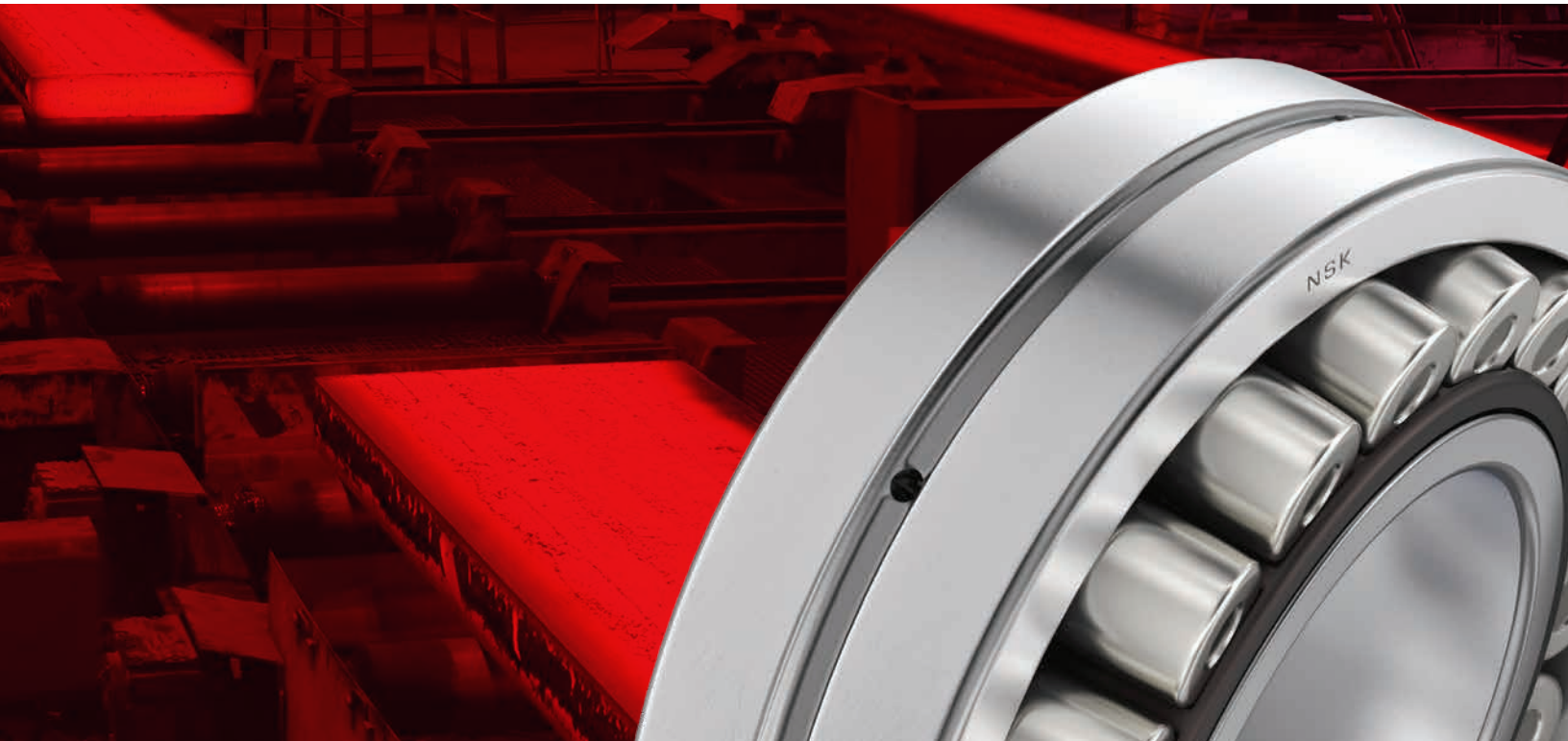


NSK

SWR™ SERIES SPHERICAL ROLLER BEARINGS

WEAR-RESISTANT SOLUTIONS FOR CONTINUOUS CASTING MACHINES



STAY IN MOTION. STAY IN CONTROL.



MADE WITH METTLE

BEARINGS FOR STEEL AND METALS MACHINERY

Massive loads. Intense heat. Extreme high speeds, ultra-low speeds, and everything in between. Staggering shock loads, misalignment, and contamination from mill scale and water vapor. From primary iron and steel making through rolling and forming mills, the operating conditions of the entire process are severe. The reliable, uninterrupted performance of rolling components is critical for accelerated production. For NSK, our product development and design is focused squarely on withstanding the manifold operating stresses of these applications with:

- › increasing capacities for high loads and high speeds
- › advanced materials for durability, wear resistance and longer life
- › lubrication and seal technology for smooth and clean running

Our product solutions are designed to optimize the performance of machinery and equipment, to assure predictable reliability and to deliver total cost-efficiency.

CONTINUOUS DURABILITY BY DESIGN

Spherical roller bearings used in guide rolls of continuous casting machines operate under extremely severe conditions and suffer from wear that would not normally occur under most other operating conditions.

Heavy loads at ultra-low speeds. Debris and water contamination. Roll bending stress. All of the ingredients for a short bearing life. In the worst cases, bearing fracture.

With extreme durability and core toughness, NSK SWR™ Spherical Roller Bearings are engineered to deliver superior resistance to wear and the onset of progressive bearing damage - promoting longer operating life and reducing unplanned maintenance downtime.



DESIGN AND OPERATING ADVANTAGES

NSK's SWR™ series spherical roller bearings are ideally designed for continuous casting machine applications, extending segment life and optimizing maintenance interval efficiencies with superior resistance to progressive wear and a longer operating life.



DESIGN FEATURES

- › Optimized, high capacity internal design
- › Outer rings manufactured with proprietary SWR steel composition and heat-treatment process
- › With wear-resistant surface treated pressed steel and heavy-duty machined brass cages
- › Dimensional series 213, 222, 223, 230, 231, 232, 240 and 241
- › For shaft diameters from 40 to 240 mm; additional series / sizes are available on request
- › Radial internal clearances C-normal, C3 and C4

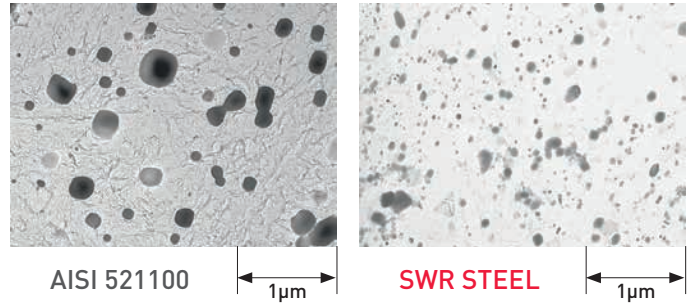
HIGH PERFORMANCE FACTOR: SWR STEEL

SWR™ Spherical Roller Bearings are the result of dedicated research efforts to extend bearing life through leading edge bearing material and heat treatment technologies. The outcome is an application-optimized solution that effectively contends with the unique operating challenges of continuous casting machines.

