



Automotive Seals Self-Study Guide

Expanding your knowledge
of seals and related components



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INTRODUCTION

This book, produced for use by SKF distributors and customers, should prove of practical value to engineers, fleet mechanics, maintenance superintendents and anyone who can benefit from a thorough understanding of seals. It will explain:

- How to select the best seal for any given application;
- How to improve performance with proper installation;
- How to spot—and correct—seal problems with the least possible amount of time and money.

How to Use this Study Guide

This self-study guide is programmed to increase performance productivity. Each chapter consists of a logical organization of material, technical diagrams and a short quiz to help you retain what you study.

Start by carefully reading the text portion of each chapter. Make notes or underline if you wish; this can help you remember what you've read.

It does not matter whether you are a fast or slow learner. At the end of the program, you will have learned the same information—and should retain it—as well as any other “student.”

The chapter quizzes are an important phase in self-study learning since they are intended to reinforce the material covered. The quiz questions are straightforward multiple choice and true-false. There are no “trick questions.” Your answers can easily be checked within the context of the chapter.

Complete each review in order before going on to the next chapter. If you are not sure of an answer to a question, check back in the chapter and review that portion again.

Brief History of the Shaft Seal

SKF invented and patented the first integrated shaft seal in 1928. It was designed to hold grease in automobile wheel bearings.

In the mid 1930's, SKF pioneered the development of custom formulating, compounding and molding elastomers (synthetic rubber). This led to other innovations in manufacturing processes, new sealing techniques, and the compounding and molding of various elastomer seals.

Today, SKF is the world's leading supplier of fluid sealing devices for the truck, automotive, farm equipment, aircraft, heavy machinery and machine tool industries.

SKF also supplies seals for aerospace missiles, earthmoving equipment, appliances, and a wide variety of pumps, hydraulic systems, motors and subassemblies.

SKF can supply more than 200 types of seals in more than 3,000 stock sizes. That includes seals in both bonded and assembled designs, with single or double lip elements, and with or without spring-loading or inner cases.

SKF seals fit shaft diameters from .188" to over 180". All are fashioned from a large and ever-growing spectrum of sealing elements and case materials.

THE SHAFT SEAL

In this world of moving parts, whenever a shaft rotates, it needs a bearing for smooth, effective operation.

In most cases, where there's a bearing, you'll find a seal helping it to do its job better. In simple terms, a shaft seal is a barrier.

Shaft seals are designed to:

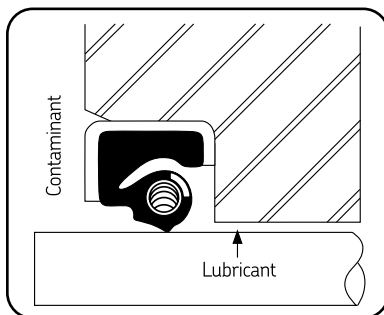
- Retain lubricants or liquids
- Confine pressure
- Exclude dirt
- Separate fluids

Seals are necessary for sealing in lubricants that are needed to protect the bearings and to seal out dirt, water and contaminants. To do both jobs effectively, all seals demand precise engineering and manufacturing.

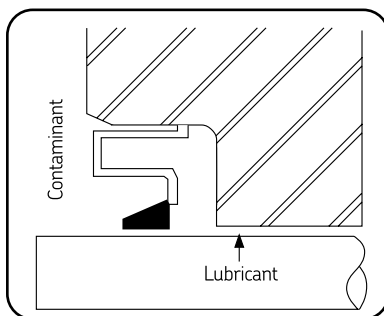
Seal designs and materials are constantly being developed, tested and improved. This testing is being done to conform with today's increased performance and durability requirements.

The material being sealed can be anything from light oil to heavy grease, or even hot turbine gases. Wheel seals are among the most common applications. The seal retains lube in the bearing, and at the same time, protects the bearing from contaminants such as water, dirt, dust and abrasives.

First, it must be decided which is more important: retention of lubricant, exclusion of foreign matter or, in some cases, both.



Retention seals retain lubricants. (fig. 1)



Exclusion seals prevent dirt from entering the bearing cavity. (fig. 2)

Retention

When the seal's basic job is to retain, the lip of the seal must face toward the lubricant or pressure being retained (fig. 1).

Exclusion

More bearings fail from the entrance of foreign material than from the loss of lubricant. Dirt, abrasives, water and other liquids can all interfere with the film of lubricant which supports the moving parts of a bearing in a sealed system.

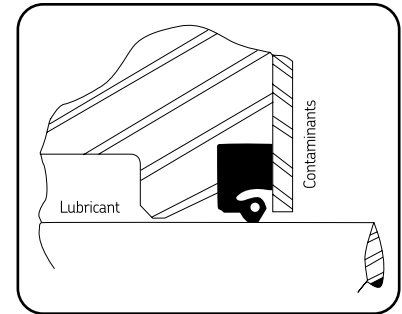
Therefore, it is vitally important for the seal to keep these materials from entering the bearing cavity. To do this best, the lip of the seal should face toward the contaminants instead of toward the bearing (fig. 2).

Retention/Exclusion

Many applications require the seal to perform both the retention and exclusion functions at the same time. For example, the seal may need to confine a lubricant, as well as exclude road dust, mud, water, or other highway contaminants.

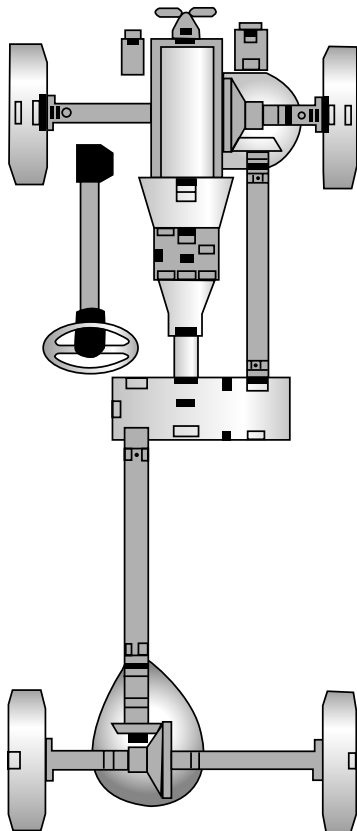
For applications that require both lube retention and dirt exclusion, a special type of protection is needed, either a combination of two seals, or dual sealing elements within one assembly (fig. 3).

The kind of seal (grease vs. oil, for example) depends on the location and function of the seal. The diagram below shows the location of the most commonly replaced oil seals on vehicles and trucks (fig. 4).



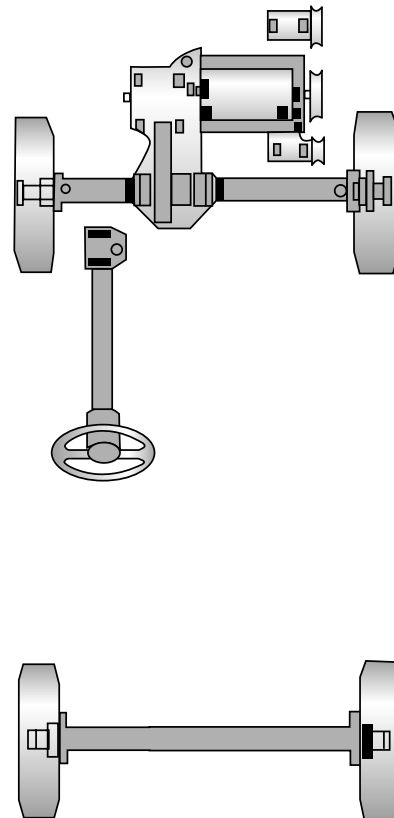
Two seals placed back-to-back retain lubricant and exclude dirt simultaneously. (fig. 3)

Typical Seal & Bearing Locations (4WD Passenger & 4WD Lt. Truck)



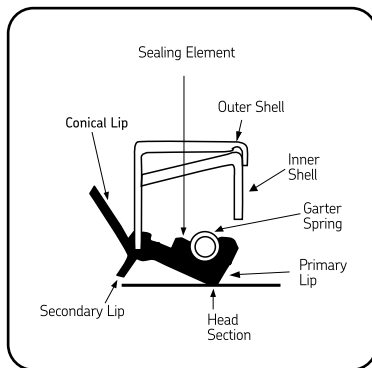
(Fig. 4)

Typical Seal & Bearing Locations (F.W.D. Passenger)



Seal Design

The shaft seal is a small and simple looking product with a big and important job. The following describes a typical seal and the function of each of its components (fig. 5).



Retention Seal (fig. 5)

Seal Components

1. **Outer Shell (Case).** The outer, cup-shaped, rigid structure of the lip seal assembly acts as a protective cover for the head of the sealing element and more importantly holds the installed seal in place.
2. **Inner Shell (Case).** A rigid cup-shaped component of a seal assembly which is placed inside the outer seal case. It can function as a reinforcing member, shield, spring retainer or lip-clamping device.
3. **Sealing Element.** The flexible elastomeric “working” component of a lip seal assembly which rides against the shaft.
4. **Primary Lip.** The flexible elastomeric component of the sealing element which contacts the rotating surface.
5. **Secondary Lip (Auxiliary Lip).** A short, non-spring-loaded lip of the sealing element which is located at the outside seal face of a radial lip seal. It is used to exclude contaminants.
6. **Garter Spring.** A coiled wire spring with its ends connected. It is used for maintaining a sealing force between the sealing element and sealing surface.
7. **Conical Lip.** To exclude contamination.

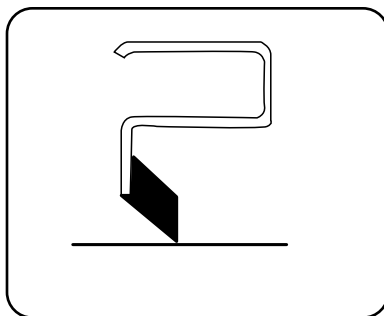
How The Seal Works

The following is a review of how the seal components work together to retain lubricants, confine pressure, exclude contaminants and separate liquids.

Retention Seals

Seals designed to retain lubricants or keep normal operating in the bearing cavity are known as retention seals.

Retention seals (normally spring-loaded) are not recommended for more than light dirt exclusion. Because of their specific function, they rarely face toward dirt or heavy contaminants.



Exclusion Seal (fig. 6)

Exclusion Seals

These seals prevent dirt, water and contaminants from entering the bearing assembly. There is a wide variety of exclusion seals. Some have a single lip and no spring reinforcement. With others, the lip action is at the outside diameter of the seal. Still others were created especially for mud applications.

Exclusion seals, with lips pointing outward, can be kept lubricated and clear of dirt by purging (forcing grease through them).

Exclusion/Retention

Two seals combined back to back, for excluding and retaining at the same time, are exclusion/retention seals. A means should be provided to lubricate the second seal, which is separated from the lubricant already in the bearing cavity by the first seal.

Packing the cavity between the sealing lips with a grease that can take the heat produced by the application will extend the life of the auxiliary lip. In some cases, this supply of lubricant must be replenished at regular intervals.

However, this combination of seals will not always do a better job than a single lip seal.

CHAPTER 1 REVIEW

To take this test simply place a card or sheet of paper under the first question. After you've read it (and answered it to yourself), slide the paper down below the next question. The correct answer to the first problem will appear directly to the right of the new question. Be sure not to skip any of the questions. This learning technique assures more than four times the normal retention rate for even this technical subject.

