Throttling Pendulum Gate O-ring Replacement Procedure
Rev. A, May 2012

This procedure covers the replacement of the gate O-ring of the Nor-Cal Pendulum Gate Valve, with the gate valve housing installed on the system. This procedure applies to all 200mm, 250mm, and 300/320mm & 350mm Throttling Gate Valves (TPV). This procedure should be read in its entirety before performing any tasks.

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Introduction, Safety and Handling

Introduction
The Nor-Cal Intellisys™ line of Pendulum Gate Valves includes several different size valves ranging from 8” (200mm) to 14” (350mm).

This procedure is designed to help protect and extend the working life of your investment. Only qualified and trained technicians should handle this valve, and critical care must be taken to prevent damage once the valve is opened. As an accompaniment to this procedure, a series of training videos is available detailing each step in the process.

There are many different sizes and configurations of Nor-Cal Pendulum Gate Valves. The photos shown throughout this document are for reference only, and might not be representative of the specific valve you are working on.

Safety
There are five basic icons that may be used throughout this document:

- **DANGER** – Bodily injury may occur if these procedures are not followed.
- **CAUTION** – Damage to the Gate Valve may occur if these procedures are not followed.
- **NOTE** – Special instructions to clarify, highlight, or help the technician.
- **Good or Bad** – Indicates correct or incorrect visual inspection of the instructions.
- **Do Not** – Indicates that this item should not be used or not be performed.
**Handling**
To prevent contamination from fingerprints or other non-UHV substances, latex gloves and clean tools must be used for handling and adjustment of all pendulum components. Changing gloves frequently during this procedure is strongly recommended. All parts must be handled carefully to avoid scratches that may damage the machined sealing surfaces, especially aluminum parts.

*Never lift the Gate Valve using the Actuator as a lift point.* Permanent damage can result. Always lift the valve by the edges of the body, and have another person help if needed.

**Preventive Maintenance Schedule:**
The below are recommendations for worst case scenarios in very aggressive processes.
- Every 10,000 wafers, replace the Gate Seal
- Every 30,000 wafers, clean, re-grease, and rebuild the Gate Assembly, remove, clean and inspect the Hard Stop for excessive wear or process damage, and replace the Hard Stop O-ring (if present).
- Every 60,000 wafers inspect seals and rebuild the main shaft assembly as required.

![DANGER](image)

**The Nor-Cal Gate valve operates with significant speed and torque.** There is a severe crushing hazard. Serious injury can result. Please observe all Danger and Caution warnings, and keep hands and fingers clear of the valve flange when it is connected to air pressure lines or electrical cables.

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**NOTE**
After cleaning all parts and surfaces with IPA, a DI wipe may be required to remove IPA residue. Prepare a table or working surface with disposable cleanroom wipes to lay parts on.
Section 1 - Tools & Materials Required

The below list is for complete valve rebuild. O-ring replacement tools are highlighted in red.

**Nor-Cal Pendulum Valve Tool Kit**

The Nor-Cal Pendulum Valve Tool Kit Contains:

- Torque wrench set (150, 300 and 450 in-lbs.)
- Modified Metric Allen wrench set (2.5mm - 10mm)
- Long-shank M5, M6 M8, M10 hex socket drivers
- Reversible standard/Phillips screwdriver #1
- Non-metallic O-ring Removal Tools
- Gate Arm Height Adjustment Gauges
- Loctite No. 222 Part No. 5010-01028
- Cleanroom approved swabs
- Modified bearing puller
- FFRM bearing grease sample and 2 oz. Krytox LVP and 240AC grease tubes
- C-ring (snap-ring) pliers
- Spring pulling hook
- Multiple use wrench (“Super Wrench”)
- SAE T-Handle Allen wrenches for Pneumatic speed adjustments
- Hard Stop removal tool
- CD-ROM Documentation and Video Training

The Pendulum Valve Tool Kit is strongly recommended for any location servicing Gate Valves. It is available from Nor-Cal Products and through part number “Pendulum Valve Tool Kit”, and contains all the tools necessary to perform Gate Valve Maintenance on each size of valve. It comes with a fully loaded documentation CD-ROM, including video training (playable on a PC) of the entire rebuild procedure.

In addition to the tools above, latex gloves, cleanroom wipes, Isopropyl Alcohol (IPA) and De-Ionized (DI) water are required for cleaning and handling the valve.

**NOTE**

All bolts on the Pendulum valves are Metric.

All torque values are listed in in-lb. To convert in-lb to N.m Multiply by 0.113

Example:

65 in-lb x 0.113 = 7.23 N.m
Section 2 - Bonnet and Gate Assembly Removal

Using the controller or tool GUI, open the pendulum valve gate.

2.1 Follow the prescribed venting procedure to vent the process chamber. Before continuing, check the turbo controller to confirm the turbo is spun down (0 rpm).

