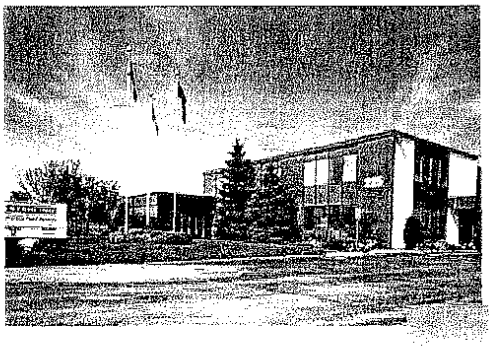
Liquid Ring Vacuum Pumps

General
Installation
&
Service
Instructions

STERLING FLUID SYSTEMS GROUP



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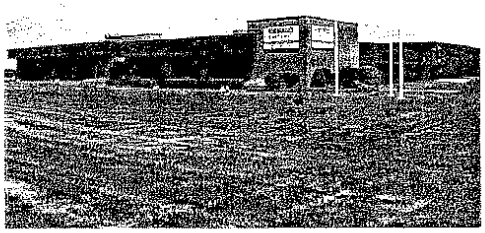

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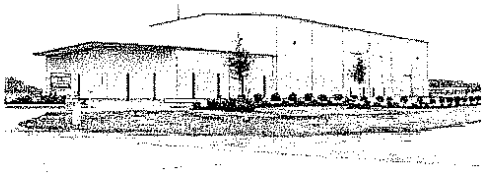

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Introduction to Sterling SIHI Liquid Ring Vacuum Pumps

Sterling SIHI's liquid ring pumps offer efficient compression of condensable vapors and gases in the rough vacuum field with a capability of up to 29" Hg vacuum (depending on the application and pump type used).

Sterling SIHI pumps use the liquid ring principle to ensure maximum safety in compression of hazardous mixtures. Reliability is ensured through the use of only one rotating assembly with no internal metal to metal contact.

Should you need any further information or assistance, please contact the Sterling SIHI office or distributor of your choice. Major locations appear on back cover of this manual.

The Liquid Ring Principle

The 'liquid ring' pump takes its name from its principle of operation. A cool liquid is introduced into a round casing and, due to centrifugal force when rotated, forms a nearly concentric ring around the pump casing.

The impeller is eccentrically mounted in the casing. Hence, at one side, the cells formed by the impeller blades and the boundary of the liquid ring increase in size; and on the other side, they decrease in size. A suction port is positioned in the area where the cell size is increasing. This port ducts the gas from the pump inlet into the lower pressure cells.

The gas introduced into the cells is then compressed by the operating liquid in the area where the cell size is decreasing. A discharge port is positioned to duct the compressed gas to the pump discharge.

Since the liquid absorbs the heat generated during compression, a small quantity of fresh cooling liquid is continually introduced via the service liquid supply port, and the resulting excess warm liquid discharges with the gas to a downstream gas/liquid separator.

The liquid used as compressant allows the liquid ring pump to perform cool, reliable compression of virtually all gases and condensable vapors while easily handling liquid and soft solid carryover.

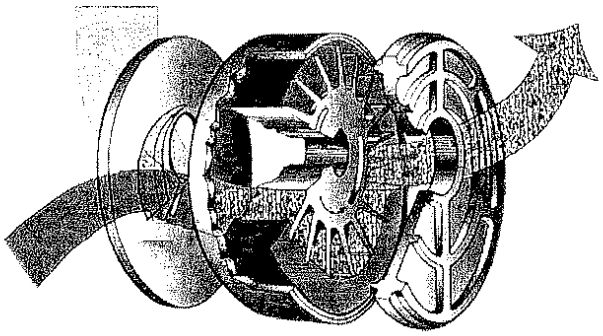


FIGURE 1

SECTION A

INSTALLATION AND OPERATION

INSTALLATION

1. Remove the pump unit from the shipping carton or skid and check for mechanical damage. Should damage be observed, report this to the shipping company responsible.

2. If the pump was purchased as a bare pump unit, mount the unit on your base or supporting frame and connect to your motor assembly using suitable flexible coupling. **NEVER operate the unit without a OSHA guard, but do not install a guard until alignment and pre-start-up rotational checks have been performed.**

3. Remove all plastic shipping plugs from the inlet, outlet and service liquid connections. Rotate pump shaft manually to ensure shaft is capable of turning. Rotation may not be easy, and a pipe wrench may be required due to packing or seal drag. If the shaft cannot be turned with a suitable wrench, contact the factory for information.

4. Align the pump and motor (per Alignment Methods – page 4) preferable using the dial gauge method.

   Note: Improper alignment is a major contributing factor to pump noise, vibration and premature failure.

5. Connect inlet, discharge and service liquid connections. Minimum piping size is the size of pump connections.

   SEE NOTE ON PAGE 3.

   NOTE: When installing inlet connections, we suggest a temporary inlet screen be employed to prevent ingress of weld slag and debris into the pumps body. Be careful to check operation when screen is installed since debris can foul the screen and result in cavitation. Do not leave temporary screens installed as they can lead to failure due to plugging, deterioration and loss in performance. To assist in the removal of the temporary screens a suitable section of inlet pipe should be removable or a spool piece installed before the screen.

   CAUTION: Pumps and baseplates are not designed to carry pipe loads. Ensure that suitable pipe supports are in place and flexible connections and/or thermal expansion provisions used as necessary. Vertical piping rise from the pump discharge should be limited to a maximum of 24". It is also recommended that a vacuum gauge be installed at the pump inlet. A suitable ¼" plug is provided on most pump inlet flanges for the gauge.

   NOTE: At the very minimum, all liquid ring pumps should be fitted with an inlet check valve of special low loss type, and a correctly sized service liquid separator in the discharge.

   Suitable accessories can be obtained from your local Sterling SIHI representative. Sterling SIHI can also provide complete factory assembles packages for you application. Contact the factory or your local representative for information.

6. Connect service liquid supply.

7. On initial start-up, or upon installation after repairs, half fill the pump with service liquid (**do not overfill!**) prior to operation. This will ensure that the seals (if installed) are not damaged by dry operation, and unit is ready for liquid priming if installed in a recirculation system (refer to section B).

   DO NOT OPERATE THE PUMP DRY OR PREMATURE FAILURE MAY OCCUR.

8. Connect the motor and any electrically controlled accessories such as service liquid solenoid valves as required. Ensure motor speeds, voltages and frequencies agree with the supple and the pump requirements.

9. Recheck alignment done previously, then install suitable OSHA specified coupling guard.

   NEVER OPERATE ROTATING EQUIPMENT WITHOUT SUITABLE GUARDING.

10. Jog the pump motor and check pump rotation. All pumps with model number **BN** rotate in a clockwise direction viewed from the motor end. Pumps with **BO** in the model number rotate counter clockwise viewed from the motor end. Arrows are provided on the pump cover. Should there be any confusion, please call the factory before operating the unit.

11. If the pump is to be used in a new installation, refer to the system arrangements depicted in section B.

12. Once the type of system has been determined and the accessories required installed, proceed with section C, "Typical Operating Sequences...".

