HOW TO DO STUFF: CHAPTER 2

PUMP MAINTENANCE

Like any other business, a water system spends a great deal of money on infrastructure and capital improvements. These expenses include piping, storage and all of the mechanical equipment required to produce, treat, and deliver water. A maintenance program is essential to insuring that the mechanical components of the system stay in good working order and provide the longest possible service life. A preventive maintenance schedule should be utilized to make sure that each piece of equipment gets the proper attention. Most preventive maintenance consists of inspecting, cleaning, and lubricating the equipment. The equipment operators can usually complete these tasks. Specially trained personnel that possess the necessary mechanical skills should handle major maintenance, including component replacement and overhaul.

PUMP MAINTENANCE

The most common piece of equipment in a water system is the centrifugal pump. There are several maintenance procedures that must be performed periodically for any centrifugal pump. Pump packing wears out, bearings must be lubricated or replaced, mechanical seals need replacing, couplings must be maintained, and motor and pump shafts must be aligned. These procedures are not difficult to learn. Some of the procedures may require the use of a few special tools. Once an operator understands the basic procedures and has a chance to put the theories into practice, it doesn't take long to become proficient at each task.

PUMP PACKING

Pump packing is one of the biggest problem areas for operators in charge of pump maintenance. Poor maintenance of pump packing is responsible for more pump damage than any other maintenance item. Improperly maintained packing can cause several problems including:

<table>
<thead>
<tr>
<th>Damage Caused by Packing Failure</th>
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<tr>
<td>• Loss of prime or suction due to an air leak</td>
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<tr>
<td>• Shaft and sleeve damage</td>
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<td>• Water contamination of bearings</td>
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<td>• Flooding of pump stations</td>
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There are many different types of pump packing available for use in today's pumps. The most common type of packing comes in a square braided stock. There are a number of different kinds of braided packing. It can be manufactured from jute, asbestos, nylon, Teflon or other synthetics. It can be lubricated with graphite, grease, or other synthetic lubricants such as Teflon. Prices for packing range from several dollars a pound for graphite-impregnated jute to hundreds of dollars a pound for pure Teflon and other synthetics.

A rule of thumb is to buy the most expensive packing that you can afford, provided that you are taking care of the rest of the pump properly. If scored or damaged shaft sleeves and out of round or bent shafts are not going to be repaired, use the cheapest packing you can get. Expensive packing will not last any longer than the cheap stuff if the sleeve is scored or the shaft is bent. If the rest of
the pump is properly cared for, the more expensive types of packing will last several times longer than the cheap packing and will usually pay for itself with a longer life.

**REMOVING OLD PACKING**

It's time to replace the packing when there is no more adjustment left in the packing gland and there is too much leakage from the stuffing box. When this occurs, all of the packing rings must be replaced. Adding an additional ring or just replacing one or two rings will only lead to premature packing failure and damage to the shaft and sleeve. Use the following procedure to remove the old packing:

1. Tag the pump in the "OFF" position and lock it out so that it can’t be accidentally restarted.
2. Isolate the pump by closing the suction and discharge valves.
3. Drain the pump by opening the drain cock or removing the drain plug in the bottom of the volute.
4. Remove the packing gland. If it is not split for removal from the shaft, it should be tied off so that it is out of the way.
5. Remove the packing rings with a packing puller (corkscrew on the end of flexible T-handle) taking care not to score the shaft sleeve.
6. Measure the distance to the lantern ring and then remove it with the packing puller. It may take a puller on each side of the lantern ring to pull it out without getting it cocked sideways. If the lantern ring is split, it can be removed from the shaft. If you're not sure the lantern ring was in the right placed to begin with, measure the distance from the face of the stuffing box to the seal water port or refer to the vendor's engineering drawing of the stuffing box for the correct position.
7. Remove the remaining packing rings and clean the stuffing box and shaft.
8. Disconnect, inspect, and clean the seal water line and seal water port.
9. Inspect the shaft or shaft sleeve. If it is scored or grooved, the pump should be dismantled and the shaft dressed or repaired by a machine shop.

