SMB BEARINGS

Understanding bearing failures

Welcome to the SMB Bearings guide to understanding bearing failures

Bearing failures present a paradox: they are both relatively rare and relatively common. They are rare because, statistically speaking, only a small percentage of bearings in use fail. The majority exceed their service life and if you are using high quality bearings and maintaining them properly, the risks are further reduced.

Yet although bearing failures may be rare in relative terms, the absolute number of bearing failures is still relatively high. That's because there are so many bearings in use that even a relatively small percentage of failures is still a high number.

Regardless of the rarity or otherwise of bearing failure, the results can be extremely costly. A failed bearing can lead to expensive unplanned downtime, or secondary damage to equipment and machinery. It's no surprise that manufacturers and other users of bearings want to know more about what causes these failures and how they can best diagnose problems with their bearings.

That's where this whitepaper fits in. This guide should give you a basic understanding of what causes bearing failures, what you can do to eliminate or reduce the risks and how you diagnose the problem correctly when you encounter damage or failure.

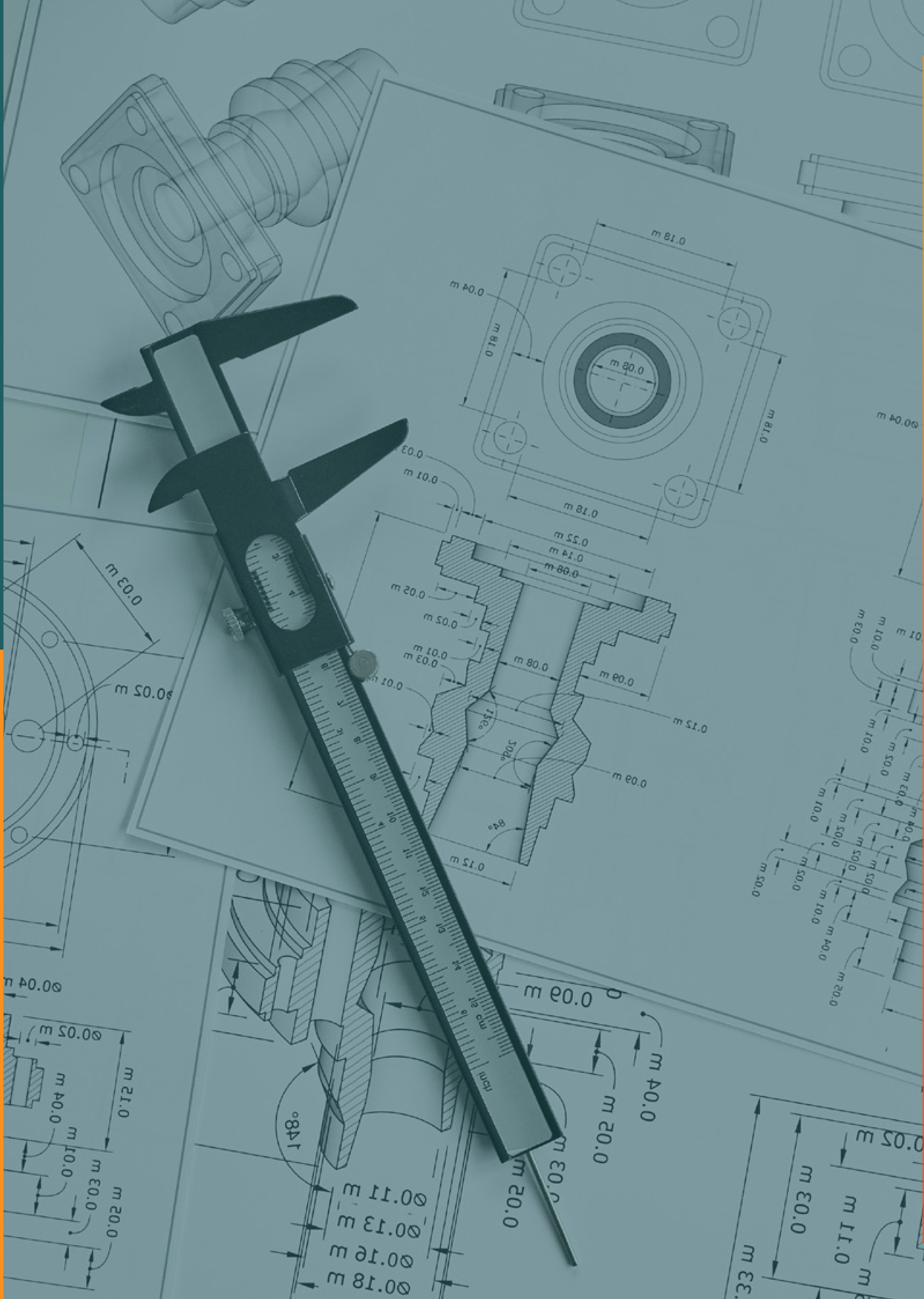
The diagnosis element is key because the story isn't over when a bearing fails. Different failures leave different imprints or clues that suggest their causes. In some cases, only expert analysis with expensive equipment can uncover the root of the problem, a luxury that not all manufacturers possess.