Routine Maintenance

Sterling SIHI liquid ring pumping equipment is designed for continuous industrial usage. Routine maintenance is minimal, however, as with all equipment some precautionary checks should be made.

CHECK FOR:

1) Leaks and satisfactory vacuum conditions.

2) Unusual noises.

3) Grease bearing every 3000 hours with lithium based bearing grease to NLGI – 3 specifications, where applicable. **NOTE: some pumps are fitted with bearings sealed for life. Pumps so fitted do not have grease nipples and are not to be greased. (Do not mix bearing greases without checking, as some grease additives are not compatible**

For troubleshooting, refer to Appendix 4.

ALIGNMENT METHODS

PREFERRED - DIAL GUAGE

The service life of the pump is dependent on good coupling alignment. Flexible couplings will not compensate for shaft misalignment. If the motor was mounted by Sterling SIHI, the pump and motor were aligned prior to shipment from the factory. Since baseplates are not perfectly rigid, handling during shipment, pipe loading and foundation stresses mandate an alignment check prior to start-up. Changes to alignment should be made by adding shims, as necessary, under the motor feet.

The dial indicator method for checking coupling alignment is preferred (refer to figures 2 and 3). To measure parallel misalignment, attach dial indicator to one coupling hub, or mount on one shaft end with the indicator button resting on the O. D. of the other coupling hub (figure 2) or shaft. To measure angular misalignment, the indicator button rests on the face of the other coupling hub near the O. D. (figure 3). Measure misalignment by rotating the shaft and dial indicator one full revolution; the other shaft remains stationary. Record the Total Indicator Reading (T.I.R.). Parallel and angular misalignment should be limited to $\pm$0.002" T.I.R.

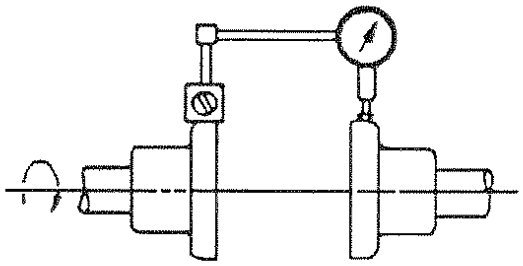


FIGURE 2

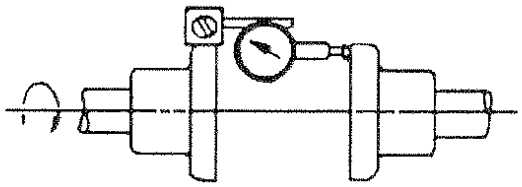


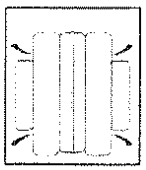
FIGURE 3

If a dial indicator is not available, an adequate alignment is possible using a straight edge, feeler gauge, micrometer or caliper. This method should be used as a last resort only.

NOTE: Reverse dial indicator alignment, or laser optical alignment, can be used satisfactorily. Please contact the factory if details are required.

CHECK PARALLEL ALIGNMENT

Check parallel alignment by placing a straight edge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling. DO NOT rotate the coupling. If the maximum offset exceeds the figure shown, correct alignment to an acceptable level.



CHECK ANGULAR ALIGNMENT

Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum dimensions. **DO NOT** rotate the coupling. The difference between the maximum and minimum must not exceed the figure given. If a correction is necessary, be sure to recheck the parallel alignment. **NOTE:** For maximum life, keep misalignment values as near to zero as possible.

SECTION B

GENERAL NOTES CONCERNING SERVICE LIQUID SUPPLY

The operation of the liquid ring pump is dependent upon a continuous supply of cool, clean service liquid, which enters the pump on the suction side and is discharged with the compressed gas. The volume of the liquid ring within the pump should be regulated for optimum performance. The service liquid entering and leaving serves to carry away the heat of compression imparted. The temperature rise from inlet to discharge normally is approximately 4°C (7°F). **NOTE**: Actual temperature rises may be higher depending on: 1) point of operation; 2) quantity of service liquid supplied; 3) gas characteristics; and 4) service liquid properties.

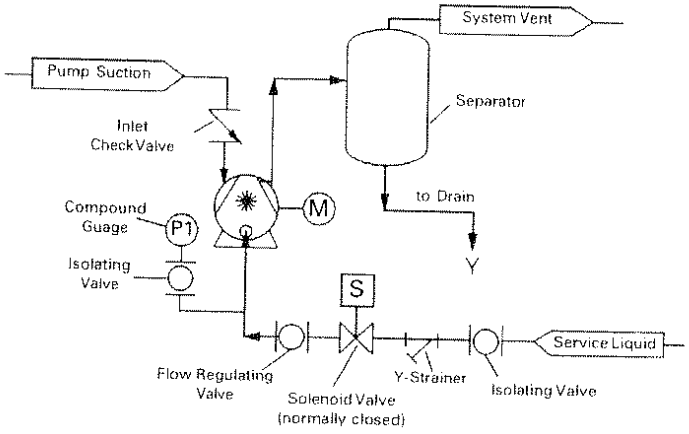
Figures 4, 5 and 6, show typical systems for supply of service liquid. In each instance, different accessory items are recommended. These items or a complete factory assembled system may be purchased from Sterling SIHI. **CAUTION**: The drawings and arrangements following are for reference, and may not be satisfactory for your application. Should you have any concerns, please contact the factory for information. Refer to Appendix I for pipe sizes and locations, Appendix II for the effects of service water vapor pressure, and Appendix III for recommended service liquid flow rates for each pump model.

DESCRIPTION OF SUPPLY SYSTEMS

System 1 – Once Through

Once through service liquid supply requires liquid to be available at some positive pressure to the liquid supply accessories prior to the pump. (You may wish to consider the use of a Sterling SIHI standard XBa package.)

Normal accessories in this mode of operation are: compound gauge, flow regulating orifice (or flow control valve), normally closed solenoid valve 'Y' pattern strainer and manual isolating valve.



Once Through System
FIGURE 4

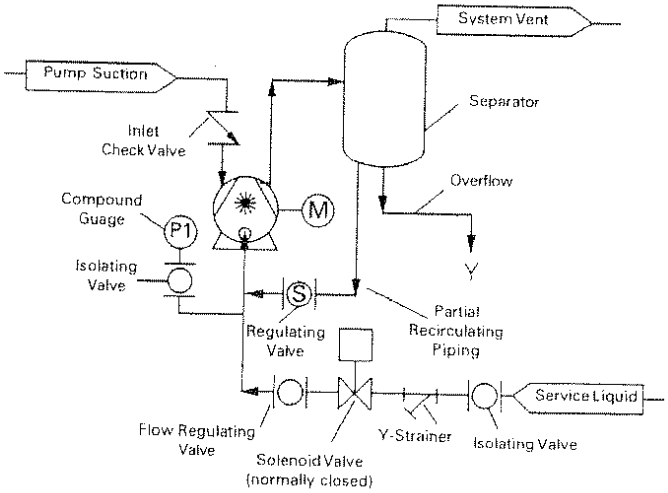
System 2 – Partial Recirculation

Figure 5 details a partial recirculation system. Partial recirculation can be employed in instances where make-up liquid is available at a temperature lower than the service liquid design temperature.

