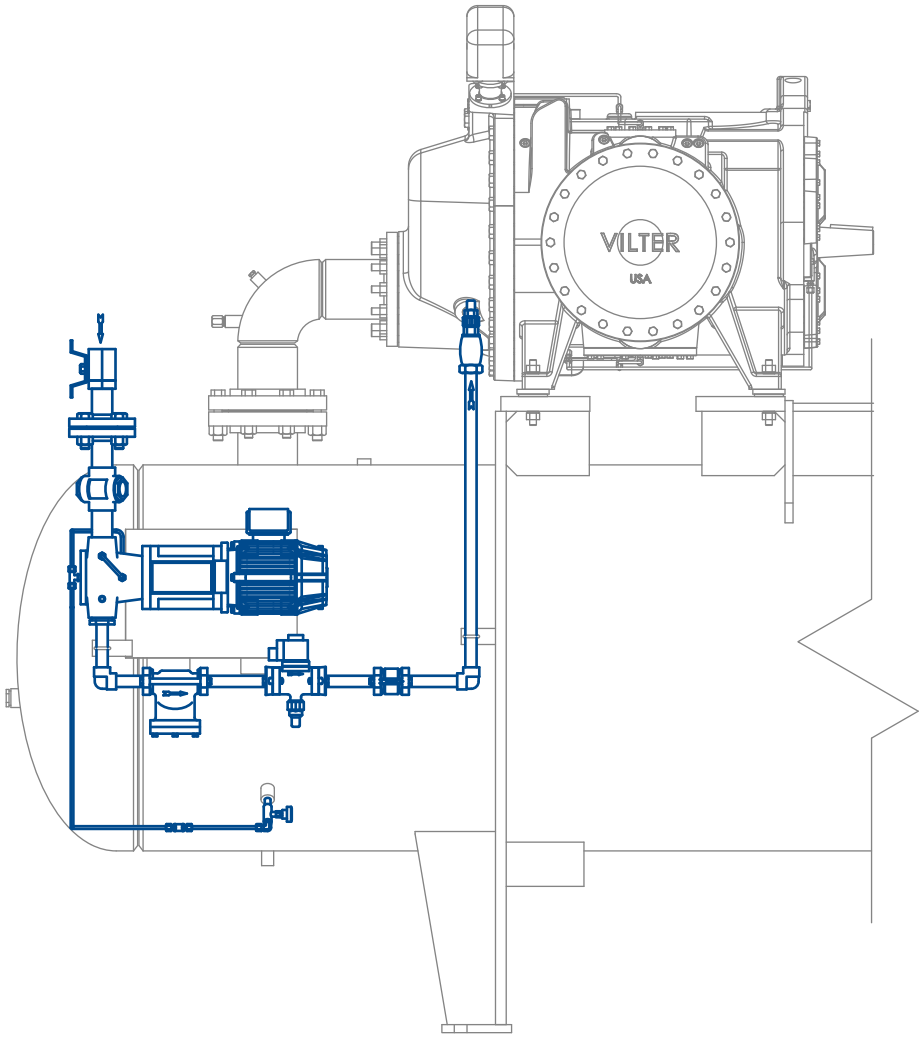
V-PLUS™ (AC Drive)

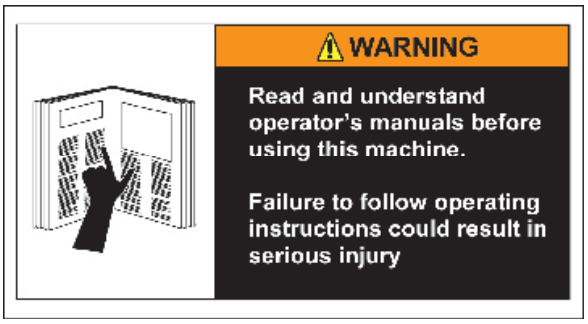
Installation, operation & maintenance manual



Vilter™

EMERSON™
Climate Technologies

Important Message



READ CAREFULLY BEFORE INSTALLING AND STARTING YOUR UNIT.

The following instructions have been prepared to assist in installation, operation V-PLUS unit. 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, service or repair any part of your unit.

Please refer to the VSS/VSM operation manual for troubleshooting, servicing and maintaining your compressor. Also refer to the Vission 20/20 manual for the microprocessor.

The V-PLUS pump is the "heart" of the system. The pump draws the liquid refrigerant from the receiver and injects it directly into the compressor discharge line. This is accomplished by developing a pressure difference between the receiver and the compressor discharge line.

Vilter screw compressor components are thoroughly inspected at the factory, assuring the shipment of a mechanically perfect piece of equipment. Damage can occur in shipment, however. For this reason, the units 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 order number, compressor serial and model number. These can be found on the compressor nameplate on the compressor.

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

Vilter Manufacturing LLC
Customer Service Department
P.O. Box 8904
5555 South Packard Ave
Cudahy, WI 53110-8904 USA
Telephone: 1-414-744-0111
Fax:1-414-744-3483
E-mail: info.vilter@emerson.com

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Appendices

External Links

VFD Programming Manual - Schneider Electric Altivar 71

Go to: www.schneider-electric.com

Search for: 1755855

List of Figures

Figure **Section Number**

How To Use This Manual

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

Section 1: General Information

Section 2: Theory of Operation

Section 3: Installation

Section 4: Operation

Section 5: Maintenance & Service

Section 6: 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

- 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.

V-PLUS Component Identification

Below are major components that can be found in each V-PLUS assembly.

1 - Purge Valve (Not Supplied by Vilter)
2 - Injector Nozzle Assembly
3 - Shut-off Valve (To Compressor)
4 - V-PLUS AC Motor
5 - In-line Check Valve
6 - Solenoid Valve
7 - Shut-off Valve (From Oil Separator)
8 - In-line Check Valve
9 - Strainer
10 - V-PLUS Pump
11 - Sight-glasses
12 - Shut-off Valve (From Receiver and To Float Valve)
13 - Float Valve

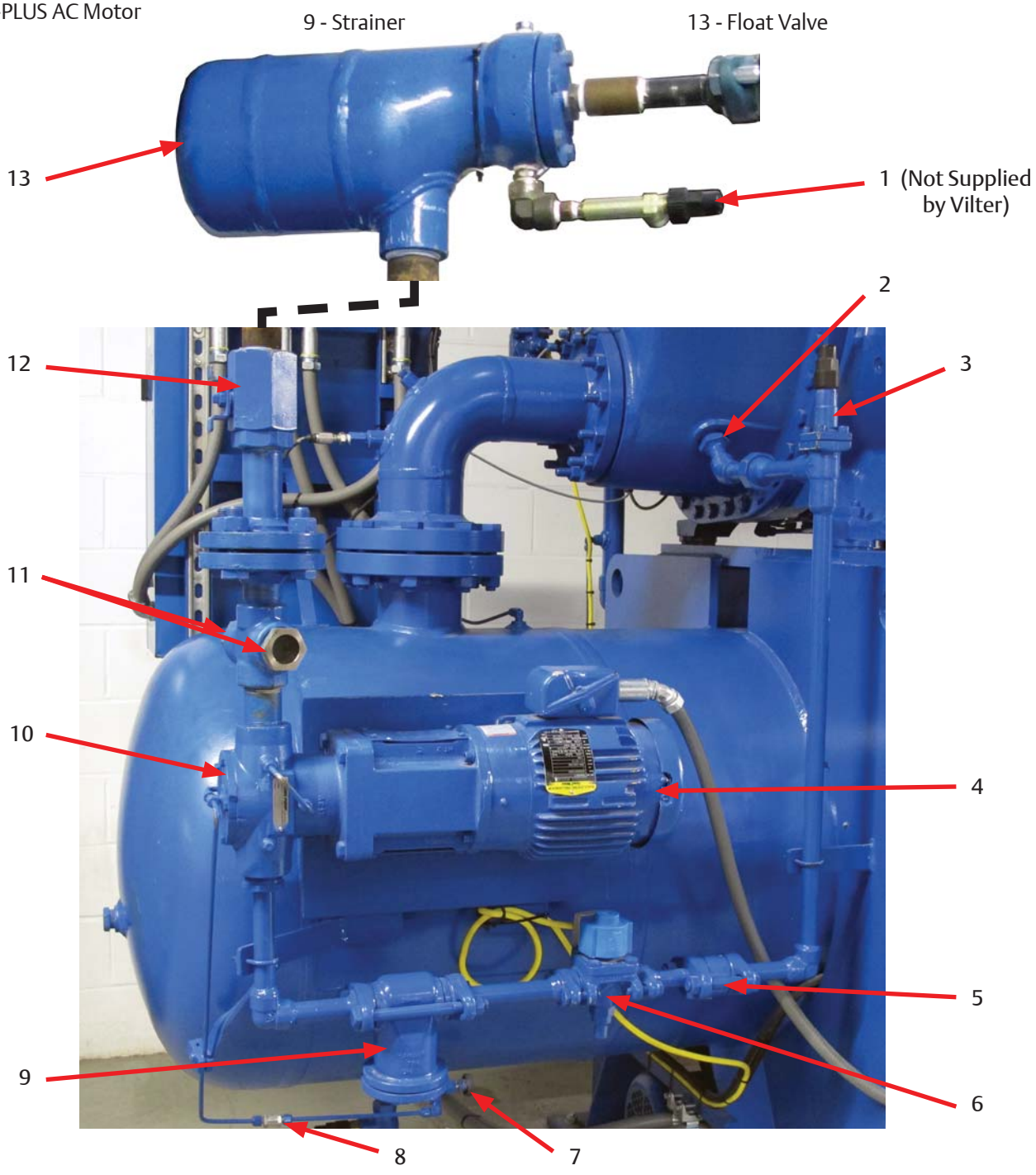


Figure 1-1. V-PLUS Components (VSS Compressor Unit Shown)

V-PLUS VFD Component Identification

Below are major components that can be found for each V-PLUS VFD assembly.

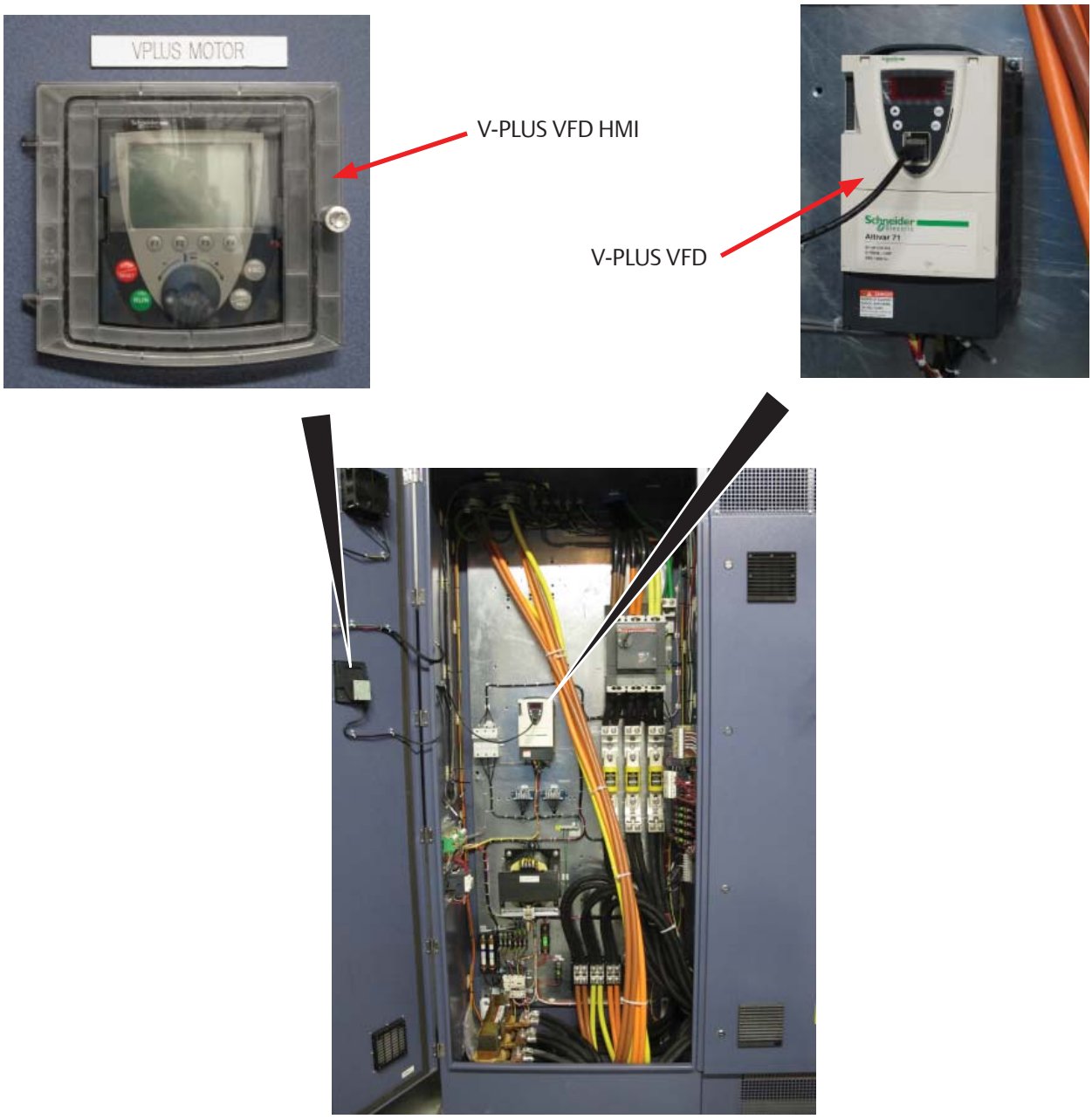


Figure 1-2. V-PLUS VFD Components (Shown in a Compressor Motor Starter Cabinet)
Note: The VFD electrical assembly can also come in its own free standing motor starter cabinet.

Instrument Identification Letters

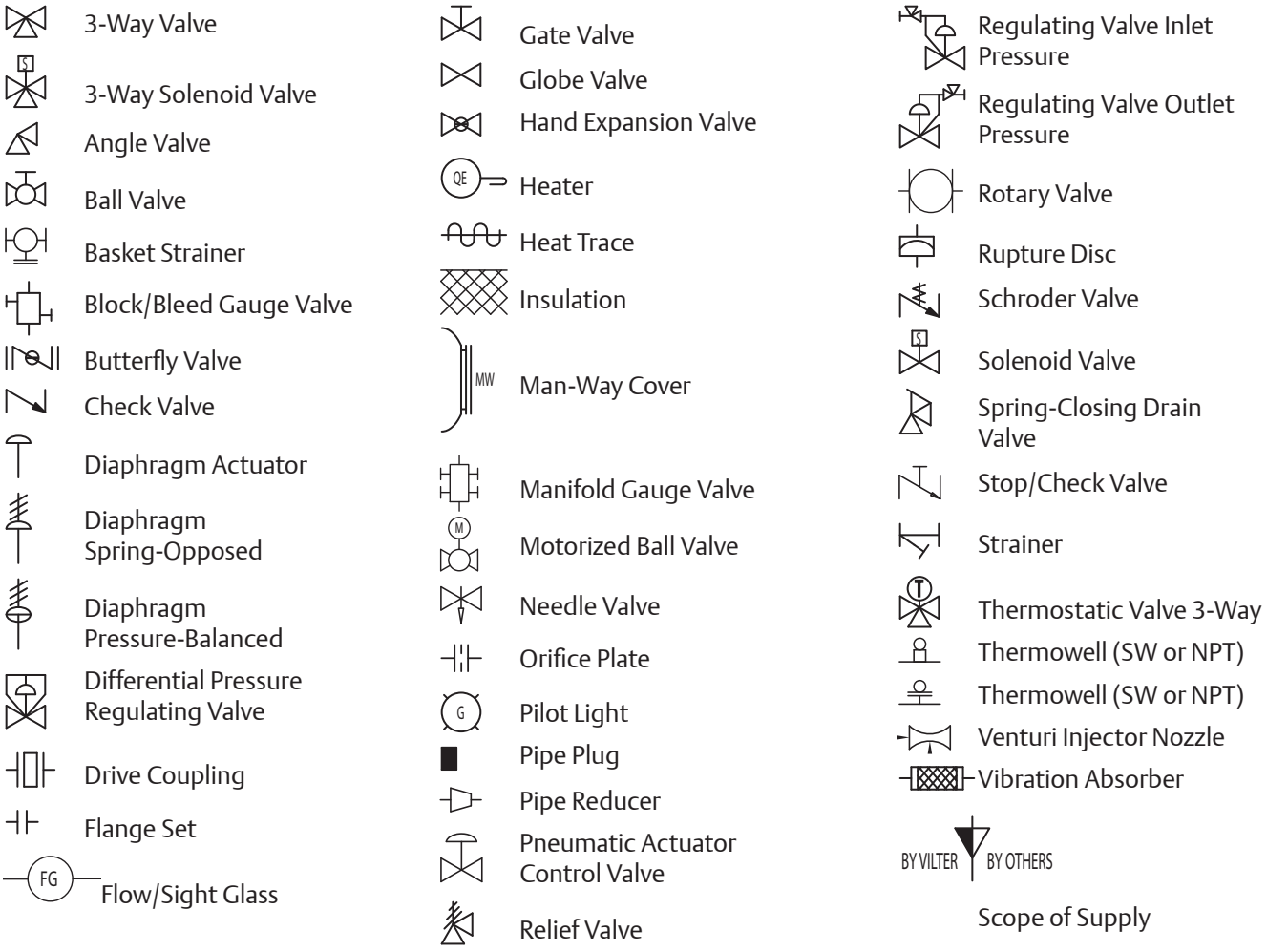
Use this list to identify components shown in the Piping & Identification Diagram.

