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Andrew Markel

Andrew Markel is the editor for Brake & Front End Magazine and has been on the staff at Babcox Media for 13 years.
He is a former technician, service writer and service manager with experience at independent shops and dealerships.
Andrew is also an ASE certified automotive technician.
Andrew has spoken at industry events such as the SAE Brake Colloquium and FMSI Annual Conference.
He has also been quoted in publications like Smart Money and Crain's Business.
He is active in motorsports and owns several vintage vehicles.

How much load can a wheel bearing carry?

On a typical passenger vehicle weighing around 3,400 pounds, each pair of front-wheel bearings, as well as the rear-wheel or axle bearings, support around 850 pounds, depending on the weight balance and driveline configuration. If it's a 6,000-pound SUV, each bearing might carry about 1,500 pounds. This load is concentrated on the relatively small bearing surfaces.

These loads do not even take into account the dynamic loads produced by cornering. These loads put on the bearing are called thrust and radial loads, and are the forces the bearing must endure when the vehicle is cornering or braking. Another force that cannot be measured is the force of impacts from potholes and curbs.

Besides reducing friction, what else does wheel bearing grease/lube do?

Lubricants aid in carrying away heat and protecting bearing surfaces from corrosion, as well as reducing friction.

How long do wheel bearings last?

Most serviceable (can be removed, cleaned, greased and refitted) wheel bearings need maintenance every 25,000 to 30,000 miles, or during every brake service.

The average life of a sealed wheel bearing and hub assembly is about 85,000 to 100,000 miles, without the opportunity for a technician to repack the bearings. You may only have one chance during a vehicle's life to replace these parts. If you miss this opportunity, it may be gone forever.

When are bearings replaced?

According to a recent Babcox Research survey, 51% of bad wheel bearings are identified and replaced as a result of a customer complaining about noise; 24% are found during a brake job; and 19% are discovered during an alignment.

What is the leading cause of wheel bearing failure?

The leading cause of a wheel bearing failing is its seal. The inside of a bearing can be a hot place. When a bearing is cooling off, the contracting metal, air and lubricant can create a vacuum that is hopefully held by the seals. If the seals are worn and can't hold the vacuum, the bearing or sealed hub unit will suck in outside air, debris and water. In some parts of the country that use salt on the roads, it is almost as bad as ocean water on wheel bearings.

As these contaminants circulate through the grease and between the races and bearings, the components wear. Once a bearing is worn, the wear rate is accelerated by seals that can no longer keep out contaminants, and increased heat may break down and eventually expel the lubricants. This is a slippery slope that could quickly lead to catastrophic failure.

Can too much grease cause a wheel bearing to fail?

Over-filling a bearing with too much grease can cause excess churning of the grease during operation and high temperatures, resulting in overheating and excess grease purging (leaking). Overheating occurs because the heat generated cannot dissipate correctly, continually building until damage occurs.

When a bearing overheats and pushes out the grease, the sealing lip can be damaged and "blown out" in the reverse direction.

Do I need to uncover why the previous bearing failed?

Yes. When a bearing wears out, it is usually a case of inadequate lubrication, faulty installation or improper adjustment. For the repair to be successful, you must first determine why the previous bearing failed. For sealed hub units, examining the internal bearings and races is impossible.

Interview the customer to find out what kind of roads they drive on and what types of loads they carry. If the customer overloads the vehicle, bearing damage could be inevitable. The most common failure pattern for bearings is for those on the passenger side of the vehicle to fail first. The passenger side bearings are exposed to the most standing water in the gutter. If the bearings on the driver side of the vehicle fail first, take an extremely close look at the passenger side bearings, as failure may not be far behind.

The lubricant and bearing surfaces have a dark appearance and coating. What happened?

Burned or oxidized lubricant may leave a dark coating on bearing surfaces. If a bearing overheats, the hot lubricant breaks down and can cause scoring and even etching of the bearing surfaces. Also, water and other corrosive elements can create this condition, which leads to spalling down the road. Remember that with tapered roller bearings, excessive pre-load can mimic this same damage. If a bearing gets really hot, cages and seals could be deformed and lead to bearing lockup.

