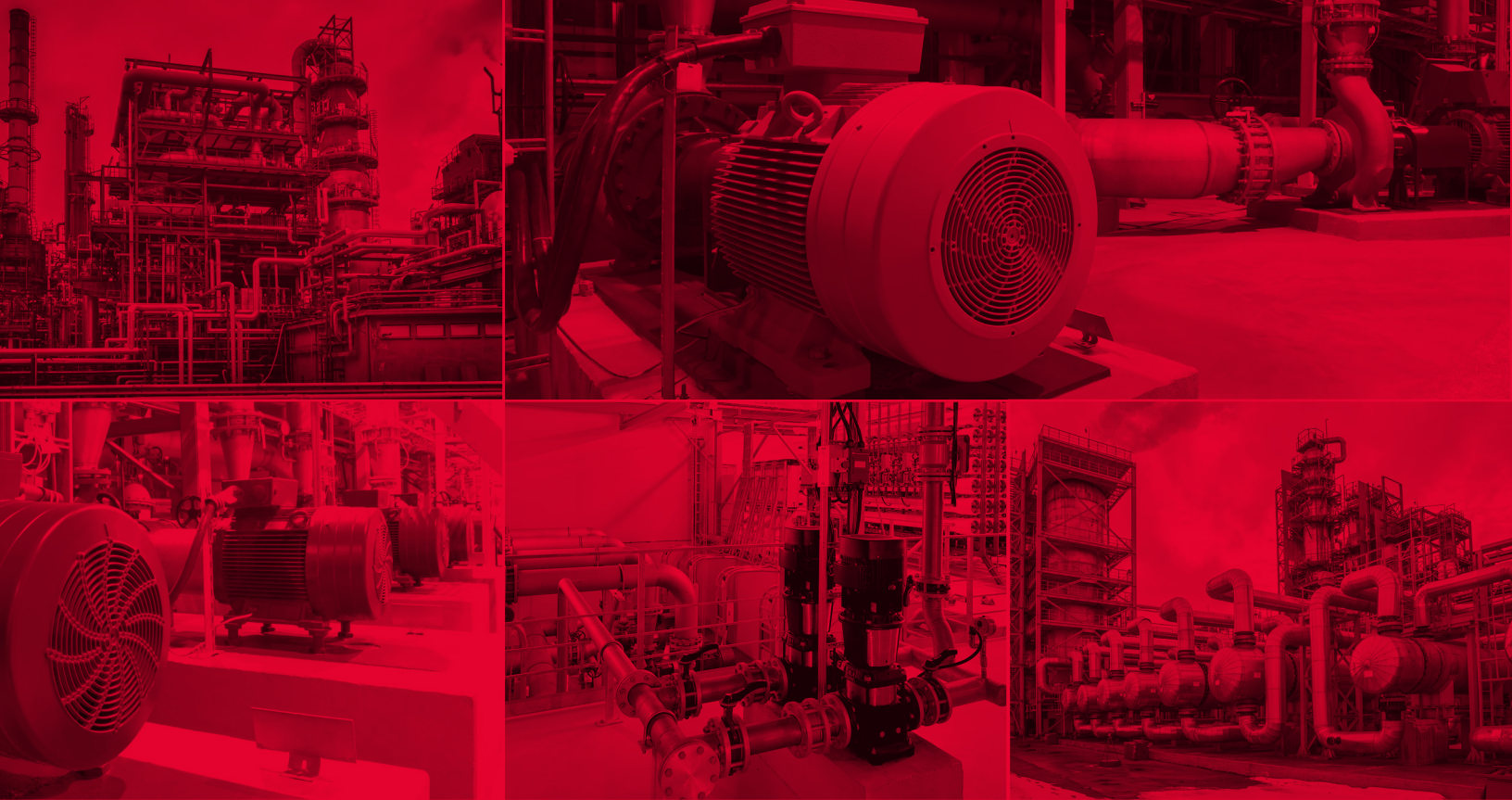


# NSK

## BEARINGS FOR PUMPS AND COMPRESSORS



STAY IN MOTION. STAY IN CONTROL.



## A GLOBAL PARTNER AND SOLUTIONS PROVIDER

As one of the world's leading manufacturers of rolling bearings, linear technology components and steering systems, we can be found on almost every continent – with production facilities, sales offices and technology centres – because our customers appreciate short decision-making channels, prompt deliveries and local service.

### PARTNERSHIP BASED ON TRUST – AND TRUST BASED ON QUALITY

Total Quality by NSK: The synergies of our global network of NSK Technology Centers.

Just one example of how we meet our requirements for high quality.

NSK is one of the leading companies with a long tradition in patent applications for machine parts. In our worldwide research centers, we not only concentrate on the development of new technologies, but also on the continual improvement of quality based on the integrated technology platform of tribology, material technology, analysis and mechatronics.

More about NSK at [www.nskamericas.com](http://www.nskamericas.com) or call us at 1.888.446.5675



	AMERICAS	EUROPE	ASIA
Manufacturing Sites	10	11	45
Sales Locations	15	17	80
Technology Centers	4	5	12

