, and falling within the parameters or our warrantee, the following procedure shall apply:

1. The salesman or field engineer shall inspect the component and report the problem to Hussmann Atlanta for consideration of responsibility.

2. The salesman or field engineer shall report the following information to Hussmann Atlanta Customer Service Coordinator.

    a) Serial number of unit in question
    b) Customer name and address
    c) Installation date
    d) Problem or complaint
    e) Suggested corrective action
    f) Estimated cost of repair

3. If Hussmann Altanta determines the responsibility is that of Hussmann Atlanta, a purchase order will be issued to the salesman or field engineer. This number is to be used in all related correspondence.

4. The sales branch will authorize work to be done to correct deficiencies.

5. Upon completion of repairs, the sales branch shall forward a claim form along with a bill for costs incurred, to the Hussmann Atlanta Manufacturing Manager. IMPORTANT!!

6. Both the written report and invoice must be marked with the purchase order number.

7. Upon receipt of written report and invoice, Hussmann Atlanta will review invoice before releasing purchase order and reimbursing the sales branch for repairs, not the contractor.

8. No invoice will be paid by Hussmann Atlanta/Custom Systems if repair authorization has not been given.

Re-issued 08-28-94

REPAIR AUTHORIZATION PROCEDURE

A. A claim form, copies enclosed, MUST ACCOMPANY ALL CLAIMS.
It is important to recognize that this form does not represent additional paperwork; rather, it simply provides the necessary facts in writing for quick evaluation of claims. CLAIMS SUBMITTED WITHOUT THE COMPLETED FORM WILL BE RETURNED AND STAMPED AS DECLINED.

B. CLAIMS MUST BE SUBMITTED WITHIN 45 DAYS AFTER THE SERVICE WAS PERFORMED. ANY CLAIMS RECEIVED BEYOND THIS DATE WILL BE RETURNED AS DECLINED.

NOTE: Any questions regarding the proper use of this claim form, contact:

Hussmann Atlanta/Custom Systems
Customer Service Coordinator
4444 Shackleford Road
Norcross, GA 30093
(404) 921-9410

Re-issued 08-28-94

HUSSMANN®

PURCHASED PARTS RETURN MERCHANDISE PROCEDURE

GENERAL

Under the terms and conditions of sales, no material may be returned to Hussmann Atlanta for credit unless you have prior approval. Hussmann Atlanta for credit unless you have prior approval. Hussmann Atlanta reserves the right to apply handling, and restocking charges on all returned material equal to 25 percent of the invoice price. Additional charges will be made if rework is necessary to restore returned material to saleable condition, if applicable.

All material authorized for return must be freight prepaid. Authorization will not be granted for the return of obsolete material or items made to special order.

MINIMUM PARTS ORDER OF $25.00

APPLYING FOR CONSENT TO RETURN

Contact Hussmann Atlanta Customer Service Coordinator, your contact may be in writing or by telephone.

Have available the following information:

1. Material to be returned. Include unit nomenclature, description, quantity, or other identifiable information, including store name and location.

2. Reason for return.

If all pertinent information is received at this time a return material authorization number (RMA#) will be issued.

CONDITIONS FOR RETURN

Any material returned without proper authorization to Hussmann Atlanta will not be accepted and no credit will be issued. The return authorization number will not be issued unless adequate information is supplied at the time request for return is made. Authorization number must appear on the outside of containers with address for receiving to be able to identify properly, or these parts will be returned to sender at their expense. The amount of credit issued for authorized returns will be final.

Re-issued 08-28-94

HUSSMANN ATLANTA CUSTOM SYSTEMS
WARRANTY CLAIM

Store Name:	Contractor:
Address:	Address:
City:	City:
State:	State:
Zip Code:	Zip Code:
Date Problem Reported:	P.O. #:
Installation Date:	Date Repairs Made:
Model #	Serial #

Reason for Claim:
Description of Work Performed:
Added Facts to Support Claim: Person Submitting Claim________________________________ Date:____________

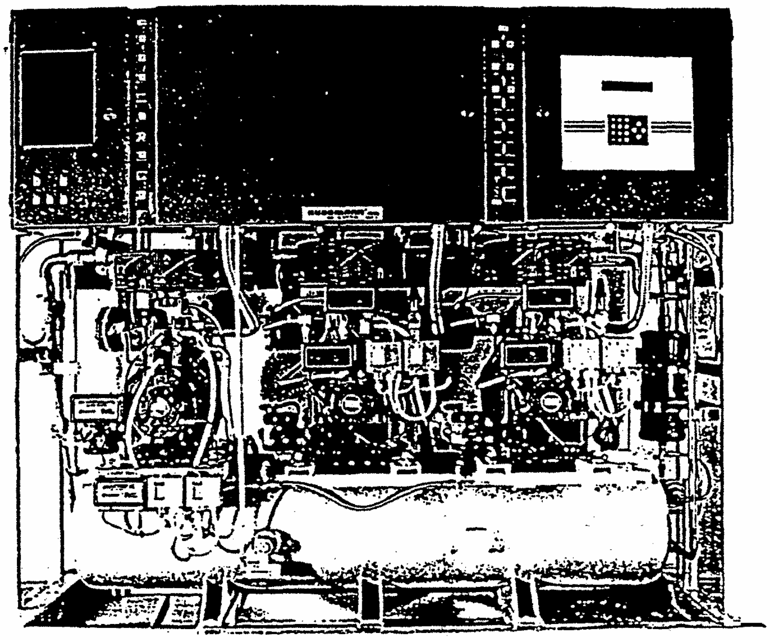


Figure 1-1 Custom System

OVERVIEW

This section is limited to the information needed to set the Custom Compressor Rack. Power Supply requirements are found under "Electrical"; piping, under "Piping"; and charging, under "Startup and Maintenance". Auxiliary units are found in the sections devoted to them or in the manuals accompanying them.

CUSTOM SYSTEM COMPONENTS

Each Custom System contains the following:

1. Copeland or Carlyle semi-hermetic compressors with:
   a. High and Low Pressure Controls
   b. Oil Pressure Safety Control
   c. Primary Overload Protection
   d. Compressor Cooling Fans on single stage low temperature application

2. Factory piping with
   a. Suction, Discharge and Liquid Header
   b. Turba-shed Oil Separator and return system
   c. Liquid Receiver
   d. Suction Filters on each compressor
   e. Liquid Filter Drier and Sightglass
   f. Liquid Level Indicator
   g. Liquid Level Switch

3. Factory-wired control panel with
   a. Pre-wired Distribution Power Block
   b. Individual component Circuit Breakers and Contacters
   c. Compressor Time Delays
   d. Color-coded wiring system

4. Items supplied separately for field installation
   a. Liquid Drier Cores
   b. Vibration Isolation Pads
   c. Loose shipped items for accessories
   d. Extra set of suction filters

SHIPPING DAMAGE

All equipment should be thoroughly examined for shipping damage before and while unloading.
This equipment has been carefully inspected at our factory and the carrier has assumed responsibility for safe arrival. If damaged, either apparent or concealed, claim must be made to the carrier.

Apparent Loss or Damage
If there is an obvious loss or damage, it must be noted on the freight bill or express receipt and signed by the carrier's agent, otherwise, carrier may refuse claim. The carrier will supply the necessary claim forms.

Concealed Loss or Damage
When loss or damage is not apparent until after equipment is uncrated, a claim for concealed damage is made. Upon discovering damage, make request in writing to carrier for inspection within 15 days and retain all packing. The carrier will supply inspection report and required claim forms.

MACHINE ROOM REQUIREMENTS

The equipment room floor must solidly support the compressor unit as a live load. Ground level installation seldom presents problems, but a mezzanine installation must be carefully engineered.

Ventilation should be 100 cfm per compressor unit horsepower. The air inlet should be sized for a maximum of 500 fpm velocity. The ventilation fans should cycle by thermostatic control.

All machine room ventilation equipment must be field supplied. Check local codes for variances.

Proper ventilation provides airflow across the compressors. Duct work may be necessary.

Provide a floor drain for disposal of condensate that may form on the compressor unit or header defrost assembly.

Equipment must be located in the machine room to provide enough working space for service personnel, and to meet electrical codes.

Consult NEC National Fire Handbook particularly "Installation of Switch Boards" and "Working Space Requirements". Figure 1-2 illustrates some suggested distances. Refer to local codes for each installation.

Receiver Refrigerant Capacities

Size	R-22	R-502	R-134a	HP62	AZ50
14 X 48	212	216	215	185	185
14 X 72	325	331	330	283	283
14 X 96	439	446	445	382	381
14 X 120	552	562	560	481	480
14 X 132	608	619	617	530	529
14 X 144	665	676	674	579	578
20 X 63	607	617	615	528	528

Receiver capacities are based on 80% liquid fill at 90F.
Consult Hussmann Engineering, Norcross, GA for other capacities.

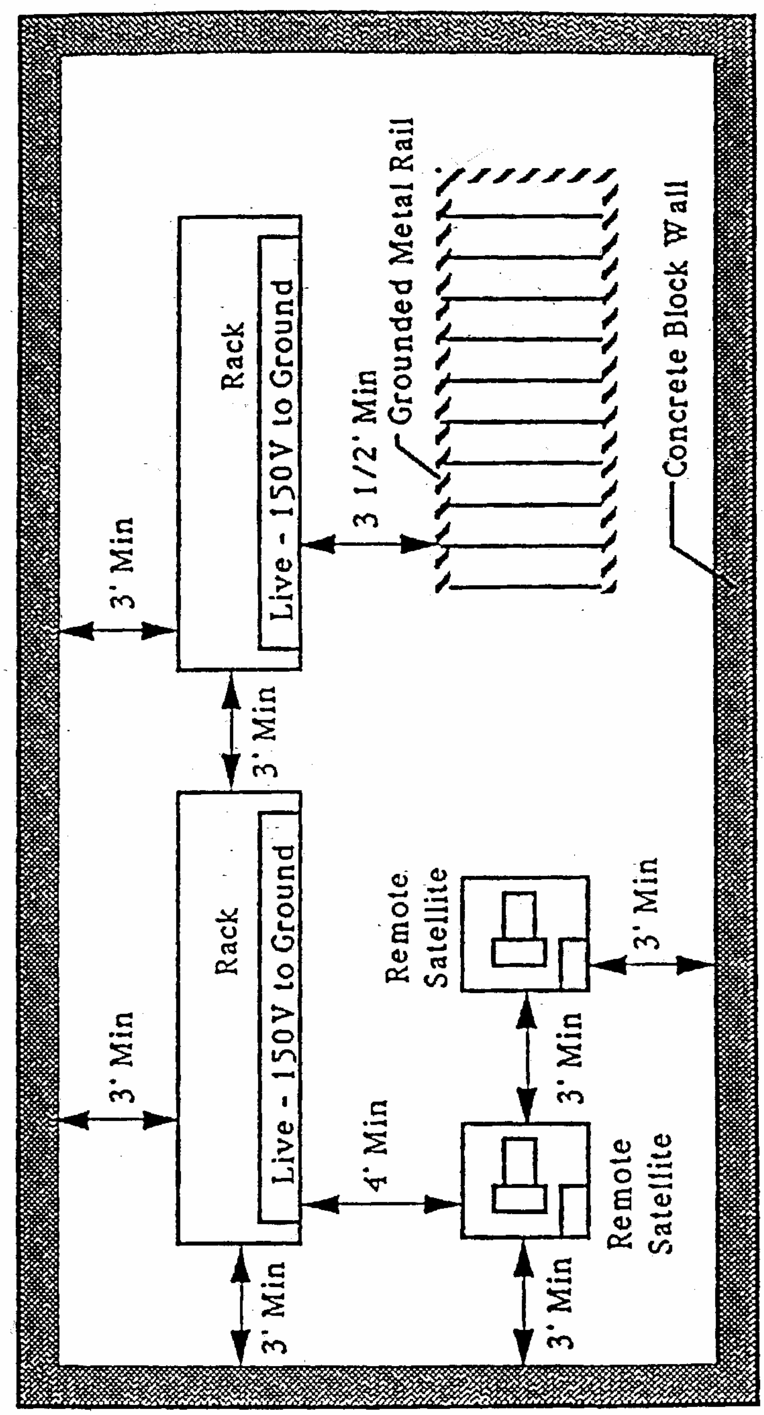


Figure 1-2 Electrical Clearance Requirements

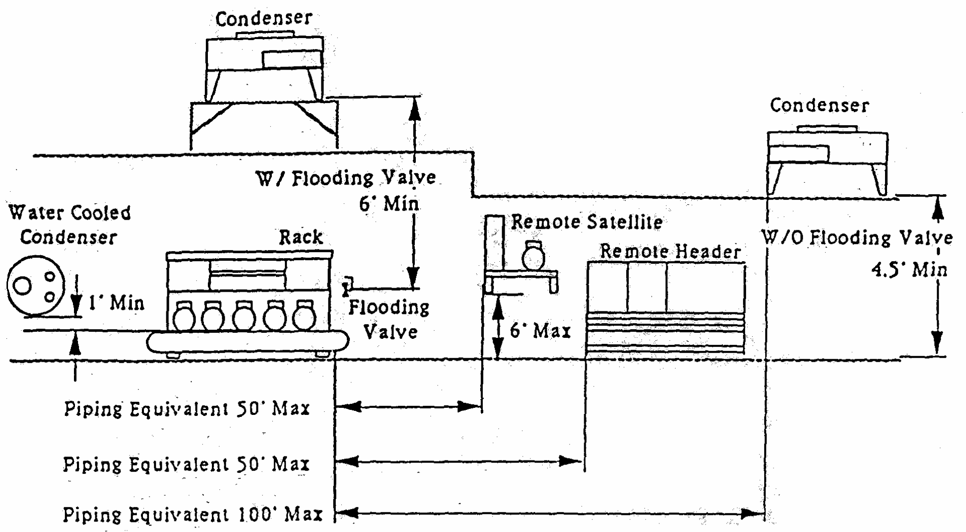


Figure 1-3 Allowable Distances

Unit Placement
When Setting the Custom Rack plan in relation to the rest of the equipment. Some minimum and maximum distances are listed. **Note:** Piping equivalent is not the same as linear distance.

Minimum Allowable Distances
From the Water Cooled Condenser Outlet to the Receiver Inlet, the minimum allowable elevation is 1 foot.

With no Flooding Valve; from the mounting surface of the air cooled Condenser to the mounting surface of the Custom Rack, the minimum allowable distance is 4.5 feet.

With a Flooding Valve; from the mounting surface of the air cooled Condenser to the center of the flooding valve, the minimum allowable distance is 6 feet.

Maximum Allowable Distances
Remote Satellites should not be placed below the level of the Custom Rack. The Satellite may be positioned above the Rack. The maximum allowable elevation is 6 feet from the bottom of the Rack.

When piping from the Rack to a Remote Satellite, the maximum allowable piping equivalent is 50 feet.

When piping from the Rack to a Remote Header, the maximum allowable piping equivalent is 50 feet.

When piping from the Rack to a Condenser, the maximum allowable piping equivalent is 100 feet.

LOCATION & LEVELING

Each Custom System must be located in the machine room so that it is accessible from all sides. A minimum of 36 inches clearance is recommended to provide easy access to equipment.

Vibration isolation pads are supplied with each rack. The entire weight of the rack must rest on these pads (see Table 1-1). The pads should be located as shown in Figure below. Cross-level the compressor unit so all compressors are level with each other.

Often machine rooms have uneven floors. To insure both proper leveling and vibration isolation in these instances, perform the following:

1. Lift the Custom System in accordance with procedures detailed on the following page.

2. Place 15 gauge 3" x 3" galvanized steel shims to compensate for uneven floors. (Shims must be field supplied).

3. Place vibration isolation pads on top of shims.

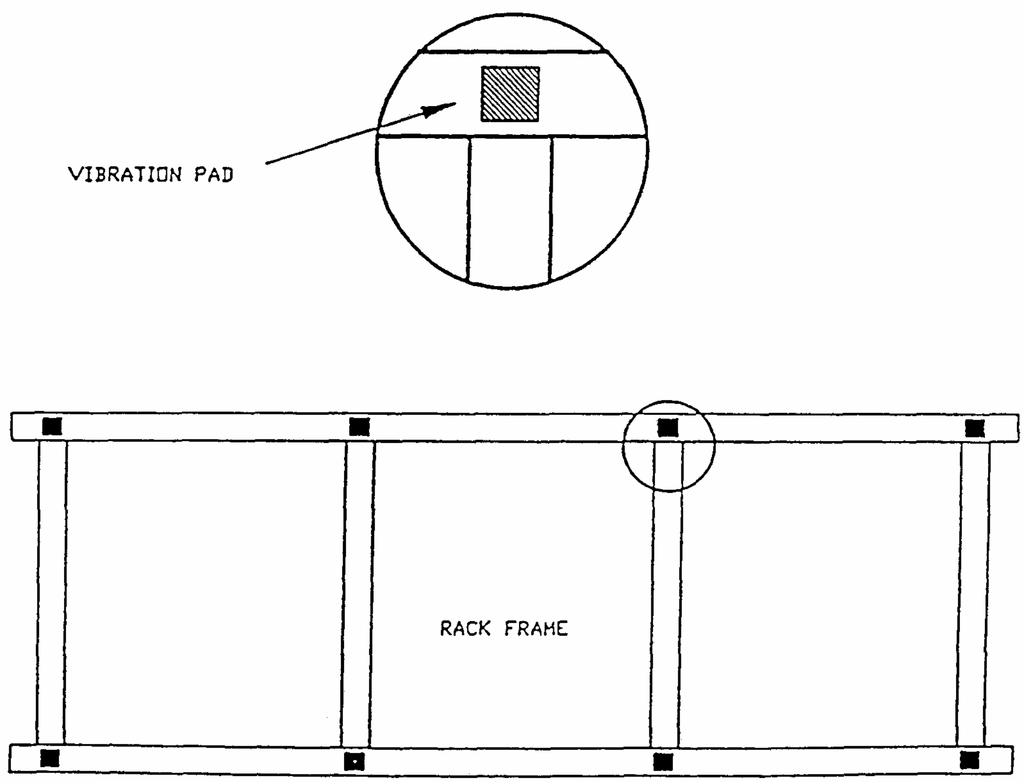


Figure 1-4 Vibration Pad Locations

Table 1-1
VIBRATION PAD QUANTITIES

# OF COMPRESSORS PER PACK	2” x 2” x 1” PAD STANDARD	3” x 3” x 2” PAD OPTIONAL
2 COMPRESSORS	8 EACH	6 EACH
3 COMPRESSORS	10 EACH	8 EACH
4 COMPRESSORS	12 EACH	8 EACH
5 COMPRESSORS	14 EACH	10 EACH
6 COMPRESSORS	18 EACH	10 EACH
7 COMPRESSORS	18 EACH	12 EACH
8 COMPRESSORS	20 EACH	12 EACH
9 COMPRESSORS	20 EACH	14 EACH
10 COMPRESSORS	20 EACH	14 EACH

HANDLING
Each compressor rack has four, 2 inch holes in the frame for rigging and lifting. Figure 1-2 illustrates the recommended method of setting up the rigging. It is important to use the spreader bar to prevent the rigging from damaging the copper tubing. Before locating in the machine room remove the shipping skid.

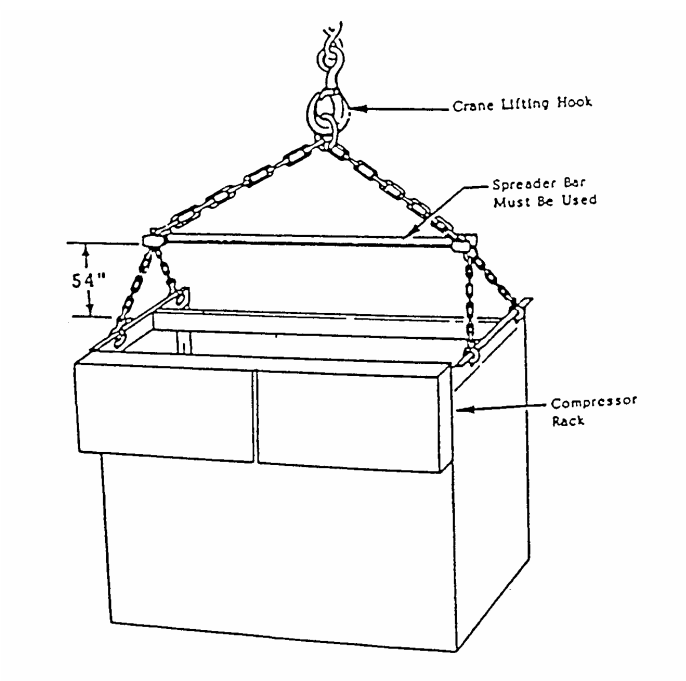


Figure 1-5 Lifting the Compressor Rack

Table 1-2
Rack Sizing Chart

Number of Compressors	Maximum Number of Circuits	Length of Rack	Approximate Weight of Rack
3	12	98	3330 lbs.
4	15	114	4290
5	20	138	5230
6	22	150	5720
7	26	178	6270

Condenser Line Sizing

Low Temperature R-22

Discharge

Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
	114	78	62	53	42	36	32	29	7/8
	160	160	128	109	87	74	66	60	1 1/8
	277	277	221	189	151	129	114	103	1 3/8
	439	439	351	300	240	205	181	164	1 5/8
	725	725	725	619	495	423	374	338	2 1/8
	1117	1117	1117	1117	894	763	675	610	2 5/8
	1762	1762	1762	1762	1410	1203	1064	963	3 1/8
105	120	82	66	56	45	38	34	31	7/8
	167	167	134	114	91	78	69	62	1 1/8
	288	288	231	197	158	135	119	108	1 3/8
	458	458	367	313	250	214	189	171	1 5/8
	756	756	756	645	516	441	390	352	2 1/8
	1164	1164	1164	1164	931	795	703	636	2 5/8
	1836	1836	1836	1836	1469	1254	1109	1003	3 1/8
110	122	83	67	57	46	39	34	31	7/8
	170	170	136	116	93	79	70	63	1 1/8
	293	293	234	200	160	137	121	109	1 3/8
	467	467	374	319	255	218	193	174	1 5/8
	770	770	770	657	526	449	397	359	2 1/8
	1187	1187	1187	1187	950	811	717	649	2 5/8
	1872	1872	1872	1872	1498	1279	1131	1023	3 1/8
115	125	86	69	59	47	40	35	32	7/8
	175	175	140	120	96	82	72	65	1 1/8
	302	302	241	206	165	141	124	113	1 3/8
	481	481	385	329	263	224	198	180	1 5/8
	677	677	677	677	541	462	409	370	2 1/8
	1222	1222	1222	1222	978	835	738	668	2 5/8
	1927	1927	1927	1927	1542	1316	1164	1053	3 1/8
120	129	88	70	60	48	41	36	33	7/8
	180	180	144	123	98	84	74	67	1 1/8
	310	310	248	212	170	145	128	116	1 3/8
	495	495	396	338	270	231	204	185	1 5/8
	696	696	696	696	557	475	420	380	2 1/8
	1257	1257	1257	1257	1006	859	759	687	2 5/8
	1982	1982	1982	1982	1586	1354	1197	1083	3 1/8

Liquid Return

Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
100	78	78	78	78	62	53	47	43	5/8
	163	163	163	163	130	111	98	89	7/8
	279	279	279	279	223	191	169	152	1 1/8
	425	425	425	425	340	290	257	232	1 3/8
	602	602	602	602	482	411	364	329	1 5/8
	1048	1048	1048	1048	839	716	633	573	2 1/8
	1618	1618	1618	1618	1295	1105	977	884	2 5/8
	2309	2309	2309	2309	1847	1577	1395	1262	3 1/8
105	76	76	76	76	61	52	46	42	5/8
	159	159	159	159	127	109	96	87	7/8
	271	271	271	271	217	185	164	148	1 1/8
	413	413	413	413	330	282	250	226	1 3/8
	585	585	585	585	468	400	353	320	1 5/8
	1018	1018	1018	1018	815	695	615	556	2 1/8
	1571	1571	1571	1571	1257	1073	949	859	2 5/8
	2242	2242	2242	2242	1794	1531	1354	1225	3 1/8
110	73	73	73	73	58	50	44	40	5/8
	154	154	154	154	123	105	93	84	7/8
	262	262	262	262	210	179	158	143	1 1/8
	400	400	400	400	320	273	242	219	1 3/8
	567	567	567	567	454	387	343	310	1 5/8
	987	987	987	987	790	674	596	539	2 1/8
	1523	1523	1523	1523	1219	1040	920	832	2 5/8
	2174	2174	2174	2174	1739	1485	1313	1188	3 1/8
115	71	71	71	71	56	48	43	39	5/8
	149	149	149	149	119	101	90	81	7/8
	253	253	253	253	202	172	153	138	1 1/8
	386	386	386	386	309	263	233	211	1 3/8
	547	547	547	547	437	373	330	299	1 5/8
	952	952	952	952	761	650	575	520	2 1/8
	1468	1468	1468	1468	1175	1003	887	802	2 5/8
	2096	2096	2096	2096	1677	1431	1266	1145	3 1/8
120	68	68	68	68	54	46	41	37	5/8
	143	143	143	143	114	98	86	78	7/8
	243	243	243	243	194	166	147	133	1 1/8
	371	371	371	371	297	253	224	203	1 3/8
	526	526	526	526	421	359	318	287	1 5/8
	916	916	916	916	733	626	553	501	2 1/8
	1413	1413	1413	1413	1131	965	854	772	2 5/8
	2017	2017	2017	2017	1614	1378	1219	1102	3 1/8

Medium Temperature R-22

Discharge

Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
100	114	78	62	53	42	36	32	29	7/8
	229	157	125	107	86	73	65	58	1 1/8
	272	272	218	186	149	127	112	102	1 3/8
	430	430	344	294	235	201	178	161	1 5/8
	712	712	712	608	486	415	367	332	2 1/8
	1257	1257	1257	1073	859	733	648	586	2 5/8
	1697	1697	1697	1449	1159	990	875	792	3 1/8
105	120	82	66	56	45	38	34	31	7/8
	165	165	132	113	90	77	68	61	1 1/8
	286	286	229	196	156	134	118	107	1 3/8
	452	452	362	309	247	211	187	169	1 5/8
	748	748	748	639	511	436	386	349	2 1/8
	1127	1127	1127	1127	901	769	681	616	2 5/8
	1781	1781	1781	1521	1217	1039	919	831	3 1/8
110	126	86	69	59	47	40	36	32	7/8
	173	173	138	118	94	81	71	64	1 1/8
	300	300	240	205	164	140	124	112	1 3/8
	474	474	380	324	259	221	196	177	1 5/8
	784	784	784	669	535	457	404	366	2 1/8
	1180	1180	1180	1180	944	806	713	645	2 5/8
	1865	1865	1865	1592	1274	1087	962	870	3 1/8
115	89	89	71	61	49	42	37	33	7/8
	179	179	144	123	98	84	74	67	1 1/8
	312	312	250	213	170	145	129	116	1 3/8
	493	493	394	337	269	230	203	184	1 5/8
	696	696	696	696	556	475	420	380	2 1/8
	1227	1227	1227	1227	982	838	741	671	2 5/8
	1656	1656	1656	1656	1325	1131	1000	905	3 1/8
120	92	92	74	63	50	43	38	34	7/8
	186	186	149	127	102	87	77	69	1 1/8
	324	324	259	221	177	151	134	121	1 3/8
	409	409	409	349	279	238	211	191	1 5/8
	722	722	722	722	578	493	436	395	2 1/8
	1274	1274	1274	1274	1019	870	770	696	2 5/8
	1720	1720	1720	1720	1376	1175	1039	940	3 1/8

For assistance, ask for Hussmann Application Engineering. 404-921-9410.

Liquid Return

Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
100	77	77	77	77	62	53	47	42	5/8
	160	160	160	160	128	109	97	87	7/8
	274	274	274	274	219	187	166	150	1 1/8
	418	418	418	418	334	286	253	228	1 3/8
	592	592	592	592	474	404	358	324	1 5/8
	1031	1031	1031	1031	825	704	623	563	2 1/8
	1590	1590	1590	1590	1272	1086	961	869	2 5/8
	2270	2270	2270	2270	1816	1550	1371	1241	3 1/8
105	75	75	75	75	60	51	45	41	5/8
	155	155	155	155	124	106	94	85	7/8
	266	266	266	266	212	181	160	145	1 1/8
	405	405	405	405	324	276	244	221	1 3/8
	573	573	573	573	458	391	346	313	1 5/8
	998	998	998	998	798	681	603	545	2 1/8
	1538	1538	1538	1538	1231	1050	929	841	2 5/8
	2196	2196	2196	2196	1757	1500	1327	1200	3 1/8
110	72	72	72	72	58	49	43	39	5/8
	150	150	150	150	120	102	91	82	7/8
	257	257	257	257	206	176	155	140	1 1/8
	391	391	391	391	313	267	236	214	1 3/8
	554	554	554	554	443	378	335	303	1 5/8
	964	964	964	964	771	658	582	527	2 1/8
	1486	1486	1486	1486	1189	1015	898	812	2 5/8
	2122	2122	2122	2122	1698	1449	1282	1160	3 1/8
115	69	69	69	69	55	47	42	38	5/8
	145	145	145	145	116	99	87	79	7/8
	248	248	248	248	198	169	150	136	1 1/8
	377	377	377	377	302	257	228	206	1 3/8
	535	535	535	535	428	365	323	292	1 5/8
	930	930	930	930	744	635	562	508	2 1/8
	1434	1434	1434	1434	1147	979	866	783	2 5/8
	2048	2048	2048	2048	1638	1398	1237	1119	3 1/8
120	66	66	66	66	53	45	40	36	5/8
	139	139	139	139	111	95	84	76	7/8
	239	239	239	239	191	163	144	131	1 1/8
	363	363	363	363	290	248	219	198	1 3/8
	515	515	515	515	412	352	311	281	1 5/8
	896	896	896	896	717	612	541	490	2 1/8
	1381	1381	1381	1381	1105	943	834	755	2 5/8
	1973	1973	1973	1973	1579	1348	1192	1078	3 1/8

Condenser Line Sizing

Low Temperature R-404a

Discharge

Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
100	96	66	53	45	36	31	27	25	7/8
	132	132	105	90	72	61	54	49	1 1/8
	230	230	184	157	126	107	95	86	1 3/8
	289	289	289	247	198	169	149	135	1 5/8
	510	510	510	510	408	348	308	279	2 1/8
	898	898	898	898	718	613	543	491	2 5/8
	1428	1428	1428	1428	1143	975	863	780	3 1/8
105	96	66	53	45	36	31	27	25	7/8
	133	133	107	91	73	62	55	50	1 1/8
	231	231	185	158	126	108	95	86	1 3/8
	293	293	293	250	200	171	151	137	1 5/8
	515	515	515	515	412	352	311	281	2 1/8
	905	905	905	905	724	618	547	495	2 5/8
	1439	1439	1439	1439	1151	983	869	786	3 1/8
110	67	67	54	46	37	31	28	25	7/8
	135	135	108	92	74	63	56	50	1 1/8
	234	234	187	160	128	109	97	87	1 3/8
	295	295	295	252	202	172	152	138	1 5/8
	520	520	520	520	416	355	314	284	2 1/8
	915	915	915	915	732	625	553	500	2 5/8
	1453	1453	1453	1453	1163	992	878	794	3 1/8
115	69	69	55	47	38	32	28	26	7/8
	138	138	110	94	75	64	57	51	1 1/8
	239	239	192	164	131	112	99	89	1 3/8
	302	302	302	258	206	176	156	141	1 5/8
	531	531	531	531	424	362	320	290	2 1/8
	934	934	934	934	747	638	564	510	2 5/8
	1483	1483	1483	1483	1187	1013	896	810	3 1/8
120	70	70	56	48	38	33	29	26	7/8
	141	141	112	96	77	66	58	52	1 1/8
	245	245	196	167	134	114	101	91	1 3/8
	308	308	308	263	210	180	159	144	1 5/8
	541	541	541	541	433	370	327	296	2 1/8
	953	953	953	953	763	651	576	521	2 5/8
	1513	1513	1513	1513	1211	1033	914	827	3 1/8

Liquid Return

Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
100	50	50	50	50	40	34	30	27	5/8
	104	104	104	104	83	71	63	57	7/8
	177	177	177	177	142	121	107	97	1 1/8
	269	269	269	269	215	184	163	147	1 3/8
	381	381	381	381	305	260	230	208	1 5/8
	664	664	664	664	531	454	401	363	2 1/8
	1023	1023	1023	1023	819	699	618	559	2 5/8
	1461	1461	1461	1461	1169	998	883	798	3 1/8
105	47	47	47	47	38	32	28	26	5/8
	98	98	98	98	78	67	59	54	7/8
	167	167	167	167	134	114	101	91	1 1/8
	254	254	254	254	203	173	153	139	1 3/8
	360	360	360	360	288	246	217	197	1 5/8
	626	626	626	626	501	428	378	342	2 1/8
	965	965	965	965	772	659	583	527	2 5/8
	1378	1378	1378	1378	1103	941	832	753	3 1/8
110	44	44	44	44	35	30	27	24	5/8
	92	92	92	92	74	63	56	50	7/8
	157	157	157	157	126	107	95	86	1 1/8
	239	239	239	239	191	163	144	131	1 3/8
	339	339	339	339	271	232	205	185	1 5/8
	589	589	589	589	471	402	356	322	2 1/8
	908	908	908	908	727	620	549	496	2 5/8
	1296	1296	1296	1296	1037	885	783	708	3 1/8
115	42	42	42	42	33	28	25	23	5/8
	86	86	86	86	69	59	52	47	7/8
	147	147	147	147	117	100	89	80	1 1/8
	224	224	224	224	179	153	135	122	1 3/8
	317	317	317	317	253	216	191	173	1 5/8
	551	551	551	551	440	376	333	301	2 1/8
	849	849	849	849	679	580	513	464	2 5/8
	1211	1211	1211	1211	969	827	732	662	3 1/8
120	39	39	39	39	31	27	24	21	5/8
	80	80	80	80	64	55	48	44	7/8
	136	136	136	136	109	93	82	74	1 1/8
	208	208	208	208	166	142	126	114	1 3/8
	294	294	294	294	235	201	178	161	1 5/8
	512	512	512	512	410	350	309	280	2 1/8
	789	789	789	789	631	539	477	431	2 5/8
	1126	1126	1126	1126	901	769	680	615	3 1/8

Medium Temperature R-404a

Discharge

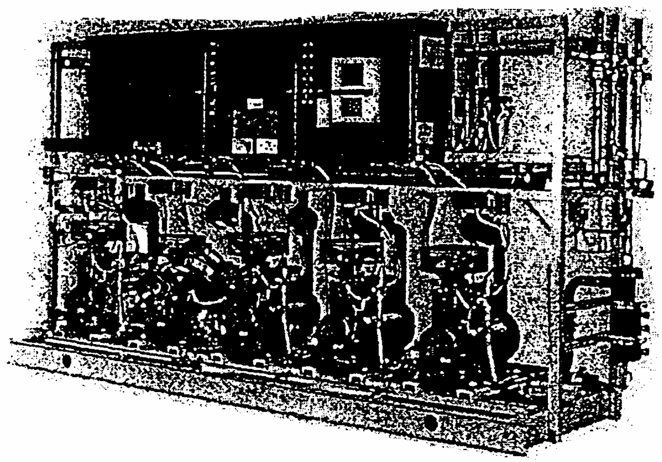
Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
100	76	76	61	52	42	36	31	28	7/8
	152	152	122	104	83	71	63	57	1 1/8
	211	211	211	180	144	123	109	98	1 3/8
	284	284	284	284	227	194	172	155	1 5/8
	585	585	585	585	468	400	353	320	2 1/8
	1030	1030	1030	1030	824	704	622	563	2 5/8
	1639	1639	1639	1639	1311	1119	990	896	3 1/8
105	77	77	62	53	42	36	32	29	7/8
	154	154	124	106	84	72	64	58	1 1/8
	215	215	215	184	147	125	111	100	1 3/8
	289	289	289	289	231	197	175	158	1 5/8
	596	596	596	596	476	407	360	325	2 1/8
	1049	1049	1049	1049	839	716	633	573	2 5/8
	1667	1667	1667	1667	1333	1138	1007	911	3 1/8
110	78	78	62	53	42	36	32	29	7/8
	157	157	125	107	86	73	65	58	1 1/8
	219	219	219	187	150	128	113	102	1 3/8
	294	294	294	294	235	201	178	161	1 5/8
	606	606	606	606	485	414	366	331	2 1/8
	1067	1067	1067	1067	854	729	645	583	2 5/8
	1694	1694	1694	1694	1355	1157	1023	926	3 1/8
115	78	78	63	54	43	37	32	29	7/8
	158	158	127	108	86	74	65	59	1 1/8
	221	221	221	189	151	129	114	103	1 3/8
	347	347	347	297	237	203	179	162	1 5/8
	611	611	611	611	488	417	369	334	2 1/8
	1075	1075	1075	1075	860	734	649	587	2 5/8
	1707	1707	1707	1707	1365	1166	1031	933	3 1/8
120	79	79	63	54	43	37	33	30	7/8
	160	160	128	109	87	74	66	60	1 1/8
	223	223	223	190	152	130	115	104	1 3/8
	299	299	299	299	239	204	181	163	1 5/8
	615	615	615	615	492	420	372	336	2 1/8
	1083	1083	1083	1083	867	740	654	592	2 5/8
	1719	1719	1719	1719	1375	1174	1039	939	3 1/8

Note: For assistance, ask for Hussmann Application Engineering. 404-921-9410.

Liquid Return

Cond Temp	Maximum Allowable mbh 25	50	75	100	150	200	250	300	Line Size
100	49	49	49	49	39	33	30	27	5/8
	101	101	101	101	81	69	61	55	7/8
	172	172	172	172	138	117	104	94	1 1/8
	262	262	262	262	210	179	158	143	1 3/8
	371	371	371	371	297	253	224	203	1 5/8
	645	645	645	645	516	441	390	352	2 1/8
	994	994	994	994	795	679	601	543	2 5/8
	1419	1419	1419	1419	1135	969	857	775	3 1/8
105	46	46	46	46	37	31	28	25	5/8
	95	95	95	95	76	65	57	52	7/8
	162	162	162	162	130	111	98	89	1 1/8
	247	247	247	247	198	169	149	135	1 3/8
	350	350	350	350	280	239	211	191	1 5/8
	608	608	608	608	486	415	367	332	2 1/8
	937	937	937	937	750	640	566	512	2 5/8
	1338	1338	1338	1338	1070	914	808	731	3 1/8
110	43	43	43	43	34	29	26	23	5/8
	89	89	89	89	71	61	54	49	7/8
	152	152	152	152	122	104	92	83	1 1/8
	232	232	232	232	186	158	140	127	1 3/8
	328	328	328	328	262	224	198	179	1 5/8
	571	571	571	571	457	390	345	312	2 1/8
	880	880	880	880	704	601	532	481	2 5/8
	1256	1256	1256	1256	1005	858	759	686	3 1/8
115	40	40	40	40	32	27	24	22	5/8
	83	83	83	83	66	57	50	45	7/8
	142	142	142	142	114	97	86	78	1 1/8
	217	217	217	217	173	148	131	118	1 3/8
	306	306	306	306	245	209	185	167	1 5/8
	533	533	533	533	426	364	322	291	2 1/8
	821	821	821	821	657	561	496	449	2 5/8
	1172	1172	1172	1172	938	800	708	640	3 1/8
120	37	37	37	37	30	25	22	20	5/8
	77	77	77	77	62	53	47	42	7/8
	132	132	132	132	106	90	80	72	1 1/8
	201	201	201	201	161	137	121	110	1 3/8
	284	284	284	284	227	194	172	155	1 5/8
	494	494	494	494	395	337	298	270	2 1/8
	762	762	762	762	610	520	460	416	2 5/8
	1088	1088	1088	1088	871	743	657	595	3 1/8

HUSSMANN®



PARALLEL SYSTEM PLANNING DATA

Contents

PLANNING

Securing Hussmann equipment requires two steps. First, Hussmann's sales representative will complete the rack specification form with the customer. This form details design conditions, Hussmann parallel or conventional unit preferences, and optional equipment. Second, this form is forwarded to Hussmann Engineering and based upon these guidelines, the best possible equipment will be selected to suit the customer's needs.

Installation contractors, architects and application engineers require the level of planning and pre-installation detail that this planning data, the store legend, and the store blueprints provide. Equipment parameters such as space requirements, structural support, piping ramifications, weights as related to roof stress, and electrical supply requirements are detailed to provide planning guidelines. (Although the machine room contractor will be supplied with these planning details, this is not intended as a Hussmann parallel system installation or service instruction.) For information beyond basic planning, such as installation, operation or maintenance, contact:

Hussmann Corporation
Customer Service Department
2700 Crestridge Court
Suwanee, Georgia 30024
(770) 921-9410

GENERAL DESCRIPTION

The Hussmann parallel system operates with up to ten reciprocating or screw compressors or fourteen scroll compressors in parallel design. The compact design reduces space requirements, yet its open construction provides convenient access to components for easy maintenance and service. Typically, all supermarket refrigeration needs are handled by low and medium temperature racks. An average low temperature rack runs at -25°F, and may have a satellite operating at -33°F. A common medium temperature unit operates at 16°F.

PARALLEL SYSTEM COMPONENTS

Each parallel system may contain the following:

1. Up to fourteen Copeland Scrolls, or two to ten of Copeland or Carlyle semi-hermetic, or two to ten of Bitzer or Carlyle screw compressors with
   a. High and Low Pressure Controls
   b. Oil Pressure Safety Control
   c. Primary Overload Protection
   d. Compressor Cooling Fans on low temperature application, or ¾ to 3 HP rating

2. Factory piping with:
   a. Suction, discharge and liquid headers
   b. Turba-shed oil separator and return system
   c. Fourteen inch receiver
   d. Suction filters on each compressor
   e. Liquid filter drier and sightglass
   f. Liquid level indicator

3. Factory-wired control with:
   a. Pre-wired distribution power block
   b. Individual component circuit breakers and contractors
   c. Compressor time delays
   d. Color-coded wiring system

4. Items supplied separately for field installation
   a. Liquid drier core
   b. Vibration isolation pads
   c. Loose shipped items for accessories

REMOTE SATELLITE COMPONENTS

Although the satellite is a separate compressor unit, its liquid refrigerant is supplied by the rack liquid manifold. The suction gases pulled by the satellite are discharge into the rack discharge manifold. The satellite components include:

1. One compressor with:
   a. High and low pressure controls
   b. Oil pressure safety control
   c. Primary overload protection
   d. Compressor Cooling Fans on low temperature application, or ¾ to 3 HP rating

2. Factory piping with:
   a. Suction and discharge stubs
   b. Oil systems with connections
   c. Suction filter

3. Factory-wired control panel with:
   a. Pre-wired distribution power block
   b. Individual component circuit breakers
   c. Compressor time delay relays

SHIPPING INFORMATION AND EQUIPMENT SIZING AND WEIGHT CHARTS

Unless otherwise directed, Hussmann parallel compressor systems will be shipped F.O.B. Norcross, GA. via common carrier. Specialized common carriers are used because of their knowledge and experience in trucking industrial equipment, and their proven on-time delivery. Hussmann parallel systems are cling wrapped and tarped prior to shipping via flatbed trailer (unless otherwise specified).

RACK SIZING CHART FOR PARALLEL COMPRESSOR RACKS*

NUMBER OF COMPRESSORS	MAXIMUM NUMBER OF CIRCUITS	RACK LENGTH (in)	APPROXIMATE RACK WEIGHT (lbs)	KIT#
2	8	66	2500	27HA
3	12	98	3330	37WB
4	15	114	4290	40WB
5	20	138	5230	43WB
6	22	150	5720	45WB
7	26	178	6270	12RA
8	31	200	6870	14RA
9	35	222	7470	16RA
10	43	244	8070	17RA

*NOTE:
(1) The above chart is for 2D, 3D, & 4D Copeland compressors & 06D Carlyle compressors
(2) If rack contains 06E Carlyle compressors, use next frame size
(3) If rack includes screw compressors, electric defrost, inverters, or suction accumulators, please contact Hussmann Atlanta for appropriate dimensions.
(4) Standard height: 78.5” Standard Width: 39”
(5) Add 30” to rack length for vertical receiver.
(6) Above weights are for shipping; add receiver refrigerant capacity from the corresponding table for operating weight.

COMPRESSOR WEIGHTS

COPELAND

BODY TYPE	WEIGHT (lbs)
M and N	300
2D and 3D	385
4D and 6D	575
3 and 9	380
4 and 6	530

COPELAND SCROLLS

HP	WEIGHT (lbs)
Up to 6	95
6-13	240

CARLYLE

BODY TYPE	WEIGHT (lbs)
06D	300
06E	385
06T	405

BITZER

BODY TYPE	WEIGHT (lbs)
HS* - 53	400
HS* - 64	541
HS* - 74	740

RECEIVER REFRIGERANT CAPACITY

Size	R-22	R-134a	HP-62	AZ-50
14 x 48	212	215	185	185
14 x 72	325	330	283	283
14 x 96	439	445	382	381
14 x 120	552	560	481	480
14 x 132	608	617	530	529
14 x 144	665	674	579	578
20 x 63	607	615	528	528

REMOTE SATELLITE DIMENSIONS

Satellite	Length (ins)	Height (ins)	Depth
Single-tier	38	40	29.5
Two-tier	38	85	29.5

Shipping weight = sum compressor weights + 115 lbs.

MACHINE ROOM REQUIREMENTS

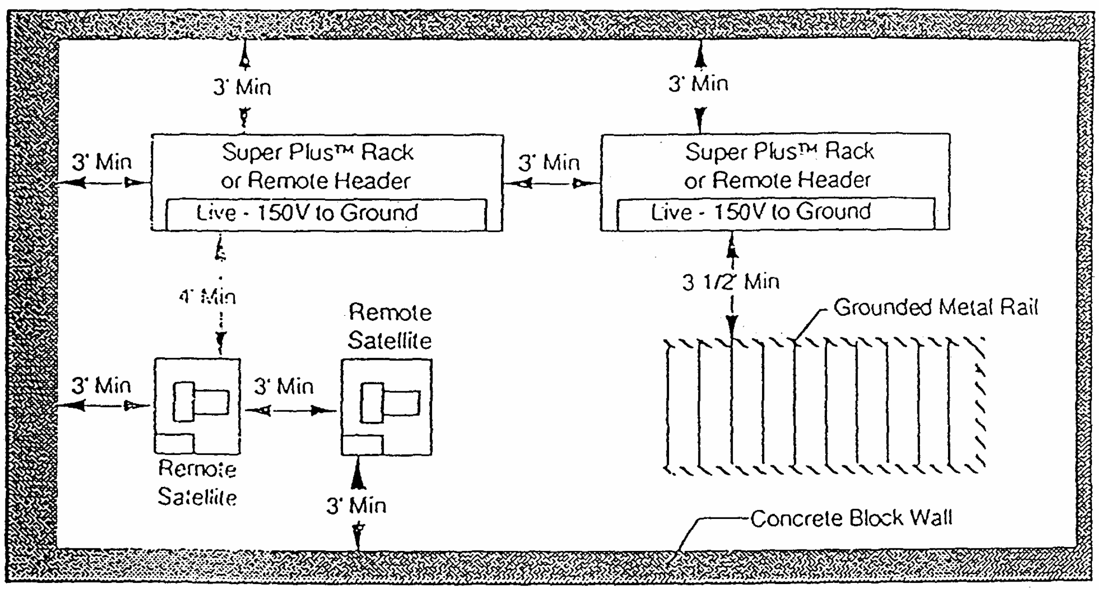
- The equipment room floor must solidly support the compressor unit as a live load. Ground level installation seldom presents problems, but a mezzanine installation must be carefully engineered.

- Ventilation should be 100 cfm per compressor unit horsepower. The air inlet should be sized for a maximum of 500 fpm velocity. The ventilation fans should cycle by thermostatic control. All machine room ventilation equipment must be field supplied. Check local codes for variances. Proper ventilation provides airflow across the compressors. Duct work may be necessary. Consideration should also be made for any other equipment installed in the machine room.

- Provide a floor drain for disposal of condensate that may form on the compressor unit or header defrost assembly.

- Equipment must be located in the machine room to provide enough working space for service personnel, and to meet electrical codes.

- Consult NEC National Fire Handbook; particularly "Installation of Switch Boards" and "Working Space Requirements". The figure below demonstrates suggested distances. Refer to local codes for each installation.



Clear Space Requirements

PLANNING FOR REMOTE DEFROST HEADER

HANGING HEADER DIMENSIONS (In.)

# OF CIRCUITS	H	W	L	WEIGHT
8	36	22	60	600
12	36	22	80	800

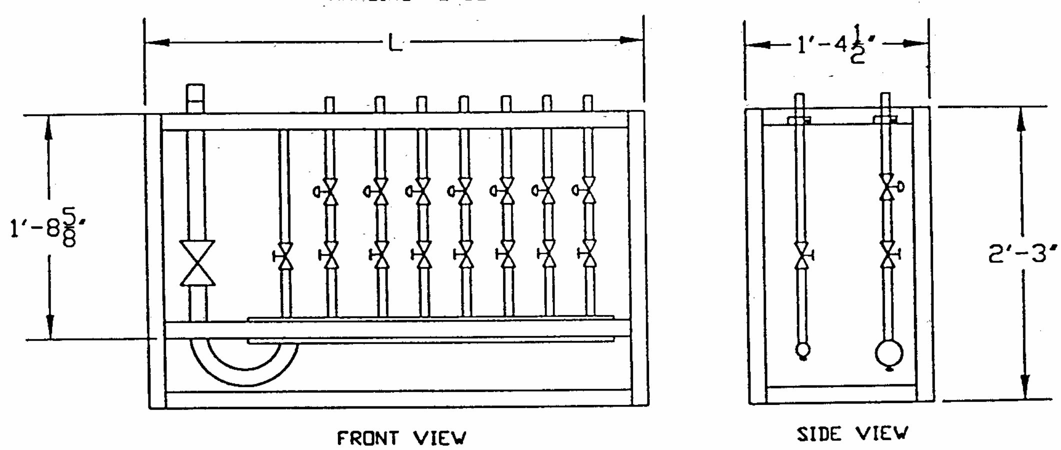
STANDING HEADER DIMENSIONS (In.)