Service liquid enters the pump and is discharged at a slightly higher temperature to the separator. Heat is lost due to radiation and convection, and a portion of the liquid (still at higher than the design temperature) is returned to the pump. The returned liquid is cooled to the design temperature by mixing with a suitable quantity of cool fresh liquid (make-up) at a lower temperature.

The quantity of make-up required is dependent on the difference in temperatures between the design service liquid temperature, the discharge temperature, the pump required operating pressure and capacity, the actual pump capacity, and the normal required liquid flow. In many instances it is possible to reduce the fresh liquid flow to 50% of the normal flow or less. The excess liquid is drained from the separator via the normal overflow.

Partial recirculation requires a Sterling SIHI XBA type separator (or similar liquid reservoir), inlet check valve normally closed solenoid valve, 'Y' strainer, and shut-off valve, as shown in figure 5.



Partial Recirc System
FIGURE 5

System 3 – Complete Recirculation

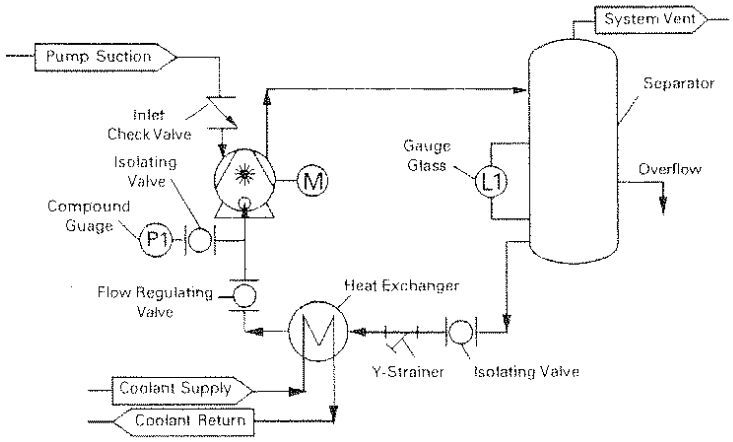
Figure 6 details the normal installation of a self-contained service liquid supply system. Sterling SIHI has standard TRB packages designed and stocked for this application. Contact your representative for more details. This arrangement is normally used where, due to cost, availability, or disposal limitations, it is desired to eliminate or minimize service liquid make-up and drain needs.

Service liquids chosen under these conditions can be water, solvents, oils, or other liquids compatible with pump materials, performance requirements, and the process.

CAUTION: **Where it is desired to use liquids other than water, please contact your local Sterling SIHI representative or the factory with details of the proposed application, prior to selection or operation of the equipment.**

In this arrangement, liquid used is discharged to a separator and returned to the pump via a sealed cooling device such as a liquid to liquid cooler (heat exchanger), or an air to liquid cooler (radiator).

Accessories required are: recirculation separator or container fitted with some form of level monitoring device(s), isolating valve for the heat exchanger, 'Y' pattern strainer, flow control valve, compound gauge, and a cooler.



TOTAL Recirc System
FIGURE 6

Other accessories which may be required could include: inlet filters or coalescing filters on the vents, gas coolers or condensers, and various accessories to make the system fit the requirements of the user.

In the event the pump will be required to operate for an extended time below 10" Hg vacuum, an orifice should be installed in the pump suction, or a recirculation pump should be employed to positively supply liquid. Please contact the factory for information.

SECTION C

TYPICAL OPERATING SEQUENCES FOR LIQUID RING PUMPS IN THE VARIOUS SERVICE LIQUID SUPPLY MODES

SYSTEM 1 - ONCE THROUGH SERVICE LIQUID SUPPLY NORMAL OPERATION

The normally closed solenoid valve should be wired to open in conjunction with motor start.

If the pump is new or repaired, or the system has been worked on, perform the checks noted in section A, items 1 through 12, prior to doing the following.

Ensure all protective guards are in place prior to proceeding, then jog the pump while observing the compound gauge. A variation in the pressure should occur if the solenoid valve is opening. If no variation occurs, check the solenoid and the supply line for closed valves or plugs.

Start the pump and run it down to the normal operating pressure. Monitor the service liquid pressure on the compound gauge with pump operating in the normal operating range, and adjust the liquid flow using a manual valve. Approximate setting on the compound gauge should be zero. However, the optimal setting occurs with valve set at the minimum opening possible, providing the pump runs smoothly and gas water discharge temperatures are satisfactory.

After setting the flow, mark the reading on the compound gauge. Monitor the service liquid pressure routinely to ensure variations are not occurring and pump operation is satisfactory.

If in the course of normal operation it is necessary to shut the unit off, stop the pump and check that the solenoid closes. If pressure is indicated on the gauge, the solenoid valve is not closing and the pump may be flooded. Repair solenoid and drain pump to shaft centerline before restarting.

CAUTION: Starting liquid ring pumps with excessive water in the casing can lead to motor overload and possible damage.

SYSTEM 2 – PARTIAL RECIRCULATION

The normally closed solenoid valve on the make-up (fresh liquid) line should be wired to open in conjunction with the motor start.

If the pump is new or repaired, or the system has been worked on, perform the checks in section A, items 1 through 12, prior to proceeding. Ensure all guards are properly installed prior to proceeding.

Jog the pump while observing the compound gauge. If the solenoid valve is opening, a variation in pressure should occur. If no variation occurs, check the solenoid and all liquid lines for closed valves or plugs.

Operation with automatic control orifice

If a make-up (fresh liquid) orifice is installed, start the pump unit and monitor operation. When the system is operating under normal conditions, check to ensure the pump runs smoothly and that pump temperature stabilizes. If pump operating temperature does not stabilize, liquid make-up rate is unsatisfactory. Re-check for plugs in the fresh liquid supply. **Do not continue to operate the unit if temperature continues to rise.**

Operation without automatic orifice

Partial recirculation always requires introduction of some cool liquid. However, the actual quantity required varies, depending on the system conditions and operating requirements.

Optimum make-up rate is the minimum flow rate required to maintain a stable service liquid supply temperature at the lowest operating pressure (highest vacuum), while remaining smooth, quiet operation. **NOTE:** Sterling SIHI recommends a minimum of 10% fresh make-up in most instances, since the separators used have relatively small liquid volumes. Leakage or evaporation could quickly result in failure, due to dry running. Should it be desired to reduce make-up liquid rates further, consult the factory, or consider installing a Sterling SIHI complete recirculation system.

Start the pump with the make-up line manual flow control valve open, approximately halfway.

Monitor the system inlet pressure until pump operates at the desired vacuum. Reduce the liquid make-up setting until the pump is just capable of maintaining system vacuum with a stable service liquid temperature.

Monitor the system in operation for a period of time to ensure temperatures are stable and pump operates smoothly. Remove flow control valve handle and wire to the line to prevent loss and ensure availability.

Monitor pump operation from time to time to ensure all remains normal during the operating cycle. If in the course of operation it is necessary to shut the unit off, stop the pump and check that the solenoid valve closes.

CAUTION: Starting liquid ring pumps with excessive water in the casing can lead to motor overload and possible pump damage.

SYSTEM 3 – COMPLETE RECIRCULATION

Liquid to liquid cooler system: prior to operation of the pump unit, ensure coolant is available to the heat exchanger.

