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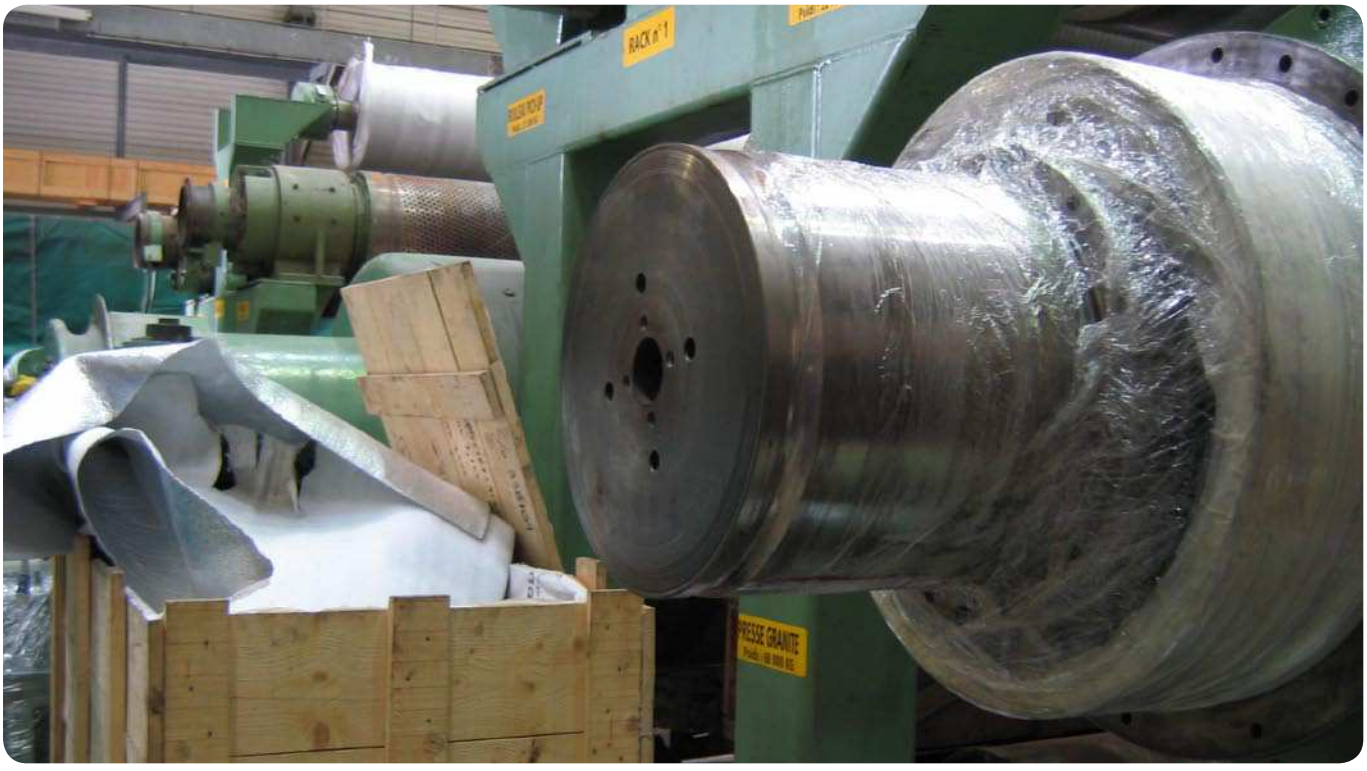
SKF Pulp & Paper Practices



Spare rolls are often stored with the bearings mounted. When rolls are taken off the machine, bearings should be cleaned then re-lubricated or sprayed with preservative oil. More information can be found in the 'Roller bearings in paper machines' handbook (publication number 10580)

SKF self-aligning bearings and the pulp & paper industry

As SKF's product manager for self-aligning bearings, my job is to make sure that your needs are met by our products. As you can imagine, I get to talk to many customers from many different industries, but I particularly enjoy working with people from the pulp and paper industry because it has been a major driver of our product development over the years.