# OF CIRCUITS	H	W	L	WEIGHT
8	60	24	72	800
12	60	24	96	1000
15	60	24	114	1150
20	60	24	144	1400
22	60	24	156	1500
26	60	24	180	1700
31	60	24	210	1950
35	60	24	234	2150
43	60	24	282	2550

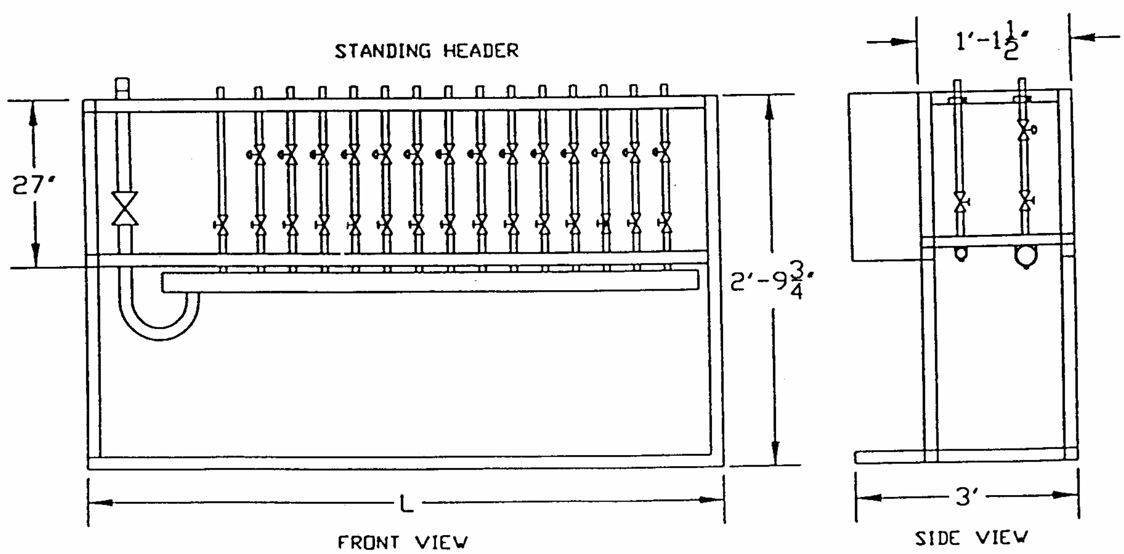
* If these dimensions do not meet your store needs, consult the engineering department at the following address and we will build a custom made header to your needs:

HUSSMANN ATLANTA
2700 Crestridgh Court
Suwanee, Georgia 30024
(770) 921-9410

HANGING HEADER



STANDING HEADER



GUIDELINES FOR FIELD WIRING

Parallel Rack components are wired as completely as possible at the factory with all work completed in accordance with UL file #SA2392, ETL file #'s 481878, 526875, & 492228. All deviations required by governing electrical codes will be the responsibility of the installer.

The main lugs in the compressor control panel are sized for copper wire only, with 75°C insulation. All wiring must be in compliance with governing electrical codes.

For Remote Header Defrost Assembly:
To the defrost control panel provide
one 208V 1PH 15A branch circuit or
one 120V 1PH 15A branch circuit for control power only
one 208V 3PH branch circuit for electric defrost power
one communications circuit for electronic controller output/input boards.
The 120V and 208V circuits may originate at the parallel system or from a separate source. Consult the store legend or electrical plans for each installation.

For 208-230/3/60 Compressor Units:
To each parallel system compressor provide
one 208-230/3/60 branch circuit
one 120V or one 208V 1PH 15A circuit
- see Note 1

To each remote air-cooled condenser provide
one 208-230/3/60 branch circuit

For 460/3/60 Compressor Units:
To each parallel system compressor provide
one 460/3/60 branch circuit
one 120V or one 208V 1PH 15A circuit
- see Note 1

To each remote air-cooled condenser provide
one 460/3/60 branch circuit

NOTE 1 - Omit when single point connection kit is used.

Electronic Controls
For ALL electronic controllers consult that manufacturers manual for wiring.

REQUIRED FIELD WIRE SIZE
Based on the full load amps of the system, select the largest connectable wire size from the table. (Based on no more than three wires in the raceway and 30°C environment per NEC.)

Total Connected FLA	Largest Connectable Wire
140A (max)	00 per ∅
248A (max)	350 mcm ∅
408A (max)	2 X (250 mcm) per ∅
608A (max)	2 X (500 mcm) per ∅

Include control circuit amps if single point connection transformer option is used.
12A for 208V systems
6A for 460V systems
(Refer to NEC for temperature derating factors.)

WHEN TO ORDER SINGLE POINT CONNECTION KIT

POWER SUPPLY		SINGLE POINT CONNECTION KIT
4 Wire 3PH 208V	L1-------- L2-------- L3-------- N---------	Not Needed
3 Wire 3PH 230/460V and 2 Wire 1PH 120 Volt	L1-------- L2-------- L3-------- H--------- N---------	Not Needed
3 Wire 3PH Delta	L1-------- L2-------- L3--------	Required

Required Ground Wiring not shown

WIRING GUIDELINES BASED ON VARIOUS COMPONENTS

Check the store legend for components requiring electrical circuits to either the compressor unit or the defrost control panel. These include:
- Defrost termination thermostat
- Thermostat controlling a header mounted liquid line solenoid
- Satellite control
- Alarm bell

All thermostat and temperature sensor wires should be sized for pilot duty at 120VA@120VAC and 120VA@208V. Run a 2-wire circuit for each system using any of the controls listed above.

Unit Cooler Fan Wiring
Provide a 120/1/60 fused power supply for each cooler. (Check the store legend to see if 208-230/1/60 is required at this location)

Evaporator Mounted Liquid Line Solenoid
Power for a liquid line solenoid in the merchandiser can be picked up from the fan circuit. (Check fan motor and solenoid voltages first)

Cooler Door Switch Wiring
Check the store legend or electrical plans, for door switch kits. The switch must be mounted to the cooler door frame, and must be wired to control the field installed liquid line solenoid and evaporator fans. Door switches are wired in series. For Koolgas applications, kit M116 includes a check valve to bypass the liquid line solenoid valve.

Sizing Wire and Overcurrent Protectors
Check the serial plate for Minimum Circuit Ampacity (MCA) and Maximum Overcurrent Protective Devices (MOPD). Follow NEC guidelines.

OPTIONAL ACCESSORIES

ELECTRONIC CONTROLLER - Features rotational compressor cycling, time delay profile, alarms, remote communication capabilities, and automatic switching to backup controls.

DEFROST CONTROL - Defrost is controlled in either the compressor control panel or remote header defrost assembly control panel. There are two types:

1. Air Defrost: Includes a defrost program timer and can be used with all types of temperature control.

2. Koolgas Defrost: Hussmann's method of defrosting refrigerators with semi-latent gas generated in the normal refrigeration process. Each defrost operation is initiated by a defrost timer. Koolgas defrost consists of the following:
   a. Constant pressure drop, main liquid solenoid valve
   b. Defrost solenoid valves, check valves, piping, and wiring - all factory installed
   c. Koolgas manifold

REFRIGERATION TEMPERATURE CONTROL
Refrigerator temperature can be controlled by the following:
1. Valves: factory or field installed
   a. Alco - EPRB, or EPRBS with suction stop feature
   b. Sporlan - (S)ORIT with suction stop feature and (S)ORIT-PI.
   c. Parker - (S)PORT and (S)PORT II
2. Thermostat and solenoid: A thermostat, optionally installed in the merchandiser operating a liquid line solenoid. The solenoid is optionally installed on the compressor unit, or can be field installed at the case.

   Note: Using liquid line solenoids installed on the compressor rack or remote header to control merchandiser temperature, may cause temperature fluctuations and liquid hydraulics in the liquid supply lines.

   HEAT RECLAIM - A system for returning heat to the store that has removed from the refrigerator units. This heat which would otherwise be wasted is returned in useable form through a heat reclaim coil.

   MECHANICAL SURGE SYSTEM - Combines surge piping and Koolgas defrost.

WINTER CONDENSING PRESSURE CONTROLS – Five methods are used to control condensing pressure during cold weather operation.

1. Flooding valves must be applied to the compressor unit when winter temperatures are expected.
2. Temperature Control: Fans are thermostatically controlled and cycled accordingly to outside temperature. Can be applied to single circuited condensers.
3. Pressure Control: Pressure regulates condensing according to need by cycling fans according to compressor discharge pressure. Can be applied to single-circuited condensers.
4. Thermal Fantrol: Used with multi-circuited condensers. Fans are cycled according to outside temperatures.
5. Split Condensers (factory or field installed) – Used on dual circuit condenser with or without heat reclaim, where a four way solenoid valve (controlled by ambient sensing temperature control or pressure control) activates to cut off one half of the condensers. Field installed situations will require double discharge and double condenser leg return piping.

ALARM SYSTEMS – The following alarms are available for use with the Parallel Rack System:

1. Refrigerant Loss Alarm/Indicator: An alarm trips if the refrigerant level in the receiver drops below a set level. This alarm automatically compensates for changes in liquid level occurring during heat reclaim.
2. Single Phase Protection: Shuts down the control circuit during single phasing of the power circuit; automatically resets when three phase power is restored.
3. Remote Alarm: In event of a power outage or any alarm condition, an alarm will sound at another location (such as a burglar alarm monitoring station or answering service)

COMPRESSOR ACCESSORIES – Compressor options include alternate vendors of pressure controls, and suction manifold insulation.

ELAPSED TIME RUNNING METERS – Individual meters keep track of the amount of time each compressor operates.

CURRENT SENSING RELAY – (Standard for compressors with line break overload.) In the event of compressor motor trip or circuit breaker trip, it prevents nuisance tripping of oil pressure safety switch.

NEMA MOTOR CONTACTORS – are factory installed on request.

REMOTE SATELLITES – are free standing units which extend the rack capacity and efficiency.

REMOTE DEFROST HEADER – Separates compressors from defrost and temperature controls.

RECEIVER SAFETY RELIEF VALVE

The receiver safety relief valve must be properly vented in accordance with local codes.

RACK TO CONDENSER PIPING

Connecting to One Manifold

1. Discharge line will be routed directly to the condenser inlet stub with at least a one foot drop to the manifold. Provide purge valve at the highest point.

2. Liquid return line will be pitched downstream, and provide trapless drainage to the rack.

Connecting to Two Manifolds

1. Discharge line will be teed upstream of the manifolds into expansion offsets with at least a one foot drop to the manifolds. Provide purge valve at the highest point.

2. Liquid return lines will be teed into the main liquid return line after six feet of vertical drop from the outlet stubs. Liquid return line will be pitched downstream, and provide trapless drainage to the Parallel Rack.

Equalizing Line

An equalizer line is piped between the parallel rack and the condenser. A check valve allowing flow only to the condenser and a shut off valve downstream of the check valve will be field supplied and installed.

RACK TO REMOTE HEADER

1. The suction stub is connected as directly as possible to the header suction manifold.

2. The liquid line stub is connected as directly as possible to the header liquid manifold.

3. If equipped with Koolgas defrost the Koolgas stub is connected as directly as possible to the Koolgas header manifold.

   Note: The remote header may use a double suction riser to aid in oil return.

RACK TO REMOTE SATELLITE

1. The compressor discharge line will be piped through a vibration absorber and check valve to its stub on the discharge manifold.

2. The compressor suction line will be piped one of two ways depending on whether Koolgas defrost is used or not.
   a. With Koolgas, the suction line will be piped through a vibration absorber to its three-way Koolgas valve on the rack.
   b. With Koolgas, the suction line will be piped through a vibration absorber to the evaporator.

Discharge Lines for Two Satellites

Installations having two satellites are teed together upstream of the discharge manifold. Use an offset tee construction. Do not use a bullhead tee.

Oil lines for Remote Satellites

All oil lines are run in 3/8" copper. Lines will be installed securely and run under tapered coverplates when crossing walkways.

Connect to the 3-way shutoff valve on the parallel rack which is immediately downstream of the oil filter to the satellite.

Install an oil equalizing line for the low-end satellite. Connect the shutoff valve on the satellite downstream of the check valve to the factory installed schrader valve at either end of the oil equalizing line. Remove the schrader core.

RACK TO HEAT RECLAIM

Because of the variety of heat reclaim systems, refer to the instructions accompanying the system.

RACK TO MERCHANDISER

Suction and liquid supply must be run from each merchandiser lineup or walk-in to the appropriate stubs on the rack or remote header.

SUCTION LINE

- Pitch in direction of flow
- May be reduced by one size at one third of merchandiser run load and again after the second third.
Do not reduce below evaporator connection size.
- Suction returns from evaporators enter at the top of the branch line.

LIQUID LINE OFFTIME AND ELECTRIC

- May be reduced by one size after one half the merchandiser load run. Do not reduce below evaporator connection size.
- Take-offs to evaporators exit the bottom of the liquid line. Provide an expansion loop for each evaporator take-off. (Minimum 3 inch diameter)

LIQUID LINE KOOLGAS DEFROST

- Increase the liquid line size inside the merchandiser by two sizes over the branch size.

Branch Size	1/2	5/8	7/8	1 1/8	1 3/8
In Case Size	7/8	1 1/8	1 3/8	1 5/8	2 1/8

- Take-offs to evaporators exit the bottom of the liquid line. Provide an expansion loop for each evaporator take-off. (Minimum 3 inch diameter)

SPECIAL PIPING FOR OPEN ROOMS

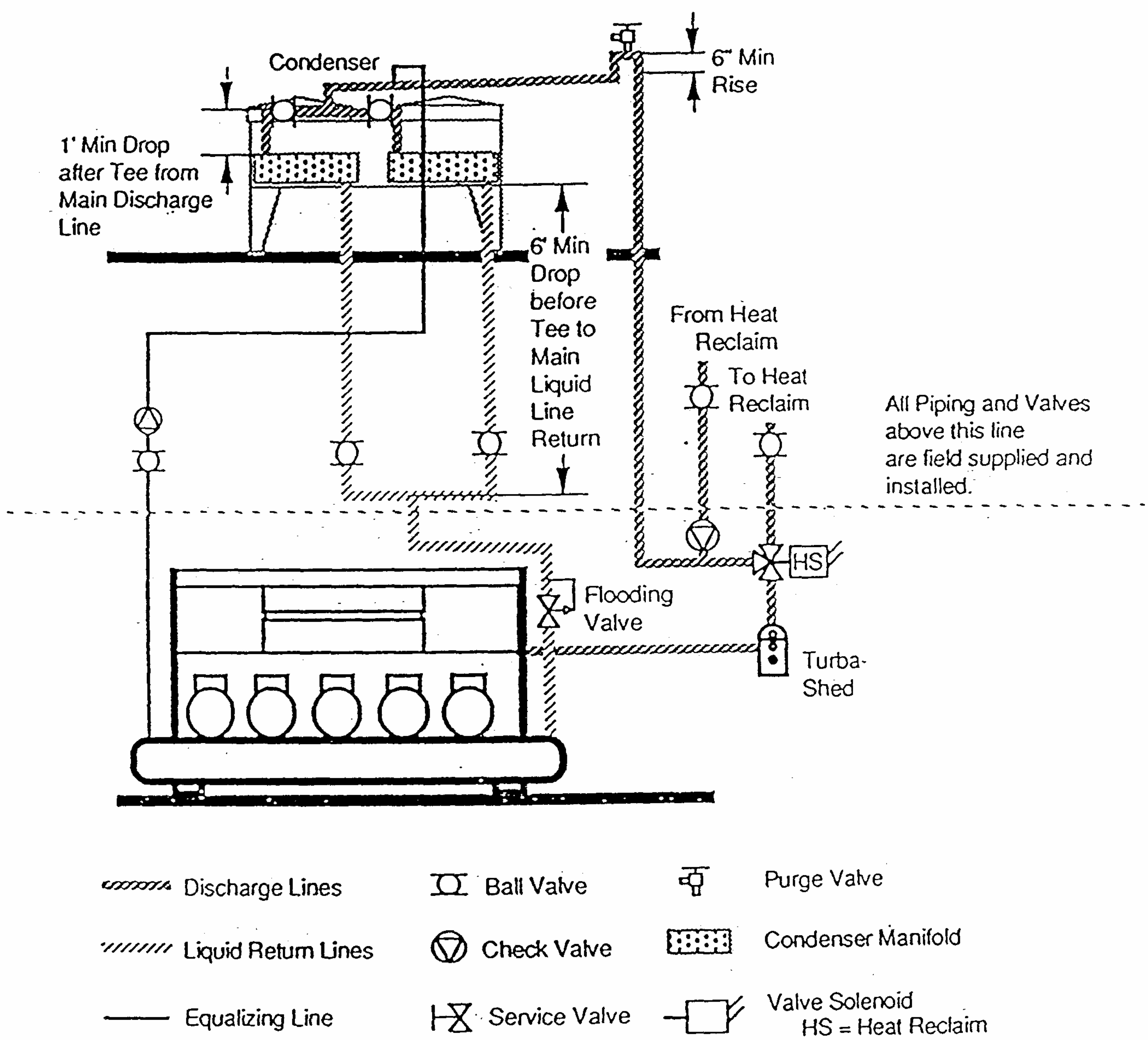
An open preparation room allows heat infiltration from the rest of the store at a rate which may jeopardize total refrigeration performance. To protect the rest of the refrigeration system, open preparation room evaporators must be piped with a Crankcase Pressure Regulating Valve (CPR).

The CPR is field supplied and installed in the suction line(s) from the evaporator(s), and the installer is responsible for proper adjustment of the valve.

HUSSMANN/ATLANTA
CUSTOM SYSTEMS

INSTALLATION
AND SERVICE MANUAL

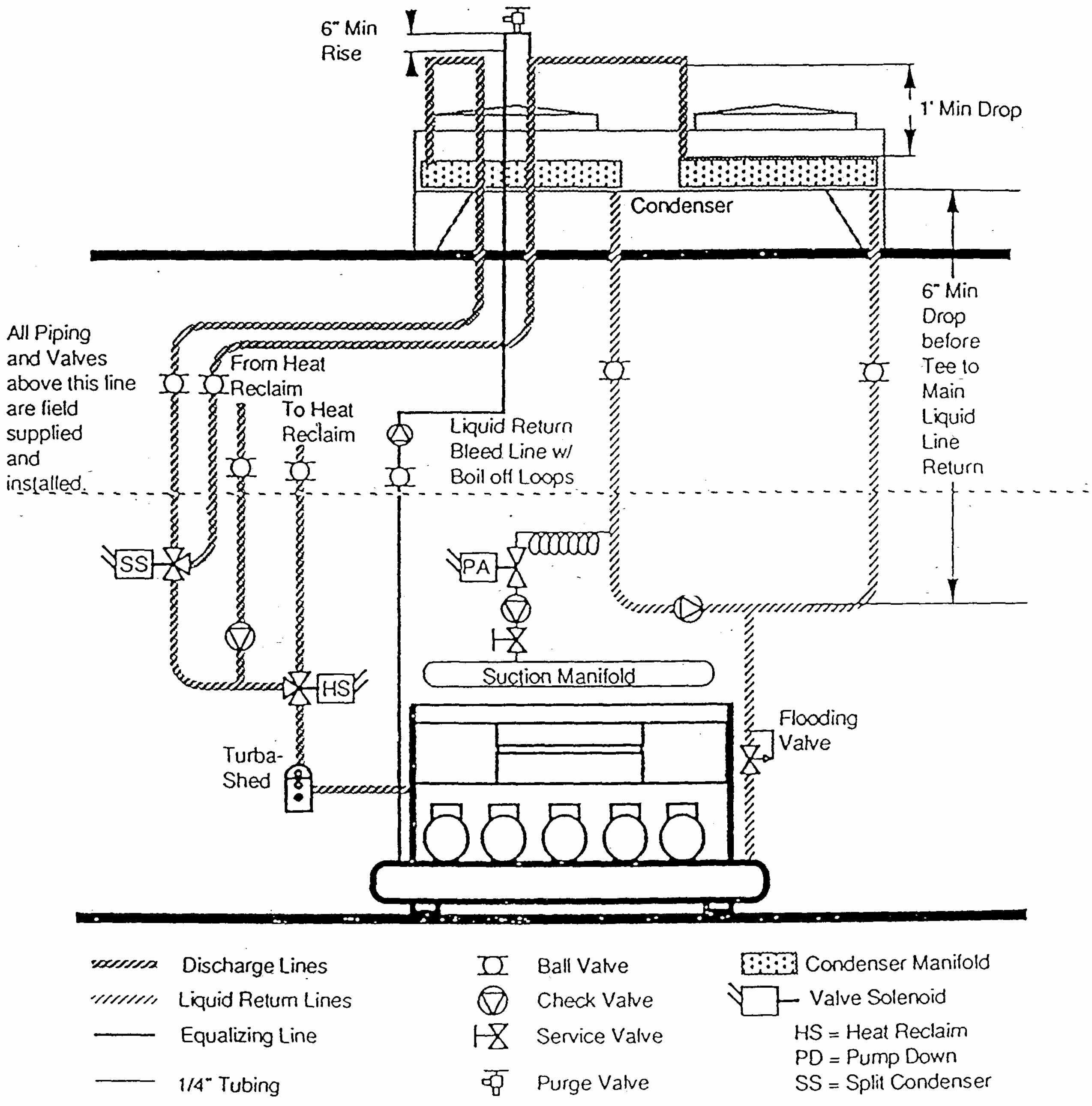
Condenser Piping w/ Heat Reclaim



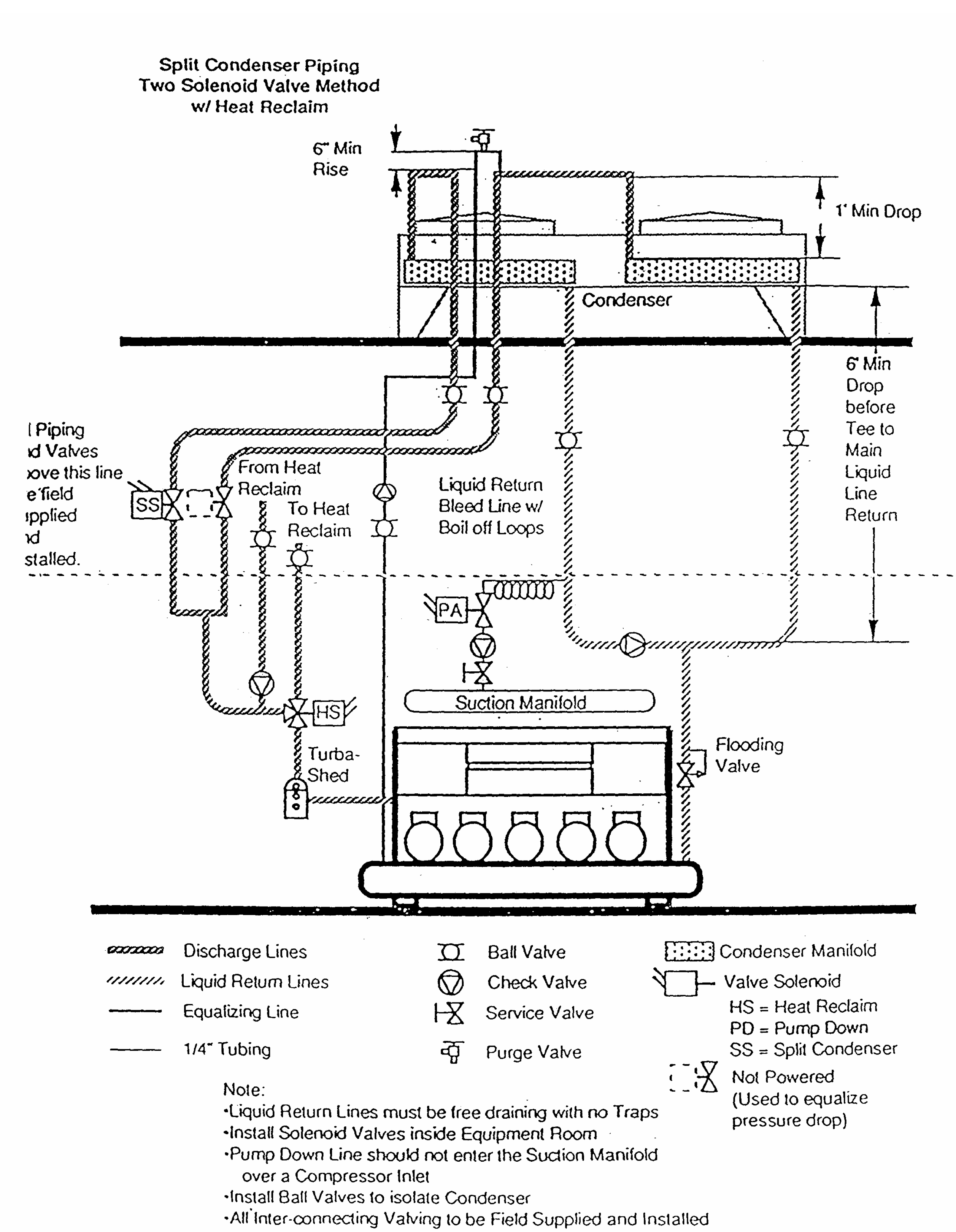
Note:

- Liquid Return Lines must be free draining with no Traps
- Install Ball Valves to isolate Condenser (Field Supplied and Installed)
- All Inter-connecting Valving to be Field Supplied and Installed

Split Condenser Piping
3-Way Valve Method
w/ Heat Reclaim



Note:
- Liquid Return Lines must be free draining with no Traps
- Install Solenoid Valves inside Equipment Room
- Pump Down Line should not enter the Suction Manifold over a Compressor Inlet
- Install Ball Valves to isolate Condenser
- All Inter-connecting Valving to be Field Supplied and Installed



Split Condenser Piping
Two Solenoid Valve Method
w/ Heat Reclaim
6" Min
Rise
1' Min Drop
Condenser
6' Min
Drop
before
Tee to
Main
Liquid
Line
Return
l Piping
d Valves
ove this line
e field
pplied
d
stalled.
SS
From Heat
Reclaim
To Heat
Reclaim
Liquid Return
Bleed Line w/
Boil off Loops
PA
Suction Manifold
HS
Turba-
Shed
Flooding
Valve
Discharge Lines
Liquid Return Lines
Equalizing Line
1/4" Tubing
Ball Valve
Check Valve
Service Valve
Purge Valve
Condenser Manifold
Valve Solenoid
HS = Heat Reclaim
PD = Pump Down
SS = Split Condenser
Not Powered
(Used to equalize
pressure drop)
Note:
•Liquid Return Lines must be free draining with no Traps
•Install Solenoid Valves inside Equipment Room
•Pump Down Line should not enter the Suction Manifold
over a Compressor Inlet
•Install Ball Valves to isolate Condenser
•All Inter-connecting Valving to be Field Supplied and Installed

UNIT PLACEMENT

When setting the parallel compressor system, plan in relation to the rest of the equipment to be installed. Note that piping equivalent is not the same as linear distance.

Minimum Allowable Distances
From the water coiled condenser outlet to the receiver inlet, the minimum allowable elevation is one foot.

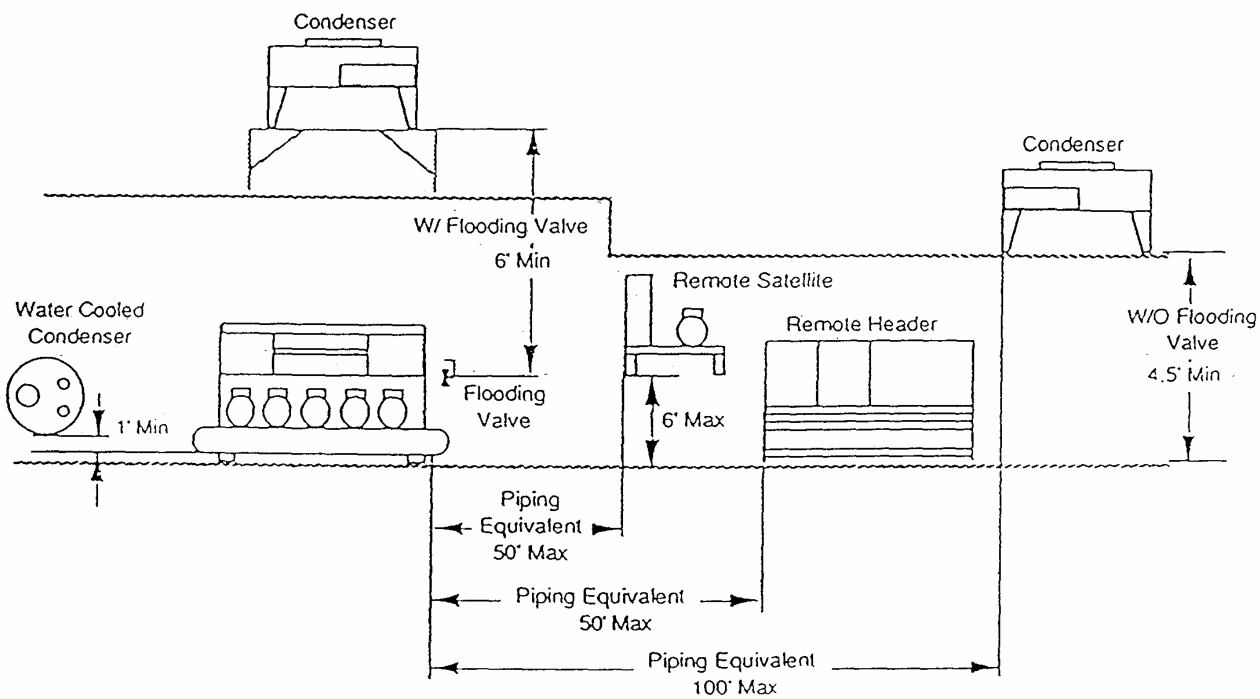
With no flooding valve: from the mounting surface of the air cooled condenser to the mounting surface of the parallel compressor system, the minimum allowable distance is 4.5 feet.

With a flooding valve: from the mounting surface of the air cooled condenser to the center of the flooding valve, the minimum allowable distance is six feet.

Maximum Allowable Distances
Remote Satellite should not be placed below the level of the parallel compressor system. The satellite may be positioned a maximum of 6 ft. above the rack.

When piping from the rack to a remote satellite, the maximum allowable piping equivalent is 50 ft. Piping should be given careful consideration when going from the rack to a remote header.

When piping from the rack to a condenser, the maximum allowable piping equivalent is 100 ft.



REMOTE CONDENSER

Location

Locate the condenser with at least three feet of clearance on all sides to provide adequate air circulation. If roof mounted, place on column supported beams or load-bearing walls. The mounting surface for the condenser should be at least six feet higher than the flooding valve. When a flooding valve is not used the minimum distance from the base of the rack to the mounting surface of the condenser is four and a half feet.

LINE SIZING

Sizing of all refrigerant lines is the responsibility of the installing contractor.

LENGTH OF LINE RUNS AND EQUIVALENT FEET

When figuring length of runs, angle valves and elbows are figured as additional length of straight pipe. Table 3-2 provides equivalent lengths for these components.

LINE SIZING CHARTS

Line sizing charts are provided in the appendix at the back of this planning guide.

Table 3-2 Equivalent Feet for Angle Valve and Elbow 90°*

Tubing Size	Angle Valve	Long Radius Elbow 90°
1/2	6	0.9
5/8	7	1.0
7/8	9	1.4
1 1/8	12	1.7
1 3/8	15	2.3
1 5/8	18	2.6
2 1/8	24	3.3
2 5/8	29	4.1
3 1/8	35	5.0
3 5/8	41	5.9
4 1/8	47	6.7

**ASHRAE 1981 Fundamentals Handbook*

Hussmann Refrigerant Line Sizing

GENERAL INFORMATION

This document supercedes all previously published line sizing data – including planning data, installation instructions, or other stand-alone documents.

REFRIGERATION LINE STUB OUTS
Stub sizes do not match line sizes. Reduction fittings are field-supplied and installed. These are general guidelines. The installer is responsible to account for any factors which may affect the system.

CONDENSER LINE SIZING
A Condenser Line Sizing chart is established for an equivalent pipe run of 100 feet. For longer runs, use the following formula:

$$\text{*Table Capacity} \times \sqrt{\frac{100}{\text{Longer Length}}} = \text{Longer Line Capacity.}$$

*NOTE: This formula applies only to remote condenser lines, and only to longer runs of these lines. A 25 ft run does not necessarily have double the capacity of a 100 ft run.

GAS DEFROST SYSTEMS
Do not use liquid lines smaller than 1/2 inch OD on any type of Gas Defrost system.

LINE SIZING TABLES

HP62 (R-404A) R-507 Medium Temp
HP62 (R-404A) R-507 Low Temp
R-134a Medium Temp (only)
R-22 Medium Temp
R-22 Low Temp

DIRECTIONS AND NOTES

Select the MBH Value which is equal to or greater than the MBH the line will be required to carry. Read the Line Size following the MBH.

MBH: values listed are always the maximum.

Super*Plus* applications: MBH values are applicable only when an equalizing line is used.

Vertical Riser: When the required refrigeration capacity is less than the figure listed in the "Vertical Riser MBH" column, the riser should be the next size smaller. When equal to or greater than the figure listed, the riser should be the same size as the main tubing run.

IMPORTANT NOTES

The Hussmann Line Sizing Charts are engineered for use with Hussmann Refrigeration Equipment.
Use of these charts will in no way place responsibility on Hussmann
when other than Hussmann Refrigeration Equipment is installed.

Line Sizing for other than Hussmann Refrigeration equipment
must be provided by that manufacturer.

When other than Hussmann engineered refrigeration equipment is applied,
select Case BTUH/Ft ratings from the Conventional values listed in the Merchandiser Data book.

Hussmann Refrigerant Line Sizing

R-404A and R-507

Medium Temperature

Evap Temp °F	Suction Line Sizing — Maximum MBH of Refrigeration per Length of Equivalent Feet, 110 °F Condenser: 50	100	150	200	250	300	Tubing Size OD	Vertical Riser MBH
10	9	6	5	4	4	—	5/8	3
	23	16	13	11	10	9	7/8	8
	47	32	26	22	20	18	1 1/8	15
	82	57	46	39	35	31	1 3/8	27
	127	89	72	62	55	50	1 5/8	42
	222	185	149	128	114	103	2 1/8	88
	342	326	264	226	201	182	2 5/8	156
	488	488	421	360	320	291	3 1/8	249
	660	660	625	536	476	432	3 5/8	370
	858	858	858	755	672	610	4 1/8	523
20	11	8	6	5	5	—	5/8	4
	29	20	16	14	12	11	7/8	9
	58	40	32	28	25	22	1 1/8	19
	101	70	56	48	43	39	1 3/8	33
	159	110	89	76	68	61	1 5/8	52
	277	229	184	158	140	127	2 1/8	109
	427	403	325	279	248	225	2 5/8	193
	609	609	578	446	396	359	3 1/8	308
	824	824	770	662	588	534	3 5/8	458
	1071	1071	1071	933	830	753	4 1/8	646
30	13	9	7	6	6	5	5/8	4
	35	24	20	17	15	13	7/8	11
	71	49	39	34	30	27	1 1/8	23
	123	85	69	59	52	47	1 3/8	41
	194	135	109	93	83	75	1 5/8	64
	342	279	225	193	171	155	2 1/8	133
	528	491	396	340	302	275	2 5/8	235
	753	753	632	542	482	438	3 1/8	375
	1019	1019	937	806	717	651	3 5/8	558
	1324	1324	1321	1136	1010	917	4 1/8	786
40	16	11	9	8	7	6	5/8	5
	43	29	24	20	18	16	7/8	14
	86	59	48	41	36	33	1 1/8	28
	149	103	83	71	63	57	1 3/8	49
	235	163	131	113	100	91	1 5/8	78
	421	337	272	233	207	188	2 1/8	161
	648	594	480	412	366	333	2 5/8	285
	926	926	765	656	584	530	3 1/8	455
	1252	1252	1135	975	867	787	3 5/8	676
	1627	1627	1597	1372	1220	1110	4 1/8	934
50	20	14	11	9	8	7	5/8	6
	57	35	29	24	22	20	7/8	17
	103	72	58	49	44	40	1 1/8	34
	179	124	100	86	76	69	1 3/8	59
	283	196	158	136	121	110	1 5/8	94
	514	406	328	281	250	227	2 1/8	195
	793	713	577	496	441	400	2 5/8	344
	1132	1132	919	790	703	638	3 1/8	549
	1531	1531	1364	1172	1042	948	3 5/8	813
	1990	1990	1920	1653	1469	1336	4 1/8	1148

Suction Line Sizing Table is established for design Conditions of 110°F Condensing Temperature. For other Condensing Temperatures use the multiplying factors listed below to determine the maximum capacity of the tubing.

Condensing Temp	Multiplying Factor
60	1.50
70	1.41
80	1.31
90	1.21
100	1.11
110	1.00
120	0.89

R-404A
and
R-507

Medium Temperature

Condenser Line Sizing

Condensing Temperature °F 60	70	80	90	100	110	120	
Discharge Maximum Allowable MBH							Line Size
39	43	46	49	52	53	54	⅞
[illegible]	86	93	98	104	107	109	1 ⅛
[illegible]	149	162	171	180	187	190	1 ⅜
[illegible]	236	255	[illegible]	284	294	299	1 ⅝
	487	527	556	585	606	615	2 ⅛
[illegible]	859	927	981	1030	1067	1083	2 ⅝
1259	1368	1474	1560	1639	1694	1719	3 ⅛
Liquid Return Maximum Allowable MBH							Line Size
70	65	59	54	49	43	37	⅝
145	134	123	112	101	89	77	⅞
247	229	210	191	172	152	132	1 ⅛
376	349	320	291	262	232	201	1 ⅜
533	493	453	412	371	328	284	1 ⅝
927	858	788	717	645	571	494	2 ⅛
1429	1324	1215	1106	994	880	762	2 ⅝
2040	1889	1735	1578	1419	1256	1088	3 ⅛

Remote Header Line Sizing

Maximum Allowable MBH	Liquid Main	Maximum Allowable MBH	Suction Main
203	1 ⅛	159	1 ⅝
309	1 ⅜	277	2 ⅛
437	1 ⅝	427	2 ⅝
761	2 ⅛	609	3 ⅛
1173	2 ⅝	824	3 ⅝
		1071	4 ⅛

Liquid Supply Line Sizing

Cond Temp °F	Maximum MBH of Refrigeration per Length of Equivalent Feet: 50	100	150	200	250	300	Tubing Size OD
80	25	17	14	12	10	9	⅜
	58	40	32	27	24	21	½
	99	75	60	51	45	41	⅝
	205	197	158	135	119	108	⅞
	350	350	321	274	242	219	1 ⅛
	533	533	533	478	424	384	1 ⅜
	755	755	755	755	672	609	1 ⅝
	1313	1313	1313	1313	1313	1266	2 ⅛
	2025	2025	2025	2025	2025	2025	2 ⅝
90	25	17	13	11	10	9	⅜
	56	39	31	26	23	21	½
	90	73	59	50	44	40	⅝
	187	187	155	132	117	106	⅞
	319	319	314	269	238	215	1 ⅛
	485	485	485	470	416	377	1 ⅜
	687	687	687	687	659	597	1 ⅝
	1195	1195	1195	1195	1195	1195	2 ⅛
	1843	1843	1843	1843	1843	1843	2 ⅝
100	24	16	13	11	10	9	⅜
	50	38	30	26	23	21	½
	81	71	57	49	43	39	⅝
	168	168	150	129	114	103	⅞
	286	286	286	261	231	209	1 ⅛
	436	436	436	436	403	365	1 ⅜
	618	618	618	618	618	580	1 ⅝
	1074	1074	1074	1074	1074	1074	2 ⅛
	1657	1657	1657	1657	1657	1657	2 ⅝
110	23	16	13	11	9	9	⅜
	45	36	29	25	22	20	½
	72	68	54	46	41	37	⅝
	149	149	144	123	109	98	⅞
	254	254	254	249	221	200	1 ⅛
	386	386	386	386	386	349	1 ⅜
	547	547	547	547	547	547	1 ⅝
	951	951	951	951	951	951	2 ⅛
	1466	1466	1466	1466	1466	1466	2 ⅝
120	21	15	12	10	9	8	⅜
	39	34	27	23	21	19	½
	62	62	51	44	39	35	⅝
	129	129	129	116	102	93	⅞
	220	220	220	220	208	188	1 ⅛
	334	334	334	334	334	329	1 ⅜
	473	473	473	473	473	473	1 ⅝
	824	824	824	824	824	824	2 ⅛
	1270	1270	1270	1270	1270	1270	2 ⅝

R-404A and R-507

Low Temperature

Evap Temp °F	Suction Line Sizing — Maximum MBH of Refrigeration per Length of Equivalent Feet 105 °F Condenser: 50	100	150	200	250	300	Tubing Size OD	Vertical Riser MBH
−40	7	5	4	3	3	3	⅞	2
	15	10	8	7	6	5	1 ⅛	5
	26	18	14	12	11	10	1 ⅜	8
	38	28	22	19	17	15	1 ⅝	13
	67	58	46	40	35	32	2 ⅛	27
	103	103	82	71	62	57	2 ⅝	48
	140	140	132	113	100	91	3 ⅛	77
	199	199	196	168	149	135	3 ⅝	115
	259	259	259	237	211	191	4 ⅛	163
	403	403	403	403	377	342	5 ⅛	294
−30	9	6	5	4	4	4	⅞	3
	19	13	11	9	8	7	1 ⅛	6
	34	23	18	16	14	13	1 ⅜	11
	50	36	29	25	22	20	1 ⅝	17
	88	76	61	52	46	42	2 ⅛	36
	136	134	108	92	82	74	2 ⅝	69
	194	194	172	148	131	119	3 ⅛	101
	262	262	256	219	195	177	3 ⅝	151
	340	340	340	310	275	249	4 ⅛	213
	530	530	530	530	493	446	5 ⅛	383
−20	12	8	7	6	5	5	⅞	4
	25	17	14	12	10	9	1 ⅛	8
	43	30	24	20	18	16	1 ⅜	14
	66	47	38	32	29	26	1 ⅝	22
	115	98	79	67	60	54	2 ⅛	46
	177	173	139	119	106	96	2 ⅝	82
	252	252	222	190	169	153	3 ⅛	131
	341	341	330	283	251	227	3 ⅝	195
	443	443	443	399	354	322	4 ⅛	275
	690	690	690	690	634	576	5 ⅛	493
−10	16	11	9	7	6	6	⅞	5
	32	22	17	15	13	12	1 ⅛	10
	55	38	30	26	23	21	1 ⅜	18
	84	60	48	41	37	33	1 ⅝	28
	147	125	100	86	76	69	2 ⅛	59
	226	220	177	152	134	122	2 ⅝	104
	323	323	283	242	215	195	3 ⅛	167
	437	437	420	360	320	290	3 ⅝	248
	568	568	568	508	451	410	4 ⅛	351
	886	886	886	886	807	733	5 ⅛	629

Suction Line Sizing Table is established for design Conditions of 105°F Condensing Temperature. For other Condensing Temperatures use the multiplying factors listed below to determine the maximum MBH capacity of the tubing.

Condensing Temp	Multiplying Factor
60	1.49
70	1.39
80	1.28
90	1.17
100	1.06
110	0.94
120	0.81

R-404A and R-507

Low Temperature

Condenser Line Sizing

Condensing Temperature °F 60	70	80	90	100	105	110	120	Line Size
Discharge Maximum Allowable MBH								
35	38	41	43	45	45	46	48	⅞
71	77	83	87	90	91	92	96	1⅛
1	134	144	151	157	158	160	167	1⅜
5	212	227	233	247	250	252	263	1⅝
	438	469	491	510	515	520	541	2⅛
	772	826	865	898	905	915	953	2⅝
139	1229	1313	1376	1428	1439	1453	1513	3⅛
Liquid Return Maximum Allowable MBH								
71	66	61	56	50	47	44	39	⅝
148	137	126	115	104	98	92	80	⅞
253	234	216	196	177	167	157	136	1⅛
385	357	328	299	269	254	239	208	1⅜
545	505	465	424	381	360	339	294	1⅝
948	879	808	737	664	626	589	512	2⅛
1462	1356	1246	1136	1023	965	908	789	2⅝
2086	1935	1779	1622	1461	1378	1296	1126	3⅛

Remote Header Line Sizing

Maximum Allowable MBH	Liquid Main	Maximum Allowable MBH	Suction Main
223	1⅛	66	1⅝
339	1⅜	115	2⅛
480	1⅝	177	2⅝
835	2⅛	252	3⅛
1287	2⅝	341	3⅝
1837	3⅛	443	4⅛
		690	5⅛

Liquid Supply Line Sizing

Cond Temp °F	Maximum MBH of Refrigeration per Length of Equivalent Feet: 50	100	150	200	250	300	Tubing Size OD
80	26	18	14	12	11	10	⅜
	59	41	32	28	24	22	½
	102	77	61	52	46	42	⅝
	211	202	162	138	122	111	⅞
	359	359	329	281	249	225	1⅛
	547	547	547	491	435	393	1⅜
	774	774	774	774	689	624	1⅝
	1347	1347	1347	1347	1347	1298	2⅛
	2077	2077	2077	2077	2077	2077	2⅝
90	25	17	14	12	10	9	⅜
	58	40	32	27	24	22	½
	93	75	60	51	45	41	⅝
	192	192	159	136	120	109	⅞
	327	327	323	276	244	221	1⅛
	499	499	499	483	427	387	1⅜
	706	706	706	706	677	613	1⅝
	1228	1228	1228	1228	1228	1228	2⅛
	1894	1894	1894	1894	1894	1894	2⅝
100	25	17	14	12	10	9	⅜
	48	39	32	27	24	22	½
	77	73	60	51	45	41	⅝
	159	159	157	135	119	108	⅞
	271	271	271	271	242	219	1⅛
	413	413	413	413	413	382	1⅜
	585	585	585	585	585	585	1⅝
	1018	1018	1018	1018	1018	1018	2⅛
	1569	1569	1569	1569	1569	1569	2⅝
110	24	16	13	11	10	9	⅜
	46	37	30	25	22	20	½
	74	70	56	48	42	38	⅝
	153	153	148	127	112	101	⅞
	262	262	262	257	228	206	1⅛
	399	399	399	399	399	360	1⅜
	564	564	564	564	564	564	1⅝
	981	981	981	981	981	981	2⅛
	1513	1513	1513	1513	1513	1513	2⅝
120	21	15	12	10	9	8	⅜
	40	35	28	24	21	19	½
	64	64	53	45	40	36	⅝
	133	133	133	120	106	61	⅞
	227	227	227	227	215	195	1⅛
	346	346	346	346	346	340	1⅜
	490	490	490	490	490	490	1⅝
	853	853	853	853	853	853	2⅛
	1315	1315	1315	1315	1315	1315	2⅝

Hussmann Refrigerant Line Sizing

R-134A

Medium Temperature

Evap Temp °F	Suction Line Sizing — Maximum MBH of Refrigeration per Length of Equivalent Feet, 110 °F Condenser: 50	100	150	200	250	300	Tubing Size OD	Vertical Riser MBH
10	4	4	3	3	2	2	5/8	2
	12	11	9	7	6	6	7/8	5
	24	22	17	15	13	12	1 1/8	10
	41	39	31	26	23	21	1 3/8	18
	65	60	48	41	37	33	1 5/8	28
	114	114	100	86	76	69	2 1/8	60
	175	175	175	152	135	122	2 5/8	105
	250	250	250	243	216	195	3 1/8	167
	339	339	339	339	321	291	3 5/8	249
	440	440	440	440	440	410	4 1/8	351
20	6	5	4	3	3	3	5/8	2
	15	13	11	9	8	7	7/8	6
	31	27	22	18	16	15	1 1/8	13
	54	47	38	32	29	26	1 3/8	22
	84	74	60	51	45	41	1 5/8	35
	145	145	124	106	94	85	2 1/8	73
	224	224	220	188	167	151	2 5/8	130
	320	320	320	301	267	242	3 1/8	207
	433	433	433	433	397	360	3 5/8	309
	563	563	563	563	560	508	4 1/8	435
30	7	6	5	4	4	3	5/8	3
	19	17	13	11	10	9	7/8	8
	39	34	27	23	20	18	1 1/8	16
	68	58	47	40	35	32	1 3/8	27
	105	92	74	64	56	51	1 5/8	44
	184	184	154	132	117	106	2 1/8	91
	283	283	273	234	207	188	2 5/8	161
	404	404	404	373	331	300	3 1/8	257
	546	546	546	546	493	447	3 5/8	383
	710	710	710	710	696	631	4 1/8	541
40	9	8	6	5	5	4	5/8	4
	24	20	16	14	12	11	7/8	10
	49	41	33	28	25	23	1 1/8	19
	85	72	58	49	44	40	1 3/8	34
	132	114	91	78	69	63	1 5/8	54
	230	230	190	162	144	131	2 1/8	112
	354	354	336	288	255	231	2 5/8	198
	505	505	505	459	407	369	3 1/8	316
	684	684	684	683	606	550	3 5/8	471
	889	889	889	889	854	775	4 1/8	664
50	11	9	8	6	6	5	5/8	4
	30	25	20	17	15	14	7/8	12
	60	50	40	35	31	28	1 1/8	24
	104	88	71	60	54	48	1 3/8	41
	164	139	112	96	85	77	1 5/8	66
	285	285	231	198	176	159	2 1/8	137
	439	439	409	351	311	282	2 5/8	242
	627	627	627	559	497	450	3 1/8	386
	848	848	848	832	739	670	3 5/8	573
	1102	1102	1102	1102	1042	944	4 1/8	810

Suction Line Sizing Table is established for design Conditions of 110°F Condensing Temperature. For other Condensing Temperatures use the multiplying factors listed below to determine the maximum M[illegible] capacity of the tubing.

