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VACUUM SYSTEMS SINCE 1993

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333 Rt 46 W

Building A,

Fairfield, NJ 07004

1-800-297-3550

www.nescompany.com

Operation & Maintenance Manual for NB Booster Pumps

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 compress ant 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 the 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

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1. General

1.1 Scope of Application

This operational manual furnishes precautionary measures and operational instructions essential for the proper installation, functioning, and maintenance of NB Roots vacuum pumps. For the longevity of the pump, it is strongly advised to thoroughly review this manual before engaging in any operation or maintenance activities. Additionally, ensure that this manual is always readily accessible at the installation site of the pump or motor-pump assembly.

| Model | Max. Speed RPM | Model | Max. Speed RPM |
|--------|----------------|---------|----------------|
| NB200 | 3600 | NB2700 | 3600 |
| NB400 | 3600 | NB2900 | 3000 |
| NB540 | 3600 | NB3600 | 3000 |
| NB720 | 3600 | NB4500 | 3000 |
| NB850 | 3600 | NB5400 | 2400 |
| NB1200 | 3600 | NB7300 | 2400 |
| NB1600 | 3600 | NB7900 | 1800 |
| NB2000 | 3600 | NB10000 | 1800 |

Table 1. Applicable pump models

1.2 General Safety Information

1.2.1 Worker Qualifications and Training:

Operators responsible for the use, maintenance, and assembly of equipment must possess the necessary qualifications for their tasks. The purchaser of the equipment is required to rigorously oversee the responsibilities, skills, and testing capabilities of operating personnel. In cases where employees lack the required expertise, appropriate training should be provided. The manufacturer or supplier can conduct training sessions for the plant's

operators. Additionally, the purchaser must ensure that competent personnel have thoroughly read and understood the entire contents of this manual.

1.2.2 Hazards of Non-compliance with Safety Instructions:

Failure to adhere to safety instructions poses risks to personal safety, environmental damage, harm to machinery and equipment, and may result in the forfeiture of the right to complain after exposure to danger. Non-compliance with safety instructions can lead to critical situations such as failure of important unit functions, breakdowns in specific maintenance or repair processes, exposure of personnel to electrical, mechanical, and chemical hazards, and environmental pollution due to the leakage of hazardous substances.

1.2.3 Compliance with Relevant Safety Regulations:

Users are responsible for ensuring compliance with the safety instructions outlined in this manual, as well as adhering to national accident prevention regulations and domestic regulations governing working conditions, equipment operation, and safety.

1.2.4 Safety Instructions for Operation:

During operation, the user must take protective measures due to the presence of parts with dangerously high or low temperatures. Protective parts connected to running components, such as couplings, must not be removed from the machine. Safely discharging any harmful media (e.g., explosive, toxic, high-temperature

substances) is crucial to prevent personal injury and environmental hazards. Users must observe relevant laws and regulations and eliminate risks associated with electricity use, following German VDE code requirements and local electricity regulations.

1.2.5 Instructions for the Safe Use of Maintenance, Inspection, Disassembly, and Assembly:

It is the customer's responsibility to ensure that personnel conducting maintenance, inspection, and assembly work have carefully studied this manual and possess the necessary qualifications.

All work on the machine must be performed when the machine is in a shutdown state, following the shutdown procedures outlined in this manual.

Pumps and motor-pump assemblies handling toxic media must undergo proper cleaning.

Safety guards must be promptly reinstalled and made functional after completing the above operations.

1.2.6 Safety Instructions for Use in Explosive Situations:

This section provides information on the operation when used in explosive situations:

1.2.6.1 Pump Sets/Systems:

When the pump and other mechanical and electronic components form a pump group, the entire pump group and each component must comply with the requirements of Directive 94/9/EC.

1.2.6.2 Types of Coupling Shield:

The use of a coupling shield in explosive hazard areas must adhere to the following principles:

Materials that do not cause sparks.

The shield should be made of steel plate and designed to account for possible deformation (e.g., stepping on the guard) to reduce the potential danger of rotating parts coming into contact with it.

1.2.6.3 Pump Monitoring:

For pumps used in explosive hazardous areas, the operator must perform the following checks:

Leakage check of the shaft seal.

If necessary, check the temperature of the bearings.

The operator must ensure that the pump is stopped in an abnormal environment and should not restart it until the environmental conditions return to normal. Relevant operating and maintenance instructions mentioned in this operating manual must be followed.

1.2.6.4 Avoiding Sparks Due to External Impact:

When the pump is used in explosive atmospheres, the operator must ensure that any external impact that could cause a spark is avoided.

1.2.6.5 Grounding Protection:

The operator must ensure that the pump has grounding protection to discharge static electricity when used in explosive hazardous areas. All metal parts in the pump assembly must be properly grounded by cables and devices, such as grounding conductors. The insulation effect of the coating should also be considered.

1.2.7 Unauthorized Modifications and Spare Parts Production:

NES will not assume any obligation or responsibility for unauthorized modifications. In such cases, it is the responsibility of the equipment operator to ensure the safe operation of the unit. For safety reasons, spare parts and accessories approved by the manufacturer should be used. Otherwise, NES will not assume any obligation or responsibility.

1.2.8 Non-compliance with Operating Instructions:

The correct and safe operation of the machine can only be ensured by observing the operating instructions in this manual. Under no circumstances should the operating limits of the pump be exceeded.

2. Description

2.1. Operational Principle

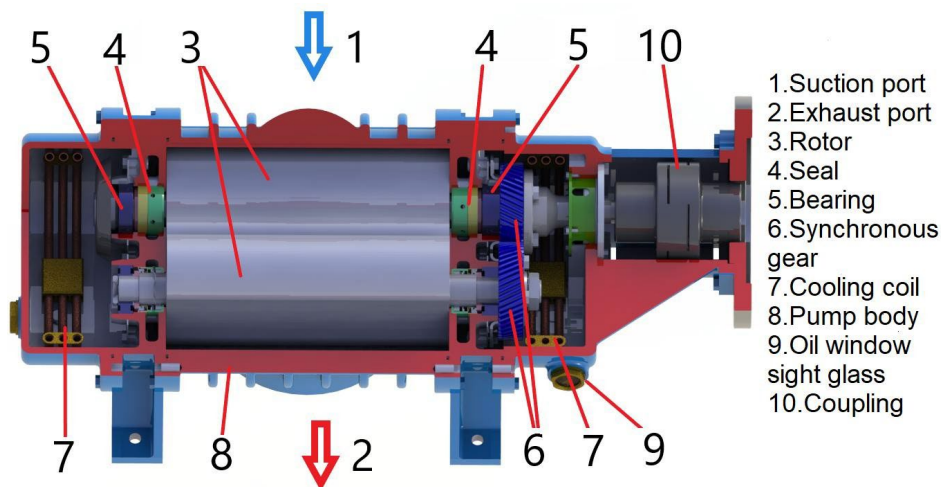
The NB Roots vacuum pump operates as a volumetric pump with two synchronized rotors rotating in opposite directions. These rotors maintain small gaps between themselves and the pump casing,

facilitating gas movement by synchronous and reverse rotation. The rotors, supported by bearings in the end cover, are kept in position by helical gears. The horizontal structure, with the air inlet at the top and exhaust port at the bottom, ensures stability during high-speed operation. Internal seals prevent oil leakage, and the absence of an exhaust valve simplifies the structure. The pump boasts a large pumping speed across a wide pressure range, operates smoothly with minimal vibration, and requires no lubrication in the pump cavity, reducing system pollution. Additionally, it offers fast start-up, reaching ultimate vacuum quickly, and has a low maintenance cost.

2.1.1 Roots Pump Features:

1. Wide pumping speed range (1.45×10^4 to 0.145 PSI)
2. Smooth operation with low vibration
3. No need for oil seal and lubrication in the pump cavity
4. Simple, compact structure
5. Fast start-up, low operation, and maintenance costs

2.2. Configuration



1. **Air Inlet:** Connects to the user's pipeline to extract gas from the target vessel.
2. **Exhaust Port:** Removes compressed gas.
3. **Rotor:** Geometrically symmetrical for low vibration, smooth running, and high speed.
4. **Seals:** Utilizes labyrinth seal plus mechanical seal for leak prevention.
5. **Bearing:** Angular contact ball bearings and roller bearings ensure high-speed operation.
6. **Synchronous Gear:** Helical teeth ensure synchronization, reduce noise, and guarantee smooth operation.
7. **Cooling Coil:** Designed with lubrication oil tanks and cooling coils for heat dissipation.
8. **Pump Body:** Provides good sealing to isolate the working medium.
9. **Oil Window Sight Glass:** Monitors oil level in the pump.
10. **Coupling:** Transmits power from the motor to the drive shaft through synchronous gears.

| No. | Part name | Material characteristics |
|-----|-----------------|--|
| 1 | Pump Body | Gray cast iron (HT250), exterior painted, various anti-corrosion coatings available on request |
| 2 | Rotor | Ductile iron (QT500), exterior painted, various anti-corrosion coatings available on request |
| 3 | Endcover | Grey iron (HT250), exterior painted, various anti-corrosion coatings available on request |
| 4 | Mechanical seal | Dynamic ring: tungsten carbide Static ring: Stainless steel housing, No. 5 graphite ring O-ring: Viton; optional Kalrez |
| 5 | Coating | Standard : None ; Optional : Ni-P: 15±5 PFA : 40±20µm |

2.3. Lubricant

NB Roots vacuum pumps undergo strict factory tests and are lubricated before leaving the factory. Proper lubrication is crucial for seals, bearings, and gears. Recommended lubricants vary with ambient temperature, ensuring effective lubrication. Using the wrong lubricant can lead to wear and heat issues. Regular lubricant changes are essential to prevent thickening, higher temperatures, and increased wear, ensuring optimal pump performance and longevity. Daily spot checks are advised for timely replenishment and replacement based on lubricant condition.

WARNING!

Insufficient oil level can lead to improper lubrication, causing damage to gears, bearings, and mechanical seals.

DANGER!

Under all circumstances do NOT try to replace the lubricant while the vacuum pump is in operation. Disregarding this caution could lead to severe damage to the equipment and pose a serious risk of injury to personnel. It is essential to check the oil level only when the vacuum pump is NOT operational. Ensure that the lubricant has been properly filled into the gear cavity and is at the correct oil level before starting the vacuum pump. Operating the vacuum pump without sufficient lubrication will cause it to cease functioning and nullify the warranty.

