SUPER PRECISION BEARINGS
FOR MACHINE TOOL APPLICATIONS

STAY IN MOTION. STAY IN CONTROL.
Machine tools are essential infrastructure to industry, providing critical components for countless manufacturing sectors. As such, optimization of precision and throughput are symbiotic: machining centers are required to minimize processing time and maximize output, all the while producing stringently high-quality finished parts.

To meet these challenges, NSK applies our prowess with advanced material technologies and optimized product design to deliver bearings for machine tools that achieve:

 › Superior running accuracy with reduced NRRO
 › Ultra-high speeds with low temperature rise
 › Higher capacity for machining versatility
 › Exceptional wear resistance for longer spindle life

With NSK Super Precision bearings, machine tool builders and operators can realize next-generation speed, capacity and reliability to accelerate throughput and efficiency. Precisely.
HEAT-RESISTANT SHX STEEL

NSK Super Precision Bearings are manufactured with high-purity Z Steel to achieve a long operating life under normal conditions in wide-ranging applications. For machine tools running at maximum capacity at ultra-high speeds under high temperatures, NSK offers NSKROBUST series bearings manufactured with special high-endurance SHX Steel with special heat treatment technology. Decisive performance advantages include:

› 4 times longer fatigue life than SUJ2 Z Steel
› Considerably higher seizure resistance (figure 1), exceeding that of heat-resistant MS5 aerospace bearing steel
› Higher wear resistance achieved with superior material hardness (figure 2)
› 20% higher limiting speeds compared to SUJ2 steel

CERAMIC BALLS

Ceramic hybrid bearings deliver advanced performance characteristics that can be transformational in machine tools. NSK offers silicon nitride (Si3N4) ceramic balls as a standard option for angular contact ball bearings to achieve ultra-high machining speeds, in addition to a considerable array of advantages:

› Higher rigidity and rotational accuracy, enabling high-accuracy machining
› Lower sliding friction in high-speed applications (figure 3)
› Lower heat generation (figure 4)
› Higher seizure resistance
› Longer grease life due to low heat generation

EQTF™ BALLS

Ultra-long life EQTF balls deliver superior wear and seizure resistance in NSKROBUST angular contact ball bearings, derived from advanced material composition and carbonitriding.

ENGINEERED POLYMER CAGES

NSK engineered polymer cages are optimized to support the ultra-high speeds of next-gen machining requirements: they’re lighter (1/6 of the weight of brass cages), self-lubricating and have a low friction coefficient. NSK Super Precision machine tool bearings equipped with engineered polymer cages generate less heat at high-speed rotation. They are also engineered to deliver high strength and excellent wear resistance.

Table 1: Characteristics and use of engineered polymer cages

<table>
<thead>
<tr>
<th>Cage Material</th>
<th>Performance Characteristics</th>
<th>Angular Contact Ball Bearings</th>
<th>Angular Contact Thrust Ball Bearings</th>
<th>Cylindrical Roller Bearings</th>
<th>Ball Screw Support Bearings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nylon 46</td>
<td>low friction and low temperature rise at high speeds; especially effective with grease lubrication</td>
<td>TYN</td>
<td>TYN</td>
<td></td>
<td>TBS</td>
</tr>
<tr>
<td>PEEK</td>
<td>high strength with excellent wear resistance; low NRRO, ultra high speeds</td>
<td>TS</td>
<td>TP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPS</td>
<td>high strength with low deformation due to centrifugal force; low NRRO, ultra high speeds</td>
<td>TSR</td>
<td>TB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NSKHPS ANGULAR CONTACT BALL BEARINGS

NSKHPS high-accuracy angular contact ball bearings deliver superlative performance for general machine tool applications. Internal design, component and materials optimization ensure efficiency and extended bearing life in high-speed and high-load applications. For reduced wear, contamination resistance and markedly improved grease life, our NSKHPS series are also available with a non-contact seal option.

DESIGN FEATURES

- Manufactured with improved steel purity, increasing bearing fatigue life by as much as 15%
- High-performance cage design options - polyamide and phenolic resin - to meet application requirements
- Available with ceramic balls for higher seizure resistance and lower heat generation
- Non-contact sealed design option
- Available with 15°, 25° and 30° contact angles
- Various preload and accuracy options
- Universal matching

SEALED DESIGN OPTION

NSKHPS sealed high-accuracy angular contact ball bearings deliver considerable operating benefits:

- Prevents contamination and lubricant breakdown, with grease life extended by as much as 50%
- Reduces wear to raceway and ball surfaces
- Zero speed loss from non-contact seal design
- Ease of handling - installation is 4 times faster, and risk of maintenance contamination is eliminated
- Simple adoption - dimensionally interchangeable with open bearings

Fig.5: Range of availability

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- Various preload and accuracy options
- Universal matching

SEALED DESIGN OPTION

NSKHPS sealed high-accuracy angular contact ball bearings deliver considerable operating benefits:

- Prevents contamination and lubricant breakdown, with grease life extended by as much as 50%
- Reduces wear to raceway and ball surfaces
- Zero speed loss from non-contact seal design
- Ease of handling - installation is 4 times faster, and risk of maintenance contamination is eliminated
- Simple adoption - dimensionally interchangeable with open bearings

Fig.5: Range of availability

NSKHPS ANGULAR CONTACT BALL BEARINGS

DESIGNATION SYSTEM

NSKHPS HIGH-ACCURACY ANGULAR CONTACT BALL BEARINGS

<table>
<thead>
<tr>
<th>Dimension Series</th>
<th>Contact Angle</th>
<th>Cage</th>
<th>Closure</th>
<th>Preload</th>
<th>Grease Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>C</td>
<td>SN24</td>
<td>TR</td>
<td>V1V</td>
<td>EL</td>
</tr>
</tbody>
</table>

- **Bore Reference No.**
- **Material - Balls**
- **Arrangement**
- **Accuracy**
- **Grease Fill**

- **Dimension Series**
- **Contact Angle**
- **Cage**
- **Closure**
- **Preload**
- **Grease Type**

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>ATTRIBUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension series</td>
<td>70</td>
</tr>
<tr>
<td>Contact angle</td>
<td>15°</td>
</tr>
<tr>
<td>Cage</td>
<td>SN24</td>
</tr>
<tr>
<td>Closure</td>
<td>V1V</td>
</tr>
<tr>
<td>Material</td>
<td>blank</td>
</tr>
<tr>
<td>Accuracy</td>
<td>P2</td>
</tr>
<tr>
<td>Grease type</td>
<td>MTE</td>
</tr>
</tbody>
</table>

