Lifeline Medical Systems

# Installation, Operation and Maintenance Manual

## LPV "Camel" Liquid Ring Medical Vacuum System

NASH Pump - Type 1 Configuration
Sizes: 3, 5, 7½ and 10 HP - Delta Series
3, 5, 7½ HP - MHF Series

This unit purchased from: _____

Date purchased: _____

Model number: _____

Serial number: _____

Option(s) included: _____

Any information, service or spare parts requests should include the machine serial number and be directed to:

**BEACONMEDÆS**
1800 Overview Drive
Rock Hill, SC 29730

Telephone: (803) 817-5600
Fax: (803) 817-5750

**BeaconMedæs reserves the right to make changes and improvements to update products sold previously and support materials without notice or obligation.**

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# Safety Precautions

The operator should carefully read the entire contents of this manual before installing, wiring, starting, operating, adjusting and maintaining the system.

The operator is expected to use common-sense safety precautions, good workmanship practices' and follow any related local safety precautions.

In addition:

- **Before starting any installation or maintenance procedures, disconnect all power to the package.**
- All electrical procedures must be in compliance with all national, state and local codes and requirements.
- All wiring should be connected by a certified electrician.
- Refer to the electrical wiring diagram provided with the unit before starting any installation or maintenance work.
- **Do not operate until pump is initially primed and connected to a constant supply of clean compressant liquid. THE PUMP WILL BE DAMAGED IF RUN DRY.** Always use a strainer to prevent sand and scale from entering the pump with liquid. Certain operating conditions in combination with water hardness may result in excessive lime deposits within the pump, which can cause it to bind. Should this condition be evident, flush the pump with a solvent at regular intervals. Contact your local **BeaconMedæs** representative for more information. Each pump has been drained and flushed with a water-soluble rust inhibitor prior to shipment. After the pump has been in service, do not store without draining as specified within this manual, since freezing can damage the pump.
- Release all vacuum from the package before removing, loosening, or servicing any covers, guards, fittings, connections, or other devices.
- Notify appropriate hospital personnel if repairs or maintenance will affect available vacuum levels.
- Prior to using the LifeLine Medical Vacuum System, the medical facility must have a Certifier perform all installation tests as specified in NFPA 99. The medical facility is also responsible for ensuring that the medical vacuum system meets the minimum requirements for medical vacuum as specified in NFPA 99.
- This is a high-speed rotating piece of machinery. Do not attempt to service any part while the machine is in operation.
- To prevent automatic starting, disconnect all electrical power before performing any maintenance functions.
- Do not operate unit without guards, shields or screens in place.
- Make sure that all loose articles, packing material, and tools are clear of the package.
- Check all safety devices periodically for proper operation.
- **Do not add lubricating oil** of any kind to the vacuum pump. Absolutely no oil is required for proper operation.
- Electrical service must be the same as specified on the control panel nameplate or damage to the equipment may occur.
- Vibration during shipment can loosen electrical terminals, fuse inserts, and mechanical connections. Tighten as necessary.

# 1. Installation

## 1.1 Uncrating

Upon delivery, the condition of the **LifeLine** "Camel" Medical Vacuum System should be carefully inspected. Any indication of damage by the carrier should be noted on the delivery receipt, especially if the system will not be immediately uncrated and installed. **BeaconMedæs** ships all systems F.O.B. factory; therefore, damage is the responsibility of the carrier, and all claims must be made with them. **LifeLine** systems may remain in their shipping containers until ready to be installed. If the unit is to be stored prior to installation, it must be protected from the elements to prevent rust and deterioration. Rotate the vacuum pump motor shafts every two weeks. This can be accomplished by removing the motor fan guard and rotating the motor fan. Although the vacuum pumps are flushed with a water-soluble preservative prior to shipment, refer to your **BeaconMedæs** representative for storage instructions.

Accessories are shipped in a separate container that is attached to the system shipping crate. TO AVOID LOSS OR DAMAGE, MAKE CERTAIN THAT ACCESSORIES ARE IDENTIFIED AND KEPT IN A SAFE PLACE UNTIL THEY ARE INSTALLED ON THE SYSTEM.

DO NOT REMOVE the protective covers from the inlet and discharge connection ports of the modules until they are ready for connection to the hospital's pipeline distribution system.

## 1.2 Location

The **LifeLine** "Camel" Medical Vacuum System should be installed indoors in a clean, well-ventilated environment. This location should be protected against flooding, freezing, excessive moisture and overhead dripping. Areas of excessive dust, dirt, or other air-borne particulate should be avoided.

Certain considerations should be given to the placement of the system. The package may be installed in any location that is flat, level and will support its weight. When selecting the location for the system, provisions should be made to permit proper piping arrangement and dismantling. Allow space for service, such as cleaning, changing filters, and component replacement. Clearance between the unit and adjacent walls should be no less than 24" to ensure sufficient airflow for cooling. There should be a minimum of three feet of clearance in front of the control panel for safe operation and maintenance. A vertical distance of 24" is required above the unit for ventilation and maintenance. Refer to the general assembly drawings in Appendix C.1 for actual dimensions.

**No special foundation is required**. However, all units must be securely bolted using all mounting holes provided. If a raised concrete pad is used, it must form a rigid support for the system. Pour a 4" to 6" concrete "housekeeping" pad large enough for the system plus approximately 6" per side. The unit's base must not overhang the concrete base. A method to drain away moisture is also necessary.

Adequate ventilation is required. The pumps are air-cooled. Therefore, it is very important that the ambient temperature should be between 40˚F and 105˚F (If the maximum ambient exceeds 105˚F, contact factory for special instructions). The system should be located as close as possible to the point of usage to prevent excessive loss of operating vacuum due to pressure drop.

## 1.3 Locations Above Sea Level

The safety relief valves and vacuum control switches on the **Lifeline** "Camel" Vacuum systems are factory set for an altitude less than or equal to 2000 ft. However, if the altitude is greater than 2000 ft, certain adjustments may be necessary to compensate for a lower barometric pressure.

### 1.3.1 Compensation for Altitude

All vacuum pumps above sea level have reduced flow and should be de-rated. After determining the correct flow needed for the medical vacuum system, multiply this number by the adjustment factor in the following chart. After determining the new flow required, use this number to size the medical vacuum system.

| Altitude Adjustment Factor | | |
|---|---|---|
| **Altitude (ft)** | **Normal Barometric Pressure (inches HG)** | **Multiplier used for Required SCFM** |
| 0 | 29.92 | 1.00 |
| 500 | 29.39 | 1.02 |
| 1,000 | 28.86 | 1.04 |
| 1,500 | 28.33 | 1.06 |
| 2,000 | 27.82 | 1.08 |
| 2,500 | 27.32 | 1.10 |
| 3,000 | 26.82 | 1.12 |
| 3,500 | 26.33 | 1.14 |
| 4,000 | 25.84 | 1.16 |
| 5,000 | 24.90 | 1.20 |
| 6,000 | 23.98 | 1.25 |
| >6,000 | Contact **BeaconMedæs** | Contact **BeaconMedæs** |

## 1.4 Vibration Control

Each system is supplied with vibration isolators and flexible connections to isolate the surrounding area and piping from undue vibration. These accessories are shipped in a separate container that is attached to the system shipping crate. The flexible connections are for straight-line connection only, and are provided for the vacuum inlet, seal water connections, as well as the discharge. It is essential to each installation that flex connections and vibration isolators are used in conjunction with one another. **Failure to do so could result in the warranty being voided.**

## 1.5 Piping

Connect piping to the system so that no strain is applied at the point of connection. Pipe strain on vacuum pump castings may cause hard-to-trace troubles after the system is in operation. Support inlet and discharge piping near the system. Allow for expansion and flexibility in those cases in which rigid piping is used in order to prevent strain from pipe expansion, bending and twisting forces. Use the provided flexible piping connections at the inlet, discharge and seal water lines as well as the resilient mounts when installing the system. Remove any foreign matter from piping by flushing the piping before connecting it to the system. After piping connections are made, check to make certain that the vacuum pump can be turned over freely by hand.

### 1.5.1 Intake Piping

Before connecting any piping, the plastic thread protector installed in the connection port must be removed. Connect the vacuum system piping to the inlet connection. Refer to the drawing(s) supplied with your system and NFPA 99 for specific piping requirements. **The main vacuum line to the receiver must never be reduced below that provided on the receiver.** Long piping runs may need to be increased in size to minimize pressure drop. Improper line sizing may result in a loss of capacity. Ideally, piping should be constructed using long radius elbows and a minimum number of turns.

All intake vacuum lines must be piped to in accordance with NFPA 99. Ensure that no restriction of airflow will occur. All piping must be either seamless copper tubing or other corrosion-resistant metallic tubing, such as galvanized steel or stainless steel, as detailed in NFPA 99.

### 1.5.2 Seal Water Piping

Connect the seal water supply to the seal water line dielectric union. Refer to the drawing(s) supplied with your system and NFPA 99 for specific piping requirements. Seal water piping connections must satisfy the following requirements:

a. Flow rate per vacuum pump shall be as specified in the table below
b. Minimum seal water supply pressure shall be 25-psig. If a 25-psig supply is not available, contact your **BeaconMedæs** Representative for an alternative.
c. The seal water shall be non-corrosive to system materials. Make certain that the seal water meets the following requirements:

Maximum ph - 6-1/2 to 8-1/2
Maximum chlorides - 100 ppm
Maximum total dissolved solids - 200 ppm
Total hardness - 200 ppm max calcium carbonate

| Seal Water Flow Rates | |
|---|---|
| System Size - Pump | Flow Rate - GPM* |
| 3 HP - Delta | 0.50 GPM |
| 3 HP - MHF | .75 GPM |
| 5HP, 7½ HP | .75 GPM |
| 10 HP | 1.0 GPM |

*Per vacuum pump

### 1.5.3 Drain Piping

Connect pipe to the seal water drain connection. Refer to the drawing(s) supplied with your system. The seal water drain line should flow by gravity to a suitable drain with an air break at the drain point. The drain loop is vented.

### 1.5.4 Exhaust Piping

Connect pipe to the air discharge connection on the Camel reservoir. This exhaust line must be piped outside of the building in accordance with NFPA 99. To ensure that no restriction of airflow will occur, size the piping according to the following chart. All piping must be either seamless copper tubing or other corrosion-resistant metallic tubing as detailed in NFPA 99. A flexible connector (shipped loose) must be installed on each exhaust port of the vacuum pump before connecting to the main exhaust line leading outdoors. Use care to avoid long horizontal pipe runs and/or dips in piping that could accumulate condensate causing high inlet back pressure. Slope horizontal pipe runs so that accumulated condensate will run back towards Camel tank. The outside pipe must be turned down and screened to prevent contamination.

**WARNING:**
**The vacuum exhaust vent must be located away from medical air intakes, doors and openings in the buildings to minimize possible contamination to the facility, in accordance with NFPA 99.**

| LifeLine Systems | System Exhaust Pipe Length (ft) - See Notes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | 50 | 75 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 |
| Simplex 3 HP | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Simplex 5 HP | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 3.00 |
| Simplex 7.5 HP | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Simplex 10 HP | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Duplex 3 HP | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Duplex 5 HP | 2.00 | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Duplex 7.5 HP | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Duplex 10 HP | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Triplex 5 HP | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 4.00 | 4.00 | 4.00 |
| Triplex 7.5 HP | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Triplex 10 HP | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |

**Notes:**
1. All pipe sizes are based on the following: copper pipe (Type L), 14.7 psia, 70° F.
2. The minimum pipe size must be maintained for the total length of the exhaust pipe. Use next larger size pipe in the event the minimum size is not available.
3. When determining the total pipe length, add all the straight lengths of pipe together in addition to the number of elbows times the effective pipe length for that pipe size. (See the table and example below.)

| Effective Pipe Length Equivalent to each 90 degree Elbow | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Pipe Size (in.)** | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 5.00 | 6.00 |
| **Eff. Pipe Length (ft)** | 3.6 | 4.9 | 6.4 | 7.9 | 9.4 | 10.0 | 11.9 | 13.2 |

**Example:**

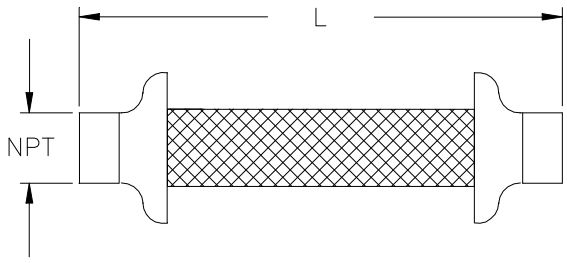
Select the pipe size for a Duplex 7.5 HP with 70 feet of straight pipe and six elbows:

A) Select the pipe size of 2" diameter for 70 feet of straight pipe.
B) Determine the eff. Pipe length for an elbow of 2" dia. (EPL= 4.9 ft / elbow).
C) Calculate the SYSTEM PIPE LENGTH {SPL (2.0" D) = 70 + (6 x 4.9) = 99.4 ft}
D) Check this SYSTEM PIPE LENGTH to see if it exceeds the minimum pipe size. In this case it does, select the next larger pipe size from the table (D = 3").
E) To double-check the pipe size, recalculate the SPL with the new diameter.
SPL (D = 3") = 70 + (6 x 7.9) = 117.4 ft. This is in the allowable range.

### 1.5.5 Air Discharge Piping

Connect pipe to the air discharge connection on the Camel reservoir and pipe outdoors per NFPA99 or applicable code.

