NES Company Inc.: NRV Rotary Vane Unit Operation Manual

This NES Company Inc. document details the proper and safe operation and maintenance of NRV oil-circulated single-stage rotary vane vacuum pumps. For maximum performance and service life of the pump, adhere to the following instructions.

Contents

1. Important Initial Safety Points

Upon receiving the pump, ensure no damage has occurred in shipping. If damage is found, contact the shipping company immediately, as well as reach out to NES Company.

If the pump is to be placed in storage where it will be inactive for a long time, check that all covers are still in place on the pump. Keep the pump in a dry and clean area to avoid corrosion. Take particular care if the pump is to be stored outdoors to prevent corrosion of the pump and its internals. It is helpful to rotate the pump by hand periodically.

The following symbols, seen in *Table 1.* may be affixed to the pump. Do not tamper with any hazard symbols found on the pump. Disregarding these symbols can and likely will lead to an avoidable injury.

		
KEEP APPENDAGES AND CLOTHING AWAY FROM THE GAS VENT	***PROTECTIVE SHIELD REQUIRED***	***TOXIC GAS PRESENT***
		
RISK OF SHOCK	***HOT SURFACE***	***HEARING PROTECTION ADVISED***

Table 1

Moving the Pump

Eye bolts on the pump are designed for lifting the pump alone. Do not attempt to lift more than the pump using the eye bolts on the pump.

Belt and Coupling Cover

Running the pump with an exposed belt or coupling drive is dangerous. Belt and coupling covers MUST be secured in position during operation. Disconnect power before removing the coupling or belt covers to access the transmission. Before reconnecting the power, ensure all covers are secured back in place.

Exhaust Restriction

Do not block or install valves on the exhaust line of the pump. Restrictions will cause higher outlet pressures and lead to overload and damage of equipment and injury.

Maintenance Operations

Any work on the machine must be performed in while the pump is in a shutdown state. Disconnect power before doing maintenance or disassembling the pump. Check that all drain plugs and covers are properly installed before reconnecting power.

Open Discharge and Cleaning

Do not discharge gas from the pump without proper ventilation or outlet destination. Oil mist and harmful process gases can cause damage if not responsibly managed.

Hot or Cold Parts and Surfaces

The pump will get hot while running. Hot metal is hot.

Dangerously cold parts and surfaces may also be present, particularly on the inlet side of the pump, depending on the application.

Care should be taken to avoid injury.

Explosive Media

- Pump Systems

  To comply with explosive environment regulations, all components in a pumps system must be individually certified to meet requirements set by regulations, including but not limited to, Directive 94/9/EC and the NEMA Guidelines.

  While the pump may be certified according to Directive 94/9/EC or the NEMA Guidelines, and supplied with an EX-certificate, the rest of the system, including the motor, may not meet the standards set forth by these directives and may not be suitable for explosive applications.

  Drive Shielding

  - Material must be non-spark causing

  -Deformation of the shield from exterior forces, like being stepped on, should be considered to avoid contact with the rotating drive assembly.

- Pump Monitoring

  The following checks should be performed before the operation of the pump to lessen risk

  - Leakage around the shaft seal
  - Temperature of bearings
  - Pump surface temperature - Monitor this during operation as well to monitor pump operating conditions.

  The pump must be shut down during abnormal conditions and not restarted until normal conditions return, and relevant maintenance has been completed.

- Impact Sparks
  Operators should avoid causing impacts that can potentially lead to sparks.
  Ground Protection
  Operators must ensure a proper connection to ground to discharge static electricity.
  Consider the insulative effects of any paint or coating.

Modification and Spare Parts

The use of parts not authorized or supplied by NES, and subsequent safe and proper operation of the pump, is the sole responsibility of the customer.

Customer Responsibilities

All maintenance, inspection, and assembly work are to be done adhering to safety protocol and instructions given in this manual.

The pump should be installed, serviced, and operated by qualified technicians with proper safety protocol. Adhere to the operation manual, as well as site and legal requirements when installing, operating, and servicing an NES Company pump. The owner is accountable for assigning tasks to qualified technicians, providing appropriate training, and ensuring safety protocol and legal requirements are all met for the operation of this pump.

NES Company is not responsible for operator accidents, poor training/preparation, and general irresponsibility/disregard.

2. Product Description

2.1 Working Principle

NRV pumps represent a series of rotary vane vacuum pumps designed for smaller-scale applications. These pumps operate by utilizing the sealing properties of oil within the pump chamber, creating a seal between a set of vanes on the rotor. A noteworthy feature is the use of springs or hydraulic pressure to push the vanes against the pump chamber. During operation, the vanes move in and out of the rotor, spreading oil across the pump chamber to achieve an effective seal.

One significant advantage of these pumps is their ability to recycle oil during operation, resulting in an extended service life with minimal maintenance requirements. The oil circulation is achieved by initially discharging it along with the pressurized process gas and subsequently separating the oil from the process gas. This separation occurs in a separator attached to the rotary vane pump. This closed circulation loop of the oil allows the pump to function without the need for additional process hardware, depending on the process gas involved. Following separation, the oil undergoes filtration through an oil filter, enabling the pump to tolerate a certain level of fine particulates without experiencing damage or a decline in performance. This inherent robustness and reliability make NRV pumps a dependable choice for various applications.

