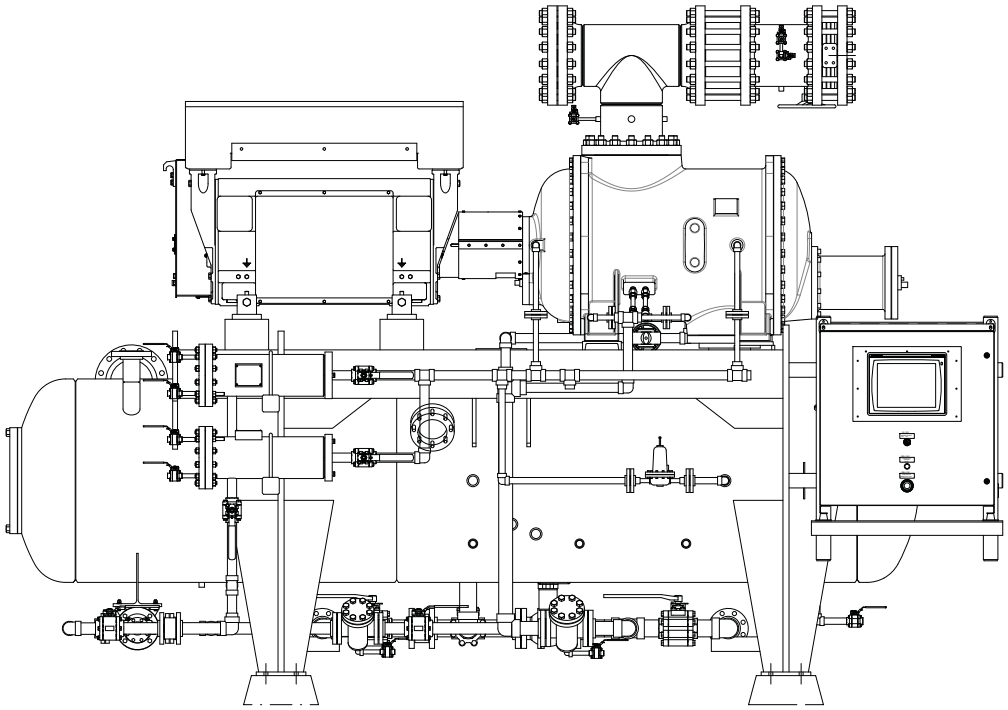
VRSG compressor unit

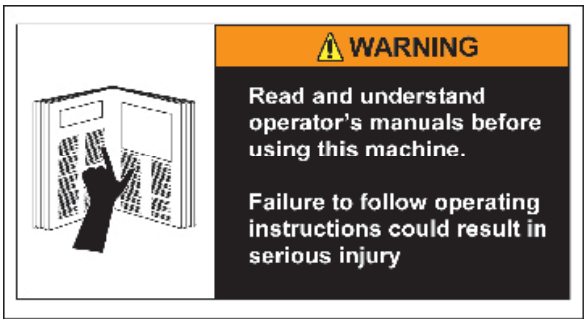
Installation, operation & maintenance manual



Vilter

EMERSON
Climate Technologies

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 Twin 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.

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 Twin 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 inquires 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

Equipment Identification Numbers:

Vilter Order Number: _____Compressor Serial Number: _____
Vilter Order Number: _____Compressor Serial Number: _____
Vilter Order Number: _____Compressor Serial Number: _____
Vilter Order Number: _____Compressor Serial Number: _____

How To Use This Manual

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

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

Appendices

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

- Other associated installation, operation and maintenance instructions can be found in the software manual and bare shaft compressor manual.
- Due to continuing changes and unit updates, always refer to the Vilter.com website 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.

Gas Compressor Unit Model Designations

The compressor unit model designation can be found on the nameplate. For nameplate location, see Component Identification on section page 1-4.

Figure 1-1. Gas Compressor Unit Model Designation

1. Compressor Model

VSG = Vilter Single Screw Compressor

VSSG = Vilter Single Screw Compressor

(Compressor models 291, 341, 451 & 601 - these are 240mm diameter rotors with counter clockwise rotation)

VRSG = Vilter Twin Screw

2. Size

CFM - Nominal CFM displacement of the compressor at 3600 rpm

3. Slide Arrangement

VVR = Variable Volume Ratio

4. Gas Compressed

L = Landfill Gas

D = Digester Service Site Application

N = Natural Gas (Primarily Methane)

G = Other Gas Type

5. Application

HP = High Stage with Oil Pump

HN = High Stage no Oil Pump

6. Driver

VFD = Variable Frequency Drive

EMD = Electric Motor Drive

ENG = Engine Drive

7. Separator Type

16 = 16 inch diameter
20 = 20 inch diameter
24 = 24 inch diameter
30 = 30 inch diameter
36 = 36 inch diameter
42 = 42 inch diameter
48 = 48 inch diameter
54 = 54 inch diameter

H = Horizontal
SH = Special Horizontal
V = Vertical
SV = Special Vertical

8. Economizer

NEC = No Economizer, Economizer Ports Plugged

HEC = Holes drilled in Economizer Plug for Oil or Unloading

9. Oil Cooler

PLT = Plate

ST = Shell and Tube

REM = Remote

10. Oil Cooling Medium

REF = Refrigerant

WTR = Water

GL = Glycol

AIR = Air

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.

Compressor Unit Component Identification

Each gas compressor unit may differ, but below are typical components that can be found on each unit.

1 - Motor
2 - Coupling and Guard
3 - Suction Strainer
4 - Suction Check Valve
5 - Suction Stop Butterfly Valve
(Typically Shipped Loose)
6 - Compressor
7 - Discharge Pipe
8 - PLC Panel
9 - Back Pressure Regulator
10 - Oil Heater
11 - Oil Sight Glass
12 - Oil Pump Strainer
13 - Oil Pump
14 - Oil Filter
(Optional Dual Oil Filters Shown)
15 - Oil Separator
16 - Discharge Connection
17 - Oil Separator Inspection Port
18 - Oil Temperature Control Valve
(Oil Mixing Valve)
19 - Remote Oil Cooler Connections
20 - Frame
21 - Block and Bleed Assembly
22 - Nameplate
23 - Oil Separator Safety Relief Valve
Line Connection

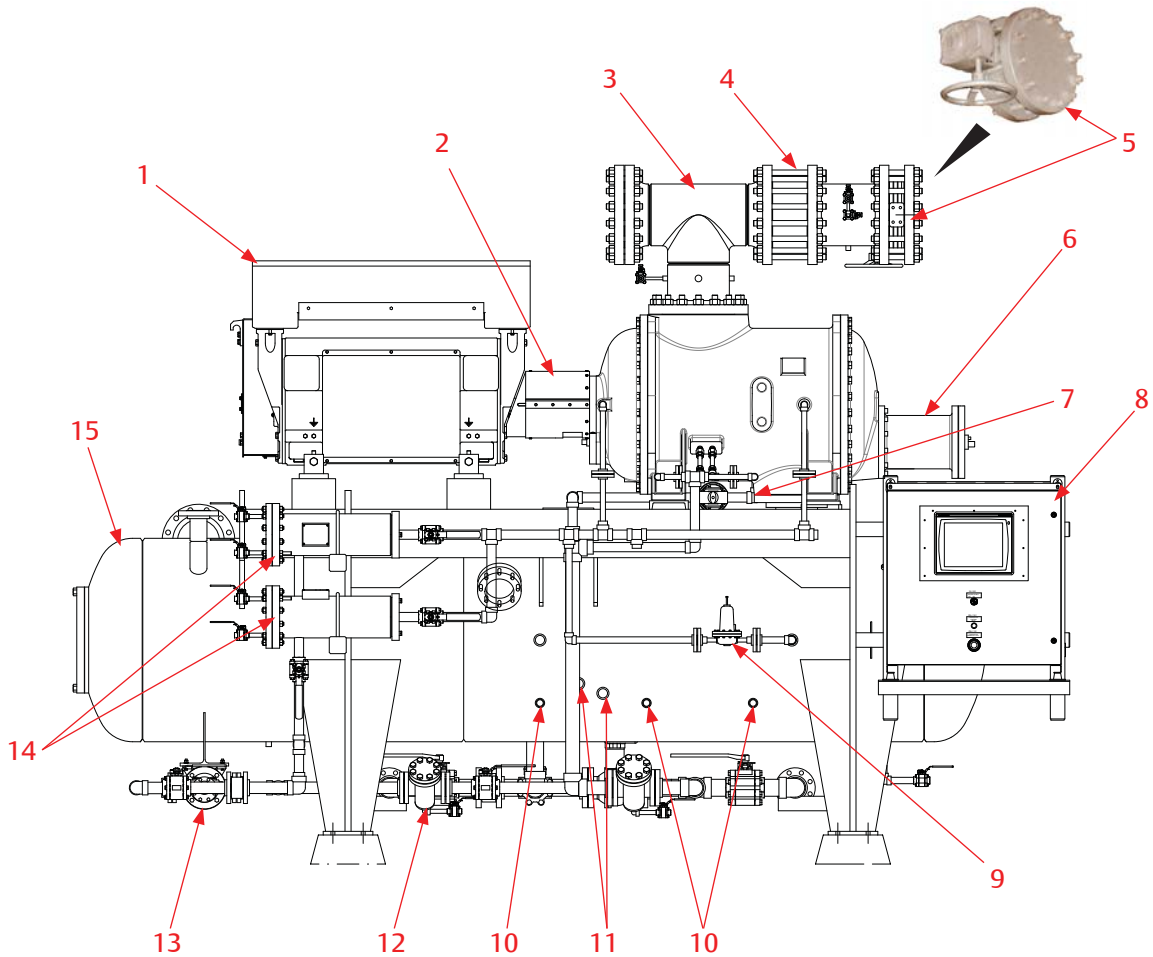


Figure 1-2. Gas Compressor Unit Components (1 of 3)

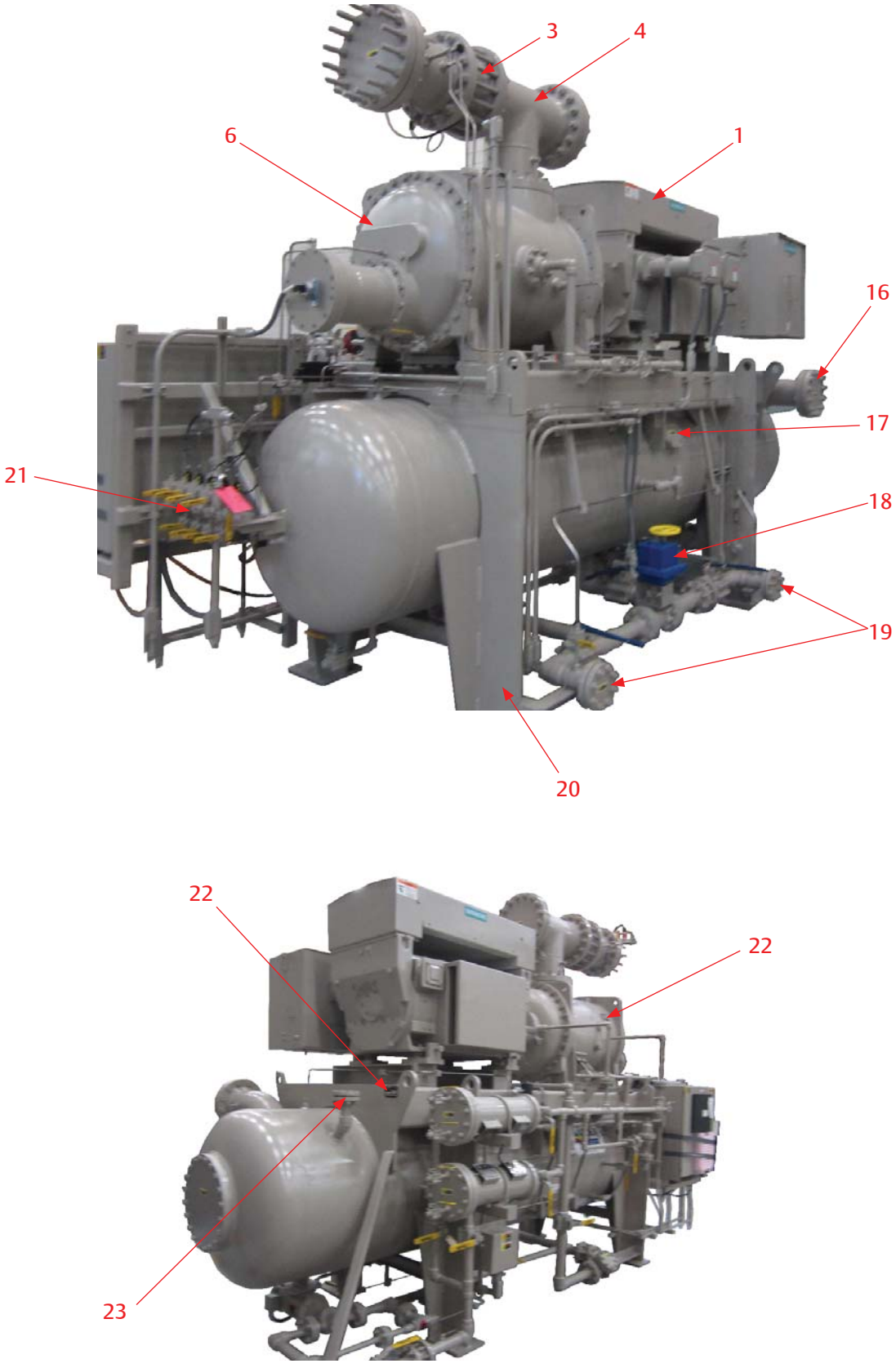


Figure 1-2. Gas Compressor Unit Components (2 of 3)

Compressor Unit Component Identification (Continued)

24 - Oil Cooler (Shell and Tube Heat Exchanger)

25 - Remote Oil Cooler (Finned Fan Heat Exchanger)

Figure 1-2. Gas Compressor Unit Components (3 of 3)

Instrument Identification Letters

Use this list to identify components shown in the Piping & Instrumentation Diagram.

A	Analysis
AAH	Concentration High
AAHH	Concentration/Detection High High
AI	Analysis/Moisture Indicator
AIT	Analysis/Detection Indicating Transmitter
AT	Analysis/Detection (Blind)
AU	Analysis/Detection Monitor
BFV	Butterfly Valve
CV	Check Valve
E	Voltage
EAH	Voltage High
EAHH	Voltage High High (Shutdown)
EI	Voltage Indication
F	Flow
FAH	Flow High
FAHH	Flow High High (Shutdown)
FAL	Flow Low
FALL	Flow Low Low
FC	Flow Controller/Fail Close
FG	Flow Gauge
FI	Flow Indication (Soft)/ Flow Sight Indicator (Glass)
FIC	Flow Indicating Controller
FIT	Flow Indicating Transmitter
FOP	Orifice Plate
FT	Flow Transmitter (Blind)
FV	Flow Control Valve
FY	Flow/Relay/Convertor
G	Gas
GIT	Gas Detecting Indicating Transmitter
GAH	Gas Detected Concentration Level High
GAHH	Gas Detected Concentration Level High High (Shutdown)
H	Hand
HH	Hand Hole
HO	Held Open (Solenoid Valve Only)
HV	Hand Valve
I	Current
IAH	Amperage High
IAHH	Amperage High High (Shutdown)
II	Current Indication
IT	Current Transmitter (Blind)
J	Power
JB	Junction Box (Wire Termination)
JI	Power Indication
JIT	Power Indicating Transmitter
JT	Power Transmitter (Blind)
K	Time Schedule
KC	Time Controller (Blind)
KI	Time Indication
KIC	Time Indication Controller
KR	Time Recorder
KY	Time/Relay/Convertor
L	Level
LAH	Liquid Level High
LAHH	Liquid Level High High (Shutdown)
LAL	Liquid Level Low
LALL	Liquid Level Low Low (Shutdown)
LC	Level Controller
LE	Level Probe (Element)
LG	Level Gauge
LI	Indication (Soft)/Level Sight Indicator (Glass)
LIT	Level Indicating Transmitter
LO	Lock Open
LSH	Level Switch High
LSHH	Level Switch High High (Shutdown)
LSL	Level Switch Low
LSLL	Level Switch Low Low (Shutdown)
LT	Level Transmitter (Blind)
LV	Level Control Valve
LY	Level/Relay/Convertor
MCC	Motor Control Center
MGV	Manifold Gauge Valve
NC	Normally Closed
NO	Normally Open
NV	Needle Valve
P	Pressure
PAH	Pressure High
PAHH	Pressure High High (Shutdown)
PAL	Pressure Low
PALL	Pressure Low Low
PC	Pressure Control
PDAH	Pressure Differential High
PDAHH	Pressure Differential High High (Shutdown)
PDAL	Pressure Differential Low
PDALL	Pressure Differential Low Low (Shutdown)
PDC	Pressure Differential Control
PDI	Differential Pressure Indication
PDIC	Pressure Differential Indicating Controller

PDIT	Pressure Differential Indicating Transmitter
PDSH	Pressure Differential Switch High
PDSHH	Pressure Differential Switch High High (Shutdown)
PDSL	Pressure Differential Switch Low
PDSLL	Pressure Differential Switch Low Low (Shutdown)
PDT	Differential Pressure Transmitter (Blind)
PDV	Pressure Differential Control Valve (Pneumatic Actuator)
PFY	Pressure Ratio Convertor/ Relay
PFC	Pressure Ratio Controller
PG	Pressure Gauge
PI	Pressure Indication (Soft)
PIC	Pressure Indicating Controller
PIT	Pressure Indicating Transmitter
PSE	Pressure Rupture Disk
PSH	Pressure Switch High
PSHH	Pressure Switch High High (Shutdown)
PSL	Pressure Switch Low
PSLL	Pressure Switch Low Low (Shutdown)
PSV	Pressure Safety Relief Valve
PT	Pressure Transmitter (Blind)
PV	Pressure Control Valve
Q	Quantity and Heat
QE	Heater Element, Immersion, Tracing
R	Radiation
S	Speed, Frequency
SC	Speed Control
SD	Shutdown
SIC	Speed Indicating Controller
T	Temperature
TC	Temperature Controller
TAH	Temperature High
TAHH	Temperature High High (Shutdown)
TAL	Temperature Low
TALL	Temperature Low Low (Shutdown)
TE	Temperature Element (RTD, Thermocouple, etc.)
TG	Temperature Gauge
TI	Temperature Indication (Soft)
TIC	Temperature Indicating Controller
TIT	Temperature Indicating Transmitter
TRV	Transfer Valve 3-Way
TSH	Temperature Switch High
TSHH	Temperature Switch High High (Shutdown)
TTSL	Temperature Switch Low
TSLL	Temperature Switch Low Low (Shutdown)
TT	Temperature Transmitter (Blind)
TV	Temperature Control Valve
TW	Temperature Thermo-well
TY	Temperature/Relay/ Convertor
U	Multi Variable
V	Vibration, Mechanical Analysis
VE	Vibration Probe
VFD	Variable Frequency Drive
VG	Block/Bleed, Gauge Valve
VSH	Vibration Switch High
VSHH	Vibration Switch High High (Shutdown)
VT	Vibration Transmitter (Blind)
VU	Vibration Monitoring System
W	Weight
XA	Status (Stopping/Not Running) Alarm/Common Alarm
XC	State Controller
XI	Running Indication
XV	Solenoid Valve
XY	State Relay/Convertor
Y	Event, State, Presence
YAH	Fire Alarm
YE	Fire Detecting Sensor
YIT	Fire Indicate and Transmit
YK	Fire Control Station
Z	Position, Dimension
ZC	Position Controller
ZE	Position Element
ZI	Position Indicator
ZIT	Position Indicating Transmitter
ZT	Position Transmitter (Blind)
ZY	Position Transmitter (Blind)
ZZ	Position Actuator (Capacity or Volume)

Symbol Identification

Use this list to identify symbols shown in the Piping & Instrumentation Diagram.


3-Way Valve

3-Way Solenoid Valve


Angle Valve


Ball Valve


Basket Strainer


Block/Bleed Gauge Valve


Butterfly Valve


Check Valve


Diaphragm Actuator

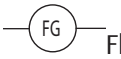

Diaphragm
Spring-Opposed


Diaphragm
Pressure-Balanced


Differential Pressure
Regulating Valve


Drive Coupling


Flange Set



Flow/Sight Glass


Gate Valve


Globe Valve


Hand Expansion Valve

Heater


Heat Trace


Insulation

Man-Way Cover


Manifold Gauge Valve

Motorized Ball Valve


Needle Valve


Orifice Plate

Pilot Light


Pipe Plug


Pipe Reducer


Pneumatic Actuator
Control Valve


Relief Valve


Regulating Valve Inlet
Pressure


Regulating Valve Outlet
Pressure


Rotary Valve


Rupture Disc


Schroder Valve

Solenoid Valve


Spring-Closing Drain
Valve


Stop/Check Valve


Strainer

Thermostatic Valve 3-Way

Thermowell (SW or NPT)

Thermowell (SW or NPT)

Venturi Injector Nozzle

Vibration Absorber

Scope of Supply

Major Component Identification

Use this list to identify major components shown in the Piping & Instrumentation Diagram.

Air Drive

Compressor

Damper or
Louver

Engine Drive

Filter

Finned Tube
Heat Exchanger

Heat Exchanger

Motor

Shell and Tube
Heat Exchanger

Fan

Tank/Drum Vessel

Positive Displacement
Pump

Major Component Identification (Continued)


Centrifugal Pump


Rotary Pump

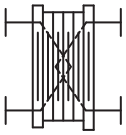
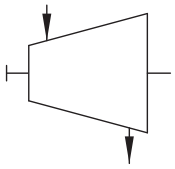


Plate & Frame Heat Exchanger


Turbine

Control and Instrument Identification


Discrete Instrument, Field Mounted


Discrete Instrument, Remote, Mount, Normally Accessible to Operator


Discrete Instrument, Local Rack Mounted, Normally Accessible to Operator


Shared Display/Control, Field Mounted


Shared Display/Control, DCS or Remote Control Panel Normally Accessible to Operator


Shared Display/Control, Local Control Panel Normally Accessible to Operator


Programmable Logic Control, Field Mounted


Safety Instrumented System, Field Mounted


Programmable Logic Control, DCS or Remote Control Panel, Normally Accessible to Operator


Safety Instrumented System Main Control Panel or DCS


Programmable Logic Control, Auxiliary (Local) Control Panel, Normally Accessible to Operator


Safety Instrumented System Auxiliary (Local) Control Panel


Computer Function, Field Mounted

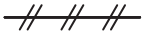

Computer Function, DCS or Remote Control Panel, Normally Accessible to Operator


Computer Function, Local Operator Panel, Normally Accessible to Operator


Interlock


Permissive

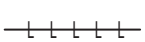
Line Type Designations


Pneumatic Signal

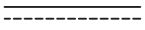

Capillary Tube


Electrical Signal

Internal System Link (Software or Data Link)


Mechanical Link

Hydraulic Signal


Customer Field Piping


Insulation

Valve and Instrument Tagging

a-bc-yz = ABC-DEFGH-IJKL

a = ABC, b = DE, c = FGH, y = IJK, z = L

A - Process cell or stage of compressor

B - Unit number in process cell or stage of compression

C - Service in process cell or stage of compression

- 1 - Gas lines
- 2 - Coolant lines
- 3 - Oil lube lines
- 4 - Refrigerant lines
- 5 - Condensate lines
- 6 - Air lines

D - Measured variable

E - Variable Modifiers

F - Readout or passive function

G - Output or active function

H - Function modifier

I - Loop number or sequential number

J - Loop number or sequential number

K - Loop number or sequential number

L - Suffix

SAMPLE TAG

105-LSH-300-A

1 - First process cell or stage of compression

0 - First unit number in process cell or stage of compression

5 - Condensate service

L - Level

S - Switch

H - High

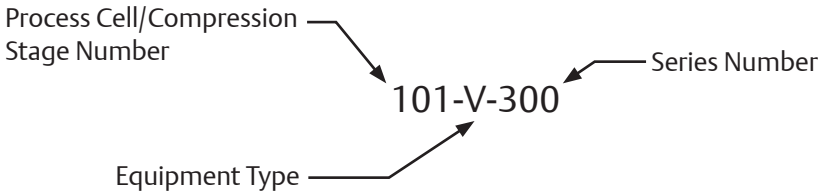
3 - Loop number or sequential number

0 - Loop number or sequential number

0 - Loop number or sequential number

A - Another exactly the same device in the same loop as 105-LSH-300

Equipment Number Identification



EQUIPMENT TYPE

A - Agitator, Mechanical Mixers, Aerators

B - Blowers

C - Compressors

D - Drivers

E - Heat Exchangers

F - Fans

P - Pumps

R - Reactors

U - Filters, Strainers

V - Vessels, Tanks, Separators, Scrubbers

Pipe Line Data Identification

AB - C - D - E - F / X - Y - Z

20-LFG-001-10-STD / PS-1-ET

A - Process cell or stage of compression
- 1 - Process cell first stage of compression
- 2 - Process cell first stage of compression
- 3 - Process cell first stage of compression
- 4 - Process cell first stage of compression
- 5 - Process cell low pressure refrigeration (booster)
- 6 - Process cell high pressure refrigeration (high stage)
- 7 - Open
- 8 - Open
- 9 - Open

B - Unit number in process cell or stage of compression

C - Service
- AR - Process Air
- BD - Blowdown
- BRR - Brine
- CHWS - Chilled Water Supply
- CHWR - Chilled Water Return
- CWR - Cooling Water Return
- CWS - Cooling Water Supply
- DR - Drain
- ER - Ethylene Refrigerant
- GLR - Glycol Return
- GLS - Glycol Supply
- H - Hydrogen
- HR - Hydrocarbon Refrigerant
- IAS - Instrument Air Supply
- LFG - Land Fill Gas
- LO - Lube Oil
- N - Nitrogen
- NG - Natural Gas
- NH - Ammonia
- PC - Process Condensate
- PG - Process Gas
- PR - Propylene Refrigerant/Propane
- SV - Safety Relief
- SO - Seal Oil
- VC - Vacuum Condensate

D - Numerical Sequence Number

E - Size
- #" - Nominal Pipe Size (Inches)

F - Standard/Other Standard
- STD -Vilter
- 0 - Other Standard (Not Vilter)

X - Insulation
- AC -Acoustic Control
- CC - Cold Service
- CP - Condensation Control
- N - Not Required
- PP - Personnel Protection
- PS - Process Stability
- TR - Traced (See Tracing Type)

Y - Insulation Thickness
- BO - By Others
- #" - Nominal Thickness (Inches)
- 0 - Insulation Not Required

Z - Heat Tracing
- ET - Electrical Heat Trace
- N - None

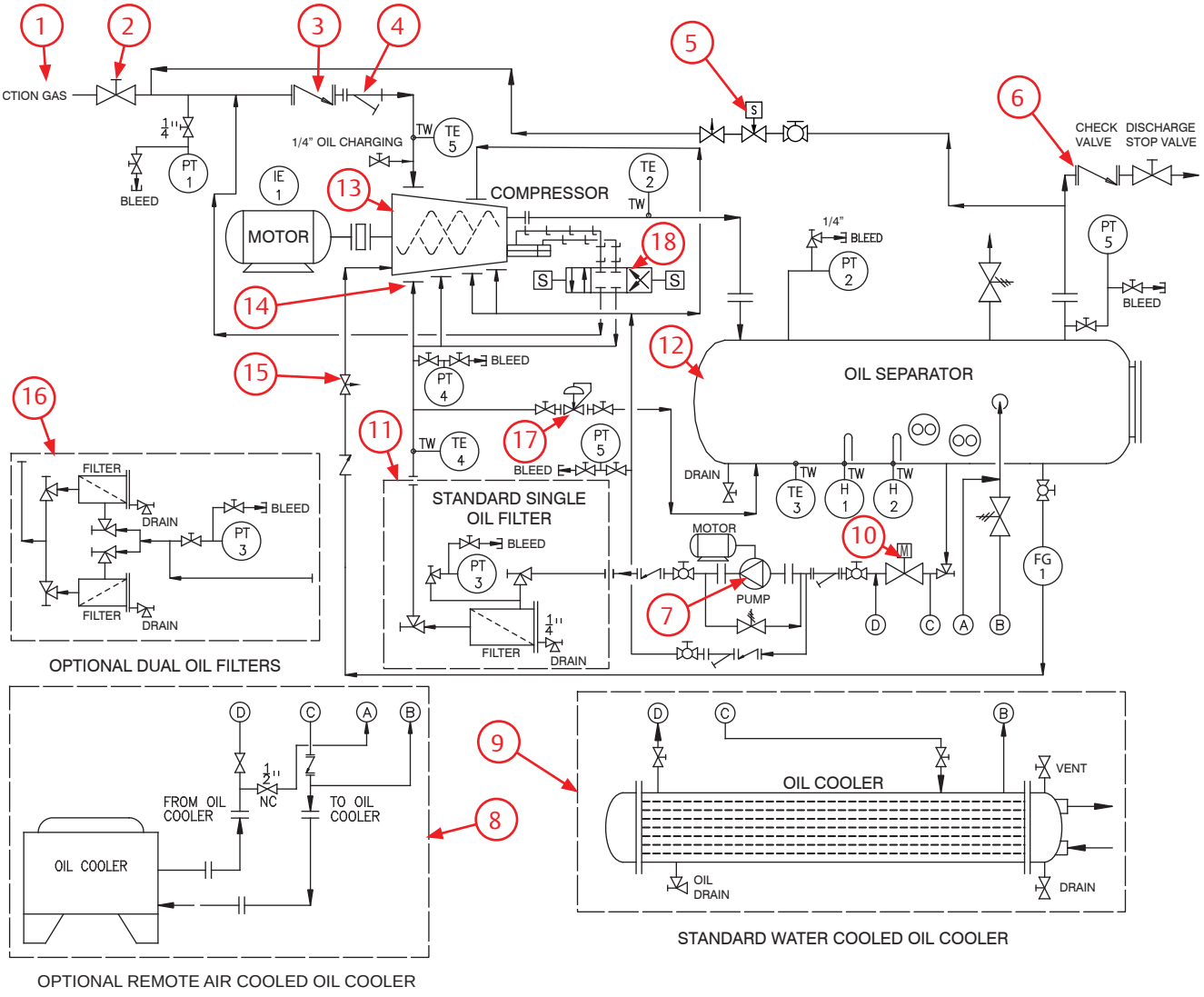


Figure 2-1. Gas Compressor Unit P&ID

The gas and oil systems work in unison, but each one will be explained separately. Reference Figure 2-1 for gas and oil flow descriptions.

Gas Flow

The gas compression process begins as processed gas enters the suction inlet (1). The processed gas flows through a stop valve (2), check valve (3) then through a suction line strainer (4) to the compressor (13). The processed gas is then pressurized through the compressor and discharged as high pressure gas vapor into the oil separator (12). In the oil separator, the oil is then separated from the discharged gas vapor by impingement separation. The high pressure gas flows out to the aftercooler and scrubber for cooling while the oil is pumped or syphoned back to the compressor.

Check valves (3) and (6) are provided to stop the back flow of gas in the system when the compressor is shut down.

An equalizing line is also installed between the high pressure side (oil separator) and low pressure side (suction) to allow separator pressure to equalize to suction pressure at shutdown. This is controlled by the equalizing solenoid (5).

Oil Life and Oil Flow

The life of the oil is directly affected by the quality of the

gas. Proper separation of any liquids must be accomplished before any liquids can get to the compressor suction. The discharge temperature of the compressor must be kept a minimum of 30°F (or 17°C) above the discharge gas dew point to prevent the condensing of liquids in the oil separator. The oil separator shell and legs must be insulated when the gas stream has a high probability of having condensables.

Oil in the gas compressor unit serves four primary purposes. They are compressor lubrication, sealing clearances between moving parts, heat removal resulting from heat of compression and friction, and hydraulic slide valve control (18). Oil flow is driven by a mechanical gear pump (7) which runs full time. Oil pressure in the system is controlled by a flow control valve (17).

As the oil is separated from the gas in the oil separator (12), it is pumped through an oil cooler (8 or 9), then filtered through a single (11) or dual oil filters (16) and back to the injection ports (14) of the compressor (13). The standard oil cooler is a shell and tube water cooled heat exchanger (9). The other option is to air cool oil remotely through a finned fan heat exchanger (8).

Furthermore, to collect oil from the coalescing side of the oil separator (12), a line is installed between the oil separator and the compressor. By opening the needle valve (15), this will allow oil dripping off the coalescing filters to be fed back to the compressor (13). In addition, the oil cooler (8 or 9) is piped in parallel to the oil temperature control valve (oil mixing valve) (10), which acts as a by-pass valve.

This is a continuous cycle.

Control System

The gas compressor unit is controlled by a Programmable Logic Controller (PLC) panel. This PLC panel's main function is to control the gas compression system from the data that it receives from the sensors around the unit. For additional control and software information, refer to the VRSG PLC Software Manual (35391CN).

Temperature Elements and Pressure Transducers

Temperature Elements (TE) and Pressure Transducers (PT) are instruments used to measure temperatures and pressures at specific locations on the gas compressor unit, see Figure 1-2. Temperature elements are typically mounted on the suction pipe, discharge pipe, oil separator and oil filter outlet pipe. Pressure transducers are typically mounted on the block and bleed assembly and directly on the suction pipe. The pressure transducers measure suction pressure, inlet and outlet oil pressure, and oil separator pressure.

Delivery Inspection

All equipment supplied by Vilter are thoroughly inspected at the factory. However, damage can occur in shipment. For this reason, the units 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 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 claims made within ten (10) days after its discovery. Refer to long term storage for additional recommendations.

Rigging and Lifting of Compressor Unit

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 unit, refer to the supplied Vilter General Assembly (GA) drawing.

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

- 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 unit to prevent damage to components.
- Use additional personnel as needed to spot and aid in maneuvering the compressor unit.
- Ensure there is plenty of space to maneuver the compressor unit and a clear path to its location.

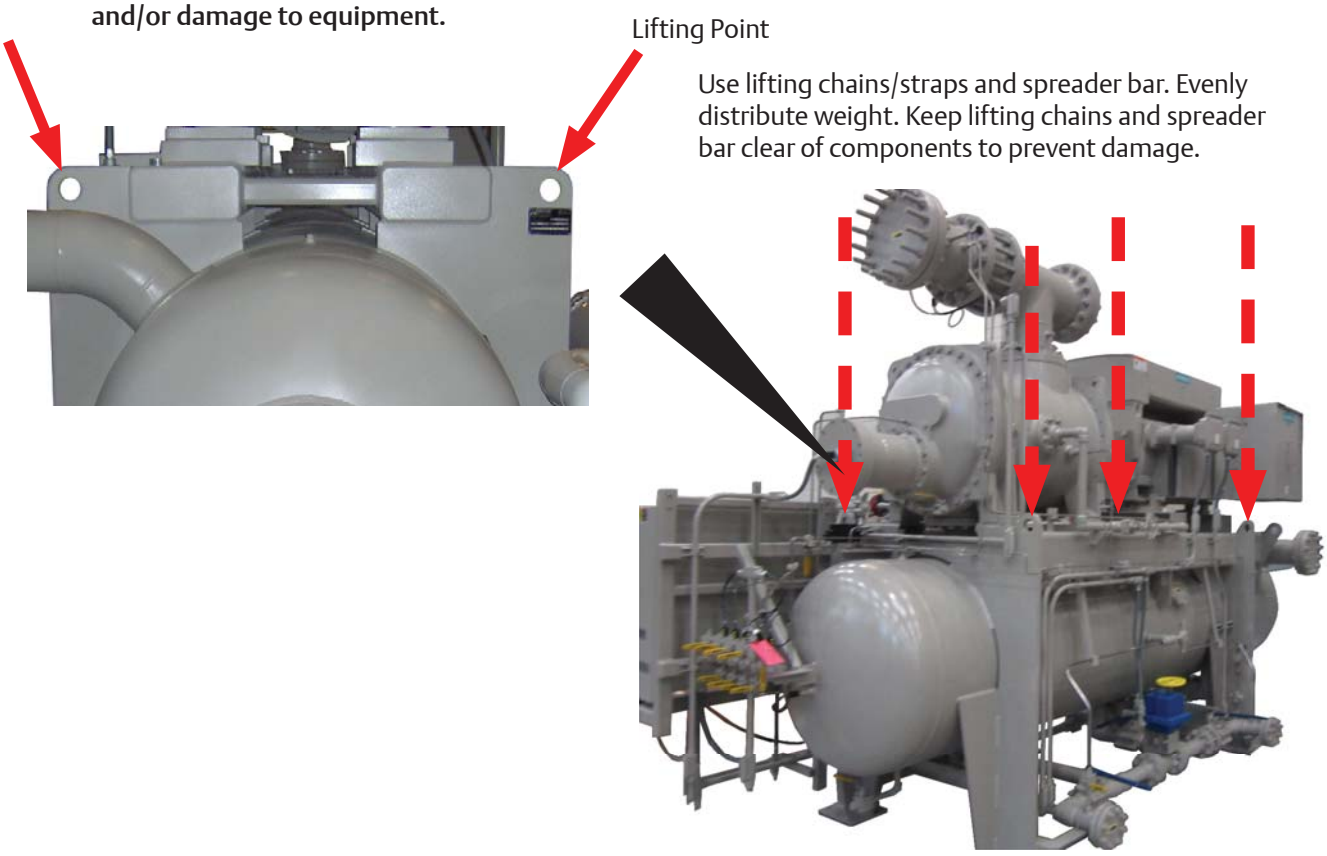


Figure 3-1. Rigging and Lifting Points

Long Term Storage Recommendations

The procedure described is a general recommendation for long term storage (over one month of no operation) of Vilter compressor units. 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 3-4.

Warranty of the system remains in effect as described in the Terms and Conditions or your order.

The following are recommendations regarding long term storage:

- If the unit is designed for indoor duty, it must be stored in a heated building.
- 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 unit is shipped with dry nitrogen holding charge of approximately 5 psi above atmospheric pressure. It is essential that the nitrogen holding charge be maintained.
- Cover all bare metal surfaces (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.
- The nitrogen or clean dry gas holding charge in the system and compressor are to be monitored on a regular basis for leakage. 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.
- Maintenance log to be kept with documenting dates to show all the procedures have been completed.
- Notify Vilter Service and Warranty Department when the compressor is started.
- For long term storage of a Twin Screw Compressor (Howden), refer to Appendices.

COMPRESSOR MOTOR

The following are general recommendations. Refer to specific motor manufacturer instructions for storage recommendations.

- Cover the motor completely to exclude dirt, dust, moisture, and other foreign materials.
- If the motor can be moved, it is suggested that the entire motor be encased in a strong, transparent plastic bag. Before sealing this bag, a moisture indicator should be attached to the side of the motor and several bags of silica-gel desiccant be placed inside the bag around the motor. When the moisture indicator shows that the desiccant has lost its effectiveness, as by a change in color, replace desiccants.
- If equipped, space heaters must be installed to keep the motor at least 10°F above the ambient temperature.
- Add grease every 3 months.
- Cover all bare metal surfaces with rust inhibitor.
- Manually rotate motor shaft several revolutions (approximately 6) every 3 months to prevent flat spots on the bearing surfaces.

AIR COOLED OIL COOLERS

The following are general recommendations. Refer to specific air cooled oil cooler manufacturer instructions for storage recommendations.

- If the coolers are to be stored or not operated for an extended period of time, the fan motors may ingress moisture if they are not protected or operated regularly. In severe cases, the moisture will reduce the insulation level of the windings or cause rusting of the bearings necessitating removal for repairs at a motor repair facility. This is a common problem with large generating installations when the coolers are often ready but commissioning of the main turbine-generator is delayed for several months.
- The simplest remedy for installed coolers is to operate the fan motors for a few hours every week during the downtime period until regular operation resumes. The fan motors on stored coolers must be protected from the elements by covering them with waterproof tarps.

Compressor Unit Inspections Prior to Storage or Installation

The compressor unit 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 and motor mounting nuts.
- Check for bent or damaged components. The compressor unit should have also been inspected prior to off-loading, see Delivery Inspection.
- Check that the nitrogen pressure is still holding pressure. The pressure gauge is located at the discharge bleed valve on the block and bleed assembly. Any leaks must be fixed and the system purged and recharged with dry nitrogen.

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:

- Dial Indicator (0.001” Graduation, 0”-1” Range) with 12” Adjustable Arm and Magnetic Base
- Feeler Gauge Set, 0.0015”-0.020” Range, 12” blade length
- Infrared Heat Gun
- Oil Pump (maximum of 2-3 GPM with motor approved for Division 1 or Division 2 and with ability to overcome suction pressure)
- Sockets and wrenches up to 2-1/2” (63.5 mm)
- Torque Wrenches (with ranges from 0 to 600 ft-lbs)
- Voltmeter

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 (Refer to Appendices for Twin Screw Long Term Storage)
- ☐ Motor Shaft (Rotate shafts at least 6 revolutions)
- ☐ Motor Bearings Greased
- ☐ Air Cooled Oil Cooler Rotated
- ☐ 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 (Refer to Appendices for Twin Screw Long Term Storage)
- ☐ Motor Shaft (Rotate shafts at least 6 revolutions)
- ☐ Motor Bearings Greased
- ☐ Air Cooled Oil Cooler Rotated
- ☐ 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)

Foundation

Vilter compressor units are low vibration machines. Under most conditions, no elaborate foundation is necessary. However a sound foundation maintains motor alignment and proper elevation, and is therefore required. Provided are recommendations for the foundation and anchoring of the compressor unit. The Vilter foundation supports the entire operating weight of the unit and is suitable for years of continuous duty. Included are specifications for concrete, rebar, aggregate, anchors and grout.

Considerations Prior to Starting

Consult professionals, such as building inspectors, structural engineers, geotechnical engineers and/or construction contractors prior to starting. Below are a few points to consider:

Site Characteristics:

- Soil information
- Site drainage
- Wind data
- Seismic zone
- Ingress and egress
- Power and power lines

Site Layout:

- Plant elevations, grading, drainage and erosion
- Accessibility to compressors for service
- Location of surrounding buildings
- Property lines and roadways
- Power
- Fire safety

Safety:

NOTE

Always check with a safety engineer before proceeding.

- Arranging equipment with adequate access space for safe operation and maintenance
- Wherever possible, arrange equipment to be served by crane. If not feasible, consider other handling methods
- Make all valves and devices safely accessible
- Use special bright primary color schemes to differentiate service lines
- Lightening protection for outdoor installations
- Relief valve venting

Foundation Materials

Materials needed to build the foundation are forms, concrete, sand, rebar, wire, grout, anchor bolts, expansion board and shims. A set of concrete forms will need to be acquired; generally, these can be rented or constructed from dimensional lumber. There should be enough 4,000 psi concrete with one inch aggregate to build the foundation. Also, there should be enough sand to provide a base of compacted sand four inches thick for the foundation to rest on, see Figure 1 - Concrete Pad with Compressor Unit Dimensions - Side View. The rebar required is ASTM 615, grade 60, sizes #4 and #6. Wires will also be needed to tie the rebar together. The recommended grout is Masterflow 648CP high performance non-shirk grout to provide at least a 1" thick pad under each foot. The recommended anchors are 5/8" Diameter HILTI HAS SS threaded rod for outdoor installations or HAS-E rods for indoor installations. Anchor bolts shall have a five inch projection and 12-3/8" embedment. The required adhesive is HIT-ICE/ HIT/HY 150 anchoring system. There should be enough one inch expansion boards to go around the perimeter of the foundation. Finally there should be enough shim stock and extra anchor bolt nuts to level the compressor unit.

Building the Foundation

Use the Vilter General Arrangement (GA) and foundation drawings to help secure a building permit and foundation construction. The Vilter GA drawing will have the necessary dimensions required to determine the overall foundation size and where to locate the compressor unit on the foundation. It will also show the dimensions required to form up the housekeeping piers that the compressor unit rests on. The Vilter foundation drawing lists the necessary information to construct a suitable foundation. It includes the rebar requirements and locations. It also shows anchor bolt locations, grouting and the concrete specifications. Using the Vilter GA drawing, Vilter foundation drawing and the information from site characteristics, site layout and safety studies will provide enough data to allow building the foundation to proceed.

The foundation is to be cast and permanently exposed against the earth. Therefore, if constructing on an existing floor, typically indoors, the floor will need to be broken up to get to the earth. If starting from undisturbed soil, it must be also be prepared accordingly. In either case, these are some check points to consider:

- Check the depth of your frost line to ensure the foundation extends below it
- Ensure the foundation rests entirely on natural rock or entirely on solid earth, but never on a combination

of both

- Check the ability of the soil to carry the load
- Check wet season and dry season soil characteristics for static loading limits and elasticity
- Check local codes for Seismic Design requirements

For examples of foundation diagrams, see to Figure 3-2 and Figure 3-3.

trolled level and a surface texture etched in place. Leave the concrete to cure for at least 28 days.

Compressor Unit Installation

Once the foundation has cured, the compressor unit can be placed on the foundation, see Figure 3-5 and Figure 3-6. With the appropriate material handling equipment, lift the compressor unit by locations shown on the Vilter GA drawing and slowly place it on the

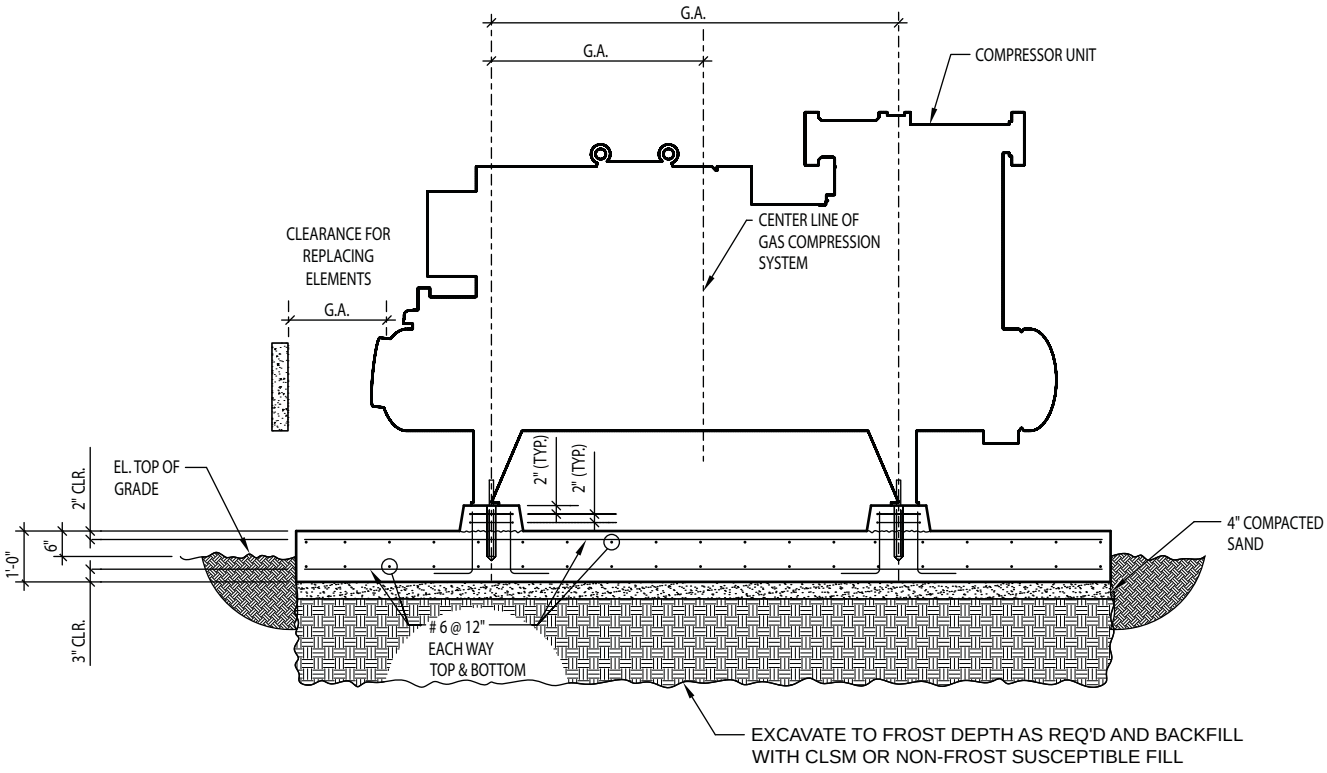


Figure 3-2. Concrete Pad with Compressor Unit Dimensions - Side View

NOTE

In Figures 3-3 and 3-8, the recommended housekeeping height of 6" is to allow maintenance/ service of the oil strainer and oil pump.

Once the site has been excavated and prepared, place four inches of sand down on the bed where the foundation will rest. The sand must be compacted before placing the forms and rebar. After the sand is compacted, use the Vilter GA drawing to construct the forms for the foundation. With forms in place, install expansion boards on the inside of the forms, for example, see Figure 3-4. Next, place your rebar in the forms as per the Vilter foundation drawing. When all rebars are in place the concrete can be poured. The concrete must then be foundation housekeeping piers. As per the Vilter GA drawing, ensure the compressor unit is correctly placed on the foundation. Once placed, use the footing of the compressor as the surface to level the compressor unit, see Figure 3-7. Place shims under the feet of the compressor unit, as needed, until it is leveled, see Figure 3-8. Select the correct drill bit and drill thru the anchor bolt hole in the mounting feet of the compressor unit to the depth called for on the Vilter foundation drawing. Finally using the HILTI instructions, put your anchor bolts in place and wait for them to cure. Then place the nuts on the anchor bolts to finger tight and prepare to grout.

Leveling and Grouting

The unit should be level in all directions. Wet the concrete pad according to the grout manufacturer's directions. Mix a sufficient amount of grout. The grout must be an expanding grout rather than shrinking to provide a tighter bond. Follow the manufacturer's recommendations for setting, precautions, mixing, and grout placement, finishing and curing. The grout must be worked under all areas of the feet with no bubbles or voids. If the grout is settled with a slight outside slope, oil and water can run off of the base. Once the grout has cured, torque the anchor bolts as per HILTI instructions.

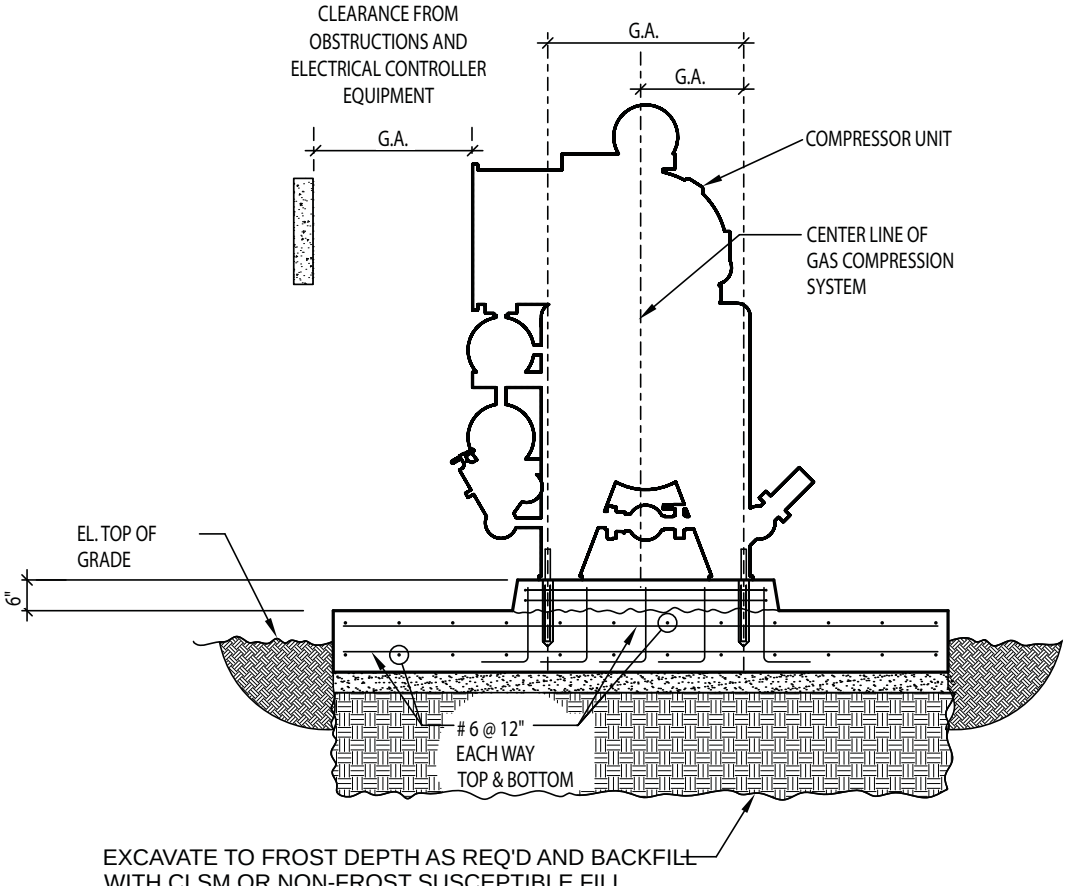


Figure 3-3. Concrete Pad with Compressor Unit Dimensions - Front View

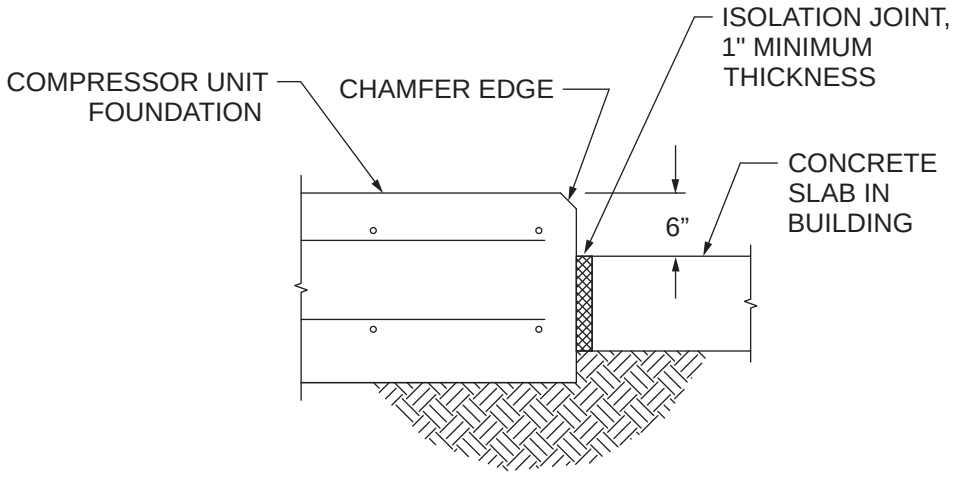


Figure 3-4. Interior Foundation Isolation

Additional Information

Codes and Standards

Vilter followed the following codes and standards when designing your foundation:

- ACI
- ASTM
- ASCE 7
- IBC 2006

Operation and Performance

The foundation was designed for:

- Outside environment severe exposure
- Ambient temperature -10 degrees F to 105 degrees F
- Unit weight 20,000 lbs
- RPM 3600
- Soil bearing capacity 1,500 lbs/sq.ft.
- Wind speed 120 MPH
- Exposure factor D
- Wind importance factor 1.15
- Concrete poured on and permanently cast against the earth

General Design Requirements

The compressor foundation is designed to:

- Maintain the compressor in alignment and at proper elevation.
- Minimize vibration and prevents its transmission to other structures
- Provide a permanently rigid support
- Provide sufficient depth to dampen vibrations.

