EXPERT IN ENGINEERED

VACUUM SYSTEMS SINCE 1993

Performance. Reliability. Efficiency.

333 Rt 46 W

Building A,

Fairfield, NJ 07004

1-800-297-3550

www.nescompany.com

Operation & Maintenance Manual for NAT Series Two-stage Vacuum Pumps

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.

MANUAL INDEX

LIST OF SECTIONS

Section 1 - INTRODUCTION

Section 2 - SERVICES REQUIRED

Section 3 – INSTALLATION

Section 4 - EXPLOSIVE / HAZARDOUS ENVIRONMENTS

Section 5 - TECHNICAL DATA

Section 6 – OPERATION

Section 7 - PREVENTATIVE AND ROUTINE MAINTENANCE

Section 8 - STORAGE AND DISPOSAL

Section 9 - SPARES AND ACCESSORIES

Section 1 - INTRODUCTION

1.1 HOW THE UNIT WORKS

a. The key elements of the vacuum pump are depicted in Figure 1.1. A direct or v-belt coupling connects an electric drive motor to a common pump drive shaft, which serves both stages of the two-stage vacuum pump. Rotors in each stage are firmly affixed to the shaft and rotate at the same speed.

b. In Figure 1.2, the pump's sequential actions are illustrated. These actions are facilitated by the offset axis of the body casing from the rotor axis. The rotational motion of the liquid within the pump functions as a compressant for the gas, and the liquid also serves as a seal, preventing gas leakage into the atmosphere.

c. The first stage of the vacuum pump discharges evacuated air (or gas) and liquid compressant into the second stage discharge manifold. In low vacuum conditions, a check valve in the second stage discharge manifold remains open, allowing the first stage discharge to flow directly to an externally located atmospheric discharge separator. Consequently, during low vacuum operation, only the first stage performs the evacuation function. In high-vacuum operation, the check valve closes, redirecting the first stage discharge to the inlet of the second stage. The combined flow then passes through the second stage before being discharged through the second stage discharge manifold to the separator.

d. Operation under both low and high vacuum conditions is depicted in Figure 1.3. To ensure proper functioning and seal clearances between the cone and rotor, a liquid compressant (seal liquid) is introduced into the vacuum pump. This seal liquid is applied at the first stage heads, as illustrated in Figure 2.1, and travels through a passage in the heads to reach the cones. It then flows through the clearance between the cones and rotor into the rotor chamber. The seal liquid, along with the evacuated gas, is discharged into the second stage discharge manifold.

e. From the second stage discharge manifold, the seal liquid follows two paths: either directly into the atmospheric discharge separator during low vacuum operation or into the second stage inlet during high vacuum operation. In the latter case, it is then discharged with the evacuated air (or gas) into the separator.

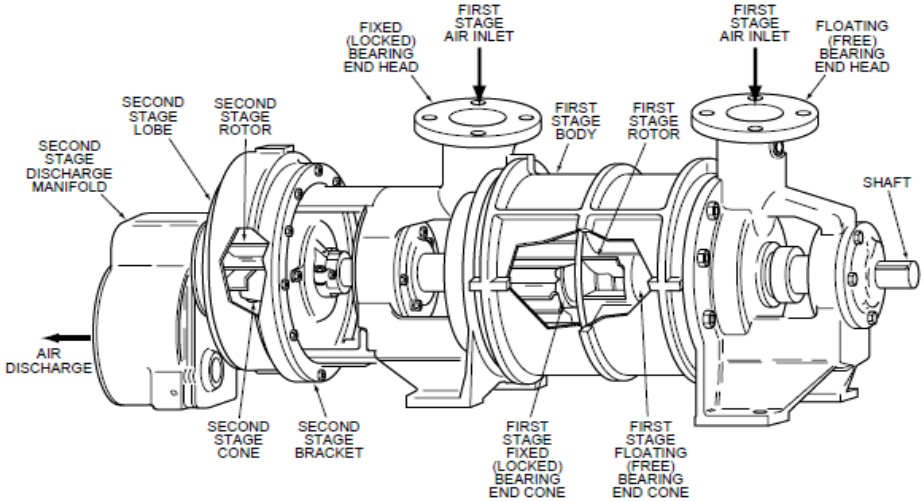


Fig. 1.1 Functional Elements of NES NAT Two Stage Vacuum Pump

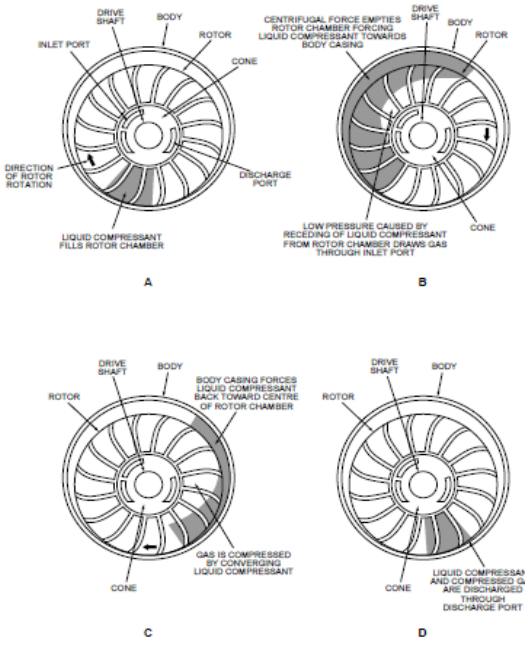


Fig. 1.2 Liquid Compressant and Air Flow

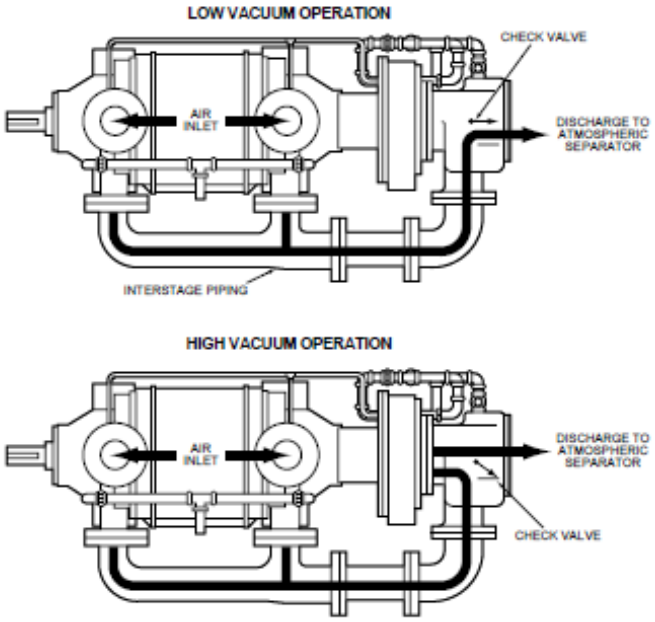


Fig. 1.3 Low and High Vacuum Operation

f. Stuffing boxes located at the first stage heads of the vacuum pump house packing rings and lantern gland seals. These stuffing boxes receive lubrication from the seal liquid. The lantern glands are supplied with seal liquid under a gauge pressure ranging from 0.14 to 0.35 bar, sourced from the second stage shroud (bracket). This application of seal liquid effectively prevents atmospheric air from entering the vacuum pump through the first stage stuffing boxes.

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. When handling the pump, lift it at four or more points on the base. If the pump is supplied without a base, utilize flat belt slings. At the floating bearing end (drive end), pass the sling between the bearing housing and head (Index No. 102, Figures 9.1 to 9.4) above the pump shaft. At the fixed bearing end (non-drive end), pass the sling through the bracket (Index No. 301 or 608, Figures 9.1 to 9.4) above the pump shaft. Ensure a level and balanced lift by using a lifting spreader bar or adjusting sling lengths.

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 guidance, a direction-of-rotation arrow is cast on both the pump's first stage body and second stage lobe (Items 101 and 601 or 606, as depicted in Figures 9.1 to 9.4).

c. The preservation warning label (see Figure 1.4, 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.

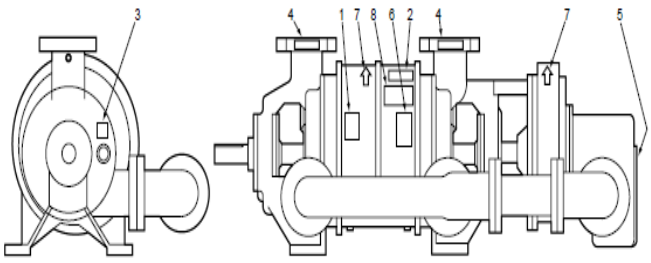


Figure 1.4. Location of Nameplate and Labels

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 inlet with a full-size connection to the process. In cases of extended inlet piping runs, exceeding 46 meters, it is recommended to use the next larger pipe size for the entire piping run. This precaution helps prevent any loss in volume flow.