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)

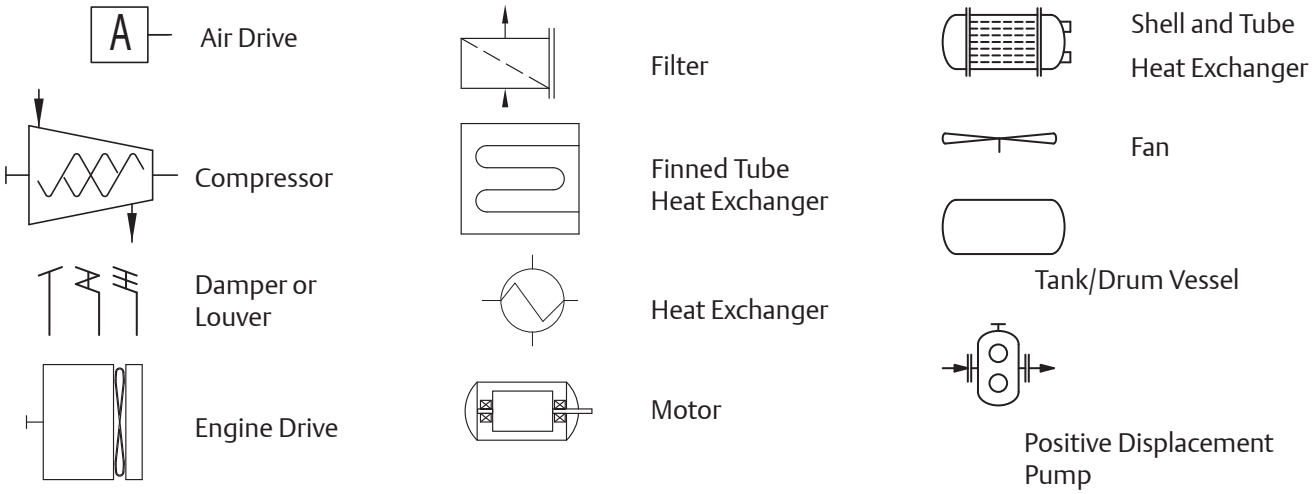
Symbol Identification

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



Major Component Identification

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



Major Component Identification (Continued)


Centrifugal Pump


Rotary Pump

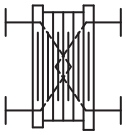
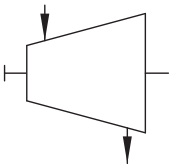


Plate & Frame Heat Exchanger


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

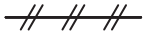

Computer Function, DCS or Remote Control Panel, Normally Accessible to Operator


Computer Function, Local Operator Panel, Normally Accessible to Operator

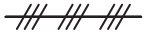
Interlock

Permissive

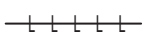
Line Type Designations


Pneumatic Signal

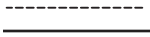

Capillary Tube

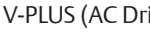

Electrical Signal

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

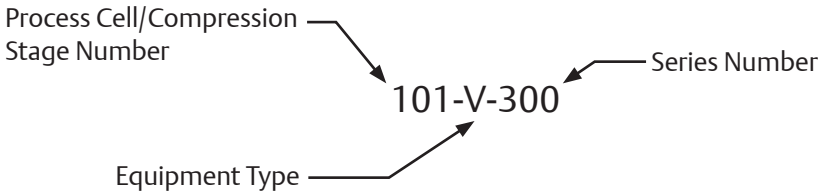
3 - Loop number or sequential number

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

Theory of Operation

The V-PLUS (Vilter Pumped Liquid Unitary System) oil cooling system cools the oil in the screw compressor unit by injecting high pressure liquid refrigerant from the condenser into the hot screw compressor discharge gas/oil stream **after** compression.

As the liquid flashes (boils off) at condensing temperature, it cools both the gas/oil prior to entry into the oil separator.

The V-PLUS pump draws liquid refrigerant from the receiver and pumps it through a nozzle directly into the discharge housing of the single screw compressor, and into the discharge line on a twin screw unit. The amount of liquid being injected by the V-PLUS pump is controlled by changing the speed of the pump with a variable speed AC motor controlled by a VFD. The VFD controls the speed of the motor to inject the proper amount of liquid to maintain an oil manifold temperature of 130° F to 140° F.

Conventional liquid injection oil cooling systems inject liquid into the compressor itself at some point in the compression cycle. This results in flash gas that the compressor must pump, requiring an increase in compressor horsepower consumption ranging from 5% at low pressure ratios to 25% at high pressure ratios. By comparison the V-PLUS system **does not** increase compressor horsepower because the liquid is injected after compression.

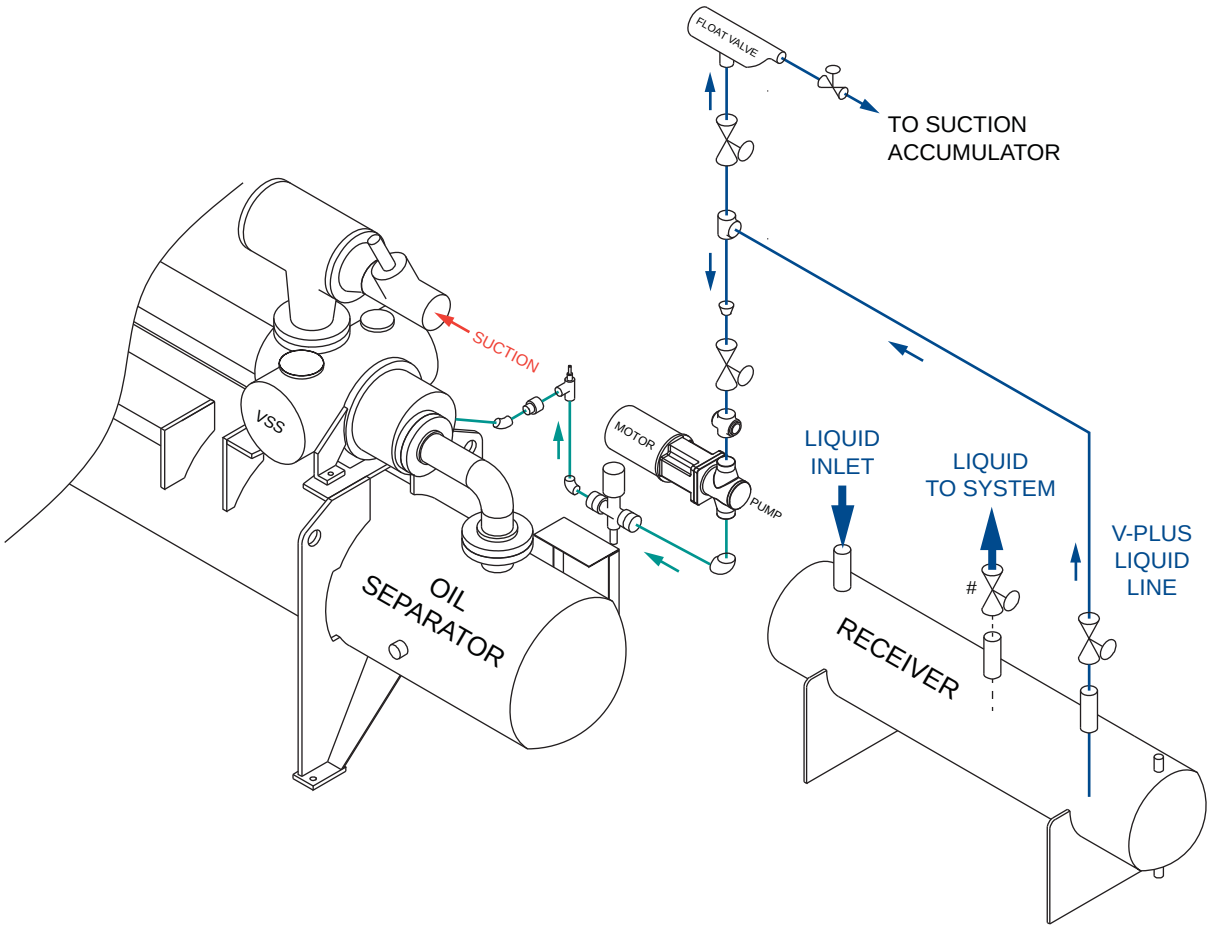


Figure 2-1. V-PLUS Flow

Delivery Inspection

All equipment supplied by Vilter is 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.

Long Term Storage Recommendations

Refer to Appendix for Motor and Pump long storage information.

Installation

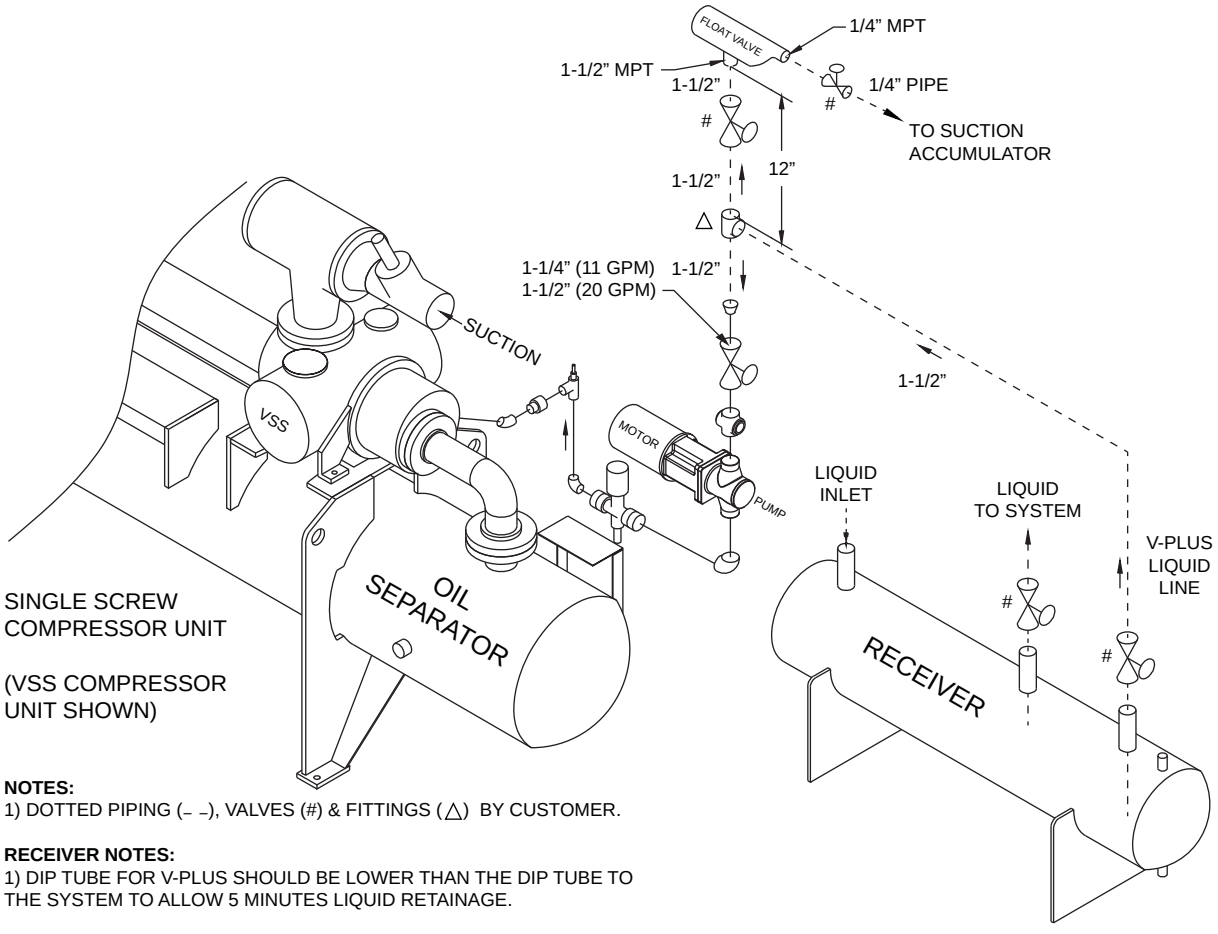
Refer to Figure 3-1

Because the V-PLUS pump is supplied with saturated liquid from the receiver, the pressure drop in the liquid supply line to the pump must be kept as low as possible to prevent flash gas formation at the pump suction. A dedicated liquid line from the receiver to the V-PLUS pump is preferred, with a dip tube in the receiver that extends below the dip tube for the main liquid to the system.

NOTE

Any Thermosyphon, V-PLUS, liquid injection system designs for a high pressure, should allow for a 10 minute supply of liquid. If a dedicated liquid source in not available, the main liquid line can be used.

The Tee on the main liquid line must point down so that the liquid source comes from the bottom of the line to avoid pulling in flash gas from the line. The Tee MUST be full size with any line size reduction taking place after the



NOTES:
1) DOTTED PIPING (– –), VALVES (#) & FITTINGS (△) BY CUSTOMER.

RECEIVER NOTES:
1) DIP TUBE FOR V-PLUS SHOULD BE LOWER THAN THE DIP TUBE TO THE SYSTEM TO ALLOW 5 MINUTES LIQUID RETAINAGE.

2) MOUNT RECEIVER AT THE SAME LEVEL AS THE COMPRESSOR UNIT.

Figure 3-1. V-PLUS Piping (VSS Compressor Unit Shown)

Tee. The main liquid line size to where the Tee is located should be sized so that the liquid line velocity does not exceed 150 FPM. This will reduce flash gas resulting from pressure drop.

All liquid supply lines to the V-PLUS pump must be schedule 80 pipe minimum. The 11 GPM requires a 1½" supply line with reduction to 1¼" at the V-PLUS pump service valve. The 20 GPM pump requires a 1½" supply line and has a 1½" service valve. Sizes are recommended to minimize pressure drop in the liquid line, although the actual pump size may be larger or smaller.

DO NOT add any stop valves beyond the valves shown on the drawings. DO NOT add any strainers in the liquid line prior to the V-PLUS pump as this will create flash gas and cause pump cavitation and loss of oil cooling.

Cleanliness

Care must be taken to clean all piping to the V-PLUS pump to prevent any dirt, scale, or slag from entering the pump during compressor operation since no pump strainers are installed.

Gas Purging Float Valve

Due to the pressure drop of the liquid through the piping and valves, flash gas will be created in the lines and at the inlet of the V-PLUS pump. This gas must be purged from the vertical line prior to the V-PLUS pump to prevent cavitation and loss of oil cooling.

The Gas Purging Float Valve must be installed at the highest elevation of the liquid supply line above the V-PLUS pump. See the installation drawings showing the proper location.

A 1/4" service valve for the bleed line and 1-1/2" isolation valve on the inlet (gas purge) is recommended. The 3/8" bleed line from the float should be piped into a suction trap or re-circulator vessel, if possible, otherwise it may be piped into a suction header.

Lubrication Line

A ¼" oil line is installed to supply oil from the screw compressor unit to the V-PLUS pump bearings and seal chamber. After the system has been running for approximately one hour, the seal area and supply oil lines of the pump should be warm. This indicates oil flow. A ¼" check valve is also installed in this line to prevent back flow of the liquid refrigerant into the screw compressor oil separator while the compressor is off.

WARNING

On a Single Screw Compressor unit oil flows to the V-PLUS pump because discharge pressure in the oil separator is slightly higher than the liquid line pressure (1-2 psid). The liquid refrigerant receiver MUST BE ON THE SAME LEVEL AS THE COMPRESSOR UNIT.

The liquid refrigerant level in the receiver must not be more than 6 feet above oil level in the compressor unit. At levels higher than this, the pump will have a head and the liquid line pressure will exceed discharge pressure and oil will not flow to the pump. This will result in V-PLUS pump bearing and seal failure.

Limitations

Although the V-PLUS oil cooling system is well engineered and can be of tremendous value when used properly, the following limitations apply:

1. This discharge temperature should be set no less than 10° F higher than the system condensing temperature and not above 140° F maximum temperature. This setting will enable all the liquid refrigerant to evaporate before the gas/oil mixture enters the oil separator.
2. The V-PLUS pump pressure differential is limited to 25 psig on standard units. For units in excess of 25 psig, consult the Home Office.
3. The V-PLUS is for use on systems with standard high pressure liquid source, sub-cooled to no lower than 20°F. For control pressure receiver source, a special 2 HP system is required. Consult the Home Office for details.
4. The main liquid refrigerant receiver must be on the same elevation as the screw compressor unit.

V-PLUS Oil Supply Valve

This valve must be fully opened prior to start-up to allow oil to lubricate bearings on the liquid ammonia pump. For valve location, see Figure 3-2.