Fill the separator/liquid reservoir to the normal operating level. In most systems, the maximum normal operating level will be the pump shaft centerline, and an overflow will be located at this level. **NOTE:** If separator runs under positive pressure, a drain trap system **must** be employed on the overflow. Connect the overflow to vented drain.

WARNING: If toxic or hazardous gases are handled, safety precautions must be followed.

Open all isolating valves in the service liquid lines between the separator and the pump, and allow service liquid to fill the lines. Refill the separator as necessary to the normal level.

Check that the pump is half full or liquid. If not, fill to the pump shaft centerline.

CAUTION: Do not operate the vacuum pump dry, or premature failure may occur, especially if fitted with mechanical seals. In addition, do not start the pump unit completely filled with liquid, or high motor shaft loads may result leading to motor overload and possible pump damage.

If the system is fitted with a recirculation pump, half closed the flow control valve before starting.

NOTE: The recirculation pump motor should be wired to start in conjunction with the start of the vacuum pump.

Jog the vacuum pump motor and ensure coolant automatic valves (if applicable) open, and recirculation pump motor (if applicable) starts and stops with vacuum pump motor. Ensure all motors rotate in the correct direction.

Start the system and check the inlet pressure and service liquid compound gauge for pressure variation. If pressure does not decrease, stop the unit and check the service liquid lines for plugs, closed valves, leaks, etc.

Restart the unit and monitor operation. Check to ensure pump operates smoothly and quietly, and that temperature of all water lines and pump are suitable.

Ensure all piping connections are tight and leak free. Routinely monitor operation from time to time to check for proper service liquid levels, leakage and smooth pump operation. Should you have any concerns, contact your local Sterling SIHI representative or the factory at your discretion.

CAVITATION PROTECTION

Sterling SIHI two stage liquid ring pumps are fitted with previsions to allow a cavitation reducing air bleed between stages. Should it be necessary to utilize this feature, check the pump drawing and remove plug denoted as part (78). Connect a bleed line with manual regulating valve to the connection, and separator vent piping.

CAUTION: Do not open plug to atmosphere, since in some operating conditions, water and/ or gas may be vented from the connection. Also ensure the gases entering the pump will not create a hazard.

Operate the pump at the design conditions and open the bleed valve until the cavitation noise subsides. Leave the air bleed open at this setting (in severe cavitation conditions, inlet air bleed to the service liquid line may also be necessary).

Sterling SIHI LPH type single stage pumps have provisions for inlet air bleed. Due to the higher operating pressure level, cavitation is normally minimal in this equipment. Please contact the factory should further information be desired.

SOLID CARRYOVER RECOMMENDATIONS

All liquid ring pumps can have their effective lives shortened due to abrasive particle carryover. If abrasive particle carryover is possible, a knockout vessel should be employed and/or a suitable inlet filter or service liquid filtration system used.

Further, it is recommended in these cases that the pump bodies be drained from time to time at shutdown to remove trapped particulates from the casing. Once drained, the pump should be refilled to shaft centerline before restarting. Most larger Sterling SIHI pumps have provisions for continuous drains. Should this be of interest, contact the factory or your Sterling SIHI representative for information.

DESCALING

WARNING: Liquid ring pumps used in areas where water has a high level of calcium carbonate or iron scale may become fouled, leading to seize-up, high motor loads and possible mechanical seal leakage.

In these instances, pump should be periodically flushed with a descalant as frequently as necessary to ensure scale build-up is removed. Recommended descalant is **"Rydlyme"**. Please call Sterling SIHI for information.

STORAGE

Cast iron pumps should be installed and put into service as soon as possible. In the event storage or installation followed by inactivity is possible, the units should be filled with a suitable rust preventative, and the shafts rotated weekly.

If the units are installed where freezing might occur, ensure that the preventative remains liquid. If the preventative solidifies, cracking of the pump parts may occur which will not be covered under warranty.

TROUBLESHOOTING TABLE – REFER TO APPENDIX IV FOR DETAILS

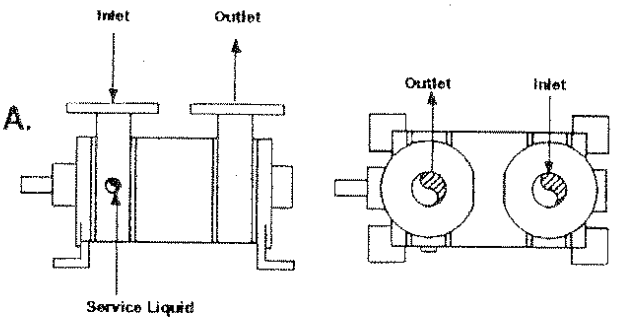
PROBLEM:	Motor Speed Low	High Discharge Pressure	High Svc. Water Temp.	Too Much Liquid	Too Little Liquid	Worn Mech. Seal or Packing
REDUCED CAPACITY	•	•	•	•	•	
EXCESSIVE NOISE		•	•	•	•	
HIGH POWER CONSUMPTION		•		•		
OVERHEATING	•	•	•		•	
VIBRATION	•	•	•	•	•	
SEAL LEAKAGE OR EXCESSIVE PACKING LEAKAGE		•				•

Typical problems and their possible causes are indicated in the above table. If the problem persists, contact your local Sterling SIHI distributor or the nearest Sterling SIHI repair facility.

APPENDIX I

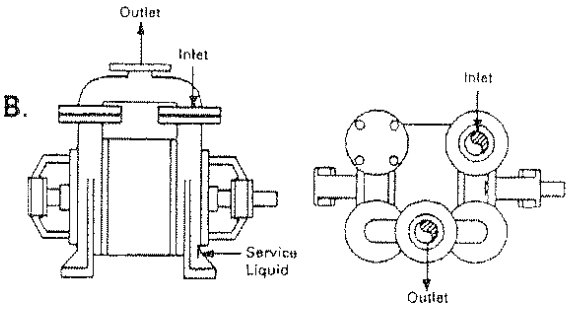
PIPING ARRANGEMENT TABLES – STANDARD CLOCKWISE DRIVEN PUMPS ONLY

A.



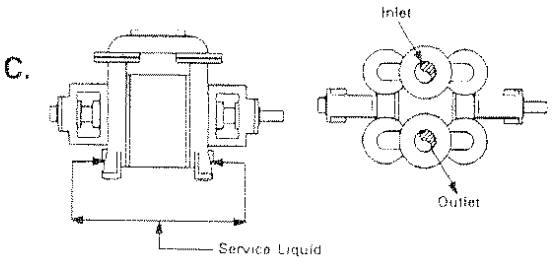
Pump Models Applicable	Inlet/Outlet Size/Rating	Service Liquid Size/Rating
LPH 20103	11/4" - 150# R.F	3/8" NPT
LPH 20105	11/4" - 150# R.F	3/8" NPT
LPH 20107	11/4" - 150# R.F	3/8" NPT
LPH 25003	11/4" - 150# R.F	3/8" NPT
LPH 25007	11/4" - 150# R.F	3/8" NPT

B.