**REPACKING THE PUMP**

Before new rings are cut, it is important to determine the size and number of packing rings that are needed for the stuffing box. This information should be available in the vendor’s engineering drawings. If these drawings are not available, measurements of the stuffing box and shaft can be used to make the determination. The correct packing size is determined using the following procedure:

1. Measure the inside diameter of the stuffing box and the outside diameter of the shaft.
2. Subtract the shaft diameter from the stuffing box diameter.
3. Divide the difference by two. (See illustration on page IX-4)
The correct number of rings can be determined using the following procedure:

1. Measure the depth of the stuffing box.

2. Divide the depth of the stuffing box by the size of the packing to get the total number of rings.

3. Subtract one from this total if a lantern ring is used in the stuffing box.

Once the size and number of rings has been determined, the new packing can be cut and installed. Great care should be taken to keep the packing material clean and free from dirt. Packing spools should be stored in plastic bags to prevent contamination. Dirt and grit in the packing rings will lead to serious shaft and sleeve damage. The two most important aspects of cutting packing rings involves cutting them the right length and cutting them so the ends will butt together squarely. Cutting rings the same length with ends that butt together squarely can be accomplished using the following procedure:

1. Cut the packing to the proper length and shape using a very sharp knife or carton cutter. Wrap the packing material around the shaft, an old sleeve, or even a piece of hardwood turned to the proper diameter. Cut all of the rings at once with the packing on the shaft to insure that the ends will butt together squarely.

2. Wrap each ring of packing around the shaft and seat it in the stuffing box completely before adding the next ring. Open the ring by twisting it instead of pulling the ends apart. A light coat of grease on the outside of the ring will make it much easier to push into the stuffing box. Stagger the joints of the rings so that they are 90 degrees apart. Make sure the lantern ring lines up with the seal water port when it is installed.

3. Install the packing gland. Make sure the gland tightened down evenly. It is usually made out of cast material and will break easily if it gets in a bind.

**ADJUSTING THE PACKING GLAND**

The final adjustment of the packing gland is made while the pump is running. The pump can be restarted once the locks and tags have been removed, the discharge and suction valves are completely opened, and the pump has been primed. More packing jobs have been ruined by improper gland adjustment than any other single reason. Adjust the packing gland using the following procedure:

1. Tighten the gland one half turn a time on each side until it just begins to put pressure on the packing.

2. Start the pump and tighten the gland until the flow of water is reduced just enough to prevent flooding the drain line. Allow the pump to run for at least five minutes while the packing rings seat. Never allow the packing to get hot during this "breaking in" period. If the packing heats up and lubricant is seen oozing from the gland, the packing is already ruined and should be removed and replaced immediately.

3. After five minutes, adjust the packing slowly until the leakage is reduced to the desired level. The appropriate amount of leakage will vary with the size of the pump and type of packing, but a general rule of thumb is 20-60 drips per minute. Tighten the gland and checking the water temperature periodically. When the water turns lukewarm there is not enough flow to cool the packing properly. Loosen the packing gland just enough to cool the water back down to room temperature. The packing gland will probably need to be checked
again, as the packing rings get properly seated. This may have to be done several times over the next 24 hours of run time.
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REMOVE OLD PACKING

\[ \frac{X - Y}{2} = \text{PACKING SIZE} \]

CUT AND FLATTEN PACKING

MAKE SURE ENDS ARE SQUARE

INSTALL NEW PACKING

STAGGER PACKING RINGS

POSITION LANTERN RING PROPERLY
Bearing Identification

The bearings in the pump and motor support the rotating equipment and protect it from radial and thrust loads. Some bearings are designed specifically for thrust load applications and will fail if they are subjected to radial loads or thrust loads in the wrong direction. Others are designed to handle radial loads and will fail if thrust loading occurs. Bearings are also made to accept both thrust and radial loads in varying degrees. The design of the bearing races will determine what type of loads a bearing can handle.

