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Installation - Operation - Maintenance

RWF

ROTARY SCREW COMPRESSOR UNITS

ALL REFRIGERANTS

MODELS
100 through 480

THIS MANUAL CONTAINS RIGGING, ASSEMBLY, START-UP, AND MAINTENANCE INSTRUCTIONS. READ THOROUGHLY BEFORE BEGINNING INSTALLATION. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE OR IMPROPER OPERATION OF THE UNIT.

YORK®
Refrigeration Systems

Contents

PREFACE 3
DESIGN LIMITATIONS 3
JOB INSPECTION 3
TRANSIT DAMAGE CLAIMS 3
COMPRESSOR and UNIT IDENTIFICATION 3
FOUNDATION 4
RIGGING and HANDLING 4
SKID REMOVAL 4
CHECKING MOTOR/COMPRESSOR ROTATION 5
COMPRESSOR/MOTOR COUPLING INSTALLATION 5
OIL PUMP COUPLING 5
HOLDING CHARGE AND STORAGE 5
COMPRESSOR UNIT OIL 5
OIL CHARGE 6
OIL HEATER(S) 6
THERMOSYPHON OIL COOLING 6
LIQUID INJECTION OIL COOLING (Optional) 7
LIQUID LINE SIZES/RECEIVER VOLUME 8
WATER-COOLED OIL COOLING (OPTIONAL) 8
ECONOMIZER - HIGH STAGE (OPTIONAL) 9
ELECTRICAL 10
MOTOR STARTER PACKAGE 10
CURRENT TRANSFORMER (CT) RATIOS 11
MINIMUM BURDEN RATINGS 11
BATTERY BACKUP 11
OPERATION and START-UP INSTRUCTIONS 12
SGC COMPRESSOR 12
COMPRESSOR LUBRICATION SYSTEM 12
NO PUMP OIL SYSTEM 12
COLD-START SYSTEM 13
DEMAND PUMP OIL SYSTEM 13
COMPRESSOR OIL SEPARATION SYSTEM 13
COMPRESSOR HYDRAULIC SYSTEM 14
VOLUMIZER VOLUME RATIO CONTROL 14
COMPRESSOR OIL COOLING SYSTEMS 15
SINGLE-PORT LIQUID INJECTION 15
BOOSTER OR SWING DUTY APPLICATION 15
DUAL-PORT LIQUID INJECTION 15
LIQUID INJECTION ADJUSTMENT PROCEDURE 15
SUCTION CHECK VALVE BYPASS 16
LOW AMBIENT OPERATION 16
INITIAL START-UP 17
INITIAL START-UP PROCEDURE 17
NORMAL START-UP PROCEDURE 17
GENERAL INFORMATION 18
NORMAL MAINTENANCE OPERATIONS 18
GENERAL MAINTENANCE 18
COMPRESSOR SHUTDOWN and START-UP 18
GENERAL INSTRUCTIONS FOR REPLACING
COMPRESSOR UNIT COMPONENTS 19
OIL FILTER (OF-1) MAIN SINGLE/DUAL 19
STRAINER - DEMAND OIL PUMP 19
STRAINER - LIQUID INJECTION 20
COALESCER FILTER ELEMENT(S) 20
CHANGING OIL 20
DEMAND PUMP DISASSEMBLY 21
DEMAND PUMP ASSEMBLY 22
TROUBLESHOOTING THE DEMAND PUMP 23
PREVENTATIVE MAINTENANCE 24
RECOMMENDED MAINTENANCE PROGRAM 25
VIBRATION ANALYSIS 25
MOTOR BEARINGS 25
OIL QUALITY and ANALYSIS 25
OPERATING LOG 26
MAINTENANCE SCHEDULE 26
TROUBLESHOOTING GUIDE 27
ABNORMAL OPERATION ANALYSIS & CORRECTION 27
SERVICING THE COLD-START VALVE 27
PRESSURE TRANSDUCERS - TESTING 27
PRESSURE TRANSDUCERS - REPLACEMENT 28
SV POSITION POTENTIOMETER
REPLACEMENT AND ADJUSTMENT 29
CAPACITY LINEAR TRANSMITTER
REPLACEMENT - SLIDE VALVE 29
VOLUMIZER® TRANSMITTER REPLACEMENT -
SLIDE STOP 30
TEMPERATURE SENSOR REPLACEMENT 30
OIL LEVEL TRANSMITTER REPLACEMENT 30
TROUBLESHOOTING THE RWF COMPRESSOR 31
OIL SEPARATION SYSTEM 31
HYDRAULIC SYSTEM 32
LIQUID INJECTION OIL COOLING SYSTEM 32
DEMAND PUMP SYSTEM 33
THERMAL EXPANSION VALVES 34
JORDAN TEMPERATURE REGULATOR VALVE 35
MOTOR REPLACEMENT 36
BARE COMPRESSOR REPLACEMENT 36
GREASE COMPATIBILITY 36
P & I DIAGRAMS 37
WIRING HARNESS 41
PROPER INSTALLATION OF ELECTRONIC EQUIPMENT
IN AN INDUSTRIAL ENVIRONMENT 44
FORMS 47
RECOMMENDED SPARE PARTS 52

SAFETY PRECAUTION DEFINITIONS

DANGER — **Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.**

WARNING — **Indicates a potentially hazardous situation or practice which, if not avoided, will result in death or serious injury.**

CAUTION — **Indicates a potentially hazardous situation or practice which, if not avoided, will result in damage to equipment and/or minor injury.**

NOTE: — **Indicates an operating procedure, practice, etc., or portion thereof which is essential to highlight.**

PREFACE

This manual has been prepared to acquaint the owner and serviceman with the INSTALLATION, OPERATION, and MAINTENANCE procedures as recommended by Frick for RWF Rotary Screw Compressor Units.

For information about the functions of the *Quantum* control panel, communications, specifications, and wiring diagrams, see publication series S90-010 O, M, CS, and E90-010 SPC.

It is most important that these units be properly applied to an adequately controlled refrigeration system. Your authorized Frick representative should be consulted for his expert guidance in this determination.

Proper performance and continued satisfaction with these units is dependent upon:

CORRECT INSTALLATION
PROPER OPERATION
REGULAR, SYSTEMATIC MAINTENANCE

To ensure correct installation and application, the equipment must be properly selected and connected to a properly designed and installed system. The Engineering plans, piping layouts, etc. must be detailed in accordance with the best practices and local codes, such as those outlined in ASHRAE literature.

A refrigeration compressor is a VAPOR PUMP. To be certain that it is not being subjected to liquid refrigerant carryover it is necessary that refrigerant controls are carefully selected and in good operating condition; the piping is properly sized and traps, if necessary, are correctly arranged; the suction line has an accumulator or slugging protection; that load surges are known and provisions made for control; operating cycles and defrosting periods are reasonable; and that high side condensers are sized within system and compressor design limits.

It is recommended that the entering vapor temperature to the compressor be superheated to 10°F above the refrigerant saturation temperature. This assures that all refrigerant at the compressor suction is in the vapor state.

DESIGN LIMITATIONS

The compressor units are designed for operation within the pressure and temperature limits as shown in Frick Pub. E70-600 SED (Check with Frick marketing dept. for availability).

JOB INSPECTION

Immediately upon delivery examine all crates, boxes and exposed compressor and component surfaces for damage. Unpack all items and check against shipping lists for any discrepancy. Examine all items for damage in transit.

TRANSIT DAMAGE CLAIMS

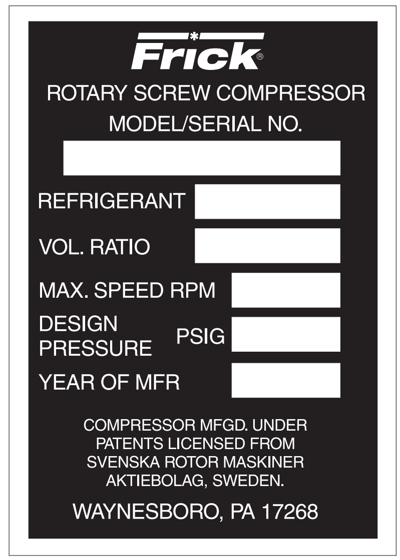
All claims must be made by consignee. This is an ICC requirement. Request immediate inspection by the agent of the carrier and be sure the proper claim forms are executed.

Report damage or shortage claims immediately to York Refrigeration, Frick Sales Administration Department, in Waynesboro, PA.

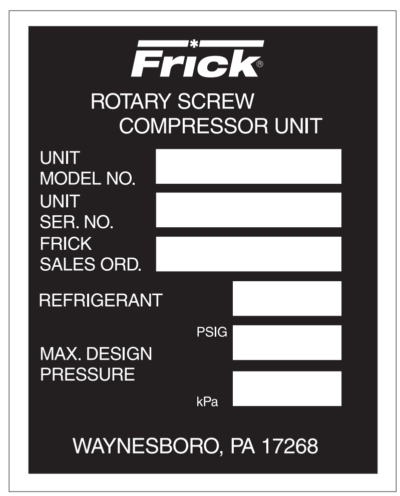
COMPRESSOR and UNIT IDENTIFICATION

Each compressor unit has 2 identification data plates. The **compressor data plate** containing compressor model and serial number is mounted on the compressor body. The **unit data plate** containing unit model, serial number and Frick sales order number is mounted on the side of the compressor base.

NOTE: When inquiring about the compressor or unit, or ordering repair parts, provide the MODEL, SERIAL, and FRICK SALES ORDER NUMBERS from these data plates.



COMPRESSOR DATA PLATE



UNIT DATA PLATE

FOUNDATION

Each **RWF** Rotary Screw Compressor Unit is shipped mounted on a wood skid which **must** be removed prior to unit installation.

CAUTION **Allow space for servicing both ends of the unit. A minimum of 36 inches is recommended.**

The first requirement of the compressor foundation is that it must be able to support the weight of the compressor package including coolers, oil, and refrigerant charge. Screw compressors are capable of converting large quantities of shaft power into gas compression in a relatively small space and a mass is required to effectively dampen these relatively high frequency vibrations.

Firmly anchoring the compressor package to a suitable foundation by proper application of grout and elimination of piping stress imposed on the compressor is the best insurance for a trouble-free installation. Use only the certified general arrangement drawings from Frick to determine the mounting foot locations and to allow for recommended clearances around the unit for ease of operation and servicing. Foundations must be in compliance with local building codes and materials should be of industrial quality.

The floor should be a minimum of 6 inches of reinforced concrete and housekeeping pads are recommended. Anchor bolts are required to firmly tie the unit to the floor. Once the unit is rigged into place (See RIGGING and HANDLING), the feet must then be shimmed in order to level the unit. The shims should be placed to position the feet roughly one inch above the housekeeping pad to allow room for grouting. An expansion-type epoxy grout must be worked under all areas of the base with no voids and be allowed to settle with a slight outward slope so oil and water can run off of the base.

When installing on a steel base, the following guidelines should be implemented to properly design the system base:

1. Use I-beams in the skid where the screw compressor will be attached to the system base. They should run parallel to the package feet and support the feet for their full length.

2. The compressor unit feet should be continuously welded to the system base at all points of contact.

3. The compressor unit should not be mounted on vibration isolators in order to hold down package vibration levels.

4. The customer's foundation for the system base should fully support the system base under all areas, but most certainly under the I-beams that support the compressor package.

When installing on the upper floors of buildings, extra precautions should be taken to prevent normal package vibration from being transferred to the building structure. It may be necessary to use rubber or spring isolators, or a combination of both, to prevent the transmission of compressor vibration directly to the structure. However, this may increase package vibration levels because the compressor is not in contact with any damping mass. The mounting and support of suction and discharge lines is also very important. Rubber or spring pipe supports may be required to avoid exciting the building structure at any pipe supports close to the compressor package. It is best to employ a vibration expert in the design of a proper mounting arrangement.

In any screw compressor installation, suction and discharge lines should be supported in pipe hangers (preferably within 2 ft. of vertical pipe run) so that the lines won't move if disconnected from the compressor. See table for Allowable Flange Loads.

ALLOWABLE FLANGE LOADS

NOZ.	MOMENTS (ft-lbf)			LOAD (lbf)		
SIZE	AXIAL	VERT.	LAT.	AXIAL	VERT.	LAT.
NPS	M_R	M_C	M_L	P	V_C	V_L
1	25	25	25	50	50	50
1.25	25	25	25	50	50	50
1.5	50	40	40	100	75	75
2	100	70	70	150	125	125
3	250	175	175	225	250	250
4	400	200	200	300	400	400
5	425	400	400	400	450	450
6	1000	750	750	650	650	650
8	1500	1000	1000	1500	900	900
10	1500	1200	1200	1500	1200	1200

Frick recommends consulting a licensed architect to determine the proper foundation requirements for any large engine or turbine drive.

When applying screw compressors at high pressures, the customer must be prepared for package vibration and noise higher than the values predicted for normal refrigeration duty. Proper foundations and proper installation methods are vital; and even then, sound attenuation or noise curtains may be required to reduce noise to desired levels.

For more detailed information on Screw Compressor Foundations, please request Frick publication S70-210 IB.

RIGGING and HANDLING

CAUTION **This screw compressor package may be top-heavy. Use caution in rigging and handling.**

The unit can be moved with rigging, using a crane or forklift, by hooking into the four lifting eyes on the oil separator. If a motor is mounted, appropriate adjustment in the lifting point should be made to compensate for motor weight. Adjustment of the lifting point must also be made for any additions to the standard package such as an external oil cooler, etc., because the center of balance will be effected.

The unit can be moved with a forklift by forking under the skid, or it can be skidded into place with pinch bars by pushing against the skid. **NEVER MOVE THE UNIT BY PUSHING OR FORKING AGAINST THE SEPARATOR SHELL OR ITS MOUNTING SUPPORTS.**

SKID REMOVAL

If the unit is rigged into place, the skid can be removed by taking off the nuts and bolts that are fastening the unit mounting supports to the skid before lowering the unit onto the mounting surface.

If the unit is skidded into place, remove the cross members from the skid and remove the nuts anchoring the unit to the skid. Using a 10-ton jack under the separator raise the unit at the compressor end until it clears the two mounting bolts. Spread the skid to clear the unit mounting support, then lower the unit to the surface. Repeat procedure on opposite end.

CHECKING MOTOR/COMPRESSOR ROTATION

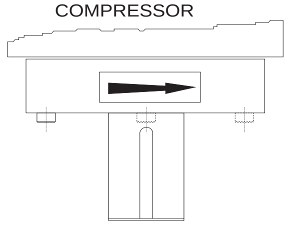
⚠WARNING

Make sure coupling hubs are tightened to the shaft before rotating the motor to prevent them from flying off and possibly causing serious injury or death.

⚠CAUTION

Injury may occur if loose clothing, etc, becomes entangled on the spinning motor shaft.

COMPRESSOR ROTATION IS CLOCKWISE WHEN FACING THE END OF THE COMPRESSOR SHAFT. Under **NO** conditions should the motor rotation be checked with the coupling center installed as damage to the compressor may result. Bump the motor to check for correct compressor rotation. After verification, install disk drive spacer, as applicable.



COMPRESSOR/MOTOR COUPLING INSTALLATION

The **RWF** unit has compressor to motor alignment through the use of a machined cast iron tunnel. This tunnel is factory set through machining tolerances ensuring motor compressor alignment. No alignment is required in the field. For replacement motors, the shaft alignment should be checked and tolerances verified with the Frick service department. See Figure 1.

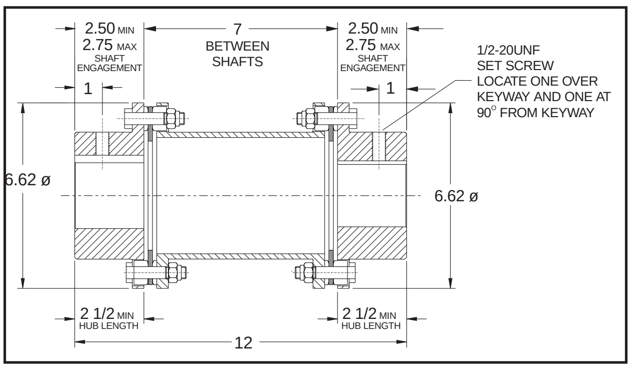


Figure 1

TORSIONAL DATA				
COUPLING PART NO.	MOTOR HUB	WEIGHT (lb)	INERTIA lb x in.^{2}	TORSIONAL in. x lb/RADIAN
720C0044H01	2.377	32.4	152	2.89×10^6
720C0044H02	2.127	33.1	153	2.89×10^6
720C0044H03	1.877	33.8	154	2.89×10^6
720C0045H01	2.377	52.6	334	4.58×10^6
720C0045H02	2.127	53.5	335	4.33×10^6
720C0045H03	2.877	50.7	330	5.06×10^6

OPERATING DATA - 60 Hz		
SPECIFICATION (Maximum)	COUPLING PART NO.	
	720C0044H0_	720C0045H0_
Power (hp)	424	740
Speed (rpm)	3,600	3,600
Torque* (in.-lb)	11,130	19,425

*Includes 1.5 service factor.

ALTERNATE OPERATING DATA - 50 Hz		
SPECIFICATION	COUPLING PART NO.	
	720C0044H0_	720C0045H0_
Power (hp)	424	740
Speed (rpm)	3,000	3,000
Torque* (in.-lb)	13,356	23,310

*Includes 1.5 service factor.

COUPLING TORQUE RATINGS		
TORQUE	COUPLING PART NO.	
	720C0044H0_	720C0045H0_
Max continuous	17,500 in.-lb	24,300 in.-lb
Peak overload	35,000 in.-lb	48,600 in.-lb

OIL PUMP COUPLING

Compressor units with direct motor/pump coupled pumps need no pump/motor coupling alignment since this is maintained by the close-coupled arrangement.

HOLDING CHARGE AND STORAGE

Each **RWF** compressor unit is pressure and leak tested at the Frick factory and then thoroughly evacuated and charged with dry nitrogen to ensure the integrity of the unit during shipping and short term storage prior to installation.

NOTE: Care must be taken when entering the unit to ensure that the nitrogen charge is safely released.

⚠WARNING

Holding-charge shipping gauges on separator and external oil cooler are rated for 30 PSIG and are for checking the shipping charge only. They must be removed before pressure testing the system and before charging the system with refrigerant. Failure to remove these gauges may result in catastrophic failure of the gauge and uncontrolled release of refrigerant resulting in serious injury or death.

All units must be kept in a clean, dry location to prevent corrosion damage. Reasonable consideration must be given to proper care for the solid state components of the microprocessor.

Units which will be stored for more than two months must have the nitrogen charge checked periodically.

COMPRESSOR UNIT OIL

⚠WARNING

DO NOT MIX OILS of different brands, manufacturers, or types. Mixing of oils may cause excessive oil foaming, nuisance oil level cutouts, oil pressure loss, gas or oil leakage and catastrophic compressor failure.

⚠CAUTION

Use of oils other than Frick Oil must be approved in writing by Frick engineering or warranty claim may be denied.

The oil charge shipped with the unit is the best suited lubricant for the conditions specified at the time of purchase. If there is any doubt due to the refrigerant, operating pressures, or temperatures; refer to Frick Pub. E160-802 SPC for guidance.

OIL CHARGE

The normal charging level is midway in the top sight glass located midway along the oil separator shell. Normal operating level is midway between the top sight glass and bottom sight glass. The table gives the approximate oil charge quantity.

RWF MODEL NO.	BASIC* CHARGE (gal.)
100	50
134	50
177	95
222	95
270	140
316	140
399	140
480	140

* Includes total in oil separator and piping. Add 5 gal. for oil cooler.

Add oil by attaching the end of a suitable pressure type hose to the oil charging valve, located on the top of the oil separator between the compressor and motor. Using a pressure-type pump and the recommended Frick oil, open the charging valve and pump oil into the separator. **NOTE: Fill slowly because oil will fill up in the separator faster than it shows in the sight glass.**

Oil distillers and similar equipment which act to trap oil must be filled prior to unit operation to normal design outlet levels. The same pump used to charge the unit may be used for filling these auxiliary oil reservoirs.

NOTE: The sight glass located in the coalescing end of the separator near the discharge connection should remain empty.

OIL HEATER(S)

Standard units are equipped with two or three 500 watt oil heaters, providing sufficient heat to maintain the oil temperature for most indoor applications during shutdown cycles to permit safe start-up. Should additional heating capacity be required because of low ambient temperature, contact Frick. The heaters are energized only when the unit is not in operation.

WARNING

DO NOT ENERGIZE THE HEATERS when there is no oil in the unit, the heaters will burn out. The oil heaters will be energized whenever 120 volt control power is applied to the unit and the compressor is not running, unless the 16 amp circuit breaker in the micro enclosure is turned off.

OIL FILTER(S)

CAUTION

Use of filter elements other than Frick must be approved in writing by Frick engineering or warranty claim may be denied.

The oil filter(s) and coalescer filter element(s) shipped with the unit are best suited to ensure proper filtration and operation of the system.

THERMOSYPHON OIL COOLING

Thermosyphon oil cooling is an economical, effective method for cooling oil on screw compressor units. Thermosyphon cooling utilizes liquid refrigerant at condenser pressure and temperature that is partially vaporized at the condenser temperature in a plate and shell vessel, cooling the oil to within 15°F of that temperature. The vapor, at condensing pressure, is vented to the condenser inlet and reliquified. This method is the most cost effective of all currently applied cooling systems since no compressor capacity is lost or compressor power penalties incurred. The vapor from the cooler need only be condensed, not compressed. Refrigerant flow to the cooler is automatic, driven by the thermosyphon principle and cooling flow increases as the oil inlet temperature rises.

EQUIPMENT - The basic equipment required for a thermosyphon system consists of:

1. A source of liquid refrigerant at condensing pressure and temperature, located in close proximity to the unit to minimize piping pressure drop. The liquid level in the refrigerant source must be 6 to 8 feet minimum above the center of the oil cooler.

2. A plate and shell oil cooler with:

Plate Side: Oil 400 lb design
Shell Side: Refrigerant 400 lb design

Due to the many variations in refrigeration system design and physical layout, several systems for assuring the above criteria are possible.

SYSTEM OPERATION - Liquid refrigerant fills the cooler shell side up to the Thermosyphon receiver liquid level.

Hot oil (above the liquid temperature) flowing through the cooler will cause some of the refrigerant to boil and vaporize. The vapor rises in the return line. The density of the refrigerant liquid/vapor mixture in the return line is considerably less than the density of the liquid in the supply line. This imbalance provides a differential pressure that sustains a flow condition to the oil cooler. This relationship involves:

1. Liquid height above the cooler.
2. Oil heat of rejection.
3. Cooler size and piping pressure drops.

Current thermosyphon systems are using two-pass oil coolers and flow rates based on 3:1 overfeed.

The liquid/vapor returned from the cooler is separated in the receiver. The vapor is vented to the condenser inlet and need only be reliquified since it is still at condenser pressure. See Figure 2.

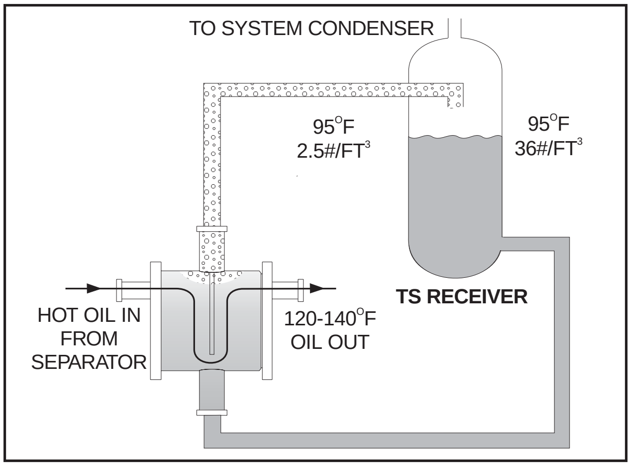


Figure 2

OIL TEMPERATURE CONTROL - Oil temperature will generally run about 15 - 35°F above condensing temperature. In many cases, an oil temperature control is not required if condensing temperature is above 65°F as oil temperature can be allowed to float with condenser temperature.

Condensing Temperature: 65°F - 105°F
Oil Temperature: 80°F - 140°F

INSTALLATION - The plate and shell type thermosyphon oil cooler with oil-side piping and a thermostatically controlled mixing valve (if ordered) are factory mounted and piped. The customer must supply and install all piping and equipment located outside of the shaded area on the piping diagram with consideration given to the following:

1. The refrigerant source, thermosyphon or system receiver, should be in close proximity to the unit to minimize piping pressure drop.

2. The liquid level in the refrigerant source must be **6** to **8 feet minimum** above the center of the oil cooler.

3. A safety valve should be installed if refrigerant isolation valves are used for the oil cooler.

The component and piping arrangement shown in Figure 3 is intended only to illustrate the operating principles of thermosyphon oil cooling. Other component layouts may be better suited to a specific installation. Refer to publication E70-900E for additional information on Thermosyphon Oil Cooling.

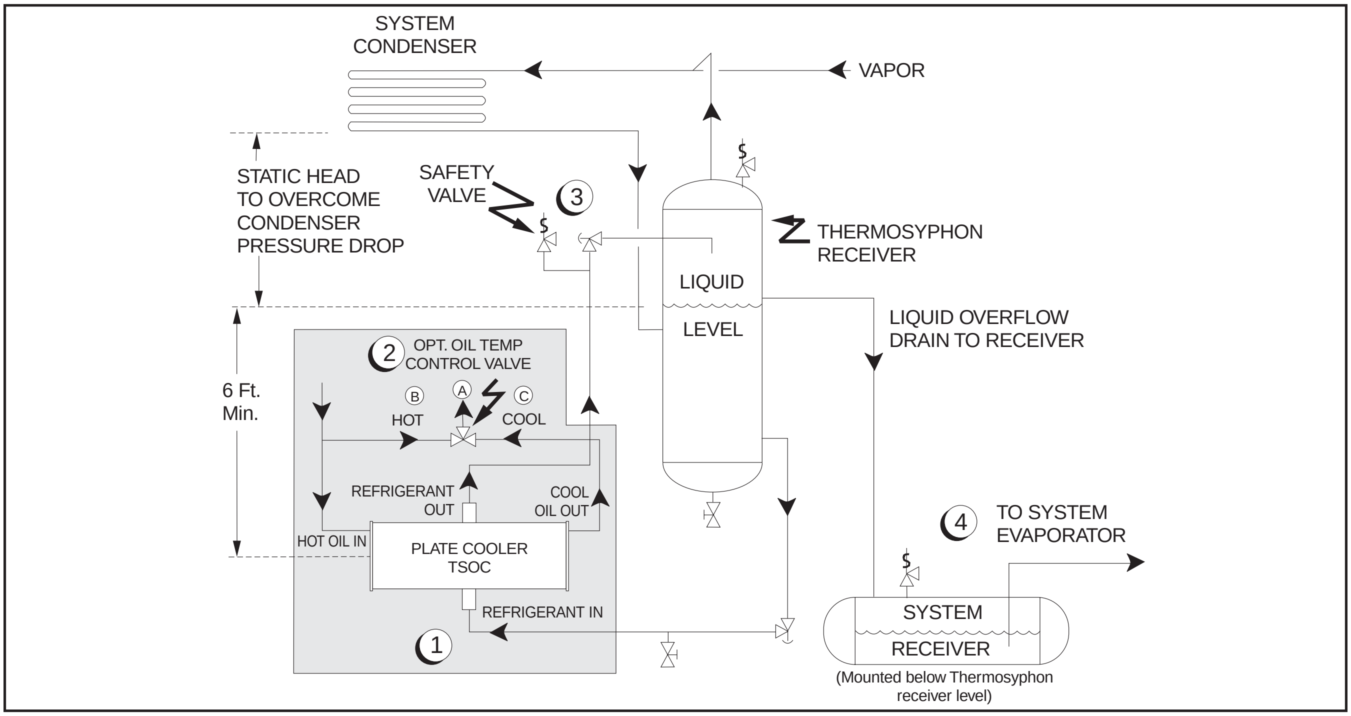


Figure 3

1. The thermosyphon oil cooler is supplied with the oil side piped to the compressor unit and stub ends supplied on the refrigerant side.
2. A three-way oil temperature control valve is required where condensing temperature is expected to go below 65°F.
3. A refrigerant-side safety valve is required in this location only when refrigerant isolation valves are installed between the cooler and thermosyphon receiver. If no valves are used between the cooler and TSOC receiver, the safety valve on the TSOC receiver must be sized to handle the volume of both vessels. Then, the safety valve on the cooler vent (liquid refrigerant side) can be eliminated.
4. The system receiver must be below the thermosyphon receiver in this arrangement.