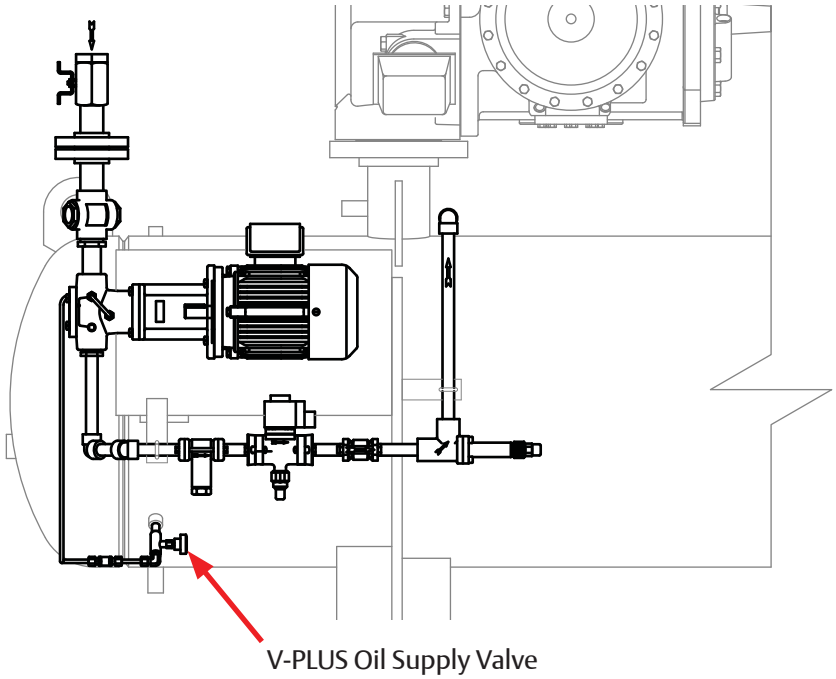


Figure 3-2. V-PLUS Oil Supply Line (VSM Compressor Unit Shown)

V-PLUS Setup Procedure for Vission 20/20 Panel

This document provides instructions to help setup the Vission 20/20 for V-PLUS control.

INTRODUCTION

This procedure provides guidelines to setup an AC Motor V-PLUS oil cooling system control on the Vission 20/20 panel.

SCOPE

Vilter AC V-PLUS oil cooling system utilizes a PID algorithm in the Vission 20/20 panel to control the speed of the V-PLUS motor. The motor speed controls the amount of liquid refrigerant being injected into the compressor which is used for oil cooling. Motor speed is based on discharge temperature. As the discharge temperature varies from the liquid injection control setpoint, a modulating 4-20ma signal wired to the AC motor VFD will adjust the speed of the motor.

ADDITIONAL HARDWARE

In order to control the V-PLUS pump motor VFD, an analog output card is required. The 4-20ma signal from the card will be wired to the VFD and will vary the speed of the V-PLUS motor - thereby increasing and decreasing the amount of liquid refrigerant that will be injected into the compressor to provide oil cooling. This board comes already installed for units with V-PLUS.

HARDWARE WIRING

The analog output card needs to be wired to the V-PLUS VFD, see Figure 3-3 and Figure 3-4.

The V-PLUS VFD needs to be wired to the V-PLUS Motor, see Figure 3-4.

The digital output card needs to wired to the V-PLUS liquid injection solenoid, see Figure 3-5.

A control relay must also be installed for the V-PLUS VFD Start, see Figure 3-4 and Figure 3-5. The control relay is not supplied by Vilter.

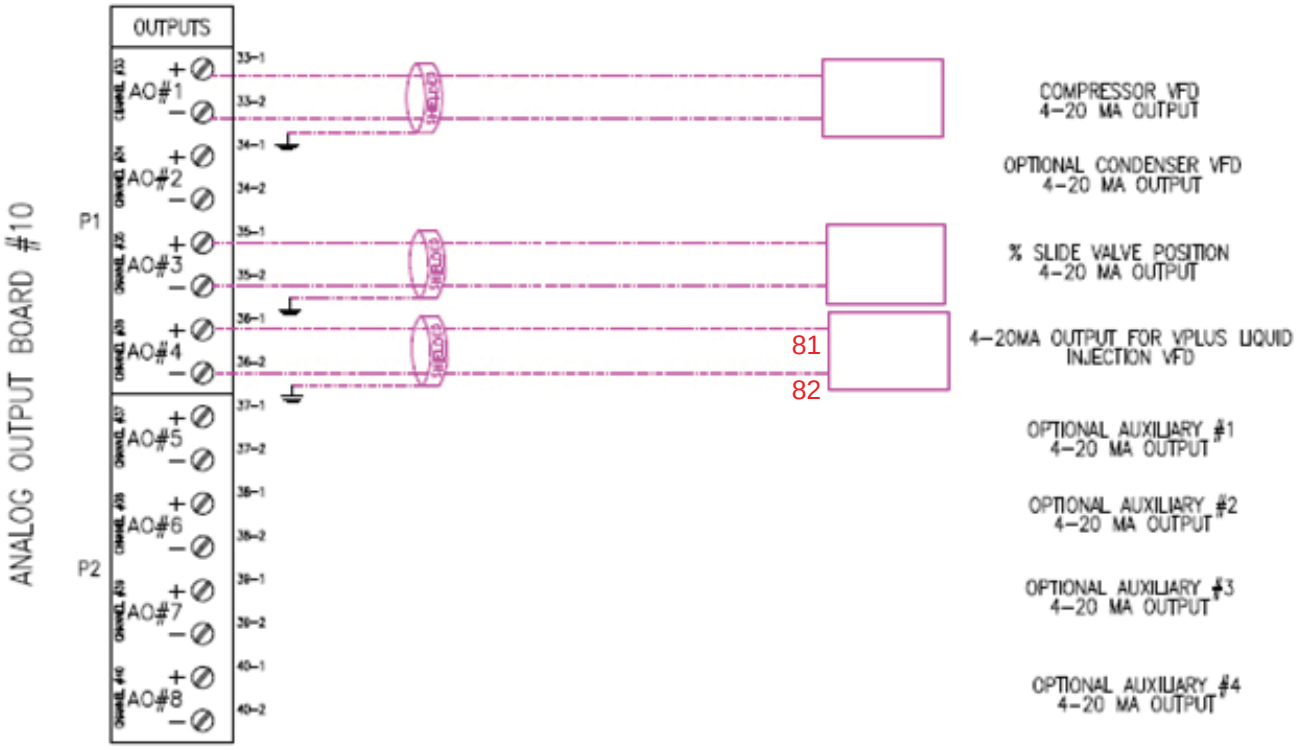


Figure 3-3. Analog Output Card Wiring to V-PLUS VFD

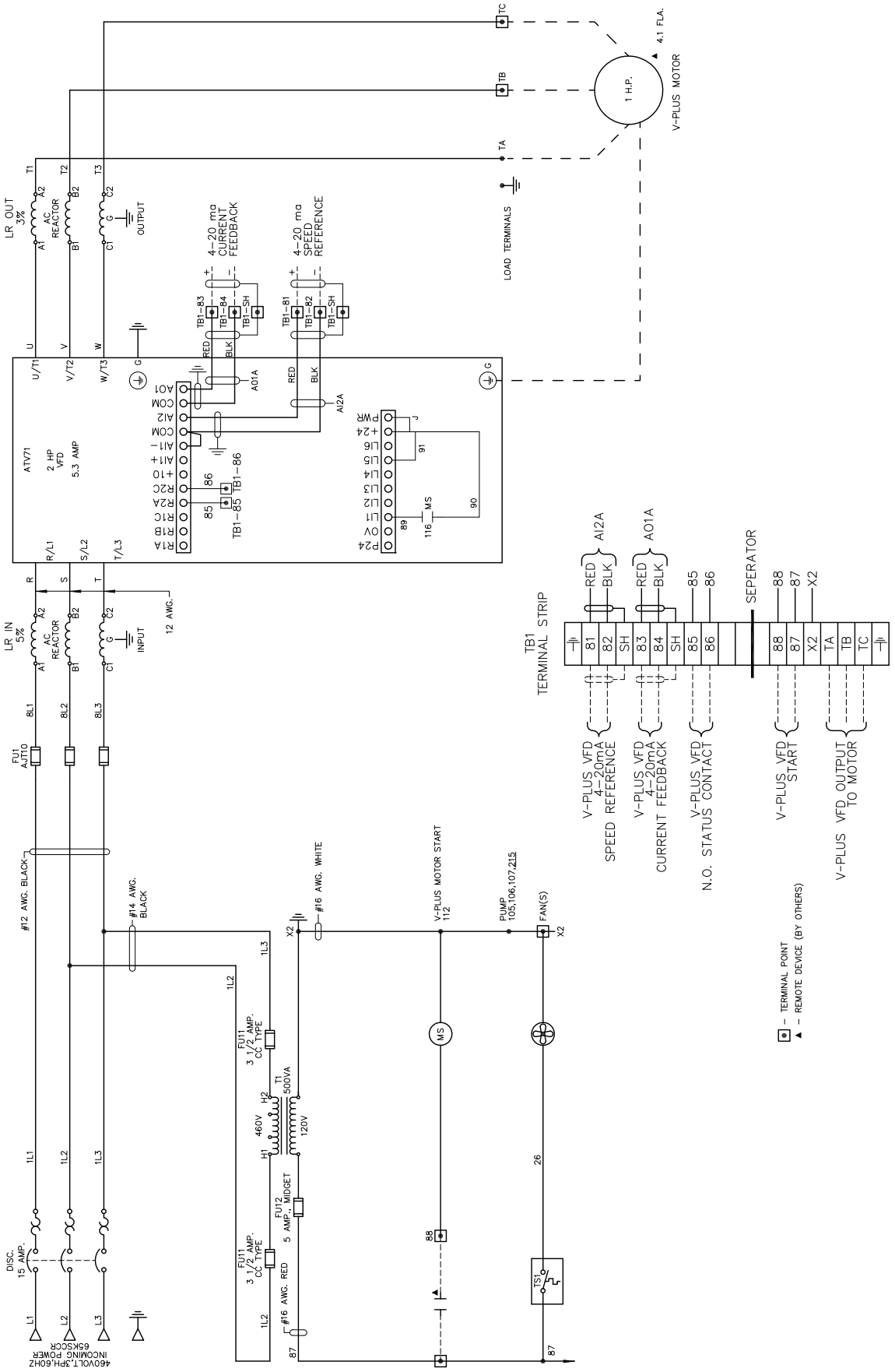


Figure 3-4. V-PLUS VFD (Altivar 71) Schematic

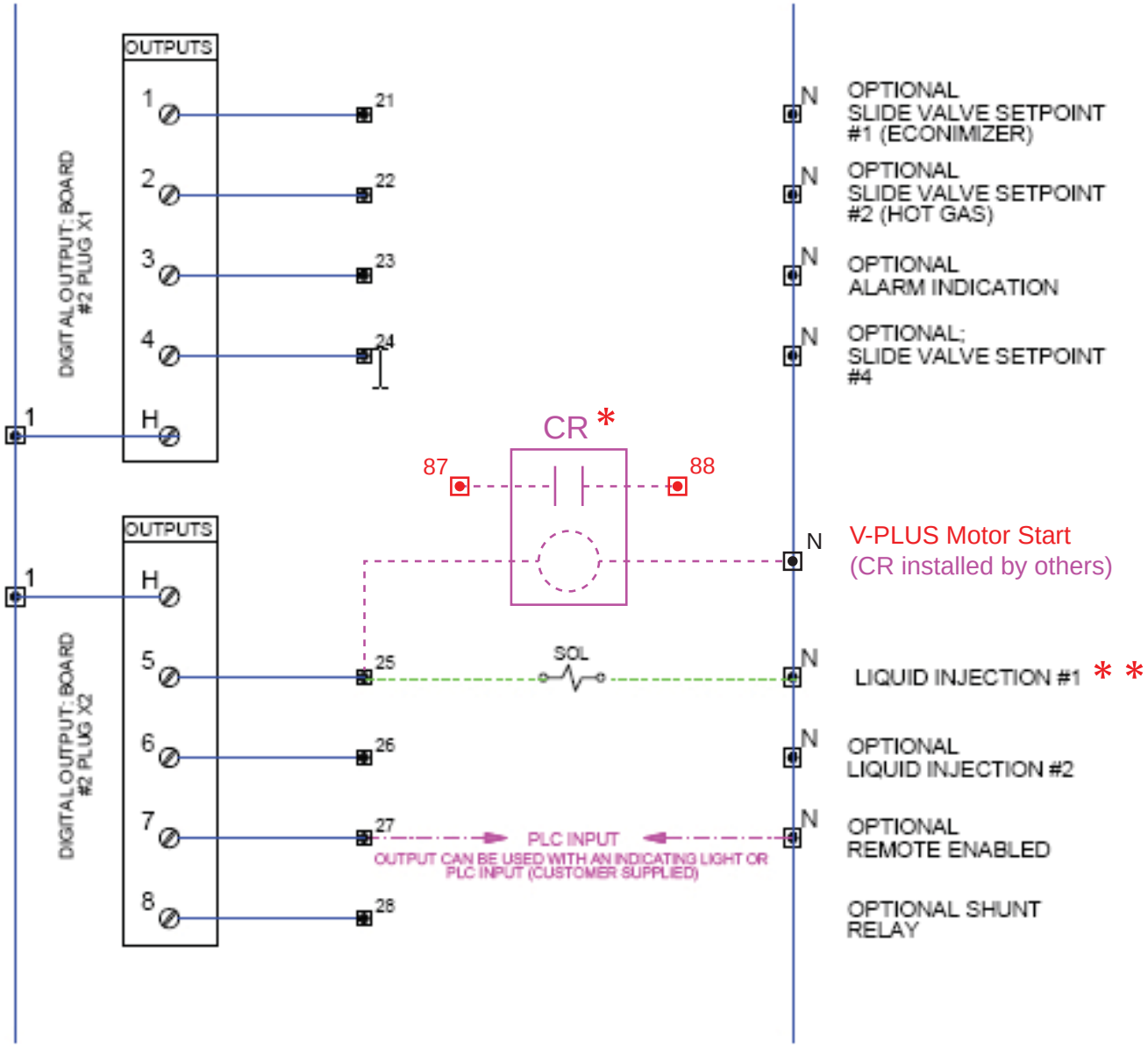


Figure 3-5. Digital Output Card Wiring to V-PLUS Liquid Injection Solenoid and V-PLUS VFD Start

* *The Control Relay (CR) can be installed in the V-PLUS panel or Vission 20/20 panel. Connections 87 and 88 are in the V-PLUS panel, see Figure 3-4.*

* * *Liquid Injection #1 Solenoid is energized and de-energized via the "Liquid Injection Setpoint #1" setpoint in the Control Limits Menu (Liquid Injection Section). The Oil Separator Temp Override Setpoint is also active and will not allow the Liquid Injection solenoid to energize until the Oil Separator Temp is above the Oil Separator Temp Override Setpoint.*

VISSION 20/20 SOFTWARE SETUP

Step 1: Configuration Screen Selection of Installed Boards

Log on and navigate to the Configuration screen, page number 6. Ensure that all boards that are physically installed in the Vission 20/20 panel have been selected or “checked”. The additional board #10 should be installed (analog output board) and selected.

Continue to Step 2.