Can wheel bearing grease wear out?

Grease is a precise combination of oil, thickener and additives. It acts like a sponge to retain and release the oil. As a result of time and temperature conditions, the oil release properties can become depleted. When this occurs, the grease is worn-out.

A cheaper hub unit has the same appearance as a high-quality, brand-name unit. What is the difference?

Bearings are precision products that require complex manufacturing processes. Inferior bearings that use low-quality steel and have poor heat-treating can wear and spall prematurely. In addition, the poor-quality steel may have inclusions of hard or soft metal that can cause a premature failure.

In summary, an inexpensive bearing may look the same as a high-quality bearing, but it is what you can’t see that makes a difference between a comeback and a satisfied customer.

Also, some cheaper hub units are using smaller bearing sizes than the OEM intended. This can lead to premature failure. Unfortunately, the only way to tell is to destroy the new bearing.

Why can’t a technician use an impact wrench to secure the axle nut?

While it may appear easier to use an impact wrench, it is not recommended. OEM and bearing manufacturers always recommend using a torque wrench for installation. During removal, an impact wrench can damage the axle nut threads and shock the CV joints. It also can create a false sense of security when adjusting a nut or bolt, which then may be under- or over-torqued. This can leave a hub assembly susceptible to failure.

Also, in almost all cases, use a new axle nut. Some axle nuts are designed to be used only once, and cannot be adjusted.

What is the right way to adjust a tapered roller bearing?

Always check the service information for the correct procedure. Overtightening adjustable tapered roller bearings is a common error that can lead to premature failure. Tapered roller bearings on the front of RWD vehicles are never preloaded. They’re snugged up with no more than 15 to 20 ft.-lbs. of torque while rotating the wheel to make sure the bearings are seated. Then the adjustment nut is loosened 1/6 to 1/4 of a turn, and locked in place with a new cotter pin. As a rule, endplay should be about 0.001 to 0.005 inches.

How does a technician know when to replace and repack wheel bearing grease?

Colored and UV dyes can be added to a grease as assembly aids or to facilitate inspections. The original color of a grease has little to do with its performance.

Automotive wheel bearing grease contains corrosion inhibitors, plus anti-wear and water-resistant additives, offering superior protection in challenging environments.

A softened sealing lip surface is the sign of a compatibility problem with the grease and seal.

The wrong grease can cause a rubber seal to swell and disintegrate. Fresh grease is smooth and buttery compared to water-laden grease, which is milky white in appearance. As little as 1% water in grease can have a significant impact on bearing life.

Wheel Bearing Lessons

Wheel bearings are either of the ball or tapered roller variety. Front-wheel bearing applications are an angular-type ball bearing, which will accept greater thrust loads than a Conrad-type bearing, and will accept a 100% load in the radial or thrust position and any combination of a 100% load. A tapered roller bearing will accept both a radial and a thrust load.

All wheel bearings come in sets that consist of an inner and outer bearing. As is the case of a rear axle that uses a “C” clip to retain the axle to the ring gear carrier, the ring gear carrier bearings handle the thrust load and the straight roller at the flange end carries the radial load.

Some rear axles will have a cartridge-type wheel bearing set containing either ball or tapered rollers.

Seals

Basic wheel bearing seal construction remains the same, consisting of a metal retainer and seal. The primary sealing materials have changed from felt to rubber products, ranging from Buna-N to Fluoroelastomers, yet felt is still used as a dust shield for the primary seal.

A seal is only as good as the surface it rides on, and that surface needs to be lubricated. If the seal lip runs on a dry surface, it will overheat and become brittle. A scratch or gouge can damage the sealing lip and cause the seal to fail. The seal must be lubricated before it is installed to prevent it from running dry. A small amount of grease on the back of the seal and a film on the spindle is recommended.

Don't force the issue by getting a bigger hammer – instead, it is highly recommended that you use a seal installer. The installer will prevent the seal from being cocked when it's installed. A shaft protector should be used when installing a seal over a splined shaft. The dust cap is also a vital part of the sealing system. A little extra care and a brass drift can make the job a lot easier.