1. A shaft seal is a barrier designed to _____.
☐ a. retain lubricants or liquids and exclude dirt
☐ b. confine pressure
☐ c. separate fluids
☐ d. all of the above

1. D

2. Packing the cavity between the sealing lips of exclusion/retention seals with a grease that can take the heat produced by the application will _____.
☐ a. shorten the life of the auxiliary lip
☐ b. extend the life of the auxiliary lip
☐ c. damage both lips
☐ d. none of the above

2. B

3. A typical vehicle may require _____.
☐ a. steering seals
☐ b. transmission rear seals
☐ c. front crank seals
☐ d. all of the above

3. D

4. Another name for the outer shell of the seal is the outer _____.
☐ a. lip
☐ b. case
☐ c. cone
☐ d. spring

4. B

5. Bearings fail more from _____ than from the loss of lubricants.
☐ a. the entrance of foreign material
☐ b. improper seal installation
☐ c. the retention of lubricant
☐ d. all of the above

5. A

6. Exclusion seals can be kept lubricated and clear of dirt by _____.
☐ a. regular cleaning
☐ b. a second seal
☐ c. a special sealing material
☐ d. purging grease through the lips
6. D
7. Every rotating shaft requires a bearing and a seal for smooth, effective operation.
☐ True ☐ False
7. T
8. A shaft seal is a barrier designed only to confine pressure.
☐ True ☐ False
8. F
9. Seals are needed to seal in lubricants necessary for the bearings, and to seal out dirt, water, and contaminants.
☐ True ☐ False
9. T
10. If the seal's basic job is to retain lubricants or liquid, the seal lip must face toward the lubricant or pressure being retained.
☐ True ☐ False
10. T
11. If the seal's basic job is to exclude contaminants, the lip of the seal should face toward the bearing, instead of toward the contaminants.
☐ True ☐ False
11. F
12. Spring-loaded seals designed to retain lubricants or keep pressure in the bearing cavity are known as exclusion seals.
☐ True ☐ False
12. F
13. Retention seals stop dirt, water, and contaminants from entering the bearing cavity.
☐ True ☐ False
13. F
14. Seal components include an outer shell, inner shell, sealing element, sealing lip and garter spring.
☐ True ☐ False
14. T
15. Two seals may never be combined within the same assembly.
☐ True ☐ False
15. F

SEALING ELEMENT (LIP) MATERIALS

SKF seals have a synthetic lip material bonded to the metal shell (case). The bonding prevents leakage between the sealing lip and the shell, and it provides a longer lasting, more effective seal. This is different from the process used for assembled seals, in which assembly pressure is used to hold the lip in place between the metal parts.

A wide variety of sealing element (lip) materials is available. Each has its own unique characteristics. Selection should be made on the basis of application, compatibility with lubricants and fluids being retained, operating temperatures, and other conditions.

Synthetics

Today, the most popular and widely used sealing materials are synthetics. These include nitriles, polyacrylates, silicones and fluoroelastomers (Viton*). Each material has its own advantages and disadvantages.

Nitrile

Nitrile is the most popular material for the major applications today. It is actually a mixture of two basic synthetic rubbers, Buna and acrylonitrile polymers. Different properties are obtained by changing the percentage of each polymer used in the mixture (or copolymer).

Nitrile has generally replaced leather as a sealing lip material.

ADVANTAGES

- + Good oil/grease compatibility
- + Abrasion resistance
- + Good low temperature and swell characteristics
- + Good manufacturing qualities
- + Relatively low in cost

DISADVANTAGES

- Lacks compatibility with synthetic oils such as phosphate ester and Skydrol
- Not recommended with EP lubes at elevated temperatures

OPERATING RANGE

Standard SKF seals with nitrile sealing lips are effective in applications involving most mineral oils and greases in temperatures ranging from -65°F to 250°F.

IDENTIFICATION

Varies from gray-black to shiny jet black

SUBSTITUTE LIP MATERIALS

Polyacrylate, silicone or fluoroelastomer (See Seal Substitutions, page 21).

Duralip

Duralip is SKF's special nitrile compound for extreme abrasion resistance. It is recommended where scale, sand, grit, dirt or other highly abrasive materials are present.

ADVANTAGES

- + Extreme abrasion resistance
- + See nitrile

DISADVANTAGES

See nitrile

OPERATING RANGE

See nitrile

IDENTIFICATION

See nitrile

SUBSTITUTE LIP MATERIALS

See nitrile

Polyacrylates

Polyacrylates are elastomers that are compatible with higher operating temperatures, as well as extreme pressure (EP) lubricants. They are available in most general purpose designs.

ADVANTAGES

- + Good compatibility with most oils, including EP lubricants
- + High resistance to oxidation and ozone
- + Better compatibility with higher operating temperatures than nitrile

DISADVANTAGES

- Low compatibility with water and some industrial fluids
- Poor compression-set characteristics

OPERATING RANGE

Seals with polyacrylate lips are effective in temperatures ranging from -40°F to 300°F.

IDENTIFICATION

Generally black with same appearance as nitrile

SUBSTITUTE MATERIALS

Nitrile, silicone or fluoroelastomer (See Seal Substitutions, page 21).

Silicone

Silicone's high lubricant absorbency minimizes friction and wear. It can be used in a wide range of temperatures. Silicone seals are made only in bonded designs.

ADVANTAGES

- + High lubricant absorbency
- + Very flexible
- + Wide temperature range

DISADVANTAGES

- Poor compatibility with oils that have become oxidized, and EP lube additives
- Tendency to tear and cut during installation
- Poor abrasion resistance
- Relatively high cost

OPERATING RANGE

Silicone seals can withstand a very wide temperature range, from -100° to 325°F.

IDENTIFICATION

Generally red or orange, but sometimes gray or blue. Silicone seals feel softer and are more flexible than other materials

SUBSTITUTE LIP MATERIALS

Fluoroelastomers, polyacrylate or nitrile (See Seal Substitutions, page 21).

Fluoroelastomers (Viton)

Fluoroelastomers are recommended for use with special lubricants and chemicals which cannot be handled by nitrile, polyacrylate or silicone. They are compatible with oils, chemicals, fuels and lubricants over a broad range of temperatures that are too extreme for other sealing elements.

Fluoroelastomers are available in standard line designs as well as large diameter seals. One fluoroelastomer, Viton, is compatible with aliphatic and aromatic hydrocarbons (carbon tetrachlorine, benzene, toluene, xylene) that are used as solvents for other rubbers.

Because of its compatibility with many different fluids over a broad temperature range, Viton also is effective in aircraft and space equipment applications.

ADVANTAGES

- + Wide temperature range
- + Low swell characteristics
- + Compatible with lubes, additives and chemicals that destroy other synthetic materials
- + Less downtime
- + Extreme abrasion resistance

DISADVANTAGES

- Relatively high cost

OPERATING RANGE

-40°F to 400°F

IDENTIFICATION

Brown to black; may also be blue or green

SUBSTITUTE LIP MATERIALS

(See Seal Substitutions, page 21).

Other Synthetics

In addition to these standard materials, SKF can supply seals with elements molded of other materials for special conditions.

Non-Synthetics

Teflon®/PTFE

SKF PTFE seals are assembled, made-to-order radial shaft seals based on PTFE (Teflon® or polytetrafluoroethylene). This thermoplastic material offers a solution for designers and engineers faced with operating conditions that exceed the capabilities of rubber compounds.

PTFE offers wider media resistance in comparison to standard elastomers with a temperature range of -100° to 500°F (-73° to 260°C). With the addition of appropriate fillers, PTFE has excellent mechanical properties, low friction and wear resistance.

ADVANTAGES

- + Superior tensile strength and abrasion resistance
- + Performs well with little or no lubrication
- + Tends to smooth rough shaft surfaces
- + Compatible with lubes and solvents. Chemically inert.
- + High speeds in excess of 15,000 fpm

DISADVANTAGES

- Can be abrasive
- Installation tool required
- Expensive

OPERATING RANGE

Teflon can handle temperatures ranging from -100°F to 500°F.

IDENTIFICATION

Teflon is easily identified by its thin wafer appearance with a plastic “feed” to it.

SUBSTITUTE LIP MATERIAL

Fluoroelastomer (See Seal Substitutions, page 21).

Felt

Felt is another non-synthetic material which has long been used as a sealing material. Made of wool and sometimes laminated with synthetic rubber washers, felt is generally limited to light dirt exclusion. However, it effectively retains

heavy lubricants such as wheel bearing grease and performs well in sparsely lubricated applications under some conditions such as small electric motors. Felt washers are available only in limited sizes.

ADVANTAGES

- + Excludes dirt and dust well
- + Retains grease efficiently
- + High lubricant absorbency

DISADVANTAGES

- Cannot confine light oils
- May trap metal particles, causing shaft wear
- Absorbs water, which may cause shaft rusting

OPERATING RANGE

-65°F to 200°F

SUBSTITUTE LIP MATERIALS

Nitrile, polyacrylate or fluoroelastomer (See Seal Substitutions, page 21).

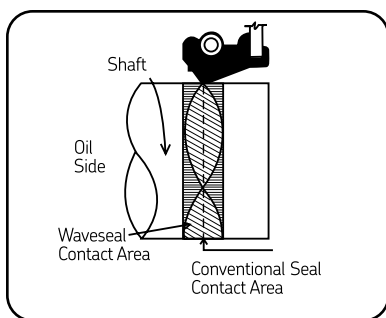
Compound Selection Chart

The compatibility of sealing element materials with most fluids currently used can be found in the Compound Selection Chart in the SKF Handbook of Seals (Catalog #457010).

This chart rates the operation of different sealing materials (minor effect, moderate effect, static only, not recommended, insufficient data) within the range of specified operating temperatures and conditions for most common lubricants, fresh or salt water, and fluids.

Sealing Lip Performance

Following is a description of the lip itself and how it works. In this example, the Waveseal will be used. The Waveseal, SKF's preferred design, provides at least 30% more service life than other radial lip seals. A number of the toughest fleet applications specify this design to assure top performance and increased service life.



The SKF Waveseal contacts a wider area of shaft than conventional seals. (fig. 1)

Waveseals®

The SKF Waveseal features a sealing process utilizing hydrodynamics, that is completely different from that of conventional seals.

In technical terms, the Waveseal is a smooth lip, birotational hydrodynamic radial lip seal. More simply, it is a shaft seal that pumps lubricant back into the sump while sealing out contaminants—no matter which way the shaft is turning.

In terms of shaft and seal wear, the SKF Waveseal is important to truck operators because:

- It offers more dependable performance and up to 30% longer service life than conventional seals.
- Its design has almost universal fleet applications.
- It is the first standard line of shaft seals utilizing hydrodynamics.

Waveseals vs. Conventional Seals

In Chapter 1, the operation of a conventional shaft seal was explained. The Waveseal is completely different. The lip of a conventional seal rides the shaft in a narrow straight line. The Waveseal has a much broader contact (fig. 1).

When the Waveseal's specially molded lip contacts the shaft, it forms a sine wave (snakelike) pattern that moves back and forth on the shaft surface. The results are significant. Using a Waveseal produces less heat, provides better lubrication, and reduces shaft wear. It also wears longer. Since the Waveseal does not depend on externally molded patterns, it does not lose pumping power as it wears.