List of lubricant

Recommended mineral-based lubricants

| Ambient temperature | Shell | ExxonMobil |
|---------------------|-------------------------|--------------------------------|
| -0.4F to 32F | TELLUS S2 M 68(ISO68) | DTE HEAVY MEDIUM(ISO68) |
| 32F to 90F | TELLUS S2 M 100(ISO100) | DTE HEAVY (ISO100) |
| 90F to 122F | — | DTE EXTRA HEAVY MEDIUM(ISO150) |

Recommended synthetic-based lubricants

| Ambient temperature | Shell | ExxonMobil |
|---------------------|---------------------------|----------------|
| -0.4F to 32F | MADRELA S4 B 68 (ISO68) | SHC626(ISO68) |
| 32F to 90F | MADRELA S4 B 100 (ISO100) | SHC627(ISO100) |
| 90F to 122F | MADRELA S4 B 150 (ISO150) | SHC629(ISO150) |

2.4 Product Specification

| Model | Unit | NB100 | NB200 | NB400 | NB540 | NB720 | NB850 | NB1200 |
|--------------------------|------------|----------------------|-------|-------|-------|-------|-------|--------|
| Max. Pumping Speed | CFM | 100 | 200 | 400 | 540 | 720 | 850 | 1200 |
| | GPM | 745 | 1490 | 2996 | 4058 | 5373 | 6388 | 8987 |
| Nominal Pumping Speed | CFM | 79 | 160 | 320 | 435 | 575 | 650 | 965 |
| | GPM | 602 | 1189 | 2378 | 3265 | 4311 | 4850 | 7228 |
| Ultimate Pressure | Torr | 7.5×10^{-4} | | | | | | |
| | mbar | 1×10^{-4} | | | | | | |
| Motor power | HP | 2.95 | 2.95 | 2.95 | 5.36 | 5.36 | 10 | 10 |
| Suggested Rotation Speed | RPM | 1450 | 2900 | 2900 | 2900 | 2900 | 2900 | 2900 |
| Max. Rotation Speed | RPM | 3600 | 3600 | 3600 | 3600 | 3600 | 3600 | 3600 |
| Inlet Flange | ANSI | 3" | 3" | 4" | 4" | 4" | 6" | 6" |
| Outlet Flange | ANSI | 3" | 3" | 4" | 4" | 4" | 6" | 6" |
| Cooling Water Flow | GPM (15°C) | 0.211 | 0.211 | 0.25 | 0.25 | 0.396 | 0.396 | 0.501 |
| Cooling Water Connection | NPT | ¼ NPT | ¼ NPT | ¼ NPT | ¼ NPT | ¼ NPT | ¼ NPT | ¼ NPT |
| Lubricant Volume | Gallon | 0.25 | 0.25 | 0.25 | 0.375 | 0.375 | 1.001 | 1.001 |
| Total Length | Inches | 23.89 | 23.89 | 27.79 | 28.26 | 31.25 | 30.11 | 33.62 |
| Total Height | Inches | 14.84 | 14.84 | 14.84 | 14.96 | 14.96 | 20 | 20 |
| Width | Inches | 11.22 | 11.22 | 11.22 | 13.26 | 13.26 | 17 | 17 |
| Pump Weight | Lbs. | 160 | 160 | 195 | 260 | 300 | 450 | 520 |

| Model | Unit | NB1600 | NB2000 | NB2700 | NB2900 | NB3600 | NB4500 |
|--------------------------|------------|----------------------|--------|--------|--------|--------|--------|
| Max. Pumping Speed | CFM | 1600 | 2000 | 2700 | 2900 | 3600 | 4600 |
| | GPM | 11983 | 14963 | 20209 | 21699 | 26943 | 34427 |
| Nominal Pumping Speed | CFM | 1288 | 1600 | 2178 | 2796 | 3478 | 4450 |
| | GPM | 9637 | 11983 | 16294 | 20907 | 26026 | 33286 |
| Ultimate Pressure | Torr | 7.5×10^{-4} | | | | | |
| | mbar | 1×10^{-4} | | | | | |
| Motor Power | HP | 10 | 10 | 15 | 20 | 20 | 25 |
| Suggested Rotation Speed | RPM | 2900 | 2900 | 2900 | 2900 | 2900 | 2900 |
| Max. Rotation Speed | RPM | 3600 | 3600 | 3600 | 3000 | 3000 | 3000 |
| Inlet Flange | ANSI | 6" | 8" | 10" | 10" | 12" | 12" |
| Outlet Flange | ANSI | 6" | 8" | 10" | 10" | 12" | 12" |
| Cooling Water Flow | GPM (15°C) | 0.501 | 0.501 | 0.739 | 1.003 | 1.003 | 1.003 |
| Cooling Water Connection | NPT | ¼ NPT | ¼ NPT | ¼ NPT | ¼ NPT | ¼ NPT | ¼ NPT |
| Lubricant Volume | Gallon | 1.001 | 1.001 | 1.001 | 1.981 | 1.981 | 1.981 |
| Total Length | Inches | 36.61 | 40.59 | 46.57 | 50.39 | 54.33 | 59.33 |
| Total Height | Inches | 20 | 20 | 20 | 25.62 | 25.62 | 25.62 |
| Width | Inches | 17 | 17 | 17 | 23.03 | 23.03 | 23.03 |
| Pump Weight | Lbs. | 580 | 685 | 790 | 1275 | 1275 | 1600 |

| Model | Unit | NB5400 | NB7300 | NB7900 | NB10000 | NB27000 | NB60000 |
|--------------------------|------------|----------------------|---------|---------|---------|---------|---------|
| Max. Pumping Speed | CFM | 5503 | 7298 | 9417 | 12713 | 27916 | 68499 |
| | GPM | 41163 | 54589 | 70439 | 95102 | 208845 | 512411 |
| Nominal Pumping Speed | CFM | 3319 | 4414 | 7569 | 10229 | 23249 | 57092 |
| | GPM | 24838 | 33016 | 56618 | 76526 | 174037 | 427009 |
| Ultimate Full Pressure | Torr | 7.5x10 ⁻⁴ | | | | | |
| | mbar | 1x10 ⁻⁴ | | | | | |
| Motor Power | HP | 30 | 30 | 40 | 40 | 74 | 148 |
| Suggested Rotation Speed | RPM | 1450 | 1450 | 1450 | 1450 | 1000 | 1000 |
| | | | | | | | |
| Max. Rotation Speed | RPM | 2400 | 2400 | 1800 | 1800 | 1200 | 1200 |
| Inlet Flange | ANSI | 14" | 16" | 14" | 20" | 24" | 32" |
| Outlet Flange | ANSI | 14" | 16" | 14" | 20" | 24" | 32" |
| Cooling Water Flow | GPM (15°C) | 1.505 | 1.505 | 2.007 | 2.509 | 8.717 | 13.208 |
| Cooling Water Connection | NPT | 3/8 NPT | 3/8 NPT | 3/4 NPT | 3/4 NPT | G1 | G1 |
| Lubricant Volume | Gallon | 7.925 | 7.925 | 10.038 | 10.038 | 15.85 | 26.421 |
| Total Length | Inches | 61.41 | 70.07 | 80.59 | 98.62 | 85.67 | 119.64 |
| Total Height | Inches | 30.74 | 30.74 | 29.4 | 29.4 | 55.9 | 70.87 |
| Width | Inches | 28.34 | 28.34 | 37.55 | 37.55 | 59.76 | 64.56 |
| Pump Weight | Lbs | 2560 | 3250 | 5400 | 6855 | 11177 | 22928 |

3.

Installation

DANGER!

Before utilizing NB series Roots vacuum pumps in environments containing flammable, explosive, or highly toxic gases, it is advisable to seek guidance from the manufacturer.

WARNING!

Qualified technicians, equipped with proper safety measures and facilities, must carry out the installation and operation of the pump or pumping unit. It is essential to strictly adhere to the operating instructions, as well as comply with relevant on-site and legal requirements. Failure to follow the operating instructions may lead to the following consequences:

Possible damage to pumps or pump sets.

WARNING!

After completing the installation, prior to powering on the pump or pump set, manually rotate the impeller. If it rotates smoothly, the pump can be activated normally. In case of any abnormalities, thoroughly inspect the pump head connection and check for foreign substances in the pump cavity.

It is imperative to use this product in accordance with the specified operating parameters. Exceeding these limits may result in pump damage, and the following parameters must be strictly observed:

Maximum speed as per product specifications

Maximum exhaust temperature of 374°F

3.1 Pre-Installation

1. Inspection: Before unpacking, carefully check for shipping damage. If any damage is found, note it on the receipt and file a claim with the shipper or insurance company immediately.

2. Protective Cover: Do not remove the protective cover and plug until the vacuum pump is installed.

3. Installation Surface: Mount the vacuum pump on a flat, level surface, preferably a rigid, sturdy support base. Adjust the pump feet height to ensure even weight distribution, preventing deformations and vibrations during operation.

4. Bolts Tightening: Before tightening bolts, ensure that the pump feet and base surfaces are level. Avoid "soft foot" by preventing tilting or twisting, which can lead to pump seizure.

5. Base for Units: For units with a base, check for "soft feet" after placement. Install the complete unit on a solid foundation or heavy floor, ensuring it is level to avoid assembly warping.

6. Vibration Dampening: Use vibration dampers or damping pads to overcome slight vibration transmission to the base or frame. Place the damping pad under the motor/vacuum pump base or frame, not directly under the pump feet.

7. Piping Connections: Align piping precisely with the pump port and support independently. Misalignment can shorten bearing and seal life or lead to rotor scraping in the pump chamber.

8. Stress-Free Placement: Ensure stress-free placement, horizontally on its support surface. Tighten mounting bolts evenly to avoid undue stress on the vacuum pump. Check mounting clearance against the specified table.

9. C-Flange Connection: Most NB series Roots vacuum pumps use a C-flange, eliminating the need for a separate motor base and coupling shield. Control the motor speed within the specified range.

10. Protective Controls: Do not remove protective controls before installation and adhere to the recommended storage period of six months in a normal indoor environment.

3.1.1 Location

- Adequate space and lighting are essential for routine maintenance, whether installed indoors or outdoors.
- Keep the installation area well-ventilated and cool to prevent pump overload or over-temperature shutdown.
- Ensure a spacious and ventilated pump area, at least 7.87 inch away from surrounding objects.
- Check for "soft foot" issues and adjust as needed.

3.1.2 Foundation

- No special foundation is required, but ensure installation on a horizontal, load-bearing surface.
- Never install on a vertical or sloping surface.

3.1.3 Air Inlet

- Minimize dust and impurity contamination of incoming gas.
- Gas should be free of flammable, explosive, or toxic gases.
- Keep the exhaust port clear to prevent pump or motor shutdown.
- Adhere to the pump's running speed and exhaust temperature limits.

3.1.4 Softfoot

- "Soft foot" refers to a pump foot not resting horizontally on the base, causing uneven stress.
- Check and adjust the gap between each pump foot and the base using shims.
- Ensure all pump feet have a clearance less than 0.00197 inch. Tighten all bolts.
- Install a micrometer on the base with the thimble touching one pump foot.
- Loosen the bolts of this pump foot, observe the pointer change, and add adjustment shims to maintain a clearance less than 0.00197 inch.
- Repeat steps for all pump feet.

3.2 Safety Measures During Installation

By following these guidelines, you ensure the proper and stable installation of the NB series Roots vacuum pump.

DANGER!

