Emerson Bearing
Service. Inventory. Solutions.

NSK SPINDLE SOLUTIONS

MOTION & CONTROL
NSK

Cylindrical Roller Bearings (Tool- and Rear-Sides)

- Double-row cylindrical bearings (NN3xxx) with tapered bores allow for precise setting of internal clearance (between rollers and outer ring bore)
- Check the bearing bore taper against shaft taper for a good match
- Radial clearance depends on OEM, spindle design, speed, operating temperature, etc. (consult OEM specs or NSK guidelines)
- Target outer ring to housing fit is 2 µm loose to 2 µm tight
- **Tool-Side:** Excessive preload (negative radial clearance) can result in high bearing running temperature and seizure
- **Rear-Side:** This bearing is usually mounted with greater radial clearance than tool-side to ensure the shaft floats within housing during axial thermal expansion

Thrust Angular Contact Ball Bearings

- Thrust angular contact ball bearings can be types BAR (30°) or BTR (40°)
- These bearings are designed to take only thrust loads due to special OD tolerance
- Angular contact bearings with standard OD tolerance may fail
- The double-row cylindrical roller bearing will support the radial load

Confirm Bearing Shaft and Housing Fits

- See NSK bearing box label for exact bearing bore and OD dimensions to the micron
- Measure the shaft OD and housing bore at the bearings' locations
- Calculate the bearing shaft and housing fits and compare with OEM specifications or NSK guidelines
- Excessive bearing-shaft interference or insufficient bearing-housing clearance fit may lead to excessive bearing preload and seizure
- Insufficient bearing-housing clearance at the rear-side may prevent the rear-side bearings and shaft from floating within housing bore during axial thermal expansion

Outer Cap

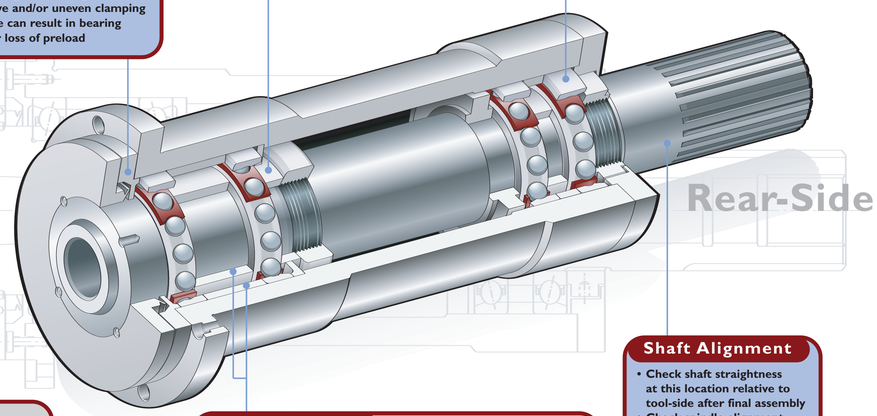
- Most spindle designs include an outer cap whose male register surface should lightly compress bearing's outer ring
- Suggested axial compression: 10 to 30 µm (0.0004 to 0.0012 in)
- The male register's surface should be flat and parallel to the outer cap mounting flange surface that contacts housing. This will ensure even clamping pressure against the bearing's outer ring
- Excessive and/or uneven clamping pressure can result in bearing noise or loss of preload

Clamping Nut Spacer

- This spacer is between the bearing inner ring and clamping nut (most spindle types)
- Spacer ensures even clamping around bearing's inner ring
- Mating surfaces should be flat and parallel

