

## Votator® II

SCRAPED SURFACE HEAT EXCHANGER

FORM NO.: 95-03057 REVISION: 01/2019

READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING THIS PRODUCT.



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## Warranty

LIMITED WARRANTY: Unless otherwise mutually agreed to in writing, (a) SPX FLOW US, LLC (SPX FLOW) goods, auxiliaries and parts thereof are warranted to the Buyer against defective workmanship and material for a period of twelve (12) months from date of installation or eighteen (18) months from date of delivery, whichever expires first, and (b) SPX FLOW services are warranted to Buyer to have been performed in a workman-like manner for a period of ninety (90) days from the date of performance. If the goods or services do not conform to the warranty stated above, then as Buyer's sole remedy, SPX FLOW shall, at SPX FLOW's option, either repair or replace the defective goods or re-perform defective services. If Buyer makes a warranty claim to SPX FLOW and no actual defect is subsequently found, Buyer shall reimburse SPX FLOW for all reasonable costs which SPX FLOW incurs in connection with the alleged defect. Third party goods furnished by SPX FLOW will be repaired or replaced as Buyer's sole remedy, but only to the extent provided in and honored by the original manufacturer's warranty. Unless otherwise agreed to in writing, SPX FLOW shall not be liable for breach of warranty or otherwise in any manner whatsoever for: (i) normal wear and tear; (ii) corrosion, abrasion or erosion; (iii) any good or services which, following delivery or performance by SPX FLOW, has been subjected to accident, abuse, misapplication, improper repair, alteration (including modifications or repairs by Buyer, the end customer or third parties other than SPX FLOW), improper installation or maintenance, neglect, or excessive operating conditions; (iv) defects resulting from Buyer's specifications or designs or those of Buyer's contractors or subcontractors other than SPX FLOW; or (v) defects resulting from the manufacture, distribution, promotion or sale of Buyer's products; (vi) damage resulting from the combination, operation or use with equipment, products, hardware, software, firmware, systems or data not provided by SPX FLOW, if such damage or harm would have been avoided in the absence of such combination, operation or use; or (vii) Buyer's use of the goods in any manner inconsistent with SPX FLOW's written materials regarding the use of such product. In addition, the foregoing warranty shall not include any labor, dismantling, re-installation, transportation or access costs, or other expense associated with the repair or replacement of SPX FLOW goods. THE WARRANTIES CONTAINED HEREIN ARE THE SOLE AND EXCLUSIVE WARRANTIES AVAILABLE TO BUYER AND SPX FLOW HEREBY DISCLAIMS ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ANY PERFORMANCE OR PROCESS OUTCOME DESIRED BY THE BUYER AND NOT SPECIFICALLY AGREED TO BY SPX FLOW. THE FOREGOING REPAIR, REPLACEMENT AND REPERFORMANCE OBLIGATIONS STATE SPX FLOW'S ENTIRE AND EXCLUSIVE LIABILITY AND BUYER'S EXCLUSIVE REMEDY FOR ANY CLAIM IN CONNECTION WITH THE SALE AND FURNISHING OF SERVICES, GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATIONS.

## Shipping Damage or Loss

If equipment is damaged or lost in transit, file a claim at once with the delivering carrier. The carrier has a signed Bill of Lading acknowledging that the shipment has been received from SPX FLOW in good condition. SPX FLOW is not responsible for the collection of claims or replacement of materials due to transit shortage or damages.

## Warranty Claim

Warranty claims must have a **Returned Material Authorization (RMA)** from the Seller or returns will not be accepted. Contact 800-252-5200 or 262-728-1900.

Claims for shortages or other errors must be made in writing to Seller within ten (10) days after delivery. This does not include transit shortage or damages. Failure to give such notice shall constitute acceptance and waiver of all such claims by Buyer.

## Safety

### READ AND UNDERSTAND THIS MANUAL PRIOR TO INSTALLING, OPERATING, OR SERVICING THIS EQUIPMENT

SPX FLOW recommends users of our equipment and designs follow the latest Industrial Safety Standards. At a minimum, these should include the industrial safety requirements established by:

1. Occupational Safety and Health Administration (OSHA)
2. National Fire Protection Association (NFPA)
3. National Electrical Code (NEC)
4. American National Standards Institute (ANSI)

#### **⚠ WARNING**

*Severe injury or death can result from electrical shock, burn, or unintended actuation of equipment. Recommended practice is to disconnect and lockout industrial equipment from power sources, and release stored energy, if present. Refer to the National Fire Protection Association Standard No. NFPA70E, Part II and (as applicable) OSHA rules for Control of Hazardous Energy Sources (Lockout-Tagout) and OSHA Electrical Safety Related Work Practices, including procedural requirements for:*

- Lockout-tagout
- Personnel qualifications and training requirements
- When it is not feasible to de-energize and lockout-tagout electrical circuits and equipment before working on or near exposed circuit parts

Before putting SPXFLOW equipment into operation, the operator shall analyze the application for all foreseeable risks, their likelihood to occur and the potential consequences of the identified risks as per ISO 31000 and ISO/IEC 31010 in their actual current version.

**Locking and Interlocking Devices:** These devices should be checked for proper working condition and capability of performing their intended functions. Make replacements only with the original equipment manufacturer's OEM renewal parts or kits. Adjust or repair in accordance with the manufacturer's instructions.

**Periodic Inspection:** Equipment should be inspected periodically. Inspection intervals should be based on environmental and operating conditions and adjusted as indicated by experience. At a minimum, an initial inspection within 3 to 4 months after installation is recommended. Inspection of the electrical control systems should meet the recommendations as specified in the National Electrical Manufacturers Association (NEMA) Standard No. ICS 1.3, Preventative Maintenance of Industrial Control and Systems Equipment, for the general guidelines for setting-up a periodic maintenance program.

**Replacement Equipment:** Use only replacement parts and devices recommended by the manufacturer to maintain the integrity of the equipment. Make sure the parts are properly matched to the equipment series, model, serial number, and revision level of the equipment.

Warnings and cautions are provided in this manual to help avoid serious injury and/or possible damage to equipment:

#### **⚠ DANGER**

*Immediate hazards which WILL result in severe personal injury or death.*

#### **⚠ WARNING**

*Hazards or unsafe practices which COULD result in severe personal injury or death.*

#### **⚠ CAUTION**

*Hazards or unsafe practices which COULD result in minor personal injury or product or property damage.*

## Care of Component Materials

**NOTE:** SPX FLOW recommends the use of an FDA-approved anti-seize compound on all threaded connections.

**⚠ WARNING**

*Failure to comply with the Care of Component Materials could lead to bodily injury.*

### Stainless Steel Corrosion

Corrosion resistance is greatest when a layer of oxide film is formed on the surface of stainless steel. If film is disturbed or destroyed, stainless steel becomes much less resistant to corrosion and may rust, pit or crack.

Corrosion pitting, rusting and stress cracks may occur due to chemical attack. Use only cleaning chemicals specified by a reputable chemical manufacturer for use with stainless steel. Do not use excessive concentrations, temperatures or exposure times. Avoid contact with highly corrosive acids such as hydrofluoric, hydrochloric or sulfuric. Also avoid prolonged contact with chloride-containing chemicals, especially in presence of acid. If chlorine-based sanitizers are used, such as sodium hypochlorite (bleach), do not exceed concentrations of 150 ppm available chlorine, do not exceed contact time of 20 minutes, and do not exceed temperatures of 104°F (40°C).

Corrosion discoloration, deposits or pitting may occur under product deposits or under gaskets. Keep surfaces clean, including those under gaskets or in grooves or tight corners. Clean immediately after use. Do not allow equipment to set idle, exposed to air with accumulated foreign material on the surface.

Corrosion pitting may occur when stray electrical currents come in contact with moist stainless steel. Ensure all electrical devices connected to the equipment are correctly grounded.

### Elastomer Seal Replacement Following Passivation

Passivation chemicals can damage product contact areas of this equipment. Elastomers (rubber components) are most likely to be affected. Always inspect all elastomer seals after passivation is completed. Replace any seals showing signs of chemical attack. Indications may include swelling, cracks, loss of elasticity or any other noticeable changes when compared with new components.

## Introduction

### Models and Specifications

The Votator II can be furnished for horizontal or vertical installation, available in the following models:

Model	Heat Transfer Area	Jacket Type
6 x 84	11 ft <sup>2</sup> (1.0 m <sup>2</sup> )	Steam/Liquid Refrigeration
6 x 72	9 ft <sup>2</sup> (0.84 m <sup>2</sup> )	Steam/Liquid Refrigeration
6 x 48	6 ft <sup>2</sup> (0.56 m <sup>2</sup> )	Steam/Liquid Refrigeration
6 x 36	4.2 ft <sup>2</sup> (0.39 m <sup>2</sup> )	Steam/Liquid Refrigeration
6 x 24	3.0 ft <sup>2</sup> (0.28 m <sup>2</sup> )	Steam/Liquid Refrigeration

This manual covers the Horizontal and Vertical Votator II, Concentric and Eccentric Designs, and the Extra Heavy Duty Votator II. Every attempt has been made to note where special considerations are needed for each model. These differences are primarily in the installation and maintenance of the units.

### Cylinder Assembly

The cylinder assembly consists of a rotating shaft inside of two tubes. The outer tube is called the jacket, and contains working fluid to heat or cool the contents of the inner, product tube. The product tube provides a heat exchange surface for the product.

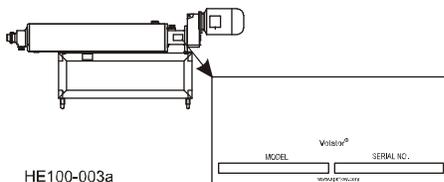
Standard product tubes are one of the following:

- Pure nickel with a hard chrome plated interior surface.
- Stainless steel with a hard chrome plated interior surface.
- Stainless steel with no plating.

### Product Side and Jacket Pressure Ratings

Check the data plate attached to the cylinder for the exact pressure rating specification of the unit.

### Machine Serial Number



**Figure 1 - Machine Serial Number Location**

The machine serial number is stamped on a serial number nameplate located on the machine side as shown in Figure 1. On vertical units (not shown), the nameplate is on the cylinder. Include the machine model and serial number with each parts order.

## **Votator II Media Configurations**

The Votator II is available in the following configurations:

- BWS-Brine/Water/Steam: For liquid and steam heating and cooling applications.
- LIQUID For water or glycol.
- VAPOR For steam or refrigeration.

## **Special Considerations for Vertical Votator II**

The Vertical Votator II cylinder assembly is shipped for on-site installation on the mounting pole. When receiving the shipment, check for the following or multiples of (depending on the order) shipped separately in their own crate or crates:

- Scraped Surface Heat Exchanger.
- Frame poles (including attached hydraulic cylinder) with hydraulic pump & reservoir assembly(s).
- Accumulators, Refrigeration Valves and Piping, if furnished.
- Mount plates, nuts & bolts, and interconnecting product piping.

## Installation

### Site Selection Considerations

### Foundation & Drainage

The Votator II should be located on a firm foundation, angled to allow liquids to drain away from the unit.

### Clearances

- The rear and sides of the unit, or unit cluster, should have adequate clearance to provide easy access for maintenance.
- The front of the Horizontal unit should have the following minimum clearances to allow for removal of the mutator shaft:

6 x 84 Votator II - 102 in (259 cm)

6 x 72 Votator II - 90 in (230 cm)

6 x 48 Votator II - 71 in (180 cm)

6 x 36 Votator II - 59 in (150 cm)

6 x 24 Votator II - 40 in (102 cm)

- The bottom of the Vertical unit should have the following minimum clearances to allow for removal of the mutator shaft:

6 x 84 Votator II - 96 in (244 cm)

6 x 72 Votator II - 84 in (214 cm)

6 x 48 Votator II - 66 in (168 cm)

6 x 36 Votator II - 54 in (137 cm)

6 x 24 Votator II - 48 in (122 cm)

### Leveling the Unit

The **Horizontal** Votator II should be leveled lengthwise (along the length of the cylinder) and crosswise by adjusting the feet on the legs.

For units that will perform CIP, set the level for a forward pitch of 0.3 degrees (1/16 inch per foot).

If CIP is not required, set the level to a pitch that will give the best drainage for the cylinder.

### Electrical Power Connections

The following electrical components for the Votator II require connection in accordance with the electrical schematics in this manual, tagged vendor specifications, and local regulations:

#### **▲ DANGER**

*The Votator II operates with high voltage. Electrical work should be performed by a Licensed Electrician in accordance with local regulations.*

- Drive Motor  
Each cylinder is furnished with a 3-phase, multi-voltage gear motor with a horsepower rating per the application: Standard Votator II accepts 7-1/2 HP (5.5 kW), 10 HP (7.5 kW), 15 HP (11kw) or 20 HP (15 kW); Extra Heavy Duty Votator II accepts 25 HP (18.8 kW), 30 HP (22.5 kW) or 40 HP (30 kW). The motor is fixed speed and suitable for use with a variable frequency controller.
- Hydraulic Pump Motor (Vertical units only)  
A 3/4 (0.5 kW) horsepower, fixed speed motor. A variable frequency controller **should not** be used for this motor.

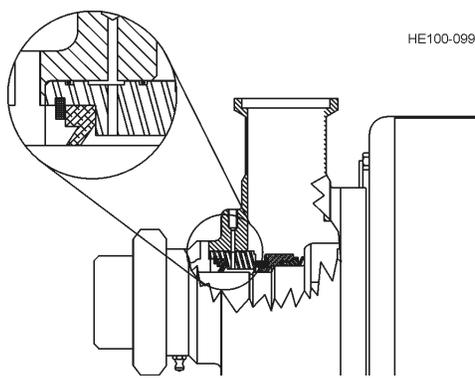
- Refrigeration Valves:
  - liquid feed solenoid valve
  - dual pressure regulating valve
  - level switch
  - hot gas pressure regulating valve
  - hot gas solenoid valve
- Freeze Protection Components (if furnished):
  - current sensing relay
  - instrument current transformer
  - digital current indicator

## Mutator Rotation Check

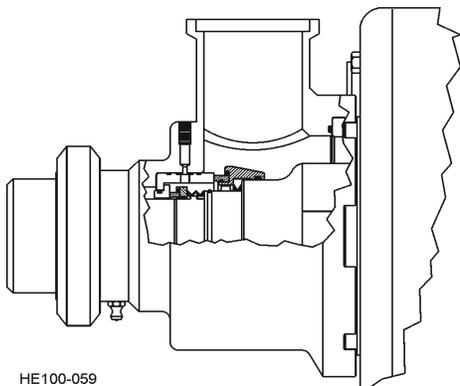
Correct mutator shaft rotation is counterclockwise when looking down the unit from the drive end (indicated by a sticker located near the motor). To check for correct rotation, momentarily start the drive motor and observe the rotation of the shaft in the back of the unit.

If the rotation of the shaft is incorrect, the drive motor is wired incorrectly. Have a Licensed Electrician change the wiring so the rotation of the shaft is correct.

## Mechanical Seals



**Figure 2 - Single Mechanical Seal**



**Figure 3 - Double Mechanical Seal**

The Votator II is furnished with either a single or double mechanical seal on both ends of the mutator shaft. Units furnished before 2005 were installed with either a single or double mechanical seal configuration. On page 11, "2005 Mechanical Seal Design" describes seals for units furnished between 2005 and 2012, and "2012 Mechanical Seal Design" describes seals for standard units finished from 2012 to the present. Certain Votator II units have also been supplied with a special "Ball-lock Mechanical Seal" or a "Packing Gland" instead. Consult your order documentation to verify the specific seal configuration for each Votator II unit.

### Single Mechanical Seal

The single mechanical seal is normally not flushed, but it can be. It is shipped with a lip seal (See Figure 2) designed to contain water or a liquid flush. The spring in the seal must be removed and the seal reinstalled with the lip in the relief position to allow flushing. This will minimize any damage to the contact surface on the stub end of the shaft.

When the single mechanical seal is rotating, there must be product or water flow to provide cooling to the rotating surfaces to avoid permanent damage to the seal assembly.

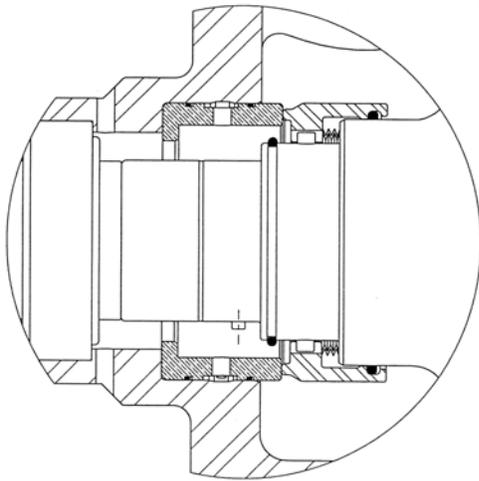
If the seal is flushed, the fluid flow should be in the range of 5 to 10 gallons per hour and not exceed 5 psig. Piping to seals should be in the bottom of head and out the top and with parallel flow, never in series.

### Double Mechanical Seal

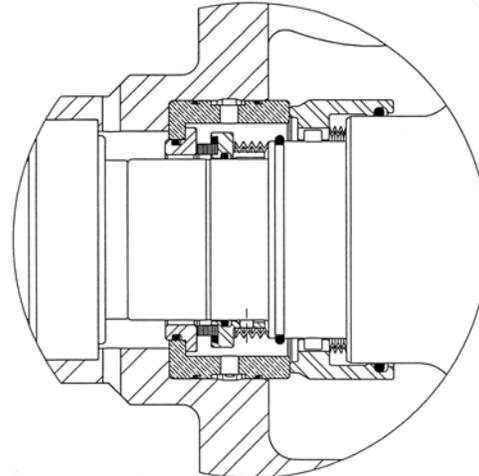
The double mechanical seal is furnished with a primary seal for product and a secondary seal to contain a steam or water flush.

### 2005 Mechanical Seal Design

Units furnished between 2005 and 2012 have a one-piece chrome-oxide coated rotating body running against a stationary ceramic head insert. It can easily be converted to a double mechanical seal by adding secondary components to contain a steam or water flush.



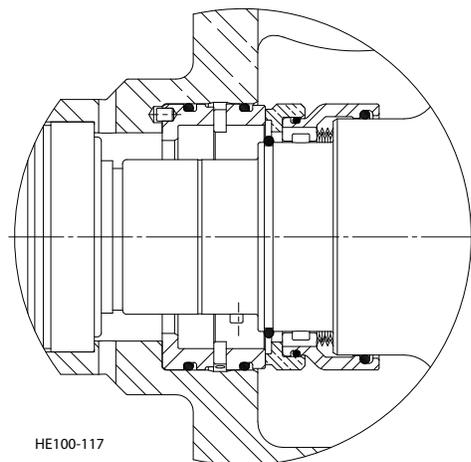
**Figure 4 - Single Mechanical Seal**



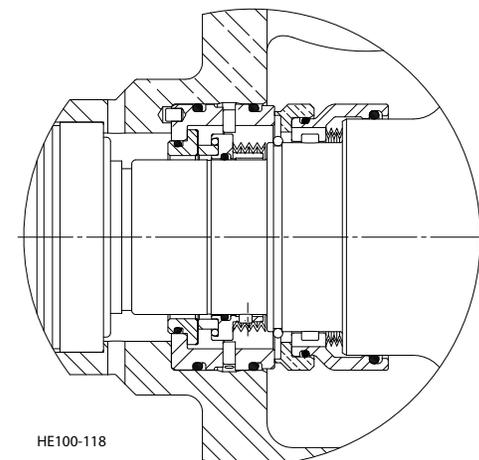
**Figure 5 - Double Mechanical Seal**

### 2012 Mechanical Seal Design

Standard units furnished starting in 2012 have removable rotary seal faces in solid carbon, silicon carbide, tungsten carbide, and narrow-face tungsten carbide materials. The stationary seal faces are made of solid ceramic or silicon carbide. Like the 2005 design, the 2012 single mechanical seal can be converted to a double mechanical seal by adding secondary components to contain a water or steam flush.



**Figure 6 - 2012 Single Mechanical Seal**



**Figure 7 - 2012 Double Mechanical Seal (shown with Narrow-Face Rotary)**

## Flush Fluid Requirements

The double mechanical seal **must be flushed** using the threaded flush ports, anytime the mutator shaft is rotated. Failure to do this will result in rapid seal failure due to excessive contaminate and heat buildup.

The fluid flow should be in the range of 5 to 10 gallons per hour, at a typical temperature of 80°F - 120°F (25°C - 49°C). Fluid composition and temperature should be selected to dissolve or suspend any product leakage and cool the mechanical seal faces, and should also be compatible with the sealing o-ring material. Piping to seal cavities for horizontal units should be in the bottom of head and out the top, piped with parallel flow, never with multiple seal cavities in series flow.

## Piping

### ⚠ CAUTION

*The safety valve should be installed on the discharge side of product pump for safety and equipment protection.*

### ⚠ DANGER

*Do not install any positive shutoff valves downstream of the Votator II unit.*

### ⚠ WARNING

*Do not allow a volume of liquid to become isolated in the jacket without relief protection. Thermal expansion created as liquid warms can generate enough force to crush tube, causing damage to internal components and drive system.*

## Suggested Media Piping for Steam

## Guidelines for Piping

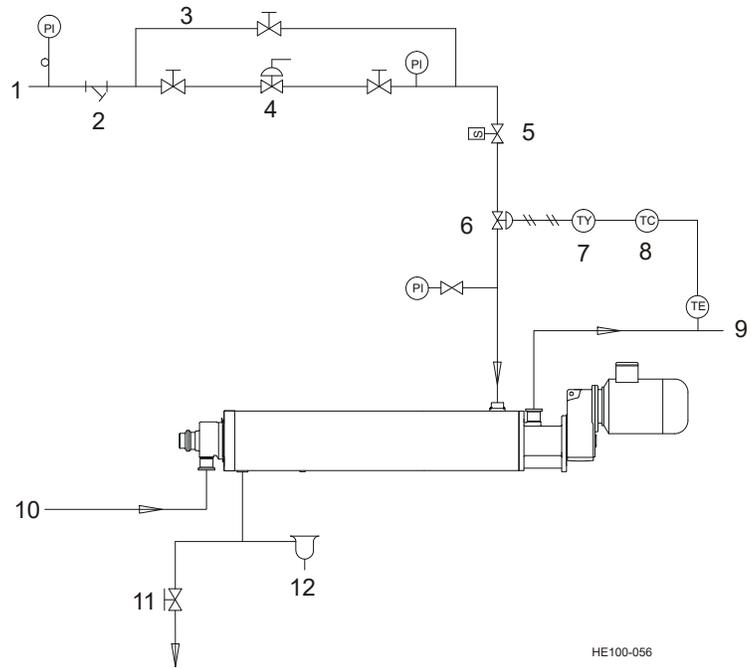
Refer to the general assembly drawings in this manual for jacket connection sizes and locations, and suggested media piping drawings.

- Support ALL piping independently.
- Provide for line expansion and contraction.
- Install a safety valve to protect jacket.
- Provide temperature indicators on both sides of Votator II unit.
- Provide pressure gauge on discharge side of pump.
- When using liquid coolant, provide a method to introduce heating media into the jacket to thaw overcooled product.
- Provide a liquid coolant system bypass line around the unit to allow the coolant system to be brought down to operating temperature without circulating coolant through the jacket.

The steam solenoid is opened, which lets pressure-controlled steam from the boiler into the jacket. A temperature sensor monitors the temperature of the product and regulates the steam flow to achieve the required temperature. Heating of the product takes place when the steam condenses into water from the transfer of heat through the jacket.

**Table 1: Call Outs For Figure 8**

1. Steam IN
2. Strainer
3. By-Pass Line
4. Steam Pressure Regulator
5. Steam Solenoid
6. Temperature Regulator
7. I/P
8. Temperature Control
9. Product OUT
10. Product IN
11. Drain Valve
12. Condensate Trap



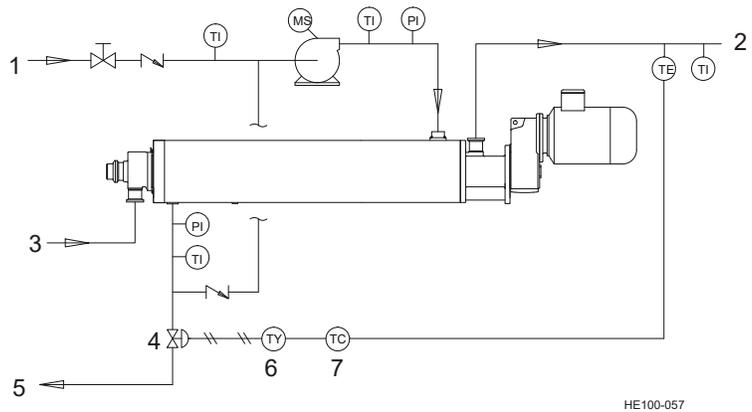
**Figure 8 - Suggested Media Piping, Steam**

### Suggested Media Piping for Water or Liquid

The media piping should flow counter-current to the product flow, and should be circulating at a rate of 50 gpm. The suggested arrangement automates the source flow to the actual heat exchange requirements to provide maximum control of the process.

**Table 2: Call Outs For Figure 9**

1. Media IN
2. Product OUT
3. Product IN
4. Temperature Regulator
5. Media OUT
6. I/P
7. Temperature Control



**Figure 9 - Suggested Media Piping, Water or Liquid**

## Refrigeration Piping Installation

### ⚠ WARNING

*Ammonia or Freon lines should be installed by fully trained and qualified Refrigeration Piping Specialists.*

### ⚠ CAUTION

*A suction trap or auxiliary receiver should be installed in the line to prevent carry-over back to compressor.*

### ⚠ DANGER

*Never install a shut-off valve on this line. Never vent or connect relief line back to suction line.*

### ⚠ CAUTION

*The relief valve is factory set for appropriate pressure and never needs adjusting.*

Analyze plant refrigeration load capacity thoroughly. The system must be sized to adequately support the additional capacity of this cylinder. All pipes must be clean and free of oil, chips and sealant residue. Excessive residue in plant piping can foul and clog cylinder refrigeration valves and components, causing costly delays in start-up. Refer to the appropriate piping schematic in this manual for Liquid Overfeed (LOF) (page 17) or Gravity Refrigeration System (page 18).

## Liquid Line Installation

The liquid line should be installed to provide a constant and steady flow of liquid. Check with system requirements and plant capacities to ensure that refrigeration piping is sized properly.

## Suction Line Installation

All Votator II refrigeration units operate best when provided with constant suction pressure. To ensure constant pressure, do the following:

- Size the suction header for at least 50% above rated capacity of cylinder.
- Do not connect to a header already in use by other equipment with widely varying loads.
- Insulate any suction line that passes through a cold room to prevent condensate formation. Install a trap or auxiliary receiver in the line.
- Keep the suction pressure at the compressor as low as possible. (Lower pressure allows greater cooling capacity.)

## Hot Gas Line (if required)

Review the following guidelines when connecting a hot gas line to the system:

- Connection of a hot gas line should be from the compressor high side of the line past an oil trap or separator, to minimize drawing in oil.
- DO NOT run line through a cold room or beside a cold suction line.
- Slope the line away from the equipment at 1/8 inch per foot (1 mm per 100 mm) minimum.
- Install a strainer or filter in addition to the recommended shut-off valves and pressure gauge.

## Pressure Relief Line

The pressure relief line MUST be exhausted to the outside of the building.

Never cap the relief line or tie it back to the suction line.

## Refrigeration Valves

### Liquid Feed Solenoid Valve

The Liquid Feed Solenoid Valve is for on/off control of liquid refrigerant flow. The valve is closed when de-energized.

### Dual Pressure Regulating Valve

The Dual Pressure Regulating Valve is shipped loose for installation in the vapor line on the discharge side of the refrigeration piping. The valve regulates high pressure for internal relief and low pressure with an on/off solenoid valve for process control. It can be furnished for manual regulating; pneumatic control with clean, dry, and oil free air from 0-60 psig; or with a 115 volt motor mounted on the regulating pilot that responds to a 4-20 milliamp electrical signal. When using air, a decrease in pressure will lower the inlet pressure, producing a lower temperature.

### Sporlan Level Master Control (LMC) or Level Switch

Gravity Systems with Accumulator are furnished with a Sporlan Level Master Control (LMC) or a Level Switch.

The LMC is a thermostatic expansion valve with a 15-watt heater element. As the level in the accumulator drops, the electrically added heat increases the pressure within the thermostatic element and opens the valve. As the liquid level rises, the electrical input is balanced by the heat transfer from the bulb to the liquid refrigerant and modulates or shuts off the liquid flow. Minor adjustments in the level response can be made by adjusting the spring tension of the expansion valve seat.

If a refrigerant level float switch is provided (single or double depending upon specifications), it is used to control the accumulator level by opening or closing a solenoid operated refrigeration valve. These systems contain that valve and an expansion valve with a flow indicating scale.

### Refrigerant Return Valve

Some Horizontal Votators have a solenoid operated Refrigerant Return Valve that is in the closed position when the solenoid is de-energized. This valve is used to stop the cooling process and is closed if hot gas is applied.