- **Preload**
- **Accuracy**
- **Grease Fill**

**Fig.5: Range of availability**

Left: open-type bearing with phenolic resin cage (TR) and ceramic balls

Above: sealed-type bearing with polyamide resin cage (TYN) and steel balls

*For additional information about bearing arrangements and possible combinations, refer to “Angular Contact Ball Bearing Combinations” on page 26.
NSKROBUST™ ANGULAR CONTACT BALL BEARINGS
FOR ULTRA HIGH-SPEED MACHINING

in order to meet accelerating production requirements, machining centers must minimize processing time. As a result, machine tool spindles have to operate at increasingly high speeds. For spindle bearings, rising to challenges in the form of seizure resistance and fatigue life are critical. NSKROBUST angular contact ball bearings are designed precisely to support ultra high-speed rotation, achieving precision-machined surfaces with exceptional reliability.

DESIGN FEATURES

› Special design series equipped with a larger complement of smaller balls to support higher limiting speeds than conventional high-accuracy series bearings (Figure 6)
› Dimensionally interchangeable with conventional bearings
› Available in four design series with alternative material configurations for inner / outer rings and balls (see Table 2)
› High-performance polyamide, phenolic and engineered PPS resin cage design options available to meet specific application requirements
› With contact angles of 15° (BSR), 18° (BNR) and 25° (BER)
› Non-contact sealed design option
› Various preload and accuracy options
› Universal matching, supporting multiple combined arrangements

Table 2: NSKROBUST series and construction

<table>
<thead>
<tr>
<th>NSKROBUST SERIES</th>
<th>BEARING RINGS</th>
<th>BEARING BALLS</th>
<th>TYPICAL APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Type</td>
<td>SUJ2 steel</td>
<td>SUJ2 steel</td>
<td>general industries, information technology</td>
</tr>
<tr>
<td>E Type</td>
<td>SUJ2 steel</td>
<td>ETP steel</td>
<td>automotive, general industries</td>
</tr>
<tr>
<td>H Type</td>
<td>SUJ2 steel</td>
<td>ceramic</td>
<td>die casting, aircraft components</td>
</tr>
<tr>
<td>X Type</td>
<td>SHX steel</td>
<td>ceramic</td>
<td>automotive, general industries</td>
</tr>
</tbody>
</table>

Table 2: NSKROBUST series and construction

DESIGNATION SYSTEM

Fig.6: Relative limiting speeds by series

Left: “SURSAVE™” bearing with PPS resin cage (TSR) and ceramic balls
Above: NSKROBUST bearing with polyamide resin cage (T) and ceramic balls

For additional information about bearing arrangements and possible combinations, refer to “Angular Contact Ball Bearing Combinations” on page 26.
A reliable, continuous supply of lubrication to the working surfaces of spindle bearings is a particular challenge. Conventional oil-air lubrication injection methods - injecting lubricant into the side of the bearing using a nozzle - can be ineffective due to the air vortex generated around the rotating bearing. NSK SPINSHOT II and ROBUSTSHOT bearings deliver two decidedly different but efficient approaches to guaranteeing a reliable, even supply of lubricant to bearings operating at ultra-high speeds.

**SPINSHOT II PERFORMANCE FEATURES**

- Heat and seizure resistance - with SHX steel inner and outer rings
- High-speed performance - in position preload up to 2.5 million \(d_{25}N\) with jacket cooling (maximum 2.7 million \(d_{25}N\) without jacket cooling)
- Silent operation - 3 to 5 dB quieter than conventional oil-air lubrication
- Orientation - remains stable in either vertical or horizontal spindle orientation
- Reduced air consumption - as low as 1/3 of that in conventional oil-air lubrication
- Low heat generation - with ceramic balls

**ROBUSTSHOT DESIGN FEATURES**

- Available in NSKROBUST series BNR (18° contact angle) and BER (25° contact angle)
- With an outer ring lubrication groove and 2 through-holes
- Additional outer ring grooves (2) with 0-rings to facilitate fit and sealing
- High-performance outer ring guided phenolic resin cage
- Equipped with ceramic balls as standard
- Various preload and accuracy options
- Universal matching and combination arrangements

**Fig.7: Spinshot II structure**

- Oil particle separation point
- Air pressure decreases at groove on circumference
- Centrifugal force
- Surface tension
- Air flow
- Oil particle

**SPINSHOT II AND ROBUSTSHOT ANGULAR CONTACT BALL BEARINGS**

<table>
<thead>
<tr>
<th>Nominal Bore Diameter</th>
<th>Dimension Series</th>
<th>Cage</th>
<th>Arrangement</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>BNR</td>
<td>T</td>
<td>E34</td>
<td>EL</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>H</td>
<td>DB</td>
<td>P3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EL</td>
<td>P4</td>
</tr>
</tbody>
</table>

**DESIGNATION SYSTEM**

- EL: extra-light preload
- L: light preload
- M: medium preload
- CAXX: special clearance, in microns
- P2: ISO class 2
- P3: dimensional accuracy ISO class 4, running accuracy ISO class 2
- P4: ISO class 4

**Nominal bore dia.** expressed in millimeters

**WARNING**
- The SPINSHOT II design is not intended to be configured as a ROBUSTSHOT bearing.

**REFERENCES**
- For additional information about bearing arrangements and possible combinations, refer to "Angular Contact Ball Bearing Combinations" on page 26.
For conventional high-capacity machining requirements, NSK has optimized internal design to deliver extended life with our NSKHPS series single row cylindrical roller bearings with machined brass cage. Where machine speed is a priority, NSKROBUST series bearings deliver superior ultra-high-speed performance with high rigidity and stability with low heat generation. Advanced material options for rings and rollers offer greater heat and seizure resistance and extended bearing fatigue life.

