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Operation & Maintenance Manual

for NRB Roots Blower

NES COMPANY

WARNING

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

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

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

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

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

NOTICE

SERVICE AND PARTS

SERVICE AND PARTS FOR NES BLOWERS 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 BLOWER SIZES MUST BE PROVIDED.

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

If the location of the nearest oЄce 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 modiτed 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 speciτed 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 notiτed 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 proτts, 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

Manual Index

List of Sections

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 NRB Roots blowers. For the longevity of the blower, 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 blower or motor-blower assembly.

Model	Max. Speed RPM	Positive Pressure Blower		Negative Pressure Blower	
		Max. Pressure (PSIG)	Max. Temperature rise (°F)	Max. Vacuum degree (In Hg)	Max. Temperature rise (°F)
NRB3206	4000	15	302	15	302
NRB3210	3600	15	302	15	302
NRB4009	4000	18	302	17	302
NRB4012	4000	15	302	15	302
NRB5507	3800	18	302	17	302
NRB5511	3800	17	302	17	302
NRB5514	3800	13	302	15	302
NRB5518	3800	10	302	15	302
NRB7017	3000	15	293	15	302
NRB7021	3000	15	293	15	293
NRB7026	3000	12	221	15	248

Table 1. Applicable blower 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.

Blowers and motor-blower 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 Blower Sets/Systems:

When the blower and other mechanical and electronic components form a blower group, the entire blower 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 Blower Monitoring:

For blowers 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 blower 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 blower 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 blower has grounding protection to discharge static electricity when used in explosive hazardous areas. All metal parts in the blower assembly must be properly grounded by cables and devices, such as grounding conductors. The insulation effect of the coating should also be taken into account.

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 blower be exceeded.

2. Description

2.1. Operational Principle

The Roots blower functions as a double-rotor compression apparatus with parallel axes for the two rotors. A small clearance is maintained between the rotors and between the rotor and the pump body and end cover to prevent any mutual contact. Both rotors are synchronized and driven by a motor through a pair of gears, rotating at equal speeds in opposite directions. Through the mutual meshing of the rotors, the blower inlet and exhaust ports are not directly connected. The rotor, casing, and end cover together form a closed basic unit volume, and its size remains constant during rotation. Gas compression is achieved by equalizing the pressure of high-pressure gas when it φows back into the basic unit volume precisely when the basic unit volume is connected to the exhaust port.

The NRB series Roots blowers feature a horizontal structure, where the blower's air inlet is positioned at the top, and the exhaust port is located at the bottom. This conτguration ensures that the blower maintains a low center of gravity, providing excellent stability during high-speed operation.

To prevent lubricant ingress into the pump body, four internal seals are incorporated in the

end cover on both sides. Additionally, an outlet shaft seal is implemented to prevent internal leakage.

The motor's power is transmitted to the drive shaft through either a coupling or a triangle tape, and subsequently, the driven shaft is actuated through the use of synchronous gears.

2.1.1 Roots Blower Features:

(1) Being a positive displacement blower, it exhibits the characteristic of delivering air under forced conditions. With a constant speed, the φow rate remains consistent (with minimal changes under pressure variations). Importantly, it avoids surge phenomena common in centrifugal blowers, maintaining smooth operational characteristics, even at low φow rates.

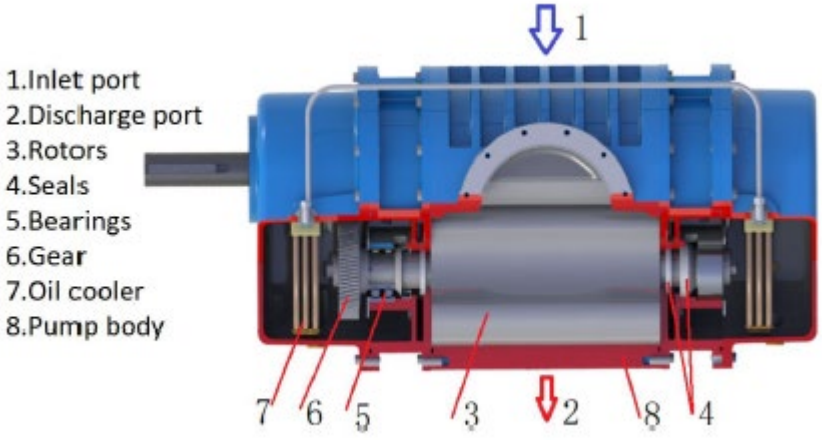
(2) As a rotary machine, it lacks a reciprocating motion mechanism and gas valve, resulting in fewer wearing parts. This design contributes to a long service life, excellent power balance, and the ability to operate at high speeds. With multiple suction and exhaust cycles per rotation, it ensures a more uniform airφow speed, eliminating the need for storage tanks, unlike piston compressors.

(3) The rotor, rotor-pump body, and end cover maintain small clearances, eliminating the need for oil lubrication during operation, as seen in sliding vane compressors. This feature guarantees that the delivered gas remains free from oil. The presence of clearances and the absence of a gas valve also enhance safety when transporting gases containing dust or liquid droplets.

(4) With minimal mechanical friction beyond synchronous gears, bearings, and mechanical seals, the Roots blower achieves high mechanical eЄciency. This is particularly evident in large Roots blowers, where both volumetric and total adiabatic eЄciency are notably high.

Furthermore, the Roots blower boasts a range of advantages, including a straightforward and compact structure, diminutive size, lightweight design, prolonged lifespan, ease of manufacturing, and a convenient, short maintenance cycle. However, it comes with its share of drawbacks, such as lacking an internal compression process, leading to low adiabatic eЄciency– particularly noticeable in smaller models. The presence of clearances results in gas leakage, which amplitτes with increasing pressure, thus constraining the evolution of Roots blowers towards high-pressure applications. Additionally, the dynamic noise generated by gas pulsation, backφow impact from inlet and exhaust, is relatively pronounced.

2.2. Conτ guration



1. Air Inlet: Connects to the user's pipeline to extract gas from the target vessel.
2. Discharge 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. Blower Body: Provides good sealing to isolate the working medium.

No.	Part name	Material characteristics
1	Blower 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

WARNING!

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

2.3. Lubricant

NRB Roots blowers 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 blower performance and longevity. Daily spot checks are advised for timely replenishment and replacement based on lubricant condition.

DANGER!

Under all circumstances do NOT try to replace the lubricant while the blower 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 blower is NOT operational. Ensure that the lubricant has been properly τlled into the gear cavity and is at the correct oil level before starting the blower. Operating the blower without suϵcient 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 PLUS 68(ISO68)	DTE HEAVY MEDIUM(ISO68)
32F to 90F	TELLUS PLUS 100(ISO100)	DTE HEAVY (ISO100)
90F to 122F	TELLUS PLUS 150(ISO150)	DTE EXTRA HEAVY MEDIUM(ISO150)

Recommended synthetic-based lubricants

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

2.4 Product Specit cation

Model	Unit	NRB3206	NRB3210	NRB4009	NRB4012	NRB5507	NRB5511	NRB5514
Flow Range	CFM	21 ⌂ 220	37 ⌂ 368	49 ⌂ 497	87 ⌂ 682	99 ⌂ 795	150 ⌂ 1172	490 - 1522
Shaft power	HP	1.07 ⌂ 4.02	1.20 ⌂ 28.16	1.79 ⌂ 45.59	2.01 ⌂ 50.95	2.54 ⌂ 69.73	2.95 ⌂ 83.14	3.48 ⌂ 95.21
Max.Rotation Speed	RPM	4000	4000	4000	4000	3800	3800	3800
Max. Vacuum Degree	In. Hg	15	15	17	15	17	17	15
Max. Pressure	PSIG	15	15	18	15	18	17	13
Inlet Flange	ANSI	3♀	4♀	4♀	4♀	6♀	6♀	6♀
Outlet Flange	ANSI	3♀	4♀	4♀	4♀	6♀	6♀	6♀
Cooling Water Flow	GPM (15■C)	0.21	0.25	0.25	0.39	0.39	0.5	0.5
Cooling Water Connection	NPT	1/4 NPT	1/4 NPT	1/4 NPT	1/4 NPT	1/4 NPT	1/4 NPT	1/4 NPT
Lubricant Volume	Gallon	0.25	0.25	0.37	0.37	1	1	1
Total Length	Inches	19.8	23.8	25	28	27.9	31.4	34.4
Total Height	Inches	14.8	14.8	15	15	20	20	20
Width	Inches	9.8	9.8	12.67	12.67	16.75	16.75	16.75
Pump Weight	Lbs	160	194	260	300	450	520	580

