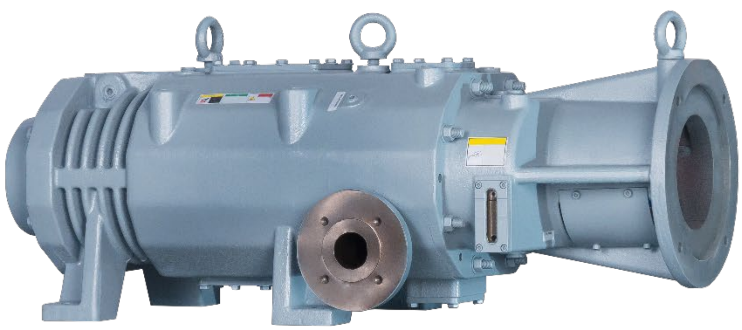
# NSP Dry Screw Unit Operation Manual

Welcome to the NES Company NSP Dry Screw Pump! NES Company is proud to provide quality pumps built to last, with minimal alterations to existing systems. NES Company has put together this helpful document detailing the proper, safe, and reliable operation of NRV pumps. For maximum performance and service life of the pump, please adhere to the instructions that follow.



# 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 are 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

NSP pumps represent a series of positive displacement, dry-running pumps renowned for their key feature of isolating the pumped material and possessing a deep vacuum capability. These pumps can achieve ultimate vacuums as high as 1Pa. The "dry screw" designation arises from their dry-running nature, with all processes and pumped materials isolated from external fluids and lubricants using oil and mechanical seals. This unique feature makes NSP pumps well-suited for industries requiring clean operations and those dealing with toxic or highly corrosive gases. NES Company recommends protective coatings, particularly for abrasive and corrosive gases.

NSP units utilize a pair of helical screw rotors rotating against each other to axially move the process material towards the outlet port. The variable pitch design of the rotors significantly enhances energy efficiency compared to constant pitch designs found in the market. Unlike other designs where most gas compression occurs at the outlet end plate, the variable pitch rotors compress the gas along the pump's body, promoting effective cooling, preventing expansion, and substantially reducing energy requirements.

The pump can be driven either through a belt or coupling transmission. The motor's power is then harnessed to drive the screws, turning against each other through a geared connection. The counter-rotating motion of the screws propels the process gas axially down the pump, directing it towards the outlet port.

## 2.2 Structural Diagram

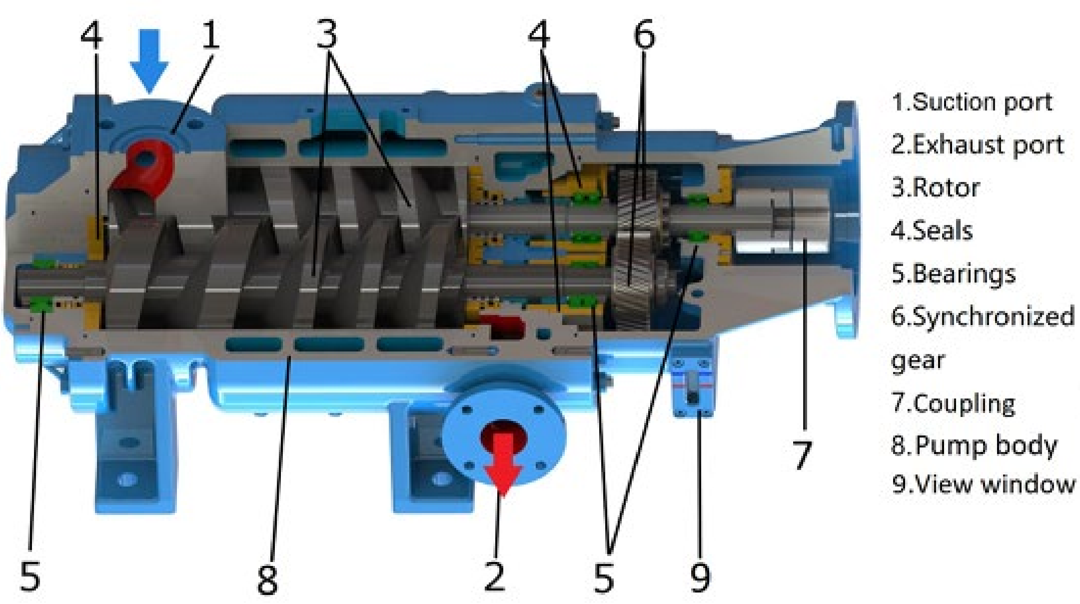



*Figure 1*

## 2.3 Description of Parts

The following are numbered in reference to *Figure 1.*

1. **Suction Port:** This refers to the inlet side of the pump, connected to the inlet pipeline, and represents the low-pressure end of the pump.
2. **Exhaust Port:** Situated on the outlet side of the pump, it is connected to the discharge location. This is where compressed, hot gas exits the pump.
3. **Rotor:** The helical, counter-rotating screws responsible for pushing and compressing gas in the pump chamber along the length of the pump.
4. **Seals:** Installed to prevent the leakage of the pumped medium and to ensure that no external substances enter the process.
   On the Suction Side: 2 double lip seals
   On the Exhaust Side: A standard configuration comprises a double lip seal and a mechanical seal; alternatively, an optional setup includes 2 double lip seals.
   On the Drive End: An oil seal is used.
5. **Bearings:** Critical components ensuring precise clearance between rotors and gears.
   On the Outlet Side (Fixed End): Angular contact ball bearing
   On the Inlet Side (Free End): Roller Bearing with high load capacity.
6. **Gears:** Heat-treated and polished gears designed to reduce noise and ensure an extended operational life.
7. **Coupling:** Installed at the end of the input shaft to transmit power from the motor to the pump.
8. **Pump Body:** Configured as a double-jacket pump body, where the inner jacket houses all mechanical rotating parts and the process medium during operation. The outer jacket facilitates the use of a cooling water layer to effectively control pump temperature.
9. **Oil Level Meter:** Indicates the oil level in the gearbox. It is advisable to maintain the oil level between the R and H lines. Regular checks for both level and contamination are recommended, with contaminated or abnormal oil levels warranting replacement

## 2.4 Product Specifications

<table>
<tr><th>Model</th><th>Flow Capacity</th><th>Power Rating</th><th>Ultimate Vacuum Pressure</th><th>Rotation Speed</th><th>Exhaust Method</th><th>Cooling Water Connection</th><th>Cooling Water Flow Rate</th><th>Seal Purge Gas Flow Rate</th><th>Weight</th></tr>
<tr><td>--</td><td>CFM</td><td>HP</td><td>Torr</td><td>RPM</td><td>--</td><td>NPT</td><td>GPM</td><td>GPM</td><td>Lbs.</td></tr>
<tr><td>NSP-150</td><td>77</td><td>5</td><td>0.01</td><td rowspan="6">3600</td><td>Side</td><td rowspan="6">1/2"</td><td>1.32-2.64</td><td rowspan="3">1.32-3.96</td><td>419</td></tr>
<tr><td>NSP-300</td><td>177</td><td>10</td><td rowspan="2">$7.5 \times 10^{-3}$</td><td>Side or Bottom</td><td rowspan="2">2.64-3.96</td><td>750</td></tr>
<tr><td>NSP-400</td><td>235</td><td>15</td><td>Side or Bottom</td><td>992</td></tr>
<tr><td>NSP-600</td><td>353</td><td rowspan="2">20</td><td>0.01</td><td>Bottom</td><td rowspan="2">3.96-5.28</td><td rowspan="3">1.32-5.28</td><td>1058</td></tr>
<tr><td>NSP-800</td><td>412</td><td>$7.5 \times 10^{-3}$</td><td>Side or Bottom</td><td>1323</td></tr>
<tr><td>NSP-1000</td><td>589</td><td>25</td><td>0.01</td><td rowspan="4">Side</td><td>5.28-6.60</td><td>1499</td></tr>
<tr><td>NSP-1500</td><td>883</td><td>50</td><td rowspan="3">0.05</td><td rowspan="3">1800</td><td rowspan="3">1”</td><td>7.93-10.57</td><td rowspan="3">3.96-6.60</td><td>3527</td></tr>
<tr><td>NSP-2500</td><td>1471</td><td rowspan="2">75</td><td>13.21-14.53</td><td>2976</td></tr>
<tr><td>NSP-3000</td><td>1766</td><td>10.57-13.21</td><td>5512</td></tr>
</table>

*Table 2*

## 2.5 Structure Materials

Table 3 below outlines the standard materials employed in the fabrication of NSP pumps. Consideration is given to potential chemicals that the pump, both internally and externally, may come into contact with, which could result in chemical corrosion. It is important to note that the pump is equipped with protective coatings, and proper care is essential to prevent wear and deterioration of these coatings.

| Part | Material |
|---|---|
| Pump Body | Ductile Iron (65-45-12)<br>Exterior Painting – Anti-corrosion coatings available upon request |
| Screw Rotors | Ductile Iron (70-50-05)<br>Anti-corrosion coatings available upon request |
| End Cover | Ductile Iron (65-45-12)<br>Exterior Painting – Anti-corrosion coatings available upon request |
| Siding Bushing | Ceramic Clad Stainless Steel |
| Mechanical Seal | Dynamic Ring: Hastelloy drive bellows, No.5 graphite ring<br>Static Ring: Tungsten carbide coated stainless steel<br>O Ring: Viton, optional Kalrez |
| Oil Seal | Viton |
| Double Lip Seal | Stainless steel and PTFE |
| Coating | Standard Coating: 15±5µm (Ni-P Alloy), 40±20µm (PFA)<br>Optional Coating: No Coating |

Table 3

## 2.6 Lubricant

NSP pumps undergo evaluation and lubrication as integral parts of the manufacturing process, ensuring quality control and proper lubrication before shipment. Despite these precautions, there is a potential loss of oil and lubricant during shipping due to mishandling or damage. Therefore, it is crucial to inspect the oil level before initiating pump operation and to add oil if it is at or below the red, R, line.

***Avoid adding or changing oil while the pump is in operation, and ensure that drain plugs are securely in place during pump operation. Oil level checks should only be performed when the pump is not running. Do not initiate pump operation without verifying the grease and oil levels.***

The use of high-grade petroleum products as lubricants is recommended, particularly those containing antioxidants, rust inhibitors, and special pressure-resistant agents. It is important to refrain from using lubricants that contain water, sulfate, resin, or tar. Refer to Table 4 for a recommended list of lubricants.

| Location | Suction End | Exhaust End |
|---|---|---|
| Lubricated Parts | Gearbox | Bearing |
| Change Interval | 6 months | 6 months |
| Quantity | 1-10 qt | 0.34-0.50 fl oz |
| Oil Type | Shell Turbo Oil T-46 | Mobil 1 synthetic Grease |
| Alternatives | | Shell Gadus S2 V100 2 |
| | Mobil SHC Series | Fomblin RT 15 |

Table 4

*Bottom alternatives in *Table 4.* suitable for semiconductor applications*

*Change intervals in *Table 4* must be shortened when project involves use of solvents*

*Clean pump and replace grease and oil in the event of liquid spillage in the pump*

**Using a Different Oil/Grease**

The oils and greases recommended in Table 4 have been carefully chosen to ensure proper and effective lubrication for all pump components, taking into account the operating temperature and viscosity requirements. The use of alternative oils or greases may result in improper functioning of the pump's moving parts. Opting for a lower viscosity oil might impede effective heat dissipation and fail to adequately separate contacting metal parts, ultimately causing substantial wear on gears and bearings. On the other hand, selecting a higher viscosity may hinder optimal performance, as it may struggle to distribute evenly across all mechanical assembly parts. Additionally, the heightened friction and increased heat generated by a higher viscosity oil can contribute to excessive wear over time.

**Neglecting to Change Oil**

Over time, the oil in the pump tends to thicken and accumulate debris and particulates resulting from the natural wear of internal components and potential minor contamination from the process medium. Therefore, it is imperative for operators to routinely change the oil in the pump at recommended intervals or even sooner. Failing to adhere to this maintenance practice can lead to premature pump failure.

The suggested oil change intervals are based on general working conditions. Operators are strongly advised to consistently assess the oil's condition in the gearbox using the oil sight glass located on the oil level check. The frequency of these checks should be determined by usage patterns, with daily or weekly inspections recommended. Establishing a customized and regular oil change schedule based on individual usage and monitoring the oil's appearance over time is crucial for maintaining optimal pump performance.

# 3. Installation

## 3.1 Overview

The unpacking, mounting, and setup of the pump follow standard procedures comparable to other vacuum pumps. However, special attention must be paid to mounting the pump flat and flush to ensure an extended pump life. Careful mounting is essential to prevent stress on the pump body, as stresses from pipes or improper mounting can lead to reduced clearances between the pump body and rotors, resulting in scraping and eventual gear and bearing failure.

**To achieve optimal results:**

Mount the pump on a flat, level surface to prevent soft foot, where uneven mounting can induce torsion stress on the pump body, potentially causing deflection when fully fastened. Ensure that piping matches up seamlessly with the pump's various inlets and outlets to avoid additional stresses on the pump. Prior to installation, carefully measure and plan piping for the pump to ensure proper alignment. Considerations for mounting should also include addressing the vibrations generated during pump operation. Buyers may explore adding damping to the pump mounts to mitigate the vibration transferred to the environment and the overall system. This not only reduces the noise produced by the pump but also minimizes the shaking and vibration throughout the entire system.

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

## 3.2 Location

Choose a location with ample lighting and sufficient space that allows trained technicians to conduct maintenance on both the pump and the entire system. Optimal conditions include well-ventilated environments and cool temperatures, as this is conducive to the efficient operation of the pump and other system components. Failure to provide suitable conditions may result in pump and fixture overheating.

Additionally, ensure that instrumentation and access to the instrument/control panel are readily visible, easily reachable, and unobstructed. Placing the pump in proximity to the process can minimize losses attributed to decreased system conductance. As a best practice, aim to keep the pump within 6 meters of the process gas to mitigate the impact of conductance losses.