Every bearing should have an identification number on its face that identifies the type and size of the bearing. This identification system is standard for bearings made by the major European manufacturers, i.e., FAG, SKF, NKG. Some bearings that are made by lesser-known manufacturers may not follow the same system. Most bearing suppliers can identify an equivalent for these situations.
There are four rules for identifying bearings by number. As with most rules, there are also some exceptions for certain sizes and applications. Bearings that follow this system will be identified by four numbers, i.e., 7311, 6207, etc. Here are the rules for bearing identification:

**RULE #1** - The first number identifies the type of bearing.

- **1210** - SELF-ALIGNING DOUBLE ROW BALL TYPE
- **2210**
- **3210** - DOUBLE ROW BALL TYPE
- **5210**
- **6210** - DEEP GROOVE BALL TYPE
- **7210** - ANGULAR CONTACT BALL TYPE

- **6 & 7 SERIES ARE MOST COMMON IN PUMPS**

**EXCEPTIONS:**

- **22210** - SPHERICAL SELF-ALIGNING
- **N210** - CYLINDRICAL ROLLER TYPE
- **_210** - MAX BEARING (DEEP GROOVE BALL W/ 12 BALLS)

**RULE #2** - The second digit from the left identifies the bearing housing size. It represents the amount of load the bearing can carry. The possible ratings are:

- **9** - Extra-Extra Light
- **0-1** - Extra Light
- **2** - Light
- **3** - Medium
- **4** - Heavy

As an example, a **6310** bearing is a Deep Groove Ball bearing with a Medium duty housing. The illustration on the following page shows some of the different housing sizes for the bearings with the same bore size.
RULE #3 - Bores or inside diameters of bearings are measured in millimeters.

EXCEPTIONS:

Pillow block bearings and American tapered roller bearings have ID's measured in inches.

EXCEPTION TO THE EXCEPTIONS:

Tapered roller bearings on foreign equipment will be measured in millimeters.

RULE #4 - The last two digits of the bearing number (when multiplied by 5) identify the bore or inside diameter of the bearing in millimeters. As an example, a 6210 bearing has a bore of 50 millimeters (10 X 5 = 50mm)

EXCEPTIONS:

XX00 - 10mm
XX01 - 12mm
XX02 - 15mm
XX03 - 17mm
**Tandem Bearings**

Pumps sometimes have bearings installed in tandem or side-by-side. This is usually an angular contact thrust bearing application. Because they touch each other, it is very important that the housings be machined to special tolerances to insure that the loading is the same on both bearings. **NEVER use bearings from different manufacturers in tandem.** There will usually be some letters at the end of the bearing model number. Bearings that are made for tandem installation will be identified with the following letters at the end of the model number:

- FAG Bearings: - 7210 BMP **UA or UO**
- SKF Bearings: - 7210 BMP **G**
- FAFNIR Bearings: - 7210 YO **SU**

**NEVER install bearings in tandem if they are not machined for tandem use.**

**Effects of Speed and Load on Bearing Life**

When an engineer decides what type and size of bearing to use in a given application, the decision is based on the calculated speed and load at which the bearing will have to operate. The life of the bearing will be affected by changes in speed and loading on the bearing. Changes in speed will impact bearing life proportionally. If the speed of the bearing doubles, the expected life of the bearing will be reduced by 50%. Changes in load do not have a proportional impact on the bearing life. If the load on a bearing is doubled, the expected life of the bearing will be reduced by 90%.

**Bearing Lubrication**

Proper bearing lubrication is an important part of getting the designed life out of pump bearings. As strange as it may sound, more bearings have failed from over-lubrication than from lack of lubrication. In fact, some bearings never require lubrication and may fail if they are greased. Shielded and sealed bearings come factory-lubricated and have sufficient lubricant to last the life of the bearing. Shielded bearings have a metal skirt that is attached to the outer race. It covers the rollers but doesn't touch the inner race. Sealed bearings have a rubber skirt that does touch the inner race.

Bearings that do require periodic grease lubrication use a surprisingly small amount of grease when compared to the bearing housing size. A properly greased bearing will have a bearing housing that is never more than 25-30% full. The grease is responsible for lubricating AND cooling the bearing.

