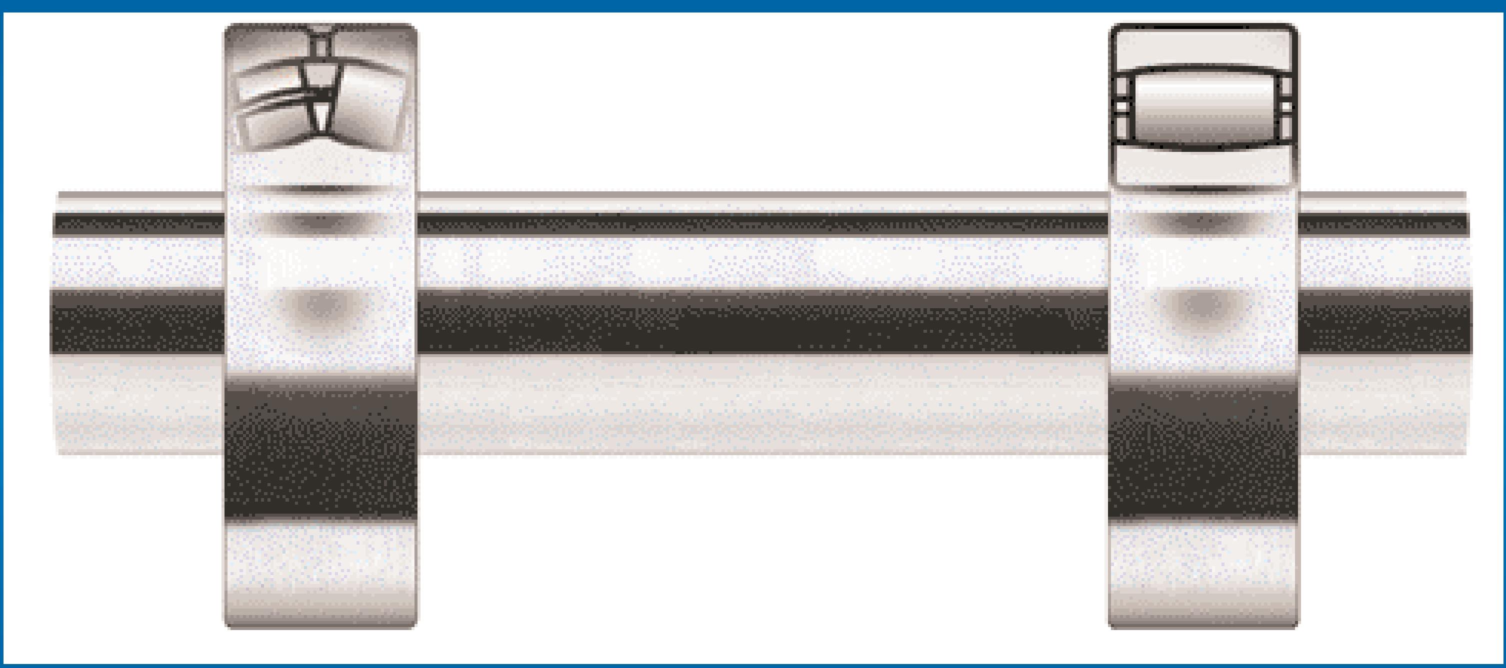
Self-aligning bearing systems



Contents

Made by SKF® stands for excellence. It symbolises our consistent endeavour to achieve total quality in everything we do. For those who use our products, “Made by SKF” implies three main benefits.

Reliability – thanks to modern, efficient products, based on our worldwide application know-how, optimised materials, forward-looking designs and the most advanced production techniques.

Cost effectiveness – resulting from the favourable ratio between our product quality plus service facilities, and the purchase price of the product.

Market lead – which you can achieve by taking advantage of our products and services. Increased operating time and reduced down-time, as well as improved output and product quality are the key to a successful partnership.

Summary

SKF's new self-aligning bearing system consists of a CARB® toroidal roller bearing as the non-locating bearing in combination with a double row spherical roller or self-aligning ball bearing as the locating bearing.

The bearing arrangement accomodates both misalignment and axial adjustment internally and without frictional resistance, with no possibility of generating internal axial forces in the bearing system. Due to the ideal interaction between the two bearings, the applied load is always distributed consistently and in the assumed (theoretical) manner between all load-carrying elements.

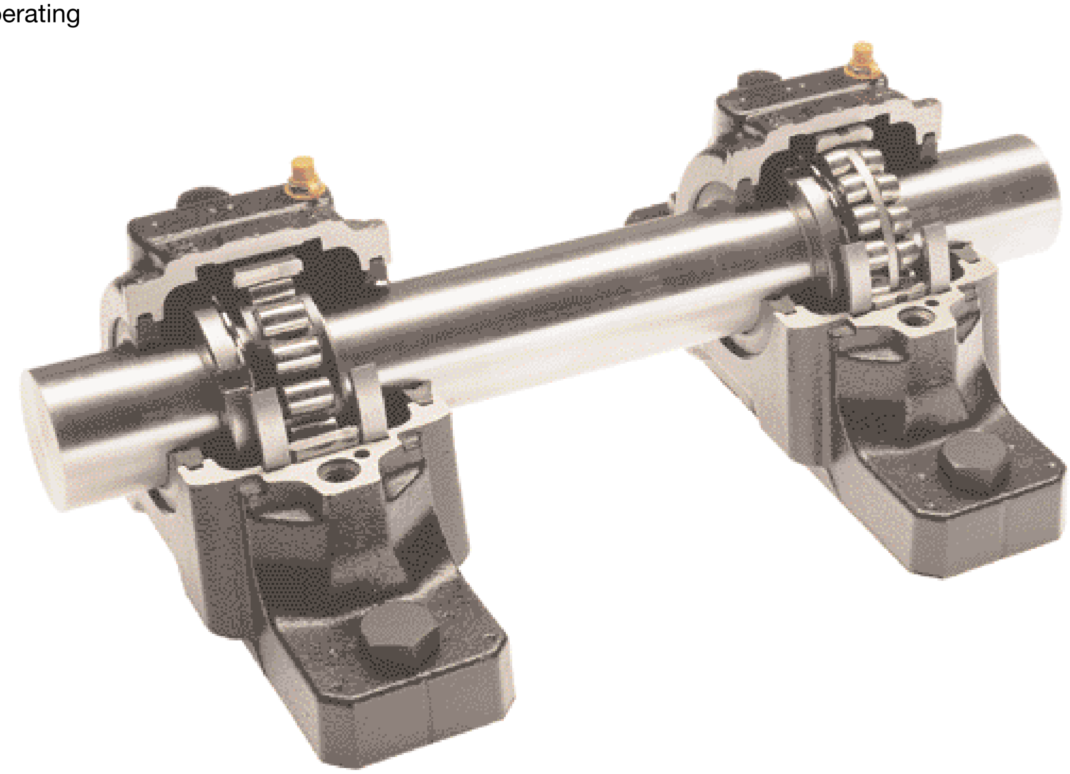
The design characteristics of both bearings in the new system are fully exploited; they function as the machine designer intends and assumes they should. This is often not the case with other bearing systems, which have some compromise in the arrangement which produces non-ideal operating conditions.

The new compromise-free SKF system delivers increased reliability and performance, enabling designers to confidently optimise the selection of bearings and the machine construction as a whole.

Both manufacturers and end users of machines achieve significant cost reductions through a leaner design and improved productivity.

Depending on the machine and application, the benefits seen with SKF's new self-aligning bearing system are:

- safer, more optimised designs
- increased bearing service life
- extended maintenance intervals
- lower running temperature
- lower vibration and noise levels
- greater throughput of the machine
- same throughput with a lighter, or simpler machine
- improved product quality/less scrap



The traditional self-aligning bearing arrangement

Bearings in rotating equipment

In typical industrial equipment, rotating shafts are generally supported by two anti-friction (rolling) bearings, one at each end of the shaft. In addition to supporting radial loads, one of the bearings must position the shaft axially with respect to its supporting structure, as well as carry any axial loads which are imposed on the shaft. This bearing is referred to as the "locating", "fixed" or "held" bearing.

The other bearing must also carry radial load, but should accommodate axial movement in order to compensate for:

- thermal elongation and contraction of the shaft or structure with temperature variations,
- manufacturing tolerances of the structure, and
- positioning tolerances at assembly of the machine.