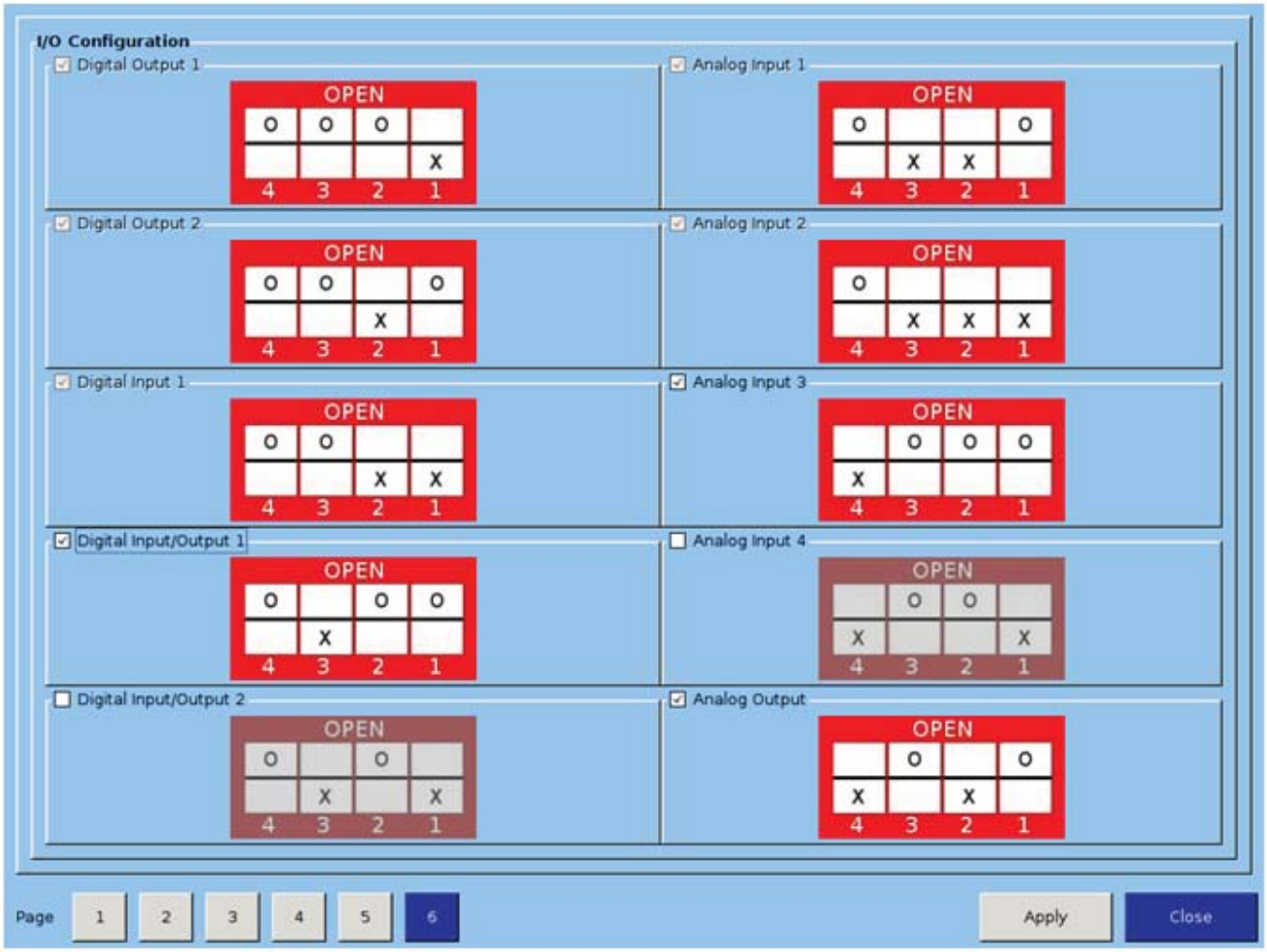


Figure 3-6. Selection of Installed Analog Output Board (Configuration Screen – Page 6)

Step 2: Setup and selection of Oil Cooling from page 2 of the Configuration screen

The oil cooling V-PLUS algorithm must be enabled from the configuration screen. The algorithm used for this is the same one that is used to control the oil cooling motorized positioning valve. Navigate to page 2 of the Configuration screen. In the middle column, towards the bottom of page 2 are the Oil Cooling selections, see Figure 3-7. Select "Liquid Injection" method and then select the "Motorized Valve" selection. Note that by selecting the positioning valve algorithm, the speed of the V-PLUS motor is being controlled based on the discharge temperature only.

Continue to step 3.

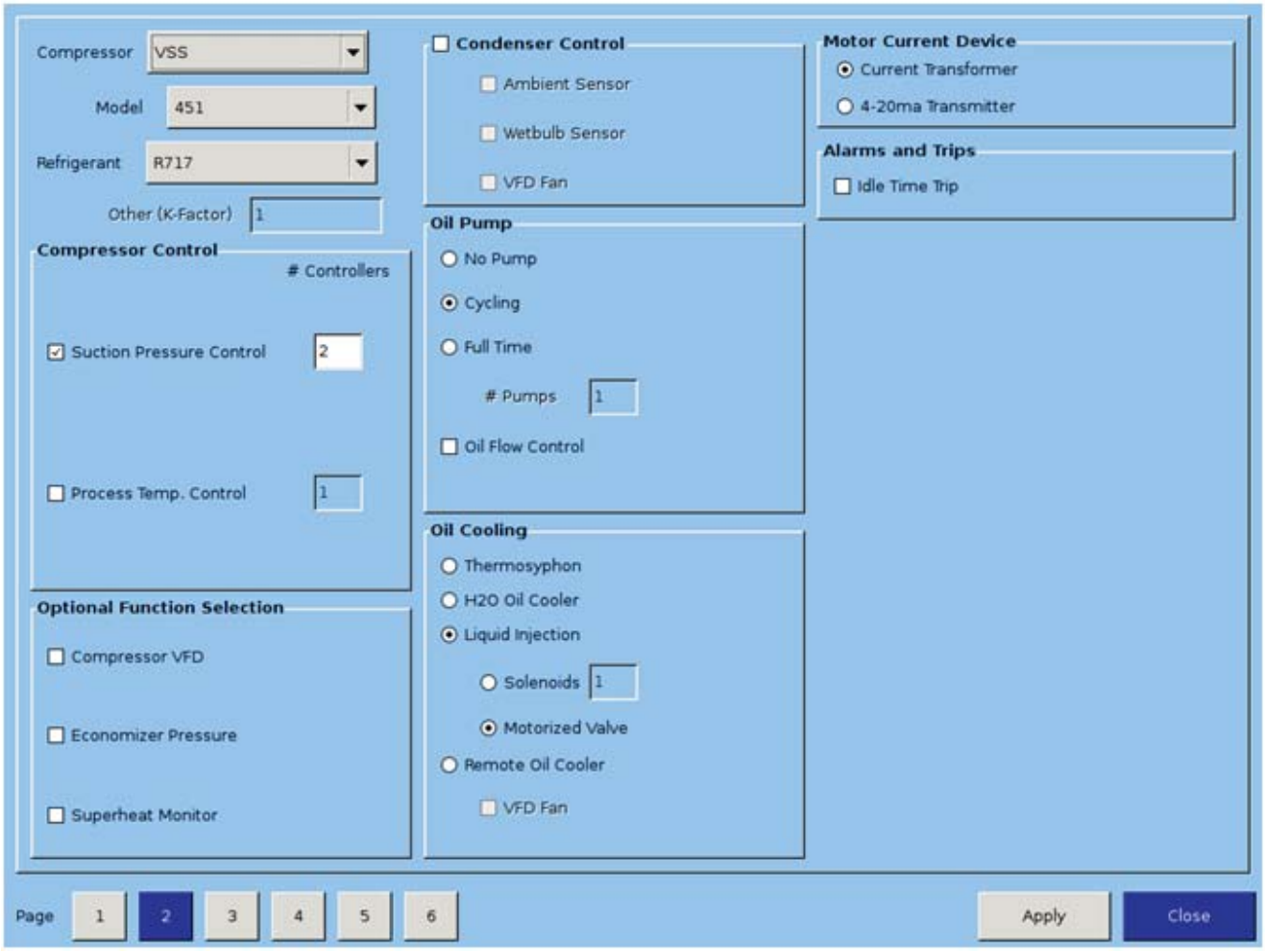


Figure 3-7. V-PLUS Oil Cooling Selection

Step 3: Setup and selection of V-PLUS / Motorized Valve Configuration.

The oil cooling V-PLUS control parameters must now be setup. Navigate to the last page of the Compressor Control settings page. Setup the Motorized Control Valve setting as show in Figure 3-8.

- Setpoint : 135 deg F.
- Motorized Valve Control: P = 25.0 I = 1.0 D = 4.0
- Minimum Valve Open Percent = De-selected.
- Avg. with Oil Manifold Temperature = De-selected.
    - This selection should be determined by the operator through testing.
- Oil Separator Temp. Override = 100 deg F.

Depending upon the size of the oil separator, the P term may have to be adjusted to give proper response of the 4-20ma signal to the VFD for the V-PLUS motor.

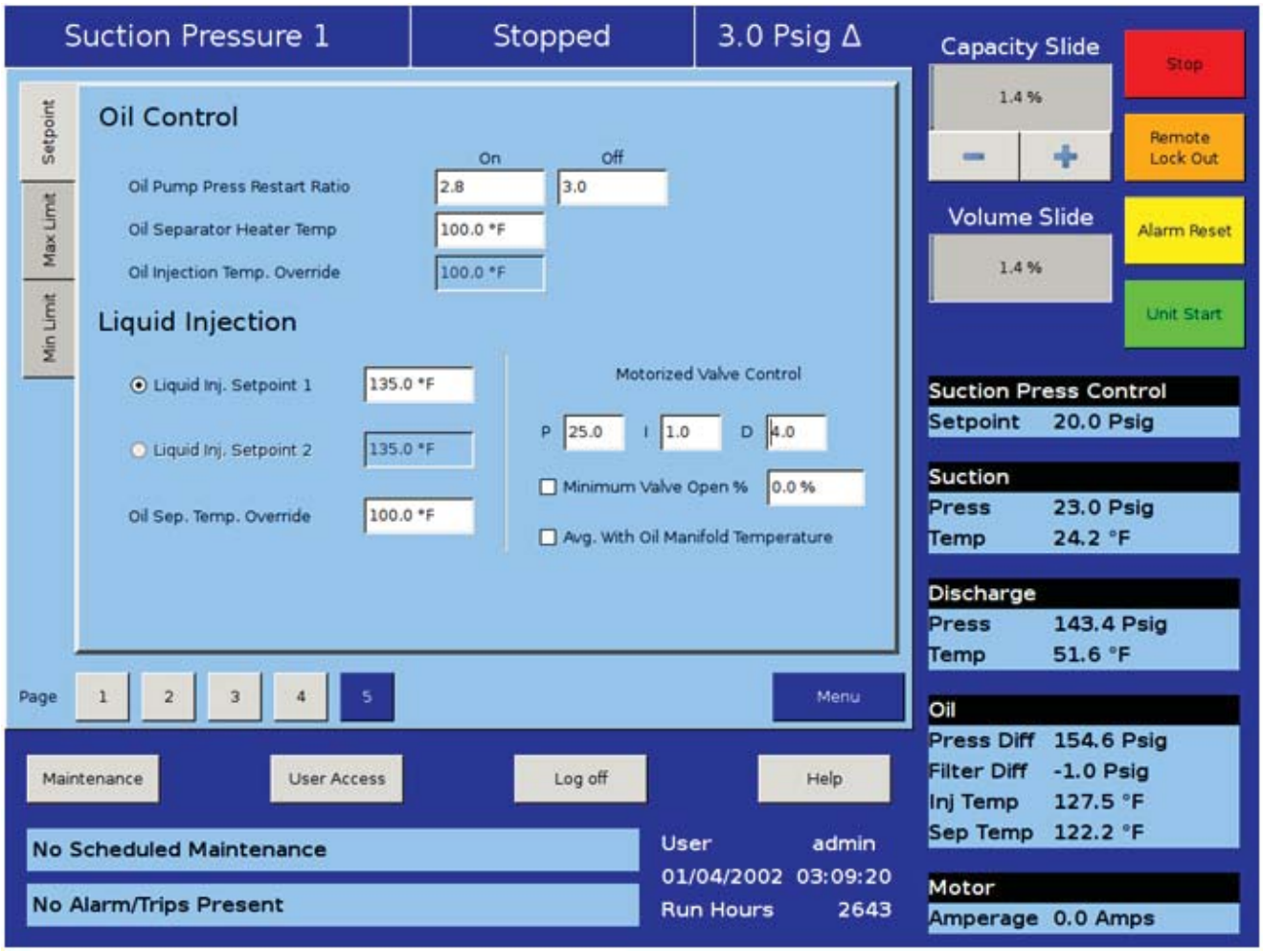


Figure 3-8. V-PLUS / Motorized Valve Control PID Parameter Setup

VFD Program Setup

(Enhancer II VFD Standard Programming for 1 HP V-PLUS Motor)

The following instructions are for setting up the program on the VFD for the 1 HP V-PLUS motor.

All V-PLUS mechanical systems and wiring must be complete before continuing.

The VFD used is a Schneider Electric Altivar 71. For further programming information for the Altivar 71:

- Go to: www.schneider-electric.com
- Search for: 1755855

Select **ENGLISH**

ESC **Change access level**
MAIN MENU
2 Access Level
EXPERT

ESC **Setup user menu name**
MAIN MENU
7 Display Config
7.1 User parameters
User menu name
RAM ENHANCER II — Press F1 3 times for space, Press F1 again for CAPS

ESC **Setup user menu parameters**
7.2 User menu
Parameter selection

In Menu		User Menu
		RAM ENHANCER II
1.1 Rated motor power	1 HP	Rated motor power
1.1 Rate motor voltage	460 VOLT	Rated motor voltage
1.1 Rated motor current	1.5 AMPS	Rated motor current
1.1 Rated motor freq	60 Hz	Rated motor freq
1.1 Rated motor speed	1760 RPMS	Rated motor speed
1.1 Motor Thermal current	1.7 AMPS	Motor Thermal current
1.1 Acceleration	6 SEC	Acceleration
1.1 Deceleration	6 SEC	Deceleration
1.1 Low speed	3.0 Hz	Low speed
1.1 High speed	60 Hz	High speed
1.4 Motor Control Type		Motor Control Type
1.3 Skip Frequency		Skip Frequency
1.3 Skip Frequency 2		Skip Frequency 2
1.3 3rd Skip Frequency		3rd Skip Frequency

ESC **Setup Display**
MAIN MENU
6 monitor config
6.1 parameter bar sect
turn off FREQ REF
turn off LOCAL REMOTE
Select/ Drive Thermal State
Select/ Motor Voltage

ESC	6.2 Monitor Screen Type Display Value type **LIST**		
ESC	Parameter selection **Frequency ref** **Output frequency** **Motor current** **Motor speed** **Run time**		
ESC	**Parameters to be changed** MAIN MENU		
	1 Drive Menu	Setting	
	1.1 Macro Configuration	**Start/Sto**p	
	1.1 Standard Motor Freq	**60**	
	1.1 Max Frequency	**60**	
	1.1 Accel	**6 SEC**	
	1.1 Decel	**6 SEC**	
	1.1 Low Speed	**3.0 HZ**	
	1.4 Motor Control Type	**2 PTS**	
	1.5 2 wire type	**level**	
	1.5 AI2 Configuration/AI2 Min Value		**4.0**
	1.5 R2 Configuration / R2 Assignment		**DRV Running**
	1.5 AO1 Configuration / AO1 Assignment		**I Motor**
	1.5 AO1 Configuration / AO1 Min Output		**4.0**
	1.5		
	1.5		
	1.6 Ref 1 Channel	AI2	
	1.6 RV Inhibition	Yes	
	1.6 Stop Key Priority (Press N Hold)	NO	
	1.6 F4 Key	NO	
	1.7 Stop Configuration / Type of Stop		**Freewheel**
	1.8 External Fault / Ext Fault Assignment		**OFF**
	1.8 BU Protection / Brake Res Fault Mgmt		**Ignore**
	*BU Protection is NOT on small Drives.		
ESC	**Save Program** **MAIN MENU** **2 Open / Save** **Save as / file 4**		
ESC			

Operation

Under normal operation the V-PLUS oil cooling system cools the screw compressor oil by drawing liquid refrigerant from the receiver and pumping it directly into the discharge line of the screw compressor.

The Vission 20/20 panel controls the speed of the V-PLUS motor and the motor speed controls the amount of liquid refrigerant being injected into the compressor. Motor speed is based on discharge temperature. As the discharge temperature varies from the liquid injection control setpoint, a modulating 4-20ma signal wired to the AC motor VFD will adjust the speed of the motor.

Basic Function of Components

For identifying components, refer to Section 1.

PUMP

The V-PLUS pump draws the liquid refrigerant from the receiver and injects it directly into the compressor discharge line. This is accomplished by developing a pressure difference between the receiver and the compressor discharge line.

MOTOR (AC)

The pump adjusts to changes in operating conditions by a solid state variable speed V-PLUS pump motor. The motor is controlled by temperature variances in the discharge and oil lines.

LUBRICATION LINE COMPONENTS

A ¼" oil line is installed to supply oil from the oil separator of the screw compressor unit to the liquid refrigerant pump. After the system has been running for approximately one hour, the seal area and supply oil lines of the pump should be warm. This indicates oil flow. A ¼" needle valve is installed in this line for controlling the amount of oil used for lubrication. A ¼" check valve is also installed in this line to prevent back flow of the liquid refrigerant into the screw compressor oil circuit while the compressor is off.

PUMP INLET PIPING COMPONENTS

All liquid supply lines to the pump will be a minimum of 1½" Sch. 80 pipe. A shut-off valve has been installed in this line. This valve enables the pump to be isolated for servicing. Also, a flow sight glass indicator has been installed in this line to enable the operator to easily determine the quality of liquid being supplied to the pump.

PUMP OUTLET PIPING COMPONENTS

The liquid pump discharge line is ¾" Sch. 80 pipe. A liquid line solenoid valve, strainer and check valve are installed in this line. The solenoid valve will stop the flow of liquid refrigerant into the screw compressor unit when the compressor is off. The strainer is installed before the solenoid to capture any large particles. The check valve is installed after the solenoid to prevent back flow of the liquid refrigerant into the V-PLUS system.

There are three shut-off valves that are installed, two in the liquid line and one in the oil line so that the V-PLUS system can be isolated for servicing.

LIQUID INJECTOR NOZZLE

The liquid injector nozzle is used to distribute the liquid refrigerant properly and efficiently into the screw compressor discharge line.

GAS PURGING FLOAT VALVE

A gas purging valve is used to prevent pump cavitation due to flash gas. If flash gas is present, this valve would collect the vapor and bleed it back to the suction side of the system.