Condensing Temp	Multiplying Factor
60	1.30
70	1.24
80	1.18
90	1.12
100	1.06
110	1.00
120	0.94

R-134A

Medium Temperature

Condenser Line Sizing

Condensing Temperature °F 60	70	80	90	100	110	120	
Discharge Maximum Allowable MBH							Line Size
25	28	31	34	37	40	43	7/8
50	56	62	69	75	82	88	1 1/8
87	98	109	120	131	142	153	1 3/8
137	154	172	189	207	225	241	1 5/8
5	320	356	392	428	464	497	2 1/8
3	565	628	691	755	817	876	2 5/8
2	901	1001	1102	1202	1302	1396	3 1/8
id Return aximum Allowable MBH							Line Size
95	90	84	79	74	69	63	5/8
197	186	175	164	153	142	132	7/8
335	317	298	280	261	243	224	1 1/8
511	483	454	426	398	370	342	1 3/8
723	683	643	603	563	524	484	1 5/8
1257	1188	1119	1049	980	911	841	2 1/8
1939	1833	1726	1618	1511	1405	1297	2 5/8
2767	2616	2643	2309	2157	2005	1852	3 1/8

Remote Header Line Sizing

Maximum Allowable mbh	Liquid Main	Maximum Allowable mbh	Suction Main
324	1 1/8	105	1 5/8
493	1 3/8	184	2 1/8
698	1 5/8	283	2 5/8
1215	2 1/8	404	3 1/8
1837	2 5/8	546	3 5/8
		710	4 1/8

Liquid Supply Line Sizing

Cond Temp °F	Maximum MBH of Refrigeration per Length of Equivalent Feet 50	100	150	200	250	300	Tubing Size OD
80	26	16	13	11	10	9	3/8
	58	38	30	26	23	20	1/2
	140	71	57	48	43	38	5/8
	292	189	151	129	114	103	7/8
	497	386	309	263	232	210	1 1/8
	757	675	540	461	408	368	1 3/8
	1072	1072	857	732	648	586	1 5/8
	1865	1865	1786	1526	1351	1223	2 1/8
	2876	2876	2876	2711	2398	2170	2 5/8
90	25	17	13	11	10	9	3/8
	57	38	31	26	23	21	1/2
	107	73	58	49	44	39	5/8
	286	193	154	131	116	105	7/8
	466	392	314	268	236	214	1 1/8
	710	686	550	469	415	375	1 3/8
	1005	1005	871	744	659	596	1 5/8
	1748	1748	1748	1550	1373	1242	2 1/8
	2696	2696	2696	2696	2436	2205	2 5/8
100	25	17	13	11	10	9	3/8
	57	39	31	26	23	21	1/2
	108	74	59	50	44	40	5/8
	285	195	156	133	118	106	7/8
	436	397	318	271	239	217	1 1/8
	663	663	555	474	419	373	1 3/8
	939	939	881	753	666	605	1 5/8
	1633	1633	1633	1566	1387	1256	2 1/8
	2519	2519	2519	2519	2462	2229	2 5/8
110	25	17	13	11	10	9	3/8
	57	39	31	26	23	21	1/2
	108	74	59	50	44	39	5/8
	237	195	156	133	118	105	7/8
	405	396	317	271	239	216	1 1/8
	617	617	555	474	419	373	1 3/8
	873	873	873	752	665	602	1 5/8
	1518	1518	1518	1518	1386	1251	2 1/8
	2341	2341	2341	2341	2341	2227	2 5/8
120	25	17	13	11	10	8	3/8
	57	39	31	26	23	20	1/2
	105	74	59	50	44	38	5/8
	219	195	156	133	118	102	7/8
	374	374	317	271	238	213	1 1/8
	569	569	554	474	419	371	1 3/8
	806	806	806	751	664	594	1 5/8
	1402	1402	1402	1402	1384	1246	2 1/8
	2162	2162	2162	2162	2162	2162	2 5/8

Evap Temp °F	Suction Line Sizing Maximum MBH of Refrigeration per Length of Equivalent Feet 105 °F Condenser 50	100	150	200	250	300	Tubing Size OD	Vertical Riser MBH
-40	9	6	5	4	3	3	⅞	3
	18	12	10	8	7	6	1⅛	6
	32	22	17	15	13	12	1⅜	10
	46	35	28	24	21	19	1⅝	17
	81	73	59	50	44	40	2⅛	35
	125	125	105	89	79	72	2⅝	61
	179	179	168	143	127	115	3⅛	99
	242	242	242	214	190	172	3⅝	147
	315	315	315	303	269	243	4⅛	208
	491	491	491	491	482	437	5⅛	374
-30	11	8	6	5	4	4	⅞	4
	24	16	13	11	9	9	1⅛	8
	42	28	23	19	17	15	1⅜	13
	60	45	36	31	27	25	1⅝	21
	105	95	76	65	57	52	2⅛	45
	161	161	135	115	102	92	2⅝	79
	231	231	216	185	164	148	3⅛	127
	312	312	312	275	244	221	3⅝	189
	406	406	406	390	345	313	4⅛	268
	633	633	633	633	620	562	5⅛	480
-20	15	10	8	7	6	5	⅞	5
	30	20	16	14	12	11	1⅛	10
	53	36	29	25	22	20	1⅜	17
	76	58	46	39	35	31	1⅝	27
	133	120	96	82	73	66	2⅛	57
	206	206	171	146	130	117	2⅝	101
	294	294	274	234	208	188	3⅛	161
	397	397	397	349	310	280	3⅝	240
	517	517	517	493	438	396	4⅛	340
	805	805	805	805	785	712	5⅛	609
-10	18	12	10	8	7	7	⅞	6
	38	26	21	18	15	14	1⅛	12
	66	45	36	31	27	25	1⅜	21
	96	72	58	49	44	40	1⅝	34
	168	151	121	103	92	83	2⅛	71
	259	259	215	184	163	147	2⅝	126
	370	370	343	294	261	236	3⅛	202
	500	500	500	438	388	352	3⅝	301
	650	650	650	618	548	497	4⅛	426
	1014	1014	1014	1014	982	890	5⅛	763

R-22

Low Temperature

Suction Line Sizing Table is established for design Conditions of 105°F Condensing Temperature. For other Condensing Temperatures use the multiplying factors listed below to determine the maximum capacity of the tubing.

Condensing Temp	Multiplying Factor
60	1.18
70	1.14
80	1.10
90	1.06
100	1.02
110	0.98
120	0.93

R-22

Low Temperature

Condenser Line Sizing

Condensing Temperature °F 60	70	80	90	100	105	110	120	
Discharge Maximum Allowable MBH								Line Size
37	42	46	50	53	56	57	60	7/8
76	85	94	102	109	114	116	123	1 1/8
131	147	163	177	189	197	200	212	1 3/8
209	234	259	281	300	313	319	338	1 5/8
432	483	535	580	619	645	657	696	2 1/8
[illegible]	873	966	1047	1117	1164	1187	1257	2 5/8
	1377	1523	1652	1762	1836	1872	1982	3 1/8
Liquid Return Maximum Allowable MBH								Line Size
98	92	88	82	78	76	73	68	5/8
205	193	184	173	163	159	154	143	7/8
349	330	314	295	279	271	262	243	1 1/8
532	503	479	450	425	413	400	371	1 3/8
754	713	678	637	602	585	567	526	1 5/8
1313	1241	1180	1109	1048	1018	987	916	2 1/8
2026	1916	1822	1742	1618	1571	1523	1413	2 5/8
2892	2735	2600	2443	2309	2242	2174	2017	3 1/8

Remote Header Line Sizing

Maximum Allowable MBH	Liquid Main	Maximum Allowable MBH	Suction Main
224	1 1/8	77	1 5/8
372	1 3/8	135	2 1/8
526	1 5/8	207	2 5/8
915	2 1/8	296	3 1/8
1411	2 5/8	401	3 5/8
		521	4 1/8
		812	5 1/8

Liquid Supply Line Sizing

Cond Temp °F	Maximum MBH of Refrigeration per Length of Equivalent Feet 50	100	150	200	250	300	Tubing Size OD
80	31	21	16	14	12	11	3/8
	71	48	38	32	29	26	1/2
	134	91	73	62	55	49	5/8
	308	243	194	165	146	132	7/8
	525	495	396	338	298	270	1 1/8
	800	800	693	591	523	473	1 3/8
	1132	1132	1100	940	831	752	1 5/8
	1970	1970	1970	1958	1735	1569	2 1/8
	3039	3039	3039	3039	3039	2786	2 5/8
90	31	21	17	14	12	11	3/8
	72	49	39	33	29	26	1/2
	136	63	74	65	55	50	5/8
	291	246	197	168	148	134	7/8
	496	496	401	343	303	274	1 1/8
	756	756	703	600	531	480	1 3/8
	1070	1070	1070	951	842	762	1 5/8
	1861	1861	1861	1861	1755	1589	2 1/8
	2871	2871	2871	2871	2871	2824	2 5/8
100	31	21	17	14	12	11	3/8
	73	49	39	33	29	26	1/2
	123	93	75	63	56	51	5/8
	274	248	199	169	150	135	7/8
	467	467	404	345	305	276	1 1/8
	711	711	709	604	535	484	1 3/8
	1007	1007	1007	960	850	769	1 5/8
	1752	1752	1752	1752	1752	1604	2 1/8
	2702	2702	2702	2702	2702	2702	2 5/8
110	31	21	17	14	12	11	3/8
	73	50	39	33	29	27	1/2
	123	94	75	64	56	51	5/8
	257	249	199	170	150	136	7/8
	438	438	406	346	306	277	1 1/8
	667	667	667	607	536	486	1 3/8
	944	944	944	944	851	771	1 5/8
	1643	1643	1643	1643	1643	1606	2 1/8
	2533	2533	2533	2533	2533	2533	2 5/8
120	31	21	17	14	12	11	3/8
	71	49	39	33	29	27	1/2
	115	94	75	64	56	51	5/8
	239	239	199	169	150	135	7/8
	408	408	404	345	305	276	1 1/8
	622	622	622	604	535	483	1 3/8
	881	881	881	881	848	767	1 5/8
	1532	1532	1532	1532	1532	1532	2 1/8
	2363	2363	2363	2363	2363	2363	2 5/8

Hussmann Refrigerant Line Sizing

R-22

Medium Temperature

Evap Temp °F	Suction Line Sizing — Maximum MBH of Refrigeration per Length of Equivalent Feet, 110 °F Condenser: 50	100	150	200	250	300	Tubing Size OD"	Vertical Riser MBH
10	10	7	5	5	—	—	5/8	3
	28	19	15	13	11	10	7/8	9
	56	39	31	26	23	21	1 1/8	18
	98	68	54	46	41	37	1 3/8	32
	144	107	86	74	65	59	1 5/8	51
	252	223	179	153	136	123	2 1/8	106
	388	388	317	272	241	218	2 5/8	187
	555	555	507	435	386	349	3 1/8	300
	750	750	750	646	573	520	3 5/8	446
	975	975	975	912	810	734	4 1/8	629
20	12	8	7	6	—	—	5/8	4
	34	23	18	16	14	12	7/8	11
	68	47	38	32	28	26	1 1/8	22
	119	82	66	56	50	45	1 3/8	39
	177	130	105	90	79	72	1 5/8	62
	308	270	217	186	165	150	2 1/8	128
	475	475	385	330	293	265	2 5/8	228
	679	679	614	527	468	424	3 1/8	364
	918	918	914	783	695	631	3 5/8	541
	1194	1194	1194	1105	981	891	4 1/8	763
30	15	10	8	7	—	—	5/8	5
	41	28	22	19	17	15	7/8	13
	82	57	45	39	34	31	1 1/8	27
	143	99	79	68	60	55	1 3/8	47
	215	157	126	108	96	87	1 5/8	74
	374	325	262	224	199	180	2 1/8	155
	577	574	462	397	352	319	2 5/8	274
	824	824	738	634	563	510	3 1/8	438
	1115	1115	1096	941	835	759	3 5/8	650
	1450	1450	1450	1328	1179	1070	4 1/8	919
40	18	12	10	8	—	—	5/8	6
	48	33	27	23	20	18	7/8	16
	98	68	54	46	41	37	1 1/8	32
	171	118	95	81	72	65	1 3/8	56
	259	187	150	129	114	104	1 5/8	89
	451	387	312	268	237	215	2 1/8	185
	696	684	551	473	420	381	2 5/8	327
	993	993	880	756	671	608	3 1/8	522
	1334	1334	1306	1122	996	905	3 5/8	777
	1747	1747	1747	1581	1406	1277	4 1/8	1096
50	22	15	12	—	—	—	5/8	7
	57	39	32	27	24	22	7/8	19
	116	80	64	55	49	44	1 1/8	38
	202	140	113	96	85	77	1 3/8	67
	310	221	178	153	135	123	1 5/8	104
	540	458	369	317	281	255	2 1/8	219
	833	808	653	560	497	451	2 5/8	387
	1189	1189	1039	893	793	720	3 1/8	617
	1609	1609	1544	1327	1178	1069	3 5/8	918
	2091	2091	2091	1870	1660	1509	4 1/8	1296

Suction Line Sizing Table is established for design Conditions of 110°F Condensing Temperature. For other Condensing Temperatures use, the multiplying factors listed below to determine the maximum capacity of the tubing.

Condensing Temp	Multiplying Factor
60	1.21
70	1.17
80	1.13
90	1.09
100	1.04
110	1.00
120	0.95

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Medium Temperature

Condenser Line Sizing

Condensing Temperature °F 60	70	80	90	100	110	120	
Discharge Maximum Allowable MBH							Line Size
35	40	44	48	53	59	63	7/8
71	80	88	97	107	118	127	1 1/8
125	139	153	170	186	205	221	1 3/8
197	220	243	268	294	324	349	1 5/8
8	454	501	555	608	669	722	2 1/8
9	802	885	979	1073	1180	1274	2 5/8
1	1082	1194	1321	1449	1592	1720	3 1/8
id Return aximum Allowable MBH							Line Size
96	91	86	82	77	72	66	5/8
201	190	180	171	160	150	139	7/8
344	326	308	292	274	257	239	1 1/8
523	496	469	445	418	391	363	1 3/8
742	703	664	631	592	554	515	1 5/8
1291	1224	1156	1098	1031	964	896	2 1/8
1991	1887	1783	1694	1590	1486	1381	2 5/8
2843	2694	2546	2419	2270	2122	1973	3 1/8

Remote Header Line Sizing

Maximum Allowable MBH	Liquid Main	Maximum Allowable MBH	Suction Main
342	1 1/8	176	1 5/8
521	1 3/8	306	2 1/8
738	1 5/8	472	2 5/8
1284	2 1/8	673	3 1/8
1980	2 5/8	911	3 5/8
2826	3 1/8	1184	4 1/8

Liquid Supply Line Sizing

Cond Temp °F	Maximum MBH of Refrigeration per Length of Equivalent Feet 50	100	150	200	250	300	Tubing Size OD
80	30	20	16	13	12	11	3/8
	70	47	37	32	28	25	1/2
	131	90	71	61	53	48	5/8
	302	238	190	162	143	129	7/8
	515	485	388	331	293	265	1 1/8
	784	784	680	580	513	464	1 3/8
	1110	1110	1079	921	815	737	1 5/8
	1932	1932	1932	1920	1701	1538	2 1/8
	2979	2979	2979	2979	2979	2732	2 5/8
90	30	20	14	14	12	11	3/8
	71	48	38	32	28	26	1/2
	133	91	72	62	54	49	5/8
	285	241	193	164	145	131	7/8
	486	486	393	336	297	268	1 1/8
	740	740	688	588	520	470	1 3/8
	1048	1048	1048	932	825	747	1 5/8
	1824	1824	1824	1824	1720	1557	2 1/8
	2812	2812	2812	2812	2812	2767	2 5/8
100	31	21	16	14	12	11	3/8
	71	48	38	33	29	26	1/2
	129	91	73	62	55	49	5/8
	268	243	194	166	146	132	7/8
	457	457	396	338	299	270	1 1/8
	696	696	694	592	524	474	1 3/8
	986	986	986	940	832	753	1 5/8
	1715	1715	1715	1715	1715	1570	2 1/8
	2645	2645	2645	2645	2645	2645	2 5/8
110	31	21	16	14	12	11	3/8
	71	48	39	33	29	26	1/2
	121	92	73	62	55	50	5/8
	251	243	195	166	147	133	7/8
	428	428	397	339	299	271	1 1/8
	652	652	652	593	524	475	1 3/8
	923	923	923	923	832	754	1 5/8
	1606	1606	1606	1606	1606	1571	2 1/8
	2478	2478	2478	2478	2478	2478	2 5/8
120	31	21	16	14	12	11	3/8
	70	48	38	33	29	26	1/2
	112	91	73	62	55	49	5/8
	234	234	194	165	146	132	7/8
	399	399	394	337	298	270	1 1/8
	608	608	608	590	522	472	1 3/8
	860	860	860	860	829	749	1 5/8
	1497	1497	1497	1497	1497	1497	2 1/8
	2309	2309	2309	2309	2309	2309	2 5/8

REFRIGERATION PROCESS

OVERVIEW

This section details the refrigeration process by tracking the refrigerant flow through the system components. Oil separation and return is explained.

The Custom System is designed with a 14” diameter receiver for increased receiver volume. The compact design reduces height and width requirements, yet provides convenient access to components for easy maintenance and service.

Typically, supermarket refrigeration falls into low or medium temperature ranges. An average low temperature rack maintains a suction temperature of -25F with a low-end Satellite operating at -33F. A common medium temperature rack operates at +16F with a low-end Satellite operating at +7. High-end Satellites are often applied to prep room cooling.

In this instruction the following constants are maintained to assist the reader.

In the diagrams refrigerant flow direction is generally clockwise and indicated by directional arrows.

Electrical solenoid valves carry the same initial abbreviations as in the electrical schematics.

Refrigeration lines not actually in the cycle being discussed are shown closed or removed. Pressure in oil lines will also retain a fixed pattern.

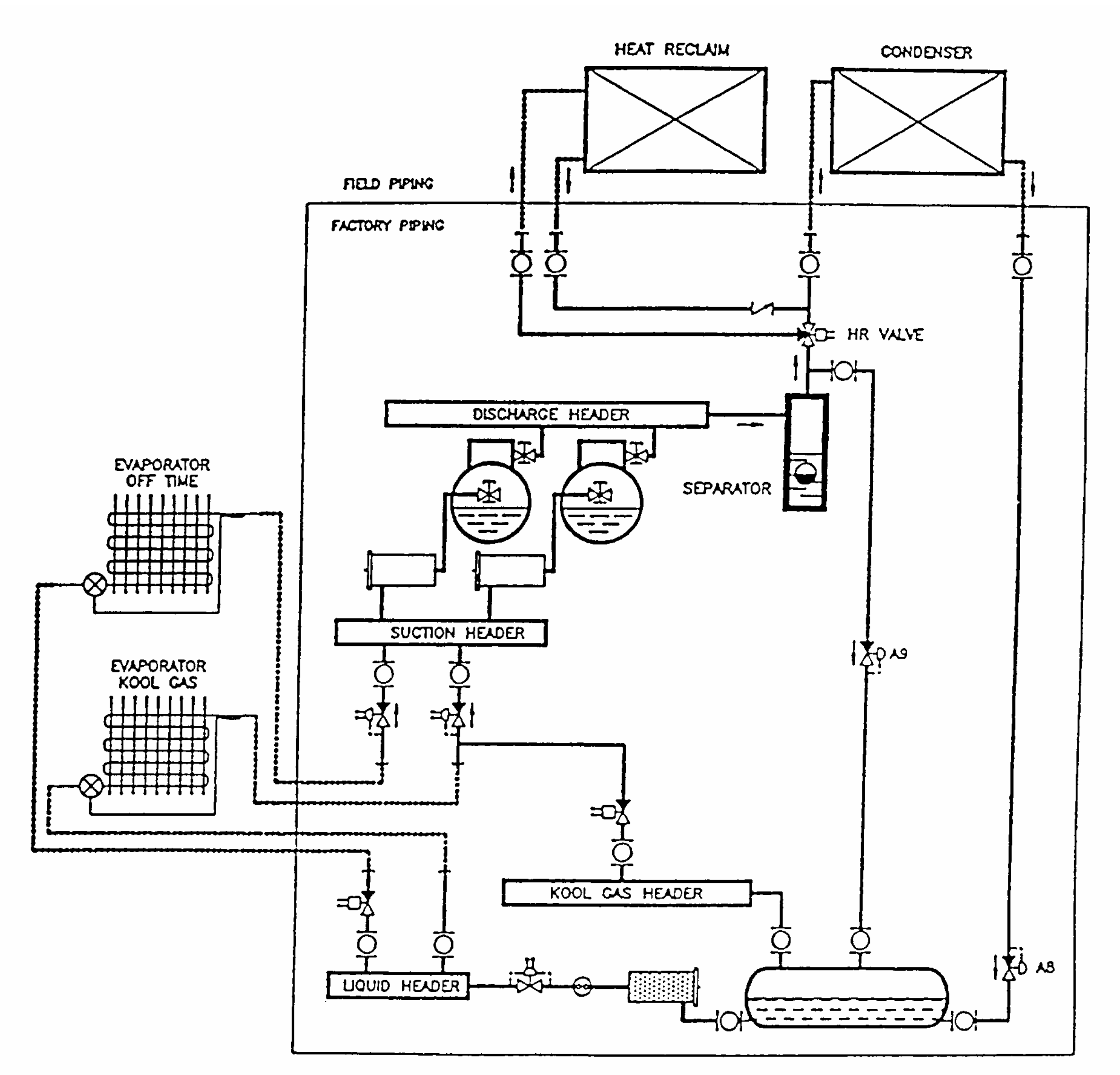


Figure 2–1 Custom System Refrigeration

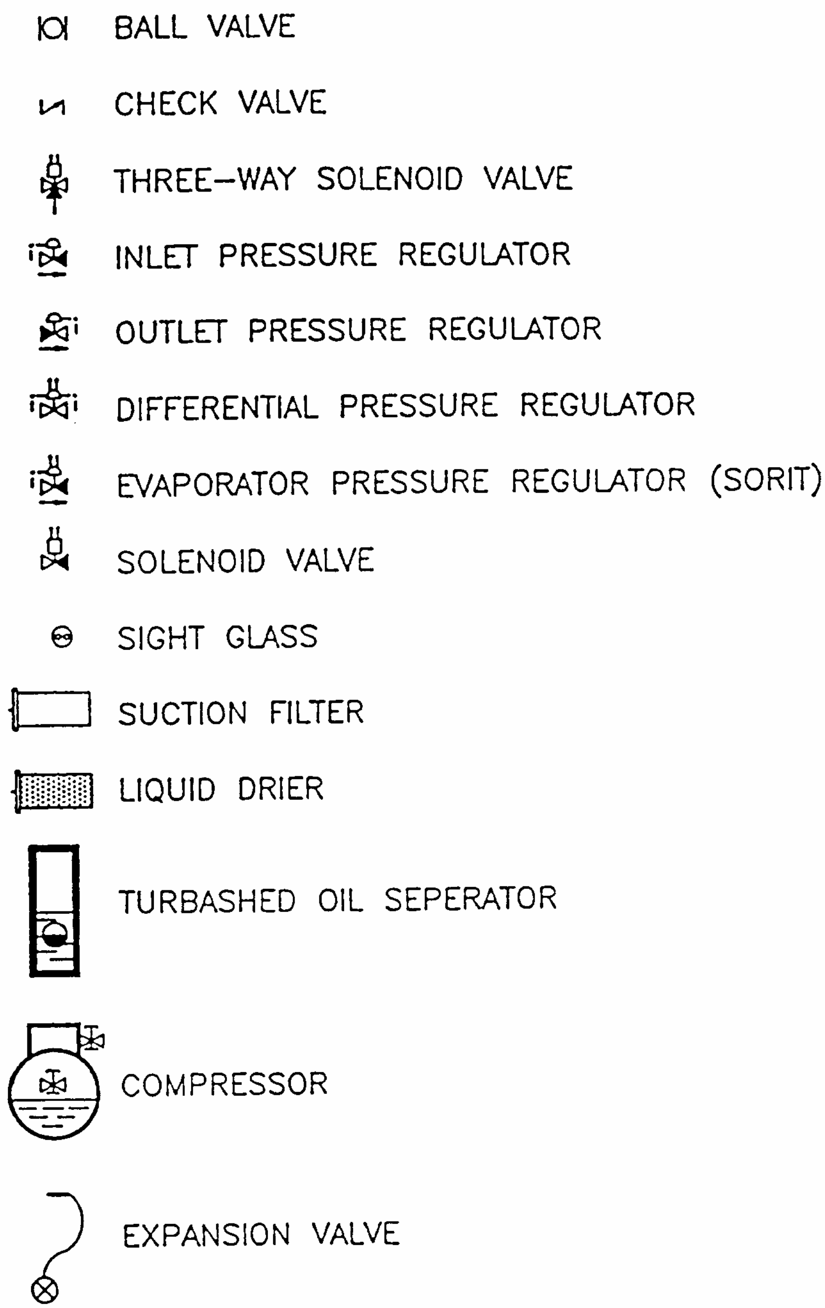


Figure 2–2 Refrigeration Symbols

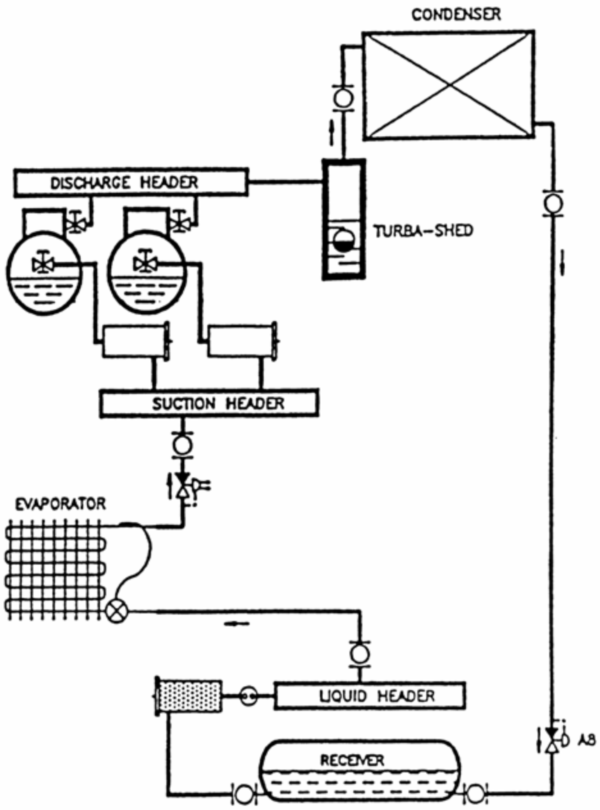


Figure 2–3 Refrigeration Cycle

BASIC REFRIGERATION CYCLE

Beginning with the Parallel Compressors, refrigerant vapor is compressed and flows to the Turba-shed. The Turba-shed separates the oil from the discharge gas by centrifugal force and screen baffles. The oil is stored in the bottom of the Turba-shed and returned to the compressors.

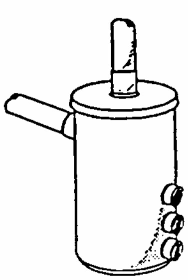


Figure 2–4 Turba-shed

A 3-Way Heat Reclaim Valve directs the superheated discharge gas to either the condenser or a Heat Reclaim device when energized. When the reclaim solenoid is de-energized the valve directs the refrigerant to the condenser. The Condenser rejects the heat that must be removed from refrigerant to cause it to condense.

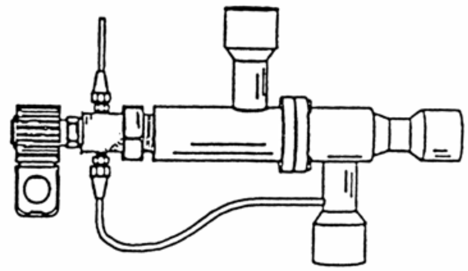


Figure 2–5 Heat Reclaim Valve

The Flooding Valve maintains head pressure in low ambient conditions by restricting liquid refrigerant flow from the Condenser. This causes liquid refrigerant to be backed up in the condenser thus reducing available heat transfer surface and causing the discharge pressure to rise.

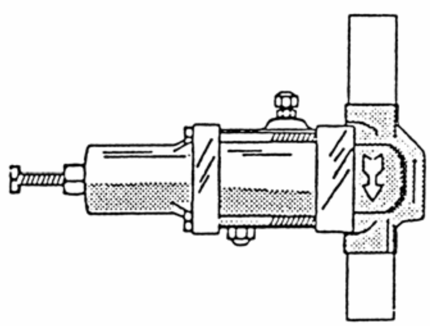


Figure 2–6 Flooding Valve

The receiver is a holding vessel for liquid refrigerant that compensates for fluctuations in liquid requirements due to changing load, defrost, and weather.

The Main Liquid Pressure Differential Valve functions during gas defrost to reduce pressure to the Liquid Header. The reduced pressure allows reverse flow of refrigerant gas through the evaporator necessary for an effective defrost.

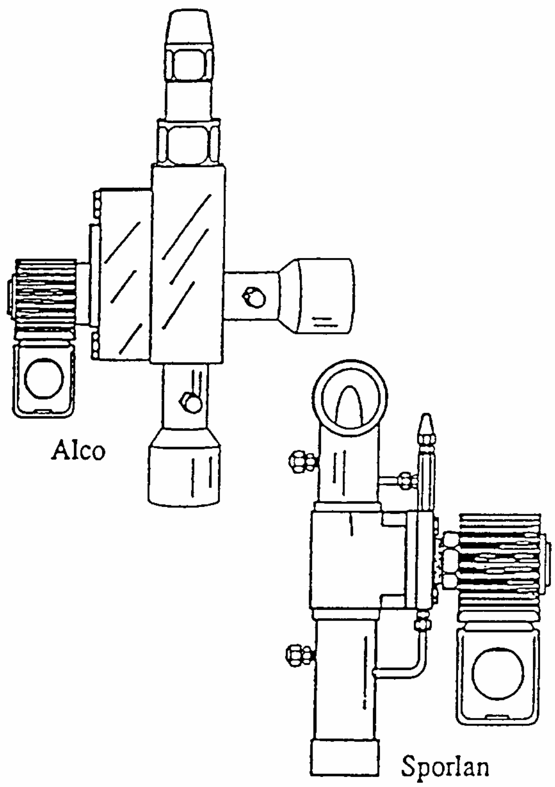


Figure 2–7 Main Liquid Pressure Differential Valve

The Liquid Header distributes liquid refrigerant to all Branch Liquid Lines.

The Branch Liquid Line Solenoid Valve closes off refrigerant supply to the evaporator, yet allows back flow of refrigerant into the Liquid Header.

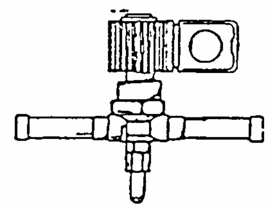


Figure 2–8 Liquid Branch Solenoid Valve

The TEV, located in the merchandiser, meters liquid refrigerant through its orifice to the low pressure side of the system where it absorbs heat from the coil causing the liquid to evaporate.

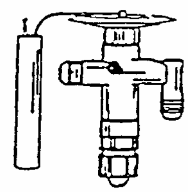


Figure 2–9 TEV

An Evaporator Pressure Regulator (EPR) may be used to control the evaporator temperature by preventing the evaporator pressure from dropping below a preset pressure.

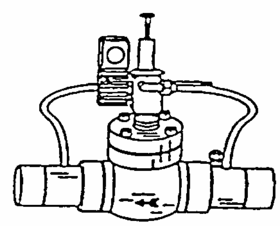


Figure 2–10 EPR Valve

At critical locations along the refrigerant path, service valves or ball valves allow isolation of components.

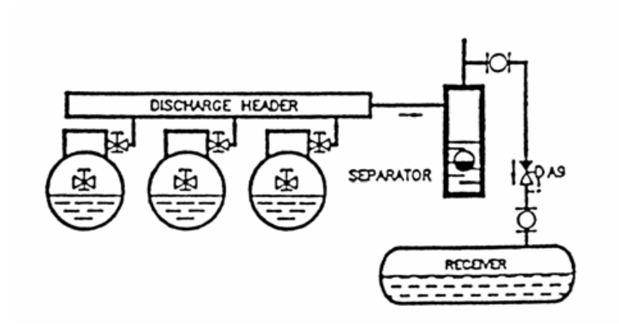


Figure 2–12 Receiver Pressure Regulation

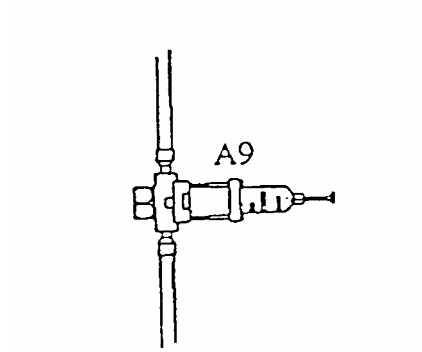


Figure 2–13 A9 Valve

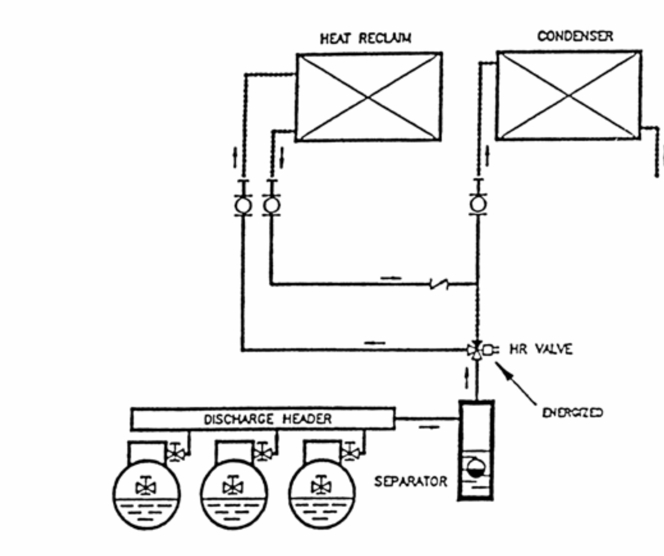


Figure 2–11 Heat Reclaim Cycle

HEAT RECLAIM CYCLE

The Heat Reclaim 3-Way Valve energizes during reclaim mode diverting discharge gas to a remote mounted air reclaim coil or water heating coil. After the discharge gas passes through the reclaim coil, it returns to the system through a check valve and then to the condenser. The check valve assures no back flow and flooding when Heat Reclaim cycle is off. During Heat Reclaim, the Heat Reclaim coil rejects superheat from the refrigerant vapor and the condenser coil rejects latent heat and produces quality liquid for the refrigeration process.

RECEIVER PRESSURE REGULATION

The Pressure Regulator Valve (A9) responds to receiver pressure. If the Receiver pressure drops below its setpoint the A9 valve opens, directing High Pressure Vapor to the Receiver. Receiver Pressure can be adjusted by turning the adjustment stem on the valve. See settings section for correct pressure setting.

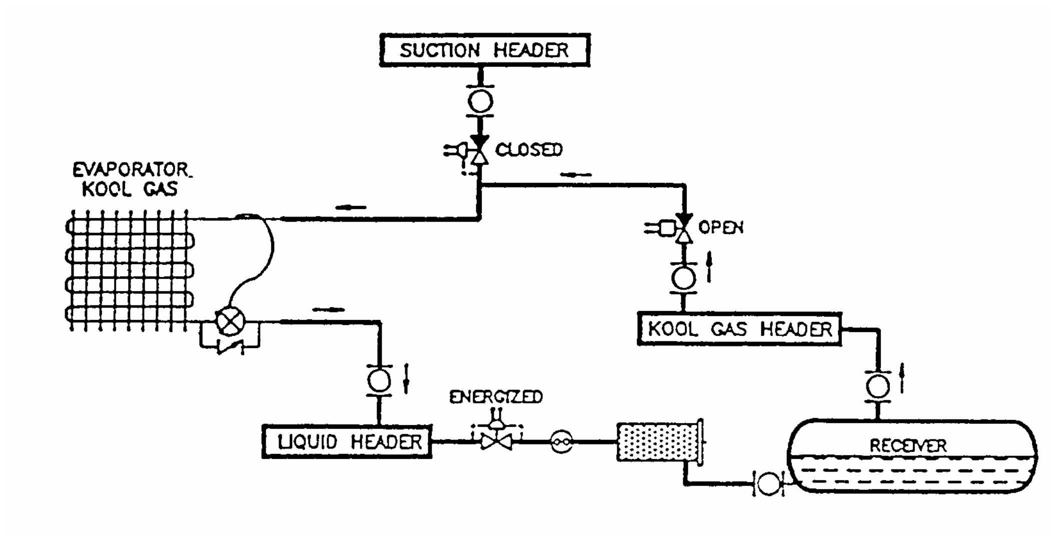


Figure 2–14 Koolgas Defrost Cycle

KOOLGAS DEFROST CYCLE

Beginning with the Receiver the Koolgas Cycle splits in two directions – Receiver Vapor and Receiver Liquid. The high pressure liquid flowing from the Receiver is throttled by the Main Liquid Line Solenoid Valve causing a pressure reduction in the Liquid Header.

If a Branch Liquid Line Solenoid Valve is used on a Koolgas circuit, the liquid circuit is designed to allow backflow into the reduced pressure Liquid Header by an external parallel check valve or by a special solenoid valve designed to allow reverse flow. When a branch of refrigeration cases enters the defrost cycle its Branch Valve allows refrigerant to flow into the Liquid Header.

The Receiver Vapor flows directly into the Koolgas Header. This Koolgas Vapor maintains the same high pressure as the receiver. A 3-Way Valve closes the suction line to the Suction Header and opens the Koolgas line to the Evaporator. Koolgas Vapor flows backward through the Evaporator, giving up heat to the Evaporator for defrost.

The Koolgas Vapor condenses and flows into the reduced pressure liquid line through a Bypass check valve around the TEV. From there it is returned to the Liquid Line Header.

If a Suction Stop or EPR with Suction Stop is used to control Evaporator temperature, the 3-Way valve is not used. When defrost is called for, the suction line control valve closes and a two-way Koolgas Valves opens the line from the Koolgas Header to the Evaporator.

OIL SYSTEM

Discharge refrigerant carries droplets of oil from the compressors' lubrication system. The Turba-shed returns the oil from its reservoir along the high pressure line to the Oil Pressure Differential Regulator Valve. This valve reduces the oil pressure to between 10 and 15 psig above the crackcase pressure of the compressor, providing even flow of oil to the Oil Level Regulators.

To balance oil level among the compressors an Equalizing Line returns any excess oil in one Oil Level Regulator to the rest of the system. A Check Valve is placed in the Equalizing Line between the Low End Satellite and the rest of the system. The check valve is necessary to keep the Low End Satellite from filling up with oil. With a High End Satellite, note that the Satellite has no Equalizing line.

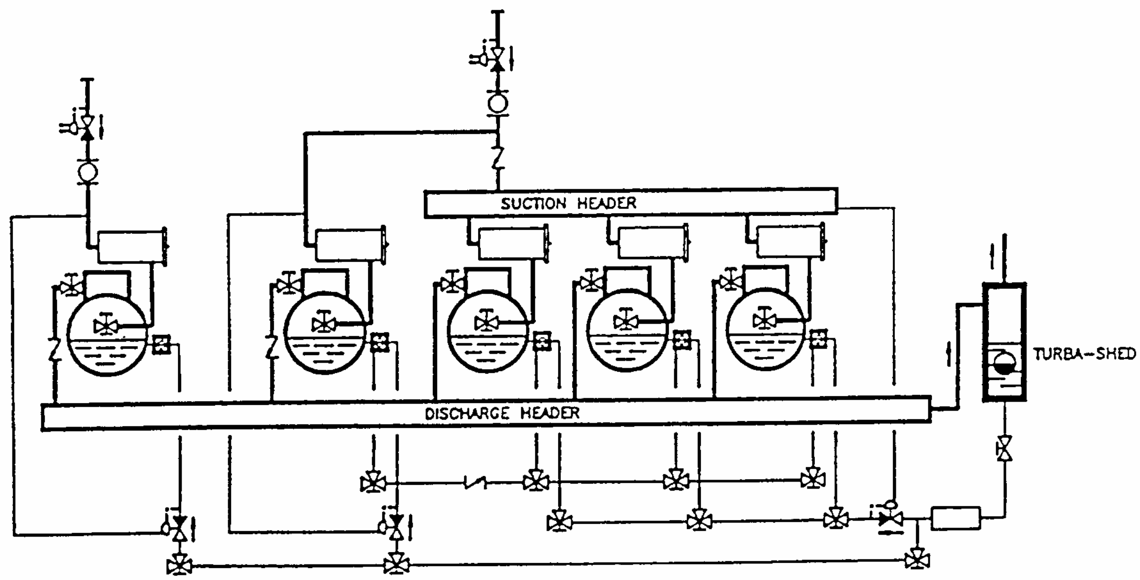


Figure 2–15 Satellite Oil System

AMBIENT SUBCOOLING

The Surge Valve directs flow of refrigerant from the condenser through the Receiver (Flow Through), or around the Receiver (Surge) in response to ambient subcooling obtained in the condenser.

During low ambient conditions the A9 Receiver Pressure Regulator will aid in maintaining pressure in the liquid header.

The Surge Valve reacts to liquid temperature from the condenser. When the liquid temperature is below 75F the Surge Valve will open allowing subcooled liquid to bypass the receiver into the liquid header. When the liquid temperature is above 75F the Surge Valve will close forcing liquid into the receiver and then into the liquid header. The Surge Valve is controlled by a t'stat that closes on drop of liquid drain temperature. The correct setting may have to be adjusted due to lower flooding valve settings.

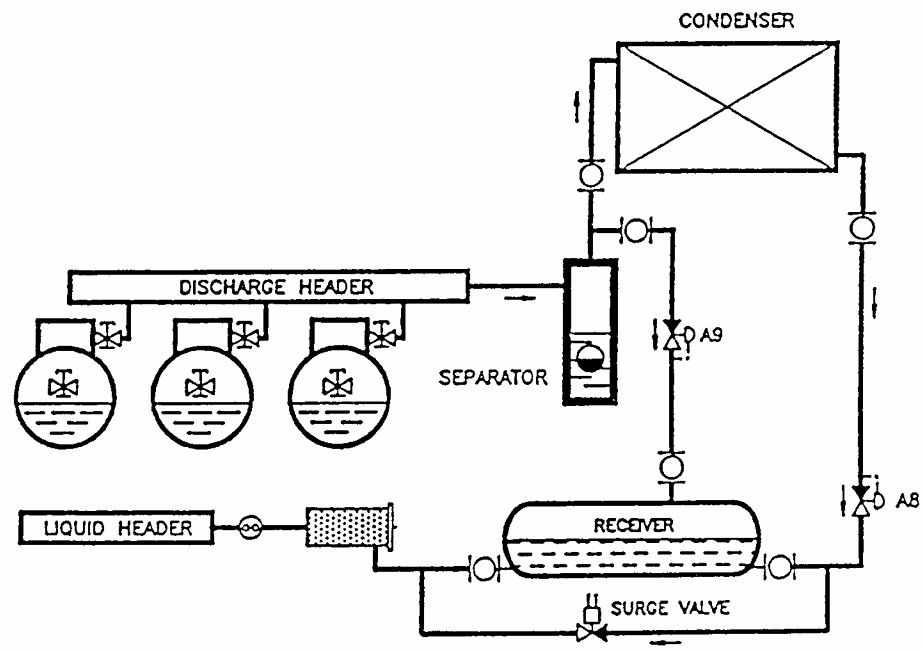


Figure 2–16 Receiver Surge
for Ambient Subcooling

MECHANICAL SUBCOOLING

By lowering the temperature of the liquid supplied to the TEV, the efficiency of the evaporator is increased. The lower temperature liquid refrigerant produces less flash gas exiting the TEV. Since mechanical subcooling uses a direct expansion device, it is not limited by ambient temperature.

A Liquid Line Solenoid Valve and a TEV control refrigerant to the subcooler. An EPR prevents the subcooler temperature from dropping below desired liquid temperature.

Electrically, a thermostat responding to main liquid line temperature controls a solenoid valve on the liquid supply line.

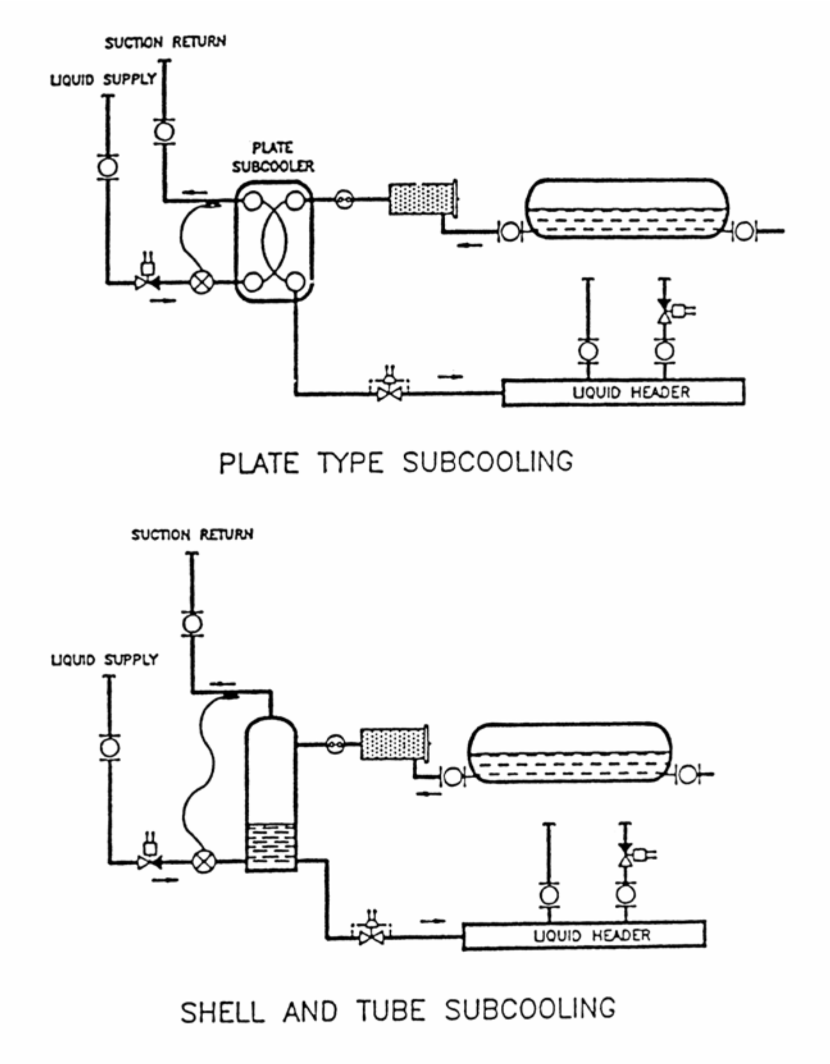


Figure 2–17 Mechanical Subcooling

TWO STAGE MECHANICAL SUBCOOLING

Due to wide ranges of load requirements with subcooling, in certain instances, a two stage subcooling control will be utilized. In two stage subcooling, there are two expansion valves piped in parallel; one valve approximately one-half the size of the other. The largest valve will be in operation during full load conditions. When the load requirements are reduced, the smaller valve will be turned on. At this time, the larger valve will be shut off. When the liquid drop leg reaches the subcooled liquid design point, both valves will be shut off.

COMPOUND RACK

A Compound System consists of two different compression stages (low/high). The two stages are interconnected by the low stage compressors discharging gas into the high stage suction.

Liquid Injection provides for proper superheat levels entering the high stage compressors of a compound system. This prevents excessive discharge temperatures on the high stage.

A TEV in the liquid refrigerant line regulates the refrigerant flow into the low stage discharge header in response to its superheat temperature.

Electrically, a thermostat responding to the high stage suction temperature controls a solenoid valve on the liquid supply line to maintain a suction temperature of approximately 65F. Power is supplied to this circuit through any one of the parallel auxiliary contactors on each low stage compressor contactor, so at least one low stage compressor must be running for the liquid injection to work. Some systems have secondary desuperheaters for backup which energize when the discharge gas of the high stage rises above 240F. The secondary device should de-energize when the high stage discharge gas temperature goes below 220F.

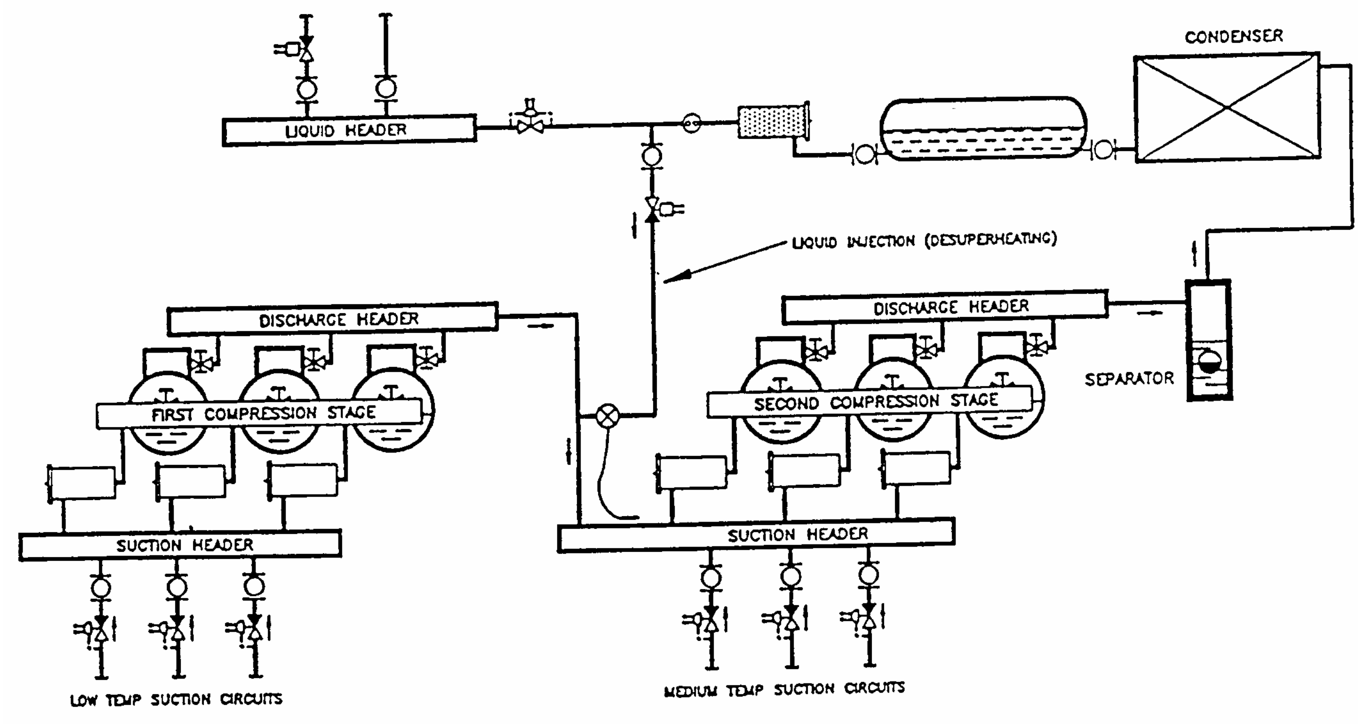


Figure 2–18 Compound Rack

DEMAND COOLING

The Demand Cooling System is designed to inject saturated refrigerant into the compressor suction cavity when the compressor internal head temperature exceeds 292F. Injection continues until the temperature is reduced to 282F. If the temperature remains above 310F for one minute the control shuts down the compressor.

