

# VSS/VSR/VSM/VSH/VSSH Single Screw Bare Shaft Compressor

## Installation, Operation and Service Manual

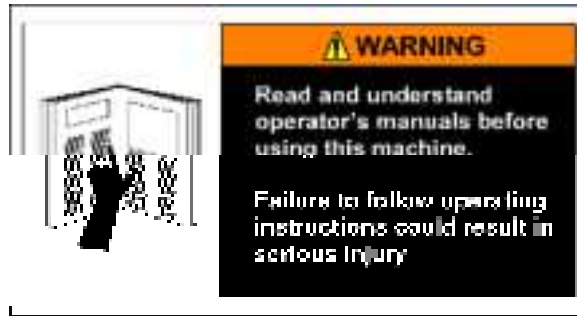


**VILTER**

  
**EMERSON**



## Important Message



### **READ CAREFULLY BEFORE INSTALLING AND STARTING YOUR COMPRESSOR.**

The following instructions have been prepared to assist in installation, operation and removal of Vilter™ Single Screw Compressors. Following these instructions will result in a long life of the compressor with satisfactory operation.

The entire manual should be reviewed before attempting to install, operate, service or repair the compressor.

Only qualified personnel shall operate, install and maintain the equipment.

Qualified personnel shall be accredited by a local regulatory agency, which requires that they are continually scrutinized by an organization whose sole mission is to establish, maintain and assure that the highest industry standards are set and met in a continuous and ongoing basis. The credentials shall address topics ranging from plant safety, operating concepts and principles and operations through the basics of refrigeration compliance and PSM (Process Safety Management) requirements.

Follow local workplace occupational safety and health regulations.

**A compressor is a positive displacement machine. It is designed to compress gas. The compressor must not be subjected to liquid carry over. Care must be exercised in properly designing and maintaining the system to prevent conditions that could lead to liquid carry over. Vilter Manufacturing is not responsible for the system or the controls needed to prevent liquid carry over and as such Vilter Manufacturing cannot warrant equipment damaged by improperly protected or operating systems.**

**Vilter™ screw compressor components are thoroughly inspected at the factory. However, damage can occur in shipment. For this reason, the equipment should be thoroughly inspected upon arrival. Any damage noted should be reported immediately to the Transportation Company. This way, an authorized agent can examine the unit, determine the extent of damage and take necessary steps to rectify the claim with no serious or costly delays. At the same time, the local Vilter representative or the home office should be notified of any claim made.**

All inquiries should include the Vilter™ sales order number, compressor serial and model number. These can be found on the compressor name plate on the compressor.

All requests for information, services or parts should be directed to:

**Vilter Manufacturing LLC**  
Customer Service Department  
5555 South Packard Ave  
Cudahy, WI 53110 USA  
Telephone: 1-414-744-0111; Fax: 1-414-744-3483  
E-mail: [info.vilter@emerson.com](mailto:info.vilter@emerson.com); Web: [Emerson.com/Vilter](http://Emerson.com/Vilter)

### Equipment Identification Numbers:

Vilter Order Number: \_\_\_\_\_ Compressor Serial Number: \_\_\_\_\_  
Vilter Order Number: \_\_\_\_\_ Compressor Serial Number: \_\_\_\_\_  
Vilter Order Number: \_\_\_\_\_ Compressor Serial Number: \_\_\_\_\_

## Standard VILTER™ Warranty Statement

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Seller warrants the products it manufactures to be free from defects in material and workmanship for a period of eighteen (18) months from the date of shipment from Seller's manufacturing plant or twelve (12) months from date of installation at the initial end users location, whichever occurs first. In addition, Seller provides the following extended warranties: (a) three (3) years from the date of shipment on single screw compressor internal rotating parts, (b) two (2) years from the date of shipment on reciprocating compressors and single screw and reciprocating compressor parts, and (c) two (2) years on all other parts on a single screw compressor unit. Such warranties do not apply to ordinary wear and tear. Seller does not warrant that the product complies with any particular law or regulation not explicitly set forth in the specifications, and Buyer is responsible for ensuring that the product contains all features necessary to safely perform in Buyer's and its customer's plants and operations. Buyer must notify Seller of any warranty claim within ten (10) days after such claim arises, otherwise Buyer waives all rights to such claim. Products supplied by Seller, which are manufactured by others, are not warranted by Seller, but rather Seller merely passes through the manufacturer's warranty to Buyer.

**SELLER EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

Unless otherwise agreed in writing, Buyer's sole remedy for breach of warranty is, at Seller's option, the repair of the defect, the correction of the service, or the providing a replacement part FOB Seller's office. Seller will not be responsible for costs of dismantling, lost refrigerant, reassembling, or transporting the product. Further, Seller will not be liable for any other direct, indirect, consequential, incidental, or special damages arising out of a breach of warranty. **THESE WARRANTY REMEDIES ARE EXCLUSIVE AND ALL OTHER WARRANTY REMEDIES ARE EXCLUDED.** Products or parts for which a warranty claim is made are to be returned transportation prepaid to Seller's factory. Any improper use, corrosion, neglect, accident, operation beyond rated capacity, substitution of parts not approved by Seller, or any alteration or repair by others which, in Seller's judgement, adversely affects the Product, shall void all warranties and warranty obligations. Further, Seller shall not be liable under the above warranties should Buyer be in default of its payment obligations to Seller under this Agreement or any credit agreement.



## Standard VILTER™ 5/15 Warranty Statement

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The seller extends warranty, from date of shipment, to a period of fifteen (15) years on all compressor bearings, five (5) years on all internal compressor parts and two (2) years on the remainder of the parts on single screw compressor units. If within such period any such product shall be proved to Seller's satisfaction to be defective, such product shall be repaired or replaced at Seller's option. Such repair or replacement shall be Seller's sole obligation and Buyer's exclusive remedy hereunder and shall be conditioned upon Seller's receiving written notice of any alleged defect within ten (10) days after its discovery and, at Seller's option, return of such parts to Seller, F.O.B., freight prepaid to Seller's factory. Expenses incurred by Buyer in repairing or replacing any defective product or any lost refrigerant will not be allowed except by written permission of Seller. This warranty is only applicable to products properly maintained and used according to Seller's instructions, the use of genuine Vilter replacement parts and recommended oil in all repairs and replacements has demonstrated adherence to a scheduled maintenance program as detailed in the Single Screw Compressor operating manual. This warranty does not apply to normal wear and tear, or damage caused by corrosion, misuse, overloading, neglect, improper operation, accident or alteration, as determined by Seller. Products supplied by seller hereunder, which are manufactured by someone else, are not warranted by Seller in any way, but Seller agrees to assign to Buyer any warranty rights in such products that the Seller may have from the original manufacturer. Labor and expenses for repair are not covered by warranty.

**THE WARRANTY CONTAINED IN THIS SECTION IS EXCLUSIVE AND IN LIEU OF ALL OTHER REPRESENTATIONS AND WARRANTIES (EXCEPT OF TITLE), EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.**

Any description of the product, whether in writing or made orally by Seller or Seller's agents, specifications, samples, models, bulletins, drawings, diagrams, engineering sheets or similar materials used in connection with Buyer's order are for the sole purpose of identifying the products and shall not be construed as an express warranty. Any suggestions by seller or Seller's agents regarding use, application or suitability of the products shall not be construed as an express warranty unless confirmed to be such in writing by Seller. The 5/15 Extended Warranty shall be applicable only if the specific maintenance guidelines as outlined in the technical manual are followed. This includes the compressor inspections, completing periodic oil analysis and the change out of the oil and oil filters, and related components as required with only genuine Vilter parts. The customer is required to keep a maintenance log and receipts demonstrating the use of Genuine Vilter parts for validation of a warranty claim, if requested.

*Note: The 5/15 warranty applies to NEW compressors only, and does NOT include used or remanufactured compressors.*

## EC Declaration of Incorporation

We hereby declare that the following machinery is intended to be incorporated into other machinery, and must not be put into service until the relevant machinery into which it is to be incorporated has been declared in conformity with the essential requirements of the Machinery Directive 2006/42/EC.

Machine Description: Industrial Compressor

Make: Vilter

Type: VSM / VSS / VSH / VSSH / VSG & VSSG Single Screw Compressor

Model Size: 97, 113, 127, 128, 145, 160, 180, 204, 222, 243, 152, 182, 202, 301, 361, 401, 501, 601, 701, 291, 341, 451, 601, 751, 901, 791, 891, 1051, 1201, 1301, 1551, 1851, 2101, 2401, 2601, 2801, 3001

Manufactured by: Vilter Manufacturing, LLC.

The following transposed harmonised European Standards have been used:

EN ISO 12100-1: 2010 - Safety of Machinery - General principles for design-Risk assessment and risk reduction.

EN ISO 13857: 2008 - Safety of Machinery - Safety distances to prevent danger zones being reached by the upper and lower limbs.

EN349: 1993 + A1: 2008 - Safety of Machinery - Minimum gaps to avoid crushing hazards.

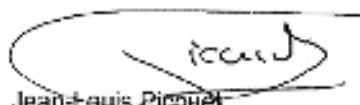
EN ISO 13850: 2015 - Safety of Machinery - Emergency stop equipment - Principles for design.

IEC/EN60204-1 (2016) - Safety of Machinery - Electrical equipment of machines - Specification for general requirements

A technical construction file for this machinery is retained at the following address:

Vilter Manufacturing, LLC.  
5555 South Packard Avenue  
P.O. Box 8904, Cudahy  
Wisconsin 53110-8904

Signed for and on behalf of Vilter Manufacturing, LLC.:

  
Jean-Louis Picquet  
Director of Single Screw Technology  
R&D Engineering

Last update: May 2019

Vilter Manufacturing, LLC.  
5555 South Packard Avenue t P.O. Box 8904 t Cudahy, Wisconsin 53110-8904  
001-414- 744-0111 t FAX: 001-414-744-3483

# Table of Contents

Section Title	Page Number
Important Message.....	i
Standard Vilter™ Warranty Statement .....	ii
Standard Vilter™ 5/15 Warranty Statement .....	iii
EC Declaration of Incorporation .....	iv

## Section 1 • General Information

How To Use This Manual.....	1-1
Additional Important Notes .....	1-1
System Unit Identification .....	1-2
Bare Shaft Refrigeration and Heat Pump Compressor Model Designations .....	1-3

## Section 2 • Theory Of Operation

Compressor .....	2-1
Capacity and Volume Control.....	2-1
Refrigerant and Oil System.....	2-2
Refrigerant Flow.....	2-2
Oil Life and Oil Flow .....	2-2
Control System .....	2-4
Temperature Elements, Pressure Transmitters and Indicators .....	2-4
Critical Application Guidelines .....	2-4
Alarm and Shutdown Readings .....	2-5
Single Screw Package Requirements .....	2-6

## Section 3 • Installation

Delivery Inspection .....	3-1
Rigging and Lifting of the Compressor .....	3-1
Bareshaft Compressor Lifting Points and Weights .....	3-1
Bareshaft Compressor Center of Gravity (Models 291-2101) .....	3-3
Bareshaft Compressor Center of Gravity (Models 2401-3001) .....	3-4
Compressor Inspections Prior to Installation .....	3-5
Recommended On-site Tools .....	3-5
Compressor Mounting .....	3-5
Notice on Using Non-Vilter Oils .....	3-5
Long Term Storage Recommendations.....	3-6
Long Term Storage Log.....	3-7
Stop/Check Valve Installation.....	3-8
Piping .....	3-9
Flange Loads.....	3-10
Slide Valve Actuator Installations Instructions .....	3-11
Installation.....	3-11
Overview.....	3-11
Actuator Motor Control Module Calibration Procedure.....	3-11
Instrumentation Requirements .....	3-12
Pressure .....	3-12
Temperature .....	3-12
Miscellaneous.....	3-13
Testing Refrigeration System For Leaks .....	3-13
Ammonia Systems .....	3-13
Halocarbon Refrigerant Systems .....	3-13
CO2 Systems .....	3-14

# Table of Contents

Section Title	Page Number
<b>Section 4 • Operation</b>	
Notice on Using Non-Vilter Oils .....	4-1
Operation .....	4-1
Control System .....	4-1
Starting, Stopping and Restarting The Compressor .....	4-1
Emergency Shutdown .....	4-2
Capacity and Volume Ration Control through Slide Valve Actuators .....	4-2
Slide Valve Actuator Operation .....	4-3
Calibrate Slide Valve Actuators (For Units Using Vission20/20™) .....	4-4
Calibrate Slide Valve Actuators (For Units Using Compact Logix PLC) .....	4-10
Compressor Control with Vission20/20™ Micro-Controller (No Slide Operation) .....	4-15
Suction Equalizing Line Setup - For VSS/VSM Compressors .....	4-16
Stop/Check Valve Operation .....	4-17
<b>Section 5 • Maintenance/Service</b>	
Maintenance and Service Schedule - For VSS/VSM Unit Only .....	5-1
Maintenance and Service Schedule - For VSH/VSSH Unit Only .....	5-2
Preventive Maintenance, Checks and Services .....	5-4
Daily .....	5-4
Weekly .....	5-4
Monthly .....	5-4
Trimonthly .....	5-4
Annually .....	5-4
Compressor Unit Isolation For Maintenance/Service (Compressors With Slide Valves) .....	5-5
Recommendations When Servicing (Compressors Without Slide Valves) .....	5-6
Preparation of Unit For Servicing .....	5-6
Compressor Unit Leak Check After Servicing .....	5-7
Oil Sampling .....	5-7
Recommendations .....	5-7
Installation of The Oil Sampler Valve .....	5-8
Pre-Sampling .....	5-8
Sampling Procedure .....	5-8
Oil Sample Analysis Report .....	5-10
Compressor Replacement .....	5-11
Removal .....	5-11
Installation .....	5-12
Compressor Inspection .....	5-13
Compressor Shaft Bearing Clearance Inspections .....	5-13
Determine Maximum Applied Force .....	5-13
Main Rotor Bearing Axial Clearance Inspection .....	5-13
Main Rotor Bearing Radial Clearance Inspection .....	5-14
Gaterotor Bearing Inspection .....	5-15
Gaterotor Inspection .....	5-16
A) Gaterotor - Main Housing Shelf Clearance .....	5-16
B) Gaterotor Float Measurement .....	5-17
C) Gaterotor Backlash Inspection .....	5-18
Important Notes .....	5-19
Additional Inspections .....	5-20
Post Inspection .....	5-20
Gaterotor Assembly Replacement (All Compressors Except VSM 301-701 and VSM 97-127 Compressors) .....	5-20
Removal .....	5-20
Installation .....	5-21

# Table of Contents

Section Title	Page Number
Gaterotor Assembly Replacement (VSM 301-701 Compressors Only).....	5-24
Removal.....	5-24
Installation.....	5-24
Gaterotor Assembly Replacement (VSM 97-127 Compressors Only).....	5-26
Removal.....	5-26
Installation.....	5-26
Gaterotor Disassembly (All Compressors Except VSM 97-127 Compressors).....	5-28
Gaterotor Blade Removal.....	5-28
Gaterotor Blade Installation.....	5-29
Gaterotor Thrust Bearing Removal.....	5-29
Gaterotor Thrust Bearing Installation.....	5-29
Gaterotor Roller Bearing Removal.....	5-30
Gaterotor Roller Bearing Installation.....	5-30
Gaterotor Disassembly (VSM 97-127 Compressors Only) .....	5-31
Gaterotor Blade Removal.....	5-31
Gaterotor Blade Installation.....	5-31
Gaterotor Thrust Bearing Removal.....	5-32
Gaterotor Thrust Bearing Installation.....	5-32
Gaterotor Roller Bearing Removal.....	5-32
Gaterotor Roller Bearing Installation.....	5-32
Compressor Shaft Seal Replacement .....	5-33
Shaft Seal Assembly .....	5-33
Handling Seal Face with Care .....	5-33
Compressor Shaft Seal Replacement - For VSS/VSM Units .....	5-34
Tools .....	5-34
Removal .....	5-34
Installation .....	5-34
Compressor Shaft Seal Replacement - For VSH/VSSH Units .....	5-36
Shaft Seal Removal Shaft Seal Removal - For Part# 25985Y and 25985YA .....	5-36
Shaft Seal Removal Shaft Seal Removal - For Part# 28985W and 28985WA .....	5-37
Prior to Shaft Seal Installation .....	5-38
Shaft Seal Installation - For Part# 25985Y and 25985Y .....	5-39
Shaft Seal Installation - For Part# 28985W and 28985WA .....	5-40
Slide Valve Actuator Assembly Replacement .....	5-41
Removal.....	5-41
Installation.....	5-41
Actuator Installation Using Anti-Rotation Bolts.....	5-42
Slide Valve Command Shaft Assembly Replacement.....	5-43
Removal.....	5-43
Installation.....	5-43
Liquid Injection Control Valve Station (Danfoss ICF 20-40 Valve Station).....	5-44
Main Rotor Assembly .....	5-46
Torque Specifications.....	5-46
Using A Torque Wrench Correctly.....	5-47
Nord-Lock® Washers .....	5-47

## Section 6 • Troubleshooting

Slide Valve Actuator Troubleshooting Guide.....	6-1
Slide Valve Actuator LED Blink Codes.....	6-4
Troubleshooting Guide - General Problems & Solutions .....	6-6

# Table of Contents

Section Title	Page Number
---------------	-------------

## Section 7 • Warranty And Parts

Warranty Claim Processing .....	7-1
Motor Warranty Procedure .....	7-2
On-Site Service Support.....	7-3
Remanufactured Bare Shaft Single Screw Compressor Process.....	7-3
Explanation of Rebuild Levels.....	7-3
Bare Shaft Compressor Description .....	7-3

## Section 8 • Spare Parts List

VSH/VSSH Recommended Spare Parts List .....	8-1
VSS Recommended Spare Parts List .....	8-3
Gaterotor .....	8-5
Shaft Seal .....	8-11
Main Rotor .....	8-13
Slide Valve Cross Shafts and End Plate.....	8-14
End Plate (VSS 2401 - VSS 3001 Only) .....	8-16
Slide Valve Carriage Assembly .....	8-18
Actuator and Command Shaft .....	8-21
Miscellaneous Frame Components .....	8-22
Miscellaneous Frame Components Tubing and Fittings.....	8-25
Replacement Tools .....	8-28
Replacement Parts .....	8-29
VSM 301-701 Recommended Spare Parts List .....	8-31
Gaterotor Assembly .....	8-32
Shaft Seal .....	8-34
Main Rotor .....	8-35
Slide Valve Cross Shafts and End Plate.....	8-36
Slide Valve Carriage Assembly .....	8-38
Actuator and Command Shaft .....	8-40
Miscellaneous Frame Components .....	8-41
Housing Accessories.....	8-43
Replacement Tools .....	8-44
VSM 97-127 Recommended Spare Parts List .....	8-46
Kits.....	8-47

## Appendices

Appendix A Torque Specifications.....	A-1
Appendix B Vilter Oil.....	B-1
Appendix C Vibration Measurements - Single Screw Compressor .....	C-1
Appendix D Liquid Injection Valve Setup Instructions and ICM/ICAD Motorized Valve Quick Start Guide ...	D-1
Appendix E Liquid Injection Valve Station ICF 20-40 Installation Guide .....	E-1
Appendix F Hand-Held Slide Valve Calibration Tool .....	F-1

# Table of Contents

Table / Figure	List of Tables and Figures	Page Number
	<b>Tables</b>	
Table 3-1. Bareshaft Compressor Component Weights.....		3-1
Table 3-2. Bareshaft Compressor Component Lifting Hole Sizes .....		3-1
Table 3-3. Maximum Allowable Flange Loads .....		3-10
Table 4-1. Command Shaft Rotation Specifications .....		4-8
Table 4-2. Stop/Check Valve Open Positions .....		4-17
Table 5-1. Maintenance/Service Schedule - For VSS/VSM Unit Only.....		5-1
Table 5-2a. Maintenance/Service Schedule (For VSH/VSSH Unit Only) .....		5-2
Table 5-2b. Maintenance/Service Schedule (For VSH/VSSH Compressor Only) .....		5-3
Table 5-3. Maximum Main Rotor Bearing Clearance.....		5-14
Table 5-4. Maximum Gaterotor Bearing Clearance.....		5-15
Table 5-5. Gaterotor Float .....		5-17
Table 5-6. Backlash Range .....		5-19
Table 5-7. Gaterotor Tool Kits .....		5-20
Table 5-8. Shaft Seal Tool Kits .....		5-34
Table 5-9. VSH/VSSH Shaft Seals .....		5-36
Table 5-10. Coils For Solenoid Valves (ICFE) .....		5-45
Table 5-11. Parts For Motorized Valve Station (ICF).....		5-45
Table 5-12. Torque Specifications (ft-lbs).....		5-46
Table 6-1. Slide Valve Actuator Troubleshooting Guide (1 of 3) .....		6-1
Table 6-2. Slide Valve Actuator LED Blink Codes (1 of 2) .....		6-3
Table 6-3. Troubleshooting Guide - General Problems & Solutions (1 of 3) .....		6-5
	<b>Figures</b>	
Figure 2-1. Refrigeration Compressor Unit P&ID (Thermosyphon Oil Cooling with Single Oil Filter Shown). 2-3		
Figure 2-2. Basic Single Screw Compressor System.....		2-6
Figure 3-1. Bareshaft Compressor Lifting Points and Component Weights .....		3-3
Figure 3-2. Bareshaft Compressor Assembly Center of Gravity (Models 97-127) .....		3-2
Figure 3-3. Bareshaft Compressor Assembly Center of Gravity (Models 291-2101) .....		3-3
Figure 3-4. Bareshaft Compressor Center of Gravity - Discharge Manifold and Main Compressor Assembly (Models 291-2101) .....		3-3
Figure 3-5. Bareshaft Compressor Assembly Center of Gravity (Models 2401-3001) .....		3-4
Figure 3-6. Bareshaft Compressor Center of Gravity - Discharge Manifold and Main Compressor Assembly (Models 2401-3001) .....		3-4
Figure 3-7. Stop/Check Valve Orientation.....		3-8
Figure 3-8. Maximum Allowable Flange Loads .....		3-10
Figure 3-9. Additional Instruments.....		3-12
Figure 4-1. Slide Valve Motor Location .....		4-2
Figure 4-2. Actuator Assembly .....		4-4
Figure 4-3. Slide Valve Calibration Screen (Vission 20/20) .....		4-5
Figure 4-4. Menu Screen and Slide Calibration Button (Vission 20/20).....		4-6
Figure 4-5. Wire Connections For Capacity and Volume Actuators .....		4-7
Figure 4-6. Photo-Chopper .....		4-9
Figure 4-7. Actuator Assembly .....		4-10
Figure 4-8. Overview, Main Menu and Instrument Calibration Screens (Compact Logix PLC).....		4-12
Figure 4-9. Slide Calibration Screen (Compact Logix PLC) .....		4-13
Figure 4-10. Photo-chopper .....		4-13

# Table of Contents

Table / Figure	Page Number
Figure 4-11. Vision 20/20 Configuration Screen - I/O Configuration (Page 8) .....	4-15
Figure 4-12. Compressor and Model Setup with Vision 20/20 .....	4-15
Figure 4-14. Suction Equalizing Line and Valve .....	4-16
Figure 5-1. Discharge Bleed Valve, Suction Equalizing Line and Valve .....	5-5
Figure 5-2. Oil Analysis Kit (VPN 3097A) .....	5-8
Figure 5-3. Oil Sampler Valve (VPN #3708A) For Gas Compression Applications .....	5-8
Figure 5-4. Oil Sampling Valve (VPN #3709A) For Ammonia and Refrigerant Compressors .....	5-9
Figure 5-5. Operating the Oil Sampling Valve .....	5-9
Figure 5-6. Stages of the Oil Sample Taking Process .....	5-10
Figure 5-7. Compressor Replacement and Hardware Assembly (VSS 2401-3001 Shown) .....	5-11
Figure 5-8. Bearing Axial Clearance Inspection .....	5-13
Figure 5-9. Bearing Radial Clearance Inspection .....	5-14
Figure 5-10. Gaterotor Bearing Clearance .....	5-15
Figure 5-11. Gaterotor and Shelf Clearance .....	5-16
Figure 5-12. Gaterotor and Shelf Clearance Measurement Steps .....	5-16
Figure 5-13. Visual Inspection Between Gaterotor and Bushing .....	5-17
Figure 5-14. Gaterotor Float Dial Location .....	5-17
Figure 5-15. Gaterotor Float .....	5-18
Figure 5-16. Alignment of Gaterotor .....	5-18
Figure 5-17. Location of Dial Indicator Magnetic Base .....	5-18
Figure 5-18. Placement of Dial Indicator .....	5-19
Figure 5-19. Measuring Backlash .....	5-19
Figure 5-20. Chipped Edge of Gaterotor .....	5-20
Figure 5-21. Gaterotor Assembly Removal and Tools .....	5-21
Figure 5-22. Gaterotor Assembly Removal .....	5-22
Figure 5-23. Gaterotor Assembly and Tools .....	5-23
Figure 5-24. Gaterotor and Shelf Clearance .....	5-23
Figure 5-25. Gaterotor Assembly Breakdown .....	5-24
Figure 5-26. Gaterotor Thrust Bearing .....	5-25
Figure 5-27. Gaterotor and Shelf Clearance .....	5-25
Figure 5-28. Gaterotor Assembly Removal .....	5-26
Figure 5-29. Gaterotor Assembly (VSM 97-127 Compressors ONLY) .....	5-27
Figure 5-30. Gaterotor and Shelf Clearance .....	5-28
Figure 5-31. Gaterotor Blade Assembly .....	5-28
Figure 5-32. Gaterotor Blade Installation .....	5-29
Figure 5-33. Gaterotor Thrust Bearing .....	5-29
Figure 5-34. Thrust Bearing Installation .....	5-29
Figure 5-35. Roller Bearing Assembly .....	5-30
Figure 5-36. Gaterotor Support (VSM 97-127) .....	5-31
Figure 5-37. Gaterotor Blade Installation .....	5-31
Figure 5-38. Gaterotor Thrust Bearing (VSM 97-127) .....	5-32
Figure 5-39. Shaft Seal Assembly .....	5-33
Figure 5-40. Handling Seal Face with Care .....	5-33
Figure 5-41. Compressor Shaft Seal Assembly .....	5-34
Figure 5-42. Compressor Shaft Seal Installation: Tapered and Straight Shafts .....	5-35
Figure 5-43. Shaft Seal Breakdown (28985Y & 28985YA) .....	5-36, 5-38
Figure 5-44. Shaft Seal Breakdown (28985W and 28985WA) .....	5-37, 5-40
Figure 5-45. Shaft with Pin .....	5-38
Figure 5-46. Shaft Seal Housing .....	5-38
Figure 5-47. The Alignment of Compressor Shaft and Mating Ring .....	5-38
Figure 5-48. Actuator Installation Using Anti-Rotation Bolts .....	5-42
Figure 5-49. Command Shaft Assembly Replacement .....	5-43
Figure 5-50. Danfoss ICF 20-40 Valve Station (Liquid Injection Control) .....	5-44



## Section 1 • General Information

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### How To Use This Manual

This manual contains instructions for refrigeration compressor units. It has been divided into eight sections and Appendices:

Section 1: General Information

Section 2: Theory of Operation

Section 3: Installation

Section 4: Operation

Section 5: Maintenance & Service

Section 6: Troubleshooting

Section 7: Warranty and Parts

Section 8: Spare Parts List

Appendices

Appendix A: Torque Specifications

Appendix B: Vilter Oil

Appendix C: Vibration Measurements - Single Screw Compressor

Appendix D: Liquid Injection Valve Setup Instructions and Quick Start Guide ICM/ICAD Motorized Valve

Appendix E: Liquid Injection Valve Station ICF 20-40 Installation Guide

Appendix F: Hand-Held Slide Valve Calibration Tool

It is highly recommended that the manual be reviewed prior to servicing system parts.

Figures and tables are included to illustrate key concepts.

Safety precautions are shown throughout the manual. They are defined as the following:

**NOTICE** - Notice statements are shown when there are important information that shall be followed. Not following such notices may result in void of warranty, serious fines, serious injury and/or death.

**WARNING** - Warning statements are shown when there are hazardous situations, if not avoided, will result in serious injury and/or death.

**CAUTION** - Caution statements are shown when there are potentially hazardous situations, if not avoided, will result in damage to equipment.

**NOTE** - Notes are shown when there are additional information pertaining to the instructions explained.

### Additional Important Notes

- Additional installation, operation and maintenance instructions can be found in the Vission20/20 manual (35391SC) or Compact Logix PLC Software Manual (35391CM).
- Due to continuing changes and unit updates, always refer to the website [Emerson.com/Vilter](http://Emerson.com/Vilter) to make sure you have the latest manual.
- Any suggestions of manual improvements can be made to Vilter™ Manufacturing at the contact information on page i.

## Section 1 • General Information

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### System Unit Identification

To keep definitions of units simple and consistent, Vilter™ has defined the following three:

- Bare Shaft Compressor
- Compressor Unit
- Package Unit

#### Bare Shaft Compressor

A bare shaft compressor is just the compressor with no coupling and motor nor foundation.



#### Compressor Unit

A compressor unit consists of the bare shaft compressor with the coupling, motor, oil separator, frame, micro-controller system and oil system. A compressor unit typically a single screw compressor unit, is not mounted on a structural steel base.



#### Package Unit

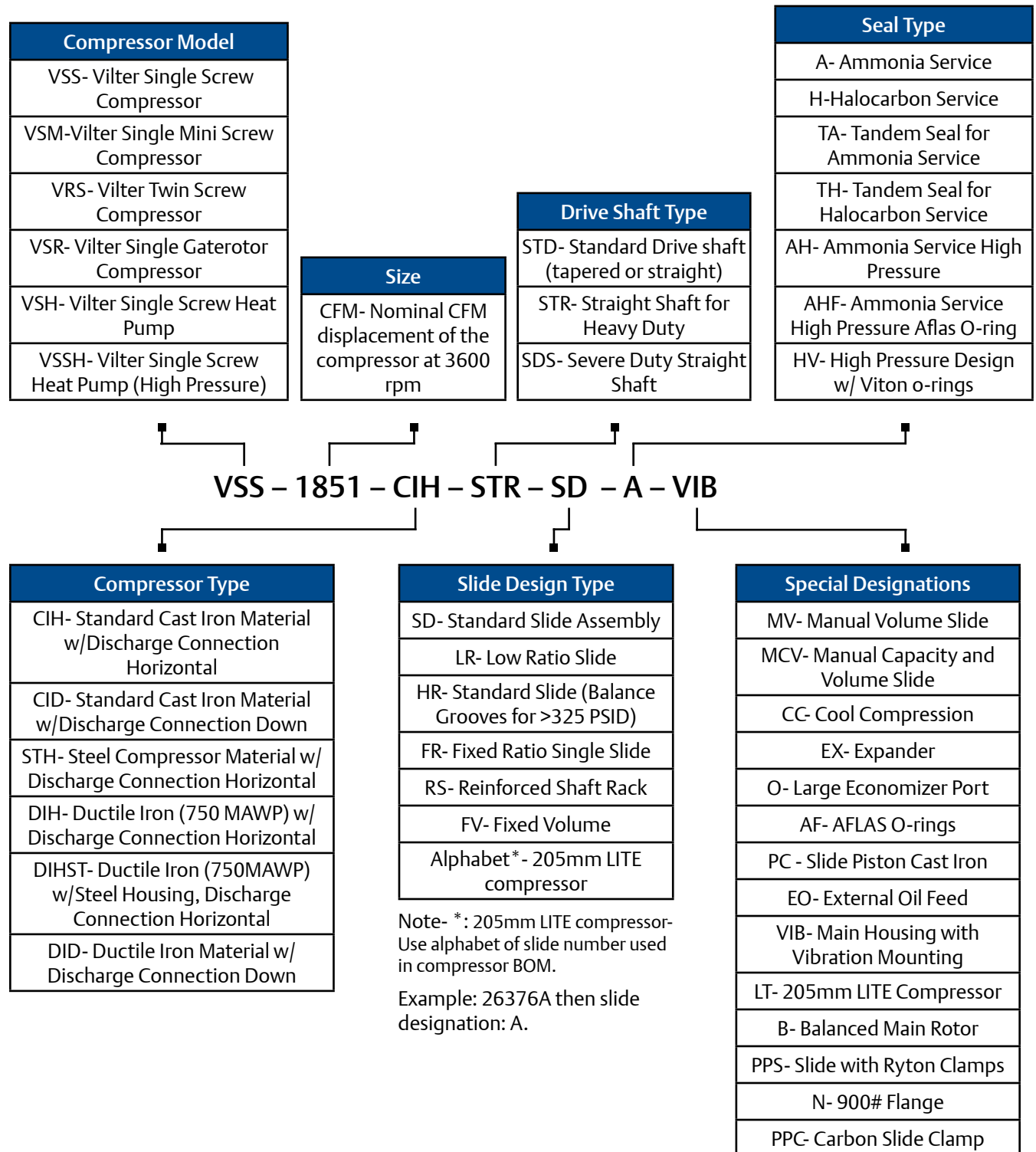
A package unit is a complete system mounted on a structural steel base with interconnecting piping.



## Section 1 • General Information

### Bare Shaft Refrigeration and Heat Pump Compressor Model Designations

The compressor bare shaft model designation can be found on the nameplate.





### Compressor

The Vilter™ Single Screw Compressor is a positive displacement, capacity and volume controlled, oil flooded, rotary compressor which uses a single main screw intermeshed by two opposing gate rotors. Gas compression occurs when the individual fingers of each gate rotor sweep through the grooves, or flutes, of the main screw as the screw rotates. Compression occurs from the time the screw flute is first closed off by the gate rotor finger, until the time when the screw flute has rotated to the point of lining up with the discharge port in the compressor housing. A labyrinth type seal is used to prevent gas at discharge pressure from leaking past the end of the screw. Any discharge gas leakage past the labyrinth seal is vented back to suction via four longitudinal holes drilled through the body of the screw.

By venting the discharge end of the main screw back to suction, forces on each end of the screw are equal. This results in zero net axial forces on the main bearings. With twin opposing gate rotors, all radial forces are cancelled out also. Main shaft bearings have no net forces except the weight of the screw and the shaft assembly.

The compressors are comprised of three rotating assemblies: the main screw assembly and the two gate rotor assemblies. Each of these rotating assemblies use a common bearing configuration consisting of a single, cylindrical rolling element bearing at one end, and a pair of angular contact ball bearings at the other end. The pair of angular contact ball bearings are used to axially fix one end of the rotating shafts, and to absorb the small amount of thrust loads on the shafts. The inner races of the ball bearings are securely clamped to the rotating shafts, while the outer races are securely held in the bearing housing, thus fixing the axial position of the shaft in relation to the bearing housings. The cylindrical roller bearings at the opposite end of the shafts allow for axial growth of the shafts while supporting the radial loads from the shafts.

The suction gas enters the compressor housing through the top inlet flange, at the driven end of the unit. The driven end of the compressor housing is flooded with gas at suction pressure. The gas enters the open end of the main screw flutes at the driven end, and becomes trapped in the screw flute as the screw rotates and the gate rotor tooth enters the end of the flute. At this point, the compression process begins. Directly after the screw flute is closed off by the gate rotor tooth, oil is injected into the groove.

The oil enters the compressor through a connection at the top of the compressor. The purpose of the injected oil is to absorb the heat of compression, to seal the gate rotor tooth in the groove, and to lubricate the moving parts.

Additional internal oiling ports are provided at the main and gate rotor bearings to cool and lubricate the bearings. The mechanical shaft seal housing also contains oiling ports to lubricate, cool and provide a sealing film of oil for the mechanical shafts seal. Excess oil flows through the check valves on the sealing baffle plate. This oil is directed at the main rotor roller bearing, which cools and lubricates the front roller bearing.

As the main screw rotates, the gate rotor is also driven, causing the gate rotor tooth to sweep the groove in the main screw. This sweeping action reduces the volume of the groove ahead of the gate rotor tooth and causes the trapped gas and oil to be compressed in the reduced volume. As the main screw continues to rotate, the gate rotor tooth continues to reduce the groove volume to a minimum, thus compressing the trapped gas to a maximum pressure. A labyrinth seal arrangement prevents the compressed gas from leaking past the end of the screw. As the gate rotor tooth reaches the end of the groove, the groove rotates to a position that lines up with the discharge port in the compressor housing and the gas/oil mixture is discharged from the screw at high pressure. This completes the compression cycle for a single flute of the main screw.

Once the gas is swept from the main screw flute through the discharge port, it passes into the discharge manifold of the compressor. From the discharge manifold, the gas/oil exits the compressor housing.

### Capacity and Volume Control

The Vilter™ compressors feature the exclusive Parallax™ Slide System, which consists of a pair of slides for each gate rotor assembly. These two independently operated slides are referred to as the capacity slide and the volume ratio slide. On the suction end of the screw, the capacity slide moves to vary the timing of the beginning of the compression process. With the slide moved all the way out to the suction end of the screw (the 100% position), the compression process begins immediately after the gate rotor tooth enters the screw flute and closes off the end of the groove. In this situation, the maximum volume of gas is trapped in the screw flute at the start of the compression process. As the slide is pulled back away from the suction end of the screw, the start of the compression process is delayed as some of the suction gas is allowed to spill back out of the screw flute until the screw rotates far enough to pass the end of the capacity slide and begin compressing. This causes a reduced volume of gas to be trapped in the screw flute when the compression process begins. In this way, the capacity of the compressor is reduced from 100% down to as low as 10% of the full rated capacity.

## Section 2 • Theory of Operation

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The capacity slide provides the means for controlling specific process set points. By continuously adjusting the flow of gas through the compressor, either suction or discharge pressure in a particular process can be controlled. When coupled with a microprocessor controller, the adjustable capacity slide allows for precise and continuous automatic control of any parameter in the process to a chosen set point.

The second slide for each gate rotor is the volume ratio slide. The purpose of the volume ratio slide is to maximize the efficiency of the compressor by matching the gas pressure within the screw flute at the point of discharge to the downstream process requirements. The volume ratio slide operates at the discharge end of the screw, and acts to vary the position of the discharge port. When the slide is extended fully to the discharge end of the screw (the 100% position), the compression process within the screw flute continues until the screw rotates far enough for the flute to pass the end of the volume ratio slide. At this point, the screw flute lines up with the discharge port and the compressed gas is expelled from the screw flute. As the volume ratio slide is pulled back away from the discharge end of the screw, the position of the discharge port is changed and the gas is allowed to escape the screw flute earlier in the compression process, at a reduced pressure.

The overall volume ratio within the compressor is determined by the distance between the front of the capacity slide (the start of compression) and the back of the volume ratio slide (the completion of compression). Therefore, the volume ratio slide must respond to changes in the downstream pressure measured in the oil separator and position itself for the required compression ratio based on the position of the capacity slide. By only compressing the gas within the screw as far as required to match the pressure in the downstream receiver, the compressor efficiency is maximized. Proper positioning of the volume ratio slide prevents either over compressing or under compressing of the gas within the screw flute. This allows the single screw compressor to efficiently handle a range of volume ratios from as low as 1.2 up to 7.0.

## Refrigerant and Oil System

The refrigeration and oil systems work in unison, but each one will be explained separately. Reference Figure 2-1 for refrigerant and oil flow descriptions. This is a typical refrigeration system with thermosyphon oil cooling.

### Refrigerant Flow

The refrigeration compression process begins as refrigerant vapor enters the suction inlet (12). The refrigerant vapor flows through a suction stop/check valve (11), then through a mesh strainer (10) to the compressor (9). The refrigerant is then pressurized through the compressor and discharged as high pressure refrigerant vapor into the oil separator (1). In the oil separator, the oil is then separated from the discharged refrigerant by impingement separation. The high pressure refrigerant flows out to the condenser for cooling while the oil is pumped or siphoned back to the compressor.

The suction stop/check valve (11) is necessary to prevent reverse rotation and potential damage or oil loss at shut down. The discharge check valve (2) is positioned to prevent the vapor or liquid refrigerant from flowing back to the separator when the compressor is shut down.

The separator should be allowed to equalize slowly to suction pressure through a small bypass line around the suction stop/check valve (11). This will allow the compressor to start without a pressure differential across it, reducing the starting power requirements.

### Oil Life and Oil Flow

Oil in the refrigeration system serves three primary purposes. They are compressor lubrication, sealing clearances between moving parts, and heat removal resulting from heat of compression and friction.

Initially, oil flow is driven by a mechanical gear pump (3). The oil internally lubricates all points inside the compressor. Once the system reaches design conditions, the oil pump can be shut off and oil flow is maintained by differential pressure. But on units with low pressure differentials such as booster and low pressure differential high stage compressors, the oil pump must remain on whenever the unit is running to maintain sufficient oil flow.

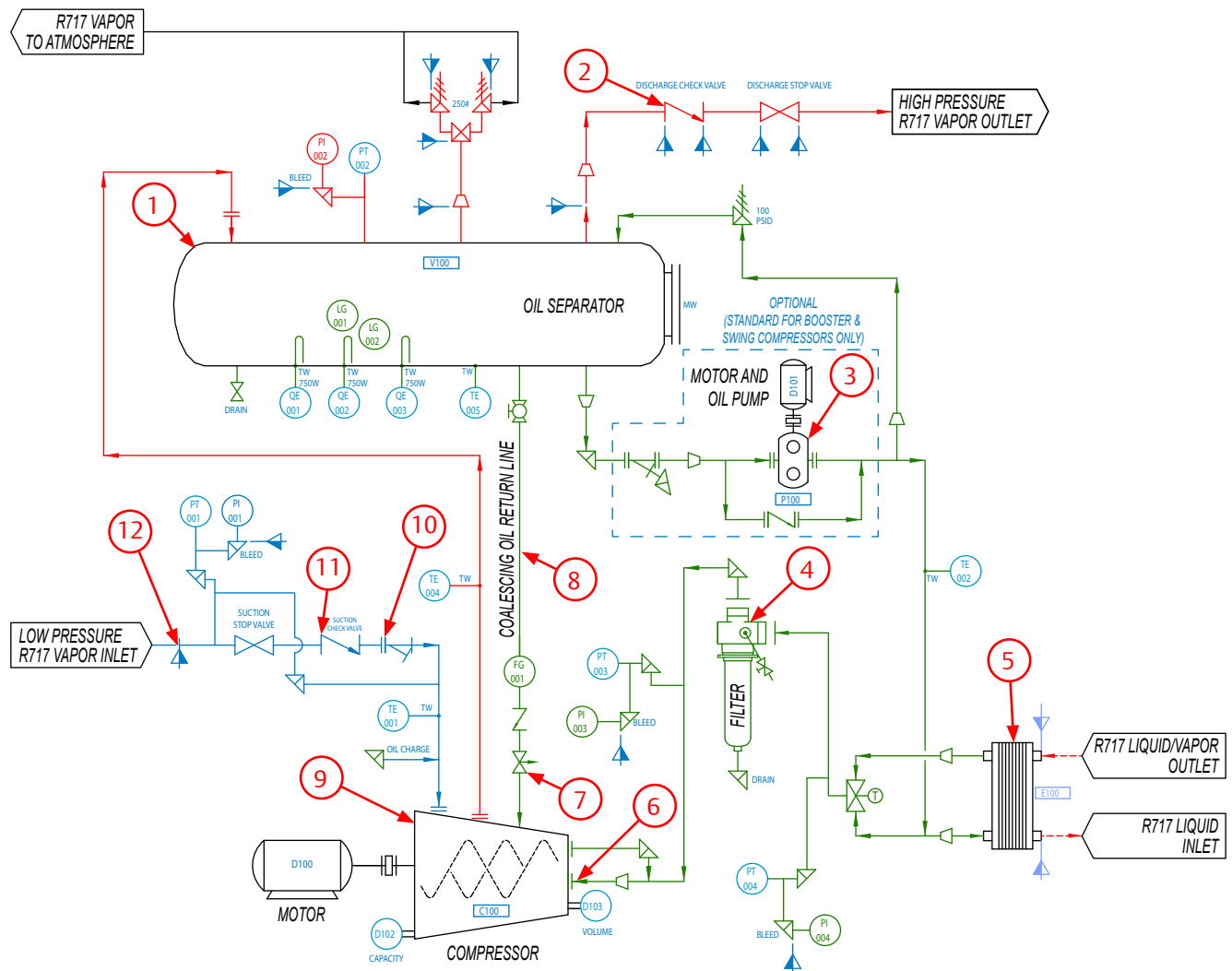
As the oil is separated from the refrigerant in the oil separator (1), it is pumped or siphoned through an oil cooler (5), then through an oil filter (4) and back to the injection port (6) of the compressor (9).

Furthermore, to collect oil from the coalescing side of the oil separator (1), an oil return line (8) is installed between the oil separator and the compressor (9). By opening the

## Section 2 • Theory of Operation

needle valve (7), this will allow oil dripping off the coalescing filters to be fed back to the compressor.

This is a continuous cycle.



**Figure 2-1. Refrigeration Compressor Unit P&ID  
(Thermosyphon Oil Cooling with Single Oil Filter Shown)**

### Control System

The compressor unit is controlled by the micro-processor, i.e. Vission 20/20 panel or PLC panel. This panel's main function is to control the refrigeration system from the data that it receives from the sensors around the unit. For additional information, refer to micro-processor manual.

### Temperature Elements, Pressure Transmitters and Indicators

Temperature elements (TE), pressure transmitters (PT) and pressure indicators (PI) are instruments used to measure temperatures and pressures at specific locations on the compressor unit. Temperature elements are typically mounted on the compressor, suction pipe, discharge pipe, oil separator, oil filter inlet and outlet pipe. Pressure transmitters are typically mounted on the block and bleed assembly. The pressure transmitters measure suction pressure, inlet and outlet oil pressure, and discharge pressure in the oil separator. Typically, pressure indicators are not mounted from the factory, except for a pressure indicator to show the nitrogen holding charge for shipping and storage purposes. If required, end users have the ability to mount pressure indicators at the block and bleed assembly.

### Critical Application Guidelines

To ensure the successful operation of the Single Screw Compressor, the guidelines described below should be followed.

1. Proper lubrication is critical to the operation of the single screw compressor. The compressor relies on the injected oil to absorb and remove the heat of compression, to seal the compression chambers formed in the flutes of the screw, and to lubricate all moving parts. For this reason, it is imperative that the oil chosen be of correct viscosity, and that sufficient oil flow be provided at all times, using an auxiliary oil pump when necessary. The oil chosen must be compatible with the process gas as well, to prevent absorption of the gas into the oil, which would dilute the oil and reduce the viscosity. Also, oil filtration to 25 micron nominal particle size is required to ensure that only clean oil is injected into the compressor. For assistance in choosing the correct oil for the application and in sizing an auxiliary oil pump, consult a Vilter™ representative.
2. Injection oil temperature must be closely controlled for optimum performance. Oil temperature must be maintained a minimum of 15 - 20°F above the gas mixture dew point at anytime to prevent condensation or liquid knockout from occurring within the compressor.

#### Note for CO2 and Heat Pump Applications

Because the oil system on the Single Screw Compressors utilizes discharge gas pressure as the means to move the injection oil through the system, it must be remembered that all components of the oil system are exposed to full discharge pressure and must be pressure rated accordingly.



### Alarm and Shutdown Readings

#### WARNING

Software programming credentials shall only be made available by the supplier. The user will only have access to operational features established by the supplier. Failure to comply may result in serious injury or death.

The control system for the Single Screw compressor must protect the machine from damage caused by running outside of normal operating conditions by providing operators with alarms when operating parameters have reached an abnormal condition, and by automatically stopping the compressor before these conditions can cause a unit failure. Pressures and temperatures of the process gas and the oil, as well as motor amperage and VFD frequency must all be continuously monitored to ensure the compressor is operating properly.

Refer to Figure 2-2 for locations of RTD and PT:

**1. Low Gas Suction Temperature** - This point protects the compressor from suction gas entering the compressor at too low of a temperature, and is activated by a direct reading from the suction temperature RTD located at the suction tee.

**2. High Gas Discharge Temperature** - This point protects the compressor against high gas temperature at the discharge of the unit, and is activated by a direct reading from the RTD located at the compressor discharge manifold.

**3. Low Oil Separator Start Temperature** - This point protects the compressor from starting with low oil temperature in the separator, and is activated by a direct reading from the RTD located at the bottom of the oil separator.

**4. Low Oil Separator Run Temperature** - Similar to the Low Oil Separator Start Temperature described above, however this point only becomes active after a predetermined period of running time, and uses a higher setpoint.

**5. Low Oil Injection Temperature** - This point protects the compressor from running with cold oil being injected into the screw housing, and is activated by a direct reading from the RTD located at the oil injection line. This point is bypassed for a predetermined period of time after starting to allow the unit time to start and warm up.

**6. High Oil Injection Temperature** - This point protects the compressor from running with hot oil being injected into the screw housing, and is activated by a direct reading from the RTD located at the oil injection line.

**7. Low Suction Pressure** - This point protects the compressor from drawing low suction pressure and is activated by a direct reading from the suction pressure transducer, which reads the pressure from a tap located at the suction stop/check valve housing.

**8. High Discharge Pressure** - This point protects the compressor from developing high discharge pressure and is activated by a direct reading from the discharge pressure transducer, which reads the pressure from a tap located at the oil separator. In addition to this alarm and shutdown, the compressor package is ultimately protected from damage due to over pressurization by at least one discharge pressure relief valve located on the oil separator. The purpose of this safety setpoint is to allow for a lower setpoint to conform to a process requirement, and to prevent the relief valve from opening.

**9. Prelube Oil Pressure** - This point acts as a permissive to start the compressor, and protects against the compressor starting with no oil lubrication. If, during a start sequence, the prelube oil pressure fails to rise above 4.0 PSID, the compressor will fail to start. The prelube oil pressure is a calculated value obtained by subtracting the discharge pressure reading from the oil manifold pressure (oil filter outlet pressure) reading.

**10. Low Oil Pressure** - This point protects the compressor from running with insufficient lubrication pressure, and becomes active after a predetermined period of running, usually sixty seconds. The oil pressure is a calculated value obtained by subtracting the suction pressure from the oil manifold pressure (oil filter outlet pressure) reading, which results in the actual pressure under which the oil is entering the screw housing.

**11. High Running Oil Filter Differential Pressure** - This point alerts operators to clogging oil filters. When the oil filters develop a high differential pressure while running at normal operating temperatures, it is an indication that they are becoming dirty and must be changed. An alarm initially warns of dirty filters; if the situation worsens before the filters are changed a shutdown will stop the compressor.

In most cases, the safety setpoints described above will have settings which are dictated by process requirements, and not necessarily mechanical constraints of the compressor. Process pressures and temperatures may vary considerably depending on the application of the compressor, and the Single Screw compressor is designed to work well in a broad range of applications. For this reason, it is impractical to suggest “initial” setpoints to fit all applications. Instead, minimum and maximum values for each safety setpoint are provided, while precise settings for the safety setpoints must be derived for each installation.

### Single Screw Package Requirements

#### Process Gas Circuit

**1. Suction Gas Stop/Check Valve** - The Single Screw compressor requires a manually operated stop valve on the suction line to the compressor to allow for isolating the compressor package from process gas. Also, a check valve is required in the suction line to limit reverse rotation of the compressor on shutdown.

**2. Suction Line Strainer** - Vilter™ strongly recommends the use of an in-line suction gas strainer to protect the Single Screw compressor from foreign material which may enter the compressor with the suction gas. This strainer is generally of stainless steel mesh construction.

**3. Process Gas/Oil Separator** - A separator vessel capable of removing the oil from the discharge gas stream with an efficiency down to at least 5 PPM oil carryover is required. Vilter's own available horizontal or vertical separator is an ASME-coded vessel which uses five stages of separation to achieve an oil loss of as little as 3 to 4 PPM.

**4. Discharge Gas Relief Valve** - To protect the compressor package from damage due to over pressurization, a relief valve must be installed inside of any discharge line hand block valves. The relief valve must be set to open at a pressure lower than the Maximum Allowable Working Pressure (MAWP) of the separator.

**5. Oil Prelube Pump** - Usually a direct driven gear type pump, the oil pump is required to prelude the compressor prior to starting and to maintain oil pressure during any periods of low compression ratio operation.

**6. Oil Cooler/ Temperature Control Valve** - An oil cooler, either air or water cooled, must be used to remove the heat of compression from the oil stream. A temperature control valve is used to maintain constant oil injection temperature to the compressor.

**7. Oil Filtration** - Large capacity micronic oil filters are required to filter the oil before injection into the Single Screw compressor. Filtration down to 25 microns nominal or less is generally acceptable. Dual filters are recommended to allow replacement of one cartridge while the compressor continues running with the other cartridge in service. If needed, separate oil filtration can be available for bearings and shaft seal.

**8. Oil Heater** - An oil heater is generally required and must be sized to maintain oil temperature of at least 90°F when the compressor is not running. For outdoor installations, low ambient temperatures and winds must be considered when sizing the oil heater. Also, insulating the separator and oil piping may be required in low temperature ambient conditions.

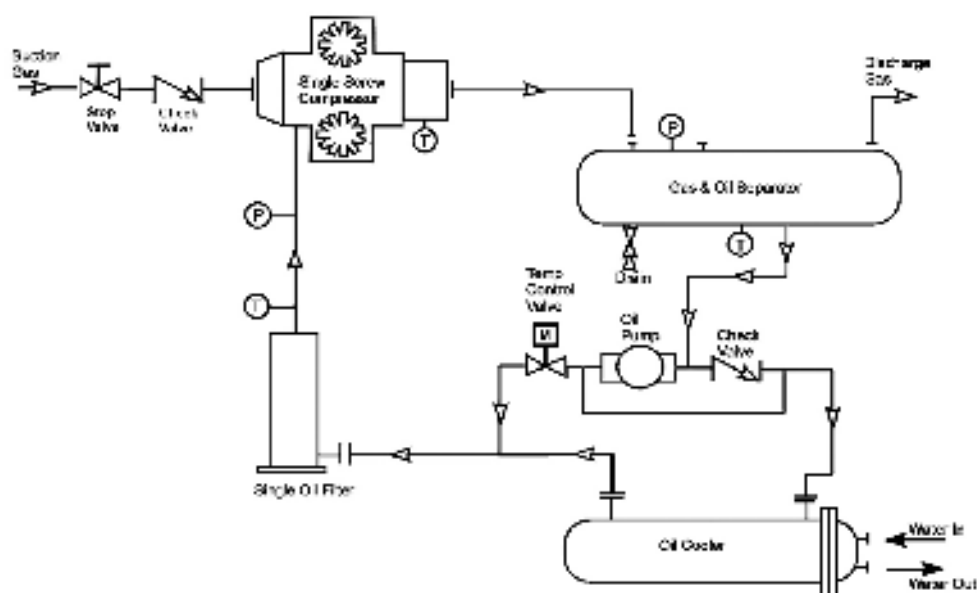


Figure 2-2. Basic Single Screw Compressor System

### NOTICE

Vilter compressors are to be installed and connected to the customer-provided piping. Vilter expects this piping to be designed and built following ASME B31.3 Process Piping Guide, plus any other local applicable codes, and that the installation will be performed by qualified personnel only.

### Delivery Inspection

Every equipment supplied by Vilter is thoroughly inspected at the factory. However, damage can occur in shipment. For this reason, the compressor should be thoroughly inspected upon arrival, prior to off-loading. Any damage noted should be photographed and reported immediately to the transportation company. This way, an authorized agent can examine the compressor, determine the extent of damage and take necessary steps to rectify the claim with no serious or costly delays. At the same time, the local Vilter representative or the home office should be notified of any claims

made within ten (10) days after its discovery. Refer to Compressor Inspections Prior to Installation for additional recommendations.

### Rigging and Lifting of the Compressor

### WARNING

When rigging and lifting a compressor unit, use proper lifting device capable of lifting and maneuvering the weight and size of the compressor unit. Use only qualified personnel and additional personnel and lifting equipment (i.e. spreader bar) as required. Failure to comply may result in death, serious injury and/or damage to equipment.

Only qualified personnel shall operate rigging and lifting equipment. Ensure that the lifting device is capable of lifting the weight of the compressor, refer to the supplied Vilter General Assembly (GA) drawing, and to Table 3-1 for weights of bare shaft compressors.

## Bareshaft Compressor Lifting Points and Weights

Table 3-1. Bareshaft Compressor Component Weights

Models	Component Weights				
	Gaterotor Bearing Housing	Gaterotor Bearing Housing Cover	Discharge Manifold	Main Compressor Assembly ONLY	Gaterotor Cover
97-127	3.3 lbs (1.6 kg)	8 lbs (4 kg)	N/A	249 lbs (113 kg)	10 lbs (5 kg)
291-601	19 lbs (9 kg)	11 lbs (5 kg)	125 lbs (57 kg)	1105 lbs (502 kg)	46 lbs (21 kg)
751-901	28 lbs (13 kg)	11 lbs (5 kg)	177 lbs (80 kg)	1450 lbs (658 kg)	33 lbs (15 kg)
1051-1301	37 lbs (17 kg)	13 lbs (6 kg)	274 lbs (125 kg)	2006 lbs (910 kg)	42 lbs (19 kg)
1501-2101	54 lbs (24 kg)	19 lbs (9 kg)	349 lbs (158 kg)	3151 lbs (1429 kg)	70 lbs (32 kg)
2401-3001	58 lbs (27 kg)	32 lbs (15 kg)	788 lbs (358 kg)	4152 lbs (1883 kg)	150 lbs (68 kg)

Table 3-2. Bareshaft Compressor Component Lifting Hole Sizes

Models	Component Lifting Hole Sizes				
	A	B	C	D	E
	Discharge Manifold (Side)	Discharge Manifold (Top)	Main Compressor Assembly ONLY (Discharge)	Main Compressor Assembly ONLY (Suction)	Gaterotor Cover
97-127	A & B Lifting Points: 1/2 - 13 UNC -2B		-	-	-
291-601	5/8-11 UNC -2B	5/8-11 UNC -2B	5/8-11 UNC -2B	5/8-11 UNC -2B	3/8-16 UNC-2B
751-901	5/8-11 UNC -2B	5/8-11 UNC -2B	5/8-11 UNC -2B	5/8-11 UNC -2B	-
1051-1301	5/8-11 UNC-2B	5/8-11 UNC -2B	3/4-10 UNC -2B	5/8-11 UNC -2B	3/8-16 UNC -2B
1501-2101	5/8-11 UNC -2B	5/8-11 UNC -2B	5/8-11 UNC -2B	5/8-11 UNC -2B	3/8-16 UNC -2B
2401-3001	5/8-11 UNC -2B	5/8-11 UNC -2B	5/8-11 UNC -2B	3/4-10 UNC -2B	5/8-11 UNC -2B

## Section 3 • Installation

To lift the compressor, use lifting points on compressor frame to attach the lifting device, see Table 3-2 and Figure 3-1 to 3-6. There are a few points to consider prior to moving it:

- Ensure that the weight is evenly distributed amongst the lifting device (i.e. lifting chains and spreader bar) prior to lifting.
- Ensure that the lifting device is not obstructed by any parts of the compressor to prevent damage to components.
- Use additional personnel as needed to spot and aid in maneuvering the compressor.
- Ensure there is plenty of space to maneuver the compressor, and a clear path to its location.

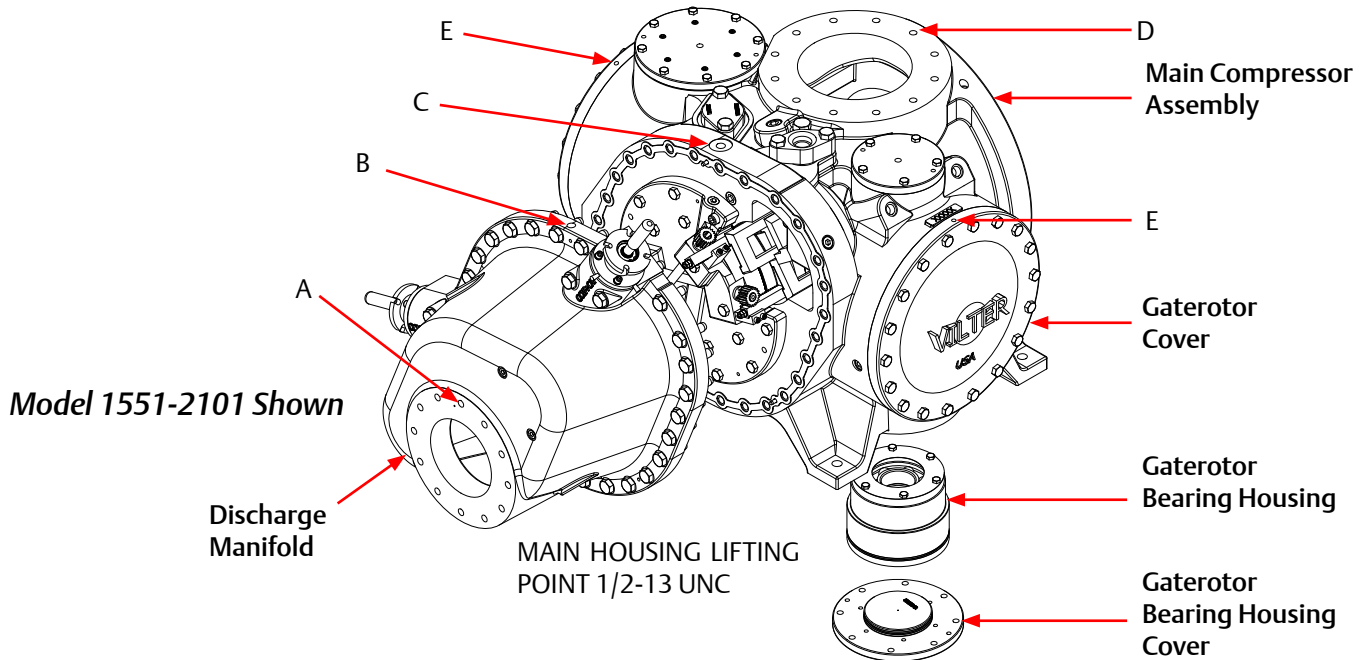


Figure 3-1. Bareshaft Compressor Lifting Points and Component Weights

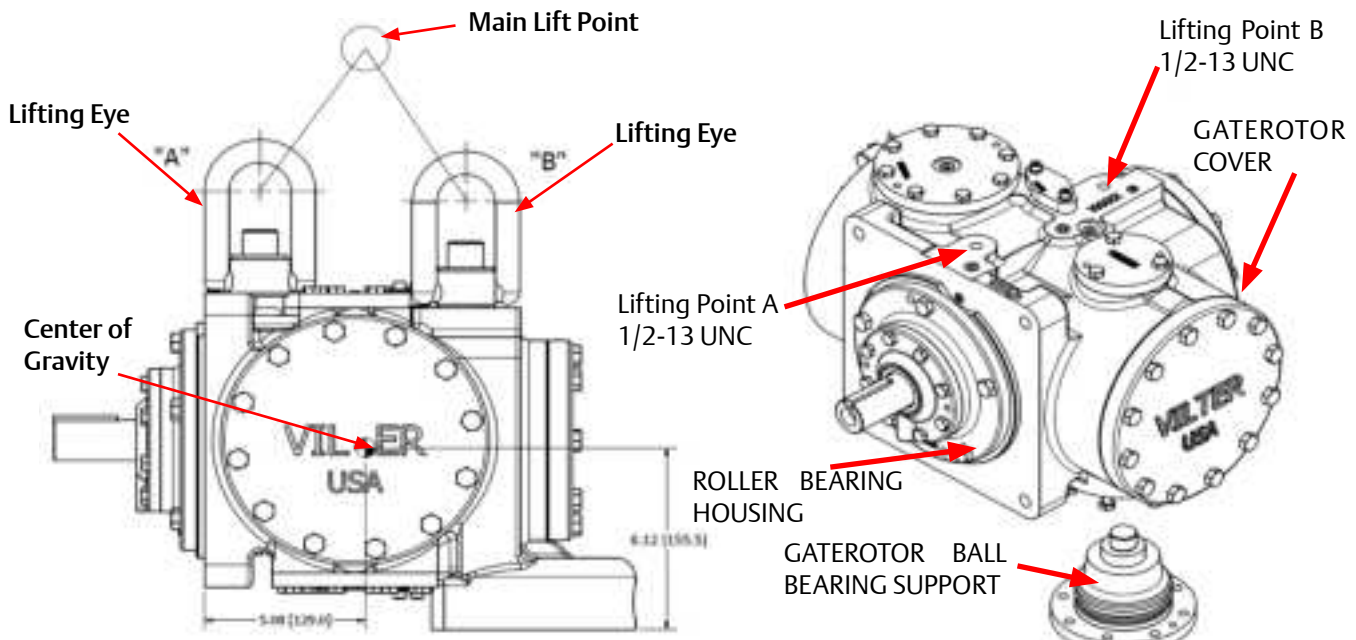


Figure 3-2. Bareshaft Compressor Assembly Center of Gravity (Models 97-127)

## Bareshaft Compressor Center of Gravity (Models 291-2101)

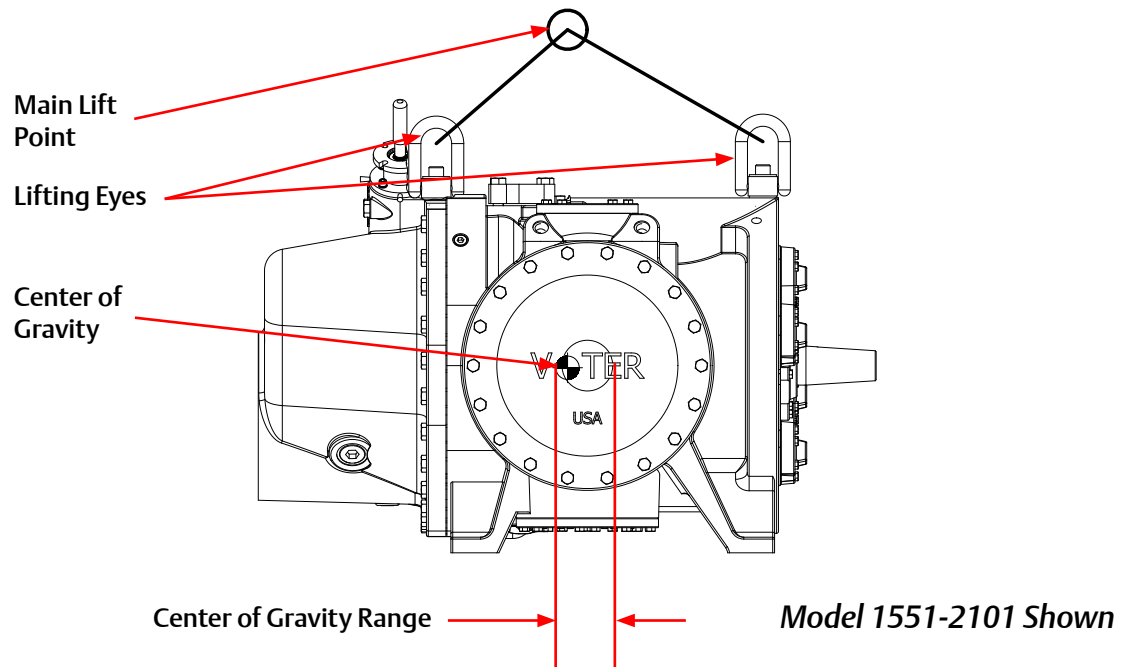


Figure 3-3. Bareshaft Compressor Assembly Center of Gravity (Models 291-2101)

*Center of gravity may differ slightly between models 291-2101. Adjust main lift point within the range to keep bareshaft compressor as leveled as possible when lifting.*

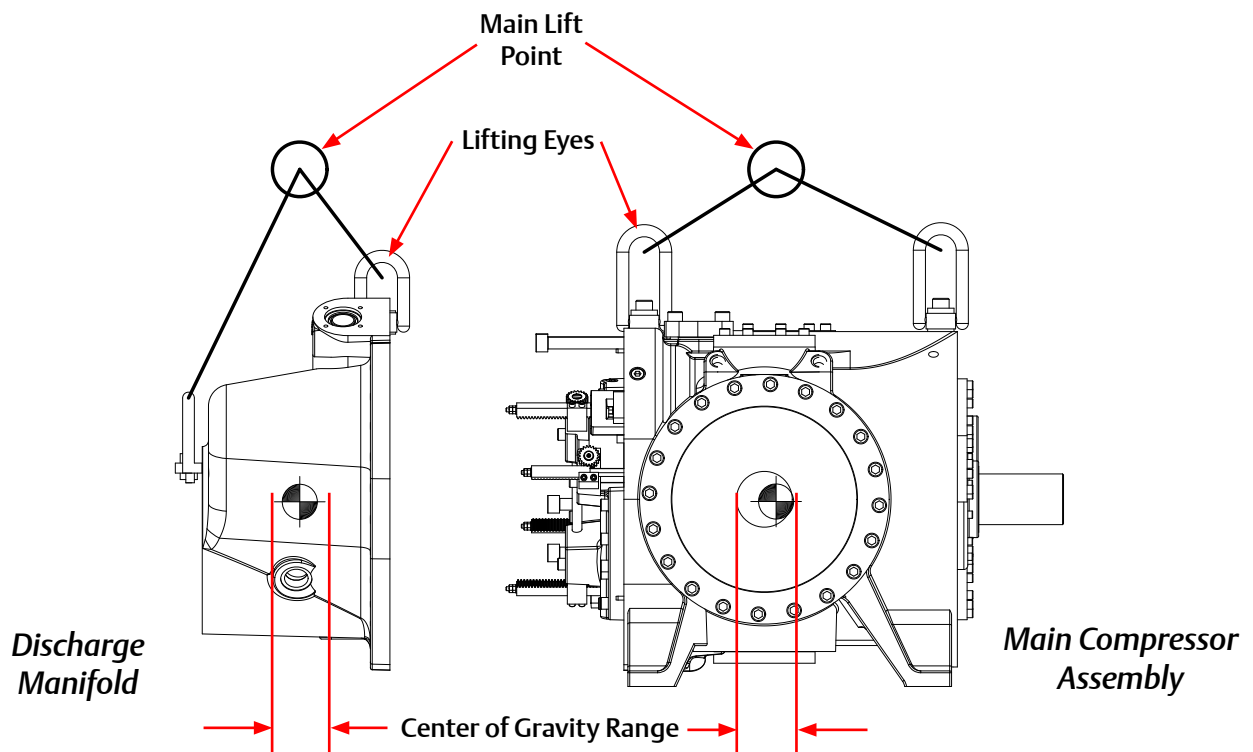


Figure 3-4. Bareshaft Compressor Center of Gravity - Discharge Manifold and Main Compressor Assembly (Models 291-2101)

Bareshaft Compressor Center of Gravity (Models 2401-3001)

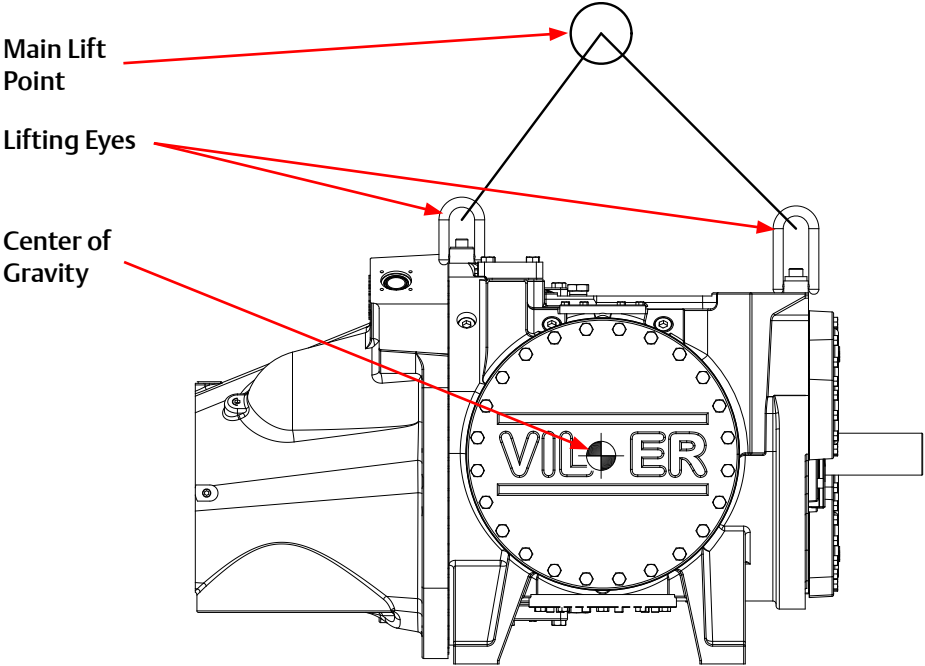


Figure 3-5. Bareshaft Compressor Assembly Center of Gravity (Models 2401-3001)

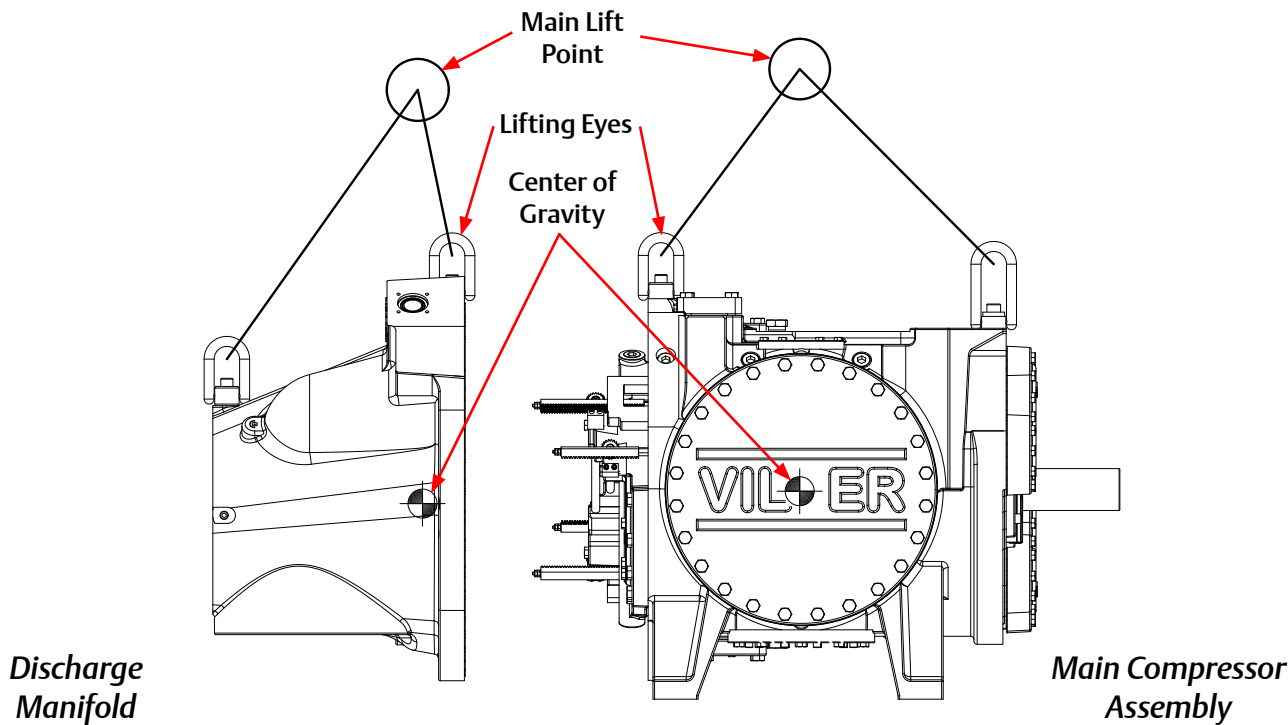


Figure 3-6. Bareshaft Compressor Center of Gravity - Discharge Manifold and Main Compressor Assembly (Models 2401-3001)

### Compressor Inspections Prior to Installation

The compressor must be inspected prior to installation since components could have come loose and/or damaged during shipment or moving.

