RECONDITIONING AND MODIFICATION SERVICES

EXTRACTING MAXIMUM SERVICE LIFE FROM BEARING ASSETS

STAY IN MOTION. STAY IN CONTROL.

OPTIMIZING PRODUCT LIFECYCLE MANAGEMENT

WITH NSK EXPERTS

With the support of NSK experts, our customers embark on a critical path to achieving optimal performance and service life from their bearing assets. And to realizing improvements in machinery and equipment that deliver measurable gains in reliability and productivity.

Beginning with bearing design, specification and installation to ongoing monitoring of bearing and machine health, NSK delivers integrated insights, products and technologies to provide sustainable contributions to maintenance and cost efficiencies.

From identifying and resolving problems that contribute to frequent bearing replacement and unplanned machine outage, to instituting training and holistic processes for maintenance improvement, NSK experts support our customers with a complete, collaborative and continuous approach.

MAXIMIZING THE SERVICE LIFE OF BEARING ASSETS

For large bearings that support machinery and equipment in metal making, papermaking, mining and quarrying operations, the severity of operating stresses often leads to the onset of wear long before bearings achieve their calculated life. In many cases, early bearing damage can be detected or foreseen and contingency planning can be implemented. Namely, adopting a reconditioning strategy to maximize the service life of these assets.

For users of large industrial bearings, reconditioning is an effective asset-management strategy that delivers significant and sustainable efficiencies, including:

- **Extract maximum bearing value** by restoring high-cost bearings to like-new performance standards to extend their service life
- **Reduce costs** with reconditioned bearings delivering savings as great as 80% versus replacement with new bearings
- **Eliminate lengthy lead times** often associated with replacing large-sized bearings
- **Optimize machine uptime** and reliability with a strategic approach to managing critical spare inventory
- **Support sustainability** by reducing material consumption and carbon emissions

With NSK Reconditioning Services, users achieve longer bearing operating life and machine uptime reliability with lower total cost of ownership.

RECONDITIONING SERVICES A CONTROLLED PROCESS

Reconditioning services can range from cleaning, preserving and repackaging bearings that have not yet seen service, to regrinding raceways and replacing components of bearings to be reused. Not all bearings can be restored and returned to use — operating conditions may have been too severe, causing damage that is too profound.

From the outset, NSK performs a rigorous analysis to evaluate a bearing's potential for successful reconditioning to like-new specifications: ensuring that any damage or wear is superficial to moderate, that dimensional and material integrity is intact, and that reconditioned bearings will achieve their original capacity to meet application requirements.

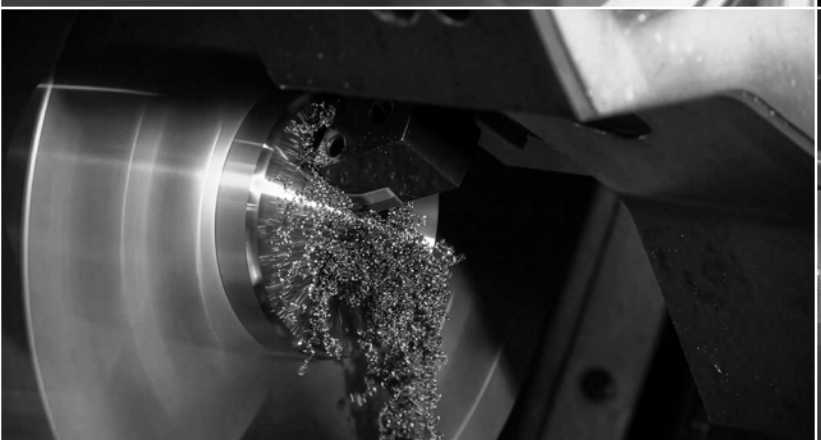
For all bearings restored at NSK's Reconditioning Center in Alliance, Ohio, our customers can expect the same adherence to process and quality assurance measures that are applied to the manufacture of original NSK bearings to ensure successful operation.

