Frick®
INDUSTRIAL REFRIGERATION

Form 070.250-IOM1 (NOV 2013)

**INSTALLATION - OPERATION - MAINTENANCE**

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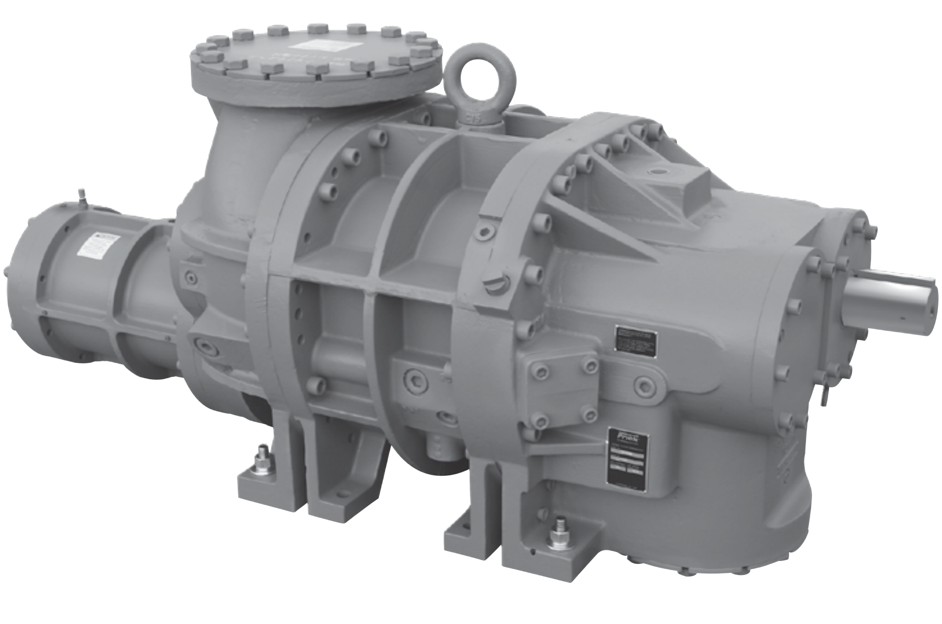
# TDS_
# ROTARY SCREW COMPRESSOR

## MODELS TDS_163 - TDS_355



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

# CONTENTS



**Referenced manuals:**

| | |
|---|---|
| 090.020-M | Quantum LX Maintenance |
| 160.802-SPC | Compressor Oil Specifications |
| 090.022-O | Quantum HD Operation |

## 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.**

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

**THE INFORMATION CONTAINED IN THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE**

# GENERAL INFORMATION

## PREFACE

This manual has been prepared to acquaint the owner and serviceman with the INSTALLATION, OPERATION, and MAINTENANCE procedures as recommended by Johnson Controls-Frick for tds_ Rotary Screw Compressors.

It is most important that these compressors be properly applied to an adequately controlled refrigerant or gas system. Your authorized Johnson Controls-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 screw compressor is a VAPOR PUMP. To be certain that it is not being subjected to pumping liquid, it is necessary that 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 are made for control; operating cycles and stand still periods are reasonable; and that high side components are sized within system and compressor design limits.

**It is required that the discharge temperature be kept high enough to prevent condensation of any moisture in the compressor and oil separator.**

## DESIGN LIMITATIONS

TDS_ compressors are designed for operation within the pressure and temperature limits which are specified by Johnson Controls-Frick and the Johnson Controls-Frick selection software COOLWARE™. They are primarily used for compressing refrigerant gas and most hydrocarbon gasses.

If your application is for sour gas, there are special requirements to protect the compressor. Contact Johnson Controls - Frick Compressor Engineering for application details.

## 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.

## STANDARD BARE COMPRESSOR

Items not included with bare compressor that are available as sales order options: Solenoid Valves, Tank Drain Tubing (T connection), Oil Feed Line (P connection), Connection Fittings, Coupling.

## 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 Johnson Controls-Frick Sales Administration Department, in Waynesboro, PA.

## COMPRESSOR IDENTIFICATION

Each compressor has an identification data plate, containing compressor model and serial number mounted on the compressor body.

**NOTICE**

**When inquiring about the compressor or unit, or ordering repair parts, provide the MODEL, SERIAL, and JOHNSON CONTROLS - FRICK SALES ORDER NUMBERS from the data plate. See Figure 1.**

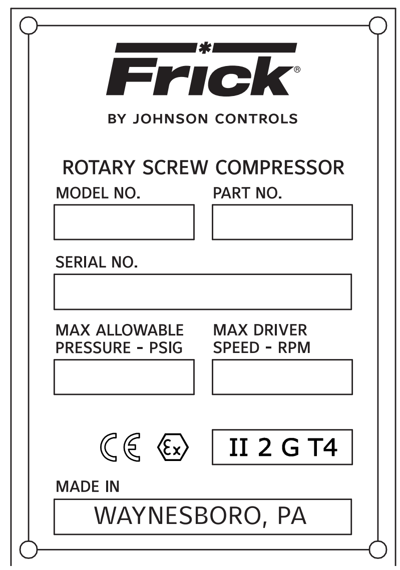



**Figure 1. Compressor Identification Data Plate**

Rotary screw compressor serial numbers are defined by the following information:

**EXAMPLE: 10240A90000015Z**

| PLANT | DECADE | MONTH | YEAR | GLOBAL SEQ NO. | ADDITIONAL REMARKS |
|---|---|---|---|---|---|
| 1024 | 0 | A | 9 | 0000015 | Z |

**Plant:** 1024 = Waynesboro, 1153 = Monterrey

**Month:**
A = JAN, B = FEB, C = MAR, D = APR, E = MAY, F = JUN,
G = JUL, H = AUG, K = SEP, L = OCT, M = NOV, N = DEC.

**Additional Remarks:**
R = Remanufactured;
R1 = Rebuild;
R2 = Rebuild Plus;
Z = Deviation from Standard Configuration.

| COMPRESSOR MODEL | ROTOR DIAMETER | ROTOR | MAX SPEED | GEOMETRICAL SWEPT VOLUME DRIVE SHAFT END | | DISPLACEMENT | |
|---|---|---|---|---|---|---|---|
| | | | | | | 3550 RPM | 2950 RPM |
| | MM | L/D | RPM | FT³/ REV | M³/REV | CFM | M³/H |
| TDSH 163S | 163 | 1.35 | 4500 | 0.10069 | 0.002849 | 357 | 504 |
| TDSH 163L | 163 | 1.7 | 4500 | 0.12679 | 0.003588 | 450 | 635 |
| TDSH/TDSL 193S | 193 | 1.35 | 4500 | 0.16653 | 0.004713 | 591 | 834 |
| TDSH/TDSL 193L | 193 | 1.8 | 4500 | 0.22204 | 0.006284 | 788 | 1112 |
| TDSH/TDSL 233S | 233 | 1.35 | 4500 | 0.29301 | 0.008292 | 1040 | 1468 |
| TDSH/TDSL 233L | 233 | 1.7 | 4500 | 0.36897 | 0.010442 | 1310 | 1848 |
| TDSH 233XL | 233 | 2.1 | 4500 | 0.45580 | 0.012899 | 1618 | 2283 |
| TDSH/TDSL 283S | 283 | 1.35 | 4200 | 0.52501 | 0.014858 | 1864 | 2630 |
| TDSH/TDSL 283L | 283 | 1.7 | 4200 | 0.66115 | 0.018711 | 2347 | 3312 |
| TDSH 283SX | 283 | 2.1 | 4200 | 0.79546 | 0.022512 | 2824 | 3985 |
| TDSH/B 355S | 355 | 1.1 | 4200 | 0.89858 | 0.025430 | 3190 | 4501 |
| TDSH/B 355L | 355 | 1.5 | 4200 | 1.12154 | 0.031739 | 3981 | 5618 |
| TDSH/B 355XL | 355 | 1.9 | 4200 | 1.42748 | 0.040398 | 5068 | 7150 |
| TDSB355U | 355 | 2.4 | 4200 | 1.80328 | 0.051033 | 6402 | 9033 |

**Table 2. Geometrical Swept Volume**

The name plates in Figure 2 show which refrigerants are compatible with the compressor as manufactured.

COMPRESSOR OPERATES ON AND IS COMPATIBLE WITH THE FOLLOWING REFRIGERANTS:

R22, R23, R32, R50, R123, R125, R134a, R142b, R170, R218, R236fa, R245fa, R290, R404A, R407C, R410A, R507, R508, R508B, R600, R600A, R717, R728, R729, R744, R1150, AMMONIA, NATURAL GAS

COMPRESSOR OPERATES ON AND IS COMPATIBLE WITH THE FOLLOWING REFRIGERANTS:

R290, R1270, NATURAL GAS

**Figure 2. Refrigerant Name Plates**

## LONG TERM STORAGE

Long term storage (6 months to 5 years) provisions are required, regardless of storage environment, if start-up and/or useful operation does not occur within six (6) months of equipment shipment. Special provisions may be required for storage of less than six (6) months if the storage area is subject to unusual environment such as high humidity, large changes in temperature, dusty atmosphere, etc.

The standard Johnson Controls-Frick Warranty for an TDS_ screw compressor covers twelve (12) months from start-up or 18 months from shipment, whichever comes first. It is recommended that arrangements be made with the local JOHNSON CONTROLS-FRICK service organization (arranged through factory service) regarding surveillance and maintenance during the storage period. It will be the customer's responsibility to submit a monthly report showing the condition of the unit and noting any discrepancies to the guidelines listed herein. Failure to comply with this Long Term Storage Recommendation may void the warranty.

| COMPRESSOR AND PACKAGED EQUIPMENT STORAGE LOG | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MODEL | SERIAL NO. | COMPRESSOR* SHAFT ROTATION 1½ TURN | ROTOR HOUSING CHARGE | CHARGE ADDED | VISUAL INSPECTION PER QAI-3 | CHARGE | CHECKED BY | DATE |
| | | | | | | | | |
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**Compressor, Motor, Oil Pump and Refrigerant Pump*

**Table 3. Storage Log**

Long term storage of equipment may lead to the deterioration of components over the period of time. Synthetic components in the compressor may deteriorate over time even if they are kept flooded with oil. A warm and dry environment is essential to minimize environmental and corrosion damage. Long term storage of the affected equipment at a customer's site may involve additional requirements and interested parties should refer to the Johnson Controls web site, www.johnsoncontrols.com/frick, for specific instructions (Location: Bare Compressors\General\Warranties\Screw Compressor Purchased for Long Term Storage).

The following guidelines must be followed to maintain the SCREW COMPRESSOR WARRANTY.