Model	Unit	NRB5518	NRB7017	NRB7021	NRB7026	NRB9027	NRB1230	NRB1248
Flow Range	CFM	350 ⌂ 1963	602 ⌂ 2809	783 ⌂ 3480	105 ⌂ 24317	620 ⌂ 5318	772 ⌂ 9021	1305 - 9278
Shaft power	HP	4 ⌂ 9.4	7.2 ⌂ 226.6	8.3 ⌂ 244	1.74 ⌂ 241.4	8 ⌂ 370.1	12 ⌂ 385	14.75 - 269
Max. Rotation Speed	RPM	3800	3000	3000	3000	2400	1800	1400
Max. Vacuum Degree	In. Hg	15	15	15	15	15	12	10
Max. Pressure	PSIG	10	15	15	12	15	9	6
Inlet Flange	ANSI	8♀	10♀	12♀	12♀	14♀	14♀	20♀
Outlet Flange	ANSI	8♀	10♀	12♀	12♀	14♀	14♀	20♀
Cooling Water Flow	GPM (15■C)	0.5	1	1	1	1.5	2	2.5
Cooling Water Connection	NPT	1/4 NPT	1/4 NPT	1/4 NPT	1/4 NPT	3/8 NPT	3/8 NPT	G 1/4
Lubricant Volume	Gallon	1	2	2	2	8	10	10
Total Length	Inches	34.4	50	54	54	61.4	80.6	98.6
Total Height	Inches	20	25.6	25.6	25.6	30.7	29.4	29.4
Width	Inches	16.75	14.5	14.5	14.5	18.1	27.7	27.7
Pump Weight	Lbs	683	1274	1450	1600	2560	5400	6856.4

3.

Installation

DANGER!

Before utilizing NRB series Roots blowers in environments containing φammable, explosive, or highly toxic gases, it is advisable to seek guidance from the manufacturer.

WARNING!

Qualiτed technicians, equipped with proper safety measures and facilities, must carry out the installation and operation of the blower or blower 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 blowers or blower sets.

WARNING!

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

It is imperative to use this product in accordance with the speciτed operating parameters. Exceeding these limits may result in blower damage ⌂ maximum speed, maximum pressure, maximum vacuum degree, maximum exhaust temperature according to product speciτcations.

3.1 Pre-Installation

1. Inspection: Before unpacking, carefully check for shipping damage. If any damage is found, note it on the receipt and τle a claim with the shipper or insurance company immediately.
2. Protective Cover: Do not remove the protective cover and plug until the blower is installed.
3. Installation Surface: Mount the blower on a φat, level surface, preferably a rigid, sturdy support base. Adjust the blower feet height to ensure even weight distribution, preventing deformations and vibrations during operation.
4. Bolts Tightening: Before tightening bolts, ensure that the blower feet and base surfaces are level. Avoid "soft foot" by preventing tilting or twisting, which can lead to blower 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 φoor, 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/blower base or frame, not directly under the blower feet.
7. Piping Connections: Align piping precisely with the blower inlet & outlet port and support independently. Misalignment can shorten bearing and seal life or lead to rotor scraping in the blower chamber.
8. Stress-Free Placement: Ensure stress-free placement, horizontally on its support surface. Tighten mounting bolts evenly to avoid undue stress on the blower. Check mounting clearance against the speciτed table.
9. Follow product spec sheet: NRB series Roots blowers speed, maximum pressure, maximum vacuum degree, maximum exhaust temperature must be strictly controlled within the range speciτed according to product speciτcations.
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 blower overload or over-temperature shutdown.
⌠ Ensure a spacious and ventilated blower area, at least 7.87 inch away from surrounding objects.
⌠ Check for "soft foot" issues and adjust as needed.

3.1.2 Foundation

⌠ The blower requires a reliable found for permanent installation like a steel base underneath the blower and motor or a separate steel plate underneath will also work.

- Soft foot can be avoided by mounting the base on a stable basis and use of shims can reduce the pressure on the blower base when the blower foot screws are tightened.

3.1.3 Air Inlet

⎧ Minimize dust and impurity contamination of incoming gas.

⎧ Gas should be free of φammable, explosive, or toxic gases.

⎧ Keep the exhaust port clear to prevent blower or motor shutdown.

⎧ Adhere to the blower's running speed and exhaust temperature limits.

3.1.4 Softfoot

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

3.2 Safety Measures During Installation

By following these guidelines, you ensure the proper and stable installation of the NRB series Roots blower.

DANGER!

Rotating components exist both inside and outside the blower/motor, and failure to operate them correctly or provide adequate protection can lead to severe personal injuries. Under no circumstances should the blower be operated when the inlet and exhaust pipes are detached. If checking the rotating components of the blower 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 blower 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 blower or motor blower kit is suspended horizontally and secure.
- Do not remove the documentation that came with the blower.
- Do not remove the blower inlet/outlet protective cover, only before the blower set is about to be installed. Avoid contamination of the blower and the entry of foreign objects into the blower 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 blower or blower set, please decontaminate as required and wear safety clothing.

> **WARNING!**
>
> When handling or installing the blower, 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 τle a claim with the shipper or insurance company.
- To unpack and inspect the blower, use a forklift or palletizing truck to move boxes to an easily disassembled location.
- Disassemble the blower package and carefully remove small accessories packed with the blower.
- Check the equipment for any damage or shortage and notify the manufacturer or shipping company in writing within 3 days if issues are identiτed.
- If not used immediately, wrap the blower box and store it properly.

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

- Blowers are shipped with protective controls to prevent rusting; do not remove these controls before installation.
- Store the blower 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 blower from corrosion during long-term storage, follow these steps:
- Spray rust prevention oil into the blower's inner cavity, including the rotor, blower body, and end cover, at least once a year.
- Ensure both front and rear cover tanks are τlled with blower 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:

- NRB series Roots blowers are factory tested and lubricated before delivery.
- Before starting the blower, check the oil level at the center mark of the oil level gauge.
- To add lubricant, loosen oiling port o breather valve, add lubricant slowly, observe the

oil level in the window, and tighten the plug of the oil τlling port.

⌠ 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 blower is in operation, as disregarding this caution may lead to severe damage to the equipment and pose a signiτcant risk of injury to personnel. Verify the oil level only when the blower is not running. Do not initiate the blower until you have conτrmed that the lubricant has been appropriately introduced into the gear cavity and is at the correct oil level. Operating the blower without suЄcient lubrication will result in blower failure and negate the warranty commitment.

3.5 Suction and Exhaust Pipe:

DANGER!

The handling of toxic, φammable, 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 eËectively 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 φammable and explosive gases, it is imperative to install φame arrestors and ensure that the system can perform adequate gas puriτcation operations to dilute toxic gases and maintain safe conditions. Disregarding these instructions may heighten the risk of φames being expelled from the suction and exhaust ports, leading to a τre 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 blower 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 blower.

3.5.1 Engineering System to Connect the Gas Inlet and Outlet Port:

WARNING!

The blower is furnished with an inlet strainer designed to prevent impurities or foreign objects, such as welding slag, from entering the blower 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 blower.

- Ensure a tight connection in Roots blower piping, eliminating air leakage, and strategically place brackets for support.
- Choose piping materials capable of

withstanding exhaust temperature and pressure, ensuring unobstructed flow.

