SKF

SKF sealed spherical roller bearings increase profits and environmental welfare

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Made by SKF® stands for excellence. It symbolises our consistent endeavour to achieve total quality in everything we do. For those who use our products, “Made by SKF” implies three main benefits.

Reliability – thanks to modern, efficient products, based on our worldwide application know-how, optimised materials, forward-looking designs and the most advanced production techniques.

Cost effectiveness – resulting from the favourable ratio between our product quality plus service facilities, and the purchase price of the product.

Market lead – which you can achieve by taking advantage of our products and services. Increased operating time and reduced down-time, as well as improved output and product quality are the key to a successful partnership.

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Economic and reliable

Sealed spherical roller bearings are characterised by several valuable properties. They are:

- sealed at both sides with rubbing seals which retain grease in the bearing;
- protected against contamination and moisture;
- ready to mount and normally maintenance-free;
- not susceptible to normal angular misalignment and shaft alignment errors;
- capable of carrying heavy loads.

Due to the integral seals and the incorporated grease fill, they are able to:

- allow simpler as well as space-saving bearing arrangements, thus saving total costs;
- provide long service life and high reliability with minimal maintenance requirements.

Of particular and ever-increasing importance is that sealed spherical roller bearings are environmentally friendly and conserve resources.

Sealed spherical roller bearings are ideal especially for bearing positions where, because of limited space or for cost reasons, sufficiently effective external seals cannot be provided.

Why sealed spherical roller bearings from SKF?

Quite simply because of the expertise behind the efficient seals.

In 1919, SKF invented the spherical roller bearing. SKF has continued to further develop and refine the design including the way it is sealed. The best proof of the total quality of SKF spherical roller bearings is their success. Twice as many SKF spherical roller bearings are used today as those of any other bearing manufacturer.

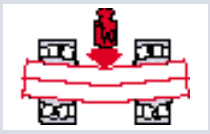
SKF spherical roller bearings are state-of-the-art products. They are the subject of a continuous improvement process designed to further enhance performance and reliability with the aim of conquering new and even more demanding applications.

SKF is active worldwide to fulfil its responsibilities and as a consequence, many bearing arrangement problems can be solved using SKF standard bearings, where otherwise expensive special bearings would have been required.

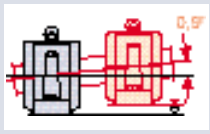
The development of the sealed spherical roller bearing has followed the SKF tradition. High demands on sealing efficiency and operational reliability had to be fulfilled. The seals have been extensively tested both in the laboratory and in the field and have proven their reliable performance and efficiency.

The use of SKF sealed spherical roller bearings will provide the following benefits:

- **Very high combined load carrying capacity**
  Both radial and axial as the internal geometry of the bearings corresponds to that of the open (unsealed) bearings.
- **Wide range of application**
  Two different seal variants and two different greases can be supplied – for normal and for high operating temperatures.
- **Long service life**
  Proven design, appropriate greases and efficient sealing make this possible.
- **Minimum maintenance requirements**
  Highly efficient seals keep contaminants and moisture out and the grease in.
- **Better for the environment**
  The bearings are normally maintenance-free. This reduces grease consumption and conserves resources – also for the user.



Rugged



Tolerant to alignment errors

Resistant to elevated temperatures

Solid contaminants excluded

Moisture cannot enter

Always operationally reliable

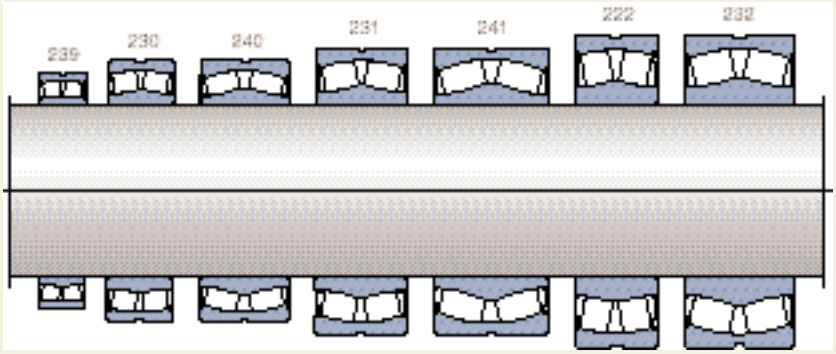
A wide assortment range

The SKF range of sealed spherical roller bearings comprises bearings with cylindrical bore for shaft diameters of 40 to 220 mm from seven different bearing series. Bearings with tapered bore can be produced to special order.