## 3.3 Foundation

The mounting surface must meet specific criteria, being horizontal, flat, and adequately load-bearing to provide sufficient support for the pump and its associated components. It is crucial to note that these pumps are not designed for installation on vertical or sloping surfaces.

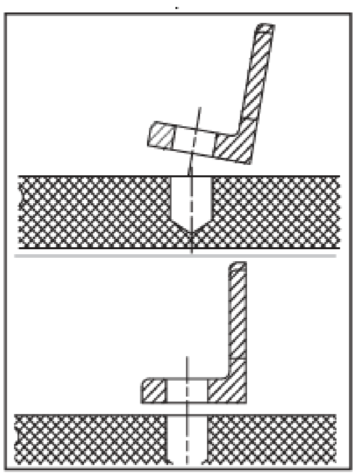


Figure 2

## 3.4 Soft Foot

Soft foot occurs when one of the pump feet fails to rest horizontally on the mounting surface. If any indication of unevenness is observed, illustrated in Figure 2 or otherwise, adjust the pump feet using shims until all feet rest flat on their mounts in a flush manner.

Clearance between the feet and the mounting surface of .076mm (.003in) or more significantly impacts the pump's lifespan. Confirm that all clearances between pump feet are .05mm (.002in) or less, and ideally, all feet are flat and in direct contact with the mounting surface. This assessment should be conducted when all bolts are loose. Add shims as needed to rectify the clearance between pump feet and the surface until they are flush or the clearance is less than .05mm.

## 3.5 Air Inlet and Outlet

Ensure that the outlet port remains unobstructed to minimize overheating issues, necessary maintenance, and power consumption. Additionally, verify that both the inlet and outlet piping are not smaller than the corresponding dimensions of the pump ports. The use of smaller exhaust or inlet pipes can result in restrictions, diminishing the pump's efficiency. Similarly, locating the pump far from the process may lead to reduced efficiency due to gas loss, a factor associated with the conductance of the piping system and the pump's design specifications. Optimal performance is achieved by employing larger diameter pipes rather than smaller ones.

## 3.6 Installation Safety Notes

***Maximum RPM – 3600***

***Maximum Exhaust Temperature – 150°C to 180°C*** *(300°F to 350°F)*

Do not attempt to service or disassemble the pump without completely disconnecting the power from the motor. The pump contains moving and spinning parts that can engage unexpectedlyService and installation tasks should be undertaken by trained technicians who adhere to appropriate safety precautions. Due to its weight and potential risks, improper handling of the pump poses a danger to both itself and the operators.

Key safety measures during lifting operations include ensuring that lifting slings are adequately rated for the applied weight and maintaining the pump and motor in a horizontal and secure position during lifting. Avoid removing documentation provided with the pump or any covers/plugs until ready for installation.

Before installation, vent and purge the system and pump to prevent contamination and the inadvertent introduction of materials into the pump. Exercise caution regarding any harmful or toxic pumping mediums the pump may have been handling. Always prioritize safety and follow recommended procedures to mitigate risks during pump servicing and installation.

## 3.7 Storage

Open the pump upon receipt and carefully inspect for any potential damage that may have occurred during shipping. If damage is identified, promptly contact NES Company. Similarly, inspect any other equipment shipped with the pump for damages.

If the pump is not intended for immediate installation, especially for an extended period, it is advisable to repackage it and store it in a suitable environment. Ensure that all covers and plugs are securely in place to protect the pump.

## 3.8 Short Term Storage (up to 6 months)

The pump and its oil/lubricants are designed to endure short-term storage of up to 6 months. The corrosion-resistant coatings and plugs are integral to preserving the pump during this period. If storage is planned, particularly outdoors, it is crucial to maintain the position of covers and plugs to prevent corrosion of the pump interiors and the accumulation of solids in the pump body. Ideally, store the pump in a dry indoor environment to preserve its condition. Shrink wrap can be utilized for added protection.

## 3.9 Long Term Storage (more than 6 months)

The primary concern during long-term storage is to shield the pump from breakdown and corrosion. Preserving the pump free of corrosion is essential for successful future installations. Here is a recommended guide for storing a dry screw pump long-term:

1. Spray rust prevention oil on pump internals, including rotors, pump cavity/body, and end cover.
2. Completely fill front and rear cover tanks with pump oil. Attach a note on the pump body to remove all excess oil/grease from both tanks before start-up. Change the oil annually.


*Figure 3*

3. Apply anti-rust oil on the drive shaft and all exposed parts, including inlet and outlet connection flanges, motor connection flanges, and other connections.
4. Cover all exposed orifices with plugs or covers to seal the pump and anti-rust oil inside. Remove any pipelines and the pump base, covering these orifices before storage.
5. Place drying bags on both sides of the pump to prevent condensation.
6. Store in a dry environment and, if possible, rotate the pump shaft monthly to prevent it from getting stuck in one position.

## 3.10 Lubrication

Monitor the oil level in the pump through the oil sight glass, as depicted in Figure 3. During pump operation, ensure that the oil level is maintained between the R (Run) and H (High) lines. If the oil level falls outside these lines, take corrective action by draining or filling until the specified condition is met. Refer to the spec sheet or the table outlining recommended oils and greases (found above) when selecting or adding oil to your machine.

**To Add Oil**

1. Loosen the plugs on both the front and back covers, as illustrated in Figure 4.
2. Gradually add the lubricant while observing the oil level in the pump's sight glass. Cease filling when the level reaches the "R" line.
3. Tighten the plugs and breathing valves from step 1.

**To Remove and Change Oil**

1. Prepare a container to collect waste oil from the pump.
2. Loosen plugs on both the front and rear covers, as seen in Figure 4.

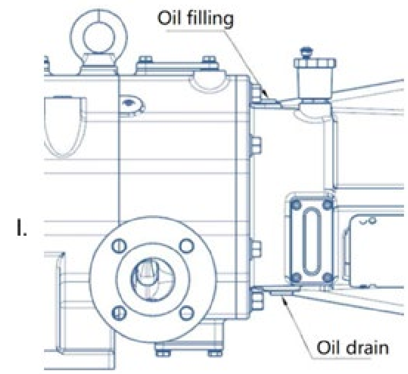



*Figure 4*

3. Loosen drain plugs and slowly drain oil from the pump.
4. If removing excess oil, stop draining when the level reaches the "H" line.
5. If changing oil, completely drain oil from the tank.

## 3.11 Suction and Exhaust Pipes

Dry screw pumps find extensive use in industries dealing with toxic and explosive media pumping. However, regardless of the application, it is imperative to ensure the cleanliness of the interior of all piping leading into the vacuum pump. This involves regular inspection and cleaning of any filters on the pump's outlet or inlet to prevent clogging or blockages. Additionally, it is recommended to change filters and strainers regularly during the process to prevent the accumulation of particulates and debris on the pump.

Furthermore, it is a mandatory practice to support any piping connected to the pump with a structure independent of the pump itself. This measure is crucial for reducing stress and loads exerted on the pump due to the weight of the piping and potential thermal expansion. To counteract loading resulting from thermal expansion or compression, the use of expansion joints is advised to alleviate stress on the pump caused by the expanding pipe. Alternatively, hoses can serve this purpose, offering the added benefit of reduced vibration.

## 3.12 Pumping Toxic Gases

When designing a system for handling toxic, corrosive, or explosive gases, it is imperative to ensure complete isolation of the process from the atmosphere. Additionally, consider purging the gas to dilute it and maintain safe values in terms of concentration and volume for toxic or explosive substances. For pumping explosive media, install flame arrestors on both the inlet and exhaust valves.

**Inlet System Connection**

- Prior to 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/replace the filter/strainer if it becomes full.
- Maintain the distance between the pump and the process within 6m to
- Ensure there are no restrictions in the exhaust piping to prevent overheating and inefficiency in the system. If the process contains gas that will condense in the pump during compression, dilution is necessary before compression. This can be achieved with a gas ballast or a separate nitrogen source. While nitrogen is the safest option for dilution, gas ballast systems are equally effective. Both methods involve adding a safe, compressible gas

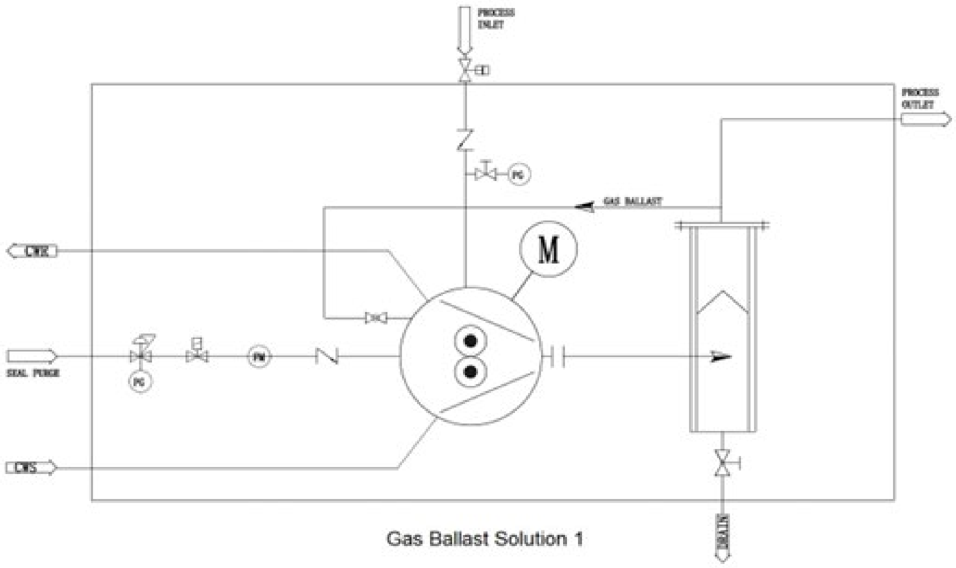
optimize pump efficiency. Larger pipes can also be used to mitigate the reduction in system conductance.

- Use appropriate bolts and a V-type O-ring seal to connect all flanges, ensuring proper sealing to prevent leaks and unwanted stresses in the system.
- 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 performance curve of the vacuum pump.

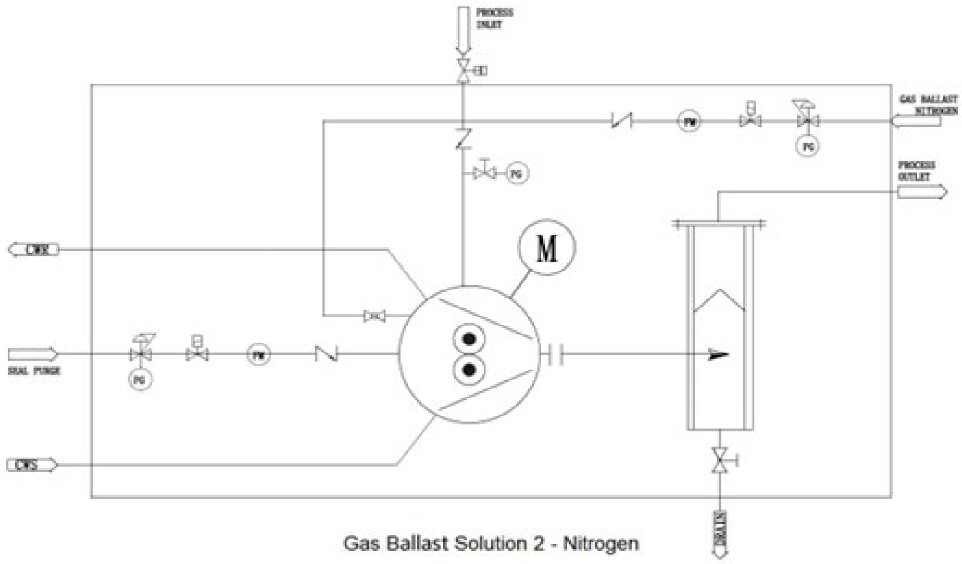
**Exhaust System Connection**

- If a silencer is used, connect it as close as possible to the pump exhaust. This can also serve as a separator for mixtures with condensable components. Dispose of any condensates responsibly according to local government guidelines.

to the process just before the inlet to dilute the condensable substance to a point where the increase in pressure will not cause condensation in the pump. A separate nitrogen source is required for a nitrogen dilution system, while a gas ballet system recirculates a small amount of incondensable process gas from a separator to dilute the incoming process gas. Two possible solutions are illustrated in the diagrams seen in Figure 5.




Gas Ballast Solution 1




Gas Ballast Solution 2 - Nitrogen

*Figure 5*

## 3.13 Cooling Water

The compression of process gas generates a substantial amount of heat, and if left unregulated, it can lead to the overheating of pump internals, eventually causing the failure of internal components. NSP pumps are equipped with a cooling jacket designed to uniformly cool the entire body of the pump. The external circulation system introduces cold liquid into the cooling inlet port of the pump, traverses through the pump body, and exits through the cooling water discharge port. Water is typically used as the cooling substance. It is advisable to use soft, portable, or deionized water for pump cooling, as prolonged use of hard water containing minerals and other solutes can result in deposits in the cooling jacket, diminishing its functionality.

