MOTION & CONTROL™

NSK

Air Turbine Bearings

for Dental Handpieces

NSK Bearings: Ten Times Higher Corrosion Resistance Improves Bearing Replacement Cycle

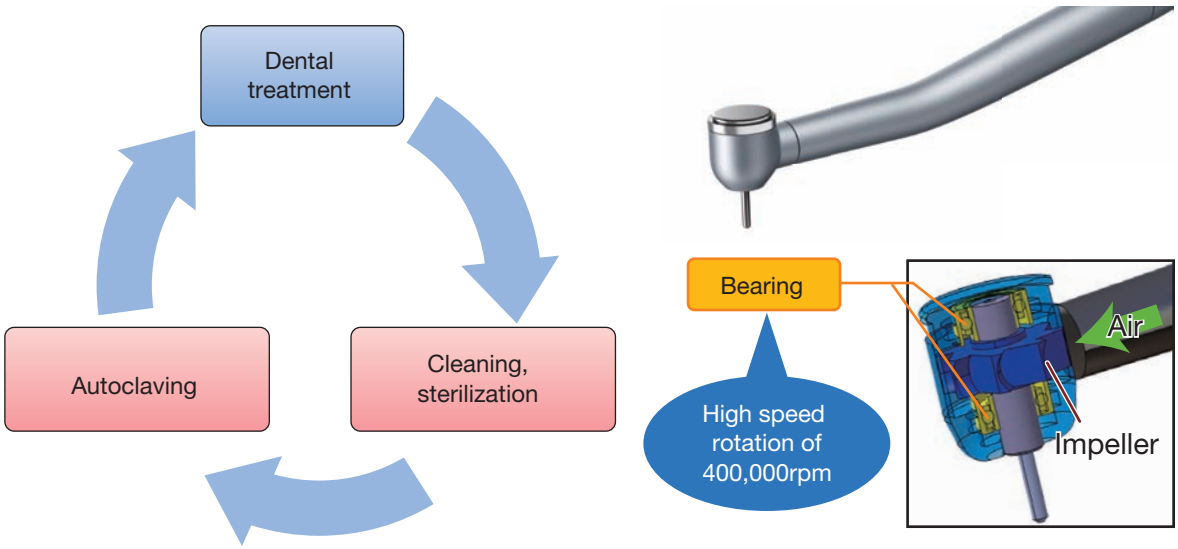
Recent Trends in Infection Control and Their Impact on Bearings

The dental handpiece is one of the most important instruments among the everyday implements used by a dental practitioner. The dental handpiece, however, poses a potential high risk of cross-contamination. To minimize cross-contamination risks and also to assure reliability and longevity of dental handpieces, these instruments are repeatedly sterilized in boiling water and disinfectants and put in an autoclave after each use. In recent years, higher awareness among patients and dental practitioners regarding cross-contamination has initiated a trend of using alkaline solutions to clean and sterilize these handpieces. These highly effective sterilizing methods could, however, cause corrosion in the bearings, which can then lead to lower performance of the dental handpieces. A corroded bearing produces increased vibration and abnormal noises in dental handpieces and eventually causes defects such as reduced rpm levels.

Solution for High Reliability and Performance, and Maximum Longevity of Handpieces

The bearings made of ES1 developed by NSK provide 10 times higher corrosion resistance than conventional bearings made of SUS440C stainless steel in an environment of exposure to a disinfectant and sterilization agent. NSK bearings offer extremely accurate revolution at an astounding speed of 400,000rpm with minimum vibration in the dental handpiece to provide safe and comfortable dental treatment.

- **Dental Handpiece Usage**



Top Runner in Bearings

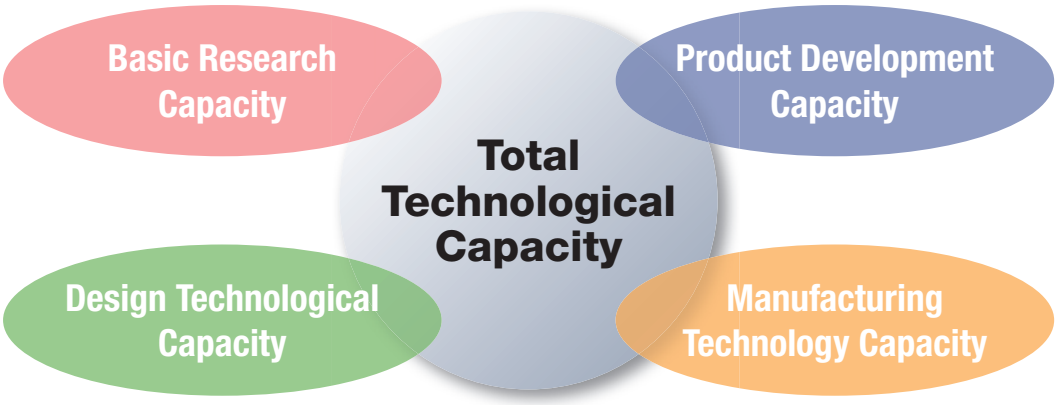
Technological Strength of NSK

NSK produced the first ball bearings made in Japan in 1916. Since that time, the company has been contributing to the advancement of various industries through the use of its high-quality bearings in industrial machinery, precision machines, and automotive components. At present, the company has the largest share of the bearings market in Japan and is one of the largest bearing suppliers in the world.

