

PUMP BEARING TRAINING



PRESENTED BY AARON DODD
NSK AMERICAS
JUNE 24, 2015

Unless otherwise specifically noted, the competitive information contained in this presentation is gathered from legally permissible sources, including, but not limited to, public records, electronic searches, unsolicited customer or end-user feedback, and industry analysts.

Think **NSK.**



- Participants are in a listen-only mode.
- To ask a question during the event, use the chat feature at the bottom left of your screen. Technical questions will be answered by ReadyTalk. Questions for our speakers can be asked at any time and will be answered during the Q&A at the end of the session.
- Visit pumpsandsystems.com in the coming days to access the recording of the webinar or download the presentation.

NSK MOTION AND CONTROL



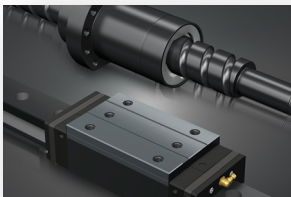
■ AUTOMOTIVE PRODUCTS

Bearing and steering systems that are compact, reliable and promote reduced fuel consumption



■ INDUSTRIAL MACHINERY

Supplying the vast array of rolling bearings to industrial OEM and aftermarket partners



■ PRECISION MACHINERY AND PARTS

Ultra precise positioning technologies for machine tool and factory automation

NSK was founded in 1916 and produced the first ball bearings in Japan. Today they are a global leader in research and development and offer a full range of bearings sold worldwide.

- *65 Manufacturing Facilities Worldwide*
- *9 Manufacturing Facilities in the Americas*



PRESENTER

Aaron Dodd joined NSK as an Application Engineer in 2011, with specialties in mining, utilities, and paper making applications. He was promoted to NSK Segment Manager for Mining and Energy in 2013.

Dodd began his career with Patriot Pumps, in Howell, Michigan, designing, repairing, and implementing pumps for dewatering and bypass pumping applications.

He holds a BSE in Mechanical Engineering from the University of Michigan.