2.2 Structural Diagram

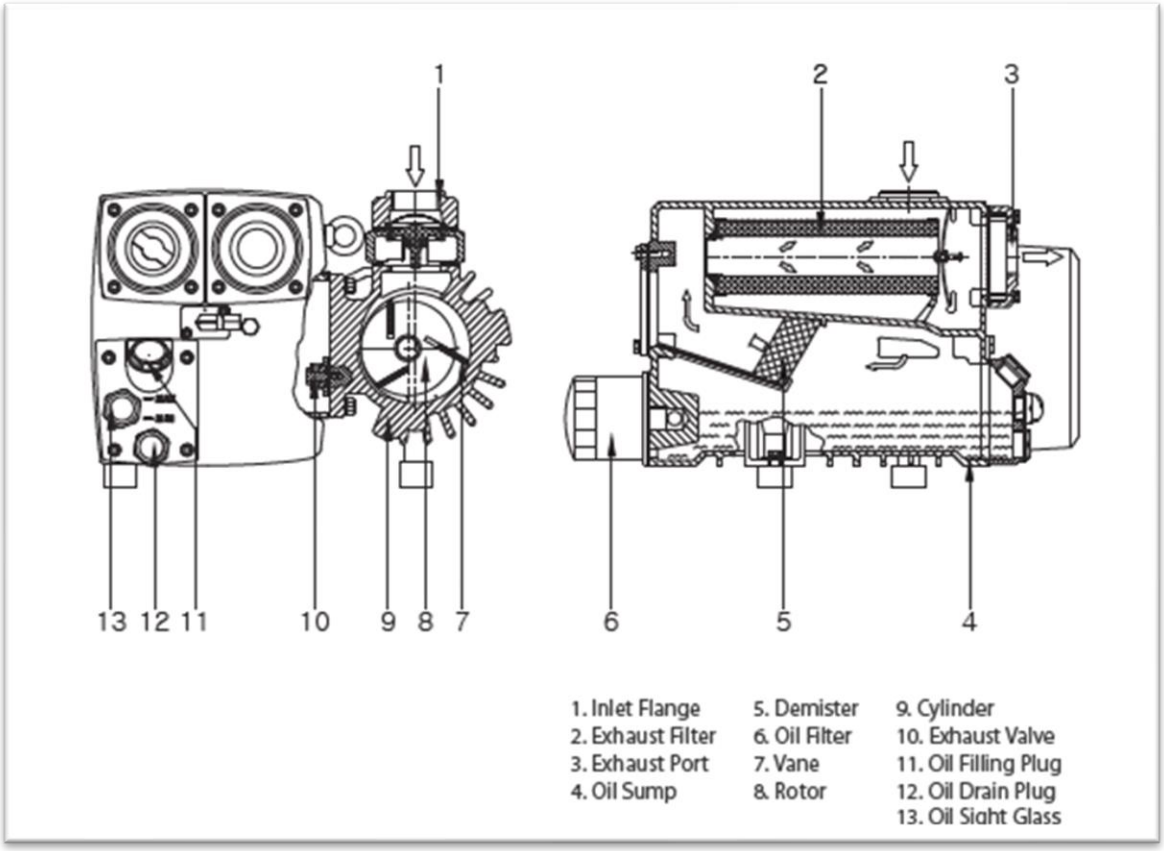


Figure 1

2.3 Description of Parts

The following are parts of the NRV Rotary Vane pump shown in *Figure 1.*

1. **Inlet Port:** The entry point of the pump, connected to the inlet pipeline, representing the low-pressure side of the pump.
2. **Outlet Port:** The discharge side of the pump, linked to the discharge location, where the compressed and heated gas exits the pump.
3. **Rotors:** Helical and counter-rotating screws that push and compress gas within the pump chamber along its length.
4. **Sealing Mechanisms:** Ensuring the containment of the pumped medium and preventing any leakage into the process.

- On the Suction Side: Two double lip seals.
- On the Exhaust Side: A combination of a double lip seal and a standard mechanical seal, with optional two double lip seals.
- On the Drive End: An oil seal is employed.

5. **Bearings:**

- On the Outlet Side (Fixed End): Angular contact ball bearing.
- On the Inlet Side (Free End): Roller Bearing with a high load capacity, crucial for maintaining precise clearance between rotors and gears.

6. **Gears:** Gears are heat-treated and polished to reduce noise and ensure a long operational life.
7. **Coupling:** Positioned at the end of the input shaft, the coupling transmits power from the motor to the pump.
8. **Pump Casing:** Designed as a double jacket pump body, with the inner jacket housing all mechanical rotating parts and the process medium during operation. The outer jacket facilitates the use of a cooling water layer to effectively control the pump's temperature.
9. **Oil Level Indicator:** This meter displays the oil level in the gearbox, with the recommended level between the R and H lines. Regular checks for level and contamination are advised, and oil should be replaced if found to be contaminated or at an abnormal level.

2.4 Product Specifications

Parameter		Units	NRV-06	NRV-08	NRV-10	NRV-16	NRV-20	NRV-31	NRV-41	NRV-64
Exhaust Vol.		CFM	4.24	5.65	7.06	11.18	14.13	21.19	28.25	44.73
Ultimate Vacuum	W/ float valve	mbar	2	0.5		2		0.5		
	W/O float valve	mbar	20							
Motor Specs		φ, V	3, 220/380 1, 220						3, 220/380	3, 220/380 1, to order
		φ /Hz/HP	3/60/0.5 1/60/0.5	3/60/0.4 1/60/0.5	3/60/0.74 1/60/0.74	3/60/0.6 1/60/0.74	3/60/1 1/60/1.15	3/60/1.48 1/60/2.01	3/6/2.01	3/60/3.39
		RPM	1720	1720	1680	3600	3400	7800	1710	1760
Operating Temperature		°F	104	104	104	104	104	104	104	104
Oil Volume		qt	0.24	0.32	0.42	0.32	0.42	1.06	1.06	2.11
Weight		lbs.	26.5	40	44	40	44	75	84	141.1
Length (bare)		inches	8.2	8	10	8	10.5	17.5	18	21.5
Width		inches	6.3	9.2	9	9.2	9	9	9	16.5
Height		inches	7.4	6.3	8.5	6.3	8.5	10	10	12
Sound Level		dBA	50	59	58	60	61	64	67	68

Table 2

Parameter		Units	NRV- 101	NRV-161	NRV-201	NRV-251	NRV-301	NRV-400	NRV-630
Exhaust Vol.		CFM	70.63	111.83	141.26	176.57	211.89	282.52	447.32
Ultimate Vacuum	W/ float valve	mbar	0.5						
	W/O float valve	mbar	20						
Motor Specs		φ, V	3, 220/380 1, to order	3, 220/380				3, to order	
		φ /Hz/HP	3, 60, 4.63	3/60/7.5	3/60/7.5	3/60/10	3/60/15	3/60/20	3/60/25
		RPM	1760	1800	1800	1800	1800	1200	1200
Operating Temperature		°F	104	104	104	104	104	104	104
Oil Volume		qt	2.11	7.25	7.25	7.25	7.25	13.7	15.85
Weight		lbs.	165.4	385	408	445	480	1210	1474
Length (bare)		inches	29	32	34	32	34	41.3	49
Width		inches	16.5	23	24.5	23	24.5	32.9	32.9
Height		inches	12	16.5	16.5	16.5	16.5	26.3	26.3
Sound Level		dB	70	72	74	74	76	72	74

Table 3 contd.

2.5 Lubricant

NRV pumps are not supplied with pre-filled oil, emphasizing the importance of filling the pump with oil before initiating operation. It is crucial to refrain from adding or changing the oil while the pump is in operation. During pump operation, ensure that drain plugs are securely fastened. Oil checks should only be conducted when the pump is not running.

Refer to Table 3 for a recommended list of lubricants. When selecting oil, consider the pump's operating temperature, which takes into account both the inlet and ambient temperatures. In instances of demanding processes, it is advisable to consult NES Company for their recommended oil.