The Temperature Sensor employees a Negative Temperature Coefficient (NTC) Thermistor to provide signals to the Control Module. The NTC resistance drops on temperature rise.

The Control Module responds to the Temperature Sensor input by energizing the Injection Valve Solenoid when 292F is exceeded. Too high or too low a resistance from the thermistor circuit will cause the Module to shutdown the compressor after one minute.

The Injection Valve meters saturated refrigerant into the suction cavity of the compressor.

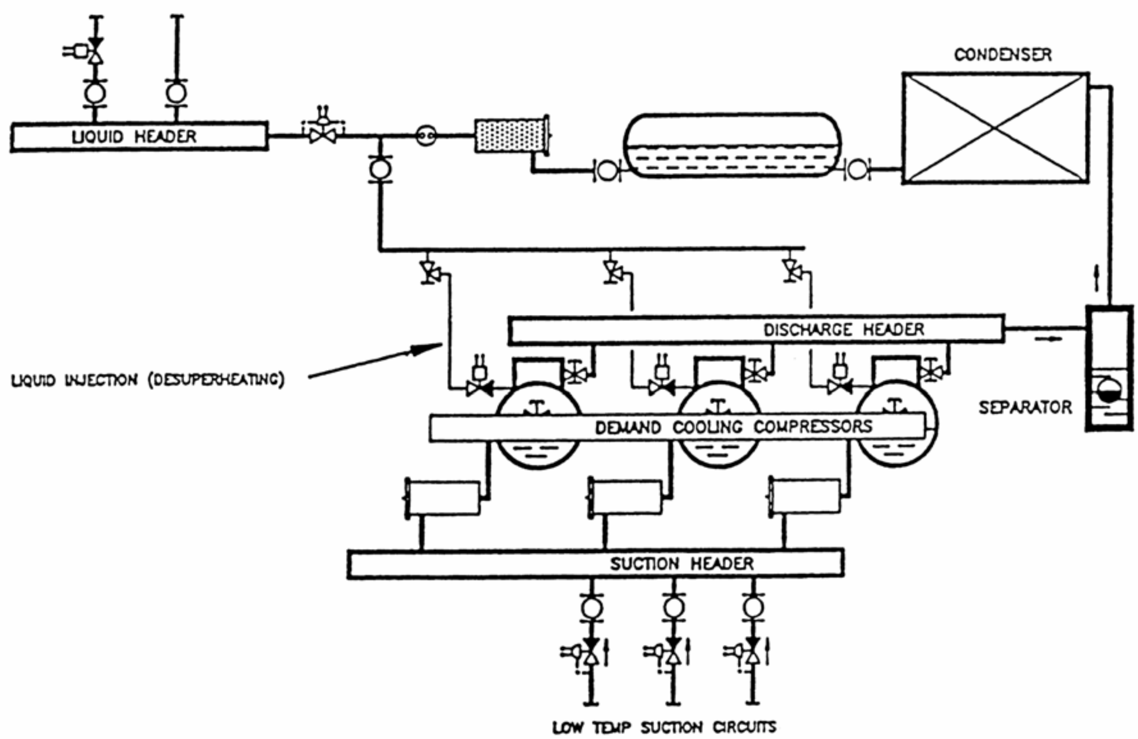


Figure 2–19 Demand Cooling

COMPOUND COOLING

The Compound Cooling system is designed as an internally compounded compressor. The same principle of the compound rack applies to the internally compounded compressor. There are two different compression stages internally and an injection expansion valve senses high stage discharge gas and injects saturated refrigerant into the low stage discharge as required.

There is an additional pressure switch on the compressor that senses the low stage discharge / high stage suction pressure and cuts the compressor off if that pressure becomes too high. The solenoid valve that feeds the injection expansion valve is interlocked with the compressor contactor so that the solenoid is open only when the compressor is running. There is also an internal head t'stat that will cut the compressor off if the high stage compressor discharge gas becomes too high.

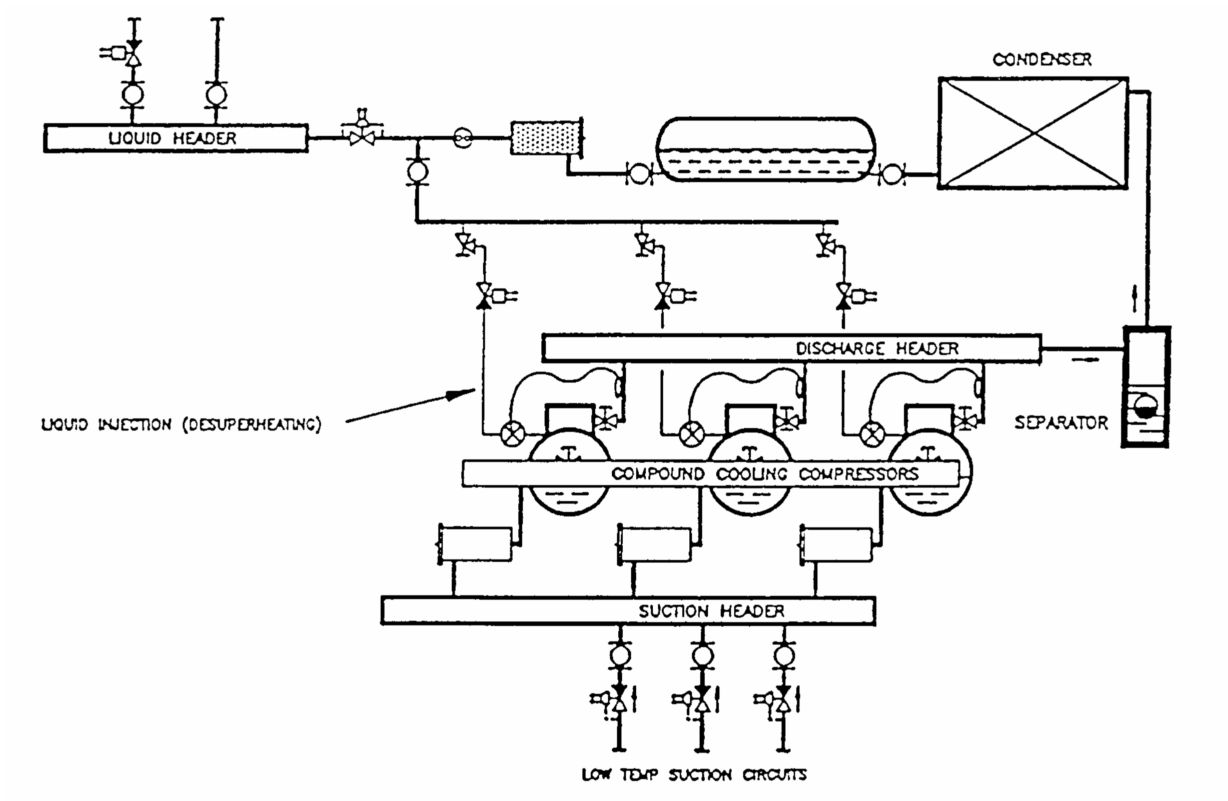


Figure 2–20 Compound Cooling

COMPONENT PIPING

OVERVIEW

This section deals with the information necessary for installing the refrigeration lines for a rack. The components are piped as completely as practical at the factory. Field piping requires only interconnection of the major components and to the refrigerators.

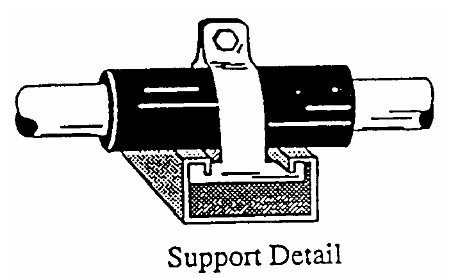
Use only clean, dehydrated, sealed refrigeration grade copper tubing. Use dry nitrogen in the tubing during brazing to prevent the formation of copper oxide. All joints should be made with silver alloy brazing material, and use 45% silver solder for dissimilar metals.

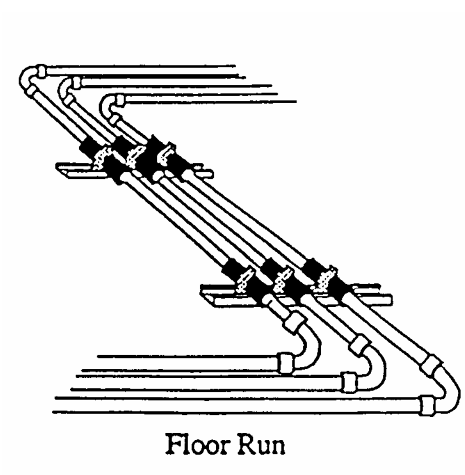
WARNING

Always use a Pressure Regulator on the nitrogen tanks.

REFRIGERATION LINE RUNS

Liquid Lines and suction lines must be free to expand and contract independently of each other. Do not clamp or solder them together. Run supports must allow tubing to expand and contract freely. Do not exceed 100 feet without a change of direction or/and offset. Plan proper pitching, expansion allowance, and P-traps at the base of all suction risers. Use long radius elbows to reduce line resistance and breakage. Avoid completely the use of 45 degree elbows. Install service valves at several locations for ease of maintenance and reduction of service costs. These valves must be UL approved for 410 paig minimum working pressure.





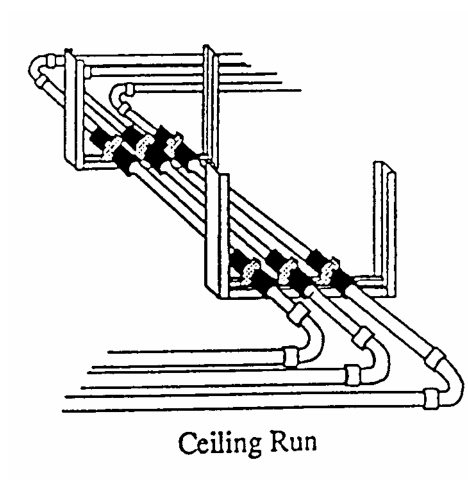


Figure 3-1 Supporting Refrigeration Lines

Through Walls or Floors

Refrigeration lines run through walls or floors must be properly insulated. Avoid running lines through the refrigeration cases. When this is done the lines must be adequately insulated – Armaflex or equivalent.

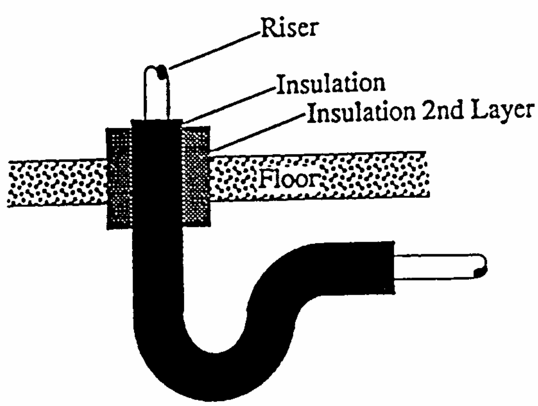


Figure 3-2 Insulating a Riser

From Machinery to Solid Object

When mounting lines from machinery to a solid object allow line freedom for vibration to prevent metal fatigue.

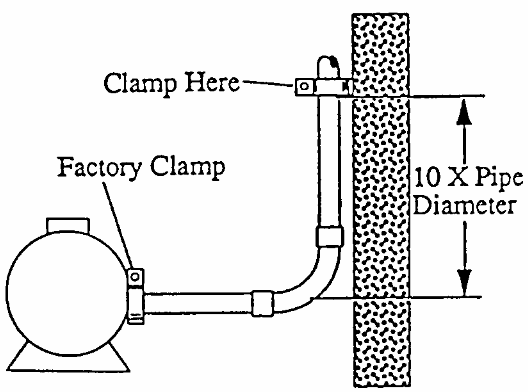


Figure 3-3 Vibration Allowance

P-Trap Construction

A P-Trap must be installed at the bottom of all suction risers to return oil to the compressors.

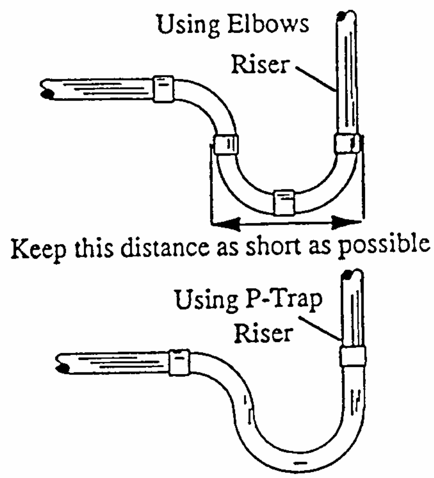


Figure 3-4 P-Trap Construction

Reduced Riser

When a reduced riser is necessary, place the reduction coupling downstream of the P-Trap.

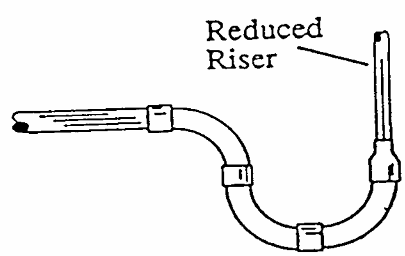


Figure 3-5 Reduced Riser

Factory Supplied Stubs

Stub sizes provided from the Manifolds do not automatically correspond to the line sizes necessary. It is the installer's responsibility to supply reduction couplings.

Protecting Valves and Clamps

When Brazing near factory installed clamps or valves be sure to protect them with a wet rag to avoid overheating.

RACK TO CONDENSER PIPING

Connecting to One Manifold

Discharge Line will be routed directly to the condenser inlet stub with a purge valve at the highest point.

Liquid Return line will be pitched downstream and provide trapless drainage to the Rack

WARNING

Vent the Receiver Safety Relief Valve properly.

Purge Valve Location

The purge valve will be installed at the highest point of an inverted P-Trap, with at least a 6” rise. (Use with approved recovery vessel.)

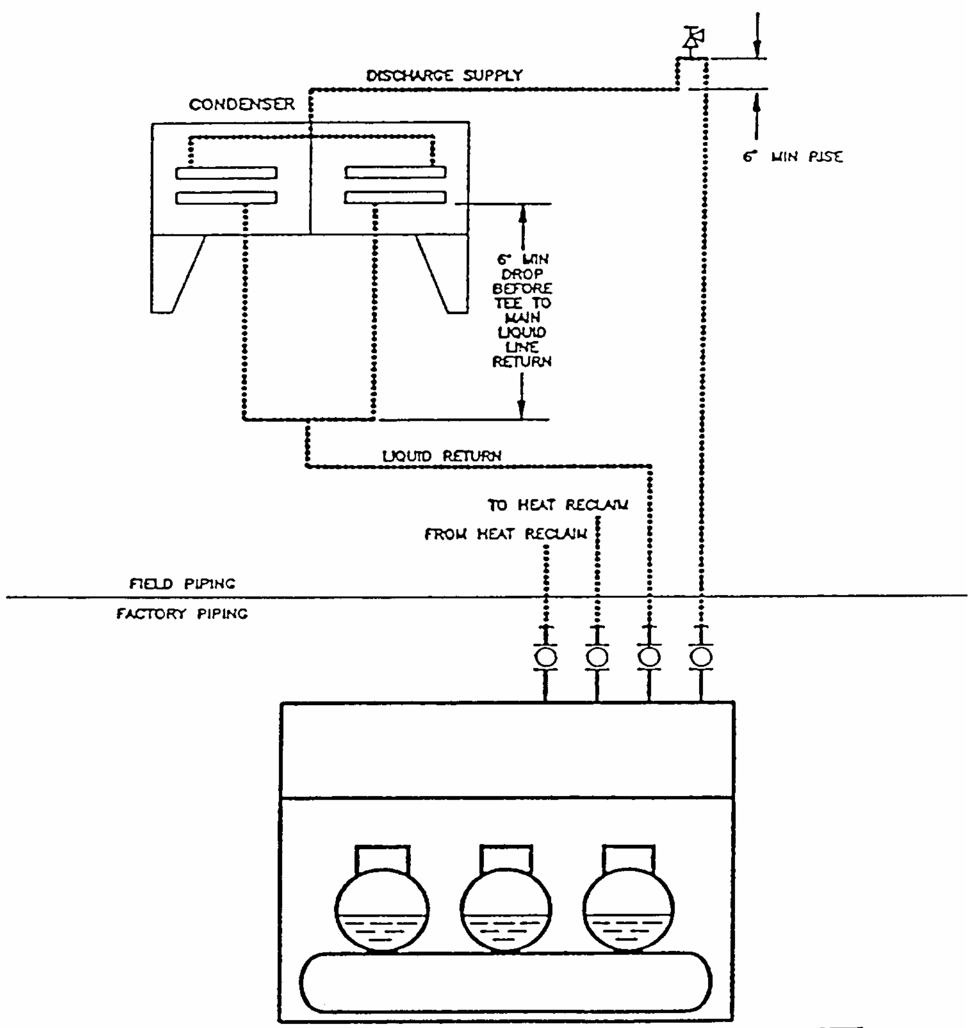


Figure 3-6 Rack to Condenser Piping

Connecting to Two Manifolds

The Discharge line will be "tee"d upstream of the manifolds into expansion offsets with at least a one foot drop to the manifolds. Provide a Purge valve at the highest point.

The Liquid Return Lines will be "tee"d into the Main Liquid Return Line after six feet of vertical drop from the outlet stubs. The Liquid Return Line will be pitched downstream, and provide trapless drainage to the Rack.

WARNING

Vent the Receiver Safety Relief Valve properly

NOTES:

- Liquid Return Lines must be free draining with no Traps.
- Install Solenoid Valves inside Equipment Room.
- All Interconnecting Valving to be Field Supplied and Installed.

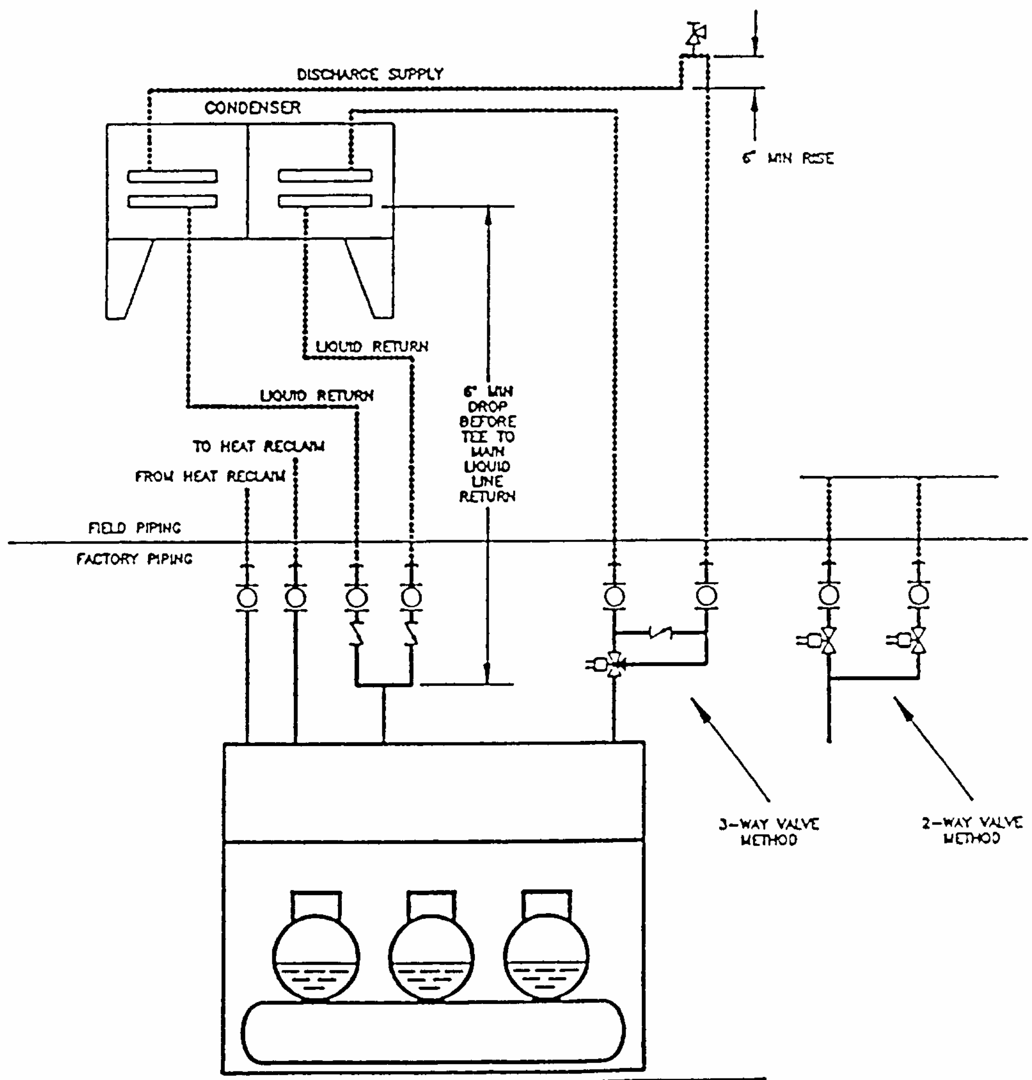


Figure 3-7 Rack to Condenser Piping, Split Condenser

RACK TO REMOTE HEADER
The Rack Suction Stub is connected as directly as possible to the Suction Header.

The Rack Liquid Line Stub is connected as directly as possible to the Liquid Header.

If equipped with Koolgas Defrost the Rack Koolgas Stub is connected as directly as possible to the Koolgas Header.

RACK TO REMOTE SATELLITE
The compressor Discharge Line will be piped through a vibration absorber to its stub on the Discharge Header.

The compressor Suction Line will be piped one of two ways depending on whether a Low-end or High-end Satellite is used. A Low-end Satellite Suction Line id piped to its check valve on the Suction Header, and from there to the evaporator. (If Koolgas Defrost is used pipe through the proper Koolgas valve.) A High-end Satellite is piped directly to the evaporator.

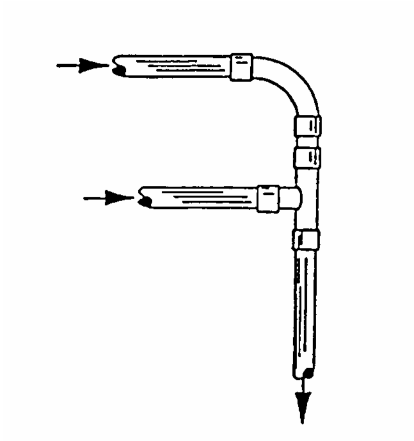


Figure 3-8 Offset Tee Construction

Discharge Lines for Two Satellites
Installations having two Satellites are “tee”d together upstream of the discharge manifold. Use an offset tee construction. Do not use a bullhead tee.

Oil Lines for Remote Satellites
All oil lines are run in 3/8 copper. Lines will be installed securely and run under tapered coverplates when crossing walkways

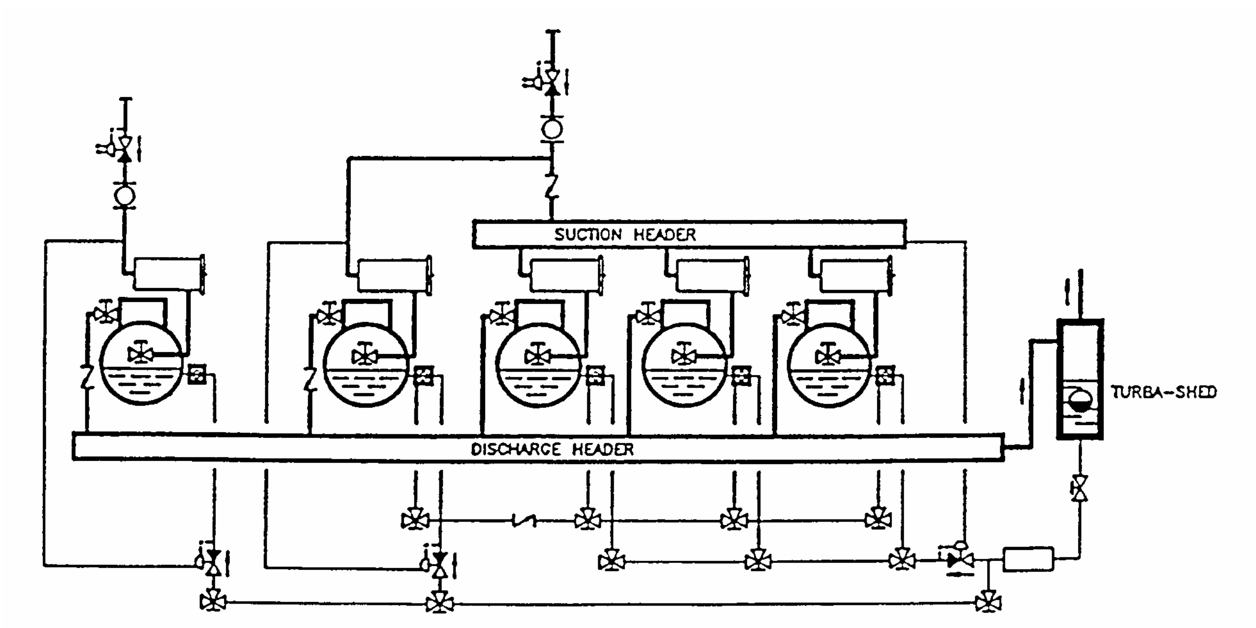


Figure 3-9 Satellite Piping

RACK TO HEAT RECLAIM

Because of the variety of Heat Reclaim systems, refer to the instructions accompanying the system to be installed at the site.

OFFSET AND EXPANSION LOOP CONSTRUCTION

Sizing

For low temperature applications multiply the length of the run in feet by .0169.

For medium temperature application multiply the length of the run in feet by .0112.

The product will be inches of linear expansion for the length of run.

Examples:
Low temperature application, a run of 84 feet of 1 3/8 inch OD.

84 X .0169 = 1.4196 inches expansion.

Select the smallest "Inches Expansion" figure equal to or greater than the product in step one from the table below. Follow that column down until it intersects the OD line size of the run. The number listed at the intersection is the "L" valve for figuring offset an expansion loop sizes.

Table 3-1 "L" Values for Figuring Offsets and Expansion Loops

Inches Expansion				OD
0.5	1.0	1.5	2.0	Line Size
10	15	19	22	7/8
11	16	20	24	1 1/8
11	17	21	26	1 3/8
12	18	23	28	1 5/8
14	20	25	31	2 1/8
16	22	27	32	2 5/8
18	24	30	34	3 1/8
20	28	34	39	4 1/8

Example:
The smallest "Inches Expansion" equal to or grater than 1.4196 is 1.5. The 1.5 column intersects with the 1 3/8 line at 21. Use "L" value 21.

For an offset multiply the "L" value by 3 to determine the length of the offset.
Example:
An "L" value of 21 would mean

3L = 3 X 21 or
3L = 63.

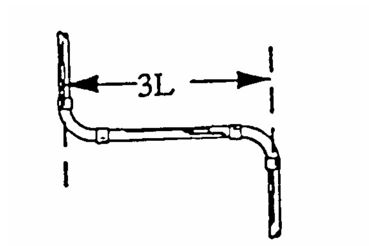


Figure 3-10 Offset Construction

The offset distance required for low temperature application for an 84 foot run of 1 3/8 line is 63 inches.

For an expansion loop multiply the "L" value by 2 if hard copper and long radius elbows are used. If the expansion loop is formed in soft copper the loop diameter equals "L".

Example:
For the same 84 foot run, a hard copper loop is 42 by 42 inches. A soft copper loop is 21 inches loop is 21 inches

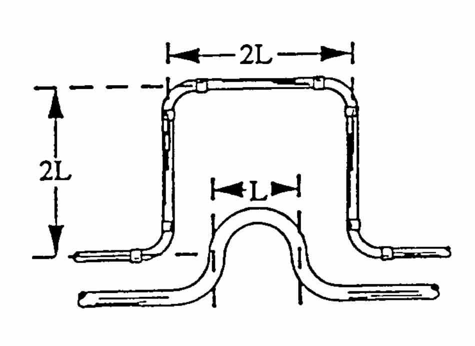


Figure 3-11 Expansion Loop Construction

Application
Do not exceed a straight run for 100 feet without constructing an offset or expansion loop. Place the offset or loop in the middle of the run to minimize pipe shift and joint stress.

SPECIAL PIPING FOR OPEN ROOMS

An open preparation room allows heat infiltration from the rest of the store at a rate which may jeopardize total refrigeration performance. To protect the rest of the refrigeration system, open preparation evaporators must be piped with a Crankcase Pressure Regulating Valve (CPR).

The CPR is field installed in the suction line(s) from the evaporator(s). And the installer is responsible for proper adjustment of the Valve. (See: Control Valve" Section for adjustment procedures.)

CONNECTING PARALLEL 3-WAY VALVES

Due to the size limitations of 3-Way Valves, some of the larger Koolgas systems will require parallel connection to 2 suction stubs at the header using an offset tee construction. Do not use a bull head tee.

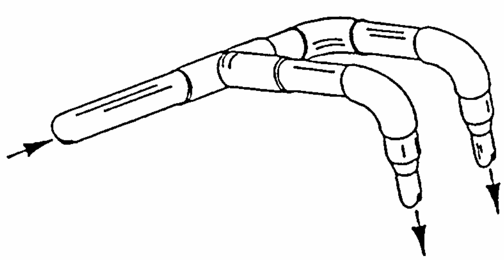


Figure 3-12 Connection to Parallel Suction Stubs

RUN LENGTHS AND EQUIVALENT FEET

When figuring run lengths angle valves and 90 degrees elbows are figured as additional straight pipe. The chart below gives equivalent lengths for these components.

Table 3-2 Equivalent Feet for Angle Valve and 90° Elbow

Tubing Size	Angle Valve	Long Radius Elbow 90°
1/2	6	0.9
5/8	7	1.0
7/8	9	1.4
1 1/8	12	1.7
1 3/8	15	2.3
1 5/8	18	2.6
2 1/8	24	3.3
2 5/8	29	4.1
3 1/8	35	5.0
3 5/8	41	5.9
4 1/8	47	6.7

*ASHRAE 1981 Fundamentals Handbook

LINE SIZING

Sizing of all refrigerant lines is the responsibility of the installing contractor. Contact Hussmann Atlanta Engineering if assistance is needed.

TABLES IN THIS SECTION

The tables supplied in this section are established for specific design conditions.

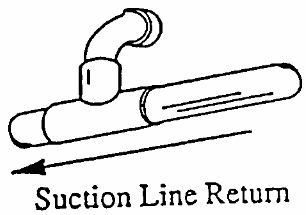
Medium Temperature:
Saturated Suction =+20°F
Condensing =+110°F

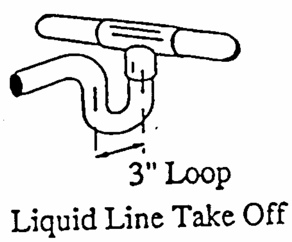
Low Temperature:
Saturated Suction =-20°F
Condensing =+105°F

BRANCH LINE PIPING

Suction line

- Pitch in direction of flow.
- May be reduced by one size at one third of case run load and again after the second third. Do not reduce below evaporator connection size.
- Suction returns from evaporators enter at the top of the branch line.





Liquid Line
Offtime and Electric Defrost

- May be reduced by one size after one half other case load run. Do not reduce below evaporator connection size.
- Take-offs to evaporators exit the bottom of the liquid line. Provide an expansion loop for each evaporator take-off. (Minimum 3 inch diameter.)

Koolgas Defrost

- Maximum of 6 evaporators per Branch System
- Increase the liquid tine size inside the case by two sizes over the branch size.

Branch Size	In Case Size
1/2	7/8
5/8	1 1/8
7/8	1 3/8
1 1/8	1 5/8
1 3/8	2 1/8

- Take-offs to evaporators exit the bottom of the liquid line. Provide an expansion loop for each evaporator take-off. (Minimum 3 inch

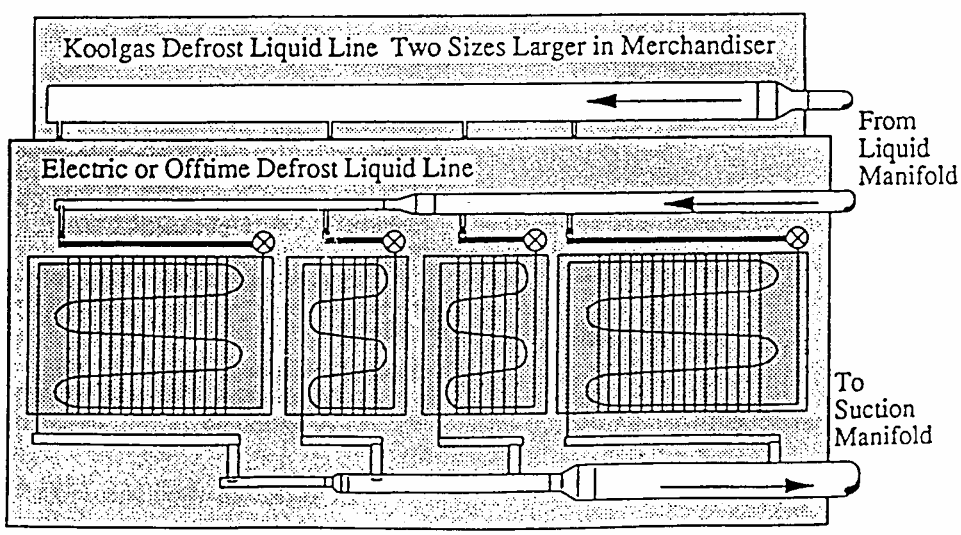


Figure 3-13 Branch Piping

Figure 4-1 Control Panel

OVERVIEW

The scope of this section is limited to main field wiring connections and to the control panel. A genartic controller layout will be used to illustrate a typical control wiring schematic. Custom wiring schematics are located on the doors of each rack. Atlanta\Custom systems are available wired for 208-230/3/60 or 460/3/60. Other voltages are available upon request. The control circuit is typically 208VAC but racks can be ordered with a single point connection (optional). Refer to the serial plate located on the control panel to determine MCA MOPD.

FIELD WIRING

Rack components are wired as completely as possible at the factory with all work completed in accordance with the National Electrical Code (NEC). All deviations required by governing electric codes will be the responsibility of the installer.

The lugs on the circuit braker package in the compressor control panel are sized for copper wire only, with 75_ C THW insulation. All wiring must be in compliance with governing electrical codes.

ELECTRICAL SUPPLY REQUIREMENTS: (See data plate)

For Remote Header Defrost Assembly:
To the defrost control panel provide:
one 208 15A branch circuit or
208/3PH with electric defrost.

For 208-230/3/60 Compressor Units:
To each System rack provide:
one 208-230/3/60 branch circuit.

To each remote air-cooled condenser provide:
one 208-230/3/60 branch circuit.

For 460/3/60 Compressor Units:
To each System rack provide:
one 460/3/60 branch circuit
one 208/1PH/15A circuit or
208/3PH circuit with electric
defrost.

To each remote air-cooled condenser provide:
one 460/3/60 branch circuit.

Dry contacts are made available upon request at the rack control panel. Contacts will close in alarm state. Contact rating is 10A @ 208V. Alarm status may be configured through an electronic controller.

WIRING GUIDELINES BASED ON VARIOUS COMPONENTS

Check the store legend for components requiring electrical circuits to either the panel, which may include:

- Remote alarm
- Electronic temperature probe
- Defrost termination thermostat
- Thermostat controlling a liquid line solenoid
- Satellite control
- Heat reclaim contact or 24V supply

All thermostat wires should be sized for rack control circuit breaker. Temperature sensor wiring should refer to the controller manufacturer's literature.

Check field wiring requirements for appropriate quantity of wires.

Unit Cooler Fan Wiring
See Manufacturer's literature for wiring requirements.

Evaporator Mounted Liquid Line Solenoid
Power for a liquid line solenoid can be picked up at the rack on terminals C and R for each respective circuit.

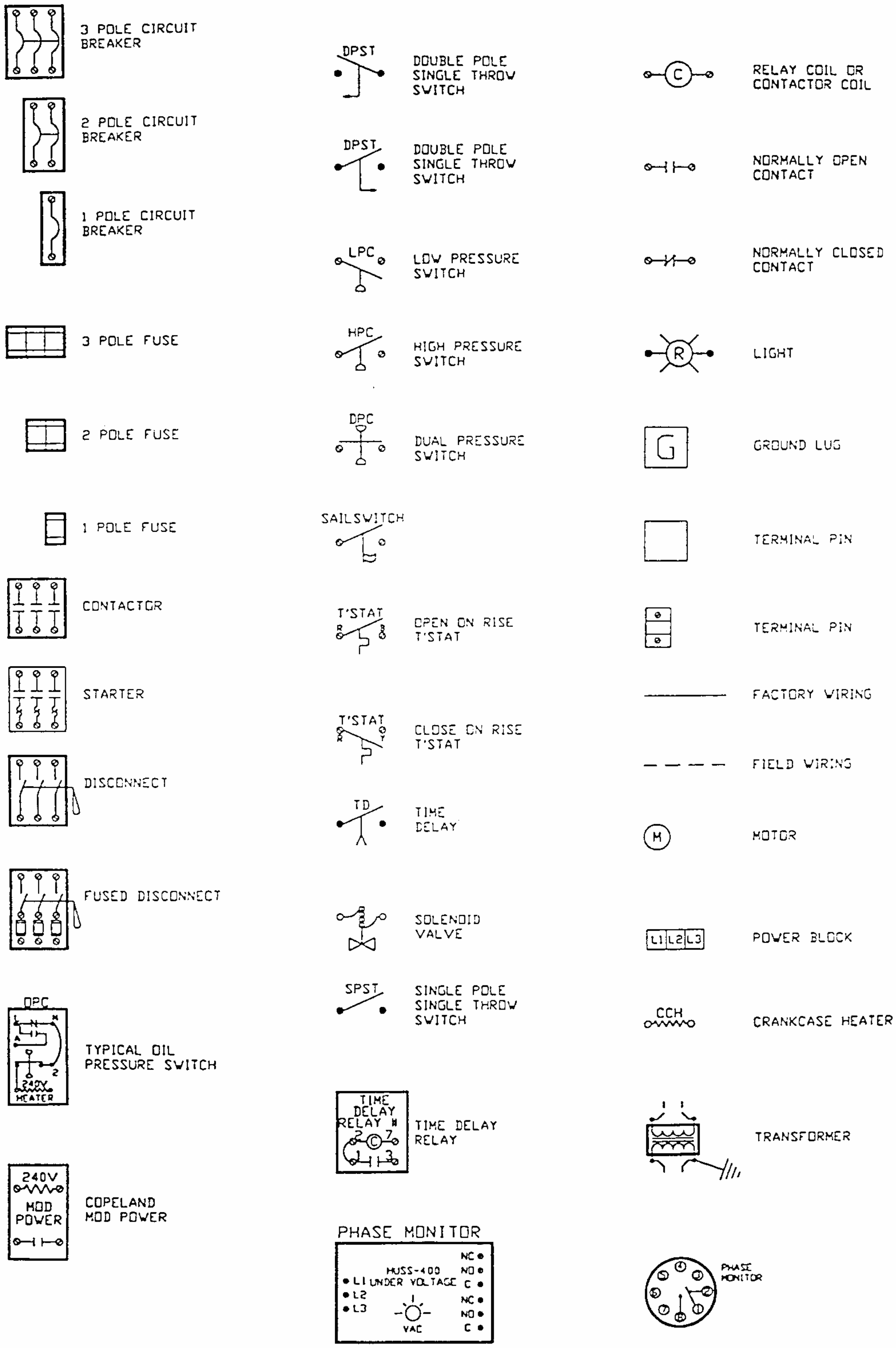
Cooler Door Switch Wiring
Check the store legend for door switch requirements. The switch must be mounted to the cooler door frame, and must be wired to control the field installed liquid line solenoid and the fan circuit. For Koolgas applications, install a check valve to bypass the liquid line solenoid valve.

Sizing Wire and Overcurrent Protectors
Check the serial plate for Minimum Circuit Ampacity (MCA) and Maximum Overcurrent Protective Devices (MOPD). Follow NEC guidelines.

Defrost Controls
The 5 basic defrost circuits are shown on the Defrost Diagram at the end of this section. These circuits may be repeated and/or intermixed in one store.

Other Controls
When other controls are used, refer to the wiring schematics included with the rack.

Electrical Symbols



Electrical Symbols
Table 4-1

ELECTRICAL DIAGRAMS

All electrical schematics reflect the standard ladder diagram.

Electrical schematics are included with each rack. Please keep in mind all diagrams in this manual are only examples! Wiring may vary, refer to the diagram included with each rack. To focus on circuit logic the diagram may separate a relay coil and it's contacts. Electrical terminal connections are clearly numbered and aid in trouble shooting should a problem arise.

Compressor Control

Each control panel is wired with independent compressor control circuits so any compressor can be electrically isolated without causing the other compressors to be shut down,

A typical compressor control will consist of the following:

1. Electrical control
2. Switchback relay contacts (optional)
3. Switchback time delay (optional)
4. Low pressure switch
5. High pressure switch
6. Oil pressure switch
7. Overload contact (if used)
8. Contactor coil
9. Demand cooling control (if used)
10. Crankcase heater (optional)
11. Lighted toggle switch

Terminal pins will be used between control points for easy testing and troubleshooting. See Figure 4-2.

Electronic Controller

The electronic controller uses a suction transducer to "read" the suction manifold pressure. From this, sequence compressors on or off through a relay board to achieve the target suction pressure.

Time Delay

Automatic time delays are built into most electronic controllers. This helps avoid short cycling. A solid state time delay will be used for backup in the unlikely event of a electronic controller failure. The time delay will only be in the circuit during switch back, if the system uses switch back control. If the system does not have optional switch back control then it will be wired in series with the operating controls. Awareness of time delays will reduce frustration and confusion when starting or troubleshooting the system.

Pressure Switches

There are basically three pressure switches in the compressor control circuit. A low pressure switch is used to close the control circuit during high suction and open the circuit during low suction pressure. A high pressure switch is use to open the control circuit during a critical high discharge pressure state. The high pressure switch is available in automatic or manual reset. An oil pressure switch senses the supply oil pressure when the compressor is running. If the oil pressure falls below the preset setting, the control circuit will open.

Oil pressure switches are preset for 6.5 psig differential (Carlyle) and 9 psig differential (Copeland). The oil failure time delays are preset for 45 seconds (Carlyle) and 120 seconds (Copeland).

*For proper setting of switches see control settings section.

Switchback Control (Optional)

During "normal" operation, the switchback relay will be de-energized allowing the electronic controller to be in full control. When the controller looses power or malfunctions. the switchback relay will energize which in turn will bypass the control power around the electronic controller and through the low pressure switch and time delay.

Crankcase Heaters (Optional)

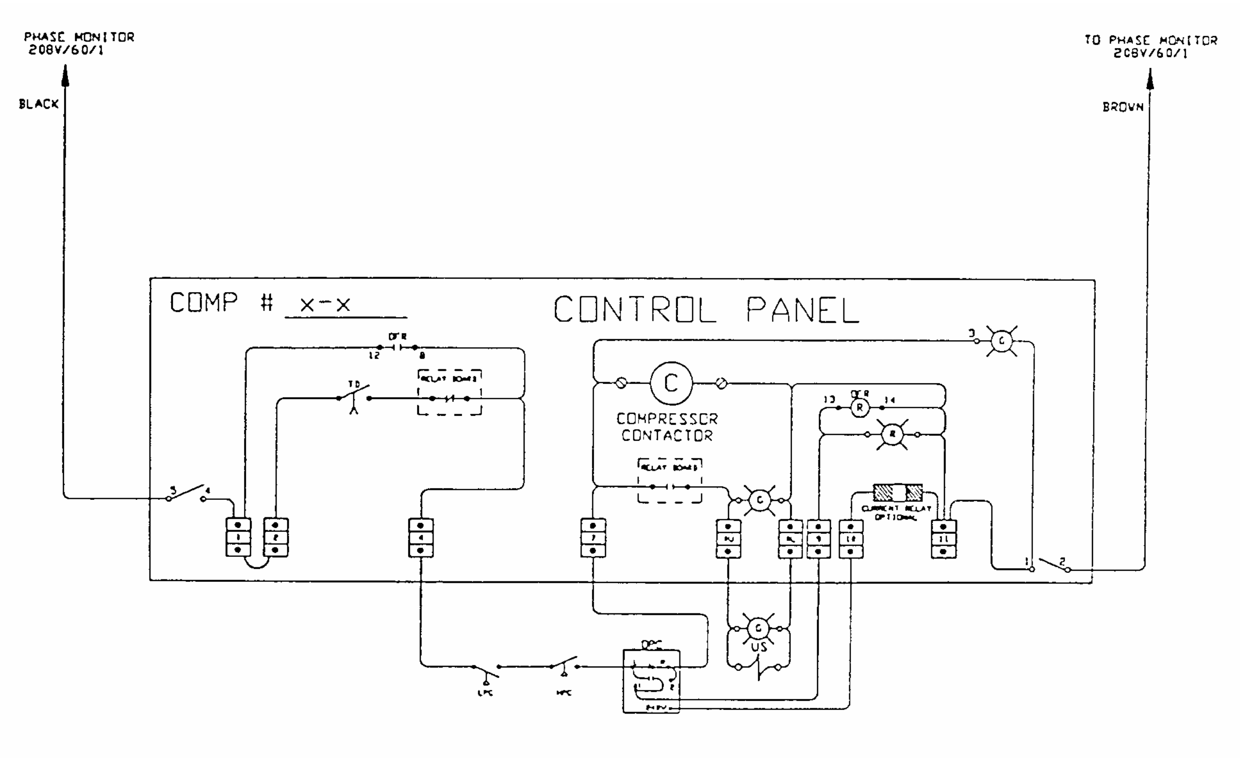
A crankcase heater is used to alleviate liquid migration to the compressor during off cycle periods. The crankcase heater is interlocked through the compressor contactor to be powered when the compressor is not running.

Oil Failure Relay

This relay is used during an oil failure to jump the electronic controller relay. This will eliminate multiple alarms if the suction pressure drops and the compressor control point opens without the oil failure relay, the suction pressure would eventually rise causing another oil failure alarm.

Current Relay (Optional)

A current relay is wired in series with the oil failure control heater. This will prevent a false oil trip if the compressor circuit breaker should trip or if the compressor goes off on internal overload.



NOTES:

1.) ALL WIRING MUST BE DONE IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE (N.E.C.) AND ALL OTHER LOCAL CODES.
2.) TIGHTEN ALL WIRE CONNECTIONS BEFORE POWER IS APPLIED.

LEGEND

US	UNLOADER SOLENOID
LPC	LOW PRESSURE CONTROL
OFC	OIL FAILURE RELAY
OPC	OIL PRESSURE CONTROL
TD	TIME DELAY
HPC	HIGH PRESSURE CONTROL
- - - - -	FIELD WIRING
———	FACTORY WIRING
[terminal block symbol]	- -TERMINAL BLOCK

Compressor Control
Figure 4-2

Defrost Control

Each control panel is wired with independent defrost control circuits so any circuit can be electrically isolated without causing the other circuits to be shut down.

A typical defrost circuit will consist of the following:

1. Lighted toggle switch.
2. Pins R and C for refrigeration power circuit.
3. Pins D and C for defrost power circuit.
4. N.C. contacts for refrigeration.
5. N.O./N.C. contacts for defrost.
6. Pins E and F for defrost termination. (Dry contact only)
7. Pins T and B for temperature control thermostat (Dry contact only) or Temperature probes can be used for electronic controllers.

See Figure 4-3 and 4-4

Defrost Controls
There are many types of defrost circuits and they are shown on the Defrost diagram in the rack. These circuits may be repeated in multiple and intermixed in any one store.

Refrigeration Mode:
During refrigeration, both the defrost point and refrigeration point are de-energized allowing L1 power to flow to the SV valve (Sorit or Liquid Solenoid). If case probes are used with the controller the refrigeration point will open when a system reaches proper operation temperature. Thus closing the refrigeration valve.

Defrost Mode:
The defrost point will energize opening power to the SV valve, refrigeration point. and closing power to the Kool/Hot gas valve (HGV) or defrost contactor (DC).

Temperature Control

Refrigeration Thermostat (Alternate)
If it is desired to have the refrigeration thermostat operate the branch liquid line solenoid on the compressor unit, wire it to the control panel in the following manner.

Determine the system number from the store legend. The system will be on the suffix of the appropriate "T" and "B" terminals.

a. Remove the jumper from the T and B terminal.
b. Connect one thermostat wire to the T terminal.
c. Connect the other thermostat wire to the B terminal.

Case Probe (Alternate)
If it is desired to monitor case temperature and operate a branch liquid line circuit, wire a case probe from the case to an analog point on the electronic controller.

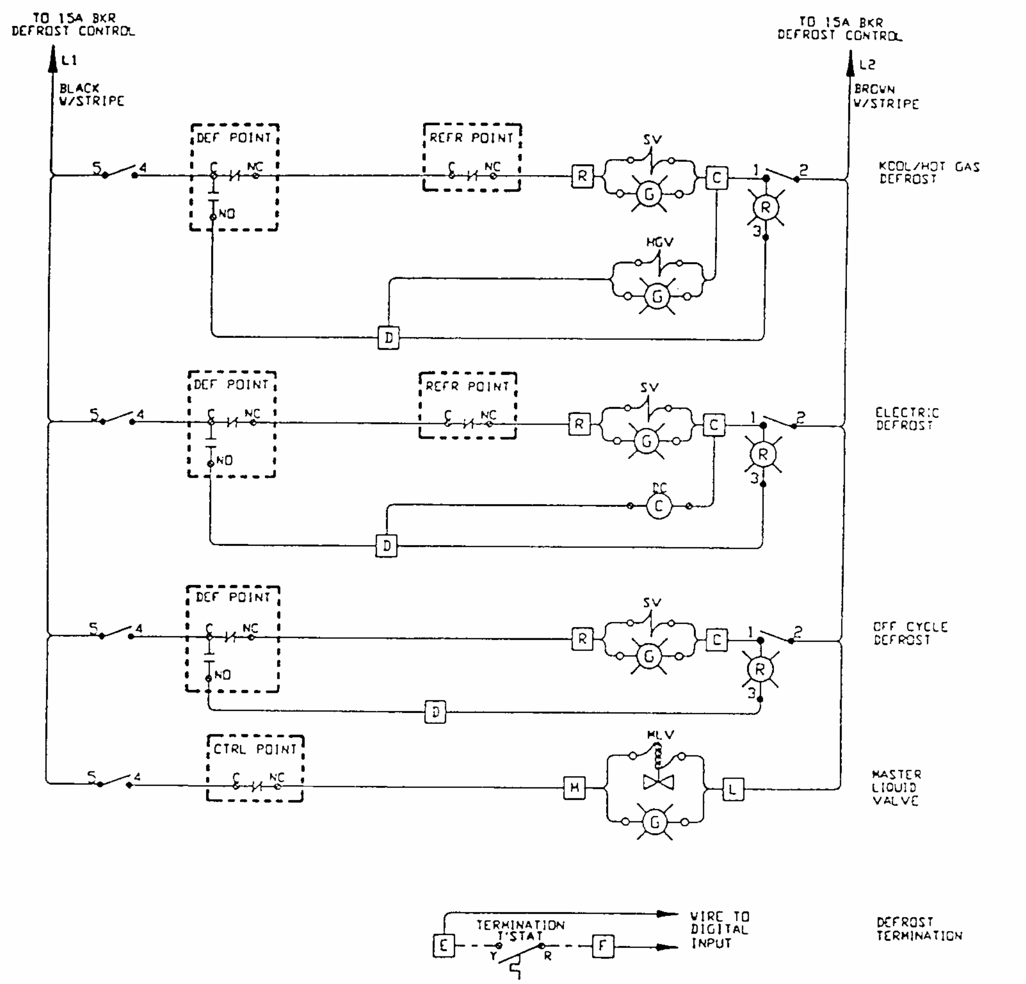
Provisions for case probes may be made from the field or factory. Refer to the controller manual for setup.