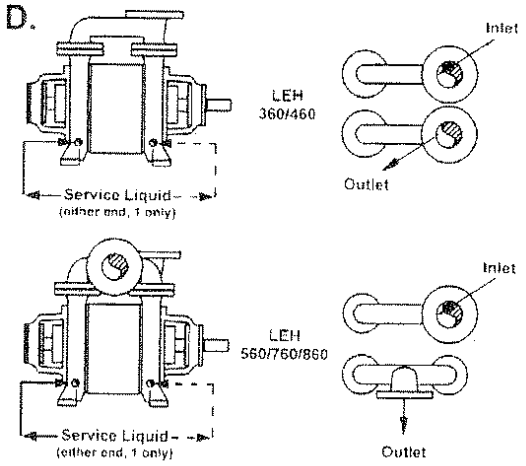
Pump Models Applicable	Inlet/Outlet Size/Rating	Service Liquid Size/Rating
LPH 40412	11/2" - 150# R.F.	1/2" NPT

C.



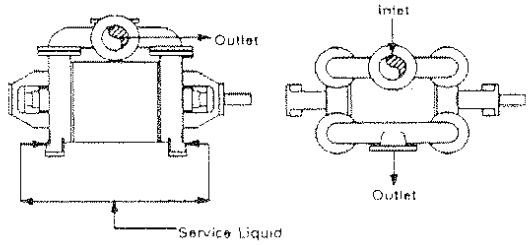
Pump Models Applicable	Inlet/Outlet Size/Rating	Service Liquid Size/Rating
LPH 40517	2" - 150# R.F	1/2" NPT
LPH 50518	21/2" - 150# R.F.	1" NPT
LPH 50523	21/2" - 150# R.F.	1" NPT

D.



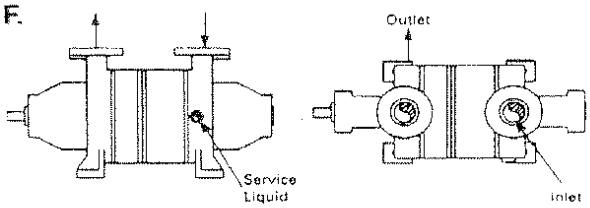
Pump Models Applicable	Inlet/Outlet Size/Rating	Service Liquid Size/Rating
LEH 360	3" - 150 # R.F.	3/4" NPT
LEH 460	3" - 150 # R.F.	3/4" NPT
LEH 560	4" - 150# R.F.	1" NPT
LEH 760	4" - 150# R.F.	1" NPT
LEH 860	4" - 150# R.F.	1" NPT

E.



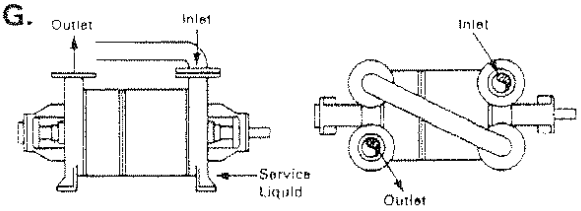
Pump Models Applicable	Inlet/Outlet Size/Rating	Service Liquid Size/Rating
LPH 60520 1)	4" - 150# R.F.	1" NPT
LPH 60527 1)	4" - 150# R.F	1" NPT
LPH 70530 1)	5" - 150# R.F	2" NPT
LPH 70540 1)	5" - 150# R.F	2" NPT
LPH 80540*	8" - 150# R.F	2" Pipe
LPH 80553*	8" - 150# R.F	2" Pipe
LPH 80557	8" - 150# R.F	2" Pipe
LEH 3400	8" - 150# R.F	2" Pipe
LPH 90554*	10" - 150# R.F	3" Pipe
LPH 90567*	10" - 150# R.F	3" Pipe
LPH 10054*	12" - 150# R.F	3" Pipe
LPH 11055*	14" - 150# R.F	4" Pipe

F.



Pump Models Applicable	Inlet/Outlet Size/Rating	Service Liquid Size/Rating
LPH 3404	11/2" - 150# R.F	1/2" NPT
LPH 3408	11/2" - 150# R.F.	1/2" NPT
LPH 3704	11/2" - 150# R.F.	1/2" NPT
LPH 3708	11/2" - 150# R.F.	1/2" NPT

G.



Pump Models Applicable	Inlet/Outlet Size/Rating	Service Liquid Size/Rating
LPH 45312	11/2" - 150# R.F.	1/2" NPT
LPH 45317	11/2" - 150# R.F	1/2" NPT
LPH 55312	2" - 150# R.F	1/2" NPT
LPH 55316	2" - 150# R.F	1/2" NPT
LPH 55320	2" - 150# R.F	1/2" NPT
LPH 65320	21/2" - 150# R.F	1" NPT
LPH 65327	21/2" - 150# R.F	1" NPT
LPH 70123	4" - 150# R.F	2" NPT
LPH 75320	4" - 150# R.F	2" NPT
LPH 75330	4" - 150# R.F	2" NPT
LPH 75340	4" - 150# R.F	2" NPT
LPH 85340*	6" - 150# R.F	2" Pipe
LPH 85353*	6" - 150# R.F	2" Pipe
LPH 95354*	8" - 150# R.F	3" Pipe
LPH 95367*	8" - 150# R.F	3" Pipe
LPH 10534*	8" - 150# R.F	3" Pipe
LPH 11535*	10" - 150# R.F	4" Pipe

NOTES:

* Drilled to 150# RF standards or supplied with companion flanges at manufacturer's discretion.

1). On 316 SS pumps, manifold discharge is vertical up, similar to arrangement (C) for these models.

APPENDIX II

EFFECTS OF SERVICE WATER TEMPERATURE

Effect of Service Water Temperature on the Capacity of Single Stage Liquid Ring Vacuum Pumps

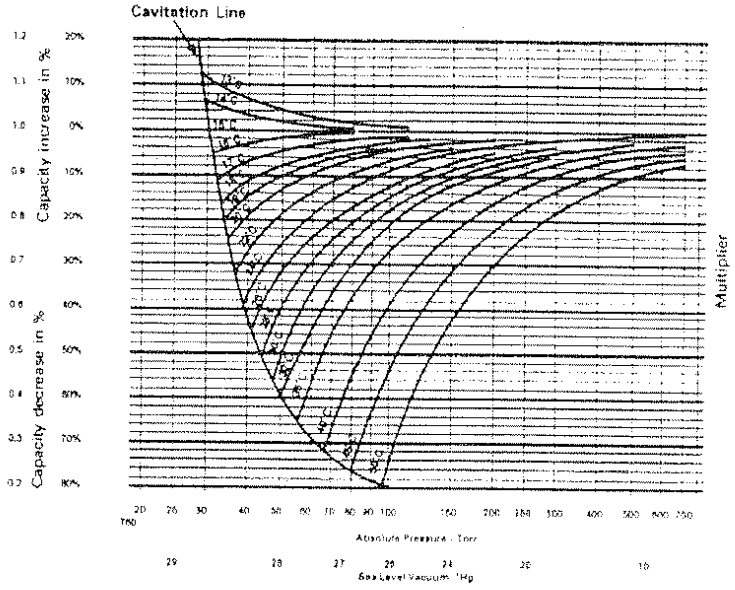


FIGURE 7

Effect of Service Water Temperature on the Capacity of Two Stage Liquid Ring Vacuum Pumps