The relationship between SKF and the paper industry certainly has been a long and fruitful one. Your industry's need for faster and wider machines in the mid 1990s led us to develop the CARB toroidal roller bearing, for instance. More recently, we have developed and introduced a large range of sealed spherical roller bearings which are widely used on auxiliary equipment. Late 2011, we extended our range of SKF Explorer spherical roller bearings. We also introduced a new heat treatment for our spherical roller bearings, CARB and spherical roller thrust bearings which is more crack resistant and less sensitive to inadequate lubrication and contamination.

You can read more about this in an article in this issue of SKF Pulp & Paper Practices.

This issue also includes an article by our pulp & paper segment's maintenance solutions manager, stressing the need for proper bearing and lubricant stores practices. This is important because it's not enough to simply select good quality bearings. To get the most from them, you also need to make sure that they are properly stored, mounted, monitored and maintained as well.

Regards,
Johan Ander,
Product Manager,
self-aligning bearings & specialty products, SKF
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New heat treatment for improved performance

Before leaving you to read Rene's article about proper bearing and lubricant storage, I would like to quickly tackle two topics. Firstly, the new heat treatment used for the most important bearing types for the pulp and paper industry and, secondly, some changes in the clearance reduction table that we showed in the first issue of SKF Pulp & Paper Practices.

The new heat treatment

SKF has launched a new heat treatment for the steel used in all our standard CARB toroidal roller bearings, spherical roller and spherical roller thrust bearings. The resulting steel is more crack resistant and less sensitive to inadequate lubrication and solid contamination. We believe it's the next step towards better performance and reliability. Think of it as an upgrade to the well respected X-Bite steel that we previously used.

This is the latest of many such steps that SKF has made and often it was the needs of the paper industry that drove development. For example, we started making spherical roller bearings that were dimensionally stable to 200 °C *(392 °F)* in the 1950s. Most of these were made from bainite steel because martensitic steel was too prone to ring cracking in heated cylinder applications.

As time passed, steel got cleaner and the oxygen content decreased resulting in increased fatigue life. Nevertheless, in the 1990s we took another big step forward with X-Bite. This was a special bainite heat treatment which led to a harder steel that was also tougher and, therefore, less sensitive to cracks.

Field experience with spherical roller bearings made from bainite and then X-Bite steel on drying cylinders led us to change our general recommendations. We now recommend standard SKF bearings for all heated cylinders except where the steam temperature is above 170 °C *(338 °F)* and there is no journal insulation. For these unusual cases, we still recommend bearings with case hardened inner rings. Such SKF bearings have the suffix HA3 or the prefix ECB.

Since September 2011, new CARB toroidal roller bearings, spherical roller and spherical roller thrust bearings are made from the upgraded steel rather than X-Bite. The bearings and the boxes that they come in are marked "WR" for "Wear Resistant". This marking is important because there are new rule of thumb factors influencing rating life calculations with the upgraded steel. If a machine has been designed for "WR" bearings, mounting an older generation bearing could give a lower fatigue life than expected.

So, what will the upgraded steel do for pulp and paper industry customers? Well, there a number of improvements actually of which the most significant are the higher toughness and the lower sensitivity to too thin oil films between the rollers and raceways.

Higher toughness

The new heat treatment results in a steel that is even harder to crack than X-Bite. Yes, the X-bite that we recommended for heated rolls and which was the through hardened steel with the highest toughness on the market. With this steel, we have taken another step to further increase the toughness and the hardness which results in a safer failure mode.

The pictures below show the test results of a spherical roller thrust bearing running under extreme conditions. Conditions chosen so that that the shoulder of the shaft washer (inner ring), made from X-Bite, would crack (→ **fig. 1**). With the same running conditions the shaft washer made from the upgraded steel didn't crack (→ **fig. 2**). Instead, spalling due to fatigue appeared.

Fig. 1 Bearing with cracked shaft washer

Fig. 2 Bearing made from upgraded steel with spalling

Less sensitive to inadequate lubrication

By inadequate lubrication, I mean too thin an oil film. This is a typical issue in heated cylinder applications when there is no insulation or when the insulation fails. In such situations, heat is transferred to the bearing, the operating temperature rises and the lubricant loses its viscosity. The oil film gets thinner, resulting in more metal to metal contact. This leads to either polishing wear (with its characteristic mirror-like raceways), micro spalling (also known as surface distress which leads to dull raceways) or, sometimes, smearing. All of these things, as you would expect, reduce bearing fatigue life.