Grease that is inside the bearing will get hot as the bearing heats up. When the grease gets hot it becomes more fluid and is thrown out of the bearing and onto the wall of the bearing housing, where it cools. Grease that is outside the bearing is drawn into the race, where it again heats up and is thrown out. This process keeps the bearing lubricated and removes heat from the bearing. If the bearing housing is full of grease there is no way for the hot grease to get out of the bearing. The lubricant inside the bearing overheats and breaks down. The bearing overheats and fails.
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Lubrication schedules for low-speed (under 2500 rpm) anti-friction bearing applications are based on the operating temperature of the bearing. Always refer to the vendor recommendations for the proper lubricant and lubrication frequency. If vendor data is not available, the following table represents a good rule of thumb for lubrication schedules:

<table>
<thead>
<tr>
<th>TEMPERATURE</th>
<th>FREQUENCY</th>
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<tbody>
<tr>
<td>130 degrees F</td>
<td>- once a year</td>
</tr>
<tr>
<td>150 degrees F</td>
<td>- once every 6 months</td>
</tr>
<tr>
<td>170 degrees F</td>
<td>- once every 3 months</td>
</tr>
<tr>
<td>190 degrees F</td>
<td>- once every 6 weeks</td>
</tr>
</tbody>
</table>

**Grease Lubrication Procedures**

The following procedure should be used for any grease lubricated anti-friction bearing that is not shielded or sealed:

1) Remove the drain plug from the bearing housing. This is usually located on the side opposite the grease fitting.

2) Run the pump for 5-10 minutes prior to adding new grease. Then stop the pump and lock and tag it for maintenance.

3) Waste the first shot of grease from the grease gun to remove contaminated grease from the tip. Add new grease to force the old grease out the drain. Continue until new grease comes out of the drain.

4) Restart the pump and allow it to run for 5-10 minutes while excess grease is expelled from the housing.

5) When no more grease comes out of the drain, stop the pump, re-tag it, and replace the drain plug.

6) Start the pump and allow it to run for 10-15 minutes. Check the bearing temperature. If it is too warm, remove the drain plug and allow the excess grease to be expelled again.

**Handling Bearings**

The most important thing to remember when handling bearings is to keep them **CLEAN**. Dirt in a bearing means damage and reduced bearing life. Always leave a new bearing in its protective wrapping until you are ready to install it. When you are ready to install it, keep the work area...
CLEAN! Clean hands, clean tools, and a clean work area are critical if contamination is to be kept out of the bearing.

The bearing is a precision instrument. It is manufactured to exacting tolerances. It does not take much to damage a bearing. The simple act of spinning a dry or dirty bearing can damage the polished races in the bearing and greatly reduce bearing life. NEVER spin a bearing with compressed air. If you drop a bearing on the floor or a table, the impact will probably cause scratches on the race. A bearing that has been dropped should not be put back into a pump. It is very likely to fail early. NEVER strike a bearing directly with a hammer! Most bearing suppliers will tell you when you strike a bearing you’ve ruined it. Many a bearing has been ruined before it ever saw any service because of improper handling and mounting techniques.

**Removing Bearing**

The extreme caution recommended in the removal and reinspection of bearings applies only when it is economically advantageous to consider re-using the bearings. In most cases it is economically wiser to replace the bearings if they must be removed. If bearings are to be re-use it is imperative that you use the right tools and use them correctly. There are several ways to remove a bearing from a shaft. An arbor press is the preferred method, but in the field a bearing puller is more commonly used. Here are some guidelines to follow to properly remove a bearing:

A) Always clean the housing before disassembling it. Never allow loose dirt to get in the housing.

B) Always press or pull the inner ring only. NEVER apply pressure or force to the outer race.

C) NEVER press or pull against shields or cages.

D) Block the press or adjust the puller so that it will pull or push square and straight.

E) When using a puller, make sure not to damage shoulders, keyways, or threads on the shaft.

F) When using a press, provide some means of catching the shaft so it doesn't hit the floor. Make sure the blocks are supporting the inner race.