Rotating components exist both inside and outside the vacuum pump/motor, and failure to operate them correctly or provide adequate protection can lead to severe personal injuries. Under no circumstances should the vacuum pump be operated when the inlet and exhaust pipes are detached. If checking the rotating components of the vacuum pump is necessary, ensure the motor power is entirely disconnected, the control cabinet is securely locked, and a warning sign is visibly displayed. During operation, the surface of the vacuum pump and its connected piping becomes notably hot, and it is crucial to refrain from touching the heated surface to prevent personnel burns.

- Keep adequate safety distance when loading and unloading cargo.
- Use only licensed lifting slings that are in good condition.
- Adjust the length of the slings to ensure that the pump or motor pump kit is suspended horizontally and secure.
- Do not remove the documentation that came with the pump.
- Do not remove the pump inlet/outlet protective cover, only before the pump set is about to be installed. Avoid

contamination of the pump and the entry of foreign objects into the pump chamber.

- Before carrying out installation work, please vent and purge the engineering system.
- If the working medium involves toxic and hazardous substances, when disassembling and cleaning the pump or pump set, please decontaminate as required and wear safety clothing.

WARNING!

When handling or installing the pump, ensure that the bracket's inclination to the horizontal surface does not surpass 10 degrees. An inclination exceeding 10 degrees could lead to the collapse of the product.

3.3. Loading, Unloading, and Storage Procedures

3.3.1 Loading and Unloading:

- Prior to unpacking, meticulously inspect the box for any shipping damage.
- If damage is observed, document the extent on the receipt or shipping slip and promptly file a claim with the shipper or insurance company.
- To unpack and inspect the pump, use a forklift or palletizing truck to move boxes to an easily disassembled location.
- Disassemble the pump package and carefully remove small accessories packed with the pump.

- Check the equipment for any damage or shortage and notify the manufacturer or shipping company in writing within 3 days if issues are identified.

- If not used immediately, wrap the pump box and store it properly.

3.3.2 Short-term Storage (less than 6 months):

- Vacuum pumps are shipped with protective controls to prevent rusting; do not remove these controls before installation.

- Store the pump in a vibration-free, dry indoor room, avoiding exposure to rain or sunlight.

- Maximum storage period is 6 months with the protective cover and plug in place.

3.3.3 Long-term Storage (6 months or more):

- To protect the pump from corrosion during long-term storage, follow these steps:

- Spray rust prevention oil into the pump's inner cavity, including the rotor, pump body, and end cover, at least once a year.

- Ensure both front and rear cover tanks are filled with vacuum pump oil.

- Apply anti-rust oil to the drive shaft and all exposed parts.

- Seal inlet, exhaust ports, and other pipe connections.

- Avoid obvious vibration during storage.

- Hang drying bags at both ends to prevent condensate.

- If possible, store in a constant temperature and humidity environment.

- Rotate the rotor manually once a month to prevent sticking.

3.4 Lubrication:

- NB series Roots vacuum pumps are factory tested and lubricated before delivery.

- Before starting the pump, check the oil level at the center mark of the oil level gauge.

- To add lubricant, loosen oiling port plugs, add lubricant slowly, observe the oil level in the window, and tighten the plug.

- To drain lubricant, loosen oil drain port plugs, drain slowly, observe the oil level, and tighten the plug.

DANGER!

Avoid attempting to change the lubricant while the vacuum pump is in operation, as disregarding this caution may lead to severe damage to the equipment and pose a significant risk of injury to personnel. Verify the oil level only when the vacuum pump is not running. Do not initiate the vacuum pump until you have confirmed that the lubricant has been appropriately introduced into the gear cavity and is at the correct oil level. Operating the vacuum pump without sufficient lubrication will result in pump failure and negate the warranty commitment.

3.5 Suction and Exhaust Pipe:

DANGER!

The handling of toxic, flammable, and explosive gases necessitate strict adherence to safety protocols, as failure to operate in accordance with safety instructions may lead to severe personal injury or even fatality. Systems involved in conveying toxic gases must undergo thorough gas purging operations to effectively dilute the toxic gases and maintain safe levels. Neglecting these guidelines could pose a serious risk of toxic gas leaks, potentially resulting in injuries or fatalities.

DANGER!

When dealing with flammable and explosive gases, it is imperative to install flame arrestors and ensure that the system can perform adequate gas purification operations to dilute toxic gases and maintain safe conditions. Disregarding these instructions may heighten the risk of flames being expelled from the suction and exhaust ports, leading to a fire or explosion hazard that could cause injuries or fatalities.

- Ensure isolation from the atmosphere and the engineering system when transporting hazardous substances.
- Ensure cleanliness and avoid foreign substances when connecting the pump to the engineering system.
- Use expansion joints at inlet and exhaust ends to prevent excessive loading.

- Support and guide piping to prevent stress on the pump; use hoses if needed for vibration reduction.

3.5.1 Engineering System to Connect the Air Inlet:

WARNING!

The vacuum pump is furnished with an inlet strainer designed to prevent impurities or foreign objects, such as welding slag, from entering the pump chamber in the engineering system. It is crucial not to remove this strainer during the initial startup. Failure to adhere to this instruction may lead to severe damage to the vacuum pump.

- The pump is equipped with an opening strainer at the inlet to prevent impurities from entering the pump chamber.
- Maintain cleanliness in the pipeline and regularly check the strainer's integrity.
- Keep the pipeline short for maximum conveying efficiency.
- Use effective sealing connections, such as O-ring (V type), at the pump suction port.
- Install an inlet check valve to isolate the pump from the process gas after shutdown.

3.5.2 Engineering System Connection Exhaust Port:

DANGER!

When discharging hazardous gas, it is essential to ensure that appropriate devices handle the exhaust gas, preventing the leakage of dangerous gas or steam to impact the surrounding environment. Failure to adhere to the safety instructions may result in personal injury or even death. Throughout the operation of the vacuum pump, it is imperative to keep the exhaust pipe unobstructed, avoiding any partial or complete blockage; otherwise, the vacuum pump may shut down or sustain damage. Failure to operate in accordance with the requirements can lead to an increase in exhaust pressure, posing a risk of explosion.

DANGER!

Non-compliance with safety instructions may result in personal injury or even death. In cases where the pumped gas contains condensable gas, ensuring the smooth removal of condensate during the vacuum pump's operation is necessary. If condensate removal is not smooth and backflow occurs, the vacuum pump may shut down or even suffer complete damage.

- Design the exhaust pipeline for sufficient pressure resistance and keep it unobstructed.
- If the pumped gas contains condensable gases, install a condensate recovery vessel.

3.6 Cooling Water:

WARNING!

Before initiating the vacuum pump and during its operation, it is crucial to ensure unobstructed cooling water flow and maintain a consistent water temperature (59°F). Abnormalities in the cooling water supply can lead to an increase in the vacuum pump lubricant temperature, causing seal failure, shutdown, and potential damage to the vacuum pump. In instances of prolonged vacuum pump operation, accumulated foreign matter in the cooling water pipe may obstruct the cooling water circuit, resulting in elevated lubricating oil temperatures and system breakdown.

WARNING!

Periodically opening the cooling water drain valve to completely discharge foreign materials is essential to eliminate these issues. Neglecting this maintenance step may lead to a shortened vacuum pump lifespan or even permanent damage.

- Use soft or deionized water for cooling to prevent calcium precipitation in the cooling water jacket.
- When connecting more than two Roots vacuum pumps to the cooling water circulation device, connect them in parallel.

3.7 Motor Drive:

- Most NB series Roots vacuum pumps are connected with a C-flange, eliminating the need for a separate motor base.
- Control the motor speed within the specified range in the product specification.

3.8. Electrical Connection:

DANGER!

When connecting explosion-proof motors to the power supply, it is imperative to use suitable cable glands to mitigate the risk of explosions. Prior to initiating the motor, ensure that the direction of rotation aligns with the indicated direction. Incorrect rotation may elevate pressure in the suction pipe, leading to potential damage to the machinery or personal injury. Additionally, before starting the motor, verify that the coupling guard cover on the front cover is correctly installed. Failure to install it properly may result in personal injury or even death.

- Connect the motor and other electrical equipment with the power supply or control cabinet disconnected.
- After wiring, turn the vacuum pump by hand to ensure free rotation.
- Check the rotation direction of the motor and follow specified steps to correct if necessary.

4. Operations

4.1 Preliminary Checks and Installation Overview

Before initiating the NB Roots vacuum pump for the first time, ensure the correct installation by following the guidelines in this manual to prevent premature wear or damage due to improper setup. Refer to the checklist below, considering the specific operational conditions and requirements of the environment in which the NB Roots vacuum pump is deployed.

(1) Placement: Install the Roots vacuum pump in a dry, well-ventilated, and clean location. (2)

Temperature: Maintain an ambient temperature between 41-104F. (3) Orientation: Install the Roots vacuum pump horizontally with adequate space for easy assembly, disassembly, and daily inspection. (4) Pipeline Connection: Ensure the pipeline connecting the pumped container is free of impurities, appropriately sized, and sealed to prevent leaks. (5) Elastic Connection: Use an elastic pipe to connect the Roots vacuum pump to the pre-stage pump to reduce vibration. (6) Chamber Inspection: Verify that no bolts, rags, or impurities are present in the pump chamber. (7) Gas Quality: The pumped gas should be free of granular solids. (8) Oil Level: Confirm the oil level through the sight glass is normal. (9) Motor Lubrication: Ensure the drive motor is adequately lubricated with proper overload protection. (10) Electrical Safety: Equip electrical components with interlocking protection devices. Ensure the Roots pump stops when the backing pump ceases operation. (11) Pre-Start: Turn off the power, affix a warning sign to prevent false starts, manually rotate the rotor, and check for smooth rotation. Address any issues if jamming or blocking occurs. (12) Motor Direction: Observe the direction of the motor fan/coupling rotation. Ensure it aligns with the arrow on the pump. For the initial start-up, operate the NB Roots vacuum pump under "no-load" conditions. If possible, open all vent valves and "flick" the motor to check for abnormal noise during operation. If no issues arise, repeat the check, allowing the motor to run for an extended period. If abnormalities occur, troubleshoot and resolve the problem before proceeding.

Upon successful checks and tests, the NB Roots vacuum pump is ready for continuous full-load operation. During the initial days of operation, regularly monitor the pump's operating parameters for any anomalies.

These checks are equally crucial when the NB Roots vacuum pump is part of a complete vacuum system. Before starting the pump, perform the necessary installation checks to avoid potential damage due to incorrect operation.

4.2 Initiating Pump Operations

WARNING!

Initiate the Roots pump only after starting the backing pump for pre-pumping. The Roots vacuum pump, functioning as a booster, should commence operation when the system pressure attains the inlet pressure set by the Roots pump.

The start-up of NB Roots vacuum pumps demands skilled operators or technicians with thorough training. Follow the procedures in the "Start-up Checklist" below after completing the required re-inspection procedures outlined in this manual.

Start-up Checklist

To prevent damage due to misuse during:

- Initial Installation
- Maintenance
- Shutdown and restart
- Equipment Relocation

WARNING!