Defrost Termination Thermostat

For each system using defrost termination thermostats, run a two-wire control circuit from all termination thermostats (in series, one per case) to the E_ and F_ terminals in the control panel with a suffix corresponding to the system number.

Note: The defrost termination thermostat must supply a dry contact closure. An isolation relay must be used for a "hot" termination thermostat.

Master Defrost Valve
The master defrost valve is used during a hot/kool gas defrost cycle to create a reverse flow through the evaporator. See Figures 4-3 and 4-4.



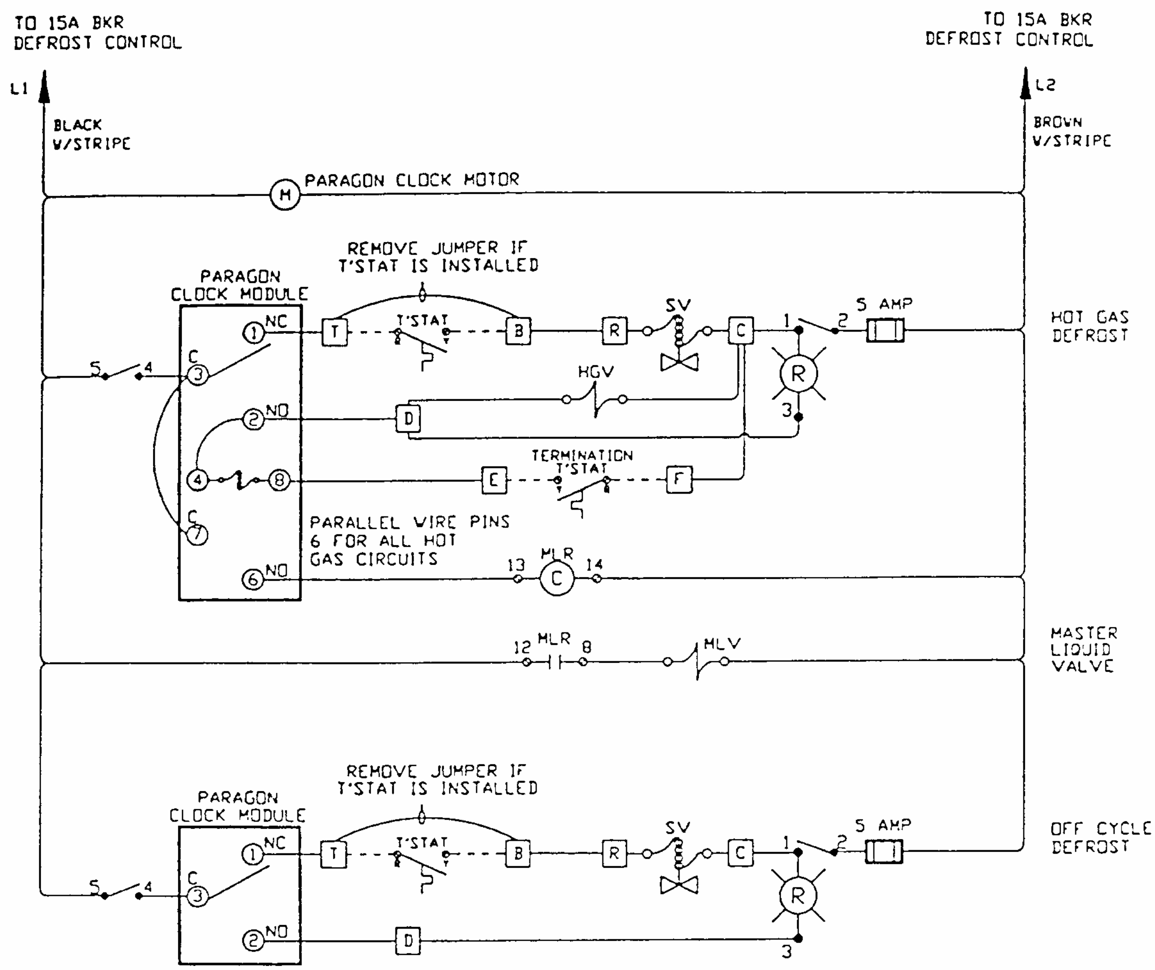
NOTES:

1.) ALL WIRING MUST BE DONE IN ACCORDANCE WITH THE (N.E.C.) AND ALL OTHER LOCAL CODES
2.) SOLENOID VALVE (SV) MAY BE SUCTION LIQUID OR BOTH
3.) FIELD WIRE REVERSE AIR RELAYS (208V) to pins D & C.
4.) CIRCUIT COLOR CODING IS, 1-RED, 2-ORG, 3-YEL, 4-BLUE, 5-PURPLE, 6-GRAY, 7-BEIGE, 8-PINK, AND START OVER WITH RED ON CIRCUIT 9

LEGEND

HGV	HOT GAS VALVE
MLV	MASTER LIQUID VALVE
DC	DEFROST CONTACTOR
SV	LIQUID/SUCTION SOLENOID
FC	EVAP FAN CONTACTOR
- - - - -	FIELD WIRING
———	FACTORY WIRING
☐	TERMINAL WIRING BLOCK

Electronic Controller Defrost Control
Figure 4-3



LEGEND

MLR	MASTER LIQUID RELAY
DC	ELECTRIC DEFROST CONTACTOR
MLV	MAIN LIQUID VALVE
SV	REFRIGERATION SOLENOID VALVE
HGV	HOT GAS SOLENOID VALVE
- - - - -	FIELD WIRING
———	FACTORY WIRING
□	TERMINAL WIRING BLOCK

NOTES

1.) ALL WIRING MUST BE DONE IN ACCORDANCE WITH THE N.E.C.
AND ALL OTHER LOCAL CODES.
2.) SOLENOID VALVE (SV) MAY BE SUCTION, LIQUID OR BOTH.
3.) FIELD WIRE REVERSE AIR RELAYS (208V) TO PINS D & C.
4.) CIRCUIT COLOR CODING IS, 1-RED, 2-ORG, 3-YEL, 4-BLUE, 5-PURPLE, 6-GRAY, 7-BEIGE, 8-PINK, AND START OVER WITH RED ON CIRCUIT 9.
5.) DISCONNECT CONTROL POWER WHEN REPLACING DEFROST MODULE. TERMINAL #6 COULD BECOME LIVE IF ANOTHER CIRCUIT VENT INTO DEFROST

Paragon Defrost Control
Figure 4-4

Alarm Control

Alarm System

The Custom System basic alarm package includes alarms for:

a. Oil Failure (each compressor)
b. Phase Loss
c. Low Liquid Level*
d. High Suction*
e. High Discharge
f. Compressor Failure

*Time Delayed

A dry set of contacts are supplied to control a remote bell or other alarm device. These contacts are rated at 10.0 amps, 120 volt. An indicator light signifies what alarm condition has been activated.

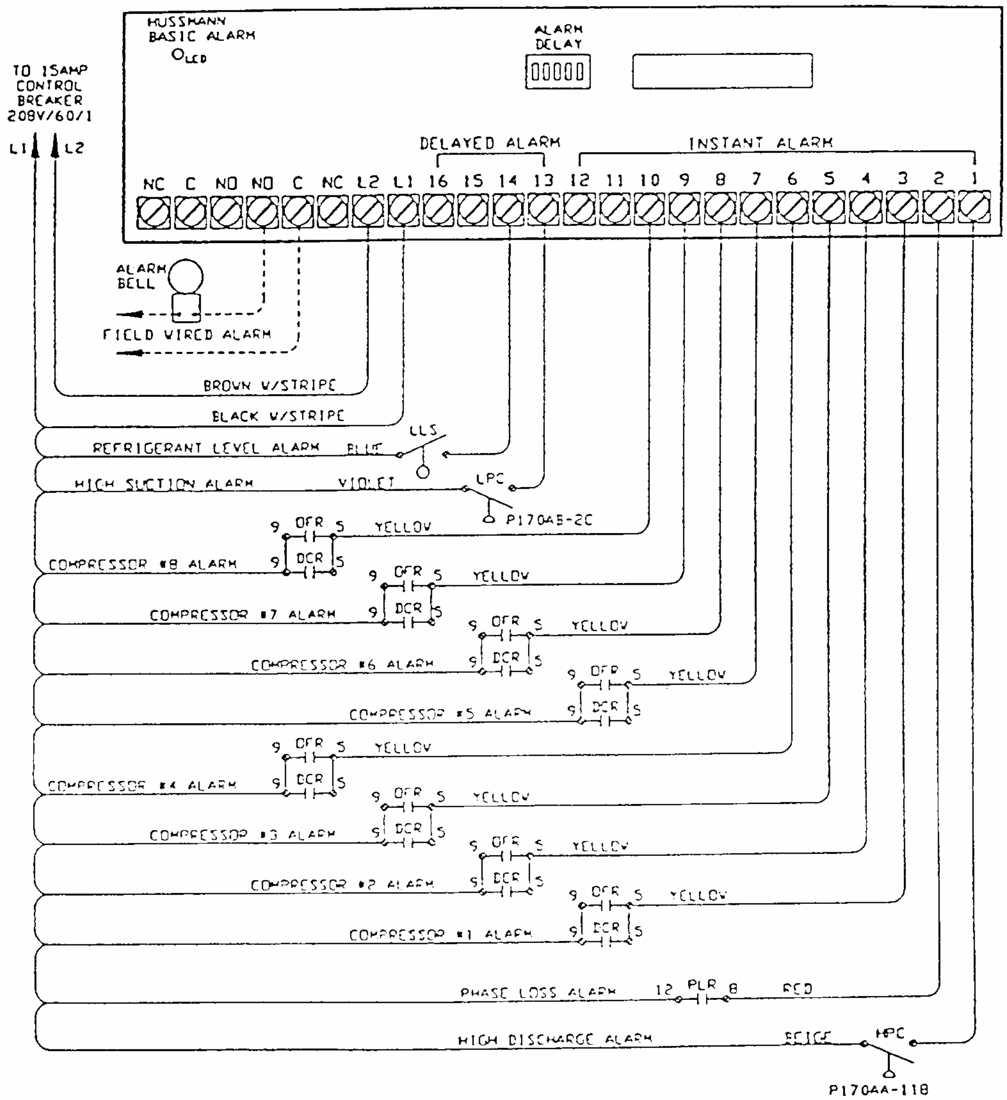
Note: If an electronic rack controller is ulitized. then the above alarms will preformed by the rack controller.

Ladder diagrams emphasize the circuit continuity and logic. They aid troubleshooting and testing by identifying point-to-point connections, and color coding rather than just physical location. A ladder diagram normally moves from left to right so the user can "read" the series of switches, relays, terminals and components that make up a circuit.

See Figure 4-5 Alarm Board

Alarm Control (Electronic)

When an Electronic Rack Controller is utilized all alarm functions are preformed by the rack controller. High suction and high discharge pressures are "read" by transducers connected to the rack controller. The liquid level can either be a digital input (standard) or an analog type input. The controller can display actual refrigerant level with the analog type (optional). Phase loss, oil failure, and the compressor failure alarms are connected through to the rack controller through a digital input. An optional modem can be installed to allow the rack controller to call out any refrigeration alarms.



Alarm Board
Figure 4-5

Invertor Control

An inverter is used to vary the speed of a compressor which in turn varies the capacity of that compressor. With the ability to vary the capacity of a compressor, refrigeration requirements can be better matched.

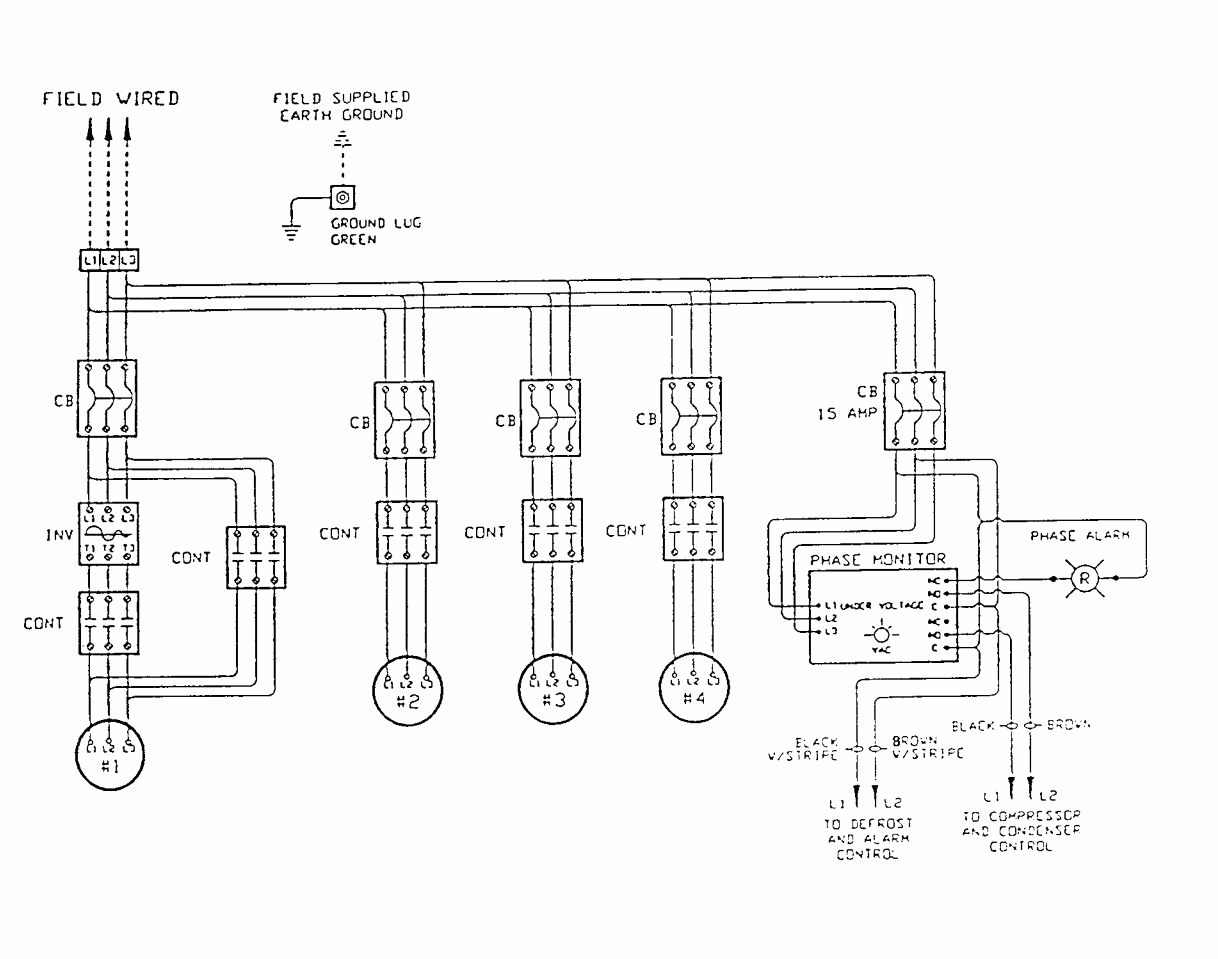
<u>Variable Speed Mode</u>

During the variable speed mode, the normally closed inverter allow control point on the controller relay board will energize causing R1, R2, TD1, and bypass relay (BPR) to de-energize. This will cause R1 and R2 normally closed contacts 12 and 4 to close. After TD2 times out, the variable speed contactor (VSC) will pull in. The variable speed contactor (VSC remains pulled in as long as the inverter allow control point is energized. There are also two auxiliary switches on the variable speed contactor (VSC). The normally closed variable speed contactor auxiliary switch (AUX) is in series with the bypass relay (BPR) coil. This switch is used to lockout the bypass relay (BPR) during the variable speed mode. The other variable speed contactor auxiliary switch (AUX) is normally open. This switch is in series with the forward run relay (FRR) coil and completes the circuit to the forward run relay in the variable speed mode. See Figure 4-6.

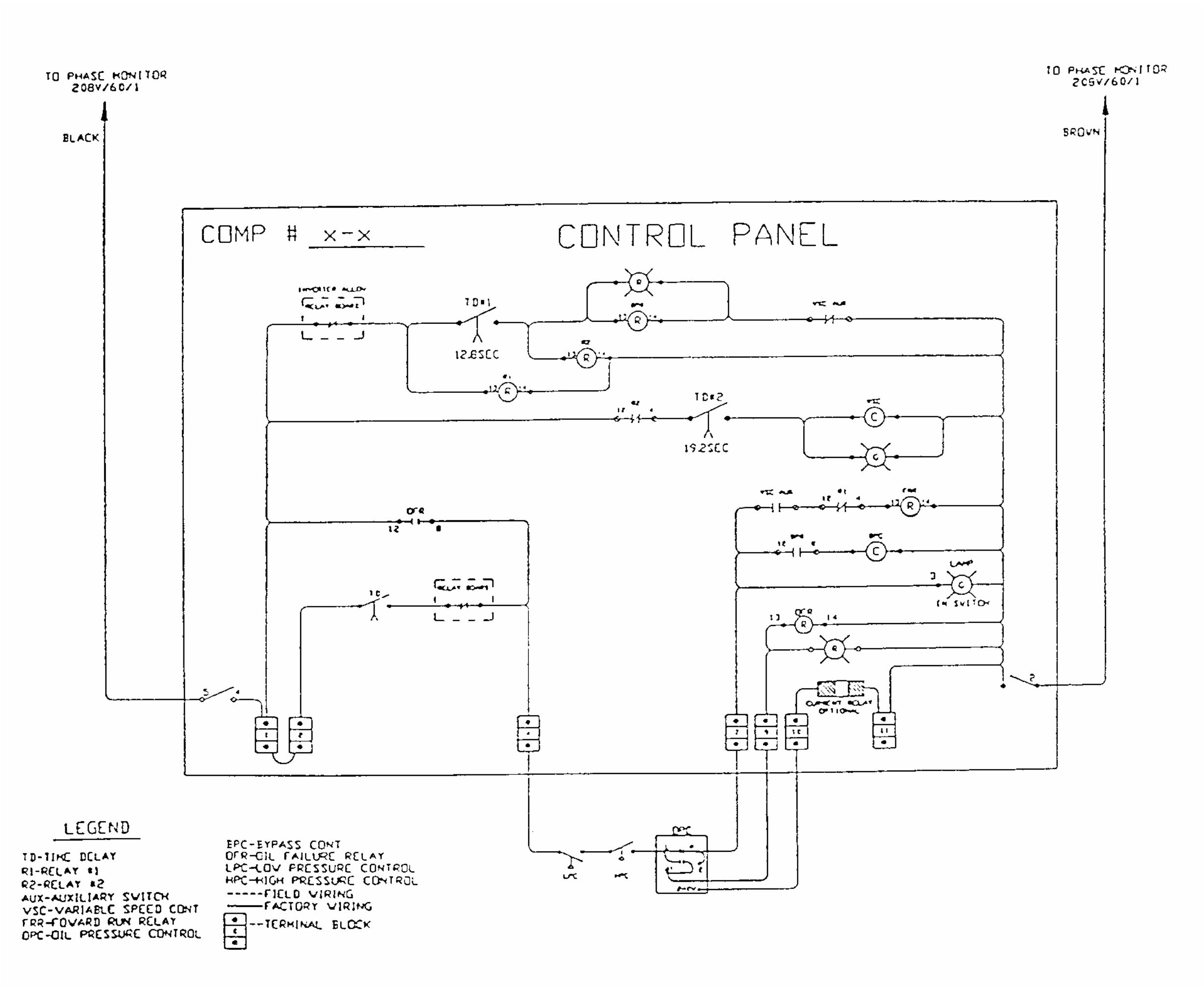
<u>By pass Mode</u>

The inverter allow control point on the controller relay board will de-energize during a fault condition. This will cause the R1 contacts 12 and 4, and de-energizing the forward run relay (FRR). Also, TD1 will begin its timing sequence. After TD1 times out, the R2 relay coil will energize. This will cause the R2 relay contacts 12 and 4 to open, causing the variable speed contactor to drop out. When the variable speed contactor drops out, the normally closed variable speed contactor auxiliary (AUX) switch to close completing the circuit to the bypass relay (BPR). The bypass relay (BPR) contacts 12 and 8 will then close allowing the bypass contactor to pull in at full 4-6 and 4-7.

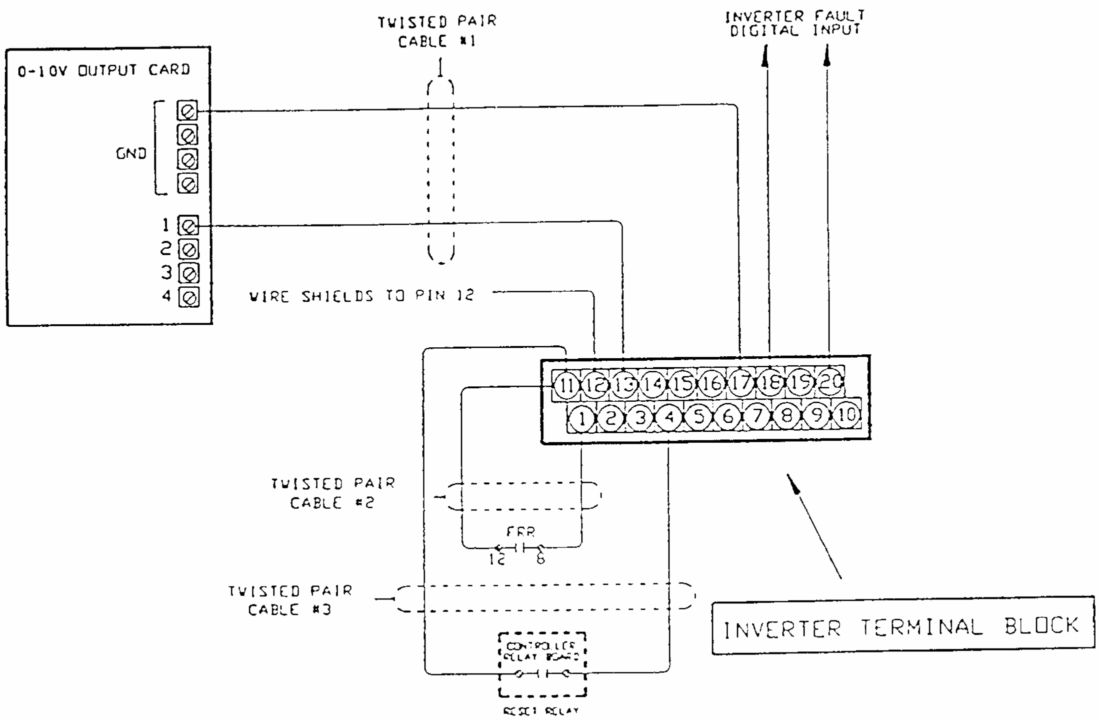
During the variable speed mode the forward run relay (FRR) normally open contacts 12 and 8 will close completing the circuit between inverter terminal #'s 11 and 1. Then a 0-10V signal from the rack controller will be sent to terminals #'s 13 and 17. If an inverter fault occurs then terminal #'s 18 and 20 on the inverter close signaling the electronic rack controller that an inverter fault has occurred The rack controller will then shut down that compressor. Then the rack controller will attempt to reset the inverter, by energizing the normally open inverter reset relay. This will complete the reset circuit on inverter terminal #'s 11 and 4. If successful it will restart the compressor. If the rack controller was unsuccessful in resting the inverter fault it will switch that compressor into the bypass mode. See Tables in Control Settings Section for inverter constant settings.



Power Distribution
Figure 4-6



Compressor Control Wiring
Figure 4-7



Inverter Control Wiring
Figure 4-8

OVERVIEW

This section deals with the Precision and Paragon Defrost Timers. When used these Time Clocks handle defrost periods of 2 hours or less. Cycles requiring longer defrost periods must be controlled through supplemental time clocks. Hussmann's Electronic Defrost Time Clock carries its own manual. Specific guidelines for setting the Time Clocks are in "Control Settings." General instructions are handled here.

PRECISION DEFROST TIMER

Three main sets of components are involved in setting up a defrost program for the system. These are:

1. Program Timer Dials rotate once in 24 hours and are slotted at one hour increments. The field technician will insert a tripper each time a defrost cycle is to start in the 24 clock day.

2. Cycle Timer Dials rotate each defrost cycle and stop in refrigeration. The field technician will set the length of each defrost cycle from 2 to 120 minutes.

3. The Time Setting Dial rotates once every 24 hours and appears to be 7 hours ahead of the program Timers. This time difference compensates for the location of the defrost switches and the pointer marked *TIME*. The field technician will set the Time Setting Dial at the approximate time of Day.

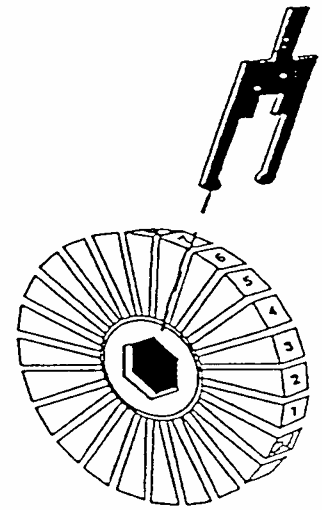


Figure 5 – 1 Inserting Tripper

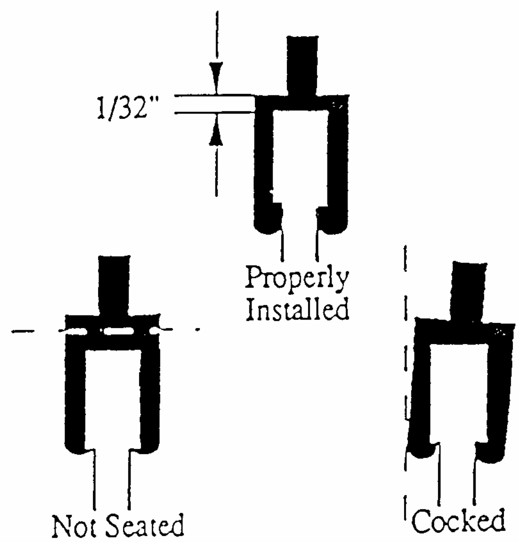


Figure 5 – 2 Proper Installation

Setting Precision Defrost Timer
Setting Defrost Start Times

Rotate the Program Timer Dials by turning the setting knob at the end of the Timer opposite the Motors. As the Dial slots for start of defrost become accessible, install a tripper for each desired time start. The slot for each tripper time is located immediately above the number on the dial face.

To install a tripper, push straight in until it is felt to snap over its holding detent. A properly installed tripper has its shoulders extended 1/32 inch above the dial face, and is square to it. A misaligned tripper can jam the timer.

<u>Setting Length of Defrost</u>

To set the length of each defrost cycle, turn the setting knob until the indicator mark is facing forward and the Cycle Timer Dial stop.

Caution: Failure to have the indicator mark visible before adjusting the Cycle Timer Dial may cause damage to the clock.

Insert the Time Setting Tool, pull the dials apart and reset teeth when required minutes of defrost is opposite the indicator mark.

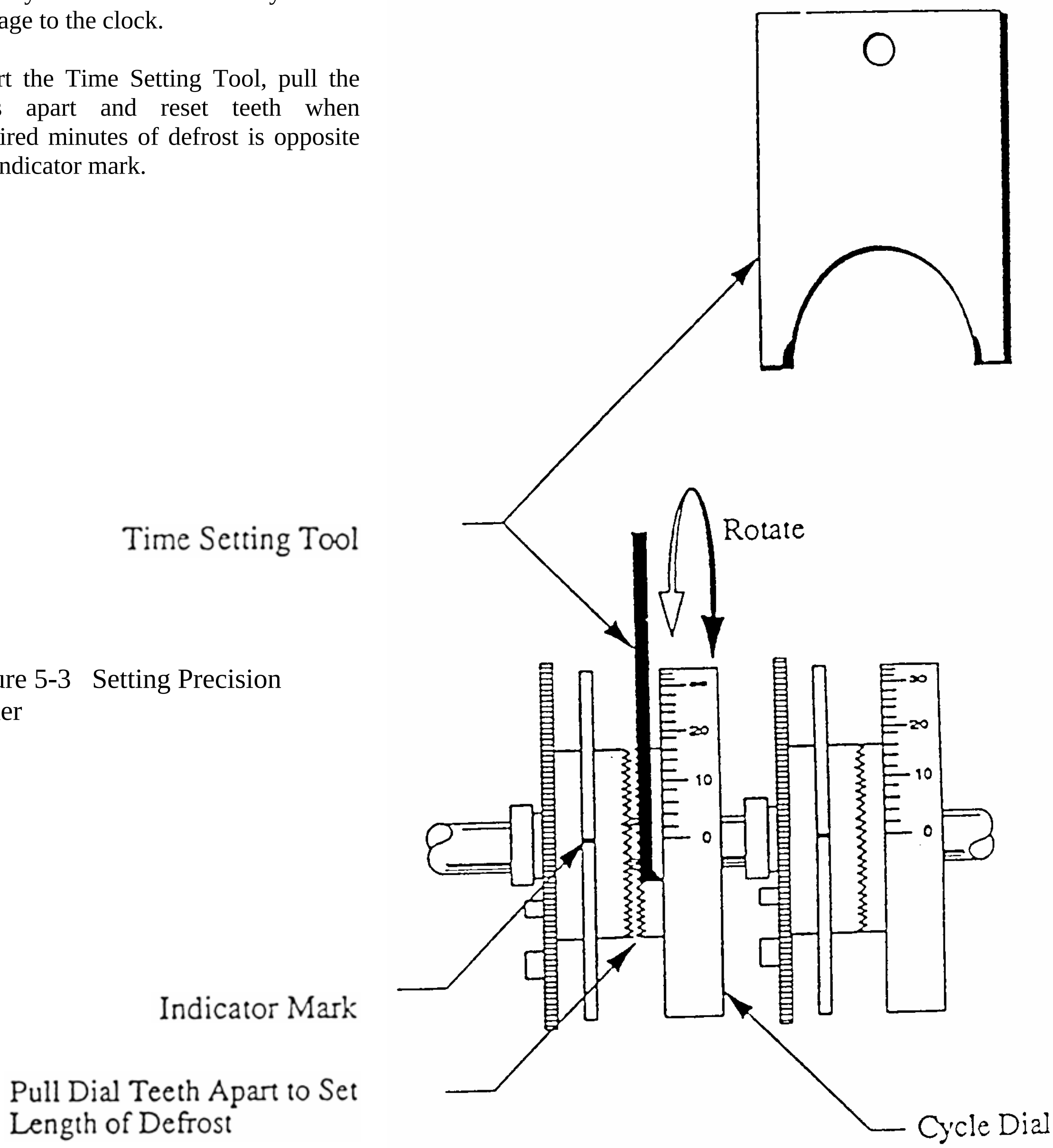
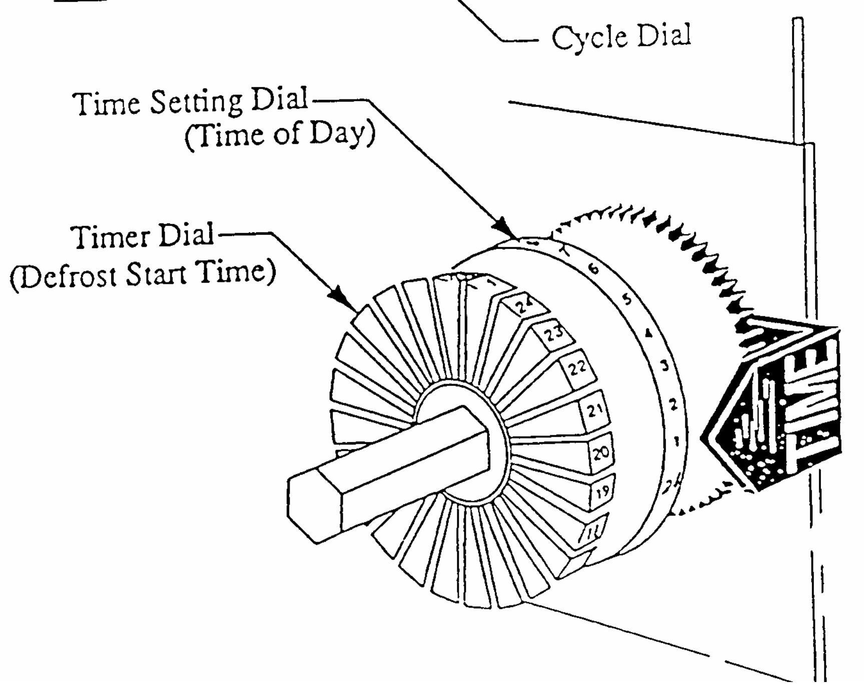


Figure 5-3 Setting Precision Timer



Setting Time of Day

Turn the setting knob until the correct time of day on the Time Setting Dial is opposite the Arrow Time Marker. Note that the time indicated on the Time Setting Dial does not match the position of the numbers on the Program Timer Dials.

Precision Alarm Switch

The timer is provided with two motors and an alarm switch which is normally open. Both motors operate continuously.
If one motor fails the other motor will continue to drive the timer. The alarm switch will close, warning that the timer requires service.

To reset the alarm switch

1. Push gear "A" toward the motor, or lever "B" will be broken.
2. Using a non-metallic object, depress the plastic cam until it snaps into position holding the switch open.

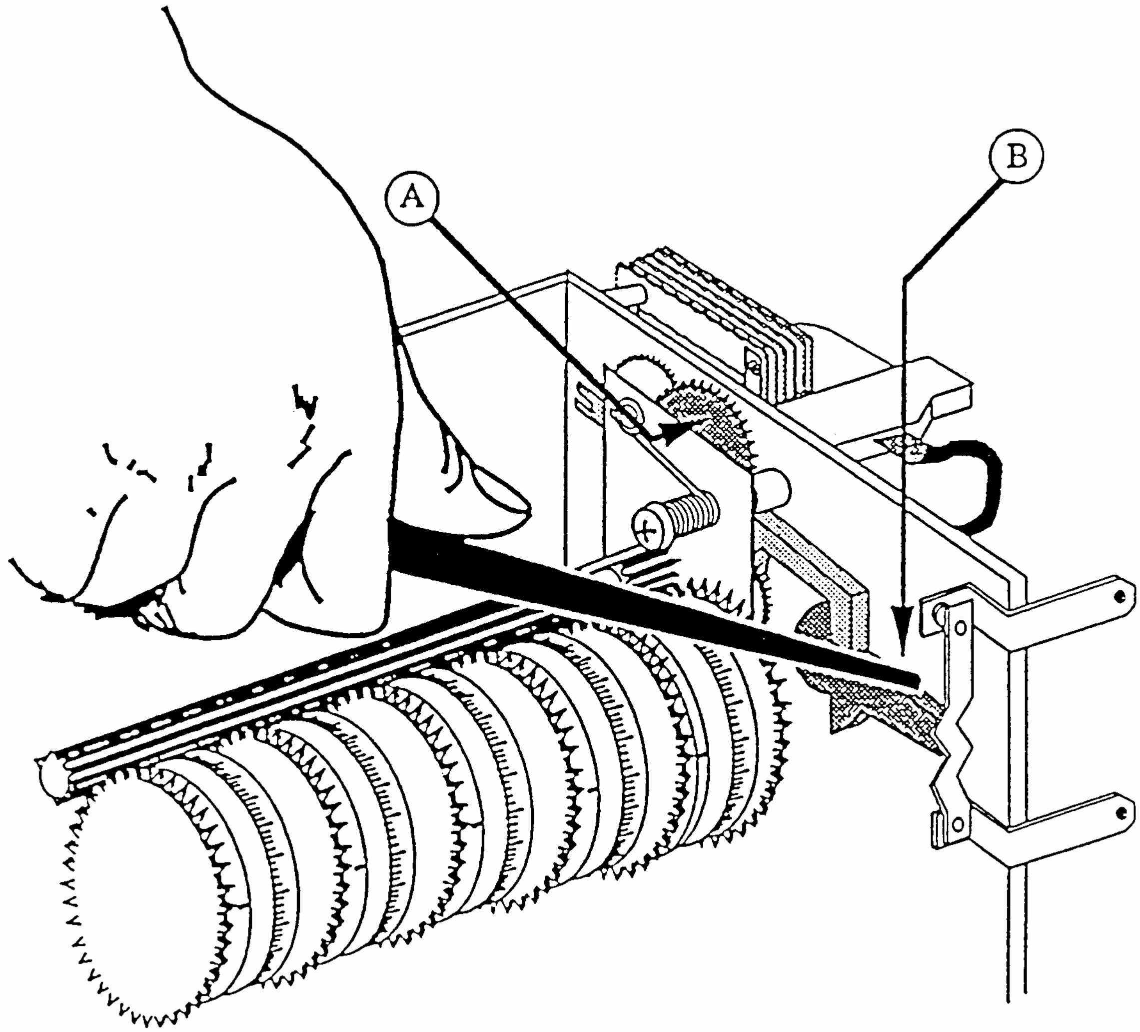


Figure 5 – 4 Resetting Alarm Switch

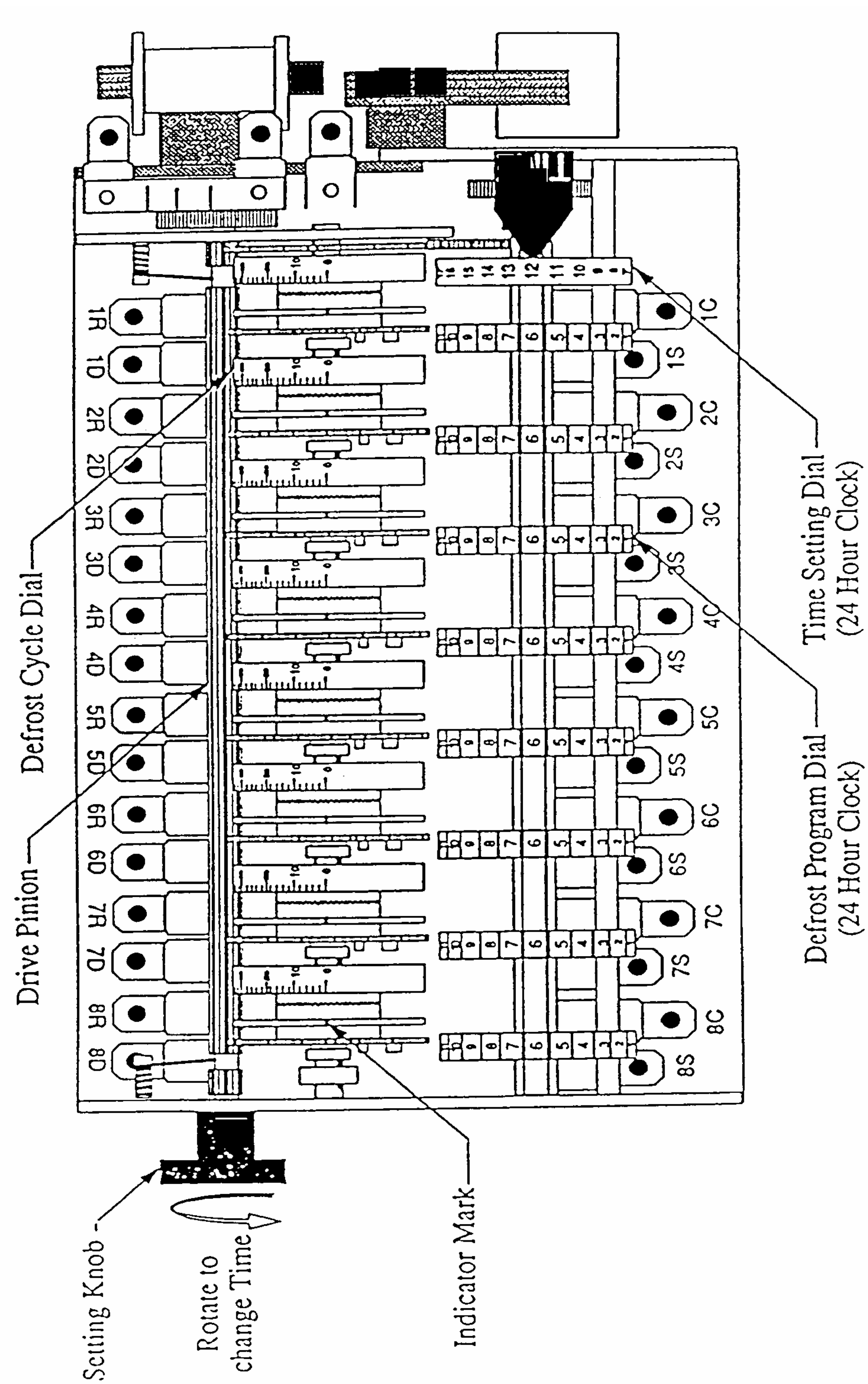


Figure 5 – 5 Precision Defrost Timer

Paragon Defrost Timer
The Paragon Defrost Timer Consists of three components. These are:

1. The Frame holds a Drive Motor Module, and as many Program Modules as needed for the defrost systems.
2. The Drive Motor Module mounts on the frame end and powers the Program modules through the Main Drive Gear. Note that the Drive Motor and the Defrost Circuits do not have to be the same voltage.
3.Program Modules contain a Time of Day Dial, which rotates once every 24 hours, and a Minute Dial, which rotates once every defrost cycle. The Time of Day Dial is notched to accept defrost start trippers either on the "EVEN HOUR" or on the "ODD HOUR" of the 24 hour dial. These Modules **cannot** be substituted for each other, or converted to the other type.

Setting Paragon Defrost Timer
Setting Defrost Start Times
Insert a black tripper in white Program Module Dial notch for each defrost start time on a system. Remove any extra trippers. (P.M. hours are represented by numbers 13 through 24.)

Setting Length of Defrost
Rotate the copper termination lever of the Minute Dial to the required minutes of defrost. Be careful not to bend the lever any further than is necessary to disengage it from the dial teeth. DO NOT MOVE THE RED TAB.

Setting the Time of Day
Rotate the Main Drive Gear on the Motor Module with an upward push of the thumb until the correct hour on the black Time of Day Dial aligns with the pointed alignment mark on the modules.

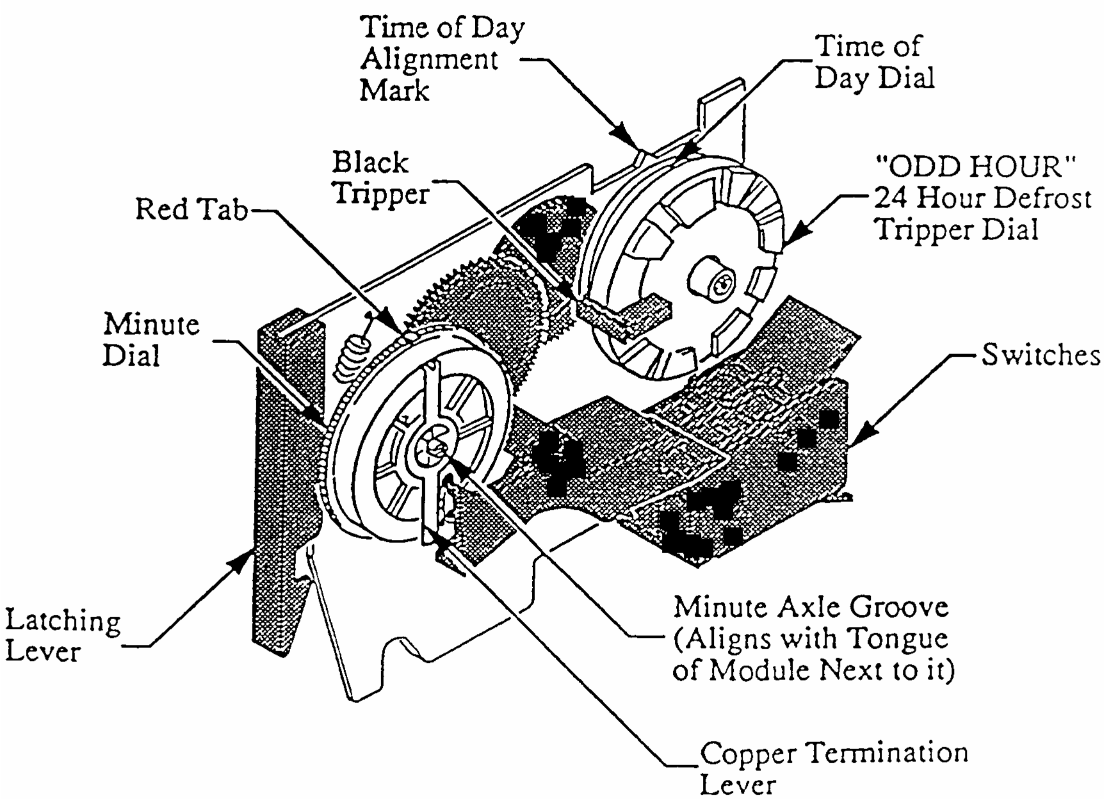


Figure 5 – 6 Paragon Program Module

Paragon Program Module Replacement

Removal

Turn off power to control panel and meter. Check the Paragon to assure technician safety.

Disconnect and mark wires from the switch at the top rear of the Module. The switch terminals are C, NC, and NO.

Adjust the timer so all the red tabs on the Minute Dials are facing directly front of the timer. At the bottom rear of the module, pull down on the plastic latching lever and out on the bottom of the Module.

Installation

Be sure power is off.

Set all the Modules including the one to be installed for the same hour on the 24 Hour Dials. Set all red tabs on the Minute Dials, including the one to be installed, in a front most position.

Slip the Module onto the slotted rod of the frame top and mate the Minute Dial axle into the axles on both sides of it.

Insure that all the red tabs are aligned, and replace wires on switch terminals. Reset time of day and turn on the control circuit.

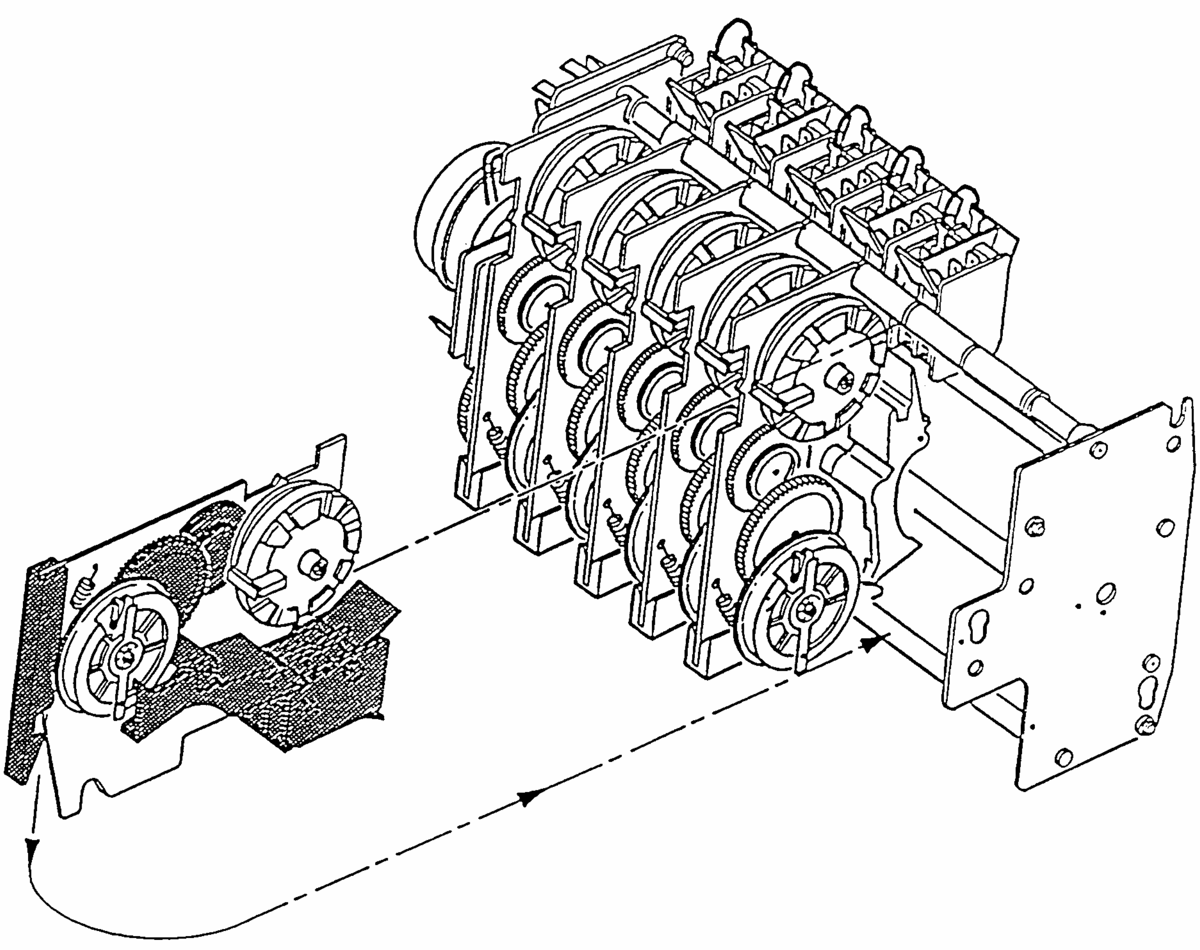


Figure 5 – 7 Program Module Removal and Installation

Paragon Program Motor Replacement

Removal

Turn off power to control and meter check the Paragon. To assure technician safety, disconnect and mark wires to motor.