NSK utilizes carbide technology in conjunction with a special alloy to achieve our proprietary SWR bearing steel. Through advanced carbonitriding, precipitation of hard and fine-grained carbonitrides is attained - significantly finer than that found in conventional material such as AISI 52100 steel. Excellent wear resistance is achieved by consistent concentration in the material composition.

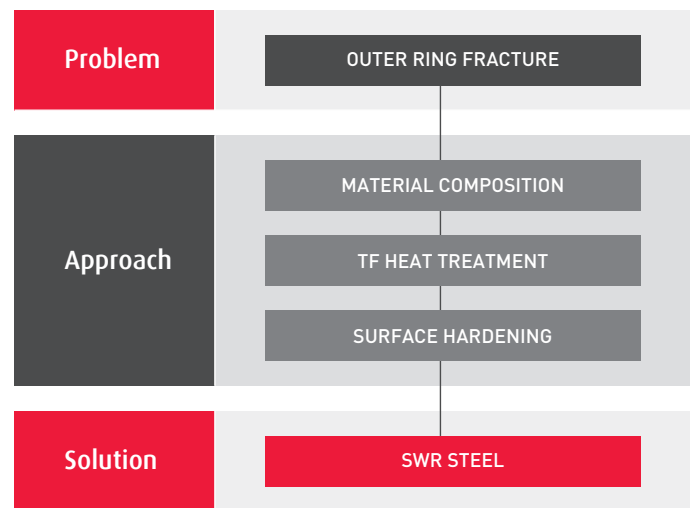
NSK Tough Steel (TF) heat-treatment technology is employed to optimize retained austenite in the material to reduce stress concentrations. This augments the wear resistance properties of the material with superior flaking life under contaminated lubrication conditions.

Finally, surface-hardening of SWR bearing steel dramatically increases core toughness, with considerably greater resistance to fracturing compared with through hardened conventional steel.



Microstructure: SWR v. AISI 52100

Material photos are the result of P-extraction replica work using transmission electron microscopy (TEM)



PROVEN ADVANTAGES

- › Superior wear resistance – 3 times that of conventional bearing steel
- › Improved flaking life property – 5 times that of conventional bearing steel
- › Higher toughness of material core (prevention of crack damage) – 5 times that of conventional bearing steel
- › Improved bearing durability extends segment roll operation, reducing maintenance costs and preventing unplanned downtime

BEARING FAILURE IN CONTINUOUS CASTING GUIDE ROLLS

IDENTIFICATION OF THE FAILURE MECHANISM

Spherical roller bearings for guide rolls operate under extreme conditions, and suffer from wear that would not otherwise occur. In the worst cases, bearings may even fracture.

The bearing operates at extremely low speed, suffering from the difficulty of drawing lubricant over the rolling contact surfaces. Matters are worsened by the entry of water and dust into the bearing interior. Wear occurs on the raceways due to differential slip of the rollers.

Stress concentration occurs at the pure rolling points with little wear, and surface originated flaking develops as a result.

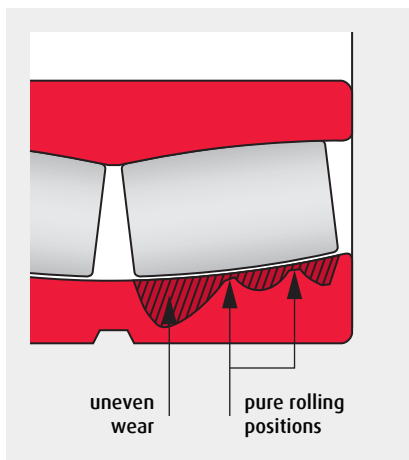
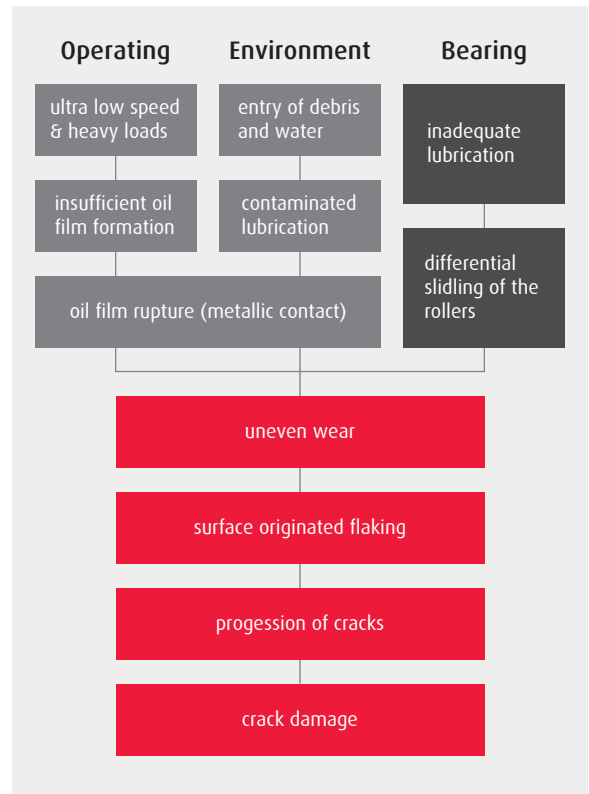
With increased flaking, vertical cracks are generated. Bending stresses acting on the outer ring propagates cracking to the point of fracture.



Pictured: outer ring wear

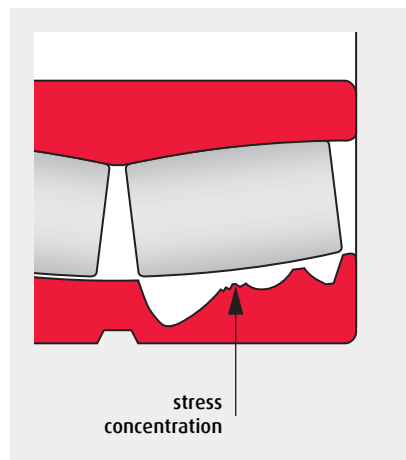


Pictured: outer ring flaking and crack damage.