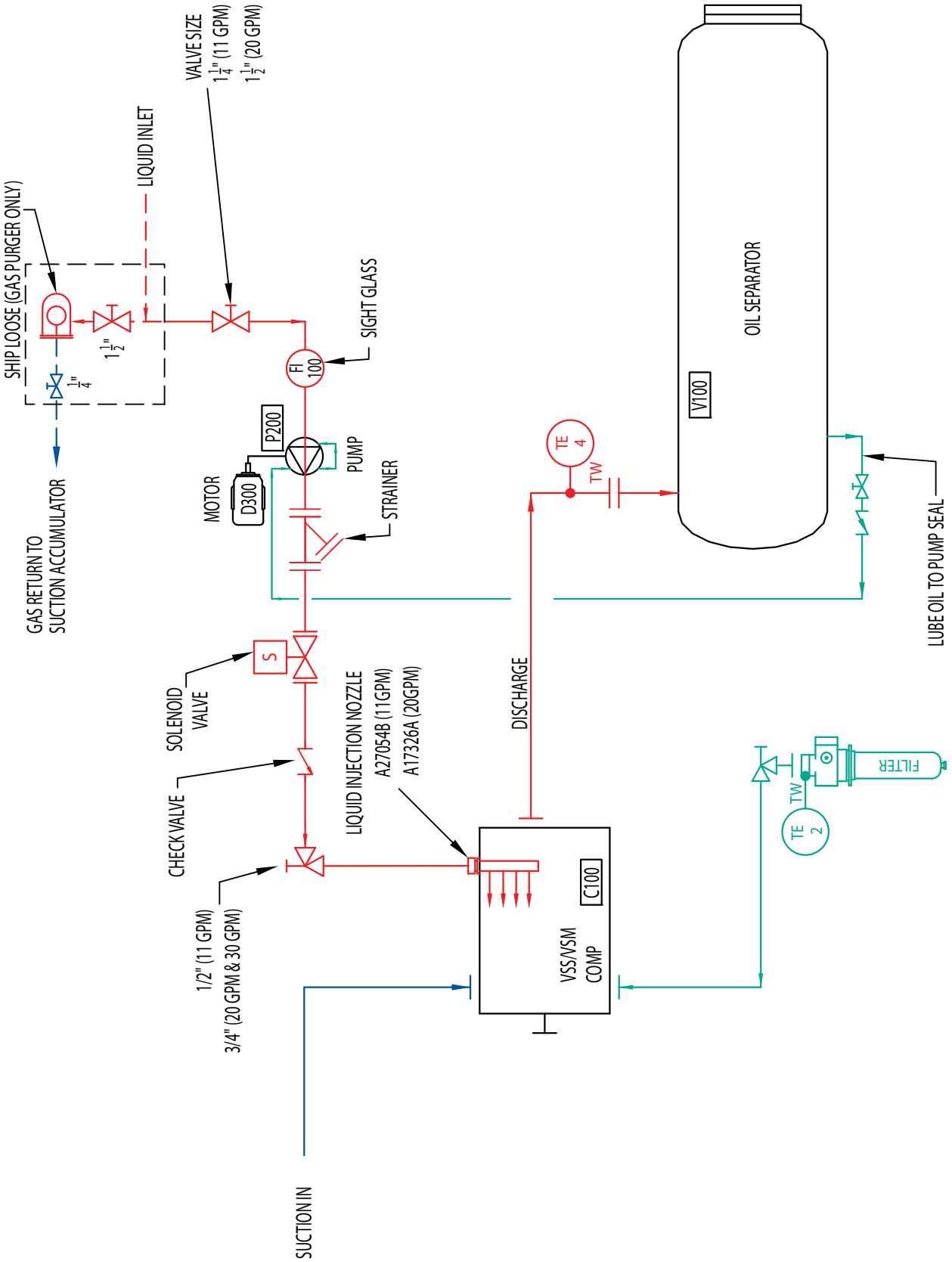


Figure 4-1. V-PLUS Piping & Instrumentation (P&I) Diagram

Maintenance

Follow manufacture instructions for maintenance for the following components. These instructions can be found in the Appendices.

- Motor
    - AC & DC Motor Installation & Maintenance (Baldor Reliance Electric)
    - VPN 3288C (1HP, 1200 RPM, 230V/460V, 143 TC Frame, TEFC Enclosure, Inverter Duty)

- Pump
    - Technical Service Manual (Viking Pump)
    - 11 GPM, VPN 2501M (Viking GG-495M)
    - 20 GPM, VPN 2501L (Viking HV-2657M)

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

Warranty Claim Processing

This section explains how the warranty claim is processed and to help clear any questions that may arise prior to contacting customer service. For additional warranty information, refer to the Warranty Statement found in the Terms and Conditions of your order.

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.
3. 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.
4. 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.
5. 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.
6. Part to be evaluated.
7. Warranty Consideration:
    - Acceptance – A credit will be provided for the customer part sales order.
    - Denial – Notification of denial will be provided to the customer.

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.

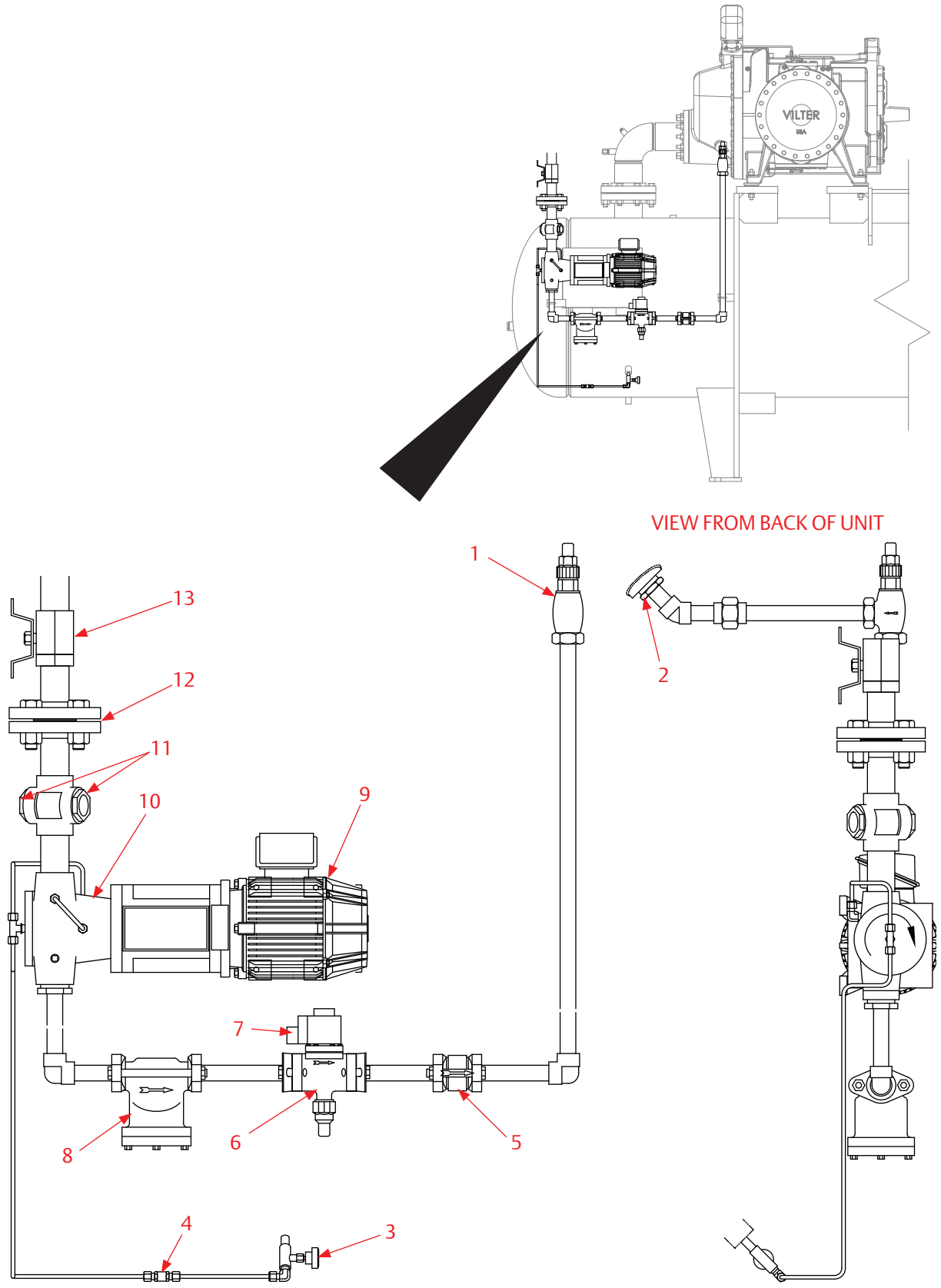


Figure 6-1. V-PLUS Assembly (11 GPM Pump) (VSS Compressor Unit Shown)

V-PLUS Assembly (11 GPM Pump)

Item No.	Description	VPN	Qty.	Tag No.
1	VALVE, 1/2 ANG SW SEAL CAP	2916AB	1	-
2	NOZZLE, 3/4 LIQ INJ BSTR 1/8 HOLES	A27054B	1	-
3	VALVE, 1/4FPT 2-WAY 0.228 TYPE 316	2029M	1	-
4	VALVE, 1/4ODT CHECK IN-LINE STN STL	2493A	1	-
5	VALVE, 5/8 CHECK IN-LINE 1/2 SW	1834AA	1	-
6	VALVE, 1/2 SOL1/2 FPT EVRAT 15 MINUS COIL	3389JF	1	-
7	COIL, 120V 12W TERM BOX GREEN LIGHT	3389DC	1	-
8	STRAINER, 1/2 W/1/2SW FLANGES	3186AS	1	-
9	MOTOR, 1HP 1200RPM 143TC XL DUAL INV DUTY	3288C	1	M300
10	PUMP, 11GPM LIQUID AMM V-PLUS 143TC MTR	2501M	1	P200
11	GLASS, 1-1/4 SIGHT CLEAR 2000#	2366D	2	-
12	GASKET, 1.25 ASME 3-1/4X1-21/32 FLG 300#	1548KA	1	-
13	VALVE, 1-1/4 BALL STD PORT STEEL	1956M	1	-

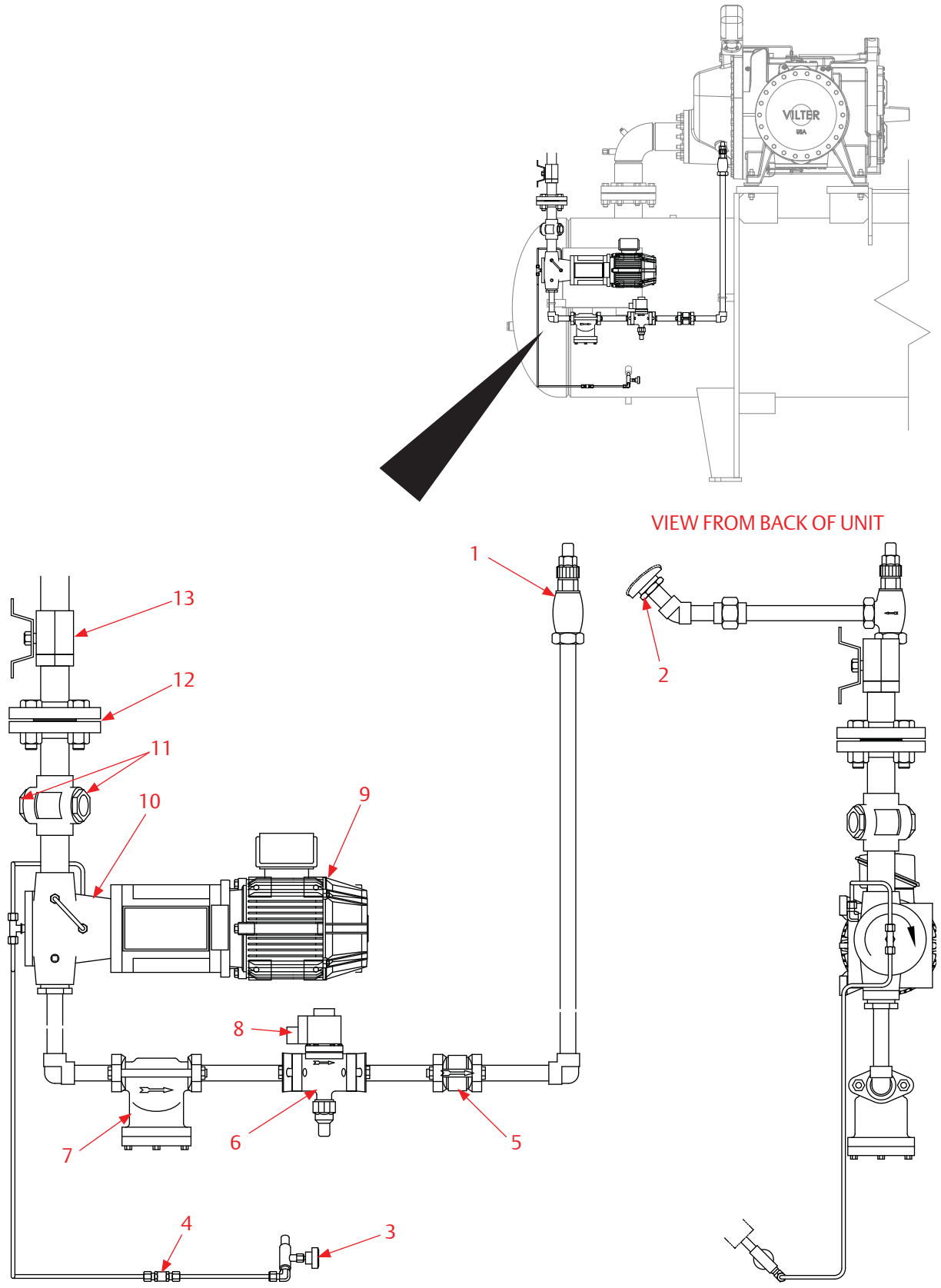


Figure 6-2. V-PLUS Assembly (20 GPM Pump) (VSS Compressor Unit Shown)

V-PLUS Assembly (20 GPM Pump)

Item No.	Description	VPN	Qty.	Tag No.
1	VALVE, 3/4 ANG SW SEAL CAP	2916BB	1	-
2	NOZZLE, V-PLUS LIQ INJECTION 3/32	A17326A	1	-
3	VALVE, 1/4FPT 2-WAY 0.228 TYPE 316	2029M	1	-
4	VALVE, 1/4ODT CHECK IN-LINE STN STL	2493A	1	-
5	VALVE, 3/4 CHECK IN-LINE 3/4 FPT	1834T	1	-
6	VALVE, 3/4 SOL 3/4SW EVRAT 20 MINUS COIL	3389JC	1	-
7	COIL, 120V 12W TERM BOX GREEN LIGHT	3389DC	1	-
8	STRAINER, 1 W/3/4SW FLGS&HD SCREEN	3186BS	1	-
9	MOTOR, 1HP 1200RPM 143TC XL DUAL INV DUTY	3288C	1	M300
10	PUMP, 20GPM LIQ AMM V-PLUS 1HP 143TC	2501L	1	P200
11	GLASS, 1-1/2 SIGHT CLEAR 1500#	2366F	2	-
12	GASKET, 1.5 ASME 3-3/4X1-29/32 FLG 300#	1548AA	1	-
13	VALVE, 1-1/2 BALL FULL PT STEEL BODY	1956AJ	1	-