Vehicle makers are setting new specifications for sealing and drag on some new vehicles because a tight seal and fuel efficiency do not go hand in hand. To meet these OEM goals, some seal and bearing manufacturers are changing designs and materials in an effort to improve the overall performance of a bearing.

Wheel Bearing Adjustment

A wheel bearing that's out of adjustment can reduce bearing life and can affect more than just the bearing. An out-of-adjustment bearing affects the operation and service life of the spindle, wheel seal and brake components. It's important to adjust the wheel bearing end play to the proper specifications. If the bearing set is adjusted too loose or too tight, it can cause the bearing to fail prematurely. In fact, a recent survey showed that more than half of the bearings on the road today are adjusted incorrectly.

Bearing adjustment wasn't critical to braking performance until the introduction of disc brakes. The caliper is mounted directly to the steering knuckle. If there was too much end play, the piston would knock back in the caliper, resulting in excessive pedal travel. The use of direct mount calipers is returning in high-performance vehicles.

The following procedure is one method for adjusting the end play in a wheel bearing set.

Tighten the adjusting nut while turning the rotor or drum. When the effort to turn the rotor or drum increases, a preload is placed on bearing assembly and all raceway surfaces are in contact, providing no end play. Back off the nut one flat to allow insertion of the cotter key. The end play can be checked with a dial indicator. Mount the indicator with a magnetic or mechanical base as close to the center of the hub as possible. The indicator tip is set on a smooth surface at the end of the spindle. Push the rotor back and set the indicator to zero. Then pull the rotor or drum out and read the dial indicator.

Allow 0.004-inch (0.100 mm) ± 0.003-inch (0.076 mm) of end play, then lock the nut with a new cotter pin. Whether you are checking a conventional wheel bearing or hub bearing, the best tool for checking adjustment is a dial indicator. Many four-wheel-drive vehicles and most trucks with a load rating of one ton and higher use a full floating axle. The axle has a bearing set, spindle and hub. The same adjustment procedure can be used for these applications.

Over tightening adjustable tapered roller bearings is a common error that can lead to premature failure. Tapered roller bearings on the front of RWD vehicles are never preloaded. They're snugged up with no more than 15 to 20 ft.-lbs. of torque while rotating the wheel to make sure the bearings are seated. Then the adjustment nut is loosened 1/6 to 1/4 a turn and locked in place with a new cotter pin.

As a rule, end play should be about 0.001-inch to 0.005-inch. There should be no play on most FWD cars, but up to 0.010-inch of play in the front bearings may be acceptable on RWD vehicles.

Hub Bearings

In the late 1970s, the hub bearing began to appear on FWD vehicles. It was a sealed, lubricated for life, pre-adjusted bearing with a mounting flange attached to the strut knuckle, or rear axle flange and a hub for the rotor, wheel and CV joint. The bearing could be either a ball or roller type. Passenger car and light truck hub bearings are not adjustable.

The hub is directly affected by the condition of the bearing. The driver may first notice a noise coming from the wheel of the vehicle when the steering wheel is turned. There will be noticeable end play when the wheel is unloaded. Checking with a dial indicator will show an end play greater than 0.004-inch (0.100 mm).

Bearing end play can also affect a wheel speed sensor and cause an intermittent ABS trouble code. If the bearing flange has runout, that runout will be magnified at the rotor friction surface. A runout of 0.0005-inch (0.00254 mm) at the bearing flange could result in 0.001-inch (0.0025 mm) runout at the rotor friction surface.

As electronic stability control (ESC) braking systems become more complex, the wheel bearing will still be the central component in the system's operation. With the introduction of the electronic wedge brake (EWB) just around the corner, the caliper, wheel speed sensor and chassis controller will become the ABS system. These changes will require greater care in the servicing of the total suspension system.

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Wheel Bearings

Most late model vehicles have sealed wheel bearings that require no adjustments or maintenance. Most wheel bearings should last up to 150,000 miles or more. So many do-it-yourselfers (and technicians) think there's no need to pay any attention to the wheel bearings when doing a brake job. Wrong! Though the bearings do not require any maintenance, they should be inspected to make sure they are capable of doing their job safely.

