

Bearings for Screw Compressors

Fiberglass-reinforced L-PPS plastic cage ensures chemical stability with improved lubricant flow around bearings.

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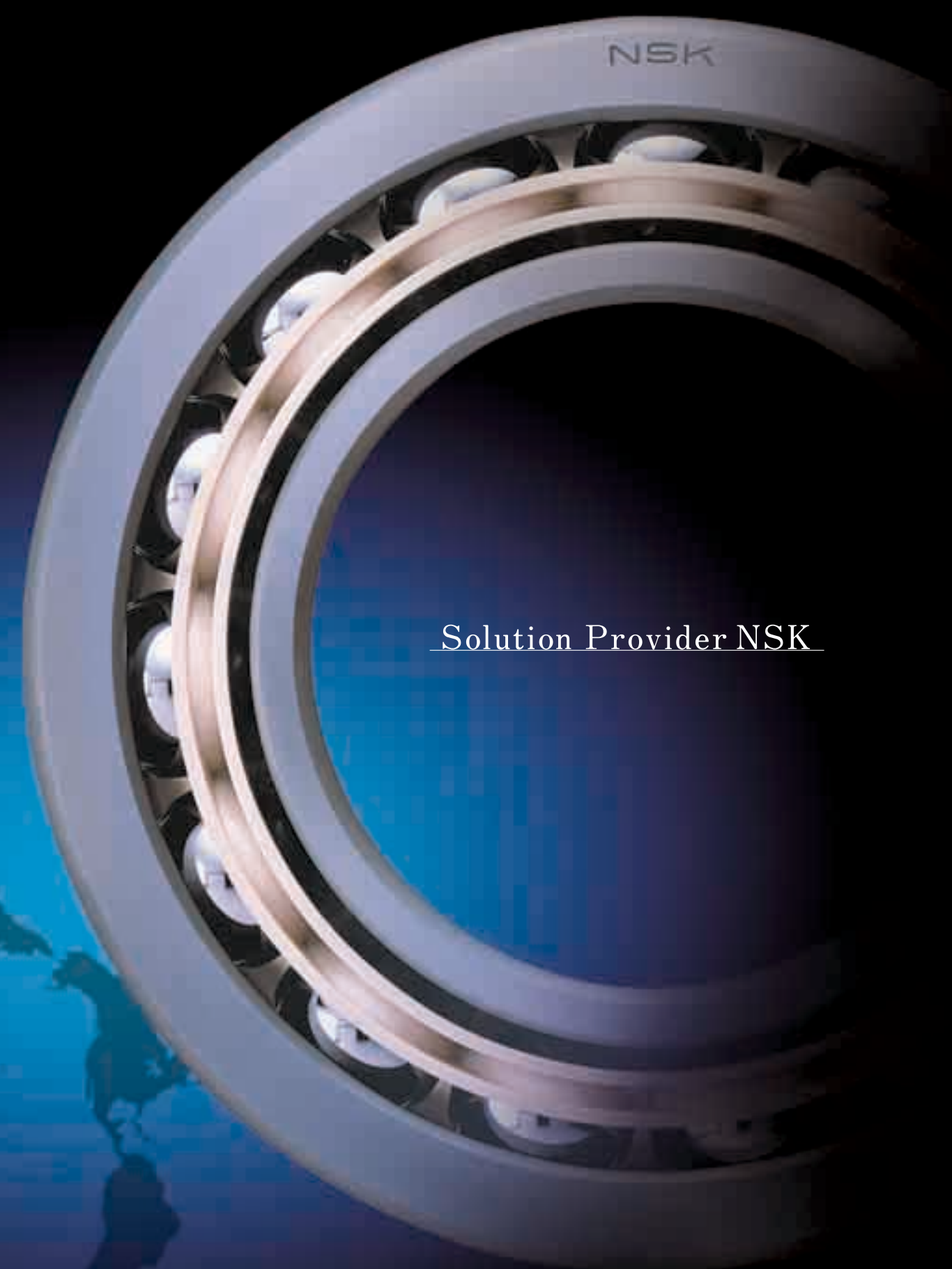


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NSK bearings have outstanding resistance to oil, chemicals and heat—the mark of their superior reliability in a variety of chemical environments.

Screw compressors are used in environments where they are exposed to such chemicals as compressor oil, refrigerants, and ammonia gas. Consequently, bearings for screw compressors must be highly resistant to oil and heat.

NSK bearings for screw compressors feature linear polyphenylene sulphide (L-PPS) plastic cages that offer superior chemical resistance and deliver high performance regardless of the operating environment.