As of October 2021

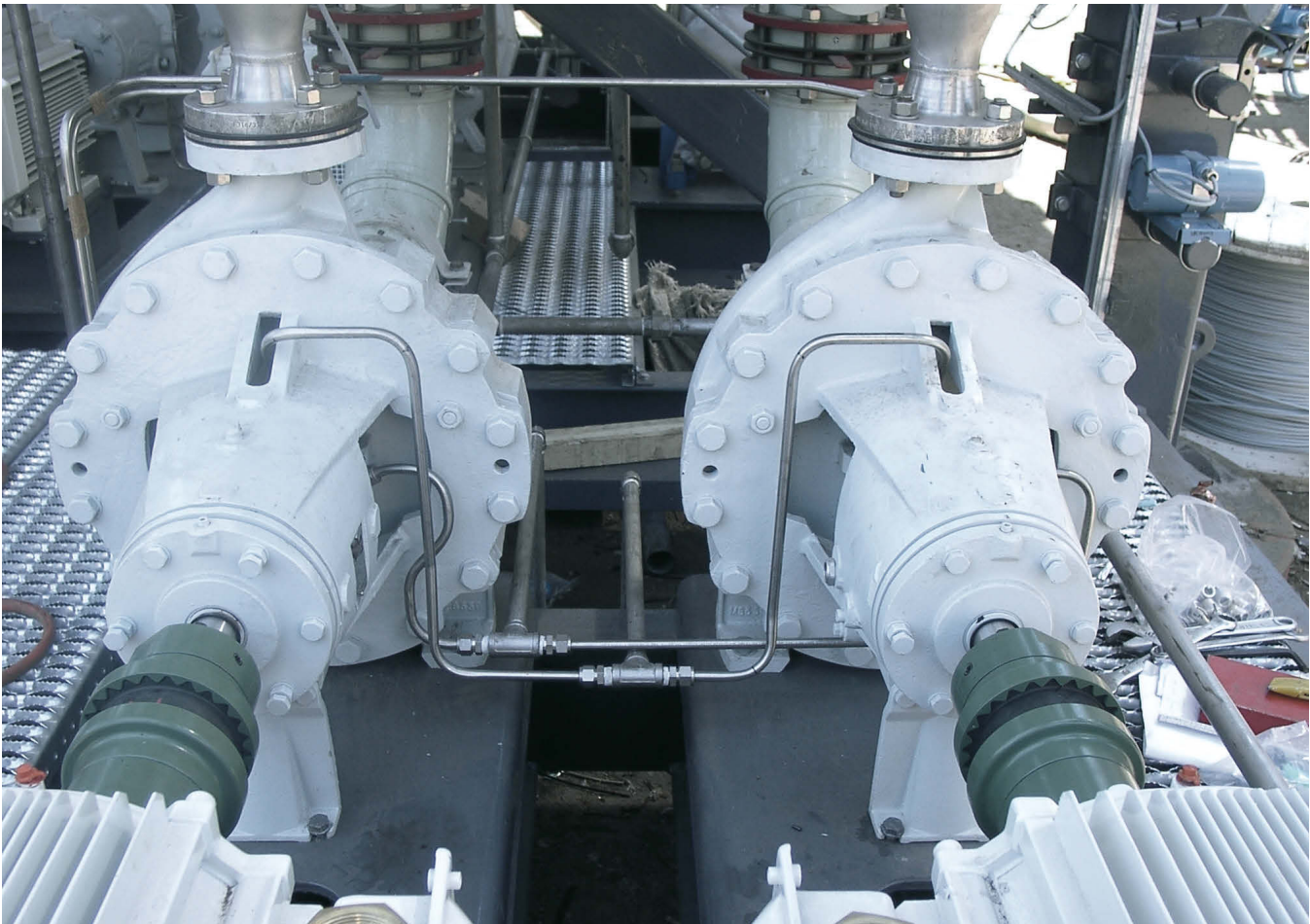
## THE NSK COMPANY

NSK commenced operations as the first Japanese manufacturer of rolling bearings in 1916. From the outset, we have been continuously expanding and improving not only our product portfolio but also our range of services for various industrial sectors. In this context, we develop technologies in the fields of rolling bearings, linear systems, components for the automotive industry and mechatronic systems. Our research and production facilities in the Americas, Europe, and Asia are linked together in a global technology network. Here we concentrate not only on the development of new technologies, but also on the continuous optimization of quality – at every process stage.

At the core of our research activities is the development of advanced material and lubricant technologies, simulation applications using a variety of analytical systems, and technological innovation in the field of mechatronics.



# SERVING THE PUMPS & COMPRESSORS INDUSTRY



## CONTENTS

INTRODUCTION .....	5
STANDARD BEARING RANGE .....	6
<b>SCOPE OF THE APPLICATIONS</b>	
BEARING SOLUTIONS FOR PUMPS .....	8
BEARING SOLUTIONS FOR COMPRESSORS .....	10
<b>SELECTION OF BEARINGS FOR PUMPS AND COMPRESSORS</b>	
<b>SPECIAL DEEP GROOVE BALL BEARINGS FOR PUMPS</b>	
HIGH CAPACITY DEEP GROOVE BALL BEARINGS .....	12
LNG PUMP BEARINGS .....	13
CREEP-FREE BEARINGS .....	14
HPS ANGULAR CONTACT BALL BEARINGS .....	16
SPECIAL BEARINGS FOR SCREW COMPRESSORS .....	20
<b>CASE STUDIES</b>	
PREVENTING CREEP IN SUBMERSIBLE PUMPS BEARINGS .....	22
REFRIGERANT SCREW COMPRESSORS WORKING WITH AMMONIA .....	23

## DECISIVE DESIGN SOLUTIONS AND IMPROVED EFFICIENCIES

Pumps and Compressors are used in a wide range of process industries where requirements are for bearings offering long life in order to increase Mean Time Between Failures (MTBF). Downtime in production processes leads to huge costs and loss of productivity. At the same time, Pump and Compressor manufacturers are looking for more compact machines leading to downsizing of bearings.

The combination of increased life time and downsizing places increasingly severe demands on ball and roller bearings; and satisfying those needs call for bearings of the highest quality and reliability.

For pump applications, depending on the pump type, bearings can run under axial loads, radial loads or combined loads; small to high speeds and different lubrication conditions. In any case, conditions are quite tough and the need for high MTBF is a challenge for bearings.

For compressor applications, bearings are subjected to high axial and radial loads. They play a key role as they have to ensure correct positioning of the rotors in the axial and radial direction. This is extremely important as good positioning of the rotors is directly linked to compressor efficiency. Therefore, axial and radial deflection of the bearings must be kept as small as possible.

All the products developed by NSK specifically for these applications, are featured in this brochure.

In addition to our standard product range, our research and development centres around the world continue to develop the next generation of application-dedicated products by understanding the unique requirements of our customers so that we can help them to continuously improve their machines. For screw compressors, we have developed cylindrical roller bearings and HPS angular contact ball bearings fitted with a patented plastic cage in Linear Poly-Phenylene Sulfide (L-PPS) offering superior characteristics compared to standard plastic cages.

Our team of application engineers, local to your operation, are in contact with OEM R&D teams helping them to find new bearing solutions at each stage of their projects. The experience accumulated after years of involvement in pump and compressor applications is the key for mutual success.

We invite you to have a look through our unique range of innovative problem solving products and if you have an interest in any of our products, please contact your NSK Sales office.

# STANDARD BEARING RANGE



## SINGLE ROW RADIAL BALL BEARINGS

**Available ranges: 600, 6800, 6900, 16000, 16100, 6000, 6200, 6300, 6400 Series**

- › Standard and special applications
- › Steel, brass or polyamide cage
- › Low noise
- › Full sealing options
- › Wide range of greases
- › Standard or special steels



## SINGLE ROW CYLINDRICAL ROLLER BEARINGS WITH BRASS CAGE, STEEL CAGE OR POLYAMIDE CAGE

- › Pressed steel cage series: EW
- › Polyamide cage series: ET
- › Machined brass cage series: EM



## SINGLE ROW ANGULAR CONTACT BALL BEARINGS\*

- › Pressed steel cage series
- › Polyamide cage series
- › Machined brass cage series

\*See also the new HPS range: page 16



## DOUBLE ROW ANGULAR CONTACT BALL BEARINGS

Available ranges: 3200 – 3300 / 5200 – 5300 Series

- › Steel or polyamide cage
- › Open
- › Shielded ZZ or ZZ
- › Sealed DDU or 2RS



## TAPERED ROLLER BEARING

- › Inch & metric sizes
- › Standard steel / carburized steel / HTF treatment
- › Custom made sets with spacers



## HPS SPHERICAL ROLLER BEARINGS

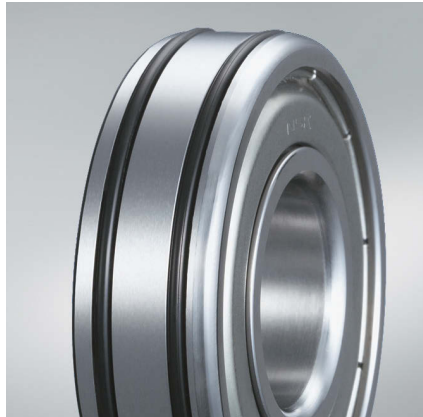
- › High load capacity
- › High limiting speed
- › High strength cage
- › Low noise and vibration

This is a non-exhaustive overview of NSK bearings used in Pumps & Compressors. If you require additional bearings, please contact NSK.

