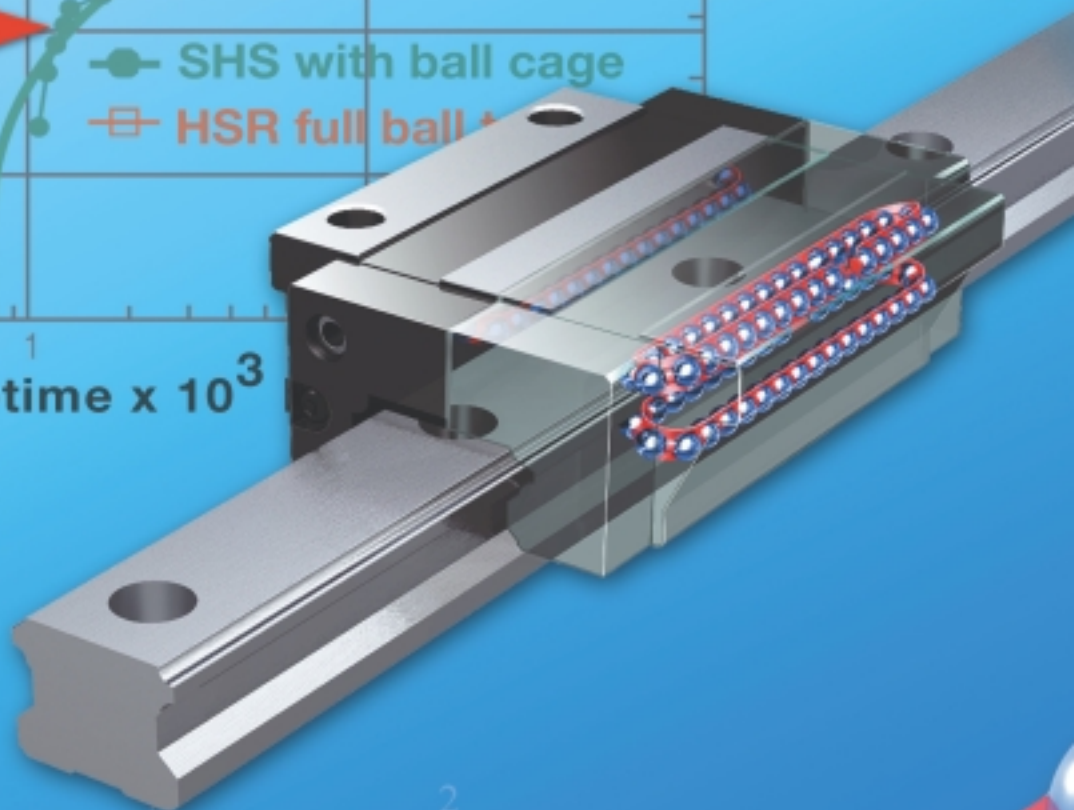
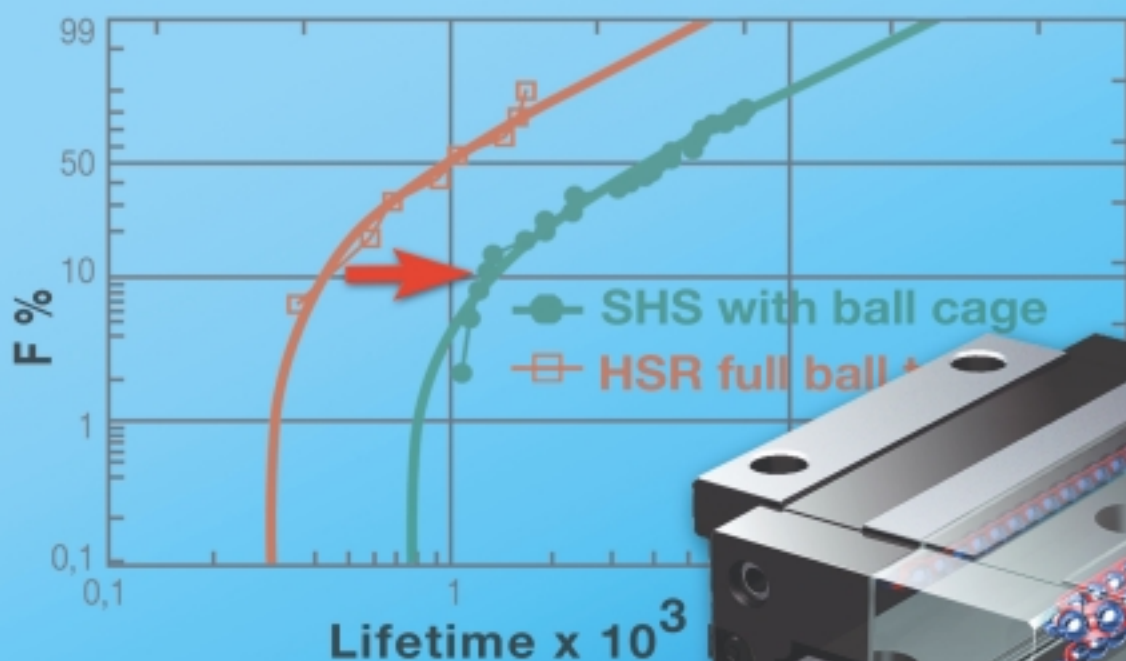