## PREPARING COMPRESSOR FOR STORAGE

Evacuate compressor to remove moisture. Evacuation lines are to be connected to port SM1. Evacuation lines are to be connected to the three Schrader valves provided with the compressor. One valve is connected to compressor suction. The other two valves are located at the block on the cylinder.

Break vacuum with dry nitrogen and bring pressure to 0 psig.

Pump oil into the same ports mentioned in step 1. Johnson Controls-Frick recommends break-in oil P/N 111Q0831809 for storage purposes. The amounts of oil needed per compressor are:

163mm - 8Gal
193mm - 12Gal
233mm - 15Gal
283mm - 25Gal
355mm - 35Gal

After compressor is oil charged, pressurize compressor to 15 psig with nitrogen.

## MAINTAINING COMPRESSOR

Ensure that the 5-15 psig nitrogen charge is maintained with 15 psig preferred.

Rotate the male rotor shaft every two weeks. Mark the shaft to ensure the rotor does not return to the original position.

The compressor must be stored inside a dry building environment.

Grease the male rotor shaft to prevent rust.

Record all information in a "Compressor Long Term Storage Log." See bottom of page 4.

**Contact Johnson Controls-Frick Service with any questions regarding long term storage.**

## DESCRIPTION

### TDS_ COMPRESSOR

The Frick TDS_ 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, two-point or four-point angular contact ball bearings to carry axial loads are mounted at the discharge end of compressor.

3. Balance piston 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 infinite step capacity control from 100 to 10%.

5. VOLUMIZER volume ratio control to allow infinitely variable volume ratio from 2.2 to 5.0 during compressor operation for all models except TDSH 283SX which is 2.2 to 4.2.

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

7. Bearing and casing design for 400 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 shaft, suitable for all types of drives. **SEE WARNING**.

**⚠ WARNING**

**Compressor rotation is clockwise when facing the compressor drive shaft. The compressor should never be operated in reverse rotation, as bearing damage will result.**

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

### COMPRESSOR LUBRICATION SYSTEM

The lubrication system on a TDS_ screw compressor 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 piston to help increase bearing life.

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

### OIL PUMP

A demand oil pump is required for low differential pressure applications (CoolWare™ will provide a warning when the oil differential pressure is too low). Oil being supplied to the compressor from the oil separator is at system discharge pressure. Within the compressor, oil porting to all parts of the compressor is vented back to a location in the compressor's body that is at a pressure lower than compressor discharge pressure. All oil entering the compressor is moved by the compressor rotors out the compressor outlet and back to the system oil separator.

## CONSTRUCTION DETAILS

**HOUSING:** All TDS_ screw compressor castings are close grain, pressure tight, grey cast iron to ensure structural integrity and mechanical and thermal stability under all operating conditions. Ductile iron and steel housings are also available for special applications. Contact Johnson Controls – Frick Sales for additional information.

**ROTORS:** The rotors are made from the highest quality rolled steel to exacting tolerances of the latest industry standard asymmetric profile. The four-lobed male rotor is directly connected to the driver. The six-lobed female rotor is driven by the male on a thin oil film.

**BEARINGS:** Antifriction bearings with $L_{10}$ rated life in excess of 50,000 hours (using the Frick Superfilter™) at design conditions are used for reduced frictional horsepower and superior rotor positioning, resulting in reduced power consumption, particularly at higher pressure ratios. Cylindrical roller bearings are provided to handle the radial loads and the thrust loads are absorbed by two-point or four-point angular contact bearings. In addition, a thrust balance piston is provided to reduce the thrust load and improve bearing life.

**SHAFT SEAL:** The compressor shaft seal is a single-face type with a spring-loaded carbon stationary surface riding against a cast iron rotating seat. The seal is capable of withstanding static pressure up to 400 psig. During operation it is vented to low pressure to provide extended life.

**VOLUMIZER VARIABLE VOLUME RATIO CONTROL:** The Frick compressor includes a method of varying the internal volume ratio to match the system pressure ratio. Control of the internal volume ratio eliminates the power penalty associated with over- or under-compression. Volume ratio control is achieved by the use of a slide stop which is a movable portion of the rotor housing that moves axially with the rotors to control discharge port location. The slide stop is moved by hydraulic actuation of a control piston. The range of adjustment is listed in the *COMPRESSOR VOLUME and CAPACITY RATIO* table.

**STEPLESS CAPACITY CONTROL:** Capacity control is achieved by use of a movable slide valve. The slide valve moves axially under the rotors to provide fully modulated capacity control from 100% to minimum load capacity. Minimum load capacity varies slightly with compressor model, pressure ratio, discharge pressure level, and rotor speed. See the TABLE 1 for minimum capacity for all TDS_ models.

The slide valve is positioned by hydraulic movement of its control piston. When in the unloaded position, gas is bypassed back to suction through a recirculation slot before compression begins and any work is expended, providing the most efficient unloading method available for part-load operation of a screw compressor.

**Table 1. COMPRESSOR VOLUME and CAPACITY RATIO**

| MODEL | MIN VI* | MAX VI* | MIN. CAPA-CITY % | SLIDE VALVE TRAVEL (IN.) | SLIDE STOP TRAVEL (IN.) |
|---|---|---|---|---|---|
| TDSH 163S | 2.2 | 5.0 | REFER TO COOLWARE™ | 5.494 | 2.140 |
| TDSH 163L | 2.2 | 5.0 | | 6.918 | 2.694 |
| TDSH 193S | 2.2 | 5.0 | | 6.497 | 2.530 |
| TDSL 193L | 2.2 | 5.0 | | 8.662 | 3.374 |
| TDSH 233S | 2.2 | 5.0 | | 7.843 | 3.055 |
| TDSH 233L | 2.2 | 5.0 | | 9.877 | 3.847 |
| TDSH 233XL | 2.2 | 5.0 | | 9.889 | 4.752 |
| TDSH 283S | 2.2 | 5.0 | | 9.526 | 3.710 |
| TDSH 283L | 2.2 | 5.0 | | 11.996 | 4.672 |
| TDSH 283SX | 2.2 | 4.2 | | 11.951 | 4.680 |
| TDSH/B 355S | 2.2 | 5.0 | | 10.360 | 5.690 |
| TDSH/B 355L | 2.2 | 5.0 | | 14.127 | 5.031 |
| TDSH/B 355XL | 2.2 | 5.0 | | 15.443 | 6.373 |
| TDSB 355U | 2.4 | 4.5 | | 15.482 | 6.399 |

* Optional 1.7 MIN - 3.0 MAX.

# INSTALLATION

## DESIGN LIMITS

General information for all of the models is provided below. **Please see CoolWare to determine the limits for a specific application.**

TDS_ units are arranged for direct motor drive and require a flexible drive coupling to connect the compressor to the motor. The rotor and bearing design set limitations must not be exceeded (See CoolWare). Refer to Johnson Controls - Frick Compressor Control Panel instruction 090.022-O for additional information on setpoint limits.

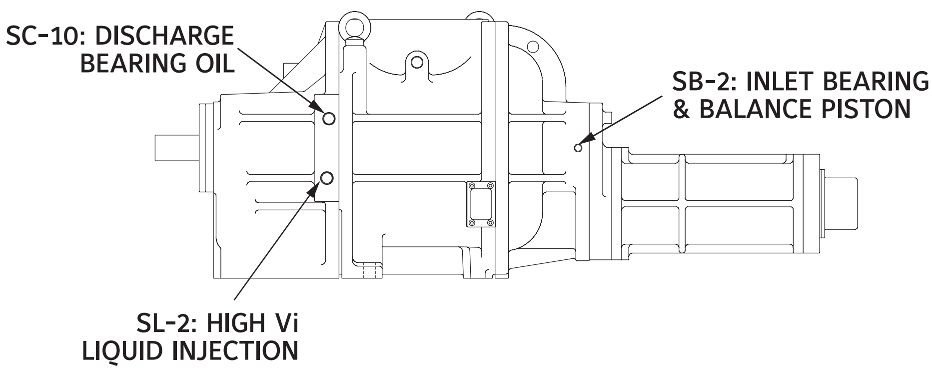
## OUTLINE DIMENSIONS

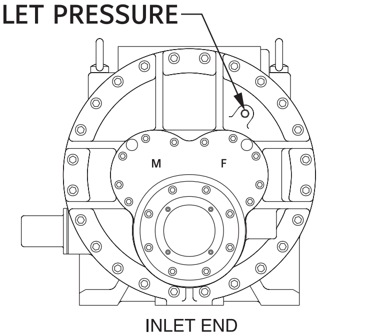
Drawings ***for reference only*** can be found on the following pages. Complete dimensions and access connections can be found on the outline drawings.

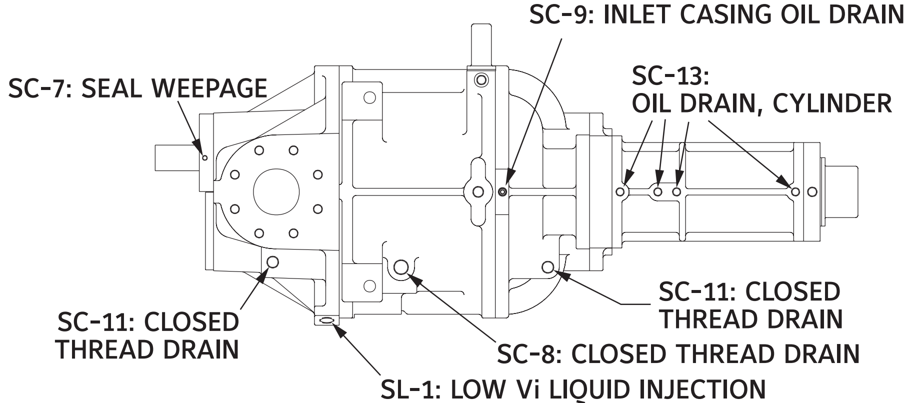
| | |
|---|---|
| TDSH 163 | DWG# 534E0424 |
| TDSH 193 | DWG# 534E0425 |
| TDSL 193 | DWG# 534E0591 |
| TDSH 233 1.35 & 1.7 | DWG# 534D0224 |
| TDSH 233 2.1 | DWG# 534E0499 |
| TDSL 233 | DWG# 534D1025 |
| TDSH 283 1.35 & 1.7 | DWG# 534E0054 |
| TDSH 283 2.1 | DWG# 534E0605 |
| TDSL 283 1.35 & 1.7 | DWG# 534E0582 |
| TDSL 283 2.4 | DWG# 534E0583 |
| TDXB 355 S, L, XL, U | DWG# 534E1406 |
| TDXH 355 S, L, XL, U | DWG# 534E1406 |

If you do not have these drawings, please request any you require by contacting Johnson Controls - Frick sales.