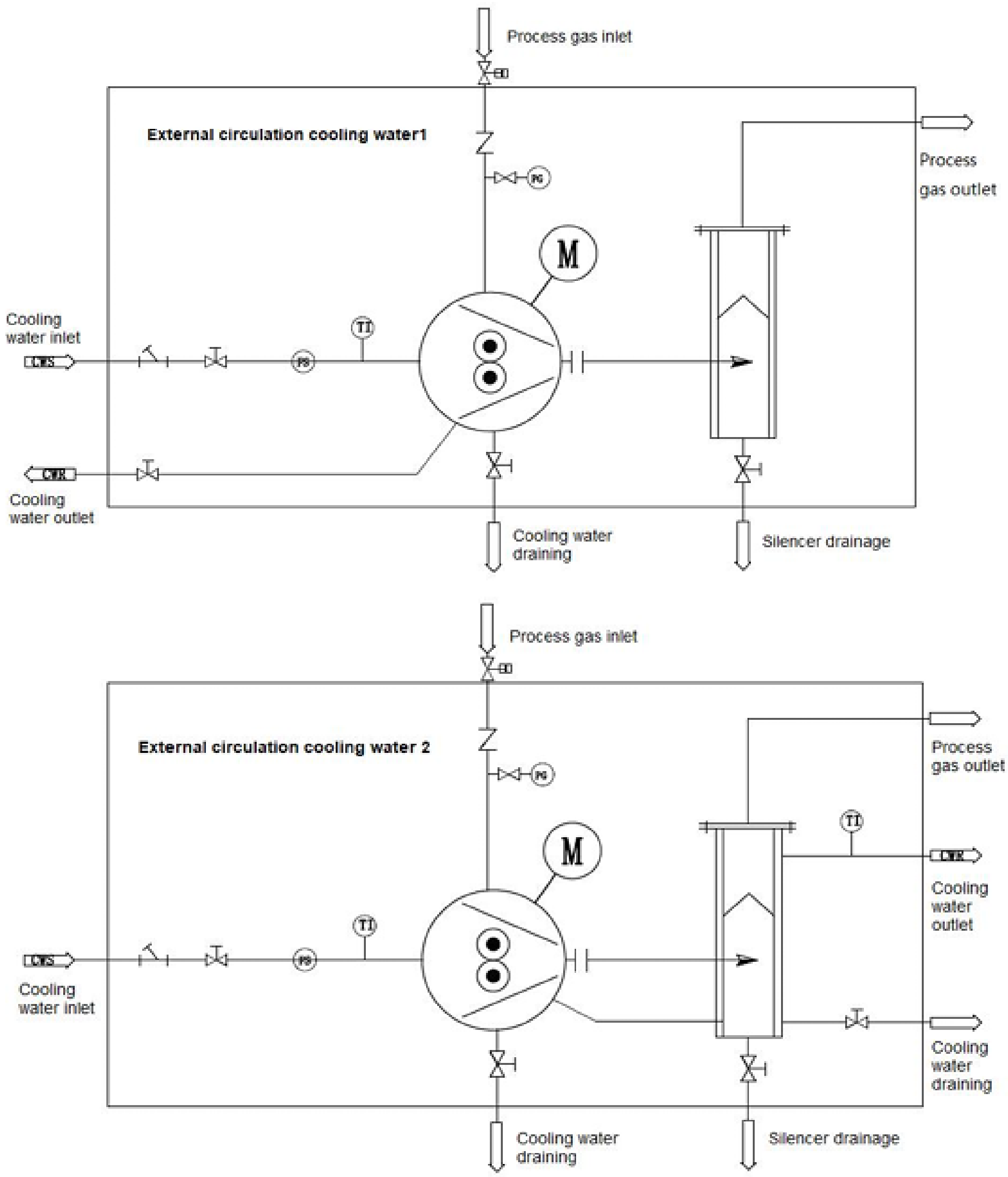



*Figure 6*

Neglecting to address these deposits and blockages will lead to a shortened lifespan of the pump. Regularly opening the drain valves on the pump can help reduce the accumulation of minerals over time. Two possible solutions are shown in *Figure 6* below.

**Cooling Water Inlet Temperature: 20°C** (68°F)

Before starting the pump and during its operation, it is crucial to supply a consistent flow of cooling water at 20°C (68°F) in the specified, pump-specific volume. Ensure that the cooling water is turned on and running before initiating the vacuum pump. Similarly, only turn off the cooling water after the pump has been shut down and allowed to return to room temperature. Failure to follow this procedure can result in residual heat damaging internal components and shortening the service life of the pump.

If more than one pump is connected to a cooling water circuit, they should be linked in parallel with each other. The same principle applies in the case of any liquid-cooled silencer or secondary cooler connected in parallel with the pump.

## 3.14 Motor Drive Mechanism

Motors can be directly connected to the pump through a C-flange connection on both the pump and motor. The pump's RPM should be regulated to achieve the desired pumping speed based on the pump performance curves. It is imperative that the pump RPM never exceeds the specified value provided in Table 2. Motor speeds can be controlled to align with the pump speed range using a Variable Frequency Drive (VFD), ensuring that the necessary Brake Horsepower (BHP) and torque are achieved.

## 3.15 Electrical Connection

Electrical wires and connections pose potential risks of errors and accidents, particularly due to the presence of high voltages and the ambiguity of active voltage in wires. Incorrectly wiring components can easily lead to expensive accidents, injuries, and damage to equipment. It is essential to adhere to the wiring diagram of the motor and ensure compliance with the appropriate voltage ratings.

**Before undertaking any work on wiring or electrical components, including the motor, it is crucial to disconnect power from the system and confirm that there are no live wires in the system.**

- Connect any sensors, wires, and other electrical equipment with the power off and completely disconnected.
- **Ensure that the motor's rotation direction aligns with the pump's rotation direction.** Starting the pump in the wrong direction can result in increased inlet pressures, posing a risk of explosion and causing damage to the pump and piping. To confirm the rotation direction, loosen the coupling guard and briefly turn on the motor for no more than 1-2 seconds. This is to verify that the rotation direction matches the intended direction indicated on the pump. Disconnect power before making any swaps or changes to wiring. The rotation of the pump should be clockwise when facing the motor mounting surface.
- Verify that the coupling guard is properly installed before restarting the pump for operation.
- For explosion-proof or severe-duty motors, use appropriate cable glands when connecting to the power supply.

## 3.16 Auxiliary Systems

These systems are implemented to rectify and enhance the operation and lifespan of the screw pump. They carry out functions related to cleaning, cooling, purging, and dilution. The correct setup of these additional systems is vital for ensuring the long-term performance of the screw pump unit. A standard connection for an auxiliary system is illustrated below in Figure 7.

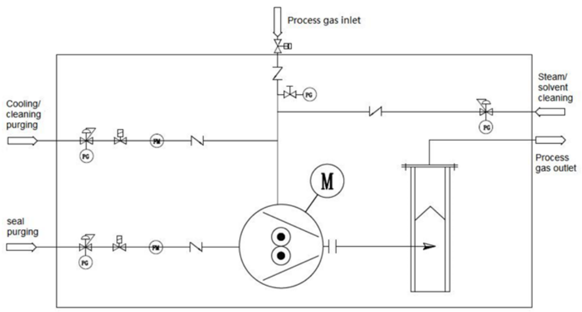



*Figure 7*

## 3.17 Seal Purge

The purpose of this system is to establish a pressure differential between the pump chamber and the front and rear covers. The objective is to maintain the separation of the lubricant and process medium, preventing contamination of both the lubricant and the process gas. Contamination in either direction can adversely impact the pump's operation, the overall system, and the discharged product from the pump. It is recommended to use inert gases such as nitrogen and argon to prevent reactions with the process gas or lubricant.

There can be multiple purge gas ports on any pump. The gas does not necessarily need to come from both ports; the purge gas may be connected via only one of the inlet ports on both ends of the pump.

**Purge Gas Pressure: 18.5-21.5 psig**

**Maximum Mechanical Seal Leakage Rate: 5.3 x $10^{-6}$ CFM**

The pressure of the gas should not exceed 42.7 psi ultimate withstand pressure. Flow rates for the gas are provided in Table 2, as well as the series spec sheet.

## 3.18 Cooling Purge

This system is employed to cool the interior of the pump body and its internals. Gas is introduced into the pump while it is running to cool the pump chamber, as a substantial amount of heat is generated during the compression process. A cool gas, typically air or nitrogen, at atmospheric pressure is introduced into the pump chamber, creating a cooling effect.

The inlet pressure of the pump should be maintained at 3 psi (150 torr), and the pressure of the purge gas should not be less than 7 psi. For specific flow rates, please refer to the specifications sheet.

## 3.19 Cleaning Purge

The purpose of a cleaning purge is to discharge, displace, and dilute pumped gases during pump shutdown. Certain toxic and corrosive gases, as well as polymers, can damage the pump or cause it to seize if left for an extended period. It is advisable to use an inert gas such as nitrogen or argon for this function.

**A recommended pressure for the purge gas is 18.5-21.5 psi, and a flow rate of 80 GPM should be employed to clean the pump. The purge gas should flow through the pump for a minimum of 20-30 minutes.**

- Cleaning purges are carried out before starting or stopping a pump. To perform a cleaning purge:
- Close the main valve at the pump inlet.
- Start the pump and purge gas for 20-30 minutes.
- Turn off the motor once the process is complete - Keep the main valve closed throughout the entire procedure.
- If the pump is not equipped with a cleaning purge system, run the pump with the main valve closed for 10-20 minutes before shutting down. The dry run of the pump may not completely remove compressed vapors and residues. If this is the case, a steam or solvent flush of the pump might be required.

## 3.20 Steam/Solvent Flushing

A flush is designed to completely rid the pump chamber of any residual gases and residues from pumping special chemicals and substances. Generally, a cleaning purge is effective in doing this, but when the pumped medium is a polymer, monomer, or resin, a cleaning purge may not yield the desired results, and pump performance may decrease or stop altogether due to damage or seizure of internals. For this reason, a more targeted purge method must be used to remove condensed and polymerized matter.

**Solvent Flushing:** Solvent flushing is done when the process material is particularly soluble in a specific chemical. The liquid is poured through the pump system, starting at the booster/secondary pump if present. Solvent flushing is combined with a cleaning purge at pump shutdown. It is necessary to control the pressure in the system to prevent the solvent from vaporizing and becoming less effective. Pressure can be modulated from the purge gas flow valve manually to be high enough to prevent solvent vaporization, and then solvent is added to the inlet of the entire system. A controlled flow of solvent at about 0.5L/min is recommended. The entire solvent flush will take around 10-15 minutes. Once done, the effects can be observed in the increased performance and lower energy consumption of the pump. Operating current should reduce and return to the rated value for the pump.

**Steam Flushing:** The goal of a steam flush can be the same as that of the cleaning purge and solvent flush. It can also serve in case the process material is temperature-sensitive. A steam purge can achieve an equal temperature profile to avoid condensation of the process gas in the pump chamber. The major difference is that this is done after the pump has been stopped and disconnected from power. Clean steam at 20-22 psi should be used in this process.

- Close the inlet valve of the pump, and open exhaust and silencer drain valves.
- Ensure power is disconnected from the pump to prevent accidental startup during this process.
- Inject steam for about 15 minutes. The duration may be longer depending on the amount of residual matter.
- Manually rotate the pump. Continue injecting steam until the pump rotates freely.
- Run the pump dry for 20-30 minutes to remove any residual steam.

## 3.21 Temperature Sensor

In the event of a blockage in the cooling lines of the system or pump body, there may be a disruption of cooling water flow to the pump. If left unchecked, this can lead to overheating and catastrophic failure of the pump. There are two mounts on the pump body to monitor the pump body temperature.

**If the pump body temperature rises above 90°C (200°F), the pump should be shut down immediately.** To automatically regulate the pump temperature, temperature sensors can be paired with a thermostatic control valve. This system controls the cooling water supplied to the pump, creating a feedback loop that ensures a constant temperature of the pump body during operation.

It's important to note that temperature sensors and control valves are not standard on all NES pumps. However, these components can be ordered through NES Company to meet the specific needs of the customer.

# 4. Operation

## 4.1 Overview

NSP dry screw units are resilient and reliable machines when operated correctly, built to provide long years of service to satisfied customers worldwide. Key to their long service life, however, is proper operation and maintenance. Starting and stopping the pump are critical moments during operation where a lot of wear and damage can occur if not done properly.

Before initiating the pump, it is essential to double-check some commonly overlooked aspects during installation that could lead to problems during startup and operation:

- Ensure that the pump is horizontally mounted, sitting flat on its base at all legs, and securely tightened down.
- Verify that there is a filter attached to the pump inlet and that it is in suitable condition for use.
- Confirm that the inlet pipe is free of dust, rust, welding slag, and other foreign objects.
- Check that drive motors are properly lubricated, equipped with overload protection, and that couplings are securely attached.
- Verify that the pump can rotate freely by hand.
- It's advisable to briefly turn the motor on and off without any load on the pump to listen for abnormal noises that might indicate a problem with the system. If any unusual sounds are detected, it is recommended to stop and troubleshoot before applying the load to the pump.

## 4.2 Pump Start Up

A convenient checklist has been formulated to assist in the startup process of the pump. Before exposing or touching any rotating components, it is crucial to disconnect power from the motor to prevent accidental starts or accidents.

The pump must undergo a preheating process before commencing operation. Caution should be exercised around hot surfaces during preheating, as pump components will become hot. Inadequate preheating may lead to steam condensation in the pump body, causing corrosion.

## 4.3 Preheating

Preheating the pump involves bringing it to operating temperature before applying a load. This ensures that all internals and lubricants reach their optimal performance ranges before encountering the stresses of pumping and compressing matter.

In addition to the wear benefits, preheating is particularly important when pumping condensable gas to avoid condensation in the chamber, which could result in pump destruction or failure.

To preheat the pump:

- Close all inlets to the pump and run the pump, referred to as running the pump dry.
- For inlet pressures ATM-200 torr: preheat for 40 minutes.
- For inlet pressures 200-35 torr: preheat for 10 minutes.

## 4.4 Pump Operation

The pump is meticulously engineered to function within specified parameters, including temperature, volume, RPM, and vacuum pressure ranges. Straying beyond these designated parameters poses significant risks. Allowing the pump to operate at performance levels beyond its design can result in damage, leaks, contamination, and various issues.

**Pressure**
Operating outside the rated pressure range may cause the process to leak past seals at an unacceptable rate, leading to rapid contamination of oil or lubrication affecting bearings or gears in the pump.