For about 50 years, NSK has been developing and manufacturing bearings used in dental air turbine handpieces in Japan. In recent years, the performance requirement for bearings has become very high because of the improvement in the performance of air turbines. NSK continues to develop various technologies with the focus on ultra-high speed rotation, long life (rolling life, autoclave resistance, and corrosion resistance), low noise, low vibration, and safety through meticulous quality control and application of high-precision technologies and manufacturing technologies of bearings that the company has developed throughout its history.

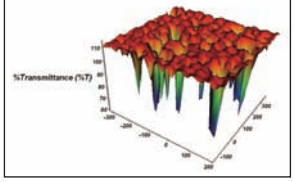
For example, NSK was one of the first bearing manufacturers to discover the effectiveness of Torlon® (polyamide-imide) as a cage material and introduce it in the world. The company actively pours its energy into the development of cage materials such as polyimide and polyether ether ketone (PEEK). NSK has also developed a high corrosion resistant material called ES1* that is perfectly suitable for dental handpiece bearings. ES1 makes it possible to improve the life of bearings significantly and enable far higher quality sterilization with no cross-contamination. In a parallel effort, the company has been pushing forward with improving the precision, manufacturing method, and optimal design of cages to meet the requirements of ultra-high speed rotation performance and longer rolling life.

*Patent granted

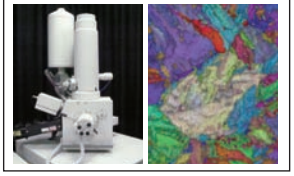


- **NSK's four core technologies that form the basis of its technologies and services**

Tribology
Tribology is an advanced friction control technology for improving load resistance and durability using grease and surface treatment.

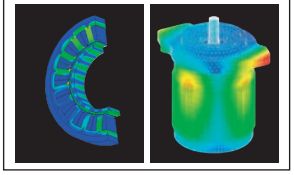


Material technology
Material technology is a key to further improving the durability and reliability of bearings that are generally exposed to a severe operating environment.



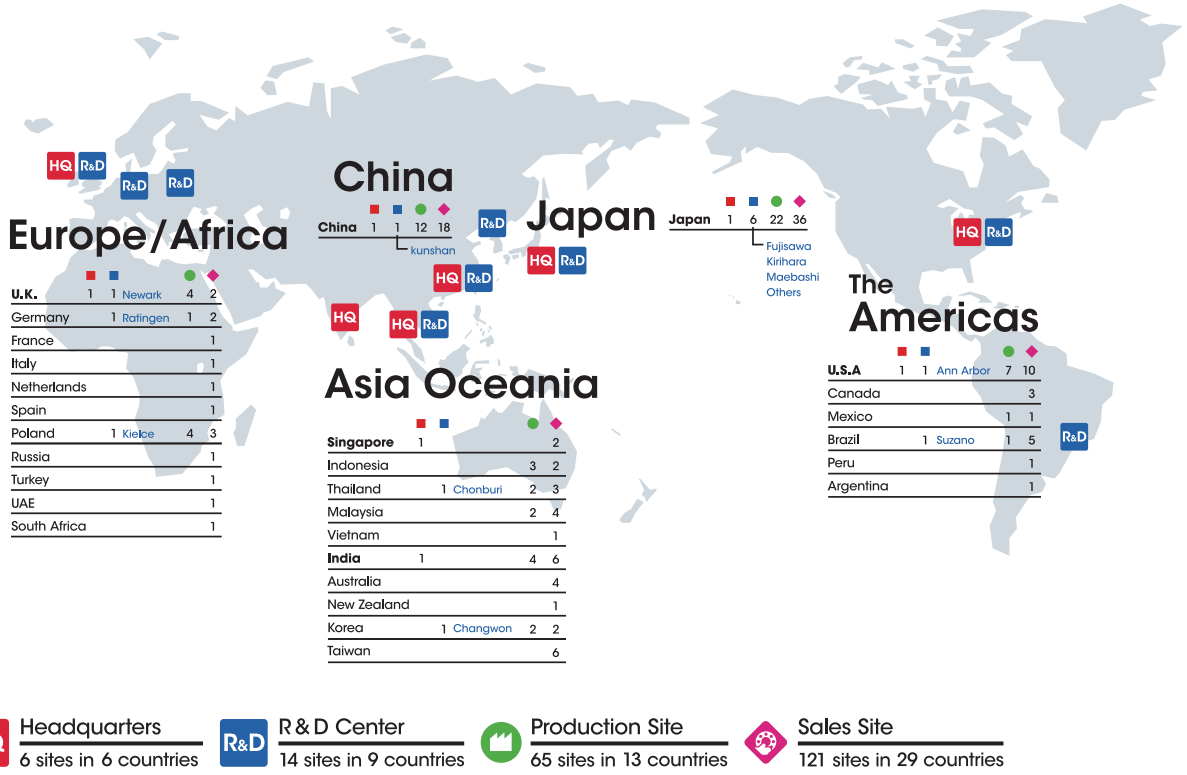
Analysis technology
Analysis technology contributes to providing a virtual evaluation of product performance as well as optimal designing of products and speeds up new product development processes.