LIQUID INJECTION OIL COOLING (Optional)

The liquid injection system provided on the unit is self-contained but requires the connection of the liquid line sized as shown in the table and careful insertion of the expansion valve bulb into the thermowell provided in the separator. High pressure gas is connected through the regulator to the external port on the liquid injection valve to control oil temperature.

NOTE: For booster applications the high pressure gas connection must be taken from a high side source (high stage compressor discharge). This should be a 3/8" line connected into the solenoid valve provided. This gas is required by the expansion valve external port to control oil temperature.

It is **IMPERATIVE** that an uninterrupted supply of high pressure liquid refrigerant be provided to the injection system at all times. Two items of **EXTREME IMPORTANCE** are the design of the receiver/liquid injection supply and the size of the liquid line.

It is recommended that the receiver be oversized sufficiently to retain a 5-minute supply of refrigerant for oil cooling. The evaporator supply must be secondary to this consideration. Two methods of accomplishing this are shown.

The dual dip tube method (Figure 4) uses two dip tubes in the receiver. The liquid injection tube is below the evaporator tube to ensure continued oil cooling when the receiver level is low.

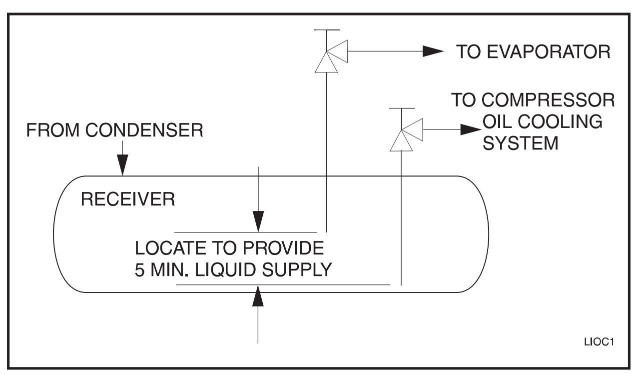


Figure 4

The level-control method (Figure 5) utilizes a float level control on the receiver to close a solenoid valve feeding the evaporator when the liquid falls below that amount necessary for 5 minutes of liquid injection oil cooling.

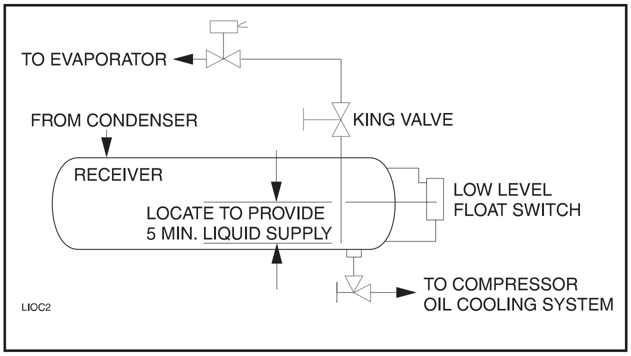


Figure 5

LIQUID LINE SIZES/RECEIVER VOLUME

Liquid line sizes and the additional receiver volume (quantity of refrigerant required for 5 minutes of liquid injection oil cooling) are given in the following table:

LIQUID LINE SIZE and RECEIVER VOLUME

RWF MODEL	LINE SIZE* SCH 80 PIPE	LINE SIZE* OD TUBING	POUND PER 5 MIN.	LIQUID VOLUME CU FT
R-717			**HIGH STAGE***	
100-134	3/4	–	80	2.0
177-270	1	–	140	4.0
316-480	1-1/4	–	250	7.0
R-717			**BOOSTER***	
100-134	1/2	–	20	0.5
177-270	3/4	–	30	1.0
316-480	1	–	40	1.5
R-22			**HIGH STAGE***	
100-134	1-1/4	1-1/8	290	4.0
177-270	1-1/2	1-3/8	570	8.0
316-480	2	2-1/2	1,050	14.0
R-22			**BOOSTER***	
100-134	3/4	7/8	44	0.6
177-270	3/4	7/8	59	0.8
316-480	3/4	7/8	92	1.2

*Based on 100 foot liquid line. For longer runs, increase line size accordingly.

WATER-COOLED OIL COOLING (OPTIONAL)

The plate and shell type water-cooled oil cooler is mounted on the unit complete with all oil piping. The customer must supply adequate water connections and install the two-way water regulating valve if ordered in lieu of a three-way oil temperature valve. It is recommended (local codes permitting) that the water regulator be installed on the water outlet connection. Insert the water regulator valve bulb and well in the chamber provided on the oil outlet connection. Determine the size of the water-cooled oil cooler supplied with the unit, then refer to table for the water connection size. **The water supply must be sufficient to meet the required flow.**

Frick recommends a closed-loop system for the waterside of the oil cooler. Careful attention to water treatment is essential to ensure adequate life of the cooler if cooling tower water is used. **It is imperative that the condition of cooling water and closed-loop fluids be analyzed regularly and as necessary and maintained at a pH of 7.4, but not less than 6.0 for proper heat exchanger life.** After initial start-up of the compressor package, the strainer at the inlet of the oil cooler should be cleaned several times in the first 24 hours of operation.

In some applications, the plate and shell oil cooler may be subjected to severe water conditions, including high temperature and/or hard water conditions. This causes accelerated scaling rates which will penalize the performance of the heat exchanger. A chemical cleaning process will extend the life of the Plate and Shell heat exchanger. It is important to establish regular cleaning schedules.

Cleaning: A 3% solution of Phosphoric or Oxalic Acid is recommended. Other cleaning solutions can be obtained from your local distributor, but they must be suitable for stainless steel. The oil cooler may be cleaned in place by back flushing with recommended solution for approximately 30 minutes. After back flushing, rinse the heat exchanger with fresh water to remove any remaining cleaning solution.

NOTE: The water-regulating valve shipped with the unit will be sized to the specific flow for the unit.

OIL COOLER DATA TABLE

RWF MODEL	TYPICAL COOLER	CONNECTION INLET	CONNECTION OUTLET
100/134 High Stage	116 Plates	3″	3″
100 - 270 Booster	66 Plates	2″	2″
177/222 High Stage	190 Plates	3″	3″
270 High Stage	288 Plates	3″	4″
316/399 Booster	56 Plates	3″	3″
316/399 High Stage	136 Plates	4″	5″
480 Booster	72 Plates	3″	3″
480 High Stage	188 Plates	4″	5″

ECONOMIZER - HIGH STAGE (OPTIONAL)

The economizer option provides an increase in system capacity and efficiency by subcooling liquid from the condenser through a heat exchanger or flash tank before it goes to the evaporator. The subcooling is provided by flashing liquid in the economizer cooler to an intermediate pressure level.The intermediate pressure is provided by a port located part way down the compression process on the screw compressor.

As the screw compressor unloads, the economizer port will drop in pressure level, eventually being fully open to suction. Because of this, an output from the microprocessor is generally used to turn off the supply of flashing liquid on a shell and coil or DX economizer when the capacity falls below approximately 45%-60% capacity (85%-90% slide valve position). This is done because the compressor will be more efficient operating at a higher slide valve position with the economizer turned off, than it will at a low slide valve position with the economizer turned on. Please note however that shell and coil and DX economizers can be used at low compressor capacities in cases where efficiency is not as important as assuring that the liquid supply is subcooled. In such cases, the economizer liquid solenoid can be left open whenever the compressor is running.

Due to the tendency of the port pressure to fall with decreasing compressor capacity, a back-pressure regulator valve (BPR) is generally required on a flash economizer system (FIG. 8) in order to maintain some preset pressure difference between the subcooled liquid in the flash vessel and the evaporators. If the back-pressure regulator valve is not used on a flash economizer, it is possible that no pressure difference will exist to drive liquid from the flash vessel to the evaporators, since the flash vessel pressure will approach suction pressure at a decreased slide valve position. In cases where wide swings in pressure are anticipated in the flash economizer vessel, it may be necessary to add an outlet pressure regulator to the flash vessel outlet to avoid overpressurizing the economizer port, which could result in motor overload. Example: A system feeding liquid to the flash vessel in batches.

The recommended economizer systems are shown below. Notice that in all systems there should be a strainer (STR) and a check valve (VCK) between the economizer vessel and the economizer port on the compressor. The strainer prevents dirt from passing into the compressor and the check valve prevents oil from flowing from the compressor unit to the economizer vessel during shutdown.

CAUTION **Other than the isolation valve needed for strainer cleaning, it is essential that the strainer be the last device in the economizer line before the compressor. Also, piston-type check valves are recommended for installation in the economizer line, as opposed to disc-type check valves. The latter are more prone to gas-pulsation-induced failure. The isolation and check valves and strainer should be located as closely as possible to the compressor, preferably within a few feet.**

For refrigeration plants employing multiple compressors on a common economizing vessel, regardless of economizer type, each compressor must have a back-pressure regulating valve in order to balance the economizer load, or gas flow, between compressors.The problem of balancing load becomes most important when one or more compressors run at partial load, exposing the economizer port to suction pressure. In the case of a flash vessel, there is no need for the redundancy of a back-pressure regulating valve on the vessel and each of the multiple compressors. Omit the BPR valve on the flash economizer vessel and use one on each compressor, as shown in FIG. 9. It is also recommended that the back-pressure regulating valves, used on economizer lines, should be specified with electric shutoff option.The electric shutoff feature is necessary to prevent flow from the common economizer vessel to the suction side of a stopped compressor, through the suction check valve bypass line, if the other compressors and the common economizer vessel are still operating and the HV2 valve on the suction bypass is open.

For refrigeration plants using a Packaged Refrigerant Recirculation (PRR) unit and a direct expansion (DX) economizer system it is necessary to operate the liquid feed sole-

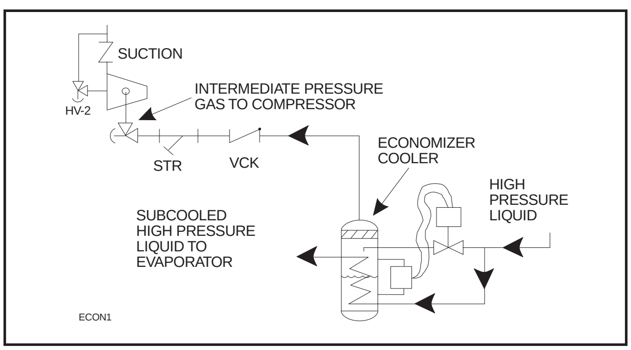


FIG. 6 - Shell and Coil Economizer System

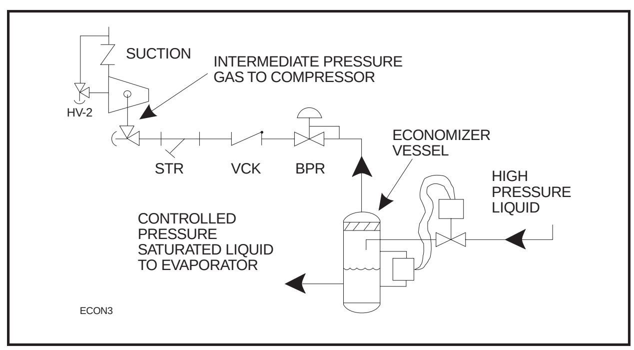


FIG. 8- Flash Economizer System

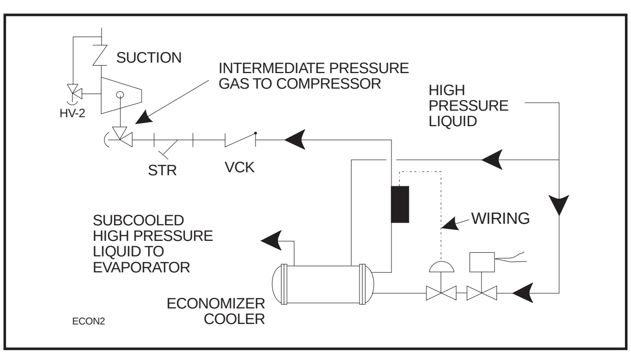


FIG. 7 - Direct Expansion Economizer System

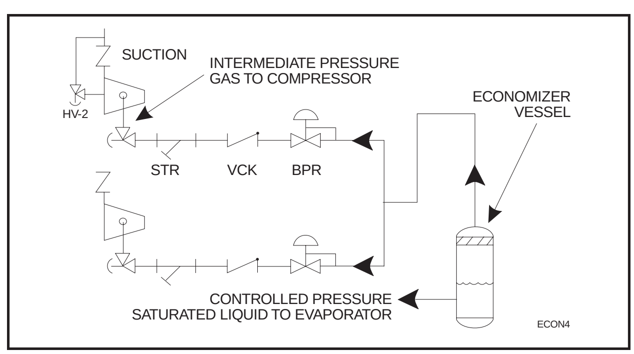


FIG. 9 -Multiple Compressor Economizer System

noid on the PRR unit and the liquid feed solenoid on the DX vessel off of a common signal to avoid liquid overfeed on the DX economizer system.

If multiple compressors are operated with a common economizer vessel, it is necessary to install a back-pressure regulator valve with an electric shutoff option in the vapor line piped to the compressor's economizer port. If an electric shut-off is not installed in the economizer vapor line, valve HV-2 must remain closed to avoid a gas bypass from the economizer line through the suction check valve bypass, back to the suction line on a compressor that is shut down.

ECONOMIZER LOAD BALANCING

The most energy efficient manner to operate an economizer system, when using multiple compressors on a common economizer vessel, is to take as much of the flash gas as possible to the compressors that are fully loaded. This can be done in at least two ways.

1. Use the economizer output from the microprocessor to turn off a solenoid, or to actuate the electric shutoff option on a back-pressure regulator, based on percent of slide valve travel. This will direct all the flash vapor to the other loaded compressors.

2. A dual-setpoint back-pressure regulator valve can be used in each of the individual economizer vapor lines. When a compressor is running near full load, the BPR valve will operate on the desired setpoint, or basically wide open, to minimize pressure drop in the line. When one compressor unloads below the slide valve position where the economizer output on the microprocessor turns on, the dual-setpoint feature of the regulator can be actuated by this output to control the pressure, on the vessel side of the regulator, to be a few psi higher. Consequently, the flash gas will be sent to the loaded compressors first, until they can't handle all the vapor and the pressure in the vessel starts to rise. Then, some of the vapor will go to the unloaded compressor to help maintain the vessel at the desired pressure. An example of a back-pressure regulator with electric shutoff and the dual-setpoint feature is an R/S A4ADS.

ELECTRICAL

NOTE: Before proceeding with electrical installation, read the instructions in the section "Proper Installation of Electronic Equipment in an Industrial Environment".

RWF units are supplied with a ***QUANTUM*** control system. Care must be taken that the controls are not exposed to physical damage during handling, storage, and installation. The single-box control door must be kept tightly closed to prevent moisture and foreign matter from entry.

NOTE: All customer connections are made in the single-box control mounted on the oil separator. This is the ONLY electrical enclosure and it should be kept tightly closed whenever work is not being done in it.

MOTOR STARTER PACKAGE

WARNING **SBC Board damage may occur without timer relay installed in control panel as shown in Starter Wiring Diagram. All Frick motor starter packages have the timer relay as standard.**

Motor starter and interlock wiring requirements are shown in the **Starter Wiring Diagram**. All of the equipment shown is supplied by the installer unless a starter package is purchased separately from Frick . Starter packages should consist of:

1. The compressor motor starter of the specified HP and voltage for the starting method specified (across-the-line, autotransformer, wye-delta, or solid state).

NOTE: If starting methods other than across-the-line are desired, a motor/compressor torque analysis must be done to ensure that sufficient starting torque is available, particularly in booster applications. Contact FRICK if assistance is required.

2. If specified, the starter package can be supplied as a combination starter with circuit breaker disconnect. However, the motor overcurrent protection/disconnection device can be applied by others, usually as a part of an electrical power distribution board.

3. The oil pump starter with fuses, or in the case where the compressor motor is a different voltage from the oil pump motor, with a circuit breaker disconnect suitable for separate power feed.

4. A 2.0 KVA control power transformer (CPT) to supply 120 volt control power to the microprocessor control system and separator oil heaters is included. If environmental conditions require more than the usual two 500 watt oil heaters, an appropriately oversized control transformer will be required. If frequent power fluctuations are anticipated or extremely noisy power lines are encountered, a regulating control transformer should be considered. Contact FRICK for assistance.

5. For customer-supplied across-the-line starters, a shunting device must be installed across the Current Transformer (terminals 3 & 4).

CAUTION **If the shunting device is not installed, the Analog I/O board on the *Quantum* panel may be severly damaged at start-up (see Figure 10).**

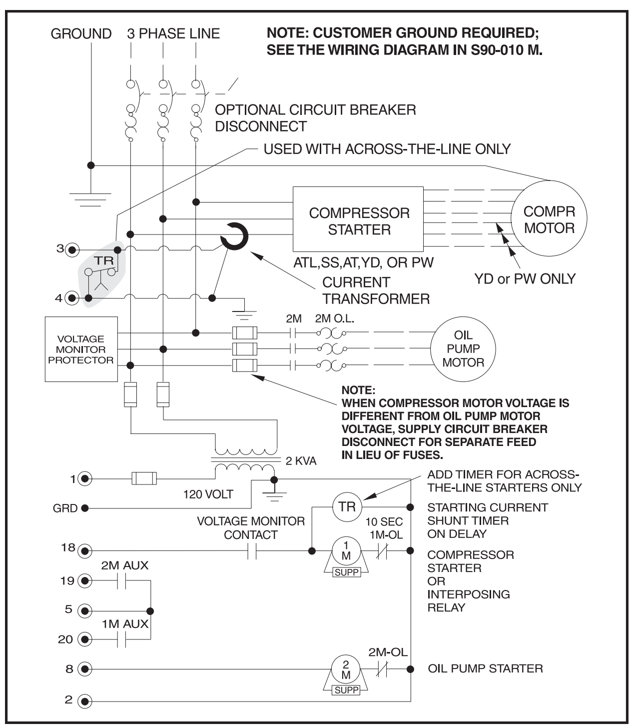


Figure 10 - STARTER WIRING DIAGRAM

6. One each normally open compressor motor and oil pump motor starter auxiliary contact should be supplied. In addition to the compressor and oil pump motor starter coils, the CT and CPT secondaries should be wired as shown on the starter package wiring diagram. The load on the control panel for the compressor motor starter coil should not exceed a Nema size 3 starter. For larger starters, an interposing relay must be used to switch the compressor motor starter coil(s).

NOTE: Do not install a compressor HAND/OFF/AUTO switch in the starter package as this would bypass the compressor safety devices.

7. The compressor motor Current Transformer (CT) is installed on any one phase of the compressor leads.

NOTE: The CT must see all the current of any one phase, therefore in wye-delta applications BOTH leads of any one phase must pass through the CT.

CURRENT TRANSFORMER (CT) RATIOS

The CT ratio for various motor sizes (with a 5 amp secondary) is given in the following table:

HP	VOLTAGE						
	200	230	380	460	575	2300	4160
20	100:5	100:5	50:5	50:5	50:5	-	-
25	100:5	100:5	50:5	50:5	50:5	-	-
30	200:5	100:5	100:5	50:5	50:5	-	-
40	200:5	200:5	100:5	100:5	50:5	-	-
50	200:5	200:5	100:5	100:5	100:5	-	-
60	300:5	200:5	200:5	100:5	100:5	-	-
75	300:5	300:5	200:5	200:5	100:5	-	-
100	400:5	300:5	200:5	200:5	200:5	-	-
125	500:5	400:5	300:5	200:5	200:5	-	-
150	600:5	500:5	300:5	300:5	200:5	-	-
200	800:5	600:5	400:5	300:5	300:5	100:5	50:5
250	800:5	800:5	500:5	400:5	300:5	100:5	50:5
300	1000:5	1000:5	600:5	500:5	400:5	100:5	50:5
350	-	1000:5	800:5	500:5	500:5	100:5	100:5
400	-	-	800:5	600:5	500:5	200:5	100:5
450	-	-	1000:5	800:5	600:5	200:5	100:5
500	-	-	1000:5	800:5	600:5	200:5	100:5
600	-	-	1200:5	1000:5	800:5	200:5	100:5
700	-	-	-	1200:5	1000:5	200:5	200:5
800	-	-	-	-	1000:5	300:5	200:5
900	-	-	-	-	1200:5	300:5	200:5
1000	-	-	-	-	-	300:5	200:5
1250	-	-	-	-	-	400:5	200:5
1500	-	-	-	-	-	500:5	300:5

MINIMUM BURDEN RATINGS

The following table gives the minimum CT burden ratings. This is a function of the distance between the motor starting package and the compressor unit.

BURDEN RATING		MAXIMUM DISTANCE FROM FRICK PANEL		
ANSI	VA	USING # 14 AWG	USING # 12 AWG	USING # 10 AWG
B-0.1	2.5	15 ft	25 ft	40 ft
B-0.2	5	35 ft	55 ft	88 ft
B-0.5	12.5	93 ft	148 ft	236 ft

CONTROL POWER REGULATOR

Compressor units that will be used in areas that suffer brownouts and other significant power fluctuations can be supplied with a control power regulator. See Figure 11, Recommended Regulator Installation.

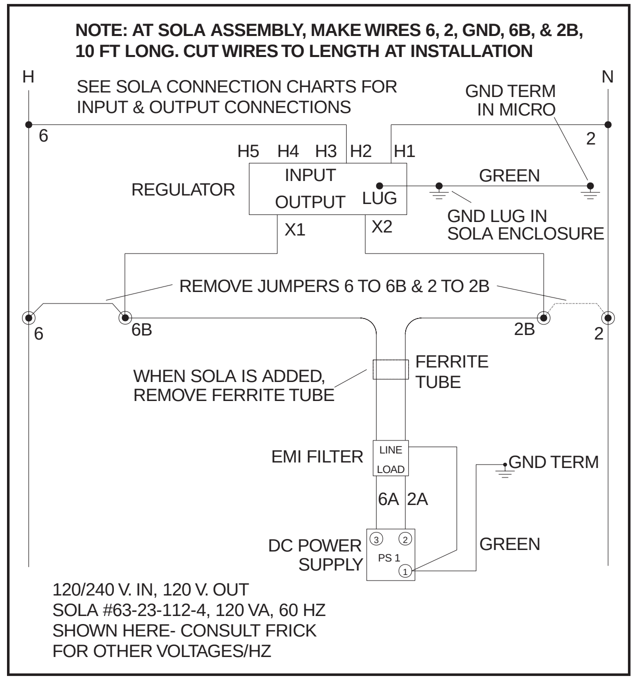


Figure 11 - Recommended Regulator Installation

BATTERY BACKUP

The battery backup is used only for date and time retention during power interruption. All setpoints and other critical information are saved on EEPROM chips.

NOTE: It is not necessary to disconnect the battery backup during extended downtime.

NOTE: The microprocessor will not operate without U24 and U35 EPROM chips installed. When U24 and U35 EPROM chips are not installed, the screen will display:

System Board Initialized

No boot device available,

Press enter to continue.

OPERATION and START-UP INSTRUCTIONS

The Frick RWF Rotary Screw Compressor Unit is an integrated system consisting of seven major subsystems:

1. Control Panel (See publications S90-010 O, M, & CS).
2. Compressor
3. Compressor Lubrication System
4. Compressor Oil Separation System
5. Compressor Hydraulic System
6. Compressor Oil Cooling System
7. Compressor Easy-Start System

The information in this section of the manual provides the logical step-by-step instructions to properly start up and operate the RWF Rotary Screw Compressor Unit.

THE FOLLOWING SUBSECTIONS MUST BE READ AND UNDERSTOOD BEFORE ATTEMPTING TO START OR OPERATE THE UNIT.

SGC COMPRESSOR

The Frick RWF rotary screw compressor utilizes mating asymmetrical profile helical rotors to provide a continuous flow of refrigerant vapor and is designed for both high-pressure and low-pressure applications. The compressor incorporates the following features:

1. High capacity roller bearings to carry radial loads at both the inlet and outlet ends of the compressor.

2. Heavy-duty, four-point angular contact ball bearings to carry axial loads are mounted at the discharge end of compressor.

3. Balance pistons located in the inlet end of the compressor to reduce axial loads on the axial load bearings and increase bearing life.

4. Moveable slide valve to provide fully modulating capacity control from 100% to approximately 10% of full load capacity.

5. VOLUMIZER® volume ratio control to allow infinitely variable volume ratio from 2.2 to 5.0 during compressor operation for all models.

6. A hydraulic unloader cylinder to operate the slide stop and slide valve.

7. Bearing and casing design for 350 PSI discharge pressure. **This PSI rating applies only to the compressor and does not reflect the design pressure of the various system components.**

8. All bearing and control oil vented to closed thread in the compressor instead of suction port to avoid performance penalties from superheating suction gas.

9. Shaft seal design to maintain operating pressure on seal well below discharge pressure, for increased seal life.

10. Oil injected into the rotors to maintain good volumetric and adiabatic efficiency even at very high compression ratios.

11. Shaft rotation clockwise facing compressor, suitable for all types of drives. **SEE FOLLOWING CAUTION.**

CAUTION **Compressor rotation is clockwise when facing the compressor drive shaft. (See Figure 12) The compressor should never be operated in reverse rotation as bearing damage will result.**

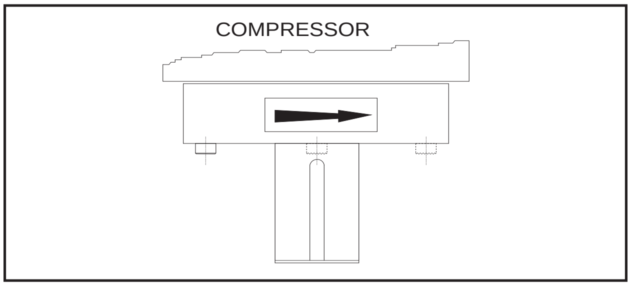


Figure 12

12. Dual compressor casing design for very low airborne noise transmission.

13. Suction flange is 300 psig ANSI type.

14. Integral suction strainer is provided.

15. "D" Flange adapter for bolting directly to motor.

COMPRESSOR LUBRICATION SYSTEM

The lubrication system on an RWF screw compressor unit performs several functions:

1. Provides lubrication to bearings and seal.

2. Provides a cushion between the rotors to minimize noise and vibrations.

3. Helps keep the compressor cool and prevents overheating.

4. Provides an oil supply to hydraulically actuate the slide valve and slide stop.

5. Provides oil pressure to the balance pistons to help increase bearing life.

6. Provides an oil seal between the rotors to prevent rotor contact or gas bypassing.

The compressor unit may be equipped with either a no pump or a demand pump lubrication system. Additionally, either system may contain dual oil filters and liquid injection, water-cooled, or thermosyphon oil cooler for compressor oil cooling.