# BEARING SOLUTIONS FOR PUMPS



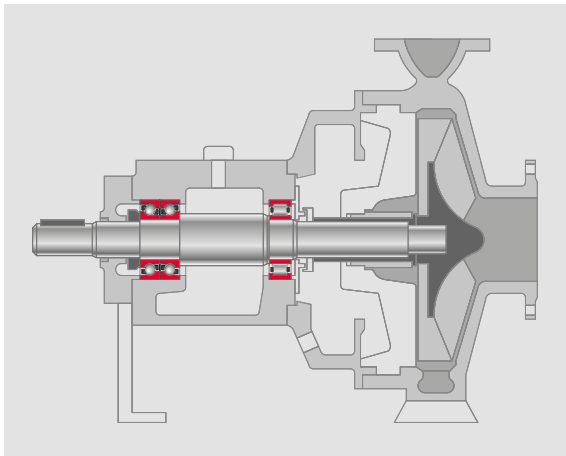
HPS Angular Contact Ball Bearings series



Creep-Free bearing



LNG pump bearing



## CENTRIFUGAL PUMPS

### Bearing Selection

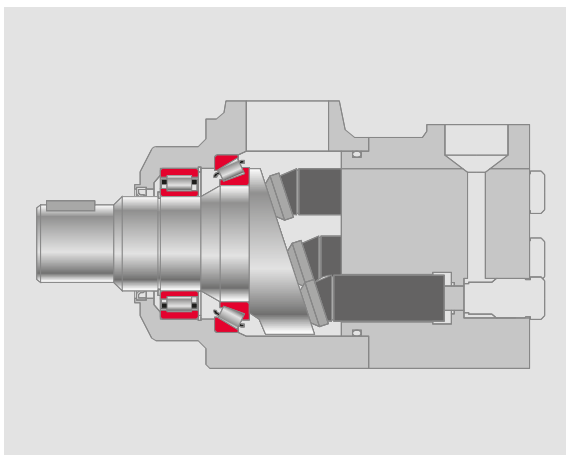
- › Cylindrical Roller Bearings
- › Angular Contact Ball Bearings
- › Double Row Angular Contact Ball Bearings
- › Deep Groove Ball Bearings – special: HR series\*

### Operating Conditions

- › Speed: 1500 rpm – 3000 rpm
- › Axial & radial loads

### Bearing Requirements

- › Long life under high axial loads
- › Small axial free play



## PISTON PUMPS

### Bearing Selection

- › Cylindrical Roller Bearings – Special L-PPS cage
- › Tapered Roller Bearings – P6X accuracy – Carburized steel
- › Needle Roller Bearings

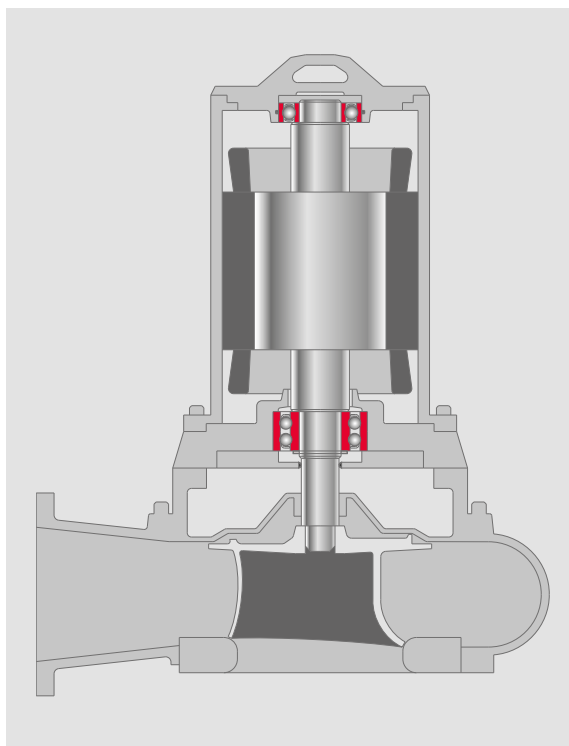
### Operating Conditions

- › Heavy axial and radial load
- › Medium speed

### Bearing Requirements

- › Reduced width tolerance for precise mounting
- › Oil compatibility with cage





## SUBMERSIBLE PUMPS

### Bearing Selection

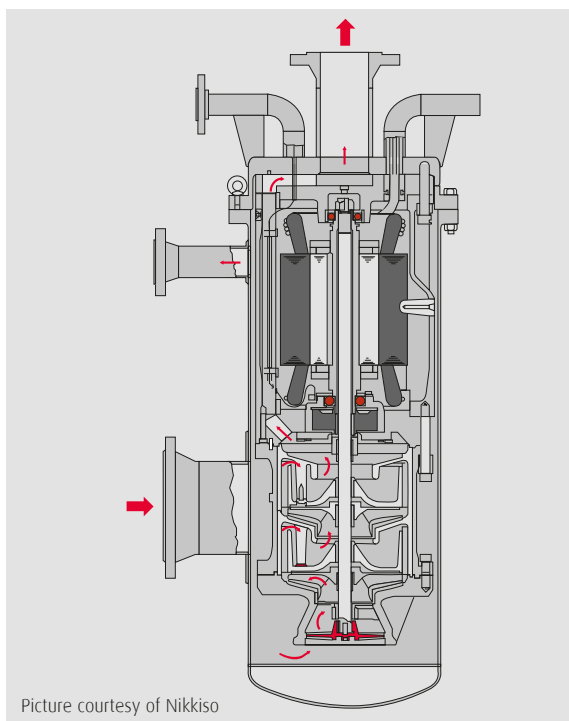
- › Cylindrical Roller Bearings
- › Angular Contact Ball Bearings
- › Double Row Angular Contact Ball Bearings
- › Deep Groove Ball Bearings – special: Creep-Free bearings\*

### Operating Conditions

- › Vertical shaft
- › Axial load
- › Large temperature difference between inner & outer rings

### Bearing Requirements

- › Sealing performance
- › Prevent top bearing creeping in housing



Picture courtesy of Nikkiso

## LNG PUMPS\*

### Bearing Selection

- › Deep Groove Ball Bearings
- › Angular Contact Ball Bearings

### Operating Conditions

- › Speed: 1160 rpm – 3600 rpm
- › Gas temperature: -196 °C up to 0 °C
- › Mainly axial load
- › Very poor lubrication

### Bearing Requirements

- › Self lubricating
- › Corrosion resistance

\* See further information on page 12 to 15

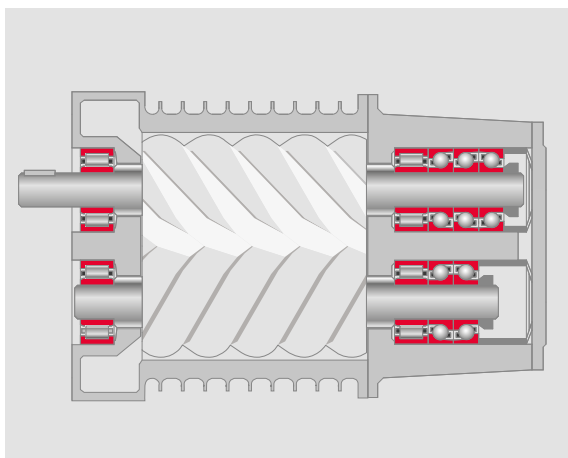
# BEARING SOLUTIONS FOR COMPRESSORS



High load capacity Cylindrical Roller Bearings with L-PPS cage



High load capacity HPS Angular Contact Ball Bearings with L-PPS cage



## OIL INJECTED SCREW COMPRESSOR

### Bearing Selection

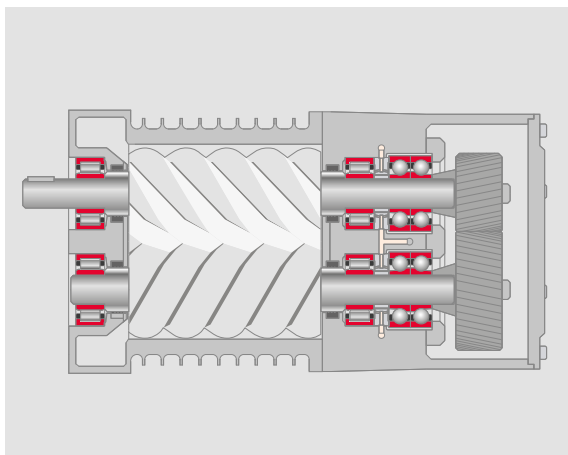
- › Cylindrical Roller Bearings – with L-PPS cage\*
- › HPS Angular Contact Ball Bearings – with L-PPS cage\*
- › Tapered Roller Bearings
- › Needle Roller Bearings