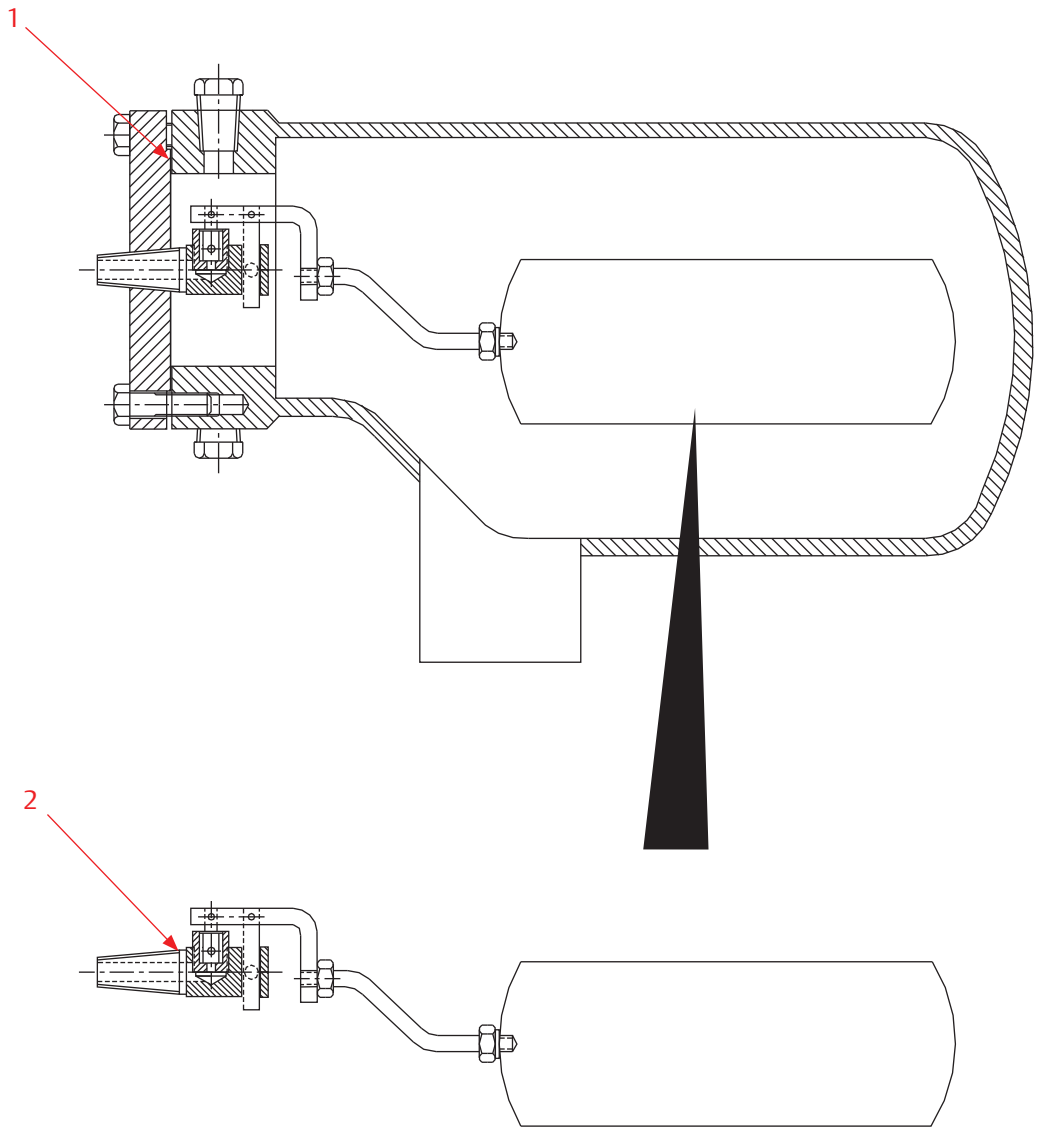


Figure 6-3. Gas Purge Float Valve Assembly

Gas Purge Float Valve Assembly

Item No.	Description	VPN	Qty.	Tag No.
1	GASKET, 3-11/16X3-1/8 FLANGE FLOAT	65544A	1	-
2	VALVE, FLOAT GAS PURGE NO CHAMBER	A14077D	1	-

Appendix A

Baldor AC & DC Motor Installation & Maintenance

AC & DC Motor Installation & Maintenance

Safety Notice Be sure to read and understand all of the Safety Notice statements in MN408. A copy is available at:
http://www.baldor.com/support/literature_load.asp?ManNumber=MN408

ACCEPTANCE
Thoroughly inspect this equipment before accepting shipment from the transportation company. If any damage or shortage is discovered do not accept until noted on the freight bill. Report all damage to the freight carrier.

SAFETY
Eye bolts, lifting lugs or lifting openings, if provided, are intended only for lifting the motor and motor mounted standard accessories not exceeding, in total 30% of the motor weight. These lifting provisions should never be used when lifting or handling the motor and driven equipment. Eye bolt lifting capacity rating is based on a lifting alignment coincident with eye bolt center line. Eye bolt capacity reduces as deviation from this alignment is increased. Be sure eye bolts are tight and prevented from turning before lifting.

INSTALLATION OUTSIDE THE USA:
Refer to MN408 and MN1383 for Compliance with European Directives. Copies are available at:
http://www.baldor.com/support/literature_load.asp

MOTOR ENCLOSURE
ODP, **Open drip proof** motors are intended for use in clean, dry locations with adequate supply of cooling air. These motors should not be used in the presence of flammable or combustible materials. Open motors can emit flame and/or molten metal in the event of insulation failure.
TEFC, **totally enclosed** motors are intended for use where moisture, dirt and/or corrosive materials are present in indoor and outdoor locations.
Explosion protected motors, as indicated by a Nationally Recognized Testing Laboratory Certification mark and marking with Class, Division and Temperature Code are intended for installation in hazardous locations as described in Article 500 of the NEC. Refer to MN408 for more details.

MOUNTING
Foot mounted machines should be mounted to a rigid foundation to prevent excessive vibration. Shims may be used if location is uneven.
Flange mounted machines should be properly seated and aligned. Note: If improper rotation direction is detrimental to the load, check rotation direction prior to coupling the load to the motor shaft.
For **V–belt drive,** mount the sheave pulley close to the motor housing. Allow clearance for end to end movement of the motor shaft. Do not overtighten belts as this may cause premature bearing failure or shaft breakage.
Direct coupled machines should be carefully aligned and the shaft should rotate freely without binding.

GENERAL
The user must select a motor starter and overcurrent protection suitable for this motor and its application. Consult motor starter application data as well as the National Electric Code and/or applicable local codes. Special motors for use by United States Government including special specifications, master plans, etc. refer to the applicable master plans and specifications involved.
On motors received from the factory with the shaft blocked, remove blocking before operating the motor. If motor is to be reshipped alone or installed to another piece of equipment, the shaft block must be installed to prevent axial movement and prevent brinelling of the bearings during shipment.

TESTING
If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, check the motor insulation resistance with a meg ohm meter. Depending on storage conditions it may be necessary to regrease or change rusted bearings. Contact Baldor District Office if resistance is less than 5 meg ohms.

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury.
WARNING: Be sure the system is properly grounded before applying power. Electrical shock can cause serious or fatal injury.

INSTALLATION
This motor must be installed in accordance with National Electric Code, NEMA MG–2, IEC standards and local codes.

WIRING
Connect the motor as shown in the connection diagrams. If this motor is installed as part of a motor control drive system, connect and protect the motor according to the control manufacturers diagrams. Refer to MN408 for additional details on lead marking. The wiring, fusing and grounding must comply with the National Electrical Code or IEC and local codes. When the motor is connected to the load for proper direction of rotation and started, it should start quickly and run smoothly. If not, stop the motor immediately and determine the cause. Possible causes are: low voltage at the motor, motor connections are not correct or the load is too heavy. Check the motor current after a few minutes of operation and compare the measured current with the nameplate rating.

GROUNDING
Ground the motor according to NEC and local codes. In the USA consult the National Electrical Code, Article 430 for information on grounding of motors and generators, and Article 250 for general information on grounding. In making the ground connection, the installer should make certain that there is a solid and permanent metallic connection between the ground point, the motor or generator terminal housing, and the motor or generator frame. In non–USA locations consult the appropriate national or local code applicable.

ADJUSTMENT
The neutral is adjustable on some DC motors. AC motors have no adjustable parts.

Noise
For specific sound power or pressure level information, contact your local Baldor representative.

VIBRATION
This motor is balanced to NEMA MG1, Part 7 standard.

BRUSHES (DC Motors)
Periodically, the brushes should be inspected and all brush dust blown out of the motor. If a brush is worn $^{1}/_{2}$, (length specified in renewal parts data), replace the brushes. Reassemble and seat the new brushes using a brush seating stone. Be sure the rocker arm is set on the neutral mark.

WARNING: Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.

INSPECTION
Before connecting the motor to an electrical supply, inspect for any damage resulting from shipment. Turn the shaft by hand to ensure free rotation. Motor leads must be isolated before the shaft will turn freely on permanent magnet motors.

DRAIN PLUGS
Condensation drain plugs are provided at four points on each endplate for various motor mounting configurations. For Washdown and totally enclosed, fan cooled or non-ventilated motors, the plugs in the lowest portion of the ends shields should be removed for operation (unless the motor has special stainless steel drains). All drains are located in the lowest portion of the ends shields.

MOUNTING
Mount the motor on a foundation sufficiently rigid to prevent excessive vibration. Grease lubricated ball bearing motors may be mounted with the feet at any angle. After careful alignment, bolt motor securely in place. Use shim to fill any unevenness in the foundation. Motor feet should sit solidly on the foundation before mounting bolts are tightened.

IP (Ingress Protection)
IP designations include two numerals, the first characteristic numeral is for ingress solid bodies and from dust.
The second for ingress protection from liquid – water.
Motors marked less than IP23 require additional protection from water.

GUARDING
After motor installation is complete, a guard of suitable dimensions must be constructed and installed around the motor/gearmotor. This guard must prevent personnel from coming in contact with any moving parts of the motor or drive assembly but must allow sufficient cooling air to pass over the motor.
If a motor mounted brake is installed, provide proper safeguards for personnel in case of brake failure.
Brush inspection plates and electrical connection cover plates or lids, must be installed before operating the motor.

STARTING

Before starting motor remove all unused shaft keys and loose rotating parts to prevent them from flying off.
Check direction of rotation before coupling motor to load. The motor should start quickly and run smoothly and with little noise. If the motor should fail to start the load may be too great for the motor, the voltage is low or the motor has been miswired. In any case immediately shut motor off and investigate the cause.

ROTATION
To reverse the direction of rotation, disconnect and lockout power and interchange any two of the three AC power leads for three phase motors. For two-phase four wire, disconnect and lockout power and interchange the AC line leads on any one phase. For two phase three wire, disconnect and lockout power and interchange phase one and phase two AC line leads.

Maintenance Procedures

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury.

WARNING: Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. Protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.

Lubrication Information

This is a ball or roller bearing motor. The bearings have been lubricated at the factory. Motors that do not have regrease capability are factory lubricated for the normal life of the bearings. **Washdown motors can not be lubricated**.

Lubricant
Baldor motors are pregreased, normally with Mobil Polyrex EM unless stated on nameplate. Do not mix lubricants due to possible incompatibility. Look for signs of lubricant incompatibility, such as extreme soupiness visible from the grease relief area. If other greases are preferred, check with local Baldor representative for recommendations.

Relubrication Intervals (For motors with regrease capability)
New motors that have been stored for a year or more should be relubricated. Lubrication is also recommended at these intervals.

LUBRICATION INSTRUCTIONS

Cleanliness is important in lubrication. Any grease used to lubricate anti friction bearings should be fresh and free from contamination. Properly clean the grease inlet area of the motor to prevent grease contamination.
1. Select service condition from Table 1.
2. Select lubrication frequency from Table 2.

LUBRICATION PROCEDURE
Bearings should be lubricated while stationary and the motor is warm.
1. Locate the grease inlet, clean the area, and replace the pipe plug with a grease fitting.
2. Locate and remove the grease drain plug, if provided.
3. Add the recommended volume of recommended lubricant until clean grease appears at the grease drain, at the grease relief, or along the shaft opening.
4. Replace the grease inlet plug and run the motor for two hours.
5. Replace the grease drain plug.

SPECIAL APPLICATIONS
For special temperature applications, consult your Baldor District Office.

Table 1 Service Conditions

Severity of Service	Ambient Temperature Maximum	Atmospheric Contamination	Type of Bearing
Standard	40° C	Clean, Little Corrosion	Deep Groove Ball Bearing
Severe	50° C	Moderate dirt, Corrosion	Ball Thrust, Roller
Extreme	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion	All Bearings
Low Temperature	<-30° C **		

* Special high temperature grease is recommended. ** Special low temperature grease is recommended.

Table 2 Lubrication Frequency (Ball Bearings)

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5000 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings. For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3 Lubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Table 4 Amount of Grease to Add

Frame Size NEMA (IEC)	Bearing Description (Largest bearing in each frame size)					
	Bearing	OD D mm	Width B mm	Weight of grease to add ounce (gram)	Volume of grease to add	
					$inches^3$	teaspoon
Up to 210 incl. (132)	6307	80	21	0.30 (8.4)	0.6	2.0
Over 210 to 280 incl. (180)	6311	120	29	0.61 (17.4)	1.2	3.9
Over 280 to 360 incl. (200)	6313	140	33	0.81 (23.1)	1.5	5.2
Over 360 to 5000 incl. (300)	NU322	240	50	2.12 (60.0)	4.1	13.4

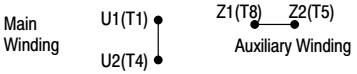
Weight in grams = 0.005 DB

Typical IEC vs NEMA Lead Marking

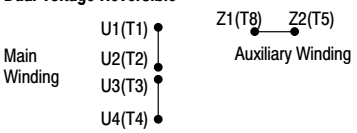
Single Phase Non-Reversible

Refer to the connection diagram provided on the Baldor motor.

Single Phase Reversible



Dual Voltage Reversible



DC Motors

Lead markings can be translated between IEC and NEMA designations as follows:

	NEMA	IEC
Armature	A1, A2	A1, A2
Series Field	S2, S2	D1, D2
Shunt Field	F1, F2	E1, E2

Refer to the connection diagram provided on the Baldor motor.

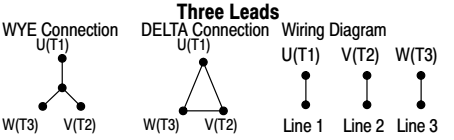
Three Phase

For single winding 3 phase motors, lead markings can be directly translated between IEC and NEMA designations. For these motors, the lead markings are:

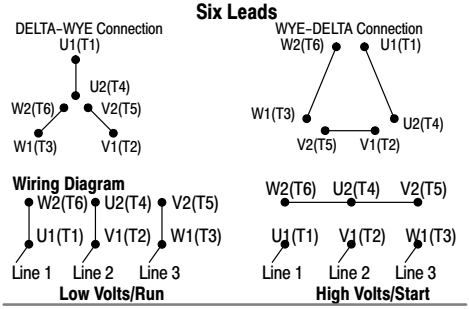
U1=T1 U2=T4 U3=T7 U4=T10
V1=T2 V2=T5 V3=T8 V4=T11
W1=T3 W2=T6 W3=T9 W4=T12

Refer to the connection diagram provided on the Baldor motor. Some examples are as follows:

Three Leads



Six Leads



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Appendix B

Viking Pump Technical Service Manual

Series 4195 and 495 / Sizes G, GG, H, HJ, AS, AK, AL

VIKING PUMP

TECHNICAL SERVICE MANUAL

HEAVY-DUTY PUMPS
SERIES 4195 AND 495
SIZES G, GG, H, HJ, HL, AS, AK, AL

CONTENTS

INTRODUCTION

The illustrations used in this manual are for identification purposes only and cannot be used for ordering parts. Obtain a parts list from the factory or a Viking® representative. Always give complete name of part, part number and material with model number and serial number of pump when ordering repair parts. The unmounted pump or pump unit model number and serial number are on the nameplate.

In the Viking model number system, basic size letters are combined with series number (4195 and 495) are used to indicate either an unmounted pump or mounted pump unit.

UNMOUNTED PUMP		UNITS
Foot Mounted		Units are designated by the unmounted pump model numbers followed by a letter(s) indicating drive style. D = Direct Drive
G4195	HL4195	
GG4195	AS4195	
H4195	AK4195	
HJ4195	AL4195	
Flange Mounted		M = Horizontal Direct Drive
G495	HL495	
GG495	AS495	
H495	AK495	
HJ495	AL495	

This manual deals only with Series 4195 and 495 Heavy Duty Pumps. Refer to Figures 1 through 14 for general configuration and nomenclature used in this manual. Pump specifications and recommendations are listed in Catalog Section 144, Series 4195 and 495 Heavy Duty Pumps.

FIGURE 1
G, GG, H, HJ and HL4195 SERIES
Foot Type Unmounted Pump with Tapped Ports

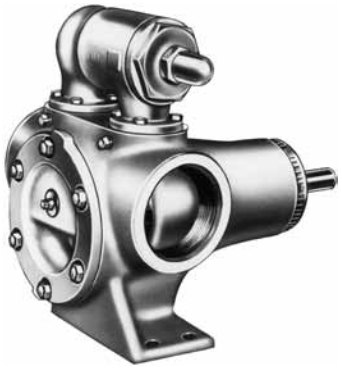


FIGURE 2
AS, AK and AL4195 SERIES
Foot Type Unmounted Pump with Tapped Ports

FIGURE 3
G, GG, H, HJ and HL495 SERIES
Unmounted Pump with Tapped Ports

FIGURE 4
AS, AK and AL495 SERIES
Unmounted Pump with Tapped Ports

SAFETY INFORMATION AND INSTRUCTIONS

IMPROPER INSTALLATION, OPERATION OR MAINTENANCE OF PUMP MAY CAUSE SERIOUS INJURY OR DEATH AND/OR RESULT IN DAMAGE TO PUMP AND/OR OTHER EQUIPMENT. VIKING'S WARRANTY DOES NOT COVER FAILURE DUE TO IMPROPER INSTALLATION, OPERATION OR MAINTENANCE.

THIS INFORMATION MUST BE FULLY READ BEFORE BEGINNING INSTALLATION, OPERATION OR MAINTENANCE OF PUMP AND MUST BE KEPT WITH PUMP. PUMP MUST BE INSTALLED, OPERATED AND MAINTAINED ONLY BY SUITABLY TRAINED AND QUALIFIED PERSONS.

THE FOLLOWING SAFETY INSTRUCTIONS MUST BE FOLLOWED AND ADHERED TO AT ALL TIMES.

Symbol Legend :

Danger - Failure to follow the indicated instruction may result in serious injury or death.

WARNING

Warning - In addition to possible serious injury or death, failure to follow the indicated instruction may cause damage to pump and/or other equipment.

BEFORE opening any liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) be sure that :

- Any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.
- The pump drive system means (motor, turbine, engine, etc.) has been "locked out" or otherwise been made non-operational so that it cannot be started while work is being done on the pump.
- You know what material the pump has been handling, have obtained a material safety data sheet (MSDS) for the material, and understand and follow all precautions appropriate for the safe handling of the material.