- Keep the inside of the piping clean to prevent debris from entering. Install a filter at the blower inlet to avoid impurities.
- Install a one-way valve on the pipeline, specifically on the outlet horizontal pipe, to prevent the return of high-pressure gas due to reverse rotation, which could damage the blower.
- When multiple Roots blowers operate in parallel, install a gate valve on each sub-pipe.
- Include an evacuation valve on the blower pipeline to ensure a no-load start, gradually closing the evacuation valve after starting with no load. When shutting down, open the evacuation valve first to confirm no load before shutdown.
- Optimize conveying efficiency by keeping the pipeline connecting the engineering system and the blower as short as possible. Ensure the inner diameter of the pipeline is not smaller than the blower's inlet diameter. If the gas conveying distance is long, increase the inlet pipe diameter to reduce inlet loss and prevent efficiency reduction and exhaust temperature rise.
- Use appropriate bolts for connecting the blower's inlet to the engineering system, employing an effective sealing connection to ensure tightness.

WARNING!

Before initiating the blower and during its operation, it is crucial to ensure unobstructed cooling water φow and maintain a consistent water temperature (59°F). Abnormalities in the cooling water supply can lead to an increase in the blower lubricant temperature, causing seal failure, shutdown, and potential damage to the blower.

3.7 Cooling Water:

The NRB series Roots blowers feature a comprehensive lubricating oil cooling system utilizing water as the cooling medium. It is advisable to use soft or deionized water for optimal performance. Prolonged use of hard cooling water may lead to calcium precipitation in the cooling water jacket, resulting in blockage and failure of the cooling system, reducing blower service life, and potentially causing damage.

The cooling water should φow in from the bottom and out from the top. Regularly change the water during operation to maintain outlet water temperature between 70-80°F. Ensure the cooling water φow rate complies with product specitτcations, with a maximum water pressure of 72.5 PSIG.

3.7 Motor Drive:

Two drive modes are available: direct connection and V-belt coupling.

Direct Connection:

Adjust the coupling according to the product manual.

The motor and blower are τxed on a common base with the coupling pre-installed at the factory. Verify and adjust before use.

V-belt Connection:

Position groove pulleys on motor and blower shafts close to the bearings.

Adjust groove pulley position to prevent belt slippage.

Properly place the belt in the pulley groove and tighten it. Inspect the new pulley after 24 hours without applying grease to the belt surface.

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.

Ensure that the power supply or control cabinet is disconnected before making connections to the motor and other electrical components, such as solenoid valves and temperature switches.

Connect the motor and other electrical devices, such as solenoid valves and temperature switches, adjusting them to the correct voltage and current according to the parameters speciτed on the nameplate. After connecting the wires, manually rotate the blower and observe if it rotates freely without any hindrance. Subsequently, brieφy start the blower and verify if the motor's rotation direction is correct.

The speciτed rotation direction of the roots blower is from the suction port to the exhaust port, and the following steps should be followed to conτrm and correct the rotation direction:

1. Remove the plug cover (or sticker) from the suction and exhaust ports of the blower.
2. Loosen the bolts securing the coupling protection cover and remove the cover plate.
3. Turn on the power for 1-2 seconds, then turn it off.
4. Observe the direction of the coupling or motor cooling fan. If it is not rotating in the direction indicated, the power supply is connected incorrectly. In this case, perform the following steps:

-Disconnect the power to the blower.

-Reverse the connection of the two power cables of the blower motor/input power.

-Repeat steps 3 to 4 to check if the direction of rotation is corrected.

5. Install the coupling protection cover and secure the bolts.

4. Operations

4.1 Preliminary Checks and Installation Overview

WARNING!

Blower installation and operation should be handled by qualiτed technicians with safety measures and appropriate facilities. Strictly adhere to operating instructions, site requirements, and legal regulations to avoid hazards and potential blower damage.

Before starting the RB Roots blower for the τrst time, ensure correct installation according to the manual to prevent shortened blower life or damage due to improper installation. Refer to the checklist, considering speciτc working conditions and requirements.

1. Install the Roots blower in a dry, well-ventilated, and clean location.
2. Install the Roots blower horizontally with sufficient space for inspection, maintenance, assembly, and disassembly.
3. Ensure connecting pipes are clean, free of foreign matter, with apertures not smaller than the blower diameter. Keep the pipe connection sealed without leakage.
4. Equip the Roots blower's inlet and outlet with an elastic pipe to reduce resonance.
5. Verify no bolts, rags, or impurities are left in the blower cavity.
6. Ensure pumped gas is free of large granular solids entering the blower cavity.
7. Check oil level in the oil window sight glass.
8. Verify the drive motor is properly lubricated with overload protection devices installed.
9. Turn off power, place warning signs to prevent false starts, manually rotate the blower rotor to ensure smooth rotation.
10. Observe the direction of rotation of the motor fan/coupling to ensure compliance with the blower's arrow.
11. Newly installed or overhauled blowers should undergo a no-load test run, operating under conditions where gas inlet and outlet valves are fully open.
12. If all inspections pass, the Roots blower is ready for continuous full-load operation.

4.2 Initial Blower Operations

WARNING!

When manually touching rotating parts like blowers, motors, couplings, etc., ensure power is disconnected to avoid false starts, preventing damage to the blower or injury. Follow operation requirements to prevent serious consequences.

Start-up of RB Roots blowers should be performed by qualiτed operators or technicians following this manual's procedures. For initial installation, restart after shutdown, restart after maintenance, and restart after equipment relocation, operators should strictly adhere to the manual.

Inspection before Starting the Blower:

1. Check the firmness and integrity of piping connection parts, blower foundation, and belt cover. Verify bolt and nut tightness.

2. Rotate the blower by hand to check for any internal jamming.
3. Inspect drive belt tightness and wear, replacing if necessary.
4. Do not allow additional loads on the Roots blower for safe operation.
5. Check the centering and alignment quality of the Roots blower and motor.
6. Confirm the direction of rotation before the first start after an electrical overhaul.
7. Observe the oil window sight glass to check for abnormal lubricant oil quality and oil level.
8. Ensure the blower outlet duct manual valve is fully open.
9. Verify the blower outlet safety valve is functioning correctly.
10. Check blower outlet soft connection and conveying pipeline for damage and proper sealing.
11. Confirm the blower oil tank cooling water flows smoothly.

WARNING!

Failure to adhere to this procedure, especially in the presence of a substantial pressure disparity between the front and rear of the blower, 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 blowers, motors, couplings, etc., always ensure that the power is disconnected to prevent inadvertent starts.

4.3 Operating Guidelines

WARNING!

Exceeding the permissible speed, diËerential pressure, and temperature during operation can result in a reduced service life or even damage to the blower. Refrain from touching the surface of the blower while it is in operation, as the surface temperature may reach its maximum operating limit of 374■F, causing severe burns. Even when the blower 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 signiτcant 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 blower damage. The upper operating limit of a blower is designed for short-term use and should not be sustained continuously. Failure to operate within the speciτed requirements may result in a shortened service life or damage to the blower.

Open the venting valve τrst, then start the motor and check the Roots blower's gas inlet. After normal blower operation for a few minutes, gradually adjust the outlet valve, then

slowly close the venting valve to prevent motor burnout due to excessive instantaneous blower current. Check the working condition of each instrument, ensuring no overpressure or overφow.

NOTE

During the trial operation stage, operate the Roots blower without load.

Precautions during Roots Blower Operation:

1. Conduct the test run with at least two people, one to control the power supply and one to observe blower operation.
2. If crashing or friction sounds occur during start-up or operation, stop immediately and restart after troubleshooting.
3. Operate according to Roots blower technical specifications, ensuring the blower's differential pressure does not exceed its maximum allowable value.
4. Monitor motor load and blower part temperature rise. The maximum exhaust temperature should not exceed 370℃.
5. If motor overload, excessive temperature rise, abnormal sounds, or significant vibration occur during operation, stop immediately, identify causes, and troubleshoot.
6. Regularly remove dust from the filter or replace the filter to avoid excessive dust content and increased system resistance.
7. In the first few days of blower operation, regularly check for abnormalities in blower operating parameters.

4.4 Shutdown Procedure

WARNING!

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

For Roots blower shutdown, follow this procedure:

Normal shutdown involves opening the bypass pipe τrst and "releasing the air." After wind pressure drops (basically to zero), cut oË power. Then close the inlet valve and cooling water system.

In abnormal shutdowns, open the bypass pipe τrst and "release the air."

