

Leakage Troubleshooting Guide

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I. SEAL LEAKAGE TROUBLESHOOTING GUIDE

Causes of Seal Leaks

If oil leakage is discovered, first determine the point of origin of the leak. The leaks may not have originated from the oil seal, and residual oil or grease on the seal itself can also be mistaken for a leak.

Seal leaks are divided into two groups: leaks from the sealing lip and leaks from the press-fit area of the housing, as illustrated in Fig. 1. Typical causes of each group of leaks are shown in factorial diagrams (Figs. 2 and 3). Examples of improper diagnosis is discussed on page I-8.

Figure 1: The Two Points of Origin of Seal Leakage

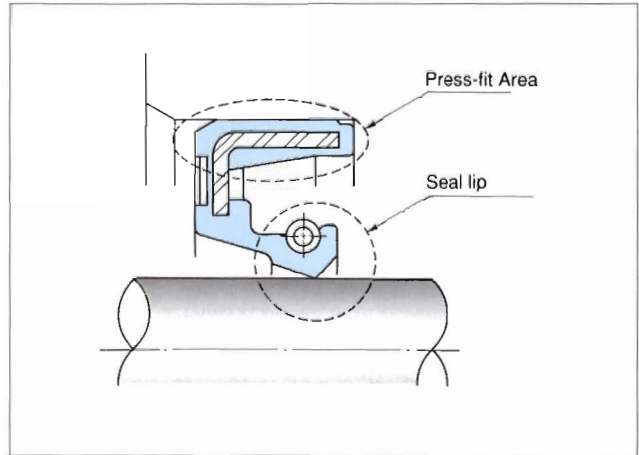


Figure 2: Lip Leakage Diagnosis

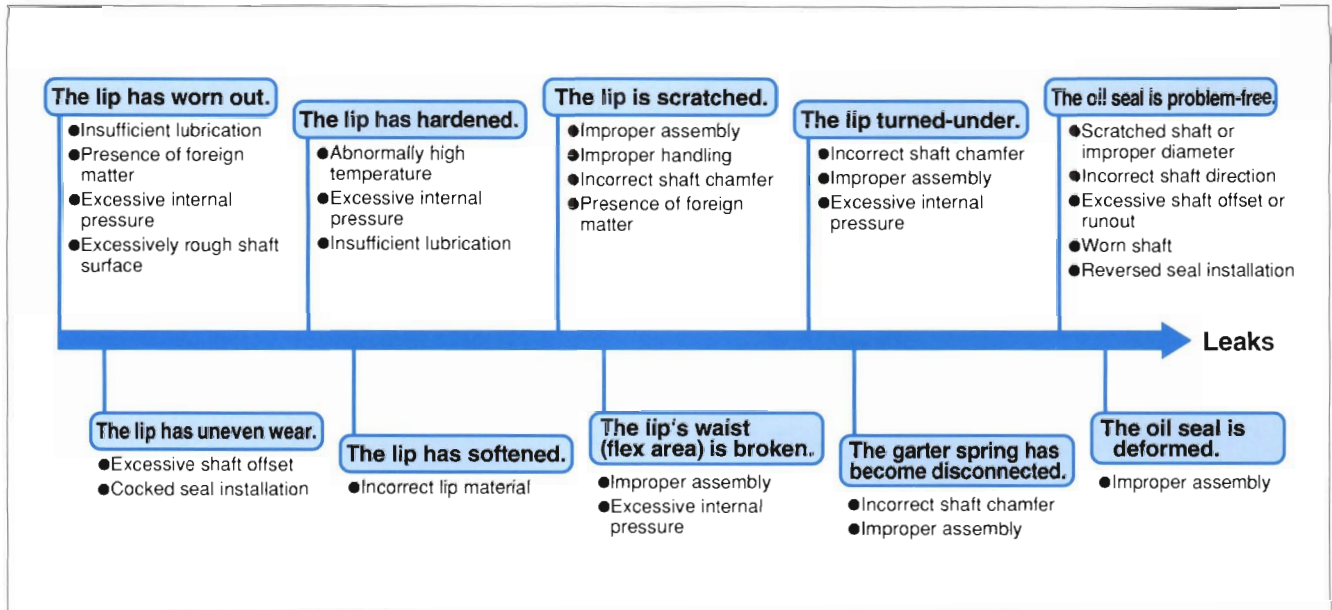
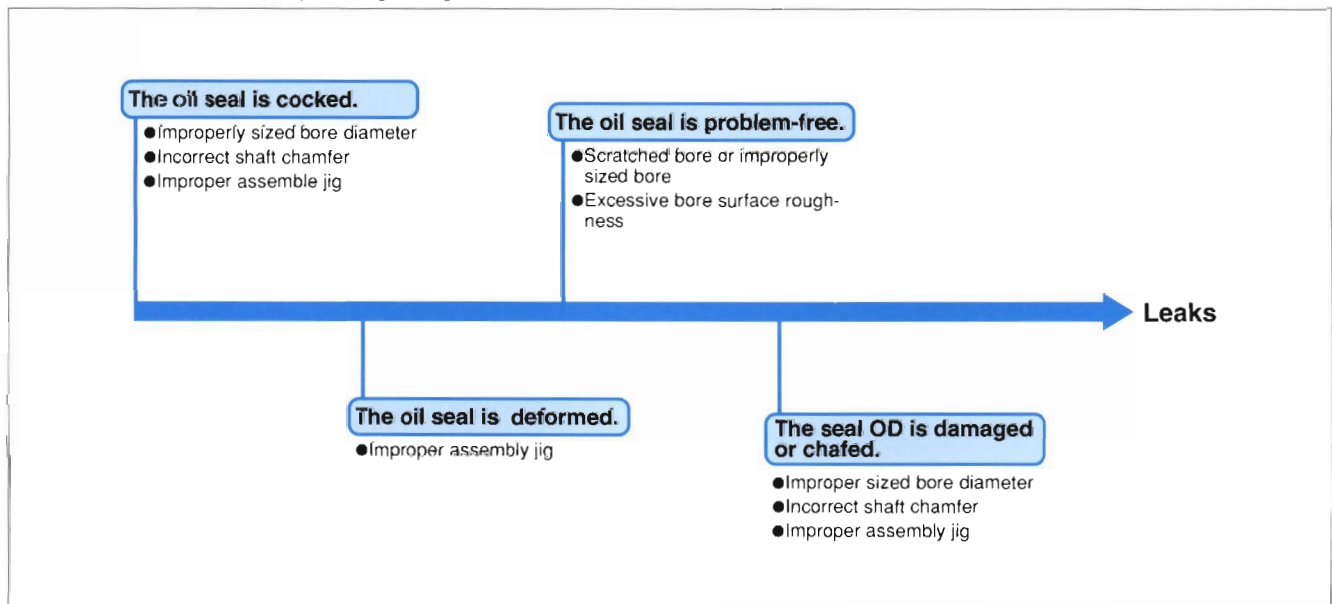
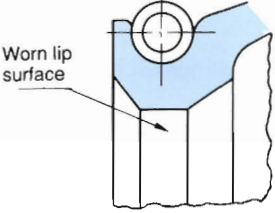
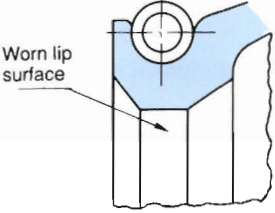
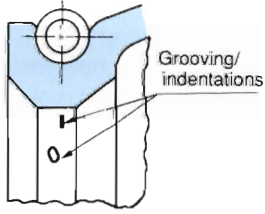
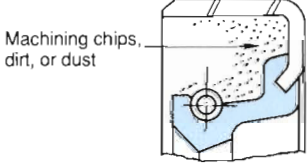
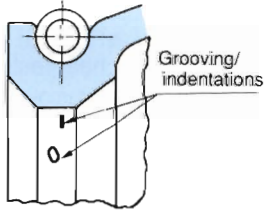
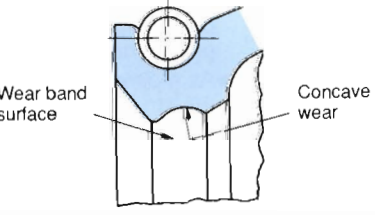