- Check for loose bolts, particularly the compressor mounting nuts.
- Look into the suction and discharge connections and inspect for any signs of corrosion on parts.
- Check for bent or damaged components. The compressor should have also been inspected prior to off-loading, see Delivery Inspection.
- Check that the nitrogen pressure is still holding pressure. Any leaks must be fixed and the system purged and re-charged with dry nitrogen.
- Prelube the compressor with the main oil pump and rotate by hand several revolutions prior to start.
- Notify Vilter™ Service and Warranty Department when the compressor is started.

#### NOTE

For Pre Start-Up and Start-Up checklists, please contact Vilter Service and Warranty Department.

### CAUTION

Before installation, follow the proper procedures to depressurize the compressor.

### Recommended On-site Tools

The tools recommended to have on site are important for troubleshooting, inspections and compressor unit operation. Besides general mechanic tools, these tools are recommended:

- Oil Pump (maximum of 2-3 GPM with motor approved for Division 1 or Division 2 and with ability to overcome suction pressure) (VPN A40849A)
- Infrared Heat Gun
- Torque Wrenches (with ranges from 0 to 600 ft-lbs)
- Sockets and wrenches up to 2-1/2" (63.5 mm)
- Voltmeter

### Compressor Mounting

The Vilter single screw compressor should be firmly mounted to the package. Isolation dampers should not be used between the compressor and the package.

See Compressor Replacement in Section 5 for more installation details.

#### Notice on Using Non-Vilter Oils

### CAUTION

Do not mix oils. Failure to comply may result in damage to equipment.

### NOTICE

Vilter does not approve non-Vilter oils for use with Vilter compressors. Use of oils not specified or supplied by Vilter will void the compressor warranty.

Due to the need for adequate lubrication, Vilter recommends only the use of Vilter lubricants, designed specifically for Vilter compressors. With extensive research that has been performed, we are able to offer per each specific application lubricating oils. Use of oil not specified or supplied by Vilter will void the compressor warranty.

Please contact your local Vilter representative or the Home Office for further information.



### Long Term Storage Recommendations

The procedure described is a general recommendation for long term storage (over one month of no operation) of Vilter compressors. It is the responsibility of the installation firm and end user to address any unusual conditions. Use the supplied long term storage log sheet to help with record keeping, see section page 3-7.

Warranty of the system remains in effect as described at the beginning of this manual.

The following are recommendations regarding long term storage:

- If the compressor is designed for indoor duty, it must be stored in a heated building, preferably air conditioned to control moisture, to prevent corrosion of the main rotor shaft and for the compressor.
- If the unit is designed for outdoor duty and is to be stored outdoors, a canvas tarp is recommended for protection until installation. Adequate drainage should be provided. Place wood blocks under the base skid so that water does not collect inside the base perimeter or low spots in the tarp.
- All compressor stop valves are to be closed to isolate the compressor from the remainder of the system. All other valves, except those venting to atmosphere, are to be open.
- The volume and capacity slide valve motor enclosures should have corrosion inhibitors installed in them and the enclosures should be sealed. On a six month basis (depending on relative humidity), check and replace inhibitors as necessary, and check for signs of corrosion.
- Cover all bare metal surfaces (main rotor shaft, coupling, flange faces, etc.) with rust inhibitor.
- Desiccant is to be placed in the control panel. If the panel is equipped with a space heater, it is to be energized. Use an approved electrical spray-on corrosion inhibitor for panel components (relays, switches, etc.)
- All pneumatic controllers and valves (Fisher, Taylor, etc.) are to be covered with plastic bags and sealed with desiccant bags inside.
- Before leaving Vilter™ Manufacturing the compressor is evacuated and pressurized, with dry nitrogen, to 5 psig. Pressure must be monitored with the gauge (provided by Vilter™) and checked on a regular basis (at least monthly).
- It is essential that the nitrogen or clean dry gas holding charge be maintained. If not already installed, it is required that a gauge is to be added to help monitor the nitrogen holding charge pressure. If a drop in

pressure occurs, the source of leakage must be found and corrected. The system must be evacuated and recharged with dry nitrogen to maintain the package integrity.

- Manually rotate the compressor shaft 6 ½ revolutions every month to prevent flat spots on the bearing surfaces. If the compressor unit is installed, wired, and charged with oil, open all oil line valves and run the oil pump for 10 seconds prior to rotating the compressor shaft. Continue running the oil pump while the compressor shaft is being turned to help lubricate the surfaces of the shaft seal. For cool compression, there is no pre-lube pump, so the driveshaft must be turned by hand.
- Maintenance log to be kept with documenting dates to show all the procedures have been completed (see next page).



## Long Term Storage Log

Company: \_\_\_\_\_ Sales Order Number: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Name (Please Print): \_\_\_\_\_ Initial: \_\_\_\_\_

Date (M/D/Y): \_\_\_\_\_

PSI Nitrogen Pressure - Current

PSI Nitrogen Pressure - Recharged (If pressure is low, identify and fix leak prior to recharging, see Compressor Unit Leak Check procedure in Section 5)

Nitrogen Leak Location (Briefly explain nature of leak):

- ☐ Compressor Shaft (Rotate shafts at least 6 revolutions)
- ☐ Motor Shaft (Rotate shafts at least 6 revolutions)
- ☐ Motor Bearings Greased
- ☐ Air Cooled Oil Cooler Rotated (If equipped)
- ☐ Bare Metal Surfaces (Check all bare metal surfaces for rust and ensure they are covered with rust inhibitor)
- ☐ Desiccants (Are desiccants still effective? If not, replace. Check control panel, motor, pneumatic controllers and valves)
- ☐ Cover Bags/Tarp (Ensure bags and tarps are not torn and are sealed over components correctly, replace if damaged)
- ☐ Valves (Stop valves are in closed position so the compressor unit is isolated. All other valves, except those venting and draining to atmosphere are to be open)
- ☐ Space Heater & Panel Components (Ensure space heater is energized and panel components are rust-free)

Name (Please Print): \_\_\_\_\_ Initial: \_\_\_\_\_

Date (M/D/Y): \_\_\_\_\_

PSI Nitrogen Pressure - Current

PSI Nitrogen Pressure - Recharged (If pressure is low, identify and fix leak prior to recharging, see Compressor Unit Leak Check procedure in Section 5)

Nitrogen Leak Location (Briefly explain nature of leak):

- ☐ Compressor Shaft (Rotate shafts at least 6 revolutions)
- ☐ Motor Shaft (Rotate shafts at least 6 revolutions)
- ☐ Motor Bearings Greased
- ☐ Air Cooled Oil Cooler Rotated (If equipped)
- ☐ Bare Metal Surfaces (Check all bare metal surfaces for rust and ensure they are covered with rust inhibitor)
- ☐ Desiccants (Are desiccants still effective? If not, replace. Check control panel, motor, pneumatic controllers and valves)
- ☐ Cover Bags/Tarp (Ensure bags and tarps are not torn and are sealed over components correctly, replace if damaged)
- ☐ Valves (Stop valves are in closed position so the compressor unit is isolated. All other valves, except those venting and draining to atmosphere are to be open)
- ☐ Space Heater & Panel Components (Ensure space heater is energized and panel components are rust-free)

## Section 3 • Installation

### Stop/Check Valve Installation<sup>1</sup>

The new design will apply only to the 2" thru 4" stop valves. Retrofitting a field installation will require replacing the bonnet assembly.

The bonnet must be installed with the spring towards the bottom, see Figure 3-7. The drill fixture is designed so that the hole for the spring will always be drilled on the opposite side from the cast-in Vilter name on the bonnet. From the outside of the valve, the casting numbers must always be towards the top of the valve.

For Stop/Check Valve Operation, refer to Section 4.

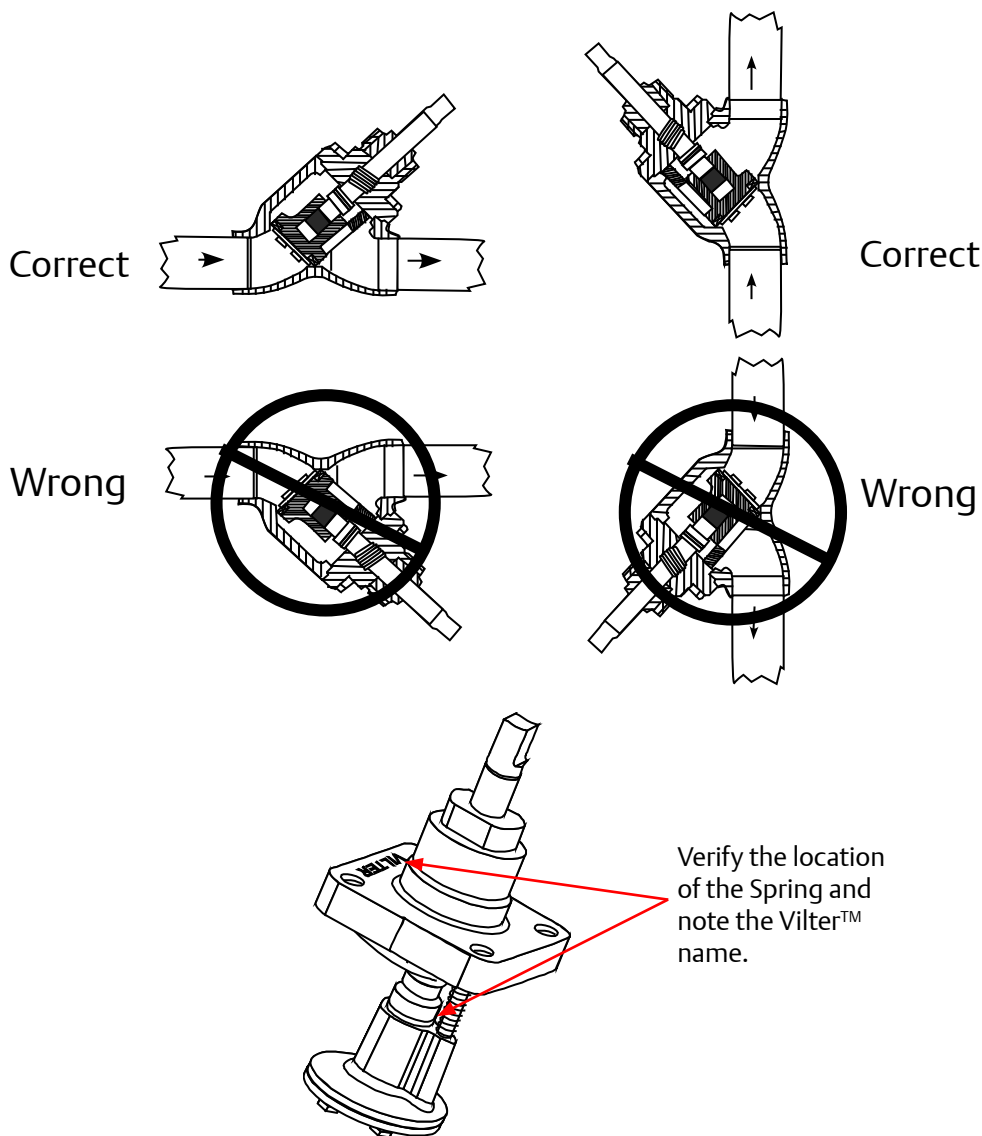


Figure 3-7. Stop/Check Valve Orientation

<sup>1</sup> For VSM-97, VSM-113 and VSM-127 this is just a Stop Valve

### Piping

Refer to the ANSI/ASME B31.5 Code for Refrigeration Piping. The necessary connections to be made to the screw compressor will vary depending on the type of oil cooling method used. Main line refrigerant suction and discharge connections are always necessary.

- Before installing piping, the compressor inlet and outlet ports should be inspected to ensure no dirt is present.
- Piping should be supported so that no piping loads are transmitted to the compressor casings.
- All piping should be inspected for cleanliness before installation. As each pipe is connected to the compressor, the coupling alignment should be checked to ensure that no alteration has taken place.
- If alignment has altered, the compressor is being strained and the piping supports must be adjusted.
- It is not sufficient merely to re-align the drive coupling, as this will not correct the cause of the strain.
- Care must be taken to avoid trapping the lines except for specific purposes. When traps are used, the horizontal dimensions should be as short as possible to avoid excessive oil trapping.
- Lines for ammonia systems must be of steel pipe with specially designed ammonia service fittings. Common pipe fittings must NEVER be used as they will not provide the same service. Steel pipe is generally used in large installations when joints are welded.

In making up joints for steel pipe, the following procedures should be followed:

- For threaded connections, all threads on the pipe and fitting should be carefully cleaned to remove all traces of grease or oil. Threads should then be wiped dry with a lintless cloth. Only thread filling compounds suitable for service should be used for making steel pipe joints. These compounds should be used sparingly, and on the pipe only. Do not put any on the first two threads to prevent any of the thread sealing compound from entering the piping system. Acetylene or arc welding is frequently used in making steel pipe joints, however, only a skilled welder should attempt this kind of work. Take care to see no foreign materials are left in the pipes and remove all burrs formed when cutting pipe.
- It is important to avoid short, rigid pipe lines that do not allow any degree of flexibility. This must be done to prevent vibration being transmitted through the pipe lines to the buildings. One method of providing the needed flexibility to absorb the vibration is to provide long lines that are broken by 90° Ells in three directions.
- A second method would be to install flexible pipe couplings as close to the compressor unit as possible with connections run in two different directions, 90° apart. These flexible connections should be installed on both the high and low side lines of the compressor unit.
- Hangers and supports for coils and pipe lines should receive careful attention. During prolonged operation of the coils, they may become coated with ice and frost, adding extra weight to the coil. The hangers must have ample strength and be securely anchored to withstand the vibration from the compressor and adequately support the pipe lines.
- For CO<sub>2</sub> piping, the pipes can have smaller diameters and they will require a greater thickness to withstand the higher pressures.
- Smaller Halocarbon and Hydrofluorocarbon installations use copper pipes with solder type fittings where possible. The use of screw type fittings in Halocarbon systems should be held to an absolute minimum, as these refrigerants, due to their physical properties, will leak through screw type joints.
- When drawn copper tubing is used for Halocarbon lines, type “K” or “L” conforming to ASTM B88 should be used. Soft annealed copper tubing conforming to ASTM B280 can also be used for tube sizes not larger than 1-3/8” in outside diameter. These requirements are in accordance with the mechanical code for refrigeration ANSI B9.1-1971. The type of copper tubing to be used for a given pressure is dependent on the strength of the copper at the design temperature. Some local codes forbid the use of Type “L”. Therefore, before installation, be sure to check local requirements. Never use type “M” as it does not have adequate wall thickness to withstand the operating pressures.
- For halocarbon piping, only wrought copper fittings should be used. Cast fittings as used for water service are porous and will allow the refrigerant to escape. Note this exception: In larger pipe sizes, wrought fittings are not available. However, specially tested cast fittings are available and these may be used with complete safety.
- When soldering copper tubing joints, only silver solder should be used for Refrigerant-22 service. Soft solder such as “50-50” should never be used, as its melting point is too low, lacks mechanical strength, and tends to break down chemically in the presence of moisture.
- Water supply and drain connections, and equipment using water, should be installed so all the water may be drained from the system after the plant has been shut down in cold weather. These precautions

## Section 3 • Installation

will avoid costly damage to the equipment due to freezing.

This information is taken from ASHRAE 15-89 and ANSI/ASME B31.5. The installing contractor should be thoroughly familiar with these codes, as well as any local codes.

### CAUTION

Accumulated liquid in the suction header can damage the compressor if not drained. Always drain headers (suction and discharge headers) prior to start-ups. Failure to comply may result in damage to equipment.

## Flange Loads

The ideal load applied to flanges of the compressor unit is zero. However, it's not practical to expect that no loads will be applied to unit connections. Thermal, dead, live, wind & seismic loads must be considered and even tolerated. Well supported external piping connected to the compressor will still result in some loads applying forces and moments in three axes to unit flanges.

The most important issue is the motor-compressor misalignment caused by external forces (F in lbf) and moments (M in ft-lbf) imposed by plant piping. In Figure 3-8 and Table 3-3, are the maximum allowable forces and moments that can be applied to compressor flanges when the compressor is mounted on an oil separator.

It must be noted that it is necessary to check for compressor shaft movement when the job is complete. In no case shall the attached piping be allowed to cause more than 0.002" movement at the compressor shaft. If more than 0.002" movement is detected the piping

Table 3-3. Maximum Allowable Flange Loads

Nozzle Dia. (in.)	Fz (lbf)	Fy (lbf)	Fx (ft-lbf)	Mzz (ft-lbf)	Myy (ft-lbf)	Mxx (ft-lbf)
4	400	400	400	300	300	300
6	600	600	600	500	500	500
8	900	900	900	1000	1000	1000
10	1200	1200	1200	1200	1200	1200
12	1500	1500	1500	1500	1500	1500
14	2000	2000	2000	2000	2000	2000

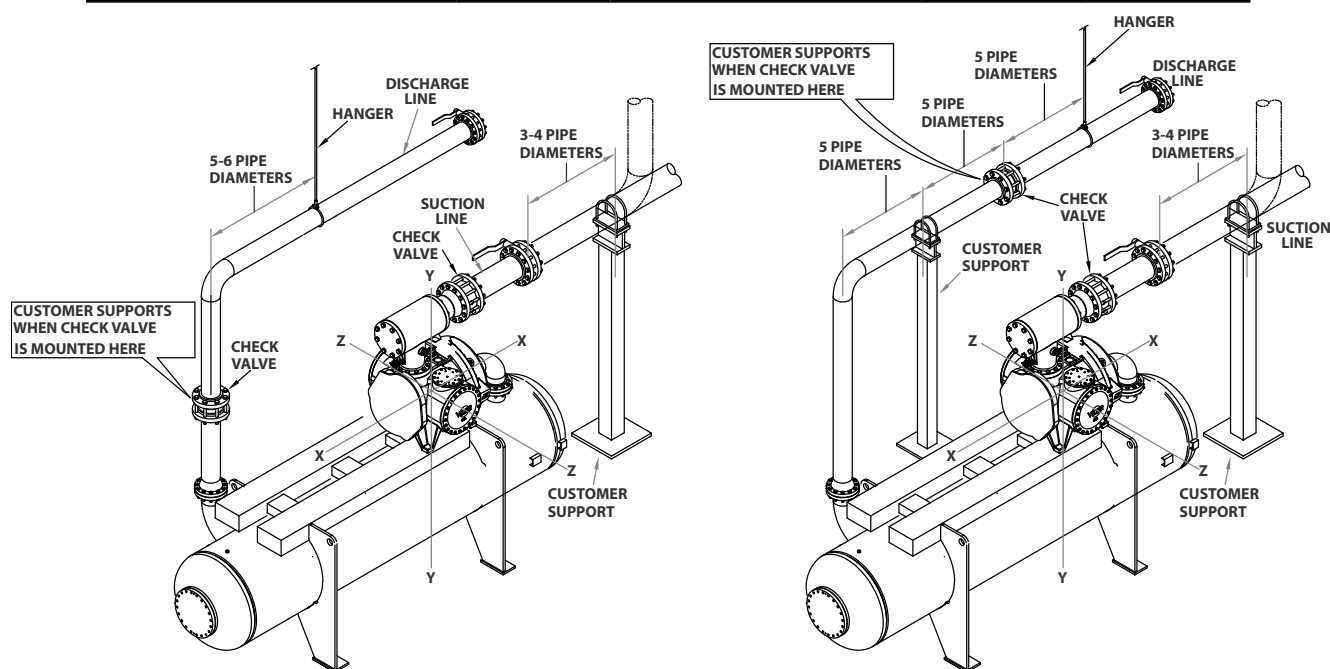


Figure 3-8. Maximum Allowable Flange Loads

## Section 3 • Installation

must be adjusted to reduce the compressor shaft movement to less than 0.002". For example, the compressor shaft should not move more than 0.002" when piping is removed or connected to the compressor.

**IMPORTANT** – piping elements shall be supported per the requirements of ASME B31.5 / B31.3 or other local codes as applicable. See guidelines below, particularly with concern to minimize loads on check valves.

### CAUTION

Accumulated liquid in the suction header can damage the compressor if not drained. Always drain headers (suction and discharge headers) prior to start-ups. Failure to comply may result in damage to equipment.

## Slide Valve Actuator Installations Instructions

### CAUTION

When installing the optical slide motor, loosen locking collar before sliding the collar down on the shaft. Do not use a screwdriver to pry locking collar into position.

### Installation

See Slide Valve Actuator Assembly Replacement in Section 5 for installation details.

### Overview

Calibration of an optical slide valve actuator is a two step process that must be done for each actuator installed of the compressor. Briefly, the steps are as follows.

- 1) The actuator motor control module, located inside the actuator housing, is calibrated so that it knows the minimum and maximum rotational positions of the slide valve it controls. The calibrated actuator will output 0 VDC at the minimum position and 5 VDC at the maximum position.
- 2) After the actuator motor control module has been calibrated for 0-5Volts, the controlling channel corresponding to the actuator motor (either the capacity or volume) has to be calibrated. This instructs the control panel to learn the rotational 0% position & rotational 100% position of the slide valve travel.

### NOTE

Because there is an optical sensor on this motor, do not attempt calibration in direct sunlight.

## Actuator Motor Control Module Calibration Procedure

1. Disable the Slide Non-Movement Alarm by going to the "Setup" menu on the control panel and choosing "Alarm Disable" for the Slide Non-Movement Option. (If applicable).
2. Completely shut off the power to the control panel completely.
3. If not already done, mount the slide valve actuator per ("Vilter Actuator set up for Capacity and Volume Slide Motors). Next, wire the actuator per the attached wiring diagrams, using the already installed electrical conduit to run the cables. The old wiring can be used to pull the new cables through the conduit to the control panel. The cables may also be externally tie-wrapped to the conduit. Run the yellow AC power cable(s) and the gray DC position transmitter cable(s) in different conduit. This prevents the DC position transmitter cable from picking up electrical noise from the AC power cable. Do not connect either of the cables to the actuators yet.

In addition, if the actuators are replacing old gearmotors on early units, you must remove the capacitors and associated wiring from inside the control panel. This is necessary to prevent electrical damage to the new actuator motor.

4. When completing the calibration of the new actuators, the motors are signaled to move to below 5%. This may not completely occur when exiting the calibration screen due to a "program timer". HOWEVER, when the compressor actually starts, the motors will travel below 5% and function correctly. The user may see that the actuators are not below 5% after calibration and try to find the reason. If the calibration screen is re-entered right away and then exited, the timer will allow the actuator to go below the 5% on the screen. This may be perceived as a problem; in reality, it is not.

### NOTE

The 0 to 5V-position transmitter output of the actuator will fluctuate wildly during the calibration process. To prevent damage to the actuators, do not connect the yellow power cable or the gray position transmitter cable until instructed to do so later on.

5. Refer to Calibrate Slide Valve Actuators (using Vision 20/20 or PLC) in Section 4 or Appendix F for more details.

### Instrumentation Requirements

#### Pressure

There are four pressure transducers required to read system pressures as listed below (see Figure 3-9):

- 1. Suction Pressure Transducer** - (15.0 - 1000 PSIG) measures the gas suction pressure into the compressor housing, which provides the permissive to start at reaching minimum suction pressure, and is used to detect low suction pressure while running and in the capacity control logic.
- 2. Discharge Pressure Transducer** - (15 - 1000 psig) measures the discharge pressure of the process gas in the separator, which provides detection of high discharge pressure, and may also be used for capacity control logic.
- 3. Oil Filter Inlet pressure transducer** - (15 - 1000 psig) measures the oil pressure as it enters the oil filter canisters and is used to calculate oil filter differential pressure to provide detection of high filter differential pressure.
- 4. Oil Manifold pressure transducer** - (15 - 1000 psig) measures the oil pressure downstream of the oil filter as the oil is injected into the compressor, and provides detection and protection against low prelube oil pressure, and low running oil injection pressure.

Additional pressure transducers may be required and installed by the customer for pressure readings at customer specified points such as process gas discharge pressure from the package boundary, cooling water pressure to and/or from the oil cooler, etc.

#### Temperature

There are four pressure temperature readings required for processor control, as listed below (see Figure 3-9):

- 5. Suction temperature RTD** - measures the temperature of the incoming suction gas, and is used to provide detection of low suction temperature when the unit is running.
- 6. Discharge temperature RTD** - measures the temperature of the gas/oil mixture as it is discharged from the compressor housing, and provides detection of high running discharge temperature.
- 7. Oil Separator temperature RTD** - measures the temperature of the oil in the separator sump, and produces the oil temperature start permissive and detection of low running separator temperature.
- 8. Oil Injection temperature RTD** - measures the temperature of the oil as it is injected into the compressor, which provides detection of either high or low running oil injection temperature.

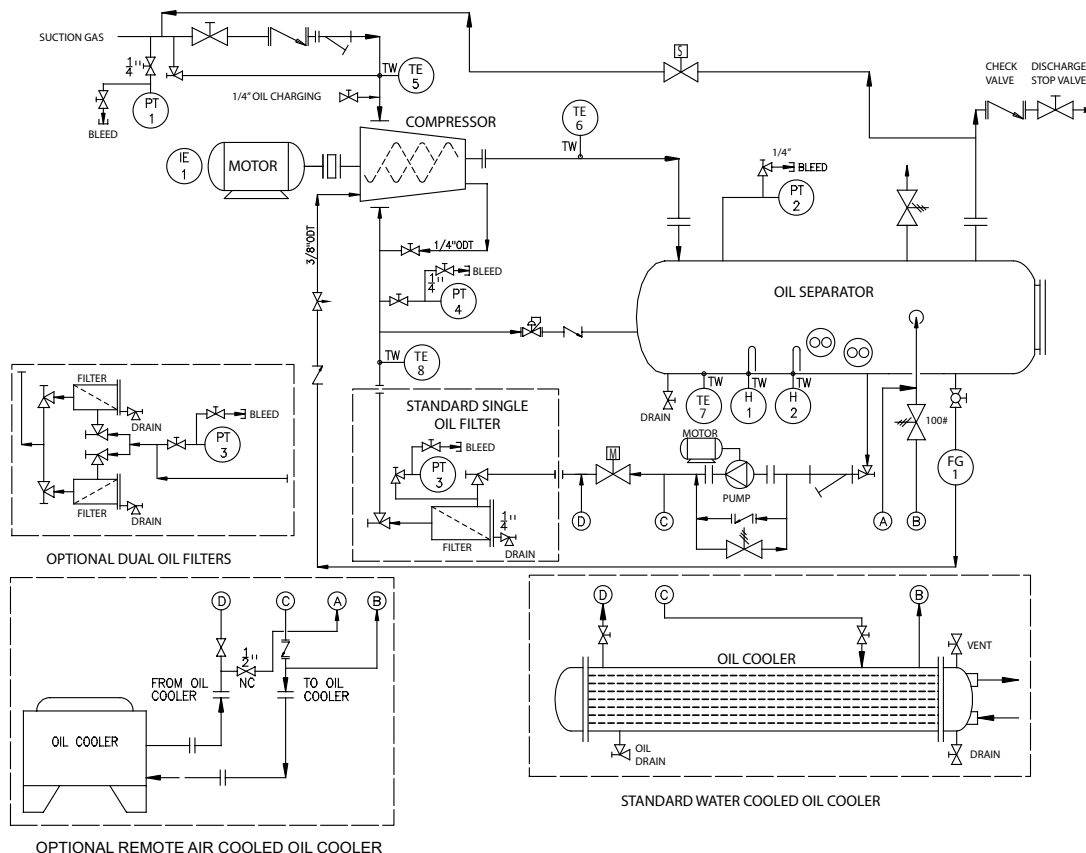


Figure 3-9. Additional Instruments

## Section 3 • Installation

\* Additional RTD's may be required and installed by the customer for temperature readings at customer specified points such as discharge gas temperature from the package boundary, cooling water temperature to and/or from the oil cooler, gas aftercooler temperature, etc.

### Miscellaneous

One additional instrument required is a current transformer mounted around one phase of the drive motor leads to measure main motor amperage. The amperage signal provides detection of high motor amperage, and is used in the capacity control logic. Also, additional input points may be required for customer connection of remote signals such as Start and Stop commands, and capacity setpoint control.

If a VFD is used, then amps are fed from the VFD starter to the PLC, therefore a current transformer is not needed.

## Testing Refrigeration System For Leaks

### CAUTION

Do not hydro test compressor unit. Failure to comply may result in damage to equipment.

### CAUTION

The compressor unit along with other system units contain many components with various pressure ratings. Pressure relief protection provided considers the design pressure of a system components. Before replacing a pressure relief valve with a relief valve having a higher pressure setting, all system components must be evaluated for acceptability.

Vilter equipment is tested for leaks at the factory. One of the most important steps in putting a refrigeration system into operation is field testing for leaks. This must be done to assure a tight system that will operate without any appreciable loss of refrigerant. To test for leaks, the system pressure must be built up. Test pressures for various refrigerants are listed in ANSI B9.1-1971 code brochure entitled "Safety Code for Mechanical Refrigeration". These pressures will usually suffice, however, it is advisable to check local codes as they may differ. Before testing may proceed, several things must be done.

First, if test pressures exceed the settings of the system, relief valves or safety devices, they must be removed and the connection plugged during the test. Secondly, all valves should be opened except those leading to the atmosphere. Then, open all solenoids and pressure regulators by the manual lifting stems. All bypass arrangements must also be opened. Because of differences in

characteristics of the various refrigerants, two different testing methods are necessary.

### Ammonia Systems

Dry nitrogen may be used to raise the pressure in an ammonia system to the proper level for the test. The gas may be put into the system through the charging valve or any other suitable opening. Adjust the pressure regulator on the bottle to prevent over-pressurization. Do not exceed the pressure rating on the vessel with the lowest pressure rating.

Carbon Dioxide should NOT be used as a testing gas in a system where ammonia is already dissolved in any moisture remaining. This will cause ammonium carbonate to precipitate when the CO<sub>2</sub> is added. If heavy enough, this precipitate may cause the machine to freeze and clog the strainer.

A mixture of four parts water to one part liquid soap, with a few drops of glycerin added, makes a good solution. Apply this mixture with a one inch round brush at all flanges, threaded joints, and welds. Repair all visible leaks. If possible, leave the pressure on over night. A small pressure drop of 5 lbs over this period indicates a very tight system.

Remember to note the ambient temperature, as a change in temperature will cause a change in pressure.

After the system is thoroughly tested, open all valves on the lowest part of the system so the gas will float away from the compressor. This prevents any dirt or foreign particles from entering the compressor and contaminating the working parts. The oil should then be charged into the compressor.

Charge a small amount of ammonia into the system and pressurize the system to its respective design pressure. Pass a lit sulfur stick around all joints and connections. Any leaks will be indicated by a heavy cloud of smoke. If any leaks are observed during this test, they must be repaired and rechecked before the system can be considered tight and ready for evacuation.

### Halocarbon Refrigerant Systems

"Oil pumped" dry nitrogen, or anhydrous CO<sub>2</sub> in this order of preference may be used to raise the pressure to the proper level for testing.

When the proper pressure is attained, test for leaks with the soap mixture previously described. After all leaks are found and marked, relieve the system pressure and repair the leaks. Never attempt to repair soldered or welded joints while the system is under pressure. Soldered joints should be opened and re soldered.

Do not simply add more solder to the leaking joint. After

## Section 3 • Installation

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all the joints have been repaired and the system is considered “tight” the system may be tested with refrigerant.

Attach a drum of the refrigerant to be used in the system and allow the gas to enter until a pressure of 5 psig is reached.

Remove the refrigerant drum and bring the pressure to the recommended test level with oil pumped dry nitrogen or CO<sub>2</sub>. Then check the entire system again for leaks, using a halide torch or electronic leak detector. Be sure to check all flanged, welded, screwed and soldered joints, all gasketed joints, and all parting lines on castings. If any leaks are found, they must be repaired and rechecked before the system can be considered tight again, remembering that no repair should be made to welded or soldered joints while the system is under pressure.

### CO<sub>2</sub> Systems

A CO<sub>2</sub> system will tend to be more prone to leaks due to the higher working pressures and the smaller molecule size, and therefore its leak detection should become a regular maintenance procedure. For a charge size of above 661 lbs, for example, the recommendation would be to perform the leak detection procedure about 4 times a year.

An oil stain will be a visual indicator of a CO<sub>2</sub> leak, but there are also leak detection sprays available in the market (such as Weicon's or Bulleye's), infrared hand held leak detectors (such as D-TEK CO<sub>2</sub>), and ultrasonic leak detectors of several brands<sup>2</sup>.

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<sup>2</sup> Information taken from Commercial CO<sub>2</sub> Refrigeration Systems Guide for Subcritical and Transcritical CO<sub>2</sub> Applications, by Emerson.



### Notice on Using Non-Vilter Oils

#### CAUTION

Do not mix oils. Failure to comply may result in damage to equipment.

#### NOTICE

Vilter does not approve non-Vilter oils for use with Vilter compressors. Use of oils not specified or supplied by Vilter will void the compressor warranty.

Due to the need for adequate lubrication, Vilter recommends only the use of Vilter lubricants, designed specifically for Vilter compressors. Use of oil not specified or supplied by Vilter will void the compressor warranty.

Please contact your local Vilter representative or the Home Office for further information.

### Operation

All operation (set-point adjustments, calibrations, monitoring) of the compressor unit is done through the micro-processor. For additional procedural information, refer to micro-processor manual (35391SC for Vision 20/20 Operating Manual or 35391CM for Compact Logix PLC Software Manual).

#### WARNING

Software programming credentials shall only be made available by the supplier. The user will only have access to operational features established by the supplier. Failure to comply may result in serious injury or death.

### Control System

#### Starting, Stopping and Restarting The Compressor

For additional control information, refer to micro-processor manual (35391SC for Vision 20/20 Operating Manual or 35391CM for Compact Logix PLC Software Manual).

#### WARNING

Software programming credentials shall only be made available by the supplier. The user will only have access to operational features established by the supplier. Failure to comply may result in serious injury or death.

#### Starting

Before the screw compressor unit can start, certain conditions must be met. All of the safety setpoints must be in a normal condition, and the suction pressure must be above the low suction pressure setpoint to ensure a load is present. When the “ON/OFF” switch or “Manual-Auto” button is pressed, the oil pump will start. When sufficient oil pressure has built up and the compressor capacity control and volume ratio slide valves are at or below 10%, the compressor unit will start.

#### NOTE

The amount of oil pressure that needs to be achieved before compressor start is at least 6 psig above the discharge pressure. For additional information on Low Oil Pressure at Start, see Troubleshooting Guide - General Problems and Solutions in Section 6.

If the compressor is in the automatic mode, it will now load and unload and vary the volume ratio in response to the system demands.

#### Stopping/Restarting

Stopping the compressor unit can be accomplished a number of ways. Any of the safety setpoints will stop the compressor unit if an abnormal operating condition exists. The compressor unit “On-Off” or stop button will turn the compressor unit off as will the low pressure setpoint. If any of these conditions turns the compressor unit off, the slide valve motors will immediately energize to drive the slide valves back to 5% limit. The control motors will be de-energized when the respective slide valve moves back below 5%. If there is a power failure, the compressor unit will stop. If the manual start on power failure option is selected, restarting from this condition is accomplished by pushing the reset button to ensure positive operator control. If the auto start on power failure option is selected, the compressor unit will start up after a waiting period. With both options,

## Section 4 • Operation

the compressor slide valves must return below their respective 5% limits before the compressor unit can be restarted.

### NOTE

Wait a minimum of 20 minutes (to allow the compressor unit to equalize to suction pressure) between pre-lubing or pushing the start button.

## Emergency Shutdown

Emergency shutdown is initiated by the following:

1. A shutdown or trip condition of a process variable while the system is in operation. If a process variable reaches a high-high or low-low shutdown setpoint, the compressor unit will automatically stop. A shutdown alarm is also generated on the control panel HMI screen annunciating the specific process variable trip condition.
2. The Local Emergency Shutdown push button located on the side of the control panel enclosure. When the Local Emergency Shutdown push button is activated, the entire unit powers down. Also, the compressor capacity and volume slide valve will stay in their last position until the unit is powered up. Once recovery has been accomplished and the unit is to be re-powered, the Local Emergency Shutdown push button must be pulled out to power up the unit and controls.

## Capacity and Volume Ratio Control through Slide Valve Actuators

Capacity and volume ratio control of the screw compressor is achieved by movement of the respective slide valves, actuated by electric motors.

When viewing the compressor from the discharge end (opposite the drive end), the upper motor is for capacity control. The command shaft turns (see Table 4-1) to decrease the capacity to 10% and reverses to increase the capacity to 100%. The lower motor is for volume ratio control. The command shaft turns to reduce the volume ratio to 2.0, and reverses to increase the volume ratio to 5.0.

Actuation of the electric motors can be done manually or automatically. To actuate the motors manually, place the desired mode selector in the manual position and push the manual Increase or Decrease buttons. In the automatic mode, the microprocessor determines the direction to actuate the electric motors. However, in the automatic mode, there is an “On” and “Off” time for the capacity control motor. The “On” time is the time in which the slide valve moves, and the “Off” time is the time in which the system is allowed to stabilize before another change in slide valve position.

The Motor Amps Load Limit protects the compressor from overloading by decreasing the compressor capacity if the motor amperage is at the Maximum Amps setpoint, or preventing an increase in capacity if the motor amperage is above the Full Load Amps setpoint. ( See manual for the appropriate microprocessor.)

### NOTE

Optical Actuators CAN NOT be manually rotated.

(The VSM 501-701 models will have motor locations opposite of figure #4-1)

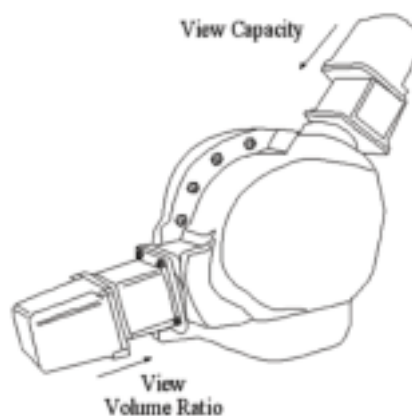


Figure 4-1. Slide Valve Motor Location

### Slide Valve Actuator Operation

The slide valve actuator is a gear-motor with a position sensor. The motor is powered in the forward and reverse directions from the main computer in the control panel. The position sensor tells the main computer the position of the slide valve. The main computer uses the position and process information to decide where to move the slide valve next.

The position sensors works by optically counting motor turns. On the shaft of the motor is a small aluminum “photochopper”. It has a 180 degree fence that passes through the slots of two slotted optocouplers. The optocouplers have an infrared light emitting diode (LED) on one side of the slot and a phototransistor on the other. The phototransistor behaves as a light controlled switch. When the photochopper fence is blocking the slot, light from the LED is prevented from reaching the phototransistor and the switch is open. When photochopper fence is not blocking the slot, the switch is closed.

As the motor turns, the photochopper fence alternately blocks and opens the optocoupler slots, generating a sequence that the position sensor microcontroller can use to determine motor position by counting. Because the motor is connected to the slide valve by gears, knowing the motor position means knowing the slide valve position.

During calibration, the position sensor records the high and low count of motor turns. The operator tells the position sensor when the actuator is at the high or low position with the push button. Refer to the calibration instructions for the detailed calibration procedure.

The position sensor can get “lost” if the motor is moved while the position sensor is not powered. To prevent this, the motor can only be moved electrically while the position sensor is powered. When the position sensor loses power, power is cut to the motor. A capacitor stores enough energy to keep the position sensor circuitry alive long enough for the motor to come to a complete stop and then save the motor position to non-volatile EEPROM memory. When power is restored, the saved motor position is read from EEPROM memory and the actuators resumes normal function

This scheme is not foolproof. If the motor is moved manually while the power is off or the motor brake has failed, allowing the motor to free wheel for too long after the position sensor loses power, the actuator will become lost.

A brake failure can sometimes be detected by the position sensor. If the motor never stops turning after a power loss, the position sensor detects this, knows it will be lost, and goes immediately into calibrate mode when power is restored.

## Section 4 • Operation

### Calibrate Slide Valve Actuators (For Units Using Vission20/20™)<sup>1</sup>

Slide valve actuators must be installed prior to calibration. Refer to Slide Valve Actuator Installation procedure. The following steps pertain to calibrating one slide valve actuator. Repeat procedure to calibrate other slide valve actuator.

#### WARNING

After stopping the compressor, allow the compressor and surrounding components to cool down prior to servicing. Failure to comply may result in serious injury.

#### CAUTION

Do not calibrate in direct sunlight. Failure to comply may result in damage to equipment.

Both the capacity and volume slide actuators should be calibrated when one or more of these have occurred:

- Compressor unit starting up for the first time.
- A new actuator motor has been installed.
- There is an error code flashing on the actuator's circuit board - an attempt to recalibrate should be made.

- The range of travel is not correct and the command shaft travel is physically correct.
- The compressor is pulling high amperage, the calibration of the volume slide should be checked.
- An actuator does not unload below 5%, or an actuator that doesn't move.
- Something is not working properly such as the actuators, RTDs or transducers.

To calibrate optical actuators, continue with the following steps:

#### NOTE

If the compressor unit is starting up for the first time or a new actuator motor has been installed, leave the power cable and position transmitter cable disconnected until step 6.

1. Stop compressor unit and allow to cool.
2. Remove screws securing actuator cover to actuator assembly. As a reference see Figure 4-2.

#### CAUTION

Wires are attached to the connector on the actuator cover. Handle actuator cover with care to prevent damage to wires. Failure to comply may result in damage to equipment.

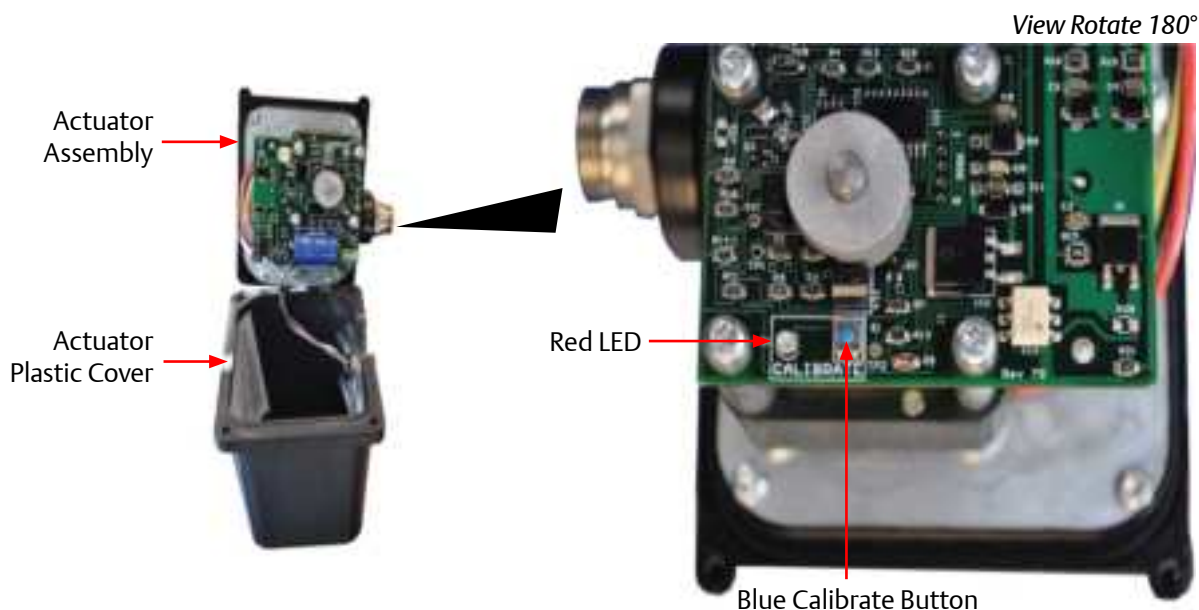


Figure 4-2. Actuator Assembly

<sup>1</sup> Does not apply to compressors that operate without slides (VSM-97, VSM-113, VSM-127).

## Section 4 • Operation

3. Carefully lift actuator cover from actuator assembly and tilt towards connectors. Raise cover high enough to be able to press the blue calibration button and be able to see the red LED on the top of assembly.
4. Logging on into the Vission20/20™ with high-level access will prompt the Calibration buttons to appear, see Figure 4-3.

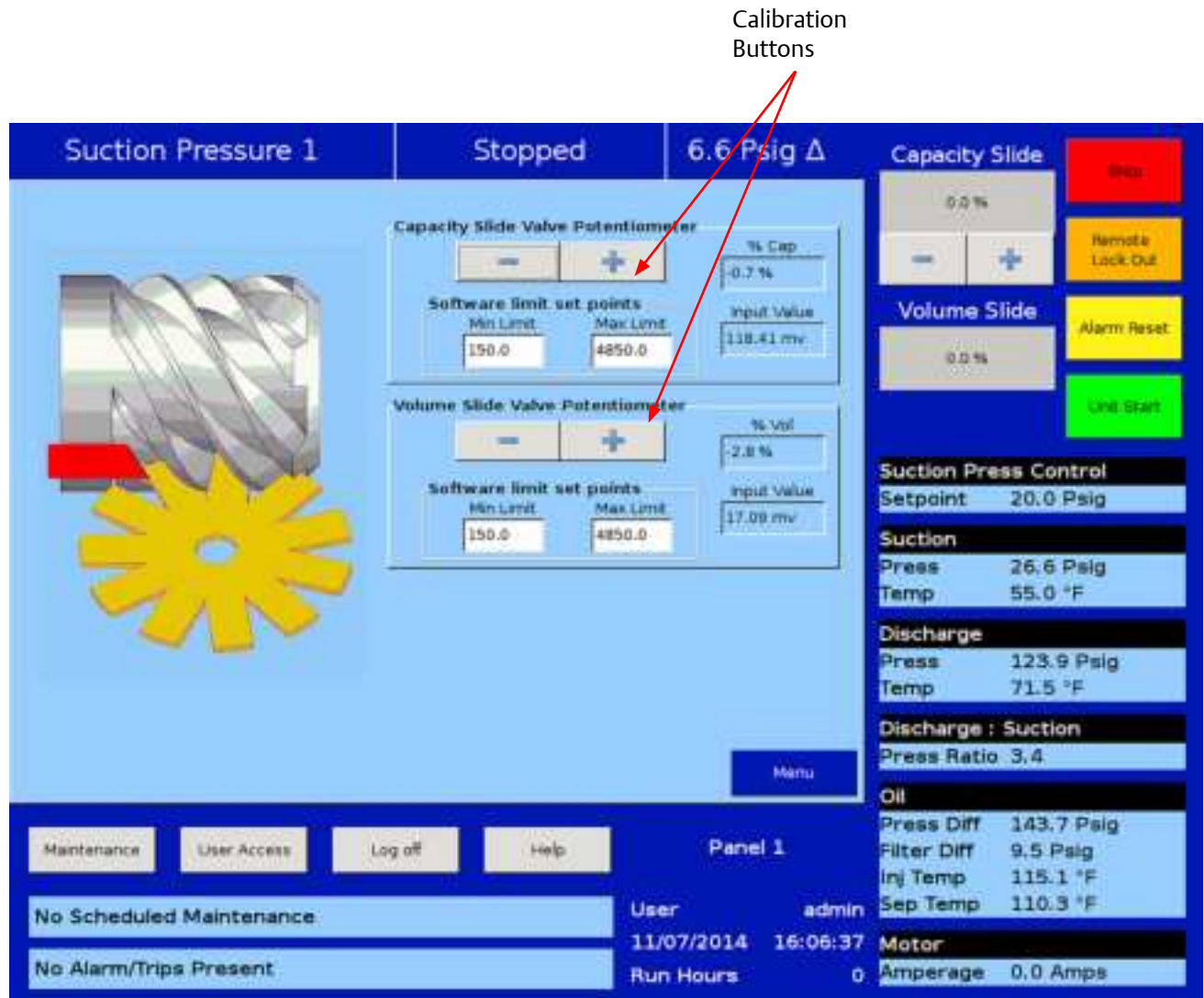


Figure 4-3. Slide Valve Calibration Screen (Vission 20/20)



Section 4 • Operation

5. On the main screen, press “Menu” then press the “Slide Calibration” button to enter the slide calibration screen, see Figure 4-4.
6. If the compressor unit is starting for the first time or a new actuator was installed, connect connectors of power cable and position transmitter cable to new actuator.



Figure 4-4. Menu Screen and Slide Calibration Button (Vission 20/20)

## Section 4 • Operation

### NOTE

If the “+” (increase) and “-” (decrease) buttons do not correspond to increase or decrease shaft rotation, swap the blue and brown wires of the “power cable” in the control panel. This will reverse the rotation of the actuator/command shaft, see Figure 4-5.

Capacity actuator wires are connected on terminals 13 & 14. Volume actuator wires are connected on terminals 15 & 16.

7. Press “+” or “-” to move the slide valve and check for the correct rotation, see Table 4-1.

### NOTE

When the actuator is in calibration mode, it outputs 0 V when the actuator is running and 5 V when it is still. Thus, as stated earlier, the actuator voltage will fluctuate during calibration. After the actuator has been calibrated, 0 V output will correspond to the minimum position and 5 V to the maximum position.

8. Quickly press and release the blue push button on the actuator one time. This places the actuator in calibration mode. The red LED will begin flashing rapidly.

## CAUTION

**DO NOT CONTINUE TO ENERGIZE THE ACTUATOR MOTOR AFTER THE SLIDE HAS REACHED THE MECHANICAL STOP.** Doing so may cause mechanical damage to the motor or shear the motor shaft key. When the slide has reached the mechanical stop position, press the button in the center of the photo-chopper to release the brake, and thereby release the tension on the actuator motor.

### NOTE

The “Slide Calibration” screen on the Control Panel has a “Current” window, which displays the actuator output voltage. These values, (the % volume and the % capacity) displayed in the window are meaningless until calibration has been completed.

9. Use the “-” button on the Control panel to drive the slide valve to its minimum “mechanical stop” position. Release the “-” button when the slowing of the motor rotation and a winding sound from the actuator motor is noted.

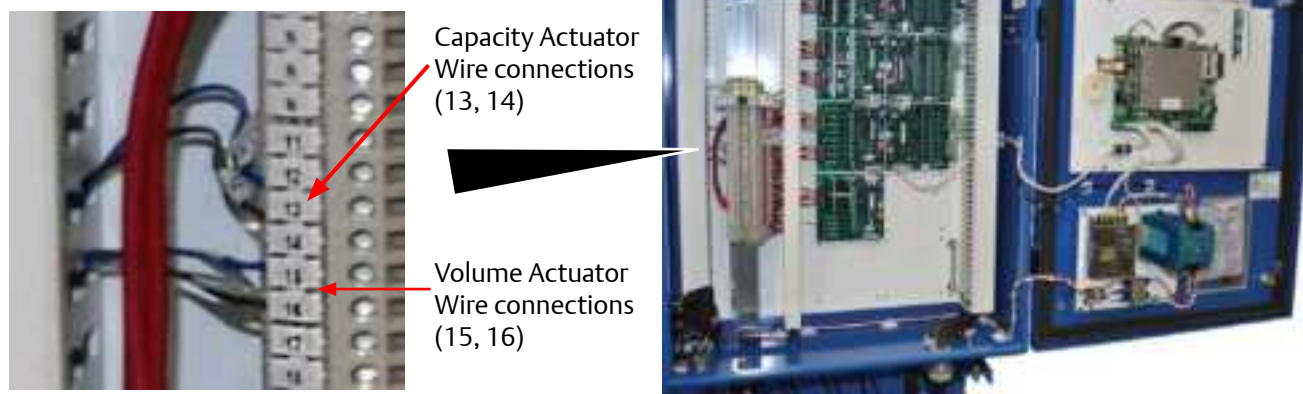


Figure 4-5. Wire Connections for Capacity and Volume Actuators

## Section 4 • Operation

**Table 4-1. Command Shaft Rotation Specifications\***

Compressor Model	Command Shaft Rotation				No. of Turns/Rotation			Angle/Slide Travel		
	Capacity		Volume		Capacity			Volume		
	INC	DEC	INC	DEC	Turns	Degrees	Travel	Turns	Degrees	Travel
VSM 71 VSM 91 VSM 101 VSM 151 VSM 181 VSM 201 VSM 301 VSM 361 VSM 401	CW	CCW	CW	CCW	0.80	288	3.141"	0.45	162	1.767"
VSM 501 VSM 601 VSM 701	CCW	CW	CCW	CW	0.91	328	3.568"	0.52	187	2.045"
VSS/VSSH 291 VSS/VSSH 341 VSS/VSSH 451 VSS/VSSH 601	CW	CCW	CW	CCW	0.91	328	3.568"	0.52	187	2.045"
VSS 751 VSS 901	CCW	CW	CCW	CW	1.09	392	4.283"	0.63	227	2.473"
VSS/VSH 791 VSS/VSH 891 VSS/VSH 1051 VSS/VSH 1201 VSS/VSH 1301	CCW	CW	CCW	CW	1.22	439	4.777"	0.74	266	2.889"
VSS 1501	CCW	CW	CCW	CW	1.36	490	5.325"	0.82	295	3.200"
VSS 1551	CCW	CW	CCW	CW	1.48	533	5.823"	0.87	313	3.433"
VSS 1801	CCW	CW	CCW	CW	1.36	490	5.325"	0.82	295	3.200"
VSS 1851 VSS 2101	CCW	CW	CCW	CW	1.48	533	5.823"	0.87	313	3.433"
VSS 2401 VSS 2601 VSS 2801 VSS 3001	CCW	CW	CCW	CW	1.80	648	7.072"	1.36	490	5.341"

\*The large gear on the command shaft has 50 teeth. The teeth are counted when moving the command shaft from the minimum stop position to the maximum stop position.

The manual operating shaft on the gear motor should be turned the opposite direction of the desired command shaft rotation.

The capacity and volume control motors are equipped with a brake, if it is necessary to operate the control motors manually, the brake must be disengaged. The brake can be disengaged by pushing on the motor shaft on the cone end. The shaft should be centered in its travel. Do not use excessive force manually operating the motor or damage may result.



## Section 4 • Operation

10. Press and hold down on the photo-chopper shaft to disengage the brake slowly, releasing tension from the motor mount, see Figure 4-6. Use the “+” button to pulse the actuator to where the slide is just off of the mechanical stop and there is no tension on the motor shaft.
11. Quickly press and release the blue button on the actuator again. The red LED will now flash at a slower rate, indication that the minimum slide valve position (zero position) has been set.
12. Use the “+” button on the Control panel to drive the slide to its maximum “mechanical stop” position. Release the “+” button when the slowing of the motor rotation and a winding sound from the actuator motor is noted.

### NOTE

If the photo-chopper spins faster than 4800 rpm, the actuator will go into an over speed fault and recalibration will be required.

13. Press and hold down on the photo-chopper shaft to disengage the brake slowly, releasing tension from the motor mount. Use the “-” button to pulse the actuator to where the slide is just off of its mechanical stop and there is no tension on the motor shaft.

### NOTE

After the blue button is pressed for the third time, an mV reading will be displayed in the Current field. Make sure the mV value is at least 150 to 200 mV higher than the max setpoint on the screen.

14. Quickly press and release the blue button on the actuator one more time. The red LED will stop flashing. The actuator is now calibrated and knows the minimum and maximum positions of the slide valve it controls.

Now the Capacity Channel is automatically calibrated based on the calibration settings made to the actuator.

## CAUTION

**Do not over tighten screws. Failure to comply may result in damage to equipment.**

15. Gently lower the plastic cover over the top of the actuator to where it contacts the base and O-ring seal. After making sure the cover is seated properly, gently tighten the four #10 screws.
16. Repeat procedure to calibrate other slide valve actuator.



**Figure 4-6. Photo-chopper**

*Press down on Photo-chopper to release tension from motor mount.*

## Section 4 • Operation

### Calibrate Slide Valve Actuators (For Units Using Compact Logix PLC)

Slide valve actuators must be installed prior to calibration. Refer to Slide Valve Actuator Installation procedure. The following steps pertain to calibrating one slide valve actuator. Repeat procedure to calibrate other slide valve actuator.

#### WARNING

After stopping the compressor, allow the compressor and surrounding components to cool down prior to servicing. Failure to comply may result in serious injury.

#### CAUTION

Do not calibrate in direct sunlight. Failure to comply may result in damage to equipment.

Both the capacity and volume slide actuators should be calibrated when one or more of these have occurred:

- Compressor unit starting up for the first time.
  - A new actuator motor has been installed.
  - There is an error code flashing on the actuator's circuit board - an attempt to recalibrate should be made.
- The range of travel is not correct and the command shaft travel is physically correct.
  - The compressor is pulling high amperage, the calibration of the volume slide should be checked.
  - An actuator does not unload below 5%, or an actuator that doesn't move.
  - Something is not working properly such as the actuators, RTDs or transducers.

To calibrate optical actuators, continue with the following steps:

#### NOTE

If the compressor unit is starting up for the first time or a new actuator motor has been installed, leave the power cable and position transmitter cable disconnected until step 7.

1. Stop compressor unit and allow to cool.
2. Remove screws securing actuator cover to actuator assembly. As a reference see Figure 4-7.

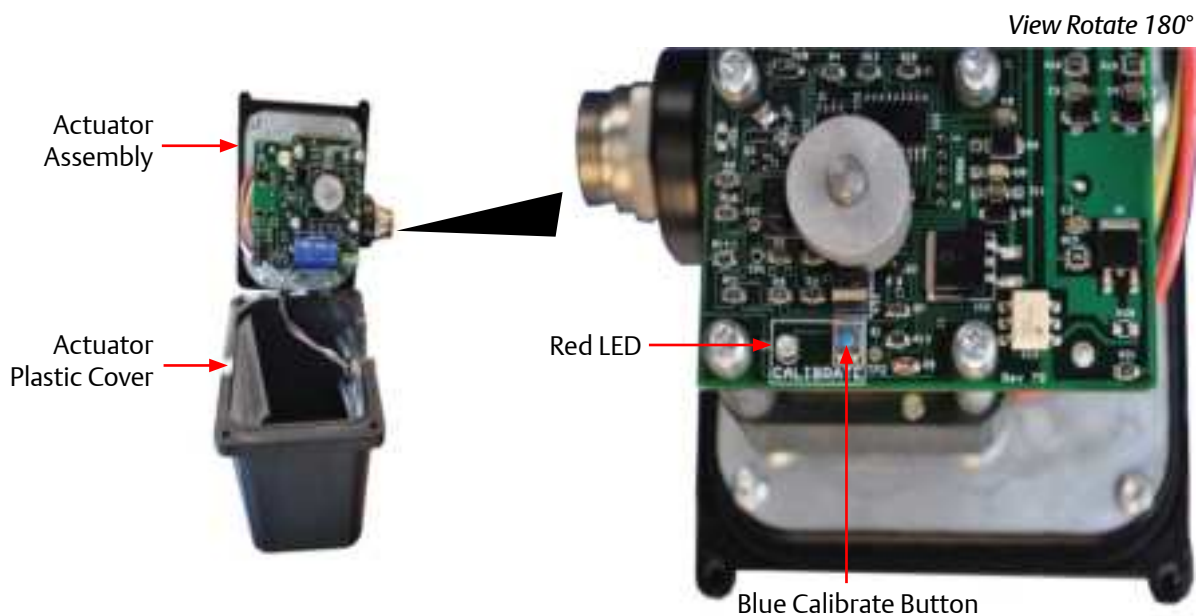


Figure 4-7. Actuator Assembly

### CAUTION

Wires are attached to the connector on the actuator cover. Handle actuator cover with care to prevent damage to wires. Failure to comply may result in damage to equipment.

3. Carefully lift actuator cover from actuator assembly and tilt towards Turck connectors. Raise cover high enough to be able to press the blue calibration button and be able to see the red LED on the top of assembly.
4. On the main screen of the PLC, press “Menu”, then “Instrument Calibration” button to enter the instrument calibration overview screen, then press “Calibrate Slides” button to enter the slide calibration screen, see Figure 4-8.
5. Logging on with high-level access will prompt the “Enter Slide Calibration Mode” button to appear.
6. Press “Enter Slide Calibration Mode” button to initiate calibration mode. The Slide Calibration button turns green and Set Max and Set Min buttons appear, see Figure 4-9.
7. If the compressor unit is starting for the first time or a new actuator was installed, connect connectors of power cable and position transmitter cable to new actuator.

#### NOTE

If the UP (increase) and DOWN (decrease) buttons do not correspond to increase (INC) or decrease (DEC) shaft rotation, swap the blue and brown wires of the “power cable” in the control panel. This will reverse the rotation of the actuator/command shaft.

8. Press UP or DOWN to move the slide valve and check for the correct rotation, see Table 4-1.

#### NOTE

When the actuator is in calibration mode, it outputs 0V when the actuator is running and 5V when it is still. Thus, as stated earlier, the actuator voltage will fluctuate during calibration. After the actuator has been calibrated, 0V output will correspond to the minimum position and 5V to the maximum position.

9. Quickly press and release the blue push button on the actuator one time. This places the actuator in calibration mode. The red LED will begin flashing rapidly.

### CAUTION

DO NOT CONTINUE TO ENERGIZE THE ACTUATOR MOTOR AFTER THE SLIDE HAS REACHED THE MECHANICAL STOP. Doing so may cause mechanical damage to the motor or shear the motor shaft key. When the slide has reached the mechanical stop position, press the button in the center of the photo-chopper to release the brake, and thereby release the tension on the actuator motor.

#### NOTE

The “Slide calibration” screen on the Control Panel has a “Current” window, which displays twice the actuator output voltage. This value, (the % volume and the % capacity) displayed in the “Current Vol” and Current Cap” Windows are meaningless until calibration has been completed.

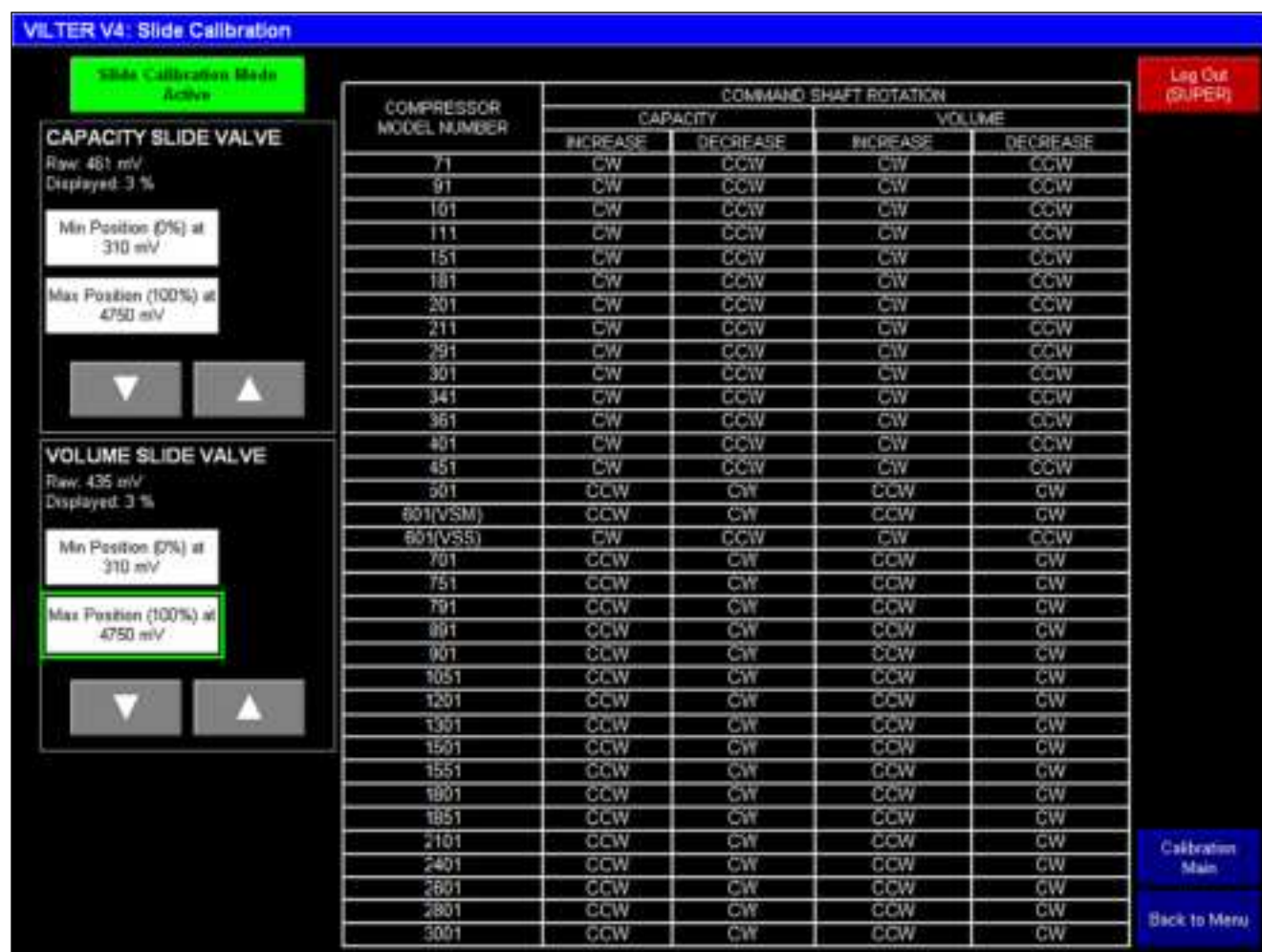
10. Use the DOWN button on the Control panel to drive the slide valve to its minimum “mechanical stop” position. Release the DOWN button when the slowing of the motor rotation and a winding sound from the actuator motor is noted.
11. Press down on the photo-chopper shaft to disengage the brake, releasing tension from the motor mount, see Figure 4-10. Use the UP button to pulse the actuator to where the slide is just off of the mechanical stop and there is no tension on the motor shaft.
12. Quickly press and release the blue button on the actuator again. The red LED will now flash at a slower rate, indication that the minimum slide valve position (zero position) has been set.
13. Use the UP button on the Control panel to drive the slide to its maximum “mechanical stop” position. Release the UP button when the slowing of the motor rotation and a winding sound from the actuator motor is noted.
14. Press down on the photo-chopper shaft to disengage the brake, releasing tension from the motor mount. Use the DOWN button to pulse the actuator to where the slide is just off of its mechanical stop and there is no tension on the motor shaft.
15. Quickly press and release the blue button on the actuator one more time. The red LED will stop flashing. The actuator is now calibrated and knows the minimum and maximum positions of the slide valve it controls. Now the capacity or volume channel of the PLC can be calibrated.