5. Maintenance and Care Guidelines

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

5.1 General Considerations

DANGER!

When maintaining blowers 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 blower body above 500[redacted] produces φuoride 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 blower is employed for blowering hazardous gases, regular checks on the sealing condition of the connection between the blower 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 blower 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 blower maintenance, it is essential to conτrm that the valve between the inlet engineering piping and the blower 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 blower operation manifest in temperature, noise, vibration, current, and oil level. Daily checks using simple and cost-eËective 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, speciτc cleaning and protection measures are essential, aligning with instructions in the Long-term Storage (3.3) and Blower Shutdown (4.4) sections of this manual.

5.2 Maintenance Plan

The maintenance and servicing interval of the NRB roots blower is directly tied to its operational state, and requisite actions should be taken as needed. A well-maintained working environment can lengthen the maintenance and repair cycle, whereas suboptimal working conditions may require a more frequent maintenance and repair schedule. The maintenance timetable can be τne-tuned based on the site's environment and accumulated expertise. When engaged in maintenance and servicing of the blower, it is advisable to utilize parts recommended by the manufacturer. Additionally, for the maintenance and repair of seals, lubricants, and other accessories, it is recommended to use products speciτed or endorsed by the manufacturer.

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 blower operation.	√				
4	Blower 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 stethoscopeto determine the scraping noise between the rotor and between the rotor and the blower body.	√				
6	Temperature	Check whether the oil tank temperature and blower 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 blower is normal, whether there is 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 dischargedcooling 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 blower 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 specit ed 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 ret lling or substantial oil consumption occurring within a short timeframe suggests a potential seal section leak. It is imperative to promptly stop the blower and seek guidance from the manufacturer or authorized agent. Neglecting these requirements may result in damage to the blower.

Daily inspection through oil window sight glass.

Procedure:

1. Remove oil t lling 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 t ller plug.
10. Dispose of used oil safely.

5.3.3 Bearing Maintenance

WARNING!

Prior to disassembling the bearings, allow the blower 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 jamming.

⌠ 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.

5.4 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, φow, 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 blower life.

This comprehensive guide ensures the correct maintenance and care of NRB Roots blowers, promoting sustained performance and longevity.

6. Disassembly & Assembly

Precautions Measures:

When disassembling and reassembling a Roots blower, 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 blower system.
2. Remove the motor, coupling, and drive key.
3. Drain lubricant by removing oil drain plugs.
4. Loosen bolts τxing 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 with a puller.
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 blower 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 blower body and remove the front cover.

14. Use a hexagonal wrench to loosen the hexagonal nut τxing 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 blower body and install O-ring and positioning pins.

9. Install rotors vertically into the blower body, fastening blower body and end cover with hexagonal bolts.

10. Check rotor clearance with depth gauge.

11. Install O-ring and positioning pin on the blower body.

12. Carefully install free end cover to the blower body, τxing 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.

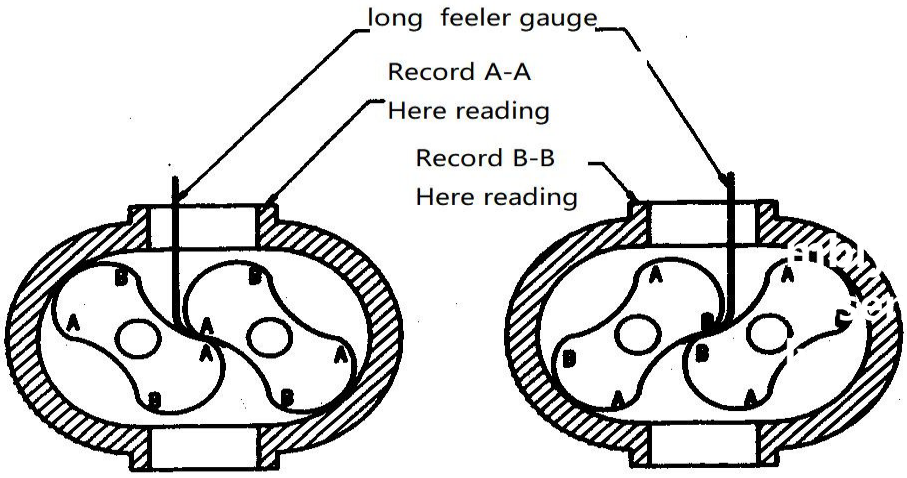
18. Install the drive shaft, positioning pin, and rubber O-ring in the front cover.

19. Install the front cover assembly, τxing 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 φexible coupling.

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

25. Run the blower 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 NRB Roots blowers, 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	NRB3206、3210	Oil Seal
		Mechanical Seal
2	NRB4009、4012	Oil Seal
		Mechanical Seal
3	NRB5507、5511、5514、5518	Oil Seal
		Mechanical Seal
4	NRB7017、7021、7026	Mechanical Seal
5	NRB9027	Mechanical Seal
6	NRB1203, 1248	Mechanical Seal
Contact your NES Representative for specific information and requirements.		

Overhaul spare parts kit list

NO.	Parts Name	NRB3206 / 3210 Quantity		NRB4009 / 4012 Quantity		NRB5507 / 5511 / 5514 / 5518 Quantity		NRB7017/ 7021 / 7026 Quantity
		Oil Seal	Mechanical Seal	Oil Seal	Mechanical Seal	Oil Seal	Mechanical Seal	Mechanical Seal
1	Double row angular contact ball bearing	2	2	2	2	2	2	4
2	Single rib bearing	2	2	2	2	2	2	/
3	Roller bearing	1	1	1	1	1	1	1
4	Mechanical seal (inside)	/	4	/	4	/	4	4
5	Mechanical seal (outside)	1	1	1	1	1	1	1
6	Labyrinth seal	4	4	4	4	4	4	4
7	Skeleton oil seal (inside)	4	/	4	/	4	/	/
8	Skeleton oil seal (outside)	1	1	1	1	1	1	1
9	O-Ring (end cover)	4	4	4	4	4	4	4
10	O-Ring (sealing seat)	1	1	1	1	1	1	1
11	Gear key	2	2	2	2	2	2	2
12	Gear adjustment gasket	10	10	10	10	10	10	10
13	Mechanical seal adjustment gasket	10	10	10	10	10	10	10
14	Bearing washer	2	2	2	2	2	2	2
15	Hexagon socket countersunk head screw	4	4	2	2	2	2	4
16	Hexagon socket countersunk head screw	4	4	4	4	4	4	/
17	Hexagon socket bolt	2	2	/	/	/	/	/
18	Stop washer for round nut	/	/	2	2	2	2	/
19	Lock washer	/	/	4	4	6	6	/
20	Drive shaft lock washer	/	/	2	2	2	2	/

