Bearing Maintenance

Management Guide



Caterpillar. The difference counts.™

Sustaining Life

Bearings are a critical aspect in sustaining safe and reliable equipment while operating Caterpillar® machines. Establishing and following a preventative maintenance program is a key factor in guaranteeing long bearing service hours and minimizing equipment downtime.



- Importance of Lubrication
- Thorough Inspection
- Hints on Replacement
- Detect—Then Correct
- FAQs
- Ten Factors Causing Premature Failure

CATERPILLAR®

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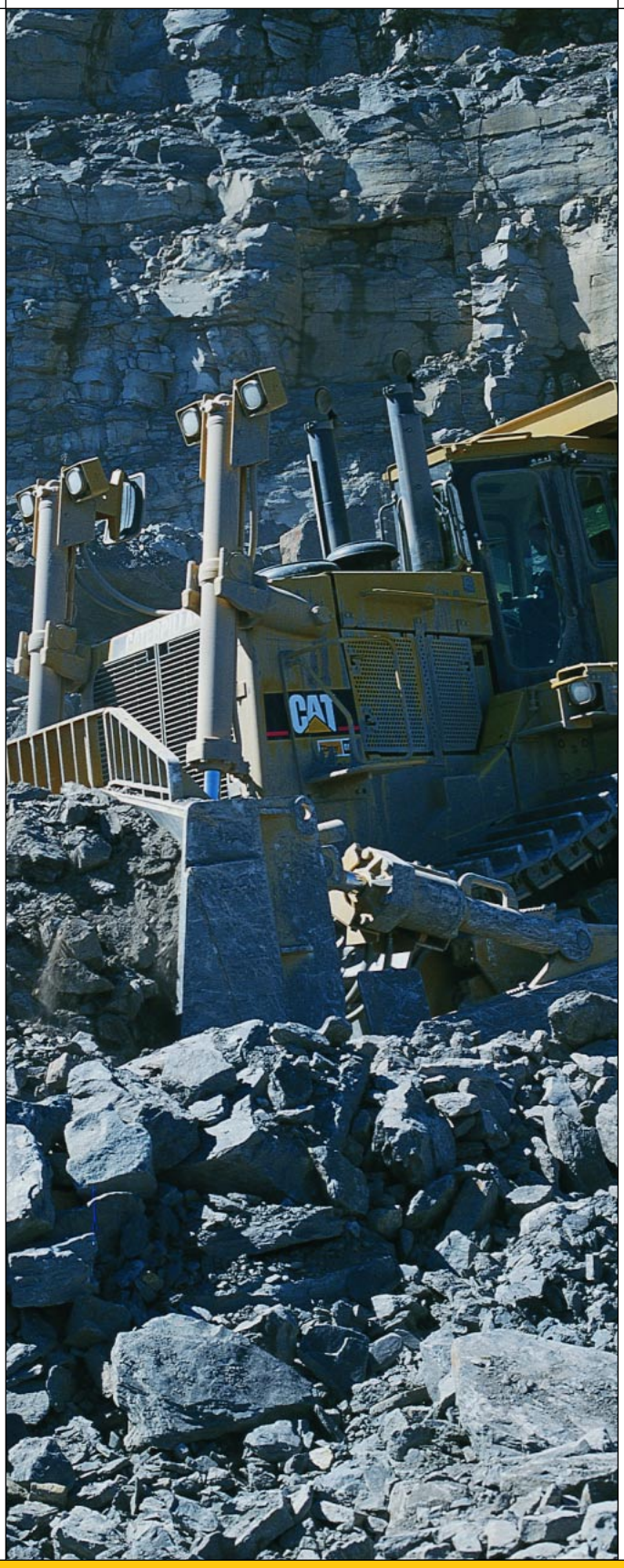
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Introduction

Caterpillar is known for having products that provide exceptional performance, extraordinary durability and long life. Caterpillar bearings offer just that and more.

Bearings are used in every drive train component and virtually every mechanical component of Caterpillar machines. But because of the varying speed, power, and torque and thrust force going through the drive train, one type of bearing does not meet all the rigorous demands. Several types of bearings are needed, with each bearing being highly crafted and precisely matched to the kind of load it carries.

Bearings serve to allow parts to move together smoothly with minimum friction, heat and wear, often under extreme loads. Caterpillar offers two fundamental types of bearings: plain (bushing) and antifriction. This brochure will focus on antifriction bearings, which use balls and rollers as the primary elements between contacting surfaces.