The upgraded steel performs much better in conditions that could lead to polishing wear and/or micro spalling. This higher performance can be estimated using rule of thumb based correction factors in the rating life calculations. For more details, please contact your local SKF application engineering department.

Let's look at a 23152 CCK/C4W33 mounted on a drying cylinder by way of example. There's no insulation, the steam temperature is 160 °C *(320 °F)* and the oil flow (ISO VG 220) is nearly 3 l/min. The load on the bearing is 15 tons and the speed is 150 r/min. The filter is a Beta25=75 so, the filtration in this example isn't good. These operating conditions result in a bearing operating temperature of 120°C *(248°F)* and, per the SKF General Catalogue, a contamination factor of 0,15. In this example, the upgraded steel will have a significant impact since it is harder and, thus, less sensitive to indentations than X-Bite.

In the conditions listed above, with a thin oil film and poor filtration, the upgraded steel has a 35% higher rating life! Of course, I selected difficult operating conditions, but these are typical of an older machine pushed over its design speed with increased steam pressure, no journal insulation, unreliable water extraction from inside the cylinder and poor oil filtration. In cases where bearings run with a suitable oil film thickness and clean oil, the differences between X-Bite and upgraded steel will, of course, be small.

Don't forget that calculated rating life is not the same as service life since it doesn't account for poor storage, handling or mounting, contamination with process water and so on. Regardless of the steel grade and heat treatment, lubricating a bearing with process water will dramatically shorten its life.

Moving on, when there is surface distress due to inadequate lubrication there are numerous micro cracks in to which oil and water will be pressed by the load contact between rollers and raceways. And, we know that dissolved water has a negative influence on bearing service life. The upgraded steel is less sensitive to inadequate lubrication so, we can expect less and smaller micro cracks. Given this, dissolved water should have less influence on service life.

Changes in the clearance reduction and axial drive-up tables for spherical roller bearings and CARB toroidal roller bearings

The table showing the recommended value for reduction of radial clearance and axial drive-up **(→ page 7 in the first issue of the SKF Pulp & Paper Practices)** has recently been modified. These modified tables were first published in the SKF Bearing Maintenance Handbook (publication number 10001 EN).

The paragraphs concerning "permissible residual clearance after mounting" have been removed. This is a good thing as there will be less premature failures due to the fact that some people always want to reach the permissible residual clearance even if it gives too tight an interference fit. It is mainly because they were not understood that these residual clearance values have been taken away.

Note that the text replacing the values will not be the same as in the existing SKF Bearing Maintenance Handbook. What you should follow is the text that will appear in the new SKF General Catalogue, which is reproduced below (→ **table 1 & 2**). The SKF Bearing Maintenance Handbook will be updated at the next reprint to be in line with the new SKF General Catalogue.

As a guideline for pulp and paper applications, I recommend, unless otherwise specified by the machinery manufacturer or SKF, to use the lower half of the clearance reduction and to try to aim for the minimum value. For example, for a dryer cylinder bearing, 23152 CCK/C4W33, the clearance value is between 0,120 and 0.150 mm and you should aim for a clearance reduction of somewhere between 0,120 and 0,135 mm.

That said, I must admit that trying to reduce the clearance in small bearings with a feeler gauge isn't easy if you're trying to aim for the lower half of the clearance reduction range. With a 22314 EK felt roll bearing, for example, the clearance reduction is between 0,035 and 0,040 mm and achieving a clearance reduction just above 0,035 mm will be nearly impossible with a feeler gauge. You could easily be below 0,035 mm in reality. As such, for smaller bearings mounted using the feeler gauge method, it's better to use the full clearance reduction recommended range. Note that, with the exception of some large bearings, the maximum value of the recommended clearance reduction is lower than it was in the past.

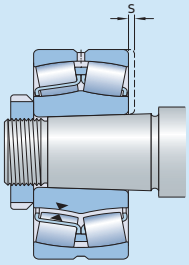
Where possible, I recommend using the SKF Drive-up method as it is much more precise. If the bearing needs a higher clearance reduction value – near or above the maximum due to load, for example – the influence on internal clearance should be taken into account. In cases of any doubt, please contact your local SKF application engineering department.