NO PUMP OIL SYSTEM

The RWF screw compressor unit is designed to be self-lubricating. Oil being supplied to the compressor from the oil separator is at system head pressure. Within the compressor, oil porting to all parts of the compressor is vented back to a point in the compressor's body that is at a pressure lower than compressor discharge pressure. The compressor's normal operation makes the compressor unit operate essentially as its own oil pump. All oil entering the compressor is moved by the compressor rotors out the compressor outlet and back to the oil separator.

For normal high-stage operation an oil pump is not required.

COLD-START SYSTEM

The RWF package is equipped with a special "cold start" discharge check valve (see Figure 13) on the gas outlet connection of the oil separator. This valve causes the oil separator to develop oil pressure rapidly on initial start in order to lubricate the compressor without requiring an oil pump, even in cold ambient temperatures with all pressures equalized.

For high-stage packages, the cold-start valve is equipped with a large spring that creates 30 psi of pressure in the oil separator (above suction pressure), for lubrication of the compressor.

WARNING **DO NOT ATTEMPT TO SERVICE THE COLD START VALVE. PLEASE CONTACT THE FRICK SERVICE DEPARTMENT.**

Once the compressor is running it will begin to force gas to the condenser at connection P2. As the condenser heats up it will begin to rise in pressure as the compressor suction pulls down in pressure. As soon as differential pressure is developed between the condenser and suction, these pressures act across a piston inside the cold-start valve to partially overcome the spring force. When the differential pressure reaches and exceeds 30 psi, the piston fully overcomes the spring force and powers the valve fully open for very low operating pressure drop.

For booster applications, the valve is equipped with a lighter spring which produces 15 psi oil pressure above suction pressure before it fully powers open.

The RWF package is also equipped with a suction check valve bypass. The oil separator will slowly bleed down to system suction pressure when the unit is stopped. This allows the compressor drive motor to have an easier start, and the discharge check valve will seat more tightly. See the "SUCTION CHECK VALVE BYPASS" section for operation.

NOTE: For alarm descriptions and shutdown or cutout parameters, see publication S90-010 O.

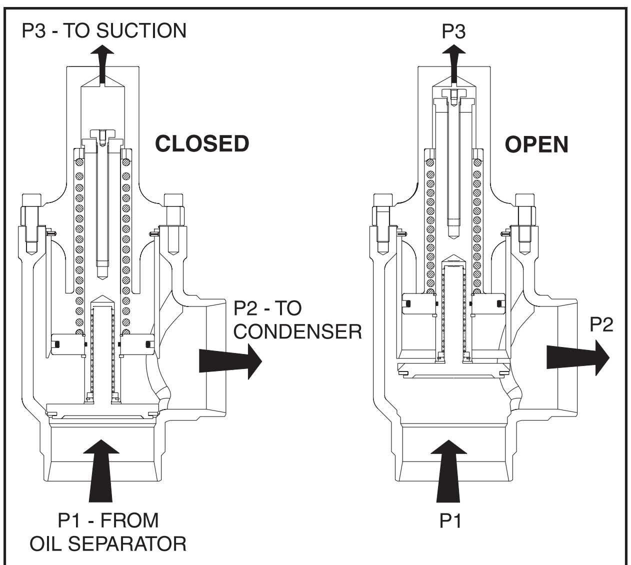


Figure 13 - Cold Start Valve

DEMAND PUMP OIL SYSTEM

This system is designed to provide adequate compressor lubrication for some high stage applications that operate with low differential pressure across the compressor suction and discharge and all booster applications.

During the period from start-up to normal operation the oil pressure alarm and oil pressure cutout setpoints will vary according to formulas built into the microprocessor control program.

NOTE: For alarm descriptions and shutdown or cutout parameters, see publication S90-010 O.

COMPRESSOR OIL SEPARATION SYSTEM

The RWF is an oil flooded screw compressor. Most of the oil discharged by the compressor separates from the gas flow in the oil charge reservoir. Some oil, however, is discharged as a mist which does not separate readily from the gas flow and is carried past the oil charge reservoir. One or more coalescer filter elements then COALESCE the oil mist into droplets which fall to the bottom of the coalescer section of the oil separator (see Figure 14). The return of this oil to the compressor is controlled by a throttling valve on both high stage and booster applications.

NOTE: Open throttling valve only enough to keep coalescer end of separator free of oil.

The sight glass located near the bottom of the coalescer section of the oil separator should remain empty during normal operation. If an oil level develops and remains in the sight glass, a problem in the oil return separation system or compressor operation has developed. Refer to MAINTENANCE for information on how to correct the problem.
NOTE: The normal charging level is midway in the top sight glass located midway along the oil separator shell.

OIL SEPARATION SYSTEMS

HORIZONTAL, MODELS 100 - 480

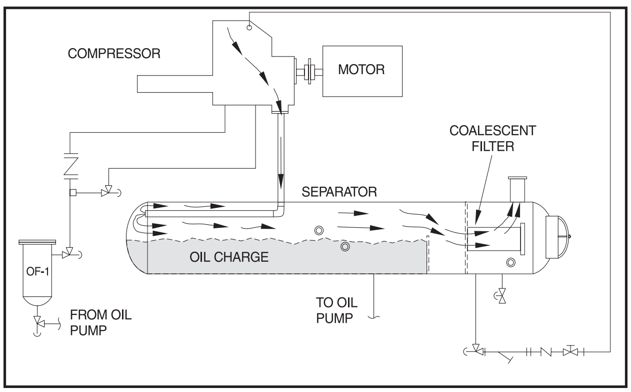


Figure 14

COMPRESSOR HYDRAULIC SYSTEM

The compressor hydraulic system moves the movable slide valve (MSV) to load and unload the compressor. It also moves the movable slide stop (MSS) to increase or decrease the compressor's volume ratio (Vi).

The hydraulic cylinder located at the inlet end of the SGC compressor serves a dual purpose. It is separated by a fixed bulkhead into two sections. The movable slide valve (MSV) section is to the left of the bulkhead and the movable slide stop (MSS) to the right. Both sections are considered double-acting hydraulic cylinders as oil pressure moves the pistons in either direction.

Both sections are controlled by double-acting, four-way solenoid valves which are actuated when a signal from the appropriate microprocessor output energizes the solenoid valve.

SINGLE-ACTING MODE - High Stage

Open valve at SC1
Close valve at SC2
Open valve at BP (bypass)

High stage compressor loading: The compressor loads when MSV solenoid YY2 is energized and oil flows from the unload side of the cylinder out port SC1, through valve ports A and T to compressor suction. Simultaneously, discharge pressure loads the slide valve.

High stage compressor unloading: The compressor unloads when MSV solenoid YY1 is energized and oil flows from the oil manifold through valve ports P and A to cylinder port SC1 and enters the unload side of the cylinder. Simultaneously, gas on the load side of the cylinder is vented through port SC2 and valve BP to compressor suction.

NOTE: To control the rate of loading and unloading, throttle the needle valve at SC1 port.

DOUBLE-ACTING MODE - Booster

Open valve at SC1
Open valve at SC2
Close valve at BP (bypass)

Booster Compressor Loading: The compressor loads when MSV solenoid YY2 is energized and oil flows from the oil manifold through valve ports P and B to cylinder port SC2 and enters the load side of the cylinder. Simultaneously, oil contained in the unload side of the cylinder flows out cylinder port SC1 through valve ports A and T to compressor suction.

Booster Compressor Unloading: The compressor unloads when MSV solenoid YY1 is energized and oil flows from the oil manifold through valve ports P and A to cylinder port SC1 and enters the unload side of the cylinder. Simultaneously, oil contained in the load side of the cylinder flows out of compressor port SC2 through valve ports B and T to compressor suction.

NOTE: To control the rate of loading and unloading, throttle valves SC1 and SC2.
NOTE: To slow all valve movements - loading, unloading, and Vi change - throttle valve 2.

CAUTION

NEVER open valve BP and valve SC2 at the same time during compressor operation.

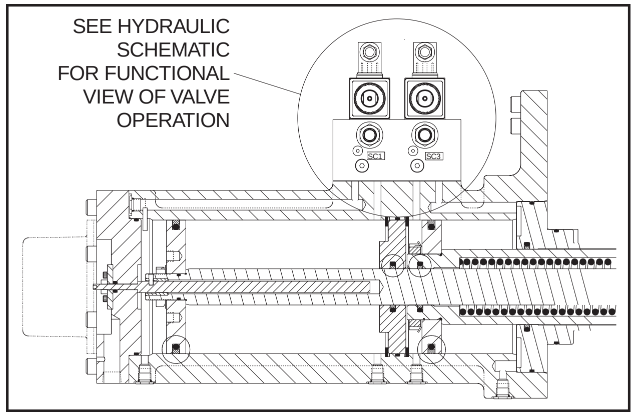


Figure 15

VOLUMIZER VOLUME RATIO CONTROL

Open valve at SC3
Open valve at SC4

Compressor Vi increase: The volume ratio Vi is increased when MSS solenoid valve YY3 is energized and oil flows from the oil manifold through valve ports P and A to compressor port SC3, enters the increase side of the cylinder and overcomes the decrease spring tension. Simultaneously, oil flows from SC4 port through valve ports B and T to compressor suction.

Compressor Vi decrease: The volume ration Vi is decreased when MSS solenoid valve YY4 is energized and oil flows from the oil manifold through valve ports P and B to compressor port SC4, enters the decrease side of the cylinder. Simultaneously, oil flows form SC3 port through valve ports A and T to compressor suction.

TO CONTROL THE RATE OF VI CHANGE, THROTTLE THE NEEDLE VALVE AT SC3 PORT.

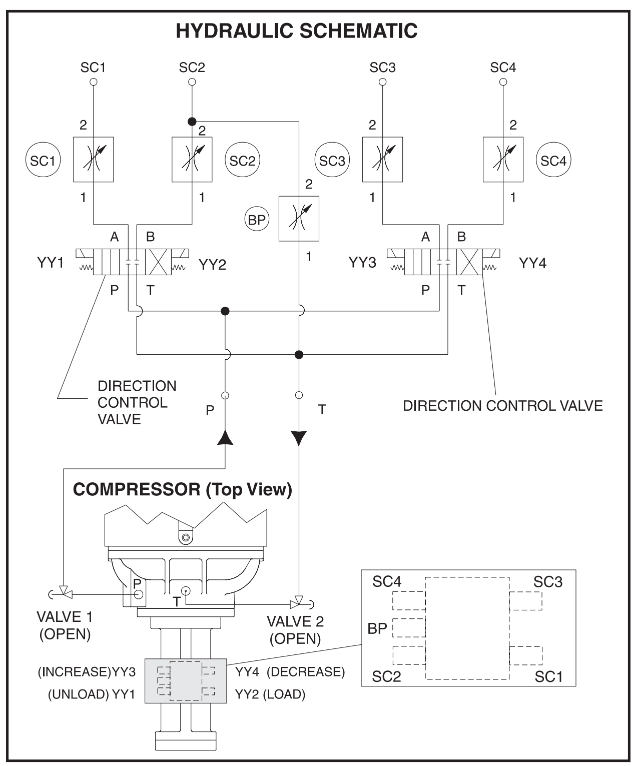


Figure 16

COMPRESSOR OIL COOLING SYSTEMS

The RWF unit can be equipped with one of several systems for controlling the compressor oil temperature. They are single or dual-port liquid injection and thermosyphon or water-cooled oil coolers. Each system is automatically controlled, independent of compressor loading or unloading.

Oil cooling systems should maintain oil temperature within the following ranges for R-717 and R-22:

Liquid Injection Oil Cooling	External* Oil Cooling
R-717 130 - 170°F R-22 130 - 150°F	120 - 140°F

* Thermosyphon oil cooling (TSOC) or Water cooled oil cooling (WCOC).

SINGLE-PORT LIQUID INJECTION

The single-port liquid injection system is designed to permit liquid refrigerant injection into one port on the compressor at any given moment and operates as outlined.

Solenoid valve YY5 is energized by the microprocessor when the temperature sensor, installed in the oil manifold, exceeds the LICO set point. High-pressure liquid refrigerant is then supplied to the temperature control valve (TCV). The temperature control valve is equalized to a constant back pressure by the differential pressure control valve (PDCV). The differential pressure control valve uses discharge gas to maintain downstream pressure. The gas downstream of the differential pressure control valve is bled off to the compressor suction to ensure steady and constant operation of the valve. **Refer to P & I DIAGRAMS section for piping and instrumentation drawings.**

BOOSTER OR SWING DUTY APPLICATION

Discharge gas from the high-stage compressor is required to assist the differential pressure control valve (PDCV) in providing the temperature control valve (TCV) with a constant back pressure.

A solenoid valve YY6 is installed before the differential pressure control valve (PDCV) to prevent migration of high pressure gas during shutdown. A Frick-installed timer limits the high pressure gas to only thirty seconds duration, since intermediate gas pressure and spring tension are sufficient to maintain closure on unit shutdown. A metering valve is also provided for use as a service valve and to allow discharge gas flow regulation to prevent excessive force and resulting closure “hammering”.

A field-installed 1/4 inch OD tubing connection is required between the high stage compressor discharge piping line (or receiver) and the check valve. **Refer to P & I DIAGRAMS section for piping and instrumentation drawings.**

NOTE: An oil pump may be required for booster or swing duty applications.

DUAL-PORT LIQUID INJECTION

The dual-port liquid injection system is designed to obtain the most efficient compressor performance at high and low compression ratios by permitting injection of liquid refrigerant into one of two ports optimally located on the compressor. This minimizes the performance penalty incurred with liquid injection oil cooling.

The dual-port system contains all the components of the single-port system with the addition of a double acting solenoid valve YY7 and operates as outlined.

Solenoid valve YY5 is energized by the microprocessor when the temperature sensor, installed in the oil manifold, exceeds the LICO set point. Liquid refrigerant is then passed through the temperature control valve (TCV) to the double-acting solenoid valve YY7. Depending on the compressor’s operating volume ratio (Vi), the microprocessor will select the flow of the liquid refrigerant to either compressor port SL-1 or SL-2, whichever is more efficient.

When the compressor operates BELOW 3.5 Vi, compressor port SL-1 supplies the liquid cooling. When the (Vi) rises ABOVE 3.5 Vi, port SL-2 supplies the liquid cooling.

The temperature control valve is equalized to a constant back pressure by the differential pressure control valve (PDCV).

Both the differential pressure control valve (PDCV) and the double-acting solenoid valve YY7 use discharge gas to maintain downstream pressure. The gas downstream of both valves is bled off to the compressor suction to ensure steady and constant operation of the valves. **Refer to P & I DIAGRAMS section for piping and instrumentation drawings.**

LIQUID INJECTION ADJUSTMENT PROCEDURE

1. Close back-pressure bleed valve (V4).

2. Set pressure regulator valve (PDCV) for approximately 40 to 60 psig.

3. Open back-pressure bleed valve (V4) approximately one quarter turn.

4. Monitor the oil temperature of the compressor. If the oil temperature rises above 170˚F, open back-pressure bleed valve (V4) a very small amount. This will reduce pressure on the equalizer and allow more refrigerant to flow to the compressor. If the oil temperature drops below 150˚F, close back-pressure bleed valve (V4) a very small amount. This will increase pressure on the equalizer and allow less refrigerant to flow to the compressor, thus raising the oil temperature. The ideal condition is to maintain an oil temperature as stable as possible. By keeping the liquid injection system correctly tuned, extreme swings in the discharge temperature and the oil temperature can be avoided. **Refer to P & I DIAGRAMS section for piping and instrumentation drawings.**

CAUTION

Back-pressure bleed valve (V4) must always be cracked open a small amount to prevent refrigerant from condensing in the tubing.

SUCTION CHECK VALVE BYPASS

The RWF unit is equipped with a low-pressure-drop suction check valve bolted directly to the compressor housing. Units that have an 8" stop valve or larger will be piped as shown in the shaded area of the illustration below. During normal operation, valve HV-1 is closed. This is a pump-out connection to allow refrigerant removal to the system suction prior to evacuation for servicing. Valve HV-2 must be open in most systems at all times. It should normally be cracked open to allow the oil separator to slowly bleed down to system suction pressure when the unit is stopped (having this valve cracked open allows the compressor drive motor to have an easier start, and the discharge check valve will seat more tightly). If the drive coupling backspins, the valve should be adjusted down until the backspin stops. If the separator oil level foams excessively on shutdown, HV-2 should be closed slightly. If the separator takes more than 20 – 30 minutes to equalize to suction pressure after shutdown, HV-2 can be opened slightly. See Figure 17.

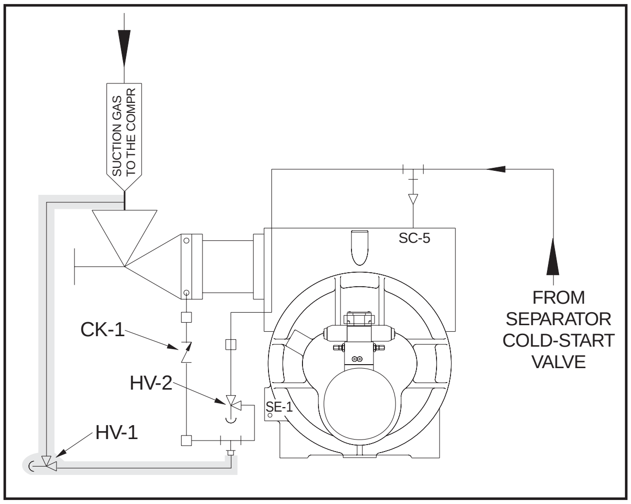


Figure 17

Check valve CK-1 is installed on all RWF packages with suction pressure below atmospheric or when installed with economizer option utilized on multiple compressor plants.

On high-stage systems, check valve CK-1 should be installed with a 40 psi spring to avoid the possibility of back-feeding to a shut-down compressor from a common economizer vessel.

On booster systems, check valve CK-1 should be installed with a 15 psi spring to avoid the possibility of air ingress into the system, if the system suction pressure is below atmospheric.

HV-2 should be closed, on systems that utilize autocycle to restart the compressor, based on increase in system suction pressure during shutdown, if slowly bleeding the oil separator gas to suction will raise the suction pressure enough to cause short cycling of the compressor.

Also, it is important to close HV-2, if the oil pump is to be run for long periods of time with the compressor stopped, to avoid oil being pumped up the suction line.

LOW AMBIENT OPERATION

It is recommended that oil separators be insulated as a minimum requirement to preserve the heat generated by the oil heaters. It is important that the coalescer end of the separator be insulated to prevent refrigerant condensation.

On systems located outdoors or in unheated buildings where the ambient temperature could drop below +40°F, insulating and/or heat tracing of the compressor lube oil systems is highly recommended.

When low ambient temperatures (below +20°F) are a possibility, it is recommended that lube oil lines, oil filters, oil pumps, and oil coolers be heat traced and insulated.

Freeze-up protection must also be provided for all water-cooled equipment

INITIAL START-UP

Initial start-up must be performed under the supervision of a FRICK authorized start-up representative to prevent voiding the compressor warranty. Prior to the start-up, the prestart check must be accomplished.

INITIAL START-UP PROCEDURE

Having performed the checkpoints on the prestart check list the compressor unit is ready for start-up. It is important that an adequate refrigerant load be available to load test the unit at normal operating conditions. The following points should be kept in mind during initial start-up.

1. It is imperative that during the initial start-up of the package that the hand expansion valve on the main oil injection line is fully open to ensure adequate oil flow. There is still an orifice installed in the compressor to control maximum oil flow. At initial start-up of the package the hand expansion valve must be fully open. After initial start-up of the package the hand expansion valve should be adjusted. There are two methods of determining the correct adjustment of this valve.

The best method to determine target discharge temperature is to run CoolWare. Run CoolWare or ScrewSelect with the operating conditions of the compressor. The program will give you a theoretical discharge temperature of the compressor. Once this temperature is known, you may adjust the hand expansion valve. The ideal discharge temperature is within 5°F + or – of the theoretical discharge temperature. Adjust the valve to achieve the theoretical discharge temperature. If you do not have access to CoolWare or ScrewSelect, 180°F is a good target discharge temperature for a high stage ammonia compressor. Booster applications and compressors using HFC and HCFC refrigerants may run cooler. Compressors with high discharge pressure may run hotter.

The first method is used for compressors with External Oil Cooling (Thermosyphon, Water Cooled, and Glycol Cooled). Before the initial startup of the compressor close the hand expansion valve completely. Open the valve back up and count the turns that it takes to fully open the valve. After the initial startup close the valve to achieve approximately 180° F discharge temperature or the theoretical temperature from CoolWare. Do not fully close the valve at any time while the compressor is running.

The second method is used for compressors with Liquid Injection Oil Cooling. Because the discharge temperature is controlled by the Liquid Injection Thermal Expansion Valve you will not be able adjust for the correct oil flow by using the discharge temperature. Before the initial startup of the compressor close the hand expansion valve completely. Open the valve back up and count the turns that it takes to fully open the valve. After the initial startup close the valve ½ way. If it took 10 turns to open the valve completely, then turn it in 5 turns. If it took 7 turns to open, then close the valve 3 ½ turns. Do not close the valve any further than ½ the number of turns required to fully open it.

Failure to properly adjust this valve can lead to excessive noise and vibration of the compressor and package, premature failure of the bearings, liquid loading of the rotors, liquid starvation of the rotors and catastrophic failure of the compressor.

2. For proper and safe operation, the compressor must be run at the proper speed and discharge pressure. Exceeding design conditions creates a potential hazard.

3. Rotate and lubricate motor bearings according to manufacturer's recommendations PRIOR to start-up as required.

4. After running the unit for approximately three hours, adjust liquid injection oil cooling if applicable. If unit has water cooled oil cooling, adjust water control valve to cooler.

5. The compressor slide valve and slide stop linear transmitters should be calibrated.

6. Pull and clean suction strainer after 24 hours of operation. If it is excessively dirty, repeat every 24 hours until system is clean. Otherwise, follow the normal **MAINTENANCE SCHEDULE**.

7. Perform vibration analysis if equipment is available.

NORMAL START-UP PROCEDURE

1. Confirm system conditions permit starting the compressor.

2. Press the **[RUN]** key.

3. Allow the compressor to start-up and stabilize. Press the **[AUTO]** key immediately below the V ratio label on the operating display screen. Press the **[AUTO]** key immediately below the SV POS label on the operating display. The compressor is now operating in the automatic mode.

4. Observe the compressor unit for mechanical tightness of the external piping, bolts and valves. Ensure that the machine is clean from oil and refrigerant leaks. If any of these occur, shut down the compressor and correct the problem as necessary using good safety precautions.

5. RETIGHTEN MANWAY BOLTS at condenser design pressure (while system is running).

RESTARTING COMPRESSOR UNIT AFTER CONTROL POWER INTERRUPTION (PLANT POWER FAILURE)

1. Check variable setpoints.

2. Follow normal start-up procedure.

GENERAL INFORMATION

This section provides instructions for normal maintenance, a recommended maintenance program, troubleshooting and correction guides, and typical P and I diagrams. For typical wiring diagrams and information about the *Quantum* control panel, consult publication S90-010 M.

WARNING **THIS SECTION MUST BE READ AND UNDERSTOOD BEFORE ATTEMPTING TO PERFORM ANY MAINTENANCE OR SERVICE TO THE UNIT.**

NORMAL MAINTENANCE OPERATIONS

When performing maintenance you must take several precautions to ensure your safety:

CAUTION

1. **IF UNIT IS RUNNING, PRESS [STOP] KEY.**
2. **DISCONNECT POWER FROM UNIT BEFORE PERFORMING ANY MAINTENANCE.**
3. **WEAR PROPER SAFETY EQUIPMENT WHEN COMPRESSOR UNIT IS OPENED TO ATMOSPHERE.**
4. **ENSURE ADEQUATE VENTILATION.**
5. **TAKE NECESSARY SAFETY PRECAUTIONS REQUIRED FOR THE REFRIGERANT BEING USED.**

WARNING **CLOSE ALL COMPRESSOR PACKAGE ISOLATION VALVES PRIOR TO SERVICING THE UNIT. FAILURE TO DO SO MAY RESULT IN SERIOUS INJURY.**

GENERAL MAINTENANCE

Proper maintenance is important in order to assure long and trouble-free service from your screw compressor unit. Some areas critical to good compressor operation are:

1. Keep refrigerant and oil clean and dry, avoid moisture contamination. After servicing any portion of the refrigeration system, evacuate to remove moisture before returning to service. Water vapor condensing in the compressor while running, or more likely while shut down, can cause rusting of critical components and reduce life.

2. Keep suction strainer clean. Check periodically, particularly on new systems where welding slag or pipe scale could find its way to the compressor suction. Excessive dirt in the suction strainer could cause it to collapse, dumping particles into the compressor.

3. Keep oil filters clean. If filters show increasing pressure drop, indicating dirt or water, stop the compressor and change filters. Running a compressor for long periods with high filter pressure drop can starve the compressor for oil and lead to premature bearing failure.

4. Avoid slugging compressor with liquid refrigerant. While screw compressors are probably the most tolerant to ingestion of some refrigerant liquid of any compressor type available today, they are not liquid pumps. Make certain to maintain adequate superheat and properly size suction accumulators to avoid dumping liquid refrigerant into compressor suction.

Keep liquid injection valves properly adjusted and in good condition to avoid flooding compressor with liquid. Liquid can cause a reduction in compressor life and in extreme cases can cause complete failure.

5. Protect the compressor during long periods of shut down. If the compressor will be sitting for long periods without running it is advisable to evacuate to low pressure and charge with dry nitrogen or oil. This is particularly true on systems known to contain water vapor.

6. Preventive maintenance inspection is recommended any time a compressor exhibits a noticeable change in vibration level, noise or performance.

COMPRESSOR SHUTDOWN and START-UP

For seasonal or prolonged shutdowns the following procedure should be followed:

1. Reduce the system pressure to the desired condition.

2. Press **[STOP]** key to cease operation of the compressor.

3. Open disconnect switches for compressor motor and oil pump starters.

4. Turn on oil heater circuit breaker.

5. Close suction and discharge service valves, also liquid injection and economizer service valves, if applicable. **Attach CLOSED TAGS.**

6. Shut off cooling water supply valve to oil cooler, if applicable. **Attach CLOSED TAG.**

7. Protect oil cooler from ambient temperatures below freezing or remove water heads.

To start-up after a seasonal or prolonged shutdown the following procedure should be followed:

1. Any water necessary for the operation of the system that may have been drained or shut off should be restored and turned on.

2. Open suction and discharge service valves, also liquid injection and economizer service valves, if applicable. Remove tags.

3. Close disconnect switches for compressor, motor and oil pump starters.

4. Turn off oil heater circuit breaker.

5. Perform checkpoints on prestart check list, then start unit.

GENERAL INSTRUCTIONS FOR REPLACING COMPRESSOR UNIT COMPONENTS

When replacing or repairing components which are exposed to refrigerant pressure proceed as follows:

1. Push **[STOP]** key on control panel to shut down unit.

2. Open disconnect switches for compressor and pump motor starters.

3. Close suction and discharge service valves, also liquid injection and economizer service valves, if applicable.

4. SLOWLY vent separator to low-side system pressure using the bypass line on the suction trap. **NOTE: Recover or transfer all refrigerant vapor, in accordance with local ordinances, before opening to atmosphere.** The separator **MUST** be equalized to atmospheric pressure.