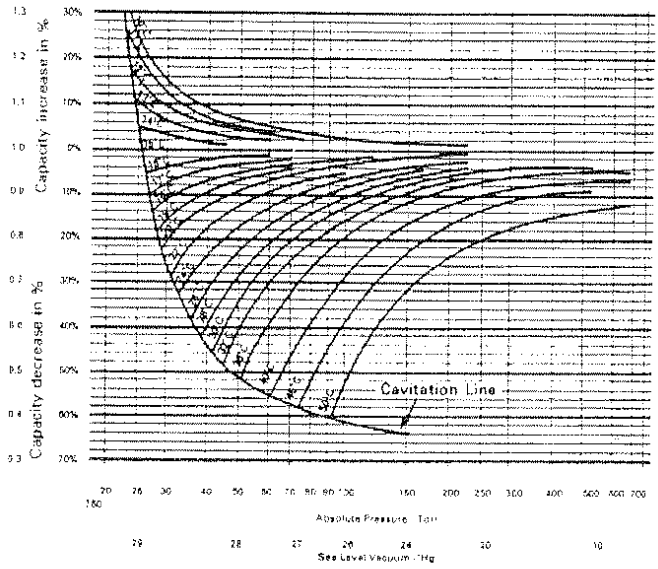


FIGURE 8

NOTES: SERVICE LIQUID TEMPERATURES

Service liquid temperatures affect pump performance. Increasing temperatures result in higher vapor pressures and reduction in effective pump performance.

Sterling SIHI standard capacity data is based on water @ 15°C (59°F). Corrections for higher temperatures are obtained from the curves above.

If liquids with vapor pressures different than water are used, effects are obtained by finding the temperature at which water has the same vapor pressure as the liquid used and applying the water correction factor for that temperature.

APPENDIX III – SERVICE LIQUID REQUIREMENTS

NOTE: For all table in this appendix, please refer to the end of each section for description of columns A, B, and C.

SINGLE STAGE PUMP TABLES

		4" Hg 658 torr			16" Hg 354 torr			20" Hg 252 torr			24" Hg 150 torr		
Model	**RPM**	A	B	C	A	B	C	A	B	C	A	B	C
3404	1750	1.0	0.5	0.3	3.0	0.8	0.5	3.8	1.0	0.5	4.4	1.0	0.6
	1450		0.4	0.2		0.7	0.4		0.8	0.4		0.9	0.5
3408	1750	1.0	0.6	0.4	3.0	1.2	0.8	3.8	1.4	0.9	4.4	1.5	0.9
	1450		0.5	0.4		1.1	0.7		1.3	0.8		1.4	0.8

		8" Hg 557 torr			16" Hg 354 torr			20" Hg 252 torr			25.4" Hg 115 torr		
Model	**RPM**	A	B	C	A	B	C	A	B	C	A	B	C
20103	3500	0.7	0.3	0.2	1.0	0.4	0.3	1.2	0.4	0.3	1.3	0.5	0.3
	2900		0.2	0.1		0.3	0.2		0.3	0.2		0.4	0.2
20105	3500	0.7	0.4	0.2	1.0	0.5	0.3	1.2	0.5	0.3	1.3	0.6	0.4
20107	3500	0.7	0.4	0.3	1.0	0.5	0.3	1.2	0.6	0.4	1.5	0.7	0.4
	2900		0.3	0.2		0.4	0.3		0.5	0.3		0.5	0.3

		8" Hg 557 torr			16" Hg 354 torr			20" Hg 252 torr			24" Hg 100 torr		
Model	**RPM**	A	B	C	A	B	C	A	B	C	A	B	C
40412	1750	1.4	0.9	0.7	2.5	1.4	1.0	3.2	1.6	1.1	3.9	1.8	1.2
	1450		0.8	0.6		1.2	0.8		1.4	0.9		1.5	1.0
40517	1750	2.0	1.3	0.9	6.0	2.5	1.6	7.0	2.7	1.7	7.3	2.7	1.7
	1450		1.2	0.8		2.2	1.3		2.3	1.4		2.4	1.4
50518	1750	4.8	2.7	1.7	7.8	3.7	2.4	9.0	4.0	2.6	10.5	4.3	2.7
	1450		2.3	1.3		3.1	1.9		3.4	2.7		3.5	2.7
50523	1750	3.1	2.2	1.7	6.5	3.8	2.6	8.4	4.3	2.9	10.2	4.6	3.0
	1450		2.0	1.4		3.2	2.1		3.7	2.4		3.9	2.4

SINGLE STAGE PUMP TABLES – SERVICE LIQUID RATES (Cont.)

		8" Hg 577 torr			16" Hg 354 torr			20" Hg 252 torr			26" Hg 100 torr		
Model	RPM	A	B	C	A	B	C	A	B	C	A	B	C
60520	1750	4.8	3.1	2.3	6.4	4.0	2.9	8.0	4.7	3.4	10	5.5	3.8
	1450		2.7	1.9		3.5	2.4		4.1	2.8		4.7	3.1
60527	1750	5.2	3.6	2.7	7.5	4.9	3.7	8.6	5.5	4.0	11	6.4	4.5
	1450		3.3	2.4		4.4	3.1		4.9	3.4		5.6	3.8
70123	1150	5.0	3.7	3.0	9.3	6.2	4.7	13	7.8	5.6	14	8.2	5.8
	975		3.5	2.7		5.6	4		6.9	4.7		7.2	4.9
	880		3.3	2.5		5.4	3.8		6.6	4.4		6.8	4.5
70530	1150	8.5	6.0	4.6	15	9.2	6.7	19	11	7.5	22	12	8.2
	975		5.4	3.9		8.2	5.6		9.5	6.4		10	6.7
	880		5.1	3.6		7.7	5.2		9.0	5.9		9.7	6.2
70540	1150	9.0	6.8	5.5	17	11	8.3	21	13	9.4	24	14	10
	975		6.1	4.6		9.9	6.9		11	7.8		12	8.3
	880		5.9	4.3		9.5	6.6		11	7.4		12	7.9
80540	880	16	11.0	8.5	27	16.0	11.5	33	18.5	13.0	38	20.0	13.5
	735		10.0	7.5		14.5	10.0		16.5	11.0		17.0	11.0
	700		9.5	7.0		14.0	9.5		16.0	10.5		17.0	11.0
80553	880	19	13.5	10.5	32	20.0	14.5	38	22.5	16.0	42	24.0	17.0
	735		12.0	9.0		18.0	12.5		20.0	14.0		21.5	14.5
	700		11.5	8.5		17.5	12.0		19.5	13.0		21.0	14.0
80557	735	14	10.5	8.5	22	15.5	12.0	27	18.0	13.5	33	20.5	15.0
	680		10.0	8.0		15.0	11.0		17.0	12.5		19.5	14.0
	575		9.5	7.0		13.5	10.0		15.5	11.0		17.5	12.0
90554	700	21	20.0	15.0	48	29.0	20.0	56	32.0	22.0	66	35.0	24.0
	600		17.5	13.0		26.0	18.0		29.0	19.0		32.0	21.0
	465		14.0	9.0		21.0	13.0		23.0	14.0		25.0	16.0