BEFORE operating the pump, be sure all drive guards are in place.

DO NOT operate pump if the suction or discharge piping is not connected.

DO NOT place fingers into the pumping chamber or its connection ports or into any part of the drive train if there is **any possibility** of the pump shafts being rotated.

WARNING

DO NOT exceed the pumps rated pressure, speed, and temperature, or change the system/duty parameters from those the pump was originally supplied, without confirming its suitability for the new service.

WARNING

BEFORE operating the pump, be sure that:

- It is clean and free from debris
- all valves in the suction and discharge pipelines are fully opened.
- All piping connected to the pump is fully supported and correctly aligned with the pump.
- Pump rotation is correct for the desired direction of flow.

WARNING

INSTALL pressure gauges/sensors next to the pump suction and discharge connections to monitor pressures.

WARNING

USE extreme caution when lifting the pump. Suitable lifting devices should be used when appropriate. Lifting eyes installed on the pump must be used **only** to lift the pump, **not** the pump with drive and/or base plate. If the pump is mounted on a base plate, the base plate must be used for all lifting purposes. If slings are used for lifting, they must be safely and securely attached. For weight of the pump alone (which does not include the drive and/or base plate) refer to the Viking Pump product catalog.

DO NOT attempt to dismantle a pressure relief valve that has not had the spring pressure relieved or is mounted on a pump that is operating.

AVOID contact with hot areas of the pump and/or drive. Certain operating conditions, temperature control devices (jackets, heat-tracing, etc.), improper installation, improper operation, and improper maintenance can all cause high temperatures on the pump and/or drive.

WARNING

THE PUMP must be provided with pressure protection. This may be provided through a relief valve mounted directly on the pump, an in-line pressure relief valve, a torque limiting device, or a rupture disk. If pump rotation may be reversed during operation, pressure protection must be provided on ***both*** sides of pump. Relief valve adjusting screw caps must always point towards suction side of the pump. If pump rotation is reversed, position of the relief valve must be changed. Pressure relief valves cannot be used to control pump flow or regulate discharge pressure. For additional information, refer to Viking Pump's Technical Service Manual TSM 000 and Engineering Service Bulletin ESB-31.

WARNING

THE PUMP must be installed in a matter that allows safe access for routine maintenance and for inspection during operation to check for leakage and monitor pump operation.

SPECIAL INFORMATION

DANGER !

Before opening any Viking pump liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) Be sure:

1. **That any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.**
2. **That the driving means (motor, turbine, engine, etc.) has been "locked out" or made non-operational so that it cannot be started while work is being done on pump.**
3. **That you know what liquid the pump has been handling and the precautions necessary to safely handle the liquid. Obtain a material safety data sheet (MSDS) for the liquid to be sure these precautions are understood.**

Failure to follow above listed precautionary measures may result in serious injury or death.

ROTATION: Viking pumps operate equally well in a clockwise or counterclockwise rotation. Shaft rotation determines which port is suction and which is discharge. Suction Port is where pumping elements (gear teeth) come out of mesh.

PRESSURE RELIEF VALVES:

1. Viking pumps are positive displacement pumps and must be provided with some sort of pressure protection. This may be a relief valve mounted directly on the pump, an inline pressure relief valve, a torque limiting device or a rupture disk.
2. There are relief valve options available on those pump models designed to accept a relief valve. Options may include a return to tank relief valve. Pumps equipped with a jacketed head plate are generally not available with a relief valve.
3. If pump rotation is reversed during operation, pressure protection must be provided on both sides of the pump.
4. The relief valve adjusting screw cap must always point towards the suction side of the pump. If pump rotation is reversed, remove the pressure relief valve and turn end for end. Refer to **Figure 5**.
5. Pressure relief valves should not be used to control flow or regulate discharge pressure.

For additional information on pressure relief valves, refer to **Technical Service Manual TSM 000 and Engineering Service Bulletin ESB-31.**

SPECIAL MECHANICAL SEALS:

This bulletin illustrates the mechanical seal which is standard in the catalog pump. A Seal Installation Drawing will be furnished with a pump fitted with a non-standard mechanical seal. Consult this Seal Installation Drawing before disassembling pump.

Modifications are required to install PTFE mechanical seals in these pumps. Contact the factory for specific information.

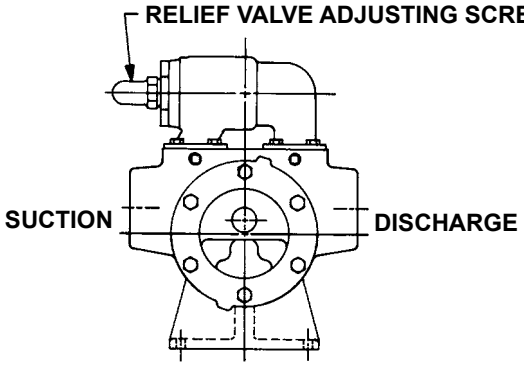


FIGURE 5

MAINTENANCE

Series 4195 and 495 pumps are designed for long, trouble-free service life under a wide variety of application conditions with a minimum of maintenance. The points listed below will help provide long service life.

CLEANING PUMP: Keep the pump as clean as possible. This will facilitate inspection, adjustment and repair work and help prevent overlooking a dirt covered grease fitting.

STORAGE: If the pump is to be stored, or not used for six months or more, the pump must be drained and a light coat of non-detergent SAE 30 weight oil must be applied to all internal pump parts. Lubricate the fittings and apply grease to the pump shaft extension. Viking suggests rotating pump shaft by hand one complete revolution every 30 days to circulate the oil.

SUGGESTED REPAIR TOOLS: The following tools must be available to properly repair Series 4195 and 495 pumps. These tools are in addition to standard mechanics' tools such as open end wrenches, pliers, screw drivers, etc. Most of the items can be obtained from an industrial supply house.

1. Soft Headed hammer
2. Allen wrenches (set screws & special mechanical seals)
3. Snap Ring Pliers
   INTERNAL – Viking Part No. 2-810-047-999
   G-GG-H-HJ-HL 4195-495
   EXTERNAL – Viking Part No. 2-810-029-375
   G-GG-H-HJ-HL 4195-495
4. Mechanical Seal Installation Sleeve
   2-751-001-730 for 0.75 inch seal; G-GG 4195-495
   2-751-004-730 for 1.25 inch seal; AS-AL 4195-495
5. Bearing Locknut Spanner Wrench – 2-810-043-375
6. Spanner Wrench, adjustable pin type for use on bearing housing end cap. – 2-810-008-375
7. Brass bar
8. Arbor press
9. Standard 5/16" 12 point socket

DISASSEMBLY

DANGER !

Before opening any Viking pump liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) Be sure:

1. **That any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.**
2. **That the driving means (motor, turbine, engine, etc.) has been "locked out" or made non-operational so that it cannot be started while work is being done on pump.**
3. **That you know what liquid the pump has been handling and the precautions necessary to safely handle the liquid. Obtain a material safety data sheet (MSDS) for the liquid to be sure these precautions are understood.**

Failure to follow above listed precautionary measures may result in serious injury or death.

1. Refer to **Figures 7 & 8**, page 5 for model to be disassembled and name of parts. Models 4195 & 495 are disassembled and assembled in the same manner. The difference between these models is the casings.
2. Mark the head and casing before disassembly to insure proper reassembly.
3. **NOTE:** The four valve capscrews, valve and gasket must be removed from the G-GG 4195-495 model before the six head capscrews are removed.

   Remove the head capscrews.
4. Tilt the top of the head back when removing to prevent the idler from falling off the idler pin.
5. Remove the idler and bushing assembly. If the idler bushing needs replacing, see **"Installation of Carbon Graphite Bushings,"** page 8.
6. Insert a brass bar or piece of hardwood in the port opening and between the rotor teeth to keep the shaft from turning. Turn the locknut counterclockwise and remove locknut. See **Figure 9 or 10**, page 6.
7. Loosen the two setscrews in the face of the bearing housing and turn the thrust bearing assembly counterclockwise and remove from casing. See **Figure 9 or 10**, page 6.
8. **H, HJ, HL:** Remove the snap ring from the shaft. See **Figure 9**, page 6.

   AS, AK, AL: Remove the bearing spacer from the shaft. See **Figure 10**, page 6.
9. Remove the brass bar or piece of hardwood from the port opening.

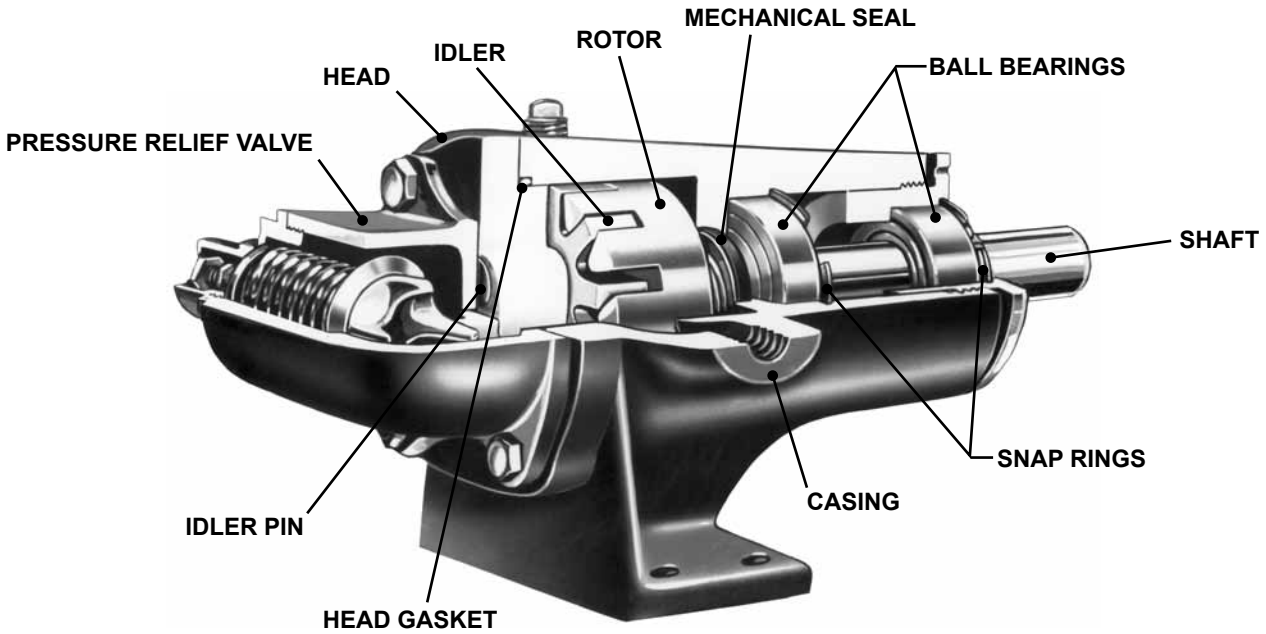
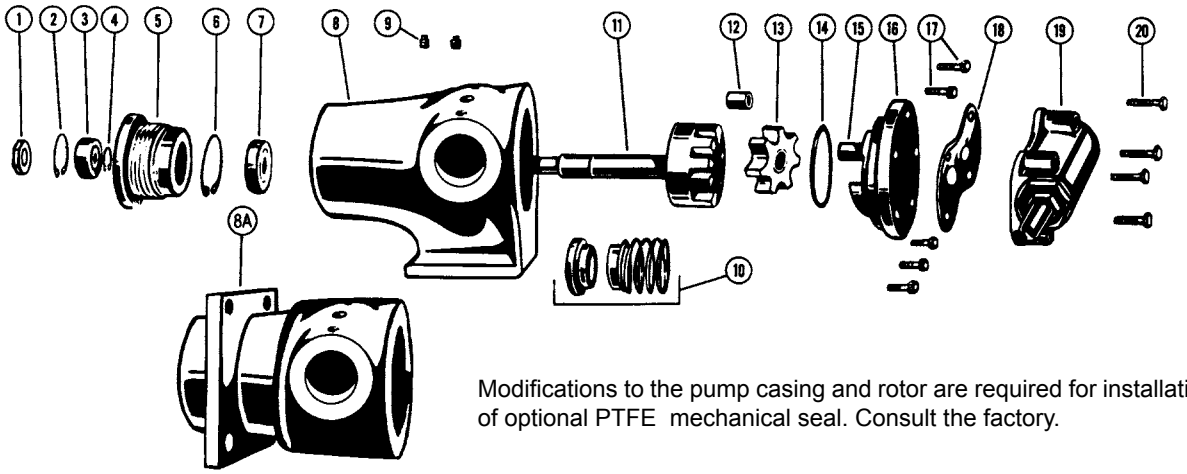


FIGURE 6
CUTAWAY FOR MODELS G, GG, H, HJ AND HL4195

CASING

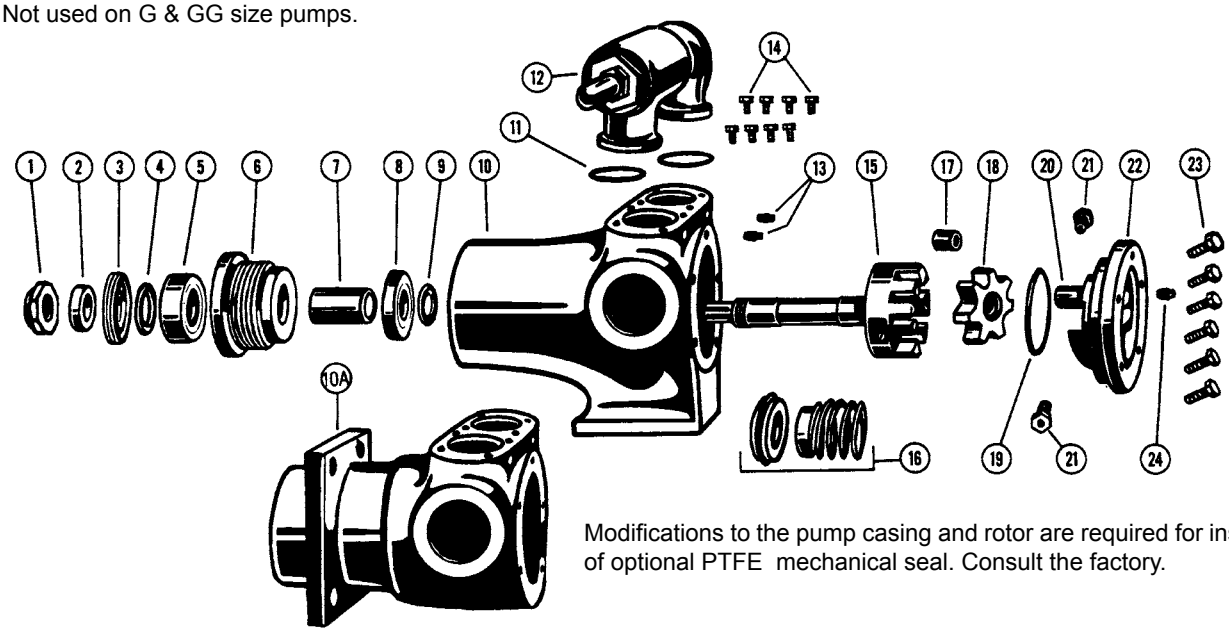


Modifications to the pump casing and rotor are required for installation of optional PTFE mechanical seal. Consult the factory.

FIGURE 7 - EXPLODED VIEW FOR MODELS G, GG, H, HJ AND HL 4195 AND 495

ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART
1	Locknut	8	Casing (4195)	14	Head O-Ring
2	Snap Ring (Outer)	8A	Casing (495)	15	Idler Pin
3	Ball Bearing (Outer)	9	Pipe Plug	16	Head and Idler Pin Assembly
4	Snap Ring for Shaft *	10	Mechanical Seal	17	Capscrew for Head
5	Bearing Housing	11	Rotor and Shaft Assembly	18	Gasket for Relief Valve
6	Snap Ring (Inner)	12	Idler Bushing	19	Relief Valve
7	Ball Bearing (Inner)	13	Idler and Bushing Assembly	20	Capscrew for Valve

* Not used on G & GG size pumps.



Modifications to the pump casing and rotor are required for installation of optional PTFE mechanical seal. Consult the factory.