**NSKROBUST DESIGN FEATURES**
- Optimized internal design for utmost bearing fatigue life
- Heat-resistant and highly rigid PEEK resin cage provides stability at ultra-high speeds
- Cage design improves effective lubricant distribution
- Low heat generation enables longer lubricant life
- Available with heat-resistant SHX steel rings and rollers for longer fatigue life (4 times) and higher limiting speeds
- Available with cylindrical and tapered bores
- Various clearance and accuracy options

**DESIGNATION SYSTEM**

**SINGLE ROW CYLINDRICAL ROLLER BEARINGS - STANDARD AND NSKROBUST**

### Table: Single Row Cylindrical Roller Bearings - Standard and NSKROBUST

<table>
<thead>
<tr>
<th>Bearing Type</th>
<th>Bore Reference No.</th>
<th>Internal Design</th>
<th>Cage</th>
<th>Radial Internal Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>10</td>
<td>RX</td>
<td>Z</td>
<td>KR</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td></td>
<td></td>
<td>CC0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P4</td>
</tr>
</tbody>
</table>

**Dimension Series**: 10 series

**Material - Rings, Rollers**: blank, SUJ2 steel, SUJ2 steel, NSKROBUST

**Cage**: RX, SHX steel, inner ring rib guided brass cage, Z, low heat generation type, TP, outer ring guided PEEK resin cage, MR, roller guided brass cage, KR

**Radial Internal Clearance**: CC0, standard for tapered bore, CC1, standard for cylindrical bore, CCGXX, special clearance, in microns, P2, P5, P2 class 2, P5 class 5, P4, P4Y, P2 class 4, special dimensional accuracy with P2 class 4 running accuracy

**Accuracy**: P2, P5 class 2, P4, P4Y, P2 class 4, special dimensional accuracy with P2 class 4 running accuracy

**Lubrication**: oil-air, NSKROBUST, SHX steel: dmn 1.8 million, NSKROBUST, SUJ2 steel: dmn 1.4 million, NSKROBUST, SUJ2 steel: dmn 1.3 million

**DESIGNATION**
- NSKROBUST: blank, optimized internal design for utmost bearing fatigue life
- Heat-resistant and highly rigid PEEK resin cage provides stability at ultra-high speeds
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- Various clearance and accuracy options

**Figures**
- **Fig.8**: Range of Availability
- **Fig.9**: Comparison of limiting speeds

**Notes**
- NSKROBUST series bearing with PEEK cage for ultra-high speeds
- NSKHPS series bearing with machined brass cage for long-life performance
NSK double row cylindrical roller bearings deliver superior performance in machining applications requiring high rigidity and high radial load capacity. Featuring NSKHS optimized internal design, high performance levels and bearing life have been dramatically increased. Higher accuracy of all bearing components has dramatically reduced rotational vibration (APTSURF) - ensuring reliable, high precision and cost-effective machine tool performance.

**NSKROBUST DESIGN FEATURES**

- Available in series NN30, NN39, NN49 and NNU49
- NSKHS high-performance range available for P5 accuracy and higher, up to 360 mm outside diameter
- Low vibration APTSURF specification available for P4 accuracy and higher, up to 360 mm outside diameter
- Standardly equipped with machined brass cage
- Advanced PPS resin cage available for NN30 series, supporting higher limiting speeds with high rigidity, low heat generation and reduced wear
- Low heat generation NN-Z series also available, specifically for free-end bearings
- Available with cylindrical and tapered bores
- Various clearance and accuracy options

**DOUBLE ROW CYLINDRICAL ROLLER BEARINGS**

**DESIGNATION SYSTEM**

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>ATTRIBUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing type</td>
<td>NN</td>
</tr>
<tr>
<td>Dimension series</td>
<td>30</td>
</tr>
<tr>
<td>Internal Design</td>
<td></td>
</tr>
<tr>
<td>Lubrication Features</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>P2</td>
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</tbody>
</table>

**DOUBLE ROW CYLINDRICAL ROLLER BEARINGS FEATURING NSKHS AND APTSURF SERIES**

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ANGULAR CONTACT THRUST BALL BEARINGS
NSKROBUST AND NSKTAC SERIES

Superior high-speed capability and high rigidity are required of ball bearings used for sustaining axial loads in machine tool spindles. For such requirements, NSK offers a trio of design options to suit prevailing performance characteristics and structure. All of these bearings are designed for use in combination with cylindrical roller bearings and are manufactured with special outer diameter tolerances to ensure that - when mounted - any radial load is supported entirely by the cylindrical roller bearings.

NSKROBUST DESIGN FEATURES
NSKROBUST bearings are designed to deliver high-speed performance with low heat generation, without compromising rigidity.

- BTR types have a 40° contact angle and deliver high rigidity with high speeds
- BAR types have a 30° contact angle and deliver higher speeds than BTR types
- Polyamide resin cages are particularly suited for stability and low friction at high speeds
- Available with ceramic balls for higher seizure resistance and lower heat generation, as well as ultra-long-life EQTF balls

NSKTAC D AND F SERIES
High rigidity is the priority with NSKTAC series double direction angular contact thrust ball bearings. TAC F series bearings are duplex sets with a 50° contact angle; TAC D series are separable double row bearings with a 60° contact angle. Both are available with machined brass cage.

INTERCHANGEABILITY
NSKTAC bearings have special width dimensions to enable simple replacement of TAC29 series bearings without shaft or housing modifications (see Figure 12). For the replacement of TAC29 series bearings, please contact NSK.

Fig.12: Interchanging NSKTAC > NSKROBUST

Left: NSKROBUST bearings with ceramic ball in “DB” arrangement
Above: NSKTAC D series double direction angular contact thrust ball bearing

Above: upgrading speed to NSKROBUST bearings - remove spacer C and replace spacer D with spacer E.

NSKROBUST ANGULAR CONTACT THRUST BALL BEARINGS

Nominal Bore Diameter | Dimension Series | Cage | Preload | Accuracy
---|---|---|---|---
100 | BAR | 10 | TYN | P4A
10 | S | DB | L

NSKTAC D AND F SERIES ANGULAR CONTACT THRUST BALL BEARINGS

Nominal Bore Diameter | Dimension Series | Accuracy | Spacer | Lubrication Features | Preload
---|---|---|---|---|---
150 | TAC | PN7 | +LXX | C7 | E44
20D | MY | C7 | DB | EL | P4A

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Above: NSKROBUST bearings with ceramic ball in “DB” arrangement

Above: upgrading speed to NSKROBUST bearings - remove spacer C and replace spacer D with spacer E.