### 1.5.6 Flex Hoses




SIMPLEX CAMEL WITH EC PUMP

| LIFELINE FLEX HOSES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HP | SEAL WATER | NPT | L | L | INLET | NPT | L | L | DISCHARGE | NPT | L | L |
| 3 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 006 | 1-1/2" | 14" | 356mm | CPL 09 008 | 3" | 22" | 559mm |
| 5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 008 | 3" | 22" | 559mm |
| 7.5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 008 | 3" | 22" | 559mm |
| 10 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 009 | 4" | 27" | 686mm |

DUPLEX CAMEL WITH EC PUMP

| LIFELINE FLEX HOSES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HP | SEAL WATER | NPT | L | L | INLET | NPT | L | L | DISCHARGE | NPT | L | L |
| 3 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 006 | 1-1/2" | 14" | 356mm | CPL 09 008 | 3" | 22" | 559mm |
| 5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 006 | 1-1/2" | 14" | 356mm | CPL 09 008 | 3" | 22" | 559mm |
| 7.5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 008 | 3" | 22" | 559mm |
| 10 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 009 | 4" | 27" | 686mm |

TRIPLEX CAMEL WITH EC PUMP

| LIFELINE FLEX HOSES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HP | SEAL WATER | NPT | L | L | INLET | NPT | L | L | DISCHARGE | NPT | L | L |
| 5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 009 | 4" | 27" | 686mm |
| 7.5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 008 | 3" | 22" | 457mm | CPL 09 009 | 4" | 27" | 686mm |
| 10 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 008 | 3" | 22" | 559mm | CPL 09 009 | 4" | 27" | 686mm |

SIMPLEX CAMEL WITH MHF PUMP

| LIFELINE FLEX HOSES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HP | SEAL WATER | NPT | L | L | INLET | NPT | L | L | DISCHARGE | NPT | L | L |
| 3 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 006 | 1-1/2" | 14" | 356mm | CPL 09 008 | 3" | 22" | 559mm |
| 5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 006 | 1-1/2" | 14" | 356mm | CPL 09 008 | 3" | 22" | 559mm |
| 7.5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 008 | 3" | 22" | 559mm |

DUPLEX CAMEL WITH MHF PUMP

| LIFELINE FLEX HOSES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HP | SEAL WATER | NPT | L | L | INLET | NPT | L | L | DISCHARGE | NPT | L | L |
| 3 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 006 | 1-1/2" | 14" | 356mm | CPL 09 008 | 3" | 22" | 559mm |
| 5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 006 | 1-1/2" | 14" | 356mm | CPL 09 008 | 3" | 22" | 559mm |
| 7.5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 008 | 3" | 22" | 559mm |

TRIPLEX CAMEL WITH MHF PUMP

| LIFELINE FLEX HOSES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HP | SEAL WATER | NPT | L | L | INLET | NPT | L | L | DISCHARGE | NPT | L | L |
| 5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 007 | 2" | 18" | 457mm | CPL 09 009 | 4" | 27" | 686mm |
| 7.5 | CPL 09 002 | 1/2" | 10" | 254mm | CPL 09 008 | 3" | 22" | 559mm | CPL 09 009 | 4" | 27" | 686mm |

## 1.6 Electrical Requirements

**WARNING!**
**BE SURE THAT ALL POWER IS TURNED OFF PRIOR TO PERFORMING ANY WORK ON THE ELECTRICAL PANEL!**

**Refer to the electrical diagram provided with the unit before starting any installation or maintenance work.**

**Do not operate vacuum pump on a voltage other than the voltage specified on the control panel nameplate.**

**All customer wiring should be in compliance with the National Electrical Code and any other applicable state or local codes.**

**Refer to the wiring diagram(s) that came with the vacuum pump system for pertinent wiring connections.**

**Ground the control panel and the motor frame solidly. Do not use the system piping for the ground.**

**Electrical power for the medical system must be supplied from the emergency life support circuit.**

Check the control voltage, phase, and amp ratings before starting the electrical installation, and make sure the voltage supplied by the hospital is the same. The wire size should be able to handle peak motor amp load of all operating units. Refer to the vacuum pump system full load amperes on the wiring diagram.

Check all electrical connections within the vacuum system that may have loosened during shipment.

Only certified electricians should make power connections to the control panel and any interconnecting wiring.

Ensure that the emergency generation system electrical supply is consistent with the vacuum system's requirements.

The electrical controls for the system were wired at the factory and were fully tested.

Three-phase power supplied from emergency generator(s) must match that of the normal supply to allow for correct direction of the motor rotation at all times.

**NOTE**: It may be necessary to switch two of the leads when performing start-up, if the pump rotation is in the wrong direction.

# 2. Preparation for Initial Start-up

## 2.1 Draining and Flushing

**WARNING!**
**ISOLATE POWER SOURCE TO THE MOTOR OF EACH VACUUM PUMP TO ENSURE THAT ACCIDENTAL STARTING CANNOT OCCUR.**

Contact your **BeaconMedæs** representative for start-up assistance.

Before starting the system, proceed as follows:

a. Remove the drain plugs from head and body of vacuum pump, and vent/receiver line of the reservoir.

b. On the seal water solenoid valve, turn the manual operator (small standard screw on side of valve) to open valve. A flat head screwdriver may be required.

c. Open the inlet valve and close the discharge valve on the anti-siphon valve.

d. Open shut-off valve for the seal water supply as rapidly as possible. Some water may spray from anti-siphon valve but it will stop quickly.

e. Open the discharge valve on the anti-siphon valve.

f. Open the shut-off valve in the seal water inlet line to the vacuum pump.

g. Allow the seal water to flow until there is clear flow from all drains including the reservoir. As soon as the flow from the vacuum pump is clear, replace the drain plugs using teflon tape or suitable pipe thread compound. Then close the shut-off valve in the seal water inlet line. Although vacuum pump is flushed with water-soluble preservative prior to shipping, a light film of rust may form before installation. This film will disappear after vacuum pump shaft is rotated several times.

h. Turn the manual operator on the seal water solenoid valve to close the solenoid valve.

i. Remove and clean the screen of seal line strainer. Replace the screen. If the system, after draining and flushing, will not be in continuous operation for two weeks or longer, contact your **BeaconMedæs** representative for preservation procedures.

## 2.2 Preliminary Inspection

Perform the following preliminary inspections on **each of the vacuum pumps separately** before starting the system:

a. Inspect all piping to make certain that the proper connections have been made in accordance with the installation drawing(s) supplied with your system. Make certain that the piping is the correct size, at proper elevation, securely connected and properly supported so that no stress is applied to system components.

b. Check the vacuum control tank to make certain that all shipping plugs and protectors have been removed and all open connections have been plugged or piped.

c. Inspect each drain loop to ensure that they are properly installed and vented.

d. Check that the power supply to the motor has the correct voltage and amperage as specified on the control panel nameplate supplied with your system.

e. Isolate the power source from the motor in order to make certain that accidental starting cannot occur.

**CAUTION**

**DO *NOT* ATTEMPT TO FREE A SEIZED VACUUM PUMP BY APPLYING POWER TO MOTOR. SEVERE DAMAGE MAY RESULT. NEVER OPERATE VACUUM PUMP WITHOUT ADEQUATE PRIME AND SEAL WATER FLOW.**

f. With main seal water supply valve open, open the shut-off valve in seal water inlet line to the vacuum pump. Check that the reservoir is full and that the water flows from drain loop to drain.

g. Check that the seal water supply pressure is 25 psig minimum.

h. Turn the power on to the system.

i. Momentarily set the HAND-OFF-AUTO selector switch on the control panel for each vacuum pump to the HAND position. Then set the switch back to the OFF position, and check that direction of rotation of each vacuum pump is as indicated by the arrow on the head of the vacuum pump. Turn the power off.

When the preliminary inspection and pre-operational check procedures have been completed, and you understand the general operations of the system as described in Section 3, General Operation, start the system and check system operation as specified in Section 4, Start-Up and Operating Checks.

# 3. General Operation

## 3.1 How the Vacuum System Works (See Figures 3-1-1 & 3-1-2)

The **BeaconMedæs** "Camel" Liquid Ring Medical Vacuum System works basically like other vacuum systems with the air from the system piping (vacuum system inlet) being drawn through the vacuum control tank, then through the inlet check valve, and finally into the inlet of the vacuum pump. The air is then discharged into the "Camel" reservoir tank, which is vented to the atmosphere (air discharge).

The **BeaconMedæs** "Camel" vacuum system is unique because it uses water instead of pistons, screws, etc., to compress the air in the vacuum pump and to produce a vacuum in the inlet lines. The water is also used to seal the internal clearances, absorb the heat of compression as well as scrub the air of impurities.

The path of the water goes through a dielectric union, anti-siphon valve, strainer, solenoid valve, and flow control valve, before it enters the vacuum pump. The water then enters the pump and combines with a spinning rotor to compress the air creating a vacuum. The vacuum pump discharges both the air and the water into a specially designed muffler/baffle system located inside the Camel water reservoir. The water is then reclaimed by the reservoir while the air is discharged to the atmosphere via the vent line.

The **BeaconMedæs** system is a package consisting of a direct driven pump and motor combination supported by a series of components which enable the system to run automatically without operator attention.
The system includes four functional groups of components:

a. Vacuum Inlet Line
b. Water Supply Line
c. Air Discharge Line
d. Camel Reservoir Tank

### 3.1.1 Vacuum Inlet Line

The vacuum inlet line is connected to the receiver with a 3-valve bypass, which allows for receiver isolation and service without shutting down the vacuum system. The vacuum inlet line continues to the vacuum pump(s) through an isolation valve and check valve. The check valve is used to isolate the vacuum pump from the system when the vacuum pump is stopped.

### 3.1.2 Water Supply Line

The water supply line includes an anti-siphon valve, strainer, solenoid valve, flow control valve and dielectric fitting. The anti-siphon valve is used to prevent back-siphoning of the seal water from the vacuum pump into the water supply. The strainer is used to catch any pipe scale or foreign matter in the water line that might harm the vacuum pump. The solenoid valve turns on the water supply when the vacuum pump runs. The flow control valve regulates the flow to a specific gpm rate as required by the vacuum pump (See Section 1.5.2). The dielectric fitting helps to isolate the vacuum system electrically from the water supply to prevent galvanic corrosion in the vacuum pump.

### 3.1.3 Air Discharge Line

The air and water is discharged into the Camel reservoir through a specially designed muffler/baffle system. The water is retained in the Camel reservoir and the air is discharged to atmosphere via the vent line. (See Section 1.5.4 for correct exhaust piping sizes)

**WARNING:**
**The vacuum exhaust vent must be located away from medical air intakes, doors and openings in the buildings to minimize possible contamination to the facility, in accordance with NFPA 99.**

### 3.1.4 Camel Reservoir Tank

The Camel reservoir has three specific functions. It separates the air and water discharge from the vacuum pumps by means of a specially designed muffler/baffle system. It reclaims discharge water and holds it for use as re-circulated seal water. Finally, it is used to dissipate heat generated by the vacuum pumps. Under normal operation, the water in the camel reservoir is replaced or turned over up to 6 times per day. The water in the reservoir is turned over by means of a fresh water purge while the system is operating.

In the unlikely event that fresh water service is lost, the camel tank acts as a water reservoir. The reservoir allows the vacuum pumps to continue to operate normally for up to 48 hours without requiring any additional water.

## 3.2 Control Panel Description and Operation

Each control panel contains the following components mounted in a NEMA 12 enclosure:

a. Non-combination across-the-line magnetic starter with thermal overload protection for each pump.
b. A 115-volt secondary control transformer for each pump.
c. A circuit breaker for each pump
d. If multiplexed, control panels contain a PLC for automatic alternation.
e. A HAND-OFF-AUTOMATIC selector switch mounted on the door of enclosure for each pump.
f. One SILENCE ALARM push button mounted on the door of enclosure.
g. Indicator Lights
    1. One green - Illuminated "Hand-Off-Auto" selector switch for each motor
    2. One amber - LAG PUMP RUN per vacuum system.
h. One RUN TIME METER for each pump

NOTE:
FOR MORE INFORMATION, REFER TO THE WIRING DIAGRAM SUPPLIED WITH YOUR UNIT.

### 3.2.1 Operation (Multiplex System)

**Selector Switch Positions**

a. HAND
The vacuum pump operates continuously. The vacuum relief valve may open.

b. AUTO
Each vacuum pump starts and stops in response to vacuum switches that monitor the vacuum level in the control tank. When the vacuum level drops to the low setting of the lead vacuum switch (VS-1), the vacuum switch sends a signal to the control panel to turn on the lead vacuum pump. If the vacuum level continues to fall after the lead pump starts, the lower setting of the lag vacuum switch (VS-2) will turn on the lag vacuum pump to compensate the demand. When the second vacuum pump turns on, however, a signal is sent to the control panel that illuminates the lag pump run light and activates the alarm. The alarm and lag run light must be reset manually when the vacuum level in the control tank reaches the high setting of the lag vacuum switch (VS-2). Pressing the "Horn Silence" push button can silence the alarm. Each time the vacuum system reaches the high setting of the lead vacuum switch (VS-1) the pumps will automatically alternate after its minimum run time has expired, meaning the previous lead vacuum pump will now become the lag vacuum pump and vice versa

c. OFF
The vacuum pump will shut down.

**Motor Overload Reset**

a. Depressing the RESET button on the starter manually resets the motor thermal overload and the relay overload.
b. The associated overload contact closes to restore power to the control circuit.

**Minimum Run Timer(s)**
All **LifeLine** "Camel" vacuum systems incorporate minimum run timers to minimize the starts and stops on the vacuum pumps.

For **multiplex** systems, there is a minimum run timer built into the PLC for each pump, but they all have the same time value. The timer is adjustable from 0 to 10 minutes. Once a pump is turned on by the PLC it will not turn it off until its minimum run timer has expired. During operation, if VS-1 is still closed but the minimum run timer has expired, the PLC will rotate to the next available unit after a 17-minute maximum run time. (See wiring schematic for recommended timer settings.)

## 3.3 Relief Valve

Every **LifeLine** system is built with an integral vacuum relief valve. The purpose of this relief valve is to prevent the pump from operating at a vacuum level that is too high. All relief valves on units are factory set at 25 inches Hg. Relief valve settings may be different for higher altitudes. (See Section 1.3.1)

**NEVER SET THE VACUUM RELIEF VALVE AT A POINT THAT EXCEEDS THE FACTORY RECOMMENDED LEVELS!**

## 3.4 Anti-Siphon Valve

This valve is designed to prevent back siphoning of polluted water into a potable water supply. When the line pressure drops to 1 psi or below, the spring-loaded disc float opens the atmospheric vent and the spring loaded check valve closes the inlet. This prevents the creation of a vacuum in the discharge line and prevents back siphoning. As water flows through the valve, it pushes the check valve open and lifts the disc float that closes the atmospheric vent, thus preventing leakage. The disc float is free floating without close fitting guides, which assures freedom from sticking. The durable silicone disc on the disc float and the check valve permits use on hot and cold water lines

**Pressure - Temperature**

| | |
|---|---|
| Working temperature: | 33° F - 210° F |
| Maximum pressure: | 150 PSI |
| Minimum pressure: | 15 PSI |

**Note:**
**This valve is not designed, tested, or approved to protect against backpressure backflow.**

## 3.5 Tank Drain

The standard tank drain consists of a manually operated ball valve.