Temperature	ISO VG Grade	Oil Type	Oil Rating
<32°F (0°C)	32	Mineral	DM-032
32°F-54°F (0°C-12°C)	68	Mineral	DM-068
54°F-86°F (12°C-30°C)	100	Mineral	DM-100
>86°F (30°C)	100	Synthetic	DS-100
>86°F (30°C)	100	Synthetic	DE-101

Table 4

In the event of liquid spillage in the pump, it is essential to thoroughly clean the pump and replace both grease and oil. This precautionary measure helps maintain optimal performance and prevent potential damage caused by liquid intrusion.

When it comes to using different oils or greases, it's crucial to note that the oils recommended in Table 3 have been specifically chosen to ensure proper lubrication for all components. The selection takes into consideration factors such as operating temperature and viscosity. The use of alternative oils or greases may not function effectively with the pump's moving parts. A lower viscosity oil may fail to dissipate heat efficiently and may not adequately separate contacting metal parts, leading to significant wear on gears and bearings. Conversely, a higher viscosity oil may struggle to move around the mechanical assembly, resulting in increased friction, excess heat, and excessive wear.

Neglecting to change the oil at regular intervals poses risks, as the oil can become thicker and contaminated with debris and particulates from the normal wear of internal parts, and potentially minor contamination from the process medium. Therefore, it is imperative for the operator to adhere to the recommended oil change intervals or even perform changes sooner if necessary. Neglecting this maintenance task may result in the premature failure of the pump.

3. Installation

3.1 Overview

The standard procedures for unpacking, mounting, and setting up the pump are comparable to those for other vacuum pumps. Special attention is crucial during the mounting process to ensure the pump is placed flat and flush. The longevity of the pump can be guaranteed by meticulously mounting it to avoid introducing stress to the pump body. Stresses arising from piping or improper mounting can result in a shortened pump life, reducing clearances between the pump body and rotor, leading to scraping, gear failure, and bearing failure eventually. To begin, it is imperative to mount the pump on a flat, level surface. Potential stresses on the pump can stem from piping that does not align with the pump's various inlets and outlets. Therefore, it is essential to plan and measure piping accurately before installation.

If not installed immediately, the pump should be stored for a maximum of six months with all protective coatings and covers intact. For details on long-term storage, refer to the operation manual.

3.2 Location

Regarding the location, choose a space with sufficient lighting and room for trained technicians to perform maintenance on both the pump and the overall system. Optimal conditions involve well-ventilated environments and cool temperatures to prevent overheating of the pump and its fixtures. Consideration should also be given to the accessibility of instrumentation and instrument/control panel access, ensuring they are open, easily reachable, and clearly visible. Placing the pump closer to the process minimizes losses due to decreased system conductance, with a recommended distance of within 6 meters of the process gas to mitigate conductance losses.

3.3 Foundation

When establishing the foundation, ensure the mounting surface is horizontal, flat, and robust enough to support the pump and its accompanying components. It is important to note that this line of pumps should not be installed on vertical or sloping surfaces. To achieve optimal results and minimize stress on the pump body, confirm that the mounting surface is flat and flush with the pump feet when fully fastened.

3.4 Soft Foot

NRV pumps are equipped with standard rubber feet, and these can be utilized for mounting using screws. If the feet lack rubber or if screws are driven into metal on the feet, it is crucial to ensure that the fasteners do not impose any strain on the pump. Strains on the pump can introduce stress, potentially causing excessive grinding or scraping from the metal internals of the pump. Therefore, careful consideration should be given to the mounting process to prevent any adverse impact on the pump.

If it is observed that the pump is not positioned flat on the mount, make adjustments to the pump feet using shims until the issue is rectified, ensuring that all pump feet rest flat on their mounts in a flush manner. Maintaining a clearance of 0.076mm (0.003in) or more between the feet and the mounting surface can significantly impact the pump's lifespan. It is essential to verify that all clearances between pump feet are 0.05mm (0.002in) or less, with the ideal scenario being that all feet are flat and in direct contact with the mounting surface. This adjustment should be carried out with all bolts in a loose state. If necessary, add shims to achieve

the desired clearance between pump feet and the surface until they are flush or the clearance is less than 0.05mm.

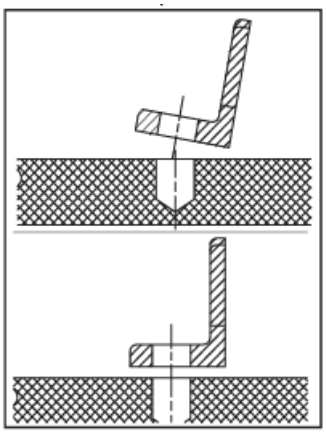


Figure 2

3.5 Suction and Exhaust Pipes

Ensure that the outlet port remains unobstructed to minimize issues related to overheating, as well as to reduce the need for maintenance and power consumption.

It is crucial to prevent any stress or force exerted on the pump from piping or hose connections. Using a vacuum-tight hose for both inlet and outlet connections is advisable, but an alternative solution is the use of piping with an expansion joint. **Avoid supporting any piping directly from the pump.**

Ensure that the dimensions of the inlet and outlet piping match or exceed the corresponding dimensions of the pump ports. Using smaller exhaust or inlet pipes can lead to restrictions and a reduction in pump efficiency. Placing the pump far from the process, beyond 6 meters, will also decrease efficiency due to gas loss, influenced by the conductance of the piping system. If the correct size is unavailable, using a larger pipe is preferable to using a smaller one, as smaller pipes may result in unexpected and poor pump performance.

Inlet System Connection

- Before starting the pump, ensure a filter or strainer is connected to the inlet to prevent solid particulates such as welding slag from entering the pump. Regularly check and clean or replace the filter/strainer if it becomes full.
- Pump efficiency decreases significantly when the distance between the pump and the process exceeds 6 meters. It is recommended to keep the process and pump within 6 meters of piping, although larger pipes can help mitigate reduced conductance effects. Avoid using inlet piping smaller than the suction opening of the pump.
- Install a check valve on the inlet pipe to prevent backflow of pumped media during shutdown. Ensure the check valve can handle the required CFM as per the vacuum pump's performance curve. A check valve or gate valve is essential to seal the pump from backward flow and isolate the process gas during and after pump shutdown. Ensure proper check

valve orientation based on gas movement.

Exhaust System Connection

- If a silencer is used, connect it as close as possible to the pump exhaust. It can also function as a separator for mixtures with condensable components.
- Dispose of condensates responsibly in accordance with local government guidelines.
- Ensure no restrictions are present in the exhaust piping to prevent system overheating and inefficiency.