Antifriction bearings consist of spherical or cylindrical elements held in races that rotate with the adjoining surfaces, preventing metal-to-metal contact and ultimately reducing friction, heat and wear. Caterpillar offers a variety of different antifriction bearings: ball bearings, roller bearings and needle bearings. All three types of bearings have similar components: hardened steel rings called races, and optional separators or cages, which provide spacing for the rolling elements between the races. In some applications, the rolling elements are in direct contact with the shaft or other mounting.

It is evident that bearings play a critical role in safe and reliable equipment operation. A bearing failure can cause metal particles to enter the machine's lubrication system, wearing gear teeth and ultimately damaging the components. Thus, maintaining high-quality operating conditions for the bearings will minimize repair costs and downtime.



This Bearing Management Guide is Not a Repair Manual.

It is not intended to help you diagnose mechanical problems, nor is it a substitute for your machine Operation and Maintenance Manual. This guide is intended to help you understand how bearings work and how they wear. With this understanding, and by following the machine Operation and Maintenance Manual, you can maximize productivity, service life and value of your Cat® machines.

Importance of Lubrication

Lubrication is an important factor in bearing maintenance. Lubrication supplies an oil film for balls and rollers, reducing friction between bearing components while providing a protective coating to prevent rust and transports heat away. Further, using the appropriate quality, type and viscosity of lubricant is vital to good bearing performance and life. Over-lubricating can lead to churning, causing friction and heat, which eventually initiates premature failure. Lack of lubricant can be harmful, given that not enough oil will be available to do the job. To ensure optimum bearing performance, Caterpillar offers a full line of Cat lubricants to meet your everyday needs.

In splash lubrication systems, such as in final drives, it is imperative to not only retain the right type and quantity of lubricant in the housing, but also to change the lubricant and filters at recommended intervals. Using lubricant rated for the proper temperature must also be noted. When operating at extreme temperatures, it can lead to oxidizing the oil and breaking down of additives.

Regardless of the type of lubrication system you are using, be sure to understand and follow the manufacturer's recommendations to establish the right type and frequency of lubrication that is needed for your specific bearing design and application. Additionally, look into setting up a scheduled oil analysis program for your machines if one has not been put in place already. This program can easily help identify abnormal wear prior to it becoming a major problem. There could possibly be no better way to detect component wear than to utilize a scheduled oil analysis program.



Thorough Inspection

Detecting defects and deterioration before failure involves periodically removing, cleaning and inspecting the bearings. Remove bearings carefully as they can easily be damaged during this removal procedure. (see Frequently Asked Questions) It is important to note that you should always use recommended tools and adhere to the outlined procedures in the machine's service manual. Avoid harmful removal procedures, such as flame cutting inner races or shrinking outer races with weld bead if possible. Using these practices can result in uncontrolled heat that can damage housings or shafts.

When the removal process is complete, bearings should always be cleaned before inspection. Follow Cat's recommended guidelines to ensure the bearings are not damaged. Only use petroleum solvents that are suggested for washing. It is important to remember that most solvents are flammable and toxic when inhaled or absorbed into the skin. Handle with caution.

To prevent contamination, clean bearings in a container that is large enough for the bearings to be splashed around without contacting the bottom where the dirt settles. Allow the bearings to soak for an extended period of time to loosen grease and dirt, possibly several hours or overnight. Use a short bristled brush that will not lose or break off its bristles. After visually inspecting the bearing to see that all dirt has been removed, rinse the bearing in a container of clean solvent; next dip the bearing in oil.

When drying the bearing, notice you should not use compressed air to spin it dry, this can cause a non-lubricated bearing surface to be damaged. To dry the bearing, hold both inner and outer races together to avoid spinning and blow air through the bearing.

After the bearing has gone through the cleaning process, examine it thoroughly for cracks in the race, dented seals, and damaged or broken separators, balls, or rollers. If a brownish-blue or bluish-black color appears, it means the bearing has been overheated. At this point, replace the bearing. If the bearing has a seal or shield, inspect it for damage or wear. If the seals are damaged or worn, you must replace the complete bearing. A worn or damaged seal will permit dirt and moisture to enter the bearing, minimizing its wear life.

Check separable bearings for pitted, scratched or flaked balls, rollers or races. If any of these signs are visible, replace the bearing. Inspect the inner surfaces and rolling components in a non-separable bearing by shining a flashlight between the balls and rollers. If you notice any pits, scratches or surface damage replace the bearings. Further, scan the outer race for proper wear patterns such as wear tracks that are centered without pits or scratches.