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 2.3):

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.

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.

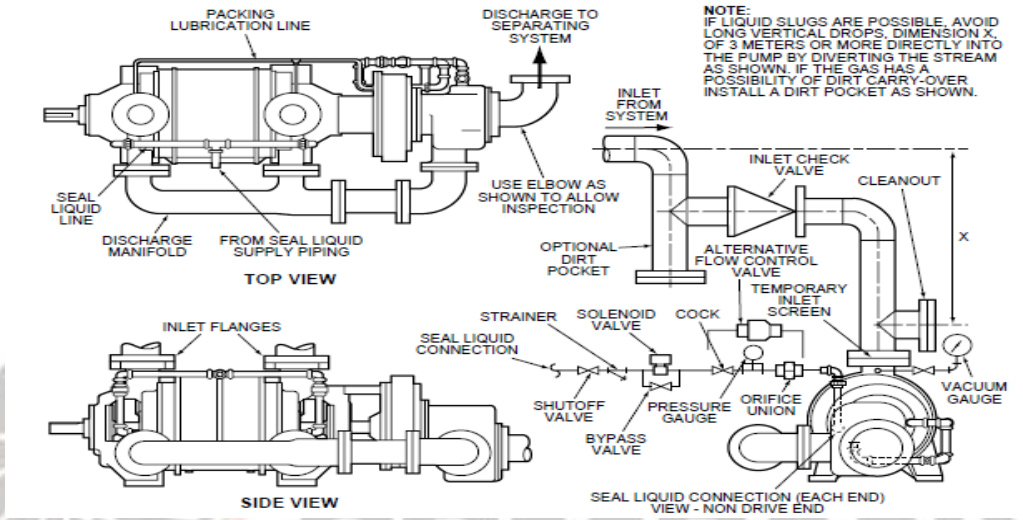


Figure 2.1. Typical Piping Connections

NOTE

WHEN AN INLET MANIFOLD IS SUPPLIED, A SINGLE SCREEN WILL BE FITTED ON THE MANIFOLD INLET FLANGE.

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. It is recommended to fit an elbow between the separating system and the pump discharge for inspection purposes. 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.

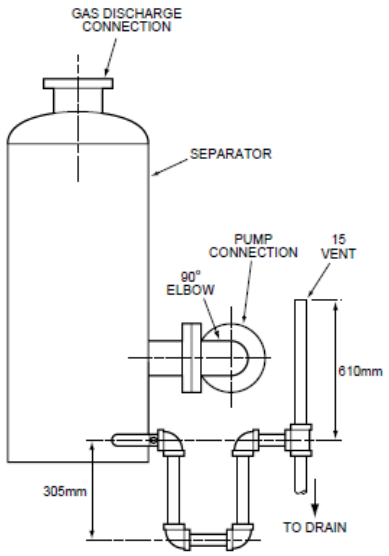


Fig. 2.2. Water Drain 'S' Bend Connected to Vacuum Pump Separator

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 connections. Normally, certain controls will be required ahead of this connection to 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. Add the following to pressures at the vacuum pump to determine the 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:

Standard lantern glands are installed in the first-stage stuffing boxes, receiving a lubricating liquid supply from the second-stage lobe. No external lantern gland supply is necessary unless indicated on the provided Installation or Arrangement drawing.

b. Mechanical Seals:

If mechanical seals are used, replacing the standard packed glands, refer to the supplied Installation or Arrangement drawing and any additional drawings to determine piping and mechanical seal flush liquid requirements.

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.

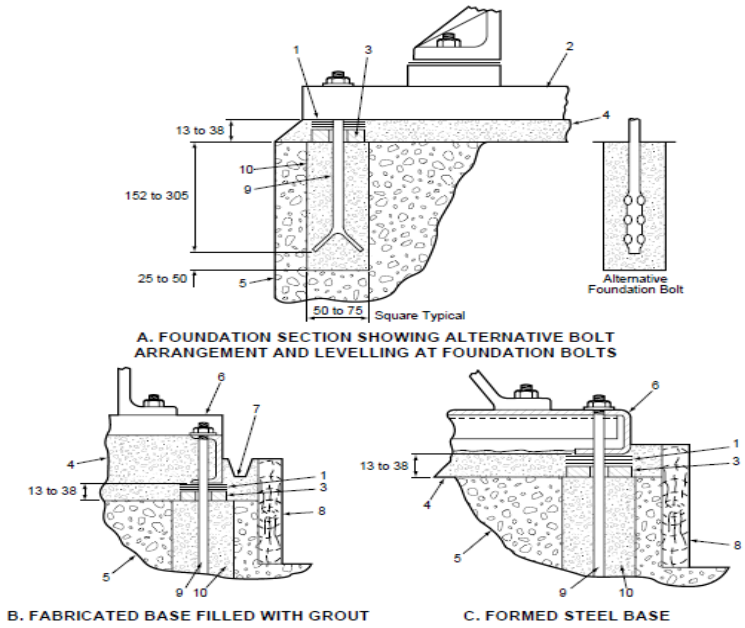
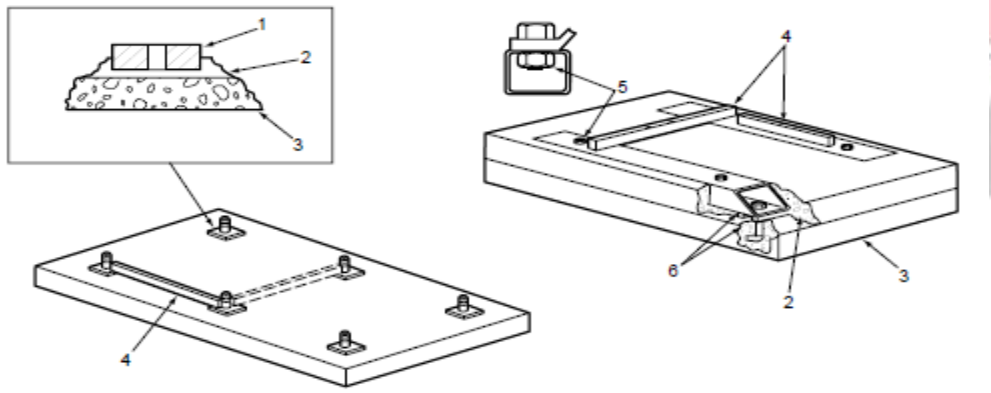


Figure 3.1 Foundation Bolt Installation and Grouting [Dimensions are in mm]



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 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 2-2.

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.

3.6 PUMP DRIVES (GENERAL)

a. Typically, NES pumps are powered by electric motors, predominantly of the induction type.

b. The drive is conveyed either directly through a flexible coupling or by means of a v-belt drive.

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.

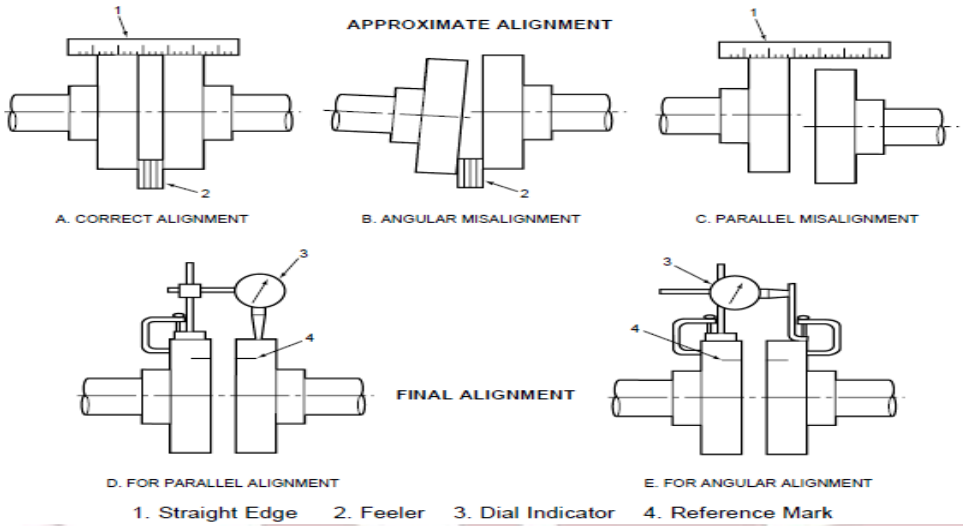


Figure 3.3 Approximate and Final Coupling Alignment Methods

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

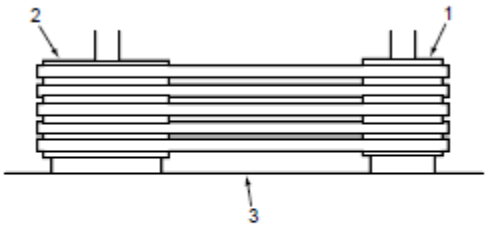
CAUTION!