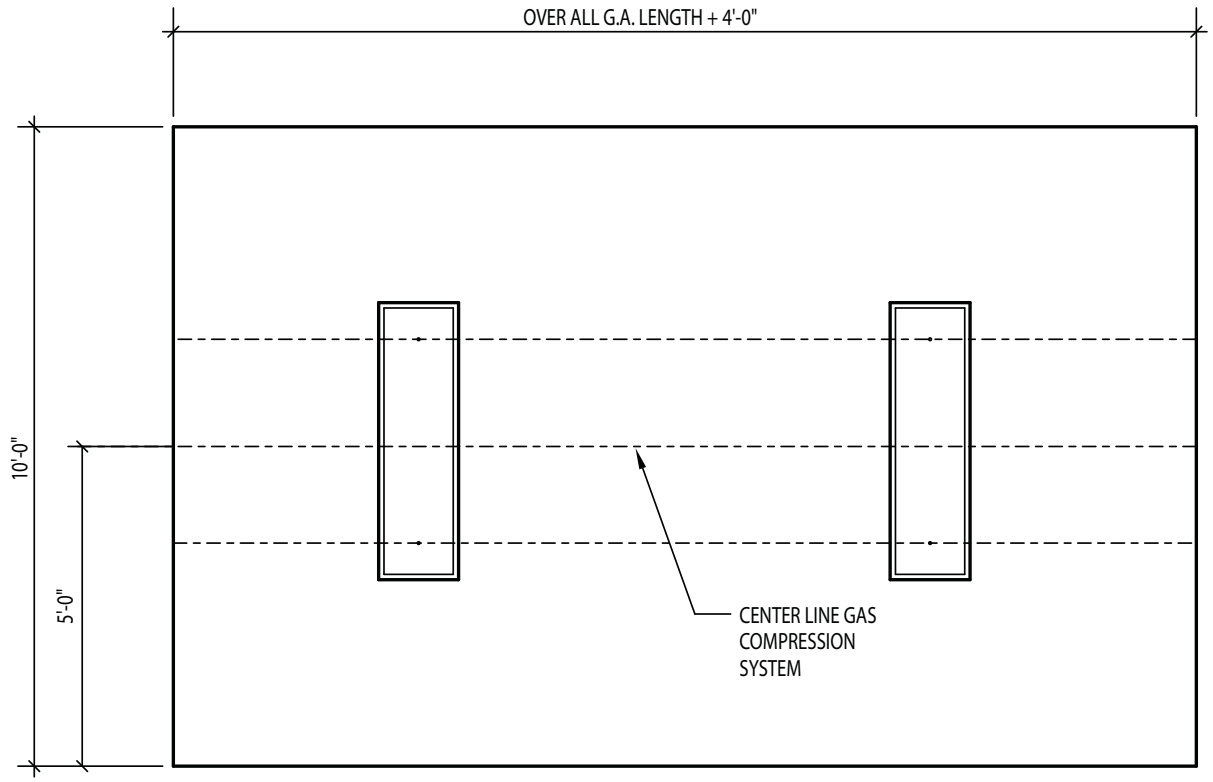


Figure 3-5. Foundation with Housekeeping Pads Dimensions - Top View

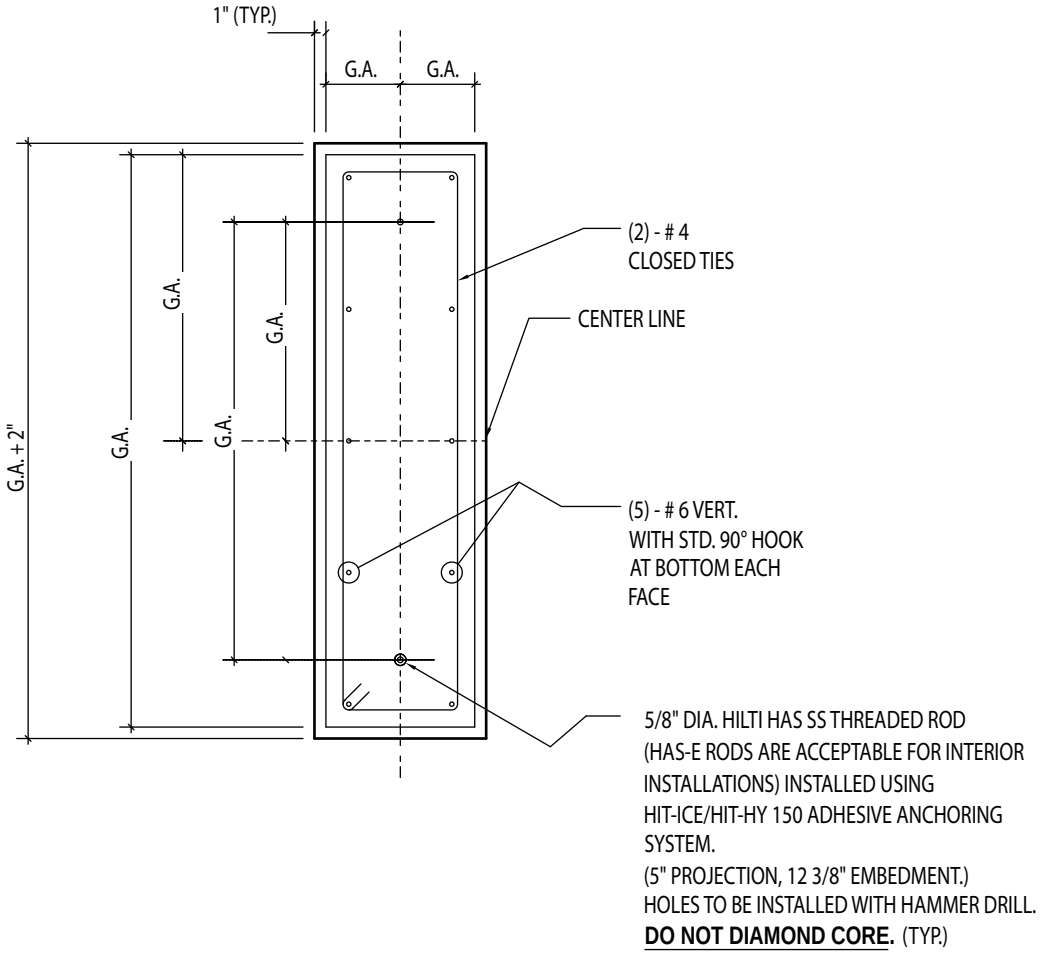


Figure 3-6. Housekeeping Pad Dimension Detail - Top View

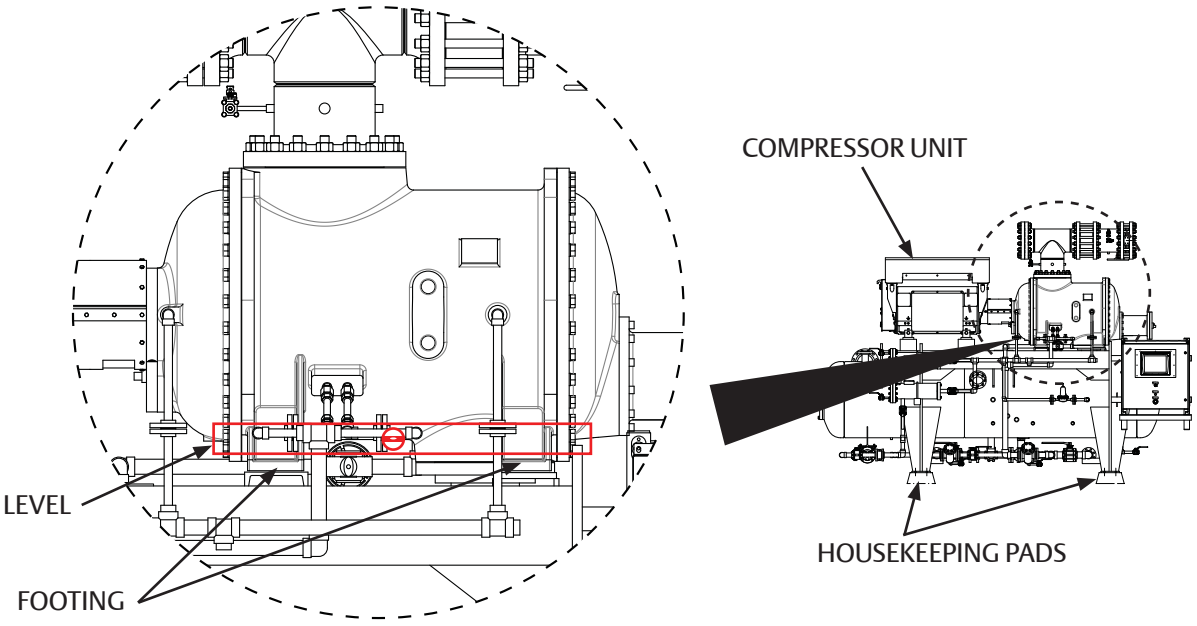


Figure 3-7. Level Compressor Unit Using Top Surface of Spherical Washers

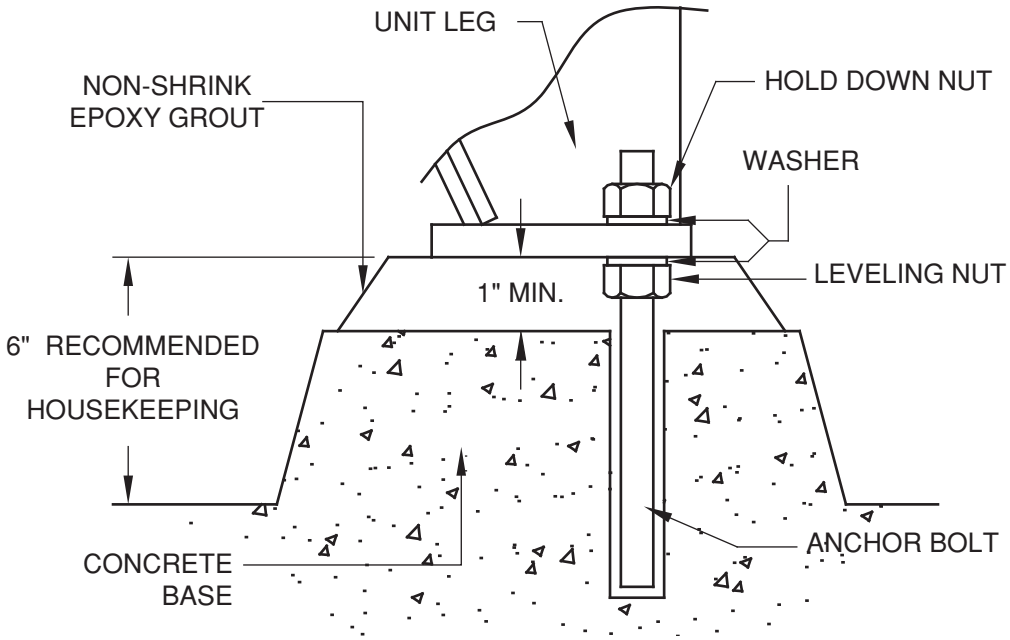


Figure 3-8. Concrete Pad Housekeeping Detail

Piping

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 3-9 and Table 3-2, 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 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 as applicable. See guidelines below, particularly with concern to minimizing loads on check valves.

Header Piping and Drains

Header drains should also be installed to allow drainage of liquids from the discharge and suction headers. See Appendices for Recommended Header Piping.

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.

Remote Air Cooled Oil Cooler Piping

If equipped with a remote air cooled oil cooler, it is important that the piping be installed correctly to and from the compressor unit and remote air cooled oil cooler. See Appendices for Recommended Air Cooled Oil Cooler Piping.

Table 3-2. 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

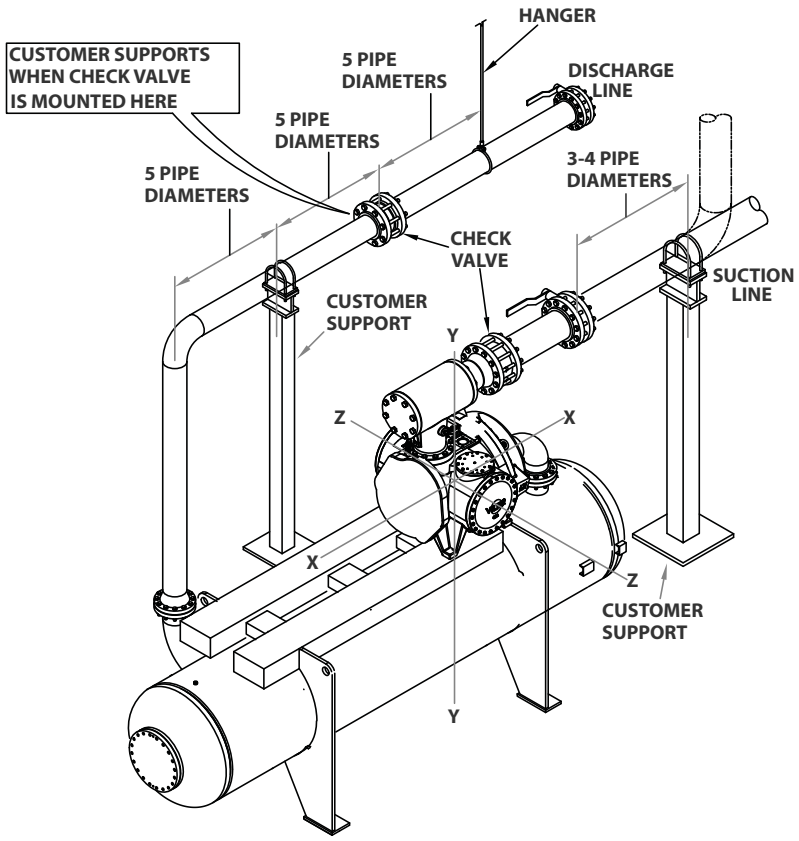


Figure 3-9. Maximum Allowable Flange Loads

General Installation Guideline for Multiple Air Coolers Installed in a Common Area

NOTE

This general installation guideline applies to all air coolers on site, whether if they are supplied by or not supplied by Vilter.

The purpose of this guideline is providing design information when multiple air cooled heat exchangers are installed in a common area. There are two main focal points of this guideline. One area is free flow area which addresses how much free area is required to prevent air flow "starvation" of the units. The second item provides a guideline as to how multiple air cooled heat exchangers should be arranged to minimize the potential of hot air recirculation due to the environment.

FREE FLOW

There are two basic guidelines that we follow to address free flow area when multiple designs are being installed in a common area.

- Air coolers should be placed at least 1 fan diameter away from the nearest obstruction. This is based on the largest fan diameter in the bay of coolers.
- Intake area to the air cooler should have an intake velocity equal to or below 500FPM as the discharge velocity is above 500FPM.

We will look at each rule and provide pictorials and calculations for each guideline. Let's assume the following coolers are being installed in a common area:

- Cooler 1 - 7' wide x 10' long with a 6' fan moving 55,000CFM of air. Face velocity is 785FPM.
- Cooler 2- 8' wide x 12' long with a 7' fan moving 72,000CFM of air. Face velocity is 750FPM.
- Cooler 3- 10' wide x 16' long with a 9' fan moving 120,000CFM of air. Face velocity is 750FPM.

ONE FAN DIAMETER

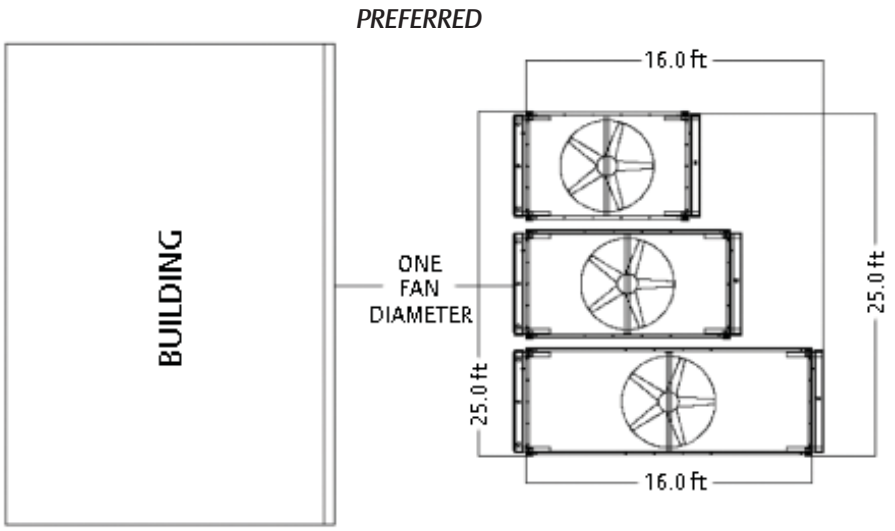
In order to keep the leg height of the installation to a minimum we want to install the coolers at least 1 fan diameter from the nearest obstruction. Referring to Figure 3-10, the nearest obstruction is the building.

Based on the information above, the largest fan diameter in the installation is 9ft. Therefore, the coolers should be placed at least 9' away from the building.

INTAKE VELOCITY

Based on the information above, we are going to solve for the leg height that will provide an intake velocity of 500FPM. We know the following:

- The total airflow of the installation is 247,000CFM
- We have an intake perimeter of 82' for all 4 sides based on the cooler placement.
- Our intake velocity guideline is 500FPM



TOTAL INTAKE PERIMETER = 82 FEET

Figure 3-10. Installation of Coolers - One Fan Diameter Next to Building

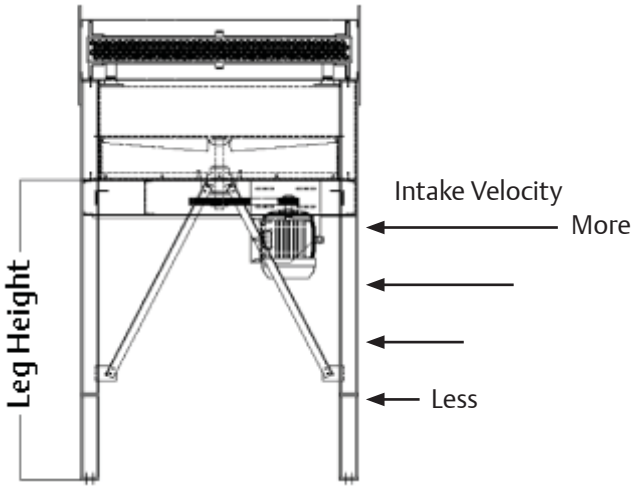


Figure 3-11. Leg Height

The equation used to calculate the leg height in Figure 3-11 is as follows:

Leg Height = (Total Airflow/Intake velocity)/Intake Perimeter

Leg Height = (247,000CFM/500FPM)/82ft

Leg Height = 6ft

In this particular case the calculated minimum height is 6 feet to maintain an intake velocity of 500FPM or less based on having the coolers place 1 fan diameter away from the nearest obstruction. Let's look at an installation where the coolers need to be placed next to the building as in Figure 3-12.

Based on the information above, we are going to solve for the leg height that will provide an intake velocity of 500FPM. We know the following:

- The total airflow of the installation is 247,000CFM
- We have an intake perimeter of 3 sides 16ft, 16ft, and 25ft which totals 57'
- Our intake velocity guideline is 500FPM

The equation used to calculate the leg height in Figure 3-11 is as follows:

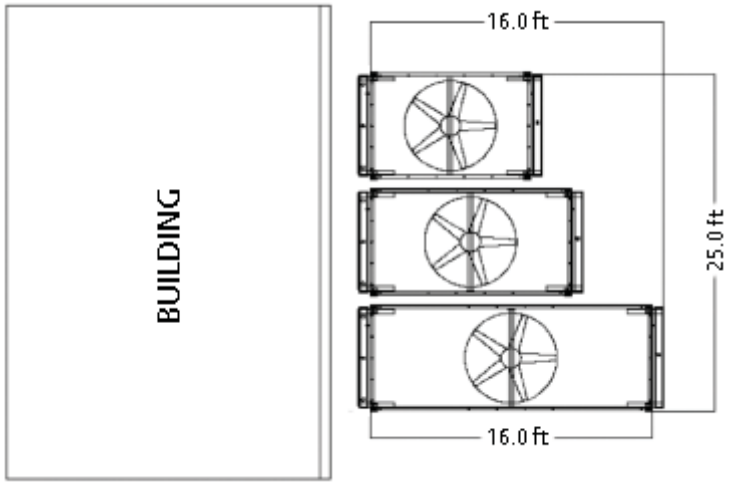
Leg Height = (Total Airflow/Intake velocity)/Intake Perimeter

Leg Height = (247,000CFM/500FPM)/57ft

Leg Height = 8.667ft

We would round the leg height up to 9ft for this particular situation.

NOT PREFERRED



TOTAL INTAKE PERIMETER = 57 FEET

Figure 3-12. Installation of Coolers - Next to Buildling

HOT AIR RECIRCULATION

There are two situations where hot recirculation could occur.

- Intake velocity of the cooler is higher than the discharge velocity
- Environmental issues such as strong cross winds which is installation specific

We addressed how to minimize the opportunity for hot air recirculation involving the operation of the air coolers under the guidelines for the Free Flow section above. However, environmental hot air recirculation is something that is outside of the control of the cooler manufacturer. If the site has the potential for strong cross winds or tunneling then you may want to consider the following items to minimize the potential of hot air recirculation due to the environment.

- All air coolers should discharge at the same elevation.
- If feasible all of the air coolers in a common area should be placed as close to the next cooler as possible.

Unfortunately this comes with a cost. By reducing the intake perimeter available, the leg height increases, which is a cost. In addition there is no guarantee that hot air recirculation can be eliminated due to environmental issues.

Discharge Elevation

In order to minimize the potential for hot air recirculation, it is recommended to install the air coolers so that they all discharge at the same elevation. This is important because not all air coolers have the same plenum heights. You can satisfy the leg height requirements by the calculation above but not satisfy the requirements for discharge elevation. Based on the size of the coolers above, cooler 1 has a plenum height of 36”, cooler 2 has a plenum height of 42”, and cooler 3 has a plenum height of 54”. Plenum heights are calculated from the standard of a 45 degree dispersion angle in API 661. If you would like more details on this calculation please contact engineering.

As you can see in Figure 3-13 in the not preferred configuration. the leg height requirement in the first calculation is satisfied. However, the coolers are not at the same discharge elevation. This could be an issue if there is a cross wind from left to right. Cooler 3 could block the discharge air flow from coolers 1 and 2 and recirculate it back down to the intake of the coolers. The best way to address this is to increase the leg heights on coolers 1 and 2 as shown in the preferred configuration.

This is especially critical if all of the air coolers are not place as close together as possible.

Cooler Placement and Spacing

The concern about cooler placement as far as proximity from one another has to do with the potential for hot air recirculation due to cross winds. Let’s look at only having coolers 1 and 3 in the same area. The leg height requirement of cooler 1 is 3.23ft so we would use a 4ft leg height. The leg height requirement for cooler 3 is 4.61ft but we would put a 7 foot leg height on the cooler due to size and for serviceability. Figure F. shows this installation.

In this case, if you get a strong cross wind from left to right there is the potential that the discharge coming from the top of cooler 1 could easily be pushed into the intake of cooler 3. Thus, in Figure 3-14, the not preferred configuration is more susceptible to the potential of hot air recirculation due to the environment and is not recommended. The preferred configuration is the recommended installation of the coolers with a space between them.

All of the information provided is a general guideline for installing multiple air coolers in a common area. If you minimally follow all of the Free Flow requirements and keep the air coolers discharging at the same elevation then you have a good basis for site layout.

Sometimes due to extenuating circumstances, the above guidelines cannot be followed. Please contact engineering to discuss remedies to accommodate different configurations.

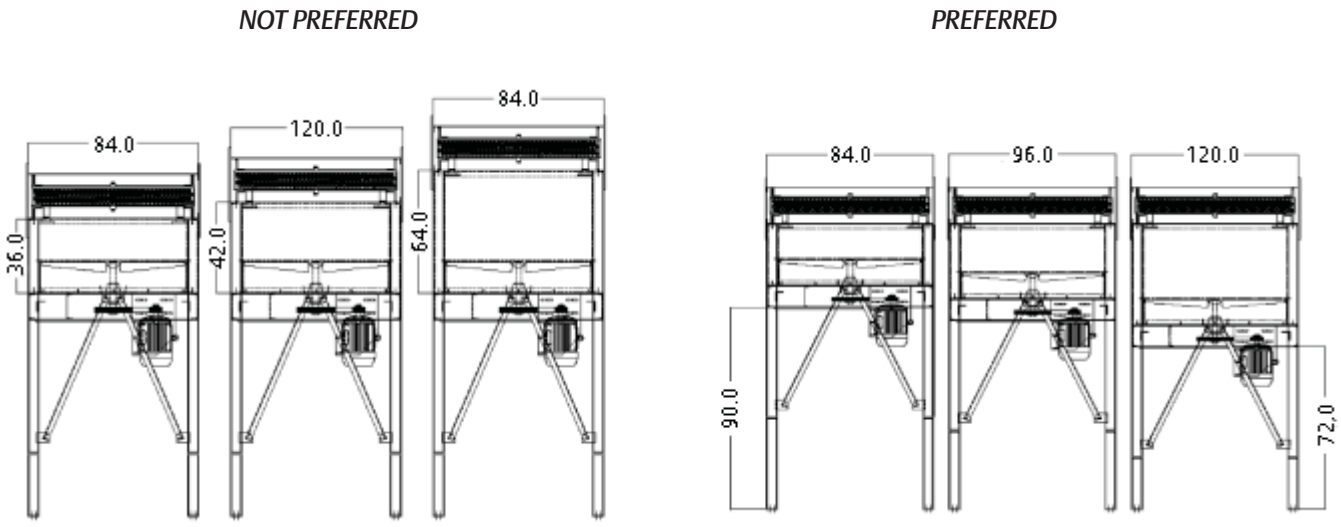


Figure 3-13. Discharge Elevation of Coolers

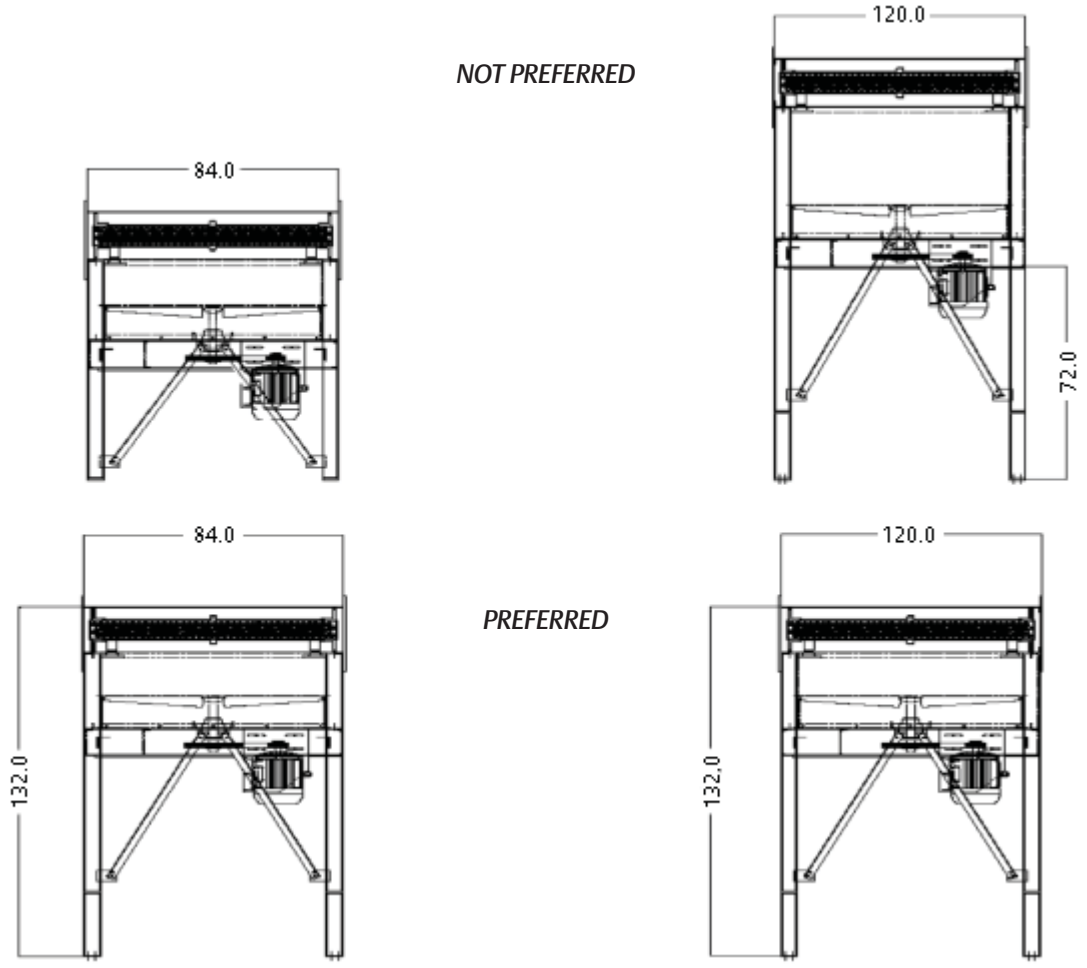


Figure 3-14. Cooler Placement and Spacing

Pressure Testing

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.

Pressure test in compliance with Chapter VI of the ASME B31.3 Process Piping Code.

Initial Oil Charging

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 gas compression 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.

Priming Remote Oil Cooler and Piping

WARNING

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

NOTICE

Failure to follow these instructions will result in bearing damage and compressor seizing and will void any and all warranties that may apply.

NOTE

This procedure is for remote oil coolers only.

Piping of oil must enter bottom connection of remote oil cooler and leave from top connection. For remote air cooled oil cooler piping, see Piping section.

(Reference Figure 3-19)

1. Verify oil level (8) is at Maximum Non-Operating Oil Level in separator (3). If oil level is not at Maximum Non-Operating Oil Level, add oil, see Initial Oil Charging - Unit Oil Charging procedure.
2. Close shut-off valve(s) (7) at oil filter inlet(s).
3. Close shut-off valve (8).
4. Open oil bypass shut-off valve (4).
5. Energize compressor unit.
6. Close oil mixing valve (oil temp. control valve) (6) via control panel. In Manual Mode, change “Manually Open (%)” value to “0”.

NOTE

The oil cooler is considered primed when the oil level in the separator is constant.

7. Run oil pump (5) for a minimum of 5 minutes and as long as needed to purge all gas from oil cooler and piping.
8. When all gas is purged, stop oil pump.

Priming Compressors and Oil Filters

NOTE

Running the compressor oil pump at this point will help lubricate the compressor bearings and shaft seal surfaces.

(Reference Figure 3-20)

9. Open shut-off valve (8).
10. Open shut-off valve(s) (7) at oil filter inlet(s).
11. Close oil bypass shut-off valve (4).
12. Open oil mixing valve (6) via control panel. In Manual Mode, change “Manually Open (%)” value to “100”.
13. Run oil pump (5) for approximately 20 seconds only.

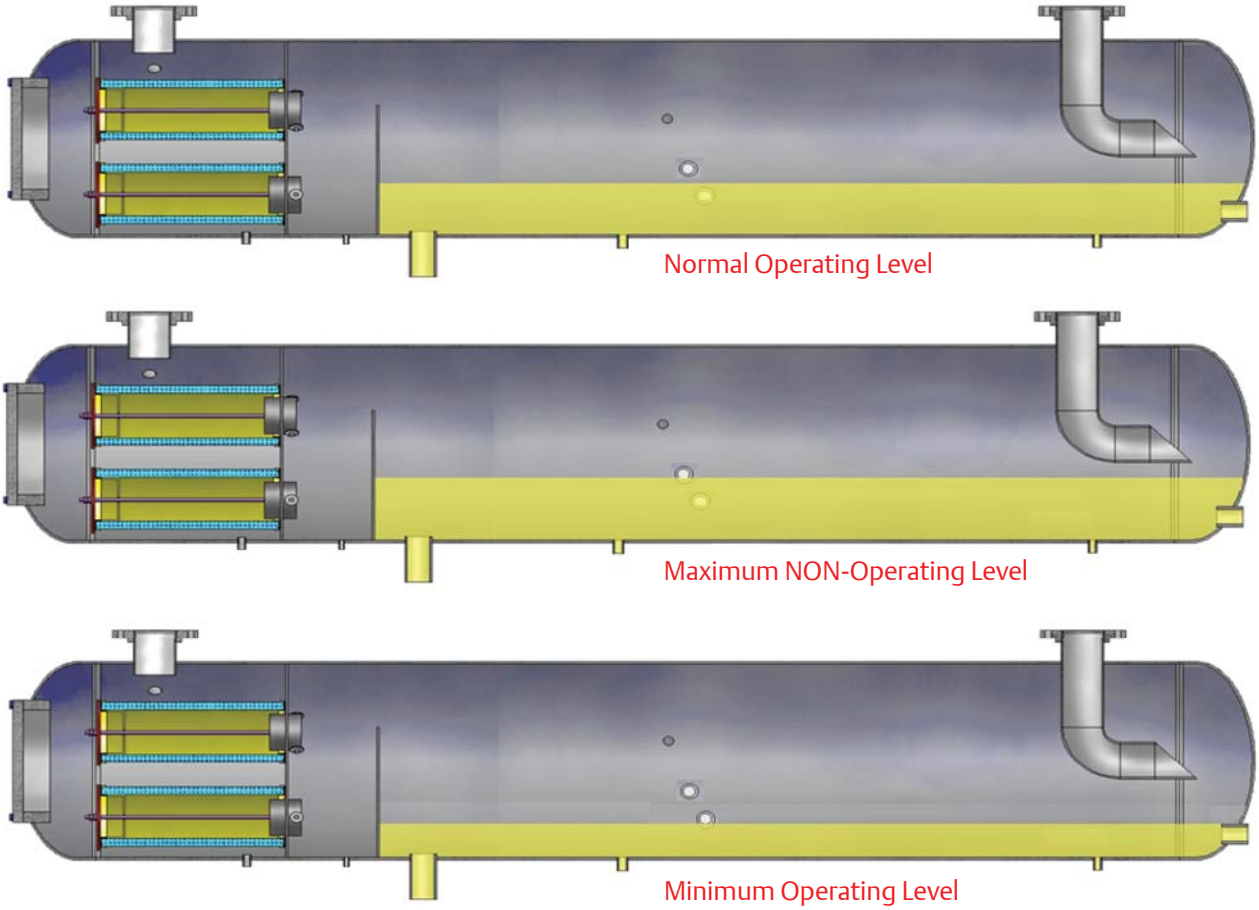


Figure 3-15. Oil Operating Levels

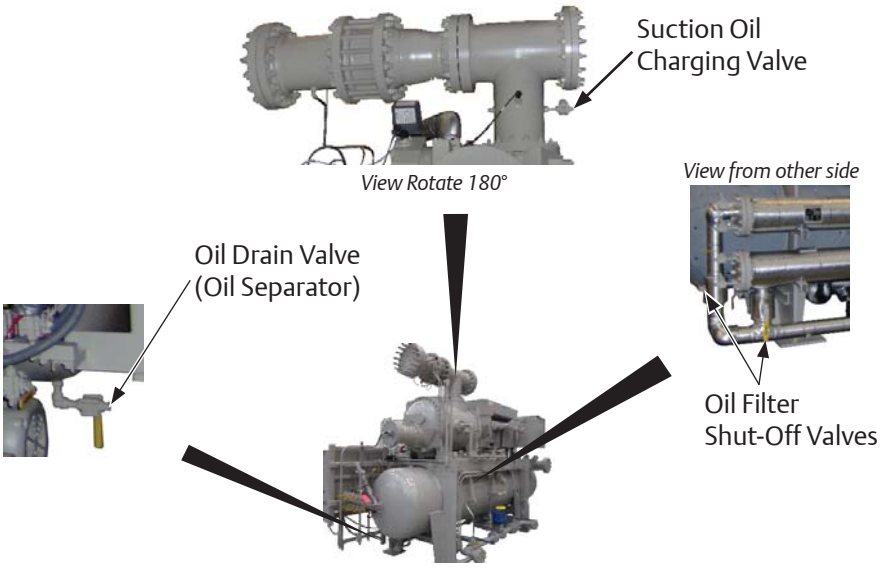


Figure 3-16. Suction Oil Charging Valve, Oil Cooler Drain Valve and Oil Filter Shut-Off Valves

14. Stop oil pump and wait for a minimum of 30 minutes. This will allow oil in the compressor (2) to drain and oil level (8) in separator (3) to settle.

NOTE

Oil mixing valve can remain in Manual Mode since the setpoint will change it to Auto mode. For further details, see PLC Compact Logix manual.

15. Refer to Pre Start-Up Checklist and ensure all items are ready prior to starting the compressor.
16. When ready, run compressor unit and allow it to reach normal operating temperature.
17. Using a properly selected oil pump, connect oil pump to suction oil charging valve (1). For suction oil charging valve location, see Figure 3-16.
18. Open suction oil charging valve (1) and fill oil separator (3) to Normal Operating Level.
19. Once the Normal Operating level has been reached, shut off the oil pump and close the suction oil charging valve (1). Disconnect and remove oil pump.

NOTE

Oil separator does not need to be filled again until oil level reaches Minimum Operating Level.

Every size of compressor will hold different amounts of oil, so amount of oil draining back into oil separator will vary.

20. More accurate fill levels can be accomplished by marking the level on the oil separator (3) after correct levels have been achieved during the unit operation and when the compressor unit has been down for 1 hour.

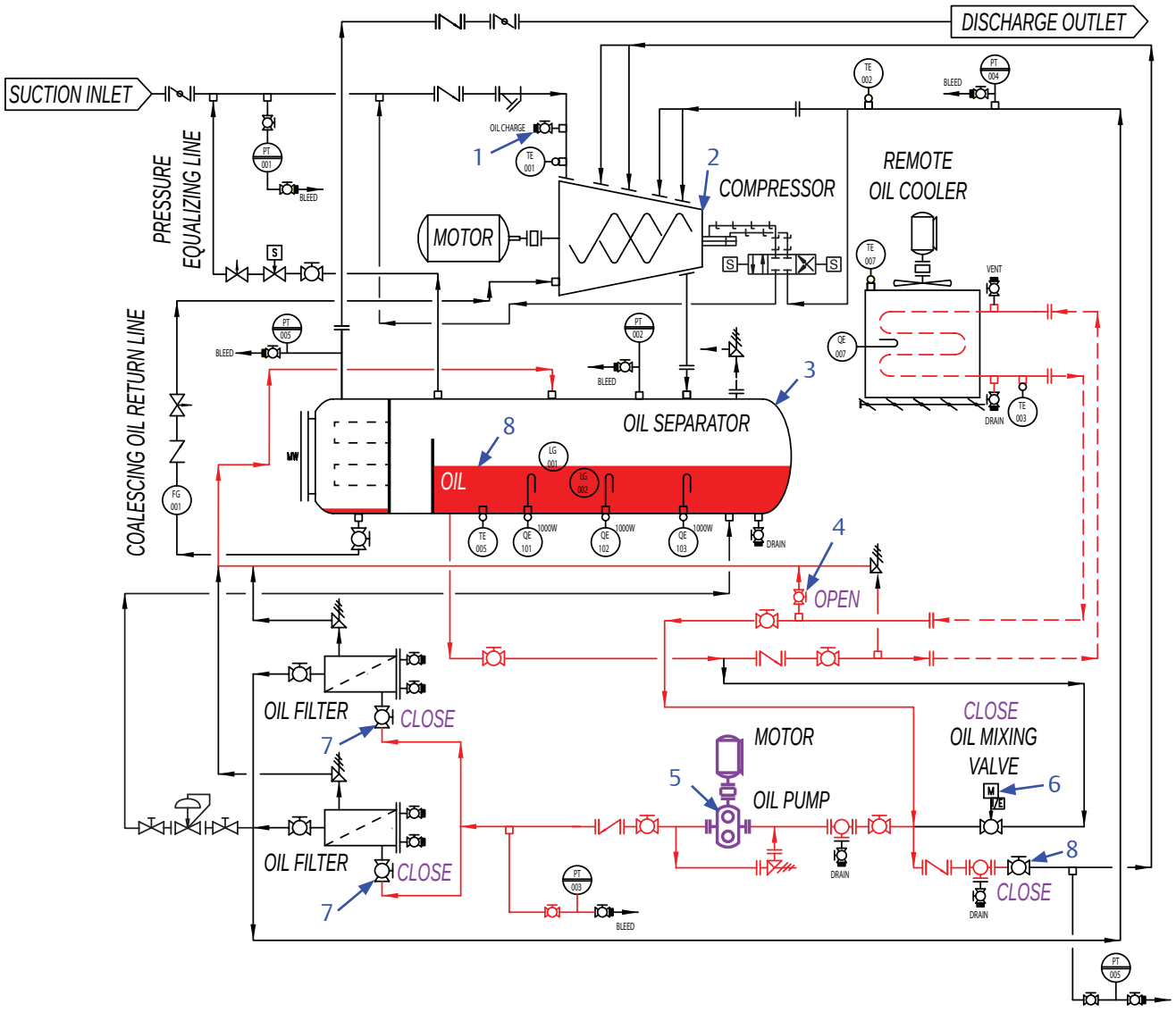


Figure 3-19. Priming Remote Oil Cooler and Piping

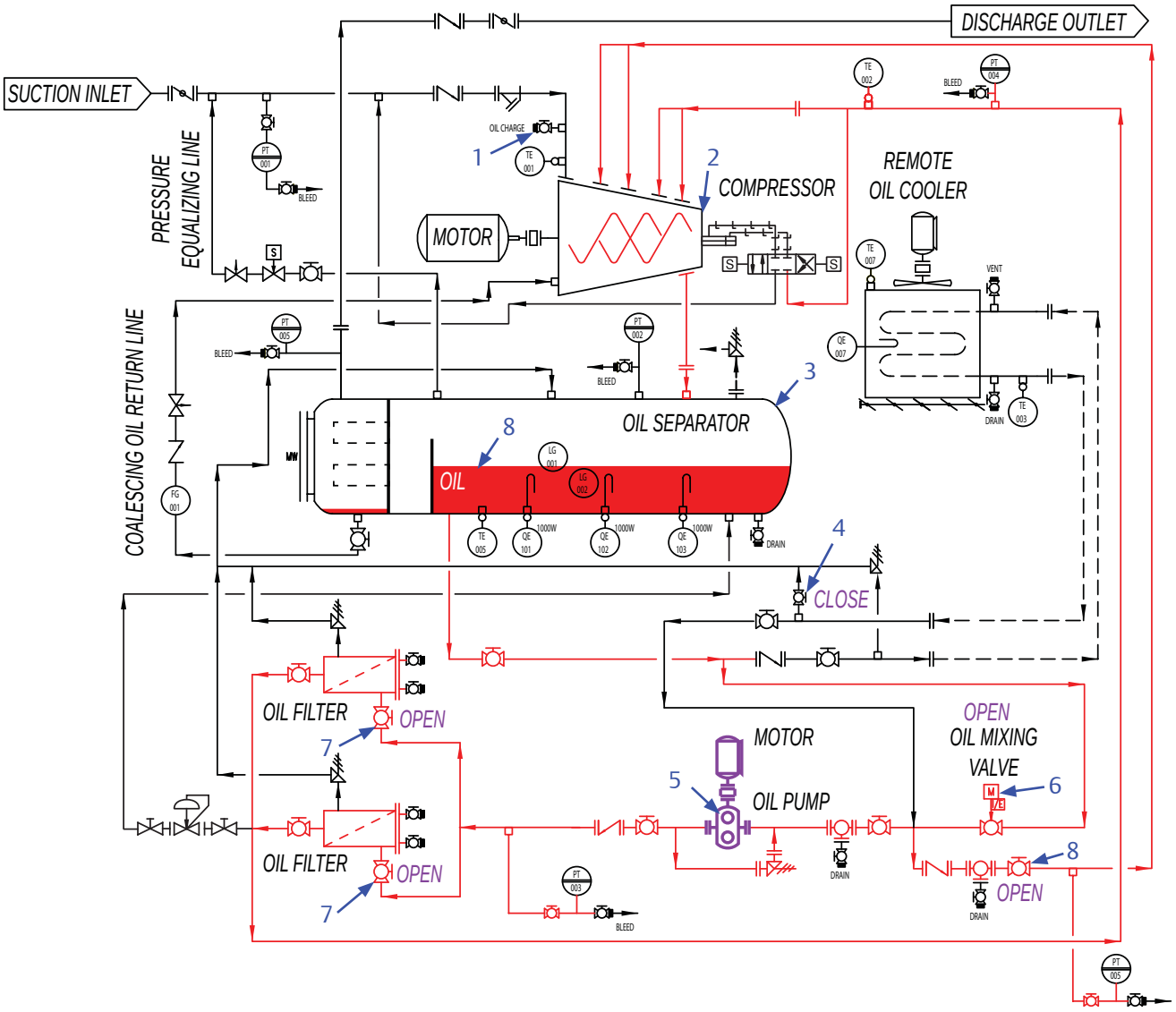


Figure 3-20. Priming Compressor and Oil Filters

Operation

All operation (setpoint adjustments, calibrations, monitoring) of the compressor unit is done through the Compact Logix PLC. For additional information, refer to the VRSG PLC Software Manual (35391CN).

Oil Inspection

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.

Inspect oil level through sight glasses on the oil separator, see Figure 4-1. Oil Operating Levels. Drain or fill oil as required. For oil draining and filling procedures, refer to Section 5.

Dual Oil Filters

On compressor units equipped with dual oil filters, only one filter should be in operation at a time.

NOTE

During operation, both oil filter outlet shut-off valves should be open. This will help minimize the sudden loss of oil pressure when switching between oil filters for servicing.

For further details, refer to Oil Filter Replacement in Section 5.

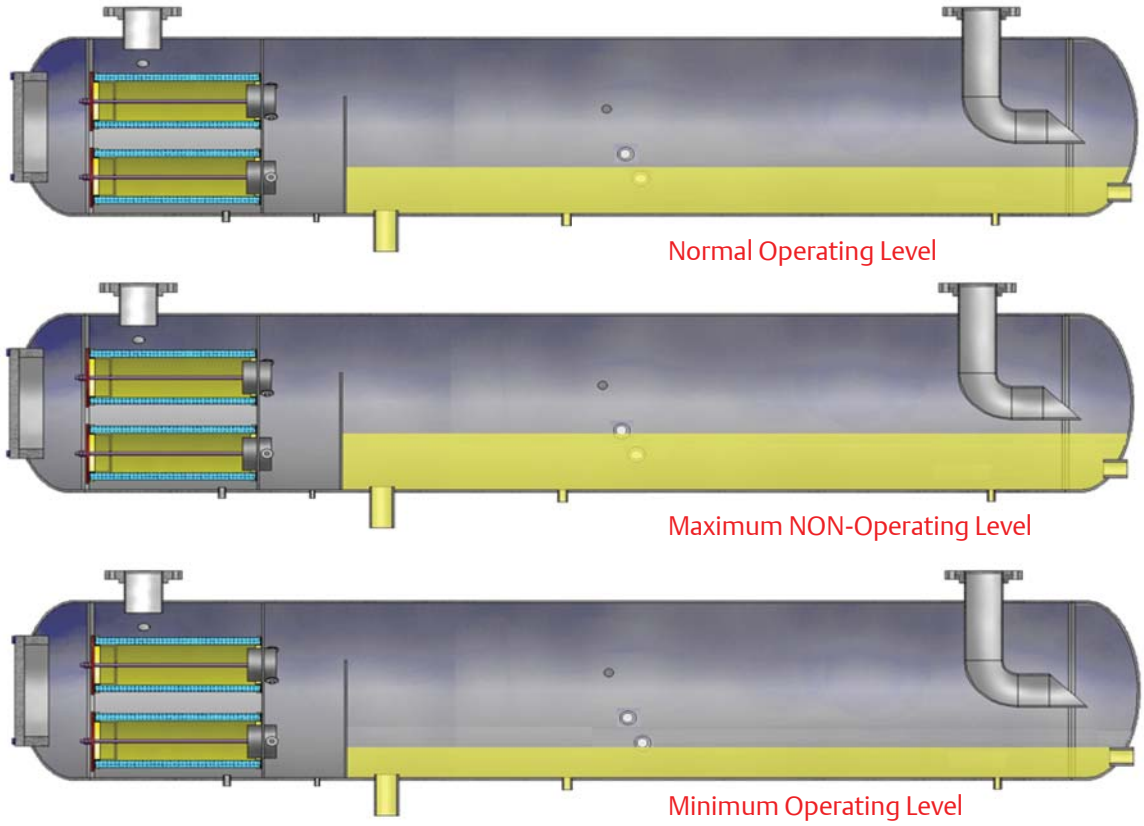


Figure 4-1. Oil Operating Levels

Control System Calibration

Equipped for automatic operation, the screw compressor unit has safety controls to protect it from irregular operating conditions, an automatic starting and stopping sequence, capacity and volume ratio control systems.

Check all pressure controls with a remote pressure source, to assure that all safety and operating control limits operate at the point indicated on the microprocessor.

The unit is equipped with block and bleed valves that are used to recalibrate the pressure transducers. To use the block and bleed valves to recalibrate the pressure transducers, the block valve is shut off at the unit and the pressure is allowed to bleed off by opening the bleed valve near the pressure transducer enclosure. The transducer can then be calibrated at atmospheric pressure (0 psig), or an external pressure source with an accurate gauge may be attached at the bleed valve.

The discharge pressure transducer cannot be isolated from its pressure source, so it is equipped with only a valve to allow an accurate pressure gauge to be attached and the pressure transducer calibrated at unit pressure.

Recheck the transducers periodically for any drift of calibration, refer to maintenance/service interval table in Section 5.

Starting, Stopping and Restarting the Compressor

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 will immediately be driven back to the 5% limit. The oil pump motor will be de-energized when the 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 (see PCL Software Operation Manual), 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, the compressor slide valve must return below the respective 5% limit 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.

Calibrate Slide Valve

For calibration information, refer to the Linear Position Indicator (LPI) calibration information in the Appendices - Howden WRV & WRVi Compressor Range Installation Manual.

Oil Temperature Control Valve (Oil Mixing Valve) Operation

INITIAL POSITION

The temperature control valve is in the closed position when initially installed.

With the temperature control valve de-energized, the valve is set to its initial position. The temperature control valve will be in the closed position with the actuator indicator displaying CLOSED.

When the temperature control valve is energized, the valve will rotate to fully OPEN.

OPERATION

With the compressor not running, when electrically energized, the PLC will turn the temperature control valve to fully open (100%).

When the compressor starts, the valve remains fully open (100%) until the oil injection temperature rises above the control setpoint. When the oil injection temperature rises above the control setpoint, the oil temperature control valve will begin to close. The hot oil from the oil separator begins to divert to the oil cooler, mixing the hot and cooled oil flow streams together downstream of the oil temperature control valve. The valve can fully close (0%) diverting the entire oil flow stream to the oil cooler.

As the oil injection temperature drops below the setpoint, the oil temperature control valve begins to open so that the oil injection temperature does not become too cold.

When the compressor stops, the valve returns to fully open (100%).

FAIL POSITION

- The temperature control valve remains in the last position when power is removed.

SCREEN DISPLAY

- The oil temperature control valve, identified as “OIL MIX” on the main PLC display screen, shows a numerical value with “%” as units. This is to be understood as “% OPEN.” It is a direct indication of the position of the ball valve.

100% OPEN

- Oil flow stream is entirely bypassing the oil cooler.

99% to 1% OPEN

- Oil flow stream is partially bypassing the oil cooler and partially diverted to the oil cooler.

0% OPEN

- Oil flow stream is entirely diverted to the oil cooler.

MANUAL OVERRIDE

The actuator of the oil temperature control valve has a handwheel that can be engaged to override the electrically determined position of the ball valve.

1. Push handwheel down and rotate to engage internal slot with flats, see Figure 4-6.

NOTE

Actuator does not have mechanical stops. Do Not rotate past open or close position. Use visual indicator to position actuator.

2. Once engaged, push down handwheel a second time to disengage gear train and rotate *CLOCKWISE* to *OPEN* or *COUNTER CLOCKWISE* to *CLOSE*.
3. To return actuator to normal operation, first check “% OPEN” on control panel. If value is 100%, return actuator to OPEN position as shown on the visual indicator. If value is 0%, return actuator to CLOSE position as shown on the visual indicator.

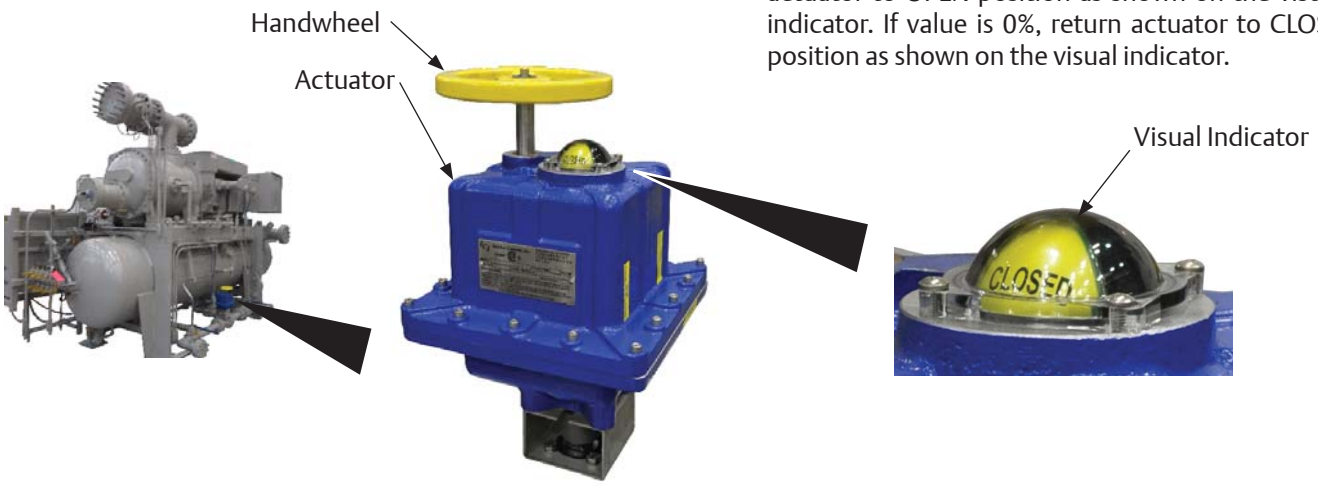


Figure 4-6. Oil Temperature Control Valve (Oil Mixing Valve)

Purging with Dry Nitrogen

Purging is recommended if the compressor will be inactive for 12 hours or more. For additional long term storage information, refer to Long Term Storage Recommendations in Section 3.

PREPARATION

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

When working with pressurized system, always wear safety glasses and/or face shield. Failure to comply may result in serious injury.

1. Press “Stop” button to stop compressor unit, see Figure 4-7.
2. Allow pressure in compressor unit to equalize to suction pressure, see Figure 4-8.
3. Close suction and discharge shut-off valves to isolate the compressor unit from house system. Lockout/tagout valves.
4. Close any other valves that may feed gas or oil to the compressor and oil separator.
5. Slowly open suction oil charging valve to depressurize compressor unit to atmosphere, see Figure 4-9. Keep valve in open position.

NOTE

Plugs are installed on bleed valves. Remove and install plugs prior to and after bleeding. Ensure to keep valves closed when removing and installing plugs.

6. Open discharge bleed valve to allow nitrogen to purge through compressor unit, see Figure 4-8.
7. Refer to PLC main screen for discharge pressure when purging.

PURGE

CAUTION

Do not purge compressor unit with oxygen. Failure to comply may result in damage to equipment.

CAUTION

Do not allow compressor to spin while purging. Regulate purging pressure as needed. Failure to comply may result in damage to equipment.

8. Connect purging hose from nitrogen cylinder to suction oil charging valve.

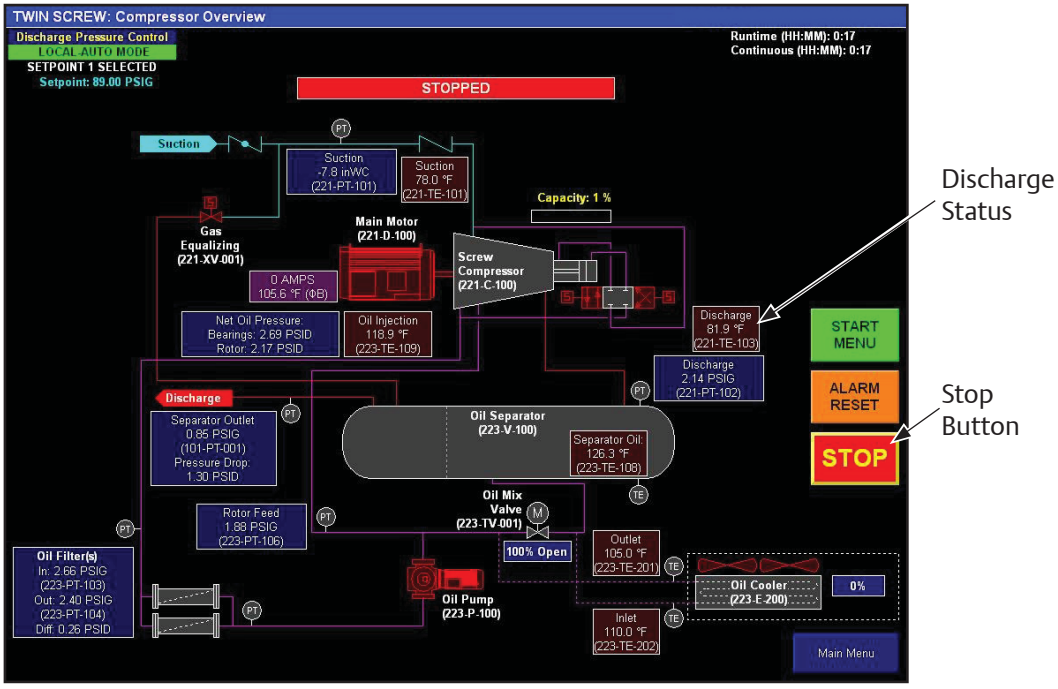


Figure 4-7. PLC Main Screen

NOTE

Purging is performed through the suction oil charging valve so that trapped gas can be pushed out of the compressor. This will help minimize metal surface oxidation of the compressor (due to the gas) while not in service.

9. Purge compressor unit for 10 minutes. Check discharge pressure on PLC main screen to make sure pressure is increasing.
10. Close discharge bleed valve while still purging.
11. Observe discharge pressure through the PLC main screen. Allow pressure to build to approximately 10 psig.
12. Once pressure is reached, stop purging and close suction oil charging valve. If pressure is greater than 10 psig, crack open discharge bleed valve, as needed, to slowly bleed the system to approximately 10 psig.
13. Wait 10 minutes to make sure there are no leaks and that the pressure is holding. If the unit does not hold pressure, check all isolation valves for correct operation; discharge, suction and oil return valves.
14. Remove purging hose from suction oil charging valve.

CAUTION

With a purged system, when getting the compressor unit ready for start-up, it is important to slowly open the suction valve to prevent a sudden rush of gas and oil. Failure to comply may result in damage to equipment.

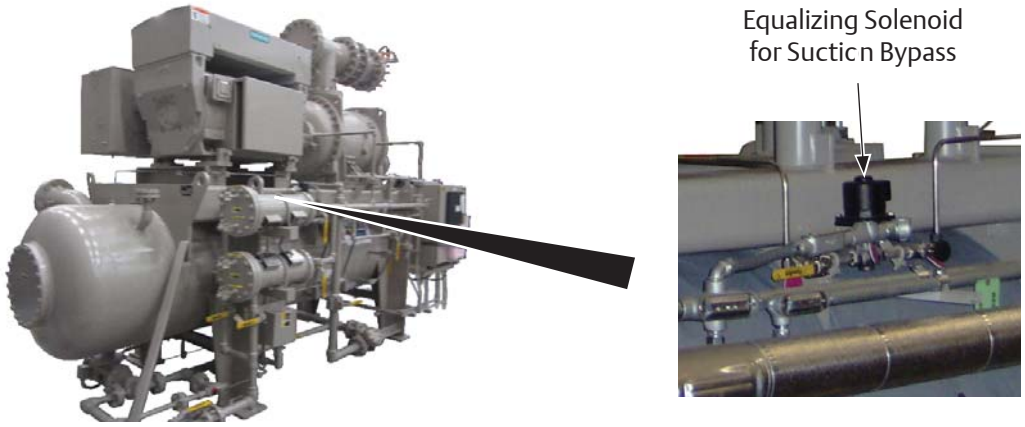


Figure 4-8. Equalizing Solenoid

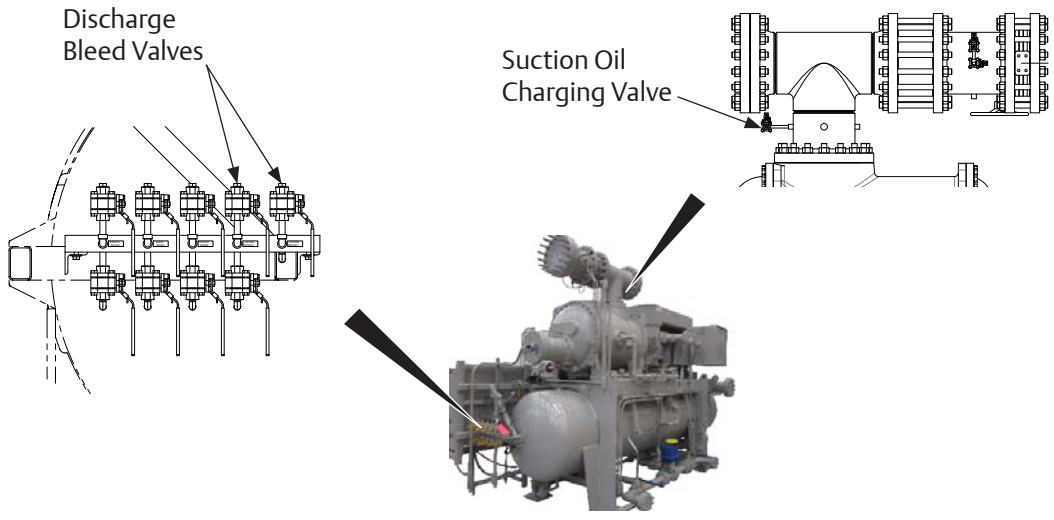


Figure 4-9. Suction Oil Charging Valve and Discharge Bleed Valve

Purging with Dry Gas

Purging is recommended if the compressor will be inactive for 12 hours or more. For additional long term storage information, refer to Long Term Storage Recommendations in Section 3.

PREPARATION

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

When working with pressurized system, always wear safety glasses and/or face shield. Failure to comply may result in serious injury.

NOTICE

To purge the compressor unit using a dry gas (i.e. methane), a purge line must be installed. If there is not enough purge pressure, connect purge line to a lower pressure line or to atmosphere. ***The purge line, associated valves and gauges are not provided from the factory and must be installed by the customer.***

1. Refer to Figure 4-10 for recommended purge line design.
2. Press “Stop” button to stop compressor unit, see Figure 4-11.
3. Allow pressure in compressor unit to equalize to suction pressure, see Figure 4-12.
4. Close suction and discharge shut-off valves to isolate the compressor unit from house system. Lockout/tagout valves.
5. Close any other valves that may feed gas or oil to the compressor and oil separator.