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4 – 12 VSS/VSR/VSM/VSH/VSSH Compressor • Installation, Operation and Service Manual • Emerson • 35391S





**Figure 4-9. Slide Calibration Screen (Compact Logix PLC)**

*Screen colors inverted for ease of reading.*



**Figure 4-10. Photo-chopper**

*Press down on Photo-chopper to release tension from motor shaft.*

## Section 4 • Operation

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16. Use the DOWN button to move the actuator towards its minimum position while watching the mV readout on the Control Panel screen. Discontinue pressing the DOWN button when the mV reading the “Current” window above the “Set Min” button is approximately 500 mV.
17. Now use the DOWN or UP buttons to position the slide valve until a value close to 300 mV is on the screen. Then, press the “Set Min” button in the capacity or volume slide valve window to tell the controller that this is the minimum mV position. Note: The value in the “Current Cap” or “Current Vol” window has no meaning right now.
18. Use the UP button to rotate the actuator towards its maximum position while watching the mV readout on the controller screen. Discontinue pressing the UP button when the mV reading in the “Current” window is approximately 4800 mV. You are nearing the mechanical stop position.
19. Pulse the UP button to carefully move the slide valve until the mV readout “saturates”, or stops increasing. This is around 4800 mV Record mV maximum reading.
20. Pulse the DOWN button until the mV just start to decrease. (This is the point where the channel drops out of saturation). Adjust mV value to 300 mV below recorded maximum mV.
21. Press the “Set Max” button.
22. Press the “Main” button to complete calibration and exit the “Slide Calibration” screen. The controller will automatically energize the actuator and drive it back to its minimum position (below 5%) for pre-start-up.

### NOTE

Now the “Current Cap” or the “Current Vol” value will be displayed in the window on the “Main” screen and the “Slide Calibration” screen.

23. Gently lower the plastic cover over the top of the actuator to where it contacts the base and O-ring seal.

### CAUTION

**Do not over tighten screws. Failure to comply may result in damage to equipment.**

24. Check and make sure the cover is seated properly, then gently tighten the four #10 screws.
25. Enable the “Slide Non-Movement Alarm” by going to the “Setup” menu and choosing “Alarm Enable” for the “Slide Non-Movement Option”.
26. Repeat procedure to calibrate other slide valve actuator.

## Compressor Control with Vission20/20™ Micro-controller (No Slide Operation)

The Vission20/20™ panel can provide control for a single screw compressor without slides as long as Analog Output Board #10 is present and selected in the Configuration screen, see Figure 4-11.

The “No Slide” operation will become active once the correct type of compressor and model has been chosen, see Figure 4-12.

The user must select either VSG/VSH or VSM from the Compressor combo box in page 2 of the Configuration Menu, and then the Model from the next box.

The choice of this type of compressor will cause the refrigerant combo box to be grayed out.

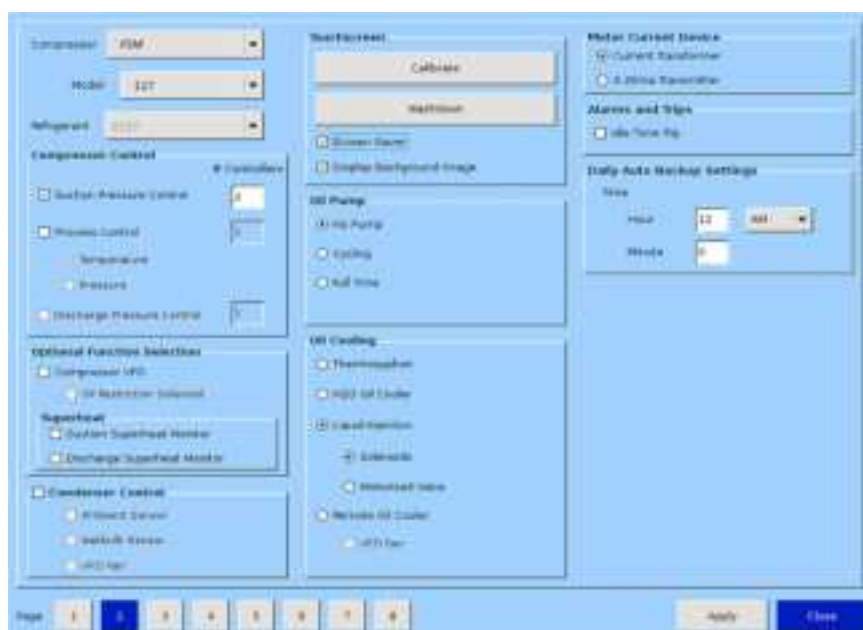
Once the compressor has been selected, the Vision 20/20™ panel touchscreen will show an indicator of VFD speed percentage, and buttons to increase and decrease it.

For more information on VFD capacity control, please check the Vision20/20™ manual (35391SC).

## WARNING

Software programming credentials shall only be made available by the supplier. The user will only have access to operational features established by the supplier. Failure to comply may result in serious injury or death.

**Figure 4-11. Vission 20/20 Configuration Screen - I/O Configuration (Page 8)**



**Figure 4-12. Compressor and Model Setup with Vission 20/20**

## Section 4 • Operation

### Suction Equalizing Line Setup - For VSS/VSM Compressors

The suction equalizing line allows system pressure to equalize to suction pressure during shutdown periods. The line is connected before the suction stop/check valve to after the suction strainer, see Figure 4-13.

#### NOTE

Valve adjustment depends on size of oil separator and how quickly system pressure should equalize to suction pressure. The larger the oil separator the longer system pressure will take to equalize to suction pressure.

1. To open valve, turn counterclockwise. To close valve, turn clockwise.
2. Fully close valve to a stop.
3. Turn valve to fully open position while counting number of turns to fully open. Note total number of turns.
4. Adjust valve to be half open. Close valve to half of the number of total turns.
5. If suction pressure needs to equalize slower, turn valve towards closed position.
6. If suction pressure needs to equalize faster, turn valve towards open position.

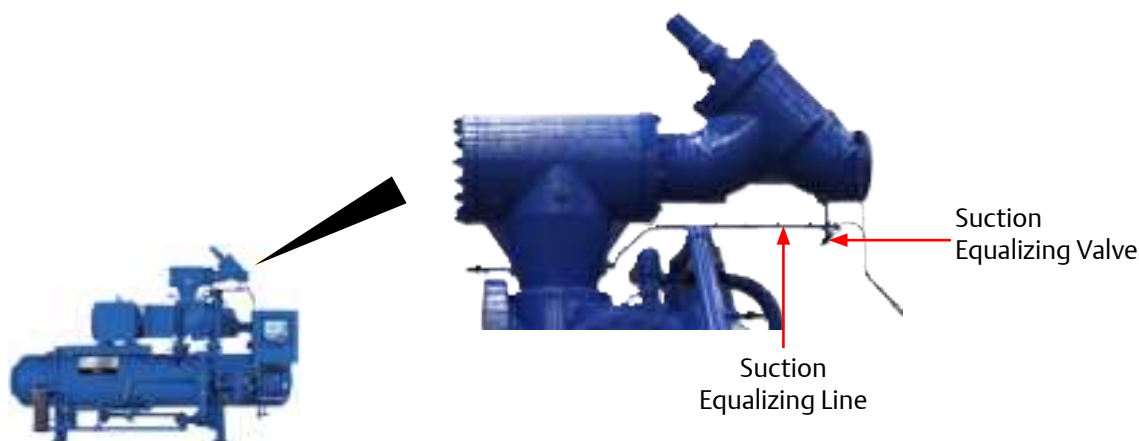


Figure 4-13. Suction Equalizing Line and Valve

#### NOTE

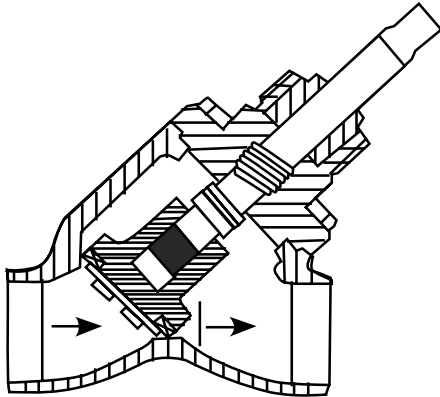
For VSH/VSSH compressors, suction equalizing is automatically controlled.



### Stop/Check Valve Operation<sup>1</sup>

Table 4-2. Stop/Check Valve Open Positions

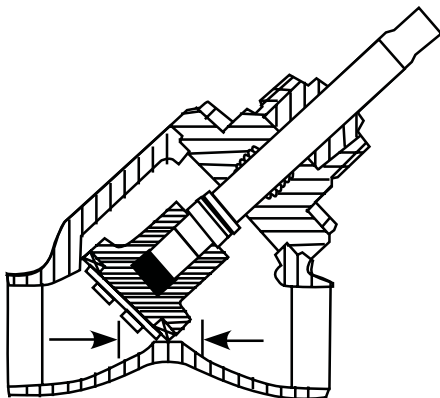
Valve Size	1.5"	2"	2.5"	3"	4"	5"	6"	8"
Number of Turns Open (From Closed Position)	2	2.25	2.75	3.25	4.5	3.75	5.75	7.75



#### Auto:

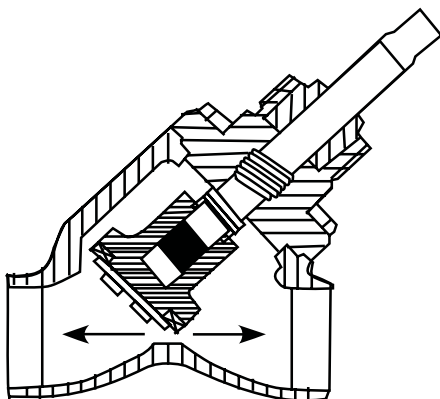
In the "Auto Position", the stop valve is operating as a check valve, allowing flow in the directions of the arrows.

To set the valve to the automatic position, fully close the valve, and turn the stem out as indicated by the chart below.



#### Closed:

In the manually "Closed Position", the stop check is operating as a conventional stop valve, not allowing flow in either direction.



#### Open:

In the manually "Open Position", with the valve stem fully back seated, the valve disc is lifted slightly, allowing flow in either direction.

<sup>1</sup> Doesn't apply to: VSM-97, VSM-113, VSM-127



### Maintenance and Service Schedule - For VSS/VSM Unit Only

Follow this table for maintaining and servicing the compressor unit at hourly intervals.

Table 5-1. Maintenance/Service Schedule - For VSS/VSM Unit Only

Group	Inspection/ Maintenance	Service Interval (Hours)													
		200	5,000	10,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000	110,000	120,000
Oil Circuit	Oil Change <sup>(1)</sup>	-	R	-	R	-	R	-	R	-	R	-	R	-	R
	Oil Analysis <sup>(2)</sup>	-	S	S	S	S	S	S	S	S	S	S	S	S	S
	Oil Filters <sup>(3)</sup>	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	Oil Strainers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Compressor Unit	Coalescing Filter	-	-	-	-	R	-	-	R	-	-	R	-	-	R
	Coalescing Drain Line	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Suction Screen	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Liquid Line Strainers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Coupling Alignment and Integrity	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Motor (Compressor)	See Motor Manual for proper lubrication procedures and service intervals.													
Control Calibration	Transducers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	RTDs/ TTs	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Slide Valve Motors	Slide valve calibration should be inspected monthly. Inspections can be performed through the control panel. If a Non-Movement Alarm appears, calibrate immediately.													
Compressor	Compressor w Slides <sup>(4)</sup>	-	I	-	I	-	I	-	I	-	I	-	I	-	I
	Compressor w/o Slides <sup>(5)</sup>	-	-	I	I	I	I	I	I	I	I	I	I	I	I
	Inspect for Back Spin	Inspect Every 5,000 Hours or As Needed													
	Inspect for Leak	Check Monthly													
	Bearings	-	-	-	-	-	-	-	-	-	-	-	-	-	I

I = Inspect    S = Sampling    R = Replace

(1) The oil should be changed at these intervals, unless oil analysis results exceed the allowable limits. The frequency of changes will depend on the system cleanliness.

(2) Oil analysis should be done at these intervals as a minimum; the frequency of analysis will depend on system cleanliness.

(3) The oil filter(s) on a minimum must be changed at these intervals or annually if not run continuously. However, the oil filter(s) must be changed if the oil filter differential exceeds 12 psi or oil analysis requires it.

(4) Inspection includes - Gaterotor Inspection (backlash measurement, shelf clearance and gaterotor float), End Play Measurement (main rotor & gaterotor), Slide Valve Inspection (if applicable).

(5) For compressors with no slides (VSM-97, VSM-113, VSM-127)

# Maintenance and Service Schedule - For VSH/VSSH Unit Only

Follow this table for maintaining and servicing the heat pump at hourly intervals.

Table 5-2a. Maintenance/Service Schedule (For VSH/VSSH Unit Only)

Group	Inspection/ Maintenance	Service Interval (Hours)													
		200	5,000	10,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000	110,000	120,000
Oil Circuit	Oil Change <sup>(1)</sup>	-	R	-	R	-	R	-	R	-	R	-	R	-	R
	Oil Analysis <sup>(2)</sup>	-	S	S	S	S	S	S	S	S	S	S	S	S	S
	Oil Filters <sup>(3)</sup>	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	Oil Strainers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Compressor Unit	Coalescing Filter	-	-	-	-	R	-	-	R	-	-	R	-	-	R
	Coalescing Drain Line	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Suction Screen	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Liquid Line Strainers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Coupling Alignment and Integrity	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Motor (Compressor)	See Motor Manual for proper lubrication procedures and service intervals.													
Control Calibration	Transducers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	RTDs/ TTs	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Slide Valve Motors	Slide valve calibration should be inspected monthly. Inspections can be performed through the control panel. If a Non-Movement Alarm appears, calibrate immediately.													
Compressor	Compressor	See Table 5-2b for Service Schedule Timeline details													
	Inspect for Back Spin	Inspect Every 5,000 Hours or As Needed													
	Inspect for Leak	Check Monthly													

I = Inspect      S = Sampling      R = Replace

(1) The oil should be changed at these intervals, unless oil analysis results exceed the allowable limits. The frequency of changes will depend on the system cleanliness.

(2) Oil analysis should be done at these intervals as a minimum; the frequency of analysis will depend on system cleanliness.

(3) The oil filter(s) on a minimum must be changed at these intervals or annually if not run continuously. However, the oil filter(s) must be changed if the oil filter differential exceeds 12 psi or oil analysis requires it.

Table 5-2b. Maintenance/Service Schedule (For VSH/VSSH Compressor Only)

Discharge Pressure (PSIG)	Differential Pressure (PSIG)	Service Interval (Hours)																				
		5,000	7500	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	100,000
300 <sup>(1)</sup> - 800	200- 300	-	-	-	I	-	-	-	I	-	-	-	I	-	-	I	-	-	I	-	-	R
	300 - 400	-	I	-	I	-	I	-	R	-	I	-	I	-	I	-	I	-	I	R	I	-
	400- 500	I	-	I	-	I	-	R	-	I	-	I	-	R	-	I	-	I	-	R	-	I
	500- 600	I	-	I	-	I	R	I	-	I	-	R	-	I	-	I	R	I	-	I	-	R
I = Inspect*      R = Replace Bearings & Inspect per Chart																						

**Notes:** \*: Inspection includes - Gaterotor Inspection (backlash measurement, shelf clearance and gaterotor float), End Play Measurement (main rotor & gaterotor), Slide Valve Inspection (if applicable).

(1): For Discharge pressure under 300 PSIG, please use Table 5-1a for maintenance and service schedule.

#### NOTE

Upon Inspection, if any component shows wear beyond what is allowed in the Service section of this document, the component(s) must be replaced.

## Section 5 • Maintenance/Service

### Preventive Maintenance, Checks and Services

Careful checking of a refrigeration system for leaks and proper operation of all components upon installation will start the system on its way to a long life of satisfactory service. To ensure the desired trouble-free operation, however, a systematic maintenance program is a prerequisite. The following PMCS is suggested in addition to the Maintenance/Service Schedule.

#### NOTE

After any maintenance work, the workplace should be cleaned and free from any hazards.

#### Daily

1. Check oil levels.
2. Check all pressure and temperature readings.
3. Check micronic oil filter inlet and outlet pressures for excessive pressure drop. Change filter when pressure drop exceeds 45 psi or every six months, whichever occurs first. For proper procedure for changing micronic oil filter and for charging oil into the system, see Operation Section.
4. Clean strainers each time filter cartridge is replaced.
5. Check compressor sound for abnormal noises.
6. Check shaft seals for excessive oil leakage. A small amount of oil leakage (approximately 6 to 15 drops per hour) is normal. This allows lubrication of the seal faces.

#### Weekly

*(Items 1 thru 6 above plus 7 thru 9)*

7. Check the refrigeration system for leaks with a suitable leak detector.
8. Check oil pressures and review microprocessor log and log sheets.
9. Check refrigerant levels in vessels.

#### Monthly

*(Items 1 thru 8 above plus 9 thru 13)*

10. Oil all motors and bearings. Follow manufacturer's instructions on lubrication.
11. Check calibration and operation of all controls, particularly safety controls.
12. Check oil cooler for any evidence of corrosion, scaling or other fouling.

13. Operate compressor capacity and volume ratio controls through their range both automatically and manually.

#### Trimonthly

*(Approximately 2000 operating hours)*

- A. Check movement of compressor rotor at drive coupling end to determine bearing float, see Compressor Shaft Bearing Float Inspections.

#### Annually

*(Items 1 thru 13 and "A" above plus 14 thru 31)*

14. Check entire system thoroughly for leaks.
15. Remove all rust from equipment, clean and paint.
16. Grease valve stems and threads for the valve caps.
17. Flush out sediment, etc. from water circuits.
18. Clean all oil strainers.
19. Clean suction strainer – compressors.
20. Check motors and fans for shaft wear and end play.
21. Check operation and general condition of microprocessor and other electrical controls.
  - Check fuses in the Vision20/20 or PLC panel.
  - Check for loose wiring connections in the Vision 20/20 or PLC panel.
  - Check relay and contact operation for relays in the Vision20/20 or PLC panel.
  - Verify set points in the Vision20/20 or PLC.
22. Clean all water strainers.
23. Check drains to make sure water will flow away from equipment.
24. Drain and clean entire oil system at receiver drain. Recharge with new clean moisture free oil. For proper procedure for changing micronic oil filter and charging oil into the system, see Start-Up and Operation section.
25. Check compressor coupling. For integrity and alignment.
26. Check oil pump for wear.
27. Check the calibration of the microprocessor pressure transducers and RTD's for accuracy.
28. Check mounting bolts for compressor and motor.
29. Verify the operation of the suction and discharge check valves.
30. Check setup of soft starts and VFDs.
31. Check oil heater operation.

### Compressor Unit Isolation For Maintenance/Service (Compressors with Slide Valves)

#### WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

#### WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

#### WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

#### WARNING

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

#### NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

The compressor unit must be isolated and depressurized to atmosphere prior to servicing.

1. Shut down the compressor unit, refer to Stopping/Restarting procedure in Section 4.
2. Turn motor and oil pump starter disconnect switches into the OFF position. Lock-out/tag-out disconnect switches.
3. If suction equalizing valve is not open, open it to allow oil separator pressure to vent to low-side system pressure, see Figure 5-1. Close valve when complete.
4. Isolate the compressor unit by closing all valves to the house system. Lock-out/tag-out valves.

#### NOTE

If drain valves are installed on suction and discharge headers, open these valves too to remove build up of liquid during shut-down periods.

5. Open any other valves that may trap gas or liquid. Lock-out/tag-out valves.
6. Recover and/or transfer all vapors per local/state codes and policies.
7. Servicing the compressor unit can proceed at this point. After servicing, ensure to perform a leak check, see Compressor Unit Leak Check procedure.

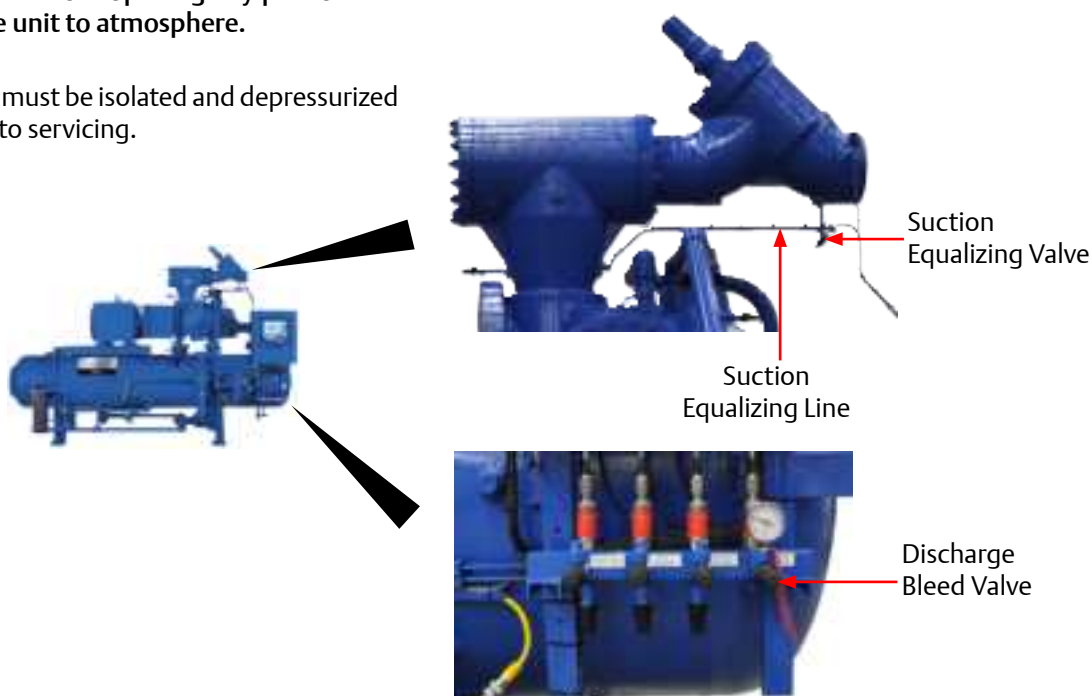


Figure 5-1. Discharge Bleed Valve, Suction Equalizing Line and Valve

### Recommendations when Servicing (Compressors Without Slide Valves)

When working on the compressor, care must be taken to ensure that contaminants (i.e. water from melting ice, dirt and dust) do not enter the compressor while it is being serviced. It is essential that all dust, oil or ice that has accumulated on the outside of the compressor be removed before servicing the compressor.

After servicing the compressor, all gaskets, O-rings, roll pins and lock washers must be replaced when reassembling the compressor.

### Preparation of Unit For Servicing

#### **WARNING**

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

- A) Shut down the unit, open the electrical disconnect switch and pull the fuses for the compressor motor to prevent the unit from starting. Put a lock on the disconnect switch and tag the switch to indicate that maintenance is being performed.

#### **WARNING**

Be cautious when isolating sections of CO<sub>2</sub> piping. CO<sub>2</sub> has a very steep pressure curve, and as sections containing CO<sub>2</sub> warm up, pressures can rise dramatically & well beyond system design.

#### **WARNING**

When working with LFG, NG or other dangerous or flammable gases, ensure there are adequate ventilation and vapor detectors. Refer to national fire and building codes. Failure to comply may result in serious injury or death.

#### **WARNING**

Avoid skin contact with any condensate or oil. Wear rubber gloves and a face shield when working with condensate or oil. Failure to comply may result in serious injury or death.

- B) Isolate the unit by manually closing the discharge Stop valve. Allow the unit to equalize to suction pressure before closing the Suction Bypass. After the unit has equalized to suction pressure and suction valve closed, use an acceptable means to depressurize the unit that complies with all Local, State and Federal Ordinances.

#### **WARNING**

**At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.**

#### **NOTICE**

**Recover or transfer all gas vapor in accordance with local ordinances before opening the compressor unit to the atmosphere.**

- C) Remove drain plugs from the bottom of compressor housing and the discharge manifold. Drain the oil into appropriate containers.



### Compressor Unit Leak Check After Servicing

The compressor unit must be checked for leaks after servicing to ensure a tight system. For additional leak testing information, refer to Chapter VI of ASME B31.3 Process Piping Code.

#### CAUTION

Do not hydro test compressor unit. Failure to comply may result in damage to equipment.

1. If servicing the compressor unit was completed, proceed to step 2. Otherwise, isolate the compressor unit from the house system, see Compressor Unit Isolation procedure.
2. Open all shut-off valves, check valves, control valves and solenoid valves in the system to be tested.
3. Slowly pressurize compressor unit through suction oil charging port with dry nitrogen.
4. Using appropriate soap solution, check for leaks on joints and connections of the serviced component.
5. If leaks are found, depressurize system and fix leaks. Repeat steps 3 and 4 until all leaks are fixed.
6. Evacuate from suction oil charging port.
7. Close all valves previously opened in the system. Remove tags as per the local lock-out/tag-out procedure.
8. Turn the motor and oil pump disconnect switches to the ON position.
9. Return compressor unit to service. Oil System Components

### Oil Sampling

#### WARNING

When working with LFG, NG or other dangerous or flammable gases, ensure there are adequate ventilation and vapor detectors. Refer to national fire and building codes. Failure to comply may result in serious injury or death.

#### WARNING

Improper selection or application of fluid diagnostic products can cause serious injury or damage. The user is solely responsible for making the final selection of products to ensure that the overall system performance and safety requirements are met. These include reviewing fluid compatibility with materials and seals.

#### WARNING

Avoid skin contact with any condensate or oil. Wear rubber gloves and a face shield when working with condensate or oil. Failure to comply may result in serious injury or death.

#### DANGER

Sampling often releases hot fluid under high velocity/pressure.

1. Hot fluid can cause severe burn injuries.
2. Skin penetration from high-pressure fluid can occur, causing severe injury, gangrene and/or death. If this happens, immediately contact an experienced medical practitioner.
3. Hot fluid escaping to the atmosphere can ignite if it comes into contact with an ignition source. This can lead to severe property damage.

### Recommendations

1. Make sure you're aware of the risks associated with the fluid being sampled or worked with. Check with the manufacturer.
2. If you have not been trained to sample, service, repair, or troubleshoot a pressurized fluid system, especially a hydraulic system, you are at risk of suffering an accident. Seek the proper training before proceeding.

## Section 5 • Maintenance/Service

### Installation of The Oil Sampler Valve

1. Lubricate the threads (1/4"-18 NPT) with Teflon tape.
2. Tighten to the max. torque 25 ft-lbs (34 N-m). Use 11/16" open wrench. Avoid over tightening.

### Pre-Sampling

Use the Vilter Oil Analysis Kit (VPN 3097A) to collect an oil sample for analysis, see Figure 5-2.

Once the sample has been taken, the label must be filled out and pasted on the bottle, and both must be placed inside the mailing tube and sealed with the pre-addressed mailing label.

Below are a few points to remember when taking a sample:

- Sample running compressor units, not cold units. Sample after minimum 30 minutes of compressor operating time.
- Sample after the oil filter.
- Sample according to the sampling procedure below.
- Ensure sampling valves and devices are thoroughly flushed prior to taking a sample.
- Ensure samples are taken as scheduled in the Maintenance and Service Schedule.
- Send samples to the oil analysis lab immediately after sampling, do not wait 24 hours.



Figure 5-2. Oil Analysis Kit (VPN 3097A)

### Sampling Procedure

THE SAMPLING PRESSURE RANGE IS LIMITED BETWEEN 5 TO 750 PSI (0.03 – 5.17 MPa). IF THE OPERATING PRESSURE IS ABOVE 750 PSI (5.17 MPa), THE OIL SAMPLING MUST BE DONE WHEN THE COMPRESSOR IS NOT RUNNING AND ENSURE THE SYSTEM PRESSURE IS WITHIN THE 5 TO 750 PSI (0.03 – 5.17 MPa) SAMPLING RANGE.

A 1/4" NPT oil sampling valve is provided either in the oil filter canister cover or in the piping after the filter (See Figure 5-3 or 5-4(a) according to application).

1. Unthread the oil sampling valve cap. For valve #3709A, you also need to turn the knurled locknut clockwise, see Figure 5-4 (b).

#### NOTE

DO NOT remove the valve from the piping or filter housing.

2. Remove the cap of the oil analysis bottle and position it carefully under the valve spout. (Make sure the valve spout is rotated to the downward position) **SLOWLY AND VERY CAREFULLY** press the "PUSH BUTTON" with your finger to open the valve, and release the button to close it, see Figure 5-5.

## WARNING

If the valve is opened too rapidly, a foamy pressurized jet of oil will gush out and splash outside the container.



Figure 5-3. Oil Sampler Valve (VPN #3708A) For Gas Compression Applications

(a) Oil Sampler Valve for Ammonia and Other Refrigerants Applications



(b) Valve shown ready for oil sampling



(c) Valve shown in lockout position



**Figure 5-4. Oil Sampling Valve (VPN #3709A) For Ammonia and Refrigerant Compressors**



**Figure 5-5. Operating the Oil Sampling Valve**

## Section 5 • Maintenance/Service

3. In most cases there will be foam in the oil, so you must fill the bottle up to the top and then wait for the foam to dissipate. Repeat this step as many times as necessary (around 4 to 6 times) until the clear oil level reaches  $\frac{3}{4}$  full, see sequence in Figure 5-6.
4. After all the foam dissipates, tighten the sample bottle cap.
5. Tighten the oil sampling valve cap.
6. For valve #3709A only: back seat the knurled lock-nut by turning it counter-clockwise. This is to prevent any accidental release, see Figure 5-4 (c).
7. Attach the filled sampling information label to the bottle and mail the sample out to the oil analysis lab immediately.

### NOTE

Missing information from the sampling label may result in longer turnaround time as the laboratory will need to request the info before the sample can be tested.

## Oil Sample Analysis Report

### NOTE

A copy of the oil analysis report is also sent to Vilter. See Appendices for a sample of the oil analysis report.

An oil analysis report will show the physical properties of the oil, such as:

- Water content
- Viscosity
- Acid number
- Particle count
- Antioxidant level
- Wear metals
- Contaminating/additive metals



Figure 5-6. Stages of the Oil Sample Taking Process

### Compressor Replacement

Notify Vilter™ prior to performing a compressor replacement. See Warranty instructions in Section 7.

#### Removal

To replace a compressor on a unit, proceed with the following steps:

### NOTICE

Dispose of used oil in an appropriate manner following all Local, State and Federal laws and ordinances.

1. Shut down and isolate the compressor unit, see Compressor Unit Isolation for Maintenance and Service procedure.

#### NOTE

Note location of cables to aid in installation.

2. Disconnect all cables from sensors on compressor and actuators.
3. Remove coupling guard, see Coupling Guard Replacement procedure.
4. Remove drive coupling, see appropriate Drive Coupling Replacement procedure.
5. Remove center member, see Drive Coupling Removal procedure.

#### NOTE

Use appropriate supporting equipment to support and keep motor, C-flange and compressor leveled.

6. If equipped with C-flange, remove bolts securing C-flange to compressor.

7. Using appropriate drain pan, drain oil by removing drain plugs from under compressor housing and discharge manifold. Allow oil to completely drain.
8. Remove all oil lines from the compressor.
9. Support suction line with appropriate supporting equipment.
10. Remove nuts and bolts securing suction strainer/check valve assembly to suction stop valve and compressor.
11. Using appropriate lifting device, remove suction strainer/check valve assembly from compressor.
12. Remove nuts and bolts securing discharge pipe to compressor and oil separator, see Figure 5-7.
13. Remove discharge pipe and gaskets from compressor and oil separator.
14. Remove nuts, flat washers, lock washers and studs securing compressor to frame.
15. Remove any additional lines and/or components to allow removal of compressor as required.

#### NOTE

Refer to Bareshaft Compressor Lifting Points and Weights portion in Section 3 for appropriate lifting hole sizes, weights and lifting points.

16. Install appropriate lifting eyes on top of compressor. See Table 3-1, 3-2, and Figure 3-1 to 3-6.
17. Using appropriate lifting device and additional personnel, remove compressor from frame.

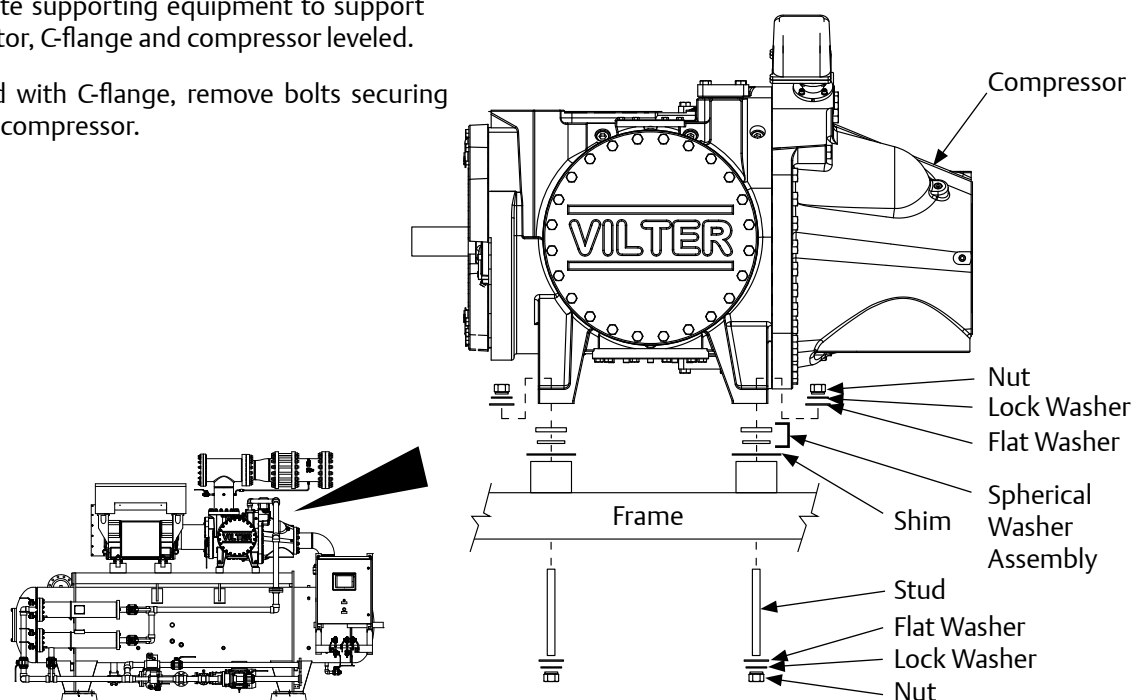


Figure 5-7. Compressor Replacement and Hardware Assembly (VSS 2401-3001 Shown)

## Section 5 • Maintenance/Service

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18. Remove shims and spherical washers from compressor mounting locations.
19. Inspect shims and spherical washers for damage, replace as required.

### Installation

20. Install shims and spherical washers on compressor mounting locations, see Figure 5-7.
21. Install appropriate lifting eyes on top of compressor. See Table 3-1, 3-2, and Figure 3-1 to 3-6

#### NOTE

Refer to Bareshaft Compressor Lifting Points and Weights portion in Section 3 for appropriate lifting hole sizes, weights and lifting points.

22. Using appropriate lifting device, position compressor on compressor mounting locations on frame.
23. Loosely install studs, lock washers, flat washers and nuts to secure compressor to frame until alignment is correct.
24. Check compressor for soft foot. Add or remove shims as required until measurements are within  $\pm 0.002$ ".
25. Tighten nuts to secure compressor to frame, refer to Appendix A.
26. If equipped with C-flange, install bolts to secure C-flange to compressor. Tighten bolts, see Appendix A.
27. Install drive coupling, see appropriate Drive Coupling Replacement procedure.
28. Install center member, see Drive Center Member Installation and Alignment procedure.
29. Install coupling guard, see Coupling Guard Replacement procedure.
30. Install nuts and bolts to secure discharge pipe to oil separator and compressor.
31. Tighten nuts on 'discharge pipe-to-compressor flange' first, then tighten nuts on 'discharge pipe-to-oil separator flange', see Appendix A.
32. Install nuts to secure suction strainer/check valve assembly to compressor and suction stop valve.
33. Tighten nuts on 'suction strainer/check valve assembly-to-compressor' first, then tighten nuts on 'suction strainer/check valve assembly-to-suction stop valve', refer to Appendix A.
34. Install all lines to compressor.
35. Install all cables to sensors on compressor and actuator.
36. Perform leak check, see Compressor Unit Leak Check procedure.

### Compressor Inspection

#### Compressor Shaft Bearing Clearance Inspections

If clearance measurements are out of tolerance, contact Vilter Technical Support for further assistance.

### CAUTION

When taking the measurements, do not exceed 300 to 500 lbs of force at point of contact or damage may result to the bearings.

#### Determine Maximum Applied Force

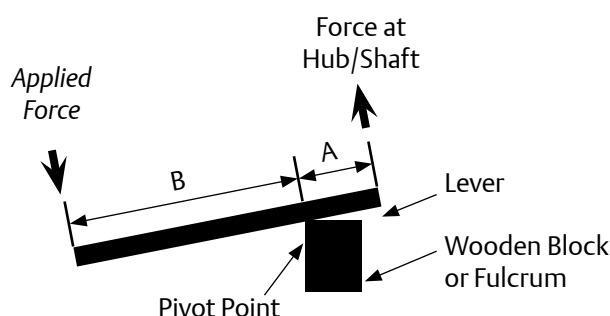
To determine maximum applied force, take maximum applied force at hub/shaft multiplied by length of A and divide by length B. This is the maximum force that should be applied on the lever.

$$(\text{Applied Force} \times A) / B = \text{Applied Force (Maximum)}$$

So, using a 36" (or 1 m) lever with pivot space of 6" (or 15 cm) would make the maximum applied force to be 60 lbf (or 235 N). Calculation is as follows:

$$(300 \text{ lbf} \times 6") / 30" = 60 \text{ lbf (Max. Applied Force)}$$

$$(1335 \text{ N} \times 15 \text{ cm}) / 85 \text{ cm} = 235 \text{ N (Max. Applied Force)}$$

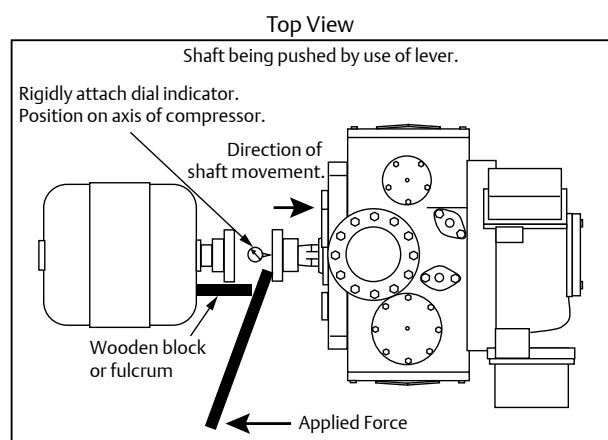
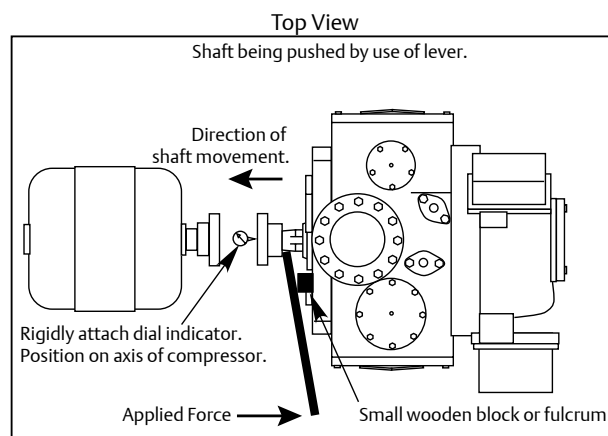


As a quick reference, Table 5-3 shows maximum applied forces for 36" lever with 6" pivot for all compressor models.

#### Main Rotor Bearing Axial Clearance Inspection

To inspect bearing axial clearance, proceed with the following steps:

1. Remove center member, see appropriate Drive Coupling Replacement procedure.
2. Install dial indicator to the compressor frame and zero indicator, see Figure 5-8.
3. Place lever arm and fulcrum behind compressor coupling half and push the coupling towards the motor. Record measurement.
4. Re-zero indicator, now position the fulcrum on the motor and use the lever arm to push the input shaft towards the compressor. Record measurement.
5. Add both measurements. If measurement is out of allowable tolerance shown in Table 5-3, the bearing may need to be replaced. Contact Vilter™ Technical Support.



**Figure 5-8. Bearing Axial Clearance Inspection**

## Section 5 • Maintenance/Service

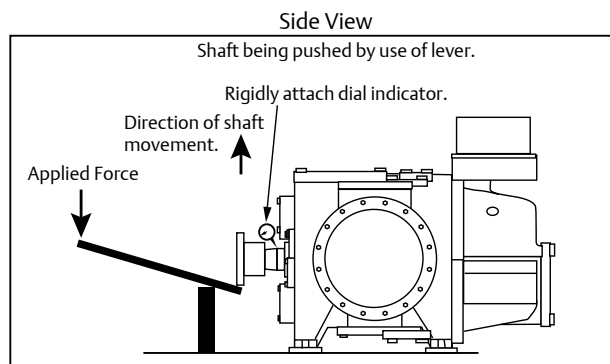
### Main Rotor Bearing Radial Clearance Inspection

6. Install dial indicator to the compressor frame and zero indicator, see Figure 5-9.

#### NOTE

Do not exceed maximum applied force. For maximum applied forces of all compressor models, see Table 5-3.

7. Place lever arm and fulcrum underneath hub and push hub upwards. Record measurement.
8. If measurement is out of allowable tolerance shown in Table 5-3, the bearing may need to be replaced. Contact Vilter™ Technical Support.



**Figure 5-9. Bearing Radial Clearance Inspection**

**Table 5-3. Maximum Main Rotor Bearing Clearance**

Compressor Model	Max. Axial Clearance in. (mm)	Max. Radial Clearance in. (mm)	Max. Force at Hub/Shaft lbf (N)	Max. Applied Force (36" Lever, 6" Pivot) lbf (N)
97-127	0.002 (0.051)	0.004 (0.102)	100 (444)	20 (89)
151, 181, 201, 152, 182, 202, 301, 361, 401		0.006 (0.152)	100 (444)	20 (89)
501, 601, 701		0.007 (0.178)	150 (667)	30 (133)
291, 341, 451, 601		0.007 (0.178)	150 (667)	30 (133)
751, 901		0.006 (0.152)	200 (890)	40 (178)
791, 891, 1051, 1201, 1301		0.006 (0.152)	300 (1335)	60 (267)
1501, 1551, 1801, 1851, 2101		0.007 (0.178)	400 (1780)	80 (356)
2401, 2601, 2801, 3001		0.006 (0.152)	600 (2670)	120 (534)



### Gaterotor Bearing Inspection

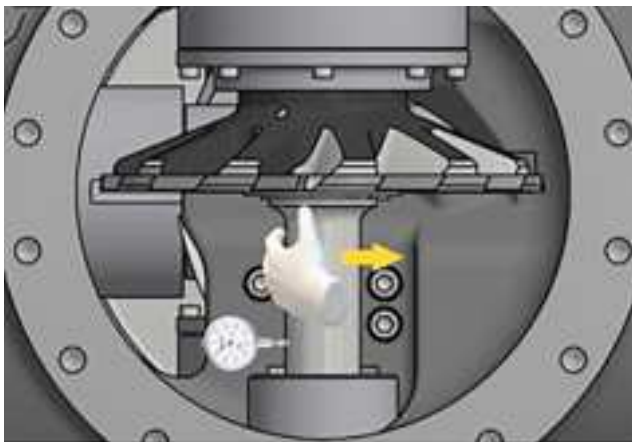
1. Position a one gallon (at least) plastic oil collection bin beneath the side cover. Carefully pry open the side cover to allow the oil to drain before finally removing the side cover.
2. To measure the gaterotor radial bearing clearance, position a dial indicator to the gaterotor shaft as shown in Figure 5-10 (a) and zero the indicator. Put a hand as shown and firmly move the shaft in the direction shown in Figure 5-10 (a). Record the measurement. See table 5-4 for the maximum radial clearance value.
3. To measure the gaterotor axial bearing clearance, position a dial indicator on the gaterotor, as shown in Figure 5-10 (b).

4. To check axial bearing clearance use a lever arm pivoting on a bolt with a small block of wood against the gaterotor to protect it, as shown in Figure 5-10 (b). Record the measurement. See Table 5-4 for the maximum axial clearance value.

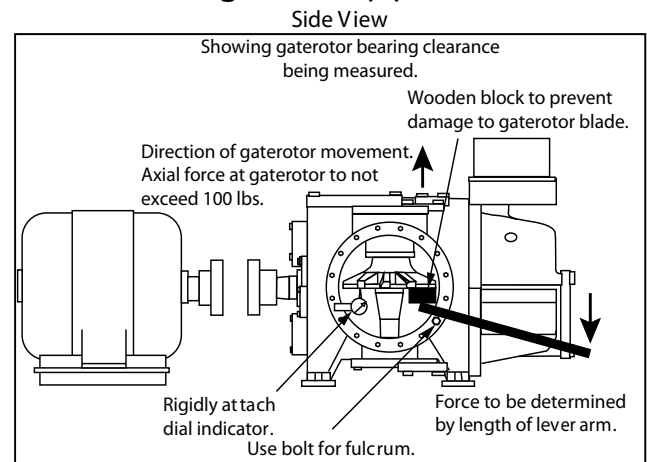
**Table 5-4. Maximum Gaterotor Bearing Clearance**

Compressor Models	Max. Axial Clearance in (mm)	Max. Radial Clearance in (mm)
All Sizes	0.002" (0.051 mm)	0.004" (0.102 mm)

**Figure 5-10 (a): Radial**



**Figure 5-10 (b): Axial**



**Figure 5-10. Gaterotor Bearing Clearance**

## Section 5 • Maintenance/Service

### Gaterotor Inspection

#### A) Gaterotor - Main Housing Shelf Clearance

Follow these steps to check the clearance between the gaterotor and the shelf, which should be between 0.003" – 0.004", see Figure 5-11.

1. Place a 0.003" feeler gauge between the gaterotor teeth, as shown in Figure 5-12 (a) and (b).

#### NOTE

Make sure the feeler gauge stays in the opening between the two teeth until it is on top of the shelf.

2. Without moving the feeler gauge, slowly rotate the gaterotor so that the feeler gauge tip stays between the gaterotor and the shelf. See Figure 5-12 (c).

### CAUTION

Do not over rotate. If the rotor catches the feeler gauge, a piece can break and fall into the rotor groove.

3. Gently pull the feeler gauge out in the direction shown in Figure 5-12 (d).

Check for 0.003-0.004" (0.076- 0.102 mm) clearance between gaterotor blade and shelf.

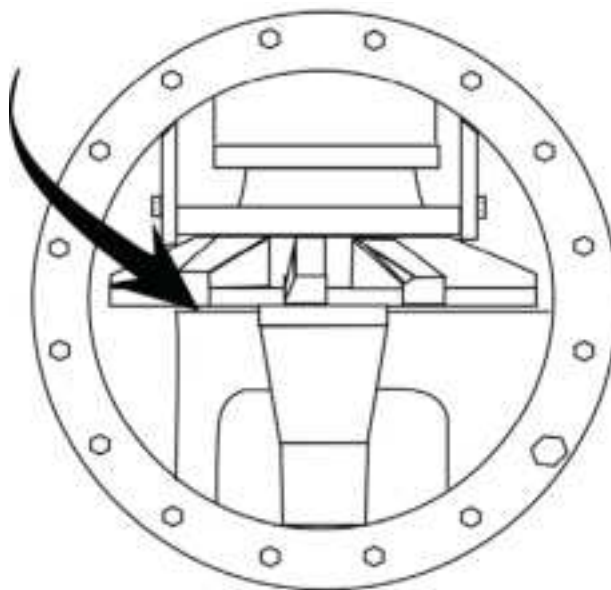
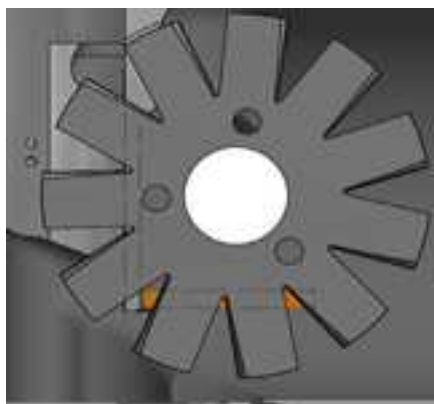


Figure 5-11. Gaterotor and Shelf Clearance

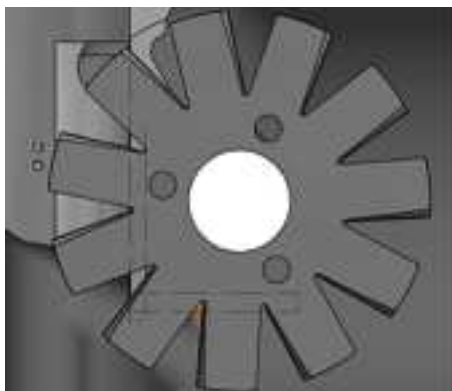
(a) Feeler Gauge Placement (Side View)



(b) Feeler Gauge Placement (Top View)



(c) Tip Of The Feeler Gauge Stays Between Gaterotor And Shelf While Rotating



(d) Feeler Gauge Must Be Pulled Out In This Direction

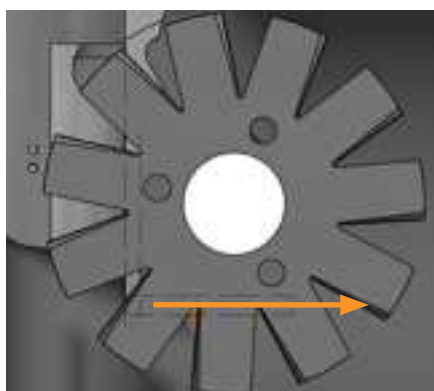


Figure 5-12. Gaterotor and Shelf Clearance Measurement Steps

## Section 5 • Maintenance/Service

- If it is easy to pull out the feeler gauge, then increase the feeler gauge thickness by 0.001" and repeat above steps 1-3. If it is slightly tight to pull it out, then the clearance corresponds to the feeler gauge thickness.

### NOTE

Replacement gaterotors are the same dimensionally as the gaterotors installed at the factory. Therefore, the same shims can be reused when replacement is needed to preserve the 0.003" – 0.004" clearance.

### Clearance and Shims

Under 0.003"	0.003" – 0.004"	Over 0.004"
Remove shims (103 in Figure 5-29, or 106 in Figure 5-23 or 5-25) to achieve 0.003" – 0.004"	Perfect!	Add shims (103 in Figure 5-29, or 106 in Figure 5-23 or 5-25) to achieve 0.003" – 0.004"

### B) Gaterotor Float Measurement

- Before doing any measurements, first conduct a visual check to see if there is any noticeable clearance between the gaterotor and its bushing, see Figure 5-13. If there is noticeable clearance, please contact Vilter Service Department.

### NOTE

The number of bushings on a gaterotor can be anywhere from one to three.

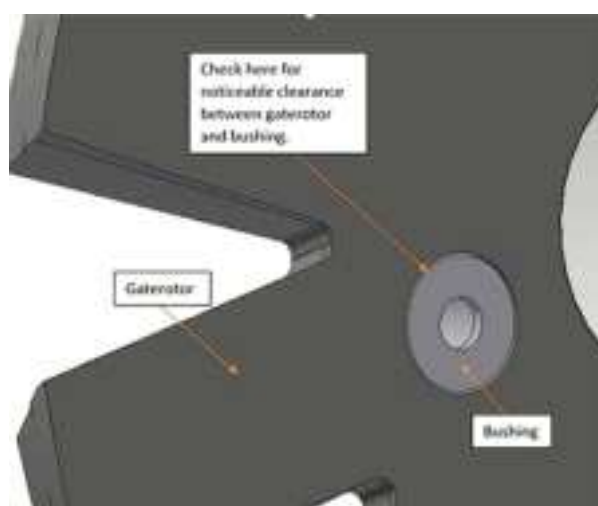
- To measure the float between the gaterotor bushing and the support damper pin (see Figure 5-15), position a dial indicator at the tip of the support as shown in Figure 5-14. Hold the gaterotor in place, then gently move the support teeth back and forth with two fingers (and record measurement). Refer to Table 5-5 to find the maximum float value.

## NOTICE

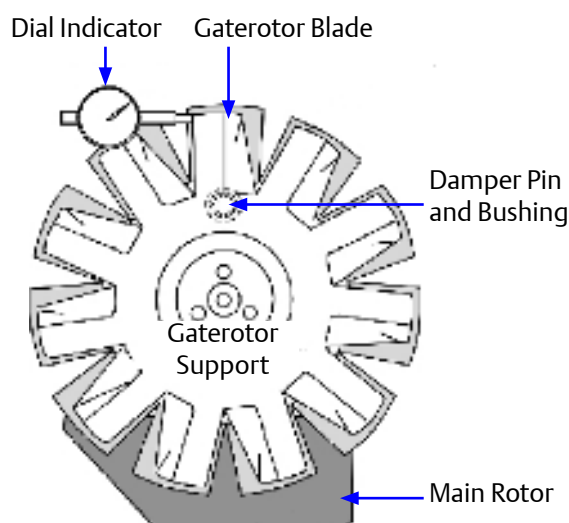
If clearance measurements are out of tolerance, contact Vilter Service Department for further assistance.

**Table 5-5. Gaterotor Float**

Model	Float in. (mm)
VSM-97 - VSM127	0.045 (1.143)
VSM 71 - VSM 401	0.045 (1.143)
VSM 501 - 701	0.045 (1.143)
VSS/VSSH 291 - 601	0.045 (1.143)
VSS 751 - 901	0.055 (1.397)
VSS/VSH 791 - 1301	0.060 (1.524)
VSS 1501 - 2101	0.060 (1.524)
VSS 2401-3001	0.060 (1.524)



**Figure 5-13. Visual Inspection Between Gaterotor and Bushing**



**Figure 5-14. Gaterotor Float Dial Location**

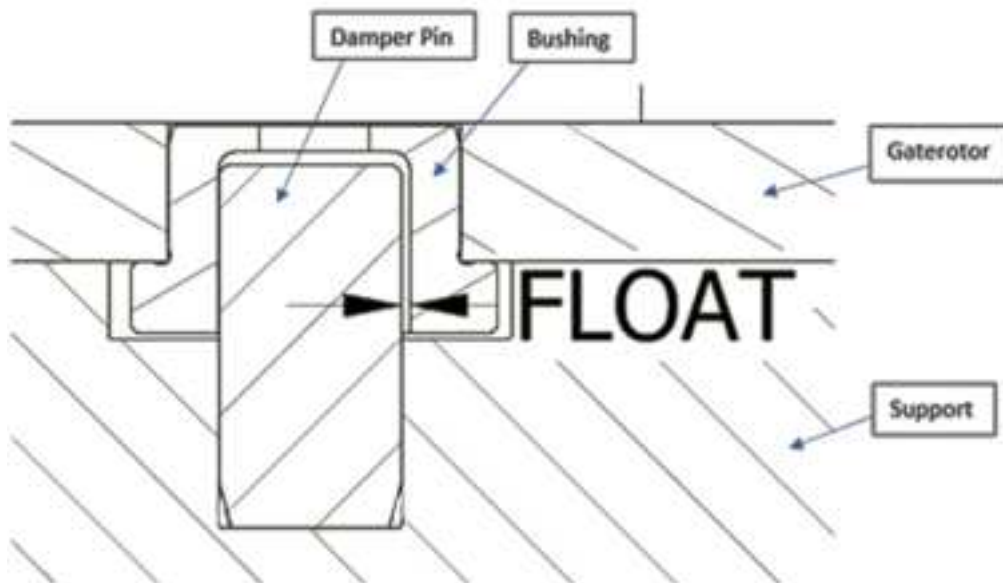


Figure 5-15. Gaterotor Float

### C) Gaterotor Backlash Inspection

Gaterotor Backlash is the clearance between the gaterotor teeth width and the main rotor groove.

Follow these steps to perform the gaterotor backlash inspection:

1. The Gaterotor should be aligned so that a tooth in the rotor is perpendicular to the Main Axis as shown in Figure 5-16. The tooth should be in the center axis of the housing.
2. A dial indicator with magnetic base can be used (Vilter part numbers 9994ARE or 9994ARJ for the dial indicator, and 9994ARD for the magnetic base). See Figure 5-17 for location.

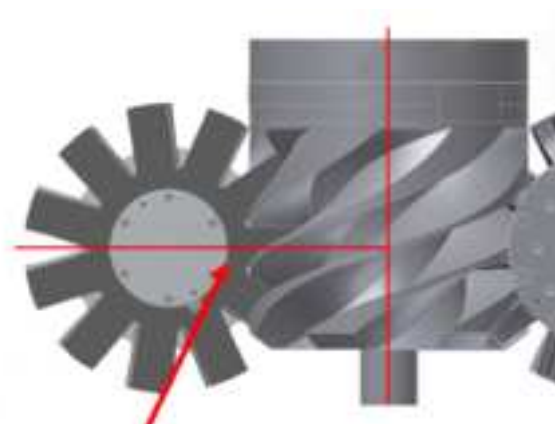


Figure 5-16. Alignment of Gaterotor

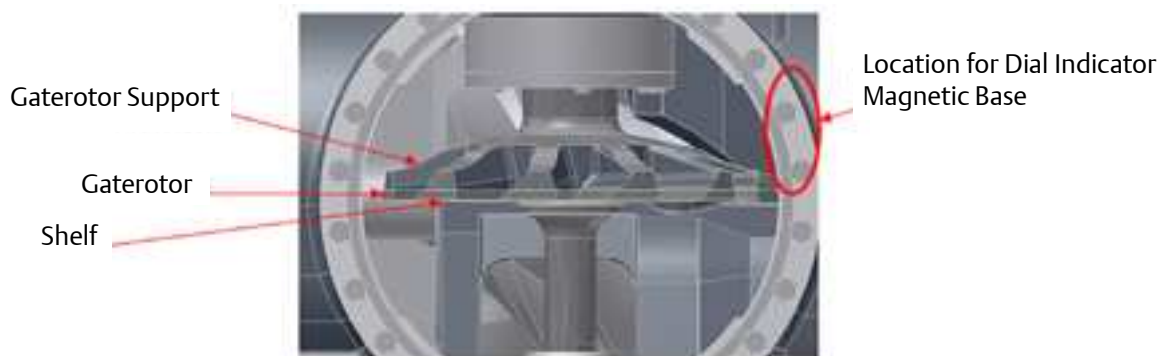


Figure 5-17. Location of Dial Indicator Magnetic Base

## Section 5 • Maintenance/Service

3. Place the Dial Indicator as square as possible on the Gaterotor tooth as shown on Figure 5-18.

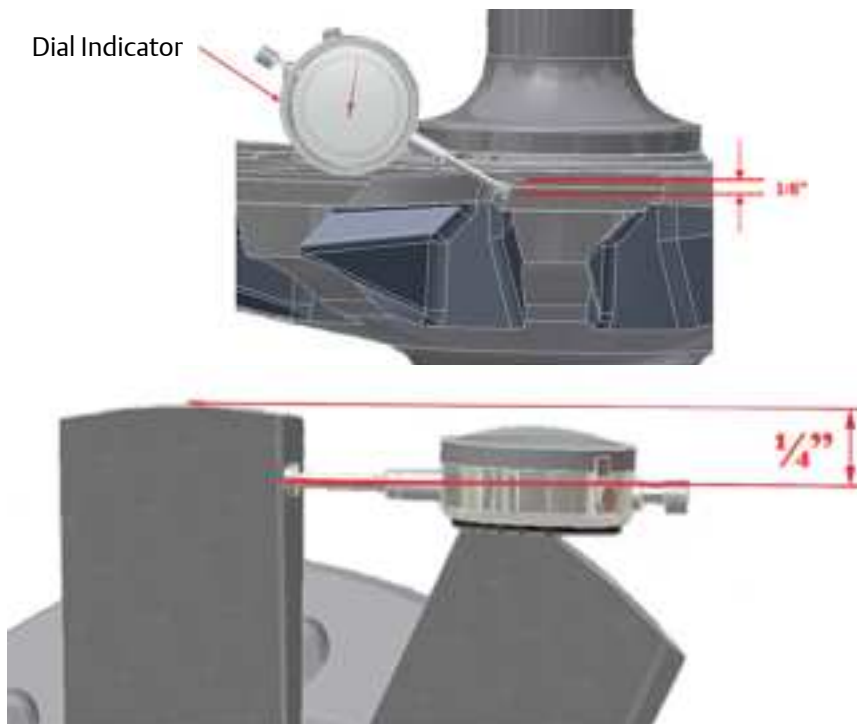


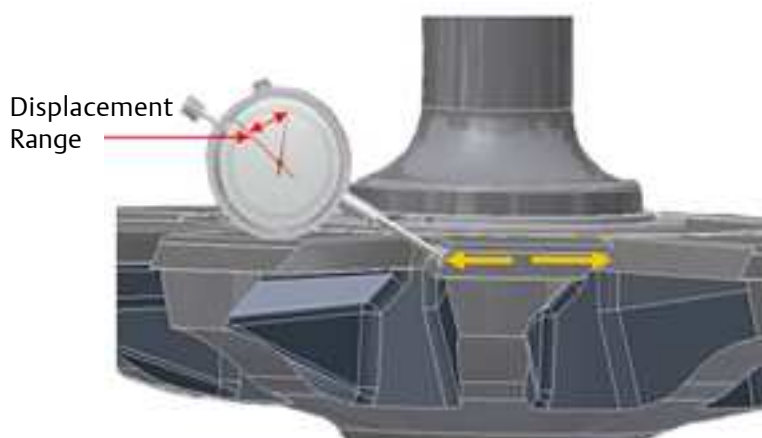
Figure 5-18. Placement of Dial Indicator

4. To measure the backlash (see Figure 5-19), move the gaterotor with two fingers back and forth rapidly several times while reading the dial indicator to see what the displacement range is. This displacement range will be the total backlash.

Contact Vilter Service Department if the measurement is above the ranges shown on Table 5-6.

Table 5-6. Backlash Range

Compressor Model	Normal backlash
VSM-97 thru VSS/VSH-1301	0.008" to 0.012"
VSS-1501 thru VSS-3001	0.008" to 0.015"



Fingers Positioning to Move the Gaterotor Back and Forth



Figure 5-19. Measuring Backlash



### Important Notes

1. Backlash cannot be checked if:
  - The gaterotor is damaged in any way.
  - The clearance between the gaterotor and the shelf is too tight.
2. Make sure you check the backlash, not the float:
  - The backlash is the clearance between the gaterotor teeth width and the rotor groove.
  - The float is the amount of play between the gaterotor bushing and the damper pins.

### Additional Inspections

In addition, visually inspect the main rotor and gaterotors for signs of abnormal wear due to dirt or other contaminants.

If some chipping is present on the edges of the gaterotor, this will not influence the compressor performance. If chipping is more than what's shown on Figure 5-20, take pictures and contact Vilter Service Department.

### Post Inspection

After all the inspections are complete, the gaterotor cover, suction tee, coupling center member and coupling guard can be reinstalled and the unit can be evacuated and leak checked before starting.

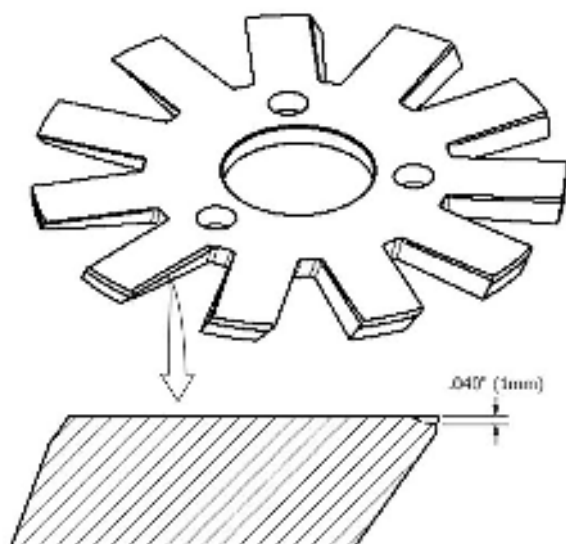


Figure 5-20. Chipped Edge of Gaterotor

## Gaterotor Assembly Replacement (All Compressors Except VSM 301-701 and VSM 97-127 Compressors)

Table 5-7 lists the gaterotor tool sets needed to remove and install gaterotor assemblies.

Table 5-7. Gaterotor Tool Kits

Model	Tool Set VPN
VSM 97- VSM 127	N/A
VSM 71-VSM 401	N/A
VSM 501-701	A25205B
VSS/VSSH 291-601	A25205B
VSS/VSH 751-1301	A25205C
VSS 1551-2101	A25205E
VSS 2401-3001	A25205F

### Removal

1. Remove center member, see appropriate Drive Coupling Replacement procedure.

#### NOTE

All parts must be kept with their appropriate side and not mixed when the compressor is reassembled.

2. Remove two upper bolts from side cover
3. Install guide studs in holes.

#### NOTE

There will be some oil drainage when the cover is removed.

4. Remove remaining bolts and side cover.
5. Turn main rotor so a driving edge of any one of the main rotor grooves is even with the back of the gaterotor support.

#### NOTE

The gaterotor stabilizer is designed to hold the gaterotor support in place and prevent damage to the gaterotor blade as the thrust bearings and housing is being removed.

6. Insert gaterotor stabilizer. The side rails are not required on VSS 451 thru 601. For the VSS 751 thru 901 and VSS 1051 thru 1301 compressors, use the side rails and assemble to the gaterotor stabilizer as

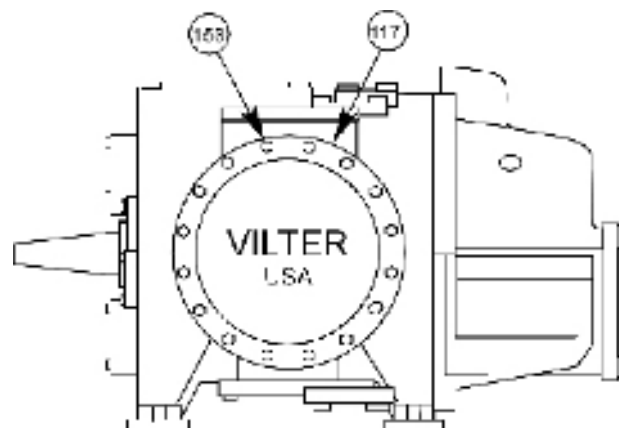
## Section 5 • Maintenance/Service

stamped. For the VSS 1551 thru 2101, use the side rails and assemble to the gaterotor stabilizer. Refer to Figure 5-21.

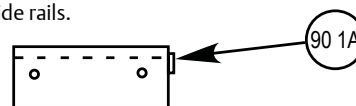
7. Remove hex head bolts and socket head bolts from thrust bearing cover.
8. Re-install two bolts into the threaded jacking holes to assist in removing thrust bearing cover. Retain the shim pack.
9. Hold gaterotor support with a suitable wrench on the flats provided near the roller bearing housing.
10. Remove the inner retainer bolts and retainer.
11. To remove the thrust bearing housing, install thrust bearing removal and installation tool with smaller puller shoe. Turn the jacking screw clockwise. The thrust bearings and housing assembly will be pulled off the shaft and out of the frame.
12. Remove bolts from roller bearing housing.
13. Re-install two bolts into jack bolt holes provided in housing to aid in removal.
14. To remove the gaterotor support, carefully move support in the opposite direction of rotation and tilt roller bearing end towards the suction end of the compressor. The compressor input shaft may have to be turned to facilitate the removal of the gaterotor support. On dual gate compressor units, repeat the procedure for the remaining gaterotor support assembly.

### Installation

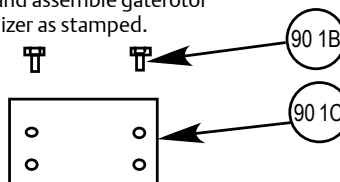
15. Install gaterotor support by carefully tilting the roller bearing end of the gaterotor support towards the suction end of the compressor. The compressor input shaft may have to be rotated to facilitate the installation of the gaterotor support. Install gaterotor stabilizer. The gaterotor stabilizer (901) will hold the gaterotor support in place as the thrust bearing housing is being installed. If the gaterotor support is not restricted from moving, the gaterotor blade may be damaged. See Figure 5-22.
16. Install the roller bearing housing (112) with a new O-ring (141). See Figure 5-23.
17. Tighten bolts (152), see Appendix A.
18. When installing the thrust bearing housing (113), a new O-ring (142) must be used when the housing is installed, see Figure 5-23. Lubricate the outside of the housing and bearings with clean compressor oil to aid in the installation. Due to the fit of the bearings on the gaterotor shaft, the thrust bearing removal and installation tool with the pusher shoe must be used. Turn the jacking screw clockwise.