High capacity freon systems have two solenoid valves: one for hot gas to activate the return valve, the other to bleed the gas to the suction line.

## Flow Control Valves

Liquid Overfeed (LOF) or Pumped Refrigeration Systems have a manually adjusted Flow Control Valve with setting scale for refrigerant flow to each Votator cylinder. This valve maintains a constant flow of liquid to the Votator and can serve as a check valve to prevent back flow of liquid during hot gas.

The indicator scale on the valve corresponds to the refrigeration tonnage. The regulator is set by multiplying the tonnage load by the desired re-circulation rate. For example, if the refrigeration load is 10 tons and 200% (3:1) overfeed is desired, set the valve at 30 on the scale reading.

## Hot Gas Pressure Regulating Valve

Systems with hot gas include a solenoid-operated Pressure Regulating Valve for introducing and maintaining constant downstream pressure for a hot gas inlet.

Pumped Refrigeration Systems include a solenoid operated Hot Gas Purge Valve for each Votator hot gas discharge line.

### **⚠ DANGER**

*Never install a shutoff valve in a relief line.*

## Pressure Relief Valve

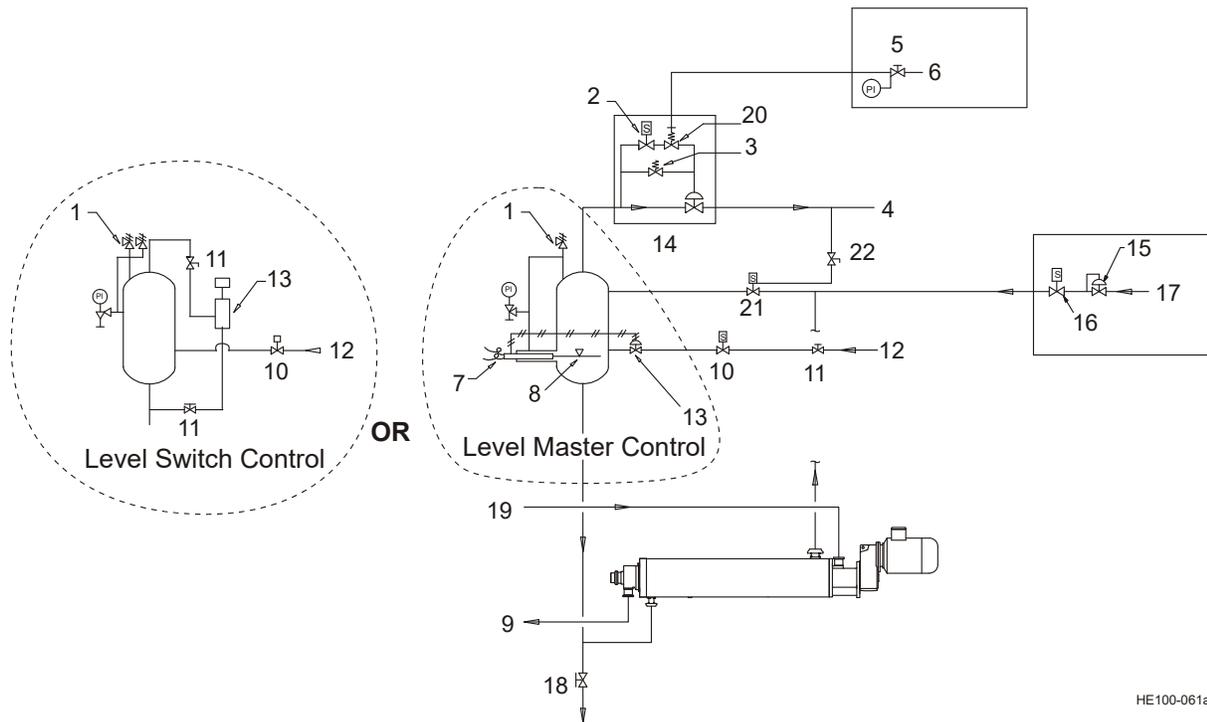
This valve is located on the accumulator and should be exhausted to outside the building. The valve is factory-set to relieve at the Votator II jacket design pressure, or the accumulator design pressure, if that is lower (some accumulators supplied in earlier years were only rated for 150 psig).



### Suggested Media Piping for Gravity Refrigeration

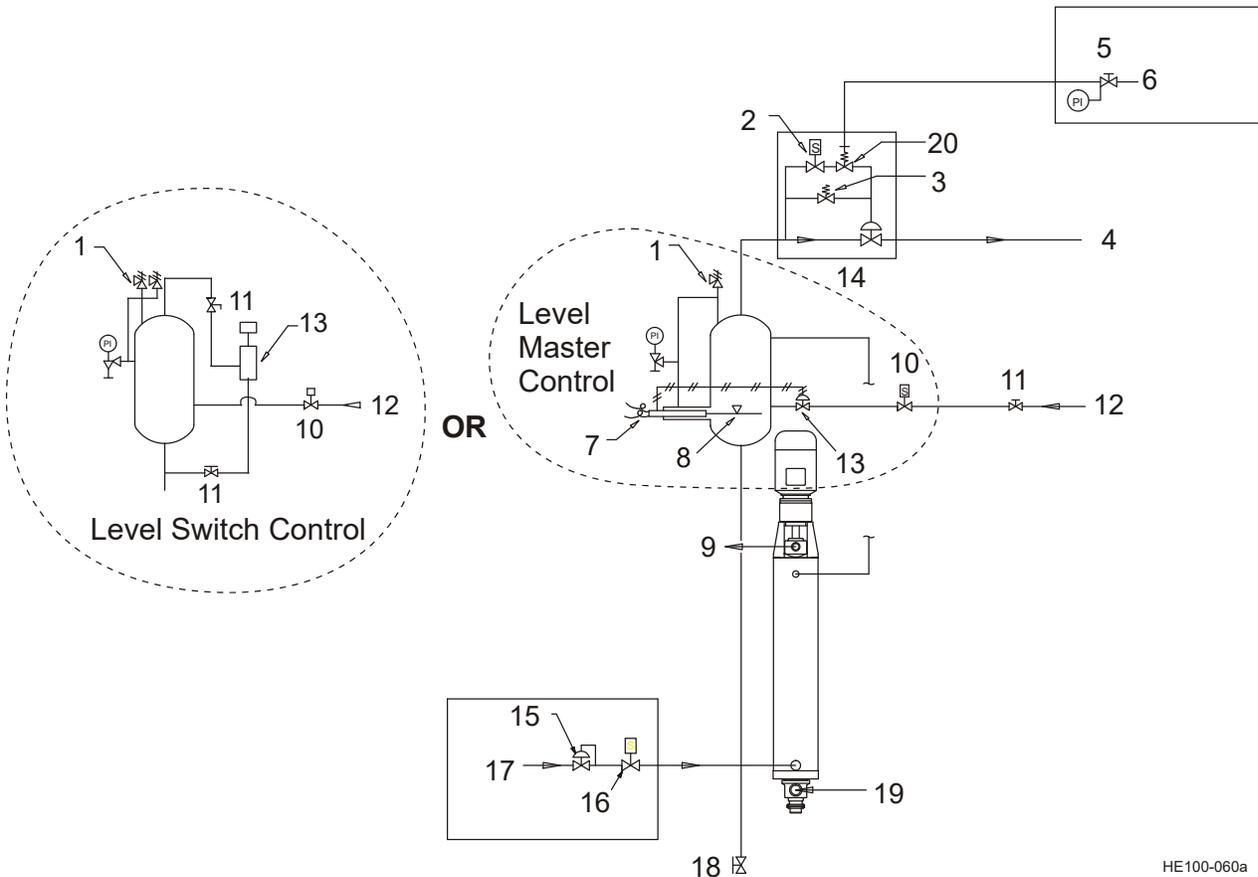
Liquid refrigerant from the receiver is stored in a surge drum located above the Votator II. The level in the surge drum is automatically controlled by the level system provided with the equipment. Gravity forces the refrigerant into the cooling jacket where it comes into contact with the heat transfer tube. The warm product causes a portion of the liquid refrigerant to change phase, causing the heat transfer tube and the product to be cooled. The cooling rate is controlled by the refrigerant back pressure, and hot gas can be used to push the liquid refrigerant from the Votator cylinder and rapidly warm the system.

**NOTE:** Set the high pressure regulating valve 5 to 10 psi higher than the outlet pressure of the hot gas pressure reducing valve and lower than the relief setting.



HE100-061a

Figure 11 - Suggested Media Piping, Gravity Refrigeration - HORIZONTAL



HE100-060a

**Figure 12 - Suggested Media Piping, Gravity Refrigeration - VERTICAL**

**Table 4: Call Outs for Figure 11 (page 18) and Figure 12**

- |  |   |
|--|---|
| 1. Safety Relief Valve (Dual)                                      | 12. Liquid Refrigerant from Low Pressure Receiver                 |
| 2. Low Pressure Solenoid Valve, see Item 14                        | 13. Level Control and Liquid Feed Expansion Valve or Level Switch |
| 3. High Pressure Regulating Valve, see Item 14                     | 14. Dual Pressure Regulating Valve (includes Items 2, 3, and 20)  |
| 4. To Low Pressure Receiver  | 15. Hot Gas Reducing Valve  |
| 5/6. Electric Control Signal or Instrument Air Regulated to 60 PSI | 16. Hot Gas Solenoid Valve  |
| 7. Level Control Heater  | 17. Hot Gas   |
| 8. Normal Operating Liquid Level                                   | 18. Drain Valve   |
| 9. Product OUT   | 19. Product IN  |
| 10. Liquid Feed Solenoid Valve                                     | 20. Low Pressure Regulating Valve, see Item 14                    |
| 11. Block Valve  | 21. Refrigerant Return Solenoid Valve (Horizontal only)           |
|  | 22. 1/4" Needle Valve with Regulating Stem (Horizontal only)      |

## Electrical Equipment

The electrical components, if furnished by SPX FLOW, Inc., are loose and require installation by the customer. The list below is keyed to the suggested wiring diagrams on the following pages and describe typical components used in analog control panels.

If a Votator PLC Control Panel was purchased for the Votator II unit, Item 3 below is furnished loose for inclusion in the Buyer's high voltage panel and Items 7 and 8 are not needed. The PLC panel for Votator II refrigeration units duplicates the control operation shown on the following pages; it serves as the operator station for the Votator II line. See the pertinent manual pages for operating instructions for the PLC panel.

ITEM	NO. of Cylinders	Qty	Description	Furnished by	
				SPX FLOW	Others
1	1	1	Cylinder Drive Motor(s)	X	
	2	2			
	3	3			
2	1	1	Motor Starters: Customer responsible for correct sizing of starter, coil, and thermal overload protection based on motor nameplate voltage, frequency, FLA's, service factor, and horsepower.		X
	2	2			
	3	3			
3	1	1	Current sensing relay and plug-in base set at motor nameplate FLA's (R-K Electronics CJD-120A-5 or equal) (Plug-in base = A-B 700-HN 125 or equal)	X	
	2	1			
	3	1			
4	1	1	Cylinder Start/Stop push buttons (Start = A-B 800H-AR1A or equal) (Stop = A-B 800H-BR6D2 or equal)		X
	2	2			
	3	3			
5	1	1	3-Position selector switch Labeled: "REFRIGERANT SYSTEM MODE" "DEFROST OFF ON" Red, push to test, pilot light Labeled: "REFRIGERANT CONTROLS ON" (A-B 800H-JR2A/800H-PRTH16R or equal)		X
	2	1			
	3	1			
6	1	1	2-Position selector switch Labeled: "VOTATOR REFRIGERATION" "OFF ON" Red, push to test, pilot light Labeled "VOTATOR REFRIGERATION ON" (A-B 800H-HR2A/800H-PRTH16R or equal)		X
	2	1			
	3	1			
7	1	1	Digital current indicator (1/8 DIN) 1.77" x 3.62" Panel Cutout Labeled: "PERCENT FULL LOAD CURRENT" (Red Lion APL-ID-400 or equal)	X	
	2	1			
	3	1			
8	1	1	Instrument transformer (Ohio Semitronics CTD-050A or equal)	X	
	2	1			
	3	1			
9	1	1	Red, push to test, pilot light Labeled: "DEFROST ON" (A-B 800H-HR2A/800H-PRTH16R or equal)		X
	2	1			
	3	1			

# Refrigeration Wiring Schematics

## Freeze Protection Components

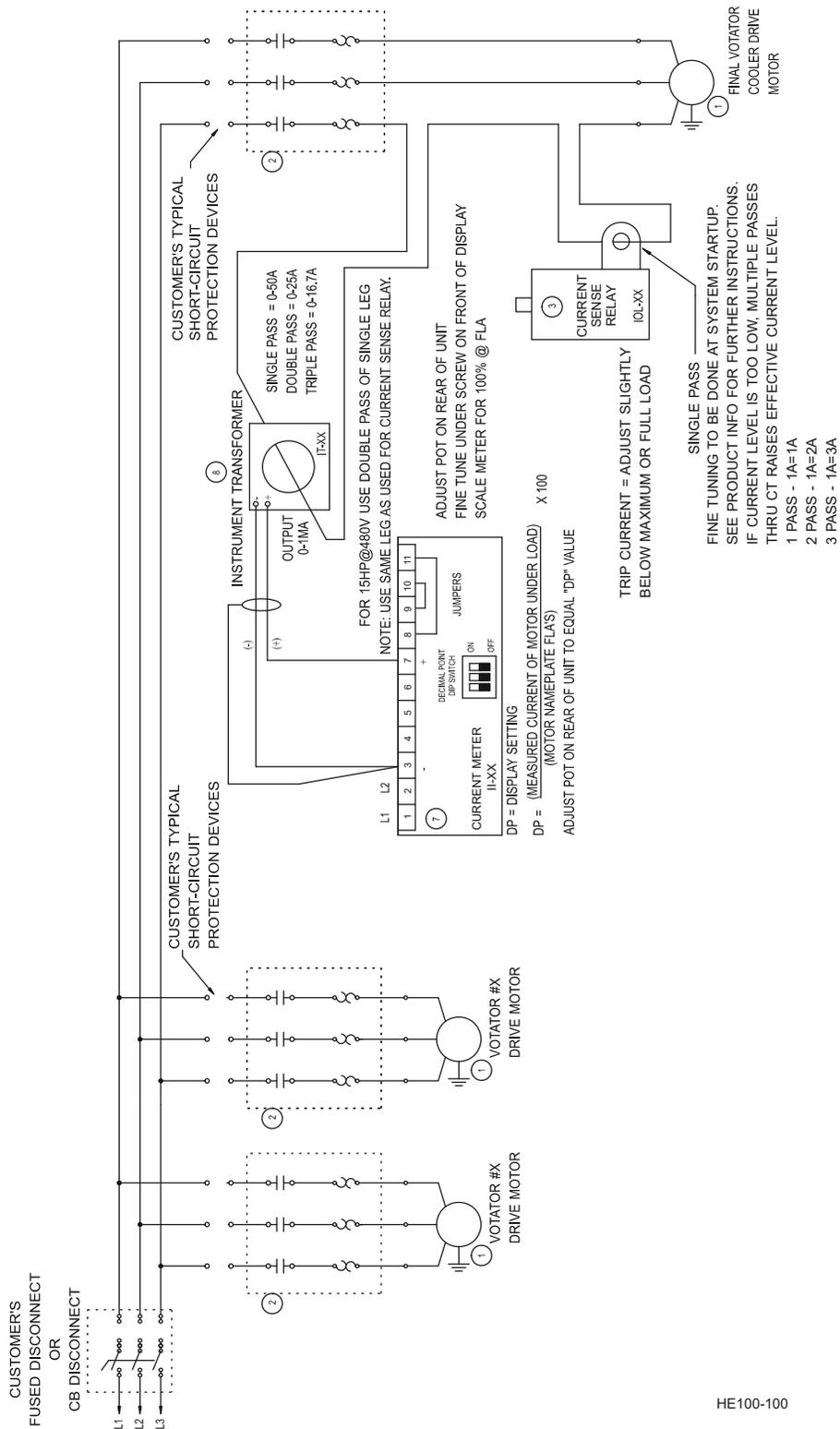
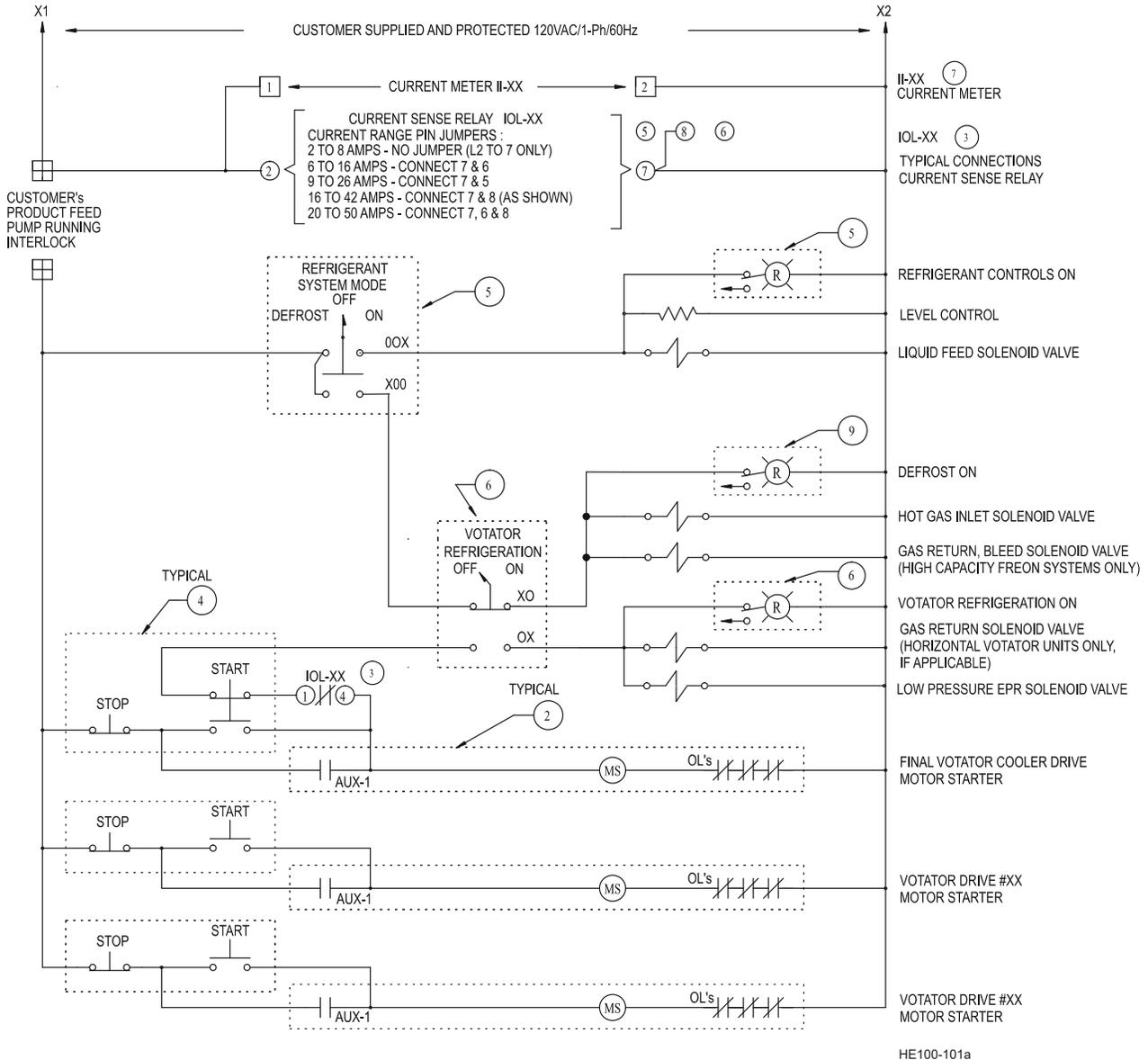


Figure 13 - Suggested Electrical Schematic - Freeze Protection Components

**Gravity Refrigeration with Level Master Control (LMC)**

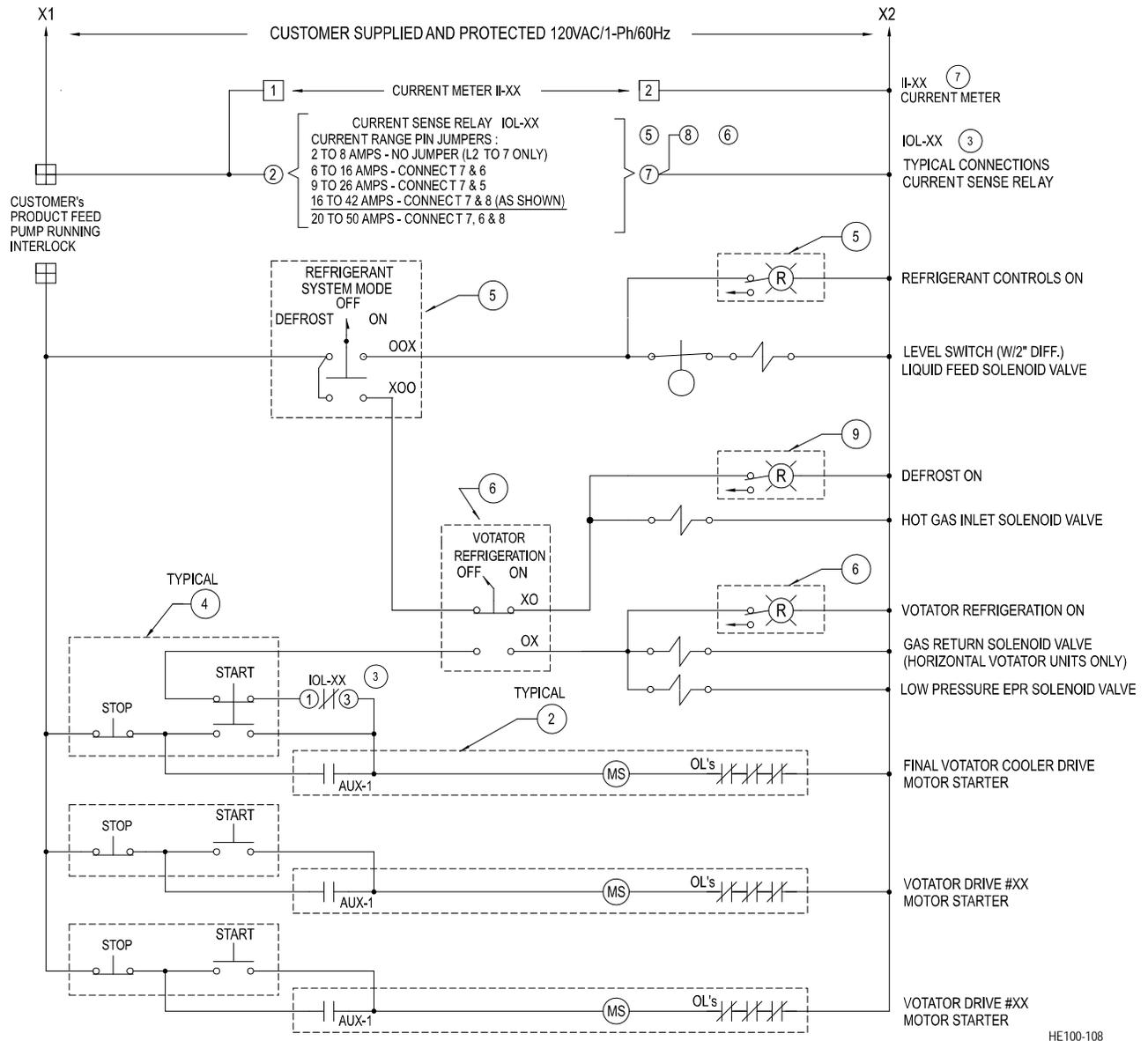
SUGGESTED WIRING SCHEMATIC FOR CONTROL CIRCUITS ONLY



**Figure 14 - Suggested Electrical Schematic - Gravity Refrigeration with Level Master Control (LMC)**

### Gravity Refrigeration with Level Switch

SUGGESTED WIRING SCHEMATIC FOR CONTROL CIRCUITS ONLY

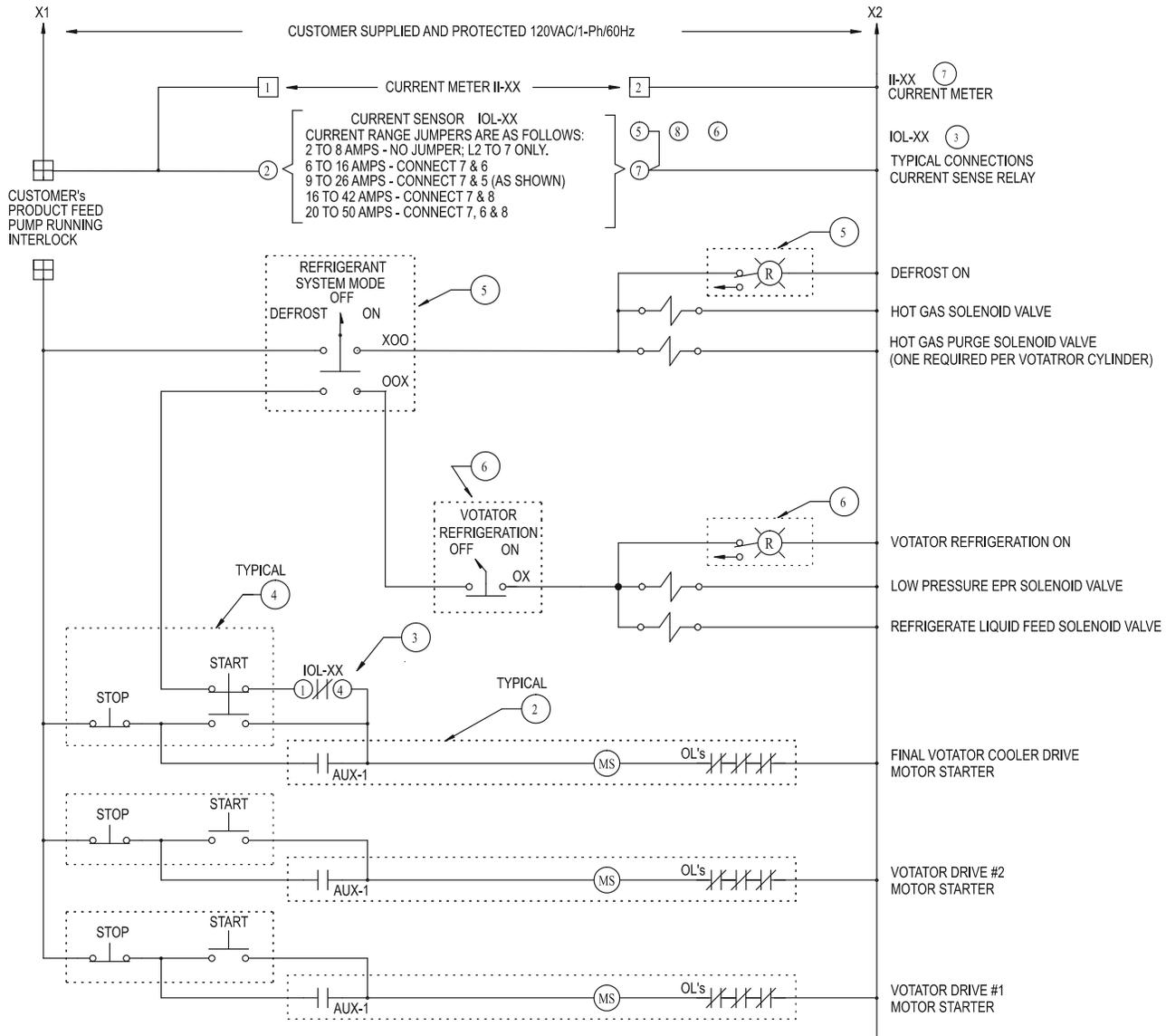


HE100-108

**Figure 15 - Suggested Electrical Schematic - Gravity Refrigeration with Level Switch**

**Liquid Overfeed Refrigeration System**

SUGGESTED WIRING SCHEMATIC FOR CONTROL CIRCUITS ONLY



HE100-102

**Figure 16 - Suggested Electrical Schematic - Liquid Overfeed Refrigeration System**

## Media System Check

### **⚠ DANGER**

Refrigeration controls should be operated and serviced only by trained and qualified personnel.

Each cylinder is tested for leaks at the factory. However, vibrations and handling during shipping can loosen piping connections. Before starting a new unit, check the system for media leaks at the Votator II cylinder, the media connections, and the piping to the cylinder, using the following procedures:

On units jacketed for steam or liquids, follow steps 1 through 6, and then drain the condensate from the cylinder.

On units jacketed for refrigeration, follow steps 1 through 6, and then pump down to remove the refrigerant.

1. If a media pressure gauge is not installed in system, install one at the media inlet of the cylinder before processing.
2. Close off the media return line from the unit.
3. Open the media inlet valve and let the pressure increase to 5 psig, then close the valve.
4. Check front, back, and all piping connections for leaks.
5. If leaks are not detected, open the inlet valve and let the system pressurize to 40 to 50 psig, then close the valve.
6. Check again for leaks at front, back, and all piping connections.