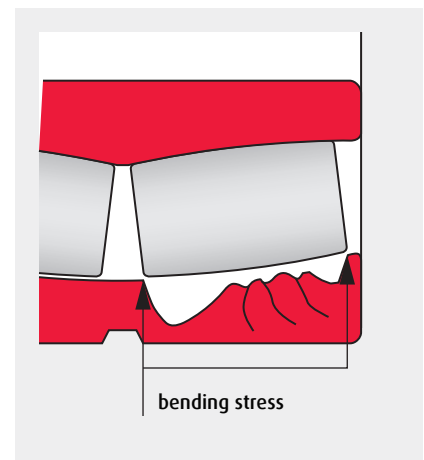
UNEVEN WEAR

Caused by improper lubrication and differential sliding of the rollers



SURFACE ORIGINATED FLAKING

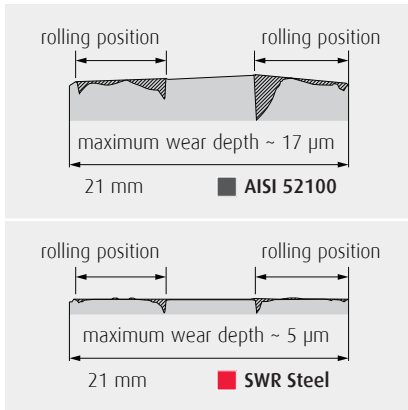
Due to stress concentration at the pure rolling positions with little wear



PROGRESSION OF CRACKS

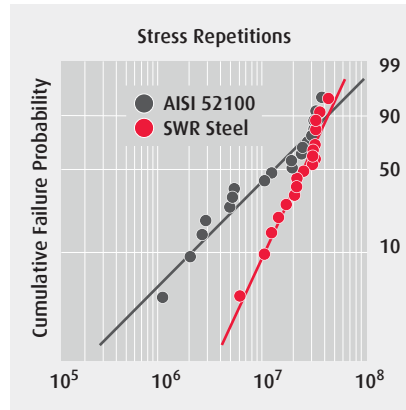
With fracture developing under the bending stress acting on the outer ring

IMPROVED WEAR RESISTANCE



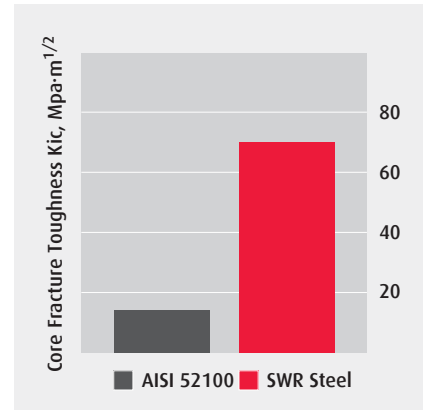
In durability testing conducted at ultra-low speed under water-infiltrated lubrication to simulate the environment of a continuous casting machine, SWR bearing steel demonstrates superior wear resistance – approximately three times that of conventional AISI 52100 steel.

IMPROVED FLAKING LIFE



When evaluating surface originated flaking under contaminated lubrication conditions using a thrust-type life tester, the high hardness achieved by carbonitriding and the reduced stress concentrations resulting from optimized retained austenite contribute to our SWR bearing steel demonstrating five times longer life than that of conventional steel.

IMPROVED CORE TOUGHNESS

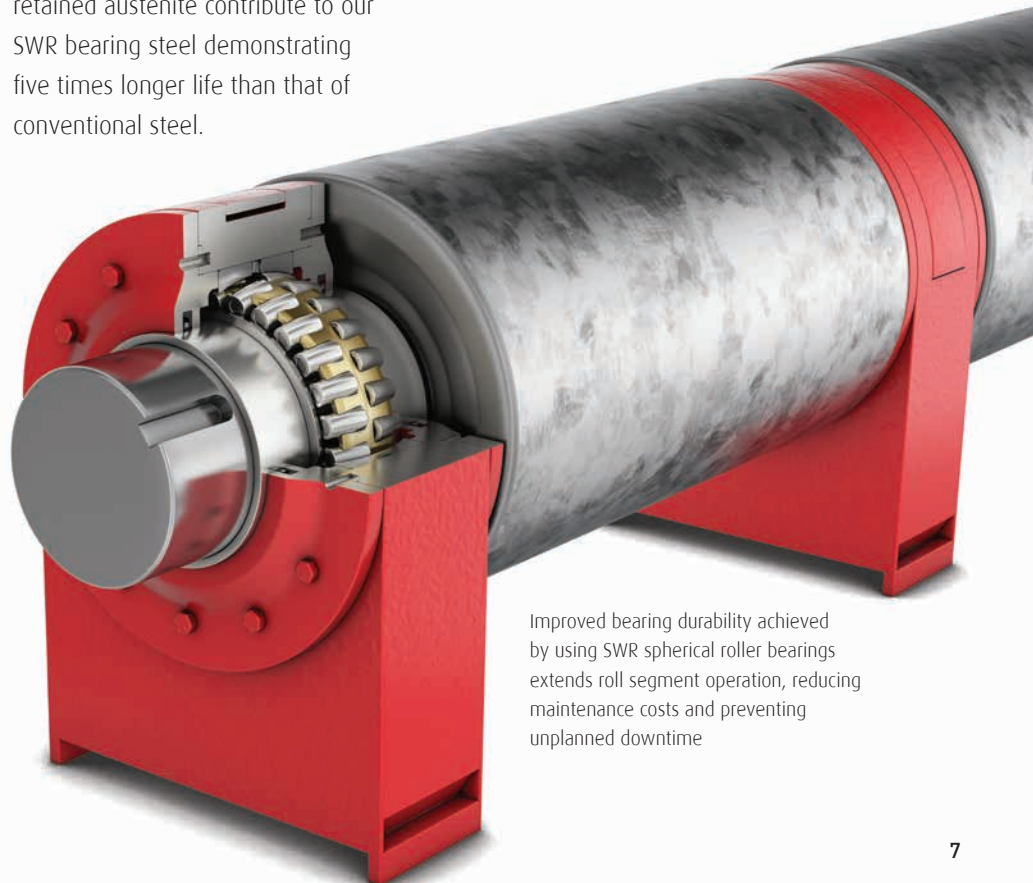


Results of core toughness tests show that fracture toughness derived from surface hardening of SWR bearing steel is five times that of conventional steel, making it more resistance to crack development and fracture.