**Temperature**
Permitting the pump to overheat can lead to the seizing and burnout of components, causing expensive damage to the pump internals. The maximum temperature can be measured at the pump's exhaust and should not exceed the following:

- For all models NSP 150-800: 150°C
- For NSP 1500 + 3000: 180°C

If the temperature limit switch is tripped, the pump should not restart until it has cooled below a set temperature.

## 4.5 Pump Shutdown

Properly shutting down the pump is equally, if not more, crucial than careful startup, as the pump now contains process matter and is likely very hot. In this state, it is susceptible to corrosion and lockup due to condensed process matter in the chamber. To prepare for shutdown, refer to the section on cleaning/flushing the pump. Once done, follow these steps to shut down the pump:

1. If not done already, close the inlet valve on the system to isolate the pump from the process material.
2. Run the pump dry for 10-20 minutes to clear any residual matter that may corrode or condense in the pump chamber. This step may also be completed during a cleaning purge or flush.
3. Turn off the motor and cut power to the pump.
4. Open drain valves and run cooling water in the pump for 3-5 minutes to bring the temperature down. This also serves to clean the cooling jacket cavity with fresh cooling water.
5. Stop running water through the pump and allow cooling water to drain out of the pump. It is especially important to do this in cold climates where cooling water

left in the pump can destroy the jacket and body of the pump. In cold environments, compressed gas can be used to completely flush all water in the jacket out. The use of compressed gas to remove all water is always a good idea regardless of temperature.

# 5. Maintenance

## 5.1 Overview

The service maintenance of the pump by qualified personnel is the final key to a long life and can determine whether the pump will last a few years or decades. Under regular running conditions, the vacuum pump will require periodic normal maintenance, as well as occasional repairs of broken or worn-out parts, similar to how a car would under normal usage. Regular maintenance includes but is not limited to oil and grease replacement and similar tasks. Other repairs will occur during the life of the pump, presenting themselves with abnormal temperatures, noise, vibration, and current/power consumption. Paying attention to this data, as well as visual signs like the appearance of the gear oil.

Keeping the pump off for an extended period will require a special course of action. This might vary depending on the special application and facility. Refer to the section on long-term storage.

## 5.2 Maintenance Plan

A maintenance plan, outlined in Table 5, is an easy and compact way to keep track of things that will need to be serviced at regular intervals. Keeping up with a maintenance plan is the first and best thing to do to lengthen the life of a pump. The plan suggested is based on general pump usage and can be changed and adapted based on individual applications and factors. For harsher environments, service intervals should be more frequent, and the opposite for cleaner applications.

| 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 | | | |
| Bearing | Is the grease darkened or contaminated? | | x | | | |
| Cooling Circulation | Are all water temperatures normal? Is the discharged water discolored? | | | x | | |
| Pipe Connection | Are the insides of the inlet and outlet pipe especially dirty? Are there dirt deposits or impurities? Is performance normal? | | | x | | |
| Gearbox | Has the oil in the pump been changed? | | | x | | |
| Bearing | Has the grease in the bearing housing been changed? | | | 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 |
| Gears and Bearings | Are any of the gears damaged? | | | | | x |
| Motor | Is the motor generally healthy and worthy of operation? | | | | | x |

*Table 5*

## 5.3 Inspection and Repair Guide

**Temperature Check**

As the pump heats up, a normal temperature distribution should be observed along the body of the pump. This is due to the variable pitch rotors that compress the process gas along the pump's body. If there is a concentration of heat detected away from the exhaust of the pump, it should be stopped immediately and inspected. Common causes of this issue include interruptions in the cooling supply and the inhalation of objects like wires, solid particles, or other items.

**Inlet Filter**

The proper installation and maintenance of the inlet filter play a crucial role in preventing solids from entering the pump. It is particularly essential to ensure the presence of a filter during the initial setup of the system due to the increased risk of contamination and the presence of loose particles that could be drawn into the vacuum pump, such as welding slag.

**Gearbox Oil Replacement**

To maintain the optimal condition of gears and bearings, it is crucial to ensure the freshness and cleanliness of the oil. The oil acts as a nearly frictionless boundary between all moving parts within the rotating assembly. Wear in mechanical systems is primarily caused by the contact and friction between metal parts. Contaminated oil diminishes its ability to protect the contacting metal components because used and worn oil tends to be more viscous and contains friction-inducing particles. Both factors contribute to increased wear on the metal parts within the rotating assembly. To assess the condition of the oil, utilize the oil sight glass to inspect for discoloration and the presence of particulates, serving as indicators of usage and potential issues with the pump internals. Consumption of a large amount of oil is an indication of a leak in a mechanical seal or gasket that should be addressed.

A list of acceptable lubricants can be found in Table 4, in section 2.6.

To replace oil and grease:

1. Ensure the pump is powered off before initiating any disassembly, and exercise caution regarding elevated temperatures on the pump surfaces and oil.
2. After the pump has cooled down and the pressure in the gearbox has been alleviated, proceed to drain the oil into a container of suitable size. Observe for large particulates and abnormal discoloration, as these may indicate potential issues. If noted, troubleshoot the pump and consider more frequent oil changes.
3. Remove and clean the oil level sight glass before reinstalling it.
4. Tighten the drain plug securely and proceed to replace the gear oil with fresh oil.
5. Finally, tighten the oil filler plug to complete the process.

## 5.4 Bearing Maintenance

Exercise caution regarding elevated temperatures in the bearings following the pump's operation, as bearings, particularly due to their location within the pump, may be significantly hot.

**For Exhaust Bearing Inspection:**

- Disassemble the nut and O-ring, ensuring the bearing remains in place.
- Thoroughly clean and inspect the bearing for any foreign particulates, as well as unusual wear.
- Properly reinstall the bearing.

**For Suction Bearing**:

- Disassemble the bolt, O-ring, lubricant cover, and bearing grease.
- Clean the bearing, followed by a detailed inspection for any signs of damage or abnormalities.
- Reinstall the bearing, applying grease using an injector, avoiding excessive amounts that could lead to overheating.
- Rotate the screw shaft approximately five times to evenly distribute the lubricant.
- Reinstall the lubrication cover and O-ring correctly.

In the event of identified abnormalities or damage in either bearing, replace the affected part and promptly contact NES Company.

## 5.5 Pipeline Inspection

It is crucial to recognize that pipes undergo corrosion over time, leading to the development of weaknesses and leaks in a system's piping. Identifying these issues early and replacing the necessary components is advantageous for both the performance and safety of the system. Operators working in proximity to the system may be exposed to potentially toxic process gas and high-voltage electrical wires that can be compromised by corrosion. Key areas requiring 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 within the system.

## 5.6 Pump Body Cleaning

Routine cleaning is an integral aspect of pump maintenance. Cleaning serves to eliminate residual compressed gases and condensed material from the pump chamber. The accumulation of material in the pump chamber, particularly during periods of inactivity, can lead to condensation and subsequent corrosion, compromising the pump's performance. A poorly maintained pump draws more power from the motor, resulting in increased energy consumption to perform its function. Over time, this inefficiency translates to higher operational costs.

To clean the pump, use a cleaning solution specifically designed for the process gas in contact with the pump. If the pump is equipped with a flushing system, utilize it. In the absence of a flushing system, follow these steps:

- 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 allow it to sit for 1 hour.
- Check 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.
- Dispose of the cleaning agent responsibly and in accordance with safety guidelines.

## 5.7 Auxiliary Systems

The auxiliary systems integrated into the pump, like the pump itself, are susceptible to environmental factors and will need periodic maintenance by qualified personnel. Conducting checks on piping, valves, instruments, gas pressure, flow, and cleanliness is a proactive measure to ensure the smooth and reliable operation of the pump's auxiliary systems, consequently contributing to the overall health of the pump system. Implementing regular inspections and promptly addressing any necessary repairs is a best practice in maintaining optimal system performance.

# 6. Assembly and Disassembly

## 6.1 Initial Precautions

Inspecting the clearance of the rotors can be accomplished through the suction port on the pump, as illustrated below. Permissible target clearances for each pump model are also provided.

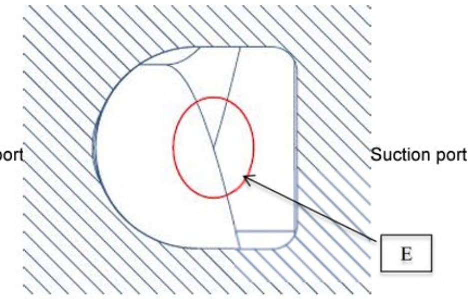



*Figure 8*

**Exhaust Port and Suction Port specify orientation of the image**

***Point "E" in Figure 8 is referenced in instructions and troubleshooting guide.***

| | NSP-150 | NSP-300 | NSP-400 | NSP-800 | NSP-1500 | NSP-3000 |
|---|---|---|---|---|---|---|
| E (mm) | 0.05-0.07 | 0.08-0.1 | 0.1-0.12 | 0.18-0.2 | 0.2-0.25 | 0.25-0.3 |

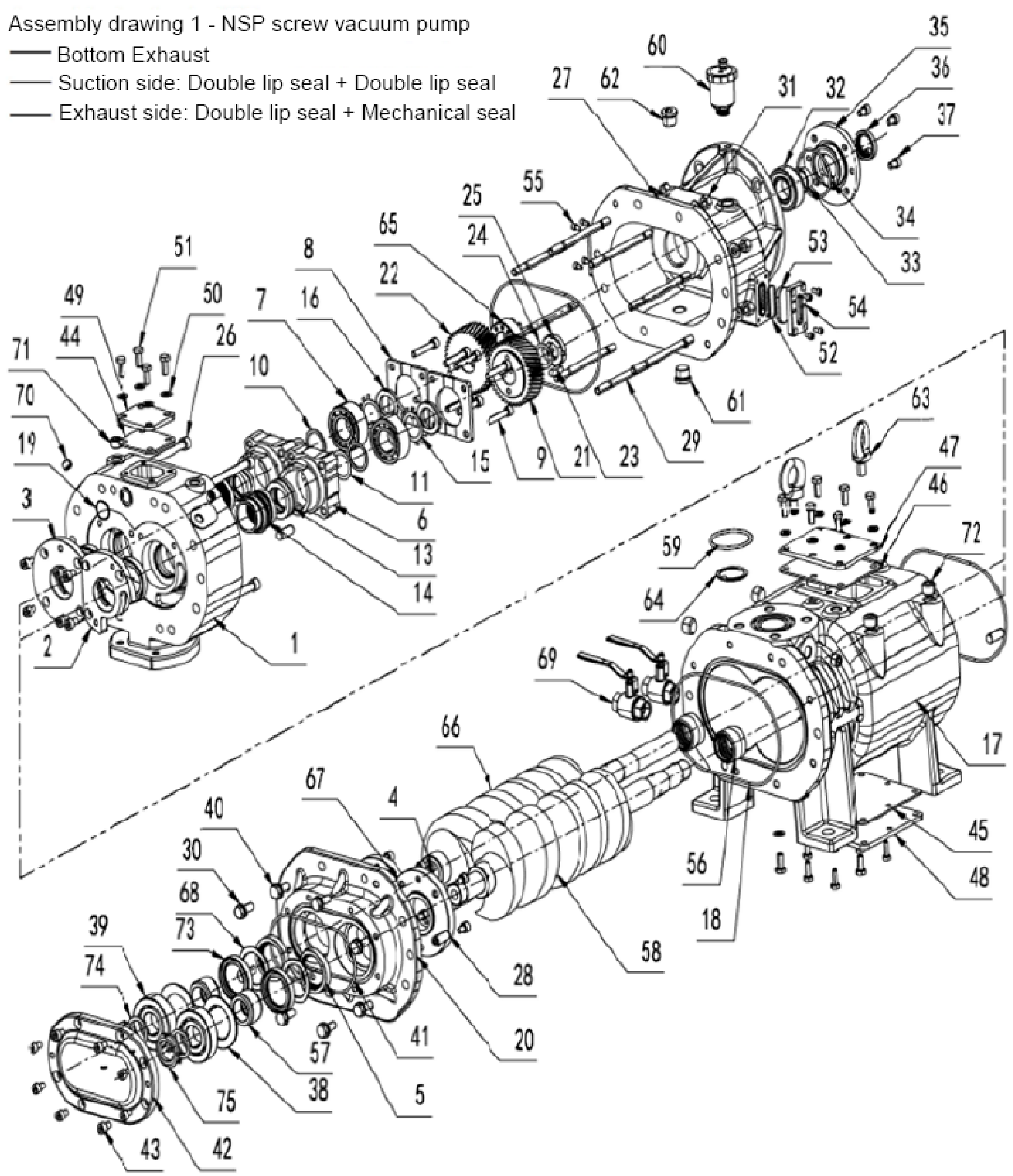
- Create fitting marks on all joints during disassembly.
- Measure the thickness of gaskets when taking apart components.
- Exercise caution to avoid breaking gaskets.
- Inspect for any unusual wear or damage to pump and system parts. Replace or repair components with signs of damage or wear.
- Store disassembled parts in a clean environment free of dust to minimize contamination of pump internals. Pay close attention to mechanical seals, bearings, gears, and O-rings.

## 6.2 Exploded Views and Parts Lists

Refer to the following diagrams for part locations and numbers. The instructions for assembly and disassembly refer to these diagrams when referencing parts.

All drawings are labeled with the type of pump referenced.