Left: NSKTAC D and F series angular contact thrust ball bearings - specific to NSKTAC D series
Left: NSKTAC D and F series angular contact thrust ball bearings - specific to NSKTAC F series
NSKHPS TAC C SERIES BALL SCREW SUPPORT BEARINGS

NSKHPS TAC C support bearings for ball screw drives are designed to deliver utmost fatigue life and performance capacity in modern machine tool feeding systems. A 60° contact angle and optimized internal design allow these bearings to support large axial forces while providing rigid and accurate ball screw support. NSKHPS TAC C bearings are available as open bearings or sealed for contamination resistance and considerably longer grease life.

DESIGN FEATURES

› Manufactured with high-purity steel, optimizing fatigue strength / bearing life and boosting dynamic load ratings
› 60° contact angle and maximized ball complement provide high axial rigidity
› Special design polyamide cage supports high speeds with low friction
› Available as open bearings or with light contact seals; non-contact seals are available for some sizes
› Heavy preload is standard
› Universal matching, supporting multiple combined arrangements

SEALED DESIGN OPTION

› Sealed NSKHPS TAC C bearings are standardly equipped with light-contact DDG seals for effective prevention of contamination and grease leakage
› Light-contact design supports high-speed operation with low torque and low heat generation
› Sealed bearings are pre-packed with WPH water-proof grease that resists high temperatures and is less likely to soften and leak

DESIGNATION SYSTEM

NSKTAC C SERIES BALL SCREW SUPPORT BEARINGS

![NSKHPS TAC C ball screw support bearing - open type](image1)

Left: NSKHPS TAC C ball screw support bearing - open type
Above: with light contact DDG seal

* For additional information about bearing arrangements and possible combinations, refer to “Angular Contact Ball Bearing Combinations” on page 26.
NSKHPS BSBD SERIES BALL SCREW SUPPORT BEARINGS

NSK’s BSBD series of support bearings for ball screw drives are designed to facilitate accurate positioning of a workpiece or machine component quickly and efficiently. A double row configuration with a 60° contact angle enables the bearings to support large axial forces in both directions with accuracy and rigidity. The bearings are supplied sealed, greased for life and ready for easy installation for both housing mounting (BSN type) and direct mounting (BSF type).

DESIGN FEATURES
- Double row angular contact thrust ball bearing design with a 60° contact angle, accommodating high axial loads in both directions
- Multi-lip contact seals ensure excellent grease retention and high resistance to dust penetration, with low friction and low heat generation at high speeds
- Greased for life, but equipped with lubrication grooves and holes to facilitate relubrication during operation
- Available as conventional BSN type for housing mounting, or extended outer ring BSF type featuring mounting holes and an extraction groove for easy direct installation and removal

MATCHED PAIRS
BSN and BSF ball screw support bearings are available as matched pairs (DT) for applications where higher load capacities and/or higher stiffness are required. The outer diameter surfaces of the bearings are marked for proper matching and alignment. Matching surfaces are adjusted in order to control preload of each individual bearing.

HEAVY SERIES
A heavy series type is available on some sizes. This type has the same inner ring dimensions, but a larger ball size and outer ring diameter, allowing higher axial loads and stiffness.

Below: extended outer ring BSF type with mounting holes and an extraction groove
Above: conventional BSN type

Above: Housing mounting of BSN design type
Above: Direct, face mounting of BSF design type

<table>
<thead>
<tr>
<th>DESIGNATION SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESIGNATION</td>
</tr>
<tr>
<td>Bearing type</td>
</tr>
<tr>
<td>Flange design</td>
</tr>
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<td>Flange type</td>
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<tr>
<td>Nominal bore dia.</td>
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<tr>
<td>Nominal outer dia.</td>
</tr>
<tr>
<td>Closure</td>
</tr>
<tr>
<td>Accuracy</td>
</tr>
<tr>
<td>Preload</td>
</tr>
<tr>
<td>Arrangement</td>
</tr>
</tbody>
</table>

NSKHPS BSBD SERIES BALL SCREW SUPPORT BEARINGS
ROBUSTSLIM HIGH-ACCURACY LOW-PROFILE ANGULAR CONTACT BALL BEARINGS

NSK ROBUSTSLIM angular contact ball bearings are designed specifically for swiveling spindle heads and rotary / tilt tables used in machine tools, and are suitable for high-precision processing with multi-axis machines. The ROBUSTSLIM series of high-accuracy low-profile angular contact ball bearings offer high rigidity on par with conventional crossed roller bearings, with lower torque and consequently, reduced energy loss.

**DESIGN FEATURES**
- Compact, space-saving design, with a 35% thinner profile than standard angular contact ball bearings
- High accuracy with low NRRO - 0.5μm or lower was achieved with BRSA130
- High moment stiffness on par with crossed roller bearings
- Lower torque than roller bearing alternatives
- Duplex back-to-back arrangement
- Non-contact seal on one side (of each bearing)

**NSK ROBUSTSLIM Angular Contact Ball Bearings**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Attribute</th>
<th>Cage</th>
<th>Material - Rings, Balls</th>
<th>Closure</th>
<th>Preload</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRSA 130</td>
<td>S</td>
<td>T21</td>
<td>SUJ2 or SUJ3 steel rings / SUJ2 balls</td>
<td>V</td>
<td>DB</td>
<td>CP45 P5</td>
</tr>
</tbody>
</table>

**Material - Balls**
- SUJ2 or SUJ3 steel balls
- Si3N4 ceramic balls

**Radial Internal Clearance**
- C3: larger than normal clearance
- CGXX: special clearance, in microns

**Bore Reference No.**
- Multiply x 5 for bore diameter in mm

**Accuracy**
- ISO class 5

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- Duplex back-to-back arrangement
- Non-contact seal on one side (of each bearing)

**NSK ROBUSTSLIM Angular Contact Ball Bearings**

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<tr>
<th>Designation</th>
<th>Attribute</th>
<th>Cage</th>
<th>Material - Rings, Balls</th>
<th>Closure</th>
<th>Preload</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRSA 130</td>
<td>S</td>
<td>T21</td>
<td>SUJ2 or SUJ3 steel rings / SUJ2 balls</td>
<td>V</td>
<td>DB</td>
<td>CP45 P5</td>
</tr>
</tbody>
</table>

**Material - Balls**
- SUJ2 or SUJ3 steel balls
- Si3N4 ceramic balls

**Radial Internal Clearance**
- C3: larger than normal clearance
- CGXX: special clearance, in microns

**Bore Reference No.**
- Multiply x 5 for bore diameter in mm

**Accuracy**
- ISO class 5

HIGH-ACCURACY DEEP GROOVE BALL BEARINGS

Delivering low noise operation with low vibration at high speeds, NSK high-accuracy deep groove ball bearings are widely used in high-speed and high-precision motor applications.