High load capacity angular contact ball bearings



High load capacity cylindrical roller bearings

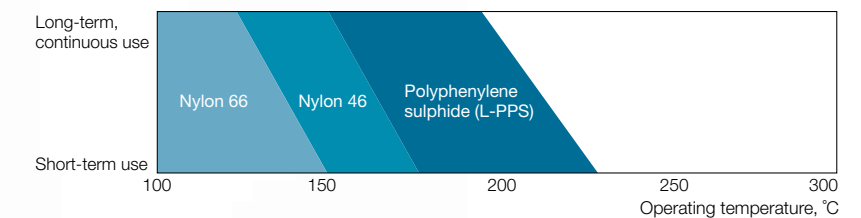
Features of screw compressor bearings

- L-PPS plastic cage**
 The plastic cage offers superior heat and wear resistance, cage strength, and chemical stability characteristics that change little even if exposed to compressor oil, refrigerants, or ammonia gas.
- Increased load capacity**
 The optimal bearing internal design with L-PPS plastic cage enables higher bearing load capacity as a result of an improved fatigue rating life.
- Increased axial load limit for angular contact bearings**
 Axial load limit is increased along with higher load capacity.
- Improved lubrication performance**
 The optimal design of the cage utilizes the rolling elements to guide cages instead of by the inner or outer rings, thereby providing for more internal space and improved lubricant flow throughout the bearings.

