Frick®
BY JOHNSON CONTROLS

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INSTALLATION - OPERATION - MAINTENANCE

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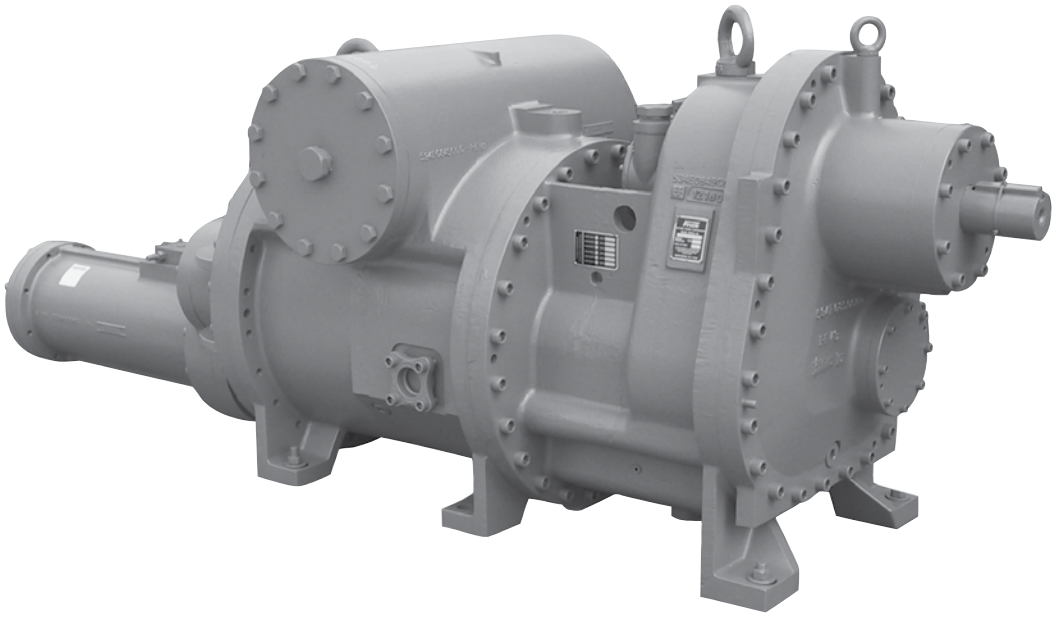
NGC
ROTARY SCREW COMPRESSOR
Gas Compressor

MODELS 100, 150, 200, 250, 300, 400 and 450



ALL GEAR RATIOS

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

GENERAL INFORMATION

INSTALLATION

OPERATION

MAINTENANCE

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 NGC Rotary Screw Compressors.

It is most important that these compressors be properly applied to an adequately controlled 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

NGC 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 natural gas and most hydrocarbon gasses. Very small amount of sour gasses and moisture are acceptable if in accordance with Johnson Controls-Frick specifications and approvals. Contact Johnson Controls-Frick Compressor Engineering for guidelines.

Sour gas applications require special attention to prevent moisture from condensing in the compressor and oil separator. Discharge temperature must be maintained at a minimum of 30 degrees F above the dew point temperature for the gas mixture being compressed. Oil separators must be insulated to ensure there are no cold spots that could cause condensation to occur, leading to subsequent acid formation. A bypass arrangement is recommended to allow the compressor to warm up to the design operating temperature prior to introducing sour gas. A dry gas purge is recommended for standby. Johnson Controls - Frick "NG" oils are specifically formulated for natural gas applications. They contain the corrosion inhibitors to promote optimum compressor life. For additional details about natural gas applications, contact Johnson Controls - Frick Compressor Engineering.

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

COMPRESSOR AND UNIT 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 these data plates. See Figure 1.

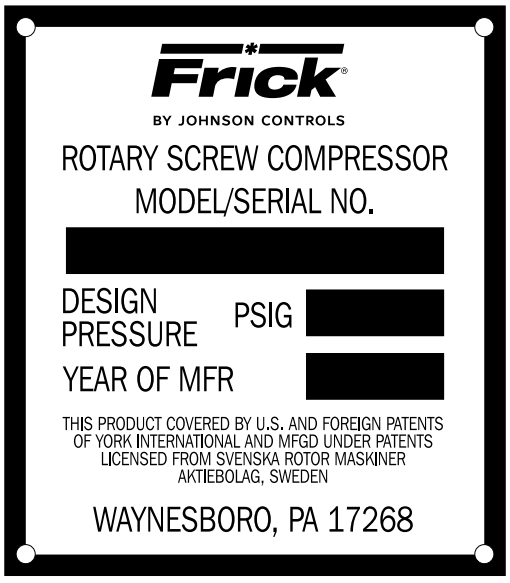


Figure 1 - Identification Data Plate

The installed gear can be read by the model number, i.e. NGC 150A. If you change the gear, please make records of the change and mark the compressor with the actual gear ratio (A, B, C, D, E or F). See Figure 2.

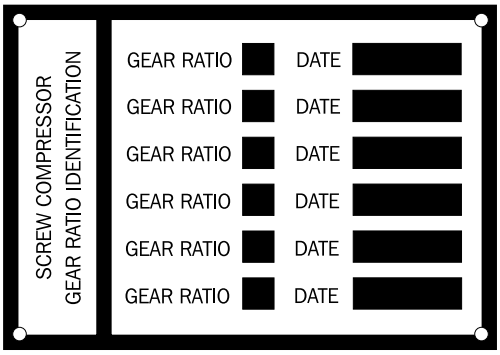


Figure 2 - Gear Ratio Data Plate

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 NGC 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.

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, 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.

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

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

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 below.

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

DESCRIPTION

NGC COMPRESSOR

The Johnson Controls - Frick NGC rotary screw compressor utilizes mating asymmetrical profile helical rotors to provide a continuous flow of 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 contact ball or angular-contact bearings are mounted at the discharge end of the compressor to carry axial loads.

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

4. Moveable slide valve to provide fully modulating capacity control from 100% to minimum capacity. See Table 1.

5. VOLUMIZER® volume ratio control to allow infinitely variable volume ratio from 2.2 to 5.0 for all NGC models (except the NGC 300: 2.0 – 4.1 and the NGC 450: 2.4 – 4.5) during compressor operation.

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

7. Housings designed for discharge pressures as noted in Table 2, GENERAL SPECIFICATIONS.

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

9. Shaft seal housing is designed 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 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. Suction and discharge flanges are ANSI B16.1 Class 300 for all models except the NGC 300 which has ANSI B16.1 Class 150 flanges.

13. Integral suction strainers are provided for all models except the NGC 400/450. The NGC 400/450 models must be fitted with a suitable strainer, #60 mesh X .0065" diameter stainless steel wire or better, to prevent damage to the compressor from particles entering the suction area.

14. Integral gearbox available with 4 different gear ratios for all models except the NGC 400/450 which have 6 ratios available.

15. Integral internal driven seal-less oil pump.

COMPRESSOR LUBRICATION SYSTEM

The lubrication system on an NGC 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 piston to help increase bearing life.
6. Provides an oil seal between the rotors to prevent rotor contact or gas bypassing.

OIL PUMP

A jackshaft driven, full-time oil pump is provided mounted on the compressor. The oil pump will provide sufficient oil pressure for low differential pressure applications. 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.

The oil pump is used to supply oil to the gears, bearings, balance piston, shaft seal and for main oil injection for the NGC 100 & 150 models. Other models, depending on operating conditions, use differential pressure to supply main oil injection. Also depending on the operating conditions, the boost in pressure from the oil pump can be used to reduce the axial bearing loads and to increase L_{10} life (CoolWare™ provides a warning when bearing life is too short).

CONSTRUCTION DETAILS

HOUSING: All NGC screw compressor castings are close grain, pressure tight, grey cast iron to ensure structural integrity and mechanical and thermal stability under all operating conditions.

ROTORS: The rotors are made from the highest quality rolled steel to the 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 an adjusted L_{10} rated life in excess of 50,000 hours, 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 four-point contact bearings. In addition, thrust balance pistons are provided to reduce the thrust load and improve bearing life.

GEARS: Helical Gears are made of AISI 8620H steel per ASTM A534. Design life for the gears is 50,000 hr. at maximum load conditions. Gears can be changed as needed by the customer to keep engines operating at full load as wellhead pressure drops.

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 controlling leakage up to 400 psig, but is vented to low pressure to provide extended life.

VOLUMIZER VARIABLE VOLUME RATIO CONTROL: The Johnson Controls - Frick compressor includes a patented 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-compression 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 table below.

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 below for minimum capacity for all NGC 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. CAPAC-ITY %	SLIDE VALVE TRAVEL (IN.)	SLIDE STOP TRAVEL (IN.)
NGC 100	2.2	5.0	12	6.50	2.53
NGC 150	2.2	5.0	12	8.18	3.19
NGC 200	2.2	5.0	15	7.84	3.06
NGC 250	2.2	5.0	23	9.89	4.75
NGC 300	2.0	4.1	20	16.94	6.95
NGC 400	2.2	5.0	12	8.99	3.69
NGC 450	2.4	4.5	26	15.48	6.40

INSTALLATION

DESIGN LIMITS

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

NGC compressors are primarily designed for direct engine drive. The NGC 100 – 300 models can be delivered with 4 different gear ratios. The NGC 400 and 450 models are available with 6 gear ratios. The rotor, gear, and bearing design limitations must not be exceeded (See CoolWare™). The table below lists some of the design limits. Other design limits are identical to standard non gear-driven compressors. Refer to Johnson Controls - Frick Compressor Control Panel instruction S90-010 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.

NGC 100 and 150	DWG# 534E0917
NGC 200	DWG# 534E1158
NGC 250	DWG# 534E1137
NGC 300	DWG# 534E0867
NGC 400	DWG# 534E1164
NGC 450	DWG# 534E1165