**DESIGN FEATURES**
- Available for dimension series 60, 62 and 63
- With ball guided polyamide cage or inner ring guided phenolic cage - selection depending on the application
- Available with ceramic balls for higher seizure resistance and lower heat generation
- Accuracy classes P2, P3, P4 and P5

**NSK High-Accuracy Deep Groove Ball Bearings**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Attribute</th>
<th>Cage</th>
<th>Material - Balls</th>
<th>Radial Internal Clearance</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>62</td>
<td>10</td>
<td>T</td>
<td>SUJ2 or SUJ3 steel balls</td>
<td>P2</td>
<td>P2 class 2</td>
</tr>
<tr>
<td>62</td>
<td>10</td>
<td>T</td>
<td>Si3N4 ceramic balls</td>
<td>P3</td>
<td>dimensional accuracy P2 class 4, running accuracy P2 class 2</td>
</tr>
<tr>
<td>63</td>
<td>10</td>
<td>T</td>
<td>blank</td>
<td>P4</td>
<td>P4 class 4</td>
</tr>
<tr>
<td>63</td>
<td>10</td>
<td>T</td>
<td>blank</td>
<td>P5</td>
<td>P5 class 5</td>
</tr>
</tbody>
</table>

**Material - Balls**
- SUJ2 or SUJ3 steel balls
- Si3N4 ceramic balls

**Radial Internal Clearance**
- C3: larger than normal clearance
- CGXX: special clearance, in microns

**Bore Reference No.**
- Multiply x 5 for bore diameter in mm
ADDITIONAL MACHINE TOOL BEARING PRODUCTS

BALL SCREW SUPPORT BEARING UNITS
These units for ball screw support in heavy-load and machine tool applications feature NSKTAC C series high-accuracy, high-rigidity angular contact thrust ball bearings. Three types of arrangements - duplex DF, triplex DFD and quadruplex DFF - in an integrated ready-to-install assembly offer considerable advantages:
› Dust-resistant unit allows the user to easily design the support side of the ball screw
› Simplified installation, with preload-controlled and ready-mounted bearings eliminating mounting complexities

MACHINE TOOL GREASES
MTS and MTE are high-performance grease products developed specifically for machine tool applications and sold exclusively by NSK. Each is available in 100 g tubes and 1 kg cans. All NSK super precision sealed angular contact ball bearings come prepacked with MTS and MTE grease.
› MTS - heat-resistant grease for high-speed machining centers
› MTE - high-load grease for lathes

NSK VERIFY APP
NSK Verify mobile application supports efficient factory automation and IT-based plant management. Scanning 2D barcodes on NSK bearing boxes allows users to assess bearing authenticity and access inspection reports online. Data export functionality empowers users to track usage history and streamline order handling, improve product traceability, and even simplify bearing selection.
› Compatible with iOS and Android devices
› Available on the App Store and Google Play
NSK manufactures universal combination bearings that are controlled to have the same amount of stand-out (face offset) on their front and back faces. As such, the specified standard preload is achieved regardless of which combination is chosen. Each universal combination bearing comes with a V-shaped mark on the surface of the outer ring to simplify identification of the correct direction when mounting and to ensure that the correct combination is achieved. The V-shaped mark points to the direction of the axial load that the inner ring supports (vis-à-vis the contact angle).

**BACK-TO-BACK ARRANGEMENT, DB**
With DB arrangements, axial loads in both directions and radial loads can be sustained. The distance between the effective load centers is large, making this combination suitable if moments are applied. In case of insufficient housing accuracy or shaft misalignment, internal load of the bearings could be large enough to risk premature failure due to the high level of moment stiffness.

**FACE-TO-FACE ARRANGEMENT, DF**
Comparatively, the distance between the effective load centers is small, so the capacity to sustain moments is inferior to the DB type. On the other hand, this type is suitable for use with housings that have less accuracy or larger shaft deflections due to low bending stiffness of the shaft.

**TANDEM ARRANGEMENT, DT**
Axial loads in one direction and combined loads can be sustained. Since axial stiffness of this type is twice the value of a single row type, this arrangement is used when the axial load in one direction is heavy. If preload is required, it needs to be applied by external means such as by use of a spring.

Table 3: Common angular contact ball bearing arrangements and characteristics

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>DB</th>
<th>DF</th>
<th>DT</th>
<th>DBD</th>
<th>DDB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load direction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moment stiffness</td>
<td></td>
<td></td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>Speed capability</td>
<td></td>
<td></td>
<td></td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>Low heat generation</td>
<td></td>
<td></td>
<td></td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>Stiffness</td>
<td></td>
<td></td>
<td></td>
<td>☺</td>
<td>☺</td>
</tr>
</tbody>
</table>

Arrangements of Universal Combination Bearings - Marks and Matching

Fig. 13: Distance between effective load centers

![Diagram of effective load centers for DB and DF arrangements]
FEATURES OF ANGULAR CONTACT BALL BEARINGS

THE EFFECT OF CONTACT ANGLE

Super precision angular contact ball bearings are available with predetermined contact angles ranging from 15° to 30°. A bearing with a larger contact angle can support higher axial loads. Smaller contact angles, while supporting less axial load, are better suited for high-speed and high radial load applications.

As shown in Figure 14, when the preload is constant - in this example light - the bearing with a 30° contact angle delivers axial rigidity roughly three times that of a bearing with a 15° angle.

Conversely, the bearing with a lower contact angle is capable of achieving higher limiting speeds, and does so with lower heat generation for a longer operating life (Figure 15).

THE EFFECT OF COMBINATIONS

As previously reviewed on page 26, angular contact ball bearings can be used either as single bearings or in combinations of two or more bearings. There is no limit to the number of rows, although two-row (duplex), three-row (triplex) and four-row (quadruplex) are the most commonly used multiple bearing sets.