## Special Considerations for Vertical Votator II

The customer is responsible for securing the top and bottom of the pole and scrape assembly. See drawing VV0015, "Votator II Vertical Mounting Suggestions" included with this manual.

### Minimum Height - Vertical Votator II

The mounting pole with hydraulic components is assembled at the factory to provide the proper height from the floor when installed. Therefore, **never trim the pole from the bottom**. Check to be sure the cylinders will be positioned with minimum clearance to ensure that the shaft can be removed correctly. See "Clearances" on page 9.

### Mounting Pole - Vertical Votator II

Attach the post mount to the floor. (The mounting disk (Figure 17) is a stainless steel disk which serves as the base for the pole.) There is a 13/16" diameter hole through the center of the disk for mounting it to the floor. Make sure the post mount is level after installation.

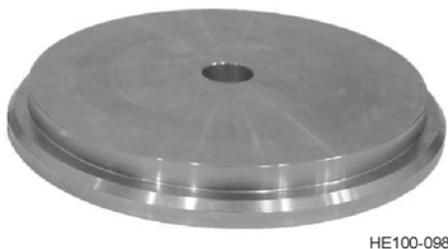
Prepare the site for attaching the top of the pole. The top of the pole can be trimmed if needed.

**NOTE:** When installing the pole, make sure the hydraulic cylinder faces toward the same side that the scrape cylinders will be mounted on.

Put the bottom of the pole over the post mount and raise it.

Attach the top of the pole to the top mounting.

**NOTE:** The pole **MUST** be vertical and plumb.



HE100-098

**Figure 17 - Mounting Disk**

## Mounting Scrape Cylinders - Vertical Votator II

Using a crane or other lift device, lift the cylinder from the pedestal (drive) end. Lifting in any other manner may damage the cylinder.

Secure the scrape cylinders in place with the four (4) stainless steel 5/8-inch bolts and lock washers provided. Maintain minimum distance between the protective cap and the floor. See "Clearances" on page 9.

## Hydraulic System - Vertical Votator II

The **Vertical** Votator II is furnished with a hydraulic cylinder, pump, motor, and fluid reservoir for removing and installing the mutator shaft and heat transfer tube.

Check all fittings and adjustments prior to use; vibrations during shipment may cause them to loosen.

### **Check and Adjust Hydraulic Cylinder**

After the heat exchanger cylinders are mounted to the pole, check to ensure the proper distance is maintained between the bottom of the hydraulic cylinder and the floor. See "Vertical Mounting Pole/Hydraulics" on page 33.

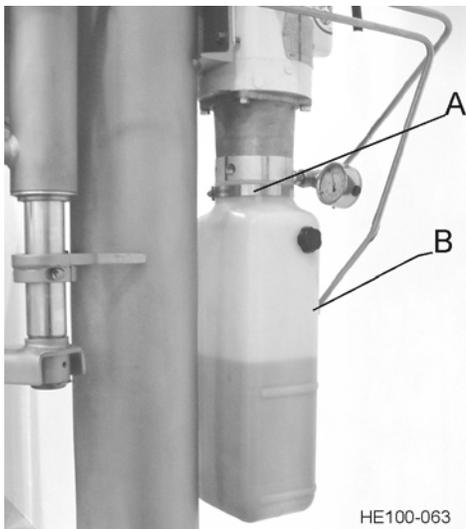
### **Fill Hydraulic Reservoir**

The system is pre-piped, but requires approximately two (2) gallons of automatic transmission fluid (Dexron III or equal), or a food-grade lubricant oil (Mobil DTE FM or equal) with a viscosity of ISO VG 32 to 68, to be added before use. Please consult the factory if it is necessary to substitute fluids.

#### **⚠ CAUTION**

*Do not mix fluid types.  
Mixing fluids will damage the equipment.*

Remove the reservoir from the pump assembly and fill it to the opening for the return line. The reservoir is sealed with an o-ring and secured by a clamp ring (See Figure 18, Item A). The pump return line (Figure 18, item B) must be removed to access the reservoir.



**Figure 18 - Removal of Reservoir**



**Figure 19 - Direction Valve**



**Figure 20 - Balance Valve**



**Figure 21 - Pressure Adjustment Screw**

### **Check Balance and Pressure Settings**

Prior to start-up, check balance and pressure settings as follows:

1. Start hydraulic pump.

**NOTE:** The hydraulic pump must be wired to an on/off switch device. Pump rotation is clockwise when viewed above motor.

2. Make sure the Direction Valve (See Figure 19 - located on the front of the unit just above the bottom product outlet) is functioning properly. It is spring loaded and is moved up for up travel of hydraulic cylinder and down for down travel.

3. Make sure the Balance Valve (See Figure 20 - located on the front of the unit, just above the Direction Valve) is set in closed position, which is fully clockwise. The valve is locked in place with a 9/16" jam nut and adjusted with a 5/32" Allen head set screw. It maintains pressure on the hydraulic cylinder when the hydraulic pump is off or in neutral position.

4. Check the hydraulic pump pressure by moving the hydraulic lift foot away from Votator II unit and running the cylinder in the full up, dead head position. At this point, it should be adjusted for a gauge reading of 300 to 400 psig at the pump.

5. The pump pressure control (See Figure 21, Item A) should be set to approximately 4-1/2 turns open in the counterclockwise direction from the closed position. This adjustment controls the system pressure and is at maximum when the setscrew is in the closed or full clockwise position. It is adjusted by a 3/16" Allen head set screw and locked by a 9/16" jam nut.

### **Gravity Refrigeration System - Vertical Votator II**

The Gravity Refrigeration System includes the following items that must be installed:

- Accumulator
- Media piping
- Valves

The accumulator, refrigeration piping, and valves are shipped loose for field installation, as shown in the drawing titled Vertical Refrigeration System located in the addendum section and Votator II Vertical Refrigeration System drawing on page 19 showing the Process Flow Diagram of the Vertical Refrigeration System. It is necessary to install these components on-site to ensure that the refrigeration system will mate properly with the Votator II cylinders.

A crane, or other lift device, is needed to lift the accumulator mounting bracket in place for installation. Lift the mounting bracket in place with a sling. Bolt the accumulator to the pole.

To simplify installation, piping is provided in three modules:

- the accumulator to the lower manifold
- the lower manifold to the cylinder flange
- the upper manifold to the accumulator

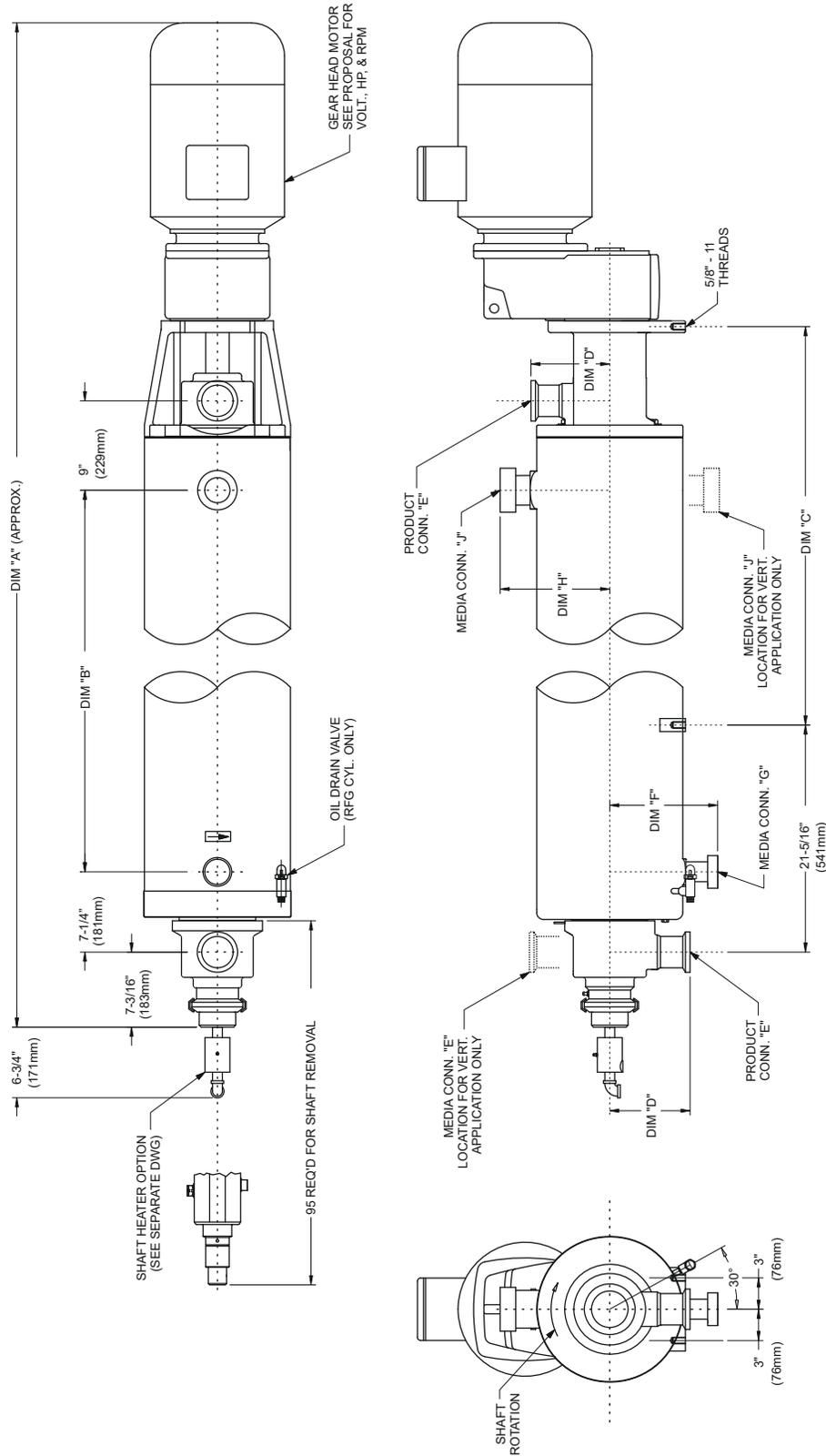
Also included are an elbow for the top of the accumulator and piping legs for connecting the modules.

The refrigeration valves and level control are packed and shipped separately. Install these components and the piping sections in accordance with the referenced drawings. A leak test **MUST** be performed after all welding is complete.

After a leak test has been successfully completed, the system piping should be coated with a paint formulated for corrosion resistance.

# Typical Dimensional Data and Hydraulic Lift System

## Votator II General Assembly



CYLINDER	DIM "F"	CONN. "G"	DIM "H"	CONN. "J"
RFG	10-1/2" (267mm)	1-1/2" RFG FLANGE	10-1/2" (267mm)	2-1/2" RFG FLANGE
LIQUID	7-5/16" (186mm)	1-1/2" FPT	8-1/4" (210mm)	1-1/2" FPT
STEAM	7-5/16" (186mm)	1-1/2" FPT	8-1/4" (210mm)	1-1/2" FPT

PRODUCT CONN.	DIM "D"
3" I-LINE CONN. "E"	7-11/16" (195mm)
3" FLANGED CONN. "E"	8-1/4" (210mm)

CYLINDER	DIM "A"	DIM "B"	DIM "C"
6 x 24	67-3/8" (1710mm)	13-1/8" (330mm)	22-3/16" (560mm)
6 x 36	83-9/16" (2122mm)	23-7/8" (606mm)	25-1/2" (648mm)
6 x 48	95-9/16" (2427mm)	35-7/8" (911mm)	37-1/2" (952mm)
6 x 72	119-9/16" (3037mm)	59-7/8" (1521mm)	61-1/2" (1562mm)
6 x 84	131-9/16" (3342mm)	71-7/8" (1826mm)	73-1/2" (1867mm)

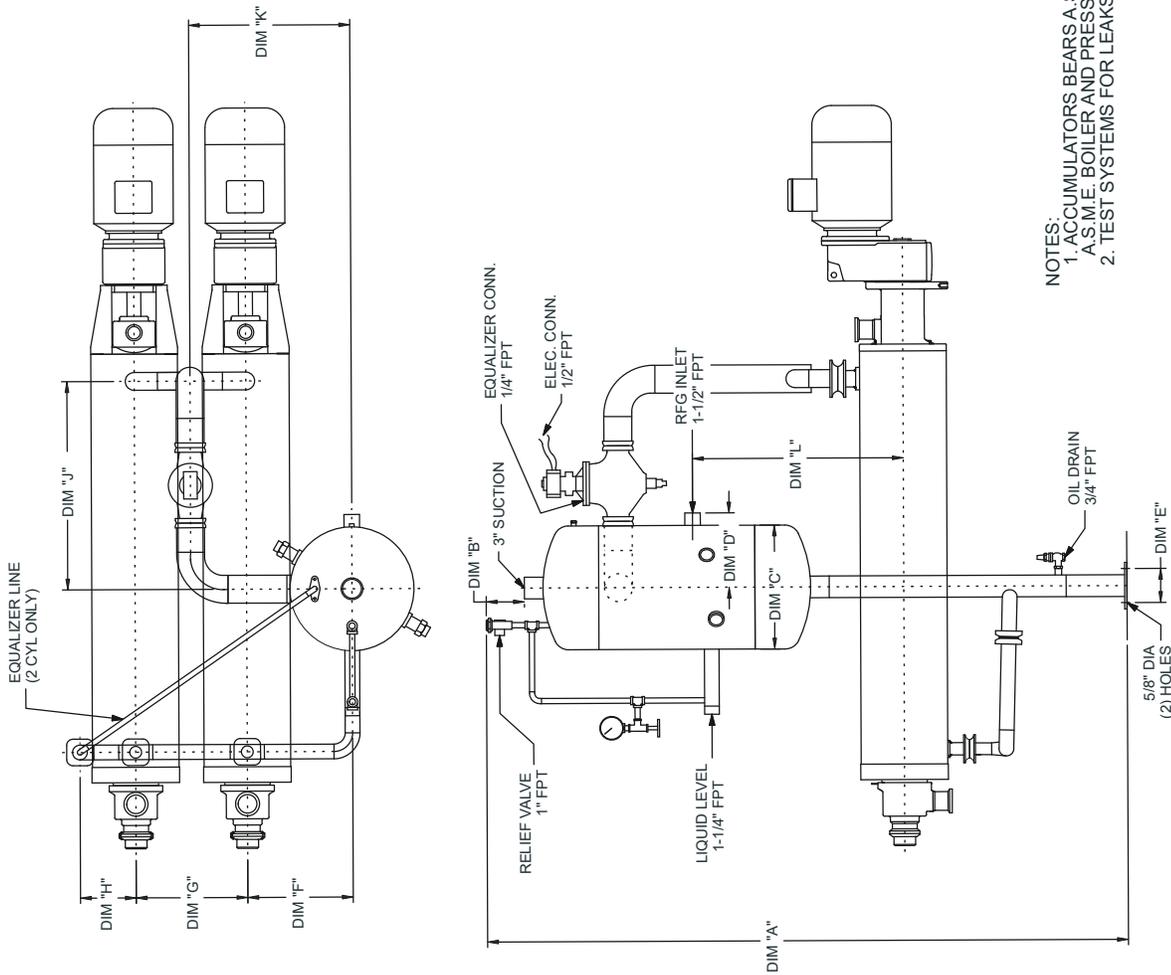
HE100-050

## Votator II General Assembly

\*Dimensions will vary slightly depending on type of motor horsepower.

Horizontal Refrigeration Assembly

NUMBER OF CYLINDERS	1	2
DIM "A"	96" (2438mm)	104" (2642mm)
DIM "B"	6-7/8" (175mm)	6-3/16" (171mm)
DIM "C"	16" (406mm)	20" (508mm)
DIM "D"	10" (254mm)	12" (305mm)
DIM "E"	4" (102mm)	5-1/2" (140mm)
DIM "F"	16" (406mm)	17" (432mm)
DIM "G"	NA	18" (457mm)
DIM "H"	NA	9" (229mm)
DIM "J"	26" (660mm)	33-5/8" (854mm)
DIM "K"	16" (406mm)	26" (660mm)
DIM "L"	32-1/2" (825mm)	34" (864mm)
MIN. RFG CHARGE	2 CU FT (57 L)	5 CU FT (142 L)
APPROX WEIGHT	450 LB (204 KG)	650 LB (295 KG)

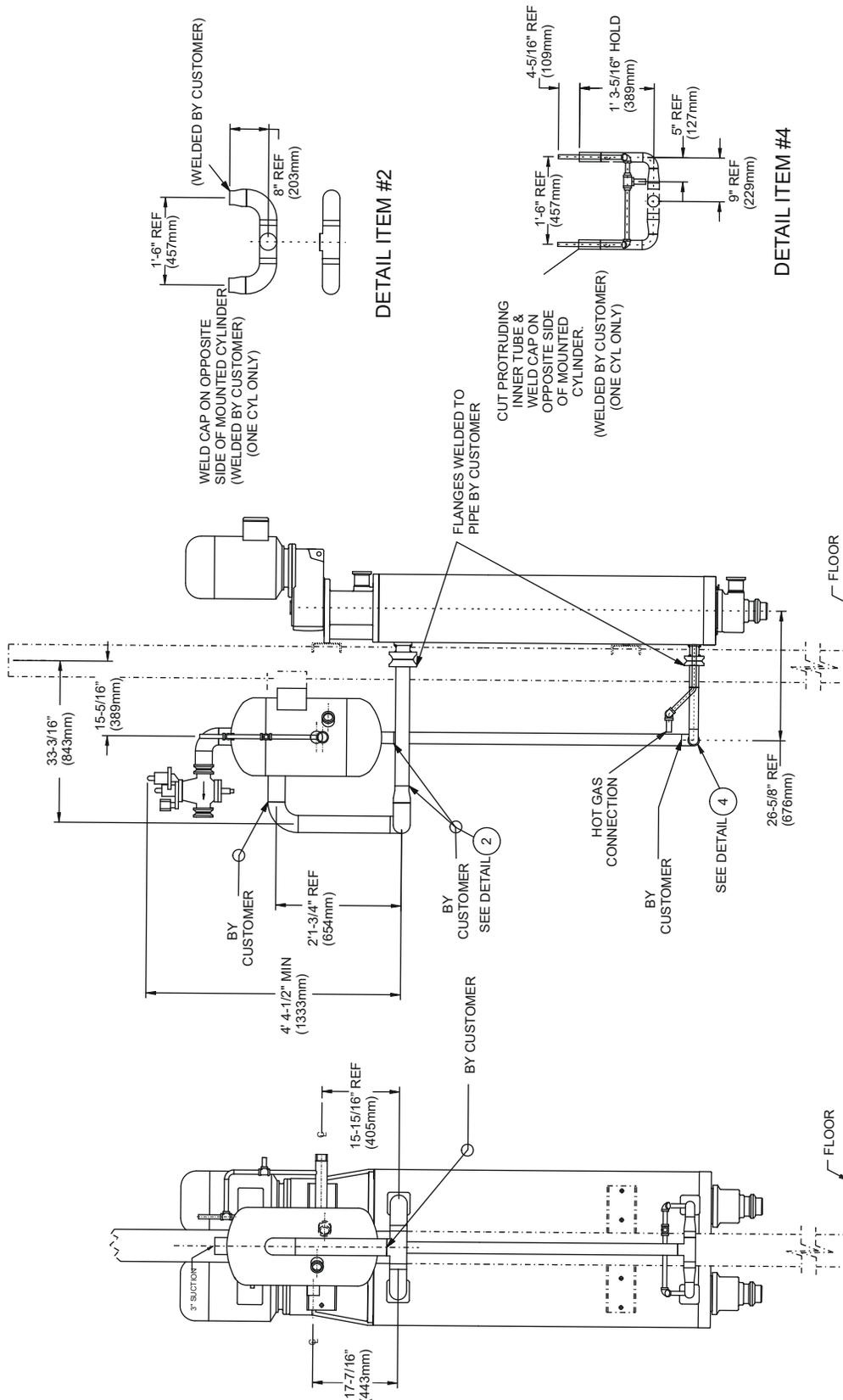


NOTES:  
 1. ACCUMULATORS BEARS A.S.M.E. STAMP FOR COMPLIANCE WITH A.S.M.E. BOILER AND PRESSURE VESSEL CODE.  
 2. TEST SYSTEMS FOR LEAKS WITH AMMONIA GAS AT 75 PSI (5.2 BAR).

Votator II Horizontal Refrigeration Assembly

HE100-048

Vertical Refrigeration System



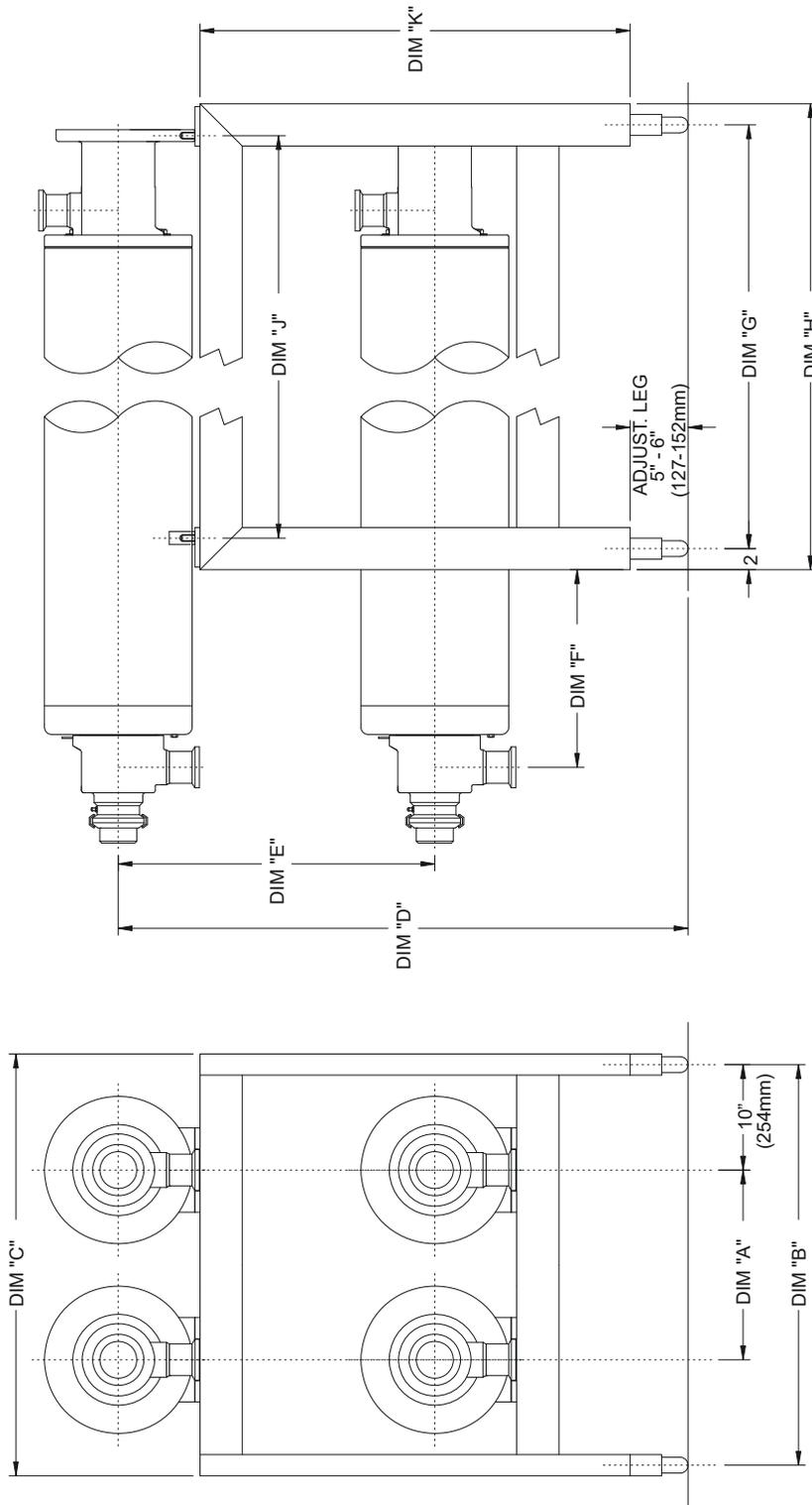
NOTES:  
 ACCUMULATORS BEARS A.S.M.E. STAMP FOR COMPLIANCE WITH  
 A.S.M.E. BOILER AND PRESSURE VESSEL CODE.

NUMBER OF CYLINDERS	1	2
MIN. RFG CHARGE	2 CU FT (57 L)	3.5 CU FT (99 L)
APPROX WEIGHT 6 x 72	450 LB (204 KG)	650 LB (295 KG)

Votator II Vertical Refrigeration System

HE100-046

Horizontal Frame Options



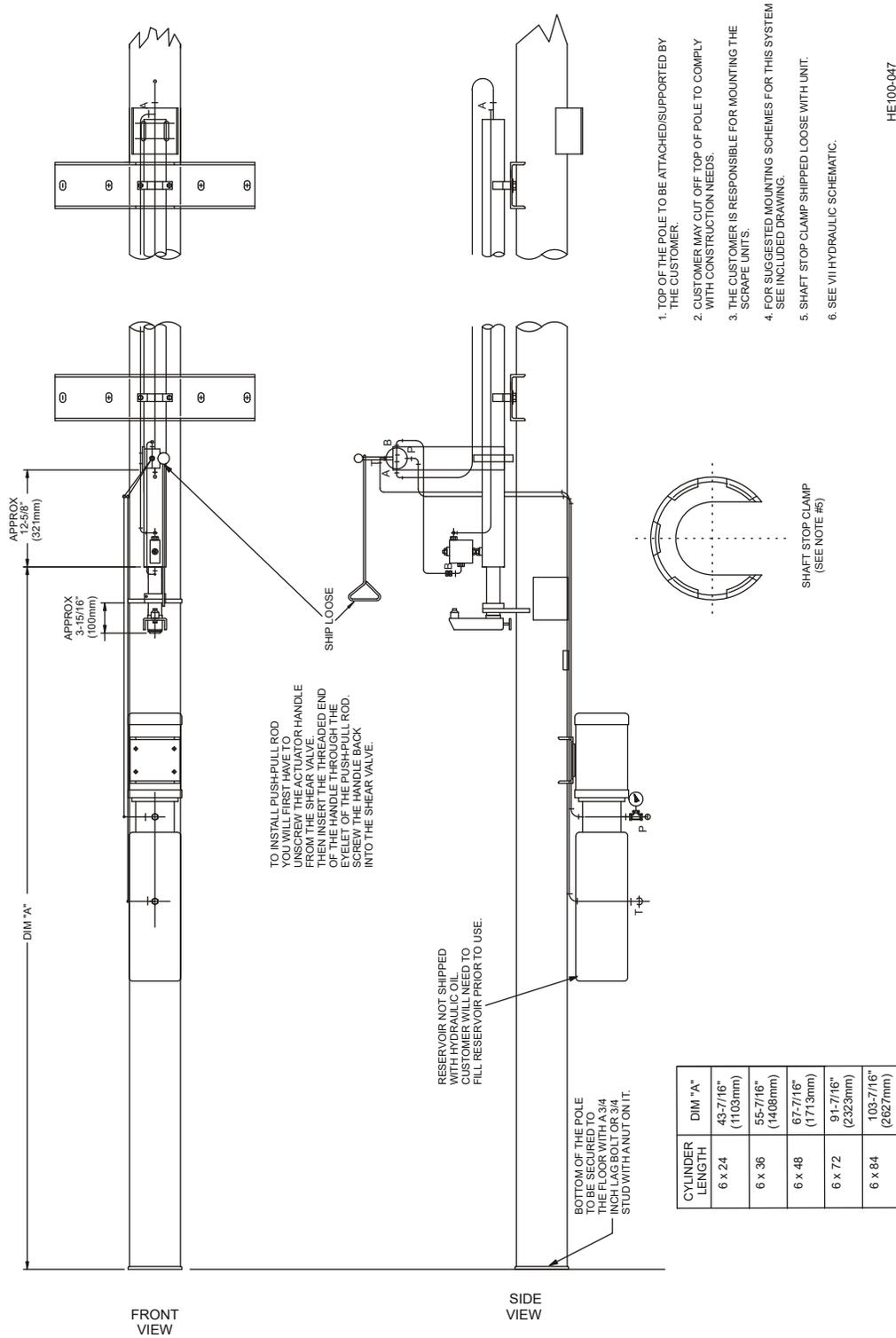
CYLINDER LENGTH	DIM "F"	DIM "G"	DIM "H"	DIM "J"
6 x 24	3-1/2" (89mm)	32" (813mm)	36" (914mm)	25-1/2" (648mm)
6 x 36	14-1/4" (362mm)	32" (813mm)	36" (914mm)	25-1/2" (648mm)
6 x 48	18-3/4" (476mm)	39-1/2" (978mm)	43-1/2" (1105mm)	37-1/2" (952mm)
6 x 72	18-3/4" (476mm)	63-1/2" (1613mm)	67-1/2" (1715mm)	61-1/2" (1562mm)
6 x 84	24-3/4" (629mm)	75-1/2" (1918mm)	79-1/2" (2019mm)	73-1/2" (1867mm)