Although visual inspection has its limitations, in many instances a good basic understanding of bearing failures can equip you with the necessary tools to diagnose the problem. Even if you cannot diagnose the exact problem, there will often be clues that can help narrow down the range of possible culprits.

The value of diagnosis lies in the corresponding remedial action. If you know what has likely caused the bearing to fail, you can take the necessary action to prevent damage or failure from repeating. This will save you hassle and potentially, a lot of money.

The guidance contained here mostly adheres to the ISO classification for bearing damage, and I have tried to avoid overly technical language. If you already understand the basics, there are more lengthy, technical guides available elsewhere. I hope that what is lost in simplicity is gained in readability and ease of use. As always, if you have more detailed questions then feel free to get in touch.

Best regards,
Chris Johnson
Managing director of SMB Bearings



Understanding failures

Most bearings will outlive their service life. Only one in approximately 200 bearings will fail. However, as research by bearing manufacturer SKF has estimated, there are so many bearings in operation that approximately 50 million bearings are replaced due to failure every year.

Having a basic understanding of how and why failures happen puts you in a better position. You are less likely to mount or store the bearing incorrectly,

you are more likely to adhere to an effective maintenance and monitoring program and, above all, you will be in a better position to correctly diagnose a problem if a bearing does fail."
The quality of a bearing is a key factor that determines whether it reaches its calculated service life, so stick with a reputable supplier. Other key factors include how the bearing is stored, whether it is correctly matched to the application, whether it is mounted correctly, and the lubricant that is used.

Estimates vary, but lubrication problems are among the most common causes of bearing failure. Lubrication problems are more complex than they sound. There is more to it than simply having the appropriate choice of lubricant. It is vital that the correct quantity of lubricant is applied, that it is applied in the correct way and that it is reapplied at the right intervals.