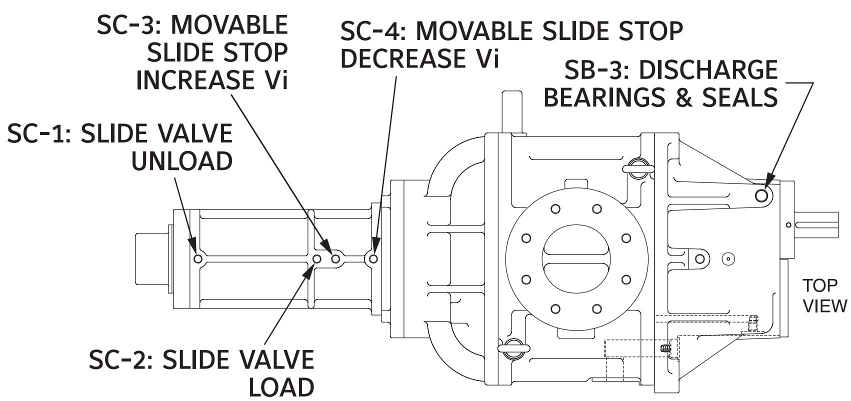
# COMPRESSOR PORT LOCATIONS - 163/193

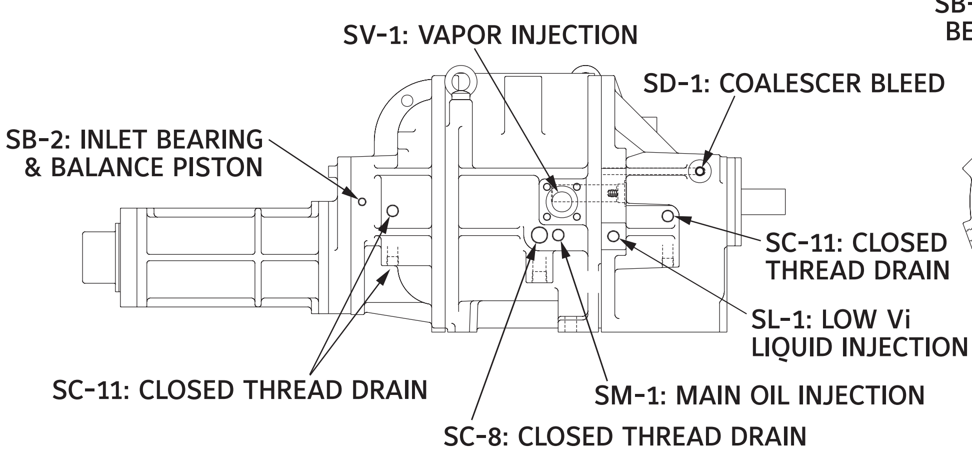


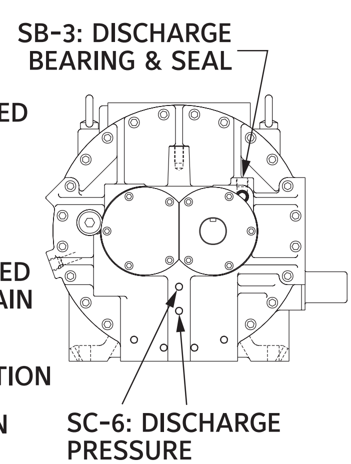



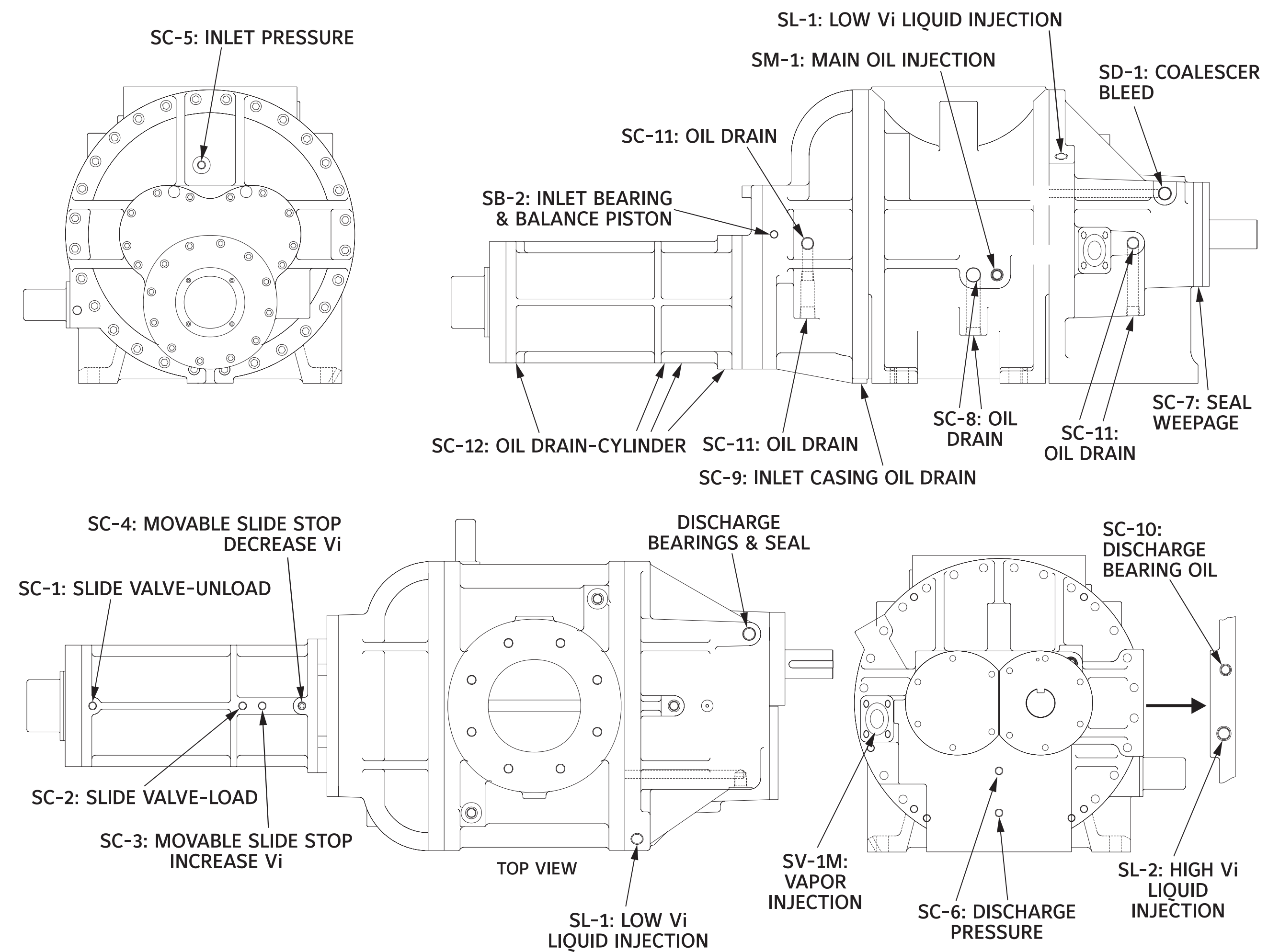

| SYMBOL | SIZE |
|---|---|
| SC-1 | 3/8-18 NPTF |
| SC-2 | 3/8-18 NPTF |
| SC-3 | 3/8-18 NPTF |
| SC-4 | 3/8-18 NPTF |
| SC-5 | 3/8-18 NPTF |
| SC-6 | 3/8-18 NPTF |
| SC-7 | 1/8-27 NPTF |
| SC-8 | 1-11½ NPTF |
| SC-9 | 3/8-18 NPTF |
| SC-10 | 3/4-14 NPTF |
| SC-11 | 3/4-14 NPTF |
| SC-13 | 3/8-18 NPTF |
| SB-2 | 3/8-18 NPTF |
| SB-3 | 3/4-14 NPTF |
| SM-1 | 3/8-18 NPTF |
| SV-1 | 1¼ SQ FLANGE |
| SL-1 | 3/4-14 NPTF |
| SL-2 | 3/4-14 NPTF |
| SE-1 | 1/2-14 NPTF |
| SE-2 | 1/2-14 NPTF |
| SD-1 | 3/4-16 UNF-2B |