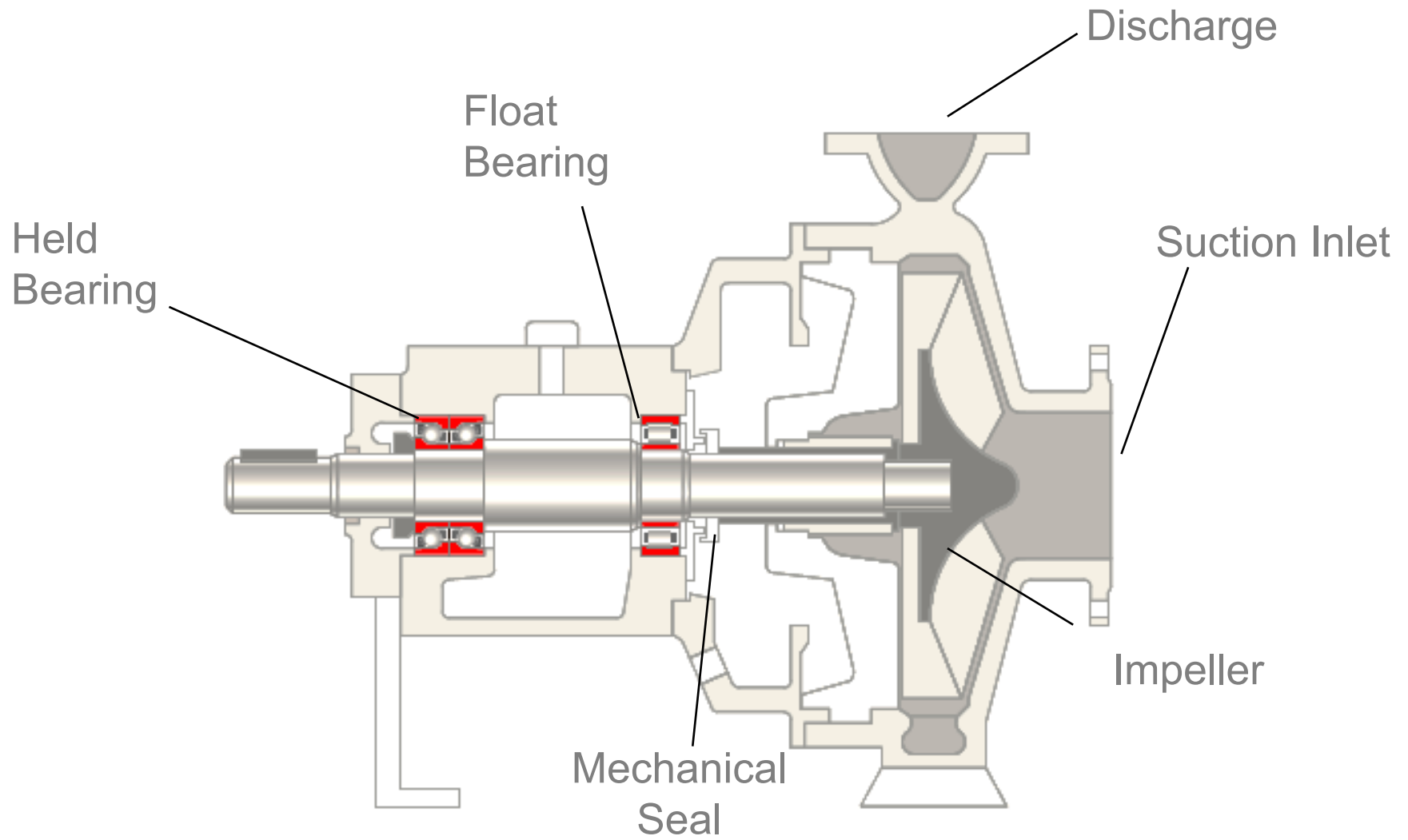


AGENDA

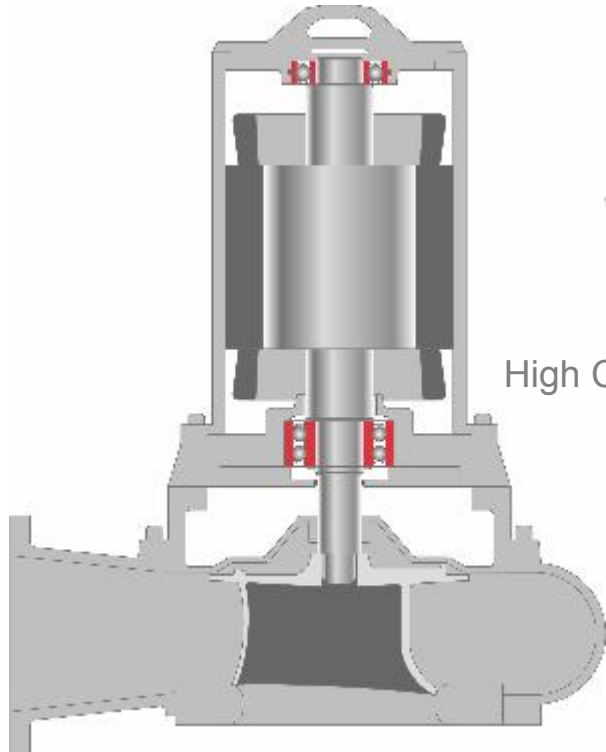
- Pump Bearing Introduction
- Pump Bearing Dynamics
- Pump Bearing Issues
- Pump and Bearing Maintenance Tips
- NSK Problem Solvers



CENTRIFUGAL PUMPS

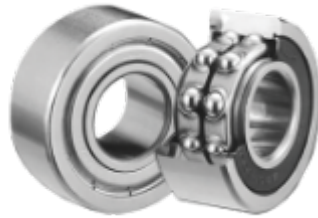
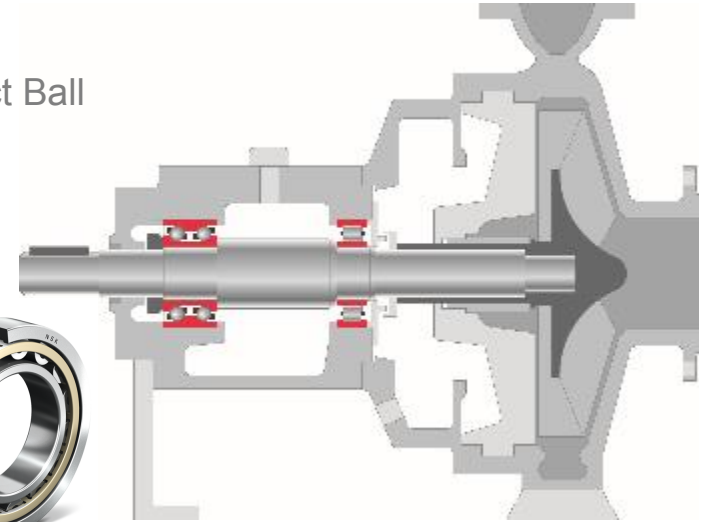


NSK BEARINGS IN PUMPS



HPS Angular Contact Ball Bearings

High Capacity Cylindrical Roller Bearings



High Capacity Double-Row Angular Contact Ball Bearings



Creep Free Bearings



WHY ARE PUMP BEARINGS UNIQUE?

- Pump bearings keep axial end movement to a minimum
- Keep the radial deflections to a minimum
- Maintains the proper clearance between the pump impeller and the housing

COMMON PUMP BEARING TYPES



Angular Contact



Double Row Angular Contact



Cylindrical

ANGULAR CONTACT BALL BEARING



Typically fixed bearing

Accommodates radial and axial loads in one direction

Various contact angles available

- 15, 25, 30, 40 degrees
- Higher contact angle means
 - Greater axial & lower radial load capacity
 - Lower speeds

Cages

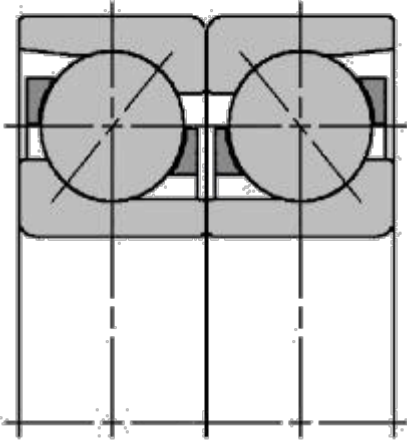
- Machined brass standard
- Also offered in steel, polyamide, and phenolic