SKF sealed spherical roller bearings, depending on series and size, are produced in the E or the CC design. The sealed bearings of the CC design generally have the same boundary dimensions as the corresponding open bearings.

The seals have been specially developed for the spherical roller bearings and effectively prevent contaminants from penetrating to the rolling contact area. This is not only true in operation, but also during bearing installation, resulting in long service life.

Two particularly suitable greases have been chosen for the bearings. One is an SKF grease recommended for normal operating temperatures. The other, a special high-temperature grease, is used in combination with fluoro rubber seals for high-temperature operation.



Unique design features

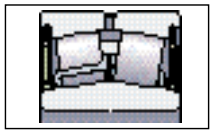
The design of SKF sealed spherical roller bearings corresponds to that of the open (unsealed) standard bearings, and incorporates the same unique design features. These include:

- symmetrical rollers with special profile;
- self-guiding rollers – an SKF patent;
- floating guide ring between the two rows of rollers;
- bearing components dimensionally stabilised for high temperatures and
- window-type steel cages.

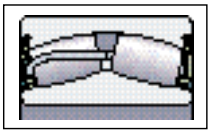
Additional features of the SKF sealed spherical roller bearings include:

- double-lip, sheet steel reinforced seals and
- a grease appropriate to the operating conditions.

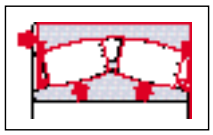
The result is a ready-to-mount, lubricated-for-life bearing unit with a long service life and which normally only requires the same space as a standard open bearing. The advantages include a simplification of the bearing arrangement design, and the option to downsize the arrangement. Equipment for relubrication is not required, there is no waste grease in cooling water systems, and there are no disposal costs for used grease.



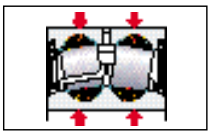
E design
The bearings have symmetrical rollers, two window-type steel cages centred on the inner ring, a flangeless inner ring and a floating guide ring between the two roller rows.



CC design
The bearings have symmetrical rollers, two window-type steel cages, a flangeless inner ring and a floating guide ring between the two roller rows. The guide ring, which is centred on the inner ring, also guides the cages.

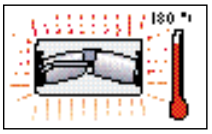


Very high load carrying capacity
The symmetrical rollers position themselves automatically so that the load is evenly distributed over the whole roller length. This results in very high load carrying capacity.



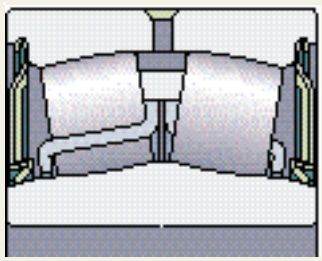
No edge stresses
Because of the special roller profile there is virtually no danger of edge stresses.

Low friction and low heat generation
The patented self-guidance of the rollers and the floating guide ring, which guides the rollers axially through the unloaded zone, keep friction and heat generation down.

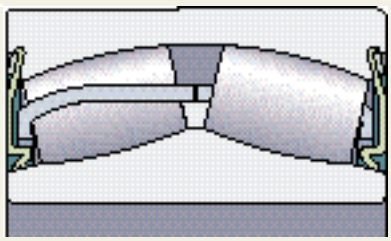


Little risk of ring breakage
High-strength, dimensionally stabilised bearing rings minimise the risk of breakage. They also allow the bearings to perform well even at very high temperatures up to +180 °C (356 °F).

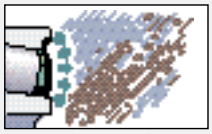
E design



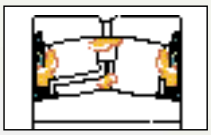
CC design



Light-weight, high-strength cages
The window-type steel cages are light but very stable and wear-resistant. They take up very little space so that an ample supply of grease can be contained in the bearing.



Well protected
The bearings have a sheet steel reinforced double-lip seal at each side. The seals are made of nitrile rubber or fluoro rubber. The nitrile rubber seals are for normal operating conditions and can operate at high speeds. The fluoro rubber seals are for high temperatures and primarily intended for low speed operation.



Well lubricated
Bearings with nitrile rubber seals for normal operating temperatures and reasonable speeds are lubricated with an SKF lithium base grease with good rust inhibiting properties. The bearings for high temperature use have fluoro rubber seals and are lubricated with a high-temperature polyurea base grease.