3 TIMES
GREATER WEAR RESISTANCE

5 TIMES
LONGER FLAKING LIFE

5 TIMES
HIGHER CORE HARDNESS



Improved bearing durability achieved by using SWR spherical roller bearings extends roll segment operation, reducing maintenance costs and preventing unplanned downtime

THE REAL-WORLD IMPACT OF NSK OPTIMIZED BEARINGS

THE LOWER COSTS OF LONGER LIFE

Scheduled maintenance is prudent practice and an anticipated cost of business, but frequent and unplanned maintenance can have a devastating impact on productivity and the total cost of operation. With relentless pressure to accelerate production while simultaneously reducing cost-per-ton, successful producers look for greater machine efficiency and longevity in every process.

SWR™ spherical roller bearings allow users who have been burdened with replacing roll segments at frequent cycles to attain the benefits of extended uptime and reduced maintenance. They dramatically outperform and outlast conventional designs, mitigating unplanned maintenance and allowing rolls to operate to the full extent of their life.

Field Endurance Evaluation:

Average segment replacement cycles: 1

Standard Spherical Roller Bearings

Average segment replacement cycles: 1.6

Maximum: 2

SWR Spherical Roller Bearings

Above: Typical ratio of extended segment replacement cycles in roller apron and pinch roll segments