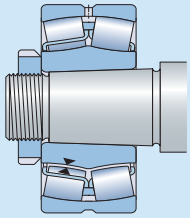
Please note that the clearance reduction and axial drive-up values, which have been used for decades, have also changed. These have worked well over the years, and were copied by other bearing manufacturers, but:

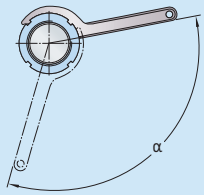
1. The table wasn't consistent with the SKF Drive-up method that uses the real thickness of the rings. Bearing ring thickness has, for most bearings, changed over the years.
2. We now have a better understanding of how interference fit can influence bearing fatigue life.
3. The basic dynamic load rating has increased. For example, for the same load and nominal life, if a bearing weighing 18 kg was needed in the 1950s, a 5,25 kg one today will do the job with much less heat generation due to friction. Due to ring thickness and elastic deformation due to load, this has a direct impact on what interference fit to chose.
4. Bearing internal geometry has also changed over the years.

Consequently, the time has come to modify the table. As promised in the first issue of SKF Pulp & Paper Practices, I will explain how to choose the correct interference fit for the operating conditions, but in a future issue. In the meantime, see the SKF Drive-up data tables (→ **table 1 & 2**) for the new recommended values for reduction of internal clearance and drive-up for spherical roller and CARB toroidal roller bearing bearings.

Philippe Gachet is an SKF application engineer who has been working with the heavy industries, particularly pulp and paper, since 1990. He can be contacted at philippe.gachet@skf.com



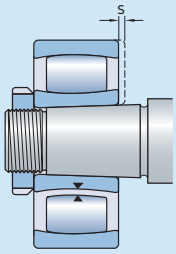


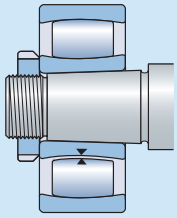


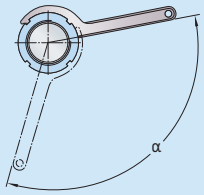
Bore diameter d		**Reduction of radial internal clearance**		**Axial drive-up s[1), 2)]** **Taper** 1:12		**Taper** 1:30		**Lock nut tightening angle[2)]** Taper 1:12
over	incl.	min	max	min	max	min	max	α
mm		mm		mm				degrees
24	**30**	0,010	0,015	0,25	0,29	–	–	100
30	**40**	0,015	0,020	0,30	0,35	–	–	115
40	**50**	0,020	0,025	0,37	0,44	–	–	130
50	**65**	0,025	0,035	0,45	0,54	1,15	1,35	115
65	**80**	0,035	0,040	0,55	0,65	1,40	1,65	130
80	**100**	0,040	0,050	0,66	0,79	1,65	2,00	150
100	**120**	0,050	0,060	0,79	0,95	2,00	2,35	
120	**140**	0,060	0,075	0,93	1,10	2,30	2,80	
140	**160**	0,070	0,085	1,05	1,30	2,65	3,20	
160	**180**	0,080	0,095	1,20	1,45	3,00	3,60	
180	**200**	0,090	0,105	1,30	1,60	3,30	4,00	
200	**225**	0,100	0,120	1,45	1,80	3,70	4,45	
225	**250**	0,110	0,130	1,60	1,95	4,00	4,85	
250	**280**	0,120	0,150	1,80	2,15	4,50	5,40	
280	**315**	0,135	0,165	2,00	2,40	4,95	6,00	
315	**355**	0,150	0,180	2,15	2,65	5,40	6,60	
355	**400**	0,170	0,210	2,50	3,00	6,20	7,60	
400	**450**	0,195	0,235	2,80	3,40	7,00	8,50	
450	**500**	0,215	0,265	3,10	3,80	7,80	9,50	**NOTE:** Applying the recommended values prevents the inner ring from creeping, but does not ensure correct radial internal clearance in operation. Additional influences from the bearing housing fit and temperature differences between the inner ring and outer ring, must be considered carefully when selecting the bearing radial internal clearance class. For additional information, contact the SKF application engineering service.
500	**560**	0,245	0,300	3,40	4,10	8,40	10,30	
560	**630**	0,275	0,340	3,80	4,65	9,50	11,60	
630	**710**	0,310	0,380	4,25	5,20	10,60	13,00	
710	**800**	0,350	0,425	4,75	5,80	11,90	14,50	
800	**900**	0,395	0,480	5,40	6,60	13,50	16,40	
900	**1 000**	0,440	0,535	6,00	7,30	15,00	18,30	
1 000	**1 120**	0,490	0,600	6,40	7,80	16,00	19,50	
1 120	**1 250**	0,550	0,670	7,10	8,70	17,80	21,70	
1 250	**1 400**	0,610	0,750	8,00	9,70	19,90	24,30	
1 400	**1 600**	0,700	0,850	9,10	11,10	22,70	27,70	
1 600	**1 800**	0,790	0,960	10,20	12,50	25,60	31,20	