# Technical Report

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$$C = bm \cdot f_c \cdot l t^{\frac{30}{2}} \cdot i^{0.7} \cdot Z t^{\frac{2}{3}} \cdot D w^{2.1} \cdot \cos \alpha$$

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$$f_c = \lambda \cdot 24,5 \cdot \left( \frac{2ra}{2ra - Dw} \right)^{0,41}$$

# Lifetime of LM Guides with Caged Ball™ Technology

## Introduction

THK was established in 1971, and since then has engaged in research and development as well as the production and distribution of linear motion systems. Today THK has a wide standard range of LM Guides for many applications. Included in THK's product portfolio are miniature series LM Guides® for micro machines, with a rail width of only 3 mm and a static capacity of  $C_0 = 0,27$  kN. The larger scale linear guides provide earthquake protection systems for buildings with a maximum rail width of 230 mm and a static capacity up to  $C_0 = 7649$  kN, in addition to many other application uses.

In 1996 a new innovative product was developed by THK - the LM Guide featuring Caged Ball™ technology. Since this new generation of LM Guides was introduced to the market, 2 million pieces have been delivered, 10% of this to manufacturers of machine tools. Driven by this success, THK plans to equip all products with this new technology as soon as possible.

### ■ The effects of caged ball technology in linear Guides

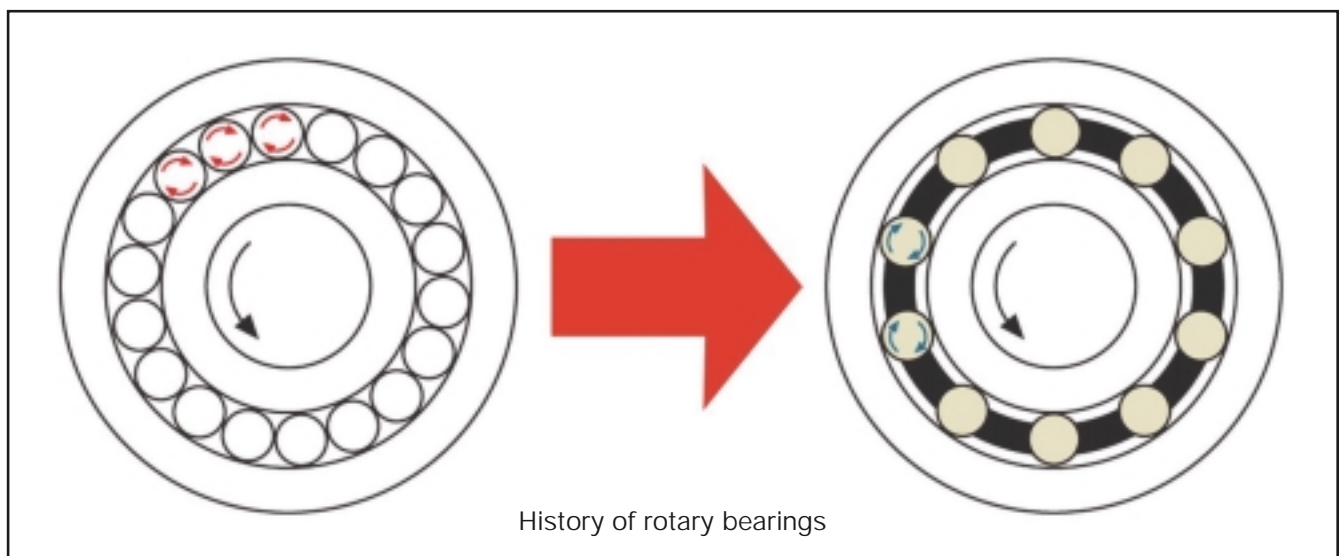
The caged ball technology prevents friction and collision between the balls resulting in low heat generation and longer lubricant life. In addition the particle emission of the linear guide is significantly reduced. Comparatively the effects of the caged ball techno-

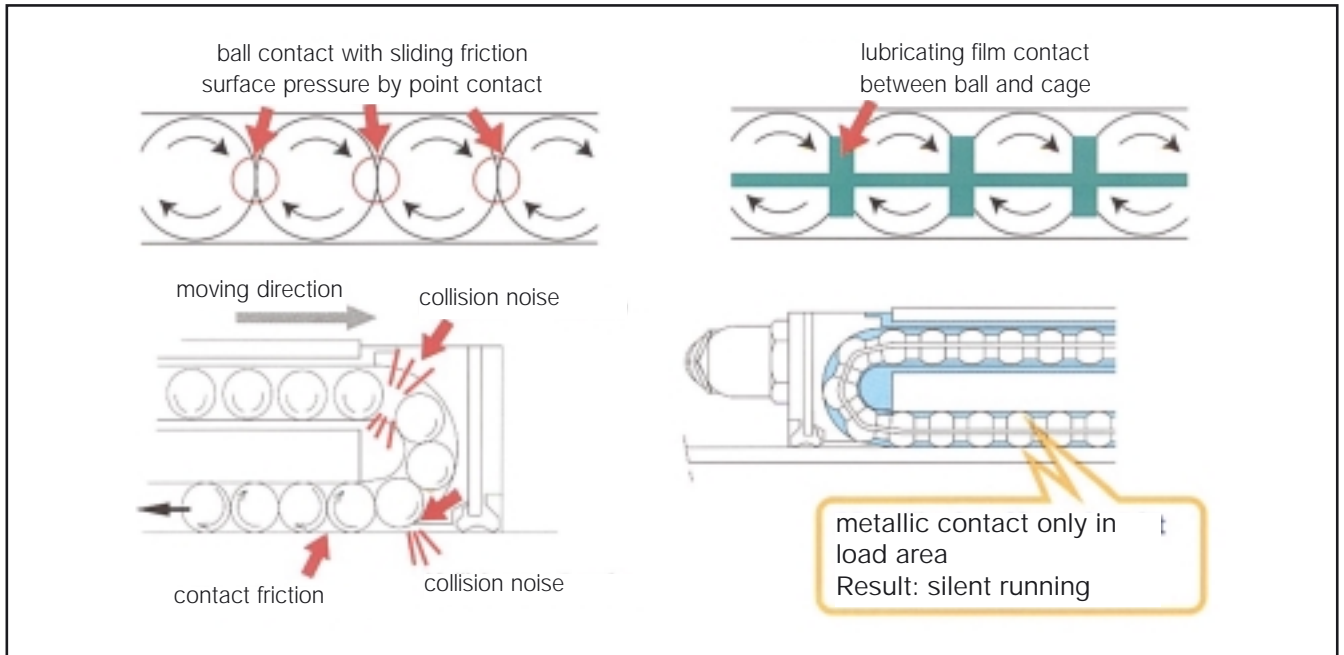
logy offer a substantial increase of performance in rotary bearings. The advantages of THK's caged ball technology have therefore been well known for a long time. In the early stages many hours of research and development were carried out to overcome early technical problems of transferring this system to a linear bearing. The main problem area