Compared to conventional seals, Waveseals:

- Generate 25-35% less heat at contact
- Produce 20% less frictional torque or drag
- Pump fluids back into the sump and ingest substantially less contaminants

*Viton is a registered trademark of E.I. DuPont.

CHAPTER 2 REVIEW

To take this test simply place a card or sheet of paper under the first question. After you've read it (and answered it to yourself), slide the paper down below the next question. The correct answer to the first problem will appear directly to the right of the new question. Be sure not to skip any of the questions. This learning technique assures more than four times the normal retention rate for even this technical subject.

1. SKF seals are available in a wide variety of sealing element materials and each has its own unique characteristics. Selection should be on the basis of _____.

☐ a. application
☐ b. compatibility with lubes and fluids
☐ c. operating temperature
☐ d. all of the above

1. D

2. Nitrile has generally replaced _____ as a sealing lip.

☐ a. felt
☐ b. silicone
☐ c. leather
☐ d. Viton

2. C

3. One of nitrile's disadvantages is that it is not compatible with _____.

☐ a. oil
☐ b. abrasion
☐ c. synthetic oils
☐ d. all of the above

3. C

4. One of polyacrylate's disadvantages is its _____.

☐ a. low compatibility with water and some industrial fluids
☐ b. high resistance to oxidation and ozone
☐ c. relatively high cost
☐ d. good compression-set characteristics

4. A

5. Teflon _____.

☐ a. is tough
☐ b. resists chemicals
☐ c. can be used in high temperature applications
☐ d. all of the above

5. D

6. Silicone's advantages include its _____.

☐ a. high lube absorbency
☐ b. good flexibility
☐ c. ability to handle a wide temperature range
☐ d. all of the above

6. D

7. Seals made of fluoroelastomers _____.
☐ a. are inexpensive
☐ b. sometimes require special molds
☐ c. lack wide temperature range resistance
☐ d. are compatible with oil
7. D
8. Felt is a non-synthetic material which has long been used as a sealing material. Its advantages include _____.
☐ a. excellent water resistance
☐ b. good exclusion of dust and dirt
☐ c. tends to smooth rough shaft surfaces
☐ d. good oil retention
8. B
9. Using a Waveseal produces significant results which include _____.
☐ a. less heat produced
☐ b. less shaft wear
☐ c. better lip lubrication
☐ d. all of the above
9. D
10. The most popular and versatile sealing materials in use today are synthetics, such as nitrile, polyacrylates, silicones and fluoroelastomers.
☐ True ☐ False
10. T
11. Nitrile is the most popular material for the majority of sealing applications today.
☐ True ☐ False
11. T
12. One of Vitons disadvantages is its poor resistance to temperature extremes.
☐ True ☐ False
12. F
13. Polyacrylates are elastomers that work well with high operating temperatures and EP lubricants.
☐ True ☐ False
13. T
14. Polyacrylates have high resistance to water.
☐ True ☐ False
14. F
15. The lip of a Waveseal rides the shaft in a straight-line pattern.
☐ True ☐ False
15. F

SEAL SELECTION

Other than faulty installation, the most common reason a seal fails is that it is not the correct seal for the application. It is very important to check the old seal and replace it with one that is correct for the application.

Replacement Seals

If the old seal being replaced was manufactured by SKF, it should have one of four identifying numbers:

1. an SKF stock number
2. an older SKF part number
3. an SKF drawing number
4. the original equipment manufacturer's part number

The SKF Master Interchange (Catalog #457012) lists the SKF stock numbers that correspond to nearly 150,000 shaft seals in use today.

The simplest method of replacement is to use the number of the old seal. If this number is unreadable or unavailable, a replacement can be selected by matching sizes with listings in the SKF Handbook of Seals (Catalog #457010).

If there is no seal listed in exactly the same width, a narrower width is usually the best choice. A wider width is perfectly acceptable if space permits, however it is often limited.

Seal Substitutions

The SKF Handbook of Seals lists different seal designs which can be substituted for the old seal (within the limits of the operating conditions). Seal materials and proper substitutes were discussed in the previous chapter. Because of the importance of knowing and understanding these materials, they will be reviewed here.

If a lip material to match the old seal cannot be found in the size listings, refer to the Substitute Material Table in the Handbook of Seals. Some of the more common seal substitutions are listed below.

- Nitrile instead of felt
- Nitrile instead of leather
- Polyacrylate instead of nitrile
- Fluoroelastomer instead of polyacrylate
- Fluoroelastomer instead of silicone
- Fluoroelastomer instead of Teflon

Remember, colors other than black usually mean special materials. Materials should generally be substituted only if immediate replacement is more important than the assurance of maximum seal life. Because of the great number of factors involved, it is not always true that a premium elastomer will do a better sealing job than a less expensive material.

If the operating temperature is above 250°F, nitrile seals substituted for polyacrylate or silicone may have a shorter life. And, while silicone has a wider temperature range than polyacrylate, it breaks down if it is exposed to oxidized oils.

Seals For New Applications

Choosing the right seal for a particular application depends on operating conditions:

1. Size
2. Speed
3. Pressure
4. Temperature/Fluid compatibility

Each of these operating conditions should influence your selection of a seal for that application.

Size

Seal dimensions (fig. 1) used in seal selection include:

Seal Bore Diameter

This is the diameter of the hole into which the seal will be fitted.

Seal Outside Diameter (O.D.)

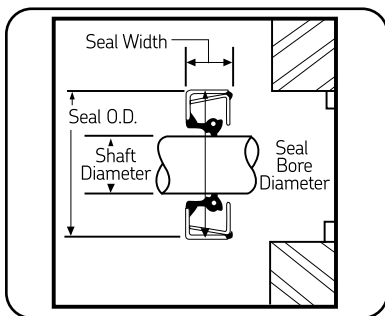
The O.D. is the seal's press-fit diameter. It is usually .004" to .010" larger than the bore so the seal will be held firmly in place.

Seal Width

This is the overall width (including the inner and outer shells).

Shaft Diameter

Because the seal's inside diameter is difficult to measure and varies with seal designs, the shaft diameter for which the seal was designed is used as the cataloged inside dimension.



(fig. 1)

Measuring the Seal O.D.

When measuring the seal's outside diameter, measurements should be taken in at least three places equally spaced around the seal. The average of these readings can then be used as the diameter.

How to Measure Seal I.D.

If you don't know the actual shaft diameter, you can estimate it by measuring the seal's inside dimensions.

It makes no difference if the seal has an inner shell or not. Simply average the three measurements of the lip inside diameter (fig. 2). Estimate shaft size as follows:

Estimated Shaft Diameter	Add to Lip I.D.
Up to 1"	.031"
1" to 2"	.021" — .047"
2" to 6"	.047" — .063"
6" to 8"	.063" — .094"
8" to 12"	.125"



A vernier is used to measure the seal's I.D. (fig. 2)

Speed

The maximum speed at which a seal can operate depends on other operating conditions. These conditions include shaft finish, pressure, temperature, eccentricity, the lubricant or fluid to be retained, and the particular design of the seal selected.

For instance, as shaft finish is improved (to the 10-20 micro-inch range) shaft speed can be increased. As shaft eccentricity (run-out) is reduced, shaft speed can be increased.

Surface speed at the contact point between the seal and the shaft (fpm: feet per minute) is generally a better indicator of seal performance than revolutions per minute (rpm).

To convert rpm to fpm, use the following formula or refer to the SKF Handbook of Seals (Catalog #457010).

$$.262 \times \text{rpm} \times \text{shaft diameter (inches)} = \text{fpm}$$

Pressure

The next aspect important to proper seal selection is pressure.

Allowable pressure goes down as shaft speed goes up.

The more pressure applied to a seal, the more lip surface contacts the shaft. More contact produces more friction and heat. Friction and heat rise as shaft speed increases. These factors cause faster wear and can shorten seal life.

Many of the bonded designs in the SKF Handbook of Seals can handle pressures of 15 psi at speeds up to 1,000 fpm. These can be found in the Handbook's table of operating conditions.

When speeds increase past 1,000 fpm, some of these same seals can handle only 5 psi.

Temperature/Fluid Compatibility

The final consideration affecting seal selection is temperature and fluid compatibility. Handbook listings are given in 16 “continuous” ratings—the relatively constant ambient temperature next to the seal, or the temperature of the lubricant it retains.

When operating conditions are under 0°F or above 200°F, the range recommended in the Handbook must be considered in selecting the type of sealing element material.

As was earlier stated, SKF's standard nitrile compound provides good service in most sealing applications from -65°F to 250°F. However, silicone, polyacrylate or fluoroelastomers provide safer operating limits and are preferred with higher or lower temperatures.

Summary

There are many factors involved in selecting seals. To avoid confusion, the SKF Handbook of Seals contains a Recommended Operating Conditions Selection Chart to assure a correct seal choice.

All of the selection factors are grouped together along with recommendations about the type of seal to use in almost every application.

CHAPTER 3 REVIEW

To take this test simply place a card or sheet of paper under the first question. After you've read it (and answered it to yourself), slide the paper down below the next question. The correct answer to the first problem will appear directly to the right of the new question. Be sure not to skip any of the questions. This learning technique assures more than four times the normal retention rate for even this technical subject.

1. A replacement seal manufactured by SKF is identified by _____.
☐ a. an SKF stock number
☐ b. an SKF drawing number
☐ c. the original equipment manufacturer's part number
☐ d. any of the above

1. D

2. Choosing the right seal for an application depends on _____.
☐ a. seal dimensions
☐ b. speed and pressure
☐ c. temperature
☐ d. all of the above

2. D

3. A substitute material for silicone is _____.
☐ a. felt
☐ b. leather
☐ c. nitrile
☐ d. none of the above

3. C

4. Nitrile seals will have shortened lifespans if the operating temperature is _____ 250°F.
☐ a. below
☐ b. above
☐ c. at
☐ d. none of the above

4. B

5. _____ is the seal's press-fit diameter; usually .004" to .008" larger than the bore.
☐ a. Shaft diameter
☐ b. Seal outside diameter
☐ c. Seal inside diameter
☐ d. Bore diameter

5. B

6. The maximum speed at which a seal can operate depends on other operating conditions. These conditions include _____.
☐ a. the design of the seal selected
☐ b. the lubricant or fluid to be retained
☐ c. pressure and temperature
☐ d. all of the above
6. D
7. If the seal has no identification numbers, you should average three measurements of the _____.
☐ a. seal width
☐ b. seal bore
☐ c. lip inside diameter
☐ d. any of the above
7. C
8. A common reason for seal failure is that it is not the right seal for the application in the first place.
☐ True ☐ False
8. T
9. If there is no seal listed in the exact same width in the SKF Handbook of Seals, a narrower width seal may be used.
☐ True ☐ False
9. T
10. Substitutions should be used only when immediate use is more important than the assurance of maximum seal life.
☐ True ☐ False
10. T
11. Using a seal with a premium elastomer lip will always do a better job than a less expensive material.
☐ True ☐ False
11. F
12. Seal bore is the diameter of the hole into which the seal will be fitted.
☐ True ☐ False
12. T
13. Seal width is the width of the inner shell only.
☐ True ☐ False
13. F
14. The outside diameter can be measured by taking one reading around the seal.
☐ True ☐ False
14. F
15. If the actual shaft diameter is unknown, you can estimate the shaft diameter by measuring the seal's outside dimensions.
☐ True ☐ False
15. F

PRE-INSTALLATION REQUIREMENTS

No matter how well made a seal is, or how carefully the proper one is chosen for an application, incorrect installation can make even a new seal worthless. Proper installation depends on three conditions:

1. Condition of the shaft
2. Condition of the bore
3. Using the proper techniques for seal installation

Shaft Requirements

Shaft Configuration

A burr-free chamfer (fig. 1) or radius (fig. 2) is required, as shown in this illustration.