Figure 3: Press-Fit Area (OD) Leakage Diagnosis



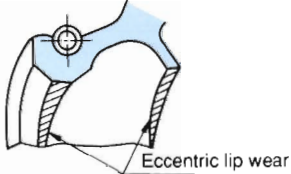
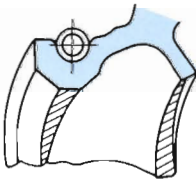
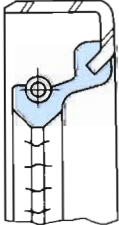
Leakage from the Seal Lip

Table 1: Leakage from the Seal Lip

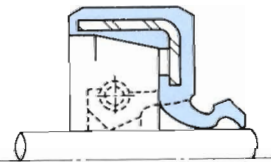
Factor	Failure mode	Cause	Solution
Insufficient lubrication	<p>The lip edge is severely worn, and the worn surface is dull and rough.</p> 	<ul style="list-style-type: none"> ● Abnormally high wear has occurred from the friction of insufficient lubrication. The amount of lubricant was below the specified level, and therefore did not reach the sealing lip. 	<ul style="list-style-type: none"> ● Add lubricant up to the specified level and operate.
		<ul style="list-style-type: none"> ● The machine design did not allow adequate oil flow to the seal lip. Examples: <ul style="list-style-type: none"> ● There is a slinger in front of the sealing lip. ● There is a drain in front of the sealing lip. ● If a spray/mist lubrication method is used, the lube did not reach the seal until several minutes after start-up. 	<ul style="list-style-type: none"> ● As a quick solution, change to a double-lip seal model, and apply grease between the lips. ● As a permanent solution, change the structure near the oil seal to allow lubricant to freely flow to the seal lip area.
Excessive lip wear	<p>The lip edge is severely worn, and there are grooves or indentations the worn surface.</p> 	<ul style="list-style-type: none"> ● Since a shaft or seal contaminated with cutting chips was used, the contaminants were embedded in the sealing lip.  <ul style="list-style-type: none"> ● Since the oil seal was assembled in the presence of dirt or dust, the contaminants became embedded in the sealing lip. ● Since the seal or housing was assembled with liquid gasket sealant, the sealant contaminated the shaft or seal. ● Since a seal or shaft with paint stains was used, the paint contaminated the shaft/seal. 	<ul style="list-style-type: none"> ● During assembly, use particular care to ensure that the oil seal or shaft is not contaminated with dirt or sand. ● Clean the machine with the same lubricant sealed in the machine.
		<ul style="list-style-type: none"> ● Since the oil seal was assembled in the presence of dirt or dust, the contaminants became embedded in the sealing lip. ● Since the seal or housing was assembled with liquid gasket sealant, the sealant contaminated the shaft or seal. ● Since a seal or shaft with paint stains was used, the paint contaminated the shaft/seal. 	<ul style="list-style-type: none"> ● During assembly, use particular care to ensure that the oil seal or shaft is not contaminated with dirt or sand. ● Clean the machine with the same lubricant sealed in the machine.
Excessive internal pressure	<p>The lip edge is severely worn, and the wear band is concave.</p> 	<ul style="list-style-type: none"> ● Pressure at the oil seal area exceeded the design pressure. 	<ul style="list-style-type: none"> ● Change to a high-pressure type oil seal. ● Provide a vent breather to maintain proper pressure.
Excessive shaft surface roughness	<p>The lip edge is severely worn, and there are circumferential grooves on the wear band.</p>	<ul style="list-style-type: none"> ● The seal lip has severe wear since the shaft finish was rougher than the specified range of 0.8 to 2.5 $\mu\text{m Rz}$. 	<ul style="list-style-type: none"> ● Smooth the shaft surface to 0.8 to 2.5 $\mu\text{m Rz}$ with emery paper (#240 or similar). Do not oscillate the emery paper axially along the shaft. ● Replace the shaft with one having the specified finish roughness.

The notation of surface roughness on the catalog comply with JIS B 0601:2001.