3.6 Installation Safety Notes

- Do not service or disassemble the pump unless the power is completely disconnected from the motor to avoid potential hazards.
- Trained technicians should handle pump servicing and installation with appropriate safety precautions.
- Ensure lifting slings are properly rated for the applied weight.
- Keep the pump and motor horizontal and secure during lifting.
- Do not remove documentation or covers/plugs until ready to install.
- Vent and purge the system and pump before installation to prevent contamination.

3.7 Short Term Storage (up to 6 months)

Keep covers and plugs in place to prevent corrosion and the accumulation of solids in the pump body, especially if stored outdoors.

Ideally, store the pump in a dry indoor environment, and consider using shrink wrap for additional protection.

3.8 Long Term Storage (more than 6 months)

Ensuring the extended preservation of the rotary vane pump involves a primary focus on shielding it from breakdown and corrosion. Proper corrosion prevention measures are vital for successful reinstallation, as rust on the pump's internals and connections can lead to unexpected performance issues or catastrophic failure. Here is a recommended guide for long-term storage:

Spray Rust Prevention Oil:

Apply rust prevention oil to pump internals, covering rotors, pump cavity/body, and the end cover. This protective coating mitigates the risk of corrosion during storage.

Complete Pump Oil Fill:

Fill the pump entirely with pump oil, ensuring that excess oil and grease are removed from both tanks before startup. It is advisable to change the oil annually to maintain optimal lubrication.

Apply Anti-Rust Oil:

Apply anti-rust oil to the drive shaft and all other exposed parts. This includes, but is not limited to, inlet and outlet connection flanges, motor connection flanges, and other exposed connections.

Cover Exposed Orifices:

Seal all exposed orifices with covers or plugs to create a protective barrier, keeping the pump and anti-rust oil securely contained. Remove pipelines and the pump base, covering these orifices before storage to prevent debris ingress.

Store in Dry Environment:

Store the pump in a dry environment to prevent moisture-related corrosion. Additionally, if feasible, rotate the pump shaft once a month to prevent it from becoming stuck in a single position.

3.9 Lubrication

The oil in the pump can be monitored through the oil sight glass, as illustrated in Figure 3.

During pump operation, it is crucial to maintain the oil level within the recommended range, which should be between the edges of the circle or within the minimum and maximum indicators on the oil sight glass. If the oil level falls outside of these indicators, corrective measures should be taken. Here are guidelines for adding or changing oil.

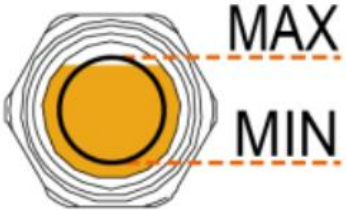


Figure 3

Temperature	ISO VG Grade	Oil Type	Oil Rating
<32°F (0°C)	32	Mineral	DM-032
32°F-54°F (0°C-12°C)	68	Mineral	DM-068
54°F-86°F (12°C-30°C)	100	Mineral	DM-100
>86°F (30°C)	100	Synthetic	DS-100
>86°F (30°C)	100	Synthetic	DE-101

Table 5

To Add Oil:

1. Loosen the Oil Fill Plug.
2. Slowly add the lubricant while observing the oil level in the pump's sight glass. Stop filling when the level is just beyond the bottom, reaching the minimum oil line.
3. Tighten the plugs from step 1.

To Remove and Change Oil:

1. Prepare a container to capture waste oil from the pump.
2. Loosen the Oil Fill Plug to allow the casing to breathe.
3. Loosen the Oil Drain Plug and slowly drain oil from the pump.
4. If removing excess oil, stop draining when the level reaches the maximum indicator.
5. If changing oil, completely drain oil from the tank.

6. Tighten drain plugs and refill with oil if changing the oil.

3.10 Pumping Toxic Gases

When designing a system for toxic, corrosive, or explosive gases, isolate the process completely from the atmosphere. Purging the gas is advisable to dilute it and maintain safe values in concentration and volume. Install flame arrestors on both inlet and exhaust valves when pumping explosive media. For gases that may condense during compression, dilution is necessary before compression, achievable with a gas ballast or separate nitrogen source.

3.11 Motor Drive Mechanism

Connect motors directly to the pump via a C-flange connection, and control pump RPM for the desired pumping speed according to the pump performance curves. Ensure pump RPM does not exceed the specified value in Table 2. Motor speeds can be controlled using a VFD to match the pump speed range, as long as the required BHP and torque are achieved.

3.12 Electrical Connection

Electrical wires and connections pose potential risks, including high voltages and uncertainties about live wires. Incorrect wiring can lead to accidents, injuries, and equipment damage. To ensure safety and proper functioning, adhere to the following electrical connection guidelines:

Power Disconnection: Before conducting any work on wiring or electrical components, especially the motor, ensure power is disconnected from the system, and confirm there are no live wires.

Connecting Sensors and Wires: Connect sensors, wires, and other electrical equipment with the power off and completely disconnected to prevent accidents and ensure safe handling.

Motor Rotation Direction: Verify that the motor rotation direction aligns with the pump rotation direction. Incorrect rotation can lead to increased inlet pressures, posing risks of explosion and damage to the pump and piping. Loosen the coupling guard and briefly turn the motor on for 1-2 seconds to confirm the rotation direction matches the pump's intended rotation, as indicated on the pump. Disconnect power before making any swaps or switches to wiring.

Clockwise Pump Rotation: Ensure the rotation of the pump is clockwise when facing the motor mounting surface for proper operation.

Coupling Guard Installation: Confirm that the coupling guard is properly installed before restarting the pump for operation.

Explosion-Proof/Severe Duty Motors: Use appropriate cable glands when connecting explosion-proof or severe-duty motors to the power supply, ensuring safe and secure electrical connections.

3.13 Cooling Purge

The cooling purge process is essential for maintaining the optimal temperature inside the pump body and internals. This involves introducing gas into the pump while it is running to cool the pump chamber, especially considering the substantial heat generated during the compression process. Here are the steps for the cooling purge:

Introducing Cooling Gas: While the pump is in operation, introduce gas into the pump chamber to achieve a cooling effect. Typically, cool gases such as air or nitrogen are used at atmospheric pressure.

Pressure Requirements: Ensure that the inlet pressure of the pump is maintained at 3 psi (150 torr) during the cooling purge. The pressure of the purge gas should not be less than 7 psi.

Flow Rate Reference: Refer to the specification sheet for the recommended flow rates during the cooling purge. This information will guide the appropriate volume of gas needed for effective cooling.