Features of cage material

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

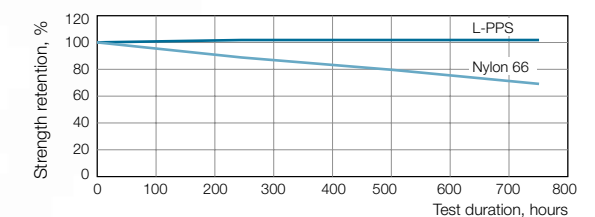
Target for heat resistance



Performance of L-PPS cage material

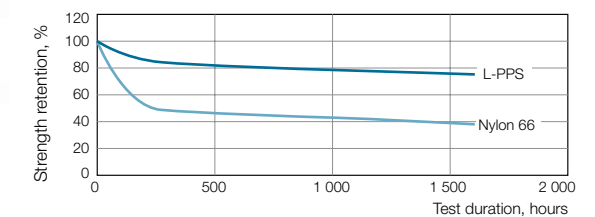
Resistance to compressor oil

Tensile strength against compressor oil at 150°C

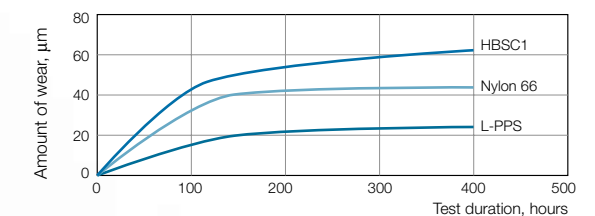


Resistance to gear oil

Tensile strength against gear oil at 180°C

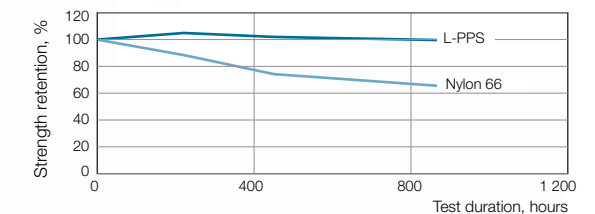


Wear resistance



Heat resistance

Heat resistance at 180°C



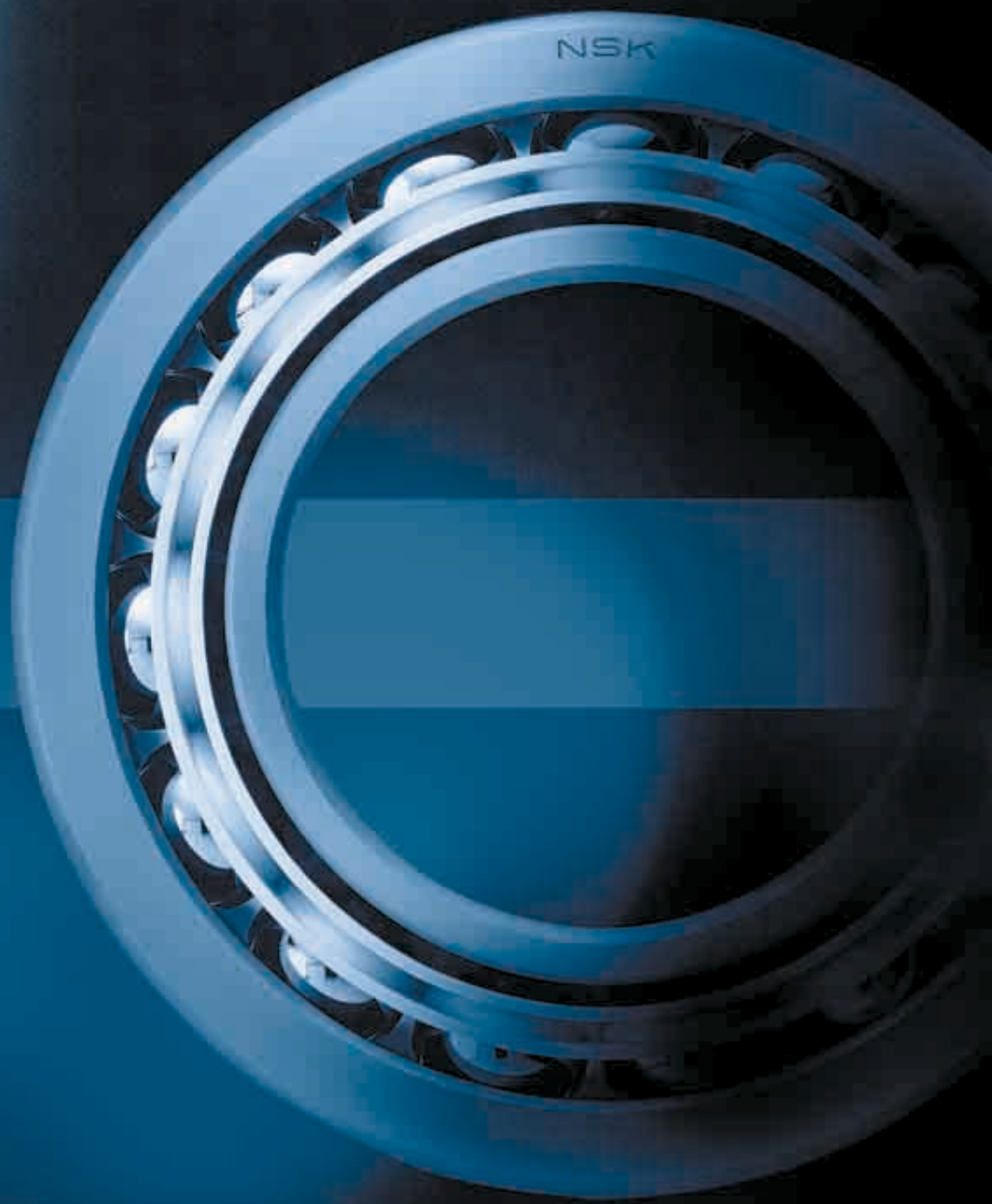
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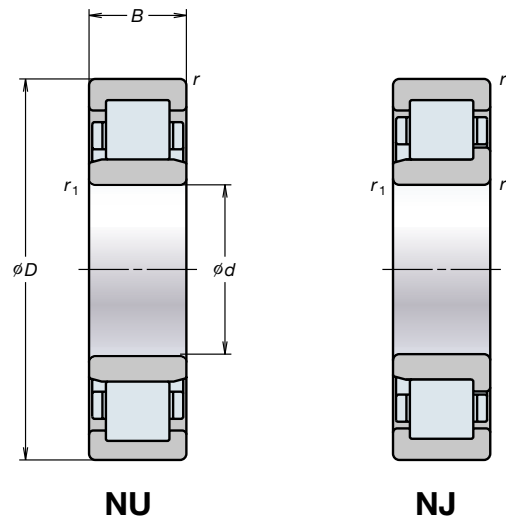
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Countermeasures



High Load Capacity Cylindrical Roller Bearings for Screw Compressors



Radial internal clearance Unit: μm

Nominal bore diameter d (mm)		Compatible CN clearance		Incompatible CC clearance	
over	incl.	min	max	min	max
10	24	20	45	20	30
24	30	20	45	25	35
30	40	25	50	25	40
40	50	30	60	30	45
50	65	40	70	35	50
65	80	40	75	40	60
80	100	50	85	45	70

Bearing Nomenclature

Example:

NU 310 E T7

Bearing type

Series and bore number

High load capacity

L-PPS plastic cage

Special specifications

Accuracy
None: ISO Normal class
P6: ISO class 6
P5: ISO class 5

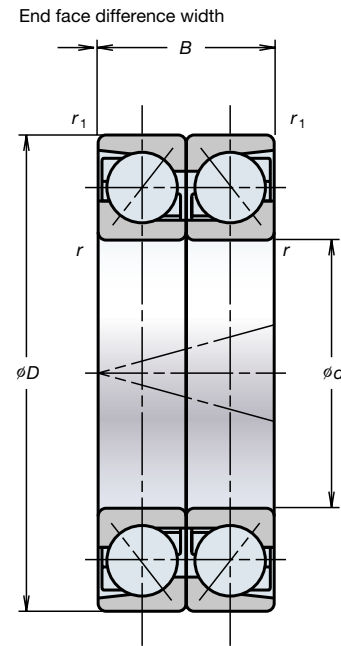
Radial internal clearance
CN (none): Normal compatibility clearance
CC: Incompatible clearance

Bearing numbers	Boundary dimensions (mm)					Basic load ratings (N)	
	d	D	B	r (min)	r_1 (min)	C_r (dynamic)	C_{0r} (static)
NU (NJ) 204ET7	20	47	14	1	0.6	25 700	22 600
NU (NJ) 304ET7	20	52	15	1.1	0.6	31 500	26 900
NU (NJ) 2204ET7	20	47	18	1	0.6	30 500	28 300
NU (NJ) 2304ET7	20	52	21	1.1	0.6	42 000	39 000
NU (NJ) 205ET7	25	52	15	1	0.6	29 300	27 700
NU (NJ) 305ET7	25	62	17	1.1	1.1	41 500	37 500
NU (NJ) 2205ET7	25	52	18	1	0.6	35 000	34 500
NU (NJ) 2305ET7	25	62	24	1.1	1.1	57 000	56 000
NU (NJ) 206ET7	30	62	16	1	0.6	39 000	37 500
NU (NJ) 306ET7	30	72	19	1.1	1.1	53 000	50 000
NU (NJ) 2206ET7	30	62	20	1	0.6	49 000	50 000
NU (NJ) 2306ET7	30	72	27	1.1	1.1	74 500	77 500
NU (NJ) 207ET7	35	72	17	1.1	0.6	50 500	50 000
NU (NJ) 307ET7	35	80	21	1.5	1.1	66 500	65 500
NU (NJ) 2207ET7	35	72	23	1.1	0.6	61 500	65 000
NU (NJ) 2307ET7	35	80	31	1.5	1.1	93 000	101 000
NU (NJ) 208ET7	40	80	18	1.1	1.1	55 500	55 500
NU (NJ) 308ET7	40	90	23	1.5	1.5	83 000	81 500
NU (NJ) 2208ET7	40	80	23	1.1	1.1	72 500	77 500
NU (NJ) 2308ET7	40	90	33	1.5	1.5	114 000	122 000
NU (NJ) 209ET7	45	85	19	1.1	1.1	63 000	66 500
NU (NJ) 309ET7	45	100	25	1.5	1.5	97 500	98 500
NU (NJ) 2209ET7	45	85	23	1.1	1.1	76 000	84 500
NU (NJ) 2309ET7	45	100	36	1.5	1.5	137 000	153 000
NU (NJ) 210ET7	50	90	20	1.1	1.1	69 000	76 500
NU (NJ) 310ET7	50	110	27	2	2	110 000	113 000
NU (NJ) 2210ET7	50	90	23	1.1	1.1	86 500	97 000
NU (NJ) 2310ET7	50	110	40	2	2	163 000	187 000
NU (NJ) 211ET7	55	100	21	1.5	1.1	86 500	98 500
NU (NJ) 311ET7	55	120	29	2	2	137 000	143 000
NU (NJ) 2211ET7	55	100	25	1.5	1.1	101 000	122 000

