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VACUUM SYSTEMS SINCE 1993

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333 Rt 46 W

Building A,

Fairfield, NJ 07004

1-800-297-3550

www.nescompany.com

Operation & Maintenance Manual for NL Series Vacuum Pumps & Compressors

NES COMPANY

WARNING

Do not operate PUMP before primed and connected to the constant supply of clean compressant liquid. **IF RUN DRY, PUMP WILL BE DAMAGED**; always use a strainer to prevent sand and scale from entering the pump with liquid sealant.

Specific operating conditions combined with water hardness may result in excessive lime deposits inside the pump, causing it to bind. Should this condition be evident, flush the pump with a solvent at regular intervals.

This pump has been drained and flushed with water-soluble preservative oil before shipment. After the pump has been in service, do not store without draining as specified in this manual. The freezing of the preservative oil can damage the pump.

USE CAUTION when removing inlet screens. Any foreign material on the screen may fall into the pump and cause extensive damage at start-up.

The base must be mounted to a leveled foundation, and final coupling alignment is done during installation. (Refer to manual No.XXX, Installation Instructions, N.E.S. Company Vacuum Pumps and Compressors.)

NOTICE

SERVICE AND PARTS

SERVICE AND PARTS FOR NES VACUUM PUMPS ARE ASSURED THROUGH A WORLDWIDE NETWORK OF SALES AND SERVICE OFFICES LISTED ON THE BACK COVER OF THIS MANUAL. ANY REQUEST FOR INFORMATION, SERVICE, AND PARTS SHOULD BE DIRECTED TO THE NEAREST NES SITE / FIELD OFFICE.

WHEN ORDERING REPLACEMENT AND SPARE PARTS, SERIAL NUMBERS AND PUMP SIZES MUST BE PROVIDED.

Serial number and pump size are located on nameplates riveted/fastened to the pump's casing/body. Parts must be identified by index number and name. Refer to pump exploded view and legend found in this manual.

If the location of the nearest office is unknown, information may be secured directly from N.E.S. Company Inc. New Jersey Head Quarters: 333 RT 46 W, BLDG: A, FAIRFIELD NJ 07004. Telephone number is 1-800-297-3550, Fax No. 973-933-6322

WARRANTY

NES Company warrants that (1) the goods will be of the kind described on its acceptance of Buyer's order as modified by any subsequent mutual agreement of the parties, (2) it will convey to Buyer good title to such goods, (3) such goods will be delivered free of any lawful security interest or lien or encumbrances unknown to Buyer, and (4) such goods will be of merchantable quality and free from defects in material or workmanship defects under normal use and prescribed maintenance for a period of two (2) years from the date of shipment. The warranties specified shall also extend to goods manufactured by others and supplied by N.E.S., unless such goods have been separately stated and quoted by N.E.S., in which case only the warranties in clauses (1), (2) and (3) shall apply. NES MAKES NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE MERCHANTABILITY OF GOODS MANUFACTURED BY ITS SUPPLIERS AND SEPARATELY STATED AND QUOTED HEREIN. N.E.S.'s warranty in clause (4) above shall not apply to goods of standard construction when handling corrosive gases of using corrosive liquid compressant nor will clause (4) apply to goods which have been damaged, altered, or negligently maintained after delivery. Buyer's exclusive remedy for

N.E.S.'s breach of the warranties outlined in clauses (1), (2) and (3) above shall be the replacement by N.E.S. of non-conforming goods with conforming goods, without extra cost to Buyer, F.O.B. point of manufacture, with transportation prepaid to U.S. destination or domestic port, and Buyer's exclusive remedy for N.E.S.'s breach of the warranty contained in clause (4) above shall be the repair by N.E.S. without charge, or the furnishing by N.E.S. F.O.B. point of manufacture, with transportation prepaid to U.S. destination or domestic port of a part or item of equipment to replace any part or item of equipment which is proved to have been defective; provided that (1) Buyer shall have notified N.E.S. of any such breach not later than ten days after the expiration of two (2) years from the date of shipment of the goods, and that (2) N.E.S. shall have the option of requiring the return of any defective material transportation prepaid to establish a claim. N.E.S. shall in no event be liable for Buyer's manufacturing costs, lost profits, goodwill, expenses, or any other consequential or incidental damages resulting from a breach by N.E.S. of any warranty. THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH EXTENDED BEYOND THE WARRANTIES SET FORTH HEREIN.

SAFETY PRECAUTIONS

1. Wear appropriate personal protective equipment, including safety glasses, lab coats, long pants, closed-toe shoes, and gloves, when working with vacuum pumps.
2. Store vacuum pumps on spill trays to prevent oil spills and ensure proper containment.
3. Insulate running areas of the vacuum pump for noise reduction, if necessary.
4. Dispose of used vacuum pump oils according to prevailing EH&S (Environmental Health and Safety) procedures.

Safety During Operation:

During continuous operation of the pump, observe the following safety precautions:

1. Ensure electrical cables/cords and power switches are in good condition and free from defects or loose connections.
2. Keep belt guards in place to prevent hands or loose clothing from getting caught in the belt pulley.
3. Avoid operating pumps near containers of flammable chemicals, flammable chemical wastes, or combustible materials such as paper or cardboard.
4. Use appropriate vacuum tubing with thick walls, avoiding thin Tygon-type hoses.
5. Avoid placing pumps in enclosed, unventilated cabinets to prevent heat buildup and exhaust accumulation.
6. Replace old tubing that has become crumbly to maintain optimal performance.
7. Use the shortest length of tubing necessary to reach the desired location.
8. Avoid using solvents that may damage the pump.
9. Always close the valve between the vacuum vessel and the pump before shutting off the pump to prevent vacuum oil from being drawn into the system.
10. Place a pan under pumps to catch and collect oil drips.
11. Regularly check oil levels and change the oil as needed. Properly dispose of vacuum pump oil contaminated with condensate following EH&S procedures.
12. For oil-filled pumps with total recirculation service, be aware that many vapors can condense in the pump oil. Use cold traps or other appropriate methods to trap evaporated materials and ensure proper venting of the pump exhaust.

Safety During Service:

Before performing maintenance or service on a vacuum pump or compressor, adhere to the following safety precautions:

1. Stop the pump and ensure all power switches and circuit breakers are turned off. Use proper tagging to indicate "Do Not Switch On."
2. Equalize the pump pressure with atmospheric pressure by passing air into or out of the piping.
3. Empty or clear the service liquid from the pump before opening it.
4. If the pump has operated with harmful liquids or media, wash it thoroughly with an appropriate liquid as specified in the Material Safety Data Sheet (MSDS) of the operating fluid.
5. Maintain a record for each pump, documenting oil change dates, bearing greasing dates, shaft rotation dates, and maintenance schedule.

Please NOTE that these rephrased instructions are provided for clarity and understanding. It is important to follow the specific safety guidelines and procedures recommended by your organization and the equipment manufacturer.

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Section 1 - INTRODUCTION

1.1 HOW THE UNIT WORKS

Figure 1-1 shows the primary functional components of NES NL pumps. An external driver, typically an electric motor, rotates a rotor and shaft assembly within a chamber formed by the casing of the body. Seal liquid, often water, is introduced into the chamber through inlets in the heads and cone. Figure 1-2 illustrates the sequence of operations within the pump. These actions are facilitated by the offset alignment of the body casing axis from the rotor axis. The rotational motion of the liquid within the pump serves to compress the gas, while also acting as a seal to prevent gas leakage into the atmosphere.

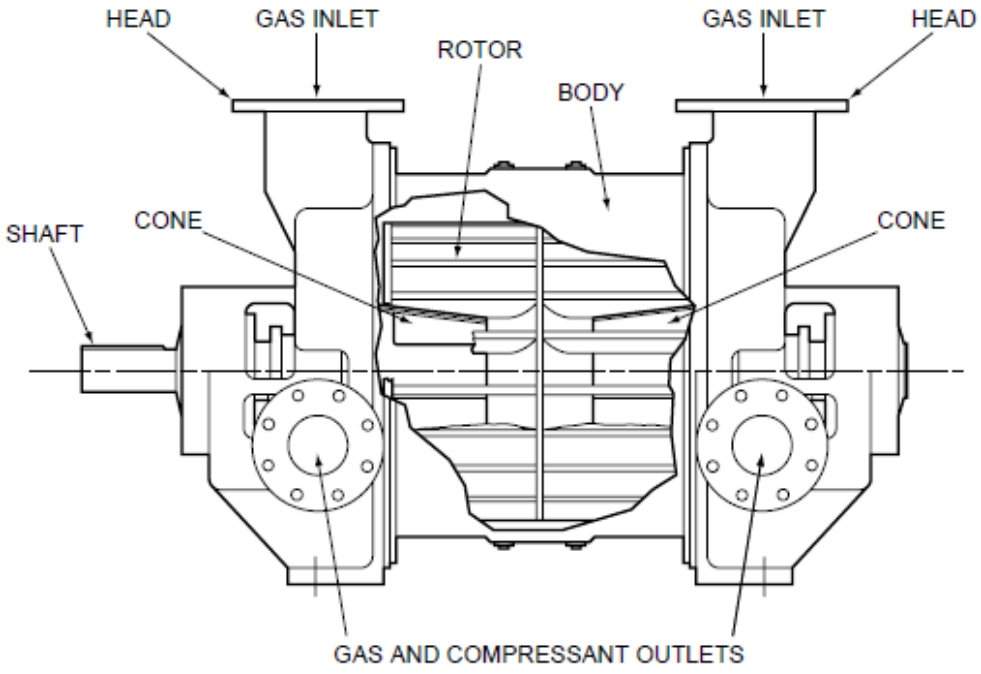


Fig. 1.1 Functional Elements of NES NL Vacuum Pump

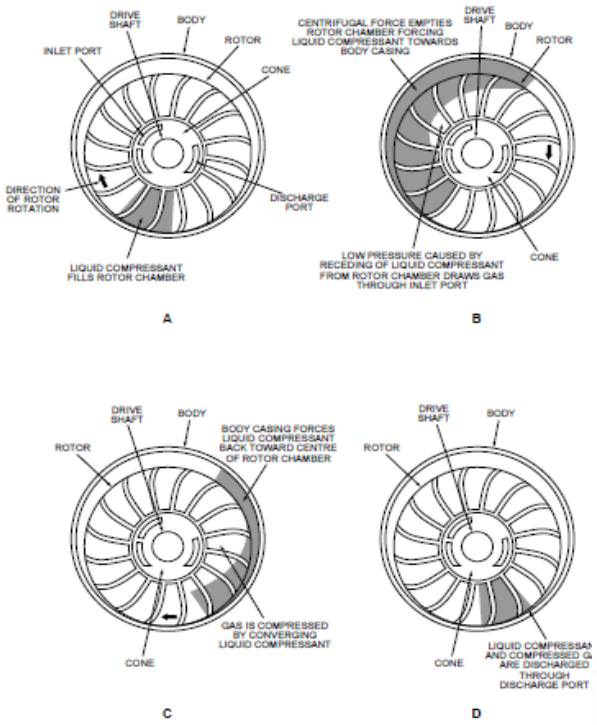


Fig. 1.2 Liquid Compressant and Air Flow

1.2 UNCRATING

a. Verify all components against the provided shipping list for the pump. Conduct a thorough inspection of the pump to detect any potential shipping-related damage. Promptly report any shortages or damages to the local carrier's representative.

b. Typically, pumps and their drive motors are shipped from the factory pre-mounted on a base, with the coupling halves separated or v-belts removed. This precaution is taken to prevent damage caused by the movement of the base during transportation. Parts of the coupling assembly are packaged in a bag securely attached to the shaft beneath the coupling guard or placed in a separate container affixed to the pump's shipping crate.

NOTE

ENSURE THAT ALL COUPLING ASSEMBLY PARTS, V-BELTS, AND ADDITIONAL ACCESSORIES ARE PROPERLY IDENTIFIED AND SAFELY STORED UNTIL THEY ARE READY TO BE INSTALLED ON THE PUMP. THIS PRECAUTION AIMS TO AVOID ANY POTENTIAL LOSS OR DAMAGE.

c. To handle the pump safely, lift it using four or more points on its base. If the pump comes equipped with skids or lacks a base, use flat belt slings around its body. Ensure that the slings are spaced adequately apart and consider using a lifting spreader bar or adjusting sling lengths to maintain a level and balanced lift of the pump.

WARNING!

ENSURE THAT THE LIFTING SLINGS USED ARE IN A SERVICEABLE CONDITION AND SUITABLE FOR THE MASS OF THE UNIT BEING LIFTED.

Refer to Table 5-1 or the Installation/General Arrangement drawing for the mass of the pump and accessories supplied with your order.

d. The shaft of the drive (motor, gear reducer, turbine, etc.) is not aligned with the pump shaft upon receipt. Correct alignment can only be achieved after leveling the base and securing it to its permanent foundation, along with making all necessary pipe connections to the pump. NES Engineering Company does not provide this service unless a NES Field Service Technician is specifically requested.

e. In the event that the pump and driver are not intended for immediate installation and operation upon receipt, it is advisable to store them in a clean, dry environment. Periodically rotate the pump shaft every two weeks to ensure the bearings are adequately coated with lubricant, thereby preventing oxidation and corrosion. Although the pump is flushed with a water-soluble preservative oil before shipment, detailed storage procedures can be found in Section 8 for reference.

1.3 PUMP MARKINGS AND LABELS

a. Every pump is equipped with nameplates and labels designed to highlight warnings, cautions, and provide essential information. The NES nameplate (refer to Figure 1.4, Item 1) located on the pump body contains specific data crucial for inquiries related to parts, service, or assembly/test data.

CAUTION!

IT IS IMPERATIVE NOT TO REMOVE OR ALTER THIS INFORMATION. RECORD THE DATA FOR FUTURE REFERENCE IN YOUR FILES OR WITHIN THIS MANUAL.

NOTE

THE PUMP TEST NUMBER IS STAMPED ON THE PUMP CASING NEAR THE GAS/COMPRESSANT DISCHARGE CONNECTION, OFFERING TRACEABILITY IN CASE THE NAMEPLATE IS DAMAGED.

b. For proper installation a direction of rotation arrow is cast on the pump body and also cast on or fitted to the pump heads.

c. The preservation warning label (see Figure 1.3, Item 8) serves to indicate the type of preservative used to shield the pump from rust formation. This preservative must be flushed out before commissioning (refer to Paragraph 6.3 for detailed instructions), and the resulting waste must be disposed of in adherence to national and local regulations.

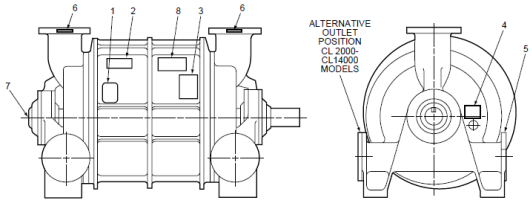


Figure 1.3. Location of Nameplate and Labels

Section 2 - SERVICES REQUIRED

2.1 PIPING (GENERAL REQUIREMENTS)

NOTE

CONSULT THE NES INSTALLATION OR ARRANGEMENT DRAWING(S) PROVIDED WITH THE PUMP FOR PRECISE PIPING REQUIREMENTS.

a. INLET PIPING (refer to Figure 2.1):

Connect the vacuum pump inlets directly to the process at full size. Similarly, connect the compressor inlets either directly to the process at full size or to the atmosphere if the compressor is being utilized as an air compressor. In cases where atmospheric inlets are used, it is advisable to install an inlet silencer, which can be provided upon request. To prevent any loss in volume flow over long inlet piping runs, adhere to the following guidelines.

Pump Inlet Size	Piping Run	
50mm >50mm	>23m >46m	Use next largest std. pipe size for whole piping run.

WARNING!

ACCESSIBLE OPEN INLET PIPING MUST BE GUARDED TO PREVENT ACCIDENTAL INJURY RESULTING FROM BODILY CONTACT WITH THE PUMP SUCTION.

CAUTION!

OPEN INLET PIPING CREATES AN ADDITIONAL NOISE HAZARD AT THE POINT OF AIR ENTRY. FOR PERMANENT INSTALLATIONS, AN INLET SILENCER SHOULD BE FITTED. DURING COMMISSIONING WITH OPEN INLETS, EAR PROTECTION SHOULD BE WORN.

b. STRAINER (refer to Figures 2.1 and 2.2):

Install a strainer in all liquid seal lines upstream of the pump to prevent dirt and other foreign matter from entering the pump during operation. In cases where a significant amount of foreign matter may be entrained in the seal liquid, it may be necessary to incorporate a cleanout or dirt pocket to facilitate the rapid filling of the strainer element. For systems with recirculated seal liquid, ensure that a strainer is positioned in the return line from the air/water separator and upstream of any heat exchanger and / or recirculation pump.

CAUTION!

FAILURE TO PREVENT FOREIGN MATTER FROM ENTERING THE PUMP VIA THE SEAL LIQUID INLET CAN LEAD TO RAPID WEAR, REDUCING THE PUMP'S LIFESPAN. THE ENTRY OF LARGE PARTICLES INTO THE PUMP MAY RESULT IN THE SUDDEN STOPPAGE OF THE PUMP AND DRIVER.

c. INLET SCREENS (refer to Figure 2.1):

Temporary inlet screens are provided on the inlet flanges of the pump upon supply. It is crucial not to discard these screens but to incorporate them to prevent welding shot and other debris from entering the pump via the inlet piping system. Periodically examine and clean the screens until no more debris is being collected. At this point, the screens should be removed.

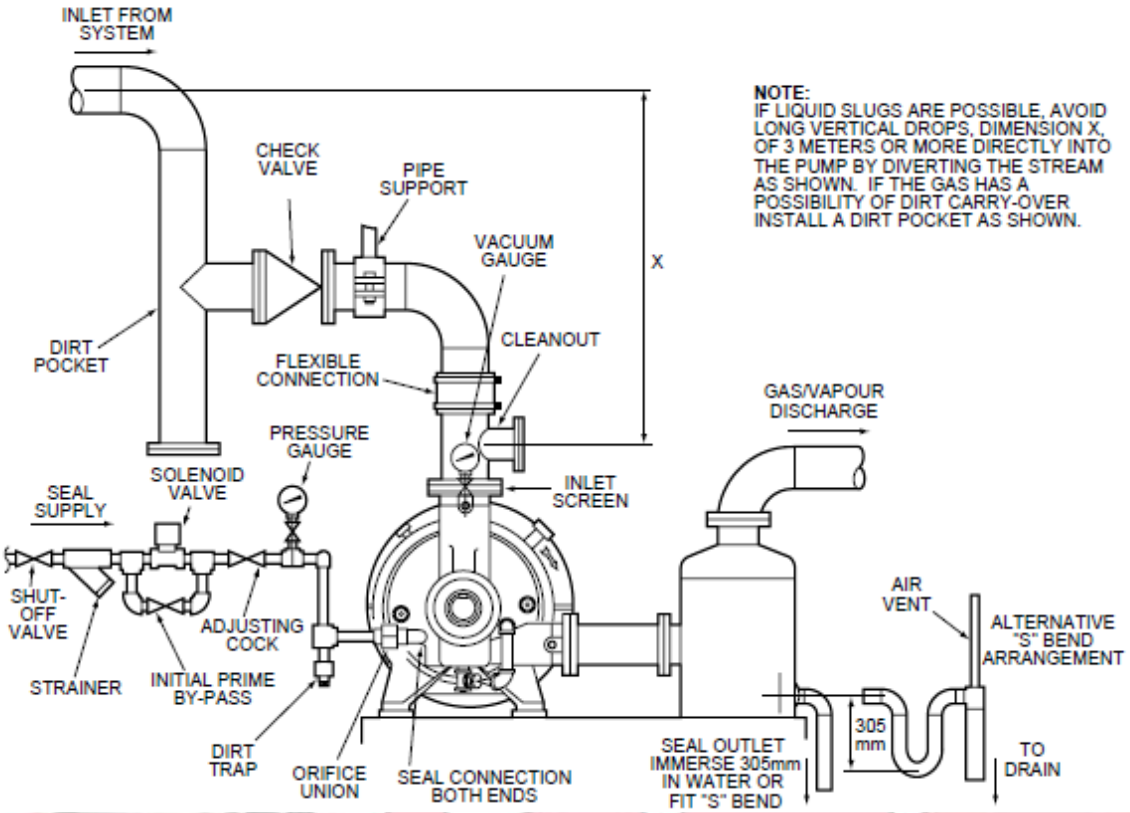


Figure 2.1. Typical Piping Connections of Vacuum Pump

NOTE

THE DESIGN OF THE SUCTION PIPING SHOULD FACILITATE THE CLEANING AND REMOVAL OF THE TEMPORARY INLET SCREENS WITHOUT DANGER OF THE COLLECTED DEBRIS ENTERING THE PUMP. RECOMMENDED CLEAN OUT ARRANGEMENTS ARE SHOWN IN FIGURE 2-1 AND ON THE PUMP LABEL ITEM 3, FIGURE 1-4A.

CAUTION!

FAILURE TO PREVENT FOREIGN MATTER FROM ENTERING THE PUMP VIA THE PUMP SUCTION CAN CAUSE RAPID WEAR OR SERIOUS DAMAGE. THE ENTRY OF LARGE PARTICLES INTO THE PUMP MAY RESULT IN THE SUDDEN STOPPAGE OF THE PUMP AND DRIVER.

d. CHECK VALVES (refer to Figure 2.1):

Install check valves exclusively in horizontal piping. Ensure proper installation with the correct direction of flow in the specified mounting position. Opt for low pressure drop, light, or balanced flap check valves to minimize performance loss. If necessary, NES can provide suitable valves upon request; please contact your NES Engineer.

CAUTION!

THE USE OF AN UNSUITABLE INLET CHECK VALVE MAY LEAD TO THE VACUUM PUMP OPERATING AT SUCTION PRESSURES OUTSIDE THE RECOMMENDED RANGE. THIS CAN RESULT IN ABNORMAL WEAR AND INCREASED OPERATING NOISE.