To drain the liquid from the tank, open the tank bypass valve and close the tank isolation valves. Then open the vent and drain valves. When draining is complete, close the vent and drain valves first, then open the tank isolation valves and close the tank bypass valve.

## 3.6 Vacuum Check Valve

Vacuum check valves are designed and engineered for the unique problems of the vacuum field. Featuring extremely low pressure drop, they open on less than 1/10" W.C. Special design permits a lightweight, stamped stainless steel disc to open fully, providing full flow with minimum resistance. A non-scuffing disc mechanism has free action at all times. Positive shut-off even at minimum flow is assured by unique elastomeric permanently molded facing (Viton or Ethylene Propylene - EPEM, or Teflon) on a specially designed stainless steel disc. Noiseless, ruggedly constructed vacuum valves have a high safety factor. Each valve is individually tested before shipment over a range from 0 to 50 psi backpressure and must show zero leakage at all pressures. All internal trim is stainless steel.

## 3.7 Emergency Shutdown / Alarms

The following conditions may arise during operation.

### 3.7.1 Motor Overload Shutdown

This will shut down the pump in question and will not re-start until the reset button on the starter inside the main control cabinet is reset. See Section 5 for troubleshooting information.

### 3.7.2 Lag Unit Running Alarm

This alarm will activate if the last available vacuum pump comes on. In the case of a duplex system, it will activate when the second pump turns on or the lag vacuum switch (VS-2) closes. In the case of a multiplex system, the lag alarm will activate when the last available unit is required to come on. For example, in a quadruplex system, if all four (4) H-O-A switches are set to "Auto", then the lag alarm will trigger when the fourth unit comes on. If on the same system, three (3) of the four (4) H-O-A switches are set to "Auto" and the other to "Off" or "Hand", then the lag alarm will activate when the third unit comes on. To silence the alarm, press the "Horn Silence" push button. In the event the lag alarm is persistent, check to see if any leaks or valves are open downstream or reduce the system load. To reset the Lag Alarm, push the "Lag Alarm Reset" pushbutton.

Please note that the lag alarm may be reset even if the lag pump is still running. This can happen due to the minimum run timer not having expired, but the lag vacuum switch itself may be open.

# 4. Start-up and Operating Checks

## 4.1 Manual Operation

Check manual operation as follows:

a. Close shut-off valve in inlet line to isolate system. Air will enter through relief valve.
b. Make certain that the seal water shut-off valve is open.
c. Apply power to system. Set the HAND-OFF-AUTO selector switch for vacuum pump No. 1 to the HAND position. Observe the vacuum gauge. The vacuum gauge should start indicating within 15 seconds. IF NO VACUUM IS INDICATED, TURN THE HAND-OFF-AUTO SELECTOR SWITCH TO THE OFF POSITION IMMEDIATELY and repeat steps a-f in Section 2.1.
d. As the vacuum pump continues to run, monitor the vacuum gauge. Check that the vacuum increases until it reaches the setting of the relief valve such that the relief valve opens.
e. Check that there is a flow of seal water from the drain loop.

**Note**
No water should be discharged from anti-siphon valve during operation. If seal water supply is shut off for any reason, perform steps c, d and e, in Section 2.1 before restarting unit.

f. Continue to operate the vacuum pump for 1/2 hour and check for the following:
   1. Stable vacuum.
   2. Check the temperature of the Vacuum pump body. If the temperature rises rapidly, SHUT DOWN VACUUM PUMP IMMEDIATELY AND DETERMINE CAUSE.
   3. Check the temperature at bearing housing area of bearing brackets on the vacuum pump. If the temperature exceeds 140°F (60°C) SHUT DOWN THE VACUUM PUMP IMMEDIATELY AND DETERMINE THE CAUSE.
   4. Unusual noise or vibration

---

**CAUTION**
**SHUT DOWN THE VACUUM PUMP IMMEDIATELY AND DETERMINE CAUSE IF THERE IS UNUSUAL NOISE OR VIBRATION OR IF THE PUMP'S BODY TEMPERATURE IS EXCESSIVE.**
Refer to the Troubleshooting, Section 5 in this manual for possible causes.

---

g. Turn the HAND-OFF-AUTO selector switch to the OFF position. Bleed the vacuum from vacuum control tank.
h. Repeat steps a through g for each vacuum pump in the system.

## 4.2 Automatic Operation

Check automatic operation as follows:

a. Set the HAND-OFF-AUTO selector switch to the AUTO position on all the vacuum pumps.
b. Monitor the vacuum gauge and check that each vacuum pump starts when the vacuum reaches the low vacuum setting of the vacuum switch. Refer to the table below for the correct switch settings. In a new installation a bleed may need to be established on the system to properly cycle the pumps.
c. Check that each vacuum pump shuts off when vacuum reaches the high setting of the vacuum switch and the minimum run timer has been satisfied.
(See the wiring schematic for recommended timer settings.)
d. For Duplex and Triplex systems, check that the vacuum pumps alternate each time a vacuum pump starts.
e. Set the HAND-OFF-AUTO selector switch for each vacuum pump to OFF position. Bleed vacuum from vacuum control tank.

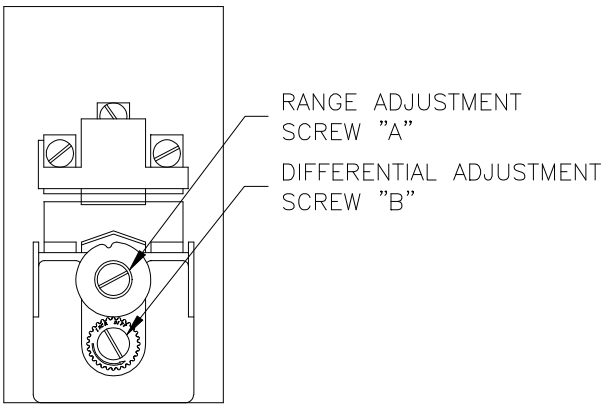
**Vacuum Switch Settings***

| For Operating Vacuum of 19 in. Hg | Setting - inches Hg Vacuum | | | | | |
|---|---|---|---|---|---|---|
| | Simplex System | | Duplex System | | Triplex System | |
| | Start | Stop | Start | Stop | Start | Stop |
| Vacuum Pump #1 | 19 | 23 | 19 | 23 | 19 | 23 |
| Vacuum Pump #2 | - | - | 17 | 21 | 17 | 21 |
| Vacuum Pump #3 | - | - | - | - | 15 | 19 |

*Settings can be field adjusted

## 4.3 Vacuum Switch Set Point Adjustments

The vacuum switch is set at the factory to the operating point(s) as stated on the wiring diagram supplied with the unit. It is good practice to cycle the switch to determine actual operating points before proceeding with readjustment. Refer to the illustration below for location of adjustment.




**Adjusting Instructions**

**FIRST** - Adjust the range (screw "A") to the required cut-in vacuum setting. Turning the screw clockwise lowers the cut-in and cut-out vacuum settings equally.
**SECOND** - Adjust the differential (screw "B") to the required cut-out vacuum setting. Turning the screw counter-clockwise will increase the cut-out vacuum setting only. Differential is the difference between cut-in and cut-out settings.

# 5. Trouble Shooting

| General Operation | |
|---|---|
| **Problem** | **Solution** |
| No power to the system | 1.) Check main circuit breaker<br>2.) Check system disconnect(s)<br>3.) Check fuses in control panel<br>4.) Check for 115V at output of control transformer(s) |
| **Manual Operation - HAND-OFF-AUTO switch in HAND position** | |
| Vacuum pump will not start. HOA indicator light is not illuminated. | 1.) Check fuse(s) in control panel<br>2.) Check motor starter in control panel<br>3.) Check motor thermal overload and relays in the control panel. Press the RESET pushbutton.<br>4.) Check the setting of the overload relays. |
| Failure to reach required vacuum | 1.) Check the vacuum switch settings and operation of the vacuum switch.<br>2.) Low seal water flow to the vacuum pump.<br>3.) Blocked or restricted inlet or discharge.<br>4.) On duplex or triplex systems, inlet check valve on the other vacuum pump stuck open.<br>5.) Check vacuum pump for mechanical damage or excessive wear. |
| Vacuum pump motor stops<br>If you have:<br>a. Normal motor amperage | 1.) Check overload relays for tripping<br>2.) Check for excessive cycling.<br>3.) Check for improperly sized motor heaters. |
| b. Excessive motor amperage | 1.) Vacuum pump horsepower demand excessive, blocked discharge, high backpressure.<br>2.) Excessive seal water flow to vacuum pump. Check flow control valve for proper operation.<br>3.) Check for low voltage.<br>4.) Check vacuum pump for build-up of scale.<br>5.) Motor defective. |
| Vacuum pump stalling<br><br>(Recognized by high-pitched screeching sound) | 1.) Check for operation beyond maximum design vacuum.<br>2.) Check vacuum switch setting and operation of the vacuum switch.<br>3.) Check operation of the inlet check valve, valve may be stuck closed.<br>4.) Excessive seal water flow to the vacuum pump. Check flow control valve for proper operation.<br>5.) Check and adjust clearance in the vacuum pump. |

| **Manual Operation - HAND-OFF-AUTO switch in HAND position** | |
|---|---|
| **Problem** | **Solution** |
| Change in vacuum pump operating temperature, noise or vibration | **CAUTION**<br>**SHUT DOWN VACUUM PUMP IMMEDIATELY.**<br>1.) If the vacuum pump bearing brackets bearing housing temperature exceeds 140°F (60°C), check for vacuum pump bearing failure or excessive grease in bearings.<br>2.) Refer to Trouble-item 5. (Vacuum pump stalling)<br>3.) If the vacuum pump is running hotter than normal, check for low seal water flow to pump. |
| **Automatic Operation - HAND-OFF-AUTO switch in AUTO position**<br>On duplex and triplex systems: | |
| Vacuum pump will not start | 1.) Refer to Trouble-item 2. (Vacuum pump will not start) |
| On **duplex** systems:<br>vacuum pumps not alternating | 1.) Check operation of high vacuum switch (VS-1). |
| On **triplex** systems:<br>vacuum pumps not alternating | 1.) Check operation of high vacuum switch (VS-1). |
| Vacuum pumps come on at same time | 1.) Check to see if the high vacuum switch (VS-1) and the low vacuum switch (VS-2) connections or settings are reversed. |
| Lag vacuum pump does not start when vacuum drops to low setting of low vacuum switch (VS-2) | 1.) Refer to Trouble-item 2. (Vacuum pump will not start)<br>2.) Check the vacuum switch settings and operation of the low vacuum switch (VS-2). |

# 6. Maintenance

## 6.1 Routine Checks

**WARNING!**
**BE SURE THAT ALL POWER IS TURNED OFF PRIOR TO PERFORMING ANY MAINTENANCE.**

### 6.1.1 Weekly

a. Check the temperature of the bearing housing area or bearing brackets on the vacuum pump.
b. Check that the vacuum level is within the vacuum range of the lead vacuum switch.

**CAUTION**
**IF BEARING HOUSING TEMPERATURE EXCEEDS 140°F (60°C) SHUT DOWN VACUUM PUMP IMMEDIATELY AND DETERMINE CAUSE.**

### 6.1.2 Six Month Intervals

a. Check for proper operation of the vacuum switches and readjust as necessary. Refer to vacuum switch instructions located in Section 4-3 of this manual.
b. On duplex and triplex systems, check for proper alternation of pumps.
c. Check operation of seal water solenoid valves.
d. Check the condition of screens in the seal line strainers and clean if necessary.
e. Check the condition of the vacuum control tank gauge glass and clean if necessary

### 6.1.3 One Year Intervals

a. The vacuum pump bearings require no lubrication. Replace bearings after 20,000 hours.
b. Clean and check for proper operation of the inlet check valves. Inspect the hinge pins, pivots, springs and clapper nut for wear. Overhaul or repair check valves if contamination, binding or wear is detected.
c. Check that the vacuum control tank relief valve is free to operate properly.
d. Remove Camel Reservoir inspection plate and check for any debris or accumulated water deposits inside reservoir. Clean and flush if necessary.

### 6.1.4 Four Year Intervals

a. Replace the seal water flow control valves. Contact your local **BeaconMedæs** representative.
b. Replace or rebuild all seal water solenoid valves. Contact your local **BeaconMedæs** representative.

# 7. Replacement Parts

Service and parts for **BeaconMedæs** systems and NASH pumps are assured through a network of sales and service offices. For information, service or parts contact your nearest **BeaconMedæs** representative.

If the location of the nearest office is unknown, or you are requesting parts and service, contact **BeaconMedæs** at 1-800-756-2590, Fax 803-817-5750.

**WHEN ORDERING REPLACEMENT AND SPARE PARTS, TEST NUMBERS, SERIAL NUMBERS AND PUMP SIZES MUST BE PROVIDED.** The test number and pump sizes are located on nameplate fastened to body of pump. If nameplate has been destroyed, the test number will be found stamped on the body. The system serial number can be found on the nameplate located inside of the control cabinet door. Parts must be identified by index number and name. Refer to pump exploded view and legend, found within this manual

# 8.0 Maintenance Record

**Model Number** _____

**Serial Number** _____

**Installation Date** _____

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date of Service** | | | | | | | | |
| **Hours** | | | | | | | | |
| **Vacuum Level** | | | | | | | | |
| **Water Level** | | | | | | | | |
| **Ambient Temp.** | | | | | | | | |
| **Pump Operating Temp.** | | | | | | | | |
| **Rebuild/ Replace Solenoids** | | | | | | | | |
| **Replace Flow Control Valves** | | | | | | | | |
| **Misc.** | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| **Serviced By** | | | | | | | | |

# 8.0 Maintenance Record

**Model Number** _____

**Serial Number** _____

**Installation Date** _____

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date of Service** | | | | | | | | |
| **Hours** | | | | | | | | |
| **Vacuum Level** | | | | | | | | |
| **Water Level** | | | | | | | | |
| **Ambient Temp.** | | | | | | | | |
| **Pump Operating Temp.** | | | | | | | | |
| **Rebuild/ Replace Solenoids** | | | | | | | | |
| **Replace Flow Control Valves** | | | | | | | | |
| **Misc.** | | | | | | | | |
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| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| **Serviced By** | | | | | | | | |

# Appendix A - NASH "Delta" EC Pump Information

## Introduction

These directions should be read carefully before the installation and start up of your Nash vacuum pump. In order to ensure operator safety and to avoid damage to the equipment it is important that the operators and the personnel in charge of the equipment are fully acquainted with the safety instructions in Section A.1. Please ensure that the equipment is operated in accordance with these safety instructions.