For VSS 451-601 compressors, do not use side rails.



For VSS 751/901 and 1051-1301 compressors, use side rails and assemble gaterotor stabilizer as stamped.



Position leading edge of main rotor groove flush with or slightly below back of gaterotor support.

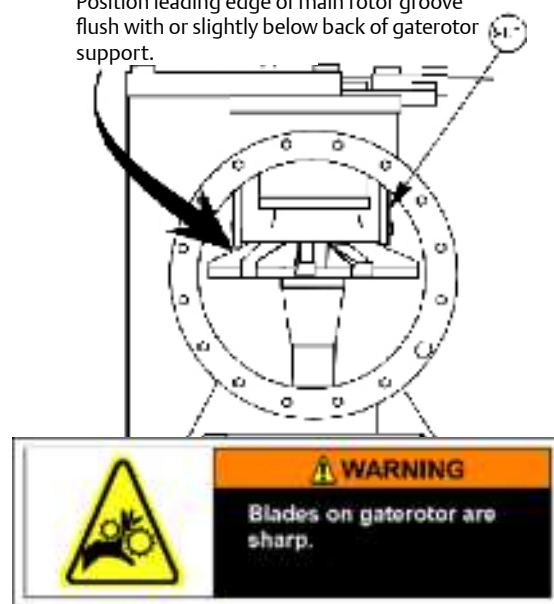


Figure 5-21. Gaterotor Assembly Removal and Tools

## Section 5 • Maintenance/Service

This will push the thrust bearings onto the shaft and push the housing assembly into the frame. Install the inner retainer (115) and bolts (151) using Loctite® 242 thread locker. Tighten bolts, see Appendix A.

19. Set clearance between gaterotor blade and shelf.
20. Place a piece of 0.003”-0.004” shim stock between gaterotor blade and shelf.

### NOTE

This measurement determines the amount of shims needed for the correct clearance.

21. Measure depth from top of compressor case to top of thrust bearing housing.
22. Use factory installed shim pack (106) and bearing housing cover (116) without the O-ring (143).

### NOTE

Replacement blades are precisely the same dimensionally as blades installed originally at factory: Therefore, the same amount of shims will be required for replacement blades.

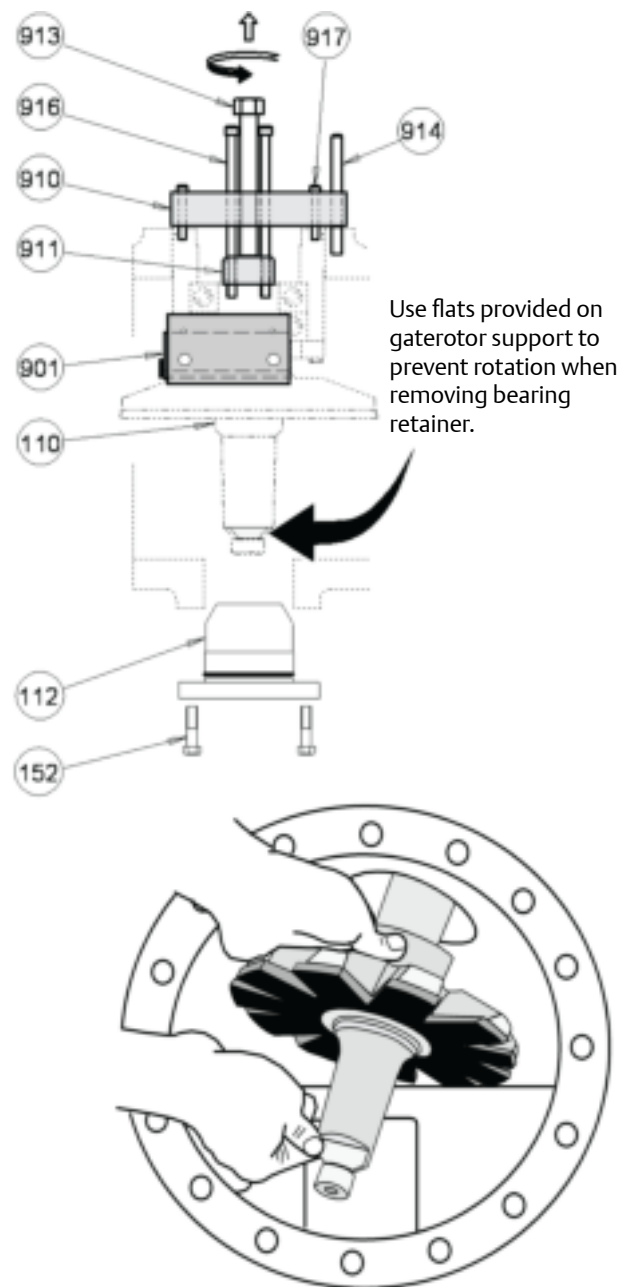


Figure 5-22. Gaterotor Assembly Removal



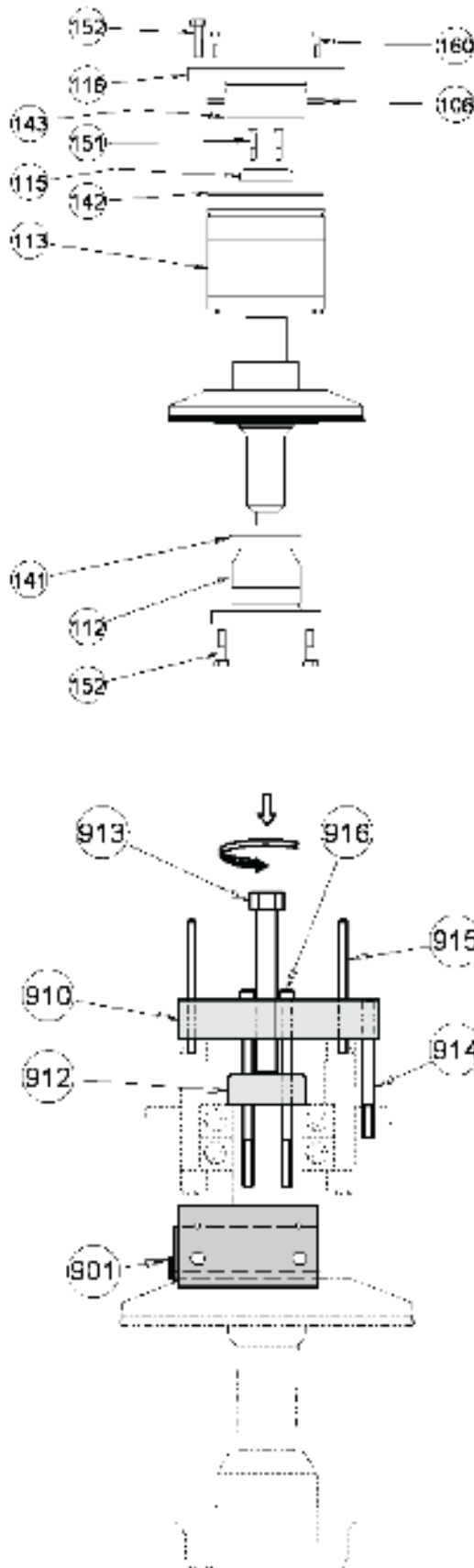


Figure 5-23. Gaterotor Assembly and Tools

23. Check the clearance between the entire gaterotor blade and the shelf, rotate the gaterotor to find the tightest spot. It should be between 0.003-0.004" (0.076-0.102 mm). Make adjustments, if necessary. It is preferable to shim the gaterotor blade looser rather than tighter against the shelf, see Figure 5-24.
24. After clearance has been set install a new O-ring (143) on bearing housing cover, install cover and tighten the bolts to the recommended torque value.
25. Install side cover with a new gasket. Tighten the bolts to the recommended torque value. The unit can then be evacuated and leak checked.

Check for 0.003-0.004" (0.076- 0.102 mm) clearance between gaterotor blade and partition.

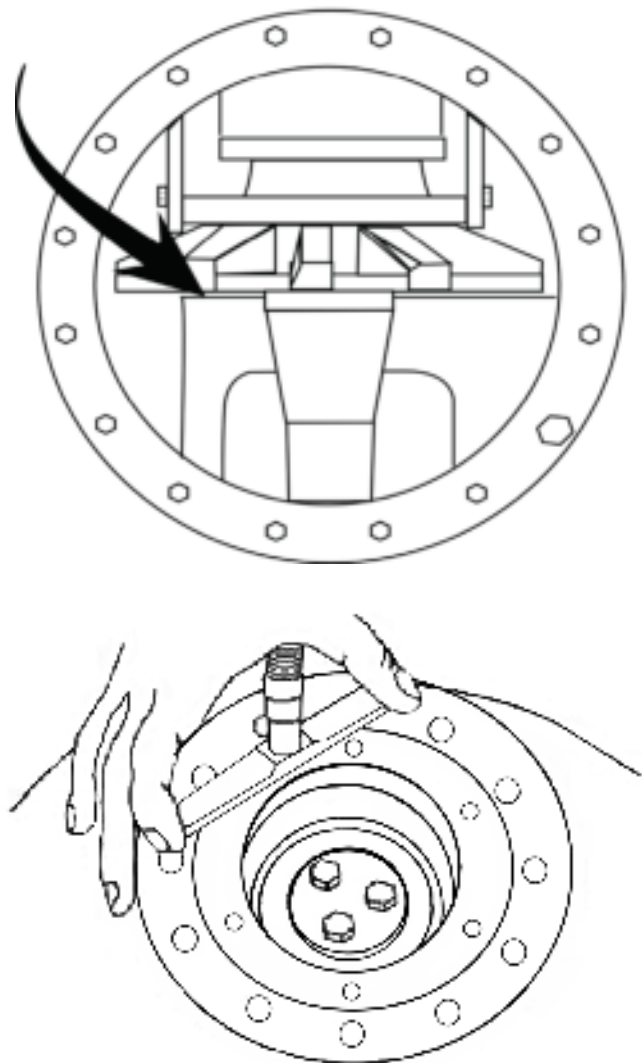


Figure 5-24. Gaterotor and Shelf Clearance

### Gaterotor Assembly Replacement (VSM 301-701 Compressors ONLY)

#### Removal

The removal of the gaterotor assembly for the VSM 301-701 compressors is similar for the VSS 751-3001 compressors except that the inner races are secured to the stationary bearing spindle.

1. Remove center member, see appropriate Drive Coupling Replacement procedure.
2. Remove the upper bolt from the side cover and install a guide stud in the hole.
3. Remove remaining bolts and side cover. There will be some oil drainage when the cover is removed.
4. The side cover that contains the suction strainer should have the suction line properly supported before the bolts securing the line to the cover can be removed. After the line is removed, the cover can be removed as described above.
5. Turn the main rotor so the driving edge of the groove is between the top of the shelf or slightly below the back of the gaterotor support. At this point install the gaterotor stabilizing tool.
6. Remove plug on the thrust bearing housing. Loosen the socket head cap screw that is located underneath the plug. This secures the inner races of the thrust bearings to the spindle.
7. Remove bolts that hold the thrust bearing housing to the compressor. Insert two of the bolts into the threaded jacking holes to assist in removing the bearing housing from the compressor. When the housing is removed, there will be shims between the spindle and thrust bearings. These control the clearance between the shelf and gaterotor blades. These must be kept with their respective parts for that side of the compressor.
8. Remove the bolts from the roller bearing housing. After the bolts have been removed, the housing can be removed from the compressor.
9. To remove the gaterotor support, carefully move the support opposite the direction of rotation and tilt the roller bearing end towards the suction end of the compressor. The compressor input shaft may have to be turned to facilitate the removal of the gaterotor support. On dual gate versions, repeat the procedure for the remaining gaterotor support assembly.

#### Installation

10. Install the gaterotor support. Carefully tilt the roller bearing end of the gaterotor support towards the suction end of the compressor. The compressor input shaft may have to be rotated to facilitate the installation of the gaterotor support.
11. Install the roller bearing housing with a new O-ring. Tighten the bolts to the recommended torque value.
12. Install the spindle with shims and O-ring, tighten bolts, see Appendix A. Measure the clearance between the shelf and blade.

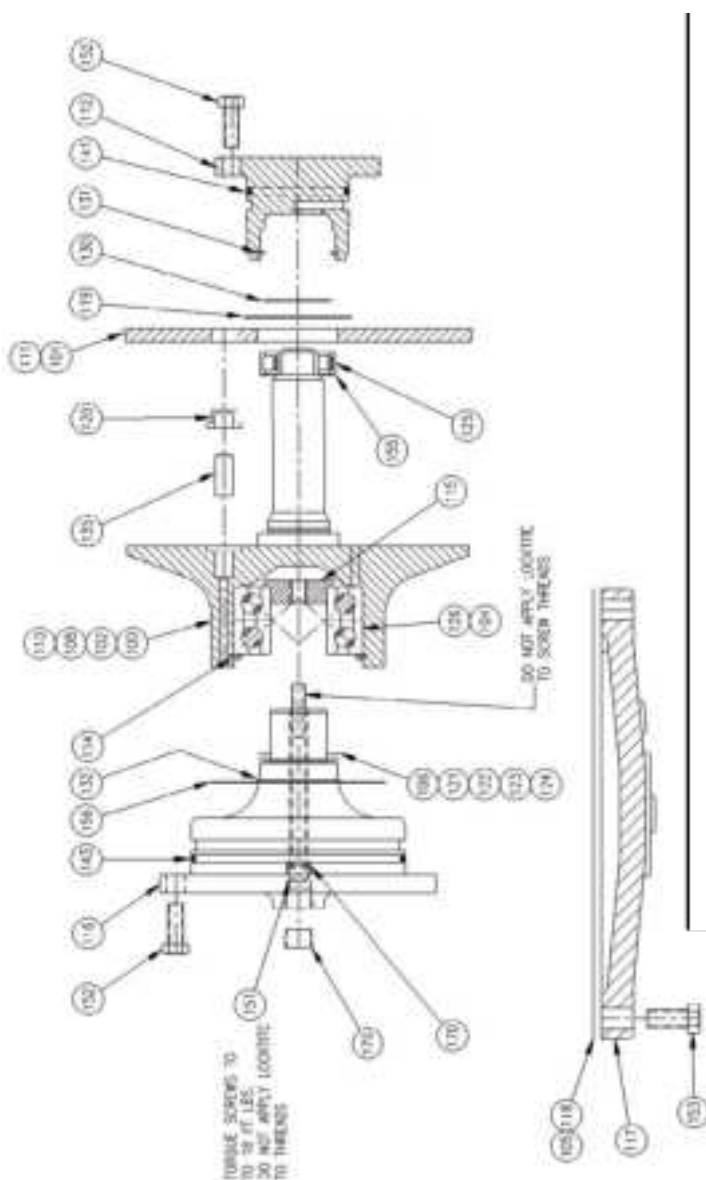


Figure 5-25. Gaterotor Assembly Breakdown

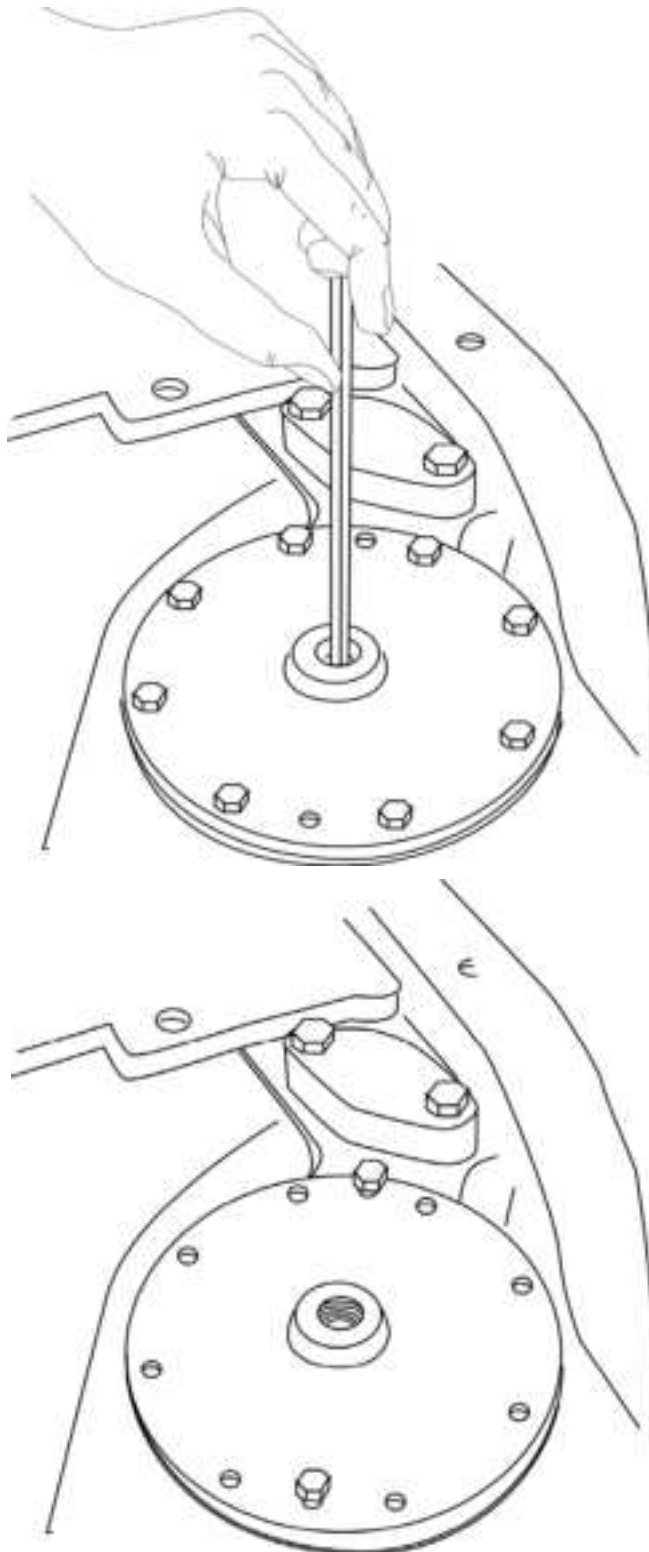
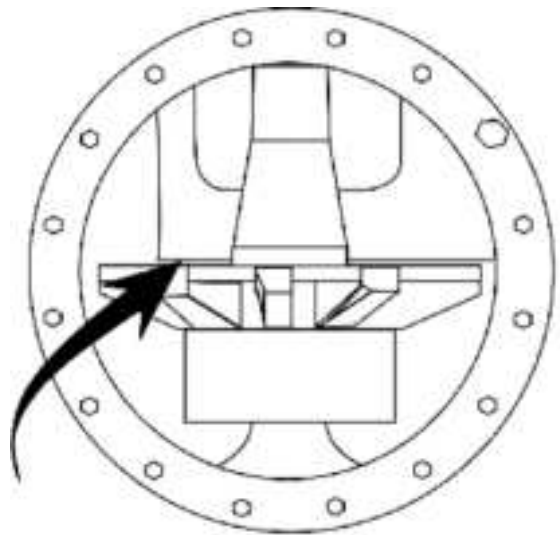


Figure 5-26. Gaterotor Thrust Bearing

13. Check the clearance between the entire gaterotor blade and the shelf, rotate the gaterotor to find the tightest spot. It should be between 0.003-0.004" (0.076-0.102 mm). Make adjustments, if necessary. It is preferable to shim the gaterotor blade looser rather than tighter against the shelf.
14. Once the clearance is set remove the spindle. Install new O-ring, apply Loctite 242 thread locker to the socket head cap screw clamping the thrust bearings to the spindle. Torque all bolts, see Appendix A.
15. Install side covers with new gaskets. Tighten bolts, see Appendix A. The unit can now be evacuated and leak checked.



Check for 0.003-0.004" (0.076- 0.102 mm) clearance between gaterotor blade and partition.

Figure 5-27. Gaterotor and Shelf Clearance

### Gaterotor Assembly Replacement (VSM 97-127 Compressors ONLY)

#### Removal

1. Remove center member.

#### NOTE

All parts must be kept with their appropriate side and not mixed when the compressor is reassembled.

2. Remove bolts from side cover.

#### NOTE

There will be some oil drainage when the cover is removed.

3. Turn main rotor so a driving edge of any one of the main rotor grooves is even with the back of the gaterotor support.
4. Remove the three screws (item 107 in Figure 5-29) that hold the housing in place.
5. Remove the gaterotor roller bearing housing (item 105 in Figure 5-29).
6. Remove O-ring (102-2), bearing and retainer ring (106).
7. Remove the 8 screws (107) that hold the ball bearing support (104) and the O-Ring (102-1).

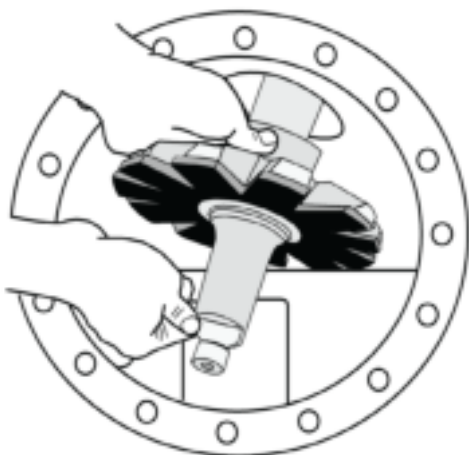


Figure 5-28. Gaterotor Assembly Removal

8. To remove the gaterotor support (101), carefully move support in the opposite direction of rotation and tilt the roller bearing end towards the suction end of the compressor. The compressor input shaft may have to be turned to facilitate the removal of the gaterotor support.
9. On dual gate compressor units, repeat the procedure for the remaining gaterotor support assembly.

#### Installation

1. Install gaterotor support by carefully tilting the roller bearing end of the gaterotor support towards the suction end of the compressor. The compressor input shaft may have to be rotated to facilitate the installation of the gaterotor support. Install gaterotor stabilizer. The gaterotor stabilizer (901) will hold the gaterotor support in place as the thrust bearing housing is being installed. If the gaterotor support is not restricted from moving, the gaterotor blade may be damaged.
2. Install the roller bearing housing (105) with a new O-ring (102-2), and make sure the O-Ring is installed in the proper groove.
3. Tighten bolts (107), see Appendix A.
4. Install thrust bearing support. Lubricate the outside of the support and bearings with clean compressor oil to aid in the installation. Tighten bolts, see appendix A.
5. Measure clearance between gaterotor blade and shelf by placing shim stock between gaterotor blade and shelf until snug. Subtract .003"-.004" from total amount of shim stock used.

#### NOTE

This measurement determines the amount of shims needed for the correct clearance.

6. Use factory installed shim pack (103) and bearing housing cover without the O-ring.

#### NOTE

Replacement blades are precisely the same dimensionally as blades installed originally at factory: Therefore, the same amount of shims will be required for replacement blades.

7. Check the clearance between the entire gaterotor

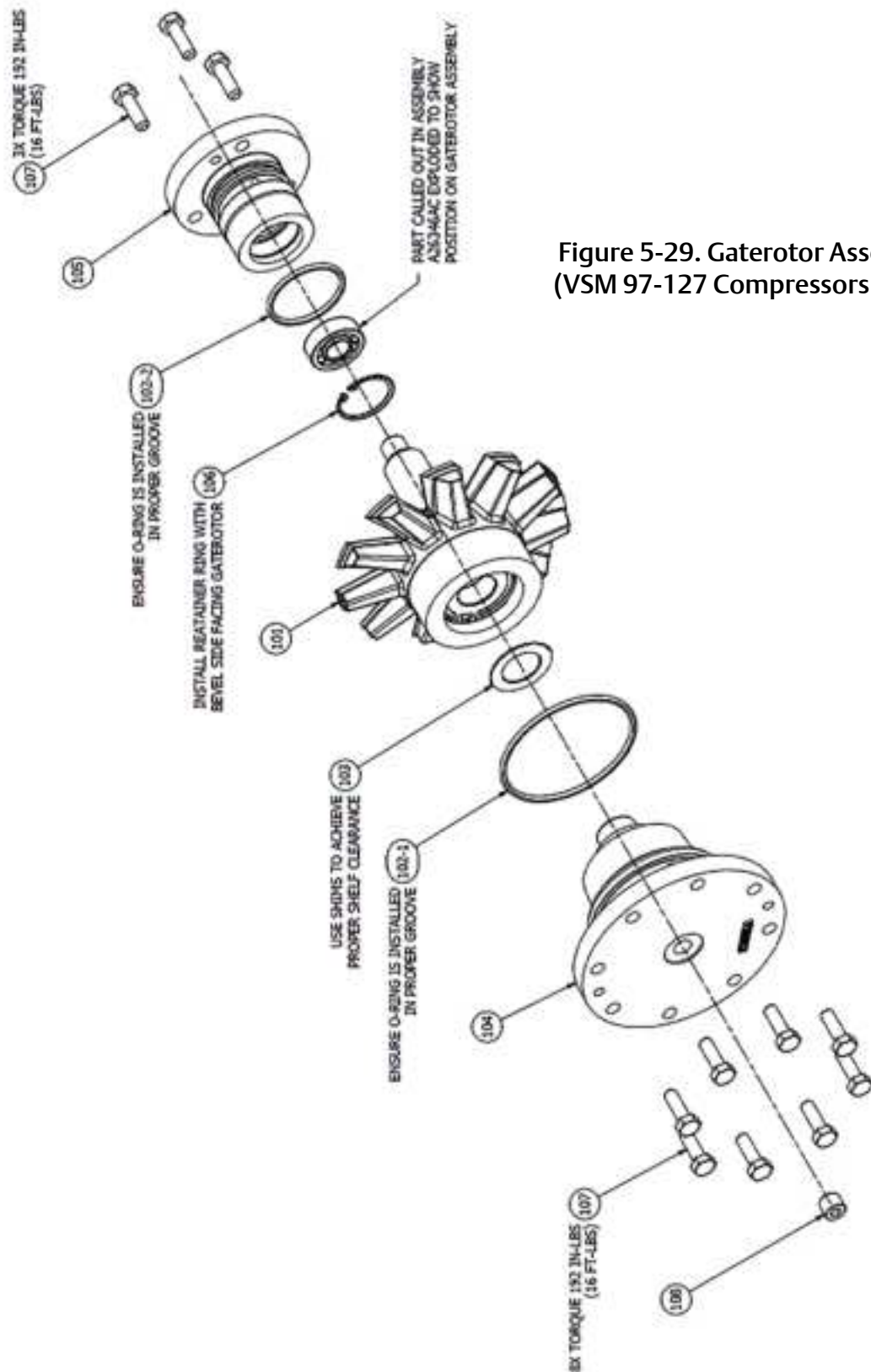


Figure 5-29. Gaterotor Assembly  
(VSM 97-127 Compressors ONLY)

blade and the shelf, rotate the gaterotor to find the tightest spot. It should be between 0.003-0.004" (0.076-0.102 mm). Make adjustments, if necessary. It is preferable to shim the gaterotor blade looser rather than tighter against the shelf, see Figure 5-30.

8. After clearance has been set install a new O-ring on bearing housing cover, install cover and tighten the bolts to the recommended torque value.
9. Install side cover with a new gasket. Tighten the bolts to the recommended torque value. The unit can then be evacuated and leak checked.

Check for 0.003-0.004" (0.076- 0.102 mm) clearance between gaterotor blade and partition.

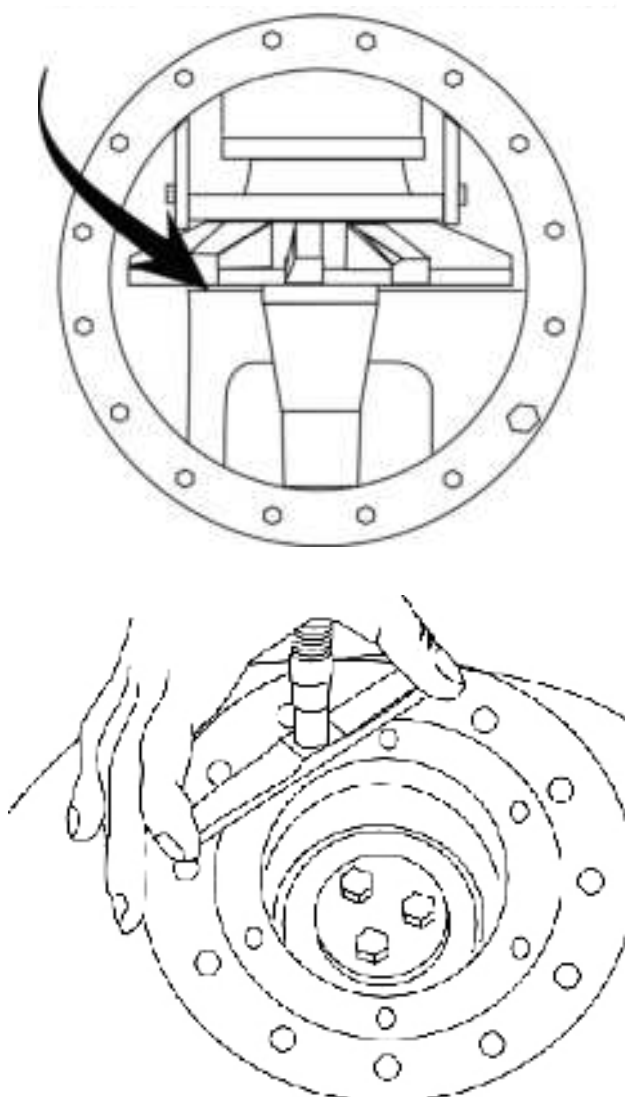


Figure 5-30. Gaterotor and Shelf Clearance

## Gaterotor Disassembly (All Compressors Except VSM 97-127 Compressors)

10. To perform gaterotor disassembly, remove gaterotor from compressor, see Gaterotor Assembly Replacement procedure (All VSS-VSM Compressors Except VSM 301-701 Compressors) or Gaterotor Assembly procedure (VSM 301-701 Compressors ONLY).

## Gaterotor Blade Removal

11. Remove the snap ring and washer from the gaterotor assembly. Lift gaterotor blade assembly off the gaterotor support, see Figure 5-31.
12. Check damper pin and bushing for excessive wear. Replace if required.

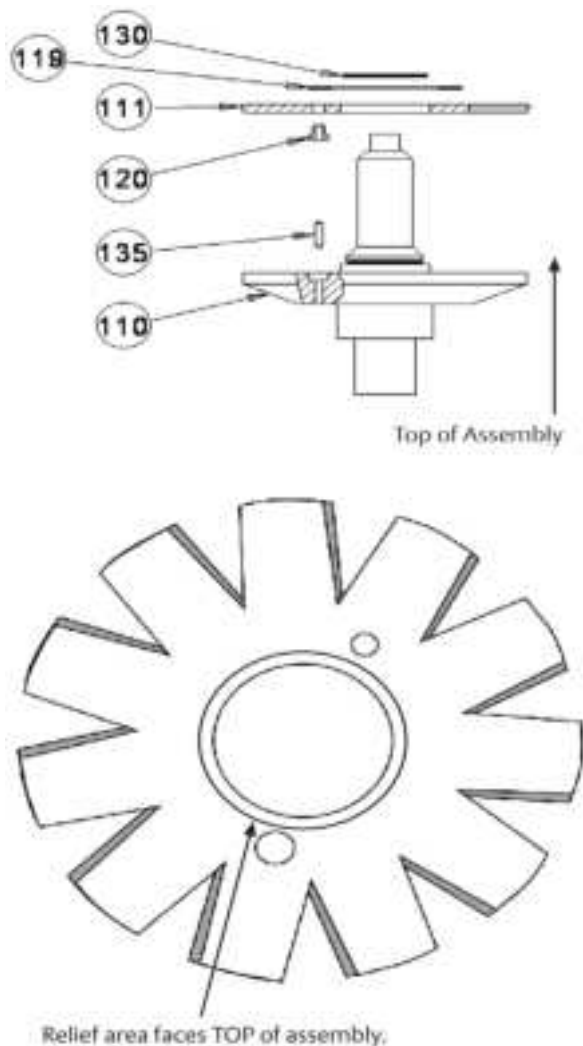


Figure 5-31. Gaterotor Blade Assembly

### Gaterotor Blade Installation

13. Install damper pin bushing (120) in gaterotor blade (111) from the back side of the blade. Be sure bushing is fully seated using red Loctite (271).
14. Place blade assembly on gaterotor support. Locating damper over pin.
15. Install washer (119) and snap ring (130) on gaterotor assembly. The bevel on the snap ring must face away from the gaterotor blade. After the gaterotor blade and support are assembled, there should be a small amount of rotational movement between the gaterotor and support.

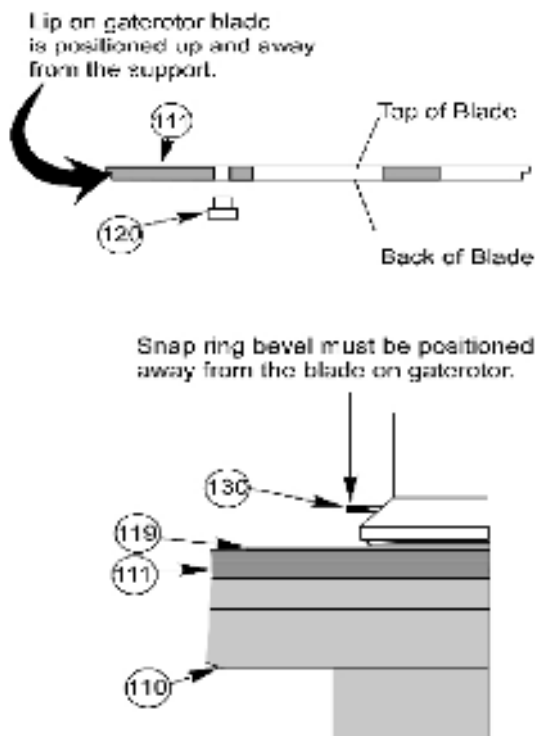
### Gaterotor Thrust Bearing Removal

For removal of thrust bearings on VSM units:

16. Remove bolts (150) from the clamping ring (114), see Figure 5-33.
17. Remove thrust bearing clamping ring.
18. Remove thrust bearings (126) from housing (113).

For removal of thrust bearings on VSS units:

19. Remove retaining ring from gaterotor support.
20. Remove bearings from support.
21. Remove bearing retainer from inner race.

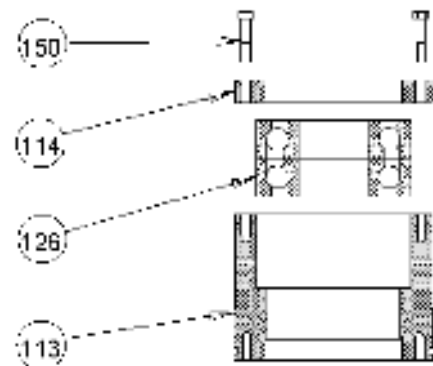


**Figure 5-32. Gaterotor Blade Installation**

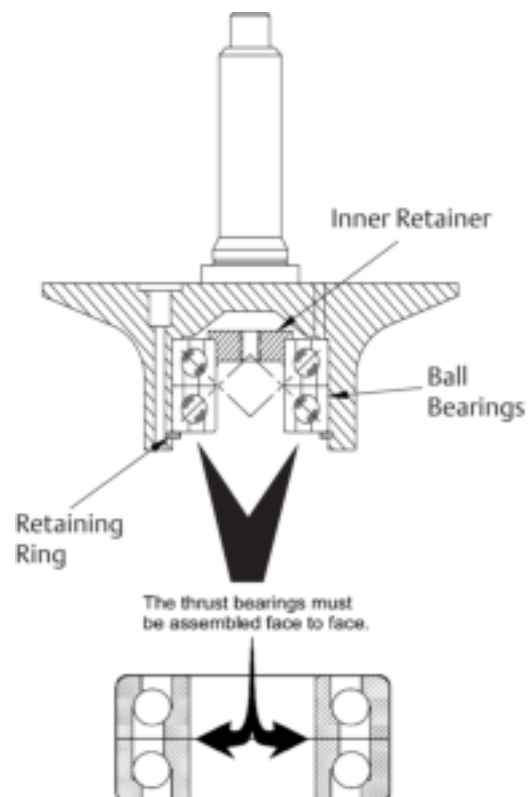
### Gaterotor Thrust Bearing Installation

**For installation of thrust bearings on VSS units**

22. Install thrust bearings (126) in the housing so the bearings are face to face. The larger sides of the inner races are placed together. A light application of clean compressor lubricating oil should be used to ease the installation of the bearings into the housing.
23. Center the bearing retainer ring on housing, use Loctite® 242-thread locker and evenly tighten the bolts to the recommended torque value, see Figure 5-34.



**Figure 5-33. Gaterotor Thrust Bearing**



**Figure 5-34. Thrust Bearing Installation**



## Section 5 • Maintenance/Service

### For installation of thrust bearings on VSM 301-701 units

24. Install retainer in the back of the inner race of one of the thrust bearings. The back of the inner race is the narrower of the two sides.
25. The bearing with the retainer should be placed in the housing first, retainer towards the support. Install the second bearing. The bearings should be positioned face to face. This means that the larger sides of the inner races are placed together. A light application of clean compressor lubricating oil should be used to ease the installation of the bearings into the gaterotor support.
26. Install the bearing retaining snap ring.

### Gaterotor Roller Bearing Removal

27. Remove the snap ring (131), which retains the roller bearing in the bearing housing, see Figure 5-35.
28. Remove the roller bearing (125) from the bearing housing (112).
29. Use a bearing puller to remove the roller bearing race (125) from the gaterotor support (110).

### Gaterotor Roller Bearing Installation

30. Match up the part numbers on the inner race to the part numbers outer race. Press the bearing race (numbers visible) onto the gaterotor support.
31. Install the outer bearing into the bearing housing so the numbers match the numbers on the inner race. Install the snap ring retainer in the housing. The bevel on the snap ring must face away from the roller bearing.

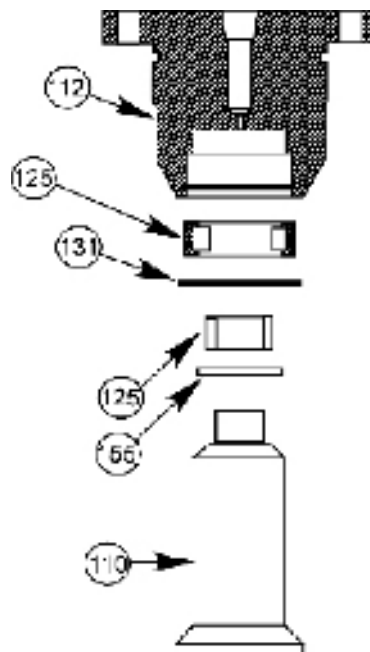


Figure 5-35. Roller Bearing Assembly



### Gaterotor Disassembly (VSM 97-127 Compressors ONLY)

1. To perform gaterotor disassembly, remove gaterotor from compressor.

#### Gaterotor Blade Removal

2. Lift gaterotor blade assembly off the gaterotor support, see Figure 5-36.
3. Check damper pin and bushing for excessive wear. Replace if required.

#### Gaterotor Blade Installation

4. Install damper pin bushing (120) in gaterotor blade (111) from the back side of the blade. Be sure bushing is fully seated using red Loctite (271), see Figure 5-37.
5. Place blade assembly on gaterotor support. Locating damper over pin, see Figure 5-36.
6. After the gaterotor blade and support are assembled, there should be a small amount of rotational movement between the gaterotor and support.

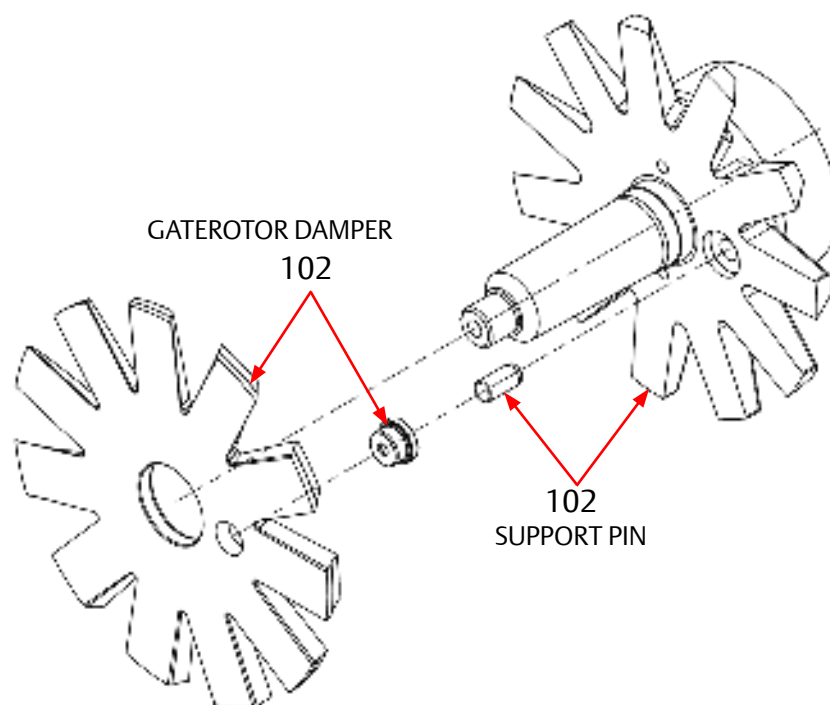


Figure 5-36. Gaterotor Support (VSM 97-127)

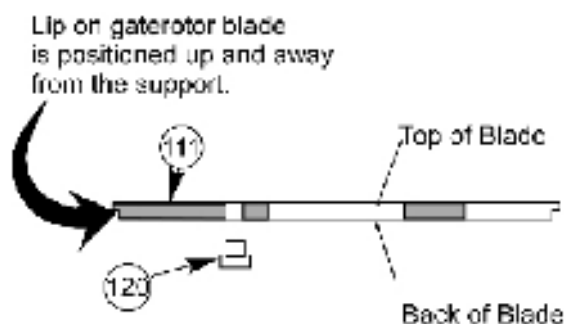


Figure 5-37. Gaterotor Blade Installation

### Gaterotor Thrust Bearing Removal

(See Figure 5-38)

7. Remove retaining ring from gaterotor support.
8. Remove bearings from support.
9. Remove bearing retainer from inner race.

### Gaterotor Thrust Bearing Installation

10. Install thrust bearings in the housing so the bearing is face out (face is visible when installed). A light application of clean compressor lubricating oil should be used to ease the installation of the bearings into the housing, see Figure 5-38.

### Gaterotor Roller Bearing Removal

11. Remove the snap ring, which retains the roller bearing in the bearing housing.
12. Remove the roller bearing from the bearing housing.
13. Use a bearing puller to remove the roller bearing race from the gaterotor support.

### Gaterotor Roller Bearing Installation

14. Match up the part numbers on the inner race to the part numbers outer race. Press the bearing race (numbers visible) onto the gaterotor support.
15. Install the outer bearing into the bearing housing so the numbers match the numbers on the inner race. Install the snap ring retainer in the housing. The bevel on the snap ring must face away from the roller bearing.

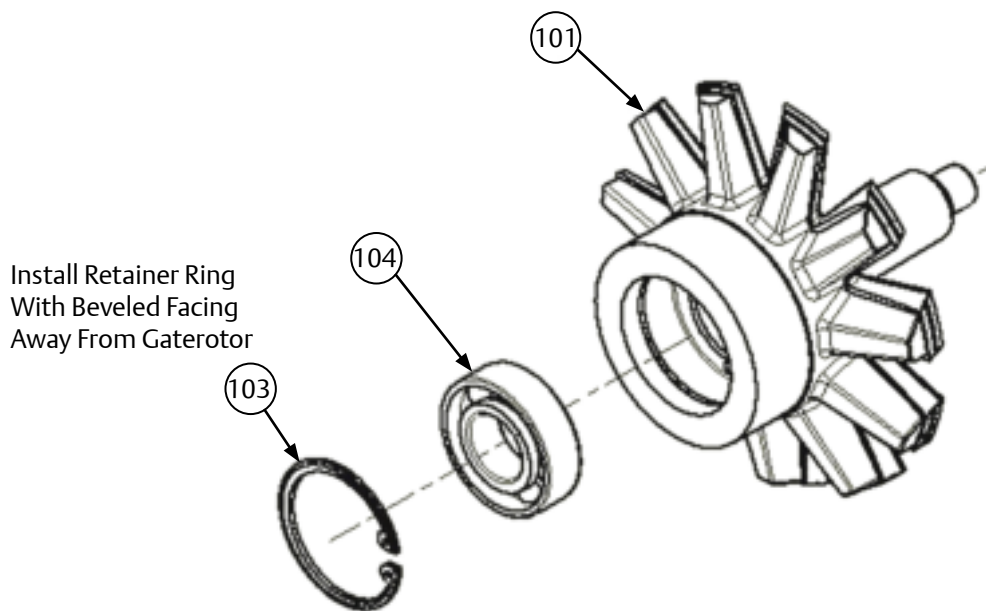


Figure 5-38. Gaterotor Thrust Bearing (VSM 97-127)

### Compressor Shaft Seal Replacement

#### Shaft Seal Assembly

The shaft seal is made up of a mating ring and a carbon or silicon carbide (SC) component.

The mating ring is the rotating part of the seal and is installed against the shaft shoulder. It has a drive notch on one end which aligns with the drive pin inserted in the shaft.

Carbon or SC component is the stationary part of the seal and is installed into the shaft seal housing using an O-ring.

The shaft seal housing with the stationary part is assembled in the compressor main housing using an O-ring, see Figure 5-39.

The shaft seal needs to be carefully handled and installed to function properly. Please see Figure 5-40 for details.



Figure 5-39. Shaft Seal Assembly



Figure 5-40. Handling Seal Face with Care

## Section 5 • Maintenance/Service

### Compressor Shaft Seal Replacement - For VSS/VSM Units

#### Tools

Table 5-8. Shaft Seal Tool Kits

Model	(VPN) for the Shaft Seal Tool Kits
VSM 97 - VSM 127	N/A
VSM 152 - VSM 401	25455A
VSM 501-701	25455B
VSS 291-601	25455B
VSS 751-1301	25455C
VSS 1551-2101	25455D

#### Removal

1. Remove bolts (281) securing shaft seal housing (218). to compressor.

#### NOTE

There will be a small amount of oil drainage as the shaft seal housing is removed.

2. Insert two of bolts (281) into threaded jacking holes to assist in removing shaft seal housing (218).
3. Remove mating ring (219C) from compressor shaft.
4. Remove oil seal (230) from shaft seal housing (218).
5. Using a brass drift and hammer, tap out cup assembly (219B) from the back side of shaft seal housing (218).
6. Remove O-ring (260).

#### Installation

### CAUTION

Care must be taken when handling the cup assembly and mating ring when installing. See Figure 5-40 for handling seal faces with care. Do not touch the carbon component of the cup assembly or mirror face on the mating ring as body oil and sweat will cause corrosion.

#### NOTE

On VSS 291 - 601 compressors equipped with an Anti-rotation pin in the shaft seal housing, when replacing the cup assembly (219B) the Anti-rotation pin in the housing must be removed. See Figure 5-42.

#### Suggestion

A spray bottle filled with clean compressor oil may be used to lubricate the faces of the seals without touching the seal.

7. Install a new oil seal (230) in seal housing (218).
8. Clean inside shaft seal housing (218) where cup assembly (219B) meets inside shaft seal housing.
9. If applicable, remove protective plastic from cup assembly (219B). **DO NOT** wipe or touch carbon component of cup assembly.
10. If carbon component of cup assembly (219B) needs cleaning, use alcohol and a lint-free cloth to clean.
11. Apply clean compressor lubricating oil to O-ring on cup assembly (219B).
12. Using shaft seal tool or similar, install cup assembly (219B) in shaft seal housing (218). If applicable, align the hole on the back of the carbon cartridge with the Anti-rotation pin in the seal housing. See Figure 5-42.
13. Clean compressor shaft and shaft seal cavity in compressor housing.
14. Apply clean compressor lubricating oil to mating ring (219C) seating area on compressor shaft. See Figure 5-42.
15. Apply clean compressor lubricating oil to inside area of mating ring (219C).

### IMPORTANT

**DO NOT** wipe or touch the face of the mating ring (219C) where face meets the carbon component of the cup assembly (219B).

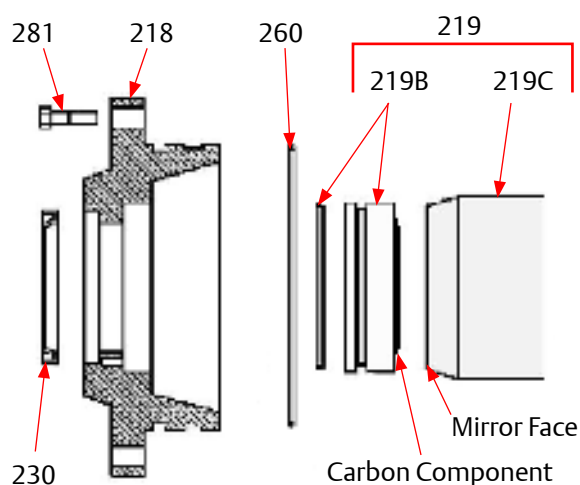


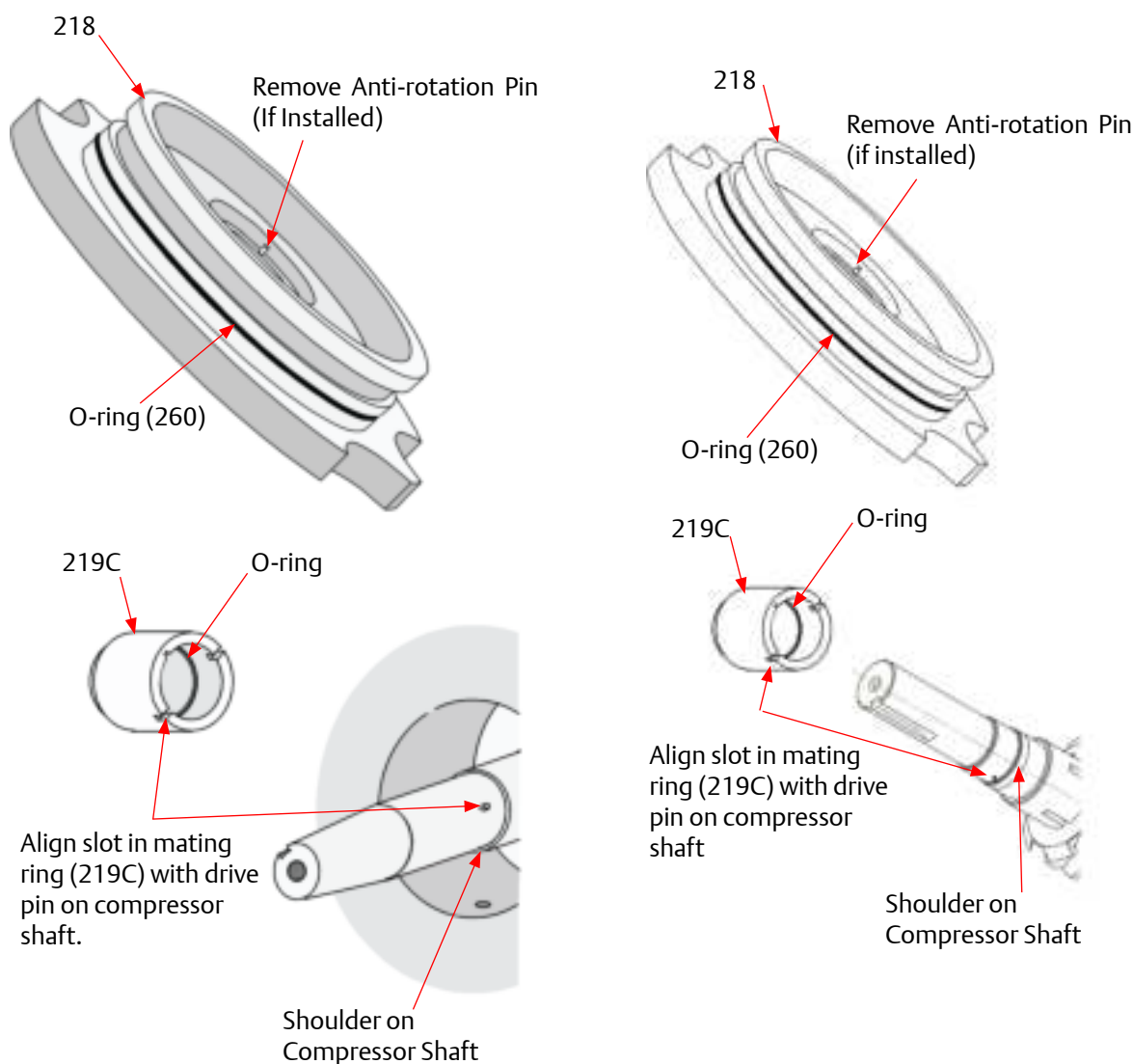
Figure 5-41. Compressor Shaft Seal Assembly

### CAUTION

Ensure the mating ring (219C) is fully seated against the shoulder of the compressor shaft. If the mating ring is not fully seated against the shoulder, the carbon component of the cup assembly (219B) will be damaged when the shaft seal housing (218) is installed. See Figure 5-40.

16. Align slot in mating ring (219C) with drive pin on compressor shaft. Carefully push mating ring on while holding onto outside area of mating ring until mating ring is fully seated against shoulder on compressor shaft. See Figure 5-42.

17. Install a new O-ring (260) on the seal housing (218), making sure the O-ring is placed in the O-ring groove and not the oil gallery groove. See Figure 5-42.
18. Lubricate both seal faces with clean compressor lubricating oil.
19. Carefully install the seal housing (218) on the compressor shaft, evenly tightening the bolts (281) to the recommended torque values (36 ft-lbs).
20. Install the coupling and coupling guard. The unit can then be evacuated and leak checked.



**Figure 5-42. Compressor Shaft Seal Installation: Tapered and Straight Shafts**

## Section 5 • Maintenance/Service

### Compressor Shaft Seal Replacement - For VSH/VSSH Units

#### Shaft Seal Removal - For Part# 25985Y and 25985YA

(see Table 5-9 and Figure 5-43)

## WARNING

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

### NOTE

There will be a small amount of oil drainage as the shaft seal housing is removed.

1. Remove bolts (281) securing shaft seal housing (218) to compressor.
2. Insert two bolts (281) into threaded jacking holes to assist in removing shaft seal housing (218).
3. Remove silicon carbide rotating face (219.6) & O-ring (219.7) from shaft.
4. Remove spring holder (219.8) from shaft.
5. Remove oil seal (230) from shaft seal housing (218).
6. Remove retaining ring (219.5) from seal housing.
7. Flip the seal housing over and carefully tap the stationary silicon carbide piece (219.3), retainer (219.4), and O-ring (219.2) out of the seal housing using brass drift and hammer.
8. Remove O-ring (260).

### NOTE

VSH/VSSH compressors are designed using the following shaft seals, see Table 5-9 for their VPN and pressure ranges.

Table 5-9. VSH/VSSH Shaft Seals

Shaft Seal	Pressure (PSI)		O-Ring Material
	Static	Dynamic	
25985Y	1800	1350	Fluoroelastomer
25985YA	1800	1350	EPDM
25985W	1800	1350	Fluoroelastomer
25985WA	1800	1350	EPDM

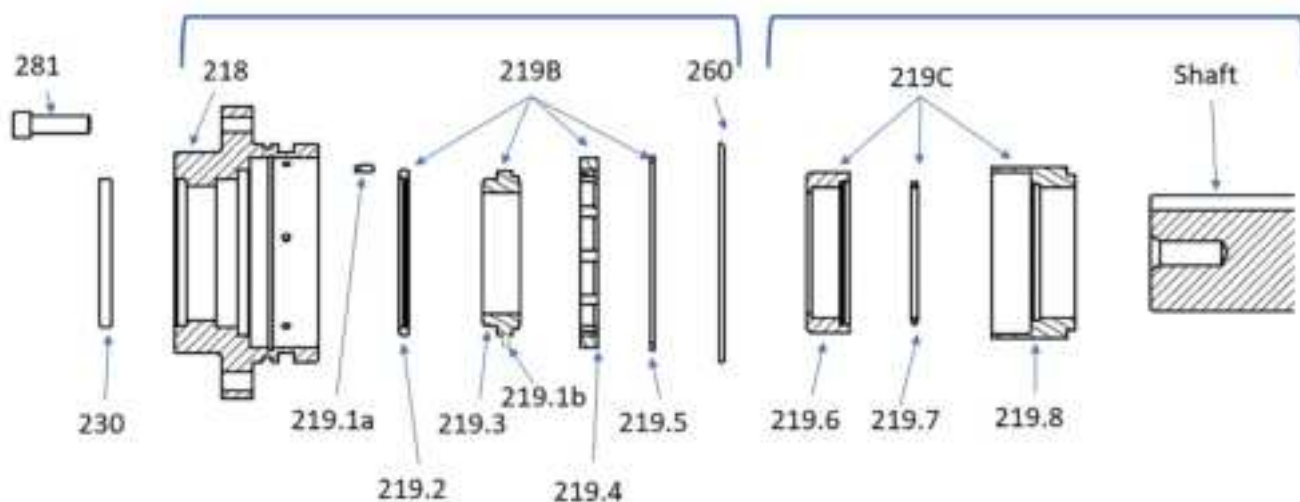


Figure 5-43. Shaft Seal Breakdown (28985Y & 28985YA)



## Section 5 • Maintenance/Service

**Shaft Seal Removal – For Part# 28985W and 28985WA**  
(see Table 5-9 and Figure 5-44)

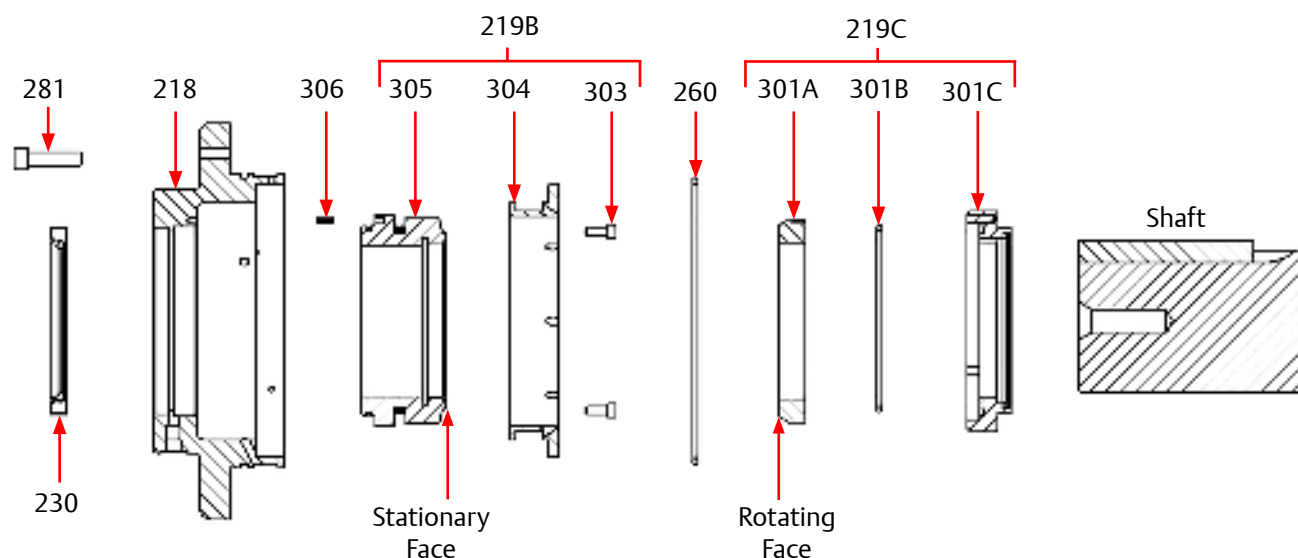
### WARNING

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

#### NOTE

There will be a small amount of oil drainage as the shaft seal housing is removed.

1. Prepare compressor for disassembly (standard nomenclature from other area of manual).
2. Loosen and remove screws (281) mounting shaft seal housing (218) to main compressor housing.
3. Carefully thread three screws (281) into the jacking holes in the shaft seal housing (218) to push it out of the main compressor housing. Do not go more than one-half turn on any screw at a time.
4. Once the shaft seal housing (218) has been removed from the compressor housing, loosen the 4 small socket cap screws (303) holding the shaft seal retainer (304) to the shaft seal housing (218).
5. Using a hammer and punch, carefully tap the seal cartridge (305) out of the shaft seal housing (218).
6. Remove oil seal (230) from shaft seal housing (218).
7. Remove the O-ring (260) from the shaft seal housing (218).
8. The rotating assembly (219C) can be firmly pulled off the compressor shaft as one assembly. Be sure to note the location of the drive pin in the main compressor shaft for re-assembly. See Figure 5-42.



**Figure 5-44. Shaft Seal Breakdown (28985W and 28985WA Only)**

## Section 5 • Maintenance/Service

### Prior to Shaft Seal Installation

# WARNING

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

### NOTE

Care must be taken when handling the cup assembly and mating ring when installing. See Figure 5-40 for Handling Seal Face with Care.

### Suggestion

A spray bottle filled with clean compressor oil may be used to lubricate the faces of the seals without touching the seal.

Follow these steps to verify the integrity of a shaft seal:

1. Check lead chamfer and outer diameter of shaft for deep scratches that may potentially damage the O-ring on the inner diameter of the shaft seal, see Figure 5-45:

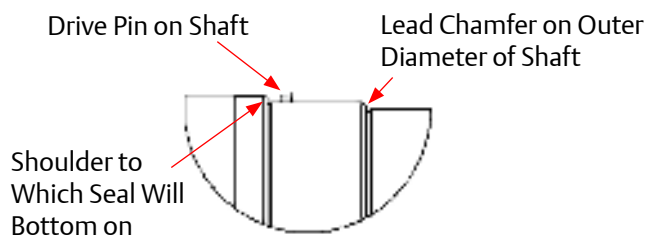


Figure 5-45. Shaft with Pin

2. Check lead chamfer and inner diameter of shaft seal housing for burrs and/or deep scratches that may potentially damage the O-ring on the outer diameter of the shaft seal, see Figure 5-46.
3. Clean compressor shaft and shaft seal cavity in compressor housing.
4. Apply clean compressor lubricating oil to the compressor shaft in mating ring seating area, see Figure 5-47.

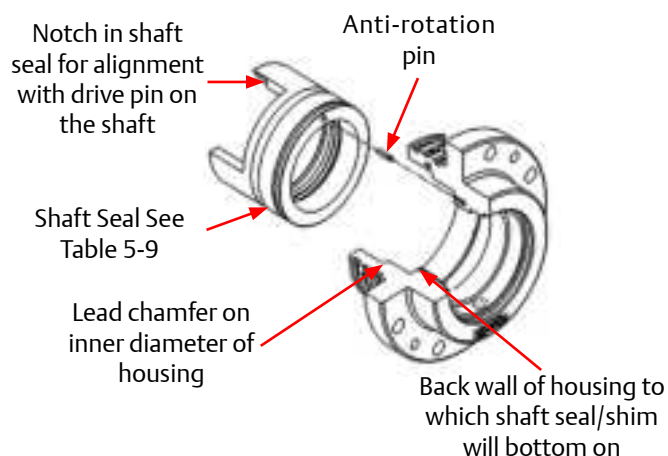


Figure 5-46. Shaft Seal Housing

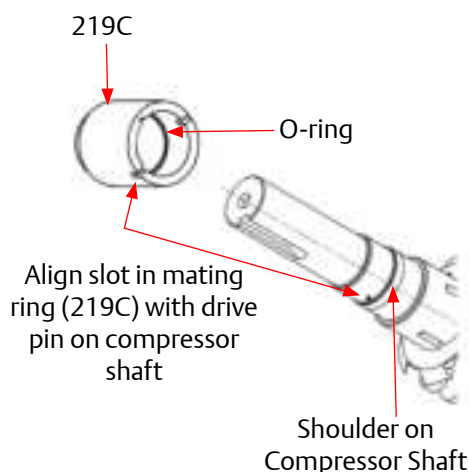


Figure 5-47. The Alignment of Compressor Shaft and Mating Ring



### Shaft Seal Installation - For Part# 25985Y and 25985YA (see Table 5-9 and Figure 5-43)

#### NOTE

Follow the “Prior to Shaft Seal Installation” steps before starting this procedure.

## WARNING

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

#### NOTE

Care must be taken when handling the cup assembly and mating ring when installing. See Figure 5-40 for Handling Seal Face with Care.

#### Suggestion

A spray bottle filled with clean compressor oil may be used to lubricate the faces of the seals without touching the seal.

## CAUTION

Do not wipe or touch the face of the mating ring (219C) where the face meets the carbon component of the stationary assembly (219B).

1. Apply clean compressor lubricating oil to inside area of spring holder (219.8), rotating Silicon carbide piece (219.6) and o-ring (219.7).
2. Carefully fit spring holder (219.8) onto shaft until it is fully seated against shoulder on compressor shaft. Be sure to align slot in spring holder (219.8) with drive pin on compressor shaft, see Figure 5-47.

## CAUTION

Ensure the spring holder (219.8) is fully seated against the shoulder of the compressor shaft. If the spring holder (219.8) is not fully seated against the shoulder, the carbon component of the stationary assembly (219B) will be damaged when the shaft seal housing (218) is installed.

3. Place O-ring (219.7) inside rotating silicon carbide piece (219.6) and carefully assemble onto shaft. You should feel some resistance in sliding this onto the shaft shoulder.
4. Install a new oil seal (230) in seal housing (218).
5. If necessary, Install anti-rotation pin (219.1a) in hole in shaft seal housing (218).
6. Install O-ring (219.2) into shaft seal housing.
7. Install stationary silicon carbide piece (219.3) in shaft seal housing with anti-rotation pin (219.1b) aligned 180 degrees away from the pin (219.1a) in step 4. You should feel some resistance to fit the stationary piece into the O-ring.
8. Fit the retainer (219.4) over the stationary piece while aligning the slots on the anti-rotation pins.
9. Install retaining ring (219.5) into groove in shaft seal housing.
10. Install a new O-ring (260) on the seal housing (218), making sure the O-ring is placed in the O-ring groove and not the oil gallery groove. Lubricate both seal faces with clean compressor lubricating oil.
11. Carefully install the seal housing (218) on the compressor shaft, evenly tightening the bolts (281) to the recommended torque values (36 ft-lbs).
12. Install the coupling and coupling guard. The unit can then be evacuated and leak checked.

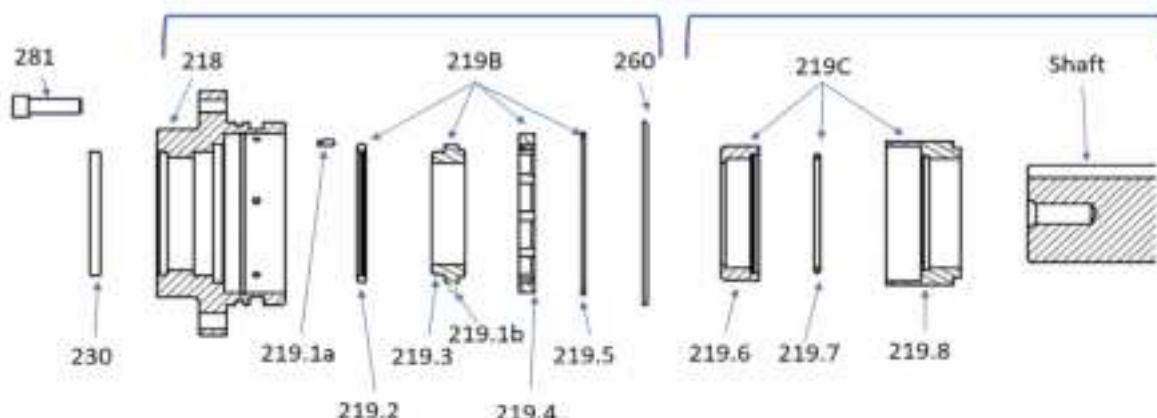


Figure 5-43. Shaft Seal Breakdown (28985Y & 28985YA)

## Section 5 • Maintenance/Service

### Shaft Seal Installation – For Part# 28985W and 28985WA

(see Table 5-9 and Figure 5-44)

#### NOTE

Follow the “Prior to Shaft Seal Installation” steps before starting this procedure.

### WARNING

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

#### NOTE

Care must be taken when handling the cup assembly and mating ring when installing. See Figure 5-40 for Handling Seal Face with Care.

#### Suggestion

A spray bottle filled with clean compressor oil may be used to lubricate the faces of the seals without touching the seal.

### CAUTION

Do not wipe or touch the face of the mating ring (219C) where the face meets the carbon component of the stationary assembly (219B).

1. Install a new oil seal (230) in seal housing (218).
2. Ensure compressor shaft is clean and free from marks and scratches.
3. Remove seal rotating face (301A) and O-ring (301B) from rotating assembly portion of the seal (assembly 219C).
4. Apply clean compressor lubricating oil to seal

seating area on the compressor shaft and inside area of rotating face support (301C).

5. Gently assemble the rotating face support (301C) onto main compressor shaft, taking care to align the drive pin in the main shaft with the keyway on the rotating face support (301C).
6. Using a small amount of Flowserve supplied grease, carefully re-assemble O-ring (301B) and rotating face (301A) over the compressor shaft, onto the rotating face support (301C).
7. Moving onto the stationary portion of the seal (219B), gently press the stationary face (305), into the seal housing (218) ensuring it is fully seated. Make sure to align the hole on the back of the stationary face (305) with the Anti-rotation pin (306) in the seal housing (218). See Figure 5-46.
8. Assemble retaining ring (304) over the seal into the shaft seal housing (218), aligning the mounting holes with the threaded holes in the shaft seal housing.
9. Apply blue Loctite 242 to the bolts (303) and tighten them down evenly in a star pattern until snug, then torquing each to 48 in-lbs (6 N-m).
10. Apply clean compressor lubricating oil to both seal faces (305 and 219C).
11. Ensure a new O-ring (260) is installed in proper groove of shaft seal housing (218).
12. Carefully assemble shaft seal housing (218) onto main compressor shaft into main compressor housing, evenly tightening the bolts (281) and torquing to their appropriate value as specified by compressor specific drawing.
13. Install the coupling and coupling guard. The unit can then be evacuated and leak checked.

