

# High-Capacity Bearings

## CARRY THE LOAD FOR CHINESE GEARBOX MANUFACTURER



**SKF's new HCCRB bearings allow for heavier loads in various-sized wind turbines.**

The signing of a contract for more than 5,000 sets of SKF's latest high-capacity cylindrical roller bearings (HCCRB) for wind turbines will impart added load-carrying capacity, more reliability and longer life to the Nanjing Gear Company's (NGC) line of gearboxes for wind generation applications.

About 50 percent of the bearings are destined for gearboxes of European and American manufacture, with the remaining half going to Chinese and other Asian-country customers.

With a range of gearboxes suitable for wind turbines from 200 kW to 2 MW, NGC will boost the competitiveness of their brand. NGC is a leading supplier in China for gearboxes for wind turbines. It is also a leading supplier in China for high-speed and heavy-load gearboxes for many industries, including steel and mining.

The HCCRB bearings will be of differing sizes—from 150 mm bore diameter up to approximately 300 mm—and utilized

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in all of the classical cylindrical bearing positions in the wind turbine gearboxes where non-separate mounting is acceptable. This is typically the case in planetary wheels.

H. Yueming, NGC general manager, says SKF was chosen for what represents NGC's biggest buy from the company to date because "In the wind power business, we attach great importance on high quality and innovation. We chose SKF because we know that the most important component to ensure reliability of the gearbox is the bearing. We will have the best bearing supplier in the world to ensure the quality of the gearboxes we produce." He adds, "We also believe that SKF will provide the best technical service in the bearing field and we hope to develop long-term cooperation to make technology exchanges to enhance our capabilities."

Zhou Zhijin, NGC vice-general manager, comments, "Successful prototype tests and technical information from SKF experts at their cylindrical roller bearing development center in Germany were very influential in finalizing the decision to select the new high-capacity version."

While the HCCRBs are a new product offering for SKF, they weren't developed exclusively for NGC.

"No, not specifically," says Albert Krauss, SKF product manager for cylindrical roller bearings. "NGC was just the first customer who is using them in series for their gearboxes. However, the NGC items are tailor-made for their" gearbox applications. Krauss adds that the HCCRBs are not yet available in all sizes, "But beyond the planetary bearings, which are usually" custom-made, "there will be a range of standard dimensions available in the future."

**Unique feature of the HCCRB.** The unique feature of the HCCRB is that load-carrying capacity has been increased substantially, while maintaining the boundary and internal dimensions of standard, cylindrical roller bearings. In effect, a bearing was created that boasts load-carrying capacity comparable to a full-complement bearing, but with the added benefits of a bearing with a cage. Along with the higher carrying capacity, the new design offers increased life. Calculations show that in one particular application, the SKF Explorer version of the HCCRB will have an increase in bearing rating life of 35 percent when compared with the standard, full-complement version, and 43 percent when compared to a standard caged version.

All of which begs the question—will these bearings serve as the gold standard for wind turbine applications?

"We believe so," says Krauss. "Most of the gearbox manufacturers are testing them, and some of them have already decided to use HCCRBs in their new gearboxes."

The bearings are made of standard-bearing steel 100Cr6, and the rings and/or rollers are black-oxidized for wind turbine applications. Krauss points out that the oxidation "assists in reducing wear in the running-in phase of the bearings in such heavily loaded applications."

**Increasing load carrying capacity.** According to ISO international standard 281, there are two ways to increase the load-carrying capacity while maintaining standardized boundary dimensions:

1. Increase the roller dimensions while maintaining the same number of rollers.
2. Increase the number of rollers and maintain the roller dimensions.

There are technical problems with the first method because increasing roller dimensions reduces the inner and outer ring thicknesses as well as the width of the side flanges. This reduction results in less ring stiffness and flange strength, which in turn increases the risk of reduced bearing life due to increased wear, fretting corrosion, ring creep or even ring fracture.

The second method offered theoretical improvements—commonly known by bearing companies—and many have applied it to its fullest extent.

A design that allows the maximum number of rollers is the full-complement design. The rollers are placed between the rings, leaving no space for a cage. Such bearings have limitations because the rollers are always in direct contact with each other, causing sliding, increased friction and heat generation. Under certain circumstances—among them higher speeds—the above-mentioned characteristics lead to wear and premature bearing failure.

Bearings with cages (the vast majority of bearings produced worldwide) do not have this problem because the rollers sit in cage pockets, preventing them from contacting each other. However, the addition of the cage takes up space, which reduces the maximum number of rollers possible.