Operate with clearance or preload

- High rigidity with preload

DUPLEX COMBINATIONS OF ANGULAR CONTACT BALL BEARINGS

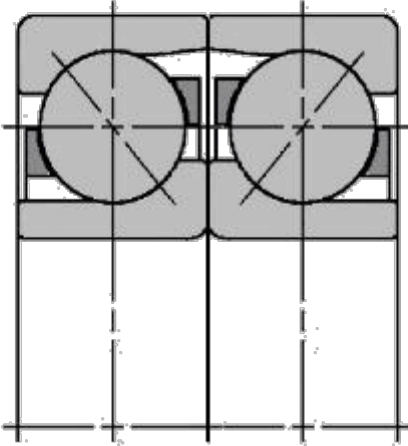
High Rigidity



DB

Back to Back

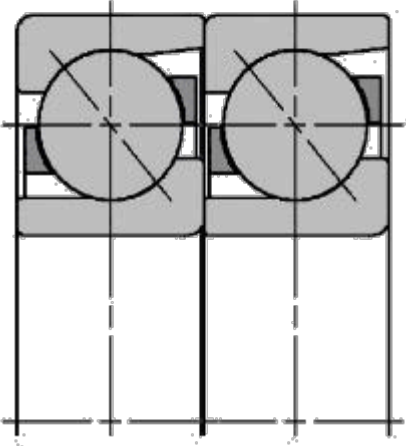
Low Rigidity



DF

Face to Face

High Thrust



DT

Tandem

ANGULAR CONTACT PUMP BEARINGS

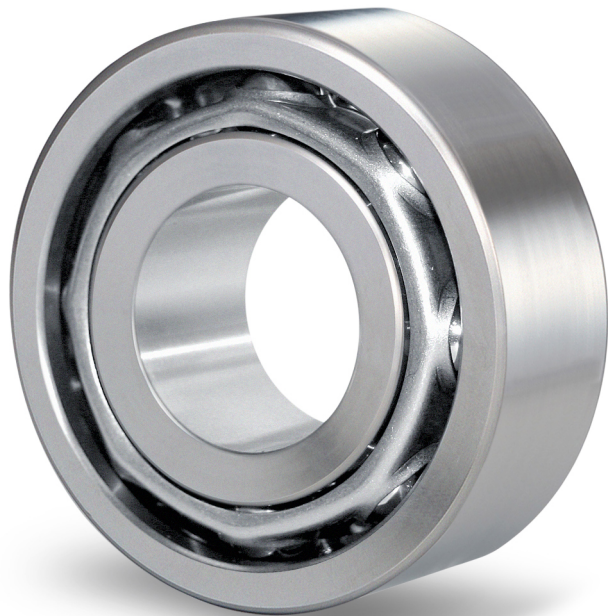
72 05 B M PC

72 | 05 | B | EA | MR | SUGA

- 72 / 73 Basic type and series
- 05 Bore size in mm (multiply by 5)
- B 40° contact angle
- EA Extra capacity
- M/MR Machined brass, high strength cage
- PC ABEC 3 tolerance, normal axial clearance
- SUGA Universally ground, slight preload

Note: BEAMR series comes in different clearance and preload options

DOUBLE ROW BALL BEARING



**Typically Fixed Bearing
Equivalent to Two single row Bearings
mounted Back to Back**

- Radial Capacity Approximately 1.7 Times a Single Bearing

Standard and Max Capacity Designs

- Max capacity has filling slot, could be issue

Open or Sealed Designs

**Accommodates Radial Loads and Axial
Loads in Both Directions (Standard Capacity
Only)**

DOUBLE ROW BALL BEARING



Typically Float Bearing

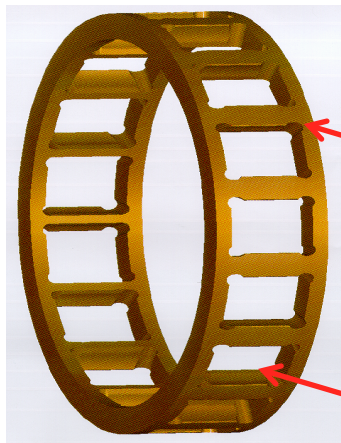
- Rings can move axially during operation

High Radial Capacity

Good Speed Capacity

Different Cage Options

- EM brass standard
- Also available in steel, polyamide, phenolic



Stress relief gives more strength

Special pocket for roller guidance

EM Brass Cage

CENTRIFUGAL PUMPS

The impeller shaft is connected to the motor by:

- Direct Coupling (Rigid or Flexible)
- Indirect Coupling Via a Belt Drive

Most common rotational speeds:

- **1200 RPM**
 - Large end suction and split case pumps
- **1800 RPM**
 - Medium sized
- **3600 RPM**
 - Smaller process pumps



CENTRIFUGAL PUMP LOADS

Mass of impeller and shaft loads due to shaft coupling or belt drive hydraulic loads

- Hydrostatic and momentum forces from fluid being pumped



PUMP COUPLING LOADS

Belt drives and flexible couplings exert a force on the pump shaft

- Belt drive force > flexible coupling
- Flexible coupling force can be reduced with better motor pump shaft alignment



