

# TECHNICAL INSIGHT

A PUBLICATION OF NSK EUROPE

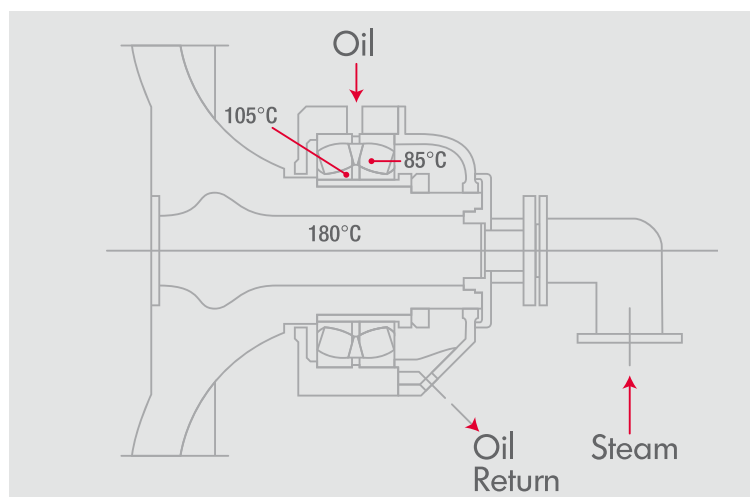
## Reduce Inner Ring Fractures with NSK “TL” (Tough and Long Life) Series of Spherical Roller Bearings

NSK is continually perfecting technology to improve bearing performance. One specific area of concern is the fracture strength of inner rings. Bearings are susceptible to cracking when used with a relatively high interference fit, particularly spherical roller bearings with tapered bores.

### Revolutionary Steel

Recognising this common problem, research engineers at NSK Ltd. in Japan developed a steel called “TL” steel. It delivers better performance in a variety of applications where fractures commonly occur, and it achieves this at a lower cost compared to other premium bearing materials.

An example of where this technology can be used is in paper mill dryers or calenders, where super-heated steam passes through the hollow shafts of the dryer rollers and through the center of the bearings. The shaft temperature rises quickly while the bearing inner rings remain cool. This results in a tremendous stress increase on the inner rings.



Steam is passed through the cylinder to heat it. The journal expands faster than the bearing, making the fit tighter. Severe hoop stress on inner ring is repeated every time the machine is started. Inner ring fracture is a common problem.

Steam temperature increases in recent years have improved high-speed operation, dryer efficiency and paper quality. These gains have come at the expense of bearing life, and have created even more stressful conditions - and more inner ring fractures.

### Costly Alternatives

Some paper mills minimise the risk of failure using a slow start-up procedure that builds up heat slowly and transfers it to the inner ring. Mills may also pre-heat the circulating oil used to lubricate the bearings. These methods can prolong bearing life, but require several hours of lost production and revenue. In fact, most mills do not invest the time, and simply take their chances at an inner ring bearing fracture. Some bearing manufacturers have tried to address the fracture problem by developing special steels, often by sacrificing other performance characteristics. One example is bainitic steel, created with a process called austempering. Bainitic steel does offer higher fracture strength but lowers hardness, thereby decreasing overall bearing life.

Other manufacturers recommend carburised grade steels for the inner rings. The carburised process is a heat-treating method that uses a furnace with a carbon-rich atmosphere to “coat” low-carbon steel with a layer of carbon that bonds to the surface. This process takes a lot of time, consumes a lot of energy and results in a premium-priced bearing. Many mills do not want to absorb the high costs of this product.

### Ideal Solution

In contrast, NSK's TL steel can satisfy the high demands of these applications and can be incorporated in a standard specification. Here are just a few of the benefits found in TL steel:

- › The inner-ring fracture strength outperforms bainitic steel, and equals that of carburised steel inner rings
- › There is no sacrifice in inner-ring hardness, so that bearing life is not compromised, as in bainitic steels
- › Testing shows that bearings made from this material equal standard bearing steels in terms of useful life
- › Costs are lower than bearings using carburised steel

The TL steel bearings increase inner-ring toughness using a special surface-hardening heat treatment. From a metallurgical standpoint, the raceways are harder than conventional bearing steel but the core remains soft. This delivers the shock resistance needed to prevent fracturing, as well as the raceway hardness for long bearing life.



### Setting Industry Standards

To evaluate TL steel's fracture resistance, NSK had to develop special "benchmark" tests to compare its bearing materials to that of competitors.

The "Inner Ring Fracture Strength Test" involves creating a pre-crack on the inner-ring of a bearing, and then mounting it on a test shaft to a prescribed interference fit. A load is then applied during a running test until the stress causes the pre-crack to expand. "Cracking life" in this test equals the total number of revolutions of the inner ring until fracture occurs.

In NSK lab testing, the TL steel features about three times the L-10 cracking life compared to NSK's conventional bearings. The TL steel also lasts longer than conventional bearings or bainitic steel bearings when used with contaminated lubricants.

This technology is especially beneficial in spherical roller bearings with tapered bores that are prone to inner ring fracture, particularly when mounted using hydraulic assist. If you face an ongoing problem with fracturing, TL steel may be the answer.

Material	Fatigue Life (millions of cycles)	
	L <sub>10</sub>	L <sub>50</sub>
Through hardened SAE 52100 (Stabilised for 200°C operation)	3.1	8.0
Bainite treated SAE 52100	1.8	3.8
Carburised SAE 52100	3.1	10
TL specification	6.1	21

Fatigue life at 130°C with contaminated lubrication

For more information, please visit [www.nsk europe.com](http://www.nsk europe.com)