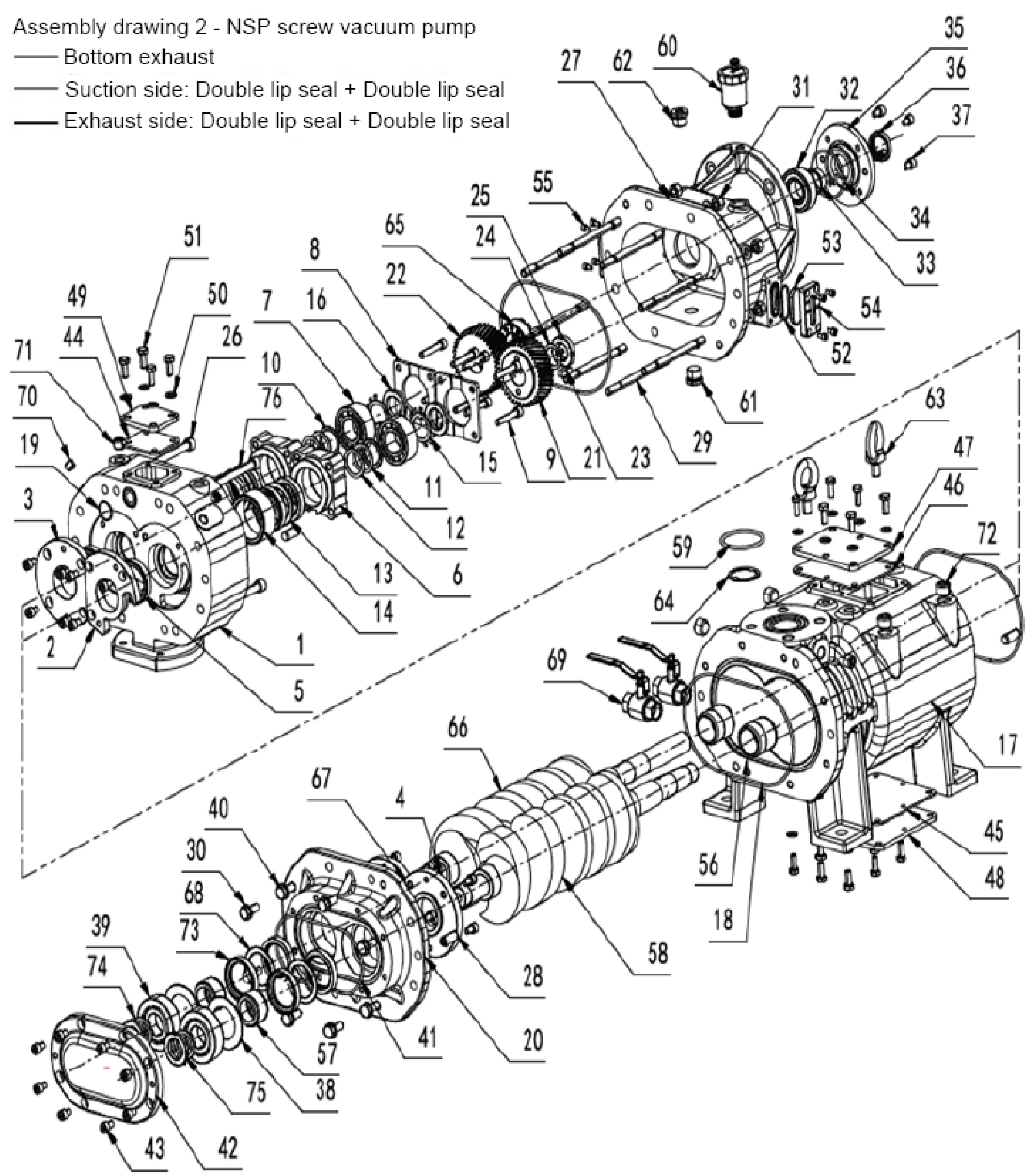
Assembly drawing 1 - NSP screw vacuum pump
— Bottom Exhaust
— Suction side: Double lip seal + Double lip seal
— Exhaust side: Double lip seal + Mechanical seal




| NO. | Part Name | Quantity | NO. | Part Name | Quantity |
|---|---|---|---|---|---|
| 75 | Locknut - suction side | 2 | 38 | Retaining ring | 2 |
| 74 | Stop washer - suction side | 2 | 37 | Hexagon Socket Head Bolt - oil seal seat | 4 |
| 73 | Double lip seal - suction side | 4 | 36 | Skeleton Oil Seal | 1 |
| 72 | Hexagon socket screw plug - pump body | 4 | 35 | Oil seal seat | 1 |
| 71 | Hexagon socket screw plug - end cover | 2 | 34 | O ring - oil seal seat | 1 |
| 70 | Hexagon socket screw plug - purge port | 2 | 33 | Bushing | 1 |
| 69 | Manual drain valve | 2 | 32 | Deep groove ball bearing | 1 |
| 68 | Washer | 2 | 31 | Hex nut | 8 |
| 67 | Suction end plate guide | 2 | 30 | Flat Washer A | 16 |
| 66 | Drive rotor | 1 | 29 | Stud | 8 |
| 65 | Gear expansion sleeve | 1 | 28 | Cylindrical pin with female thread | 6 |
| 64 | Inlet filter | 1 | 27 | Front cover | 1 |
| 63 | Lifting ring screw | 2 | 26 | Hexagon Socket Head Bolt - exhaust end cover | 4 |
| 62 | Hexagon socket screw plug | 1 | 25 | Round nut | 1 |
| 61 | Hexagon socket magnetic screw plug | 1 | 24 | Stop washer for round nut | 1 |
| 60 | Automatic exhaust valve | 1 | 23 | Gear key | 1 |
| 59 | O ring - suction port | 1 | 22 | Drive gear | 1 |
| 58 | Driven rotor | 1 | 21 | Driven gear | 1 |
| 57 | Suction end bushing | 2 | 20 | Suction end cover | 1 |
| 56 | Exhaust end bushing | 2 | 19 | O ring - water hole | 1 |
| 55 | Hexagon Socket Head Bolt - sight glass platen | 8 | 18 | O ring - pump body | 3 |
| 54 | Sight glass platen | 2 | 17 | Pump body | 1 |
| 53 | Oil window glass | 2 | 16 | Locknut - exhaust side | 2 |
| 52 | O ring - sight glass window | 2 | 15 | Stop washer - exhaust side | 2 |
| 51 | Hex bolt | 18 | 14 | Mechanical seal static ring | 2 |
| 50 | Flat Washer C | 18 | 13 | Mechanical seal dynamic ring | 2 |
| 49 | End cap upper cover plate | 1 | 12 | Adjusting washer - 0.3 | 2 |
| 48 | Pump body lower cover plate | 1 | 11 | Adjusting washer - 0.1 | 2 |
| 47 | Pump body upper cover plate | 1 | 10 | Adjusting washer - 1.2 | 2 |
| 46 | Pump body upper cover plate-rubber pad | 1 | 9 | Hexagon Socket Head Bolt - Bearing Platen | 8 |
| 45 | Pump body lower cover plate-rubber pad | 1 | 8 | Bearing Platen | 2 |
| 44 | End cap upper cover plate-rubber pad | 1 | 7 | Double-row Angular Contact Ball Bearing | 2 |
| 43 | Hexagon Socket Head Bolt - back cover | 8 | 6 | Bearing seat | 2 |
| 42 | Back cover | 1 | 5 | Double lip seal - exhaust side | 2 |
| 41 | O ring - back cover | 1 | 4 | Hexagon Socket Head Bolt S316 | 16 |
| 40 | Hex bolt - suction end cover | 8 | 3 | Exhaust end plate guide B | 1 |
| 39 | Cylindrical Roller Bearing | 2 | 2 | Exhaust end plate guide A | 1 |
| | | | 1 | Exhaust end cover - bottom exhaust | 1 |

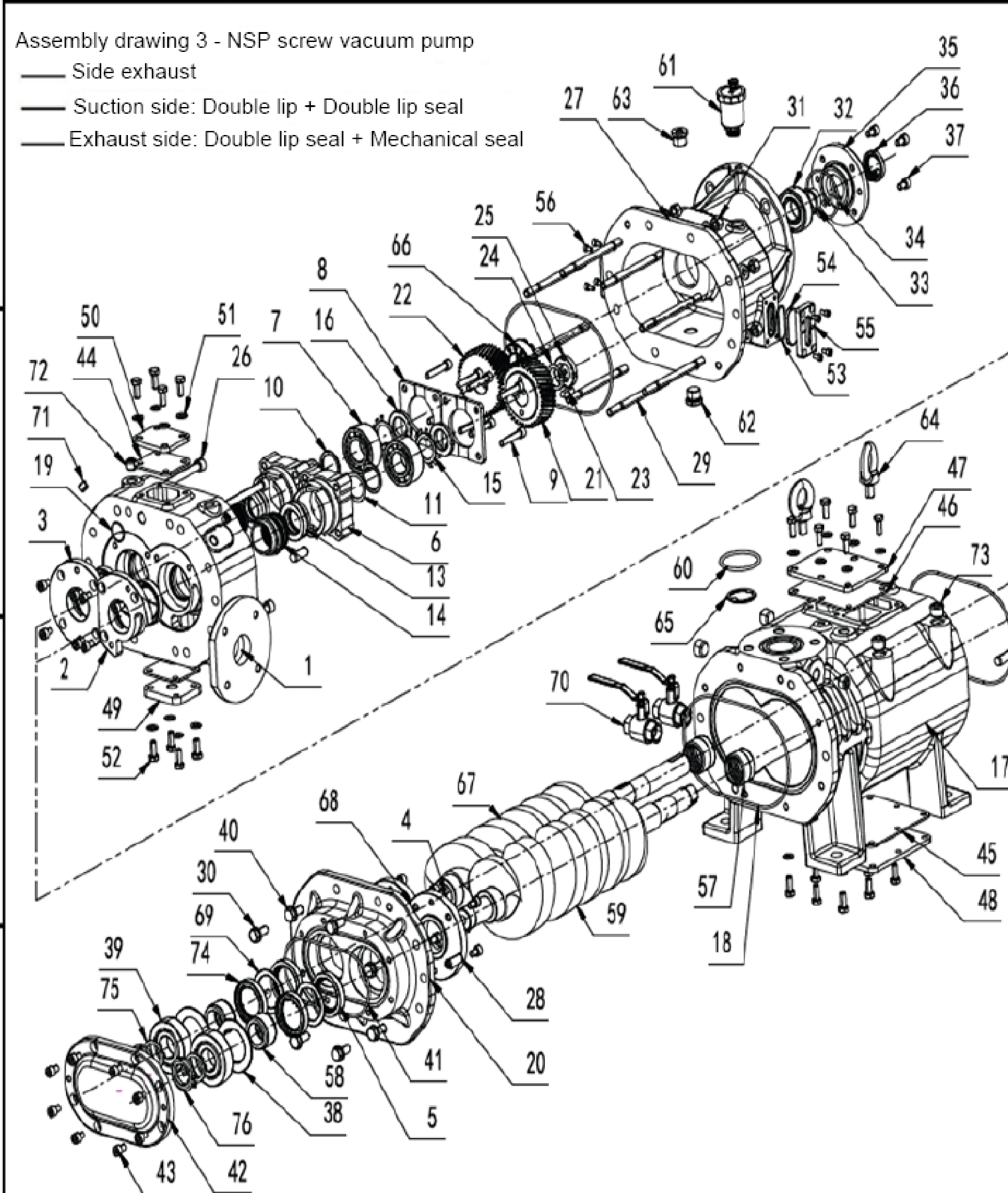
Assembly drawing 2 - NSP screw vacuum pump

- Bottom exhaust
- Suction side: Double lip seal + Double lip seal
- Exhaust side: Double lip seal + Double lip seal



| NO. | Part Name | Quantity |
|---|---|---|
| 40 | Hex bolt - suction end cover | 8 |
| 41 | O ring - back cover | 1 |
| 42 | Back cover | 1 |
| 43 | Hexagon Socket Head Bolt - back cover | 8 |
| 44 | End cap upper cover plate-rubber pad | 1 |
| 45 | Pump body lower cover plate-rubber pad | 1 |
| 46 | Pump body upper cover plate-rubber pad | 1 |
| 47 | Pump body upper cover plate | 1 |
| 48 | Pump body lower cover plate | 1 |
| 49 | End cap upper cover plate | 1 |
| 50 | Flat Washer C | 18 |
| 51 | Hex bolt | 18 |
| 52 | O ring - sight glass window | 2 |
| 53 | Oil window glass | 2 |
| 54 | Sight glass platen | 2 |
| 55 | Hexagon Socket Head Bolt - sight glass platen | 8 |
| 56 | Exhaust end bushing | 2 |
| 57 | Suction end bushing | 2 |
| 58 | Driven rotor | 1 |
| 59 | O ring - suction port | 1 |
| 60 | Automatic exhaust valve | 1 |
| 61 | Hexagon socket magnetic screw plug | 1 |
| 62 | Hexagon socket screw plug | 1 |
| 63 | Lifting ring screw | 2 |
| 64 | Inlet filter | 1 |
| 65 | Gear expansion sleeve | 1 |
| 66 | Drive rotor | 1 |
| 67 | Suction end plate guide | 2 |
| 68 | Washer | 2 |
| 69 | Manual drain valve | 2 |
| 70 | Hexagon socket screw plug - purge port | 2 |
| 71 | Hexagon socket screw plug - end cover | 2 |
| 72 | Hexagon socket screw plug - pump body | 4 |
| 73 | Double lip seal - suction side | 4 |
| 74 | Stop washer - suction side | 2 |
| 75 | Locknut - suction side | 2 |
| 76 | Lip seal - exhaust side | 4 |