Pump Equipped with Cleaning Purge System: If the pump is equipped with a cleaning purge system, follow the specified procedures for optimal results.

No Cleaning Purge System: In the absence of a cleaning purge system, run the pump with the main valve closed for 10-20 minutes before shutting it down. The dry run alone may not completely eliminate compressed vapors and residues. If residue removal is insufficient, consider a steam or solvent flush of the pump as needed.

3.14 Temperature Sensor

The temperature sensor and control system play a crucial role in preventing overheating and catastrophic pump failure. Here are the guidelines for implementing and managing temperature control in the pump:

Cooling Line Blockage Awareness: Be vigilant for potential blockages in the cooling lines of the system or pump body, as this can disrupt the flow of cooling water to the pump.

Temperature Monitoring Points: Two mounts are provided on the pump body for the installation of temperature sensors. These sensors monitor the temperature of the pump body.

Shut Down on High Temperature: If the pump body temperature exceeds 90°C (200°F), promptly shut down the pump to prevent overheating and potential catastrophic failure.

Thermostatic Control Valve Integration: Consider pairing temperature sensors with a thermostatic control valve to automatically regulate the pump's temperature. The control valve manages the flow of cooling water to the pump based on the feedback received from temperature sensors. This feedback loop ensures a consistent and controlled temperature of the pump body during operation.

Availability of Temperature Control Components: Note that temperature sensors and control valves are not standard features on all NES pumps. However, these components can be customized and ordered through NES Company to meet the specific requirements of the customer.

3.15 Gas Ballast Valve

A gas ballast valve proves invaluable in scenarios where incoming gas concentration requires pre-compression dilution in a vacuum pump. The objective is to ensure that the outlet concentration of potentially hazardous gases, which may include toxic or explosive elements, remains sufficiently low for safe environmental handling. For all applications involving potential hazards, it is advisable to incorporate a gas ballast valve. For specific inquiries tailored to your process, feel free to reach out to NES Company, ensuring that the gas ballast valve is customized to meet the safety and operational requirements of your particular application.

4. Operation

4.1 Introduction:

NRV rotary vane units stand out as durable and dependable machines when operated correctly, delivering extended service to satisfied customers worldwide. However, ensuring a prolonged service life hinges on proper operation and maintenance. Critical moments during operation, such as starting and stopping the pump, require careful attention to avoid wear and damage. Before initiating operations, it's crucial to double-check commonly overlooked installation aspects that could lead to issues during startup and operation:

- Verify that the pump is horizontally mounted, flat on its base at all legs, and securely tightened.
- Ensure a filter is attached to the pump inlet and in ready-to-use condition.

- Confirm that the inlet pipe is free of dust, rust, welding slag, and other foreign objects.
- Check that drive motors are lubricated, equipped with overload protection, and couplings are properly attached.
- Ensure the pump can rotate freely by hand.
- It's advisable to briefly turn the motor on and off with no load on the pump to listen for abnormal noises, addressing any detected issues before applying a load.

4.2 Pump Startup:

Before accessing or touching any rotating components, disconnect power from the motor to prevent accidental starts or accidents. Preheating the pump is necessary before starting operation, with caution about hot surfaces during preheating. Inadequate preheating can result in steam condensation and corrosion in the pump body.

4.3 Pump Operation:

The pump is engineered to function within specified temperature, volume, RPM, and vacuum pressure ranges. Operating beyond these parameters risks damage, leaks, contamination, and other problems.

Pressure: Operating outside the rated pressure range may lead to unacceptable seal leakage, contaminating the oil or lubrication that works on pump bearings or gears.

Temperature: Allowing the pump to overheat can cause component seizing and burnout. Maximum temperature, measured at the pump's exhaust, should not exceed specified values in Table 2. If the temperature limit switch is triggered, restarting the pump should only occur once it has cooled below a set temperature.

4.4 Pump Shutdown:

Properly shutting down the pump is crucial, especially considering the presence of process matter and the elevated temperature. Neglecting this phase could lead to corrosion and pump lockup due to condensed process matter in the chamber. If the pump is water-cooled, avoid shutting off the water supply before stopping the pump, and keep the water off for 3-5 minutes post-pump shutdown.

5. Maintenance

5.1 Overview:

The extended lifespan of the pump, whether spanning a few years or decades, is contingent upon diligent service maintenance performed by qualified personnel. Similar to a car's need for periodic maintenance and occasional repairs under normal usage, a vacuum pump operates optimally with routine care. Regular maintenance encompasses tasks such as oil and grease replacements, among other simple yet essential activities. Repairs, prompted by abnormal temperatures, noise, vibration, and current/power consumption, may arise during the pump's lifecycle. Observing data and visual signs like changes in gear oil appearance is crucial.

Addressing the unique requirements for keeping the pump inactive for an extended duration involves specific measures, subject to the application and facility specifications outlined in the section on long-term storage.

5.2 Maintenance Plan:

A comprehensive maintenance plan, as depicted in Table 5, provides a concise and systematic approach to track necessary services at regular intervals. Adhering to this plan stands as the primary strategy to enhance the pump's

longevity. The suggested plan is grounded in general pump usage but remains adaptable to individual applications and influencing factors. In environments with harsh conditions, service intervals should be more frequent, while cleaner applications may warrant less frequent maintenance.

Item	Checkpoint	Daily	Monthly	Quarterly	Twice Yearly	Annually
Gas Inlet/Outlet	Are pressures and temperatures normal?	x				
Oil Level Sight Glass	Are oil levels normal? Any visible leaks?	x				
Cooling Liquid	Are supply and temperature normal? Any leaks?	x				
Motor Load	Is the current draw of the motor normal and in specified range?	x				
Rotation	Is the rotation smooth and in a clockwise direction?	x				
Vibration and Noise	Are sounds and vibrations normal? Are there any scraping noises?	x				
Temperature	Are exhaust and vacuum surface temperature normal?	x				
Inlet Filter	Are there any blockages, and does the filter look generally clean?		x			
Oil Level Sight Glass	Is the oil seriously discolored (white or black), and are there large particulates in the oil?		x			
Pipe Connection	Are the insides of the inlet and outlet pipe especially dirty? Are there dirt deposits or impurities? Is performance normal?			x		
Rotors and Pump Chamber	Is there dirt or any signs of damage on the pump rotors or chamber?				x	

Gearbox	Is the oil sight glass clean and clearly transparent?				x	
Disassembly	Disassemble the pump and inspect the condition of the components, replacing damaged parts.					x
Seals	Check that all seals and O-rings are in healthy condition and replace those that aren't.					x
Motor	Is the motor generally healthy and worthy of operation?					x

Table 6

5.3 Inspection and Maintenance Guidelines

Temperature Check:

Monitor the pump's temperature distribution during operation, ensuring a uniform heat distribution along the pump body. If an abnormal concentration of heat is detected away from the exhaust, cease operation immediately for inspection. Potential causes include interrupted cooling supply or inhalation of objects like wires or solid particles.