Bearing numbers	Boundary dimensions (mm)					Basic load ratings (N)	
	d	D	B	r (min)	r_1 (min)	C_r (dynamic)	C_{0r} (static)
NU (NJ) 2311ET7	55	120	43	2	2	201 000	233 000
NU (NJ) 212ET7	60	110	22	1.5	1.5	97 500	107 000
NU (NJ) 312ET7	60	130	31	2.1	2.1	150 000	157 000
NU (NJ) 2212ET7	60	110	28	1.5	1.5	131 000	157 000
NU (NJ) 2312ET7	60	130	46	2.1	2.1	222 000	262 000
NU (NJ) 213ET7	65	120	23	1.5	1.5	108 000	119 000
NU (NJ) 313ET7	65	140	33	2.1	2.1	181 000	191 000
NU (NJ) 2213ET7	65	120	31	1.5	1.5	149 000	181 000
NU (NJ) 2313ET7	65	140	48	2.1	2.1	233 000	265 000
NU (NJ) 214ET7	70	125	24	1.5	1.5	119 000	137 000
NU (NJ) 314ET7	70	150	35	2.1	2.1	205 000	222 000
NU (NJ) 2214ET7	70	125	31	1.5	1.5	156 000	194 000
NU (NJ) 2314ET7	70	150	51	2.1	2.1	274 000	325 000
NU (NJ) 215ET7	75	130	25	1.5	1.5	130 000	156 000
NU (NJ) 315ET7	75	160	37	2.1	2.1	240 000	263 000
NU (NJ) 2215ET7	75	130	31	1.5	1.5	162 000	207 000
NU (NJ) 2315ET7	75	160	55	2.1	2.1	330 000	395 000
NU (NJ) 216ET7	80	140	26	2	2	139 000	167 000
NU (NJ) 316ET7	80	170	39	2.1	2.1	256 000	282 000
NU (NJ) 2216ET7	80	140	33	2	2	186 000	243 000
NU (NJ) 2316ET7	80	170	58	2.1	2.1	355 000	430 000
NU (NJ) 217ET7	85	150	28	2	2	167 000	199 000
NU (NJ) 2217ET7	85	150	36	2	2	217 000	279 000
NU (NJ) 2317ET7	85	180	60	3	3	395 000	485 000
NU (NJ) 218ET7	90	160	30	2	2	182 000	217 000
NU (NJ) 2218ET7	90	160	40	2	2	242 000	315 000
NU (NJ) 2318ET7	90	190	64	3	3	435 000	535 000
NU (NJ) 220ET7	100	180	34	2.1	2.1	310 000	305 000
NU (NJ) 320ET7	100	215	47	3	3	380 000	425 000
NU (NJ) 2220ET7	100	180	46	2.1	2.1	335 000	445 000
NU (NJ) 2320ET7	100	215	73	3	3	570 000	715 000

Consult with NSK for special specifications.

High Load Capacity Angular Contact Ball Bearings for Screw Compressors



Axial internal clearance Unit: μm

Bore diameter d (mm)		CNA clearance		CNB clearance	
over	incl.	min	max	min	max
10	18	4	14	13	23
18	30	6	16	18	28
30	50	8	18	22	32
50	80	12	24	27	39

End face difference width: 0 ± 0.005

Bearing Nomenclature

Example: **7310 B EA T7 DB CNA**

Series and bore number

Contact angle 40°

High load capacity

L-PPS plastic cage

Special specifications

Accuracy
None: ISO Normal Class
P6: ISO Class 6
P5: ISO Class 5

Combination axial clearance
CNA: Smaller than CNB clearance
CNB: Standard clearance

DB (DF) arrangement

Bearing numbers	Boundary dimensions (mm)					Basic load ratings (N)	
	d	D	B	r (min)	r_1 (min)	C_r (dynamic)	C_{0r} (static)
7202BEAT7DB (DF)	15	35	22	0.6	0.3	15 100	9 600
7302BEAT7DB (DF)	15	42	26	1	0.6	22 200	13 800
7203BEAT7DB (DF)	17	40	24	0.6	0.3	17 900	12 200
7303BEAT7DB (DF)	17	47	28	1	0.6	26 000	16 600
7204BEAT7DB (DF)	20	47	28	1	0.6	24 100	16 300
7304BEAT7DB (DF)	20	52	30	1.1	0.6	30 500	20 900
7205BEAT7DB (DF)	25	52	30	1	0.6	27 200	20 400
7305BEAT7DB (DF)	25	62	34	1.1	0.6	42 000	29 800
7206BEAT7DB (DF)	30	62	32	1	0.6	36 500	28 600
7306BEAT7DB (DF)	30	72	38	1.1	0.6	56 000	41 000
7207BEAT7DB (DF)	35	72	34	1.1	0.6	50 500	39 000
7307BEAT7DB (DF)	35	80	42	1.5	1	62 500	49 000
7208BEAT7DB (DF)	40	80	36	1.1	0.6	59 500	49 000
7308BEAT7DB (DF)	40	90	46	1.5	1	82 500	65 500
7209BEAT7DB (DF)	45	85	38	1.1	0.6	62 500	54 000