The NASH Model "Delta" EC pumps meet the following regulations within their proper range of application:
89/392/CEE - machines
All Model EC pumps are marked "CE"

Do not operate or apply these pumps in a manner different than noted in this manual. Special versions of the pump may result in changes to the technical specification and operating performance. In the case of any questions, please consult our Technical Service Department. Please provide the pump model and serial number.

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## A.1 Safety

### A.1.1 Operational

While the pump is running the following safety pre-cautions should be adhered to:

- Avoid the suction and discharge connections.
- Do not touch the casing and the cover while the pump is working and conveying hot fluids.
- Do not go close to the pump while it is working with a special or toxic fluid and the mechanical seal is leaking.
- Do not allow the pump to run for long periods of time, if it is creating loud and prolonged noises.
- Check the safety system periodically.

### A.1.2 Service

Prior to any repair service being performed, the following safety precautions should be adhered to:

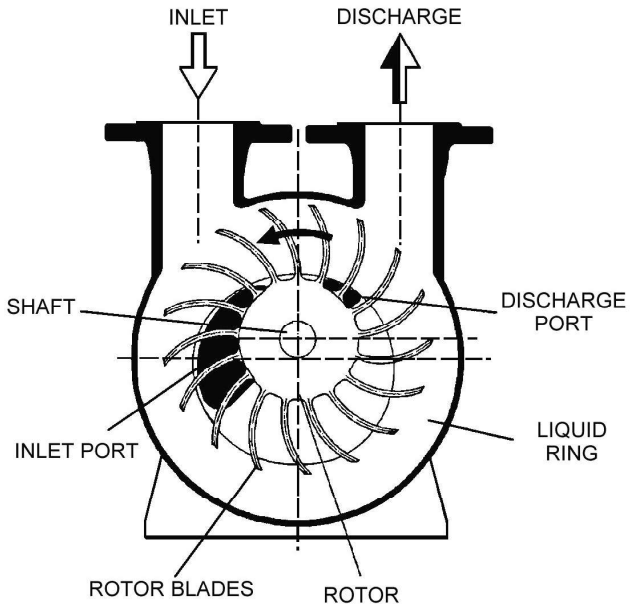
- Stop the pump as described in Section 4.5.2.
- Bleed air into/out of the piping so that the pump internal pressure is the same as atmospheric pressure.
- Be sure that the current supply is off, the circuit breaker is open, locked, and tagged out.
- Empty the pump of service liquid as described in Section 4.3.
- Remove the pump from the package, disconnecting the piping as described in section 9.
- If the pump has been operated with a harmful liquid, careful washing with an appropriate liquid will be necessary. Handle/lift pump as shown in Section A.3.1.

## A.2 Description

This bulletin contains information for owners and operators of Nash "Delta" EC series vacuum pumps. This information includes a description of how to operate and maintain these vacuum pumps.

### A.2.1 How the Nash vacuum pump works

The "Delta" series model EC liquid ring vacuum pump consists of a cylindrical body within which a rotor with fixed blades rotates, with the rotor axis being eccentric to the body. The service liquid, usually water, is spun by the rotor and produces a ring of liquid that rotates concentrically within the body. Because of the eccentricity between the body and the rotor, buckets or chambers are formed with a progressively increasing and decreasing volume, thus producing vacuum and pressure. In this way gasses are drawn in and discharged. During operation, service liquid must continuously be admitted to the pump in order to absorb the heat of compression and to compensate for the volume of liquid exhausted together with the gas through the discharge port. To obtain the published performances, the service liquid temperature should be 60°F (15°C). When water is used as the service liquid, the inlet vacuum should not be higher than 29"Hg. to prevent cavitation.



*IDLE END VIEW*

## A.3 Application

### A.3.1 Operation as a vacuum pump

The "Delta" EC pumps can handle gasses compatible with the specified material of construction. Small quantities of liquid and non-abrasive solids can also be carried over with the gas. If water is used as the service liquid at a temperature of 60°F (15°C) and with atmospheric discharge pressure (1013 mbar), the minimum pressure at the inlet port is approximately 29" Hg (33mbar). Lower inlet pressures can be obtained if a gas ejector is fitted to the inlet of the pump. Refer to published performance curves for pump capacity and absorbed power at the desired vacuum level. The minimum inlet pressure that can be achieved is dependent upon the vapor pressure of the service liquid. When the vapor pressure is very close to the inlet pressure, cavitation may occur in the pump. If cavitation occurs, as indicated by unusual noise coming from the pump at high vacuum levels, it is recommended that an anti-cavitation bleeder be fitted in the suction line.

**WARNING:**
**Do not operate the pump for prolonged periods of cavitation. Prolonged periods of cavitation will cause internal erosion and will result in serious damage to the pump.**

| Table A-1 Vacuum Operating Limits | |
|---|---|
| **Maximum Rotation and Speed** | 3500 RPM (EC 50)<br>1800 RPM (EC 90/125/150/250) |
| **Maximum Vacuum** | 29" HgVac/1.0 HgAbs<br>(980 mbar/33 mbar Abs) |
| **Maximum Discharge Pressure** | 0.5 PSIG (0.03 Barg) |
| **Maximum Inlet Gas Temperature** | 212°F (100°C) |
| **Maximum Service Liquid Temperature** | 160°F (70°C) |

### A.3.2 Inlet gas or vapor

The inlet gases or the vapor/gas mixture should not contain solid particles. However, the pump can handle small quantities of liquids or powders. If the temperature of the inlet gas or vapor is higher then160°F, the service liquid flow rate should be increased by up to 50% over the flows specified in Table A-2.

| Table A-2 Seal Water Flow Rates | |
|---|---|
| System Size - Pump | Flow Rate - GPM* |
| 3 HP | 0.50 GPM |
| 5HP, 7½ HP | 0.75 GPM |
| 10 HP | 1.0 GPM |

*Per vacuum pump

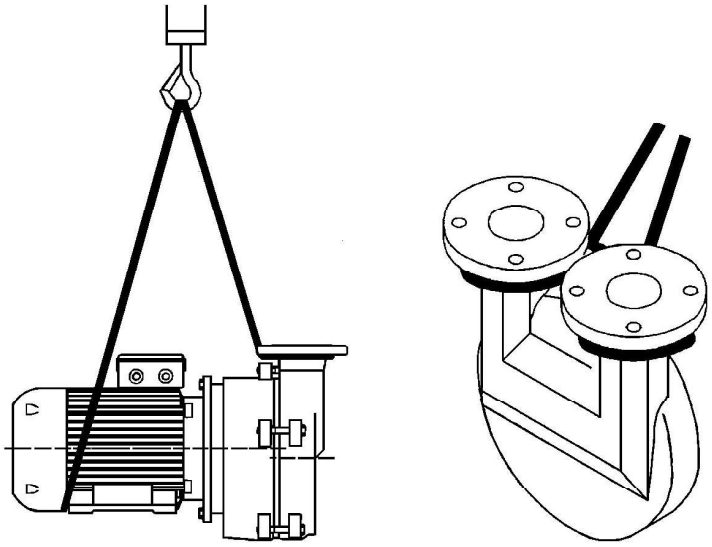
### A.3.3 Service Liquid

While the pump is operating, it must continuously be fed with clean service liquid. Solid particles in the service liquid, such as sand or mud will reduce the life of the pump. If solids are present in the service liquid, it is recommended that a strainer be added to the seal piping plan. Service liquid temperature should be maintained at all times to assure proper operation. Higher than recommended service liquid temperatures will result in reduced pump capacity. In certain high inlet temperature cases, it is recommended to use a pre-condenser in order to improve pump cooling.

## A.4 Installation

### A.4.1 On Site Positioning

The "Delta" EC pumps do not require any specialized foundations in order to be mounted. The pump should be set horizontally on an even surface and fixed through the motor feet on close-coupled pumps, or through the bracket feet on pedestal mounted pumps. If there are motor feet present on pedestal mounted pumps, do not bolt the motor feet to the foundation. The motor feet should be left freestanding. When lifting the pump with a crane, use the hoist cable locations as shown in the diagram below. Please be sure that the hoisting device is of sufficient capacity to handle the loading.



### A.4.2 Connections

#### A.4.2.1 Electrical Connections

**WARNING**

**Before carrying out any work, open, lock, and tag out the main circuit breaker. Electrical connections should be made in compliance with all local and federal regulations.**

Check motor power, voltage, frequency, and phase against those listed on the motor nameplate. Voltage is to be within +5% and frequency within +2% in order to being in acceptable limits. Motor is to be properly grounded.

#### A.4.2.2 Inlet and Discharge Connections

The pump is shipped with the suction and discharge ports closed by protection caps, which should be removed only when connecting the piping. The inlet and discharge connections are vertical and are marked with arrows cast into the pump. The piping to the connections should not have diameters smaller than those of the connections and the load should not rest on the flanges. All piping is to be properly supported such that no loading is placed on the pump. Handle all gaskets carefully. Gaskets must be set between the flanges concentrically, so as not to create any obstruction or reduce the flow section.

## A.5 Operation

### A.5.1 Preparation for initial start-up

Contact your **BeaconMedæs** representative for start up assistance.

### A.5.2 Service Liquid

Piping connections must be made to a service liquid supply. The usual service liquid is fresh water at 60°F (15°C).

**WARNING**

**The service liquid flow must be started before starting the pump drive motor, even if the pump is only being operated to check the direction of rotation.**

### A.5.3 Draining and Flushing

Before starting the vacuum pump upon completion of alignment, remove the seal water drain plugs. Open the service liquid shut-off valve. Allow the service liquid to flow until there is a clear flow from all drains. Although the vacuum pump is flushed with inhibiting oil prior to shipment, a light film of rust may form before installation is complete. This film will disappear after the pump shaft has been manually rotated a few times. Close the service liquid shut off valve. Replace the service liquid drain plugs using a pipe thread sealant.

### A.5.4 Preliminary Inspection

Perform the following preliminary inspections before starting the pump. Be sure to follow all steps listed to ensure personnel safety and equipment protection.

1. Isolate all power sources to the driver unit in order to make sure that no accidental starting occurs.
2. Inspect the pump to make certain that all drain plugs have been properly installed.
3. Manually prime the pump with service liquid, either through the service liquid piping or through the suction connection. The liquid volume for the initial start-up is indicated in the following table:

**Liquid Volume for Initial Start-up**

| Pump Size | Volume Gallons (liters) |
|---|---|
| EC 50 | .1 (0.4) |
| EC 90 | .25 (1.0) |
| EC 125 | .25 (1.1) |
| EC 150 | .25 (1.3) |
| EC 250 | .5 (2.1) |

4. Inspect the separator, receiver, and heat ex-changer (if used) to make sure that all shipping plug protectors have been removed and that all open connections have been plugged or piped.
5. Inspect all piping to make certain that proper connections have been made to the pump and its basic system is in accordance with the **BeaconMedæs** installation drawing(s) that have been supplied with the pump. Make certain that all piping is the correct size, securely connected, and properly supported.
6. Check vacuum pump and/or drive hold down bolts for tightness.
7. Inspect all other major operational component connections associated with the pump to make sure that they are in accordance with the recommendations of their respective equipment manufacturers.

8. Inspect all pump control components (valves, gauges, etc.) to ensure that they have been installed in accordance with the **BeaconMedæs** installation drawing(s). Make certain that these components are correctly oriented in the piping scheme in order to achieve the proper direction of flow and functional operation.
9. Inspect the pump inlet to ensure that the inlet screen and clean out connections have been properly made and are free of tools, equipment, and debris.
10. Make certain that the liquid discharge connection is free of obstructions.
11. Remove the motor fan guard and rotate the motor fan in the specified direction of rotation as marked on the pump body. Because of the direct-drive configuration, the pump shaft will also turn. **THE PUMP SHAFT MUST ROTATE FREELY**. If the pump shaft is bound and can not be freed by rotating it manually, contact your **BeaconMedæs** representative for assistance.

**WARNING**

**Do not attempt to free a pump shaft from a binding or bound condition by applying power to the drive motor. Severe damage may result.**

12. With the main supply valves open and the pump primed, bump the drive motor in order to check for proper direction of shaft rotation.

**WARNING**

**Never operate the pump without adequate prime and service liquid flow. High service liquid supply pressures do not necessarily indicate that the flow is adequate. Check for flow from vacuum pump discharge or water trap silencer.**

### A.5.5 Starting and Stopping the Pump

#### A.5.5.1 Starting

**WARNING**

**If the pump is to be checked in a system, notify the appropriate hospital personnel before placing a pump on line, particularly when placing the pump online for the first time. Starting up a system unexpectedly may cause personnel injury.**

Once the preliminary inspection and pre-operational check procedures have been completed, start the pump and check pump operation as follows:

1. Check the pump and system for adequate prime and then turn on all main water supply sources to the pump and heat exchanger (if used).
2. Open the inlet valve to the pump.
3. Start the pump motor.
4. Open and adjust the service liquid shut off valve. Determine the correct liquid flow rate by means of a flow gauge or by measuring the overflow at the separator tank.
5. Lock the adjusting valve. If a solenoid valve is used instead of a normal valve, the motor starting up should control this. The use of a solenoid valve eliminates the possibility of starting the pump flooded. Therefore, it should open when the motor is energized.
6. Check that the motor power consumption is in accordance with the nameplate data by means of an ammeter
7. Check that the pump operation is free from any excessive vibration and noise.