FIGURE 8 - EXPLODED VIEW FOR MODELS AS, AK AND AL 4195 AND 495

ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART
1	Locknut	9	Bearing Retainer Washer	16	Mechanical Seal
2	Bearing Spacer Collar	10	Casing (4195)	17	Idler Bushing
3	End Cap for Bearing Housing	10A	Casing (495)	18	Idler and Bushing Assembly
4	Lip Seal for Bearing Housing	11	O-Rings for Relief Valve	19	Head O-Ring
5	Ball Bearing (Outer)	12	Relief Valve	20	Idler Pin
6	Bearing Housing	13	Pipe Plug	21	Check Valve
7	Bearing Spacer	14	Capscrew for Valve	22	Head and Idler Pin Assembly
8	Ball Bearing (Inner)	15	Rotor and Shaft Assembly	23	Capscrew for Head

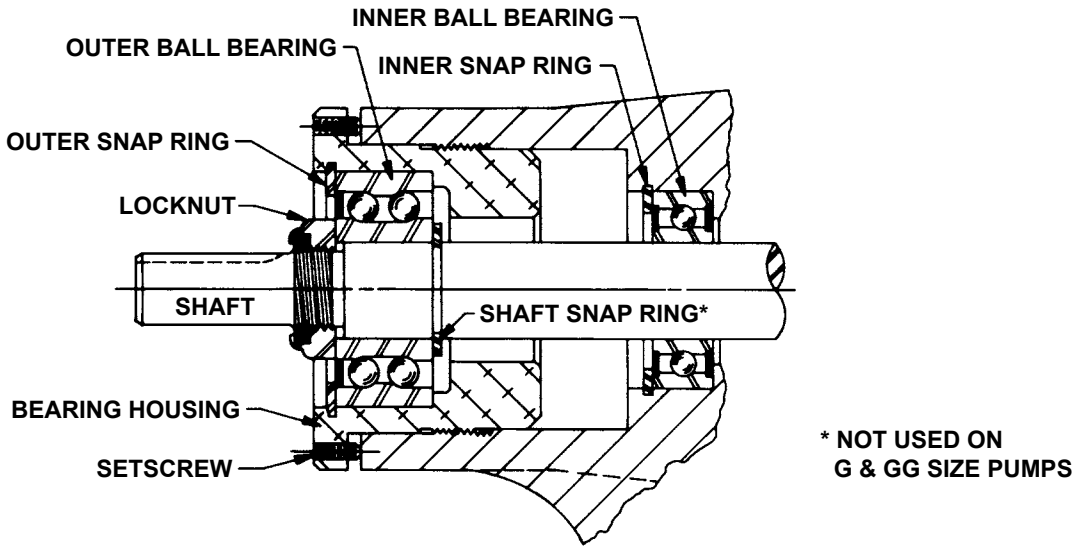


FIGURE 9 - THRUST BEARING ASSEMBLY G, GG, H, HJ AND HL SIZES

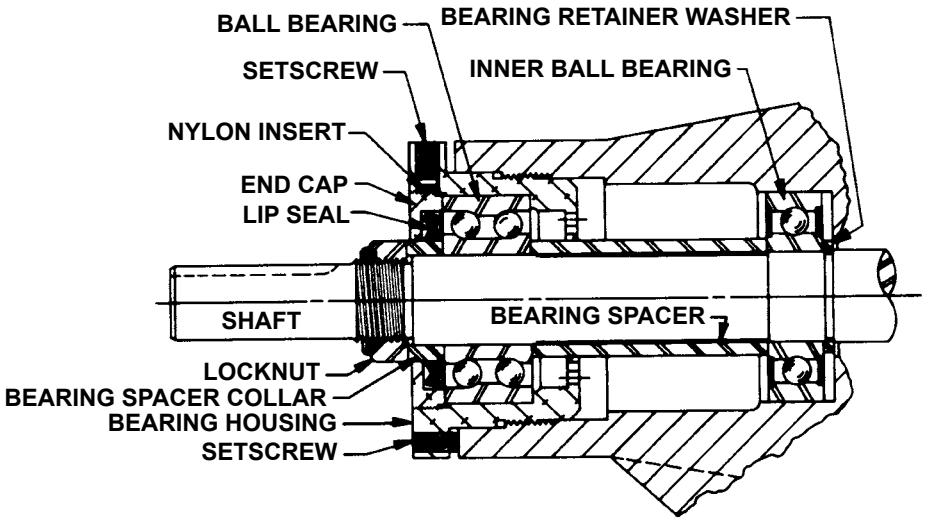


FIGURE 10 - THRUST BEARING ASSEMBLY AS, AK AND AL SIZES

10. The rotor and shaft can now be removed by tapping on the end of the shaft with a lead hammer or, if using a regular hammer, use a piece of hardwood between the shaft and hammer. The rotary member of the seal will come out with the rotor and shaft.

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

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

13. **G, GG, H, HJ, HL:** Remove the inner snap ring and single row ball bearing from the casing.

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

14. Remove the seal seat or stationary part of the seal from the casing.

15. Disassemble the thrust bearing assembly.

G, GG, H, HJ, HL: Remove the outer snap ring from the bearing housing and remove the ball bearing. See **Figure 9.**

AS, AK, AL: Loosen the two setscrews in the flange outside diameter. Rotate the end cap and lip seal counterclockwise and remove. Remove the ball bearing. See **Figure 10.**

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

When making major repairs, such as replacing a rotor and shaft; it is advisable to also install a new mechanical seal, head and idler pin, idler and bushing. See **"Installation of Carbon Graphite Bushings,"** page 8.

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

Wash the bearings in clean solvent. Blow out the bearings with compressed air. Do not allow the bearings to spin; turn them slowly by hand. Spinning the bearings will damage the race and balls. Make sure the bearings are clean, then lubricate with non-detergent SAE 30 weight oil and check for roughness. Roughness can be determined by turning the outer race by hand. Replace the bearings if they have roughness.

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

ASSEMBLY

Standard Mechanical Seal
(Synthetic Rubber Bellows Type)

READ CAREFULLY BEFORE REASSEMBLING PUMP

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

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

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

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

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

1. Coat the idler pin with non-detergent SAE 30 weight oil and place idler and bushing on idler pin in the head. If replacing a carbon graphite bushing, refer to **"Installation of Carbon Graphite Bushings,"** page 8.
2. Clean the rotor hub and casing seal housing bore. Make sure both are free from dirt and grit. Coat the outer diameter of seal seat and inner diameter of seal housing bore with non-detergent SAE 30 weight oil.
3. Start the seal seat in the seal housing bore. If force is necessary protect the seal face with a clean cardboard disc and gently tap it in place with a piece of wood. Be sure the seal seat is completely seated in the bore.
4. Place a tapered installation sleeve on the shaft, refer to **Figure 11.** The sleeve is furnished with G, GG, AS, AK and AL replacement mechanical seals. Coat the rotor shaft, tapered installation sleeve and inner diameter of the mechanical seal rotary member with a generous amount of non-detergent SAE 30 weight oil. Petrolatum may be used but grease is not recommended.
5. Place the seal spring on the shaft against the rotor hub. Refer to **Figure 12.**

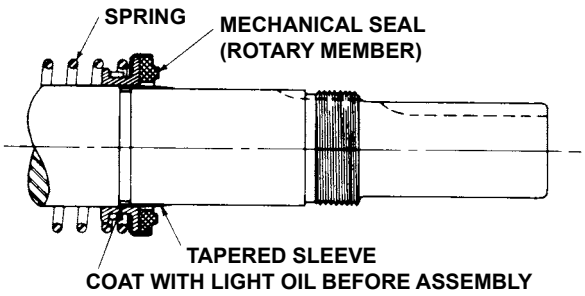


FIGURE 11

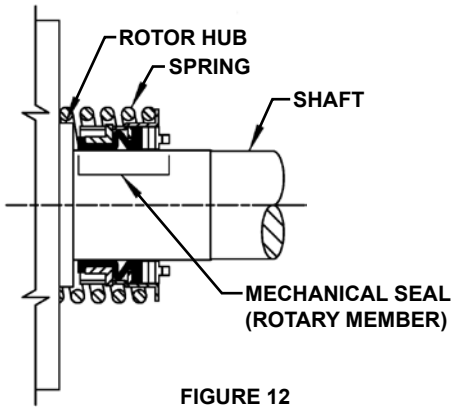


FIGURE 12

6. Slide the rotary member, lapped contact surface facing away from the spring, over installation sleeve on shaft until just contacting the spring. Do not compress the spring. Remove the installation sleeve.
7. Coat the rotor shaft with non-detergent SAE 30 weight oil. Install the rotor and shaft into the casing, slowly pushing until the ends of the rotor teeth are just below the face of the casing. Take care not to damage the seal seat.
8. Leave the rotor in this position. Withdrawal of the rotor and shaft may displace the carbon seal rotating face and result in damage to the seal.
9. Place the O-ring or gasket on the head and install the head and idler assembly on pump. The pump head and casing were marked before disassembly to insure proper reassembly. If not, be sure the idler pin, which is offset in the pump head, is positioned up and equal distance between port connections to allow for proper flow of liquid through the pump.
10. Tighten the head capscrews evenly.
11. If the pump was equipped with a relief valve and was removed during disassembly, install on the head with new O-Rings or gaskets. The relief valve adjusting screw cap must always point towards the suction port. Refer to **Figure 5,** page 3. For relief valve repair or adjustments, see **"Pressure Relief Valve Instructions,"** Page 9.
12. In 2005, the use of single seal bearings were phased out. Pumps now use "Sealed for Life" bearings that have seals on both sides. The new bearings can be installed either side first and do not need to be packed with grease. For older models with single seal bearings, pack the inner ball bearing with multi-purpose grease, NLGI #2.

G, GG, H, HJ, HL: Drive the bearing into the bore. Tap the inner race with a brass bar and lead hammer to position bearing. Install the inner snap ring.

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

13. **H, HJ, HL:** Install the shaft snap ring in groove in the shaft. See **Figure 9**, page 6.

    AS, AK, AL: Install the bearing spacer over the shaft and against the single row ball bearing. See **Figure 10**, page 6.

14. Pack the lubrication chamber between the inner ball bearing and double row ball bearing in the thrust bearing assembly approximately one-half full of multi-purpose grease, NLGI #2. The thrust bearing assembly will take the remaining space. See **Figure 9 and 10**, page 6.

15. Pack the double row ball bearing with multi-purpose grease, NLGI #2.

    G, GG, H, HJ, HL: Install the ball bearing into the bearing housing with shield side toward the coupling end of the shaft. See **Figure 9**, page 6. Install the snap ring into bearing housing to retain ball bearing. This snap ring has a tapered edge to fit tapered groove in bearing housing. The tapered edge is located away from the ball bearing.

    AS, AK, AL: Install the ball bearing into the bearing housing. Install the lip seal in the bearing housing end cap. The lip should face towards the end of the shaft. Put the bearing spacer collar in the lip seal and install in the bearing housing and tighten the set screws securely. See **Figure 10**, page 6.

16. Insert a brass bar or piece of hardwood through the port opening between the rotor teeth to keep the shaft from turning.

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

18. Remove the brass bar or hardwood from port opening.

19. Adjust pump end clearance, refer to **"Thrust Bearing Adjustment".**

DANGER !

Before starting pump, be sure all drive equipment guards are in place.

Failure to properly mount guards may result in serious injury or death.

THRUST BEARING ADJUSTMENT

See **Figures 9 and 10.**

Loosen the two screws in the face of the thrust bearing assembly.

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

To set end clearance:

1. While turning the rotor shaft, rotate the thrust bearing assembly clockwise until a noticeable drag occurs. This is zero end clearance.
2. Mark the position of the bearing housing with respect to the casing.
3. Rotate the thrust bearing assembly counterclockwise the distance listed below as measured on outside of bearing housing.
4. After the adjustment is made, tighten the two setscrews in the face of the bearing housing assembly to secure the position.

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

PUMP SIZE	DISTANCE IN INCHES ON O.D. OF BEARING HOUSING	STANDARD END CLEARANCE
G, GG	0.44" (7/16")	.003
H, HJ , HL	0.56" (9/16")	.003
AS , AK , AL	0.5" (1/2")	.003

INSTALLATION OF CARBON GRAPHITE BUSHINGS

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

1. A press must be used for installation.
2. Be certain the bushing is started straight.
3. Do not stop pressing the operation until the bushing is in the proper position, as starting and stopping may result in a cracked bushing.
4. Check the bushing for cracks after installation.

PRESSURE RELIEF VALVE INSTRUCTIONS

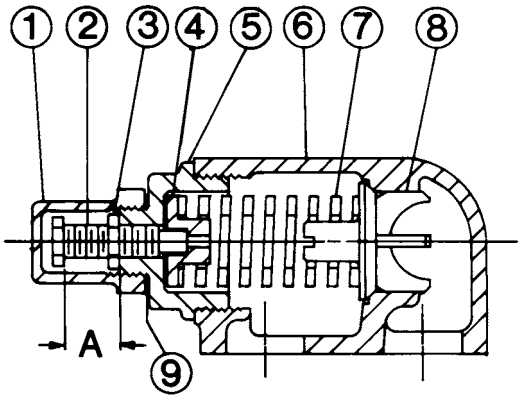


FIGURE 13
VALVE - G, GG, H, HJ and HL SIZES

VALVE - LIST OF PARTS			
1.	Valve Cap	**6.**	Valve Body
2.	Adjusting Screw	**7.**	Valve Spring
3.	Lock Nut	**8.**	Poppet
4.	Spring Guide	**9.**	Cap Gasket
5.	Bonnet		

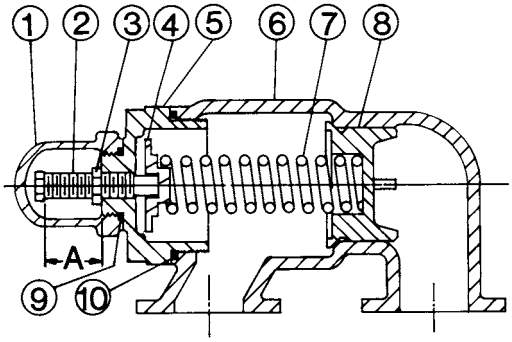


FIGURE 14
VALVE - AS, AK and AL SIZES

VALVE - LIST OF PARTS			
1.	Valve Cap	**6.**	Valve Body
2.	Adjusting Screw	**7.**	Valve Spring
3.	Lock Nut	**8.**	Poppet
4.	Spring Guide	**9.**	Cap Gasket
5.	Bonnet	**10.**	Bonnet O-Ring

DISASSEMBLY

DANGER !

Before opening any Viking pump liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) Be sure:

1. **That any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.**
2. **That the driving means (motor, turbine, engine, etc.) has been "locked out" or made non-operational so that it cannot be started while work is being done on pump.**
3. **That you know what liquid the pump has been handling and the precautions necessary to safely handle the liquid. Obtain a material safety data sheet (MSDS) for the liquid to be sure these precautions are understood.**

Failure to follow above listed precautionary measures may result in serious injury or death.

Mark the valve and head before disassembly to ensure proper reassembly.

1. Remove the valve cap.
2. Measure and record the length of extension of the adjusting screw. Refer to **"A"** on **Figures 13 and 14**.
3. Loosen the locknut and back out the adjusting screw until spring pressure is released.
4. Remove the bonnet, spring guide, spring and poppet from the valve body. Clean and inspect all parts for wear or damage and replace as necessary.

ASSEMBLY

Reverse the procedures outlined under **"Disassembly."** If the valve is removed for repairs, be sure to replace in the same position. The relief valve adjusting screw cap must always point towards suction side of the pump. If the pump rotation is reversed, remove the relief valve and turn end for end. Refer to **Figure 5**, page 3.

DANGER !

Before starting pump, be sure all drive equipment guards are in place.

Failure to properly mount guards may result in serious injury or death.

PRESSURE ADJUSTMENT

If a new spring is installed or if the pressure setting of the pressure relief valve is to be changed from that which the factory has set, the following instructions must be carefully followed.

1. Carefully remove the valve cap which covers the adjusting screw.

   Loosen the locknut which locks the adjusting screw so the pressure setting will not change during operation of the pump.
2. Install a pressure gauge in the discharge line for actual adjustment operation.
3. Turn the adjusting screw in to increase the pressure and out to decrease the pressure.
4. With discharge line closed at a point beyond pressure gauge, the gauge will show the maximum pressure the valve will allow while the pump is in operation.

IMPORTANT

When ordering parts for the pressure relief valve, always give the model number and serial number of the pump as it appears on the nameplate and the name of the part wanted. When ordering springs, be sure to give the pressure setting desired.

VIKING PUMP

IDEX CORPORATION

WARRANTY

Viking warrants all products manufactured by it to be free from defects in workmanship or material for a period of one (1) year from date of startup, provided that in no event shall this warranty extend more than eighteen (18) months from the date of shipment from Viking. The warranty period for Universal Seal series pumps ONLY (Universal Seal models listed below) is three (3) years from date of startup, provided that in no event shall this warranty extend more than forty-two (42) months from the date of shipment from Viking.

UNDER NO CIRCUMSTANCES SHALL VIKING BE LIABLE UNDER THIS WARRANTY OR OTHERWISE FOR SPECIAL, INCIDENTAL, INDIRECT, CONSEQUENTIAL OR PUNITIVE DAMAGES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, LOST OR UNREALIZED SALES, REVENUES, PROFITS, INCOME, COST SAVINGS OR BUSINESS, LOST OR UNREALIZED CONTRACTS, LOSS OF GOODWILL, DAMAGE TO REPUTATION, LOSS OF PROPERTY, LOSS OF INFORMATION OR DATA, LOSS OF PRODUCTION, DOWNTIME, OR INCREASED COSTS, IN CONNECTION WITH ANY PRODUCT, EVEN IF VIKING HAS BEEN ADVISED OR PLACED ON NOTICE OF THE POSSIBILITY OF SUCH DAMAGES AND NOTWITHSTANDING THE FAILURE OF ANY ESSENTIAL PURPOSE OF ANY PRODUCT.

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See complete warranty at www.vikingpump.com.