This second bearing is referred to as the "non-locating", "floating" or "free" bearing.

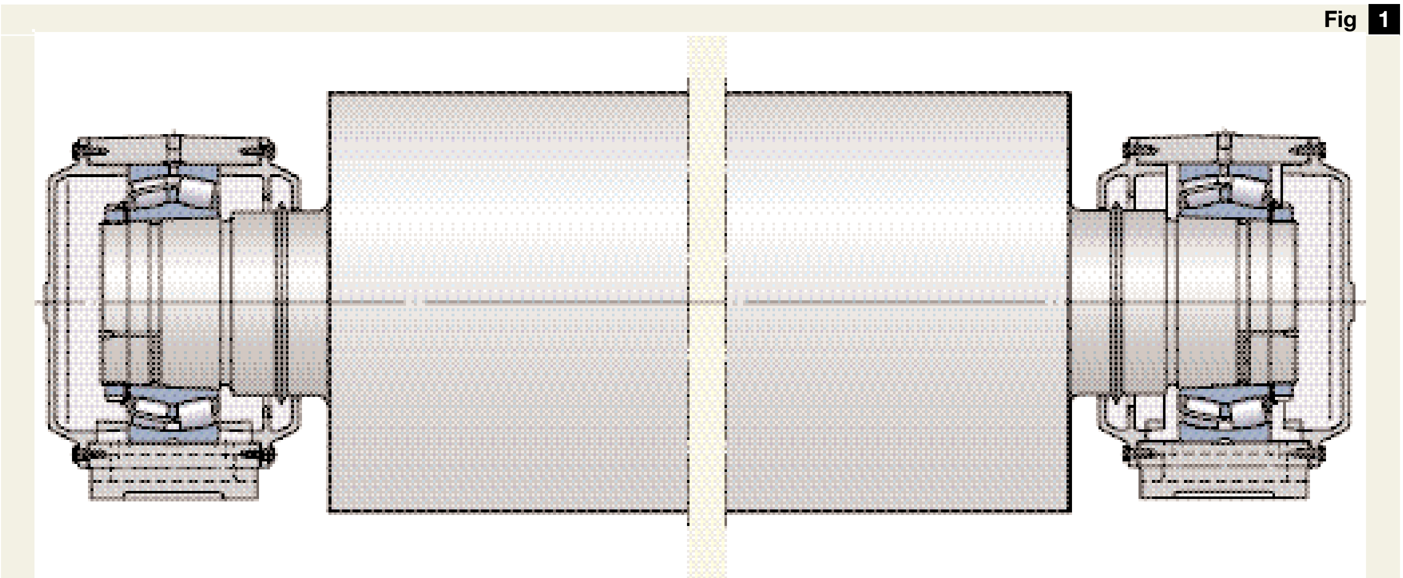
Using a self-aligning ball or a spherical roller bearing at both positions

This bearing combination has long been the basis of many industrial bearing arrangements – a simple, robust arrangement capable of withstanding high radial as well as thrust loads whilst easily internally accomodating the misalignment typically imposed through machining and assembly tolerances, thermal distortion or deflection under load. There are, however, consequences to using self-aligning ball bearings or spherical roller bearings in the non-locating position (➔ **fig 1**).

The non-locating bearing must slide axially, usually inside the housing, to accommodate shaft expansion or contraction. To achieve this movement, one of the bearing rings must be mounted with a loose fit and axial space needs

Traditional arrangement of two self-aligning bearings with the bearing to the right "axially free"

Fig 1



to be provided for the intended movement. In many cases, the loose fit compromises the design of the machine, as under certain load conditions, the bearing ring will spin and damage the housing, accelerate wear and increase vibration, which all adds up to additional maintenace and repair costs. It also means that the shaft is supported less rigidly in the radial direction.

Cause of bearing system failures

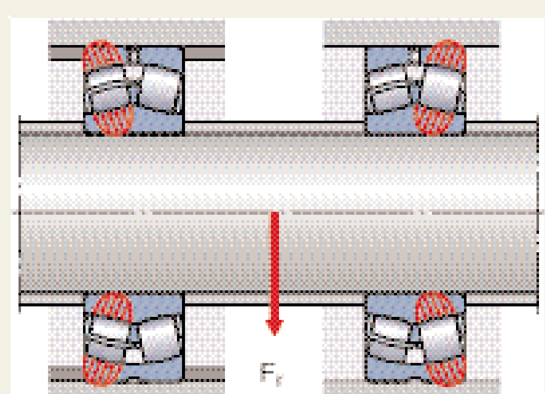
If a loose fit is needed for axial movement of the non-locating bearing, then it is necessary that the fit remains loose during operation. Maintaining this loose fit is not as simple as it sounds:

- At start-up, machine components must heat up to normal operating temperature. The outer ring of the bearing usually expands faster than the housing bore. This different rate of expansion can eliminate clearance and restrict axial movement.
- If the bearing housing seating form is not within specification (either manufactured with ovality or taper, or, more commonly, distorted in the application due to being mounted on a base which is not sufficiently flat and rigid – either from the beginning or when the machine is loaded) then the bearing ring will be held in place and be unable to move to accommodate the required axial movement.
- The wear process from the loose ring under unfavourable load conditions can also create a condition known as fretting corrosion, which can effectively “rust” the bearing ring in place.

If the non-locating bearing ring cannot move for any of the above reasons, then both bearings become axially preloaded, meaning that as the shaft or structure changes temperature and therefore length, very high axial loads are generated between the two bearings (➔ **fig 2**). This is a well-known consequence of the compromise brought about by the need for a loose fit of the non-locating bearing in this type of arrangement.

Non-locating bearing restricted from axial motion

Fig 2



Influence of friction

A more general, but less recognised, consequence of a bearing installed with a loose fit is that there is always a certain amount of friction between the loose bearing ring and the housing (or shaft) seating. In order for the shaft to expand or contract in the axial direction, it must first overcome the frictional resistance at the sliding contact. This resistance has the magnitude $F_a = F_r \times \mu$, where F_a is axial force, F_r is the radial load carried by the non-locating end bearing, and μ is the coefficient of friction between the loose bearing ring and the housing or shaft (for steel-steel and steel-cast iron interfaces, values for μ are typically around 0,12–0,16 for surfaces in good condition). Therefore, both bearings on the shaft are subjected to an additional thrust load, equivalent to several percent of the radial load (➔ **fig** 3). As a result of these internal thrust forces, the load distribution within the bearings is adversely affected, with each row of rollers carrying a different load (➔ **fig** 4).

Unstable load distribution

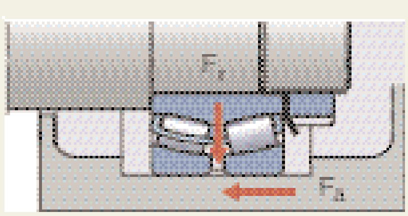
In cases with relatively high speeds, the load distribution is variable and unstable. To visualise how this mechanism occurs, picture the inner ring of one bearing being slightly askew on the shaft relative to the true axis of rotation – this is a common situation, typically a result of machining inaccuracy of the shaft, deflection of the shaft, combination of tolerances of shaft, adapter sleeve and bearing ring, and mounting inaccuracy. Then, as the inner ring rotates, it performs a very small “wobbling” motion, which imparts a small axial oscillation to the shaft. This oscillation is then transmitted to the inner ring of the second bearing in the shaft arrangement. As the inner rings move back and forth with a frequency equal to the shaft speed, the two rows of rollers are alternately loaded and unloaded (or at least change the amount of load they experience). In some cases, the axial motion is transmitted to the outer ring of the non-locating bearing, bringing about axial ”scuffing” or fretting wear in the housing. The typical results of this uneven load distribution can be generalised as:

- in high load applications – elevated internal stresses, elevated temperature, impaired lubrication, accelerated bearing wear, reduced bearing fatigue life (reduction in fatigue life can be calculated)
- in high speed applications – high operating temperatures, alternating acceleration and deceleration of the roller sets with fluctuating load distribution, high forces on the bearing cages, increased rate of wear, high vibration and noise levels, rapid deterioration of grease, general reliability problems. (It is not possible to calculate any of these effects – this is the distinction between fatigue life and service life.)

These factors occur to a greater or lesser extent in all such bearing arrangements, even when the components are new and tolerances are within specification. If there is something other than normal friction which prevents movement of the non-locating bearing ring then the situation is equivalent to having a very high coefficient of friction (μ) at the non-locating bearing, and the adverse effects during operation are correspondingly severe.

