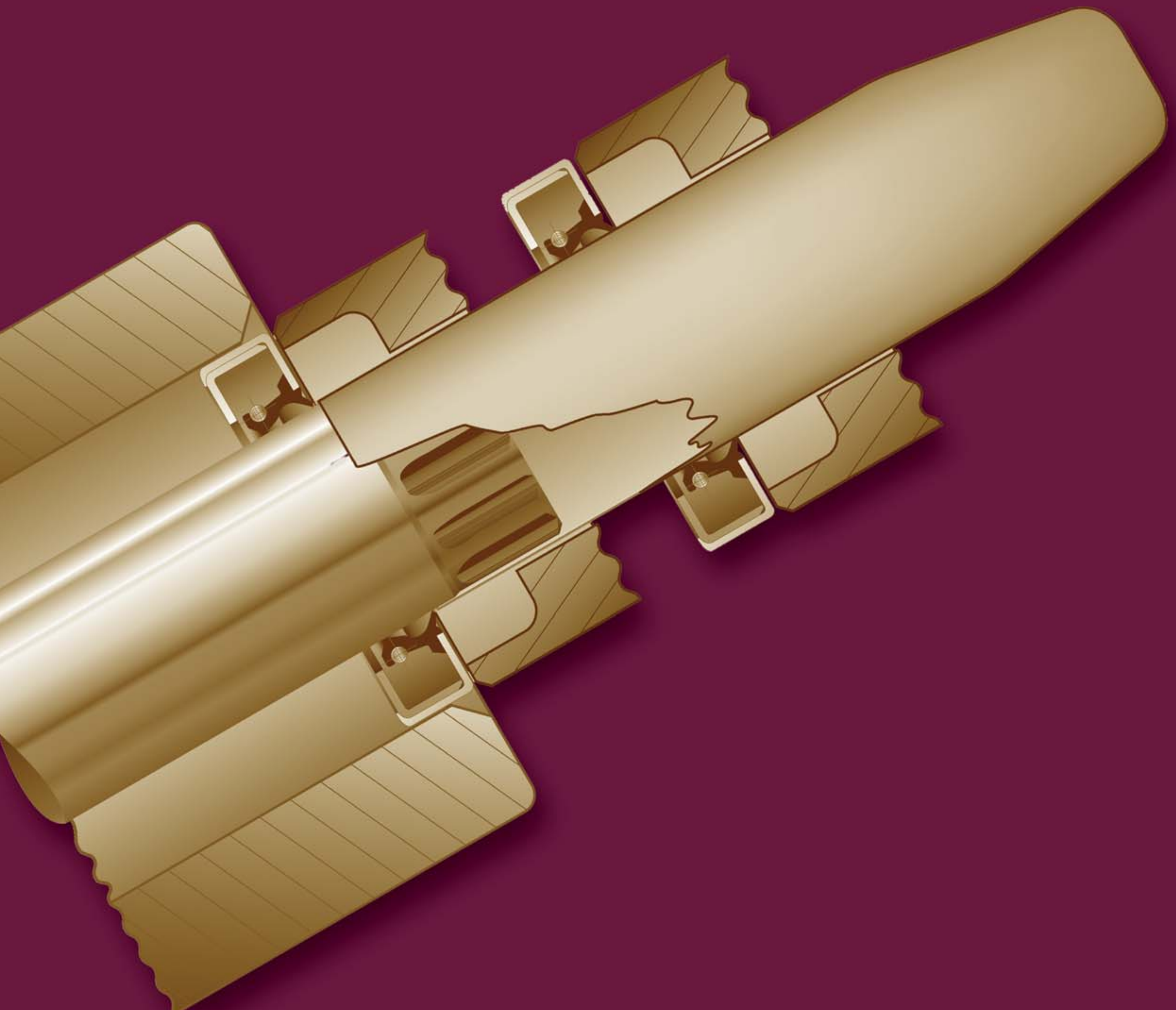


shaft seal installation

Introduction.