Where economy is desirable

Long service life, high reliability, minimum maintenance and compact arrangement design have fuelled high demand for SKF spherical roller bearings throughout industry. One prime example is the steelmaking industry. The demands made on bearings when steel is produced include extremely heavy loads, high temperatures and high contamination (water, dirt, scale and coolant additives) – all factors which can be minimised when the correct bearings and seals are used.

Applications

- Metallurgical
- Mining & construction
- Pulp & paper
- Fluid machinery
- Materials handling
- Industrial gearboxes
- Textile
- Robotics
- Railways

Requirements

- Long service life
- High load carrying capacity
- Insensitive to angular misalignments and other errors of alignment
- Minimum maintenance
- Reduced operating costs
- Improved environment

Solution

Instead of tonnes of grease – freedom from maintenance

Normally a continuous casting plant requires 10 to 100 tonnes of grease to protect the bearings.

Sealed spherical roller bearings enable a maintenance-free solution. The bearings are filled with a high-performance, high-temperature grease which does not have to be renewed. And, although the bearings have integral rubbing seals, the bearings have the same high load carrying capacity as their unsealed counterparts.

Reduce costs with the SKF Trouble-Free Operation™ programme

Today's tough competition makes it critical to utilise manufacturing plants and machines to their fullest. Proper bearing maintenance will help keep equipment running, but this requires foresight, planning and the use of the best available bearing accessories, mounting/dismounting methods and tools, and maintenance equipment.

SKF provides all the products and services needed to achieve maximum equipment uptime, through the SKF Trouble-Free Operation programme. The benefits include reduced spare part stores, minimised unplanned stops, and reduced repair downtime.

SKF service engineer on site

Single source for all bearings

SKF mounting and dismounting tools

The programme offers:

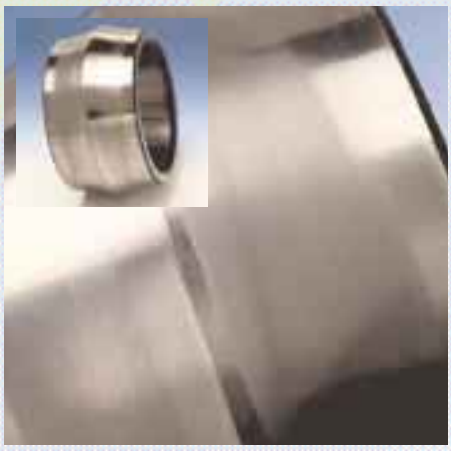
- high quality bearings and accessories, whenever and wherever they are needed;
- top-of-the-line mounting/dismounting tools, monitoring equipment, seals and lubricants;
- efficient and meaningful mounting/dismounting and maintenance training and
- advanced application engineering services locally and worldwide.

More information about the SKF Trouble-Free Operation programme concept will be supplied on request from your local SKF sales office or sales representative.

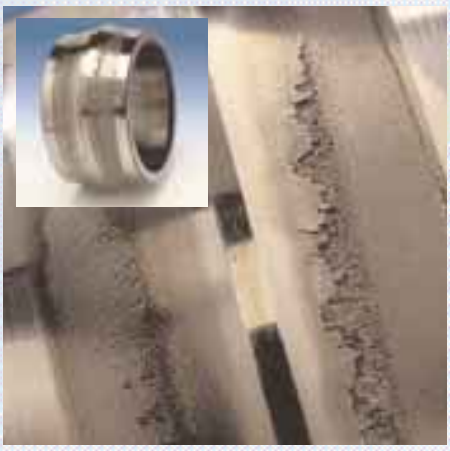
Expert advice from the SKF application engineering service

Practical SKF seminars cover all there is to know about mounting and maintaining rolling bearings

Particles in the lubricant
Dirt in the bearing will damage both raceways and rollers. The bearing will work, but scaling will soon start at one of the indentations resulting in breakdown. Proper external seals, clean lubricant and a clean assembly process provide effective protection from this type of bearing damage. However, the best and simplest method is to use SKF sealed spherical roller bearings.



Insufficient lubricant
Inadequate lubrication will cause wear on the surfaces subjected to load. Subsequent stress concentration around these areas will result in scaling. Lubricant forms a film which prevents direct contact between the steel surfaces. If the film is too thin the contacting surface peaks will weld togheter and then tear apart, leaving small pits in the surfaces. Integral seals contribute to efficient lubrication by keeping the lubricant in position inside the bearing.