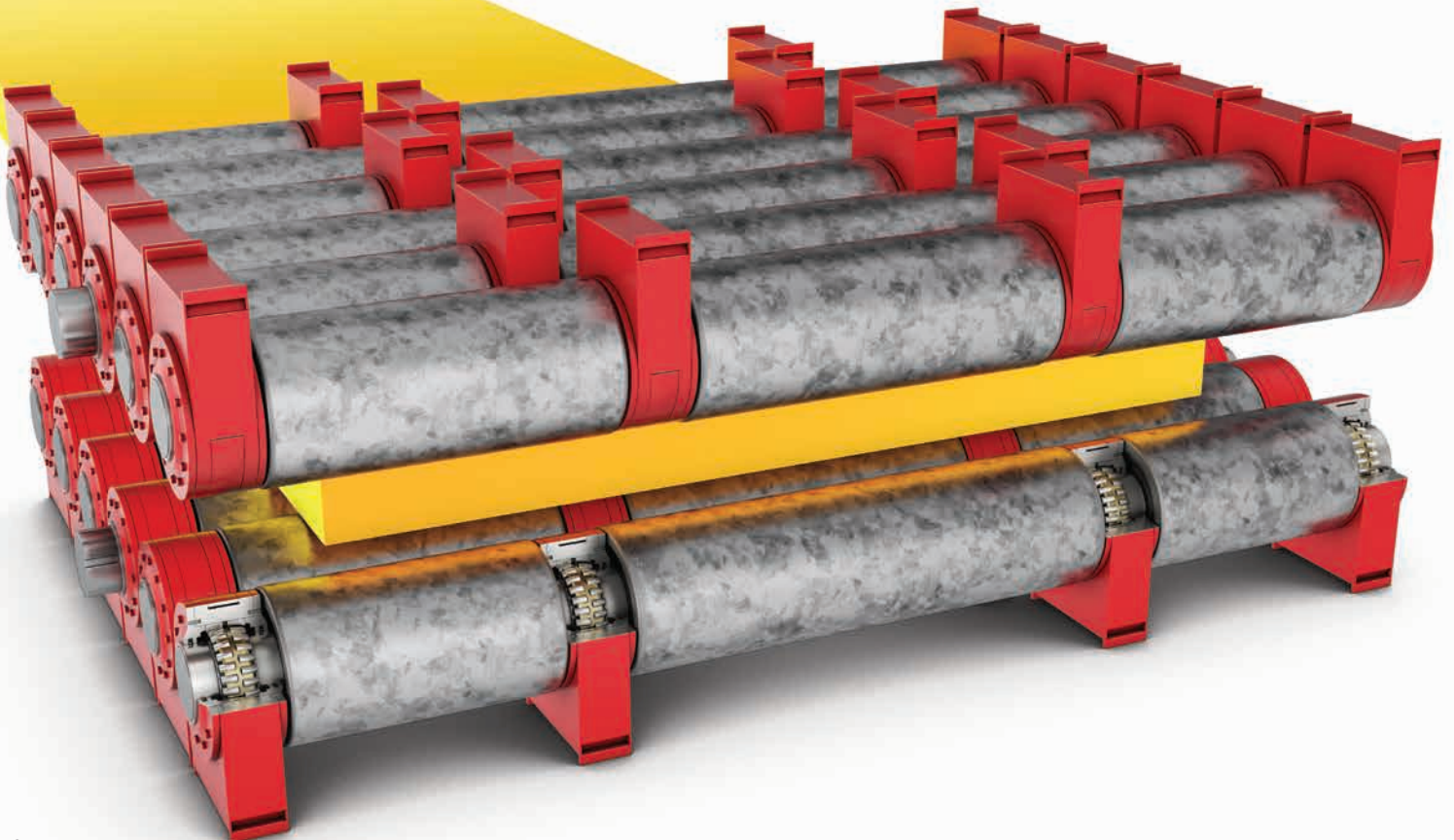


Fig. 1 - Bearing Arrangement For Single Rolls

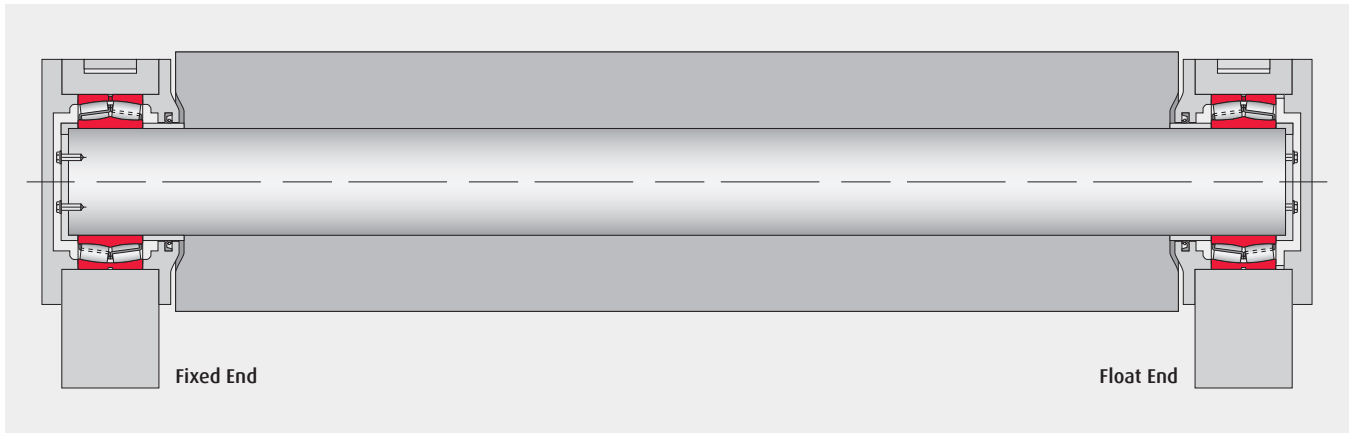


Fig. 2 - Bearing Arrangement For Combination Rolls

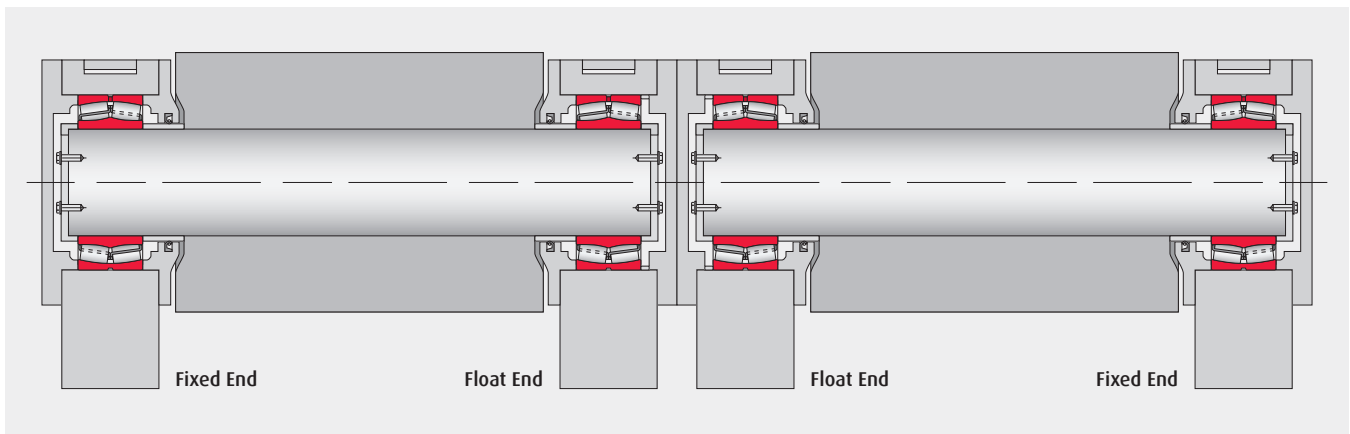
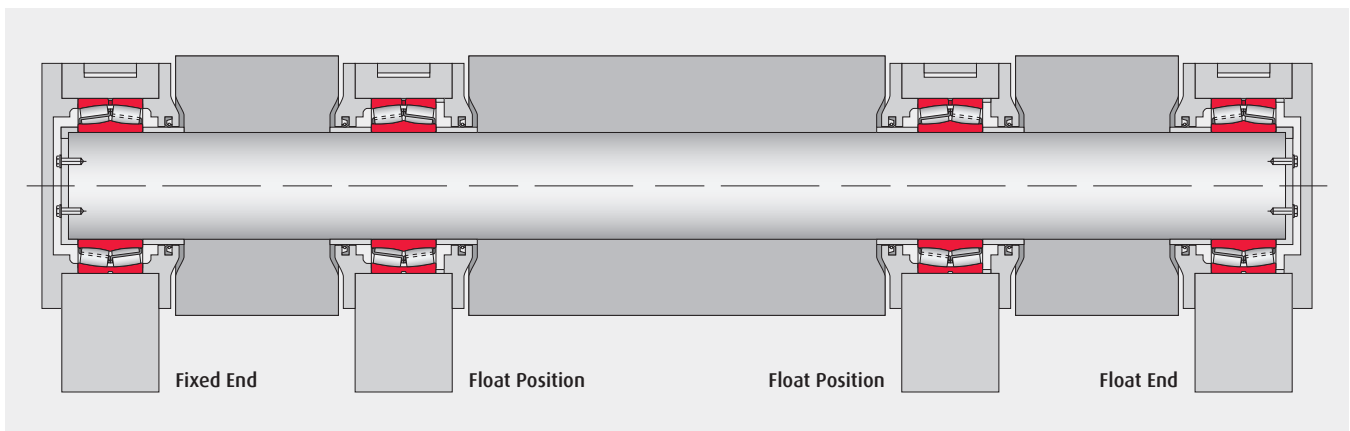
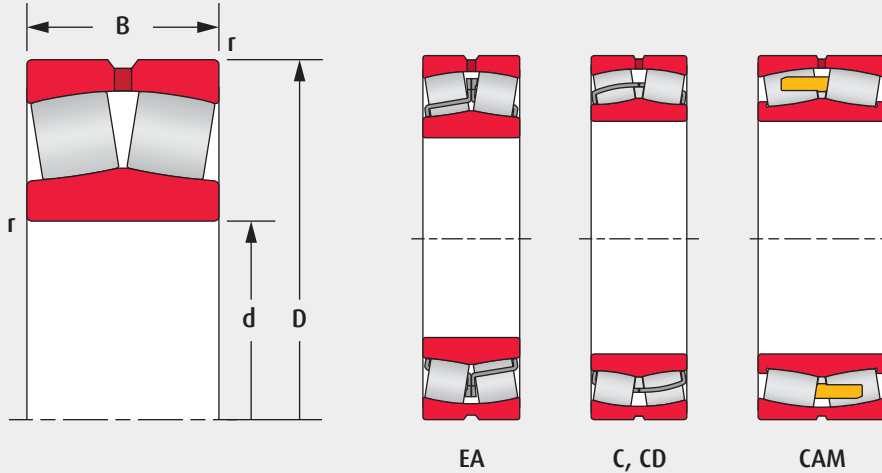