Friction between outer ring and housing induces axial load

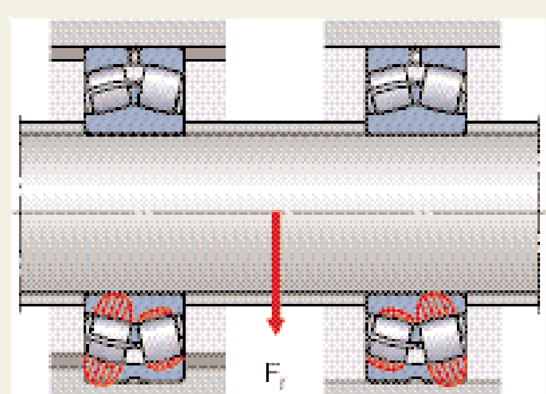
Fig 3



$F_a = F_r \times \mu$

Uneven load distribution due to axial friction forces

Fig 4



A typical example of shaft expansion and its effects

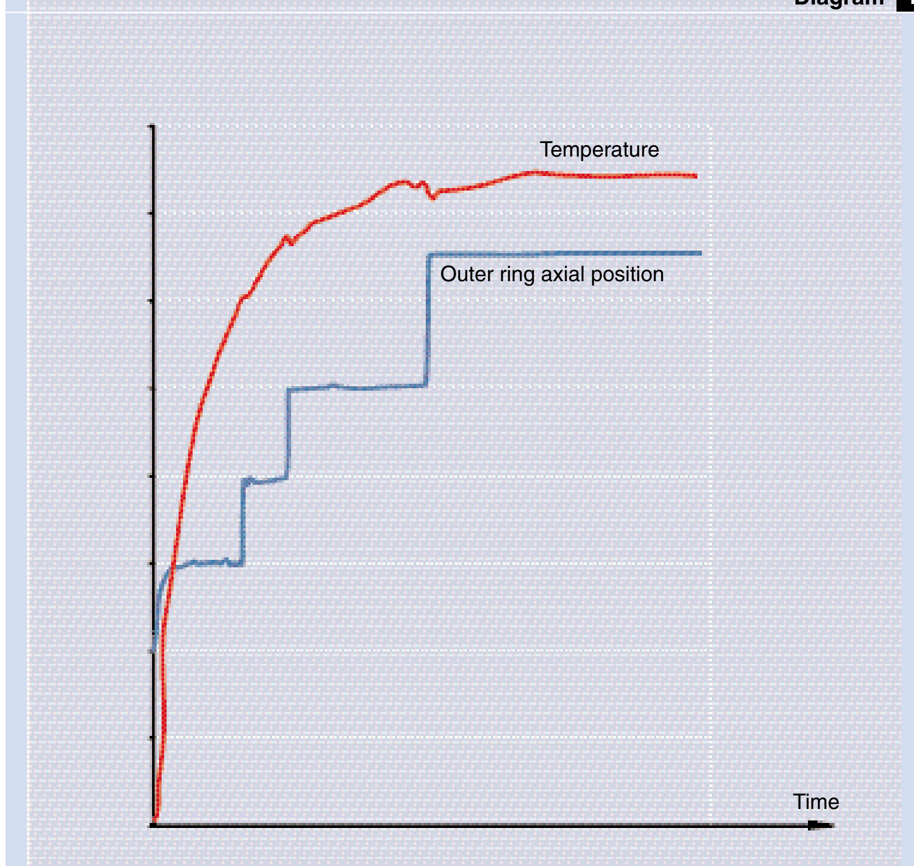
Diagram 1 shows measurements taken at the outer ring of an oil-lubricated spherical roller bearing at the non-locating position on a paper machine roll, during the machine start-up period.

It is apparent that the friction between the bearing and the housing is real and does have a significant effect on the bearing arrangement. As the operating temperature increases, the outer ring axial movement is characterised by stationary periods, with occasional sudden large movements. It is clearly noticed that the movements only occur when the axial forces have built to such a level that the stick-slip friction is overcome. With each movement of the outer ring, there is an immediate and noticeable reduction in the operating temperature, as the internal axial load is reduced.

This process is repeated until (or unless) a steady-state operating condition is reached, and then will be repeated (in reverse) with any decrease in temperature of the shaft or structure. (Shutdown, idle running, change in process parameters.) During steady state running conditions, it is likely that there will be some residual axial loading (uneven load distribution between the roller sets)

Note that for SKF “CC” and “E” spherical roller bearings, the ratio of axial load to radial load must be quite high (15 % or more) before there is a significant increase in the total rolling friction inside the bearing (total friction = load-dependent friction + viscous friction from the lubricant). Therefore, for bearings under nominally pure radial load, there must be a significant axial force resulting from friction between the bearing ring and housing in order for temperature variations such as those in the diagram to be noticeable. The fact that a change in temperature is easily measured shows that the friction factor acting will be > 0,1.

Diagram 1



Axial position of outer ring and corresponding bearing temperature during start-up

Axial force over time – characteristic examples

The size of the induced axial forces, in the traditional self-aligning bearing arrangement, and the way in which they vary over time (and therefore what the average force – average equivalent friction factor μ – over the lifetime of the bearing system will be) depends on a large number of different, and largely unpredictable parameters, including:

- the initial mounted radial clearance in each bearing
- the amount and direction by which the inner and outer rings of each bearing are axially offset relative to each other after mounting
- the magnitude of the radial load on the non-locating bearing
- the nature of the radial load on the non-locating bearing (steady or fluctuating, uni-directional or random)
- level of vibrations from outside sources
- surface finish of the non-locating bearing ring and seating
- lubrication conditions between non-locating bearing ring and seating
- looseness of fit (individual diametrical tolerances of the non-locating bearing ring and seating
- form tolerance of the non-locating bearing seating (ovality and taper)
- distortion of the non-locating bearing seating with load
- distortion of the non-locating bearing seating with thermal changes
- relative rate of thermal axial expansion (contraction) of rotating and stationary components (shaft and structure)
- relative rate of thermal radial expansion (contraction) of non-locating bearing ring and seating
- axial stiffness of the supporting structure

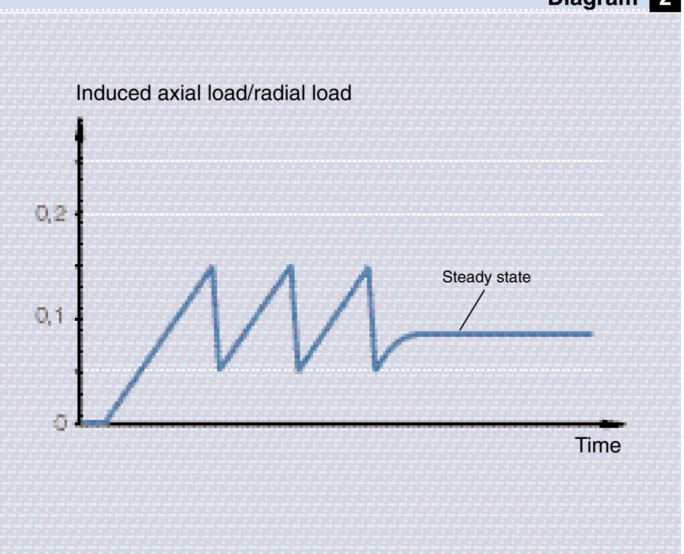
It is obvious that more internal clearance is beneficial in reducing the chance of high induced axial forces. However, excessive clearance also means that few rolling elements carry the load, which also results in reduced bearing fatigue life, and there is in general a higher risk of poor operating conditions within the bearings.

In the examples below it is assumed that the shaft expands in relation to the structure.

Except with very precise tolerances and painstaking measurements at assembly, it is impossible to know what will actually occur with any individual machine.