**A.5.5.2 Stopping**

The following steps should be followed when shutting down the pump:

1. Turn off the electric power to the drive motor.
2. Close the service liquid shut off valve. In the case of a solenoid valve this will automatically close when power is removed.

**WARNING**

**The service liquid supply valve must be closed when the pump is not running.**

3. Close the inlet valve once the pump has stopped rotating.
4. When the pump has been shut down with a suction pressure greater than 27"HgVac (100mbarA), air should be bled into the suction pipe to assure trouble free starting.

## A.6 Maintenance

### A.6.1 Introduction

One of the main features of the "Delta" EC pump is its simple design, great sturdiness and requirement of minimum maintenance. In order to avoid inconvenience and trouble, the operators should be reminded that:
The pump should not be operated without service liquid. Damage to the mechanical seal will result. Solid impurities are to be retained by a filter. If the service liquid is water, it is necessary to control its hardness. If the water has a high salt content, the scale deposits resulting will increase the power absorbed by the motor and will wear the pump parts. It is necessary to remove the scale deposits, and clean the pump frequently. The main maintenance operations that may be necessary are:

- Replacement of the mechanical seal.
- Replacement of the valves.
- Internal cleaning of the pump.
- Replacement of the bearings (see table below for sizes).

If maintenance operations involve disassembly and re-assembly, please follow the directions in Section A.5.

### A.6.2 Bearing Lubrication

The "Delta" EC pumps are fitted with airtight, pre-lubricated bearings. No bearing lubrication is required. Under normal operating conditions, it is recommended that the bearings be replaced after approximately 20,000 working hours. See the table below for the bearing sizes of the various size pumps.

| Replacement Bearing Sizes | |
|---|---|
| Pump Size | Bearing Size |
| EC 90 | 6306 2Z |
| EC 125 | 6306 2Z |
| EC 150 | 6308 2Z |
| EC 250 | 6308 2Z |

## A.7 Disassembly and Re-Assembly

### A.7.1 Before Disassembling

Disassembly of the "Delta" EC pump for repairs and maintenance is an easy operation, but should be carried out only by skilled personnel provided with suit-able equipment. If these directions are not adhered to, faulty operation or damage not covered by warranty could result.

### A.7.2 Disassembly

The parts and materials required to disassemble the pump are as follows:

Parts

1. Liquid joint sealant
2. Bearings
3. Mechanical seal

Tools

1. Socket wrench set.
2. Allen wrenches
3. Mallet
4. Screwdrivers
5. Bearing puller
6. Spanner wrench (made using figure 5)
7. Snap ring pliers
8. 8" length of pipe

Before disassembling the pump the following must be done:

1. Isolate, lock, and tag-out all sources of electrical input.
2. Isolate, drain and bleed the pump and piping.

**WARNING**

**If the pump has been operated with a harmful liquid, wash/ clean with an appropriate liquid. If possible this should be done with the pump in operation to ensure complete cleaning of all internal components.**

3. Disconnect the suction, discharge, and service liquid lines.

#### A.7.2.1 Disassembly of Inlet/Discharge Cover and Plate

Refer to the cross sectional views of the pumps at the back of this manual.

1. Remove 5 hex screws (905) and remove cover (102) and plate (137) together. Use of a mallet to lightly tap the cover will aid in its removal.
2. Remove 1 allen screw (872) and remove plate from cover. Insert a hex screw (905) into the drain hole to aid in removal of the plate.
3. Remove 2 hex screws (902) that secure valve (435) and valve cover (360) to cover and remove both.

#### A.7.2.2 Disassembly of Rotor and Mechanical Seal

1. Remove small flange (232), O-Ring (401), and hex nut (233).
2. Pull rotor (230) from shaft. Use two screwdrivers to assist in prying the rotor from the shaft.
3. Remove rotating element of mechanical seal from rotor as well as the stationary seat and O-ring from intermediate casing.
4. Remove 4 hex screws (901) from motor/casing connection and remove casing. Use a mallet to lightly tap the casing to aid in its removal.

### A.7.3 Re-assembling

Prior to re-assembling, eliminate any scale deposits, clean all parts, and inspect to ensure that they are in good condition. Exercise care when cleaning not to damage any parts when using a scraper.
The procedure for re-assembling the pump is as follows:

**NOTE: All of the following steps should be performed with the motor or bracket placed vertically.**

1. Install mechanical seal O-ring and stationary seat into intermediate casing (109).
2. Lock intermediate casing (109) to motor or bracket flange using 4 hex screws (901).

| Recommended Axial Clearances | |
|---|---|
| Pump Size | Clearance |
| EC 25 | .003 - .004 |
| EC 50 | .003 - .004 |
| EC 90 | .003 - .005 |
| EC 125 | .004 - .005 |
| EC 150, 250 | .005 - .007 |

3. Screw pin (800) to the motor shaft.
4. Place rotating portion of mechanical seal onto rotor hub.
5. Place rotor onto shaft.
6. Screw nut (233) to the rotor and tighten firmly.
7. Check axial clearances. See table No. 6 for the recommended clearances:
8. Place O-ring (401) into position and screw plug (232) firmly into place.
9. Replace and lock into place valve (435) and valve cover (360) using 2 hex screws (902).
10. Place a bead of liquid sealant on contact surfaces of the plate (137).
11. Tighten plate (137) to cover (109) using allen screw (872). Tapping plate lightly with a mallet will aid in seating the plate.
12. Place a bead of liquid sealant on contact surface of the intermediate casing.
13. Place cover (109) onto intermediate casing and secure with 5 hex screws (905).

## A.8 Storage

### A.8.1 2-6 Months

When the pump is expected to be inoperative for a period of 2-6 months, it is recommended that the pump be completely drained as described in Section A.4.3. After draining, pour rust preventative into the suction and operate the pump for a very short time.

### A.8.2 6+ Months

When the pump is expected to be inoperative for a period longer than six months, it is recommended that the pump be completely drained as described in Section A.4.3. After draining, dry the internal parts of the pump by blowing air though the pump and fill the pump with a descalent fluid through both the suction and discharge ports. Store the pump in a dry location. Rotate rotor every six months and change descalent fluid with fresh fluid if necessary.

**WARNING**

**If proper storage procedures are not followed, the rotor could freeze in place due to the formation of scale deposits.**

## A.9 Repair and Warranty Orders

If a warranty is claimed, the pump is to be shipped to our company in a closed package. It is to be emptied and cleaned before packaging. For safety reasons, if the pump has been working with harmful or dangerous liquids it is to be washed with appropriate materials.

## A.10 Spare Parts

When ordering spare parts please refer the part name, its item number, the pump model, and also the nameplate references and the serial number. Some parts are standard and therefore, generally available from **BeaconMedæs** stock.

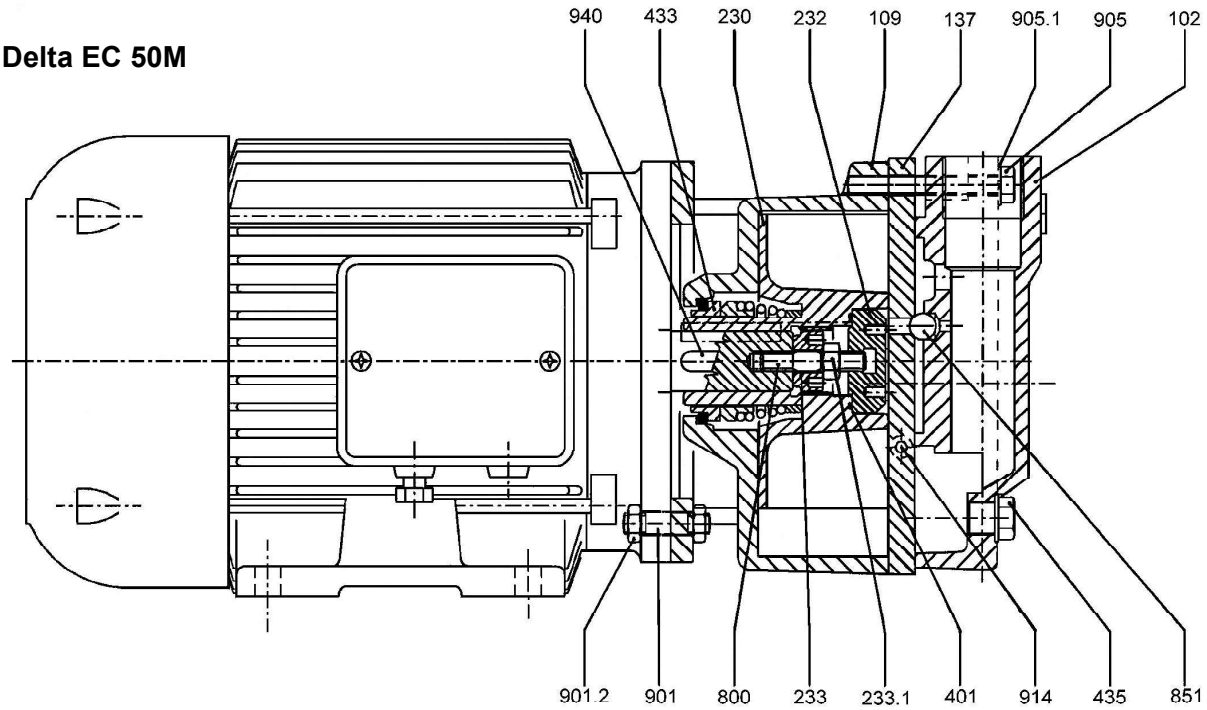
## A.11 Parts List

Refer to the cross sectional diagrams for item identification.

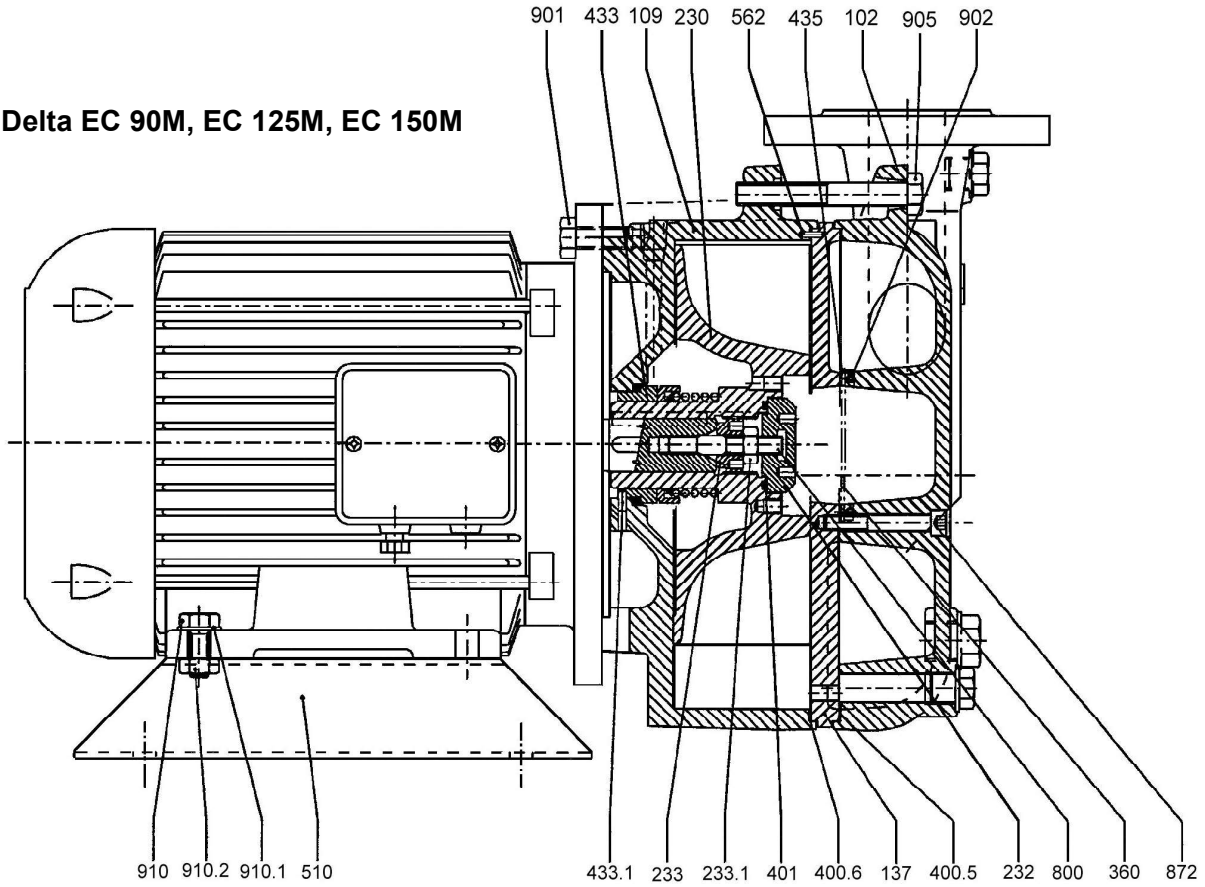
| PARTS LIST | | | |
|---|---|---|---|
| Item Number | Description | Item Number | Description |
| 102 | Casing | 562 | Locating Pin |
| 109 | Housing | 600 | Bearing Cover |
| 137 | Port Plate | 601 | Bearing Cover |
| 210 | Shaft | 606 | Coupling Guard |
| 230 | Rotor | 800 | Adjusting Screw |
| 232 | Rotor Lock Nut | 807 | Screw |
| 233 | Adjusting Lock Nut | 840 | Lock Nut |
| 233.1 | Lock Nut | 851 | Vari-Port Valve |
| 321 | Outboard Bearing | 872 | Screw |
| 322 | Inboard Bearing | 901 | Hex Bolt |
| 335 | Circlip | 901.2 | Hex Nut |
| 340 | Circlip | 902 | Valve Plate Screw |
| 360 | Valve Plate | 905 | Hex Bolt |
| 400.5 | Liquid Gasket | 905.1 | Washer |
| 400.6 | Liquid Gasket | 907 | Hex Bolt |
| 401 | O-Ring | 910 | Hex Bolt |
| 433 | Mechanical Seal | 910.1 | Washer |
| 433.1 | Locating Pin | 910.2 | Hex Nut |
| 435 | Drain Plug | 914 | Anti-Cavitation Valve |
| 507 | Dust Seal | 940 | Rotor Key |
| 510 | Motor Foot Riser | 945 | Shaft Key |
| 515 | Pedestal | | |