Bearing numbers	Boundary dimensions (mm)					Basic load ratings (N)	
	d	D	B	r (min)	r_1 (min)	C_r (dynamic)	C_{0r} (static)
7309BEAT7DB (DF)	45	100	50	1.5	1	97 000	79 500
7210BEAT7DB (DF)	50	90	40	1.1	0.6	65 000	59 500
7310BEAT7DB (DF)	50	110	54	2	1	121 000	101 000
7211BEAT7DB (DF)	55	100	42	1.5	1	79 500	74 000
7311BEAT7DB (DF)	55	120	58	2	1	138 000	117 000
7212BEAT7DB (DF)	60	110	44	1.5	1	95 500	90 500
7312BEAT7DB (DF)	60	130	62	2.1	1.1	159 000	137 000
7213BEAT7DB (DF)	65	120	46	1.5	1	108 000	107 000
7313BEAT7DB (DF)	65	140	66	2.1	1.1	176 000	154 000
7214BEAT7DB (DF)	70	125	48	1.5	1	117 000	117 000
7314BEAT7DB (DF)	70	150	70	2.1	1.1	191 000	175 000
7215BEAT7DB (DF)	75	130	50	1.5	1	122 000	127 000
7315BEAT7DB (DF)	75	160	74	2.1	1.1	207 000	197 000
7216BEAT7DB (DF)	80	140	52	2	1	136 000	140 000
7316BEAT7DB (DF)	80	170	78	2.1	1.1	223 000	220 000

Consult with NSK for 3-row arrangements of DBD or DFD. Axial internal clearance (μm)

Bearing Maintenance and Inspection

Maintenance

Bearings and operating conditions must be periodically inspected and maintained to maximize bearing life, to prevent mechanical failure, ensure reliable operation, raise productivity, and enhance cost performance.

Maintenance should be performed regularly according to work standards that may vary according to machine operating conditions. Operating conditions should be monitored, lubricant replenished or changed, and the machine periodically disassembled and overhauled.

1. Inspection under operating conditions

Review lubricant properties, check operating temperatures, and inspect for any vibrations and bearing noise to determine bearing replacement periods and replenishment intervals of the lubricant.

2. Inspection of the bearing

Be sure to thoroughly examine the bearings during periodic machine inspections and part replacement. Check the raceway for any damage and confirm if the bearing can be reused or should be replaced.

Inspection points

Items to be checked while the machine is running should include bearing noise, vibrations, temperature, and lubricant condition.

1. Bearing noise

Sound detection instruments can be used during operation to ascertain the volume and characteristics of bearing rotation noise through sound patterns that are readily distinguishable, which can reveal the presence of bearing damage such as slight flaking. Three typical noise conditions are described in Table 1.

2. Bearing vibration

Bearing irregularities can be analyzed by performing a quantitative analysis of vibration amplitude and frequency using a frequency spectrum analyzer. Measured data varies depending on the operating conditions of the bearing and the location of the vibration pick-up. Therefore, this method requires the determination of evaluation standards for each measured machine.

Table 1. Bearing irregularity causes and countermeasures

Irregularities		Possible causes	Countermeasures
Noise	Loud metallic sound	Abnormal load	Improve the fit, internal clearance, preload, or position of housing shoulder.
		Incorrect mounting	Improve machining accuracy, alignment accuracy or mounting accuracy of shaft and housing, or use the correct mounting method.
		Insufficient or improper lubricant	Replenish the lubricant or select another lubricant.
	Loud regular sound	Contact of rotating parts	Modify the labyrinth seal, etc.
		Flaws, corrosion, or scratches on raceways caused by foreign matter	Replace or clean the bearing, improve sealing conditions, or use clean lubricant.
		Brinelling	Replace the bearing and use care when handling.
	Irregular sound	Flaking on raceway	Replace the bearing.
		Excessive clearance	Improve the fit, clearance, or preload.
		Contamination by foreign particles	Replace or clean the bearing, improve the seals, and use clean lubricant.
Abnormal temperature rise	Flaws or flaking on balls	Replace the bearing.	
	Excessively small clearance	Improve the fit, clearance, or preload.	
	Excessive amount of lubricant	Reduce amount of lubricant and select stiffer grease.	
	Insufficient or improper lubricant	Replenish lubricant or select a proper one.	
	Abnormal load	Improve the fit, internal clearance, preload, or position of housing shoulder.	
Vibration (Axial runout)	Incorrect mounting	Improve machining accuracy, alignment accuracy or mounting accuracy of shaft and housing, or use the correct mounting method.	
	Creep on fitted surface, or excessive seal friction	Correct the seals, replace the bearing, and correct the fitting or mounting.	
	Brinelling	Replace the bearing, and use care when handling bearings.	
Leakage or discoloration of lubricant	Flaking	Replace the bearing.	
	Incorrect mounting	Correct the squareness between the shaft and housing shoulder or side of spacer.	
Leakage or discoloration of lubricant	Penetration of foreign particles	Replace or clean the bearing components and improve sealing.	
	Too much lubricant, or contamination by foreign matter or wear debris	Reduce the amount of lubricant. Select a stiffer grease. Replace the bearing or lubricant. Clean the housing and adjacent parts.	