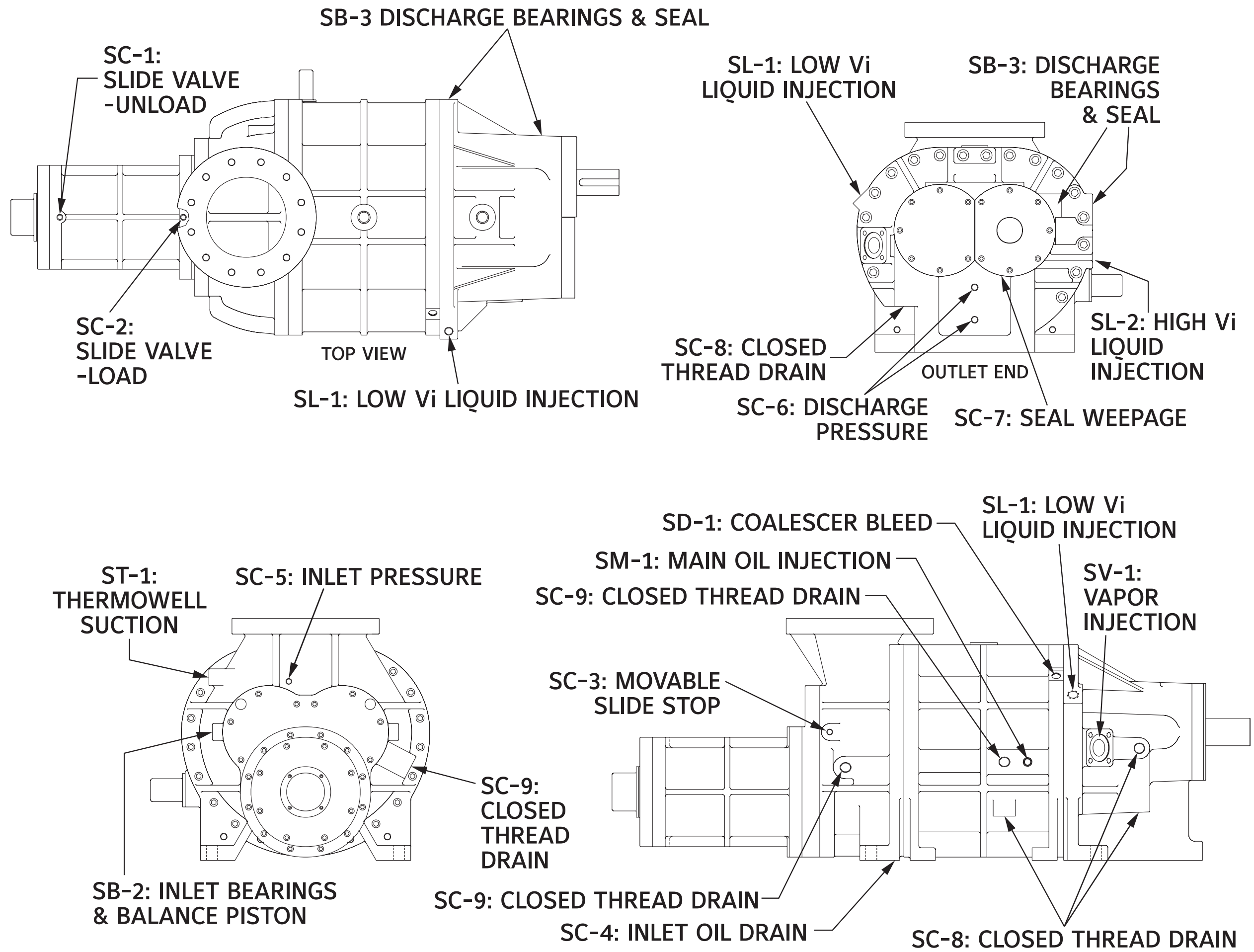



## COMPRESSOR PORT LOCATIONS - 233



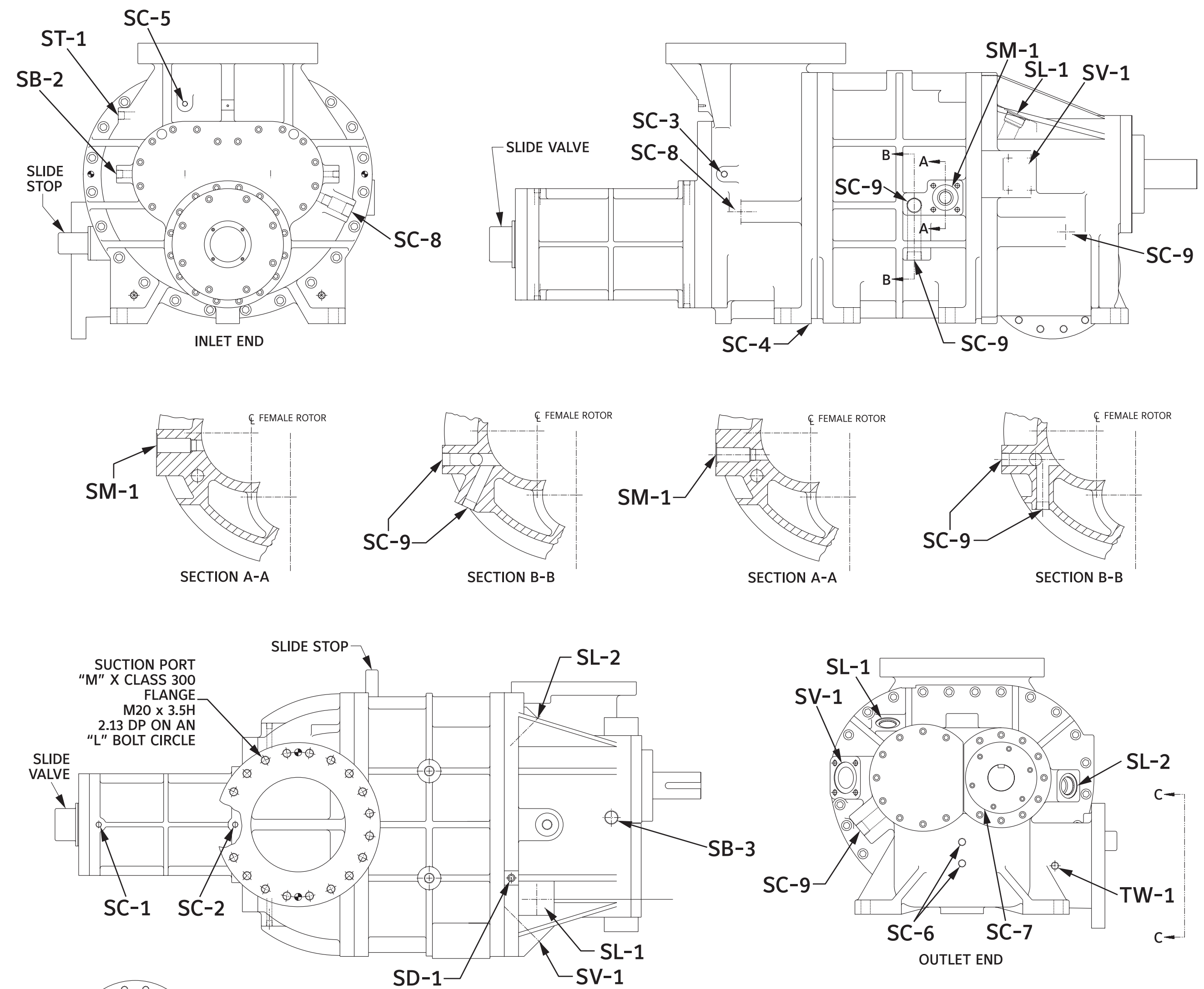

| SYMBOL | SIZE |
|---|---|
| SB-2 | 3/8-18 NPTF |
| SB-3 | 3/4-14 NPTF |
| SC-1 | 3/8-18 NPTF |
| SC-2 | 3/8-18 NPTF |
| SC-3 | 3/8-18 NPTF |
| SC-4 | 3/8-18 NPTF |
| SC-5 | 3/8-18 NPTF |
| SC-6 | 3/8-18 NPTF |
| SC-7 | 1/8-27 NPTF |
| SC-8 | 1-11½ NPTF |
| SC-9 | 3/8-18 NPTF |
| SC-10 | 3/4-14 NPTF |
| SC-11 | 3/4-14 NPTF |
| SC-12 | 3/8-18 NPTF |
| SD-1 | 1 1⁄16-12 UN-2B |
| SL-1 | 3/4-14 NPTF |
| SL-2 | 3/4-14 NPTF |
| SM-1 | 3/4-14 NPTF |
| SV-1M | 1½ SQ FLANGE |

## COMPRESSOR PORT LOCATIONS - TDS_ 283

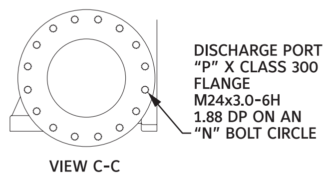



| SYMBOL | SIZE |
|---|---|
| SB-2 | 3/4-14 NPTF |
| SB-3 | 1-11½ NPTF |
| SC-1 | 3/8-18 NPTF |
| SC-2 | 3/8-18 NPTF |
| SC-3 | 3/8-18 NPTF |
| SC-4 | 1/2-14 NPTF |
| SC-5 | 3/8-18 NPTF |
| SC-6 | 3/8-18 NPTF |
| SC-7 | 1/8-27 NPTF |
| SC-8 | 1-11½ NPTF |
| SC-9 | 1¼-11½ NPTF |
| SD-1 | 1¹⁄₁₆-12 UN-2B |
| SL-1 | 1-11½ NPTF |
| SL-2 | 1-11½ NPTF |
| SM-1 | 1-11½ NPTF |
| ST-1 | 2 SQ FLANGE |

## COMPRESSOR PORT LOCATIONS - TDS_ 355




TOP VIEW




VIEW C-C

| SYMBOL | SIZE |
|---|---|
| SB-2 | 3/4-14 NPTF |
| SB-3 | 1½-11½ NPTF |
| SC-1 | 1/2-14 NPTF |
| SC-2 | 1/2-14 NPTF |
| SC-3 | 1/2-14 NPTF |
| SC-4 | 1/2-14 NPTF |
| SC-5 | 3/8-18 NPTF |
| SC-6 | 3/4-14 NPTF |
| SC-7 | 1/8-27 NPTF |
| SC-8 | 1¼-11½ NPTF |
| SC-9 | 1½-11½ NPTF |
| SD-1 | 1¹⁄₁₆-12 UN-2B |
| SL-1 | 2½-12 NPTF |
| SL-2 | 2½-12 NPTF |
| SM-1 | 2" FLANGE |
| ST-1 | 3¼-14 NPTF |
| SV-1 | 3" FLANGE |
| TW-1 | 3/4-14 NPTF |

## HOLDING CHARGE AND STORAGE

Every TDS_ compressor is pressure and leak tested at the Johnson Controls–Frick factory and then thoroughly evacuated and charged with dry nitrogen to ensure its integrity during shipping and short term storage prior to installation.

All compressors must be kept in a clean, dry location to prevent corrosion damage. Compressors that will be stored for more than two months must have their nitrogen charge checked periodically (see pages in GENERAL INFORMATION for complete instructions).

### ⚠ WARNING

**Holding-charge shipping gauges (if mounted) are rated for 30 psig and are for checking the shipping charge only. They must be removed before pressure testing and operating the system. Failure to remove these gauges may result in catastrophic failure of the gauge resulting in serious injury or death.**

**Access valves are bronze and they must be replaced with steel plugs when package is assembled.**

### ⚠ CAUTION

**THIS EQUIPMENT HAS BEEN PRESSURIZED WITH NITROGEN GAS. TEMPORARY VALVES AND GAUGES HAVE BEEN INSTALLED.**

1. **RELIEVE PRESSURE PRIOR TO OPENING LINES OR MAKING FIELD CONNECTIONS.**
2. **REMOVE CHARGING VALVES OR GAUGES PRIOR TO PRESSURIZING SYSTEM.**
3. **REFER TO INSTALLATION OPERATION AND MAINTENANCE MANUAL FOR ADDITIONAL INFORMATION.**

**ESCAPING GAS MAY CAUSE INJURY.**

## RIGGING AND HANDLING

The compressor can be moved with rigging, using a crane or forklift, by hooking into the two lifting rings on the main housing (some models only have one ring). The compressor lifting rings shall only be used to lift the compressor itself. See Figure 3.

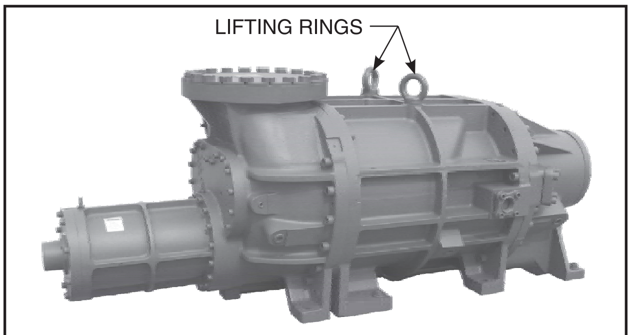



**Figure 3. Lifting Rings, Model 355**

## FOUNDATION

Each TDS_ Rotary Screw Compressor is shipped mounted on a wooden skid, which must be removed prior to unit installation.