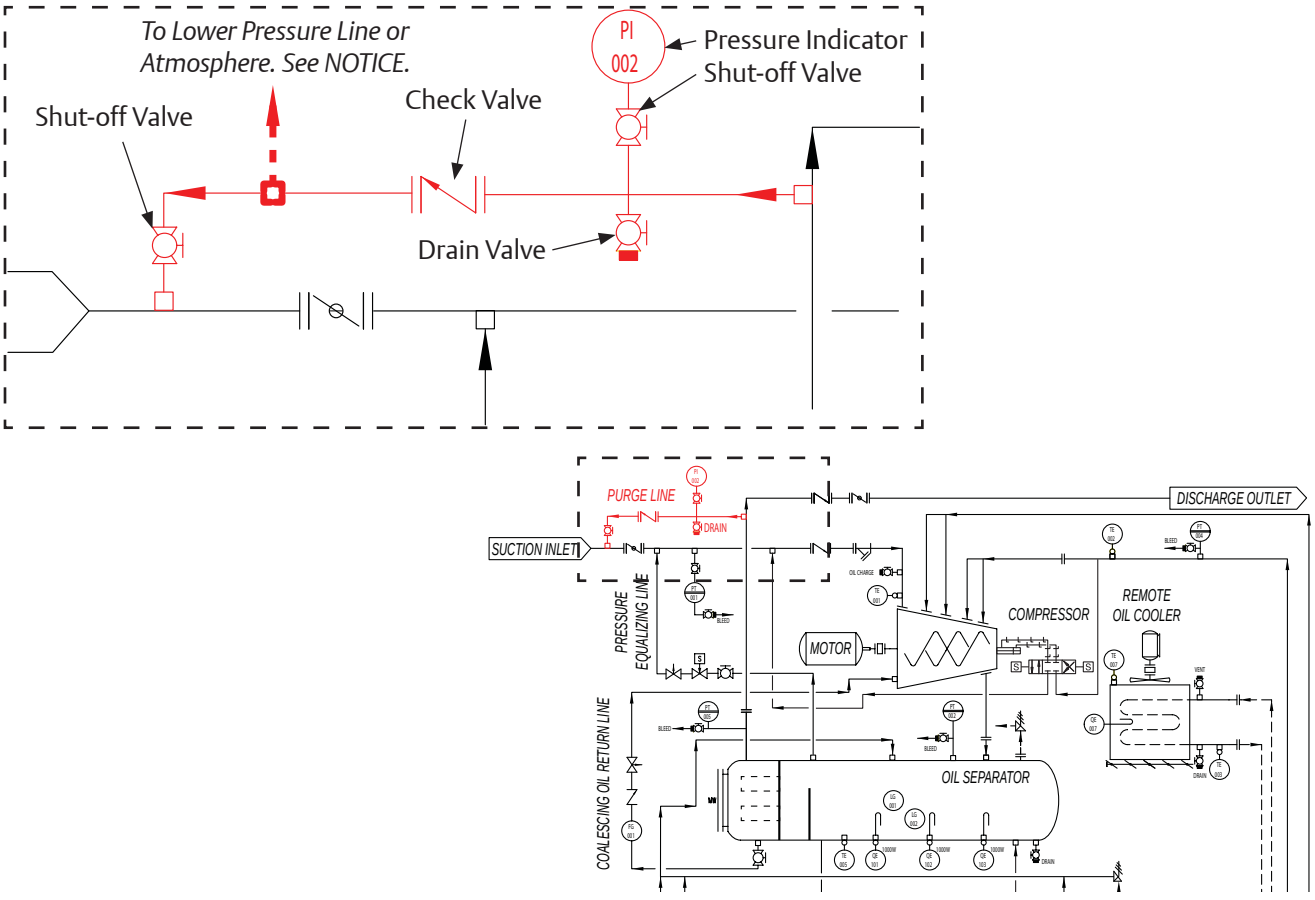


Figure 4-10. Customer Purge Line

NOTE

Plugs are installed on bleed valves. Remove and install plugs prior to and after bleeding. Ensure to keep valves closed when removing and installing plugs.

6. Slowly open suction oil charging valve and bleed remaining pressure in compressor unit to atmosphere, see Figure 4-13. Leave suction oil charging valve in open position.
7. If equipped with pressure indicator on purge line, open shut-off valve to pressure indicator.
8. If not equipped with pressure indicator, refer to PLC main screen for discharge pressure when purging.

PURGE

CAUTION

Do not purge compressor unit with oxygen. Failure to comply may result in damage to equipment.

CAUTION

Do not allow compressor to spin while purging. Regulate purging pressure as needed. Failure to comply may result in damage to equipment.

9. Connect purging hose from gas cylinder to suction oil charging valve.

NOTE

Purging is performed through the suction oil charging valve so that trapped gas can be pushed out of the compressor. This will help minimize metal surface oxidation of the compressor (due to the gas) while not in service.

10. Purge compressor unit for 10 minutes. Check pressure indicator or discharge status on PLC main screen to make sure pressure is increasing.
11. Close shut-off valve on purge line while still purging.
12. Observe discharge pressure of compressor unit through the PLC main screen.
13. Allow pressure to build to approximately 10 psig in the compressor unit.
14. Once pressure is reached, stop purging and close suction oil charging valve.
15. Wait 10 minutes to make sure there are no leaks and that the pressure is holding. If the unit does not hold pressure, check all isolation valves for correct operation; discharge, suction and oil return valves.
16. Remove purging hose from suction oil charging valve.

CAUTION

With a purged system, when getting the compressor unit ready for start-up, it is important to slowly open the suction valve to prevent a sudden rush of gas and oil. Failure to comply may result in damage to equipment.

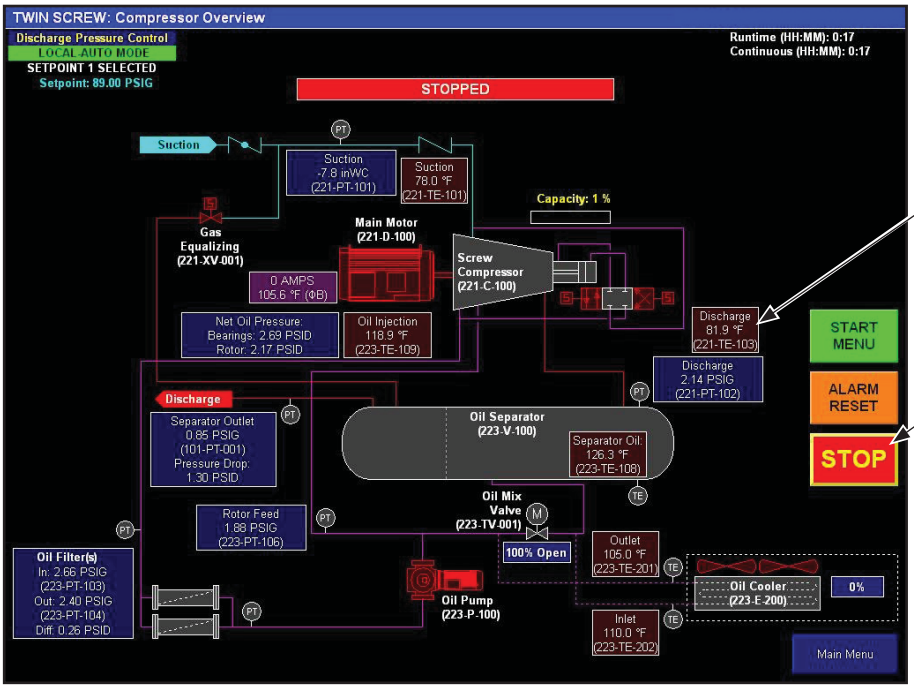


Figure 4-11. PLC Main Screen

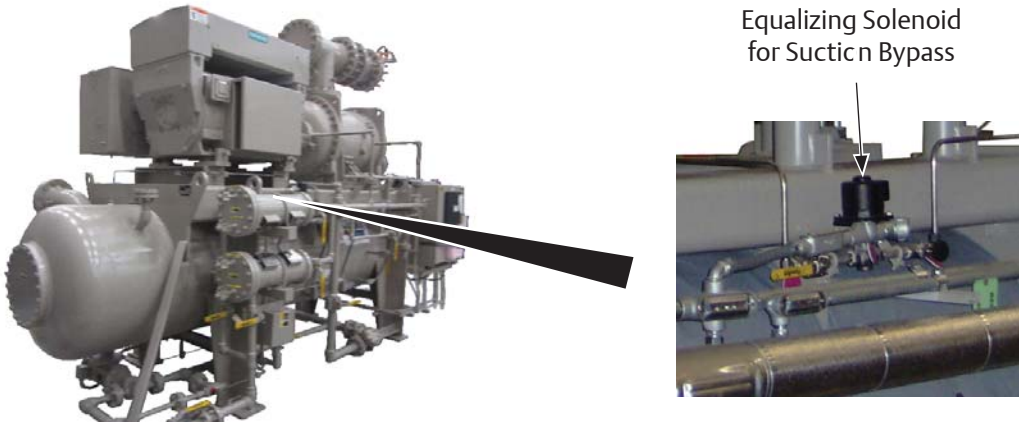


Figure 4-12. Equalizing Solenoid

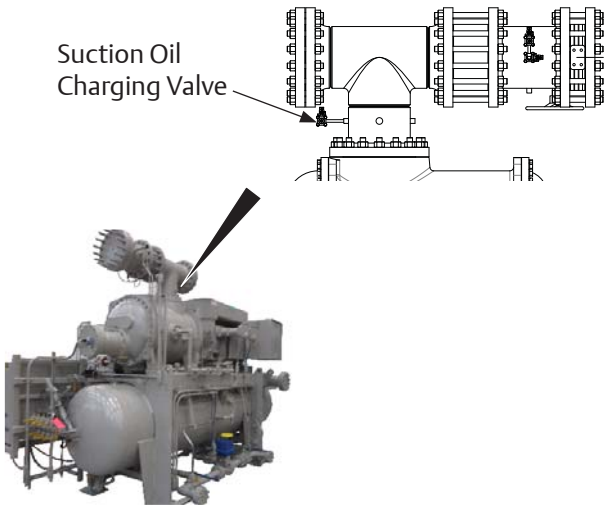


Figure 4-13. Suction Oil Charging Valve

Coalescing Oil Return Line Setup

Over time, oil will accumulate on the coalescing side of the oil separator. As a result, an oil return line with a shut-off valve, sight-glass, check valve and needle valve are installed between the coalescing side and compressor to return this oil back to the compressor.

To adjust the return flow, proceed with the follow procedure:

NOTE

Do not fully open the needle valve unless directed by Vilter Customer Service. Leaving the needle valve fully open will reduce efficiency of the compressor unit.

1. Open shut-off valve on coalescing side of oil separator, see Figure 4-14.
2. While the unit is in operation, crack open needle valve and observe oil flow through sight-glass.
3. Slowly open needle valve more until a small amount of oil is seen in the sight-glass.

NOTE

The sight-glass should never be full with oil.

4. Periodically check oil in the sight-glass and ensure that there is flow.

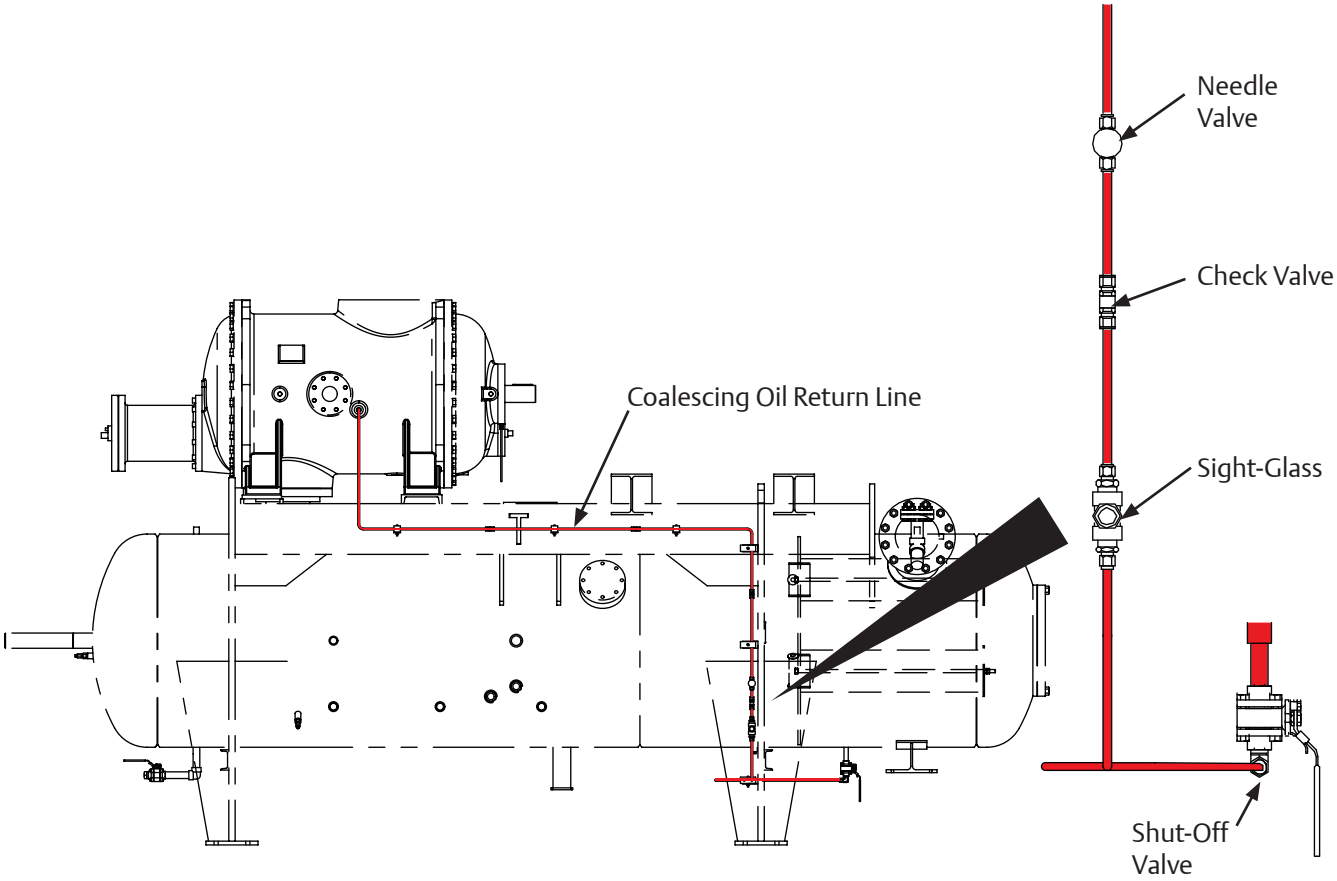


Figure 4-14. Coalescing Oil Return Line

Back Pressure Relief Regulator Operation

The back pressure relief regulator is used to control upstream oil pressure.

The back pressure relief regulator should be adjusted to 35 psi over the discharge pressure.

For additional setup instructions, refer to Appendices.

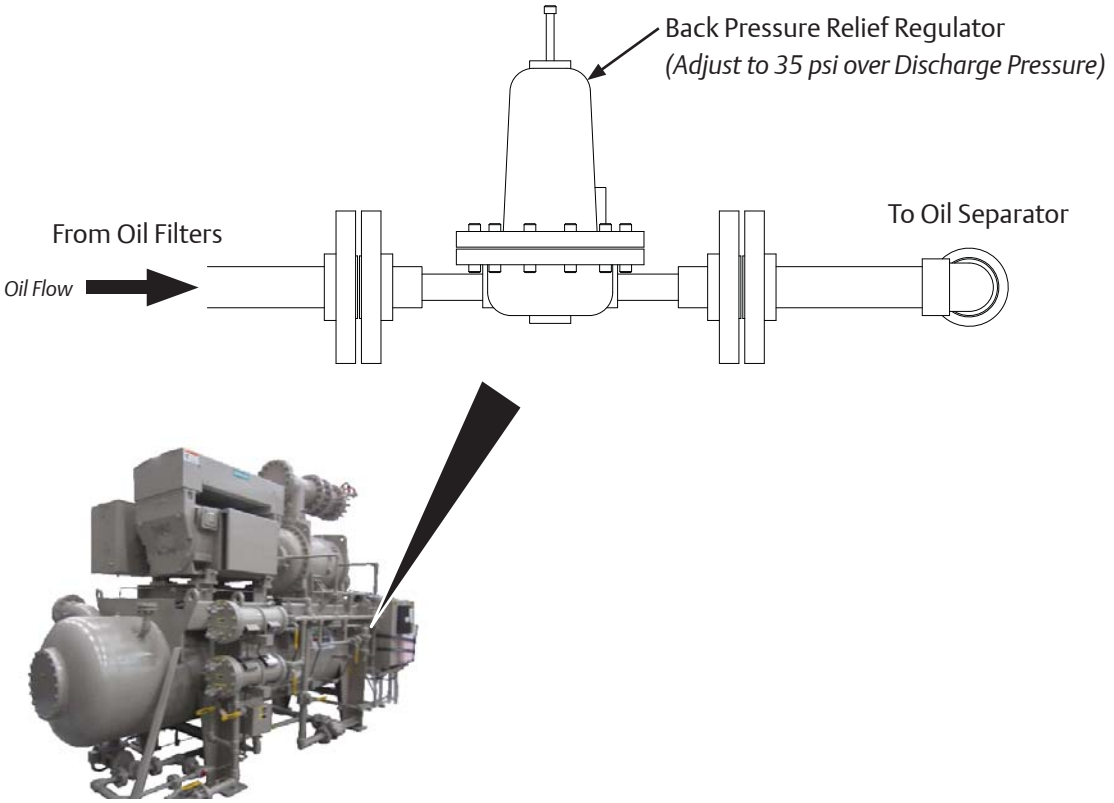


Figure 4-15. Back Pressure Relief Regulator

Maintenance and Service Schedule

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

Table 5-1. Maintenance/Service Schedule

Group	Inspection/ Maintenance (2)	Service Interval (Hours) (1) (Based on dry clean gas)													
		200	2,500	5,000	10,000	15,000	20,000	25,000	30,000	35,000	40,000	45,000	50,000	55,000	60,000
Oil Circuit	Oil Change	Replace oil based on oil analysis report or visual contamination.													
	Oil Analysis	Oil sampling is recommended every 2 to 3 months for the first year. Thereafter, as required, increase sampling time period if contamination of oil is unlikely or decrease sampling time period if contamination of oil is evident. Take an oil sample any time during operation If there's reason to believe that the oil is contaminated. For additional information on oil, refer to Oil and Oil Flow operation.													
	Oil Filters (3)	-	-	-	-	R	-	-	R	-	-	R	-	-	R
	Oil Strainer	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Compressor Unit	Coalescing Filter (4)	-	-	-	-	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
	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.													
	Vibration Analysis	Vibration analysis is recommended to be performed at least once per year.													
Control Calibration	Transducers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	RTDs	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Capacity Slide Valve	Slide valve calibration should be inspected monthly. Inspections can be performed through the control panel.													
Compressor (5) (6)	Compressor	-	I	-	I	-	I	-	I	-	I	-	I	-	I
	Bearings (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	I

I = Inspect S = Sampling R = Replace

(1) Vilter recommends that a Preventative Maintenance Program be developed by Vilter GC (Gas Compression) Service Center.
(2) Daily records should be kept on suction, discharge, oil pressures & temperatures, along with ensuring Temp Leaving Oil Separator is above Dew Point.
(3) Replace oil filters when pressure drop reaches 7 PSID (maximum allowable pressure drop is 15 PSID).
(4) Replace coalescing filters when pressure drop reaches 7 PSID.
(5) The life of the compressor will be increased by purging the compressor unit with dry nitrogen or sweet, dry natural gas at shutdown.
(6) Header drains should periodically be drained for liquid build-up to prevent compressor damage, see Piping in Section 3.
(7) Refer to Howden WRV & WRVi Range Compressor Installation Manual.

Maintaining Proper Operation

To ensure proper operation, the following items should be checked:

- Calibrate all transducer and RTDs.
- Check capacity and volume actuator calibration.
- Check fuses in the PLC panel.
- Check for loose wiring connections in the PLC panel.
- Check relay and contact operation for relays in the PLC panel.
- Verify the operation of the suction and discharge check valves.
- Check for correct rotation of all motors on the package (compressor, oil pump, and fan motors).
- Check that the piping to the oil cooler is correct.
- Check setup of soft starts and VFDs.
- Verify set points in the PLC.
- Check oil heater operation.
- Verify oil line check valve is installed for correct flow .
- Check for loose bolts on the compressor unit. Tighten any loose bolts.

Compressor Unit Isolation for Maintenance/Service

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.

WARNING

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

WARNING

Follow local lockout/tagout procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

NOTICE

Recover or transfer all gas vapor in accordance with local ordinances before opening compressor 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.

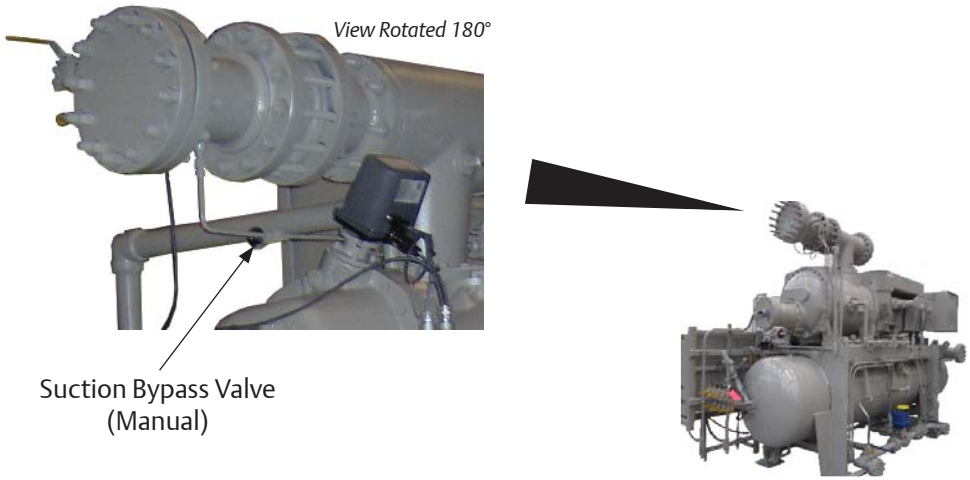


Figure 5-1. Suction By-Pass Valve Location (Manual) (1 of 2)

2. If equipped with equalizing solenoid to control suction by-pass, allow solenoid to remain open until pressures equalize, see Figure 5-1 (2 of 2).
3. Turn motor and oil pump starter disconnect switches into the OFF position. Lockout/tagout disconnect switches.
4. If equipped with manual suction by-pass valve and it is not open, open suction by-pass valve to allow oil separator pressure to vent to low-side system pressure, see Figure 5-1 (1 of 2). Close suction by-pass valve when complete.
5. Isolate the compressor unit by closing all valves to the house system. Lockout/tagout 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.

6. Open any other valves that may trap liquid. Lockout/tagout valves.
7. Recover or transfer all gas vapors.
8. Open discharge pressure bleed valve at block and bleed assembly and allow remaining pressure in oil separator to equalize to atmospheric pressure.
9. Servicing the compressor unit can proceed at this point. After servicing, ensure to perform a leak check, see Compressor Unit Leak Check procedure.

Compressor Unit Leak Check

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. Typically, no evacuation is required for open loop systems. If evacuation is required, evacuate from suction oil charging port. Otherwise, bleed nitrogen to atmosphere.
7. Close all valves previously opened in the system. Open suction and discharge shut-off valves. Remove tags as per local lockout/tagout procedure.
8. Turn motor and oil pump disconnect switches to the ON position.
9. The compressor unit can now be started, refer to Start-Up procedure in Section 4.

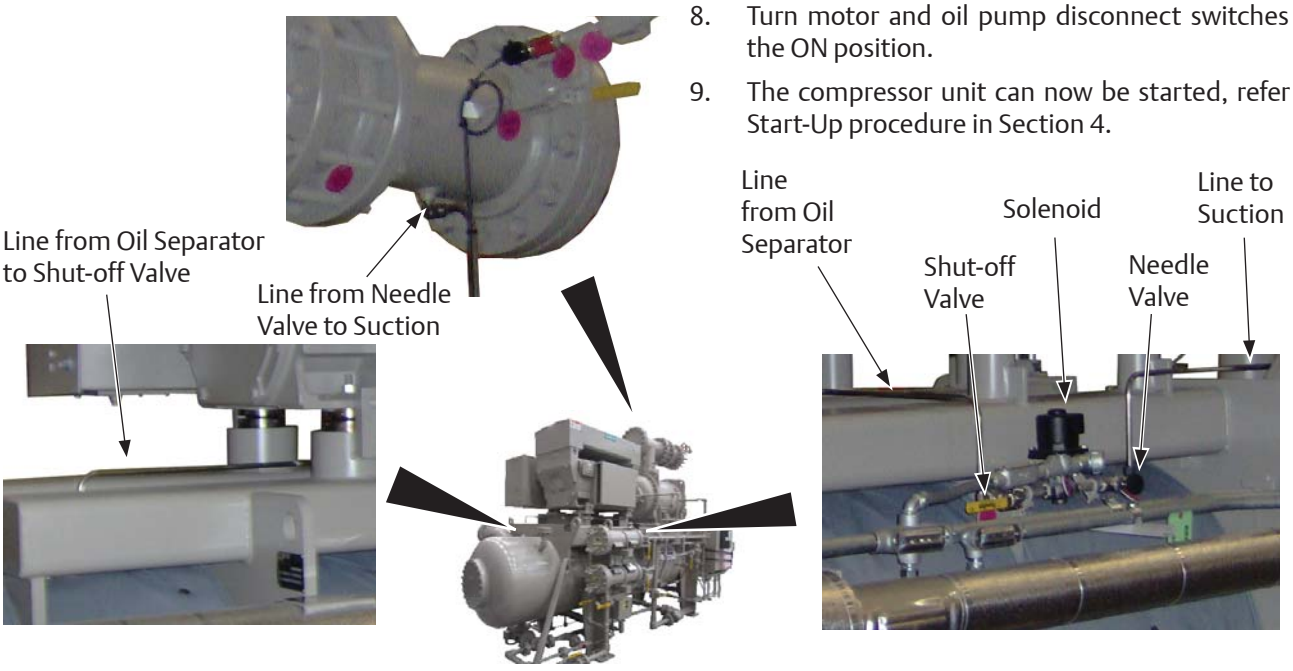


Figure 5-1. Suction By-Pass Valve Location (Equalizing Solenoid) (2 of 2)

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

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.

Use Vilter Oil Analysis Kit (VPN 3097A) to collect an oil sample for analysis. For an example, see Figure 5-2. Fill out label for bottle. Place in mailing tube and seal with the preaddressed mailing label. Below are a few points to remember when taking a sample:

- Sample running compressor units, not cold units.
- Sample upstream of the oil filter.
- Create specific written procedures for sampling.
- 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 immediately to the oil analysis lab after sampling, do not wait 24 hours.

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
- Contaminate/additive metals

Figure 5-2. Oil Analysis Kit

Oil Charging

WARNING

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

CAUTION

Do not add oil to the coalescent side of the oil separator. Failure to comply may result in damage to equipment.

Normal oil level operating range must be maintained for optimum performance and to prevent damage to equipment. See Figure 4-1. for normal operating levels. There are a couple of ways to maintain oil, while the compressor unit is in operation and during shutdown.

Tool Required:

- Oil Pump, Maximum 2-3 GPM with Motor approved for Division 1 or Division 2 and with ability to overcome suction pressure.

Charging During Operation:

During operation, if the oil level is low, add oil to the operating compressor through the suction oil charging valve, see Figure 5-3. Pump oil into the compressor until the oil level reaches the normal operating level. Watch this level carefully to maintain proper operation. Never allow the oil to reach a level higher than the Maximum Operating Level, since this may impair the operation and efficiency.

1. Using a properly selected oil pump, connect oil pump to suction oil charging valve, see Figure 5-3.
2. Open suction oil charging valve and fill oil separator to Normal Operating Level.
3. Once the Normal Operating Level has been reached, shut off the oil pump and close the valve. Disconnect and remove oil pump.

Charging During Shutdown:

During shutdown, if oil is to be added, charging can be performed through the drain valve located underneath the oil separator, see Figure 5-3. During shutdown, oil can be added to the Maximum Non-Operating Level. For shutdown procedure, see Compressor Unit Isolation procedure.

1. Using a properly selected oil pump, connect oil pump to oil separator drain valve.
2. Open oil separator drain valve and fill oil separator to Maximum NON-Operating Level.
3. Once Maximum NON-Operating Level has been reached, shut off oil pump, close oil separator drain valve and remove oil pump.

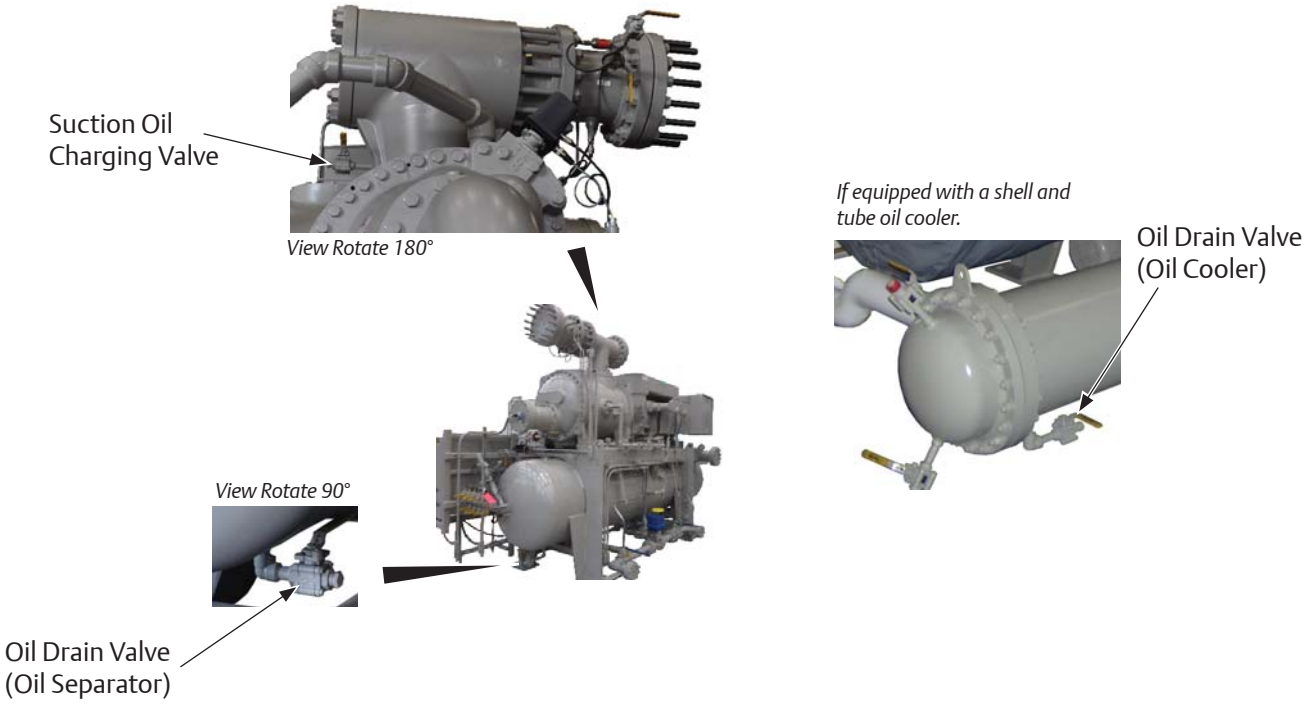


Figure 5-3. Suction Oil Charging Valve, Oil Cooler Drain Valve and Oil Separator Drain Valve

Oil Draining

WARNING

Do not drain oil from drain valve while the compressor unit is running. Shutdown the unit and allow pressures to equalize to suction pressure prior to draining. Failure to comply may result in serious injury.

The compressor unit must be shut down prior to draining due to high pressures in the oil system, see Compressor Unit Isolation procedure.

Draining can be performed through the drain valve located underneath the oil separator, see Figure 5-3. If the compressor unit is equipped with a shell and tube oil cooler, a drain valve is also provided underneath the shell and tube oil cooler.

Draining of the remote oil cooler can be performed at the remote oil cooler drain valves. If equipped with lower level drains on the supply and return lines, these too can be utilized for draining. For additional information, see Recommended Remote Air Cooled Oil Cooler Piping in Appendices.

Oil Filter Replacement

WARNING

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

Change the oil filter as outlined in the Maintenance and Service Interval, see Table 5-1. Maintenance & Service Interval.

NOTE

Ensure to check the oil pressure drop and record it daily.

If the compressor unit is equipped with only a single oil filter, the compressor unit must be shut down prior to servicing, see Stopping/Restarting procedure in Section 4.

If the compressor unit is equipped with dual oil filters, then one oil filter can be isolated and serviced one at a time during operation. Each oil filter can have single or dual oil filter elements depending on the size of compressor used, see Table 5-2 and Figure 5-4.

Table 5-2. Oil Filter Elements and Compressor Models

Oil Filter Element Qty.	VSG/VSSG Models
Single Element	301 - 701
Dual Elements	751 - 3001

To replace an oil filter element, continue with the following steps:

Parts Required:

- Oil Filter Element (VPN 1833G)

REMOVAL

NOTE

Both outlet shut-off valves should be open. If the outlet valve is closed for the oil filter that is not in operation, slowly open the outlet shut-off valve until fully open. This will help reduce a sudden pressure drop when switching oil filters for servicing.

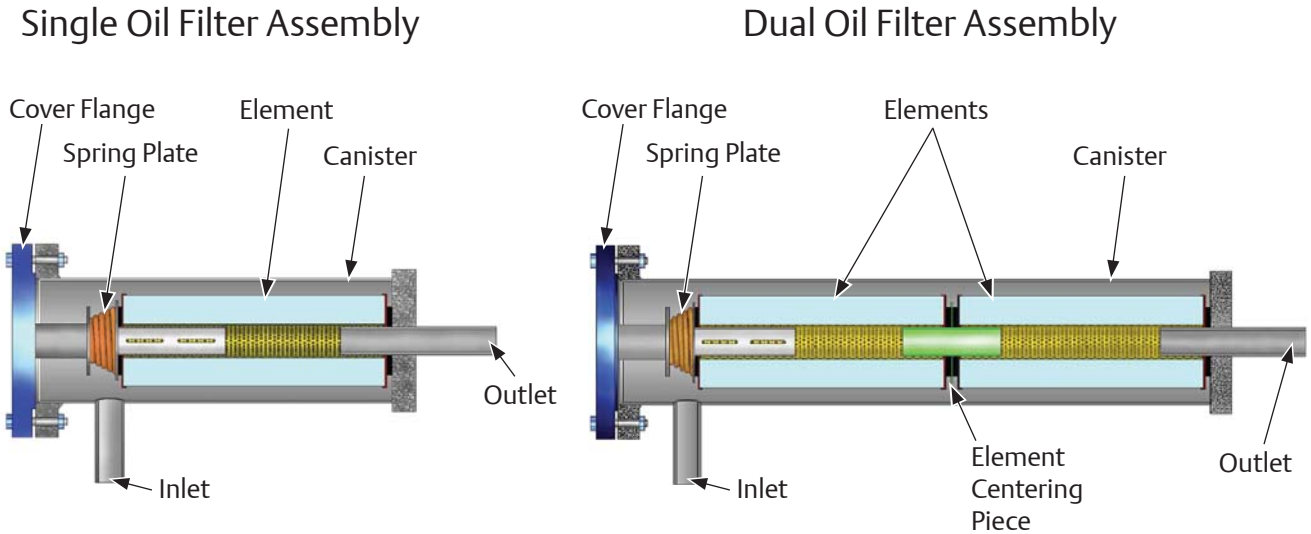


Figure 5-4. Oil Filter Assemblies (Single and Dual)

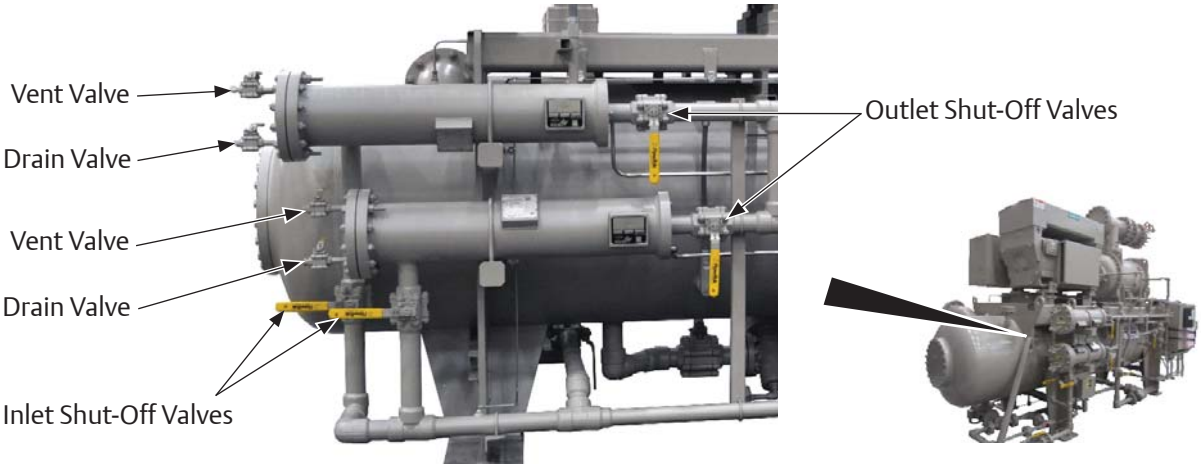


Figure 5-5. Oil Filter Drain, Vent and Shut-Off Valves

1. If equipped with dual oil filters, open inlet shut-off valve for non-operating oil filter to put it into operation, see Figure 5-5.
2. To isolate oil filter for servicing, close inlet and outlet shut-off valves for the oil filter.

NOTE

To reduce unwanted oil splash from a vent or drain valve, connect a hose to the valve port and direct the gas and oil into a drain pan.

3. Slowly release pressure in the oil filter canister by opening the vent valve. Allow pressures to equalize to atmosphere.

NOTICE

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

4. Using an drain pan, open drain valve and allow the oil to completely drain from the oil filter canister.

NOTE

Note orientation of components to aid in installation.

5. Remove bolts and nuts securing cover flange to the oil filter canister. Remove cover flange and spring plate. Retain spring plate.
6. If equipped with a single oil filter element, remove filter element from oil filter canister.
7. If equipped with dual oil filter elements, remove two filter elements and filter element centering piece from oil filter canister. Retain filter element centering piece.
8. Thoroughly clean the oil filter canister, spring plate and centering piece. Inspect spring plate and centering piece, if damaged, replace as required.

INSTALLATION

NOTE

Ensure oil filter element on the outlet side is fully seated on the outlet pipe when installed.

9. If equipped with single oil filter element, install oil filter element in canister in orientation noted during removal.
10. If equipped with dual oil filter elements, install two oil filter elements and centering piece in orientation noted during removal.
11. Position spring plate in orientation noted during removal and install bolts and nuts to secure cover flange to oil filter canister.
12. Tighten nuts, see Appendix A.
13. Using dry nitrogen gas, pressurize oil filter canister through vent valve and check for leaks.
14. Close the vent valve and drain valve.
15. Open outlet shut-off valve for the oil filter that is not in operation.
16. Repeat for second oil filter, as required.

Coalescing Filter Replacement

WARNING

Use appropriate lifting devices and additional personnel when lifting heavy components. Ensure lifting devices are capable of lifting the weight of the component. Use lifting points (i.e. bolt holes designated for lifting eye bolts) that are provided on the component. Failure to comply may result in serious injury.

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.

NOTE

For coalescing filters (11-7/8 in. O.D.), a tubing (3/4 in. O.D. x 6 ft. long) can be used to aid in removal and installation of the filter.

Change the oil filter as outlined in the Maintenance and Service Interval, see Table 5-1. Maintenance & Service Interval.

REMOVAL

1. Isolate the compressor unit, see Compressor Unit Isolation procedure.
2. If required, install lifting eyes on oil separator manhole cover, see Figure 5-6.
3. Secure appropriate lifting device to oil separator manhole cover.
4. Remove all bolts except top four bolts securing oil separator manhole cover to oil separator vessel.
5. Adjust lifting device as needed to hold weight of oil separator manhole cover.
6. Remove remaining four bolts and oil separator manhole cover from oil separator vessel.
7. Remove nuts, flat washer and filter cover plate securing coalescing oil filter to hold-down rod.
8. With assistance of second person, remove coalescing filter from oil separator vessel.
9. Repeat steps 7 and 8 to remove additional coalescing filters, as required.

INSTALLATION

10. Install tubing over hold-down rod. Position tubing as far back as possible.
11. With assistance of second person, position

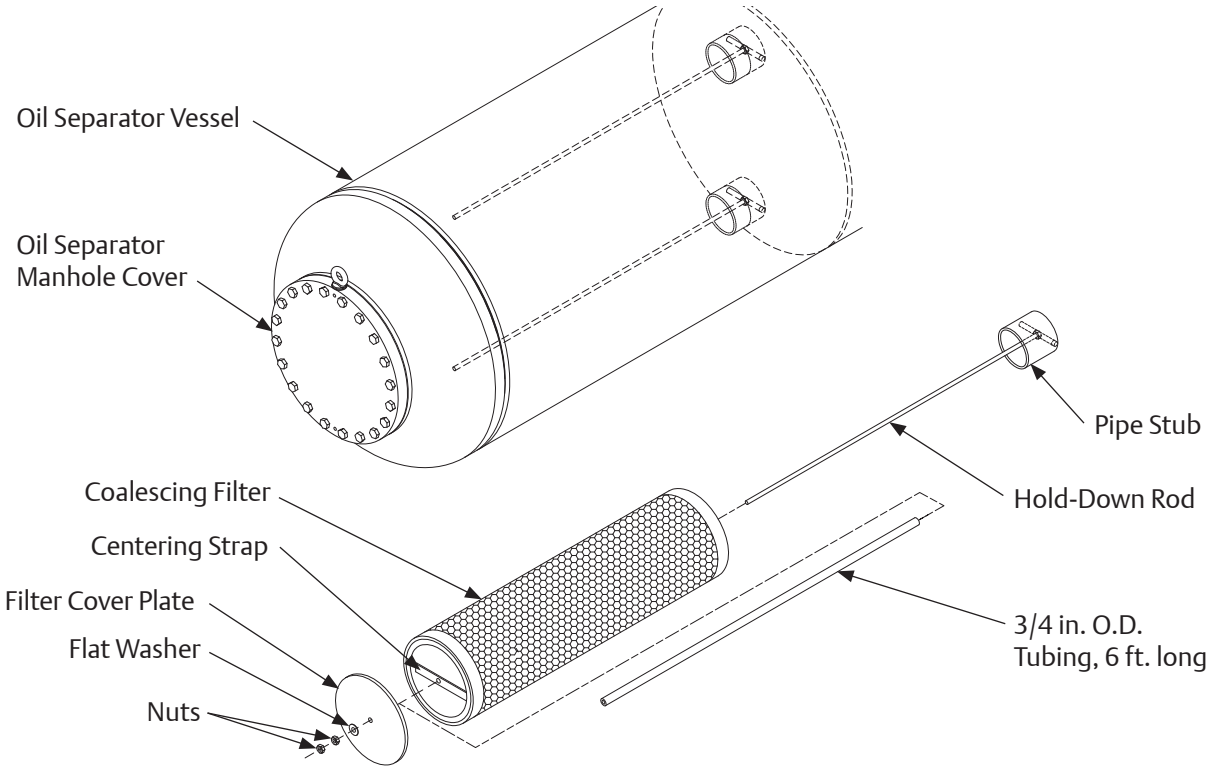


Figure 5-6. Oil Separator Manhole Cover and Coalescing Filter Assembly

coalescing filter over tubing and through hole of centering strap.

12. Push coalescing filter into vessel until fully seated on pipe stub.
13. Remove tubing.
14. Position filter cover plate and flat washer on hold-down rod on end of the coalescing filter.
15. Install nut to secure flat washer and cover plate to coalescing filter. Tighten nut to 25 ft-lbs.
16. Install second nut to prevent first nut from moving.
17. Repeat steps 10 to 16 for installing additional coalescing filters.
18. Position oil separator manhole cover on oil separator vessel.
19. Install bolts to secure oil separator manhole cover to oil separator vessel.
20. Tighten bolts, see Appendix A.
21. Perform Compressor Unit Leak Check procedure.

Oil Pump Strainer

To clean the oil pump strainer, proceed with the following steps.

NOTICE

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

WARNING

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

WARNING

Follow local lockout/tagout procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

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.

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. Isolate strainer by closing shut-off valves located before and after strainer.

NOTE

Depending on where the strainer is located, the oil outlet and inlet valves to the oil cooler, the oil mixing valve and oil supply valve from the oil separator may need to be closed.

4. Position drain pan under drain valve.
5. Open strainer drain valve and allow oil to completely drain, see Figure 5-7.
6. Remove bolts securing strainer cover to strainer. Remove strainer cover, gasket and screen. Retain screen. Discard gasket.
7. Wash screen in solvent and blow it with clean air.
8. Inspect screen for damage, replace as required.
9. Clean strainer cavity with clean lint-free cloth.
10. Install in reverse order of removal. For torque specifications, see Appendix A.
11. Close strainer drain valve.
12. Repeat steps for second strainer, if equipped.
13. Open shut-off valves.
14. Check replaced components for leaks.
15. Turn disconnect switches to the ON position for the compressor unit and oil pump motor starter, if equipped. The compressor may be started.

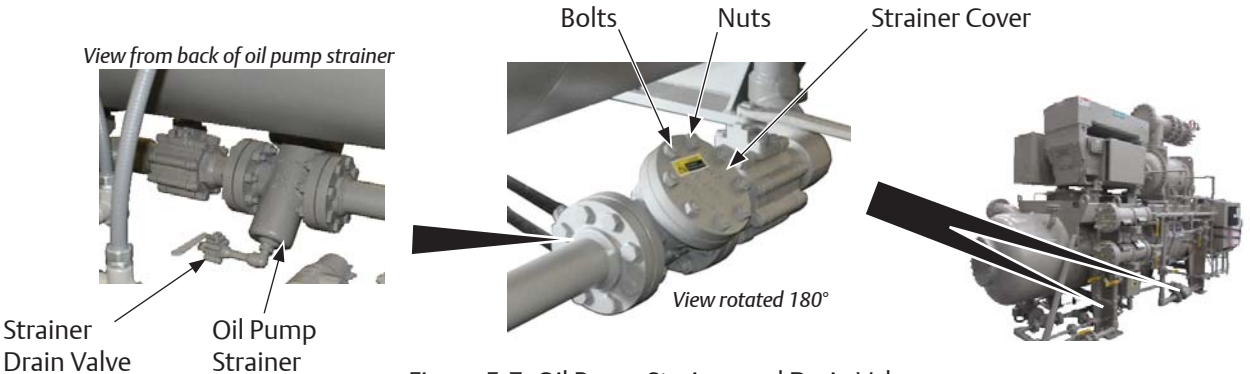


Figure 5-7. Oil Pump Strainer and Drain Valve

Drive Coupling (Form-Flex BPU) Hub Installation

On all single screw units, the coupling assembly is shipped loose and will have to be installed and aligned on site. This is to allow a check of proper electrical phasing and direction of motor rotation. The motor and compressor have been aligned from the factory with the coupling hubs already installed. Using a dial indicator for aligning is recommended.

NOTE

Drive coupling type and size can be determined by the information on the compressor nameplate when ordering; Order Number and Compressor Model Number.

To install the coupling, proceed with the following steps:

WARNING

Follow local lockout/tagout procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

1. Ensure disconnect switches are in the OFF position for the compressor unit and oil pump motor starter, if equipped.
2. If hubs are already installed on motor shaft and compressor shaft, proceed to Drive Center Member Installation and Alignment procedure.
3. If coupling assembly is already assembled, the lock nuts are not torqued. Remove lock nuts and bolts securing hubs to disc packs. Remove both hubs. Leave the disc packs attached to center member.
4. Clean hub bores and shafts. Remove any nicks or burrs. If bore is tapered, check for good contact pattern. If bore is straight, measure bore and shaft diameters to ensure proper fitment. The keys should have a snug side-to-side fit in the keyway with a small clearance over the top.

NOTE

If hub position on shaft does not allow enough room to install bolts, install bolts and disc pack before mounting hub on shaft.

Hubs come in two different types, straight bore and tapered bore. Tapered bore hubs have additional hardware. Typically, a compressor will have a tapered shaft and therefore use a tapered bore hub.

STRAIGHT BORE HUBS

5. For straight bore hubs, install key in keyway of shaft.
6. Install hub on shaft. If installing straight bore hubs on motor and compressor shafts, allow 1/16” gap between the outer face of the hub to the outer face of the shaft for both hub installation. This will allow some play when installing the spacer. If installing a straight bore hub and a taper bore hub, allow a 1/8” gap between the outer face of the straight bore hub to the outer face of the straight shaft, see Table 5-3.
7. Install clamping bolts in hub.
8. Tighten clamping bolts, see Table 5-4.
9. Install set screw in hub to secure key.
10. Tighten set screw, see Table 5-4. Repeat steps for second straight bore hub.

TAPERED BORE HUBS

11. For taper bore hubs, install key in keyway of shaft.
12. Install hub on shaft.
13. If lock washers are being used, install hub cap, lock washers and bolt on shaft.
14. If locking tab is being used, install hub cap, locking tab and bolt on shaft.
15. Tighten bolt and draw hub up shaft to a stop.

Table 5-3. Shaft and Hub Distances

Coupling Size	Shaft Gap for Tapered Compressor & Straight Motor Shaft Combination	Shaft Gap for Straight Compressor & Straight Motor Shaft Combination	Distance Between Hub Faces
BP38U	6.25” (158.75 mm)	5.125” (130.18 mm)	5.00” (127 mm)
BP41U			
BP47U			
BP54U			
BP54U			
BP56U			

16. If locking tab is being used, bend locking tabs in gap towards shaft and around bolt.
17. Install set screw in hub cap to secure key in keyway of shaft.

Drive Center Member Installation and Alignment

NOTE

Always adjust motor to the compressor. The compressor is aligned to the frame.

18. Adjust motor position as needed to obtain a distance of 5" between both hub faces.
19. Soft Foot. The motor must sit flat on its base (+/- 0.002"). Any soft foot must be corrected prior to center member installation.

NOTE

If the driver or driven equipment alignment specification is tighter than these recommendations, the specification should be used. Also, be sure to compensate for thermal movement in the equipment. The coupling is capable of approximately four time the above shaft alignment tolerances. However, close alignment at installation will provide longer service with smoother operation.

The flex disc pack is designed to an optimal thickness and is not to be used for axial adjustments.

20. *Axial Spacing*. The axial spacing of the shafts should be positioned so that the flex disc packs are flat when the equipment is running under normal operating conditions. This means there is a minimal amount of waviness in the flex disc pack when viewed from the side. This will result in a flex disc pack that is centered and parallel to its mating flange faces. Move the motor to obtain the correct axial spacing, see Table 5-3 and Figure 5-8.
21. *Angular Alignment*. Rigidly mount a dial indicator on one hub or shaft, reading the face of the other hub flange. Rotate both shafts together, making sure the shaft axial spacing remains constant. Adjust the motor by shimming and/or moving so that the indicator reading is within 0.002" per inch of coupling flange, see Figure 5-9.
22. *Parallel Offset*. Rigidly mount a dial indicator on one hub or shaft, reading the other hub flange outside diameter. Indicator set-up sag must be compensated for. Rotate both shafts together. Adjust the equipment by shimming and/or moving so that the indicator reading is within 0.002" per inch of the axial length between flex disc packs, see Figure 5-9.

With the coupling in good alignment the bolts will fit through the holes in the flanges and the disc packs more easily.

NOTE

All bolt threads should be lubricated. A clean motor oil is recommended. On size 226 and larger, a link must be put on bolt first. Remove the disc pack alignment bolt. Proceed to mount the second disc pack to the other hub in the same way.

Ensure that the beveled part of the washer is against the disc pack.

23. Install bolts and locking nuts to secure both disc packs to center member.

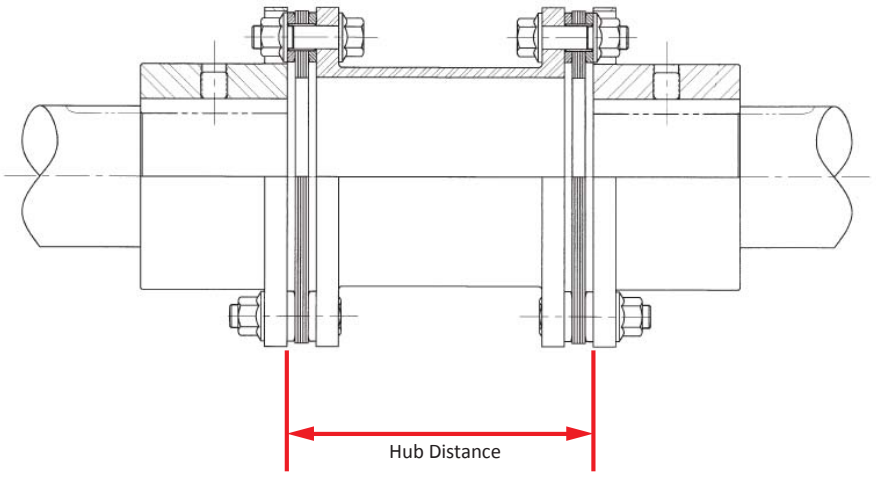
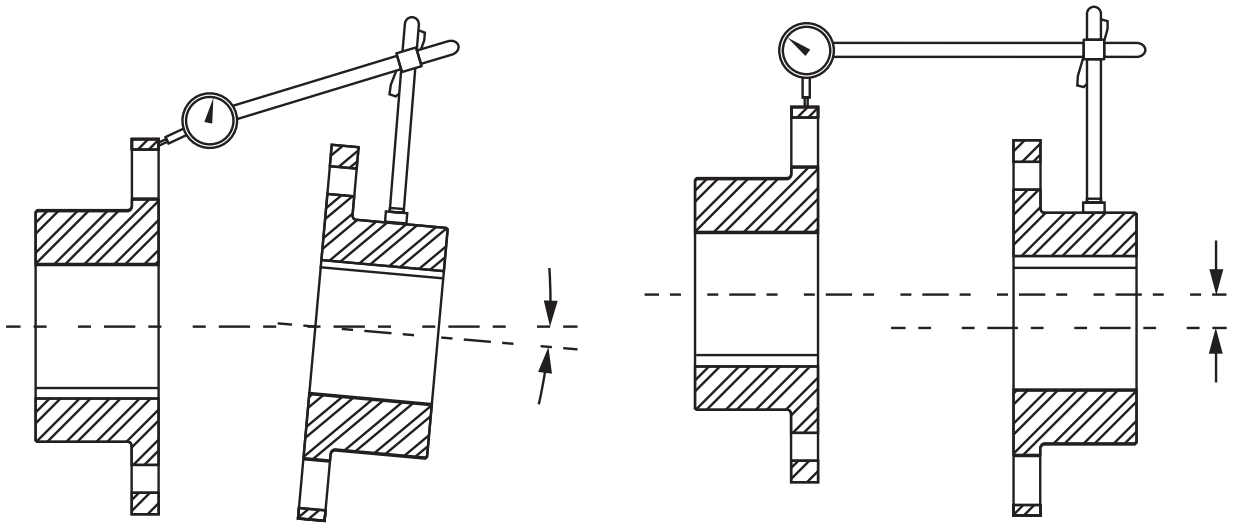


Figure 5-8. Hub Distance (Axial Spacing)



Angular Alignment *Parallel Offset*

Figure 5-9. Angular Alignment and Parallel Offset

24. Tighten locking nuts.
25. If room is required to install center member, adjust hub position accordingly. If both the motor and compressor hubs are straight bores, adjust either hubs. If one hub is tapered and the other a straight, adjust the straight bore hub.
26. Using additional supports supporting center member. Install bolts and locking nuts to secure center member to compressor hub.
27. Tighten locking nuts.
28. Position hubs, ensure distance between face of both hubs is 5".

NOTE

If there is waviness with the disc pack installed, adjust distance accordingly until disc pack is straight.

29. Install bolts and locking nuts to secure disc pack to motor hub.
30. Tighten locking nuts, see Table 5-4.

Table 5-5. Disc Pack Installation Torque Specifications

Coupling Size	Lock Nut Size	Tightening Torque ft-lbs (Nm)
BP38U	5/16-24	22 (30)
BP41U	7/16-20	55 (75)
BP47U	9/16-18	120 (163)
BP54U	9/16-18	120 (163)
BP56U	9/16-18	120 (163)

31. Perform hot alignment. Run compressor unit and allow to warm up completely.
32. Power down compressor unit and re-check

Table 5-4. Hub Clamp Bolt and Set Screw Torque Specifications

Coupling Series/Size	Clamping Bolt			Set Screw	
	# Bolts	Size-Pitch	Torque ft-lbs (Nm)	Size	Torque ft-lbs (Nm)
BH38U	4	1/4-28	12 (16)	3/8	10 (13)
BH41U	4	5/16-24	23 (31)	3/8	10 (13)
BH47U	4	3/8-24	49 (66)	1/2	20 (27)
BH54U	4	7/16-20	78 (106)	1/2	20 (27)
BH56U	4	1/2-20	120 (163)	5/8	40 (54)
DP42	4	1/2-20	120 (163)	1/2	20 (27)

alignments. Loosen motor mounting nuts to add shims or to adjust alignments as required.

33. Install coupling guard.

Drive Coupling (Form-Flex BPU) Center Member and Hub Removal

To remove coupling assembly, proceed with the following steps:

WARNING

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

WARNING

Follow local lockout/tagout procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

NOTE

Drive coupling type and size can be determined by the information on the compressor nameplate when ordering; Order Number and Compressor Model Number.

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. Remove coupling guard.
5. Remove lock nuts and bolts securing disc pack to hub on compressor shaft.
6. If additional room is required to remove the center member, loosen clamping bolts on straight bore hub(s).
7. Move straight bore hub on shaft as required to allow center member removal.
8. Remove lock nuts and bolts securing disc pack to hub on motor shaft. Remove center member.
9. For straight bore hubs, remove clamping bolts and hub from shaft.
10. For tapered bore hubs, remove bolt, lock washers, large washer and hub from shaft.

Coupling Guard Replacement

NOTE

Coupling guards may differ slightly but this replacement procedure can be used to remove and install them. The coupling guard assembly described in this procedure is VPN A28412D.

REMOVAL

Reference Figure 5-10

1. Shut down compressor unit, see Compressor Unit Isolation for Maintenance/Service procedure.
2. Remove screw (2) securing telescoping guard (7) to upper guard (1).
3. Remove eight screws (2) securing upper guard (1) to lower guard (4).
4. Remove seven screws (2) securing upper guard (1) to base plate (3). Remove upper guard.
5. Remove center member, see Drive Coupling (Form-Flex BPU) Center Member and Hub Removal procedure.
6. Remove four screws (2) securing lower guard (4) to base plate (3). Remove lower guard and telescoping guard (7).
7. Remove telescoping guard (7) from lower guard (4).
8. Remove two screws (6) and flat washers (5) securing base plate (3) to compressor. Remove base plate.

INSTALLATION

9. Install two screws (6) and flat washers (5) to secure base plate (3) to compressor. Tighten to 200 ft-lbs.
10. Position telescoping guard (7) in lower guard (4).
11. Install four screws (2) to secure lower guard (4) to base plate (3). Tighten screws to 15 in-lbs.
12. Install center member, see Drive Coupling (Form-Flex BPU) Center Member and Hub Removal procedure.
13. Install seven screws (2) to secure upper guard (1) to base plate (3). Tighten screws to 15 in-lbs.
14. Install eight screws (2) to secure upper guard (1) to lower guard (4). Tighten screws to 15 in-lbs.
15. Loosely install screw (2) to secure telescoping guard (7) to upper guard (1).
16. Position telescoping guard (7) within 1/2 inch of motor. Tighten screw (2) to 15 in-lbs.
17. Return compressor unit to service.

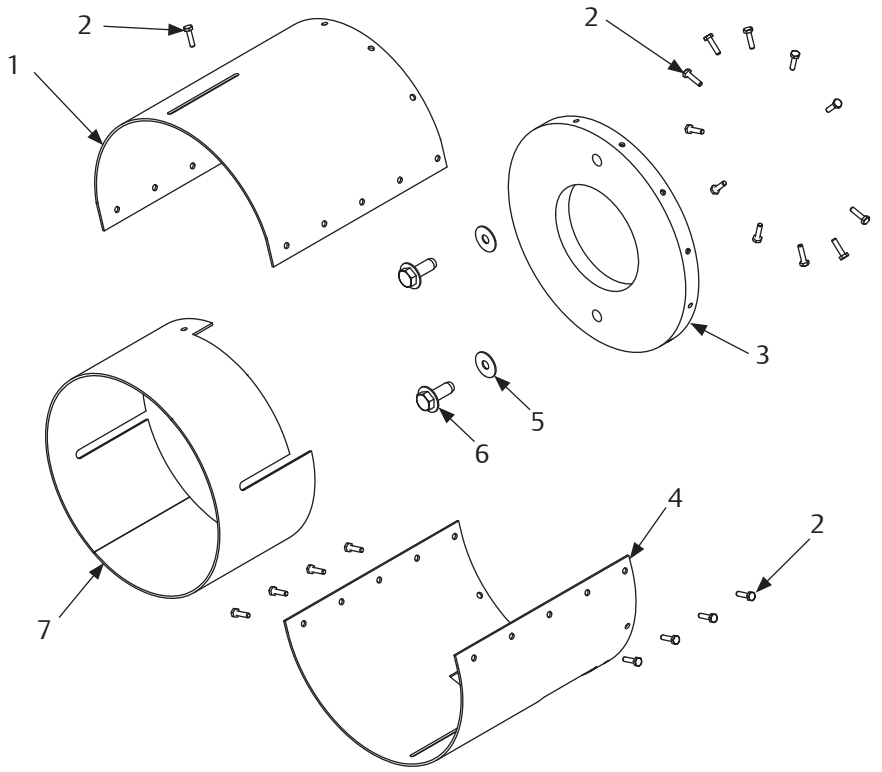


Figure 5-10. Coupling Guard Assembly (VPN A28412D shown)

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

WARNING

When rigging and lifting a bare shaft compressor, use proper lifting device capable of lifting and maneuvering the weight and size of the compressor. 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.