Failure to adhere to this procedure, especially in the presence of a substantial pressure disparity between the front and rear of the pump, and the absence of an overload protection device in the motor, may lead to severe damage or casualties. When manually interacting with any rotating components such as vacuum pumps, motors, couplings, etc., always ensure that the power is disconnected to prevent inadvertent starts.

| Start-up Checklist | | |
|---|--------------------------|---|
| We recommend that the following procedures be followed to avoid damage to the vacuum pump due to misuse | | |
| ➤ Initial Installation | | ➤ Maintenance |
| ➤ Shutdown and restart | | ➤ Equipment Relocation |
| Check date: | | Operator: |
| 1 | <input type="checkbox"/> | Check that the vacuum pump oil level is normal. (See instructions in the lubrication section of section 2.3/3.4 of this manual for details) |
| 2 | <input type="checkbox"/> | Manual rotation of the rotor to ensure smooth rotation without jamming |
| 3 | <input type="checkbox"/> | Check to confirm that the air inlet is closed and the exhaust port is open |
| 4 | <input type="checkbox"/> | Check to make sure the cooling water inlet is on, the cooling water outlet is on, and the cooling water is circulating normally |
| 5 | <input type="checkbox"/> | Make sure the vacuum pump rotates in the same direction as indicated by observing the direction of motor fan/coupling rotation by flicking (instant start/stop). If the direction is wrong, adjust the power cord connection. |
| 6 | <input type="checkbox"/> | Turn on the Roots pump after the no-load operation of the backing vacuum pump reaches the allowable starting pressure of the Roots pump. Check the operating parameters of the pump for any abnormalities, such as excessive vibration, high oil temperature, high noise, high current, etc. These abnormalities are usually caused by improper lubrication and improper installation. If there is any abnormality, stop the pump immediately and refer to the troubleshooting section to restart it after eliminating the fault. |
| 7 | <input type="checkbox"/> | Open the air inlet load and run for 1-2 hours, then recheck the operating parameters (see 2.4 Product Specification for details of each operating parameter). If there is any abnormality, stop immediately and refer to the troubleshooting section to restart after eliminating the fault. |

Roots Vacuum Pump Start-up Procedure

(1) Start the backing pump. (2) Open the valve of the pre-pumping pipeline of the backing pump and the valve on the air inlet of the Roots pump. (3) After the system pressure reaches the allowable pressure of the Roots vacuum pump, close the pre-pumping valve and start the Roots vacuum pump. For systems without a pre-pumping pipeline and valve, start the Roots vacuum pump after reaching the starting pressure. This process can be automated by a pressure sensor. (4) Depending on the vacuum system's size, start the Roots vacuum pump after the backing pump has reached the allowed starting pressure to prevent overheating and seizing.

4.3 Operating Guidelines

WARNING!

Exceeding the permissible speed, differential pressure, and temperature during operation can result in a reduced service life or even damage to the vacuum pump. Refrain from touching the surface of the vacuum pump while it is in operation, as the surface temperature may reach its maximum operating limit of 374°F, causing severe burns. Even when the vacuum pump is stopped, ensure that its surface has cooled to room temperature before any contact.

WARNING!

Failure to adhere to these operating requirements may result in significant personal injury. The temperature is monitored by a temperature sensor (thermocouple), so it is crucial to verify that the sensor is in proper working condition. Incorrect temperature detection can compromise protection and potentially lead to vacuum pump damage. The upper operating limit of a vacuum pump is designed for short-term use and should not be sustained continuously. Failure to operate within the specified requirements may result in a shortened service life or damage to the vacuum pump.

Points to consider during Roots vacuum pump operation: (1) Operate within technical specifications. (2) Maintain inlet pressure below 0.192 PSI and maximum differential pressure within limits. (3) Monitor motor load and part temperatures. Maximum temperature rise should not exceed 104°F, with a maximum temperature of 176°F. If using a water ring pump as the backing pump, the maximum pump temperature should not exceed 212°F. (4) Watch for abnormal vibrations and noises during operation. (5) In case of motor overload, high temperature rise, abnormal sound, or vibration, shut down immediately. Investigate and resolve the causes before restarting.

4.4 Shutdown Procedure

WARNING!

Before halting pump operation, disconnect the Roots pump from the vacuum system and proceed to purge/flush the vacuum pump to clear the pump chamber and piping. Failure to adhere to these instructions may result in vapor condensation within the pump body, leading to corrosion or damage. Initiate the shutdown process by stopping the Roots pump first, followed by the backing pump. Stopping the pumps in the wrong sequence can result in motor damage to the Roots pump.

Follow the outlined procedure for a safe and effective shutdown of the Roots vacuum pump: The shutdown procedure involves isolating the Roots pump inlet valve, running the pump dry to remove residual gases and impurities, stopping the Roots vacuum pump and backing pump in a specific order, and bleeding air into the backing pump's inlet after stopping.

5. Maintenance and Care Guidelines

NB Roots vacuum pumps are engineered for prolonged performance under diverse working conditions. Regular checks, maintenance, and repairs, in line with operational requirements, are instrumental in extending the pump's service life and preventing damage resulting from improper use.

5.1 General Considerations

DANGER!

When maintaining vacuum pumps used for handling hazardous gases, especially when dealing with contaminated lubricants/grease and the replacement of spare parts, it is imperative to implement necessary decontamination and safety protection measures. The heating of the pump body above 500°F produces fluoride pyrolysis products, which are extremely hazardous and should be avoided through skin contact or inhalation. Neglecting safety instructions may lead to personal injury or even death. In cases where the vacuum pump is employed for pumping hazardous gases, regular checks on the sealing condition of the connection between the vacuum pump and the process piping are essential to prevent the leakage of toxic gases into the atmosphere. Disregarding safety instructions may result in personal injury or even death. Prior to vacuum pump maintenance, it is crucial to ensure that all electrical connections have been appropriately disconnected, and a prominent sign should be displayed to prevent accidental power activation during maintenance. Non-compliance with safety instructions may lead to personal injury or even death. Additionally, before vacuum pump maintenance, it is essential to confirm that the valve between the inlet engineering piping and the vacuum pump is correctly closed/disconnected and clearly marked to prevent inadvertent activation of the inlet valve during maintenance. Failure to follow safety instructions may result in personal injury or even death.

Most abnormalities in vacuum pump operation manifest in temperature, noise, vibration, current, and oil level. Daily checks using simple and cost-effective measuring instruments are highly recommended. Focus on the gearbox oil's condition, directly observable through the oil window sight glass without additional instruments.

For prolonged shutdowns, specific cleaning and protection measures are essential, aligning with instructions in the Long-term Storage (3.3) and Pump Shutdown (4.5) sections of this manual.

5.2 Maintenance Plan

The maintenance cycle correlates with the pump body's operating condition. Adjustments based on the project environment and experience are permissible. During maintenance, use manufacturer-recommended parts, seals, lubricants, and accessories.

| No. | Maintenance items | Checkpoint | Each day | Each month | Each quarter | Six months | Each year |
|-----|-------------------------|---|----------|------------|--------------|------------|-----------|
| 1 | Gas inlet/outlet | Are the pressure and temperature within the specified range? | √ | | | | |
| 2 | Oil level sight glass | Is the gearbox oil level in the proper position, too high or too low oil level will damage the gears and bearings, is there oil leakage? | √ | | | | |
| 3 | Motor load | Does the motor current change by testing? Is the current intensity within the specified range? An increase in current reflects abnormal pump operation. | √ | | | | |
| 4 | Pump and motor rotation | Is the rotation smooth and in the correct direction (clockwise)? | √ | | | | |
| 5 | Noise and vibration | Are there abnormal sounds and vibrations? Use the stethoscope to determine the scraping noise between the rotor and between the rotor and the pump body. | √ | | | | |
| 6 | Temperature | Check whether the oil tank temperature and vacuum pump surface temperature are normal? | √ | | | | |
| 7 | Oil level sight glass | Check the oil level, if the oil level drops in a short period of time, please check whether the seal including mechanical seal and lip seal fails. | √ | | | | |
| 8 | Oil level sight glass | Check the color of lubricant, contaminated oil is white or black, serious discoloration needs to replace the oil, clean the oil level sight glass. | | √ | | | |
| 9 | Bearing | Check whether the bearing lubricant is darkened, contaminated, or failed. | | √ | | | |
| 10 | Oil cooling system | Check whether the flow of cooling water is normal, if abnormalities are found check the cooling system. | | | √ | | |
| 11 | Pipe connection | Check whether the sealing performance of the engineering pipeline connected to the vacuum pump is normal, whether there are impurities and dirt deposits inside the pipeline, and clean it if there is. | | | √ | | |
| 12 | Gearbox | Change the lubricant in the gearbox. | | | √ | | |
| 13 | Bearing | Change bearing lubricant. | | | √ | | |
| 14 | Gearbox | Change lubricant in gear box, clean oil level sight glass. | | | | √ | |
| 15 | Bearing | Change bearing lubricant. | | | | √ | |
| 16 | Cooling Circulation | Check the flow of cooling water and the color of the discharged cooling water, check whether the temperature rise of in and out water of the cooling water is normal, if abnormalities are found | | | | √ | |

5.3 Inspection and Repair Guide

5.3.1 Temperature Check

- Normal Operation: Increased temperature due to gas compression.
- Abnormal Operation: Immediate inspection if local pump temperature rises excessively; measure clearance for corrective action.

5.3.2 Gearbox Oil Replacement

WARNING!

The gearbox contains internal pressure, and if there is a need to change the gearbox oil, the oil change procedure must be carried out after shutting down the system. Failure to adhere to the specified operation may result in personal injury due to the internal pressure or the high-speed rotation of gears, leading to the ejection of hot oil (above 194°F). Frequent gearbox oil

refilling or substantial oil consumption occurring within a short timeframe suggests a potential seal section leak. It is imperative to promptly stop the pump and seek guidance from the manufacturer or authorized agent. Neglecting these requirements may result in damage to the vacuum pump.

Daily inspection through oil window sight glass.

Procedure:

1. Remove oil filling port plug.
2. Collect discharged lubricant.
3. Drain oil.
4. Clean oil window.
5. Reassemble oil window.
6. If oil is discolored, clean until clean oil is discharged.
7. Clean oil drain plug.
8. Inject appropriate oil.
9. Reinstall oil filler plug.
10. Dispose of used oil safely.

5.3.3 Bearing Maintenance

WARNING!

Prior to disassembling the bearings, allow the pump body to cool down. Failure to wait for proper cooling may pose a risk of sustaining burns from high temperatures.

Free End Bearing

- Disassemble rear cover and end cover.
- Check for foreign objects or seizure after cleaning.
- Assemble in reverse order.

Fixed End Bearing

- Disassemble completely for inspection.

- Clean and check for foreign bodies or seizure.
- Consult the manufacturer for abnormalities.

5.3.4 Pipeline Checks

- Check cooling water pipes for corrosion or damage.
- Ensure secure power connections.
- Inspect engineering and exhaust piping for corrosion or damage.