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 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

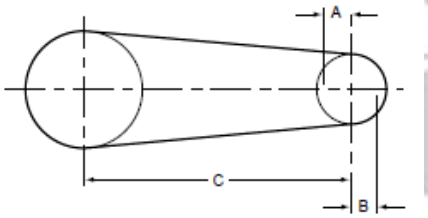
Figure 3.4

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 3.5 V-Belt Centre-Distance Determination

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

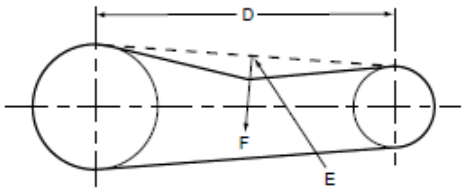
d-5. Apply a perpendicular force to any ONE of the belts at the center of span D using a spring scale. The force should be sufficient to deflect the belt by 16mm per meter of span length.

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 3.6 Checking V-Belt Tension

INSTALLATION AND TAKE-UP ALLOWANCE TABLE				
Belt Pitch Length (In)	Installation Allowance (In)			Minimum Take-up Allowance (In)
	SPA A	SPB B	SPC C	
21.86 to 33.07	0.98	1.18		0.98
33.46 to 45.66			1.96	
46.06 to 59.05				1.96
59.44 to 72.04				
72.44 to 85.43				
85.82 to 111.41				
111.81 to 137.79				
138.52 to 163.77				2.75
164.17 to 202.36				3.93
205.51 to 242.12				
243.30 to 295.27				
299.21 to 334.64				4.92
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
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 – AT TWO STAGE VACUUM PUMPS				
		PUMP MODEL – IRON CONSTRUCTION				
		NAT-404	NAT-704 NAT-706	NAT-1004 NAT-1006	NAT-2004 NAT-2006	NAT-3004
Total Mass – Unit Dry (Lbs.)		970	1464	2046	4601	7441
Total Mass – Unit Wet (Lbs.)		1010	1539	2183	4960	8047
MASS of COMPONENT PARTS (lb.)						
Index No.	Part Name	NAT-404	NAT-704 NAT-706	NAT-1004 NAT-1006	NAT-2004 NAT-2006	NAT-3004
101	Body – first stage	159	200	306	690	1179
102	Head – floating bearing end	126	145	198	516	712
103	Head – fixed bearing end	126	145	236	516	712
104 & 105	Cone – first stage	13	15	24	64	110
110	Rotor – first stage	73	139	229	631	1100
111	Shaft	40	60	119	300	432
119	Bearing – floating	4	4	9	11	15
120	Bearing – fixed	4	4	13	15	15
601 or 606	Lobe – second stage	44	68	123	282	600
605	Cone – second stage	13	15	24	57	172
608 or 301	Bracket	33	55	79	143	454
610	Rotor – second stage	31	53	106	240	481
634	Manifold – second stage	64	90	150	209	386
639	Manifold – cover	N/A	N/A	24	40	194
N/A = Not applicable.						

Table 5.2 Lubricating Grease Data

GENERAL REQUIREMENTS:

A. Premium quality industrial bearing grease.
B. Consistency grade: NLGI #2
C. Oil viscosity (minimum):
   @100°F (38° C)- 500 SSU (108 cSt)
   @ 210°F (99° C)- 58 SSU(10 cSt)
D. Thickener (Base): Lithium or Lithium Complex for optimum WATER RESISTANCE.
E. Performance characteristics at operating temperature:
   1. Operating temperature range; at least 0°F to 250°F (18° to 121°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
   4. Extreme Pressure (E.P.) agents
H. Additives – Objectionable:
   1. Molybdenum disulfide
   2. Tackiness agents

NES STANDARD GREASE RECOMMENDATIONS:

The following is a list, by manufacturer, of some grease that exhibits the desired characteristics required by NES Company Inc.

Grease Manufacturer	Product
AMOCO	Super Permalube or Amolith 2EP
B.P. Oil	Energrease LS-EP2
Castrol Oil	Spheerol SW 2 E.P.
Chevron Oil	Ulti-Plex Synthetic EP2
Exxon	Unirex N2 or Unirex EP2
Mobil Oil	Mobilith SHC 100 or Mobilith AW2
Shell Oil	Alvania 2 or Alvania EP2
Texaco Oil	Starplex 2 or Marfak MP2
Thames	Lithium EP2

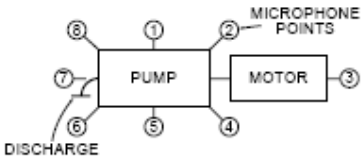
Table 5.3	OIL SELECTION DATA – AT – 3004 UNITS ONLY		
ACTUAL OIL TEMPERATURE	-44.6 to 125.6 °F	114.8 to 154.4 °F	145.4 to 185 °F
AGMA VISCOSITY GRADE	2	4	6
VISCOSITY cST @ 40 deg C SSU @ 100 deg F	 61.2 – 74.8 284 – 347	 135 – 165 626 – 765	 288 – 352 1335 – 1632 1
MANUFACTURER	LUBRICANT	LUBRICANT	LUBRICANT
For more information, please contact your NES representative.			

Table 5.4		PUMP MAINTENANCE PARTS DATA				
PART NAME	INDEX NO.	DESCRIPTION / QUANTITY				
		NAT-404	NAT-704 NAT-706	NAT-1004 NAT-1006	NAT-2004 NAT-2006	NAT-3004
Gland Packing – First Stage Dimensions	1	3/8'' Sq. x 8.26'' long	3/8'' Sq. x 9.76'' long	1/2'' Sq. x 12.24'' long	1/2'' Sq. x 15.74'' long	5/8'' Sq. x 19.25'' long
Qty Rings per Stuffing Box		4	4	5	5	5
Lantern Ring	10	Standard	Standard	Standard	Standard	Standard
Gland Packing – Second Stage	1 -1					
Dimensions		5/16'' Sq. x 6.14'' long	3/8'' Sq. x 7.51'' long	3/8'' Sq. x 8.74'' long	1/2'' Sq. x 12.99'' long	1/2'' Sq. x 19.25 long
Qty Rings per Stuffing Box		4	4	4	5	5
Body Gaskets – First Stage 0.0098 Inches Thick	101 – 3					
Qty Floating Bearing End		6	8	5	3	7
Qty Fixed Bearing End		4	4	3	5	6
Cone Gaskets – First Stage 0.0098 Inches Thick						
Qty Floating Bearing End	104 – 3	1	1	1	1	1
Qty Fixed Bearing End	105 - 3	1	1	1	1	1
Lobe Gasket – Second Stage 0.0098 Inches Thick, Qty	601 – 3	1	1	1	1	1
Floating Bearing	119	Single row ball bearing	Single row ball bearing	Single row ball bearing	Spherical roller bearing	Taper roller bearing clearance 0.020 Inches
Fixed Bearing	120	Single row ball bearing	Single row ball bearing	Double row angular contact ball bearing	Spherical roller bearing	Taper roller bearing clearance 0.020 Inches
Lip Seal – Floating and Fixed Bearing Inner Cap	5	N/A	N/A	N/A	N/A	5.625'' shaft dia. 6.875'' bore dia. 0.625'' wide
Lip Seal – Fixed Bearing Outer cap	5 – 1	N/A	N/A	N/A	N/A	4.5'' shaft dia. 5.5'' bore dia. 0.5'' wide
For more information, please contact your NES representative.						

Table 5.5	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 5.6	NOISE DATA - AT VACUUM PUMPS				
MAXIMUM READING at PUMP DESIGN SPEED :-					
PUMP MODEL					
	NAT-404	NAT-704 NAT-706	NAT-1004 NAT-1006	NAT-2004 NAT-2006	NAT-3004
DESIGN SPEED (RPM)	1170	980	730	500	450
OVERALL SOUND PRESSURE LEVEL "A" Weighted dB(A)	76	79	85	81	87
MICROPHONE LOCATION (See diagram below	5	1	5	5	1
SOUND POWER LEVEL Where overall sound pressure level exceeds 85 dB(A)	-	-	-	-	-

Note: 1. Sound Pressure Level Ref. 2 x 10-5 N/m2



2. Sound Power Level Ref. 10-12 Watts.
3. M.L. = Microphone Location (See Diag.).
4. ACCESSORIES:
Inlet Manifold, Discharge Separator, Silencer
5. Microphone Height: 1.6m above floor level.
6. Microphone Points: 1m from Unit Envelope.
7. Noise Data shown for Suction Pressures 34 to 50 mbA.