Inlet Filter: Proper installation and cleaning of the inlet filter are crucial to prevent solids from entering the pump. It is especially vital during the initial stages of system use due to the risk of contamination. Examples of potential contaminants include welding slag.

Oil Change: Maintaining fresh, contaminant-free oil is essential for preserving gears and bearings, minimizing friction, and preventing wear in the rotating assembly. Check for oil discoloration and particulates using the oil sight glass. Excessive oil consumption may indicate a mechanical seal or gasket leak, requiring attention. Refer to Table 4 for acceptable lubricants.

To replace oil:

1. Power down the pump and exercise caution around hot surfaces.
2. Once the system has cooled and gearbox pressure is relieved, carefully drain the oil into an appropriate container, making note of any particulates or discoloration.
3. Take off and cleanse the oil level sight glass before reinstalling it.
4. Securely tighten the drain plug.
5. If applicable, replace the oil filter.
6. Swap the current gear oil with fresh, uncontaminated oil.
7. Ensure the oil filler plug is securely tightened.

5.4 Pipeline Inspection:

Recognizing that pipes undergo corrosion over time is crucial. The development of weaknesses and leaks in a system's piping can be addressed early on by replacing the necessary components. This proactive approach benefits both the performance and safety of the system and the operators who may be exposed to potentially toxic process gas or high voltage electrical wires compromised by corrosion. Key areas that demand attention include:

- The piping, joints, and seals associated with the inlet, exhaust, and other system components.
- Piping related to any auxiliary systems connected to the dry screw pump.
- Any electrical connections present within the system.

5.5 Pump Body Cleaning:

Regular maintenance involves cleaning the pump to eliminate residual compressed gases and condensed materials from the pump chamber. The accumulation of materials, particularly during periods of inactivity, can lead to condensation, subsequent corrosion, and a decline in performance. A dirty pump draws more power from the motor, resulting in increased energy consumption to carry out its function. Over time, this inefficiency can significantly raise operational costs.

To clean the pump, follow these steps:

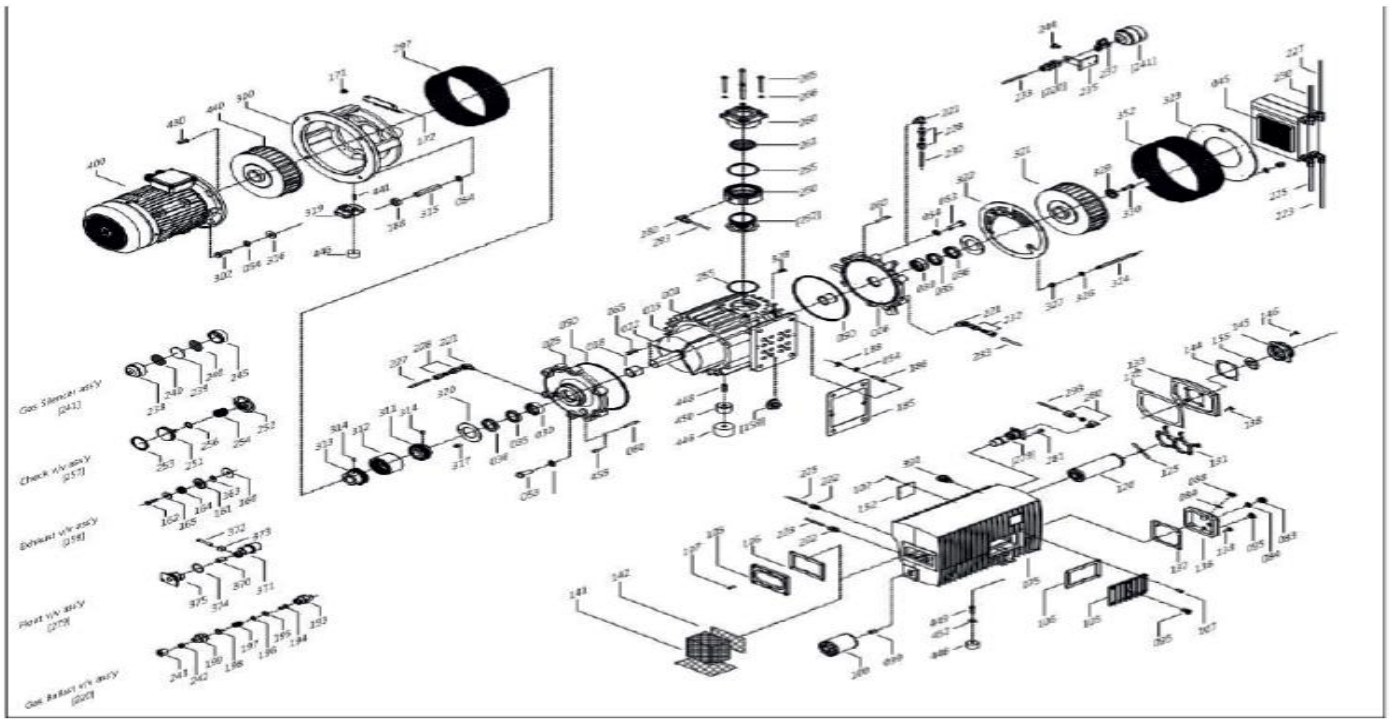
Identify a cleaning solution tailored to the process gas the pump comes in contact with and use it for cleaning. If a flushing system is available, utilize it. In the absence of a flushing system, proceed as follows:

- Shut down the pump and close the inlet valve.
- Disconnect both inlet and outlet pipelines from the pump body.
- Seal the exhaust port of the pump with a blind flange.
- Fill the pump entirely with the cleaning solution and let it sit for 1 hour.
- Verify if the pump rotors rotate freely by hand. If so, remove the blind flange and drain the cleaner from the pump.
- Reconnect all pipelines securely and appropriately.
- Dispose of the cleaning agent in a safe and responsible manner.