### ⚠ CAUTION

**Allow proper spacing for servicing (see Dimensional Outline Drawing).**

The first requirement of the compressor foundation is that it must be able to support the weight.

| | | | |
|---|---|---|---|
| 163S | 1,220 lb | 233S | 2,670 lb |
| 163L | 1,280 lb | 233L | 2,950 lb |
| 193S | 1,720 lb | 233XL | 3,300 lb |
| 193L | 1,895 lb | 283S | 4,100 lb |
| 355S | 7,200 lb | 355XL | 9,200 lb |
| 355L | 8,240 lb | 355U | 10,200 lb |

Screw compressors are capable of converting large quantities of shaft power into gas compression in a relatively small space. The compression process creates relatively high frequency vibrations that require sufficient mass in the base to effectively dampen them.

The best insurance for a trouble-free installation is to firmly anchor the compressor to a suitable foundation using proper bolting and by preventing piping stress from being imposed on the compressor. Once the compressor is rigged into place, its feet must be shimmed to level it. There must be absolutely no stresses introduced into the compressor body due to bolting of the feet and flanges.

In any screw compressor installation, suction and discharge lines should be supported in pipe hangers (preferably within 2 feet 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. SIZE NPS | MOMENTS (ft-lbf) | | | LOAD (lbf) | | |
| | AXIAL $M_R$ | VERT. $M_C$ | LAT. $M_L$ | AXIAL P | VERT. $V_C$ | LAT. $V_L$ |
| 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 | 1,000 | 750 | 750 | 650 | 650 | 650 |
| 8 | 1,500 | 1,000 | 1,000 | 1,500 | 900 | 900 |
| 10 | 1,500 | 1,200 | 1,200 | 1,500 | 1,200 | 1,200 |
| 14 | 2,000 | 1,800 | 1,800 | 1,700 | 2,000 | 2,000 |

**Table 4. Allowable Flange Loads**

## CUSTOMER CONNECTIONS

As a minimum you must connect to the following locations in addition to suction and discharge.

| | |
|---|---|
| SB-2 | Inlet Bearings and Balance Piston |
| SB-3 | Compressor oil supply |
| SM-1 | Main oil injection |
| SC-1 | Slide Valve Unload Port |
| SC-2 | Slide Valve Load Port |
| SC-3 | Volume Ratio Increase Port |
| SC-4 | Volume Ratio Decrease Port |
| SD-1 | Coalescer Bleed |

Other connections are available for instrumentation and service as noted on the Dimensional Outline drawing. The electrical connections for the slide stop and the slide valve transmitters and the solenoid valve coils must be connected to your control system.

The oil supply system for the compressor must be designed for a total pressure drop of no more than 15 psi with a new oil filter element. This is critical for the proper operation of the balance piston which is used to ensure the life of the male axial bearing. Excessive pressure drop in the oil circuit can also prevent proper operation of the slide valve and slide stop pistons.

## OIL SYSTEM REQUIREMENTS

**⚠ WARNING**

**Access valves in brass material must be removed and the holes filled with steel plugs when package is assembled.**


**Figure 4. Caution/Identification Tag on Access Valve**

The oil system must provide oil to the compressor within limitation on:

- Oil selection
- Oil pressure
- Oil temperature
- Oil cleanliness

### OIL SELECTION

The selected oil most be suitable for the application, refrigerant and operation condition. The compressor bearing require a minimum viscosity based on size and speed, rpm. A maximum viscosity of 100 cSt should not be exited. Frick compressor oils per 160.802-SPC are recommended. Frick Coolware compressor selection program include properties for the Frick oils and provide information on viscosity requirement for a given compressor selection.

### OIL PRESSURE

The complete oil system shall be designed for a pressure drop no higher than 15 psi with a clean oil filter element. These is critical for the proper function of the balance piston and ensure the life of the axial bearings. At booster, low pressure and low pressure ratio operation an oil pump must be build in to provide sufficient oil pressure.

The control system should have means to check the oil pressure and compare to both suction and discharge pressure. In general oil pressure shall be minimum (1.5 times the suction pressure +15 psi) and higher than (discharge pressure – 25 psi). For application with economizer and/or sideload the oil pressure shall additional be more than 15 psi above the pressure at the side port when in operation.

Advanced control systems like the Frick Quantum will check on the oil pressure in many more ways in order to keep the compressor running beyond these basic limits e.g. keep compressor running safely in partial loaded condition.

### OIL COOLING REQUIREMENTS

Compressor oil needs to be cooled to control the discharge temperature, maintain proper oil viscosity and to preserve the life of the oil. Normally the discharge temperature will be in the 170° - 180°F range (see CoolWare™).

One application that typically requires higher discharge temperatures (as high as 250°F) is natural gas gathering at the wellhead. Moisture is normally present in the gas and it is imperative that the discharge temperature be at least 40°F higher than the discharge dew point temperature for the gas. Run Coolware with the "Water Saturated" block checked to get the discharge dew point temperature for your application. Oil temperatures as high as 170°F can be used to achieve the necessary discharge temperature to prevent moisture from condensing in the oil separator. Contact Johnson Controls–Frick for additional information for natural gas compression.

The main oil injection line that is connected to port SM1 must have a regulating valve to permit adjustment of the oil flow to maintain the desired discharge temperature at all times.

The use of a three-way mixing valve is recommended to keep the oil temperature in the normal range of 120° - 140°F. The valve will provide warm oil to the compressor quickly, reducing the pressure drop caused by cold, viscous oil. This ensures proper oil flow and temperature over the full range of operating conditions.

### OIL FILTER(S)

Use of filter elements other than Johnson Controls-Frick must be approved in writing by Johnson Controls-Frick engineering or a warranty claim may be denied. Typical oil filter specification is 5 micron absolute (98.6% effecient) per ISO 4572 to obtain the recommended oil cleanliness.

## OIL PUMP

If your TDS_ compressor application requires an oil pump, it is recommended that a strainer be mounted upstream to protect it. Frick supplied pumps are a positive displacement gear type that must have a safety relief valve to ensure the oil pressure will not be more than 50 psi above compressor discharge pressure for all models.

**⚠ CAUTION**

**If oil pressure exceeds 55 PSI above compressor discharge it could cause catastrophic compressor failure due to male axial bearing failure. See CoolWare™ for your application's requirements.**

## OIL HEATER(S)

Your package must be equipped with oil heaters that provide sufficient heat to prevent condensation from occurring during shutdown cycles.

## COMPRESSOR OIL

**⚠ WARNING**

**DO NOT MIX OILS of different brands, manufacturers, or types. Mixing of oils can cause excessive oil foaming, nuisance oil level cutouts, oil pressure loss, gas or oil leakage and catastrophic compressor failure. For most applications, CoolWare will select a specific Frick oil for the gas/refrigerant being used. Depending on the application, a different oil can be selected provided it is of the proper viscosity and is compatible with the gas/refrigerant and compressor elastomers.**

## COMPRESSOR

### COMPRESSOR ROTATION IS CLOCKWISE WHEN FACING THE END OF THE COMPRESSOR SHAFT

Confirm motor will rotate the compressor clockwise before installing the coupling.

### MOTOR MOUNTING (FOOT MOUNTED ONLY)

1. Thoroughly clean the motor feet and mounting pads of grease, burrs, and other foreign matter to ensure firm seating of the motor.
2. Attach the motor to the base using bolts and motor raising blocks, if required.
3. Weld the four kick bolts (not included with compressor) into place so that they are positioned to allow movement of the motor feet.
4. After the motor has been set, check to see that the shafts are properly spaced for the coupling being used. Check the appropriate Dimensional Outline drawing for the minimum clearance required between the shaft ends to change the shaft seal.

### COMPRESSOR/MOTOR COUPLING REQUIREMENTS.

Frick TDS_ compressors are arranged for direct motor drive and require a flexible drive coupling to connect the compressor to the motor.

With a foot-mounted motor, it is essential that the coupling be properly aligned to ensure proper bearing and seal performance.

1. Coupling must be selected and installed so that it doesn't transmit any axial load to the compressor shaft.
2. Set up the minimum distance between compressor shaft and motor shaft to allow for seal removal (see Outline drawings).
3. Coupling must be able to take up any misalignment between motor and compressor. It is critical to the life of the shaft seal that misalignment is kept to the minimum possible value. Be sure to follow the coupling manufacturer's guidelines for checking and correcting any misalignment. See the next section for Johnson Controls–Frick requirements.

### COUPLING ALIGNMENT REQUIREMENTS

Coupling alignment must be performed prior to start-up. After the compressor has been installed on the job site, alignment must be checked again and if necessary corrected prior to start-up. After a few hours operation, the alignment must be checked while the package is still hot. Correct hot alignment is critical to ensure the life of the shaft seal and compressor bearings.

**Maximum radial runout is .004" total indicator reading.**
**Maximum axial runout is .004" total indicator reading.**

A dial indicator or another appropriate measuring device is to be used to determine the Total Indicator Runout.

Indicator bracket sag must be checked as all brackets have some flexibility. The best way to measure this is to attach the dial indicator and bracket on a pipe at the coupling span distance. Zero the indicator in the 12:00 position, and rotate the pipe so the indicator is in the 6:00 position. The reading on the indicator in the 6:00 position is the bracket sag. This value must be included in the dial indicator readings when affixed to the coupling for an accurate alignment.

## COUPLING ALIGNMENT PROCEDURE

The life of the compressor shaft seal and bearings, as well as the life of the motor bearings, is dependent upon proper coupling alignment. Couplings may be aligned at the factory but realignment MUST ALWAYS be done on the job site after the unit is securely mounted on its foundation. Initial alignment must be made prior to start-up and rechecked after a few hours of operation. Final (HOT) field alignment can only be made when the unit is at operating temperature. After final (HOT) alignment has been made and found to be satisfactory for approximately one week, the motor may be dowelled to maintain alignment.

**NOTICE**

**Frick recommends cold aligning the motor .005" high. This cold misalignment compensates for thermal growth when the unit is at operating temperature.**

## HOT ALIGNMENT OF COMPRESSOR/MOTOR

Hot alignments can only be made after the unit has operated for several hours and all components are at operating temperatures.

Shut down the unit and quickly affix dial indicator to coupling motor hub, then take readings of both the face and rim of the compressor hub. If these readings are within tolerance, record reading, attach coupling guard and restart unit. However, if the reading is not within limits, compare the hot reading with the cold alignment and adjust for this difference; i.e. if the rim at 0° and 180° readings indicates that the motor rises .005" between its hot and cold state, .005" of shims should be removed from under the motor.