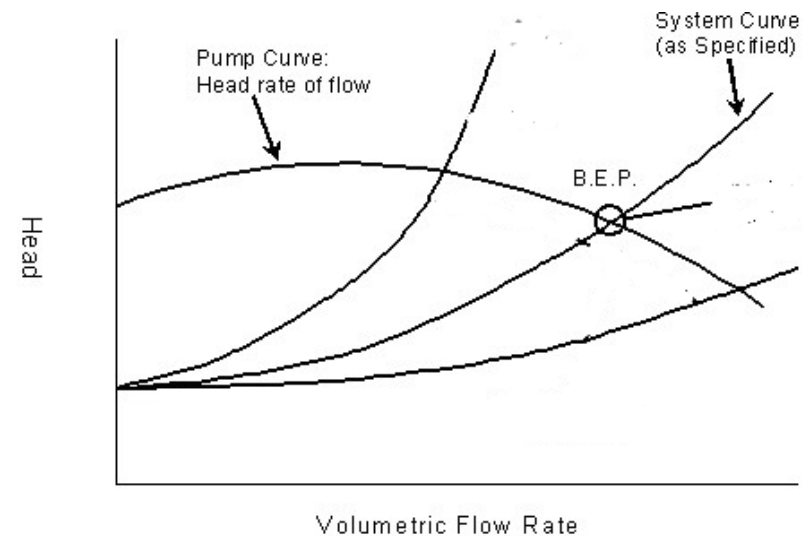
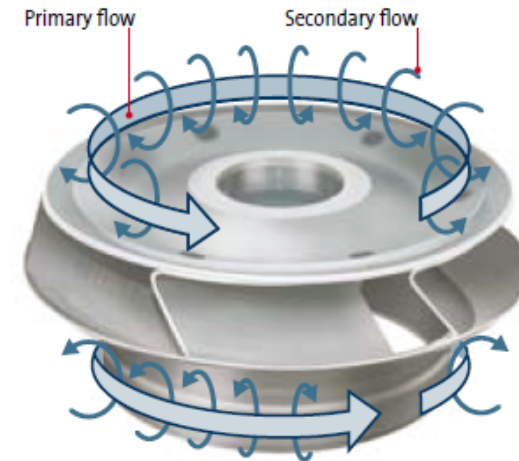
HYDRAULIC LOADS

Due to the unequal velocity of the fluid flowing through the casing

- Influenced by casing design
- Influenced by piping

Increases in magnitude and changes direction at other flow conditions

At a minimum when pump is operating at the “best efficiency point” (or BEP)



BEARING LIFE

A common cause of bearing failure in pump applications is water contamination

- The amount of water that can be considered contamination is dependent upon the type of grease and its water content limit



LUBRICATION TYPES

Grease

- Sealed in bearing or injected into pump cavity

Oil bath

- Bearing rolling elements roll through an oil reservoir in the housing

Oil ring

- A ring is fitted on the shaft and rotates through the oil bath to fling oil onto the bearing

Oil mist

- Atomized oil droplets are sprayed into the bearing housing with compressed air



SEALING OF SHAFT AT THE HOUSING

Purpose

- Keep solid and liquid contaminants from reaching the bearing
- Retain the lubricant

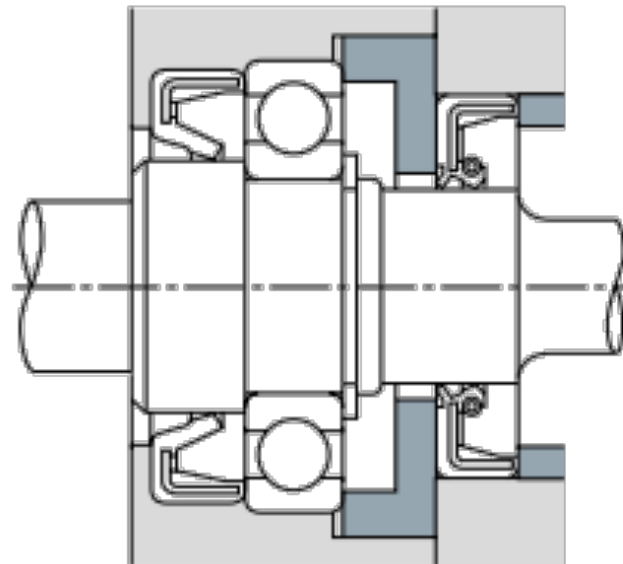
Most common

- Radial lip seal
- Labyrinth seal

RADIAL LIP SEAL

Effectiveness is dependent upon the lubricant and the shaft surface finish

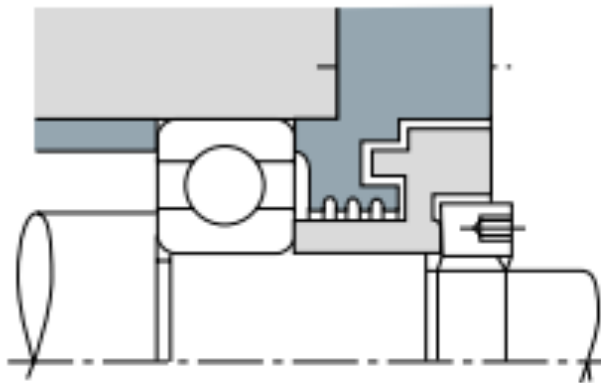
- Excessive friction can cause high temperatures and wear on the seal and on the shaft
- Typically short life (2000 - 4000 hrs)