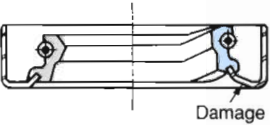
Leakage from the Seal Lip

Factor	Failure mode	Cause	Solution
Eccentric lip wear	<p>Large shaft-to-bore offset</p> <p>The lip wear band width is uneven around the circumference, and the minimum and maximum wear locations correspond well on the main lip and the secondary lip.</p> 	<ul style="list-style-type: none"> Machine has high shaft-to-bore misalignment 	<ul style="list-style-type: none"> Improve the concentricity of the shaft and housing.
		<ul style="list-style-type: none"> Shaft has high dynamic runout 	<ul style="list-style-type: none"> Improve the shaft runout.
	<p>Cocked seal installation</p> <p>The lip wear band is uneven around the circumference, and the minimum and the maximum wear locations of the main and secondary lips are inversely related.</p> 	<ul style="list-style-type: none"> The oil seal was installed cocked because the housing bore diameter is too small. 	<ul style="list-style-type: none"> Use a housing within the design dimensions.
		<ul style="list-style-type: none"> The oil seal was installed cocked due to an unchamfered or incorrectly chamfered housing. The oil seal was installed cocked because the assembly jig was cocked. 	<ul style="list-style-type: none"> Correctly chamfer the housing. (Refer to Chapter F.) Improve the assembly jig. (Refer to Chapter G.)
Lip hardening	<p>Abnormally high temperature</p> <p>The lip wear band is smooth and glossy. The entire sealing lip is hardened and there are cracks.</p> 	<ul style="list-style-type: none"> The oil temperature near the sealing lip exceeded the heat-resistance limits of the rubber. 	<ul style="list-style-type: none"> Investigate the cause and take appropriate measures to prevent future temperature rises.
		<ul style="list-style-type: none"> The oil temperature exceeded the design temperature limits due to changes in the application conditions. 	<ul style="list-style-type: none"> Replace with a seal with a better heat-resistant lip material. Example: Change from nitrile rubber (NBR) to acrylic rubber (ACM). Change from acrylic rubber (ACM) to fluorocarbon rubber (FKM). Note that a change of lip material also changes the oil resistance.
Insufficient lubrication	<p>Excessive internal pressure</p> <p>The lip wear band is wide and glossy. There are cracks on the sliding lip.</p>	<ul style="list-style-type: none"> The application pressure exceeded the limits of the oil seal. 	<ul style="list-style-type: none"> Change to a high-pressure type oil seal. Provide a vent to relieve pressure.
		<ul style="list-style-type: none"> A dry-wear condition occurred because the machine had an insufficient lubricant level. A dry-wear condition occurred because the machine's mist-type oil supply is inadequate. 	<ul style="list-style-type: none"> Add lubricant up to the specified level and operate. As a quick solution, change to a double-lip seal model, and apply grease between the lips. As a permanent solution, change the structure near the oil seal to allow oil to flow freely up to the seal lip.
Lips softening	<p>Inappropriate lip material</p> <p>The seal lip is swollen and soft.</p>	<ul style="list-style-type: none"> The seal lip has become swollen because the wrong lip material was selected. 	<ul style="list-style-type: none"> Change to an oil seal featuring a lip material that does not swell up in the presence of the lubricant used.
		<ul style="list-style-type: none"> The seal lip swelled because it was soaked in solvents or gasoline, or was not wiped off after washing. 	<ul style="list-style-type: none"> Do not wash the oil seal in solvents.