As illustrated in Figure 16, when the combination is constant - in this example back-to-back - rigidity and load capacity increase with the number of rows of bearings, but limiting speeds decrease. Therefore, higher rigidity can be achieved by sacrificing speed, and conversely higher speeds can be achieved by sacrificing rigidity to a certain extent.

THE EFFECT OF PRELOAD

NSK has defined standard preload levels as extra-light (EL), light (L), medium (M) and heavy (H). Preload affects the performance of angular contact ball bearings in much the same way as the contact angle.

As shown in Figure 17, for any predetermined contact angle both radial and axial rigidity can be increased by increasing the preload. Conversely, higher preloads reduce attainable limiting speeds.

In addition to negatively impacting speed, higher preloads result in higher heat generation and declining bearing life (Figure 18).

Caution: High speeds combined with higher preload risk bearing seizure.

Note: NSK ROBUST series bearings are also available with 18° contact angle.
FEATURES OF CYLINDRICAL ROLLER BEARINGS

Cylindrical roller bearings support only radial loads, but deliver the benefit of a larger radial load capacity than angular contact ball bearings. In general, double row cylindrical roller bearings are used for high rigidity applications such as lathes, while single row cylindrical roller bearings are used in high-speed applications such as machining centers.

THE EFFECT OF INTERNAL RADIAL CLEARANCE

The performance of cylindrical roller bearings is effected by internal radial clearance after mounting. Figure 19 illustrates that 0 μm to slightly negative clearance is optimal in terms of both rigidity and bearing life. In order to achieve rigidity for fixed-end bearings, radial clearance is set to slightly below zero. Radial clearance below -3 μm will have negligible increase to rigidity, while bearing life will decline sharply.

Positive clearance of approximately +3 μm is commonly used in free-end bearings. Depending on the bearing size and operating speed, a more detailed examination may be required. Internal radial clearance decreases during operation. This must be taken into account when setting internal radial clearance during mounting, especially with high-speed applications.

RADIAL CLEARANCE AND TEMPERATURE RISE

Figure 20 illustrates temperature rise in cylindrical roller bearings after mounting. The bearing with -30 μm internal radial clearance displays a strong temperature rise and a drop in limiting speed. Mounting a bearing with an excessively negative internal radial clearance will not allow that bearing to perform to its potential.

ADJUSTING INTERNAL RADIAL CLEARANCE

Cylindrical bore

Bearing dimensions are matched to those of the shaft and housing. As a result of the shaft and housing fits, internal radial clearance will change from Δr to Δr'. No further adjustment of the internal radial clearance is possible.

Tapered bore

The distance by which the bearing is driven onto the shaft determines the amount of inner ring expansion, internal radial clearance will change from Δr to Δr' to Δr'' to achieve the desired internal radial clearance.

ISO standards for 1:12 tapered bores have a wide tolerance range for the taper angle. NSK has established its own narrower tolerances for precision cylindrical roller bearings.

- KR tolerance has a very narrow range that is positioned towards the lower limit of the standard ISO range. The narrow tolerance of KR tapered bores supports easier clearance control during mounting. NSK applies KR tolerance as standard to bore diameters up to 400 mm
- K tolerance is positioned midrange in accordance to the ISO standard. NSK applies K tolerance to bore diameters larger than 400 mm

INTERNAL RADIAL CLEARANCE CLASSES

CC0 clearance - NSK recommended

This class offers medium radial clearance, eliminating the upper and lower limits of CC9 and CC1 respectively with a smaller range. NSK recommends CC0 for ease of use in customer applications that target this clearance range.

CC9 clearance

With the lowest internal clearance of the three classes, bearings with CC9 clearance need only to be driven onto the shaft a very short distance, mitigating the negative influence of interference on bearing accuracy or deformation of the shaft bore. However, if the bearing’s internal clearance is at the lower end of the CC9 range prior to installation and the drive-up distance to achieve the desired mounted clearance is extremely small, there is an increased risk of creep damage between the shaft and the inner ring of the bearing when under high-speed and/or high-load operation.

Fig.21: Cylindrical bore

Fig.22: Tapered bore

Fig.23: Internal clearance example: NN3020TBKR

CC1 clearance

CC1 clearance has been traditionally adopted, in part due to the absence of any risk of creep damage considering the distance that the bearing is driven onto the shaft. However, if the bearing’s internal clearance is at the higher end of the CC1 range prior to installation and the drive-up distance to achieve the desired mounted clearance on the tapered shaft is considerable, there is a risk of detrimentally impacting bearing accuracy or causing deformation of the inside shaft bore. This is particularly true in the case of a thin hollow shaft with a large bore diameter.
**ACCURACY CLASSES AND TOLERANCES**

**THE IMPORTANCE OF TOLERANCES**

Accuracy classes dictate tolerances that encompass both the running accuracy (runout) and the dimensional accuracy (external tolerances) of bearings.

As illustrated in Figure 24, radial runout is the measure by which the rotational axis of the bearing deviates from the centerline axis of the spindle shaft while remaining parallel. Axial runout measures the degree to which the axis of rotation is tilted and deviating from parallelism.

Dimensional accuracies measure the tolerance range of deviations in outer and bore diameters in manufacturing (see Figure 25). Appropriate determination and selection are crucial to ensure proper shaft and housing fits. When using bearings in combination arrangements it is important to match the accuracies of the bearings selected. Mismatched bore and outside diameter tolerances in bearing combinations can lead to uneven load sharing and bearing failure.

**ACCURACY CLASS P4Y**

NSK’s proprietary P4Y accuracy standard has a special, tightly controlled range of external tolerances with a Class 4 (P4) running accuracy. Since the variation of bearing bore and outer diameter is minimized (see Figure 25), P4Y is particularly well suited for universal combination bearings.

Tables 4 and 5 illustrate the median tolerance range of P4Y relative to all accuracy classes.

**SPECIAL WIDTH ACCURACY CLASS P3W**

Class 3W is an NSK proprietary standard in which the tolerances for the inner and outer ring width are in a special class, while other tolerances are per Class 3. The width tolerances are the same for the inner and outer rings. This standard can apply to universal arrangement bearings (SU, DU, DUD, and QU). Minimizing differences in width improves assembly and reduces the need for adjustments (see Figure 25 and Table 6).