5.3.5 Pump Body Cleaning

WARNING!

Ensure to power off the motor after filling the vacuum pump with a cleaning agent. Running the vacuum pump with cleaner-filled can lead to malfunctions or even damage to the vacuum pump.

Use appropriate cleaning agent.

Procedure:

1. Close suction port valve.
2. Disconnect connections.
3. Seal exhaust port with blind flange.
4. Fill pump body with cleaner.
5. Stand for over an hour.
6. Rotate pump body.
7. Discharge cleaning agent.
8. Check pump rotation.
9. Reconnect connections.
10. Safely dispose of used cleaning agent and sediment.

5.4 Purging

If equipped with auxiliary purging systems (seal, cooling, cleaning), adhere to design guidelines and schedule regular inspections for piping, valves, and instruments. Daily checks

for gas source pressure, flow, and cleanliness are crucial.

5.5 Cleaning Guide

For systems designed with auxiliary cleaning systems (solvent, steam), follow design guidelines strictly. Regular inspections and maintenance of piping, valves, instruments, and adherence to cleaning agent and steam requirements are vital for prolonged pump life. This comprehensive guide ensures the correct maintenance and care of NB Roots vacuum pumps, promoting sustained performance and longevity.

6. Disassembly & Assembly

Precautions Measures:

When disassembling and reassembling a Roots vacuum pump, adhere to the following precautions:

1. **Record Rotor Clearances:** Measure and document rotor clearances before disassembly.
2. **Handle Parts Carefully:** Avoid heavy hammer impacts, store removed parts safely to prevent damage.
3. **Document Replacement Reasons:** Detail reasons for replacement and record the use of replaced parts.
4. **Clean Parts Before Reassembly:** Thoroughly clean parts and remove burrs before reassembling.
5. **Protect Gaskets:** Take care not to damage gaskets at joint connections during pipe disassembly.
6. **Record Gasket Thickness:** Measure and record gasket thickness for various parts.

7. **Use Protective Gear:** Wear protective gloves and ensure all tools are clean during disassembly.

8. **Inspect for Damage:** Check for abnormal wear or damage during disassembly, especially in connecting parts.

9. **Preserve Removed Parts:** Store removed parts in a clean, rust-free, and dust-free environment, especially seals, bearings, and gears.

10. **Clean Disassembled Parts:** Use a cleaning agent to wipe all disassembled parts; replace worn or damaged parts with company-regulated products.

11. **Adjust Rotor Clearance:** Adjust rotor clearances according to the clearance chart.

12. **Conduct Leak Detection:** Perform leak detection after assembly.

13. **Conduct Trial Operation:** After reassembly, conduct trial operation and necessary performance tests before installation and use.

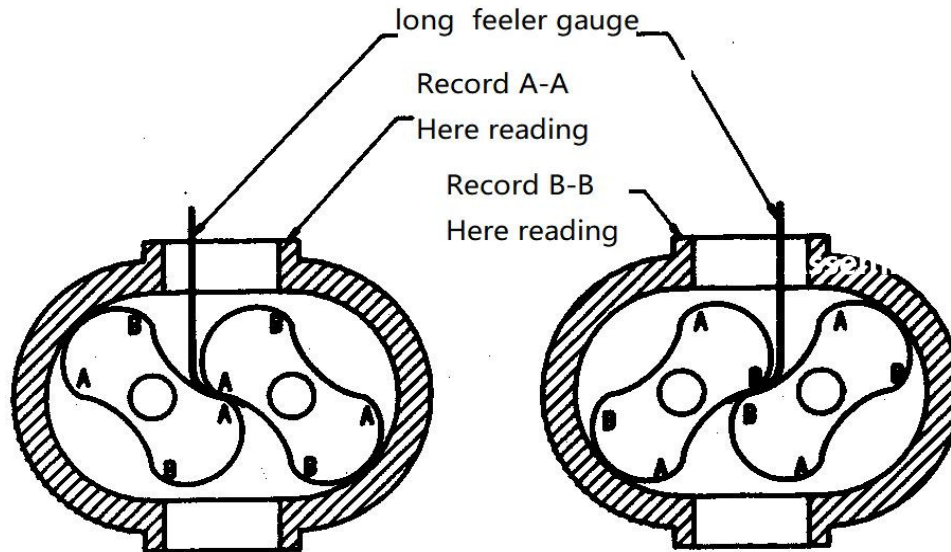
6.1 Disassembly

1. Remove all accessories from the pump system.
2. Remove the motor, coupling, and drive key.
3. Drain lubricant by removing oil drain plugs.
4. Loosen bolts fixing the seal seat, then remove the seal seat carefully.
5. Disassemble front and back covers, removing end O-rings.
6. Remove the drive shaft and associated components.

7. Loosen hexagonal bolts connecting the rear end cap, remove back cover part, and extract mechanical seal components.
8. Carefully remove bearings, mechanical seal components, and the back cover.
9. Remove O-ring from the pump body end face and auxiliary parts on the end cover.
10. Front and back covers are now removed. Note: Static ring and labyrinth removal are unnecessary unless the end cover is replaced.
11. Unscrew the round nut on the gear end, remove the round nut stop washer, and mark the position of the keyway on the rotors.
12. Use a puller to unload synchronous gears, gears keys, and rotors.
13. Unscrew hexagonal nut connecting the end cover and pump body, and remove the front cover.
14. Use a hexagonal wrench to loosen the hexagonal nut fixing the bearing plate and remove the locking washer.
15. Remove the front cover assembly, marking front and back covers for reassembly.

6.2 Assembly

1. Remove scratches on sealing surfaces and thoroughly clean all parts.
2. Install labyrinth and mechanical seal static ring on the end cover.
3. Position rotors vertically, placing gear end cover carefully.
4. Install mechanical seal dynamic ring on the shaft, lubricating the sealing surface.
5. Install double-row ball bearing, oil retainer plate, bearing platen, and locking washer.
6. Check rotor and end cover clearance; ensure proper free-end clearance.
7. Install gear key, drive gear, driven gear, stop washers, and hex nuts.
8. Add spacer at the bottom of the pump body and install O-ring and positioning pins.
9. Install rotors vertically into the pump body, fastening pump body and end cover with hexagonal bolts.
10. Check rotor clearance with depth gauge.
11. Install O-ring and positioning pin on the pump body.
12. Carefully install free end cover to the pump body, fixing it with hexagonal bolts.
13. Install mechanical seal dynamic ring and free end bearing.
14. Install oil retainer plate, hexagonal bolt, shaft washer, oil slinger, and elastic pin.
15. Install back cover parts, including oil cooler, O-ring, water pass-through bolt, and oil window sight glass.
16. Adjust inter-rotor clearance horizontally.
17. Bend the protruding part of the locking spacer into the groove of the locking nut.
18. Install the drive shaft, positioning pin, and rubber O-ring in the front cover.
19. Install the front cover assembly, fixing it with hex bolts.
20. Install a new mechanical seal static ring on the seal seat, press in the oil seal.
21. Install the mechanical seal dynamic ring on the drive shaft.
22. Measure the compression of the outer mechanical seal using a depth gauge.



23. Install the seal seat, ferrule joint, external cooling pipe, drive key, and flexible coupling.

24. Install the motor connecting flange, coupling screws, and coupling guard cover.

25. Run the pump according to assembly and operation instructions.

26. Observe the oil level frequently during initial operation to identify any potential issues.

6.3 Spare Parts List

When disassembling and assembling NB Roots vacuum pumps, the service parts listed in the table below cannot be reused after complete disassembly, including seals, bearings, and other parts. These parts are available for purchase as "kits" or "single parts". Note: Synchronous gears are not included in the repair parts and should be purchased separately if needed.

| NO. | Applicable Models | Structure Type |
|---|-------------------------------|------------------|
| 1 | NB200、 400 | Oil Seal |
| | | Mechanical Seal |
| 2 | NB540、 720 | Oil Slinger Seal |
| | | Oil Seal |
| | | Mechanical Seal |
| 3 | NB850、 1200、 1600、 2000、 2700 | Oil Slinger Seal |
| | | Oil Seal |
| | | Mechanical Seal |
| 4 | NB2900、 3600、 4500 | Oil Seal |
| | | Mechanical Seal |
| 5 | NB5400、 NB7300 | Mechanical Seal |
| 6 | NB7900、 NB10000 | Mechanical Seal |
| For more information, please contact your NES Representative. | | |



| NO . | Parts Name | NB200、NB400 | | NB540、NB720 | | |
|---------|---|-------------|-----------------|-------------|----------|-----------------|
| | | Quantity | | Quantity | | |
| | | Oil Seal | Mechanical Seal | Oil Slinger | Oil Seal | Mechanical Seal |
| 1 | Double row angular contact ball bearing | 2 | 2 | 2 | 2 | 2 |
| 2 | Roller bearing | 2 | 2 | 2 | 2 | 2 |
| 3 | Mechanical seal (inside) | / | 4 | / | / | 4 |
| 4 | Mechanical seal (outside) | 1 | 1 | 1 | 1 | 1 |
| 5 | Labyrinth Seal | 4 | 4 | / | 4 | 4 |
| 6 | Oil slinger dynamic ring | / | / | 4 | / | / |
| 7 | Oil slinger static ring | / | / | 4 | / | / |
| 8 | Skeleton Oil Seal (inside) | 4 | / | / | 4 | / |
| 9 | Skeleton Oil Seal (outside) | 1 | 1 | 1 | 1 | 1 |
| 10 | O-Ring (end cover) | 4 | 4 | 4 | 4 | 4 |
| 11 | O-Ring (sealing seat) | / | / | 1 | 1 | 1 |
| 12 | Coupling elastomer | 1 | 1 | 1 | 1 | 1 |
| 13 | Gear key | 2 | 2 | 2 | 2 | 2 |
| 14 | Gear adjustment gasket | 10 | 10 | 10 | 10 | 10 |
| 15 | Mechanical seal adjustment gasket | / | / | 10 | 10 | 10 |
| 16 | Bearing washer | 2 | 2 | 2 | 2 | 2 |
| 17 | Hexagon socket countersunk head screw | 4 | 4 | 2 | 2 | 2 |
| 18 | Hexagon socket bolt | 2 | 2 | / | / | / |
| 19 | Stop washers for round nut | / | / | 2 | 2 | 2 |
| 20 | Lock washer | / | / | 4 | 4 | 4 |
| 21 | Drive shaft lock washer | / | / | 2 | 2 | 2 |