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FRAME CONFIGURATION	DIM "A" (BETWEEN CENTERS)	DIM "B"	DIM "C"	DIM "D"	DIM "E" (BETWEEN CENTERS)	DIM "K"
1 CYL	NA	20" (508mm)	22" (559mm)	36" (914mm)	NA	22-3/4" (578mm)
2 CYL (SINGLE ROW)	18" (457mm)	38" (965mm)	40" (1016mm)	36" (914mm)	NA	22-3/4" (578mm)
2 CYL (1 OVER 1)	NA	20" (508mm)	22" (559mm)	54" (1372mm)	30" (762mm)	40-3/4" (1035mm)
3 OR 4 CYL (2 OVER 2)	18" (457mm)	38" (965mm)	40" (1016mm)	54" (1372mm)	30" (762mm)	40-3/4" (1035mm)

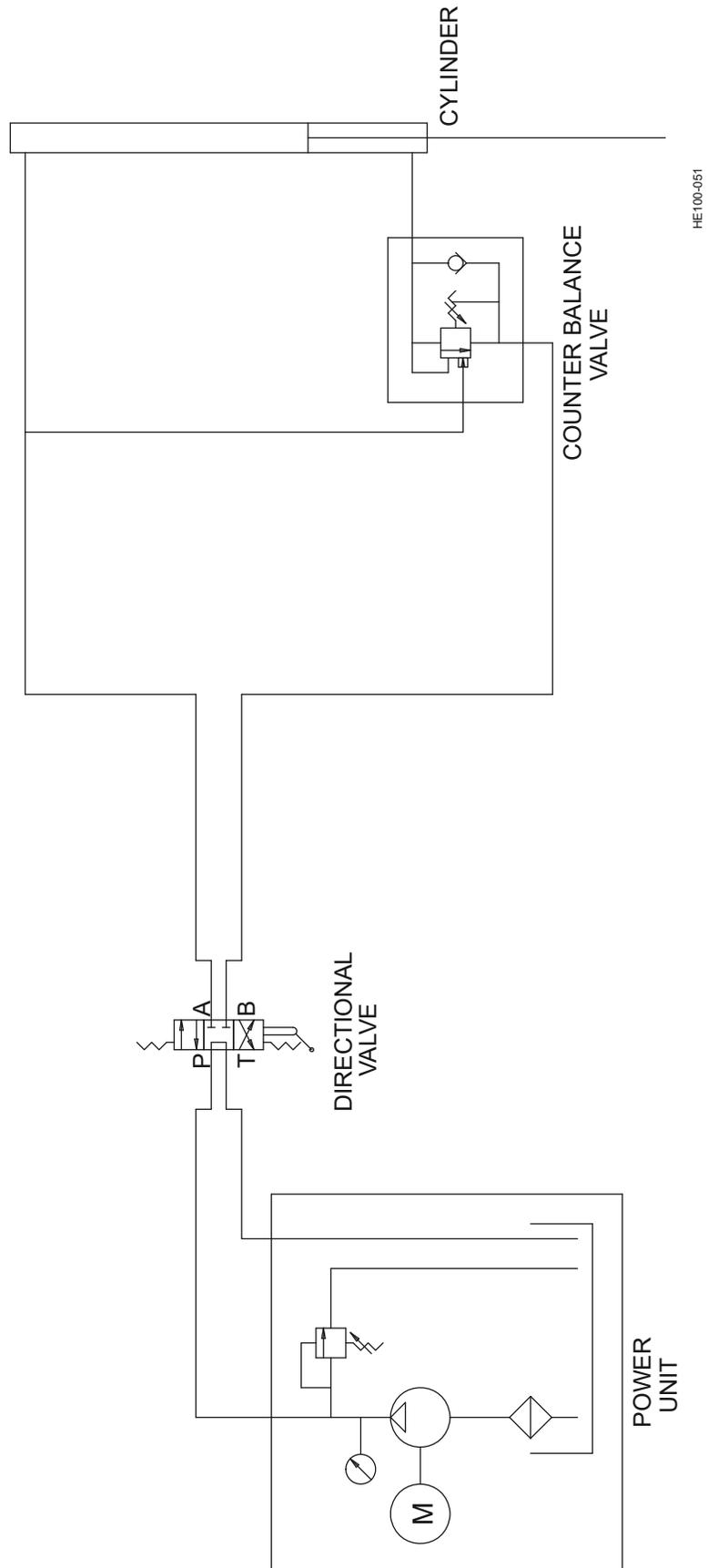
Votator II Horizontal Frame Options

### Vertical Mounting Pole/Hydraulics



### Votator II Vertical Mounting Pole/Hydraulics

Vertical Hydraulic Schematic



## Operation

### Pre-Startup Check

These instructions are general and should be used only as a guide. It may be necessary to modify them to conform to actual in-plant requirements. Changes should be documented by plant personnel.

Before starting the Votator II, perform the following system checks:

#### **▲ WARNING**

*Do not operate equipment without guards and interlocks properly installed.*

- Check that the Votator II is properly assembled. All product connections, and heating/cooling media connections should be assembled and tight.
- If steam or water flush is required for mechanical seals, open the supply valve and set the pressure and flow rate.
- Momentarily start the motor (1-3 seconds) to determine if the shaft is rotating. If the shaft is not rotating, turn off power to the motor and determine why the shaft will not turn.
- Check the heating/cooling media to determine if the temperature and pressure are at required values and that there is an adequate supply of heating/cooling media.
- Check to determine if product is available and pressures are at the required values.

#### **For Refrigeration Units Only**

- Check that the main suction line is fully open.
- Check for proper compressor back pressure.
- Open the liquid refrigerant supply valve, turn the system refrigerant on and verify that the accumulator is full to float level.

### Pre-production Run Setup

#### **▲ CAUTION**

*The Votator II has not been passivated as part of the manufacturing process. If the heat transfer tube is chrome-plated nickel, **DO NOT expose it to acid or acid cleaners.***

**NOTE:** *The following steps are not applicable to aseptic units, which require special sterilization procedures.*

Before running product, sterilize the interior of the Votator II heat exchanger tube, mutator shaft, heads, and product piping leading to the unit.

Use sanitizing solution compatible with the materials of the Votator II. If a chlorine solution is used, it must not exceed 50 ppm at 75°F (24°C) and surface contact must be limited to 10 minutes.

### Startup Procedure

Startup summary liquid/steam
Establish seal flush flow (if required)
Check media availability
Start product or water flow
Start mutator shaft
Establish operating pressure (if required)
Admit steam/coolant flow
Switch to product flow (if necessary)
Adjust media for desired product temperature
Redirect product flow (if necessary)

startup summary refrigeration
Establish seal flush flow (if required)
Turn refrigerant "ON"
Start product or water flow
Start mutator shaft
Establish operating pressure (if required)
Turn cylinder refrigeration "ON"
Adjust refrigeration PSIG
Adjust media for desired product temperature
Redirect product flow (if necessary)

### Heating/Liquid Cooling Applications

1. Start the product pump using product or compatible liquid, such as water.
2. After the product flow is established, start the Votator II mutator shaft motor. **Do not run the Votator II without product flow.**
3. Establish operating pressure.

**NOTE:** Maintain an operating pressure that will result in desired product characteristics. In heating applications; operating pressure should be at a minimum of 15 pounds above jacket steam pressure. This will eliminate internal boiling and fouling of the product side of the heat transfer cylinder.

4. Gradually admit dry, saturated steam or coolant to reach system operating temperature. For steam units, open the steam valve and immediately open the bypass valve at the trap to drain condensate. Close the bypass valve after all condensate is drained.
5. If running material other than product, switch to product and adjust to desired processing rate.
6. When operating conditions have been reached, redirect the product to the desired out-flow point.

### Refrigeration Applications - Pumped and Gravity Systems

1. Start the product pump using product or compatible liquid, such as water.
2. After product flow is established, start the Votator II mutator shaft motor. **Do not run the Votator II without product flow.**
3. Turn the cylinder refrigeration "on."
4. Adjust the back pressure control valve on the accumulator to approximately 20 psig above normal operating pressure.
5. Gradually reduce the setting on the back pressure control valve to obtain proper product temperature.
6. If running material other than product, switch to product and adjust to desired processing rate.
7. When operating conditions have been reached, redirect the product to the desired out-flow point.

## Shutdown Procedure

### ⚠ CAUTION

*The steam or refrigeration supply valves must be shut off BEFORE stopping product flow. Failure to do this could result in product burn-on or freezing in heat exchanger cylinders.*

These instructions are general and should be used only as a guide. It may be necessary to modify them to conform to actual in-plant requirements. Changes should be documented by plant personnel. Emergency Shut-Down procedures should be documented by plant personnel after assessing system-wide requirements.

Where product characteristics permit, shut off the mutator shaft, media flow and the pump. Otherwise, it may be necessary to heat or cool the product to ambient temperature to avoid burn-on or freeze-up.

In instances where the product goes to a filler, it may be necessary to provide a surge tank or a recirculation line.

With continuous operations, a steam line connected to the product line can enable steam to soften and remove product in the tube at shut down.

The final option is to have hot water chase product from the tube at the end of the run.

## Preventing Tube Scoring

Scoring of the heat exchanger tube can have many causes. The most common are temperature extremes, material problems in the heat exchanger tube, or units operated without product or CIP flow.

The following suggestions will help prevent tube scoring:

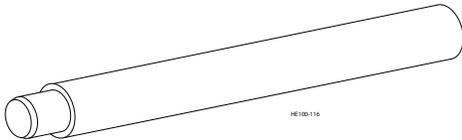
- Do not pump cold product into a unit that is still hot from cleaning (this can cause temporary bowing of the tube). Wait until the tube has cooled before running cold product.
- Do not leave sterilizing water or solution in the tube after sterilization is complete. Drain the tube completely of sterilizing water or solution. Fill the tube with product prior to starting.
- Make sure that condensate is drained completely in BWS cylinders. The steam trap must be large enough to carry away all condensate.

## Maintenance

### Routine Maintenance - Horizontal Votator II

(For Vertical Votator II, see page 39)

1. Tools required:
  - Rubber or plastic mallet
  - Large adjustable wrench (2-3/8 inch) or SPX FLOW model 79-2 Sanitary Wrench for removing the shaft locknut
  - Two adjustable or open-end wrenches (15/16 inch) for removing the bearing clamp on the non-driven head
  - One 3/8 inch nut driver and one common screwdriver for removing the shaft guard on the drive end
  - One small common screwdriver for removing the keeper o-ring on the seal
  - Head Removal Tool (HRT), part number LL121191. (See Figure 22.)
2. Lock out power.
3. Drain product piping and disconnect.
4. Loosen the latch on the bayonet lock and disengage the head by rotating it clockwise.
5. Lift the head and pull the assembly out about 1 inch, and rest the shaft on the heat transfer tube.
6. Remove the hinged clamp and bearing cap.
7. Remove the shaft locknut (**left hand threads**).
8. Insert the Head Removal Tool (HRT) through the bearing and into the threaded end of the shaft, then slide the head over the tool so that the seal face is past the end of the shaft. Grasp the end of the tool and the head and carry it to a table or other stable work surface for further maintenance if needed.
9. Insert the plastic shaft skid in the unit, install it on top and rotate the shaft so the skid is under the shaft. Remove both the shaft and skid from the unit. Place them on a table or cradle.
10. Remove the product head on the drive end (if required) by removing the shaft guard held in place by four bolts. Rotate the head counter-clockwise to disengage it. Check the condition of the o-ring in the head before reinstalling it.
11. The mechanical seals are the same on top and bottom, and if servicing is required:
  - Remove the keeper o-ring and all seal components, seal body with seal ring, backing ring, u-cup and wavy spring. If it is a double mechanical seal, the secondary seal and spring must be removed before disassembling the primary seal.
  - Inspect the o-rings and seal faces for scratches or cracks. If the seal parts require replacement, refer to pages 57 and 76 or pages 58 and 72.



**Figure 22 - Head Removal Tool**

#### ⚠ CAUTION

*Failing to use the Head Removal tool can result in damage to the seal face. Use of the HRT prevents chipping the stationary seal face on the end of the shaft during removal or replacement of the head.*

- When assembling the **single mechanical seal**, place the wave spring on the shaft, followed by the seal backing ring and the u-cup, with the opening of the cup facing the body of the shaft. Position the seal body and install the keeper o-ring.
  - When assembling the **double mechanical seal**, place the wave spring on the shaft and then the seal body with o-ring. Position the seal body and install the keeper o-ring, followed by the secondary seal and wave spring.
  - Check all seal assemblies to verify that they are locked in position by the drive pins and that they can be easily compressed.
12. Inspect the condition of the scraper blades and replace them if necessary. Install the new blades while the shaft is on the cradle or table, attaching two rows of scraper blades on the top of the mutator, and place the shaft skid over the blades. Turn the mutator and shaft skid over so that the skid is on the bottom of the table or cradle, and install the other two rows of blades on top. **Always install blades with the flat side up.**
  13. Apply anti-seize compound to the drive end splines and the next 3 inches of stub shaft length.
  14. Use the shaft skid to slide the mutator in the heat exchanger cylinder and lift up the mutator slightly to remove the shaft skid.
  15. Check the condition of the o-ring in the product head and lubricate it lightly. Replace the bearing in the product head if necessary. **Make sure the grease ring on the bearing is facing the product side of the head.** Insert the HRT into the end of the shaft. Slide the bearing race over the tool and onto the shaft to protect the stationary seal face during assembly.
  16. Seat the bearing in the head, using a plastic mallet, if required.
  17. Install the shaft locknut and bearing cap, position the product head over the bayonet ring and turn it counter-clockwise. Close the locking latch.
  18. Grease the bearing. (Not required for Extra Heavy Duty Votator II.)

## Routine Maintenance - Vertical Votator II

1. Tools required:
  - Rubber or plastic mallet
  - Large adjustable wrench (2-3/8 inch) or SPX FLOW model 79-2 Sanitary Wrench for removing the shaft locknut
  - Two adjustable or open-end wrenches (15/16 inch) for removing the bearing clamp on the non-driven head
  - One 3/8 inch nut driver and one common screwdriver for removing the shaft guard on the drive end
  - One small common screwdriver for removing the keeper o-ring on the seal
2. Lock out power.
3. Drain product piping and disconnect.

4. Position hydraulic lift foot under bottom product head.
5. Loosen the latch on the bayonet lock and disengage the head by rotating it clockwise.
6. Lower the mutator shaft to the floor with the hydraulic cylinder.
7. Check the conditions of the scraper blades and replace if necessary. Service the top mechanical seal, if required.  
**Blades are installed with the flat side facing out.**
8. If the lower mechanical seal needs servicing, remove the shaft and head from the lift cradle, or remove two scraper blades from the mid section of the mutator shaft and raise the mutator shaft so that the center of one set of blade pins is positioned in the middle of the bayonet ring.
9. Install the shaft lock clamp and secure with the locking latch.
10. Lower the hydraulic cylinder so that the clamp supports the mutator.
11. Remove the hinge clamp and bearing cap.
12. Remove the shaft lock nut (**left hand threads**) while firmly supporting the product head and carefully removing it from the mutator shaft.
13. The mechanical seals are the same on top and bottom, and if servicing is required:
  - Remove the keeper o-ring and all seal components, seal body with seal ring, backing ring, u-cup and wavy spring. If it is a double mechanical seal, the secondary seal and spring must be removed before disassembling the primary seal.
  - Inspect o-rings and seal faces for scratches or cracks. If the seal parts require replacement, refer to pages 57 and 76 or pages 58 and 72.
  - When assembling the **single mechanical seal**, place the wave spring on the shaft, followed by the seal backing ring and the u-cup with the opening of the cup facing the body of the shaft. Position the seal body and install the keeper o-ring.
  - When assembling the **double mechanical seal**, place the wave spring on the shaft and then the seal body with o-ring. Position the seal body and install the keeper o-ring, followed by the secondary seal and wave spring.
  - Check all seal assemblies to verify that they are locked in position by the drive pins and that they can be easily compressed.
14. To remove the top product head, remove the shaft guard held in place by four bolts, and rotate the head counter-clockwise to disengage it. Check the condition of the o-ring in the head before reinstalling it.
15. Check the condition of the o-ring in the product head, lubricate it lightly, and carefully place the head with the bearing on the mutator shaft. **The grease ring on the bearing should be facing the product side of the head.**

16. Seat the bearing in the head using a plastic mallet, if required, and install the shaft locknut and bearing cap.
17. Apply anti-seize compound to the drive end splines and the next 3 inches of stub shaft length. Place the shaft and head back into the lift cradle if necessary.
18. When installing the mutator shaft in the unit, carefully guide the blades in the cylinder while the mutator is raised. It may be necessary to turn the mutator shaft slightly to align the spline in the motor drive.

**⚠ WARNING**

*To avoid injury, the same person should operate the hydraulic controls and guide the mutator shaft.*

19. Rotate the product head counter-clockwise to engage the bayonet lock, and close the locking hatch.
20. Grease the bearing. (Not required for Extra Heavy Duty Votator II.)

**Scheduled Maintenance**

The following table is provided only as a guideline. It may be necessary to modify the schedule to conform to actual in-plant requirements. All changes should be documented by plant personnel.

**Table 5: Table of Scheduled Maintenance**

Frequency	Component	Suggested Service
<b>Weekly</b>	Mutator Shaft Bearing	Lubricate each fitting with a handgun, approximately three shots. Use a suitable NLGI Grade-2 bearing grease. (Not required for Extra Heavy Duty Votator II.)
	Shaft Assembly	Remove shaft assembly at least once a week. Always use the removal trough skid to avoid bottom blades scoring the heat transfer tube. Replace the mechanical seal shell o-rings.
	Product Tube	Inspect the tube's inner chrome surface to be sure it is smooth and bright. If rough areas, marks or chrome plating deterioration exist, locate and correct the cause. Replace the tube, if necessary.
	Scraper Blades	Examine scraper blades weekly, or after 40 operating hours. Based on amount of wear, establish service frequency.
		Maintain blades in good condition for longest machine life and best production rates. Reserve a complete set of spare blades for routine replacement. Worn or rough blades reduce heat transfer and can damage the heat transfer tube.
	Jacket/ Accumulator	Purge gathered oil from accumulator section of accumulator jacket. If refrigerant charge is dumped from accumulator daily, oil is carried back with it.
<b>Monthly</b>	Inlet and Outlet Fittings	Replace o-rings on inlet and outlet fittings monthly, or more frequently as needed.
	Gear motor	Check oil level and add as required.
<b>Semi-Annually</b>	Refrigerant	Inspect for oil and/or contaminants.
	Flange o-rings	Replace o-rings at least every 12-18 months.

## Preventive Maintenance

- Correct problems as soon as they are discovered.
- Inspect equipment frequently following changes in product formulation, processing conditions or CIP regimen.
- Always note and report any abnormal or unusual conditions.
- Follow a regular preventive maintenance schedule. Many factors determine the interval required for scheduled servicing. The severity of the application and the time between scheduled shutdowns are two of the most significant.

When new units are first put into service, they should be disassembled after each production run and inspected for any obvious wear patterns. These initial inspections will establish a process history, as well as provide a basis for establishing a preventive maintenance schedule. Inspections should focus primarily on tube, shaft, blade and seal components. During normal production runs, note any abnormal conditions such as unusual noise, leakage or vibration and take corrective action.

## Mutator Shaft Bearing

The Votator II has only one serviceable ball bearing assembly, located in the Opposite Drive End Head of the unit. Lubrication of this bearing while in service is done through the use of the grease fitting located on the Opposite Drive End Head.

Install the bearing with lubrication ring in line with the grease fitting.

Use a suitable NLGI grade-2 bearing grease for the shaft bearing. Do not over-lubricate. Excessively packed bearings will overheat and fail prematurely.

Frequency of lubrication is dependent on the environment; daily if it is in contact with water or steam, otherwise weekly lubrication usually is sufficient.

### **▲ WARNING**

*Never immerse the Front Mutator Shaft Bearing in cleaning solution or subject to steam. Clean the bearing with a dry cloth and lubricate.*

Inspection of bearing should be ongoing. If looseness is detected, replace the bearing immediately. Worn-out bearings cause shaft misalignment that will cause mechanical seals and gearbox to wear out prematurely.

## Extra Heavy Duty Votator II Shaft Bearing

The shaft bearing on the Extra Heavy Duty Votator II located in the opposite drive end head is a sealed bearing and does not require lubrication.



**Figure 23 - Lubrication Ring Orientation**

## Shafts

Keep all shaft surfaces smooth and clean, especially in the seal and bearing areas. Take special care while cleaning and maintaining seals and bearings to ensure that these areas of the shaft are not scratched or damaged.

Shaft porosity can be detected by making an adaptor for the threaded end of the shaft and pressurizing it with air. Pinholes will be detected as air bubbles by submersing the shaft in a water bath. Leaky shafts can be repaired at SPX FLOW, Inc.

Bent or imbalanced shafts will cause premature bearing, seal and blade wear, and may damage tube walls. Check the shafts annually for straightness and balance.

## Gear Drive

**Table 6: Lubrication Quantities**

NORD gearbox	Orientation	Quantity
SK 4282	Horizontal	4.97 qt.
	Vertical	5.71 qt.
SK 5282	Horizontal	7.93 qt.
	Vertical	9.30 qt.

Follow manufacturer recommendations for gear oil replacement. When draining oil, examine it closely for foreign matter or debris; flushing or gear replacement may be required.

**NOTE: Consult the sticker on the NORD gearbox to verify the correct lubricant.**

The current standard lubricant for the NORD gearbox is **Mobil SHC Cibus™ 220**. For alternates, see NORD document U11000. For quantities (fill capacity for an empty gearbox), see Table 6. The gearbox (SK 4282 or SK 5282) is indicated on the identification plate.

## Blades

Blades that have developed a heel greater than SPX FLOW, Inc. specifications should be sharpened per instructions in this manual. Blades worn beyond the minimum sharpening dimensions should be replaced. Worn blades reduce heat transfer, result in poor performance and may damage product tubes. See “Scrapper Blade Maintenance” on page 46.

## Mechanical Seals

**NOTE: Double mechanical seals MUST BE flushed to prevent seal faces from overheating.**

Votator II heat exchangers are equipped with single or double mechanical seals at each end of the mutator shaft.

Mechanical seal faces with nicks, blisters, grooves, or any abnormality on the seal face, must be replaced. Elastomers that are brittle, deformed, cut, or have any abnormality must be replaced. It is an excellent practice to replace all elastomers and gaskets whenever maintenance is performed.

## Tubes

A frequent cause of tube wall damage is careless handling when removing or installing the mutator shaft. The shaft trough skid should always be used when removing or installing the mutator shaft in the Horizontal Votator II (or the Vertical unit if in a horizontal position) to prevent the blade mounting pins from scoring and damaging the tube wall.

A common way to damage tube ends is to bang or drop the shaft journals when removing or inserting the shaft.

Tubes should be examined for wear anytime the shaft is removed or at least once every 3 months. Chrome plated tubes should be inspected for flaking of the chrome. Normally, tubes will develop phonographic patterns from blade contact and rotation; this phonographic pattern is generally visible to the eye but is not significant unless detectable by touch. Scoring is significant when the

base metal has been damaged; roughness of the tube wall is obvious both visually and by touch. A badly scored tube will make cleaning more difficult, reduce heat transfer, result in poor performance and increase blade wear.

Re-conditioning the tube is the only way to restore performance. If there is suspicion that scoring has penetrated the tube wall, the unit can be pressure tested by turning on the jacket media and observing the inside of the tube for leaks.

Tubes should be removed every 12 to 18 months for cleaning debris from the media side. Jacket side o-rings should be replaced when tubes are reinstalled.

## Care of Heat Exchanger Tube

**NOTE:** Repair work must be performed by a shop with ASME certified welders. The heat exchanger tubes are ASME coded parts. Failure to get repairs done by an ASME coded machine shop with certified welders will void the warranty and possibly void insurance. SPX FLOW, Inc. has all required certifications necessary for repair of ASME coded parts.

You probably recognize that your Votator® and Thermutator® Heat Exchangers are valuable elements of your production facility. Day in and day out, they continuously and efficiently heat and cool products that often cannot be handled in any other equipment. You may not be aware that these units are considered pressure vessels under the ASME Code, and that SPX FLOW, Inc. is the only facility authorized to make OEM repairs to the removable tubes that maintain their ASME Code certification. This certification is your assurance that the equipment meets its original design pressure rating.

The removable tubes are wear parts, and must be replaced when they lose too much metal. Their inner surface is scraped by rotating blades and is potentially exposed to corrosive or abrasive products or cleaners. In some cases chrome plating is applied to resist mechanical wear, but it eventually wears away or the tubes become damaged or scored and lose performance. SPX FLOW, Inc. can inspect the tubes against the original drawings and determine whether they can be honed to restore a smooth inner surface, while keeping enough tube wall thickness to satisfy the ASME Code design calculations. Removable tubes that are worn beyond repair are condemned by our facility for your protection.

A breach in the removable tube that occurs during operation could be an extremely costly and hazardous event. In a recent incident, a removable tube was honed by an unauthorized machine shop that removed too much metal. The extremely thin tube wall flexed under the pressure of the product and the scraping blade edge, until one blade penetrated and tore a hole in the tube. Consequences of this kind of failure can include: contamination of product - with a damaging recall; circulation of product throughout a media system like a refrigeration compressor installation; and/or release of a hazardous substance like ammonia refrigerant inside your facility! Even if these are not high risks in your application, your production line will be down or operating at reduced capacity for some time until a replacement tube can be obtained.

Having your tubes professionally repaired by SPX FLOW, Inc. just makes sense, but there are other potential benefits as well. Maintaining ASME certification keeps you in compliance with state and local regulations, depending on the location of your facility. It is also a requirement of most business insurance carriers, so you are helping to protect your company against potential fines and uninsured losses. With stakes this high, tube repair by SPX FLOW, Inc. is the smart bet.

## Product Side

The heat exchanger tube is designed to last a long time with little maintenance.

If tubes wear out prematurely, one or more of the following may be the cause:

- Failure to use shaft trough when removing mutator shaft will cause scratching or gouging of tube wall.
- Careless assembly and installation of blades.
- Rotating shaft without product or product flow.
- Use of the wrong detergent or incorrect use of a detergent.
- Starting shafts against stiffened or solidified product in tubes.
- Starting the flow of jacket media (Ammonia, Freon, Steam, Water, etc.) before establishing full product flow under operating pressures.
- Failure to clear tubes of product after every use.
- Starting operation before dissolving particles such as salt, sugar, detergents, etc.
- Using dull blades or blades that have been sharpened below minimum width specifications.
- Using blades other than those furnished by Waukesha Cherry-Burrell.
- Worn mutator shaft bearings.

## Inspection of Chrome Plated Nickel or Stainless Steel Tubes

During each inspection of the scraper blades, inspect the inside surface of the tube for scoring, gouging, and roughness. When the surface of the plating is damaged or worn through, it may be rechromed to original specifications by Waukesha Cherry-Burrell. SPX FLOW has the equipment and product knowledge to repair the tube back to factory specifications and determine if the tube will comply with ASME specifications.

### **⚠ CAUTION**

*Acid cleaners are not recommended for chrome plated nickel heat transfer tubes. Cleaners should be compatible with the elastomers in the heat exchanger.*

## Inspection of Stainless Steel Tubes

During each inspection of the scraper blades, inspect the inside surface of the tube for scoring, gouging, and roughness. Shallow score marks, shallow gouges, and roughness can be taken out by honing the tube followed by polishing. Depending on the damage to the tube, Waukesha Cherry-Burrell may be able to rehone the tube to comply with ASME code specifications.

## Jacket Side

### For Units Using Steam, Water, Or Liquid

The jacket side of the heat transfer tube has a sealed cover that allows the media flow to circulate around the tube. If it becomes coated with foreign matter and heat transfer is reduced, it can be cleaned by pumping a detergent solution compatible with the carbon steel jacket at a rate of about 100 gpm. The frequency of this cleaning process will vary greatly from one installation to another.

### For Units Using Refrigerant

The jacket side of the heat transfer tube will become fouled with oil and sludge over time and prevent efficient heat transfer. This tube does not have a sealed flow spiral and can be cleaned by removing it from the jacket. It should be removed for cleaning every 12 to 18 months.

**NOTE:** *If you plan to clean the tube with anything other than the materials and methods mentioned previously, please contact Customer Service.*

## Cleaning the Flanges

Remove the o-rings and clean the grooves thoroughly of all residue and buildup. Care must be taken in cleaning the flanges, as they are part of the seal mechanism of the unit.

Install new o-rings any time the unit is disassembled.

**NOTE:** *Replace the o-rings every 12-18 months.*

Lubricate the o-rings.

## Leak Testing

Each cylinder is thoroughly tested for leaks at the factory. It is necessary to check for leaks in the refrigeration system any time the piping is opened to the atmosphere for maintenance or repair.