G) If a vise and drift are used, make sure the vise has brass jaws and never strike the shaft directly with a hammer.
**INSTALLING NEW BEARINGS**

Bearings in most pumps are designed to press onto the shaft instead of into the bearing housing. They can be mounted by force (pressed or driven) or they can be heated and mounted without force. Most small bore bearings (2" and smaller) can be pressed or driven on fairly easily. Larger bearings must be heated when installed.

Before installing a bearing make sure that the shaft and keyways are cleaned and polished with emery cloth to remove burrs and slivers. The bearing seats should be cleaned any oiled. The bearing shoulder should be cleaned and checked for runout using a dial indicator (see mechanical seals). If the runout is more than 0.003" the shaft should be reworked to square up the bearing shoulder. Misalignment of the bearing by 0.003" will reduce the bearing life by 90%.

**HEATING THE BEARING**

Bearings are heat stabilized to 250°F. This means that even though the metal expands when it gets hot, it will rerun to its original shape if the temperature does not exceed 250°F. When the bearing is heated to 190-220°F the inner race will expand enough to allow the bearing to slide on the shaft without the use of force.

Bearings can be heated using a small oven to supply dry heat, an oil bath similar to a deep fryer, or a light bulb placed under a steel funnel. The oven supplies a fairly constant temperature that can be monitored, but may not be practical in a field setting. The oil bath heater is messy and may contaminate the bearing if the oil gets dirty. The light and funnel heat the inner race directly, but temperature must be monitored closely.

One way to monitor the bearing temperature is with the use of a welder's temperature stick. This is a waxy substance that melts at a specific temperature. Marking the outside of the inner race with a "temp stick" that melts at 200°F allows you to quickly check to see if the bearing is hot enough to mount. Be sure to hold the bearing firmly against the shaft shoulder until it cools. If the heated bearing won't easily slide on the shaft, the shaft can be made smaller by packing it in dry ice to cool and shrink it.

Induction heaters that use magnet fields to heat the bearing can also be used. They are fairly expensive, but worth the cost if you have to replace many large bearings.
PRESSING BEARINGS

Many of the considerations for removing bearings are also true for installing them using force:

A) Pressure or impact must NEVER be transmitted through the rolling elements.

B) Always make sure the bearing is pressed onto the shaft straight and square.

C) NEVER strike the bearing directly with a hammer.

D) NEVER allow any force to be applied to the shields or cage.

E) If the shaft is held in a vise, make sure to use brass jaws.

F) Make sure the bearing is securely seated against the shaft shoulder.

G) Once the bearing is on the shaft, cover it to protect it until the unit is completely assembled.
Mechanical seals are sometimes used instead of packing to prevent leakage where the shaft enters the stuffing box. The most common type of mechanical seal has two faces, which mate to prevent water from passing through them. One of the seal faces, the insert, is mounted stationary in the gland ring that bolts to the stuffing box. The gland ring replaces the packing gland that is used in packed pumps. The other seal face, the seal ring, is mounted on the shaft and rotates. The face of the seal ring is held against the insert face by a spring, or set of springs, that is compressed and positioned by a locking collar.

As we mentioned earlier, the spring forces the seal faces together when the pump is not running. Seal water is used to force the seal faces apart when the pump runs. This prevents the seals from rubbing and overheating. Failure of the seal water system can quickly cause a seal failure. The life of a mechanical seal is also dependent on the tolerances and condition of the shaft, pump bearings, and the stuffing box. A shaft that is bent, bearings that are worn, or a stuffing box face that is not square will result in a premature seal failure. And it doesn't take much to cause a seal failure. As we will see later, being off by as little as 0.002"-0.010" can cause a seal to fail early. The same rule of thumb that applies to using expensive packing materials also applies to the use of mechanical seals. Don't use a mechanical seal if you are not going to check and maintain the tolerances in the rest of the pump.
MECHANICAL SEAL COMPONENTS

Some older pumps may use a single spring mechanical seal like the one described on the previous page. Many newer pumps will use a multiple spring mechanical seal. There are several advantages that a multiple spring seal has over a single spring unit. The small springs are not as susceptible to distortion at high speeds as are the larger single springs. As a result, they will exert a more even closing pressure on the seal ring at all times. The same size spring can also be used on a wider range of shaft sizes.