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

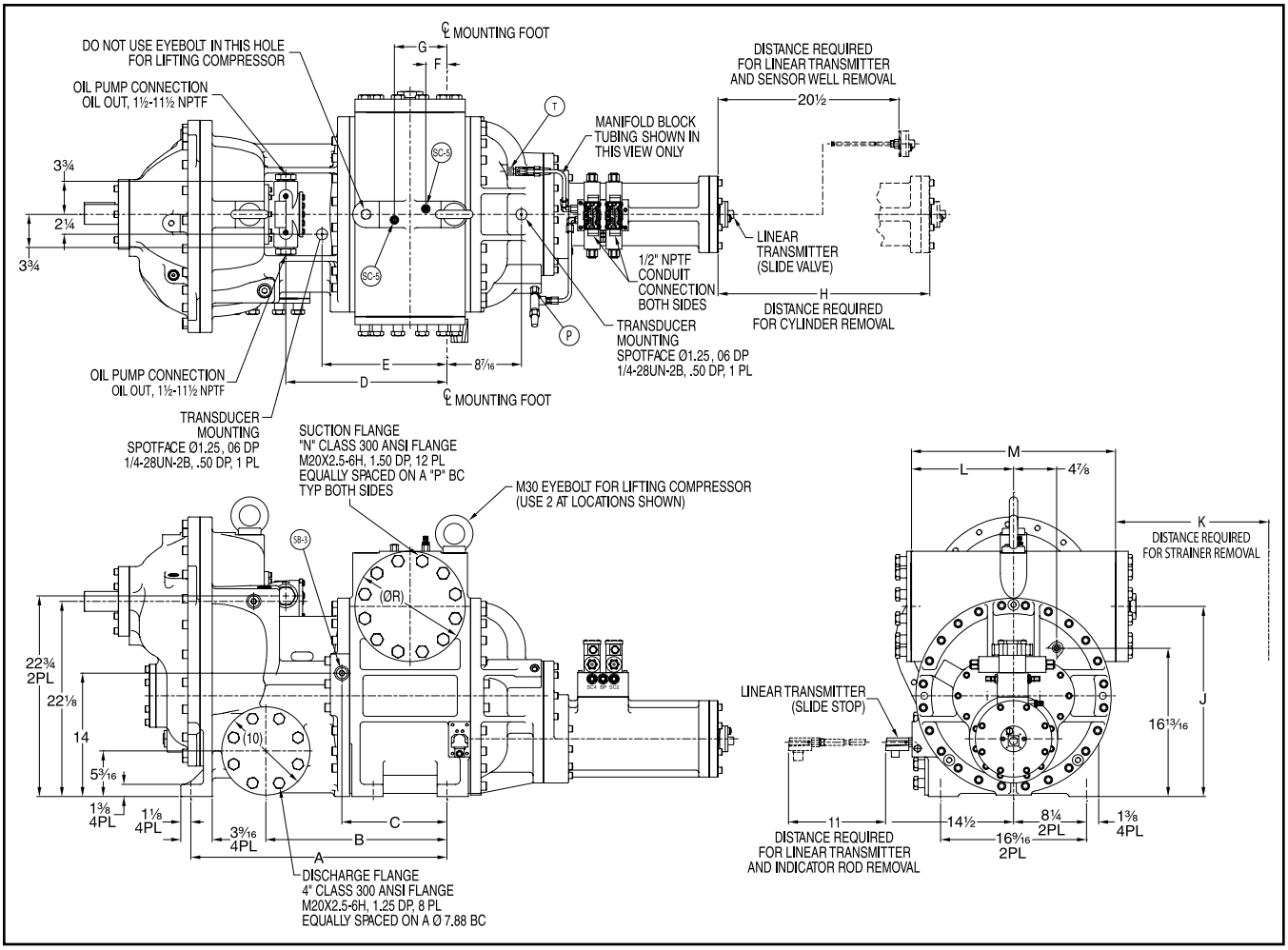
TABLE 2 - GENERAL SPECIFICATIONS

	NGC 100 gear A–D NGC 150 gear A–D	NGC 200 gear A–D NGC 250 gear A–D	NGC 300 gear A-D
Design working pressure (PSIG)	400	400	300
Drive speed minimum (RPM) *	600	600	600
Drive speed maximum (RPM) *	A–C: 2400 D: 2000	1800	1800
Maximum power input (BHP)	A: 210; B-D:250 @ 1800 RPM	A: 550; B: 700; C–D: 800 @ 1800 RPM	A: 600 B–D: 800 @ 1800 RPM
Oil pressure above discharge pressure max.* (PSI)	50	50	50
Min. Oil pressure below discharge pressure* (PSI)	15	15	15

	NGC 400 gear A-F	NGC 450 gear A–F
Design working pressure (PSIG)	400	400
Drive speed minimum (RPM) *	600	600
Drive speed maximum (RPM) *	A–D: 1800; E: 1500; F: 1400	A–D: 1800; E: 1500; F: 1400
Maximum torque input (BHP)	1700 @ 1200 rpm	1700 @ 1200 rpm
Oil pressure above discharge pressure max.* (PSI)	50	50
Min. Oil pressure below discharge pressure* (PSI)	15	15

* See CoolWare for additional information

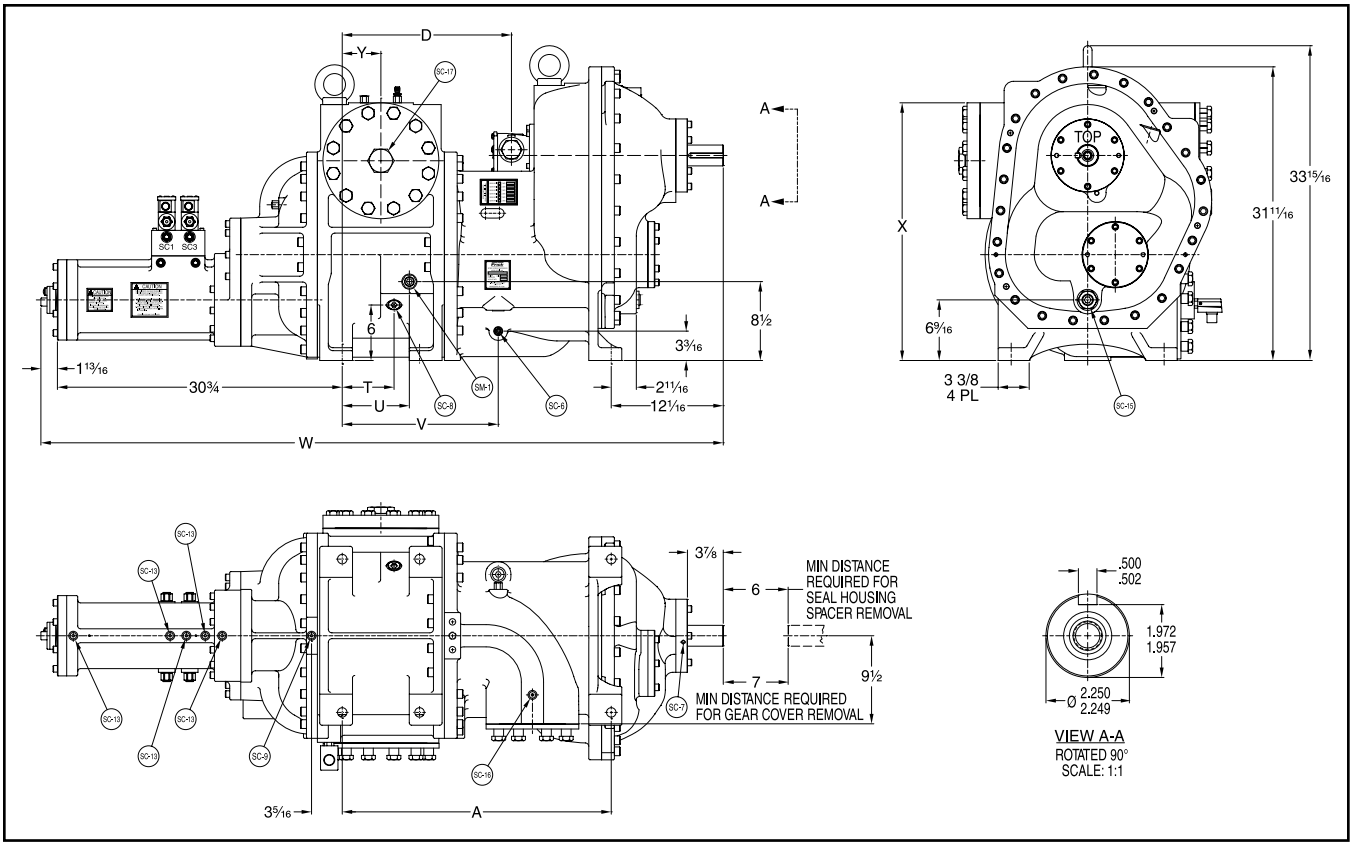
NGC 100 & 150 DIMENSIONS



MODEL	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	T	U	V	W	X	Y
NGC 100	25⅝	17⅛	8½	14⅞	10¾	1⁹⁄₁₆	3⁵⁄₁₆	22½	20¹³⁄₁₆	22	11¹⁄₁₆	22⅛	5	9¼	11	3⁹⁄₁₆	4¹⁵⁄₁₆	13⅜	70³⁄₁₆	26⁵⁄₁₆	2½
NGC 150	29	20½	11⅞	18¼	14⅛	2⅜	5¹⁵⁄₁₆	24	21⁹⁄₁₆	23	11⁹⁄₁₆	23⅛	6	10⅝	12½	5⁹⁄₁₆	7¼	16¹³⁄₁₆	73⅝	27¹³⁄₁₆	4³⁄₁₆

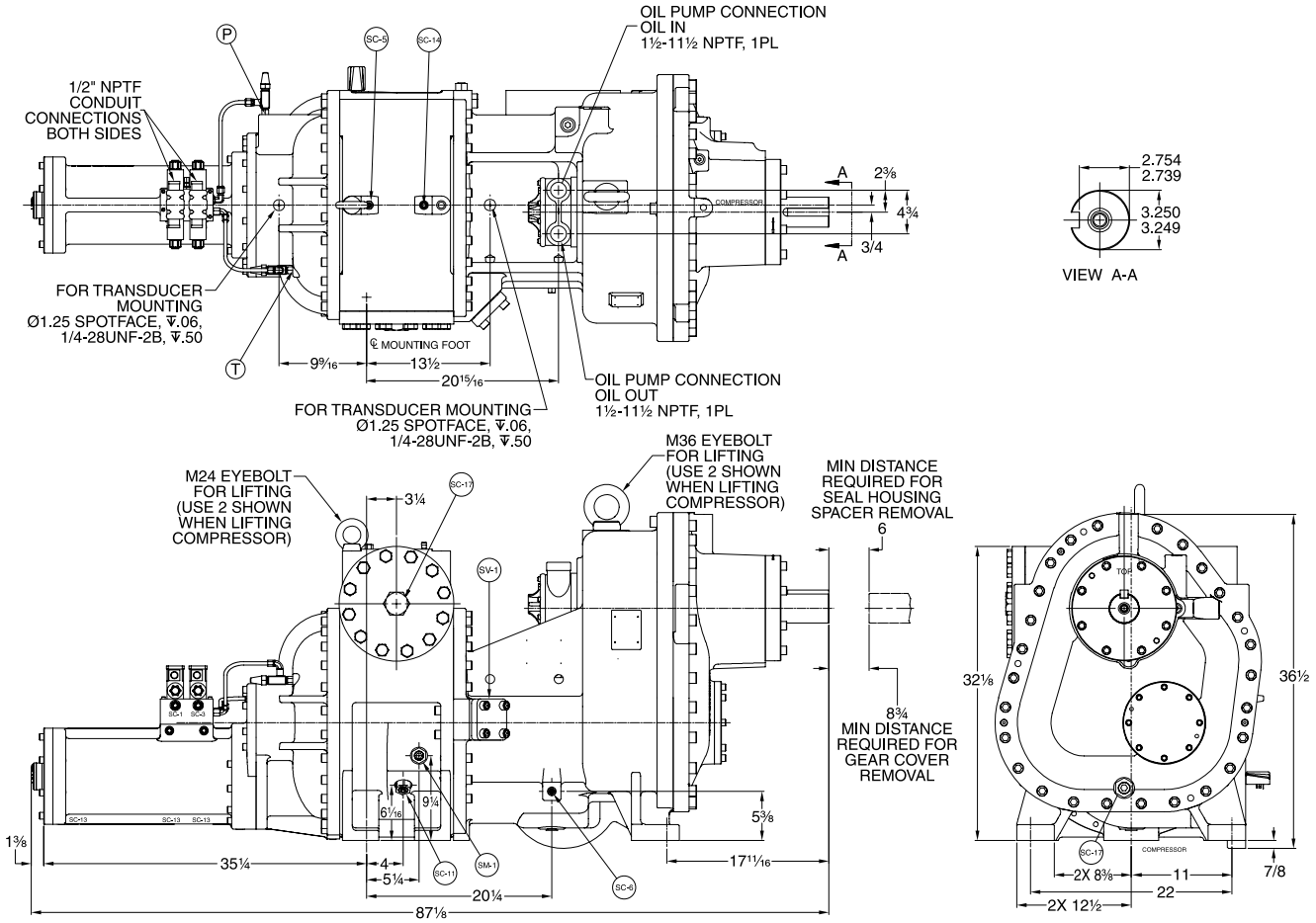
NGC 100 & 150 CONNECTION LEGEND		
SYMBOL	**SIZE**	**DESCRIPTION**
SB-2	3/4-14 NPTF	INLET BEARINGS & BALANCE PISTON
SB-3	1½ - 11½ NPTF	DISCHARGE BEARINGS
SC-1	1/2-14 NPTF	SLIDE VALVE-UNLOAD
SC-2	1/2-14 NPTF	SLIDE VALVE-LOAD
SC-3	1/2-14 NPTF	MOVEABLE SLIDE STOP
SC-4	1/2-14 NPTF	INLET OIL DRAIN
SC-5	3/8-18 NPTF	INLET PRESSURE
SC-6	3/4-14 NPTF	DISCHARGE PRESSURE
SC-7	1/8-27 NPTF	SEAL WEEPAGE
SC-8	1¼ - 11½ NPTF	CLOSED THREAD DRAIN
SC-9	1½ - 11½ NPTF	CLOSED THREAD DRAIN
SD-1	11/16-12 UN-2B	COALESCER BLEED (STD THREAD O-RING PORT)
SE-1	1/2-14 NPTF	ELECTRICAL CONNECTION
SE-2	1/2-14 NPTF	ELECTRICAL CONNECTION
SL-1	2½-12 UN -2B	LOW Vi LIQUID INJECTION
SL-2	2½-12 UN -2B	HIGH Vi LIQUID INJECTION
SM-1	2 IN FLANGE	MAIN OIL INJECTION
ST-1	3/4-14 NPTF	THERMOWELL-SUCTION
SV-1	3 IN FLANGE	VAPOR INJECTION
TW-1	3/4-14 NPTF	THERMOWELL-DISCHARGE