Valid only for solid steel shafts and general applications.
1) Not valid for the SKF Drive-up Method.
2) The listed values are to be used as guideline values only, as it is difficult to establish an exact starting position. Also the axial drive-up s differs slightly between the different bearings series.

Table 1. Drive-up data for spherical roller bearings with a tapered bore
Table from SKF Maintenance Handbook







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80	**100**	0,040	0,050	0,66	0,79	1,65	2,00	150	
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280	**315**	0,135	0,165	2,00	2,40	4,95	6,00		
315	**355**	0,150	0,180	2,15	2,65	5,40	6,60		
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Table 2. Drive-up data for CARB toroidal roller bearings with a tapered bore
Table from SKF Maintenance Handbook

Store rooms often reflect maintenance practice

When I visit a mill for the first time, I always ask to visit the workshop and the store room for spare parts and lubricants. This often gives a useful insight into how the maintenance department operates.

I often see that the customer has chosen quality products from reliable suppliers, but then stores them in places where they will degrade fast. This is especially true for lubricants with barrels and containers put in places that are not used for any other purpose because they are small, dark, cold and dirty. That said, it is not uncommon to see bearings and seals kept in a place where it is difficult to keep order and cleanliness under control either (→ **fig. 1**).

Smaller bearings are often bought in bulk packaging and, after taking a few out, the packaging is torn and open. The products are literarily left lying there collecting dust. If the environment is humid, moisture will be absorbed by the dust and find its way deep in to the product. When such bearings are used on a machine, people wonder why they fail so fast and so often.

With larger bearings the situation is slightly different, but not any better. They are single packed, but are often taken out of the packaging to check the type. Does it have a tapered bore or a cylindrical one? Does the designation on the bearing differ from what it says on the box? Sometimes new bearings are used leaving a perfectly good box to keep bearings that were dismounted from the machine and which are assumed to be still in good order. People can then forget to change the designation on the outside of the box which can create confusion. Instead of what they think they have in stock, they have a completely different bearing in the box. That means that when a job needs such a bearing, it needs to be purchased and delivered urgently. To avoid such things from happening, training and management is needed.

It's also a question of culture: Have you ever been in an environment where the floors were dirty, the walls were black from dust and the light was dim? (→ **fig. 2**) Suppose you were to find a piece of paper in your pocket in this environment, what would you do? Many people would throw it on the floor.

Imagine now that you are in a clean environment, with shiny floors, clean walls and bright light. Would you throw the paper on the floor? I doubt it. This is an important reason to create clean workshops and store rooms. It will be simpler and more natural to keep it clean. I know a company that used white storage racks and painted their production machines white for this very reason.

At one mill that I am working with at the moment, SKF undertook a failure analysis on over 100 bearings. The bearings were collected over a few months and tagged so that their application could be identified. Analysis of the causes of failure showed that contamination was their biggest problem. This could, of course, be the result of a number of reasons including the way the bearings are stored. It turned out that new bearings in stock were already contaminated with layers of dust and light corrosion (→ **fig. 3**). To eliminate this problem, the store rooms were upgraded.

We found a similar situation with the mill's lubricants. On inspection, we learnt that there was water in the lubricant before it was even used (→ **diagram 1**). This was the result of poor storage practices.