Table 5.7 Seal Water Flow Rates

SEAL WATER FLOW RATES	
PUMP MODEL	FLOWRATE - GPM
NAT-404	8.98
NAT-704	15.05
NAT-706	15.05
NAT-1004	30.11
NAT-1006	30.11
NAT-2004	39.89
NAT-2006	39.89
NAT-3004	59.96

Table 5.8 Seal Water Guidelines

SEAL WATER GUIDELINES	
Guidelines for Suitable Water are :-	
Minimum PH	7
Maximum Chlorides	10 ppm
Maximum Total Dissolved Solids	200ppm
Maximum Hardness	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 5.9 Seal Water Orifice Data

SEAL WATER ORIFICE DATA	
PUMP MODEL	ORIFICE DIA - INCHES
NAT-404	0.43
NAT-704	0.58
NAT-706	0.45
NAT-1004	0.72
NAT-1006	0.63
NAT-2004	0.91
NAT-2006	0.73
NAT-3004	1.12

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 5.9.

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 5.7. 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 method of flow control is not suitable for installations where seal water is recirculated without the aid of a centrifugal pump.

e. AT condenser exhaust units typically have a seal water flow rate tailored to specific application conditions, often exceeding the values in Table 5.7. Refer to contract manuals supplied with packaged units.

CAUTION!

BOTH STAGES MUST BE PRIMED, AND 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 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 starting the pump after aligning it as detailed in Section 3, Installation, remove the seal water drain plugs from the vacuum pump (see Figures 9-1 to 9-4 for the location of these plugs). Open the shut-off valve for the seal water supply and allow the seal water to flow until there is a clear flow from the first stage drains. Rotate the pump shaft manually a few times, then replace the first stage drain plugs using a pipe thread compound. Although the pump is flushed with inhibiting oil prior to shipment, a light film or rust may form before installation is complete. This film will disappear after the pump shaft has been manually rotated a few times.

c. Repeat this procedure until there is a clear flow from the second stage drains. Shut off the seal water supply and refit 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.)

6.4 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.

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. Prime both stages of the pump by adding the amount of water specified in Table 6-1 to the pump at the priming plugs located at the top of the first stage body and the second stage lobe (see Figures 9-1 to 9-4 for the location of these plugs).

k. 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.

Priming Quantity - Gallon		
Pump Model	First Stage	Second Stage
NAT-404	6.07	2.11
NAT-704 NAT-706	10.03	2.90
NAT-1004 NAT-1006	20.07	5.01
NAT-2004 NAT-2006	23.77	6.07
NAT-3004	50.19	16.11

Table 6.1 Priming Data

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 AT-3004 PUMPS ONLY: check to ensure that the oil levels in the bearing oiler sight glasses (Index No. 8, Figure 9-4) 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 7-5. For oil specification and grade selection, refer to Table 5-3 and Section 7-5.

CAUTION!

DO NOT OPERATE THE PUMP BEFORE CHECKING THE OIL LEVELS.

m. 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.

6.5 START-UP AND OPERATING CHECKS

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 ON LINE, ESPECIALLY WHEN PLACING THE PUMP ONLINE FOR THE FIRST TIME. STARTING UP A SYSTEM UNEXPECTEDLY MAY CAUSE PERSONNEL INJURY.

Note: Refer to Locating Troubles, Paragraph 6-6, if any operating difficulties arise when performing the following 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 14°C 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 1.5A) 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.

6.6 LOCATING TROUBLES

NES Two-Stage Vacuum Pumps 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 5.7. This involves collecting and measuring the water discharged over a specific duration, followed by calculating the flow in GPM.

b. When an orifice regulates the seal water flow, ensure that the pressure gauge upstream of the orifice reads 10psi g.

c. If a solenoid valve is present in the seal water supply line (refer to Figure 2.1), assess its operation by deactivating and then reactivating power to the valve. Upon reapplication of power, the solenoid in the valve should produce an audible click, indicating proper functioning.

CAUTION!

PRIOR TO CONDUCTING THE ABOVE CHECK, ENSURE THAT THE VACUUM PUMP IS DEACTIVATED OR THE SOLENOID VALVE IS BYPASSED. AVOID OPERATING THE PUMP WITHOUT SEAL WATER SUPPLY TO PREVENT ANY RISKS.

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

e. Confirm that the pump operates at the designated rpm, which may differ from the test rpm stamped on the pump nameplates (Refer to Section 15).

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.

g. Inspect the air discharge piping for any restrictions. Back pressure exceeding 5 psi gauge at the air discharge can diminish vacuum levels (increase absolute suction pressure) and elevate the required driving power.

h. Assess the operation of the interstage check valve in the second stage discharge manifold to ensure the clapper functions freely and seats correctly. Refer to Figure 1.3 and Figures 9.1 to 9.4.

i. 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. At each of the intervals mentioned (and during any maintenance/repair work), it is also advisable to inspect the pressure boundary parts (i.e., body, heads, lobe, bracket, manifolds, and manifold cover. Refer to Figures 9.1 to 9.4). If signs indicate, isolate the equipment and water pressure test the pump to 1.5 times the working pressure to determine the extent of damage. Replace faulty components immediately to prevent danger to personnel and plant equipment.

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 or Section 7.5, 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. Replace the stuffing box packing as specified in Section 7.6.

b. Inspect the interstage check valve (Figures 9.1 to 9.4) as specified in Section 7.7. Ensure the elastomer on the clapper is intact.

c. Verify that the shroud vent check valves operate freely.

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

7.4 BEARING LUBRICATION - NAT-404, NAT-704/6, NAT-1004/6, NAT-2004/6 UNITS

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 7.4c.

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. Pumps equipped with grease fittings (an option on some NAT models) should be relubricated via the grease fittings as follows:

b-1. Shut down and isolate the pump.

b-2. Remove the gland guards from the floating and fixed bearing end heads.

b-3. Remove the 1/8-inch square head vent plugs from the floating and fixed bearing inner and outer bearing caps (Figures 9.1 to 9.3).

b-4. Utilize a grease gun to administer grease that complies with the recommendations of Table 5-2 until old grease is discharged from the bearing cap vent holes.

b-5. Inspect the discharged grease for signs of contamination with water or other fluids and indications of overheating. If contamination or overheating is evident, clear out the old grease and assess the bearing's condition as specified in Section 7.4c.

b-6. In the absence of contamination or overheating of the grease, reinstall all the 1/8-inch vent plugs removed in step b-3.

b-7. Replace the gland guards.

b-8. 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.

c. For pumps without grease fittings or when checking for contamination is necessary, proceed as follows:

c-1. Shut down and isolate the pump.

c-2. Remove the gland guards and loosen the bearing cap set screws and nuts (where fitted), as shown in Figures 9.1 to 9.3, and slide back the bearing caps (115, 116, 117, 118).

c-3. Assess the grease inside the bearing housing for contamination or the presence of water.

c-4. If the grease is deemed satisfactory, apply grease to both sides of the bearing in accordance with the recommendations provided in Table 5-2. Employ a clean putty knife or a similar tool to pack the bearing until the grease aligns with the edge of the bearing's inner and outer race. Load each bearing cap to a level between 1/4 and 1/3 full and reattach the caps, taking care to prevent any dirt from entering the bearing housing.

c-5. In the event of grease contamination, thoroughly clean the bearing and housing using a solvent to eradicate all traces of grease. Inspect the bearing for any signs of damage such as pitting of balls/rollers or raceways, or discoloration due to overheating. If such damage is evident, replace the bearing. If the bearing is deemed satisfactory, repack it with grease following the procedure outlined in Section c-4.

NOTE

For bearing replacement, refer to the NES Maintenance Bulletin listed in Table 1.1.

c-6. Reinstall the gland guards.

c-7. Restart the pump and closely monitor the bearing housing temperatures as outlined in Section b-8.

7.5 BEARING LUBRICATION - NAT-3004 UNITS

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.

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.

Interval for Operating Temperature Range*			
≤140°F	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

*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.

7.6 STUFFING BOX PACKING

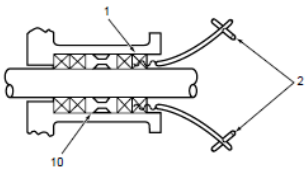
a. Establish a preventative maintenance schedule for tightening and replacing the packing in the pump's stuffing boxes. In pumps utilized in continuous process systems, the packing in stuffing boxes should be replaced during the annual shutdown. In severe process applications, more frequent replacement 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: Document the position and number of packing rings on each side of the lantern gland in the first-stage stuffing boxes. This information is essential during re-assembly to ensure correct alignment of the lantern gland. 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.

Note: Steps a-2 to a-9 are applicable to the first-stage stuffing boxes. The procedure for removing packing from second-stage stuffing boxes in bracket 301 or 608 is identical, except no lantern ring is used.

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. Create two lantern gland pullers from 2 or 3mm diameter steel wire as illustrated 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 the stuffing box before the installation of new packing.

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.

Note: Steps a-16 to a-19 are specific to first-stage stuffing boxes. The process for installing packing in the second-stage stuffing box is identical, except for the absence of a lantern ring.

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.