Water in the lubricant
Water penetrating because of inadequate external seals will cause deep corrosion and considerable wear. The bearing has been standing still for some time, evidenced by the galvanic corrosion where the rollers have been in contact with the bearing ring. Corrosion of this nature is dangerous because it causes scaling and cracking of the bearing. This type of bearing damage can be avoided by employing efficient seals and correct anticorrosive lubricant.

Seal selection guidelines

SKF sealed spherical roller bearings are available with seals of either

- nitrile rubber (NBR) or
- fluoro rubber (FPM).

These materials have properties that make them particularly suited for specific applications, which are described in the following paragraphs.

Nitrile rubber
Nitrile rubber, or more properly acrylonitrile butadiene rubber, is virtually the universal material for all types of seal. The material is a co-polymer of acrylonitrile and butadiene and has, among other properties, good resistance to

- many mineral oils and greases with mineral oil base,
- animal and vegetable oils and greases, and to
- hot water.

The operating temperature range is –50 to +110 °C (–58 to +230 °F). The material will harden at elevated temperatures.

Fluoro rubber
Fluoro rubber has very good thermal and chemical resistance and is also resistant to ageing and ozone attack. Seals of this material have exceptional properties. Even under extreme environmental conditions they will withstand temperatures up to +200 °C (392 °F) They are also resistant to oils and hydraulic fluids, fuels, mineral acids and aliphatic and aromatic hydrocarbons which would cause nitrile rubber to fail.

Because of their special properties, fluoro rubber seals are available as standard on most SKF sealed spherical roller bearings.

Warning: The chemical composition of fluoro rubber is very stable and harmless under the above operating conditions. However, if subjected to extreme temperatures there is a risk that toxic vapours can be formed. This situation may occur for instance when a cutting torch is used to dismount and scrap bearings. Safety instructions for how to act in these situations are supplied by SKF on request.

Seals for spherical roller bearings

See also SKF catalogue 4006 "CR seals".

Selection of SKF sealed spherical roller bearings

Table 1

Seal material	Grease	Bearing design (designation suffix)	Permissible operating conditions Rotational speed	Temperature °C
Nitrile rubber (NBR)	SKF normal temperature grease	Can be relubricated (2CS with polymer band removed)	Speed rating in bearing table if bearing is relubricated	up to +110
		Cannot be relubricated (2CS with polymer band)	50 % of speed rating in bearing table	up to +70
Fluoro rubber (FPM)	High temperature grease	Can be relubricated (2CS2 with polymer band removed)	Speed rating in bearing table if bearing is relubricated	up to +180
		Cannot be relubricated (2CS2 with polymer band)	Speed rating in bearing table	up to +180
		Cannot be relubricated (2CS2W – no relubrication feature)	Speed rating in bearing table	up to +180

Seal selection

Several factors influence the choice of seal type on SKF spherical roller bearings. The most important are

- the circumferential speed of the sealing lip;
- the thermal conditions, and
- the chemical resistance or required mechanical properties.

Depending on the application, one or another of these factors will dominate. However, the price, availability and the grease used must also be taken into account. **Table** 1 gives an overview of the standard seals and the greases used for SKF sealed spherical roller bearings. It also indicates suitability of the bearings in respect of rotational speed and temperature conditions.

Design of bearing arrangements

For the axial location of sealed spherical roller bearings on shaft ends, SKF nuts KM(L) with locking washers MB(L) are recommended. For bearings having a bore diameter larger than 200 mm nuts of series HM 30 with locking clip, series MS 30, are available.

When axially securing sealed spherical roller bearings in position, care should be taken to see that no adjacent component, e.g. shaft or housing shoulder, can foul the sealing lip. When using a nut to locate the bearing, it is necessary to insert an intermediate ring between the bearing and the nut, and to extend the threaded portion of the shaft (➔ **fig** 1).The outside diameter of this ring should not exceed the maximum limits shown in the bearing table.

To make the dismounting of bearings with bore diameters of 80 mm and above easier, it is advisable to use the SKF oil injection method, where oil under high pressure is injected between shaft seating and bearing. This considerably reduces the force required to dismount the bearing, and also practically eliminates any risk of the seating or bearing being damaged.

To use the oil injection method, it is necessary to provide the requisite ducts and distributor grooves in the shaft (➔ **fig** 2). Details of the recommended dimensions for the ducts, grooves and connecting threads will be found, for example, in the SKF catalogue 4003 “Large bearings”.