NGC 100 & 150 DIMENSIONS



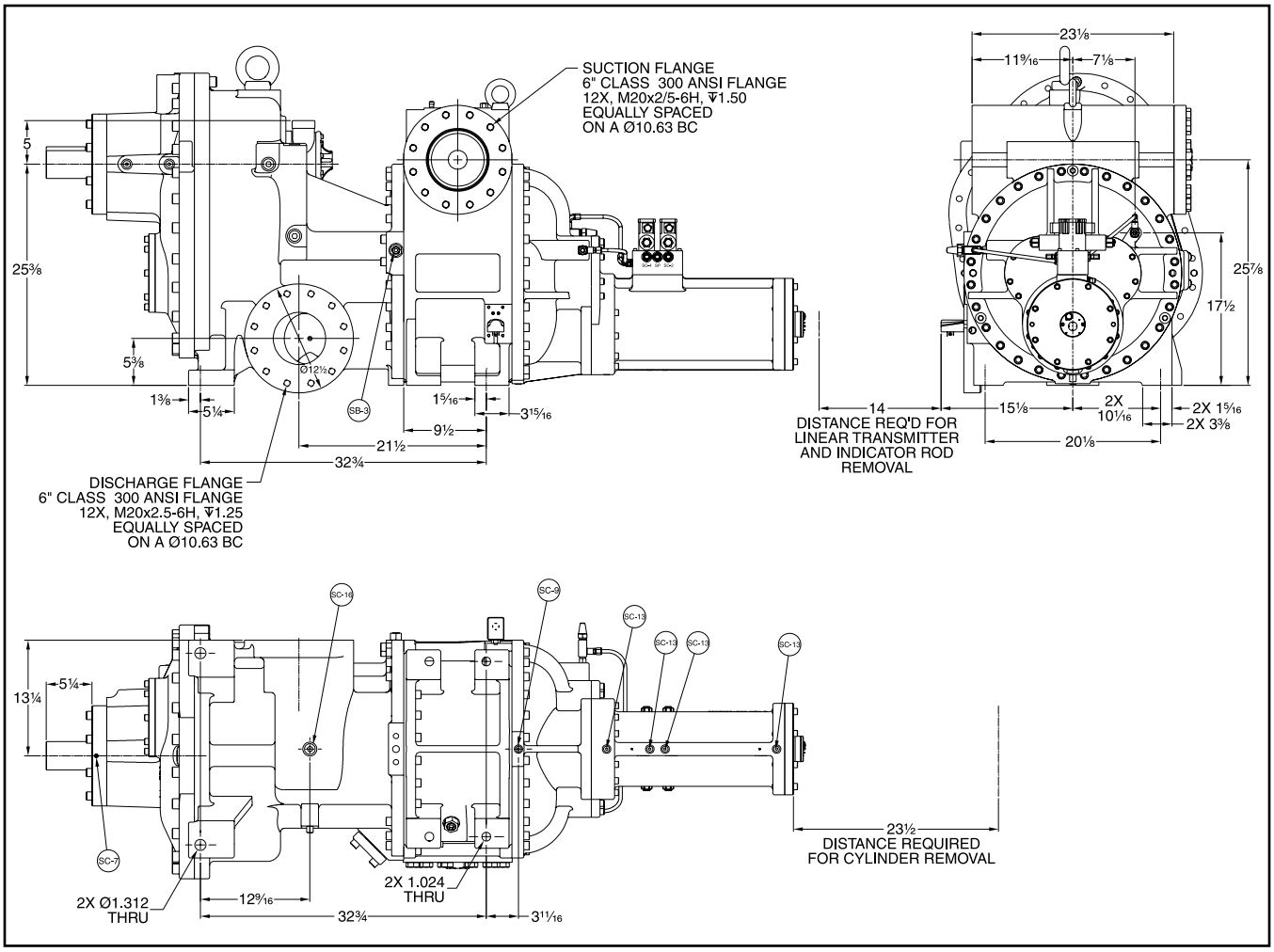
MODEL	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	T	U	V	W	X	Y
NGC 100	25⅝	17⅛	8½	14⅞	10¾	1⁹⁄₁₆	3⁵⁄₁₆	22½	20¹³⁄₁₆	22	11¹⁄₁₆	22⅛	5	9¼	11	3⁹⁄₁₆	4¹⁵⁄₁₆	13⅜	70³⁄₁₆	26⁵⁄₁₆	2½
NGC 150	29	20½	11⅞	18¼	14⅛	2⅜	5¹⁵⁄₁₆	24	21⁹⁄₁₆	23	11⁹⁄₁₆	23⅛	6	10⅝	12½	5⁹⁄₁₆	7¼	16¹³⁄₁₆	73⅝	27¹³⁄₁₆	4³⁄₁₆

NGC 200 DIMENSIONS

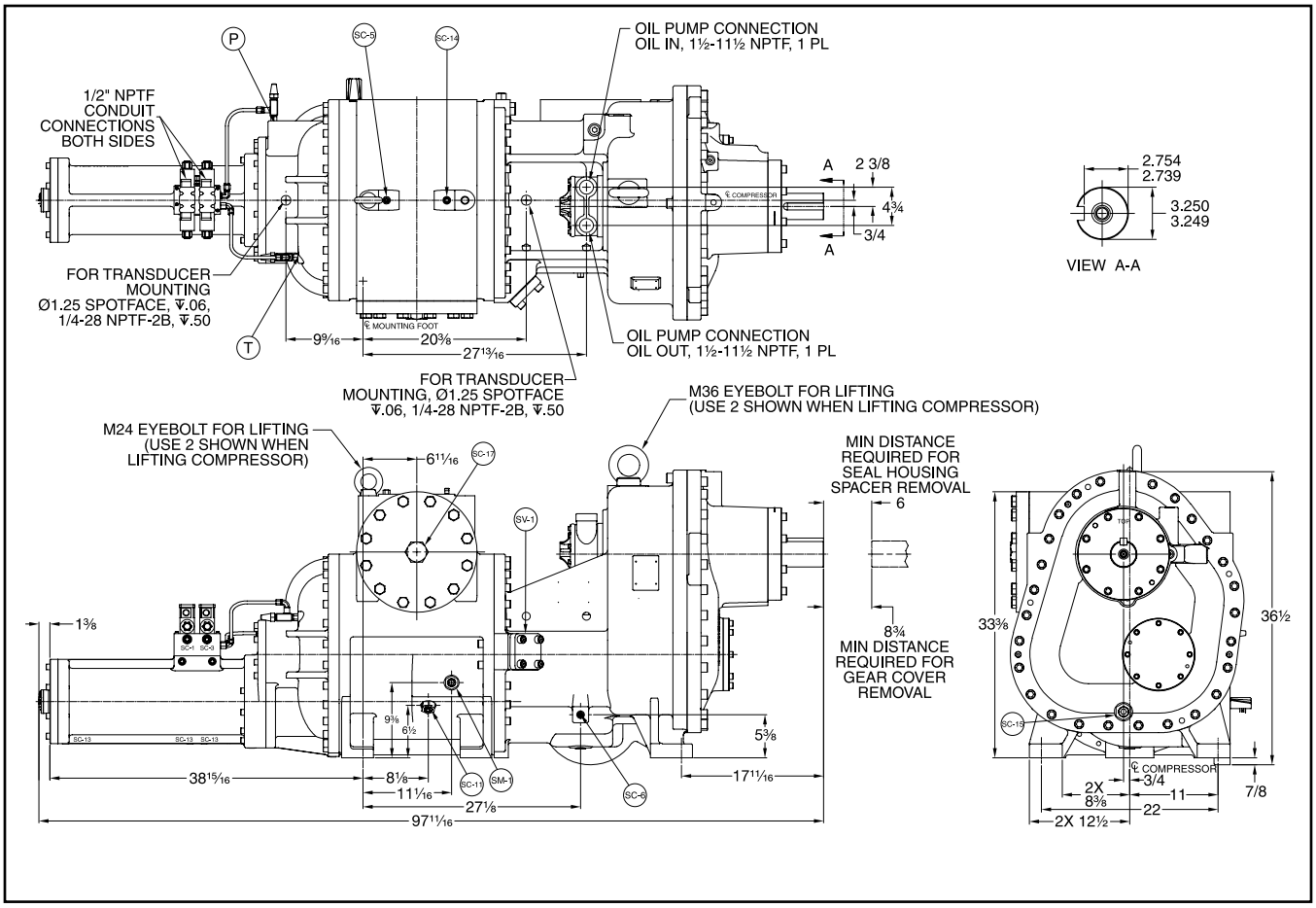


NGC 200 CONNECTION LEGEND			
SYMBOL	COMPRESSOR HOUSING PORT SIZE	STRAIGHT THREAD ADAPTER WITH FEMALE PIPE THREAD	DESCRIPTION
P	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	MANIFOLD BLOCK PRESSURE
SB-3	11/16-12 UN-2B STRAIGHT THREAD O-RING	1/2-14 NPTF	COMPRESSOR OIL SUPPLY
SC-5	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	INLET PRESSURE
SC-6	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	DISCHARGE PRESSURE
SC-7	1/8-27 NPTF	—	SEAL WEEPAGE
SC-9	9/16-18 UNF-2B STRAIGHT THREAD O-RING	—	INLET HOUSING OIL DRAIN
SC-11	15/16-12 UN-2B STRAIGHT THREAD O-RING	3/4-14 NPTF	CLOSED THREAD DRAIN
SC-13	9/16-18 UNF-2B STRAIGHT THREAD O-RING	—	OIL DRAIN CYLINDER
SC-14	9/16-18 UNF-2B STRAIGHT THREAD O-RING	—	INLET PRESSURE
SC-15	15/16-12 UN-2B STRAIGHT THREAD O-RING	1½ - 11½ NPTF	GEAR BOX OIL DRAIN
SC-16	11/16-12 UN-2B STRAIGHT THREAD O-RING	—	DISCHARGE HOUSING OIL DRAIN
SC-17	2-11½ NPTF	—	INLET PRESSURE
SM-1	15/16-12 UN-2B STRAIGHT THREAD O-RING	3/4-14 NPTF	MAIN OIL INJECTION
SV-1	2 IN SQUARE FLANGE	—	VAPOR INJECTION-TONGUE & GROOVE
T	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	MANIFOLD BLOCK TANK