A bad wheel bearing may not always make itself known by chirping, squealing or making noise. Many do make it obvious that they have reached the end of the road, but others just roll silently along until they suddenly fail.

A wheel bearing failure can have serious consequences if it occurs while driving at highway speeds and the vehicle loses a wheel. That's why the wheel bearings should always be inspected for looseness or roughness when the brakes are serviced.

The wheel bearings in most vehicles are designed for normal, light-duty driving. They are not designed to handle unusually high cornering forces or excessive loads. Consequently, many passenger cars and even some light trucks and SUVs have double ball bearing wheel bearings inside their hubs rather than stronger roller bearings. It's a cost-cutting step that automakers use in many applications. But when a vehicle is driven hard and subjected to unusually high cornering loads, it puts a lot of strain on the wheel bearings and can cause premature bearing failure. This is a common occurrence on police cars, race cars, even taxis and delivery vehicles.

The traditional way of checking sealed wheel bearings is to rotate each wheel by hand while listening and feeling for any roughness or play in the hub. On late model vehicles with sealed wheel bearings or bearing cartridges, there should usually be little or no play, and certainly no roughness or noise.

The crude way to check for play is to raise the vehicle so the wheel is off the ground, then grab tire at the 12 o'clock and 6 o'clock positions and rock the tire back and forth. If there is any noticeable play, the bearings are loose and need to be replaced.

If there is just a little play, the amount of play can be measured with a dial indicator. Place the dial indicator against the hub and rock the wheel in and out. As a rule, there should be no more than .005 inches of play in the bearings if the bearings are good.

Another check is to rotate the tire by hand while measuring play, but be careful not to confuse rim or hub runout with looseness in the bearings. As a rule hub, runout should be .0015 inches or less, and no more than .002 to .003 inches of runout at the lip of the rim. If there is too much runout, try reindexing the wheel on the hub, or remove the wheel and measure runout on the rotor or hub itself.

There's another way to check for wear and internal hub problems on vehicles that have antilock brakes with a wheel speed sensor built into the hub assembly. The sensor ring is part of the bearing assembly, so excessive play, wear or looseness in the hub will often cause the sensor ring to wobble as it rotates. Wheel speed sensors are very sensitive to changes in the air gap between the tip of the sensor and the sensor ring. Consequently, a worn bearing may cause an erratic signal that sets a Wheel Speed Sensor (WSS) code and turns on the ABS warning light. Or it may not.

A scan tool that can access the ABS system and display individual voltage or speed readings, or a digital storage oscilloscope can also be used to observe the WSS outputs to detect bearing wear. Any variations in the WSS output would be most noticeable while turning sharply or cornering under a load. The speed of the inner wheel will obviously read slower than the outside wheel when rounding a curve. But if the WSS signal suddenly drops out or changes drastically, it could indicate wear or too much play and movement inside the sealed hub assembly.

Internal corrosion inside a sealed hub assembly can also play havoc with the WSS signal. The wheel bearings may still be okay, but corrosion on the sensor ring can cause an erratic speed signal. This can set a WSS code and turn on the ABS warning light. If the WSS sensor is removable, the fix has been to remove and clean the sensor, and then add some zinc corrosion inhibitor to the hub cavity, but if the sensor is integral and cannot be removed, the only fix possible is to replace the entire hub assembly.

On older vehicles with serviceable wheel bearings, the bearings should be cleaned, inspected and repacked every 30,000 to 50,000 miles. There are still a lot of these older vehicles on the road, and the bearings on most are poorly maintained because few motorists know the bearings require maintenance.

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Bearing service life

Each bearing is designed to "live" in a particular environment. The bearing has a "life expectancy" because it is a wear part and, as such, is destined to die a "natural death".

The bearing’s service life is a function of its capacity to withstand fatigue; or in more tangible terms, the number of bearing turns up until the first signs of spalling appear.

When rolling bodies roll on the raceway, they create significant cyclic, compression and shear stress loading. Like potholes in roads caused by the constant passage of cars and vehicles, bearing rings crack under the repeated passage of the rolling bodies.

Under standard conditions, the bearing will eventually be damaged: contacts between rolling bodies and rings give rise to extremely high loads, both compression stress loading at the surface and shearing stress loading in sub-layers. The bearing's service life corresponds to its ability to withstand this stress loading.