2.1.1 VACUUM PUMP DISCHARGE PIPING

a. Vacuum pump discharge piping should be full size from the pump to a suitable separating system (see Figure 2-2). The discharge piping between the pump and the separating system should not rise above the centerline of the pump discharge connection unless specifically indicated on the Installation or Arrangement drawing. The discharge of seal liquid from the vacuum pump separator should flow by gravity to a suitable drain. Pipe sizes must be sufficient to prevent water buildup in the separator, which may reduce gas/water separation efficiency. The air discharge from the top of the vacuum pump separator should be piped full size to a venting location or equipped with a discharge silencer.

CAUTION!

SLIGHT CARRY-OVER OF WATER DROPLETS INTO THE AIR DISCHARGE FROM THE TOP OF THE SEPARATOR MAY OCCUR WHEN THE VACUUM PUMP OPERATES AT HIGH SUCTION PRESSURES OR WITH LARGE AMOUNTS OF WATER ENTERING THE PUMP SUCTION. THIS MAY CAUSE SLIGHT WETTING OF FLOOR SURFACES, WHICH CAN BE AVOIDED BY PIPING TO A SUITABLE VENTING LOCATION.

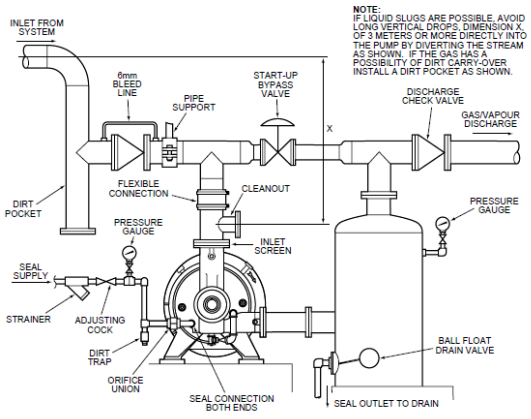


Fig. 2.2 Typical Piping Connections of Compressor

2.1.2 COMPRESSOR DISCHARGE PIPING

The compressor discharge should be fully piped to a separator positioned as close to the compressor as feasible, as depicted in Figure 2-2. The discharge line leading to the compressor separator should not ascend above the centerline of the compressor discharge, unless explicitly specified in the Installation or Arrangement drawing. The gas discharge line exiting the separator should be fully piped to the receiver or the system. Meanwhile, the seal liquid discharge line from the separator should flow naturally by gravity to an appropriate drain.

2.2 LIQUID COMPRESSANT (SEAL WATER)

a. Liquid Compressant (usually water):

A sufficient quantity of liquid compressant, typically water, is essential for proper pump operation. It should be maintained at a minimum pressure as specified in Table 2-1. Optimal pump performance is usually achieved when the coolest available water is used.

b. Refer to Section 6.2:

For comprehensive details on seal liquid requirements and recommended control methods, please refer to Section 6.2.

Type of Service	*Minimum Pressure in bar g at Pump Connections
Vacuum Pump Recirculated Water (NES Supplied Heat Exchanger)	0.7 0.35 pressure drop across heat exchanger
*Indicated pressure is that required at pump/compressor connections. Normally, certain controls will be required ahead of this connection for start and stop flow of water and to assist in adjustment of water quantities. When these additional controls are used, the pressure drop through these controls must be added to the pressure required at the vacuum pump/compressor in order to determine necessary minimum supply pressure:	
Orifice Control:	0.7
Flow Control Valve:	1.0
Solenoid Control Valve:	0.7
Example: A vacuum pump with a seal water flow control and a solenoid control valve:	
Pressure at Vacuum Pump:	0.7
Flow Control Valve:	1.0
Solenoid Valve:	0.7
Total:	**2.4**
Thus, the minimum supply pressure required for this vacuum pump is 2.4 bar g.	

Table 2-1. Seal Water Minimum Pressure

2.3 LANTERN GLAND OR MECHANICAL SEAL LIQUID

a. Lantern Glands:

When external lantern gland liquid feeds are designated or mechanical seals are installed, ensure a clean liquid supply, typically water, is provided. Include valves in this piping system to control both the flow and pressure of the liquid, as outlined in Section 6.

2.4 DRAINS

Drains must be sized to allow gravity flow from separators at a rate equivalent to that supplied to the pump. If the anticipation of liquid carry-over from the system to the pump exists, this quantity must also be considered in sizing the drains.

CAUTION!

IF THERE IS ANY RISK THAT THE DISCHARGED SEAL LIQUID MIGHT BE CONTAMINATED BY THE PROCESS OR MAY BE UNACCEPTABLE FOR DISCHARGE INTO DRAINS ACCORDING TO NATIONAL AND LOCAL REGULATIONS, TESTS SHOULD BE CONDUCTED BY AN AUTHORIZED, COMPETENT BODY PRIOR TO COMMISSIONING. NO LIQUIDS SHOULD BE ALLOWED TO PASS INTO DRAINS THAT MAY VIOLATE REGULATIONS IN FORCE.

2.5 POWER SUPPLY

a. Voltage Matching:

The available voltage must match the motor nameplate data and that indicated for solenoid valves, if supplied or required.

b. Solenoid Valve Voltage:

Note that solenoid valve voltage requirements may differ from the motor voltage.

c. Starter and Supply Lines:

Starter and supply lines must be appropriately sized to match power requirements.

WARNING:

All electrical installation work should be carried out by a qualified electrician.

Section 3 – INSTALLATION

3.1 LOCATION

a. The pump should be situated in a location that is easily and entirely accessible, shielded against flooding, freezing, excessive moisture, and overhead dripping. Adequate provisions should be made to facilitate proper piping arrangement and dismantling. The chosen location should allow sufficient clearance as specified on the NES Installation or Arrangement drawing(s) provided with your unit. Alternatively, overhead lifting equipment can be utilized to transfer the pump to a workshop.

3.2 FOUNDATION

a. The foundation must provide a rigid support for the pump to maintain proper alignment. It should be placed on hard, compacted soil or on piles driven to a depth ensuring they rest on solid, compacted soil.

b. Create pockets at each foundation bolt position to accommodate the foundation bolts or as specified on the supplied Installation or Arrangement drawing. This can be achieved using styrofoam or equivalent materials or by constructing removable wooden boxes.

c. Pour concrete to a height within 13 to 38mm of the finished foundation level (refer to Figure 3.1).

d. Allow the concrete to set. Position the foundation bolts in the base or pump skids, ensuring they hang freely when lifted. Align the base or pump so that the bolts enter the foundation pockets and lower onto packing plates or shims set at the finished foundation height. Fill the pockets with concrete to secure the foundation bolts in the correct positions. Allow the concrete to set before removing the base for final leveling and installation.

3.3 SETTING BASE, SKIDS OR PUMP

a. Ensure that bases are specifically designed to provide robust support for both the pump and drives, offering rigid support at all foundation bolt locations.

b. Carefully level skids to ensure a solid and stable support under all pump feet.

c. When pumps are installed without a base or skids, ensure they are rigidly supported on a smooth surface, with each foot leveled appropriately.

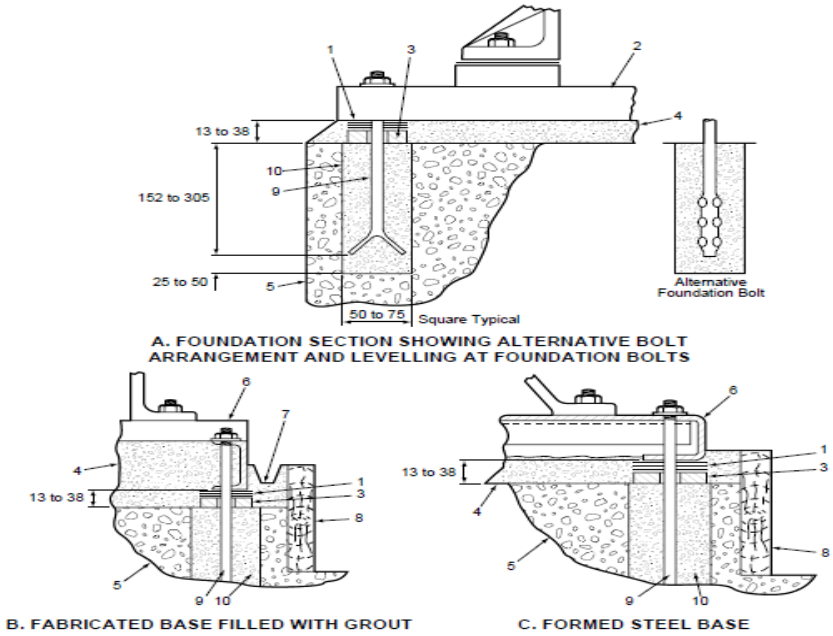
d. After verifying and leveling the foundation bolt locations, proceed to install the base or pump carefully.

In cases where skids are used, position the pump and skid on the foundation, making necessary shims under the foundation bolts. For final leveling and shimming, remove the pump from the skids (refer to Figure 3.2).

e. Before tightening the foundation bolts, place shims under each bolt as illustrated in Figure 3.1.

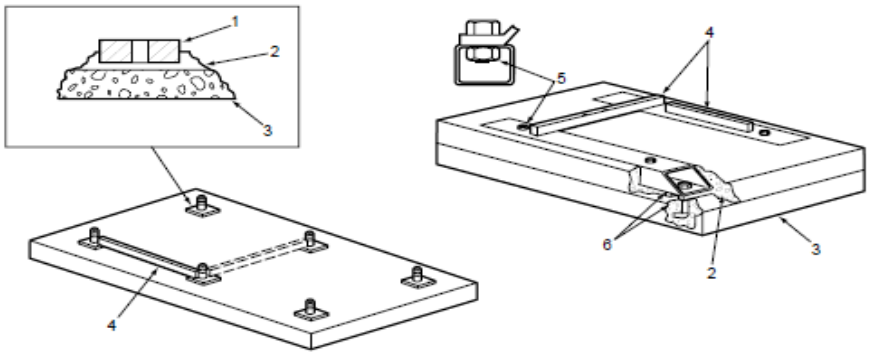
f. Ensure that the foundation bolt nuts are tightened evenly.

g. With skids and bases in place, confirm that the final coupling or v-belt drive alignment can be successfully established. For guidance, refer to Section 3.7 or 3.8 as applicable.



Note: Dimensions are in mm

Figure 3.1 Foundation Bolt Installation and Grouting



1. Pad (Level carefully in both directions).
2. Grout
3. Concrete Foundation
4. Level
5. Pump Mounting Nuts (Welded to Skid)
6. Steel shim blocks

Note:
Level pads with each other; use shims if necessary. Level accurately between skids before grouting; shim with steel blocks each side of all four foundation bolts.

Figure 3.2 Preparing Foundation Pads and Installing and Grouting Skids

WARNING!

ALL LIFTING OPERATIONS SHOULD BE CARRIED OUT EXCLUSIVELY BY COMPETENT PERSONNEL WHO ARE TRAINED IN THE PROPER USE OF LIFTING EQUIPMENT. IT IS CRUCIAL TO ENSURE THAT ALL LIFTING EQUIPMENT IS IN A SERVICEABLE CONDITION AND DEEMED SUITABLE FOR THE MASS INTENDED TO BE LIFTED. FAILURE TO ADHERE TO THESE PRECAUTIONS MAY RESULT IN SERIOUS INJURY OR EQUIPMENT DAMAGE.

NOTE

REFER TO TABLE 5.1 AND 5.2 FOR THE MASS OF THE PUMP. ADDITIONALLY, FOR THE MASS OF ACCESSORIES, CONSULT THE INSTALLATION OR ARRANGEMENT DRAWING(S) PROVIDED WITH YOUR ORDER.

3.4 GROUTING

a. In cases where an accessible space is formed between a fabricated base and the foundation, it is recommended to fill it with grout to ensure uniform load distribution. Use a high-strength, non-shrinking, non-expanding grout mixture.

b. For grouting when skids are used, refer to Figure 3.2.

c. Allow the grout to set completely before attempting any alignment.

3.5 PIPE INSTALLATION

NOTE

THE PUMP IS DISPATCHED WITH THREAD AND FLANGE PROTECTORS PRE-INSTALLED IN ALL OPEN CONNECTION POINTS TO SAFEGUARD THE PUMP FROM DAMAGE. TO ENSURE A CLEAN INSTALLATION AND PREVENT THE ENTRY OF CEMENT DUST AND OTHER DEBRIS, IT IS ESSENTIAL TO REMOVE THESE PROTECTORS. THIS REMOVAL SHOULD BE PERFORMED AFTER COMPLETING ALL FOUNDATION WORK BUT BEFORE MAKING ANY PIPING CONNECTIONS.

a. Refer to the NES Installation or Arrangement drawing(s) supplied with the pump for specific piping requirements.

b. Consult Section 2.1 for general piping requirements.

c. When connecting piping to the pump, ensure it is done without strain, as pipe strain on pump castings may lead to challenging-to-trace problems once the pump is in operation. Obtain permissible flange loadings from your NES Engineer.

CAUTION!

PIPING MUST BE INSTALLED IN A MANNER THAT ALLOWS CONNECTION TO THE PUMP WITHOUT CAUSING SPRINGING OR PULLING ON THE PIPING AND WITHOUT TRANSMITTING EXCESSIVE STRAIN TO THE PUMP. CONSIDERATION MUST BE GIVEN TO THERMAL EXPANSION, BENDING, AND TORSIONAL MOMENTS IN THE DESIGN OF PIPING CONNECTIONS AND SUPPORTS.

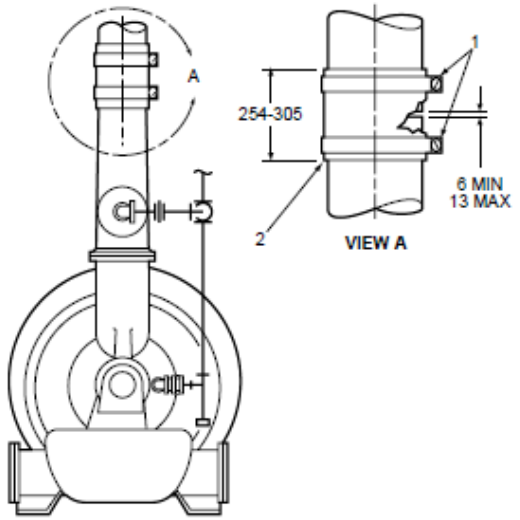
d. Install a proper cleanout or removable piping section ahead of the pump inlet to facilitate the cleaning of inlet screens before their removal. Refer to Section 2.1 and Figure 2.1.

e. Use dirt pockets as an inexpensive form of insurance to protect the pump from the entry of pipe scale, welding shot, and foreign material

present in the inlet piping. Refer to Section 2-1 and Figure 2.1.

f. Flexible piping connections are necessary for installations where the pump is mounted on a vibration isolation base.

g. If the separator water discharge is not via a sealed pipe system or immersed in a water tank or sump, it should be fitted with an 'S' bend configuration as shown in Figure 2.1.



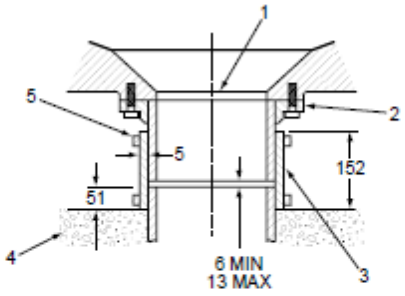
1. Hose Clamp (2 required)
2. Neoprene Composition Hose, 13mm

Fig. 3.3 Recommended Flexible Inlet Connections, NL-2000 to NL-14000 series

h. When used bottom discharge connections (NL-4000 series and larger) should be made as shown in Figure 3.4.

h. Flush seal liquid piping to remove any foreign matter before connecting it to the pump. The piping should be full size to the pump connection and properly supported to avoid strain in the piping and pump connection. Install a strainer in the seal liquid piping to prevent rust and scale from entering the pump, refer to Section 2-1b and Figure 2-1. By incorporating an isolating valve, a strainer, and an adjusting valve or cock in that order, the strainer may be isolated to enable cleaning out when the pump is not operating.

j. When spray nozzles are required, piping should be as detailed in Figure 3.5 or as shown on the Installation or Arrangement drawing.



1. Pump Bottom Discharge
2. Pipe Flange
3. Neoprene Composition Hose
4. Concrete Foundation
5. Hose Clamp (2 required)

Fig. 3.4 Recommended Flexible Connections from Bottom

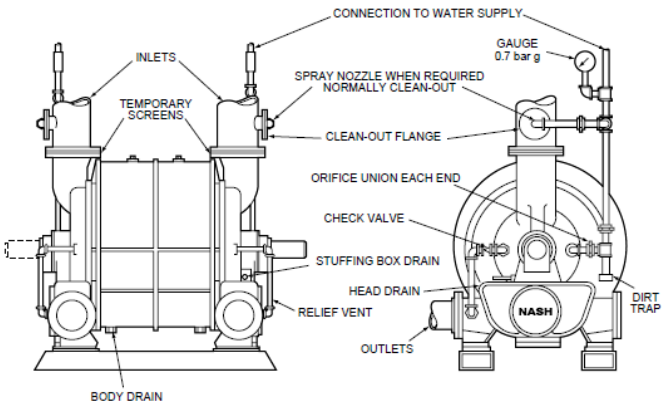


Fig. 3.5 Typical Seal Water piping with spray Nozzles

3.6 PUMP DRIVES (GENERAL)

a. Typically, NES pumps are powered by electric motors, predominantly of the induction type. Alternatively, steam turbines can also be utilized.

b. The drive is transferred directly through flexible coupling, a gearbox and coupling, or via a v-belt drive.

c. In instances where steam turbines or large electric motors are employed, multiple pumps can be driven in tandem. For this purpose, pumps are equipped with double extended shafts for interconnection via flexible couplings. Alternatively, they can be driven from a line shaft with pulley drives to each pump.

d. Motor and speed-reducing gearbox drives are commonplace. Gearboxes must be appropriately sized to accommodate the moment of inertia of the pump rotor and water ring, as well as the maximum starting torque of the driving motor, which may exceed the full load torque by several times.

e. NL-6000G and NL-9000G series pumps feature built-in reduction gears, enabling direct drive from electric motors.

NOTE

NES PUMPS DO NOT POSE ANY UNCOMMON CHALLENGES WITH DIRECT ON-LINE (D.O.L.) STARTING OR SYNCHRONOUS MOTOR PULL-IN. THERE IS NO NECESSITY FOR SPECIAL HIGH STARTING TORQUE MOTORS.

3.7 COUPLING ALIGNMENT

a. Couplings may be provided separately and need to be fitted after the installation of the pump and driver. When a pump and driver are supplied mounted on a base, the couplings are typically pre-fitted on the shafts, but the drive pins or driving elements are removed for shipment.

CAUTION!

WHEN COUPLING HALVES ARE FITTED TO THE PUMP AND DRIVER SHAFTS, AS SUPPLIED, IT IS CRUCIAL TO CONDUCT THE COUPLING ALIGNMENT CHECKS BELOW BEFORE FITTING THE DRIVING PINS OR DRIVING ELEMENT AND OPERATING THE MOTOR.

b. Standard NES-supplied couplings typically include taper-locking type bushes fitted in each coupling half, facilitating easy installation and removal.

c. Upon customer order, alternative coupling types with a plain shaft bore may be provided. In such instances, it might be necessary to heat the coupling halves to facilitate easy installation onto the shafts.

CAUTION!

COUPLINGS SHOULD NEVER BE FORCED ONTO THE PUMP OR DRIVER SHAFTS. IF A SLIP FIT IS NOT ACHIEVED, EXPAND THE COUPLING HALF BY HEATING IT TO A MAXIMUM TEMPERATURE OF 302°F. DO NOT FORCE THE COUPLING HALF, AS DOING SO MAY CAUSE DAMAGE TO THE PUMP OR DRIVER BEARINGS, OR THE PUMP'S INTERNAL SURFACES OR PARTS.

NOTE

A FLEXIBLE COUPLING ALLOWS FOR SOME DEGREE OF MISALIGNMENT, SUCH AS THAT CAUSED BY TEMPERATURE CHANGES OR OTHER VARIATIONS FOR A SHORT PERIOD. HOWEVER, CONTINUOUS OPERATION REQUIRES THE COUPLING TO BE IN ALIGNMENT UNDER ALL CIRCUMSTANCES.

CAUTION!

EXCESSIVE MISALIGNMENT LEADS TO WEAR, VIBRATION, AND LOADS THAT RESULT IN PREMATURE BEARING FAILURE, MECHANICAL SEAL WEAR, OR THE EVENTUAL SEIZING OF THE PUMP.

d. APPROXIMATE ALIGNMENT

Conduct an approximate alignment before attempting the final alignment, as follows:

d-1. Level the base (using shims) and securely fasten it to its permanent foundation at all foundation locations. Refer to Section 3.3.

d-2. Roughly align the pump and driver shaft centerlines in the horizontal plane (make them straight enough) so that final alignment adjustments can be made at the driver only.

d-3. Roughly align the pump and driver shaft centerlines in the vertical plane (make them level enough) so that final alignment adjustments can be made at the driver only. It may be necessary or desirable to shim the feet of the pump to achieve adequate elevation.

NOTE

PUMPS DRIVEN BY GEAR REDUCERS AND/OR MOTORS NOT SUPPLIED BY NES SHOULD BE INSTALLED SO THAT THE CENTERLINE OF THE DRIVEN SHAFT IS APPROXIMATELY 0.8 TO 1.6MM HIGHER THAN THE CENTERLINE OF THE DRIVER SHAFT. THIS ALLOWS FINAL ALIGNMENT AS DETAILED IN SECTION 3.7E.

d-4. On couplings with taper-locking bushes secured by set screws, adjust the coupling gap to that specified on the Installation or Arrangement drawing supplied with your order.