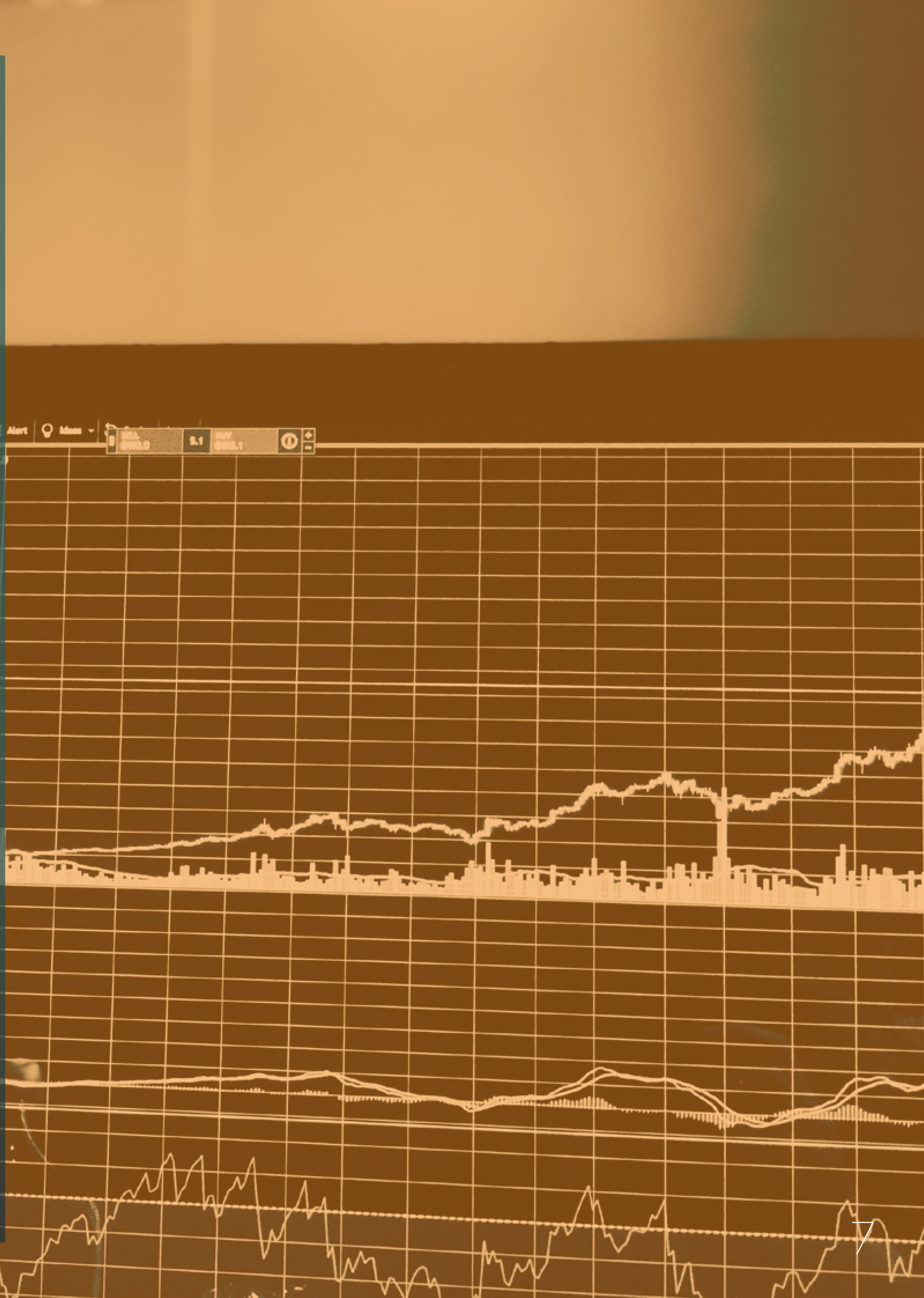
Monitoring and inspection

There is usually a gap or window between the onset of damage and the failure of the bearing. This will vary depending on the application and the quality of the bearing. In fast moving bearings, failure could quickly follow. In equipment that rotates more slowly, a bearing might remain serviceable for many months after the onset of damage.

Due to this gap, it makes sense to monitor and inspect bearings regularly. If damage or the symptoms of damage can be detected early, a bearing can be replaced or alternative remedial action implemented in time to avert a failure. Ideally, a bearing could be replaced during scheduled downtime, removing the costs of unplanned halts in production.

Given what is at stake, it is no surprise that many manufacturers invest in high tech equipment to help monitor the condition of their bearings.
Various monitoring technologies can spot damage at a far earlier stage than would be apparent using normal human senses. Vibration analysis is the most common of these but other technologies, such as infrared imaging or ultrasound, are also used.