### Operating Conditions

- › Medium speed
- › Large axial & radial loads
- › Oil circulation

### Bearing Requirements

- › Specific axial & radial clearances to provide precise screw guidance
- › Plastic cage compatibility with special oils.



## OIL FREE SCREW COMPRESSOR

### Bearing Selection

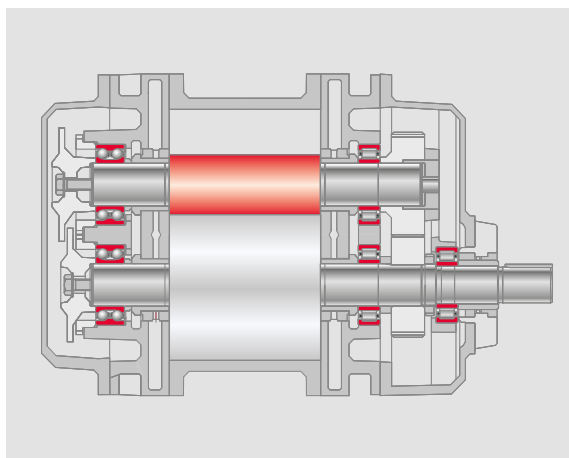
- › Cylindrical Roller Bearings – with outer ring guided brass cage, P6 or P5 accuracy
- › Angular Contact Ball Bearings – with outer ring guided brass cage, P6 or P5 accuracy
- › 4-point contact ball bearings – with outer ring guided brass cage, P6 accuracy, reduced axial clearance

### Operating Conditions

- › High speed (0.7 M.dmn–1.4 M.dmn)
- › Moderate axial & radial loads
- › Oil jet lubrication

### Bearing Requirements

- › Specific axial & radial clearances to provide precise screw guidance
- › High speed performance
- › Heat resistance



## ROOTS BLOWER

### Bearing Selection

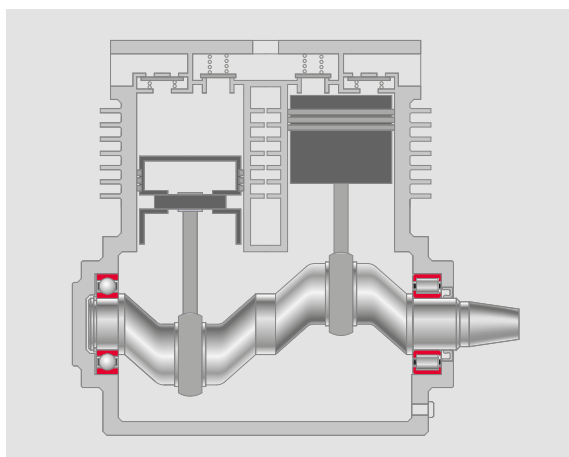
- › Cylindrical Roller Bearings
- › Angular Contact Ball Bearings
- › Double Row Angular Contact Ball Bearings
- › Deep Groove Ball Bearings

### Operating Conditions

- › Oil-free
- › Medium to high temperature
- › Vibration

### Bearing Requirements

- › Long life
- › Heat resistance



## PISTON COMPRESSOR

### Bearing Selection

- › Cylindrical Roller Bearings
- › High Capacity Deep Groove Ball Bearings
- › Needle Roller Bearings
- › Special bearing solution for oil free types

### Operating Conditions

- › High radial load associated with reciprocating motion

### Bearing Requirements

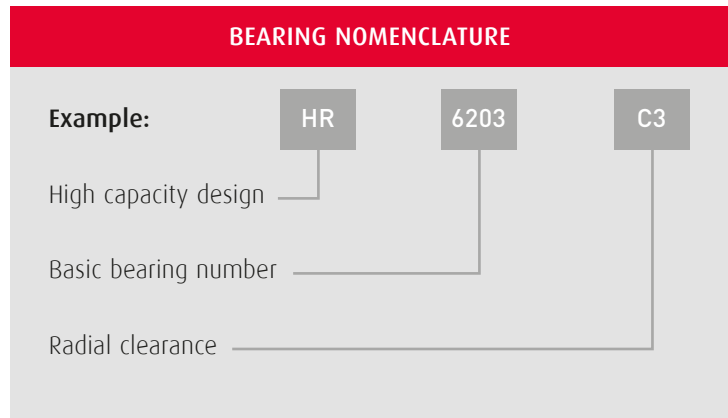
- › Long life under tough conditions

\* See further information on page 20/21

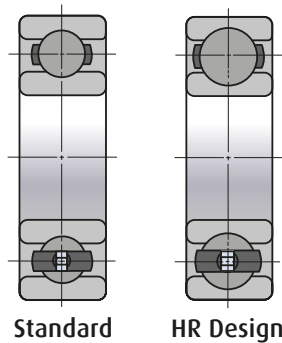
# SPECIAL DEEP GROOVE BALL BEARINGS FOR PUMPS

## HIGH CAPACITY DEEP GROOVE BALL BEARINGS

High capacity deep groove ball bearings (HR series) have bigger rolling elements than standard deep groove ball bearings. Typically this will provide a 7% to 19% increase in dynamic load rating, depending on size, resulting in a 22% to 68% increase in ISO L10 life. The HR series can dramatically improve the life of a machine or can be used to downsize existing machines.



**Bigger rolling elements:**  
load capacity increased



BORE DIAMETER (MM)	PARTS NO.	NEW HR SERIES		STANDARD		C <sub>r</sub> INCREASED RATIO
		Basic load rating (N)		Basic load rating (N)		
		C <sub>r</sub>	C <sub>Or</sub>	C <sub>r</sub>	C <sub>Or</sub>	
15	6202	8 550	3 950	7 650	3 750	1.12
	6302	13 300	5 900	11 400	5 450	1.17
17	6203	11 300	5 350	9 550	4 800	1.18
	6303	15 600	7 100	13 600	6 650	1.15
20	6304	18 200	9 050	15 900	7 900	1.14
25	6205	15 300	8 100	14 000	7 850	1.09
	6305	23 700	12 200	20 600	11 200	1.15
30	6206	23 300	12 800	19 500	11 300	1.19
	6306	29 800	15 800	26 700	15 000	1.12
35	6207	28 300	16 000	25 700	15 300	1.10
	6307	39 500	21 500	33 500	19 200	1.18
40	6208	32 500	19 900	29 100	17 800	1.12
	6308	47 000	26 200	40 500	24 000	1.16
45	6209	36 500	22 600	31 500	20 400	1.16
	6309	57 000	34 500	53 000	32 000	1.08
50	6210	39 000	25 800	35 000	23 200	1.11
	6310	66 500	40 500	62 000	38 500	1.07
55	6211	48 000	32 000	43 500	29 300	1.10
	6311	78 000	46 000	71 500	44 500	1.09
60	6212	58 000	38 000	52 500	36 000	1.10

Standard HR series are open types. Shielded and sealed versions are also being produced. Please contact NSK.