### How Cage Feature was Developed

The unique feature of the HCCRB was achieved by a completely new window-type cage design that resulted in two versions:

1. An outer ring shoulder-guided cage (code JA).
2. An inner ring shoulder-guided cage (code JB).

With these cages, an extra one or two rollers per row can be added to the bearings for the standard range, all of them separated by a cage. For customized bearings, even more rollers are possible. It is these rollers that deliver the additional carrying capacity, while the cage increases bearing life and overall

Bearing Execution	Standard	SKF Explorer*		
Customized bearing for wind gearbox application	Full complement cylindrical roller bearing	High-capacity cylindrical roller bearing with an outer ring guided cage (JA)	High-capacity cylindrical roller bearing with an inner ring guided cage (JB)	Integrated standard cylindrical roller bearing with a machined brass cage
Number of rollers per row	29	28	26	24
Relative calculated bearing	100	135	109	92

\*SKF Explorer bearings with increased load-carrying capacity.

performance compared to a full-complement version.

The new cages differ from the standard cage in a number of ways that are not readily apparent.

Most noticeable is that the standard cage is oriented around the connection circle of the mid-points of all rollers, while the new cages are moved toward the outer ring (JA type) or the inner ring (JB type), thus allowing more space for more rollers (Fig. 1).

The new cage designs were tested with prototype HCCRB bearings for more than one year in many different tests to fully evaluate their capabilities and compare them with bearings fitted with standard cages and full-complement bearings. All tests showed no limitations of the new bearing designs compared to standard designs. In fact, the new cage designs provide the following additional benefits:

1. Improved oil flow via the decreased cross section of the cage, which reduces heat generation.
2. Lower weight that reduces inertia forces.
3. Reduced slip in low-load conditions, which reduces the risk of smearing.

#### Comparisons of Different Designs in Wind Turbine Gearbox

Figure 2 shows a gearbox application where the bearing under consideration is supporting a planetary wheel. Calculations of four different bearing types show that the two new HCCRB bearings significantly outperform both the standard caged version and the standard full complement version.

The new HCCRB bearings will enable NGC to offer higher load carrying capacity to their customers while affording them either enhanced gearbox reliability or a smaller gearbox, depending on the expected loads to be transmitted through it. And with wind turbine designs increasing in size and MW output all over the world, this positions NGC for greater new-business potential for large-sized turbines. 

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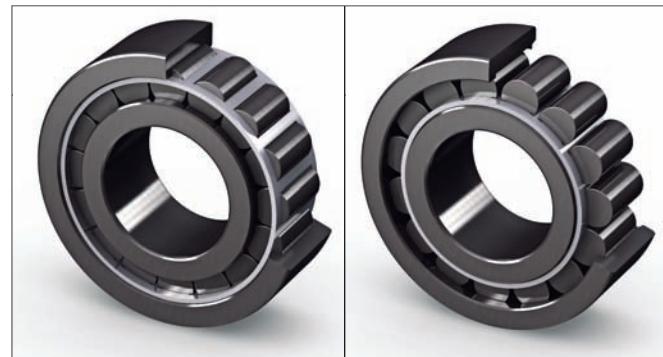


Figure 1—Type JA left; Type JB right.

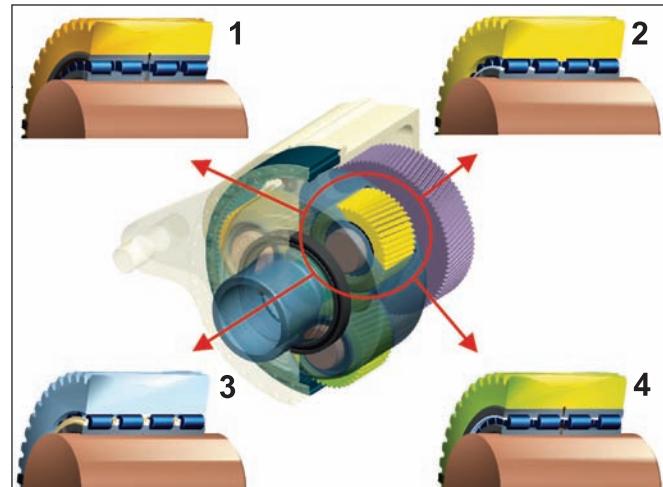


Figure 2—(1) Full-complement bearing; (2) HCCRB version JB; (3) standard CRB with brass cage; (4) HCCRB version JA.



Nanjing Gear Co. headquarters.