---

Table 4: Inner ring tolerances P4Y

<table>
<thead>
<tr>
<th>Bore diameter (mm)</th>
<th>Class 5</th>
<th>Class 4</th>
<th>Class P4Y</th>
<th>Class 3</th>
<th>Class 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>high</td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>over including</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 50</td>
<td>0 -6</td>
<td>0 -6</td>
<td>0 -3</td>
<td>0 -6</td>
<td>0 -6</td>
</tr>
<tr>
<td>50 80</td>
<td>0 -6</td>
<td>0 -7</td>
<td>0 -5</td>
<td>0 -7</td>
<td>0 -4</td>
</tr>
<tr>
<td>80 120</td>
<td>0 -10</td>
<td>0 -8</td>
<td>0 -6</td>
<td>0 -8</td>
<td>0 -5</td>
</tr>
<tr>
<td>120 150</td>
<td>0 -13</td>
<td>0 -10</td>
<td>0 -7</td>
<td>0 -10</td>
<td></td>
</tr>
</tbody>
</table>

---

Table 5: Outer ring tolerances P4Y

<table>
<thead>
<tr>
<th>Outside dia. (mm)</th>
<th>Class 5</th>
<th>Class 4</th>
<th>Class P4Y</th>
<th>Class 3</th>
<th>Class 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>high</td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>over including</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 50</td>
<td>0 -7</td>
<td>0 -6</td>
<td>0 -6</td>
<td>0 -6</td>
<td>0 -4</td>
</tr>
<tr>
<td>50 80</td>
<td>0 -7</td>
<td>0 -7</td>
<td>0 -6</td>
<td>0 -7</td>
<td>0 -4</td>
</tr>
<tr>
<td>80 120</td>
<td>0 -10</td>
<td>0 -9</td>
<td>0 -6</td>
<td>0 -8</td>
<td>0 -5</td>
</tr>
<tr>
<td>120 150</td>
<td>0 -11</td>
<td>0 -9</td>
<td>0 -7</td>
<td>0 -9</td>
<td></td>
</tr>
<tr>
<td>150 180</td>
<td>0 -13</td>
<td>0 -10</td>
<td>0 -7</td>
<td>0 -10</td>
<td></td>
</tr>
<tr>
<td>180 200</td>
<td>0 -15</td>
<td>0 -11</td>
<td>0 -9</td>
<td>0 -11</td>
<td></td>
</tr>
<tr>
<td>200 215</td>
<td>0 -15</td>
<td>0 -11</td>
<td>0 -9</td>
<td>0 -11</td>
<td></td>
</tr>
</tbody>
</table>

---

Table 6: Inner / outer ring width tolerances P3W

<table>
<thead>
<tr>
<th>Outside dia. (mm)</th>
<th>Class 3</th>
<th>Class 3W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>over including</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 80</td>
<td>-250</td>
<td>-100</td>
</tr>
<tr>
<td>80 120</td>
<td>-380</td>
<td>-100</td>
</tr>
<tr>
<td>120 140</td>
<td>-380</td>
<td>-100</td>
</tr>
<tr>
<td>145 150</td>
<td>-380</td>
<td>-100</td>
</tr>
<tr>
<td>165 170</td>
<td>-380</td>
<td>-100</td>
</tr>
</tbody>
</table>

The accuracy classes of NSK Super Precision Bearings are specified by ISO 492 as well as ABMA Standard 20 in the case of angular contact ball bearings.
Lubrication is essential to machine tool bearings to achieve the level of performance for which they were designed. Optimal selection of lubricant and lubrication methods will ensure reduced friction and wear inside the bearing and thereby prevent seizure. Appropriate lubrication of the rolling contact surfaces extends the rolling fatigue life of bearings. Circulating lubrication can mitigate frictional heat or heat transferred to the bearing, preventing overheating and lubricant deterioration. Adequate lubrication helps to prevent ingress of foreign material and guards against corrosion or rusting.

**GREASE LUBRICATION**

For grease lubrication of bearings in high-speed machine tool spindles that require low temperature rise and long life, a consistency No.2 or No.3 grease with a synthetic base oil (diester, diester + mineral oil, etc.) is recommended. Grease life depends, to a large degree, upon operating temperature. It is therefore necessary to maintain a cool running temperature to extend grease life.

Refer to Table 7 for common brand names and properties of greases widely used in machine tool spindles and ball screw support bearings.

**OIL MIST LUBRICATION**

Oil mist lubrication sprays oil by turning it into a mist using compressed air. With this method it is necessary to adjust the oil quantity to support adequate lubrication at high speeds, as well as to accommodate the effects of the branches in distribution tubing and possible leakage.

As this method involves potential environmental hazards, OSHA regulations should be considered.

**OIL-AIR LUBRICATION**

Oil-air lubrication feeds oil into a compressed air stream by means of a mixing valve that intermittently discharges the minimum quantity of oil using a constant-quantity piston. The oil flows along the wall of a pipe and approaches a constant flow rate.

Oil-air lubrication is recommended primarily in the main spindles of machine tools and other high-speed applications.