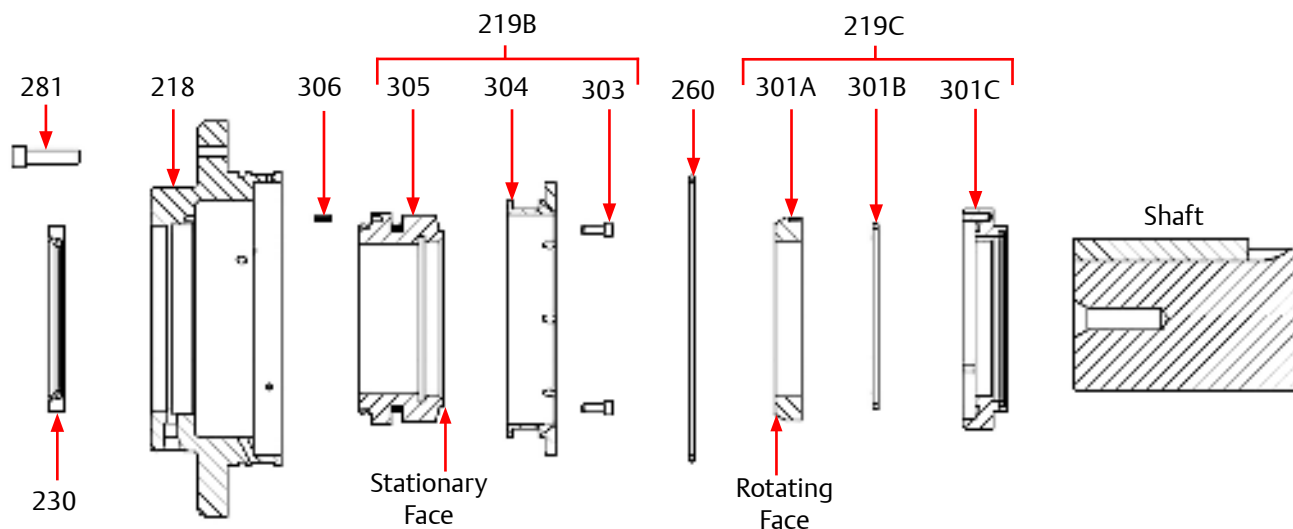


Figure 5-44. Shaft Seal Breakdown (28985W and 28985WA Only)

### Slide Valve Actuator Assembly Replacement

To replace slide valve actuator assembly, proceed with the following steps:

#### Removal

### WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

### WARNING

Follow local lock-out/tag-out procedure. Compressors must be depressurized before attempting to do any work on them. Failure to comply may result in serious injury, death and/or damage to equipment.

#### NOTE

This procedure is applicable to both capacity and volume slide valve actuator assemblies.

1. Shut down the compressor unit, refer to Stopping/Restarting procedure in Section 4.
2. Turn disconnect switches to the OFF position for the compressor unit and oil pump motor starter, if equipped.
3. Allow compressor, motor and surrounding components to cool prior to servicing.
4. Disconnect connectors from actuator.

#### NOTE

Note orientation of components to aid in installation.

5. First remove E-clips, then remove Locking Retainers, next loosen and remove Grooved Bolts and Washes that securing actuator assembly to actuator mount. See Figure 5-48 for parts details.
6. Remove actuator assembly from actuator mount.

### Installation

### CAUTION

When installing the slide valve actuator assembly, loosen locking collar down the shaft. Do not use a screwdriver to pry locking collar into position.

7. Position actuator assembly on mount as noted in removal.
8. Install washers and grooved bolts to secure actuator assembly to actuator mount, torque them to 6 lb-ft. Then install locking retainers. Last push E-clips into grooved bolt heads. Refer to Actuator Installation Using Anti-Rotation Bolts (see next page) for details.
9. Tighten screws, see Appendix A.

### CAUTION

If installing new actuator, do not connect connectors of power cable or position transmitter cable to new actuator once installed. Connecting connectors to new actuator will occur during calibration procedure. Failure to comply may result in damage to equipment.

10. Leave connectors disconnected to actuator assembly.
11. Calibrate actuator assembly, see Slide Valve Calibration procedure in Section 4 or Appendix F.

Section 5 • Maintenance/Service

Actuator Installation Using Anti-Rotation Bolts

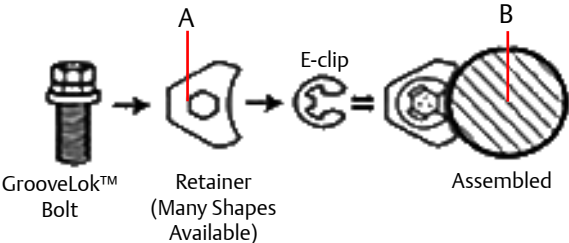
Tools Needed: A 7/16" open wrench or torque wrench with 7/16" crowfoot wrench adapter.

Part #: The parts come with the actuator. Retrofit kit # is 25972R (Includes 4 sets of bolts, washers, retainers & E-clips).

- 1. Install the Grooved Bolt and Washer and torque them to 6 lb-ft. See figure 5-48 (a).

NOTE

It may be necessary to adjust the bolt position so that one of the bolt edges is parallel to line A and B, then the retainer will drop-on easily. If required, tighten bolt further for this alignment.



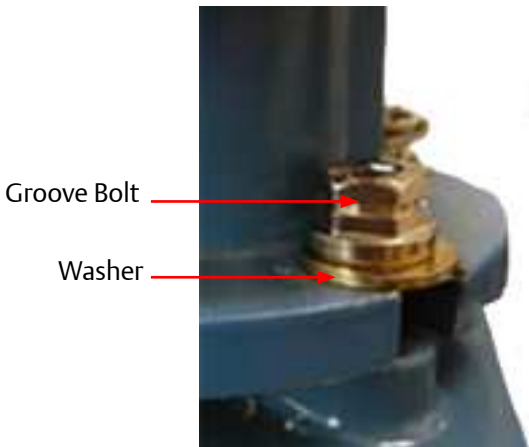
- 2. Position Locking Retainer over Grooved Bolt, with the shallow curved edge toward the center of the command shaft housing. See figure 5-48 (b).

NOTE

The locking retainer hex hole is offset 3° so flipping it over gives it new positioning.



- 3. Push E-Clip into Grooved Bolt Head. Once E-clip is on make sure it rotates back and forth freely. This will ensure E-Clip is completely seated. See figure 5-48 (c).



(a) Groove bolt and washer



(b) Locking Retainer



(C) E-clip

Figure 5-48. Actuator Installation Using Anti-Rotation Bolts

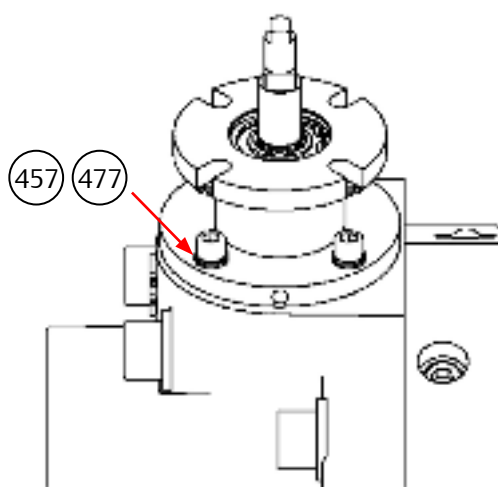
### Slide Valve Command Shaft Assembly Replacement

#### Removal

##### NOTE

The following steps can be used to remove or install either the capacity or volume command shaft assemblies.

1. Shut down and isolate compressor unit, see Compressor Unit Shutdown and Isolation procedure.
2. Remove actuator, see Actuator Assembly Replacement procedure.
3. Remove four socket head cap screws (457) and Nord-Lock washers (477) securing the command shaft assembly to the discharge manifold.
4. The command shaft and mounting plate may now be removed from the compressor.



#### Installation

5. Install a new o-ring (446) into the groove on the compressor discharge manifold. You may use clean compressor lubricating oil on the o-ring.
6. Install the command shaft onto the compressor discharge manifold. Ensure that the command shaft tongue is engaged in the cross-shaft slot inside the compressor discharge manifold. Rotate the command shaft assembly so that the vent holes point downward. This will prevent water and dust from entering the vent.
7. Secure the command shaft assembly to the discharge manifold using the four socket head cap screws and Nord-Lock washers and apply the proper torque.
8. Perform leak check, see Compressor Unit Leak Check Procedure.

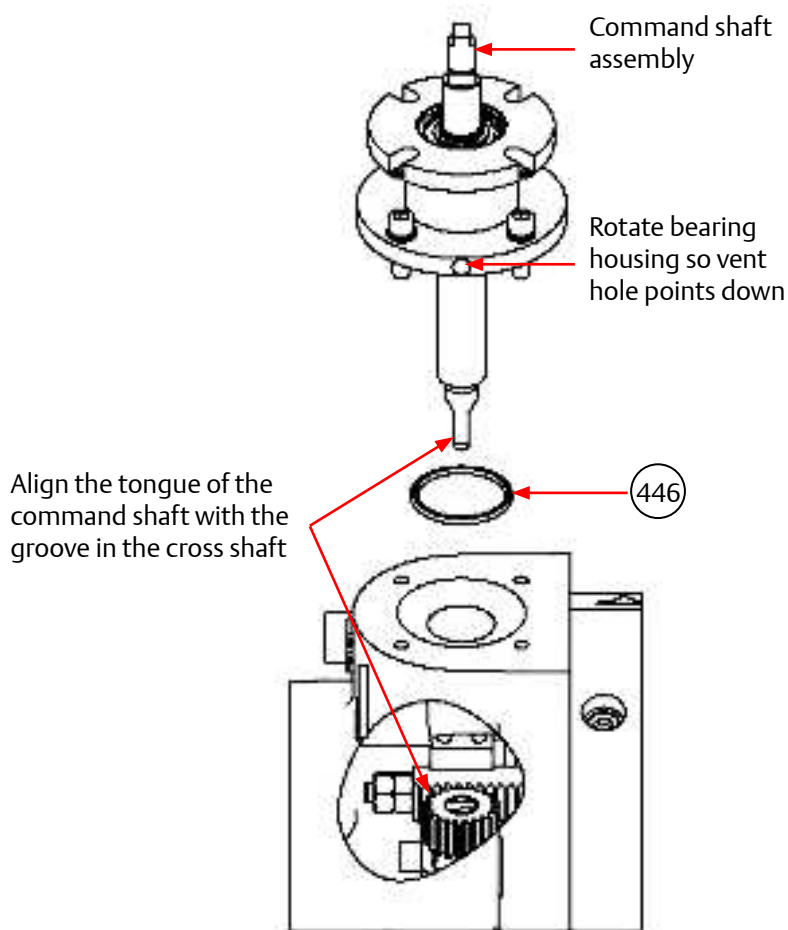


Figure 5-49. Command Shaft Assembly Replacement

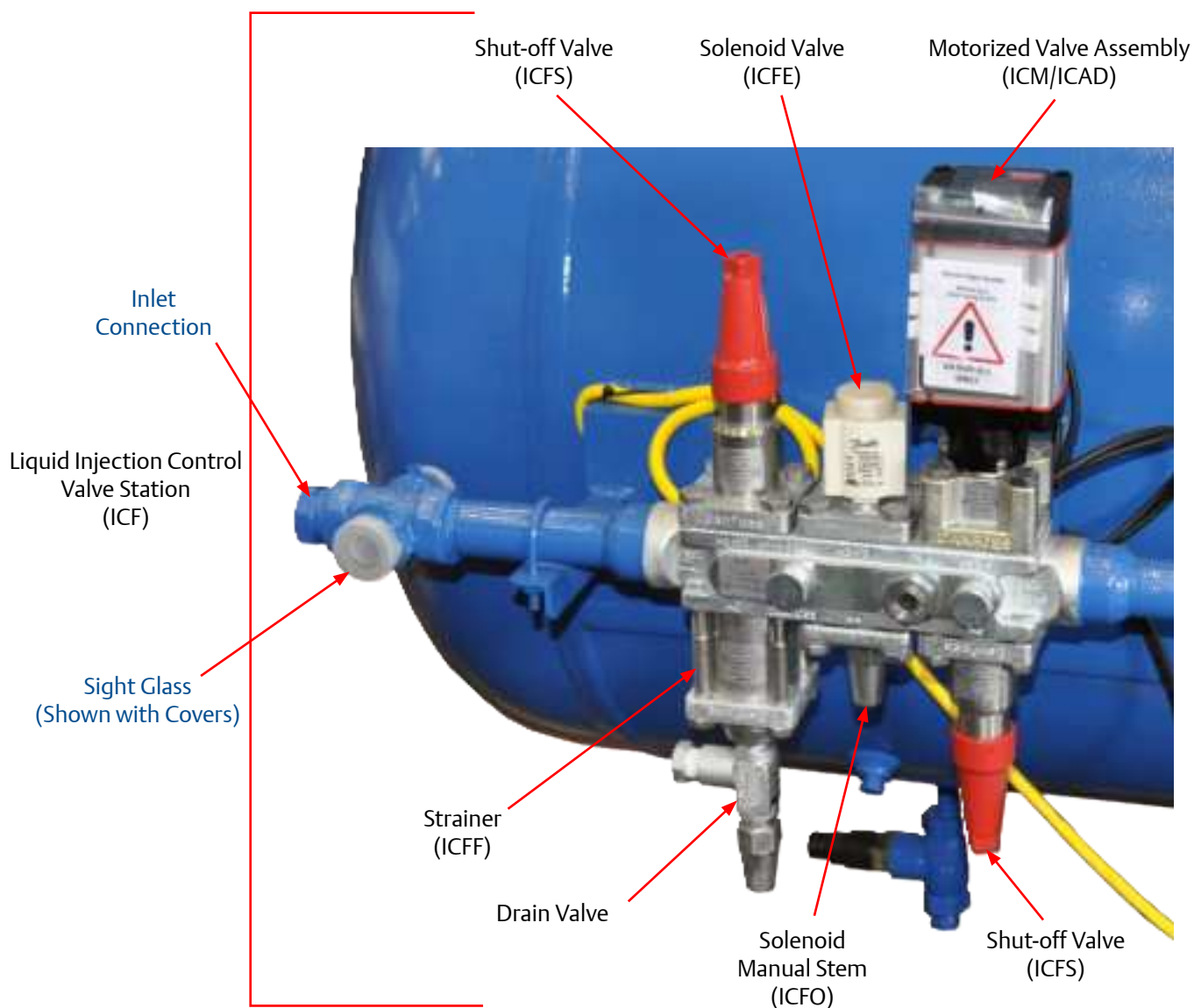
### Liquid Injection Control Valve Station (Danfoss ICF 20-40 Valve Station)

For liquid injection control operation, refer to Section 2. For additional information regarding setup, installation, programming and troubleshooting, refer to Appendices.

The liquid injection control valve station (ICF) consists of these parts (Danfoss part acronyms are shown in parentheses):

- Shut-off Valves (ICFS), Inlet and Outlet
- Solenoid Valve (ICFE) with Manual Stem (ICFO)
- Motorized Valve Assembly (ICM valve assembly with ICAD motor actuator)
- Strainer (ICFF) with Drain Valve

For parts and service kits, refer to Tables 5-10 and 5-11.



**Figure 5-50. Danfoss ICF 20-40 Valve Station (Liquid Injection Control)**



Table 5-10. Coils for Solenoid Valves (ICFE)

VILTER™ PART NO	VOLTAGE	Hz	HOLDING	CONNECTION	PILOT LIGHT
3389DA	110-120VAC	60	14W	DIN	
3389DB	110-120VAC	60	14W	DIN	GREEN
3389DC	110VAC	60	12W	TERMINAL BOX	GREEN
3389DD	220VAC	60	12W	TERMINAL BOX	GREEN
3389DD1	220VAC W/110VAC LED BOX	60	12W	-	LED

Table 5-11. Parts for Motorized Valve Station (ICF)

VILTER™ PART NO	DESCRIPTION
3389EA	ICAD 600 MOTOR ACTUATOR W/10M CABLES
3389EE	ICAD 900 MOTOR ACTUATOR W/10M CABLES
3389AE1	CABLES, 10M FOR ICAD ACTUATOR
3389AE2	TOP COVER FOR ICAD ACTUATOR
3389EB	CONTROLLER EKC 347, LIQUID LEVEL
3389FD	MODULE B66 FUNCTION (FOR ICF VALVE STATION)
3389FA	MAGNETIC TOOL FOR ICM VALVE MANUAL OPERATION 20,25, AND 32
3389FC	MAGNETIC TOOL FOR ICM VALVE MANUAL OPERATION 40, 50, AND 65
3389FB	ICM 20 SERVICE KIT (VALVE SEAT)
3389FE	ICM 25 SERVICE KIT (VALVE SEAT)
3389FF	ICM 32 SERVICE KIT (VALVE SEAT)






### Main Rotor Assembly

Due to the procedures and tools involved in the disassembly and reassembly, the main rotor assembly must be performed by qualified individuals. Please consult the factory if maintenance is required.

### Torque Specifications

Refer to the following table for torque specifications.

**Table 5-12. Torque Specifications (ft-lbs)**

TYPE BOLT	HEAD MARKINGS	NOMINAL SIZE NUMBERS OR INCHES									
		#10	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8
SAE GRADE 2 COARSE (UNC)			5	10	18	29	44	63	87	155	150*
SAE GRADE 5 COARSE (UNC)			8	16	28	44	68	98	135	240	387
SAE GRADE 5 FINE (UNF)				16							
SAE GRADE 8 COARSE (UNC)			11	22	39	63	96	138	191	338	546
SOCKET HEAD CAP SCREW (ASTM A574) COARSE (UNC)		5	13	26	46	73	112	155	215	380	614
NOTES:	1) Torque values on this sheet are not to override those given on the individual drawings.										
	2) When using loctite, the torque value on this sheet are only accurate if bolts are tightened immediately after loctite is applied.										
	* The proof strength of Grade 2 bolts is less for sizes 7/8 and above and therefore the torque values are less than smaller sizes of the same grade.										



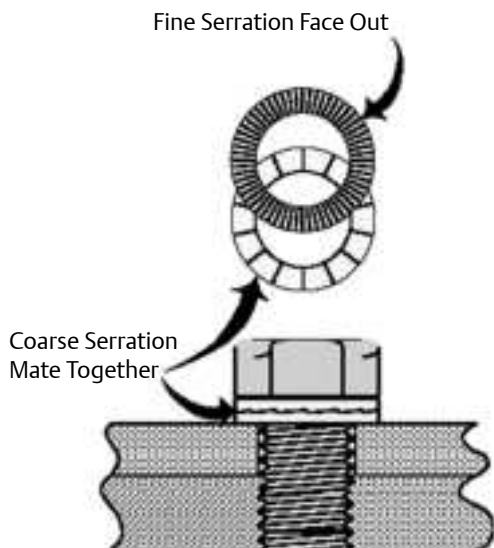
### Using A Torque Wrench Correctly



#### Torque Wrenches

USING A TORQUE WRENCH CORRECTLY INVOLVES FOUR PRIMARY CONCERNS:

- A. A smooth even pull to the break point is required. Jerking the wrench can cause the pivot point to break early leaving the bolt at a torque value lower than required. Not stopping when the break point is reached results in an over torque condition.
- B. When more than one bolt holds two surfaces together there is normally a sequence that should be used to bring the surfaces together in an even manner. Generally bolting is tightened incrementally in a diametrically staggered pattern. Some maintenance manuals specify a tightening scheme. If so, the manual scheme shall be followed. Just starting on one side and tightening in a circle can cause the part to warp, crack, or leak.
- C. In some cases threads are required to be lubricated prior to tightening the bolt/nut. Whether a lubricant is used or not has considerable impact on the amount of torque required to achieve the proper preload in the bolt/stud. Use a lubricant, if required, or not if so specified.
- D. Unlike a ratchet wrench a torque wrench is a calibrated instrument that requires care. Recalibration is required periodically to maintain accuracy. If you need to remove a bolt/nut do not use the torque wrench. The clockwise/counterclockwise switch is for tightening right hand or left hand threads not for loosening a fastener. Store the torque wrench in a location where it will not be bumped around.



#### Nord-Lock® Washers

- A. The Nord-Lock® lock washer sets are used in many areas in the single screw compressors that require a vibration proof lock washer.
- B. The lock washer set is assembled so the coarse serrations that resemble ramps are mated together.
- C. Once the lock washer set is tightened down, it takes more force to loosen the bolt that it did to tighten it. This is caused by the washers riding up the opposing ramps.



Table 6-1. Slide Valve Actuator Troubleshooting Guide (1 of 3)

Problem	Reason	Solution
The actuator cannot be calibrated.	Dirt or debris is blocking one or both optocoupler slots.	Clean the optocoupler slots with a cotton swab and rubbing alcohol.
	The photo-chopper fence extends less than about half way into the optocoupler slots.	Adjust the photo-chopper so that the fence extends further into the optocoupler slots. Make sure the motor brake operates freely and the photo-chopper will not contact the optocouplers when the shaft is pressed down.
	The white calibrate wire in the grey Turck cable is grounded.	Tape the end of the white wire in the panel and make sure that it cannot touch metal.
	Dirt and/or condensation on the position sensor boards are causing it to malfunction.	Clean the boards with an electronics cleaner or compressed air.
	The calibrate button is stuck down.	Try to free the stuck button.
	The position sensor has failed.	Replace the actuator.
	Push button is being held down for more than $\frac{3}{4}$ second when going through the calibration procedure.	Depress the button quickly and then let go. Each $\frac{3}{4}$ second the button is held down counts as another press.

## Section 6 • Troubleshooting

**Table 6-1. Slide Valve Actuator Troubleshooting Guide (2 of 3)**

Problem	Reason	Solution
The actuator goes into calibration mode spontaneously.	The white calibrate wire in the grey Turck cable is grounding intermittently.	Tape the end of the white wire in the panel and make sure that it cannot touch metal.
	A very strong source of electromagnetic interference (EMI), such as a contactor, is in the vicinity of the actuator or grey cable.	Increase the distance between the EMI source and the actuator. Install additional metal shielding material between the EMI source and the actuator or cable.
	There is an intermittent failure of the position sensor	Replace the actuator.
The actuator goes into calibration mode every time power is restored after a power loss	The motor brake is not working properly.	Get the motor brake to where it operates freely and recalibrate.
	The position sensor's EEPROM memory has failed	Replace the actuator.
The actuator does not transmit the correct position after a power loss.	The motor was manually moved while the position sensor was not powered.	Recalibrate.
	The motor brake is not working properly.	Get the motor brake to where it operates freely and recalibrate.
	The position sensor's EEPROM memory has failed	Replace the actuator.
There is a rapid clicking noise when the motor is operating.	The photo-chopper is misaligned with the slotted optocouplers.	Try to realign or replace the actuator.
	The photo-chopper is positioned too low on the motor shaft.	Adjust the photo-chopper so that the fence extends further into the optocoupler slots.
	A motor bearing has failed	Replace the actuator.
The motor operates in one direction only	There is a loose connection in the screw terminal blocks.	Tighten
	There is a loose or dirty connection in the yellow Turck cable.	Clean and tighten
	The position sensor has failed.	Replace the actuator.
	There is a broken motor lead or winding	Replace the actuator.

Table 6-1. Slide Valve Actuator Troubleshooting Guide (3 of 3)

Problem	Reason	Solution
The motor will not move in either direction	The thermal switch has tripped because the motor is overheated	The motor will resume operation when it cools. This could be caused by a malfunctioning control panel. Consult the factory.
	Any of the reasons listed in “The motor operates in one direction only”	See above.
	The command shaft is jammed.	Free the command shaft.
	Broken gears in the gear-motor.	Replace the actuator.
	Blown relays or fuses.	Check and replace blown relays and/or fuse
The motor operates intermittently, several minutes on, several minutes off.	Motor is overheating and the thermal switch is tripping.	This could be caused by a malfunctioning control panel. Consult the factory.
The motor runs sporadically	Bad thermal switch.	Replace the actuator.
	Any of the reasons listed in “The motor operates in one direction only”	See above.
The motor runs but output shaft will not turn.	Stripped gears inside the gear rotor, or the armature has come unpressed from the armature shaft.	Replace the actuator.

## Section 6 • Troubleshooting

Slide Valve Actuators communicate problems discovered by internal diagnostics via LED blink codes. Only one blink code is displayed, even though it is possible that more than one problem has been detected.

**Table 6-2. Slide Valve Actuator LED Blink Codes\* (1 of 2)**

Flash Pattern * = ON - = OFF	Meaning
* _ * _ * _ * _ * _ * _ * _	Calibration step 1.
* _ _ * _ _ * _ _ * _ _ * _ _	Calibration step 2.
* _ _ * _ _ _ _ _ _ _ _ _ _ _	<p>This indicates a zero span. This error can only occur during calibration. The typical cause is forgetting to move the actuator when setting the upper limit of the span. If this is the case, press the blue button to restart the calibration procedure. This error can also occur if either or both of the slotted optocouplers are not working. If this is the case, the slide valve actuator will have to be replaced.</p> <p>The operation of the slotted optocouplers can be tested as follows:</p> <ol style="list-style-type: none"> <li>1. Manually rotate the motor shaft until the aluminum photo-chopper fence is not blocking either of the optocoupler slots.</li> <li>2. Using a digital multimeter, measure the DC voltage between terminal 3 of the small terminal block and TP1 on the circuit board (see Note 1). The measurement should be between 0.1 and 0.2 Volts.</li> <li>3. Next, measure the DC voltage between terminal 3 and TP2 on the circuit board. You should measure between 0.1 and 0.2 Volts.</li> </ol>
* _ _ _ _ _ _ _ _ _ _ _ _ _ _	<p>This error means that the slide valve actuator is no longer transmitting accurate position information. The actuator should be recalibrated as soon as possible, after the cause of the over-speed is identified and corrected. This error will not clear until the actuator is re-calibrated.</p> <p>This code can be caused by:</p> <ol style="list-style-type: none"> <li>1. The motor speed exceeding the position sensors ability to measure it at some time during operation. A non-functioning motor brake is usually to blame.</li> <li>2. The actuator is being operated where strong infrared light can falsely trigger the slotted optocouplers, such as direct sunlight. Shade the actuator when the cover is off for service and calibration. Do not operate the actuator with the cover off.</li> </ol>

## Section 6 • Troubleshooting

Table 6-2. Slide Valve Actuator LED Blink Codes (2 of 2)

Flash Pattern * = ON - = OFF	Meaning
* _ * _ * _ _ _ _ _ _ _ _ _ _	<p>The motor is overheated. The actuator motor will not run until it cools. Once the motor cools, the actuator will resume normal operation.</p> <p>Motor overheating is sometimes a problem in hot humid environments when process conditions demand that the slide valve actuators reposition often. Solutions are available; consult your Vilter™ authorized distributor for details.</p> <p>Another possible cause for this error is a stuck motor thermal switch. The thermal switch can be tested by measuring the DC voltage with a digital multimeter between the two TS1 wire pads (see Note 2). If the switch is closed (normal operation) you will measure 0 Volts.</p>
* _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	<p>The 24V supply voltage is low. This will occur momentarily when the actuator is powered up and on power down.</p> <p>If the problem persists, measure the voltage using a digital multimeter between terminals 3 and 4 of the small terminal block. If the voltage is less than 24V, the problem is in the supply to the board. If the voltage is <math>\geq 24V</math>, replace the actuator.</p>
_ * _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	<p>The EEPROM data is bad. This is usually caused by loss of 24V power before the calibration procedure was completed. The actuator will not move while this error code is being displayed. To clear the error, calibrate the actuator. If this error has occurred and the cause was not loss of 24V power during calibration, possible causes are:</p> <ol style="list-style-type: none"> <li>1. The EEPROM memory in the micro-controller is bad.</li> <li>2. The large blue capacitor is bad or has a cracked lead.</li> </ol>
* _ _ _ _ _ _ _ _ _ _ * _ _ _ _ _ _ _ _ _ _	<p>Micro-controller program failure. Please notify your Vilter™ authorized distributor.</p>

\*There are two versions of slide valve actuators, version A and B. Only version B is able to display LED blink codes. Slide valve actuator version B can be distinguished by only having a single circuit board as supposed to two circuit boards in version A.

Note 1: TP1 and TP2 are plated-thru holes located close to the slotted optocouplers on the board. They are clearly marked on the board silkscreen legend.

Note 2: The TS1 wire pads are where the motor thermal switch leads solder into the circuit board. They are clearly marked on the board silkscreen legend and are oriented at a 45 degree angle.

## Section 6 • Troubleshooting

Table 6-3. Troubleshooting Guide - General Problems & Solutions (1 of 3)

Problem	Solution
Low Oil Pressure at Start	<ul style="list-style-type: none"> <li>• After failing to start compressor with “Prelube Oil Pump Inhibit”, first allow Discharge pressure, Oil Filter In pressure and Out pressure to equalize. Then restart compressor. If compressor fails to start due to low oil pressure, continue troubleshooting with items below.</li> <li>• Reset Prelube Oil Pressure Setpoint in Alarms and Trip Setpoints screen to lowest recommended setpoints.</li> <li>• Check calibration of oil manifold transducer, discharge pressure transducer, and suction transducer.</li> <li>• Check for correct oil pump motor rotation and operation.</li> <li>• Ensure transducer isolation valves are open.</li> <li>• Verify that the correct transducer ranges are selected.</li> <li>• Check to see all oil line valves are open except the oil dump valve used to fill the lines and oil cooler.</li> <li>• Check oil strainer for dirt.</li> <li>• Check oil filter pressure drop.</li> <li>• Check “Prelube Oil Pressure Safety Changeover” setpoint is sufficient in Timers Screen.</li> <li>• Prelube Oil Pressure is Manifold Pressure minus Discharge Pressure.</li> </ul>
Low Run Oil Pressure	<ul style="list-style-type: none"> <li>• Check solutions in “Low Oil Pressure at Start”.</li> <li>• Check that there is proper discharge pressure ratio to create differential pressure, otherwise oil pressure can’t be maintained. Oil pressure is manifold oil pressure minus the suction pressure. It is a net pressure.</li> </ul>
Oil flow or oil pressure problems	<ul style="list-style-type: none"> <li>• Clean oil strainer screen.</li> <li>• Change oil filter, maybe plugged or collapsed.</li> <li>• Oil pump gears worn internally, excessive end-clearance.</li> <li>• Oil priming valve used on air-cooled cooler units is open.</li> <li>• Relief in-line check valve stuck open.</li> <li>• Pressure ratio too low, oil pump should be on.</li> </ul>
Faulty pressure or temperature readings	<ul style="list-style-type: none"> <li>• Check that the correct pressure or temperature range is selected in the Instrument Calibration menu.</li> <li>• Check cable connections at device, terminal strips, and PLC input card for correct wiring and shielding (RF noise).</li> <li>• Check calibration of RTDs and transducers.</li> </ul>



**Table 6-3. Troubleshooting Guide - General Problems & Solutions (2 of 3)**

Problem	Solution
Oil Loss Issues	<ul style="list-style-type: none"> <li>Oil return line from coalescing side of oil separator to suction is closed, not open enough (3/4 turns should be sufficient), or plugged with debris</li> <li>The check valve in the oil return line could be stuck closed or the flow is in the wrong direction</li> <li>There may be water in the oil affecting the coalescing elements</li> <li>Coalescent elements in need of replacement due to age or damage (water contamination)</li> <li>The operating conditions are not correct (too high of suction and/or too low discharge pressure) This creates increased gas flow which could make the oil separator too small</li> <li>The suction or discharge check valve is not working correctly causing oil to escape when the unit stops</li> <li>Viscosity of oil incorrect; send sample for testing</li> <li>There is an oil leak somewhere in the system</li> </ul>
High oil temperature (liquid injection)	<ul style="list-style-type: none"> <li>Check for correct setting of all manual values.</li> <li>Check for correct operation of 3-way oil mixing valve.</li> <li>If you are controlling a step type oil cooler or a VFD oil cooler, verify the correct one is selected in the Configuration Screen and the amount of steps are entered in the Remote Oil Cooler Control Screen.</li> <li>Check the oil cooler and associated piping to make sure it is full of oil before starting.</li> <li>Check the oil strainer for debris and clean if necessary.</li> <li>Verify that the volume slide actuator is functioning correctly and that the correct compressor size (type) is selected.</li> <li>Check that all fans are working.</li> <li>Check for correct fan rotation on the oil cooler.</li> <li>Check that your operating conditions are within the “As Sold” design conditions.</li> </ul>
Capacity/Volume Slide Actuator Alarms/Trips/Symptoms:	<ul style="list-style-type: none"> <li>Calibration method not correct</li> <li>Actuator or Gear motor not working, or off on overload</li> <li>Slide valve carriage assembly out of position, slides binding</li> <li>Cross-shaft gears, broken pins</li> <li>Command shaft broken</li> <li>Slide valve rack or rack shaft damaged</li> <li>Check balance piston movement</li> <li>Reference Slide Valve Actuator Troubleshooting Guide</li> <li>Check I/O fusing</li> </ul>

## Section 6 • Troubleshooting

Table 6-3. Troubleshooting Guide - General Problems & Solutions (3 of 3)

Problem	Solution
High Amp Draw	<ul style="list-style-type: none"><li>• Check calibration at full load.</li><li>• Check CT ratio entered in Vission 20/20.</li><li>• Check slide valve calibration, especially volume slide.</li></ul>
Vibration	<ul style="list-style-type: none"><li>• Check that unit is leveled and secured to mounting pad or floor.</li><li>• Check supported pipes (i.e. suction and discharge pipe) and make sure they are adequately supported.</li><li>• Check for loose bolts and nuts.</li><li>• Check condition of compressor and motor (i.e. alignments)</li></ul>
Excessive Motor Backspin	<ul style="list-style-type: none"><li>• If there is more than normal motor backspin at shutdown, check suction check valve for proper operation.</li></ul>

### Warranty Claim Processing

This section explains how the warranty claim is processed and to help clear any questions that may arise prior to contacting customer service. For additional warranty information, refer to the Terms and Conditions of your order. Vilter™ contact information can be found on page iii.

1. The warranty process starts with contacting a Vilter Service and Warranty (S&W) department representative. *Ensure to have the original Vilter sales order number for the equipment available to better assist you.*
2. Our Vilter S&W representative will confirm if the equipment is within the warranty time frame as described in the warranty statement.

If the equipment (Part/Compressor/Compressor Motor) is within the warranty time frame, proceed to the following section regarding the type of equipment:

#### Process for returning Products covered by the warranty:

**STEP 1.** To return a defective Product or part under this warranty, you will need to provide the Vilter™ compressor order number on all submitted documents.

For a parts warranty request, you will also need to provide:

- The Vilter™ serial number of the compressor;
- A detailed and accurate description of the issue;
- A valid purchase order for the new part(s)—you must pay the freight;
- One copy of Return Merchandise Authorization (RMA) sent to you for your records;
- One copy of RMA sent to you to include in the return shipment of parts back to Vilter™ for warranty consideration.

**STEP 2.** Return the parts (freight prepaid) to:

**VILTER MANUFACTURING CORPORATION**  
5555 South Packard Avenue  
Cudahy, WI 53110-8904

**STEP 3.** Upon receipt of the returned part(s), Vilter™ will complete a timely evaluation of the part(s).

**STEP 4.** You will be contacted with Vilter's decision once the final report is completed.

**STEP 5.** If approved, the approved warranty will be credited (excluding freight) to your account. Vilter™ will retain the returned part(s) for final disposition. If a warranty request is not approved, you will be provided with a written response and the parts will be held for 30 days. After such time, Vilter™ will dispose of the parts. If you wish to have the part(s) returned, you will need to contact Vilter™ and the part(s) will be returned freight collect.

#### Procedure for parts not manufactured by Vilter™:

Although Vilter™ does not provide any warranty for parts and products that are not manufactured by Vilter™, Vilter™ does pass through any manufacturer's warranty to you (to the maximum extent permitted by the manufacturer). Vilter™ will work with you in facilitating your warranty claim with the manufacturer.

To facilitate your warranty claim, please follow the following four steps:

**STEP 1.** Determine if the part or product is within the OEM's warranty.

**STEP 2.** If the defective part or product is not a motor, send a description containing the specifications of the part/product and the defect to:

[Service.Vilter@Emerson.com](mailto:Service.Vilter@Emerson.com)

If the defective part or product is a motor or starter, please complete the form on the next page and return it to:

[Service.Vilter@Emerson.com](mailto:Service.Vilter@Emerson.com).

**STEP 3.** Vilter™ will communicate with you, if necessary, to ascertain additional information and will reasonably assist with the OEM to determine the part/product's warranty status.



## Motor Warranty Procedure

To facilitate your warranty claim, please follow the steps outlined below:

1. Determination if motor is within the OEM warranty.
2. Please complete the following and return to [Service.Vilter@Emerson.com](mailto:Service.Vilter@Emerson.com), along with a picture of the motor's nameplate.
3. Vilter will assist with the motor OEM to determine the motor's warranty status.

Model: _____	
Serial Number: _____	
Manufacturer: _____	
Run Hours: _____	Start Date: ____/____/____ Month Day Year
Grease Type: _____	
	<div>Starter Type:</div> <div><input type="checkbox"/> Soft Start</div> <div><input type="checkbox"/> Across the Line</div> <div><input type="checkbox"/> VFD</div>
Alignment Data Available: <input type="checkbox"/> Yes, please include with information	<input type="checkbox"/> No
Lubrication Records Available: <input type="checkbox"/> Yes, please include with information	<input type="checkbox"/> No
Vibration Report: <input type="checkbox"/> Yes, please include with information	<input type="checkbox"/> No

Describe Motor Symptoms:

#### 4. If the motor falls within the OEM's warranty time frame:

- The motor will need to be taken to a manufacturer approved shop for diagnosis. Vilter can help with locating motor shops that are manufacturer approved in your area. The shop will diagnose the root cause, submit a report to the OEM, and the motor OEM will make the determination of warranty coverage.
- If warranty is approved, the OEM will either have the motor repaired by the motor shop or send a new replacement motor to the site.

**Note:** Motor warranty is a "pass thru warranty" as stated in Vilter Manufacturing's standard warranty statement which means that the original motor OEM is the provider of the warranty. Vilter does assist with the expediting of the claim but any dispensation of warranty is provided solely by the motor OEM.

Motor manufacturer warranty covers only repair or replacement of the motor. It does not cover removal and installation charges, incidental charges associated with the removal and installation process, loss of product or shipping to and from the manufacturer or approved shop. This is standard motor manufacturer warranty policy regardless of brand or application. If the end user requires additional information regarding warranty coverage, the individual motor manufacturer warranty terms can be found on their associated websites.

## Section 7 • Warranty and Parts

**STEP 4.** For defective motor or starter claims, if the motor or starter falls within the OEM's warranty time frame:

- The motor or starter will need to be taken to a manufacturer approved shop for diagnosis. Vilter™ can help you locate motor shops in your area that are manufacturer approved. The shop will diagnose the root cause, submit a report to the OEM, and the motor OEM will make the determination of warranty coverage.
- If a warranty claim is approved, the OEM will either have the motor or starter repaired by the motor shop or send a new replacement motor to the site.

### On-Site Service Support

If on site support is required, contact a Vilter S&W department representative to start this process.

*Warranty does not cover labor or expenses.*

1. A quote, a service rate sheet, and the service terms and conditions will be provided.
2. Submit a PO.
3. Schedule the service visit.

### Remanufactured Bare Shaft Single Screw Compressor Process

These instructions are an overview of how the process works when a bare shaft compressor is in need of being remanufactured. This is to help clear any questions that may arise prior to contacting customer service.

The process begins by contacting Vilter's Customer Service Department. Vilter contact information can be found on page iii.

- Request a "VSS/VSM Single Screw Compressor Rebuild Form".
- Submit the Rebuild Form and a Purchase Order (PO) for the inspection. A fee is required for the initial inspection and tear down report; contact Vilter Customer Service representative for the latest fee.
- A Return Material Authorization (RMA) number will be provided.
- Send the compressor to Vilter in the condition as stated on the Rebuild Form (i.e. no oil in the compressor). Charges may apply if conditions are not met.

- A report will be sent to you after the inspection has been completed explaining what level of rebuild is necessary along with the cost.

#### NOTE

Inspection and rebuild times will vary, contact Vilter Customer Service representative for further details.

- Submit a new PO for the amount that will be needed for the rebuild. The inspection cost will be waived upon receipt of the new PO. Make sure to provide your "Ship to Address" and "Billing Address".

### Explanation of Rebuild Levels

#### Level 1

Compressor is in good condition. Replace bearings, gaskets, shaft seal and O-rings. All hardware is intended to be re-used (when possible). Parts are organized in part kit form.

#### Level 2

Compressor is in good condition, but requires new gate rotor blades. Replace all items in Level 1 plus new gate rotor blades and bushings.

#### Level 3

Current Reman Compressor requires complete rebuilding and re-conditioning to "as-new" condition. All the components listed in Level 2 are replaced plus all hardware, slide assemblies, pistons, and a main rotor (if damaged) and/or gate rotor supports.

#### NOTE

A Level 1 and Level 2 rebuild will include washing the housing and repainting over the current paint. A Level 3 rebuild will include blasting all the current paint off before repainting.

### Bare Shaft Compressor Description

Single Screw Bare Shaft Compressor features include:

- Cast grey iron frame with cast ductile iron discharge manifold and gate rotor covers with discharge connection horizontal.
- Standard drive shaft is tapered.
- Standard slide assembly.
- Viton shaft seal O-rings.
- Crating with Purge & Gauge.
- Does not include hand wheels or slide valve motors.



## **VSH/VSSH Recommended Spare Parts List**

**For VSH/VSSH compressor spare parts,  
please contact Vilter Engineering Service for the list.**

### **Note**

**Please have your Model # and Sales Order # available when ordering.  
These are found on the compressor's Name Plate.**

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.





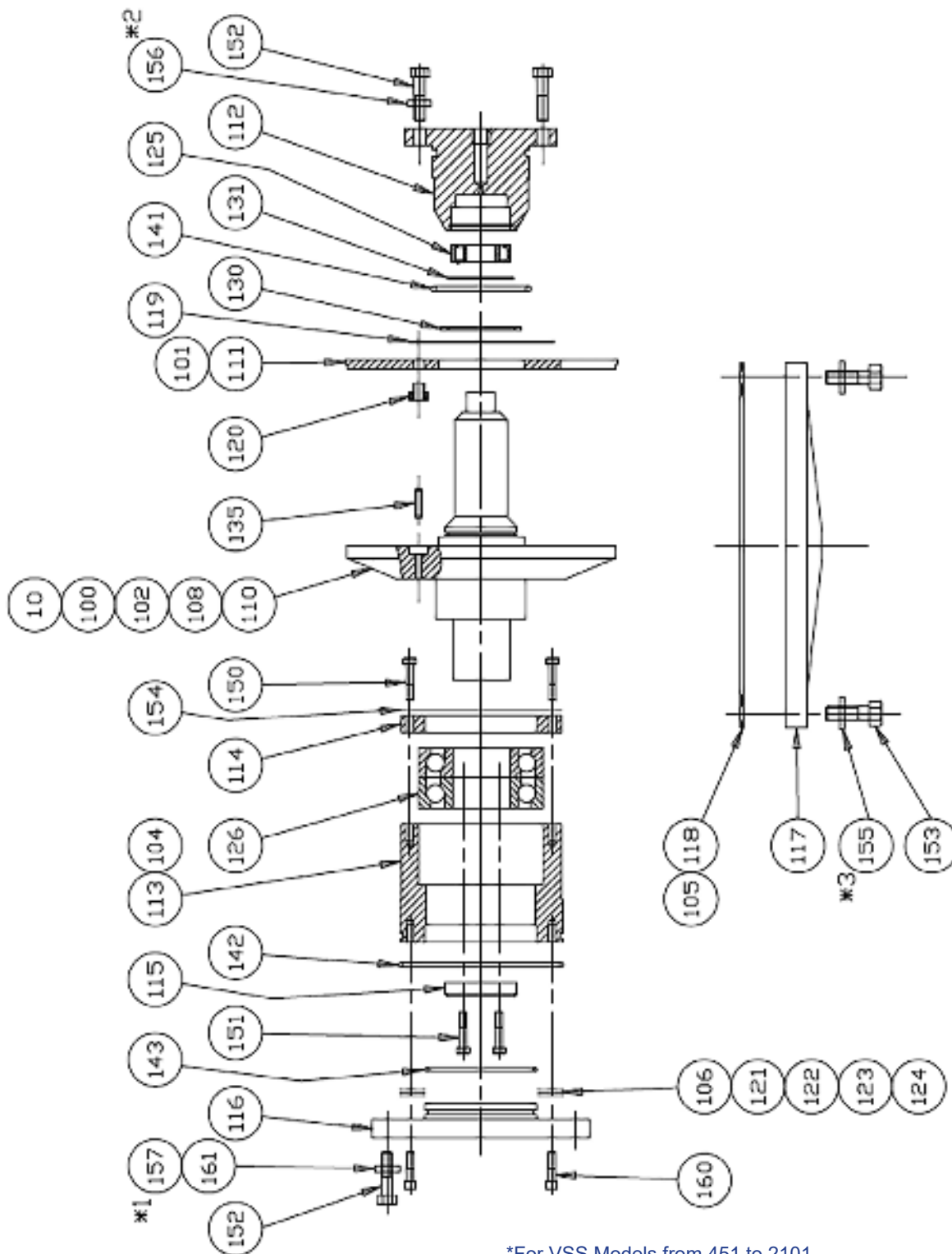
**VSS  
Recommended  
Spare Parts List**

**Refer to the Custom Manual  
Spare Parts Section for Specific Applications**

**Please have your Model # and Sales Order # available when ordering.  
These are found on the compressor's Name Plate.**

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

## Gaterotor



\*For VSS Models from 451 to 2101

Filter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

## Section 8 • Spare Parts List

### Gaterotor

ITEM	DESCRIPTION	MODEL NUMBER					
		VSS 451		VSS 601		VSS 751	
		QTY	VPN	QTY	VPN	QTY	VPN
-	Gaterotor BLADE AND BEARING REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 125, 126, 130, 131, 141, 142, 143)	AR	KT712A	AR	KT712B	AR	KT712C
-	Gaterotor BLADE REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 130, 141, 142, 143)	AR	KT713A	AR	KT713B	AR	KT713C
100	SUPPORT ASSEMBLY 110 & 135B.	2	A25159BB	2	A25159BA	2	A25159CB
102	Gaterotor SUPPORT ASSEMBLY (100, 111, 120B, 119, 130)	2	A25161BB	2	A25161BA	2	A25161CB
105	Gaterotor GASKET SET (118, 141, 142, 143)	2	A25164B	2	A25164B	2	A25164C
106	SHIM PACK SET ((2) 121, (2) 122, (1) 123, (1) 124)	2	A25165B	2	A25165B	2	A25165C
110	SUPPORT	2	25606A	2	25520A	2	25612A
111	Gaterotor	2	25557A	2	25534A	2	25608A
112	SMALL BEARING HOUSING	2	25518D	2	25518D	-	N/A
113	LARGE BEARING HOUSING	2	25517A	2	25517A	-	N/A
114	RETAINER	2	25008A	2	25008A	-	N/A
115	RETAINER	2	25009A	2	25009A	-	N/A
116	BALL BEARING COVER	2	25258A	2	25258A	-	N/A
117	Gaterotor COVER	2	25519A	2	25519A	-	N/A
118	Gaterotor COVER GASKET	2	25259A	2	25259A	2	25088A
119	WASHER	2	25007A	2	25007A	2	25086A
120A	BUSHING, SMALL DOWEL PIN	2	25006A	2	25006A	2	25087A
120B	BUSHING, LARGE DOWEL PIN	2	25760A	2	25760A	2	25760B
121	SHIM 0.002"	AR	25010AA	AR	25010AA	AR	25089AA
122	SHIM 0.003"	AR	25010AB	AR	25010AB	AR	25089AB
123	SHIM 0.005"	AR	25010AC	AR	25010AC	AR	25089AC
124	SHIM 0.010"	AR	25010AD	AR	25010AD	AR	25089AD
125	ROLLER BEARING	2	2864B	2	2864B	2	2864C
126	BALL BEARING	4	2865BP	4	2865BP	4	2865A
130	RETAINING RING	2	2866A	2	2866A	2	2866B
131	RETAINING RING	2	2867A	2	2867A	2	2867E
135A	DOWEL PIN, SM, 0.250" O.D.	2	2868B	2	2868B	2	2868F
135B	DOWEL PIN, LG, 0.4375" O.D.	2	25910A	2	25910A	2	25910B
141	O-RING ROLLER BEARING HOUSING	2	2176M	2	2176M	2	2176N
142	O-RING BALL BEARING HOUSING	2	2176R	2	2176R	2	2176CQ
143	O-RING BRG HSG COVER	2	2176N	2	2176N	2	2176U
150	HEX HEAD CAP SCREW ( 1/4-20 NC X 1-1/4 )	12	2796AJ	12	2796AJ	-	N/A
151	HEX HEAD CAP SCREW (5/16-18 NC X 1-1/4)	6	2796B	6	2796B	-	N/A
152	HEX HEAD CAP SCREW ( 3/8-16 NC X 1-1/4)	40	2796CJ	40	2796CJ	-	N/A
153	HEX HEAD CAP SCREW (1/4-20 NC X 1)	32	2795E	32	2795E	-	N/A
160	SOCKET HEAD CAP SCREW	12	2795E	12	2795E	-	N/A

AR = As required

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

## Section 8 • Spare Parts List

### Gaterotor

ITEM	DESCRIPTION								
		VSS 901		VSS 1051		VSS 1201		VSS 1301	
		QTY	VPN	QTY	VPN	QTY	VPN	QTY	VPN
-	Gaterotor BLADE AND BEARING REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 125, 126, 130, 131, 141, 142, 143)	AR	KT712D	AR	KT712E	AR	KT712F	AR	KT712Y
-	Gaterotor BLADE REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 130, 141, 142, 143)	AR	KT713D	AR	KT713E	AR	KT713F	AR	KT713Y
100	SUPPORT ASSEMBLY 110 & 135B.	2	A25159CA	2	A25159DB	2	A25159DA		
102	Gaterotor SUPPORT ASSEMBLY (100, 111, 120B, 119, 130)	2	A25161CA	2	A25161DB	2	A25161DA	2	A25161DH
105	Gaterotor GASKET SET (118, 141, 142, 143)	2	A25164C	2	A25164D	2	A25164D	2	A25164D
106	SHIM PACK SET ((2) 121, (2) 122, (1) 123, (1) 124)	2	A25165C	2	A25165C	2	A25165C	2	A25165C
110	SUPPORT	2	25553A	2	25614A	2	25587A	2	25587A
111	Gaterotor	2	25554A	2	25610A	2	25588A	2	25588F
118	Gaterotor COVER GASKET	2	25088A	2	25132A	2	25132A	2	25132A
119	WASHER	2	25086A	2	25086A	2	25086A	2	25086A
120A	BUSHING, SMALL DOWEL PIN	2	25087A	2	25104A	2	25104A	2	25104A
120B	BUSHING, LARGE DOWEL PIN	2	25760B	2	25760B	2	25760B	2	25760B
121	SHIM 0.002"	AR	25089AA	AR	25089AA	AR	25089AA	AR	25089AA
122	SHIM 0.003"	AR	25089AB	AR	25089AB	AR	25089AB	AR	25089AB
123	SHIM 0.005"	AR	25089AC	AR	25089AC	AR	25089AC	AR	25089AC
124	SHIM 0.010"	AR	25089AD	AR	25089AD	AR	25089AD	AR	25089AD
125	ROLLER BEARING	2	2864C	2	2864G	2	2864G	2	2864G
126	BALL BEARING	4	2865A	4	2865A	4	2865A	4	2865A
130	RETAINING RING	2	2866B	2	2866B	2	2866B	2	2866B
131	RETAINING RING	2	2867E	2	2867L	2	2867L	2	2867L
135A	DOWEL PIN, SM, 0.250" O.D.	2	2868F	2	2868H	2	2868H	2	2868H
135B	DOWEL PIN, LG, 0.4375" O.D.	2	25910B	2	25910B	2	25910B	2	25910B
141	O-RING ROLLER BEARING HOUSING	2	2176N	2	2176AJ	2	2176AJ	2	2176AJ
142	O-RING BALL BEARING HOUSING	2	2176CQ	2	2176AM	2	2176AM	2	2176AM
143	O-RING BRG HSG COVER	2	2176U	2	2176U	2	2176U	2	2176U

AR = As required

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

## Section 8 • Spare Parts List

### Gaterotor

ITEM	DESCRIPTION	MODEL NUMBER					
		VSS 1551		VSS 1501		VSS 1801	
		QTY	VPN	QTY	VPN	QTY	VPN
-	Gaterotor BLADE AND BEARING REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 125, 126, 130, 131, 141, 142, 143)	AR	KT712L	AR	KT712G	AR	KT712H*
-	Gaterotor BLADE REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 130, 141, 142, 143)	AR	KT713G	AR	KT713G	AR	KT713H*
101	Gaterotor ASSEMBLY (111, 120)	2	A25160EB	2	A25160EB	2	A25160EA
102	Gaterotor SUPPORT ASSEMBLY (100, 111, 120B, 119, 130)	2	A25161EB	2	A25161EB	2	A25161EA
104	SHIM 350MM GATEROTOR BALL BRG VSS	2	25977U				
105	Gaterotor GASKET SET (118, 141, 142, 143)	2	A25164E	2	A25164E	2	A25164E
106	SHIM PACK SET ((2) 121, (2) 122, (1) 123, (1) 124)	2	A25165E	2	A25165E	2	A25165E
110	SUPPORT	2	25665C	2	25087A	2	25665E
111	Gaterotor	2	25647A	2	25647A	2	25645A
112	SMALL BEARING HOUSING	2	26507A	2	25667A	2	25667A
113	LARGE BEARING HOUSING	2	26506A	2	25669A	2	25669A
114	RETAINER	2	25141A	2	25141A	2	25141A
115	RETAINER	2	25789A	2	25789A	2	25789A
116	BALL BEARING COVER	2	25351A	2	25351A	2	25351A
117	Gaterotor COVER	2	26508B	2	25354A	2	25354A
118	Gaterotor COVER GASKET	2	26509A	2	25790A	2	25790A
119	WASHER	2	25788A	2	25788A	2	25788A
120A	BUSHING, SMALL DOWEL PIN	-	N/A	2	25104A	2	25104A
120B	BUSHING, LARGE DOWEL PIN	2	25760C	2	25104A	2	25104A
121	SHIM 0.002"	AR	25791AA	AR	25791AA	AR	25791AA
122	SHIM 0.003"	AR	25791AB	AR	25791AB	AR	25791AB
123	SHIM 0.005"	AR	25791AC	AR	25791AC	AR	25791AC
124	SHIM 0.010"	AR	25791AD	AR	25791AD	AR	25791AD
125	ROLLER BEARING	2	2864K	2	2864K	2	2864K
126	BALL BEARING	4	2865K	4	2865K	4	2865K
130	RETAINING RING	2	2866G	2	2866G	2	2866G
131	RETAINING RING	2	2867R	2	2867R	2	2867R
135A	DOWEL PIN, SM, 0.250" O.D.	-	N/A	2	2868H	2	2868H
135B	DOWEL PIN, LG, 0.4375" O.D.	2	25910C	2	2868H	2	2868H
141	O-RING ROLLER BEARING HOUSING	2	2176U	2	2176U	2	2176U
142	O-RING BALL BEARING HOUSING	2	2176BD	2	2176BD	2	2176BD
143	O-RING BRG HSG COVER	2	2176P	2	2176P	2	2176P
150	HEX HEAD CAP SCREW ( 1/4-20 NC X 1-1/4 )	12	2796CJ	12	2796CJ	12	2796CJ
151	HEX HEAD CAP SCREW (5/16-18 NC X 1-1/4)	8	2796N	8	2796N	8	2796N
152	HEX HEAD CAP SCREW ( 3/8-16 NC X 1-1/4)	32	2796CJ	32	2796CJ	32	2796CJ
153	HEX HEAD CAP SCREW (1/4-20 NC X 1)	44	2796R	44	2796R	44	2796R
160	SOCKET HEAD CAP SCREW	16	2795G	16	2795G	16	2795G

AR = As required

\* For serial numbers before 5580 \*\* For serial numbers after 5580

## Section 8 • Spare Parts List

### Gaterotor

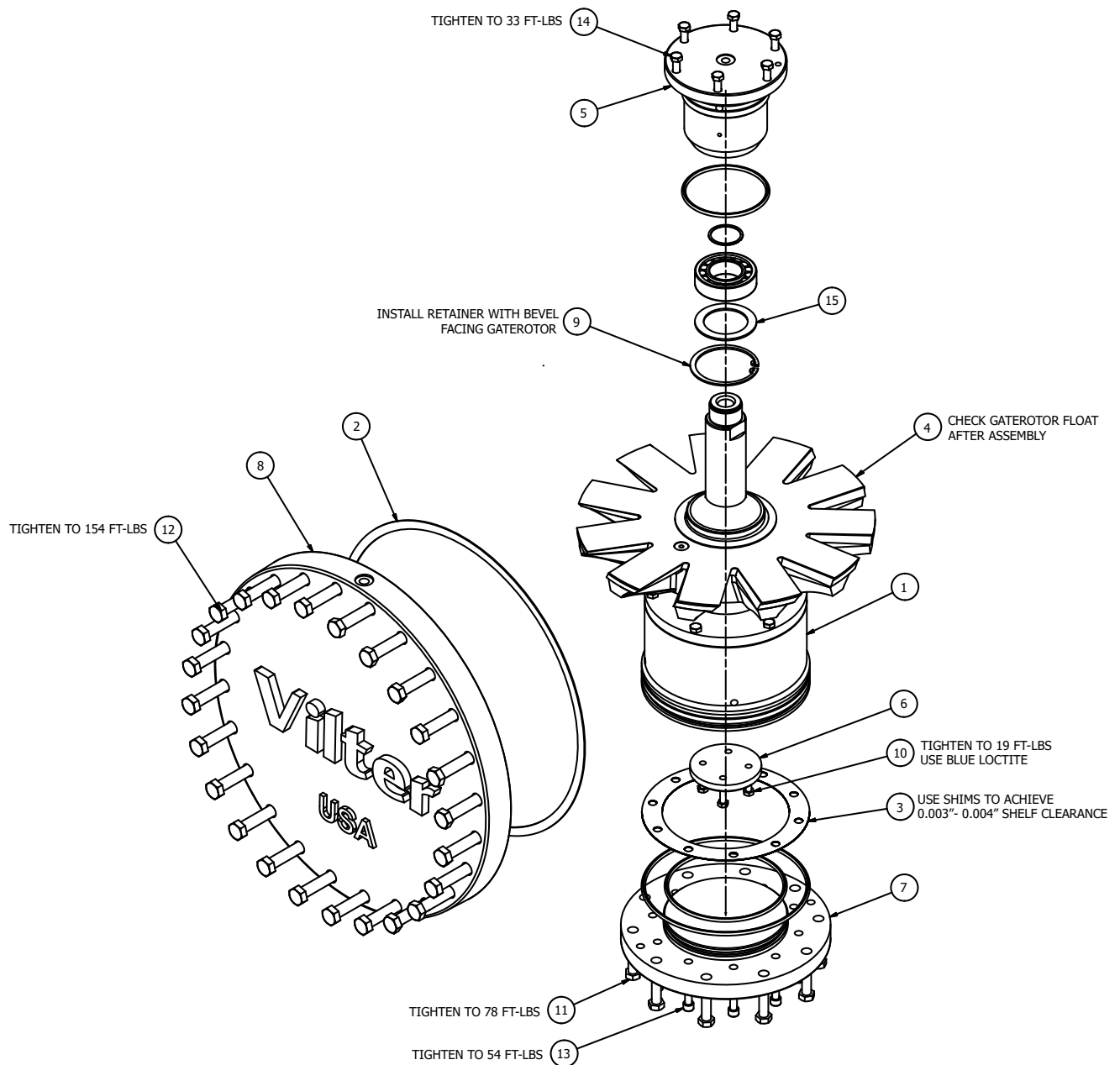
ITEM	DESCRIPTION	MODEL NUMBER			
		VSS 1851		VSS 2101	
		QTY	VPN	QTY	VPN
-	Gaterotor BLADE AND BEARING REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 125, 126, 130, 131, 141, 142, 143)	AR	KT712M*	AR	KT712K* KT712KN**
-	Gaterotor BLADE REPLACEMENT KIT (111, 118, 120A, 120B, 121, 122, 123, 124, 130, 141, 142, 143)	AR	KT713H*	AR	KT713L
101	Gaterotor ASSEMBLY (111, 120)	2	A25160EA	2	A25160EA
102	Gaterotor SUPPORT ASSEMBLY (100, 111, 120B, 119, 130)	2	A25161EA	2	A25161EC
104	SHIM 350MM GATEROTOR BALL BRG VSS	2	25977U	2	25977U
105	Gaterotor GASKET SET (118, 141, 142, 143)	2	A25164E	2	A25164E
106	SHIM PACK SET ((2) 121, (2) 122, (1) 123, (1) 124)	2	A25165E	2	A25165E
110	SUPPORT	2	25665E	2	25665D
111	Gaterotor	2	25645A	2	25744D
112	SMALL BEARING HOUSING	2	26507A	2	26507A
113	LARGE BEARING HOUSING	2	26506A	2	26506A
114	RETAINER	2	25141A	2	25141A
115	RETAINER	2	25789A	2	25789A
116	BALL BEARING COVER	2	25351A	2	25351A
117	Gaterotor COVER	2	26508B	2	26508B
118	Gaterotor COVER GASKET	2	26509A	2	26509A
119	WASHER	2	25788A	2	25788A
120A	BUSHING, SMALL DOWEL PIN	-	N/A	-	N/A
120B	BUSHING, LARGE DOWEL PIN	2	25760C	2	25760C
121	SHIM 0.002"	AR	25791AA	AR	25791AA
122	SHIM 0.003"	AR	25791AB	AR	25791AB
123	SHIM 0.005"	AR	25791AC	AR	25791AC
124	SHIM 0.010"	AR	25791AD	AR	25791AD
125	ROLLER BEARING	2	2864K	2	2864K
126	BALL BEARING	4	2865K	4	2865K
130	RETAINING RING	2	2866G	2	2866G
131	RETAINING RING	2	2867R	2	2867R
135A	DOWEL PIN, SM, 0.250" O.D.	-	N/A	-	N/A
135B	DOWEL PIN, LG, 0.4375" O.D.	2	25910C	2	25910C
141	O-RING ROLLER BEARING HOUSING	2	2176U	2	2176U
142	O-RING BALL BEARING HOUSING	2	2176BD	2	2176BD
143	O-RING BRG HSG COVER	2	2176P	2	2176P
150	HEX HEAD CAP SCREW ( 1/4-20 NC X 1-1/4 )	12	2796CJ	12	2796CJ
151	HEX HEAD CAP SCREW (5/16-18 NC X 1-1/4)	8	2796N	8	2796N
152	HEX HEAD CAP SCREW ( 3/8-16 NC X 1-1/4)	32	2796CJ	32	2796CJ
153	HEX HEAD CAP SCREW (1/4-20 NC X 1)	44	2796R	44	2796R
160	SOCKET HEAD CAP SCREW	16	2795G	16	2795G

AR = As required

\* For serial numbers before 5580

\*\* For serial numbers after 5580

### Gaterotor



\*VSS 2401 thru VSS 3001 Only

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

## Section 8 • Spare Parts List

### Gaterotor

ITEM	DESCRIPTION	QTY	VSS 2401	VSS 2601	VSS 2801	VSS 3001
			VPN	VPN	VPN	VPN
-	Gaterotor BLADE AND BEARING REPLACEMENT KIT	AR	KT712N	KT712P	KT712Q KT712QAF*	KT712R
-	Gaterotor BLADE REPLACEMENT KIT	AR	KT713P	KT713Q	KT713R KT713RAF*	KT713S
001	BALL BEARING	1	A25163G	A25163G	A25163G	A25163G
002	SEAL GATEROTOR	1	A25164F	A25164F	A25164F	A25164F
003	SHIM	1	A25165F	A25165F	A25165F	A25165F
004	SUPPORT	1	A25222FH	A25222FG	A25222FF	A25222FE
005	BEARING HOUSING	1	26089B	26089B	26089B	26089B
006	GATEROTOR BEARING HOUSING COVER	1	25789B	25789B	25789B	25789B
007	GATEROTOR COVER	1	26087B	26087B	26087B	26087B
008	RETAINING RING (3.346 X 0.109) BEVELED	1	26132C	26132C	26132C	26132C
009	HEX HEAD CAP SCREW (5/16 -18 NC X 1-1/4)	1	2867R	2867R	2867R	2867R
010	HEX HEAD CAP SCREW (1/2-13 NC X1-3/4)	4	2796B	2796B	2796B	2796B
011	HEX HEAD CAP SCREW (5/8-11 NC X 2-3/4)	10	2796EL	2796EL	2796EL	2796EL
012	HEX HEAD CAP SCREW (3/8-16 NC X 1-3/4)	24	2796GQ	2796GQ	2796GQ	2796GQ
013	HEX HEAD CAP SCREW (3/8-16 NC X 1-1/4)	10	2795AH	2795AH	2795AH	2795AH
014	ROLLER BEARING SHIM	6	2796CJ	2796CJ	2796CJ	2796CJ
015	BEARING RETAINER	1	25977Z	25977Z	25977Z	25977Z

AR = As required

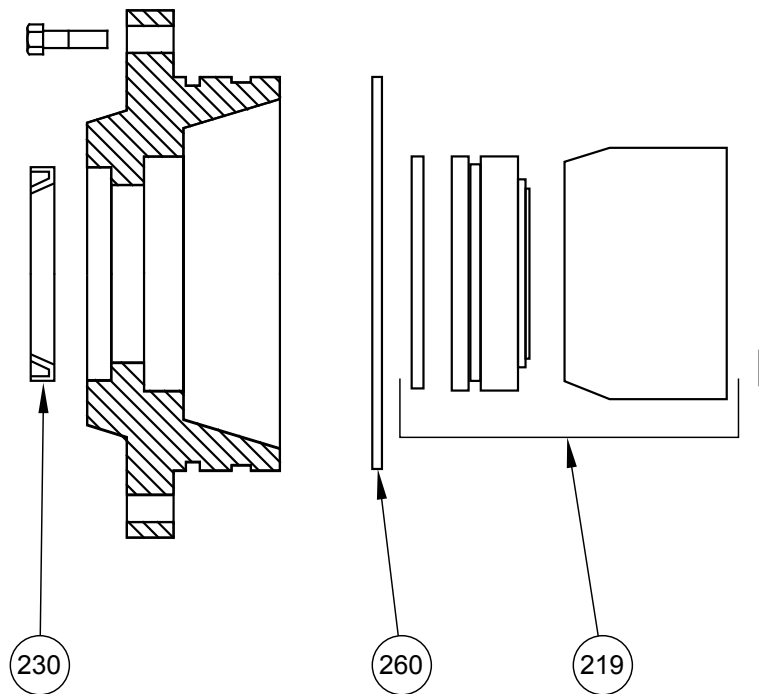
\* AFLAS

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## Shaft Seal

### Shaft Seal With Stationary Carbon Face



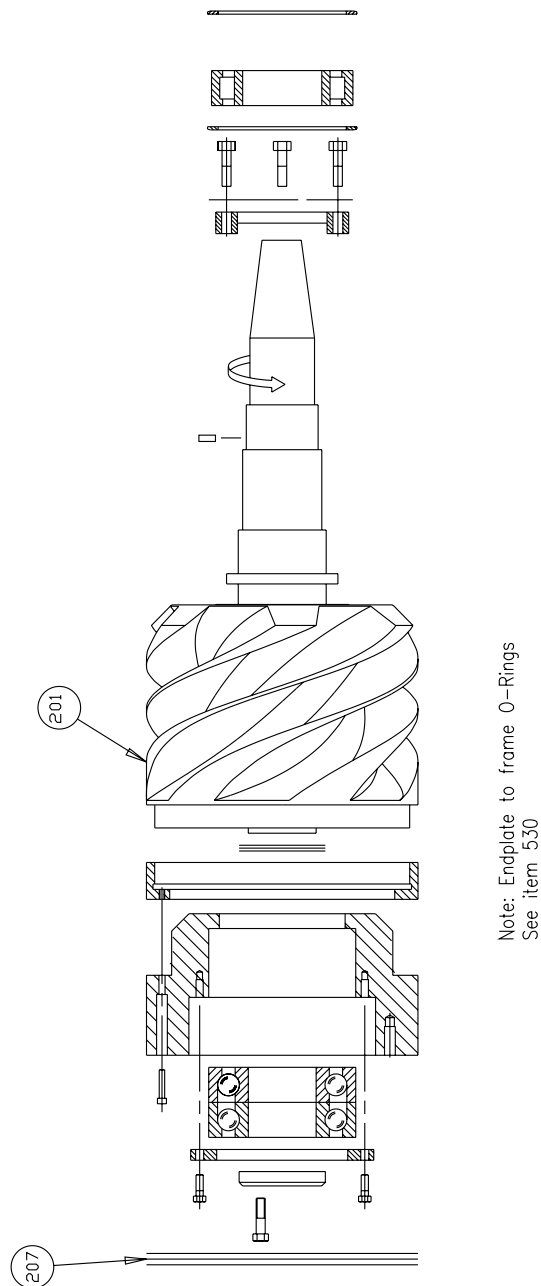
ITEM	DESCRIPTION	MODEL NUMBER				
		QTY	VSS 291 thru VSS 601	VSS 751 thru VSS 1301	VSS 1551 thru VSS 2101	VSS 2401 thru VSS 3001
	SHAFT SEAL AMM KIT (219, 230, 260)	1	KT709A	KT709B	KT709E	KT709F
	SHAFT SEAL R22 KIT (219, 230, 260)	1	KT781A	KT781B	KT781C	KT781F
230	OIL SEAL	1	25040A	2930F	2930B	2930G
260	O-RING	1	2176F	2176AC	2176BH	2176BD