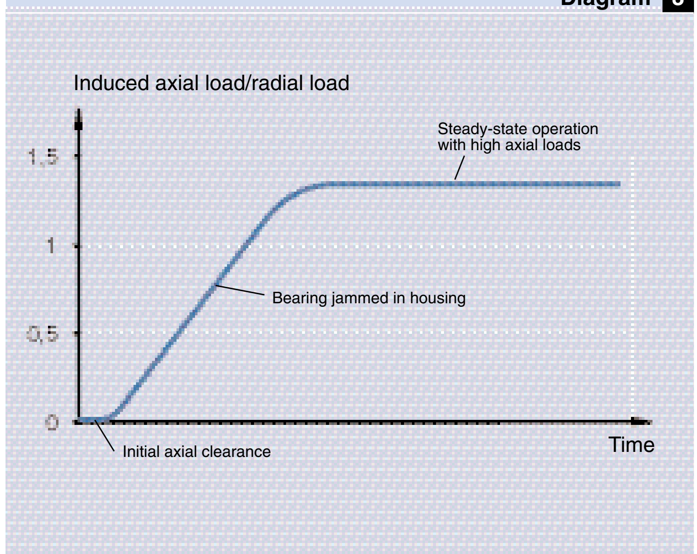
Small initial axial clearance (rings centred at mounting) – start-up period

Diagram 2



Bearing jammed in housing

Diagram 3



The new self-aligning bearing system

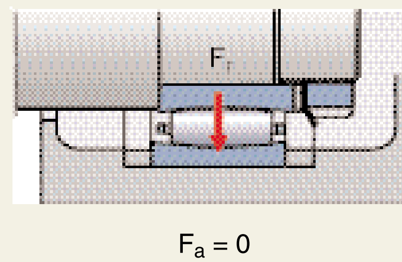
Until recently, the design compromises in each case simply had to be accepted. Now, however, a completely new design of non-locating rolling element bearing has enabled all the compromises to be eliminated from shaft/bearing systems.

The new bearing type is the toroidal roller bearing, so called because of the form of the curvature at the contact surfaces within the bearing. The toroidal roller bearing has a single row of long rollers with a slightly curved profile. The internal design enables the bearing to accommodate axial movement internally, like a cylindrical or needle roller bearing, without any frictional resistance. This eliminates the need for a loose fit for any of the bearing rings. There is also no possibility for generating additional axial (thrust) forces between the two bearings on the shaft (➔ **fig 1**).

In addition to eliminating all the axial interaction between the bearings, the roller and raceway profile in the toroidal roller bearing is designed to automatically adjust the roller position inside the bearing so that the load is distributed evenly along the roller contact length, irrespective of any misalignment. This means that there is no possibility for high edge stresses, so the bearing always operates at the optimum stress level, and therefore achieves its theoretical fatigue life under all conditions (➔ **fig 2**).

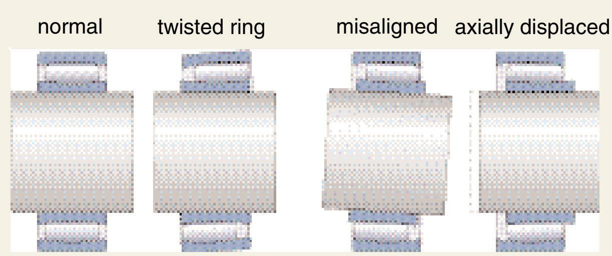
The combination of the self-aligning properties, and the frictionless axial adjustment, ensures that the load is distributed as evenly and consistently as possible along all the rows of rolling elements in both bearings on the shaft. The actual distribution will depend on the externally applied radial and axial loads. An optimised load distribution will mean that stresses are low, temperature is minimised, maximum fatigue life is always achieved, and the chance of vibrations and cage damage are reduced. In addition, because tight fits can be used for all bearing rings in the system, the risk of worn out housings due to spinning rings can be eliminated (➔ **fig 3**).

Fig 1



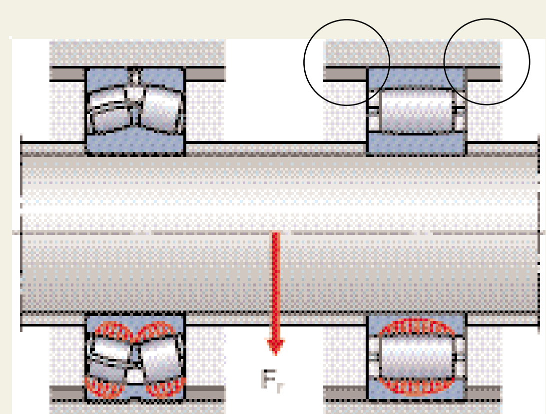
No axial force induced with toroidal roller bearing

Fig 2



Toroidal roller bearing contact surface ensures even load distribution along roller length

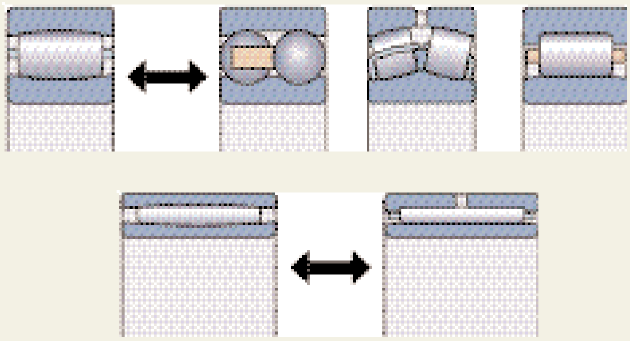
Fig 3



Please note that when using CARB, the outer ring of the non-locating bearing must also be fixed!

No internally induced axial load ensures even load distribution in both bearings

Fig 4



CARB® is available in various ISO Dimension Series

SKF toroidal roller bearing

The first toroidal roller bearing was introduced by SKF in 1995. Known as CARB®, the new bearing is available in a range of ISO Dimension Series, equivalent to self-aligning ball and spherical roller bearings used in standard bearing housings and other common types of assemblies. The range also covers wide, low section series equivalent to needle roller bearings (➔ **fig** 4).

CARB enables machine manufacturers and users to optimise bearing arrangements, simply by substituting the equivalent size toroidal roller bearing at the non-locating bearing position. The locating bearing remains as before, and other standard components (housings, adapter sleeves etc.) are utlilised. This new standard bearing system ensures that the potential for unreliable bearing performance and reduced service life is avoided, thereby reducing maintenance requirements and increasing machine availability.

Low load performance

One potentially beneficial feature in many applications of bearing arrangements using CARB and a double row bearing as the fixed bearing, is that due to the optimised load distribution, the system is perfectly suited to deliver maximum fatigue (L_{10}) life under heavy load conditions, but will also function very well at low load levels, compared with the traditional solution using two double row bearings. The reason for the reduced susceptibility to underloading can be explained as follows:

– any row of rolling elements must be subjected to a certain minimum radial load, so that the roller set rotates smoothly at a near-synchronous speed. This minimum load reduces damage from skidding of the rollers (raceway smearing damage, cage hammering, noise, vibration, elevated temperatures, grease degradation). The amount of load needed depends on the mass of the rolling elements, the rotational speed, and the lubricant viscosity.

In a spherical roller bearing which is operating with pure radial load, both rows of rollers share the load equally. (necessary radial load factor = 1 from **Diagram** 1).

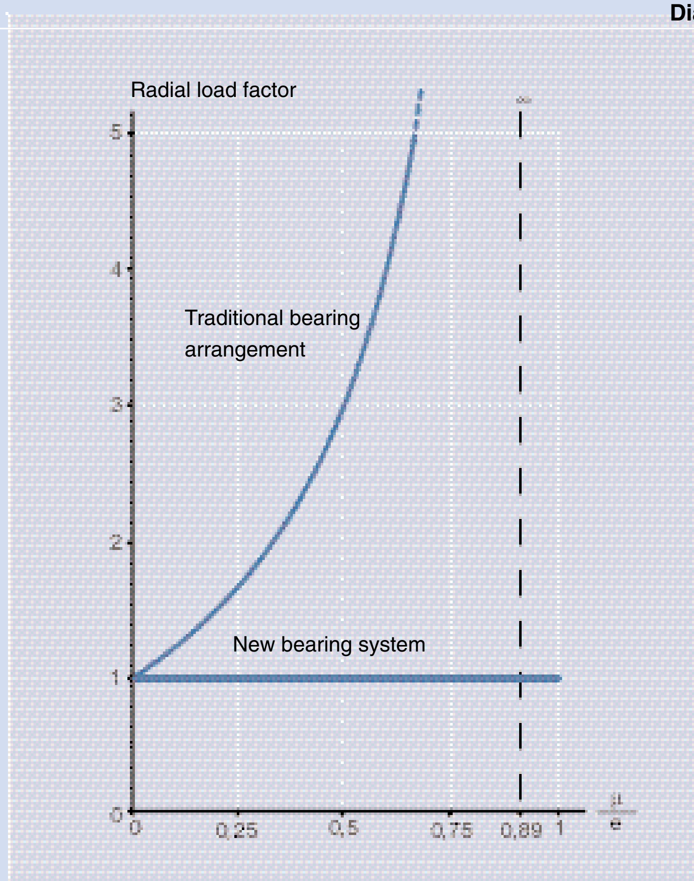
However when there is any axial adjustment of one bearing ring relative to the other, the load distribution changes, and the effective load on one row is reduced (➔ **fig** 4 on **page 6**). Therefore, in order to be sure that the least loaded row still has enough load to keep it rotating properly, the total radial load on the bearing must be increased (i.e. multiplied by a radial load factor, ➔ **Diagram** 1) for a given friction factor μ between outer ring and housing when shaft axial displacement occurs (given ratio of axial to radial load) in order to maintain the required minimum load level on the least loaded row.