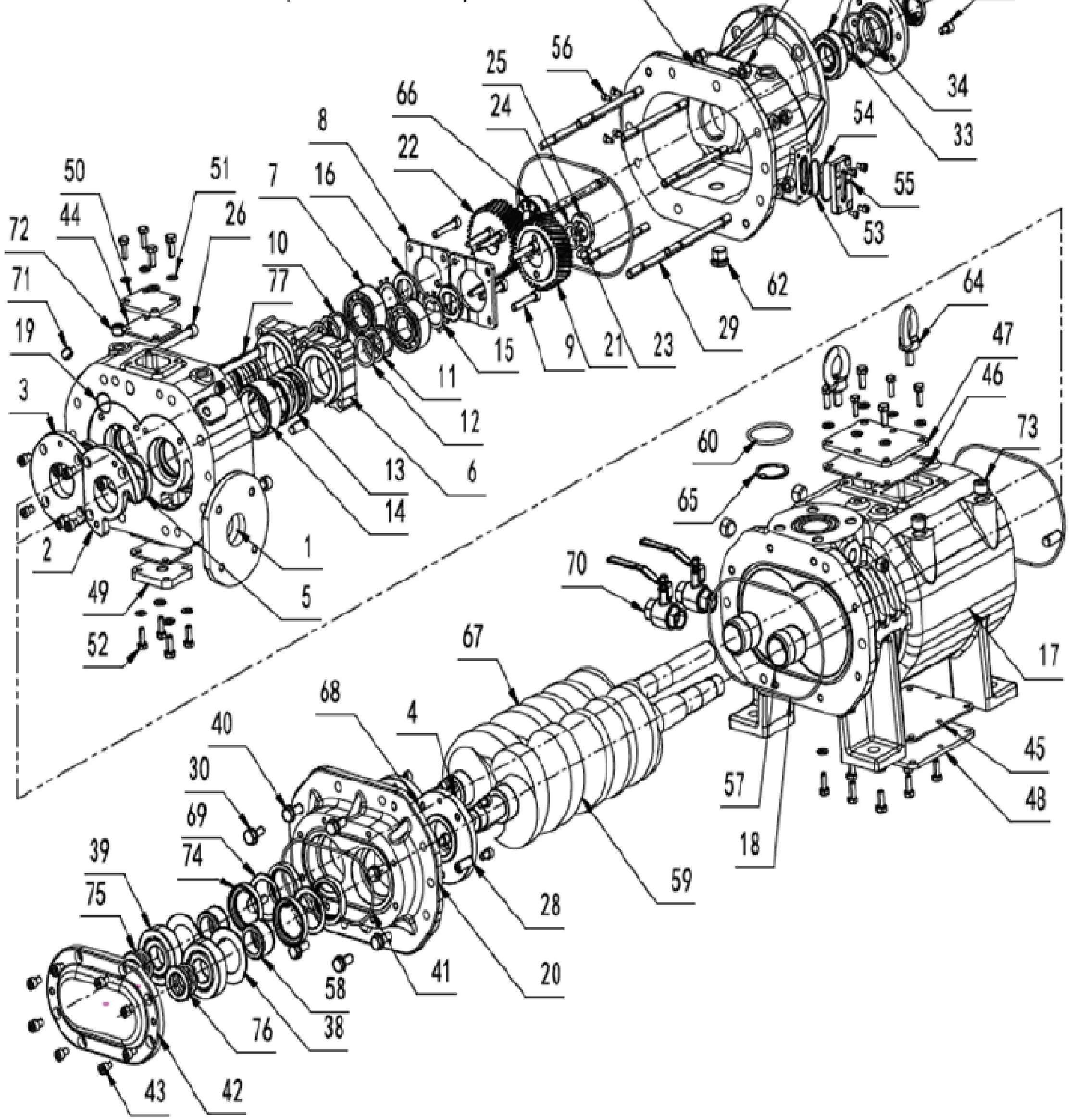
| NO. | Part Name | Quantity |
|---|---|---|
| 1 | Exhaust end cover - bottom exhaust | 1 |
| 2 | Exhaust end plate guide A | 1 |
| 3 | Exhaust end plate guide B | 1 |
| 4 | Hexagon Socket Head Bolt S316 | 16 |
| 5 | Double lip seal - exhaust side | 2 |
| 6 | Bearing seat | 2 |
| 7 | Double-row Angular Contact Ball Bearing | 2 |
| 8 | Bearing Platen | 2 |
| 9 | Hexagon Socket Head Bolt - Bearing Platen | 8 |
| 10 | Adjusting washer - 1.2 | 2 |
| 11 | Adjusting washer - 0.1 | 2 |
| 12 | Adjusting washer - 0.3 | 2 |
| 13 | Lip seal gasket | 2 |
| 14 | Lip seal seat | 2 |
| 15 | Stop washer - exhaust side | 2 |
| 16 | Locknut - exhaust side | 2 |
| 17 | Pump body | 1 |
| 18 | O ring - pump body | 3 |
| 19 | O ring - water hole | 1 |
| 20 | Suction end cover | 1 |
| 21 | Driven gear | 1 |
| 22 | Drive gear | 1 |
| 23 | Gear key | 1 |
| 24 | Stop washer for round nut | 1 |
| 25 | Round nut | 1 |
| 26 | Hexagon Socket Head Bolt - exhaust end cover | 4 |
| 27 | Front cover | 1 |
| 28 | Cylindrical pin with female thread | 6 |
| 29 | Stud | 8 |
| 30 | Flat Washer A | 16 |
| 31 | Hex nut | 8 |
| 32 | Deep groove ball bearing | 1 |
| 33 | Bushing | 1 |
| 34 | O ring - oil seal seat | 1 |
| 35 | Oil seal seat | 1 |
| 36 | Skeleton Oil Seal | 1 |
| 37 | Hexagon Socket Head Bolt - oil seal seat | 4 |
| 38 | Retaining ring | 2 |
| 39 | Cylindrical Roller Bearing | 2 |




| NO. | Part Name | Quantity | NO. | Part Name | Quantity |
|---|---|---|---|---|---|
| 76 | Locknut - suction side | 2 | 38 | Retaining ring | 2 |
| 75 | Stop washer - suction side | 2 | 37 | Hexagon Socket Head Bolt - oil seal seat | 4 |
| 74 | Double lip seal - suction side | 4 | 36 | Skeleton Oil Seal | 1 |
| 73 | Hexagon socket screw plug - pump body | 4 | 35 | Oil seal seat | 1 |
| 72 | Hexagon socket screw plug - end cover | 2 | 34 | O ring - oil seal seat | 1 |
| 71 | Hexagon socket screw plug - purge port | 2 | 33 | Bushing | 1 |
| 70 | Manual drain valve | 2 | 32 | Deep groove ball bearing | 1 |
| 69 | Washer | 2 | 31 | Hex nut | 8 |
| 68 | Suction end plate guide | 2 | 30 | Flat Washer A | 16 |
| 67 | Drive rotor | 1 | 29 | Stud | 8 |
| 66 | Gear expansion sleeve | 1 | 28 | Cylindrical pin with female thread | 6 |
| 65 | Inlet filter | 1 | 27 | Front cover | 1 |
| 64 | Lifting ring screw | 2 | 26 | Hexagon Socket Head Bolt - exhaust end cover | 4 |
| 63 | Hexagon socket screw plug | 1 | 25 | Round nut | 1 |
| 62 | Hexagon socket magnetic screw plug | 1 | 24 | Stop washer for round nut | 1 |
| 61 | Automatic exhaust valve | 1 | 23 | Gear key | 1 |
| 60 | O ring - suction port | 1 | 22 | Drive gear | 1 |
| 59 | Driven rotor | 1 | 21 | Driven gear | 1 |
| 58 | Suction end bushing | 2 | 20 | Suction end cover | 1 |
| 57 | Exhaust end bushing | 2 | 19 | O ring - water hole | 1 |
| 56 | Hexagon Socket Head Bolt - sight glass platen | 8 | 18 | O ring - pump body | 3 |
| 55 | Sight glass platen | 2 | 17 | Pump body | 1 |
| 54 | Oil window glass | 2 | 16 | Locknut - exhaust side | 2 |
| 53 | O ring - sight glass window | 2 | 15 | Stop washer - exhaust side | 2 |
| 52 | Hex bolt | 22 | 14 | Mechanical seal static ring | 2 |
| 51 | Flat Washer C | 22 | 13 | Mechanical seal dynamic ring | 2 |
| 50 | End cap upper cover plate | 1 | 12 | Adjusting washer - 0.3 | 2 |
| 49 | End cap lower cover plate | 1 | 11 | Adjusting washer - 0.1 | 2 |
| 48 | Pump body lower cover plate | 1 | 10 | Adjusting washer - 1.2 | 2 |
| 47 | Pump body upper cover plate | 1 | 9 | Hexagon Socket Head Bolt - Bearing Platen | 8 |
| 46 | Pump body upper cover plate-rubber pad | 1 | 8 | Bearing Platen | 2 |
| 45 | Pump body lower cover plate-rubber pad | 1 | 7 | Double-row Angular Contact Ball Bearing | 2 |
| 44 | End cap upper cover plate-rubber pad | 1 | 6 | Bearing seat | 2 |
| 43 | Hexagon Socket Head Bolt - back cover | 8 | 5 | Double lip seal - exhaust side | 2 |
| 42 | Back cover | 1 | 4 | Hexagon Socket Head Bolt S315 | 16 |
| 41 | O ring - back cover | 1 | 3 | Exhaust end plate guide B | 1 |
| 40 | Hex bolt - suction end cover | 8 | 2 | Exhaust end plate guide A | 1 |
| 39 | Cylindrical Roller Bearing | 2 | 1 | Exhaust end cover - side exhaust | 1 |

Assembly drawing 4 - NSP screw vacuum pump

- Side exhaust
- Suction side: Double lip seal + Double lip seal
- Exhaust side: Double lip seal + Double lip seal



| NO | Part Name | Quantity |
|---|---|---|
| 1 | Exhaust end cover - side exhaust | 1 |
| 2 | Exhaust end plate guide A | 1 |
| 3 | Exhaust end plate guide B | 1 |
| 4 | Hexagon Socket Head Bolt_S316 | 16 |
| 5 | Double lip seal - exhaust side | 2 |
| 6 | Bearing seat | 2 |
| 7 | Double-row Angular Contact Ball Bearing | 2 |
| 8 | Bearing Platen | 2 |
| 9 | Hexagon Socket Head Bolt - Bearing Platen | 8 |
| 10 | Adjusting washer - 1.2 | 2 |
| 11 | Adjusting washer - 0.1 | 2 |
| 12 | Adjusting washer - 0.3 | 2 |
| 13 | Lip seal gasket | 2 |
| 14 | Lip seal seat | 2 |
| 15 | Stop washer - exhaust side | 2 |
| 16 | Locknut - exhaust side | 2 |
| 17 | Pump body | 1 |
| 18 | O ring - pump body | 3 |
| 19 | O ring - water hole | 1 |
| 20 | Suction end cover | 1 |
| 21 | Driven gear | 1 |
| 22 | Drive gear | 1 |
| 23 | Gear key | 1 |
| 24 | Stop washer for round nut | 1 |
| 25 | Round nut | 1 |
| 26 | Hexagon Socket Head Bolt - exhaust end cover | 4 |
| 27 | Front cover | 1 |
| 28 | Cylindrical pin with female thread | 6 |
| 29 | Stud | 8 |
| 30 | Flat Washer A | 16 |
| 31 | Hex nut | 8 |
| 32 | Deep groove ball bearing | 1 |
| 33 | Bushing | 1 |
| 34 | O ring - oil seal seat | 1 |
| 35 | Oil seal seat | 1 |
| 36 | Skeleton Oil Seal | 1 |
| 37 | Hexagon Socket Head Belt - oil seal seat | 4 |
| 38 | Retaining ring | 2 |
| 39 | Cylindrical Roller Bearing | 2 |
| 40 | Hex bolt - suction end cover | 8 |
| 41 | O ring - back cover | 1 |
| 42 | Back cover | 1 |
| 43 | Hexagon Socket Head Bolt - back cover | 8 |
| 44 | End cap upper cover plate-rubber pad | 2 |
| 45 | Pump body lower cover plate-rubber pad | 1 |
| 46 | Pump body upper cover plate-rubber pad | 1 |
| 47 | Pump body upper cover plate | 1 |
| 48 | Pump body lower cover plate | 1 |
| 49 | End cap lower cover plate | 1 |
| 50 | End cap upper cover plate | 1 |
| 51 | Flat Washer C | 22 |
| 52 | Hex bolt | 22 |
| 53 | O ring - sight glass window | 2 |
| 54 | Oil window glass | 2 |
| 55 | Sight glass platen | 2 |
| 56 | Hexagon Socket Head Bolt - sight glass platen | 8 |
| 57 | Exhaust end bushing | 2 |
| 58 | Suction end bushing | 2 |
| 59 | Driven rotor | 1 |
| 60 | O ring - suction port | 1 |
| 61 | Automatic exhaust valve | 1 |
| 62 | Hexagon socket magnetic screw plug | 1 |
| 63 | Hexagon socket screw plug | 1 |
| 64 | Lifting ring screw | 2 |
| 65 | Inlet filter | 1 |
| 66 | Gear expansion sleeve | 1 |
| 67 | Drive rotor | 1 |
| 68 | Suction end plate guide | 2 |
| 69 | Washer | 2 |
| 70 | Manual drain valve | 2 |
| 71 | Hexagon socket screw plug - purge port | 2 |
| 72 | Hexagon socket screw plug - end cover | 2 |
| 73 | Hexagon socket screw plug - pump body | 4 |
| 74 | Double lip seal - suction side | 4 |
| 75 | Stop washer - suction side | 2 |
| 76 | Locknut - suction side | 2 |
| 77 | Lip seal - exhaust side | 4 |

## 6.3 Disassembly

1. Remove all accessories attached to the pump.
2. Open the drain valves on the pump body and eliminate all cooling water from the pump.
3. Drain any remaining oil from the pump; avoid reinstalling drain and fill plugs after completion.
4. Loosen the head bolts (37) on the oil seal seat (35) and carefully remove it, taking care not to damage the oil seal (36) mounted on the oil seal seat (35).
5. Loosen the nut (31) and remove the front cover (27).
6. Loosen the screws on the gear expansion sleeve (66), then remove the drive gear (22).
7. Remove the nut (25) and the driven gear (21). A puller may be useful for steps 6 and 7.
8. Loosen the nut (76) and use the disassembly hole on the suction end cover (20) to remove it.
9. Utilize tools to remove the cylindrical roller bearing (39), retaining ring (38), gasket (69), double lip seal (74), and suction end sleeves (58) in the suction end cover (20).
10. Loosen the bolt (4) and remove the suction end cover guide (68). This completes suction end disassembly.
11. Remove the head bolts (26) and use lifting equipment to raise the exhaust end cover.
12. Remove the head bolt (9) and take off the bearing housing (8).
13. Loosen the bolt (9) and remove the bearing gland (8).
14. Loosen the nut (16) and use a puller to remove the bearing seat (6) sequentially using the threaded holes.
15. Remove the double-row angular contact bearing, then remove the adjusting pads (10, 11, 12) from the rotor shafts.
16. Lift the exhaust end cover from the drive and driven rotors (67) and (59) with lifting equipment.
17. Loosen bolt (4) and remove exhaust end plate guides (2, 3).
18. Remove double lip seal (5) and unscrew shaft sleeves (57, 58).
19. Remove lip seal seat (14) from the exhaust cover, as well as lip seal (77) and lip seal gasket (13).
20. Remove cover (47, 48, 49, 50) and cover gasket (44, 45, 46).
    **this completes all disassembly work**

## 6.4 Assembly

1. Use bolts (52) to secure cover plates (47, 48, 49, 50) and rubber pads (44, 45, 46) on the pump body (17) and exhaust cover (1).
2. Utilize a tool to press the double lip seal (5) into the exhaust end plate guide (2, 3).
3. Use bolt (4) to attach the exhaust end plate guide (2, 3) to the exhaust cover (1).
4. Vertically insert the drive and driven rotors (67, 59) into the assembly base simultaneously.
5. Employ the lifting screw (64) to lower the exhaust end cover onto the assembly vertically, ensuring careful alignment of the rotors.
6. Apply lubricant to the O-ring of the exhaust end sleeve (57) and install it onto the shaft ends, ensuring contact with the end face of the rotors.
7. Apply lubricant to the O-ring of the mechanical seal static ring (14) and press it into the exhaust end cover.