CAUTION!

EXCESSIVE VARIATION IN THE COUPLING GAP MAY CAUSE PREMATURE COUPLING AND/OR BEARING FAILURE.

d-5. Check coupling halves to ensure that the coupling fit to the shaft is not too loose. A loose fit (when used) should not have a diametral clearance greater than 0.10mm, or excessive stresses may cause premature key and keyway failures.

NOTE

THE GAP BETWEEN THE SHAFTS SHOULD BE NO LESS THAN THE COUPLING GAP. IF COUPLING HALVES MUST BE OVERHUNG, IT IS GOOD PRACTICE TO OVERHANG BOTH HALVES BY AN EQUAL AMOUNT (REFER TO THE INSTALLATION OR GENERAL ARRANGEMENT DRAWING).

d-6. When inserting shims under the motor's feet, sandwich the thinner shim layers between thicker layers to prevent bending and create even footings.

WARNING!

THE SHIMS MAY BE EXTREMELY SHARP. WEAR GLOVES WHEN CUTTING AND FITTING SHIMS IN PLACE.

d-7. Securely fasten the pump to the base after accomplishing rough alignment in both the vertical and horizontal planes and achieving the proper coupling gap.

d-8. Make all final piping connections to the pump after accomplishing rough alignment and before performing the final alignment.

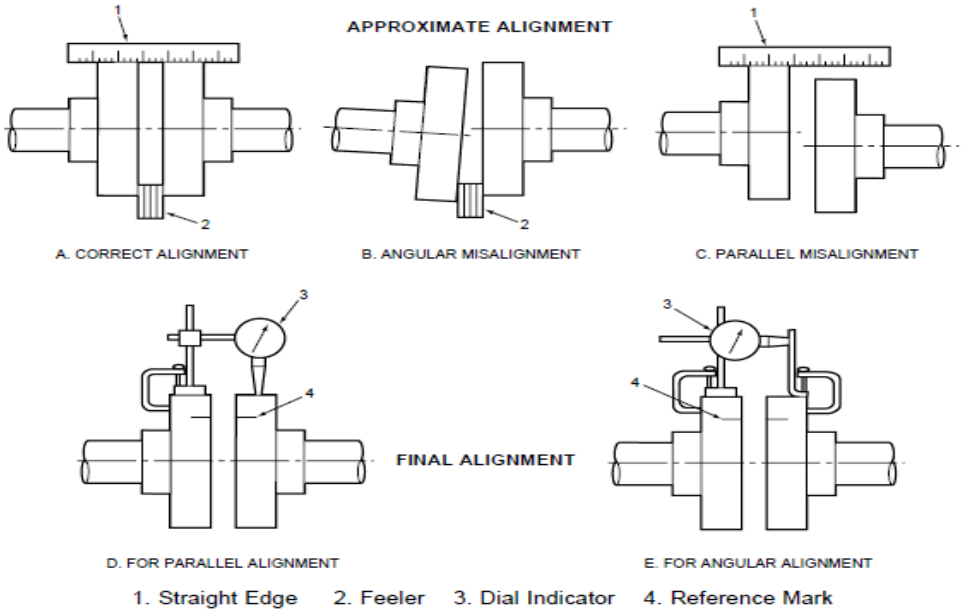


Figure 3.6 Approximate and Final Coupling Alignment Methods

e. FINAL ALIGNMENT

After completing the approximate alignment, proceed with the final alignment using a dial indicator (refer to Figure 3.3). It is crucial to shim the driving unit for final alignment.

e-1. Mark a reference or benchmark on the outside diameter of both coupling halves.

e-2. If necessary, separate the coupling halves and install a dial indicator as illustrated in Figure 3.3 for angular alignment. Use a small V-block magnetic mount or a strap-type dial indicator mount for the best attachment method.

e-3. Rotate both shafts simultaneously and note the highest and lowest dial indicator readings. Ensure that the reference marks on both coupling halves remain in alignment during the dial indicator readings.

NOTE

ALWAYS MAINTAIN ALIGNMENT OF THE REFERENCE MARKS ON BOTH COUPLING HALVES WHEN RECORDING DIAL INDICATOR READINGS.

e-4. Shim and position the driver unit, repeating the third step until the readings are within (less than) 0.10mm of the total dial indicator reading for a complete revolution of the shafts. Ensure that the dial indicator reading is a maximum of 0.05mm on each side.

e-5. After completing the angular alignment in steps e-2 through e-4, reattach the dial indicator for parallel alignment, following the procedure in Figure 3-3. Repeat steps 3 and 4.

e-6. Once steps 1 through 5 are finished, securely tighten the unit to the base and recheck both angular and parallel alignments until the requirements of step 4 are met for both angular and parallel alignment.

e-7. Verify the coupling gap for the coupling halves to ensure it is within the recommended value.

e-8. Reset the coupling gap if necessary and fully tighten all set screws.

Post Alignment

Upon completing the final alignment procedure, follow these steps:

f-1. Install coupling pins or other applicable driving elements specific to the coupling type.

f-2. Fully tighten nuts and set screws uniformly.

Important: Special couplings tailored to customer specifications include manufacturer's instructions. Always consult these instructions during installation, adjustment, and maintenance.

f-3. Install and securely fasten the coupling guard.

WARNING!

DO NOT ATTEMPT TO START THE EQUIPMENT WITHOUT THE PROPERLY INSTALLED AND SECURED COUPLING GUARD. NES ENGINEERING COUPLING GUARDS, WHEN PROVIDED, MEET CURRENT SAFETY STANDARDS. DO NOT MODIFY ANY GUARDS WITHOUT CONSULTING YOUR NES ENGINEER BEFOREHAND.

f-4. During pump operation, monitor for excessive noise and vibration. Improper alignment may cause one or both of these issues.

NOTE

DURING ROUTINE MAINTENANCE AND ANY REPAIR WORK, THOROUGHLY INSPECT FLANGE ALIGNMENT AND RESILIENT ELEMENTS FOR SIGNS OF WEAR.

3.8 V-BELT DRIVE ALIGNMENT

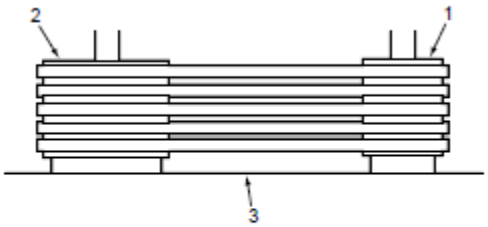
CAUTION!

AVOID FORCING V-BELT SHEAVES ONTO THE PUMP SHAFT. IF THE BUSHING RESISTS SLIDING ONTO THE SHAFT, USE A SCREWDRIVER IN THE SAW CUT TO ALLEVIATE TIGHTNESS. DO NOT EXERT FORCE ON THE SHEAVE, AS IT MAY CAUSE DAMAGE TO BEARINGS OR INTERNAL PARTS OF THE PUMP.

a. Pumps mounted on bases with motor and slide rails provide ample adjustment range for v-belt drive installation and take-up, following specified procedures.

b. When positioning the motor relative to the pump shaft for a v-belt drive, consider belt tightening according to Table 3.1. Check your General Arrangement drawing for any special requirements. The dimensions in this table under SPZ, SPA, SPB, and SPC represent the minimum distances below the standard center distance for belt installation (refer to Figure 3-5). The dimensions under "minimum take-up allowance" indicate the minimum distances to allow for belt tightening.

c. V-belts should be factory or field-matched in required sets for optimal performance.



1. Driver Sheave
2. Driven Sheave
3. Straightedge

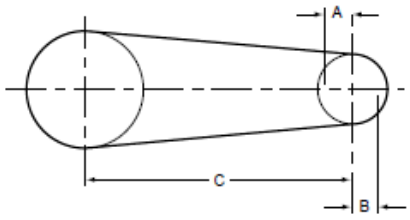
Figure 3.7 Four Point V-Belt Alignment Method

d. Install the V-belts following these instructions:

d-1. Place the belt(s) in the grooves without exerting force.

d-2. Align the belt drive using the four-point method with a straightedge. Alignment is achieved when two points (near and far) on the face of each sheave touch the straightedge (see Figure 3-4).

d-3. Determine installation and take-up allowance dimensions by referring to Table 3-1 for the appropriate belt pitch length. Allow for moving the centers closer together by the amount specified in Table 3-1 to facilitate belt installation without damage (refer to Figure 3-5). Account for center adjustment based on the Minimum Take-Up Allowance in Table 3-1 to compensate for manufacturing tolerance, possible stretch, and wear of belts during initial run-in and operation



A. Allowance for V-Belt Installation
B. Allowance for V-Belt Take-up
C. Centre Distance

Figure 3.7 V-Belt Centre-Distance Determination

d-4. Measure the span length of the installed belt (dimension D in Figure 3-6).

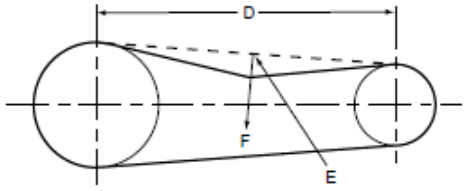
d-5. Apply a perpendicular force to any ONE of the belts at the center of span D using a spring scale. The force should be sufficient to deflect the belt by 16mm per meter of span length.

d-6. Compare the deflection force from step d-5 with the values in Table 3-2. Initially tighten the belt to the specified value for the run-in period. The ideal tension is the least tension that prevents belt slipping under peak load conditions.

d-7. Reinstall the V-belt drive guard and secure all fasteners.

WARNING!

ALWAYS ENCLOSE V-BELT DRIVES WITH A GUARD BEFORE STARTING THE DRIVER. NES V-BELT GUARDS, WHEN SUPPLIED, ADHERE TO CURRENT SAFETY STANDARDS. DO NOT ATTEMPT TO MODIFY ANY GUARDS WITHOUT CONSULTING YOUR NES ENGINEER.



D. Span Length E. Deflection F. Force

Figure 3.8 Checking V-Belt Tension

INSTALLATION AND TAKE-UP ALLOWANCE TABLE					
Belt Pitch Length (In)	Installation Allowance (In)				Minimum Take-up Allowance (In)
	SPZ Z	SPA A	SPB B	SPC C	
16.14 to 20.86	0.78	0.98	1.18	1.96	0.98
21.86 to 33.07					
33.46 to 45.66					1.96
46.06 to 59.05					
59.44 to 72.04					
72.44 to 85.43					
85.82 to 111.41					
111.81 to 137.79					2.75
138.52 to 163.77					
164.17 to 202.36					3.93
205.51 to 242.12					
243.30 to 295.27					4.92
299.21 to 334.64					
349.60 to 400.39					
417.32 to 492.12					

Table 3.1 V-Belt Drive Installation Dimensions

Belt Section	Force required to deflect belt 0.62 Inches per Feet of span		
	Small Pulley Diameter (In)	Newton (N)	Pound Force
SPZ	3.16 to 3.74	13 to 20	2.86 to 4.4
	3.93 to 5.51	20 to 25	4.4 to 5.5
SPA	3.14 to 5.19	25 to 35	5.51 to 7.93
	5.51 to 7.87	35 to 45	7.93 to 10.14
SPB	4.40 to 8.81	45 to 65	10.14 to 14.55
	9.29 to 12.40	65 to 85	14.55 to 19.18
SPC	8.81 to 13.97	85 to 115	19.18 to 25.79
	14.76 to 22.04	115 to 150	25.79 to 33.73

Table 3.2 V-Belt Tension

d-8. Monitor the tension regularly during the initial 24 to 48 hours, verifying it against the value determined in steps d-5 and d-6. If any changes occur, readjust the belt tension. After 48 hours, stop the driver and recheck the tension. Compare this tension with the value in Table 3-2 and adjust it if necessary.

CAUTION!

EXCESSIVE TENSIONING SHORTENS BELT AND BEARING LIFE.

PRIME THE PUMP AND TURN ON THE SEAL WATER SUPPLY BEFORE STARTING THE PUMP, EVEN FOR CHECKING THE DIRECTION OF ROTATION.

e. After completing piping connections (Section 3-5), ensure that the pump rotates freely, and the v-belt drive turns the pump in the correct direction of rotation. Refer to Section 6 for pump operation.

f. Keep the V-belts free of foreign material at all times and regularly inspect the V-belt drive. Look for:

Small cracks on the V-belt side and base - Generally caused by insufficient belt tension, but excessive heat and/or chemical fumes can also lead to the same failure.

V-belt swelling or softening - Caused by excessive contamination by oil, certain cutting fluids, or rubber solvent.

Whipping during running - Usually caused by incorrect tensioning, primarily on long center drives.

NOTE

STORE V-BELTS IN A DRY STOCKROOM AND CAREFULLY AVOID CONTACT WITH HOT PIPES AND DIRECT SUNLIGHT. WHEN HANDLING, IF POSSIBLE, KEEP THE BELTS LOOSELY IN SINGLE COILS AND REFRAIN FROM TYING THEM WITH THIN STRING.

FOR A DRIVE THAT WILL STAND UNUSED FOR AN EXTENDED PERIOD, IT IS ADVISABLE TO RELAX THE BELT TENSION TO PREVENT BELT DAMAGE. IN SUCH CASES, RE-TENSION THE BELTS BEFORE START-UP.

Section 4 - EXPLOSIVE / HAZARDOUS ENVIRONMENTS

4.1 GENERAL INSTALLATION CONSIDERATIONS

a. Packaged units provided by NES will be equipped with necessary components to meet safety standards for the relevant process environment, including the pump materials of construction.

WARNING: Before relocating any existing pumps in such environments, discuss the safety aspects of pump construction with your NES Engineer.

b. Bare shaft pumps supplied will necessitate special additional equipment, such as motors, valves, electrical monitoring equipment, etc., designed and certified for such use.

c. Guards for couplings and v-belts should be constructed of non-sparking materials. This can be achieved through either a fully manufactured guard in suitable material or a specially manufactured guard with additional clearances and non-sparking rubbing strips fitted in selected areas.

d. For v-belt drive installations, it may also be necessary to consider fitting F.R.A.S. belts (Fire Resistant Anti-Static). These belts are designed to comply with the "fire-resistant anti-static" requirements of B.S.3790 and the National Coal Board Specification Number 244.

If in doubt, seek expert advice from your NES Engineer.

Section 5 - TECHNICAL DATA

5.1 INTRODUCTION

The data given in this section shows the standard for the pump series.

5.2 TECHNICAL DATA CONTENTS

Table 5 – 1	MASS / CONSTRUCTION DATA – NL VACUUM PUMPS & COMPRESSORS										
PUMP / COMPRESSOR MODEL	MATERIAL of CONSTRUCTION See Note 2.	TOTAL MASS UNIT DRY (Lb.)	TOTAL MASS UNIT WET (Lb.)	MASS of COMPONENT PARTS (Lb)							
				Index No. Part Name	101 Body	102 & 103 Head	104 & 105 Cone	110 Rotor	111 Shaft	119 Floating Bearing	120 Fixed Bearing
NL-400	Iron	500.44	518.08		158.73	125.66	14.10	72.75	35.05	3.52	3.52
	Bronze	628.31	645.95		198.41	156.52	17.63	90.38	35.93	3.52	3.52
NL-700	Iron	765.00	798.07		200.62	145.50	16.09	138.89	57.32	3.08	3.08
	Bronze	914.91	947.98		251.32	182.98	20.06	174.16	59.52	3.08	3.08
NL-1000	Iron	1150.81	1216.95		308.64	200.62	24.25	231.48	108.02	7.27	13.66
	Bronze	1388.91	1455.05		385.80	251.32	30.86	288.80	110.23	7.27	13.66
NL-1400	Iron	1955.5	2054.71		346.12	379.19	48.50	449.74	182.98	9.25	9.25
	Bronze	2156.12	2255.32		379.19	416.67	59.52	493.83	187.39	9.25	9.25
	CIBF	2048.09	2147.3		346.12	379.19	59.52	493.83	187.39	9.25	9.25
NL-1500	Iron	1351.43	2116.44		361.55	354.94	55.11	478.40	187.39	18.07	18.07
NL-2000	Iron	2850.57	3024.74		690.04	515.88	63.93	630.52	249.12	10.80	10.80
	Bronze	3117.33	3291.50		756.18	564.38	81.57	690.04	255.73	10.80	10.80
	CIBF	2954.19	3128.36		690.04	515.88	81.57	690.04	255.73	10.80	10.80
NL-3000	Iron	4799.46	5101.49		1179.47	712.09	110.23	1091.29	425.49	15.43	15.43
	CIBF	4960.40	5262.43		1179.47	712.09	138.89	1197.11	436.51	15.43	15.43
NL-4000	Iron	8509.84	9105.09		1951.09	1091.29	180.77	1576.31	650.36	25.35	25.35
NL-6000	Iron	13999.35	14969.39		3340.00	2028.25	319.67	3108.51	947.98	48.50	48.50
NL-9000	Iron	19003.85	20723.45		5324.16	2854.98	496.04	4706.86	1565.28	61.72	61.72
NL-14000	Iron	29983	33290		8730.3	2800	701	7000	2700	68.3	68.3

Notes:
1. For conversion purposes, 1 kg = 2.205 lb.
2. CIBF = Cast Iron with Bronze Rotor and Cones, Stainless Steel Shaft.
3. For mass of gear parts on NL 6000G and 9000G Series pumps, refer to Table 5-2.

TABLE 5-2	MASS / CONSTRUCTION DATA - NL 6000G and NL 9000G GEAR PARTS					
PUMP OR COMPRESSOR MODEL	MASS of COMPONENT PARTS (lb.)					
	Index No. Part Name	123 Gear	124 Pinion	125 Gear Casing	126 Bracket	127 Bearing
NL6000G		965.62	176.4	101.4	200.62	20.06
NL9000G		1020.7	690	125.66	200.62	20.06

Note: 1. For conversion purposes 1 lb. = 0.45 kg .

TABLE 5-3	MATERIAL CLASS / STANDARDS - ISO METRIC PRODUCTS
CATEGORY	INFORMATION
Pump Parts	Relevant British / International Standard for Material(s) of Construction
Gaskets	Non-asbestos
Packing	Non-asbestos
Safety	BS.5304 - British Standard Code of Practice for Safety of Machinery
Pipe Threads	BS.21 - Pipe Threads for Tubes and Fittings where Pressure - Tight Joints are Made on the Threads

TABLE 5-4	LUBRICATING GREASE DATA - NL MODELS WITH GREASE LUBRICATED BEARINGS

GENERAL GREASE SPECIFICATIONS

GENERAL REQUIREMENTS

A. Premium quality industrial bearing grease.
B. Consistency grade: NLGI#2
C. Oil viscosity (minimum):
38 deg C - 2316 cSt (500 SSU)
99 deg C - 271 cSt (58 SSU)
D. Thickener (Base): Lithium, Lithium Complex or Polyurea for optimum WATER RESISTANCE
E. Performance characteristics at operating temperature:
1. Operating temperature range: at least 18 to 121 deg C
2. "Long life" performance
3. Good mechanical and chemical stability
F. Additives - Mandatory:
1. Oxidation inhibitors
2. Rust inhibitors
G. Additives - Optional:
1. Anti-wear agents
2. Corrosion inhibitors
3. Metal deactivators
H. Additives - Objectionable:
1. Extreme pressure (EP)* agents
2. Molybdenum disulphide (mos)
3. Tackiness agents

*Some greases exhibit EP characteristics without the use of EP additives. These characteristics are not objectionable.

GREASE RECOMMENDATIONS

NES STANDARD GREASE RECOMMENDATIONS (By Manufacturer)

The following is a list of some greases that exhibit the desired characteristics required by NES:

GREASE MANUFACTURER	PRODUCT
BP	Energrease LS2
Shell	Alvania R2
Mobil	Mobilux 2
Esso	Beacon 2
Texaco	Multifak Multipurpose 2
Gulf	Gulfcrown No. 2
Century	Lupus A2
Nynas	Alexol L-42

NOTE: This list is not an endorsement of these products and is to be used only for reference. A customer can have his local lubricant supplier cross reference these greases for an equivalent or current grease. The grease consistency of all the products above comply with NLGI No. 2 (National Lubricating Grease Institute NLGI Scale).