Fig. 3 - Bearing Arrangement For Segmented Rolls

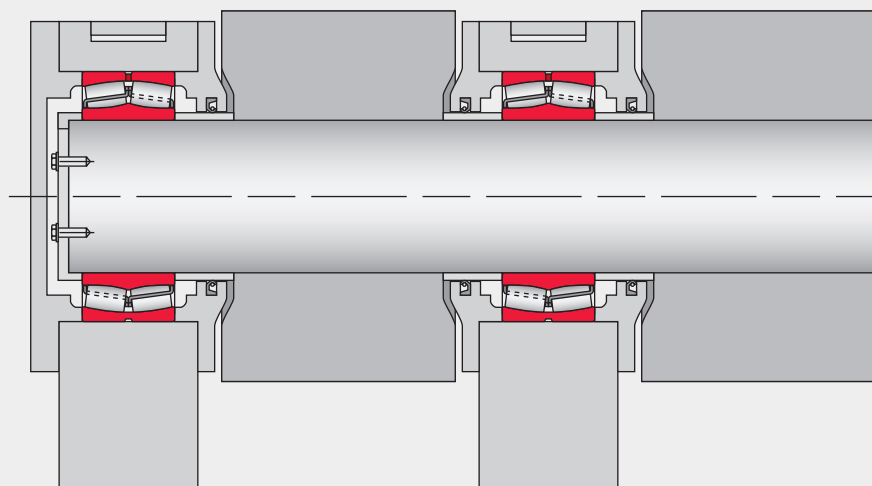


Additional and alternative bearing solutions are available for float positions; contact NSK.

BEARING DIMENSIONS AND OPERATING VALUES

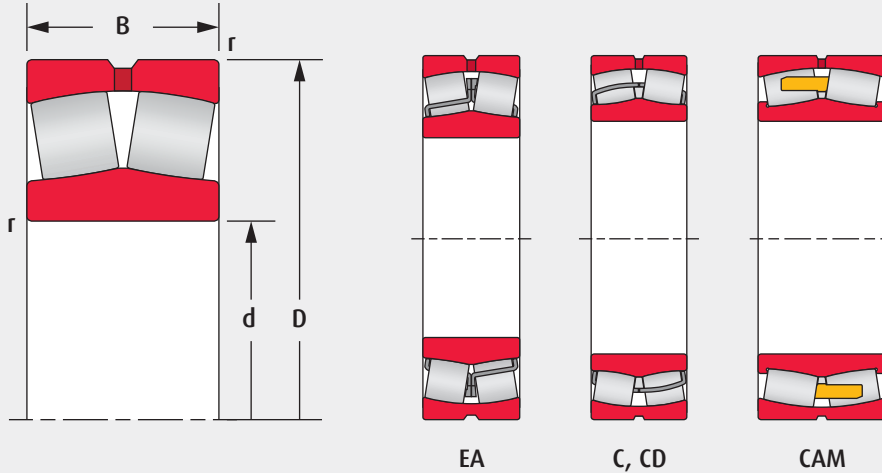


| BASIC BEARING NO. | BEARING DIMENSIONS | | | | BASIC LOAD RATINGS | | | |
|-------------------|--------------------|-----|------|---------|--------------------|---------|---------|---------|
| | mm | | | | N | | lbf | |
| | d | D | B | r (min) | Dynamic | Static | Dynamic | Static |
| 22208SWREA | 40 | 80 | 23 | 1.1 | 90 500 | 99 500 | 20 500 | 22 500 |
| 22308SWRCAM | | 90 | 33 | 1.5 | 136 000 | 153 000 | 30 500 | 34 500 |
| 22210SWREA | 50 | 90 | 23 | 1.1 | 99 000 | 119 000 | 22 500 | 27 000 |
| 22211SWREA | 55 | 100 | 25 | 1.5 | 119 000 | 144 000 | 27 000 | 32 500 |
| 21311SWREA | | 120 | 29 | 2.0 | 142 000 | 174 000 | 32 000 | 39 000 |
| 23012SWRC | 60 | 95 | 26 | 1.1 | 98 500 | 141 000 | 22 000 | 31 500 |
| 22212SWREA | | 110 | 28 | 1.5 | 142 000 | 174 000 | 32 000 | 39 000 |
| 21312SWREA | | 130 | 31 | 2.1 | 190 000 | 244 000 | 42 500 | 55 000 |
| 22312SWRCAM | | 130 | 46 | 2.1 | 246 000 | 288 000 | 55 500 | 64 500 |
| 22213SWRCAM | 65 | 120 | 31 | 1.5 | 152 000 | 190 000 | 34 000 | 42 500 |
| 22313SWRCAM | | 140 | 48 | 2.1 | 265 000 | 315 000 | 59 500 | 71 000 |
| 22214SWREA | 70 | 125 | 31 | 1.5 | 225 000 | 232 000 | 50 500 | 52 000 |
| 22215SWREA | 75 | 130 | 31 | 1.5 | 238 000 | 244 000 | 53 500 | 55 000 |
| 22216SWREA | 80 | 140 | 33 | 2.0 | 264 000 | 275 000 | 59 500 | 62 000 |
| 21316SWREA | | 170 | 39 | 2.1 | 355 000 | 375 000 | 80 000 | 84 500 |
| 22316SWRCAM | | 170 | 58 | 2.1 | 390 000 | 480 000 | 87 500 | 108 000 |
| 22217SWREA | 85 | 150 | 36 | 2.0 | 310 000 | 325 000 | 69 500 | 73 000 |
| 22218SWREA | 90 | 160 | 40 | 2.0 | 360 000 | 395 000 | 81 000 | 89 000 |
| 23218SWRC | | 160 | 52.4 | 2.0 | 340 000 | 490 000 | 76 500 | 110 000 |
| 22318SWREA | | 190 | 64 | 3.0 | 665 000 | 705 000 | 149 500 | 158 500 |
| 22219SWRCAM | | 95 | 170 | 43 | 2.1 | 296 000 | 395 000 | 66 500 |