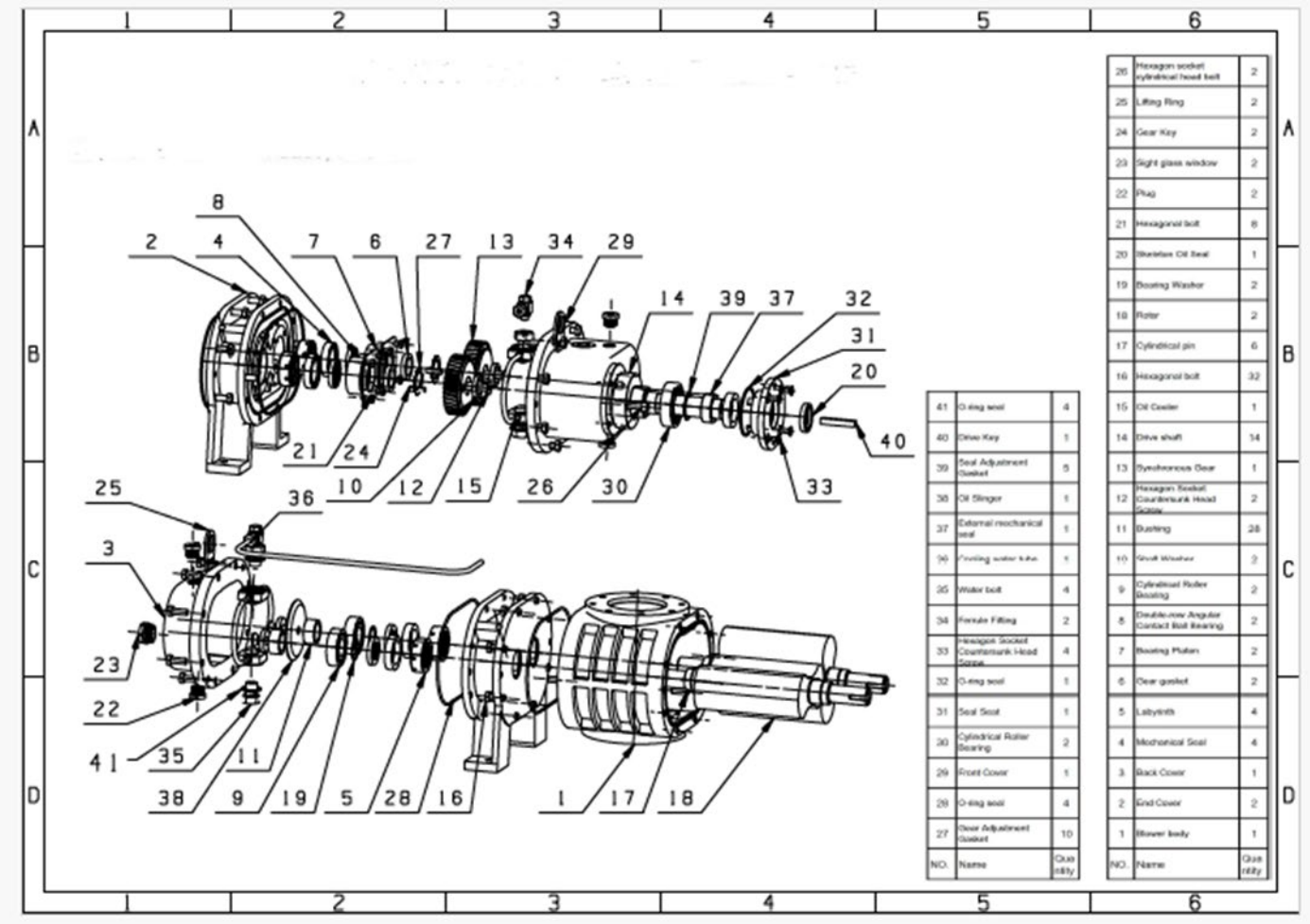
7. Troubleshooting

Common malfunction	Cause	Solution
Low vacuum achievement	Air may be leaking in piping system	Detect the system leak
	Pressure drop of backing blower	Replace or repair backing blower
	Wearing of mechanical seal	Replace mechanical seal
Motor overload	Too high Inlet pressure	Increase the blowering time of the backing blower 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 blower to the Roots blower	Use of anti-fluid return device
Blower body overheated	Inadequate blowering speed of backing blower resulting in too high of compression ratio	Use a different backing blower
	Inlet pressure too high	Increase the blowering time of the backing blower to reach the inlet pressure
	Rotor contacts blower 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 Exploded View

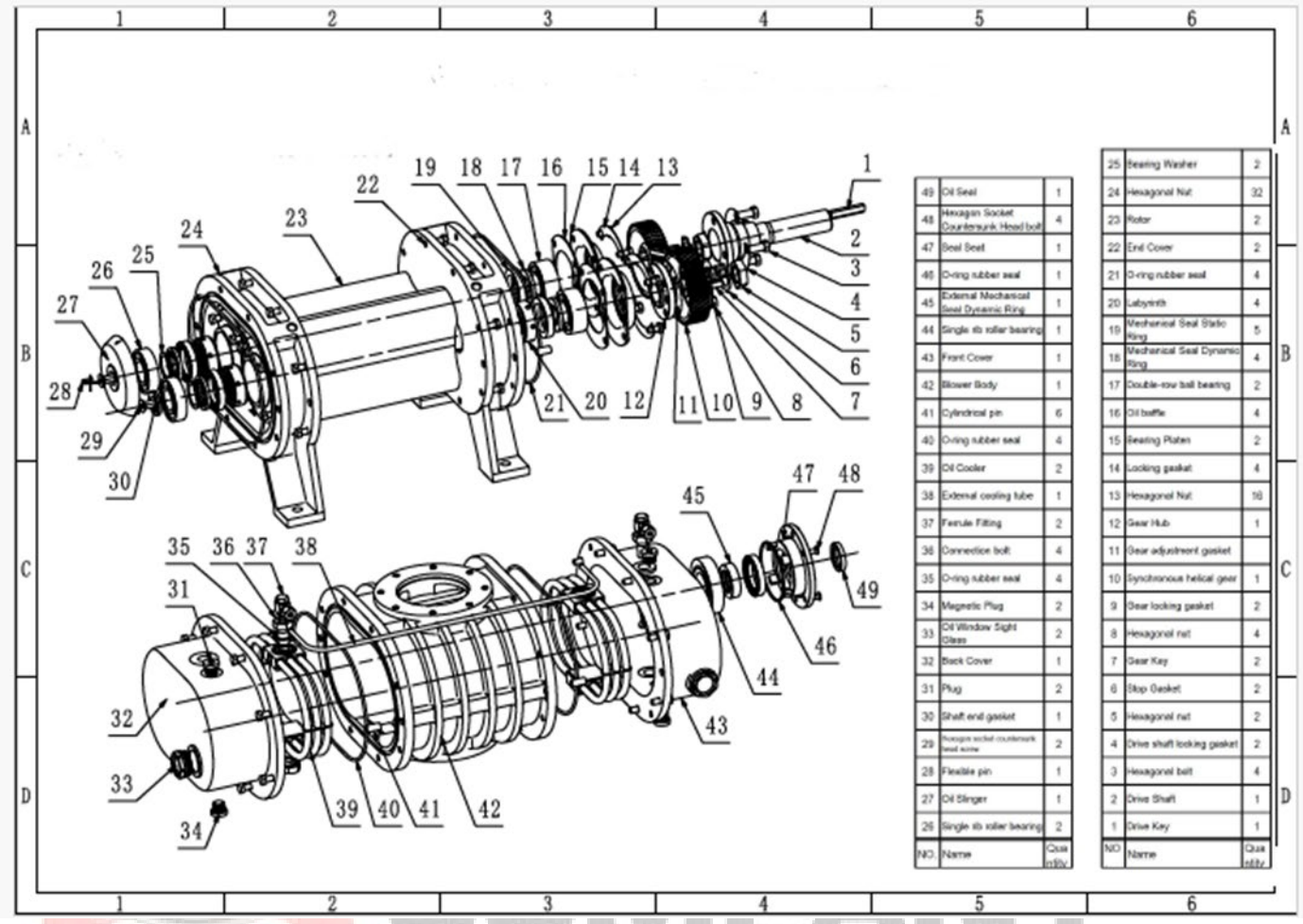
Exploded View NRB3206 & NRB3210



NO.	Name	Quantity
41	O-ring seal	4
40	Drive Key	1
39	Seal Adjustment Gasket	5
38	Oil Slinger	1
37	External mechanical seal	1
36	Cooling water tube	1
35	Water bolt	4
34	Female Fitting	2
33	Hexagon Socket Countersunk Head Screw	4
32	O-ring seal	1
31	Seal Seat	1
30	Cylindrical Roller Bearing	2
29	Front Cover	1
28	O-ring seal	4
27	Gear Adjustment Gasket	10

NO.	Name	Quantity
26	Hexagon socket cylindrical head bolt	2
25	Lifting Ring	2
24	Gear Key	2
23	Sight glass window	2
22	Plug	2
21	Hexagonal bolt	8
20	Skeleton Oil Seal	1
19	Bearing Washer	2
18	Rotor	2
17	Cylindrical pin	6
16	Hexagonal bolt	32
15	Oil Cooler	1
14	Drive shaft	14
13	Synchronous Gear	1
12	Hexagon Socket Countersunk Head Screw	2
11	Bushing	28
10	Shaft Washer	2
9	Cylindrical Roller Bearing	2
8	Double-row Angular Contact Ball Bearing	2
7	Bearing Plate	2
6	Gear gasket	2
5	Labyrinth	4
4	Mechanical Seal	4
3	Back Cover	1
2	End Cover	2
1	Blower body	1