The bearing's service life is predicted, it is statistical data. In fact, it is mainly based on the probability of encountering conditions that will lead to cracking: high stress loading combined with material heterogeneity.

For example, car wheel bearings are designed such that 90 % of them will easily achieve 500,000 kilometres. Thus, it may be predicted that 999 out of 1,000 will achieve 100,000 kilometres.

AAP 7670.077-3M
Houchin Manual, Chapter 4 Spare Parts List, Axle Assemblies Figure 2, Item 2.

Bearing, AKLM501349/AKLM501310 (SKF LM501349/501310)

SKF Bearings – Re-Lubrication Intervals (Refer SKF Website)

The re-lubrication intervals t_f for bearings with a rotating inner ring on horizontal shafts under normal and clean operating conditions can be obtained from diagram 1, as a function of:

- the speed factor A multiplied by the relevant bearing factor b_f where
  - A = n d_m [mm/min]
  - b_f = bearing factor dependent on bearing type and load conditions (table 1)
  - d_m = bearing mean diameter [mm] = 0,5 (d + D)
  - n = rotational speed
- the load ratio C/P

The re-lubrication interval t_f is the estimated number of operating hours, that a high-quality grease, consisting of mineral oil and a lithium base thickener, can perform adequately when the operating temperature is 70 °C *(160 °F)*.

When bearing operating conditions differ, the re-lubrication intervals (diagram 1) need to be adjusted.

If the speed factor A exceeds 70% of the recommended limits (table 1), verify the influence of the selected lubricant on the speed limits that are provided under Speeds and check whether the rotational speed is within these limits.

When using high performance greases, an extended re-lubrication interval and grease life may be possible.

Adjustments of re-lubrication intervals due to operating conditions and bearing types

Operating Temperature

To account for the accelerated ageing of grease with increasing temperature, SKF recommends halving the obtained intervals (diagram 1) for every 15 °C *(27 °F)* increase in operating temperature above 70 °C *(160 °F)*. The high temperature performance limit HTPL for the grease (diagram 2) should not be exceeded.

The **re-lubrication interval t_f may be extended at temperatures below 70 °**C *(160 °F)* if the temperature is not close to the lower temperature performance limit LTPL (diagram 2).

SKF does not recommend extending the re-lubrication interval t_f by more than a factor of two.

Do not extend the obtained t_f values (diagram 1) for full complement bearings or thrust roller bearings. Moreover, it is not advisable to use re-lubrication intervals in excess of 30,000 hours (3.42 years).

Grease Service Life

It is important to take into consideration the grease service life of the grease. Grease service life is the time over which proper bearing function is sustained by a particular quantity and category of grease.

Recommendation – Wheel Bearing Grease Replacement Extension

Based on the re-lubrication guidance provided by the SKF web site, the re-packing of the “Wheel Bearings” on this equipment is not dependent on the rotational life (operating hours) of the bearings.

This is because the bearings are never rotated at anywhere near their design performance and therefore do not degrade the grease as there is no increase in temperature above ambient. When moved the equipment is moved at a speed between 10 and 30 kilometres per hour for no more than 20 minutes.

The maximum recommended “Wheel Bearing” re-lubrication interval is 60 Months (5 Years). This is based on the following two parameters;

1. The bearings are never taxed in performing their design purpose as the equipment to which they are fitted is basically static for the majority of it’s life, and

2. DEF(AUST) 206F states that the maximum shelf life of any POL product that can be considered as being fit for use is 72 months (6 Years).

The shelf life is for a POL in an unopened container, stored in accordance with DEF(AUST) 206F. As the wheel bearing grease, once installed in the wheel, is effectively sealed off from the environment by a lubricant seal on inner side of the bearings and a bearing cap on the outside, there would be negligible degradation due to the environment.

AAP 7670.077-3M
Houchin Manual, Chapter 1, Section 3, Table 3.
Recommended Wheel Bearing Grease as Shell Retinax ‘A’.
This has been superseded by Shell Gadus S2 V220 2. Shelf Life up to 5 years