TABLE 5-5	OIL SELECTION DATA - Oil lubricated bearings and pump gear lubrication		
ACTUAL OIL TEMPERATURE	-7 to 52 deg C	46 to 68 deg C	63 to 85 deg C
AGMA VISCOSITY GRADE	2	4	6
VISCOSITY cST @ 40 deg C SSU @ 100 deg F	 61.2 - 74.8 284 - 347	 135 - 165 626 - 765	 288 - 352 1335 - 1632
MANUFACTURER	LUBRICANT	LUBRICANT	LUBRICANT
American Oil Co. (AMOCO) Ashland Oil Inc. Atlantic Richfield Co. (ARCO) BP Oil Chevron Oil Co. Continental Oil Co. (CONOCO) Gulf Oil Company E.F.Houghton & Co. EXXON Modil Oil Corp. Phillips Petroleum Co. Shell Oil Company Standard Oil Co. of Ohio Sun Oil Co. (SUNOCO) Texaco Inc Union Oil Co. of Calif.	Am. Ind. Oil 68 ETC (R&O) 30 Duro S-315 Energol HLP-C 68 OC Turbine Oil 68 Dectol R&O Oil 33 Gulf Harmony 68 Hydro-Drive HP-300 Teresstic 68 DTE Oil Heavy Medium Magnus Oil 315 Turbo Oil 68 Industron 53 Sunvis 931 Regal Oil 68 R&O Unax RX 68	Am. Ind. Oil 150 ETC (R&O) 70 Duro S-700 Energol HLP-C 150 OC Turbine Oil 150 Dectol R&O Oil 76 Gulf Harmony 150 Hydro-Drive MIH 40 Teresstic 150 DTE Oil Extra Heavy Magnus Oil 700 Turbo Oil 150 Industron 66 Sunvis 961 Regal Oil 150 R&O Unax RX 150	Am. Ind. Oil 320 ETC (R&O) 150 Duro S-1500 Energol C320 OC Turbine Oil 320 Dectol R&O Oil 116 Gulf Harmony 320 - Teresstic 320 DTE Oil AA Magnus Oil 1500 Tellus Oil 320 Industron 100 Sunvis 9112 Regal Oil 320 R&O Unax AW 320

TABLE 5-6	PUMP MAINTENANCE PARTS DATA - NL 200 - NL 1000 MODELS				
PART NAME	INDEX NO.	DESCRIPTION / QUANTITY			
		NL200	NL400	NL700	NL1000
Gland Packing DimensionsQty. Rings per Stuffing Box(See Note 3)	1	1/4" Section 1 5/8" ID x 2 1/8" OD 5	3/8" Section 2 1/4" ID x 3" OD 5	3/8" Section 2 5/8" ID x 3 3/8" OD 5	1/2" Section 3 3/8" ID x 4 3/8" OD 6
Body Gaskets 0.0098 Inch Thick Qty. Floating Bearing end: Qty. Fixed Bearing end:	101-3	 5 6	 4 6	 5 7	 3 5
Cone Gaskets 0.0098 Inch Thick Qty. Floating Bearing end: Qty. Fixed Bearing end:	 104-3 105-3	 1 1	 1 1	 1 1	 1 1
Floating Bearing:	119	Single row ball bearing	Single row ball bearing	Single row ball bearing	Single row ball bearing
Fixed Bearing:	120	Single row ball bearing	Single row ball bearing	Single row ball bearing	Double row angular contact ball bearing

Note: 1. All Dimensions are in inch unless otherwise shown. For conversion purposes 1" = 25.4 mm
2. Body Gasket quantity may vary depending on assembly requirements.
3. If Lantern Rings are fitted, one less Packing Ring is required.
4. *USA reference No. 5315.

For more information, please contact your NES representative.

TABLE 5-7	PUMP MAINTENANCE PARTS DATA - NL 1400 - NL 14000 MODELS				
	INDEX NO.	DESCRIPTION / QUANTITY			
		NL1400	NL1500	NL2000	NL3000
Gland Packing Dimensions Qty. Rings per Stuffing Box (See Note 3)	1	14.5 Section 100 ID x 129 OD 6	5/8" Section 5	1/2" Section 4 1/2" ID x 5 1/2" OD 6	5/8" Section 5 5/8" ID x 6 7/8" OD 6
Body Gaskets 0.0098 Inch Thick Qty. Floating Bearing end: Qty. Fixed Bearing end:	101-3	 7 8	 5 7	 3 5	 6 8
Cone Gaskets 0.0098 Inch Thick Qty. Floating Bearing end: Qty. Fixed Bearing end:	 104-3 105-3	 1 1	 1 1	 1 1	 1 1
Floating and Fixed Bearings:	119 120	Spherical roller bearing	Spherical roller bearing	Spherical roller bearing	Taper roller bearing Roller-Cup clearance 0.02 inch
Lip Seal - Floating and Fixed Bearing Inner:	5	100 shaft dia. 120 bore dia. 9.5 wide	4.0" shaft dia. 4.75" bore dia. 0.438" wide	N/A	4.5" shaft dia. 5.5" bore dia. 0.5" wide
Lip Seal - Floating Bearing Outer:	5-1	75 shaft dia. 100 bore dia. 10 wide	3.0" shaft dia. 4.0" bore dia. 0.438" wide	N/A	N/A
	INDEX NO.	DESCRIPTION / QUANTITY			
		NL4000	NL6000	NL9000	NL14000
Gland Packing Dimensions Qty. Rings per Stuffing Box (See Note 3)	1	3/4" Section 5	3/4" Section 7	3/4" Section 6	3/4" Section 6
Body Gaskets 0.0098 Inch Thick Qty. Floating Bearing end: Qty. Fixed Bearing end:	101-3	 6 8	 4 6	 5 7	 10 10
Cone Gaskets 0.0098 Inch Thick Qty. Floating Bearing end: Qty. Fixed Bearing end:	 104-3 105-3	 1 1	 1 1	 1 1	 1 1
Floating and Fixed Bearings:	119 120	Taper roller bearing Roller-Cup clearance 0.0161 inch	Taper roller bearing Roller-Cup clearance 0.0181 inch	Taper roller bearing Roller-Cup clearance 0.0161 inch	Taper roller bearing Roller-Cup clearance 0.0161 inch
Lip Seal - Floating and Fixed Bearing Inner:	5	6.25" shaft dia. 7.25" bore dia. 0.438" wide	7.75" shaft dia. 8.75" bore dia. 0.438" wide	8.375" shaft dia. 9.875" bore dia. 0.688" wide	4.5" shaft dia. 5.5" bore dia. 0.5" wide
Pinion Bearings:	127	N/A			N/A

Note: 1. All Dimensions are in inch unless otherwise shown. For conversion purposes 1" = 25.4 mm
2. Body Gasket quantity may vary depending on assembly requirements.
3. If Lantern Rings are fitted, one less Packing Ring is required.
4. N/A = Not applicable.

For more information, please contact your NES representative.

TABLE 5-8	NOISE DATA - NL VACUUM PUMPS			
	MAXIMUM READINGS at PUMP UNIT DESIGN SPEED:-			
PUMP MODEL	DESIGN SPEED (rpm)		OVERALL SOUND PRESSURE LEVEL "A" WEIGHTED dB(A)	SOUND POWER LEVEL Where: overall sound pressure level exceeds 85 dB(A)
NL 401/2	1320	dB M.L	85 5	
NL 403	1320	dB M.L	85 5	
NL 701/2	980	dB M.L	86 5	
NL 703	980	dB M.L	86 5	
NL 1001/2	770	dB M.L	85 5	
NL 1003	770	dB M.L	85 5	
NL1401	740	dB M.L	83 5	
NL 1402		dB M.L		
NL 1501	640	dB M.L	78 5	
NL 1502	640	dB M.L	78 5	
NL 2001/2	550	dB M.L	87 5	
NL 2003	550	dB M.L	87 5	
NL 3001/2	450	dB M.L	82 5	
NL 3003	450	dB M.L	82 5	
NL 4001/2	400	dB M.L	82 5	
NL 4003	400	dB M.L		
NL 6001/2	324	dB M.L	82 5	
NL 6003	324	dB M.L	87 5	
NL 9001/2	277	dB M.L	84 5	
NL 9001/2G	277	dB M.L		
NL 9003	277	dB M.L		
NL 9003G	277	dB M.L		
NL14001/2	277	dB M.L		
NL14003	277	dB M.L	95 5	

Note:

1. Sound Pressure Level Ref. 2 x 10^{-5} N/m^2
2. Sound Power Level Ref. 10^{-12} Watts.
3. M.L. = Microphone Location (See Diag.).
4. ACCESSORIES: Discharge Manifold, Separator, Silencer
5. Microphone Height: 1.6m above floor level.
6. Microphone Points: 1m from Unit Envelope.

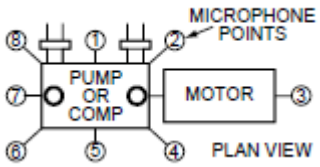


TABLE 5-9	NOISE DATA - NL COMPRESSORS			
	MAXIMUM READINGS at UNIT DESIGN SPEED:-			
PUMP MODEL	DESIGN SPEED (rpm)		OVERALL SOUND PRESSURE LEVEL "A" WEIGHTED dB(A)	SOUND POWER LEVEL Where: overall sound pressure level exceeds 85 dB(A)
NL 401	1170	dB M.L	84 5	
NL 701	980	dB M.L	86 5	
NL 1001	885	dB M.L	88 5	
NL 1401	735	dB M.L	91 5	
NL 1402		dB M.L		
NL 1501	705	dB M.L		
NL 2001	590	dB M.L	90 5	
NL 3001	450	dB M.L	91 5	
NL 4001	400	dB M.L	96 5	
NL 6001		dB M.L		
NL 6001G		dB M.L		
NL 9001		dB M.L		
NL 9001G		dB M.L		
NL 14001G		dB M.L		

Note:

1. Sound Pressure Level Ref. 2 x 10^{-5} N/m^2
2. Sound Power Level Ref. 10^{-12} Watts.
3. M.L. = Microphone Location (See Diag.).
4. ACCESSORIES:
   Discharge Manifold, Separator.
5. Microphone Height: 1.6m above floor level.
6. Microphone Points: 1m from Unit Envelope.

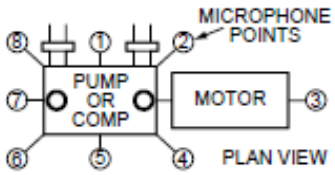


TABLE 5-10	SEAL WATER GUIDELINES
Guidelines for Suitable Water are:-	
Minimum PH Maximum Chlorides Maximum Total Dissolved Solids Maximum Hardness	7 10 ppm 200ppm 200ppm
Note: 1. Water that is not clean or is abrasive should be avoided whenever possible. 2. Extremely hard water may result in the formation of scale deposits within the pump. Such deposits can be removed by periodic treatment or the installation of a water treatment system.	

TABLE 5-11	SEAL WATER FLOW RATES						
	NL VACUUM PUMPS						
PUMP MODEL	Flow Rate GPM	PUMP MODEL	Suction Pressure (In Hg A)	Flow Rate GPM	PUMP MODEL	Suction Pressure (In Hg A)	Flow Rate GPM
NL 401 NL 402 NL 403	6 12 12	NL 2001	29.3 – 24.4 24.4 –19.5	10 20	NL 6002	29.3 - 14.6 14.6 - 9.7 Below 9.7	60 70 120
NL 701 NL 702 NL 703	10 20 18	NL 2002	29.3 - 9.7 Below 9.7	20 40	NL 6003	29.3 - 9.7 Below 9.7	60 140
		NL 2003	29.3 - 11.7 Below 11.7	30 60	NL 9001	29.3 - 24.4 24.4 - 19.5 Below 19.5	50 60 75
NL 1001 NL 1002 NL 1003	15 20 30	NL 3001	29.3 - 24.4 24.4 - 19.5 Below 19.5	10 20 30	NL 9002	29.3 - 19.5 19.5 - 9.7 Below 9.7	90 120 140
NL 1401 NL 1402	21.6 24	NL 3002	29.3 - 14.6 Below 14.6	40 70			
		NL 3003	29.3 - 9.7 Below 9.7	25 70	NL 9003	29.3 - 9.7 Below 9.7	140 200
NL 1501 NL 1502	20 25	NL 4001	29.3 - 19.5 Below 19.5	30 40	NL 14001	29.3 - 24.4 24.4 - 19.5 Below 19.5	80 90 100
		NL 4002	29.3 - 19.5 19.5 - 9.7 Below 9.7	40 50 60	NL 14002	29.3 - 19.5 19.5 - 14.6 14.6 - 9.7 Below 9.7	120 135 180 200
		NL 4003	29.3 - 9.7 Below 9.7	30 100			
		NL 6001	29.3 - 24.4 24.4 - 19.5 Below 19.5	40 45 55	NL 14003	29.3 - 9.7 Below 9.7	100 300

TABLE 5-12	SEAL WATER FLOW RATES
	NL COMPRESSORS
The recommended seal water flow rate for NL Compressors is 0.25 GPM per HP shaftpower absorbed. The shaft power absorbed varies with both operatingspeed and compressor discharge pressure. To determine the shaft power absorbed refer to the NES Performance Curve for the compressor modeland speed. For assistance in determining seal water flow contactyour **NES Engineer**. For minimum seal water supply pressure requirementsrefer to **Table 2-1**.	

TABLE 5-13	SEAL WATER ORIFICE DATA		
NL VACUUM PUMPS			
PUMP MODEL	ORIFICE DIA (inch)	PUMP MODEL	ORIFICE DIA (inch)
NL 400	0.4	NL 3000	0.81
NL 700	0.5	NL 4000	0.69
NL 1000	0.59	NL 6000	0.81
NL 1400	0.62	NL 9000	0.94
NL 1500	0.59	NL 14000	None
NL 2000	0.69		

1. For piping arrangement see Figure 2-1.
2. Pressure gauge setting should be 0.7 bar g.

Section 6 – OPERATION

6.1 PREPARATION FOR INITIAL START-UP

Seek assistance from a NES Engineer for startup, if needed.

6.2 LIQUID COMPRESSANT (SEAL WATER)

a. Normal pump operation requires a supply of clean liquid compressant, typically water, at the correct pressure and flow rate. This water, serving to seal clearances between the rotor and cone(s), is referred to as seal water.

b. If the quality of water intended for use as the liquid compressant (or seal water) is unknown or in doubt, conduct a water analysis, and share the results with a NES Engineer for comments. A general guide to seal water quality requirements is provided in Table 5.10.

Note: Minimum seal water quality depends on operating conditions and pump material of construction. Consult your NES Engineer for assistance.

c. Install a strainer upstream of the pump and any seal water controls to prevent the ingress of solid particles, such as pipe scale (refer to Section 2.1 b).

d. Normal seal water flow rates are outlined in Table 5.11 & 5.12. Variations in flow rate can impact pump performance, and by regulating it, optimal results can be achieved under specific operating conditions. Various methods for correctly regulating seal flow are outlined below:

d-1. Water Meter or Flow Indicator - Install a water meter or flow indicator to show the actual seal water flow rate to the pump. Use a valve or adjusting cock upstream of the meter or flow indicator to regulate the flow as per Table 5.7 requirements.

d-2. Seal Water Orifice and Pressure Gauge - Use a square-edged orifice to control the seal water flow (see Figure 2-1 for piping arrangement). Refer to Table 5.8 for the required orifice diameter. A pressure gauge setting of 0.7 bar g will provide the normal seal flow rate. Adjust the upstream cock or valve until the correct reading is observed. Final adjustment should be made with the pump at the normal operating duty.

d-3. Flow Control Valve - In many installations, a pressure-compensating flow control valve may be employed to automatically ensure a constant seal water flow rate, regardless of the upstream supply pressure. The valve manufacturer's stated minimum pressure differential across the valve (usually 1 bar g) is necessary for proper functioning.

This flow control method is suitable only for installations where flow rate adjustment is unnecessary. For instance, it is ideal for vacuum pumps that operate with a fixed seal water flow as outlined in Table 5-11, or for compressors that maintain a constant discharge pressure. However, this valve type is not appropriate for compressors that use a recirculated seal water system, where water is returned from the discharge separator at the gas discharge pressure.

e. Pumps or compressors experiencing significant water carry-over, such as water entering via the gas inlet, may necessitate seal water flows lower than the standard at the pump seal water connections. For pumps or compressors utilizing seal liquids other than water, flow rates may deviate from those specified in Tables 5-11 and 5-12. In such instances, it is advisable to reach out to your NES Engineer for guidance.

f. In installations lacking a flowmeter, it is advisable to verify the seal water flow rate. This verification can be accomplished by collecting water discharged from the separator outlet over a measured time period and subsequently calculating the flow rate in gallons per minute.

CAUTION!

THE LIQUID COMPRESSANT FLOW MUST BE TURNED ON BEFORE THE PUMP DRIVE MOTOR IS OPERATED, EVEN IF THE PUMP IS ONLY BEING OPERATED TO CHECK THE DIRECTION OF ROTATION.

ENSURE CORRECT REGULATION OF THE LIQUID COMPRESSANT FLOW. EXCESSIVE FLOW MAY INCREASE

POWER ABSORPTION ABOVE DRIVE MOTOR LIMITS AND REDUCE PUMP LIFE THROUGH EROSION.

6.3 LANTERN GLAND LIQUID

a. Lantern glands are an optional installation in a pump, typically upon customer request. To reduce leakage from the pump shaft packing, connect the lantern gland piping to the pump inlet.

b. Lantern glands are utilized to manage air ingress into the pump through the shaft packing and should be linked to a clean liquid source, typically water. Employ a strainer, an adjusting valve, and a pressure gauge (0-14.5 PSIG) to regulate the flow. While the pump is in operation, adjust the gauge to 2.9 PSI gauge pressure.

CAUTION!

EXCESSIVE LANTERN GLAND LIQUID PRESSURE WILL CAUSE EXCESSIVE PACKING WEAR AND EXTERNAL LEAKAGE.

6.4 DRAINING AND FLUSHING

a. Before shipment, the pump is flushed with specially prepared rust preventative oil. This oil, forming an emulsion with water, will appear as a milky liquid.

b. Before initiating the pump following alignment completion outlined in Section 3, Installation, remove the seal water drain plugs (identified as Index No. 22, 22-1, or 22-2 in Figures 9-1 to 9-9) from the pump heads and body. Open the shut-off valve for the seal water supply and allow the seal water to flow until clear flow is observed from all drains. While the pump is flushed with inhibiting oil before shipment, a light rust film may develop before installation completion. This film will dissipate after the pump shaft has been rotated a few times. Close the shut-off valve for the seal water supply and reinstall the drain plugs using a pipe thread compound.

CAUTION!

IT IS THE RESPONSIBILITY OF THE USER TO DETERMINE IF THIS RUST PREVENTATIVE IS HAZARDOUS WASTE AT THE TIME OF DISPOSAL. PLEASE BE CERTAIN THAT DISPOSAL OF THE MATERIAL IS IN COMPLIANCE WITH ALL APPLICABLE LAWS AND REGULATIONS. (SEE ALSO SECTION 8, STORAGE AND DISPOSAL.)

6.5 PRELIMINARY INSPECTION

Conduct the following preliminary inspections before starting the pump:

WARNING!

PERFORM ALL OF THE FOLLOWING STEPS IN ORDER TO ENSURE PERSONNEL SAFETY AND EQUIPMENT PROTECTION.

a. Isolate all power sources to the driver unit to ensure no accidental starting occurs.

b. Inspect the pump to ensure that all drain plugs have been properly installed. Prime the pump manually with liquid compressant until there is a flow from the overflow

c. Inspect the separator, the receiver, and the heat exchanger (if used) to ensure that all shipping plug protectors have been removed and that all open connections have been plugged or piped.

d. Inspect all piping to ensure that proper connections have been made to the pump and its basic system in accordance with the NES Installation or Arrangement drawing(s) that have been supplied with the pump. Ensure that all piping is the correct size, securely connected, and properly supported.

e. Check pump and drive hold-down bolts and base or soleplate foundation bolts for tightness. Where earthing bosses are supplied and indicated on the Installation or Arrangement drawing(s), check that the earthing (or ground) connections have been made.

f. Inspect all other major operational component connections associated with the pump to ensure compliance with the recommendations of their respective equipment manufacturers.

g. Inspect all pump control components (control valves, gauges, etc.) to ensure they have been located in accordance with the NES Installation or Arrangement drawing(s). Confirm that these components are correctly oriented in the piping scheme to achieve the proper direction of flow and functional operation.

h. Inspect the pump inlet to ensure that the inlet screen and cleanout connections have been properly made and are free of tools, equipment, and debris.

i. Ensure that the liquid discharge connection is free of obstructions.

j. Remove the coupling or v-belt guard and rotate the pump shaft by hand in the specified direction of rotation. The specified direction of rotation is indicated by an arrow cast on the pump body and lobe and is illustrated on the Installation drawing.

THE PUMP SHAFT MUST ROTATE FREELY. If the pump shaft is bound and cannot be freed by rotating it manually, contact your NES Engineer for assistance.

CAUTION!

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.

NEVER OPERATE THE PUMP WITHOUT ADEQUATE PRIME AND LIQUID SEAL FLOW. HIGH LIQUID SEAL SUPPLY PRESSURES DO NOT NECESSARILY INDICATE THAT THE FLOW IS ADEQUATE. CHECK FOR FLOW FROM PUMP DISCHARGE (OR SEPARATOR WATER OUTLET).

l. On NL 3000, NL 4000 and NL 14000 Series Pumps:- check to ensure that the oil levels in the bearing oiler sight glasses (Index No. 8, Figures 9-6 and 9-9) are at the top of the red oil level line. If the oil level is below the top of the red line add oil as specified in Section 7-6. For oil specification and grade selection refer to Table 5-5 and Section 7-6.

m. On NL 6000G and NL 9000G Series pumps check the oil level in gear casing sight glass (Index No. 8, Figure 9-8). If the oil is below the top of the red line add oil as specified in Section 7-7. For oil specification and grade refer to Table 5-5 and Section 7-7.

CAUTION!

DO NOT OPERATE THE PUMP BEFORE CHECKING THE OIL LEVELS.

n. With the main supply valves open and the pump primed, as in step c, bump the drive motor for the pump to check for the proper direction of shaft rotation.

WARNING!

ENSURE THAT THE COUPLING OR V-BELT DRIVE IS ENCLOSED WITH A GUARD BEFORE STARTING THE DRIVE MOTOR.

6.6 START-UP AND OPERATING CHECKS, VACUUM PUMP ONLY

Upon completion of the preliminary inspection and preoperational check procedures, initiate the pump and assess its operation using the following steps:

WARNING!

IF THE PUMP IS TO BE CHECKED IN A SYSTEM, NOTIFY THE APPROPRIATE PLANT PERSONNEL BEFORE PLACING A PUMP ONLINE, ESPECIALLY WHEN PLACING THE PUMP ONLINE FOR THE FIRST TIME. STARTING UP A SYSTEM UNEXPECTEDLY MAY CAUSE PERSONNEL INJURY.

NOTE

REFER TO LOCATING TROUBLES, SECTION 6.8, IF ANY OPERATING DIFFICULTIES ARISE DURING THE SUBSEQUENT STEPS:

a. Inspect the pump and the system to ensure adequate priming, then activate all main water supply sources to the pump or heat exchanger.

CAUTION!

WHEN MECHANICAL SEALS ARE FITTED, ENSURE THAT FLUSH SUPPLIES ARE TURNED ON BEFORE OPERATING THE PUMP.

b. With the water supply sources activated and all personnel and equipment clear of the pump system, apply power to the drive motor.