CAUTION **Oil entrained refrigerant may vaporize, causing a separator pressure increase. Repeat venting and recovery procedure, if necessary.**

5. Make replacement or repair.

6. Isolate the low pressure transducer, PE-4, to prevent damage during pressurization and leak test.

7. Pressurize unit and leak test.

8. Evacuate unit.

9. Open suction and discharge service valves, low pressure transducer, and also liquid injection and economizer service valves, if applicable.

10. Close disconnect switches for compressor and oil pump motor starters.

11. Unit is ready to put into operation.

12. Perform checkpoints on prestart checklist, then start unit.

OIL FILTER (OF-1) MAIN SINGLE/DUAL

RWF compressor 100 through 480 units are furnished with one main oil filter (OF-1). A second oil filter (OF-2) is installed as optional equipment to facilitate the changing of the filter element(s) without unit shutdown.

CAUTION **Use of filter elements other than Frick must be approved in writing by Frick engineering or warranty claim may be denied.**

The procedure to change filter cartridge(s) is as follows:

1. If a single oil filter is installed, push **[STOP]** key on microprocessor panel to shutdown unit, then open disconnect switches for compressor and oil pump motor starters.

If dual oil filters are installed, open the outlet, then inlet service valves of the standby filter.

CAUTION **Open inlet service valve slowly to prevent a sudden pressure drop which could cause an oil filter differential alarm.**

2. Close outlet then inlet service valves of filter being serviced.

3. Open bleed valve and purge pressure from the oil filter cartridge. **NOTE: Recover or transfer all refrigerant vapor, in accordance with local ordinances, before opening to atmosphere.**

4. Remove the plug from the bottom of the filter canister and drain the oil. Remove the canister cover and discard the gasket. Remove the screws securing the filter assembly. Pull the filter assembly from the canister and discard the gasket and the element.

5. Flush the canister with clean compressor oil; wipe dry with a clean, lint-free cloth; and replace the plug.

6. Install a new element and tighten the nut on the end plate to 10 ft-lb torque. Then, while holding the nut with a wrench, apply a second nut to act as a locknut. Replace the gasket and reinstall the filter assembly into canister, securing with screws tightened to 7 ft-lb torque. Fill the canister with new Frick refrigeration oil.

WARNING **DO NOT MIX OILS of different brands, manufacturers, or types. Mixing of oils may cause excessive oil foaming, nuisance oil level cutouts, oil pressure loss, gas or oil leakage and catastrophic compressor failure.**

CAUTION **Use of oils other than Frick Oil in Frick compressors must be approved in writing by Frick engineering or warranty claim may be denied.**

Replace the gasket and reinstall the canister cover. Torque cover bolts first to finger tight, then 65 ft-lb, then 130 ft-lb.

7. Close purge valve.

8. Open outlet service valve and leak test.

9. Filter is ready to place in service.

STRAINER - DEMAND OIL PUMP

To clean the demand oil pump strainer, the unit must be shut down. The procedure is as follows:

1. Push **[STOP]** key on microprocessor panel to shutdown unit, then open disconnect switches for compressor and oil pump motor starters.

2. Close strainer inlet service valve.

3. Open drain valve located in the strainer cover and drain oil into a container.

4. Remove capscrews securing strainer cover, strainer cover, gasket and element. Retain gasket.

5. Wash element in solvent and blow clean with air.

6. Wipe strainer body cavity clean with a lint free clean cloth.

7. Replace cleaned element, gasket and reattach cover using retained capscrews.

8. Close drain valve and open strainer inlet service valve.

9. Check for leakage.

10. Close disconnect switches for compressor and oil pump motor starters.

11. Start unit.

STRAINER - LIQUID INJECTION

To clean the liquid injection strainer the unit must be shut down. The procedure is as follows:

1. Push **[STOP]** key on microprocessor panel to shut down unit, then open disconnect switches for compressor and oil pump motor starters.

2. Close liquid supply service valve located before liquid solenoid.

WARNING **Excessive pressure from expanding refrigerant trapped between stop valve and solenoid may cause gasket and o-ring failure and uncontrolled refrigerant release.**

3. Close service valve located between the compressor and the liquid injection thermovalve.

4. Carefully loosen capscrews securing the strainer cover to the strainer. Allow pressure to relieve slowly.

5. When all entrapped refrigerant has been relieved, carefully remove loosened capscrews (as liquid refrigerant is sometimes caught in the strainer), strainer cover and strainer basket.

6. Wash the strainer basket and cover in solvent and blow clean with air.

7. Reassemble strainer.

8. Open service valve between compressor and liquid injection thermovalve and check for leakage.

9. Screw out manual solenoid valve stem.

10. Carefully open liquid supply service valve.

11. Leak test.

12. Close disconnect switches for compressor and oil pump motor starters.

13. Start unit.

COALESCER FILTER ELEMENT(S)

When changing the coalescer filter element(s) it is recommended that the oil be changed, cartridge(s) in oil filters OF-1 and OF-2 if applicable be changed and the following applicable strainer elements be removed and cleaned.

CAUTION **Use of filter elements other than Frick must be approved in writing by Frick engineering or warranty claim may be denied.**

1. Refer to **CHANGING OIL,** Steps 1 through 8.

2. Loosen manway cover retainer bolts, remove retainers, manway cover and cover gasket. Discard cover gasket.

3. Remove and retain nut securing coalescer filter retainer.

4. Remove retainer, coalescer filter element and 2 O-rings. Discard filter elements.

5. Install new coalescer filter element(s).

CAUTION **Seat element in center of locating tabs on separator bulkhead.**

6. Replace coalescer filter retainer and nut. Torque nut to 21 ft-lb. **DO NOT OVERTIGHTEN NUT.**

7. Install a new manway gasket and replace manway cover.

8. Tighten manway bolts. **NOTE: RETIGHTEN AFTER THE COMPRESSOR UNIT IS REPRESSURIZED, SINCE MANWAY BOLTS WILL LOOSEN.**

9. Refer to **CHANGING OIL,** Steps 9 through 14.

CHANGING OIL

WARNING **DO NOT MIX OILS of different brands, manufacturers, or types. Mixing of oils may cause excessive oil foaming, nuisance oil level cutouts, oil pressure loss, gas or oil leakage and catastrophic compressor failure.**

CAUTION **Use of oils other than Frick Oil in Frick compressors must be approved in writing by Frick engineering or warranty claim may be denied.**

Shut down the unit when changing oil. At the same time all oil filter cartridges must be changed and all oil strainer elements removed and cleaned. The procedure is as follows:

1. Press the **[STOP]** key on the microprocessor panel to stop the compressor unit.

2. Open the disconnect switch for the compressor motor starter.

3. Close the suction and discharge service valves; also close the liquid-injection and economizer service valves, if applicable.

4. SLOWLY vent separator to low-side system pressure using the bypass line on the suction trap. **NOTE: Recover or transfer all refrigerant vapor, in accordance with local ordinances, before opening to atmosphere. The separator MUST be equalized to atmospheric pressure.**

CAUTION **Oil entrained refrigerant may vaporize, causing a separator pressure increase. Repeat venting and recovery procedure, if necessary.**

5. Open the drain valve(s) located on the underside of the separator and drain the oil.

6. Drain the oil filter(s) OF-1 and, if applicable, the oil coolers and filter OF-2.

7. Remove the old filter cartridges, then install new ones (as previously described in the section **OIL FILTER (OF-1) MAIN SINGLE/DUAL**).

8. Remove, clean, and reinstall strainer elements in the strainers.

9. Evacuate the unit to 29.88" Hg (1000 microns) vacuum.

10. Open the suction service valve and pressurize the unit to system suction pressure. Close the suction valve and leak test.

11. Add oil by attaching a suitable pressure-type hose to the oil-charging valve located on top of the separator. Using a pressure-type oil pump and recommended Frick oil, open the charging valve and fill the separator until the oil level is midway in the top sight glass. **NOTE: Fill slowly because**

oil will fill up in the separator faster than it shows in the sight glass. Refer to the table in the **OIL CHARGE** section for approximate oil charge quantities.

12. Open the suction and discharge service valves, and also the liquid injection and economizer service valves, if applicable.

13. Close the disconnect switch for the compressor motor starter.

14. Start the unit.

DEMAND PUMP DISASSEMBLY

DANGER

BEFORE OPENING ANY VIKING PUMP LIQUID CHAMBER (PUMPING CHAMBER, RESERVOIR, JACKET, ETC.) ENSURE:

1. THAT ANY PRESSURE IN THE CHAMBER HAS BEEN COMPLETELY VENTED THROUGH SUCTION OR DISCHARGE LINES OR OTHER APPROPRIATE OPENINGS OR CONNECTIONS.

2. THAT THE DRIVING MEANS (MOTOR, TURBINE, ENGINE, ETC.) HAS BEEN "LOCKED OUT" OR MADE NON-OPERATIONAL SO THAT IT CANNOT BE STARTED WHILE WORK IS BEING DONE ON THE PUMP.

FAILURE TO FOLLOW ABOVE LISTED PRECAUTIONARY MEASURES MAY RESULT IN SERIOUS INJURY OR DEATH.

1. Mark head and casing before disassembly to ensure proper reassembly. The idler pin, which is offset in the pump head, must be positioned up and equal distance between port connections to allow for proper flow of liquid through the pump.

2. Remove the head capscrews.

3. Tilt top of head back when removing to prevent idler from falling off idler pin.

4. Remove idler and bushing assembly. If idler bushing needs replacing, see **INSTALLATION OF CARBON GRAPHITE BUSHINGS**.

5. Insert a brass bar or piece of hardwood in the port opening and between rotor teeth to keep shaft from turning. Turn the locknut counterclockwise and remove locknut. See Figure 18 or 19.

6. Loosen two setscrews in face of bearing housing and turn thrust bearing assembly counterclockwise and remove from casing. See Figure 18 or 19.

7. GG, HJ, HL: Remove snap ring from shaft. See Figure 1. **AS, AK, AL:** Remove bearing spacer from shaft. See Figure 2.

8. Remove brass bar or piece of hardwood from port opening.

9. The rotor and shaft can now be removed by tapping on end of shaft with a lead hammer or, if using a regular hammer, use a piece of hardwood between shaft and hammer.

The rotary member of the seal will come out with rotor and shaft.

10. AS, AK, AL: Remove bearing retainer washer. The washer may have stayed with rotor and shaft when removed or is against ball bearing. See Figure 19.

11. Remove the mechanical seal rotary member and spring from rotor and shaft assembly.

12. GG, HJ, HL: Remove inner snap ring and single-row ball bearing from casing.

AS, AK, AL: Remove single-row ball bearing from casing.

13. Remove seal seat or stationary part of seal from casing.

14. Disassemble thrust-bearing assembly.

GG, HJ, HL: Remove outer snap ring from bearing housing and remove ball bearing. See Figure 18.

AS, AK, AL: Loosen two set screws in flange outside diameter. Rotate end cap and lip seal counterclockwise and remove. Remove ball bearing. See Figure 19.

The casing should be examined for wear, particularly in the area between ports. All parts should be checked for wear before pump is put together.

When making major repairs, such as replacing a rotor and shaft, it is advisable to also install a new mechanical seal, head and idler pin, idler, and bushing. See **INSTALLATION OF CARBON GRAPHITE BUSHINGS**.

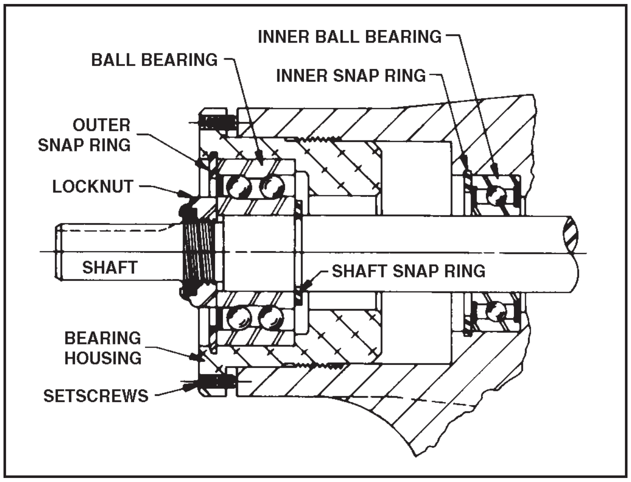


Figure 18. Thrust-Bearing assembly (GG, HJ, HL)

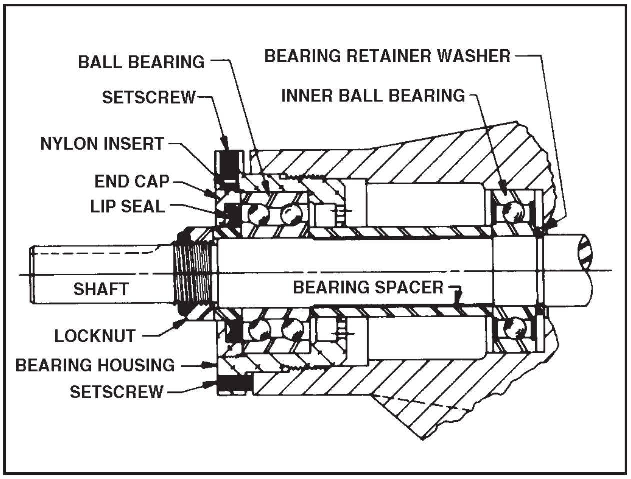


Figure 19. Thrust-Bearing assembly (AS, AK, AL)

Clean all parts thoroughly and examine for wear or damage. Check lip seals, ball bearings, bushing, and idler pin and replace if necessary. Check all other parts for nicks, burrs, excessive wear and replace if necessary.

Wash bearings in clean solvent. Blow out bearings with compressed air. Do not allow bearings to spin; turn them slowly by hand. Spinning bearings will damage race and balls. Make sure bearings are clean, then lubricate with refrigeration oil and check for roughness. Roughness can be determined by turning outer race by hand. Replace bearings if bearings have roughness.

Be sure shaft is free from nicks, burrs and foreign particles that might damage mechanical seal. Scratches on shaft in seal area will provide leakage paths under mechanical seal. Use fine emery cloth to remove scratches or sharp edges.

DEMAND PUMP ASSEMBLY

Assembly Notes On Standard Mechanical Seal (Synthetic Rubber Bellows Type)

NOTE: Read carefully before reassembling pump

The seal used in this pump is simple to install and good performance will result if care is taken during installation.

The principle of mechanical seal is contact between the rotary and stationary members. These parts are lapped to a high finish and their sealing effectiveness depends on complete contact.

Prior to installing rotary portion of mechanical seal, prepare and organize rotor shaft, head and idler assemblies and appropriate gaskets for quick assembly

Once rotary portion of mechanical seal is installed on rotor shaft, it is necessary to assemble parts as quickly as possible to ensure that the seal does not stick to shaft in wrong axial position. The seal will stick to the shaft after several minutes setting time.

Never touch sealing faces with anything except clean hands or clean cloth. Minute particles can scratch the seal faces and cause leakage.

1. Coat idler pin with refrigeration oil and place idler and bushing on idler pin in head. If replacing a carbon-graphite bushing, refer to "Installation of Carbon Graphite Bushings".

2. Clean rotor hub and casing seal housing bore. Make sure both are free from dirt and grit. Coat outer diameter of seal seat and inner diameter of seal housing bore with refrigeration oil.

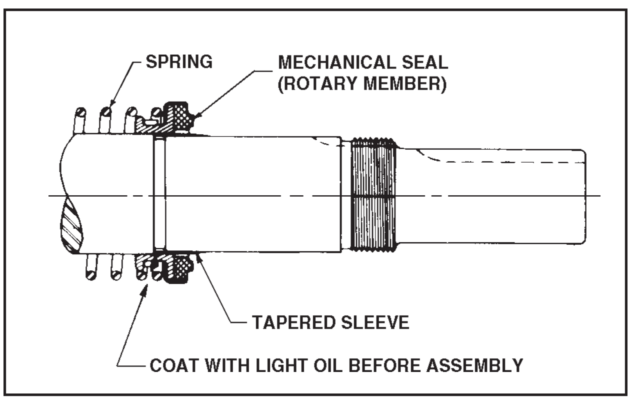


Figure 20

3. Start seal seat in seal housing bore. If force is necessary, protect seal face with a clean cardboard disc and gently tap it in place with a piece of wood. Be sure seal seat is completely seated in the bore.

4. Place tapered installation sleeve on shaft. Refer to Figure 20. Sleeve is furnished with GG, AS, AK, and AL replacement mechanical seals. Coat rotor shaft, tapered installation sleeve, and inner diameter of mechanical seal rotary member with a generous amount of refrigeration oil. Petrolatum may be used but grease is not recommended.

5. Place seal spring on shaft against rotor hub. Refer to Figure 21.

6. Slide rotary member, with lapped contact surface facing away from spring, over installation sleeve on shaft until just contacting the spring. Do not compress spring. Remove installation sleeve.

7. Coat rotor shaft with refrigeration oil. Install shaft slowly pushing until the ends of rotor teeth are just below the face of the casing.

8. Leave the rotor in this position. Withdrawal of rotor and shaft may displace the carbon seal rotating face and result in damage to the seal.

9. Place O-ring gasket on head and install head and idler assembly on pump. Pump head and casing were marked before disassembly to ensure proper reassembly. If not, be sure idler pin, which is offset in pump head, is positioned up and equal distance between port connections to allow for proper flow of liquid through pump.

10. Tighten head capscrews evenly

11. Pack inner ball bearing with multipurpose grease, NLGI #2.

GG, HJ, HL: Install bearing in casing with sealed side towards head end of pump. Drive the bearing into the bore. Tap the inner race with a brass bar and lead hammer to position bearing. Install inner snap ring.

AS, AK, AL: Install bearing retainer washer over the shaft before installing ball bearing. Install ball bearing in casing with sealed side towards head end of pump. Drive the bearing into the bore. Tap the inner race with a brass bar and lead hammer to position bearing.

12. GG, HJ, HL: Install shaft snap ring in groove in the shaft. See Figure 1.

AS, AK, AL: Install bearing spacer over shaft and against single row ball bearing. See Figure 19.

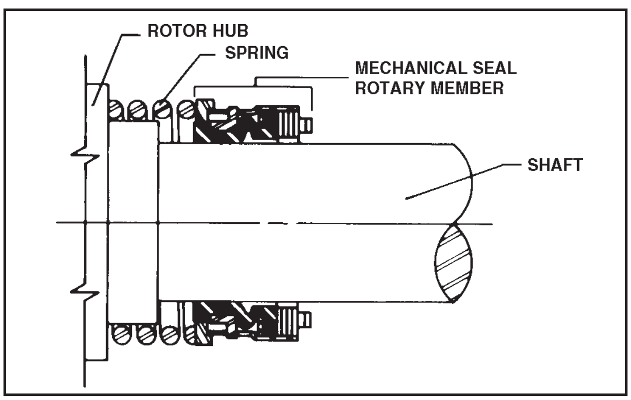


Figure 21

13. Pack lubrication chamber between inner ball bearing and double-row ball bearing in the thrust-bearing assembly approximately one-half full of multipurpose grease, NLGI #2. The thrust-bearing assembly will take the remaining space. See Figure 1 and 2.

14. Pack double-row ball bearing with multipurpose grease, NLGI #2.

GG, HJ, HL: Install ball bearing into bearing housing with shield side toward coupling end of shaft. See Figure 1. Install snap ring into bearing housing to retain ball bearing. This snap ring has a tapered edge to fit tapered groove in bearing housing. The tapered edge is located away from ball bearing.

AS, AK, AL: Install ball bearing into bearing housing. Install lip seal in bearing housing end cap. The lip should face towards end of shaft. Put bearing spacer collar in lip seal and install in bearing housing and tighten setscrews securely. See Figure 2.

15. Insert brass bar or hardwood through port opening between rotor teeth to keep shaft from turning.

16. Start thrust-bearing assembly into casing. Turn by hand until tight. This forces rotor against head. Replace and tighten locknut or shaft.

17. Remove brass bar or hardwood from port opening.

18. Adjust pump end clearance.

⚠ DANGER **BEFORE STARTING PUMP, ENSURE THAT ALL DRIVE EQUIPMENT GUARDS ARE IN PLACE. FAILURE TO PROPERLY MOUNT GUARDS MAY RESULT IN SERIOUS INJURY OR DEATH.**

THRUST BEARING ADJUSTMENT

See Figures 1 and 2.

Loosen two screws in face of thrust-bearing assembly.

If shaft cannot be rotated freely, turn thrust-bearing assembly counterclockwise until shaft can be turned easily.

1. While turning rotor shaft, rotate thrust-bearing assembly clockwise until noticeable drag occurs. This is zero end clearance.

2. Mark position of bearing housing with respect to the casing.

3. Rotate thrust-bearing assembly counterclockwise the distance listed below as measured on outside of bearing housing.

4. Tighten two setscrews in face of bearing housing after adjustment is made to secure thrust-bearing assembly position.

For viscosities above 2500 SSU, add additional end clearance (0.004" for GG, HJ and HL size pumps and 0.005" for AS, AK and AL size pumps).

Pump Size	Distance (in.) on O.D. of Bearing Housing	End Clearance (in.)
GG	7/16	.003
HJ, HL	9/16	.003
AS, AK, AL	1/2	.003

INSTALLATION OF CARBON GRAPHITE BUSHINGS

When installing carbon graphite bushings, extreme care must be taken to prevent breaking. Carbon graphite is a brittle material and easily cracked. If cracked, the bushing will quickly disintegrate. Using a lubricant and adding a chamfer on the bushing and the mating part will help in installation. The additional precautions listed below must be followed for proper installation:

1. A press must be used for installation.

2. Be certain bushing is started straight.

3. Do not stop pressing operation until bushing is in proper position. Starting and stopping will result in a cracked bushing.

4. Check bushing for cracks after installation.

TROUBLESHOOTING THE DEMAND PUMP

⚠ DANGER **BEFORE OPENING ANY PUMP LIQUID CHAMBER (PUMPING CHAMBER, RESERVOIR, JACKET ETC.) ENSURE:**

1. THAT ANY PRESSURE IN CHAMBER HAS BEEN COMPLETELY VENTED THROUGH SUCTION OR DISCHARGE LINES OR OTHER APPROPRIATE OPENINGS OR CONNECTIONS.

2. THAT THE DRIVING MEANS (MOTOR, TURBINE, ENGINE, ETC.) HAS BEEN "LOCKED OUT" OR MADE NON-OPERATIONAL SO THAT IT CANNOT BE STARTED WHILE WORK IS BEING DONE ON PUMP.

FAILURE TO FOLLOW ABOVE LISTED PRECAUTIONARY MEASURES MAY RESULT IN SERIOUS INJURY OR DEATH.

Mark valve and head before disassembly to ensure proper reassembly.

If trouble does develop, one of the first steps toward finding the difficulty is to *install a vacuum gauge in the suction port and a pressure gauge in the discharge port*. Readings on these gauges often will give a clue as to where to start looking for the trouble.

Vacuum Gauge—Suction Port

1. High reading would indicate:
- a. Suction line blocked - foot valve stuck, gate valve closed, strainer plugged.
- b. Liquid too viscous to flow through the piping.
- c. Lift too high.
- d. Line too small.

2. Low reading would indicate -
- a. Air leak in suction line.
- b. End of pipe not in liquid.
- c. Pump is worn.
- d. Pump is dry - should be primed.

3. Fluttering, jumping, or erratic reading:
- a. Liquid vaporizing.
- b. Liquid coming to pump in slugs - possibly an air leak or insufficient liquid above the end of the suction pipe.
- c. Vibrating from cavitation, misalignment, or damaged parts.

Pressure Gauge - Discharge Port

1. High reading would indicate:
- a. High viscosity and small and/or long discharge line.
- b. Gate valve partially closed.
- c. Filter plugged.
- d. Vertical head did not consider a high specific gravity liquid.
- e. Line partially plugged from buildup on inside of pipe.
- f. Liquid in pipe not up to temperature.
- g. Liquid in pipe has undergone a chemical reaction and has solidified.
- h. Relief valve set too high.

2. Low reading would indicate:
- a. Relief valve set too low
- b. Relief valve poppet not seating properly.
- c. Too much extra clearance.
- d. Pump worn.

3. Fluttering, jumping, or erratic reading:
- a. Cavitation.
- b. Liquid coming to pump in slugs.
- c. Air leak in suction line.
- d. Vibrating from misalignment or mechanical problems.

Some of the following may also help pinpoint the problem:

1. Pump does not pump.
- a. Lost its prime - air leak, low level in tank.
- b. Rotating in wrong direction.
- c. Motor does not come up to speed.
- d. Suction and discharge valves not open.
- e. Strainer clogged.
- f. Relief valve set too low, relief valve poppet stuck open.
- g. Pump worn out.
- h. Any changes in the liquid system, or operation that would help explain the trouble, e.g. new source of supply, added more lines, inexperienced operators, etc.
- i. Tighten end clearance.
- j. Head position incorrect.

2. Pump starts, then loses its prime.
- a. Low level in tank.
- b. Liquid vaporizing in the suction line.
- c. Air leaks or air pockets in the suction line; leaking air through packing or mechanical seal.
- d. Worn out.

3. Pump is noisy
- a. Pump is being starved (heavy liquid cannot get to pump fast enough). Increase suction pipe size or reduce length.
- b. Pump is cavitating (liquid vaporizing in the suction line). Increase suction pipe size or reduce length; if pump is above the liquid, raise the liquid level closer to the pump; if the liquid is above the pump, increase the head of liquid.
- c. Check alignment.
- d. May have a bent shaft or rotor tooth. Straighten or replace.
- e. May be a foreign object trying to get into the pump through the suction port.

4. Pump not up to capacity
- a. Starving or cavitating - increase suction pipe size or reduce length.
- b. Strainer partially clogged - clean.
- c. Air leak in suction piping or along pump shaft.
- d. Running too slowly - is motor the correct speed and is it wired up correctly
- e. Relief valve set too low or stuck open.
- f. Pump worn out.
- g. Tighten end clearance.
- h. Head position incorrect.

5. Pump takes too much power.
- a. Running too fast - is correct motor speed, reducer ratio, sheave size, etc. being used.
- b. Liquid more viscous than unit sized to handle - heat the liquid, increase the pipe size, slow the pump down, or get a bigger motor.
- c. Discharge pressure higher than calculated - check with pressure gauge. Increase size or reduce length of pipe, reduce speed (capacity), or get bigger motor.
- d. Pump misaligned.
- e. Extra clearance on pumping elements may not be sufficient for operating conditions. Check parts for evidence of drag or contact in pump and increase clearance where necessary

6. Rapid Wear.

Examination of a pump that has gradually lost its ability to deliver capacity or pressure would show a smooth wear pattern on all parts. Rapid wear shows up as heavy grooving, galling, twisting, breaking, or similar severe signs of trouble.

PREVENTATIVE MAINTENANCE

Performing a few preventative maintenance procedures will extend the life of your pump and reduce the cost per gallon pumped.

1. Lubrication - Grease all zerks after every 500 hours of operation or after 60 days, whichever occurs first. If service is severe, grease more often. Do it gently with a hand gun. Use #2 ball bearing grease for normal applications. For hot or cold applications, use appropriate grease.

2. Packing Adjustment - Occasional packing adjustment may be required to keep leakage to a slight weep; if impossible to reduce leakage by gentle tightening, replace packing or use different type. See Technical Service Manual on particular model series for details on repacking.

3. End Clearance Adjustment - After long service the running clearance between the end of the rotor teeth and the head may have increased through wear to the point where the pump is losing capacity or pressure. Resetting end clearance will normally improve pump performance. See Technical Service Manual on particular model series for procedure on adjusting end clearance for the pump involved.