After the initial hot alignment adjustment is made, restart unit and bring to operating temperature. Shut down and recheck hot alignment. Repeat procedure unit hot alignment is within specified tolerance.

**⚠ CAUTION**

**INSTALL COUPLING GUARD BEFORE OPERATING COMPRESSOR.**

## SV POSITION POTENTIOMETER REPLACEMENT AND ADJUSTMENT

The Slide Valve Position potentiometer is located on the end of the compressor unloader cylinder (see Figure 4).

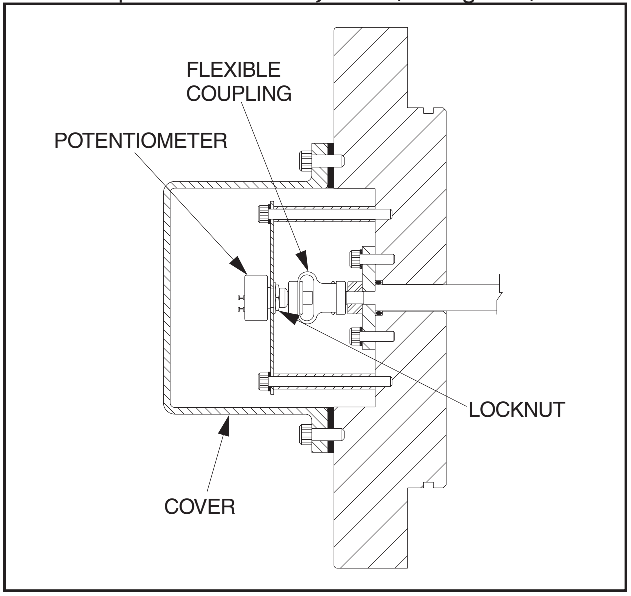



**Figure 5. Potentiometer**

**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 locknut to remove the potentiometer from the base plate. The potentiometer should slip out of the coupling. (For early versions, three retainer clips that secure the potentiometer to the base plate will need removed.)

**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.

**NOTICE**

**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.

## VOLUMIZER POTENTIOMETER REPLACEMENT AND ADJUSTMENT

The VOLUMIZER potentiometer is located under a cover on the right side of the compressor (facing shaft) at the inlet end. See Figure 5.

**1.** Shut off control power.

**2.** Remove the potentiometer cover and gasket.

**3.** Remove the potentiometer and mounting bracket.

**4.** Install new potentiometer and bracket.

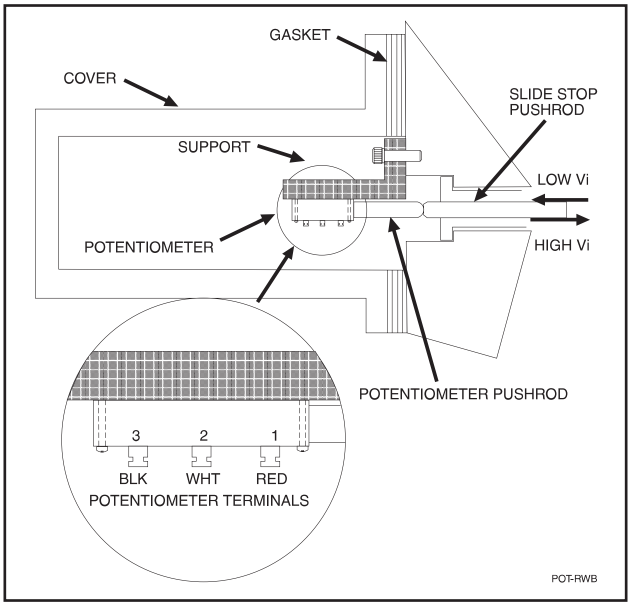



**Figure 6. Potentiometer**

**5. ADJUSTMENT** must be made with the compressor running and the slide valve fully unloaded. With the slide stop at maximum (Vi) position, check that the potentiometer pushrod is in contact with the slide stop pushrod. If not, the bracket must be ground or trimmed until contact is made. Completely decrease the slide stop. The Operating display at this time should indicate a (Vi) of 2.2. If greater than 2.2, adjust potentiometer POT #2 on the SBC until 2.2 is indicated. If 2.2 is not obtainable, get as close as possible and proceed to the next step. Adjustment of POT #2 and POT #1 are interactive and POT #1 may require adjustment to allow POT #2 to come into range. Now, completely increase the slide stop. The display at this time should indicate a (Vi) of 5.0 (4.2 for TDSH 283SX, 4.5 for TDSB 355U). If less than 5.0 (4.2 for TDSH 283SX, 4.5 for TDSB 355U), adjust potentiometer POT #1 on the SBC until 5.0 (4.2 for TDSH 283SX, 4.5 for TDSB 355U) is indicated. Repeat this sequence until the slide stop indicates 2.2 when fully decreased and 5.0 (4.2 for TDSH 283SX, 4.5 for TDSB 355U) when fully increased.

**NOTICE**

**THE TOTAL TRAVEL ON THE VOLUMIZER® POTENTIOMETER IS .394 INCH.**

## COMPRESSOR HYDRAULIC SYSTEM

**(The solenoid valves and manifold block are available as a sales order option)**

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 TDS 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.

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 SC-2 and enters the load side of the cylinder. Simultaneously, oil contained in the unload side of the cylinder flows out cylinder port SC-1 through valve ports A and T to compressor closed thread port.

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 SC-1 and enters the unload side of the cylinder. Simultaneously, oil contained in the load side of the cylinder flows out compressor port SC-2 through valve ports B and T to compressor closed thread port.

**NOTICE**

**High Stage Operation: An alternative piping arrangement has been provided to increase slide valve response time during high stage operation.**

**⚠ CAUTION**

**NEVER OPEN VALVE 1 AND VALVE 2 AT THE SAME TIME DURING COMPRESSOR OPERATION.**

Higher operating pressures will slow the compressor unloading response time. Unloading response time can be increased by closing valve 1 (oil manifold pressure) and opening valve 2 to compressor suction pressure. See Figure 7.

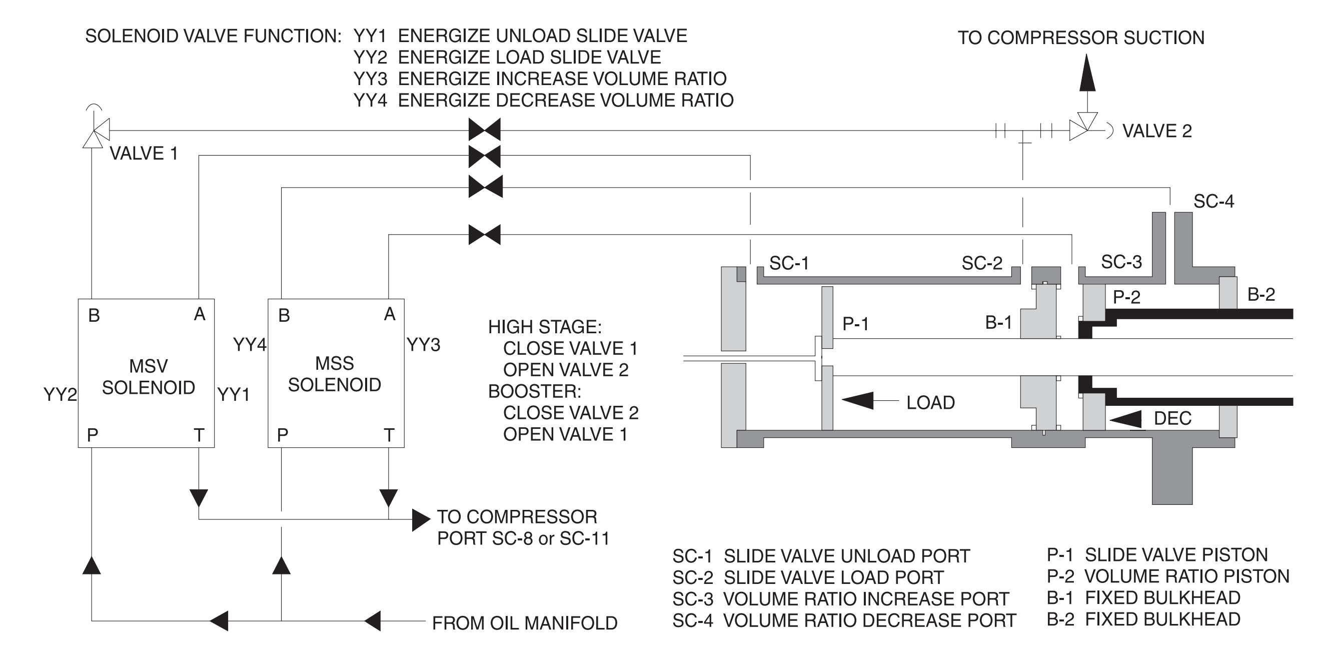
## VOLUMIZER VOLUME RATIO CONTROL

### VI Increase

The volume ratio Vi is increased when MSS solenoid YY3 is energized and oil flows from the oil manifold through valve ports P and A to cylinder port SC-3 and enters the increase side of the cylinder. Simultaneously, oil contained in the decrease side of the cylinder flows out cylinder port SC-4 through valve ports B and T to compressor closed thread port.

### VI Decrease

The volume ratio Vi is decreased when MSS solenoid YY4 is energized and oil flows from the oil manifold through valve ports P and B to cylinder port SC-4 and enters the decrease side of the cylinder. Simultaneously, oil contained in the increase side of the cylinder flows out cylinder port SC-3 through valve ports A and T to compressor closed thread port.




**MSV and MSS HYDRAULIC CYLINDER and SOLENOID VALVES**

**Figure 8. Hydraulic Schematic**

## LOW AMBIENT OPERATION

It is recommended that package oil separators be insulated as a minimum requirement to preserve the heat generated by the oil heaters, to prevent condensation and secure lubrication at start-up.

## BALANCE PISTON PRESSURE REGULATOR FOR TDSH 355 COMPRESSORS

A Balance Piston Pressure Regulator is required to reduce the extended overbalance from the thrust balance piston at part load.