In **Diagram** 1 e is the calculation factor for spherical roller bearings which is given in tables of the SKF General Catalogue. The factor e varies between 0,15 and 0,40, depending on bearing contact angle.

In a traditional shaft arrangement with two spherical roller bearings, where friction between the non-locating bearing ring and housing means that the load distribution is rarely perfect, the radial load required for satisfactory operation is drastically increased compared with an ideal system, and for equivalent friction factors approaching 0,89 it is not possible to adequately load the bearings.

If a toroidal roller bearing is used at the non-locating position then with purely radial externally applied loads both rows of rollers in the locating spherical roller bearing should always be equally loaded. Therefore the radial load factor to be used to determine the applied load required to achieve satisfactory operation is always equal to 1 as described in **Diagram** 1.

Diagram 1

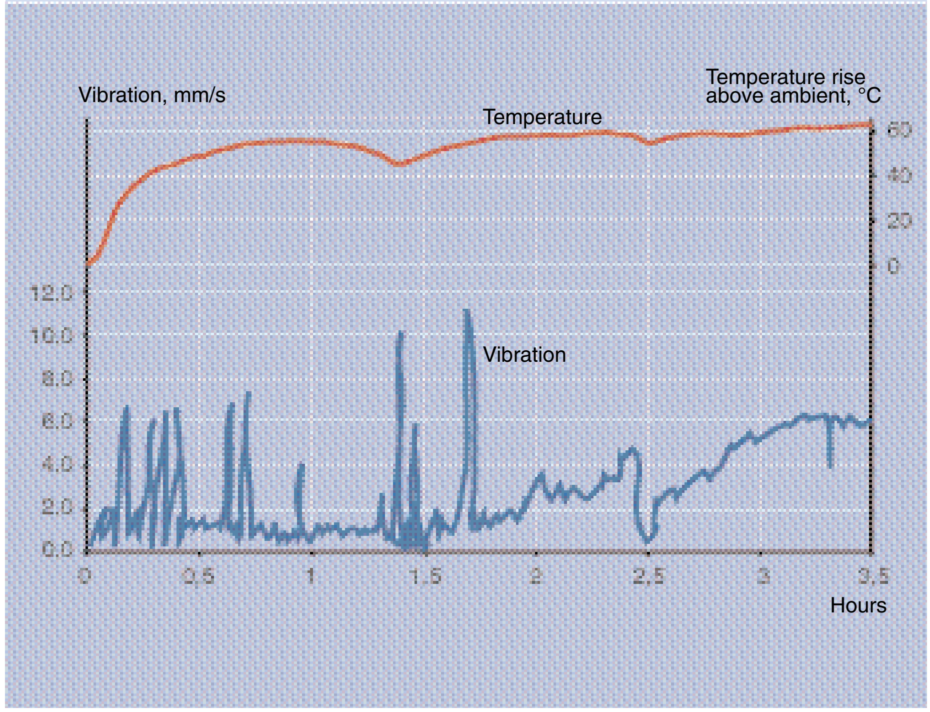


Required radial load for smooth operation of two spherical roller bearings, as a function of housing friction

Improvement of operating conditions and reliability

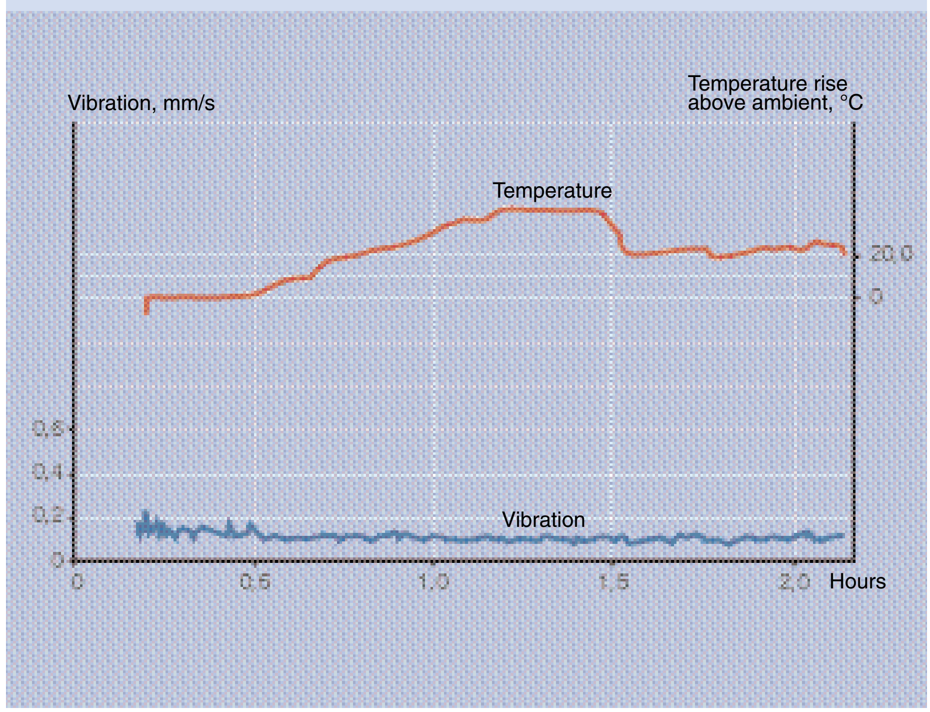
The following three examples demonstrate the immediate improvements in operating parameters (temperature, vibration levels) and consequently the increased reliability/decreased maintenance effort which is obtained through the better internal load distribution as a result of the frictionless axial freedom in the toroidal roller bearing. The first case (➔ **Diagram** 2 and 3) is a very large axial flow fan, which was originally equipped with spherical roller bearings (size 22244/C3) at both locating and non-locating positions. During commissioning the overall vibration level fluctuated greatly with intermittent very high peaks and high bearing temperature at approximately 60 °C above ambient (➔ **Diagram** 2). The non-locating bearing was then replaced by the toroidal roller bearing of the same size (C 2244/C3). The result was the elimination of the high vibration peaks and quick stabilisation of bearing temperature at approximately 20 °C above ambient (➔ **Diagram** 3).

Diagram 2



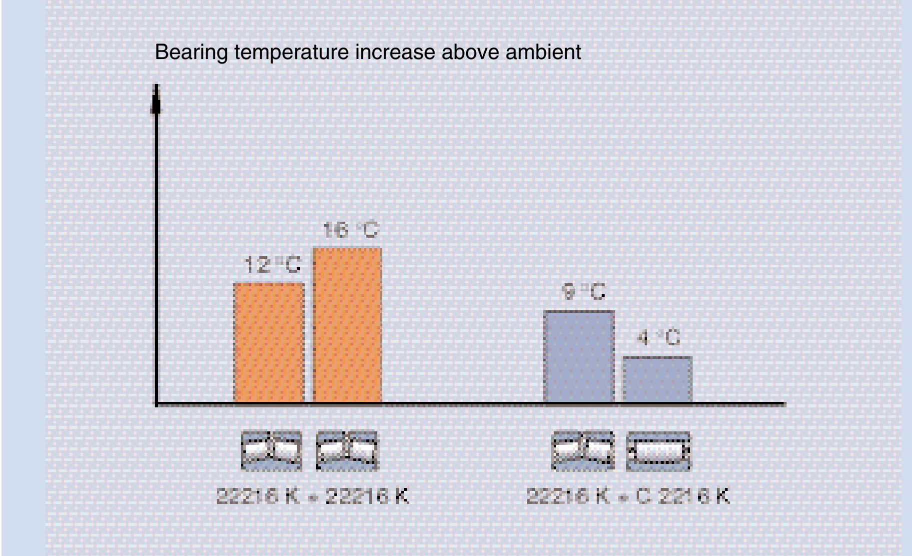
Fan with spherical roller bearing 22244/C3 at both positions