| NO. | Parts Name | NB850、NB1200、NB1600、 NB2000、NB2700 | | | NB2900、 NB3600、 NB4500 |
|-----|---|---------------------------------------|-------------|--------------------|------------------------------|
| | | Quantity | | | Quantity |
| | | Oil Slinger | Oil Seal | Mechanical Seal | Mechanical Seal |
| 1 | Double row angular contact ball bearing | 2 | 2 | 2 | 4 |
| 2 | Roller bearing | 2 | 2 | 2 | 1 |
| 3 | Mechanical seal (inside) | / | / | 4 | 4 |
| 4 | Mechanical seal (outside) | 1 | 1 | 1 | 1 |
| 5 | Labyrinth Seal | / | 4 | 4 | 1 |
| 6 | Oil slinger dynamic ring | 4 | / | / | / |
| 7 | Oil slinger static ring | 4 | / | / | / |
| 8 | Skeleton Oil Seal (inside) | / | 4 | / | / |
| 9 | Skeleton Oil Seal (outside) | 1 | 1 | 1 | 1 |
| 10 | O-Ring (end cover) | 4 | 4 | 4 | 4 |
| 11 | O-Ring (sealing seat) | 1 | 1 | 1 | 1 |
| 12 | Coupling elastomer | 1 | 1 | 1 | 1 |
| 13 | Gear key | 2 | 2 | 2 | 2 |
| 14 | Gear adjustment gasket | 10 | 10 | 10 | 10 |
| 15 | Mechanical seal adjustment gasket | 10 | 10 | 10 | / |
| 16 | Bearing washer | 2 | 2 | 2 | 2 |
| 17 | Hexagon socket countersunk head screw | 2 | 2 | 2 | 4 |
| 18 | Hexagon socket bolt | / | / | / | / |
| 19 | Stop washers for round nut | 2 | 2 | 2 | / |
| 20 | Lock washer | 6 | 6 | 6 | 4 |
| 21 | Drive shaft lock washer | 2 | 2 | 2 | / |

| NO. | Parts Name | NB5400、NB7300 | NB7900、NB10000 |
|-----|---|---------------|----------------|
| 1 | Double row angular contact ball bearing | 4 | 4 |
| 2 | Self-aligning bearing | 1 | 1 |
| 3 | Mechanical seal (inside) | 4 | 4 |
| 4 | Mechanical seal (outside) | 1 | 1 |
| 5 | Labyrinth Seal | 4 | 4 |
| 6 | Oil slinger dynamic ring | / | / |
| 7 | Oil slinger static ring | / | / |
| 8 | Skeleton Oil Seal (inside) | / | / |
| 9 | Skeleton Oil Seal (outside) | 1 | / |
| 10 | O-Ring (end cover) | 2 | 4 |
| 11 | O-Ring (sealing seat) | 1 | 1 |
| 12 | Coupling elastomer | / | / |
| 13 | Gear key | 2 | 2 |
| 14 | Gear adjustment gasket | 10 | 10 |
| 15 | Mechanical seal adjustment gasket | / | / |
| 16 | Bearing washer | 2 | |
| 17 | Hexagon socket countersunk head screw | / | / |
| 18 | Hexagon socket bolt | / | / |
| 19 | Stop washers for round nut | / | 4 |
| 20 | Lock washer | / | / |
| 21 | Drive shaft lock washer | / | / |

7. Troubleshooting

| Common malfunction | Cause | Solution |
|-------------------------------|---|---|
| Low vacuum achievement | Air may be leaking in piping system | Detect the system leak |
| | Pressure drop of backing pump | Replace or repair backing pump |
| | Wearing of mechanical seal | Replace mechanical seal |
| Motor overload | Too high Inlet pressure | Increase the pumping time of the backing pump to reach the inlet pressure |
| | Contact between the rotor end face and endcover end face | Adjustment of rotor end face clearance should be done |
| | Backflow of fluid from backing pump to the Roots pump | Use of anti-fluid return device |
| Pump body overheated | Inadequate pumping speed of backing pump resulting in too high of compression ratio | Use a different backing pump |
| | Inlet pressure too high | Increase the pumping time of the backing pump to reach the inlet pressure |
| | Rotor contacts pump body | Make adequate adjustments and repairs |
| Oil tank temperature too high | Too much gearbox lubricant | Drain a part of the lubricant |
| | Inadequate cooling | Check the cooling device |
| | Inadequate lubrication of gears, bearings, and mechanical seals | Confirm oil volume and check lubrication |
| Makes abnormal sound | Bad or insufficient assembly | Reassembly should be done |
| | Gear and rotor may be offset, so that the rotor is noisy | Readjust of the rotor relative position |

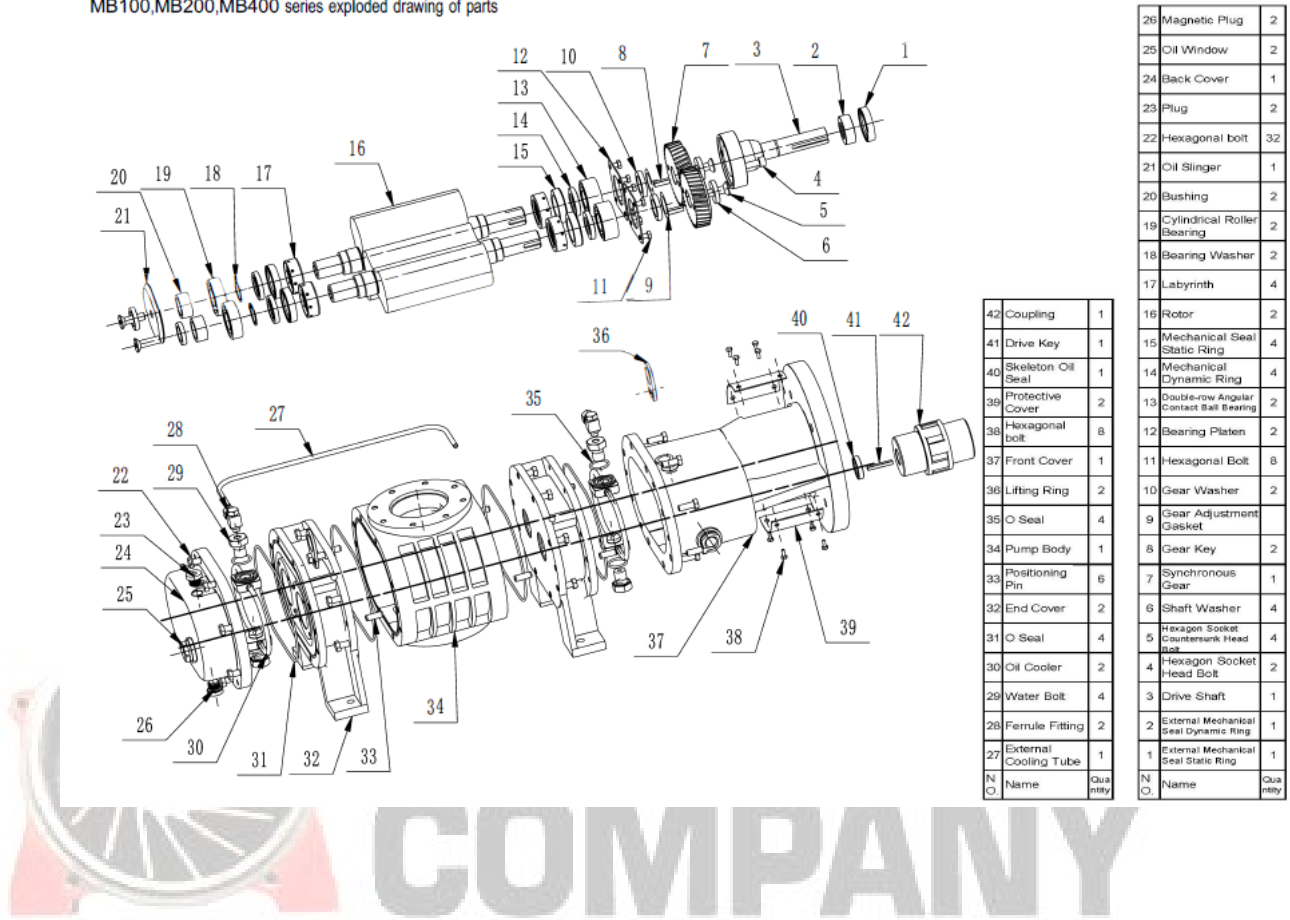
08 Reference Drawings

8.1 Clearance Table

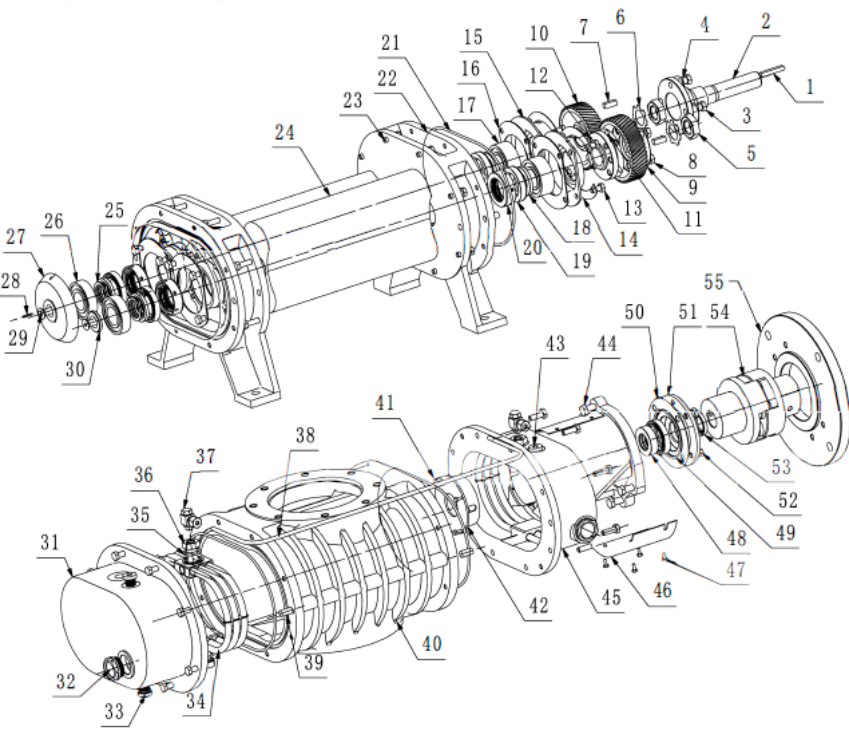
| Roots Vacuum Pump Clearance Table | | | | | Unit-Inches |
|-----------------------------------|-----------------|-----------------|-----------------|------------------------|-----------------|
| Model | Fixed End | Free End | Between Roots | Roots & Pump Body | |
| | | | | At The Positioning Pin | At The Port |
| NB200 | 0.0031 – 0.0051 | 0.0118 – 0.0169 | 0.0059 – 0.0118 | 0.0031 – 0.0070 | 0.0059 – 0.0098 |
| NB400 | 0.0031 – 0.0051 | 0.0118 – 0.0169 | 0.0059 – 0.0118 | 0.0031 – 0.0070 | 0.0059 – 0.0098 |
| NB540 | 0.0039 – 0.0059 | 0.0110 – 0.0169 | 0.0059 – 0.0118 | 0.0031 – 0.0078 | 0.0059 – 0.0110 |
| NB720 | 0.0039 – 0.0059 | 0.0110 – 0.0169 | 0.0059 – 0.0118 | 0.0031 – 0.0078 | 0.0059 – 0.0110 |
| NB850 | 0.0039 – 0.0070 | 0.0149 – 0.0188 | 0.0059 – 0.0118 | 0.0070 – 0.0118 | 0.0110 – 0.0161 |
| NB1200 | 0.0039 – 0.0070 | 0.0141 – 0.0188 | 0.0059 – 0.0118 | 0.0070 – 0.0118 | 0.0110 – 0.0161 |
| NB1600 | 0.0039 – 0.0070 | 0.0169 – 0.0220 | 0.0059 – 0.0118 | 0.0070 – 0.0118 | 0.0110 – 0.0161 |
| NB2000 | 0.0039 – 0.0070 | 0.0208 – 0.0259 | 0.0059 – 0.0118 | 0.0070 – 0.0118 | 0.0110 – 0.0161 |
| NB2700 | 0.0039 – 0.0070 | 0.0251 – 0.0299 | 0.0059 – 0.0118 | 0.0078 – 0.0129 | 0.0118 – 0.0169 |
| NB2900 | 0.0059 – 0.0090 | 0.0208 – 0.0271 | 0.0098 – 0.0141 | 0.0078 – 0.0118 | 0.0149 – 0.0188 |
| NB3600 | 0.0059 – 0.0090 | 0.0267 – 0.0318 | 0.0098 – 0.0141 | 0.0078 – 0.0118 | 0.0149 – 0.0188 |
| NB4500 | 0.0059 – 0.0090 | 0.0311 – 0.0370 | 0.0098 – 0.0141 | 0.0078 – 0.0118 | 0.0149 – 0.0188 |
| NB5400 | 0.0070 – 0.0098 | 0.0200 – 0.0248 | 0.0129 – 0.0181 | 0.0090 – 0.0129 | 0.0129 – 0.0181 |
| NB7300 | 0.0070 – 0.0098 | 0.0299 – 0.0338 | 0.0129 – 0.0181 | 0.0090 – 0.0129 | 0.0129 – 0.0181 |
| NB7900 | 0.0110 – 0.0141 | 0.0350 – 0.0421 | 0.0261 – 0.0318 | 0.0118 – 0.0188 | 0.0208 – 0.0271 |
| NB10000 | 0.0110 – 0.0141 | 0.0531 – 0.0598 | 0.0261 – 0.0318 | 0.0118 – 0.0188 | 0.0208 – 0.0271 |