If you do not visually notice any signs of wear or damage, lightly lubricate the bearing and slowly turn the outer race. Never spin it. If a clicking or sticking is observed, clean the bearing again. If the condition still exists after cleaning, you will need to replace the entire bearing. A thrust bearing or tapered roller bearing can be tested the same way, but place the bearing on a clean surface, lightly apply hand pressure and turn the bearing.

If no signs of wear or damage are indicated and the bearing has low service hours, it can be reused after cleaning. However, if the bearing has high service hours, it is suggested to go with a replacement. This is a precaution due to the fact that the bearing might possibly fail and destroy other critical systems.

Remember that many times it is challenging to determine if a bearing is reusable just by visually inspecting it. Rolling contact stress fatigue originates beneath the surface and cannot be seen. When choosing whether to replace or reuse a bearing, consider the load, application, and the number of service hours. In most situations, it is more economical to replace a bearing that is in severe applications, under heavy load, or has high service hours.

Note that if you are not planning on reinstalling the inspected bearing immediately, perform the following steps: oil the bearing, wrap it in clean, oil proof paper, place it in a box and store it in a dry, dust-free place. These precautions will help avoid corroding and shortening of the bearing life.

Hints on Replacement



Any time during inspection you decide to replace a bearing, be sure you replace it with a genuine Cat bearing. Only then are you assured of the proper performance and long life of your machine.

Bearings must be compatible with the machine in the areas of lubrication, fit, surface and load-carrying ability. Many times a bearing will look like an original, yet it might not be a correct replacement. Bearings that are not compatible in all areas can fail prematurely.

Cat equipment requires the use of many specialized bearings. Some bearings are imprinted with the manufacturer's code that supplies information on the bearing's general dimensions. Cat bearings are made specifically for Cat products, therefore, they have no stamped dimensions. In some cases, even though a bearing might portray the same identification code as a standard bearing, it might be unique and have the ability to provide longer life in certain applications. For example, a bearing could have a particular surface finish or heat treat, or possibly include a different roller crown or cage design. It is vital that you avoid using a standard bearing when a special bearing is specified. Selecting the incorrect bearing will shorten the life and can create further damage.

Detect—Then Correct

If you correctly maintain your bearings, they will not incur premature failure, however, they will eventually fail due to rolling contact stress fatigue. A premature failure happens when bearings fail at low hours for causes beyond normal material fatigue. If you identify any signs of possible bearing failure, such as excessive noise and vibration, excessive heat, lubricant loss or shaft resistance to turning, refer to the "Trouble Shooting Antifriction Bearings" chart. This chart may help you determine the indicators, causes and proper repair options. If the recommended maintenance options do not correct the problem, disassemble the bearing and try to recognize the cause again.

Keep in mind, determining the cause is usually easier said than done. A visual examination may identify the type of damage, but it may not aid it recognizing what is causing the problem. Take this situation for example, if a bearing has scored and heat-discoloration on the roller ends, you know it is burned up and needs to be replaced. Yet, the cause could be linked to various factors, such as insufficient or improper lubrication, improper adjustment or any combination of these factors. For this instance, you should carefully investigate the mounting, installation and parts affecting the bearing operation to decipher the cause of the damage. Remember, if you merely replace the failed bearing without finding and fixing the root cause, the replacement bearing will most likely endure the same wear and damage as the original.

PROBLEM INDICATORS	CAUSES	OPTIONS
Excessive Noise and Vibration	Insufficient lubrication	Fill with correct amount of proper lubricant.
	Incorrect lubricant	Use recommended lubricant.
	Defective bearing	Replace bearing.
	Dirt	Replace bearing.
	Corrosion	Replace bearing. Use lubricant that resists corrosion.
	Improper Load	Adjust to specification.
	Misalignment	Determine what is misaligned: housing, shaft, or bores. Shaft may be bent or housing bores not aligned. Replace shaft or housing.
	Bearings fit too loose	Chrome plate or metalize shaft or bore and regrind to specification, replace bearing if seating surfaces are worn.
	Improper mounting	Replace bearing. Correct installation/mounting problem.
Excessive Heat	Insufficient lubrication	Fill with correct amount of proper lubricant.
	Incorrect lubricant	Use recommended lubricant.
	Improper setting	Adjust to specification.
	Misalignment	Determine what is misaligned: housing, shaft, or bores. Shaft may be bent or housing bores not aligned. Replace shaft or housing.
	Lubricant churning	Use less lubricant or use a lower viscosity lubricant. Be sure to use recommended lubricant.
	Spinning race	Either inner or outer race is sliding around its seated surface. Use proper sized components.
Lubricant Loss	Too much grease	Grease to proper level.
	Improper lubricant	Use high-temperature grease.
	Leakage through seal	Replace seal. Check shaft for scratches or burrs that may have damaged seal.
Shaft Resistant to Turning	Incorrect lubricant	Use recommended lubricant.
	Dirt	Clean bearing. Replace seals and bearing if damaged.
	Corrosion	Replace bearing. Use lubricant that resists corrosion.
	Improper setting	Adjust to specification.
	Lack of lubrication	Add proper lubricant. Check for damage.
	Seal tight	Use proper size and type of seal.
	Bearing cocked	If new installation, remove bearing and clean all mating surfaces. Reinstall bearing if not damaged.
	Leakage between bearings caps and housing	Replace gasket.