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## Section 8 • Spare Parts List

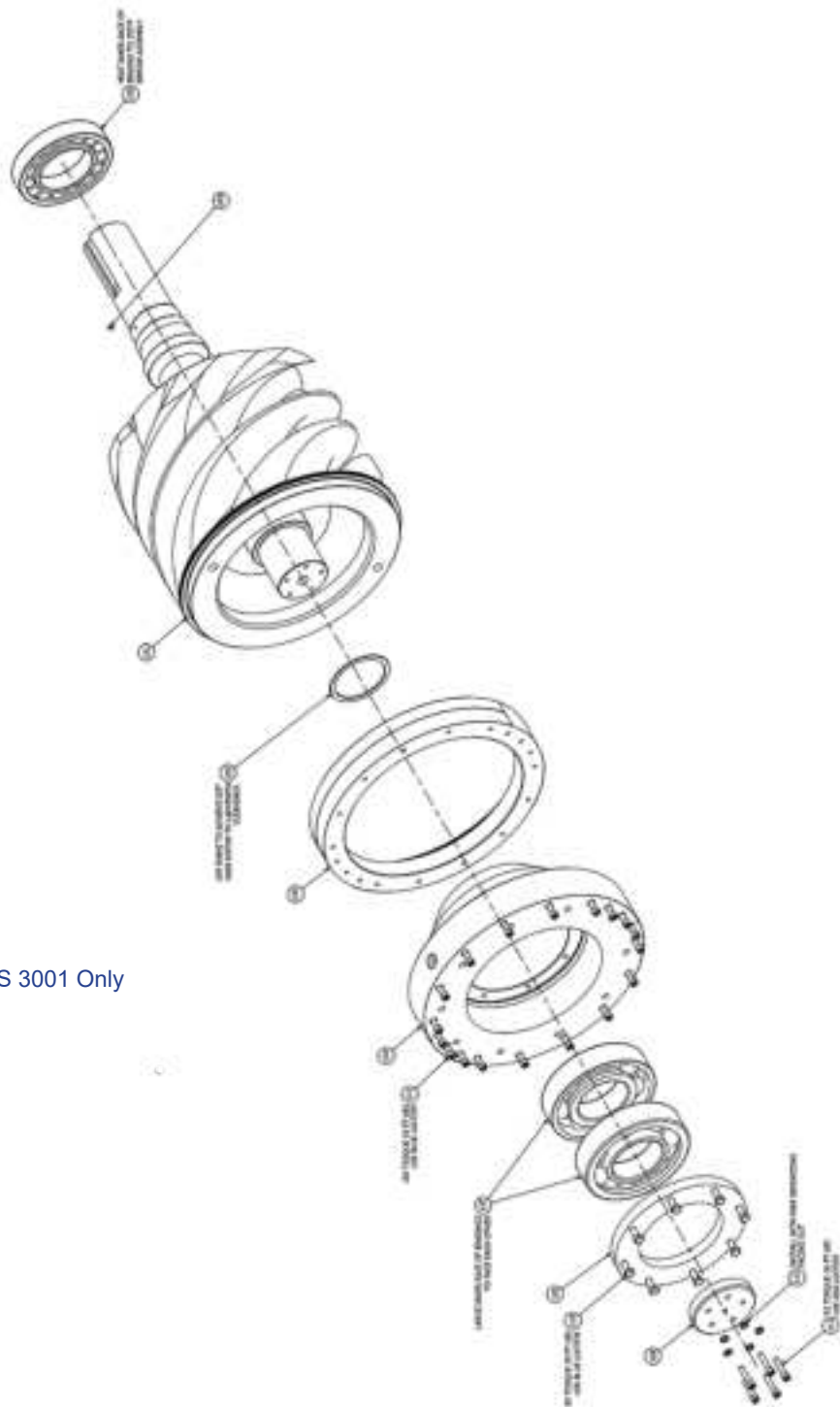
## Main Rotor

ITEM		207	201
MODEL NUMBER	QTY	DESCRIPTION	
		SHIM PACK	ROTOR ASSEMBLY
VSS 451	1	A25177B	A25226BB
VSS 601	1	A25177B	A25226BA
VSS 751	1	A25177C	A25226CB
VSS 901	1	A25177C	A25226CA
VSS 1051	1	A25177D	A25226DB
VSS 1201	1	A25177D	A25226DA
VSS 1301	1	A25177D	A25752HA
VSS 1501	1	A25177E	A25226EB
VSS 1551	1	A25177E	A25226EC
VSS 1801	1	A25177E	A25226EA
VSS 1851	1	A25177E	A25226ED
VSS 2101	1	A25177E	A25226EE



\*For VSS Models from 451 to 2101

Main Rotor



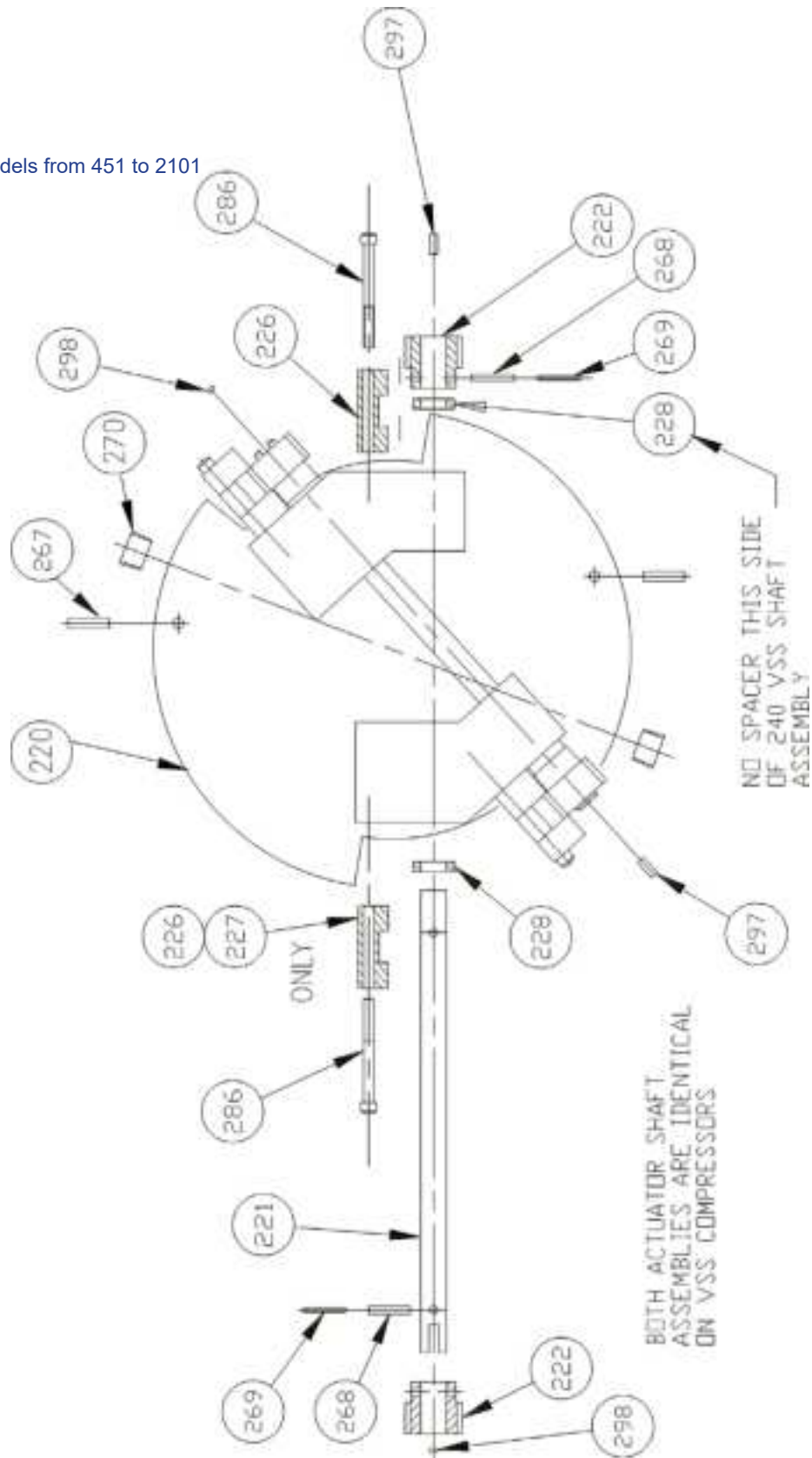
\*VSS 2401 thru VSS 3001 Only

ITEM	DESCRIPTION	MODEL NUMBER				
		QTY	VSS 2401	VSS 2601	VSS 2801	VSS 3001
	ROTOR ASSEMBLY	1	A25226AN	A25226AM	A25226AL	A25226AK
102	SHIM PACK	1	A25177G	A25177G	A25177G	A25177G

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## Slide Valve Cross Shafts and End Plate

\*For VSS Models from 451 to 2101



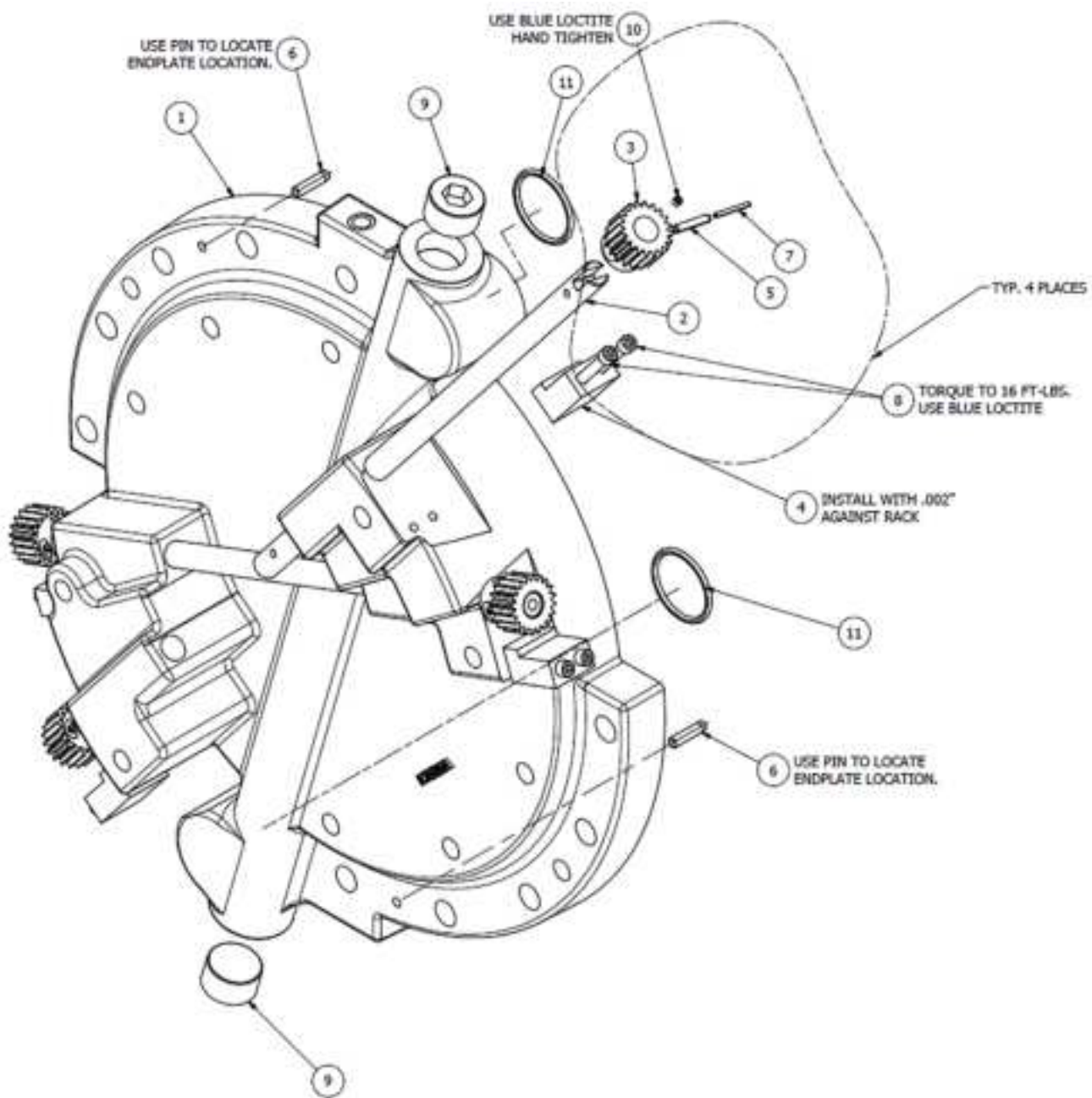
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## Slide Valve Cross Shafts and End Plate

ITEM	DESCRIPTION	MODEL NUMBER									
		QTY	VSS 291 thru VSS 601	QTY	VSS 751 thru VSS 901	QTY	VSS 1051 thru VSS 1301	QTY	VSS 1501 VSS 1801	QTY	VSS 1551 thru VSS 2101
221	SHAFT	2	25843A	2	25844A	2	25845A	2	25793A	2	25793A
222	GEAR	4	25027A	4	25027A	4	25027A	4	25027A	4	25027A
226	RACK CLAMP	2	25913A	4	25913C	4	25913C			4	25913C
227	RACK CLAMP	2	25913B	-	N/A	-	N/A	-		-	N/A
228	SPACER	2	25847A	4	25033C	4	25033C	4	25033C	4	25033C
267	DOWEL PIN	-	N/A	2	2868B	2	2868B	2	2868B	2	2868B
268	EXPANSION PIN	4	1193D	4	1193D	4	1193D	2	1193D	4	1193D
269	EXPANSION PIN	4	2981AA	4	2981AA	4	2981AA	2	2981AA	4	2981AA
270	PIPE PLUG	-	N/A	2	2606E	2	2606E	2	2606E	2	2606A
286	SOCKET HEAD CAP SCREW	8	2795F	8	2795F	8	2795F	8	2795F	8	2795F
297	SET SCREW	2	2060J	2	2060J	2	2060J			2	2060J
298	SET SCREW	2	2060H	2	2060H	2	2060H			2	2060H

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End Plate (VSS 2401 - VSS 3001 Only)



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### End Plate (VSS 2401 - VSS 3001 Only)

ITEM	VSS 2401 thru VSS 3001	Quantity	DESCRIPTION
018	PIPE PLUG SOCKET HEX	2	13163F
019	O-RING (1.609 X 1.887) NEOPRENE	2	2176X
270	FLUSH SEAL PLUG 3/4-14 NPTF SOCKET HEAD	2	2606A
269	ROLL PIN (M2.5 X 26) STEEL	4	2981AA
286	SCREW (1/4-20 NC X 2) CAP SOCKET HEAD ASTM A574	8	2795Q
226	RACK CLAMP	4	25913E
298	SET SCREW (10-32 NF X 3/16) CUP PNT HEX	4	2060H
222	GEAR	4	25027A
220	END PLATE ASSEMBLY	1	A25849FA A25849FAAF* A25849FAV**
221	COMMAND SHAFT	1	A25994F A25994FAF* A25994FV**
268	ROLL PIN (.187 X 1)	4	1193D
267	DOWEL PIN (1/4 X 1) STEEL	2	2868B

\* AFLAS

\*\* VITON

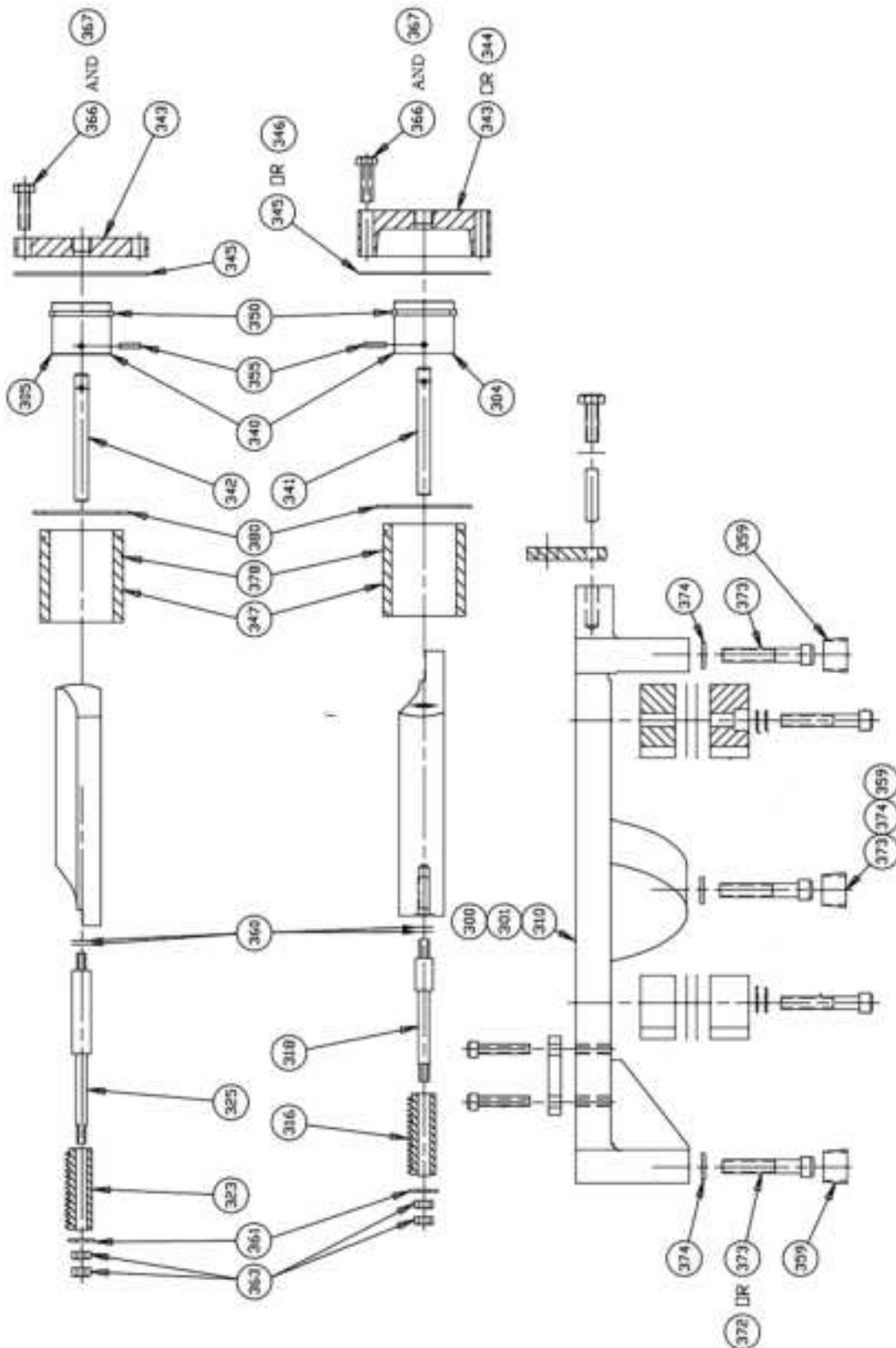
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## Slide Valve Carriage Assembly

### Volume Slide

### Capacity Slide

### Carriage Assembly



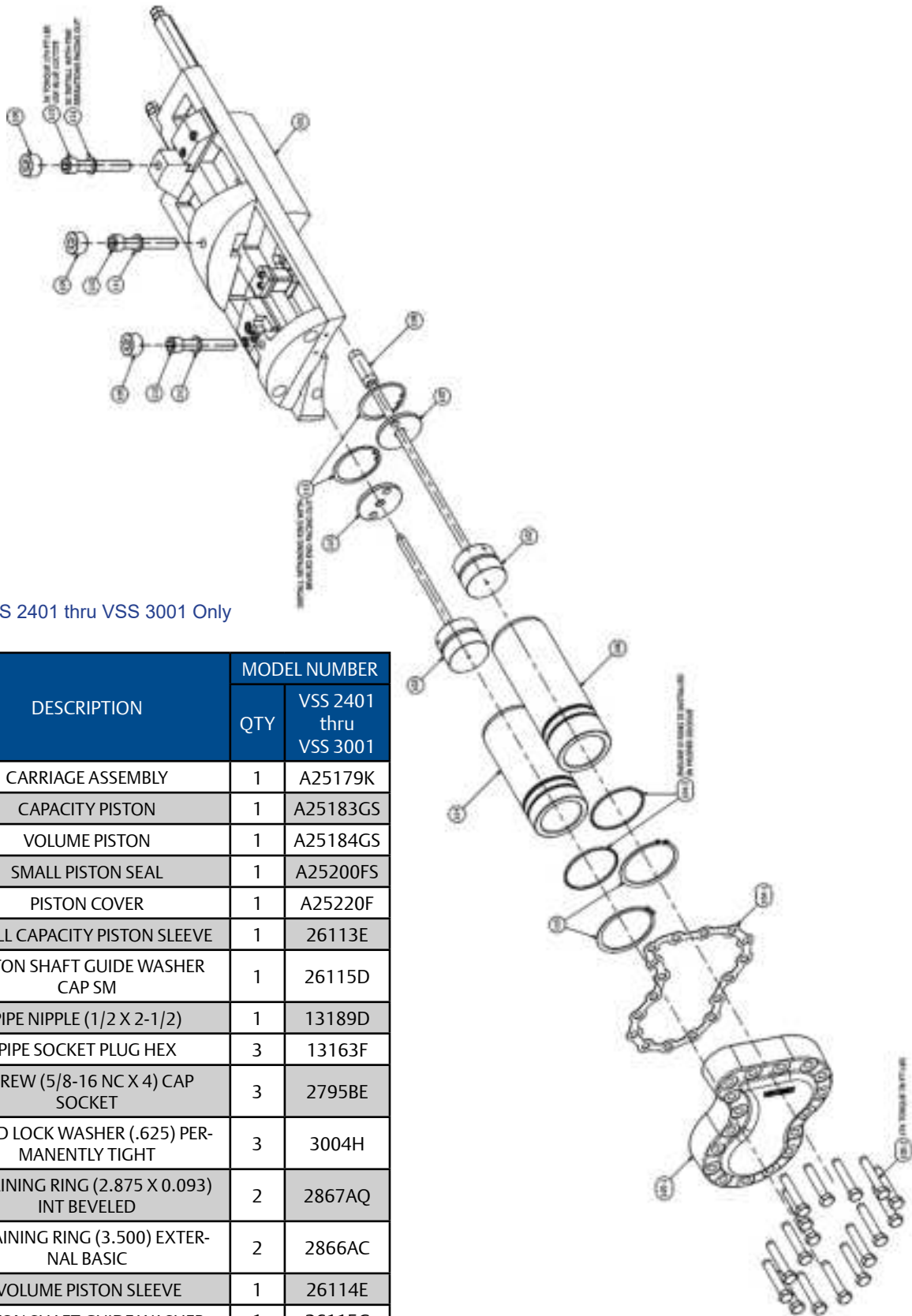


## Slide Valve Carriage Assembly

ITEM	DESCRIPTION	MODEL NUMBER							
		QTY	VSS 291 thru VSS 601	QTY	VSS 751 thru VSS 901	QTY	VSS 1051 VSS 1201	QTY	VSS 1501 thru VSS 2101
300	CARRIAGE ASSEMBLY	2	A25179B	2	A25179C	2	A25179D	2	A25179E
304	CAPACITY PISTON (340, 341, 350, 355)	2	A25183B	2	A25183C	2	A25183D	2	A25183E
305	VOLUME PISTON (340, 342, 350, 355)	2	A25184B	2	A25184C	2	A25184D	2	A25184E
307A	GASKET (345)	2	25900A	-	N/A	-	N/A	2	A25200E
307B	GASKET SET (345, 378)	-	N/A	2	A25200C	2	A25200D	-	N/A
316	RACK	2	25024AH	2	25080AH	2	25080CH	2	25779AH
323	RACK	2	25023AH	2	25080BH	2	25080DH	2	25080DH
325	SHAFT	-	N/A	-	N/A	-	N/A	2	25778A
340	PISTON	-	N/A	4	25076A	4	25138A	4	25782A
341	CAPACITY PISTON SHAFT	-	N/A	2	25078A	2	25078E	2	25784A
342	VOLUME PISTON SHAFT	-	N/A	2	25078B	2	25078F	2	25783A
343A	COVER, SEPARATE VOL. & CAP.	4	25022A	2	25123B	4	25123D	-	N/A
343B	COVER, ONE PIECE CAST	2	25399D	2	25279A	2	25401A	2	25690A
344	COVER, SEPARATE VOL. & CAP.	-	N/A	2	25123A	-	N/A	-	N/A
345A	GASKET, SEPARATE VOL. & n/a CAP COVERS.	4	25021A	2	25124B	4	25124C	-	N/A
345B	GASKET, ONE PIECE CAST COVER	2	25900A	2	25902A	2	25901A	2	25384A
346	GASKET, ONE PIECE CAST COVER	-	N/A	2	25124A	-	N/A	-	N/A
347	PISTON SLEEVE	-	N/A	2	25079A	-	N/A	4	25786A
350	PISTON RING SET	4	2953AA	4	2953AB	4	2953AC	4	2953AD
355	EXPANSION PIN	4	1193PP	4	1193PP	4	1193PP	4	1193PP
359	PIPE PLUG	6	2606D	6	2606D	6	2606D	6	2606E
360	LOCK WASHER (PAIR)	4	3004C	4	3004C	4	3004C	4	3004C
361	WASHER	4	13265B	4	13265B	4	13265B	4	13265B
363	NUT	8	2797A	8	2797A	8	2797A	8	2797A
366A	HEX HEAD CAP SCREW, SEPARATE VOL. & CAP COVERS.	24	2796N	12	2796B	24	2796B	-	N/A
366B	HEX HEAD CAP SCREW, ONE PIECE CAST COVER.	24	2796B	12	2796P	24	2796P	28	3796BL
367	HEX HEAD CAP SCREW	-	N/A	12	2796BN	-	N/A	-	N/A
373	SOCKET HEAD CAP SCREW	-	N/A	6	2795N	6	2795P	6	2795AG
374	LOCK WASHER (PAIR)	-	N/A	6	3004C	6	3004D	6	3004D
378	O-RING	-	N/A	2	2176Y	-	N/A	4	2176AG
380	RETAINER RING	-	N/A	2	2866C	-	N/A	4	2866G

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

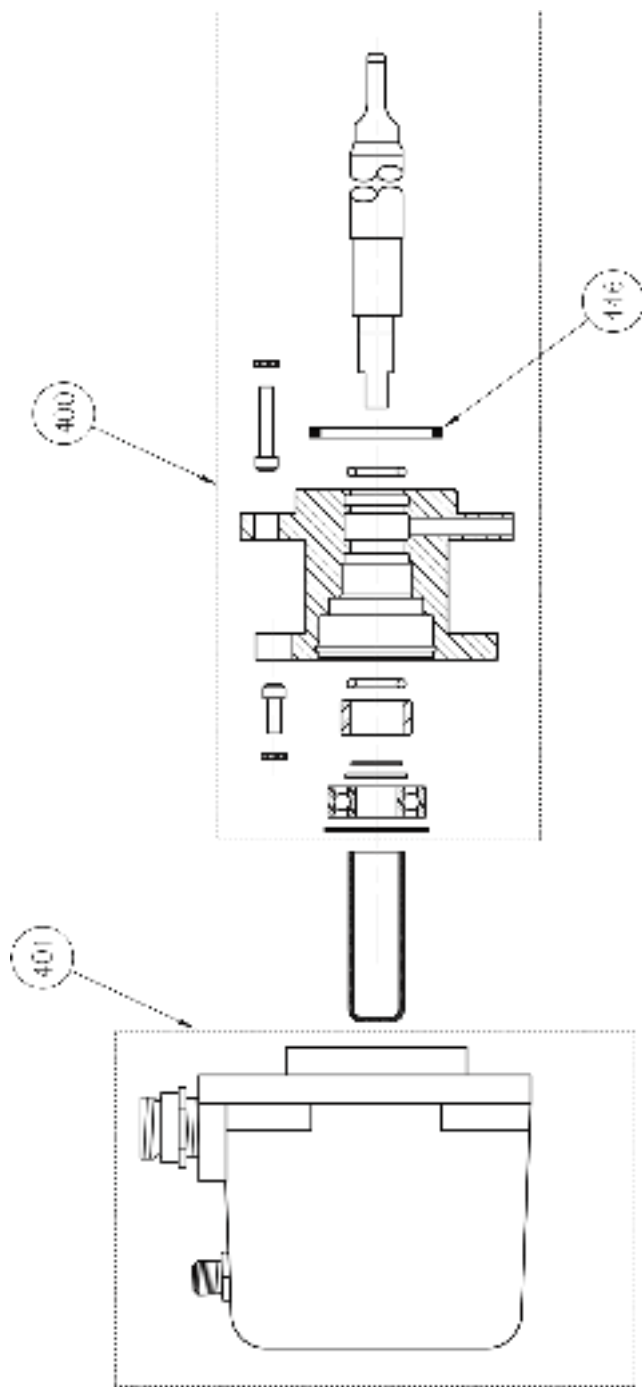
## Slide Valve Carriage Assembly



\*VSS 2401 thru VSS 3001 Only

ITEM	DESCRIPTION	MODEL NUMBER	
		QTY	VSS 2401 thru VSS 3001
101	CARRIAGE ASSEMBLY	1	A25179K
102	CAPACITY PISTON	1	A25183GS
103	VOLUME PISTON	1	A25184GS
104	SMALL PISTON SEAL	1	A25200FS
105	PISTON COVER	1	A25220F
106	SMALL CAPACITY PISTON SLEEVE	1	26113E
107	PISTON SHAFT GUIDE WASHER CAP SM	1	26115D
108	PIPE NIPPLE (1/2 X 2-1/2)	1	13189D
109	PIPE SOCKET PLUG HEX	3	13163F
110	SCREW (5/8-16 NC X 4) CAP SOCKET	3	2795BE
111	NORD LOCK WASHER (.625) PER- MANENTLY TIGHT	3	3004H
112	RETAINING RING (2.875 X 0.093) INT BEVELED	2	2867AQ
113	RETAINING RING (3.500) EXTER- NAL BASIC	2	2866AC
114	VOLUME PISTON SLEEVE	1	26114E
115	PISTON SHAFT GUIDE WASHER	1	26115C

Actuator & Command Shaft

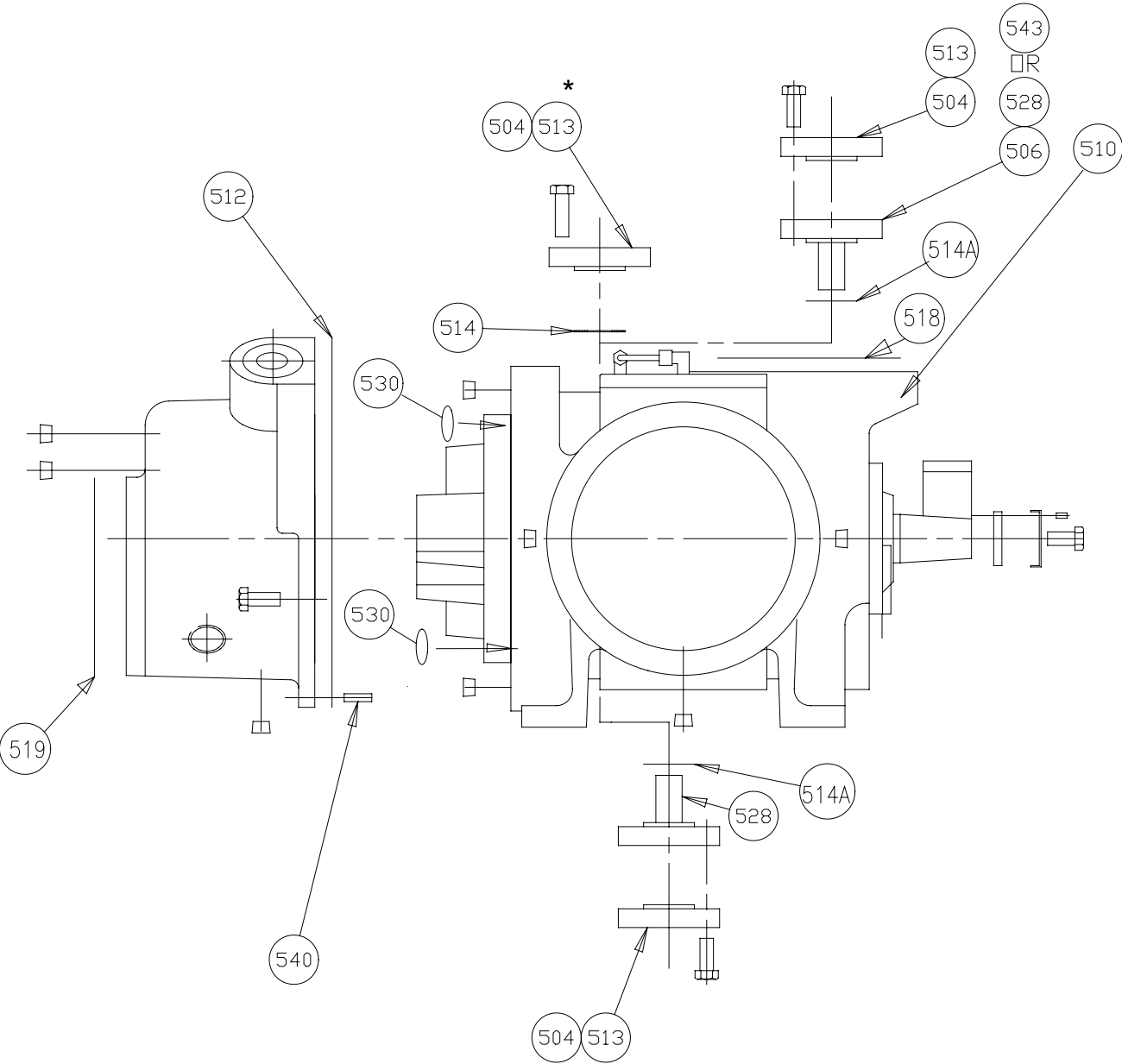


ITEM	DESCRIPTION	MODEL NUMBER					
		QTY	VSS 291 thru VSS 601	VSS 751 thru VSS 901	VSS 1051 VSS 1201 VSS 1301	VSS 1551 thru VSS 2101	VSS 2401 thru VSS 3001
400	COMMAND SHAFT ASSEMBLY	2	A25994B	A25994C	A25994D	A25994E	A25994F
401	SLIDE VALVE ACTUATOR	2	25972D	25972D	25972D	25972D	25972D
446	O-RING SEAL	2	2176X	2176X	2176X	2176X	2176X

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Miscellaneous Frame Components

VSS Screw Compressor



\*For VSS Models from 451 to 2101 \*

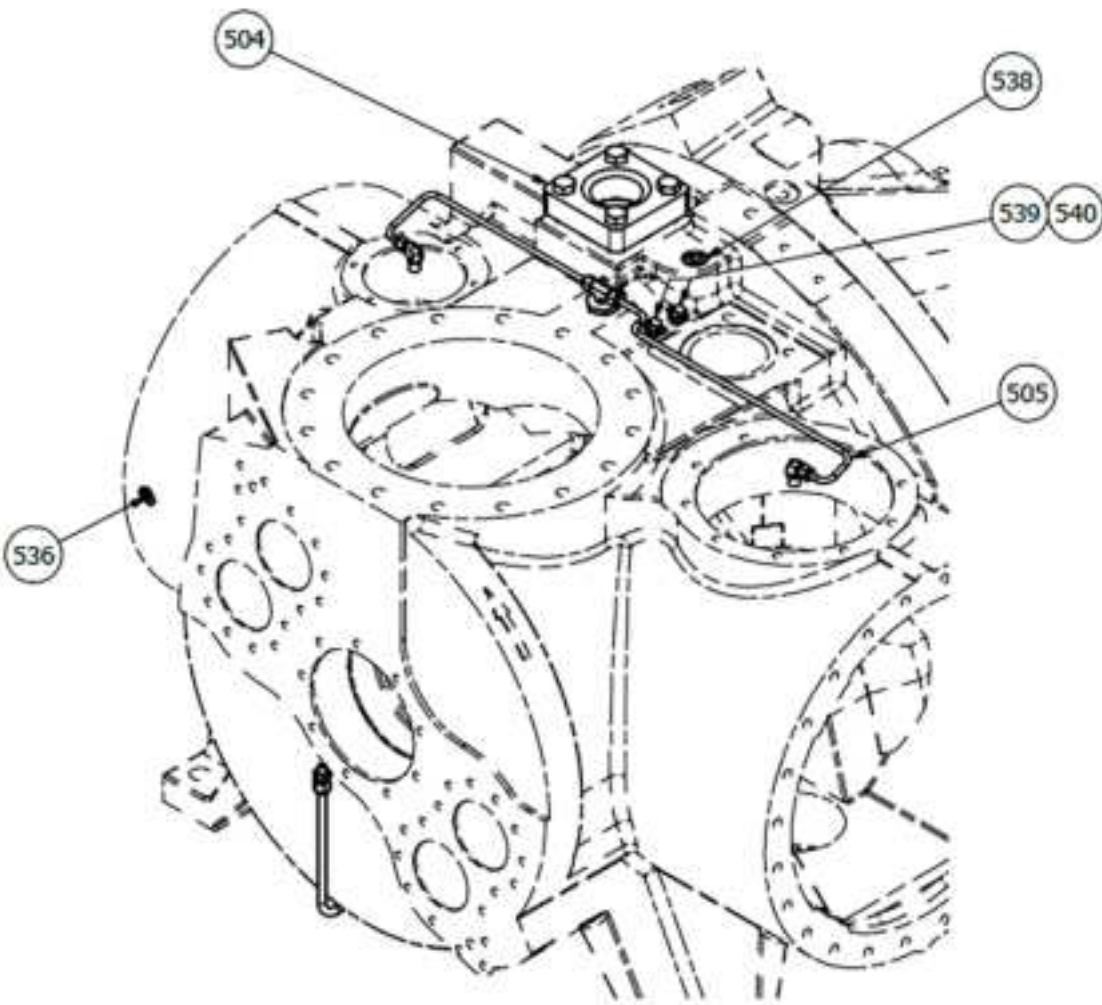
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## Miscellaneous Frame Components

ITEM	DESCRIPTION	MODEL NUMBER											
		QTY	VSS 291 thru VSS 601	QTY	VSS 751 VSS 901	QTY	VSS 1051 VSS 1201	QTY	VSS 1301	QTY	VSS 1501 VSS 1801	QTY	VSS 1551 thru VSS 2101
-	GASKET & O-RING KIT	1	KT710AN	1	KT710B	1	KT710C	1	KT710J	1	KT710D	1	KT710D
504A	FLANGE SET (513A, 514A, 545A)	1	A25190A	1	A25190A	1	A25190B	1	A25190A	1	A25190C	1	A25190C
504B*	FLANGE SET (513B, 514B, 545B)	2	A25190B	-	N/A	2	A25190B	2	A25190B	2	A25190A	2	A25190D
504C*	FLANGE SET (513B, 514C, 545C)	-	N/A	2	A25190A	-	N/A	-	N/A			-	N/A
506A	PLUG SET, ECONOMIZER (514C, 528, 545B)	1	A25243BE	1	A25243CC	1	A25243DC	1	A25243DD			-	N/A
506B	PLUG SET, ECONOMIZER (514A, 514C, 528, 545C)	-	N/A	-	N/A	-	N/A	-	N/A			1	A25243ED
511	DISCHARGE MANIFOLD	1	25502A	1	25540A	1	25597A			1	25663A		
512	MANIFOLD GASKET	1	25503A	1	25541A	1	25324A	1	25324A	1	25676A	1	25676A
513A	FLANGE	1	25058ASW	1	25058ASW	1	25058B	1	25058ASW	1	12477C	1	12477C
513B	FLANGE	2	25058B	2	25058ASW	2	25058B	2	25058B	-	N/A	2	25058ASW
514A	GASKET	1	11323D	1	11323D	1	11323E	1	11323D	1	11323F	1	11323F
514B	GASKET	2	11323E	-	N/A	2	11323E	2	11323E	-	N/A	2	11323S
514C	GASKET	2	11323D	2	11323S	2	11323E	2	11323E	-	N/A	2	11323G
518	GASKET, SUCTION	1	25199C	1	25199C	1	25199D	1	25199D	1	25199D	1	25199D
519	GASKET, DISCHARGE	1	25199B	1	25199B	1	25199C	1	25199C	1	25199C	1	25199C
528	ECONOMIZER PLUG	2	25397G	2	25397A	2	25391D	2	25391A	1	25393A	2	25393A
530	O-RING	2	2176AB	2	2176J	2	2176J	2	2176AB			2	2176J
536	PIPE PLUG 3/4" MPT	-	N/A	-	N/A	6	2606A	6	2606A	3	2606E	3	2606A
540	DOWEL PIN	2	2868B	2	2868B	2	2868B	2	2868B	2	2868K	2	2868K
542	PIPE PLUG 3/4" MPT	-	N/A	-	N/A	-	N/A	-	N/A	1	13163F	1	13163F
545A	HEX HEAD CAP SCREW	2	2796GP	2	2796GP	2	2796C	2	2796GP	4	11397E	4	11397E
545B	HEX HEAD CAP SCREW	4	2796C	4	2796C	4	2796C	4	2796C	-	N/A	4	2796GP
545C	HEX HEAD CAP SCREW	-	N/A	4	2796GP	-	N/A	-	N/A	-	N/A	12	11397E
547	HEX HEAD CAP SCREW	8	2796C	24	2796GP	24	2796GP	24	2796F	-	N/A	-	N/A

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## Miscellaneous Frame Components



\*VSS 2401 thru VSS 3001 Only

ITEM	DESCRIPTION	QTY	VSS 2401 thru VSS 3001
504	FLANGE SET 1.250 VSS 401MM	1	A25190EA
505	TUBING VSS2401-3001	1	A25201F
536	PLUG 1/2-14NPTF FLUSH SEAL SOC HD	2	2606E
538	PLUG 3/4-14NPTF FLUSH SEAL SOC HD	3	2606A
539	PLUG, LIQUID INJECTION	4	26293A
540	O-RING 0.171X0.499 NEOPRENE	4	2176DD
*	GASKET & O-RING KIT	1	KT710E
*	FLANGE	1	12478G
*	PLUG SET, ECONOMIZER	1	A25243BB

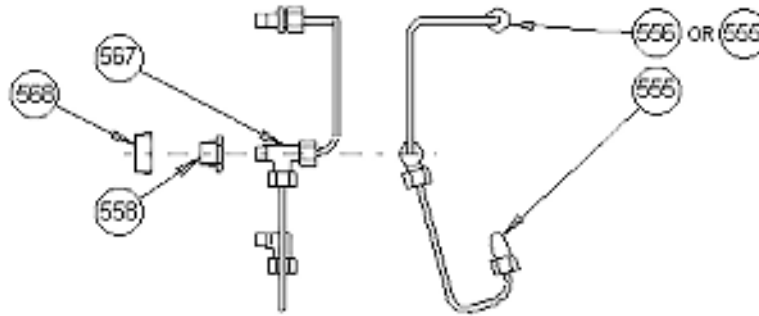
### NOTES

\* Not Shown

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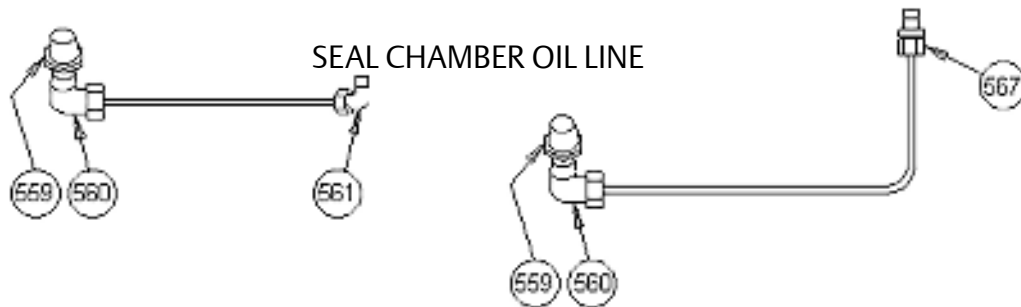
## Miscellaneous Frame Components (Tubing and Fittings)

### Gaterotor BEARING SUPPLY LINES



VSS 451 THRU VSS 1801

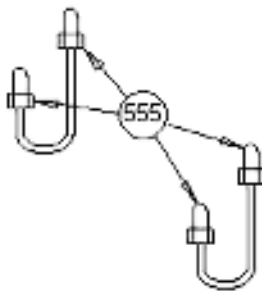
### SEAL CHAMBER OIL LINE



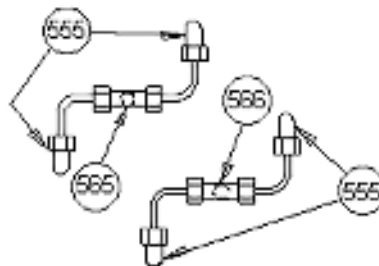
VSS 451 THRU VSS 1201

VSS 1501 & VSS 1801

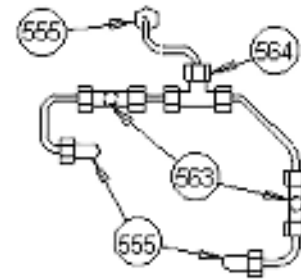
### SLIDE VALVE BALANCE PISTON EQUALIZING LINE



VSS 451 & VSS 601



VSS 751 & VSS 901



VSS 1051 & VSS 1201

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## Section 8 • Spare Parts List

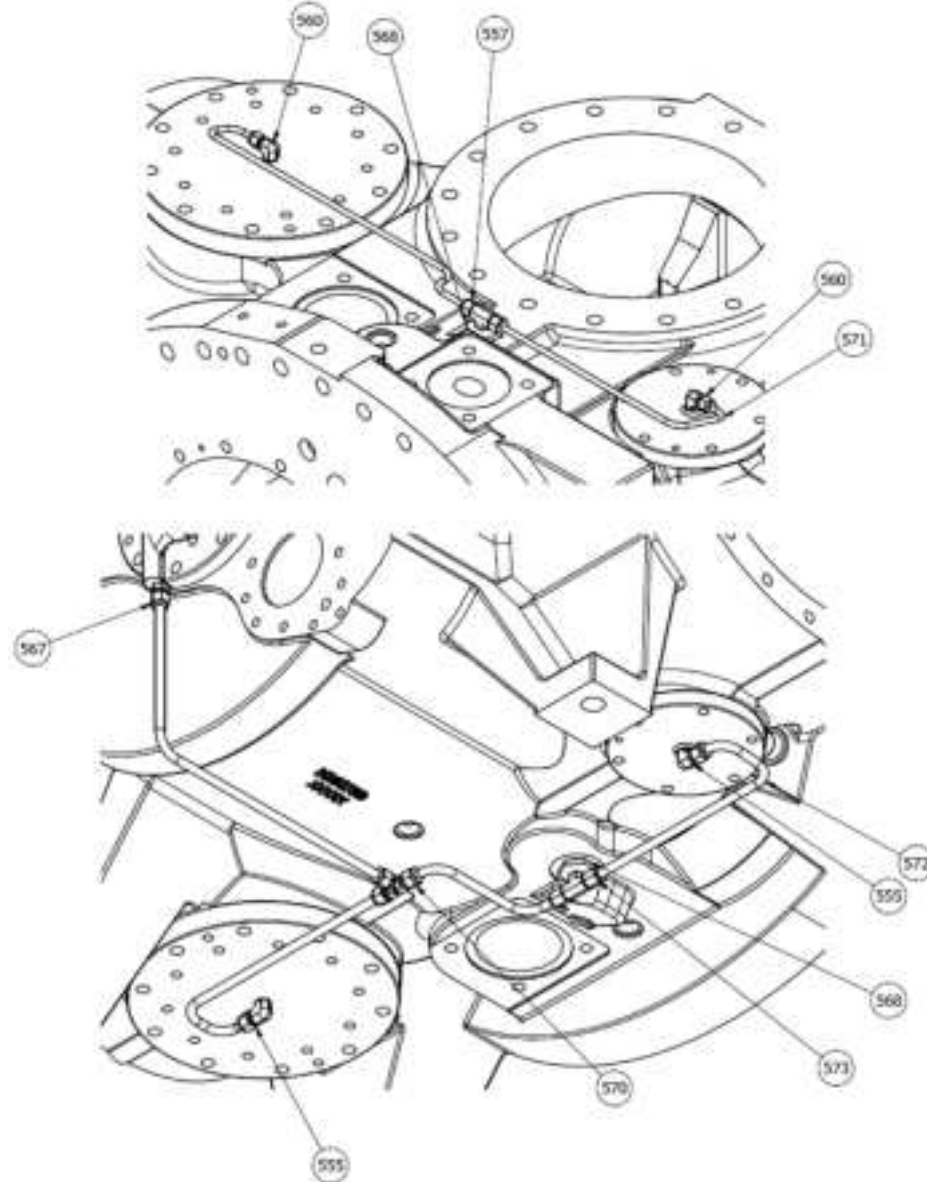
### Miscellaneous Frame Components (Tubing and Fittings)

ITEM	DESCRIPTION	MODEL NUMBER							
		QTY	VSS 451 VSS 601	QTY	VSS 751 VSS 901	QTY	VSS 1051 VSS 1201	QTY	VSS 1501 VSS 1801
555	ELBOW 1/4 ODT X 1/4 MPT 90° MALE	5	13375D	5	13375D	3	13375D	2	13375D
556	STRAIGHT 1/4 ODT X 1/4 MPT	1	13229D	1	13229D	2	13229D	-	N/A
557	TEE, RUNNING 1/4 OD X 1/4 MPT MALE	1	1509A	1	1509A	1	1509A	1	13376D
558	HEX BUSHING	1	13231AA	1	13231AA	1	1101H	1	13231AA
559	HEX BUSHING	-	N/A	-	N/A	1	1101K	1	1101K
560	ELBOW 3/8 ODT X 1/2 MPT 90° MALE	1	13375Z	1	13375Z	1	13375Z	1	13375Z
561	ELBOW 3/8 OD X 1/4 MPT 90° MALE	1	13375F	1	13375F	1	13375F	-	N/A
562	PLUG	1	2606E	1	2606E	1	2606A	-	N/A
563	TEE 1/4 ODT X 1/4 ODT X 1/4 MPT BRANCH	-	N/A	-	N/A	2	13376D	-	N/A
564	TEE 1/4	-	N/A	-	N/A	1	13239C	-	N/A
565	TEE 1/4T X 1/4T X 1/4 FPT FEMALE	-	N/A	2	1884A	-	N/A	-	N/A
566	NIPPLE 1/4 X 2-1/2 PIPE	-	N/A	2	13181D	-	N/A	-	N/A
567	CONNECTOR 1/2-13 NC-2 X 1 SET	-	N/A	-	N/A	-	N/A	1	13299C
568	REDUCING BUSHING 1 X 1/4	-	N/A	-	N/A	-	N/A	1	1101M

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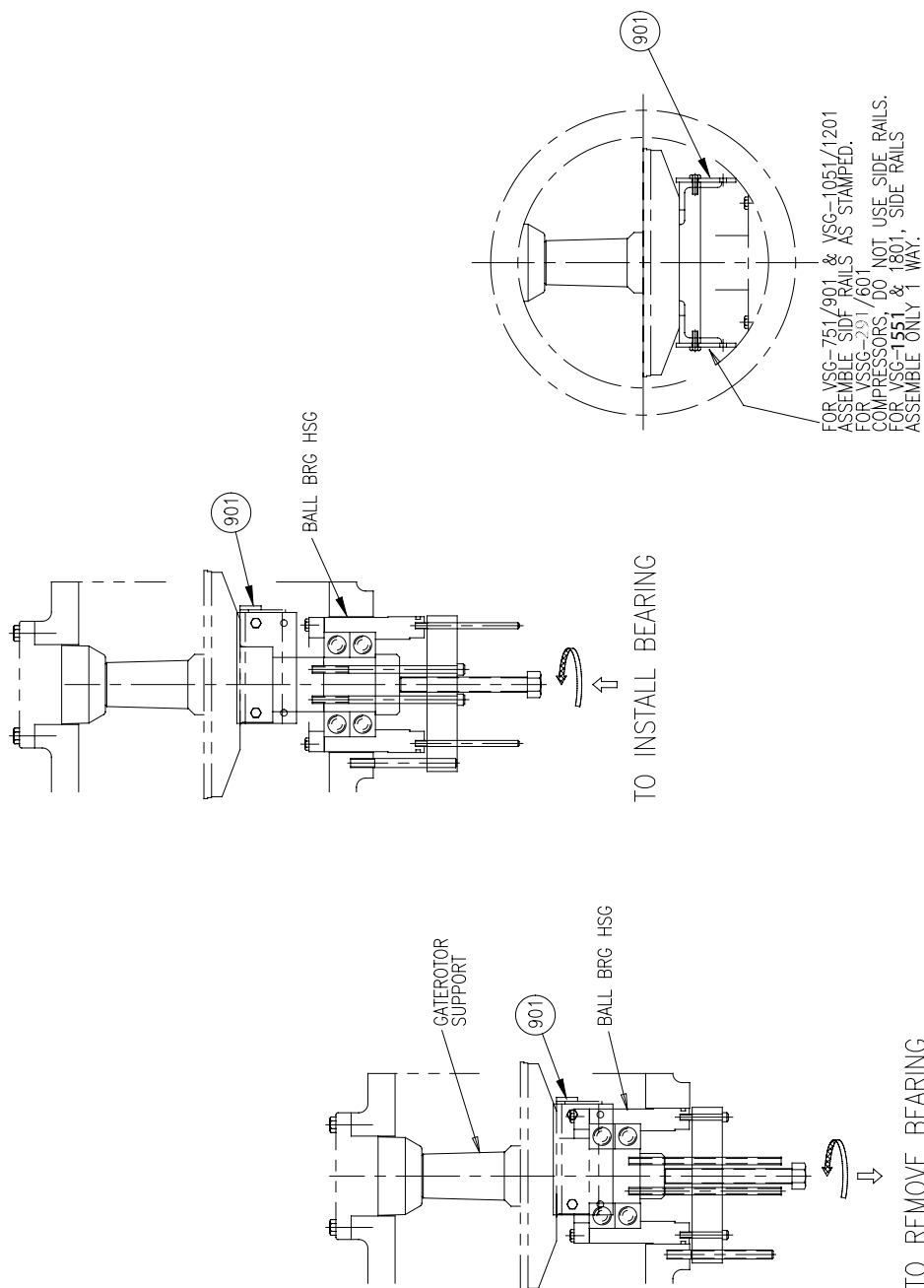
## Miscellaneous Frame Components (Tubing and Fittings) (VSS 2401 - VSS 3001)



ITEM	DESCRIPTION	QTY	VSS 2401- VSS 3001
555	MALE ELBOW (3/8 ODX 1/4MPT) 90°	2.00	13375F
557	BRANCH MLE TEE (1/4ODTX1/4ODTX1/4MPT)	1.00	13376D
560	MALE ELBOW (1/4ODTX1/4MPT) 90°	2.00	13375D
567	COMPRESSION CONNECTOR (3/8 ODT X 1/8MPT)	1.00	13229W
568	BUSHING (1 X 1/4) HEXAGON	2.00	1101M
570	UNION TUBE TEE (3/8)	1.00	13239E
573	BRANCH MALE TEE (3/80 DT X 1/4MPT)	1.00	2084A
571	STEEL TUBING (1/4 X .035) SMLS	2.00	3509A
572	STEEL TUBING (3/8 X .035) SMLS	4.00	3509B

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## Replacement Tools



ITEM	DESCRIPTION	MODEL NUMBER					
		QTY	VSS 291 thru VSS 601	VSS 751 VSS 901	VSS 1051 VSS 1201 VSS 1301	VSS 1551 thru VSS 2101	VSS 2401 thru VSS 3001
900	Gaterotor TOOLS	1	A25205B	A25205C	A25205C	A25205E	A25205F
901A	Gaterotor STABILIZER SET (901A, 901B, 901C)	1	A25698A	A25698A	A25698A	N/A	N/A
901B	Gaterotor STABILIZER SET (901A, 901B, 901C, 901D)	1	N/A	N/A	N/A	A25699A	N/A

## Replacement Parts

COMPONENT	DESCRIPTION	VPN	QTY	WHERE USED
VSS Units Suction Strainer	Strainer Screen, 4" & 5"	2881A	1	4" & 5" Suction Strainer
	Strainer Screen, 6"	2881B	1	6" Suction Strainer
	Strainer Screen, 8"	2881C	1	8" Suction Strainer
	Strainer Cover Gasket	2555E	1	4" & 5" Suction Strainer
	Strainer Cover Gasket	2555F	1	6" Suction Strainer
	Strainer Cover Gasket	2555G	1	8" Suction Strainer
Safety Relief Valves	300 Psig R-717 Relief Valve	1498GG	2	300 Psig R-717 Dual Relief Valve
	250 Psig R-717 Relief Valve	1498EE	2	250 Psig R-717 Dual Relief Valve
	300 Psig Halocarbon Relief Valve, 1/2"x 5/8"	1498GA	2	300 Psig Halocarbon Dual Relief Valve
	300 Psig Halocarbon Relief Valve, 3/4"x 1"	1498GJ, 1498GK, 1498GKA	2	300 Psig Halocarbon Dual Relief Valve
	300 Psig Halocarbon Relief Valve, 1"x 1"	1498GN	2	300 Psig Halocarbon Dual Relief Valve
Liquid Injection	2 Ton R-717 Thermostatic Expansion Valve *	2629J	1	2 Ton R-717 Liquid Injection System *
	5 Ton R-717 Thermostatic Expansion Valve **	2629A	1	5 Ton R-717 Liquid Injection System **
	10 Ton R-717 Thermostatic Expansion Valve **	2629B	1	10 Ton R-717 Liquid Injection System **
	15 Ton R-717 Thermostatic Expansion Valve **	2629C	1	15 Ton R-717 Liquid Injection System **
	20 Ton R-717 Thermostatic Expansion Valve ***	2629D	1	20 Ton R-717 Liquid Injection System ***
	30 Ton R-717 Thermostatic Expansion Valve ***	2629E	1	30 Ton R-717 Liquid Injection System ***
	50 Ton R-717 Thermostatic Expansion Valve ***	2629F	1	50 Ton R-717 Liquid Injection System ***
	75 Ton R-717 Thermostatic Expansion Valve ***	2629G	1	75 Ton R-717 Liquid Injection System ***
	100 Ton R-717 Thermostatic Expansion Valve ***	2629H	1	100 Ton R-717 Liquid Injection System ***
	Power Head Assembly	2637A	1	2 thru 15 Ton Thermostatic Expansion Valve
	Power Head Assembly	2637B	1	20 thru 100 Ton Thermostatic Expansion Valve
	120V R-717 Solenoid Valve	2562E	1	5 thru 15 Ton R-717 Liquid Injection System
	120V R-717 Solenoid Valve	2875F	1	20 thru 100 Ton R-717 Liquid Injection System
	Solenoid Valve Coil	2650VA	1	KIT REPLACEMENT W/S8F W/STRAINER

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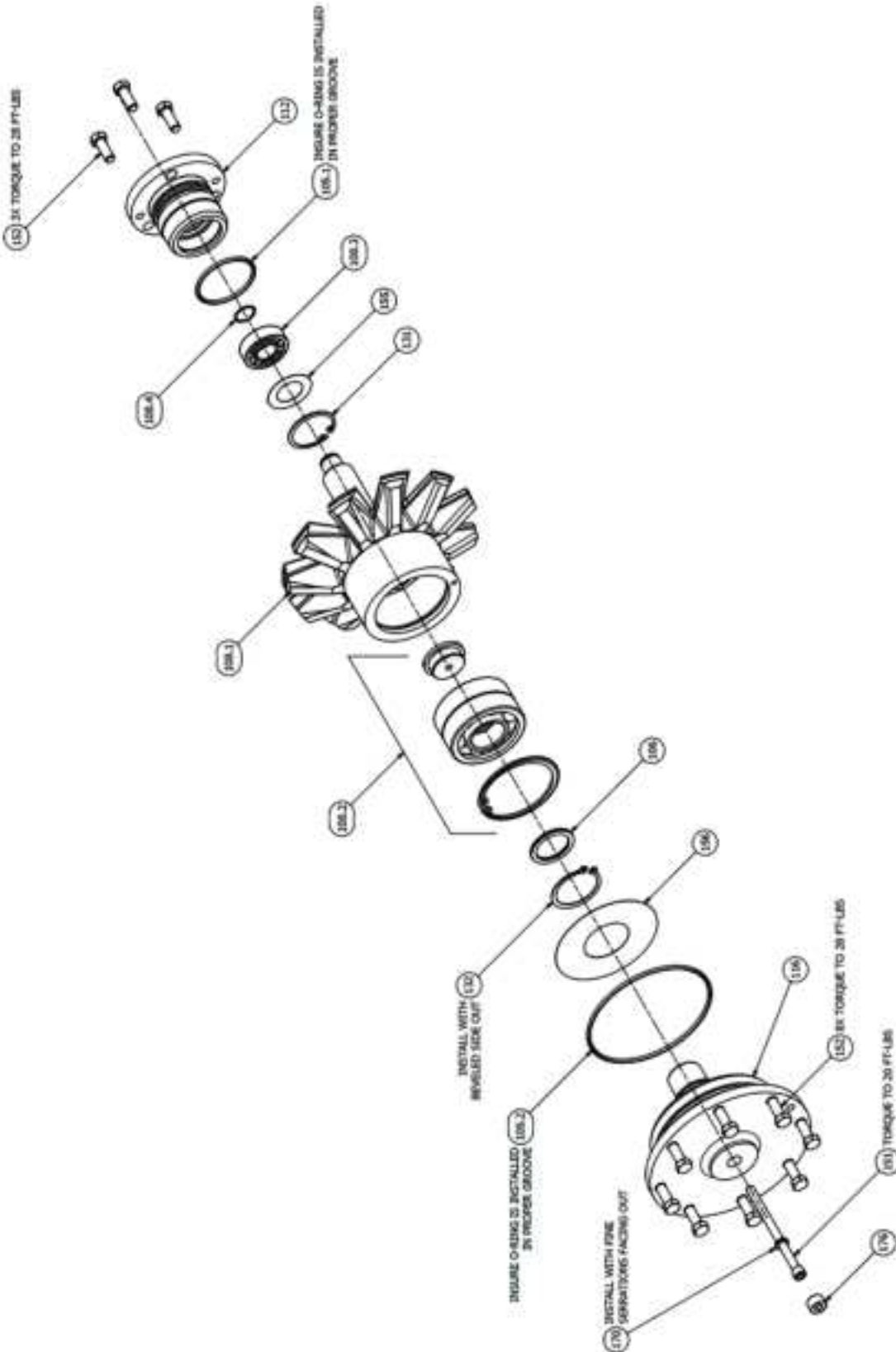


**VSM 301-701  
Recommended  
Spare Parts List**

**Refer to the Custom Manual  
Spare Parts Section for Specific Applications**

**Please have your Model # and Sales Order # available when ordering.  
These are found on the compressor's Name Plate.**

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## Gaterotor Assembly

Part totals indicated are for one Gaterotor assembly, machines with two Gaterotors will require double the components listed below.

ITEM	DESCRIPTION	MODEL NUMBER							
		QTY	VSM 301	VSM 361	VSM 401	QTY	VSM 501	VSM 601	VSM 701
	Gaterotor BLADE REPLACEMENT KITS	AR	KT1098A	KT1098B	KT1098C	AR	KT1098D	KT1098E	KT1098F
	Gaterotor BEARING REPLACEMENT KITS	AR	KT759F	KT759G	KT759H	AR	KT759BG (REMAN)	KT759BH (REMAN)	KT759BJ (REMAN)
105	SEAL GATEROTOR	1	A25164A A25164AV*	A25164A A25164AV*	A25164A A25164AV*	1	A25164B	A25164B	A25164B
105.1	O-RING	1	2176L	2176L	2176L	1	2176M	2176M	2176M
105.2	O-RING	1	2176F	2176F	2176F	1	2176R	2176R	2176R
106	SHIM GATEROTOR	1	A25165A	A25165A	A25165A	1	A25165B	A25165B	A25165B
108	SUPPORT GATEROTOR	1	A25222AB	A25222AA	A25222AC	1	A25222BB	A25222BA	A25222BC
108.1	SUPPORT GATEROTOR	1	A25161AB	A25161AA	A25161AC	1	A25161BB	A25161BA	A25161BC
108.2	BALL BEARING	1	A25163A	A25163A	A25163A	1	A25163B	A25163B	A25163B
108.3	ROLLER BEARING	1	2864F	2864F	2864F	1	2864B	2864B	2864B
108.4	RETAINING RING 0.781 ID X .065 X .031	1	2928Y	2928Y	2928Y	1	2928W	2928W	2928W
112	HOUSING GATEROTOR ROLLER BEARING	1	25407B	25407B	25407B	1	25407C	25407C	25407C
116	SUPPORT Gaterotor BALL BEARING	1	25408B	25408B	25408B	1	25408C	25408C	25408C
131	RETAINING RING	1	2867S	2867S	2867S	1	2867A	2867A	2867A
132	RETAINING RING 1.875 x 0.062 EXTERNAL BEVELED	1	2866J	2866J	2866J	1	2866K	2866K	2866K
151	SCREW	1	2795AP	2795AP	2795AP	1	2795AAA	2795AAA	2795AAA
152	SCREW 3/8-16 NC X 1	11	2796CG	2796CG	2796CG	12	2796CG	2796CG	2796CG
155	SHIM	AR	25977D	25977D	25977D	AR	25977G	25977G	25977G
156	SHIM	AR	25977C	25977C	25977C	AR	25977H	25977H	25977H
170	WASHER .312	1	3004C	3004C	3004C	1	3004C	3004C	3004C
176	PLUG 3/8-18NPTF FLUSH SEAL SOC HD	1	2606D	2606D	2606D	1	2606D	2606D	2606D

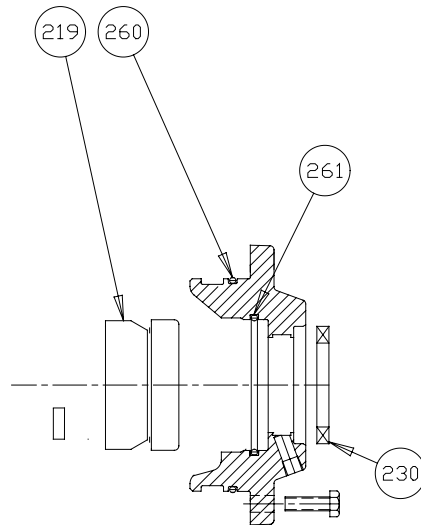
### NOTES

AR = As Required

\* Viton

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## Shaft Seal



ITEM	DESCRIPTION	MODEL NUMBER		
		QTY	VSM 301-401	VSM 501-701
*	SHAFT SEAL KIT (AMM) 219, 230, & 260	1	KT709D	KT709A
*	SHAFT SEAL KIT (HALO) 219, 230, & 260	1	KT781D	KT781A
219	SHAFT SEAL.	1	A	A
230	OIL SEAL.	1	2930C	25040A
244	TEFLON SEAL	1	25939A	25939A
252	RETAINER RING	1	2928M	2928M
260	O-RING	1	2176U	2176F
261	O-RING (205 Only)	1	2176AE	N/A

### NOTES

- \* Not pictured.
- A Sold only as kit.