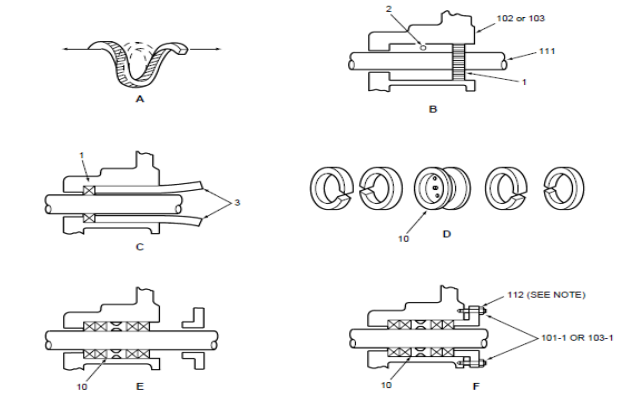
a-17. Place the lantern gland (10) back into its original position, as marked during removal (refer to Figure 7-3 Part E).

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 by hand, following Figure 7-3 Part F.

a-20. Initiate the pump as per the instructions in Section 6-5. 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.

a-21. Make adjustments to the glands as outlined in Section 6-5, step h.



Note: Rotated 90 degrees to show gland studs and nuts

1. Packing Ring
2. Lantern Gland Supply Connection
3. Packing Ring Pusher
10. Lantern Gland
101-1. Gland Nut
102 Floating Bearing End Head
103. Fixed Bearing End Head
103-1. Gland Nut
111. Shaft
112. Packing Gland Assembly

Figure 7.3 Packing Stuffing Boxes

7.7 INTERSTAGE CHECK VALVE INSPECTION

a. Shut down the pump and isolate it.

b. Drain the pump by extracting the seal water drain plugs from the first and second stages (refer to Figures 9-1 to 9-4 for the locations of the drain plugs).

c. Take off the pump discharge elbow or discharge separator to gain access to the interstage check valve through the pump's discharge connection.

d. Manually lift the valve clapper and allow it to fall closed. Ensure that the clapper falls freely and seats squarely against the valve seat.

e. Inspect the valve seat for any signs of pitting, scoring, or wear. Utilize a small mirror and torch for a detailed examination inside the clapper.

f. Clean any deposits around the valve and seat.

g. Verify the securement of retaining cotter pins in the securing screws or hinge posts.

h. If the valve seat is damaged, it will adversely affect the pump's performance in two-stage operation, and the valve must be replaced. Refer to the Maintenance Bulletin specified in Table 1-1 for the replacement procedure of the interstage check valve.

i. Reinstall all drain plugs using a thread sealing compound.

j. Reattach the discharge elbow or piping removed in step c.

k. Reprime both the first and second stages of the pump following the instructions in Section 6-4, step j.

CAUTION!

ALWAYS REPRIME THE PUMP FIRST AND SECOND STAGES AFTER DRAINING THE PUMP. INADEQUATE PRIMING MAY CAUSE DAMAGE TO PUMP INTERNAL PARTS.

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 all drain plugs for seal water from the pump (refer to Figures 9.1 to 9.4 for the plug locations). Allow all liquid to drain from the pump and then reinstall the 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. Remove the priming plug from the top of the second stage lobe and add the preserving oil in the quantity specified in Table 6.1.

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.

b-9. Exclusively for NAT-3004 units: Perform an oil change in the fixed and floating bearing housings according to the instructions outlined in Section 7.5f.

NOTE

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

b-10. 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 7.6.

c. Solely for NAT-3004 units: If the pump has been in storage for over six months, conduct an oil change in the fixed and floating bearing housings.

d. Flush the pump following the specifications in Section 6.3. 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

NOTE

PACKAGED UNITS MAY HAVE UNDERGONE PRESERVATION WITH ALTERNATIVE OILS FOR LONG-TERM PROTECTION. PLEASE REFER TO ANY SPECIFIC INSTRUCTIONS OR CONTRACT MANUALS PROVIDED WITH THESE UNITS.

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

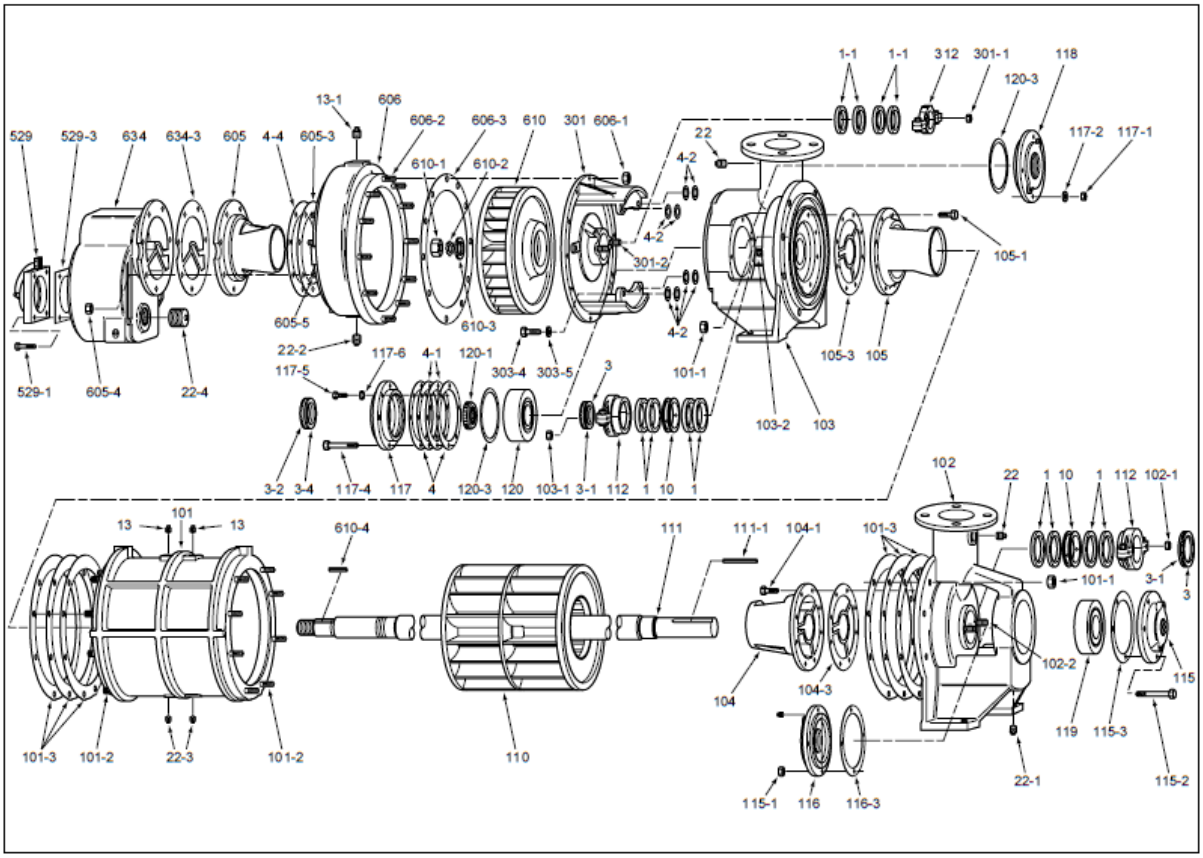


Fig. 9.1 Exploded View of NES NAT-404, NAT-704, and NAT-706 Two Stage Vacuum Pumps

Legend for Figure 9-1.