2.2 If necessary, vent the turbo pump by removing the VCR cap on the turbo isolation valve. Reinstall the VCR cap with a new VCR gasket once atmospheric pressure in the turbo pump is reached.

**CAUTION**

There may be a pressure difference between the turbo pump and the chamber. Maximum differential pressure across the 300/320 & 350 gate during actuation is 29 Torr. Maximum differential pressure across the 250 gate during actuation is 24 Torr. Maximum differential pressure across the 200 gate during actuation is 20 Torr. The ΔP between the turbo and the chamber is not to exceed these values when actuating the gate valve. Actuating the gate valve at pressures in excess of this maximum will cause permanent damage and invalidate the warranty.

2.3 Return the Gate Valve to the closed position, and remove the Bonnet by loosening the captive bonnet bolts. The reason for closing the gate before this operation is to avoid possible damage to the gate assembly during removal of the bonnet.

2.4 Once the bonnet has been removed, open the gate again to gain access to the power bolt. This can be done by touching the OPEN button on the APC or IQ controller, but please observe the warning below.

**DANGER**

The Nor-Cal Gate valve operates with significant speed and torque. There is a severe pinching and crushing hazard. Serious injury can result. Please keep hands and fingers clear of the moving gate when it is opened or closed with the bonnet cover removed. Once the gate is open, please disconnect the power source to the valve controller to render it in a safe state and prevent inadvertent actuation of the valve during service.
2.5 Alternatively, disconnect the power cable to the controller and open the gate using a screwdriver in the end of the belt cover to retract the gate. Counter-Clockwise rotation opens the Gate, and clockwise motion closes the Gate.

Removing the Gate Assembly from the valve

2.6 Loosen the two captive bolts from the spring cover on bottom of gate assembly [A] and remove spring using the spring hook removal tool, or a plastic zip-tie [B]. To prevent scratching the gate, never use a metal screwdriver or other unapproved tool.
2.7 Using the appropriate long shank, hex socket driver, remove Power Bolt and Power Bolt Washer from the bottom center of the Gate assembly.

[Figure 2-C, Removing the Power Bolt]

CAUTION

If the Power Bolt does not come out easily, do not force it out. Use DI water as a lubricant, by squirting it into the threads. Ease-out the Power Bolt by using a back & forth motion and large amounts of DI to slowly work it out. Inspect the Power Bolt and Gate Arm as defined in 2.9

2.8 Remove the Gate from the Gate Arm by lifting the Gate off the arm and sliding it out, being careful not to scratch the Gate in the process.

[Figure 2-D, Lift-up and slide-out the Gate Assembly]
2.9 Inspect Power Bolt threads and note their integrity. Inspect Gate Arm threads and note the presence of any particles. Thoroughly clean any particles from Power Bolt threads and Gate Arm threads with IPA or DI, and cleanroom wipes, until no trace of particles is left in either.

![Figure 2-E, Check the Power Bolt threads for debris]

2.10 Inspect the Gate arm and Power Bolt for past over torque damage. Look for damaged threads on the Power Bolt and for a “mushroomed” shoulder where the unthreaded portion has expanded. In the Gate Arm, look for a small recess where the Power Bolt has dug-in to the Arm (Fig 2-F below.) If either of these conditions is present, the Gate Plate may not rotate properly. See Section 4.3 for information on proper Gate rotation.

![Figure 2-F, Inspect the Gate Arm and Power Bolt for over torque damage.]

2.11 Test the condition of the Power Bolt by threading the entire length into and out of the Gate Arm thread by hand. If the Power Bolt does not move freely throughout the travel, there may be debris in the threads. In this case, loosen Power Bolt, clean all threads and re-try. If this does not solve the problem, try a new Power Bolt. If still, this does not solve the problem, the Gate Arm threads are damaged. Replace both the Gate Arm and Power Bolt. Refer to the complete Pendulum Gate Valve Rebuild Manual.
Section 3 - O-ring Removal and Installation

The Pendulum Gate Valve line has many different o-ring sizes, compounds and cross-sections. The correct o-ring must be installed properly. For questions, contact Nor-Cal Products for information about the O-ring type used in the original manufacture of the valve.

NOTE
NO Grease should be applied for o-ring installation

3.1 Remove the old O-ring with an O-ring pick. Never use a metallic tool or screwdriver. Use DI water as a lubricant if necessary. Thoroughly clean the groove with IPA and a wipe.

For D-shaped, or “teardrop” cross-section seals, skip to Step 3.4

Round O-rings
3.2 Using DI water as a lubricant, partially fill the groove with DI, place the new O-ring on the groove, and press it down in the groove with your thumbs at the 4 vent holes.
3.3 Once the first 4 points are seated, press the O-ring into the groove at points 180° apart, going around the rest of the o-ring, seating it. Use as much DI as needed to facilitate installation.