# SPECIAL DEEP GROOVE BALL BEARINGS FOR PUMPS



## LNG PUMP BEARINGS

LNG pump bearings are employed as upper and lower support bearings on the mainshaft of a motor which drives the special pumps used for receiving and discharging LNG to road tankers and storage tanks. The bearings, immersed in Liquefied Natural Gas (LNG) at  $-162^{\circ}\text{C}$ , are using the cryogenic liquid as a lubricant while operating at speeds up to 3,600 rev/min.

### BEARING NOMENCLATURE

Example:

6315

H

T35D

C3

Basic bearing number

Stainless steel

Fluororesin cage

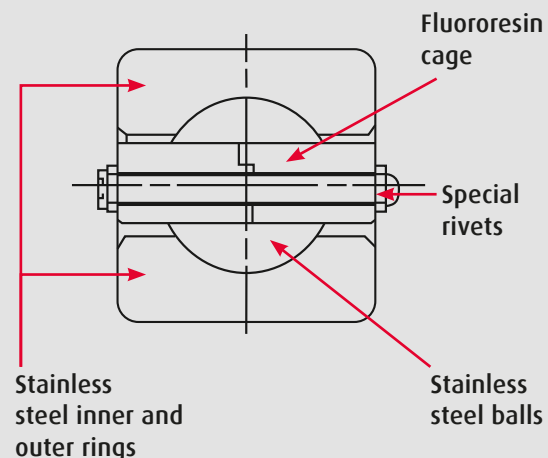
Radial clearance



To cope with these tough conditions, NSK developed deep groove\* ball bearings using special materials. Rings and balls are made from martensitic stainless steel to provide corrosion resistance. The bearing cage is made from Fluororesin, a material that offers the extremely useful property of being self-lubricating, even at very low temperatures. This is significant because during operation, the cage – a two piece unit held together by special rivets – actually transfers a thin film of Fluororesin from the retainer pocket to the ball, and then to the raceway surface, maintaining good lubrication conditions. NSK LNG pump bearings extend service intervals in this very demanding environment.

\* Some sizes are also available as angular contact ball bearings.

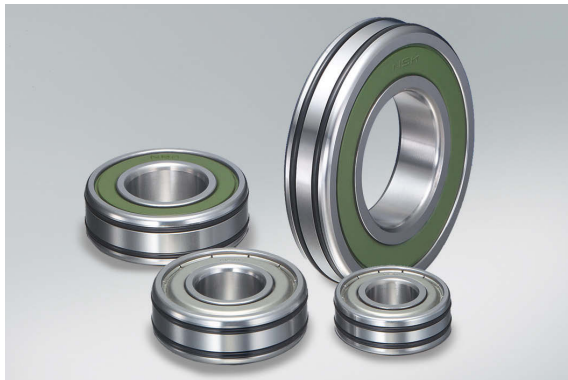
### Bearing structure



# SPECIAL DEEP GROOVE BALL BEARINGS FOR PUMPS

## CREEP-FREE BEARINGS

NSK introduces a new bearing series that is indispensable in the pump free-end bearing position, and for any applications with creep problems. O-ring compression provides dramatically enhanced creep resistance. As the boundary dimensions are identical, the housing does not need to be reworked when replacing standard bearings. This results in reduced cost of the conversion.



### BEARING NOMENCLATURE

#### Example:

Creep-Free Bearing  
(with O-ring)

Basic bearing number

Seal type

Radial clearance

CX

6203

ZZ

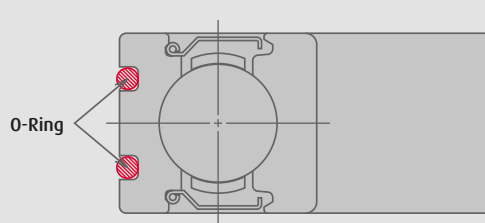
C3

BEARING BORE DIAMETER	BEARING OUTER DIAMETER	BEARING WIDTH	BEARING LOAD RATINGS		RECOMMENDED HOUSING FITS*	BEARING NUMBER			
d mm	D mm	B mm	C <sub>r</sub> (N)	C <sub>0r</sub> (N)		Open type	Shield type	Contact seal type**	Non-contact type
10	26	8	4 550	1 970	G6 or H7	CX-6000			
	30	9	5 100	2 390		CX-6200	ZZ	DDU	VV
	35	11	8 100	3 450		CX-6300			
12	28	8	5 100	2 370		CX-6001			
	32	10	6 800	3 050		CX-6201	ZZ	DDU	VV
	37	12	9 700	4 200		CX-6301			
15	32	9	5 600	2 830		CX-6002			
	35	11	7 650	3 750		CX-6202	ZZ	DDU	VV
	42	13	11 400	5 450		CX-6302			
17	35	10	6 000	3 250		CX-6003			
	40	12	9 550	4 800		CX-6203	ZZ	DDU	VV
	47	14	13 600	6 650		CX-6303			
20	42	12	9 400	5 000		CX-6004			
	47	14	12 800	6 600		CX-6204	ZZ	DDU	VV
	52	15	15 900	7 900		CX-6304			
25	47	12	10 100	5 850		CX-6005			
	52	15	14 000	7 850		CX-6205	ZZ	DDU	VV
	62	17	20 600	11 200		CX-6305			
30	55	13	13 200	8 300		CX-6006			
	62	16	19 500	11 300		CX-6206	ZZ	DDU	VV
	72	19	26 700	15 000		CX-6306			
35	62	14	16 000	10 300		CX-6007			
	72	17	25 700	15 300		CX-6207	ZZ	DDU	VV
	80	21	33 500	19 200		CX-6307			
40	68	15	16 800	11 500		CX-6008			
	80	18	29 100	17 900		CX-6208	ZZ	DDU	VV
	90	23	40 500	24 000		CX-6308			
45	75	16	20 900	15 200		CX-6009			
	85	19	31 500	20 400		CX-6209	ZZ	DDU	VV
	100	25	53 000	32 000		CX-6309			

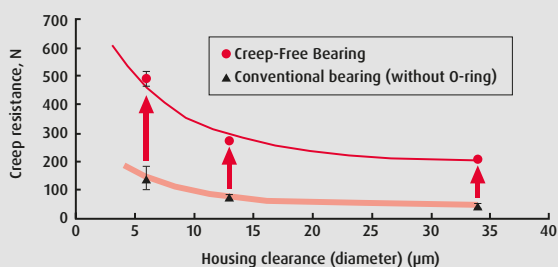
\* Although the recommended fits are G6 or H7, G6 is specified when conditions prioritize location under light pre-load.

\*\* Low-contact seal available for seal type bearings. Contact NSK for details.