If you cannot afford such equipment, or if the investment is not practicable, then more traditional methods of inspection are still recommended. Before failure, many bearing problems show up with the familiar symptoms of heat, noise and vibration.



Heat, noise and vibration

Heat, noise and vibration are the key parameters of any basic monitoring regime. While using your own senses may not match up with the latest monitoring equipment, it can still give some warning. Just be aware that due to the limitations of the human senses, by the time these symptoms are observable the level of damage may already be extensive.

Listen to your bearings. Bearings in good condition make a soft purring noise. Squeaking or grinding sounds are usually indicative of poor condition. Pay attention to vibration. Although all machines vibrate, mechanical problems are usually accompanied by increases in vibration.

Temperature is perhaps the key variable as temperature increases are symptomatic of so many bearing problems.

You might notice a natural increase in temperature after first starting a machine or when first using it after regreasing. In most other instances though, temperature increases should prompt further investigation.

Checking the lubrication is a key part of this investigation. Check the seals for lubricant leaks or for signs of damage that might have permitted the ingress of contaminants. Relubricate according to schedule and ensure reservoir levels are correct. If you are using systems to automatically relubricate, make sure these are functioning as intended.

A more frequent regrease is a good fix for many common problems. For example, if the lubricant is contaminated, then relubricating more frequently but with smaller amounts will help purge the lubricant of contaminants.

Bearings are not always accessible, but visual checks should be performed during routine shutdowns of equipment. The machinery should be cleaned to reduce the risk of contaminants entering the bearing. Lubricant samples can be taken. It is often a good idea to keep samples of the original lubricant for comparison. You can spread the lubricant over a thin sheet of paper and examine it under a light to check for signs of contamination.
Having checked the lubricant, you want to examine and clean any exposed external surfaces. These should be cleaned with a lint-free cloth. Look for signs of corrosion or cracks. If practicable, you can rotate the shaft. If there is an uneven level of friction or resistance, this may also indicate a problem with the bearings.

The seals are a common culprit in many bearing problems, so be extra vigilant when inspecting these for signs of wear or damage.

Even if the seals themselves are not the issue, they are only effective on a smooth counterface. Check to make sure the latter is not damaged, worn or corroded.

All of these checks should be performed systematically, as part of a routine condition monitoring exercise for all your equipment. Be warned though that these symptoms, although indicative of problems, could be the result of secondary damage. In other words, they might tell you a problem exists, but they will not necessarily allow you to diagnose it correctly.

Bearing failures can be diagnosed to help prevent a recurrence. Most failures leave trademark imprints or clues. When discussing these, it is useful to refer to the ISO classification system, as this provides a common terminology for describing bearing failures.

The ISO 15243, which was last updated in 2017, sets out six main categories or modes into which bearing failures can be grouped;

1. Fatigue
2. Wear
3. Corrosion
4. Electrical erosion
5. Plastic deformation
6. Fracture and cracking

In the following section, we briefly describe each of these failure modes and the subcategories within them. We also look at some of the clues or imprints each of these failure modes leaves behind, which can help inform diagnostic assessments and remedial actions that could prevent recurrence.

Fatigue

Wear

Corrosion

Electrical erosion

Plastic deformation

Fracture and cracking

Fatigue

Stress changes can produce damage at both the surface level and the sub-surface level of the rolling elements. Fatigue can be initiated at the subsurface level, meaning the cracks begin below surface level and are not immediately visible. This will often lead to increases in noise and vibration. The crack will usually work its way to the surface over time. The bearing may remain serviceable after spalling has begun, but the deterioration will gradually increase.

Fatigue can also be initiated at the surface level. This is most often a consequence of damage to a rolling contact surface resulting from inadequate lubrication.

Although the damage is at the surface level, it is often not visible to the naked eye but will be visible under a microscope. Microspalls are only a few microns in size, so the surface will simply look dull and grey.