Shaft Materials

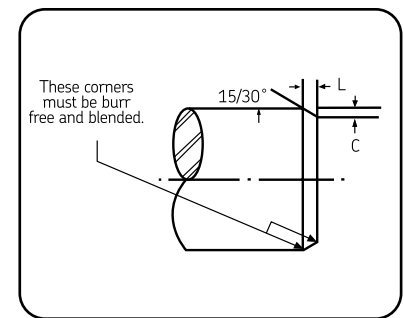
Seals perform best on medium carbon steel (SAE 1035 or 1045) or stainless steel shafts. High-quality chrome-plated and nickel-plated surfaces properly finished also are acceptable.

NOTE: Brass, bronze, and alloys of aluminum, zinc or magnesium are not recommended.

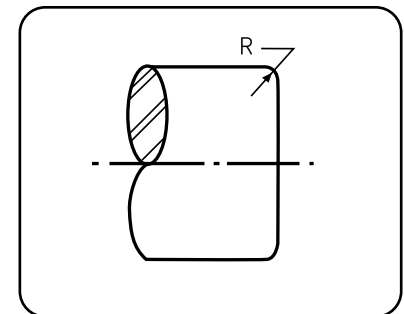
Shaft Tolerance

For satisfactory seal performance, shaft diameter should fall within the limits recommended by the Rubber Manufacturer's Association:

Nominal Shaft Diameter	Tolerance
Up to and including 4.000"	+/- 0.003"
4.001" to 6.000"	+/- 0.004"
6.001" to 10.000"	+/- 0.005"
10.001" and larger	+/- 0.006"



These corners must be burr free and blended (fig. 1).



The shaft radius should be smooth (fig. 2).

Shaft Hardness

Under normal conditions, the shaft's sealing surface should be hardened to Rockwell C30 minimum. There is no conclusive evidence that further hardening will increase seal life.

Shaft Finish

The surface of the shaft, or shaft finish, is critical to proper seal performance. Ideally, the shaft should be smooth enough to maintain contact with the seal lip, but rough enough to hold the lubricant film in place.

Machine lead is always present after the shaft has been machined to size on a lathe. It is necessary to dress the shaft surface to remove the lead introduced during the machining operation.

Seal and original equipment (OE) manufacturers agree that the following shaft conditions should be met:

- Shaft finish should fall between 10 to 20 micro inches AA (Arithmetical Average)
- Shafts should be ground with mixed number rpm ratios
- The finish or surface of the shaft should be free of machine lead
- The entrance edge should be chamfered or rounded

Plunge grinding is the recommended method for removing machine lead and assuring proper shaft finish (fig. 3). Conventional machining can form grooves running diagonally along the shaft. These spiral marks, called machine lead, invisible to the eye, will auger or pump lubricant out of the assembly. This will cause leakage and lip damage, especially at higher speeds.



Plunge grinding is the recommended method for shaft finish (fig. 3).

However, even plunge grinding can sometimes cause machine lead. To avoid this problem, follow these finishing recommendations:

1. Dress the grinding wheel gradually, using a cluster-head tool.
2. Use a mixed number rpm ratio between the grinding wheel and shaft (for example, 3.5 to 1) (fig. 4).
3. Be sure to let the grinding wheel spark out—run until there are no more sparks flying from the wheel.

Remove any burrs, nicks, rough spots or grooves. These marks can damage the seal's lip as it makes contact with the shaft.

Shaft Eccentricity

There are two kinds of shaft eccentricity that affect seal performance.

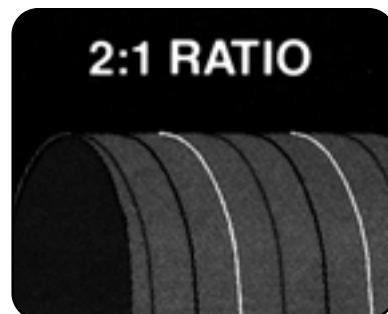
1. Shaft-to-Bore Misalignment
2. Dynamic Run-Out

Shaft-to-Bore Misalignment (STBM)

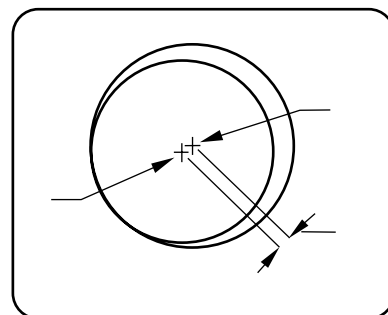
Shaft-to-bore-misalignment (STBM) is the amount by which the shaft is off center, with respect to the bore's center. This is common to some degree. It is caused by inaccuracies in machining and assembly, or from wear in bearings or bushings (fig. 5).

Dynamic Run-Out

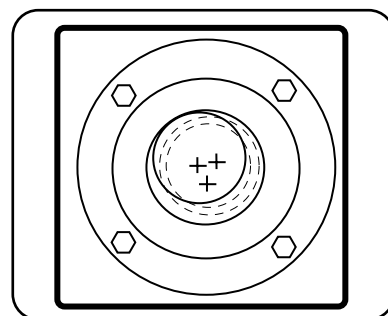
Dynamic run-out is the amount by which the shaft does not rotate around the true center. It is called “dynamic” because it happens when the shaft is rotating. Misalignment, shaft bending, lack of shaft balance and other manufacturing inaccuracies are common causes of dynamic run-out (fig. 6).



Use a mixed number rpm ratio (fig. 4).



Note how the shaft is off center when there is shaft-to-shaft bore misalignment (fig. 5).



Dynamic run-out is the amount by which the shaft does not rotate around the true center (fig. 6).

Seals can handle more STBM than dynamic run-out. Too much eccentricity tends to increase friction and create abnormal wear. The faster the seal lip must move, the less distance it can travel while still following the shaft. So, as shaft speed (rpm) increases, the allowable amount of dynamic run-out decreases.

Refer to the Recommended Operating Conditions Chart in the SKF Handbook of Seals (Catalog #457010) for shaft-to-bore misalignment and dynamic run-out ranges.

Shaft Speed

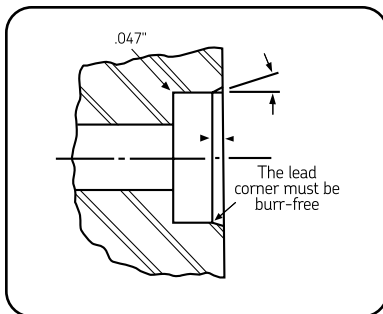
Maximum speeds for effective seal operation depend on a number of factors. These include shaft finish, pressure, temperature, eccentricity, lubricant or fluid being retained, seal type and other conditions. For example, shaft speeds may be increased when shaft finish is improved or eccentricity (run-out) is reduced.

Bore Requirements

Bore Configuration

The lead corner, or entering edge, of the bore should be chamfered and burr-free. The inside corner of the bore should have a maximum radius of .047" (fig. 7). An inside corner too rounded, or a corner with too large a radius can cause the seal to distort when pressed into the bore.

In a stepped bore, the width of the seal bore should exceed the width of the seal by a minimum of .016".



The lead corner must be burr-free (fig. 7).

Bore Tolerance

Seals are manufactured according to precise size requirements. Seal outer diameters are normally .004" to .010" larger than the seal bore. To assure the needed press-fit of SKF seals, use the dimensions listed below.

Bore Diameter	Bore Tolerance	Nominal Press-Fit:	
		Seals With Metal O.D.	Seals With Rubber O.D.
Up to 1.000"	+/- .001"	.004"	.006"
1.001 to 3.000"	+/- .001"	.004"	.007"
3.001 to 4.000"	+/- .0015"	.005"	.008"
4.001 to 6.000"	+/- .0015"	.005"	.010"
6.001 to 8.000"	+/- .002"	.006"	.010"
8.001 to 9.000"	+/- .002"	.008"	.010"
9.001 to 10.000"	+/- .002"	.008"	.010"
10.001 to 20.000"	+ .002"	.008"	—
	- .004"		
20.001 to 40.000"	+ .002"	.008"	—
	- .006"		
40.001 to 60.000"	+ .002"	.008"	—
	- .010"		

Bore Hardness

There are no specific Rockwell hardness recommendations. Bore hardness must only be high enough to maintain sufficient interference with the seal's outside diameter.

Bore Material

Ferrous and other commonly used metallic materials (like aluminum) are acceptable for the bore.

Bore Finish

A bore finish of approximately 125 micro-inches or smoother (75 to 100 micro-inches for aluminum) should be maintained to avoid leakage between the seal outer diameter and housing.

SKF factory-applies a coating of Bore-Tite to the O.D. on popular seals. During installation, this coating efficiently fills minor bore imperfections.

Pre-Lubrication

Pre-lubrication of the seal lip is an important step that should not be forgotten. This provides a film on which the seal can ride until there is ample lubrication in the seal cavity.

The best pre-lube to use is the lubricant being retained. This avoids any problems caused by mixing two different lubricants.

For example, it avoids the chance of picking a pre-lube which might damage the seal lip, causing it to shrink, swell, or soften. It also eliminates the possibility of using a grease with a limit of 200°F in an application where the temperature might run 250°F or 300°F.

Tools

The best tool to use for seal installation is either an arbor or hydraulic press that applies uniform pressure against the seal. If a press is not available or practical, use a round tool such as a bearing cup. If the tool must follow the seal into the bore, it should be slightly smaller than the O.D. of the seal. (An outside diameter ten thousandths of an inch smaller than the bore is ideal.) For best results, the center of the tool should be open so that pressure is only applied at the outer edge of the seal.

Hammering

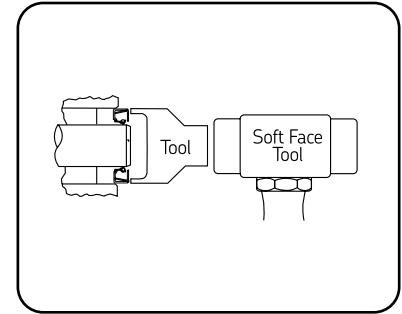
Seals that are to be flush with the outside of the housing can be pressed in with a block of wood. In this case, it is acceptable to use a steel hammer and apply force on a wood workpiece.

When the blow is going through steel (such as a steel ring), use a soft-faced or dead-blow hammer or mallet (fig. 8).

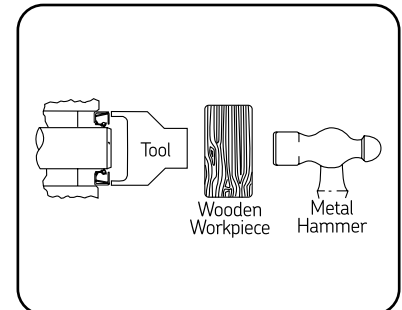
The block of wood absorbs the shock wave created by the impact (fig. 9). A hammer blow with no absorbing material can dislodge the garter spring from the seal. That will prevent the seal from doing its job. It may even interfere with the action of the seal lip, or find its way into the bearing.