8.2 Exploded View

Structure Type: Mechanical seal
MB100,MB200,MB400 series exploded drawing of parts



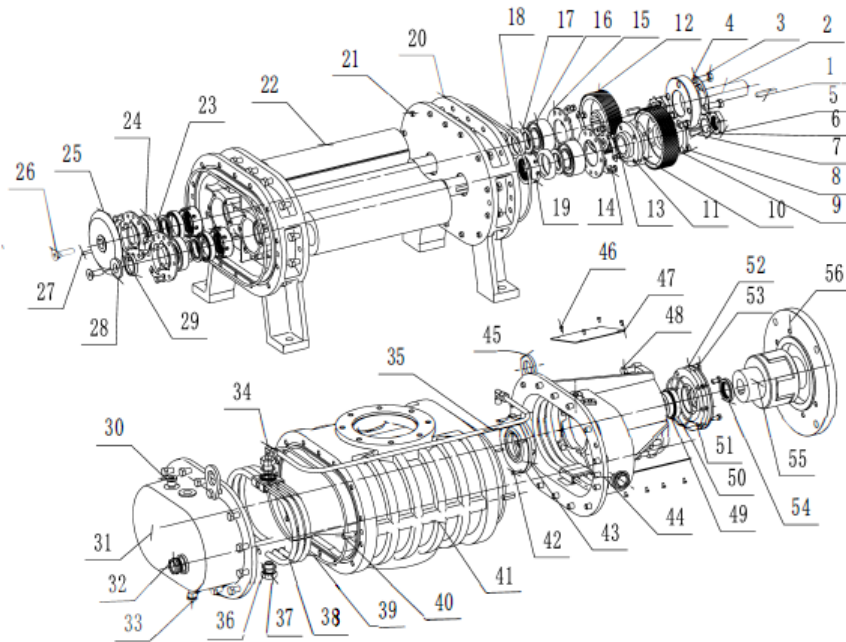
Structure Type: Mechanical seal
MB540,MB720 series exploded drawing of parts



| | | | | | |
|----|---------------------------------------|----------|----|--------------------------------------|----------|
| | | | 28 | Flexible pin | 1 |
| 55 | Motor connection flange | 1 | 27 | Oil Slinger | 1 |
| 54 | Flexible coupling | 1 | 26 | Single retaining edge roller bearing | 2 |
| 53 | Skeleton Oil Seal | 1 | 25 | Bearing Washer | 2 |
| 52 | Hexagonal bolt | 4 | 24 | Rotor | 2 |
| 51 | Seal seat | 1 | 23 | Hexagonal Nut | 32 |
| 50 | Mechanical seal adjustment gasket | | 22 | End Cover | 2 |
| 49 | O-ring rubber seal | 1 | 21 | O-ring rubber seal | 4 |
| 48 | External Mechanical Seal Dynamic Ring | 1 | 20 | Labyrinth | 4 |
| 47 | Hexagonal bolt | 8 | 19 | Mechanical Seal Static Ring | 5 |
| 46 | Protective Cover | 2 | 18 | Mechanical Seal Dynamic Ring | 4 |
| 45 | Front Cover | 1 | 17 | Double-row ball bearing | 2 |
| 44 | Hexagonal bolt | 4 | 16 | Oil baffle | 4 |
| 43 | Plug | 2 | 15 | Bearing Platen | 2 |
| 42 | Oil collection box | 1 | 14 | Locking gasket | 4 |
| 41 | Phillips screw | 4 | 13 | Hexagonal Nut | 16 |
| 40 | Pump body | 1 | 12 | Gear Hub | 1 |
| 39 | Cylindrical pin | 6 | 11 | Gear Adjustment Gasket | |
| 38 | External cooling tube | 1 | 10 | Synchronous helical gear | 1 |
| 37 | Ferrule Fitting | 2 | 9 | Gear locking gasket | 2 |
| 36 | Connection bolt | 4 | 8 | Hexagonal Nut | 4 |
| 35 | O-ring rubber seal | 4 | 7 | Gear Key | 2 |
| 34 | Oil Cooler | 2 | 6 | Stop Gasket | 2 |
| 33 | Magnetic Plug | 2 | 5 | Hexagonal Nut | 2 |
| 32 | Oil Window | 2 | 4 | Drive shaft locking gasket | 2 |
| 31 | Back Cover | 1 | 3 | Hexagonal bolt | 4 |
| 30 | Shaft end gasket | 1 | 2 | Drive Shaft | 1 |
| 29 | Hexagon socket countersunk head screw | 2 | 1 | Driver Key | 1 |
| N | Name | Quantity | N | Name | Quantity |



Structure Type: Mechanical seal
MB850,MB1200,MB1600,MB2000,MB2700 series exploded
drawing of parts

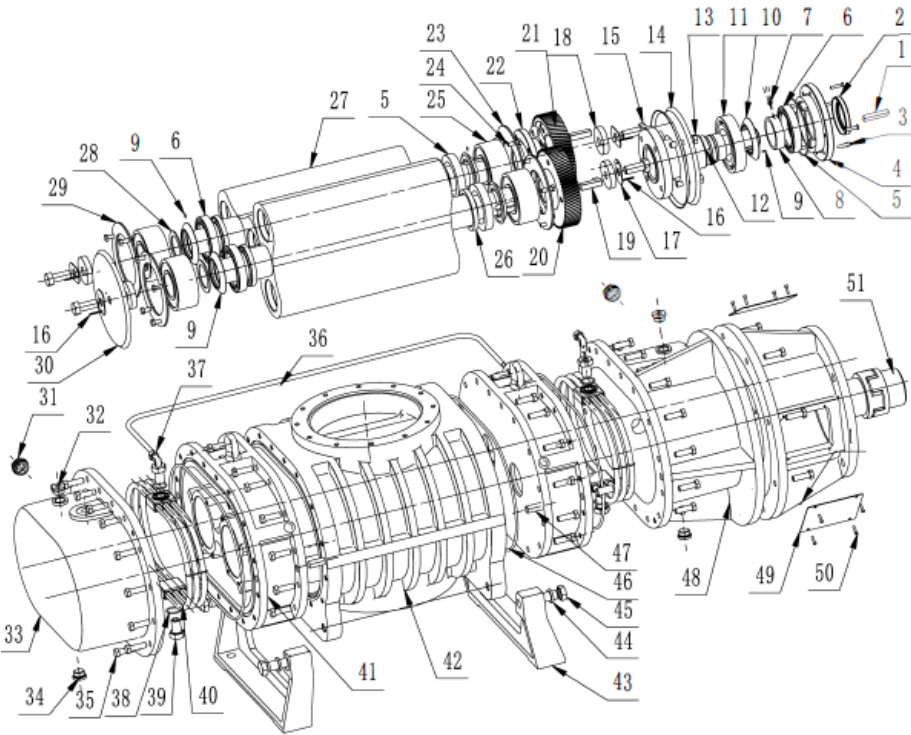


| | | |
|----|-----------------------------------|----------|
| 56 | Motor connection flange | 1 |
| 55 | Coupling | 1 |
| 54 | Skeleton Oil Seal | 1 |
| 53 | Hexagonal bolt | 4 |
| 52 | Seal seat | 1 |
| 51 | Mechanical seal adjustment gasket | 1 |
| 50 | O-ring seal | 1 |
| 49 | External Mechanical Seal | 1 |
| 48 | Hexagonal bolt | 4 |
| 47 | Coupling shield | 2 |
| 46 | Hexagon socket bolt | 8 |
| 45 | Lifting ring | 2 |
| 44 | Front cover | 1 |
| 43 | Oil collection box | 1 |
| 42 | Hexagonal bolt | 4 |
| 41 | Pump body | 1 |
| 40 | Positioning pin | 6 |
| 39 | O-ring seal | 4 |
| 38 | Oil Cooler | 2 |
| 37 | Water Bolt | 4 |
| 36 | O-ring seal | 4 |
| 35 | Cooling tube | 1 |
| 34 | Ferrule Fitting | 2 |
| 33 | Magnetic Plug | 2 |
| 32 | Oil Window | 2 |
| 31 | Back cover | 1 |
| 30 | Plug | 2 |
| 29 | Gasket | 1 |
| N | Name | Quantity |

| | | |
|----|---|----------|
| 28 | Shaft Washer | 1 |
| 27 | Flexible pin | 1 |
| 26 | Hexagon Socket Countersink Head Bolt | 2 |
| 25 | Oil Slinger | 1 |
| 24 | Cylindrical Roller Bearing | 2 |
| 23 | Bearing Washer | 2 |
| 22 | Rotor | 2 |
| 21 | Hexagonal bolt | 56 |
| 20 | End Cover | 2 |
| 19 | Labyrinth | 4 |
| 18 | Mechanical Seal Static Ring | 4 |
| 17 | Mechanical Seal Dynamic Ring | 4 |
| 16 | Double-row Angular Contact Ball Bearing | 2 |
| 15 | Bearing Flaten | 4 |
| 14 | Locking gasket | 6 |
| 13 | Hexagonal bolt | 18 |
| 12 | Synchronous Gear | 1 |
| 11 | Gear Hub | 1 |
| 10 | Gear Adjustment Gasket | |
| 9 | Gear locking gasket | 2 |
| 8 | Hexagonal Nut | 4 |
| 7 | Gear Key | 2 |
| 6 | Stop Gasket | 2 |
| 5 | Hexagonal Nut | 2 |
| 4 | Locking gasket | 2 |
| 3 | Hexagonal bolt | 4 |
| 2 | Drive Shaft | 1 |
| 1 | Driver Key | 1 |
| N | Name | Quantity |