Frequently Asked Questions

1. What tools do I need to perform proper maintenance of bearings?

You should always work with clean, recommended or approved tools. Do not use a wooden mallet. Also work in clean surroundings, such as on a metal or metal-covered bench.

2. How should I properly handle a bearing?

Always handle the bearings with clean, dry hands or even clean canvas gloves. Never hold a bearing with dirty or moist hands, as contamination can easily be transmitted to the bearing. When you are finished handling the bearing, lay the bearing out on a clean surface.



3. What should I use to clean a bearing?

To clean a bearing you should use uncontaminated solvents and flushing oils. If it is necessary to wipe the bearing, only use clean lint-free rags. It is important to note that you should never use cotton waste or dirty rags to wipe a bearing. Further, never use the same container for both cleaning and final rinse of used bearings.

4. What is the technique I should use to dry a bearing?

To dry a bearing, hold both the inner and outer races together and blow air through the bearing. You should never spin any bearing with compressed air.

5. How should I store a bearing?

When storing a bearing, remember the most important factor is protecting the bearing from dirt and moisture. You should be sure to keep the bearing wrapped in oil-proof paper. Be sure that you do not scratch or nick bearing surfaces while handling and storing the bearing.

6. What should I know about installing bearings?

When installing a new bearing, install the bearing as it comes from the package, without washing if it was received in a clean container. When installing used bearings you should thoroughly clean the inside of housing prior to the installation process.

7. What should I know about lubricants?

Lubricants are a critical aspect of bearing maintenance. It is vital that you always keep lubricants clean when applying them, and cover the containers when not in use. Further, always use the correct type and amount of lubrication, as this will play a key role in bearing wear life.

Ten Factors Causing Premature Failure

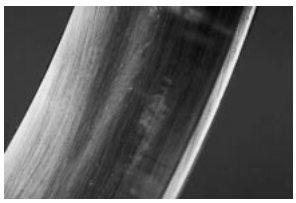
1. Overloading



Overloading is an especially common factor in premature bearing failure. Overloading causes the oil to generate heat, which affects the oil viscosity. Heat will cause the oil viscosity to decrease and make the lube film thin, allowing contact between the rolling components and raceway. The contact can cause damage similar to the damage caused by insufficient lubrication.

Caterpillar's Solution: Caterpillar bearings are designed as an integral part of the total machine system. By always using genuine Cat parts, you will ensure the integrity of those systems and provide high performance and long life, especially under high load applications.

2. Improper Lubrication



As mentioned before, proper lubrication is vital to high-quality bearing performance and service life. Insufficient lubrication allows for metal-to-metal contact of the major elements and especially of the roller end against the rib, producing scoring in these areas. Heat has the ability to turn various elements and roller ends dark blue, or perhaps in extreme cases, black.

Caterpillar's Solution: In applications where inadequate lubrication is a concern, Caterpillar uses a proprietary bearing technology called "textured" bearings. Texturing allows for better oil retention on the contact surfaces which leads to longer bearing life especially in high load, slow speed applications.

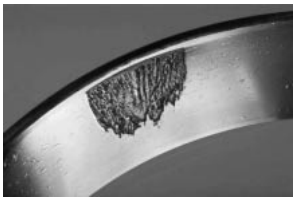
3. Contamination



Contamination is any foreign substance that has the ability to damage a bearing. Moisture, dirt, sand or any type of abrasive material will cause premature bearing breakdown. It is important to be able to recognize symptoms of contamination, such as scratching, scoring, brushing, pitting, grooving, bruising, matte or satin finish or rust. Several causes of contamination involve debris manufactured into the system, cracked housings or hoses, dirt access through failed seals, minute metal particles and contaminated lubricant.