Having given due consideration to all aspects of the shaft seal assembly (including the bore, the shaft, and the design of the seal itself), what remains is to successfully install the seal you've selected or designed.

Simple as that may sound, proper installation is not always easy. As a matter of fact, it can be quite difficult, which explains why improper installation is the number one cause of shaft seal failure! With that in mind, we at R.L. Hudson & Company have prepared this *Shaft Seal Installation Guide*. We hope that it will be helpful as you install shaft seals. Keep in mind that good installation practices include inspection of the seal and other components just prior to installation, use of the proper equipment during installation, and protection of the assembly after installation. If you have questions, please call us. We'll do whatever it takes to make sure you get the sealing solutions you need.

"...improper installation is the number one cause of shaft seal failure!"

Pre-Installation.

Because it is the most important part of the seal, the sealing lip should be closely inspected to make sure there are no nicks or tears at any point around its circumference. You should also be certain that the lip is not turned back. Either a torn or turned lip will quickly fail in service.

If the seal design incorporates a garter spring, you should check to be sure that the spring hasn't been displaced out of its groove as a result of handling. The seal O.D. should also be free of damage such as cuts, dents, or scores. No matter where it is located, any damage should immediately disqualify a new seal from use. And because damage (especially the hard-to-see variety) can result from service, you should never reinstall a used seal. Because even the smallest amount of outside contamination can be detrimental to a sealing system, new seals that have passed inspection should still always be wiped clean prior to installation.

"No matter where it is located, any damage should immediately disqualify a new seal from use."

Beyond the seal itself, the bore (and housing) should also be carefully examined. Housing edges must be free of burrs or other imperfections that can easily damage the O.D. of an incoming seal. The edges of the bore must be burr- and nick-free. The bore roughness and chamfer must meet RMA and SAE guidelines as shown in ***Figure 1***.

The shaft should be inspected to ensure there are no nicks or burrs, and it should be finished to RMA (Rubber Manufacturing Association – Publications OS-1 and OS-1-1) standards as listed in ***Table 1***. The chamfer of the shaft should also be free of nicks or burrs, and it should follow the recommended guidelines as shown in ***Figure 2***. Above all, keep in mind that

BORE DIMENSIONS

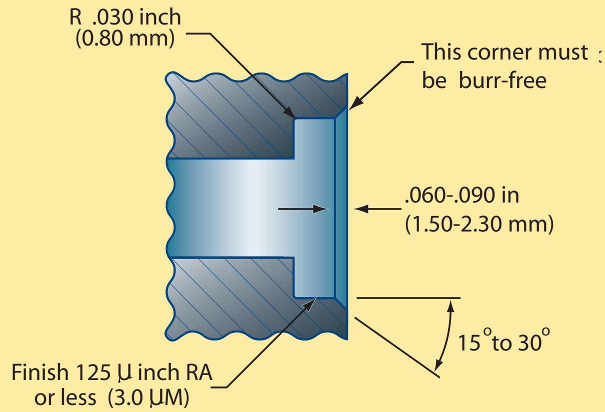


Figure 1: Bore chamfer, radius, and surface finish recommendations

a new seal should never be run in the same shaft wear track as an old seal.

If grooving of the shaft surface exists from previous service, three options are available. A spacer can be placed within the bore (behind the seal) in order to make sure the seal contacts an ungrooved portion of the shaft. Alternatively, a metallic wear sleeve may be fitted over (and, if need be, adhered to) the damaged shaft to provide a more suitable sealing surface. Use of a thin-walled sleeve will normally make it possible to thus retrofit a damaged shaft surface without changing the seal dimensions or design. In some cases, it may be necessary to refinish or replace the shaft.