Structure Type: Mechanical seal
MB2900,MB3600,MB4500 series exploded drawing of parts



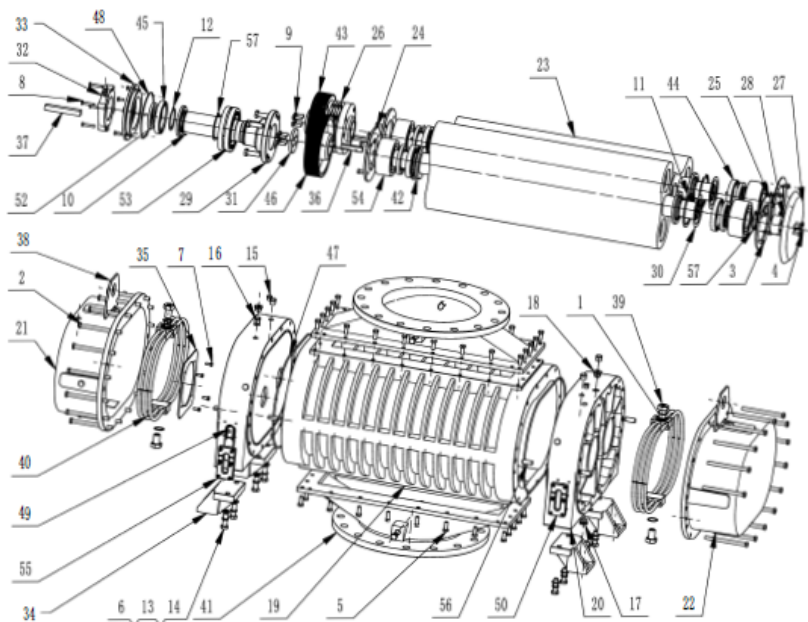
| | | |
|----|-----------------------|----------|
| 51 | Coupling | 1 |
| 50 | Hexagonal bolt | 8 |
| 49 | Protective Cover | 2 |
| 48 | Front Cover | 1 |
| 47 | Positioning pin | 6 |
| 46 | O-ring seal | 4 |
| 45 | Hexagonal bolt | 4 |
| 44 | Flexible gasket | 4 |
| 43 | Pump foot | 2 |
| 42 | Pump body | 1 |
| 41 | End Cover | 2 |
| 40 | Oil cooler | 2 |
| 39 | Water bolt | 4 |
| 38 | O-ring seal | 4 |
| 37 | Ferrule Fitting | 2 |
| 36 | External cooling tube | 1 |
| 35 | Hexagonal bolt | 72 |
| 34 | Magnetic Plug | 2 |
| 33 | Back cover | 1 |
| 32 | Plug | 2 |
| 31 | Oil window | 2 |
| 30 | Oil Slinger(back) | 1 |
| 29 | Bearing Platen(back) | 2 |
| 28 | Bearing gasket | 2 |
| 27 | Rotor | 2 |
| N | Name | Quantity |
| O | | |

| | | |
|----|---|----------|
| 26 | Labyrinth | 4 |
| 25 | Double row Angular Contact Ball Bearing | 4 |
| 24 | Hexagonal bolt | 16 |
| 23 | Bearing Platen(front) | 2 |
| 22 | Gear Hub | 1 |
| 21 | Gear Adjustment Gasket | |
| 20 | Synchronous Gear | 1 |
| 19 | Gear key | 2 |
| 18 | Shaft end gasket | 4 |
| 17 | Locking gasket | 2 |
| 16 | Flexible pin | 4 |
| 15 | Hexagonal bolt | 4 |
| 14 | Oil Slinger(front) | 2 |
| 13 | Hexagonal bolt | 4 |
| 12 | Drive Shaft | 1 |
| 11 | Cylindrical Roller Bearing | 1 |
| 10 | Mechanical Seal Dynamic Ring | 5 |
| 9 | Flexible pin | 5 |
| 8 | Dynamic ring retainer | 1 |
| 7 | Hexagon socket set screws | 3 |
| 6 | Mechanical Seal Static Ring | 5 |
| 5 | O-ring seal | 1 |
| 4 | Seal seat | 1 |
| 3 | Hexagon Socket Countersunk Head Bolt | 4 |
| 2 | Skeleton Oil Seal | 1 |
| 1 | Driver Key | 1 |
| N | Name | Quantity |
| O | | |



COMPANY

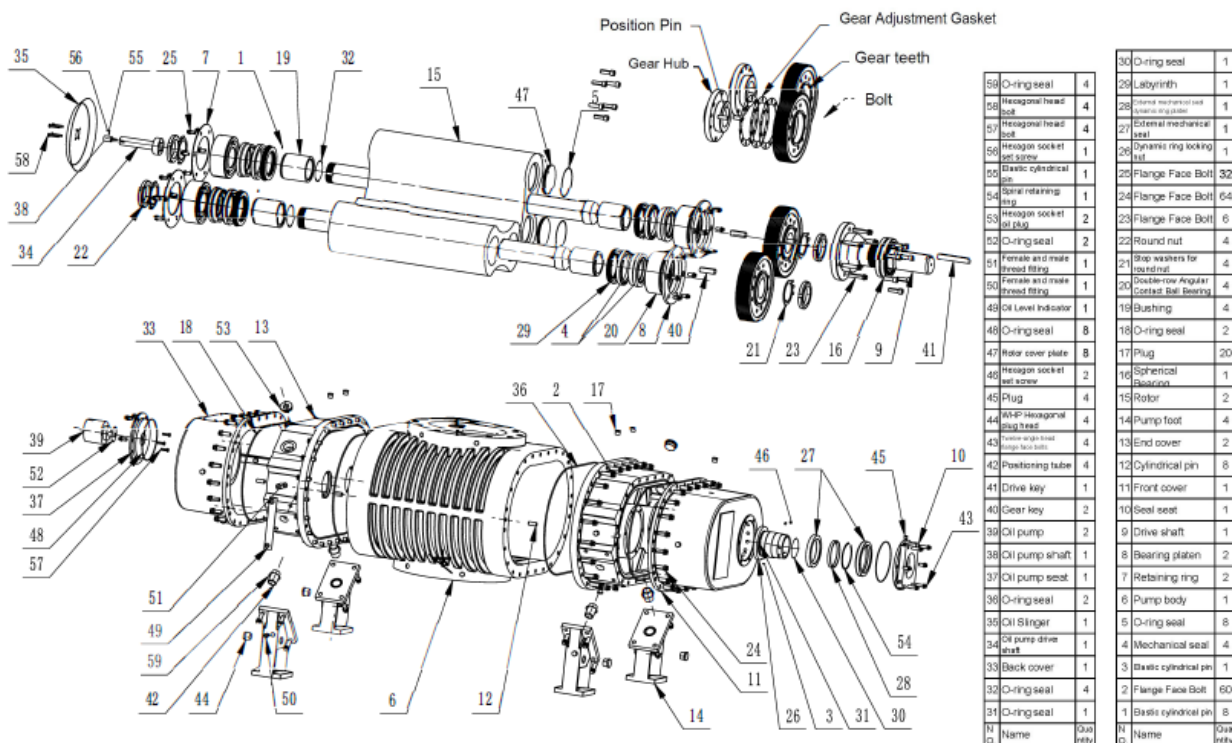
MB5400,MB7300 series exploded drawing of parts



| | | | | | |
|------|-------------------------------------|-------------|------|----------------------------------|-------------|
| 57 | Shaft retaining ring | 2 | | | |
| 56 | Shaft retaining ring | 2 | 28 | Oil Slinger Gasket | 1 |
| 55 | Cylindrical pin | 8 | 27 | Oil Slinger | 1 |
| 54 | Hexagon socket screw | 24 | 26 | Gear Adjustment Gasket | 10 |
| 53 | Double row deep groove ball bearing | 4 | 25 | Retaining ring | 2 |
| 52 | Spherical roller bearings | 1 | 24 | Bearing platen | 2 |
| 51 | Skeleton Oil Seal | 1 | 23 | Rotor | 2 |
| 50 | Sight glass platen | 4 | 22 | Back cover | 1 |
| 49 | O-ring seal | 4 | 21 | Front cover | 1 |
| 48 | O-ring seal | 1 | 20 | End cover | 2 |
| 47 | O-ring seal | 2 | 19 | Pump body | 1 |
| 46 | Drive gear | 1 | 18 | Plug | 2 |
| 45 | Mechanical Seal Static Ring | 5 | 17 | Magnetic Plug | 2 |
| 44 | Mechanical Seal Dynamic Ring | 5 | 16 | Plug | 18 |
| 43 | Driven gear | 1 | 15 | Plug | 4 |
| 42 | Labyrinth | 4 | 14 | Flat washer | 8 |
| 41 | Air inlet and outlet connector | 2 | 13 | Flexible gasket | 8 |
| 40 | Oil cooler | 2 | 12 | Elastic retaining ring for shaft | 1 |
| 39 | Water Bolt | 4 | 11 | Elastic retaining ring for hole | 4 |
| 38 | Lifting ring | 2 | 10 | Flexible pin | 5 |
| 37 | Drive key | 1 | 9 | Hexagonal bolt | 8 |
| 36 | Gear Key | 2 | 8 | Hexagonal bolt | 4 |
| 35 | Oil baffle | 1 | 7 | Hexagonal bolt | 8 |
| 34 | Pump foot | 4 | 6 | Hexagonal bolt | 12 |
| 33 | Seal seat | 1 | 5 | Hexagonal bolt | 44 |
| 32 | Seal seat cover | 1 | 4 | Hexagonal bolt | 4 |
| 31 | Shaft Gasket | 2 | 3 | Hexagonal bolt | 16 |
| 30 | Mechanical seal gasket | 2 | 2 | Hexagonal bolt | 32 |
| 29 | Drive shaft | 1 | 1 | O-ring seal | 4 |
| N.C. | Name | Qty mbly | N.C. | Name | Qty mbly |



MB7900,MB10000 series exploded drawing of parts



COMPANY