Leakage from the Seal Lip

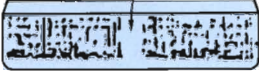

Factor		Failure mode	Cause	Solution
Scratches on the lip	Improper assembly	There are visible scratches on the sealing edge.	<ul style="list-style-type: none"> ●The seal lip was scratched through contact with shaft keyways or splines. 	<ul style="list-style-type: none"> ●Cap the keyways or splines to prevent scratching.
			<ul style="list-style-type: none"> ●The seal lip was scratched because it was assembled over burrs or other defects in the shaft chamfer. 	<ul style="list-style-type: none"> ●Remove burrs and defects.
	Improper handling		<ul style="list-style-type: none"> ●The seal lip was scratched because the lip came into contact with sharp metal parts during transit or storage. 	<ul style="list-style-type: none"> ●Improve the transit/storage method.
			<ul style="list-style-type: none"> ●The seal lip was scratched because the oil seal was handled with gloves contaminated with machine cutting chips. 	<ul style="list-style-type: none"> ●Avoid touching the seal lip edge.
	Improper shaft chamfer		There are visible scratches on the sealing edge.	<ul style="list-style-type: none"> ●The lip was caught at the shaft end and scratched because the shaft was incorrectly chamfered.
Contamination on the seal	<ul style="list-style-type: none"> ●There is contamination on the seal lip edge. ●There are indentations on the lip sliding area. 	<ul style="list-style-type: none"> ●A shaft contaminated with cutting chips was used, and the chips became lodged in the lip ●Since parts contaminated with metal shavings were used, the shavings became lodged in the lip edge. ●Since a dusty or dirty shaft or oil seal was used, foreign matter caught in the lip edge. 	<ul style="list-style-type: none"> ●Wash the machine parts thoroughly prior to assembly. 	
Lip turn-under	Improper shaft chamfer	Part of the lip is folded under and pinched to the shaft.	<ul style="list-style-type: none"> ●The lip was caught on the shaft end and folded under due to a poor shaft chamfer. 	<ul style="list-style-type: none"> ●Chamfer the shaft to the correct size, and apply grease to the chamfered area before assembly.
	Improper assembly		<ul style="list-style-type: none"> ●The lip folded under due to improper shaft and housing assembly. 	<ul style="list-style-type: none"> ●Assemble the unit carefully by aligning the shaft and housing bore. Apply grease to the shaft end.
	Excessive internal pressure	Part or all of the lip folded under.	 <ul style="list-style-type: none"> ●Abnormally high pressure occurred during operation, blowing out the lip. 	<ul style="list-style-type: none"> ●Change to a pressure-free structure. ●Use pressure-resistant oil seals.
Broken waist (flex section) of the lip	Improper assembly	There are cracks on the hinge flex area of the lip.	<ul style="list-style-type: none"> ●The lip hinge flex section cracked because the lip was squeezed out of shape during assembly. 	<ul style="list-style-type: none"> ●Assemble the unit carefully by aligning the shaft and housing bore.
	High internal pressure		<ul style="list-style-type: none"> ●The lip hinge flex section cracked due to excessive pressure during a post-assembly pressure test (air-leak test). 	<ul style="list-style-type: none"> ●Avoid testing at a pressures higher than the design limits of the seal.
			<ul style="list-style-type: none"> ●The lip hinge flex section cracked due to pressures exceeding the design limits. 	<ul style="list-style-type: none"> ●Change to a structure that does not produce excessive pressure. ●Change to a pressure-resistant oil seal.

Leakage from the Seal Lip

Factor	Failure mode	Cause	Solution	
Garter spring disconnected	Garter spring disconnected	<ul style="list-style-type: none"> ●The lip caught on an improperly chamfered shaft end, and popped the garter spring. 	<ul style="list-style-type: none"> ●Properly chamfer the shaft and apply grease to the chamfered area before assembly. 	
		<ul style="list-style-type: none"> ●The garter spring was disconnected because of improper shaft and housing assembly 	<ul style="list-style-type: none"> ●Assemble the unit carefully by aligning the shaft and housing bore. Apply grease to the shaft chamfer. 	
Oil seal deformation	Seal is damaged causing lip deformation. <div style="text-align: center; margin-top: 10px;">  </div>	<ul style="list-style-type: none"> ●The oil seal was deformed due to an inappropriate assembly jig. 	<ul style="list-style-type: none"> ●Improve the assembly jig. 	
The oil seal is problem-free.	Scratches or porosity on shaft	—	<ul style="list-style-type: none"> ●There were visible scratches or porosity in the shaft's contact area. 	<ul style="list-style-type: none"> ●Place a shim behind the oil seal to displace the lip contact area to a virgin shaft finish location. ●Remove scratches or porosity and refinish.
	Shaft has machine lead on its surface	—	<ul style="list-style-type: none"> ●Shaft was finished by lathe cutting only. 	<ul style="list-style-type: none"> ●Smooth out the shaft sliding area using emery paper (#240 or similar) without axial movement.
	Shaft eccentricity	—	<ul style="list-style-type: none"> ●The grinder or emery paper moved axially during the finish operation 	<ul style="list-style-type: none"> ●Change the machining method (finish without axial feed, plunge direction only).
	Shaft eccentricity	—	<ul style="list-style-type: none"> ●A worn bearing allowed shaft runout to exceed the design limits. 	<ul style="list-style-type: none"> ●Change the bearing.
	Shaft eccentricity	—	<ul style="list-style-type: none"> ●A general-purpose oil seal was used for a structurally large shaft runout. 	<ul style="list-style-type: none"> ●Change to an oil seal that resists eccentricity.
Shaft wear	—	<ul style="list-style-type: none"> ●The oil seal was installed with dirt or metal shaving contamination. ●The lubricant was degraded or contaminated with dirt or other foreign matter. ●Contaminants entered into the lip contact area. 	<ul style="list-style-type: none"> ●Wash the machine components thoroughly, then place a shim behind the oil seal to displace the lip contact to a new area on the shaft. ●For a small amount of dust, change to an oil seal with a dust lip or dust cover. 	
	—	<ul style="list-style-type: none"> ●A non-ferrous metal shaft was used. 	<ul style="list-style-type: none"> ●Use an appropriate shaft material and hardness. 	
Reversed installation orientation	—	<ul style="list-style-type: none"> ●The oil seal was installed incorrectly during assembly. 	<ul style="list-style-type: none"> ●Insert the oil seal with its seal lip directed towards the fluid side. 	