Running Traces and Applied Loads

As the bearing rotates, the raceways of the inner ring and the outer ring make contact with the rolling elements. This results in a darkening of both the rolling elements and raceways. It is normal for the running trace to be marked on the raceway, and the extent and shape of this running trace provides a useful indication of loading conditions.

It is possible to determine from careful observation of the running traces whether the bearing is carrying a radial load, a large axial load, or a moment load, or if there is extreme

rigidity variations of the housing. Unexpected load applied on the bearing or excessive mounting error or the like can also be determined, providing a clue to the investigation of causes for bearing failure.

Typical running traces of deep groove ball bearings are shown in Fig. 1, and representative running traces of roller bearings are shown in Fig. 2.

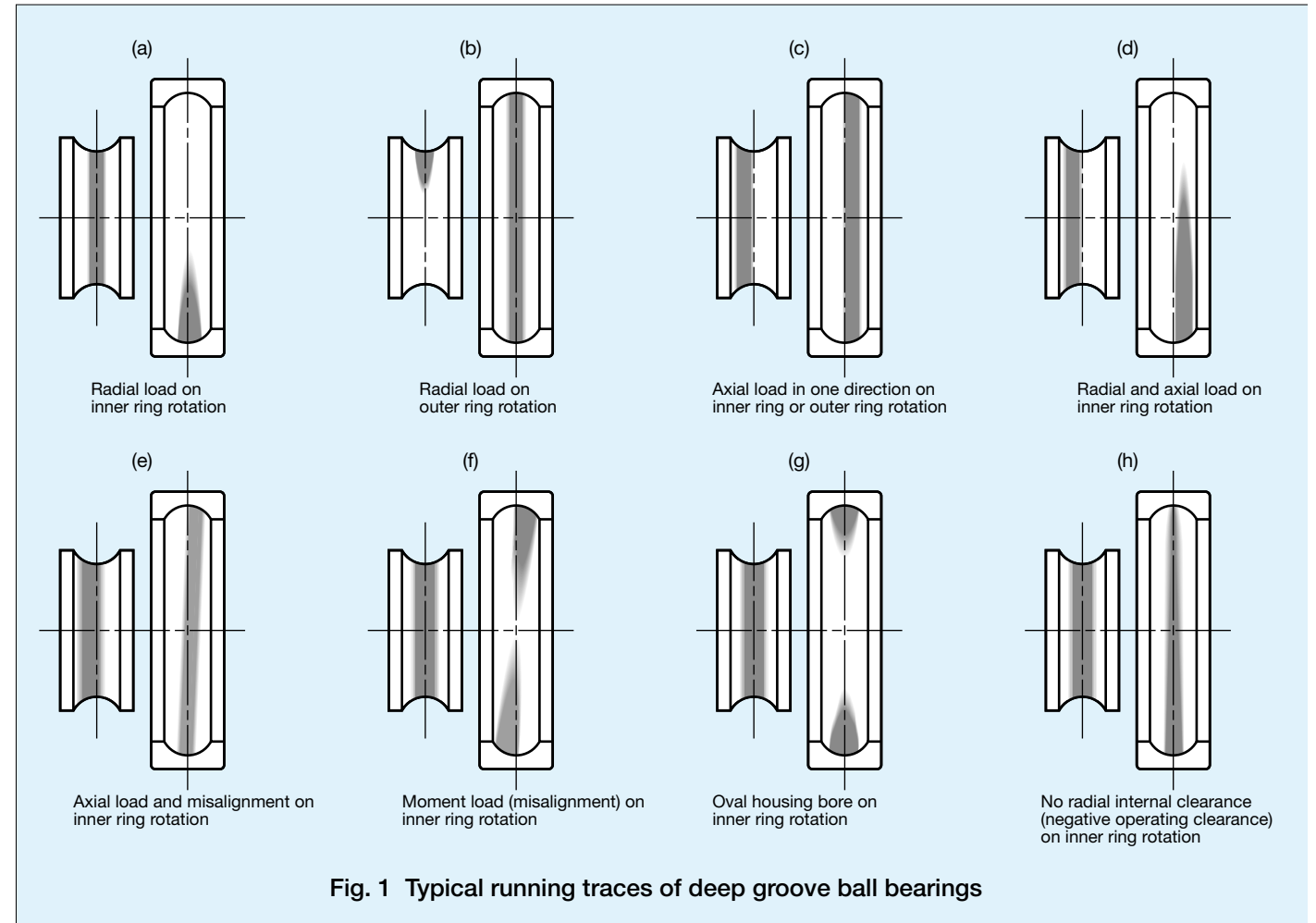


Fig. 1 Typical running traces of deep groove ball bearings

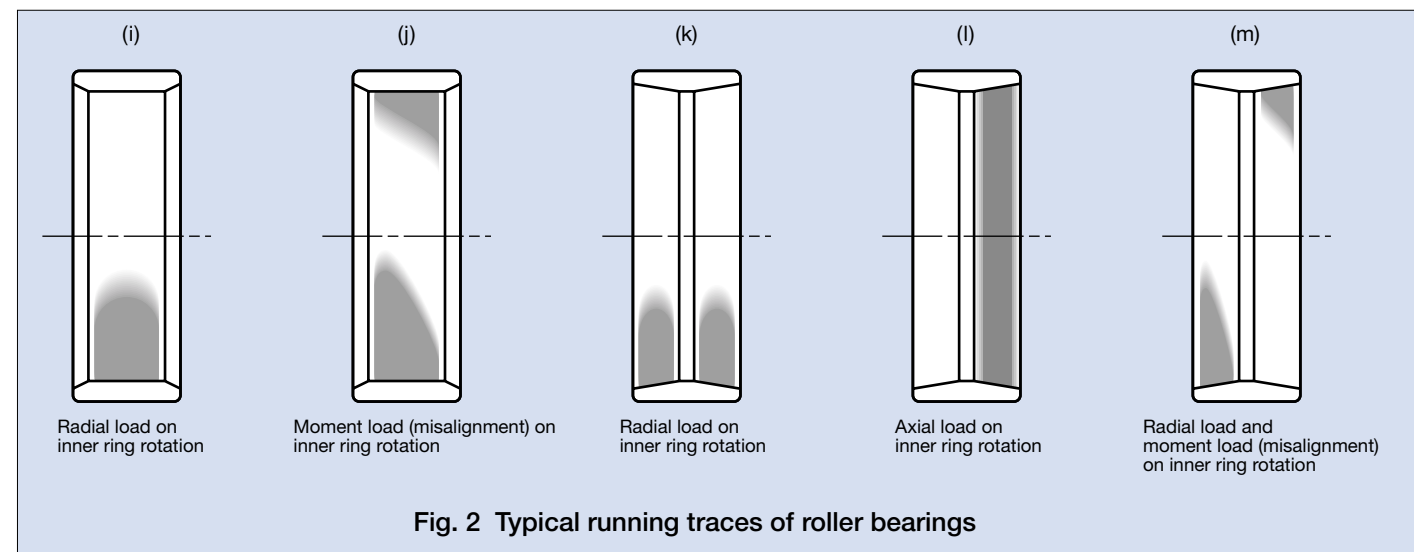


Fig. 2 Typical running traces of roller bearings

Bearing Damage and Countermeasures

Flaking



Location	Possible cause	Countermeasures
Suction side and discharge side of male/female rotor shaft	<ul style="list-style-type: none"> Excessive load Incorrect mounting Unsuitable bearing clearance 	<ul style="list-style-type: none"> Check load conditions Improve mounting method Reconfirm bearing internal clearance

Cage damage



Location	Possible cause	Countermeasures
Suction side and discharge side of male/female rotor shaft	<ul style="list-style-type: none"> Incorrect mounting Large moment load Improper lubrication 	<ul style="list-style-type: none"> Improve mounting method Improve lubricant and lubrication method

Smearing



Location	Possible cause	Countermeasures
Suction side and discharge side of male/female rotor shaft	<ul style="list-style-type: none"> High speed and light load Improper lubricant 	<ul style="list-style-type: none"> Improve bearing internal clearance Improve lubricant

Creep



Location	Possible cause	Countermeasures
Suction side and discharge side of male/female rotor shaft	<ul style="list-style-type: none"> Insufficient interference 	<ul style="list-style-type: none"> Improve interference Use proper tightening torque

Fretting