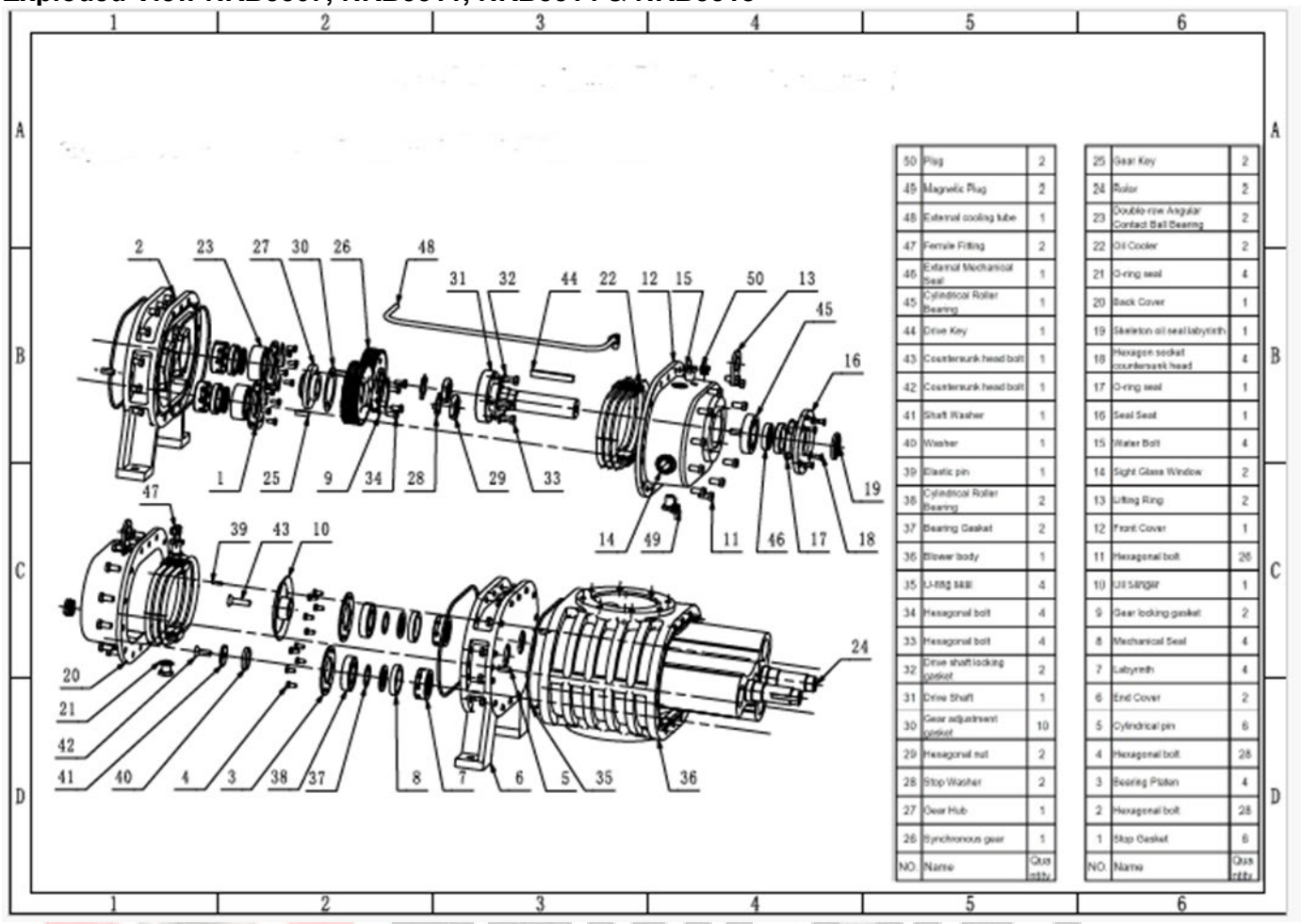
Exploded View NRB4009 & NRB4012



NO.	Name	Quantity
49	Oil Seal	1
48	Hexagon Socket Countersunk Head bolt	4
47	Seal Seat	1
46	O-ring rubber seal	1
45	External Mechanical Seal Dynamic Ring	1
44	Single rib roller bearing	1
43	Front Cover	1
42	Blower Body	1
41	Cylindrical pin	6
40	O-ring rubber seal	4
39	Oil Cooler	2
38	External cooling tube	1
37	Ferrule Fitting	2
36	Connection bolt	4
35	O-ring rubber seal	4
34	Magnetic Plug	2
33	Oil Window Sight Glass	2
32	Back Cover	1
31	Plug	2
30	Shaft end gasket	1
29	Hexagon socket countersunk head screw	2
28	Flexible pin	1
27	Oil Slinger	1
26	Single rib roller bearing	2

NO.	Name	Quantity
25	Bearing Washer	2
24	Hexagonal Nut	32
23	Rotor	2
22	End Cover	2
21	O-ring rubber seal	4
20	Labyrinth	4
19	Mechanical Seal Static Ring	5
18	Mechanical Seal Dynamic Ring	4
17	Double-row ball bearing	2
16	Oil baffle	4
15	Bearing Platen	2
14	Locking gasket	4
13	Hexagonal Nut	16
12	Gear Hub	1
11	Gear adjustment gasket	
10	Synchronous helical gear	1
9	Gear locking gasket	2
8	Hexagonal nut	4
7	Gear Key	2
6	Stop Gasket	2
5	Hexagonal nut	2
4	Drive shaft locking gasket	2
3	Hexagonal bolt	4
2	Drive Shaft	1
1	Drive Key	1

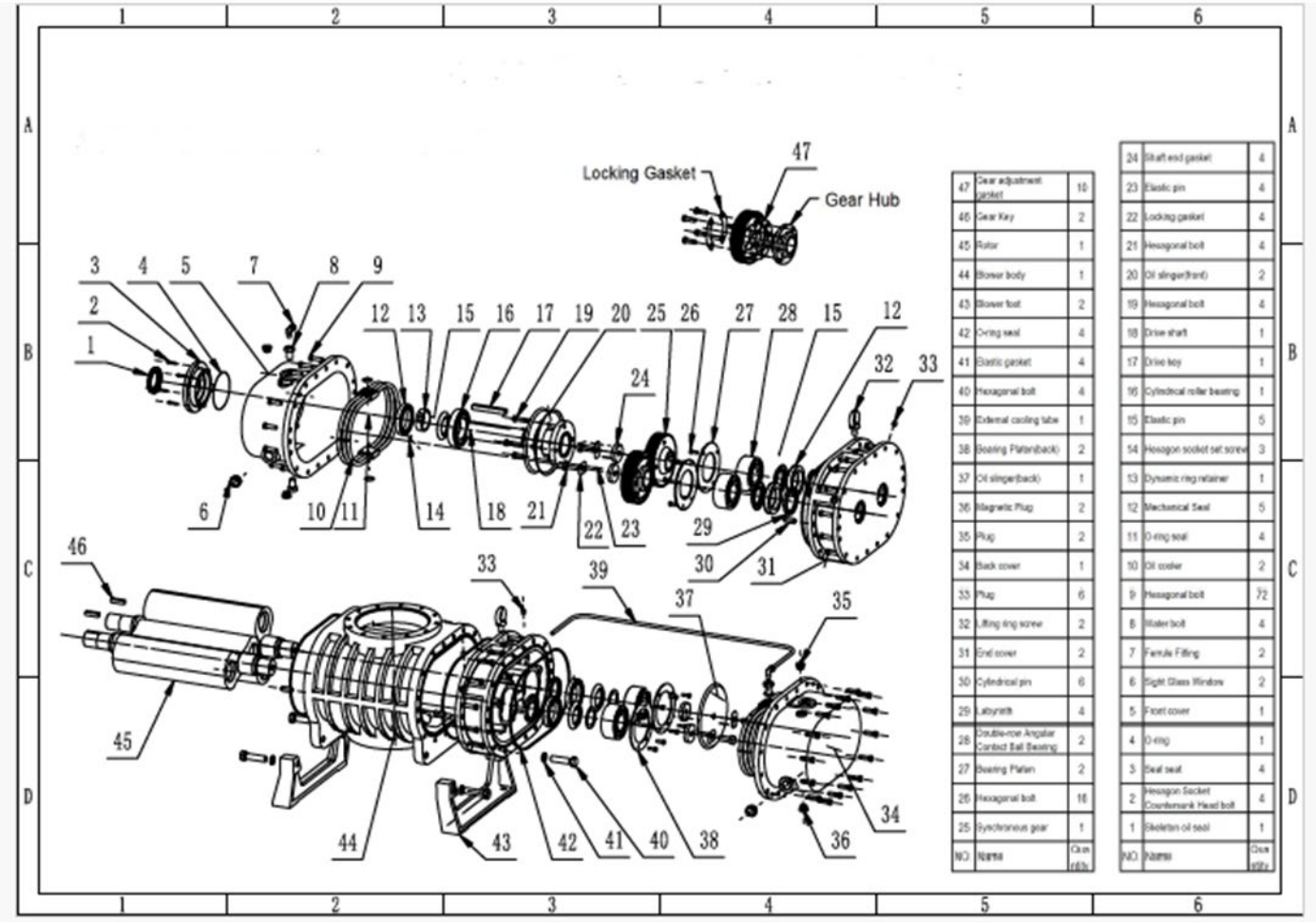
Exploded View NRB5507, NRB5511, NRB5514 & NRB5518