Index No.	**Qty	Part Name	Index No.	**Qty	Part Name	Index No.	**Qty	Part Name
*1	8 rings	First Stage Packing	*104-3	1	Floating Bearing Cone Gasket	120-1	1	Fixed Bearing Self-Locking Nut
*1-1	4 rings	Second Stage Packing	105	1	Fixed Bearing End Cone			
*3	2	First Stage Slinger	105-1	8	Fixed Bearing End Cone Screw	*120-3	2	Fixed Bearing Gasket
*3-1	2	First Stage Slinger Spring				301	1	Bracket
*3-2	1	Second Stage Slinger	*105-3	1	Fixed Bearing End Cone Gasket	301-1	2	Bracket Gland Stud Nut
*3-4	1	Second Stage Slinger Spring				301-2	2	Bracket Gland Stud
*4	AR	Shim	110	1	First Stage Rotor	303-4	4	Bracket Screw
*4-1	AR	Shim	110-1	1	Rotor Key (Bronze Rotor Only)	303-5	4	Bracket Washer
*4-2	AR	Shim				312	1	Packing Gland Assembly
*4-4	AR	Shim	111	1	Shaft	529	1	Interstage Check Valve
*10	2	Lantern Gland	111-1	1	Shaft Key	529-1	4	Interstage Check Valve Screw
13	2	Priming Plug	112	2	Packing Gland Assembly			
13-1	1	Priming Plug	115	1	Floating Bearing Outer Cap	*529-3	1	Interstage Check Valve Gasket
22	2	Drain Plug	115-1	4	Floating Bearing Outer Cap Nut (AT-404 only)	605	1	Second Stage Cone
22-1	2	Drain Plug				*605-3	5	Second Stage Cone Gasket
22-2	1	Drain Plug	115-2	4	Floating Bearing Outer Cap Bolt	605-4	6	Second Stage Cone Stud Nut
22-3	2	Drain Plug				605-5	6	Second Stage Cone Stud
22-4	1	Drain Plug	*115-3	1	Floating Bearing Outer Cap Gasket	606	1	Second Stage Lobe
101	1	First Stage Body				606-1	12,9	Second Stage Lobe Stud Nut
101-1	16,20	First Stage Body Stud Nut	116	1	Floating Bearing Inner Cap	606-2	12,9	Second Stage Lobe Stud
101-2	16,20	First Stage Body Stud	*116-3	1	Floating Bearing Inner Cap Gasket	*606-3	1	Second Stage Lobe Gasket
*101-3	10,12	First Stage Body Gasket				610	1	Second Stage Rotor
102	1	Floating Bearing End Head	117	1	Fixed Bearing Outer Cap	610-1	1	Second Stage Rotor Nut
102-1	2	Floating Bearing End Gland Nut	117-1	4	Fixed Bearing Cap Nut (AT-404 only)	+610-2	1	Second Stage Rotor Lock Tab Washer
102-2	2	Floating Bearing End Gland Stud	117-2	4	Fixed Bearing Cap Lockwasher (AT-404 only)	610-3	1	Second Stage Rotor Washer
103	1	Fixed Bearing End Head	117-4	4	Fixed Bearing Outer Cap Bolt	610-4	1	Second Stage Rotor Key
103-1	2	Fixed Bearing End Gland Nut	117-5	3	Fixed Bearing Outer Cap Screw	634	1	Second Stage Discharge Manifold
103-2	2	Fixed Bearing End Gland Stud	117-6	3	Fixed Bearing Outer Cap Lockwasher	*634-3	1	Second Stage Discharge Manifold Gasket
104	1	Floating Bearing End Cone	118	1	Fixed Bearing Inner Cap			
104-1	8	Floating Bearing End Cone Screw	*119	1	Floating (Free) Bearing			
			*120	1	Fixed (Locked) Bearing			

*Minimum recommended spares.
**First quantity applies to AT-404, second quantity applies to AT-704 and AT-706.
+Used on pumps after September 15 1981.
AR - As required.

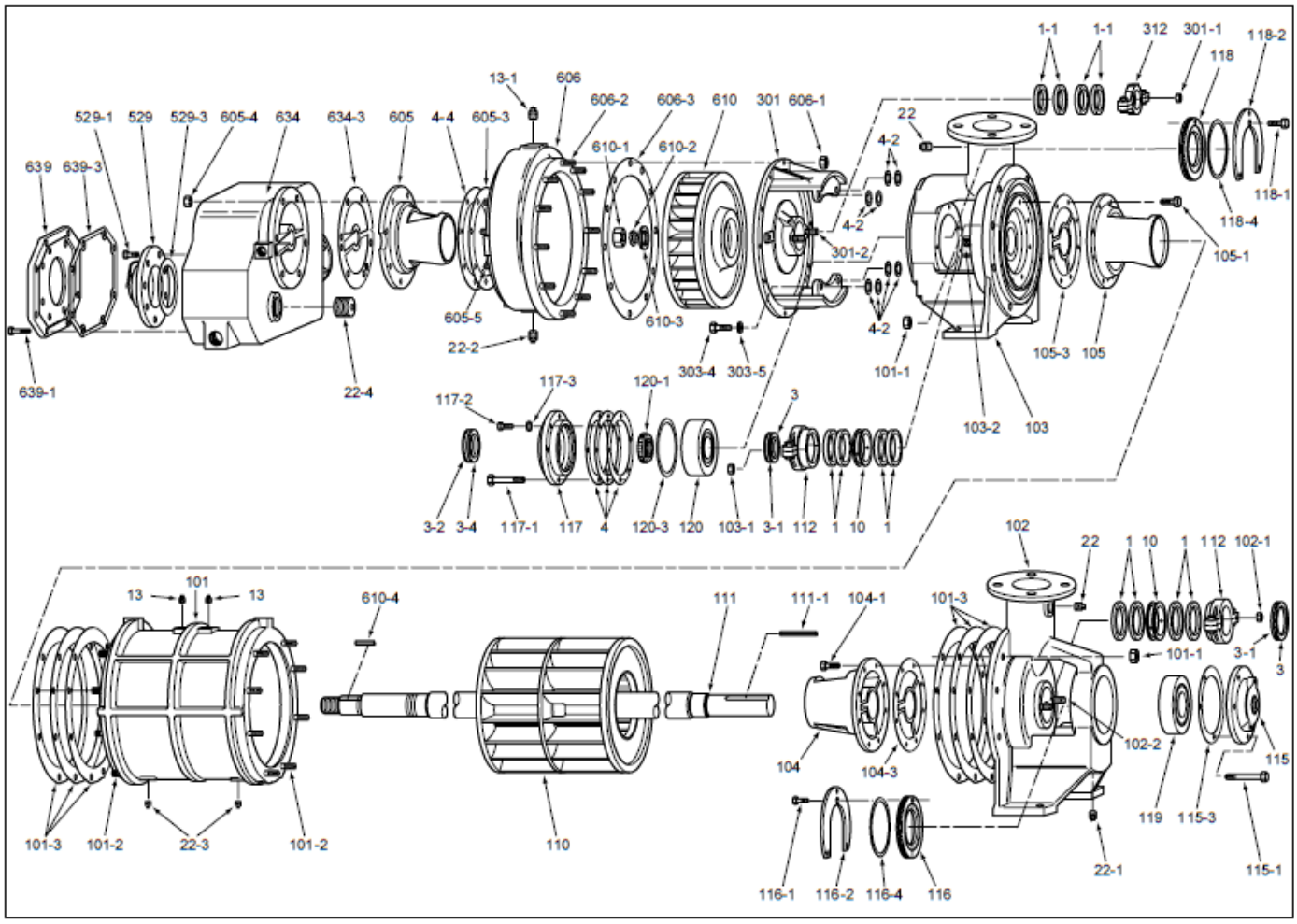


Fig. 9.2 Exploded View of NES NAT-1004, and NAT-1006 Two Stage Vacuum Pumps

Legend for Figure 9-2.

Index No.	Qty	Part Name	Index No.	Qty	Part Name	Index No.	Qty	Part Name
*1	10 rings	First Stage Packing	105	1	Fixed Bearing End Cone	120-1	1	Fixed Bearing Self-Locking Nut
*1-1	4 rings	Second Stage Packing	105-1	8	Fixed Bearing End Cone Screw	*120-3	2	Fixed Bearing Gasket
*3	2	First Stage Slinger	*105-3	3	Fixed Bearing End Cone Gasket	301	1	Bracket
*3-1	2	First Stage Slinger Spring	110	1	First Stage Rotor	301-1	2	Bracket Gland Stud Nut
*3-2	1	Second Stage Slinger	110-1	1	Rotor Key (Bronze Rotor Only)	301-2	2	Bracket Gland Stud
*3-4	1	Second Stage Slinger Spring	111	1	Shaft	303-4	4	Bracket Screw
*4	AR	Shim	111-1	1	Shaft Key	303-5	4	Bracket Washer
*4-1	AR	Shim	112	2	Packing Gland Assembly	312	1	Packing Gland Assembly
*4-2	AR	Shim	115	1	Floating Bearing Outer Cap	529	1	Interstage Check Valve
*4-4	AR	Shim	115-1	3	Floating Bearing Outer Cap Bolt	529-1	8	Interstage Check Valve Screw
*10	2	Lantern Gland	*115-3	1	Floating Bearing Outer Cap Gasket	*529-3	1	Interstage Check Valve Gasket
13	2	Priming Plug	116	1	Floating Bearing Inner Cap	605	1	Second Stage Cone
13-1	1	Priming Plug	116-1	1	Floating Bearing Inner Cap Bolt	*605-3	5	Second Stage Cone Gasket
22	2	Drain Plug	116-2	1	Floating Bearing Inner Cap Clamp	605-4	6	Second Stage Cone Stud Nut
22-1	2	Drain Plug	*116-4	1	Floating Bearing Inner Cap O-Ring	605-5	6	Second Stage Cone Stud
22-2	1	Drain Plug	117	1	Fixed Bearing Outer Cap	606	1	Second Stage Lobe
22-3	2	Drain Plug	117-1	3	Fixed Bearing Outer Cap Bolt	606-1	12	Second Stage Lobe Stud Nut
22-4	1	Drain Plug	117-2	3	Fixed Bearing Cap Screw	606-2	12	Second Stage Lobe Stud
101	1	First Stage Body	117-3	3	Fixed Bearing Outer Cap Lockwasher	*606-3	1	Second Stage Lobe Gasket
101-1	16	First Stage Body Stud Nut	118	1	Fixed Bearing Inner Cap	610	1	Second Stage Rotor
101-2	16	First Stage Body Stud	118-1	1	Fixed Bearing Inner Cap Bolt	610-1	1	Second Stage Rotor Nut
*101-3	8	First Stage Body Gasket	118-2	1	Fixed Bearing Inner Cap Clamp	+610-2	1	Second Stage Rotor Lock Tab Washer
102	1	Floating Bearing End Head	*118-4	1	Fixed Bearing Inner Cap O-Ring	610-3	1	Second Stage Rotor Washer
102-1	2	Floating Bearing End Gland Nut	119	1	Floating (Free) Bearing	610-4	1	Second Stage Rotor Key
102-2	2	Floating Bearing End Gland Stud	*119	1	Floating (Locked) Bearing	634	1	Second Stage Discharge Manifold
103	1	Fixed Bearing End Head	*120	1	Floating Bearing Cone Gasket	*634-3	1	Second Stage Discharge Manifold Gasket
103-1	2	Fixed Bearing End Gland Nut				639	1	Second Stage Discharge Manifold Cover
103-2	2	Fixed Bearing End Gland Stud				639-1	8	Manifold Cover Bolt
104	1	Floating Bearing End Cone				*639-2	1	Manifold Cover Gasket
104-1	8	Floating Bearing End Cone Screw						
*104-3	3	Floating Bearing Cone Gasket						