SINGLE STAGE PUMP TABLES – SERVICE LIQUID RATES

		8" Hg 557 torr			16" Hg 354 torr			20" Hg 252 torr			26" Hg 100 torr		
Model	RPM	A	B	C	A	B	C	A	B	C	A	B	C
90567	700	43	30.0	24.0	72	45.0	32.0	86	51.0	36.0	104	56.0	39.0
	600		28.0	21.0		40.0	28.0		46.0	31.0		51.0	33.0
	465		24.0	18.0		35.0	23.0		40.0	25.0		44.0	28.0
10054	565	72	48.0	36.0	106	67.0	48.0	123	72.0	52.0	144	78.0	55.0
	490		44.0	30.0		61.0	41.0		67.0	46.0		73.0	49.0
	420		36.0	24.0		50.0	33.0		56.0	36.0		62.0	39.0
11055	475	35	23.0	17.0	52	33.0	23.0	60	36.0	26.0	70	39.0	28.0
	415		21.0	15.0		29.0	20.0		32.0	22.0		35.0	24.0
	335		18.0	12.0		25.0	16.0		28.0	17.0		29.0	18.0

Column A (Once through) shows the amount of service liquid required by the pump, in U.S. gallons per minute. When installed with partial recirculation, part of this water is reused. The amount of make-up liquid for this kind of operation is shown in columns B and C.
Column B amount of make-up when service liquid at pump is approx. 9°F (5°C) warmer than the make-up temperature.
Column C amount of make-up when service liquid at pump is approx. 18°F (10°F) warmer then the make-up temperature.

TWO STAGE PUMP TABLES – SERVICE LIQUID RATES

		20" Hg 252 torr			25" Hg 125 torr			27" Hg 75 torr			28.9" Hg 25 torr		
Model	RPM	A	B	C	A	B	C	A	B	C	A	B	C
25003	3500	1.2	0.5	0.3	1.35	0.5	0.3	1.4	0.6	0.4	1.5	0.6	0.4
	2900		0.4	0.2		0.4	0.2		0.4	0.2		0.4	0.2
25007	3500	1.2	0.6	0.4	1.35	0.6	0.4	1.4	0.7	0.4	1.5	0.7	0.4
	2900		0.5	0.3		0.5	0.3		0.6	0.4		0.6	0.4
3704	1750	3.7	1.2	0.8	4.4	1.3	0.8	4.7	1.4	0.8	5.0	1.4	0.8
	1450		1.0	0.6		1.1	0.7		1.2	0.7		1.2	0.7
3708	1750	4.7	1.7	1.1	5.5	1.7	1.0	5.7	1.7	1.0	6.0	1.7	1.0
	1450		1.4	0.9		1.5	0.9		1.5	0.8		1.4	0.8
45312	1750	3.2	1.7	1.2	3.4	1.6	1.1	3.5	1.6	1.0	3.5	1.5	1.0
	1450		1.4	0.9		1.4	0.9		1.3	0.8		1.3	0.8

TWO STAGE PUMP TABLES – SERVICE LIQUID RATES (cont.)

		20" Hg 252 torr			25" Hg 125 torr			27" Hg 75 torr			28.9" Hg 25 torr		
Model	RPM	A	B	C	A	B	C	A	B	C	A	B	C
45317	1750	3.3	1.9	1.4	3.8	2.0	1.4	3.9	2.0	1.4	4.1	2.0	1.3
	1450		1.6	1.1		1.7	1.1		1.7	1.1		1.6	1.0
55312	1750	8.5	4.2	2.7	9.0	4.0	2.5	9.8	4.0	2.5	12.0	4.2	2.6
	1450		3.2	1.9		3.2	1.9		3.2	1.9		3.3	1.9
55316	1750	9.0	4.4	2.9	10.0	4.5	2.9	10.9	4.4	2.8	13.5	4.7	2.8
	1450		3.7	2.0		3.7	2.3		3.5	2.1		3.7	2.7
55320	1750	10.0	4.9	3.2	12.0	5.3	3.4	13.2	5.4	3.4	16.0	5.6	3.4
	1450		4.2	2.7		4.4	2.7		4.4	2.7		4.4	2.5
65320	1750	7.3	4.7	3.5	8.8	5.4	3.9	9.4	5.3	3.7	10.2	5.6	3.8
	1450		4.3	2.9		4.6	3.1		4.5	3.0		4.7	3.0
65327	1750	7.3	5.1	3.9	8.8	5.8	4.3	9.4	5.7	4.1	10.2	6.0	4.2
	1450		4.5	3.3		4.9	3.4		4.9	3.3		5.0	3.3
75320	1150	14	8.8	6.5	18	10	7.3	20	10.7	7.3	23	11	7.5
	975		7.7	5.4		8.6	5.6		9.1	5.9		9.0	5.6
	880		7.4	5.1		8.3	5.4		8.4	5.3		8.8	5.4
75330	1150	16	11	7.8	19	12	8.3	21	12.2	8.6	24	13	8.8
	975		9.6	6.8		10	7.2		10.7	7.2		11	7.2
	880		8.7	5.9		9.5	6.3		9.8	6.4		10	6.5
75340	1150	16	11	8.7	20	13	9.8	23	14.1	10.3	26	15	11
	975		9.9	7.2		11	7.8		11.9	8.0		12	8.0
	880		9.7	6.9		11	7.5		11.4	7.6		12	7.7
85340	880	27	18	14	41	22	16	45	24.3	16.7	49	25	17
	735		17	12		21	14		20.2	13		20	13
	700		17	12		20	13		19.6	12.5		19	12

TWO STAGE PUMP TABLES – SERVICE LIQUID RATES (cont.)

		20" Hg 252 torr			25" Hg 125 torr			27" Hg 75 torr			28.9" Hg 25 torr		
Model	RPM	A	B	C	A	B	C	A	B	C	A	B	C
85353	1150	37	24	18	53	30	21	58	30	21	62	31	21
	975		22	16		25	17		25	16		25	16
	880		21	15		24	16		24	15		23	15
95354	700	84	55	42	113	66	46	121	65	48	132	70	46
	600		50	36		55	37		56	37		55	35
	465		42	29		46	30		46	28		43	26
95367	700	100	78	55	165	91	62	179	92	62	194	93	62
	600		72	50		80	53		81	53		80	48
	465		56	39		65	42		63	38		62	36
10534	590	58	34	23	79	46	32	86	47	32	93	46	31
	490		30	18		40	24		40	26		39	25
	400		22	13		30	18		30	18		28	17
11535	470	57	37	29	75	43	29	80	42	28	84	42	28
	415		33	24		37	26		35	23		35	22
	335		27	18		23	19		27	16		26	16

Column A shows the amount of service liquid required by the pump, in U.S. gallons per minute.
When installed with partial recirculation, part of this water is reused. The amount of make-up liquid for this kind of operation is shown in columns B, C, and D.
Column B shows amount of make-up when service liquid at pump is approx. 9°F (5°C) warmer than the make-up temperature.
Column C shows amount of make-up when service liquid at pump is approx. 18 °F (10°C) warmer than the make-up temperature.