Mechatronics technology
NSK's proprietary mechatronics technology combines the company's electronics technologies with its mechatronics knowhow accumulated through product development and manufacturing conditions.



Full-fledged Global Service Network

NSK has a long track record of overseas business activities during which the company has built up a highly efficient global support network for our customers in a wide range of industries all over the world. NSK's business operation is structured around its five regional business units in the Americas, Europe/Africa, Asia/Oceania, China and Japan. NSK operates 65 locations in Japan and 200 production sites and sales locations (excluding representative offices) as well as technical service locations in about 28 countries around the world. At all locations, our Business Division Headquarters, Functional Division Headquarters and Regional Headquarters work in close collaboration to respond fast and accurately to the wide-ranging needs of our global customers.



Fujisawa Technology Center (Fujisawa City, Kanagawa Prefecture)

Fujisawa Technology Center is the central hub of NSK's corporate research and development activities. Almost all business units related to the development of technologies from the product planning phase through research, development, production, and introducing the product into the market, are assembled in this Center. There are about 1,000 engineers working at the Center. It continues to produce innovative products that satisfy our customers through the combined technologies of various applications.

ISO 9001 Certified Manufacturing Plants and Wide-ranging Equipment

State-of-the-art Manufacturing Plant

NSK has two plants for manufacturing dental handpiece bearings, one in Japan and the other in Malaysia. Both plants in Japan and Malaysia are ISO 9001 certified and have the latest high-tech equipment for manufacturing high-quality miniature ball bearings. The bearings are assembled in Class 1000 (or ISO6) cleanrooms at these plants and are put through the most stringent quality management. NSK also has a system in place to assure traceability of all its products so that the company can quickly respond to any problem in product quality.

Fujisawa Plant
NSK Micro Precision Co., Ltd.
Kanagawa Prefecture, Japan

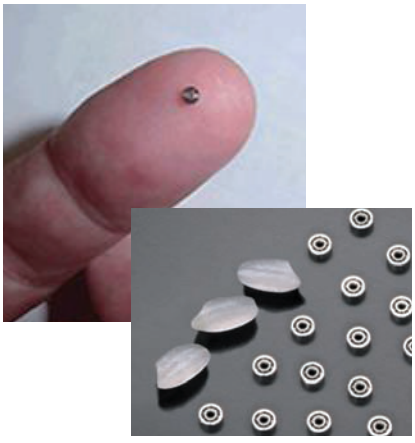
Malaysia Plant
NSK Micro Precision(M) Sdn. Bhd.
Kuala Lumpur, Malaysia

Cutting-edge Manufacturing Equipment and Inspection System

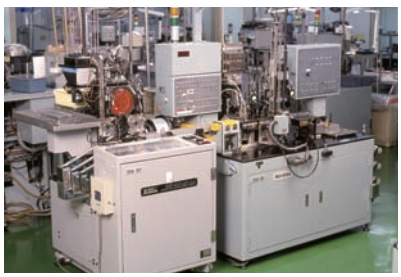
Miniature ball bearings require submicron level manufacturing precision. NSK uses technological capabilities refined over years of hard effort and production lines with the latest precision machining tools to deliver processing accuracy at the submicron level.

Multi-layer washing equipment

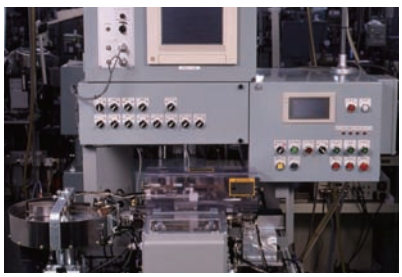
Grinding machines



World smallest class bearings



Assembly machines



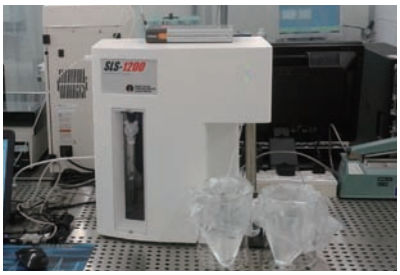
Automatic inspection equipment

Complete System of Measuring and Analysis Equipment

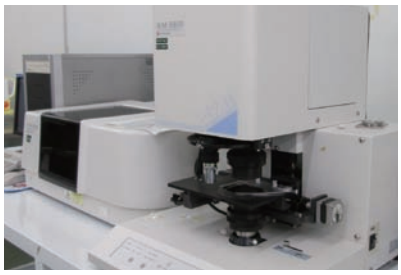
NSK has a wide-range of cutting-edge measuring and analysis equipment that is used for improving, maintaining, and confirming the manufacturing quality and developing improved dental handpiece bearings.