Fig. 1 Bearings, if left unpackaged, collect dust

Fig. 2 Dust is captured in open grouting.

Fig. 3 Bearing, in storage, corroded by humidity.

Like bearings or valves, lubricants should be considered as working components in mechanical systems. Just as one would not install a dirty or damaged bearing on a piece of equipment using the wrong tools, "damaged" lubricants should not be added to the machine. The first step toward achieving proactive maintenance of your lubricants, and ultimately your equipment, begins with proper in-plant storage and handling.

Some basic guidelines, based on my experience, follow.

Storage of parts

Lighting

Adequate lighting is important in a store room setting. Think about your general lighting needs first and then about specialized needs for specific areas. There are different lighting options available, but for a store room the minimum is 200 lux.

Floor

Firstly, the floor of a store room should have sufficient load-carrying capacity. Laden forklift trucks can damage floors easily. Racks can also easily create a high load on the floor.

Floors should be easy to clean. This means that dirt should be easy to detect and remove. Therefore, seamless and light coloured floors with a smooth, shiny surface are recommended. There are a number of suitable solutions on the market like epoxy or urethane.

Walls

Store room walls should be able to carry all the necessary racks and boards. They should be light coloured to create a bright working environment. They should be sealed and not have edges or ridges where dust can accumulate.

Ceiling

The ceiling should be sealed and not have any areas where dust can accumulate. It should be no lower than 2,40 m to ensure adequate ventilation and space for personal manoeuvrability. This often is determined by law. Depending on the roof construction, the ceiling may need to be insulated in order to keep a constant temperature inside without having high costs for cooling in summer and heating in winter.

Racks

For storing bigger parts it is advisable to use racks in the store room that can be adjusted in height. In this way the racks can be used in the most efficient way (→ **fig. 4**) Because the ceilings of rooms are often high, the room can be arranged efficiently in this way. For the smaller parts, smaller racks can be used.

Parts should never be left on the floor either in the store room or the workshop. Left on the floor, the parts cannot be located, There should be a place for everything and everything should have a place. On top of that, parts may get dirty or even damaged by trolleys or trucks.

Recommended storage time

For the recommended storage time of bearings, see (→ **table 3**). The limitation on storage is due to the preservatives, the lubricant, the sealing and the packaging material itself (→ **fig. 5**).

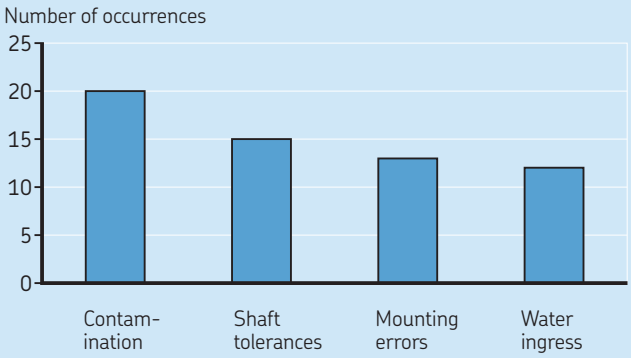

Diagram 1 Bearing failure analysis

Fig. 4 Racks with adjustable shelves

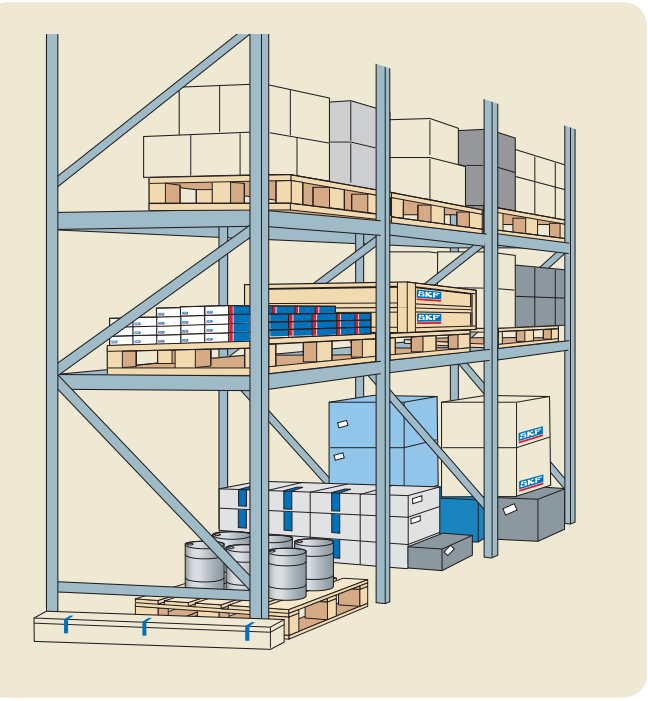

Table 3 Recommended maximum storage time (from the packing date)[1)]