### **⚠ WARNING**

*Do not open valves or check for leaks until the electrical system checkout is completed. Personnel must wear safety goggles and protective clothing.*

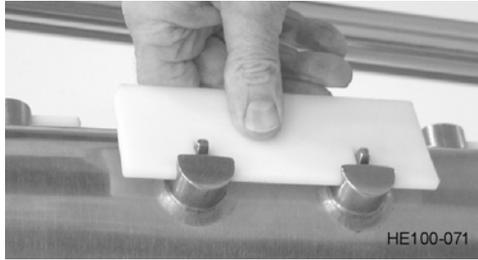
## Scraper Blade Maintenance

### Blade Inspection

The blades should be inspected for wear and signs of fatigue or cracking at the pin location and should be replaced if damage has occurred. Failure to replace damaged blades may result in breakage, which can damage other blades or the heat transfer tube, and result in blade particles in the product.

### **⚠ CAUTION**

*High concentrations of acid or caustic should be avoided if plastic scraper blades are used. Cleaners should be compatible with the elastomers in the heat exchanger.*



**Figure 24 - Scraper Blade Removal**

## Scraper Blade Removal & Replacement

1. Remove the scraper blades by lifting up and pulling them from the pins.
2. PEEK and Celcon plastic blades have a locking groove. After lifting, push them to the right before pulling them from the pins.

**NOTE:** Keep the blades in the same position on the mutator shaft throughout the life of the blade. Make sure the blades are removed and reinstalled in the same location on the shaft.

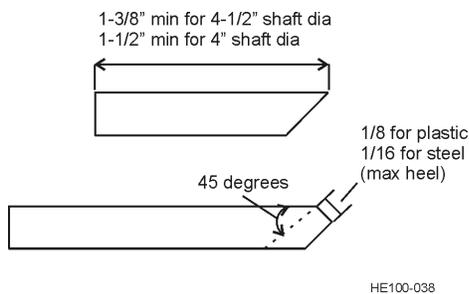
Reverse this procedure for installation. Make sure the beveled edge is installed toward the shaft.

## Scraper Blade Wear

Worn blades reduce heat transfer efficiency and can cause excessive wear on the product tube wall.

As the scraper blades scrape across the interior of the heat exchanger tube, they wear into the contour of the tube. A flat surface called the heel, and a burr or feathered edge develops at the contact area on the side of the blade that is against the tube wall. See Figure 25.

The blades must be maintained to achieve maximum performance. When the heel of the blade reaches a maximum of 1/16" (1.6 mm) on metal blades or 1/8" (3.2 mm) on plastic blades, they must be replaced or re-sharpened.



**Figure 25 - Blade Wear and Sharpening**

## Blade Sharpening

Scraper blades can be sharpened by several methods, depending on the blade material.

The best method utilizes a high speed 45° cutter and fixture that keeps the back side of the blade perpendicular to the cutting edge. The cutting edge of the blade should be parallel to the back surface of the blade within 1/64".

A new universal blade is 2 inches wide by 6 inches long.

For mutator shafts that are 4-1/2 inches in diameter or larger, the blade should not be sharpened to a blade width of less than 1-3/8 inches.

For mutator shafts that are 4 inches in diameter, the blade should not be sharpened to a blade width of less than 1-1/2 inches.

Stainless steel blades for the 5-1/4 inch mutator shafts are 1-9/16 x 23-29/32. The minimum width after sharpening is 1-3/8 inches and the sharpening edge is at a 15-degree angle.

## Maintenance of Horizontal Votator II

**NOTE:** For Vertical units, see page 53.



**Figure 26 - Removal of Hinged Clamp**



**Figure 27 - Removal of Shaft Locknut**



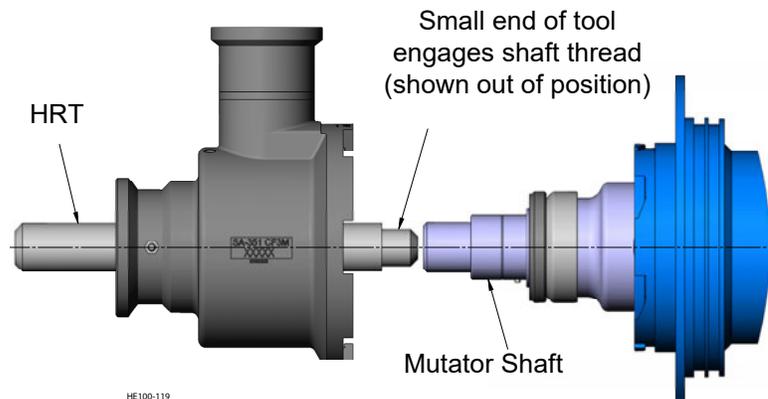
**Figure 29 - Shaft Removal**

**⚠ DANGER**

Before doing any maintenance work on the Votator II, lock out and tag out equipment.

### Shaft Removal - Horizontal Unit

1. Check to make sure all supply lines to the unit are closed, locked out and tagged out.
2. Disconnect the product piping and seal flush lines.
3. Rotate the head in the OFF direction until you feel the head disengage.
4. Pull the head and shaft assembly out approximately one (1) inch.
5. Remove the hinged clamp that holds the shaft nut guard in place. See Figure 26.
6. Remove the shaft locknut (the locknut is left hand threaded). See Figure 27.
7. Insert the HRT as shown in Figure 28 and slide the head and bearing off the shaft to protect the stationary seal face during disassembly.

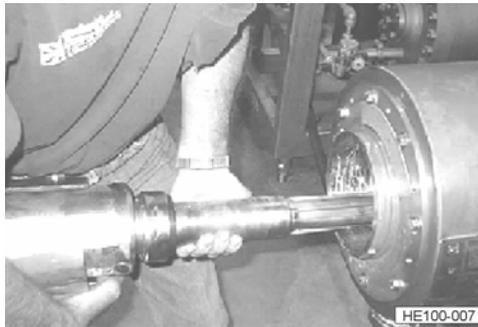


**Figure 28 - Use of Head Removal Tool (HRT)**

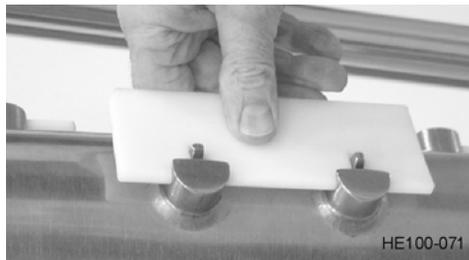
8. Lift the shaft so that shaft removal skid can be inserted between the shaft and the tube.

**⚠ CAUTION**

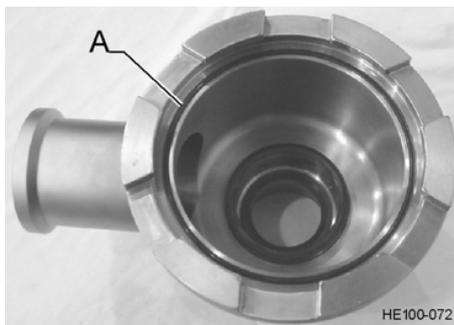
NEVER remove the mutator shaft without using the shaft removal skid. Failure to do so will result in permanent damage to heat transfer tube.



**Figure 30 - Removal of Shaft Drive End**



**Figure 31 - Scraper Blade Removal**



**Figure 32 - Drive End Head O-ring**



**Figure 33 - Mechanical Seal Installation**

9. Slide the shaft removal skid into the tube.
10. Pull the shaft and shaft removal skid from the tube as a unit. This will ensure that the tube will not be scored when the shaft is removed.

11. Remove the scraper blades and service them as necessary. See "Scraper Blade Maintenance" on page 46

**NOTE:** Keep the blades in the same position on the mutator shaft throughout the life of the blade. Make sure the blades are removed and reinstalled in the same location on the shaft.

### Shaft Installation - Horizontal Unit

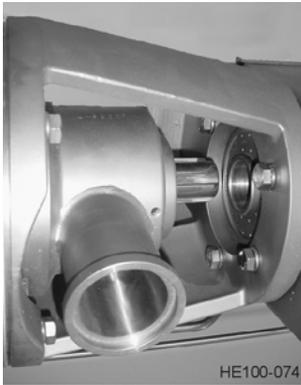
1. If the drive end head has been removed, make sure the o-ring (See Figure 32, Item A) is installed. Lubricate it lightly.
2. Install the drive end head (if necessary).

3. Install the mechanical seal on the drive end of the shaft as shown in Figure 33. See "Mechanical Seal Maintenance" on page 57.

4. Install all scraper blades on the mutator shaft.

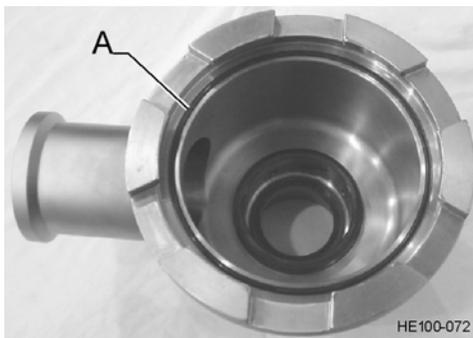
**NOTE:** Keep the blades in the same position on the mutator shaft throughout the life of the blade. Make sure the blades are removed and reinstalled in the same location on the shaft.

5. Place the shaft in the shaft removal skid.
6. Apply anti-seize compound to the drive end splines and the next 3 inches of stub shaft length.
7. Push the shaft and shaft removal skid into the tube as a unit. This will ensure that the tube will not be scored when the shaft is replaced.



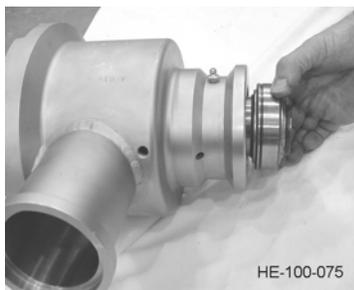
**Figure 34 - Align Shaft Splines with Gear Reducer**

8. Push the spline of the shaft partially into the gear reducer. The shaft may need to be rotated slightly for the splines to seat in the gear reducer. See Figure 34.
9. Lift the shaft slightly to remove the shaft removal skid.



**Figure 35 - Opposite Drive End Head O-ring**

10. Make sure the o-ring (Figure 35, item A) is installed in the opposite drive end head. Lubricate it lightly



**Figure 36 - Install Head Shaft Bearing**

11. Install the opposite drive end head by reversing the procedure for the removal of the head.
12. Install the shaft bearing in the head. Install the HRT into the end of the shaft and slide the head and bearing onto the shaft. Remove the HRT.
13. Push on the bearing retainer and secure it with the clamp.
14. Install the shaft nut onto the shaft (**nut is left hand threaded**) and tighten the nut against the bearing's inner race



**Figure 37 - Installation of Shaft Lock-nut**



**Figure 38 - Installation of Hinged Clamp**

**⚠ DANGER**

*Before doing any maintenance work on the Votator II, lock out and tag out equipment.*

**⚠ DANGER**

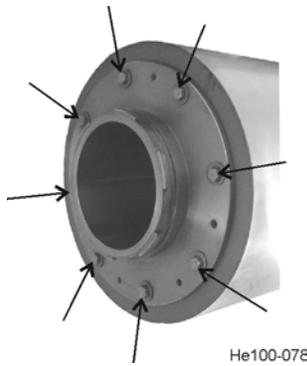
*Before removing the heat exchanger tube from the jacket, all refrigerant must be evacuated from the jacket assembly.*

15. Lift the shaft and head, place it over the tube ring and position the bayonet closure. Close the locking latch and secure it by tightening the latch retainer nut.

16. Install all product connections and seal flush piping.
17. Inspect the unit for correct assembly.
18. Remove tag-out and lock-out. Prepare the unit for operation.

### Heat Exchanger Tube Removal - Horizontal Unit

1. Check to ensure that all supply lines to the unit are closed and locked and tagged out.
2. Make sure that the entire unit is purged of fluids (product, coolant, refrigerant, etc.)
3. Remove the mutator shaft and drive end head as described in this section.
4. Remove the locking latch and associated hardware holding the front cover in place.
5. Remove the eight (8) 3/8-inch bolts that hold the removable tube to the jacket. See Figure 39.



**Figure 39 - Removal of Tube to Jacket Bolts**



**Figure 40 - Tube Removal**

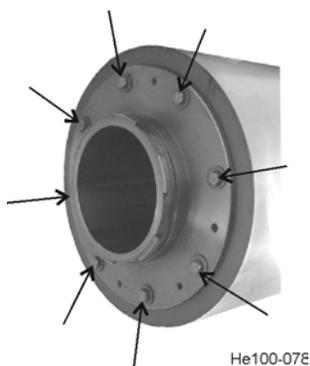
6. Take four (4) bolts and thread them into the "B" holes. The "B" holes are located at the 12, 3, 6, and 9 o'clock locations. **DO NOT TIGHTEN!**
7. Using an X pattern, gradually tighten the bolts to withdraw the tube from the jacket. Considerable effort may be needed to overcome any stickiness.

If the tube does not start to pull away from the jacket as the bolts are tightened, stop and do the following:

- **Make sure the product head on the drive end is removed.**
  - Place a block of wood across the drive end of the tube and apply pressure to force the tube opposite the drive end.
  - When the tube is loose, use bolts to complete removal.
  - If the tube cannot be budged, contact SPX FLOW, Inc.
8. Pull the tube out of the jacket. Take care to avoid marring the jacket cylinder during heat transfer tube removal. Mark the tube and jacket so that the tube can be reinstalled in the same jacket. See Figure 40. On liquid units, install a new packing ring.

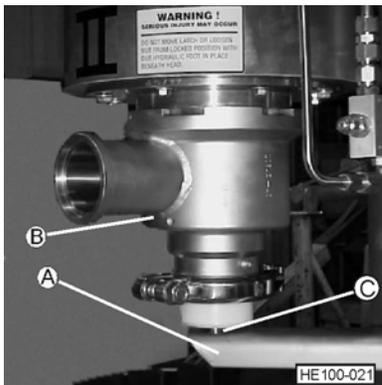
### Heat Exchanger Tube Installation - Horizontal Unit

1. Inspect the jacket cylinder interior and wipe out all dirt and impurities.
2. Lubricate the sealing surfaces inside the jacket cylinder and install new o-rings in the tube.
3. Carefully insert the tube into the jacket cylinder. Support pins of the heat exchanger tube should be at 5 o'clock and 7 o'clock positions during insertion.
4. Push the tube into the cylinder as far as it will go.
5. Thread the eight (8) 3/8-inch bolts through the flange of heat exchanger tube into jacket cylinder.
6. Tighten the bolts in a crossing pattern until the tube is snugged down to the jacket cylinder.
7. Torque the bolts to 240 in-lbs (20 ft-lbs).
8. Install the front cover.
9. Install the latch hardware.
10. Install the drive end head.
11. Install the shaft (with mechanical seals).
12. Install the opposite drive end head.



**Figure 41 - Install Tube to Jacket Bolts**

## Maintenance of Vertical Votator II



**Figure 42 - Location Of Hydraulic Arm For Removal**



**Figure 43 - Disengaging Locking Latch**

### **⚠ DANGER**

Before doing any maintenance work on the Votator II, lock out and tag out equipment.

### Shaft Removal - Vertical Unit

1. Purge all product from the unit.
2. Disconnect product piping from the opposite drive end head.
3. Lower the arm of hydraulic lift so that the arm can be positioned under the opposite drive end head. (See Figure 42, Item A).
4. Raise the arm of hydraulic lift to just below the opposite drive end head (See Figure 42, Item B) and position the lift pin (See Figure 42, Item C) to go into the shaft nut.
5. Raise the arm so that the lift pin is engaged in the head and just barely pushing against the shaft nut.

### **⚠ WARNING**

Do not move the latch or loosen the nut from the locked position without the hydraulic foot in place beneath the head.

6. Unlatch the locking latch.
7. The head has an ON-OFF engraving on the rim, located just above the product outlet. Rotate the head in the OFF direction until the head disengages.
8. Lower the head until the hydraulic rod is fully extended. See Figure 44 on page 54.
9. Once the shaft is in the down position, the blades may be removed from shaft.

**NOTE:** Keep the blades in the same position on the mutator shaft throughout the life of the blade. Make sure the blades are removed and reinstalled in the same location on the shaft.

10. If the shaft is to be removed from unit, lift the head and shaft off the lift pin and move the head away from the unit while a second person guides the spline end of the shaft out of the unit.
11. Place the shaft and head assembly on a table or suitable frame for servicing.



**Figure 44 - Shaft Fully Extended**



**Figure 46 - Align One Half of Blade Alignment Tool**

12. The scraper blades can be removed and serviced at this time.

### Shaft Installation - Vertical Unit

1. Check the condition of the o-ring in the head and lubricate it lightly. Assemble the head to the shaft if necessary, following procedures under "Shaft Installation - Horizontal Unit" on page 49.
2. Assemble the head to shaft.
3. Apply anti-seize compound to the drive end splines and the next 3 inches of stub shaft length.
4. Slide the splined end of the shaft into the unit.
5. Lift the head onto the lift pin.



**Figure 45 - Head Installed on Pin**

6. Install the scraper blades.

**NOTE:** Keep the blades in the same position on the mutator shaft throughout the life of the blade. Make sure the blades are removed and reinstalled in the same location on the shaft.

7. If an optional blade aligning tool is used, install it on the bayonet ring of the heat transfer tube. Place each half of the ring on the bayonet and rotate it as one piece.
8. Raise the shaft slowly, tucking the blades into the shaft while the shaft and blade assembly is being inserted into the tube.

**NOTE:** If the lift binds, STOP and back off the hydraulic pressure. Check that the blades have not swung fully out and are not binding on the edge of the alignment tool. If this happens, check the blades and replace as necessary. Restart the lift, taking care to guide the blades into the alignment tool.

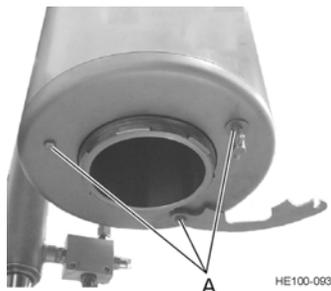
9. If the blade aligning tool is not used, the individual controlling the hydraulic lift should use one hand to guide each pair of blades into the tube.



**Figure 47 - Blade Alignment Tool Installed**



**Figure 48 - Close Locking Latch**



**Figure 49 - Remove Front Jacket Cover Bolts**

10. As the shaft is raised into the gear reducer, it may be necessary to rotate the shaft slightly to ensure that the splines are meshed correctly.
11. Continue to raise the shaft until the head is about six (6) inches from being engaged.
12. Once the last set of blades has been started in the tube, remove the alignment tool, if used.
13. Continue to raise the head slowly, aligning the teeth of head with the spaces of the tube. Raise and turn the head so that the teeth are engaged and the product port is facing forward.
14. Close the locking latch. See Figure 48.
15. Install product piping and electrical connections.

### Heat Exchanger Tube Removal -Vertical Unit

The hydraulic lift on the vertical unit can be used to remove the heat transfer tube from the jacket of the unit.

#### **⚠ DANGER**

*Before removing the heat exchanger tube from the jacket, all refrigerant must be evacuated from the jacket assembly.*

1. Remove the mutator shaft from the unit as described in this section.
2. Remove the shaft and head from the hydraulic lift.
3. Place the assembly on a table or maintenance frame.
4. Remove the driven end product head.
5. Remove the three (3) bolts holding the front jacket cover in place. See Figure 49.
6. Remove the non-driven product head from the mutator shaft.



**Figure 50 - Head Reinstalled**



**Figure 51 - Insert Jack Screws**

7. Reattach the head to the tube. See Figure 50. Reattach the shaft nut cover and clamp, and use the lift to position the non-driven end head.
8. Loosen the bolts on the jacket flange.
9. Lower the head slightly with the hydraulic cylinder to allow the tube to move down.

**NOTE:** The tube may slide out easily or it may need coaxing out.

10. Lower the lift arm slightly to allow the tube to move down. At the 12, 6, 3, and 9 o'clock positions, the tube flange is threaded for jack screws. Thread two (2) bolts into either the 12 & 6 or 3 & 9 o'clock positions.
11. Tighten bolts about 1/2 turn alternately on each side until the flange loosens from the jacket. It may be necessary to lower the foot on the hydraulic cylinder slightly while removing the tube from the jacket.
12. Lower the head and tube assembly and service it as required.
13. Lubricate and install new o-rings on both ends of the tube.
14. Install a new packing ring (on steam or liquid tubes).
15. To reinstall the tube, reverse the procedure.
16. Torque bolts to 240 in-lbs (20 ft-lbs).

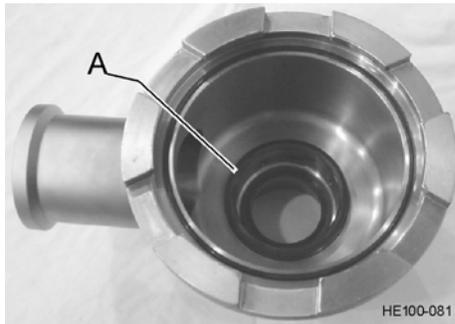
**NOTE:** Take care to orient the tube flange holes to line up with the holes in the jacket.



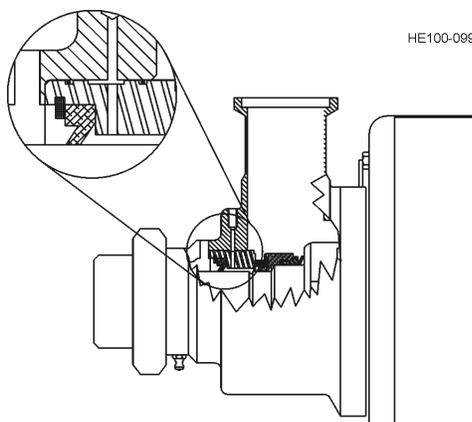
**Figure 52 - Lower Tube and Service**

## Mechanical Seal Maintenance

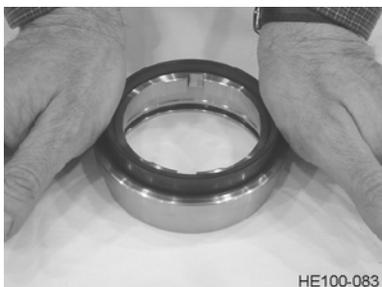
### Single Mechanical Seal



**Figure 53 - Seal Head Insert Removal**



**Figure 54 - Lip Seal Orientation**



**Figure 55 - Press Insert Down Evenly with Both Hands**

The mechanical seals on the Votator II are the same on both the non-driven and driven ends of the unit. The o-rings and seal materials have been selected for the product specifications. Various options are shown in the Parts Lists starting on page 64.

Units furnished before 2005 were installed with either a single or double mechanical seal configuration. For a detailed parts drawing breakdown, see "Two-Piece Single Mechanical Seal (with flushing lip seal), 1997-2004" on page 76.

### Seal Head Insert Removal and Installation

The Seal Head Insert located in the product head is removed by tapping the back of the seal with a plastic block or rod. Make sure to hold the insert or use a soft cloth to catch it to prevent it from dropping when removed.

**NOTE:** To prevent damage to the seal face, do not place the seal face down on any surface during maintenance.

If the mechanical seal is going to be flushed, remove the springs in the lip seal to protect the stub ends on the mutator shaft. Install the seal in the relief position as shown in Figure 54.

To install a new insert, lubricate the o-rings and the inside bore. Insert it in the head with an even distribution of force on the face. The face must be protected with plastic to avoid damage.

### Seal Body Insert (Rotating Seal Face) Used Before 2012

The rotating seal face is referred to as the Seal Body Insert. This part is designed to wear at a greater frequency than the seal head insert. An o-ring holds the insert stationary in the seal body.

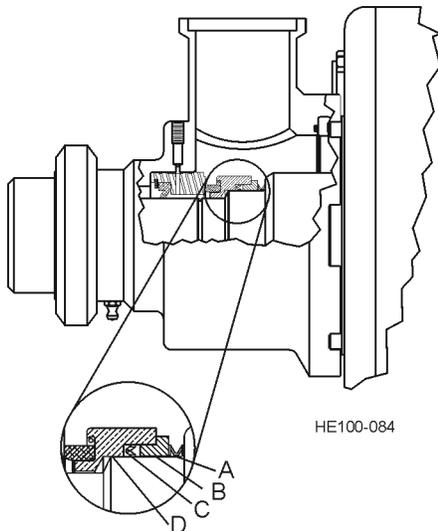
**NOTE:** Do not use a lubricant on the Seal Body Insert o-ring because the insert must remain stationary with respect to the body. If necessary, water can be used as a lubricant.

The seal insert is symmetrical and can be reversed if one side becomes scratched.

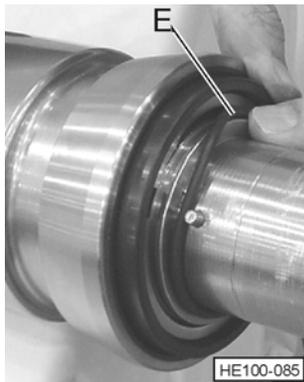
The seal body is held in place on the mutator shaft by two seal drive pins. Each one should be  $\frac{3}{32}$ " (+/-0.015) above the stub shaft surface. It is extremely important that these pins are not rounded on the edges and that this dimension is maintained. If the pins are higher than  $\frac{3}{32}$ ", the seal will jam; if the pins are too low, the body will rotate. See Figure 57 on page 58.

Install the Seal Body Insert in the Seal Body as follows:

1. Place the o-ring in the Seal Body.
2. Push the Seal Body Insert down evenly with both hands until it bottoms out. See Figure 55.

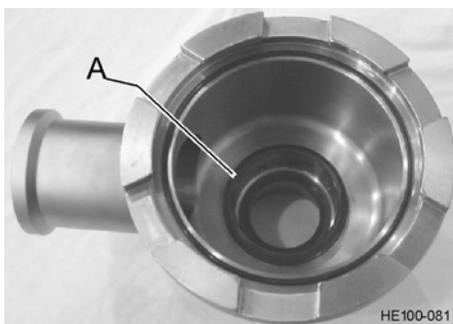


**Figure 56 - Orientation of Seal Components**



**Figure 57 - Install Keeper O-ring**

## One-Piece Single and Double Mechanical Seals



**Figure 58 - Seal Head Insert Removal**

**NOTE:** To prevent damage to the seal face, do not place the seal face down on any surface during maintenance.

## Single Mechanical Seal Installation

After the head insert and the body insert are installed, install the remaining components as follows:

1. Place the wavy washer spring (See Figure 56, Item A) on the shaft.
2. Install the seal back-up ring. (See Figure 56, Item B).
3. Install the U cup seal with the opening facing toward the product side, as shown in Figure 56, Item C.
4. Place the seal body (See Figure 56, Item D) on the shaft, aligning the slots with seal drive pins.
5. Install the "keeper" o-ring (See Figure 57, Item E) on the shaft to keep the rotating parts assembled.
6. Inspect the seal to ensure that it moves freely with the spring and that the drive pins keep it stationary with respect to the mutator shaft.

For a detailed parts drawing breakdown, see "One-Piece Single & Double Mechanical Seal (2005-2012)" on page 72. Units furnished before 2005 had a removable seal body insert as described below. In 2005, all single and double mechanical seals were furnished with a one-piece primary seal body. Starting in 2012, a new seal body design with a removable wear face is furnished.

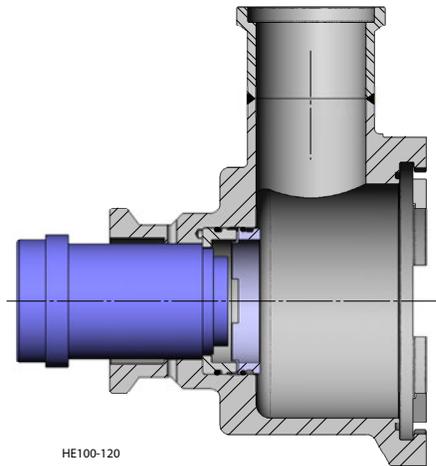
## Primary/Secondary Seal Head Insert Removal and Installation

The primary seal head insert located in the product head is removed by tapping the back of the seal with a plastic block or rod. It contains the secondary seal head insert and the two parts can be removed as an assembly or separately, as the secondary ring is held in the primary by an o-ring. Make sure to hold the insert or use a soft cloth to catch it to prevent it from dropping when removed.

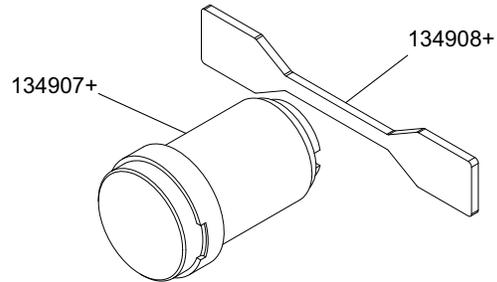
To install a new primary or secondary insert, lubricate the o-rings and the inside bore. Insert it in the head with an even distribution of force on the face. Protect the face with plastic to avoid damage.