Note:

If pump operation becomes unstable, leading to increased vibration levels and a decrease in pumping volume, immediately shut down the system and identify the cause.

c. While the pump is stabilizing at the required inlet vacuum, verify the flow of liquid seal (water) to the pump. Confirm that the liquid seal is flowing out of the separator drain.

d. Continuously monitor the temperature of the pump casing during the start-up procedure. If the temperature rises rapidly or exceeds 14oC above the liquid compressant temperature, promptly shut down the unit and investigate the cause.

e. After starting the pump, monitor the temperature of the bearing housings until the temperatures stabilize for a minimum of 30 minutes.

CAUTION!

IF A BEARING BRACKET TEMPERATURE IS MORE THAN 62.6°F ABOVE THE PUMP CASING TEMPERATURE, SHUT DOWN THE PUMP IMMEDIATELY AND DETERMINE THE CAUSE.

IF ABNORMAL BEARING NOISE, VIBRATION, ODOR, OR SMOKING OCCUR, SHUT DOWN THE PUMP IMMEDIATELY AND DETERMINE THE CAUSE.

f. Inspect the pump for vibration and noise. Abnormal levels of vibration and noise indicate issues with the NES pump. Immediately shut down the pump and investigate the cause.

g. Confirm the speed (RPM) of the pump shaft rotation using a tachometer inserted in the center of the motor shaft. For v-belt driven pumps, compute the pump speed by multiplying it by the drive ratio (Refer to the Installation or Arrangement drawing supplied.) Compare the measured speed with the rated speed for the pump. The rated operating speed and capacity can be determined from the purchase specifications or by consulting with your NES Engineer.

NOTE

THE SPEED INDICATED ON THE PUMP NAMEPLATE (ITEM 1, FIGURE 1.4A) REPRESENTS THE SPEED AT WHICH THE PUMP WAS TESTED DURING MANUFACTURE AND MAY NOT NECESSARILY BE THE SPEED SELECTED FOR ON-SITE OPERATION.

h. After the pump has been running steadily for ten minutes with a consistent water leakage from the stuffing boxes, it is essential to adjust the glands following this procedure:

WARNING!

TAKE CARE TO AVOID INJURY, AS THE GLAND ADJUSTMENT PROCEDURE REQUIRES REMOVING THE GLAND GUARDS. USE A CORRECT-SIZE SPANNER, KEEP HANDS AWAY FROM THE ROTATING SHAFT DURING ADJUSTMENT, AND AVOID WEARING LOOSE CLOTHING THAT MAY COME INTO CONTACT WITH THE SHAFT AREA. ALWAYS REPLACE THE GLAND GUARDS AFTER THE FINAL ADJUSTMENT.

h-1. Stop the pump and carefully remove the gland guards, taking care not to misplace the securing screws. Shift the gland guards away from the pump to ensure a clear standing area around the pump.

h-2. Confirm that no personnel are in proximity to the pump or exposed shafts, then restart the pump. Allow the pump to run at normal temperature and vacuum/pressure.

h-3. Once a consistent leakage from the stuffing boxes is evident, adjust each gland by tightening the gland nuts evenly, one flat at a time, using an appropriately sized spanner.

h-4. Repeat this adjustment at ten-minute intervals until there is a leakage of approximately 45 to 60 drops per minute from each gland, with no signs of overheating. This dripping is essential to provide lubrication for the packing and prevent scoring and burning of the shaft.

h-5. Monitor the pump operation for 30 minutes to ensure that the leakage rate is satisfactory and that there is no overheating.

h-6. Stop the pump and reinstall the gland guards, securely tightening all fasteners.

h-7. Restart the pump and allow it to operate at normal temperature and vacuum.

6.7 START-UP AND OPERATING CHECKS, COMPRESSOR ONLY

Upon completion of the preliminary inspection and pre-operational check procedures, initiate the compressor and assess its operation using the following steps:

WARNING!

IF THE COMPRESSOR IS TO BE CHECKED WITHIN A SYSTEM, INFORM THE RELEVANT PLANT PERSONNEL BEFORE PUTTING THE COMPRESSOR ONLINE, ESPECIALLY WHEN DOING SO FOR THE FIRST TIME. STARTING A SYSTEM UNEXPECTEDLY MAY RESULT IN PERSONNEL INJURY.

NOTE

REFER TO LOCATING TROUBLES, SECTION 6-8, IF ANY OPERATING DIFFICULTIES ARISE WHEN PERFORMING THE FOLLOWING STEPS.

a. Ensure that the compressor and the system have sufficient priming before activating all primary water supply outlets to the compressor and the heat exchanger.

b. Fully open the separator bypass valve.

c. With the water supply outlets activated and all personnel and equipment kept clear of the compressor system, energize the driver. Gradually close the separator bypass valve until the separator pressure gauge reads a maximum of 2.9 PSI gauge pressure.

Dimensions are nominal bore sizes in mm. Valve sizes below 50mm are ball valves, 50mm and above are butterfly valves. Compressor

Compressor Size	Valve and Line Size	Start-up Bypass Interval (seconds)
NL 401	80	60
NL 701	80	60
NL 1001	100	120
NL 1401	100	180
NL 1501	100	180
NL 2001	150	180
NL 3001	150	180
NL 4001	150	240
NL 6001	200	240
NL 9001	250	300

Table 6-1. Start-up Bypass Intervals, Compressors only

CAUTION!

THE PRESSURE READ AT THE SEPARATOR PRESSURE GAUGE MUST NOT EXCEED 2.9 PSIG FOR THE TIME SPECIFIED IN TABLE 6.1 IN ORDER TO PREVENT UNSTABLE OPERATION AND POSSIBLE DAMAGE.

IN ONCE-THROUGH SYSTEMS, IF THE SEPARATOR WATER LEVEL RISES ABOVE THE GAUGE GLASS, SHUT DOWN THE COMPRESSOR IMMEDIATELY AND CHECK FOR RESTRICTION IN THE WATER DISCHARGE FROM THE SEPARATOR. IF THE SEPARATOR PRESSURE IS BELOW 2.9 PSIG, THROTTLE A DISCHARGE VALVE AND RECHECK. DURING NORMAL OPERATION, THE SYSTEM BACK PRESSURE WILL BE SUFFICIENT TO PRESSURIZE THE SEPARATOR. IF THE SYSTEM BACK PRESSURE IS NOT SUFFICIENT TO PRESSURIZE THE SEPARATOR, A DISCHARGE ORIFICE MAY BE REQUIRED. CONSULT YOUR NES ENGINEER FOR RECOMMENDATIONS.

NOTE

IN THE CASE OF A TURBINE-DRIVEN COMPRESSOR, IT MAY BE NECESSARY TO READJUST (OPEN) THE SEPARATOR BYPASS VALVE TO MAINTAIN THE 2.9 PSIG VALUE WHILE THE TURBINE IS RAMPING UP TO SPEED. IF COMPRESSOR OPERATION BECOMES UNSTABLE, YOU MAY OBSERVE INCREASED LEVELS OF COMPRESSOR VIBRATION AND A DECREASE IN PUMPING VOLUME. GRADUALLY OPEN THE SEPARATOR BYPASS VALVE TO ATTEMPT TO STABILIZE THE COMPRESSOR. IF STABILIZATION IS ACHIEVED, PARTIALLY CLOSE (THROTTLE) THE SEPARATOR BYPASS VALVE. IF THE COMPRESSOR FAILS TO STABILIZE, SHUT DOWN THE SYSTEM IMMEDIATELY AND INVESTIGATE THE CAUSE. IF THE COMPRESSOR IS BEING EVALUATED WITHIN THE SYSTEM, CONSIDER PARTIALLY CLOSING THE DISCHARGE ISOLATION VALVE TO ATTAIN THE REQUIRED 2.9 PSIG SEPARATOR BACK PRESSURE.

d. While the compressor is undergoing stabilization at the discharge pressure setting, verify the flow of liquid seal (water) to the compressor. For once-through systems, ensure that the liquid seal flows out of the ball float. In recirculated systems, confirm that the recirculation pump (if used) is operational.

e. Continuously monitor the temperature of the compressor casing throughout the startup process. If the temperature increases rapidly or exceeds 57.2℉ above the liquid compressant temperature, promptly shut down the unit and identify the cause.

f. Upon starting the compressor, monitor the temperature of the bearing housing until it stabilizes for a minimum of 30 minutes.

CAUTION!

If the bearing housing temperature exceeds 62.6℉ above the compressor casing temperature, immediately shut down the compressor and investigate the cause.

g. Inspect the compressor for abnormal vibration and noise. Excessive vibration and noise are indicative of abnormal conditions in a NES compressor. If observed, shut down the compressor immediately and determine the cause.

h. Verify the speed (RPM) of the compressor shaft rotation by removing the access plug from the fixed bearing outer cap and inserting a tachometer, utilizing a shaft extension if necessary. Compare the measured speed with the rated speed for the compressor.

i. Once the compressor has completed the stabilization interval specified in Table 6-1 for operation at 2.9 PSIG, gradually close the separator bypass valve until the normal discharge operating pressure is attained. Monitor for abnormal noise or vibration as the separator bypass valve is closed. If abnormal conditions arise, gradually open the separator bypass valve until they disappear. Then, close the separator bypass valve again to achieve the normal discharge operating pressure. If noise or vibration recurs, shut down the compressor and determine the cause.

j. With the compressor stabilized at the normal discharge operating pressure, repeat steps d through h.

k. After the compressor has been running steadily for ten minutes with consistent leakage from the stuffing box, adjust the gland packing according to the procedures detailed in Section 6-6, steps h-1 to h-7.

6.8 LOCATING TROUBLES

NES NL Vacuum Pumps and compressors typically require minimal attention, primarily focused on assessing their capacity to achieve full volume or maintain a consistent vacuum or pressure. For systems utilizing a v-belt drive, it is essential to regularly check v-belt tension, following the guidelines outlined in Section 3-8 d-4 to d-8, and inspect the v-belts for signs of excessive wear. V-belts commonly have a service life of 24,000 hours. In case of operational challenges, perform the following checks:

a. Confirm the appropriate seal water flow rate as outlined in Table 5.11 & 5.12. This involves collecting and measuring the water discharged over a specific duration, followed by calculating the flow in GPM.

b. Verify the correct direction of the pump shaft rotation, as indicated on the pump body.

c. Confirm that the pump operates at the designated rpm, which may differ from the test rpm stamped on the pump nameplates (Refer to Section 1.5). Tachometer should be used as mentioned in section 6.6g.

e. Inspect the air discharge piping for any restrictions. Back pressure at the air discharge can diminish vacuum levels (increase absolute suction pressure) and elevate the required driving power.

f. Examine the gas inlet line for any restrictions. Undersized inlet piping and obstructions can lead to higher vacuum levels (lower absolute pressure) at the pump compared to the work or process. Refer to section 2.1

g. If the pump is shut down due to changes in temperature, noise, and/or vibration from normal operating conditions, scrutinize bearing lubrication, bearing condition, and the alignment of the coupling or v-belt drive. Refer to Sections 3.7 and 3.8 for alignment procedures and v-belt tensioning.

Note: If the issue persists despite these checks, it is possible that the internal clearances of the first and second stage rotors have altered due to wear. Checking and adjusting these clearances necessitate dismantling the pump. Contact your NES Engineer before proceeding with pump dismantling. They will provide assistance in identifying and rectifying the issue.

Section 7 - PREVENTATIVE AND ROUTINE MAINTENANCE

NOTE

FOR SIGNIFICANT OVERHAULS, PLEASE REFER TO THE MAINTENANCE BULLETIN ALSO PROVIDED WITH YOUR PUMP.

7.1 PERIODIC MAINTENANCE

NOTE

THE FOLLOWING SCHEDULES SHOULD BE ADJUSTED AS NECESSARY FOR YOUR SPECIFIC OPERATING CONDITIONS.

a. During each specified interval (and during any maintenance or repair activities), it is recommended to inspect the pressure boundary components (such as body, heads, and mechanical seal glands if present) for indications of corrosion, cracking, etc. This practice is especially crucial for compressor setups but is also deemed good practice for all pumps. If signs of damage are detected, it is advisable to isolate the equipment and conduct a water pressure test on the pump, applying 1.5 times the working pressure to assess the extent of damage. Any faulty components should be promptly replaced to mitigate risks to personnel and equipment within the plant.

7.2 SIX-MONTH INTERVALS

a. If the drive coupling is lubricated, fill it with oil or grease following the coupling manufacturer's instructions.

b. Inspect the pump bearings and lubricate if necessary, as specified in Section 7.4, 7.5 or Section 7.6, as applicable.

c. Relubricate the drive motor bearings according to the motor manufacturer's instructions.

d. Clean the seal liquid line strainer (see Figure 2.1).

NOTE
MORE FREQUENT CLEANING MAY BE NECESSARY DEPENDING ON OPERATING CONDITIONS.

7.3 TWELVE-MONTH INTERVALS

a. Inspect the pump bearings and lubricate, if necessary, as specified in Sections 7.4, 7.5 or 7.6 as applicable.

b. Replace the stuffing box packing as specified in Section 7.6.

c. When mechanical shaft seals are provided, check for leakage and ensure cool operation.

7.4 BEARING LUBRICATION, GREASE LUBRICATION – WITHOUT GREASE FITINGS

Series NL 400, 700, 1000 & 2000

a. These pumps have grease-lubricated bearings. Bearings are lubricated before shipment and require no lubrication for approximately six months.

Note: If the pump has been in storage for over six months before installation, it is recommended to check the condition of the grease as detailed in Section 7.4B.

CAUTION!
RELUBRICATE ONLY WITH GREASE THAT COMPLIES WITH THE SPECIFICATIONS GIVEN IN TABLE 5.2. ADDING INCOMPATIBLE GREASE MAY CAUSE LUBRICATION BREAKDOWN, RESULTING IN PREMATURE BEARING FAILURE.

b. At each lubrication interval or when it is necessary to check for contamination, proceed as follows:-

b-1. Shut down and isolate the pump.

b-2. Remove the gland guards and unscrew the bearing cap set and nuts (where Fitted) see Figures 9-1 to 9-3 and 9-5 and slide back the bearing caps (115, 116, 117, 118).

b-3. Check the condition of the grease within the bearing housing for contamination or the presence of water.

b-4. Check the condition of the grease within the bearing housing for contamination or the presence of water. If the grease is deemed satisfactory, apply grease to both sides of the bearing in accordance with the recommendations provided in Table 5-4. Utilize a clean putty knife or a similar tool to pack the bearing until the grease reaches the edge of both the inner and outer race of the bearing. Fill each bearing cap to a level of 1/4 to 1/3 full and reinstall the caps to prevent any dirt from entering the bearing housing.

b-5. In the event that the grease is contaminated, clean out both the bearing and the housing using a solvent to eliminate all traces of grease. Inspect the bearing for any damage. If the bearing displays any indications of damage such as pitting of balls/rollers, damage to raceways, or discoloration due to overheating, it should be replaced. If the bearing is found to be satisfactory, repack it with grease as per Section b-4.

NOTE

FOR GUIDANCE ON BEARING REPLACEMENT, REFER TO THE NES MAINTENANCE BULLETIN LISTED IN TABLE 1-1.

b-6. Replace the gland guards.

b-7. Initiate the pump and bring it to normal operating conditions. Periodically check the bearing housing temperatures during the initial two hours of operation. The bearing housing temperature should not surpass 62.6°F above the pump body temperature. If this temperature difference is exceeded and continues to rise, shut down the pump and investigate the cause.

7.5 BEARING LUBRICATION, GREASE LUBRICATION – WITH GREASE FITINGS

Series NL 1400, 1500, 6000, 9000, 6000G & 9000G fixed bearing.

a. Bearings are pre-lubricated before shipment and typically do not require additional lubrication for approximately six months.

b. During each lubrication interval or when contamination needs to be checked, follow these steps:

b-1. For NL 6000, NL 6000G, NL 9000, and NL 9000G Series only: Remove the vent plug located in the outer bearing cap (22, Figure 9-7).

b-2. While the pump is in operation, apply grease as specified in Table 5-4 to the grease fittings (23) until grease emerges from the slot or vent hole in the outer bearing cap.

b-3. Inspect the condition of the expelled grease. If contamination is observed, the bearing housing and bearing must be thoroughly cleaned following the procedures outlined in Section 7-4 and Maintenance Bulletins listed in Table 1-1.

b-4. Reinstall the vent plug removed in step b-1.

7.6 BEARING LUBRICATION – OIL LUBRICATED

a. This pump model utilizes oil-lubricated bearings, and it is crucial to identify and use the appropriate grade of oil before extended operation of the pump.

CAUTION!

THE FOLLOWING PROCEDURE MUST BE EXECUTED TO ACCURATELY DETERMINE THE OIL VISCOSITY GRADE SUITABLE FOR THE OPERATING TEMPERATURE OF THE BEARINGS. FAILURE TO DETERMINE AND USE THE CORRECT OIL GRADE WILL DIMINISH BEARING LIFE AND MAY RESULT IN PREMATURE FAILURE.

b. To determine the correct oil viscosity grade, follow these steps:

b-1. Start the pump and operate under duty conditions. Use a precise surface temperature measuring instrument to measure the temperature of the first-stage body casing (Index No. 101) and the temperature at the pump discharge connection. The higher of these temperatures is the OPERATING TEMPERATURE of the liquid ring.

b-2. Use the same temperature instrument to measure the OIL TEMPERATURE by placing it against the lower quadrant of the bearing housings in the heads (Index No. 102, 103) or the outer bearing caps (Index No. 115, 117).

b-3. Monitor the OPERATING AND OIL TEMPERATURES every 15 minutes for the first hour and every 30 minutes thereafter until stabilization occurs.

NOTE

THE PUMP REQUIRES 2 TO 3 HOURS OF CONTINUOUS OPERATION BEFORE STABILIZATION OCCURS.

b-4. Choose the AGMA viscosity grade for the actual STABILIZED OIL TEMPERATURE determined by referring to Table 5.3.

Note: Oil viscosity grades other than those in Table 5.3 may be used if they meet a minimum viscosity requirement of 33 cSt at the ACTUAL STABILIZED OIL TEMPERATURE.

CAUTION!
IF THE STABILIZED OIL TEMPERATURE IS GREATER THAN 185°F, CONSULT YOUR NES ENGINEER.

c. Oils that meet NES general requirements are listed in Table 5.3. This table serves as a guide to oil selection and does not endorse any particular product.

General requirements are listed below:

PREMIUM QUALITY, industrial R&O type turbine, circulating, or hydraulic oils.

VISCOSITY INDEX (VI) equal to or greater than 90.

VISCOSITY GRADE selected to meet the actual, stabilized oil temperature.

GOOD WATER SEPARATION and DEMULSIBILITY PROPERTIES.

MANDATORY ADDITIVES: 1) Rust and oxidation inhibitors 2) Anti-foam agents

OPTIONAL ADDITIVES: 1) Anti-wear agents 2) Corrosion inhibitors 3) Pour depressants 4) VI improvers 5) Metal deactivators

UNDESIRABLE ADDITIVES: 1) Extreme pressure (EP) agents 2) Moly-disulfide (MoS2) 3) Detergent-dispersant agents (motor oils) 4) Alkaline agents 5) Emulsifiers 6) Fatty-oil agents

d. Choose an oil with the required viscosity grade that fulfills all NES general requirements. To change the oil, follow step f.

e. OIL LEVEL MAINTENANCE:

If the oil level in the sight glass oiler (Index No. 8, Figure 9-4) drops below the top of the red oil level line during operation, proceed as follows:

e-1. Verify that the vents (Index No. 24) are clear to ensure proper venting.

e-2. Thoroughly clean the area around the cap at the top of the oiler to prevent potential oil contamination. Remove the cap from the oiler.

e-3. Pour oil of the same grade and type currently in use, using a clean container, until the oil level reaches the top of the red line (and no higher) while the unit is operating. Reattach the cap onto the oiler.

CAUTION!
IF MORE THAN 150ml OF OIL HAS TO BE ADDED AT ANY ONE TIME, OR IN ANY 8 HOURS OF OPERATION, SHUT DOWN THE UNIT AND DETERMINE THE CAUSE.

f. OIL CHANGE PROCEDURE:

Following the initial week and first month, and subsequently at the intervals indicated in Table 7.1, execute the oil change as outlined below:

f-1. Deactivate and isolate the unit.

Interval for Operating Temperature Range*			
140 F or less	140 – 159.8 F	159.8 – 179.6 F	179.6 – 199.4 F
6 months	3 months	1 month	2 weeks

Table 7.1 Oil Change Intervals

f-2. Clear the vicinity around the drain plugs (Index No. 22.3, Figure 9.4) located at the bottom of the floating and fixed bearing caps (Index No. 115, 117) to avoid any potential contamination of the oil cavity.

*Intervals provided serve as a general reference only. In cases of severe operating conditions or changes, oil change service intervals may need to be reduced.

f-3. Position suitable clean containers beneath the drain plugs and allow all the oil to drain from the bearing caps into the containers.

f-4. Examine the drained oil for indications of contamination, following the guidelines in Table 7.2. If contamination is detected, identify the source and address the issue. Seek assistance from your NES Engineer if needed.

Oil Condition	Inspection Method	Cause for Rejection
Water Contamination	Visual	Hazy or Cloudy appearance not to be confused with foaming
	Crackle Test	Cracking sound when oil sample is heated
Solids Contamination	Visual	Particles observed
	Filtration	
	Absorption	
Ferrous (rust) Solids Contamination	Magnet	Ferrous particles attracted
Oxidation / Chemical Breakdown	Visual Compare to Identical Fresh Oil	Oil sample discolored, sludge formation or pungent odor detected

Table 7.2 Oil Condition, Field Inspection Guide

f-5. Clean the threads of the drain plugs and reinstall them into the bearing caps.