Roundness measuring instrument

Surface roughness/shape measuring instrument



Laser particle counter (LPC)



Fourier Transfer Infrared (FTIR) analyzer

Ion chromatography (IC) instrument

Gas chromatography (GC) instrument

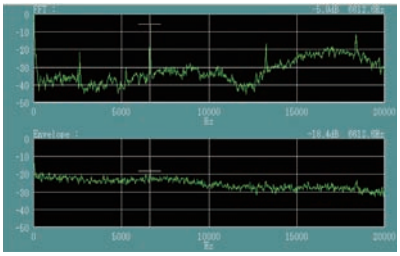
Full Evaluation System

NSK has installed the company's proprietary evaluation equipment that is used to evaluate the rotation of bearings assembled in an air turbine and verify the rolling life performance. NSK has significantly improved the rolling life performance of its bearings by using ultrahigh precision balls and high-precision parts that the company has developed ahead of other manufacturers in the world.

Evaluation equipment

Quick Acoustic Analysis Software

NSK uses the company's proprietary acoustic analysis software (ACOUS-NAVI) to quickly analyze abnormal noise detected in bearings used in the products manufactured at your company and provides the required solution.



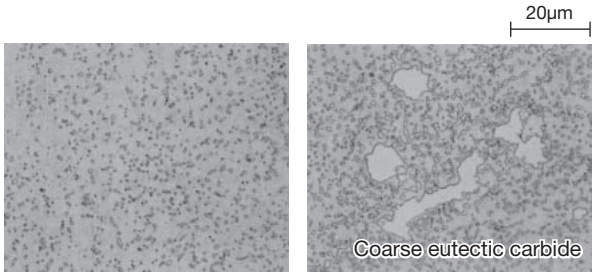
ACOUS-NAVI analysis screen

Outstanding Features of NSK Dental Handpiece Bearings

Long Life and High Corrosion Resistance ES1 Stainless Steel Bearing

NSK has developed a high corrosion resistant material called ES1 that is highly suitable for manufacturing dental handpiece bearings. ES1 has made it possible to improve the life of bearings significantly and assure highly effective sterilization with no cross-contamination. The use of ES1 has improved the bearing material, and as a result, the bearing has far superior corrosion resistance than the conventional SUS440C stainless steel bearings. The electrical and chemical verification result of our anodic polarization measurement confirms that the current density (corrosion rate) in the passive state range of ES1 bearing is about one-tenth lower than conventional stainless steel bearings, which proves that ES1 has superior corrosion resistance.

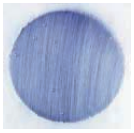
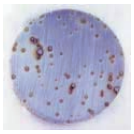
• Microstructure



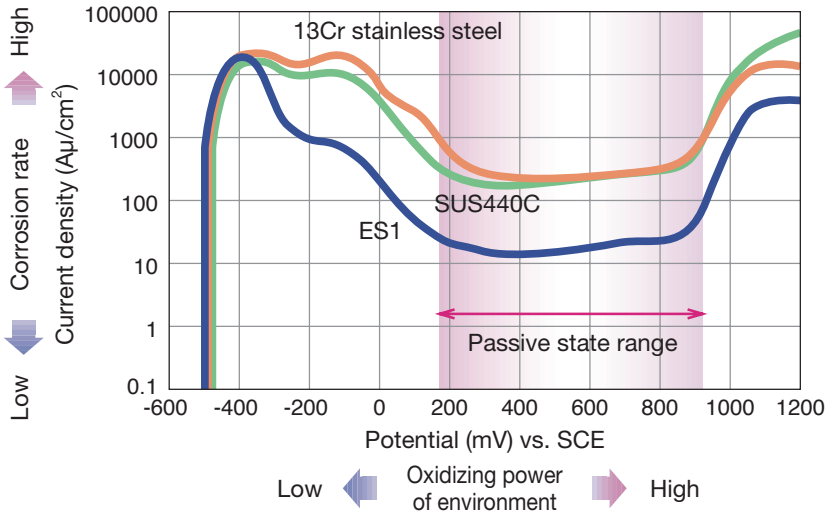
ES1

Standard dental handpiece bearing material

• Corrosion resistance (Salt spray test)

	Specimen	Bearing
ES1		
SUS440C		

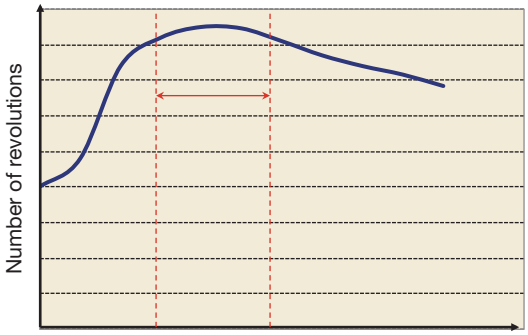
• Anodic polarization measurement result