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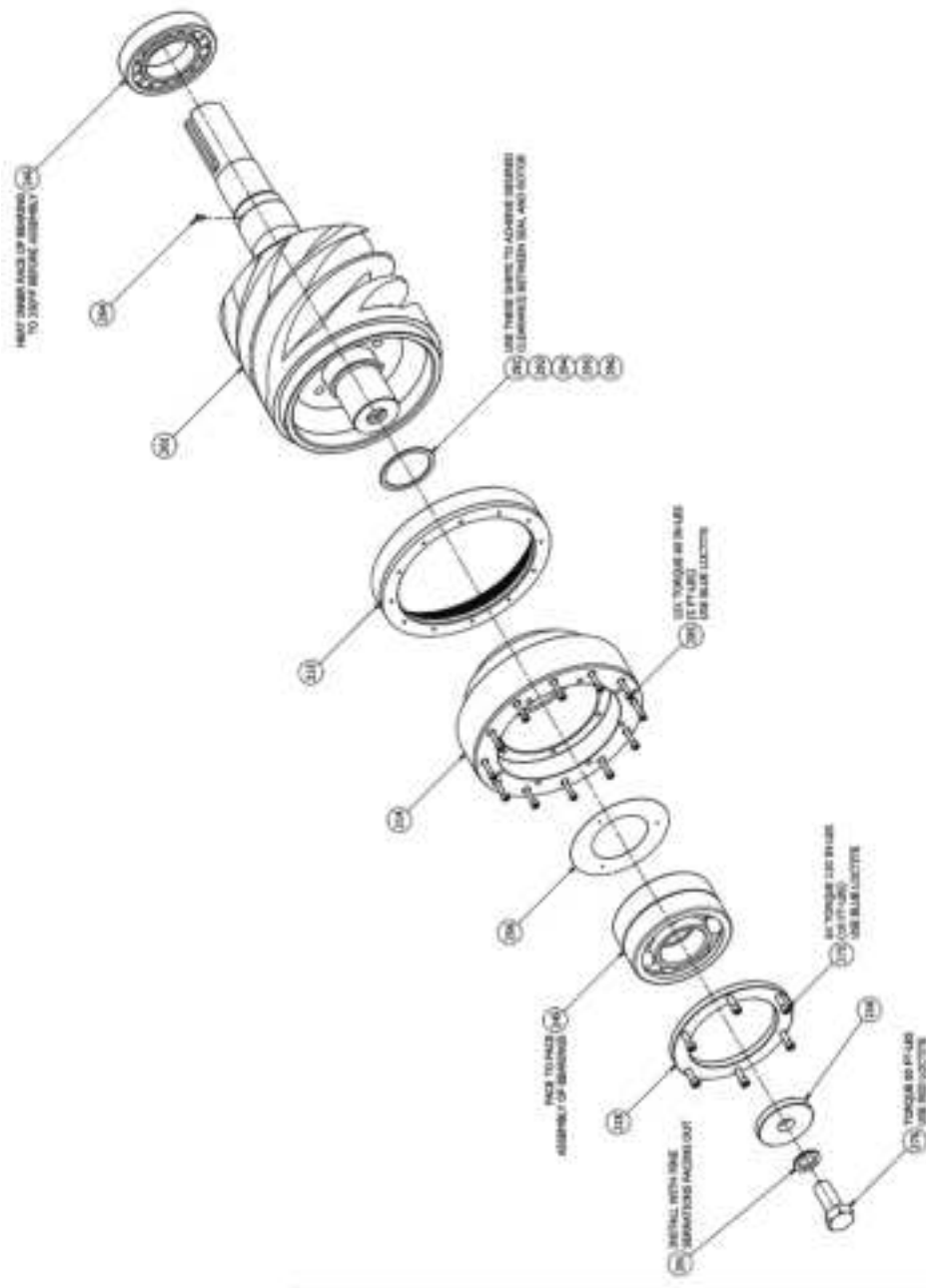


## Section 8 • Spare Parts List

### Main Rotor

Models VSM 301-401 Counter Clockwise ONLY

Models VSM 501-701 Clockwise ONLY

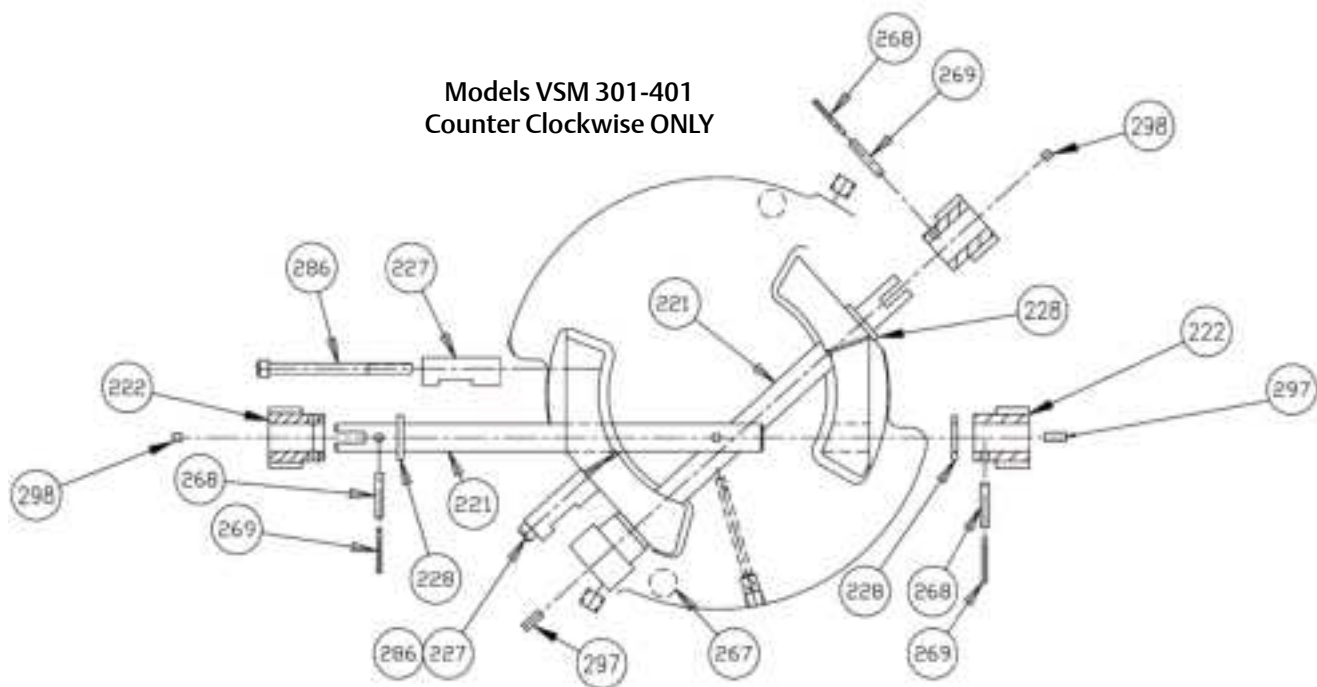


ITEM	DESCRIPTION	MODEL NUMBER							
		QTY	VSM 301	VSM 361	VSM 401	QTY	VSM 501	VSM 601	VSM 701
	MAIN ROTOR ASSEMBLY.	1	A25226AB	A25226AA	A25226AC	1	A26010BB	A26010BA	A26010BC
201	ROTOR	1	A25716AB	A25716AA	A25716AC	1	A26007BB	A26007BA	A26007BC

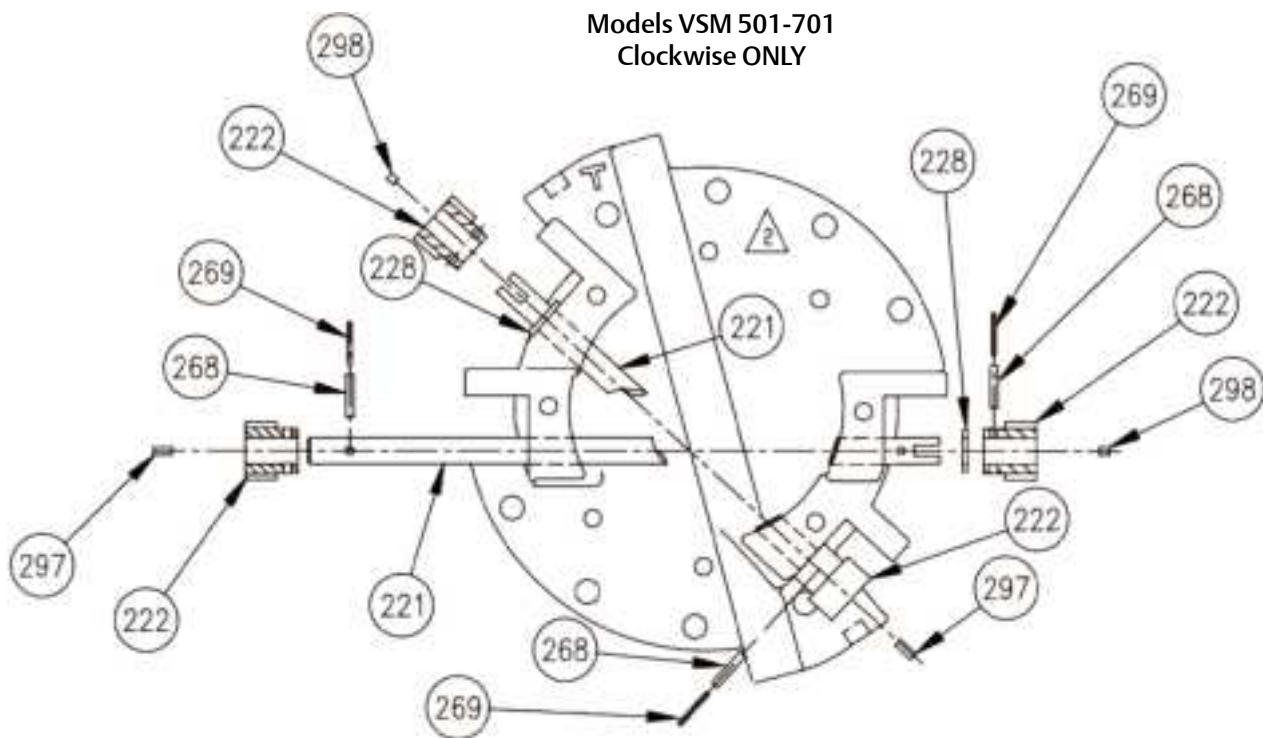
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Slide Valve Cross Shafts & End Plate

Models VSM 301-401  
Counter Clockwise ONLY



Models VSM 501-701  
Clockwise ONLY



### Slide Valve Cross Shafts & End Plate

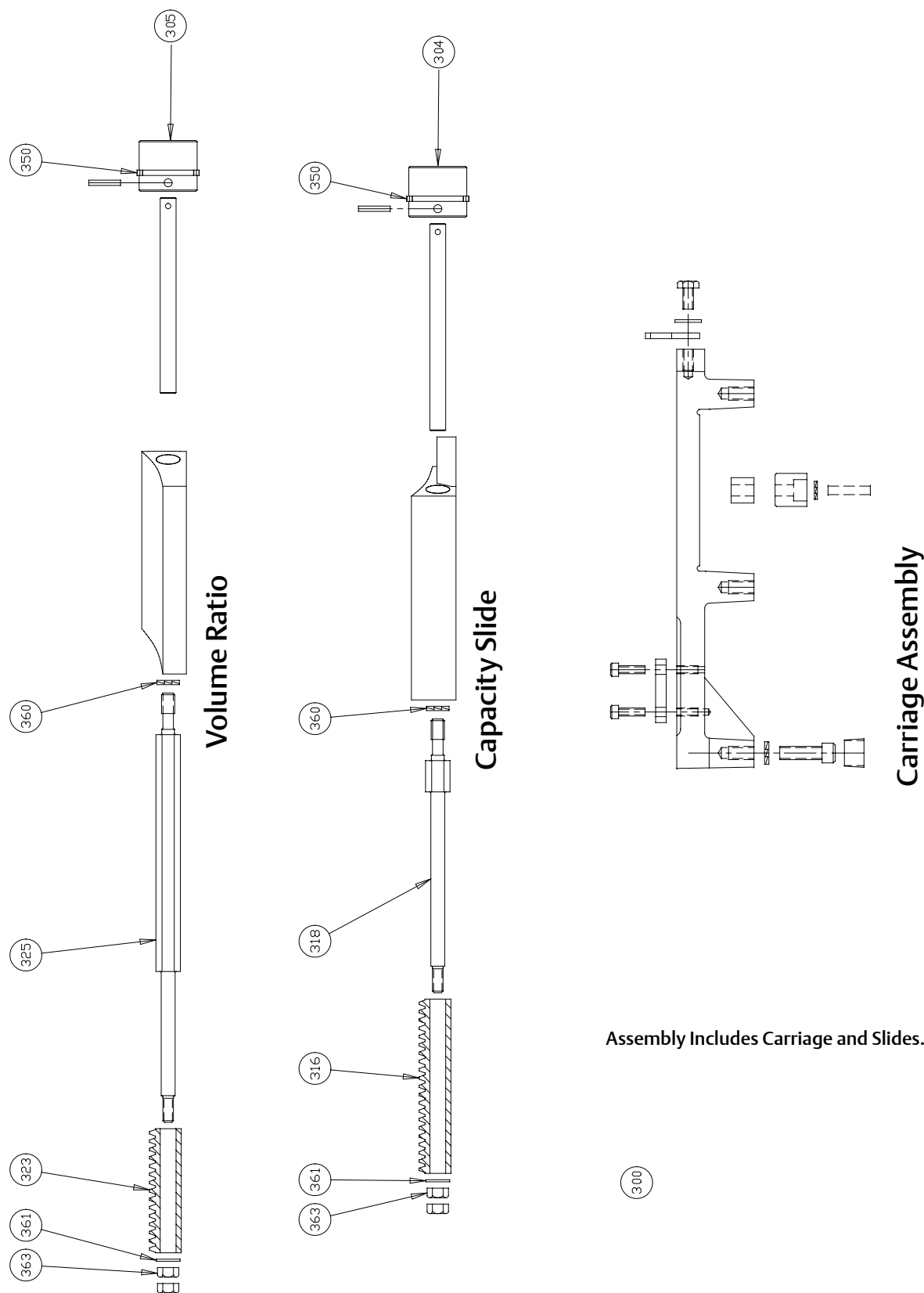
ITEM	DESCRIPTION	MODEL NUMBER							
		QTY	VSM 301	VSM 361	VSM 401	QTY	VSM 501	VSM 601	VSM 701
-	OIL BAFFLE ASSEMBLY (1) 217, (1) 244, (1) 248, (1) 249, (1) 252	1	A25942AA	A25942AA	A25942AA	1	A26034B	A26034B	A26034B
	SHIM ASSORTMENT (2) 240, (2) 241, (1) 242, (1) 243	1	A25177A	A25177A	A25177A	1	A26035B	A26035B	A26035B
217	OIL BAFFLE PLATE	1	25938A	25938A	25938A		26045A	26045A	26045A
220	END PLATE.	1	25719D	25719D	25719D	1	26025B	26025B	26025B
221	SHAFT	2	25941A	25941A	25941A	2	25843A	25843A	25843A
222	GEAR.	4	25027A	25027A	25027A	4	25027A	25027A	25027A
227	CLAMP.	4	25913A	25913A	25913A	-	N/A	N/A	N/A
228	SPACER.	4	25847A	25847A	25847A	4	25847A	25847A	25847A
293	SHIM 0.002"	AR	25409AA	25409AA	25409AA	2	26027BA	26027BA	26027BA
294	SHIM 0.003"	AR	25409AB	25409AB	25409AB	2	26027BB	26027BB	26027BB
295	SHIM 0.005"	AR	25409AC	25409AC	25409AC	1	26027BC	26027BC	26027BC
296	SHIM 0.010"	AR	25409AD	25409AD	25409AD	1	26027BD	26027BD	26027BD
244	TEFLON RING	1	25939A	25939A	25939A	1	25929B	25929B	25929B
248	CHECK VALVE	1	3120A	3120A	3120A	1	3120A	3120A	3120A
249	CHECK VALVE	1	3120B	3120B	3120B	1	3120B	3120B	3120B
252	RETAINING RING	1	2829M	2829M	2829M	1	2928N	2928N	2928N
255	WASHER	-	N/A	N/A	N/A	2	25977E	25977E	25977E
256	WASHER	-	N/A	N/A	N/A	2	25977F	25977F	25977F
268	EXPANSION PIN.	4	1193D	1193D	1193D	4	1193D	1193D	1193D
269	EXPANSION PIN.	4	2981AA	2981AA	2981AA	4	2981AA	2981AA	2981AA
271**	PLUG SOLID	1	25422A	25422A	25422A	-	N/A	N/A	N/A
281	HEX HEAD CAP SCREW.	6	2796N	2796N	2796N	8	2796B	2796B	2796B
286	SOCKET HEAD CAP SCREW.	8	2795F	2795F	2795F	2	2795D	2795D	2795D
297	SET SCREW.	2	2060J	2060J	2060J	2	2060J	2060J	2060J
298	SET SCREW.	2	2060H	2060H	2060H	2	2060H	2060H	2060H

NOTE:

\*\* Required at top located single gaterotor only.

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Slide Valve Carriage Assembly



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## Slide Valve Carriage Assembly

ITEM	DESCRIPTION	MODEL NUMBER		
		QTY	VSM 301-401	VSM 501-701
300	CARRIAGE ASSEMBLY.	1	A25179A	A26012B
304	CAPACITY PISTON 340, 341, 350 & 355.	1	A25183A	A25183B
305	VOLUME PISTON 340, 342, 350 & 355.	1	A25184A	A25184B
316	CAPACITY RACK.	1	25023BH	25024AH
318	CAPACITY RACK SHAFT.	1	25772C	25772A
323	VOLUME RATIO RACK.	1	25023CH	25023AH
325	VOLUME RATIO RACK SHAFT.	1	25772D	25772B
350	PISTON RING SET.	2	2953AE	2953AA
360	LOCK WASHER (PAIR).	2	3004C	3004C
361	WASHER.	2	13265B	13265B
363	NUT.	4	2797A	2797A
372*	SOCKET HEAD CAP SCREW.	1	N/A	2795M

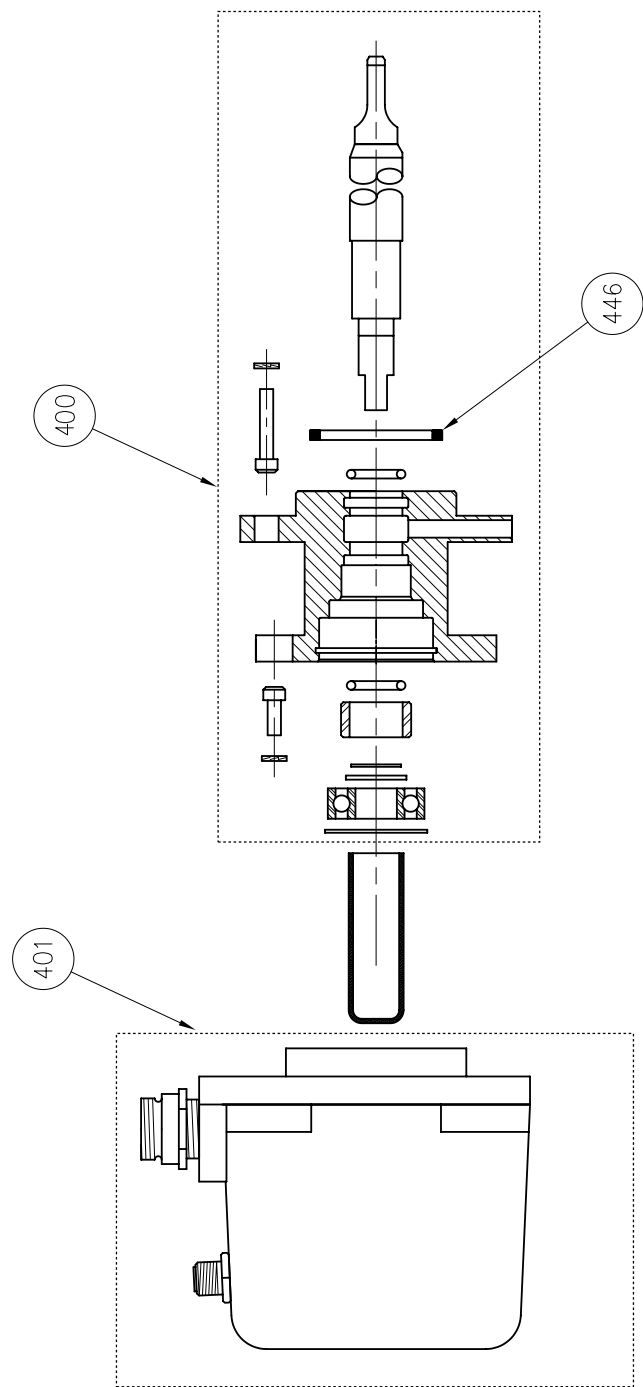
### NOTES:

There are two slide valve carriages per compressor. Each one each has its own Volume Ratio and Capacity slide valves. The above totals are per side of the compressor, double the quantities if both slide valve carriages are being worked on.

\* = Not Pictured.

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Actuator & Command Shaft

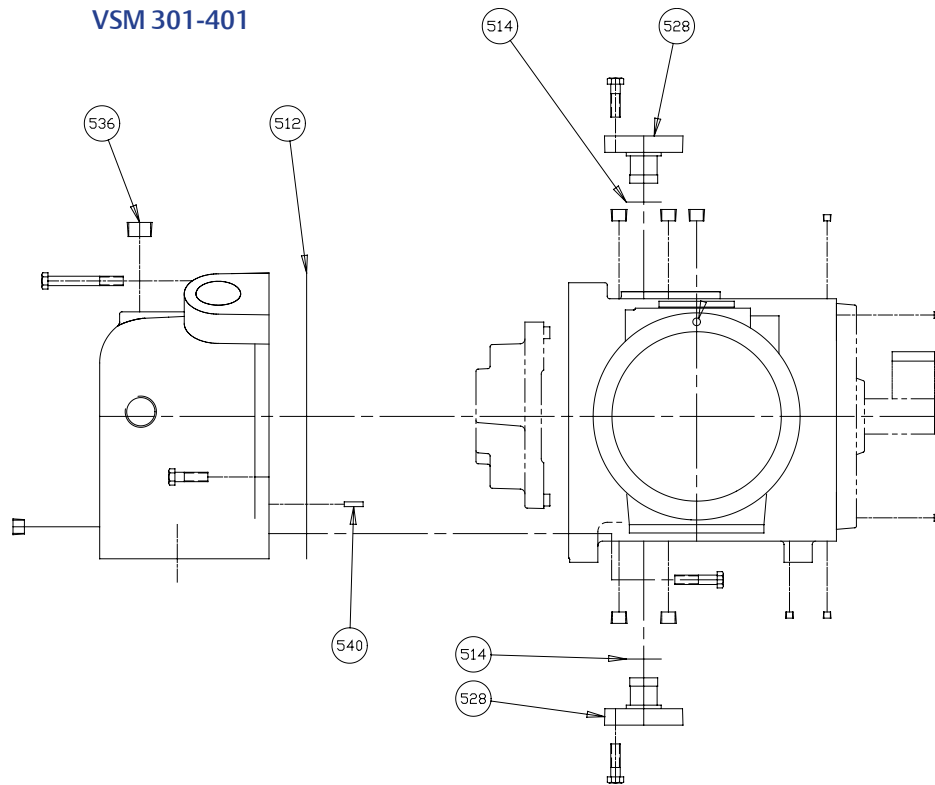


ITEM	DESCRIPTION	MODEL NUMBER		
		QTY	VSM 301-401	VSM 501-701
400	COMMAND SHAFT ASSEMBLY	2	A25994A	A25994B
401	SLIDEVALVE ACTUATOR	2	25972D	25972D
446	O-RING SEAL	2	2176X	2176X

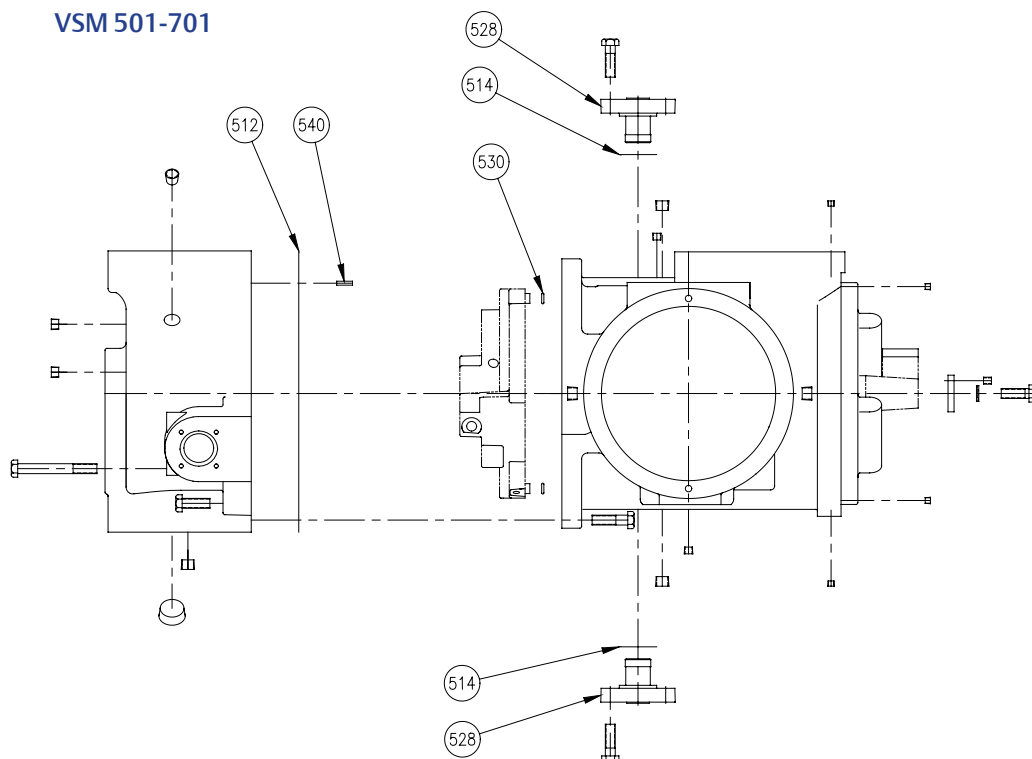
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## Miscellaneous Frame Components

VSM 301-401



VSM 501-701



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### Miscellaneous Frame Components

ITEM	DESCRIPTION	MODEL NUMBER			
		QTY	VSM 301-401	QTY	VSM 501-701
512	MANIFOLD GASKET.	1	25737A	1	26037A
514	ECON-O-MIZER GASKET.	2	11323G	2	11323D
522	COUPLING LOCK PLATE	-	N/A	1	25004D
523	LOCK WASHER	-	N/A	1	3004H
528	ECON-O-MIZER PLUG.	2	25419A	2	25397K
530	O-RING	-	N/A	2	2176BF
540	DOWEL PIN	2	2868B	2	2868B
542	PIPE PLUG	3	2606C	10	2606B
551	HEX HEAD CAP SCREW	-	N/A	2	2796C
570	BEARING OIL PLUG	1	25978A	-	N/A
571	PLUG	1	25979A	-	N/A
572	SPRING	1	3148A	-	N/A
*	GASKET / O-RING SET	1	KT1075A	1	KT1075B

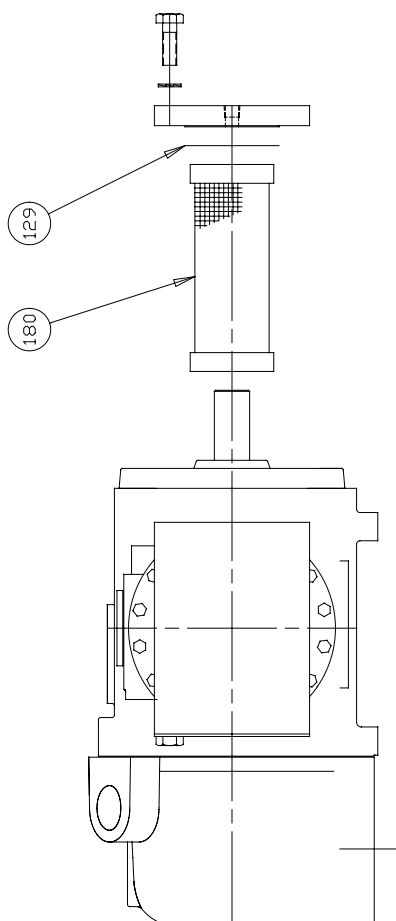
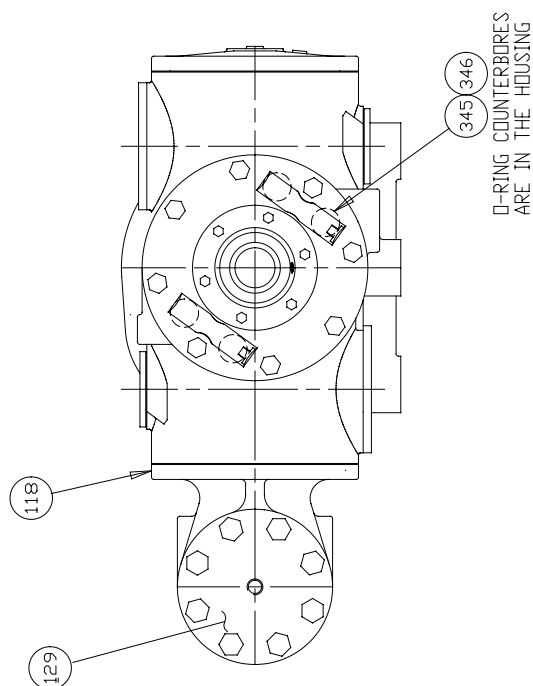
#### NOTES.

\* Not Pictured.

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.



## Housing Accessories



## Housing Accessories

ITEM	DESCRIPTION	MODEL NUMBER	
		QTY	VSM 301-701
117	Gaterotor COVER.	1	25416B
118	COVER GASKET.	2	25259B
129	GASKET.	1	11323T
180	INLET SCREEN.	1	25920A
343	PISTON COVER. *	1	25724B

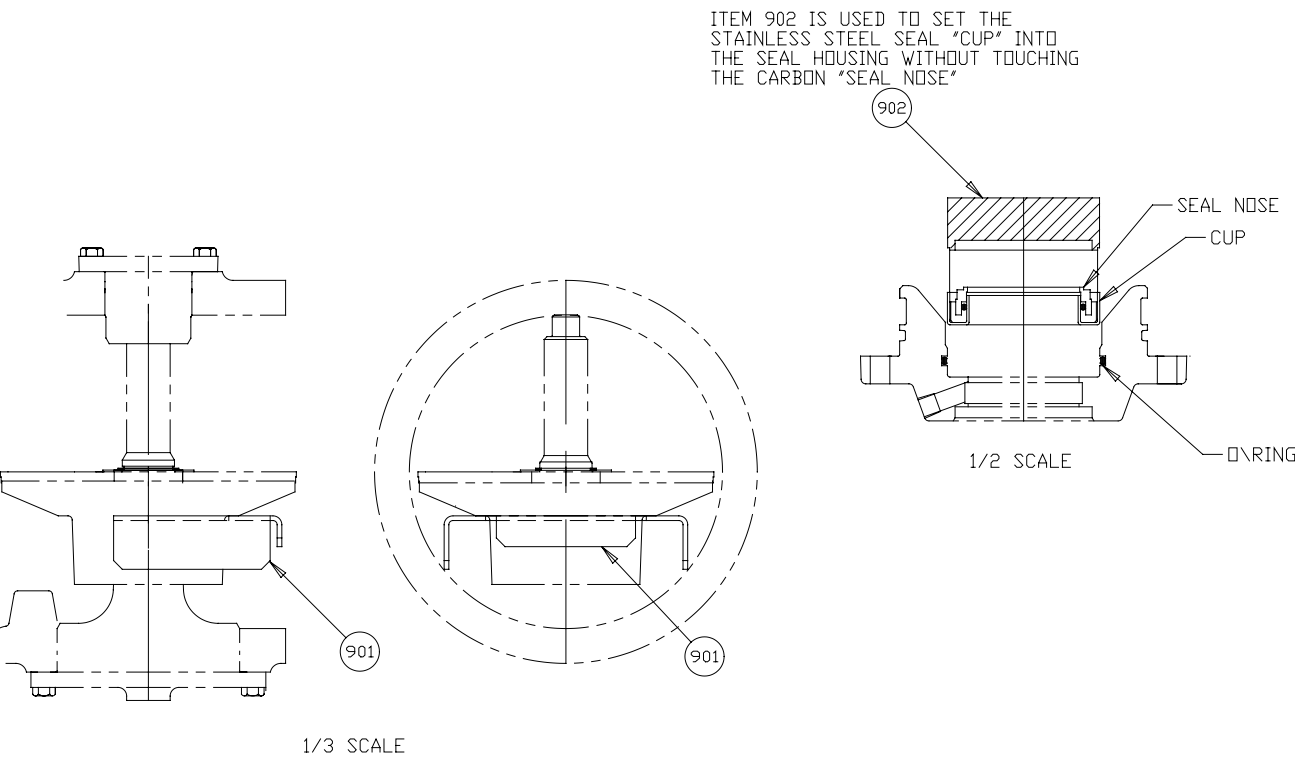
NOTES.

\* Not Pictured.

ITEM	DESCRIPTION	MODEL NUMBER		
		QTY	VSM 301-401	VSM 501-701
345	O-RING.	4	2176BX	2176CA
346	O-RING.	2	2176BG	2176BG

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

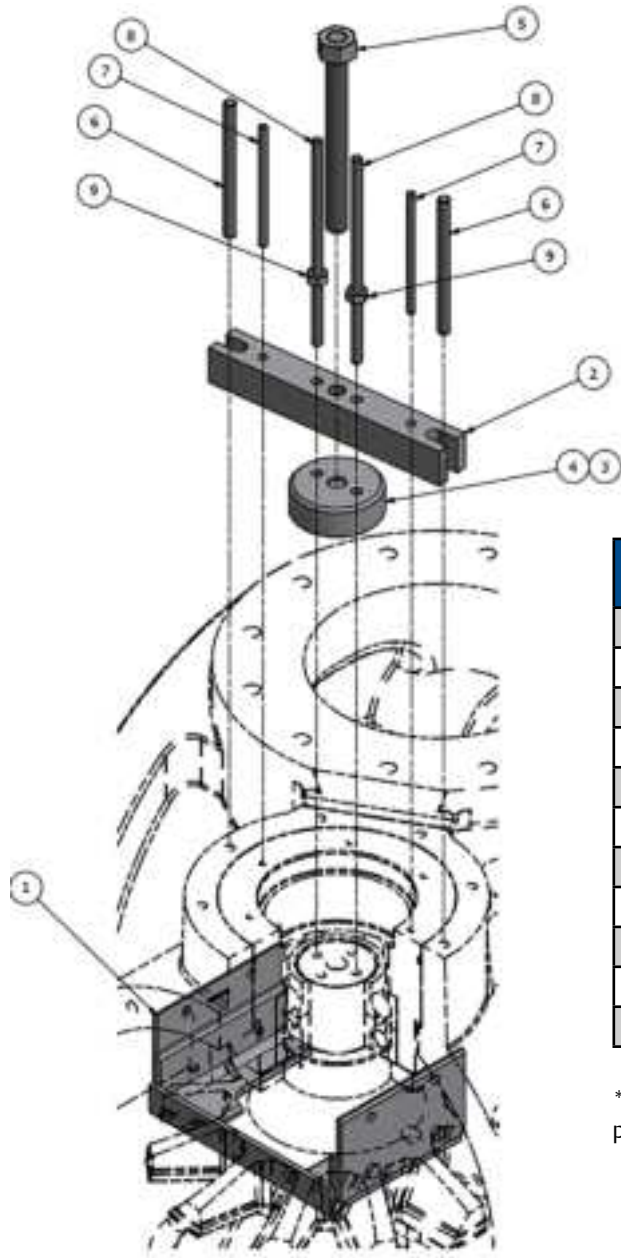
Replacement Tools



ITEM	DESCRIPTION	MODEL NUMBER		
		QTY	VSM 301-401	VSM 501-701
900	GATEROTOR TOOLS	1	A25205B	A25205B
901	GATEROTOR STABILIZER.	1	25742A	25742B
902	SEAL INSTALLATION TOOL	1	25455A	25455B

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

## Replacement Tools



ITEM	DESCRIPTION	QTY	PART NUMBER
-	GATEROTOR TOOL SET	1	A25205B*
1	STABILIZER GATEROTOR ASSEMBLY	1	A25698A
2	BAR BEARING PULLER	1	25204A
3	SHOE PULLER 1.875	1	25157A
4	SHOE PULLER 2.500	1	25157B
5	JACKSCREW	1	A25156B
6	STUD .375-16 X 4.9	2	25908A
7	STUD .250-20 X 4.4	2	25908B
8	STUD .312-18 X 7.5	2	25908C
-	SCREW 1/4-20 NC X 1-3/4 CAP SOCK	2	2795W
9	PLAIN NUT 5/16-18NC-2B HEX	2	1726B

\* Assembly A25205B contains all parts listed. Parts are shown independently for illustration purposes only.

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

**VSM 97-127  
Recommended  
Spare Parts List**

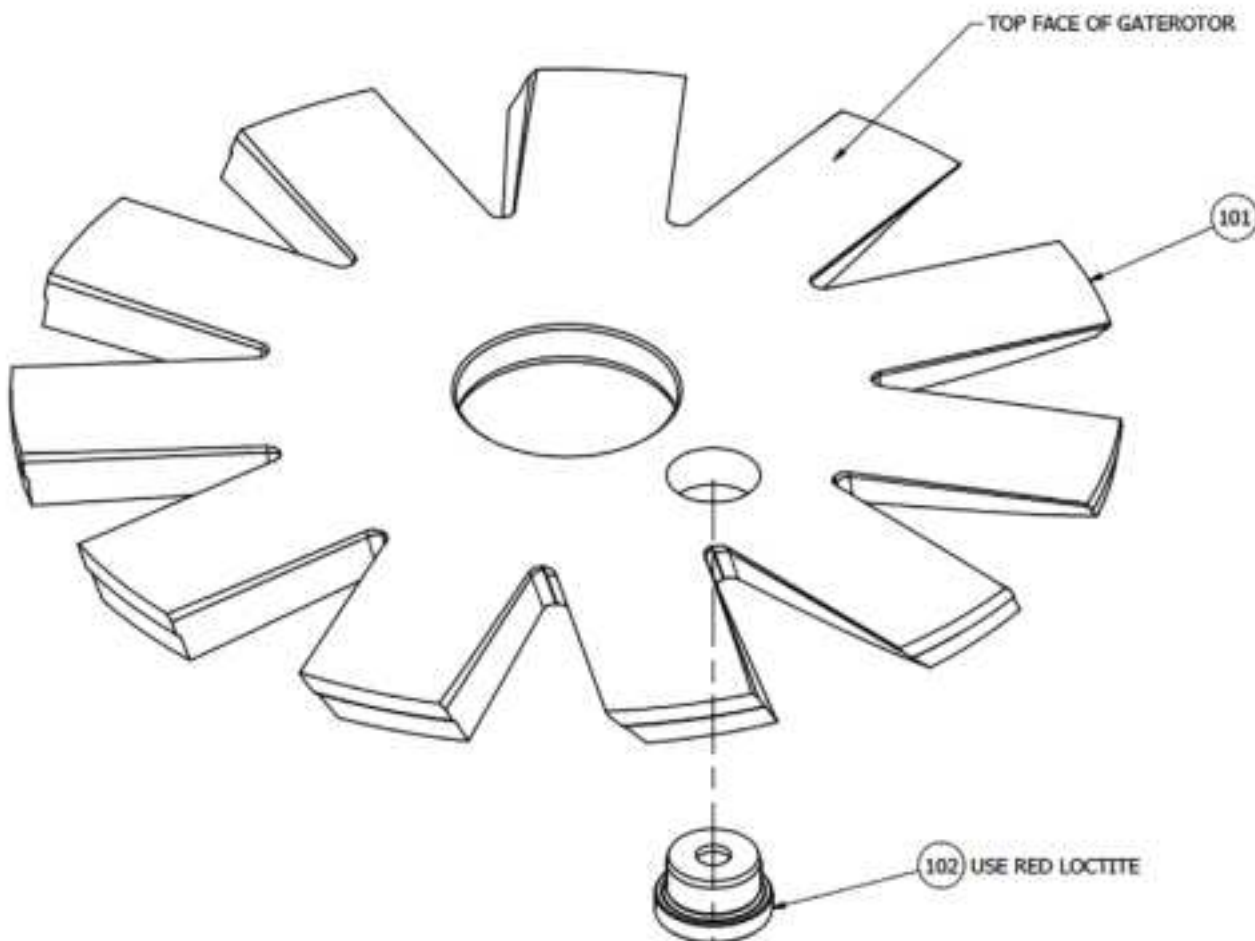
**Refer to the Custom Manual  
Spare Parts Section for Specific Applications**

**Please have your Model # and Sales Order # available when ordering.**

**These are found on the compressor's Name Plate.**

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.

## Kits



### Gaterotor Kits For VSM127\*

ITEM	VPN	QUANTITY	DESCRIPTION
-	KT759J	1	Blade & Bearing
-	KT1098G	1	Blade

\*Contact Vilter for Other Sizes

### Shaft Seal Kit

ITEM	VPN	QUANTITY	DESCRIPTION
-	KT709P	1	Shaft Seal Kit (143mm Compressor)

Vilter parts get renewed from time to time, so be sure to ask if the part listed in your manual is still the best for your compressor. Parts that appear on diagrams might be shown separately for reference, but are sold as an assembly or kit only.



## Appendix A • Torque Specifications

### Torque Specifications

Refer to the following tables for torque specifications.

**Table A-1. Torque Specifications (ft-lbs)**

TYPE BOLT	HEAD MARKINGS	NOMINAL SIZE NUMBERS OR INCHES									
		#10	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8
SAE GRADE 2 COARSE (UNC)			5	10	18	29	44	63	87	155	150*
SAE GRADE 5 COARSE (UNC)			8	16	28	44	68	98	135	240	387
SAE GRADE 5 FINE (UNF)				16							
SAE GRADE 8 COARSE (UNC)			11	22	39	63	96	138	191	338	546
SOCKET HEAD CAP SCREW (ASTM A574) COARSE (UNC)		5	13	26	46	73	112	155	215	380	614
NOTES:	1) Torque values on this sheet are not to override those given on the individual drawings.										
	2) When using loctite, the torque value on this sheet are only accurate if bolts are tightened immediately after loctite is applied.										
	* The proof strength of Grade 2 bolts is less for sizes 7/8 and above and therefore the torque values are less than smaller sizes of the same grade.										

**Table A-2. Torque Specifications for 17-4 Stainless Steel Fasteners (ft-lbs)**

Type Bolt/Nut	Head Markings	Nominal Size Numbers or Inches								
		#10	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"
Hex & Socket Head Cap Screws	 	3	8	14	25	40	60	101	137	245
Nut		-	8	-	25	-	-	-	-	-

**NOTE:**

Continue use of red loctite #271 (VPN 2205E) on currently applied locations. Use blue loctite #243 (VPN 2205F or 2205G) on all remaining locations.





## Oil Analysis Report



Customer Name  
Customer Address

## PRODUCT ANALYSIS REPORT

No Action Required

Report Date:	3/4/2013
Report Number:	*****
Customer	Customer
Comp. Mfr.	Vilter
Oil Type	VILTER-717
Serial Number	****.***
Model Number	VSM-601
Hrs. on Fluid	6049
Hrs. on Machine	11239
Sample Date	Feb 21, 2013
Receive Date	Mar 01, 2013
I.D. #	*****

## Evaluation:

The fluid is in good condition. Sample again in 6 months.

## Physical Properties Results \*

Sample Date (Lube Hours)	Feb 21, 2013 (6049)	Oct 19, 2012 (4809)	Jul 26, 2010 (5190)
Water by Karl Fischer (ppm)	19.5	147.7	41.4
Viscosity 40 C (cSt)	64.23	64.47	66.00
TAN Total Acid #	0.077	0.106	0.080
ISO Code	21/20/16	21/19/16	21/19/14

## Spectrochemical Analysis

Wear Metals (ppm)			
Silver (Ag)	0	0	0
Aluminum (Al)	0	0	0
Chromium (Cr)	0	0	0
Copper (Cu)	0	0	0
Iron (Fe)	0	0	0
Nickel (Ni)	0	0	0
Lead (Pb)	0	0	0
Tin (Sn)	0	0	0
Titanium (Ti)	0	0	0
Vanadium (V)	0	0	0
Contaminant/Additive Metals (ppm)			
Barium (Ba)	0	0	0
Calcium (Ca)	0	0	0
Magnesium (Mg)	0	0	0
Molybdenum (Mo)	0	0	0
Sodium (Na)	0	0	0
Phosphorus (P)	0	0	0
Silicon (Si)	0	0	0
Zinc (Zn)	0	0	0

Thank you for this opportunity to provide technical assistance to your company. If you have any questions about this report, please contact us at 1-800-637-8628, or fax 1-989-496-2313 or email us at [tslab@oil-services-lab.com](mailto:tslab@oil-services-lab.com)

CC List

Accuracy of recommendations is dependent on representative oil samples and complete correct data on both unit and oil

\* Property values should not be construed as specifications

### Storage Guidelines For Vilter B and FL Type Lubricants

Vilter Type B and FL lubricants are ester-based fluids and are hygroscopic by nature. This means that they absorb water moisture from the surrounding environment. Compared to mineral based lubricants which are typically saturated with water at less than 100 PPM, ester based lubricants become saturated with water at approximately 2,500 PPM.

High water moisture levels cannot be tolerated in the refrigeration systems where ester based lubricants are utilized and require specific handling and storage guidelines, in addition to the normal precautions for system dehydration prior to system start-up.

All Vilter lubricants are manufactured to meet strict requirements to ensure minimal water moisture content as shipped. The following guidelines are provided for the end-user of the equipment as a means to minimize the water content of lubricants in storage.

#### Guidelines

- Use a suitable dehydration process for the complete refrigeration system to ensure that the system as a whole is completely dry and water free. This can be accomplished by the use of vacuum pumps and checked by a vacuum gauge to ensure that a suitable micron value has been reached, and maintained.
- Store all lubricant containers in a dry environment. Do not expose the lubricant to the atmosphere by opening the container until the compressor sump or separator is ready to be charged.
- Keep the lubricant in its original container. Some plastic containers allow water moisture to pass through the container itself.
- If possible, use container sizes appropriate to the compressor charge to avoid leaving partially filled containers open for long period of times. Vilter B Type lubricant is available in 5 and 55 gallon containers.
- Refrigeration systems using ester based lubricants will require suitable high capacity moisture filter/driers to maintain low total moisture content in the refrigerant and lubricant.

#### Compatibility & Misc.

- Vilter Type B lubricant has been extensively tested with many of the components in a refrigeration system. Elastomers, driers, etc. for use with HFCs have demonstrated no adverse effects when tested for hardness, swelling and brittleness.
- Vilter Type B lubricant cannot be used in conjunction with a mineral based oils are not miscible with HFCs. The performance of a refrigeration system is optimized when the lubricant is allowed to be miscible with the refrigerant to aid in the oil return to the compressor. If the oil used in an HFC refrigeration system does not provide oil return capability, the oil will tend to accumulate in the evaporator reducing the overall system capacity.
- CFC and HCFC refrigerants should not be used with Vilter Type B lubricant since these types of refrigerants greatly reduce the viscosity of ester based lubricants, resulting in inadequate compressor lubrication.

**Table B-1 Oil Recommendations for Standard Warranty Coverage  
Single Screw Compressors Only**

Vilter Oil Type	717	HCL-68	F-68	FL-100	B-68	HC-68
ISO Grade	68	68	68	100	68	68
@ 100°F (cSt)	77	75.7	65.67	76.4	71	67.2
Viscosity Index	100	132	79	115	108	168
Spec. Gravity	0.867	0.835	0.876	0.96	0.957	0.989
Density lbm/gal, 60°F	7.4	6.95	7.3	8.26	7.96	8.25
Flash Point - °F	440	525	295	558	505	425
Fire Point - °F	475	570	315	633	560	465
Pour Point - °F	-38.2	-67	-31	Pending	-45	-55
Floc Point - °F	-25	NA	-75	NA	NA	NA
Refrigerant Type	R-717	R-717 R-22 R-1270	R-22	R-22	R-134a R-507 R-404A R-407C R-410A	R-290

## Table B-2 Cross Reference Index

Vilter Part No.	Oil Type	Vilter Lube Type	Container Size	Applications
2939A	HMO	R717	5 gallon pail	R-717 (Ammonia)
2939AFG	HMO	717FG	55 gallon drum	R-717 (Ammonia)
2939B	HMO	R717	5 gallon pail	R-717 (Ammonia)
2939BFG	HMO	717FG	55 gallon drum	R-717 (Ammonia)
3098A	PAG	HC-68	5 gallon pail	R-290
3098B	PAG	HC-68	55 gallon drum	R-290
3099A	PAG	HC-100	5 gallon pail	Hydrocarbon
3100A	Naphthenic	VILTER D	5 gallon pail	R-22, R-123 & R-414A
3100B	Naphthenic	VILTER D	55 gallon drum	R-22, R-123 & R-414A
3101A	POE	FL-100	5 gallon pail	R-22
3101B	POE	FL-100	55 gallon drum	R-22
3103A	PAO	HCL-68	5 gallon pail	Ammonia
3103B	PAO	HCL-68	55 gallon drum	Ammonia
3103C	PAO	HCL-15	5 gallon pail	R-717
3105A	BLEND	F-68	5 gallon pail	R-22, R-123 & R-502
3105B	BLEND	F-68	55 gallon drum	R-22, R-123 & R-502
3106A	POE	B-68	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3106B	POE	B-68	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3107A	POE	B-120	5 gallon pail	R-134A, R-404A, R-407C, R-410A
3107B	POE	B-120	55 gallon drum	R-134A, R-404A, R-407C, R-410A
3143A	PAO-100	METHANE	5 gallon pail	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3143B	PAO-100	METHANE	55 gallon drum	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3143C	PAO-68	METHANE	5 gallon pail	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3143D	PAO-68	METHANE	55 gallon drum	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3143G	PAO-150	METHANE	5 gallon pail	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3143H	PAO-150	METHANE	55 gallon drum	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3143J	PAO-100	DIGESTER	5 gallon pail	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3143K	PAO-100	DIGESTER	55 gallon drum	Hydrocarbon/natural gas, Landfill gas, Turbine feed gas
3339A	PAO	CO <sub>2</sub> GAS	5 gallon pail	CO <sub>2</sub> , CO
3339B	PAO	CO <sub>2</sub> GAS	55 gallon drum	CO <sub>2</sub> , CO
3456A	POE	B-32	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A)
3456B	POE	B-32	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A)
3595A	HMO	NH3-100-CI	5 gallon pail	Ammonia
3595B	HMO	NH3-100-CI	55 gallon drum	Ammonia
3603B	POE	B-68AWAF	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3603C	POE	B-68AWAF	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3603D	POE	B-100AWAF	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3603E	POE	B-100AWAF	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3636A	PAO	CO <sub>2</sub>	5 gallon pail	Gas streams containing moisture, CO <sub>2</sub> , CO and/or H <sub>2</sub> S
3636B	PAO	CO <sub>2</sub>	55 gallon drum	Gas streams containing moisture, CO <sub>2</sub> , CO and/or H <sub>2</sub> S
3643A	PAO	XG 105-100	5 gallon pail	Hydrocarbon/natural gas
3643B	PAO	XG 105-100	55 gallon drum	Hydrocarbon/natural gas
3653A	POE	POE-100	5 gallon pail	Air Compressor Lubricant
3653B	POE	POE-100	55 gallon drum	Air Compressor Lubricant



### Vibration Measurements - Single Screw Compressor

#### Scope

The vibration criteria provided applies to broad-band vibration measurements taken on the bearings and housing of the Single Screw compressors under steady-state operating conditions within the nominal operating speed range in addition to the piping and tubing on the compressor unit. They relate to both acceptance testing and operational monitoring. The evaluation criteria is intended to apply to both continuous and non-continuous monitoring situations. The scope does not address the diagnostic evaluation of the condition of the roller element bearings. The criteria are applicable only for the vibration produced by the machine itself and not for vibration which is transmitted to the machine set from external sources. Information used in this chapter was taken from ISO Standard 10816-3, Mechanical Vibration – Evaluation of Machine Vibration by Measurements on Non-Rotating Parts – Part 3, First Edition, 1998.

### Measurement Procedures and Operational Conditions

#### Measurement Equipment

The measurement equipment shall be capable of measuring broad-band rms vibration with flat response over a frequency range of at least 10 Hz to 1000 Hz. Depending on the vibration criteria, this may require measurements

of displacement or velocity or combinations thereof.

Care should be taken to ensure that the measuring system is not influenced by environmental factors such as:

- temperature variations;
- magnetic fields;
- sound fields;
- power source variations;
- transducer cable length;
- transducer orientation.

Particular attention should be given to ensure that the vibration transducers are correctly mounted and that such mountings do not degrade the accuracy of the measurements.

### Compressor Measurement locations

Measurements taken on the compressor will usually be taken on exposed parts that are normally accessible. Care shall be taken to ensure that measurements reasonably represent the vibration of the bearing housing and do not include any local resonances or amplification. The locations and directions of vibration measurements shall be such that they provide adequate sensitivity to the machine dynamic forces. Typically, this will require two radial measurement locations on each bearing cover on the gate rotor housing support and back plate (near the compressor shaft). Vertical and horizontal directions are preferred for Single Screw compressors. The specific locations and directions shall be recorded with the measurement.

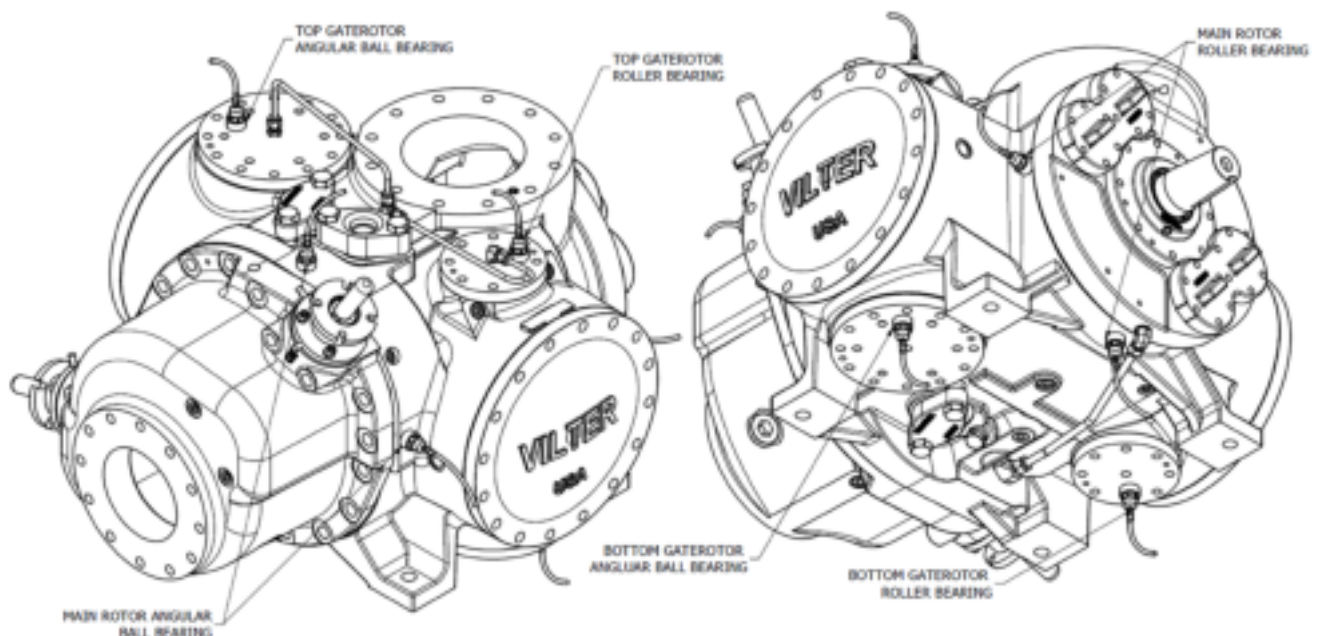


Figure C-1. Compressor Bearing Vibration Measurement Location

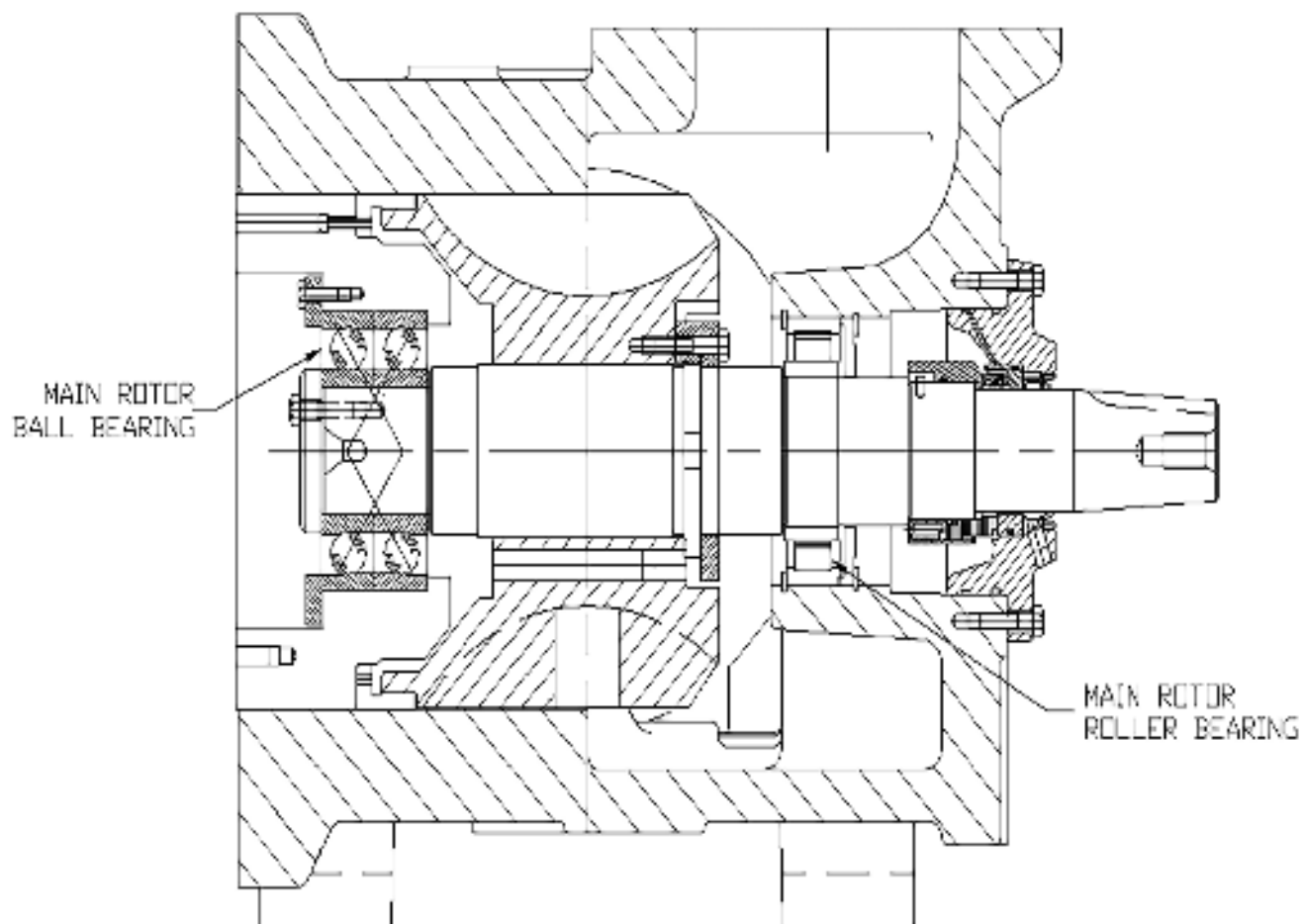


Figure C-2. Main Rotor Cross-Section VSS/VSMC Compressors

### Continuous and Non-continuous Monitoring

While it is common practice on large or critical machinery to have installed instrumentation for continuous on-line monitoring of vibration values at key measurement points, this is not necessarily carried out in industrial applications.

Changes in unbalance, bearing performance, alignment, etc. can be detected with sufficient reliability from periodic measurements with permanently installed or hand-held instruments. The use of computers for trend analysis and warning against malfunctions is also becoming more common.

### Operational Conditions

Measurements shall be carried out when the compressor has reached normal steady-state operating temperatures and with the machine running under specified conditions. If the measured vibration is greater than the acceptance criteria allowed and an excessive background vibration is suspected, measurements should be made with the machine shut down to determine the degree of external influence. If the vibration with the machine stationary exceeds 25% of the value measured when the machine is running, corrective action may be necessary to reduce the effect of the background vibration.

### Evaluation

There are two evaluation criteria used to assess vibration severity on various classes of machines. One criteria considers the magnitude of observed broad-band vibration; the second considers changes in magnitude, irrespective of whether they are increases or decreases.

#### Criterion 1: Vibration Magnitude

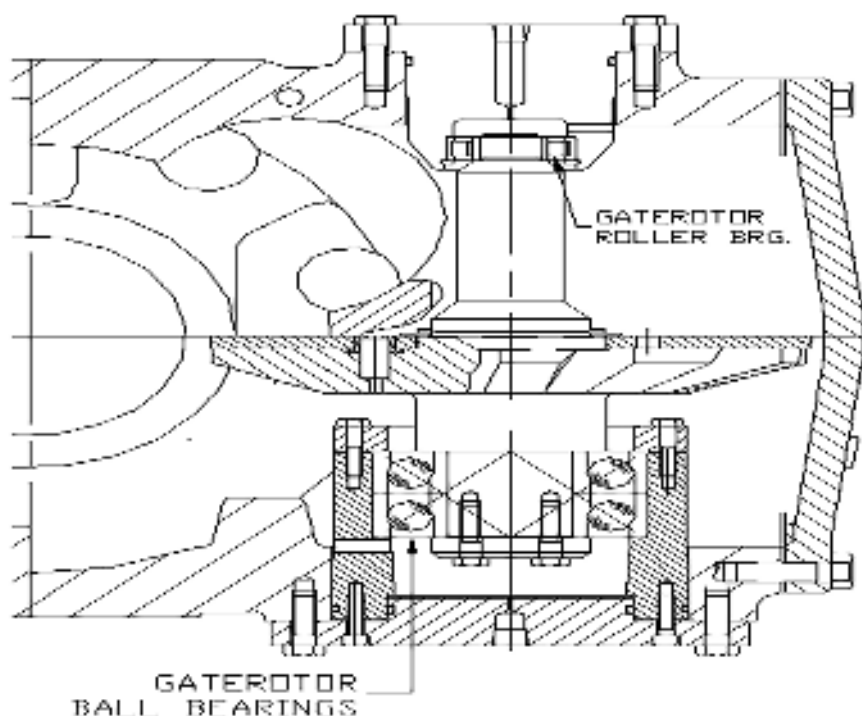
This criterion is concerned with defining limits for vibration magnitude consistent with acceptable dynamic loads on the bearings and acceptable vibration transmission into the environment through the support structure and foundation. The maximum vibration magnitude observed at each bearing or pedestal is assessed against the evaluation zones for the support class. The evaluation zones have been established from international experience.

The following evaluation zones are defined to permit a qualitative assessment of the vibration of a given machine and provide guidelines on possible actions.

- Zone A: The vibration of newly commissioned machines would normally fall within this zone.

- Zone B: Machines with vibration within this zone are normally considered acceptable for unrestricted long-term operation.
- Zone C: machines with vibration within this zone are normally considered unsatisfactory for long term continuous operation. Generally, the machine may be operated for a limited period in this condition until a suitable opportunity arises for remedial action.
- Zone D: Vibration values within this zone are normally considered to be of sufficient severity to cause damage to the machine.

Numerical values assigned to the zone boundaries are not intended to serve as acceptance specifications, which shall be subject to agreement between Vilter™ manufacturing and the customer. However, these values provide guidelines for ensuring that gross deficiencies or unrealistic requirements are avoided. In certain cases, there may be specific features associated with a particular machine which would require different zone boundary values (higher or lower) to be used



NOTE: GATEROTOR RPM = 6/11 (.545) \* MAIN SHAFT RPM

Figure C-3. Gaterotor Cross-Section VSS/VSR/VSMC Compressors

## Appendix C • Vibration Measurements - Single Screw Compressor

### Evaluation Zone limits

The values for the zone boundaries given below are based on the maximum broad-band values of velocity and displacement when measurements are taken from two orthogonally oriented radial transducers. Therefore when using these tables, the higher of each of the values measured from the two transducers in each measurement plane should be used. When the maximum measured values of velocity and displacement are compared to the corresponding values in the table, the severity zone which is most restrictive shall apply.

### Operational limits

For long-term operation, it is common practice to establish operational vibration limits. These limits take the form of ALARM and TRIP set points.

**ALARM:** To provide a warning that a defined value of vibration has been reached or a significant change has occurred, at which remedial action may be necessary. In general, if an ALARM situation occurs, operation can continue for a period while investigations are carried out to identify the reason for the change in vibration and define any remedial action.

**TRIP:** To specify the magnitude of vibration beyond which further operation of the machine may cause damage. If the TRIP value is exceeded, immediate action should be taken to reduce the vibration or the machine should be shut down.

Different operational limits, reflecting differences in dynamic loading and support stiffness, may be specified for different measurement positions and directions.

VIBRATION MEASUREMENTS – SINGLE SCREW COMPRESSOR*					
Support Class	ZONE	RMS Displacement		RMS Velocity	
		μmm	mils	mm/s	In/sec
	A	0-30	0-1.15	0-2.3	0-.09
	B	30-57	1.15-2.25	2.3-4.5	.09-.18
	C	57-90	2.25-3.55	4.5-7.1	.18-.28
	D	Above 90	Above 3.55	Above 7.1	Above .28

\*RMS= 0.707 X peak (sine wave only)

Table C-1. Vibration Zone Values

### Setting of ALARMS

The ALARM values may vary considerably, up or down, for different machines. The values chosen will normally be set relative to a baseline value determined from experience for the measurement position or direction for that particular machine.

It is recommended that the ALARM value should be set higher than the baseline by an amount equal to 25% of the upper limit for zone B. If the baseline is low, the ALARM may be below zone C.

Where there is no established baseline (for example with a new machine) the initial ALARM setting should be based either on experience with other similar machines or relative to agreed acceptance values. After a period of time, the steady-state baseline value will be established and the ALARM setting should be adjusted accordingly.

It is recommended that the ALARM value should not

normally exceed 1.25 times the upper limit of zone B.

If the steady-state baseline changes (for example after a machine overhaul), the ALARM setting should be revised accordingly.

### Setting of TRIPS

The TRIP values will generally relate to the mechanical integrity of the machine and be dependent on any specific design features which have been introduced to enable the machine to withstand abnormal dynamic forces. The values used will, therefore, generally be the same for all machines of similar design and would not normally be related to the steady-state baseline value used for setting ALARMS.

There may, however, be differences for machines of different designs and it is not possible to have clear guidelines for absolute TRIP values. In general, the TRIP value will be within zone C or D, but it is recommended that



the TRIP value should not exceed 1.25 times the upper limit of zone C.

### Vibration limits For piping and Tubing

The piping and tubing on the compressor units must be supported with the appropriate brackets and supports to minimize the vibration levels. These brackets and supports should also be strategically placed to prevent the natural frequency from matching the normal operating speed. The typical goal is to have the natural frequency of an assembly to be at least 10% above or below the operating speed. In the case when a compressor is operated by a VFD (Variable Frequency Drive), there is a high probability that there will be an opportunity to match either the natural frequency of the assembly or its 2nd or 3rd order since the compressor's speed will vary within a large range of RPM's.

The compressor unit should first be operated at either the normal operating speed or if it utilizes a VFD, through the operating range of speed. Visual observations of the vibration levels of all the piping and tubing should first be observed. After this initial survey, the vibration measurement equipment should be individually mounted or attached to each specific piece of piping or tubing as required in the location of what is perceived as the maximum amplitude or worse vibration.

While there are references which specifically allow higher levels of vibration for piping, the goals for the vibration levels of the piping and tubing on the compressor unit should still utilize the same criteria outlined in this standard. If possible, the vibration levels should be within the zone boundaries of Zone B or better. These values will ensure that the stress levels in the piping and tubing are acceptable for continuous operation. These values provide guidelines for ensuring that gross deficiencies or unrealistic requirements are avoided. In certain cases, there may be specific features associated with a particular compressor unit which would require different zone boundary values.

For compressors that are operated at a fixed speed, brackets and supports may be added or moved to reduce the vibration levels of the specific component. If the compressor is operated utilizing a VFD, a skip frequency should be inputted into the controls to ensure the compressor passes through the harmonic and that it operates either below or above the operating speed that matches the natural frequency of the specific component. It is not unusual to have three or four skip frequencies within the normal operating ranges of a compressor utilizing a VFD.



## **Appendix D**

# **Liquid Injection Valve Setup Instructions and ICM/ICAD Motorized Valve Quick Start Guide**

### Danfoss ICM/ICAD Valve Setup Instructions

The following items need to be setup in order for the valve to operate properly.

1. Press the “Circle” button on the valve. A value of “01” should be shown on the screen.
2. Press the “Circle” button. There should be a value of “1” shown. If not use the up/down arrows to change it to the correct value. Press the “Circle” button when done.
3. Press the “Up” arrow button. A value of “02” should be shown on the screen.
4. Press the “Circle” button. There should be a value of “1” shown. If not use the up/down arrow buttons to change it to the correct value. Press the “Circle” button when done.
5. Press the “Up” arrow button. A value of “03” should be shown on the screen.
6. Press the “Circle” button. There should be a value of “2” shown. If not, use the up/down arrow buttons to change it to the correct value. Press the “Circle” button when done.
7. Press the “Up” arrow button until a value of “04” is shown on the screen.
8. Press the “Circle” button. There should be a value of “50” shown. If not, use the up/down arrow buttons to change it to the correct value. Press the “Circle” button when done.
9. Press the “Up” arrow button until a value of “07” is shown on the screen.
10. Press the “Circle” button. There should be a value of “1” shown. If not, use the up/down arrow buttons to change it to the correct value. Press the “Circle” button when done.
11. Press the “Up” arrow button until a value of “10” is shown on the screen.
12. Press the “Circle” button. Press the up/down arrow button to change the value to “11”. Press the “Circle” button.
13. Press the “Up” arrow button until a value of “26” is shown on the screen.
14. Press the “Circle” button. Press the up/down arrow buttons to change the value to the correct valve that is on the unit. The value number is listed on the valve. The values and valves are as follows:
  - 0: No valve selected. Alarm A1 will become active.
  - 1: ICM20 with ICAD 600
  - 2: ICM25 with ICAD 600
  - 3: ICM32 with ICAD 600
  - 4: ICM40 with ICAD 900
  - 5: ICM50 with ICAD 900
  - 6: ICM65 with ICAD 900
15. Press the “Circle” button.

The valve is now ready to be used.



## **ICM/ICAD Motorized Valve**

### **Installation, Programming, and Trouble-shooting**

**Contents**

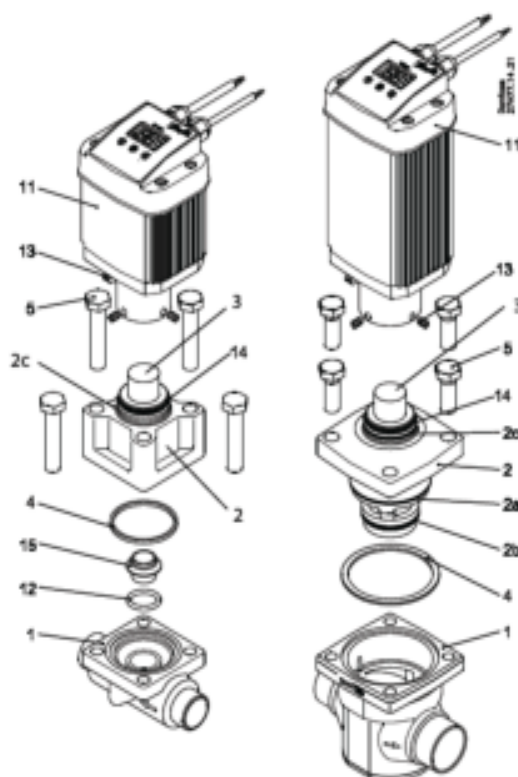
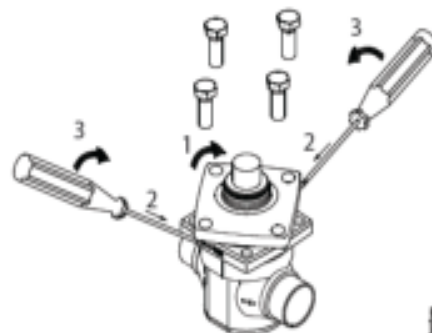
	<b>Page</b>
Installation .....	3
Wiring the ICAD .....	5
ICAD Overview .....	8
ICAD Programming .....	9
Troubleshooting	
The Manual Tool .....	10
Service parameters .....	10
Alarms .....	11
Tips .....	11
Common questions.....	12

## Installation

1. The ICM valve and ICAD motor actuator must be installed in horizontal pipelines with the motor actuator pointing upwards.
2. To prevent damage to O-rings and the valve seat, remove the one-piece ICM bonnet and function module from the valve body prior to welding the valve body in the line. For ICM 20 (3/4" size) the valve seat is not integrated with the valve bonnet and must be separately removed from the valve body with a 12 mm hex key prior to welding (see diagrams below).