Wear

Abrasive wear refers to the progressive removal of material. Abrasive particles wear down the rotating elements over time. Often, the metal cage is the first component to begin suffering the impact of this.

Bearings will experience some light wear during the initial running in-stage. More severe wear is usually the result of inadequate lubrication or the presence of solid contaminants. The visible signs of this form of damage are usually dull surfaces.

The second type of wear is adhesive wear. Also known as smearing, this is where material is transferred from one surface to another. The process is usually accompanied by friction and heat and is uncommon under normal operating conditions. It is a vicious cycle because it hardens the material and thins the oil film.

Corrosion

Moisture corrosion can be caused by ineffective sealing arrangements. Marine applications face environmental conditions where the risks of this are high. It is also a common form of bearing failure in paper machines and in the food and beverage sector.

Frictional corrosion can be further broken down into either fretting corrosion or false brinelling. Small particles can break away from a bearing's surface and when exposed to air they will oxidise quickly.

Fretting corrosion is visible in the form of rust on the outside surface of the outer ring or the bore part of the inner ring.

False brinelling can occur in the contact areas due to micromovements. When this takes place, rust will usually be observable in the indentations. This can often result from vibration that equipment is subjected to during standstill.

Electrical erosion

When electrical current passes from one ring to another via the rolling elements, damage can occur. The heat damages the material and the signs of this are often visible in the form of discolouration or shallow craters where material has broken away. Sometimes, you might spot zig-zag shaped burn marks on the raceways.

Current leakage erosion is a similar problem. In this instance, the craters will be shallower during the initial stages, because the current is smaller. Over time, this form of damage often leaves a trademark washboard pattern.

Plastic deformation

Shock loads, improper handling or static overloading can all cause overload deformation. Whichever of these three is the cause, the resulting damage will look the same.

If a new bearing is making noise, in addition to the possibility of incorrect mounting, it might be that it was damaged in transit or storage. The importance of storage is often underestimated, but it is critical at every stage.

During manufacturing, in storage and in transit – the bearings must be stored and cared for correctly to keep them protected. This is another reason for working with a trusted supplier.

Deformation can also take the form of indentations from debris. Contaminants can enter the bearing via the seals or the lubricant. Even soft particles can be problematic if they are large enough. This reinforces the importance of clean lubricants and careful handling.

Fracture and cracking

If concentrations of stress exceed the tensile strength of the material, the result can be a forced fracture. Rough treatment is a common cause of forced fracture. For example, someone might wrongly attempt to mount their bearings using a hammer and chisel.

Fatigue fractures, in contrast, occur when the fatigue strength of the material is exceeded under cyclic bending. The repeated bending causes a hairline crack to emerge.

Another process to be aware of in this category is known as thermal cracking. When two surfaces slide against one another the frictional heat produced can sometimes lead to cracks. These will usually be at right angles to the sliding.

Frequently asked questions

What makes a quiet bearing?

Noise in a bearing is caused by several factors that increase vibration. Rough or damaged balls or raceways, poor ball or raceway roundness, contamination inside the bearing, inadequate lubrication, incorrect shaft or housing tolerances and incorrect radial play can all contribute to noise.

Will relubrication make rough bearings smooth again?

Relubrication cannot make rough bearings smooth. Roughness or excessive vibration indicates wear. Removing old or dirty lubricant can help to a degree but the underlying problem will remain. The bearing will feel smooth with fresh grease but be aware this will only be temporary.

What are corrosion-resistant bearings?

As the name suggests, corrosion-resistant bearings can be used in applications where corrodible materials would be unsuitable, such as food processing, chemical manufacturing, pharmaceutical production and marine applications. Stainless steel is the most obvious material choice for this type of bearing, but ceramic bearings can also be used.

Can you relubricate bearings with shields and seals?

Relubricating bearings with shields or seals can increase operational efficiency, and energy efficiency, as well as extending the service life of the bearing. SMB's expert relubrication system enables us to relubricate ball bearings without removing shields.

Got any more questions?

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