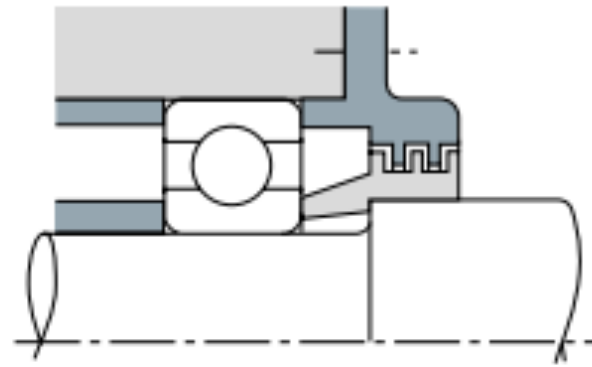
LABYRINTH SEALS

Offers little or no additional friction

- Typically long life
- Provides natural venting



(a) Axial Labyrinth



(b) Radial Labyrinth

FAILURE ANALYSIS


Failure types

- Lubrication
- Contamination
- Load issues
- Alignment issues

FAILURE ANALYSIS-LUBRICATION

Cause

Effect

Lack Of  Increased Friction And Wear.

Not Maintaining Proper Oil Level Or Adding Proper Grease Amount  Premature Failure

Too Much  Increased Friction

High Oil Sump Or To Much Grease  Increased Torque Roller Skidding

FLAKING



FAILURE ANALYSIS- CONTAMINATION

Cause

Effect

Environment



Water
Corrosives

Sealing
To



Allows Contamination

Enter. Particle Denting

Storage



Open Containers /
Packages

CONTAMINATION



FAILURE ANALYSIS- OVER LOADING

Cause

Running Pump
Right of BEP



Effect

Over Heating
Brinelling

Belt Tension



Bearing Preload

OVER LOADING



FAILURE ANALYSIS- UNDER LOADING

Cause

Running Pump
Left Of BEP



Effect

Over Heating
Brinelling / Skidding

Closed Valves



Recirculation
Vibration

UNDER LOADING



FAILURE ANALYSIS- ALIGNMENT

Cause

Effect

Motor To Pump → Increased Vibration

Installation Base → Cage Damage
Soft Foot

Piping → Distorted Housings