SHAFT DIMENSIONS

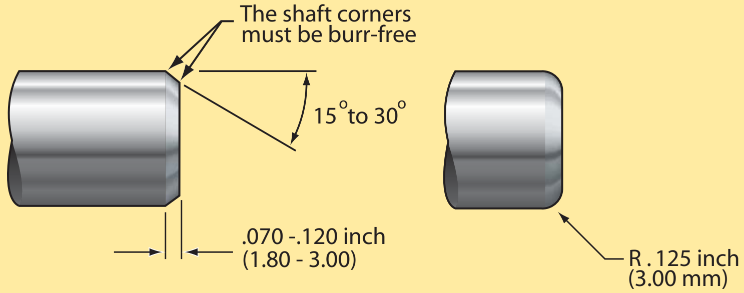


Figure 2: Shaft chamfer and radius recommendations

SHAFT SURFACE FINISH

PARAMETER	RMA 0S-1 (1985) & OS-1-1 (1999)	SAE J946 (1991) (CONF. TO ISO 6194/1)
Grinding Chatter	None allowed > 45 cycles (lobes)	Not Specified
(OOR) Out of Roundness	> 0.0050 mm (0.0002 in) at a max. of 2 lobes > 0.0025 mm (0.0001 in) at a max. of 7 lobes	Not Specified
Shaft Lead	Less than 0 +/- 0.05 °	Less than 0 +/- 0.05°
Ra (Surf. Roughness Avg.)	0.20-0.43 μm (8-17 μin)	0.25-0.50 μm (10-20 μin)
Rz (Average Peak-to-Valley Height)	1.65-2.90 μm (65-115 μin)	Not Specified
Rpm (Average Peak-to-Mean Height)	0.50-1.25 μm (20-50 μin)	Not Specified
Instrument Parameters	0.25 mm (0.010 in) cutoff length 5μm (0.0002 in) 90° diamond stylus tip radius M-1 digital Gaussian filter	0.75 mm (0.030 in) cutoff length

Table 1: Shaft Surface Finish Specifications

Installation.

Because a shaft seal should never run without proper lubrication, both the seal lip and the shaft should be lubricated (typically with the same oil or grease being sealed) prior to installation of the seal. In addition to making the installation both easier and less potentially damaging to the seal, lubrication also helps protect the sealing element during the initial break-in period. Continued lubrication minimizes wear and maximizes service life.

Figure 3 shows a double lip seal packed with grease between the primary and secondary lips. When two seals are installed in tandem, the entire space between the two seals may be packed with grease. In some cases, seal suppliers will pre-lube seals upon request.

GREASE PACKING

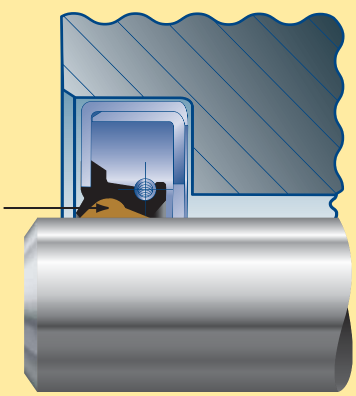


Figure 3: Grease packing to provide seal and shaft lubrication

As obvious as it may sound, care must be taken to install the seal in the right direction. If replacing a previously used seal, be sure to note the direction in which the primary lip of the old seal was facing, then ensure that the primary lip of the new seal faces the same way. Failure to orient the seal properly relative to the fluid being sealed will result in instantaneous leakage upon startup.

But even if it's facing the right direction, the seal must also be installed at a right angle (perpendicular) to the centerlines of both the shaft and the bore. Anything less than a right angle means the seal is angularly misaligned (*cocked*). Installing a standard shaft seal into a housing can be a problem if there is no counterbore to help align and seat the seal. Even if initial installation is perfect, the absence of a counterbore makes it easy for the seal to become cocked when the shaft is slipped into place (see ***Figure 4***). Seal cocking is most common in blind

"But even if it's facing the right direction, the seal must also be installed at a right angle (perpendicular) to the centerlines of both the shaft and the bore ."

designs that prevent the field assembly team from seeing whether the seal is properly seated.