NGC 200 DIMENSIONS

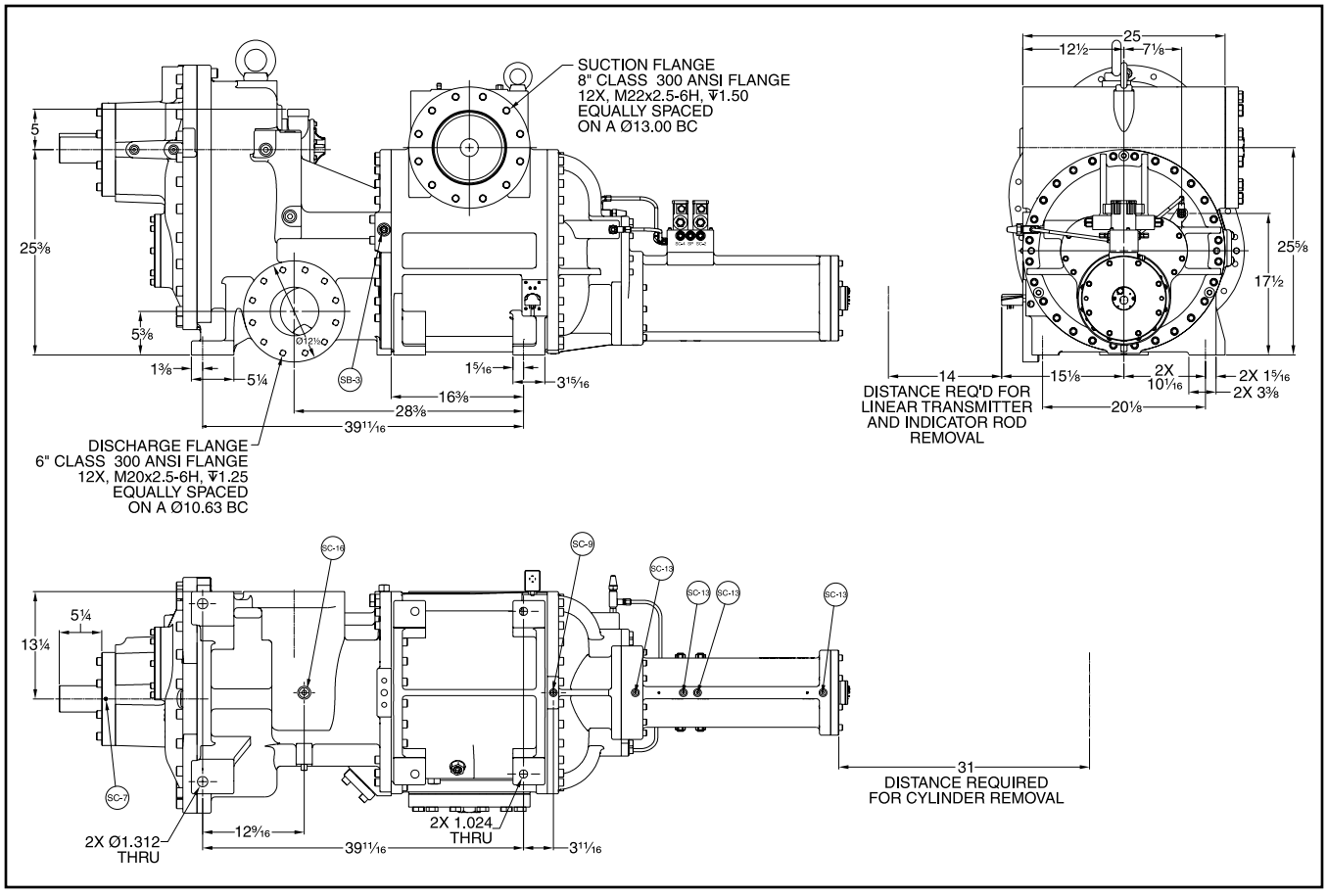


NGC 250 DIMENSIONS

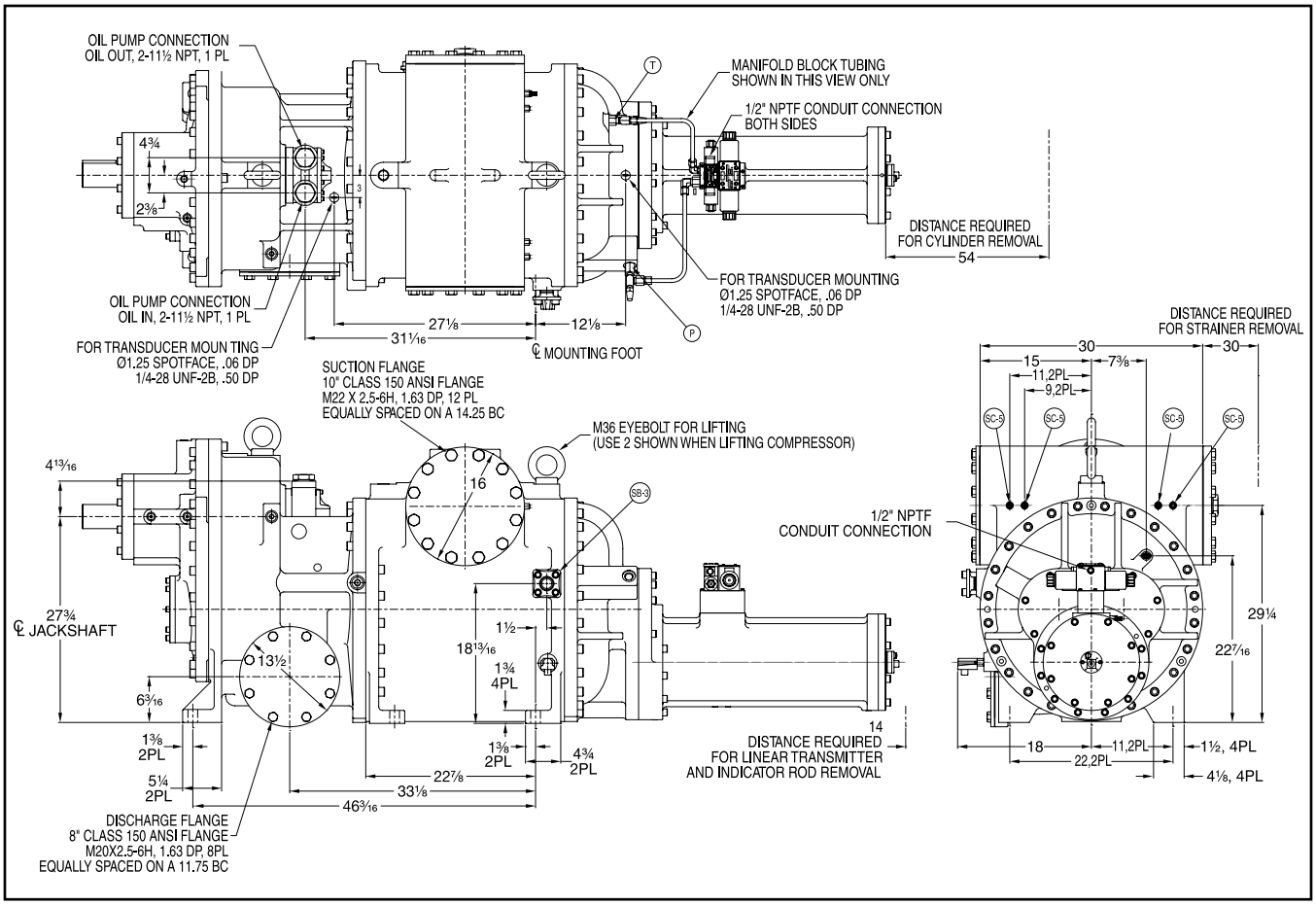


NGC 250 CONNECTION LEGEND			
SYMBOL	COMPRESSOR HOUSING PORT SIZE	STRAIGHT THREAD ADAPTER WITH FEMALE PIPE THREAD	DESCRIPTION
P	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	MANIFOLD BLOCK PRESSURE
SB-3	11/16-12 UN-2B STRAIGHT THREAD O-RING	1/2-14 NPTF	COMPRESSOR OIL SUPPLY
SC-5	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	INLET PRESSURE
SC-6	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	DISCHARGE PRESSURE
SC-7	1/8-27 NPTF	—	SEAL WEEPAGE
SC-9	9/16-18 UNF-2B STRAIGHT THREAD O-RING	—	INLET HOUSING OIL DRAIN
SC-11	15/16-12 UN-2B STRAIGHT THREAD O-RING	3/4-14 NPTF	CLOSED THREAD DRAIN
SC-13	9/16-18 UNF-2B STRAIGHT THREAD O-RING	—	OIL DRAIN CYLINDER
SC-14	9/16-18 UNF-2B STRAIGHT THREAD O-RING	—	INLET PRESSURE
SC-15	15/16-12 UN-2B STRAIGHT THREAD O-RING	1½ - 11½ NPTF	GEAR BOX OIL DRAIN
SC-16	11/16-12 UN-2B STRAIGHT THREAD O-RING	—	DISCHARGE HOUSING OIL DRAIN
SC-17	2-11½ NPTF	—	INLET PRESSURE
SM-1	15/16-12 UN-2B STRAIGHT THREAD O-RING	3/4-14 NPTF	MAIN OIL INJECTION
SV-1	2 IN SQUARE FLANGE	—	VAPOR INJECTION-TONGUE & GROOVE
T	9/16-18 UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	MANIFOLD BLOCK TANK