Whatever tool is used, the seating force must be applied and spread out over the entire circumference of the seal. A direct blow on one side of the seal distorts the shell, causing the lip to be pressed against the shaft. This can produce friction between the lip and shaft surface.

If installation pressure is applied to the seal's inside diameter, the shell is forced upward. This lifts the lip from the shaft surface. If the seal is cocked (not perpendicular to the shaft) there will be too much contact on one side, and not enough contact on the other. The seal will leak as the shaft is deflected by shaft-to-bore misalignment or run-out.



Use a soft face mallet when force is being applied through a seal tool to install the seal (fig. 8).



A piece of wood absorbs the metal hammer's impact (fig. 9).

Tool Checklist

Remember to use tools that save rather than spoil the seal.

RECOMMENDED TOOLS

- Arbor press

- Soft-face hammer

- Installation tools in order of preference:

 - Tool that is tailor-made for seal installation

 - Standard driving plug

 - Old bearing cup

 - Wood block

AVOID

- Direct hammer blows on seal face

- Drift or punch

- Steel-to-steel

- Chisel or screwdriver

- Starting seal into bore at an angle (cocked)

CHAPTER 4 REVIEW

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1. Proper seal installation depends on the _____.
☐ a. condition of the shaft
☐ b. condition of the bore
☐ c. use of correct techniques for seal placement
☐ d. all of the above

1. D

2. Shaft finish is critical to proper seal performance. Therefore, _____.
☐ a. the shaft surface requires machine lead
☐ b. the leading edge must be chamfered or rounded
☐ c. the surface finish should be between 5-7 micro-inches
☐ d. all of the above

2. B

3. Maximum speed for effective seal performance is affected by _____.
☐ a. operating temperature
☐ b. lubricant retention
☐ c. internal pressure
☐ d. all of the above

3. D

4. To avoid leakage between the seal's outer diameter and housing, _____.
☐ a. the bore finish should be approximately 125 micro-inches
☐ b. the inside corners must be well-rounded
☐ c. a specific Rockwell hardness must be followed
☐ d. all of the above

4. A

5. The seal can be installed in the bore after _____.
☐ a. the shaft has been checked
☐ b. the bore has been checked
☐ c. pre-lubrication
☐ d. all of the above

5. D

6. A chisel or screwdriver is _____ for seal installation.
☐ a. recommended
☐ b. never recommended
☐ c. always used
☐ d. none of the above
6. B
7. Seals perform best on aluminum or zinc shafts.
☐ True ☐ False
7. F
8. Ideally, the shaft should be smooth enough to keep in contact with the seal lip, but rough enough to keep the lubricant film in place.
☐ True ☐ False
8. T
9. Shafts require constant polishing and machining.
☐ True ☐ False
9. F
10. Plunge grinding is the recommended method to obtain a smooth shaft finish.
☐ True ☐ False
10. T
11. Shaft-to-bore misalignment (STBM) is often caused by inaccuracies in machining and assembly.
☐ True ☐ False
11. T
12. Dynamic run-out is the amount by which the shaft is off center with respect to the bore's center.
☐ True ☐ False
12. F
13. Revolutions per minute (rpm) of the shaft is a better indicator of seal performance than feet per minute (fPm).
☐ True ☐ False
13. F
14. The recommended pre-lube for a seal is oil.
☐ True ☐ False
14. F
15. A direct blow on one side of the seal generates force out and around the seal's entire circumference.
☐ True ☐ False
15. F

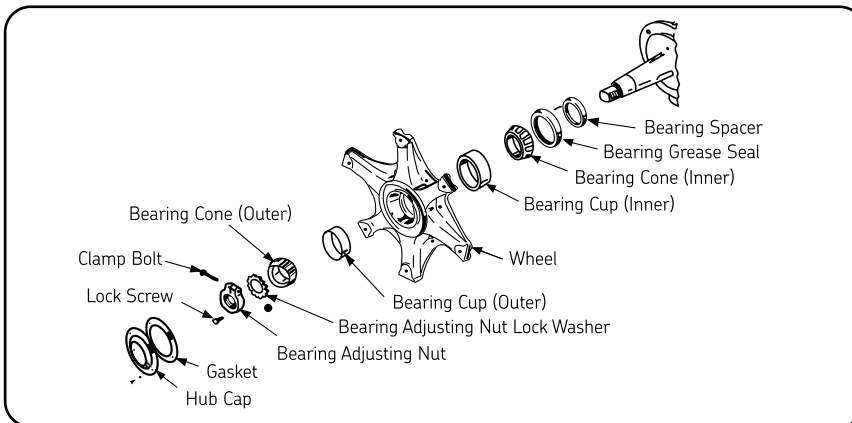
GREASE SEAL INSTALLATION

In this chapter, you will find complete instructions for installing grease seals on the front and drive axle.

First, you should get in the habit of replacing the seal whenever you pull the wheel.

The old seal may have been nicked or bent when the wheel was removed. Some of the seal's press fit in the hub may have been lost during removal of the bearing. If so, the seal will not fit as tight as it should which will prevent it from retaining lube and excluding dirt. Reusing an old seal can cause problems such as failure of the wheel bearing or brake lining.

Before discarding the old seal, check it for damage. This will be explained in Chapter 6. Then proceed with the following guidelines for seal installation.

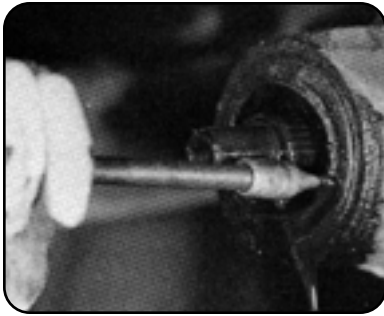


A typical front wheel assembly is shown above (fig. 1).

Seal Installation — Front Axle (fig. 1)

Remove the Front Wheel Assembly

1. Jack up the wheel off the ground and support the axle with safety stands.
2. Remove the hubcap, axle nut locking device (cotter pin, safety wire, locking washer tab or bolt).
3. Remove the locking nut, adjusting nut, lock washer and outer bearing cone. Since the arrangement and design of washers, locks and nuts is different with each manufacturer, be sure to note the order in which they should be replaced after the seal is installed.



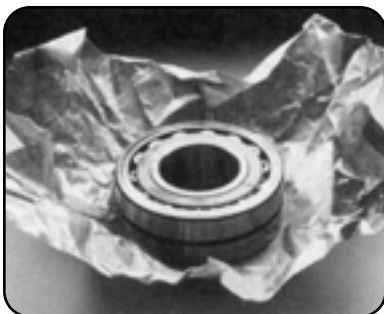
Pry out the old seal (fig. 2).



Rinse the bearing in clean solvent (fig. 3).



Compressed air may be used to dry the cleaned bearing (fig. 4).



Store bearings in protective, waterproof paper (fig. 5).

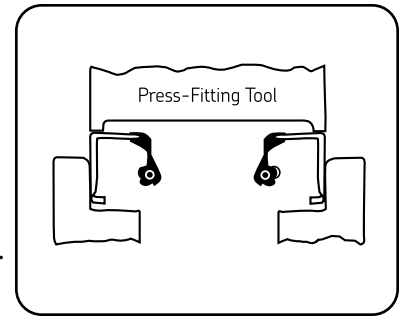
4. Slide the wheel and hub assembly off the spindle. Be careful not to drag the inner bearing over the spindle thread. If possible chain the wheel to the dolly for safety.
5. Remove the bearing spacer and pin from the spindle. Pry out the old seal with a rolling head pry bar (fig. 2). Using a drift to drive the bearing and seal out can damage the bearing cage.
6. Remove the inner bearing cone. Record the worn seal's part number so you can refer to it when selecting the new seal replacement.
7. If pulling more than one wheel, be sure to keep all of the parts of each wheel assembly together and separate from the other wheels.

Cleaning and Inspection

1. Clean the hub cavity and cap, removing all old lubricant. Use a brush to clean the drum and brake mechanism. Wipe the spindle clean.
2. Use a recommended solvent to remove dirt and grease from the bearing and related wheel/axle parts. Rinse the bearing in another—separate—bucket of clean solvent (fig. 3). Let the bearings dry naturally in the air. Compressed air that is completely free of moisture may be used to blow out the bearing, but only if all dirt and chips have been removed (fig. 4). Do not allow bearing roller to spin. **Caution:** Air pressure and equipment must conform to OSHA standards.
3. Inspect bearing cones and cups. Replace them if they are pitted, rough or damaged.
4. Dip cleaned bearings in a protective lubricant, or coat bearing surfaces with a light grease. Wrap the bearings in waterproof paper and place them in a clean box or carton. Keep bearings covered until you are ready to install the new seal (fig. 5).
5. Inspect the spindle bearing and seal surface for burrs or roughness. Be careful not to scratch the sealing surfaces when polishing out roughness. Even small marks can permit lubricant to seep out under the sealing lip.
6. Check where the seal lip makes contact. If you can feel a worn groove with your fingernail, there will be leakage, even with a new seal (see Speedi-Sleeves, Chapter 7). Replace the bearing spacer if it is grooved or worn.

Installation Checklist

1. **Check the bore.** The leading edge must be deburred. A rounded corner or chamfer should be provided.
2. **Check the shaft.** Remove surface nicks, burrs, grooves and spiral machine marks (machine lead).
3. **Check the shaft end.** Remove burrs or sharp edges. The shaft end should be chamfered in applications where the shaft enters the seal against the sealing lip.
4. **Check splines and keyways.** Sharp edges should be covered with a lubricated assembly sleeve, shim stock or tape to protect the seal lip.
5. **Check dimensions.** Be sure shaft and bore diameters match those specified for the seal selected.
6. **Check for parts interference.** Watch out for other machine parts that might rub against the seal and cause friction and damaging heat.
7. **Check the seal.** Damage may have occurred prior to installation. A sealing lip that is turned back, cut or otherwise damaged should be replaced.
8. **Check seal direction.** Make sure that the new seal faces in the same direction as the original one. Generally, the lip faces the lubricant or fluid to be retained.
9. **Use the correct installation tool.** Press-fitting tools should have an outside diameter approximately .010" smaller than the bore size. For best results, the center of the tool should be open so that pressure is applied only at the outer edge of the seal (fig. 6).
10. **Pre-lubricate the sealing element.** Before installation, wipe the element with the lubricant being retained.
11. **Never hammer directly on the surface of the seal.** Use proper driving force, such as a soft-face tool, arbor press, or soft workpiece (wood). Apply force evenly around the outer edge to avoid cocking the seal.
12. **Position the seal properly in the housing and inspect for alignment and installation damage.**



The press-fitting tool should be .010" less than the bore I.D. (fig. 6).

Post-Installation Tips

- When painting, be sure to mask the seal. Avoid getting paint on the lip, or the shaft where the lip rides. Also, mask the vents so they will not become clogged.
- If paint is to be baked or the mechanism otherwise subjected to heat, the seals should not be heated to temperatures higher than their materials can tolerate.
- In cleaning or testing, do not subject seals to any fluids or pressures that could damage them. Check the Compound Selection Chart in the SKF Handbook of Seals (Catalog #457010) when in doubt.