## Cross Sectional Diagrams

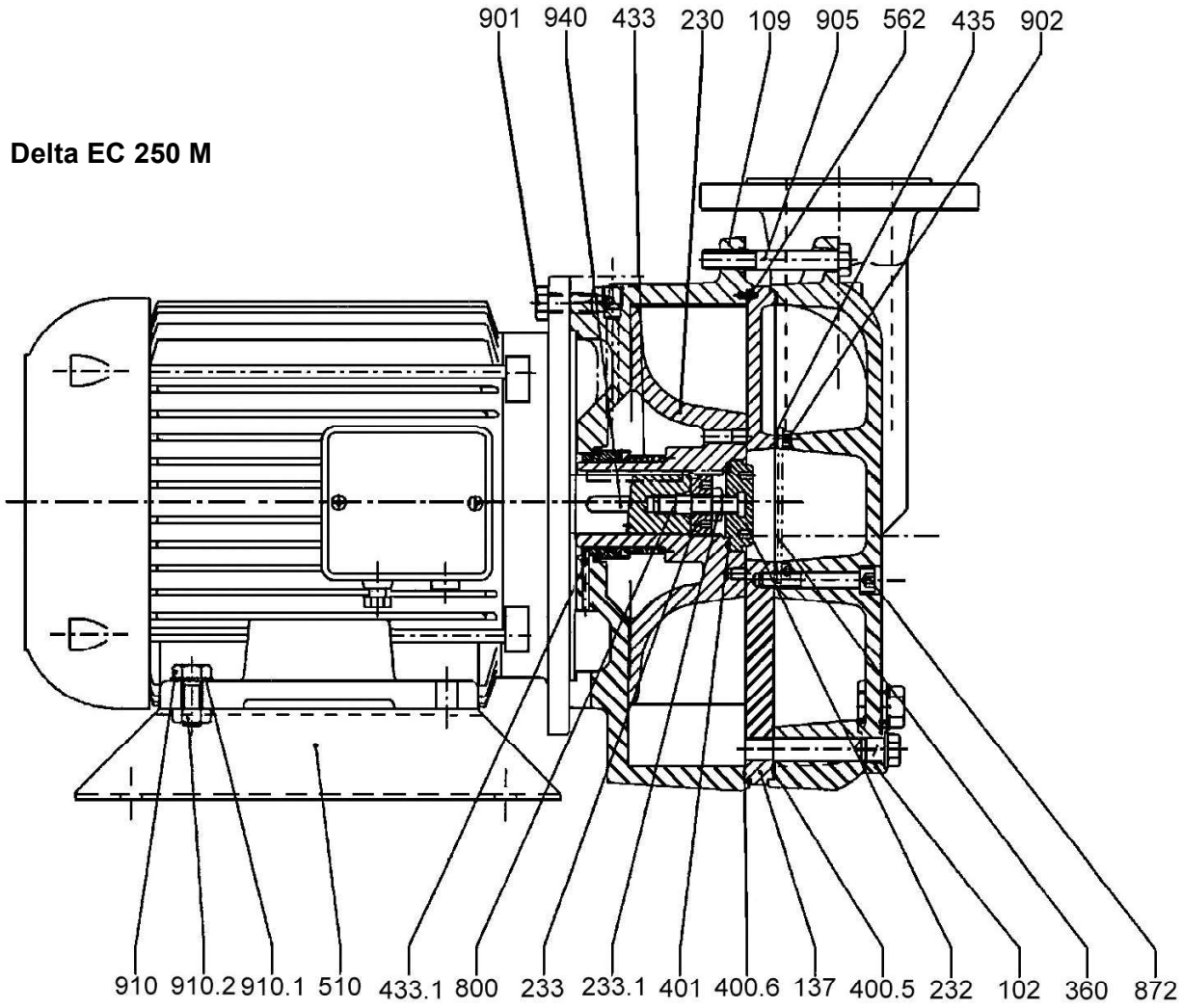
### Delta EC 50M




### Delta EC 90M, EC 125M, EC 150M



**Delta EC 250 M**



# Appendix B - NASH MHF Pump Information

## Introduction

These directions should be read carefully before the installation and start up of your Nash vacuum pump. In order to ensure operator safety and to avoid damage to the equipment it is important that the operators and the personnel in charge of the equipment are fully acquainted with the safety instructions in Section B.1. Please ensure that the equipment is operated in accordance with these safety instructions.

Do not operate or apply these pumps in a manner different than noted in this manual. Special versions of the pump may result in changes to the technical specification and operating performance. In the case of any questions, please consult our Technical Service Department. Please provide the pump model and serial number.

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## B.1 Safety

### B.1.1 Operational

While the pump is running the following safety pre-cautions should be adhered to:

- Avoid the suction and discharge connections.
- Do not touch the casing and the cover while the pump is working and conveying hot fluids.
- Do not go close to the pump while it is working with a special or toxic fluid and the mechanical seal is leaking.
- Do not allow the pump to run for long periods of time, if it is creating loud and prolonged noises.
- Check the safety system periodically.

### B.1.2 Service

Prior to any repair service being performed, the following safety precautions should be adhered to:

- Stop the pump.
- Bleed air into/out of the piping so that the pump internal pressure is the same as atmospheric pressure.
- Be sure that the current supply is off, the circuit breaker is open, locked, and tagged out.
- Empty the pump of service liquid.
- If the pump has been operated with a harmful liquid, careful washing with an appropriate liquid will be necessary.

## B.2 Description

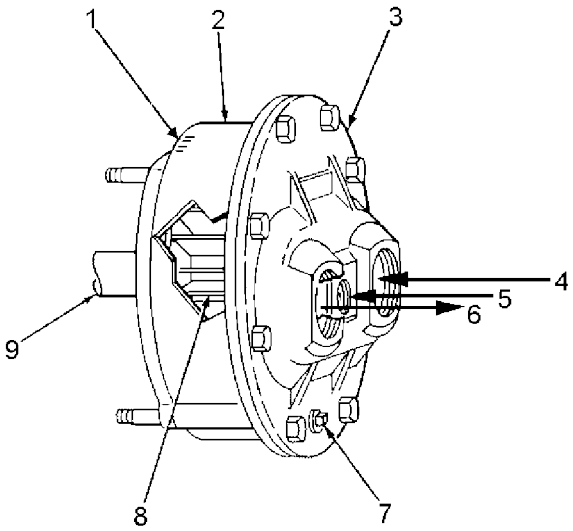
This bulletin contains information for owners and operators of Nash MHF 50, MHF 80, and MHF 120 vacuum pumps. This information includes a description of how to operate and maintain these vacuum pumps.

### B.2.1 How the Nash vacuum pump works

The main functional assemblies of a Nash vacuum pump are shown in Figure 1-1. A motor that is directly coupled turns a rotor (8) in the vacuum pump to the drive shaft (9). MHF pumps are assembled to the electric motor shaft. The rotor (8) lies within a chamber formed by the casing of the lobe (2).

Liquid compressant (usually water), which is called the seal liquid, is applied to the chamber from a liquid inlet (5, Figure 1-1) through the head (3). Figure 1-2 shows the functional operation of the vacuum pump. The actions illustrated therein and described below are made possible because the axis of the lobe (2, Figure 1-2) casting is offset from the axis of the rotor (3) and the head.

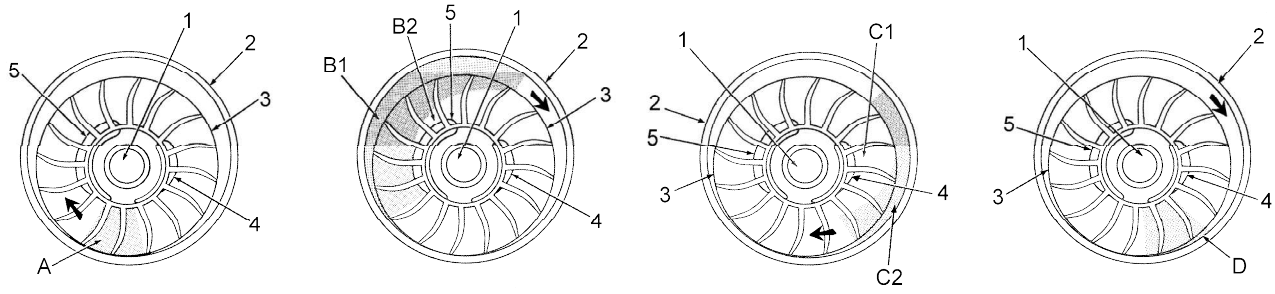
a. Inlet liquid compressant fills the rotor sector at point A, Figure 1-2.
b. Centrifugal force empties the sector at point B1, forcing the liquid compressant towards the lobe (2) casing. Low pressure at point B2, caused by the receding of the liquid compressant from the center of the rotor (3) chamber, draws air through the head air inlet port (5).
c. Air is compressed by converging the liquid compressant at point Cl. The liquid compressant is forced back toward the center of the rotor (3) chamber at point C2.
d. The liquid compressant and compressed air are discharged at point D.




1. Test Number
2. Lobe
3. Head
4. Air Air Inlet
5. Liquid Compressant inlet
6. Air Discharge
7. Drain Plug
8. Rotor
9. Drive Shaft (Motor or Pedestal Assembly}

**Figure 1-1. Functional Assemblies of Vacuum Pump**

The motion of the liquid being rotated in the pump operates as a compressant for the air pump. In addition, the liquid compressant acts as a seal, preventing air leakage to the atmosphere.




1. Drive Shaft
2. Lobe
3. Rotor
4. Head Discharge Port
5. Head Inlet Port

**Fig 1-2 Functional Operation of Vacuum Pump**

## B.3 Operation

### B.3.1 Preparation for initial start-up

Contact your **BeaconMedæs** representative for start up assistance.

### B.3.2 Liquid Compressant (Seal Liquid)

Proper operation of the vacuum pump requires that liquid compressant (seal liquid) be supplied at the proper rate of flow. The ideal liquid compressant is fresh water at 60°F (15°C). The seal liquid supply flow rates should be as specified in Table B-1. Variations in the flow rate of ±25 percent will not damage the vacuum pump, but wide variations may decrease vacuum pump capacity. See Figure 2-1 for recommended piping connections for the seal liquid supply.

**Table B-1 Seal Water Flow Rates**

| System Size - Pump | Flow Rate - GPM* |
|---|---|
| 3 HP | 0.75 GPM |
| 5HP | 0.75 GPM |
| 7½ HP | 0.75 GPM |

*Per vacuum pump

**WARNING**

**The seal liquid flow must be started before starting the pump drive motor, even if the pump is only being operated to check the direction of rotation.**

### B.3.3 Draining and Flushing

Before starting the vacuum pump, remove the drain plug (22, Figure 9-1) from the vacuum pump. Open the shut-off valves for the seal liquid supply and the initial prime bypass. Allow the seal liquid to flow until there is a clear flow from all drains. Although the vacuum pump is flushed with inhibiting oil prior to shipment, a light film of rust may form before installation is complete. This film will disappear after the vacuum pump shaft has been manually rotated a few times. Close the shut-off valve for the initial prime bypass only. Reinstall the drain plug using a pipe thread compound.

### B.3.4 Preliminary Inspection

Perform the following preliminary inspections before starting the vacuum pump.

**WARNING**

**Perform all of the following steps in order to ensure personnel safety and equipment protection.**

a. *Isolate all power sources to the motor to* make certain no accidental starting occurs.
b. Inspect the pump to make certain that the drain plug has been installed.
c. Inspect all piping to make certain that proper connections have been made to the pump and its basic system in accordance with the **BeaconMedæs** installation drawing(s) supplied with your system.

d. Inspect all vacuum pump control devices (such as flow control valves, solenoid valves, orifices, etc.) *to make certain that they have been located in accordance with the* **BeaconMedæs** *installation drawing(s).* Make certain that these components are correctly oriented in the piping scheme in order to achieve the proper direction of flow and functional operation.

e. Open the shut-off valve for the seal liquid supply and the initial prime bypass shut-off valve. Allow the seal liquid to flow until it flows from the pump discharge to prime the pump. Close the initial prime bypass shut-off valve.

**WARNING**

**Never operate the pump without adequate prime and service liquid flow. Severe damage may result. High service liquid supply pressures do not necessarily indicate that the flow is adequate. Check for flow from vacuum pump discharge or water trap silencer.**

f. Remove the motor fan guard and rotate the motor fan in the specified direction of rotation as marked on the pump body. Because of the direct-drive configuration, the pump shaft will also turn. **THE PUMP SHAFT MUST ROTATE FREELY**. If the pump shaft is bound and cannot be turned freely by rotating it manually, contact your **BeaconMedæs** representative for assistance. Reinstall the guard.

**WARNING**

**Do not attempt to free a pump shaft from a binding or bound condition by applying power to the drive motor. Severe damage may result.**

### B.3.5 Start-Up and Operating Checks

**WARNING**

**If the pump is to be checked in a system, notify the appropriate hospital personnel before placing a pump on line, particularly when placing the pump online for the first time. Starting up a system unexpectedly may cause personnel injury.**

Once the preliminary inspection and pre-operational check procedures have been completed, start the pump and check pump operation as follows:

a. Make certain that the pump is primed and the shut-off valve for the seal liquid supply is open.

b. Apply power to the drive motor.

c. Check the speed of the pump shaft rotation with a tachometer and compare the measured speed with the rated rpm for the pump. The rated rpm and capacity can be determined from the Engineering Data Sheet or by consulting your **BeaconMedæs** representative. (A test rpm is shown on the nameplate fastened to the pump lobe; however, this nameplate data may not show the exact operating speed for your application.)

d. Maintain a constant check on the temperature of the pump casing. If the temperature rises rapidly or is 25°F (14°C) or more above the temperature of the seal liquid, **SHUT DOWN THE PUMP IMMEDIATELY AND DETERMINE THE CAUSE**.

e. Check the temperature at the motor bearing housing areas. The temperature should not exceed the limits specified in the motor manufacturer's instructions.