Relative air humidity	Temperature	Storage time
%	°C	years
60	20–25	10
75	20–25	5
75	35–40	3
Uncontrolled tropical conditions		1

[1)] Recommendation is valid for open bearings only.
For lubricated (sealed) bearings, recommended time is 3 years maximum.

Fig. 5 Old bearings in storage (dated 1971 – 1977)

Storage of lubricants

Most lubricants have supplier recommended shelf lives based largely upon the additive package. For example, the performance of lubricants containing rust inhibitors may degrade after as little as six months in storage. Learn how to read the coded date on the container label. Shelf life is based on ideal storage conditions and most manufacturers provide a recommended storage procedure to maximize lubricant shelf life. The following conditions have been proven to adversely affect a lubricant's storage life:

1 Temperatures

Temperature fluctuations will cause movement of air between the atmosphere and the head-space of the container. For partially full containers, with greater head-space, this air movement is increased. Although the drum is sealed and does not leak lubricant, a container still inhales air when the temperature drops and exhales as the temperature rises. Along with the air, moisture and small airborne particles enter the oil container possibly leading to degradation of the base stock and additives. Also, water might condense within the drum, drop to the bottom and get pumped to the machine during a top-off. Extreme hot or cold can cause chemical degradation. As mentioned earlier, rust inhibitors may suffer significant performance losses after only six months of normal storage.

2 Humidity

Petroleum-based lubricants are hygroscopic. When exposed to humid air, they naturally absorb airborne moisture. The moisture immediately begins to degrade the additive package and accelerates oxidation of the lubricant's base stock once it is put into service.

Fig. 6 Horizontal storage

3 Storage

Containers and drums must be stored in a clean and dry location. Storage temperatures should remain moderate at all times. Lubricants in storage should be located away from all types of industrial contamination including dust and humidity. Ideally, lubricants are stored in the horizontal position on proper storage racks allowing the containers to be rotated and used on a first-in, first-out basis (→ **fig. 6**).

While indoor storage of lubricants is recommended, this is not always possible due to environmental, financial or space constraints. If lubricants must be stored outdoors, track lubricant consumption carefully and replenish inventories "just-in-time" to minimize exposure to adverse conditions. If lubricants must be stored outside, shelter them from rain, snow and other elements. Lay drums on their sides in a horizontal position with the tap point below the lubricant level. This will greatly reduce the risk of the seals drying out and the ingestion of moisture caused by breathing. If the drums must be placed upright in outdoor storage, employ drum covers or tilt drums to drain the moisture that gathers on the top around the bungs. Avoid outdoor storage of water-based fluids where extreme temperatures can have an even more damaging effect through freezing and evaporation.

Once the seal is broken and the container is put into use, care must be taken to ensure control over contamination ingress. If equipped with a proper pressure relief, bulk tanks should use filter breathers to control contamination ingestion. Drums and pails should be capped when not in use. If your drums are frequently used, bung breather filters may be your best solution.

When you prepare a meal, you want it to be prepared in a clean kitchen using fresh, good quality ingredients. Then you are sure that the end result will only depend on the way that the meal is prepared. In maintenance, you want to make sure that the materials you are using are in good condition and kept in a clean environment. A lot of unnecessary failures can be prevented this way. It is a small investment for a significant benefit.

Regards,
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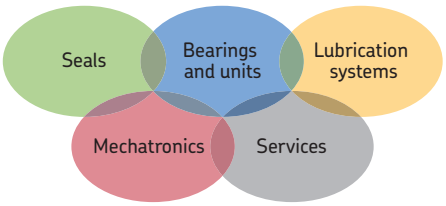

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