NOTE

DO NOT USE A THREAD COMPOUND ON THE DRAIN PLUGS.

f-6. Remove the caps from the oilers and, using a clean container, add oil until the level reaches the top of the red line on the sight glass. Each bearing housing has an approximate capacity of 0.5 liters.

f-7. Allow several minutes for the oil level to stabilize, and add more oil as needed.

f-8. Reattach the caps onto the oilers.

f-9. Examine the areas around the drain plugs, where the shaft enters the bearing caps, and where the bearing caps mate with the heads to ensure there are no oil leaks. If a leak is identified, determine the cause and rectify.

f-10. Initiate the unit following the instructions in Section 6-5.

f-11. While the unit is in operation, monitor the oil level, add oil as needed, and check for leaks.

CAUTION!

THE OIL LEVEL SHOULD BE AT THE TOP OF THE RED LINE (AND NO HIGHER) WHILE THE UNIT IS OPERATING. DO NOT UNDERFILL OR OVERFILL, AS EITHER CAN RESULT IN GREATLY REDUCED BEARING LIFE.

NOTE

THE OIL LEVEL IN THE SIGHT GLASS MAY BE ABOVE THE RED LINE WHEN THE UNIT IS SHUT DOWN.

7.7 GEAR LUBRICATION

Series: NL 6000G, NL 9000G

a. The gears in NL series gear pumps receive lubrication via splash from a reservoir situated at the bottom of the gear casing. Maintaining the appropriate oil level is crucial. Running the pump with insufficient oil level can lead to inadequate distribution and insufficient lubrication. Conversely, having a high oil level can result in churning, generating excessive heat and foaming, thereby reducing the oil's lifespan.

b. Follow these steps to ensure the correct oil level is maintained:

b-1. Before starting the pump, remove the cap from the sight glass oiler and ensure that the vent hole is clear.

b-2. Add oil as specified in Table 7-3 and Table 5-5.

NOTE

THE TEMPERATURE INDICATED IN TABLE 7-3 CORRESPONDS TO THE PUMP'S OPERATING TEMPERATURE OR THE AMBIENT TEMPERATURE, WHICHEVER IS HIGHER.

Temperature	19.4-86°F	70-114.8°F	100.4-140°F
AGMA Viscosity Grade	2	4	6

Table 7-3. AGMA Viscosity Grade for Pump Operating Temperature

b-3. Once the oil level reaches the top of the red line indicator, replace the sight glass cap and oil filler.

b-4. While operating the pump, monitor the sight glass oil level for a decrease. When the level drops, add oil to return it to the top of the red line. This oil level must be maintained while the pump is in operation.

c. Follow these steps to change the gear lubrication oil:

c-1. Remove the drain plugs (Index No. 22, Figure 9-8) from the gear casing (125) and allow all the oil to drain into a suitable container.

c-2. Reinstall the drain plugs.

c-3. Add new oil, chosen according to specifications in Table 7-3 and Table 5-5, using the filler located on the side of the gear casing.

c-4. Ensure the correct working oil level is achieved as outlined in steps 7-7 b-3 and b-4.

7.8 STUFFING BOX PACKING

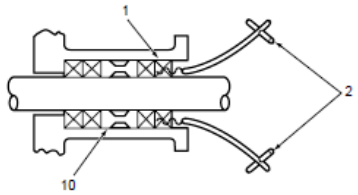
a. Establish a preventative maintenance schedule for tightening and replacing the packing in the pump's stuffing boxes. In pumps utilized in continuous process systems, the packing in stuffing boxes should be replaced during the annual shutdown. In severe process applications, more frequent replacement may be necessary, especially if the liquid compressant in the pump is contaminated by foreign material or is incompatible with the existing packing material. The packing material typically consists of 4 or 5 rings of graphite-impregnated synthetic fiber, with dimensions specified in Table 5-4. In certain cases, a different packing material may be required based on the liquid compressant used.

Note: When lantern rings are fitted, one less packing ring is required.

When replacing the packing in a stuffing box, follow these steps:

a-1. Move the slinger (Index No. 3 or 3-2, Figures 9-1 to 9-4) and slinger spring (3-1 or 3-4) away from the stuffing box on the shaft.

a-2. Loosen and remove the gland nuts (102-1, 103-1) from the studs.



1. Packing Ring
2. Packing Pullers
10. Lantern Gland (first stage only)

Figure 7.1 Removing Stuffing Box Packing

Figure 7.2 Stuffing Box Lantern Gland Puller

a-3. Move the packing gland assembly (112) as far away from the stuffing box as possible. Remove the two nuts, lockwashers, and screws holding the halves of the packing gland assembly together, then take out the two halves.

a-4. Insert the tips of packing pullers (2, Figure 7-1) into the packing (1).

a-5. Pull the packing out of the stuffing box.

a-6. When lantern rings are fitted, form two lantern gland pullers from 2 or 3mm diameter steel wire as shown in Figure 7-2.

a-7. Maneuver the bent tip of each lantern gland puller around the outer diameter of the lantern gland in the stuffing box until the pullers catch in the slots in the lantern gland on opposite sides.

a-8. Extract the lantern gland from the stuffing box.

a-9. Screw the tips of packing pullers (2, Figure 7-1) into the remaining packing in the stuffing box and pull the packing out.

a-10. Thoroughly clean stuffing box and check shaft for severe scoring and wear. Severe scoring will rapidly wear the packing and should be rectified by metal spraying or replacement of the shaft. Contact your NES Representative for assistance in determining the re-usability of the shaft.

a-11. Follow this procedure to install the new packing in the stuffing boxes:

Note

The packing has a shelf life of 1 year. Ensure the use of fresh packing only.

a-12. Create two hard rubber strips to fit between the outer diameter of the shaft (111) and the inner diameter of the stuffing box, as depicted in Figure 7-3 Part C. These strips will serve as packing ring pushers.

a-13. Apply lubrication to the inside diameter of the packing rings, using Molykote G-n paste or an equivalent.

a-14. Open the packing ring into a spiral by pulling the ends axially apart, as illustrated in Figure 7-3 Part A.

a-15. Guide each packing ring onto the shaft and into the stuffing box area, following the steps outlined in Figure 7-3 Part B.

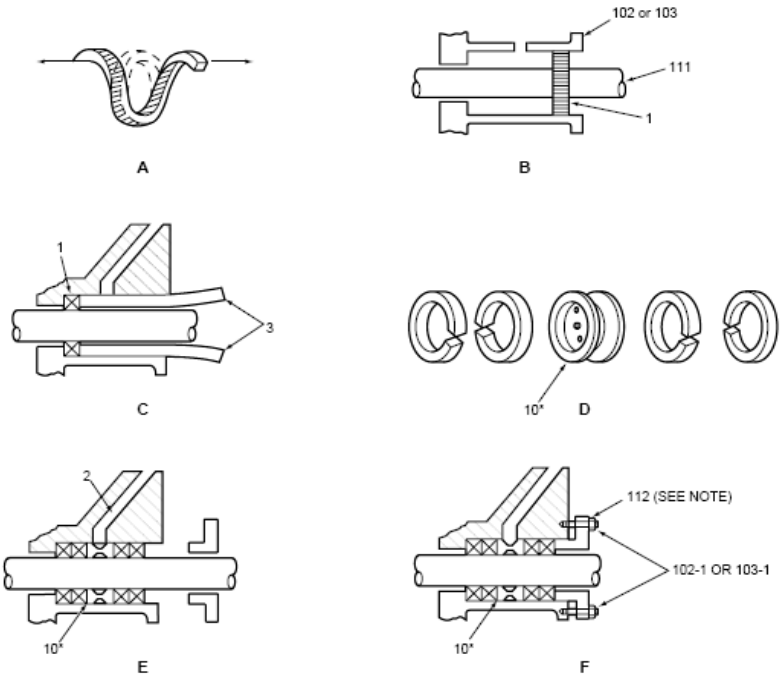
a-16 Using the pushers created in step a-12, firmly insert the initial packing ring into the stuffing box, ensuring it is properly seated against the end of the stuffing box, as depicted in Figure 7-3 Part C. Arrange the butted ends of each succeeding ring so that they are staggered by 180 degrees (refer to Figure 7-3 Part D). Verify that each packing ring is securely seated.

a-17. Place the lantern gland (10) back into its original position, as marked during removal (refer to Figure 7-3 Part E).

a-18. Install the remaining packing rings according to the instructions in step a-16.

a-19. Affix the two halves of the packing gland assembly onto the shaft and secure them with two screws, lockwashers, and nuts. Slide the packing gland assembly onto the gland studs until it is flush against the last packing ring installed. Install and evenly tighten the gland nuts (102-1 OR 103-1) by hand, following Figure 7-3 Part F.

a-20. Initiate the pump as per the instructions in Section 6.6 or 6.7. Monitor the temperature of the pump stuffing box area during pump operation. Ensure there is continuous leakage from the stuffing box. If no leakage occurs or if the stuffing box overheats, shut down the pump and identify the cause. Replace the packing if necessary.



1. Packing Ring
2. Lantern Gland Supply Connection
3. Packing Ring Pusher
10. Lantern Gland*
102. Floating Bearing End Head
102-1. Gland Nut
103. Fixed Bearing End Head
103-1. Gland Nut
111. Shaft
112. Packing Gland Assembly
*When used.

Figure 7.3 Packing Stuffing Boxes

Section 8 - STORAGE AND DISPOSAL

8.1 SHUTDOWN PERIODS

a. If the pump is inactive for 2 to 3 weeks, manually rotate the pump and recirculating pump (if applicable) at least once every week to prevent rust accumulation between cast iron parts, which could lead to seizing. If the pump needs to be taken out of service for more than 3 weeks up to one year, follow the steps below to prevent seizing during storage due to rust formation:

NOTE

THE PRESERVATION OIL USED WILL ONLY BE EFFECTIVE IN PREVENTING SEIZING UNDER GOOD STORAGE CONDITIONS. THE ONE-YEAR PERIOD MENTIONED ABOVE IS BASED ON INDOOR, COVERED, AND DRY CONDITIONS. FAILURE TO ADHERE TO THESE CONDITIONS MAY RESULT IN THE PRESERVATION LOSING ITS EFFECTIVENESS IN A FEW MONTHS.

b. The following preservation procedures are applicable to all pumps with cast iron parts only, maintained as indicated in the note above.

b-1. Remove pipe plugs (22, 22-1 or 22-2) from pump body (101) and heads (102,103) and drain all liquid from pump. Replace pipe plugs.

b-2. Disconnect the discharge piping and seal off the pump discharge flange.

b-3. Fill the first stage of the pump to approximately one-quarter capacity with water-soluble preserving oil, such as Houghton Rust Veto MP or an equivalent, through the inlet flange.

b-4. Start the pump and rotate it for 5 to 15 seconds, then shut it down. Repeat this process by starting the pump again, rotating for 5 to 15 seconds, and shutting down.

b-5. Drain all preserving oil from the pump by removing the specified pipe plugs. After draining, replace the pipe plugs using pipe thread compound.

b-6. Remove all packing following the instructions in Section 7-6 and flush the stuffing boxes with a rust inhibitor. Do not repack the stuffing boxes, and make a note of the lantern rings' positions for future reassembly.

b-7. Touch up any areas where paint has chipped, applying Houghton's Rust Veto #344 coating compound or an equivalent to external surfaces as necessary.

b-8. Seal off the pump inlet.

NOTE

FOR EXTENDED PRESERVATION PROCEDURES DURING STORAGE PERIODS SURPASSING ONE YEAR, SEEK GUIDANCE FROM YOUR NES ENGINEER.

b-9. When preparing to return the pump to service, adhere to the following steps:

a. Remove the seals from the pump inlet and discharge flanges and reconnect the piping.

b. Replace the packing in the stuffing boxes with new packing as directed in Section 7.8.

d. Flush the pump following the specifications in Section 6.4. After the preservation oil has been thoroughly flushed from the pump, rotate the pump and, if applicable, the recirculating pump at weekly intervals until the pump is seamlessly reintegrated into continuous service.

8.2 DISPOSAL OF WASTE

a. The diluted preservation oil generated after flushing is not considered a pollutant when effective waste disposal methods are employed. However, it is crucial to keep this material out of sewers and streams.

b. Comply with regulations for the disposal of waste petroleum oil. Implement a de-emulsification process to separate the product. Consider the oily layer as waste oil, and neutralize the aqueous layer for release into the treatment plant, following appropriate regulations.

c. Dispose of waste products under regular operating conditions based on the type of compressant used. Always adhere to health and safety requirements.

WARNING!

ADHERE TO NATIONAL AND LOCAL REGULATIONS IN EFFECT AT ALL TIMES.

Section 9 - SPARES AND ACCESSORIES

9.1 EXPLODED VIEWS AND LEGENDS

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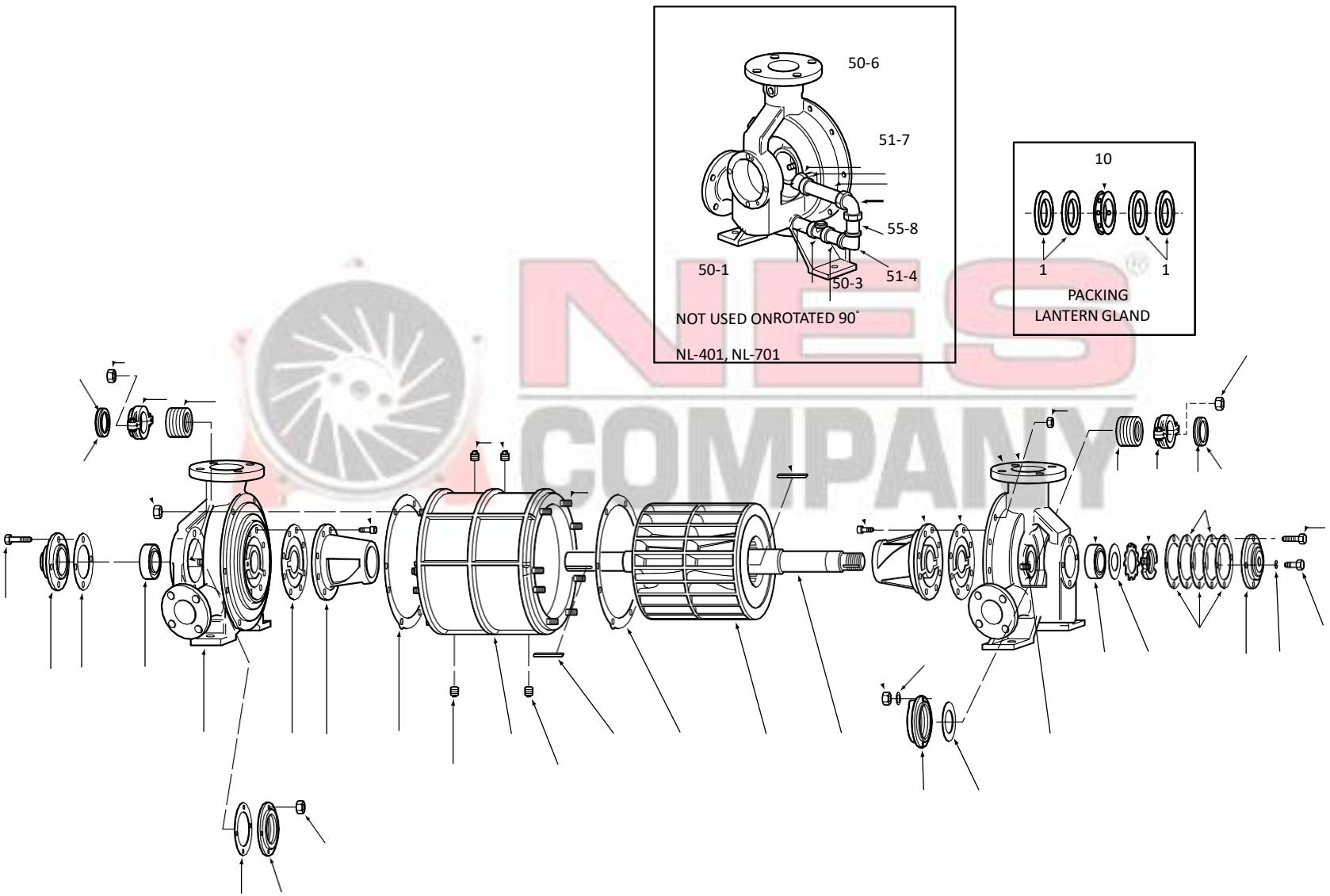
Fig. 9.1 Exploded View of NES NL 400 & 700 Vacuum Pumps

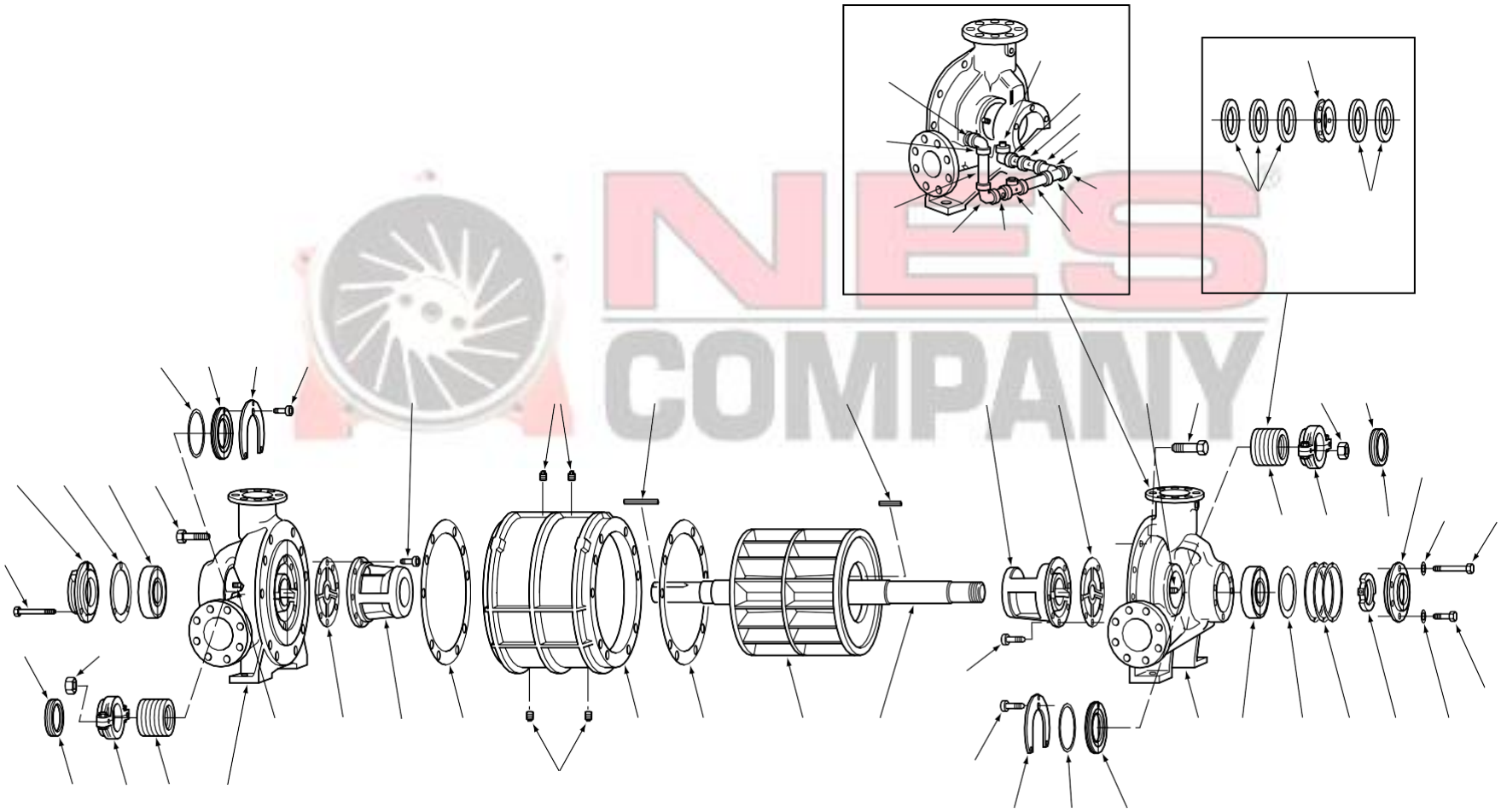


Legend for Figure 9.1

Index No.	Qty.	Part Name	Index No.	Qty.	Part Name
*1	10 rings	Packing	105	1	Fixed Bearing End Cone
*3	2	Slinger	105-1	8	Fixed Bearing End Cone Screw
*3-1	2	Slinger Spring	*105-3	1	Fixed Bearing End Cone Gasket
*4	AR	Shim	110	1	Rotor
*4-3	AR	Shim Gasket	*110-1	1	Rotor Key
+10	2	Lantern Gland			(For Bronze and Stainless Steel Rotors Only)
22-1	2	Pipe Plug (Drain)	111	1	Shaft
22-2	2	Pipe Plug	111-1	1	Shaft Extension Key
++50-1	2	Pipe Nipple	112	2	Packing Gland Assembly
++50-3	2	Pipe Nipple	115	1	Floating Bearing Outer Cap
++50-6	2	Pipe Nipple	115-1	4	Floating Bearing Cap Nut
++51-4	2	90-Degree Pipe Elbow	115-2	4	Floating Bearing Outer Cap Screw
++51-7	2	90-Degree Pipe Elbow	*115-3	1	Floating Bearing Outer Cap Gasket
++53-9	2	90-Degree Dresser Elbow	116	1	Floating Bearing Inner Cap
++55-5	2	Pipe Nipple	*116-3	1	Floating Bearing Inner Cap Gasket
++55-8	2	Pipe Nipple	117	1	Fixed Bearing Outer Cap
++57-2	2	Check Valve	117-1	4	Fixed Bearing Cap Nut
101	1	Body	117-2	4	Fixed Bearing Cap Lockwasher
101-1	16	Body Nut	117-4	4	Fixed Bearing Outer Cap Screw
101-2	16	Body Stud	117-5	3	Fixed Bearing Outer Cap Screw
*101-3	10	Body Gasket	117-6	3	Fixed Bearing Outer Cap Lockwasher
102	1	Floating Bearing End Head	118	1	Fixed Bearing Inner Cap
102-1	2	Floating Bearing End Gland Nut	*119	1	Floating Ball Bearing
102-2	2	Floating Bearing End Gland Stud	*120	1	Fixed Ball Bearing
103	1	Fixed Bearing End Head	120-1	1	Fixed Bearing Locknut
103-1	2	Fixed Bearing End Gland Nut	120-2	1	Fixed Bearing Lockwasher
103-2	2	Fixed Bearing End Gland Stud	*120-3	2	Fixed Bearing Gasket
104	1	Floating Bearing End Cone			
104-1	8	Floating Bearing End Cone Screw			
*104-3	1	Floating Bearing End Cone Gasket			

*Minimum recommended spares.
+When used
++Used on NL 402, NL 403, NL 702 and NL 703 only.AR - As required.