Reassemble the Wheel

1. Pack the hub cavity between the two bearing cups with an approved wheel bearing grease to the level of the cup's smallest diameter.
2. Pack the bearing cones, using a pressure packer if possible. If not, force the grease into the cavities between the rollers and cage by hand from the large end of the cone. Coat the ends of the rollers freely with grease.
3. Insert the inner bearing cone in the grease-filled hub. Place the pre-lubed seal in the hub with the lip facing the bearing cone. Seal it properly.
4. Position the spacer on the spindle. Align the hole and pin. Apply a light film of lubricant to the spindle to prevent rusting.
5. Use a wheel dolly to center the wheel assembly on the spindle. Push the wheel on far enough so the seal is in safe contact with its riding surface on the bearing spacer or spindle. Install the outer bearing cone, washer and adjusting nut in reverse order of removal.
6. Adjust the bearing according to the manufacturer's instructions. Secure the locking nut and locking device. Fill the hub cap with grease, position the new gasket with sealant on the hub cap, and install.
7. For oil bath seals replacement, see Scotseal, Chapter 8.

Seal Installation -Drive Axle

Remove the Drive Wheel Assembly

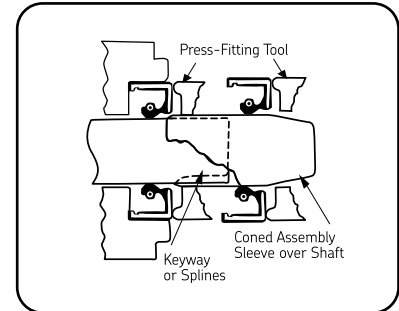
1. Jack up the wheel. Support the axle with safety stands.
2. Remove the axle flange nuts and lock washers. Install pulling screws in axle flange holes, if provided. If not, strike the axle flange in the center sharply with a heavy hammer. It may require several blows to bounce the shaft loose so the tapered washers and axle shaft can be removed.
3. Loosen the bearing lock ring nut set screw (when used) and remove the lock nut. Some drive axles use a locking washer between the outer nut and the bearing adjusting nut. One or more of the tabs bent over the outer nut and seal assembly must be bent away from the nut before a socket of the correct size will fit over the nut. Then remove the lock nut, lock washer or ring, and adjusting nut.

All other procedures for wheel removal, inspection, seal installation and reassembly are the same as for the front axle.

Other Applications

Installation procedures for transmissions, pinions, prop shafts, timing covers and other fleet seal applications are somewhat similar, but with these precautions:

- Seals should be press-fitted with a press-fitting tool and installation force should be applied as closely as possible to the outside edge of the seal.
- If a seal is installed into the housing bore with the shaft already installed, a sleeve-type or hollow fitting tool should be used to protect the lip as it is fitted over the shaft.
- Seals have flexible sealing members smaller than the shafts on which they function. When the shaft is assembled through the back of the seal, no special precautions are necessary other than removing nicks, burrs, and other rough spots from the shaft. The shaft end should be chamfered when it enters the seal against its lip.
- If the shaft is not tapered, or if a keyway or spline is present, a thin-wall coned assembly is recommended. Sharp spline and keyway edges should be covered with a lubricated assembly sleeve, shim stock or tape to protect the seal lip (fig. 7).



A coned assembly sleeve may be used to protect the seal lip (fig. 7),

CHAPTER 5 REVIEW

To take this test, simply place a card or sheet of paper under the first question. After you've read it (and answered it to yourself), slide the paper down below the next question. The correct answer to the first problem will appear directly to the right of the new question. Be sure not to skip any of the questions. This learning technique assures more than four times the normal retention rate for even this technical subject.

1. An old seal should be replaced when _____.
☐ a. it has been nicked
☐ b. some of the press-fit in the hub is lost
☐ c. it has been bent
☐ d. all of the above
1. D
2. Reusing an old seal can cause failure of the _____.
☐ a. wheel
☐ b. brake lining
☐ c. bearing
☐ d. any of the above
2. D
3. _____ can damage the bearing cage.
☐ a. Prying out the old seal with a rolling head pry bar
☐ b. Driving the bearing and seal out with a drift
☐ c. Removing the inner bearing cone
☐ d. All of the above
3. B
4. Bearing cones and cups should be _____ if they are pitted or damaged.
☐ a. lubricated
☐ b. replaced
☐ c. rotated
☐ d. all of the above
4. B
5. A light film of _____ prevents rusting on the spindle.
☐ a. SKF Bore-Tite
☐ b. lubricant
☐ c. wax paper
☐ d. powdered metal epoxy type filler
5. B
6. The press-fitting tool used in installation should be _____ the bore I.D.
☐ a. .010" less than
☐ b. .010" more than
☐ c. .025" less than
☐ d. equal to
6. A

7. A thin-wall coned assembly sleeve is recommended when _____.
☐ a. the shaft is not tapered
☐ b. a keyway is discovered
☐ c. a spline is present
☐ d. all of the above
7. D
8. Edges of the keyway and spline should be lubricated with _____.
☐ a. straight mineral oil
☐ b. a hard, fibrous grease
☐ c. ordinary engine oil
☐ d. SKF Bore-Tite
8. B
9. When you pull the wheel, change the seal.
☐ True ☐ False
9. T
10. It is unnecessary to check the old seal for damage before dumping it.
☐ True ☐ False
10. F
11. Small scratches on the shaft can allow some lubricant to seep under the sealing lip.
☐ True ☐ False
11. T
12. Replace bearing cups and cones if they are pitted, rough or damaged.
☐ True ☐ False
12. T
13. All drive axles use a locking washer between the outer nut and the bearing adjusting nut.
☐ True ☐ False
13. F
14. Use a sleeve-type or hollow fitting tool when installing a seal into the housing bore of a pinion with the shaft already inserted.
☐ True ☐ False
14. T
15. Seals are press-fitted in transmissions by applying force as close as possible to the inside edge of the seal.
☐ True ☐ False
15. F

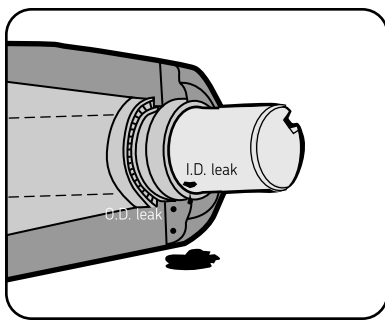
TROUBLESHOOTING

You now know the various types of seals available, can select the right seal for the right application, and are able to install it. But before you replace that next seal, there are some troubleshooting points that will round out your knowledge of seals.

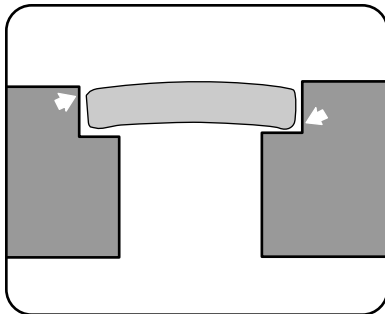
Preliminary Survey

The best way to troubleshoot is to follow a sequence of steps that should lead you to the problem.

1. What was the seal supposed to do? How well has it done the job in the past? If there is a history of failures, the problem may not be caused by the seal itself.
2. Was it the right seal? Check the seal's part number and look up its recommended applications. If the correct seal has been installed and there is no history of repeated failures, the problem requires further investigation.
3. Pinpoint the source of the leak. It may be either an I.D. leak or an O.D. leak. Also, find out when the leak first occurred and see if this relates to a change in maintenance or operating procedures (fig. 1).



Check the seal area for leaks (fig. 1).



This seal was cocked during installation (fig. 2).

Investigate Clues

Seal Markings

The two areas that should be thoroughly checked are the seal outer diameter (O.D.) and the seal inner diameter (I.D.). Tell-tale marks on either of these areas can give you a good idea of why the seal failed.

The Solution

The first surface to check is the O.D. If the seal has been properly installed, the press-fit markings will be fairly uniform and straight.

Cocked Seal

Markings also can be tell-tale signs that the seal was cocked during installation.

Light scratches on the front of the seal would appear when the seal was first inserted. Since the seal was cocked, it takes additional force to seat the back half. This extra force causes heavier markings on the back of the seal (fig. 2).

The Solution

If the seal is cocked, you have only one solution. Remove it and put in a new one, but be sure it's straight.

Lip Wear Patterns

Look for clues in the sealing member of the seal. A small cut or nick could be the source of the leak. But if everything looks intact, it's time to look at the wear pattern of the lip.

A new seal that has never been installed has a sharp edge on its sealing lip at the contact point. Following a period of normal operation, the lip's sharp edge will be flattened some by normal wear. If the lip has been substantially worn away, the seal may not be getting enough lubrication, the shaft may be corroded, or the finish too rough. Extreme wear could also be caused by shaft-whip.

If you find a leaking seal with a wide wear band on one side, but a narrow band on the other, you can suspect high STBM (unless O.D. markings indicated the seal was cocked). The lip area with the greatest wear indicates the direction of shaft misalignment.

Initial leakage will generally occur in the area that shows little or no seal wear. This is because of inadequate lip contact. But as the worn side is hardened from excess pressure and heat, it may crack and cause additional leakage.

The Solution

Check the shaft-to-bore alignment. Correct the alignment.

Operating Pressure

Excess pressure can crush the lip against the shaft. Heavy friction will eventually force the garter spring through the lip. Excess pressure can blow the lip completely off (fig. 3).

The Solution

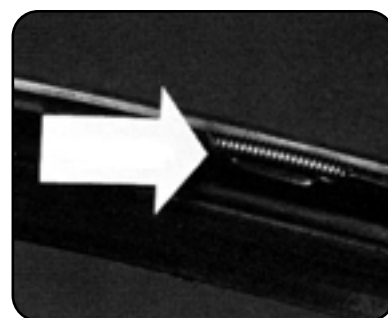
We recommend two ways to prevent seal failure caused by medium pressure.

First, check all the air vents. Dirt or paint may block proper air flow. Second, if the system is clean, try using a high pressure seal such as the CRW5 and CRWA5.

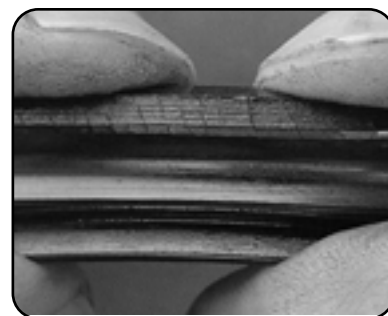
Excessive Temperature

The condition of the sealing element can also tell us about temperature conditions. If the lip is hardened and brittle with many cracks in its surface, overheating is probably the cause (fig. 4).

A seal lip gradually hardens as it ages, but it should remain flexible if temperatures do not exceed the recommended maximums for the sealing material.



Excess pressure can blow the lip off (fig. 3).



Overheating can cause cracks on the seal surface (fig. 4).

Sometimes heat is high enough to break down the oil, but not hot enough to harden the lip. In this case, sludge accumulates and is deposited on the seal lip.

The Solution

When a sludge deposit cracks or breaks off, leakage paths are created. A change in seal material or design will do little to improve sealing performance. Instead, find a lubricant that is more stable at high temperatures. Either that, or try to reduce the operating temperature.

Incorrect Lubricant

A modern lubricant may employ many chemicals to improve its performance. Unfortunately, additives that improve the lube may adversely affect the seal.