NGC 250 DIMENSIONS

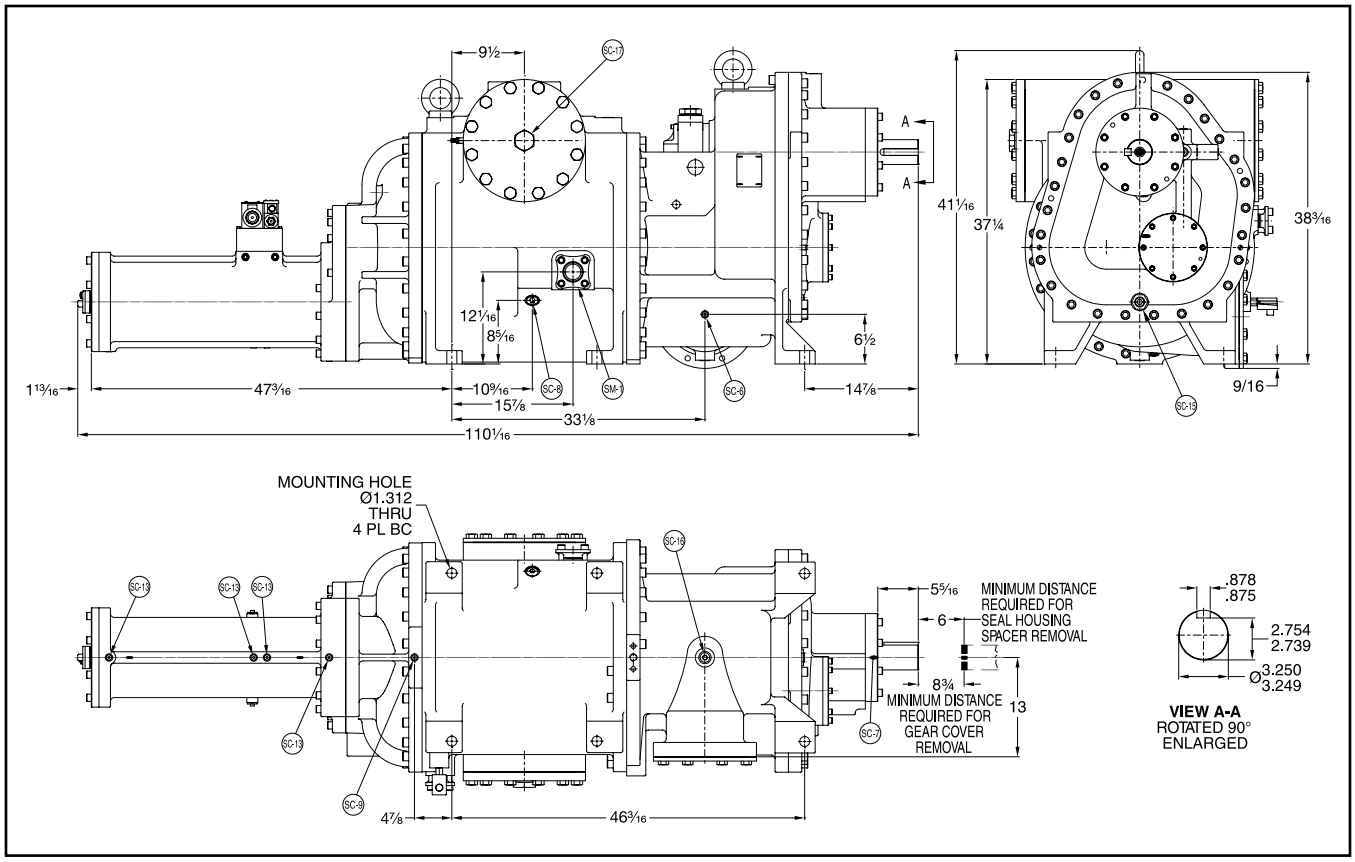


NGC 300 DIMENSIONS

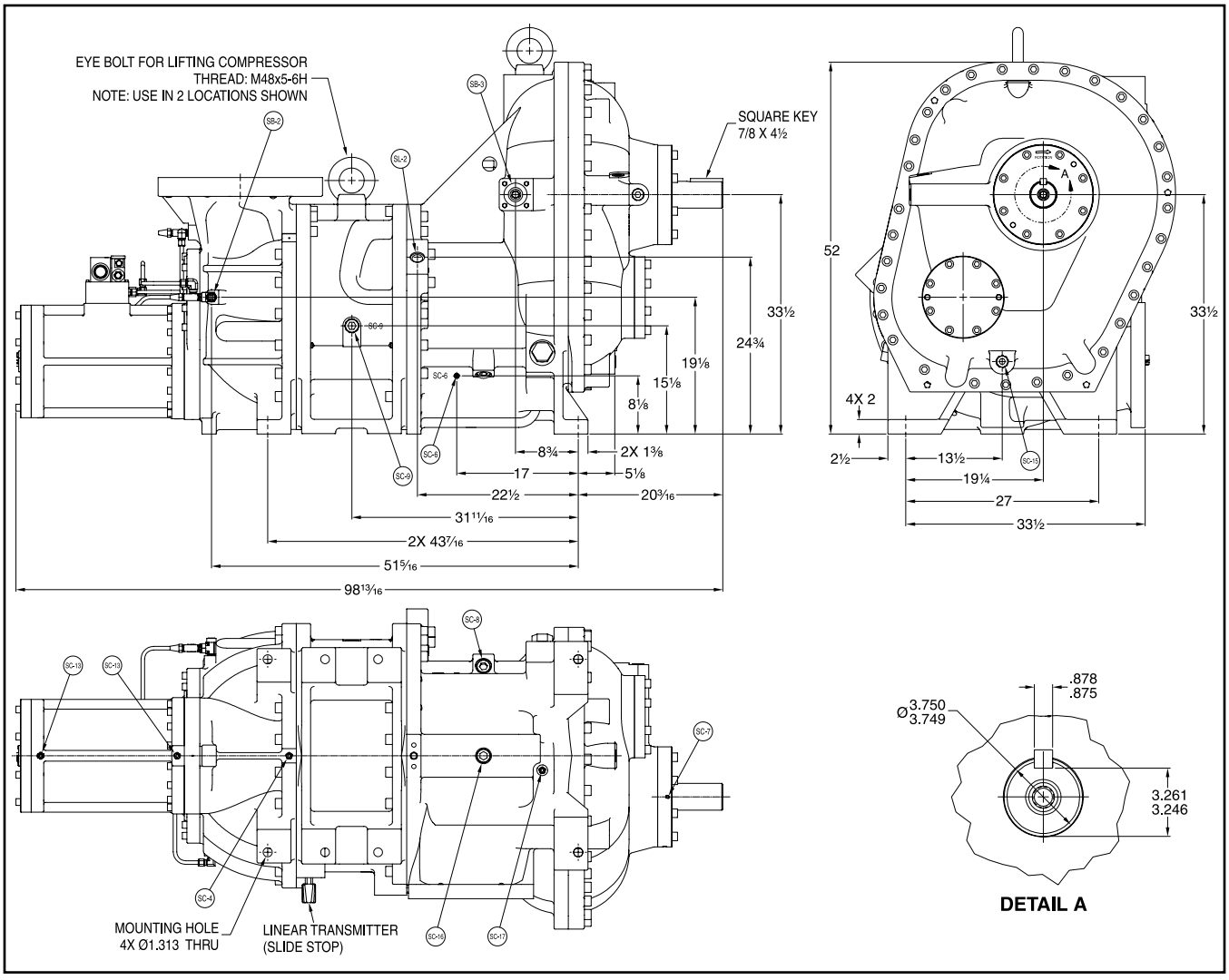


NGC 300 CONNECTION LEGEND			
SYMBOL	**COMPRESSOR HOUSING PORT SIZE**	**STRAIGHT THREAD ADAPTER WITH FEMALE PIPE THREAD**	**DESCRIPTION**
SB-3	1 1/4 SQUARE FLANGE	—	COMPRESSOR OIL SUPPLY
SC-5	9/16-18UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	INLET PRESSURE
SC-6	9/16-18UNF-2B STRAIGHT THREAD O-RING	1/4-18 NPTF	DISCHARGE PRESSURE
SC-7	1/8-27 NPTF	—	SEAL WEEPAGE
SC-8	1 5/16-12UN-2B STRAIGHT THREAD O-RING	—	CLOSED THREAD DRAIN
SC-9	9/16-18UNF-2B STRAIGHT THREAD O-RING	—	INLET HOUSING OIL DRAIN
SC-13	9/16-18UNF-2B STRAIGHT THREAD O-RING	—	CYLINDER OIL DRAIN
SC-15	1 5/8-12UN-2B STRAIGHT THREAD O-RING	1-11 1/2 NPTF	GEAR BOX OIL DRAIN
SC-16	1 1/16-12UN-2B STRAIGHT THREAD O-RING	—	DISCHARGE HOUSING OIL DRAIN
SC-17	2-11 1/2 NPTF	—	INLET PRESSURE
SM-1	2 SQUARE FLANGE	—	MAIN OIL INJECTION
T	3/4-16UNF-2B STRAIGHT THREAD O-RING	1/2-14 NPTF	MANIFOLD BLOCK TANK