Casings
Impeller Rubs
Vibration

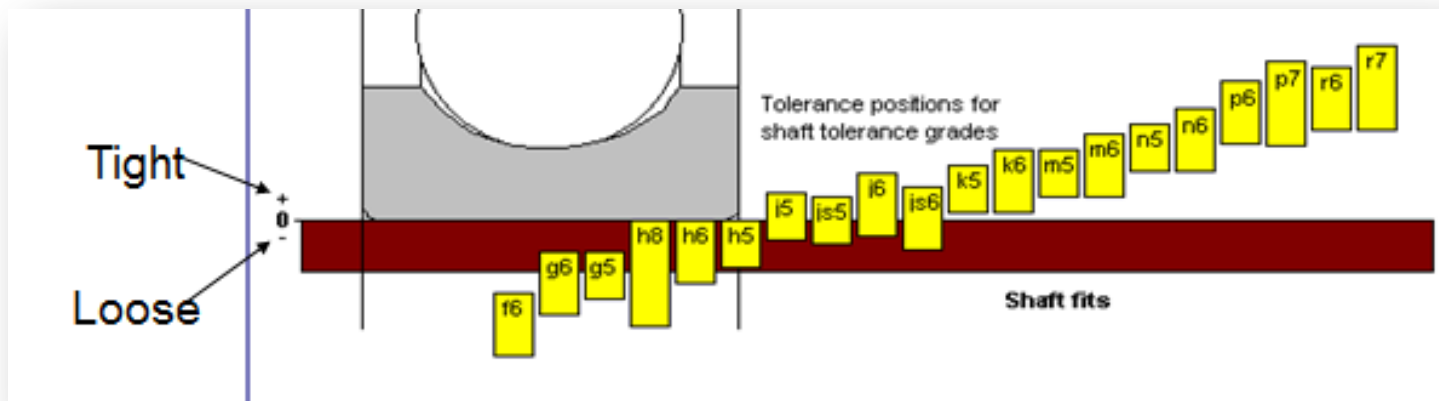
ALIGNMENT



BEARING FITS

Shaft fits

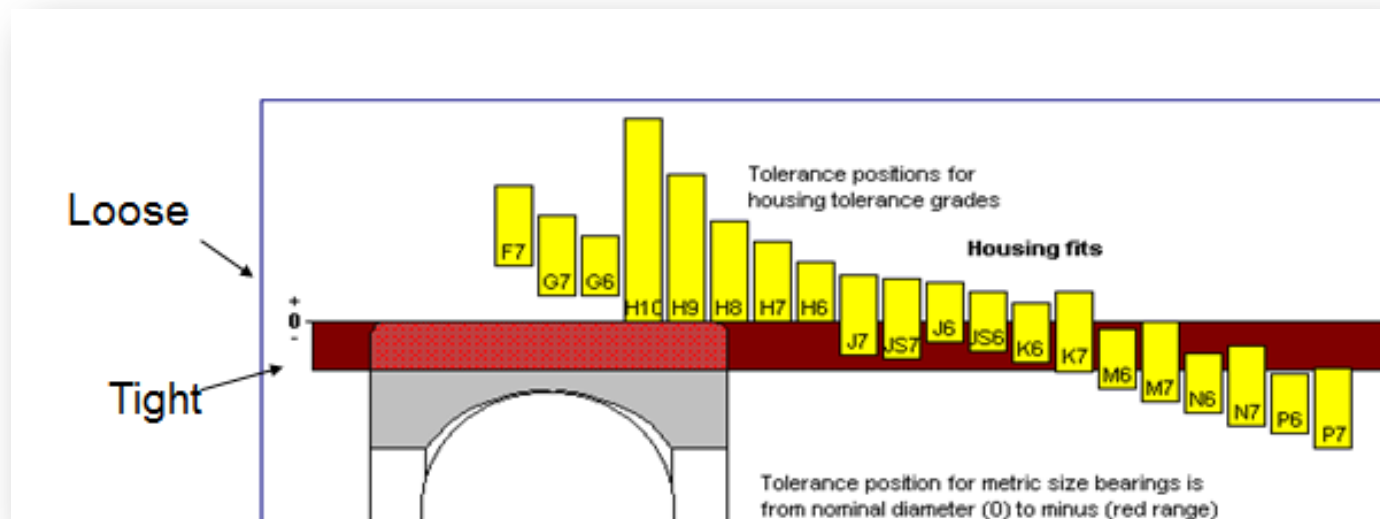
- Interference fit between inner ring and shaft
- Use heavier fits than normal if
 - Bearing is mounted on hollow shaft or sleeve
- Use lighter fits than normal if
 - Bearing is mounted on a stainless steel shaft and
 - Has a large temperature difference between inner and outer rings



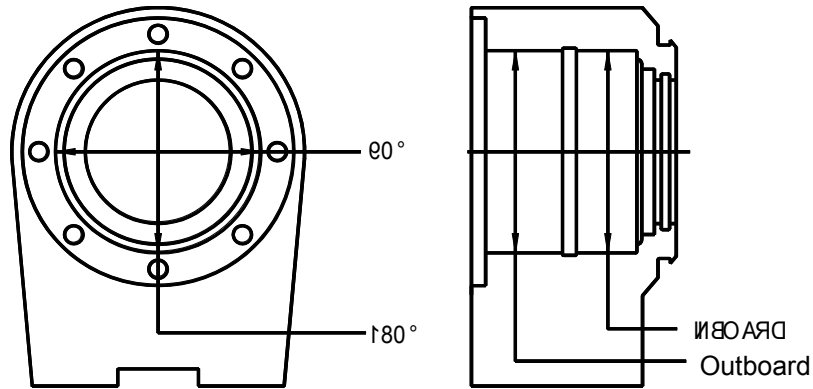
BEARING FITS

Housing fits

- Slight clearance between outer ring and housing
- Use looser fits for large bearings that also have a temperature difference between outer ring and housing



HOUSING MEASURING PROCEDURE



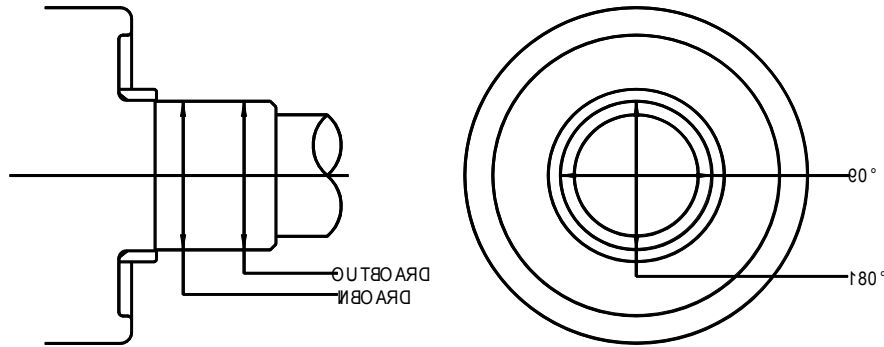
Measure housing bore in 4 places

- Top to bottom
- Side to side
- Front and back

	90°	180°	Difference	Over
Inboard				
Outboard				
Difference				

Chock Bore Tolerances						
Bearing OD (mm)		Designation	Fit		Wear Limit	
Over	Including		Inches	mm	Inches	mm
120	150	F9	+0.0056 +0.0017	+0.143 +0.043	0.0095	0.230
150	180	Nonstandard	+0.0056 +0.0017	+0.143 +0.043	0.0100	0.250
180	250	Nonstandard	+0.0059 +0.0020	+0.150 +0.050	0.0105	0.260
250	315	Nonstandard	+0.0061 +0.0022	+0.156 +0.056	0.0110	0.270