Diagram 3



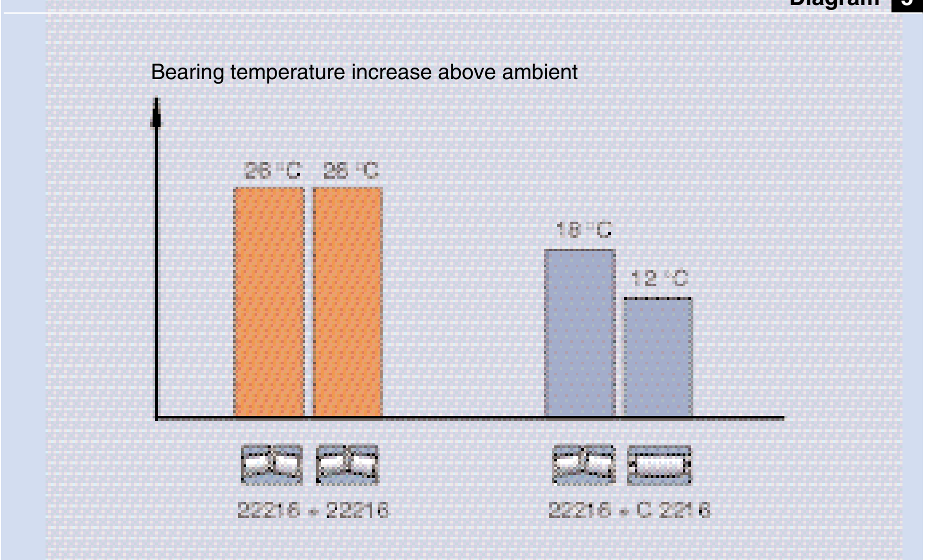
The same fan with toroidal roller bearing C 2244/C3 at non-locating position

Diagram 4



Industrial fan rebuilt with toroidal roller bearing. Grease lubrication, 3 000 r/min

Diagram 5



Industrial fan rebuilt with toroidal roller bearing. Oil lubrication, 3 000 r/min

Two other real cases of rebuilds of industrial fans are shown in **Diagram** 4 and 5. Both examples are conventional centrifugal fans where the non-locating spherical roller bearings were replaced by toroidal roller bearings of the same size.

In both fans, the operating temperature of the non-locating bearing dropped dramatically; the locating bearing temperature was also reduced but to a lesser extent. (This is as expected, as the locating bearings carry some axial load from the fan impellers and therefore should run somewhat hotter than the non-locating bearings.)

Cost reduction through downsizing

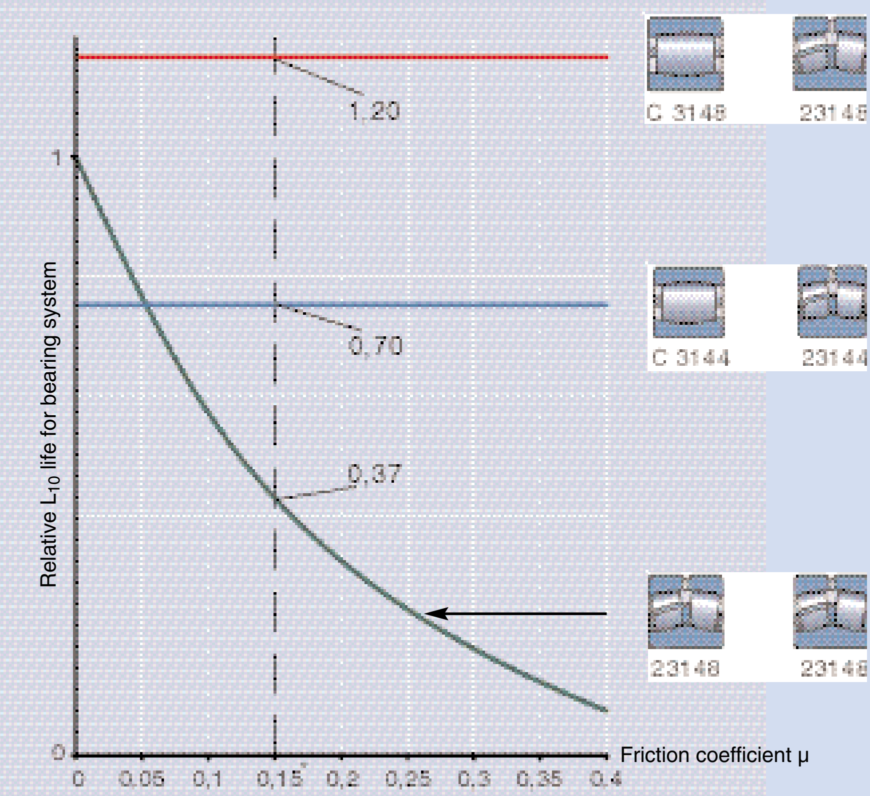
In addition to the obvious performance enhancements, operating cost reductions and productivity improvements that the CARB/spherical solution can give, there are additional benefits that can be realised from this new and unique self-aligning bearing system. The bearing system with CARB as the non-locating bearing has no internally generated thrust forces ($F_a = 0$ for both bearings) whereas traditional bearing arrangements do have thrust forces ($F_a = F_r \times \mu$ for both bearings). From this it is a simple matter to calculate the difference in fatigue life obtained in each system. In cases where the life of a conventional arrangement restricts machine performance, substituting a toroidal roller bearing at the non-locating position could significantly extend service life.

Where a conventional arrangement provides adequate service life, then using the new bearing system design, but with smaller bearings in both positions, can also often achieve the required life (➔ **Diagram** 6). Therefore, there can be significant opportunities to not only use smaller, less expensive bearing assemblies without the risks of failure associated with axial preloading and general lack of axial freedom, but also to reap the flow-on cost benefits by the consequential size and weight reduction of other structural components.

For example, if one size smaller bearing, housing, seal and adapter sleeve assembly can be utilised at each end of a shaft, then the potential savings can include:

- bearing assembly purchase price
- bearing assembly weight
- shaft diameter and length reduction (material cost and weight savings)
- support structure size and weight reduction[1] (material cost and weight savings)
- less stringent machining and assembly tolerances[1] (production time savings)
- transportation cost reduction as a result of decreased overall machine weight

Diagram 6



*) μ = 0,15 for steel against cast iron

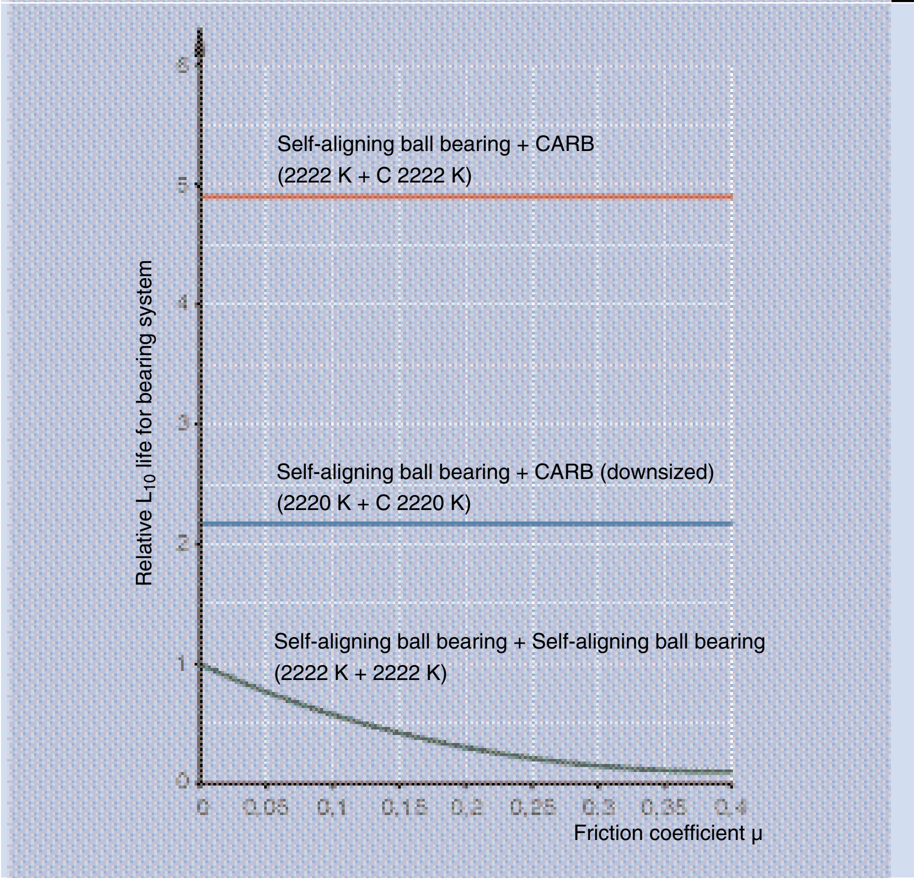
The new self-aligning bearing system can give better life even with smaller bearings

[1] As there is no risk of cross-location of the bearings due to the frictionless internal axial movement in CARB, there is less importance placed upon the form and rigidity of the supporting structure for the bearings, meaning that lighter, more flexible and less precise components can be tolerated without a corresponding reduction in bearing performance.