## B.4 Troubleshooting

Nash Type MHF vacuum pumps require little attention other than periodic checking of the ability of the vacuum pump to obtain full volume or maintain constant vacuum. If operating difficulties arise, make the following checks:

a. Check for proper seal liquid flow rate. The seal liquid flow rate shall be as specified in Table B-1.

b. Check for the correct direction of pedestal assembly or drive motor shaft rotation as shown by the arrow cast in the head of the vacuum pump.

c. Check that the vacuum pump operates at the correct rpm-not necessarily the rpm stamped on the vacuum pump nameplate.

d. Check for an obstruction in the discharge piping. Backpressure at the pump discharge reduces capacity, reduces vacuum, and increases the driving horsepower that is required.

e. Check for a restriction in the air inlet line by reading the vacuum gauge in the inlet piping, as close to the pump as possible. Undersize inlet piping and line obstructions produce a higher vacuum on the vacuum gauge than the readings obtained at the work or process.

f. Check process piping for leaks and/or malfunctioning valves.

g. If the pump is shut down because of a change in temperature, noise and/or vibration from the normal operating conditions, check the condition of the pump pedestal or motor bearings, or coupling. Contact your **BeaconMedæs** representative for assistance.

h. If the pump assembly causing the trouble has been dismantled previously, check for improper re-assembly of pump and pedestal assembly parts.

If the trouble is not located through these checks, call your **BeaconMedæs** representative before dismantling or disassembling the pump. He will assist in locating and correcting the trouble.

## B.5 Maintenance

### B.5.1 Periodic Maintenance

#### B.5.1.1 General

a. Check that the seal liquid flow rate is as specified in Table B-1.

#### B.5.1.2 Monthly

a. Clean the seal liquid line strainer.

#### B.5.1.3 Semi-Annually

a. Check and lubricate the motor bearings as specified in the motor manufacturer's standard recommendations.
b. Check for proper operation of the seal liquid solenoid valve.

#### B.5.1.4 Annually

a. Check the inlet check valve for proper operation.
b. Check that the vacuum relief valve is free to operate properly.

### B.5.2 Bearing Lubrication

Refer to the motor manufacturer's instructions for motor bearing lubrication requirements.

### B.5.2 Shutdown Periods

If the vacuum pump must be taken out of service for more than two weeks, perform the following steps:

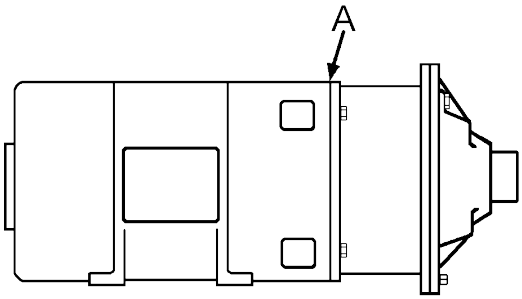
a. Remove the drain plug from the pump and drain all liquid compressant.
b. On all iron vacuum pumps, apply a good flushing oil (rust inhibitor) at the liquid compressant inlet and run the pump for not more than one minute to coat the interior with oil.
c. Rotate the motor shaft by hand every two weeks during the shutdown period.

When the pump is to be put back into service, start it in accordance with the starting directions in Section B.3.

## B.6 Disassembly and Re-Assembly

### B.6.1 Before Disassembling

The vacuum pump operates most efficiently when the rotor-to-head clearance is the same as that set by the factory. Continued use over a long period of time may cause this internal clearance to change. If pump operation indicates that trouble has developed, it may be necessary to dismantle the pump to inspect for readjustment of this clearance. If wear has been uniform on the head and on the rotor port face, clearance can be readjusted by removing shims that are located at gap "A". Clearance adjustment is made as specified in Section B.6.5, step a.4.




If the need for a dismantling operation is indicated, disassemble the pump as follows, marking all parts as they become accessible to ensure that they can be reassembled in the proper position.

### B.6.2 Disassembly

Disassembly of the vacuum pump for inspection, adjustment of rotor to head clearance, and/or replacement of defective parts requires certain materials and common hand tools that may have to be fabricated.

The parts and materials required to disassemble the pump are:

***Materials***

a. Set of replacement gaskets for vacuum pump. **DO NOT REINSTALL USED GASKETS.**
b. Set of replacement shims for vacuum pump.
c. Replacement shaft seal assembly (2, Figure 9-1)
d. Cleaning solution, such as Oakite Safety Solvent or equivalent
e. Loctite 262 or equivalent
f. Yellow grease or Vaseline
g. Clean light oil
h. Pipe nipple as specified in Section B.6.4, step j
i. Wooden block as specified in Section B.6.4, step f

***Hand Tools***

a. Socket wrench set with shaft extension. In most cases, open-end or box wrenches can be substituted for socket wrenches.
b. Machinist's hammer
c. Leaf (feeler) gauge set
d. Mechanical puller with slotted jaws
e. Propane torch and 350°F (177°C) temp stick
f. Diagonal pliers
g. Large screwdriver

**Before disassembling the pump the following must be done:**

1. **Isolate, lock, and tag-out all sources of electrical input.**
2. Isolate, drain and bleed the pump and piping.
3. Disconnect the suction, discharge, and service liquid lines.

#### B.6.2.1 Disassembly Procedure

To disassemble the vacuum pump:

a. Disconnect piping from air inlet and discharge and the liquid compressant inlet ports. (See Figure 1-1)
b. On stainless steel pumps, disconnect inlet and discharge flanges (138 and 139, Figure 9-1) from pump. Remove and discard flange gaskets (138-3 and 139-3).

**Note**
The vacuum pump can be disassembled in place mounted on its base. If there is not enough room to remove pump parts, proceed as follows: disconnect electrical connections to motor and remove four motor mounting bolts. Lift vacuum pump and place on a sturdy net work surface. Make sure that the motor feet are flat on work surface with head (103, Figure 11-1) and lobe (106) flanges overhanging end of work surface. Clamp or bolt the feet of the motor to the work surface.

c. Remove drain plug (22, Figure 11-1) and drain *all* liquid from the pump.
d. Remove eight head screws (103-1) from head (103).
e. Lift off head (103) and head gasket (103-3) from lobe (106). Discard gasket (103-3).

**Note:**
Check that the gap between the OD of rotor (110) and shroud bore of lobe (106) does not exceed 1/32 inch (0.8 mm). Check inside the face of the head for score marks between inlet and outlet ports. Score marks running from inlet to outlet ports 1/16 inch (1.6 mm) or deeper are not acceptable. Check rotor to ensure that the blades are not damaged or bent. Refer to Section B.8.3.

f. Wedge balled-up rag between rotor (110) and lobe (106). Turn rotor counterclockwise until rag is jammed and prevents rotor from turning.

**CAUTION**
**DO NOT ALLOW ROTOR (110) TEMPERATURE TO EXCEED 350°F (177°C) WHEN PERFORMING THE FOLLOWING STEP.**

g. Using propane torch and 350°F (177°C) temp stick, heat rotor nut (110-1) and hub area to temperature of 300° to 350°F (149° to 177°C) to loosen Loctite 262 applied during assembly.

**WARNING**
**Use gloves when handling heated parts to avoid burns.**

h. Using socket wrench, remove rotor nut (110-1). Remove rotor washer (110-2).
i. On all iron pumps, remove four, lobe nuts (106-1) securing lobe (106) to the pedestal or motor.

**Note:**
If mechanical puller screw has removable tip, remove tip to expose hollow end and ***do not*** center punch rotor nut (110-1) in step j.

j. Center punch top of rotor nut and install rotor nut on shaft (302 or 401) finger-tight to protect end of shaft.

k. Install mechanical puller on lobe (106) with either tip of puller screw seated in center punch in rotor nut or with hollow end of puller screw against rotor nut and puller arms secured to lobe with two head screws (103-1) and flat washers.

**Note**
Shims (4) may fall out as lobe (106) moves away from motor.
Retain shims (4) for re-assembly.

l. On stainless steel pumps, install mechanical puller on rotor (110) with tip of puller screw seated in center punch in rotor nut or with hollow end of puller screw against rotor nut and internal puller lips under rotor inner lip.

m. Using box wrench, tighten puller until rotor (110) breaks free of shaft (302 or 401).

**Note**
If rotor (110) does not break free of shaft (302 or 401), reheat rotor hub area as specified in step f and repeat step 1.

n. On all iron pumps, proceed as follows:

1. Loosen puller screw and remove rotor nut.

**Note**
If mechanical puller screw tip was removed, replace tip before performing step n.2.

2. Tighten puller until shaft seal assembly (2) is free of shaft journal. Remove puller.
3. Carefully remove lobe (106), rotor (110) and shaft seal assembly (2) as a unit and place drive end of lobe on a flat surface.
4. Remove rotor (110), rotating seal (2-1) and seal spring (2-3) from lobe (106).

o. On stainless steel pumps, proceed as follows:

1. Remove puller and rotor nut.
2. Remove rotor from shaft.
3. Loosen four setscrews (2-4) in rotating seal (2-1) and remove rotating seal from shaft.
4. Remove four lobe nuts (106-1) securing lobe (106) to pedestal and remove lobe.

p. Using wooden handle of a hammer or other wooden tool, press stationary seal (2-2) out of lobe (106). Place a rag or other soft material on bench to prevent damage to stationary seal when it falls from lobe.

**Note**
Perform step q only if rotor key (110-4) is damaged and requires replacement.

q. Using diagonal pliers, pry rotor key (110-4) out of motor shaft (401) or pedestal shaft (302). Removal of the key may be difficult. This is a normal condition.

**Note**
Perform step r only if the slinger (3) is damaged and requires replacement or if the motor requires disassembly.

r. Remove slinger (3) from shaft (302 or 401). This completes disassembly of vacuum pump.

s. If the shaft sleeve (114) is damaged or worn and requires replacement, use propane torch and 350°F (177°C) temp stick, and heat shaft sleeve to 300° to 350°F (149° to 177°C) to loosen Loctite 262 that bonds shaft sleeve to motor shaft. Then pry shaft sleeve off the motor shaft.

t. On all iron pumps if a lobe stud (106-2) is broken or damaged and requires replacement, unscrew broken or damaged lobe and stud and remove from lobe (106). On all iron pumps MHF 80 and MHF 120 vacuum pumps, if either of two lower lobe studs (106-2) require replacement, heat stud area to 300° to 350°F (149° to 177°C) with propane torch to loosen Loctite 262 and then remove lobe stud. On stainless steel pumps, heat stud area in same manner to remove *any* lobe stud that requires replacement.

### B.6.3 Inspection of Disassembled Parts

With the vacuum pump, disassembled, inspect parts for wear from corrosion or erosion. Clean all foreign material from the inside face of the head (103, Figure 9-1), the rotor (110) and the internal surfaces of the lobe (106). If any of the parts are worn or damaged, contact your **BeaconMedæs** representative to determine if the parts must be replaced.

### B.6.4 Reassembling the Pump

**CAUTION**

**On stainless steel pumps, use Loctite anti-seize or equivalent on all threaded fasteners and use Teflon tape, Loctite PST pipe sealant or equivalent on pipe threads to avoid galling and pick-up.**

Following the inspection of the pump parts, reassemble the pump as follows:

a. On all iron type MHF pumps, if the shaft sleeve (114, Figure 9-1) was removed, install a new shaft sleeve on the motor shaft (401).
b. If lobe studs (106-2) were removed, install new lobe studs in lobe (106). On all iron size MHF vacuum pumps, if lobe studs are to be installed in two lower through lappings in lobe, clean tapping and new lobe stud threads with Oakite Safety Solvent and let solvent dry. Then apply Loctite 262 to lobe tapping and lobe stud threads and install lobe studs. On stainless steel pumps, clean lappings and *any* new lobe stud threads and apply Loctite 262 in same manner
c. On stainless steel pumps, install holding pin (2-5), if removed, in lobe with pin protruding no more than 1/16 inch (1.6 mm) into lobe interior.
d. Remove new shaft seal assembly (2) parts from wrapping carefully and keep cardboard shipping disc between sealing faces. In handling make certain not to drop rotating seal (2-1) or stationary seal (2-2) and take particular care not to chip or scratch sealing faces.
e. Apply small amount of light oil (not grease) to O-ring on stationary seal (2-2) and bore of lobe (106).

**Note**
On stainless steel pumps, make sure that slot in stationary seal (2-2) is aligned with holding pin (2-5) when performing step f.

f. Install stationary seal, shiny face up, in lobe bore.
g. Place cardboard shipping disc on stationary seal to protect sealing face and press stationary seal into lobe with a piece of wood with smooth flat end. Trim end of piece of wood to 2-1/4 inch (57 mm) maximum diameter. Use care, push squarely and firmly until stationary seal (2-2) bottoms in lobe bore. Remove cardboard shipping disc and clean and oil sealing face of stationary seal using clear light oil (not grease).

**Note**
If the motor is not mounted on a base, clamp or bolt the motor feet to a sturdy flat work surface so that lobe (106) flange will overhang edge of work surface when installed.