SHAFT MEASURING PROCEDURE



Measure shaft diameter in 4 places

- Top to bottom
- Side to side
- Front and back

	90°	180°	Difference	Over
Inboard				
Outboard				
Difference				

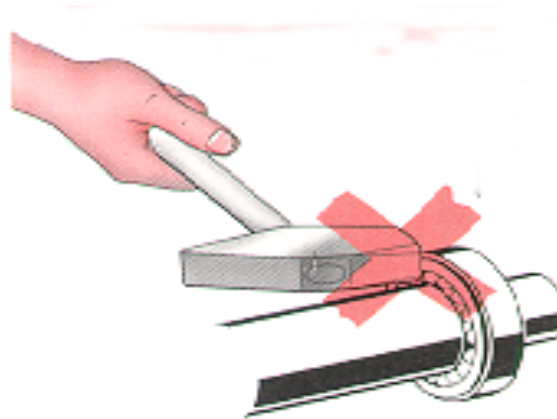
Journal Tolerances (Excluding Split Caster Block Bearing Seats)						
Bearing Bore (mm)		Fit			Wear Limit	
Over	Including	Designation	Inches	mm	Inches	mm
50	80				0.0000	0.000
80	120	f7	-0.0014 -0.0028	-0.036 -0.071	0.0045	0.110
120	180	f7	-0.0017 -0.0033	-0.043 -0.083	0.0050	0.130

DISASSEMBLY AND BEARING REMOVAL PROCEDURES

BEARING SAFETY

Safe handling

- Do not hit bearings with a hammer
- Bearing steel is hard and brittle
- Will fracture on impact
- Sharp pieces could fly



USE PROPER TOOLS

DO NOT USE

- Torches
- Hammers
- Brass Rods
- Chisels

MOUNTING CONSIDERATIONS - WORK AREA PREPARATION

Clean area where bearings are installed

- Dirt
- Grinding dust
- Dirty rags

Clean shaft and housing and all parts prior to bringing into build up area

Make sure all parts are available

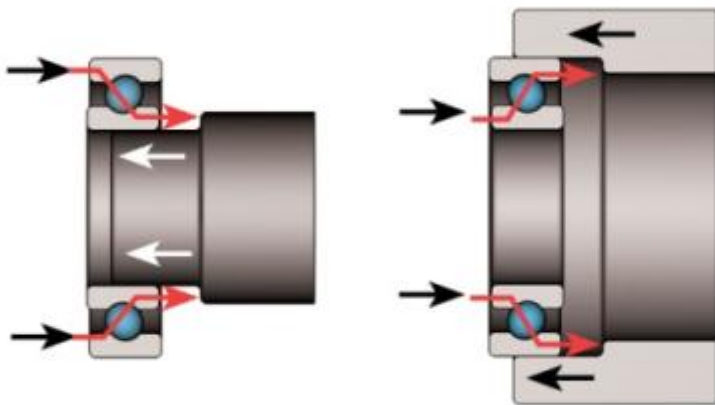
- Including nuts, bolts, seals, o-rings

Check shaft and housing dimensions

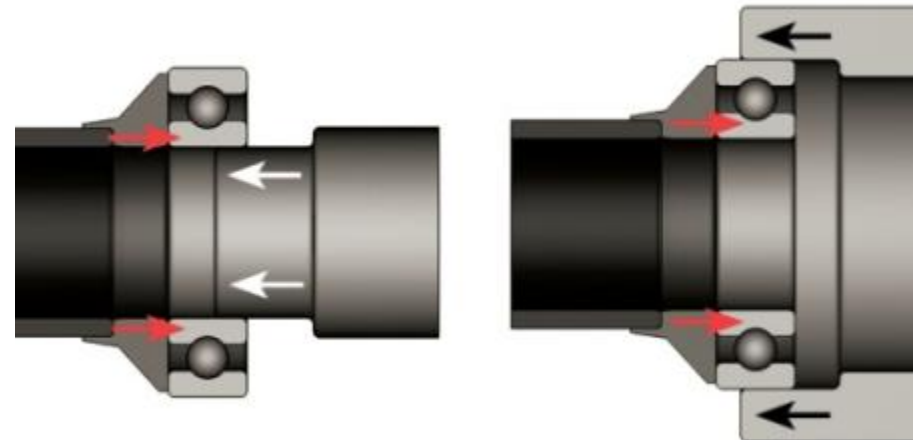
- Burrs, nicks, surface damage
 - Diameter
 - Roundness
 - Fillet
 - Shoulder height
-

BEARING MOUNTING PROCEDURES

Press on the Ring that is Being Installed



IMPROPER



CORRECT

Simultaneous press fitting of inner and outer rings

Or

Press on the ring with tight fit

NSK PROBLEM SOLVERS

FEATURES OF NSK BEAMR STYLE ANGULAR CONTACT

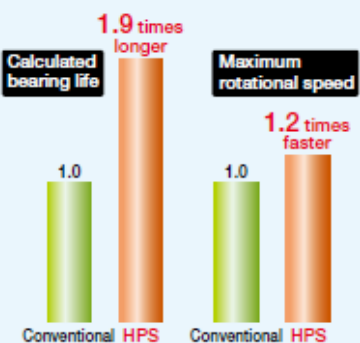
High performance

Bearing life

90% longer

Maximum rotational speed

15% to 20% faster



Metric	Conventional	HPS
Calculated bearing life	1.0	1.9 times longer
Maximum rotational speed	1.0	1.2 times faster