13. Install appropriate lifting shackles on compressor. Use all four lifting points locating on compressor frame, see Figure 5-11.
14. Using appropriate lifting device and additional personnel, remove compressor from frame.

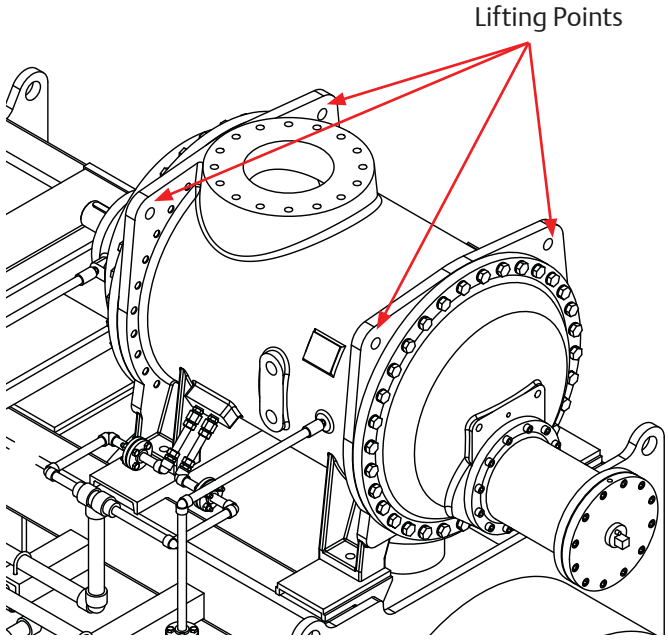


Figure 5-11. VRSG Compressor (Model 3700 Shown)

15. Remove shims and spherical washers from compressor mounting locations, if equipped.
16. Inspect shims and spherical washers for damage, replace as required, if equipped.

INSTALLATION

17. Install shims and spherical washers on compressor mounting locations, if equipped.
18. Install appropriate lifting shackles on compressor.
19. Using appropriate lifting device, position compressor on compressor mounting locations on frame.
20. Loosely install studs, lock washers, flat washers and nuts to secure compressor to frame until alignment is correct.
21. Check compressor for soft foot. Add or remove shims as required until measurements are within +/- 0.002".
22. Tighten nuts to secure compressor to frame, refer to Appendix A.
23. Install bolts to secure compressor to discharge flange.
24. Tighten bolts to secure compressor to discharge flange, see Appendix A.
25. Install nuts to secure suction strainer/check valve assembly to compressor and suction stop valve.
26. 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.
27. Install all lines to compressor.
28. Install all cables to sensors on compressor.
29. Install coupling, see Drive Coupling Installation and Alignment procedure .
30. Install coupling guard, see Coupling Guard Replacement procedure.
31. Perform leak check, see Compressor Unit Leak Check procedure.

Compressor Maintenance

For compressor maintenance information, refer to the Howden WRV & WRVi Compressor Range Installation Manual in the Appendices.

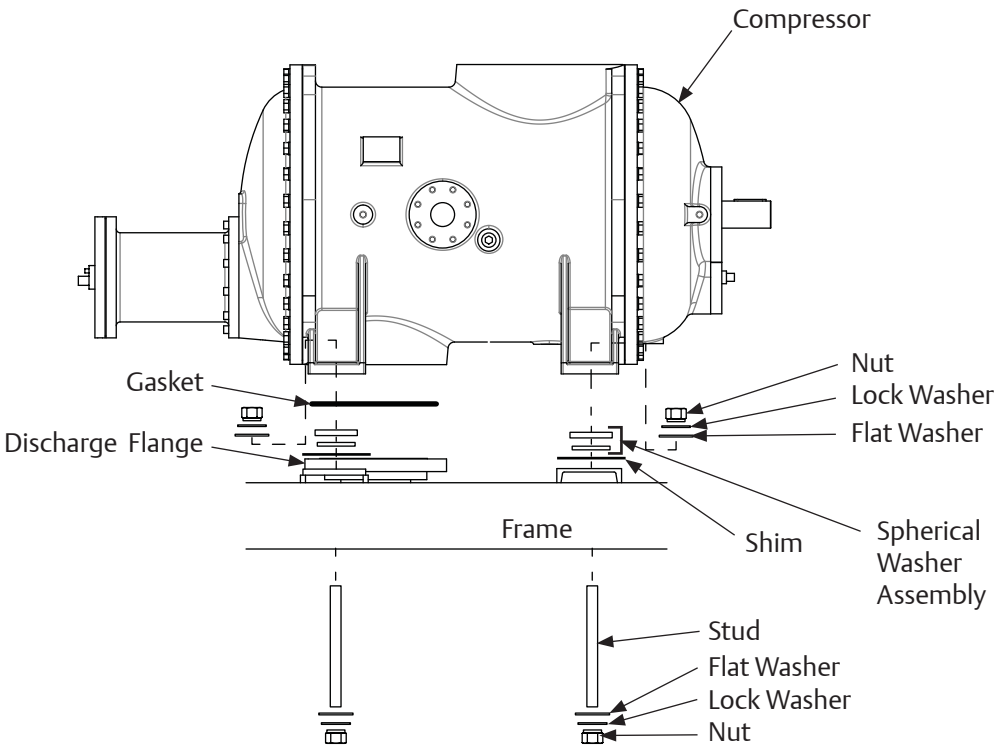


Figure 5-12. Compressor Replacement and Hardware Assembly (Model 3700 Shown)

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

For additional troubleshooting information on Howden compressors, refer to the Howden WRV & WRVi Range Compressor Installation Manual in the Appendices.

Problem	Solution
Low Oil Pressure at Start	• 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. • Reset Prelube Oil Pressure Setpoint in Alarms and Trip Setpoints screen to lowest recommended setpoints. • Check calibration of oil manifold transducer, discharge pressure transducer, and suction transducer. • Check for correct oil pump motor rotation and operation. • Ensure transducer isolation valves are open. • Verify that the correct transducer ranges are selected. • Check to see all oil line valves are open except the oil dump valve used to fill the lines and oil cooler. • Check oil strainer for dirt. • Check oil filter pressure drop. • Check "Prelube Oil Pump Time Limit" setpoint is sufficient in Compressor Timer Setpoints screen. • Note: Prelube pressure is manifold pressure minus discharge pressure.
Low Run Oil Pressure	• Check solutions in "Low Oil Pressure at Start". • 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.
Oil flow or oil pressure problems	• Clean oil strainer screen. • Change oil filter, maybe plugged or collapsed. • Oil pump gears worn internally, excessive end-clearance. • Oil priming valve used on air-cooled cooler units is open. • Relief in-line check valve stuck open.
Faulty pressure or temperature readings	• Check that the correct pressure or temperature range is selected in the Instrument Calibration menu. • Check cable connections at device, terminal strips, and PLC input card for correct wiring and shielding (RF noise). • Check calibration of RTDs and transducers.

Table 6-1. Troubleshooting Guide - General Problems & Solutions (2 of 3)

Problem	Solution
Oil Loss Issues	• Oil return line from coalescing side of oil separator to suction is closed, not open enough 3/4 turn should be sufficient, or plugged with debris. • The check valve in the oil return line could be stuck closed or the flow is in the wrong direction. • There may be water in the oil affecting the coalescing elements. • Coalescent elements in need of replacement due to age or damage (water contamination). • 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. • The suction or discharge check valve is not working correctly causing oil to escape when the unit stops. • Viscosity of oil incorrect; send sample for testing. • There is an oil leak somewhere in the system.
High oil temperature (liquid injection)	• Check for correct setting of all manual values. • Check for correct operation of 2-way automatic oil mixing valve. • In the “Vilter Only” menu, ensure that you select “Yes this unit has the oil mixing valve” to enable it. • If controlling a step type oil cooler or a VFD oil cooler, verify the correct one is selected in the “Vilter Only” menu and the amount of steps are entered in the menu screen “Oil Cooler Step Control” menu. • Check the oil cooler and associated piping to make sure it is full of oil before starting. • Check the oil strainer for debris and clean if necessary. • Check that all fans are working. • Check for correct fan rotation on the oil cooler. • Check the operating conditions are within the “As Sold” design conditions.

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

Problem	Solution
High Amp Draw	• Check Main Motor Amps scaling and PLC.
Vibration	• Check that unit is leveled and secured to mounting pad or floor. • Check supported pipes (i.e. suction and discharge pipe) and make sure they are adequately supported. • Check for loose bolts and nuts. • Check condition of compressor and motor (i.e. alignments)
Excessive Motor Backspin	• If there is more than normal motor backspin at shutdown, check suction check valve for proper operation.

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 the Terms and Conditions of your order. Vilter contact information can be found on page i.

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:

PART

1. Submit a Purchase Order (PO) to procure the replacement part:
    - The correct Vilter part number and the quantity.
    - The original Vilter sales order for the equipment.
2. Request a Return Material Authorization (RMA) number:
    - Please provide as much information describing the mode of failure to be recorded on the RMA document. This will assist us with providing a quicker review once we have received the warranty part (ex. Part does not calibrate, part does not read correct temperature, etc.).
    - Any additional parts returned on the RMA that is not listed, will be returned freight collect or scrapped. The RMA is valid for 60 days from the RMA request date.
3. After replacing the warranty part:
    - Ship the part to Vilter per the instructions on the RMA document.
    - Please include a copy of the RMA document in the box for identification purposes when the part is received.
4. Part to be evaluated.
5. Warranty Consideration:
    - Acceptance – A credit will be provided for the customer part sales order.
    - Denial – Notification of denial will be provided to the customer.

COMPRESSOR

- Due to the site specific nature of compressor warranty, all warranty responses must be mitigated through a Vilter S&W department representative.

COMPRESSOR MOTOR

The warranty is a pass through warranty as stated in the equipment warranty and as such will be determined by the manufacturer. *All expenses (i.e. shipping, removal/installation, alignment) are not covered by Vilter's nor the manufacturer's warranty.*

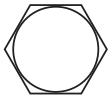
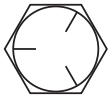
1. The motor will need to be taken to the nearest Electrical Apparatus Service Association (EASA) repair facility or motor manufacturer approved repair facility.
2. The motor shop will provide the motor manufacturer with the failure analysis.
3. The motor manufacturer will make the warranty disposition.

On Site Service Support

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

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.

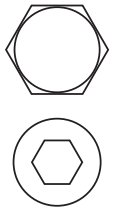
Warranty does not cover labor or expenses.
For warranty statement, refer to the Terms and Conditions of your order.

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 Coarse (UNF)		-	-	18	-	-	-	-	-	-	-
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	115	215	380	614

1) Torque values in this table are not to override other specific torque specifications when supplied.

2) When using loctite, torque values in this table 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.

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 SERVICES LABORATORIES
www.oil-services-lab.com

PRODUCT ANALYSIS REPORT

No Action Required

Report Date:	3/4/2013
Report Number:	*********
Customer	Customer
Comp. Mfr.	Vilter
Oil Type	VILTER METHANE 100
Serial Number	****-***
Model Number	VRSG-3700
Hrs. on Fluid	6049
Hrs. on Machine	11239
Sample Date	Feb 21, 2013
Receive Date	Mar 01, 2013
I.D. #	*********

Customer Name
Customer Address

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

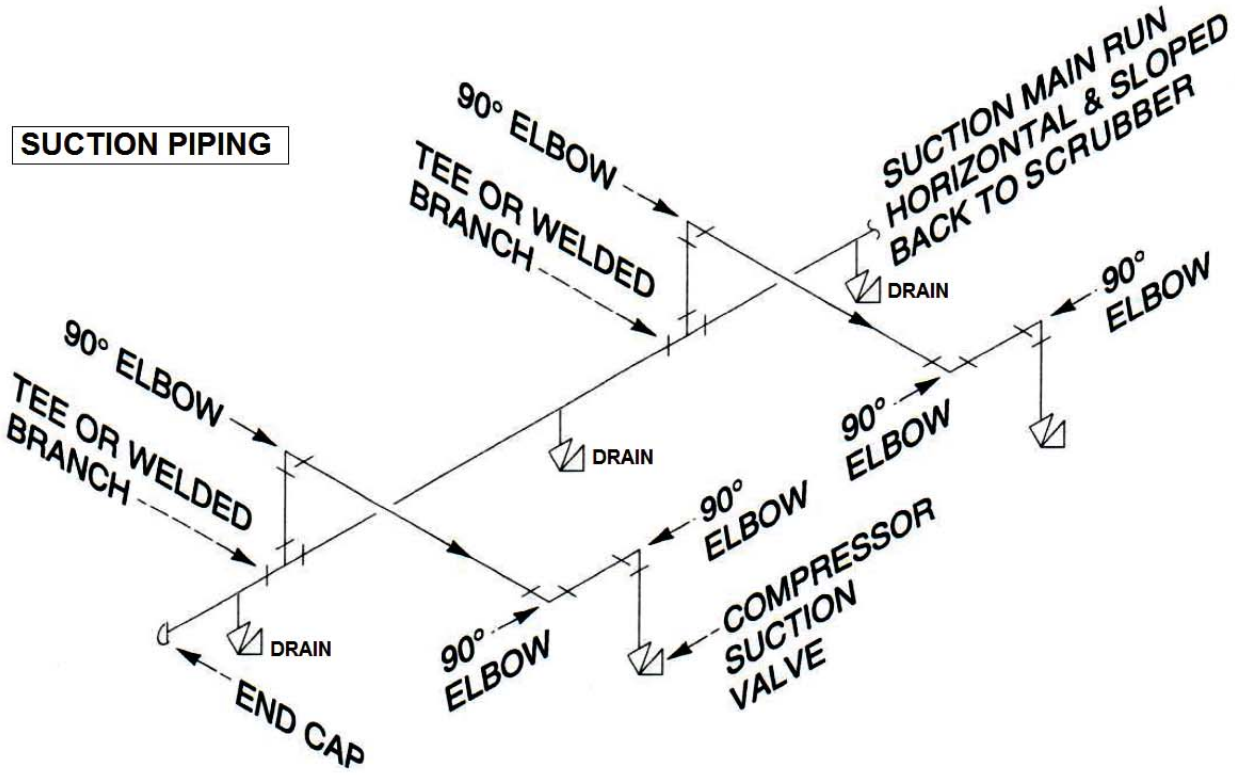
Wear Metals (ppm)			
Silver (Ag)	0	0	0
Aluminum (Al)	0	0	0
Chromium (Cr)	0	0	0
Copper (Cu)	0	0	0
Iron (Fe)	0	0	0
Nickel (Ni)	0	0	0
Lead (Pb)	0	0	0
Tin (Sn)	0	0	0
Titanium (Ti)	0	0	0
Vanadium (V)	0	0	0
Contaminant/Additive Metals (ppm)			
Barium (Ba)	0	0	0
Calcium (Ca)	0	0	0
Magnesium (Mg)	0	0	0
Molybdenum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

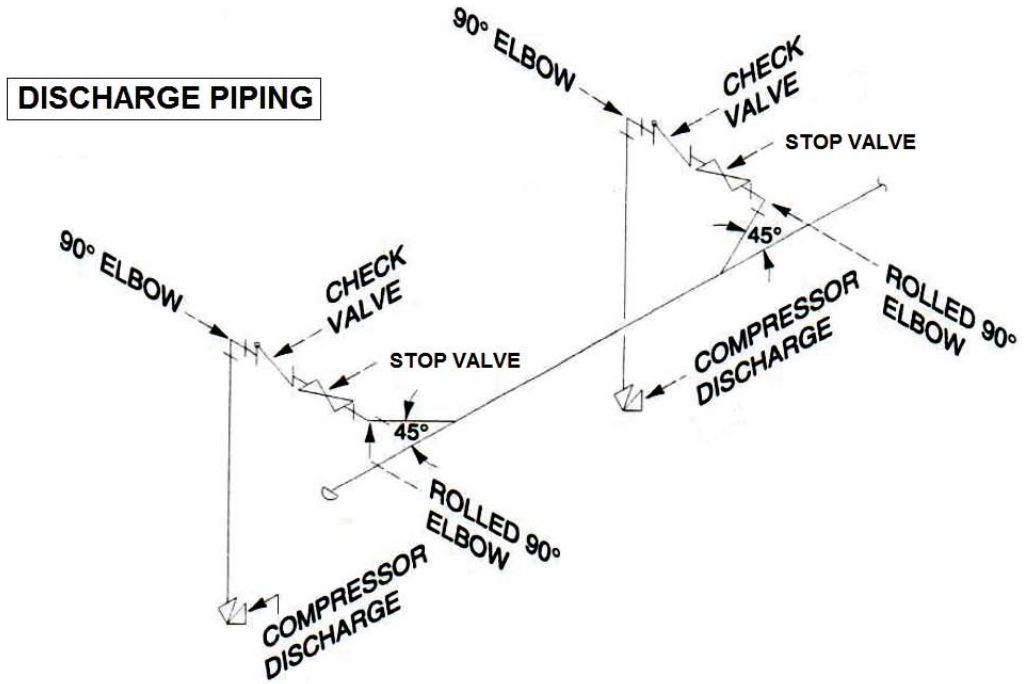
Thank you for this opportunity to provide technical assistance to your company. If you have any questions about this report, please contact us at 1-800-637-8628, or fax 1-989-496-2313 or email us at tslab@oil-services-lab.com

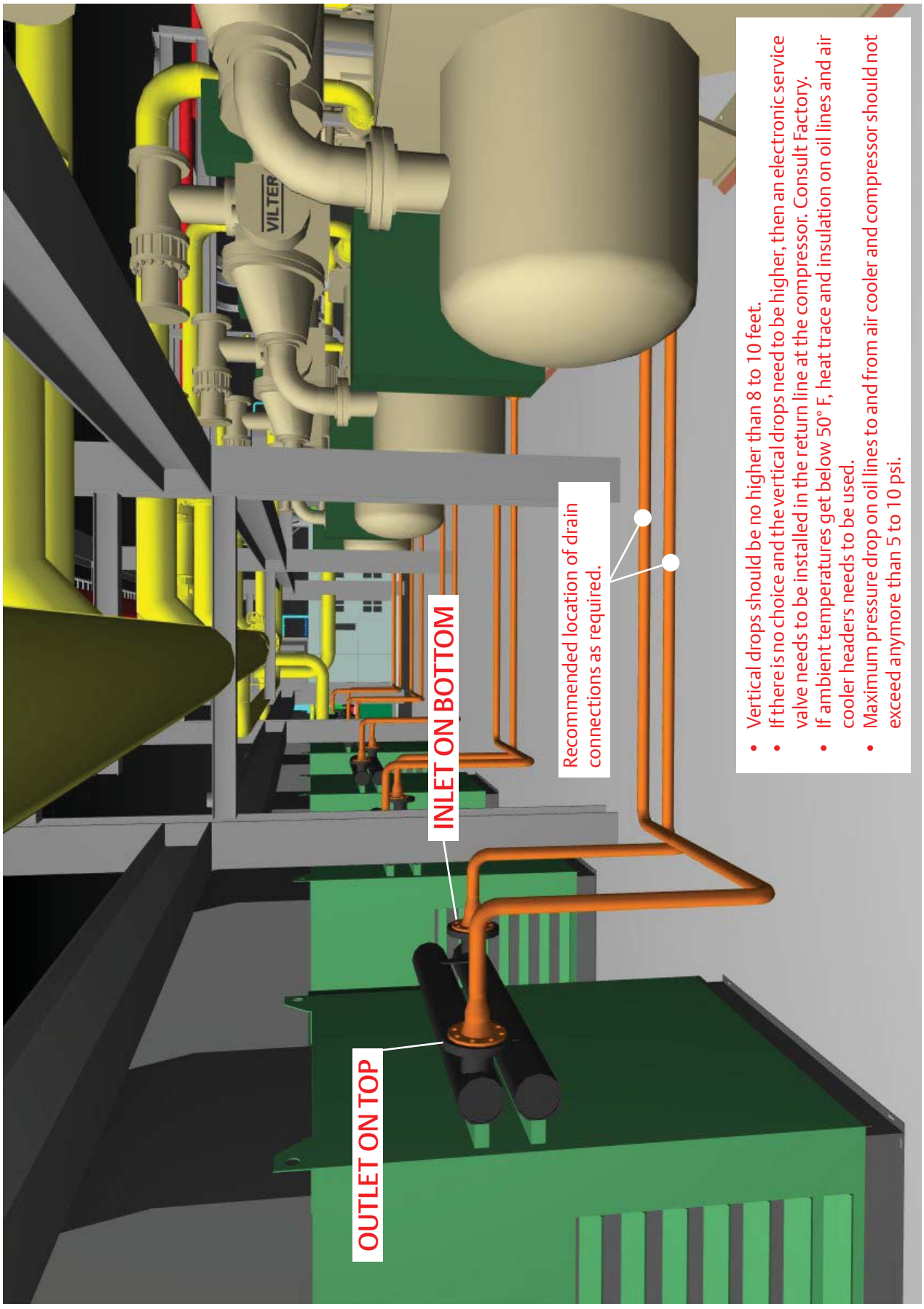
CC List

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


SUCTION PIPING
90° ELBOW
TEE OR WELDED BRANCH
SUCTION MAIN RUN HORIZONTAL & SLOPED BACK TO SCRUBBER
DRAIN
90° ELBOW
90° ELBOW
TEE OR WELDED BRANCH
DRAIN
90° ELBOW
90° ELBOW
COMPRESSOR SUCTION VALVE
DRAIN
END CAP


DISCHARGE PIPING
90° ELBOW
CHECK VALVE
STOP VALVE
45°
ROLLED 90° ELBOW
90° ELBOW
CHECK VALVE
STOP VALVE
COMPRESSOR DISCHARGE
45°
ROLLED 90° ELBOW
COMPRESSOR DISCHARGE


OUTLET ON TOP
INLET ON BOTTOM
Recommended location of drain connections as required.
• Vertical drops should be no higher than 8 to 10 feet.
• If there is no choice and the vertical drops need to be higher, then an electronic service valve needs to be installed in the return line at the compressor. Consult Factory.
• If ambient temperatures get below 50° F, heat trace and insulation on oil lines and air cooler headers needs to be used.
• Maximum pressure drop on oil lines to and from air cooler and compressor should not exceed anymore than 5 to 10 psi.

Appendix E

Back Pressure Regulator - IOM Manual

MODEL 123 — BASIC
BACK PRESSURE / RELIEF REGULATOR

SECTION I

I. DESCRIPTION AND SCOPE

The Model 123 is a back pressure relief regulator used to control upstream (inlet or P_1) pressure. Sizes are 1/2", 3/4", 1", 1-1/2" and 2" (DN15, 20, 25, 40 and 50). With proper trim utilization, the unit is suitable for liquid, gaseous, or steam service. Refer to Technical Bulletin 123-TB for design conditions and selection recommendations.

⚠ CAUTION A

This is not a safety device and must not be substituted for a code approved pressure safety relief valve or rupture disc.

SECTION II

II. INSTALLATION

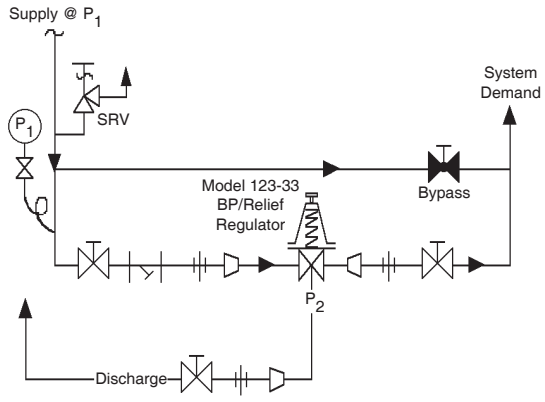
⚠ CAUTION B

For welded installations, all internal trim parts, seals and diaphragm(s) must be removed from regulator body prior to welding into pipeline. The heat of fusion welding will damage non-metallic parts if not removed. NOTE: This does not apply to units equipped with extended pipe nipples.

1. An inlet block valve should always be installed.
2. If service application is continuous such that shutdown is not readily accomplished, it is recommended that an inlet block valve, outlet block valve, and a manual bypass valve be installed.
3. Pipe unions should be installed to allow removal from piping.
4. An inlet pressure gauge should be located approximately ten pipe diameters upstream and within sight. An outlet pressure gauge is optional.
5. All installations should include an upstream relief device if the inlet pressure could exceed the pressure rating of any equipment or the maximum inlet pressure rating of the unit.

⚠ CAUTION C

Installation of adequate overpressure protection is recommended to protect the regulator and all downstream equipment from damage in the event of regulator failure.



Recommended Piping Schematic for Back Pressure/Relief Station

6. Clean the piping of all foreign material including chips, welding scale, oil, grease and dirt before installing the valve. Strainers are recommended.
7. In placing thread sealant on pipe ends prior to engagement, ensure that excess material is removed and not allowed to enter the regulator upon startup.
8. Flow Direction: Install so the flow direction matches the arrow cast on the body. The body has an angle configuration with a side inlet and bottom outlet.
9. Regulator may be installed in a vertical or horizontal pipe. If it is a steam system, ensure the piping is properly trapped and oriented.

10.A. Basic Regulator- (See Figure 1): Regulator may be rotated around the pipe axis 360°. Recommended positions are with spring chamber vertical upwards, or horizontal. Orient such that the spring chamber vent hole does not collect rainwater or debris.

10.B. Cryogenic Regulator -
Option-5 or -36 (See Figure 2):

a. Recommended installation is with spring chamber hanging vertical downward below the body. This method allows water to drain; i.e. rain water.
b. Recommend inert purge gas to spring chamber through vent hole and out drain hole.

⚠ WARNING 1

The maximum inlet pressure is equal to 1.5 times the larger number of the stated range spring on the nameplate, and is the recommended "upper operative limit" for the sensing diaphragm. Higher pressures could damage the diaphragm. (Field hydrostatic tests frequently destroy diaphragms. DO NOT HYDROSTATIC TEST THROUGH AN INSTALLED UNIT; ISOLATE FROM TEST.)

11. Regulators are not to be direct buried underground.

12. For insulated piping systems, recommendation is to not insulate regulator.

SECTION III

III. PRINCIPLE OF OPERATION

1. Movement occurs as pressure variations register on the diaphragm. The registering pressure is the inlet, P_1 or upstream pressure. The range spring opposes diaphragm movement. As inlet pressure drops, the range spring pushes the diaphragm down, closing the port; as inlet pressure increases, the diaphragm pushes up and the port opens.

2. A complete diaphragm failure may cause the regulator to fail closed.

SECTION IV

IV. STARTUP

1. Start with the block valves closed. A bypass valve may be used to maintain inlet pressure in the upstream system without changing the following steps.

2. Relax the range spring by turning the adjusting screw counterclockwise (CCW) a minimum of three (3) full revolutions. This reduces the inlet (upstream) pressure setpoint.

3. If it is a "hot" piping system, and equipped with a bypass valve, slowly open the bypass valve to preheat the system piping and to allow slow expansion of the piping. Ensure proper steam trap operation if installed. Closely monitor inlet (upstream) pressure, via gauge, to assure not over-pressurizing. ***NOTE:*** *If no bypass valve is installed, extra caution should be used in starting up a cold system; i.e. do everything slowly.*

4. Crack open the inlet (upstream) block valve.

5. Slowly open the outlet (downstream) block valve observing the inlet (upstream) pressure gauge. Determine if the regulator is flowing. If not, slowly rotate the regulator adjusting screw counterclockwise (CCW) until flow begins.

6. Continue to slowly open the outlet (downstream) block valve until fully open.

7. Observing the inlet (upstream) pressure gauge, rotate the adjusting screw clockwise (CW) slowly until the inlet pressure begins to rise. Rotate CW until the desired setpoint is reached.

8. Continue to slowly open the inlet (upstream) block valve. If the inlet (upstream) pressure exceeds the desired setpoint pressure, rotate the adjusting screw CCW until the pressure decreases.

9. When flow is established steady enough that both the outlet and inlet block valves are fully open, begin to slowly close the bypass valve if installed.

10. Develop system flow to a level near its expected normal rate, and reset the regulator setpoint by turning the adjusting screw CW to increase inlet pressure, or CCW to reduce inlet pressure.

11. Reduce system flow to a minimum level and observe setpoint. Inlet pressure will rise from the setpoint of Step 9. (Ensure that this rise does not exceed the stated upper limit of the range spring by greater than 50%, i.e. 30 - 80 psig (2.1 - 5.5 Barg) range spring, at maximum flow the inlet pressure should not exceed 1.5 x 80 psig (5.6 Barg), or 120 psig (8.3 Barg). If it does, consult factory.)

12. Increase flow to maximum level if possible. Inlet (upstream or P_1) pressure should fall off. Readjust setpoint as necessary at the normal flow rate.

SECTION V

V. SHUTDOWN

1. On systems with a bypass valve, and where system pressure is to be maintained as the regulator is shut down, slowly open the bypass valve while closing the inlet (upstream) block valve. Fully close the inlet (upstream) block valve. (When on bypass, the system pressure must be constantly observed and manually regulated. Close the outlet (downstream) block valve.

CAUTION D

Do not walk away and leave a bypassed regulator unattended.

2. If the regulator and system are both to be shutdown, slowly close the inlet (upstream) block valve. Close the outlet (downstream) valve only if regulator removal is required.

SECTION VI

VI. MAINTENANCE

WARNING 2

SYSTEM UNDER PRESSURE. Prior to performing any maintenance, isolate the regulator from the system and relieve all pressure. Failure to do so could result in personal injury.

A. General:

1. Maintenance procedures hereinafter are based upon removal of the regulator unit from the pipeline where installed.

2. Owner should refer to owner's procedures for removal, handling, cleaning and disposal of nonreuseable parts, i.e. gaskets, etc.

3. Refer to Figure 1 for basic regulator, Figure 2 for cryogenic regulator, and Figure 3 for blow-up of the composition seat trim.

B. Diaphragm Replacement:

WARNING 3

SPRING UNDER COMPRESSION. Prior to removing spring chamber, relieve spring compression by removing the adjusting screw. Failure to do so may result in flying parts that could cause personal injury.

1. Securely install the body (1) in a vise with the spring chamber (2) directed upwards.

2. Rotate the adjusting screw (17) CCW until removed from the spring chamber (2).

3. Draw or embed a match mark on the body (1) and spring chamber (2) flanges.

4. Remove diaphragm flange nuts (8) and bolts (7).

5. Remove spring chamber (2), range spring (18) and spring button (19).

6. Remove diaphragm sub-assembly consisting of the diaphragm(s) (3), pressure plate (2), lock washer (13), piston (14), piston nut (6) and pusher plate gasket (5). ***NOTE:*** *Refer to the quantity of diaphragms (12) incorporated per the bill of materials listing. Depending on inlet pressure level, multiple metal diaphragms may be "stacked".*

7. Loosen the piston nut (6) and separate all parts (3, 5, 13, 14 & 20) of the diaphragm sub-assembly. Clean the pusher plate gasket (5) surface if the piston (14) is to be reused.

8. Inspect pressure plate (20) for deformation due to over-pressurization. If deformed, replace.

9. Remove diaphragm gasket (4) for metal diaphragm. ***NOTE:*** *No diaphragm gasket (4) for composition diaphragm.*

10. Clean body (1) and diaphragm flange. ***NOTE:*** *On regulators originally supplied as "special cleaned", Option-5, -36 or -55, maintenance must include a level of cleanliness equal to Cashco's cleaning standard #S-1134. Contact factory for details.*

11. For metal diaphragms (3), place the diaphragm gasket (4) on the body (1) flange. A light coat of gasket sealant is recommended.

12. Reassemble diaphragm sub-assembly by placing piston (14) in a vise, post upwards, grasping on the hexagonal surface. Place the pusher plate gasket (5), diaphragm(s) (3), pressure plate (20) and lock washer (13) over the threaded post. Ensure that the pressure plate (20) is placed with curved outer rim down next to the diaphragm (3) surface. Place a thread sealant compound on the threads of the piston (14) post prior to tightening the piston nut (6) to the following torque values:

Diaphragm	Regulator Size		Piston Material	Torque	
	in	(DN)		Ft-lbs	(Nm)
Metal	1/2"	(15)	Brass	20-25	(27-34)
	3/4"-2"	(20-50)	Brass	35	(47)
	1/2"-2"	(15-50)	SST		
Composition	1/2"	(15)	Brass	20-25	(27-34)
	3/4"-2"	(20-50)	Brass	20	(27)
	1/2"-2"	(15-50)	SST		

13. Insert the diaphragm sub-assembly into the body (1). Rotate the assembly to ensure that the piston (14) is not binding in the cylinder (12).

14. Place the range spring (18) onto the retainer hub of the pressure plate (20).

15. Place multi-purpose, high temperature grease into depression of spring button (19) where adjusting screw bears. Set spring button (19) onto range spring (18); ensure spring button (19) is laying flat.

16. Aligning the matchmarks, place spring chamber (2) over the above stacked parts. Install all bolts (7) and nuts (8). Mechanically tighten bolting (7 & 8) in a cross pattern that allows the spring chamber (2) to be pulled down evenly. Recommended torque values are as follows:

Regulator Size		Bolt Size	Metal Diaph.		Comp. Diaph.	
in	(DN)		Ft-lbs	(Nm)	Ft-lbs	(Nm)
1/2"	(15)	3/8-24	25	(34)	22	(30)
3/4"-2"	(20-50)	7/16-20	35	(47)	30	(41)

NOTE: *Never replace bolting (7 & 8) with just any bolting if lost. Bolt heads and nuts are marked with specification identification markings. Use only proper grades as replacements.*

17. Reinstall adjusting screw (17) with locknut (9).

18. Spray liquid leak detector to test around bolting (7 & 8) and body (1) / spring chamber (2) flanges for leakage. Ensure that an inlet pressure is maintained during this leak test of at least mid-range spring level; i.e. 20-60 psig (1.4 - 4.1 Barg) range spring, 40 psig (2.8 Barg) test pressure minimum.

C. Trim Replacement:

1. Trim removal requires the diaphragm sub-assembly be removed. Refer to previous procedures, Section VI.B.

2. Remove the cylinder sub-assembly (12) from the body (1) by rotating CCW.

3. Inspect the inside surface of the cylinder (12.1) at four points:

   a. Seat (12.2) ring erosion/wear on seating surfaces. If wear is excessive consider utilizing Option-15, stellited seat surfaces.
   b. Seat (12.2) wire drawing between cylinder (12.1) and seat (12.2) where pressed in. If wear exists here, consult factory.
   c. At metal-to-metal surface between body (1) and cylinder (12). If wear exists here, consult factory.
   d. Where the piston (24) ribbed guides bear (guide zone). See Figure 3.

   If wear is significant at any of these points, both the cylinder sub-assembly (12) and piston sub-assembly (14, or 14, 15 and 16) should be replaced. ***NOTE:*** *Cashco, Inc. does not recommend replacing the seat (12.2) within the cylinder (12.1). The cylinder sub-assembly (12) and piston (14) should be replaced as a set. However, composition seat discs (15) may be replaced individually.*

4. If a composition (soft) seat trim design is utilized, use the following sub-steps:
   a. Tighten the "flats" of the seat disc screw (16) within a vise. Firmly hand-grip the piston (14) and turn CCW to loosen the seat disc screw (16). If too tight, place a wrench on the hex portion of the piston (14) and rotate. Remove the piston (14).
   b. Remove the seat disc (15) and clean the recessed piston (14) area where the seat disc (15) is placed. If the edges which form the recess of the piston (14) are worn, also replace piston (14) and seat disc screw (16).
   c. Place seat disc (15) into recessed end of piston (14).
   d. Place thread sealant on threaded portion of seat disc screw (16) and manually rotate piston (14) into seat disc screw (16) (still fixed in vise) to secure seat disc (15). Tighten seat disc screw (16) firmly. Do not over-tighten to the point of embedding the seat disc screw (16) into the seat disc (15); the seat disc (15) should lay flat with no rounded surface. A mechanical aid is normally not required; hand tightening is normally sufficient.

5. If stellited seat surfaces are utilized, follow a procedure similar to the removal of the seat disc screw (16) with composition seat above. The stellited seat cone (36) will, however, require that it be tightened as much as possible.

6. Clean the body (1) cavity and all parts to be reused according to owner's procedures. ***NOTE:*** *On regulators originally supplied as "special cleaned", Option-5, -36 or -55, maintenance must include a level of cleanliness equal to Cashco's cleaning standard #S-1134. Contact factory for details.*

7. Use special care when cleaning the flat mating surfaces of the body (1) and cylinder (12) shoulder. This pressurized joint is metal-to-metal with no gasket.

8. Lubricate the cylinder (12) threads lightly with thread sealant. Install the cylinder (12) into the body (1) and impact until tightly seated.

9. Reinstall the diaphragm sub-assembly in accordance with Section VI.B., Diaphragm Replacement.

10. Bench test unit for suitable operation. ***NOTE:*** *Regulators are not tight shutoff devices. Even if pressure falls below set point, a regulator may or may not develop bubble tight shutoff. In general, tighter shutoff can be expected with composition seat.*

11. Spray liquid leak detector around body (1) flange to test for leakage. Test pressure should be the maximum allowed.

SECTION VII

VII. TROUBLE SHOOTING GUIDE

1. Erratic Operation, chattering.	
Possible Causes	**Remedies**
A. Oversized regulator.	A1. Check actual flow conditions, resize regulator for minimum and maximum flow. A2. Increase flow rate. A3. Decrease regulator pressure drop; decrease inlet pressure by placing throttling orifice in inlet piping union. A4. Install next step higher range spring. Contact factory. A5. Before replacing regulator, contact factory.
B. Inadequate rangeability.	B1. Increase flow rate. B2. Decrease regulator pressure drop. B3. Install next step higher range spring. Contact factory.
C. Worn piston/cylinder; inadequate guiding.	C. Replace trim.

2. Regulator inlet (upstream) pressure too high.	
Possible Causes	**Remedies**
A. Regulator undersized.	A1. Confirm by opening bypass valve together with regulator. A2. Check actual flow conditions, resize regulator; if regulator has inadequate capacity, replace with larger unit.
B. Plugged trim.	B. Remove trim and check for plugged holes in cylinder.
C. Incorrect range spring (screwing out CCW of adjusting screw does not allow bringing pressure level to a stable and proper level).	C. Replace range spring with proper lower range. Contact factory.
D. Too much proportional band (rise).	D. Review P.B. (rise) expected. Contact factory.
E. Restricted diaphragm movement.	E Ensure no moisture in spring chamber at temperatures below freezing. Ensure no dust or debris entering vent opening. If rainwater or debris can enter, re-orient spring chamber.

3. Leakage through the spring chamber vent hole.	
Possible Causes	**Remedies**
A. Normal-life diaphragm failure.	A. Replace diaphragm.
B. Abnormal short-life diaphragm failure.	B1. Can be caused by excessive chattering. See No. 1 remedy chatter. B2. Can be caused by corrosive action. Consider alternate diaphragm material. B3. For composition diaphragms, ensure not subjecting to over-temperature conditions. B4. Upstream (inlet) pressure buildup occuring that overstresses diaphragms.

4. Sluggish Operation.	
Possible Causes	**Remedies**
A. Plugged spring chamber vent.	A. Clear vent opening.
B. Plugged piston guides.	B. Remove trim and clean.
C. Fluid too viscous.	C. Heat fluid. Contact factory.

SECTION VIII

VIII. ORDERING INFORMATION
NEW REPLACEMENT UNIT vs PARTS "KIT" FOR FIELD REPAIR

To obtain a quotation or place an order, please retrieve the Serial Number and Product Code that was stamped on the metal name plate and attached to the unit. This information can also be found on the Bill of Material ("BOM"), a parts list that was provided when unit was originally shipped. (Serial Number typically 6 digits). Product Code typical format as follows: (last digit is alpha character that reflects revision level for the product).

□□□-□□□7-□□□□□□□□□

NEW REPLACEMENT UNIT:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. With this information they can provide a quotation for a new unit including a complete description, price and availability.

⚠ CAUTION

Do not attempt to alter the original construction of any unit without assistance and approval from the factory. All purposed changes will require a new name plate with appropriate ratings and new product code to accommodate the recommended part(s) changes.

PARTS "KIT" for FIELD REPAIR:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. Identify the parts and the quantity required to repair the unit from the "BOM" sheet that was provided when unit was originally shipped.

NOTE: *Those part numbers that have a quantity indicated under "Spare Parts" in column "A" reflect minimum parts required for inspection and rebuild, - "Soft Goods Kit". Those in column "B" include minimum trim replacement parts needed plus those "Soft Goods" parts from column "A".*

If the "BOM" is not available, refer to the cross-sectional drawings included in this manual for part identification and selection.

A Local Sales Representative will provide quotation for appropriate Kit Number, Price and Availability.

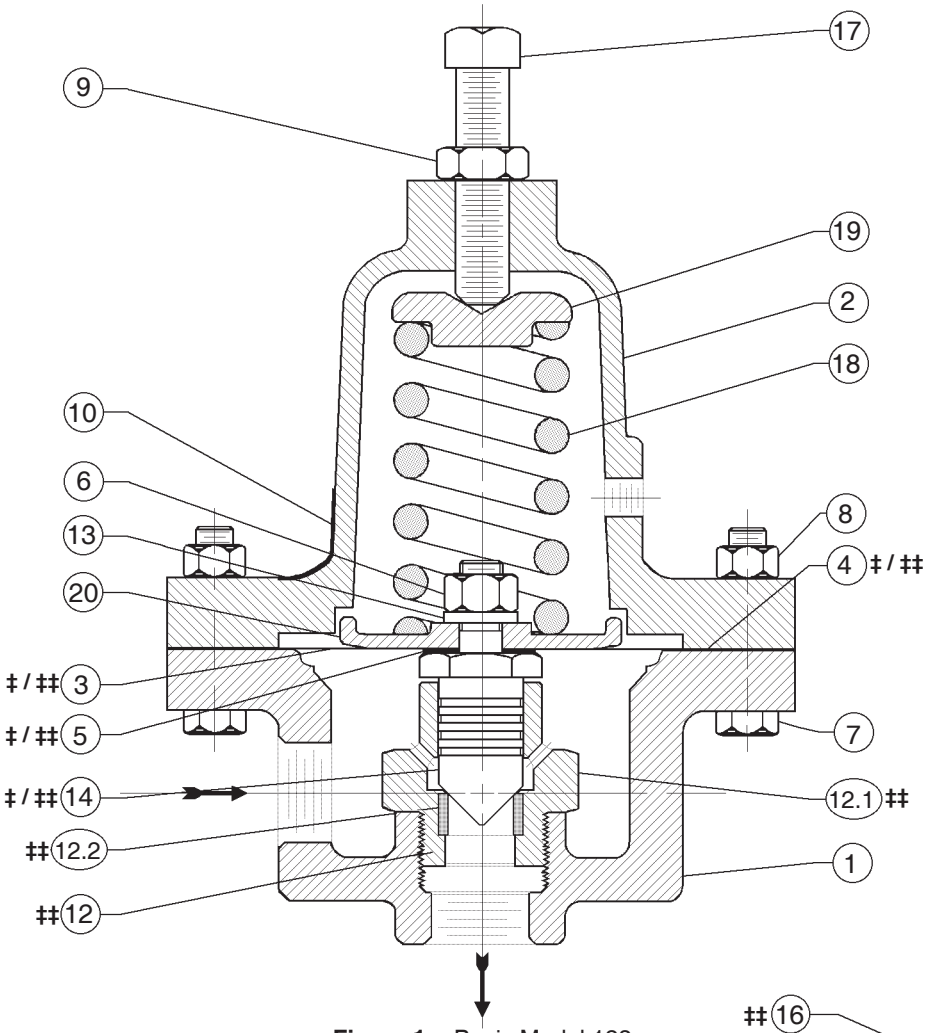


Figure 1: Basic Model 123
Metal Seat

ITEM NO.	REPAIR DESCRIPTION	PARTS Kit A	Kit B
1	Body		
2	Spring chamber		
3	Diaphragm	‡	‡‡
4	Diaphragm Gasket	‡	‡‡
5	Piston Gasket or	‡	‡‡
	Pusher Plate Gasket	‡	‡‡
6	Piston Nut		
7	Cap Screw		
8	Nut		
9	Lock Nut		
10	Nameplate		
12	Cylinder Subassembly		‡‡
12.1	Cylinder		‡‡
12.2	Seat		‡‡
13	Lock Washer		
14	Piston		‡‡
15	Seat Disc	‡	‡‡
16	Seat Disc Screw		‡‡
17	Adjusting Screw		
18	Spring		
19	Spring Button		
20	Pressure Plate		

ITEMS NOT SHOWN

21	Pusher Plate		
22	Closing Cap		
23	Closing Cap Gasket	‡	‡‡
35	Pipe Plug (Body)		
36	Stellited Seat Cone		

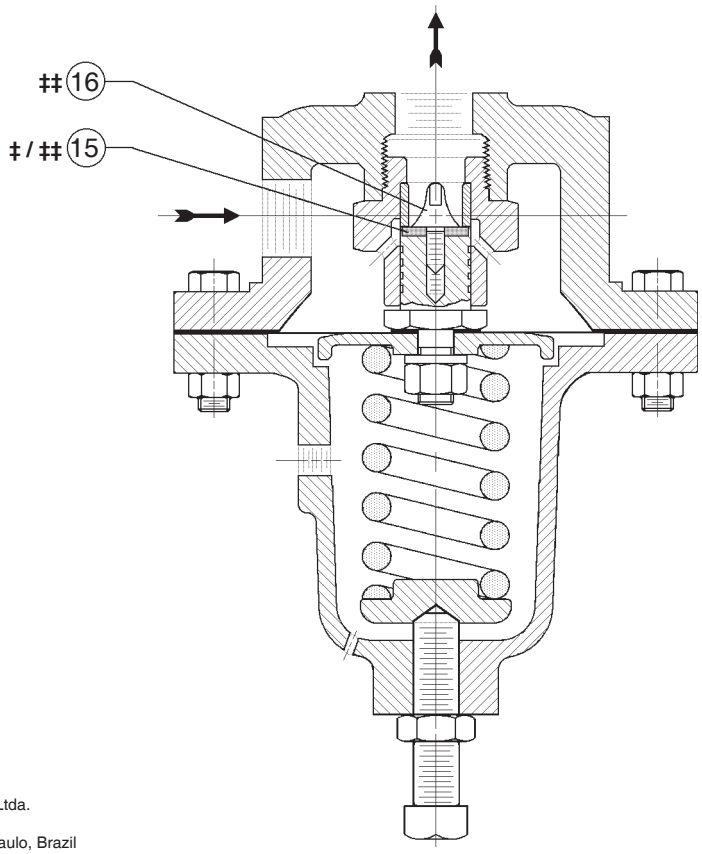


Figure 2: Cryogenic Model 123
Composition Seat
-5 or -36 Option

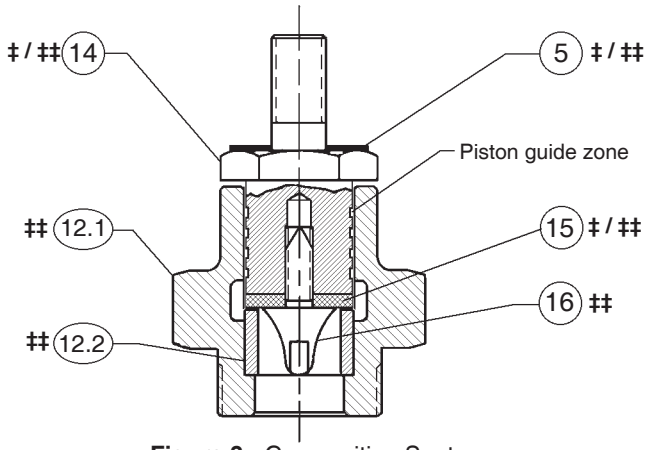


Figure 3: Composition Seat

Cashco, Inc.
P.O. Box 6
Ellsworth, KS 67439-0006
PH (785) 472-4461
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Email: brazil@cashco.com

Printed in U.S.A. IOM-123 Basic

Appendix F

Howden Compressors - Long Term Storage

Howden Compressors
133 Barfillan Drive
GLASGOW G52 1BE

Howden Oil Injected Bare Shaft Compressors, Storage, Care & Maintenance.

Howden oil-injected compressors are prepared as per attached Works Standard Instruction WSI-001 prior to packing and shipping:

Howden Oil-injected compressors are supplied with a 12 month from commission, or 18 months from date of shipment (whichever comes first) warranty. Occasionally compressors are not put to use upon delivery, the following procedures should be employed when storing compressors for prolonged periods.

Unpackaged Compressors

Compressors should not be subjected to significant ambient temperature variations and be stored in an indoor heated area, in an as dry environment as possible; unit should also be stored away from heavy machinery and welding areas.

Minimum Checks:

Weekly:
The Nitrogen pressure should be checked and re-charged if necessary. (If prolonged storage is known prior to shipment a pressure gauge can be fitted.)

Monthly:
Compressor drive shaft should be rotated clockwise a minimum of five times to keep the shaft seal faces lubricated, a nitrogen pressure check should be undertaken after this procedure.

Yearly:
The suction flange should be removed and the inhibiting oil re-injected, Nitrogen charge should be re-applied.

A minimum of 2 Litres of Mobil Armo 524 Inhibiting oil (or approved equivalent) should be sprayed into the suction port, if possible rotate the male shaft clockwise after injecting oil, this will distribute oil throughout the compressor. The two actuating cylinder connections should be opened and a small amount of above inhibiting oil injected into both (this area is isolated from the rest of the compressor).

Dry Nitrogen should be re-injected via the supplied valve; a blanking plug on the opposite side of the compressor should be ‘opened’ to allow the Nitrogen charge to be bled into the unit.

Extended Prolonged Storage:
When warranty extensions are contractually agreed the above will continue warranty cover for a maximum period up to five years (60months) from date of shipment, and we recommend that prior to further storage or installation the compressor be returned to Howden for inspection and test, a nominal charge would be made for this service, but this will re-validate the original 12/18 month warranty on the unit, or an additional storage period, as above.

Should a compressor return be unpractical a workshop annual inspection should be undertaken, all elastomers replaced and the shaft seal inspected and overhauled or replaced as required. Employing a Howden approved engineer for this inspection will re-validate the original 12/18 month warranty on the unit.

Cont’d

Howden Compressors
133 Barfillan Drive
GLASGOW G52 1BE

Packaged Compressors

Compressor packages should not be subjected to significant ambient temperature variations and be stored in an indoor heated area, in an as dry environment as possible, the unit should also be stored away from heavy machinery and welding areas. The compressor should be spaded and Nitrogen charged, or the complete oil and gas system suitably pressurised.

Minimum Checks:

Weekly:
The purge gas pressure should be checked and re-charged if necessary. (If prolonged storage is known prior to shipment a pressure gauge can be fitted.)

Monthly:
The Compressor coupling spacer should be removed and the shaft should be rotated clockwise a minimum of five times to keep the shaft seal faces lubricated, a purge gas pressure check should be undertaken after this procedure.

Yearly:
The suction pipe work should be removed and the inhibiting oil re-injected, purge gas should be re-applied if possible.

A minimum of 2 Litres of Mobil Armo 524 Inhibiting oil (or approved equivalent) should be sprayed into the suction port, if possible rotate the male shaft clockwise after injecting oil, this will distribute oil throughout the compressor. The two actuating cylinder connections should be opened and a small amount of above inhibiting oil injected into both (this area is isolated from the rest of the compressor).

If possible Dry Nitrogen should be re-injected via the supplied valve, a blanking plug or connection on the opposite side of the compressor should be ‘opened’ to allow the Nitrogen charge to be bled into the unit.

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Should a compressor return be unpractical a workshop annual inspection should be undertaken, all elastomers replaced and the shaft seal inspected and overhauled or replaced as required. Employing a Howden approved engineer for this inspection will re-validate the original 12/18 month warranty on the unit.

Records:

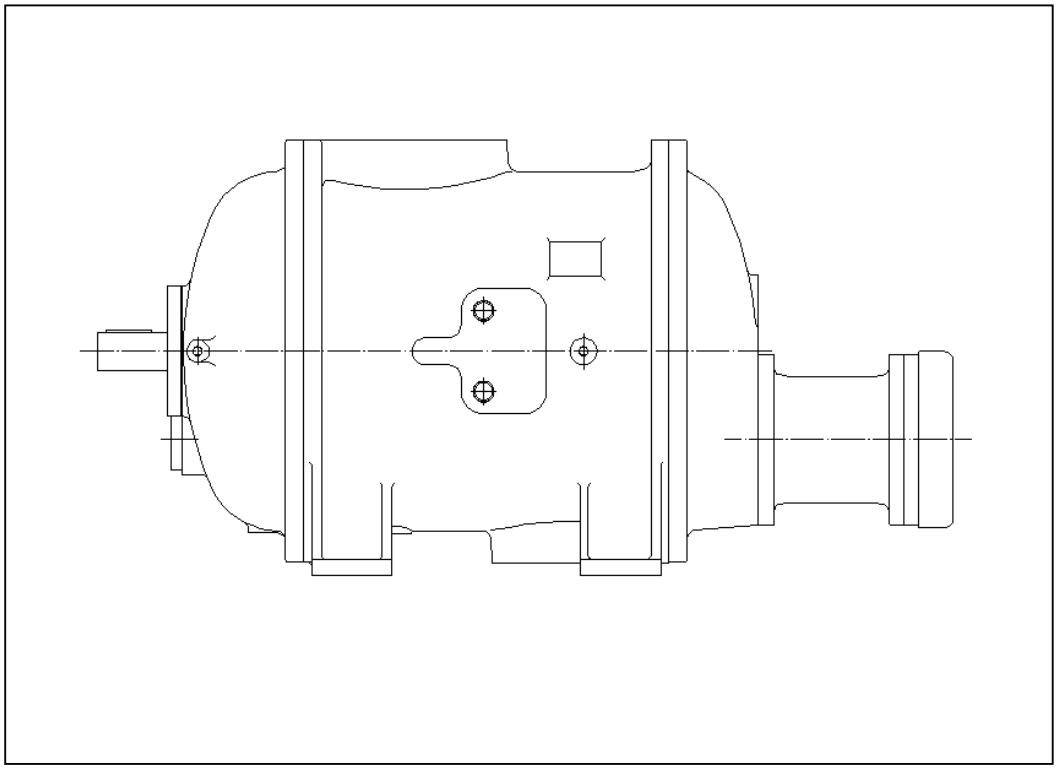
A record/log of the above procedures should be maintained for review.

Kerr Bryson
HOWDEN COMPRESSORS LIMITED

Enc: WSI-001

Appendix G

Howden WRV & WRVi Compressor Range Installation Manual



WRV & WRVi Compressor Range

Installation Manual

READ CAREFULLY BEFORE INSTALLING AND STARTING YOUR COMPRESSOR

This manual relates to WRV and WRVi Compressors.

These instructions have been prepared to ensure that your compressor gives long and satisfactory service.

The entire manual should be read before reverting to any one specific section for information.

One copy should be given to the personnel responsible for installing and operating the compressor.

Whilst every care is taken to ensure that the information in this manual is correct, no liability can be accepted by Howden Compressors Limited for loss, damage, injury or consequential costs of any kind caused by any errors in, or omissions from, the information given.

All requests for information, service or spares should be directed to:

HOWDEN COMPRESSORS LIMITED
Compressor Business Unit
133 Barfillan Drive
Glasgow, G52 1BE
UNITED KINGDOM

Telephone number: +44 (0)141 882 3346
Fax number: +44 (0)141 883 5901
E-mail: sales@howdencompressors.co.uk
Web site: www.howden.com

Alternatively contact our North American Sales Office at:

HOWDEN COMPRESSORS LLC
1850B N Gravers Road
Plymouth Meeting
PA 19462
USA

Telephone number: 01 610 313 9800
Fax number: 01 610 313 9215
E-mail: sales@howdencompressors.com
Web site: www.howden.com

All enquiries should be accompanied by the Howden Compressors Ltd Contract Number and the Compressor Serial Number taken from the nameplate on the side of the compressor body.

2.1 THE WRV/WRVi COMPRESSOR

The Howden WRV/WRVi Oil Injected Compressor is a positive displacement, capacity controlled, oil flooded, rotary machine.

A feature of the WRVi compressor range is the facility to adjust the volume ratio by altering the size of the discharge port to obtain the desired ratio in the range 2.2:1 to 5.0:1.

The WRVi compressors are supplied with two oil injection ports on the side of the main casing. If no oil injection is required due to the duty then it is not necessary to pipe up to these connections and the plugs can remain fitted to the casing. Older compressor models, which had no oil injection, were identified as WCV units on the name plates.

Note: The plugged WRVi is the direct replacement for a WCV unit.

The accurately machined helical rotors are called Male and Female. The Male (driving) rotor has four lobes that mesh with six flutes in the Female (driven) rotor, both rotors having the same outside diameter. Each rotor is supported by two plain white metal thick walled journal bearings fitted adjacent to the compression chamber.

As the lubricating oil is at discharge pressure plus 2.1 bar (30 psi) for standard range compressors and at 3.1 bar (45 psi) for the 'H' designated compressors, the bearings act as shaft seals within the compressor.

Rotor end thrust is accommodated by angular contact ball bearings on both male and female rotors and balance pistons at both ends of the male rotor. One side of each balance piston is subject to pressure from lubricating oil and the other side at suction pressure. The balance pistons therefore, oppose the normal rotor end thrust, and as a result, the angular contact bearings are lightly loaded and have a long life.

In the case of the WRViT model, the thrust bearings are white metal lined tilting pads with balance piston fitted at the inlet end of the male rotor only.

Compression is achieved by the meshing of the two helical rotors on parallel shafts housed in a casing.

The male rotor has lobes formed helically along the rotor length and these mesh with corresponding flutes on the female rotor. The meshing and disengaging of the lobes and flutes within the compressor casing creates enclosed spaces which expand in volume (the suction phase) to a point determined by the shape of the suction port where the interlobe space is sealed. As the rotors continue their rotation and the rotor lobes and flutes remesh, the gas now trapped in the interlobe spaces is compressed. At a point determined by the discharge port shape, the decreasing interlobe space is opened to discharge and the gas escapes at pressure.

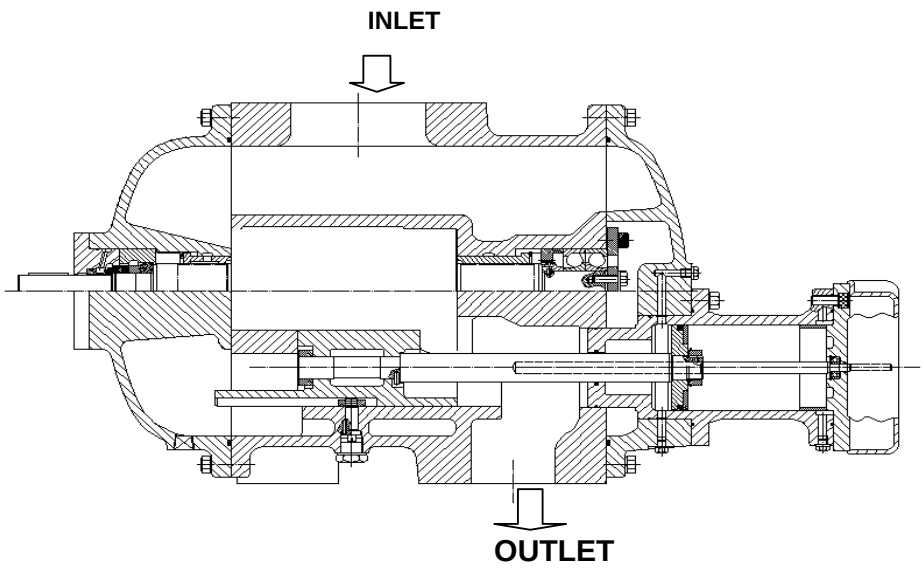
2.1 THE WRV/WRVi COMPRESSOR (continued)

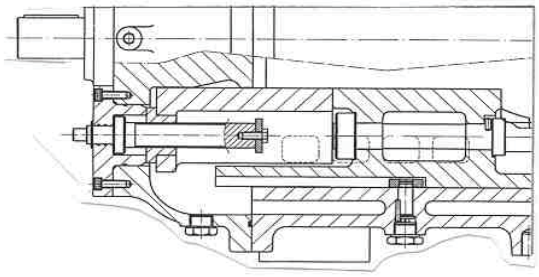
Capacity control is achieved by means of a slide valve in the casing operated by a piston in a hydraulic cylinder mounted on the compressor. Movement of the slide valve alters the point at which gas compression begins by allowing the gas from the start of the compression phase to re-circulate back to suction. This in effect decreases the volume of gas compressed. At the same time, the slide valve alters the size of the outlet port to keep the compression ratio constant. By this means, stepless capacity control is provided with an approximately proportionate saving in power.