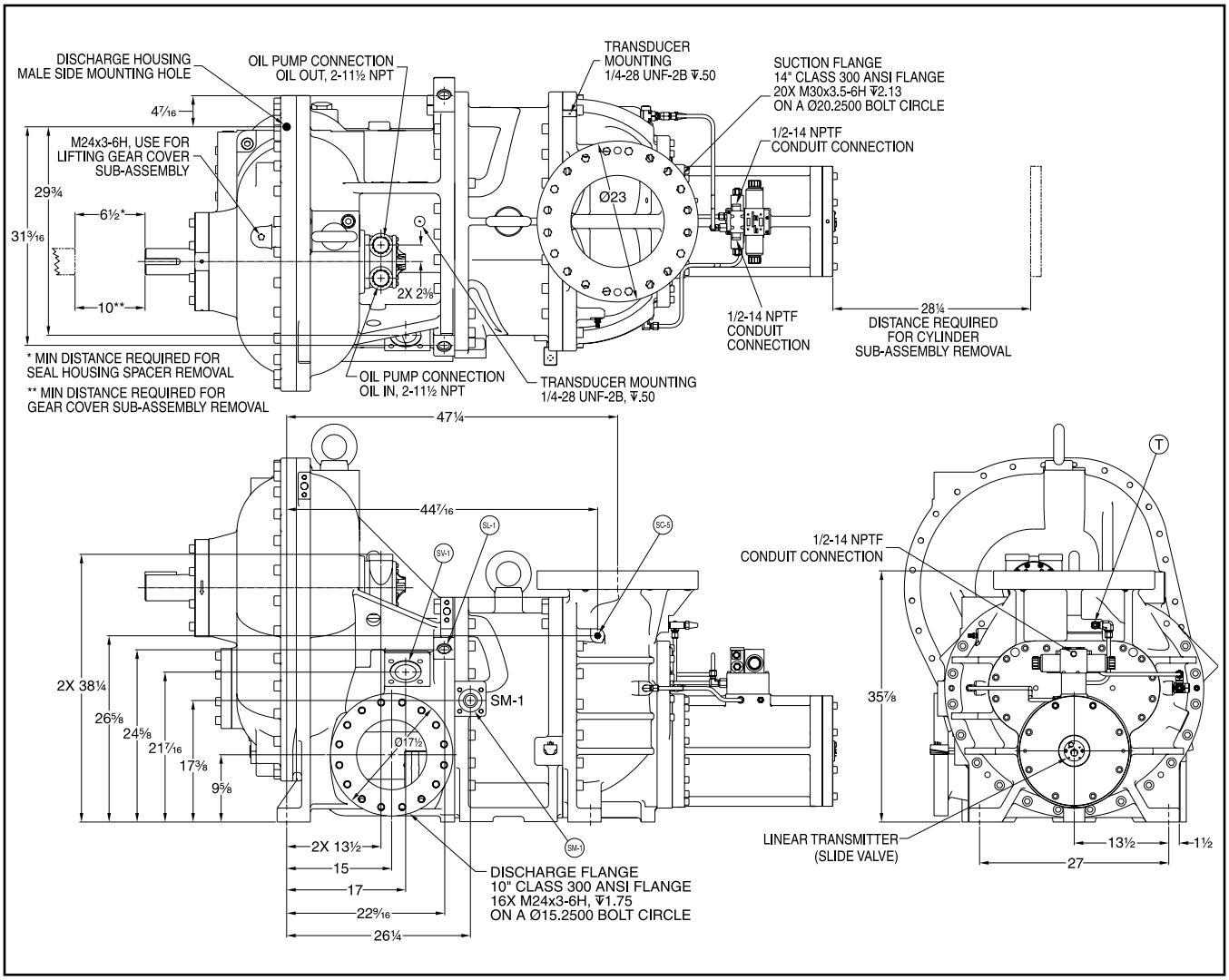
NGC 300 DIMENSIONS



NGC 400 DIMENSIONS

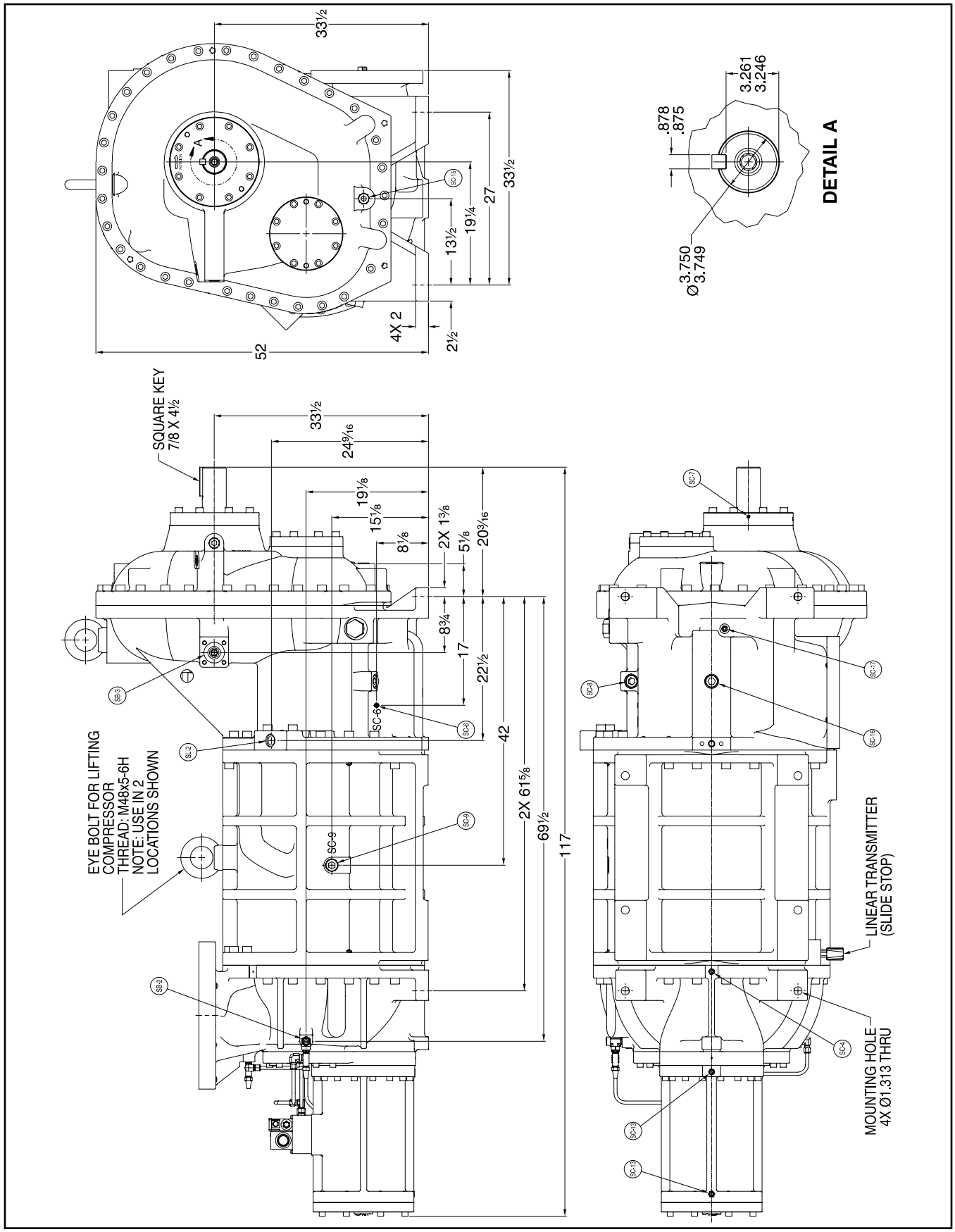


NGC 400 DIMENSIONS



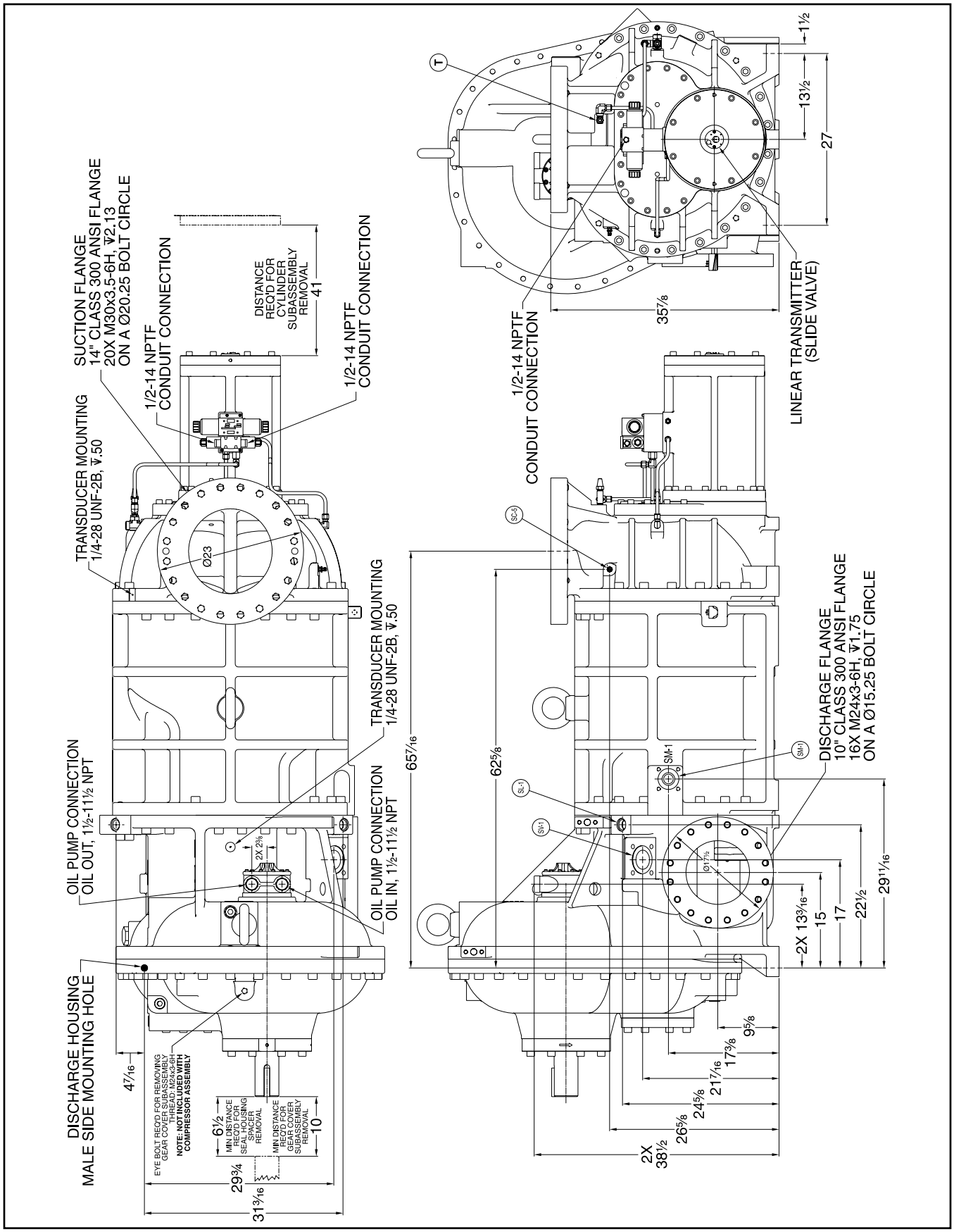
400/450 COMPRESSOR CONNECTION LEGEND		
SYMBOL	**COMPRESSOR HOUSING PORT SIZE**	**DESCRIPTION**
SB-2	3/4-14 NPTF	INLET BEARINGS, BALANCE PISTON, & MANIFOLD BLOCK PRESSURE
SB-3	2 IN SQUARE FLANGE	COMPRESSOR OIL SUPPLY
SC-4	1/2-14 NPTF	INLET OIL DRAIN
SC-5	3/8-18 NPTF	INLET PRESSURE
SC-6	3/8-18 NPTF	DISCHARGE PRESSURE
SC-7	1/8-27 NPTF	SEAL WEEPAGE
SC-8	1¼ - 11½ NPTF	CLOSED THREAD DRAIN
SC-9	1½ - 11½ NPTF	CLOSED THREAD DRAIN
SC-13	1/2-14 NPT	OIL DRAIN CYLINDER
SC-15	1¼ - 11½ NPT	GEAR COVER OIL DRAIN
SC-16	1½ - 11½ NPT	DISCHARGE HOUSING OIL DRAIN
SC-17	1/2-14 NPTF	DISCHARGE HOUSING SUMP DRAIN
SL-1	1¼ - 11½ NPTF	LOW VI LIQUID INJECTION
SL-2	1¼ - 11½ NPTF	HIGH VI LIQUID INJECTION
SM-1	2 IN SQUARE FLANGE	MAIN OIL INJECTION
SV-1	3 IN SQUARE FLANGE	ECONOMIZER
T	1/2-14 NPTF	MANIFOLD BLOCK TANK

NGC 450 DIMENSIONS



See legend with NGC 400 Dimensions.

NGC 450 DIMENSIONS



HOLDING CHARGE AND STORAGE

Every NGC 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.

⚠ CAUTION

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

RIGGING AND HANDLING

The compressor can be moved with rigging, using a crane or forklift, by hooking into the two lifting rings at each end of the main housings. The compressor lifting rings shall only be used to lift the compressor itself. See Figure 3.

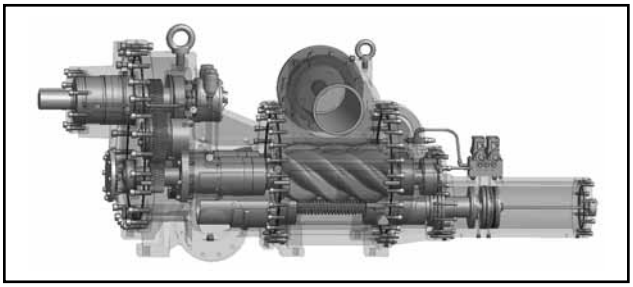


Figure 3 - Lifting Rings

FOUNDATION

Each NGC 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.

NGC 100	2900 lb	NGC 300	6,700 lb
NGC 150	3150 lb	NGC 400	10,000 lb
NGC 200	4400 lb	NGC 450	13,200 lb
NGC 250	4800 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 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. SIZE NPS	MOMENTS (ft-lbf)			LOAD (lbf)		
	AXIAL	VERT.	LAT.	AXIAL	VERT.	LAT.
	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	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

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
P	Manifold block pressure
T	Manifold block tank
Oil pump in and out	

Other connections are available for instrumentation and service as shown on your P + I diagram.

The electrical connections for the slide stop and the slide valve transmitters must be connected to your control system.

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.

NOTICE

The Frick oil recommended for the application is the best suited lubricant for the conditions specified at the time of purchase. If there is any doubt due to the gas composition, operating pressures, or temperatures, refer to Johnson Controls-Frick publications 160-810 NGO and E160-802 SPC for guidance.

OIL PUMP

NGC models that are supplied with an oil pump use an integral seal–less type. You must connect to the inlet and outlet of the pump. It is recommended that a strainer be mounted upstream to protect the pump. The pump is 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 except the NGC 400 & 450. For some applications, NGC 400 and 450 models require the pump pressure boost to reduce axial load on the male rotor. This is done to increase the life of the male axial bearing (see CoolWare). These models use pressure boost up to 50 psi above compressor discharge and require an appropriate safety relief valve.

⚠ 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.

The fixed volume flow of the pump will require a parallel bypass-line for some applications. Please see CoolWare™ for the specific oil flow for your application.

Nominal oil pump flow at 1800 rpm inlet drive speed is:

NGC 100 and 150	32 GPM
NGC 200, 250 and 450	56 GPM
NGC 300 and 400	75 GPM

COMPRESSOR

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

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

COMPRESSOR/MOTOR COUPLING REQUIREMENTS

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

Coupling must be selected and installed so that it doesn't transmit any axial load to the compressor shaft.

Set up the minimum distance between compressor shaft and engine shaft to allow for seal removal and gear cover removal (see Outline drawings).

1. 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.
2. For all engine applications, a torsional vibration analysis of the complete system must be performed including: engine - coupling - compressor (including gearing). This is to ensure that the system will run well away from any natural frequencies. Johnson Controls - Frick will on request deliver data for torsional stiffness, rotating mass and inertia of the compressor components.

COUPLING ALIGNMENT REQUIREMENTS

The life of the compressor shaft seal and bearings is dependent upon proper coupling alignment. Coupling alignment must be performed prior to start-up. After the package 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.

Dial indicators or another appropriate measuring device are to be used to determine the Total Indicator Runout.

⚠ WARNING

TOTAL INDICATOR AXIAL RUNOUT MUST NOT EXCEED .004" (TIR).

⚠ WARNING

TOTAL INDICATOR RADIAL RUNOUT MUST NOT EXCEED .004" (TIR).