### 2012 Primary/Secondary Seal Head Insert Removal and Installation

The primary seal head insert from 2012 onward has two parts, a gland and a seat, but is removed by pushing with the special Seal Installation/Removal tool. Part number 135228+ is a kit which includes the tool, part number 134907+; and handle, part number 134908+ (See Figure 61).



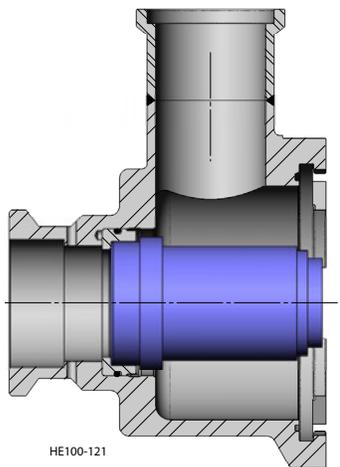
**Figure 59 - Gland and Seat Removal**



**Figure 61 - Seal Installation/Removal Tool kit 135228+**

The gland contains the secondary seal head insert, if present, which is held in the primary by an o-ring. Make sure to hold the insert or use a soft cloth to catch it to prevent it from dropping when removed.

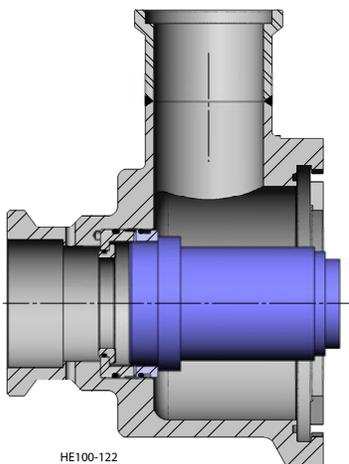
**NOTE:** To prevent damage to the seal face, do not place the seal face down on any surface during maintenance.



**Figure 60 - Gland Installation**

To install a new primary or secondary insert, lubricate all o-rings. Use the fit of the o-ring at the top of the head bore to verify that the inserts are correctly aligned in the bore. Make sure to align the anti-rotation pin with the hole in the bottom of the head bore.

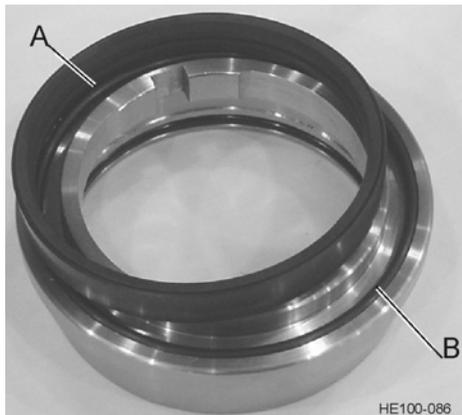
Insert the stainless steel gland into the head, using the Seal Installation/Removal Tool with an even distribution of force. Then install the secondary insert into the gland. Finally, align the lugs on the stationary seal face with the spaces between the lugs on the gland, and insert it until it meets the gland.



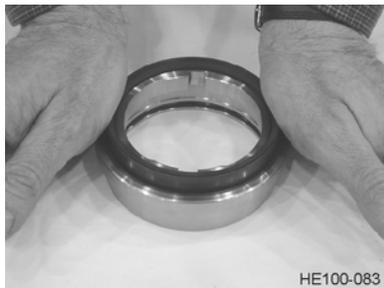
**Figure 62 - Seal Installation**



**Figure 63 - One-Piece Seal Body**



**Figure 64 - O-ring Installation on Primary Seal**



**Figure 65 - Press Insert Down Evenly with Both Hands**



**Figure 66 - 2012 Primary Seal Body**

### One-Piece Primary Seal Body (Rotating Seal Face)

See Figure 63.

### Removable Seal Body Insert (Rotating Seal Face)

The rotating seal face is referred to as the Seal Body Insert. This part is designed to wear at a greater frequency than the seal head insert. An o-ring holds the insert stationary in the seal body.

### Assembly of Removable Primary Seal Body

The Primary Seal Body has two o-rings; one on the outside diameter of the ring, and the other on the inside diameter that holds the ring stationary.

The o-rings can be hand-stretched slightly to fit snugly in the grooves. Preferred assembly is with the o-ring dry. If necessary, water or soapy water can be used as a lubricant.

1. Install one o-ring (See Figure 64, Item B) on the outside diameter of the ring.
2. Install the other o-ring (See Figure 64, Item A) on the inside diameter of the primary seal.
3. Push the insert down evenly with both hands until it bottoms in the housing (Figure 65).
4. Vent trapped air by placing a small flat screwdriver blade between the seal ring and the outside o-ring.

**NOTE:** Air can be become trapped behind the Primary Seal Insert after assembly. This air must be vented by placing a small flat screwdriver blade between the seal ring and the outside o-ring to provide a vent for trapped air.

5. While the screwdriver is in place, push down firmly on the ring.
6. Release the screwdriver and check the seal to ensure that it is firm and solid.
7. Place the inner o-ring in the seal body (apply lubrication to this o-ring).

### Assembly of 2012 Primary Seal Body

The 2012 primary seal body has one o-ring and three anti-rotation pins that hold the insert stationary on the body.

To install the insert in the seal body:

1. Lubricate and place the seal face o-ring in the body.
2. Align the anti-rotation pins with the slots on the seal face.
3. Push the seal face down evenly with both hands until it snaps over the o-ring.
4. Place the inner o-ring in the seal body (apply lubrication to this o-ring).

### Assembly of Secondary Seal Body (For Double Mechanical Seal Only)

The secondary seal body has one o-ring that holds the insert stationary in the body.

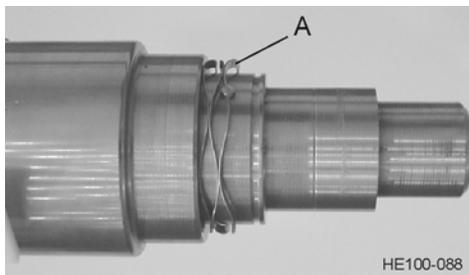
To install the insert in the seal body:

1. Place the o-ring in the body (no lubrication).
2. Push the insert down evenly with both hands until it bottoms out.
3. Place the o-ring in the seal body (lubrication should be applied to this o-ring).

### Seal Assembly Installation on Shaft

After the head insert and the body insert are installed, the remaining components are installed as follows:

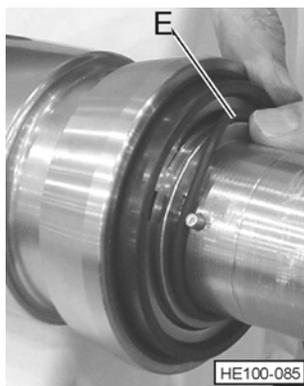
1. The primary seal body is held in place on the mutator shaft by two seal drive pins. Each one should be  $5/32"$  (+/- 0.015") above the stub shaft surface. The secondary seal body is held in place by one seal drive pin. It should be  $3/32"$  (+/-0.015") above the stub shaft surface. It is extremely important that these dimensions be maintained. If the pins are too high, the seal will jam; if they are too low, the body will rotate. See Figure 67 and Figure 70
2. Place the wavy washer spring (See Figure 67, Item A) on the shaft. Place the seal body (Figure 68) or one-piece seal on the shaft, aligning the slots with the seal drive pins.
3. Inspect the seal to ensure that it moves freely with the spring and that the drive pins keep it stationary with respect to the mutator shaft.



**Figure 67 - Install Wavy Spring**



**Figure 68 - Install Seal Body**



**Figure 69 - Install Keeper O-ring**



**Figure 70 - Double Mechanical Seal Installed**

4. Assemble the Secondary Seal Wavy Washer on the shaft, if required (See Figure 70).
5. Slide the seal body over the seal body drive pin so that the o-ring in the body seats in the groove in the mutator shaft.
6. Check the seal to ensure that it moves freely with the spring and that the drive pins hold it stationary with respect to the shaft.



**Figure 71 - Exposing Top Mechanical Seal**

**Servicing Mechanical Seals - Vertical Votator II**

The top mechanical seal can be serviced by lowering the shaft to the floor and removing the seals from the shaft while the spline end is in the heat transfer tube. See Figure 71. See “Mechanical Seal Maintenance” on page 57 for information regarding servicing the seal.

The bottom mechanical seal can be serviced with the mutator shaft in the unit by using the shaft clamp. See Figure 72.

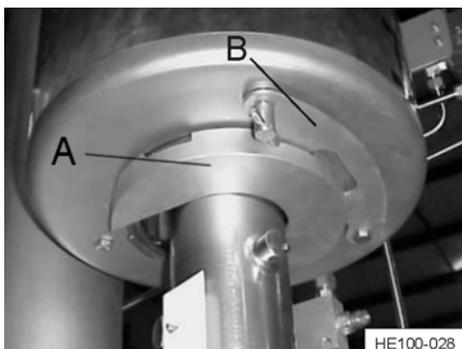
1. Lower the shaft approximately two (2) feet or to a convenient height.
2. Remove the top two (2) exposed scraper blades.
3. Position the shaft so that the blade pins are centered between the the bayonet ring on the heat transfer tube.
4. Install the shaft clamp around the teeth of the tube and shaft. (See Figure 73, Item A)
5. Close the locking latch. (See Figure 73, Item B)
6. Lower the shaft until a pin from the right or left side contacts the shaft clamp.



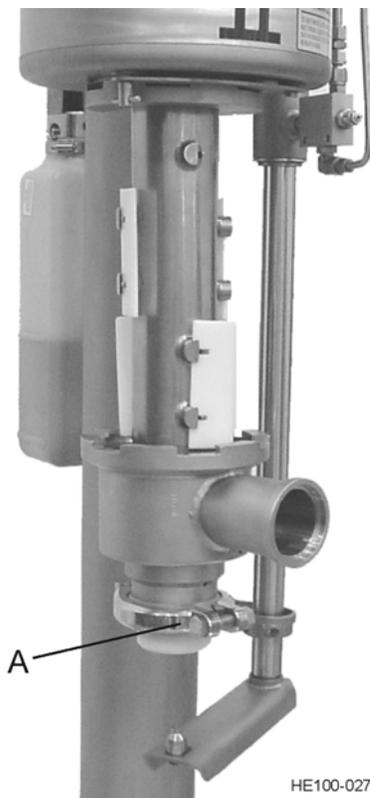
**Figure 72 - Shaft Clamp**

**CAUTION**

**THE SHAFT MUST BE SUPPORTED BY A PIN AND NOT BY A SCRAPER BLADE.**



**Figure 73 - Installed Shaft Clamp**



**Figure 74 - Remove Head Clamp**

7. Lower the hydraulic arm and rotate it out of the way.
8. Remove the clamp on the head. (See Figure 74, Item A) and shaft nut guard.
9. While supporting the head, remove the shaft nut. **(The nut is left-hand threaded.)**

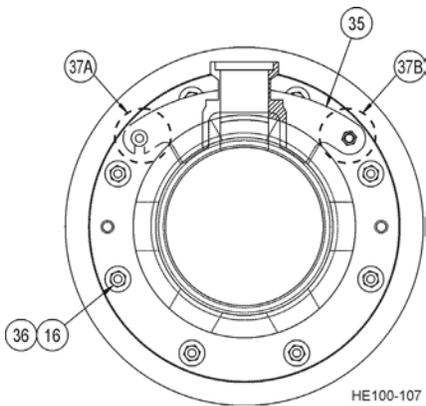
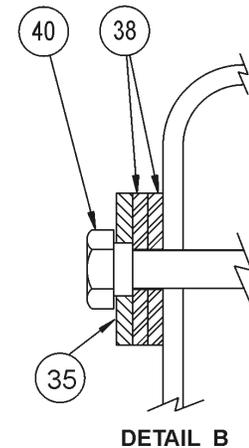
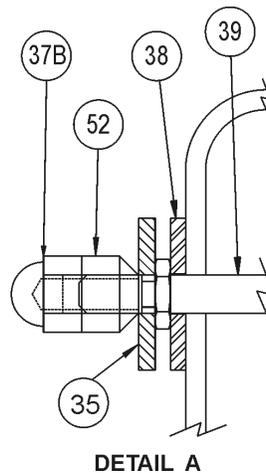
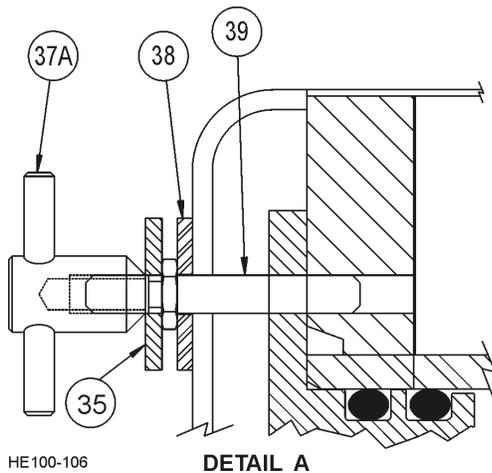


**Figure 75 - Shaft With Head Removed**

10. Grasp the head with both hands and remove it from the shaft.
11. The seals can now be serviced. See “Mechanical Seal Maintenance” on page 57.
12. To install, reverse the procedure.

# Parts Lists

## Latch



ITEM	PART DESCRIPTION	QTY	PART #
35	VII Locking Latch	1	LL923221
36	Washer Plain 3/8" 18-8 Narrow	8	43-30
37A	Wing Nut	1	LL2200281
37B	Acorn Nut	1	LL711155
38	Spacer	3	LL2200321
39	Stud	1	LL2200277
40	Hexagon Head Shoulder Screw	1	LL925499
52	Spacer Washer	1	LL931315

## Product Heads

APPLICATION	DESCRIPTION	PART #
Opposite Drive End	Concentric 3" I-Line	LL923245
	Concentric 3" Flanged	LL118415
	Concentric/XHD Bearing 3" Flanged	LL120325
	Concentric/XHD Bearing 3" I-Line	LL119402
	Eccentric 3" I-Line	LL118337
	Eccentric 3" Flanged	LL118419
	Eccentric/Oval/XHD Bearing 3" Flanged	LL120326
	Eccentric/Oval/XHD Bearing 3" I-Line	LL118391
	Eccentric/Oval Spider Head	LL121314
	Concentric Spider Head	LL121359
Drive End	Concentric 3" I-Line	LL923255
	Concentric 3" Flanged	LL118414
	Eccentric/Oval 3" I-Line	LL118336
	Eccentric/Oval 3" Flanged	LL118418

**CAUTION**

Product heads comply with the ASME pressure vessel code and must not be changed between units of the same design. Also, a concentric head is not interchangeable with an eccentric/oval design.

**Votator II Blades**

MATERIAL	REMARKS	PART NO.	QUANTITY				
			6x84	6x72	6x48	6x36	6x24
410SS		LL900127	28	24	16	12	8
CELCON		LL900129					
BRASS		LL916284					
17-7 SS		LL900124					
PEEK		LL118683					
MD PEEK		LL118683MD					
410SS	Open Style	LL125801					
BRASS		LL918089					
17-7 SS		LL919100					
CELCON	Open Style with holes	LL900133					
410SS		137467+					
PEEK		LL121856					

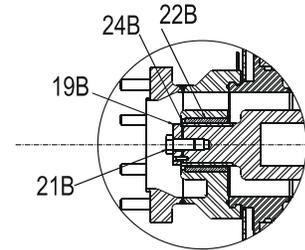
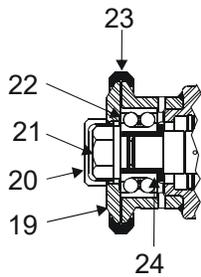
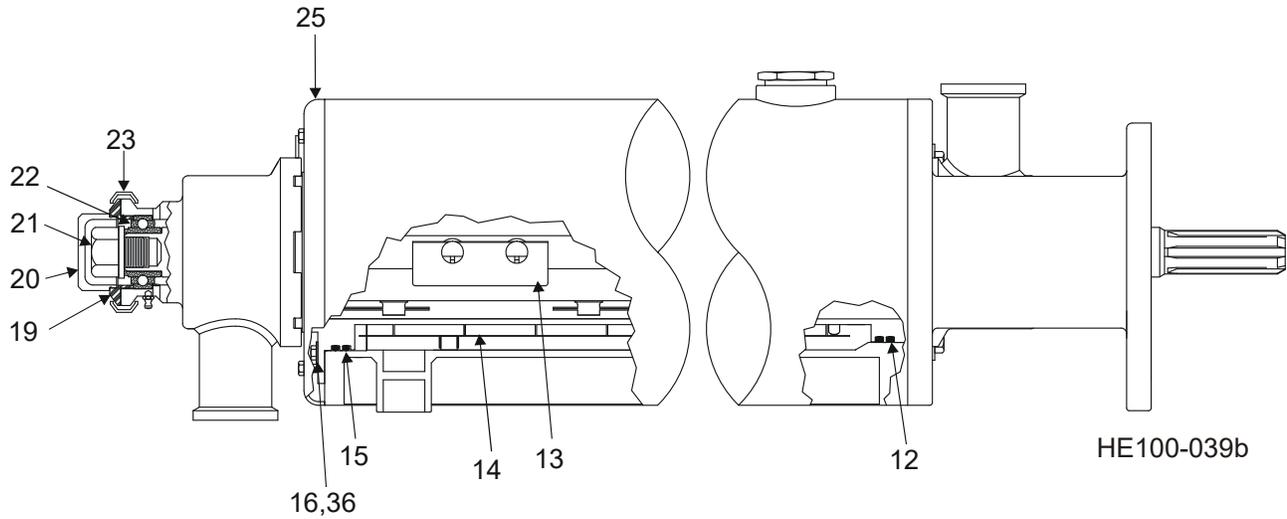
MATERIAL	REMARKS	PART NO.	QUANTITY 2-ROW INLINE BLADE DESIGN (2014)				
			6x84	6x72	6x48	6x36	6x24
DELTRIN	For 5-1/4" shaft, 2-Row Inline Blade design only	133041+	6	6	4	2	2
		131818+	2	0	0	2	0
410SS		133029+	6	6	4	2	2
		132985+	2	0	0	2	0
PEEK		133411+	6	6	4	2	2
		133412+	2	0	0	2	0

MATERIAL	REMARKS	PART NO.	QUANTITY 4-ROW INLINE BLADE DESIGN (1997)				
			6x84	6x72	6x48	6x36	6x24
DELTRIN	For 5-1/4" shaft, 4-Row Inline blade design only	128675+	N/A	8	4	N/A	2
		128675M1	N/A	2	2	N/A	N/A
		128675M2	N/A	2	2	N/A	N/A
410SS		LL926752	N/A	8	4	N/A	2
		LL926752M1	N/A	2	2	N/A	N/A
		LL926752M2	N/A	2	2	N/A	N/A
POLY		LL3005185	N/A	12	8	N/A	2

**Labels**

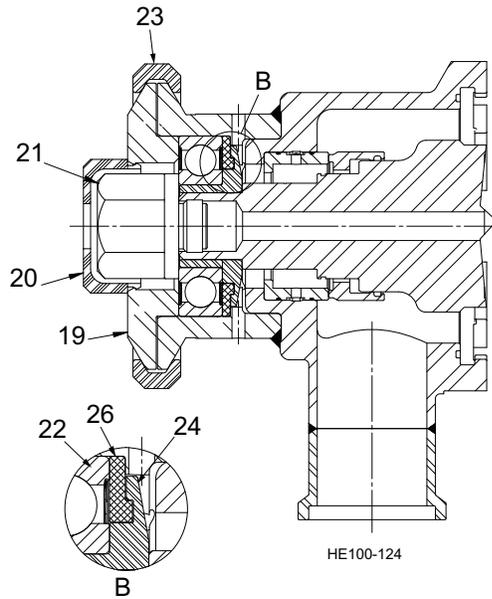
PART NUMBER	DESCRIPTION
LL927603	Corrosion Prevention
LL725499	Caution/Warning Shaft Guard
LL119170	Danger - Contents Under Pressure
LL125098	3-A Label
LL119169	Safety Instructions
LL930514	SPX FLOW, Inc./WCB Logo Horizontal
LL930513	SPX FLOW, Inc./WCB Logo Vertical
LL931360	Caution/Warning Product Head Locking Latch (Vertical)
LL931407	Caution/Warning Product Head Locking Latch (Vertical)

### Cylinder Assembly



**Spider Head Option**

**Extra Heavy Duty Bearing Option-  
obsolete after 2009**



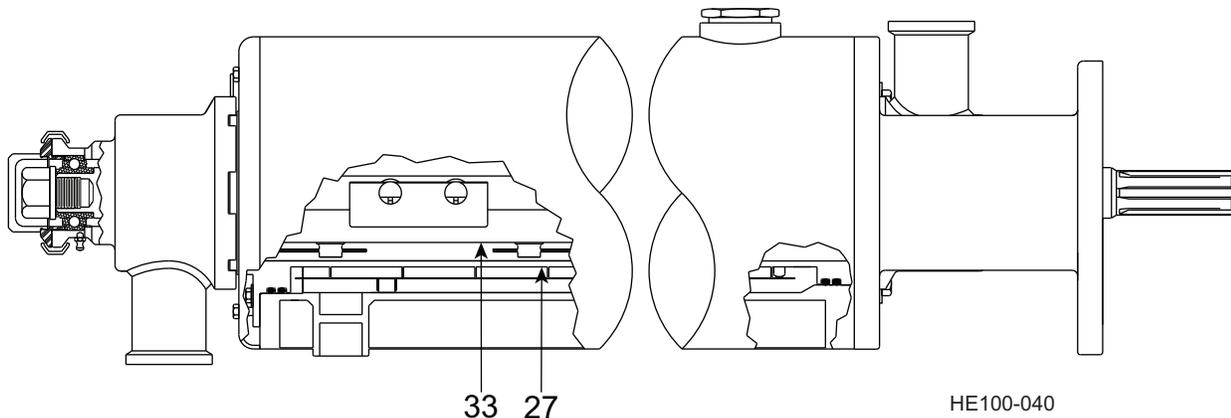
**Extra Heavy Duty Bearing Option (Current Design)**

## Cylinder Assembly

ITEM	PART DESCRIPTION	QTY	MODEL/MATERIAL	PART #
12	Jacket O-ring (Drive End)	2	EPDM	E70444
			Neoprene (Rfg)	R70444
			Fluoroelastomer	V75444
13	Blades	AR	PEEK	LL118683
			410 SS	LL900127
			Celcon	LL900129
			Brass	LL918089
			410 SS (5-1/4" dia. only)	LL926752
14	Packing, Concentric and Eccentric	1	LIQ only	LL710015
	Packing, Oval	1	Liquid Jacket	LL710296
15	Jacket O-ring (Opposite Drive End)	2	EPDM	E70446
			Neoprene (Rfg)	R70446
			Fluoroelastomer	V75446
16	Heavy Hex Head Bolt 3/8-16 x 1	8	ASME SA193-B8, Class 1	LL928781
19	Bearing Retainer	1	Votator II	LL923214
			Extra Heavy Duty Votator II (obsolete after 2009)	LL118393
			Extra Heavy Duty Votator II (Current design)	128476+
19B	Clamp Ring	1	Spider Head Only	LL117678
20	Shaft Nut Guard	1	Horizontal	LL923212
			W/ Shaft Heater (horizontal or vertical)	
			Vertical	LL929346
21	Shaft Locknut	1	Votator II	LL119275A
			Extra Heavy Duty Votator II (obsolete after 2009)	LL118395
			Extra Heavy Duty Votator II (Current design)	128477+
21A	Shaft Locknut Wrench	1	All	79-2
21B	Hex Head Cap Screw	1	Spider Head Only	LL718934
22 *	Ball Bearing	1	Votator II	LL923215
			Extra Heavy Duty Votator II (obsolete after 2009)	LL118392
			Extra Heavy Duty Votator II (Current design)	128473+
22B	Sleeve Bearing	1	Spider Head Only	LL117679F
23	Hinged Sanitary Clamp	1	Votator II	0346223+
			Extra Heavy Duty Votator II (both designs)	0348223+
24 *	Bearing Sleeve	1	Extra Heavy Duty Votator II (obsolete after 2009)	LL118394
			Extra Heavy Duty Votator II (Current design)	128474+
24B	Shaft Sleeve	1	Spider Head Only	LL117680C
26 *	Stator	1	Extra Heavy Duty Votator II (Current design)	128475+
*	XHD Bearing Assembly	1	Extra Heavy Duty Votator II (Current design)	128472+

\* For the Extra Heavy Duty Bearing Option (Current Design) only, XHD Bearing Assembly (128472+) includes: item 22, Bearing (128473+); item 24, Bearing sleeve (128474+); and item 26, Stator (128475+). Order part number 128472+ to get these parts assembled at the factory.

### Cylinder Assembly - Shaft



#### Item 33 (Shaft) Part Numbers

##### 2-Row Staggered Blade Design Shafts

SIZE	SHAFT MODEL	PART #
6 x 24	4" dia	LL122760
	4-1/2" dia	LL936881
6 x 36	4" dia	LL935518
	4-1/2" dia	LL935563
	4-1/2" dia	LL935563
6 x 48	4" dia	LL936743
	4-1/2" dia	LL936786
	EHD 4" dia	LL122335
6 x 72	2-1/2" dia	LL935679
	4" dia	LL934809
	4-1/2" dia	LL935423
	EHD 4" dia	LL123534
	EHD 4-1/2" dia	LL122585
6 x 84	4" dia	LL124774
	4-1/2" dia	LL121858
	EHD 2-1/2" dia	131148+
	EHD 4" dia	131149+

##### 2-Row Inline Blade Design Shafts (2014)

SIZE	SHAFT MODEL	PART #
6 x 24	5-1/4" dia	135289+
6 x 36	5-1/4" dia	135375+
6 x 48	5-1/4" dia	135290+
6 x 72	5-1/4" dia	133003+
6 x 84	5-1/4" dia	135291+

##### 4-Row Inline Blade Design Shafts (1997)

SIZE	SHAFT MODEL	PART #
6 x 72	5-1/4" dia	LL936147
	EHD 5-1/4" dia	LL122617

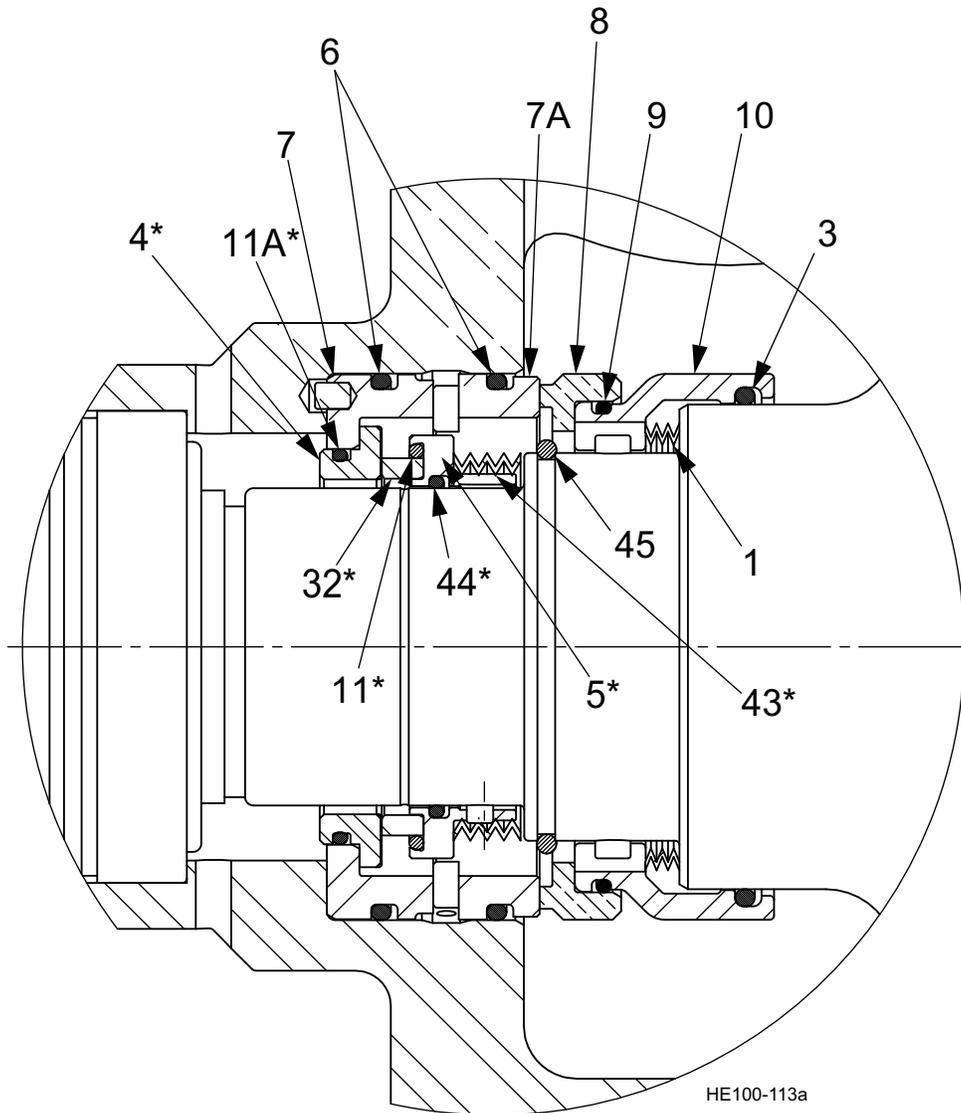
**NOTE:** These shaft designs can be used both with the 2012 Single and Double Mechanical Seal on page 71 as well as the Double Mechanical version of the One-Piece Seal on page 73. For shafts compatible with the obsolete Two-Piece Single Mechanical Seals, see page 77.