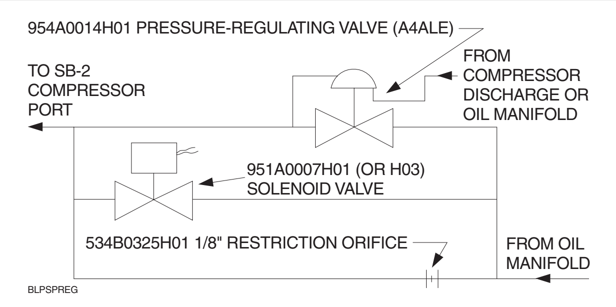



**Figure 7. Pressure Regulating Valve**

**HIGH-STAGE SB-2 OIL SUPPLY LINE DIAGRAM:** Shows the three additions described below arranged in parallel.

**PRESSURE-REGULATING VALVE:** Discharge pressure determines compressor thrust balance. The proper setting for the pressure-regulating valve is 50 psi below DISCHARGE pressure. This pressure may vary based on operating conditions.

**SOLENOID VALVE:** Energizing, or opening, the solenoid valve pressurizes the balance piston with full oil pressure from the oil manifold, bypassing the A4ALE Pressure Regulating Valve. De-energizing, or closing, the solenoid valve pressurizes the balance piston with oil pressure regulated by the A4ALE Pressure Regulating Valve.

Signals from the control panel operate the solenoid valve (output module 12 on Frick micro panel). The solenoid valve should open when the slide valve position is 70% or greater, and close when the slide valve position is 65% or less. These may vary based on operating conditions.

**ORIFICE:** The orifice ensures oil supply to the inlet end bearings during upset conditions such as start-up.

# OPERATION

## OPERATION AND START-UP INSTRUCTIONS

The Frick TDS_ Rotary Screw Compressor will be a component in an integrated system. As such the compressor requires some specific operation and conditions to ensure trouble-free running.

The information in this section of the manual provides the logical step-by-step instructions to properly start up and operate the TDS_ Rotary Screw Compressor in your Unit. Only matters which may influence the proper operation of the TDS_ compressor are included.

**NOTICE**

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

### INITIAL START-UP

Prior to the start-up, the prestart check must be accomplished. See Forms section for Checklist.

### INITIAL START-UP PROCEDURE

Having performed the prestart check, the compressor unit is ready for start-up. It is important that an adequate gas 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. For proper and safe operation, the compressor must be run at the proper speed and discharge pressure. Exceeding design conditions creates a potential hazard.

2. After 1 to 3 hours of operation adjust oil cooling system.

3. 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.

4. Perform baseline vibration analysis if equipment is available.

### NORMAL START-UP PROCEDURE

1. Confirm system conditions permit starting the compressor.

2. Start.

3. Observe the compressor unit for mechanical tightness of the external piping, bolts and valves. Ensure that the machine has no oil and vapor leaks. If any of these occur, shut down the compressor and correct the problem as necessary using good safety precautions.

# MAINTENANCE

## GENERAL INFORMATION

This section provides instructions for normal maintenance, a recommended maintenance program, and troubleshooting and correction guides.

**⚠ WARNING**

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

**⚠ CAUTION**

**Cylinder assembly under high spring load. Consult manual before disassembly. Improper disassembly may cause injury due to spring tension release.**

## NORMAL MAINTENANCE OPERATIONS

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

**⚠ WARNING**

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.**

### GENERAL MAINTENANCE

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

**1. Keep 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 of oil and lead to premature bearing failure. Dual oil filters are recommended so that the filters can be changed without shutting down the package.

**4. Avoid slugging the compressor with liquids (oil).** While screw compressors are probably the most tolerant of any compressor type available today about ingestion of some liquid, they are not liquid pumps. Make certain a properly sized suction accumulator is used to avoid dumping liquid into compressor suction.

**5. Protect the compressor during long periods of shutdown.** If the compressor will be sitting for long periods without running, it is advisable to evacuate to low pressure and charge with oil (or dry nitrogen for packages). 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.

### 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.**

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. Stop the compressor unit.
2. Lock out the motor starter.
3. Close the suction and discharge service valves
4. Using appropriate equipment, lower the compressor pressure to 0 psig.
5. Open the drain valve(s) and drain oil into a suitable container.
6. Drain the oil filter(s) and the oil coolers.
7. Remove the old filter cartridges, and install new ones.
8. Remove, clean, and reinstall elements in the strainers.
9. Evacuate the unit.
10. Open the suction service valve and pressurize the unit to system suction pressure. Close the suction valve and leak test.
11. Add oil.
12. Open the suction and discharge service valves
13. Remove the lockout from the motor starter.
14. Start the unit

### RECOMMENDED MAINTENANCE PROGRAM

In order to obtain maximum compressor performance and ensure reliable operation, a regular maintenance program should be followed. The compressor unit should be checked regularly for leaks, abnormal vibration, noise, and proper operation. A log should also be maintained. Oil analysis should be performed on a regular basis. It is a valuable tool that can identify the presence of moisture, acid, metallics and other contaminants that will shorten compressor life if not corrected. In addition, an analysis of the compressor vibration should be made periodically.

## 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 baseline 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.

## OIL QUALITY AND ANALYSIS

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

1. Only use Frick oil or high quality oils approved by Johnson Controls-Frick for your application.

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

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

### OPERATING LOG

The use of an operating log as included in this manual permits thorough analysis of the operation of a 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

## 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 | 10,000 | 15,000 | 20,000 | 25,000 | 30,000 | 35,000 | 40,000 | 45,000 | 50,000 | 55,000 | 60,000 | 65,000 | 70,000 | 75,000 | 80,000 | 85,000 | 90,000 | 95,000 |
| Change Oil | As Directed By Oil Analysis | | | | | | | | | | | | | | | | | | | | | |
| Oil Analysis | | ■ | Every 6 Months | | | | | | | | | | | | | | | | | | | |
| Replace Filters | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | |
| Clean Oil Strainers | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | |
| Clean Liquid Strainers | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | |
| Replace Coalescers | | | | | | | | | ■ | | | | | | ■ | | | | | | ■ | |
| Check and Clean Suction Strainer | ■ | ■ | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | |
| Check Alignment | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | |
| Check Coupling (a) | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | |
| Suction & Disch Flange Bolts (b) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Vibration Analysis (c) | ■ | Every 6 Months, More Frequently If Levels Increase | | | | | | | | | | | | | | | | | | | | |
| Replace Shaft Seal | When Leak Rate Exceeds 7 - 8 Drops Per Minute | | | | | | | | | | | | | | | | | | | | | |

a. Check bolts, shim packs, center inserts, keys, and all bolt torques.
b. Verify tightness of bolts on suction and discharge flanges. See table below for torque requirements.
c. Vibration measurement must be carried out continuously to obtain optimum preventative control on bearings. If not continuously controlled, then every 6 months, more frequently if levels increase.

**NOTE: The bolt torque requirements for the compressor flange to separator flange are based on:**

a. Gaskets: Garlock® Blue-Gard® 3300
b. Bolts: class 8.8 or stronger hex head bolts, lightly oiled and clean

| TDSH Flange Bolt Torque | | | | |
|---|---|---|---|---|
| TDS_ Compressor Model | Discharge Flange to Separator Flange | | Suction Flange | |
| | Bolt Size (in.) | Torque (ft-lb) | Bolt Size (in.) | Torque (ft-lb) |
| 163S | M20 X 2.5 | 100 | M16 X 2.0 | 120 |
| 163L | M20 X 2.5 | 100 | M16 X 2.0 | 120 |
| 193S | M20 X 2.5 | 140 | M20 X 2.5 | 180 |
| 193L | M20 X 2.5 | 140 | M20 X 2.5 | 160 |
| 233S | M20 X 2.5 | 160 | M20 X 2.5 | 160 |
| 233L | M20 X 2.5 | 160 | M20 X 2.5 | 200 |
| 233XL | M20 X 2.5 | 160 | M22 X 2.5 | 220 |
| 283S | M22 X 2.5 | 230 | M22 X 2.5 | 220 |
| 283L | M22 X 2.5 | 230 | M22 X 2.5 | 220 |
| 283SX | M22 X 2.5 | 230 | M24 X 3.0 | 220 |
| 355_ | M24 X 3.0 | 240 | M30 X 3.5 | 350 |

**Table 5. TDSH Flange Bolt Torque**

the system and to recognize immediately any deviations from normal operating conditions. It is recommended that readings be taken at least daily.

## 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 TDS_ compressor:

1. Insufficient or excessive gas load.
2. Excessively high suction pressure.
3. Excessively high suction superheat.
4. Excessively high discharge pressure.
5. Inadequate refrigerant charge or low receiver oil 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 gas/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.

## BARE COMPRESSOR REPLACEMENT

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

1. Verify that the starter is locked out.
2. Remove gas/refrigerant
3. Remove all tubing, piping, and wiring that is connected to the compressor.
4. Disconnect the coupling from the driver shaft.
5. While supporting the compressor assembly with a crane, remove the bolts at the compressor feet.
6. Thoroughly clean the compressor feet and mounting pads of burrs and other foreign matter to ensure firm seating of the compressor.
7. Thoroughly clean the new compressor and remove all cover plates and protection etc.
8. Install new gaskets and sealing in all connections.
9. Set the new compressor in place and shim feet where required.
10. Reattach the drive coupling.
11. Check the shaft alignment.
12. Complete tubing, piping, and wiring.

## SHUTDOWN DUE TO IMPROPER OIL PRESSURE (High Stage and Booster)

**The compressor must not operate with incorrect oil pressure.**

1. Refer to CONTROL SETUP

## TROUBLESHOOTING THE TDS_ COMPRESSOR (Frick RWB II Package)

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

## NOTICE

**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 THE COMPRESSOR.**

## TROUBLESHOOTING THE HYDRAULIC SYSTEM

| SYMPTOM | PROBABLE CAUSES and CORRECTIONS |
|---|---|
| SLIDE VALVE WILL NOT LOAD OR UNLOAD | Solenoid coils may be burned out, replace.<br>Valve may be closed. Open hydraulic service valves.<br>Solenoid spool may be stuck or centering spring broken, replace.<br>Check outputs 2 and 3 and fuses.<br>Solenoid may be mechanically actuated 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.<br>Dirt inside solenoid valve preventing valve from operating both ways, clean.<br>Solenoid may be mechanically actuated 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.<br>Dirt inside solenoid valve preventing valve from operating both ways, clean.<br>Solenoid may be mechanically actuated by inserting a piece of 3/16" rod against armature pin and pushing spool to opposite end. If valve works, problem is electrical. |
| SLIDE STOP WILL NOT FUNCTION EITHER DIRECTION | Solenoid coils may be burned out, replace.<br>Solenoid service valves may be closed, open.<br>Manually actuate solenoid. If slide stop will not move mechanical problems are indicated. Consult Frick factor or Frick. |