⚠ CAUTION

CARE MUST BE USED WHEN CORRECTING FOR PARALLEL MISALIGNMENT TO ENSURE THAT THE AXIAL SPACING AND ANGULAR MISALIGNMENT IS NOT SIGNIFICANTLY DISTURBED.

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. See Figure 4.

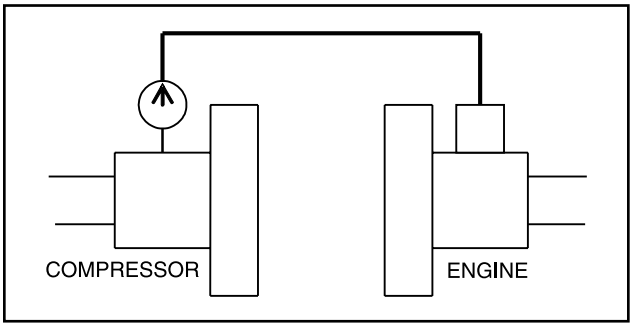


Figure 4 - Alignment between Compressor and Engine

⚠ WARNING

Make sure all coupling components are properly attached before starting the engine. It is critical to prevent them from flying off and possibly causing serious injury or death.

⚠ CAUTION

Injury could occur if loose clothing, etc, becomes entangled on the spinning engine shaft, coupling components or the compressor shaft. Always install all guards and covers before starting engine.

COMPRESSOR/MOTOR COUPLINGS INSTALLATION

Before installing the coupling perform the following:

1. Inspect the shaft of the compressor to ensure that no nicks, grease, or foreign matter is present.
2. Inspect the coupling components to make sure that they are free of burrs and are clean.
3. Check that the key (is so equipped) fits the compressor hub and shaft properly.
4. During installation of the coupling hub be carefully not to put any excess load on the compressor bearings and shaft seal in any way. Never hammer on the hub as this can lead to bearing failure.
5. Coupling shall be aligned according to coupling manufacturer's requirements.
6. Check that no axial force will be transmitted to the compressor.
7. Check and redo the alignment after 200 hours of operation. See the maintenance schedule.

OIL HEATER(S)

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

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 $\beta_5 = 75$ according to ISO 4572 is required to obtain the recommended oil cleanliness class 16/14/11 according to ISO 4406.

OIL COOLING REQUIREMENTS

Oil cooling is required to keep the temperature of the discharge gas from exceeding 250°F. The discharge temperature must be high enough to prevent moisture from condensing in the compressor and oil separator. The use of a three-way mixing valve is recommended to keep the oil temperature in the proper range.

DEHYDRATION / EVACUATION TEST

Evacuate the system to 1000 microns. Valve off the vacuum pump and hold vacuum for one hour.

Pass – Vacuum cannot rise more than 500 microns during one hour hold period.

Fail – Vacuum rise is more than 500 microns during one hour hold period. Identify and repair any system leaks. Repeat vacuum test until requirements are met.

ELECTRICAL INSTALLATION

SLIDE STOP TRANSMITTER

The slide stop transmitter measures the position of the slide stop (SS) using a 4 to 20mA signal that is sent to your control system. The controller will adjust the position of SS according to system pressures. The correct SS position is important to achieve the most efficient compressor operation. Connect to +/- and signal. Refer to Johnson Controls- Frick compressor panel instructions S90-010 for calibration procedure.

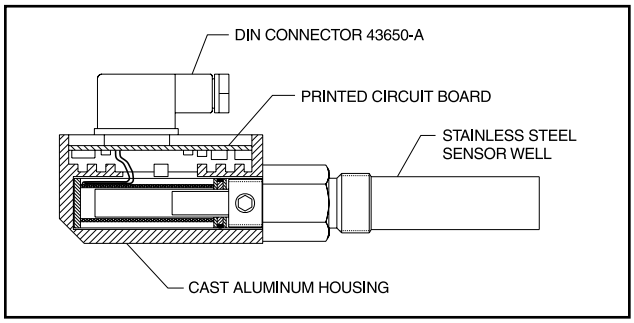


Figure 5 - Slide Stop Transmitter

CAPACITY SLIDE VALVE TRANSMITTER

The slide valve transmitter measures the position of the slide valve (SV) and sends a 4 to 20mA signal to your control system. The controller will adjust the position of the SV according to the engine load set point. The correct position is important to properly load the compressor and engine. It is important not to overload the compressor and engine. Observe the maximum power input and ensure design limitations are not exceeded. Connect to +/- and signal. Refer to Johnson Controls- Frick compressor panel instructions for calibration procedure S90-010.

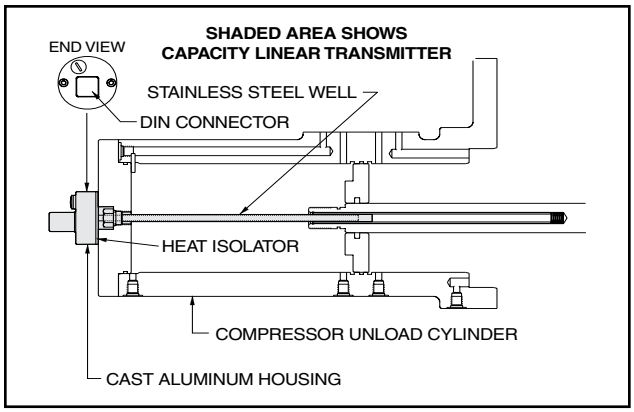


Figure 6 - Capacity Slide Valve Transmitter

DIRECTIONAL CONTROL VALVES

Solenoids YY1, YY2, YY3 and YY4 must be wired to give the correct function. A description of their function is given in the **OPERATION** chapter. For control system information refer to Johnson Controls - Frick Compressor Control Panel S90-010. See wiring diagram in Figure 7.

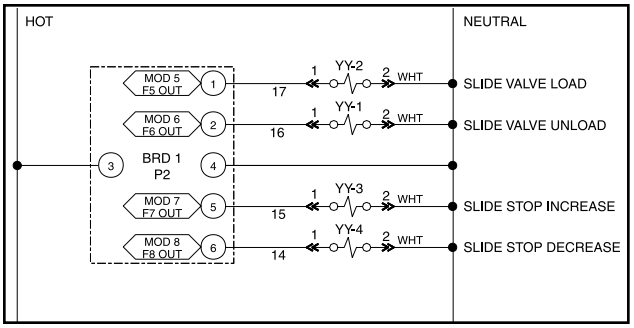


Figure 7 - Directional Control Valve Wiring Diagram

OPERATION

OPERATION AND START-UP INSTRUCTIONS

The Johnson Controls - Frick NGC 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 NGC Rotary Screw Compressor in your Unit. Only matters which may influence the proper operation of the NGC compressor are included.

⚠ WARNING

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

COMPRESSOR HYDRAULIC SYSTEM

(24 VDC Solenoid valves and distribution block are available as sales order option)

The compressor hydraulic system (See Figure 8) actuates the movable slide valve (MSV) to load and unload the compressor. It also actuates 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 NGC compressor serves a dual purpose. It is separated by a fixed bulkhead into two sections. The MSV section is to the left of the bulkhead and the MSS is to the right if you are facing the right side of the compressor. Both operations 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

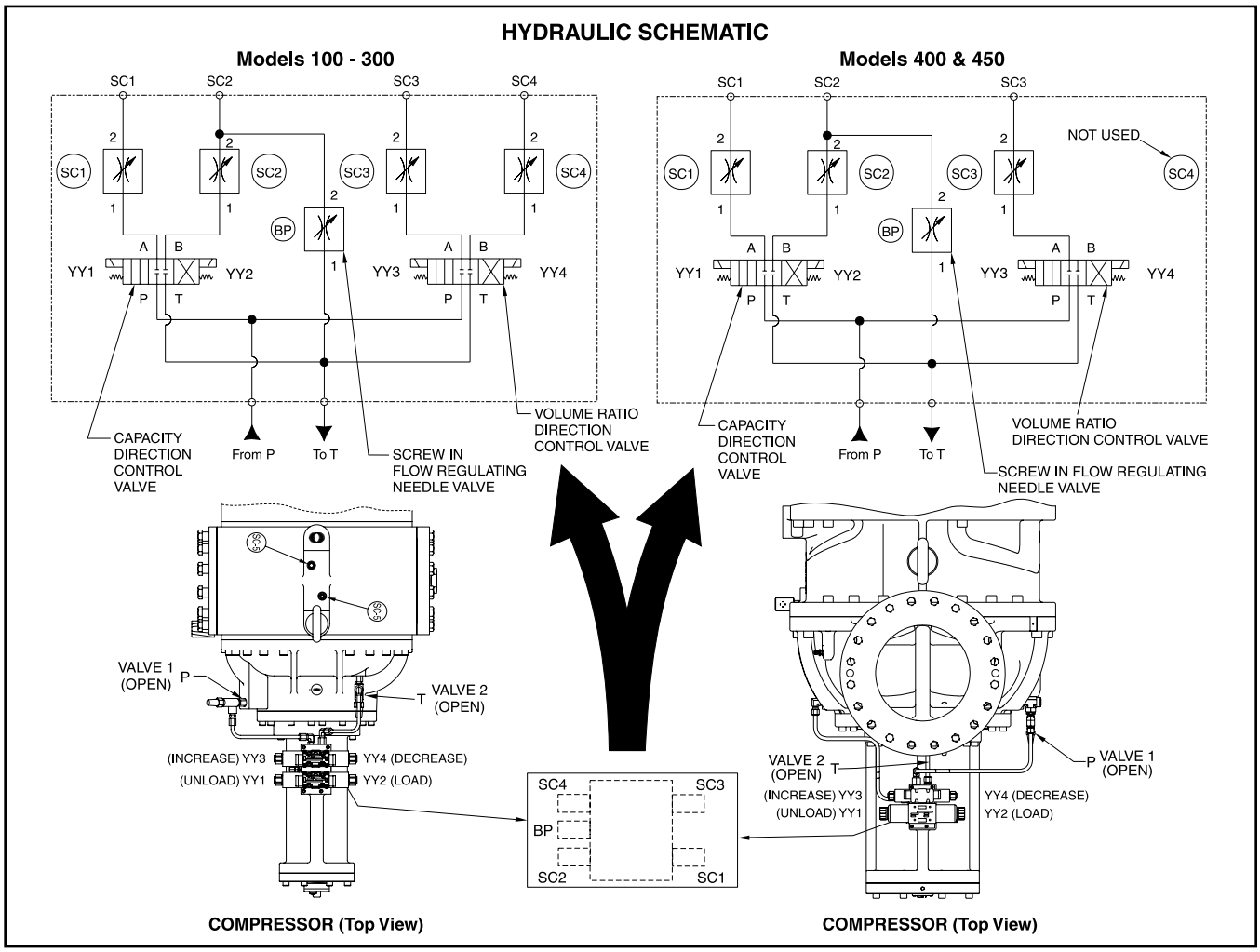


Figure 8 - Hydraulic Schematic

vented through port SC2 and valve BP to compressor suction.

NOTICE

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

DOUBLE-ACTING MODE - Booster (low differential)
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.

NOTICE

To control the rate of loading and unloading, throttle valves SC1 and SC2.

NOTICE

To slow all valve movements - loading, unloading, and VI change - throttle valve 2.

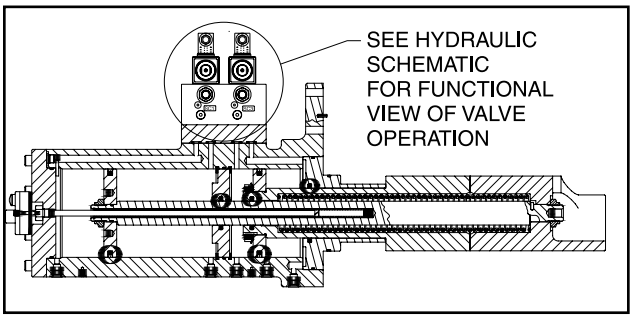


Figure 9 - Solenoid Valve Block

⚠ CAUTION

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

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.