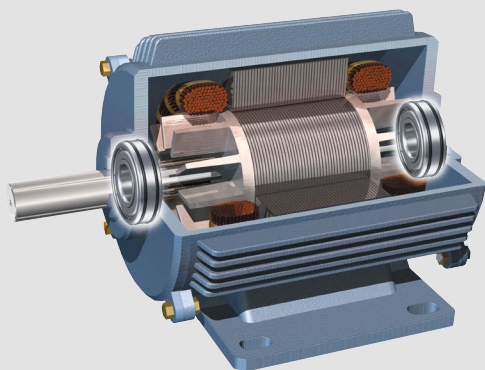
## Structure of the Creep-Free Bearing



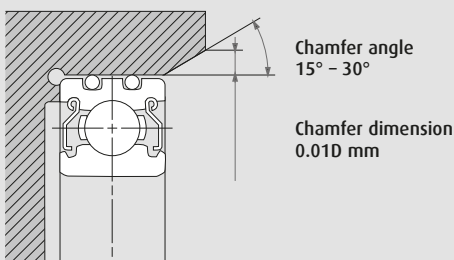
## Creep limit load test (example: 6204)



## Application example Pump Motor Bearings



## Housing shape and dimension



## 1. STRUCTURE AND PERFORMANCE OF CREEP-FREE BEARINGS

Compression of the O-rings, which are mounted in two grooves on the outer ring, improve creep prevention. No special machining is required; bearings can be used with the same housing as standard bearings. In creep limit load tests, the more housing clearance is reduced, the greater the improvement in creep prevention. This is due to the compression of the O-ring mounted in the outer ring.

## 2. FEATURES AND APPLICATIONS OF CREEP-FREE BEARINGS

### › Prevents creeping

O-ring compression prevents creep.

### › No special machining of the housing is required

Bearings can be replaced since boundary dimensions are identical to standard bearings.

### › Easy to assemble

Assembly is easy since bearings can be fitted with a loose tolerance.

### › Reusable housing

Very little abrasion occurs on the bore surface of the housing, making reuse possible.

## 3. NOTE ON MOUNTING CREEP-FREE BEARINGS

Housing shape and dimension: the housing shape must be in accordance with sketch. We recommend a groove and a chamfer, chamfer angle being between 15° and 30°, and its minimum dimension being 0.01 x Bearing Outer Diameter. For more information, please see NSK brochure "Creep Free Bearings".

## HPS ANGULAR CONTACT BALL BEARINGS



**Centrifugal pump in a waste water treatment plant** – Angular contact ball bearings are widely used in centrifugal pumps and screw compressors. Original Equipment Manufacturers are looking for more compact design of their machines leading to increasing load conditions for the bearings. The answer to this is the new HPS Series of angular contact ball bearings



Continually developing products with greater strength and higher accuracy, NSK introduces HPS (High Performance Standard) angular contact ball bearings. These bearings fully incorporate the advantages of NSK's world-class design, materials, and manufacturing technology, setting a new standard for bearings. This allows premium performance in each feature you can expect from an angular contact ball bearing: high speed, high load capacity, excellent running accuracy, and high reliability.

## SPECIAL FEATURES OF THE NEW HPS ANGULAR CONTACT BALL BEARINGS

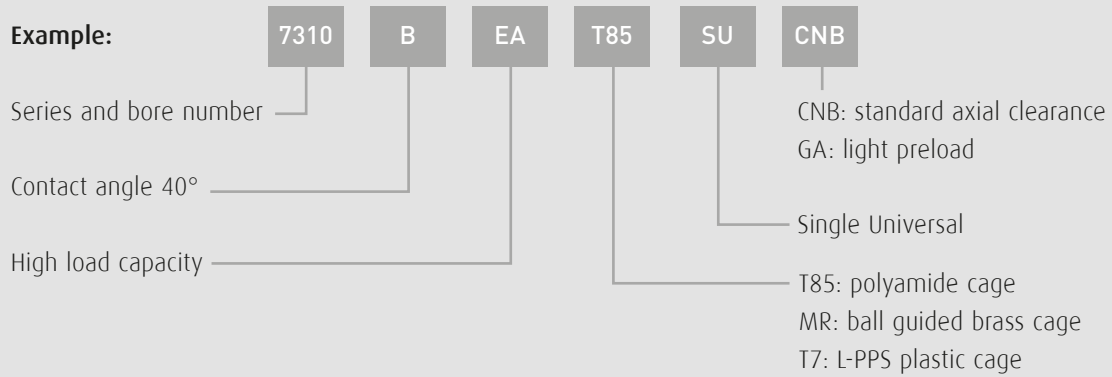
- › **High load capacity:** 5% increase compared to previous series. Thanks to improved steel cleanliness, optimum internal design and manufacturing process, NSK HPS bearings achieve higher load ratings resulting in an extended life time (up to 18%) or the possibility to downsize.
- › **High rotating speed:** Between 15 and 20% more than conventional series. Permissible speed has been increased by 15-20%, due to internal design, precise processing and manufacturing technology.
- › **High precision:** Improved dimensional and running accuracy. New HPS series are manufactured with P5 (ISO Class 5) running accuracy, and P6 (ISO Class 6) dimensional accuracy
- › **Universal matching:** In standard, every HPS bearing is manufactured with universal design to be mounted in a pair, triplex or quad set
- › **Tight axial clearance/preload tolerance:**  
From 8 to 12  $\mu\text{m}$  enabling precise shaft positioning
- › **Three high performance cages available**  
T85: Polyamide 4-6, for general purpose applications  
T7: L-PPS (Linear Poly-Phenylene Sulphide),  
for oil-injected screw compressors  
MR: Machined brass (ball guided) for high reliability applications (including API pumps)



# HPS ANGULAR CONTACT BALL BEARINGS

## BEARING NOMENCLATURE

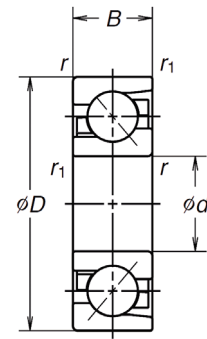
**Example:**



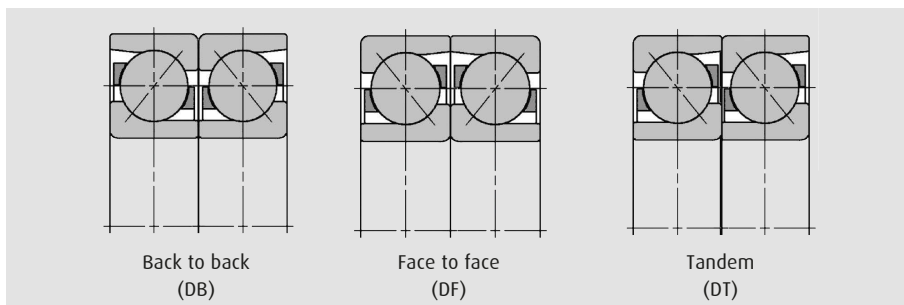
## Matched Measured Axial Clearance (µm)

BORE DIAMETER (MM)		CNB		GA	
over	Incl.	Min.	Max.	Min.	Max.
12	18	17	25	-2	6
18	30	20	28	-2	6
30	50	24	32	-2	6
50	80	29	41	-3	9

For DB and DF arrangements



**Different possible arrangements:** HPS bearings can be mounted in back-to-back pairs (DB) as well as face-to-face pairs (DF), or tandem (DT).