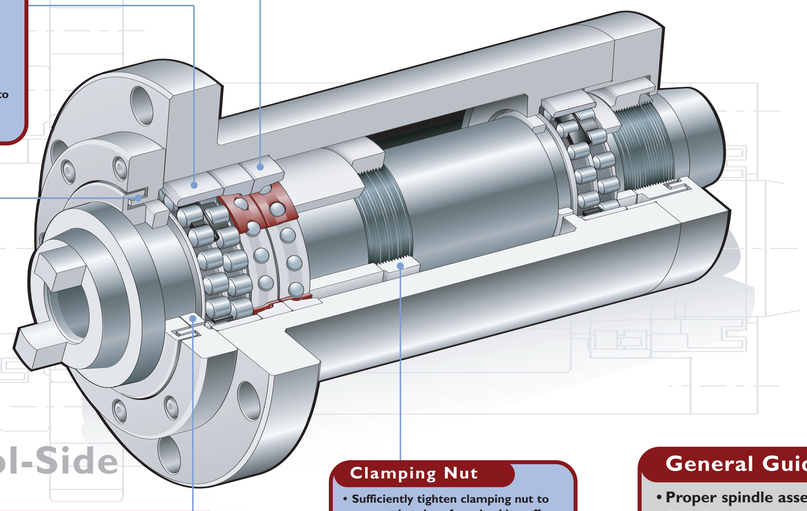
Rear-Side Angular Contact Ball Bearings

- Rear-side bearings and shaft must float within housing bore to allow axial thermal expansion. Therefore, a clearance fit should exist between the rear-side bearing OD and housing bore
- Calculate clearance fit with housing bore measurement and bearing OD from box label
- Compare calculated clearance fit with OEM specification or NSK guidelines
- Spindle rear-side bearings usually have light preload or less
- High-speed spindles may use a single-row cylindrical roller bearing with a line to line housing fit instead of angular contact ball bearings



Tool-Side Labyrinth Seal

- Most spindle designs should include a labyrinth seal to minimize contamination
- Labyrinth designs that incorporate an air barrier should use clean, dry air
- Avoid aiming coolant directly into spindle nose



Shaft Alignment

- Check shaft straightness at this location relative to tool-side after final assembly
- Check spindle alignment with drive source
- Avoid excessive belt tension for belt-driven spindles

Clamping Nut

- Sufficiently tighten clamping nut to prevent bearings from backing off
- If bearings become loose, the bearing set may lose preload and rigidity, the spindle may not machine properly or it may make noise
- Check shaft-bearing assembly straightness after tightening

General Guidelines

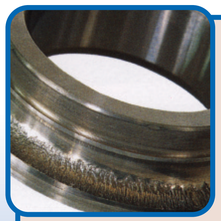
- Proper spindle assembly begins with a clean environment and tools
- Check accuracy of bearings' mating components (roundness, coaxiality, runout, finish, cylindricity, etc.) to conform with OEM specifications or NSK guidelines
- Check spindle radial and axial runouts after assembly
- Bearing lubrication (grease or oil-air) usually requires run-in after spindle rebuild
- Bearing operating temperature is one guide to spindle integrity
- Ideal bearing temperature at max. rpm should be less than 105°F at the housing surface

Bearing Spacers

- Spacers between bearings increase bending rigidity at the spindle tool-side
- Spacers may lower bearing running temperature due to separation, depending on spindle design and operating conditions
- When necessary, bearing mounted preload can be reduced or increased by offsetting spacers
- Reducing preload may allow higher spindle speed or lower bearing operating temperature, especially for grease-lubricated bearings
- Increasing preload can be used to increase spindle rigidity

Locating Spacers

- This spacer is adjacent and forward of the double-row cylindrical roller bearing (NN3xxx)
- Spacer width determines the bearing's position along the shaft taper and establishes the mounted radial internal clearance
- Grind spacer to specific width after setting radial internal clearance and before final mounting of NN3xxx bearing

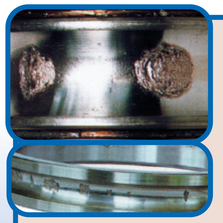


Contamination

Contamination results in discoloration or rust on bearing surfaces. Possible causes are entry of foreign particles, coolant or water into the spindle. Air barriers that supply moist shop air to the spindle labyrinth can be another cause of corrosion. Contamination can cause lubrication breakdown, excessive bearing heat, noise, vibration, and eventual bearing seizure. Contamination can be avoided by maintaining clean work areas, tools and hands. Avoid assembling spindles in areas where machining or grinding occurs. Sealed bearings may provide relief against bearing contamination, depending on the conditions.

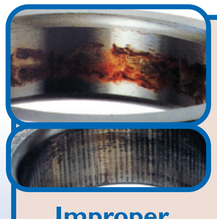
Misalignment

Misalignment appears as heavy wear marks diagonally across the raceway. A bearing becomes misaligned due to inaccurate mating components, faulty assembly, crashes, etc. Spindles with misalignment problems experience difficulties such as vibration, inability to machine parts accurately or hold fine surface finishes, and ultimately may result in bearing seizure. Inspect spindle components such as shafts, housings, spacers, and locknuts for runout, flatness, burrs, or foreign particles. Inspect spindle quality and trueness after assembly and after spindle crashes.