From assessment to execution, it's a tightly controlled process with possible scenarios and service levels, including:

- **Visual inspection and repackaging (R1)** of bearings from user inventory to ensure a ready-for-service state free of obvious damage
- **Reclamation (R2)** of spherical roller bearings for continuous casting with machine and hand-polishing rings, vibratory polishing rollers and sandblasting cages
- **Reconditioning (R3)** bearings by regrinding and polishing raceways, vibratory polishing as required and verifying dimensions, angles and clearances
- **Rebuilding (R4)** bearings by Reconditioning (R3) and replacing irreversibly damaged components

At each service level, all bearings are cleaned, preserved and repackaged for return to users.






RESTORATION PROCESS / SERVICE LEVEL	R1	R2	R3	R4
Pressure cleaning	■	■	■	■
Inspection and damage analysis	■	■	■	■
Dimensional verification - rings, raceways, bore, roller angles			■	■
New components - rolling elements, cages				■
Regrinding - raceways and spacers, including minor repairs			■	■
Polishing / vibratory finish		■	■	■
Size, angle verification *			■	■
Clearance verification, resetting			■	■
Cleaned, preserved, wrapped and packed	■	■	■	■

* specific to reconditioning tapered roller bearings

REPOWERING A WIDE RANGE OF BEARING TYPES

Reconditioning is a viable consideration for a wide range of rolling bearing types used in heavy industrial equipment for industries such as mining, steel, pulp and paper, cement and power generation, where the ability to restore performance and extend the service life of high-value bearings pays significant dividends with reduced replacement costs and machine downtime.

The suitability of any bearing for reconditioning depends on a number of technical and economic factors including bearing size, replacement cost, availability and application criticality.

Deep groove ball bearings

Angular contact ball bearings

Spherical roller bearings

Spherical roller thrust bearings

Cylindrical roller bearings, single row

Cylindrical roller bearings, double row

Cylindrical roller bearings, full complement

Cylindrical roller thrust bearings

Most rolling bearing types can be reconditioned provided their technical condition permits successful restoration and return to service without compromise. Consideration is typically extended to large-size, high-value bearings that often comprise a critical spares strategy employed by users.

Typical bearing types within scope for NSK reconditioning services include:

- **Ball bearings** including single row deep groove and angular contact ball bearings
- **Roller bearings** including spherical roller bearings, cylindrical roller bearings, tapered roller bearings and thrust roller bearings
- **Special design / special application bearings** including multi-row tapered and cylindrical roller bearings for rolling mills; Sendzimir bearings for cluster mills; triple ring bearings for controlled crown rolls in papermaking; slewing rings

Tapered roller bearings, single row

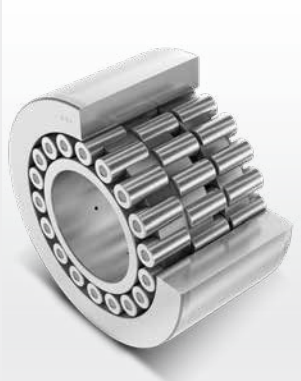
Tapered roller bearings, double row

Tapered roller thrust bearings

Triple ring bearings

Work roll bearings

Back-up roll bearings



Sendzimir bearings

Slewing rings

MODIFICATION SERVICES TO MEET APPLICATION DEMANDS

Modifications are another means by which NSK supports users to extract maximum value and service from their bearing assets by improving performance, extending service life and adapting bearings to operating conditions that they may not have been fully designed and manufactured to accommodate. The resulting benefits from modifications range from improved bearing handling, installation and lubrication, to augmented operating characteristics
to accommodate thermal expansion,
high loads and high speeds.