## TROUBLESHOOTING THE OIL PUMP AND SYSTEM

| SYMPTOM | PROBABLE CAUSES and CORRECTIONS |
|---|---|
| PUMP WILL NOT PRODUCE ENOUGH OIL PRESSURE AT START-UP | Check that service valves are open.<br>Filter cartridges may be blocked. Check PSID across filters.<br>Strainer may be blocked. Clean.<br>Oil pressure regulator set too low or stuck open. Readjust or repair.<br>Pump worn out. Repair or replace. |
| OIL PRESSURE RAPIDLY DROPS OFF WHEN COMPRESSOR STARTS | Main oil injection throttling valve too wide open or oil pressure regulating valve improperly adjusted. Readjust both valves. |
| NOISE and VIBRATION | Pump strainer blocked. Clean.<br>Pump worn out. Repair or replace. |
| OIL PRESSURE DROPS AS HEAD PRESSURE INCREASES | Normal behavior. Set main oil injection and oil pressure for maximum head pressure condition. |
| MAIN UNIT FILTER PSID IS TOO HIGH | Filters clogged with dirt. Replace.<br>Oil is too cold. Allow oil to warm up and check again.<br>Service valve on filter outlet is partially closed. Open valves fully. |

# READ THIS FIRST: 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

__ Package installed according to Frick publication 070.210-IB, Screw Compressor Foundations.
__ Confirm that motor disconnect is open
__ Isolate suction pressure transducer
__ Pressure test and leak check unit
__ Evacuate unit
__ Check alignment
__ Remove compressor drive coupling guard
__ Remove coupling center and **DO NOT reinstall** (motor rotation must be checked without center)
__ 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 electric drive motor bearings **PRIOR** to checking motor rotation
__ 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)
__ Check for **PROPER PIPE SUPPORTS** and correct foundation
__ Check to ensure **ALL** piping **INCLUDING RELIEF VALVES** is completed

## Electrical Checks

__ Package installed according to Frick publication 090.400-SB, Proper Installation of Electrical Equipment In An Industrial Environment.
__ 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
__ Ensure all electrical panels are free from installation debris, **METAL PARTICLES**, and moisture

## 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
__ Leave micro energized to ensure oil heaters are on and oil temperature is correct for start-up
__ **DO NOT energize compressor drive motor !** This should only be done by authorized Factory Field Service Technicians.

**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 alignment) 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 motor rotation
4. Verify oil pump motor rotation
5. Verify the % of FLA on the micro display
6. Verify and finalize alignment (if applicable)
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 listed under the maintenance section of the IOM.**

**Please complete and sign this form & fax to 717-762-8624 as confirmation of completion.**

Frick Sales Order Number: ____________________
Compressor Model Number: ____________________
Unit Serial Number: ____________________
End User Name: ____________________
Address of Facility: ____________________
City, State, Zip: ____________________

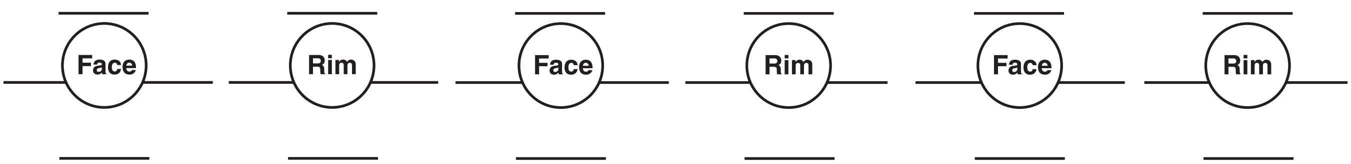
Print Name: ____________________
Company: ____________________
Job Site Contact: ____________________
Contact Phone Number: ____________________

Signed: ____________________

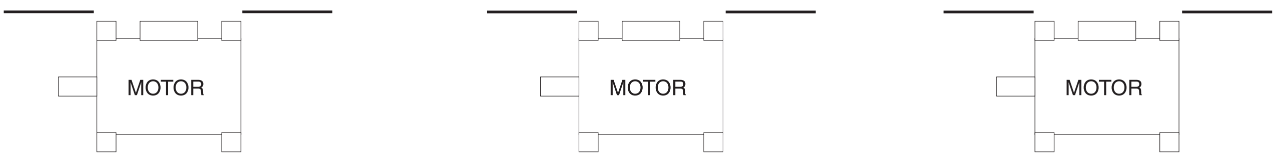
## DRIVE TRAIN ALIGNMENT

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




Thickness of Shims Added | Thickness of Shims Added | Thickness of Shims Added




| Compressor Operating Log Sheet | | | | Starter Operating Log Sheet | | | |
|---|---|---|---|---|---|---|---|
| Date | | | | Average Current | | | |
| Time | | | | Current Phase A | | | |
| Hour Meter Reading | | | | Current Phase B | | | |
| Equip. Room Temp. | | | | Current Phase C | | | |
| Suction Pressure | | | | Full Load Amps | | | |
| Suction Temperature | | | | Output Frequency | | | |
| Suction Superheat | | | | Output Voltage | | | |
| Discharge Pressure | | | | DC Bus Voltage | | | |
| Discharge Temperature | | | | Input Power kW | | | |
| Corresponding Temperature | | | | Actual Speed | | | |
| Oil Pressure | | | | Speed Command | | | |
| Oil Temperature | | | | Ambient Temp F. | | | |
| Oil Filter Pressure Drop | | | | Convert Heatsink Temp. F. | | | |
| Separator Temperature | | | | Baseplate Temp. F. | | | |
| Slide Valve Position | | | | VSD Operating Mode | | | |
| Volume Ratio (VI) | | | | Harmonic Filter Present | | | |
| Motor Amps / FLA % | | | | Harmonic Filter Mode | | | |
| Capacity Control Setpoint | | | | Water Pump Energized | | | |
| Oil Level | | | | Precharge Relay Energized | | | |
| Oil Added | | | | Trigger SCR's Energized | | | |
| Seal Leakage (Drops/Min.) | | | | DC Inverter Link Current | | | |
| Evaporator. EWT F. | | | | Motor Winding Temp. F. | | | |
| Evaporator LWT F. | | | | Humidistat % RH | | | |
| Condenser EWT F. | | | | Vyper Coolant Temp. F. | | | |
| Condenser LWT F. | | | | Total kWh | | | |

# VIBRATION DATA SHEET

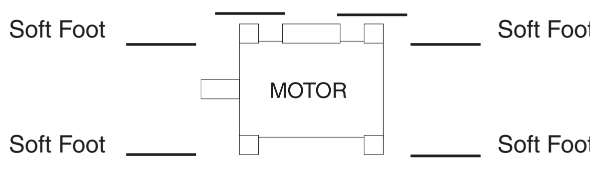
**Date:** ____________________________
End User: ____________________________
Address: ____________________________

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

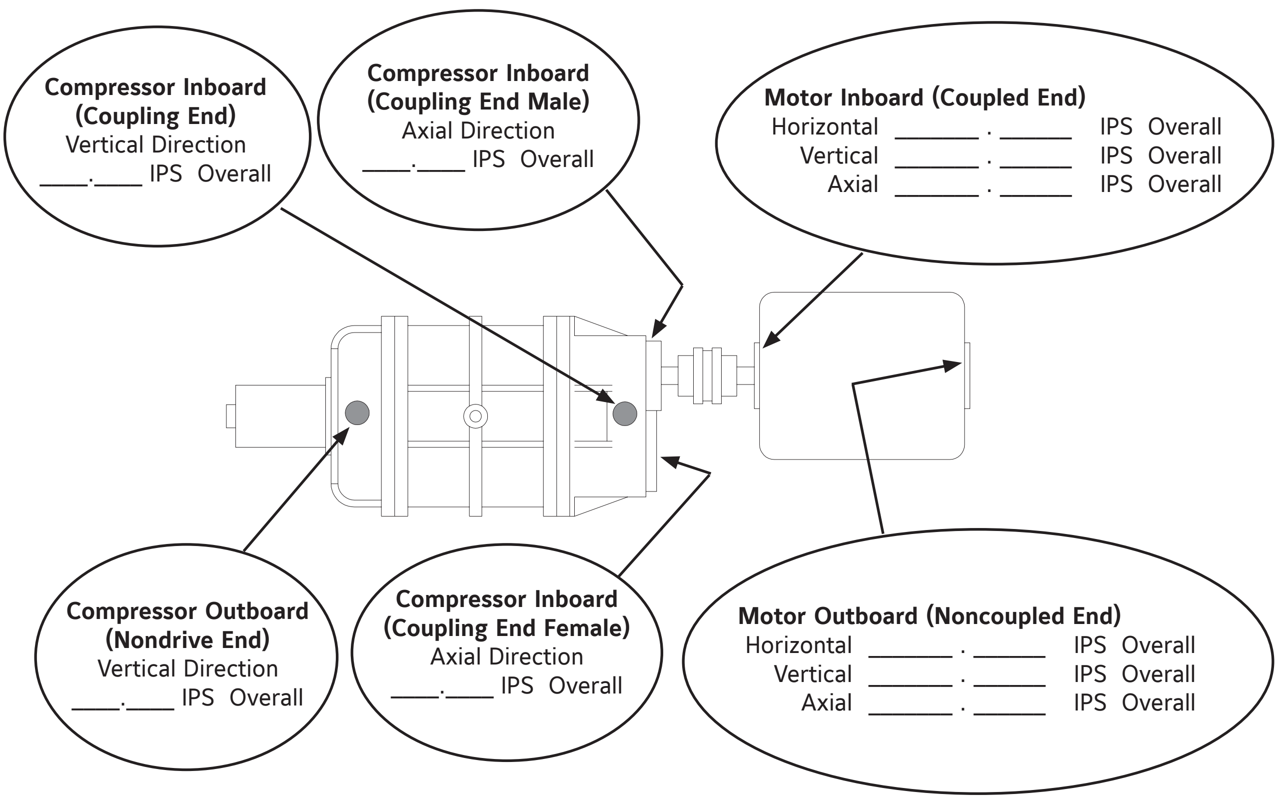
Equipment ID (As in Microlog): ________________
Compressor Model Number: ________________
Compressor Serial Number: ________________
Unit Serial Number: ________________
National Board Number: ________________
Running Hours: ________________
Manufacturer and Size of Coupling: ________________
Motor Manufacturer: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

**Final Hot Alignment**


**Total Thickness of Shims Added**




| SUCTION | DISCHARGE | OIL | SEPARATOR | SLIDE VALVE POSITION % |
|---|---|---|---|---|
| Press # | Press # | Press # | Temp °F | Vi Ratio |
| Temp °F | Temp °F | Temp °F | | F.L.A. % |



# Index

**April 2016 Form Revisions**

p.2 – Added bookmark Table of Contents PDF functionality
p.8 – Noted drawings reference 163 and 193
p.16 – Removed typical package reference information
– Update Vi adjustment by compressor model

– New Frick logo added throughout

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