Leakage from the Press-Fit Area (Seal OD)

Table 2: Leakage from the Press-Fit Area (Seal OD)

Factor	Failure mode	Cause	Solution
Cocked seal installation	Before removing the oil seal: ●The oil seal is cocked with respect to the housing and shaft. After oil seal is removed: ●Contact at the press-fit is not even.	●The oil seal was cocked because the housing bore diameter was undersized.	●Finish the housing bore to the proper ID.
		●The oil seal was cocked due to an unchamfered or improperly chamfered housing.	●Chamfer the housing bore. (Refer to Chapter F.)
		●The oil seal was cocked because the assembly jig was cocked.	●Improve the assembly jig. (Refer to Chapter G.)
Seal deformation	●The fit trace is disconnected locally. <div style="text-align: center;">  </div>	●The oil seal was deformed because of an improperly designed assembly jig.	●Improve the assembly jig.
		●A gap in the press-fit occurred due to seal deformation from rough handling.	●Handle the seal carefully.
Scrapes or gouges on the OD	After the oil seal is removed: ●There are longitudinal scratches on the oil seal press-fit. The rubber was gouged.	●The oil seal was cocked because the housing bore diameter was undersized.	●Finish the housing bore to the proper ID.
		●Scratching occurred at the OD of the oil seal due to an unchamfered or improperly chamfered housing.	●Chamfer the housing bore. (Refer to Chapter F.)
		●The OD of the seal was gouged due to misalignment of the assembly jig with the housing.	●Properly align the jig with the housing.
The oil seal is problem-free.	<div style="text-align: center;">  </div>	●The housing bore ID surface was scratched because the seal was inserted with metal shavings or other foreign matter caught between the seal and the bore. ●The bore ID surface is scratched due to repeated seal removal and installation. ●There was large porosity on the bore ID.	●Apply a thin coat of liquid gasket sealant so that the scratches and porosity on the bore ID hole are filled. Use care not to contaminate the seal lip or the shaft with the sealant.
		●The housing bore ID surface was scratched due to seal installation with burrs on the bore chamfer.	●Remove the seal and check for grooving on the chamfered area of the housing bore. Remove these grooves and apply liquid gasket sealant to the bore ID surface.
		●The bore ID surface is too rough.	●Quick solution: Apply liquid gasket sealant to the housing bore ID. ●Permanent solution: Finish the bore ID surface to the correct roughness. (See pages F-8 to F-13.)

Examples of Leak Misdiagnosis

- ① Leaks from the mating surfaces of the machine
 - The gasket is deformed.
 - The mounting bolts are loose.
 - There are defects in the mating parts (i.e., indentations, burrs).
- ② Leaks caused by scratches or porosity in the housing, or other machine covers
- ③ Residual oil or grease from assembly on the air side of the oil seal
- ④ Extrusion of pre-lube grease or oil from initial assembly