BEARING NUMBERS	BOUNDARY DIMENSIONS (MM)					BASIC LOAD RATINGS (N)		LIMITING SPEED (MIN <sup>-1</sup> )
	d	D	B	r (min)	r <sub>1</sub> (min)	C <sub>r</sub>	C <sub>or</sub>	
7201BEA	12	32	10	0.6	0.3	8 150	3 750	30 000
7301BEA	12	37	12	1.0	0.6	11 100	4 950	26 000
7202BEA	15	35	11	0.6	0.3	9 800	4 800	26 000
7302BEA	15	42	13	1.0	0.6	14 300	6 900	22 000
7203BEA	17	40	12	1.0	0.3	11 600	6 100	22 000
7303BEA	17	47	14	1.1	0.6	16 800	8 300	20 000
7204BEA	20	47	14	1.0	0.6	15 600	8 150	19 000
7304BEA	20	52	15	1.1	0.6	19 800	10 500	18 000
7205BEA	25	52	15	1.0	0.6	17 600	10 200	17 000
7305BEA	25	62	17	1.1	0.6	27 200	14 900	15 000
7206BEA	30	62	16	1.0	0.6	23 700	14 300	14 000
7306BEA	30	72	19	1.1	0.6	36 500	20 600	13 000
7207BEA	35	72	17	1.1	0.6	32 500	19 600	12 000
7307BEA	35	80	21	1.5	1.0	40 500	24 400	11 000
7208BEA	40	80	18	1.1	0.6	38 500	24 500	11 000
7308BEA	40	90	23	1.5	1.0	53 000	33 000	10 000
7209BEA	45	85	19	1.1	0.6	40 500	27 100	10 000
7309BEA	45	100	25	1.5	1.0	62 500	39 500	9 000
7210BEA	50	90	20	1.1	0.6	42 000	29 700	9 500
7310BEA	50	110	27	2.0	1.0	78 000	50 500	8 000
7211BEA	55	100	21	1.5	1.0	51 500	37 000	8 500
7311BEA	55	120	29	2.0	1.0	89 000	58 500	7 500
7212BEA	60	110	22	1.5	1.0	61 500	45 000	7 500
7312BEA	60	130	31	2.1	1.1	102 000	68 500	6 700
7213BEA	65	120	23	1.5	1.0	70 000	53 500	7 100
7313BEA	65	140	33	2.1	1.1	114 000	77 000	6 300
7214BEA	70	125	24	1.5	1.0	75 500	58 500	6 700
7314BEA	70	150	35	2.1	1.1	124 000	87 500	6 000
7215BEA	75	130	25	1.5	1.0	78 500	63 500	6 300
7216BEA	80	140	26	2.0	1.0	87 500	70 000	6 000

# SPECIAL BEARINGS FOR SCREW COMPRESSORS

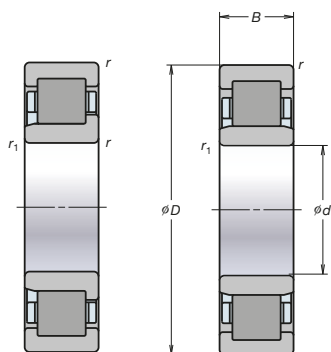
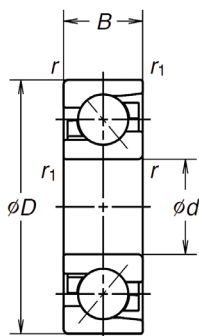


## FEATURES OF SCREW COMPRESSOR BEARINGS

- › **L-PPS plastic cage:** This plastic cage offers superior heat and wear resistance, cage strength, and chemical stability. These characteristics change little even if the bearing is exposed to compressor oil, refrigerants, or ammonia gas. L-PPS is greatly superior to traditional polyamide cage material.
- › **Increased load capacity:** The optimal bearing internal design associated with the L-PPS plastic cage provides higher bearing load ratings resulting in improved fatigue life.
- › **Increased axial load limit for angular contact bearings:** Higher load ratings result in increased axial load.
- › **Improved lubrication performance:** The optimised cage design is rolling element guided thereby allowing more internal free space, resulting in flow of lubricant improved.

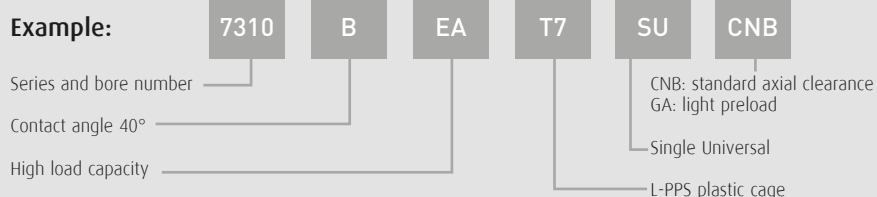
**Pictured (Upper):** High load capacity Cylindrical Roller Bearings with L-PPS cage

**Pictured (Lower):** High load capacity HPS Angular Contact Ball Bearings with L-PPS cage



## BEARING NOMENCLATURE (HPS ANGULAR CONTACT BALL BEARING)

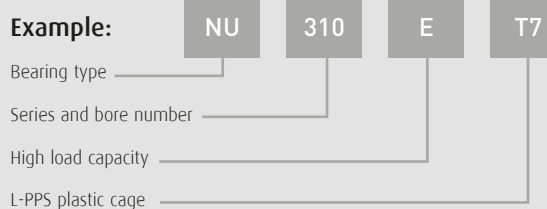
**Example:**



This screw compressor specification includes all HPS features, and L-PPS « T7 » cage.  
Range: From 12 to 80 mm bore (7201BEA to 7216BEA))

## BEARING NOMENCLATURE (HIGH LOAD CAPACITY CYLINDRICAL ROLLER BEARINGS)

**Example:**



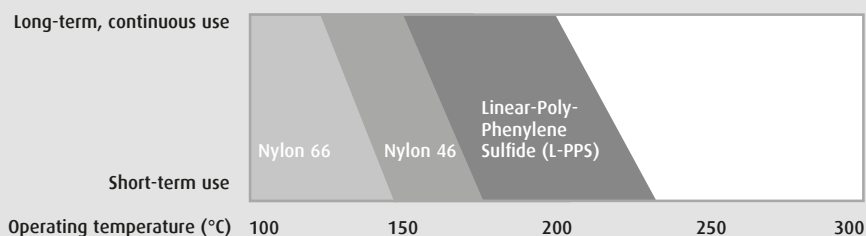
This screw compressor specification includes high-capacity design, and L-PPS « T7 » cage.  
Range: From 20 to 100 mm bore (NU204ET7 to NU2320ET7)



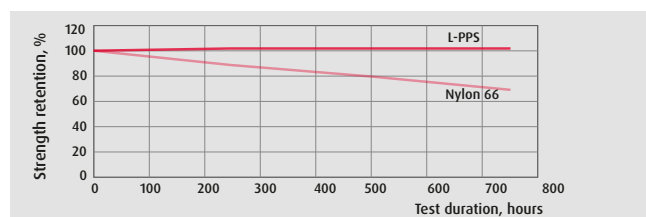
## FEATURES OF CAGE MATERIAL

Material	Nylon 66	Nylon 46	L-PPS
Features	<ul style="list-style-type: none"> <li>Standard cage material</li> </ul>	<ul style="list-style-type: none"> <li>High crystallization rate provides superior high temperature strength</li> <li>Superior heat resistance</li> </ul>	<ul style="list-style-type: none"> <li>Greater heat resistance than nylon 46</li> <li>Superior resistance to oil and chemicals</li> <li>Wear resistant</li> <li>Good dimensional stability</li> </ul>
Standard grade	<ul style="list-style-type: none"> <li>Contains fiberglass</li> </ul>	<ul style="list-style-type: none"> <li>Contains fiberglass</li> </ul>	<ul style="list-style-type: none"> <li>Contains fiberglass</li> </ul>
Plastic melting point	<ul style="list-style-type: none"> <li>262 °C</li> </ul>	<ul style="list-style-type: none"> <li>290 °C</li> </ul>	<ul style="list-style-type: none"> <li>280 °C</li> </ul>