RECOMMENDED MAINTENANCE PROGRAM

In order to obtain maximum compressor unit performance and ensure reliable operation, a regular maintenance program should be followed.

The compressor unit should be checked daily for leaks, abnormal vibration, noise, and proper operation. A log should also be maintained. There should be continued monitoring of oil quality and oil analysis testing. In addition, an analysis of the unit's vibration should be periodically made.

VIBRATION ANALYSIS

Periodic vibration analysis can be useful in detecting bearing wear and other mechanical failures. If vibration analysis is used as a part of your preventive maintenance program, take the following guidelines into consideration.

1. Always take vibration readings from exactly the same places and at exactly the same percentage of load.

2. Use vibration readings taken from the new unit at start-up as the base line reference.

3. Evaluate vibration readings carefully as the instrument range and function used can vary. Findings can be easily misinterpreted.

4. Vibration readings can be influenced by other equipment operating in the vicinity or connected to the same piping as the unit.

MOTOR BEARINGS

Follow the motor manufacturer's maintenance recommendations for lubrication. See illustration of schedule for standard motor, Figure 22.

CAUTION **Make sure the motor bearings are properly lubricated before start-up as required by the motor manufacturer.**

OIL QUALITY and ANALYSIS

High quality refrigeration oil is necessary to ensure compressor longevity and reliability. Oil quality will rapidly deteriorate in refrigeration systems containing moisture and air or other contaminants. In order to ensure the quality of the refrigeration oil in the compressor unit:

1. Only use Frick refrigeration oil or high quality refrigeration oils approved by Frick for your application.

2. Only use Frick filter elements. Substitutions must be approved in writing by Frick engineering or warranty claim may be denied.

3. Participate in a regular, periodic oil analysis program to maintain oil and system integrity.

LUBRICATION SCHEDULE / INSTRUCTIONS

SYNC. RPM	FRAME SERIES	SERVICE CYCLE* - BALL BEARING**	
		8 HR/DAY OPERATION	24 HR/DAY OPERATION
3600	360-5800	150 DAYS (1200 HRS)	50 DAYS (1200 HRS)
1800	360	390 DAYS (3120 HRS)	130 DAYS (3120 HRS)
	400-440	270 DAYS (2160 HRS)	90 DAYS (2160 HRS)
	5000-5800	210 DAYS (1680 HRS)	70 DAYS (1680 HRS)
1200	360-440	390 DAYS (3120 HRS)	130 DAYS (3120 HRS)
	5000-5800	270 DAYS (2160 HRS)	90 DAYS (2160 HRS)

* LUBRICATION SCHEDULE FOR SEVERE SERVICE (VIBRATION, SHOCK AND/OR ENVIRONMENTAL EXTREME) = 1/3 OF THE ABOVE INTERVALS.

** LUBRICATION SCHEDULE FOR ROLLER BEARINGS = 1/3 OF THE ABOVE INTERVALS.

- LUBRICATE BEARINGS WITH POWER IN THE OFF CONDITION.
- CLEAR AND CLEAN THE GREASE FITTINGS AND SURROUNDING AREA.
- REMOVE THE PIPE PLUG FROM THE VENTING PORT OPPOSITE THE GREASE FITTING.
- USING A LOW PRESSURE GREASE GUN APPLY 2 OZS. (60 GRAMS) OF GREASE AT EACH FITTING. DO NOT OVER GREASE.
- WITH THE VENT PORTS OPEN, OPERATE THE MOTOR FOR A MINIMUM OF 15 MINUTES AND UNTIL ANY GREASE FLOW HAS CEASED AT THE VENTING PORTS.
- REMOVE POWER.
- REPLACE THE VENT PIPE PLUGS.
- REPLACE ANY AND ALL GUARDS AND COVERS THAT MAY HAVE BEEN REMOVED TO ACCESS THE MOTOR.

THE FACTORY INSTALLED, RECOMMENDED LUBRICANT IS LISTED ON THE MOTOR DATA PLATE. THE FOLLOWING PRODUCTS ARE DEEMED SUITABLE LUBRICANTS UNDER NORMAL SERVICE CONDITIONS BUT MAY NOT BE CHEMICALLY COMPATIBLE OR INTERCHANGEABLE ONE TO THE OTHER OR CORRECT FOR ALL AMBIENT OR SERVICE CONDITIONS. FOLLOW ALL MANUFACTURER'S GUIDELINES WHEN INTRODUCING ALTERNATES - WHEN DOUBT EXISTS, PURGE THE BEARINGS AS DESCRIBED IN THE INSTRUCTION MANUAL.

CHEVRON OIL CO. - SRI#2
EXXON CORP. - POLYREX
SHELL OIL CO. - DOLIUM R
EXXON CORP. - UNIREX#2
MOBIL OIL CO. - MOBILUX#2

Figure 22

OPERATING LOG

The use of an operating log as included in this manual (see Table of Contents) permits thorough analysis of the operation of a refrigeration system by those responsible for its maintenance and servicing. Continual recording of gauge pressures, temperatures, and other pertinent information, enables the observer and serviceman to be constantly familiar with the operation of the system and to recognize immediately any deviations from normal operating conditions. It is recommended that readings be taken at least every four hours.

MAINTENANCE SCHEDULE

This schedule should be followed to ensure trouble-free operation of the compressor unit.

MAINTENANCE	FREQUENCY OR HOURS OF OPERATION (MAXIMUM)																					
	200	1000	5000	8000	10000	15000	20000	25000	30000	35000	40000	45000	50000	55000	60000	65000	70000	75000	80000	85000	90000	95000
CHANGE OIL	As directed by oil analysis																					
OIL ANALYSIS		■	Then every 6 months																			
REPLACE FILTER	■		■		■		■		■		■		■		■		■		■		■	
CLEAN OIL STRAINERS	■		■		■		■		■		■		■		■		■		■		■	
CLEAN LIQUID STRAINERS	■		■		■		■		■		■		■		■		■		■		■	
REPLACE COALESCER									■						■						■	
CHECK AND CLEAN SUCTION STRAINER	■	■	■		■		■		■		■		■		■		■		■		■	
CHECK COUPLING	■		■		■		■		■		■		■		■		■		■		■	
VIBRATION ANALYSIS	Every 6 months, more frequently if levels increase																					
REPLACE SEAL	When leak rate exceeds 7 - 8 drops per minute																					

TROUBLESHOOTING GUIDE

Successful problem solving requires an organized approach to define the problem, identify the cause, and make the proper correction. Sometimes it is possible that two relatively obvious problems combine to provide a set of symptoms that can mislead the troubleshooter. Be aware of this possibility and avoid solving the "wrong problem".

ABNORMAL OPERATION ANALYSIS and CORRECTION

Four logical steps are required to analyze an operational problem effectively and make the necessary corrections:

1. Define the problem and its limits.

2. Identify all possible causes.

3. Test each cause until the source of the problem is found.

4. Make the necessary corrections.

The first step in effective problem solving is to define the limits of the problem. If, for example, the compressor periodically experiences high oil temperatures, do not rely on this observation alone to help identify the problem. On the basis of this information the apparent corrective measure would appear to be a readjustment of the liquid injection system. Lowering the equalizing pressure on the thermal expansion valve would increase the refrigerant feed and the oil temperature should drop.

If the high oil temperature was the result of high suction superheat, however, and not just a matter of improper liquid injection adjustment, increasing the liquid feed could lead to other problems. Under low load conditions the liquid injection system may have a tendency to overfeed. The high suction superheat condition, moreover, may only be temporary. When system conditions return to normal the units' liquid injection will overfeed and oil temperature will drop. In solving the wrong problem a new problem was created.

When an operating problem develops compare all operating information on the MAIN OPERATING SCREEN with normal operating conditions. If an Operating Log has been maintained the log can help determine what constitutes normal operation for the compressor unit in that particular system.

The following list of abnormal system conditions can cause abnormal operation of the RWF compressor unit:

1. Insufficient or excessive refrigeration load.

2. Excessively high suction pressure.

3. Excessively high suction superheat.

4. Excessively high discharge pressure.

5. Inadequate refrigerant charge or low receiver level.

6. Excessively high or low temperature coolant to the oil cooler.

7. Liquid return from system (slugging).

8. Refrigerant underfeed or overfeed to evaporators.

9. Blocked tubes in water cooled oil cooler from high mineral content of water.

10. Insufficient evaporator or condenser sizing.

11. Incorrect refrigerant line sizing.

12. Improper system piping.

13. Problems in electrical service to compressor unit.

14. Air and moisture present in the system.

Make a list of all deviations from normal plant operation and normal compressor unit operation. Delete any items which do not relate to the symptom and separately list those items that might relate to the symptom. Use the list as a guide to further investigate the problem.

The second step in problem solving is to decide which items on the list are possible causes and which items are additional symptoms. High discharge temperature and high oil temperature readings on a display may both be symptoms of a problem and not casually related. High suction superheat or a low receiver level, however, could cause both symptoms.

The third step is to identify the most likely cause and take action to correct the problem. If the symptoms are not relieved move to the next item on the list and repeat the procedure until you have identified the cause of the problem. Once the cause has been identified and confirmed make the necessary corrections.

SERVICING THE COLD-START VALVE

⚠WARNING

DO NOT ATTEMPT TO SERVICE THE COLD START VALVE. PLEASE CONTACT THE FRICK SERVICE DEPARTMENT.

PRESSURE TRANSDUCERS - TESTING

1. Shut down the compressor and allow pressures to equalize.

2. Isolate suction transducer PE-4 from the unit and depressurize. **NOTE: Recover or transfer all refrigerant vapor, in accordance with local ordinances, before opening to atmosphere.**

3. Measure the voltage of PE-4 on connector P4 (terminals WHT and BLK) on the SBC with a digital voltmeter.

4. The voltage reading should be 1.48 VDC to 1.72 VDC at standard atmospheric pressure (14.7 PSIA or 0 PSIG). When checking transducers at higher elevations, an allowance in the readings must be made by subtracting approximately 0.02 VDC per 1000 feet of elevation above sea level. Therefore, if PE-4 is measured at 5000 feet elevation under relatively normal weather conditions, the output voltage should differ by 0.10 VDC to read between 1.38 VDC and 1.62 VDC.

5. Isolate the oil pressure transducer PE-1 from the package and open it to atmosphere.

6. Measure the voltage of PE-1 on connector P4 (terminals WHT and BLK) on the SBC.

7. The voltage reading should be between 1.1 VDC and 1.29 VDC at standard atmospheric pressure. PE-1, PE-2, and PE-3 all have a span of 500 PSI as compared to PE-4 with a span of 200 PSI. Therefore, atmospheric pressure changes have a lesser effect which is 0.0067 VDC per 1000 feet of elevation and 0.00067 VDC per 0.1 inch Hg barometric deviation.

8. Isolate transducer PE-2 from the package and depressurize. **NOTE: Recover or transfer all refrigerant vapor, in accordance with local ordinances, before opening to atmosphere.**

9. Measure the voltage of PE-2 on connector P4 (terminals WHT and BLK) on the SBC.

10. The voltage reading should be between 1.1 VDC and 1.29 VDC at standard atmospheric pressure (see Step 12).

11. Since the discharge pressure, PE-3, cannot be closed off from its sensing point (code requirements), close all transducers from atmosphere and open them to their sensing points so all transducers can equalize to separator pressure.

12. Measure the voltage of PE-3 on connector P4 (terminals WHT and BLK) on the SBC.

13. Measure the voltage of PE-1 on connector P4 (terminals WHT and BLK) on the SBC.

14. These two voltages should be within .04 VDC of one another.

15. Test is complete.

PRESSURE TRANSDUCERS - REPLACEMENT

1. Shut off control power.

2. Close the applicable transducer isolation valve. **NOTE: To change the discharge pressure transducer (PE-3), it will be necessary to depressurize the entire compressor package. Follow "General Instructions For Replacing Compressor Unit Components" before going to step 3.**

3. Refer to the WIRING HARNESS section, External Transducers for Board #1, to identify the wiring harness connectors.

4. Loosen screw and disconnect wiring harness connector from transducer.

5. Unscrew the transducer using a wrench on the metal hex at the base of the transducer. **DO NOT ATTEMPT TO LOOSEN OR TIGHTEN TRANSDUCERS BY THEIR TOP CASING.**

6. Install new transducer.

7. Reconnect the wiring harness to the transducer.

8. Reopen the transducer isolation valve.

9. Turn on control power.

PRESSURE TRANSDUCER CONVERSION DATA

Sensor Voltage	200 psi Range - PSI		500 psi Range - PSIG*	
	low	high	low	high
1.0	29.92"	9.57"	29.92"	4.10
1.1	29.92"	0.30	29.92"	16.60
1.2	29.92"	5.30	17.10"	29.10
1.3	19.74"	10.30	4.10	41.60
1.4	9.57"	15.30	16.60	54.10
1.5	0.30	20.30	29.10	66.60
1.6	5.30	25.30	41.60	79.10
1.7	10.30	30.30	54.10	91.60
1.8	15.30	35.30	66.60	104.10
1.9	20.30	40.30	79.10	116.60
2.0	25.30	45.30	91.60	129.10
2.1	30.30	50.30	104.10	141.60
2.2	35.30	55.30	116.60	154.10
2.3	40.30	60.30	129.10	166.60
2.4	45.30	65.30	141.60	179.10
2.5	50.30	70.30	154.10	191.60
2.6	55.30	75.30	166.60	204.10
2.7	60.30	80.30	179.10	216.60
2.8	65.30	85.30	191.60	229.10
2.9	70.30	90.30	204.10	241.60
3.0	75.30	95.30	216.60	254.10
3.1	80.30	100.30	229.10	266.60
3.2	85.30	105.30	241.60	279.10
3.3	90.30	110.30	254.10	291.60
3.4	95.30	115.30	266.60	304.10
3.5	100.30	120.30	279.10	316.60
3.6	105.30	125.30	291.60	329.10
3.7	110.30	130.30	304.10	341.60
3.8	115.30	135.30	316.60	354.10
3.9	120.30	140.30	329.10	366.60
4.0	125.30	145.30	341.60	379.10
4.1	130.30	150.30	354.10	391.60
4.2	135.30	155.30	366.60	404.10
4.3	140.30	160.30	379.10	416.60
4.4	145.30	165.30	391.60	429.10
4.5	150.30	170.30	404.10	441.60
4.6	155.30	175.30	416.60	454.10
4.7	160.30	180.30	429.10	466.60
4.8	165.30	185.30	441.60	479.10
4.9	170.30	190.30	454.10	491.60
5.0	175.30	195.30	466.60	504.10
At 0 psig	**1.094 V**	**1.494 V**	**0.968 V**	**1.268 V**

* Below 0 PSIG measured in inches of mercury.

SV POSITION POTENTIOMETER REPLACEMENT AND ADJUSTMENT

The Slide Valve Position potentiometer is located on the end of the compressor unloader cylinder (applies to models 100 - 270), see Figure 23.

1. Shut off control power.

2. Remove the four socket head cap screws securing the potentiometer cover to the unloader cylinder.

3. Unsolder leads to the potentiometer and remove.

4. Loosen the setscrew on the potentiometer side of the flexible coupling.

5. Remove the three retainer clips securing the potentiometer to the base plate. The potentiometer should slip out of the coupling.

6. Install the new potentiometer and reassemble.

7. Adjustment:

ROUGH ADJUSTMENT is made with the slide valve fully unloaded and the control power off. Remove connector P5. With a digital voltmeter, measure the resistance across the red and white wires, having removed them from the SBC. The resistance should be 1000 +/- 50 ohms. If adjustment is necessary, loosen the locknut and rotate the potentiometer clockwise or counterclockwise until the resistance reading is a close to a 1000 ohms as possible. Retighten the locknut and replace wires. **NOTE: Mechanical travel of the slide valve potentiometer is 300 degrees rotation when the slide stop is confirmed to be in the 2.2 Vi position. The travel will be less than 300 degrees if the slide stop is in any position above 2.2 Vi.**

FINE ADJUSTMENT must be made with the slide valve fully unloaded and the compressor running. The Operating display at this time should indicate a slide valve position of 0%. If the display is greater than 0%, adjust potentiometer POT #4 on the SBC until 0% is indicated. If 0% is not attainable, get as close as possible and then proceed to the next step. The adjustments of POT #4 and POT #3 are interactive and POT #3 may require adjustment to allow POT #4 to come into range.

Completely load the slide valve. The display at this time should indicate 100%. If the display is less than 100%, adjust potentiometer POT #3 on the SBC until 100% is indicated.

Repeat this sequence until the slide valve indicates 0% fully unloaded and 100% fully loaded.

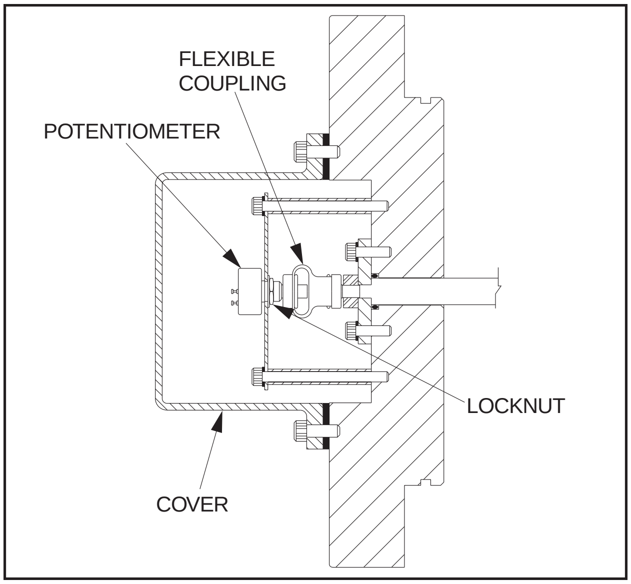


Figure 23

CAPACITY LINEAR TRANSMITTER REPLACEMENT - SLIDE VALVE

The Capacity Linear Transmitter is located on the end of the compressor unload cylinder (applies to models 100 - 270), see Figure 24.

The linear transmitter with hermetic enclosure is based on the inductive measuring principle. It features removable electronics (from the sensor well) eliminating the need to evacuate the compressor for replacement. This type of transmitter is dedicated to capacity control and is not adjustable.

1. Shut off control power.

2. Remove DIN connector plug from transmitter.

3. Loosen cap screws.

4. Remove transmitter unit.

5. Install new transmitter unit.

6. Tighten cap screws.

7. Apply DIN connector plug to transmitter.

8. Turn on control power.

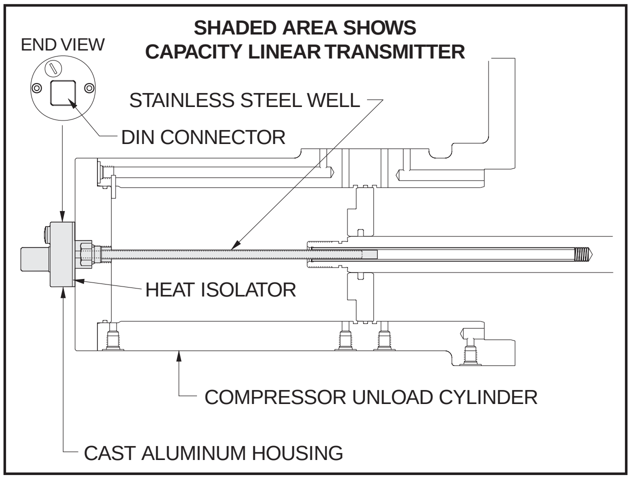


Figure 24

VOLUMIZER® TRANSMITTER REPLACEMENT - SLIDE STOP

The VOLUMIZER® Transmitter is located on the right side of the compressor (facing shaft) at the inlet end (see Figure 25).

The linear transmitter with hermetic enclosure is based on the inductive measuring principle. It features removable electronics (from the sensor well) eliminating the need to evacuate the compressor for replacement. This type of transmitter is dedicated to volume ratio control and has no user adjustments.

1. Shut off control power.

2. Remove DIN connector plug from transmitter.

3. Loosen set screws.

4. Remove transmitter unit.

5. Install new transmitter unit.

6. Tighten set screws.

7. Apply DIN connector plug to transmitter.

8. Turn on control power.

NOTE: For calibration of the Volumizer® unit, refer to the Analog Calibration instructions in publication S90-010 O.

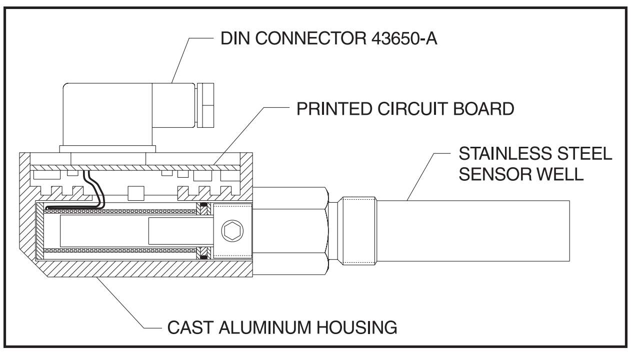


Figure 25 - VOLUMIZER® TRANSMITTER

TEMPERATURE SENSOR REPLACEMENT

CAUTION **This device is static sensitive. Please follow proper ESD procedures when handling.**

1. Shut off control power.

2. Remove DIN connector plug from transmitter (See Figure 27).

3. Unscrew knurled ring and remove transmitter unit.

4. Apply thermal compound to new sensor assembly, insert into thermal well, and tighten knurled ring.

5. Apply DIN connector plug to transmitter.

6. Turn on control power.

NOTE: The temperature sensor is factory set. If calibration is required, refer to Analog Calibration instructions in publication S90-010 O.

OIL LEVEL TRANSMITTER REPLACEMENT

The Oil Level Transmitter is located on the front of the separator near the bottom/center (see Figure 26).

The linear transmitter with hermetic enclosure is based on the capacitive measuring principle. It features removable electronics (from the sensor well) eliminating the need to evacuate the compressor for replacement. This transmitter is dedicated to oil level control and has no user adjustments.

1. Shut off control power.

2. Remove DIN connector plug from transmitter.

3. Loosen set screws.

4. Remove transmitter unit.

5. Install new transmitter unit.

6. Tighten set screws.

7. Apply DIN connector plug to transmitter.

8. Turn on control power.

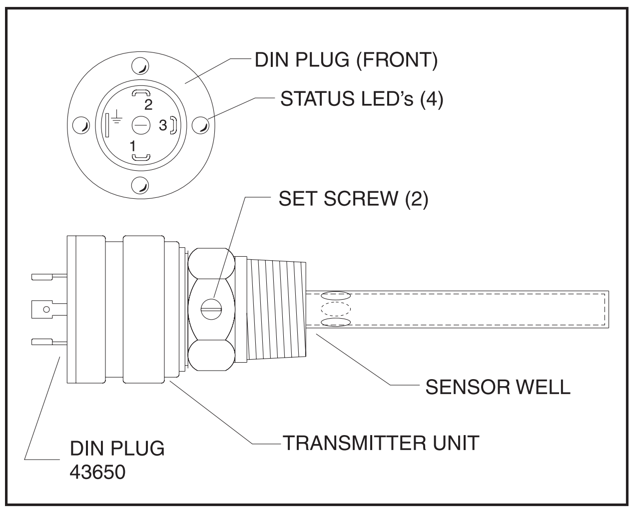


Figure 26 - OIL LEVEL TRANSMITTER

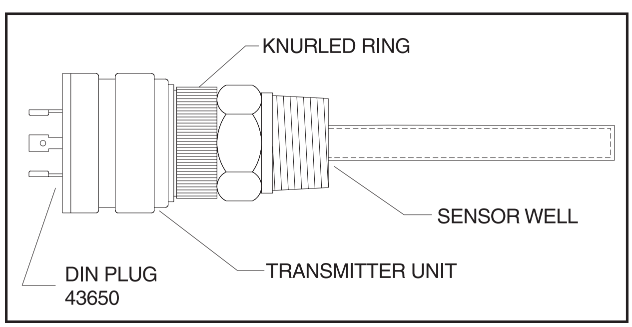


Figure 27 - TEMPERATURE TRANSMITTER

TROUBLESHOOTING THE RWF COMPRESSOR

SYMPTOM	PROBABLE CAUSES and CORRECTIONS
EXCESSIVE NOISE and VIBRATION	Main oil injection valve may be closed. Open valve. Bearing damage or excessive wear. CONTACT Frick Factor or Frick service. Coupling loose on shaft. Tighten coupling. Replace if damaged. Misalignment between motor and compressor. Realign motor and compressor. Refrigerant flood back. Correct system problem.
SLIDE VALVE and/or SLIDE STOP WILL NOT MOVE	4-way hydraulic control valve failed. Repair or replace. Slide stop indicator rod stuck. Contact Frick Factor or Frick service for assistance. Check both S.V. and S.S. feedback devices for wiring and resistance. Compressor must be running with sufficient oil pressure. Unloader piston stuck. Contact Frick Factor or Frick service for assistance. Slipper seals worn out or damaged. Contact Frick Factor or Frick service for assistance.

NOTE: Troubleshooting the compressor is limited to identifying the probable cause. If a mechanical problem is suspected contact the Service Department, Frick . DO NOT ATTEMPT TO DISASSEMBLE COMPRESSOR.

TROUBLESHOOTING THE OIL SEPARATION SYSTEM

SYMPTOM	PROBABLE CAUSES and CORRECTIONS
GRADUAL OIL LOSS WITH AN OIL LEVEL IN THE COALESCER SECTION SIGHT GLASS	Maintaining too high an oil level, lower level. Refrigerant carryover or liquid injection overfeeding, correct operation. Loss of suction superheat. Adjust evaporator feeds. Contaminated oil, damaged or not seated coalescer filter elements. Replace oil charge and coalescers. Coalescer return valve closed. Open return valve. Coalescer return valve closed. Open valve. Coalescing oil return line strainer blocked. Clean. Needle valve blocked. Clean.
RAPID LOSS WITH NO OIL LEVEL IN THE COALESCER SECTION SIGHT GLASS	On shutdown, compressor unit suction check valve did not close. Repair valve. Suction check valve bypass valve open. Close valve. Coalescers loose or not seated properly. Correct or replace. On economized unit: economizer check valve not working. Repair or replace. Economizer check valve not in automatic position or manually opened. Place in auto position.
SHAFT SEAL LEAKAGE	If leakage exceeds normal allowable rate of 7 drops per minute, replace seal.

TROUBLESHOOTING THE HYDRAULIC SYSTEM

SYMPTOM	PROBABLE CAUSES and CORRECTIONS
SLIDE VALVE WILL NOT LOAD OR UNLOAD	Solenoid coils may be burned out. Replace. Valve may be closed. Open hydraulic service valves. Solenoid spool may be stuck or centering spring broken. Replace. Check outputs 2 and 3 and fuses. Check LED on coil. If lit, there is power to the coil. Check coil. Solenoid may be actuated mechanically by inserting a piece of 3/16" rod against armature pin and pushing spool to opposite end. Push A side to confirm unload capability. If valve works, problem is electrical.
SLIDE VALVE WILL LOAD BUT WILL NOT UNLOAD	A side solenoid coil may be burned out. Replace. Dirt inside solenoid valve preventing valve from operating both ways. Clean. Check LED on coil. If lit, valve is functioning mechanically. Problem is electrical. Solenoid may be actuated mechanically by inserting a piece of 3/16" rod against armature pin and pushing spool to opposite end. Push A side to confirm unload capability. If valve works, problem is electrical.
SLIDE VALVE WILL UNLOAD BUT WILL NOT LOAD	A side solenoid coil may be burned out. Replace. Dirt inside solenoid valve preventing valve from operating both ways. Clean. Check LED on coil. If lit, valve is functioning mechanically. Problem is electrical. Solenoid may be actuated mechanically by inserting a piece of 3/16" rod against armature pin and pushing spool to opposite end. Push A side to confirm unload capability. If valve works, problem is electrical.
SLIDE STOP WILL NOT FUNCTION EITHER DIRECTION	Solenoid coils may be burned out. Replace. Solenoid service valves may be closed. Open. Manually actuate solenoid. If slide stop will not move mechanical problems are indicated. Consult Frick factor or Frick service.