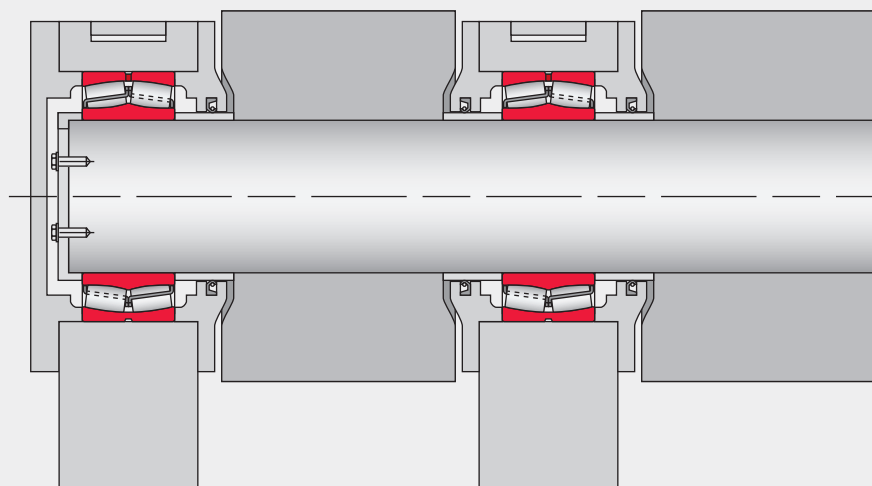


| BASIC BEARING NO. | BEARING DIMENSIONS | | | | BASIC LOAD RATINGS | | | |
|-------------------|--------------------|-----|----|---------|--------------------|-----------|---------|---------|
| | mm | | | | N | | lbf | |
| | d | D | B | r (min) | Dynamic | Static | Dynamic | Static |
| 23020SWRCD | 100 | 150 | 37 | 1.5 | 212 000 | 335 000 | 47 500 | 75 500 |
| 24020SWRC | | 150 | 50 | 1.5 | 276 000 | 470 000 | 62 000 | 105 500 |
| 24120SWRCAM | | 165 | 65 | 2.0 | 345 000 | 535 000 | 77 500 | 120 500 |
| 22220SWREA | | 180 | 46 | 2.1 | 455 000 | 490 000 | 102 500 | 110 000 |
| 23022SWRCAM | 110 | 170 | 45 | 2.0 | 293 000 | 465 000 | 66 000 | 104 500 |
| 24022SWRC | | 170 | 60 | 2.0 | 380 000 | 645 000 | 85 500 | 145 000 |
| 23122SWRCAM | | 180 | 56 | 2.0 | 480 000 | 630 000 | 108 000 | 141 500 |
| 24122SWRC | | 180 | 69 | 2.0 | 460 000 | 750 000 | 103 500 | 168 500 |
| 22222SWREA | 120 | 200 | 53 | 2.1 | 605 000 | 645 000 | 136 000 | 145 000 |
| 23024SWRCAM | | 180 | 46 | 2.0 | 395 000 | 525 000 | 89 000 | 118 000 |
| 24024SWRCAM | | 180 | 60 | 2.0 | 480 000 | 680 000 | 108 000 | 153 000 |
| 24124SWRCAM | | 200 | 80 | 2.0 | 695 000 | 905 000 | 156 000 | 203 500 |
| 22224SWRCAM | 130 | 215 | 58 | 2.1 | 490 000 | 690 000 | 110 000 | 155 000 |
| 23224SWRCAM | | 215 | 76 | 2.1 | 790 000 | 970 000 | 177 500 | 218 000 |
| 22324SWRCAM | | 260 | 86 | 3.0 | 845 000 | 1 120 000 | 190 000 | 252 000 |
| 23026SWRCD | | 200 | 52 | 2.0 | 400 000 | 655 000 | 90 000 | 147 000 |
| 24026SWRCAM | 130 | 200 | 69 | 2.0 | 620 000 | 865 000 | 139 500 | 194 500 |
| 24126SWRCAM | | 210 | 80 | 2.0 | 590 000 | 1 010 000 | 132 500 | 227 000 |
| 22226SWREA | | 230 | 64 | 3.0 | 820 000 | 940 000 | 184 500 | 211 500 |
| 23226SWRCAM | | 230 | 80 | 3.0 | 875 000 | 1 080 000 | 196 500 | 243 000 |

BEARING DIMENSIONS AND OPERATING VALUES

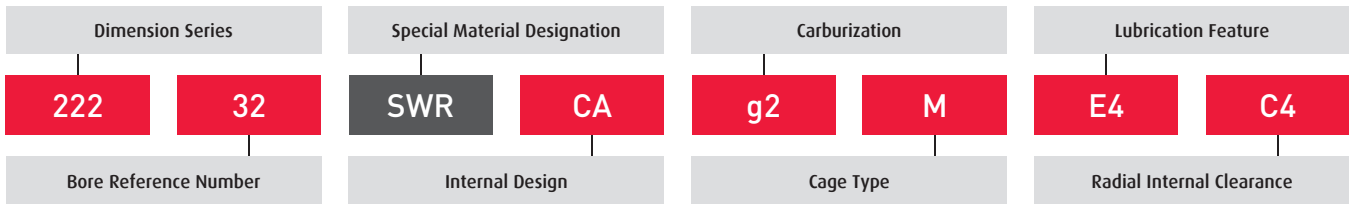


| BASIC BEARING NO. | BEARING DIMENSIONS | | | | BASIC LOAD RATINGS | | | |
|-------------------|--------------------|-----|-----|---------|--------------------|-----------|---------|---------|
| | mm | | | | N | | lbf | |
| | d | D | B | r (min) | Dynamic | Static | Dynamic | Static |
| 23028SWRCD | 140 | 210 | 53 | 2.0 | 420 000 | 715 000 | 94 500 | 160 500 |
| 24028SWRCAM | | 210 | 69 | 2.0 | 635 000 | 905 000 | 143 000 | 203 500 |
| 23128SWRCAM | | 225 | 68 | 2.1 | 725 000 | 945 000 | 163 000 | 212 500 |
| 24128SWRCAM | | 225 | 85 | 2.1 | 835 000 | 1 160 000 | 187 500 | 261 000 |
| 22228SWRCAM | | 250 | 68 | 3.0 | 835 000 | 945 000 | 187 500 | 212 500 |
| 23228SWRCAM | | 250 | 88 | 3.0 | 835 000 | 1 300 000 | 187 500 | 292 500 |
| 23030SWRCD | 150 | 225 | 56 | 2.1 | 470 000 | 815 000 | 105 500 | 183 000 |
| 24030SWRCAM | | 225 | 75 | 2.1 | 740 000 | 1 090 000 | 166 500 | 245 000 |
| 23130SWRC | | 250 | 80 | 2.1 | 725 000 | 1 180 000 | 163 000 | 265 500 |
| 24130SWRC | | 250 | 100 | 2.1 | 890 000 | 1 530 000 | 200 000 | 344 000 |
| 22230SWRCD | | 270 | 73 | 3.0 | 765 000 | 1 129 000 | 172 000 | 254 000 |
| 23230SWRC | | 270 | 96 | 3.0 | 975 000 | 1 560 000 | 219 000 | 350 500 |
| 23032SWRCD | 160 | 240 | 60 | 2.1 | 540 000 | 955 000 | 121 500 | 214 500 |
| 24032SWRCAM | | 240 | 80 | 2.1 | 845 000 | 1 260 000 | 190 000 | 283 500 |
| 24132SWRC | | 270 | 109 | 2.1 | 1 040 000 | 1 760 000 | 234 000 | 395 500 |
| 22232SWRCD | | 290 | 80 | 3.0 | 910 000 | 1 320 000 | 204 500 | 296 500 |
| 23034SWRCD | 170 | 260 | 67 | 2.1 | 640 000 | 1 090 000 | 144 000 | 245 000 |
| 24034SWRC | | 260 | 90 | 2.1 | 825 000 | 1 520 000 | 185 500 | 341 500 |
| 23134SWRCAM | | 280 | 88 | 2.1 | 940 000 | 1 570 000 | 211 500 | 353 000 |
| 24134SWRC | | 280 | 109 | 2.1 | 1 080 000 | 1 860 000 | 243 000 | 418 000 |
| 22234SWRCD | | 310 | 86 | 4.0 | 990 000 | 1 500 000 | 222 500 | 337 000 |
| 23234SWRC | | 310 | 110 | 4.0 | 1 200 000 | 1 910 000 | 270 000 | 429 500 |