was the stress applied to the plastic chain cage caused by the transition between linear and curving movement. After several years of research this problem was solved with specific production technology.

### ■ The caged ball offers the following advantages:

- Running stability at high speed
- Long lifetime
- Low maintenance
- Low noise level
- Smooth running
- Low particle emission





**■ Lifetime of LM Guides with caged ball**

One of the important advantages of caged ball technology is the increased lifetime of the linear guide.

Each THK product is endurance tested before being launched to the market.

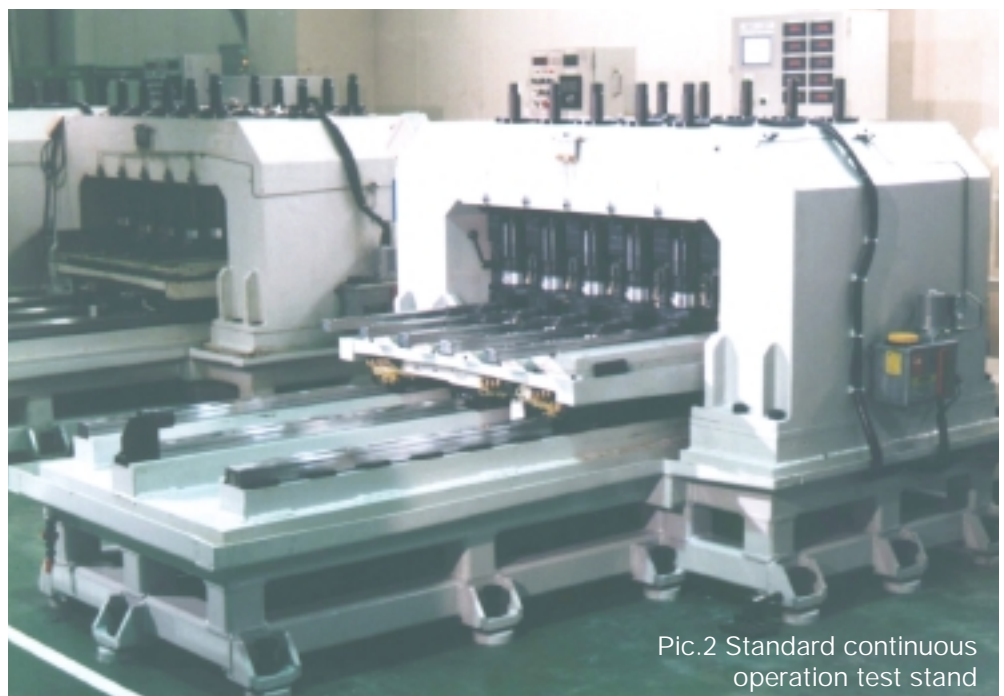
The LM Guide featuring caged ball technology undertook a detailed and extensive endurance test to measure load capacity and high speeds for each product size. Picture 2 shows a testing device, where 10 linear bearings can be tested simultaneously. THK has more than 40 of such testing devices available, with the possibility to test 400 blocks at the same time. It is thought that THK is the only manufacturer with such a high capacity of testing facilities. Picture 3 shows a graphical representation of the results of one of the numerous endurance tests with the caged ball linear Guide SHS25 and the conventional full ball type HSR25. The block was tested with

a load equal to 50% of the dynamic load capacity. The nominal calculated lifetime results were 400km. The test result shows a lifetime of 420km for the full ball type HSR and of 1.347km for the caged ball type SHS. Hence we can conclude, that the lifetime of the caged ball type is 3,2 times higher than the conventional full ball types. Furthermore it is necessary