D-Seal or “teardrop” shaped seals
3.4 For the teardrop cross-section o-ring, a different method works best. The point of the o-ring goes towards the center of the Gate, and the flat side goes down in the groove.
3.5 Using DI water as a lubricant, partially fill the groove with DI, place the new seal on the groove, and press it down in the groove with your thumb at one of the vent holes.
3.6 Next, stretch the O-ring to reduce its cross-section, and roll it into the groove.
3.7 Push-back the O-ring to relieve the stretch, then press, stretch and roll again continuing around the gate.
3.8 Continue to push back the O-ring, so that the last section needs to be stretched to get in the groove. The D-Seal will feel slightly loose in its groove.
3.9 Ensure that there are no twists or bumps in the o-ring after the o-ring is seated. Unlike a round O-ring, a D-shaped seal will feel loose in the groove when completely installed.
3.10 Blow out the leftover DI by forcing CDA or Nitrogen into the 4 vent holes. Make sure you’re wearing goggles, as DI will spray out from the other vent holes. Repeat on all 4 vent holes until no DI comes out.
Section 4 – Re-installing the Gate Assembly

4.1 Spread ¼ bead of Krytox® LVP bead on the non-threaded (shoulder) surface of the Power Bolt.

![Figure 4-A, Spread ¼ bead on the Power Bolt shoulder]

4.2 Reinstall Gate Assembly back on to Gate Arm lifting it up and on, to avoid scratching the underside of the Gate Assembly. Locate the threads in the gate arm with your little finger, and center the Gate Assembly on the Gate Arm.

⚠️ CAUTION ⚠️

*DO NOT* use Loctite when installing the Power Bolt.

Use the long-shank socket extension to torque the Power Bolt.

![Figure 4-B, Torque the Power Bolt]

<table>
<thead>
<tr>
<th>300/320 &amp; 350 Valve</th>
<th>250 Valve</th>
<th>200 Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>450 in-lb.</td>
<td>350 in-lb.</td>
<td>150 in-lb.</td>
</tr>
</tbody>
</table>

4.3 After torquing the Power Bolt twist the Gate back and forth around the Power Bolt to make sure the Gate assembly moves freely using only 2 fingers to hold it. (Figure 4-C.)
Binding may be a sign of debris in the power bolt connection or a damaged power bolt (see Section 2.9).

4.4 Check for Gate "wobble" by lifting up and down on both sides of the Gate. If there is significant Gate wobble (more than 3mm of travel) the Power Bolt and/or Gate Arm threads may be damaged. In this case, loosen Power Bolt, clean all threads, and re-try. If this does not solve the wobble problem, replace the Power Bolt and the Gate Arm. Refer to the complete Pendulum Gate Valve Rebuild Manual.

**NOTE**
No wobble and a loose, non-binding gate are ideal. However, it is better to have a slight wobble than to have a tight gate that does not rotate. The Power Bolt Washer thickness and over-torque damage determines the amount of gate binding, and contributes to the degree of wobble. The Gate Arm and Power Bolt may need to be replaced if binding or excess wobble is present.

4.5 Use the Spring Hook to reinstall the Coil Spring, then add the Spring Cover. Torque Spring Cover Plate captive bolts.

4.6 Wipe down the Gate Assembly again using IPA or DI water, and finish with clean dry disposable cleanroom wipes.
4.7 Gently push the Gate Assembly back into the valve body, and verify there is no mechanical scraping during opening/closing.

4.8 Clean the inside of bonnet with IPA and a cleanroom wipe, followed by a DI wipe and dry wipe.

4.9 Wipe down the Bonnet flange, O-ring and external flange mating area with IPA or DI, then re-install the Bonnet onto the gate valve housing. Make sure you do not damage the Bonnet sealing surface by bumping the Bonnet against the alignment pins.

4.10 Install bonnet bolts by hand, and then torque bolts to 100 in-lb.

**NOTE**

Consider using a small amount of vacuum grease or other anti-seize compound on the bonnet bolts to facilitate easier bonnet removal in the future.

4.11 Re-connect the power cables, power-up and perform chamber leak-ups.
Appendix A – Spare Parts

**NOTE**

Nor-Cal defines the valve size by the main bore opening, not by the size of wafer processed in the tool. Please refer to the part number for confirmation.

<table>
<thead>
<tr>
<th>Part Description</th>
<th>Part Number</th>
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<tbody>
<tr>
<td>200 Gate O-ring</td>
<td>2-266*</td>
</tr>
<tr>
<td>200 Bonnet O-ring</td>
<td>2-274*</td>
</tr>
<tr>
<td>200 Power Bolt</td>
<td>56-02055</td>
</tr>
<tr>
<td>200 Power Bolt Washer (polyimid)</td>
<td>56-00039</td>
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<tr>
<td>200 Rotary Pad (polyimid)</td>
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</tr>
<tr>
<td>250 Bonnet O-ring</td>
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<td>300/320 Gate O-ring</td>
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<tr>
<td>Pendulum Valve Tool Kit</td>
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</tbody>
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* Indicates reference size, not actual part number. Please contact Nor-Cal Products for compound-specific part number information.