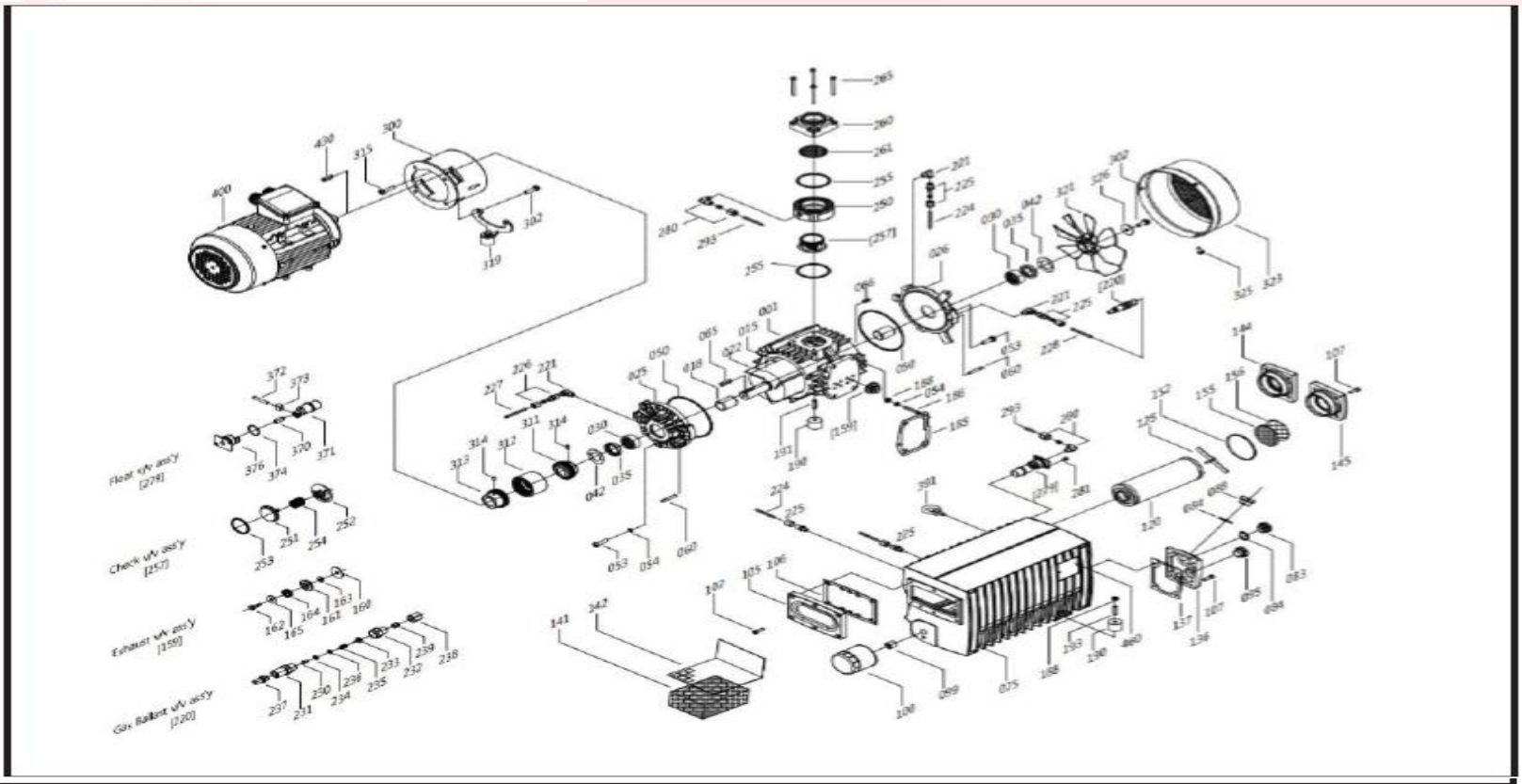
5.6 Auxiliary Systems:

The auxiliary systems integrated with the pump, akin to the pump itself, are susceptible to natural forces and necessitate periodic maintenance attention. Conducting thorough checks on piping, valves, instruments, gas pressure, flow, and cleanliness serves as an effective means to ensure the seamless and healthy operation of the pump's supporting systems, consequently maintaining the overall efficiency of the pump system. Implementing routine inspections for these systems is considered good practice, allowing for prompt identification of issues and facilitating timely repairs.

6. Exploded Views and Parts List



NO.	Part Name	Q'ty 064	NO.	Part Name	Q'ty 064	NO.	Part Name	Q'ty 064	NO.	Part Name	Q'ty 064
1	Cylinder	1	142	Expanded metal	1	234	Gas ballast valve lip	1	319	Assist base foot	1
15	Rotor	1	144	Exhaust cover (C)	1	235	Gas ballast spring	1	321	Fan (pump sided)	1
18	Bearing	2	145	Exhaust cover (O)	1	236	Gas ballast valve plate	1	323	Fan cover (pump sided)	1
22	Vane	3	152	O-ring	1	237	Gas ballast valve filter	1	325	Bolt	2
25	A-end plate	1	155	Exhaust screen-in	1	238	Gas ballst valve nut	1	326	Washer	1
26	B-end plate	1	156	Exhaust screen-out	1	239	Gas ballast valve ring	1	370	Nozzle Body	1
30	Bearing	2	[159]	Exhaust valve Ass'y	2	250	Check valve body	1	371	Float valve ball	1
35	Retainer	2	160	Exhaust valve lip	2	251	Check valve cock	1	372	Float valve pin	1
42	Cover	2	161	Exhaust valve body	2	252	Check valve guide	1	373	Float valve rubber	1
50	O-ring	2	162	Exhaust valve bolt	2	253	Check valve o-ring	1	374	Float valve o-ring	1
53	Bolt	6	163	Exhaust valve nut	2	254	Check valve spring	1	376	Float valve body	1
54	Washer	10	164	Exhaust valve spring	2	255	O-ring	2	391	Bolt	1
60	Taper pin	4	165	Exhaust valve washer	2	[257]	Check valve Ass'y	1	400	Motor	1
65	key(A-end plate sided)	1	185	Gasket	1	260	Inlet flange	1	430	key	1
66	key(B-end plate sided)	1	186	Bolt	4	261	Inlet screen	1	460	Name plate	1
75	Oil sump	1	188	Nut	6	265	Bolt	4			
83	Oil sight glass	1	190	Rubber foot	2	266	Washer	4			
84	O-ring	2	191	Bolt	2	275	Nonreturn (optional)	1			
88	Plug	1	[220]	Gas ballast valve Ass'y	1	278	Washer	1			
95	Plug	1	221	Hydraulic fitting	3	[279]	Floate valve Ass'y	1			
99	Oil filter bolt	1	222	Nipple	1	280	BSLM Nipple	3			
100	Oil filter	1	223	Pipe	1	281	Bolt	2			
105	Oil sump cover	1	224	Pipe	1	293	Pipe	1			
106	Gasket	1	225	BSLM Nipple	2	300	Coupling guard	1			
107	Bolt	18	226	BSLM Nipple	2	302	Bolt	4			
120	Exhaust filter	2	228	Pipe	1	311	Coupling Hub(P)/M28	1			
125	Filter spring	2	230	Gas ballast valve cock	1	312	Coupling sleeve/M28	1			
136	Oil inlet plate	1	231	Gas ballast valve body	1	313	Coupling Hub(M)/M28	1			
137	Gasket	1	232	Gas ballast valve nipple	1	314	Bolt	2			
141	Demister	1	233	Gas ballast valve guide	1	315	Bolt	3			