Rotate the main drive gear until the axle tongues and grooves are vertical (red tabs will be directly above the axle).

Loosen the hex head bolt next to the motor. Slide the module up until the three locator studs clear the key slots.

Installation

Be sure power is off. Check new motor voltage application.

Rotate the main drive gear until the axle tongues and grooves are vertical (red tabs will be directly above the axle).

Place locator studs in key slots and slide down. Tighten hex head bolt. Reconnect wires.

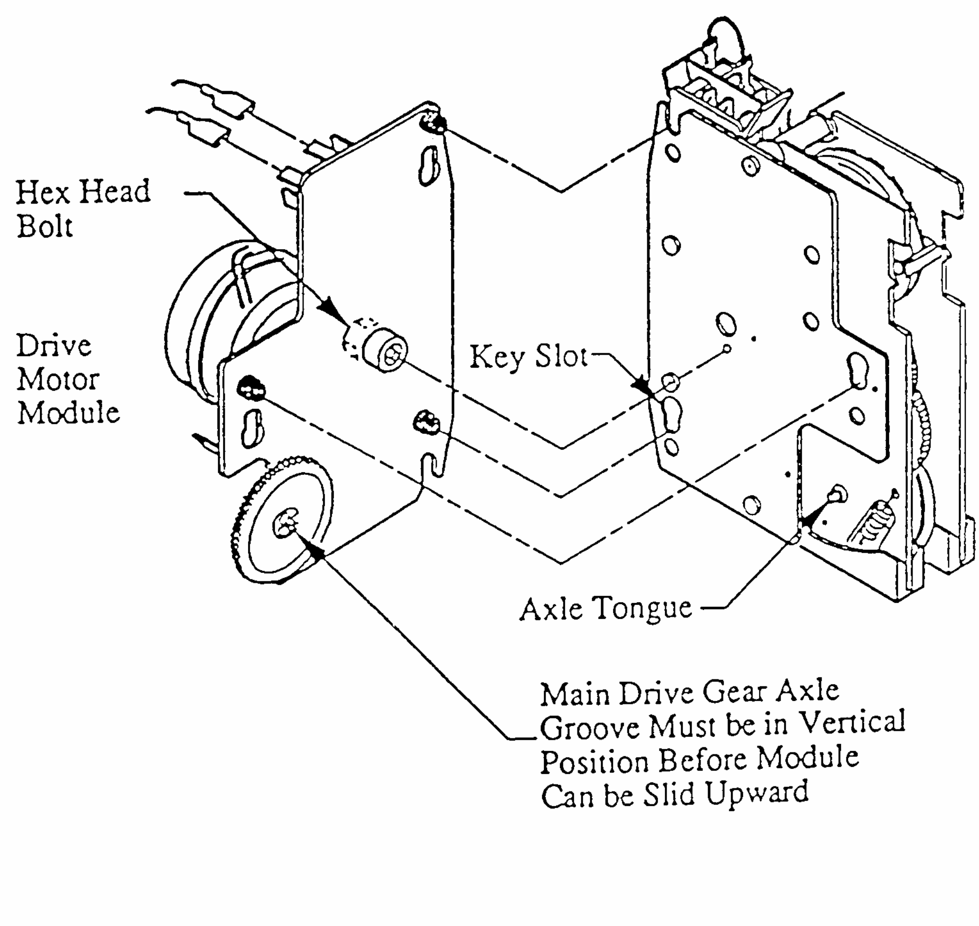


Figure 5-8 Motor Removal and Installation

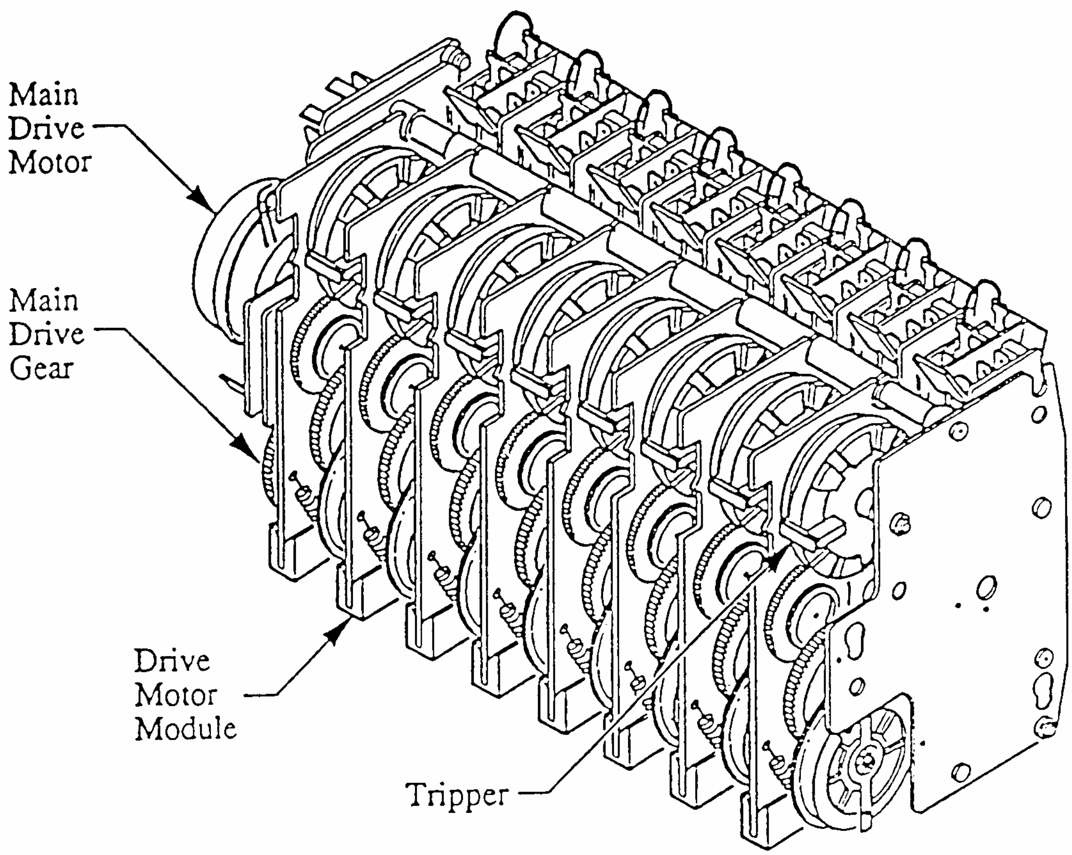


Figure 5-9 Paragon Defrost Timer

CONTROL VALVES

OVERVIEW

This section deals with the operation and maintenance of the major valves which may be found with the Custom System.

EPR VALVE

Evaporator Pressure Regulator Valves respond to upstream pressure and are used to maintain a minimum evaporator temperature. Remember two keys when dealing with rack mounted EPRs. The first is the pressure drop from the merchandiser to the machine room. The final test for setting an EPR should always be evaporator discharge air temperature or product temperature. The second is that low pressure drop EPR Valves, like used on the Custom System, require an external high pressure supply to power the main piston chamber. This high pressure supply must maintain a positive differential of at least 50 psig above the down stream side of the valves. Lower pressure differentials may cause valve malfunction.

Basically all EPR and ORI valves open on upstream suction pressure rise. Achieve the desired suction pressure by balancing Adjustment Spring (#1) against Upstream Suction Pressure (#2) and Fixed Pressure Counter Spring (#3). As upstream pressure rises it closes the high pressure inlet to the Main Valve Chamber (#4). The downstream bleed off reduces the Main Chamber pressure to the point that piston spring (#5) and Upstream Pressure (#6) open the main valve.

EPR Valves equipped with a Suction Stop Solenoid are used with Koolgas Defrost. When de-energized, this solenoid causes the Main Valve to close completely.

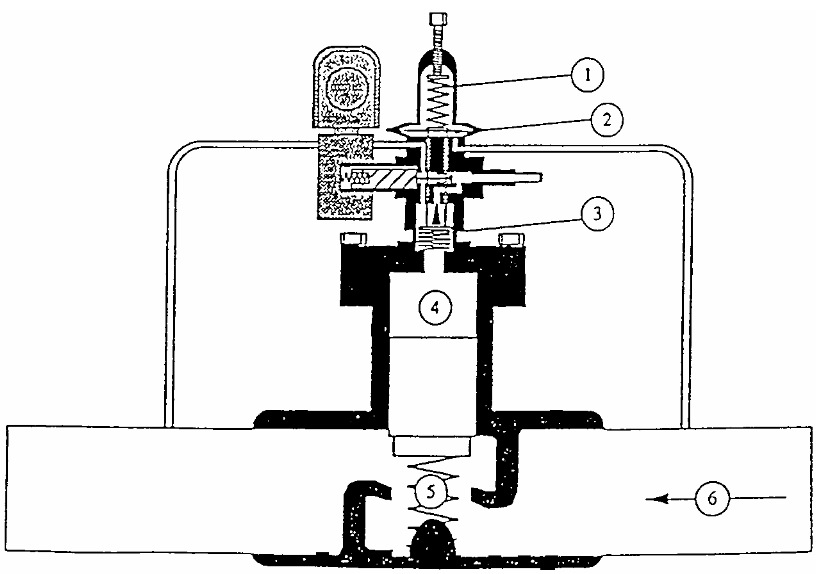


Figure 6-1 EPR Valve with Suction Stop Solenoid

Troubleshooting EPR Valves

Malfunction	Cause	Action
Fails to Open	Dirt holding pilot port open	Disassemble and clean
	Solenoid not energized -bad solenoid -circuit open -stuck in defrost mode	 Replace solenoid find and repair open correct defrost clock problem
Fails to Close	High pressure inlet strainer plugged	Clean or replace
	High pressure line pinched, shut off or plugged	Clean or replace. If oil filled, repipe so high pressure line is not an oil trap
	Sleeve or piston scored, allowing high pressure leak from piston chamber	Replace
	Dirt in piston chamber, causing drag	Clean or replace
	High pressure supply lower than defrost vapor pressure	Repipe
	(Sporlan) Faulty T-seal or Gasket	Repipe
Does not Regulate Temperature	Low high pressure supply, 50 psig or more required in differential between high pressure and down stream suction	Increase pressure supply
	Condensation in long high pressure line	Insulate and/or relocate to higher pressure source

CPR VALVE

The Crankcase Pressure Regulator protects the rest of the system from the large loads caused by open prep rooms. Installed in the suction line, this valve prevents down stream pressure from rising above a given point.

To set the CPR Valve attach compound gauges up and downstream of the valve and as closely as possible to the valve.

Set the prep room temperature control low enough to be calling for cooling. Manually turn off one or more compressors on the rack to cause a suction pressure rise.

Set the CPR to throttle at 35 psig, maintaining that pressure down stream. The up stream pressure will increase above 35 psig.

Set the temperature control to 45°F discharge air temperature, or local codes.

If a CPR Valve does not operate or leaks around the adjustment screw, it generally must be replaced.

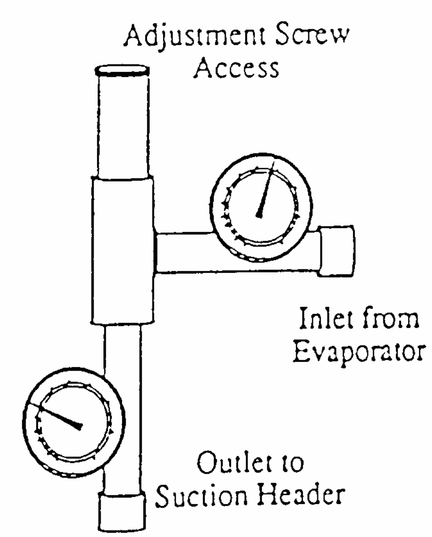


Figure 6-2 CPR Valve Adjustment

KOOLGAS VALVES

`Koolgas valving is piped in one of two ways. With a stop suction EPR or CDA a simple 2-way solenoid valve is used. Without, a 3-way solenoid valve is used. Unless there is damage to the valve body itself, both the 2-way and 3-way valve may be disassembled and repaired in the field.

The 3-way valve is normally in refrigeration mode. Energizing the solenoid opens the pilot valve port, which directs high pressure Koolgas vapor to the piston chamber. Pushed to its opposite position, the piston assembly stops the suction line and opens the Koolgas line. A bleed port in the piston provides for de-compression of the piston chamber when the pilot port closes.

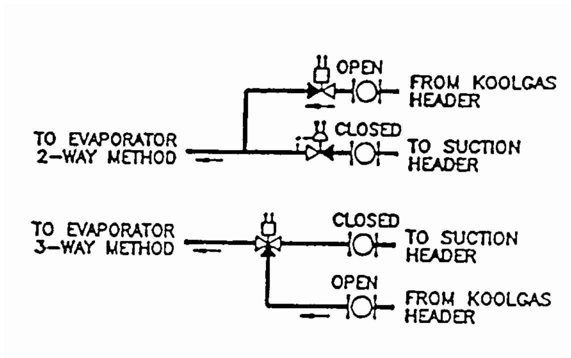


Figure 6-3 Koolgas Valve Piping

Both the EPR and the 2-way solenoid valves are normally closed, so the EPR must be powered only during refrigeration and the 2-way valve only during defrost.

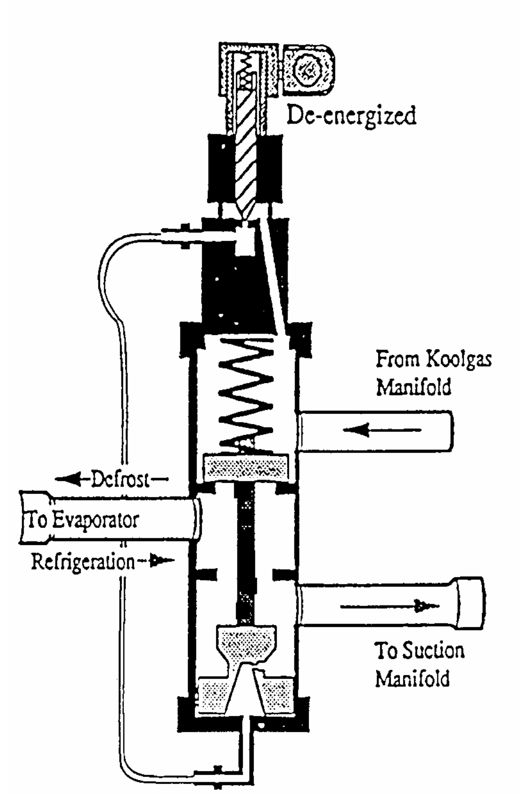


Figure 6-5 3-Way Solenoid Valve

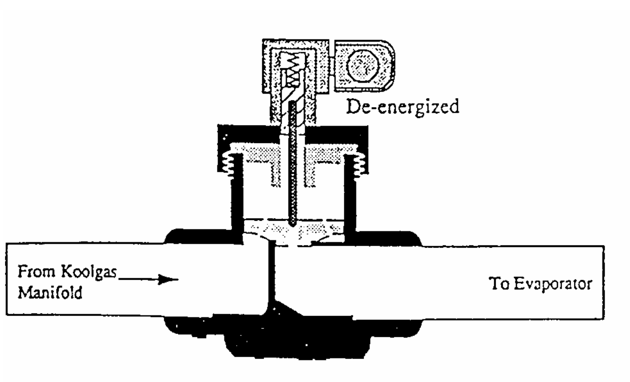


Figure 6-4 2-Way Solenoid Valve

Troubleshooting Koolgas Valves

Malfunction	Cause	Action
Fails to Open	Dirt plugging pilot port	Disassemble and clean
	Solenoid not energized	
	-bad solenoid	Replace solenoid
	-circuit open	Find and repair open
	-NOT in defrost mode	Correct defrost clock problem
Fails to Close	Piston port plugged	Clean or replace
	Barrel or piston scored	Replace
	Dirt in piston chamber, causing drag	Clean or replace
	Stuck in defrost mode	Correct defrost clock problem

MAIN LIQUID LINE SOLENOID VALVES

The Sporlan Main Liquid Line Solenoid Valve goes into differential mode when the coil is de-energized or fails. When the Pilot Port (1) opens, Upstream pressure (2) fills the Main Valve Chamber (3) and forces the Main Valve towards a closed position. The downstream pressure (4) falls to the point that the Pilot Valve Spring (5) can not keep the downstream outlet closed. The Main Valve Chamber starts to empty and upstream pressure forces the main valve towards open.

Differential Mode Quick Test

1. Connect pressure gauges up- and downstream of the valve.

2. All branches on the rack must be in refrigeration mode.

3. Disconnect power to Solenoid.

4. Check gauges for differential.

NOTE: Low refrigerant demand may prevent the differential from building up to the valve's real setting.

Downstream pressure
+ pilot spring pressure
=upstream pressure.

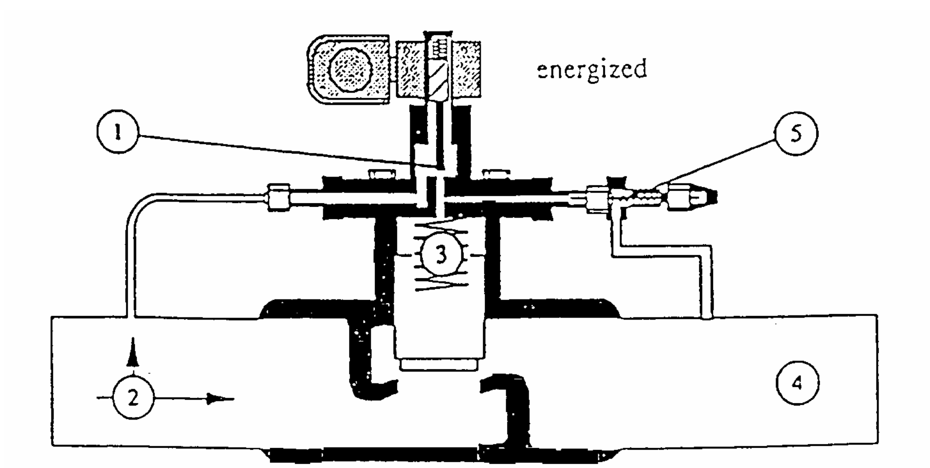


Figure 6-6 Sporlan Main Liquid Line Solenoid

The Alco Main Liquid Line Solenoid Valve goes into differential mode when the coil is de-energized or fails. Upstream liquid (1) is forced through the modulating valve (2) when the upstream pressure exceeds downstream pressure (5) plus the spring pressure (4).

In refrigeration mode, the solenoid valve (3) is held open allowing flow around the modulating valve (2).

Downstream pressure
+ spring pressure
=upstream pressure

Differential Mode Quick Test

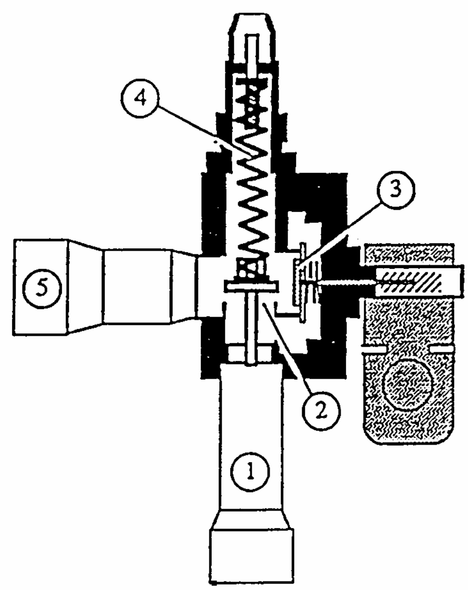
1. Connect pressure gauges up- and downstream of the valve.

2. All branches on the rack must be in refrigeration mode.

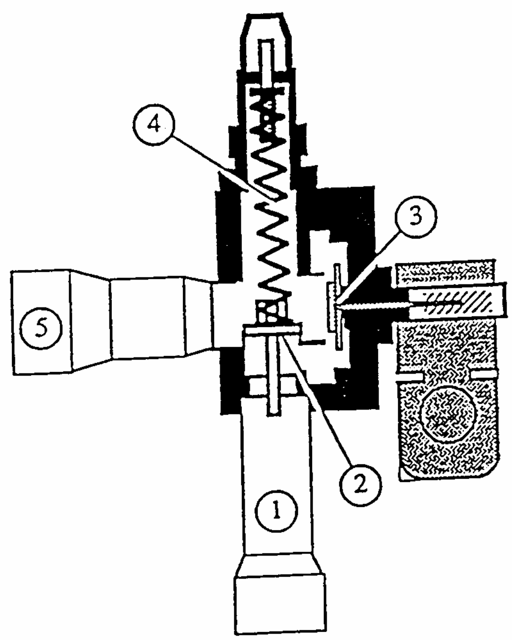
3. Disconnect power to Solenoid.

4. Check gauges for differential.

NOTE: Low refrigerant demand may prevent the differential from building up to the valve's real setting.



Differential Mode – Coil De-energized



Refrigeration Mode – Coil Energized

Figure 6-7 Alco Main Liquid Line Solenoid

BRANCH LIQUID LINE SOLENOID VALVES

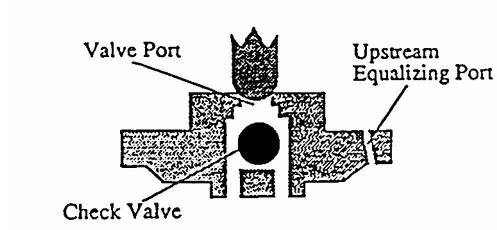
The Branch Liquid Line Solenoid Valve closes off refrigerant supply to the evaporator, yet allows back flow of refrigerant into the Liquid Manifold for Koolgas Defrost.

When the Solenoid is de-energized the Valve Port (1) is held closed. Higher Pressure (5) upstream fills the Valve Chamber (3) through the Equalizing Port (4), keeping the Valve closed.

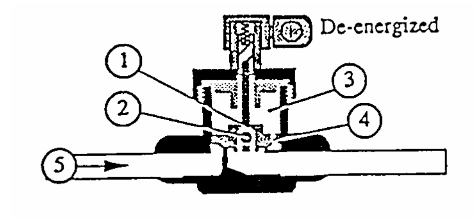
In refrigeration the Valve Port (1) opens, emptying Valve Chamber (3) through the Check Valve (2) faster than the Equalizing Port (4) can fill it. Higher Pressure (5) upstream forces the Valve open.

During Defrost, Valve Port (1) opens, removing kick spring force from the valve. Higher Pressure (5) downstream back flows, closing the Check Valve (2) and forcing the Valve up. Equalizing Port (4) allows Valve Chamber (3) pressure to escape upstream.

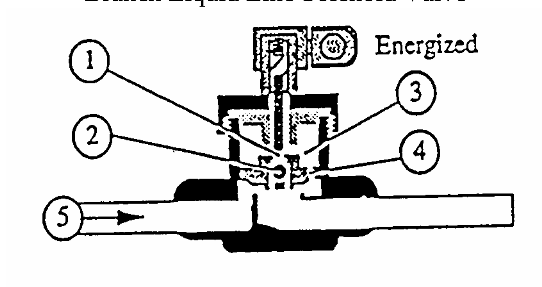
Note: The Solenoid of the branch valve is energized during refrigeration and from back flow during defrost.



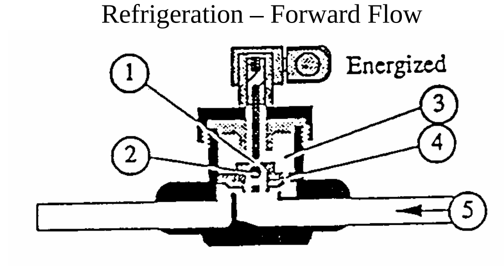
Valve Detail



Branch Liquid Line Solenoid Valve



Refrigeration – Forward Flow



Defrost – Back Flow

Figure 6-8 Branch Liquid Line with Back Flow

Malfunction	Cause	Action
Fails to Open	Dirt plugging valve port or equalizing port	Disassemble and clean
	Solenoid not energized -bad solenoid -circuit open	 Replace solenoid Find and repair open
Fails to Close	Dirt in valve port or equalizing port	Clean or replace
	Barrel or piston scored	Replace
	Dirt in piston chamber, causing drag	Clean or replace

TEV

The Thermal Expansion Valve regulates refrigerant flow into the evaporator by responding to the temperature of superheated vapor at the outlet of the evaporator.

Primary Method for Setting Expansion Valve Superheat

1. Measure the temperature of the suction line at the point the bulb is clamped.

2. Obtain the suction pressure that exists in the suction line at the bulb location by either of the following methods:

   a. If the valve is externally equalized, a gauge in the external equalizer line will indicate the desired pressure directly and accurately.

OR

   b. 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.

3. Convert the pressure obtained in 2a or 2b above to saturated evaporator temperature by using a temperature-pressure chart.

4. Subtract the two temperatures obtained in 1 and 3 – the difference is superheat.

Secondary Method for Setting Expansion Valve Superheat

Before attempting to set a TEV be sure the merchandiser is within 10°F of its normal operating range. Attach temperature probes at both the TEV bulb location (under the clamps), and between the TEV and the evaporator Inlet.

While the valve is hunting the temperature difference between the two probes should not exceed 3-5°F. The differential may fall to zero. To reduce differential, turn the adjusting stem counter clockwise and wait at least 15 minutes before checking results.

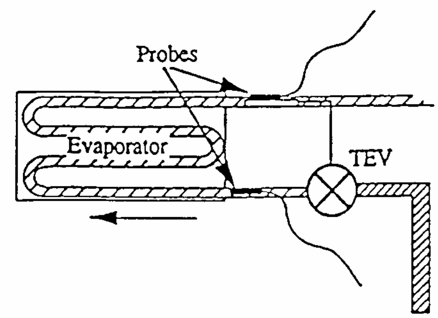


Figure 6-9 Probe Locations for Setting TEV

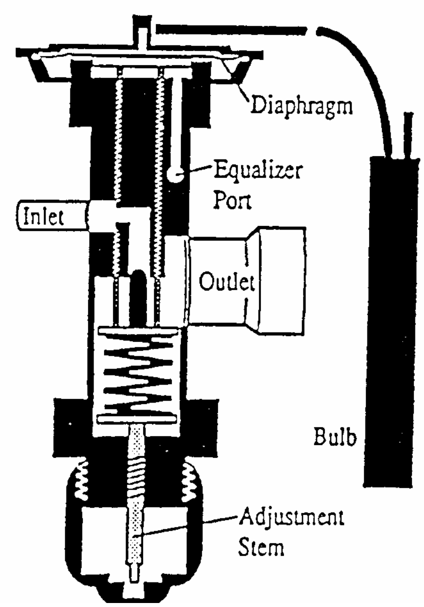


Figure 6-10 TEV

Troubleshooting the TEV

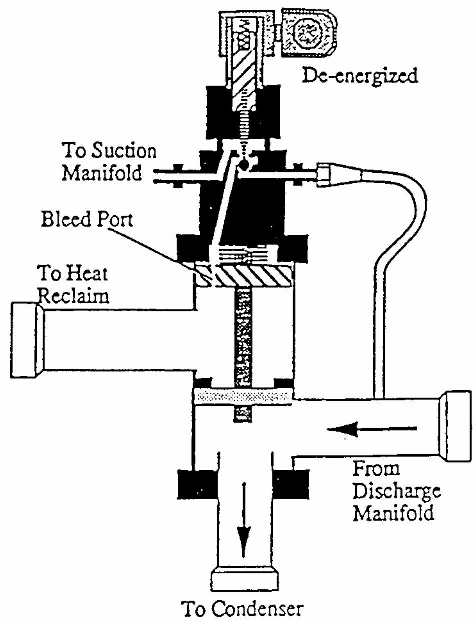
Malfunction	Cause	Action
Evaporator Starved	Superheat adjusted too high	Adjust to proper superheat
	Moisture	Dehydrate and install new liquid line filter dryer
	Dirt plugging strainer or valve mechanism	Remove and clean or replace
	Wax	Clean valve and install wax trapping dryer
	Equalizer Internal misapplied External plugged Capped Restricted Incorrect location	 Install externally equalized TEV Clear Install properly Correct or repipe Repipe
	Flash gas upstream of TEV	Head pressure too low, raise head pressure Liquid supply line not exiting branch line from bottom, repipe Liquid supply line too small, repipe
	Insufficient pressure drop across valve	Raise head pressure Install valve with adequate capacity at reduced pressure
	"Dead" bulb	Replace
	Undersized TEV	Install correct size
Evaporator Flooded	Superheat adjusted too low	Adjust to proper superheat
	Bulb not getting good thermal pickup	Check bulb and correct for good contact, location, and ambient influence
	Moisture or dirt holding valve open	Clean and dehydrate and install new liquid line filter dryer
	Oversized TEV	Install correct size
	Valve damage or valve seat leak	Repair or replace
Poor Performance	Uneven circuit load on multiple evaporators	Balance load (lightly loaded evaporator is controlling TEV, starving loaded evaporator.)
	Moisture or dirt	Clean and dehydrate and install new liquid line filter dryer
	TEV miss-sized	Install correct size

HEAT RECLAIM

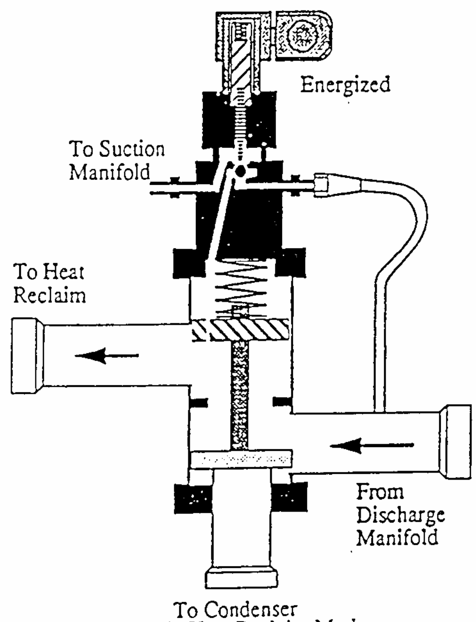
A 3-Way Heat Reclaim Valve directs the refrigerant to either the Condenser or a Heat Reclaim Coil. When the solenoid is de-energized the valve directs the refrigerant to the condenser.

When the solenoid is de-energized the high pressure inlet is stopped and the passage between suction and valve chamber is open. When the solenoid is energized the suction outlet is stopped and the passage between high pressure and the valve chamber is open.

"B" version of the valve has a bleed port through the drive piston to the suction manifold. The bleed port provides a vent for fluids trapped in the Heat Reclaim circuits during normal operation.



Valve in Normal Operation



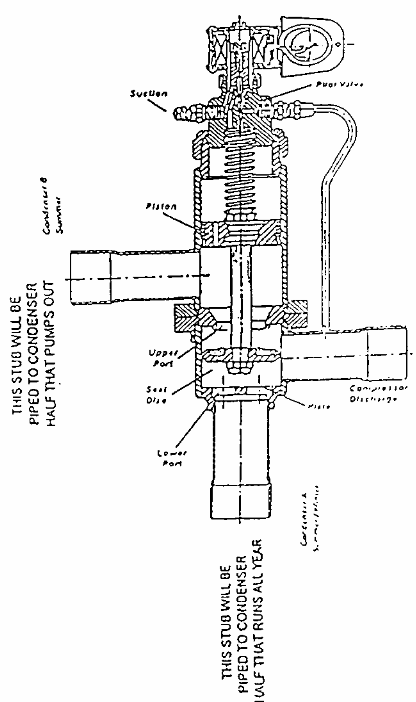
Valve in Heat Reclaim Mode

Figure 6-11 3-Way Heat Reclaim Valve

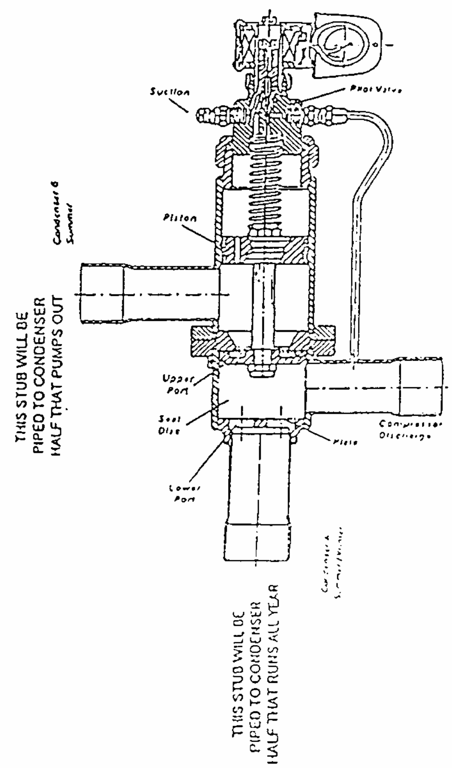
3 –WAY SPLIT CONDENSING VALVES

A 3-Way Split Condenser Valve directs the refrigerant to either both coils of a split condenser or one coil of a split condenser. When the solenoid is de-energized, the seat disc is in the position that evenly splits the flow between both coils of the condenser. When the solenoid is energized, the seat disc moves to close the upper port. The refrigerant flow is then directed to the condenser coil that is set to operate all year. The “B” version of this valve has a small bleed port that pumps out the condenser coil that is not operating when the valve is energized.

As well, any Hussmann/Atlanta System will have a split condenser pump-out on the liquid drop leg that consists of a solenoid valve in series with a small orifice expansion valve. When the split condenser valve is energized, this solenoid valve is energized allowing for a quick pumpout through the expansion valve as well as through the bleed port of the 3-way valve.



De-energized Mode



Energized Mode

FLOODING VALVE AND RECEIVER PRESSURE REGULATING VALVE

The Flooding Valve and the Receiver Pressure Regulating Valve work together--the operation of one effects the operation of the other. The Flooding Valve responds to upstream pressure from the Condenser. The Receiver Pressure Regulating Valve responds to downstream pressure in the Receiver.

The Pressure Regulator Valve (A9 Valve) responds to Receiver pressure. If the Receiver pressure drops below its set point the A9 Valve opens, directing Hot High Pressure Vapor to the Receiver.

The Flooding Valve (A7 or A8) maintains head pressure in low ambient conditions by reducing the available condensing area. Restricting liquid refrigerant flow from the Condenser, the Flooding Valve prevents the liquid refrigerant from leaving the Condenser as fast as it is forming, so the Condenser floods with its own condensate.

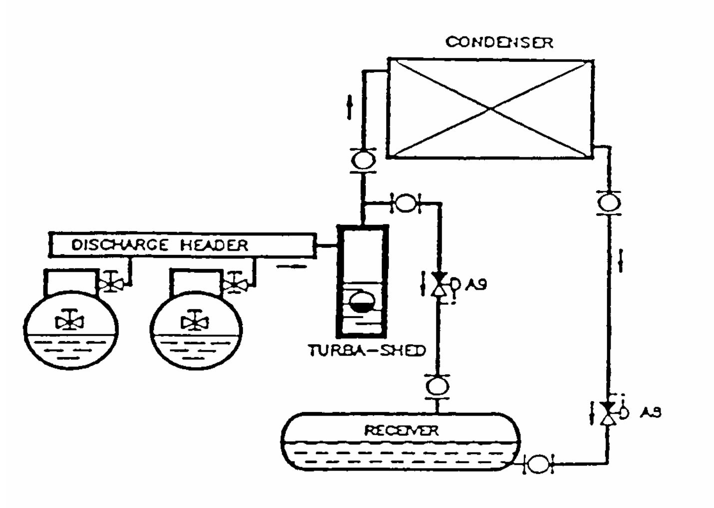


Figure 6-12 Condenser and Receiver Pressure Regulation

A7 and A8 Valve Operation

Upstream Pressure (1) from the condenser must be sufficient to hold Diaphragm (2) off Valve Port (3) so main Valve Chamber (4) stays filled and holds Main Valve (5) open. When upstream pressure falls below Adjustment Spring (6) set point, the valve port closes, the main Valve Chamber (4) empties through the bleed port--closing the main valve.

(1/2 Turn = 35 psig change.)

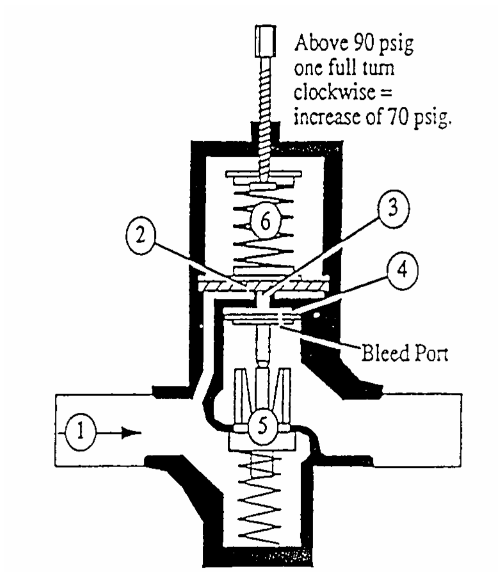


Figure 6-13 A8 Flooding Valve

Malfunction	Cause	Action
Fails to Open	Set too high	Reduce spring tension
	Dirt blocking Valve Port	Clean or replace
Fails to Close	Diaphragm dirty or misaligned	Clean, replace or align
	Set too low	Increase spring tension
	Dirt in bleed port	Clean or replace
	Installed backwards	Re-install with direction of flow

A9 Valve Operation

Downstream Pressure (1) must be sufficient to keep Adjustment Spring (2) from opening Valve Port (3). If receiver pressure falls below the spring set point, the valve port opens, allowing Upstream Pressure (4) to fill the Valve Chamber (5), opening the Main Valve (6). (One full turn = 25 psig change.)

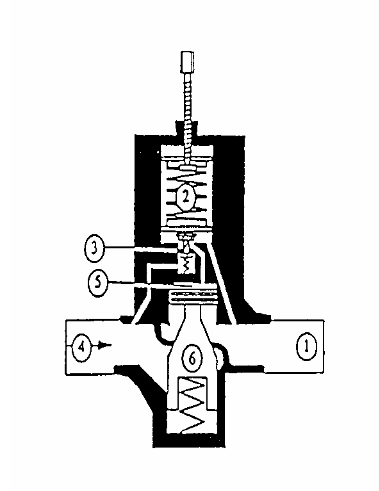


Figure 6-14 A9 Receiver Pressure Regulator

Troubleshooting Receiver Pressure Regulator

Malfunction	Cause	Action
Fails to Open	Set too high	Reduce spring tension
	Dirt blocking Valve Port	Clean or replace
	Diaphragm dirty or misaligned	Clean, replace or align
Fails to Close	Set too low	Increase spring tension
	Dirt in bleed port	Clean or replace
	Installed backwards	Re-install with direction of flow

SURGE RECEIVER VALVES

The Surge Valve directs the flow of refrigerant around the Receiver (Surge) in response to ambient subcooling obtained in the condenser.

When the refrigerant temperature returning from the condenser drops below its set point, the surge valve is energized (open) directing refrigerant flow around the receiver.

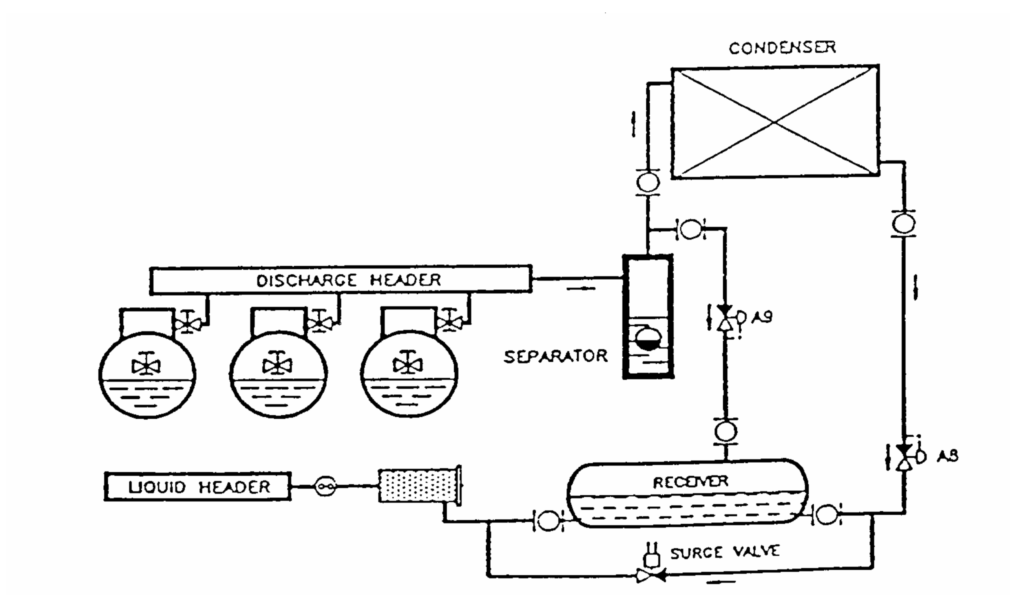


Figure 6-15 Receiver Surge Cycle

MECHANICAL SUBCOOLING

By lowering the temperature of the liquid supplied to the TEV, the efficiency of the evaporator is increased. The lower temperature liquid refrigerant produces less flash gas exiting the TEV.

Shell and Tube Subcooler
Electrically, a thermostat responding to main liquid line temperature of the rack receiving subcooling controls a solenoid valve on the liquid supply line from the unit supplying subcooling.

A standard liquid line solenoid valve and a TEV control refrigerant on the rack. An EPR on the unit supplying the subcooling prevents the subcooler temperature from dropping below

Shell and Tube Subcooler Controls
Thermostat setting is 50°F with minimum differential, or customer specifications.

The TEV should be set with the highest possible superheat that will still maintain the desired liquid temperature.

EPR setting is listed on the store legend.

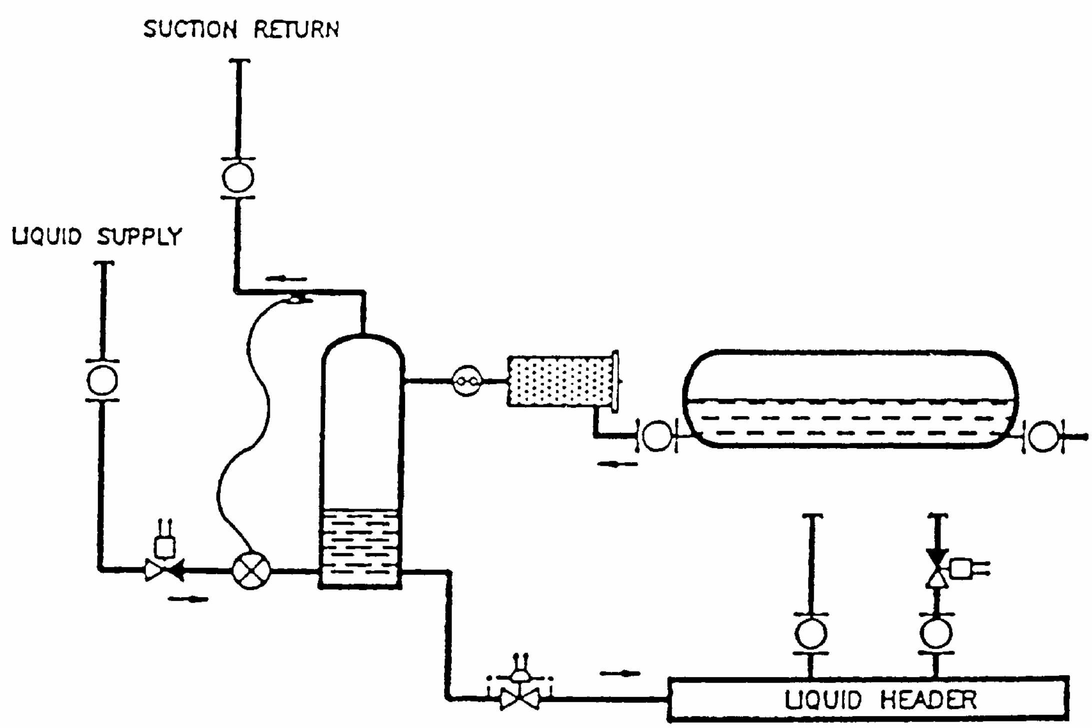


Figure 6-16 Shell and Tube Subcooler

Plate Subcooler

Electrically, a thermostat responding to main liquid line temperature immediately down stream of the Plate Subcooler controls a solenoid valve on the liquid supply line from the Liquid manifold. This circuit is supplied with power through parallel auxiliary contactors on the compressor motor contactors.

A liquid line solenoid valve and a TEV control refrigerant flow to the Plate Heat Exchanger. An EPR on the return suction line prevents the subcooler temperature from dropping below desired liquid temperature.

Plate Subcooler Controls

Thermostat setting is 50°F with minimum differential, or customer specifications.

The TEV should be set with the highest possible superheat that will still maintain the desired liquid temperature.

EPR setting is listed on the store legend.

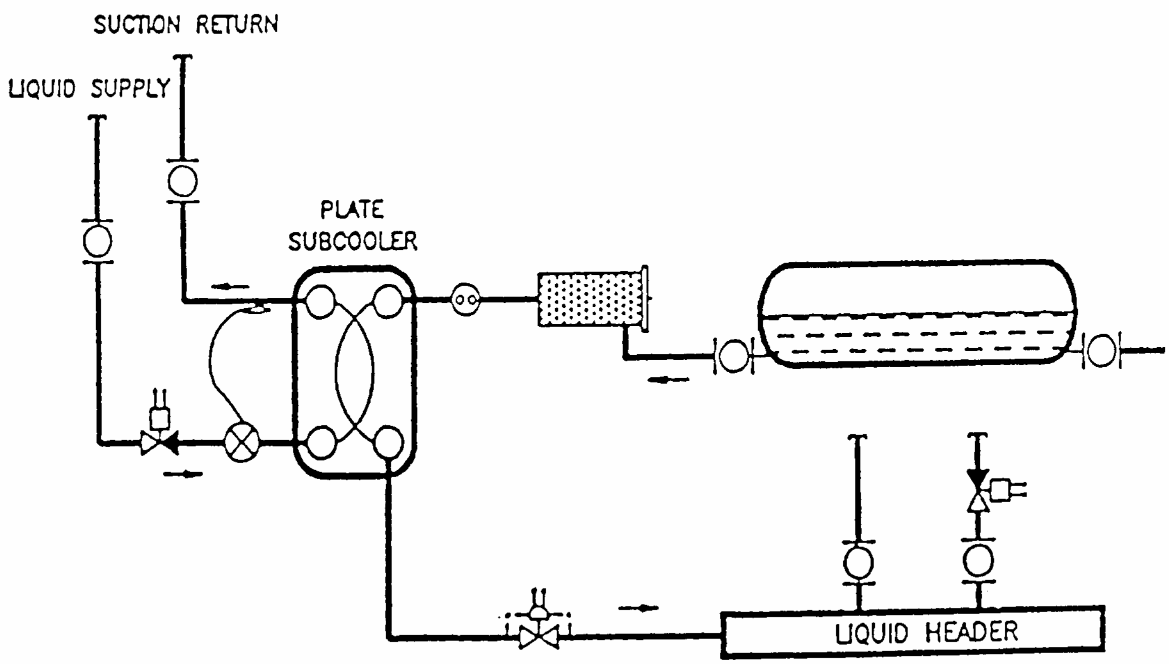


Figure 6-17 Plate Subcooler

TWO-STAGE MECHANICAL SUBCOOLER CONTROL

Electrically, a thermostat responding to liquid drop leg temperature will turn on the subcooler. The setpoint of this control will be the subcooling temperature design point. The setpoint of the control for the one-half or full expansion valve is the liquid drip leg as well. This setpoint is determined by the expansion valve selection and will vary from store to store.

DEMAND COOLING

The Demand Cooling System is designed to inject saturated refrigerant into the suction cavity when the compressor internal head temperature exceeds 292°F. Injection continues until the temperature is reduced to 282°F. If the temperature remains above 310°F for one minute the control shuts down the compressor. After correcting the cause of shutdown, manual reset is required.

The System Parts

Temperature Sensor
Control Module
Injection Valve

The Temperature Sensor employees a Negative Temperature Coefficient (NTC) Thermistor to provide signals to the Control Module. The NTC resistance drops on temperature rise.

Temperature °F	Approximate Ohm Reading
77	90,000
282	2,420
292	2,110
310	1,660

The Control Module responds to the Temperature Sensor input by energizing the Injection Valve Solenoid when 292°F is exceeded. Too high or too low a resistance from the thermistor circuit will cause the Module to shutdown the compressor after one minute.

The Injection Valve meters saturated refrigerant into the suction cavity of the compressor. The valve orifice is carefully sized to meet the requirements of a specific compressor. Valve sizes correspond to the four compressor bodies---2D, 3D, 4D, 6D.

Component Testing

Remove power to the system. Unplug the Temperature Sensor from the Module. The Sensor should ohm out between 1,600 ohms and 100,000 ohms.

Leave the Sensor unplugged and restart the system. There should be no voltage between terminals "S" and "L2" on the Module. The inlet and outlet sides of the Injection Valve should feel the same temperature. After one minute the alarm relay should trip. Remove power to the system. Press the manual reset on the Module.

Using a small piece of wire jump the Sensor circuit at the female plug in the Module. Restart the system. There should be voltage between terminals "S" and "L2" on the Module. The outlet side of the Injection Valve should feel colder than the inlet side. After one minute the alarm relay should trip.

Remove power to the system. Press the manual reset on the Module.

Remove the jumper wire and plug in the Temperature Sensor.

Restart the System.

Alarm Circuit

The Alarm Circuit has three terminals in the Control Module.
"L"--Common
"M"--Normally Closed
"A"--Normally Open

"L" and "M" are wired into the compressor control circuit so an alarm condition removes the compressor from the line and power to the Module. A manual reset is required to call attention the alarm condition.

Alarm Relay

The Alarm Relay is activated after a one minute delay under the following three conditions:

Compressor discharge temperature exceeds 310°F.

A shorted circuit or very low Thermistor Resistance.

An open circuit or very high Thermistor Resistance.

Operational Notes

Demand Cooling does NOT replace head cooling fans which are still required on low temperature applications.

Temperature Sensor cable must not touch any hot surfaces or the cable will be damaged.

COMPOUND RACK VALVING

Liquid Injection provides for proper superheat levels entering the second stage compressors of a compound system. This prevents excessive discharge temperatures on the second stage.

Electrically, a thermostat responding to the first stage discharge temperature controls a solenoid valve on the liquid supply line from the liquid manifold. Power is supplied to this circuit through any one of the parallel auxiliary contactors on each first stage compressor contactor, so at least one first stage compressor must be running for the liquid injection to work. A TEV in the liquid refrigerant line regulates the refrigerant flow into the first stage discharge manifold in response to its superheat temperature. (Factory set at 25°F superheat.)