TROUBLESHOOTING THE LIQUID INJECTION OIL COOLING SYSTEM

SYMPTOM	PROBABLE CAUSES and CORRECTIONS
HIGH OIL TEMPERATURE	Insufficient liquid supply. Check receiver level and pressure drop at injection solenoid. Equalizer pressure too high. Lower. Suction superheat too high. Correct system problem. Thermal valve power head lost charge. Replace. Liquid strainer blocked. Clean. Liquid solenoid coil failed. Replace. Excessive load. Thermovalve undersized. Reduce load or install larger thermovalve.
LOW OIL TEMPERATURE	Equalizing pressure too low. Raise. Suction superheat too low or liquid coming back on compressor. Correct system problem. Low load conditions. Valve oversized. Increase load or use smaller thermovalve.
OIL TEMPERATURE FLUCTUATES	System conditions rapidly fluctuate causing liquid injection system to overrespond. Stabilize system operation.

TROUBLESHOOTING THE DEMAND PUMP SYSTEM

SYMPTOM	PROBABLE CAUSES and CORRECTIONS
PUMP WILL NOT PRODUCE ENOUGH OIL PRESSURE TO START COMPRESSOR	Check pump rotation. Check that service valves are open. Filter cartridges may be blocked. Check PSID across filters. Strainer may be blocked. Clean. Oil pressure regulator set too low or stuck open. Readjust or repair. Pump worn out. Repair or replace.
OIL PRESSURE RAPIDLY DROPS OFF WHEN COMPRESSOR STARTS RESULTS IN COMPRESSOR DIFFERENTIAL ALARM	Main oil injection throttling valve too wide open or oil pressure regulating valve improperly adjusted. Readjust both valves.
OIL PRESSURE FLUCTUATES	Liquid injection overfeeding or refrigerant flood back from system. Make necessary adjustments or corrections
NOISE and VIBRATION	Pump strainer blocked. Clean. Liquid refrigerant overfeed. Adjust liquid injection. Pump worn out. Repair or replace.
GREASE LEAKS FROM VENT PORT IN THE SIDE OF THE PUMP BODY	Normal leakage which will cease after initial operation. Black oil leaking from this vent indicates oil seal wear or failure. If leakage exceeds normal allowable rate of 7 drops per minute, replace seal.
OIL PRESSURE DROPS AS HEAD PRESSURE INCREASES	Normal behavior. Set main oil injection and oil pressure for maximum head pressure condition.
MAIN FILTER PSID IS TOO HIGH	Filters clogged with dirt. Replace. Oil is too cold. Allow oil to warm up and check again. Service valve on filter outlet is partially closed. Open valves fully.

THERMAL EXPANSION VALVES

In situations where system load conditions increase or decrease over extended periods of time and the liquid injection thermal expansion valve is not adequate for the new conditions, an improvement in valve performance may be achieved by increasing or decreasing discharge tube size.

NOTE: DO NOT ATTEMPT TO ADJUST SUPERHEAT ADJUSTMENT STEM ON BOTTOM OF VALVE IN AN EFFORT TO CHANGE THE VALVE'S PERFORMANCE. THIS ADJUSTMENT IS PRESET AT THE FACTORY. ONLY ADJUST 1/4" BLEED VALVE ON EQUALIZING LINE.

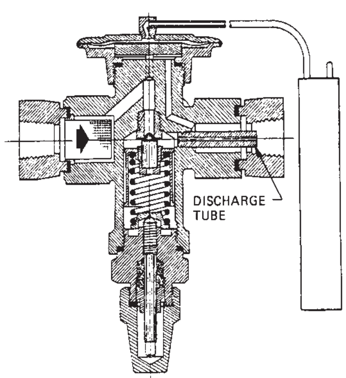


Figure 28 - TYPE D (1-15 TONS) R-717

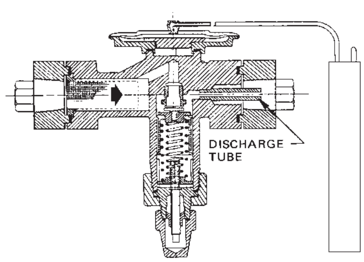


Figure 29 - TYPE A (20-100 TONS) R-717

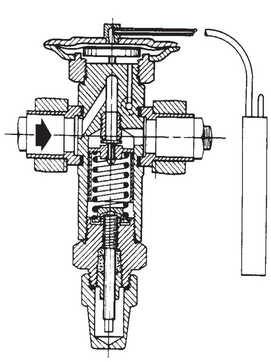


Figure 30 - TYPE H (2-1/2 TO 16 TONS) R-22

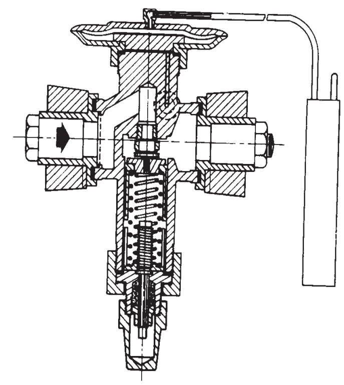


Figure 31 - TYPE M (12 TO 34 TONS) R-22

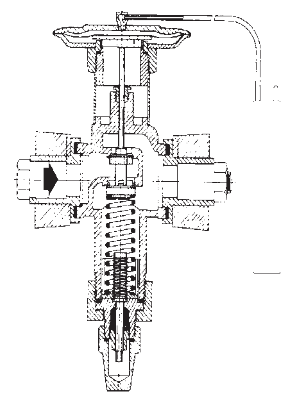


Figure 32 - TYPE V (52 TO 100 TONS) R-22

R-717 TX VALVE SIZES

TX VALVE MODE	PORT SIZE	DISCHARGE TUBE SIZE
DAE - 1	1/16	1/32
DAE - 2	1/16	1/16
DAE - 5	7/64	5/64
DAE - 10	3/16	7/64
DAE - 15	3/16	5/32
AAE - 20	5/16	1/8
AAE - 30	5/16	5/32
AAE - 50	3/8	3/16
AAE - 75	3/8	NONE
AAE - 100	7/16	NONE

R-22 TX VALVE SIZES

TX VALVE MODE	FPT CONNECTION
HVE - 2-/1/2	1/2
HVE - 5-1/2	1/2
HVE - 11	1/2
HVE - 16	1/2
MVE - 12	1
MVE - 21	1
MVE - 34	1
VVE - 52	1
VVE - 70	1
VVE - 100	1

JORDAN
TEMPERATURE REGULATOR VALVE

The Jordan valve is a high volume, temperature-regulating valve that requires minimal differential across the valve to ensure adequate flow for cooling.

The Jordan valve must be mounted on a horizontal line with the flow arrow pointing toward the direction of flow. However, the valve may be mounted at any angle perpendicular to the horizontal line, including inverted, if necessary.

Sensing Bulb, Vertical Mounting - When the sensing bulb is to be mounted vertically (pointing down), no special precaution is necessary. If the bulb is to be mounted vertically, in an inverted position, a special capillary is needed because the tip of the sensing bulb is higher than the capillary end.

Sensing Bulb, Horizontal Mounting - When mounting the sensing bulb horizontally it must be mounted so that the word "TOP" which is stamped on the capillary end of the bulb appears accordingly. **NOTE: No angular mounting of the sensing bulb is permitted.**

Adjustment - To increase the oil temperature, increase the spring tension by turning the knurled nut at the base of the spring. To decrease the oil temperature, decrease the spring tension by turning the knurled nut at the base of the spring (see Figure 33).

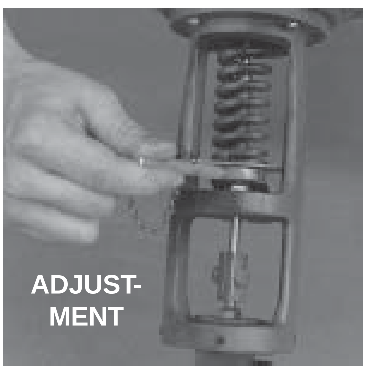


Figure 33

Action - The valve should be set as a reverse acting valve, however there are times when the valve may be set as a direct acting valve. If you experience what seems to be a total absence of oil cooling you will need to check the action of the valve. To check the action you will need to remove the cap-flange and disc-guide.

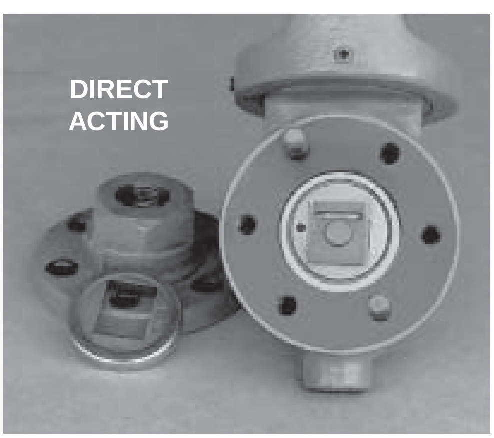


Figure 34

If the hole in the valve plate is to the left and the slot in the valve disc is on the top this valve is set for Direct Acting (see figure 34). To change the action of the valve to Reverse Acting simply rotate the valve plate and the valve disc 180° so that the hole on the plate is on the right and the slot on the disk is at the bottom (see figure 35).

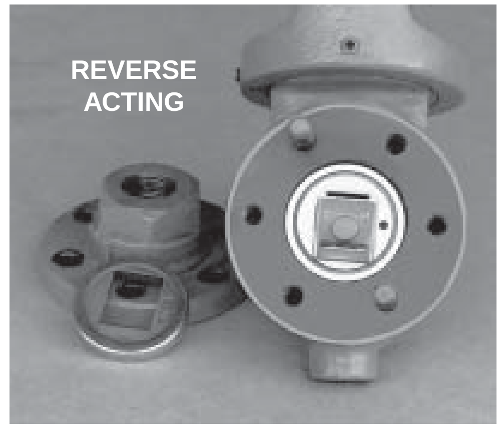


Figure 35

Stroke Adjustment - After the valve action has been changed it may be necessary to make a stroke adjustment. This ensures that the full capacity of the valve is available, if necessary, to keep the oil at the predetermined temperature.

To prepare for a stroke adjustment do the following.

- Remove the disc-guide, valve-disc, and valve-plate.
- Expose the sensing bulb in a vertical position to an ambient temperature of about 80°F.
- Release all spring tension by loosening the knurled nut.
- Loosen the disc-pin locking nut and allow at least 10 minutes for the valve to react (see figure 36).

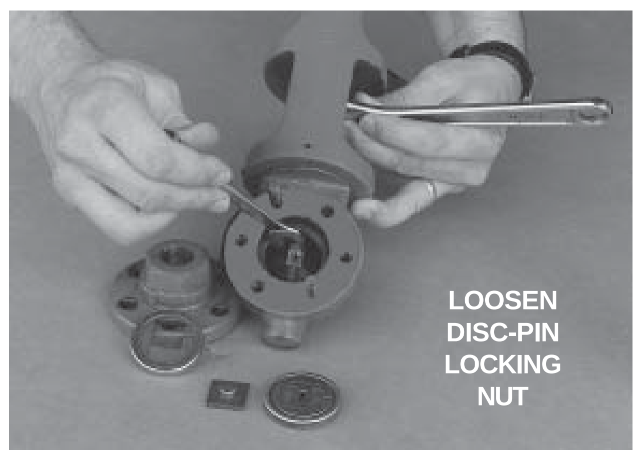


Figure 36

- Rotate the disc-pin so that when the valve-plate is installed the bottom of the pin is between the middle and the bottom of the slot.
- Hold the coupling with a wrench and tighten the disc-pin locking nut.
- Install the valve-plate and valve-disk for reverse action (see figure 3).
- Install the disk-guide and cap-flange.
- Increase the spring tension to about 30% by turning the knurled nut at the base of the spring approximately 20 quarter turns.

Install the valve and adjust the spring tension accordingly to maintain the predetermined oil temperature. The recommended oil temperatures are 130°F for ammonia and 140°F for R-22. Check with Frick service for recommended oil temperatures for other refrigerants.

If all of the above steps have been properly performed and the desired oil temperature can not be achieved, contact Frick Service.

MOTOR REPLACEMENT

The following procedure is required when a motor is replaced in the field.

1. Verify that main power to the unit is disconnected and tag the switch.

2. Disconnect the coupling from the motor shaft.

3. Remove the two bolts from the motor feet.

4. While supporting the motor with a crane, remove the eight bolts connecting the motor to the tunnel, then remove the motor.

5. Thoroughly clean the motor feet and mounting pads of burrs and other foreign matter to ensure firm seating of the new motor.

6. While supporting the new motor with the crane, install and hand tighten the eight bolts to connect the motor to the tunnel. Then torque the bolts in a star pattern to 250 ft-lb.

7. Then install the two bolts in the in the motor feet and torque them to 250 ft-lb. Remove the crane from motor.

8. Reattach coupling to the motor.

BARE COMPRESSOR REPLACEMENT

The following procedure is required only when a bare compressor is replaced in the field.

1. Verify that main power to the unit is disconnected and tag the switch.

2. Remove all tubing, piping, and wiring that is connected to the compressor.

3. Disconnect the coupling from the motor shaft.

4. While supporting the motor and compressor assembly with a crane, remove the bolts at the motor feet, compressor feet, and separator flange.

5. Thoroughly clean the compressor and motor feet and mounting pads of burrs and other foreign matter to ensure firm seating of the compressor.

6. Clean the discharge flange surfaces on the compressor and separator.

7. Set the assembly on a clean surface and remove the two pins and bolts connecting the compressor to the tunnel and remove the compressor.

8. Assemble the new compressor to the tunnel by inserting the two pins and hand tightening the bolts. then torque the bolts in a star pattern to 250 ft-lb.

9. Install a gasket on the compressor discharge connection of the separator.

10. Using the crane, set the new assembly in place and shim the motor and compressor feet wherer required.

11. Reattach the drive coupling.

12. The shaft alignment must be checked and tolerances verified with the Frick service dept.

13. Complete tubing, piping and wiring per the P & I and wiring diagrams.

SHUTDOWN DUE TO IMPROPER OIL PRESSURE (HIGH STAGE and BOOSTER)

The compressor must not operate with incorrect oil pressure.

1. Refer to CONTROL SETUP - "OIL SETPOINTS DISPLAY" in S90-010 O.

GREASE COMPATIBILITY

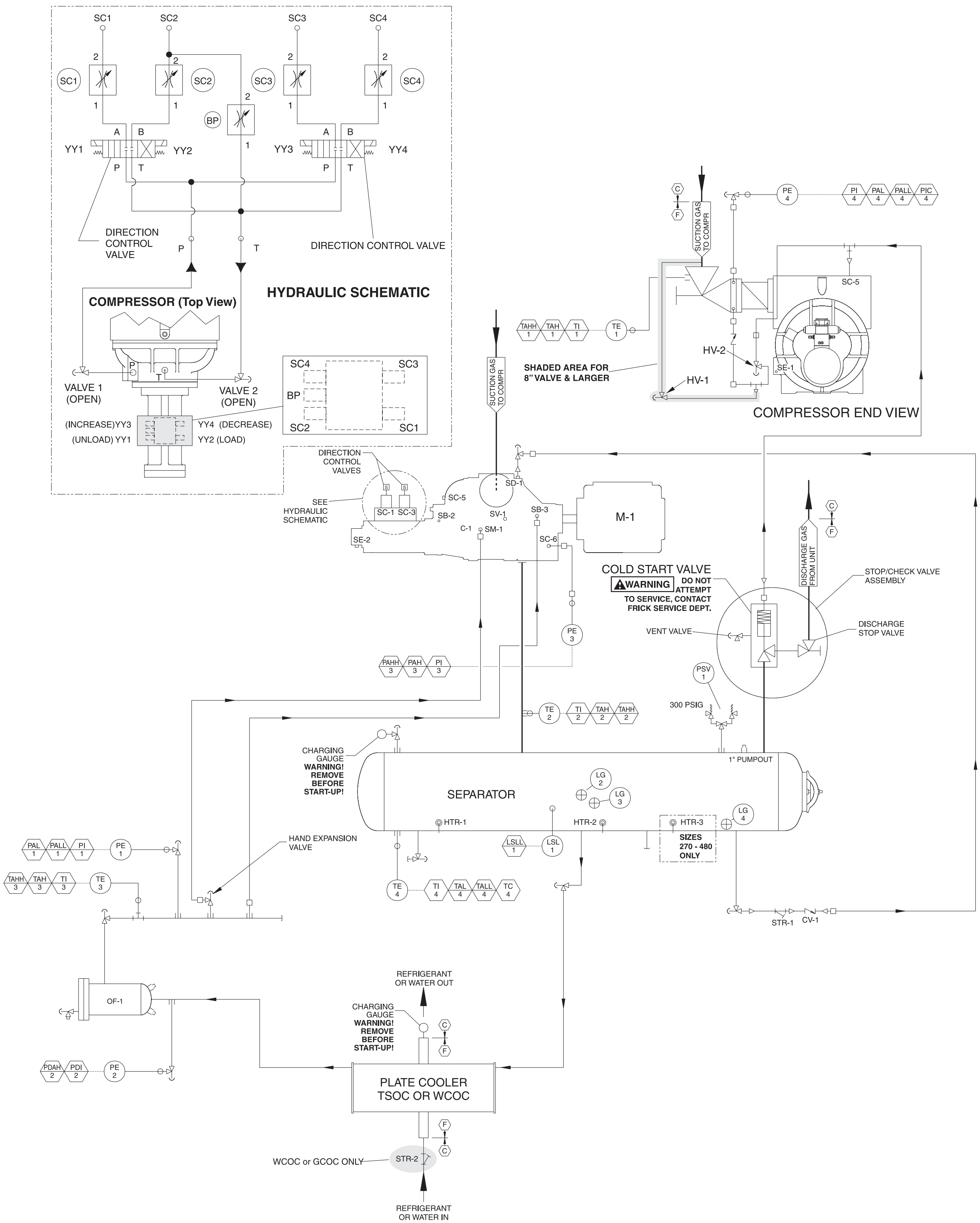
If it becomes necessary to mix greases, be careful not to combine different oil bases or thickeners. DO NOT mix a mineral oil-base grease with a synthetic oilbase grease. Also, a grease with a lithium thickener should not be mixed with one containing a sodium thickener. The table illustrates the compatibility of various types of grease based on results by National Lubricating Grease Institute (NLGI). The chart indicates a great variance in compaibility with the greases tested.

NLGI Grease Compatibility Chart

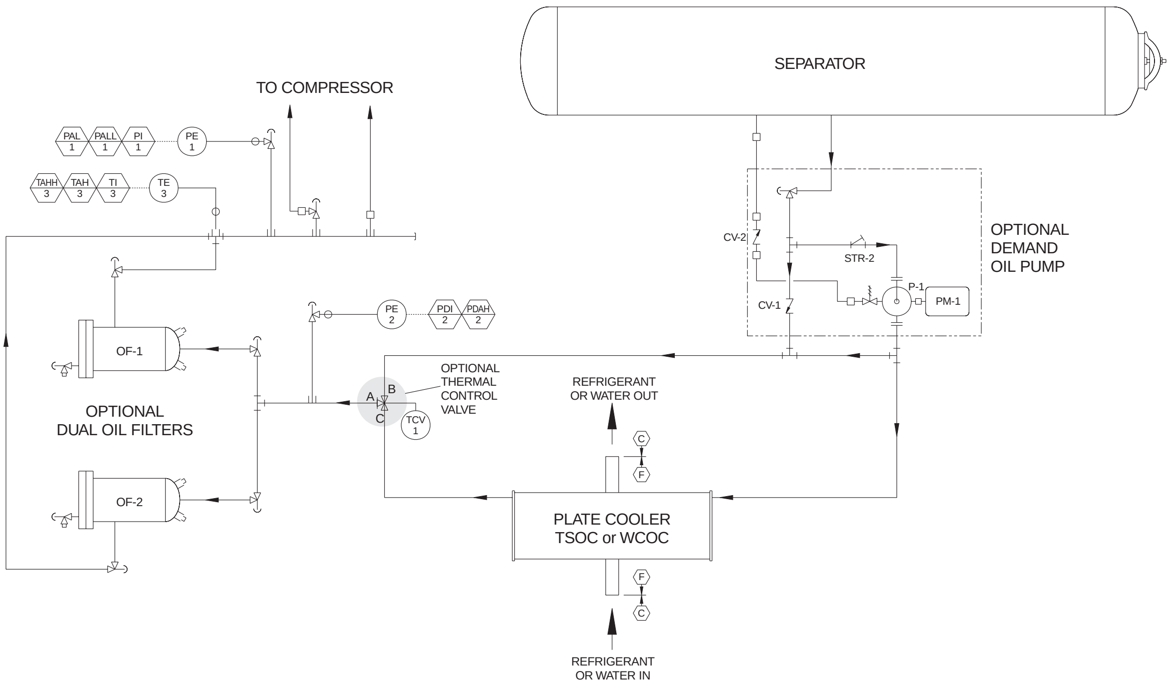
	Aluminum Complex	Barium	Calcium	Calcium 12-hydroxy	**Calcium Complex***	Clay	Lithium	Lithium 12-hydroxy	Lithium Complex	Polyurea
Aluminum Complex	–	I	I	C	I	I	I	I	C	I
Barium	I	–	I	C	I	I	I	I	I	I
Calcium	I	I	–	C	I	C	C	B	C	I
Calcium 12-hydroxy	C	C	C	–	B	C	C	C	C	I
Calcium Complex	I	I	I	B	–	I	I	I	C	C
Clay	I	I	C	C	I	–	I	I	I	I
Lithium	I	I	C	C	I	I	–	C	C	I
Lithium 12-hydroxy	I	I	B	C	I	I	C	–	C	I
Lithium Complex	C	I	C	C	C	I	C	C	–	I
Polyurea*	I	I	I	I	**C**	I	I	I	I	–

B = Borderline Compatibility
C = Compatible
I = Incompatible
* Standard

P & I DIAGRAM


HYDRAULIC SCHEMATIC
COMPRESSOR (Top View)
DIRECTION CONTROL VALVE
VALVE 1 (OPEN)
VALVE 2 (OPEN)
(INCREASE)YY3
(UNLOAD) YY1
YY4 (DECREASE)
YY2 (LOAD)
SUCTION GAS TO COMPR
SHADED AREA FOR 8" VALVE & LARGER
COMPRESSOR END VIEW
DIRECTION CONTROL VALVES
SEE HYDRAULIC SCHEMATIC
M-1
COLD START VALVE
WARNING DO NOT ATTEMPT TO SERVICE, CONTACT FRICK SERVICE DEPT.
VENT VALVE
DISCHARGE GAS FROM UNIT
STOP/CHECK VALVE ASSEMBLY
DISCHARGE STOP VALVE
300 PSIG
CHARGING GAUGE WARNING! REMOVE BEFORE START-UP!
SEPARATOR
1" PUMPOUT
SIZES 270 - 480 ONLY
HAND EXPANSION VALVE
OF-1
REFRIGERANT OR WATER OUT
PLATE COOLER TSOC OR WCOC
WCOC or GCOC ONLY
STR-2
REFRIGERANT OR WATER IN

P & I DIAGRAM - OPTIONAL DUAL OIL FILTERS, DEMAND OIL PUMP, THERMAL CONTROL VALVE



LEGEND (Covers all P & I diagrams in this manual)

C	COMPRESSOR
CV	CHECK VALVE
DP	DISCHARGE PRESSURE
FG	FLOW GLASS
HV	HAND VALVE
HTR	HEATER
LG	LEVEL GLASS
LSLL	SEPARATOR LOW OIL LEVEL SHUTDOWN
M	MOTOR
1MC	MOTOR CONTROL CENTER
2MC	MOTOR CONTROL CENTER
NOS	NO OIL SWITCH
OF	OIL FILTER
OP	OIL PRESSURE
P	DEMAND PUMP
PAH	HIGH DISCHARGE PRESSURE ALARM
PAHH	HIGH DISCHARGE PRESSURE SHUTDOWN
PAL	LOW PRESSURE ALARM
PALL	LOW PRESSURE SHUTDOWN
PDAH	HIGH PRESSURE DIFFERENTIAL ALARM
PDI	PRESSURE DIFFERENTIAL INDICATOR
PDSLL	COMPRESSOR LOW DIFFERENTIAL PRESSURE CUTOUT
PE	PRESSURE TRANSDUCERS
PI	PRESSURE INDICATOR
PIC	PRESSURE INDICATION CONTROLLER
PM	PUMP MOTOR
PS	PRESSURE SWITCH CONTROL
PSV	HIGH PRESSURE SAFETY VALVE
SP	SUCTION PRESSURE
STR	STRAINER
TAH	HIGH TEMPERATURE ALARM
TAHH	HIGH TEMPERATURE SHUTDOWN
TAL	LOW OIL TEMPERATURE ALARM
TALL	LOW OIL TEMPERATURE SHUTDOWN
TC	TEMPERATURE CONTROLLER
TCV	THERMAL CONTROL VALVE
TE	TEMPERATURE ELEMENT
TI	TEMPERATURE INDICATOR
TS	TEMPERATURE SWITCH
TSH	TEMPERATURE SWITCH HIGH ALARM
TW	THERMOWELL
VI	VI CONTROL
SB-2	INLET BEARING & BALANCE PISTON
SB-3	DISCHARGE BEARINGS & SEAL
SC-1	SLIDE VALVE - UNLOAD
SC-2	SLIDE VALVE - LOAD
SC-3	MOVEABLE SLIDE STOP
SC-4	MOVEABLE SLIDE STOP
SC-5	INLET PRESSURE
SC-6	DISCHARGE PRESSURE
SC-7	SEAL WEEPAGE
SC-8	OIL DRAIN CONNECTION
SC-9	INLET HOUSING OIL DRAIN
SC-13	OIL DRAIN CYLINDER
SE-1	ELECTRICAL CONNECTION
SE-2	ELECTRICAL CONNECTION
SL-1	LIQUID INJECTION LOW VI
SL-2	LIQUID INJECTION HIGH VI
SM-1	MAIN OIL INJECTION
SV-1	VAPOR INJECTION TONGUE & GROOVE
SD-1	COALESCER BLEED STR THD O-RING PORT
TW-1	THERMOWELL

PRESSURE TRANSDUCERS INDICATE:

PE-1	OIL PRESSURE (MANIFOLD)
PE-2	OIL PRESSURE BEFORE FILTER
PE-3	DISCHARGE PRESSURE
PE-4	SUCTION PRESSURE

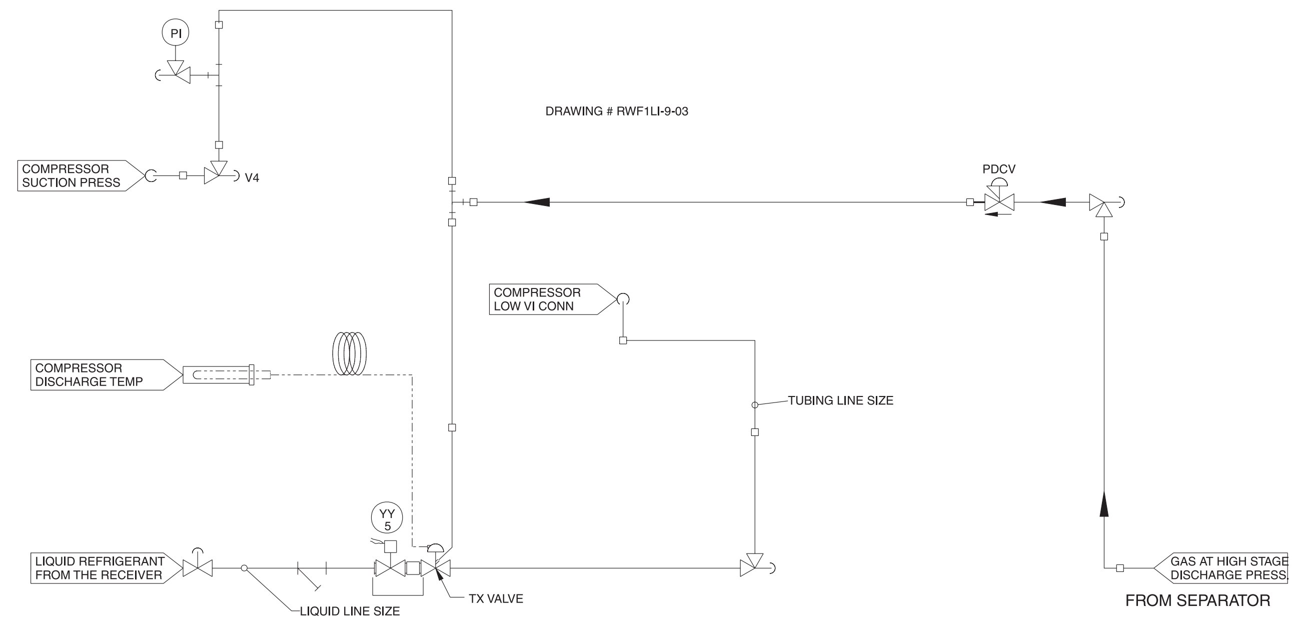
TEMPERATURE PROBES INDICATE:

TE-1	SUCTION GAS TEMPERATURE
TE-2	DISCHARGE GAS TEMPERATURE
TE-3	LUBE OIL TEMPERATURE
TE-4	SEPARATOR OIL TEMPERATURE

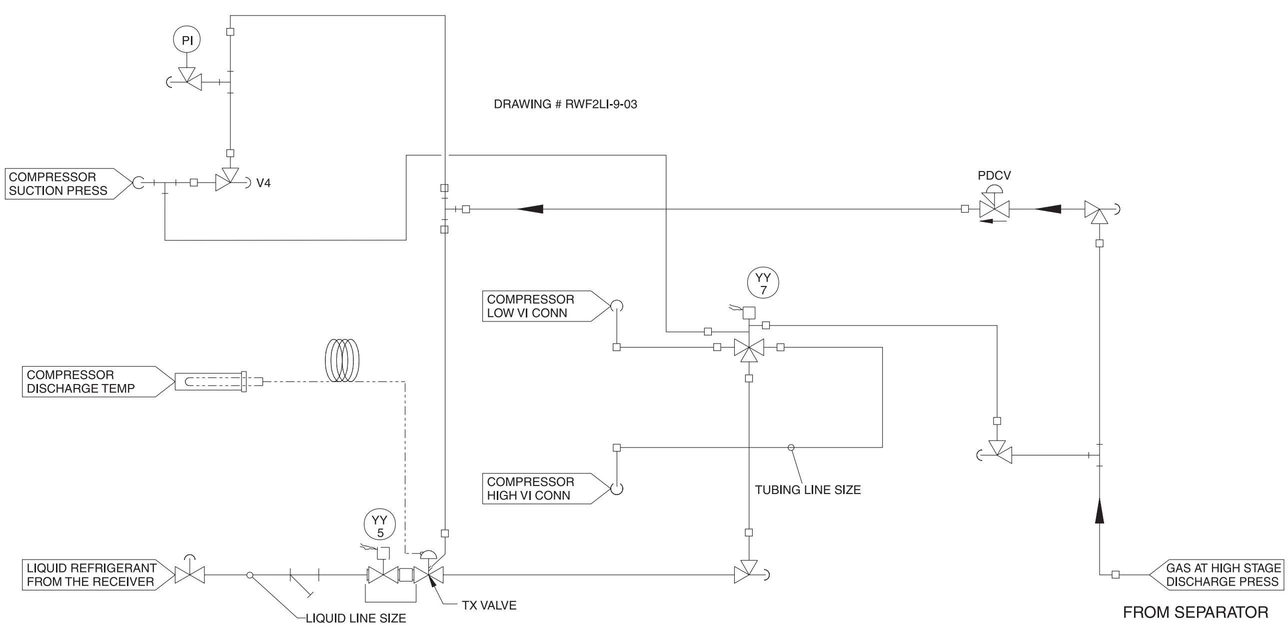
SOLENOID VALVE FUNCTION:

YY-1	ENERGIZE UNLOAD SLIDE VALVE
YY-2	ENERGIZE LOAD SLIDE VALVE
YY-3	ENERGIZE INCREASE VOLUME RATIO
YY-4	ENERGIZE DECREASE VOLUME RATIO

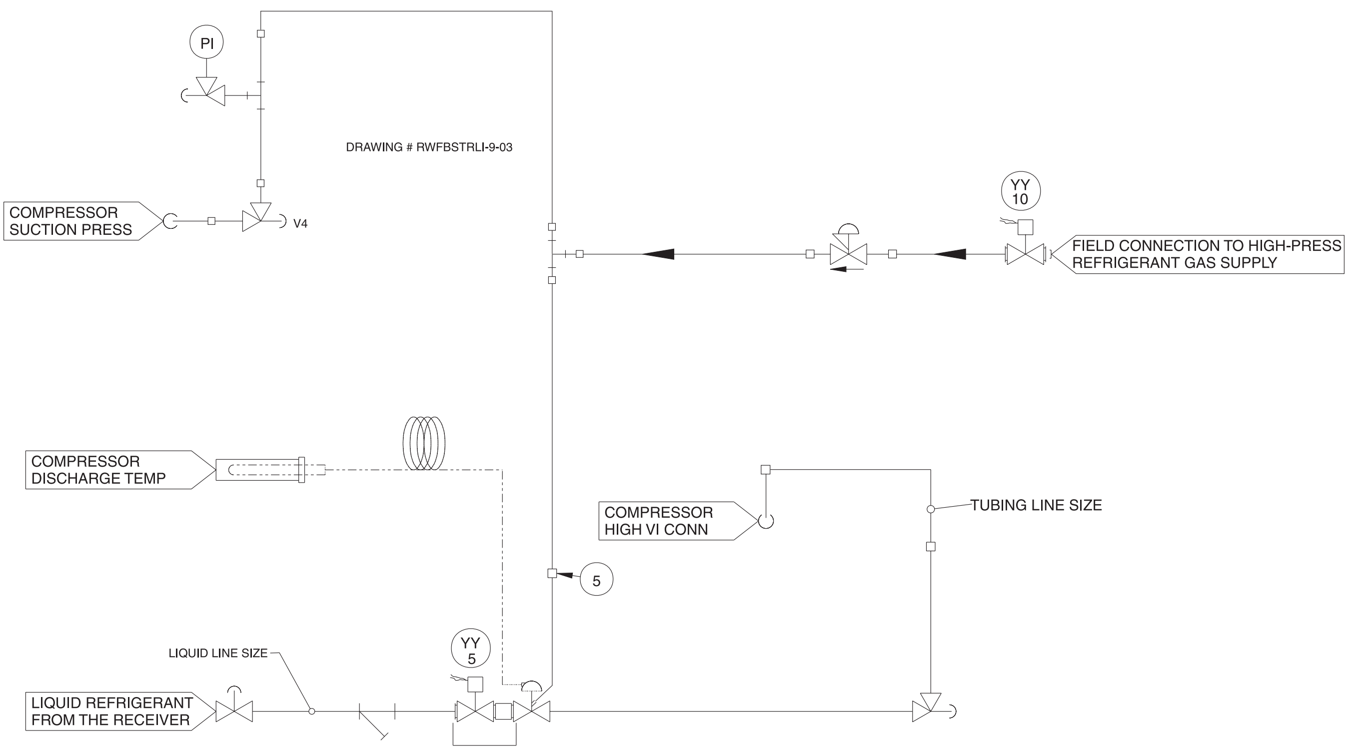
P & I DIAGRAM, LIQUID INJECTION – SINGLE PORT



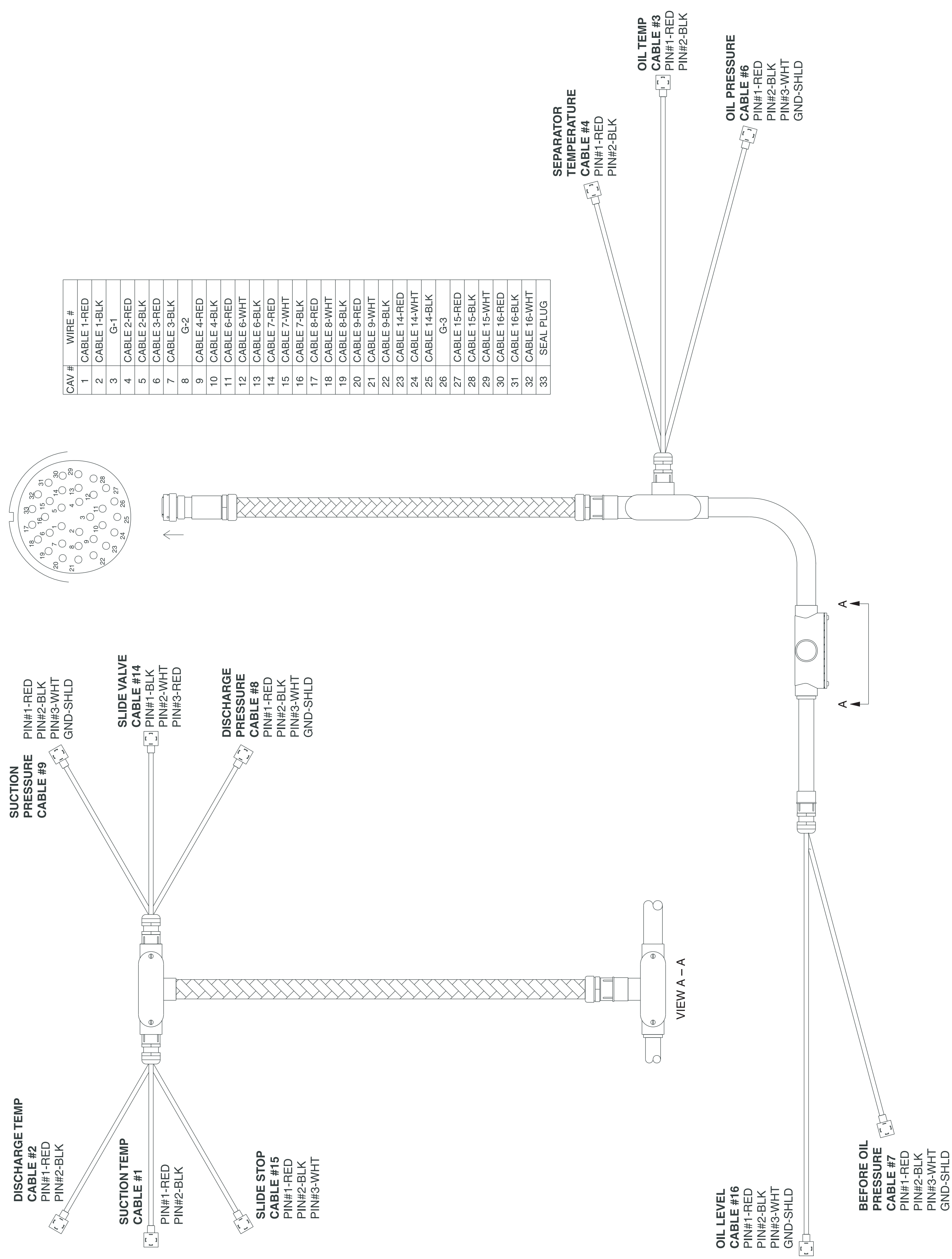
P & I DIAGRAM, LIQUID INJECTION – DUAL PORT



P & I DIAGRAM, LIQUID INJECTION – BOOSTER

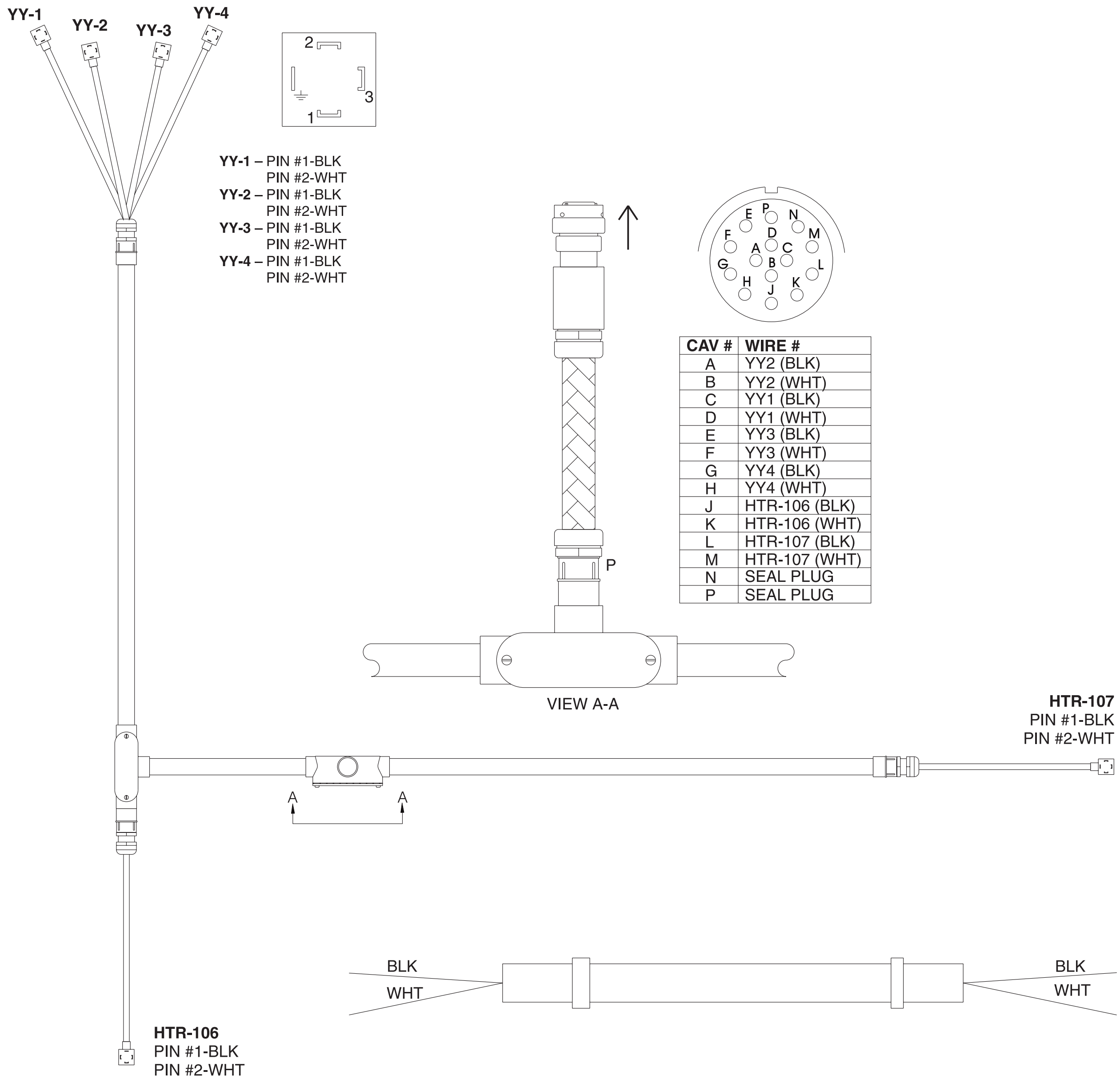


WIRING HARNESS - External Transducers for Board #1



CAV #	WIRE #
1	CABLE 1-RED
2	CABLE 1-BLK
3	G-1
4	CABLE 2-RED
5	CABLE 2-BLK
6	CABLE 3-RED
7	CABLE 3-BLK
8	G-2
9	CABLE 4-RED
10	CABLE 4-BLK
11	CABLE 6-RED
12	CABLE 6-WHT
13	CABLE 6-BLK
14	CABLE 7-RED
15	CABLE 7-WHT
16	CABLE 7-BLK
17	CABLE 8-RED
18	CABLE 8-WHT
19	CABLE 8-BLK
20	CABLE 9-RED
21	CABLE 9-WHT
22	CABLE 9-BLK
23	CABLE 14-RED
24	CABLE 14-WHT
25	CABLE 14-BLK
26	G-3
27	CABLE 15-RED
28	CABLE 15-BLK
29	CABLE 15-WHT
30	CABLE 16-RED
31	CABLE 16-BLK
32	CABLE 16-WHT
33	SEAL PLUG

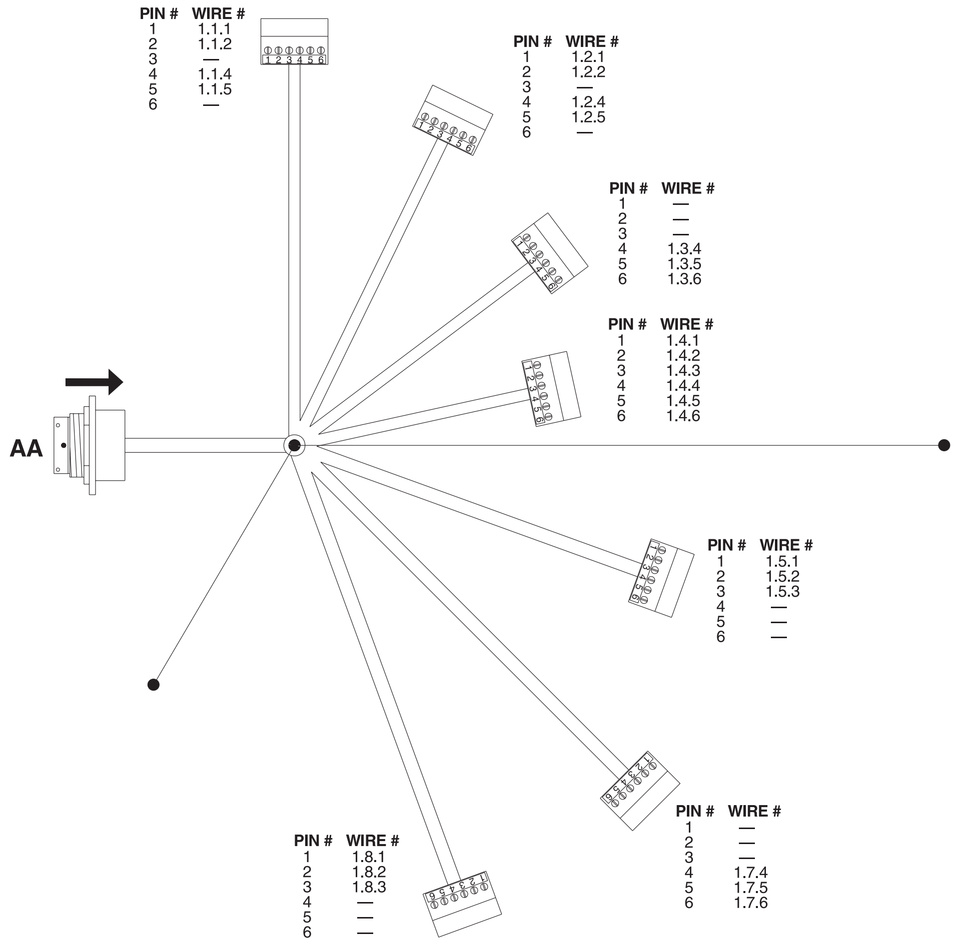
WIRING HARNESS - External AC to Heaters and Valves



CAV #	WIRE #
A	YY2 (BLK)
B	YY2 (WHT)
C	YY1 (BLK)
D	YY1 (WHT)
E	YY3 (BLK)
F	YY3 (WHT)
G	YY4 (BLK)
H	YY4 (WHT)
J	HTR-106 (BLK)
K	HTR-106 (WHT)
L	HTR-107 (BLK)
M	HTR-107 (WHT)
N	SEAL PLUG
P	SEAL PLUG

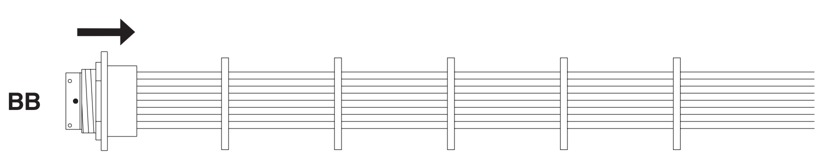
WIRING HARNESS - Internal Analog Board #1

CAV NO.	WIRE NO.
1	1.1.1
2	1.1.2
3	G-1
4	1.1.4
5	1.1.5
6	1.2.1
7	1.2.2
8	G-2
9	1.2.4
10	1.2.5
11	1.3.4
12	1.3.5
13	1.3.6
14	1.4.1
15	1.4.2
16	1.4.3
17	1.4.4
18	1.4.5
19	1.4.6
20	1.5.1
21	1.5.2
22	1.5.3
23	1.7.4
24	1.7.5
25	1.7.6
26	G-3
27	1.8.1
28	1.8.3
29	1.8.2
30	1001
31	1000
32	1002
33	SEAL PLUG



WIRING HARNESS - AC Conduit - Quantum to DBS Panel

WIRING HARNESS - Internal AC to Heaters and Valves



CAV NO.	WIRE NO.
A	YY2-17
B	YY2-2
C	YY1-16
D	YY1-2
E	YY3-15
F	YY3-2
G	YY4-14
H	YY4-2
J	HTR-106
K	HTR-102
L	HTR-107
M	HTR-102
N	HTR-108
P	HTR-102

PROPER INSTALLATION OF ELECTRONIC EQUIPMENT IN AN INDUSTRIAL ENVIRONMENT

In today's refrigeration plants, electronic controls have found their way into almost every aspect of refrigeration control. Electronic controls have brought to the industry more precise control, improved energy savings and operator conveniences. Electronic control devices have revolutionized the way refrigeration plants operate today.

The earlier relay systems were virtually immune to radio frequency interference (RFI), electromagnetic interference (EMI), and ground loop currents. Therefore installation and wiring were of little consequence and the wiring job consisted of hooking up the point-to-point wiring and sizing the wire properly. In an electronic system, improper installation will cause problems that outweigh the benefits of electronic control. Electronic equipment is susceptible to RFI, EMI, and ground loop currents which can cause equipment shutdowns, processor memory and program loss, erratic behavior, and false readings. Manufacturers of industrial electronic equipment take into consideration the effects of RFI, EMI, and ground loop currents and incorporate protection of the electronics in their designs. These manufacturers require that certain installation precautions be taken to protect the electronics from these effects. All electronic equipment must be viewed as sensitive instrumentation and therefore requires careful attention to installation procedures. These procedures are well known to instrument engineers, but are usually not followed by general electricians.

There are a few basics, that if followed, will result in a trouble-free installation. The National Electric Code (NEC) is a guideline for safe wiring practices, but it does not deal with procedures used for electronic control installation. **Use the following procedures for electronic equipment installation.** These procedures do not override any rules by the NEC, but are to be used in conjunction with the NEC code.

WIRE SIZING

Size supply wires one size larger than required for amperage draw to reduce instantaneous voltage dips caused by large loads such as heaters and contactors and solenoids. These sudden dips in voltage can cause the processor, whether it be a microprocessor, a computer, or a PLC to malfunction momentarily or cause a complete reset of the control system. If the wire is loaded to its maximum capacity, the voltage dips are much larger, and the potential of a malfunction is very high. If the wire is sized one size larger than required, the voltage dips are smaller than in a fully loaded supply wire, and the potential for malfunction is much lower. The NEC code book calls for specific wire sizes to be used based on current draw. An example of this would be to use #14 gauge wire for circuits up to 15 amp or #12 gauge wire for circuits of up to 20 amp. Therefore, when connecting the power feed circuit to an electronic industrial control, use #12 gauge wire for a maximum current draw of 15 amp and #10 wire for a maximum current draw of 20 amp. Use this rule of thumb to minimize voltage dips at the electronic control.

VOLTAGE SOURCE

Selecting the voltage source is extremely important for proper operation of electronic equipment in an industrial environment. Standard procedure for electronic instrumentation is to provide a "clean" separate source voltage in order to prevent EMI, from other equipment in the plant, from interfering with the operation of the electronic equipment. Connecting electronic equipment to a breaker panel (also known as lighting panels and fuse panels) subjects the electronic equipment to noise generated by other devices connected to the breaker panel. This noise is known as electromagnetic interference (EMI). EMI flows on the wires that are common to a circuit. EMI cannot travel easily through transformers and therefore can be isolated from selected circuits. **Use a control transformer to isolate the electronic control panel from other equipment in the plant that generate EMI. (Figure 1)**

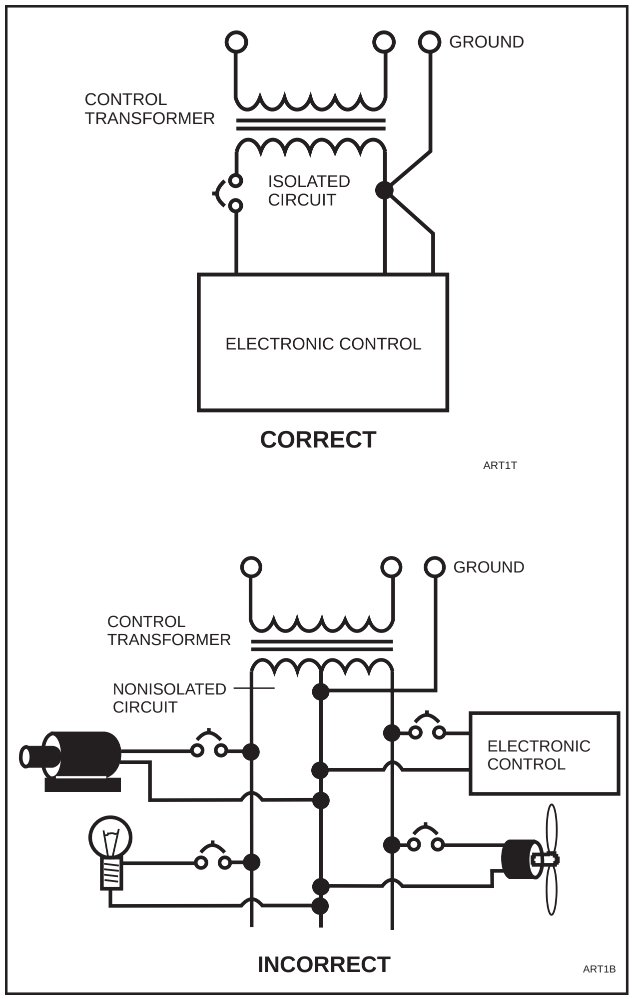


Figure 1

GROUNDING

Grounding is the most important factor for successful operation and is also the most overlooked. The NEC states that control equipment may be grounded by using the rigid conduit as a conductor. This worked for the earlier relay systems, but it is not acceptable for electronic control equipment. Conduit is made of steel and is a poor conductor relative to a copper wire. Electronic equipment reacts to very small currents and must have a good ground in order to operate properly; therefore, **copper grounds are required for proper operation. Note: aluminum may be used for the large three-phase ground wire.**

The ground wire must be sized the same size as the supply wires or one size smaller as a minimum. The three phase power brought into the plant must also have a ground wire, making a total of four wires. In many installations that are having electronic control problems, this essential wire is usually missing. A good ground circuit must be continuous from the plant source transformer to the electronic control panel for proper operation. (Figure 2) Driving a ground stake at the electronic control will cause additional problems since other equipment in the plant on the same circuits will ground themselves to the ground stake causing large ground flow at the electronic equipment.