Fig. 9.2 Exploded View of NES NL 1000 Vacuum Pumps.

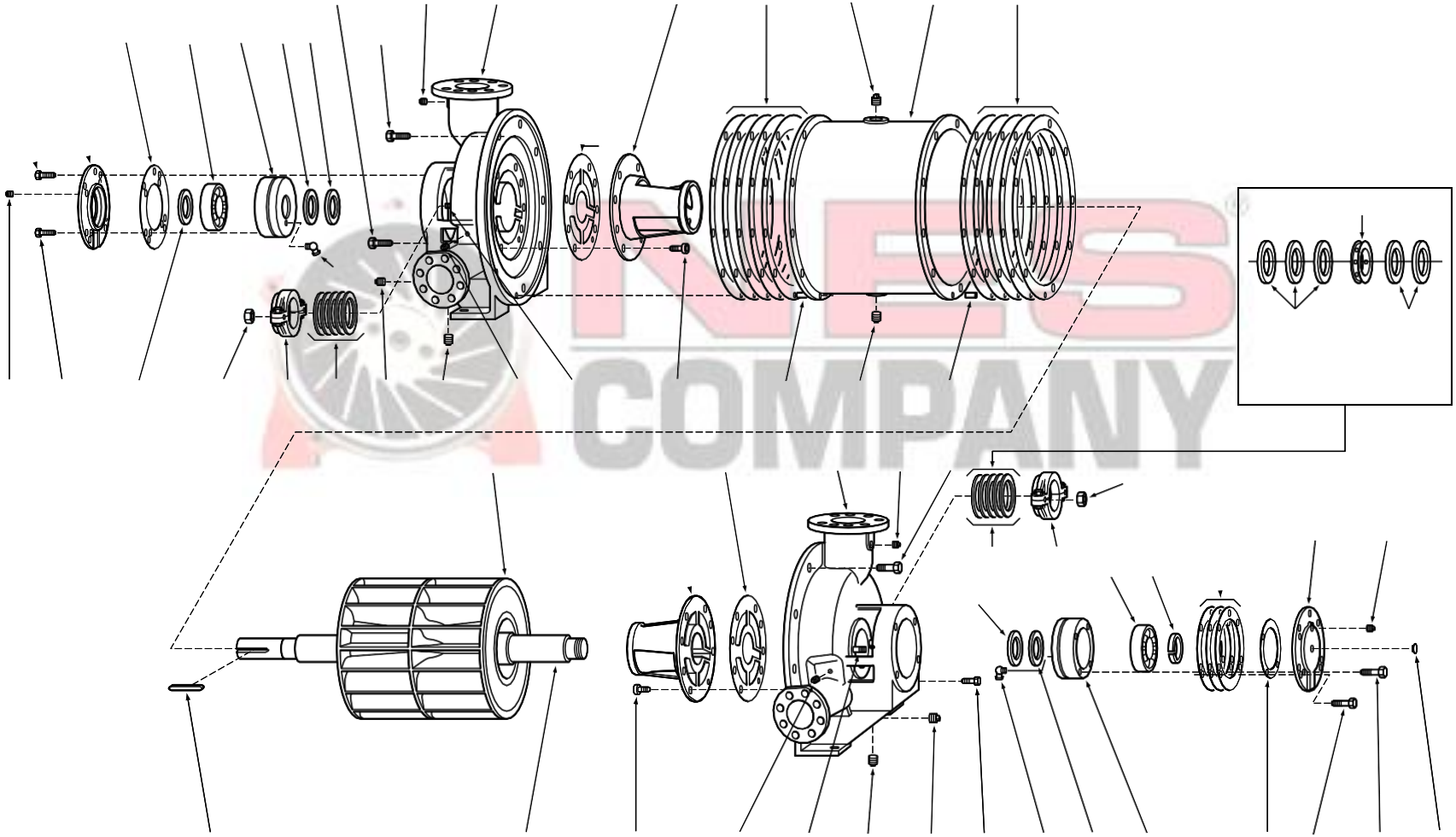


Legend for Figure 9.2

Index No.	Qty.	Part Name	Index No.	Qty.	Part Name
*1	12 rings	Packing	*104-3	1	Floating Bearing End Cone Gasket
*3	2	Slinger	105	1	Fixed Bearing End Cone
*3-1	2	Slinger Spring	105-1	8	Fixed Bearing End Cone Screw
*4	AR	Shim	*105-3	1	Fixed Bearing End Cone Gasket
+10	2	Lantern Gland	110	1	Rotor
22-1	2	Pipe Plug (Drain)	+110-1	1	Rotor Key
22-2	2	Pipe Plug			(For Bronze and Stainless Steel Rotors Only)
++22-14	2	Pipe Plug	111	1	Shaft
++50-1	2	Pipe Nipple	111-1	1	Shaft Extension Key
++50-3	2	Pipe Nipple	112	2	Packing Gland Assembly
++50-5	2	Pipe Nipple	115	1	Floating Bearing Outer Cap
++50-7	2	Pipe Nipple	115-1	3	Floating Bearing Outer Cap Screw
++50-9	2	Pipe Nipple	*115-3	1	Floating Bearing Outer Cap Gasket
++51-2	2	90-Degree Pipe Elbow	116	1	Floating Bearing Inner Cap
++51-10	2	90-Degree Pipe Elbow	116-1	1	Floating Bearing Inner Cap Screw
++53-13	2	90-Degree Dresser Elbow	116-2	1	Floating Bearing Inner Cap NLamp
++54-6	2	Pipe Tee	*116-4	1	Floating Bearing Inner Cap O-Ring
++55-11	2	Pipe Nipple	117	1	Fixed Bearing Outer Cap
++55-12	2	Pipe Nipple	117-1	3	Fixed Bearing Outer Cap Screw
++57-8	2	Check Valve	117-2	3	Fixed Bearing Outer Cap Lockwasher
++59-4	2	45-Degree Pipe Elbow	117-4	3	Fixed Bearing Outer Cap Screw
101	1	Body	117-5	3	Fixed Bearing Outer Cap Lockwasher
*101-3	8	Body Gasket	118	1	Fixed Bearing Inner Cap
102	1	Floating Bearing End Head	118-1	1	Fixed Bearing Inner Cap Screw
102-1	10	Floating Bearing End Head Screw	118-2	1	Fixed Bearing Inner Cap Clamp
102-2	2	Floating Bearing End Gland Nut	*118-4	1	Fixed Bearing Inner Cap O-Ring
102-4	2	Floating Bearing End Gland Stud	*119	1	Floating Ball Bearing
103	1	Fixed Bearing End Head	*120	1	Fixed Ball Bearing
103-1	10	Fixed Bearing End Head Screw	120-1	1	Fixed Bearing Locknut
103-2	2	Fixed Bearing End Gland Nut	*120-3	1	Fixed Bearing Gasket
103-4	2	Fixed Bearing End Gland Stud			
104	1	Floating Bearing End Cone			
104-1	8	Floating Bearing End Cone Screw			

*Minimum recommended spares.
+When used
++Used on NL 1002, and NL 1003 only.
AR - As required.

Fig. 9.3 Exploded View of NES NL 1400 & NL 1500 Vacuum Pumps

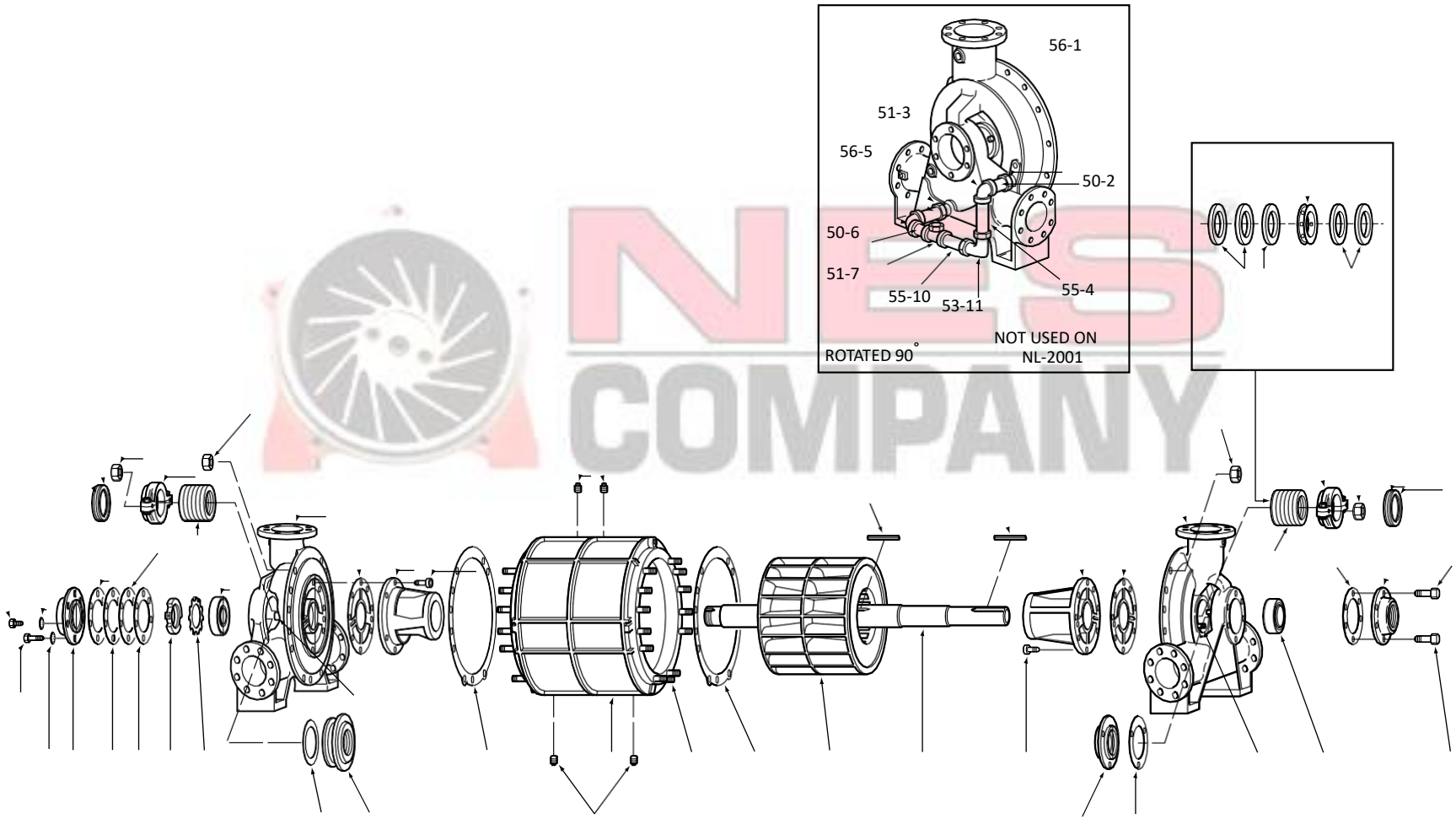


Legend for Figure 9.3

Index No.	Qty.	Part Name	Index No.	Qty.	Part Name
*1	12 Rings	Packing (10 Rings on NL 1500)	103-5	1	Screw
*3	2	Slinger	103-6	1	Groove Pin
*4	AR	Shim	104	1	Floating Bearing End Cone
*5	2	Lip Seal - Inner	104-1	8	Cone Screw
*5-1	1	Lip Seal - Outer	*104-3	1	Cone Gasket
+10	2	Lantern Gland	105	1	Fixed Bearing End Cone
22	4	Plug (Qty 3 NL 1500)	105-1	8	Cone Screw
22-1	2	Plug	*105-3	1	Cone Gasket
22-2	2	Plug	110	1	Rotor
22-3	2	Plug (Qty 1 NL 1500)	111	1	Shaft
22-4	2	Plug	111-1	1	Shaft Key
22-5	2	Plug	112	2	Gland Assembly
23	2	Grease Fitting	115	1	Floating Bearing Outer Cap
101	1	Body	115-1	4	Screw
*101-3	15	Body Gasket	115-2	4	Screw
102	1	Floating Bearing End Head	*115-3	1	Cap Gasket
102-1	2	Gland Nut	117	1	Fixed Bearing Outer Cap
102-2	2	Gland Stud	117-1	4	Screw
102-4	8	Screw	117-2	4	Screw
102-5	1	Screw (Not Shown)	*117-3	1	Cap Gasket
102-6	1	Groove Pin	117-4	1	Cap Nameplate
103	1	Fixed Bearing End Head	*119	1	Floating Bearing
103-1	2	Gland Nut	*120	1	Fixed Bearing
103-2	2	Gland Stud	*120-1	1	Bearing Locknut
103-4	8	Screw	121	2	Bearing Cartridge

*Minimum recommended spares.
+When used
AR - As required.

Fig. 9.4 Exploded View of NES NL 2000 Vacuum Pumps.

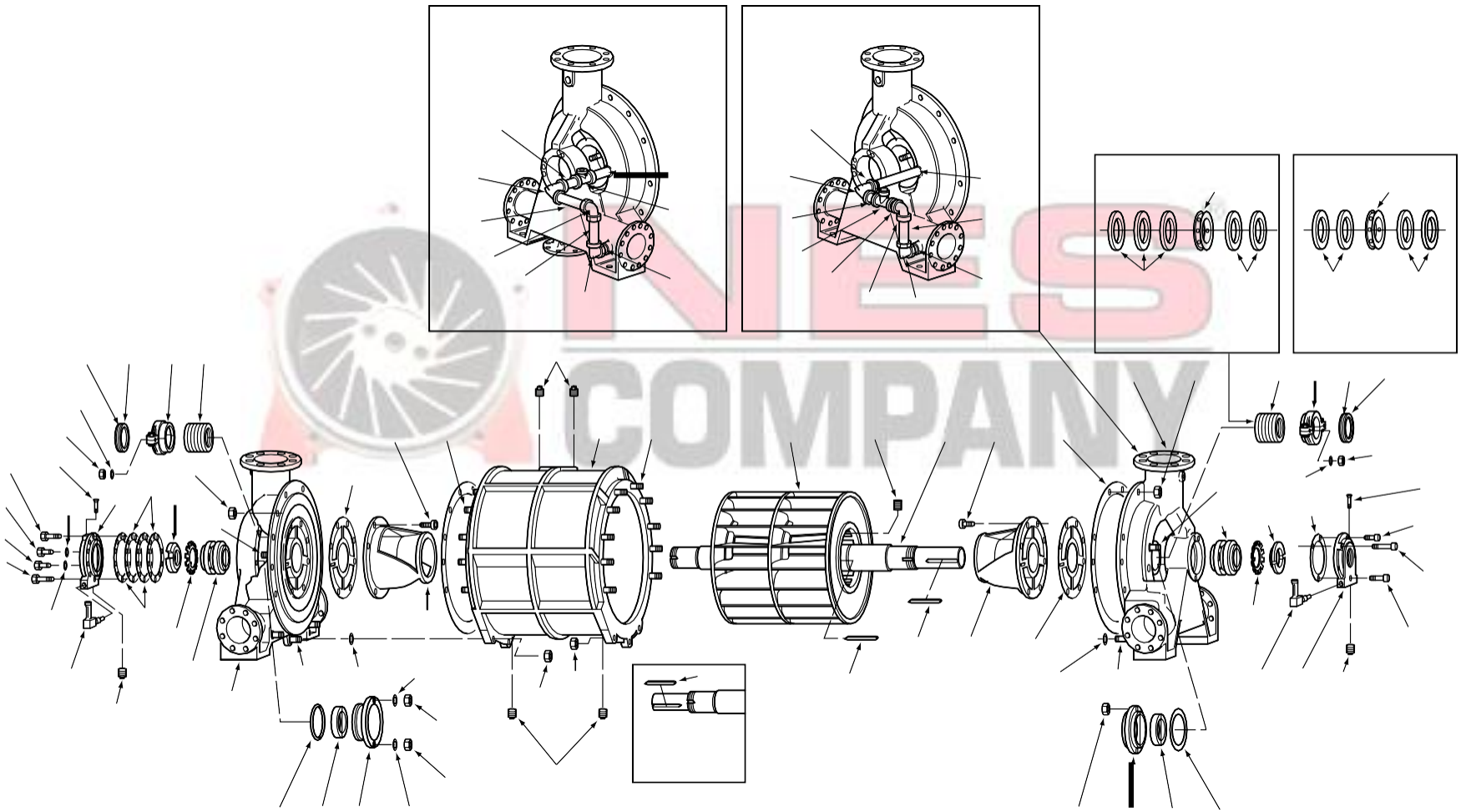


Legend for Figure 9.4

Index No.	Qty.	Part Name	Index No.	Qty.	Part Name
*1	12 Rings	Packing	104	1	Floating Bearing End Cone
*3	2	Slinger	104-1	8	Floating Bearing End Cone Screw
*3-1	2	Slinger Spring	*104-3	1	Floating Bearing End Cone Gasket
*4	AR	Shim	105	1	Fixed Bearing End Cone
*4-3	AR	Shim Gasket	105-1	8	Fixed Bearing End Cone Screw
+10	2	Lantern Gland	*105-3	1	Fixed Bearing End Cone Gasket
22-1	2	Plug	110	1	Rotor
22-2	2	Plug (Drain)	+110-1	1	Rotor Key
++50-2	2	Pipe Nipple			(For Bronze and Stainless Steel Rotors Only)
++50-6	2	Pipe Nipple	111	1	Shaft
++50-8	2	Pipe Nipple	111-1	1	Shaft Extension Key
++51-3	2	90-Degree Pipe Elbow	112	2	Packing Gland Assembly
++51-7	2	90-Degree Pipe Elbow	115	1	Floating Bearing Outer Cap
++53-11	2	90-Degree Dresser Elbow	115-1	3	Floating Bearing Outer Cap Screw
++55-4	2	Pipe Nipple	115-2	3	Floating Bearing Outer Cap Screw
++55-10	2	Pipe Nipple	*115-3	1	Floating Bearing Outer Cap Gasket
++56-1	2	Reducing Bushing	116	1	Floating Bearing Inner Cap
++56-5	2	Reducing Bushing	*116-3	1	Floating Bearing Inner Cap Gasket
++57-9	2	Check Valve	117	1	Fixed Bearing Outer Cap
101	1	Body	117-1	3	Fixed Bearing Outer Cap Screw
101-1	26	Body Nut	117-2	3	Fixed Bearing Outer Cap Lockwasher
101-2	26	Body Stud	*117-3	1	Fixed Bearing Outer Cap Gasket
*101-3	8	Body Gasket	117-4	3	Fixed Bearing Outer Cap Screw
102	1	Floating Bearing End Head	117-5	3	Fixed Bearing Outer Cap Lockwasher
102-1	2	Floating Bearing End Gland Nut	118	1	Fixed Bearing Inner Cap
102-2	2	Floating Bearing End Gland Stud	*118-1	1	Fixed Bearing Inner Cap O-Ring
103	1	Fixed Bearing End Head	*119	1	Floating Roller Bearing
103-1	2	Fixed Bearing End Gland Nut	*120	1	Fixed Roller Bearing
103-2	2	Fixed Bearing End Gland Stud	*120-1	1	Fixed Bearing Locknut
			*120-2	1	Fixed Bearing Lockwasher

*Minimum recommended spares.
+When used
++Used on NL 2002, and NL 2003 only.
AR - As required.

Fig. 9.5 Exploded View of NES NL 3000 & NL 4000 Vacuum Pumps.