Seal cocking is problematic for several reasons. For example, it can contribute to uneven wearing of the sealing lip. Cocking also increases the chances that any garter spring might become dislodged from its groove in the lip (a phenomenon known as *spring pop out*). Damage to the lip itself and/or to the seal O.D. is also more likely. In addition, seal cocking increases the temperature at the interface between the shaft and the seal lip. High temperature hastens hardening and cracking of the seal. ***Table 2*** shows how underlip temperature increases as a result of seal cocking.

SEAL COCKING

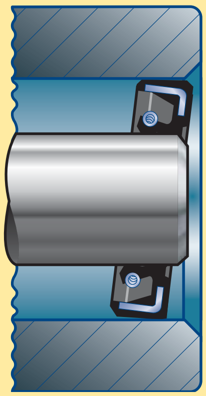


Figure 4: Misaligned (cocked) seal

FLANGE SEAL

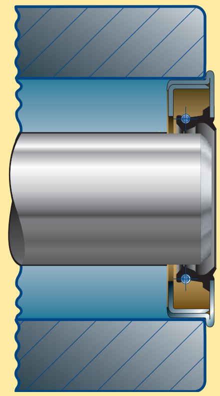
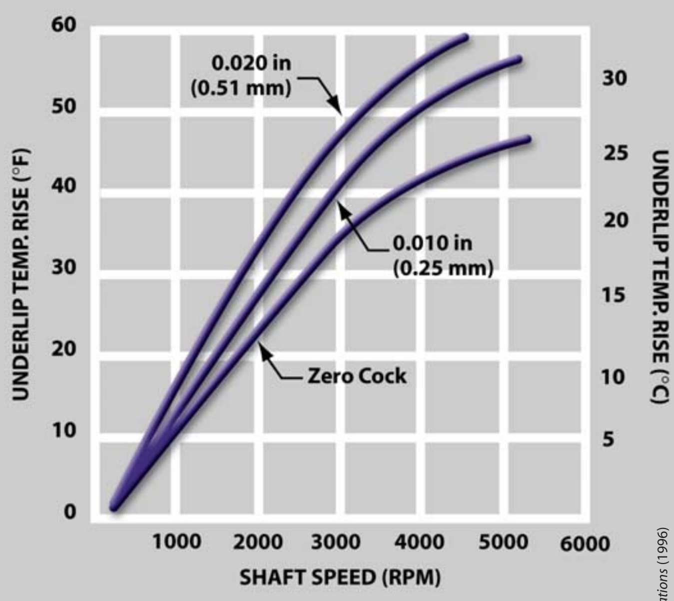


Figure 5: Use of a "TAY" design to prevent seal cocking

Sometimes seal cocking can be prevented through use of special designs; the non-standard "TAY" shaft seal is a perfect example. The TAY design features a flange on the outside diameter of the seal. This flange helps to ensure that the seal seats properly against the housing face during initial installation (see ***Figure 5***). Because the presence of the flange also helps prevent the possibility of subsequent misalignment, seal cocking concerns can be prevented.



Material ....Nitrile (NBR)
Shaft size ....76.2 mm (3.000 in)
Sump temp. ....93°C (200°F)
Lubricant ....SAE 30
DRO ....0.13 mm (0.005 in)
STBM ....0.13 mm (0.005 in)
Pressure ....Zero
Sump level ....Full

Table 2: Underlip Temperature (°C) Versus Shaft Speed for Various Values of Seal Angular Misalignment.

Source: Horve, *Shaft Seals for Dynamic Applications* (1996)

Seal cocking can also be prevented by the use of a properly designed or selected installation tool, and the right amount of force. Without the right tool, it's easy to damage or distort the seal lip or case. Installation tools (such as the one shown in ***Figure 6***) are generally made of steel and are designed to contact the seal near the O.D. (where the seal is most resistant to deformation). Pressing at the more vulnerable seal I.D. can distort the case and lead to leakage in service. The tool shown in Figure 6 is also advantageous because it is designed to bottom out on the housing face, thus preventing seal cocking.