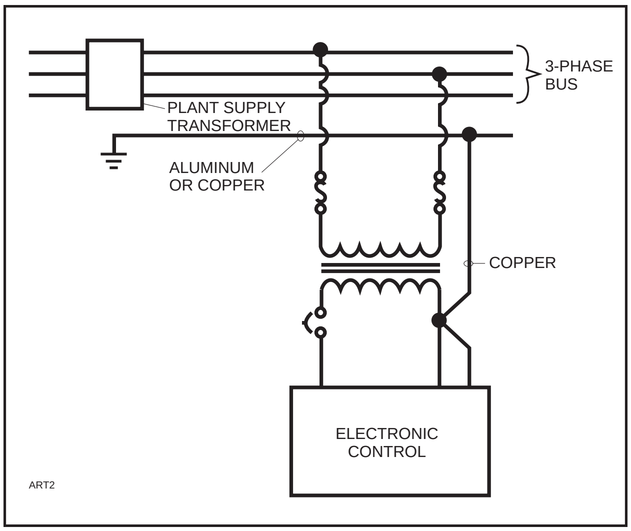


Figure 2

WIRING PRACTICES

Do not mix wires of different voltages in conduit. An example of this would be the installation of a screw compressor package. The motor voltage is 480 volts and the panel control power is 120 volts. **The 480 volt circuit must be run from the motor starter to the motor in its own conduit. The 120 volt circuit must be run from the motor starter control transformer to the control panel in its own separate conduit.** If the two circuits are run in the same conduit, transients on the 480 volt circuit will be inducted into the 120 volt circuit causing functional problems with the electronic control. Dividers must be used in wire way systems (conduit trays) to separate unlike voltages. The same rule applies for 120 volt wires and 220 volt wires. **Also, never run low voltage wires in the same conduit with 120 volt wires. (Figure 3)**

Never run any wires through an electronic control panel that do not relate to the function of the panel. Electronic control panels should never be used as a junction box. These wires may be carrying large transients that will interfere with the operation of the control. An extreme example of this would be to run the 480 volts from a motor starter through the control panel to the motor.

When running conduit to an electronic control panel, take notice of the access holes (knockouts) provided by the manufacturer. These holes are strategically placed so that the field wiring does not interfere with the electronics in the panel. **Never allow field wiring to come in close proximity with the controller boards since this will almost always cause problems.**

Do not drill a control panel to locate conduit connections. You are probably not entering the panel where the manufacturer would like you to since most manufacturers recommend or provide prepunched conduit connections. Drilling can cause metal chips to land in the electronics and create a short circuit. **If you must drill the panel, take the following precautions:** First cover the electronics with plastic and tape it to the board with masking or electrical tape. Second, place masking tape or duct tape on the inside of the panel where you are going to drill. The tape will catch most of the chips. Then clean all of the remaining chips from the panel before removing the protective plastic. It would be a good idea to call the manufacturer before drilling the panel to be sure you are entering the panel at the right place.

When routing conduit to the top of an electronic control panel, condensation must be taken into consideration. Water can condense in the conduit and run into the panel causing catastrophic failure. **Route the conduit to the sides or bottom of the panel and use a conduit drain.** If the conduit must be routed to the top of the panel, use a sealable conduit fitting which is poured with a sealer after the wires have been pulled, terminated and the control functions have been checked. **A conduit entering the top of the enclosure must have an "O" ring-type fitting between the conduit and the enclosure** so that if water gets on top of the enclosure it cannot run in between the conduit and the enclosure. This is extremely important in outdoor applications.

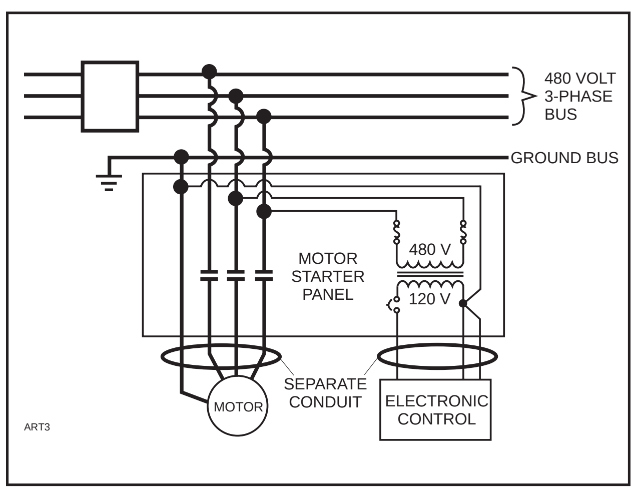


Figure 3

Never add relays, starters, timers, transformers, etc. inside an electronic control panel without first contacting the manufacturer. Contact arcing and EMI emitted from these devices can interfere with the electronics. Relays and timers are routinely added to electronic control panels by the manufacturer, but the manufacturer knows the acceptable device types and proper placement in the panel that will keep interference to a minimum. If you need to add these devices contact the manufacturer for the proper device types and placement.

Never run refrigerant tubing inside an electronic control panel. If the refrigerant is ammonia, a leak will totally destroy the electronics.

If the electronic control panel has a starter built into the same panel, be sure to run the higher voltage wires where indicated by the manufacturer. EMI from the wires can interfere with the electronics if run too close to the circuitry.

Never daisy-chain or parallel-connect power or ground wires to electronic control panels. Each electronic control panel must have its own supply wires back to the power source. Multiple electronic control panels on the same power wires create current surges in the supply wires which can cause controller malfunctions. Daisy-chaining ground wires allows ground loop currents to flow between electronic control panels which also causes malfunctions. (Figure 4)

It is very important to read the installation instructions thoroughly before beginning the project. Make sure you have drawings and instructions with your equipment. If not, call the manufacturer and have them send you the proper instructions. Every manufacturer of electronic equipment should have a knowledgeable staff, willing to answer your questions or fax additional information. Following correct wiring procedures will ensure proper installation of your electronic equipment.

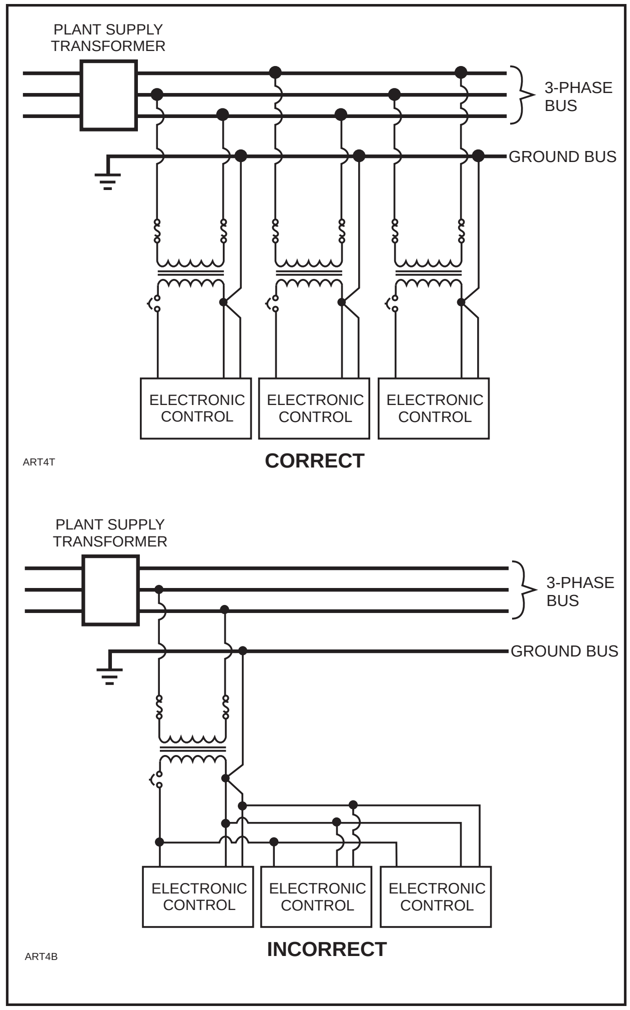


Figure 4

OPERATING LOG SHEET

SCREW COMPRESSOR
Operating Log Sheet

Frick Order No. ____________________

Compr. Ser. No. ____________________

Unit Location ____________________

Date												
Time												
Hour Meter Reading												
Equipment Room Temp./Outdoor Temp.			/	/	/	/	/	/	/	/	/	/
Compressor		Suction Pressure										
Compressor		Suction Temperature										
Compressor		Suction Superheat										
Compressor		Discharge Pressure										
Compressor		Corresponding Temperature										
Compressor		Actual Discharge Temperature										
Compressor		Oil Pressure										
Compressor		Oil Temperature										
Compressor		Oil Filter Press. Drop - ΔP										
Compressor		Slide Valve Position %										
Compressor		Volume Ratio (V.I.)										
Compressor		FLA %										
Compressor		Seal Leakage (drops/min)										
Capacity Control Setpoint												
Oil Sep.		Separator Temperature										
Oil Sep.		Oil Level (example ◒ ●)	○ ○	○ ○	○ ○	○ ○	○ ○	○ ○	○ ○	○ ○	○ ○	○ ○
Oil Sep.		Oil Added (gallons)										
Evap.	Brine	Inlet Temperature										
Evap.	Brine	Outlet Temperature										
Evap.	Brine	Pressure Drop - ΔP										
Evap.	Brine	Flow Rate - GPM										
Condenser	Air	Air On Temperature										
Condenser	Air	Air Off Temperature										
Condenser	Water	Inlet Temperature										
Condenser	Water	Outlet Temperature										
Condenser	Water	Pressure Drop - ΔP										
Condenser	Water	Flow Rate - GPM										
Condenser	Leaving Liquid Refrigerant Temperature											
Rcvr/Econ		Level										
Rcvr/Econ		Pressure										
Remarks:												

Note: Temperature and Pressure Units in °F and PSIG respectively unless otherwise noted.

RWF COMPRESSOR PRESTART CHECKLIST

The following items MUST be checked and completed by the installer prior to the arrival of the Frick Field Service Supervisor. Details on the checklist can be found in this manual. Certain items on this checklist will be reverified by the Frick Field Service Supervisor prior to the actual start-up.

Mechanical Checks

__ Confirm that motor disconnect is open
__ Isolate suction pressure transducer
__ Pressure test and leak check unit
__ Evacuate unit
__ Remove motor tunnel cover
__ Remove coupling center and **do not reinstall**
__ Check for correct position of all hand, stop, and check valves prior to charging unit with oil or refrigerant
__ Charge unit with correct type and quantity of oil
__ Lubricate motor bearings (if applicable)
__ Check oil pump alignment (if applicable)
__ Check for correct economizer piping (if applicable)
__ Check separate source of liquid refrigerant supply (if applicable, liquid injection oil cooling)
__ Check water supply for water-cooled oil cooler (if applicable, water cooled oil cooling)
__ Check thermosyphon receiver refrigerant level (if applicable, thermosyphon oil cooling)

Electrical Checks

__ Confirm that main disconnect to motor starter and micro is open
__ Confirm that electrical contractor has seen this sheet, all pertinent wiring information, and drawings
__ Confirm proper power supply to the starter package
__ Confirm proper motor protection (breaker sizing)
__ Confirm that all wiring used is stranded copper and is 14 AWG or larger (sized properly)
__ Confirm all 120 volt control wiring is run in a separate conduit from all high voltage wiring
__ Confirm all 120 volt control wiring is run in a separate conduit from oil pump and compressor motor wiring
__ Confirm no high voltage wiring enters the micro panel at any point
__ Check current transformer for correct sizing and installation
__ Check all point-to-point wiring between the micro and motor starter
__ Confirm all interconnections between micro, motor starter, and the system are made and are correct

After the above items have been checked and verified:

__ Close the main disconnect from the main power supply to the motor starter
__ Close the motor starter disconnect to energize the micro
__ Manually energize oil pump and check oil pump motor rotation
__ Manually energize compressor drive motor and check motor rotation
__ Leave micro energized to ensure oil heaters are on and oil temperature is correct for start-up

Summary: The Frick Field Service Supervisor should arrive to find the above items completed. He should find an uncoupled compressor drive unit (to verify motor rotation) and energized oil heaters with the oil at the proper standby temperatures. Full compliance with the above items will contribute to a quick, efficient and smooth start-up.

The Start-up Supervisor will:

1. Verify position of all valves
2. Verify all wiring connections
3. Verify compressor driver rotation
4. Verify oil pump motor rotation
5. Verify the % of FLA on the micro display
6. Verify and finalize alignment
7. Calibrate slide valve and slide stop
8. Calibrate temperature and pressure readings
9. Correct any problem in the package
10. Instruct operation personnel

Note: Customer connections are to be made per the electrical diagram for the motor starter listed under the installation section and per the wiring diagram found in Frick publication S90-010 M.

Sign this form & fax to 717-762-2422 to confirm completion.

Signed: ______________________________
Print Name: ______________________________
Company: ______________________________

START-UP REPORT

Sold To: ____________________ Contact Name: ____________________ Date: ____________
End User: ____________________ Contact Name: ____________________ Phone: ____________
End User Address: ____ Fax No: ____________
City, State, Zip: ______________________________ Start-up Rep. ____________________

Unit General Information

Unit Model # ____________________ Customer Package Identification # ____________________
Compressor Serial # ____________________ Separator National Board # ____________________
Unit Serial # ____________________ Oil Cooler National Board # ____________________
Refrigerant ☐ R-717 ☐ R-22 ☐ R-290 ☐ Other ____________
Lube Oil Type ☐ 2A ☐ 3 ☐ 4 ☐ 9 ☐ Other ______ Design Operating Conditions
Lube System ☐ None ☐ Prelube ☐ Cycling ☐ Full ☐ Demand ______ °Suct./ ______ °Disch.
Oil Cooling ☐ TSOC ☐ WCOC ☐ S-LIOC ☐ D-LIOC ☐ GCOC
Oil Filters ☐ Single ☐ Dual Micro Log I.D. ____________

Micro Information

Micro Type ☐ Quantum ☐ Plus ☐ Standard ☐ Electromechanical U3, U4, U5 Program ________
SBC / CPU Serial # ________ Rev. ___ U24/U35 Program ID/OS Ver # ________ and Date ________
U36 Bios Ver # ______ and Date ________ U42 Keyboard Ver # ________ and Date ________
Digital I/O Board #1 Serial # ________ Rev. ______ U8 Digital I/O Ver # ________ and Date ________
Digital I/O Board #2 Serial # ________ Rev. ______ U8 Digital I/O Ver # ________ and Date ________
Analog Board #1 Serial # ________ Rev. ______ U13 Analog Ver # ________ and Date ________
Analog Board #2 Serial # ________ Rev. ______ U13 Analog Ver # ________ and Date ________

Compressor Motor Information

Manufacturer ____________________ Frame Size ________ H.P. ________ RPM ________
Serial # ____________________ Service Factor ________ Voltage ________ Hz ______ FLA ________
Design ________ Code ________ Bearing Type ☐ Antifriction ☐ Sleeve

Compressor Motor Starter Information

Manufacturer ____________________ Serial # ____________________
Starter Type ☐ WDCT ☐ ATL ☐ Auto-Trans ☐ Solid State ☐ Digital DBS ☐ Standalone DBS
CT Location Checked ☐ CT Phase ______ CT Ratio ______ Transition Time ________ DBS Ver. # ________

Oil Pump Information

Pump Manufacturer ____________ Model # ____________ Serial # ____________
Motor Manufacturer ____________ H.P. ________ RPM ________ Serial # ____________
Service Factor ______ Voltage ______ Hz ________ FLA ________ Design ______ Code ____ Starter Size ____

Special Options

☐ DX Economizer ☐ Frick Supplied Starter ☐ PC Control System ☐ Other

Prestart Checks

☐ Position of all valves ☐ All wiring connections ☐ Motor rotation ☐ Oil pump motor rotation
☐ All micro settings ☐ Cold alignment ☐ Proper oil charge ☐ Installation, Foundation

Factory Setup Options (Quantum™)

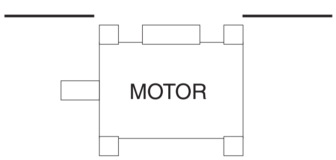
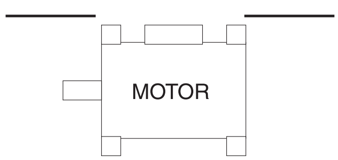
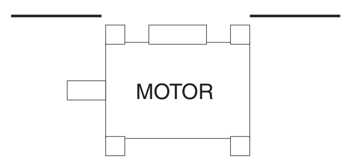
☐ RWB II ☐ RWF ☐ RXF ☐ RDB 3-Step ☐ RDB 4-Step ☐ Other ☐ GSV II ☐ GST ☐ GSF ☐ GSB
☐ No Pump ☐ Prelube ☐ Cycling ☐ Full Time ☐ Dual ☐ Oil Filter Transducer ☐ Yes ☐ No
Refrigerant ________ K-Factor for User Defined Refrigerant ________ Slide Valve Travel ________
Dual Dischaarge Control ☐ Enabled ☐ Disabled Liquid Injection Cooling ☐ Enabled ☐ Disabled
Main Oil Injection Control ☐ Enabled ☐ Disabled Balance Piston Setup ☐ Enabled ☐ Disabled
Oil Log Setup ☐ Enabled ☐ Disabled Enable Aux 1 & 2 ☐ None ☐ 1 ☐ 2 ☐ Both

Adjustable Safety Setpoints

High Discharge Pressure Stop Load _____ Force Unload ____ Alarm ______ Delay _____ Shutdown ____ Delay ____
High Discharge Temp. Stop Load _____ Force Unload ____ Alarm ______ Delay _____ Shutdown ____ Delay ____
Motor Amps ____ Volts _____ Service Factor _______ Horsepower _______ CT Factor ______ Recycle Delay ______
Low Motor Amps Shutdown _____ Delay ______ Force Unload Inhibit Delay ______
High Motor Amps Stop Load _____ Force Unload ____ Alarm ______ Delay _____ Shutdown ____ Delay ____
High Oil Temperature Alarm _______ Delay ______ Shutdown ______ Delay ______
Low Oil Temperature Alarm _______ Delay ______ Shutdown ______ Delay ______ High Level Shutdown Delay ____
Low Separator Oil Temp. Alarm _______ Delay ______ Shutdown ______ Delay ______

Drive Train Alignment

Ambient Temperature at Time of Alignment _______ Oil Separator Temperature at Time of Alignment ________
Motor Coupling Type __________ Size ___________ Distance Between Coupling Hub Faces _________
Soft Foot Check ☐ OK as Found ☐ Shimming Required Amount of Shims used to Correct _________
Indicator Readings in ☐ in./1000 ☐ mm Indicator Clamped to ☐ Motor ☐ Compressor
Indicator Readings Facing ☐ Compressor ☐ Motor Magnetic Center Checked ☐ Marked ☐ N/A
Compressor Coupling Hub Runout __________ Motor Coupling Hub Runout ____________

Initial Cold Alignment	Initial Hot Alignment	Final Hot Alignment
Face Rim	Face Rim	Face Rim
Thickness of Shims Added	Thickness of Shims Added	Thickness of Shims Added
		

Operating Log Sheet

Date							
Time							
Hour Meter Reading							
Equip. Room Temp.							
Suction Pressure							
Suction Temperature							
Suction Superheat							
Discharge Pressure							
Discharge Temperature							
Corresponding Temperature							
Oil Pressure							
Oil Temperature							
Oil Filter Pressure Drop							
Separator Temperature							
Slide Valve Position							
Volume Ratio (VI)							
Motor Amps / FLA %							
Capacity Control Setpoint							
Oil Level							
Oil Added							
Seal Leakage (Drops/Min.)							

VIBRATION DATA SHEET

Date: ______________________________
End User: ______________________________
Address: ______________________________

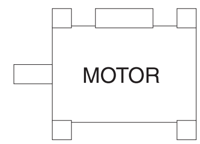
Sales Order Number: ______________________
Installing Contractor: ______________________
Service Technician: ______________________

Equipment ID (As in Microlog): ________________
Compressor Serial Number: ________________
Unit Serial Number: ______________________
National Board Number: ________________
Running Hours: ______________________
Manufacturer and Size of Coupling: ____________
Motor Manufacturer: RAM ____________________
Motor Serial Number: ______________________
RPM: ______ Frame Size: _________ H.P. ________
Refrigerant:
Ambient Room Temperature: __________°F
Operating Conditions:

Final Hot Alignment

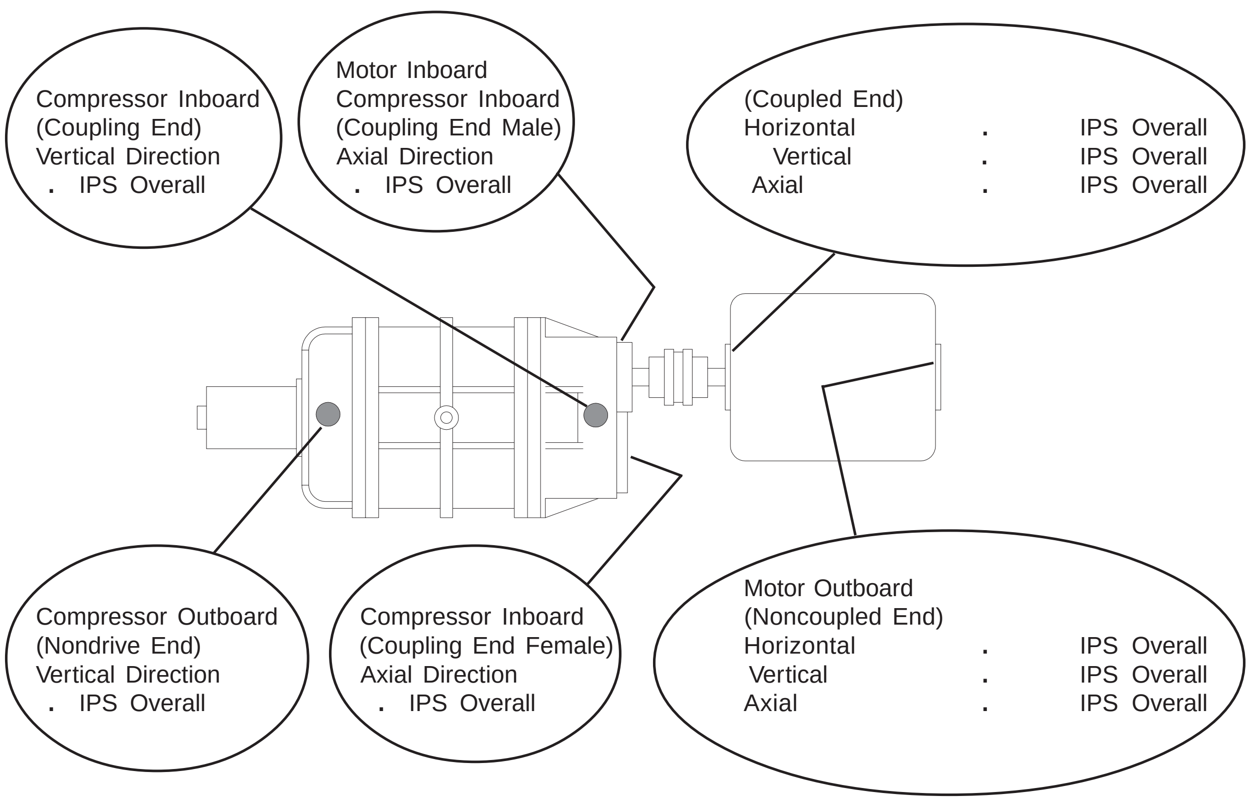
Total Thickness of Shims Added

Soft Foot **Soft Foot**



Soft Foot **Soft Foot**

SUCTION	**DISCHARGE**	**OIL**	**SEPARATOR**	**Slide Valve Position %**
Press #	Press #	Press #	Temp °F	V.I. Ratio
Temp °F	Temp °F	Temp °F		F.L.A. %



RECOMMENDED SPARE PARTS - CURRENT DESIGN

QUANTUM™ CONTROL:			
Assembly, VGA Display, Phillips (Display only, 649C1078H01)	1	ALL	642C0052G01
Inverter, Sharp & Phillips (TDK)	1	ALL	333Q0001582
Power Supply	1	ALL	640C0022G01
Cable, CCFT Backlight Inverter (for Phillips Display)	1	ALL	649D4824H01
Keypad, Overlay	1	ALL	640D0060H01
Board, Analog	1	ALL	640C0026G01
Board, Digital	1	ALL	640C0024G01
Module, Output, 280V (For 115/230V)	2	ALL	111Q0281061
Module, Input, 90-140V (For 115V)	1	ALL	333Q0000116
Fuse, 5 Amp, 250V, I/O Board	4	ALL	333Q0001326
Relay, 3PDT, 115V	1	ALL	333Q0000206
Relay, 2PDT, 24VDC	1	ALL	333Q0001095
Fuse, 2 Amp, Quantum Panel	1	ALL	333Q0001672
UNIT:			
Temperature Probe, Element Less Well (TE-1—4)	1	ALL	649A0994H01
Transducer, Pressure, 0—200 PSIA (PE-4)	1	ALL	913A0110H01
Transducer, Pressure, 0—500 PSIA (PE-1—3)	1	ALL	913A0110H02
Coil, 120V 60Hz, 110V 50Hz, Solenoid Valve	2	ALL	951A0092H04
Coil, 220V 50Hz, 240V 60Hz, Solenoid Valve	2	ALL	951A0092H05
Coil, 240V 50Hz, Solenoid Valve	2	ALL	951A0092H06
Seal Kit, Solenoid Valve	1	ALL	951A0056H34
Transmitter, Linear, Slide Valve (less well)	1	ALL	534D1251H03
Transmitter, Linear, Slide Stop (less well	1	ALL	534C1478H02
Heater, Oil, 500W, 120V	1	ALL	913A0092G01
Heater, Oil, 1000W, 120V	1	ALL	913A0092G02
Heater, Oil, 500W, 240V	1	ALL	913A0092G03
Heater, Oil, 1000W, 240V	1	ALL	913A0092G04
Filter, Coalescing, Convoluted	A/R	ALL	531B0065H01
Gasket, Manway For Coalescer	1	ALL	531A0105H04
Element, Oil Filter, SuperFilter™ (Required for 1-2-3 Warranty)	A/R	ALL	531A0218H01
Gasket, End Cover For 531A0218H01 Above	A/R	ALL	959A0082H01
Gasket, Clamping Plate For 531A0218H01 Above	A/R	ALL	959A0053H01
Seal, Center for 531A0218H01 Above	A/R	ALL	900A0007H01
Gasket, Bottom For 531A0218H01 Above	A/R	ALL	333Q0001236
Shaft Seal Replacement Kit	1	100 &134	534M0163G02
Shaft Seal Replacement Kit	1	177 - 270	534M0163G03
Shaft Seal Replacement Kit	1	316 - 480	534M0163G04

NOTE: This list is based on one unit. When stocking for more than one unit, the quantity should be adjusted to meet your individual requirements.

YORK Refrigeration Systems
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