---

**Table 7: Common grease types and properties**

<table>
<thead>
<tr>
<th>Brand Name / NSK Code</th>
<th>Grease</th>
<th>Base Oil</th>
<th>Base Oil Viscosity, mm²/s (40°C)</th>
<th>Working Temp. Range (°C)</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSK M-8 Grease / M8</td>
<td>Barium complex</td>
<td>Mineral oil + Diester oil</td>
<td>22</td>
<td>&lt;260</td>
<td>20 to 130</td>
</tr>
<tr>
<td>NSK M-8 Grease / M8</td>
<td>Barium complex</td>
<td>Mineral oil + Diester oil</td>
<td>10/ 2</td>
<td>&lt;220</td>
<td>-10 to 130</td>
</tr>
<tr>
<td>Turmogrease Highspeed</td>
<td>Lithium soap</td>
<td>Poly-α-olefin + Diester oil</td>
<td>6/ 2</td>
<td>&lt;250</td>
<td>50 to 120</td>
</tr>
<tr>
<td>ENSGREASE / NENS</td>
<td>Barium complex</td>
<td>Mineral oil + Diester oil</td>
<td>12/ 2</td>
<td>&lt;260</td>
<td>20 to 130</td>
</tr>
<tr>
<td>Lubricants MBU 8 EP / NIE</td>
<td>Barium complex</td>
<td>Mineral oil</td>
<td>115</td>
<td>&lt;220</td>
<td>-10 to 130</td>
</tr>
<tr>
<td>EAN Grease / EAN</td>
<td>Poly-α-olefin oil</td>
<td>Poly-α-olefin oil</td>
<td>6/ 2</td>
<td>&lt;260</td>
<td>40 to 160</td>
</tr>
<tr>
<td>EAN Grease / EAN</td>
<td>Poly-α-olefin oil</td>
<td>Poly-α-olefin oil</td>
<td>6/ 2</td>
<td>&lt;260</td>
<td>40 to 160</td>
</tr>
<tr>
<td>Alvania S2 / AS2</td>
<td>Lithium</td>
<td>Mineral oil</td>
<td>130</td>
<td>26/ 2</td>
<td>-10 to 110</td>
</tr>
<tr>
<td>NSK WPH Grease / WPH</td>
<td>Poly-α-olefin oil</td>
<td>Poly-α-olefin oil</td>
<td>15/ 2</td>
<td>95.8</td>
<td>239</td>
</tr>
<tr>
<td>NSK FS2 Grease / FS2</td>
<td>Poly-α-olefin oil</td>
<td>Poly-α-olefin oil</td>
<td>15/ 2</td>
<td>95.8</td>
<td>239</td>
</tr>
<tr>
<td>Multistem No. 2 / NS2</td>
<td>Lithium soap</td>
<td>Poly-α-olefin + Diester oil</td>
<td>15/ 2</td>
<td>205</td>
<td>-10 to 110</td>
</tr>
<tr>
<td>Klüberplex REM 41-132 / BE4</td>
<td>Mineral oil + Diester oil</td>
<td>Mineral oil + Diester oil</td>
<td>12/ 2</td>
<td>&lt;260</td>
<td>&lt;40 to 150</td>
</tr>
</tbody>
</table>

1) For special application environments such as operating temperatures close to the low end or high end of the range, or vacuum, etc., please contact NSK.
2) Caution: Grease containing anti-oxidizers or zinc-based materials.
3) Caution: Ester oil-based greases cause acrylic materials to swell.

---

**Table 8: Comparison of lubricating methods**

<table>
<thead>
<tr>
<th>Lubricating Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grease lubrication</td>
<td>&gt; Cost is low &lt;br&gt; &gt; Limitation of temperature rise is possible</td>
<td>&gt; Maintenance is low &lt;br&gt; &gt; If packed grease deteriorates, seizure may occur &lt;br&gt; &gt; May allow penetration of dust or cutting fluid</td>
</tr>
<tr>
<td>Oil mist lubrication</td>
<td>&gt; Since new oil is always fed, no fear of oil deterioration &lt;br&gt; &gt; Dust and cutting fluid cannot easily enter</td>
<td>&gt; Pollution of environment &lt;br&gt; &gt; Oil supply quantity varies depending on the oil viscosity and temperature, so controlling a small flow rate is difficult &lt;br&gt; &gt; It is difficult to confirm that oil is actually fed</td>
</tr>
<tr>
<td>Oil-air lubrication</td>
<td>&gt; Since oil quantity control is possible, the optimum quantity of oil is fed and heat generation is low &lt;br&gt; &gt; In addition to little heat generation, there is a cooling effect of the air, so the temperature rise is low &lt;br&gt; &gt; Since new oil is always fed, no fear of oil deterioration &lt;br&gt; &gt; Dust, cutting fluid cannot easily enter</td>
<td>&gt; Moisture may enter bearings &lt;br&gt; &gt; Environmental pollution mist is slight</td>
</tr>
<tr>
<td>Jet lubrication</td>
<td>&gt; Since the oil flow rate is high, dust and cutting fluid cannot enter and seizure hardly ever occurs &lt;br&gt; &gt; Because of cooling by oil, the bearing temperature can be controlled to some degree</td>
<td>&gt; Frictional loss is high &lt;br&gt; &gt; Since oil leaks, it is difficult to use for vertical spindles &lt;br&gt; &gt; Cost is high</td>
</tr>
</tbody>
</table>
RUNNING-IN PROCEDURES

If operating speed is suddenly increased after bearings are mounted, bearings may be damaged due to insufficient lubrication, or the lubricant may deteriorate. Proper running-in with gradual increases of operating speed is indispensable, especially for grease-lubricated bearings where grease must be allowed to spread evenly. Spindle assemblies operating under oil mist and oil-air lubrication are at risk of a sudden temperature rise at initial operation or shortly thereafter. Running-in for bearings with these lubricating systems requires much less time than for grease-based systems, and is highly recommended.

CONTINUOUS RUNNING-IN METHOD

Continuous running-in works by gradually increasing the operating speed from the low-speed zone. Maximum operating speed is commonly divided into ten stages to determine the target speed with incremental increases from the low-speed zone. Maximum Continuous running-in works by gradually increasing the operating speed from the low-speed zone.

INTERMITTENT RUNNING-IN METHOD

Initially, run the spindle continuously at about 500 min⁻¹ (100 min⁻¹ for larger machines) for 15 minutes to allow the grease to settle. Take the maximum operating speed and divide it into eight to ten stages to determine the maximum target speed for each stage:

- begin at a reasonably low operating speed
- increase speed each stage
- continue until the maximum operating speed is reached
- allow 30 minutes to 2 hours for the temperature to stabilize before you increase speed to the next stage.

Figure 26 shows patterns of temperature development that show patterns of temperature development that stabilize before you increase speed to the next stage. Allow between 30 minutes and 2 hours for the temperature to stabilize before you increase speed to the next stage.

During intermittent running-in, the spindle is stopped to run the spindle at that speed for about 1 hour. Speed increase causes a sudden supply of grease to the bearing's interior, resulting in a sharp temperature rise. During intermittent running-in, the spindle is stopped to allow the temperature to stabilize. This saves time compared to the continuous running-in method.

The number of target speed stages and cycles to be performed in each speed stage varies according to spindle design and arrangement.

Fig. 26: Bearing temperature change during running-in

![Fig. 26: Bearing temperature change during running-in](image)

Fig. 27: Cycle structure during intermittent running-in

![Fig. 27: Cycle structure during intermittent running-in](image)
For additional technical information about NSK rolling bearing and linear motion products for machine tools, refer to:

- E1254K - NSK Super Precision Bearings
- E3162K - NSK Precision Machine Components
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