Low load, high speed

In high speed applications where there are light loads and the possibility of misalignment, self-aligning ball bearings have been the standard solution. These applications can also benefit greatly from using the toroidal roller bearing at the non-locating position, for all the same reasons as described previously for the spherical roller bearing solution. Self-aligning ball bearings are much more susceptible to damage from axial preloading than spherical roller bearings, so eliminating the possibility of friction-induced axial forces has even greater significance in avoiding premature failure (➔ **Diagram** 7).

Diagram 7



System life comparison for self-aligning ball bearings

Eliminating risk of poor operating conditions

The diagrams showing comparative bearing system lives (➔ **Diagram** 6 and 7) are simplifications.

The calculations assume that there is no external axial load on the shaft system, and that both bearings carry nominally radial load (such as a belt conveyor pulley, paper machine roll, continuous caster roll, table roll). The axial forces used to determine the L_{10} fatigue life are then only those generated within the bearing system itself.

Should there really be external axial forces (which is often the case) then the calculated difference between the two types of bearing system will be reduced; the slope of the curve for the traditional arrangement will be less, sometimes appreciably so. Nevertheless, the same principle applies, in that the traditional bearing arrangement will still experience some variation of the internal load distribution due to internally generated forces, in addition to the nominal externally applied loads, whereas the new system will not.

For any specific case, it is almost impossible to know what the equivalent "average" value of μ will be over the life of the bearing system (i.e. which position on the x-axis of the graph is relevant). As seen earlier, there are an infinite number of combinations involving bearing clearance, initial offset, housing bore tolerance and condition, etc.

Some machines may operate with a low "average" μ, but there is always a significant chance that an individual machine may have a high average μ for any number of unquantifiable reasons.

The new self-aligning bearing system, with a toroidal roller bearing in the non-locating position, eliminates any possibility of the high μ factor, as by definition μ is always equal to zero.

Note:
Bearing system fatigue life = $L_{10,\,sys}$

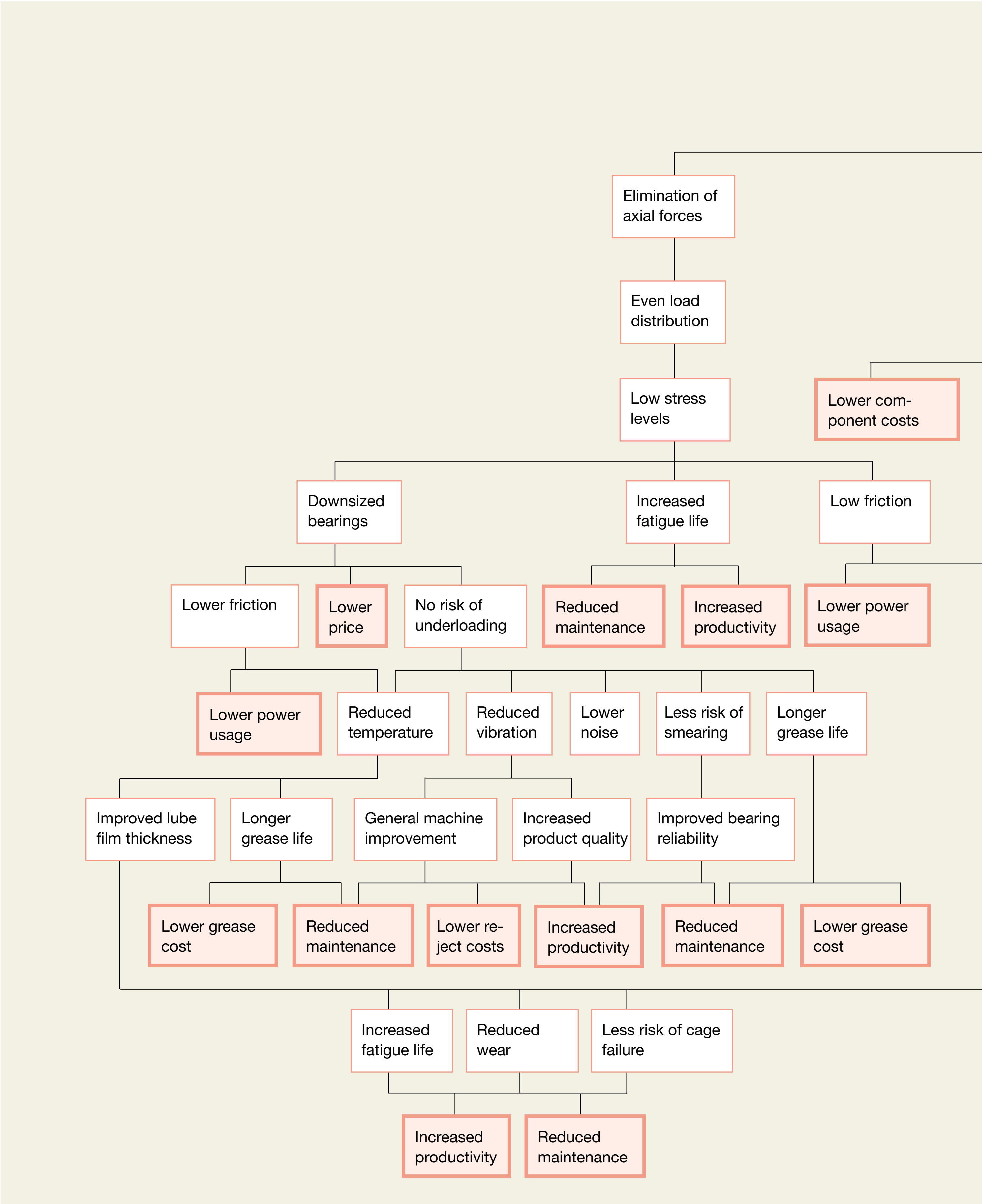
$$\frac{1}{(L_{10,\,sys})^e} = \frac{1}{(L_{10,\,loc})^e} + \frac{1}{(L_{10,\,non\text{-}loc})^e}$$