High accuracy

Rotational accuracy

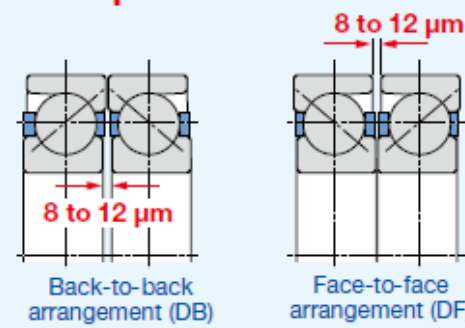
Class P5

Dimensional accuracy

Class P6

Universal arrangement

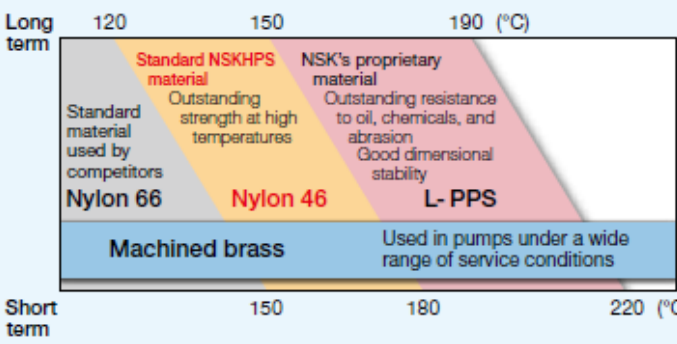
Axial clearance range:
8 to 12 μm



Back-to-back arrangement (DB)

Face-to-face arrangement (DF)

Features and heat resistance of cage material

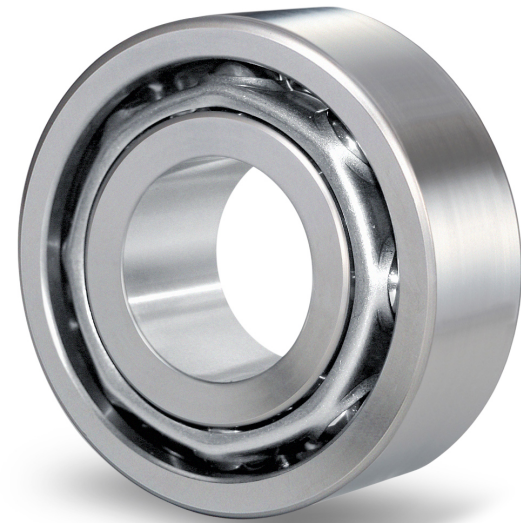


Material	Long term (°C)	Short term (°C)	Notes
Standard material used by competitors (Nylon 66)	~120	~150	Standard material used by competitors
Standard NSKHPS material	~120	~150	Outstanding strength at high temperatures
Nylon 46	~150	~180	NSK's proprietary material
L-PPS	~180	~220	Outstanding resistance to oil, chemicals, and abrasion; Good dimensional stability
Machined brass	~180	~220	Used in pumps under a wide range of service conditions



FEATURES OF NSK EP/UR DOUBLE ROW ANGULAR CONTACT BEARING

- “EP” high purity steel and “UR” heat treatment gives 2-4 X bearing life compared to standard steels.
- Higher 40 degree contact angle for higher axial stiffness and capacity.
- Advanced cage design for improved lubrication and strength.



SLURRY PUMP OPERATION

- Slurry pumps pump a mixture of solids and liquids
- This slurry introduces harsher conditions such as vibration and contamination to the bearing stack.
- NSK “TF” Steel will extend the life of bearings in slurry pumps.



SPECIAL “TF” TOUGH STEEL™ MATERIAL OPTION FOR CONTAMINATED ENVIRONMENTS

Benefits

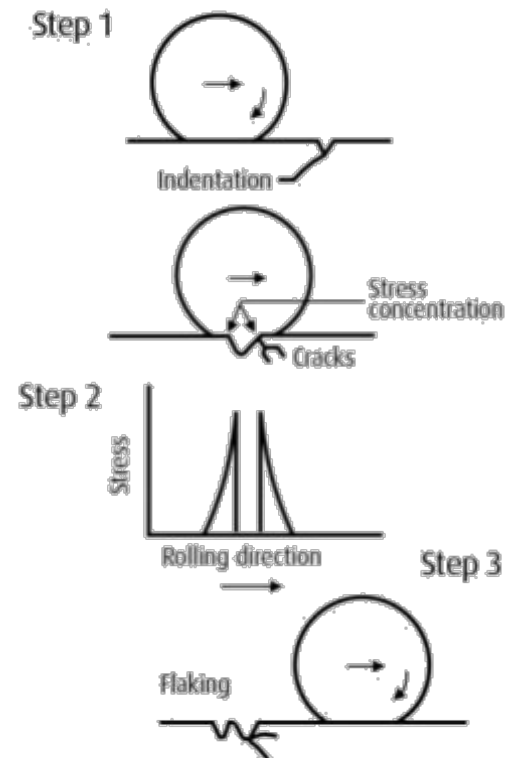
- Extend maintenance interval
- Respond to contaminated environment
- Long life under contaminated environment

Technology

- Special material and heat treatment to prevent surface initiated failures

Result

- 2 times life under contaminated conditions



SLURRY PUMP CASE STUDY

- NSK was asked to help improve life of angular contact bearings in slurry pumps
- Main cause of failure was contamination
- NSK proposed using HTF tough steel™
- Two common failure modes, were poor installation and contamination

Previous life: 2-3 months

NSK life : 1 year

Cost savings: \$60,000



QUESTIONS

PUMP BEARING TRAINING

Visit pumpsandsystems.com/webinars to see this entire webinar, as well as the questions and answers.

PRESENTED BY AARON DODD
NSK AMERICAS
JUNE 24, 2015



NSK

Think **NSK.**