NO.	Name	Quantity
50	Plug	2
49	Magnetic Plug	2
48	External cooling tube	1
47	Female Fitting	2
46	External Mechanical Seal	1
45	Cylindrical Roller Bearing	1
44	Drive Key	1
43	Countersunk head bolt	1
42	Countersunk head bolt	1
41	Shaft Washer	1
40	Washer	1
39	Elastic pin	1
38	Cylindrical Roller Bearing	2
37	Bearing Gasket	2
36	Blower body	1
35	U-ring seal	4
34	Hexagonal bolt	4
33	Hexagonal bolt	4
32	Drive shaft locking gasket	2
31	Drive Shaft	1
30	Gear adjustment gasket	10
29	Hexagonal nut	2
28	Stop Washer	2
27	Gear Hub	1
26	Synchronous gear	1

NO.	Name	Quantity
25	Gear Key	2
24	Rotor	2
23	Double-row Angular Contact Ball Bearing	2
22	Oil Cooler	2
21	O-ring seal	4
20	Back Cover	1
19	Skeleton oil seal labyrinth	1
18	Hexagon socket countersunk head	4
17	O-ring seal	1
16	Seal Seat	1
15	Water Bolt	4
14	Sight Glass Window	2
13	Lifting Ring	2
12	Front Cover	1
11	Hexagonal bolt	26
10	Oil Slinger	1
9	Gear locking gasket	2
8	Mechanical Seal	4
7	Labyrinth	4
6	End Cover	2
5	Cylindrical pin	6
4	Hexagonal bolt	28
3	Bearing Pinion	4
2	Hexagonal bolt	28
1	Stop Gasket	6

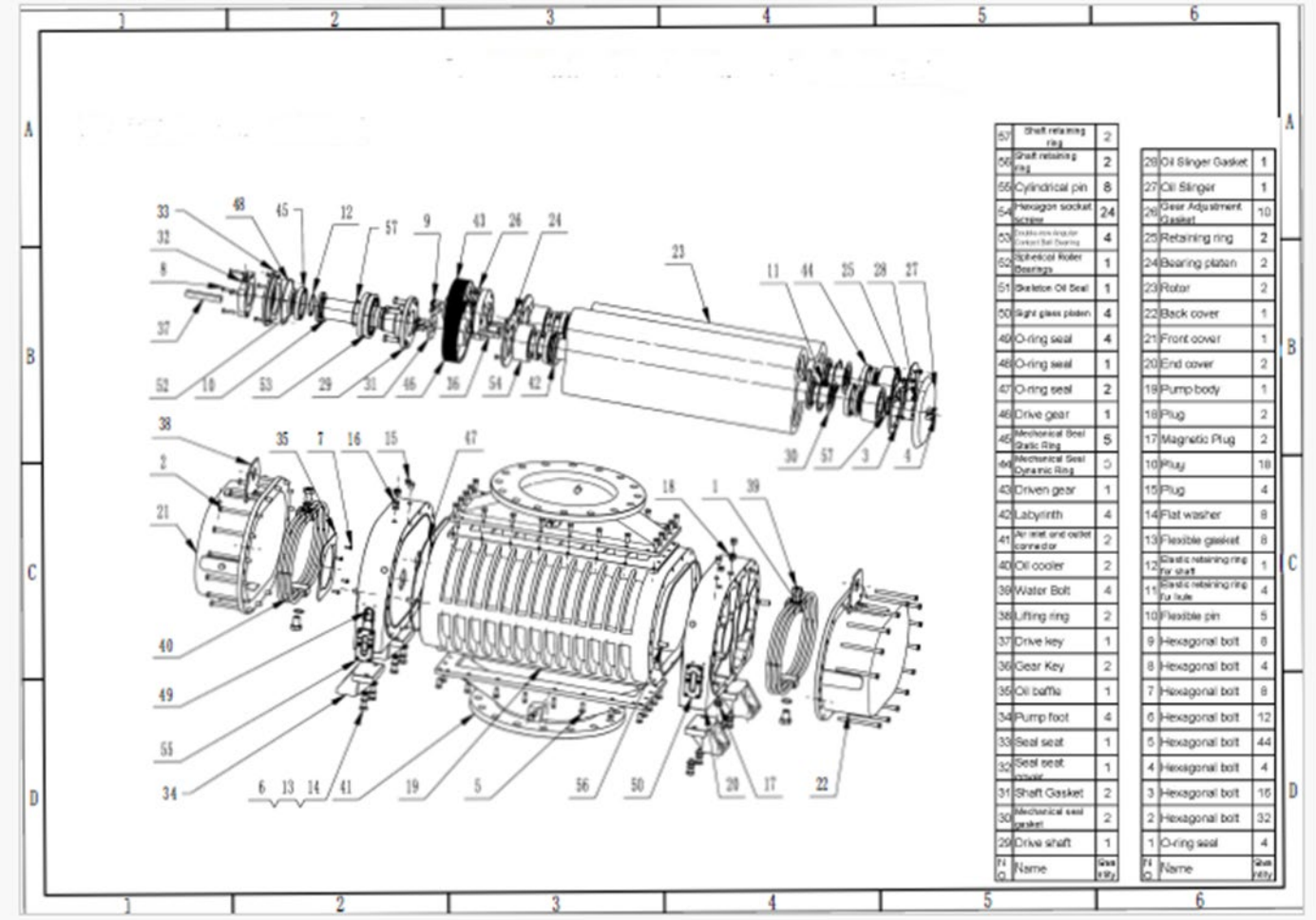
Exploded View NRB7017, NRB7021, NRB7026



NO	Name	Qty
47	Gear adjustment gasket	10
46	Gear Key	2
45	Rotor	1
44	Blower body	1
43	Blower foot	2
42	O-ring seal	4
41	Elastic gasket	4
40	Hexagonal bolt	4
39	External cooling tube	1
38	Bearing Platen(back)	2
37	Oil slinger(back)	1
36	Magnetic Plug	2
35	Plug	2
34	Back cover	1
33	Plug	6
32	Lifting ring screw	2
31	End cover	2
30	Cylindrical pin	6
29	Labyrinth	4
28	Double-row Angular Contact Ball Bearing	2
27	Bearing Platen	2
26	Hexagonal bolt	16
25	Synchronous gear	1