The piston is actuated by lubricating oil fed from the lubricating oil manifold to one or other side of the piston. As oil is fed to the cylinder, the slide valve will move on load (towards the inlet end). When the oil feed is stopped, the slide valve will be locked in position. To off load the compressor, the oil trapped in the cylinder is allowed to escape to the oil return connection on the compressor and the slide valve will move off load (towards the outlet end) as oil is pumped to the opposite side of the piston.

The WRVi model, in addition to the above, also has the facility of selecting manually, a Vi ratio most suitable to the operating duty.

2.2 TYPICAL SECTIONAL ARRANGEMENT DRAWING:





MANUAL Vi ADJUSTMENT-WRVi

SECTION 3 - LUBRICATION OIL SPECIFICATION

Howden compressors are fitted, as standard, with neoprene 'O' rings.

These 'O' rings are compatible with the majority of standard refrigerants and many oils, but compatibility with all possible combinations of refrigerant and oil cannot be guaranteed.

Should you wish to review this matter, please do not hesitate to contact Howden Compressors Limited, who will be pleased to provide recommendations and costs for any special 'O' ring materials which may be required.

Typical Standard Refrigerants:

R717, R22, R134a, R404A, R407C, R410A, R507

Typical Oils:

Mineral Oil
Polyol Ester Oil
Poly Alkylene Glycol Oil
Alkyl Benzene Oil

Oil Viscosity:

For the majority of ammonia refrigeration applications, oil viscosity of 68 centistokes at 40^{o}C is the appropriate selection. However, with many other refrigerants, eg; R134a with high condensing temperatures, or applications involving hydrocarbon gases, a specific oil selection is required.

Howden Compressors Limited offers a consultancy service to all users of HCL product. Please consult the applications department of HCL who will be happy to advise on grade of oil applicable to the refrigerant or gas at the specific duty application.

4.1 ALIGNMENT OF COMPRESSOR COUPLINGS

Misalignment causes a vibration which affects other parts of the compressor, leading to premature failure of bearings, seals, etc. Drive couplings fitted to WRV compressors must be aligned correctly.

The coupling alignment tolerance figures can be seen under Section 5.2

Coupling gap dimensions should be set with the coupling held in a repeatable position, i.e. hard together or hard apart. This ensures that each coupling half is moved to the same axial position as each check is made.

The actual coupling gap should be correct when the shafts are in their normal running condition.

When setting the gap, the axial float of each shaft should be determined and the "hard together" or "hard apart" dimensions calculated.

Example: Compressor driven directly by turbine

Compressor shaft float 0.000mm (0.000")

Turbine shaft float 0.250mm (0.010")

The normal running position of the compressor shaft is thrusting towards the turbine and the turbine thrusting towards the compressor.

Required coupling gap 3.175mm (0.125")

If the gap is checked with the coupling "hard apart" it should be:

Required coupling gap	3.175mm (0.125")
plus Compressor shaft float	0.000mm (0.000")
plus Turbine shaft float	0.250mm (0.010")
= "Hard apart" gap	3.425mm (0.135")

If the gap is checked with the coupling "hard together" ie in the normal running condition, it should be equal to the required gap 3.175mm (0.125").

4.2 COUPLING ALIGNMENT - BASIC RULES

1. Compressor to be mounted on baseframe and mounting feet checked for soft foot and corrected where necessary.

2. Alignment to be set before connecting any pipework to the compressor.
   Allowable TIR = +/- 0.15mm Radially and Axially.

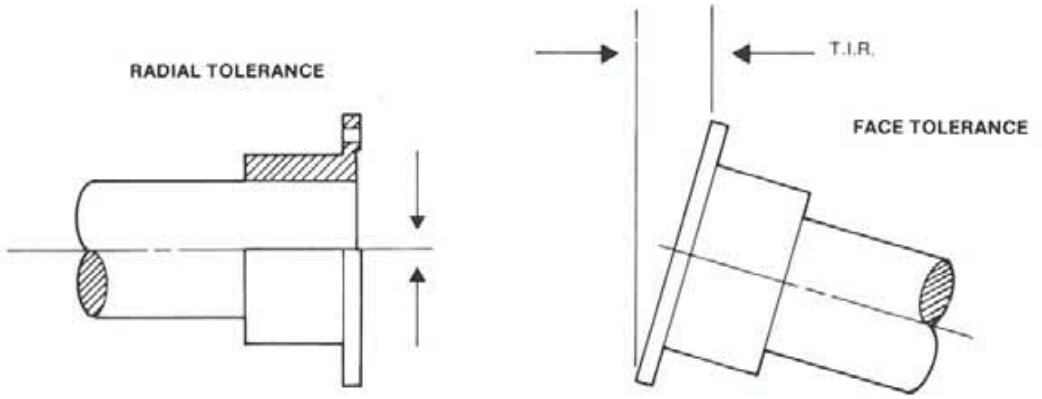
3. Under no circumstances should suction and discharge piping be strained into position. Distortion of the casing will cause premature failure of the compressor. A vertical and horizontal clock gauge must be mounted on the compressor input shaft/coupling hub to ensure no alteration occurs when pipes are being connected. Only after this is completed should the coupling hubs be connected.

   Note: Coupling hubs must **not** be hammered onto the compressor shaft.

4.3 ALIGNMENT TOLERANCE

The maximum acceptable line-up tolerance for couplings on compressor installations is as follows:

RADIAL TOLERANCE **FACE TOLERANCE**



Application	Radial Tolerance	Face Tolerance
A) Motor to Gearbox or Compressor ie Couplings operating up to 3,600 rpm.	A) 0.15mm (0.006") TIR	A) TIR 0.005mm/cm Dia. Of coupling
B) Gearbox to Compressor ie couplings Operating above 3,600 rpm.	B) 0.10mm (0.004")TIR	B) TIR 0.005"/inch Dia. Of coupling.

Radial Tolerance
Eccentricity = ½ TIR on circumference
TIR denotes Total Indicator Reading obtained by Clock Gauge

4.4 PIPING

Before installing the piping, the compressor inlet and outlet ports should be inspected to ensure no dirt is present.

Note that the pipes and fitting used should not restrict flows. To avoid this, always use piping with a bore ¼" larger than the thread diameter of the compressor port, eg, WRVi 255 oil connection to actuator cylinder thread is 1/2" BSP and so a 3/4" OD pipe should be used.

All piping should be supported so that no strain is transmitted to the compressor casings.

The 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 unit, as this will not correct the strain being imposed on the compressor. Oil injected refrigeration compressors must have a suction strainer permanently fitted directly on the compressor inlet.

Note that the oil pipes and fittings used should not restrict flows. To avoid this, always use piping with an OD 1/4" (6mm) larger than the thread diameter of the compressor port, eg, connection thread is 3/4" BSP and so a 1"OD pipe or metric equivalent should be used.

Before installing the piping, the compressor gas inlet and outlet ports and oil injection holes should be inspected to ensure no dirt is present.

Note: All piping should be supported so that no strain is transmitted to the compressor casing.

The 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. The pipes should be corrected and the supports adjusted accordingly.
It is not acceptable to re-align the drive unit as this will not correct the strain being imposed on the compressor.

Oil injected refrigeration compressors must have a suction strainer permanently fitted on the compressor inlet.

The set pins supplied with the suction and discharge flanges are for transport only and should be replaced with contract set pins or studs having correct thread engagement length.

When fitting the suction flange to the compressor, ensure that the tapped holes in the casing are cleaned out and free from water. Fit setpins/studs, coating the threads with pipe sealer to prevent ingress of water into tapped holes.

5.1 FIRST START UP

Installation of the compressor will have been carried out in accordance with Section 5 of this manual. The commissioning engineer should, however, ascertain that the correct procedures have been followed, in particular the coupling alignment must be checked, then proceed as follows:

1. Disconnect the coupling between the drive and the compressor and check that the motor rotation is correct for the compressor drive looking on the compressor input shaft.

   WRV and **WRVi** compressors - **CLOCKWISE**
   MRV compressors - **ANTI-CLOCKWISE**

2. Fill the oil tank with lubricating oil of the correct grade to the required level, as indicated on the tank level sight glass.

3. Ensure that the pipe from the oil filter to the manifold, the manifold and oil pipes to the compressor are clean and that new clean filter elements are fitted.

4. The lubricating oil pressure differential relief valve should be set to give a 2.1 bar (30 psi) oil manifold differential pressure for standard range compressors and 3.1 bar (45 psi) oil manifold differential pressure for 'H' range compressors at the correct operating temperature and with clean oil filter elements fitted.

5. Check the operation of any safety trips fitted by running the drive unit disconnected from the compressor and mechanically operating the trips.

   Check that the trips are set to act at a point which will protect the compressor from damage. The lubricating oil differential trip can be set at 0.83 bar (12 psi) on the standard range and 1.5 bar (22 psi) on 'H' range by partially closing the oil filter isolation valve to reduce the differential oil pressure to the point where the trip operates. As the filters become dirty, the differential oil pressure will drop to this figure, which is the minimum acceptable pressure.

6. Check that the compressor turns freely by hand and reconnect the coupling between the drive unit and the compressor.

7. Check that the cooling water is turned on to the lubricating oil cooler, if fitted.

8. Check that all gas inlet and outlet isolating valves are open.

9. Check that the Volume ratio Vi screw is in the minimum position.
   Rotate screw in a clockwise direction for minimum (2.2) Vi type only.

5.1 FIRST START UP (continued)

Notes:

1. Do not adjust the volume ratio Vi screw when compressor is on load.

2. The compressor should be in the unloaded position prior to start up.
   If the compressor is started without first being unloaded, a higher starting torque will be required.

10. Start the auxiliary lubricating oil pump.

11. Check that the volume ratio Vi screw is in the required operating position.
    See section 6.2 for details.

12. Calibrate the Capacity Linear Position Indicator as per Section 6.4
    Note: Linear Position Indicator not available on Auto Vi compressors.

13. Start the drive unit and check that all gauges are indicating correctly.

14. Run the compressor for 30 minutes at minimum gas flows and check that all readings are normal, then operate the capacity control valve to the required position. This position will be indicated on the dial mounted on the hydraulic cylinder.

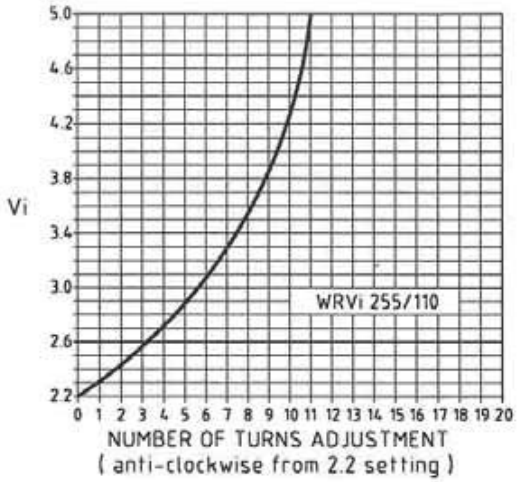
15. If possible, check the slide valve control over the full range of capacity.

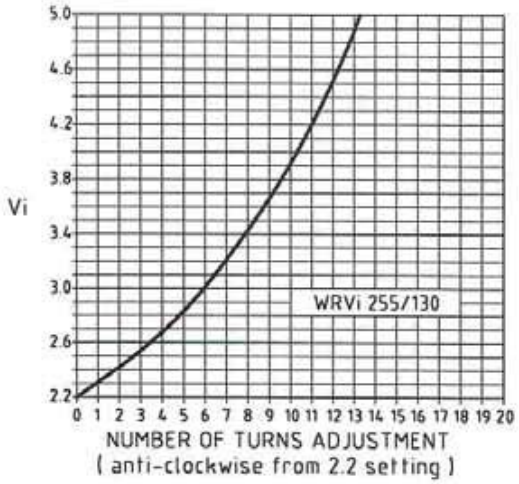
5.2 MANUAL Vi ADJUSTMENT (Vi type compressor)

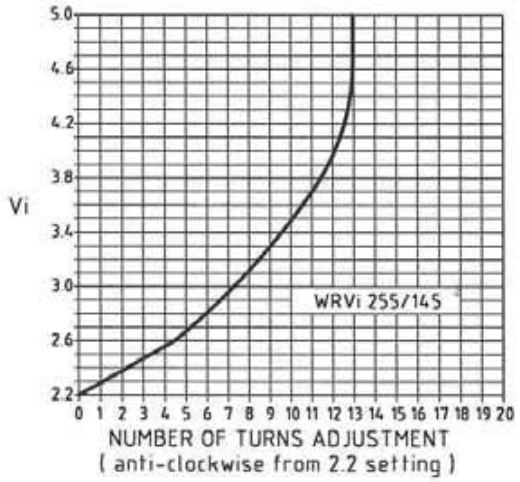
1. The Volume Ratio can be adjusted between 2.2 and 5.0 by rotating the square drive screw below the input drive shaft. Turn clockwise for minimum load (2.2) and anticlockwise for maximum load (5.0).
   Refer to graphs under section 6.3 for number of turns.

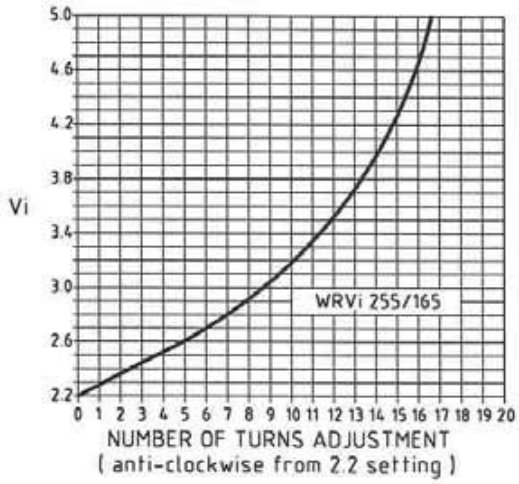
Note: Before making any adjustments to the Volume Ratio, the slide valve must be fully unloaded. From a safety aspect, it is recommended that the compressor be stationary.

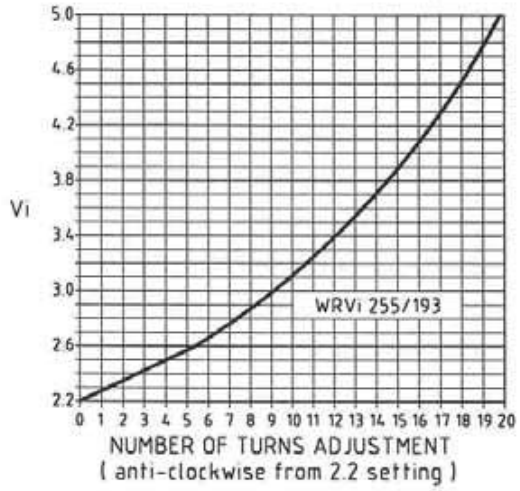
5.3 SLIDE VALVE STOP SETTINGS



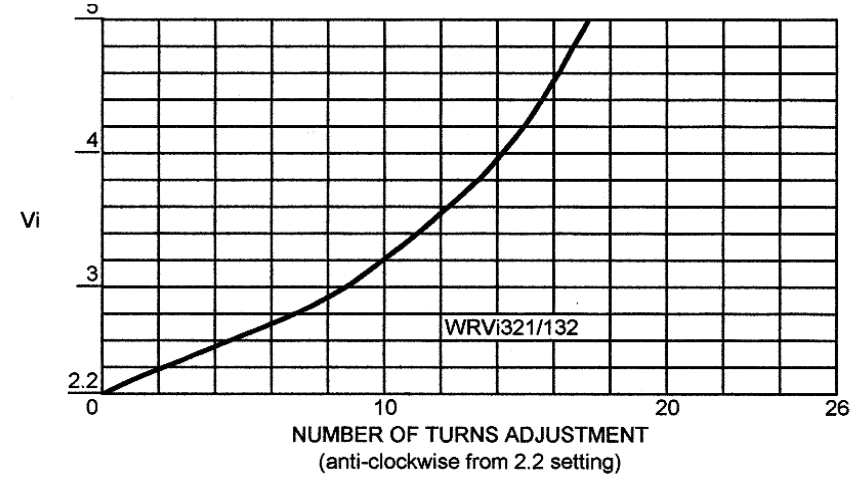


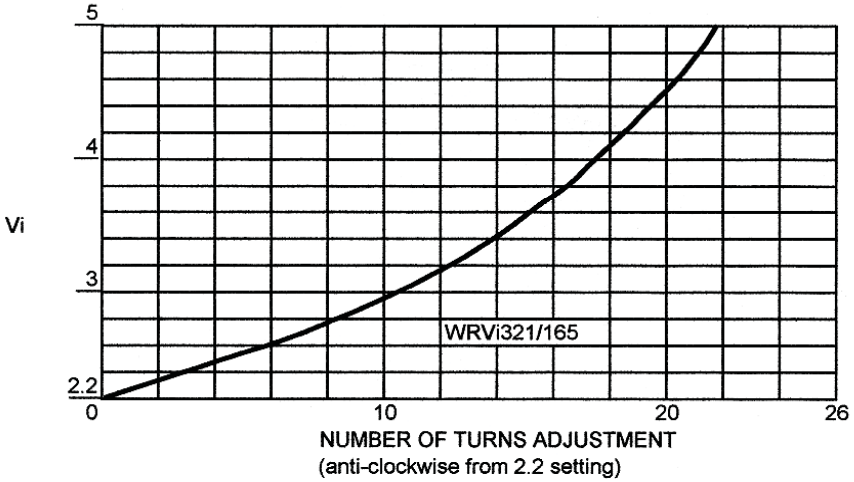


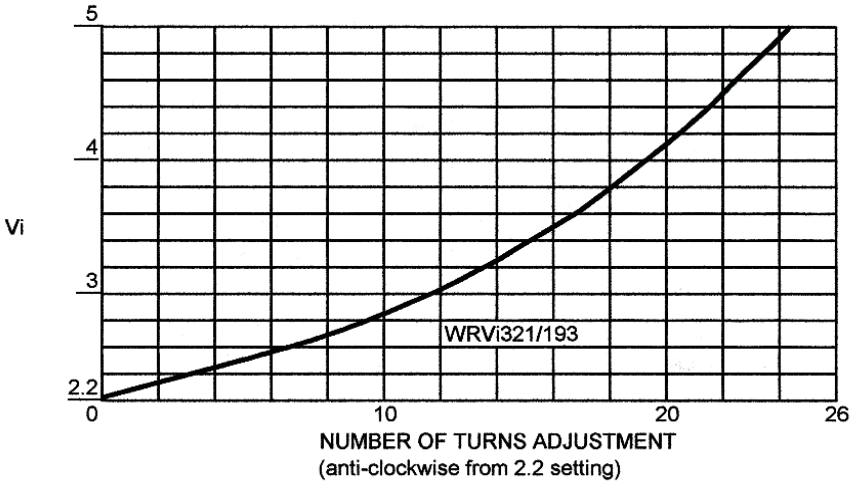




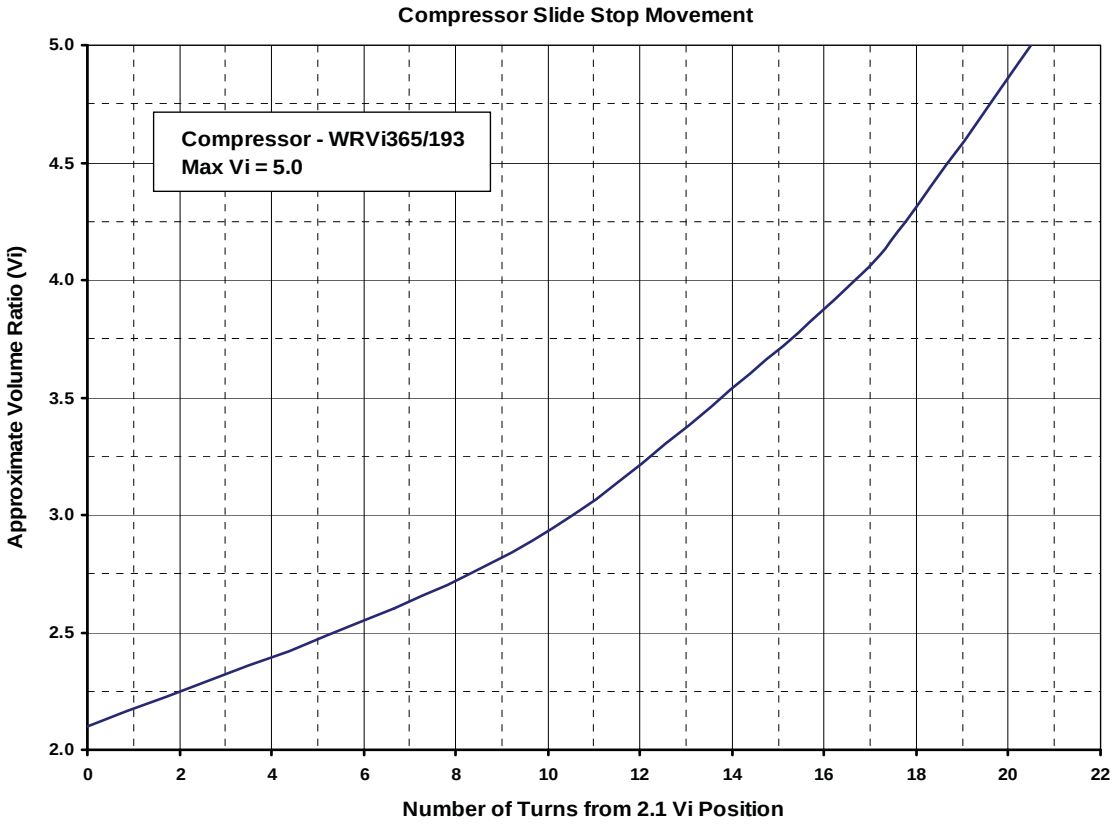
5.3 SLIDE VALVE STOP SETTINGS WRVi 321

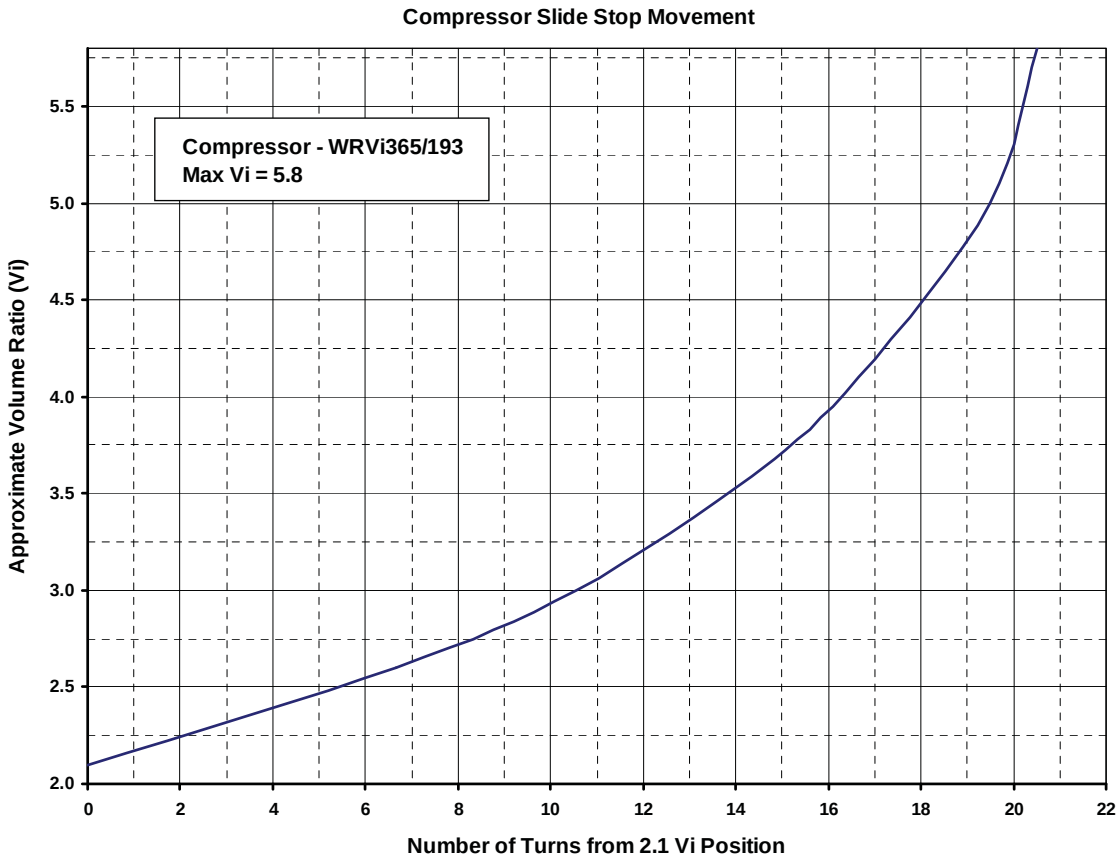




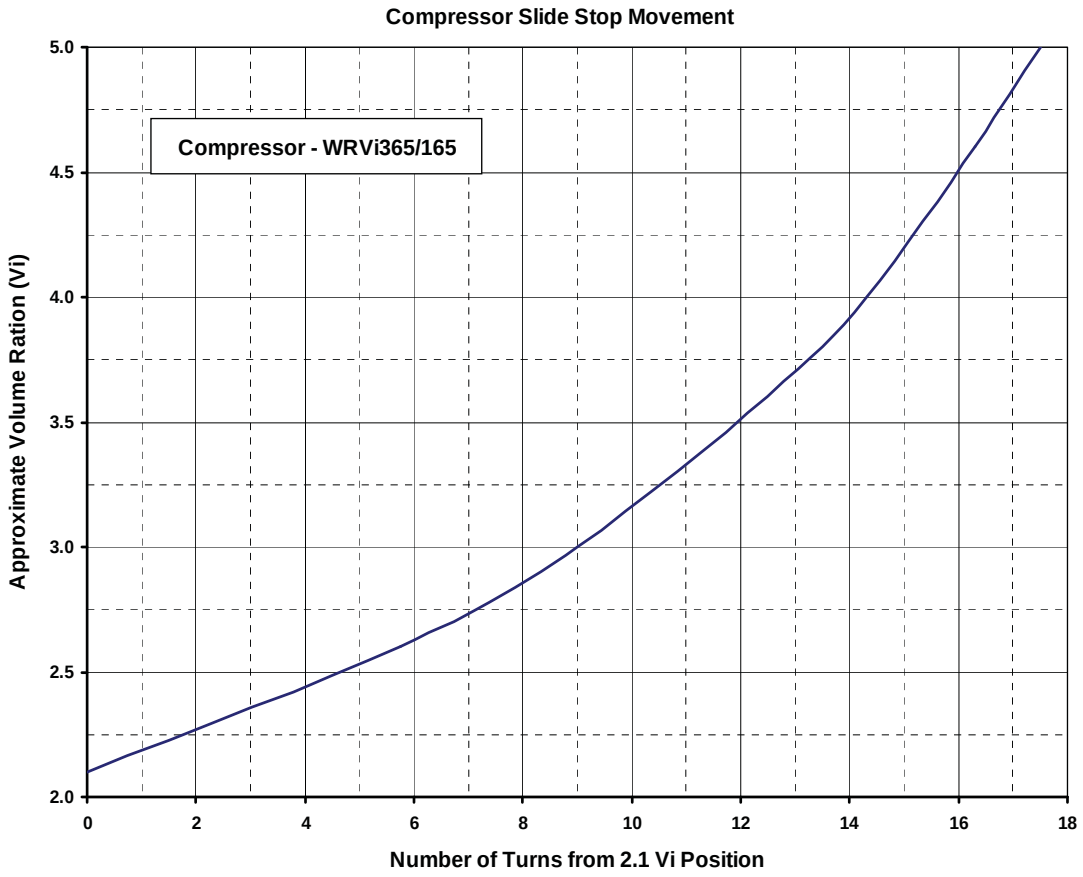


5.3 SLIDE VALVE STOP SETTINGS FOR WRVi365/193





5.3 SLIDE VALVE STOP SETTINGS FOR WRVi365/165



5.4 LINEAR POSITION INDICATOR (LPI)

General:

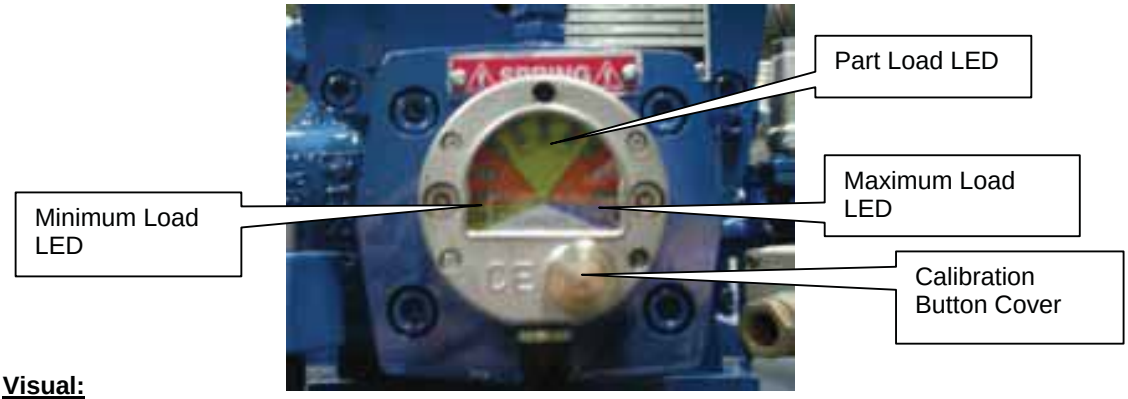
An electronic device called a Linear Potentiometer gives an indication of the position of the slide valve which can be used by the compressor control system.

The Linear Position Indicator (LPI) is an electronic contact-less displacement sensor inserted into a sensor well which allows the LPI to be removed from compressor without loss of oil or gas from the compressor.

The LPI has several usable options built into one device.

The slide valve position can be indicated in three different ways:

- Visual Light emitting diodes (LED)
- Visual and by an analogue output 4-20mA
- Visual and by a digital 24 V DC signal output on minimum and maximum slide valve position



Visual:

It is always possible to see the position of the slide valve.
At minimum load a yellow LED is illuminated at the lowest light on the left of the LPI.
At maximum load a blue LED is illuminated at the lowest light on the right of the LPI.
At part load only some of the LED are illuminated, eg, At 50% load only half of the LED will be illuminated.

Note: The compressor can only be allowed to start with the slide valve in the minimum load position. Therefore a signal from the minimum load electronic position switch is always required or if the 4 – 20 mA signal is being used, then a 4 mA signal is required.

5.4 LINEAR POSITION INDICATOR (LPI)

Visual and by an Analogue Output (4-20mA):

The minimum load position is given by the 4 mA output and the maximum load position is given by the 20 mA output. (**White Wire**)

Part load positions are indicated by intermediate values between 4 and 20 mA.
The LED's on the indicator also give a visual indication of part load operation. It should be noted that part load slide valve position is not a direct indication of actual compressor capacity at part load. Use of the 4 – 20 mA signal is common for many control systems and may be used on its own, if required, for all control functions for single and multiple compressor installations, subject to a suitable control system.

Connections:

Wiring Plug Connections	**Function**
1= Brown	Supply Voltage + 24V DC
2- White	Output Signal 4-20 mA
3=Blue	Common – 0 VDC

Visual and by a Digital 24V Output on Minimum and Maximum load:

There is also another option that can be used to control and get the minimum signal for start-up. This option works the same as the mechanical micro-switches but instead uses the electronic switches incorporated in the LPI unit. These electronic switches give a 24 V DC output.
A digital output is given on the Minimum and Maximum position of the slide valve and an interposing relay, which must be incorporated in the control panel in place of each mechanical micro-switch, is activated by the digital signal completing the control circuit signal. This interposing relay must have contacts with suitable ratings. The interposing relay replaces the original switch function.
The LED's only give a visual indication of the slide valve position.

If the slide valve is in the minimum position and the LED for minimum is illuminated, there will be a digital output on the **green/yellow wire.**
If the slide valve is in the maximum position and all the LED's are illuminated, there will be a digital output on the **black wire**.

Existing installations equipped with the mechanical micro-switches can use this option.

Connections:

Wiring Plug Connections	**Function**
1= Brown	Supply Voltage + 24V DC
3=Blue	Common – 0 VDC
4=Black	Digital Output Max. Load
5=Green/Yellow	Digital Output Min. Load

Choose the best way for giving a start signal and connect the wires according to the table.

5.4 LINEAR POSITION INDICATOR OPERATION & CALIBRATION

All compressors with variable Vi are despatched from Howden Compressors facility with Vi set at 2.2 and the LPI calibrated to suit Vi 2.2.
When the Slide Valve is in the unloaded position, the 10% minimum load LED should be illuminated.
To check that the LPI indicates maximum load when the slide valve is in the fully loaded position, ie all LED's are illuminated, the following checks should be made.

Move the slide valve to 100% (by using the oil pump or if the system is shut down, use a manual oil pump or air pressure). By pressurising the outboard side of the actuator piston the slide valve will be moved to the fully loaded position. The LPI should indicate 100% by illuminating all LED's.

If this is not the case please repeat the calibration procedure as follows:

Linear Position Indicator (LPI) Calibration Procedure

1. Move slide valve to Minimum Load position.

2. Remove calibration button cover.

3. Connect power supply to LPI, 24v DC max.

4. With slide valve in **Minimum Load** position, push calibration button **once.** Red LED will light, after 15-20 seconds light will turn to "**Flashing Red"**.

5. Move slide valve to **Full/Maximum Load** position.

6. With slide valve in **Full/Maximum Load** position, push calibration button **once**, Red LED will light for 15 seconds and then go off. Green LED will now light.

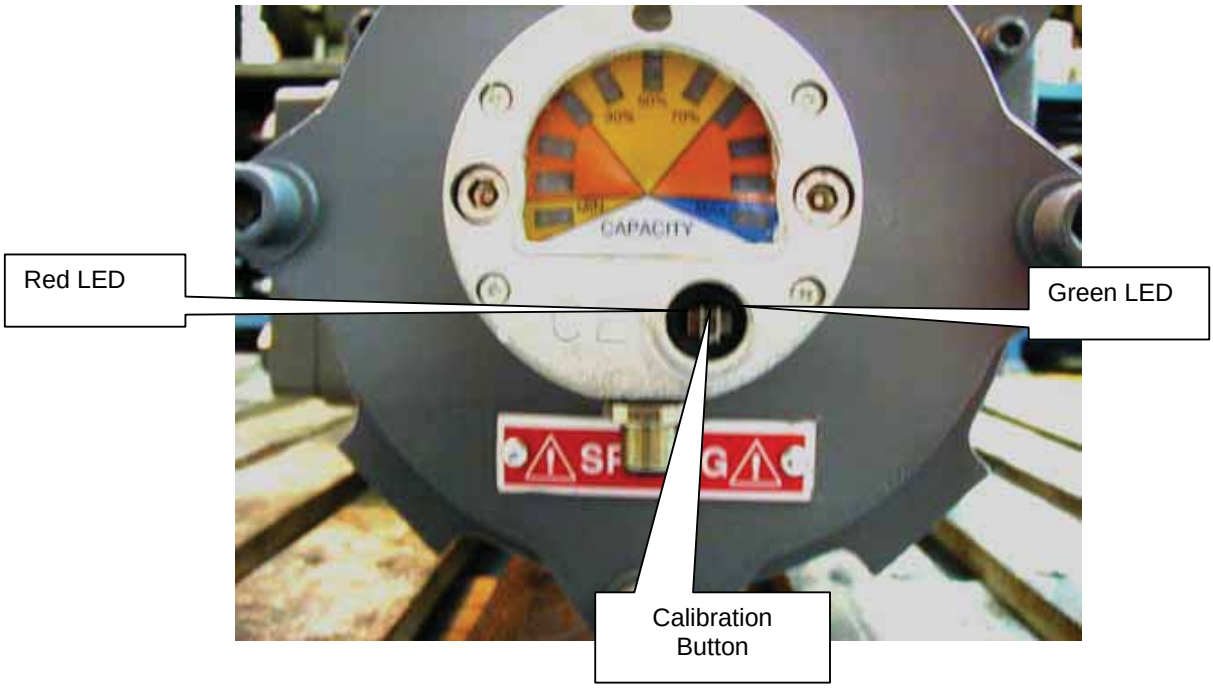
7. Calibration is now complete and sensor should now red maximum or 100% capacity.

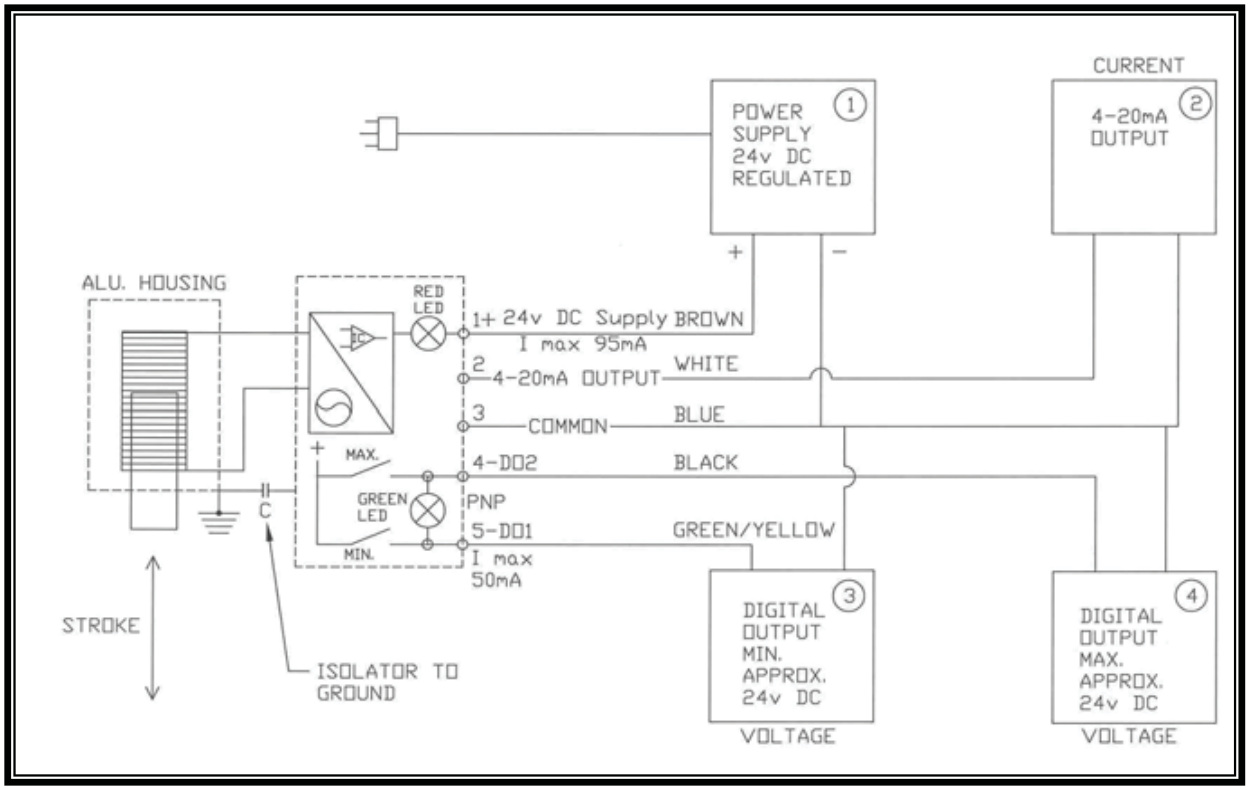
8. Refit button cover.

Note:

1. If Vi is changed, LPI **must** be re-calibrated.
2. The Minimum Load position gives a 4mA output and the Maximum Load gives a 20mA output.

The LPI Linear Position Indicator





LPI Wiring Diagram

5.5 ATEX TYPE LINEAR POSITION INDICATOR (LPI)

General:

An electronic device called a Linear Position Indicator gives an indication of the position of the slide valve which can be used by the compressor control system.

The Linear Position Indicator (LPI) is an electronic non contact transmitter inserted into a sensor well which allows the LPI to be removed from compressor without loss of oil or gas from the compressor.

The slide valve position can be indicated by an analogue output 4-20mA signal.

Note: The compressor should only be allowed to start with the slide valve in the minimum load position.

Analogue Output (4-20mA):

The minimum load position is given by the 4 mA output and the maximum load position is given by the 20 mA output.

Part load positions are indicated by intermediate values between 4 and 20 mA.

Use of the 4 – 20 mA signal is common for many control systems and may be used on its own, if required, for all control functions for single and multiple compressor installations, subject to a suitable control system.

Connections:

Plug Connections	Function
1	Supply Voltage + 24V DC
2	Common – 0 VDC
3	Output Signal 4-20 mA

Note: ATEX LPI Sensors are supplied with an Intrinsic safety barrier, and installation must be carried out according to the standards in force for the country in question.

Checking the ATEX LPI Calibration

All compressors with variable Vi are despatched from Howden Compressors facility with Vi set at 2.2 and the LPI calibrated to suit.

When the Slide Valve is in the unloaded position a 4mA output signal is achieved, and at maximum load a 20mA output signal. However, if the factory Vi setting is not appropriate and needs to be adjusted, re-calibration of the LPI sensor will be required.

ATEX Linear Position Indicator (LPI) Calibration Procedure

1. Move slide valve to Minimum Load position.

2. Apply supply voltage for 5 minutes before commencing calibration.

3. Push the calibration button for 5 seconds to enter calibration mode, the red LED will change from normally flashing to off.

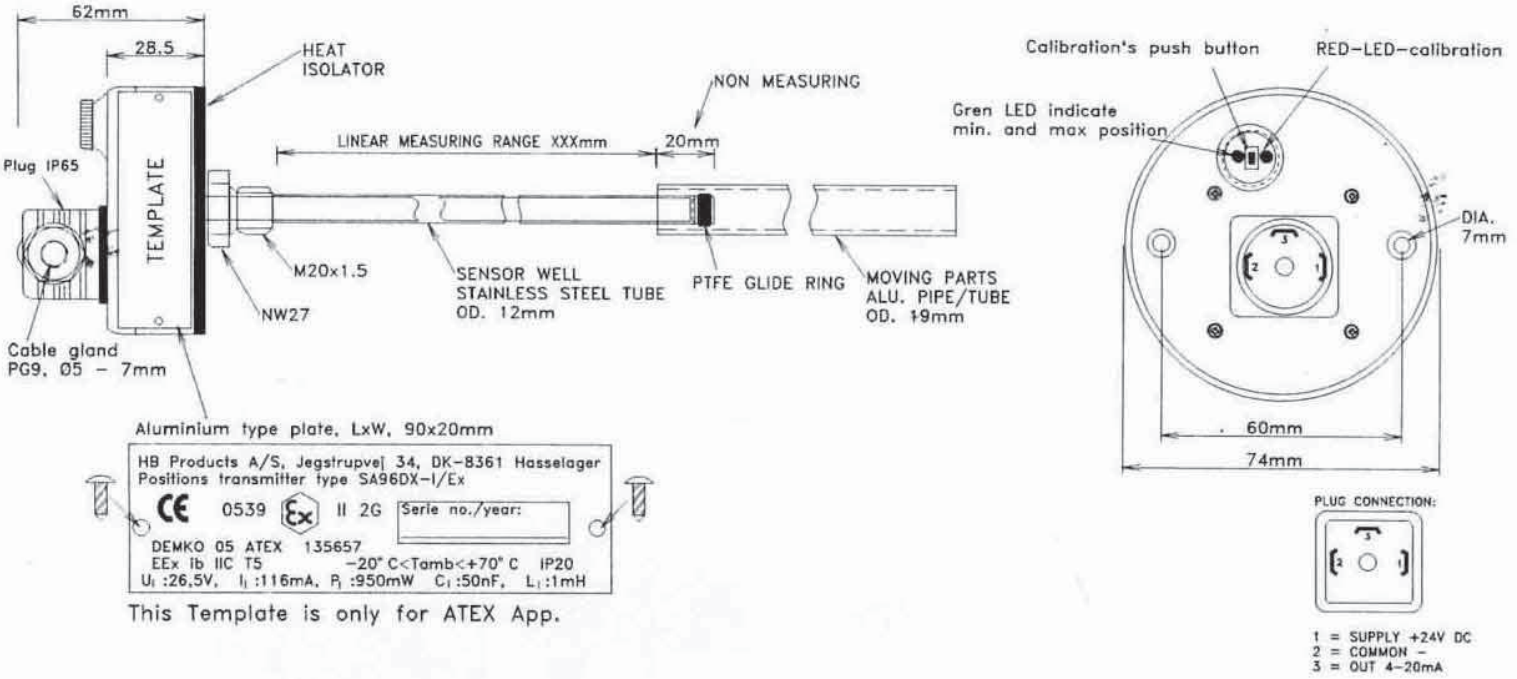
4. Move the slide valve to the minimum position, and then push the calibration button ONCE. The red LED is now illuminated constantly, when the red LED switches off it is ready for the 100% slide valve position calibration.

5. Move slide valve to the 100% maximum load position, and push the calibration button TWICE.

6. The red LED will flash quickly for a few seconds, once the LED returns to normal flash the calibration is complete.

The green LED indicates slide valve maximum and minimum valve travel end positions.

5.5 ATEX LPI SENSOR DRAWINGS



NOTE:

POWER SUPPLY/AMPLIFIER HAS TO MEET FOLLOWING DATA:

SUPPLY VOLTAGE :	12–26,5V DC
SHORT-CIRCUIT CURRENT :	min. 50mA
TRANSFORMER TYPE:	Isolated
APPROVAL:	ATEX/cULus/IECEx

When used in Ex-area the installation has to be carried out according to standards in force for the country in question.

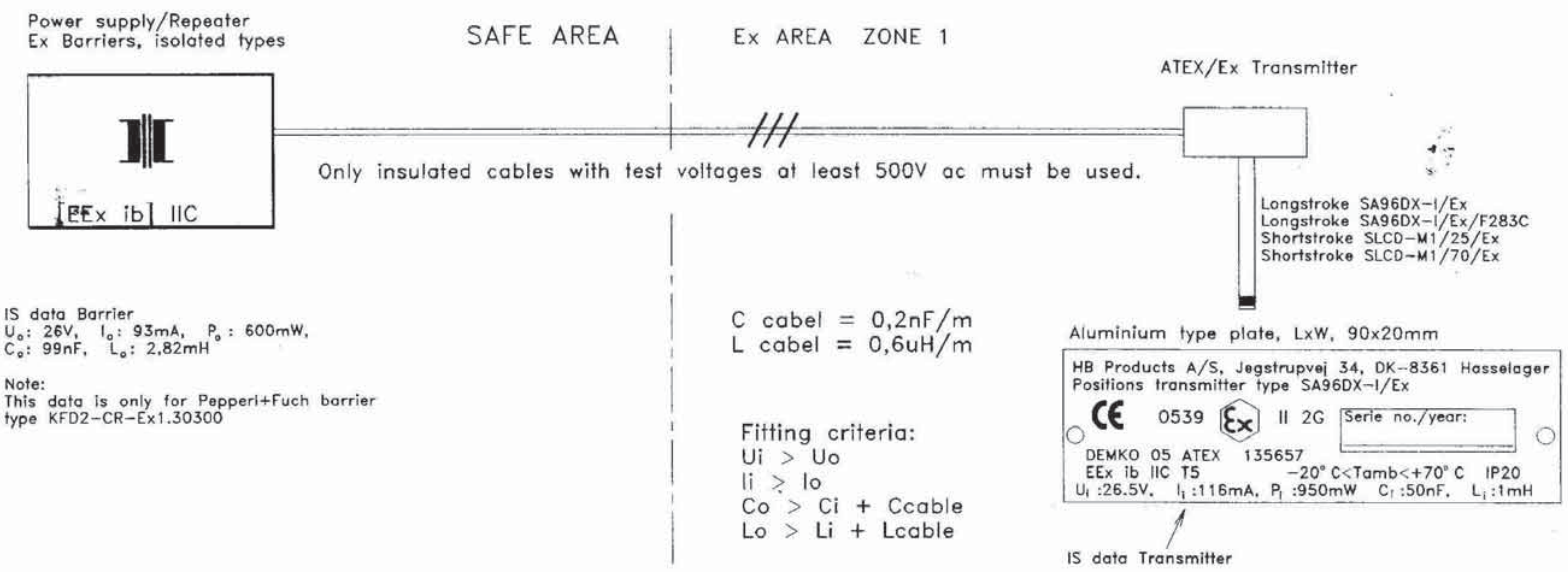
The Equipment must be electrically connected via an approved and certified galvanically isolated interface barrier placed outside the hazardous area.

COMPRESSOR TYPE/SIZE	LENGT SENSOR WELL IN mm	ASSEMBLY PART NO. ATEX TYPE
XRV 127	165	XR12000-A
XRV 163/204	250	XR24000-A
WRV 163	180	M3001001-A
WRV 204	250	M3001002-A
WRVI 255	350	M3001003-A
WRVI 321	410	M3001004-A

Date:	Ver. no.
03-10-06	01
Ver. date:	
Ver. date:	
Ver. date:	
Ver. date:	

ATEX Types HOWDEN LPI	HB Products A/S Jegstrupvej 34 DK-8361 Hasselager	SA96DX-I/xxx/Ex		*Approved by:*
		Const: ME	Drawing no. ATEX-LPI	Page: 1
				UL-DEMKO

Installation example in Ex area zone 1



NOTE:

POWER SUPPLY/AMPLIFIER HAS TO MEET FOLLOWING DATA:

SUPPLY VOLTAGE :	12-26,5V DC
SHORT-CIRCUIT CURRENT :	min. 50mA
TRANSFORMER TYPE:	Isolated
APPROVAL:	ATEX

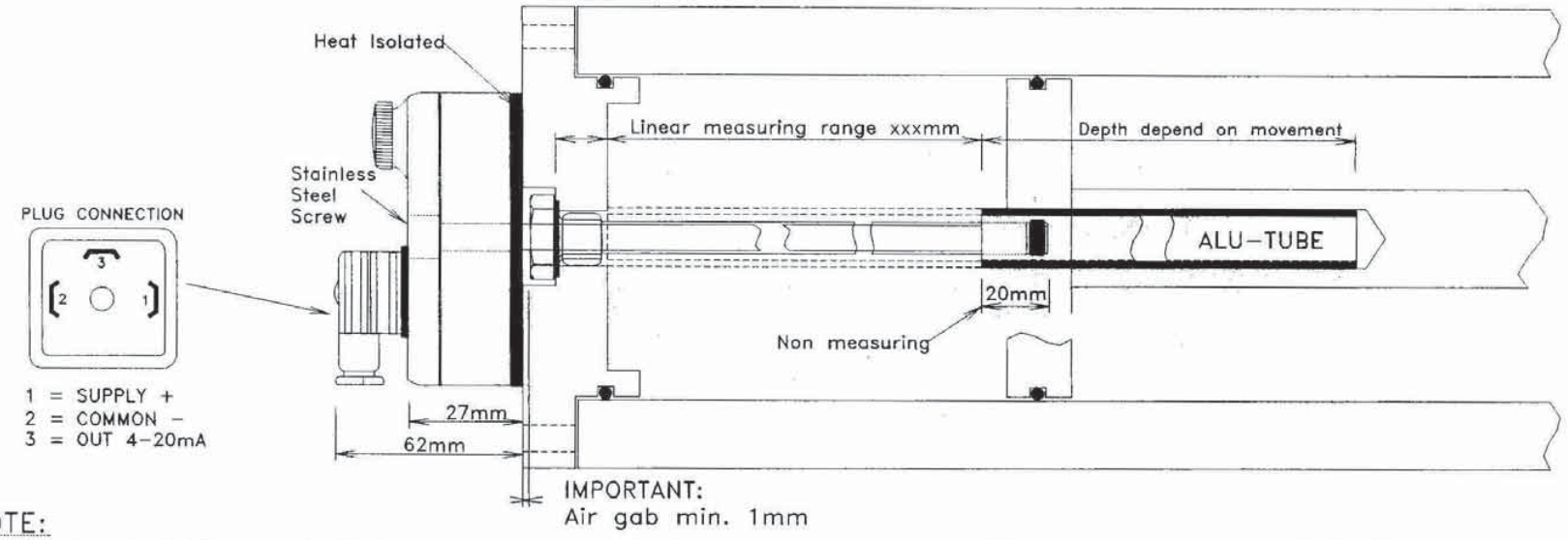
When used in Ex-area the installation has to be carried out according to standards in force for the country in question.

The Equipment must be electrically connected via an approved and certified galvanically isolated interface barrier placed outside the hazardous area.

Date:	Ver. no.
01-12-05	01
Ver. date:	

ATEX log: SA96DX-I No. A002 page 2	HB Products A/S Jegstrupvej 34 DK-8361 Hasselager	INSTALLATION: SA96DX-I/F283C/SLCD-M1__/Ex		*Approved by:*
		Const: ME	Drawing no. SA96EX02	Page: 2 of 2
				UL-Demko

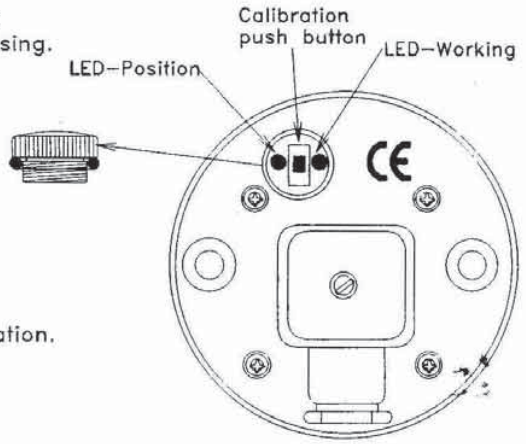
Mounting Instruction for all Longstroke Transmitters type SA96DX-I/xxx/Ex



NOTE:

Heat isolator should be mounted between kompressor and alu-housing, fixed with M6 stainless steell Head Cap Screw, to avoid heat transmission from the compressor to the transmitter housing.

IECEx, ATEX and cULus types:
To save power on the EX type the LED's switch OFF after 5min.
To activate the LED push once on the push button.



Calibration must be done before operation:

1. Apply Supply voltage min. 5 min. before Calibration.
2. Push the Cal. switch for 5 sek. to get the transmitter in Calibration mode the red LED change from normal flash to OFF.
3. Move the Slide valve to 0% position, and then push the calibration's button once, the red LED is now constaintly ON, when the red LED switch OFF its ready for 100% calibration.
4. Now move the Slide valve to 100% position, and push the calibration button twice, the red LED flash quickly, when the red LED flash normaly the calibration is done.

* The green LED indicate end position.

<1% = green LED flash.
>99% = green LED ON.

5.6 ASSEMBLY PROCEDURE FOR MAXIMUM AND MINIMUM LIMIT SWITCHES

1. Assemble the maximum switch support bracket and the minimum switch support bracket. The holes for these brackets are pre-drilled.

2. Assemble the switches to the brackets.

3. Ensure the slide valve is in the minimum position (off load, ie, indicator spindle turned fully anti-clockwise) slip the spaces onto the cam spindle.

4. Assemble the two cams on the spindle.

5. Turn the inner cam anti-clockwise until it operates the minimum micro-switch, lock the cam in this position with the grub-screw.

6. Move the slide valve to the maximum position (on load, ie, the indicator spindle turned fully clockwise) and turn the outer cam clockwise onto its peak position until it operates the maximum switch, lock the cam in this position with the grub screw. The switches can be heard to “click” when the peak on the cams pass over the contact on the switch.

7. The slide valve can be moved to maximum and minimum position by introducing air under pressure to the actuator cylinder through the tapped holes provided. Introducing air to the hole furthest away from the compressor body will move the slide valve to the “Max-load” position.

8. Move the slide valve to the “Max-load” position as described in 7. Fit and lock the indicator knob on the cam shaft with the slot on the knob in line with the “MAX” mark on the indicator plate.

9. Check the full travel of the valve against the indicator plate and ensure the slot on the indicator knob indicates the maximum (100%) and minimum (approximately 20%) positions.

10. Connect wires to switch terminals.

5.7 PROCEDURE FOR FITTING POTENTIOMETER

1. Power down electrical supply.

2. Disconnect the three wires to the potentiometer.

3. Mark gear mesh point on both gears.

4. Looking on the gear, rotate it in an anti-clockwise direction until the potentiometer shaft reaches the minimum position. Now mark the gear and the potentiometer to fix their orientation to each other.

5. Rotate the shaft of the new potentiometer to the same minimum position and mark the potentiometer same as original, fit the gear and align its mark to the mark on the new potentiometer and tighten the grub screw to fix their orientation.

6. Mark the potentiometer shaft where it has to be shortened, remove gear and cut shaft. Now fit potentiometer to mounting bracket and refit gear, line up marks on gear and potentiometer to correct orientation and secure grub screw.

7. Refit the assembly to the cylinder cover with the potentiometer still in the same minimum position and ensure the original marks on the gear teeth are in the correct mesh.

8. Lightly press down the assembly when tightening the bracket to the cylinder end cover to reduce gear backlash.

9. Re-connect the three wires to the potentiometer.

7.1 NORMAL START

1. Check the level in the oil tank.

2. Check that all necessary gas, oil and water valves are open.

3. Start the lubricating oil pump motor.

4. Ensure the capacity control valve is in the fully unloaded position.
   Adjust the volume ratio Vi screw to the required setting. Vi type only.
   (Turning fully clockwise sets Vi = 2.2). Refer to graphs under 6.3 for number of turns.

5. After the oil pump has been running for approximately 15 – 20 seconds, start the drive unit and check that all gauges are indicating normal readings.
6. Load the compressor - oil to outer end cylinder ports activates compressor slide valve to go "on load " position.

Note: A log should be kept of the instrument readings so that deviations from the normal running can easily be seen by the Engineer in charge of the installation.

7.2 NORMAL STOP

1. Stop the drive unit.

2. After the compressor stops, the control system should be operated to move the slide valve into the off load position, unless the control system does this automatically.

3. After the compressor stops rotating, stop the lubricating pump motor

The compressor is now ready for the next start-up sequence.

8.1 PRECAUTIONS DURING SHUTDOWN

The Howden WRV screw compressor operates on an oil/gas mixture and short periods of shutdown will not adversely affect the unit.

If the compressor is shut down for an extended period, the suction and discharge valves should be closed and the lubricating oil pump should be run for approximately 10 minutes each week to distribute oil through the set.

Turn the compressor driveshaft a few times every week by hand. This will help to avoid Brinelling of the anti friction bearings.

If the shutdown period is three months or more, the above procedure should be continued, and in addition, the compressor set should be run for one hour every three months. See Section 7.1 - Normal Start.

During a shutdown period in cold conditions, any water cooled items of the plant should be drained or the cooling water flow maintained to prevent frost damage.

Users may use suitable inhibiting oils in the Howden Screw Compressor prior to a long shutdown.

If you have any doubts about the compatibility of any inhibiting oil with your gas or existing lubrication oil, please contact the manufacturer or your dealer.

9.1 GENERAL COMMENTS

The compressor is designed to give long periods of trouble free operation with the minimum of maintenance.

A yearly inspection is recommended for all Howden compressor installations. Some installations may require an annual statutory insurance survey. An Annual Inspection kit will be required for this inspection.

The purpose of the yearly inspection survey is to check if there is any wear of the journal and thrust bearings, slide valve guide block, PTFE seals and Actuator piston and seals, and if any wear is found, for these components to be renewed.