Modifications indicated at left:

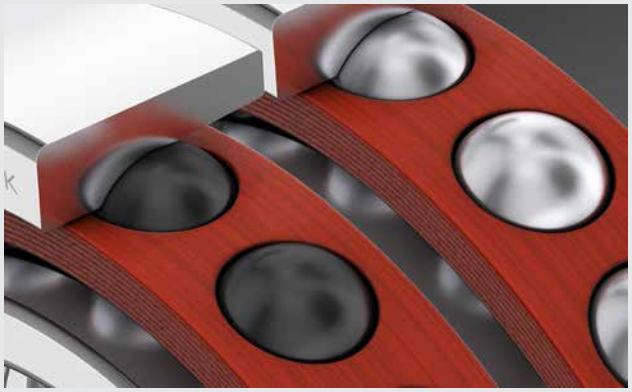
1) modifying bearing bores, from cylindrical to tapered

2) adding inner and outer ring lubrication grooves and holes

3) modifying bearing clearance, increasing and decreasing

NSK modification services promote improved operating efficiency by aligning bearing features and performance to the specific demands of the application for which they were originally ordered. Services include:

- **Modifying bearing bore profiles** from cylindrical to 1:12 or 1:30 tapered
- **Adding lubrication features** to inner and outer rings; plugging existing lubrication holes
- **Adjusting clearance and preload** by removing material or upsizing rolling elements
- **Replacing rolling elements** with ceramic or coated (black oxide, diamond-like) equivalents
- **Machining bearing rings** to add snap ring or v-grooves, loading slots, lock pin holes, keyways and lifting holes, or to remove ribs
- **Fabricating spacers** to precision tolerances or grinding spacers to adjust endplay
- **Replacing grease** from a wide range of available formulations including solid lubricants



Pictured, clockwise from bottom left:

1) exchanging rolling elements from steel to ceramic to achieve current insulation or higher limiting speeds

2) adding solid lubricant from a wide range of available formulations

3) fabricating spacers to precision tolerances or grinding spacers to adjust endplay

ROLLING BEARING DAMAGE AND RECONDITIONING

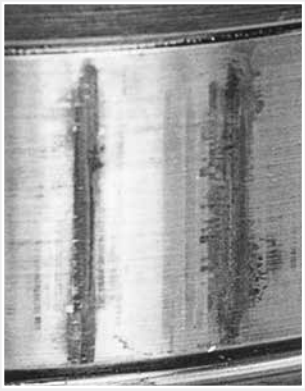
The ability to successfully recondition a bearing is determined by stringent evaluation of its technical condition to ensure like-new capacity that will meet application challenges can be achieved.

Raceway damage should be limited to light or moderate surface wear or degradation to ensure internal clearances and rolling contact geometries are retained after grinding.

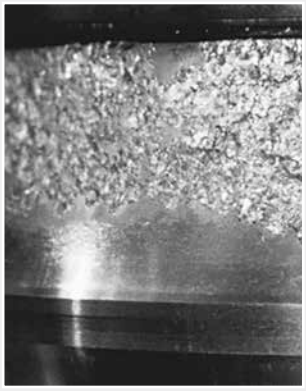
Deep or widespread surface damage, structural cracks and fractures, or damage that has altered material integrity such as overheating are ultimately non-repairable.

Illustrated below are commonly encountered occurrences of bearing damage along with their general prognosis for reconditioning, indicated as follows:

- Commonly reconditioned
- Potential to recondition
- Uncommon to recondition



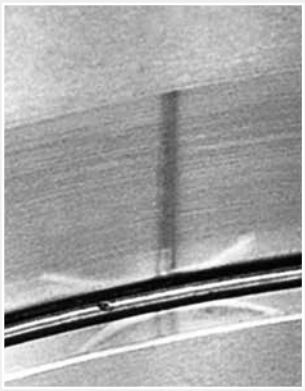
Wear



Flaking

Pitting

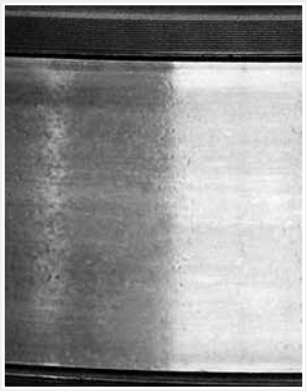
Scoring



Fretting

Electrical erosion

Corrosion



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