Shock Load

Raceways exhibit severe flaking and denting at ball-spaced intervals. This damage occurs when a stationary spindle or bearing is subjected to shock loads. Spindles and bearings subjected to shock loads contribute to spindle vibration, noise, and inability to machine parts accurately or make parts with fine surface finishes, and ultimately result in bearing seizure. During spindle assembly, avoid severe impacts such as heavy blows with hammers or dropping the spindle or bearings. Avoid placing the spindle or machine in an area subjected to jarring vibration such as near a press or where forklifts drop materials.

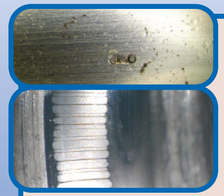


Improper Inner Ring Fit

Wear or fretting occurs on a portion of the bearing bore. This damage can be caused by insufficient interference fit between the bearing and shaft. Additionally, the bearing inner rings may not be clamped sufficiently against the shaft's shoulder. The result may be low spindle rigidity, noise, vibration, excessive bearing heat, poor machining, and eventually bearing seizure. During very high-speed operation, the inner rings of angular contact bearings tend to expand off the shaft due to centrifugal forces. Therefore high-speed spindles may require additional interference fit.

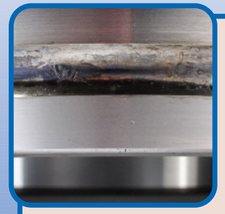
Improper Outer Ring Fit

Wear or fretting occurs on the circumference of the bearing outer diameter. The bearing's outer ring should not rotate in the housing. This can result in spindle vibration, noise, excessive bearing wear and heat, and eventual seizure. Check the fit between the bearing and housing bore. Also ensure proper clamping of the bearing outer ring in the axial direction. For belt-driven spindles, over tightening the belt can distort a proper bearing-housing fit at the rear-side.



Electric Corrosion

Bearing's raceways and rolling elements exhibit heat discoloration, pitting, a striped pattern or fluting. This damage occurs when electric current passes through the bearing. This damage can result in excessive bearing heat, lubrication breakdown, vibration, and eventual bearing seizure due to the rough bearing surfaces. Improper electrical grounding of the machine may cause electric corrosion in bearings.

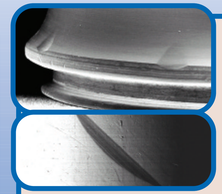


Excessive Loads

Flaking and heavy wear appear on raceways and rolling elements. This damage is very similar to fatigue damage, yet spindle bearings rarely fail due to fatigue. Rather, failure is more commonly due to excessive loads, contamination, crashes, component inaccuracies or lubrication issues. Bearings subjected to excessive loads will experience extreme wear on the raceways and dramatically reduced bearing life. Prior to bearing seizure, there may be excessive bearing heat and preload, lubrication breakdown, noise, or spindle vibration. Compare the spindle's use with the OEM's intended applied loads and operation.

Vibration

Small indentations or shallow dents appear on the raceways and balls. Bearing damage is similar to shock loading but less severe. Damage becomes worse over time due to rotation, and can result in excessive bearing heat, lubrication breakdown, noise, vibration, and eventual bearing seizure. Isolate bearings and spindles from vibration.



Improper Installation

Raceways and balls exhibit cuts and transfer-marks. Usually occurs when a bearing is installed by pushing the outer ring over the balls leaving cuts on the raceway edge at ball-spaced intervals, and crescent-shaped cuts on the balls. During rotation, these balls quickly transfer these cuts to the raceway ball paths leading to excessive bearing heat and preload, noise, lubrication breakdown, and seizure. Install bearings properly by pushing the inner ring onto the shaft or by pushing against the inner and outer ring simultaneously. Ideally, heat the inner ring before installing the bearing on the shaft. To help install the spindle and bearings into a tight housing bore, expand the housing bore with a heat lamp.

Seizure

Severe damage of raceways or rolling elements is often accompanied by heat-discoloration, extreme wear, fracture or melting of the cage. This damage is often caused by excessive preload, excessive speed, grease breakdown due to contamination or improper grease break-in. Spindle bearings with oil-air lubrication systems sometimes experience seizure due to clogged oil-air lines or components, nozzle aim points that do not direct the oil directly into the bearing, or improper oil type. Note this catastrophic failure may be the final result of any of the previously pictured problems left uncorrected.

www.ca.nsk.com

MISSISSAUGA – During office hours: 1.800.387.9362 MONTREAL – During office hours: 1.800.361.5861 VANCOUVER – During office hours: 1.800.663.5445