The following are the maximum acceptable floats in the Thrust Bearings:

WRV 163 and 204,	0.003mm (0.0001")
WRVi 255 and 321 & 365	0.003mm (0.0001")
WRVT 255/110 and 130	0.160mm (0.0063")
WRVT 255/145,165,193 and 220	0.200mm (0.0079")
WRVT 321	0.275mm (0.0108")
WRVT 365	0.425mm (0.0167")
WRVT 510	0.450mm (0.0177")

After four years of operation it is recommended that an approved Howden service engineer completes a major overhaul on the compressor. After this time, the thrust bearings must be renewed. The bearings may still be serviceable, but all bearings have a finite lifespan and replacement at this point may forestall an expensive compressor breakdown at a later date.

When the compressor is being inspected or overhauled it must be in a clean area.

On WRV and WRVi compressors the inspection overhaul procedure is different between the 163 and the 204/255/321 compressor due to construction variations.
On all WRVT compressors the inspection procedure is different to the WRV compressor due to the thrust bearing configuration. Please ensure that the correct procedure is used for the size and type of compressor involved.

Alternatively, Howden Compressors Limited have a specialist Overhaul Department where compressors are inspected, a report sent, and only on receipt of client's instructions the compressor will be overhauled. Prior to despatch, the compressor is fully tested and supplied with a one year warranty.

The following are all available for the WRV and WRVi Compressor range:

SERVICE MANUALS SPARES KITS OVERHAUL KITS

Special tools to ease dismantling and reassembly

Please contact Howden Compressors Ltd, Compressor Business Unit, for further information. Address in the foreword of this manual.

9.2 COMPRESSOR RECORD

COMPRESSOR TYPE / SERIAL No	CONTRACT No	COMMISSIONING DATE

CLIENT / USER

OPERATING DUTY

COMP. SUCTION PRESSURE
COMP. DISCHARGE PRESS.
OIL SUPPLY PRESSURE
OIL SUPPLY TEMPERATURE
PRODUCT / GAS TYPE
INPUT SPEED

TYPE OF LUBRICATING OIL

SERVICE HISTORY

	HOURS	DATE	PARTS REPLACED
1st SERVICE			

	HOURS	DATE	PARTS REPLACED
2nd SERVICE			

	HOURS	DATE	PARTS REPLACED
3rd SERVICE			

Our Compressor Business Unit can offer you a comprehensive range of facilities to ensure the continued reliable operation of your Howden compressor.

We can supply:

1. A comprehensive range of direct replacement compressors, supplied with a warranty.

2. Approved parts and technical information to allow **urgent** repairs to be carried out on site.

3. A field engineer to service or supervise the installation and commissioning of the compressor.

4. Quotations for price and delivery of spare parts.

5. A comprehensive service contract or survey incorporating full vibration analysis tailored specifically to meet customer requirements and time schedules.

   For further information and details of the above please contact the Compressor Business Unit directly at the address in the foreword of this Manual.

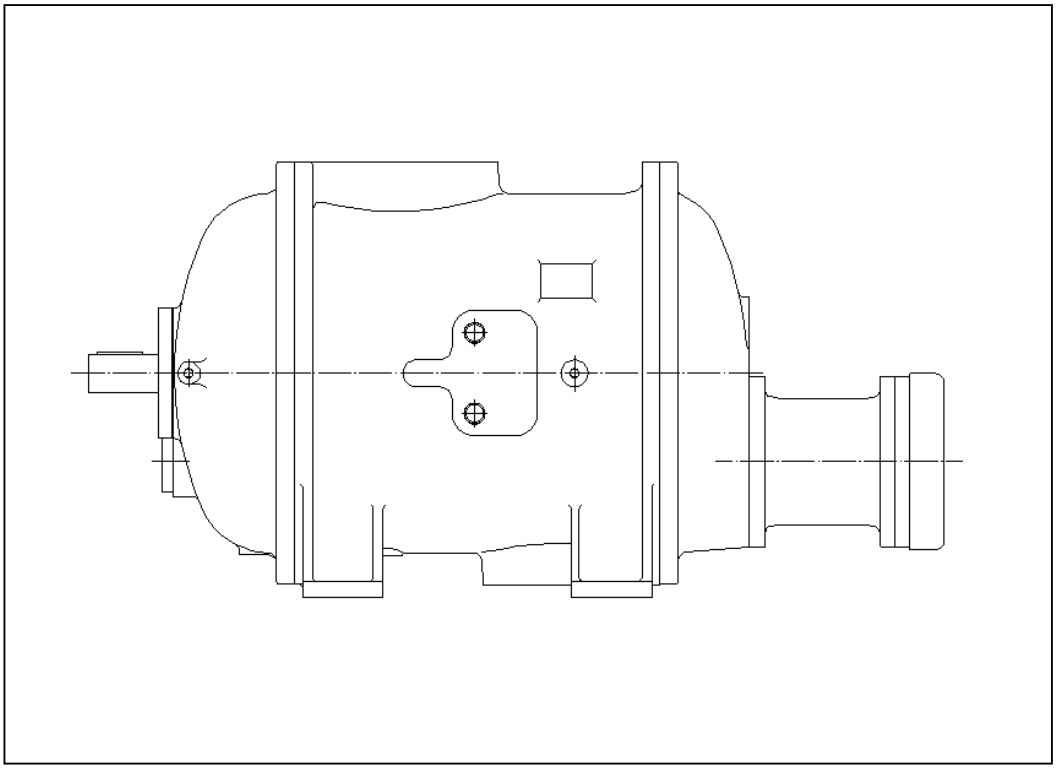
Howden Compressors Limited
Compressor Business Unit
133 Barfillan Drive
Glasgow G52 1BE
UNITED KINGDOM

Tel: +44 (0)141 882 3346
Fax: +44 (0)141 883 5901
e-mail: sales@howdencompressors.co.uk
Web: www.howden.com

Howden Compressors LLC
1850B North Gravers Road
Plymouth Meeting
PA 19462
USA

Tel: 001 610 313 9800
Fax: 001 610 313 9215
e-mail: sales@howdencompressors.com
Web: www.howden.com

Howden



WRV & WRVi

COMPRESSOR RANGE

SERVICE MANUAL

INDEX TO SECTIONS

SECTION 1

FOREWORD

READ CAREFULLY BEFORE INSTALLING AND STARTING YOUR COMPRESSOR

These instructions have been prepared to ensure that your compressor gives long and satisfactory service.

Detailed instructions for carrying out an annual inspection or overhaul procedure is included for the following range of compressors:

MK1G-1H/WRV163

MK6-6A-6B/WRV204

MK6-6A-6B/WRVi255

MK6-6A/WRVi321

MK1/WRVi365

The entire manual should be read before reverting to any one section for specific information.

One copy should be given to the personnel responsible for installing and operating the compressor.

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

HOWDEN COMPRESSORS
Compressor Business Unit
133 Barfillan Drive
Glasgow
G52 1BE
UK

Telephone: 0044 (0)141 882 3346
Fax: 0044 (0)141 882 8648
E-mail: hcl@aftersales@howden.com
Website: www.howden.com

or

HOWDEN COMPRESSORS LLC
1850B North Gravers Road
Plymouth Meeting
PA 19462
USA

Telephone: 001 610 313 9800
Fax: 001 610 313 9215
E-mail: sales@howdencompressors.com
Website: www.howden.com

All enquiries should be accompanied by the Howden Compressors Contract Number and the Compressor Serial Number, taken from the nameplate on the side of the compressor body.

SECTION 2

DESCRIPTION

2.1 THE WRV COMPRESSOR

The Howden WRV & WRVi Oil Injected Compressor is a positive displacement, capacity controlled, oil flooded, rotary machine.

Compression is achieved by the meshing of two helical rotors on parallel shafts housed in a casing.

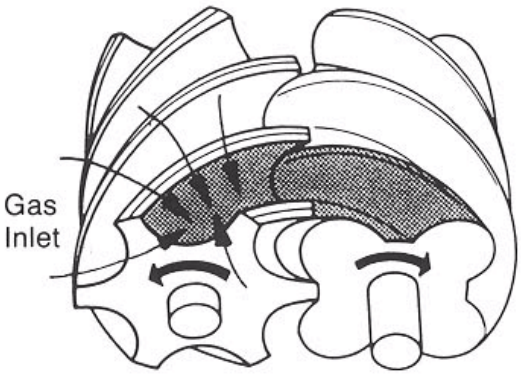
The accurately machined helical rotors are called Male and Female. The Male (driving) rotor has four lobes which mesh with six flutes in the female (driven) rotor, both rotors having the same outside diameter. Each rotor is supported by two plain white metal, thick walled, journal bearings fitted adjacent to the compression chamber. Angular contact bearings, offloaded by internal balance pistons accommodate the axial thrust load.

Capacity control is achieved by means of a hydraulically controlled slide valve in the compressor. This allows internal gas re-circulation, thus controlling the capacity from 100% down to nominally 10% with power saving.

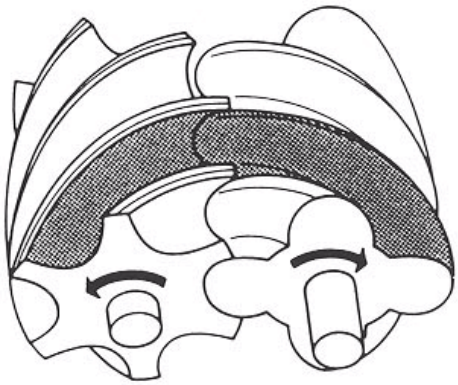
Various methods of hydraulic cylinder control are available and the appropriate literature provided by the compressor set supplier, should be studied before carrying out any work on this equipment.

2.2 THE COMPRESSION CYCLE (DIAGRAMMATIC ONLY)

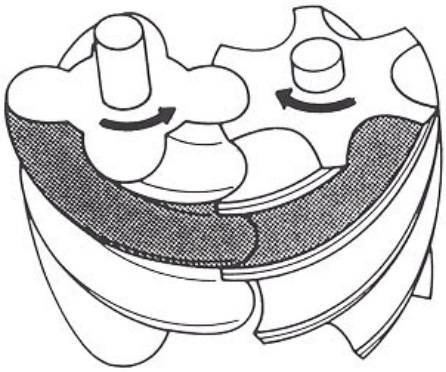
1. Gas is drawn in to fill the interlobe space between adjacent lobes on top side of rotors at Inlet End.



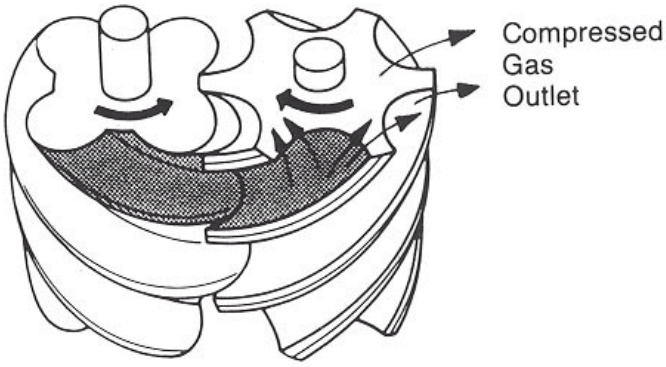
2. As the rotors rotate, the interlobe space moves past the inlet port so sealing the interlobe space. Viewed from the top side of rotors at Inlet End.



3. Continued rotation progressively reduces the space occupied by the gas, causing compression. Viewed from underside of rotors at Discharge End.



4. When the interlobe space becomes exposed to the outlet port the gas is discharged. Viewed from the underside of rotors at Discharge End.



2.3 DESCRIPTION OF A GAS SYSTEM FOR A TYPICAL REFRIGERATION COMPRESSOR SET

Gas is drawn into the compressor through a non-return valve and then a strainer is fitted directly on the inlet flange and discharged into an oil tank/separator. The non-return valve is necessary to prevent the compressor being “motored” in the reverse direction when it is stopped with high gas pressure at the outlet.

If necessary, a second non-return valve is positioned at the outlet of the tank to prevent the entry of gas or liquid refrigerant.

Primary separation of the oil mixed with the gas is achieved in the tank, secondary separation takes place in a wire mesh element separator positioned close to the tank outlet.

In some separator designs the wire mesh is replaced by a separator cartridge.

The separated oil drains into the oil tank. A further secondary separator vessel may also be fitted where a very high separation efficiency is required. The oil separated is usually drained into the compressor through a small bore pipe which can be fitted with a protective filter and an isolating valve.

2.4 DESCRIPTION OF AN OIL SYSTEM FOR A TYPICAL REFRIGERATION COMPRESSOR SET

Oil at outlet pressure is drawn from the tank by the oil pump, passed through a cooler and micronic filters to the manifold where it is fed to the bearings, balance piston, shaft seal, compression chamber and hydraulic actuator.

When liquid refrigerant injection is used there is no oil cooler.

A differential pressure relief valve in the system before the filters maintains a manifold pressure in the range of 30 psi (2 kg/cm^2) for a standard range compressor set and 40 psi (2.7 kg/cm^2) for an ‘H’ designated compressor set. When the compressor operates on a continuous duty, duplex micronic filters may be fitted, allowing one filter element to be changed while the other is in operation.

Approved lubricating oils for refrigeration compressors are listed under Section 2.5.

2.5 RECOMMENDED LUBRICATING OILS

Howden compressors are fitted, as standard, with neoprene ‘O’ rings.

These ‘O’ rings are compatible with the majority of standard refrigerants and many oils, but compatibility with all possible combinations of refrigerant and oil cannot be guaranteed.

Should you wish to review this matter, please do not hesitate to contact Howden Compressors Limited, who will be pleased to provide recommendations and costs for any special ‘O’ ring materials which may be required.

Typical Standard Refrigerants:

R717, R22, R134a, R404A R407C, R410A, R507

Typical Oils:

Mineral Oil
Polyol Ester Oil
Poly Alkylene Glycol Oil
Alkyl Benzene Oil

Oil Viscosity:

For the majority of ammonia refrigeration applications, oil viscosity of 68 centistokes at 40ºC is the appropriate selection. However, with many other refrigerants, eg; R134a with high condensing temperatures, or applications involving hydrocarbon gases, a specific oil selection is required.

Howden Compressors Limited offer a consultancy service to all users of HCL product.
Please consult the applications department of HCL who will be happy to advise on grade of oil applicable to the refrigerant or gas at the specific duty application.

SECTION 3

INSTALLATION

3.1 ALIGNMENT OF COMPRESSOR COUPLINGS

The couplings supplied with this compressor must be aligned using the method described below:

If a compressor only is supplied the coupling alignment tolerance figures can be seen under Section 3.2.

During alignment checks, both half couplings should be rotated together from 0° to 90°, 180°, 270° and 360° and readings of radial and facial alignment recorded. Turning both half couplings together ensures that readings are recorded at the same point on each half coupling, thus eliminating the effect of any irregularities on the outside diameters, or faces of the half coupling.

Commence alignment by setting the faces of the coupling halves parallel in the vertical plane. The axes will now be parallel in the horizontal plane and further adjustment to obtain the correct centre heights will require equal shimming under each foot of the unit being adjusted. The units are now positioned vertically and horizontally.

Further adjustment to obtain the correct coupling gap, radial and facial alignment, will only require movement of one unit on the existing shim size.

Coupling gap dimensions should be set with the couplings held in a repeatable position, ie, hard together or hard apart. This ensures that each coupling half is removed to the same axial position as each check is made.

The actual coupling gap should be correct when the shafts are in their normal running condition. If the combined float of the driving and driven shaft exceeds the coupling gap tolerance, the value and direction of float for both shafts will be shown on the General Arrangement Drawing.

When setting the gap the axial float of each shaft should be determined and the “hard together” or “hard apart” dimension calculated.

Example: Compressor driven directly by a turbine.

Compressor shaft float	0.050mm (0.002”)
Turbine shaft float	0.250mm (0.010”)

The normal running position of the compressor shaft is towards the turbine and the turbine normally runs thrusting towards the compressor.

Required gap	3.175mm (0.125”)

If the gap is checked with the couplings “hard apart” it should be:

Plus Compressor shaft float	0.000mm (0.000”)
Plus Turbine shaft float	0.250mm (0.010”)
= “Hard apart” gap	3.425mm (0.135”)

3.1 ALIGNMENT OF COMPRESSOR COUPLINGS (Continued)

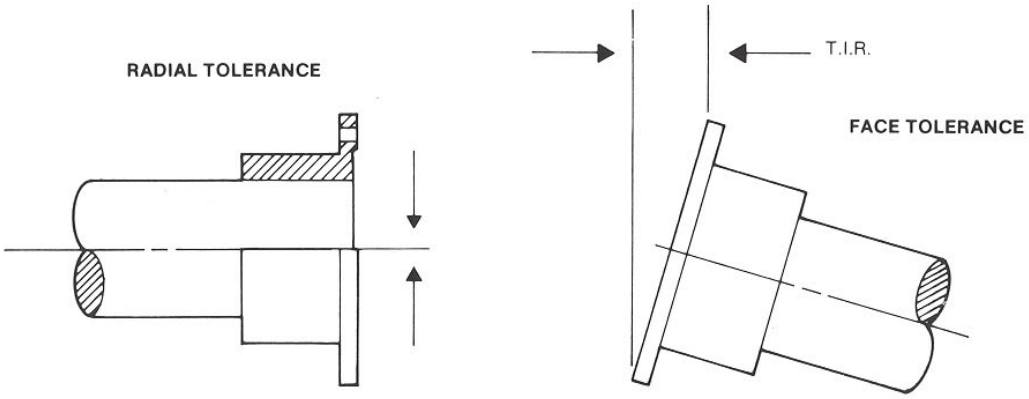
If the gap is checked with the couplings “hard together”, ie, in the normal running condition, it should be equal to the required coupling gap: 3.175mm (0.125”).

NOTE: If a “limited float” coupling is used with an electric motor whose shaft has no thrust bearing, the gap must be correct with the motor shaft on its magnetic centre. In this instance the facial alignment check should be made, rotating the driven half coupling only as the drive (motor) half coupling is not located axially, or preferably by a “double-clock” method, which avoids the problem of repeated axial position.

3.2 ALIGNMENT TOLERANCE

The maximum acceptable line-up tolerance for couplings on compressor installations is as follows:

RADIAL TOLERANCE **FACE TOLERANCE**



Application

A. Motor to Gearbox or Compressor ie couplings operating up to 3,600 rpm

Radial Tolerance	**Face Tolerance**
0.15mm (0.006”) TIR	TIR 0.005mm/cm or 0.005”/in Dia. Of coupling

B. Gearbox to Compressor i.e. couplings operating above 3,600 rpm

Radial Tolerance	**Face Tolerance**
0.10mm (0.004”) TIR	TIR 0.005mm/cm or 0.005”/inch Dia. Of coupling

Radial Tolerance
Eccentricity = ½ TIR on circumference

TIR denotes Total Indicator Reading obtained by Clockgauge

3.3 DOWELLING

Only one unit of any assembly will be dowelled before despatch. Dowels should be fitted to ease re-alignment when components are removed for overhaul.

3.4 PIPING

Before installing the piping the compressor inlet and outlet ports should be inspected to ensure no dirt is present.

Note that the pipes and fitting used should not restrict flows. To avoid this always use piping with a bore ¼" larger than the thread diameter of the compressor port, eg, WRV 204 oil injection connection thread is ¾" BSP and so a 1" OD pipe should be used.

NOTE: All piping should be supported so that no strain is transmitted to the compressor casings.

The 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 unit as this will not correct the strain being imposed on the compressor. Oil injected refrigeration compressors must have a suction strainer permanently fitted directly on the compressor inlet.

SECTION 4

FIRST START UP

4.1 FIRST START

Installation of the compressor will have been carried out in accordance with Section 3 of this manual. The Commissioning Engineer should however ascertain that the correct procedures have been followed, in particular the coupling alignment must be checked, then proceed as follows:

1. Disconnect the coupling between the drive and the compressor and check that the direction of rotation is correct to drive the compressor in a clockwise direction, looking on the compressor input shaft. (Anti-clockwise if compressor MRV model).
2.
3. Fill the oil tank with lubricating oil of the correct grade to the required level as indicated on the tank level sight glass.

4. Ensure that the manifold and oil pipes to the compressor are clean then start the lubricating pump motor to circulate the oil and clean the system.

5. The lubricating oil pressure differential control valve should be set to give a 30 psi (2 kg/cm²) oil manifold differential pressure for a standard range compressor and 40 psi (2.7 kg/cm²) oil manifold differential pressure for an 'H' designated compressor at correct operating temperature, with clean oil filter elements fitted.

6. Check the operation of any safety trips fitted by running the drive unit disconnected from the compressor and mechanically operating the trips, check that the actual settings are in accordance with the contract specification. The lubricating oil differential pressure trip can be set at 12 psi (0.85 kg/cm²) on a standard range compressor and 22 psi (1.54 kg/cm²) on 'H' designated compressors by partially closing the oil filter outlet isolation valve and thereby reducing the differential oil pressure. As the filters become dirty the differential oil pressure will drop to these figures, which are the minimum accepted value.

7. Check that the compressor turns freely by hand and reconnect the coupling between the drive unit and the compressor.

8. Check that the cooling water is turned on to the lubricating oil cooler, if fitted.

9. Check that all gas inlet and outlet isolating valves are open.

10. Start the lubricating oil pump motor.

    NOTE: The compressor should be unloaded prior to start up. If the compressor is started without first being unloaded a higher starting torque will be required.

11. Start the drive unit and check that all gauges are indicating correctly.

12. Run the compressor for 30 minutes at minimum gas flows and check that all readings are normal, then operate the capacity control valve to the required position. This position will be indicated on the dial mounted on the hydraulic cylinder.

13. If possible, check the slide valve control over the full range of capacity.

SECTION 5

NORMAL OPERATION

5.1 NORMAL START

1. Check the level of the oil in the tank.

2. Check that all the necessary gas, oil and water valves are open.

3. Start the lubricating oil pump motor.

4. Ensure the capacity control valve is in the fully unloaded position.

5. Start the drive unit and check that all gauges are indicating normal readings.

5.2 NORMAL STOP

1. Stop the drive unit.

2. After the compressor stops, the control system should be operated to move the slide valve into the off load position unless the control system does this automatically.

3. After the compressor stops rotating, stop the lubricating oil pump motor.

4. Close all gas and water isolating valves.

The compressor is now ready for the next start up sequence.

NOTE: A log should be kept of the instrument readings so that deviations from normal running conditions can be easily seen by the Engineer in charge of the installation.

SECTION 6

PROCEDURES DURING SHUTDOWN

6.1 PROCEDURES DURING SHUTDOWN

The Howden WRV Screw Compressor operates on an oil/gas mixture and short periods of shutdown will not adversely affect the unit.

If the compressor is shut down for an extended period the lubricating oil pump should be operated for approximately ten minutes weekly, to distribute oil throughout the set.

Turn the compressor driveshaft a few times every week by hand. This will help to avoid Brinelling of the anti-friction bearings.

If the shutdown period is three months or more the above procedure should be continued and, in addition, the compressor set should be run for one hour every three months.

Alternatively, for greater corrosion protection, the normal lubricating oil can be drained off, replaced with inhibiting oil and the set run for one hour initially, then one hour every three months.

NOTE: Before the compressor set is returned to normal use, the inhibiting oil must be removed and the system filled with regular oil.

During a shutdown period in cold conditions any water cooled items of plant should be drained, or the cooling water flow maintained to prevent frost damage.

6.2 INHIBITING OILS APPROVED FOR USE WITH HOWDEN SCREW COMPRESSORS

A list of approved inhibiting oils suitable for use on the Howden Screw Compressor prior to a prolonged shutdown is shown in Fig. 1.

If you have any doubts about the compatibility of these oils with your gas please contact the manufacturer or your dealer.

SHELL	ENSIS ENGINE OIL 10W
ESSO	RUST-BAN 335 OR 337
MOBIL	MOBILARMA 524
CALTEX	CALTEX PRESERVATION OIL 10W

Fig. 1

SECTION 7

MAINTENANCE

7.1 GENERAL COMMENTS

The compressor is designed to give long periods of trouble free operation with the minimum of maintenance. A yearly inspection is recommended for all Howden Compressor installations. Some installations may require an annual statutory insurance survey.

The purpose of the yearly inspection survey is to check if there is any significant wear of the thrust bearings, slide valve guide block or PTFE seals and, if any wear is found, for these components to be renewed.

Where axial movement condition monitoring equipment is fitted to the compressor, a continuous indication of the thrust bearing condition is monitored and the bearing check can be extended to once every two years.

It is not anticipated, however, that a major overhaul will be required until approximately after four years operation. After this time the thrust bearings must be renewed.

When the compressor is being inspected or overhauled it must be dismantled in a clean area.

The inspection overhaul procedure is different between the WRV163 & WRV204 compressors and the, WRVi255, WRVi321 & WRVi365 compressors due to construction variations. Please ensure that the correct procedure is used for the size of compressor involved.

Always refer to the sectional and external arrangement drawings.

All fasteners should be torqued to the value specified as stated under Torque Specifications in Section 9.1 using appropriate torque wrenches.

All lockwashers, tabwashers, ‘O’ rings and PTFE seals must be renewed on assembly. Section 9.2 describes lockwasher assembly procedure.

Special tools to ease dismantling and re-assembly can be provided, as listed in Section 9.3. Details of these can be obtained from the Compressor Business Unit, Howden Compressors. Section 10 details all Part Numbers of normally replaceable components.

7.2 PREPARATION FOR ANNUAL INSPECTION

Before dismantling the compressor, certain precautions should be taken in the interests of safety:

1. Isolate the drive unit.

2. Depressurise and purge the system.

3. Disconnect the drive unit coupling from the compressor.

4. Place a receptacle under the outlet end of the compressor to catch any oil which may drip from the hydraulic cylinder when the cylinder cover is removed or when the outlet end cover is removed.

5. Ensure all lifting equipment, ie, eye bolts, slings, and shackles are safe and serviceable.

To enable a check to be made of floats and condition of seals and guide block on the compressor during annual maintenance, a certain amount of dismantling is required. This differs slightly between the 163 compressor and the 204, 255, 321 & 365 compressors.

7.3 DISMANTLING PROCEDURE FOR ANNUAL INSPECTION

Commence at discharge end with the Hydraulic Actuator

No matter which size compressor is involved, extract the 3 off cap screws holding the Aluminium cover to the cylinder cover, if fitted, and remove. Extract the cap screws securing the Cylinder Cover to the Hydraulic Cylinder and remove the cover, including the limit switches and indicator spindle which are attached to it (Fig. 2).

NOTE: Some compressors will have a LPI sensor fitted as an option instead of switches, and will not have the cylinder switch cover fitted.

7.3 DISMANTLING PROCEDURE FOR ANNUAL INSPECTION (Continued)

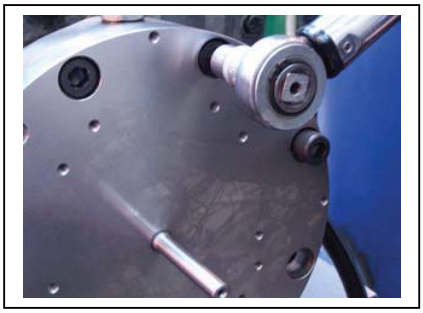


Fig. 2

Fig. 3

NOTE: The indicator spindle has to clear a dowel pin which moves along the spiral groove in the spindle, therefore this cover must be kept in an axial position when withdrawing until the spindle clears the dowel pin (Fig 3). The LPI Sensor is housed inside a sensor well attached to the cover and this must also be removed axially.

IMPORTANT: It is essential that the spiral groove engaging the dowel pin is marked for correct re-assembly to avoid damage to the potentiometer.

Move the slide valve to bring the actuator piston to the outer end of the cylinder. Do not move the slide valve past its minimum position at the capacity stop as it may come off the guide block at the inlet end of the compressor when unlocking the piston lockwasher and locknut.

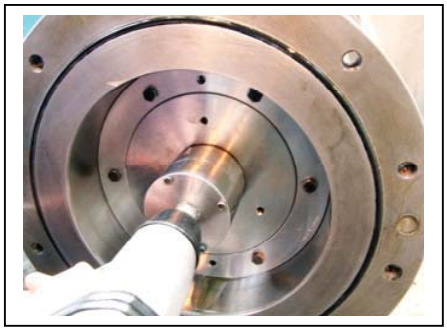


Fig. 4

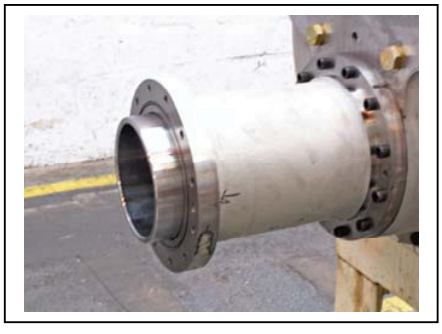


Fig. 5

Unlock the piston lockwasher and locknut and remove (Fig. 4).
Remove the actuator stop sleeve, if fitted, from the cylinder bore (Fig. 5).
Withdraw the piston (Fig. 6) using the appropriate tool listed for the compressor size. See Section 9.3.

7.3 DISMANTLING PROCEDURE FOR ANNUAL INSPECTION (Continued)

Removing the Combined Outlet Cover/Cylinder 163 Compressor

Fit an eyebolt to the tapped hole at the top of the outlet cover, attach a sling to the eyebolt to support the weight of the cover (Fig. 7).

Fig. 6

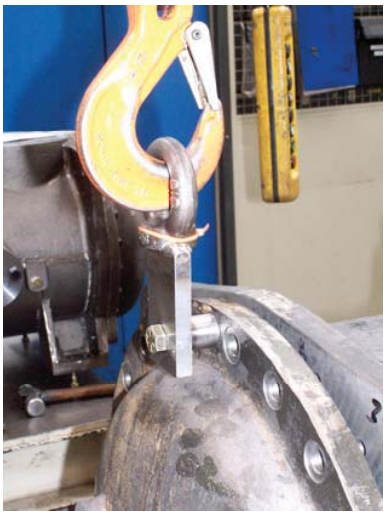


Fig. 7

7.3 DISMANTLING PROCEDURE FOR ANNUAL INSPECTION (Continued)

Extract the set pins securing the discharge cover to the main casing body. (Fig. 8) Push the piston rod to the bottom of the cylinder.

Carefully draw the cover clear of the piston rod/valve spindle. Care should be taken to prevent damage to the actuator cylinder which is part of the cover.

At this stage, the slide valve can be withdrawn from the compressor for a visual inspection. (Fig. 9)

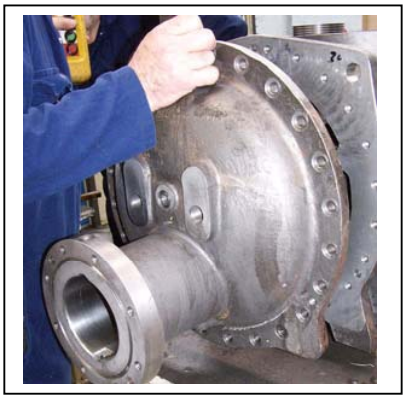


Fig. 8

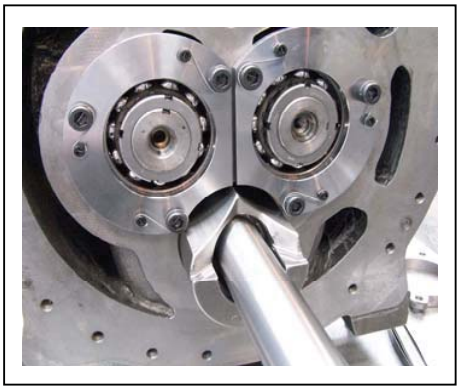


Fig. 9

A light shone from the slide valve bore will permit a visual inspection of the rotors. (Fig. 10-11)

Fig. 10

Fig. 11

7.3 DISMANTLING PROCEDURE FOR ANNUAL INSPECTION (Continued)

Removing the Cylinder and End Cover WRV204, WRVi255, WRVi321 & WRVi365 Compressors

The hydraulic cylinder and end cover are separate items in the above compressor and are removed as follows:

Removing the Hydraulic Cylinder

Extract the cap screws or setscrews securing the cylinder to the end cover (Fig. 12). Support the cylinder with a sling and using the jacking holes provided in the cylinder flange, jack out the cylinder (Fig. 13).

Fig. 12

Fig. 13

Removing the End Cover

Extract most of the set pins securing the outlet end cover to the main casing (Fig. 14).

Fig. 14

7.3 DISMANTLING PROCEDURE FOR ANNUAL INSPECTION (Continued)

Fit an eye bolt to the top of the outlet cover flange and use suitable lifting equipment to support the weight of the cover (Fig. 15).
Remove the set pins locating the cover to the main casing and remove the cover.

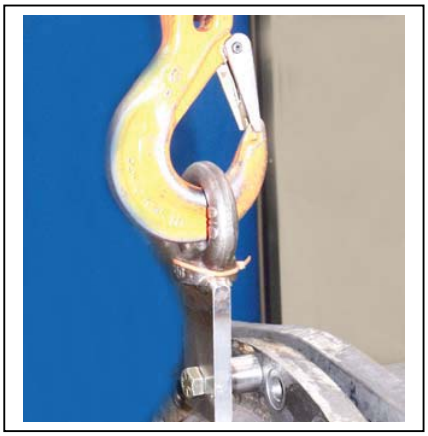


Fig. 15

Fig. 16

Take care to avoid damage to the piston rod/valve spindle (Fig. 16).

Removing the Slide Valve

Withdraw the slide valve using suitable lifting equipment to support the weight of the valve, especially on WRVi255, WRVi321, & WRVi365 compressors (Fig. 17).

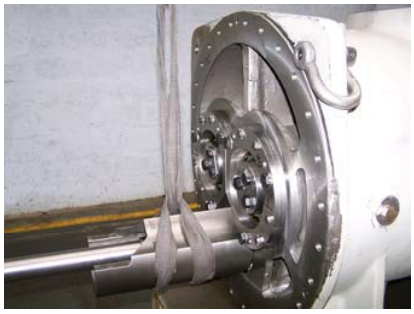


Fig. 17

7.3 DISMANTLING PROCEDURE FOR ANNUAL INSPECTION (Continued)

Now that the slide valve has been removed by shining a light from the valve bore, a visual inspection of the rotors can be achieved (Figs. 18 - 19).

Fig. 18

Fig. 19

PTFE Seals.

The compressor has now been dismantled enough to permit the inspection and replacement of the PTFE seals and 'O' rings in the actuator cylinder, (Fig. 20) also the piston, should they be required (Fig. 21).

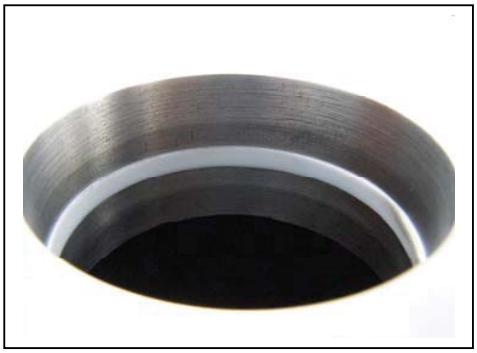


Fig. 20

Fig. 21

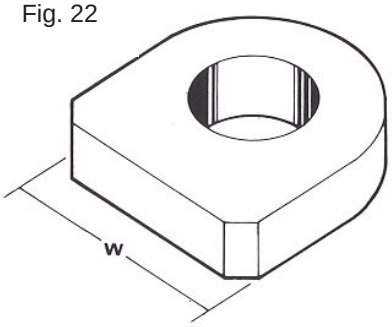
7.4 CHECKING CLEARANCES

Guide Block

The guide block which locates the slide valve should also be checked for wear every 30,000 hours or every 4 years whichever comes first. See Fig. 22 and relative table for dimensions.

Guide Block to Slide Valve Slot

Fig. 22



Compressor Size by Rotor Diameter	Dimension 'W'	Clearance
163 mm	24.987/24.975 mm (0.984"/0.9833")	0.046/0.013 mm (0.0018"/0.005")
204mm	29.987/29.975 mm (1.181"/1.180")	0.046/0.013 mm (0.0018"/0.005")
255mm	41.262/41.250 mm (1.625"/1.624")	0.050/0.013 mm (0.002"/0.005")
321mm	44.990/44.965 mm (1.771"/1.770")	0.060/0.010mm (0.0024"/0.004")
365mm	49.991/49.965mm	0.065/0.009mm (0.0025"/0.004")

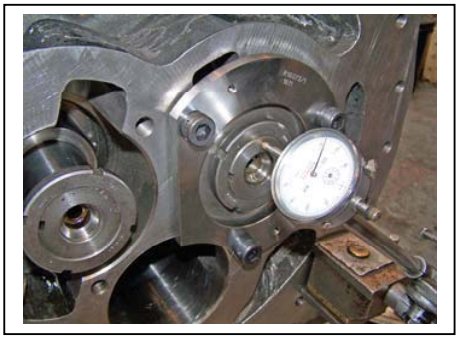
7.4 CHECKING CLEARANCES (Continued)

To check the Thrust Bearing Float

To check the thrust bearing float, set a dial indicator up axially on the shaft end. Access must be gained to the inlet end of the female rotor by removing the rotor cover. Push or pull the rotor, to its limit in either direction.

Record the indicator reading and then push or pull the rotor to its limit in the opposite direction. The difference in indicator readings is the thrust bearing axial float. This procedure must be followed for both male and female rotors. This reading should not exceed 0.025mm (0.001”). Any increase over this reading will necessitate replacement of the thrust bearings. The thrust bearings are fitted with a small pre-load, the maximum float permitted is 0.025mm (0.001”). If in excess of this the bearings must be changed.

NOTE: Should the thrust bearing float be within limits, no further work on the rotors is recommended, i.e. journal bearing clearances would not necessarily be measured.
Any increase on this figure will necessitate replacement of the thrust bearings, the procedure for which is described per Section 8.2-8.3 or 8.4-8.5.



Maximum Thrust Bearing Float

Please note that due to a change in bearing selection, which now means that bearings are fitted with a pre-load condition, the maximum float permitted is 0.025mm (0.001”) regardless of compressor size.

Fig. 23

NOTES:

It is extremely important that the fasteners on the thrust bearing retaining plates of the WRV163 and WRV204 compressors are torqued exactly to the specified setting of 14Nm. Over-torquing will not permit correct operation of the thrust bearing, resulting in premature failure.

Should the thrust bearing float be within limits, no further work on the rotors is recommended, ie, journal bearing clearances would not necessarily be measured. Where the thrust bearing float is outside limits and, therefore, the thrust bearings have to be slackened off and removed, the opportunity would then be taken to measure journal bearing condition, and proceed as for major overhaul.

Where a compressor is fitted with condition monitoring, no check on the thrust bearings will be required. See Section 7.1. A 4 yearly check on the guide block wear, and an annual check on the PTFE seal condition is all that is necessary.

7.5 RE-ASSEMBLY AFTER ANNUAL INSPECTION

When all checks and corrections have been made, and assuming no major problems have developed, the compressor can be re-assembled. (Refer to the Sectional Arrangement drawing supplied and torque specifications as advised under Section 9.1)

WRV163 Compressor

Ensure the guide block is in position in the slide valve bore, insert the slide valve and push it all the way to the 'on load' position (Fig. 24).
Insert an eyebolt into the outlet end cover flange and with the aid of suitable lifting equipment re-assemble the outlet end cover/hydraulic cylinder (Fig. 25).
Secure with set pins to the main casing. Remove the lifting sling and eyebolt.

Fig. 24

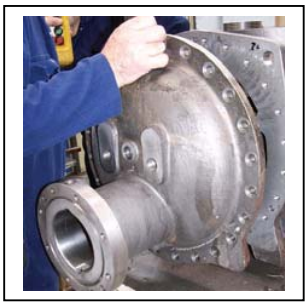


Fig. 25

Refit the piston into place in the hydraulic cylinder. Secure with new lockwasher and locknut (Fig. 26). Replace the actuator stop sleeve. Fit the cylinder end cover, taking care to ensure the dowel is properly located in the spiral groove of the indicator spindle (Fig. 27).

Fig. 26

Fig. 27

Secure the cover with cap screws. Ensure the limit switches are in position securely fastened, assemble the limit switch cover, if fitted, and secure with cap screws.

For compressors fitted with LPI sensors, refit the cylinder end cover and secure the cover with capscrews. Refit and secure the LPI sensor.

7.5 REASSEMBLY PROCEDURE FOR ANNUAL INSPECTION (Continued)

WRV204, WRVi255, WRVi321 & WRVi365

Ensure the guide block is in position in the slide valve bore, insert the slide valve and push it all the way to the on load position (Fig. 28).
Insert an eyebolt into the outlet end cover flange and with the aid of suitable lifting equipment re-assemble the outlet end cover and secure (Fig. 29).

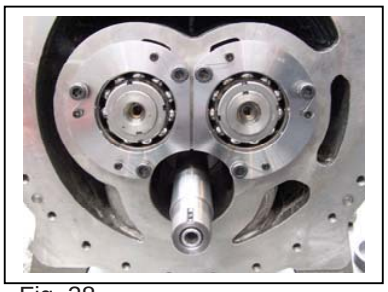


Fig. 28

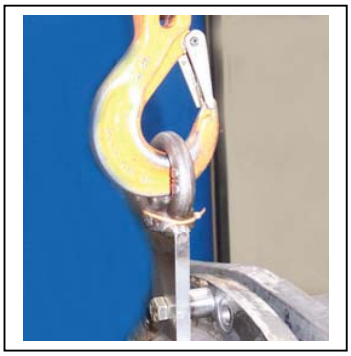


Fig. 29

Attach a sling to the hydraulic cylinder, re-assemble to the outlet end cover and secure with cap screws (Fig. 30).

Refit the piston into place in the hydraulic cylinder. Secure with new lockwasher and locknut (Fig. 31). Replace the actuator stop sleeve. Fit the cylinder end cover taking care to ensure the dowel is properly located in the spiral groove of the indicator spindle (Fig. 32).

Fig. 30

Fig. 31

Fig. 32

Secure the cover with cap screws. Ensure the limit switches are in position securely fastened, assemble the limit switch cover, if fitted, and secure with cap screws.

For compressors fitted with LPI sensors, refit the cylinder end cover and secure the cover with capscrews. Refit and secure the LPI sensor.

SECTION 8

OVERHAUL

8.1 GENERAL PROCEDURES

Although a yearly inspection and maintenance programme is recommended if no condition monitoring equipment is fitted, it is essential that a major overhaul is carried out after approximately 4 years operation or earlier, dependant on site conditions.

To carry out a major overhaul proceed as follows:

1. If necessary, isolate, depressurise and purge the system.
2. Disconnect the driving and driven half coupling.
3. Disconnect all gas and oil pipes attached to the compressor.
4. Remove the ¾" or 1" BSP taper plug from the bottom of the inlet end cover, and collect the oil which drains off.
5. Remove the gas inlet strainer.
6. Remove the dowel pins (if fitted) and the holding down bolts from the compressor feet.
7. Lift the compressor to the location, which should be a clean, dry area, where dismantling and assembly will take place.

Notes about Dismantling and Re-assembly

The dismantling and assembly method varies slightly between the WRV163 & WRV204 compressors and the WRVi255, WRVi321 & WRVi365 compressors due to differences in construction. It is, therefore, essential the correct procedure is used for the size of compressor involved.

Reference should always be made to the Sectional Arrangement drawing supplied.

Use only proper locknut spanners to avoid damage to the locknut slots.

Special tools to facilitate assembly and dismantling operations can be supplied on request.

A list of special tools is located in Section 9.3 of this manual.

All lockwashers, tabwashers, 'O' rings and PTFE seals must be renewed on assembly.

All lockwashers must be assembled according to the procedure as described per Section 9.2.

All fasteners should be torqued to the specified values as stated under Section 9.1.

8.2 DISMANTLING 163 COMPRESSOR FOR MAJOR OVERHAUL

The compressor to be dismantled as per procedures for Annual Inspection under Section 7.3 then proceed:

Checking Journal Bearing Clearance (163mm)

At this point in the dismantling procedure the journal bearing clearance should be checked to determine whether the journal bearings need to be replaced as part of the compressor overhaul.

Ensure the thrust retaining plate on the WRV163 compressor is removed (Figs. 33-34).

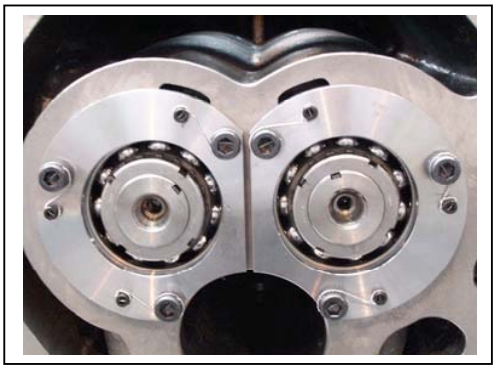


Fig. 33

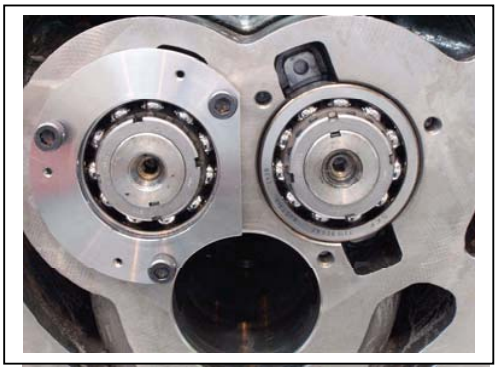


Fig. 34

Procure a piece of round bar ½" (13mm) diameter and approximately 14" (355mm) long. Set up a dial indicator in a convenient position on the main casing to allow the spindle of the dial indicator to lie on the rotor or rotor locknut.

Set the dial indicator to zero.

Insert the short piece of bar into the hole on the end of the rotor shaft.
By raising and lowering the bar, a reading is shown on the dial indicator. This reading is the shaft lift, by removing 0.001" (0.025mm) from this reading because of the angle of lift, you are left with the bearing clearance.
Check this figure against the table of bearing clearances shown on Fig. 35.

8.2 DISMANTLING 163 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

Repeat the procedure on both rotors. If there is any doubt about the clearance of a bearing, renew the bearing.

As the inlet end bearings are more lightly loaded they then only require to be inspected if the outlet end bearings require to be replaced.

Compressor Size	Drawing Clearance mm	Drawing Clearance inches	Maximum Allowable Clearance
163	0.070/0.1102	0.0028”/0.0043”	0.150mm/0.006”

Fig. 35 WRV163 Bearing Journal Clearances

Carry on the dismantling procedure by unlocking the lockwashers and locknuts securing the thrust bearings (Figs.36 & 37) and remove. The adjusting ring behind the thrust bearing has threaded extensions which enable the ring to be extracted by the use of jacking screws, the operation of jacking out the adjusting ring withdraws the thrust bearing with it (Figs. 37-39).

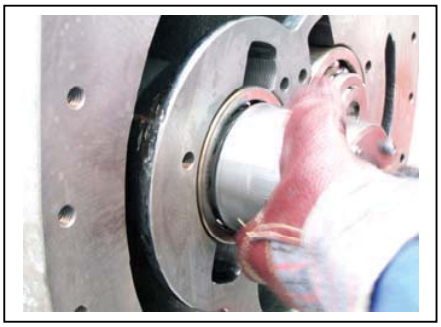


Fig. 36

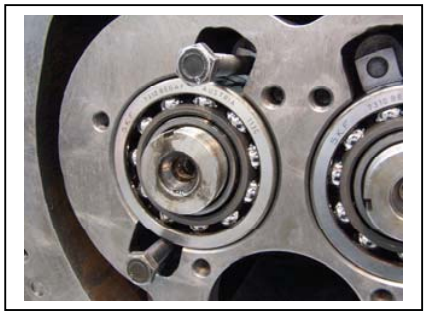


Fig. 37

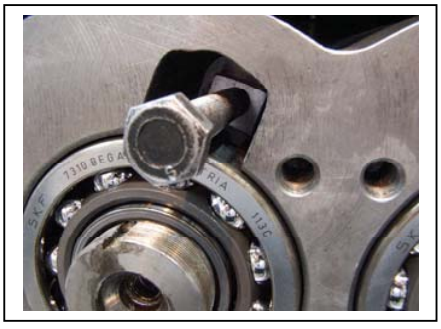


Fig. 38

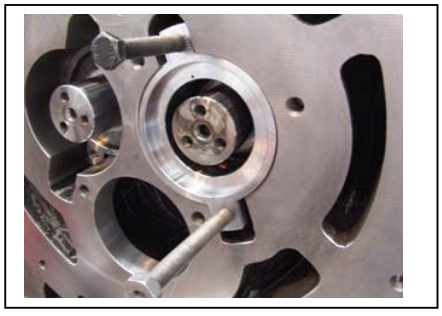


Fig. 39

8.2 DISMANTLING 163 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

Removing the Inlet Shaft Seal (163mm)

Withdraw the driven half coupling key from the input shaft. Extract the cap screws (Fig. 40) from the shaft seal cover and, using the jacking screw holes provided in conjunction with the T-bar jacking tools, remove the shaft seal cover. Follow on with the removal of the Input Shaft Seal Assembly (Figs. 41-42), ie, the stationary seat with 'O' ring seal, the shaft seal and balance piston/labyrinth seal. Jacking holes are provided for withdrawing the balance piston using 'T' bar tools.

Fig. 40

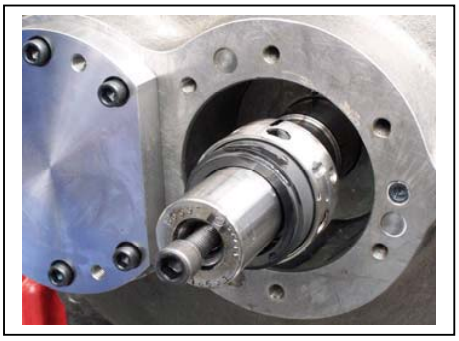


Fig. 41

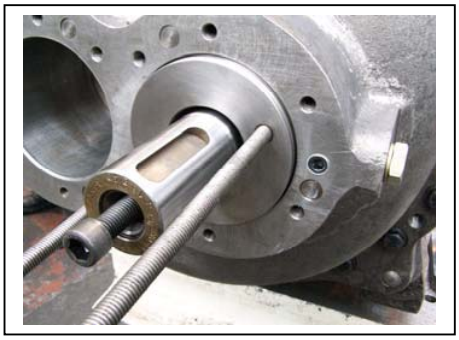


Fig. 42

8.2 DISMANTLING 163 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

Removing the Inlet End Cover (WRV163mm)

Fit an eyebolt into the tapped hole at the top of the inlet cover flange.

Attach a sling to the eyebolt and support the weight of the cover using some form of lifting gear (Fig. 43).

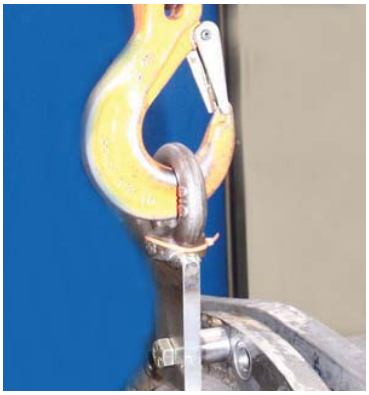


Fig. 43

Fig. 44

Extract most of the screws securing the inlet cover to the main casing. Remove the dowel pins locating the inlet cover to the main casing (Fig.44). Remove the rest of the screws and carefully slide the inlet cover over the extended shaft of the male rotor, taking the 'O' ring seal with it taking great care to avoid damaging the inlet end journal bearings, which are situated in the inlet end cover (Fig. 45).

Fig. 45

8.2 DISMANTLING 163 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

Removing the Rotors (163mm)

Now that the inlet and outlet end casings and the thrust bearings have been removed as described previously, the rotors can be withdrawn from the main casing as shown in Figs.46-47. See table Fig. 48 for estimated rotor weight.

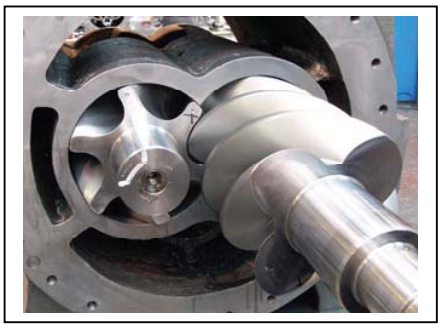


Fig. 46

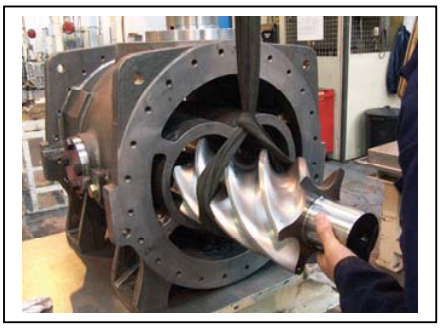


Fig. 47

ESTIMATED WEIGHTS OF ROTORS

Rotor Size	Male		Female	
	lbs	kg	lbs	kg
163/1.80	93	42	71	32
163/1.45	79	36	59	27

Fig. 48

The journal bearings can now be extracted from the Main and Inlet casings using an extractor tool. See Tool List Section 9.3.

Fit new journal bearings using assembly tool in preparation for re-assembly.

The journal bearings are located by a dowel pin and are retained by circlips.

8.3 RE-ASSEMBLY 163 COMPRESSOR AFTER OVERHAUL

When repair or rectification work has been completed the compressor should be assembled as follows.

1. Lubricate the bearing bores with lubricating oil and lift in the rotors, ensure the lobes mesh at the serial numbers on the rotors.
2. Assemble the inlet casing to the main casing, locate with the dowel pins, and secure with set pins. (See Torque Specification in Section 9.1)
3. Locate the thrust bearing adjustment plates over the rotor shafts at the outlet end and slide them into position. Heat the angular contact thrust bearings using an oil bath or induction heater to a temperature of approx 100°C and assemble to the rotors.
4. Prior to wire locking the thrust retaining plate in place, it is necessary to check that the rotor outlet end clearance is correct.
5. Fit lockwasher/locknut and secure (Fig. 36).

8.3 RE-ASSEMBLY 163 COMPRESSOR AFTER OVERHAUL (Continued)

Checking Rotor to main casing Outlet End Clearance (163mm)

1. Remove the thrust retaining plate (if fitted).
2. The adjusting plate behind the thrust bearings has two lugs with tapped holes for withdrawal purposes.
3. Insert jacking screws into the lugs and lightly tension the screws until resistance if felt (Fig. 49).
4. The action of tightening the screws draws the rotors hard against the outlet end of the main casing.
5. Remove the jacking screws.
6. Replace the thrust retaining plate and the retaining screws (Figs. 33-34).
7. Fit a clock gauge in a suitable point on the casing with the spindle of the gauge touching the end of the rotor (Fig 50).
8. Set the clock dial to zero.
9. Torque up the plate retaining screws using a torque wrench to 14Nm.
10. Note the movement on the clock gauge. This is the rotor outlet end clearance and should correspond to the table as per Fig. 51.
11. Adjustment, if necessary, is carried out by machining of the thrust bearing withdrawal plates.

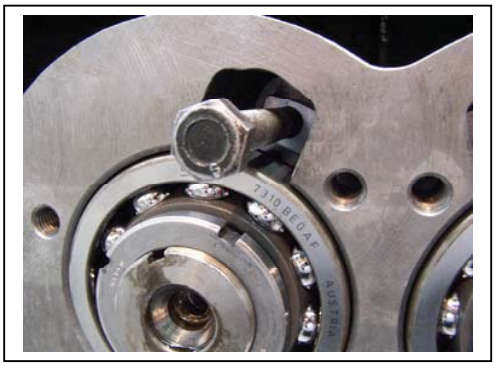


Fig. 49

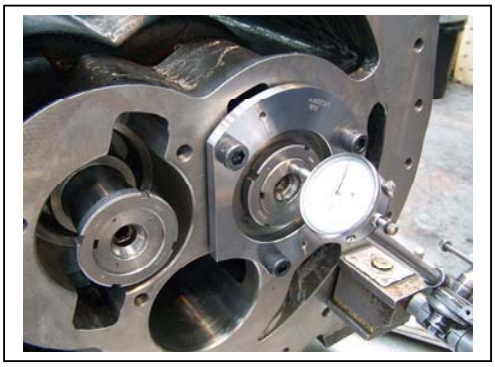


Fig. 50

Rotor Outlet End Clearance 163 Compressor	Maximum Allowable Clearance
0.050/0.075mm	0.100mm
0.002/0.003”	0.004”

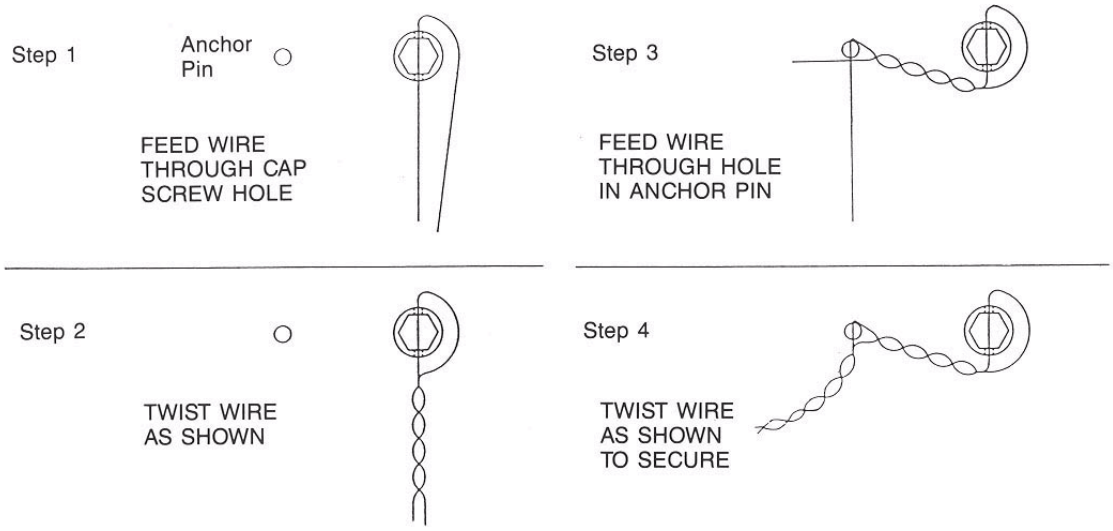
Fig. 51 WRV 163 Outlet End Clearance

8.3 RE-ASSEMBLY 163 COMPRESSOR AFTER OVERHAUL (Continued)

When the clearances are finalised, the retaining cap screws on the Thrust Retaining Plate should be wire locked using the following method:

The grade of wire used should be 1/16" diameter Annealed S.S. Safety Wire.

Adjustment, if necessary, is carried out by machining of the adjusting plate behind the thrust bearings (Fig. 52).



Re-assemble the combined outlet cover/cylinder (163mm)

Re-assembly as described per Section 7.5 for 163 compressor, then proceed:

Re-assemble the input shaft seal (163mm)

Re-assemble the components in the following sequence:

1. Assemble the balance piston on the rotor shaft, locating dowel with the driving pin facing outward.
2. Lubricate the shaft seal and assemble to the rotor shaft, locate in the outward facing dowel/driving pin of the balance piston.
3. Assemble the stationary seat with a new 'O' ring fitted on the outside diameter recess.
4. Fit the seal housing with new 'O' ring and secure with capscrews, tightening them in a systematic order to avoid tilting.

The torque setting of the cap screws is 35lbs ft (48Nm).
To complete the assembly fit the coupling key and compressor driven half coupling.

8.4 DISMANTLING WRV204, WRVi255, WRVi321 & WRVi365 COMPRESSORS FOR MAJOR OVERHAUL

The compressor to be dismantled as per procedure for Annual Inspection under Section 7.2, then proceed:

Checking Journal Bearing Clearance (WRV204) As per procedure for WRV163 Section 8.2

Checking Journal Bearing Clearance (WRVi255, WRVi321 & WRVi365)

Slacken back the set pins securing the thrust housing end cover, to ensure it is not binding on the outer rim of the thrust bearing (Figs. 53-54).
This necessitates the use of a slightly different technique for measuring bearing lifts, since there is no longer a hole in the rotor end in which to insert a lever to lift the rotor.
In this case, the dial indicator must be mounted on top of the rotor. The rotor end must be jacked or levered up at the bottom of the thrust retaining plate to obtain a reading.
The bearing clearance is equal to the indicated reading minus 0.001" (0.025mm).
Repeat the procedure on the other rotor. If there is any doubt about the clearance of a bearing, renew the bearing. As the inlet end bearings are more lightly loaded they only require to be inspected if the outlet end bearings show signs of wear.