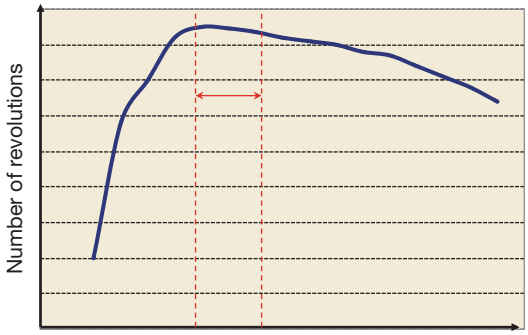


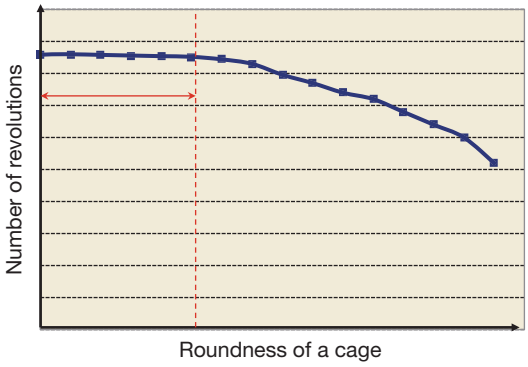
Ultra-high Speed Rotation

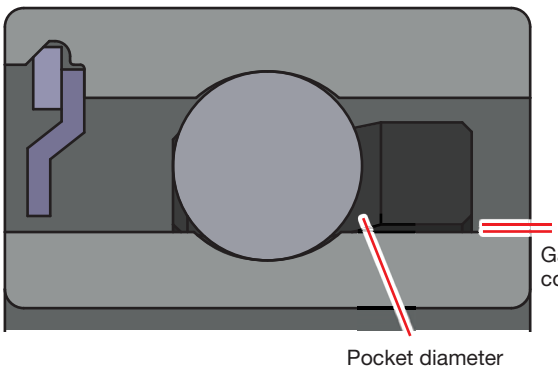
To maintain ultra-high speed rotation and long rolling life of air turbine bearings, it is particularly necessary to produce a high precision cage based on the optimal design. NSK makes continuous efforts to optimize the design and improve the precision of cage parts for ultra-high speed rotation. As a result, we have been successful in maintaining a stable number of revolutions even at 500,000rpm.

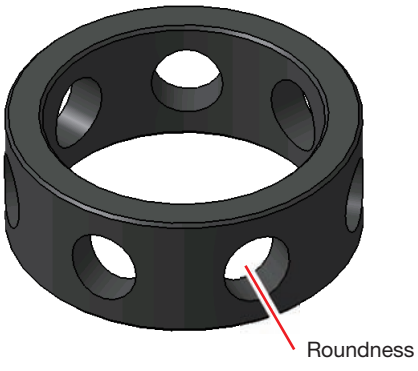
- **Examples of optimal design of elements and control values**







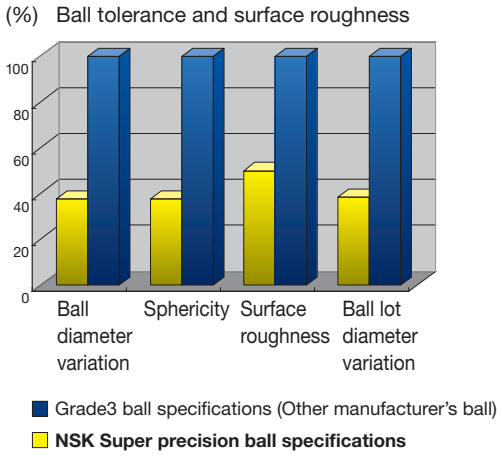




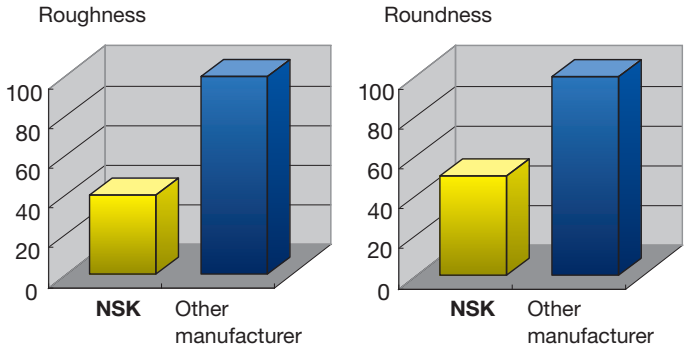
High Parts Machining Precision for Ultra-high Speed Rotation and Long Rolling Life, Low Vibration, and Low Noise

In addition to sophisticated material technologies and optimal cage designs, parts machining precision is particularly important in order to maintain the ultra-high speed rotation and long rolling life of air turbine bearings. NSK Group manufactures ultra-high precision bearing balls (far surpassing the world highest standard of balls, namely Grade 3) with original specifications. The company expertly uses these ultra-high precision bearing balls for its products. NSK has also further improved the precision of the bearing rings using the high production technologies that the company has built up over the years. The company applies these technologies for NSK air turbine bearings as standard specifications.