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.

INITIAL STARTUP

Prior to the start-up, the packager's prestart check must be accomplished.

INITIAL STARTUP PROCEDURE

Having performed the packager's 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 vibration analysis if equipment is available.

NORMAL STARTUP 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, troubleshooting and correction guides. Changing gear sets is not part of the normal service program. Gear changes must only be performed by JOHNSON CONTROLS - FRICK personnel or other specially trained personnel. Drawings and a step-by-step picture series showing how to perform a gear change are available from JOHNSON CONTROLS - FRICK. A number of special tools are needed to do a gear change and a special tool KIT is available from JOHNSON CONTROLS - FRICK that must be used.

⚠ 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:

1. IF UNIT IS RUNNING, PRESS [STOP] KEY.
2. STOP ENGINE AND LOCK OUT STARTER 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 GAS BEING USED.

GENERAL MAINTENANCE

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

1. Keep gas 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. Dual oil filters are recommended so that the filters can be changed without shutting down the package.

4. Avoid slugging 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 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.

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 engine 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 engine starter.
14. Start the unit

OIL PUMP

The oil pump is integral and directly driven by the compressor drive shaft. There is no dynamic seal and the end clearance is fixed. Service will normally not be needed as long as the pump provides adequate pressure.

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 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.

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 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. The following list of abnormal system conditions can cause abnormal operation of the NGC compressor:

1. Insufficient or excessive gas load.
2. Excessively high suction pressure.
3. Excessively high discharge pressure.
4. Excessively high or low temperature coolant to the oil cooler.
5. Excessive liquid entering the compressor (slugging).
6. Insufficient oil cooling.
7. Excessive oil cooling
8. Incorrect gas line sizing.
9. Improper system piping.
10. Wrong operation of hydraulic operated slide valve.
11. Problems in electrical service to compressor.
12. Moisture present in the system.

Make a list of all deviations from normal compressor 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.

MAINTENANCE SCHEDULE

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

	FREQUENCY OR HOURS OF OPERATION (MAXIMUM)																					
MAINTENANCE	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 Oil Filters	■		■		■		■		■		■		■		■		■		■		■	
Clean Oil Strainers	■		■		■		■		■		■		■		■		■		■		■	
Clean Liquid Strainers	■		■		■		■		■		■		■		■		■		■		■	
Replace Coalescers									■						■						■	
Check and Clean Suction Strainer	■		■		■		■		■		■		■		■		■		■		■	
Vibration Analysis	■	Every 6 Months, More Frequently If Levels Increase																				
Replace Shaft Seal	When Leak Rate Exceeds 7 - 8 Drops Per Minute																					

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 causally related.

The third step is to identify the most likely cause and take action to correct the problem. If the symptoms are not relieved, move on 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.

CAPACITY LINEAR TRANSMITTER REPLACEMENT - SLIDE VALVE

The Capacity Linear Transmitter is located on the end of the compressor cylinder (see Figure 10). 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.

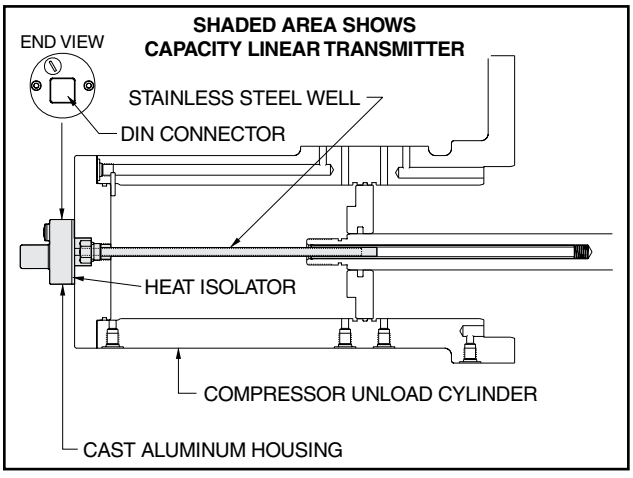


Figure 10 - Capacity Linear Transmitter

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 11).

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 setscrews.
4. Remove transmitter unit.
5. Install new transmitter unit.
6. Tighten setscrews.
7. Apply DIN connector plug to transmitter.
8. Turn on control power.

NOTICE

For calibration of the Volumizer® unit, refer to the Analog Calibration instructions in publication 090-020 O.

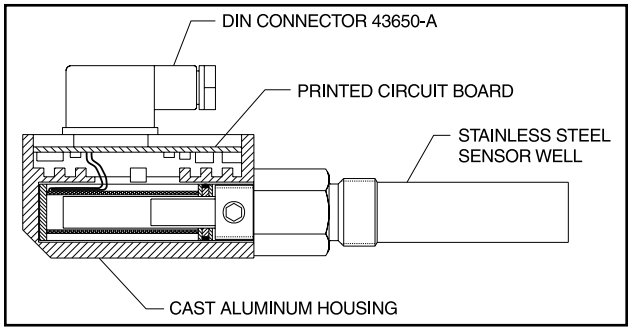


Figure 11 - Volumizer® Transmitter

TROUBLESHOOTING THE NGC COMPRESSOR

SYMPTOM	PROBABLE CAUSES and CORRECTIONS
SLIDE VALVE and/or SLIDE STOP WILL NOT MOVE	4-way hydraulic control valve failed. Repair or replace. Slide stop indicator rod stuck. Contact Johnson Controls – 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 Johnson Controls – Frick service for assistance. Piston Seals worn out or damaged. Contact Johnson Controls - Frick Service for assistance.

NOTICE

Unless the Service Technician has been certified by Johnson Controls – Frick to rebuild our compressors, troubleshooting the compressor is limited to identifying the probable cause. If a mechanical problem is suspected contact Johnson Controls – Frick Service. DO NOT ATTEMPT TO DISASSEMBLE COMPRESSOR.

TROUBLESHOOTING THE HYDRAULIC SYSTEM

SYMPTOM	PROBABLE CAUSES and CORRECTIONS
SLIDE VALVE WILL NOT LOAD OR UNLOAD	Solenoid coils burned out. Replace. Valve closed. Open hydraulic service valves. Solenoid spool stuck or centering spring broken. Replace. 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 Johnson Controls - Frick Service.

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. 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	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. 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. Oil is too cold. Allow oil to warm up and check again. Service valve on filter outlet is partially closed. Open valves fully.

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

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

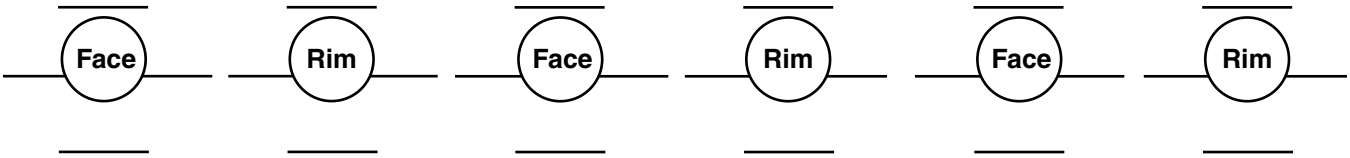
The compressor must not operate with incorrect oil pressure.

1. Refer to CONTROL SETUP

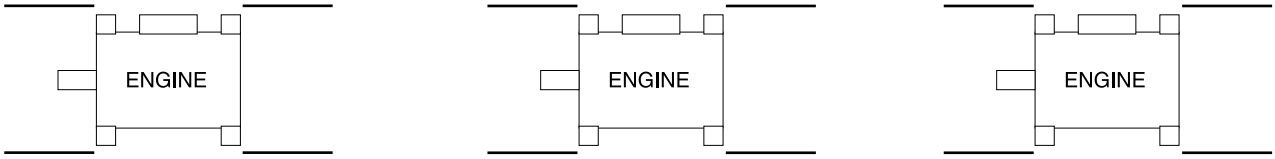
DRIVE TRAIN ALIGNMENT

Ambient Temperature at Time of Alignment _____ Oil Separator Temperature at Time of Alignment _____
Engine 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 ☐ Engine ☐ Compressor
Indicator Readings Facing ☐ Compressor ☐ Engine 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



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.)							

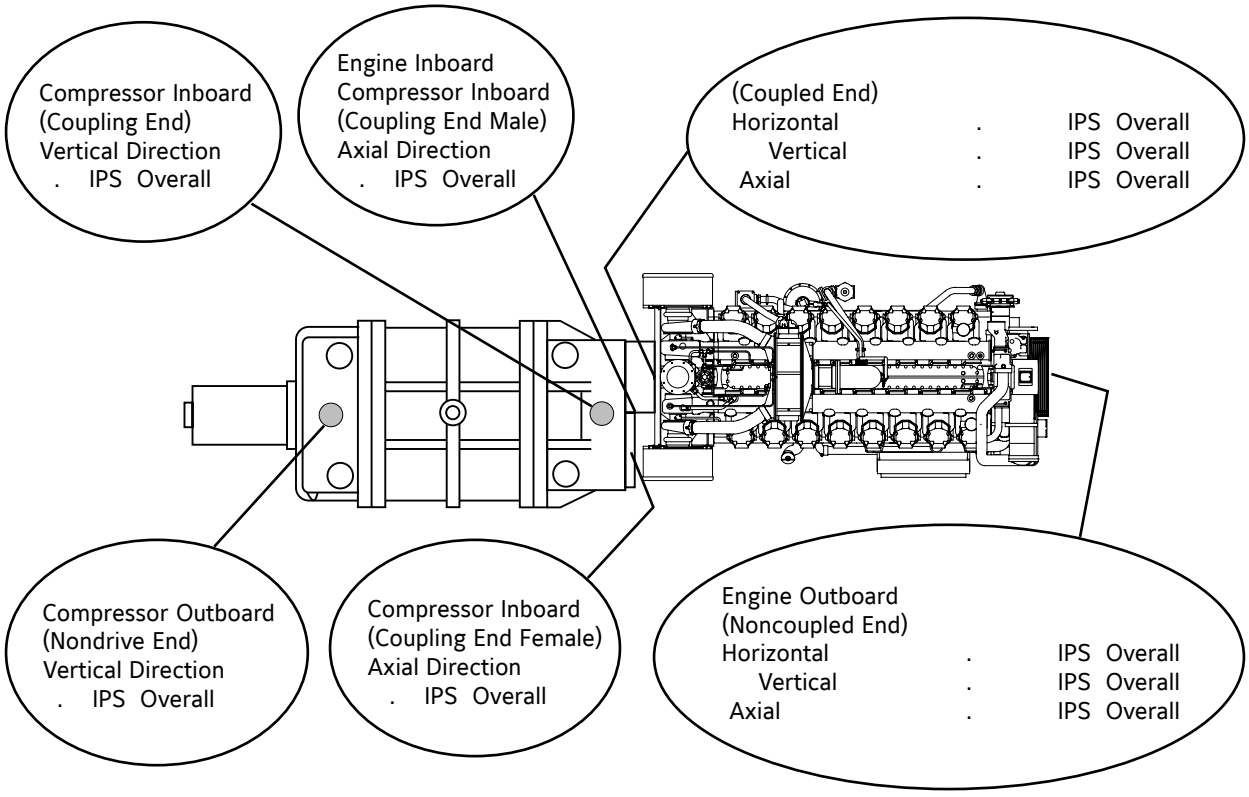
VIBRATION DATA SHEET

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: _____
Engine Manufacturer: _____
Engine Serial Number: _____
RPM: _____ Frame Size: _____ H.P. _____
Refrigerant: _____
Ambient Temperature: _____°F
Operating Conditions:

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



Index

NOTES

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