The components of a multiple spring seal should be broken into two groups. One group forms the stationary unit of the seal and the other group forms the rotary unit.

THE STATIONARY UNIT

The stationary unit consists of the gland ring, the seal insert, the insert mounting ring, and the gland gasket. The gland ring holds the seal insert. The seal insert is held in place and positioned by an Insert mounting ring (usually an O-ring). The O-ring also prevents leakage between the insert and the seal gland plate. The gland gasket prevents leakage between the gland plate and the stuffing box face.

THE ROTATING UNIT

The rotating unit of the seal consists of a locking collar, springs and spring pins, a compression ring, drive pins, shaft packing O-ring, and the seal.

The collar of a multiple spring seal is usually secured to the shaft with set screws. The springs and spring pins link the compression ring to the collar. The compression ring presses against and seals the shaft-packing ring to prevent leakage around the shaft. The shaft seal presses against the seal ring to hold it against the insert. The drive pins extend from the compression ring into the seal ring and are used to spin the seal ring.

SEALING POINTS

There are four main sealing points inside the mechanical seal. The primary seal is at the seal face, Point A. If a seal leaks from this point it will need repair or, more likely replacement. The shaft packing and insert mounting rings seal leakage at Points B&D. Point C is sealed by the gland gasket. Anytime a mechanical seal leaks, there is a problem that will require some work to correct. However, there is only one point, the point at the seal faces that will likely require replacing the seal. Leakage at any of the other points can be fixed by replacing an inexpensive O-ring instead of a $500 seal. The labor required to replace the O-ring will vary depending on whether it's the gland gasket or the shaft packing ring that must be replaced.
SEALING POINTS ON A MECHANICAL SEAL

POINT C
Gland Gasket

POINT D
Insert Mounting

POINT A
Face

POINT B
Shaft Packing
**Mechanical Seal Installation**

A mechanical seal installed in a pump that meets all original manufacturer specs may last 20-25 years. This is the reason that systems choose a pump with a $500 mechanical seal instead of one that uses $15 worth of pump packing. However, when the condition of a pump is allowed to deteriorate, a mechanical seal may not last as long a packing would in a new pump.

**Checking Pump Tolerances**

If mechanical seals are used, the pump must be maintained to some very strict tolerances with regard to the shaft and stuffing box. Before checking these measurements, the shaft and stuffing box should be cleaned and buffed. All burrs and sharp edges on keyways should also be removed. Every time a seal is replaced, the procedure should include checking the following shaft and stuffing box tolerances:

**Maximum Endplay - 0.010"**

Endplay is the axial or lateral (end-to-end) movement of the shaft. A dial indicator is placed against the shaft shoulder. The shaft is tapped on both ends with a soft mallet and the results are read on the dial indicator. This reading should not exceed 0.010".

**Maximum Shaft Deflection - 0.002"**

The maximum shaft deflection or whip (side-to-side) movement should not exceed 0.002". The shaft deflection is measured by placing the dial indicator as close to the stuffing box face as possible and lifting the shaft at the impeller end to check the side-to-side movement. Excessive movement is usually due to damaged bearings.
CHECKING FOR SHAFT DEFLECTION OR WHIP

MAXIMUM SHAFT RUN-OUT - 0.003"

Shaft run-out is caused by the wobble of a bent shaft. Run-out should be checked by taking readings on at least two points on the shaft. First, place the dial indicator on the shaft in the area of the stuffing box face and turn the shaft. Then move the dial indicator to the coupling end of the shaft and repeat the measurement. Excessive run-out will result in bearing damage, which will cause vibration. The vibration will cause a premature seal failure.
CHECKING FOR RUN-OUT
MAXIMUM STUFFING BOX FACE RUN-OUT - 0.005"

If the stuffing box face is not perpendicular to the shaft, the seal insert will not mate squarely with the rotating seal. This misalignment will cause the seal to wobble as it spins, again resulting in premature seal failure. This is measured by attaching the dial indicator to the shaft with the stuffing box bolted in place. The instrument is then placed against the face of the stuffing box and the run-out is measured as the shaft is turned.