SINGLE STAGE HIGH VACUUM PUMP TABLES – SERVICE LIQUID RATES

		455 (12" hgV)			354 (16" Hg V)			252 (20" Hg V)			150 (24" Hg V)			100 (26" Hg V)			49 (28" Hg V)			25 (29" Hg V)		
Model	RPM	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
LEH 360	1750	5.5	2.9	2.1	7	3.7	2.5	8.5	4.3	2.7	10	4.6	2.8	11	4.3	2.7	12	4	2.4	13	4.2	2.4
	1450		2.4	2.6		3.2	2		3.5	2.2		3.8	2.3		3.6	2.1		3.3	1.9		3.2	1.7
LEH 460	1750	5.5	3.3	2.5	7	4.3	3	8.5	5	3.3	10	5.4	3.4	11	4.9	3.1	12	4.6	2.8	13	4.9	2.8
	1450		2.7	1.9		3.6	2.4		4.2	2.6		4.5	2.7		4	2.5		3.6	2.1		3.6	2
LEH 560	1750	5.5	4.4	3.2	7	4.5	3.3	8	4.5	3.3	9	4.5	3.3	11	5.7	3.8	12	5.3	3.4	12.5	4.2	2.8
	1450		3.8	2.6		3.8	2.7		3.9	2.7		3.9	2.7		4.1	2.5		3.8	2.3		3.4	2.1
LEH 760	1750	5.5	4.9	3.6	7	5	3.7	8	5.2	3.9	9.5	5.4	3.9	11	6.1	4.2	12	6	4	13	4.8	3.3
	1450		4.2	2.9		4.3	3		4.5	3.1		4.6	3.2		5	3.3		4.9	3.1		4	2.6
LEH 860	1750	5.5	3.3	2.8	7	4.6	3.7	8	5.2	4.1	10	5.7	4.4	12	7	5	13	6.9	4.7	14	5.9	4.2
	1450		3	2.5		4.1	3.2		4.6	3.5		5	3.6		5.7	3.8		5.6	3.6		4.9	3.3
LEH 3400	550	21	13	9	28	15	11	37	17	11	49	19	12	57	20	12	65	21	13	69	20	12
	700		14	10		18	13		22	15		24	10		25	16		23	14		21	12
	840		16	13		20	16		25	19		29	20		30	20		29	18		27	16

APPENDIX IV

TROUBLE SHOOTING

1) Insufficient vacuum (to high inlet pressure)

Cause 1: Incorrect gauges, or low atmospheric pressure when using vacuum gauges.

Solution: Calibrate gauges and measure the absolute pressure at the site.

Cause 2: Insufficient pump capacity due to process conditions, leading to pump undersizing. Process difficulties could include: excessive non-condensable carryover or leakage; pre-condenser condensable carryover to high coolant temperature or improper coolant flows; or fouled heat transfer surfaces due to high condensate carryovers from drain fouling.

Solution: Check design conditions especially gas and liquid temperatures at the pump. Perform dry sealed system leak test after tightening all flanges and threaded connections. Check for proper gasket installation and condenser drain conditions.

Cause 3: Inlet line plugs or excessive pressure drop.

Solution: Measure vacuum at the pump casing and compare to other monitoring points in the system. Remove or reduce excessive pressure drops (plugs, valves, check valves, improper piping, etc.)

Cause 4: Service liquid vapor pressure too high due to insufficient cooling, contamination or wrong service liquid.

Solution: Check design conditions and rectify cooling problem as required.

Cause 5: High discharge pressure caused by plugged lines, improper installation of separator (vertical rise between separator and pump discharge too high) or poor plumbing practices.

Solution: Check discharge lines for causes of discharge pressure. Contact Sterling SIHI if discharge pressure cannot be changed (have design data available when calling). Check installation details per manual sections A, B and C.

Cause 6: Low rotational speed.

Solution: Check motor details. Check rotational sped and direction.

Cause 7: Pump damage or shaft not turning (contact Sterling SIHI for information).

Solution: Listen for improper noise or monitor vibration levels. Check internal clearances. Check to ensure pump inlet shaft rotates.

2) High motor amperage

Cause 1: High motor speed – wrong motor installed.

Solution: Check motor nameplate and confirm proper selection with Sterling SIHI representative and/or with purchase order or specifications.

Cause 2: Improper discharge piping installation (too small, or too much vertical rise from discharge connection to separator or plugged separator vent connections). Refer to section B.

Solution: Check piping details, refer to installation notes, sections A and B.

Cause 3: High discharge pressure caused by plugged vents, flooded separators, or high vent pressures.

Solution: Check for properly opened vent lines, open overflow from separators and or proper vented drain connection from separator drain and overflow.

Remove the offending condition. If pressure cannot be lowered, check design conditions with Sterling SIHI. Replacement motor may be required.

Cause 4: Excessive service liquid or carryover from the system.

Solution: Reduce service liquid flow and/or install knockout system prior to the pump. Attach continuous drain connections to drain or to separator. When possible, reduce excess liquid. If carryover is continuous from the system, note rates and contact Sterling SIHI for information on required motor sizing.

Cause 5: Improper motor sizing as a result of service liquid viscosity or density.

Solution: Determine design conditions and contact Sterling SIHI for information and proper selection details.

3) Noise: **Most Sterling SIHI equipment operates at less than 85 dba at 3 to 5' when installed depending on pump size.**

Causes 1: Cavitation (or grinding noises) in the pump casing caused by insufficient non-condensable flow. This can result from operation at too high vacuum, too high service liquid temperature, too little service flow, or too much condensable vapor.

Solution: Compare operating service flow rate with data in appendix 3, and adjust accordingly.

Compare service water temperature with the data on page 11, figures 7 and 8.

Regulate inlet pressures and/or decrease service water temperatures as required. If partially recirculated service liquid is being used increase the make-up rate.

If pump is pulling from condenser, check condenser discharge temperature and pressure. Reduce condenser discharge gas temperature if possible by increasing coolant flow or cleaning condenser as applicable. Increase condenser pressure if lower than design.

In two stage pumps install air bleed valve in center intermediates or crossover manifold cover plug and bleed air into pump to reduce cavitation noise. **(WARNING: it is suggested air be piped from the discharge separator vent not from atmosphere and care must be taken to ensure bleed does not result in problems due to increased oxygen content).** In single stage pumps bleed air in the suction as required or as possible, but remember to note the warning.

Causes: Slipping belts on V-belt drive-units or bearing problems (described usually as high pitched noises such as squealing).

4) Vibration: **Typical vibration levels should be less than 2-3 mils displacement on any plane.**

Causes 2: Vibration is usually caused by misalignment in direct driven units. Other sources are bearing failures, internal mechanical failures or inlet slug conditions.

Solution: Properly align pumps per page 3. Check and replace bearings as required, check shaft run out with dial gauge if necessary.

If inlet slug conditions exist, install a knockout or flow equalizer system as required. Contact Sterling SIHI for information.

Should you have any suggestions to improve our service to you, please contact the nearest Sterling SIHI location provided at the end of this manual.

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Thank you for purchasing a quality SIHI pump product.

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NOTES:

Liquid Ring Vacuum Pumps

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