Description	Size	Part #
Shaft Skid, Standard (horizontal Votator only)	6 x 24	LL934744  132461+
	6 x 36	
	6 x 48	
	6 x 72	
	6 x 84	
Shaft Skid, Eccentric/Oval	all	LL934394

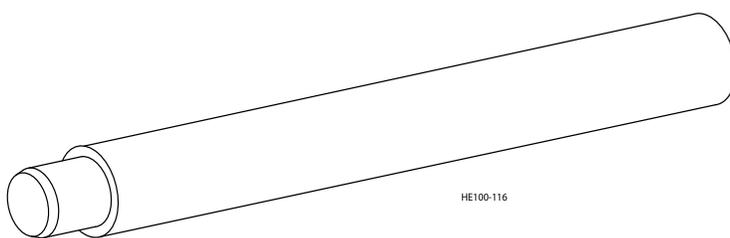
**Cylinder Assembly - Removable Tube****Item 27 (Removable Tube) Part Numbers**

SIZE	APPLICATION	CODE TYPE	DESCRIPTION	PART #	
6 x 24	LIQ	UM	316 SS TW/WO RINGS	LL936879	
		UM	316 SS CR	130906+	
		UM	NI/CR	134928+	
	VAPOR	UM	316 SS TW/W RINGS	LL118829	
		UM	NI/CR	135038+	
6 x 36	LIQ	UM	NI/CR	134929+	
		UM	316 SS TW/WO RINGS	LL930078	
		UM	ECC NI/CR	134935+	
		UM	316 SS TW/CR/WO RINGS	LL123554	
	VAPOR	UM	NI/CR	135039+	
		UM	316 SS TW/W RINGS	LL930077	
		UM	ECC 316 SS TW/CR/W RINGS	132087+	
6 x 48	LIQ	UM	NI/CR	134930+	
		UM	316 SS TW/WO RINGS	LL934342	
		UM	316 SS CR/WO RINGS	LL936802	
		UM	ECC NI/CR	134936+	
		UM	ECC SS TW/CR/WO RINGS	LL122369	
	VAPOR	UM	NI/CR	135040+	
		UM	316 SS TW/W RINGS	LL930582	
		UM	ECC NI/CR	135047+	
6 X 72	LIQ	UM	NI/CR	134931+	
		UM	316 SS TW/WO RINGS	LL929263	
		UM	316 SS TW/CR/WO RINGS	LL930735	
		UM	CS/CR	LL121057	
		UM	ECC NI/CR	135048+	
		UM	ECC TW/CR/WO RINGS	LL123513	
		UM	OVAL NI/CR (400 PSI & 60 PSI)	135210+	
		U	316 SS (800 PSI)	LL935644	
		VAPOR	U	NI/CR	135041+
			UM	316 SS TW/W RINGS	LL928761
			UM	CS/CR	LL120274
			UM	ECC NI/CR	135048+
			U	316 SS TW/CR/W RINGS	LL930351
	UM		OVAL NI/CR (400 PSI & 60 PSI)	135209+	
	U		316 SS (800 PSI)	LL928641	
	6 X 84	LIQ	UM	316 SS TW/WO RINGS	LL122017
			UM	NI/CR	134932+
UM			316 SS TW/CR W/O RINGS	LL125960	
UM			CS/CR	LL121059	
VAPOR			UM	316 SS TW/WO RINGS	LL122018
		UM	316 SS TW/W RINGS	LL122019	
		UM	316 SS TW/CR W/RINGS	LL124775	
		UM	CS/CR	LL121058	
		UM	NI/CR	135042+	

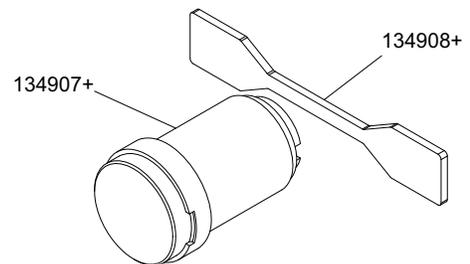
**2012 Single and Double Mechanical Seal**



\* Used on Double Mechanical Seal only



**ODE Head Installation/Removal Tool  
LL121191**



**Seal Installation/Removal Tool Kit  
135228+**

Use ODE Head Installation Tool LL121191 to protect head insert when installing or removing the opposite drive end product head. Seal installation tool kit 135228+ can be used for inserting and removing the gland and seal. The small end is used for secondary seal installation and removal and removal of the gland and seat. The large end is used for gland and seal seat installation.

## 2012 Single and Double Mechanical Seal

ITEM	DESCRIPTION	QTY PER SEAL	MATERIAL OPTION	PART #
1	Spring-VII Product Seal (Wavy Washer)	1	Standard	LL922313A
			Buna	N70237
3	O-ring	1	EPDM	E70237
			FKM	V70237-680
4*	Seal ring	1	Chrome oxide	LL934871
5*	Seal Body-VII Secondary	1		LL932357
			Buna	N70239
6	O-ring	2	EPDM	E70239
			FKM	V70239
7	Gland-VII Pinned Seal Seat	1	316LSS	129426+
			Ceramic	122986+
7A	Seat-Seal Head Insert	1	Silicon Carbide	122987+
			Tungsten Carbide	122988+
			Carbon	129059+
			Silicon Carbide	129061+
8	Seal Face-VII Rotary	1	Tungsten Carbide	129062+
			Tungsten Carbide (narrow face)	129402+
			Buna	N70152
9	O-ring	1	EPDM	E70152
			FKM	V70152
10	Seal Body-VII Positive Drive	1	Standard	128896+
			Buna	N70147
11*	O-ring	1	EPDM	E70147
			FKM	V70147
			Buna	N70146
11A*	O-ring	1	EPDM	E70146
			FKM	V70146
32*	Insert-Seal Body	1		LL934083
43*	Spring-VII Outer Seal (Wavy Washer)	1	Standard	LL932362
			Buna	N70140
44*	O-ring	1	EPDM	E70140
			FKM	V70140
			Buna	N70230
45	O-ring	1	EPDM	E70230
			FKM	V70230

Seal face material options (items 7A and 8): Permissible material combinations are: Carbon/Ceramic; Carbon/Silicon Carbide; Silicon Carbide/Silicon Carbide; and Tungsten Carbide/Silicon Carbide.

Items 4, 5, 11, 11A, 32, 43, and 44 are required when the seal must be flushed.

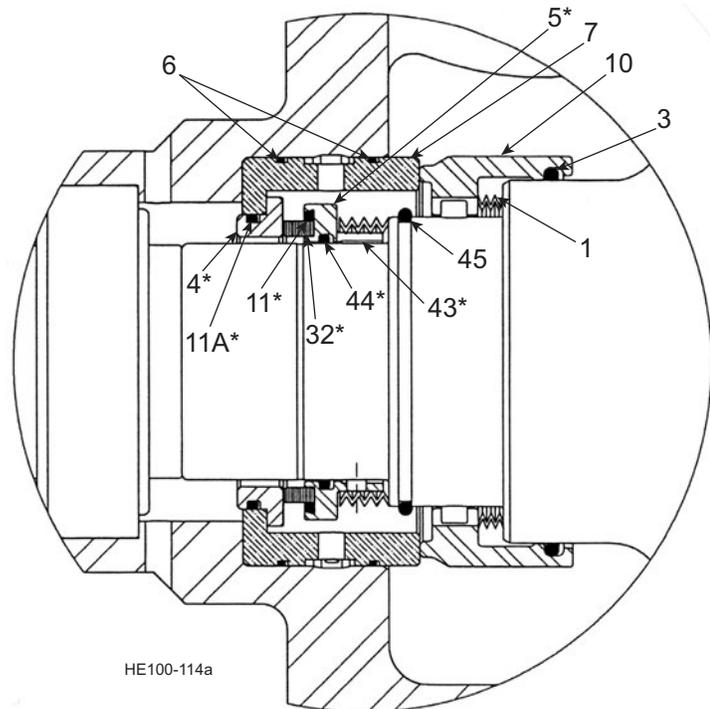
\* Used on Double Mechanical Seal only.

## One-Piece Single & Double Mechanical Seal (2005-2012)

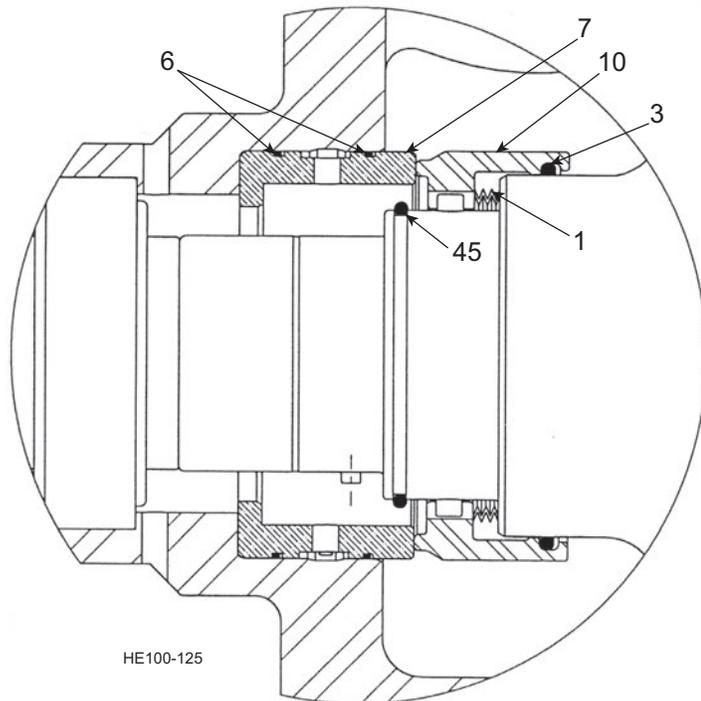
### 2005 Mechanical Seal Design

Units furnished between 2005 and 2012 have a one-piece chrome-oxide coated rotating body running against a stationary ceramic head insert. It can easily be converted to a double mechanical seal by adding secondary components (indicated with \*) to contain a steam or water flush.

### Double Mechanical Seal - Secondary



### Single Mechanical Seal - Primary

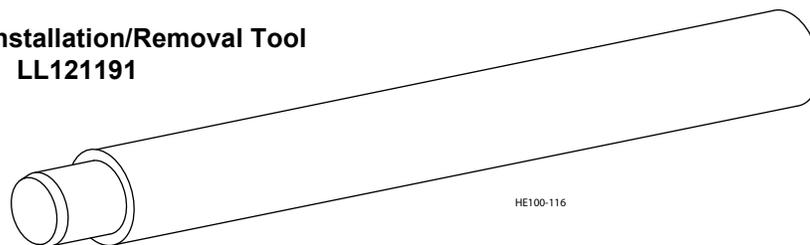


**One-Piece Single & Double Mechanical Seal, 2005-2012**

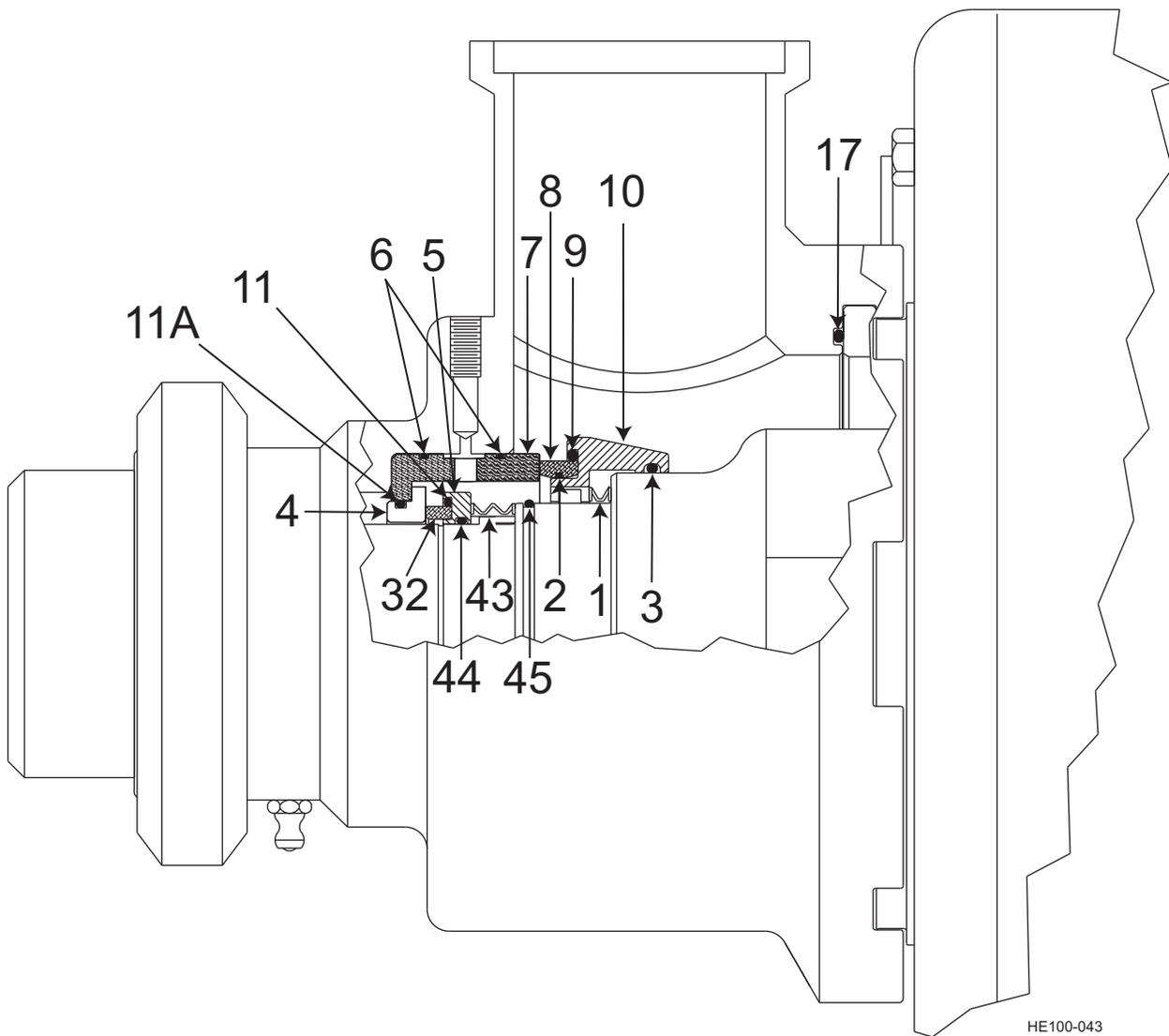
ITEM	DESCRIPTION	QTY PER SEAL	MATERIAL OPTION	PART #
1	Wavy Washer (Primary)	1	Standard	LL922313
3	Seal Body O-ring (Primary)	1	Buna	N70237
			EPDM	E70237
			FKM	V70237-680
4*	Seal Ring (Secondary), if required	1	All	LL934871
5*	Seal Body (Secondary), if required	1	All	LL932357
			Buna	N70044
			EPDM	E70044
6	Seal Head Insert O-ring (Primary)	2	FKM	V70044-680
			Ceramic	LL934873
7	Seal Head Insert (Primary)	1	Ceramic	LL934873
10	One Piece Seal Body (Primary)	1	Chrome Oxide/316SS	LL122411
11*	Seal Ring/Body O-ring (Secondary)	1	Buna	N70147
			EPDM	E70147
			FKM	V70147
11A*	Seal Ring/Body O-ring (Secondary)	1	Buna	N70146
			EPDM	E70146
			FKM	V70146
17	Product Head O-ring	2 per cyl	Buna	N70259
			EPDM	E70259
			FKM	V70259-680
32*	Seal Body Insert (Secondary)	1	All	LL934083
43*	Wavy Washer (Secondary)	1	All	LL932362
44*	Seal Body O-ring (I.D. Secondary)	1	Buna	N70140
			FKM	V70140
			EPDM	E70140
45	Seal Keeper O-ring (Primary)	1	Buna	N70230
			FKM	V70230
			EPDM	E70230

**NOTE:** Use ODE Head Installation Tool LL121191 to protect head insert when installing or removing the opposite drive end product head.

**ODE Head Installation/Removal Tool  
LL121191**



## Two-Piece Single & Double Mechanical Seal, 2000-2004



HE100-043

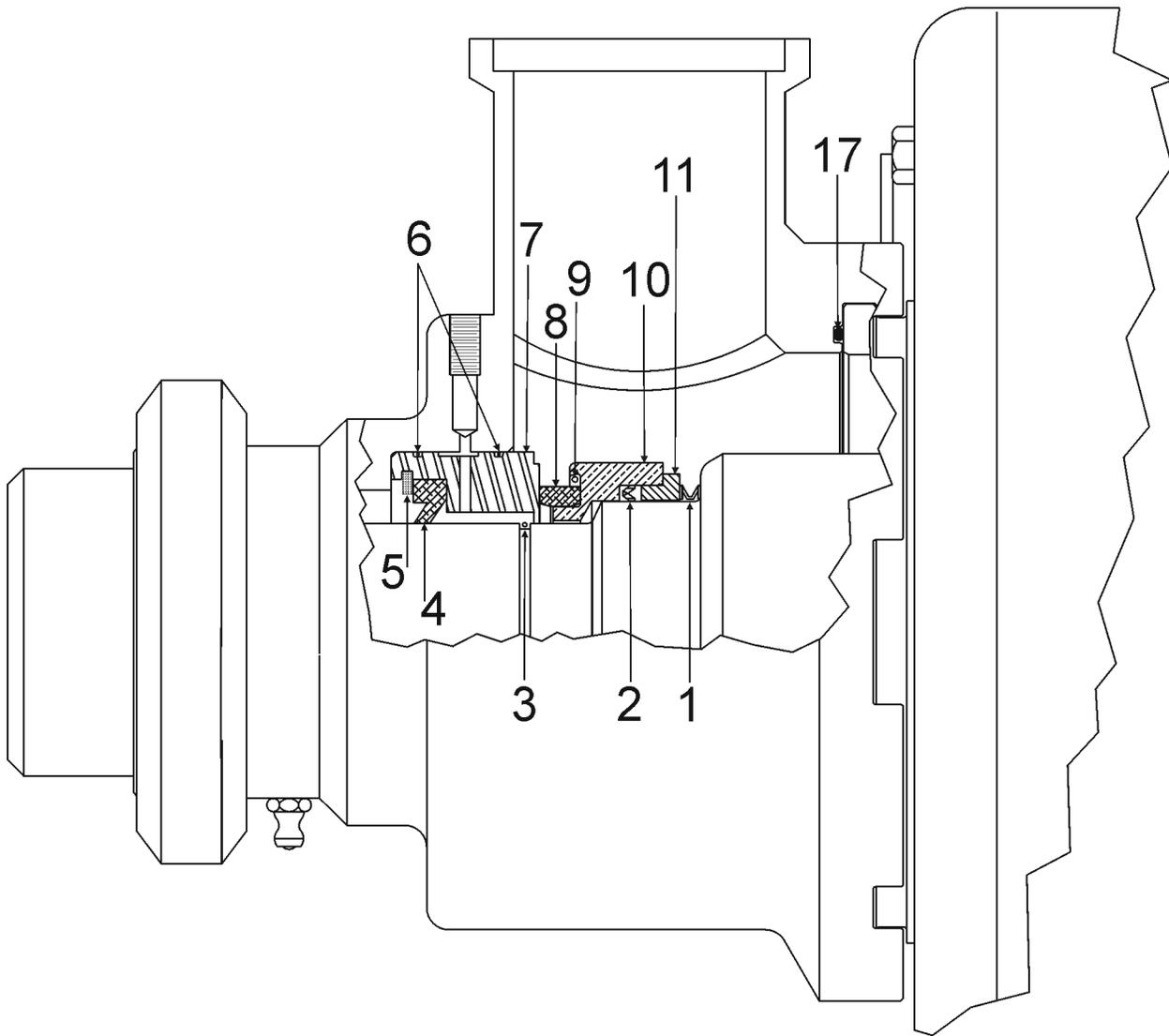
This is the standard mechanical seal for most Votator IIs manufactured between 2000 and 2004. The primary seal body is positioned on the 2.75-inch stub ends on the mutator. If the unit has a double mechanical seal, including secondary items 4, 5, 11, 11A, 32, 43, and 44, the secondary seal body (Item 5) is positioned on the 2.25-inch stub ends of the mutator.

An alternative seal available is the Ball-Lock Seal Design, which must be reviewed by Application Engineering.

**Two-Piece Single & Double Mechanical Seal, 2000-2004**

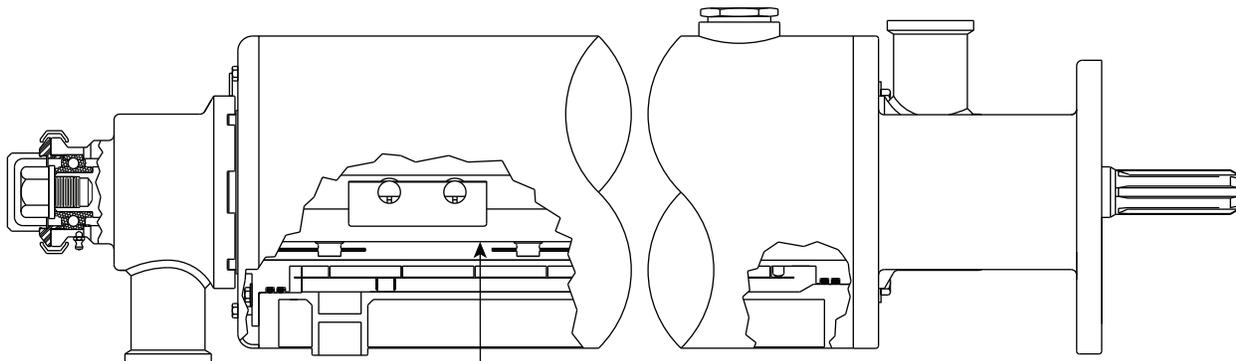
ITEM	DESCRIPTION	QTY PER SEAL	MATERIAL OPTION	PART #
1	Wavy Washer (Primary)	1	Standard	LL922313
2	Seal Body Insert O-ring (I.D. Primary)	1	Buna	N70042-674
			EPDM	E70042
3	Seal Body O-ring (Primary)	1	Buna	N70237
			EPDM	E70237
			FKM	V70237-680
4	Seal Ring (Secondary), if required	1	All	LL934871
5	Seal Body (Secondary), if required	1	All	LL932357
6	Seal Head Insert O-ring (Primary)	2	Buna	N70044
			EPDM	E70044
			FKM	V70044-680
7	Seal Head Insert (Primary)	1	Ceramic	LL934873
			Carbon	LL932351
8	Seal Body Insert (Primary)	1	Siliconized Graphite	LL932352
			Ceramic	LL934332
			Buna	N70240
9	Seal Body Insert O-ring (O.D. Primary)	1	EPDM	E70240
			FKM	V70240-680
			All	LL932358
10	Seal Body (Primary)	1	Buna	N70147
			EPDM	E70147
			FKM	V70147
11A	O-ring	1	Buna	N70146
			EPDM	E70146
			FKM	V70146
17	Product Head O-ring	2 per cyl	Buna	N70259
			EPDM	E70260
			FKM	V70260-680
32	Seal Body Insert (Secondary)	1	All	LL934083
43	Wavy Washer (Secondary)	1	All	LL932362
44	Seal Body O-ring (I.D. Secondary)	1	Buna	N70140
			EPDM	E70140
			FKM	V70140
45	Seal Keeper O-ring (Primary)	1	Buna	N70230
			EPDM	E70230
			FKM	V70230

**Two-Piece Single Mechanical Seal (with flushing lip seal), 1997-2004**



HE100-042

**Shaft (item 33) as shown in Cylinder Assembly**



33

HE100-040a

**Two-Piece Single Mechanical Seal (with flushing lip seal), 1997-2004**

ITEM	DESCRIPTION	QTY per seal	MATERIAL OPTION	PART #
1	Wavy Washer	1	Standard	LL922313
			Particulate Option	LL19625A
2	Seal Body U-cup	1	Buna	LL700014A05
			EPDM	LL700014A03
			FKM	LL700014A08
3	Seal Keeper O-ring	1	Buna	N70226
			EPDM	E70226
			FKM	V70226-680
4	Flushing Lip Seal	1	All	LL925472
5	Retaining Ring	1	All	LL930685
6	Seal Head Insert O-ring	2	Buna	N70044
			EPDM	E70044
			FKM	V70044-680
7	Seal Head Insert	1	Chrome Oxide/316 SS	LL923210
			Ceramic	LL928508
			Carbon	LL110892A4
8	Seal Body Insert	1	Siliconized Graphite	LL929270
			Ceramic	LL110892C1
			Pin Option (Ceramic)	LL934610
			Buna	N70235
9	Seal Body Insert O-ring	1	EPDM	E70235
			FKM	V70235-680
			Standard	LL110893A
10	Seal Body	1	Pin Option	LL927352
			Standard	LL110203CI
11	Seal Back Up Ring	1	Buna	N70259
			EPDM	E70259
			FKM	V70259-680
17	Product Head O-ring	2 per cyl	Buna	N70259
			EPDM	E70259
			FKM	V70259-680

**NOTE:** Use ODE Head Installation Tool LL121191 to protect head insert when installing or removing the opposite drive end product head.

**NOTE:** Items 4, 5, 11, 11A, 32, 43, and 44 are required when the seal must be flushed.

**Shafts for Two-Piece Single Mechanical Seal**

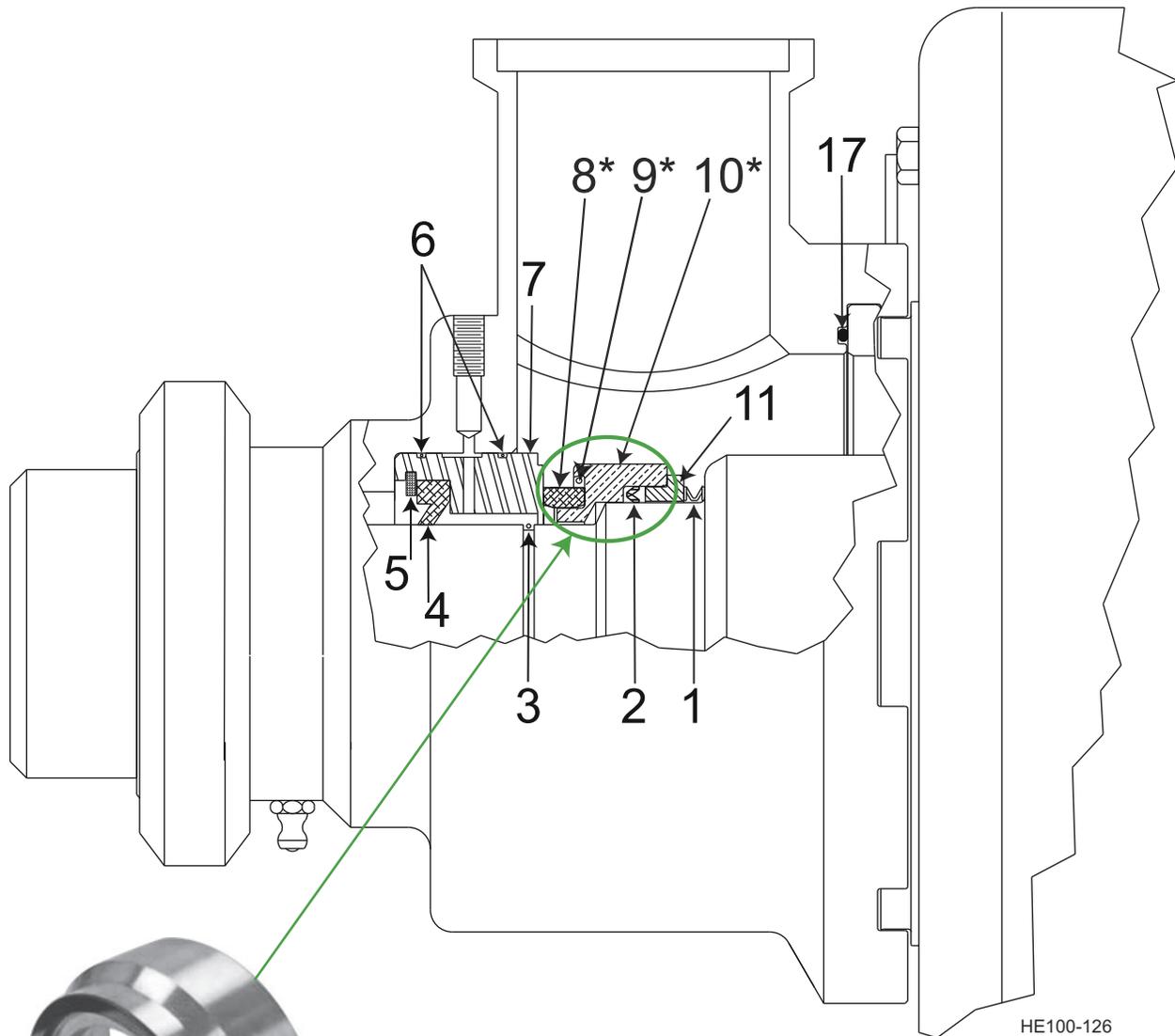
See item 33 in Cylinder Assembly

SIZE	SHAFT MODEL	PART #
6 x 24	5-1/4" dia	LL118919
6 x 36	2-1/2" dia	LL935989
	4" dia	LL930524
	4-1/2" dia	LL936898
6 x 48	2-1/2" dia	LL935987
	4" dia	LL936764
	4-1/2" dia	LL936765
	5-1/4" dia	LL935921

SIZE	SHAFT MODEL	PART #
6 x 72	2-1/2" dia	LL936763
	4" dia	LL929847
	4-1/2" dia	LL935650
	5-1/4" dia	LL929872
	ECC 4" dia	LL936761
6 x 84	EHD 4-1/2" dia	LL123855
	4-1/2" dia	LL122304

**NOTE:** For current standard shafts, see page 68.

**Two-Piece Single Mechanical Seal  
(Retrofit of the One-Piece Design - 2005)**



**Optional Replacement  
One-Piece Seal LL122410**

This is the standard rotating single mechanical seal for all Votator IIs manufactured between 1997 and 2004. The seal body is positioned on the 2.25-inch diameter stub ends of the mutator. This seal can be retrofitted to a one piece design by replacing items 8, 9, and 10 with a chrome oxide one piece body, p/n LL122410, and running it against a ceramic head insert, part number LL928508.