**CAUTION**

**Make certain that lobe (106) is centered on shaft and not cocked when performing the following step. Ceramic stationary seal (2-2) can be damaged and made unserviceable by contact with shaft shoulder or edge of shaft sleeve (114) if lobe (106) is cocked.**

h. Position lobe (106) with nameplate pad at top and carefully slide lobe over shaft (301 or 402).
i. Install and tighten four lobe nuts (106-1) securing lobe to motor.
j. On all iron pumps:

1. Apply small amount of light oil (not grease) to rubber bore of rotating seal (2-1) and shaft sleeve (114) and shaft shoulder. Clean and oil sealing face of rotating seal with dean light oil (not grease).
2. Prepare 1-1/4 inch pipe nipple for sizes MHF 50, MHF 80, or a 2-inch pipe nipple for size MHF 120, approximately 6 inches (152 mm) long. File one end flat and square with pipe axis and chamfer the inner diameter on same end approximately 1/32 inch (0.8 mm) by 45 degrees.
3. Slide rotating seal (2-1) over shaft (301 or 402) up to shaft shoulder with shaft sleeve (114), center rotating seal and start it onto shaft sleeve by hand.
4. Slide nipple prepared in step j.2 over shaft (301 or 402) and center flat end of the nipple against the lip of the rubber driving band of the rotating seal. (See Figure 5-10.) Push squarely and firmly on nipple until sealing face of rotating seal contacts sealing face of stationary seal (2-2). End of rotating seal (2-1) should be approximately 1/16 inch (1.6 mm) beyond shaft shoulder.
5. Make certain that the rubber driving band is not extruded or otherwise deformed. If the rubber driving band is deformed, remove rotating seal (2-1) carefully by hand and repeat step j.4.
6. Clean shaft extension beyond rotating seal, key-way and threads of shaft (301 or 402), shaft key (1104), bore and keyway in rotor (110), rotor washer (110-2) and threads of rotor nut (110-1) with Oakite Safety Solvent. Allow solvent to dry.
7. Apply coating of Loctite 262 to rotor key (110-4) and insert rotor key into keyway in shaft.
8. Install seal spring (2-3) over shaft. Insert folded thickness of tissue or paper between end of seal spring and rotating seal. Push seal spring against rotating seal retainer with tissue or paper wedge, so seal spring stays in position centered on shaft. (See Figure 5-11.)
9. Apply coating of Loctite 262 to bore and keyway of rotor (110).
10. Install rotor on shaft.
11. Apply coating of Loctite 262 to both faces of rotor washer (110-2) and install rotor washer on shaft.
12. Wedge balled-up rag between rotor (110) and lobe (106). Turn rotor clockwise until rag is jammed and prevents rotor from turning.
13. Apply sufficient Loctite 262 to wet threads of shaft.
14. Place rotor nut (110-1) into 1-inch socket (for sizes MHF 50, MHF 80) or 1-1/16 inch socket (for size MHF 120) mounted on short extension and fill interior of nut with Loctite 262.
15. Install rotor nut on shaft using care to minimize amount of Loctite 262 that is spilled.
16. Tighten rotor nut to 45 to 50 foot-pounds (61 to 68 N·m) on sizes MHF 50, MHF 80, and to 85 to 90 foot-pounds (115 to 122 N·m) on sizes MHF 120.

k. On stainless steel pumps:

1. Insert rotor key (110-4) into keyway in shaft.
2. Install rotor (110) on shaft.
3. Install rotor washer (110-2) on shaft. If
4. Wedge balled-up rag between rotor and lobe. Turn rotor clockwise until rag is jammed and prevents rotor from turning.
5. Thoroughly lubricate shaft and rotor nut (110-1) threads with DTE medium machine oil or equivalent.
6. Install rotor nut on shaft using 1-inch socket (for sizes MHF 50 and MHF 80) or 1-1/16 inch socket (for size MHF 120) mounted on short extension. Remove any burrs. Tighten rotor nut to 45 to 50 foot-pounds (61 to 68 Am) on sizes MHF 50 and MHF 80 and to 85 to 90 foot-pounds (115 to 122 Am) on size MHF 120.

1. Remove rag from between rotor and lobe.

m. Mount dial indicator on lobe with foot of indicator on face of rotor at OD. Check that runout of rotor face does not exceed 0.004 inch (0.10 mm).

n. Loosen four lobe nuts (106-1) to allow 1/8-inch (3 mm) play.

**Note**
On all iron pumps, lightly grease head-mounting face of lobe and install approximately 0.030-inch (0.76-mm) thickness of new head gaskets (103-3) when performing step o.

o. Install new head gasket (103-3) on lobe. Orient head (103) with cast name "NASH" at top and drain plug hole at bottom and secure to lobe with eight head screws (103-1).

**Note**
On all iron pumps, make certain that reducer bushing (28) is installed in outlet port in head (103) on sizes MHF 50, MHF 80.

### B.6.5 Adjusting Rotor-to-Head Clearance

**CAUTION**
**Make sure to apply and maintain 100 pounds force (445 Newtons) minimum to end of shaft when performing steps A through D.**

a. Determine thickness of shims (4, Figure 9-1) required to set running clearance between face of rotor blades and inside face of head as follows:

**Note**
To check clearance on assembled pump, loosen four lobe nuts (106-1) to allow 1/8 inch (3 mm) play and remove shims (4).

1. Remove cap from motor end bell. Mount mechanical puller at idle end of motor with puller jaws engaging edge of fan shield or cast protusions for motor draw bolts, and puller screw centered in end of motor shaft. Tighten puller to push motor shaft and rotor (110) as far as possible towards head (103) to take up free end play in motor bearings. Then proceed to step a.4.
2. Push assembled head and lobe firmly towards motor so that head contacts the rotor blade ends. Tighten four lobe nuts (106-1) *finger tight only* to maintain contact.

3. Using feeler gauge, measure gap A between lobe and motor mounting flanges at four points 90 degrees apart. Make certain that feeler gauge leaves are tight fit in gap. Record four measurements.
4. Add four measurements recorded in step a.5 and divide total by 4 to determine average shim gap and add 0.008 to 0.010 inch (0.20 to 0.25 mm) to average. Make certain that gap is not underestimated since this will reduce running clearance.
5. Select two sets of shims (4) equal to sum calculated in step a.6. Shim thickness can be slightly greater than calculated value but NOT less.

**CAUTION**
**DO NOT MOVE LOBE (106) ANY MORE THAN NECESSARY WHEN PERFORMING FOLLOWING STEPS SINCE ANY EXCESS MOVEMENT MAY AFFECT PERFORMANCE OF SHAFT SEAL.**

b. Loosen lobe nuts (106-1) just enough [approximately 0.010 inch (0.25 mm) l to install shims (4).

c. Use pair of screwdrivers and move lobe just enough to install one set of shims (4) between lobe and pedestal or motor on each side of pump between top and body lobe studs (106-2).

d. Tighten lobe nuts (106-1).

e. Remove tools installed in step a. 1, 2 or 3.

f. Tighten the lobe nuts (106-1).

g. Push shaft (302 or 401) towards pump end and manually turn shaft to ensure that shaft turns freely with no rubs or binding. If rubs or binding is detected, loosen four lobe nuts to allow 1/8-inch (3 mm) play, remove shims (4) and repeat steps a through f.

h. On stainless steel pumps, proceed as follows:

1. Remove head (103) and gasket (103-3); clean head and lobe (106) flange faces.
2. Remove rotor nut (110-1) and washer (110-3).
3. Remove rotor (110) and rotor key (110-1).
4. Perform step j.6, Section B.6.4.
5. Clean and lightly oil face of rotating seal (2-1) and stationary seal (2-2) using clear light oil (not grease).
6. Reinstall tools installed in steps a.1, 2 or 3, and apply and maintain 100 pounds force (445 Newtons) minimum to end of shaft.
7. Using clean depth gauge, measure and record distance from face of stationary seal to shaft shoulder. **USE CARE NOT TO SCRATCH OR CHIP FACE OF STATIONARY SEAL.**
8. Subtract 7/8 inch (22.2 mm) from dimension recorded in step h.7.
9. Lightly oil inner diameter of Teflon ring in rotating seal.
10. Slide rotating seal onto shaft until sealing faces are in contact. Remove clips from rotating seal. **USE CARE NOT TO DAMAGE TEFLON RING OR SEAL FACES.**
11. Compress rotating seal to obtain dimension computed in step h.8. Make sure that rotating seal is compressed to proper dimension and square with shaft; tighten four setscrews (2-4) to secure rotating seal to shaft.
12. Clean any oil from shaft and shaft shoulder.
13. Perform steps f.7 and f.8, Section B.6.4.
14. Install rotor on shaft against shaft shoulder. Turn rotor clockwise to take up slack in keyway. Fill rotor shaft bore cavity with Loctite 262.

15. Install rotor washer (110-3) on shaft.
16. Perform step j.12, Section B.6.4.
17. Perform step j.l3, Section B.6.4, and fill lathe center in end of shaft with Loctite 262.
18. Perform steps f.l4, f.15 and f.l6, Section B.6.4.
19. Perform steps I and a, Section B.6.4.
20. Perform steps e and g.
21. Install new flange gaskets (138-3 and 139-3) and secure inlet and discharge flanges (138 and 139) to pump.

i. Install drain plug (22) in head (103). This completes re-assembly of pump. Pump must be realigned in accordance with instructions in Bulletin No.642, Installation Instructions, Nash Vacuum Pumps and Compressors, if pump was removed from base for disassembly. Contact your **BeaconMedæs** representative for more information. Drain and flush as specified in Section B.3.3 and start unit as specified in Section B.3.4 and Section B.3.5 to place pump back in service.

**CAUTION**
**MAKE CERTAIN THAT LIQUID COMPRESSANT (SEAL LIQUID) SUPPLY IS TURNED ON BEFORE STARTING PUMP MOTOR. SHAFT SEAL WILL BE DAMAGED IF PUMP IS RUN DRY.**

## B.7 Repair and Warranty Orders

If a warranty is claimed, the pump is to be shipped to our company in a closed package. It is to be emptied and cleaned before packaging. For safety reasons, if the pump has been working with harmful or dangerous liquids it is to be washed with appropriate materials.

## B.8 Spare Parts

When ordering spare parts please refer the part name, item number, the pump model, and also the nameplate references and the serial number. Some parts are standard and therefore, generally available from **BeaconMedæs** stock.

## B.9 Parts List

Refer to the cross sectional diagrams for item identification.

| PARTS LIST | | | | | |
|---|---|---|---|---|---|
| **Item Number** | **Qty.** | **Description** | **Item Number** | **Qty.** | **Description** |
| *2 | 1 | Shaft Seal Assembly | 106-2 | 4 | Lobe Stud |
| 2-1 | NP | Rotating Seal | 110 | 1 | Rotor |
| 2-2 | NP | Stationary Seal | *110-1 | 1 | Rotor Nut |
| †2-3 | NP | Seal Spring | *110-2 | 1 | Rotor Washer |
| ‡2-4 | NP | Setscrew | *110-4 | 1 | Rotor Key |
| ‡2-5 | NP | Holding Pin | †114 | 1 | Shaft Sleeve |
| *3 | 1 | Slinger | ‡138 | 1 | Inlet Flange |
| *4 | AR | Shims | ‡138-1 | 2 | Flange Screw |
| 22 | 1 | Drain Plug | *‡138-3 | 1 | Flange Gasket |
| **28 | 1 | Reducing Bushing | ‡139 | 1 | Discharge Flange |
| 103 | 1 | Head | ‡139-1 | 2 | Flange Screw |
| 103-1 | 8 | Head Screw | *‡139-3 | 1 | Flange Gasket |
| *103-3 | 1 | Head Gasket | 401 | - | Motor Shaft |
| 106 | 1 | Lobe | | | |
| 106-1 | 4 | Lobe Nut | | | |

*Minimum recommended spares
** Used on all iron MHF 50 and MHF 80 pumps only
† Used on all iron vacuum pumps only
‡ Used on Stainless steel pumps only
NP - Not procurable
AR - As required

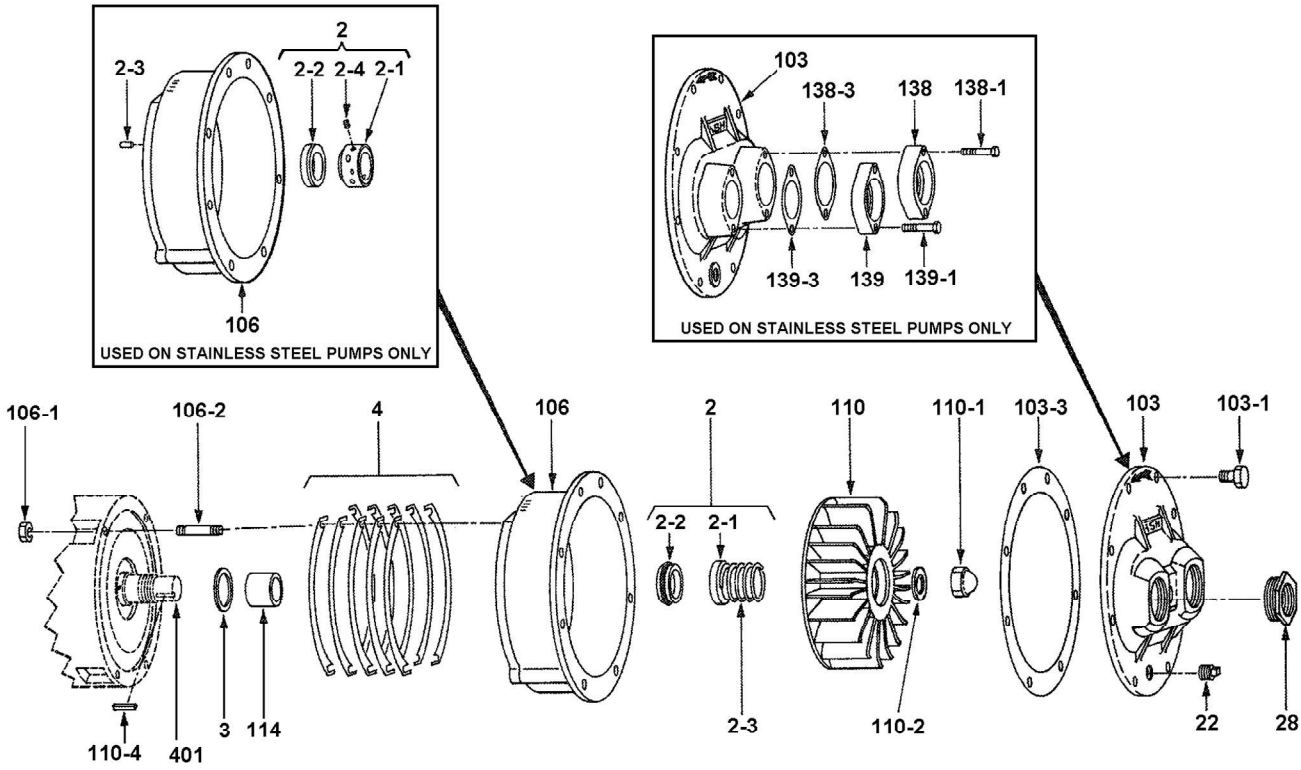



**Fig 9-1 MHF 50, 80, 120 Vacuum Pumps Exploded View**