- **Example of precision of balls**



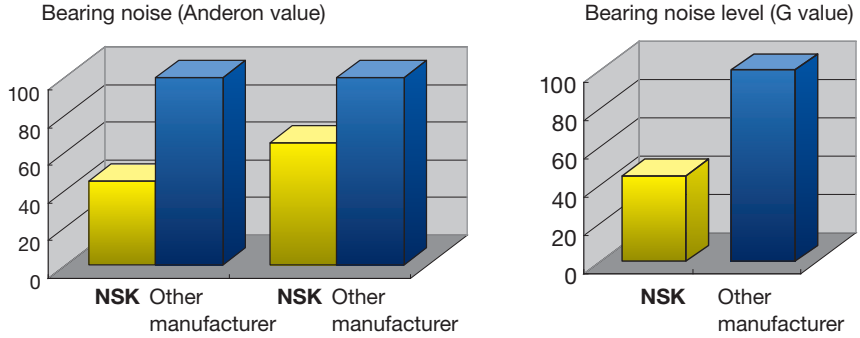
- **Example of ring precision**



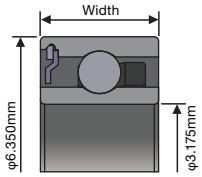
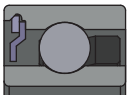
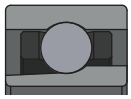
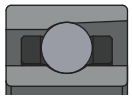
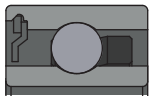
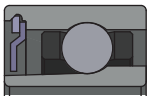
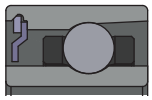
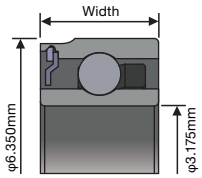
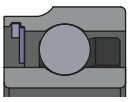
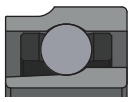
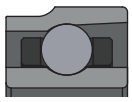
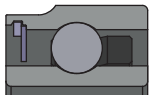
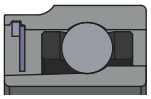
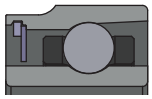
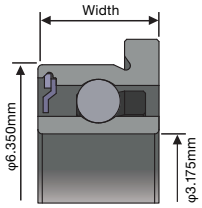
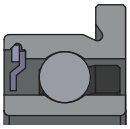
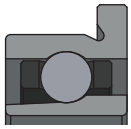
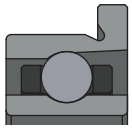
Low Noise and Low Vibration

NSK has significantly minimized the acoustical noise and vibrations of bearings by improving their roughness and roundness using NSK's advanced machining technologies as well as with the adoption of ultra-high precision parts.

- **Bearing noise and vibration level that surpass other manufacturers' bearings**



Product Lineup

Bearing series	Width	Deep groove bearing	Angular contact bearing	
			Inner ring counterbore	Outer ring counterbore
100 Series (Smooth type) 	**2.380mm** (0.0937")			
		B3Z-**100X**	BH3Z-**101X**	BH3Z-**102X**
	2.779mm (0.1094")			
		B3Z-**100**	BH3Z-**101A**	BH3Z-**102A**
150 Series (Groove type) 	**2.380mm** (0.0937")			
		B3Z-**150X**	BH3Z-**151X**	BH3Z-**152X**
	2.779mm (0.1094")			
		B3Z-**150**	BH3Z-**151A**	BH3Z-**152A**
200 Series (Flange type) 	**2.380mm** (0.0937")			
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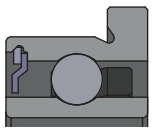
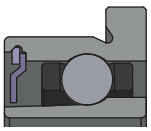
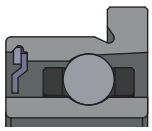
	2.779mm (0.1094")			
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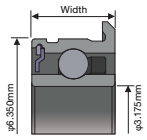
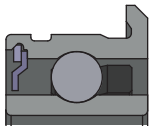
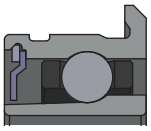
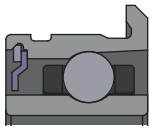
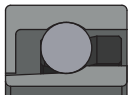
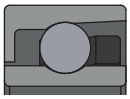
250 Series 	**2.779mm** (0.1094")			
		FBC3Z-**250**	FBH3Z-**251A**	FBH3Z-**252A**

Standard specifications

- Ceramic ball bearings
- To maximize bearing performance, NSK has adopted ABEC9(P2) grade tolerance for the inner ring bore diameter. The tolerance of other parts is ABEC7(P4) grade.
- NSK can supply bearings with two classifications of the inner ring bore diameter tolerance (from -0.0025 to -0.00125, and from -0.00125 to 0mm).
- NSK can manufacture bearings with custom laser markings upon request.
- NSK uses the high-safety low-viscosity lubricating oil CF1 as standard specification. Bearings with BF7 grease are also available.