*Minimum recommended spares.
+Used on pumps after September 15 1981.
AR - As required.

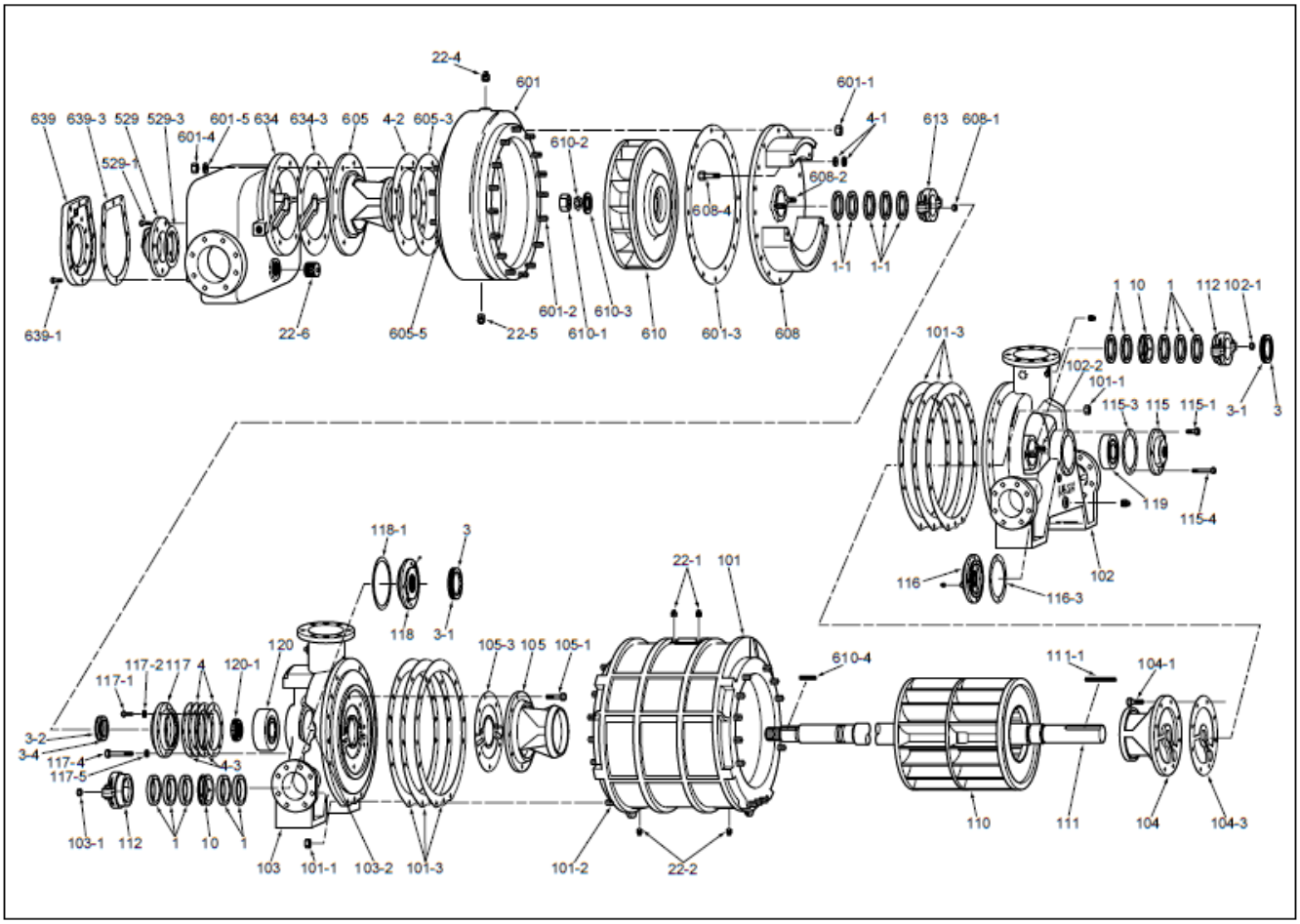


Fig. 9.3 Exploded View of NES NAT-2004, and NAT-2006 Two Stage Vacuum Pumps

Legend for Figure 9-3.

Index No.	Qty	Part Name	Index No.	Qty	Part Name	Index No.	Qty	Part Name
*1	10 rings	First Stage Packing	105	1	Fixed Bearing End Cone	529	1	Interstage Check Valve
*1-1	5 rings	Second Stage Packing	105-1	8	Fixed Bearing End Cone Screw	529-1	8	Interstage Check Valve Screw
*3	2	First Stage Slinger						
*3-1	2	First Stage Slinger Spring	*105-3	1	Fixed Bearing End Cone Gasket	*529-3	1	Interstage Check Valve Gasket
*3-2	1	Second Stage Slinger						
*3-4	1	Second Stage Slinger Spring	110	1	First Stage Rotor	601	1	Second Stage Lobe
*4	AR	Shim	111	1	Shaft	601-1	16	Second Stage Lobe Stud Nut
*4-1	AR	Shim	111-1	1	Shaft Key	601-2	16	Second Stage Lobe Stud
*4-2	AR	Shim	112	2	Packing Gland Assembly	*601-3	1	Second Stage Lobe Gasket
*4-3	AR	Shim Gasket	115	1	Floating Bearing Outer Cap	601-4	8	Second Stage Lobe Stud Nut
*10	2	First Stage Lantern Gland	115-1	3	Floating Bearing Outer Cap Screw	601-5	8	Second Stage Lobe Washer
22-1	2	Priming Plug				605	1	Second Stage Cone
22-2	2	Drain Plug	*115-3	1	Floating Bearing Outer Cap Gasket	*605-3	5	Second Stage Cone Gasket
22-4	1	Priming Plug				605-5	8	Second Stage Cone / Lobe Stud
22-5	1	Drain Plug	115-4	3	Floating Bearing Outer Cap Bolt	608	1	Bracket
22-6	1	Drain Plug						
101	1	First Stage Body	116	1	Floating Bearing Inner Cap	608-1	2	Bracket Gland Stud Nut
101-1	13	First Stage Body Stud Nut	*116-3	1	Floating Bearing Inner Cap Gasket	608-2	2	Bracket Gland Stud
101-2	13	First Stage Body Stud				608-4	4	Bracket Screw
*101-3	8	First Stage Body Gasket	117	1	Fixed Bearing Outer Cap	610	1	Second Stage Rotor
102	1	Floating Bearing End Head	117-1	3	Fixed Bearing Outer Cap Screw	610-1	1	Second Stage Rotor Nut
102-1	2	Floating Bearing End Gland Nut	117-2	3	Fixed Bearing Outer Cap Washer	+*610-2	1	Second Stage Rotor Lock Tab Washer
102-2	2	Floating Bearing End Gland Stud	117-4	3	Fixed Bearing Outer Cap Bolt	610-3	1	Second Stage Rotor Washer
103	1	Fixed Bearing End Head	117-5	3	Fixed Bearing Outer Cap Washer	610-4	1	Second Stage Rotor Key
103-1	2	Fixed Bearing End Gland Nut	118	1	Fixed Bearing Inner Cap	613	1	Packing Gland Assembly
103-2	2	Fixed Bearing End Gland Stud	*118-1	1	Fixed Bearing Inner Cap O-Ring	634	1	Second Stage Discharge Manifold
104	1	Floating Bearing End Cone	*119	1	Floating (Free) Bearing	*634-3	1	Second Stage Discharge Manifold Gasket
104-1	8	Floating Bearing End Cone Screw	*120	1	Fixed (Locked) Bearing	639	1	Second Stage Discharge Manifold Cover
*104-3	1	Floating Bearing Cone Gasket	120-1	1	Fixed Bearing Self-Locking Nut	639-1	10	Manifold Cover Bolt
						*639-3	1	Manifold Cover Gasket

*Minimum recommended spares.
+Used on pumps after September 15 1981.
AR - As required.