Disulfide additives, for example, give lubricants anti-wear properties, but they also cure or harden the sealing element. Many EP (extreme pressure) lubes have additives that become more active as they heat up. They also become more harmful to the seal.

The Solution

When the sealing member softens with use, or when there is not sufficient overheating to explain the hardening you observe, the problem could be that the lubricant and seal are incompatible. The remedy is to go back to the SKF Handbook of Seals and check seal material/fluid compatibility specifications.

Case Still Unsolved?

If none of the clues discussed so far are present, there still are a few things that you can do:

- Check for foreign particles that may be temporarily trapped under the lip.
- If it's a spring-loaded seal, check to see if the garter spring is still intact.
- A small nick or cut hardly visible to the eye may turn an otherwise good seal into a leaker. Look for this type of damage when leakage is slight.
- Compare the fit of a failing seal with a new seal on the same shaft. If it feels loose but is unworn, the cause may be swelling—a reaction to the fluid being sealed. Check the compatibility rating in the SKF Handbook of Seals.

CHAPTER 6 REVIEW

To take this test, simply place a card or sheet of paper under the first question. After you've read it (and answered it to yourself), slide the paper down below the next question. The correct answer to the first problem will appear directly to the right of the new question. Be sure not to skip any of the questions. This learning technique assures more than four times the normal retention rate for even this technical subject.

1. An alternating pattern of smooth and marked areas on the O.D. indicates that the seal was probably _____.

☐ a. pressed into an out-of-round, over-size bore
☐ b. cocked during installation
☐ c. flattened by normal wear
☐ d. misaligned

1. A

2. If a seal is cocked, it should be _____.

☐ a. replaced
☐ b. straightened
☐ c. ignored
☐ d. lubricated

2. A

3. Improper wear can cause a shaft to leak as a result of _____.

☐ a. excessive STBM
☐ b. excessive pressure
☐ c. a cocked seal
☐ d. all of the above

3. D

4. Pressure-caused seal failures may be corrected by _____.

☐ a. opening air vents which may be plugged with dirt or paint
☐ b. straightening the seal
☐ c. reducing operating temperature
☐ d. all of the above

4. A

5. If the seal lip is hardened and brittle with many cracks in its surface, _____ is probably the cause.

☐ a. pressure
☐ b. eccentricity
☐ c. overheating
☐ d. a cocked seal

5. C

6. Disulfide additives _____.
☐ a. give lubricants anti-wear properties
☐ b. harden the sealing element
☐ c. both of the above
☐ d. neither of the above
6. C
7. Many seal failures can be traced back to the condition of the shaft or bore, or to poor installation.
☐ True ☐ False
7. T
8. The first surface to check for wear patterns or markings is the inside diameter (I.D.) of the seal.
☐ True ☐ False
8. F
9. Improper installation can cause the seal to leak.
☐ True ☐ False
9. T
10. If the lip of the seal wears away during normal operation, less lubrication is required by the seal.
☐ True ☐ False
10. F
11. If a leaking seal has a wide wear band on one side and a narrow band on the other, high STBM can be suspected.
☐ True ☐ False
11. T
12. Heavy friction caused by excess pressure will eventually force the garter spring through the lip.
☐ True ☐ False
12. T
13. If a sealing lip is hardened and brittle with cracks in the surface, the cause is probably excessive temperature.
☐ True ☐ False
13. T
14. Chemicals that are used to improve a lubricant's performance will not spoil a seal.
☐ True ☐ False
14. F
15. A small cut or nick on the sealing lip has no damaging effect on a good seal.
☐ True ☐ False
15. F

WEAR SLEEVES

Continuous contact between a rotating shaft and a seal always causes shaft polishing friction. Under normal operating conditions, the friction causes a slight wear track on the shaft.

But, as operating conditions worsen, shaft wear can accelerate. Heat, dirt, excessive speed, lack of lubrication, eccentricity or a cocked seal can produce a deep groove on the surface. The ultimate result is a leak.

If this groove can be felt with a paper clip or with your finger nail, it has become too deep to accommodate a replacement seal without leaking.

There are three solutions:

1. Reworking or remetalizing the shaft surface at a machine shop—High cost, requires hours of fleet downtime.
2. Replacing the shaft—Also expensive, with substantial fleet downtime.
3. Installing a wear sleeve—Comparatively low in cost with virtually no downtime.

When it comes to correcting yokes, flanges and shafts, a wear sleeve requires the least amount of downtime and cost. Applied over the damaged shaft, it makes the shaft usable again, eliminates shaft leaks, and smooths out damaged surfaces—all faster and less expensive than re-metalizing or replacing the shaft.

SKF offers one special type of wear sleeve designed for even more efficient shaft repair—Speedi-Sleeves® (fig. 1).

Speedi-Sleeves®

Speedi-Sleeves offer fleet operators a way to quickly repair worn shaft surfaces right in the garage. Downtime is reduced since installation takes only a few minutes, often without removing the shaft.

There is no resizing of the seal. Unlike conventional thick sleeves, Speedi-Sleeves use the original size seal. No matter whether the Speedi-Sleeve is used on a crankshaft, transmission, or pinion, both labor and hard parts inventory costs are substantially reduced.

Speedi-Sleeves are precision-made of ultra-thin, stainless steel. Once installed, it provides a new leakproof barrier and a long-lasting wear surface for the new seal that can outlast the original shaft finish.



The Speedi-Sleeve repairs damaged shafts efficiently (fig. 1).

ADVANTAGES

- + Corrects crankshaft, pinion, and transmission surfaces
- + Repairs yokes, flanges and shafts
- + Can be used without changing the seal size or part number
- + Requires little downtime

Each sleeve is built with a removable flange and includes a special tool for installation. This tool is placed over the Speedi-Sleeve. Both the tool and sleeve are tapped into position on the shaft, yoke or flange.

The flange on the Speedi-Sleeve allows the sleeve to be pulled-on instead of pushed-on, eliminating sleeve distortion.

When the Speedi-Sleeve is positioned, the tool slides off easily. The flange can be left intact, or cut and peeled off along a pre-cut line.

Speedi-Sleeves fit seal-worn end yokes (fig. 2), steering gear shafts, front and rear crankshafts and almost every part from almost every manufacturer represented in your rigs.

It takes only a few Speedi-Sleeves to meet the needs of even the biggest operators. In most cases there's no need to stock more than one size sleeve for each seal application or location.

Re-sleeving can be part of the fleet's regular preventive maintenance schedule. It takes little time to tap on a Speedi-Sleeve when the rig is already in for replacement of seals and bearings, or when a shaft is disassembled for general service.

Speedi-Sleeve Installation

Speedi-Sleeves are available for shaft diameters ranging from .498" to 8.005". Each sleeve kit contains a disposable installation tool and is marked with the shaft range for proper selection. Follow these guidelines for proper Speedi-Sleeve installation:

1. Clean the surface where the seal contacted the shaft. File down and polish any burrs or rough spots.
2. Measure the diameter where the sleeve will be positioned on an unworn portion of the shaft. Measure in three positions and average the reading, in case the shaft is out of round (fig. 3). If the average diameter is within the range for a given Speedi-Sleeve, there is sufficient press-fit built into the sleeve to keep it from sliding or spinning. No cement is necessary.



Speedi-Sleeves fit seal-worn end yokes (fig. 2).



Take three measurements to average shaft diameter (fig. 3).

3. If the groove does not require filling, apply a light layer of non-hardening sealant to the inner surface of the sleeve.
4. If the shaft is deeply scored, fill the groove with powdered metal epoxy type filler. Install Speedi-Sleeve before the metal hardens.
5. Undersize shafts: Shaft diameters a few thousandths under the published minimum may be sleeved if cement is used.
6. Oversize shafts: Diameters larger than the published maximum can be sleeved if first machined with a finish 125 rms or better. Note that the use of Speedi-Sleeve eliminates the need for special grinding or preparation of the surface.
7. Speedi-Sleeves are wide enough to cover the wear pattern of both standard and wider combination seals. Where extra wide combinations are encountered, a second sleeve can be installed to butt against the first. The flange is then peeled off to provide the clearance necessary for the seal housing to slide into place. The Speedi-Sleeve installation flange can be left in place as an oil flinger to prevent surges of oil from being pumped into the seal lip by the action of the adjacent bearing.
8. Determine how far back the sleeve must be positioned to cover the old seal wear tracks. Measure to the exact point, or mark directly on the surface.
9. The sleeve must be placed over the worn area, not just bottomed or left flush with the end of the shaft.
10. Drop the Speedi-Sleeve into the end of the installation tool so only the flange end projects. The flange end of the sleeve goes on the shaft first. Gently pound the center of the tool until the sleeve reaches the point marked (fig. 4).
11. Speedi-Sleeves may be installed to any depth required. If the installation tool supplied with sleeve is too short, a length of pvc tube with a squared-off, burr-free end can be substituted. Inside tube diameters should be larger than the shaft by:

Shafts less than 3":	1/32" to 1/8"
Shafts 3" to 6":	1/32" to 3/16"
Shafts more than 6":	3/64" to 7/32"
12. If clearance is needed, the Speedi-Sleeve flange can be removed easily with side cutters and pried away. The flange will peel off along a pre-cut line (fig. 5).



Tap the tool until the sleeve is positioned properly (fig. 4).



Peel off the flange along the pre-cut line (fig. 5).

CHAPTER 7 REVIEW

To take this test, simply place a card or sheet of paper under the first question. After you've read it (and answered it to yourself), slide the paper down below the next question. The correct answer to the first problem will appear directly to the right of the new question. Be sure not to skip any of the questions. This learning technique assures more than four times the normal retention rate for even this technical subject.

1. _____ can cause a seal lip to groove the shaft.

- ☐ a. Dust, heat and dirt
- ☐ b. Lack of lubrication
- ☐ c. A cocked seal
- ☐ d. All of the above

1. D

2. The Speedi-Sleeve is an ultra-thin wear sleeve made of _____.

- ☐ a. bronze
- ☐ b. stainless steel
- ☐ c. zinc
- ☐ d. magnesium

2. B

3. Applying a wear sleeve over a damaged surface can _____.

- ☐ a. eliminate shaft leaks
- ☐ b. make the shaft usable again
- ☐ c. smooth out damaged surfaces
- ☐ d. all of the above

3. D

4. Speedi-Sleeves can be used on _____.

- ☐ a. transmissions
- ☐ b. pinions
- ☐ c. front and rear crankshafts
- ☐ d. all of the above

4. D

5. If the shaft is deeply scored, the groove should be _____.

- ☐ a. filled with an epoxy type filler
- ☐ b. filed down to a smooth surface
- ☐ c. lubricated with oil
- ☐ d. all of the above

5. A

6. The inside diameter of a pvc tube used to install a 4" Speedi-Sleeve should be _____ larger than the shaft.
☐ a. at least 1/2"
☐ b. less than 1/2"
☐ c. 1/32" – 3/16"
☐ d. 3/4" 6. C
7. When a seal groove on a shaft can be felt with a fingernail or paper clip, it must be repaired.
☐ True ☐ False 7. T
8. Shaft wear can accelerate as operating conditions worsen.
☐ True ☐ False 8. T
9. Continuous contact between a seal and rotating shaft will always cause shaft polishing friction.
☐ True ☐ False 9. T
10. A deeply scored shaft can only be corrected by remetalizing the surface or replacing the shaft.
☐ True ☐ False 10. F
11. Installing a Speedi-Sleeve is expensive and requires substantial downtime.
☐ True ☐ False 11. F
12. The first step to Speedi-Sleeve installation is removal of the shaft.
☐ True ☐ False 12. F
13. The surface of the Speedi-Sleeve can actually outlast the original shaft surface.
☐ True ☐ False 13. T
14. When installing a Speedi-Sleeve over a shaft, the original size seal can still be used.
☐ True ☐ False 14. T
15. Each Speedi-Sleeve is built with a removable flange and includes a special tool for installation.
☐ True ☐ False 15. T

Rear Wheel Seal and Pinion Installation

Rear Wheel Seals and Bearings For Disc and Drum Brakes

Note: Before starting any removal procedures, determine if the axle shafts are held in place by C-shaped locks at the inner end, or by a retainer plate bolted to the axle housing. Then follow the steps below appropriate to “C-lock” or “non-C-lock” type of axle shaft. If unsure, remove the differential carrier cover.