### Removing ICM 25 to 65 bonnets

- 1) Remove the 4 bolts
- 2) Rotate the bonnet as shown
- 3) Pry the bonnet out of the valve body by using screw drivers between the bonnet and valve body as shown



No.	Part description
1	ICM body (housing)
2	ICM bonnet/function module
2a	O-ring for bonnet/function module
2b	O-ring for bonnet/function module
2c	O-ring for sealing ICAD motor with ICM valve
3	ICM adapter/valve stem
4	ICM bonnet gasket
5	Bolts for ICM
11	ICAD motor actuator
12	O-ring for ICM 20 seat orifice
13	ICAD screws
14	Guide ring
15	ICM 20 valve seat orifice

**Care should be taken to protect the ICM function module while it is removed from the valve body.**

3. Weld the valve body in line making sure the arrow on the valve body is pointing in the direction of flow.
4. Remove all debris from the valve body before re-installing the bonnet.
5. Install the bonnet/function module into the valve body.
  - a. For ICM 20, make sure that the removable orifice seat is installed in the valve body with the small O-ring between the orifice seat and body. Make sure the bonnet gasket is installed and in good condition.
  - b. For ICM 25 through ICM 65, check that the two O-rings on the bonnet and gasket located between the bonnet and valve body are installed and in good condition. A light coating of refrigerant oil on the bonnet O-rings will facilitate installation of the bonnet.
6. Install the four bolts and torque to the following specifications:

Valve body	Nm	ft lbs
ICM 20	50	37
ICM 25	80	59
ICM 32	80	59
ICM 40	90	66
ICM 50	100	74
ICM 65	110	81

7. Install the ICAD motor actuator on the ICM valve:
  - a. The ICM valve must not be in its fully opened position while the ICAD motor is calibrated with the valve at a later step. Therefore, if the opening degree of the ICM valve was changed from the factory setting, it should be set to an opening degree between 0% and 75% using the manual magnet tool. To easily ensure correct positioning, turn the manual tool counter-clockwise until it is clear that it cannot be turned further.
  - b. Make sure that the ICM adapter/valve stem and inner ICAD motor magnets are completely dry and free from any debris.
  - c. For applications below freezing, the ICM adapter O-ring (position 2c in the diagram on page 3) must be removed, and Molycote G 4500 grease (supplied with ICAD motor) needs to be applied in the O-ring groove on the adapter and on the O-ring before it is re-installed on the ICM adapter. The Molycote grease ensures a good seal between the ICAD motor and the ICM adapter to prevent moisture from entering the ICAD magnets.
  - d. Place the ICAD motor on the valve stem.
  - e. Push the ICAD motor completely down to the identification ring on the valve stem and use a 2.5 mm hex key to tighten the set screws evenly so the ICAD motor is centered on the ICM adapter (torque: 3 Nm/ 2.5 lb-ft).



## Wiring the ICAD

**Note: The ICAD is powered by a 24 Volt DC power source.**

There are two cables pre-mounted and connected to the ICAD motor actuator. Never try to open the ICAD motor because the special moisture seal will be damaged.

The power cable consists of 3 wires:

- Green: (–) common (ground)
- Brown: (+) positive from 24VDC power source
- White: (+) positive from UPS/battery backup (optional)

The control cable consists of 7 wires:

- Yellow: (–) common (ground)
- Gray: (+) positive 4-20mA or 0-20mA input to control ICAD motor
- Blue: (+) positive 4-20mA or 0-20mA output from ICAD for valve position feedback
- Pink: (+) positive 2-10V or 0-10V input to control ICAD motor. Also used as a digital input with the yellow wire for on/off solenoid valve operation.
- White: common alarm (digital NPN transistor output when combined with yellow wire)
- Brown: indicates ICM is fully open (digital NPN transistor output when combined with yellow wire)
- Green: indicates ICM is fully closed (digital NPN transistor output when combined with yellow wire)

## Electrical Data

Supply voltage is galvanically isolated from input and output wires.

### Supply voltage

24 V d.c., +10% / -15%

Load ICAD 600: 1.2 A

ICAD 900: 2.0 A

### Fail safe supply

Min. 19 V d.c.

Load ICAD 600: 1.2 A

ICAD 900: 2.0 A

### Analog input - Current or Voltage

#### Current

0/4 - 20 mA

Load: 200  $\Omega$

#### Voltage

0/2 - 10 V d.c.

Load: 10 k $\Omega$

### Analog output

0/4 - 20 mA

Load:  $\leq 250 \Omega$

*Digital input - Digital ON/OFF input by means of voltage free contact (Signal/Telecom relays with gold-plated contacts recommended) – Voltage input used*

ON: contact impedance < 50  $\Omega$

OFF: contact impedance > 100 k $\Omega$

### Digital output - 3 pcs. NPN transistor output

External supply: 5 - 24 V d.c. (same supply as for ICAD can be used, but please note that the galvanically isolated system will then be spoiled).

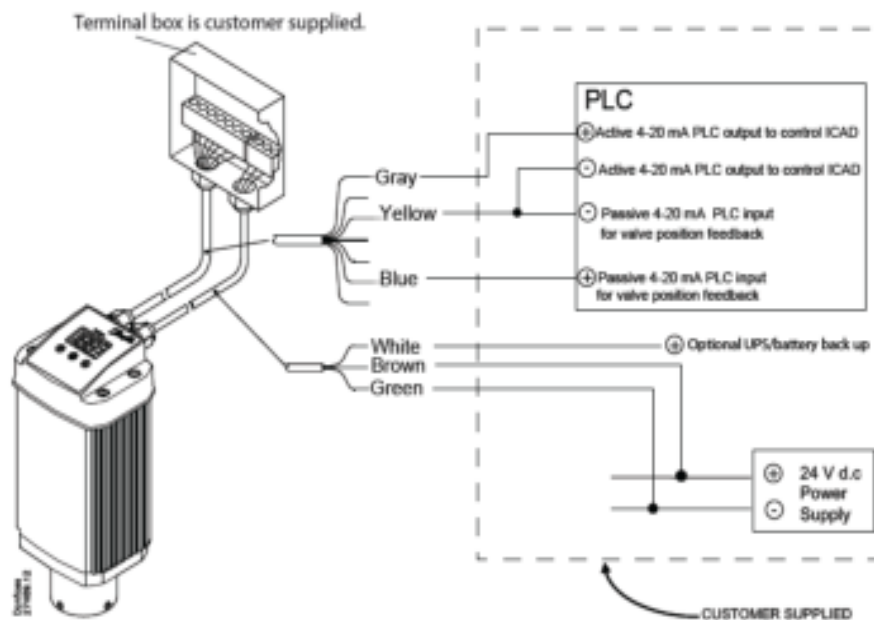
Output load: 50  $\Omega$

Load: Max. 50 mA

# Wiring diagram showing ICAD wired with a PLC or other type of third-party electronics

## Note:

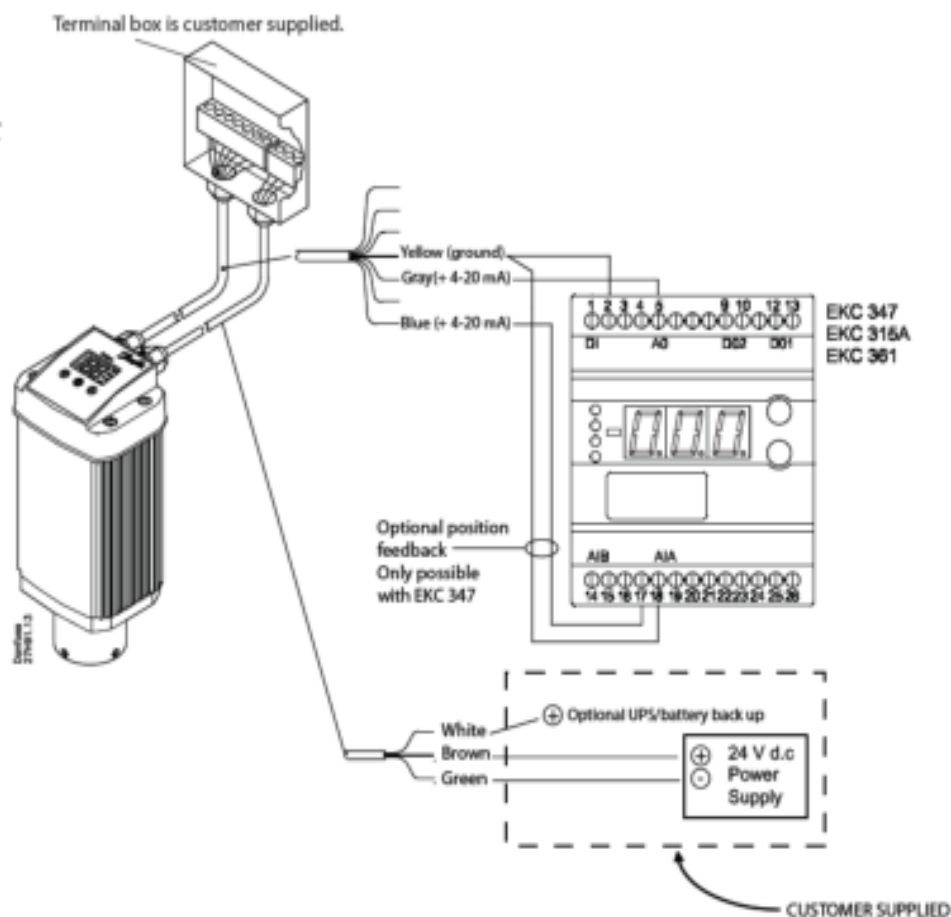
The ICAD supplies the power for the 4-20 mA feedback signal.



# Wiring diagram with Danfoss EKC controllers

## Note:

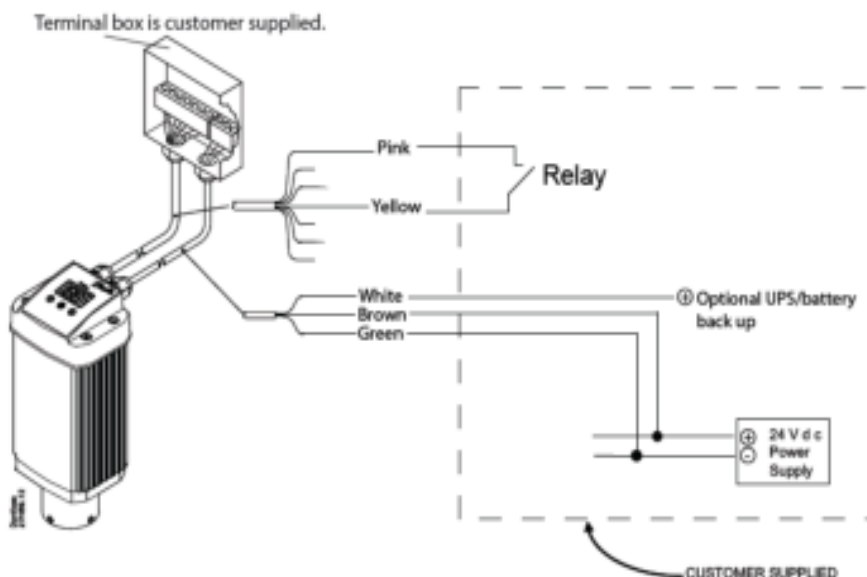
For instructions on completely wiring an EKC controller, please see the relevant EKC controller manual.



**Wiring diagram showing ICAD wired with a digital input for ON/OFF solenoid valve operation**

**Note:**

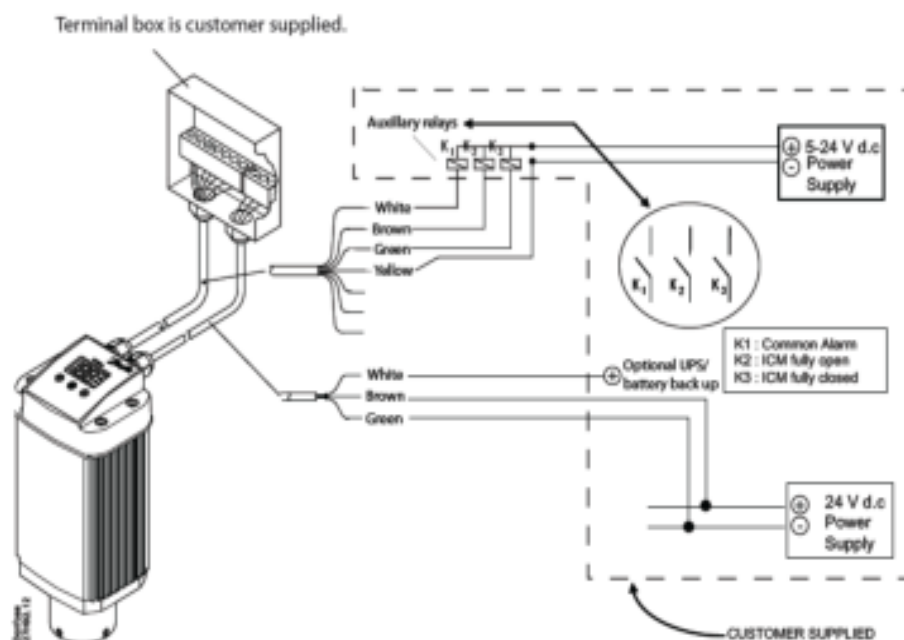
The ICAD motor can be programmed to open or close when the relay is closed. See parameter j09 in programming section.



**Wiring diagram showing ICAD digital outputs wired with customer supplied auxiliary relays**

**Note:**

The same 24 Vd.c. power supply that powers the ICAD can be used with the ICAD digital outputs to power auxiliary relays (or other small load devices), but please note that the system will no longer be galvanically isolated.



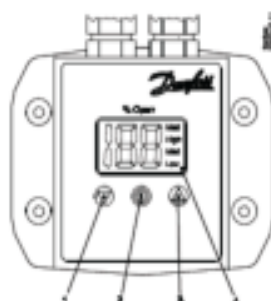
## ICAD Overview

Before programming it is important to understand the functionality of the ICAD actuator:

1. The ICAD is a digital stepper motor. As such, it will count steps up and down from the position it believes it is in. Every time, the ICAD is powered on, it will drive itself to the closed position in order to re-establish its base point of reference. It will then move back to the position corresponding to the signal it is receiving from the control wiring.
2. The ICAD can be put into manual mode to move it (using the up and arrows) to a location different from the location that the signal is telling it to be in (see parameter j01, p. 6). When in the manual mode, the display screen will be flashing and will continue to flash flashing the % opening of the valve until the ICAD is taken out of the manual mode.
3. The ICAD can be operated in analog mode (for modulating operation) or in digital mode for solenoid operation. The ICAD can receive a variety of control signals (see parameter j03, p. 6) and can send a valve position output signal to modulate another ICAD or to a PC or PLC for monitoring. (see parameter j06, p. 6)
4. Because the ICAD employs a digital stepper motor, its speed can be adjusted to any percentage of full speed through the parameter menu. (see parameter j04, p. 6)
5. The ICAD can be connected to a 24 VDC UPS (Uninterruptible Power Supply) and can be programmed for actions when the normal power has been cut and the ICAD is operating off of the UPS power. (see parameter j07 and j12, p. 6)

## Operating the ICAD Menu

1. In order to access the menu, PRESS and HOLD the middle button (2) until the menu screen appears.



1. Down arrow push button
2. Enter
3. Up arrow push button
4. Display

2. Once you are in the menu, use the up (3) and down (1) arrow keys to move through the list of parameters.
3. To display the current setting of a parameter press the middle button.
  - a. To change the value of a parameter setting, use the up or down arrow to establish the new setting while in that particular parameter's display mode.
  - b. Once the new setting for a parameter has been selected, push the center button to save the change and return to the menu.
4. Repeat this procedure for all parameters.
5. Exit from the parameter list by pressing and holding the middle button for 2 seconds. The ICAD will automatically exit if no buttons are pushed for 20 seconds.

## Programming the ICAD

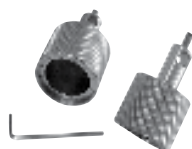
When the ICAD motor is first powered, the ICAD display will flash an A1 alarm. This means that the ICM valve size that is being used with the ICAD motor needs to be selected in parameter **i26**. Parameter **i26** is password protected and will not appear in the parameter list until the user enters the password in parameter **i10**. The password is "11," and will allow the user to access parameter **i26** where the appropriate valve size is selected. When the ICM valve size is selected, the ICAD will calibrate itself to the ICM valve and will then be ready for control by a 4-20mA signal. For most applications, this is the only programming that will need to be done if the ICAD is going to be controlled by a 4-20mA input.

## ICAD Parameters

Description	Display name	Min.	Max.	Factory setting	Unit	Comments
ICM OD (Opening Degree)	-	0	100	-	%	ICM valve Opening Degree is displayed during normal operation. Running display value (see <b>i01</b> , <b>i05</b> ).
Main Switch	<b>i01</b>	1	2	1	-	Internal main switch 1: Normal operation 2: Manual operation. Valve Opening Degree will be flashing. With the down arrow and the up arrow push buttons the OD can be entered manually.
Mode	<b>i02</b>	1	2	1	-	Operation mode 1: Modulating – ICM positioning according to Analog Input (see <b>i03</b> ) 2: ON/OFF - operating the ICM valve like an ON/OFF solenoid valve controlled via Digital Input. See also <b>i09</b> .
Analog Input signal	<b>i03</b>	1	4	2	-	Type of Analog Input signal from external controller 1: 0 - 20 mA 2: 4 - 20 mA 3: 0 - 10 V 4: 2 - 10 V
Speed at ON/OFF and Modulating Mode	<b>i04</b>	1	100	100	%	Speed can be decreased. Max. speed is 100 % Not active when <b>i01</b> = 2 If <b>i02</b> = 2 the display will indicate speed in display. <b>Low</b> , <b>Med</b> and <b>High</b> also means ON/OFF operation. If <b>i04</b> < = 33, <b>Low</b> is displayed 33 < <b>i04</b> < = 66, <b>Med</b> is displayed If <b>i04</b> > = 67 <b>High</b> is displayed
Automatic calibration	<b>i05</b>	0	1	0	-	Not active before <b>i26</b> has been operated. Always auto reset to 0. <b>CA</b> will flash in the display during calibration, if Enter push button has been activated for two seconds.
Analog Output signal	<b>i06</b>	0	2	2	-	Type of AO signal for ICM valve position 0: No signal 1: 0 - 20 mA 2: 4 - 20 mA
Fail safe	<b>i07</b>	1	4	1	-	Define condition at power cut when fail safe is installed. 1: Close valve 2: Open valve 3: Maintain valve position 4: Go to OD given by <b>i12</b>
Digital Input function	<b>i09</b>	1	2	1	-	Define function when DI is ON (short circuited DI terminals) when <b>i02</b> = 2 1: Open ICM valve (DI = OFF => Close ICM valve) 2: Close ICM valve (DI = OFF => Open ICM valve)
Password	<b>i10</b>	0	199	0	-	Enter number to access password protected parameters: <b>i26</b> Password = <b>11</b>
Old Alarms	<b>i11</b>	A1	A99	-	-	Old alarms will be listed with the latest shown first. Alarm list can be reset by means of activating down arrow and up arrow at the same time for 2 seconds.
OD at powercut	<b>i12</b>	0	100	50	-	Only active if <b>i07</b> = 4 If fail safe supply is connected and powercut occurs ICM will go to entered OD.
ICM configuration	<b>i26</b>	0	6	0	-	<b>NB:</b> Password protected. Password = <b>11</b> At first start up <b>A1</b> will flash in display. Enter valve type 0: No valve selected. Alarm <b>A1</b> will become active. 1: ICM20 with ICAD 600 2: ICM25 with ICAD 600 3: ICM32 with ICAD 600 4: ICM40 with ICAD 900 5: ICM50 with ICAD 900 6: ICM65 with ICAD 900

## Troubleshooting

### The Manual Tool



The manual tool should always be ordered with any ICM/ICAD assembly. This tool gives the user the ability to remove the ICAD actuator and manually rotate the valve in the open or close direction depending on need and application. When using the manual tool, a clockwise rotation will open the valve and a counter-clockwise rotation will close the valve.

#### NOTE:

*It is very important to remember that when rotating the valve manually you are changing the position from that in the actuator's memory. If power is removed from the actuator prior to using the manual tool, no problem will occur because, once the ICAD is powered up again, it will automatically recalibrate to the fully closed position before returning to the position in memory to which the control signal last set the valve. This recalibration will not occur if power is not removed from the ICAD prior to using the manual tool, and erroneous operation will likely occur. Always remove power before using the manual tool, and restore power afterward to ensure recalibration and trouble-free operation.*

## Service Parameters

The user will be able to troubleshoot and determine many of the conditions and set points within the ICAD by accessing the Service Menu. A list of those service parameters follows below:

#### Service Menu

Description	Display name	Min.	Max.	Unit	Comments
OD %	50	0	100	%	ICM valve Opening Degree
AI [mA]	51	0	20	mA	Analog Input signal
AI [V]	52	0	10	V	Analog Input signal
AO [mA]	53	0	20	mA	Analog Output signal
DI	54	0	1	-	Digital Input signal
DO Close	55	0	1	-	Digital Output Closed status. ON when OD < 3 %
DO Open	56	0	1	-	Digital Output Open status. ON when OD > 97 %
DO Alarm	57	0	1	-	Digital Output alarm status. ON when an alarm is detected
MAS mP SW ver.	58	0	100	-	Software version for MASTER Microprocessor
SLA mP SW ver.	59	0	100	-	Software version for SLAVE Microprocessor

It is also possible to restore the original factory settings to the ICAD by the following procedure:

#### To restore factory settings:

1. Remove the power supply.
2. Activate down arrow and up arrow push buttons at the same time.
3. While holding the up and down arrow reconnect the power supply.
4. Release down arrow and up arrow push buttons.
5. When the display on ICAD is alternating between showing: **CA** and **A1** the factory resetting is complete.

## Alarms

There are a number of alarms which are excellent indicators of improper installation or set-up:

Description	ICM alarm text	Comments
No valve type selected	<b>A1</b>	At start-up <b>A1</b> and <b>CA</b> will be displayed
Controller fault	<b>A2</b>	Internal fault inside electronics
Input error	<b>A3</b>	Not applicable if <b>j01</b> = 2 or <b>j02</b> = 2 When <b>j03</b> = 1 and AI > 22 mA When <b>j03</b> = 2 and AI > 22 mA or AI < 2 mA When <b>j03</b> = 3 and AI > 12 V When <b>j03</b> = 4 and AI > 12 V or AI < 1 V
Low voltage of fail safe supply	<b>A4</b>	If 5 V d.c. < Fail safe supply < 18 V d.c.
Check Supply to ICAD	<b>A5</b>	If supply voltage < 18 V d.c.

## Troubleshooting Tips

Problem	Possible cause and solution
<b>The valve is not working and an A1 is flashing in the display.</b>	The ICM valve size was not selected in parameter <b>j26</b> . See the programming section on page 9.
<b>The valve does not appear to be opening or closing properly</b>	<ol style="list-style-type: none"> <li>1. The ICAD was not mounted properly on the valve stem. <b>Solution:</b> Check to make sure that the ICAD was mounted evenly on the ICM valve</li> <li>2. The ICAD is not receiving a proper input signal. <b>Solution:</b> Use the service parameters (<b>j51</b> for a mA input or <b>j52</b> for a voltage input) to check the input signal that the ICAD is receiving.</li> </ol>
<b>The valve position feedback signal is not working when using customer supplied controller/PLC</b>	<ol style="list-style-type: none"> <li>1. A power supply was installed in the 4-20mA/0-20mA feedback loop. The ICAD motor actuator supplies the power for the 4-20mA/0-20mA feedback loop. <b>Solution:</b> Remove any power source that may be supplied to the feedback loop.</li> <li>2. Wiring problem. <b>Solution:</b> Check the service parameter <b>j53</b> to see what the ICAD is outputting. If this does not reveal anything, check the current output (yellow and blue wires in ICAD control cable) with an ammeter.</li> <li>3. The feedback output signal was turned off in parameter <b>j06</b>. <b>Solution:</b> Check to make sure the setting in parameter <b>j06</b> is correct.</li> </ol>
<b>For all other problems, contact Danfoss.</b>	

**Common Questions*****What happens in the event of a power failure?***

The ICAD will remain in the position it is in when power is lost. There are two ways to address this condition:

- Add a UPS (Uninterruptible Power Supply) to the power wiring. This is easily accomplished with the green and white wires in the power cable. A UPS is available from Danfoss. The UPS can provide service for up to 9 ICAD 600's or up to 6 ICAD 900's.

***Note: The UPS is not a continuous power supply. It is used to change the valve position (usually to close the valve) in the event of a power failure. Therefore, the system is not to be run in the UPS mode.***

- Add a solenoid valve in front of the ICM. This is a very simple solution provided that there is no issue associated with the additional pressure drop through the solenoid valve.

***How much power do I need to supply to the ICAD?***

The total power required depends on both the ICAD size and the number of ICAD's powered by the DC power supply. The power for each ICAD is:

- For the ICAD 600 (used on ICM 20, 25, and 32), the power requirement is approximately 30 W
- For the ICAD 900 (used on ICM 40, 50, and 65), the power requirement is approximately 50 W

***How can I monitor the valve position remotely?***

The control wiring provides for a 4 to 20 mA or 0 to 20 mA signal output (blue and yellow wires). This signal can be sent to:

- A remote display
- A PLC or PC
- Another ICAD motor to give the same opening position



## Appendix E

# Liquid Injection Valve Station ICF 20-40 Installation Guide

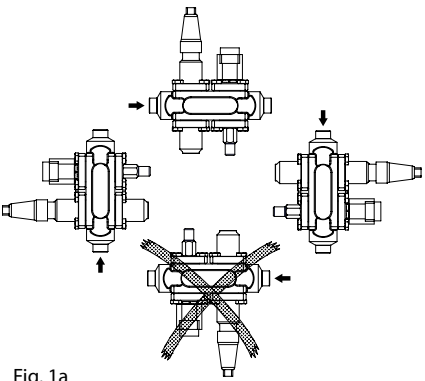
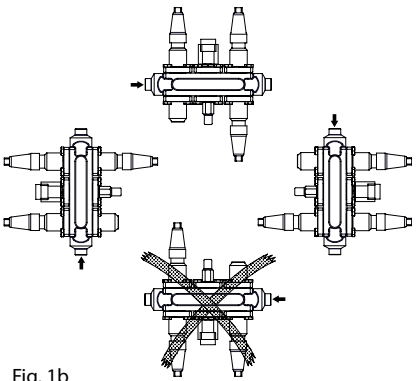
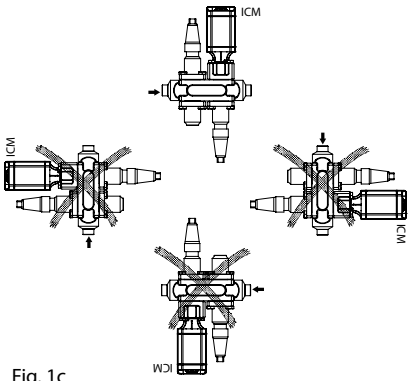
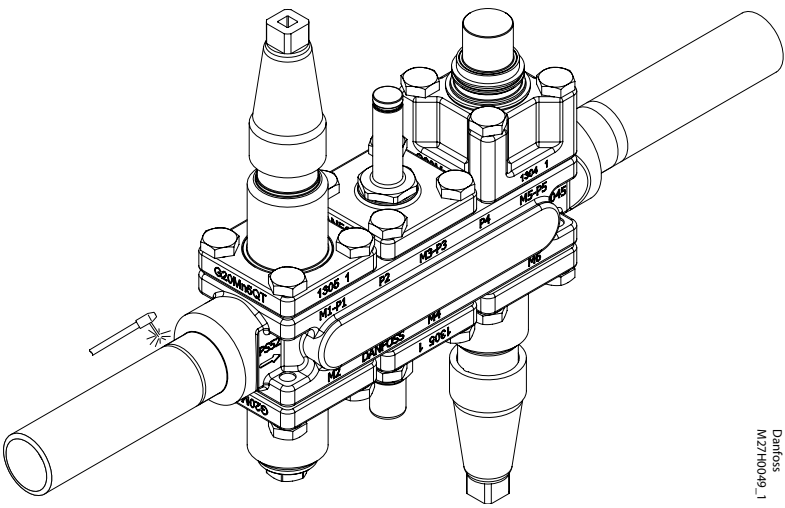
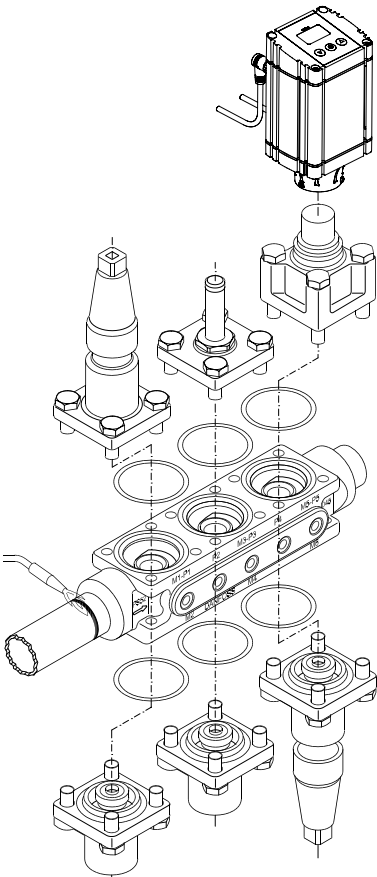
# Installation Guide

## Valve Station

### ICF 20-40

027R9782

027R9782

Direction and position		
ICF xx-4	ICF xx-6	ICF xx-4 / ICF xx-6 with ICM
 <p>Fig. 1a</p>	 <p>Fig. 1b</p>	 <p>Fig. 1c</p>
Welding		
TIG/MIG/SMAW welding	Other welding methods	
<p>Inlet and outlet stop valves must be closed all the time before commissioning of the installation in order to prevent rust formations in the valve. The stop valves are closed when delivered from the factory. ICF must be cooled during the welding (e.g. by means of a wet cloth).</p>  <p>Fig. 2</p>	<p>Remove all parts before welding. When the valve is assembled make sure that some rust protective oil is supplied in the valve. Before commissioning inlet and outlet valves must be closed at all time.</p>  <p>Fig. 3</p>	

## Service and maintenance



For both ICF 20 and ICF 25-40  
with ICM and ICFE 25-40

### Please Note:

When used in CO<sub>2</sub>, the o-rings (see fig. 4)  
on the ICM and ICFE 25-40 modules can  
swell (grow).

At service it is recommend that new  
o-rings are installed, before the ICM  
and ICFE 25-40 function modules are  
reinstalled in the ICV valve body.

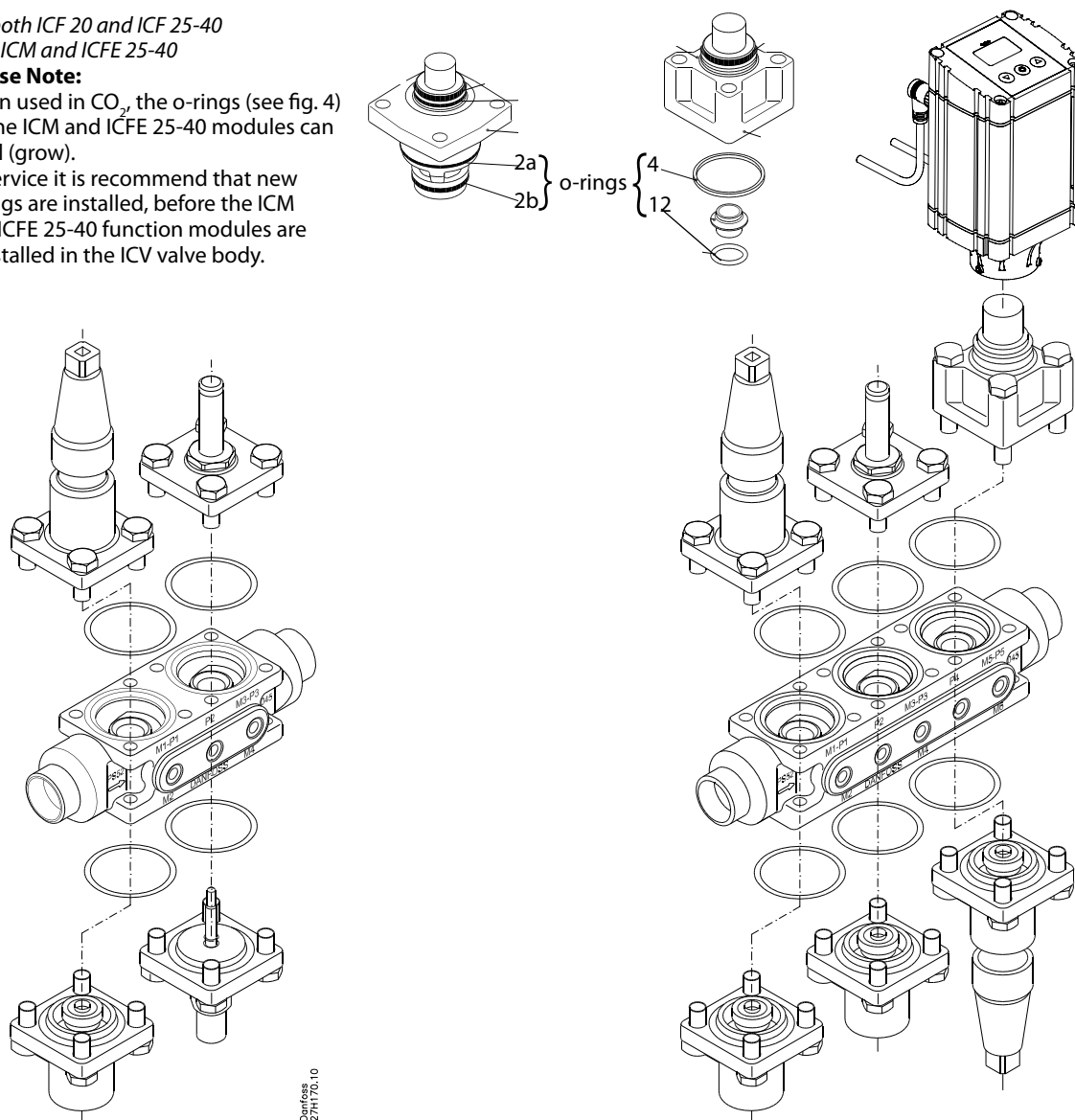


Fig. 4

## Tightening torques

### For the 4 bolts in all ICF modules

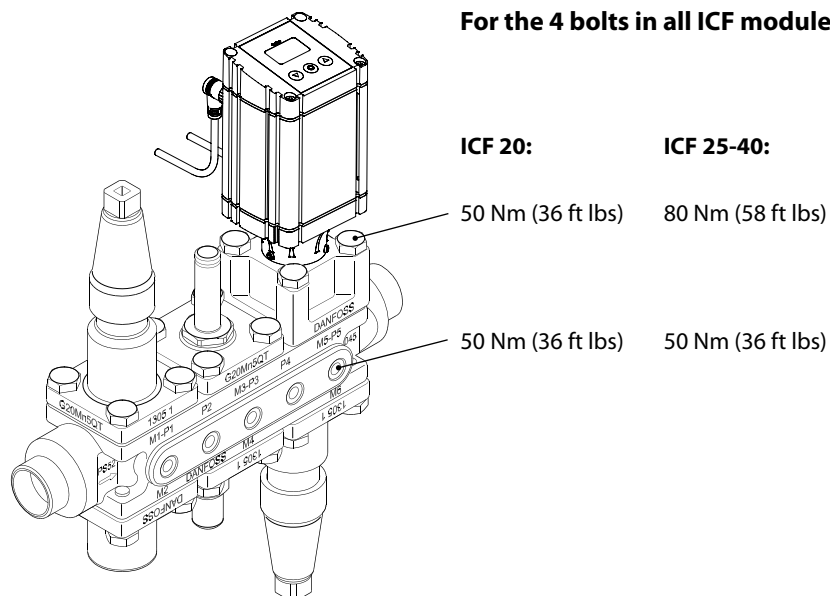
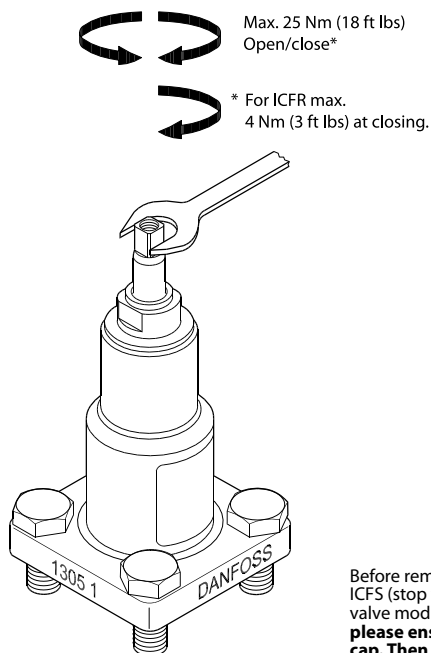


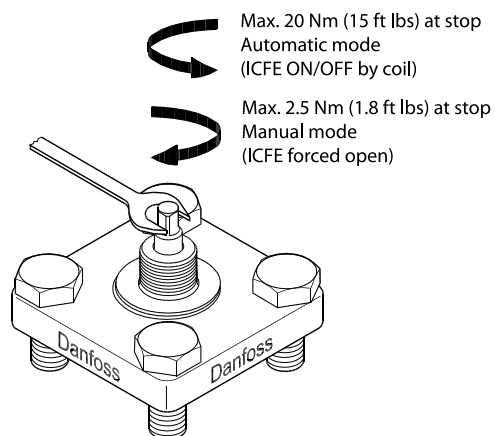
Fig. 5

## ICF 20

ICFS - stop valve module  
ICFR - manual regulating valve module  
ICFN - stop/check valve module



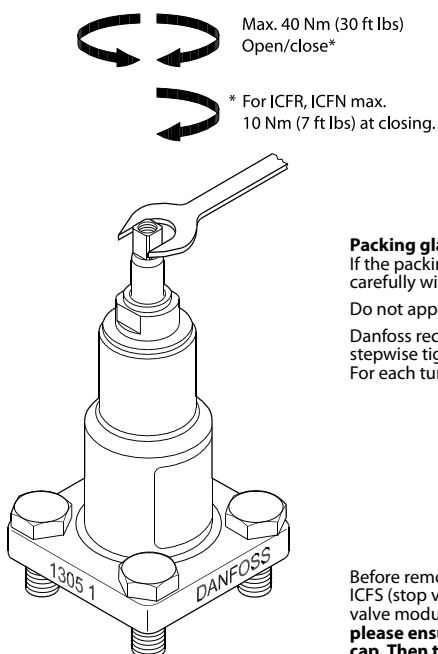
ICFO - manual opening module



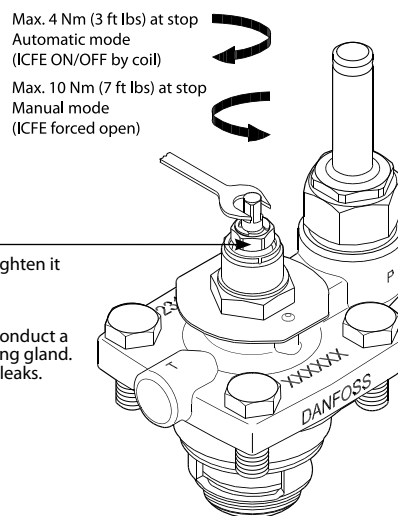
Before remounting the cap on the modules  
ICFS (stop valve module), ICFR (manual regulating  
valve module) or ICFN (stop/check valve module)  
**please ensure that the gasket is present in the  
cap. Then tighten the cap with 16 Nm (12 ft lbs).**

## ICF 25 - 40

ICFS - stop valve module  
ICFR - manual regulating valve module  
ICFN - stop/check valve module



ICFE - solenoid valve module



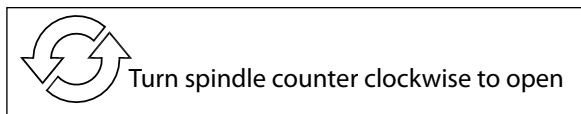
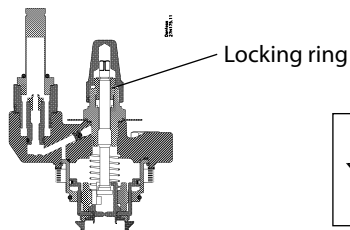
**Packing gland**  
If the packing gland is leaking, tighten it  
carefully with a wrench.  
Do not apply too much force.  
Danfoss recommends that you conduct a  
stepwise tightening of the packing gland.  
For each turn check for possible leaks.

Before remounting the cap on the modules  
ICFS (stop valve module), ICFR (manual regulating  
valve module) or ICFN (stop/check valve module)  
**please ensure that the gasket is present in the  
cap. Then tighten the cap with 24 Nm (18 ft lbs).**

### Operating the manual opener on ICFE 25 solenoid module

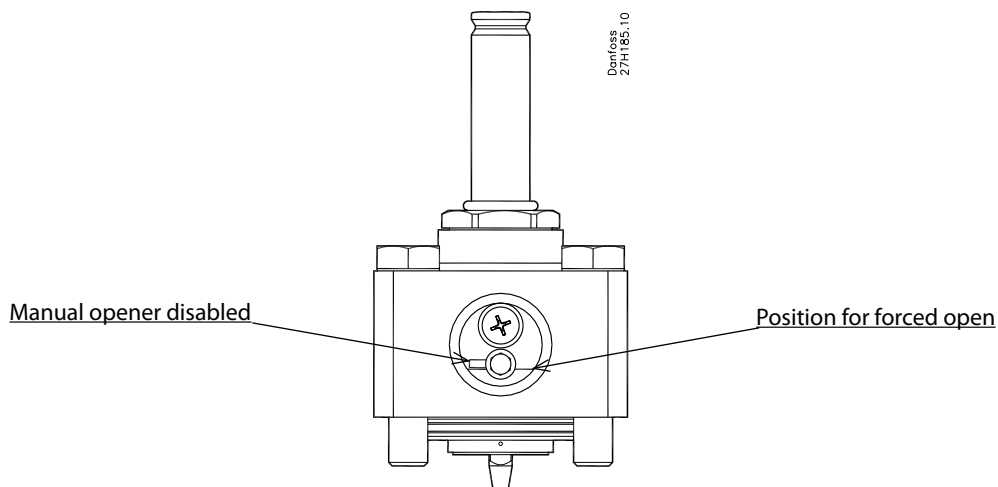
To force open the solenoid by the manual stem turn it **counter clockwise** full way up. (Manual mode)  
 To operate the solenoid in automatic mode, turn the manual stem **clockwise** until the locking ring stops.  
 Do not force the spindle further. If the locking ring is damaged or removed the spindle will start to leak.  
**The valve cannot be forced closed by the manual stem.**

ICFE 25-40 solenoid valve module



### Operating the manual opener on ICFE 20H solenoid valve module

Remove the cap on the side of the ICFE 20H  
 At 9 o'clock position the manual opener is disabled (not active)  
 To force the ICFE 20H solenoid to open use a 5 mm Allen key and turn it **clockwise** to 3 o'clock position.



## Module location

### ICF 20-4

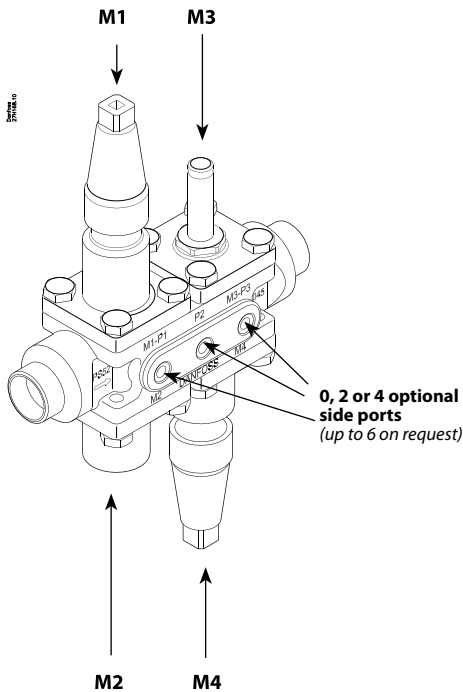


Fig. 6

In order to supply the ICF valve station best suited for liquid lines and hot gas lines certain function modules are dedicated to specific module ports.

Function	M1	M2	M3	M4
ICFS 20 - Stop valve module				
ICFR 20A - Manual regulating valve module				
ICFF 20 - Filter module				
ICFE 20 - Solenoid valve module				
ICFE 20H - Solenoid valve module				
ICFA 10 - Electronic expansion valve module				
ICFO 20 - Manual opening module				
ICFC 20 - Check valve module				
ICFN 20 - Stop/check valve module				
ICM 20-A, B or C - Motor valve module				
ICFB 20 - Blank top cover				



location not possible

### ICF 20-6

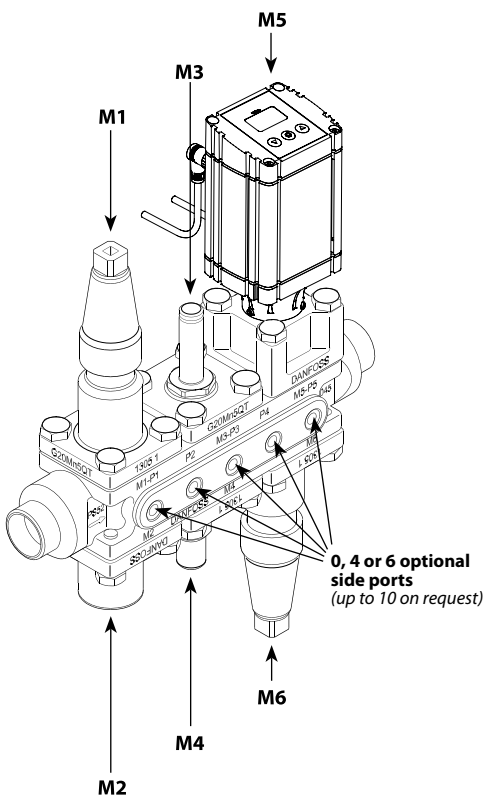


Fig. 7

In order to supply the ICF valve station best suited for liquid lines and hot gas lines certain function modules are dedicated to specific module ports.

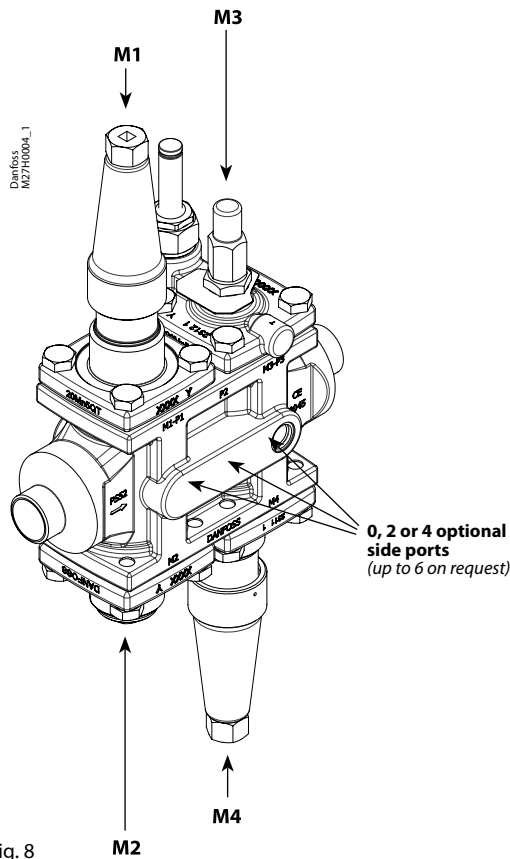
Function	M1	M2	M3	M4	M5	M6
ICFS 20 - Stop valve module						
ICFR 20A - Manual regulating valve module						
ICFF 20 - Filter module						
ICFE 20 - Solenoid valve module						
ICFE 20H - Solenoid valve module						
ICFA 10 - Electronic expansion valve module						
ICFO 20 - Manual opening module						
ICFC 20 - Check valve module						
ICFN 20 - Stop/check valve module						
ICM 20-A, B or C - Motor valve module						
ICFB 20 - Blank top cover						



location not possible


## Module location

### ICF 25-4 → 40-4

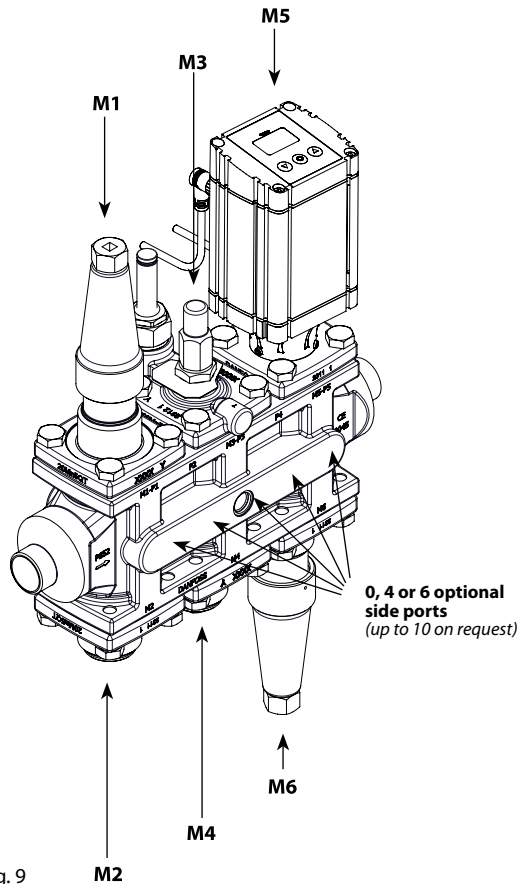


In order to supply the ICF valve station best suited for liquid lines and hot gas lines certain function modules are dedicated to specific module ports.

Function	M1	M2	M3	M4
ICFS 25-40 - Stop valve module				
ICFR 25-40 A or B - Manual regulating valve module				
ICFF 25-40 - Filter module				
ICFE 25-40 - Solenoid valve module				
ICFC 25-40 - Check valve module				
ICFN 25-40 - Stop/check valve module				
ICM 25-A or C - Motor valve module				
ICFB 25-40 - Blank top cover				
ICFW 25-40 - Welding module, 25DIN				


 location not possible

### ICF 25-6 → 40-6



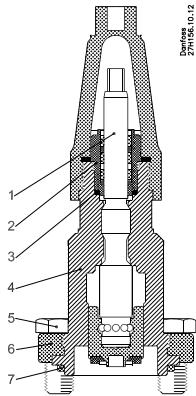
In order to supply the ICF valve station best suited for liquid lines and hot gas lines certain function modules are dedicated to specific module ports.

Function	M1	M2	M3	M4	M5	M6
ICFS 25-40 - Stop valve module						
ICFR 25-40 A or B - Manual regulating valve module						
ICFF 25-40 - Filter module						
ICFE 25-40 - Solenoid valve module						
ICFC 25-40 - Check valve module						
ICFN 25-40 - Stop/check valve module						
ICM 25-A or C - Motor valve module						
ICFB 25-40 - Blank top cover						
ICFW 25-40 - Welding module, 25DIN						

 location not possible

**The function modules - ICF 20**

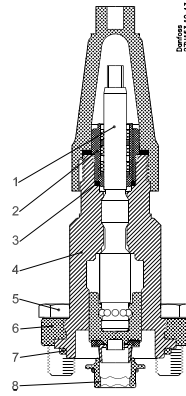
*ICFS 20 stop valve module*



Danfoss  
27H156, 10, 12

1. Spindle
2. Thread part
3. AL-gasket
4. Bonnet
5. Hex-head bolt
6. Flange
7. Gasket

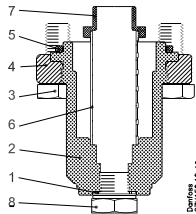
*ICFR 20 manual regulating valve module*



Danfoss  
27H152, 10, 13

1. Spindle
2. Thread part
3. AL-gasket
4. Bonnet
5. Hex-head bolt
6. Flange
7. Gasket
8. Seat

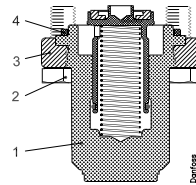
*ICFF 20 filter module*



Danfoss  
27H153, 10, 10

1. Gasket
2. Bonnet
3. Hex-head bolt
4. Flange
5. Gasket
6. Filter element
7. Plug
8. Plug 1/4" RG or 3/8" NPT

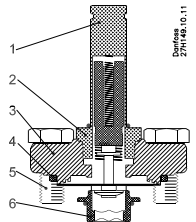
*ICFC 20 check valve module*



Danfoss  
27H158, 11, 10

1. Bonnet
2. Hex-head bolt
3. Flange
4. Gasket

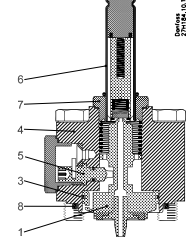
*ICFE 20 solenoid valve module*



Danfoss  
27H148, 10, 11

1. Armature tube
2. Armature tube nut
3. Flange
4. Gasket
5. Hex-head bolt
6. Seat

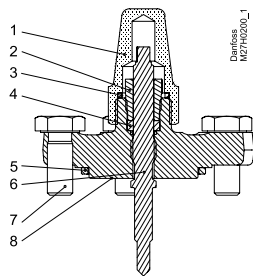
*ICFE 20H solenoid valve module*



Danfoss  
27H148, 10, 10

1. Piston
3. Piston ring
4. Bonnet cylindre
5. Manual opener
6. Armature tube
7. Armature tube nut
8. Gasket

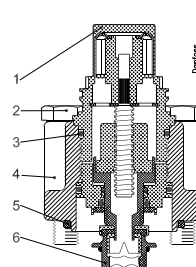
*ICFO 20 manual opening module*



Danfoss  
M27H200, 1

1. Seal cap
2. Gland nut
3. Seal cap gasket
4. Sealing ring
5. Rubber gasket
6. Spindle
7. Hex-head bolt
8. Flange

*ICM 20 A, 20 B or 20 C motor valve module*



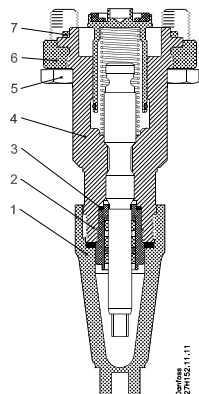
Danfoss  
27H157, 10, 11

1. Adapter
2. Hex-head bolt
3. O-ring
4. Bonnet
5. Gasket
6. Seat



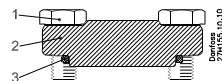
## The function modules - ICF 20

*ICFN 20 stop/check valve module*



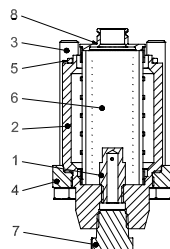
1. Spindle
2. Thread part
3. AL-gasket
4. Bonnet
5. Hex-head bolt
6. Flange
7. Gasket

*ICFB 20 blank top cover module*



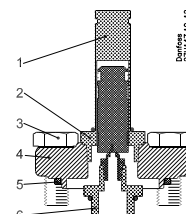
1. Hex-head bolt
2. Flange
3. Gasket

*ICFF 20E extended filter module*



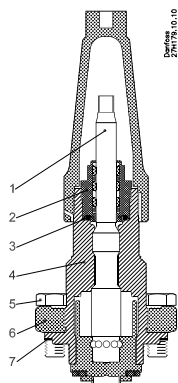
1. Dirt protection plug
2. Bonnet
3. Hex-head bolt M12x80
4. Flange
5. Gasket
6. Filter element
7. Plug 3/8" NPT
8. Filter adaptor

*ICFA 10 Electronic expansion valve*



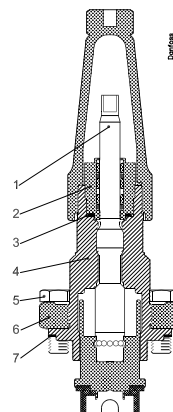
1. Armature tube
2. Armature tube nut
3. Hex-head bolt
4. Flange
5. Gasket
6. Adaptor

*ICFS 25-40 stop valve module*



1. Spindle
2. Thread part
3. O-ring
4. Bonnet
5. Hex-head bolt
6. Flange
7. Gasket

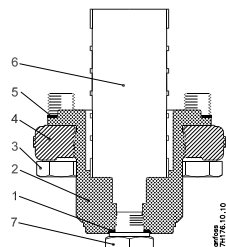
*ICFR 25- 40 A or B manual regulating valve module*



1. Spindle
2. Thread part
3. O-ring
4. Bonnet
5. Hex-head bolt
6. Flange
7. Gasket

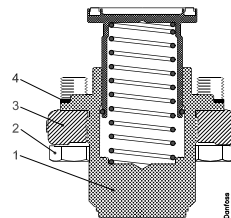
# The function modules - ICF 25-40

*ICFF 25-40 filter module*



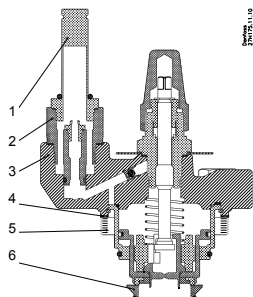
1. Al gasket
2. Bonnet
3. Hex-head bolt
4. Flange
5. Gasket
6. Filter element
7. Plug 1/4" RG or 3/8" NPT

*ICFC 25-40 check valve module*



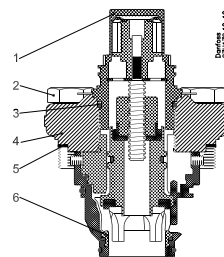
1. Bonnet
2. Hex-head bolt
3. Flange
4. Gasket

*ICFE 25-40 solenoid valve module*



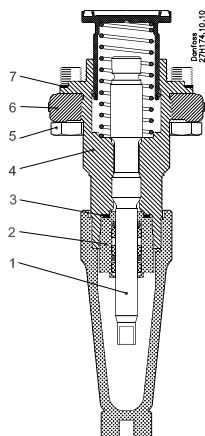
1. Armature tube
2. Armature tube nut
3. Bonnet
4. Gasket
5. Hex-head bolt
6. Seat

*ICM 25 A or 20 B motor valve module*



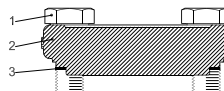
1. Adapter
2. Hex-head bolt
3. O-ring
4. Bonnet
5. Gasket
6. Seat

*ICFN 25-40 stop/check valve module*



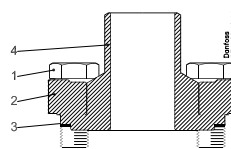
1. Spindle
2. Thread part
3. O-ring
4. Bonnet
5. Hex-head bolt
6. Flange
7. Gasket

*ICFB 25-40 blank top cover module*



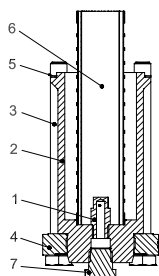
1. Hex-head bolt
2. Flange
3. Gasket

*ICFW 25-40 Welding module 25 DIN*



1. Hex-head bolt
2. Flange
3. Gasket
4. Weld connection

*ICFF 25-40E extended filter module*



1. Dirt protection plug 3/8" NPT
2. Bonnet
3. Hex-head bolt M12x140
4. Flange
5. Gasket
6. Filter element
7. Plug 3/8" NPT

## ENGLISH

### Installation

#### Refrigerants

Applicable to HCFC, non flammable HFC, R717 (Ammonia) and R744 (CO<sub>2</sub>).

The use of ICF valve stations with flammable hydrocarbons is not recommended.

The ICF is only recommended for use in closed circuits. For further information please contact Danfoss.

#### Temperature range

-60/+120°C (-76/+248°F)

#### Pressure range

The ICF is designed for a max. working pressure of 52 bar g (754 psi g).

#### Technical data

The ICF can be used in suction, liquid, hotgas and liquid/vapor lines. The ICF are available with 4 or 6 function modules. The ICF regulates the flow of the medium by modulation or on/off function, depending on function modules installed on the ICF.

#### Regulating range

Dependent on the chosen type and combination of modules installed in the valve.

#### Installation

The ICF must be installed according to fig. 1. The ICF must be installed with the arrow in the direction of the flow).

The ICF will be delivered with all the function modules fully assembled. The modules can be taken off for service or inspection and may be rotated 4 x 90° in relation to the valve body upon installation.

The ICF may be fitted with a spindle for manual opening of the solenoid valve.

The ICF is designed to withstand a high internal pressure. However, the piping system should be designed to avoid liquid traps and reduce the risk of hydraulic pressure caused by thermal expansion.

It must be ensured that the ICF is protected from pressure transients like "liquid hammer" in the system.

#### Welding

The ICF valve station can be welded by using either TIG/MIG/SAW welding (fig. 2) or gas welding (fig. 3).

#### Attention!

It is not necessary to remove any of the modules before TIG/MIG/SAW welding; however, it must be ensured that the valve is cooled during the welding (e. g. by wet cloth) and that the ICF is protected against weld splatter. Inlet and outlet stop valves must be closed all the time before commissioning in order to protect ICF against rust formations.

The ICF valves are delivered with closed stop valves. During Gas welding the modules must be removed.

Avoid welding debris and dirt in the valve body and the function module. The housing must be free from stresses (external loads) after installation. The ICF must not be mounted in systems where the outlet side of the ICF is open to atmosphere. The outlet side of the ICF must always be connected to the system or properly capped off, for example with a welded-on end plate.

#### Surface protection and identification

The external surface is zinc-chromated to provide corrosion protection according to EN 12284:2003 8.13. The Zinc-Chromatization does not cover the welding connections. After installation has been completed the external surface of the valve must be protected against corrosion with a suitable top coating. Protection of the ID label when painting the ICF is recommended.

Precise identification of the ICF is made via the ID label on each of the 4 or 6 function modules.

### Maintenance

#### Service

The ICF valve stations are easy to service. Do not open the ICF while the it is still under pressure.

Debris blocking the bolt hole will need cleaning. Upon opening and removal of the function modules:

- Check that the O-rings on the function module has not been damaged. A valve with a damaged o-ring might not modulate according to the specification.

#### For both ICF 20 and ICF 25 - 40 with ICM



#### Please Note:

When used in CO<sub>2</sub>, the o-rings (see fig.4) on the ICM and ICFE 25-40 modules can swell (grow).

At service it is recommend that new o-rings are installed, before the ICM function module is reinstalled in the ICF valve body.

- Check that the piston and cylinder is free of scratches and look for wear marks. If the wear is excessive the function module should be replaced to prevent false pilot signal around the piston ring.
- Check that the movement of the cylinder and valve seat is free and with low friction.
- If the teflon valve plate has been damaged, the function module must be replaced.

- On ICM 20 motor valve modules check that the PEEK seat has not been damaged or scratched. If damaged or scratched; replace the PEEK seat.

#### Assembly

Remove any dirt from the housing before the ICF is assembled.

- Check that all channels in the ICF are free of particles or similar debris. If possible, apply some refrigeration oil to ease the insertion of the modules and to protect the O-rings.

#### Tightening (fig. 5)

Tighten the top cover with a torque wrench, to the values indicated in the table.

Use only original Danfoss parts, including O-rings and gaskets for replacement.

Materials of new parts are certified for the relevant refrigerant.

In cases of doubt, please contact Danfoss.

Drawings are only for illustration, not for dimensioning or construction. Danfoss accepts no responsibility for errors and omissions.

Danfoss Industrial Refrigeration reserves the right to make changes to products and specifications without prior notice.



# Appendix F

## Hand-Held Slide Valve Calibration Tool

Hand-Held Slide Valve Calibration Tool  
By Vilter™

The Slide Valve Calibration Tool allows the operator to perform the calibration procedure of Vilter’s slide valve actuators (VPN 25972D) single-handedly, while standing at the actuator, without multiple trips to the panel screen, or the need of another person at the panel.

How It Works

The calibration tool replaces the power cable that feeds the actuator during normal operation, and provides 115 volts to the actuator motor using the CW and CCW push buttons. The regular control cable which provides 24 volts DC to the actuator must be connected at all times.

The greatest advantage from this set up is that the operator can perform the whole calibration procedure in front of the compressor, and therefore can easily detect if the actuator is driving the slide valves up against the mechanical stop inside the compressor.

Calibration Procedure

- 1. Look for the motor control cable on the actuator (connector J2), and disconnect it. Connect the calibration tool’s turck connector to the actuator.
- 2. Remove the screws securing the actuator cover to the actuator assembly, and carefully lift the actuator cover and tilt it towards connectors. Raise the cover high enough to attain access to the blue calibration button and be able to see the red LED on the top of assembly.
- 3. Press “CW” or “CCW” on the calibration tool to move the slide valve and check for the correct rotation, see the Increase Direction for **Single Screw Compressors Table** on the next page to establish which one is the **increase** button and which one the **decrease** button for your compressor model.



For use in non-hazardous locations

Features

The calibration procedure may be performed directly at the actuator, so the operator can immediately detect when the actuators start to slow down and reach the mechanical stop
Using this tool bypasses the standard calibration procedure which requires several trips between the actuator and the control panel, or to have two operators available
Electrical Rating of 125V and 5A (not fuse protected)
Light and easy to move around the compressors room
Pendant switch for easy access and comfortable handling

- 4. Quickly press and release the blue push button on the actuator once. This places the actuator in calibration mode. The red LED will start flashing rapidly.
- 5. Use the **decrease** button on the calibration tool to drive the slide valve to its minimum “mechanical stop” position. Release the **decrease** button when the slowing of the motor rotation and a winding sound from the actuator motor is noted.
- 6. Press and hold down on the photo-chopper shaft to disengage the brake slowly, releasing tension from the motor mount. Use the **increase** button to pulse the actuator to where the slide is just off of the mechanical stop and there is no tension on the motor shaft.

## Appendix F • Hand-Held Slide Valve Calibration Tool

**Slide Valve Increase Direction  
for Single Screw Compressors Table**

Compressor Model Number	Capacity Slide Valve	Volume Slide Valve
151 VSM / VSG	CW	CW
152 VSM / VSG	CW	CW
181 VSM / VSG	CW	CW
182 VSM / VSG	CW	CW
201 VSM / VSG	CW	CW
202 VSM / VSG	CW	CW
291 VSS / VSSH / VSSG	CW	CW
301 VSM / VSG	CW	CW
341 VSS / VSSH / VSSG	CW	CW
361 VSM / VSG	CW	CW
401 VSM / VSG	CW	CW
451 VSS / VSSH / VSSG	CW	CW
501 VSM / VSG	CCW	CCW
601 VSM / VSG	CCW	CCW
601 VSS / VSSH / VSSG	CW	CW
701 VSM / VSG	CCW	CCW
751 VSS / VSG	CCW	CCW
791 VSS/VSH/VSG	CCW	CCW
891 VSS/VSH/VSG	CCW	CCW
901 VSS / VSG	CCW	CCW
1051 VSS / VSH / VSG	CCW	CCW
1201 VSS / VSH / VSG	CCW	CCW
1301 VSS / VSH / VSG	CCW	CCW
1501 VSS / VSG	CCW	CCW
1551 VSS / VSG	CCW	CCW
1801 VSS / VSG	CCW	CCW
1851 VSS / VSG	CCW	CCW
2101 VSS / VSG	CCW	CCW
2401 VSS / VSG	CCW	CCW
2601 VSS / VSG	CCW	CCW
2801 VSS / VSG	CCW	CCW
3001 VSS / VSG	CCW	CCW

- Quickly press and release the blue button on the actuator again. The red LED will now flash at a slower rate, indicating that the minimum slide valve position (zero position) has been set.
- Use the **increase** button on the calibration tool to drive the slide to its maximum “mechanical stop” position. Release the **increase** button when the slowing of the motor rotation and a winding sound from the actuator motor is noted.
- Press and hold down on the photo-chopper shaft to disengage the brake slowly, releasing tension from the motor mount. Use the **decrease** button to pulse the actuator to where the slide is just off of its mechanical stop and there is no tension on the motor shaft.



- Quickly press and release the blue button on the actuator one more time. The red LED will stop flashing. The actuator is now calibrated and knows the minimum and maximum positions of the slide valve it controls.
- Disconnect the calibration tool's turck from the actuator, and connect the motor control cable on the actuator (connector J2).

### Order Vilter Slide Valve Calibration Tool Using VPN 75002

**General Inquiries**  
5555 S. Packard Ave.  
Cudahy, WI 53110  
United States  
Phone: 414-744-0111  
Fax: 414-744-3483  
Web: [www.Vilter.com](http://www.Vilter.com)

**Customer Service**  
Phone: 1-800-862-2677  
[Service.Vilter@emerson.com](mailto:Service.Vilter@emerson.com)

**Parts**  
[Parts.Vilter@Emerson.com](mailto:Parts.Vilter@Emerson.com)

For more product information and to order online visit:  
[VPI.Emerson.com](http://VPI.Emerson.com)







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Vilter is a technology leader in energy-efficient, environmentally conscious solutions in its industry. The 150-year history of the Vilter brand tells a rich story of perseverance and drive to cultivate continuous innovation within the industrial refrigeration and gas compression industries. Vilter offers unprecedented efficiency, productivity and reliability in cooling, recovery, and compression. It combines best-in-class technology with proven engineering and design to create quality products and latest solutions for customers worldwide.

## About Emerson

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**Emerson.com**

**Emerson.com/Vilter**

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