NO.	Part Name	Q'ty 301	NO.	Part Name	Q'ty 301	NO.	Part Name	Q'ty 301	NO.	Part Name	Q'ty 301
1	Cylinder	1	152	Name plate	1	242	Gas ballast valve ring	1	327	Nut	12
15	Rotor	1	155	Exhaust screen	1	243	Gas ballast valve nut	1	328	Key	1
18	Bearing	2	[159]	Exhaust valve Ass'y	4	244	Bolt	2	352	Cooler mounting screen	1
22	Vane	3	160	Exhaust valve lip	4	245	Silencer body	1	370	Nozzle Body	1
25	A-end plate	1	161	Exhaust valve body	4	250	Check valve body	1	371	Flaot	1
26	B-end plate	1	162	Exhaust valve bolt	4	251	Check valve cock	1	372	Pin	1
30	Bearing	2	163	Exhaust valve nut	4	252	Check valve guide	1	373	Bolt	1
35	Retainer	2	164	Exhaust valve spring	4	253	Check valve o-ring	1	374	O-ring	1
36	Retainer	2	165	Exhaust valve washer	4	254	Check valve spring	1	375	Float cap	1
45	Oil cooling	1	170	Clamp	2	255	O-ring	2	391	Bolt	1
50	O-ring	2	171	Bolt	9	256	O-ring	1	400	Motor	1
53	Bolt	9	172	Protection mesh	1	[257]	Check valve Ass'y	1	430	Key	1
54	Washer	20	185	Gasket	1	260	Inlet flange	1	440	Fan (Motor sided)	1
60	Taper pin	4	186	Bolt	4	261	Inlet screen	1	441	Bolt	4
65	Key(A-end plate sided)	1	188	Nut	7	265	Bolt	4	441	Bolt	4
75	Oil sump	1	193	Gas ballast valve body	1	266	Washer	4	448	Bolt	1
83	Oil sight glass	1	194	Gas ballast valve cock	1	278	Washer	1	449	Bolt	1
84	O-ring	2	195	Gas ballast valve lip	1	[279]	Floate valve Ass'y	1	450	Assist ring	2
88	Plug	1	196	Gas ballast valve plat	1	280	BSLM Nipple	2	452	Washer	1
95	Plug	2	197	Gas ballast valve spring	1	281	Bolt	2	446	Rubber foot	3
99	Oil filter bolt	1	198	Gas ballast valve guid	1	293	Pipe	1			
100	Oil filter	1	199	Gas ballast valve nipple	1	297	Motor mounting screen	1			
105	Oil sump cover	2	[220]	Gas ballast valve Ass'y	1	300	Coupling guard	1			
106	Gasket	2	221	Hydraulic fitting	3	302	Bolt	4			
107	Bolt	14	222	BSLM Nipple	2	311	Coupling Hub(P)/M42	1			
120	Exhaust filter	4	223	Pipe	1	312	Coupling sleeve/M42	1			
125	Filter spring	4	225	Pipe	1	313	Coupling Hub(M)/M42	1			
131	Exhaust filter guide	1	226	BSLM Nipple	2	314	Bolt	2			
132	Gasket	1	227	Pipe	1	315	Bolt	3			
133	Exhaust cover	1	230	Pipe	1	316	Washer	2			
136	Oil inlet plate	1	232	BSLM Nipple	1	317	Bolt	4			
137	Gasket	1	233	Pipe	1	319	Assist base foot	1			
138	Bolt	7	235	Gas ballast valve bracket	1	320	Retainer cover	2			
141	Demister	1	237	Ball valve	1	321	Fan (pump sided)	1			
142	Expanded metal	1	238	Silencer body	1	322	Fan cover braket body	1			
144	Gasket	1	239	Silencer screen	1	323	Fan cover braket cover	1			
145	Exhaust cover	1	240	Silencer filter	2	324	Bolt	6			
146	Bolt	4	[241]	Silencer Ass'y	1	326	Washer	12			

6.1 Spare Parts Kit

Every pump has an overhaul spare parts kit specific to that pump. Each kit comes with a variety of seals, gaskets, and other parts that may wear out in the future. It is a wise idea to have these parts on hand in the event they are needed to minimized pump down time. For further information on the availability of NES Company NRV Series single-stage oil-circulated rotary vane vacuum pump spare parts kits, please contact your NES representative.

Each spare parts kit includes:

Part Name	Quantity
O-Ring	4
Gasket	5
Vane	1
Oil Seal	3
Exhaust Filter	1
Oil Filter	1
Bearing	2

Table 7

7. Troubleshooting Checklist

All references to "E" refer to point "E" in Figure 8, Section 6.1

Apparent Issue	Common Cause	Solution
Low Vacuum Degree	Clogged filter	Clean or replace filter element
Motor Overload	Clogged filter	
	Intake of solid objects	Remove any foreign solids. Replace rotors or pump chamber if damaged. Then measure screw clearance and make adjustments.
	Increase in inlet pressure	Check for other abnormalities
Overheating	Excessive oil in the pump reservoir	Check and adjust the oil level in the pump.
	Inlet temperature high	Reduce inlet temperature.
	Compression ratio is too high	Check inlet and outlet pressures for abnormalities.
	Interference between rotors and pump chamber	Disassemble and look for the cause of the interference.
Vibration	Misalignment of rotating parts in the pump.	Reconfigure the position of rotating parts in the pump.
	Incorrect assembly	Reassemble the pump correctly.
	Abnormal rise in inlet pressure	Check for the cause of this rise in pressure.
	Damage to gears or bearings	Replace damaged parts.
Bearing Damage	Improper lubrication	Replace lubricants with fresh, correct lubricant.
	Low oil level	Fill oil to correct level, and check pump for leaks that might lead to the loss of oil.

Table 8

8. Technical Dimensions

All drawings labeled with the corresponding pump model, for any further questions, please feel free reach out to NES Company via phone or email.