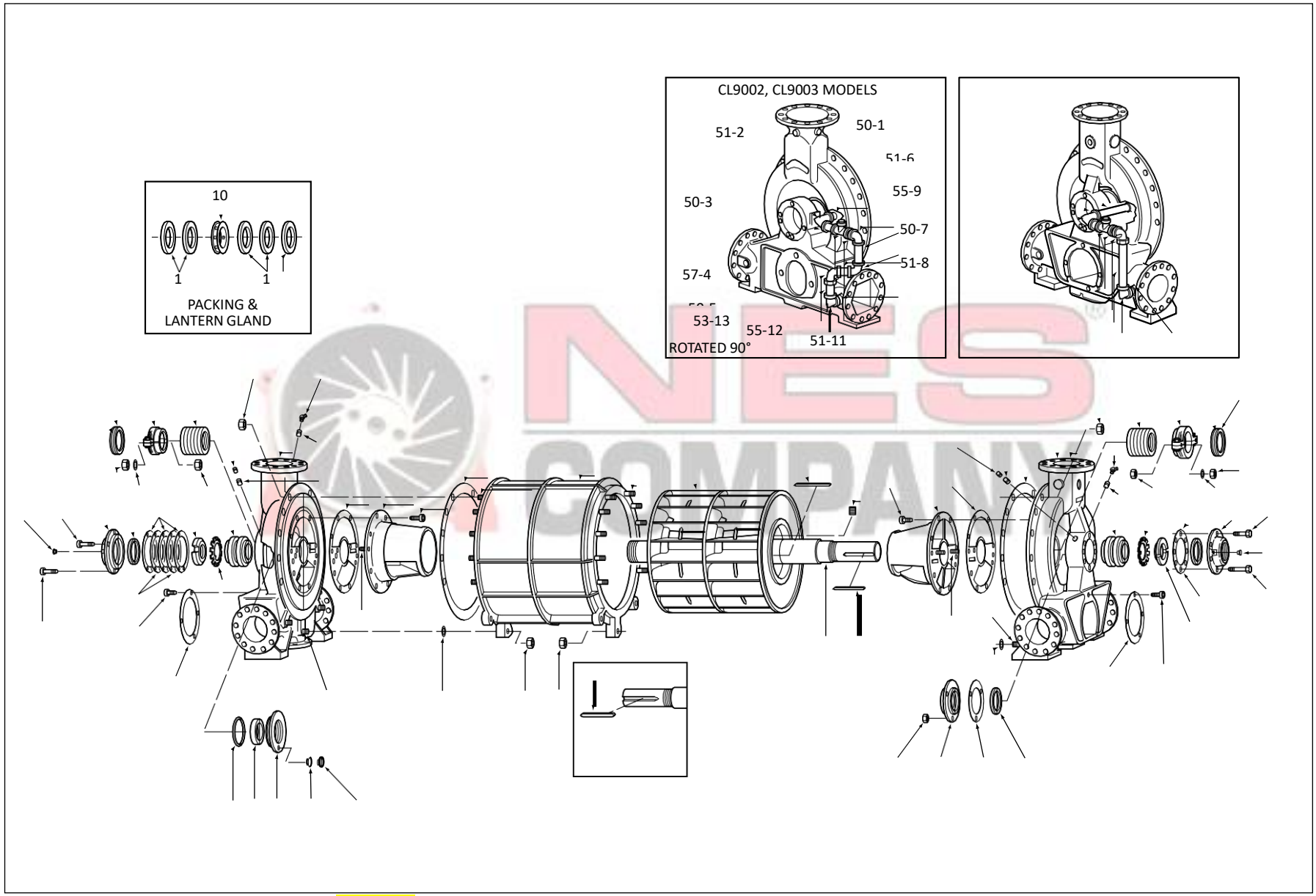


Legend for Figure 9.5

Index No.	Qty.**	Part Name	Index No.	Qty.	Part Name	Index No.	Qty.	Part Name
*1	12,10 rings	Packing	104	1	Floating Bearing End Cone	117-7	1	Fixed Bearing Outer Cap Screw
*3	2	Slinger Slinger	104-1	8	Floating Bearing End Cone Screw	117-8	2	Fixed Bearing Outer Cap Screw
*3-1	2	SpringShim	*104-3	1	Floating Bearing End Cone Gasket	117-9	2	Fixed Bearing Outer Cap Lockwasher
*4	AR	Shim Lip	105	1	Fixed Bearing End Cone	117-10	1	Fixed Bearing Outer Cap Screw
*4-3	AR	Seal	105-1	8	Fixed Bearing End Cone Screw	117-11	1	Fixed Bearing Outer Cap Lockwasher
5	2	Oiler	*105-3	1	Fixed Bearing End Cone Gasket	118	1	Fixed Bearing Inner Cap
8	2	Lantern Gland	110	1	Rotor	*118-1	1	Fixed Bearing Inner Cap O-Ring
+10	2	Plug	+110-1	1	Rotor Key (Bronze Only)	*119	1	Floating Bearing
22-1	2	Plug (Drain)	+110-2	2	Rotor Set Screw	119-1	1	Floating Bearing Locknut
22-2	2	Plug (Oil Drain)	111-1	1	Shaft Key	119-2	1	Floating Bearing Locknut Lockwasher
22-3	2	Breather	+111-2	1	Shaft Key Fixed Bearing End (Double Extended Only)	*120	1	Fixed Bearing
24	2	Body	112	2	Gland Assembly	120-1	1	Fixed Bearing Locknut
101	1	Body Stud Nut	115	1	Floating Bearing Outer Cap	120-2	1	Fixed Bearing Locknut Lockwasher
101-1	20	Body Stud	115-1	4	Floating Bearing Outer Cap Nut	++50-1	2	Pipe Nipple
101-2	20	Body Gasket	115-2	3	Floating Bearing Outer Cap Screw	++50-2	2	Pipe Nipple
*101-3	13, 11	Floating Bearing End Head	*115-3	1	Floating Bearing Outer Cap Gasket	++50-3	2	Pipe Nipple
102	1	Floating Bearing End Stud Nut	115-4	3	Floating Bearing Outer Cap Screw	++50-4	2	Pipe Nipple
102-1	3	Floating Bearing End Stud	115-5	1	Floating Bearing Outer Cap Screw	++50-6	2	Pipe Nipple
102-2	3	Floating Bearing End Stud Gasket	116	1	Floating Bearing Inner Cap	++51-3	2	Pipe Elbow
*102-3	19, 16	Floating Bearing End Gland Stud Nut	*116-3	1	Floating Bearing Inner Cap Gasket	++51-4	2	Pipe Elbow
102-4	2	Floating Bearing End Gland Stud Washer	117	1	Fixed Bearing Outer Cap	++51-7	2	Pipe Elbow
102-5	2	Floating Bearing End Gland Stud	117-1	3	Fixed Bearing Outer Cap Nut	++52-5	2	Street Elbow
102-6	2	Fixed Bearing End Head	117-2	3	Fixed Bearing Outer Cap Lockwasher	++53-9	2	Dresser Elbow
103	1	Fixed Bearing End Stud Nut	117-4	3	Fixed Bearing Outer Cap Screw	++53-10	2	Dresser Elbow
103-1	3	Fixed Bearing End Stud	117-5	1	Fixed Bearing Outer Cap Nut	++55-5	2	Pipe Nipple - Threaded one end.
103-2	3	Fixed Bearing End Stud Gasket	117-6	1	Fixed Bearing Outer Cap Lockwasher	++55-8	2	Pipe Nipple - Threaded one end.
*103-3	20, 17	Fixed Bearing End Gland Stud Nut				++55-9	2	Pipe Nipple - Threaded one end.
103-4	2	Fixed Bearing End Gland Stud Washer				++57-1	2	Check Valve
103-5	2	Fixed Bearing End Gland Stud				++57-2	2	Check Valve
103-6	2					++58-7	2	Pipe Union

*Minimum recommended spares.
**First quantity applies to NL 3000 Series, second quantity applies to NL 4000 Series.
+When used
++Used on NL 3002 and NL 3003 or NL 4002 and NL 4003 only as applicable.

Fig. 9.6 Exploded View of NES NL 6000 & NL 9000 Vacuum Pumps.

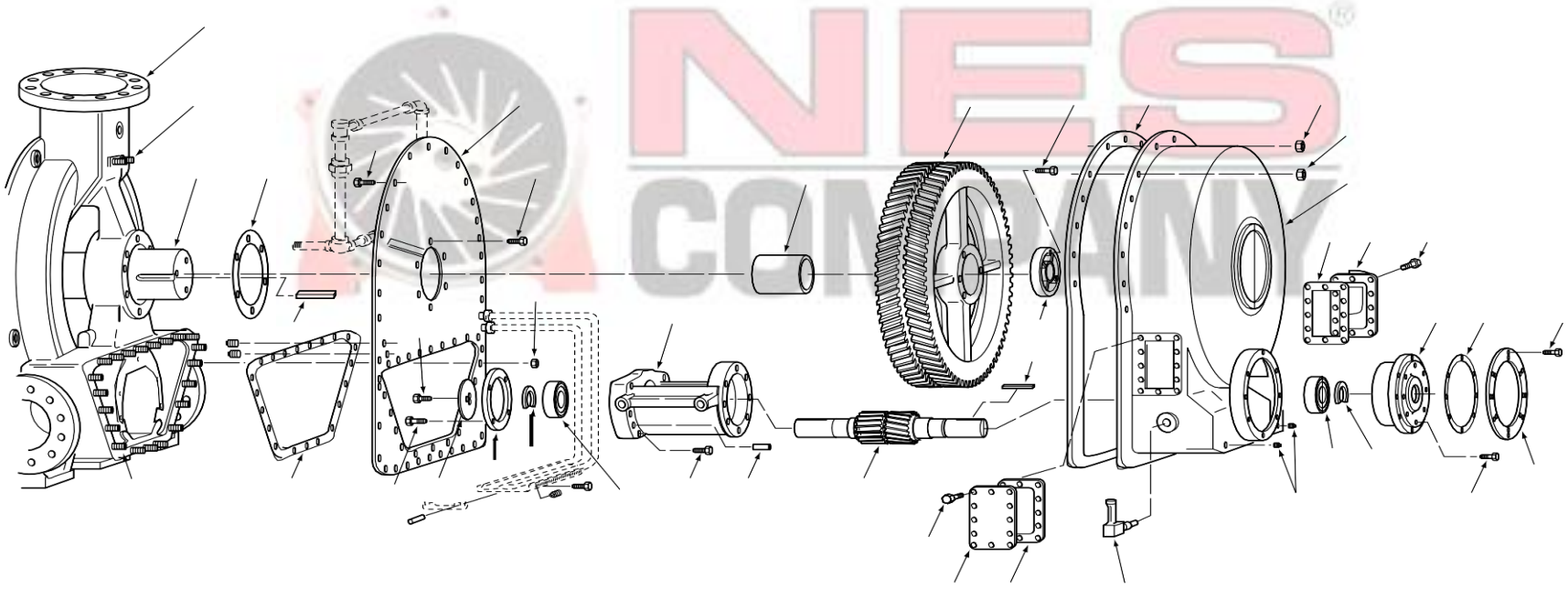


Legend for Figure 9.6

Index No.	Qty.**	Part Name	Index No.	Qty.**	Part Name	Index No.	Qty.	Part Name
*1	12 rings	Packing	104-6	12,16	Floating Bearing End Cone Screw	117-4	2	Fixed Bearing Outer Cap Washer (NL 9000 Series Only)
*3	2	Slinger						
*3-1	2	Slinger Spring	105	1	Fixed Bearing End Cone			
*4	AR	Shim	105-1	2	Fixed Bearing End Gland Stud Nut	117-5	3	Fixed Bearing Outer Cap Screw
*4-3	AR	Shim						
*5	2	Lip Seal	105-2	2	Fixed Bearing End Gland Stud Washer	117-6	1	Fixed Bearing Outer Cap Screw (NL 9000 Series Only)
*5-1	1	Outer Lip Seal (Qty 2 on Double Extended Shaft)	*105-3	1	Fixed Bearing End Cone Gasket	117-7	3	Fixed Bearing Outer Cap Screw
+10	2	Lantern Gland						
22-1	2	Plug	105-4	2	Fixed Bearing End Gland Stud Nut	117-8	3	Fixed Bearing Outer Cap Lockwasher
22-2	2	Plug (Drain)						
23	2	Grease Fitting	105-5	2	Fixed Bearing End Cone Gland Stud	118	1	Fixed Bearing Inner Cap
23-1	2	Reducing Bush						
101	1	Body	105-6	12,16	Fixed Bearing End Cone Screw	*118-1	1	Fixed Bearing Inner Cap O-Ring
101-1	20,28	Body Stud Nut						
101-2	20,28	Body Stud	110	1	Rotor	*119	1	Floating Bearing
*101-3	8	Body Gasket	+110-1	1	Rotor Key (Bronze Only)	119-1	1	Floating Bearing Locknut
102	1	Floating Bearing End Head	+110-2	2	Rotor Set Screw	119-2	1	Floating Bearing Locknut Lockwasher
102-1	3	Floating Bearing End Stud Nut	111	1	Shaft			
			111-1	1	Shaft Key	*120	1	Fixed Bearing
102-2	3	Floating Bearing End Stud	+111-2	1	Shaft Key Fixed Bearing End (Double Extended Only)	120-1	1	Fixed Bearing Locknut
*102-3	12	Floating Bearing End Stud Gasket	112	2	Gland Assembly	120-2	1	Fixed Bearing Locknut Lockwasher
102-4	1	Floating Bearing End Head Cover Plate	115	1	Floating Bearing Outer Cap	++50-1	2	Pipe Nipple
			115-1	2	Floating Bearing Outer Cap Nut	++50-3	2	Pipe Nipple
102-5	4	Head Cover Plate Screw				++50-5	2	Pipe Nipple
103	1	Fixed Bearing End Head	115-2	2	Floating Bearing Outer Cap Screw	++50-6	2	Pipe Nipple
103-1	3	Fixed Bearing End Stud Nut				++50-7	2	Pipe Nipple
103-2	3	Fixed Bearing End Stud	*115-3	1	Floating Bearing Outer Cap Gasket	++50-10	2	Pipe Elbow
*103-3	12	Fixed Bearing End Stud Gasket	115-4	3	Floating Bearing Outer Cap Nut	++51-2	2	Pipe Elbow
						++51-6	2	Pipe Elbow
103-4	1	Fixed Bearing End Cover				++51-7	2	Pipe Elbow
103-5	4	Plate	115-5	1	Floating Bearing Outer Cap Screw	++51-8	2	Pipe Elbow
104	1	Head Cover Plate Screw				++51-11	2	Pipe Elbow
104-1	2	Floating Bearing End Cone	115-6	3	Floating Bearing Outer Cap Screw	++53-9	2	Dresser Elbow
						++53-13	2	Dresser Elbow
104-2	2	Floating Bearing End Gland Stud Nut	116	1	Floating Bearing Inner Cap	++55-5	2	Pipe Nipple - Threaded one end.
*104-3	1	Floating Bearing End Gland Stud Washer	*116-3	1	Floating Bearing Inner Cap Gasket	++55-8	2	Pipe Nipple - Threaded one end.
104-4	2	Floating Bearing End Cone Gasket	117	1	Fixed Bearing Outer Cap			
			117-1	4	Fixed Bearing Outer Cap Nut	++55-9	2	Pipe Nipple - Threaded one end.
104-5	2	Floating Bearing End Gland Stud Nut	117-2	4	Fixed Bearing Outer Cap Lockwasher	++55-12	2	Pipe Nipple - Threaded one end.
		Floating Bearing End Cone Gland Stud				++57-4	2	Check Valve

*Minimum recommended spares.
**First quantity applies to NL 6000 Series, second quantity applies to NL 9000 Series.
+When used
++Used on NL 6002 and NL 6003 or NL 9002 and NL 9003 only as applicable.
AR - As required.

Fig. 9.7 Exploded View of NES NL 6000G & NL 9000G Vacuum Pumps.

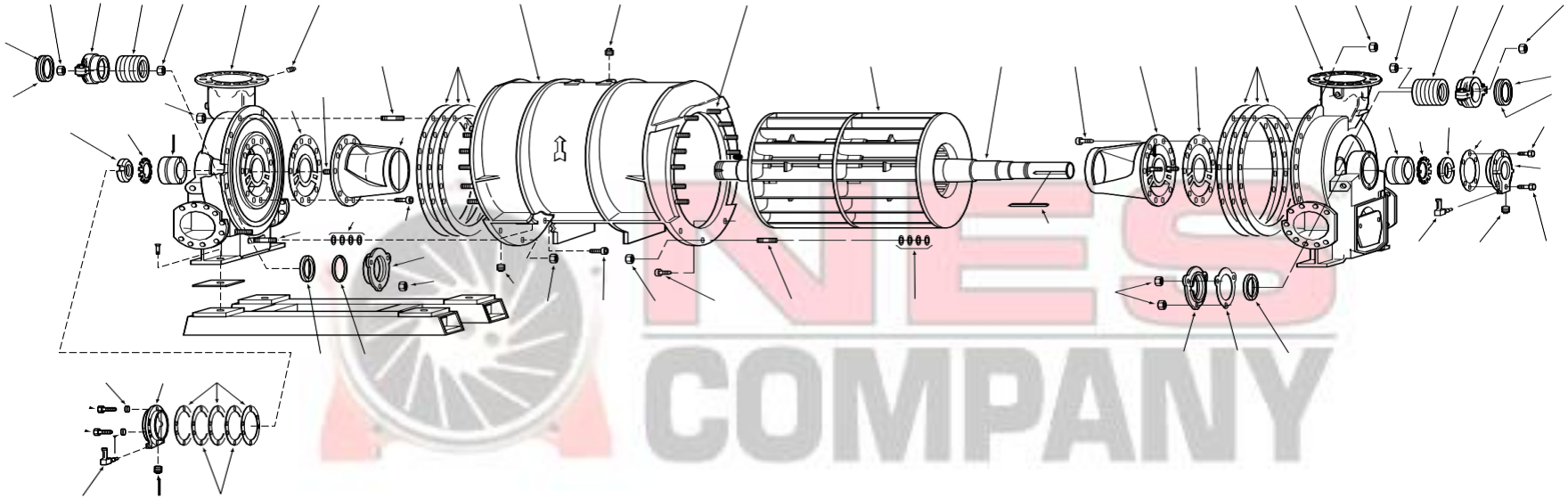


Legend for Figure 9.7

Index No.	Qty.	Part Name	Index No.	Qty.	Part Name
8	1	Oiler	128-1	3	Bearing Cover Bolt
9	1	Shaft Sleeve	128-2	4	Bearing Cover Bolt
22	2	Drain Plug	129	1	Gear Casing Plate
24	1	Filler-Strainer-Breather Cap	129-1	8	Gear Casing Plate Nut
102	1	Head	129-2	16	Gear Casing Plate Bolt
102-6	1	Head Gasket	129-3	1	Gasket Head
102-7	22	Head Stud	129-4	6	Gear Casing Plate Bolt
102-8	22	Head Stud Nut	130	1	Bearing Cap Plate
102-9	2	Head Stud	130-1	8	Bearing Cap Plate Bolt
102-10	8	Gear Casing Nut	145	1	Pinion Bearing Cap
111	1	Shaft	145-1	8	Pinion Bearing Cap Bolt
123	1	Gear	*145-3	1	Bearing Cap Gasket
123-1	1	Shaft Key	146	1	Gear Retaining Plate
124	1	Pinion	146-1	3	Retaining Plate Bolt
124-1	1	Pinion Key	147	1	Inspection Cover
125	1	Gear Casing	147-1	12	Inspection Cover Bolt
*125-3	1	Gear Casing Gasket	147-3	1	Inspection Cover Gasket
126	1	Pinion Bracket	148	1	Oil Spinner
126-1	8	Pinion Bracket Bolt	152	1	Inspection Cover/Filler Assembly
126-3	1	Pinion Bracket Pin	152-1	12	Inspection Cover/Filler Assembly Bolt
*127	2	Pinion Bearing	152-3	1	Inspection Cover/Filter Assembly Gasket
*127-1	2	Bearing Retaining Ring			
128	1	Bearing Cover			

*Minimum recommended spares.

Fig. 9.8 Exploded View of NES NL 14000 Vacuum Pumps.



Legend for Figure 9.8

Index No.	Qty.	Part Name	Index No.	Qty.	Part Name
*1	12 rings	Packing	105-1	14	Fixed Bearing End Cone Screw
*3	2	Slinger	105-2	2	Fixed Bearing End Cone Stud
*3-1	2	Slinger Spring	*105-3	1	Fixed Bearing End Cone Gasket
*4	AR	Shims	105-4	2	Fixed Bearing End Cone Jamnut
*4-1	AR	Shims	110	1	Rotor
*5	2	Lip Seal	111	1	Shaft
8	2	Oiler	111-1	1	Shaft Key
22	2	Drain Plug	112	2	Packing Gland Assembly
22-1	2	Pipe Plug	112-1	4	Packing Gland Nut
22-3	2	Oil Drain Plug	115	1	Outer Floating Bearing Cap
22-4	2	Plug	115-1	2	Outer Floating Bearing Cap Screw
101	1	Body	115-2	3	Outer Floating Bearing Cap Nut
101-1	24	Body Nut	*115-3	1	Outer Floating Bearing Cap Gasket
101-2	24	Body Stud	115-4	1	Outer Floating Bearing Cap Screw
*101-3	20	Body Gasket	116	1	Inner Floating Bearing Cap
102	1	Floating Bearing End Head	*116-3	1	Inner Floating Bearing Cap Gasket
102-1	1	Floating Bearing End Head Nut	117	1	Outer Fixed Bearing Cap
102-2	1	Floating Bearing End Head Stud	117-1	3	Outer Fixed Bearing Cap Screw
102-3	30	Floating Bearing End Head Gasket	117-2	3	Outer Fixed Bearing Cap Washer
102-4	2	Floating Bearing End Head Screw	*117-3	1	Outer Fixed Bearing Cap Gasket
103	1	Fixed Bearing End Head	117-4	3	Outer Fixed Bearing Cap Nut
103-1	1	Fixed Bearing End Head Nut	117-5	3	Outer Fixed Bearing Cap Screw
103-2	1	Fixed Bearing End Head Stud	117-6	3	Outer Fixed Bearing Cap Washer
103-3	30	Fixed Bearing End Head Gasket	118	1	Inner Fixed Bearing Cap
103-4	2	Fixed Bearing End Head Screw	*118-1	1	Inner Fixed Bearing Cap O-Ring
104	1	Floating Bearing End Cone	*119	1	Floating Bearing
104-1	14	Floating Bearing End Cone Screw	119-1	1	Floating Bearing Locknut
104-2	2	Floating Bearing End Cone Stud	119-2	1	Floating Bearing Lockwasher
*104-3	1	Floating Bearing End Cone Gasket	*120	1	Fixed Bearing
104-4	2	Floating Bearing End Cone Jamnut	120-1	1	Fixed Bearing Locknut
105	1	Fixed Bearing End Cone	120-2	1	Fixed Bearing Lockwasher

*Minimum recommended spares.
AR - As required.