R22 Compound System Startup

The medium temperature section must be started first. With the medium temperature section running bring on the low-temp compressors one at a time. The first stage thermostat maintains between 50° and 65°F.

High Pressure Safeties

1st stage is set at 150 psig.
2nd stage is set at 325 psig.

*Check piping section for component layout.

OIL SYSTEM

Regulation Valve

The special oil pressure differential valve is used to reduce the high pressure in the combination oil separator and reservoir to a pressure slightly above the suction pressure to prevent overfeeding of the compressor float. The valve has an adjustment range of 3 to 20 psi differential pressure. Typically, this pressure should be approximately 10 to 15 psig above the suction pressure.

NOTE: A separate oil pressure differential valve should be used to supply oil to a high-end Satellite.

Adjustments are made at the bottom of the valve. To adjust, remove the valve cap and turn the stem with a valve wrench. To increase the differential, screw the stem in; to decrease the differential, screw the stem out. (See Figure 5-3) One turn gives 4 psi of adjustment.

NOTE: An increase in differential means higher oil pressure into the floats.

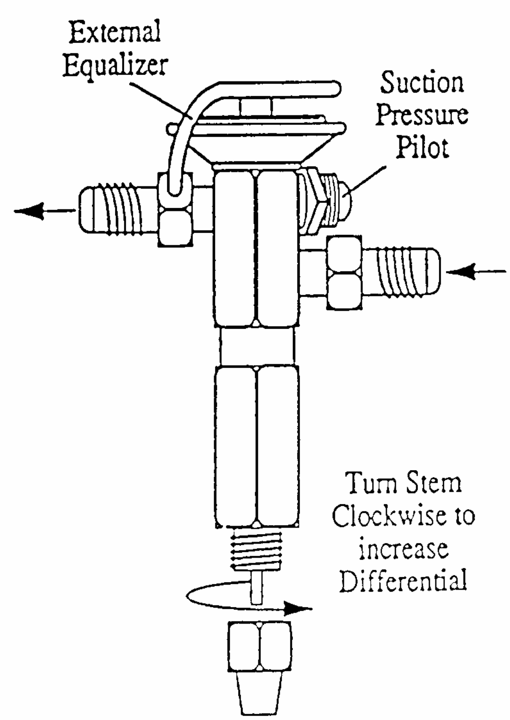


Figure 6-18 Oil Pressure Differential Valve

Oil Differential Pressure Regulating Valve

The oil pressure differential valve reduces oil pressure from high side pressure to a range of 3 to 20 psig above the suction pressure. Typically, the valve would be set between 10 and 15 psig above the suction pressure to prevent over feeding of the oil level regulator. A separate Oil Pressure Differential Regulating Valve must be applied for each different suction pressure on one oil system.

Turning the adjustment stem clockwise ¼ turn will increase the pressure to the oil level regulators about 1 psig.

¼ turn clockwise = 1 psig increase.

Oil Level Regulators

For any brand of oil level regulator to work accurately the unit and each compressor must be level. Both Sporlan and AC & R regulators may be damaged by over adjusting. Do not exceed 175 psig when testing to prevent damage to the floats. A sightglass filled with oil may indicate a damaged regulator.

Before beginning adjusting, isolate the compressor by turning off its control circuit.

Sporlan Oil Level Control OL-1 Series

The Sporlan Oil Level Regulator comes preset to maintain oil level at the center line of the sightglass. If there is any question as to the actual set point of the regulator, turn the adjustment stem counterclockwise until the top stop is reached. Then adjust the oil level down to the desired height by turning the stem clockwise. Each full turn will represent about .05 inches change in oil level.

Do not exceed 9 turns from the top stop going down, or the control may be damaged.

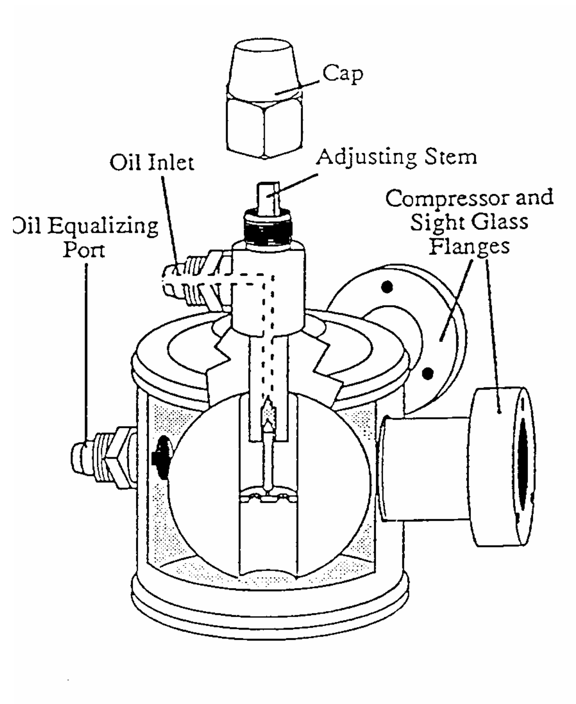


Figure 6-19 Sporlan Oil Level Regulator

AC&R Oil Level Regulator

The AC & R Oil Level Regulator comes preset to maintain oil level 1/8 inch below the center line of the sightglass. Turn the adjustment stem counterclockwise to increase the oil level. Each full turn will represent about .055 inches change in oil level.

Do not exceed:

*5 turns clockwise (downward)

*4 turns counterclockwise (upward) from original factory setting.

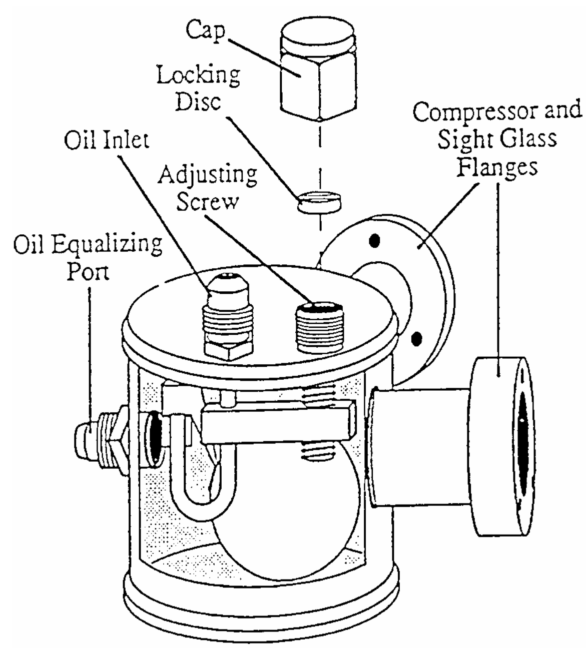


Figure 6-20 AC & R Oil Level Regulator

S-9300 OIL LEVEL CONTROLLER

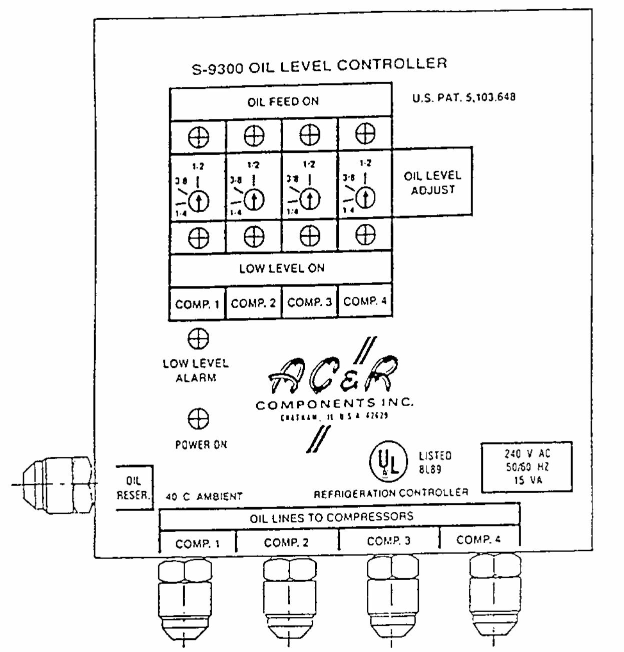
SERVICE MANUAL

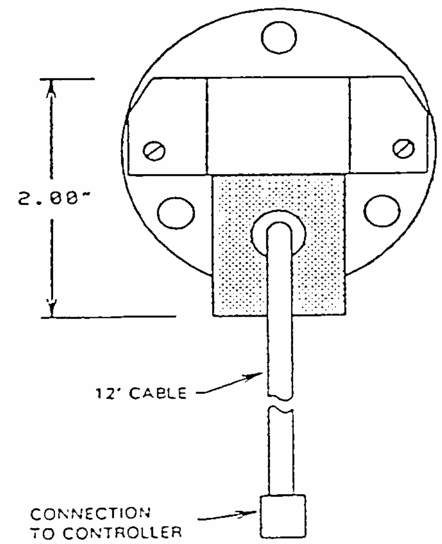
AC&R COMPONENTS INC.
CHATHAM, IL U.S.A. 62629

2-025-043
S-9300 SM

S-9300 OIL LEVEL CONTROLLER

AC&R COMPONENTS INC
CHATHAM, IL U.S.A. 62629





S-9330 TRANSDUCER/
SIGHT GLASS ASSY.

The S-9300 Oil Level Controller was developed as the first of a new type of oil level control technology for use on multiple compressor refrigeration systems.

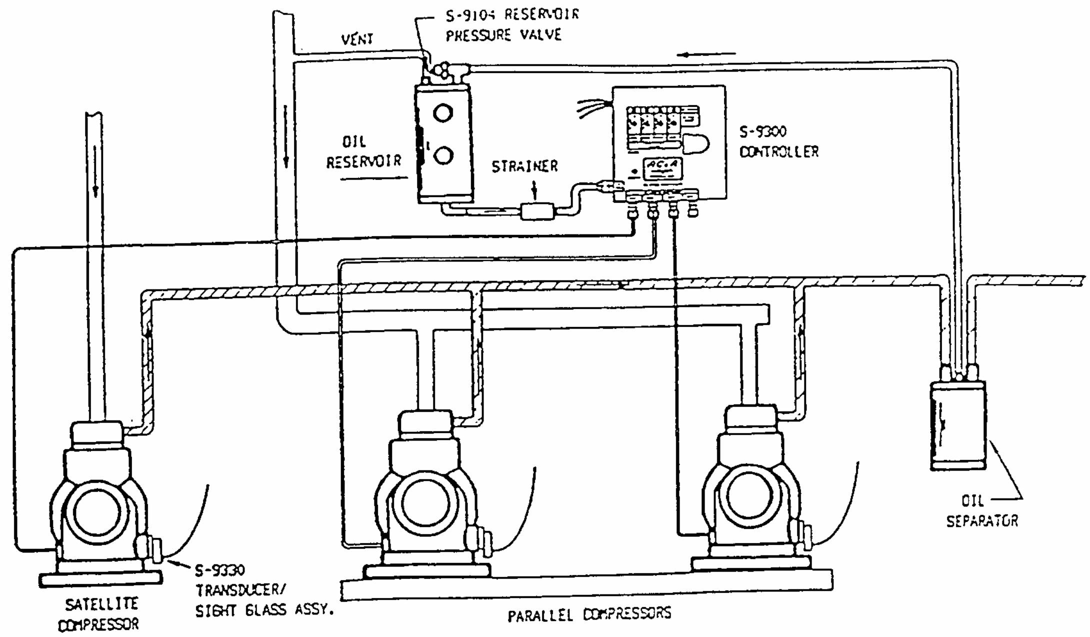
This electronic oil level controller maintains a preset compressor oil level, allowing it to replace the mechanical float type oil level control on selected systems. The S-9300 uses an optical transducer which allows the user to select the desired control level remotely from the compressor.

The S-9300 was developed specifically for systems where accurate control and ability to hold the same level thru a range of pressure drops are important requirements.

AC & R pioneered the Separator/Reservoir/Control Valve oil level control system and thousands of these systems are in service. The S-9300 represents an improvement of this original control system by providing the many new features described below.

S-9300 DESIGN FEATURES:

* Accurate oil level control, unaffected by:
  - variations in pressure drop
  - variations in compressor oil pumping rate
* Level adjustments allow each compressor to be individually set.
* Low level alarm monitor on all 4 compressors with common dry contact output.
* Same unit for parallel and/or satellite compressors.
* Soft seated flow control valve eliminates oil build-up during the off cycle.
* Eliminates the need for oil balancing lines between the compressors in most applications.
* Optical level sensing through the sight-glass.
* Modulated pulse feed eliminates oil feed problems due to foaming.
* 4 compressor controller unit provides simplified wiring installation for supermarket compressor rack applications.
* 3/8" SAE flare fittings allows use of typical oil return piping methods.
* All electronic and electrical components can be serviced without opening the system.



S-9300 SERIES SYSTEM

OPERATION:

In parallel compressor refrigeration systems used in supermarkets, the oil pumped by the compressors must be returned to the compressors by an oil level control system to insure that the crankcase levels meet the need for proper lubrication and minimum pumping horsepower.

To provide even distribution of oil to the parallel compressors, the oil level control system shown above is used. The oil is separated from the discharge gas by the Oil Separator and passed to the Oil Reservoir which holds the excess oil in the refrigeration system.

The crankcase oil level required by the compressor manufacturer can be set at the S-9300 Oil Level Controller. This setting is compared with the level signal received from the S-9330 Transducer that is mounted on the side of the compressor on the 3-020-057 sight glass.

The S-9300 Oil Level Controller senses the level of oil in each compressor using the S-9330 Transducers. If the level in one or more compressors is below the Controller setpoints, the Controller will pulse feed oil from the Oil Reservoir to that compressor until the level reaches the setpoint.

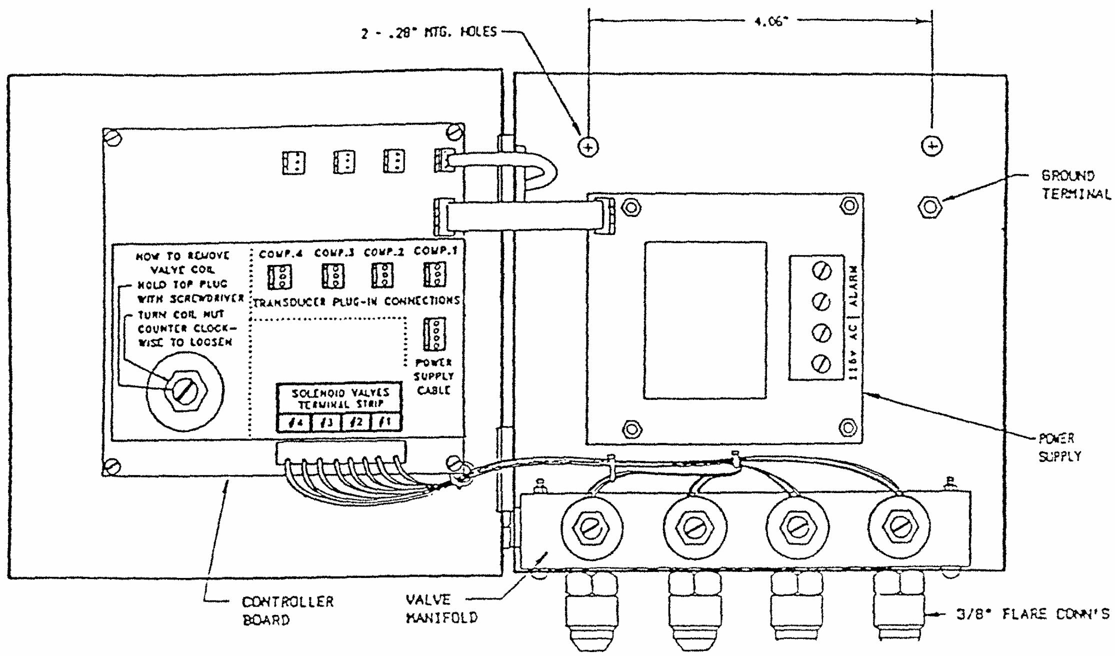
The S-9300 control circuit incorporates time delays that prevent oil feed for momentary low level conditions and to feed only when the oil has been low for at least 9 seconds.

The S-9310 control circuit incorporates time delays that prevent oil feed for momentary low level conditions and to feed only when the oil has been low for at least 9 seconds. After the “on” delay time, the controller will pulse feed oil to the crankcase at a maximum rate of 6 seconds off and 16 seconds on. Oil will feed in this manner until the level set on the front panel for that compressor is achieved.

The level adjustment is accomplished by setting the angle of the adjustment “arrow” at the same angle as the level scale marking on the front panel.

The Low Level Alarm energizes the Alarm Relay after a 45 sec delay. The alarm will continue as long as the oil level is below 1/8 glass in any of the compressor S-9330 Transducers. The RED “Low Level On” LED’s will stay on whenever the oil level goes below 1/8 glass.

The S-9300 Controller has GREEN LED’s which turn on when the flow control valves are feeding oil to the compressors. A RED LED indicator light shows that one of the compressors is in Low Level Alarm. The Yellow LED shows that the S-9300 has AC power for operation.



CONTROLLER COMPONENTS:

The S-9300 Oil Level Controller consists of 3 parts:

(1) S-9300 Control Box
(2) S-9330 Oil Level Transducer
(3) 3-020-057 sight glass required to mount the Transducer

Details on these parts are as follows:

(1) S-9300 CONTROL BOX:
The Control Box open view shows the box with the front cover hinged open for wiring or service.

CONSTRUCTION:
- Sturdy hinged steel box easily opened for wiring.
- Controller board is mounted to the front cover.
- Power supply board is mounted to the back wall of the box.
- 4 solenoid valve manifold is mounted to the lower wall of the box.

FRONT PANEL ITEMS:
- 4 Green LED's turn ON when oil is feeding.
- Level adjustments allow each compressor to be individually set
- Yellow "POWER ON" LED proves that power is applied to the Controller Board.
- Red "LOW LEVEL ALARM" LED indicates that one or more compressors have a low level
- Red "LOW LEVEL ON" LED's indicate when the oil level is below 1/8 glass.
- Legends along the lower edge and left side direct the installer to make the correct piping connections.

CONTROLLER BOARD:
- Connects to the Power Supply with a 4 position cable.
- Has 4 transducer plug-in position headers, 1 for each compressor S-9330 transducer. Labels indicate compressor number.

POWER SUPPLY BOARD:
- Class 2. current limiting, UL1585 Recognized transformer.
- Red "POWER ON" LED warns serviceman that unit is "HOT"
- Terminal strip marked for "115v AC" or "230v AC" and "ALARM" positions.

OIL FEED VALVES:
- 5 connections are shown on the front legend of the control box.
  3/8” flare fitting – OIL RESERVOIR
  3/8” flare fittings – COMP 1, COMP 2, COMP 3, COMP 4
- Solenoid coils are replaceable for service.
- Solenoid coil wires are connected according to the label on the back of the Controller Board.

(2) S-9330 OIL LEVER TRANSDUCER
- Transducer mounts to the 3-020-057 sight glass using the 2 holes shown in the Transducer mounting ears.
- Mount with ‘WIRE EXIT LOW’ so that the Transducer nests between the bolt heads used to mount the sight glass to the compressor.
- Transducer is sealed with gaskets for moisture protection.
- Cable length is 8 feet.
- Cable is terminated with 3 position polarized connector to plug into the back of the Controller Board.
- Coil excess cable adjacent to the control box.

(3) 3-020-057 SIGHT GLASS
-Mount on compressor side on one of the compressor sight glass locations.
- Sight glass includes mounting holes for installation and removal of the S-9330 Oil Level Transducer.

In the field installation kit, the Transducer and the Sight Glass are shipped as a pre-assembled unit and installation procedure described below will change accordingly.

INSTALLATION:

(1) Mount the S-9300 control box using the mounting holes in the back wall of the box.
(2) All S-9300 unused compressor feed connections MUST be capped.
(3) Install the 3-020-057 sight glass on one of the compressor sight glass openings in each compressor.
(4). Assign compressor numbers #1 #2 #3 #4 and MARK transducer cables at both ends with compressor numbers
(5) Install the S-9330 transducer to the 3-020-057 sight glass. Use the captivated lock-washer type screws furnished with the sight glass.
(6) Install the AC & R Oil Line Strainer S-9105 in the oil line from the reservoir to the S-9300 Control Box.
(7) Pipe the oil feed lines from the S-9300 control box to the compressor crankcase connection using 3/8” OD copper tubing.

    At the compressor end of the oil feed line, the installer can select any available compressor fitting which accesses the crankcase. One possible location is the ¼”NPT opening on the side of a typical semi-hermetic compressor
(8) Run the S-9330 Transducer cable to the S-9300 control box and thru the leafed plastic plug in the left side wall.

INSTALLATION: (Continued)

(9) Plug the S-9330 Transducer connector into the back of the Controller Board in the correct compressor position. This is indicated by the label on the back of the Controller Board as "Comp. 1", "Comp. 2", "Comp. 3", "Comp. 4".

(10) Run the marked AC power thru the ½" conduit hole on the right side wall of the control box. Power supply 115v or 230v AC as marked, 12 va AC power wiring is applied to the Power Supply board terminal strip.

(11) Optionally, wire the Alarm Relay dry contact output to the terminal strip positions marked on the Power Supply Board.

(12) Set the Oil Level Adjust for each compressor oil level.

(13) Check all joints for leaks. Check all wiring.

(14) Apply AC power to the Power Supply and verify that the Power Supply Board LED and the Amber Controller Board "ON" LED are on.

SERVICE INSTRUCTIONS:

Since the S-9300 Oil Level Controller will be typically used with multiple compressor supermarket racks, the trouble-shooting instructions are written with that installation in mind.

Before the oil level controller can control the oil level, the reservoir or separator/reservoir must have a supply of oil to feed to the compressors.

Excessive oil can return from the system after defrost and enter the compressor thru the suction line. The S-9300 cannot correct this problem.

If the supply of oil in the system is low or if the oil/refrigerant mixture being fed thru the S-9300 contains a large percentage of refrigerant, a low oil level alarm or low oil pressure trip can result.

CAUTION: The feed solenoid port is sized to GRADUALLY return oil to the crankcase. If the oil being returned contains a high percentage of refrigerant, it can take a number of feed cycles to bring the actual oil level up to the setpoint.

In other words, an upward adjustment will not bring an instantaneous increase in oil level.

Compressor oil level problems can be listed as:
- Oil level too low
- Oil level too high
- Low oil on startup
- Crankcase fills when compressor is off

Low oil on startup can be caused by an accumulation of refrigerant in the crankcase during the off-cycle. This refrigerant boils as the crankcase pressure falls in the crankcase resulting in heavy forming and a high oil pumping rate.

The S-9300 will feed after a 9 second delay to try to catch up with the demand. The best solution is to prevent refrigerant from condensing in the crankcase during the compressor off-time by using a pump-down cycle or some other means.

Both the Power Supply Board and the Controller Board are easily removed in the event that service is required.

TROUBLE SHOOTING CHART

Oil Level Too LOW / Compressor RUNNING

Problem Symptoms	Possible Remedies
Insufficient oil in reservoir	- Bring oil back from system. - Add oil
Controller Board AMBER LED is off	- Check Power Supply LED. Check AC voltage supply if off. - Reinstall cable to Controller Board If Amber LED still off replace cable and Controller Board.
AMBER LED is on (Power OK)	- Re-adjust oil level upward. - Check for switched compressor piping. - Check if transducer is plugged in to the correct compressor number on back of controller board. - Correct transducer wiring if switched - Remove transducer and check sight glass surface. - Check transducer by swapping transducers with another compressor. - Replace Controller board.

Oil Level Too HIGH / Compressor RUNNING

Problem Symptoms	Possible Remedies
GREEN LED for the high level compressor IS NOT cycling the oil feed solenoid	- Re-adjust oil level downward. - Check for switched compressor piping. - Excessive oil coming in thru suction line after defrost. - Check for dirt or defective solenoid plunger seat. Replace if necessary.
GREEN LED for the high level compressor IS cycling the oil feed solenoid	- Re-adjust oil level downward. - Check for switched compressor piping. - Correct transducer wiring if switched. - Remove transducer and check sight glass surface. - Check transducer by swapping transducers with another compressor. - Replace Controller board.

WARNINGS:

- Do NOT run AC power wiring thru the box left wall or thru the box top wall.
- DISCONNECT POWER at MAIN PANEL before installing or servicing.
- When replacing a compressor, unplug the S-9330 transducer and cap off the oil feed line.
- Line voltage wiring must NOT be in contact with the front panel controller board.

S-9310 OIL LEVEL CONTROLLER

SERVICE MANUAL

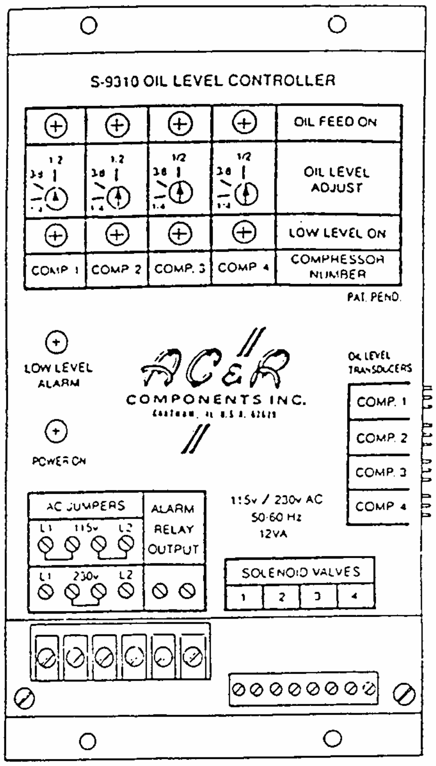
AC&R

COMPONENTS INC.

CHATHAM, IL U.S.A. 62629

2-025-044
S-9310 SM

S-9310 OIL LEVEL CONTROLLER



PANEL MOUNT DESIGN

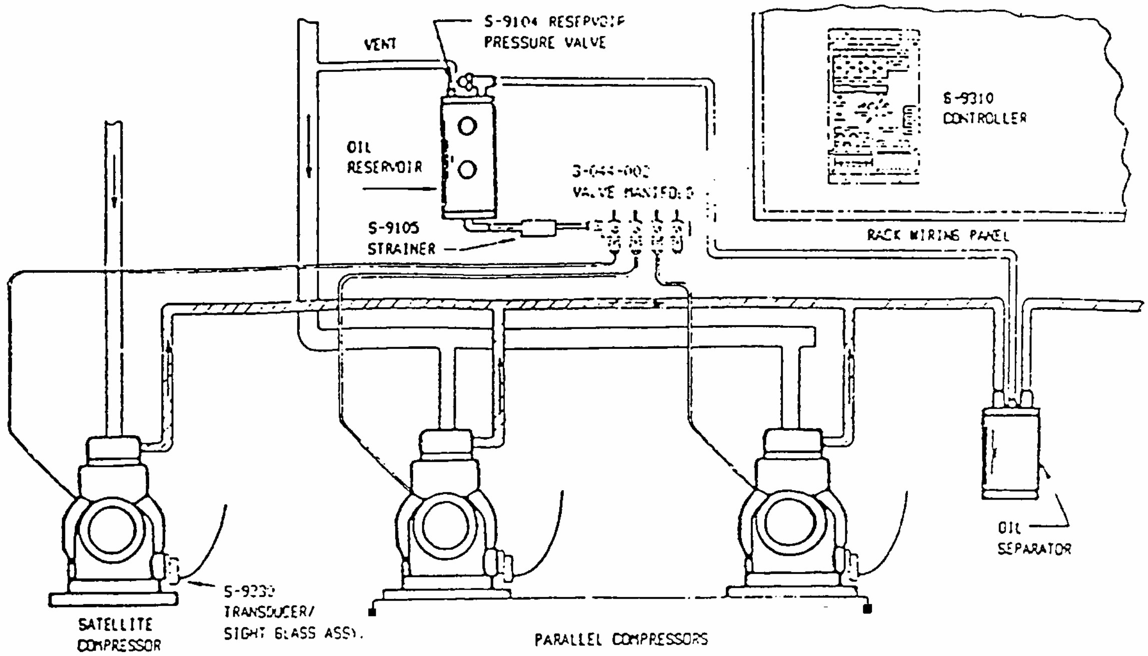
The S-9310 Oil Level Controller was developed for use on multiple compressor refrigeration systems where the user needs the capability of mounting the level controller in the compressor rack wiring panel.

This electronic oil level controller maintains a preset compressor oil level, allowing it to replace the mechanical float type oil level control on selected systems. The S-9310 uses an optical transducer which allows the user to select the desired control level remotely from the compressor.

AC & R pioneered the Separator/Reservoir/Control Valve oil level control system and thousands of these systems are in service. The S-9310 represents an improvement of this original control system by providing the many new features described below.

S-9310 DESIGN FEATURES:

* Panel mount oil level controller
* Accurate oil level control, unaffected by:
  - variations in pressure drop
  - variations in compressor oil pumping rate
* Level adjustments allow each compressor to be individually set
* Low level alarm monitor on all 4 compressors with common dry contact output.
* Same unit for parallel and/or satellite compressors.
* Soft seated flow control valve eliminates oil build-up during the off cycle.
* Optical level sensing through the sight-glass.
* Modulated pulse feed eliminates oil feed problems due to foaming.
* 4 compressor controller unit provides simplified wiring installation for supermarket compressor rack applications.
* 3/8" SAE flare fittings allows use of typical oil return piping methods.



S-9310M SERIES SYSTEM

OPERATION:

In parallel compressor refrigeration systems used in supermarkets, the oil pumped by the compressors must be returned to the compressors by an oil level control system to insure that the crankcase levels meet the need for proper lubrication and minimum pumping horsepower.

To provide even distribution of oil to the parallel compressors, the oil level control system shown above is used. The oil is separated from the discharge gas by the Oil Separator and passed to the Oil Reservoir which holds the excess oil in the refrigeration system.

The crankcase oil level required by the compressor manufacturer can be set at the S-9310 Oil Level Controller. This setting is compared with the level signal received from the S-9330 Transducer that is mounted on the side of the compressor on the 3-020-057 sight glass.

The S-9310 Oil Level Controller senses the level of oil in each compressor using the S-9330 Transducers. If the level in one or more compressors is below the Controller setpoints, the Controller will pulse the four oil feed solenoid valves in the valve manifold S-9310M. The manifold will feed the oil from the Oil Reservoir to that compressor until the level reaches the setpoint.

The S-9310 control circuit incorporates time delays that prevent oil feed for momentary low level conditions and to feed only when the oil has been low for at least 9 seconds. After the "on" delay time, the controller will pulse feed oil to the crankcase at a maximum rate of 6 seconds off and 16 seconds on. Oil will feed in this manner until the level set on the front panel for that compressor is achieved.

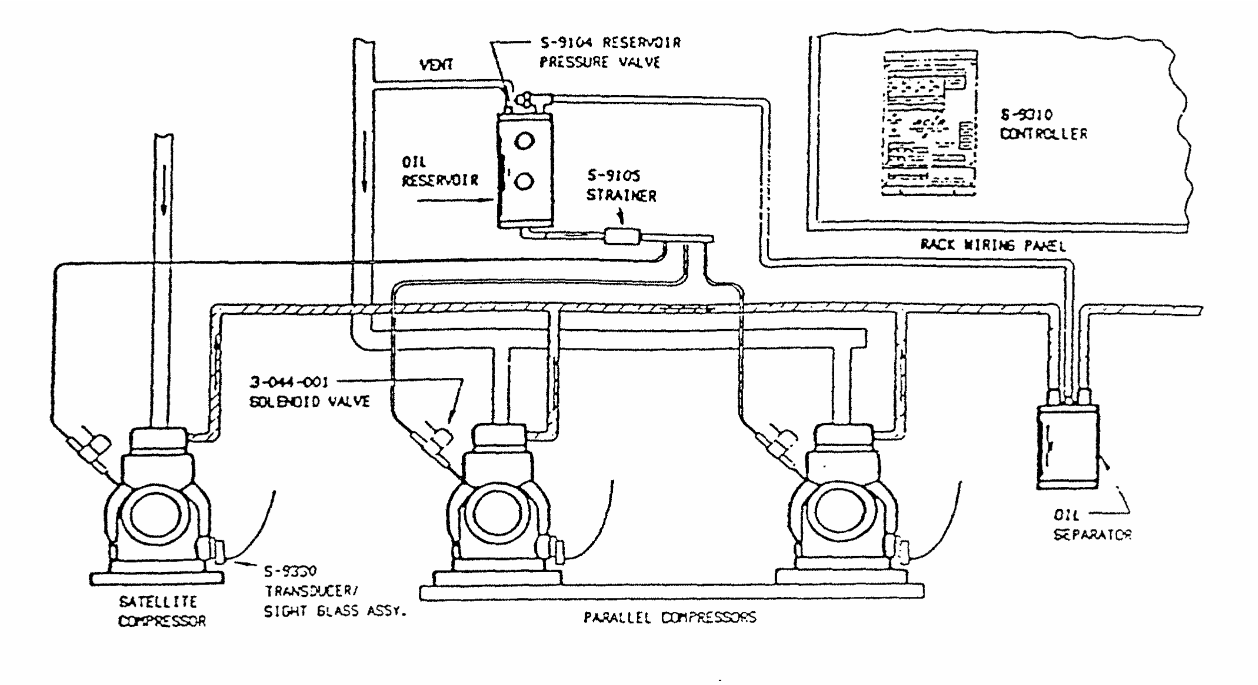
The level adjustment is accomplished by setting the angle of the adjustment "arrow" at the same angle as the level scale marking on the front panel.

The Low Level Alarm energizes the Alarm Relay after a 45 sec delay. The alarm will continue as long as the oil level is below1/8 glass in any of the compressor S-9330 Transducers.

The RED "Low Level On" LED's will stay on whenever the oil level goes below 1/8 glass.

The S-9310 Controller has GREEN LED's which turn on when the flow control valves are feeding oil to the compressors. A RED LED indicator light shows that one of the compressors is in Low Level Alarm. The Yellow LED shows that the S-9310 has AC power for operation.

The previous system figure showed the use of a 4 solenoid valve manifold. This manifold simplifies piping and reduces the number of fabricated joints required for installation. As an option, individual 3-044-001 oil feed solenoid valves can be applied as shown in the piping figure below. When the individual valves are used, a factory fabricated manifold must be constructed to feed oil to the individual solenoid valves.



S-9310 SERIES SYSTEM

CONTROLLER COMPONENTS:

The AC & R Panel Mount Oil Level Controller consists of 4 parts:
(1) S-9310 Oil Level Controller
(2) S-9330 Oil Level Transducer
(3) 3-020-057 sight glass required to mount the Transducer
(4) 3-044-002 4 Solenoid Valve Manifold or up to four
3-044-001 Oil Feed Solenoid Valves
Details on these parts are as follows:

(1) S-9310 OIL LEVEL CONTROLLER CONSTRUCTION:
- Controller board is mounted to an aluminum back plate with mounting holes for panel mounting.
- Terminal strips are provided for:
  - (a) Connecting 115v or 230v AC power
  - (b) Alarm relay connections
  - (c) Solenoid valve coil wires
- Class 2, current limiting, UL1585 UL Recognized transformer.
- Alarm relay SPST, pilot duty rated 250v AC, 125 VA MAX.
  Close on alarm.

FRONT PANEL ITEMS:
- 4 Green LED’s turn ON when oil is feeding.
- Level adjustments allow each compressor to be individually set.
- Yellow “POWER ON” LED proves that power is applied to the Controller Board.
- Red “LOW LEVEL ALARM” LED indicates that one or more compressors have a low level.
- Red “LOW LEVEL ON” LED’s indicate when the oil level is below 1/8 glass.
- Legend along lower left edge shows proper jumper locations for using either 115v or 230v AC power supply.
- Right edge legend indicates the plug-in locations for four S-9330 transducer headers, one for each compressor.
- Lower edge legends show the wiring locations for AC power, Alarm Relay and the oil feed solenoids.

(2) S-9330 OIL LEVEL TRANSDUCER

- Transducer mounts to the 3-020-057 sight glass using the 2 holes shown in the Transducer mounting ears.
- Mount with 'WIRE EXIT LOW' so that the Transducer nests between the bolt heads used to mount the sight glass to the compressor.
- Transducer is sealed to the sight glass with a gasket for moisture protection.
- Cable length is 12 feet.
- Cable is terminated with 3 position polarized connector to plug into the back of the Controller Board.
- Coil excess cable in the rack wiring pane.

(3) 3-020-057 SIGHT GLASS

- Mounts on compressor side on one of the compressor sight glass locations.
- Sight glass includes mounting holes for installation and removal of the S-9330 Oil Level Transducer.

(In the field installation kit, the Transducer and the Sight Glass are shipped as a pre-assembled unit and the installation procedure described below will change accordingly.)

(4) OIL FEED SOLENOID VALVES:

(a) S-9310M 4 Solenoid Valve Manifold
  3/8"flare oil reservoir connections
  3/8" flare oil feed connections to feed up to four compressors

(b) 3-044-001 Solenoid Valve
  Provided for separate mounting to the compressor
  3/8" flare connections
  The installer must pipe each valve inlet to a manifold at the oil reservoir and each valve outlet to the 4 compressors being controlled and marked as COMP 1, COMP 2, COMP 3, COMP 4.

- Solenoid coils are replaceable for service.

<u>INSTALLATION:</u>

(1). Mount the S-9310 controller using the mounting holes provided at the upper and lower edges of the backplate Use #8 size mounting screws

(2) Install the 3-020-057 sight glass on one of the compressor sight glass openings in each compressor.

(3) Assign compressor numbers #1 #2 #3 #4 and MARK transducer cables at both ends with compressor numbers.

(4) Install the S-9330 transducer to the 3-020-057 sight glass. Use the captivated lock-washer type screws furnished with the sight glass.

(5) Install an AC & R Oil Line Strainer S-9105 in the oil line from the reservoir to the solenoid valve manifold.

(6) Pipe the oil feed lines from the solenoid valves to a compressor crankcase connection. At the compressor end of the oil feed line, the installer can select any available compressor fitting which accesses the crankcase. One possible location is the ¼" NPT opening on the side of a typical semi-hermetic compressor.

(7) Wire the solenoid valves to the lower right edge of the S-9310 controller following the compressor number sequence indicated.

(8) Run the S-9330 Transducer cables from the transducers into the rack wiring panel.

INSTALLATION: (Continued)

(9) Plug the S-9330 Transducer connectors into the correct compressor position. This is indicated by the legend on the right edge of the Controller as “COMP 1”, “COMP 2”, “COMP 3”, “COMP 4”.

(10) Install the power supply jumpers according to the available AC power and the wiring instructions shown on the lower left edge of the front panel. Power supply is 115v or 230v AC 12 va. CAUTION: Failure to install the jumpers correctly will result in destruction of the controller.

(11) Optionally, wire the Alarm Relay dry contact output to the terminal strip positions marked on the Front Panel.

(12) Set the Oil Level Adjust for each compressor oil level.

(13) Check all joints for leaks. Check all wiring.

(14) Apply AC power verify that the Amber Controller Board “ON” LED is on.

SERVICE INSTRUCTIONS:

Since the S-9310 Oil Level Controller will be typically used with multiple compressor supermarket racks, the trouble-shooting instructions are written with that installation in mind.

Before the oil level controller can control the oil level, the reservoir or separator/reservoir must have a supply of oil to feed to the compressors.

Excessive oil can return from the system after defrost and enter the compressor thru the suction line. The S-9310 cannot correct this problem.

If the supply of oil in the system is low or if the oil/refrigerant mixture being fed thru the S-9310 contains a large percentage of refrigerant, a low oil level alarm or low oil pressure trip can result.

CAUTION: The feed solenoid port is sized to GRADUALLY return oil to the crankcase. If the oil being return contains a high percentage of refrigerant, it can take a number of feed cycles to bring the actual level up to the setpoint.

In other words, an upward adjustment will not bring an instantaneous increase in oil level.

Compressor oil level problems can be listed as:
- Oil level too low
- Oil level too high
- Low oil on startup
- Crankcase fills when compressor is off

Low oil on startup can be caused by an accumulation of refrigerant in the crankcase during the off-cycle. This refrigerant boils as the crankcase pressure falls in the crankcase resulting in heavy foaming and a high oil pumping rate.

The S-9310 will feed after a 9 second delay to try to catch up with the demand. The best solution is to prevent refrigerant from condensing in the crankcase during the compressor off-time by using a pump-down cycle or some other means.

TROUBLE SHOOTING CHART

Oil Level Too LOW / Compressor RUNNING

Problem Symptoms	Possible Remedies
Insufficient oil in reservoir	- Bring oil back from system. - Add oil
Controller Board AMBER LED is off	- Check AC voltage supply if off. - Check AC jumper installations - Dis-connect transducer cables If Amber LED lights, one of the transducers are shorted. Replace.
AMBER LED is on (Power OK)	- Re-adjust oil level upward. - Check for switched compressor piping. - Check if transducer is plugged in to the correct compressor number on back of controller board. - Correct transducer wiring if switched - Remove transducer and check sight glass surface. - Check transducer by swapping transducers with another compressor. - Replace S-9310 Controller.

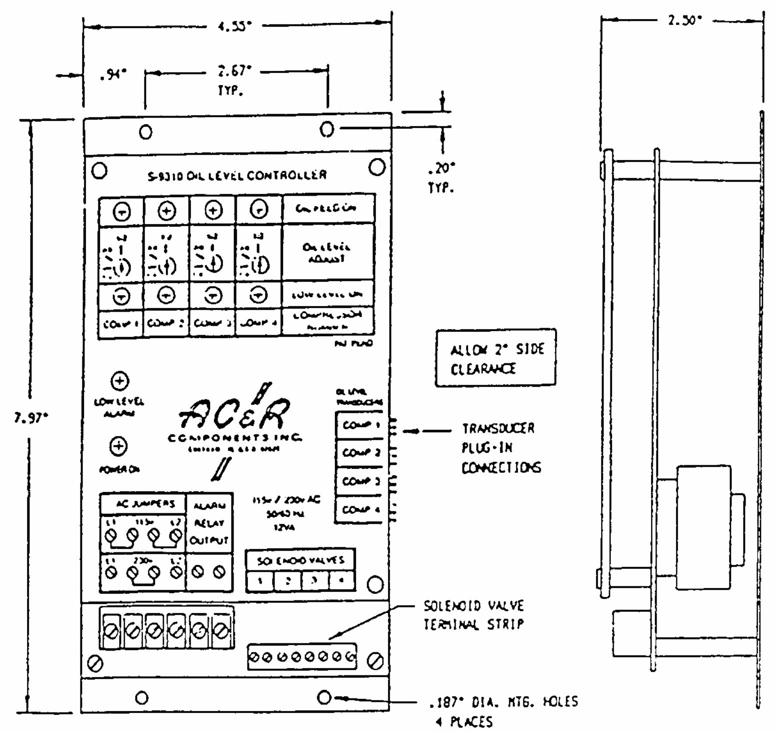
Oil Level Too HIGH / Compressor RUNNING

Problem Symptoms	Possible Remedies
GREEN LED for the high level compressor IS NOT cycling the oil feed solenoid	- Re-adjust oil level downward. - Check for switched compressor piping. - Excessive oil coming in thru suction line after defrost. - Check for dirt or defective solenoid plunger seat. Replace if necessary.
GREEN LED for the high level compressor IS cycling the oil feed solenoid	- Re-adjust oil level downward. - Check for switched compressor piping. - Correct transducer wiring if switched. - Remove transducer and check sight glass surface. - Check transducer by swapping transducers with another compressor. - Replace S-9310 Controller.

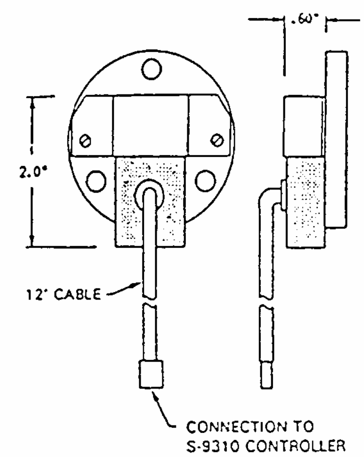
<u>WARNINGS:</u>

- DISCONNECT POWER before installing or servicing.
- When replacing a compressor, unplug the S-9330 transducer and cap off the oil feed line.
- Line voltage wiring must NOT be in contact with the front panel controller board.

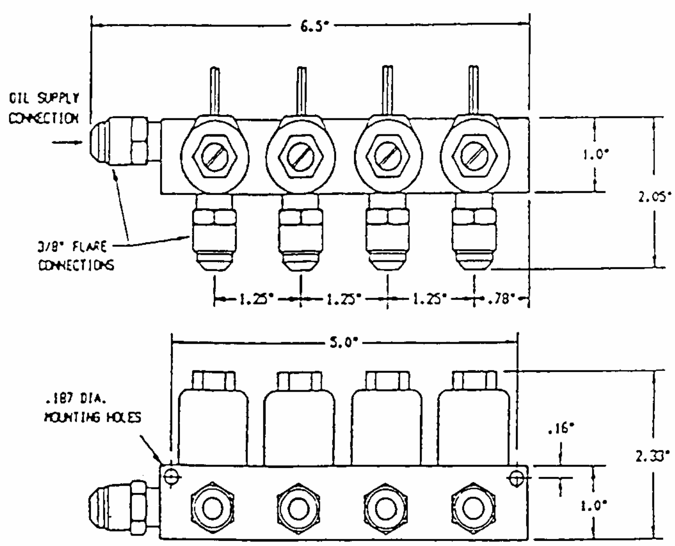
S-9310 OIL LEVEL CONTROLLER



S-9330 TRANSDUCER/ SIGHT GLASS ASSY.



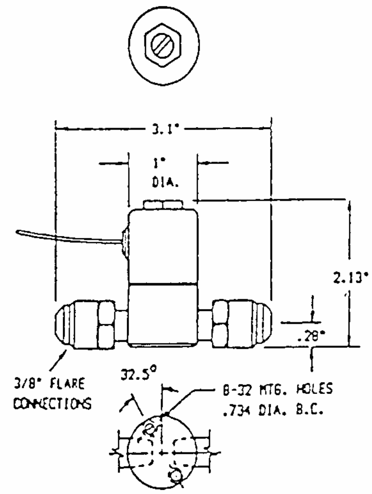
3-044-002 VALVE MANIFOLD
(as used in S-9310M Series System)



3-044-001 SOLENOID VALVE
(as used in S-9310 Series System)

TO REMOVE THE SOLENOID COIL

HOLD TOP PLUG WITH SCREWDRIVER
TURN COIL NUT COUNTER-CLOCKWISE TO LOOSEN



ACR COMPONENTS INC.
CHATHAM, IL U.S.A. 62629

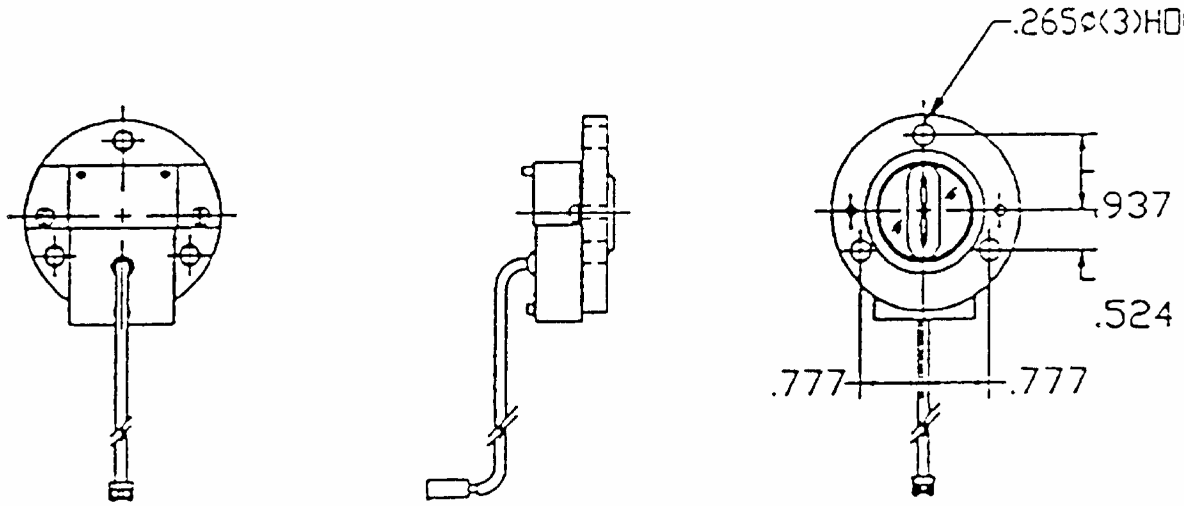
701 South Main Street Chatham, IL 62629
Phone 1-800-327-2272

S–9330 INSTRUCTION SHEET

The S–9330 optical level transducer is intended to be used with AC&R's oil level controllers S–9300 & S–9310. The transducer may also be used as a DC analog output device and interface with existing equipment. The S–9330 is supplied with a standard adapter kit number 3–033–201 for mounting to a 3 bolt flanged connection.

SPECIFICATIONS:

Supply Voltage – 12V DC ± .2v DC
Max. Current – 20 Milliamps
Wiring Code – Red = +
Black = – (ground)
Green = Signal
Cable Length – 12 feet *



*The cable length can be lengthened using AC&R's 12 ft. extension number 3–044–003 or by splicing the cable to a similar 22ga, 3 conductor wire. Max length is 100 ft.

INSTALLATION:

1. Pick appropriate o–rings for sealing.
2. Mount glass to compressor or similar device using the bolts supplied. Snug all bolts evenly & then tighten. **DO NOT** fully install 1 bolt at a time. This cracks the glass and **VOIDS THE WARRANTY.**
3. Connect the S–9330 to the appropriate device. **DO NOT** run the transducer wire with other high voltage wires. This may cause interference.
4. When using the S–9330 with AC&R's S–9300 or S–9310 an AC&R oil filter #S–4004 or S–4005 must be used! This also applies if the transducer is being used to control oil but not being used in conjunction with either S–9300 or S–9310. Not using the oil filter will **VOID THE WARRANTY.**

U.S. PATENTS 5,103,648 & OTHER PATENTS PENDING

Introduction

Parker A8

Parker A9

Sporlan Y825

Liquid Line Deferential Valve

Evaporator Pressure Regulator

Low Pressure Control

Copeland Sentronic Oil Failure Control

High Pressure Control

Copeland Demand Cooling Module

If you are unfamiliar with the operation, or need set points, for any of these valves or controls,
Refer to your Hussmann installation and service manual.