| BASIC BEARING NO. | BEARING DIMENSIONS | | | | BASIC LOAD RATINGS | | | |
|-------------------|--------------------|-----|-----|---------|--------------------|-----------|---------|---------|
| | mm | | | | N | | lbf | |
| | d | D | B | r (min) | Dynamic | Static | Dynamic | Static |
| 23036SWRCD | 180 | 280 | 74 | 2.1 | 750 000 | 1 270 000 | 168 500 | 285 500 |
| 24036SWRCAM | | 280 | 100 | 2.1 | 1 210 000 | 1 750 000 | 272 000 | 393 500 |
| 23136SWRCAM | | 300 | 96 | 3.0 | 1 320 000 | 1 760 000 | 296 500 | 395 500 |
| 24136SWRCAM | | 300 | 118 | 3.0 | 1 490 000 | 2 040 000 | 335 000 | 458 500 |
| 22236SWRCD | | 320 | 86 | 4.0 | 1 020 000 | 1 540 000 | 229 500 | 346 000 |
| 23038SWRCAM | 190 | 290 | 75 | 2.1 | 970 000 | 1 350 000 | 218 000 | 303 500 |
| 24038SWRCAM | | 290 | 100 | 2.1 | 1 220 000 | 1 840 000 | 274 500 | 413 500 |
| 24138SWRCAM | | 320 | 128 | 3.0 | 1 710 000 | 2 330 000 | 384 500 | 524 000 |
| 22238SWRCAM | | 340 | 92 | 4.0 | 1 140 000 | 1 730 000 | 256 500 | 389 000 |
| 23238SWRC | | 340 | 120 | 4.0 | 1 440 000 | 2 350 000 | 323 500 | 528 500 |
| 23040SWRCAM | 200 | 310 | 82 | 2.1 | 1 180 000 | 1 700 000 | 265 500 | 382 000 |
| 24040SWRCAM | | 310 | 109 | 2.1 | 1 420 000 | 2 120 000 | 319 000 | 476 500 |
| 24140SWRCAM | | 340 | 140 | 3.0 | 1 960 000 | 2 660 000 | 440 500 | 598 000 |
| 22240SWRCAM | | 360 | 98 | 4.0 | 1 300 000 | 2 010 000 | 292 500 | 452 000 |
| 23044SWRCAM | 220 | 340 | 90 | 3.0 | 1 360 000 | 1 980 000 | 305 500 | 445 000 |
| 24044SWRCAM | | 340 | 118 | 3.0 | 1 310 000 | 2 490 000 | 294 500 | 560 000 |
| 24144SWRCAM | | 370 | 150 | 4.0 | 1 800 000 | 3 200 000 | 404 500 | 719 500 |
| 22244SWRCAM | | 400 | 108 | 4.0 | 1 570 000 | 2 430 000 | 353 000 | 546 500 |
| 23244SWRC | | 400 | 144 | 4.0 | 2 010 000 | 3 400 000 | 452 000 | 764 500 |
| 24048SWRCAM | 240 | 360 | 118 | 3.0 | 1 730 000 | 2 730 000 | 389 000 | 613 500 |
| 24148SWRCAM | | 400 | 160 | 4.0 | 2 660 000 | 3 800 000 | 598 000 | 854 500 |

DESIGNATION SYSTEM



| DESIGNATION | ATTRIBUTE | |
|-------------------------------------|-----------|---|
| Dimensional Series | 213 | extra heavy duty type |
| | 222 | medium duty type |
| | 223 | heavy duty type |
| | 230 | very light duty type |
| | 231 | light duty type |
| | 232 | medium duty type, wide |
| | 240 | very light duty type, wide |
| | 241 | light duty type, wide |
| Bore Reference Number | | multiply x 5 for bore diameter in mm; 500 mm and greater expressed with a "/" eg. /500 = 500 mm |
| Special Material Designation | SWR | Super Wear Resistant material technology |
| Internal Design | EA | high capacity design, steel cage |
| | CA | high capacity design, brass cage |

| DESIGNATION | ATTRIBUTE | |
|----------------------------------|-----------|--|
| Carburization | g | complete bearing |
| | g2 | outer ring |
| | g5 | inner and outer ring |
| Cage Type | blank | two piece steel cage |
| | CD | two piece steel cage with guide ring |
| | M | machined brass cage with guide ring |
| Lubrication Features | blank | no lubrication features |
| | E3 | lubrication holes in the outer ring |
| | E4 | lubrication groove and holes in the outer ring |
| Radial Internal Clearance | blank | normal clearance |
| | C3 | greater than normal clearance |
| | C4 | greater than C3 |



IMPROVEMENT PAYS

END-TO-END SERVICE DELIVERS CUSTOMER SUCCESS

Improvement never ends. And we never stop looking for better ways to support our customers in a complete, collaborative and continuous way. The focus of NSK isn't simply on a quick fix for immediate gain – it's about incremental and sustainable improvement to deliver long-term benefits. When NSK is on-site, we're there to understand our customers' challenges and identify problems contributing to frequent bearing replacement, breakdowns caused by poor specification, high energy costs from inefficient product selection and lost production because of downtime. We collaborate with our customers to institute an Asset Improvement Program (AIP) that encompasses process and maintenance management, diagnostic and educational support to deliver measurable gains in output and cost-efficiency. With NSK, our customers embark on a critical path to realizing improvements in equipment, productivity, people and financial performance.





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