Optional specifications

- Stainless steel ball bearings are also available.
- Bearings with different widths for the outer ring and inner ring are also available.

Integral bearing			
Inner ring counterbore		Outer ring counterbore	
			
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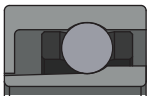	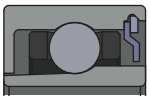	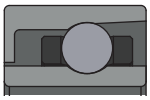	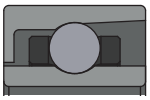
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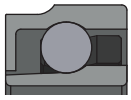		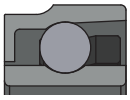	
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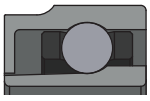	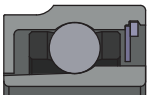	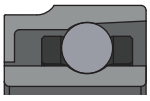	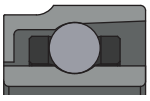
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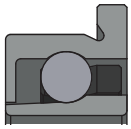		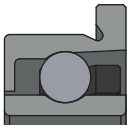	
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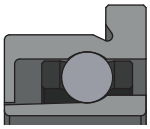	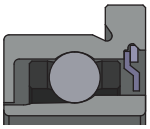	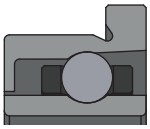	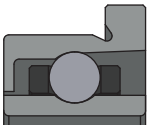
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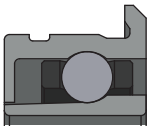
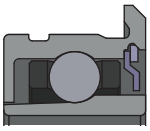
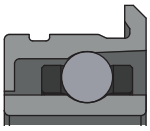
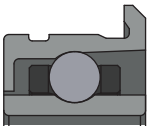
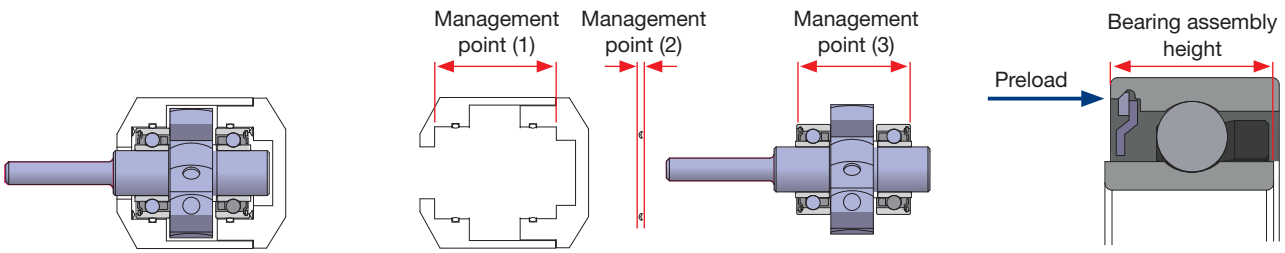
			
FBH3Z-**253A**	FBH3Z-**253B**	FBH3Z-**254A**	FBH3Z-**254**

Preload stabilization

Stabilization of preloading using a spring is extremely important for air turbine bearings. There are three management points ((1) to (3) below) for this task. For optimal performance of bearings, the bearing assembly height at the time of preloading is absolutely important. NSK can verify the design setting value of the bearing assembly height at your company to assure stable preloading.



Example of Product Code

Please use the following example product code of an NSK standard dental handpiece bearing (Smooth type 100 series) as a guide to select a bearing according to requirements such as bearing width, material, and lubricant to be used.

B3Z100X -H-20SN34 T52C ZS CG9 7A U438 CF1X
(1) (2) (3) (4) (5) (6) (7) (8)