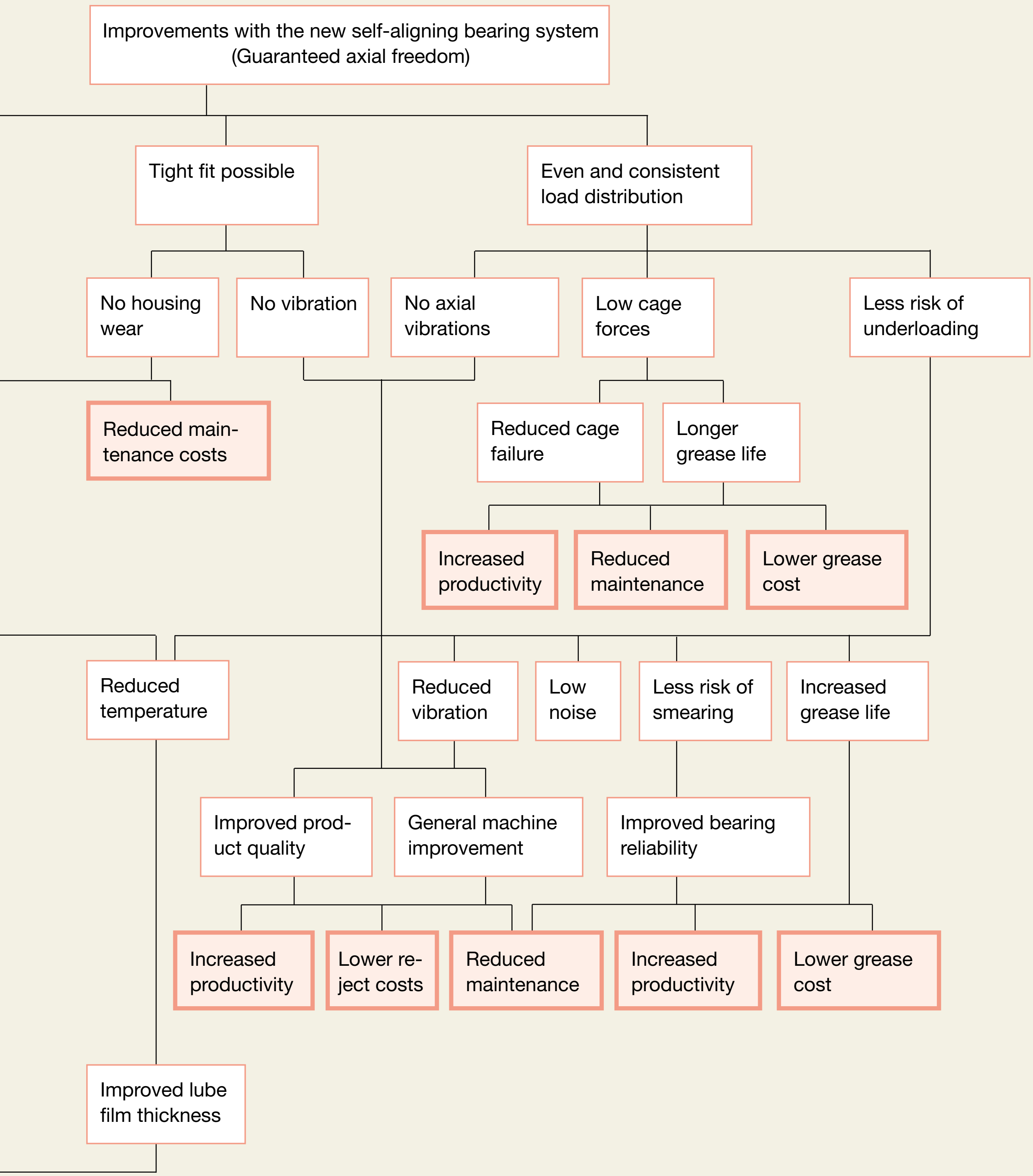
For roller bearings, e = 9/8
For ball bearings, e = 10/9

The compromise-free solution

With the new self-aligning bearing system, utilising a CARB toroidal roller bearing at the non-locating position, the many excellent design features and operating capabilities of SKF double-row spherical roller bearings and self-aligning ball bearings can now be fully exploited to provide the best possible reliability, and to optimise the selection of the bearings and the overall design of machine.

The new self-aligning bearing system





Improvements with the new self-aligning bearing system

Operating conditions	Typical applications	Temperature reduction	Vibration and noise reduction	Housing or shaft wear reduction	Improved reliability eliminates cata-strophic failures
High load Low speed	Wheel Continuous caster Screw conveyor Grinding mill Press rolls Gear shaft			• •	• •
Medium to high load Medium to high speed	Drying cylinder Conveyor pulley Roller table Calender Crusher Propulsion equipment Flour mills Gear shaft Felt roll Wire roll	• •	• •	• •	• •
Light load High speed	Industrial fan Blower Agricultural machinery Gear shaft Suction roll	• • •	• •	• •	• • •
Eccentric motion Centrifugal loads	Vibrating screen Washing machine Crank press	• •		• • •	• • •
Indeterminate loads Medium to high speed	Shredder Chipper Industrial lawnmower Large electric motor Crusher Blower Mixer Harvester Pump	• •	•	• • •	• •
Heated rotors Large thermal expansion	Paper dryer Heated calender Cooker Mixer Yankee dryer Heat exchanger		• • •	•	

no influence: – little influence: • some influence: • • strong influence: • • •

Reduced maintenance	Increased throughput	Decreased stoppage time	Increase L_{10} life or downsize	Simpler cheaper structure	Simpler installation procedure
••	•	•••	••	•	
••	•	••	••	••	
•••		•••	•	•	
•••	••	••	••		
•••	•	••	•	•	••
••	••	••	•••	•••	•••

Influences of the new self-aligning bearing system for different types of machines

The SKF Group – a worldwide corporation

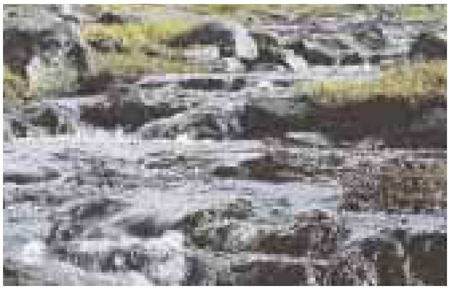
SKF is an international industrial Group operating in some 130 countries and is world leader in bearings.

The company was founded in 1907 following the invention of the selfaligning ball bearing by Sven Wingquist and, after only a few years, SKF began to expand all over the world.

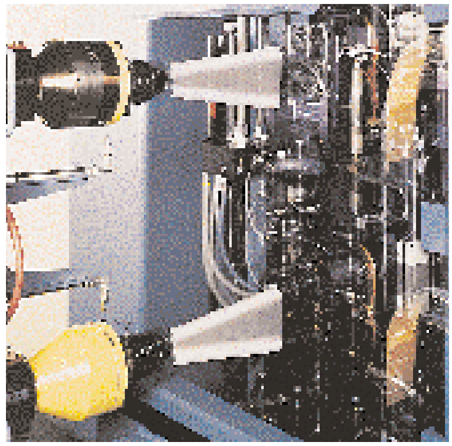
Today, SKF has some 40 000 employees and around 80 manufacturing facilities spread throughout the world. An international sales network includes a large number of sales companies and some 7 000 distributors and retailers. Worldwide availability of SKF products is supported by a comprehensive technical advisory service.

The key to success has been a consistent emphasis on maintaining the highest quality of its products and services. Continuous investment in research and development has also played a vital role, resulting in many examples of epoch-making innovations.

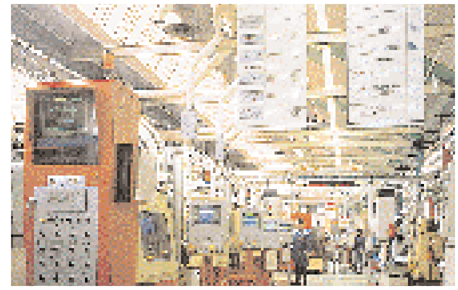
The business of the Group consists of bearings, seals, special steel and a comprehensive range of other high-tech industrial components. The experience gained in these various fields provides SKF with the essential knowledge and expertise required in order to provide the customers with the most advanced engineering products and efficient service.



The SKF Group is the first major bearing manufacturer to have been granted approval according to ISO 14001, the international standard for environmental management systems. The certificate is the most comprehensive of its kind and covers more than 60 SKF production units in 17 countries.



The SKF Engineering & Research Centre is situated just outside Utrecht in The Netherlands. In an area of 17 000 square metres (185 000 sq.ft) some 150 scientists, engineers and support staff are engaged in the further improvement of bearing performance. They are developing technologies aimed at achieving better materials, better designs, better lubricants and better seals – together leading to an even better understanding of the operation of a bearing in its application. This is also where the SKF Life Theory was evolved, enabling the design of bearings which are even more compact and offer even longer operational life.



SKF has developed the Channel concept in factories all over the world. This drastically reduces the lead time from raw material to end product as well as work in progress and finished goods in stock. The concept enables faster and smoother information flow, eliminates bottlenecks and bypasses unnecessary steps in production. The Channel team members have the knowledge and commitment needed to share the responsibility for fulfilling objectives in areas such as quality, delivery time, production flow etc.

SKF manufactures ball bearings, roller bearings and plain bearings. The smallest are just a few millimetres (a fraction of an inch) in diameter, the largest several metres. SKF also manufactures bearing and oil seals which prevent dirt from entering and lubricant from leaking out. SKF's subsidiaries CR and RFT S.p.A. are among the world's largest producers of seals.

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