MAXIMUM STUFFING BOX ECCENTRICITY - 0.005"

When the stuffing box is concentric to the shaft, the distance from the outside of the shaft to the inside of the stuffing box is the same all the way around the stuffing box. If it is closer on one side than the other it is said to be eccentric to the shaft. This condition places the seal faces off-center and alters the hydraulic loading of the seal faces which will reduce the seal life. This is measured by attaching the dial indicator to the shaft, as with stuffing box face run-out, and measuring either the bore (inside) and register (outside) of the stuffing box.
INSTALLING THE SEAL

Before attempting to install a mechanical seal, be sure to look at the engineering drawing that comes with it. There are a number of dimensions shown on these drawings, but one of them is very important to the proper installation of the seal. On the drawing you will find a dimension that identifies the distance from the face of the stuffing box to the back edge of the locking collar on the rotating element. This is known as the location dimension. It will allow the locking collar to be positioned at a point on the shaft that will give the seal the proper compression when the gland ring is installed. The location dimension for the seal shown below is distance "E".

TYPICAL MULTIPLE SPRING SEAL DIMENSIONS

Once the location dimension has been determined and the shaft and stuffing box have been dressed, the following procedure should be followed to properly install the seal:

1) Scribe a reference mark (also called the witness mark) on the shaft that will line up with the stuffing box face.

2) Remove the shaft and scribe another mark, the location mark, on the shaft that is the same distance from the reference mark as the location dimension on the drawing.
3) Lubricate the shaft with a silicone lubricant (usually supplied with the seal.)

4) Mount the insert in the gland ring. Lightly lubricate the insert mounting O-ring and position it in the gland ring. Gently press the insert into the gland ring and seat it. Always try to avoid direct contact with the seal face. Make sure your hands are clean in case you do have to apply pressure directly to the seal face as you seat it.

5) If the seal is being installed from the impeller end of the shaft, slide the gland ring over the shaft and past the reference mark. Avoid bumping the insert against the shaft. If the seal is installed from the coupling end of the shaft, the gland ring will go on last.

6) Install the rotary unit parts on the shaft in the proper order. Lubricate the shaft packing O-ring and take care not to roll or pinch it as it slides into place. Again, try to avoid contact with the seal face.

7) Set the back of the locking collar on the location mark and tighten the set screws firmly and evenly.

8) Reassemble the pump, making sure to clean and flush the stuffing box.
9) Seat the gland ring and ring gasket to the stuffing box face by tightening the gland nuts/bolts evenly and firmly. Check manufacturer's specs for proper torque.
STARTUP PROCEDURES

The following recommendations cover startup procedures for most mechanical seals:

A) **Never run a seal dry!** It probably won't hurt to bump the motor to check rotation, but running the seal dry for even a few seconds can seriously damage it.

B) Vent the stuffing box before starting the pump. Even if the pump has a flooded suction, air can still get trapped in the upper portion of the stuffing box. This is especially important in vertical installations.

C) New seals may leak somewhat during initial startup. Allow a reasonable amount of time (30-60 minutes should do it) for the seal faces to "wear-in" to each other.

D) Do not open the seal faces for inspection unless absolutely necessary. Seals establish a wear pattern which micro-scopically matches the two faces. When the insert is removed it cannot be put back together with any hope of matching the original wear pattern.

E) Outside seals on vertical turbine pumps can be set by raising and lowering the shaft with the adjusting nut on top of the motor. Raise the shaft the distance equal to the compression distance for the spring. Lock the rotating assembly on the shaft and then lower the shaft to compress the spring. **ALWAYS free the rotating assembly on a vertical turbine pump before attempting to adjust the impeller clearance or damage to the seal may result.**