Caterpillar's Solution: When contamination is an issue, Caterpillar offers "debris resistant" bearings. These bearings utilize a combination of specialized material and heat treat to produce bearings that are extremely resilient to debris and contaminants in the oil.

4. Distortion



When the housing or shaft is out of round, the bearing roller components are forced together where there is a minimum amount of clearance. The heightened pressure can result in the race and other rolling elements to incur surface flaking, something that typically happens with normal fatigue.

Caterpillar's Solution: see "Improper Fit"

5. Misalignment



To maximize bearing life, the supporting seats and shoulders must meet manufacturer's specific limits. If the misalignment is beyond those particular limits, the load on the bearing will be intense on only a segment of the roller and races, causing excessive stress and premature failure at that single point.

Ten Factors Causing Premature Failure Continued

Caterpillar's Solution: Caterpillar's specialized roller profile provides optimum load distribution across the bearing, even when misalignment is present. This serves to minimize stress in the bearing and maximize bearing life.

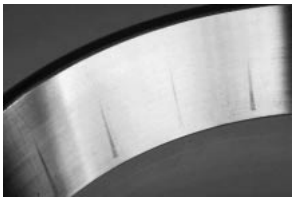
6. Improper Fit



Having proper bearing fit is essential to capitalizing on bearing performance and life. A variety of improper fits can cause significant damage, including forcing a bearing onto a shaft that is too large for the inside diameter of the bearing race, fitting an outer race insecurely (too loose) in its housing and having a loose fit between the shaft and the inside bore of the bearing. These inadequate fits can cause split races, fretting corrosion and creep wear.

Caterpillar's Solution: Caterpillar bearings are made with specialized tolerances for precise fit of the bearing to the shaft or housing and ensures exact positioning of related parts.

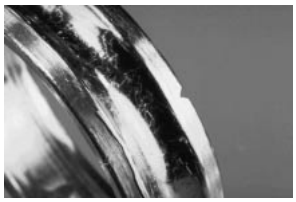
7. Vibration Damage



Anti-friction bearings must roll while under a load. Subsequently, subjecting a bearing to vibration while it remains immobile can cause depressions on the race from fretting.

Caterpillar's Solution: In Caterpillar bearings, eliminating vibration is a prime factor in determining the type of bearing cage required. Brass cages and nonmetallic bearing cages are two types which minimize vibration and provide maximum life in harsh applications.

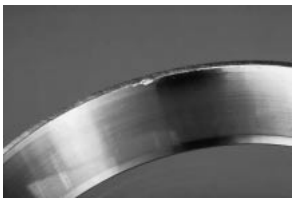
8. Defects in Material



Defects in antifriction bearings are particularly rare, especially when it comes to the material, forming, machining, heat treat, grinding and assembly difficulties. The minimization of defects is a result of the extreme cleanliness of bearing steals and stringent quality control measures used in manufacturing facilities that supply Caterpillar bearings. Note that usually only a metallurgist can characterize these types of defects from other causes of premature failures.

Caterpillar's Solution: Caterpillar bearings are manufactured to the highest material quality standards in the industry and will always provide for the optimum performance and component life of our machines.

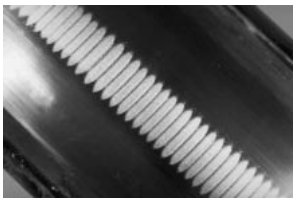
9. Improper Servicing Techniques



It is critical to always follow the manufacturer's recommendations summarized in your service manual. Further, this means using the proper tools. Using inappropriate tools and procedures when removing, installing and handling bearings can cause damage and possibly failure.

Caterpillar's Solution: Always refer to your Cat equipment's Operation and Maintenance Manual and other service literature for proper procedures and servicing techniques.

10. Electrical Current



Bearings pass electrical currents that initiate an arcing and burning at the points of contact between the races and rollers. This may produce a single burn or multiple grooves called "fluting." A burned bearing allows for excessive noise and will need to be replaced.

Caterpillar's Solution: Be sure to find and repair the root cause of the electrical ground to avoid damage to the new bearing.

Notes



Expect More from the Experts



Maximize the Life of Your Bearings

For any machine to be safe, reliable and productive, proper bearing maintenance is an absolute must. That's because bearings are used in—and affect the performance of—virtually all mechanical components. You could cross your fingers and hope nothing ever goes wrong. Or you could take a proactive approach by eliminating bearing problems before they begin, with prevention and scheduled maintenance programs that will ultimately minimize repair costs and downtime. And that's what you really want from any machine.

For more information, see us today or visit our Web site at www.cat.com

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