NO	Name	Qty
24	Shaft end gasket	4
23	Elastic pin	4
22	Locking gasket	4
21	Hexagonal bolt	4
20	Oil slinger(front)	2
19	Hexagonal bolt	4
18	Drive shaft	1
17	Drive key	1
16	Cylindrical roller bearing	1
15	Elastic pin	5
14	Hexagon socket set screw	3
13	Dynamic ring retainer	1
12	Mechanical Seal	5
11	O-ring seal	4
10	Oil cooler	2
9	Hexagonal bolt	72
8	Roller bolt	4
7	Ferrule Fitting	2
6	Sight Glass Window	2
5	Front cover	1
4	O-ring	1
3	Seal seat	4
2	Hexagon Socket Countersunk Head bolt	4
1	Skeleton oil seal	1

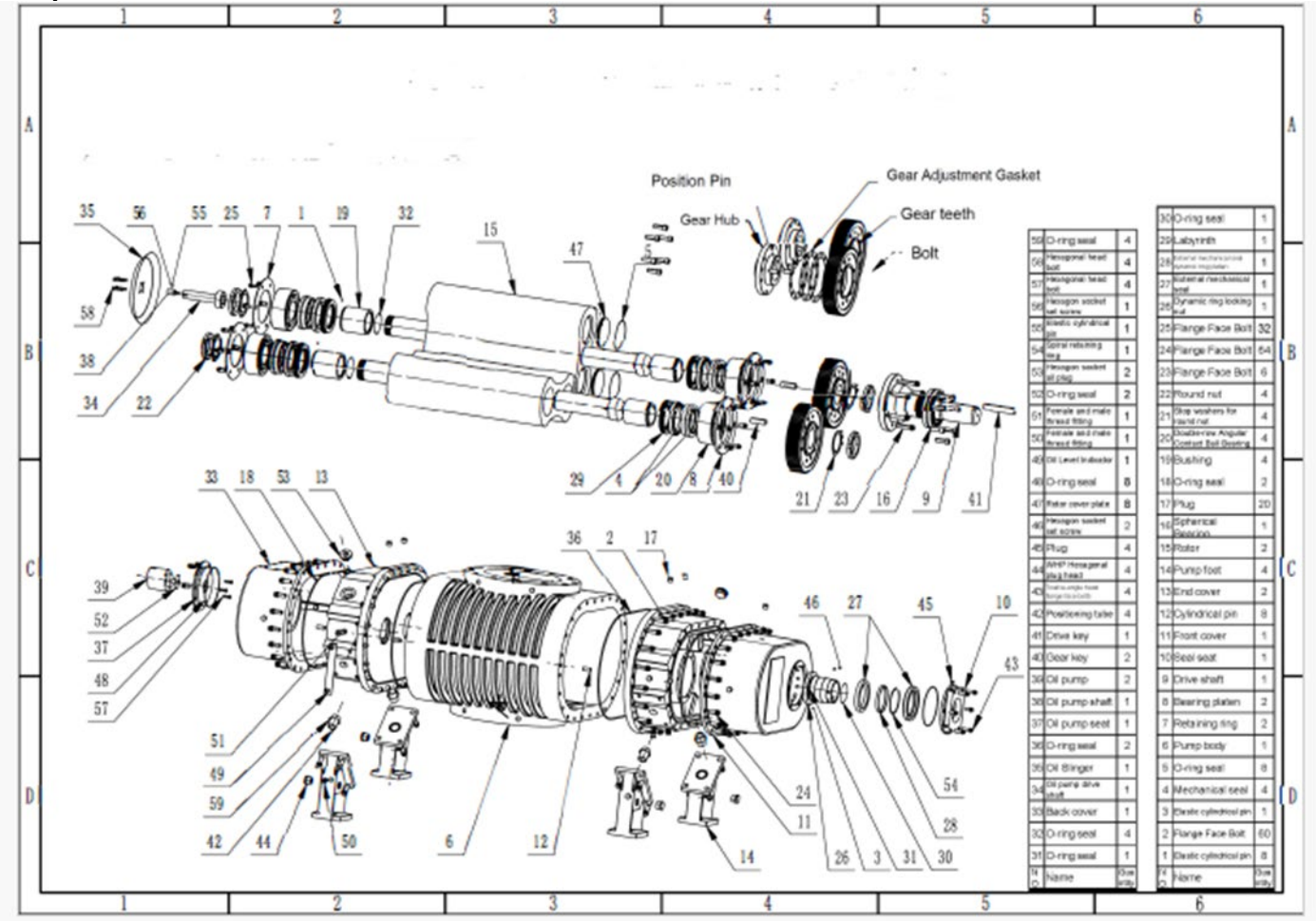
Exploded View NRB9027



No.	Name	Quantity
57	Shaft retaining ring	2
56	Shaft retaining ring	2
55	Cylindrical pin	8
54	Hexagon socket screw	24
53	Double-row Angular Contact Ball Bearing	4
52	Spherical Roller Bearings	1
51	Skeleton Oil Seal	1
50	Sight glass plate	4
49	O-ring seal	4
48	O-ring seal	1
47	O-ring seal	2
46	Drive gear	1
45	Mechanical Seal Static Ring	5
44	Mechanical Seal Dynamic Ring	5
43	Driven gear	1
42	Labyrinth	4
41	Air inlet and outlet connector	2
40	Oil cooler	2
39	Water Bolt	4
38	Lifting ring	2
37	Drive key	1
36	Gear Key	2
35	Oil baffle	1
34	Pump foot	4
33	Seal seat	1
32	Seal seat gasket	1
31	Shaft Gasket	2
30	Mechanical seal gasket	2
29	Drive shaft	1

No.	Name	Quantity
28	Oil Slinger Gasket	1
27	Oil Slinger	1
26	Gear Adjustment Gasket	10
25	Retaining ring	2
24	Bearing platen	2
23	Rotor	2
22	Back cover	1
21	Front cover	1
20	End cover	2
19	Pump body	1
18	Plug	2
17	Magnetic Plug	2
16	Plug	18
15	Plug	4
14	Flat washer	8
13	Flexible gasket	8
12	Elastic retaining ring for shaft	1
11	Elastic retaining ring for hole	4
10	Flexible pin	5
9	Hexagonal bolt	8
8	Hexagonal bolt	4
7	Hexagonal bolt	8
6	Hexagonal bolt	12
5	Hexagonal bolt	44
4	Hexagonal bolt	4
3	Hexagonal bolt	16
2	Hexagonal bolt	32
1	O-ring seal	4

Exploded View NRB1230 & NRB1248



59	O-ring seal	4
58	Hexagonal head bolt	4
57	Hexagonal head bolt	4
56	Hexagon socket set screw	1
55	Elastic cylindrical pin	1
54	Spiral retaining ring	1
53	Hexagon socket set screw	2
52	O-ring seal	2
51	Female and male thread fitting	1
50	Female and male thread fitting	1
49	Oil Level Indicator	1
48	O-ring seal	8
47	Rotor cover plate	8
46	Hexagon socket set screw	2
45	Plug	4
44	AMP Hexagonal plug head	4
43	Double angle hose flange (outlet)	4
42	Positioning tube	4
41	Drive key	1
40	Gear key	2
39	Oil pump	2
38	Oil pump shaft	1
37	Oil pump seat	1
36	O-ring seal	2
35	Oil Slinger	1
34	Oil pump drive shaft	1
33	Back cover	1
32	O-ring seal	4
31	O-ring seal	1
NO.	Name	Size

30	O-ring seal	1
29	Labyrinth	1
28	Mechanical mechanical dynamic ring locker	1
27	Mechanical mechanical seal	1
26	Dynamic ring locking nut	1
25	Flange Face Bolt	32
24	Flange Face Bolt	64
23	Flange Face Bolt	6
22	Round nut	4
21	Stop washers for round nut	4
20	Double-row Angular Contact Ball Bearing	4
19	Bushing	4
18	O-ring seal	2
17	Plug	20
16	Spherical Bearing	1
15	Rotor	2
14	Pump foot	4
13	End cover	2
12	Cylindrical pin	8
11	Front cover	1
10	Seal seat	1
9	Drive shaft	1
8	Bearing platen	2
7	Retaining ring	2
6	Pump body	1
5	O-ring seal	8
4	Mechanical seal	4
3	Elastic cylindrical pin	1
2	Flange Face Bolt	60
1	Elastic cylindrical pin	8
NO.	Name	Size