INSTALLATION TOOLS

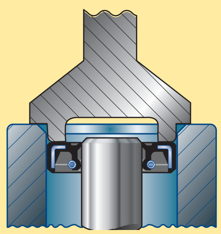


Figure 6: Tool designed to bottom out on the housing face

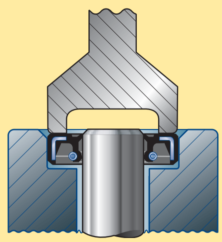


Figure 7: Tool designed to bottom the seal in a stepped housing

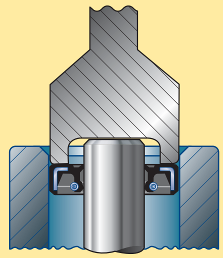


Figure 8: Tool designed to bottom out on the shaft face

Depending on the specifics of the application, the tool may also be designed such that it can keep pressing until the seal bottoms out (as in a stepped housing, see ***Figure 7***) or until the tool bottoms out against the shaft face (see ***Figure 8***).

Depending on the application, the seal may be installed with the shaft already in place, or the shaft may be fitted into the assembly after the seal has been installed into the housing. Either way, it is necessary to protect the sealing lip from splines, keyways, burrs on the shaft, and improperly finished chamfering areas. Use of a shield and/or lubrication can help. An assembly cone (acting as either a cap, as in ***Figure 9***, or a sleeve, as in ***Figure 10***) can

ASSEMBLY CONES

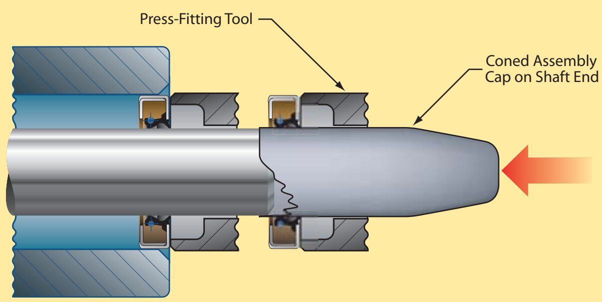


Figure 9: Use of cone as cap

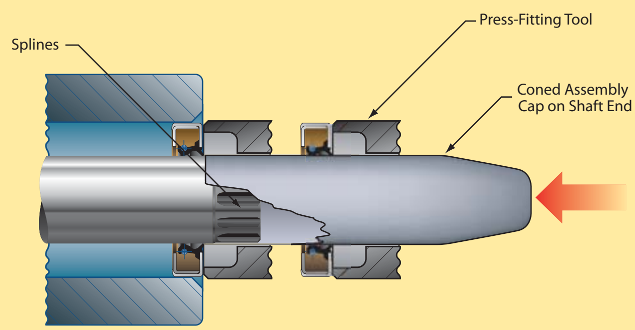


Figure 10: Use of cone as sleeve

be temporarily fitted onto or over the shaft to facilitate avoidance of potential hazards. If *lip inversion* (the turning over of the sealing lip due to friction during installation) is a concern, the cone can be oiled, or it can be made of a low-friction material such as PTFE. Assembly cones must be routinely inspected to make sure they have no burrs or scratches.

But even proper tools are no guarantee of good installation. Without the right amount of force, the seal will still not be installed properly. If installation is taking place in a factory, this force is often supplied by a hydraulic or pneumatic press. Use of such automated presses can eliminate guesswork by providing a constant force with which to push the seal into its housing. Because this force is closely controlled, the chances of inadvertently damaging the seal are greatly reduced. Factory installations also tend to be cleaner due to the ability to more closely control the work environment.