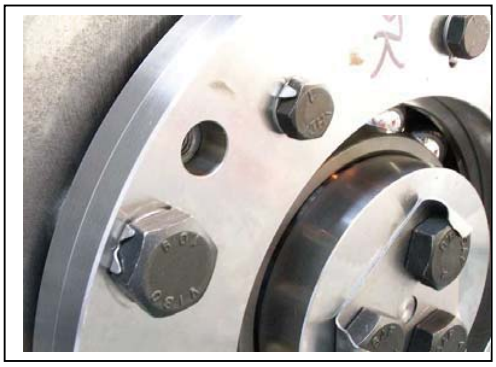


Fig. 53

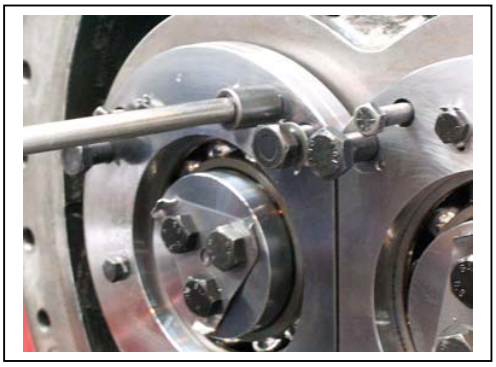


Fig. 54

8.4 DISMANTLING 204, 255, 321 & 365 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

If the journal bearing clearance inspection shows the bearing diametrical clearance is less than the maximum allowable, (see Fig. 55), the advantages of a further period of trouble free running with new journal bearings should be considered before deciding to re-use the existing bearings.

Compressor Size	Drawing Clearance		Maximum Allowable Clearance
	mm	Inches	
204	0.070/0.110	0.0028”/0.0043”	0.150mm/0.006”
255	0.095/0.136	0.0037”/0.0054”	0.180mm/0.007”
321	0.130/0.170	0.0052”/0.0068”	0.226mm/0.009”
365	0.175/0.220	0.0069”/0.0087”	0.295mm/0.012”

Fig. 55 Journal Bearing Clearances

Removing the Input Shaft Seal

After the driven half coupling and key have been removed, extract the cap screws from the shaft end cover and using the jacking holes provided and using ‘T’ bar jacking tools, remove the shaft cover (Fig. 56).

Fig. 56

8.4 DISMANTLING 204, 255, 321 & 365 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

Removing the Input Shaft Seal (Continued)

Pull out the shaft seal, taking care not to damage the carbon face of the seal. (Fig. 57) Withdraw the inlet balance piston using T-bar jacking tools in the jacking holes provided. (Fig. 58) Follow this up by removing the stationary seat from the seal cover.

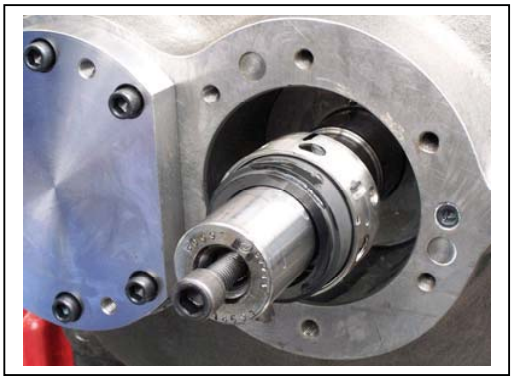


Fig. 57

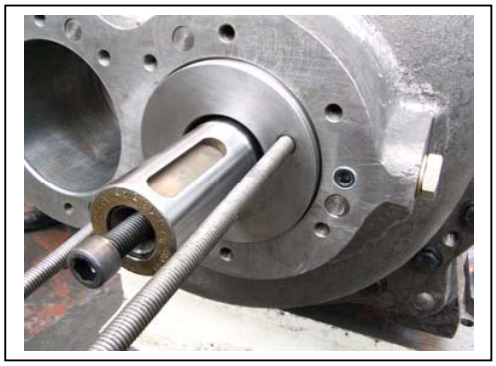


Fig. 58

Removing the Vi adjuster-WRVi255, WRVi321 & WRVi365 Compressors.

Remove the retaining clip at the back of the square Vi adjusting screw and push the adjusting screw into the compressor.
Extract the capscrews fixing the Vi cover and remove the cover.

Removing the Inlet End Cover

Fit an eyebolt at the top of the inlet end cover to the main casing (Fig. 59).

Remove the dowel pins locating the inlet cover to the main casing.

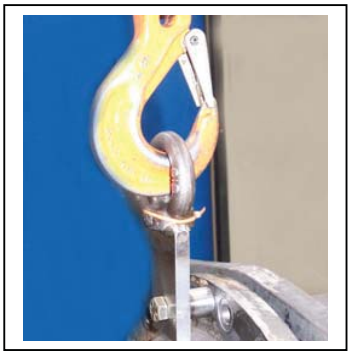


Fig. 59

Fig. 60

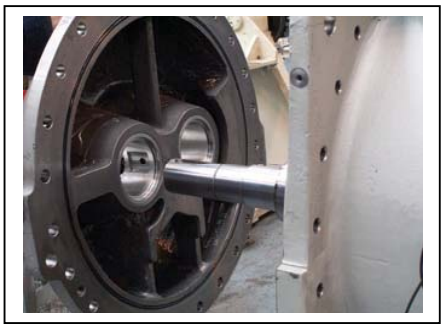


Fig. 61

8.4 DISMANTLING 204, 255, 321 & 365 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

Removing the Inlet End Cover (Continued)

Remove the rest of the set pins and carefully slide the inlet cover over the extended shaft of the male rotor taking the 'O' ring seal with it (Figs. 60-61).

Removing the Rotors

In preparation for removing the rotors, unlock the thrust bearing lockwasher (Fig. 62) and remove the bolts from the male and female rotors (Fig. 63).

A construction variation between the above compressors and the WRV163 & WRV204 compressor is that thrust bearing housings are fitted in the WRVi255, WRVi321 & WRVi365 compressors.

Before removing the rotors, the thrust bearings must be withdrawn. It has been known that the thrust housings, which have jacking holes provided for removal purposes, have been used as bearing extractors by jacking out the housings and drawing the bearings off with them. This method of thrust bearing removal is not recommended. The risk of the thrust housing flange being distorted, due to the tight fit of the thrust bearing, is a possibility and would have a detrimental effect on the outlet end clearance. The correct procedure is as follows:

1. Remove the set screws securing the thrust housings to the main casing.
2. Fit three long studs and a jacking plate (See Tool Section 9.3).
3. Using a suitable hydraulic jack and cylinder between the jacking plate and the end of the rotor shaft , apply pressure to the cylinder with the pump, press each rotor in turn out of the thrust bearings and the casings (Fig. 64).
4. The rotors will require to be carefully supported as shown (Figs. 65-66) and the weight of the various sizes of rotors is given in the following table (Fig. 67).

Fig. 62

Fig. 63

8.4 DISMANTLING 204, 255, 321 & 365 COMPRESSOR FOR MAJOR OVERHAUL (Continued)

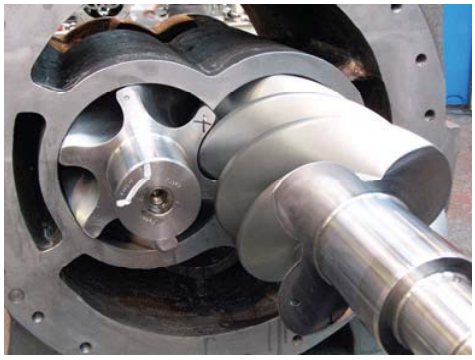


Fig. 64

Fig. 65

Fig. 66

Rotor Size	Estimated Weights			
	Male		Female	
	lbs	Kgs	lbs	kgs
204/1.10	128	58	98	44
204/1.65	171	78	131	59
255/1.10	267	121	231	106
255/1.65	353	160	298	135
255/2.20	437	198	364	161
321/1.32	527	239	435	197
321/1.65	630	286	515	234
321/1.93	763	346	593	269
365/1.65	990	450	770	350
365/1.93	1111	505	891	405

Fig. 67. Rotor Weights

The thrust bearing sleeves and the angular contact thrust bearings can now be easily removed. The balance piston and balance piston sleeves are now accessible and, with the aid of the screwed 'T' bars, (see Special Tool List, Section 9.3) the pistons and sleeves are removed.

The journal bearings can now be extracted from the Main and Inlet casings using an extractor tool. See Tool List Section 9.3.

Fit new journal bearings using assembly tool in preparation for re-assembly.

The journal bearings are located by a dowel pin and are retained by circlips.

8.5 RE-ASSEMBLY WRV204, WRVi255, WRVi321 & WRVi365 COMPRESSORS AFTER OVERHAUL

When repair or rectification work has been completed, the compressor should be assembled as follows:

1. Lubricate the bearing bores with lubricating oil and lift in the rotors, ensure the lobes mesh at the serial numbers on the rotors.
   Assemble the inlet casing to the main casing, locate with the dowel pins, and secure with set pins. (See Torque Specification in Section 9.1)
2. For WRV204 Refer to Section 8.2 Re-assembly WRV163 Compressor after overhaul.
3. For WRVi255, WRVi321 & WRVi365 compressors proceed as follows:
4. Assemble the balance piston sleeves into the outlet end casing, fit the balance pistons followed by the thrust bearing sleeves.
5. Heat the angular contact thrust bearings using an oil bath or induction heater to a temperature of approx 100°C, and assemble to the rotors.
6. Fit bearing retaining plate and lockwasher and secure (Fig. 63). Torque as per specification Section 9.1

The angular contact thrust bearings are designed to take axial thrust only. The thrust bearing is not a tight fit on the OD in the thrust housing. This being the case, it is necessary to clamp the outer ring of the bearing to prevent it from rotating with the rotor. To do this the thrust plate is to be ground to give an interference on the outer race of the bearings and the required interference is as shown in the table below (Fig. 68).

Compressor Size	Interference fit in outer race	
255 mm	0.0015”/ 0.004”	0.038mm/ 0.100mm
321 mm	0.0015”/ 0.0045”	0.040mm/ 0.115mm
365 mm	0.0015”/ 0.004”	0.038mm/ 0.100mm

Fig. 68 Thrust Bearing Nip

Fig. 69

At this stage of the assembly, the rotor outlet end clearance must be checked to ensure the clearance is correct (Fig. 69).

Checking Rotor to Main Casing Outlet End Clearance

For WRV204 Compressors refer to WRV163 procedure Sect 8.3
For WRVi255, WRVi321 & WRVi365 Compressors slacken the set screws securing the thrust bearing housing to the main casing. Do not remove them.

8.5 RE-ASSEMBLY WRVi255, WRVi321 & WRVi365 COMPRESSORS AFTER OVERHAUL (Continued)

Checking Rotor Outlet End Clearance

Insert the jacking screw into the holes provided on the bearing housing flange and lightly tighten the jacking screws until resistance is felt.

The action of tightening the jacking screws draws the rotors against the outlet face of the main casing. Ensure the adjusting pieces are located between the flange of the thrust sleeve and main casing. (Fig 71)

Set up a dial indicator on a convenient part of the main casing with the indicator spindle touching on the end of the rotor. Remove the tension from the jacking screws and ease them back a few threads. Set the dial indicator to zero.

Apply the torque wrench to the set screw securing the thrust bearing housing to the main casing and tighten the screws to the specified torque value (used in Section 9.1).

NOTE: The movement shown on the indicator dial is the rotor outlet end clearance. Check it against the table, Fig. 70.

Compressor Size	Rotor Outlet End Clearance	Maximum Allowable Clearance
204 mm	0.002”/0.003” (0.050/0.075mm)	0.004” (0.100mm)
255 mm	0.003”/0.004” (0.075.0.100mm)	0.005” (0.125mm)
255/220	0.008”/0.010” (0.200/0.250mm)	0.011” (0.280mm)
321 mm	0.012”/0.014” (0.300/0.350mm)	0.015” (0.375mm)
365mm	0.012”/0.014” (0.300/0.350mm)	0.015” (0.375mm)

Fig. 70 Rotor to Main Casing Outlet End Clearance

Adjustment, if necessary, is carried out by machining of the adjusting washers behind the thrust bearing sleeve (WRVi255, WRVi321 & WRVi365) (Fig. 71).
WRV204 Compressor rotor outlet end clearance is carried out by grinding the balance pistons (Fig 72) .

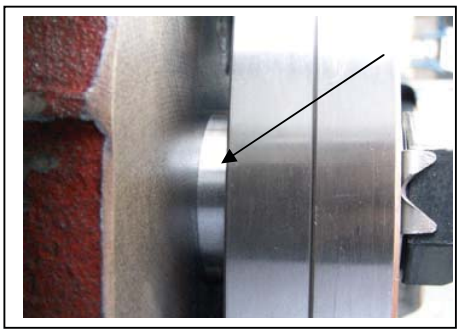


Fig. 71

Fig. 72

8.5 RE-ASSEMBLY WRV204, WRVi255, WRVi321 & WRVi365 COMPRESSORS AFTER OVERHAUL (Continued)

Re-assemble the Outlet End Cover and Hydraulic Cylinder

Re-assembly as described per Section 7.5 for WRV204, WRVi255, WRVi321 & WRVi365 compressors.
Then proceed:

Re-assemble the Vi Cover WRVi255, WRVi321 & WRVi365 Compressors.

Pull Vi adjusting screw until the nut is against the inlet cover.
Refit the Vi adjuster cover ensuring new 'O' rings are in place and secure with fixing capscrews.
Refit circlip retaining ring to secure adjusting screw to cover.

NOTE: Reset Vi adjusting screw to original position.

Re-assemble the Input Shaft Seal

Re-assemble the component in the following sequence:

1. Enter the inlet balance piston ensuring it locates on the drive dowel.
2. Lubricate the shaft seal and assemble to the rotor shaft, locate in the outward facing dowel/driving pin of the inlet balance piston.
3. Refit balance piston sleeve (WRV204 Only).
4. Fit new 'O' ring to stationary seat and fit to seal cover, ensuring seat locates on anti-rotation dowel.
5. Fit the seal cover with a new 'O' ring and secure with cap screws, tightening in a systematic fashion to avoid tilting.

To complete the assembly, fit the coupling key and the compressor driven half coupling.

SECTION 9

SPECIAL INSTRUCTIONS

9.1 TORQUE SPECIFICATIONS

Fig.73 Torque Specifications for Fasteners on WRV163 compressors.

PART NUMBER	TYPE OF FASTENER	TORQUE lb ft	TORQUE Nm
R25055	40mm Locknut Actuator Piston	206	150
G26019	¼" UNC x 5/8" Long Set Screw Piston Seal Retaining Plate	8	11
M0216050	M12 x 60 Long Capscrew Cylinder to outlet cover	69	95
M0313050	½" x 2" Long Set Screw Inlet and Outlet Casings	80	110
R16154	Locknut M42 Slide Valve	225	165
G25062	½" x 1" Long Capscrew Thrust Bearing Clamp Plate	10	14
G39007	50mm Locknut Thrust Bearing Retaining Locknut	210	284
G25058	3/8" x 1" Long Capscrew Rotor Cover Plates	35	48
G29012	M16 x 40mm Long Capscrew Cylinder End Cover to Cylinder	175	240
G21015	5/8" x 2" Long Setscrew Superfeed Flange	160	220

Fig.74 Torque Specifications for Fasteners on WRV204 compressors.

PART NUMBER	TYPE OF FASTENER	TORQUE lb ft	TORQUE Nm
R25055	40mm Locknut Actuator Piston	150	206
G26019	¼" UNC x 5/8" Long Set Screw Piston Seal Retaining Plate	8	11
M0216050	M12 x 60 Long Capscrew Cylinder to outlet cover	69	95
M0316060	M16 x 60mm Long Set Screw Inlet and Outlet Casings	175	240
R20313	36mm Locknut Slide Valve	125	167
G29012	M16 x 40mm Long Capscrew Thrust Bearing Clamp Plate	10	14
G27001	M12 x 40mm Long Setscrew Bearing Retaining Plate	69	95
G29007	M10 x 30 Long Capscrew Rotor Cover Plates	40	55
G29012	M16 x 40mm Long Capscrew Cylinder End Cover to Cylinder	175	240
G21047	3/4" x 1-3/4" Long Setscrew Superfeed Flange	208	285

9.1 TORQUE SPECIFICATIONS (Continued)

Fig. 75 Torque Specifications for Fasteners on WRVi255 compressors.

PART NUMBER	TYPE OF FASTENER	TORQUE lb ft	TORQUE Nm
R25055	40mm Locknut Actuator Piston	150	206
G26019	¼" UNC x 5/8" Long Set Screw Piston Seal Retaining Plate	8	11
M0212045	M12 x 45 Long Capscrew Cylinder to outlet cover	69	95
M0116070	M16 x 70 Long Set Screw Inlet and Outlet Casings	175	240
M0212035	M12 x 35 Long Capscrew Vi Housing & Rotor Cover	69	95
VR25126-2	Locknut M42 Slide Valve	165	225
M0116050	M16 x 50 Long Capscrew Bearing Retaining Plate	175	240
M0116060	M16 x 60 Long Setcrew Thrust Housing	175	240
G21026	3/8" UNC x 1" Setscrew Thrust Plate	35	48
M0112025	M12 x 25 Setscrew Vi Screw Stop Plate	69	95
G21039	5/8"UNC x 1-1/2" Long Setscrew Superfeed Flange	160	220

Fig. 76 Torque Specifications for Fasteners on WRVi321 compressors.

PART NUMBER	TYPE OF FASTENER	TORQUE lb ft	TORQUE Nm
R32115	1-3/4" Locknut Actuator Piston	180	245
G21026	3/8"UNC x 1" Long Set Screw Piston Seal Retaining Plate	35	48
M0216060	M16 x 50 Long Capscrew Cylinder to outlet cover	175	240
M0216050	M16x 70 Long Set Screw Inlet and Outlet Casings	175	240
M0324080	M24 x 80 Long Capscrew End Casings to Main Casings	585	790
M0216040	M16 x 40 Long Vi Housing to Inlet	175	240
VR3149-2	M60 Locknut Piston Rod to Slide Valve	270	371
G21016	½"UNC x 1" Long Setcrew Bearing Retaining Plate	80	110
M0120070	M20 x 70 Long Setscrew Thrust Housing	334	460
M0120060	M20 x 60 Long Setscrew Thrust Plate	334	460
M0116040	M16 x 40 Long Setscrew Vi Screw Stop Plate	175	240
G22006	¾" UNC x 2" Long Set Screw Superfeed Flange	285	391

9.1 TORQUE SPECIFICATIONS (Continued)

Fig. 77 Torque Specifications for Fasteners on WRVi365 compressors.

PART NUMBER	TYPE OF FASTENER	TORQUE lb.ft	TORQUE Nm
VR36148-2	45mm Locknut Actuator Piston	180	245
G21026	3/8"UNC x 1" Long Set Screw Piston Seal Retaining Plate	35	48
M0216060	M16 x 60 Long Capscrew Cylinder to outlet cover	175	240
M0124100	M24 x 100 Long Set Screw Inlet and Outlet Casings	575	790
M0216045	M16 x 45 Long Vi Housing to Inlet	175	240
VR36149-2	45mm Locknut Piston Rod to Slide Valve	180	245
M0110030	M10 x 30 Long Setcrew Bearing Retaining Plate	22	30
M0216060	M16 x 60 Long Capscrew Rotor covers	175	240
M0120070	M20 x 70 Long Setscrew Thrust Housing	170	230
M0120060	M20 x 60 Long Setscrew Bearing retaining Plate	334	460
M0216045	M16 x 45 Long Setscrew Cylinder End cover	175	240
G22019	¾" UNC x 2¼"" Long Set Screw Superfeed Flange	285	391

9.2 PROCEDURE FOR FITTING LOCKWASHERS

This instruction applies to all lockwashers used on Howden Compressors, for the purpose of retaining, in position, the locknuts locating the bearings, thrust collars, pistons, etc.

A typical example of the items concerned is shown below (Fig.105).

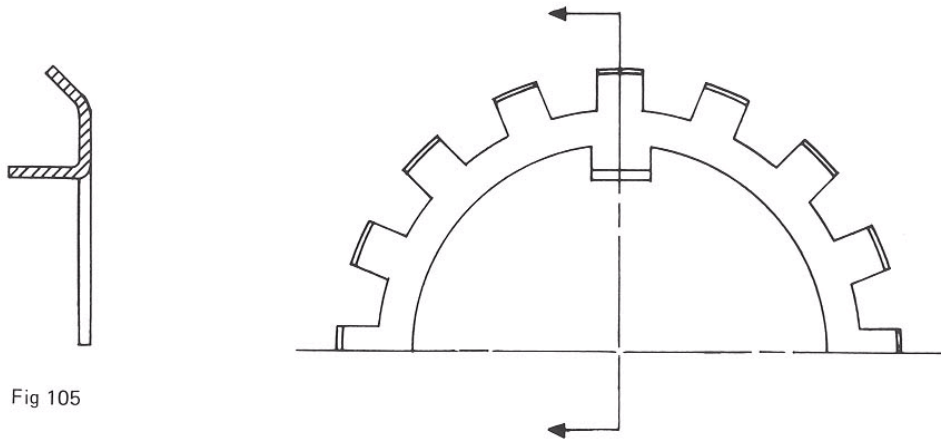


Fig 105

Assembly method:
In all cases where this type of lockwasher is used, the components must be assembled without the lockwasher and torqued to the prescribed value. The locknut must then be removed, the lockwasher dipped in oil and placed on the shaft, the locknut replaced and again torqued to the prescribed value.

This assembly process limits the amount of relative movement between the locknut and the lockwasher under torque, and avoids the possibility of the inner tank being damaged.

9.3 SPECIAL TOOLS

Tools can be provided for ease of dismantling/assembly. However, they are not a mandatory requirement.

WRV163 Compressor Tools	Part No.
Locknut Spanner 30mm for Valve Spindle	19274J
Locknut Spanner 40mm for Piston	19187J
Locknut Spanner 50mm for Thrust Bearing	17916J
Piston Withdrawal Gear	163045J
Pull Rod for Slide Valve	163046J
Withdrawal Tool for Output Shaft Balance Piston	163122J
Jacking Screws to Thrust Bearing	163123J
Bearing Extraction Tools for WRV163	163063J
Dummy Thrust Bearing WRV163	163188J
Jacking Bolt 14T ¼" UNC	32436JC

WRV204 Compressor Tools	Part No.
Locknut Spanner 40mm for Piston Locknut	19187J
Locknut Spanner 36mm	204-5009
Assembly/Withdrawal Tool for Journal Bearings	204-5101
Jacking Plate for Rotor Removal when using Hydraulic Jack	204-5088

WRVi 255 Compressor Tools	Part No.
Locknut Spanner M50	33152J
T-Screws for Extractor purposes	17411J
Assembly/Withdrawal Tool for Crane Seal and Labyrinth Seal	17413J
Assembly Tool for Journal Bearings	17414J
Assembly/Withdrawal Tool for Balance Piston	17418J
Withdrawal Tool for Balance Piston Sleeves	32747J
Locknut Spanner 40mm for Piston Locknut	19187J
Locknut Spanner 60mm Piston Rod to Slide Valve	33181J
T-Screws for Pulling Piston to Off Load Position	32784J
Rotor Jacking Plate	33180J

WRVi 321 & WRVi365 Compressor Tools	Part No.
Jacking Plate for Rotor Removal when using a Hydraulic Jack	32919J
Extractor for Balance Pistons	32920J
Extractor for Inlet Balance Piston Sleeve and Mechanical Seal	32921J
Locknut Spanner for Piston – (WRVi321 Only)	32922J
T-Screws for Extraction purposes 5/8” UNC	32924J
T-Screws for Pulling Piston to Off Load Positions	32993J
Extractor Tool for Balance Piston Sleeves	32949J
Extractor Tool for Piston	32927J
Thrust Bearing Assembly Tool	32928J
Journal Bearing Assembly and Withdrawal Tool	32929J
Jacking Screws for Thrust Housings	32994J
Locknut Spanner for Coupling	32995J
Locknut Spanner M60	32948J
Locknut Spanner for Piston – (WRVi365 Only)	360001J

SECTION 10

SPARES

10.1 WRV WRVi RECOMMENDED SPARES LIST

Spares are available for all WRV compressors in the form of the following kits:

SHAFT SEAL KIT
Shaft seal and cover 'O' Ring

ANNUAL INSPECTION KIT
All 'O' Rings and seals required for an annual inspection.

JOURNAL BEARING KIT
1 Set of Inlet and Outlet Journal Bearings.

THRUST BEARING KIT
1 Set of Thrust Bearings.

NOTE:
An Annual Inspection Kit is required when changing the journal bearing or the thrust bearings.

For further information and details of the above, please contact our Compressor Business Unit directly.

HOWDEN COMPRESSORS
Compressor Business Unit
133 Barfillan Drive
Glasgow
G52 1BE
UK

Telephone: 0044 (0)141 882 3346
Fax: 0044 (0)141 882 8648
E-mail: hcl@aftersales@howden.com
Website: www.howden.com

or

HOWDEN COMPRESSORS LLC
1850B North Gravers Road
Plymouth Meeting
PA 19462
USA

Telephone: 001 610 313 9800
Fax: 001 610 313 9215
E-mail: sales@howdencompressors.com
Website: www.howden.com

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS: Mk1G/H WRV(H) 163/145 & 180

Replacement Shaft Seal Kit – KWS163-1G

PART NUMBER	DESCRIPTION	QUANTITY
KWS163-1G	Input Shaft Seal c/w Cover 'O' Ring	1

Annual Inspection Kit – KW163-1

PART NUMBER	DESCRIPTION	QUANTITY
G31002	Spring Washer – ½"	48
G33001	Bonded Seal ⅜" BSP	3
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking Wire – 1/32" Dia.	2 metres
Q4521	Lockwasher 50mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Piston)	1
R16044	Lockwasher 30mm (Piston Rod / Slide Valve)	1
R16164	PTFE Ring (Actuator Piston)	1
R20044	Joint for Superfeed	2
R25145	PTFE Ring (Piston rod)	1
R16101 - OK	'O' - Ring Kit containing:	
	G44001 – 'O'Ring (Piston Rod)	1
	G44005 – 'O'Ring (Actuator Spindle)	1
	G44006 –' O'Ring (Cylinder Cover)	1
	G44052 – 'O'Ring (Main / Inlet / Outlet)	2
	G44053 – 'O'Ring (Actuator Piston)	1
	G44054 – 'O'Ring (Rotor Covers)	2
	G44055 – 'O'Ring (Cylinder Spigot)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60114	Retaining Ring (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

Replacement Thrust Bearing Kit – KWT163

PART NUMBER	DESCRIPTION	QUANTITY
G51081	Angular Contact Bearing	4

Replacement Journal Bearing Kit – KWJ163

PART NUMBER	DESCRIPTION	QUANTITY
R16063	Outlet End Journal Bearing	2
R16083	Inlet End Journal Bearing	2
G34045	Dowel Pin ¼"	4

Note: For Viton or Fluorosilicone 'O' Rings please contact:
Howden Compressors Limited, Compressor Business Unit, 133 Barfillan Drive, Glasgow, G52 1BE, UK
Telephone: +44 (0)141 882 3346 Fax: +44 (0)141 882 8648

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS: Mk6 6A & 6B WRV(H) 204/110, 145, 165 & 193

Replacement Shaft Seal Kit – KWS204

PART NUMBER	DESCRIPTION	QUANTITY
KWS204	Input Shaft Seal c/w Cover 'O' Ring	1

Annual Inspection Kit – KW204-6

PART NUMBER	DESCRIPTION	QUANTITY
R20224	Rotor Locking Plate	2
G26019	Tuflock Screw ¼" UNC x ⅝" LG	6
G31015	Spring Washer M16	56
G33001	Bonded Seal ⅜" BSP	2
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	3
G33008	Bonded Seal ¼" BSP	4
G34060	Dowel Pin 6mm Dia. x 10mm LG	4
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking wire – 1/32" Dia.	2 metres
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20313	Locknut (Slide Valve)	1
R20493	Superfeed Joint	1
R25055	Piston Locknut 40mm	1
R20065	PTFE Piston Ring	1
R25145	PTFE Piston Rod Ring	1
R20101 - OK	'O' Ring Kit containing:	
	G44001 – 'O'Ring (Piston Rod)	1
	G44005 – 'O'Ring (Actuator Spindle)	1
	G44007 – 'O'Ring (Actuator Piston)	1
	G44021 – 'O'Ring (Main / Inlet / Outlet)	2
	G44071 – 'O'Ring (Rotor Covers)	2
	G44072 – 'O'Ring (Cylinder Spigot)	1
	G44073 –' O'Ring (Cylinder Dia.)	1
	G44074 – 'O'Ring (Cylinder Face)	2
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60178	Circlip (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

Replacement Thrust Bearing Kit – KWT204

PART NUMBER	DESCRIPTION	QUANTITY
G51034	Angular Contact Bearing	4

Replacement Journal Bearing Kit – KWJ204-5/6

PART NUMBER	DESCRIPTION	QUANTITY
R20232	Inlet End Journal Bearing	2
R20242	Outlet End Journal Bearing	2
G34060	Dowel Pin 6mm	4

Note: For Viton or Fluorosilicone 'O' Rings please contact:

Howden Compressors Limited, Compressor Business Unit, 133 Barfillan Drive, Glasgow, G52 1BE, UK
Telephone: +44 (0)141 882 3346 Fax: +44 (0)141 882 8648

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS: Mk6 & 6A 6B WRVi 255/110, 130, 145, 165, 193

Replacement Shaft Seal Kit – KWS255-6

PART NUMBER	DESCRIPTION	QUANTITY
KWS255-6	Input Shaft Seal c/w Cover 'O' Ring	1

Annual Inspection Kit – KW255-6

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x ⅝" LG	6
G32009	Straight Tab Washer ⅜"	8
G32013	Straight Tab Washer ⅝"	6
VR25500-BK	Bonded Seal Kit containing:	
	G33001 – Bonded Seal ⅜" BSP	6
	G33003 – Bonded Seal ¾" BSP	3
	G33004 – Bonded Seal 1" BSP	2
	G33005 – Bonded Seal 1-¼" BSP	2
	G33008 – Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G55012	Gasket – S/Feed	1
Q5163	Lockwasher 40mm (Piston)	1
R25125	PTFE Ring (Actuator Piston)	1
R25135	Adjusting Washer (Thrust Bearings)	6
R25883	Rotor Locking Plate	2
G60009	Circlip (Journal Bearings)	4
G60086	Circlip (Vi Adjuster)	1
M0702016	Spring Washer – 16 Dia.	56
R25145	PTFE Ring (Piston Rod / Guide Bracket)	1
VR25101 - OK	'O' Ring Kit containing:	
	G44001 – 'O'Ring (Piston Rod)	1
	G44002 – 'O'Ring (Piston)	1
	G44005 –' O'Ring (Ind. Spindle)	1
	G44008 – 'O'Ring (Casing)	2
	G44020 – 'O'Ring (Cylinder. Spigot)	1
	G44070 – 'O'Ring (Covers)	3
	G44075 –' O'Ring (Act. Cylinder.)	2
	M6000269 –' O'Ring (Cylinder. Flange.)	1
	M6002962 – 'O'Ring (Vi Spindle)	2
	M6009453 – 'O'Ring (Cover)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

Replacement Thrust Bearing Kit – KWT255

PART NUMBER	DESCRIPTION	QUANTITY
G51035	Angular Contact Bearing	4

Replacement Journal Bearing Kit – KWJ255

PART NUMBER	DESCRIPTION	QUANTITY
R25663	Inlet End Journal Bearing	2
R25643	Outlet End Journal Bearing	2
G36005	Dowel Pin	4

Note: For Viton or Fluorosilicone 'O' Rings please contact:
Howden Compressors Limited, Compressor Business Unit, 133 Barfillan Drive, Glasgow, G52 1BE, UK
Telephone: +44 (0)141 882 3346 Fax: +44 (0)141 882 8648

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS: Mk6 6A WRV 321, ALL L/D'S

Replacement Shaft Seal Kit – KWS321-6

PART NUMBER	DESCRIPTION	QUANTITY
KWS321-6	Input Shaft Seal c/w Cover 'O' Ring	1

Annual Inspection Kit – KW321-6

PART NUMBER	DESCRIPTION	QUANTITY
G32009	Straight Tab Washer ⅜"	6
G32014	Straight Tab Washer ½"	8
G33001	Bonded Seal ⅜" BSP	2
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾"	4
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-¼" BSP	1
G33006	Bonded Seal 1-½" BSP	2
G33007	Bonded Seal 2"	2
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip (Female I.E. Journal Bearing)	2
G60071	Circlip (O.E. Journal Bearings)	2
M0702024	Spring Washer – M24	64
M0704020	Straight Tab Washer – M20	6
M6602040	Circlip (Vi Adjuster)	1
R32015	PTFE Piston Ring (Actuator Piston)	1
R32055	PTFE Piston Rod Ring (Piston Rod / Guide Bracket)	1
R32135	Lockwasher 1-¾" UNC (Actuator Piston)	1
R32175	Adjusting Washer (Thrust Bearings)	6
R32555	Rotor Locking Plate	2
VR32101 - OK	WRV 321 'O' Ring Kit containing:	
	G44005 –'O'Ring (Actuator Spindle)	1
	G44030 – 'O'Ring (Actuator Cylinder Spigot)	1
	G44038 – 'O'Ring (Actuator Piston)	1
	G44046 – 'O'Ring (Seal housing / Rotor Covers)	3
	G44048 – 'O'Ring (Piston Rod / Cylinder Bore)	1
	G44049 – 'O'Ring (Actuator Cylinder / End Cover)	2
	G44050 – 'O'Ring (Balance Piston Sleeves)	2
	G44051 – 'O'Ring (Main Casing / Inlet / Outlet)	2
	G44072 – 'O'Ring (Vi Adjuster Dia)	1
	M6003962 – 'O'Ring (Vi Adjuster Face)	2
	M6026935 – 'O'Ring (Actuator Cylinder Dia)	1

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

Replacement Thrust Bearing Kit – KWT321

PART NUMBER	DESCRIPTION	QUANTITY
G51063	Angular Contact Bearing	4

Replacement Journal Bearing Kit – KWJ321

PART NUMBER	DESCRIPTION	QUANTITY
R32063	Inlet End Journal Bearing	2
R32083	Outlet End Journal Bearing	2
G36013	Dowel Pin	4

Note: For Viton or Fluorosilicone 'O' Rings please contact:
Howden Compressors Limited, Compressor Business Unit, 133 Barfillan Drive, Glasgow, G52 1BE, UK
Telephone: +44 (0)141 882 3346 Fax: +44 (0)141 882 8648

RECOMMENDED SPARES LIST

MODELS Mk1 WRVi 365, ALL L/D'S

Replacement Shaft Seal Kit – KWS365

PART NUMBER	DESCRIPTION	QUANTITY
KWS365	Input Shaft Seal c/w Cover O'ring XR12112-3	1

Annual Inspection Kit – KW365

PART NUMBER	DESCRIPTION	QUANTITY
G32020	Tab Washer ¾"	8
G32021	Tab Washer 7/16"	12
G55074	Joint 4" NB (Superfeed Port)	1
M0701024	Plain Washer 24mm	72
M6601240	Circlip – Internal (Journal Bearings)	4
M6602060	Circlip – External (Vi Adjuster)	1
Q4521	Lockwasher 50mm (Piston Rod / Actuator Piston)	1
R32175	Adjusting Washer (Thrust Bearings)	8
R32555	Rotor Locking Plate	2
R36401-BK	Bonded Seal Kit	
	G33001 Bonded Seal 3/8" BSP	5
	G33002 Bonded Seal ½" BSP	3
	G33003 Bonded Seal ¾" BSP	4
	G33004 Bonded Seal 1" BSP	2
	G33006 Bonded Seal 1-1/2" BSP	2
	G33007 Bonded Seal 2" BSP	3
VR36101-OK	O-Ring Kit containing:	
	G44005 – O'Ring – (Actuator Spindle)	1
	G44079 – O'Ring – (Core Hole Cover, bott)	1
	G44050 – O'Ring – (Female Rotor Cover)	2
	XR12112-3 – O'Ring - (Seal Housing)	4
	M6005953 – O'Ring – (Adjusting Screw)	2
	M6009453 – O'Ring – (Core Hole Cover, Side)	1
	M6011453 – O'Ring – (Vi Cover)	1
	M6022625 – O'Ring – (Cylinder Spigot)	1
	M6031935 – O'Ring – (Cylinder Spigot)	1
	M6035935 – O'Ring – (Actuator Cylinder)	2
	M6089168 – O'Ring – (Main Casing / Covers)	2
VR36134-3	Turcon Glyd Ring T40	1
VR36135-3	O'Ring (Glyd Seal)	1
VR36141-3	Turcon Glyd Ring T40	1

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

Replacement Thrust Bearing Kit – KWT365

PART NUMBER	DESCRIPTION	QUANTITY
G51063	Angular Contact Bearing	5

Replacement Journal Bearing Kit – KWJ365

PART NUMBER	DESCRIPTION	QUANTITY
M6510020	Spring Pin	4
VR36086-2	Inlet End Journal Bearing	2
VR36088-2	Outlet End Journal Bearing	2

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HOWDEN COMPRESSOR MODELS

Mk1A-F WRV 163/145 & 180

☐ **Replacement Shaft Seal Kit – KWS163**

PART NUMBER	DESCRIPTION	QUANTITY
G60205	Input Shaft Seal	1
G44054	O'Ring	1

☐ **Annual Inspection Kit – KW163-1**

PART NUMBER	DESCRIPTION	QUANTITY
G31002	Spring Washer – ½"	48
G33001	Bonded Seal 3/8" BSP	3
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking Wire – 1/32" Dia.	2 metres
Q4521	Lockwasher 50mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Piston)	1
R16044	Lockwasher 30mm (Piston Rod / Slide Valve)	1
R16164	PTFE Ring (Actuator Piston)	1
R20044	Joint for Superfeed	2
R25145	PTFE Ring (Piston rod)	1
R16101 - OK	O' - Ring Kit	1 Kit containing:
	G44001 – O'Ring (Piston Rod)	1
	G44005 – O'Ring (Actuator Spindle)	1
	G44006 – O'Ring (Cylinder Cover)	1
	G44052 – O'Ring (Main / Inlet / Outlet)	2
	G44053 – O'Ring (Actuator Piston)	1
	G44054 – O'Ring (Rotor Covers)	2
	G44055 – O'Ring (Cylinder Spigot)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60114	Retaining Ring (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT163**

PART NUMBER	DESCRIPTION	QUANTITY
G51081	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ163**

PART NUMBER	DESCRIPTION	QUANTITY
R16063	Outlet End Journal Bearing	2
R16083	Inlet End Journal Bearing	2
G34045	Dowel Pin ¼"	4

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Mk1G WRV(H) 163/145 & 180

☐ **Replacement Shaft Seal Kit – KWS163-1G**

PART NUMBER	DESCRIPTION	QUANTITY
G60235	Input Shaft Seal	1
G44054	O'Ring	1

☐ **Annual Inspection Kit – KW163-1**

PART NUMBER	DESCRIPTION	QUANTITY
G31002	Spring Washer – ½"	48
G33001	Bonded Seal 3/8" BSP	3
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking Wire – 1/32" Dia.	2 metres
Q4521	Lockwasher 50mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Piston)	1
R16044	Lockwasher 30mm (Piston Rod / Slide Valve)	1
R16164	PTFE Ring (Actuator Piston)	1
R20044	Joint for Superfeed	2
R25145	PTFE Ring (Piston rod)	1
R16101 - OK	O' - Ring Kit	1 Kit containing:
	G44001 – O'Ring (Piston Rod)	1
	G44005 – O'Ring (Actuator Spindle)	1
	G44006 – O'Ring (Cylinder Cover)	1
	G44052 – O'Ring (Main / Inlet / Outlet)	2
	G44053 – O'Ring (Actuator Piston)	1
	G44054 – O'Ring (Rotor Covers)	2
	G44055 – O'Ring (Cylinder Spigot)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60114	Retaining Ring (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT163**

PART NUMBER	DESCRIPTION	QUANTITY
G51081	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ163**

PART NUMBER	DESCRIPTION	QUANTITY
R16063	Outlet End Journal Bearing	2
R16083	Inlet End Journal Bearing	2
G34045	Dowel Pin ¼"	4

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Mk1A-F WRV 163/145 & 180

Fitted with viton O'rings

☐ **Replacement Shaft Seal Kit – KWS163-V**

PART NUMBER	DESCRIPTION	QUANTITY
G60205-V	Input Shaft Seal	1
M6200347	O'Ring	1

☐ **Annual Inspection Kit – KW163-1-V**

PART NUMBER	DESCRIPTION	QUANTITY
G31002	Spring Washer – ½"	48
G33001	Bonded Seal 3/8" BSP	3
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking Wire – 1/32" Dia.	2 metres
Q4521	Lockwasher 50mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Piston)	1
R16044	Lockwasher 30mm (Piston Rod / Slide Valve)	1
R16164	PTFE Ring (Actuator Piston)	1
R20044	Joint for Superfeed	2
R25145	PTFE Ring (Piston rod)	1
R16102 - OK	O' - Ring Kit (Viton)	1 Kit containing:
	M6200112 – O'Ring (Piston Rod)	1
	M6200226 – O'Ring (Actuator Spindle)	1
	M6200241 – O'Ring (Cylinder Cover)	1
	M6200242 – O'Ring (Main / Inlet / Outlet)	2
	M6200261 – O'Ring (Actuator Piston)	1
	M6200347 – O'Ring (Rotor Covers)	2
	M6203848 – O'Ring (Cylinder Spigot)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60114	Retaining Ring (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT163**

PART NUMBER	DESCRIPTION	QUANTITY
G51081	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ163**

PART NUMBER	DESCRIPTION	QUANTITY
R16063	Outlet End Journal Bearing	2
R16083	Inlet End Journal Bearing	2
G34045	Dowel Pin ¼"	4

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HOWDEN COMPRESSOR MODEL

Mk1G WRV(H) 163/145 & 180

Fitted with viton O'rings

☐ **Replacement Shaft Seal Kit – KWS163-1G-V**

PART NUMBER	DESCRIPTION	QUANTITY
G60235-V	Input Shaft Seal	1
M6200347	O'Ring	1

☐ **Annual Inspection Kit – KW163-1-V**

PART NUMBER	DESCRIPTION	QUANTITY
G31002	Spring Washer – ½"	48
G33001	Bonded Seal 3/8" BSP	3
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking Wire – 1/32" Dia.	2 metres
Q4521	Lockwasher 50mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Piston)	1
R16044	Lockwasher 30mm (Piston Rod / Slide Valve)	1
R16164	PTFE Ring (Actuator Piston)	1
R20044	Joint for Superfeed	2
R25145	PTFE Ring (Piston rod)	1
R16102 - OK	O' - Ring Kit (Viton)	1 Kit containing:
	M6200112 – O'Ring (Piston Rod)	1
	M6200226 – O'Ring (Actuator Spindle)	1
	M6200241 – O'Ring (Cylinder Cover)	1
	M6200242 – O'Ring (Main / Inlet / Outlet)	2
	M6200261 – O'Ring (Actuator Piston)	1
	M6200347 – O'Ring (Rotor Covers)	2
	M6203848 – O'Ring (Cylinder Spigot)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60114	Retaining Ring (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT163**

PART NUMBER	DESCRIPTION	QUANTITY
G51081	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ163**

PART NUMBER	DESCRIPTION	QUANTITY
R16063	Outlet End Journal Bearing	2
R16083	Inlet End Journal Bearing	2
G34045	Dowel Pin ¼"	4

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Mk2A-H WRV(H) 204/110 & 165

☐ **Replacement Shaft Seal Kit – KWS204-2/3/4**

PART NUMBER	DESCRIPTION	QUANTITY
G60056	Shaft Seal	1
G44033	O'Ring	1

☐ **Annual Inspection Kit – KW204-2**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	6
G32010	Straight Tab Washer ¼"	6
G32014	Straight Tab Washer ½"	12
G44001	O'Ring (Piston Rod)	2
G44005	O'Ring (Actuator Spindle)	1
G44006	O'Ring (Cylinder / Cylinder End Cover)	2
G44007	O'Ring (Actuator Piston)	1
G44010	O'Ring (Main / Outlet Mk2)	1
G44013	O'Ring (F/m Balance Piston Sleeve)	1
G44017	O'Ring (O.E. Journal Bearings – old brgs only)	2
G44021	O'Ring (Main / Inlet)	1
G44031	O'Ring (Guide Bracket)	1
G44032	O'Ring (Oil injection Pipe Mk2)	2
G44033	O'Ring (Rotor Covers)	4
G44034	O'Ring (Injection Pipe)	1
G51001	Ball Bearing (Actuator Spindle)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60006	Retaining Ring (I.E. Journal Bearings)	2
G60068	Oil Return Pipe Lock Plate	4
Q4522	Lockwasher 45mm (Coupling)	1
Q4683	Lockwasher 65mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20065	PTFE Piston Ring	1
R20155	Adjusting Washer	8
R25145	PTFE Piston Rod Ring	2
R25205	PTFE Connecting Tube Ring	2

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT204**

PART NUMBER	DESCRIPTION	QUANTITY
G51034	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ204-2/3/4**

PART NUMBER	DESCRIPTION	QUANTITY
R20103	Inlet End Journal Bearing	2
R20123	Male Outlet End Journal Bearing	1
R20143	Outlet End Journal Bearing	1
G34004	Dowel Pin 5/16" Dia. x 5/8" LG	2
G34007	Dowel Pin 5/16" Dia. x ½" LG	2

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HOWDEN COMPRESSOR MODELS

Mk3/4-4B WRV(H) 204/110 & 165

☐ **Replacement Shaft Seal Kit – KWS204-2/3/4**

PART NUMBER	DESCRIPTION	QUANTITY
G60056	Shaft Seal	1
G44033	O'Ring	1

☐ **Annual Inspection Kit – KW204-3-4B**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	6
G32010	Straight Tab Washer ¼"	6
G32014	Straight Tab Washer ½"	12
G33001	Bonded Seal 3/8" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	3
G33008	Bonded Seal ¼" BSP	4
G44001	O'Ring (Piston Rod)	2
G44005	O'Ring (Actuator Spindle)	1
G44006	O'Ring (Cylinder / Cylinder End Cover)	2
G44007	O'Ring (Actuator Piston)	1
G44013	O'Ring (F/m Balance Piston Sleeve)	1
G44017	O'Ring (O.E. Journal Bearings – old brgs only)	2
G44021	O'Ring (Main / Inlet)	2
G44031	O'Ring (Guide Bracket)	1
G44033	O'Ring (Rotor Covers)	4
G44034	O'Ring (Injection Pipe)	1
G51001	Ball Bearing (Actuator Spindle)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60006	Retaining Ring (I.E. Journal Bearings)	2
Q4522	Lockwasher 45mm (Coupling)	1
Q4683	Lockwasher 65mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20044	Joint for Superfeed	2
R20065	PTFE Piston Ring	1
R20085	Lockwasher 50mm	1
R20155	Adjusting Washer	8
R20204	PTFE Sleeve	1
R25145	PTFE Piston Rod Ring	2
R25205	PTFE Connecting Tube Ring	2

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT204**

PART NUMBER	DESCRIPTION	QUANTITY
G51034	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ204-2/3/4**

PART NUMBER	DESCRIPTION	QUANTITY
R20103	Inlet End Journal Bearing	2
R20123	Male Outlet End Journal Bearing	1
R20143	Outlet End Journal Bearing	1
G34004	Dowel Pin 5/16" Dia. x 5/8" LG	2
G34007	Dowel Pin 5/16" Dia. x ½" LG	2

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Mk5-5E WRV(H) 204/110, 145, 165 & 193

☐ **Replacement Shaft Seal Kit – KWS204-5**

PART NUMBER	DESCRIPTION	QUANTITY
G60179	Shaft Seal	1
G44071	O'Ring	1

☐ **Annual Inspection Kit – KW204-5**

PART NUMBER	DESCRIPTION	QUANTITY
R20224	Rotor Locking Plate	2
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G31015	Spring Washer M16	56
G33001	Bonded Seal 3/8" BSP	2
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	3
G33008	Bonded Seal ¼" BSP	4
G34060	Dowel Pin 6mm Dia. x 10mm LG	4
G39006	Locknut 45mm (Coupling)	1
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking wire – 1/32" Dia.	2 metres
Q4522	Lockwasher 45mm (Coupling)	1
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20313	Locknut (Slide Valve)	1
R20493	Superfeed Joint	1
R25055	Locknut 40mm (Actuator Piston)	1
R20065	PTFE Piston Ring	1
R25145	PTFE Piston Rod Ring	1
R20101 - OK	O' Ring Kit	1 Kit containing:
	G44001 - O'Ring (Piston Rod)	1
	G44005 - O'Ring (Actuator Spindle)	1
	G44007 - O'Ring (Actuator Piston)	1
	G44021 - O'Ring (Main / Inlet / Outlet)	2
	G44071 - O'Ring (Rotor Covers)	2
	G44072 - O'Ring (Cylinder Spigot)	1
	G44073 - O'Ring (Cylinder Dia.)	1
	G44074 - O'Ring (Cylinder Face)	2
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60178	Circlip (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT204**

PART NUMBER	DESCRIPTION	QUANTITY
G51034	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ204-5/6**

PART NUMBER	DESCRIPTION	QUANTITY
R20232	Inlet End Journal Bearing	2
R20242	Outlet End Journal Bearing	2
G34060	Dowel Pin 6mm	4

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Mk 5 WRV(H) 204 ALL L/D'S

Replacement Shaft Seal Kit – KWS204-5-V

☐ **Annual Inspection Kit – KW204-5-V (Viton)**

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G31015	Spring Washer M16	56
G33001	Bonded Seal 3/8" BSP	2
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	3
G33008	Bonded Seal ¼" BSP	4
G34060	Dowel Pin 6mm Dia. x 10mm LG	4
G39006	Locknut 45mm (Actuator Piston)	1
G51001	Ball Bearing (Actuator Spindle)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60178	Circlip (Journal Bearings)	4
G72002	Locking wire – 1/32" Dia.	2 metres
Q4522	Lockwasher 45mm (Coupling)	1
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20065	PTFE Piston Ring	1
R20102 - OK	Viton O' Ring Kit	1 Kit containing:
	M6200112 - O'Ring (Actuator spindle)	1
	M6200226 - O'Ring (Piston rod)	1
	M6200428 - O'Ring (Actuator Piston)	1
	M6203885 - O'Ring (Main/Inlet/Outlet)	2
	M6212453 - O'Ring (Cylinder / Main)	1
	M6213453 - O'Ring (Rotor Covers)	2
	M6216453 - O'Ring (Cylinder Spigot)	1
	M6218453 - O'Ring (Cylinder)	2
R20224	Rotor Locking Plate	2
R20313	Locknut (Slide Valve)	1
R20493	Superfeed Joint	1
R25055	Piston Locknut 40mm	1
R25145	PTFE Piston Rod Ring	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT204**

PART NUMBER	DESCRIPTION	QUANTITY
G51034	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ204-5/6**

PART NUMBER	DESCRIPTION	QUANTITY
R20232	Inlet End Journal Bearing	2
R20242	Outlet End Journal Bearing	2
G34060	Dowel Pin 6mm	4

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Mk6 & 6A WRV(H) 204/110, 145, 165 & 193

☐ **Replacement Shaft Seal Kit – KWS204**

PART NUMBER	DESCRIPTION	QUANTITY
G60236	Shaft Seal	1
G44071	O'Ring	1

☐ **Annual Inspection Kit – KW204-6**

PART NUMBER	DESCRIPTION	QUANTITY
R20224	Rotor Locking Plate	2
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G31015	Spring Washer M16	56
G33001	Bonded Seal 3/8" BSP	2
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	3
G33008	Bonded Seal ¼" BSP	4
G34060	Dowel Pin 6mm Dia. x 10mm LG	4
G51001	Ball Bearing (Actuator Spindle)	1
G72002	Locking wire – 1/32" Dia.	2 metres
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20313	Locknut (Slide Valve)	1
R20493	Superfeed Joint	1
R25055	Piston Locknut 40mm	1
R20065	PTFE Piston Ring	1
R25145	PTFE Piston Rod Ring	1
R20101 - OK	O' Ring Kit	1 Kit containing:
	G44001 - O'Ring (Piston Rod)	1
	G44005 - O'Ring (Actuator Spindle)	1
	G44007 - O'Ring (Actuator Piston)	1
	G44021 - O'Ring (Main / Inlet / Outlet)	2
	G44071 - O'Ring (Rotor Covers)	2
	G44072 - O'Ring (Cylinder Spigot)	1
	G44073 - O'Ring (Cylinder Dia.)	1
	G44074 - O'Ring (Cylinder Face)	2
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60178	Circlip (Journal Bearings)	4

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT204**

PART NUMBER	DESCRIPTION	QUANTITY
G51034	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ204-5/6**

PART NUMBER	DESCRIPTION	QUANTITY
R20232	Inlet End Journal Bearing	2
R20242	Outlet End Journal Bearing	2
G34060	Dowel Pin 6mm	4

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Mk 6 WRV(H) 204, ALL L/D'S

☐ **Annual Inspection Kit – KW204-6-F (Flourosilicone)**

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G31015	Spring Washer M16	56
G33001	Bonded Seal 3/8" BSP	2
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	3
G33008	Bonded Seal ¼" BSP	4
G34060	Dowel Pin 6mm Dia. x 10mm LG	4
G51001	Ball Bearing (Actuator Spindle)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60178	Circlip (Journal Bearings)	4
G72002	Locking wire – 1/32" Dia.	2 metres
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20065	PTFE Piston Ring	1
R20103 - OK	O' Ring Kit	1 Kit containing:
	M6300112 - O'Ring (Actuator spindle)	1
	M6300226 - O'Ring (Piston rod)	1
	M6300428 - O'Ring (Actuator Piston)	1
	M6303885 - O'Ring (Main/Inlet/Outlet)	2
	M6312453 - O'Ring (Cylinder / Main)	1
	M6313453 - O'Ring (Rotor Covers)	2
	M6316453 - O'Ring (Cylinder Spigot)	1
	M6318453 - O'Ring (Cylinder)	2
R20224	Rotor Locking Plate	2
R20313	Locknut (Slide Valve)	1
R20493	Superfeed Joint	1
R25055	Piston Locknut 40mm	1
R25145	PTFE Piston Rod Ring	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk 6 WRV(H) 204, ALL L/D'S

☐ **Annual Inspection Kit – KW204-6-V (Viton)**

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G31015	Spring Washer M16	56
G33001	Bonded Seal 3/8" BSP	2
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	3
G33008	Bonded Seal ¼" BSP	4
G34060	Dowel Pin 6mm Dia. x 10mm LG	4
G51001	Ball Bearing (Actuator Spindle)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60178	Circlip (Journal Bearings)	4
G72002	Locking wire – 1/32" Dia.	2 metres
Q5163	Lockwasher 40mm (Actuator Piston)	1
R20065	PTFE Piston Ring	1
R20102 - OK	O' Ring Kit	1 Kit containing:
	M6200112 - O'Ring (Actuator spindle)	1
	M6200226 - O'Ring (Piston rod)	1
	M6200428 - O'Ring (Actuator Piston)	1
	M6203885 - O'Ring (Main/Inlet/Outlet)	2
	M6212453 - O'Ring (Cylinder / Main)	1
	M6213453 - O'Ring (Rotor Covers)	2
	M6216453 - O'Ring (Cylinder Spigot)	1
	M6218453 - O'Ring (Cylinder)	2
R20224	Rotor Locking Plate	2
R20313	Locknut (Slide Valve)	1
R20493	Superfeed Joint	1
R25055	Piston Locknut 40mm	1
R25145	PTFE Piston Rod Ring	1

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk1-4F WRV(H) 255/110, 130, 145, 165, 193 & 220

Replacement Shaft Seal Kit – KWS255

PART NUMBER	DESCRIPTION	QUANTITY
G60206	Shaft Seal	1
G44070	O'Ring (Was G44013)	1

Annual Inspection Kit – KW255-1-4F

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	8
G32010	Straight Tab Washer ¼"	6
G32013	Straight Tab Washer 5/8"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G44003	O'Ring (Pre Mk4 models – Injection tube)	2
G44022	O'Ring (Pre Mk4 models – Balance Pistons)	2
G44027	O'Ring (Pre Mk4 models – Journal Bearings) not required when new bearings are fitted.	2
G51001	Ball Bearing (Actuator Spindle) (Actuator Spindle)	1
G72002	Locking Wire – 1/32" Dia.	2 metres
Q4274	Lockwasher 60mm (Couplng)	1
Q4506	Lockwasher 85mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Piston)	1
R20085	Lockwasher 50mm (Slide Valve- where fitted)	1
R25135	Adjusting Washer	6
R25154	Superfeed Joint	2
R25205	PTFE Ring (Injection Tube – Pre Mk4)	2
R20204	PTFE Sleeve (Injection Tube - Mk4)	1
R25125	PTFE Ring (Actuator Piston)	1
R25145	PTFE Ring (Piston Rod)	2
R25101 - OK	O' Ring Kit	1 Kit containing:
	G44001 – O'Ring (piston Rod)	2
	G44002 – O'Ring (Actuator Piston)	1
	G44005 – O'Ring (Actuator Spindle)	1
	G44008 – O'Ring (Main / Inlet / Outlet)	2
	G44070 – O'Ring (Rotor covers - Was G44013)	4
	G44020 – O'Ring (Piston Rod Guide Bracket)	1
	G44034 – O'Ring (Injection Tube)	1
	G44075 – O'Ring (Cylinder – Was G44004)	2
G55012	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip (Journal Bearings)	3

Replacement Thrust Bearing Kit – KWT255

PART NUMBER	DESCRIPTION	QUANTITY
G51035	Angular Contact Bearing	4

Replacement Journal Bearing Kit – KWJ255

PART NUMBER	DESCRIPTION	QUANTITY
R25663	Inlet End Journal Bearing	2
R25643	Outlet End Journal Bearing	2

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk4G WRV(H) 255/110, 130, 145, 165, 193 & 220

☐ **Replacement Shaft Seal Kit – KWS255**

PART NUMBER	DESCRIPTION	QUANTITY
G60206	Shaft Seal	1
G44070	O'Ring	1

☐ **Annual Inspection Kit – KW255-4G**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	8
G32013	Straight Tab Washer 5/8"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
Q4274	Lockwasher 60mm (Couplng)	1
Q4506	Lockwasher 85mm (Thrust Bearings)	2
Q5163	Lockwasher 40mm (Piston)	1
R20085	Lockwasher 50mm	1
R25135	Adjusting Washer	6
R20204	PTFE Sleeve	1
R25125	PTFE Piston Ring	1
R25145	PTFE Piston Rod Ring	2
R25101 - OK	O' Ring Kit	1 Kit containing:
	G44001 – O'Ring (piston Rod)	2
	G44002 – O'Ring (Actuator Piston)	1
	G44005 – O'Ring (Actuator Spindle)	1
	G44008 – O'Ring (Main / Inlet / Outlet)	2
	G44070 – O'Ring (Rotor covers - Was G44013)	4
	G44020 – O'Ring (Piston Rod Guide Bracket)	1
	G44034 – O'Ring (Injection Tube)	1
	G44075 – O'Ring (Cylinder – Was G44004)	2
G55012	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	3

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT255**

PART NUMBER	DESCRIPTION	QUANTITY
G51035	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ255**

PART NUMBER	DESCRIPTION	QUANTITY
R25663	Inlet End Journal Bearing	2
R25643	Outlet End Journal Bearing	2

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

WRV(H) 255, MK4G MODEL, ALL L/D'S

☐ **Annual Inspection Kit – KW255-4G-V (Viton)**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	8
G32013	Straight Tab Washer 5/8"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G55012	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	3
Q4274	Lockwasher 60mm	1
Q4506	Lockwasher 85mm	2
Q5163	Lockwasher 40mm	1
R20085	Lockwasher 50mm	1
R20204	PTFE Sleeve	1
R25102 - OK	O' Ring Kit - Viton	1 Kit containing:
	M6200112 – O'Ring	1
	M6200226 – O'Ring	2
	M6200227 – O'Ring	1
	M6200258 – O'Ring	4
	M6200266 – O'Ring	2
	M6203925 – O'Ring	2
	M6204375 – O'Ring	1
	M6204385 – O'Ring	1
R25125	PTFE Piston Ring	1
R25135	Adjusting Washer	6
R25145	Piston Rod Ring	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk5 WRV(H) 255/110, 130, 145, 165, 193 & 220