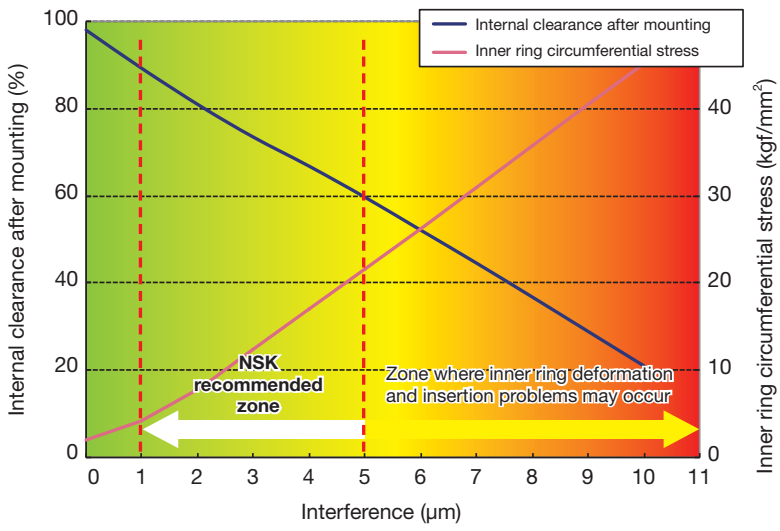
(1) B3Z100X: Model name indicating basic bearing number for air turbine
(2) -H-20SN34: Ceramic ball (**-H-26:** Optional stainless steel ball)
(3) T52C: Torlon® polyamide-imide cage
C, J, P, etc.: Cage type
(4) ZS: Single shield
(5) CG9: RIC 0.008mm to 0.010mm (Recommended by NSK)
(6) 7A: Special tolerance class (ABEC7+ID: ABEC9)
(7) U438: Special specification for air turbine
(8) CF1X: Special oil (Food grade) or **BF7N:** Special grease

Delivering the Optimal Performance of NSK Bearings

Importance of a perfect fitting

To get optimal performance out of NSK air turbine bearings, the bearings must be correctly fitted on the shaft and in the housing. To provide this optimal performance, Class ABEC9 tolerance (from -0.0025mm to 0mm) is used for the inner ring bore of NSK bearings. NSK can supply bearings with two classifications of ring bore diameter tolerance (from -0.0025 to -0.00125, and from -0.00125 to 0mm). This choice of tolerance makes it easy to stabilize the bearing fitting on the shaft. A stable fitting reduces air turbine vibrations, noises, and irregularities in the revolutions per minute, thereby assuring long life.

- **Shaft material: Martensitic stainless steel (SUS400 family)**
  (Please contact NSK to use bearings for shafts made of stainless steel other than martensitic stainless steel.)



Contact NSK immediately if you encounter troubles

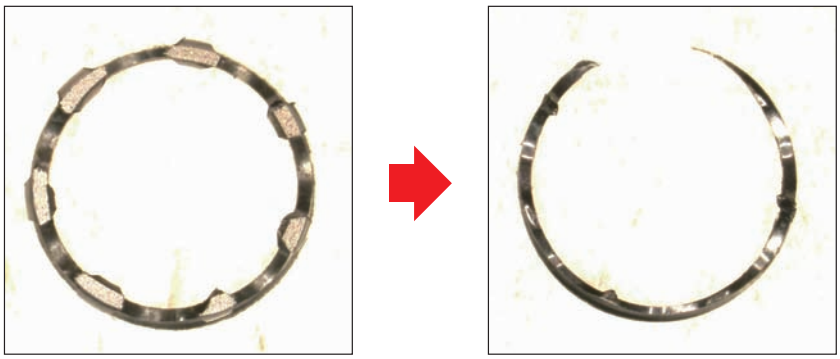
Bearings are used for wide-ranging applications and are a critical part that significantly affects the performance of a product and device. An air turbine in particular is a precision medical device used at an ultrahigh speed rotation of about 500,000rpm. Even a slight deviation in the performance of bearings will significantly affect the operation of a product and device. There are, however, cases where it is often difficult to determine whether a trouble symptom is caused by a bearing or some other part. NSK finds the solution to all your troubleshooting needs with its rich experience of over 50 years and the full advantage of the company's advanced analysis technologies.

Troubles you may encounter

Case 1: Unable to get expected results despite efforts to improve air turbine performance.
Case 2: Irregular acoustic noise (tone) of air turbine
Case 3: The acoustic noise (low tone) is stable, but the vibrations are somewhat large and the rolling life is short.
Case 4: The acoustic noise has a low tone that we think is highly favorable, but we are not sure.

• Bearing wear

Generally, the rolling life of air turbine bearings comes to an end when the cage is worn or damaged, which slows down the revolutions per minute and causes increased vibrations. Reducing and controlling cage wear is the key factor for extending rolling life. NSK's high optimal designing capability and parts machining precision together with the customers' high assembly technologies and the dental practitioner's good maintenance of a dental handpiece are indispensable to reducing and controlling cage wear.



Even cage wear　　End of rolling life (long life)

Please contact NSK if a cage is not evenly worn as shown in the photo above.
In cases such as below, NSK may be able to help resolve the problem.

- Poor precision bearings
- Low assembly precision of handpiece manufacturer
- Poor maintenance of handpiece by dental practitioner

MOTION & CONTROL™

NSK

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NSK LTD. HEADQUARTERS, TOKYO JAPAN
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SHENYANG P: +86-24-2334-2868
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WUHAN P: +86-27-8556-9630
QINGDAO P: +86-532-5568-3877
GUANGZHOU P: +86-20-3817-7800
CHANGSHA P: +86-731-8571-3100
LUOYANG P: +86-379-6069-6188
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