8. Repeat the process for the mechanical seal dynamic ring (13) and confirm the static ring has tension by manual pressing.
   *For pumps with another double lip seal over a mechanical seal, install that at this point*
9. Install the bearing seat (6) and adjusting gaskets (10, 11, 12) on the two shafts. Ensure accurate labeling to avoid mixing up the gaskets, as they are specific.
10. Install the angular contact bearing (7) on top of the bearing seat (6).
11. Install washers (15) and nuts (16) onto the rotors and lock the nuts once tightened.
12. Use bolt (9) to attach the bearing gland (8) onto the bearing seat.
13. Install O-rings (18, 19), and press pin (28) into its place in the pump body.
14. Using lifting equipment, vertically install the exhaust cover (1) onto the pump body and secure it in place with bolt (26).
15. Install lifting bolt (64).
16. Attach the suction end plate guide (68) to the suction end cover (20).
17. Install double lip seal (74) and gasket (69) into the suction end cover.
18. Install the female cylindrical pin (28) and O-ring (18) on the suction end cover, followed by the suction end sleeve (58) on the two rotor shafts.
19. Install the suction end cover onto the pump body and fasten it with bolt (40).
20. Install retaining ring (38) into the suction end cover, followed by the roller bearing (39).
21. Tighten lock nut (76) and stop washer (75) and secure them in place.
22. Install O-ring (40) in its groove and use bolts (43) to attach the back cover (42) onto the suction end cover.
23. Install gear key (23) and gear (21) on the driven rotor (59) and lock them in place with stop washer (24) and nut (25).
24. Place the drive gear (22) and the gear expansion sleeve (66) on the driving rotor (67).
   *Measure part E again with a feeler gauge to ensure it is within spec*
25. Install stud (29), pin (28), and O-ring (18) in the exhaust end cover (1).
26. Place front cover (27) on the exhaust end cover (1) and secure it with nut (31) and stud (29).
27. Install bearing (32) into the front cover (27) and then install the shaft sleeve (33) on the driving rotor shaft.
28. Insert the oil seal (36) into the oil seal seat (35), place O-ring (34) into the groove of the oil seal seat, and apply lubricant to the oil seal. *Slowly install it on the drive rotor, ensuring the groove faces down. Fasten it with bolt (37).
29. Complete the reinstallation of final components, including the oil sight glass, filler plugs, and drain plugs. Refill with oil and grease.
   *Once done the assembly is complete*

## 6.5 Spare Parts

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.

Each spare parts kit includes:

| Part Name ( Location ) | Quantity | |
|---|---|---|
| | Mechanical Seal Pumps | Double Lip Seal Pumps |
| Mechanical Seal (Exhaust Cover) | 2 | / |
| Single Lip Seal (Exhaust Cover) | 2 | / |
| Double Lip Seal (Exhaust Cover) | / | 4 |
| Double Lip Seal (Suction Cover) | 4 | 4 |
| Bushing (Suction Cover) | 2 | 2 |
| Oil Seal (Gearbox) | 1 | 1 |
| Deep Groove Ball Bearing (Exhaust Cover) | 2 | 2 |
| Roller Bearing (Suction Cover) | 2 | 2 |
| Deep Groove Ball Bearing (Front Cover) | 1 | 1 |
| O-Ring (Suction Cover) | 1 | 1 |
| O-Ring (Pump Body) | 2 | 2 |
| O-Ring (Exhaust Cover) | 1 | 1 |
| O-Ring (Seal Seat) | 1 | 1 |
| O-Ring (Suction Side Bushing) | 2 | 2 |
| O-Ring (Exhaust Side Bushing) | / | 2 |
| O-Ring (Suction Inlet Port) | 1 | 1 |
| O-Ring (Exhaust Outlet Port) | 1 | 1 |

*Table 6*

# 7. Troubleshooting Checklist

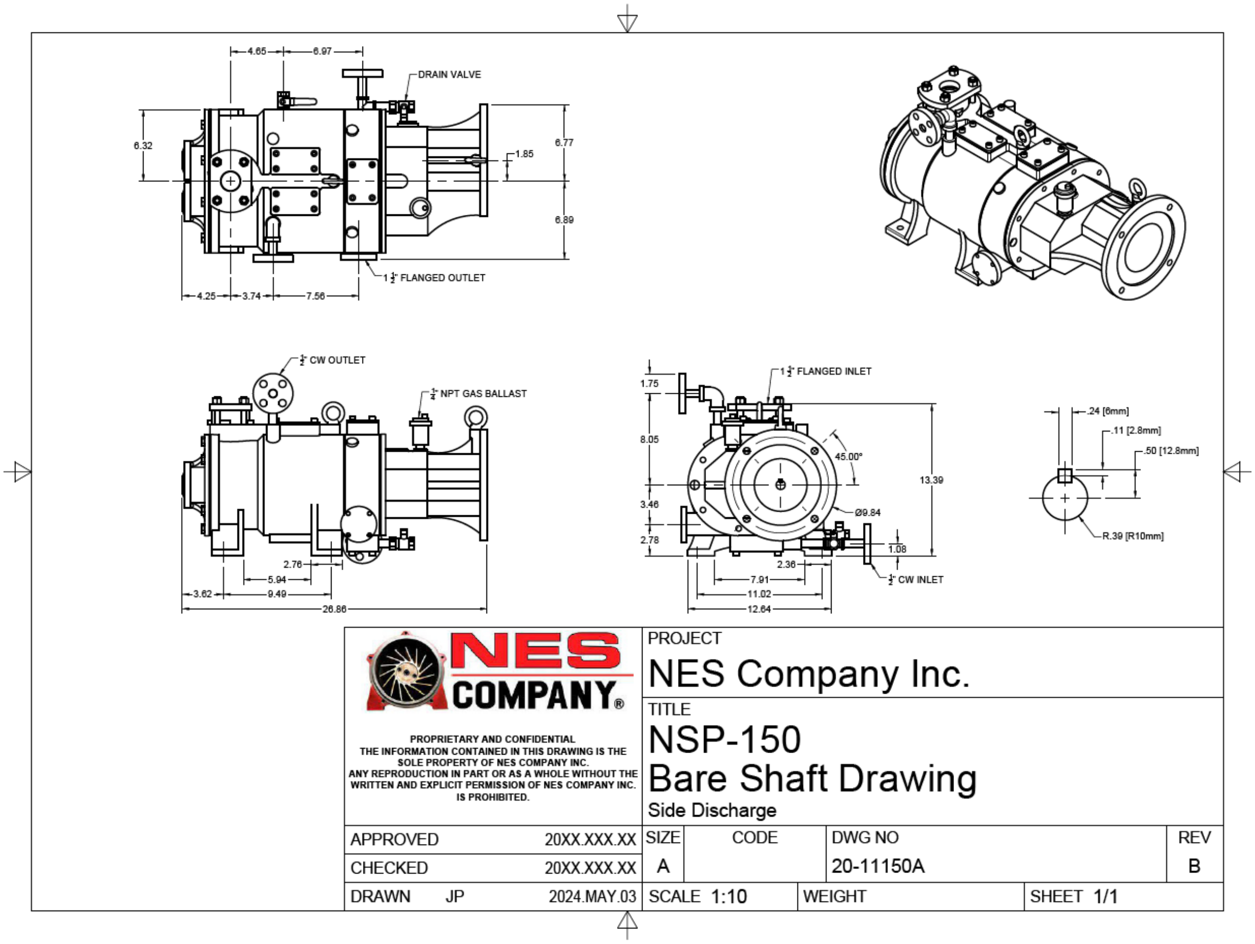
***All references to "E" refer to point "E" in Figure 8, Section 6.1***

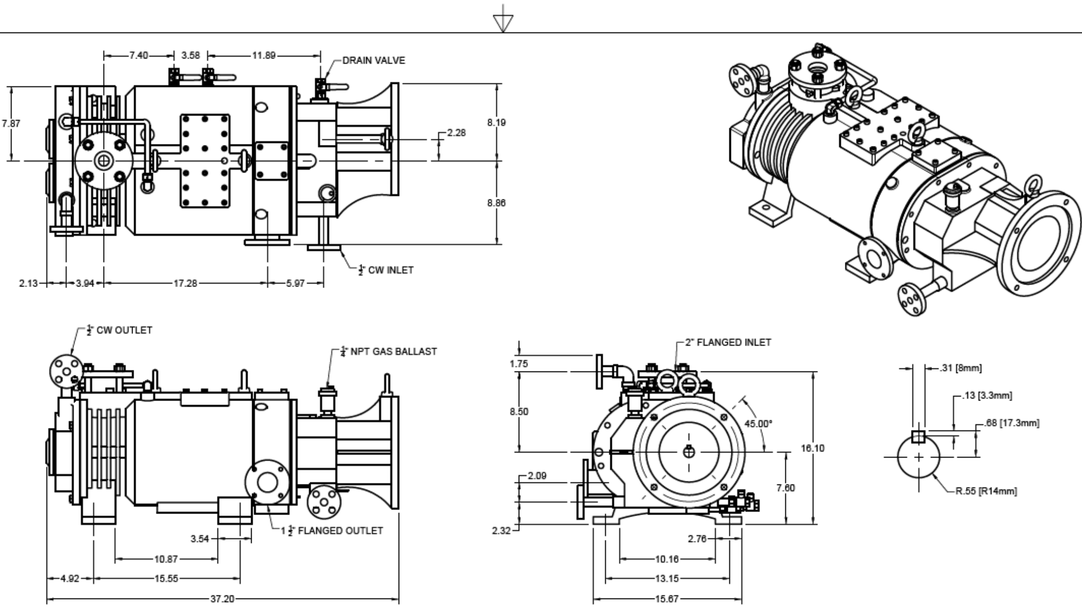
| Apparent Issue | Common Cause | Solution |
|---|---|---|
| Low Vacuum Degree | Large screw clearance | Check and readjust clearance (E) |
| | Clogged filter | Clean or replace filter element |
| Motor Overload | Clogged filter | |
| | Intake of solid objects | Remove any foreign solids.<br>Replace rotors or pump chamber if damaged.<br>Then measure screw clearance and make adjustments. |
| | Increase in inlet pressure | Check for other abnormalities |
| | Jammed screw | Clean the pump with normal processes.<br>Disassemble and inspect internals for damage. |
| | Clogged drainage | Clean drainage nozzles and pipes. |
| Overheating | Excessive lubricant in gearbox | 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. |
| | No cooling liquid flow | Clean cooling lines and jacket. |
| Vibration | Misalignment of gears and rotors. | Reconfigure the position of the gear and screw. The protrusion of the gear should be within 0.03mm |
| | 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 gears. |
| Bearing or Gear 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 7*

# 8. Technical Dimensions

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






| | | | |
|---|---|---|---|
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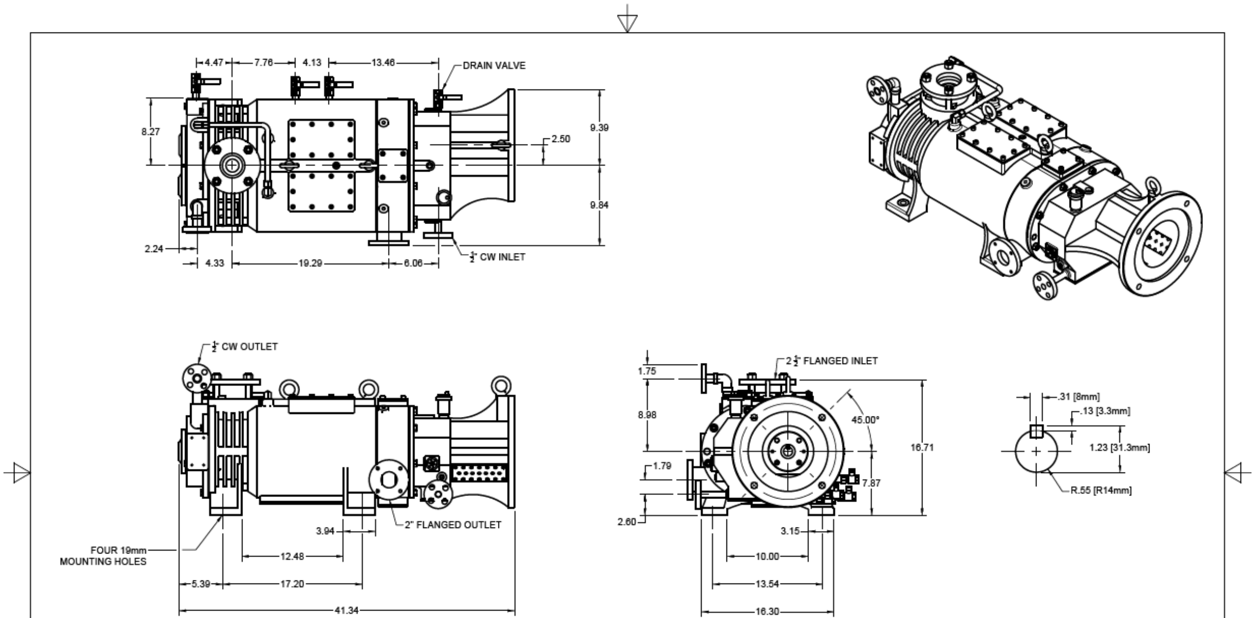
| APPROVED 20XX.XXX.XX | SIZE A | CODE | DWG NO 20-11300A — REV B |
| CHECKED 20XX.XXX.XX | | | |
| DRAWN JP 2024.AUG.16 | SCALE 1:12 | WEIGHT | SHEET 1/1 |