09.02

☐ **Replacement Shaft Seal Kit – KWS255**

PART NUMBER	DESCRIPTION	QUANTITY
G60206	Shaft Seal	1
G44070	O'Ring	1

☐ **Annual Inspection Kit – KW255-5**

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	8
G32013	Straight Tab Washer 5/8"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
Q5163	Lockwasher 40mm	1
R20085	Lockwasher 50mm	1
R25135	Adjusting Washer	6
R25883	Rotor Locking Plate	2
R20204	PTFE Sleeve	1
R25125	PTFE Piston Ring	1
R25145	PTFE Piston Rod Ring	2
R25101 - OK	O' Ring Kit	1 Kit containing:
	G44001 – O'Ring (piston Rod)	2
	G44002 – O'Ring (Actuator Piston)	1
	G44005 – O'Ring (Actuator Spindle)	1
	G44008 – O'Ring (Main / Inlet / Outlet)	2
	G44070 – O'Ring (Rotor covers - Was G44013)	4
	G44020 – O'Ring (Piston Rod Guide Bracket)	1
	G44034 – O'Ring (Injection Tube)	1
	G44075 – O'Ring (Cylinder – Was G44004)	2
G55012	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	3

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT255**

PART NUMBER	DESCRIPTION	QUANTITY
G51035	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ255**

PART NUMBER	DESCRIPTION	QUANTITY
R25663	Inlet End Journal Bearing	2
R25643	Outlet End Journal Bearing	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

MK1-4F WRV(H) 255, ALL L/D'S

Annual Inspection Kit – KW255-1-4F-V (Viton)

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	8
G32010	Straight Tab Washer ¼"	6
G32013	Straight Tab Washer 5/8"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G55012	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	3
G72002	Locking Wire	2
Q4274	Lockwasher 60mm	1
Q4506	Lockwasher 85mm	2
Q5163	Lockwasher 40mm	1
R20085	Lockwasher 50mm	1
R20204	PTFE Sleeve	1
R25102 - OK	Viton O' Ring Kit	1 Kit containing:
	M6200112 - O'Ring	1
	M6200226 - O'Ring	2
	M6200227 – O'Ring	1
	M6200258 – O'Ring	4
	M6200266 – O'Ring	2
	M6203925 – O'Ring	2
	M6204375 – O'Ring	1
	M6204385 – O'Ring	1
R25125	PTFE Piston Ring	1
R25135	Adjusting Washer	6
R25145	PTFE Piston Rod Ring	2
R25154	Superfeed Joint	2
R25205	Connecting Tube Ring (PTFE)	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk5 WRV(H) 255 ALL L/D'S

Annual Inspection Kit – KW255-5-V (Viton)

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G31003	Spring Washer – 5/8"	48
G32009	Straight Tab Washer 3/8"	8
G32013	Straight Tab Washer 5/8"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G55012	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	3
Q5163	Lockwasher 40mm	1
R20085	Lockwasher 50mm	1
R20204	PTFE Sleeve	1
R25102 - OK	Viton O' Ring Kit	1 Kit containing:
	M6200112 - O'Ring	1
	M6200226 - O'Ring	2
	M6200227 – O'Ring	1
	M6200258 – O'Ring	4
	M6200266 – O'Ring	2
	M6203925 – O'Ring	2
	M6204375 – O'Ring	1
	M6204385 – O'Ring	1
R25125	PTFE Piston Ring	1
R25135	Adjusting Washer	6
R25145	PTFE Piston Rod Ring	2
R25883	Rotor Locking Plate	2

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk6 WRVi 255 ALL L/D'S

Annual Inspection Kit – KW255-6-V (Viton)

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G32009	Straight Tab Washer 3/8"	8
G32013	Straight Tab Washer 5/8"	6
G51001	Ball Bearing (Actuator Spindle)	1
G55012	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	4
G60086	Circlip	1
M0702016	Spring Washer – M16	56
Q5163	Lockwasher 40mm	1
R25125	Piston Ring (PTFE)	1
R25135	Adjusting Washer	6
R25145	Piston Rod Ring	1
R25883	Rotor Locking Plate	2
VR25102 - OK	WRVi 255 Viton O' Ring Kit	1 Kit containing:
	M6200112 - O'Ring	1
	M6200226 - O'Ring	1
	M6200258 – O'Ring	3
	M6200266 – O'Ring	2
	M6200269 – O'Ring	1
	M6202962 - O'Ring	2
	M6203925 – O'Ring	2
	M6204375 – O'Ring	1
	M6204385 – O'Ring	1
	M6209453 – O'Ring	1
VR25500-BK	WRVi255 Bonded Seal Kit	1
	G33001 - Bonded Seal 3/8" BSP	4
	G33002 - Bonded Seal ½" BSP	2
	G33003 - Bonded Seal ¾" BSP	3
	G33004 - Bonded Seal 1" BSP	2
	G33005 - Bonded Seal 1 ¼" BSP	2
	G33008 - Bonded Seal ¼" BSP	4

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk4-4E – 5 WRVT 255/110, 130, 145, 165, 193 & 220

Replacement Shaft Seal Kit – KWST255

PART NUMBER	DESCRIPTION	QUANTITY
G60198	Shaft Seal	1
G44070	O'Ring	1

Annual Inspection Kit – KWT255-4-5

PART NUMBER	DESCRIPTION	QUANTITY
R20224	Rotor Locking Plate	2
G31003	Spring Washer – 5/8"	48
G32010	Straight Tab Washer ¼"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	1
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G44027	O'Ring	2
R25101 - OK	O' Ring Kit	1 Kit containing:
	G44001 – O'Ring (piston Rod)	2
	G44002 – O'Ring (Actuator Piston)	1
	G44005 – O'Ring (Actuator Spindle)	1
	G44008 – O'Ring (Main / Inlet / Outlet)	2
	G44070 – O'Ring (Rotor covers - Was G44013)	4
	G44020 – O'Ring (Piston Rod Guide Bracket)	1
	G44034 – O'Ring (Injection Tube)	1
	G44075 – O'Ring (Cylinder – Was G44004)	2
G51001	Ball Bearing (Actuator Spindle)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	4
Q4274	Lockwasher 60mm	1
Q5163	Lockwasher 40mm	1
R20085	Lockwasher 50mm	1
R20204	PTFE Sleeve	1
R25125	PTFE Piston Ring	1
R25145	PTFE Piston Rod Ring	2
R25154	Superfeed Joint	2

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

Replacement Thrust Bearing Kit – KWTT255

PART NUMBER	DESCRIPTION	QUANTITY
G51114	Floating Seal	2
G51115	Tilting Pad	44

Replacement Journal Bearing Kit – KWJ255

PART NUMBER	DESCRIPTION	QUANTITY
R25663	Inlet End Journal Bearing	2
R25643	Outlet End Journal Bearing	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk4 – 5 WRVT 255 ALL L/D'S

☐ **Annual Inspection Kit – KWT255-4-5-V (Viton)**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	48
G32010	Straight Tab Washer ¼"	6
G32014	Straight Tab Washer ½"	4
G33001	Bonded Seal 3/8" BSP	1
G33003	Bonded Seal ¾" BSP	4
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	2
G33008	Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60009	Circlip	4
M6200252	O'Ring	2
Q4274	Lockwasher 60mm	1
Q5163	Lockwasher 40mm	1
R20085	Lockwasher 50mm	1
R20204	PTFE Sleeve	1
R20224	Rotor Locking Plate	2
R25102 - OK	WRV Viton O' Ring Kit	1 Kit containing:
	M6200112 O'Ring	1
	M6200226 O'Ring	2
	M6200227 O'Ring	1
	M6200258 O'Ring	4
	M6200266 O'Ring	2
	M6203925 O'Ring	2
	M6204375 O'Ring	1
	M6204385 O'Ring	1
R25125	PTFE Piston Ring	1
R25145	PTFE Piston Rod Ring	2
R25154	Superfeed Joint	1

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk6 WRVi 255/110, 130, 145, 165, 193

Rev: 07.02

☐ **Replacement Shaft Seal Kit – KWS255-6**

PART NUMBER	DESCRIPTION	QUANTITY
G60238	Shaft Seal	1
G44070	O'Ring – Seal Cover	1

☐ **Annual Inspection Kit – KW255-6**

PART NUMBER	DESCRIPTION	QUANTITY
G26019	Tuflock Screw ¼" UNC x 5/8" LG	6
G32009	Straight Tab Washer 3/8"	8
G32013	Straight Tab Washer 5/8"	6
VR25500-BK	Bonded Seal Kit	1 Kit containing:
	G33001 – Bonded Seal 3/8" BSP	6
	G33003 – Bonded Seal ¾" BSP	3
	G33004 – Bonded Seal 1" BSP	2
	G33005 – Bonded Seal 1-1/4" BSP	2
	G33008 – Bonded Seal ¼" BSP	4
G51001	Ball Bearing (Actuator Spindle)	1
G55012	Gasket – S/Feed	1
Q5163	Lockwasher 40mm	1
R25125	Piston Ring	1
R25135	Adjusting Washer	6
R25883	Rotor Locking Plate	2
G60009	Circlip	4
G60086	Circlip	1
M0702016	Spring Washer – 16 Dia.	56
R25145	PTFE Piston Rod Ring	1
VR25101 - OK	O' Ring Kit	1 Kit containing:
	G44001 - O'Ring – Piston Rod	1
	G44002 - O'Ring – Piston	1
	G44005 – O'Ring – Ind. Spindle	1
	G44008 – O'Ring – Casing	2
	G44020 – O'Ring – Cylinder. Spigot	1
	G44070 – O'Ring – Covers	3
	G44075 – O'Ring – Act. Cylinder.	2
	M6000269 – O'Ring – Cylinder. Flange.	1
	M6002962 – O'Ring – Vi Spindle	2
	M6009453 – O'Ring – Cover	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT255**

PART NUMBER	DESCRIPTION	QUANTITY
G51035	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ255**

PART NUMBER	DESCRIPTION	QUANTITY
R25663	Inlet End Journal Bearing	2
R25643	Outlet End Journal Bearing	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS
Mk4-4F WRV(H) 321/132, 165, 193 & 220

☐ **Replacement Shaft Seal Kit – KWS321**

PART NUMBER	DESCRIPTION	QUANTITY
G60207	Shaft Seal	1
G44046	O'Ring	1

☐ **Annual Inspection Kit – KW321-4**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32014	Straight Tab Washer ½"	8
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G33007	Bonded Seal 2" BSP	2
G40001	Lockwasher 100mm – Thrust Bearings	2
G44006	O'Ring (Old Bearings)	2
G44047	O'Ring (Old Bearings)	2
G51001	Ball Bearing (Actuator Spindle)	1
Q4683	Lockwasher 65mm – Coupling	1
R32035	PTFE Connecting Tube Ring	2
R32134	Superfeed Joint (132/165)	2
R32135	Lockwasher 1-3/4" UNC	1
R32175	Adjusting Washer	6
R32255	Lockwasher 60mm	1
R 32015	PTFE Piston Ring	1
R32055	PTFE Piston Rod Ring	2
R32274	PTFE Sleeve	1
R32101-OK	O' Ring Kit	1 Kit containing:
	G44004 – O' Ring	2
	G44005 – O' Ring	1
	G44030 – O' Ring	1
	G44038 – O' Ring	1
	G44041 – O' Ring	1
	G44046 – O' Ring	4
	G44048 – O' Ring	2
	G44049 – O' Ring	2
	G44050 – O' Ring	2
	G44051 – O' Ring	2
G55101	Superfeed Joint (193/220)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2

☐ **Replacement Thrust Bearing Kit – KWT321**

PART NUMBER	DESCRIPTION	QUANTITY
G51063	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ321**

PART NUMBER	DESCRIPTION	QUANTITY
R32063	Inlet End Journal Bearing	2
R32083	Outlet End Journal Bearing	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk4 WRV(H) 321 ALL L/D'S

Annual Inspection Kit – KW321-4-V

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32014	Straight Tab Washer ½"	8
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G33007	Bonded Seal 2" BSP	2
G40001	Lockwasher 100mm	2
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Superfeed Joint (193/220)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2
M6200261	O'Ring	2
Q4683	Lockwasher	1
R32015	PTFE Piston Ring	1
R32035	PTFE Connecting Tube Ring	2
R32055	PTFE Piston Rod Ring	2
R32102 - OK	O' Ring Kit	1 Kit containing:
	M6200112 – O'Ring	2
	M6200229– O'Ring	1
	M6200235– O'Ring	1
	M6200265 – O'Ring	1
	M6200267 – O'Ring	1
	M6200271 – O'Ring	4
	M6200399 – O'Ring	2
	M6200445– O'Ring	2
	M6200446– O'Ring	2
	M620452A – O'Ring	2
R32134	Superfeed Joint (132/165)	2
R32135	Lockwasher 1-3/4" UNC	1
R32175	Adjusting Washer	6
R32255	Lockwasher 60mm	1
R32274	Sleeve (PTFE)	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk4-4E WRVT 321/132, 165, 193 & 220

☐ **Replacement Shaft Seal Kit – KWS321**

PART NUMBER	DESCRIPTION	QUANTITY
G60207	Input Shaft Seal	1
G44046	O'Ring	1

☐ **Annual Inspection Kit – KWT321-4**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G51001	Ball Bearing (Actuator Spindle)	1
Q4683	Lockwasher 65mm	1
R32134	Superfeed Joint (132/165)	2
R32135	Lockwasher 1-3/4" UNC	1
R32255	Lockwasher 60mm	1
R32434	Rotor Locking Plate	2
R32015	Piston Ring	1
R32035	PTFE Connecting Tube Rings	2
R32055	PTFE Piston Rod Ring	2
R32274	PTFE Sleeve	1
R32101 - OK	O' Ring Kit	1 Kit containing:
	G44004 – O'Ring	2
	G44005 – O'Ring	1
	G44030 – O'Ring	1
	G44038 – O'Ring	1
	G44041 – O'Ring	1
	G44046 – O'Ring	4
	G44048 – O'Ring	2
	G44049 – O'Ring	2
	G44050 – O'Ring	2
	G44051 – O'Ring	2
G55101	Superfeed Joint (193/220)	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Journal Bearing Kit – KWJ321**

PART NUMBER	DESCRIPTION	QUANTITY
R32063	Inlet End Journal Bearing	2
R32083	Outlet End Journal Bearing	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk4 WRVT 321, ALL L/D'S

Annual Inspection Kit – KWT321-4-V (Viton)

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2
Q4683	Lockwasher 65mm	1
R32015	PTFE Piston Ring	1
R32035	PTFE Connecting Tube Ring	2
R32055	PTFE Piston Rod Ring	2
R32102 - OK	WRV-321 Viton O' Ring Kit	1 Kit
R32134	Superfeed Joint (132/165)	2
R32135	Lockwasher 1-3/4" UNC	1
R32255	Lockwasher 60mm	1
R32274	PTFE Sleeve	1
R32434	Rotor Locking Plate	2

Suction and Discharge joints are not part of Inspection Kit.
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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk5 WRV(H) 321/132, 165, 193 & 220

☐ **Replacement Shaft Seal Kit – KWS321**

PART NUMBER	DESCRIPTION	QUANTITY
G60207	Shaft Seal	1
G44046	O'Ring	1

☐ **Annual Inspection Kit – KW321-5**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32014	Straight Tab Washer ½"	8
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G33007	Bonded Seal 2" BSP	2
G51001	Ball Bearing (Actuator Spindle)	1
R32135	Lockwasher 1-3/4" UNC Piston/Rod	1
R32175	Adjusting Washer	6
R32255	Lockwasher 60mm S/U Piston Rod	1
R32555	Rotor Locking Plate	2
R32015	PTFE Piston Ring	1
R32055	PTFE Piston Rod Ring	2
R32274	PTFE Sleeve	1
R32101 – OK	O' Ring Kit	1 Kit containing:
	G44004 – O'Ring	2
	G44005 – O'Ring	1
	G44030 – O'Ring	1
	G44038 – O'Ring	1
	G44041 – O'Ring	1
	G44046 – O'Ring	4
	G44048 – O'Ring	2
	G44049 – O'Ring	2
	G44050 – O'Ring	2
	G44051 – O'Ring	2
G55101	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT321**

PART NUMBER	DESCRIPTION	QUANTITY
G51063	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ321**

PART NUMBER	DESCRIPTION	QUANTITY
R32063	Inlet End Journal Bearing	2
R32083	Outlet End Journal Bearing	2

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk5 WRV(H) 321, ALL L/D'S

☐ **Annual Inspection Kit – KW321-5-V (Viton)**

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32014	Straight Tab Washer ½"	8
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾" BSP	2
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G33007	Bonded Seal 2" BSP	2
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Superfeed Joint	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2
R32015	PTFE Piston Ring	1
R32055	PTFE Piston Rod Ring	2
R32102 – OK	Viton O' Ring Kit	1 Kit containing:
	M6200112 – O'Ring	1
	M6200229 – O'Ring	2
	M6200235 – O'Ring	1
	M6200265 – O'Ring	2
	M6200267 – O'Ring	4
	M6200271 – O'Ring	2
	M6200399 – O'Ring	2
	M6200445 – O'Ring	1
	M6200446 – O'Ring	1
	M620452A – O'Ring	2
R32135	Lockwasher 1-3/4" UNC Piston/Rod	1
R32175	Adjusting Washer	6
R32255	Lockwasher 60mm S/U Piston Rod	1
R32274	PTFE Sleeve	1
R32555	Rotor Locking Plate	2

Suction and Discharge joints are not part of Inspection Kit.
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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk5 WRVT 321, ALL L/D'S

Annual Inspection Kit – KWT321-5

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2
Q4683	Lockwasher 65mm	1
R32015	PTFE Piston Ring	1
R32055	PTFE Piston Rod Ring	2
R32101 - OK	WRV-321 Neoprene O' Ring Kit	1 Kit
R32135	Lockwasher 1-3/4" UNC	1
R32255	Lockwasher 60mm	1
R32274	PTFE Sleeve	1
R32434	Rotor Locking Plate	2

Suction and Discharge joints are not part of Inspection Kit.
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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk5 WRVT 321, ALL L/D'S

Annual Inspection Kit – KWT321-5-V (Viton)

PART NUMBER	DESCRIPTION	QUANTITY
G31003	Spring Washer – 5/8"	12
G31011	Spring Washer 7/8" Dia.	64
G32009	Straight Tab Washer 3/8"	6
G32013	Straight Tab Washer 5/8"	4
G32014	Straight Tab Washer ¾"	8
G32020	Straight Tab Washer ¾"	6
G33001	Bonded Seal 3/8" BSP	4
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾" BSP	6
G33004	Bonded Seal 1" BSP	2
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	3
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	1
G60071	Circlip	2
R32015	PTFE Piston Ring	1
R32055	Piston Rod Ring (PTFE)	2
R32102 – OK	WRV 321 Viton O' Ring Kit	1 Kit
R32135	Lockwasher 1-3/4" UNC	1
R32255	Lockwasher 60mm	1
R32274	Sleeve (PTFE)	1
R32434	Rotor Locking Plate	2

Suction and Discharge joints are not part of Inspection Kit.
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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk6 WRV 321, ALL L/D'S

☐ **Replacement Shaft Seal Kit – KWS321-6**

PART NUMBER	DESCRIPTION	QUANTITY
G60239-N	Input Shaft Seal	1
G44046	O'Ring	1

☐ **Annual Inspection Kit – KW321-6**

PART NUMBER	DESCRIPTION	QUANTITY
G32009	Straight Tab Washer 3/8"	6
G32014	Straight Tab Washer ½"	8
G33001	Bonded Seal 3/8" BSP	2
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾"	4
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	2
G33007	Bonded Seal 2"	2
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	2
G60071	Circlip	2
M0702024	Spring Washer – M24	64
M0704020	Straight Tab Washer – M20	6
M6602040	Circlip	1
R32015	Piston Ring (PTFE)	1
R32055	PTFE Piston Rod Ring (PTFE)	1
R32135	Lockwasher 1-3/4" UNC	1
R32175	Adjusting Washer	6
R32555	Rotor Locking Plate	2
VR32101 - OK	WRV 321 Neoprene O' Ring Kit	1 Kit containing:
	G44005 – O'Ring	1
	G44030 – O'Ring	1
	G44038– O'Ring	1
	G44046 – O'Ring	3
	G44048 – O'Ring	1
	G44049 – O'Ring	2
	G44050 – O'Ring	2
	G44051– O'Ring	2
	G44072 – O'Ring	1
	M6003962 – O'Ring	2
	M6026935 – O'Ring	1

Suction and Discharge joints are not part of Inspection Kit.
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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk6 WRV(H) 321, ALL L/D'S

☐ **Annual Inspection Kit – KW321-6-F**

PART NUMBER	DESCRIPTION	QUANTITY
G32009	Straight Tab Washer 3/8"	6
G32014	Straight Tab Washer ½"	8
G33001	Bonded Seal 3/8" BSP	2
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾"	4
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	2
G33007	Bonded Seal 2"	2
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	2
G60071	Circlip	2
M0702024	Spring Washer – M24	64
M0704020	Straight Tab Washer – M20	6
M6602040	Circlip	1
R32015	Piston Ring (PTFE)	1
R32055	PTFE Piston Rod Ring (PTFE)	1
R32135	Lockwasher 1-3/4" UNC	1
R32175	Adjusting Washer	6
R32555	Rotor Locking Plate	2
VR32103 – OK	WRV 321 Fluorosilicone O' Ring Kit	1 Kit containing:
	M6300112 – O'Ring	1
	M6300229 – O'Ring	1
	M6300267 – O'Ring	3
	M6300271 – O'Ring	2
	M6300399 – O'Ring	2
	M6300445 – O'Ring	1
	M6300446 – O'Ring	1
	M6303962 – O'Ring	2
	M630452A – O'Ring	2
	M6312453 – O'Ring	1
	M6326935 – O'Ring	1

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RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

Mk6 WRVi (H) 321, ALL L/D'S

☐ **Replacement Shaft Seal Kit (Viton) – KWS321-6-V**

PART NUMBER	DESCRIPTION	QUANTITY
G60239-V	Input Shaft Seal	1
M620067	O'Ring	1

☐ **Annual Inspection Kit (Viton) – KW321-6-V**

PART NUMBER	DESCRIPTION	QUANTITY
G32009	Straight Tab Washer 3/8"	6
G32014	Straight Tab Washer ½"	8
G33001	Bonded Seal 3/8" BSP	2
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾"	4
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	2
G33007	Bonded Seal 2"	2
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	2
G60071	Circlip	2
M0702024	Spring Washer – M24	64
M0704020	Straight Tab Washer – M20	6
M6602040	Circlip	1
R32015	Piston Ring (PTFE)	1
R32055	PTFE Piston Rod Ring (PTFE)	1
R32135	Lockwasher 1-3/4" UNC	1
R32175	Adjusting Washer	6
R32555	Rotor Locking Plate	2
VR32102 - OK	WRV i321 Viton O' Ring Kit	1 Kit containing:
	M6200112 – O'Ring	1
	M6200229 – O'Ring	1
	M6200267 – O'Ring	3
	M6200271 – O'Ring	2
	M6200399 – O'Ring	2
	M6200445 – O'Ring	1
	M6200446 – O'Ring	1
	M6203962 – O'Ring	2
	M620452A – O'Ring	2
	M6212453 – O'Ring	1
	M6226935 – O'Ring	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

Rev:

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk6 WRVi 321, ALL L/D'S

☐ **Replacement Shaft Seal Kit – KWS321-6**

PART NUMBER	DESCRIPTION	QUANTITY
G60239-N	Input Shaft Seal	1
G44046	O'Ring	1

☐ **Annual Inspection Kit – KW321-6**

PART NUMBER	DESCRIPTION	QUANTITY
G32009	Straight Tab Washer 3/8"	6
G32014	Straight Tab Washer ½"	8
G33001	Bonded Seal 3/8" BSP	2
G33002	Bonded Seal ½" BSP	4
G33003	Bonded Seal ¾"	4
G33004	Bonded Seal 1" BSP	1
G33005	Bonded Seal 1-1/4" BSP	1
G33006	Bonded Seal 1-1/2" BSP	2
G33007	Bonded Seal 2"	2
G51001	Ball Bearing (Actuator Spindle)	1
G55101	Joint 3" NB	1
G60004	Retaining Ring (Actuator spindle – Outer)	1
G60005	Retaining Ring (Actuator spindle – Inner)	1
G60070	Circlip	2
G60071	Circlip	2
M0702024	Spring Washer – M24	64
M0704020	Straight Tab Washer – M20	6
M6602040	Circlip	1
R32015	Piston Ring (PTFE)	1
R32055	PTFE Piston Rod Ring (PTFE)	1
R32135	Lockwasher 1-3/4" UNC	1
R32175	Adjusting Washer	6
R32555	Rotor Locking Plate	2
VR32101 - OK	WRV 321 Neoprene O' Ring Kit	1 Kit containing:
	G44005 – O'Ring	1
	G44030 – O'Ring	1
	G44038 – O'Ring	1
	G44046 – O'Ring	3
	G44048 – O'Ring	1
	G44049 – O'Ring	2
	G44050 – O'Ring	2
	G44051 – O'Ring	2
	G44072 – O'Ring	1
	M6003962 – O'Ring	2
	M6026935 – O'Ring	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

☐ **Replacement Thrust Bearing Kit – KWT321**

PART NUMBER	DESCRIPTION	QUANTITY
G51063	Angular Contact Bearing	4

☐ **Replacement Journal Bearing Kit – KWJ321**

PART NUMBER	DESCRIPTION	QUANTITY
R32063	Inlet End Journal Bearing	2
R32083	Outlet End Journal Bearing	2

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS
Mk1 WRVi 365, ALL L/D'S

Replacement Shaft Seal Kit – KWS365

PART NUMBER	DESCRIPTION	QUANTITY
VR36225-3	Input Shaft Seal	1
XR12112-3	O'Ring	2

Annual Inspection Kit – KW365

PART NUMBER	DESCRIPTION	QUANTITY
G32020	Tab Washer ¾"	8
G32021	Tab Washer 7/16"	12
G55074	Joint 4" NB	1
M0701024	Plain Washer 24mm	72
M6601240	Circlip – Internal	4
M6602060	Circlip – External	1
Q25036-1	Lockwasher 50mm	1
R32175	Adjusting Washer	8
R32555	Rotor Locking Plate	2
R36401-BK	Bonded Seal Kit	
	G33001 Bonded Seal 3/8" BSP	5
	G33002 Bonded Seal ½" BSP	3
	G33003 Bonded Seal ¾" BSP	4
	G33004 Bonded Seal 1" BSP	2
	G33006 Bonded Seal 1-1/2" BSP	2
	G33007 Bonded Seal 2" BSP	3
VR36101-OK	O-Ring Kit (Viton)	
	G44005 – O'Ring – (Actuator Spindle)	1
	G44079 – O'Ring – (Core Hole Cover, bott)	1
	G44050 – O'Ring – (Female Rotor Cover)	2
	XR12112-3 – O'Ring - (Seal Housing)	4
	M6005953 – O'Ring – (Adjusting Screw)	2
	M6009453 – O'Ring – (Core Hole Cover, Side)	1
	M6011453 – O'Ring – (Vi Cover)	1
	M6022625 – O'Ring – (Cylinder Spigot)	1
	M6031935 – O'Ring – (Cylinder Spigot)	1
	M6035935 – O'Ring – (Actuator Cylinder)	2
	M6089168 – O'Ring – (Main Casing / Covers)	2
VR36134-3	Turcon Glyd Ring T40	1
VR36135-3	O'Ring (Glyd Seal)	1
VR36141-3	Turcon Glyd Ring T40	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

Replacement Thrust Bearing Kit – KWT365

PART NUMBER	DESCRIPTION	QUANTITY
G51063	Angular Contact Bearing	5

Replacement Journal Bearing Kit – KWJ365

PART NUMBER	DESCRIPTION	QUANTITY
M6510020	Spring Pin	4
VR36086-2	Inlet End Journal Bearing	2
VR36088-2	Outlet End Journal Bearing	2

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS
Mk1 WRVi 365, ALL L/D'S (Viton)

Replacement Shaft Seal Kit – KWS365-V

PART NUMBER	DESCRIPTION	QUANTITY
N0xxxx08040	Input Shaft Seal	1
M6223935	O'Ring	2

Annual Inspection Kit – KW365-V

PART NUMBER	DESCRIPTION	QUANTITY
G32020	Tab Washer ¾"	8
G32021	Tab Washer 7/16"	12
G55074	Joint 4" NB	1
M0701024	Plain Washer 24mm	72
M6601240	Circlip – Internal	4
M6602060	Circlip – External	1
Q25036-1	Lockwasher 50mm	1
R32175	Adjusting Washer	8
R32555	Rotor Locking Plate	2
R36401-BK	Bonded Seal Kit	
	G33001 Bonded Seal 3/8" BSP	5
	G33002 Bonded Seal ½" BSP	3
	G33003 Bonded Seal ¾" BSP	4
	G33004 Bonded Seal 1" BSP	2
	G33006 Bonded Seal 1-1/2" BSP	2
	G33007 Bonded Seal 2" BSP	3
VR36102-OK	O-Ring Kit (Viton)	
	M6200112 – O'Ring – (Actuator Spindle)	1
	M6200262 – O'Ring – (Core Hole Cover, bott)	1
	M6200271 – O'Ring – (Female Rotor Cover)	2
	M6205953 – O'Ring – (Adjusting Screw)	2
	M6209453 – O'Ring – (Core Hole Cover, Side)	1
	M6211453 – O'Ring – (Vi Cover)	1
	M6222625 – O'Ring – (Cylinder Spigot)	1
	M6231935 – O'Ring – (Cylinder Spigot)	4
	M6235935 – O'Ring – (Actuator Cylinder)	2
	M6289168 – O'Ring – (Main Casing / Covers)	2
VR36136-3	Turcon Glyd Ring T40	1
VR36135-3	O'Ring (Glyd Seal)	1
VR36141-3	Turcon Glyd Ring T40	1

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Replacement Thrust Bearing Kit – KWT365

PART NUMBER	DESCRIPTION	QUANTITY
G51063	Angular Contact Bearing	5

Replacement Journal Bearing Kit – KWJ365

PART NUMBER	DESCRIPTION	QUANTITY
M6510020	Spring Pin	4
VR36086-2	Inlet End Journal Bearing	2
VR36088-2	Outlet End Journal Bearing	2

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk2, 2A & 2B XRV 127/165 R1

☐ **Replacement shaft seal kit – KXDS127**

PART NUMBER	DESCRIPTION	QUANTITY
XR12096-3	Input Shaft Seal	1
G44059	O'Ring – Inlet Cover	1

☐ **Annual Inspection Kit – KX127-2**

PART NUMBER	DESCRIPTION	QUANTITY
G44059	O'Ring – Inlet Cover	1
XR12059-3	Actuator Piston Seal	1
XR12106-3	O'Ring – Actuator Cyl. Cover	2
XR16102-3	O'Ring - Piston/Slide Valve	1
XR16515-3	Locknut M30 (S/Lock)	1
XR16522-2	Indicator Pin	1
M0905010	Grub Screw	1

☐ **Overhaul Kit – KXD127-2**

PART NUMBER	DESCRIPTION	QUANTITY
G33001	Bonded Seal 3/8" BSP	2
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	1
G33008	Bonded Seal ¼" BSP	3
G51001	Ball Bearing (Actuator Spindle)	1
G57057	Microswitch	2
G60004	Retaining Ring	1
G60005	Retaining Ring	1
M1701008	Washer – 8mm Dia.	1
M1701010	Washer – 10mm Dia.	10
M1701012	Washer – 12mm Dia.	26
M1701020	Washer – 20mm Dia.	4
Q4273	Lockwasher S	1
Q5163	Lockwasher 40mm	2
XR12014-2	Labyrinth Insert	1
XR12032-2	Floating Bush	2
XR12033-2	Bearing Spacer	2
XR12060-3	Disc Spring	2
XR12457-3	Cylindrical Roller Bearing	3
XR12097-3	Cylindrical Roller Bearing	1
XR12101-3	Angular Contact Bearing	4
XR16295-3	Potentiometer (1k OHM)	1
XR12101 - OK	O' Ring Kit	1 Kit containing:
	G44005 – O'Ring – Indicator Spindle	1
	G44059 - O'Ring – G' Box Cover	1
	G44076 - O'Ring – G' Box/Main	1
	XR12106-3 - O'Ring – Covers	6
	XR12107-3 - O'Ring – Gas Seal	2
	XR16102-3 – O'Ring – Piston/Slide Valve	1
	XR12109-3 - O'Ring – Man. Vi Spindle	2
	XR12112-3 - O'Ring - Main/Outlet	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

When undertaking a compressor overhaul, all of the above three Kits are required.

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk2, 2A & 2B XRV 127/165 R3-5

☐ **Replacement Shaft Seal Kit – KXGS127**

PART NUMBER	DESCRIPTION	QUANTITY
XR12124-3	Input Shaft Seal (Short Seat)	1
XR12105-3	O'Ring – Shaft Seal Hsg.	1
XR12110-3	O'Ring – Shaft Seal Hsg.	1

☐ **Annual Inspection Kit – KX127-2**

PART NUMBER	DESCRIPTION	QUANTITY
G44059	O'Ring – G'Box Cover	1
XR12059-3	Actuator Piston Seal	1
XR12106-3	O'Ring – Act. Cyl Cover	2
XR16102-3	O'Ring – Piston/Slide Valve	1
XR16515-3	Locknut M30 (S/Lock) (up to Mk2)	1
XR16522-2	Indicator Pin	1
M0905010	Grub Screw	1

☐ **Overhaul Kit – KXG127-2**

PART NUMBER	DESCRIPTION	QUANTITY
G33001	Bonded Seal 3/8" BSP	2
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	1
G33008	Bonded Seal ¼" BSP	3
G51001	Ball Bearing (Actuator Spindle)	1
G57057	Microswitch	2
G60004	Retaining Ring	1
G60005	Retaining Ring	1
G60156	Circlip	1
M1701008	Washer – 8mm Dia.	1
M1701010	Washer – 10mm Dia.	10
M1701012	Washer – 12mm Dia.	26
M1701020	Washer – 20mm Dia.	4
Q4273	Lockwasher	1
Q5163	Lockwasher 40mm	2
XR12014-2	Labyrinth Insert	1
XR12032-2	Floating Bush	2
XR12033-2	Bearing Spacer	2
XR12060-3	Disc Spring	2
XR12457-3	Cylindrical Roller Bearing	4
XR12101-3	Angular Contact Bearing	4
XR12103-3	Cylindrical Roller Bearing	1
XR12116-3	Angular Contact Thrust Bearing	2
XR16295-3	Potentiometer (1k OHM)	1
XR12102 - OK	O' Ring Kit	1 Kit containing:
	G44005 - O'Ring – Indicator Spindle	1
	G44059 - O'Ring – G'Box Cover	1
	G44076 - O'Ring – G'Box/Main	1
	XR12105-3 - O'Ring – Shaft Seal Hsg.	1
	XR12106-3 - O'Ring – Covers	6
	XR12107-3 - O'Ring – Gas Seal	2
	XR16102-3 - O'Ring – Piston/Slide Valve	1
	XR12109-3 - O'Ring – Man.Vi Spindle	2
	XR12110-3 - O'Ring – Shaft Seal Hsg.	1
	XR12112-3 - O'Ring – Main/Outlet	1

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODEL

XRV 127 VITON

☐ **Replacement Shaft Seal Kit – Viton - KXDS127 - XRV127/R1 Compressors, All Models**

PART NUMBER	DESCRIPTION	QUANTITY
M6222953	O'Ring	1
XR12096-3	Input Shaft Seal	2

☐ **Annual Inspection Kit – Viton - KX127-2-V - XRV127/R1-5 Compressors, Mk2 Model**

PART NUMBER	DESCRIPTION	QUANTITY
M0905010	Grub Screw	1
M6208453	O'Ring	2
M6222953	O'Ring	2
XR12059-3	Actuator Piston Seal	1
XR16522-2	Indicator Pin – Solid (4.8)	1
XR16527-2	Lock Nut M30 (Extended)	1

☐ **Overhaul Kit – Viton - KXD127-2-V - XRV127/R1 Compressors, MK 2 Model**

PART NUMBER	DESCRIPTION	QUANTITY
G33001	Bonded Seal 3/8" BSP	2
G33002	Bonded Seal ½" BSP	1
G33003	Bonded Seal ¾" BSP	1
G33008	Bonded Seal ¼" BSP	3
G51001	Ball Bearing (Actuator Spindle)	1
G57057	Microswitch	2
G60004	Retaining Ring	1
G60005	Retaining Ring	1
M1701008	Washer – 8mm Dia.	1
M1701010	Washer – 10mm Dia.	10
M1701012	Washer – 12mm Dia.	26
M1701020	Washer – 20mm Dia.	4
Q4273	Lockwasher	1
Q5163	Lockwasher 40mm	2
XR12014-2	Labyrinth Insert	1
XR12032-2	Floating Bush	2
XR12033-2	Bearing Spacer	2
XR12060-3	Disc Spring	2
XR12097-3	Cylindrical Roller Bearing	1
XR12101-3	Angular Contact Bearing	4
XR12103 - OK	XRV (R1) Viton O' Ring Kit	1
XR12457-3	Cylindrical Roller Bearing	3
XR13295-3	Potentiometer (1K OHM)	1

Suction and Discharge joints are not part of Inspection Kit.
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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk2, 2A, 2B, 2C & 2D XRV 163/165 & 193

Replacement Shaft Seal Kit – KXS163

PART NUMBER	DESCRIPTION	QUANTITY
G60205	Input Shaft Seal	1
XR16105-3	O'Ring – Seal Housing	1

Annual Inspection Kit – KX163-2C

PART NUMBER	DESCRIPTION	QUANTITY
M0905010	Grub Screw	1
M1701010	Washer – 10mm Dia.	4
XR16079-3	Actuator Piston Seal	1
XR16102-3	O'Ring – Piston/Slide Valve	1
XR16105-3	O'Ring – Covers	3
XR16522-2	Indicator Pin	1
XR16515-3	Locknut M30 (S/Lock) (up to Mk2B)	1

Overhaul Kit – KX163

PART NUMBER	DESCRIPTION	QUANTITY
G33002	Bonded Seal ½" BSP	3
G33003	Bonded Seal ¾" BSP	4
G33010	Bonded Seal 1/8"BSP	2
G51001	Ball Bearing (Actuator Spindle)	1
G57057	Microswitch	2
G60004	Retaining Ring	1
G60005	Retaining Ring	1
G60175	Circlip	2
M1701010	Washer – 10mm Dia.	27
M1701016	Washer – 16mm Dia.	30
M1701020	Washer – 20mm Dia.	12
Q4521	Lockwasher 50mm	2
Q4792	Lockwasher 30mm	1
XR16029-2	Outlet End Floating Bush	2
XR16047-2	Labyrinth Insert	1
XR16049-4	Thrust Bearing Assembly	2
XR16072-3	Superfeed Joint	1
XR16080-2	Disc Spring	2
XR16531-3	Cylindrical Roller Bearing	4
XR16295-3	Potentiometer (1k OHM)	1
XR16101 - OK	O' Ring Kit	1 Kit containing:
	G44005 – O'Ring – Ind. Spindle	1
	G44065 – O'Ring – Main/Outlet	2
	XR16102-3 – O'Ring – Piston/Slide Valve	1
	XR16101-3 - O'Ring – Man. Vi Spindle	2
	XR16104-3 - O'Ring – Gas Seals	2
	XR16105-3 - O'Ring – Covers etc.	9
	XR16106-3 - O'Ring – Inlet Bearings	2
	XR16460-3 - O'Ring – Vi Cover	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

When undertaking a compressor overhaul, all of the above three Kits are required.

Additional Parts: KX163 – AUTO Vi

PART NUMBER	DESCRIPTION	QUANTITY
M1701004	Washer – 4mm.	2
M1701005	Washer – 5mm.	3
G33010	Bonded Seal 1/8" BSP	2
XR20776-3	O'Ring	1
XR16280-3	Variseal 4mm.	1
XR16265-3	Glyd Ring	1
XR16266-3	Slyd Ring	1

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk3, 3A, 3B, 3C, 3D & 3E XRV 204/110, 145, 165 & 193

☐ **Replacement Shaft Seal Kit – KXS204**

PART NUMBER	DESCRIPTION	QUANTITY
G60224	Shaft Seal	1
XR20104-3	O'Ring - Seal Housing	1

☐ **Annual Inspection Kit – KX204-3D**

PART NUMBER	DESCRIPTION	QUANTITY
M1701012	Washer – 12mm Dia.	4
R25065	Indicator Pin	1
XR20100-3	O'Ring – Slide Valve/Piston	1
XR20104-3	O'Ring – Act. Cylinder Cover	4
XR20875-3	Actuator Piston Seal	1
XR20782-3	Locknut M35 (S/Lock) (up to Mk 3C)	1
M0905010	Grub Screw	1

☐ **Overhaul Kit – KX204**

PART NUMBER	DESCRIPTION	QUANTITY
G33002	Bonded Seal ½" BSP	3
G33003	Bonded Seal ¾" BSP	4
G33008	Bonded Seal ¼" BSP	1
G33010	Bonded Seal 1/8"BSP	2
G51001	Ball Bearing (Actuator Spindle)	1
G57057	Microswitch	2
G60004	Retaining Ring	1
G60005	Retaining Ring	1
G60017	Circlip	2
M1701012	Washer – 12mm Dia.	12
M1701016	Washer – 16mm Dia.	34
M1701020	Washer – 20mm Dia.	12
Q4683	Lockwasher 65mm	2
Q5163	Lockwasher 40mm	1
XR16295-3	Potentiometer (1k OHM)	1
XR20042-2	Outlet End Floating Bush	2
XR20053-2	Labyrinth Insert	1
XR20237-3	O'Ring – Man. Vi Adjustment	2
XR20060-2	Disc Spring	2
XR20910-3	Cylindrical Roller Bearing	2
XR20101 - OK	O' Ring Kit	1 Kit containing:
	G44005 - O'Ring – Indicator Spindle	1
	G44066 - O'Ring – Inlet/Main/Outlet	2
	XR16105-3 - O'Ring – Vi Adj. Cover	1
	XR20100-3 – O'Ring – Slide Valve/Piston	1
	XR20102-3 - O'Ring – Gas Seal	2
	XR20104-3 - O'Ring – Covers etc.	8
	XR20105-3 - O'Ring – Inlet Bearing	2
XR20520-4	Thrust Bearing Assembly	2
XR20823-3	Cylindrical Roller Bearing	2

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

When undertaking a compressor overhaul, all of the above three Kits are required.

☐ **Additional Parts: KX204 – AUTO Vi**

PART NUMBER	DESCRIPTION	QUANTITY
M1701004	Washer – 4mm Dia.	2
M1701005	Washer – 5mm Dia.	6
G33010	Bonded Seal 1/8" BSP	2
XR20776-3	O'Ring	1
XR16280-3	Variseal 4mm	1
XR20730-3	Glyd Ring	1

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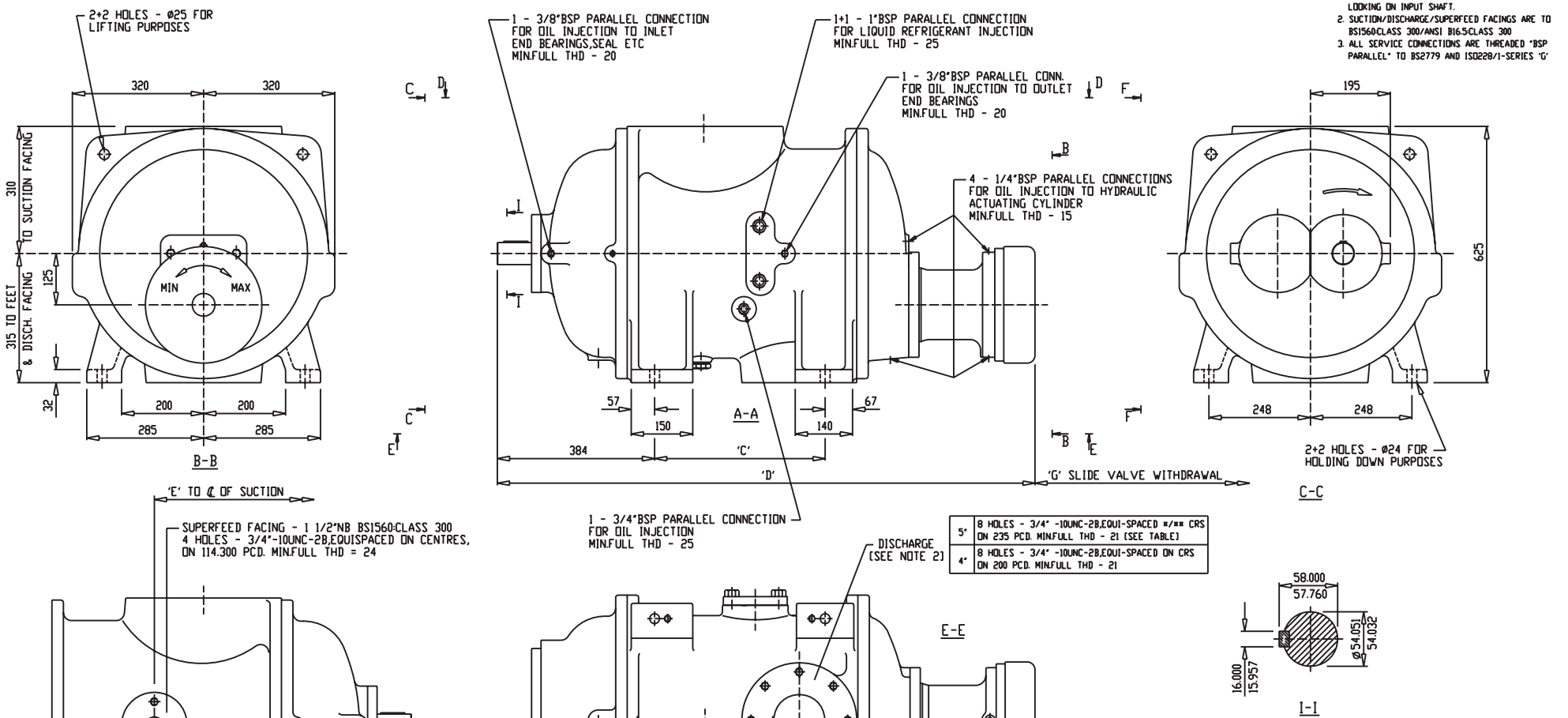
NOTE
1. ROTATION OF INPUT SHAFT IS CLOCKWISE WHEN LOOKING ON INPUT SHAFT.
2. SUCTION/DISCHARGE/SUPERFEED FACINGS ARE TO BS1560-CLASS 300/ANSI B16.5-CLASS 300
3. ALL SERVICE CONNECTIONS ARE THREADED "BSP PARALLEL" TO BS2779 AND ISO228/1-SERIES 'G'



5"	8 HOLES - 3/4" -10UNC-2B,EQUI-SPACED #/## CRS ON 235 PCD. MIN.FULL THD - 21 (SEE TABLE)
4"	8 HOLES - 3/4" -10UNC-2B,EQUI-SPACED ON CRS ON 200 PCD. MIN.FULL THD - 21

8"	12 HOLES - 7/8" -9UNC-2B,EQUI-SPACED ON CRS ON 330.200 PCD. MIN.FULL THD - 30
6"	12 HOLES - 3/4" -10UNC-2B,EQUI-SPACED ON CRS ON 269.900 PCD. MIN.FULL THD - 25

COMPRESSOR	DIMN A	DIMN B	DIMN C	DIMN D	DIMN E	DIMN F	DIMN G	SUCTION BORE	DISCH BORE	COMPR WEIGHT(Kg)
WRV/204110	504	119	303	1201	13	1/2"	195	6" DN150	4" DN100	790
WRV/204145	507	188	375	1273	80	1/2"	300	8" DN200	5"# DN125	885
WRV/204165	504	230	416	1314	123	3/4"	300	8" DN200	5"## DN125	905
WRV/204193	507	285	470	1370	175	3/4"	345	8" DN200	5"# DN125	940

NOTE:- # = ON CENTRES FOR L/D=1.45 AND 1.93
= OFF CENTRES FOR L/D=1.65

MOD.	ZONE	MODIFICATION	SIGN DATE
9			
8			
7			
6			
5			
4			
3		MODEL USAGE UPDATED	99.01.18
2		DRILLING DETAILS AMENDED	C MacL
2		FOR 5" DISCHARGE FACING	97.07.22
1		DRILLING DETAILS AMENDED	WMacL
1		FOR DISCHARGE FACING	96.03.06

UNLIMITED MACHINED SIZES TO BE WITHIN ±

MODEL 6 6A

DRN.	GH
CHKD.	W MacL
DATE	95.09.21

WRV204/RANGE COMPRESSOR
EXTERNAL ARRANGEMENT

SCALE:-
DRAWING No. R20737
MOD. 3

HOWDEN COMPRESSORS LIMITED, GLASGOW, U.K.

HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk2, 2A, 2B, 2C & 2D XRV 163/165 & 193

Replacement Shaft Seal Kit – KXS163

PART NUMBER	DESCRIPTION	QUANTITY
G60205	Input Shaft Seal	1
XR16105-3	O'Ring – Seal Housing	1

Annual Inspection Kit – KX163-2C

PART NUMBER	DESCRIPTION	QUANTITY
M0905010	Grub Screw	1
M1701010	Washer – 10mm Dia.	4
XR16079-3	Actuator Piston Seal	1
XR16102-3	O'Ring – Piston/Slide Valve	1
XR16105-3	O'Ring – Covers	3
XR16522-2	Indicator Pin	1
XR16515-3	Locknut M30 (S/Lock) (up to Mk2B)	1

Overhaul Kit – KX163

PART NUMBER	DESCRIPTION	QUANTITY
G33002	Bonded Seal ½" BSP	3
G33003	Bonded Seal ¾" BSP	4
G33010	Bonded Seal 1/8"BSP	2
G51001	Ball Bearing (Actuator Spindle)	1
G57057	Microswitch	2
G60004	Retaining Ring	1
G60005	Retaining Ring	1
G60175	Circlip	2
M1701010	Washer – 10mm Dia.	27
M1701016	Washer – 16mm Dia.	30
M1701020	Washer – 20mm Dia.	12
Q4521	Lockwasher 50mm	2
Q4792	Lockwasher 30mm	1
XR16029-2	Outlet End Floating Bush	2
XR16047-2	Labyrinth Insert	1
XR16049-4	Thrust Bearing Assembly	2
XR16072-3	Superfeed Joint	1
XR16080-2	Disc Spring	2
XR16531-3	Cylindrical Roller Bearing	4
XR16295-3	Potentiometer (1k OHM)	1
XR16101 - OK	O' Ring Kit	1 Kit containing:
	G44005 – O'Ring – Ind. Spindle	1
	G44065 – O'Ring – Main/Outlet	2
	XR16102-3 – O'Ring – Piston/Slide Valve	1
	XR16101-3 - O'Ring – Man. Vi Spindle	2
	XR16104-3 - O'Ring – Gas Seals	2
	XR16105-3 - O'Ring – Covers etc.	9
	XR16106-3 - O'Ring – Inlet Bearings	2
	XR16460-3 - O'Ring – Vi Cover	1

Suction and Discharge joints are not part of Inspection Kit.
These are available at extra cost as required.

When undertaking a compressor overhaul, all of the above three Kits are required.

Additional Parts: KX163 – AUTO Vi

PART NUMBER	DESCRIPTION	QUANTITY
M1701004	Washer – 4mm.	2
M1701005	Washer – 5mm.	3
G33010	Bonded Seal 1/8" BSP	2
XR20776-3	O'Ring	1
XR16280-3	Variseal 4mm.	1
XR16265-3	Glyd Ring	1
XR16266-3	Slyd Ring	1

Rev: 09.00

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HOWDEN
COMPRESSORS

RECOMMENDED SPARES LIST

HOWDEN COMPRESSOR MODELS

Mk3, 3A, 3B, 3C, 3D & 3E XRV 204/110, 145, 165 & 193

Replacement Shaft Seal Kit – KXS204

PART NUMBER	DESCRIPTION	QUANTITY
G60224	Shaft Seal	1
XR20104-3	O'Ring - Seal Housing	1

Annual Inspection Kit – KX204-3D

PART NUMBER	DESCRIPTION	QUANTITY
M1701012	Washer – 12mm Dia.	4
R25065	Indicator Pin	1
XR20100-3	O'Ring – Slide Valve/Piston	1
XR20104-3	O'Ring – Act. Cylinder Cover	4
XR20875-3	Actuator Piston Seal	1
XR20782-3	Locknut M35 (S/Lock) (up to Mk 3C)	1
M0905010	Grub Screw	1

Overhaul Kit – KX204

PART NUMBER	DESCRIPTION	QUANTITY
G33002	Bonded Seal ½" BSP	3
G33003	Bonded Seal ¾" BSP	4
G33008	Bonded Seal ¼" BSP	1
G33010	Bonded Seal 1/8"BSP	2
G51001	Ball Bearing (Actuator Spindle)	1
G57057	Microswitch	2
G60004	Retaining Ring	1
G60005	Retaining Ring	1
G60017	Circlip	2
M1701012	Washer – 12mm Dia.	12
M1701016	Washer – 16mm Dia.	34
M1701020	Washer – 20mm Dia.	12
Q4683	Lockwasher 65mm	2
Q5163	Lockwasher 40mm	1
XR16295-3	Potentiometer (1k OHM)	1
XR20042-2	Outlet End Floating Bush	2
XR20053-2	Labyrinth Insert	1
XR20237-3	O'Ring – Man. Vi Adjustment	2
XR20060-2	Disc Spring	2
XR20910-3	Cylindrical Roller Bearing	2
XR20101 - OK	O' Ring Kit	1 Kit containing:
	G44005 - O'Ring – Indicator Spindle	1
	G44066 - O'Ring – Inlet/Main/Outlet	2
	XR16105-3 - O'Ring – Vi Adj. Cover	1
	XR20100-3 – O'Ring – Slide Valve/Piston	1
	XR20102-3 - O'Ring – Gas Seal	2
	XR20104-3 - O'Ring – Covers etc.	8
	XR20105-3 - O'Ring – Inlet Bearing	2
XR20520-4	Thrust Bearing Assembly	2
XR20823-3	Cylindrical Roller Bearing	2

Suction and Discharge joints are not part of Inspection Kit. These are available at extra cost as required.

When undertaking a compressor overhaul, all of the above three Kits are required.

Additional Parts: KX204 – AUTO Vi

PART NUMBER	DESCRIPTION	QUANTITY
M1701004	Washer – 4mm Dia.	2
M1701005	Washer – 5mm Dia.	6
G33010	Bonded Seal 1/8" BSP	2
XR20776-3	O'Ring	1
XR16280-3	Variseal 4mm	1
XR20730-3	Glyd Ring	1

Rev:

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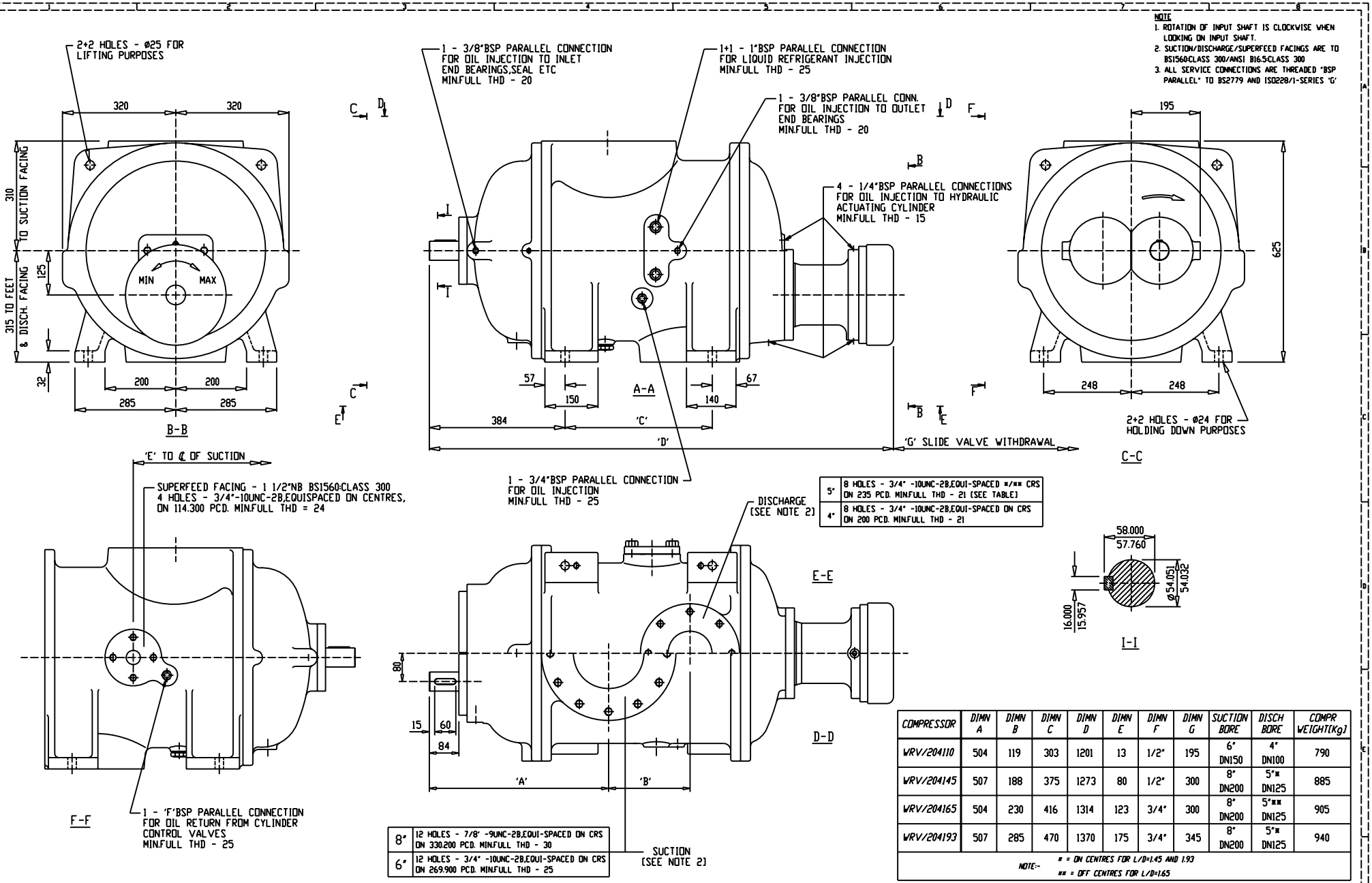

COMPRESSOR	DIMN A	DIMN B	DIMN C	DIMN D	DIMN E	DIMN F	DIMN G	SUCTION BORE	DISCH BORE	COMPR WEIGHT(Kg)
WRV/204110	504	119	303	1201	13	1/2"	195	6" DN150	4" DN100	790
WRV/204145	507	188	375	1273	80	1/2"	300	8" DN200	5"* DN125	885
WRV/204165	504	230	416	1314	123	3/4"	300	8" DN200	5"** DN125	905
WRV/204193	507	285	470	1370	175	3/4"	345	8" DN200	5"* DN125	940

NOTE:- * = ON CENTRES FOR L/D=1.45 AND 1.93
** = OFF CENTRES FOR L/D=1.65

NO.	MOD.	ZONE	MODIFICATION	SIGN/DATE
9				
8				
7				
6				
5				
4				
3			MODEL USAGE UPDATED	99.08.18
2			DRILLING DETAILS AMENDED	C MacL
2			FOR 5" DISCHARGE FACING	97.07.22
1			DRILLING DETAILS AMENDED	WMacL
1			FOR DISCHARGE FACING	96.03.06

UNLIMITED MACHINED SIZES TO BE WITHIN ±

MODEL 6 6A

DRN. GH
CHKD. W MacL
DATE 95.09.21

WRV204/RANGE COMPRESSOR
EXTERNAL ARRANGEMENT

SCALE:-
DRAWING No. R20737
MOD. 3

HOWDEN COMPRESSORS LIMITED, GLASGOW, U.K.