## Two-Piece Single Mechanical Seal (Retrofit of the One-Piece Design - 2005)

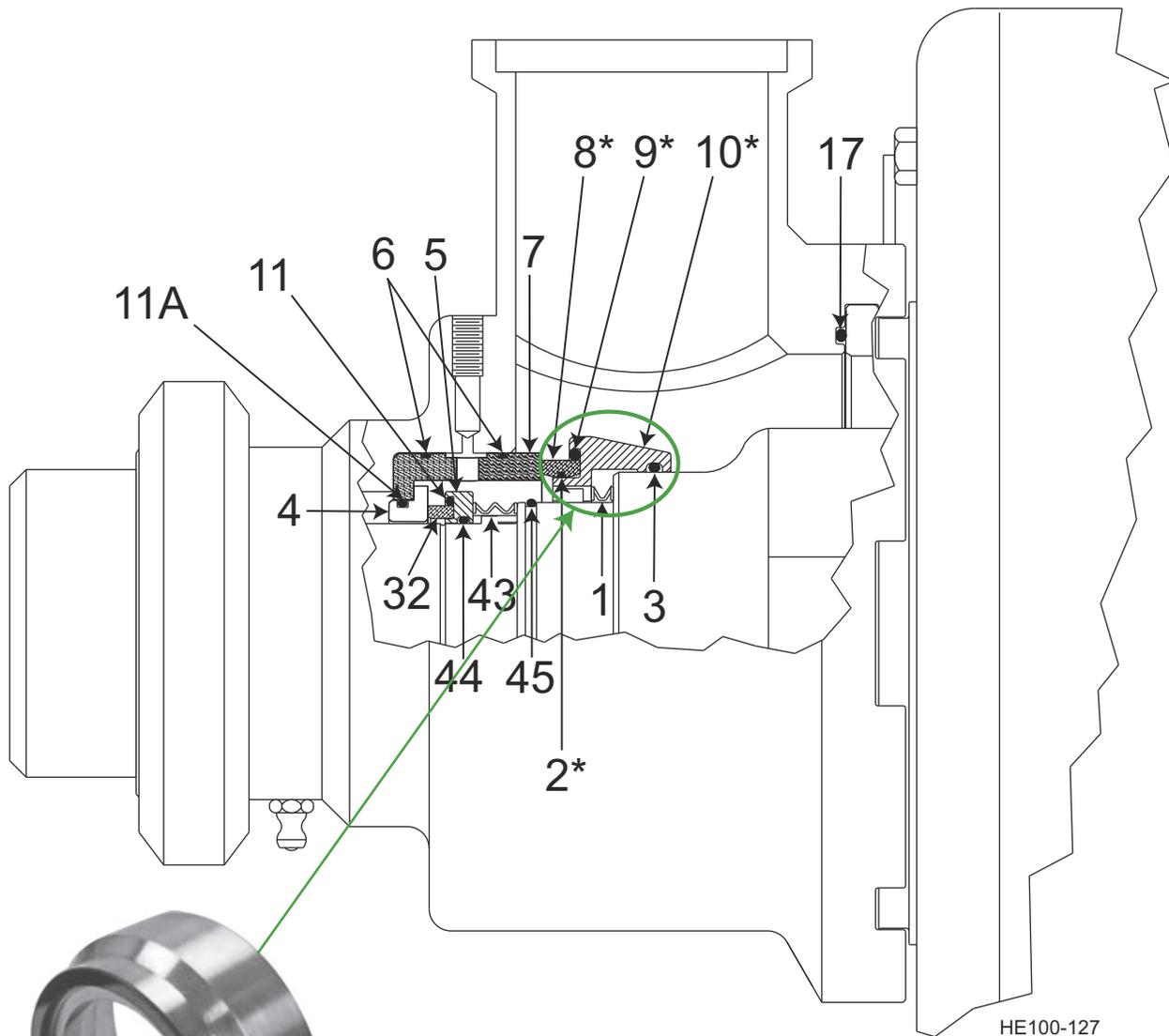
ITEM	DESCRIPTION	QTY per seal	MATERIAL OPTION	PART #
1	Wavy Washer	1	Standard	LL922313
			Particulate Option	LL19625A
2	Seal Body U-cup	1	Buna	LL700014A05
			EPDM	LL700014A03
			FKM	LL700014A08
3	Seal Keeper O-ring	1	Buna	N70226
			EPDM	E70226
			FKM	V70226-680
4	Flushing Lip Seal	1	All	LL925472
5	Retaining Ring	1	All	LL930685
6	Seal Head Insert O-ring	2	Buna	N70044
			EPDM	E70044
			FKM	V70044-680
7	Seal Head Insert	1	Chrome Oxide/316 SS	LL923210
			Ceramic	LL928508
8*	Seal Body Insert	1	Carbon	LL110892A4
			Siliconized Graphite	LL929270
			Ceramic	LL110892C1
			Pin Option (Ceramic)	LL934610
9*	Seal Body Insert O-ring	1	Buna	N70235
			EPDM	E70235
			FKM	V70235-680
10*	Seal Body	1	Standard	LL110893A
			Pin Option	LL927352
11	Seal Back Up Ring	1	Standard	LL110203C1
17	Product Head O-ring	2 per cyl	Buna	N70259
			EPDM	E70259
			FKM	V70259-680

**NOTE:** Use ODE Head Installation Tool LL121191 to protect head insert when installing or removing the opposite drive end product head.

**NOTE:** Items 4, 5, 11, 11A, 32, 43, and 44 are required when the seal must be flushed.

\* This seal can be retrofitted to a one piece design by replacing items 8, 9, and 10 with a chrome oxide one piece body, p/n LL122410

**Two-Piece Double Mechanical Seal  
(Retrofit of the One-Piece Design - 2005)**



**Optional Replacement  
One-Piece Seal LL122411**

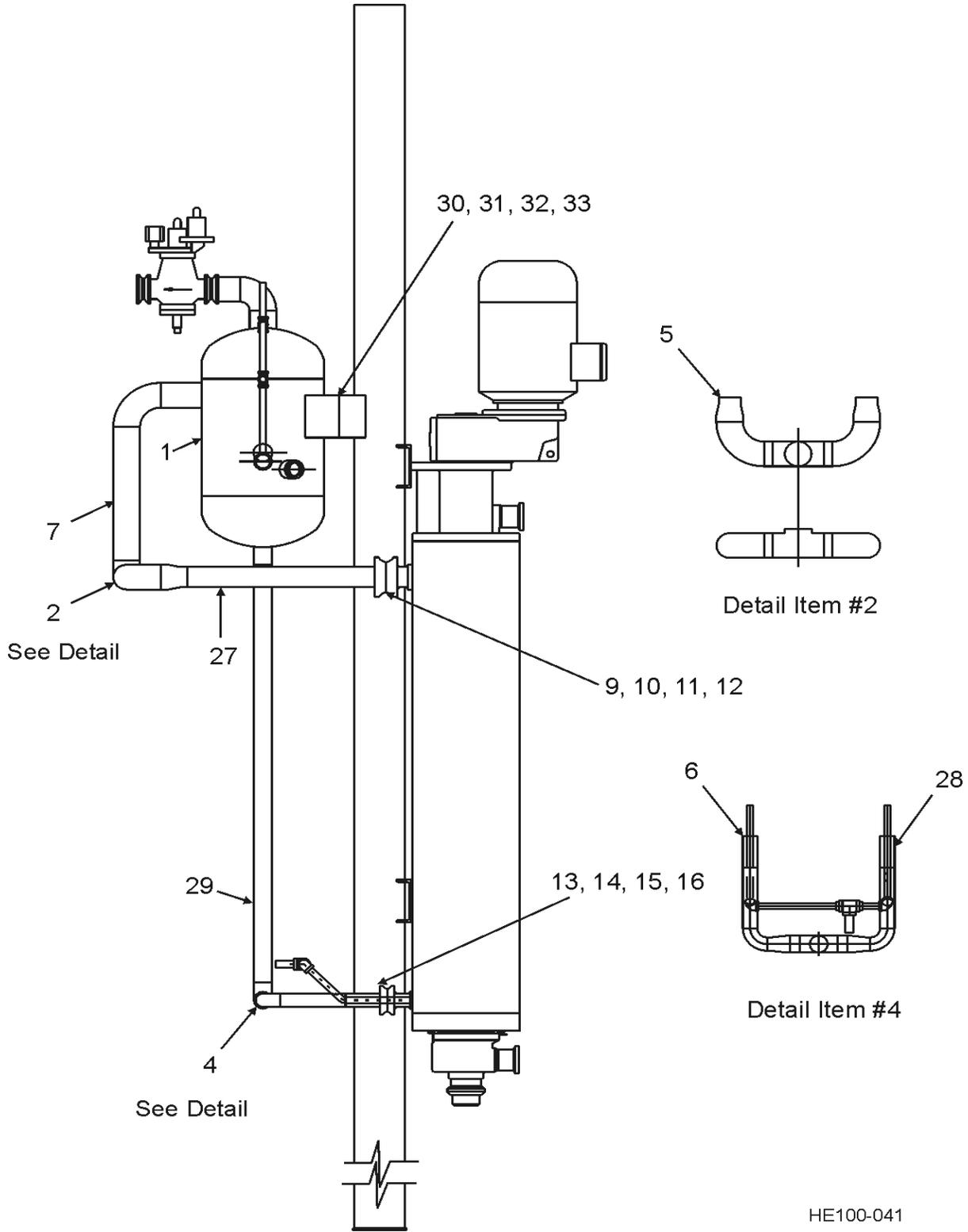
This is the standard double mechanical seal for all Votator IIs manufactured between 2000 and 2004. The primary seal body is positioned on the 2.75-inch diameter stub ends of the mutator and the secondary seal body (Item 5) is positioned on the 2.25-inch diameter stub ends. The two-piece primary seal body can be retrofitted to a one-piece design by replacing items 2, 8, 9, and 10 with a chrome oxide seal body, p/n LL122411 running against a ceramic head insert, p/n LL934873.

## Two-Piece Double Mechanical Seal (Retrofit of the One-Piece Design - 2005)

ITEM	DESCRIPTION	QTY per seal	MATERIAL OPTION	PART #
1	Wavy Washer (Primary)	1	Standard	LL922313
2*	Seal Body Insert O-ring (I.D. Primary)	1	Buna	N70042-674
			EPDM	E70042
			FKM	V70042
3	Seal Body O-ring (Primary)	1	Buna	N70237
			EPDM	E70237
			FKM	V70237-680
4	Seal Ring (Secondary)	1	All	LL934871
5	Seal Body (Secondary)	1	All	LL932357
6	Seal Head Insert O-ring (Primary)	2	Buna	N70044
			EPDM	E70044
			FKM	V70044-680
7	Seal Head Insert (Primary)	1	Chrome Oxide/316 SS	LL934872
			Ceramic	LL934873
8*	Seal Body Insert (Primary)	1	Carbon	LL932351
			Siliconized Graphite	LL932352
			Ceramic	LL934332
9*	Seal Body Insert O-ring (O.D. Primary)	1	Buna	N70240
			EPDM	E70240
			FKM	V70240-680
10*	Seal Body (Primary)	1	All	LL932358
11	Seal Ring/Body O-ring (Secondary)	1	Buna	N70147
			EPDM	E70147
			FKM	V70147
11A	O-ring	1	Buna	N70146
			EPDM	E70146
			FKM	V70146
17	Product Head O-ring	2 per cyl	Buna	N70259
			EPDM	E70259
			FKM	V70259-680
32	Seal Body Insert (Secondary)	1	All	LL934083
43	Wavy Washer (Secondary)	1	All	LL932362
44	Seal Body O-ring (I.D. Secondary)	1	Buna	N70140
			EPDM	E70140
			FKM	V70140
45	Seal Keeper O-ring (Primary)	1	Buna	N70230
			EPDM	E70230
			FKM	V70230

\* This seal can be retrofitted to a one piece design by replacing items 2, 8, 9, and 10 with a chrome oxide seal body, p/n LL122411.

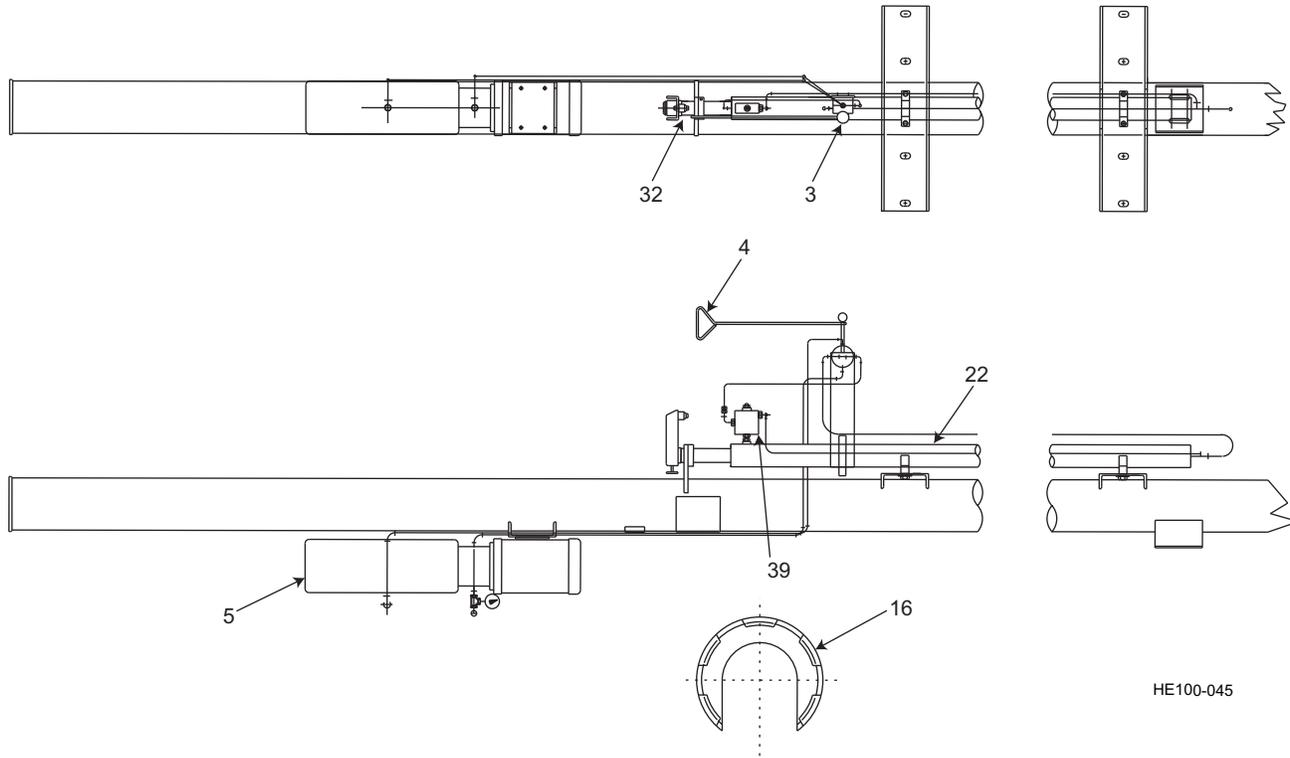
### Vertical Refrigeration Piping



## Vertical Refrigeration Piping

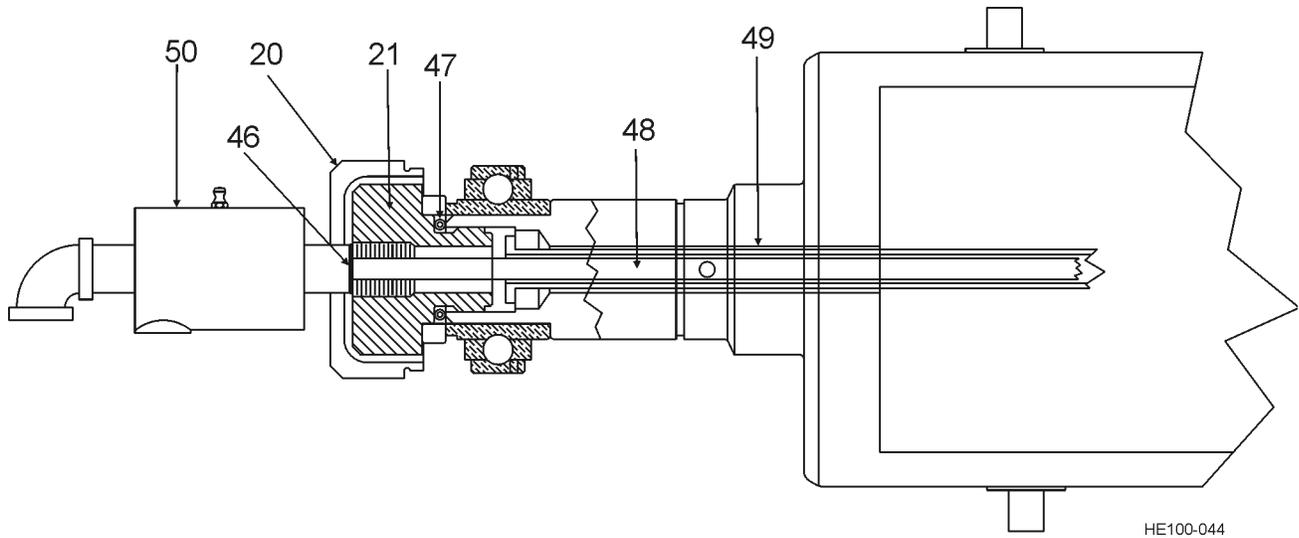
ITEM	DESCRIPTION	QTY per Acc	NOTES	PART #
1	Accumulator	1	16" Diameter	LL929516
2	Refrigeration Piping	1	Upper Accumulator Piping	LL930348
4	Refrigeration Piping	1	Lower Accumulator Piping	LL930349
5	Weld Cap	AR	One Cylinder Only	LL901386
6	Weld Cap	AR	One Cylinder Only	LL901387
7	Refrigeration Piping	1	Upper Accumulator Piping	LL930347
9	S W Refrigeration Flange	AR	2-1/2 Male	LL700017A62
10	Refrigeration Flange Gasket	AR	2-1/2	LL710260
11	Square Head Machine Bolt	4 per flg	3/4 - 10 x 3-1/2 Lg	LL723931
12	Hex Nut	4 per flg	3/4 - 10	LL710112
13	S W Refrigeration Flange	AR	1-1/2 Female	LL919616
14	Refrigeration Flange Gasket	AR	1-1/2	LL917488
15	Square Head Machine Bolt	4 per flg	5/8 - 11 x 3 Lg	LL301535
16	Hex Nut	4 per flg	5/8 - 11	LL710011
27	Carbon Steel Pipe	AR	2-1/2 Sch 40	LL006396
28	Carbon Steel Pipe	AR	1-1/2 Sch 80	LL003028
29	Carbon Steel Pipe	AR	2 Sch 40	LL001149
30	Hex Head Cap Screw	2	1/2 - 13 x 1 Lg	LL712482
31	Flat Washer	2	1/2	LL710292
32	Spring Lock washer	2	1/2	LL712553
33	Hex Nut	2	1/2 - 13	LL711662

**Vertical Frame/Hydraulics**



ITEM	DESCRIPTION	QTY per pole	MODEL	PART #
3	Hydraulic Valve	1	All	LL928736
4	Push - Pull Handle	1	All	LL929343
5	Hydraulic Power Assembly,	1	3/4 HP CLR	LL121635
			3/4 HP CLR	LL928737
			3/4 HP CLR	
			3/4 HP CLR	
			3/4 HP CLR	
			3/4 HP CLR	
	Pump/Adapter Kit Only	1		LL928737-1
16	Shaft Stop Clamp	1	4" Shaft	LL935529
			4-1/2" Shaft	LL931279
			5-1/4" Shaft	LL935191
22	Hydraulic Cylinder	1	6 x 24 Cylinder	LL121897
			6 x 36 Cylinder	LL121898
			6 x 48 Cylinder	LL121899
			6 x 72 Cylinder	LL121884
			6 x 84 Cylinder	LL121900
32	Pivot Pin	1	All	LL928742
39	Counter-Balance Valve	1	All	LL936709

**Shaft Heater (Optional)**



ITEM	DESCRIPTION	MODEL	QTY	PART #
20	Shaft Nut Guard	All	1	LL929346
21	Shaft Locknut	All	1	LL119275A
46	Gasket	All	1	LL117720
47	O-ring	All	1	N70222-674
48	Shaft Heater Pipe	6 x 24 Cylinder	1	LL123001
		6 x 36 Cylinder	1	LL112278E
		6 x 48 Cylinder		
		6 x 72 Cylinder		
		6 x 84 Cylinder		
49	Heater Pipe Support	6 x 24 Cylinder	1	LL936930
		6 x 36 Cylinder	1	LL934075
		6 x 48 Cylinder	1	LL936598
		6 x 72 Cylinder	1	LL929942
		6 x 84 Cylinder	1	LL123553
50	Rotary Joint	All	1	LL700043D61

## Troubleshooting

<b>Problem</b>	<b>Possible cause</b>	<b>Suggested action</b>
<b>Freeze-up.</b>	Power failure.	Check power supply.
	Product outlet temperature too low.	Adjust process to raise product outlet temperature.
	Product flow rate too low.	Adjust process to increase product flow. Check that pump is matched to process.
	Product ran out of supply tank prematurely.	Adjust supply to prevent supply lines from running dry.
	Incorrect start-shutdown procedure.	Refer to “Startup Procedure” on page 36.
<b>Heat transfer not at expected level.</b>	Process not set correctly.	Check current process to system specs at time of installation.
	Product pressure lower than steam pressure in jacket.	Utilize back valve to assure that system pressure is at a minimum of 10 psi (0.7 bar) above the media pressure.
	Oil in system.	Check and drain oil regularly from accumulator and other oil separators, oil legs or pots in refrigeration system.
	Steam on jacket super heated.	Use only dry and saturated steam.
	Oil deposits on transfer tube.	Remove heat transfer tube and clean any deposits on tube. Add filter system to remove impurities from cooling agents.
	Liquid flow rate on jacket too low.	Use jacket recycle loop at a flow of 50 GPM.
	One or several system valves or floats not functioning properly.	Inspect and test system valves and floats as indicated in “Preventive Maintenance” on page 42. Replace as necessary.
	Water and air in cooling system.	See “Water and Air in Refrigeration System” on page 89.
<b>Tube Scoring.</b>	Temperature extremes.	Replace tube if scoring becomes great. Refer to “Care of Heat Exchanger Tube” on page 44.
<b>Lower back pressure required to achieve desired refrigerant temperatures.</b>	System operating at a high vacuum causing water in refrigeration system.	Refer to “Water and Air in Refrigeration System” on page 89.
<b>Increased compressor head pressure.</b>	Air in refrigeration system.	Refer to “Water and Air in Refrigeration System” on page 89.

<b>Problem</b>	<b>Possible cause</b>	<b>Suggested action</b>
<b>Increased gas discharge temperature.</b>	Air in refrigeration system.	Refer to “Water and Air in Refrigeration System” on page 89.
<b>Seal head will not install properly.</b>	Twisted when installed.	Lubricate before installing.
	Installed wrong size, distorted o-ring, or cut o-ring.	Replace o-ring.
	Wrong o-ring compound (ring is a different color than normal).	Replace with specified o-ring. If unsure of correct o-ring, contact SPX FLOW.
	Damaged seal head insert.	Replace entire seal.
	Recess in head for seal head insert damaged.	Contact SPX FLOW for repair instructions.
<b>Leakage across seal body.</b>	O-ring twisted when installed.	Lubricate before installing.
	Wrong o-ring compound (ring is a different color than normal).	Replace with specified o-ring. If unsure of correct o-ring contact SPX FLOW.
	Damaged seal body.	Replace entire seal.
	Damaged seal backing ring.	Replace seal backing ring.
	Damaged shaft at o-ring sealing surface.	Contact SPX FLOW for repair instructions.
	Seal ring rotating in seal body.	Assemble ring in body without lubrication.

Problem	Possible cause	Suggested action
<b>Product leaking:</b>	Seal insert cocked when installed.	Remove and reinstall, making sure the o-ring is not twisted.
• Between lapped or polished surfaces of seal head insert and seal body.	Seal body and/or seal faces worn or damaged.	Replace entire seal.
• Around o-rings of interface of head and seal head insert.	Seal insert cracked.	Replace seal insert.
• Around interface of seal body and shaft.	Seal springs weak.	Replace springs.
	Seal backing ring deformed.	Replace backing ring.
	Seal body freedom diminished.	Disassemble, clean, inspect, lubricate pieces and reassemble.
	Seal drive pin worn or missing.	Replace with new seal drive pin.
	Seal retaining ring out of place.	Inspect retaining ring and lip seal. Replace as necessary.
	Insufficient spring pressure to hold body and insert together after several hours of running.	Replace springs.
	Seal body and/or seal insert damaged by handling.	Always lay seal faces on clean cloth. Move mutator shaft into operating position carefully. Do not ram shaft into place. Inspect seal for damage, replace as necessary.
	New or repaired seal body installed against a worn or damaged seal insert, a worn part, or a worn seal body.	Both need to be in good condition. Replace.
	Excessive wear of seal body insert.	Do not operate shaft for more than a few moments without product in cylinder.
	Seal drive pins too high.	Install per dimensions on page 57 or 61 of manual.

## Unthawing A Frozen System

To unthaw a system that has frozen-up, perform the following procedures. The cause of freeze-up **MUST BE** corrected before operation is restarted. See the Troubleshooting Chart starting on page 86 for cause and solution aids.

1. Turn refrigeration or coolant source OFF.
2. Heat mutator shaft with shaft heater attachment using hot water (if applicable).
3. Cautiously pump hot water or hot product through unit. Immediately shut down pump if excessive pressure is encountered. If hot gas defrost line is connected, thaw by blowing hot gas through the jacket
4. Continue pumping until shaft can be rotated by bumping the motor.
5. Severe freeze-ups may necessitate disassembly of equipment to remove blockage.
6. Resume normal start-up procedure. The cause of freeze-up **MUST BE** corrected before operation is restarted. See the Troubleshooting Chart on page 86 for cause and solution aids.

## Water and Air in Refrigeration System

Water and ammonia combine to form ammonium hydroxide, which combines with oil to form sludge. Sludge is extremely difficult to remove.

Water condenses at the accumulator's pressure and temperature and remains to dilute the liquid ammonia. Ammonia diluted with water has a higher boiling point that requires lower back pressure to achieve the desired refrigerant temperature.

Air in ammonia increases the compressor head pressure and increases the gas discharge temperature. Higher head pressure and temperature may carbonize or vaporize oil. Air also contains moisture that the ammonia refrigerant absorbs.

To avoid difficulties with water and air:

- Regularly purge refrigeration system of air and noncombustible gases. An automatic air purger in the system is recommended.
- Grease all valve stems to keep packing soft. Soft packing allows a better seal to prevent leakage of air past stems, if the systems ever separate on a vacuum.
- Tighten up stuffing boxes to seal out air and moisture.
- Avoid operating system on a high vacuum.

**Notes**



Votator<sup>®</sup> II

SCRAPED SURFACE HEAT EXCHANGER

**SPXFLOW**

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