CORRECT VS. INCORRECT TECHNIQUES

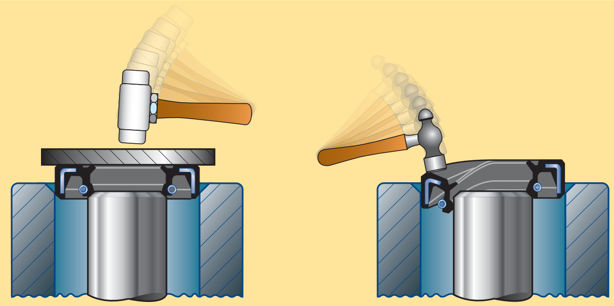


Figure 11: Use of a strike plate to prevent deformation

In contrast, installations done in the field tend to be both dirtier (due to reduced environmental control) and less precise (due to forced reliance on less reliable installation aids). Tools such as those used in factories aren't as common in the field. Installation force is often provided solely by hand-operated arbor presses or soft-faced mallets (used in conjunction with strike plates, see ***Figure 11***). The results are almost always less consistent than with automated equipment. And because of these inconsistencies, the chances of inadvertently damaging the seal are greater.

In some cases, it may be helpful to apply a thin coat of bore sealant to the O.D. of the seal. This adhesive coating can help the seal stay in place (and form a more leak-proof seal) once it's installed in the housing. Be careful, however, that any sealant you may use does not contaminate other parts of the seal, particularly the lip, or the surface of the shaft. Such contamination can impair or inhibit the functioning of the seal by blocking the proper development of the lip-shaft interface.

Post-Installation.

Following installation, it's a good idea to double-check one last time that the proper functioning of the seal will not be impinged on by other parts of the assembly. Such impingement could lead to unplanned (and unwanted) friction, heat, and wear, all of which can contribute to premature seal failure.

You should also be cognizant of any treatments (such as painting or cleaning) to which the assembly in general (and the seal in particular) may be subjected. Unless proper precautions are taken to shield the seal, post-installation treatments can impair the seal's functionality and thus hasten its failure. For example, you should be careful to ensure that a painted assembly does not remain in the bake oven any longer than necessary to cure the paint; prolonged heat exposure can be very detrimental to the seal lip material.

"Unless proper precautions are taken to shield the seal, post-installation treatments can impair the seal's functionality and thus hasten its failure."

SEAL INSTALLATION CHECKLIST

- ❑ Is the seal in good condition?
- ❑ Is the spring properly in place, or has it been displaced during handling?
- ❑ Have you carefully wiped the seal clean (so as not to damage it)?
- ❑ Have you made sure there are no nicks, scratches, or spiral grooves on the shaft surface?
- ❑ Have you pre-lubricated the seal's lip for initial break-in?
- ❑ Are you installing the seal with the lip facing in the right direction?
- ❑ Are you installing the seal at a right angle to the centerlines of the bore and shaft?
- ❑ Have you made sure that bore adhesives do not contaminate the shaft or seal lip?
- ❑ Have you taken measures to keep the lip from being damaged by passing over splines, threads, or burrs on the shaft?
- ❑ Have you inspected the bore to make sure there are no burrs or scratches?
- ❑ Have you ensured proper protection for the seal during painting or cleaning operations?
- ❑ Is adequate ventilation provided for internal pressure in the seal area?
- ❑ Have you made sure that assembly components do not rub and that any vents are not clogged?

Table 3: Seal Installation Checklist

Finally, the overall design of the assembly can hold hidden dangers that, if not addressed, can doom any shaft seal. For example, the assembly must provide adequate ventilation for the internal pressure within the seal area. Without proper ventilation, pressure can build to dangerous levels, even to the point of blowing the seal out of its housing. If a vent exists, make sure it is not clogged during painting. Clogged vents can cause excessive pressure to build up that could blow out the seal.

Table 3 can serve as a checklist to ensure that you have considered all of the important installation issues described in this guide.

For more information on shaft seals, please visit our web site (www.rlhudson.com), and click on the "Shaft Seal Design Guide" icon on the right hand side of the home page.

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& Company

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