A8 Valve Adjustment

Step #1 Connect a discharge pressure gauge to a compressor discharge service valve.

Step #2 Shut off the ball valve going to the A9 valve.

Step#3 Loosen the lock nut on the A8 valve and back the valve stem completely out. This is done by turning the valve adjustment stem in the counter clock wise direction.

Step#4 Reduce the discharge pressure below desired set point by 20 to 25 psig. This can be accomplished several different ways.

1)Force on all the condenser fans.
2)Reduce the system load by shutting down circuits,
3)Shutting off compressors.
4)Or by combining any of the above methods.

Step#5 Turn the adjustment stem on the A8 valve most of the way in. This is done by turning the stem in the clock wise direction. Discharge pressure will slowly begin to rise. When the pressure rises 10 to 15 psig above the desired set point begin backing out the A8 adjustment stem until valve dumps. A sudden drop in discharge pressure will indicate the valve has dumped. Allow the system to stabilize then adjust the A8 valve to the desired set point. It is better to make small adjustments to the A8 valve during this stage of adjustment. Tighten the lock nut when the desired set point is reached. Recheck discharge pressure after lock nut is tightened.

Step#6 Make sure to return any forced condenser fans, circuits, or compressors to normal running condition.

Step#7 Open the ball valve going to the A9 valve.

Step #8 Remove the discharge pressure gauge.

A9 Valve Adjustment

Step#1 Connect a discharge pressure gauge to a compressor discharge service valve.

Step#2 Shut off the service valve going into the receiver from the A9 valve.

Step#3 Loosen the Lock Nut on the A9 valve and back the adjustment stem all the way out. This is done by turning the valve adjustment stem in the counter clock wise direction.

Step#4 Connect the high side hose of a guage manifold set to the shrader tap between the A9 valve and the service valve going into reciever.

Step#5 Connect the center hose of a gauge manifold set to the suction header.

Step#6 Make sure the discharge pressure is 10 to 15 psig above the desired A9 valve set point.

Step#7 Open the high side hand wheel on the gauge manifold set, this will allow flow between The center hose and the high pressure gauge hose.

Step#8 Adjust the A9 valve stem in the clock wise direction to the desired set point and tighten the lock nut.

Step#9 Close the hand wheel on the gauge manifold set and disconnect hoses.

Step#10 Disconnect the discharge pressure gauge going to the compressor discharge service valve.

Step#11 Open the service valve going into receiver from the A9 valve.

Step#12 Make sure all controls are returned to normal running condition.

Y825 Valve Adjustment

Step #1 Close all the oil float service valves. This is done by turning the valve stem in the clock wise direction until they bottom out.

Step #2 Connect a low pressure gauge to the suction header.

Step #3 Connect the low side gauge hose of a gauge manifold set to the schrader connection at the end of the supply oil manifold.

Step #4 Connect the center hose of the gauge manifold set to the suction header.

Step #5 Open the hand wheel on the gauge manifold set for a few seconds then close it off again.

Step #6 Subtract the suction header pressure from the oil header pressure.

Step #7 If adjustment is necessary, turn Y825 valve adjustment stem in the clock wise direction to increase pressure and turn it counter clock wise to reduce pressure. Always open the hand wheel on the gauge manifold for a few seconds and recalculate oil pressure after every adjustment.

Step #8 Remove all gauges from the system.

Step #9 Open all the oil float service valves.

Liquid Line Deferential Valve Adjustment

Step #1 Shut off the Kool/Hot gas ball valve on the first gas defrost circuit and put that circuit in defrost. Make sure that no other circuits that are gas defrost, are in, or will go in defrost while adjustments are being made.

Step #2 Connect two high side gauges, one on each side of the liquid line differential valve.

Step #3 Subtract the outlet pressure from the inlet pressure, this is your differential pressure.

Step #4 If adjustment is necessary, turn valve adjustment stem in the clock wise direction to increase the deferential pressure and turn it counter clock wise to reduce the deferential pressure.

Step #5 Remove the high side guages.

Step #6 Take the first gas defrost circuit out of defrost and open the Kool/Hot gas ball valve for that circuit.

SORIT Evaporator Pressure Regulator Adjustment

Step #1 Connect a low pressure gauge to the suction manifold.

Step #2 Connect a low pressure gauge to the evaporator side of the SORIT valve in need of adjustment.

Step#3 Make sure the suction header pressure is 5 to 10 psig lower than the desired set point.

Step#4 Turning the SORIT valve adjustment stem in the clock wise direction will cause the evaporator pressure to go up. Turning the stem in the counter clock wise direction will cause the evaporator pressure to go down.

Step #5 Wait a few minutes to allow system pressures to stabilize then recheck the SORIT valve set point.

Step #6 Remove the low side gauges.

Low Pressure Controls

Step #1 Turn off the control circuit for the compressor that needs it's low pressure control set.

Step #2 Bypass any time delays, electronic rack control relay, electronic overload module with built in time delay and switch back relay if used.

Step #3 Connect a low pressure gauge to the suction header.

Step #4 Front seat oil supply and oil equalizer line service valves on the compressor whose low pressure control is being adjusted.

Step #5 Make sure rack suction pressure is above the desired cut in point of the low pressure control. You may have to turn off the other compressors to raise the suction pressure.

Step #6 Connect a low pressure gauge to the compressor suction service valve on the compressor whose low pressure control is being adjusted.

Step #7 Front seat the suction service valve.

Step #8 Jump out the low pressure control and turn on the compressor. Look at the gauge connected to the suction service valve, when the pressure reaches 0 psig turn off the compressor.

Step #9 Adjust the cut in point of the low pressure control 20 to 25 psig above the desired cut in point by looking at the scale on low pressure control.

Step #10 Slowly open the suction service valve and watch the low pressure gauge. When the pressure reaches the desired cut in close off the suction service valve.

Step #11 Remove the jumper on the low pressure control. Turn the compressor control circuit on. Slowly turn the cut in adjustment toward the desired cut in point. When the compressor turns on you have reached your desired cut in point.

Step #12 Slowly open the suction service valve and watch the gauge connected to the suction service valve. Make sure the compressor cuts in at the proper pressure. If fine tuning of the low pressure control is needed, front seat the suction service valve again then adjust the cut in on the low pressure control. Slowly open the suction service valve while watching the gauge connected to the suction service valve. Repeat until the desired cut in point is reached. When you are finished adjusting the cut in of the low pressure control open the suction service valve fully.

Step #13 Turn the deferential adjustment on the low pressure control to a value greater than your desired cut out point.

Step #14 Slowly front seat the suction service valve while watching the gauge connected to the suction service valve. When the desired cut point is reached stop turning the suction service valve.

Step #15 Slowly turn the deferential adjustment on the low pressure control towards the desired cut out point. When the compressor turns off you have reached your desired cut out point.

Step #16 Open the suction service valve fully then begin to front seat it while watching the gauge connected to the suction service valve. Make sure the compressor cuts out at the proper pressure. If fine tuning of the low pressure control is needed adjust the cut out on the low pressure control. Repeat this step until the desired cut out point is reached. When you are finished adjusting the cut out of the low pressure control open the suction service valve fully.

Step #17 Disconnect the low pressure gauges from the system.

Step #18 Open oil supply and oil equalizer line service valves that were closed during step #4.

Step #19 Turn off the control circuit on the compressor whose low pressure control you set.

Step #20 Remove any jumpers you installed during step #2.

Step #21 Turn the compressor control circuit back on.

Sentronic Test

Step #1 With the compressor running unplug the cable from transducer.

Step #2 The sentronic oil failure should have time out then lock the compressor out on oil failure. Verify that the proper oil failure lamp is lit. If the rack is equipped with an electronic rack controller make sure that the proper digital input was turned on.

Step #3 Reconnect the cable that was disconnected in step #1, then push the reset button on the sentronic oil failure control.

High Pressure Control Adjustment

Step #1 Set the cut out of the high pressure control to the desired set point. Use the scale on the high pressure control to set cut out point.

Step #2 Set the cut in of the high pressure control to the desired set point. Use the scale on the high pressure control to set cut in point.

Demand Cooling Test

Step #1 Turn off the compressor whose demand cooling module you want to test.

Step #2 Unplug sensor from Demand Cooling module then turn compressor back on.

Step #3 Once the compressor starts it should run for about one minute before locking out on Demand cooling.

Step #4 Turn off the compressor again, this time jump the temperature sensor at he Demand cooling module.

Step #5 Push the reset on the Demand cooling module. When the compressor starts the liquid injection solenoid should be energized. The compressor should run for about one minute then lock out on Demand cooling.

Step #6 Turn off the compressor again, remove jumper and push reset button on the Demand Cooling module.

Step #7 Plug the sensor back into the Demand Cooling module then turn compressor back on.

CONTROL SETTINGS

GENERAL DESCRIPTION

There are nine potential control settings required to be set up prior to startup.
They are as follows:

1. Low Pressure Controls (R404A, R22, & 507)
2. Satellite Pressure Controls
3. Compressor Oil Failure Controls
4. Heat Reclaim Lockout
5. Split Condenser Control Settings
6. Condenser Settings
7. Winter Condensing Pressure Controls
8. EPR Pressure Settings
9. Defrost Timer Settings
10. Inverter Settings

Adjust settings for the above controls from the tables that follow:

LOW PRESSURE

R404a Low Temperature

Design Suct Temp F	Comp #6 Cut in psig	Comp #6 Cut out psig	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
−33	15	11	14	10	13	9	12	8	11	7	10	6
−30	17	13	16	12	15	11	14	10	13	9	12	8
−28	18	14	17	13	16	12	15	11	14	10	13	9
−25	19	15	18	14	17	13	16	12	15	11	14	10
−23	20	16	19	15	18	14	17	13	16	12	15	11
−21	22	17	21	17	20	16	19	15	18	14	17	13
−20	23	19	22	18	21	17	20	16	19	15	18	14
−16	25	21	24	20	23	19	22	18	21	17	20	16
−15	26	22	25	21	24	20	23	19	22	18	21	17
−10	30	26	29	25	28	24	27	23	26	22	25	19

Design Suct Temp F	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
−33	15	11	14	10	13	9	11	7	10	6
−30	17	13	16	12	15	11	13	9	12	8
−28	18	14	17	13	16	12	14	10	13	9
−25	19	15	18	14	17	13	15	11	14	10
−23	20	16	19	15	18	14	16	12	15	11
−21	22	18	21	17	20	16	18	14	17	13
−20	23	19	22	18	21	17	19	15	18	14
−16	25	21	24	20	23	19	21	17	20	16
−15	26	22	25	21	24	20	22	18	21	17
−10	30	26	29	25	28	24	26	22	25	21

Design Suct Temp F	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
−33	15	11	13	9	11	7	10	6
−30	17	13	15	11	13	9	12	8
−28	18	14	16	12	14	10	13	9
−25	19	15	17	13	15	11	14	10
−23	20	16	18	14	16	12	15	11
−21	22	18	20	16	18	14	17	13
−20	23	19	21	17	19	15	18	14
−16	25	21	23	19	21	17	20	16
−15	26	22	24	20	22	18	21	17
−10	30	26	28	24	24	22	25	21

Table 7-1 Parallel Control Settings
for Low Pressure Controls

LOW PRESSURE CONTROLS

R404a Medium Temperature

Design	Comp #6		Comp #5		Comp #4		Comp #3		Comp #2		Comp #1	
Suct	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out
Temp F	psig	psig	psig	psig	psig	psig	psig	psig	psig	psig	psig	psig
7	45	41	44	40	43	39	42	37	41	36	40	35
10	48	44	47	43	46	42	45	41	44	40	43	39
12	50	46	49	45	48	44	47	43	46	42	45	41
14	53	49	52	48	51	47	50	46	49	45	48	44
15	54	50	53	49	52	48	51	47	50	46	49	45
16	55	51	54	50	53	49	52	48	51	47	50	46
20	60	56	59	55	58	54	57	53	56	52	55	51
23	64	59	62	58	61	57	60	56	59	55	58	54
25	65	60	64	59	62	58	61	57	60	56	59	55

Design	Comp #5		Comp #4		Comp #3		Comp #2		Comp #1	
Suct	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out
Temp F	psig	psig	psig	psig	psig	psig	psig	psig	psig	psig
7	45	39	43	36	41	34	39	32	36	30
10	48	42	46	40	44	38	42	35	40	33
12	50	44	48	42	46	40	44	38	42	35
14	52	46	50	44	48	42	46	40	44	38
15	53	47	51	45	49	43	47	41	46	39
16	55	49	53	47	51	45	49	43	47	41
20	59	53	57	51	55	49	53	47	51	45
23	64	57	61	55	59	53	57	51	55	49
25	67	60	65	58	62	56	60	54	58	52

Design	Comp #4		Comp #3		Comp #2		Comp #1	
Suct	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out	Cut in	Cut out
Temp F	psig	psig	psig	psig	psig	psig	psig	psig
7	45	39	43	36	41	34	39	32
10	48	42	46	40	44	38	42	35
12	50	44	48	42	46	40	44	38
14	52	46	50	44	48	42	46	40
15	53	47	51	45	49	43	47	41
16	55	49	53	47	51	45	49	43
20	59	53	57	51	55	49	53	47
23	64	57	61	55	59	53	57	51
25	67	60	65	58	62	56	60	54

Table 7-2 Parallel Compressor Control Settings
for Low Pressure Controls

LOW PRESSURE CONTROLS

R507 Low Temperature

Design Suct Temp F	Comp #6 Cut in psig	Comp #6 Cut out psig	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
−33	15	11	14	10	13	9	12	8	11	7	10	5
−30	18	13	16	12	15	11	14	10	13	9	12	8
−28	19	14	18	13	16	12	15	11	14	10	13	9
−25	20	15	19	14	18	13	16	12	15	11	14	10
−23	21	16	20	15	19	14	18	13	16	12	15	11
−21	23	19	22	18	21	16	20	15	19	14	18	13
−20	24	20	23	19	22	18	21	16	20	15	19	14
−16	26	22	25	21	24	20	23	19	22	18	21	16
−15	27	23	26	22	25	21	24	20	23	19	22	18
−10	32	27	31	26	30	25	29	24	27	23	26	22

Design Suct Temp F	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
−33	15	11	14	10	13	9	11	7	10	5
−30	18	13	16	12	15	11	13	9	12	8
−28	19	14	18	13	16	12	14	10	13	9
−25	20	15	19	14	18	13	15	11	14	10
−23	21	16	20	15	19	14	16	12	15	11
−21	23	19	22	18	21	16	19	14	18	13
−20	24	20	23	19	22	18	20	15	19	14
−16	26	22	25	21	24	20	22	18	21	16
−15	27	23	26	22	25	21	23	19	22	18
−10	32	27	31	26	30	25	27	23	26	22

Design Suct Temp F	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
−33	15	11	13	9	11	7	10	5
−30	18	13	15	11	13	9	12	8
−28	19	14	16	12	14	10	13	9
−25	20	15	18	13	15	11	14	10
−23	21	16	19	14	16	12	15	11
−21	23	19	21	16	19	14	18	13
−20	24	20	22	18	20	15	19	14
−16	26	22	24	20	22	18	21	16
−15	27	23	25	21	23	19	22	18
−10	32	27	30	25	27	23	26	22

Table 7-3 Parallel Compressor Control Settings
for Low Pressure Controls

LOW PRESSURE CONTROLS

R507 Medium Temperature

Design Suct Temp F	Comp #6 Cut in psig	Comp #6 Cut out psig	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
7	47	43	46	42	45	41	44	40	43	38	42	37
10	51	46	49	45	48	44	47	43	46	42	45	41
12	53	48	52	47	51	46	49	45	49	44	47	43
14	56	52	55	51	54	49	53	48	52	47	51	46
15	57	53	56	52	55	51	54	49	53	48	52	47
16	58	54	57	53	56	52	55	51	54	49	53	48
20	64	59	63	58	62	57	61	56	59	55	58	54
23	67	63	66	62	65	61	64	59	63	57	62	57
25	68	64	67	63	66	62	65	61	64	58	63	58

Design Suct Temp F	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
7	47	41	45	38	43	36	41	34	38	32
10	51	44	48	42	46	40	44	37	42	35
12	53	46	51	44	48	42	46	40	44	37
14	55	48	53	46	51	44	48	42	46	40
15	56	49	54	47	52	45	49	43	47	41
16	58	52	56	49	54	47	52	45	49	43
20	63	56	61	54	58	52	56	49	54	47
23	67	61	65	58	63	56	61	54	58	52
25	70	64	68	62	66	59	64	57	62	55

Design Suct Temp F	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
7	47	41	45	38	43	36	41	34
10	51	44	48	42	46	40	44	37
12	53	46	51	44	48	42	46	40
14	55	48	53	46	51	44	48	42
15	56	49	54	47	52	45	49	43
16	58	52	56	49	54	47	52	45
20	63	56	61	54	58	52	56	49
23	67	61	65	58	63	56	61	54
25	70	64	68	62	66	59	64	57

Table 7-4 Parallel Compressor Control Settings
for Low Pressure Controls

LOW PRESSURE CONTROLS

R22 Low Temperature

Design Suct Temp F	Comp #6 Cut in psig	Comp #6 Cut out psig	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
-33	9	5	8	4	7	3	6	2	5	1	4	0
-30	10	6	9	5	8	4	7	3	6	2	5	1
-28	11	7	10	6	9	5	8	4	7	3	6	2
-25	12	8	11	7	10	6	9	5	8	4	7	3
-23	13	9	12	8	11	7	10	6	9	5	8	4
-21	14	10	13	9	12	8	11	7	10	6	9	5
-20	15	11	14	10	13	9	12	8	11	7	10	6
-16	17	13	16	12	15	11	14	10	13	9	12	7
-15	18	14	17	13	16	12	15	11	14	10	13	9
-10	22	18	21	17	20	16	19	15	18	14	17	13

Design Suct Temp F	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
-33	9	5	8	4	7	3	5	1	4	0
-30	10	6	9	5	8	4	6	2	5	1
-28	11	7	10	6	9	5	7	3	6	2
-25	12	8	11	7	10	6	8	4	7	3
-23	13	9	12	8	11	7	9	5	8	4
-21	14	10	13	9	12	8	10	6	9	5
-20	15	11	14	10	13	9	11	7	10	6
-16	17	13	16	12	15	11	13	9	12	7
-15	18	14	17	13	16	12	14	10	13	9
-10	22	18	21	17	20	16	18	14	17	13

Design Suct Temp F	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
-33	9	5	7	3	5	1	4	0
-30	10	6	8	4	6	2	5	1
-28	11	7	9	5	7	3	6	2
-25	12	8	10	6	8	4	7	3
-23	13	9	11	7	9	5	8	4
-21	14	10	12	8	10	6	9	5
-20	15	11	13	9	11	7	10	6
-16	17	13	15	11	13	9	12	7
-15	18	14	16	12	14	10	13	9
-10	22	18	20	16	18	14	17	13

Table 7-5 Parallel Compressor Control Settings
for Low Pressure Controls

LOW PRESSURE CONTROLS

R22 Medium Temperature

Design Suct Temp F	Comp #6 Cut in psig	Comp #6 Cut out psig	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
7	34	30	33	29	32	28	31	27	30	26	29	25
10	37	33	36	32	35	31	34	30	33	29	32	28
12	39	35	38	34	37	33	36	32	35	31	34	30
14	41	37	40	36	39	35	38	34	37	33	36	32
15	42	38	41	37	40	36	39	35	38	34	37	33
16	43	39	42	38	41	37	40	36	39	35	38	34
20	47	43	46	42	45	41	44	40	43	39	42	38
23	49	45	48	44	47	43	46	42	45	41	44	40
25	51	47	50	46	49	45	48	44	47	43	46	42
30	59	55	58	54	57	53	56	52	55	51	54	50
35	65	61	64	60	63	59	62	58	61	57	60	56

Design Suct Temp F	Comp #5 Cut in psig	Comp #5 Cut out psig	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
7	34	28	32	26	30	24	28	22	26	20
10	37	31	35	29	33	27	31	25	29	23
12	39	33	37	31	35	29	33	27	31	25
14	41	35	39	33	37	31	35	29	33	27
15	42	36	40	34	38	32	36	30	34	28
16	43	37	41	35	39	33	37	31	35	29
20	47	41	45	39	43	37	41	35	39	33
23	50	44	48	42	46	40	44	38	42	36
25	53	47	51	45	49	43	47	41	45	39
30	59	53	57	51	55	49	53	47	51	45
35	65	59	63	57	61	55	59	53	57	51

Design Suct Temp F	Comp #4 Cut in psig	Comp #4 Cut out psig	Comp #3 Cut in psig	Comp #3 Cut out psig	Comp #2 Cut in psig	Comp #2 Cut out psig	Comp #1 Cut in psig	Comp #1 Cut out psig
7	34	28	32	26	30	24	28	22
10	37	31	35	29	33	27	31	25
12	39	33	37	31	35	29	33	27
14	41	35	39	33	37	31	35	29
15	42	36	40	34	38	32	36	30
16	43	37	41	35	39	33	37	31
20	47	41	45	39	43	37	41	35
23	50	44	48	42	46	40	44	38
25	53	47	51	45	49	43	47	41
30	59	53	57	51	55	49	53	47
35	65	59	63	57	61	55	59	53

Table 7-6 Parallel Compressor Control Settings

SATELLITE PRESSURE CONTROL

For low-end Satellites, the temperature of refrigerators connected to the Satellite must be controlled by a thermostat controlling the motor contactor. For high-end Satellites the compressor is controlled by the low pressure control (pumpdown). Adjust the Satellite compressor low and high pressure controls according to Tables 7-10 through 7-12.

Low-End Satellite Low Pressure Control Settings		
	Refrigerant	Cut-Out (psig)
Medium Temperature	R22 R404A R507	2 2 3
Low Temperature	R404A R507	1 2

NOTE: Set the differential at minimum
Table 7-20 Satellite Low Pressure Control (Low-End)

High-End Satellite Low Pressure Control Settings		
Refrigerant	Cut-Out (psig)	Cut-In (psig)
R22 R404A R507	29 39 41	49 63 66

Table 7-11 Satellite Low Pressure Control (High-End)

Refrigerant	Control Settings psig
R404A, R507, R22	325

Table 7-12 High Pressure Safety Controls

OTHER CONTROLS (IF USED)

Compressor	Oil Pressure Differential Switch		Time Delay (Seconds)
	Cut-in (psig)	Cut-out (psig)	
Copeland	7 - 11	12 - 18	120
Carlyle	4 - 6	9 - 12	45

Oil failure control is a manual reset safety device.
Table 7-13 Compressor Oil Failure Control

Refrigerant	SETTINGS (psig)	
	Cut-in	Cut-out
R507	186	163
R404A	180	158
R22	150	130

Table 7-14 Heat Reclaim Lockout Pressure Setting

Thermostat	
Cut-out	45°F
Cut-in	40°F

Table 7-15 Split Condenser Control Settings

Thermostat	
Cut-out	55°F
Cut-in	50°F

Table 7-16 Subcooler Control Settings

CONDENSER PRESSURE AND TEMPERATURE SETTINGS
HACVB, HACVF, HACVG, HACVI, HACVV, HACVW

Refrigerants 404A, 507, and 22

CONDENSER FAN ALIGNMENT		PRESSURE SETTINGS (PSIG)							AMBIENT CONTROL								
									PRESSURE		TEMPERATURE (F)						
		PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC1	PC2	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7
1X2	CI	195	205						215		40	75					
	CO	155	165						190		35	70					
1X3	CI	195	200	210					215		40	50	75				
	CO	155	160	170					190		35	45	70				
1X4	CI	195	200	205	215				215		40	50	70	75			
	CO	155	160	165	175				190		35	45	65	70			
1X5	CI	195	200	205	210	215			215		40	50	70	75	80		
	CO	155	160	165	170	175			190		35	45	65	70	75		
1X6	CI	195	200	205	210	215	220		215		40	50	60	65	70	75	
	CO	155	160	165	170	175	180		190		35	45	55	60	65	70	
1X7	CI	195	200	205	210	215	220	225	215		40	50	60	65	70	75	80
	CO	155	160	165	170	175	180	185	190		35	45	55	60	65	70	75
2X2	CI	195	205						200	215	40	75					
	CO	155	165						175	190	35	70					
2X3	CI	195	200	210					200	215	40	50	75				
	CO	155	160	170					175	190	35	45	70				
2X4	CI	195	200	205	215				200	215	40	50	70	75			
	CO	155	160	165	175				175	190	35	45	65	70			
2X5	CI	195	200	205	210	215			200	215	40	50	70	75	80		
	CO	155	160	165	170	175			175	190	35	45	65	70	75		
2X6	CI	195	200	205	210	215	220		200	215	40	50	60	65	70	75	
	CO	155	160	165	170	175	180		175	190	35	45	55	60	65	70	
2X7	CI	195	200	205	210	215	220	225	200	215	40	50	60	65	70	75	80
	CO	155	160	165	170	175	180	185	175	190	35	45	55	60	65	70	75

CONDENSER FAN ALIGNMENT		SPLIT CONDENSER THERMOSTAT SETTING (F)	HEAT RECLAIM PRESSURE OVERRIDE (PSIG)	PRESSURE LOCKOUT (PSIG)
ALL MODELS	CI	50	190	165
	CO	55	265	140

Flooding Valve		Note: For every 10 lb increase in flooding valve setting, increase:
Set Point	A-9	1. All thermostat settings by 3F.
150 psig	140 psig	2. All pressure settings by 10lbs.

Figure 7-17 Condenser Settings

WINTER CONDENSING PRESSURE CONTROL

With two or more compressors running adjust the controls as follows:

Application	Flooding (1) Valve (Liquid) (2) (psig)	Receiver (2) Pressure Control (Gas) (psig)
R507	217	204
R404A	210	197
R22	175	165

Table 7-18 Winter Condensing Pressure Control Settings

(1) Increase this pressure by one psig for every two feet in height that the condenser is above the 88" minimum distance above the valve not floor.

(2) It may be desirable at times to go below these recommended pressure settings in the interest of power savings, but discretion should be used so as not to affect refrigeration performance. Absolute minimum receiver pressure is 140 psig for R503, and 125 psig for R22. Even these settings may result in marginal performance.

EPR SETTINGS

Evaporator Temperature (°F) (1)	EPR Pressure Settings (2) (psig)
-25° -22° -20° -15°	12 (R507) 14 (R507) 15 (R507) 20 (R507)
-25° -22° -20° -15°	12 (R404A) 14 (R404A) 15 (R404A) 19 (R404A)
-25° -20° -15°	5 (R22) 8 (R22) 11 (R22)
+6°	39 (R507) 37 (R404A) 27 (R22)
+9°	42 (R507) 40 (R404A) 30 (R22)
+12°	46 (R507) 44 (R404A) 33 (R22)

Evaporator Temperature (°F) (1)	EPR Pressure Settings (2) (psig)
+15°	50 (R507) 47 (R404A) 36 (R22)
+18°	54 (R507) 51 (R404A) 39 (R22)
+21°	58 (R507) 55 (R404A) 42 (R22)
+25°	64 (R507) 61 (R404A) 47 (R22)
+30°	71 (R507) 68 (R404A) 53 (R22)
+35°	80 (R507) 75 (R404A) 60 (R22)

Table 7-19 EPR Pressure Settings

(1) Pressure settings are based on a normal two psi pressure drop assumed to be in the suction line when the control is mounted in the machine room.

(2) When EPR's are applied, temperature must be controlled by a thermostat (sensing fan discharge air) which operates a branch liquid line solenoid valve installed at the case. Consult individual case installation instructions for the thermostat setting. For Koolgas systems, a bypass check valve must be installed around the solenoid valve.

DEFROST TIMER SETTINGS

Defrost is accomplished by means of the time clocks supplied in the control panel. These time clocks provide time-initiated, time or Temperature terminated defrost action. Each system defrost can be tailored to suit the application. Space defrost periods on any load to allow for recovery time. Arrange defrost periods so only one Koolgas defrost system is energized at any one time for either the low or medium temperature compressors. Off time defrost loads should be arranged to allow no more than %33 of unit capacity on defrost at one time.

The settings in tables 7-20 through 7-30 are approximate and may change due to revisions in refrigerator instructions. The specific refrigerator instructions should be referred to for current data. The most recent date of publication will take precedence.

Tables 7-20 through 7-30 give approximate defrost timer settings for most installations. Adjust timing and frequency in accordance with voltage conditions and store conditions. Where liquid lines are long, increase off-time defrost to compensate for "pump down" time, as some refrigeration effect continues until the liquid line clears of liquid.

ICE CREAM REFRIG	DEFROST LENGTH (MIN)			# OF DEF
	ELECTRIC	REV AIR	KOOLGAS	PER DAY
GC GCI GGC GTC GWIC GWIT GWI6	60	90	24	1
NC1 NC1N NCN NCW NFCW NCE	60	90	24	1
G5C G5CH G6C G6CH	36	60	22	4
NC6 NC6H	36	60	22	4
R6C R6CL	72	--	22	1
RCA RCH	40	--	20	1
NRC NRCH	40	--	20	1

Table 7-20 Ice Cream Defrost Settings

FROZEN FOOD REFRIG	DEFROST LENGTH (MIN)			# OF DEF
	ELECTRIC	REV AIR	KOOLGAS	PER DAY
FML FMLG	46	--	14	2
GF GFI GG GTF GWI GWIT GWI6	60	90	20	1
NF1 NF1N NFN NFW NFCW NFE	60	90	20	1
G5F G5FL G5FH G6F G6FL G6FH	36	60	22	2
NF6 NF6H NF6L	36	60	22	2
R6F R6FL	72	--	22	1
RFA RFH	40	--	20	1
NRF NRFH	40	--	20	1

Table 7-21 Frozen Food Defrost Settings

MEAT REFRIGERATOR	DEFROST LENGTH (MIN)				# OF DEF
	ELEC	REV AIR	KOOLGAS	OFF TIME	PER DAY
CGDM CSDM	40	--	--	90	1
NEBDH NEBSH	40	--	--	90	1
FHM FHMG FHMH FHMGH FHMS FHMSG	--	46	14	46	4
MHF MHFG MHFH MHFGH	--	46	14	46	4
NM3 NM3G NM4 NM4G	--	46	14	46	4
NDD3 NDD3G NDD4 NDD4G	--	46	14	46	4
FM FMG FMV FMGV FMGC VFMGC FMGCD	46	70	14	70	2
NM1 NM1G	46	70	14	70	2
FMR FMRV FMRG FMRGV FMRGC	46	70	14	70	2
CGDMG CGDMGT CSDMG	--	90	14	90	1
NEGDF NEGSF NEGDT	--	90	14	90	1
GF GFI GG GWIT GWI GTF GWI6	60	60	20	--	1
NF1 NF1N NFN NFW NFCW	60	60	20	--	1
MWI MWI6	--	60	14	60	3
VGL VGK VGS VGLR VGSR	--	110	10	110	1
NVGB NVGC NVGA	--	110	10	110	1

Table 7-22 Meat Defrost Settings

DELI & CHEESE REFRIG	DEFROST LENGTH (MIN)				# OF DEF
	ELEC	REV AIR	KOOLGAS	OFF TIME	PER DAY
CGDM CSDM	--	--	--	100	1
NEBDH NEBSH	--	--	--	100	1
FHM FHMG FHMH FHMGH FHMS FHMSG	--	40	14	40	4
MHF MHFG MHFH MHFGH	--	40	14	40	4
NM3 NM3G NM4 NM4G	--	40	14	40	4
NDD3 NDD3G NDD4 NDD4G	--	40	14	40	4
FM FMG FMV FMGV FMGC VFMGC FMGCD	70	--	14	70	2
NM1 NM1G	70	--	14	70	2
RDM RDMH	--	--	12	60	1
CGDMG CGDMGT CSDMG	--	--	--	90	1
NEGDF NEGSF NEGDT	--	--	--	90	1
RMA RMFA NRD NRFL	--	--	12	60	1
CWI CWI6 MWI MWI6	--	--	14	56	4
VGL VGK VGS VGLR VGSR	--	--	--	110	1
NVGB NVGC NVGA	--	--	--	110	1
DMD DMDH DMDA	--	40	14	40	4
NDD5 NDD5H NDD5A	--	40	14	40	4
VBL VBS VBK VBT	--	--	--	60	1
NVBA NVBB NVBC	--	--	--	60	1

Table 7-23 Deli and Cheese Defrost Settings

DAIRY REFRIGERATOR	DEFROST LENGTH (MIN)			# OF DEF
	REV AIR	KOOLGAS	OFF TIME	PER DAY
DMZ DMZA DMZH DMX DMXA DMXH	40	14	40	3
ND5LZ ND5Z ND5HZ ND5LX ND5X ND5HX	40	14	40	3
JVMR JVMRS	--	--	60	4
RDM	--	12	60	1
RMA RMFA	--	12	60	1
NRD NRFL	--	12	60	1
SH4R SH6R SH8R	--	12	36	12

Table 7 – 24 Dairy Defrost Settings

FLORAL REFRIGERATOR	DEFROST LENGTH (MIN)			# OF DEF
	REV AIR	KOOLGAS	OFF TIME	PER DAY
RMFA NRFL	--	12	60	1

Table 7-25 Floral Defrost Settings

PRODUCE REFRIGERATOR	DEFROST LENGTH (MIN)			# OF DEF
	REV AIR	KOOLGAS	OFF TIME	PER DAY
BULK PRO PHSM PH PHRO P NP1 NP2	--	12	40	4
PACK PRO PHSM PH PHRO P NP1 NP2	--	12	40	4
PVWI PWI PWIRO PVWI6 PWI6 PWIRO6	--	--	46	3
EPWI EPWI6	--	--	46	3

Table 7-26 Produce Defrost Settings

BAKERY REFRIGERATOR	DEFROST	LENGTH (MIN)		# OF DEF
	REV AIR	KOOLGAS	OFF TIME	PER DAY
CGBR NEBBDT	--	--	40	2

Table 7-27 Bakery Defrost Settings

SEAFOOD REFRIGERATOR	DEFROST	LENGTH (MIN)		# OF DEF
	REV AIR	KOOLGAS	OFF TIME	PER DAY
CGFM CSFM	--	--	100	1
NESDH NESSH	--	--	100	1
CGFMG CSFMG	--	--	90	1
VFL VFS VFK VFT	--	--	110	1
NVSA NVSB NVSC	--	--	110	1

Table 7-28 Seafood Defrost Settings

WALK-IN AND PREP ROOM	DEFROST	LENGTH (MIN)		# OF DEF
	ELECTRIC	KOOLGAS	OFF TIME	PER DAY
LOW TEMP ICE CREAM	24	16	--	2.
LOW TEMP FROZEN FOOD	24	16	--	2
MED TEMP MEAT/DELI	24	16-24	90	2
MED TEMP DAIRY/BEV	--	16	60	2
MED TEMP PRODUCE	--	16	60	2
MED TEMP PREP AREA	--	16	120	1

Table 7-29 Walk-in and Prep Room

OTHER MERCHANDISERS	DEFROST	LENGTH (MIN)		# OF DEF
	REV AIR	KOOLGAS	OFF TIME	PER DAY
MEAT - DSRP	50	14-16	--	3
CHEESE - DSRP	--	12	50	3
PRODUCE - DSRP DSRPY	--	12	50	3

Table 7-30 Other Merchandisers Defrost Settings

INVERTER CONTROL SETTINGS

GPD-503 Magnetek Inverter Control Settings for Scroll compressors Only.

CONSTANT#	SETTING	FUNCTION
SN01 *		KVA (HP) select
SN02	OB	Volts per hertz pattern
SN03**	1110	2 wire control operation
SN04	0100	Coast to stop
SN05	1011	1-Stop command from external contact only 2-Reverse disabled 3-0-10V output proportional to current
SN10	1000	Stall prevention deceleration time is 10 sec.
SN14	0010	Constant torque setting
CN01***	230 460	1 - For 230V rated GPD 503's 2 - For 460V rated GPD 503's
CN02	60	Frequency-Max. (Fmax)
CN09****		Motor Amp. rating = FLA X 1.15
CN15	75	Set the lower limit frequency to 45 Hertz. 75% = 45 Hz
CN23	6	Carrier frequency upper limit
CN24	6	Carrier frequency lower limit
CN36	2	Number of auto-restart
BN01	3	Acceleration time (seconds)
BN02	3	Deceleration time (seconds)

NOTES:
- * Check the drive for proper drive HP setting.
- ** After entering 1110, display board will show 0000.
- *** If the motor is rated for 200V set setting for 200.
- ****FLA X Motor service factor, do not exceed the drives name plate AMP rating.

INVERTER CONTROL SETTINGS

GPD-503 Mgnetek Inverter Control Settings for Semi-Hermetic Compressors Only.

CONSTANT#	SETTING	FUNCTION
SN01 *		KVA (HP) select
SN02	OB	Volts per hertz pattern
SN03 **	1110	2 Wire control operation
SN04	0100	Coast to stop
SN05	1011	1 Stop command from external contact only 2 Reverse disabled 3 0-10V output proportional to current
SN10	1000	Stall prevention deceleration time is 10 seconds
SN14	0010	Constant torque setting
CN01 ***	230 460	1 For 230V rated GPD 503's 2 For 460V rated GPD 503's
CN02	60	Frequency-Max. (Fmax)
CN09 ****		Motor [illegible]p rating = FLA 1.15
CN15	50	Set the lower limit frequency to 30 Hertz 50%=30HZ
CN23	6	Carrier Frequency upper limit
CN24	6	Carrier Frequency lower limit
CN36	2	Number of auto-restart
BN01	3	Acceleration time (seconds)
BN02	3	Deceleration time (seconds)

NOTES
- * Check the drive for proper drive HP setting, see technical manual appendix 3.
- ** After entering 1110, display board will show 0000.
- *** If the motor is rated for 200v set setting for 200.
- **** FLA X Motor service factor, do not exceed the drives name plate AMP rating.

INVERTER CONTROL SETTINGS

GPD-503 MAGNETEK INVERTER CONTROL SETTINGS FOR SCREW AND OPEN DRIVE

CONSTANT#	SETTING	FUNCTION
SN01 *		KVA (HP) select
SN02	OF	Volts per hertz pattern
SN03 **	1110	2 Wire control operation
SN04	0100	Coast to stop
SN05	1011	1 Stop command from external contact only 2 Reverse disabled 3 0-10V output proportional to current
SN10	1000	Stall prevention deceleration time is seconds
SN14	0010	Constant torgue setting
CN01 ***	230 460	1 For 230V rated GPD 503's 2 For 460V rated GPD 503's
CN02	68	Frequency-Max. (Fmax)
CN03	200	Voltage-Max. (Vmax)
CN04	60	Frequency-Max. Voltage Point(Fa) 60
CN05	3	Frequency-Midpoint (FB)
CN06	20 20 40	Voltage-midpoint (Vc) For 230V For 460V
CN07	3	Frequency-Min (Fmin)
CN08	20 40	Voltage-Min (Vmin) for 230V For 460V
CN09 ****		Motor Amp. rating = FLA X 1.15
CN15	38	Set the lower limit frequency to 25 Hertz 38% = 25HZ
CN23	6	Carrier Frequency upper limit

NOTES:
- * Check the drive for proper drive HP setting, see technical manual appendix 3.
- ** After entering 1110, display board will show 0000.
- *** If the motor is rated for 200V set setting for 200.
- **** FLA X Motor service factor, do not exceed the drives name plate AMP rating.

STARTUP AND MAINTENANCE

Warning

Know whether a circuit is open at the power supply or not. Remove all power before opening control panels. **Note:** Some equipment has more than one power supply.

Always use a pressure regulator with a nitrogen tank. Do not exceed 2 pounds of pressure and vent lines when brazing. Do not exceed 350 pounds of pressure for leak testing high side. Do not exceed 150 pounds of pressure for leak testing low side.

STARTUP

Leak Testing

Visually inspect all lines and joints for proper piping practices.

Isolate

Compressors – Frontseat Service Valves on Suction and Discharge. Close oil supply line immediately downstream of the Turba-shed.

Pressure Transducers – Close Angle Valves.

Open

Ball vales – to branches, condenser, heat reclaim, receiver.

Main Liquid Line Solenoid Valve -
Solenoid should be non regulating position.

Branch Liquid Line Solenoid Valve -
solenoid should be energized or manual open used.

Suction Stop EPR Vales – Suction Stop EPR requires energized solenoid to be open.

Split Condenser – Both sides open. De-energize valve solenoid.

Disconnect

Defrost Time Clock – Disconnect power to the clock or set electronic controllers in manual. Be sure all branches are in refrigeration mode.

Verify

Refrigerant requirements for System, Compressors, and TEV's in merchandisers and coolers.

Electrical supply and component requirements.

Warning

Always recapture test charge
in approved recovery vessel.

Test Charge

Using properly regulated dry nitrogen and R22 pressurize the system with vapor only. Charge about 25 pounds of R22 through a dehydrator. Through another line add dry nitrogen to bring the system pressure up to 150 psig. Using an electronic leak detector inspect all connections. If a leak is found, isolate, repair, and retest. Be sure system is at 150 psig and all valves closed to isolate the leak are opened. After the last leak is repaired and retested, the system must stand unaltered for 12 hours with no pressure drop from 150 psig.

Oil Levels
Check oil levels for each compressor and the Turba-shed:

Compressor sight glass 1/8 to ½ full,
Turba-shed between two lower sight glasses.

If the oil level is low add only Suniso 3G or Texaco Capella WF32. See screw compressor section for oil type used in screw compressor systems.

Warning

Always recapture charge in approved recovery vessel.

Evacuation
Nitrogen and moisture will remain in the system unless proper evacuation procedures are followed. Nitrogen left in the system may cause head pressure problems. Moisture causes TEV ice blockage, wax build up, acid oil, and sludge formation.

Do not simply purge the system – this procedure is expensive, harmful to the environment, and may leave moisture and nitrogen behind.

Do not run the compressors to evacuate – this procedure introduces moisture into the compressor's crankcase oil and does not produce adequate vacuum to remove moisture from the rest of the system at normal temperatures.

Setup
Using all copper lines and packless valves, connect an eight CFM or larger vacuum pump to a 7/8" header and from the header to at least three access ports on the rack. Connect one micron vacuum gauge at the pump and one at the furthest point in the system from the rack. Plan procedures so breaking the vacuum with refrigerant will not introduce contaminates into the system. The vacuum pump must be in good condition filled with fresh oil to achieve desired results.

Procedure
Pull a vacuum to 1500 microns. If the vacuum fails to hold, determine the cause and correct. Begin again with the first of the three required evacuations.

Break the vacuum with R22 vapor to a pressure of about 2psig. Do not exceed the micron gauge transducer's maximum pressure limit. Liquid refrigerant may cause damage to components through thermal shock or a pressure surge to the transducer of the micron gauge.

Repeat first two steps.

Install the suction and liquid drier cores.

Pull a vacuum to 500 microns. Close vacuum header valves and allow system to stand for a minimum of 12 hours. If the 500 micron vacuum holds, charging may begin. If not the cause must be determined and corrected. Repeat the entire evacuation procedure from the first step.

Pre-charge Check List

While the system is being evacuated preparation for charging can begin. During any of the pull downs check:

Check rack controller
Program if applicable.

Merchandisers
Electrical requirements and power supply
Electrical connections tight and clean
Proper fan operation
Thermostat setting.

Walk-in coolers and freezers
Electrical requirements and power supply
Electrical connections tight and clean
Proper fan operation
Thermostat setting.

Condensers
Electrical requirements and power supply
Electrical connections tight and clean
Proper fan operation
Thermostat or pressure settings
Damper operation, if equipped.

Heat Reclaim and other systems
Electrical requirements and power supply
Electrical connections tight and clean
Component operation.

Note: Remember to reinstate control to unit components jumpered to make test.

Set all mechanical pressure controls. Compressors should still be isolated from the rest of the system. Set all electronic compressor controls into switchback so the mechanical controls are in command of all system functions.

During the last evacuation look up and make a list of the required control settings for the system. A copy of the equipment legend will be needed to determine the system's design operating points. High and low pressure, heat reclaim lockout, winter control settings, and other controls on the system should be noted.

Warning

Never trap liquid refrigerant
between closed valves.
A hydraulic explosion
may result.

Charging

Open
Compressors – Backseat Service Valves on Suction and Discharge. Open oil supply line immediately downstream of the Turba-shed.

Pressure Transducers – Open Angle Valves.

Connect
Defrost Time Clock_– Connect poser to the clock and set proper time.

Leave open
Ball valves – to branches, condenser, heat reclaim, receiver.

Main Liquid Line Solenoid Valve – Now under control of defrost clock.

Branch Liquid Line Solenoid Valve – Back out manual open screws.

Suction Stop EPR – Suction Stop EPR under control of defrost clock.

Split Condenser – Operation under pressure controls.

Check
Oil levels for all compressors and Turba-shed.

Close the Ball Valve immediately downstream of the Receiver and connect the proper refrigerant to its Access Port. Slowly open the liquid valve on the refrigerant tank and charge the Receivers to 60% on the liquid gauge. Discount refrigerant tank and open the ball valve.

CAUTION: The remaining charge must be added only as vapor through the suction header.

Charge the system to approximately 30% of the receiver on the liquid gauge. Turn on compressor number one to speed up charging. Its suction pressure should remain below 20 psig for low temperature and below 45 psig for medium temperature units. If necessary, turn on more compressors. Monitor the oil levels carefully. At the first sign of trouble or unusual compressor operation shut off the system.

After 30% charge is achieved, check oil levels. Bring on each compressor one at a time.

Check:

- Suction and discharge pressure
- Oil Pressure
- Voltage differential and balance
- Ampere draw and balance

Allow the full rack to operate until it stabilizes. If the Receiver charge drops below 15% add more vapor until a 15% level is obtained. Watch oil levels, receiver liquid level and possible flood back from evaporator.

Shut off all compressors and recheck oil levels in each compressor and the Turba-shed. Leak testing, evacuation and initial charging are now completed.

R22 Compound System Start-u

The medium temperature section must be started first. With the medium temperature section running bring on the low-temp compressors one at a time. Adjust the thermostat to maintain between 50F and 65F.

Final Checks

Once the system is up and running it is the responsibility of the installer to see that all the fine adjustments are made so the Rack delivers maximum temperature performance and efficiency for the customer. These include:

- Defrost scheduling and timing
- Condenser controls
- Winter controls
- Sub-cooling
- Compound System Operation
- EPR, and ORI settings
- TEV superheat adjustment
- CPR settings
- High and low pressure controls
- Main liquid line solenoid differential
- Thermostat settings
- Adjustments to electronic controls

Thoroughly inspect all field piping while the equipment is running and add supports where line vibration occurs. Be sure additional supports do not conflict with pipe expansion and contraction.

When merchandisers are completely stocked, check the operation of the system again.

At 48 hours of operation replace the liquid drier and suction filter cores.

At 90 days recheck the entire system, including all field wiring. Change the oil filter using a Sporlan SF-283-F. Future maintenance costs may be reduced if an oil acidity test is run at this time. Replace acid oil.

MAINTENANCE

Compressor Replacement

Since each machine room tends to be unique, plan carefully as to how you will move the compressor without harming personnel, equipment or the building. Before beginning removal of old compressor make replacement unit ready to install:

Verify

Replacement compressor
- Electrical requirements
- Refrigerant application
- Capacity
- Piping hookup location and design
- Suction and discharge gaskets
- Mounting requirements.

Have compressor in an easily accessible position, uncrated and unbolted from shipping pallets.

Disconnect Electrical Supply

Turn off motor and control panel power supplies to the Rack.

Turn off control circuit and open all compressor circuit breakers.

Tag and remove electrical wires and conduit from the compressor.

Isolate Compressor from Rack

Frontseat Suction and Discharge Service Valves. Close oil supply and equalizing lines.

Bleed compressor pressure through both discharge and suction access ports into an approved recovery vessel.

Remove oil supply and equalizing lines.

Remove externally mounted components which will be re-used on the replacement compressor.

Plug holes to compressor manufacturer's specifications.

Remove bolts from suction and discharge service valves.

Remove mounting bolts.

When moving the compressor, use a come-along, hoist or hydraulic lift to carry the weight.

Do not use the rack piping or panel to support a hoist or come-along.

Do not use ceiling trusses to support a hoist or come-along.

The rear support channel on the rack or a properly constructed ceiling rail may be used to support a hoist or come-along.

To make hookup and lifting easier, an eye bolt may be installed in the rear top of the compressor head.

If a compressor removal table is used, slide the compressor fully on to the table, then roll table to overhead hoist or hydraulic lift area.

When the old compressor has been removed, clean the suction and discharge service valve gasket surfaces to shiny metal. Clean the gasket surfaces on the new compressor to shiny metal. Be careful not to groove or round the surfaces. Gasket surfaces must be clean to prevent leaking.

Install the new compressor in reverse order of removal. Do not open the new compressor to the system until after it has been leak tested and triple evacuated.

Note: Oil level regulator sight glasses are designed to provide a hermetic seal when internally pressurized. Some leaking may occur when a deep vacuum is pulled.

Cleaning the Turba-shed™

Should the Turba-shed require cleaning, first shut down the system. Isolate the Turba-shed and bleed off pressure into an approved recovery vessel. Remove the top and bottom sight glasses and the oil supply line. With a clean, dry, regulated pressure source like nitrogen, blow out any sludge or dirt. Install the sightglasses using new o-rings.

Parker Number 2-23,
Compound 557
Precision Rubber, number 023,
Compound 2337

Leak test, evacuate, and charge with fresh oil (only Suniso 3G or Texaco Capella WF32). See Screw compressor section for oil type used in screw compressor systems. Open valves closed to isolate the oil system and bring the rack back on line.

Replacing Drier and Filter Cores

Shut down the system. Isolate the core to be replaced and bleed off pressure into an approved recovery vessel. Open housing, replace core and close up. Pressurize, leak test and bring back into line.

PRE-STARTUP CHECK LIST

- ☐ Leak test system
- ☐ Evacuate system
- ☐ Check all electrical connections
- ☐ Check pressure switch settings and thermostat settings.
- ☐ Set electronic controllers in manual control
- ☐ Charge receiver
- ☐ Start system
- ☐ Check ALL operations.

POST-STARTUP CHECK LIST

- ☐ Fine tune defrost schedules
- ☐ Condenser controls
- ☐ Winter controls
- ☐ Sub-cooler operation
- ☐ Compound system operation
- ☐ EPR, ORI settings
- ☐ TEV superheats
- ☐ Recheck pressure controls
- ☐ Main Liquid differential valve
- ☐ Thermostat settings
- ☐ Adjust electronic controls
- ☐ Replace liquid drier at 48 hours
- ☐ Replace oil filter at 90 days