Loosen differential pinion shaft locking bolt (fig. 1).



Remove C-Lock (fig. 2).



Pry out seal (fig. 3).

Bearing/Seal Removal

1. Raise the rear end of the car on a hoist or support it on jack stands. Both rear wheels must be elevated. Do not work on cars supported only by bumper jacks.
2. Remove the hub cap or wheel cover. Use a wrench or jack handle to take off wheel lug nuts. Pull straight back to remove the wheel.
3. Detach any retaining clips or bolts holding brake drums to axle shaft flanges. Remove brake drums.

Note: Brake adjustment may have to be backed off. Emergency brake must be off.

4. Brush dirt from the brake drum

C-Lock Axles

5. Place a container or pan under the differential and remove the differential carrier cover. Allow the rear axle lubricant to drain.
6. Loosen the differential pinion shaft locking bolt. Remove the pinion shaft (fig.1).
7. Push in on the axle shaft (toward the center of the car). Remove the C-lock from the grooved end of the shaft (fig. 2). Replace the pinion shaft and locking bolt temporarily, to keep differential gears in position.
8. Pull the axle shaft from the housing. Be careful not to damage the bearings and seal, which remain in the housing.
9. Insert a suitable tool (pry bar) behind the seal and pry it from the bore (fig. 3). Discard the seal. Never reuse old seals.

10. Place the legs of a slide hammer behind the bearing and remove it.
11. Inspect the old bearing for nicks, pitting and damage. If there is any damage, the entire bearing must be replaced. Never interchange new and old bearing parts.

Non C-Lock Axles

5. Remove the nuts holding the retainer plate to the backing plate (fig. 4).
6. Slide the retainer plate off of the studs. To prevent the brake backing plate from slipping off, reinstall and finger tighten the lower nuts.
7. Grip the axle shaft flange with a puller or slide hammer. Remove the axle shaft and bearing assembly (fig. 5).
8. Remove the seal from the housing.
9. Inspect the old bearing for nicks, pitting and damage. If there is any damage, the entire bearing must be replaced. Never interchange new and old bearing parts.
10. To replace the bearing, put the axle in a vise. Use a chisel and hammer to nick the bearing retainer in 3 or 4 places. Be careful not to damage the axle shaft.
11. Slide the loosened retainer from the shaft (fig. 6).
12. Place the shaft in an arbor press. Press the bearing off the shaft and discard it.



Remove nuts holding retainer plate (fig. 4).



Grip axle shaft flange with a slidehammer (fig. 5).



Slide off retainer (figl. 6).

Bearing/Seal Installation

Be sure the new seal and bearing are correct for the application. Check part numbers against the old seal. Use the SKF Services Passenger Car and Light Truck Seals and Bearing Catalog (SKF #457205).

Steps listed below apply to either C-lock or non C-lock axles.

C-Lock Axles

1. Inspect the axle shaft and housing for nicks or scratches. Carefully file or polish to remove surface imperfections.

Note: Deep scores or grooves on the shaft where the seal makes contact must be repaired. (Refer to **Chapter 7: Wear Sleeves.**)



Pre-lube seal with differential lubricant (fig. 7).



Tap new bearing into shaft cavity (fig. 8).



Replace differential cover with new gasket (fig. 9).

2. Pre-lube the seal with same lube as contained in the differential (fig. 7). Put a light coat of grease on and around all surfaces of the bearing.
3. Use a bearing installation tool to press the new bearing into the axle shaft cavity. (The tool should only contact the press fit outer race.) The bearing is at proper depth when in contacts the bearing seat in the axle tube. Be sure the bearing is seated squarely – not cocked – against the shoulder.

4. Place the new seal on a seal installation tool. Position the seal in the axle bore. Use a mallet to tap the seal into the bore until it "bottoms out" and is flush with the end of the housing (fig. 8).

Note: The sound of the mallet changes when the seal bottoms out.

5. Remove the differential pinion shaft locking bolt. Remove the shaft. Slide the axle shaft into place. Make sure the shaft splines do not damage the new seal. It will be necessary to turn the axle slightly to engage the splines into the differential side gear.
6. Install the C-lock on the inner end of the axle shaft. Pull the shaft outward so the C-lock seats squarely in the counterbore of the differential side gear.
7. Insert the differential pinion shaft through the case and gears. The lock bolt hole should align with the hole on the shaft. Install the lock bolt and tighten to approximately 15-22 ft. lbs.
8. Clean the differential housing and cover. Use a new gasket when installing the cover (fig. 9).
9. Fill the differential with lubricant to the bottom of the filler hole.

Non C-Lock Axles

1. Inspect the axle shaft and housing. Clean shaft cavity. Lubricate the new bearing and seal, as described above (steps 1 and 2, under C-Lock Axle instructions).
2. Use an arbor press to install the new bearing on the axle shaft (fig. 10). Always apply pressure to the press-fit race (in this case the inner race is press fit).
3. Press on the bearing retainer.

Note: Never press the bearing and retainer onto the shaft at the same time.

4. Insert the new seal. Use a seal installation tool to press it into the housing.
5. Carefully insert the shaft and bearing into the housing. Avoid damaging the seal. Be sure the bearing is seated properly in the housing.
6. Install the retainer plate over the axle housing studs. Torque securing nuts to 35 ft. lbs.

Rear Wheel Reassembly (Both C-lock and Non C-Lock)

1. Install the brake drum.
2. Replace the wheel.
3. Replace lug nuts and tighten evenly.
4. Lower the car.
5. Torque lug nuts to manufacturer's recommended specifications.
6. Install the hubcap or wheel cover.



Use arbor press to install bearing (fig. 10).

Pinion Seal Replacement

Pinion seal maintenance recommendations vary by manufacturer. Generally these seals must be replaced when leaks develop. Pinion seals should be checked and replaced whenever servicing a universal joint.

Replacement of the pinion seal usually requires removal and installation of only the pinion shaft nut and flange.

Note: A circular mounting flange, U-bolts or straps are used to hold the driveshaft in position on the differential pinion. The mounting flange attaches directly to the pinion yoke, while U-bolts/straps contact the bearing cups.



Mark the driveshaft and pinion flange (fig. 11).



Support driveshaft (fig. 12).



Pry out old pinion seal (fig. 13).

Seal Removal

1. Raise the car on a hoist.
2. Make a mark where the driveshaft and the pinion flange meet (fig. 11). The driveshaft and flange were balanced at the factory and must be reassembled in the same position.
3. Disconnect the driveshaft by unbolting the mounting flange. If straps or U-bolts are used, tape the bearing cups in place (be careful not to lose bearing rollers). Remove the straps or U-bolts.
4. Support the driveshaft to prevent strain on the universal joint, and the transmission extension housing seal (fig. 12).
5. With a torque wrench placed on the pinion nut, record the pinion bearing preload.
6. Support the pinion yoke and remove the pinion nut and the washer.
7. Place a pan under the seal to hold any lube that drains from the rear axle.
8. Mark the pinion yoke and shaft to identify correct position for reassembly. Remove the pinion yoke.
9. Use a seal puller or suitable tool to pry out the old seal (fig.13). Discard the old pinion seal. Be careful not to damage the seal housing. Never reuse old seals.

Seal Installation

1. Select a new seal for the application. Refer to the SKF Passenger Car, Light and Medium Truck Seals and Bearing Catalog (SKF#457205).
2. Clean and inspect the pinion yoke seal surface (fig. 14). If damaged, it may be repaired using a shaft repair kit: the SKF Speedi-Sleeve. (See Chapter 7: Wear Sleeves.)
3. Apply lubricant to the seal lips (fig. 15). With an SKF seal installation tool and adapter (or similar tool), press the seal into the housing. The seal should be centered and seated squarely.
4. Check pinion shaft splines and yoke for burrs or damage. Wipe the pinion clean.
5. Apply lubricant to the outer diameter of the pinion yoke and on flange splines.
6. Replace the pinion yoke on the shaft. Match previously made marks so shaft and yoke align.
7. While holding the flange, tighten the pinion nut to previously recorded disassembly or preload torque.
8. Connect rear end of the driveshaft to pinion yoke. Align previously made markings.
9. Replace the circular mounting flange or install U-bolts or straps, and secure the driveshaft in position.
10. Add lubricant to within 1/8"-1/4" from the bottom of the filler hole. Do not overfill.
11. Lower the car.



Inspect pinion yoke seal surface (fig. 14).



Apply lube to seal lips (fig. 15).

CHAPTER 8 REVIEW

To take this test, simply place a card or sheet of paper under the first question. After you've read it (and answered it to yourself), slide the paper down below the next question. The correct answer to the first problem will appear directly to the right of the new question. Be sure not to skip any of the questions. This learning technique assures more than four times the normal retention rate for even this technical subject.

1. Both rear wheels must be elevated when removing rear wheel bearings and seals.
☐ True ☐ False T
2. When performing a seal and/or bearing removal on a "C-lock" type of axle shaft, you do not have to allow the rear axle lubricant to drain.
☐ True ☐ False F
3. After removing a seal from a C-lock axle, you may save it to re-install after servicing.
☐ True ☐ False F
4. You must replace a bearing if you discover nicks, pitting or damage during inspection.
☐ True ☐ False T
5. When performing service on a Non C-lock axle type shaft, reinstall and finger tighten the lower nuts of the brake backing plate to prevent it from slipping off.
☐ True ☐ False T
6. While preparing a C-lock axle shaft for bearing and/or seal installation, there is no need to file or polish nicks or scratches from the axle surface.
☐ True ☐ False F
7. You should use a bearing installation tool to press the new bearing into the axle shaft cavity.
☐ True ☐ False T
8. When installing the retainer plate over the axle housing studs during Non-C-lock installation, be sure to torque the securing nuts to 35 ft. lbs.
☐ True ☐ False T

9. Replacement of the pinion seal usually requires removal and installation of only the pinion shaft nut and flange.
☐ True ☐ False
10. During pinion seal removal, there is no need to support the driveshaft to prevent strain on the universal joint.
☐ True ☐ False
11. Before pinion seal installation, it is important to clean and inspect the pinion yoke seal surface.
☐ True ☐ False
12. Add lubricant to within 1/8" – 1/4" from the bottom of the filler hole during pinion seal installation, and be sure not to overfill.
☐ True ☐ False

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NOTES

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