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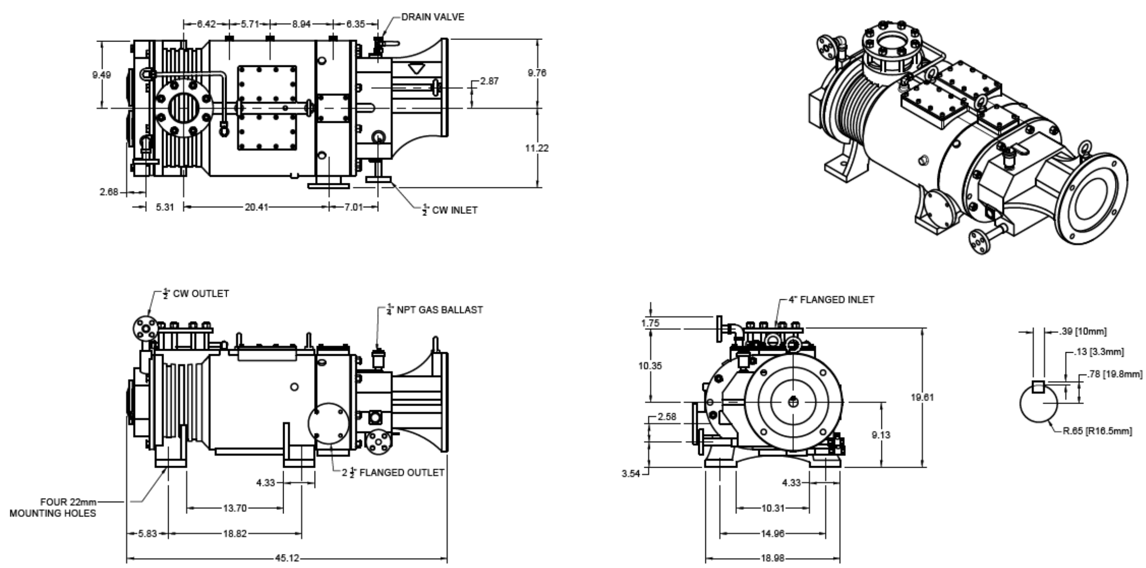
PROJECT
NES Company Inc.

TITLE
NSP-400
Bare Shaft Drawing
Side Discharge

| | | | | | |
|---|---|---|---|---|---|
| APPROVED | 20XX.XXX.XX | SIZE | CODE | DWG NO | REV |
| CHECKED | 20XX.XXX.XX | A | | 20-11400A | B |
| DRAWN JP | 2024.AUG.15 | SCALE 1:14 | | WEIGHT | SHEET 1/1 |

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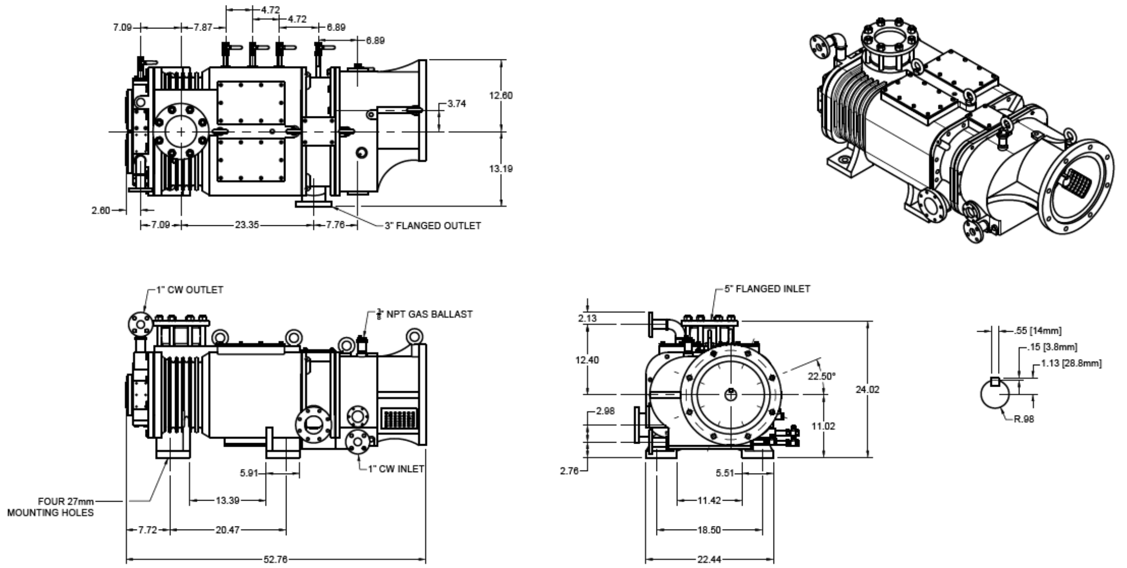
PROJECT
NES Company Inc.

TITLE
NSP-800
Bare Shaft Drawing
Side Discharge

| | | | | | |
|---|---|---|---|---|---|
| APPROVED | 20XX.XXX.XX | SIZE | CODE | DWG NO | REV |
| CHECKED | 20XX.XXX.XX | A | | 20-11800A | B |
| DRAWN JP | 2024.AUG.16 | SCALE 1:16 | | WEIGHT | SHEET 1/1 |

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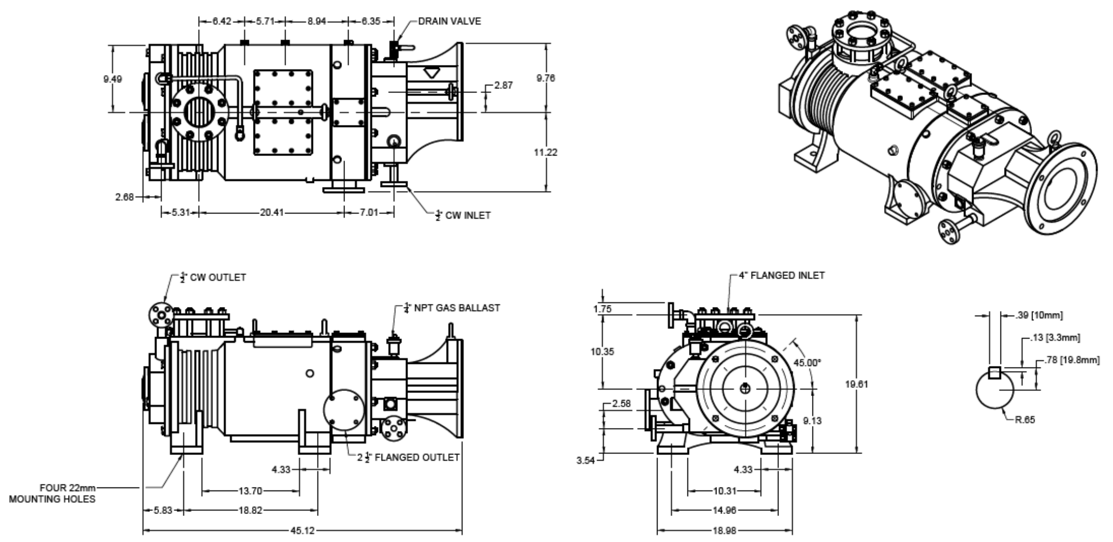
PROJECT
NES Company Inc.

TITLE
NSP-1500
Bare Shaft Drawing
Side Discharge

| | | | | | |
|---|---|---|---|---|---|
| APPROVED | 20XX.XXX.XX | SIZE | CODE | DWG NO | REV |
| CHECKED | 20XX.XXX.XX | A | | 20-111500A | B |
| DRAWN JP | 2024.AUG.16 | SCALE 1:20 | WEIGHT | SHEET 1/1 | |

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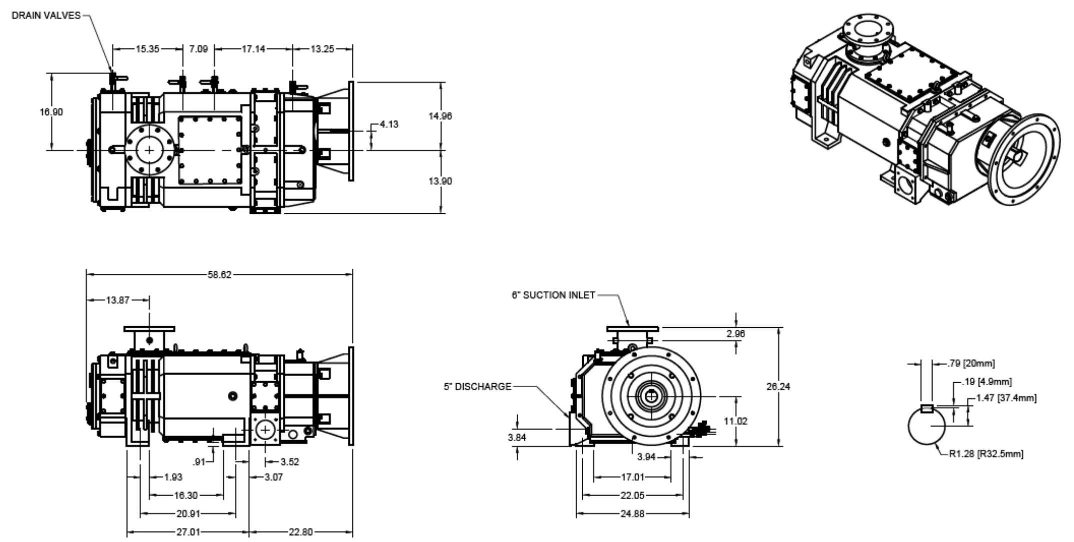
| | TITLE NSP-1000 Bare Shaft Drawing Side Discharge | | | | |
| APPROVED 20XX.XXX.XX | SIZE | CODE | DWG NO | | REV |
| CHECKED 20XX.XXX.XX | A | | 20-111000A | | B |
| DRAWN JP 2024.AUG.16 | SCALE 1:16 | | WEIGHT | SHEET 1/1 | |

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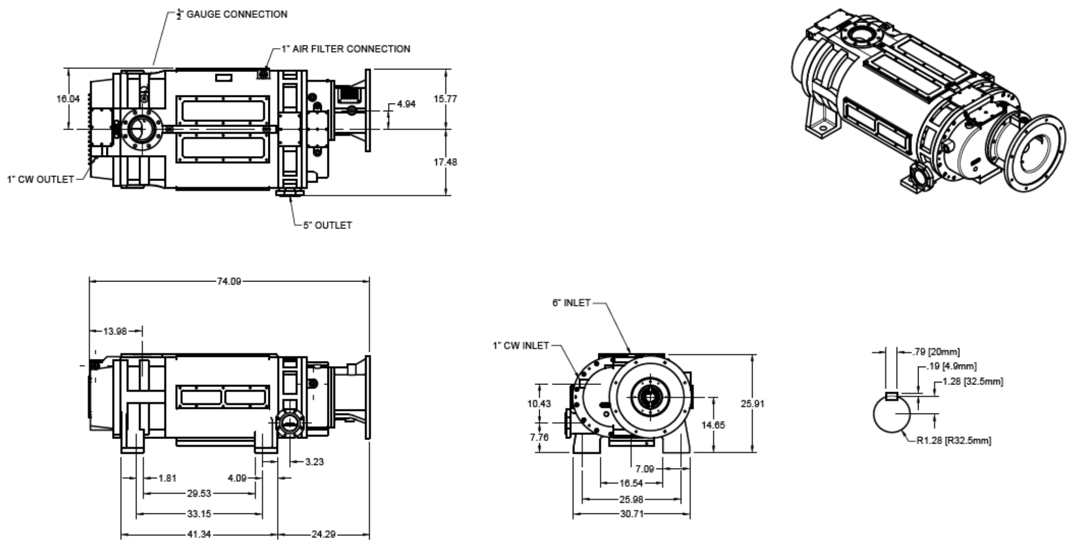
PROJECT
NES Company Inc.

TITLE
NSP-2500
Bare Shaft Drawing
Side Exhaust

| | | | | | |
|---|---|---|---|---|---|
| APPROVED 20XX.XXX.XX | SIZE | CODE | DWG NO | | REV |
| CHECKED 20XX.XXX.XX | A | | 20-112500A | | B |
| DRAWN JP 2024.AUG.05 | SCALE 1:25 | | WEIGHT | SHEET 1/1 | |




| NES COMPANY® | PROJECT<br>NES Company Inc. | | | |
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| APPROVED 20XX.XXX.XX | SIZE | CODE | DWG NO | REV |
| CHECKED 20XX.XXX.XX | A | | 20-113000A | B |
| DRAWN JP 2024.AUG.06 | SCALE 1:30 | WEIGHT | SHEET 1/1 | |