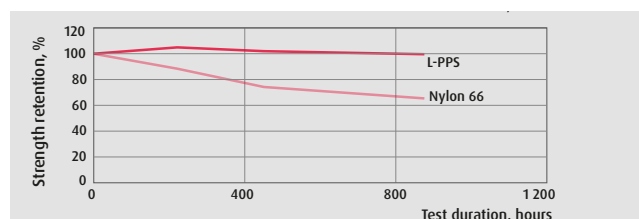
## Target for heat resistance



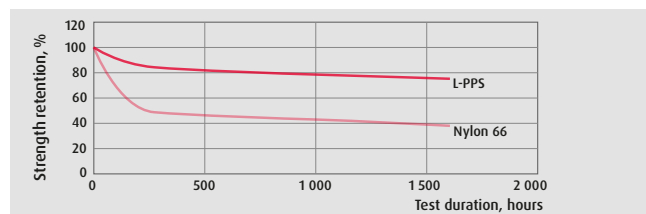
## Performance of L-PPS cage material



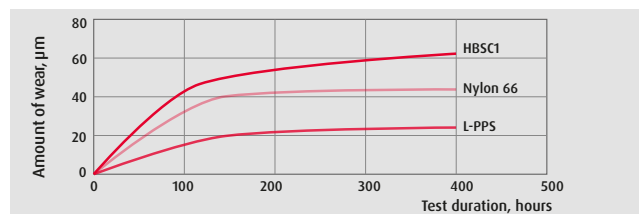
Resistance to compressor oil | Tensile strength – compressor oil at 150 °C



Heat resistance | Heat resistance at 180 °C



Resistance to gear oil | Tensile strength – gear oil at 180 °C



Wear resistance (μm)

# CASE STUDIES

## BEARING SOLUTIONS FOR PUMPS & COMPRESSORS

### PREVENTING CREEP ON SUBMERSIBLE PUMPS BEARINGS

Submersible pumps are widely used in a variety of applications such as construction, waste water, mining, agriculture and general industry. Most submersible pumps comprise of a vertical electric drive motor coupled directly to the impeller. They are required to operate for long periods with the minimum amount of maintenance.

#### BEARING ARRANGEMENT

The bottom, locating bearing, is generally a double row angular contact ball bearing or a pair of angular contact bearings. This reacts the axial load and radial load generated by the pumped fluid. The bearing is heavily loaded and needs to be correctly selected to reach target life. The top free bearing, is generally a deep groove ball bearing. This takes a light radial load. C3 clearance is generally used to compensate for clearance reduction due to heat generation from the electric motor.

#### CREEP PHENOMENON ON TOP BEARINGS

The lightly loaded top bearing should, theoretically, have a very long life. However, its life is sometimes drastically reduced by creep. The combined effect of light radial load and loose fit in the housing can result in creep between outer ring and housing. Creep is a phenomenon where relative slippage occurs between fitted surfaces. Creep produces a polish on the bearing ring surface, occasionally accompanied by scoring or wear.

#### COUNTERMEASURE

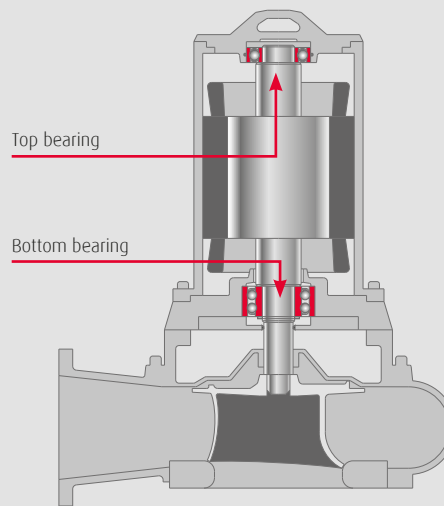
One popular countermeasure used by pump manufacturers is to machine an annular groove in the housing bore and to insert an O-ring. The O-ring prevents creep between bearing outside diameter and housing.

#### NSK SOLUTION

NSK Creep-Free bearings offer more: with their integrated double O-rings, they provide better creep prevention. They provide submersible pump manufacturers with the following advantages:

- › Very good creep prevention
- › Easy assembly. The Creep-Free bearings can be fitted with a loose housing bore tolerance
- › Housing is re-usable as very little abrasion occurs on the housing bore
- › Cost reduction. Pump manufacturers do not need to machine a groove in the housing bore and insert their own O-ring.

Traditional submersible pump



Creep-Free bearing

## REFRIGERANT SCREW COMPRESSORS WORKING WITH AMMONIA

Refrigerant compressors are designed specifically for air conditioning, heat pumping, and industrial refrigeration. Refrigerant compressors are specifically designed to be the heart of an industrial cooling or air-conditioning system (HVAC). They are integral components of the refrigeration cycle, in which refrigerant gases are cyclically evaporated and condensed. There are three main types of refrigerant compressors: scroll, screw, and piston.

### BEARING ARRANGEMENT

Refrigerant screw compressors comprise of two screws in mesh. Gas enters at the inlet side and is gradually compressed along the screw. Compressed gas leaves through the outlet port. At the inlet, a cylindrical roller bearing is used on both male and female screw to carry the radial load. At the outlet, a cylindrical roller bearing is also used for radial loads. However, it is combined with a set of angular contact ball bearings which reach the high axial load associated with the compression. The common refrigerant gases such as Chlorofluorocarbons (CFCs) are now banned substances. New compressors are now exposed to Hydrochlorofluorocarbons (HCFCs) or Hydrofluorocarbons (HFCs). The problem of global warming and ozone layer depletion is driving the use of “natural” refrigerants such as carbon dioxide (CO<sub>2</sub>) or ammonia (NH<sub>3</sub>).

### TROUBLES WITH CAGES WHEN USING AMMONIA

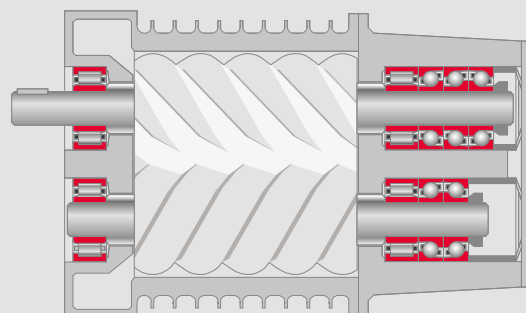
When using ammonia as a refrigerant, the oil used for lubrication should be miscible with ammonia. Consequently synthetic oils are necessary. Polyamide cages which are quite popular in screw compressors bearings are not suitable when operating above 70 °C with synthetic oils (which could contain additives). Ammonia also has an adverse effect on polyamide. There is a rapid ageing of the cage and a decrease in the strength which can lead to cage failure. Brass cages

show corrosion crack when in contact with ammonia. In the past, cages made of cast iron were used for ammonia compressors. Cast iron cages show good results but are not popular and are quite expensive.

### NSK SOLUTION

For refrigerant screw compressors NSK offers its L-PPS cage for both cylindrical roller bearings and angular contact ball bearings. The L-PPS cage provides superior heat and wear resistance, cage strength and chemical stability characteristics that change little, even if exposed to compressor oil, refrigerants or ammonia gas.

Typical Refrigerant – Screw Compressor





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