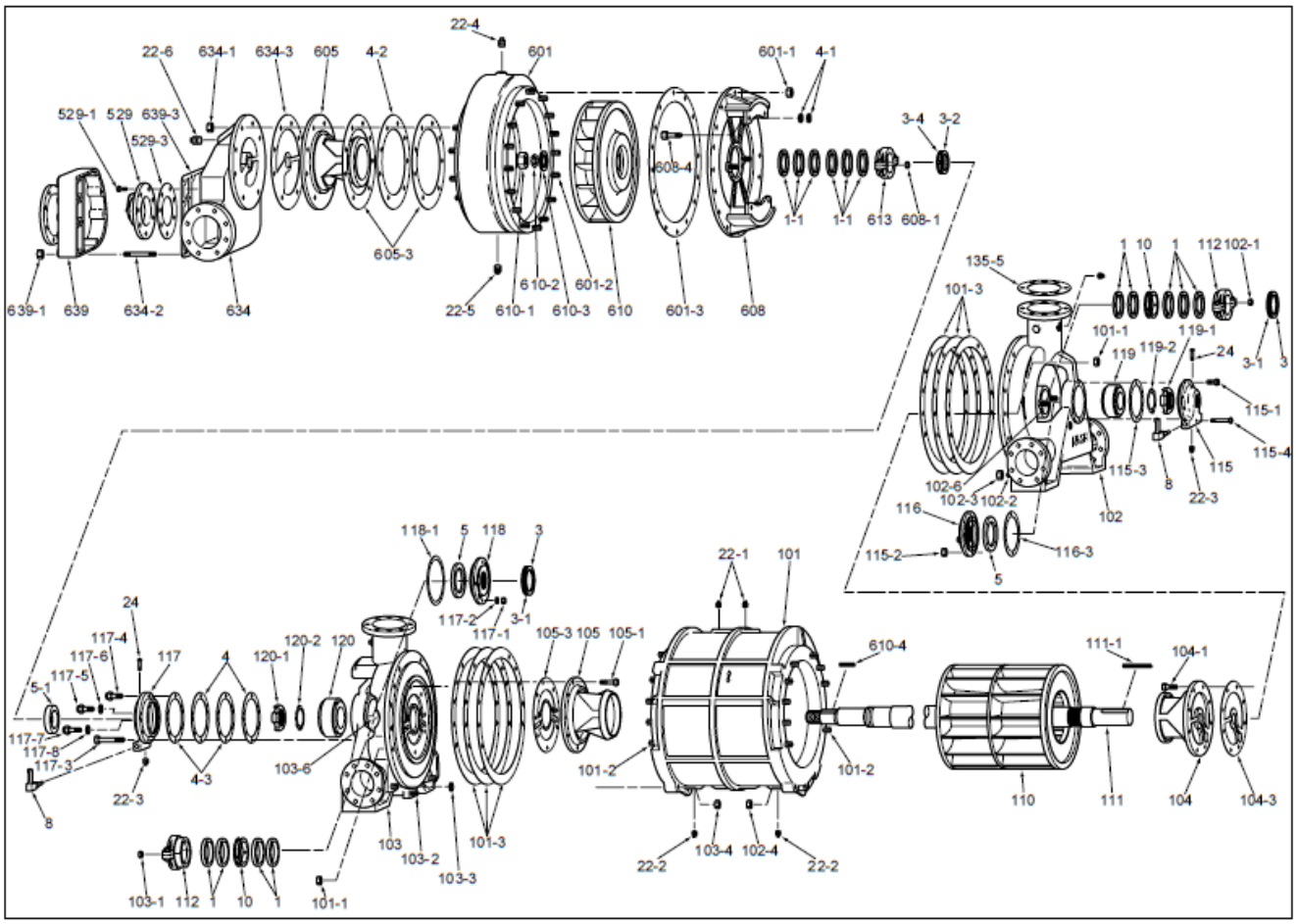


Fig. 9.4 Exploded View of NES Two Stage Vacuum Pumps

Legend for Figure 9-4.

Index No.	Qty	Part Name	Index No.	Qty	Part Name	Index No.	Qty	Part Name
*1	10 rings	First Stage Packing	104-1	8	Floating Bearing End Cone Screw	118	1	Fixed Bearing Inner Cap
*1-1	5 rings	Second Stage Packing	*104-3	1	Floating Bearing End Cone Gasket	*118-1	1	O-Ring
*3	2	First Stage Slinger	105	1	Fixed Bearing End Cone	*119	1	Floating Bearing
*3-1	2	First Stage Slinger Spring	105-1	8	Fixed Bearing End Cone Screw	119-1	1	Floating Bearing Locknut
*3-2	1	Second Stage Slinger	*105-3	1	Fixed Bearing End Cone Gasket	119-2	1	Floating Bearing Lockwasher
*3-4	1	Second Stage Slinger Spring	110	1	First Stage Rotor	*120	1	Fixed Bearing
*4	AR	Shim	110-1	1	Rotor Key (Bronze Rotor Only)	120-1	1	Fixed Bearing Locknut
*4-1	AR	Shim	111	1	Shaft	120-2	1	Fixed Bearing Lockwasher
*4-2	AR	Shim	111-1	1	Shaft Key	529	1	Interstage Check Valve Assembly
*4-3	AR	Shim	112	2	Gland Assembly	529-1	8	Check Valve
5	2	Lip Seal	115	1	Floating Bearing Outer Cap	*529-3	1	Check Valve Gasket
5-1	1	Lip Seal	115-1	3	Floating Bearing Outer Cap Screw	601	1	Second Stage Lobe
8	2	Oiler (With Sight Glass)	115-2	3	Floating Bearing Outer Cap Nut	601-1	12	Second Stage Lobe Stud Nut
10	2	Lantern Gland	*115-3	1	Floating Bearing Outer Cap Gasket	601-2	12	Second Stage Lobe Stud
22-1	2	Priming Plug	115-4	1	Floating Bearing Outer Cap Bolt	*601-3	1	Second Stage Lobe Gasket
22-2	2	Drain Plug	116	1	Floating Bearing Inner Cap	605	1	Second Stage Cone
22-3	2	Drain Plug	*116-3	1	Floating Bearing Inner Cap Gasket	*605-3	AR	Second Stage Cone Gasket
22-4	1	Priming Plug	117	1	Fixed Bearing Outer Cap	605-5	8	Second Stage Cone/Head Stud
22-5	1	Drain Plug	117-1	3	Fixed Bearing Outer Cap Nut	608	1	Bracket
22-6	3	Drain Plug	117-2	3	Fixed Bearing Outer Cap Washer	608-1	2	Stuffing Box Stud Nut
24	2	Vent	117-3	1	Fixed Bearing Outer Cap Bolt	608-2	2	Bracket Stud
101	1	First Stage Body	117-4	3	Fixed Bearing Outer Cap Screw	608-4	4	Bracket Body Bolt
101-1	20	First Stage Body Stud Nut	117-5	1	Fixed Bearing Outer Cap Screw	610	1	Second Stage Rotor
101-2	20	First Stage Stud	117-6	1	Fixed Bearing Outer Cap Washer	*610-1	1	Second Stage Rotor Locknut
*101-3	13	First Stage Body Gasket	117-7	1	Fixed Bearing Outer Cap Screw	*610-2	1	Second Stage Rotor Lock Tab Washer
102	1	Floating Bearing End Head	117-8	1	Fixed Bearing Outer Cap Washer	610-3	1	Second Stage Rotor Washer
102-1	2	Stuffing Box Stud Nut				610-4	1	Shaft Rotor Key
102-2	3	Floating Bearing End Head Stud				613	1	Gland
102-3	16	Floating Bearing End Head Stud Gasket				634	1	Second Stage Manifold
102-4	3	Floating Bearing End Head Stud Nut				634-1	8	Second Stage Manifold Nut
102-6	2	Stuffing Box Stud				634-2	12	Second Stage Manifold Stud
103	1	Fixed Bearing End Head				*634-3	1	Second Stage Manifold Gasket
103-1	2	Stuffing Box Stud Nut				639	1	Second Stage Manifold Cover
103-2	3	Fixed Bearing End Head Stud				639-1	12	Second Stage Manifold Cover Nut
103-3	17	Fixed Bearing End Head Stud Gasket				*639-3	1	Second Stage Manifold Cover Gasket
103-4	3	Fixed Bearing End Head Stud Nut						
103-6	2	Stuffing Box Stud						
104	1	Floating Bearing End Cone						

*Minimum recommended spares. AR - As required.