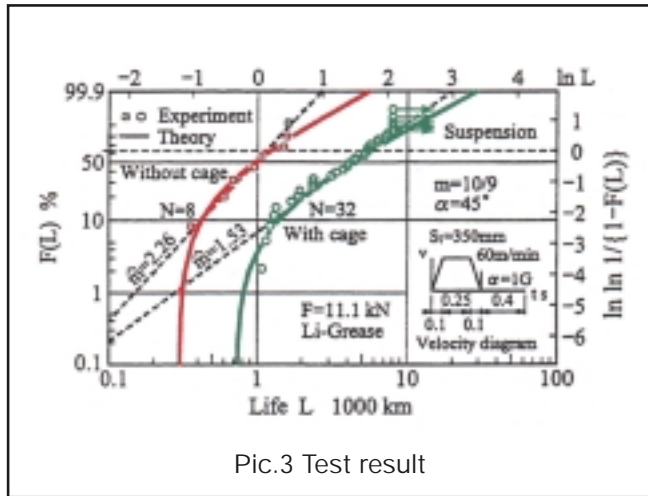
to highlight the fact that the full ball type was lubricated every 100km, whereas the caged ball type completed the test with only the initial grease. The same test but with other types and sizes shows similar results.

In summary, a LM Guide with Caged Ball technology achieves, in general, a two to three times higher lifetime compared with a full ball linear Guide.

In comparison of this technology, almost 100% of the rotary bearings currently used are now equipped with a ball cage.



Pic.2 Standard continuous operation test stand



Pic.3 Test result

The reason for the increase of lifetime of linear bearings with caged technology is due to eliminating friction and reducing fatigue of the balls and the lubricant. The grease pockets in the caged ball form an active lubricant reservoir, which provides optimum lubrication during motion, and

therefore promotes longer life by being better spaced. THK are proud of the extensive testing and results produced and have since published these results in various institutional magazines for machines, lubrication and tribology and in a variety of technical magazines.

■ Increase of dynamic load rating

Based on these test results, THK increased the dynamic load rating for LM Guides with caged ball technology in 2001. This was not due to a change in the theoretical calculation formula but due to several years reliable test data. A comparison of the old and new dynamic load rating C is shown in table 1.

The test result shows the dynamic load rating  $C = 33,1$  kN was achieved. For safety reasons, THK has chosen a lower value  $C = 31,7$  kN. Compared with the old load capacity this means an increase of 1,43. THK is continually striving to improve their products and to increase their reliability, and such tests as these show this.

Table1: Dynamic load rating C for the type SHS25 Unit: kN

C old	C new	C from test result
22,1	31,7	33,1

Summary

For more than 30 years THK has delivered and will continue to deliver LM Guides to industry. The markets in which THK operate range from the machine tool industry - with its extremely hard conditions, to robotics, production facilities for the semiconductor industry, handling equipment, through to the consumer goods market. In almost all industrial areas today THK linear motion products can be found. Due to the rising customer demands requiring high precision, high speed and longer lifetime the LM Guide featuring caged ball technology plays an important key role, which the conventional LM Guides can no longer match.

In addition, the DIN645-1,2 (1997) standard has taken over the standard dimensions of the THK type HSR as the general standard dimensions. This gives evidence of how widely accepted the THK brand is and the contribution of THK LM Guides to technical progression.

For further information and consulting please contact THK

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