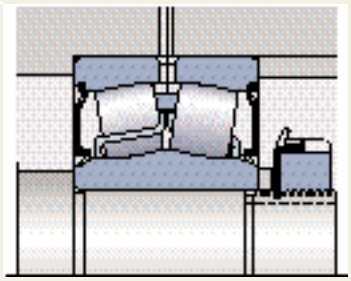
As with other bearings with integral seals, SKF sealed spherical roller bearings should not be exposed to direct jets of water. If there is a risk of free water reaching the seals, it is advisable to provide additional external sealing for the bearing (➔ **fig** 3).

Due to the efficient integral seals no additional external seals are normally required, which implies that compact bearing arrangements can be produced in most cases. However, where the environmental conditions are very tough (heavy contamination, water spray etc.) external seals should be employed.

See also SKF catalogue 4003 “Large bearings”.

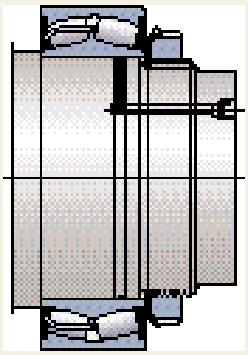
An intermediate ring between bearing and locking washer (of the nut) protects the seal

Fig 1



Bearing seating with oil ducts and grooves for easy dismounting

Fig 2



A sealed spherical roller bearing in an SNL plummer block housing

Fig 3

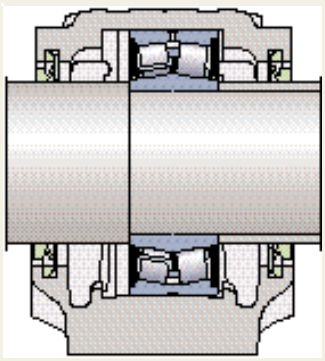


Table 2

Property	SKF normal temperature grease	High temperature grease
Consistency (NLGI Scale)	2	2 – 3
Soap base	lithium	polyurea
Colour	light brown	light beige
Base oil	mineral	ester
Operating temperature range, °C	–20 to +110	–25 to +180
Dropping point to ISO 2176, °C	min. 180	min. 250
Kinematic viscosity of base oil at 40 °C, mm^2/s	200	440
at 100 °C, mm^2/s	16	38

Technical data for grease used in SKF sealed spherical roller bearings

The same grease should be used for relubrication as that originally supplied in the bearing. When relubricating, care should be taken not to damage the seals.

Lubrication

SKF sealed spherical roller bearings are supplied filled with high performance grease and are ready to mount. There is a choice of two standard greases: A normal temperature high quality SKF lithium base grease having a mineral oil base, and a special high-temperature grease with a polyurea base. The most important technical data are given in **Table** 2.

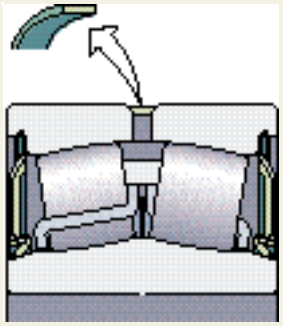
Relubrication
SKF sealed spherical roller bearings are maintenance-free under normal operating conditions. If they operate under moderate loads and temperatures they can be considered as lubricated for life. When speeds and temperatures are high, relubrication can be beneficial. When relubrication is to be adopted, bearings incorporating relubrication features must be ordered. These bearings are identified by the absence of suffix W in the bearing designation (➔ designation scheme on **page 21**).

Grease can be supplied via the annular groove and three lubrication holes in the outer ring. The bearing must rotate during relubrication to achieve proper distribution of the grease.

The lubrication holes in these bearings are covered as standard with a polymer band, which must be removed before mounting (➔ **fig** 4).

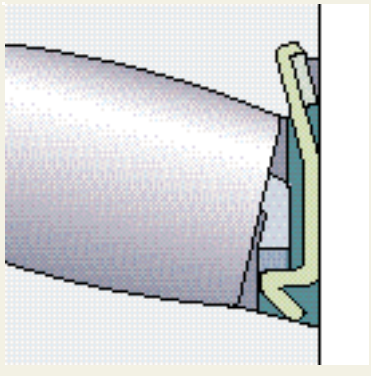
Series BS2-22 bearing with polymer band

Fig 4



Retaining rings hold the seal in the outer ring

Fig 5



The appropriate quantity of grease to be supplied to the bearing when relubricating can be obtained from

G = 0,0005 B D

where
G = grease quantity required for relubrication, g
B = bearing width, mm
D = bearing outside diameter, mm

The seals of SKF sealed spherical roller bearings having a bore diameter of 110 mm and above are secured by retaining rings inserted in the outer ring (➔ **fig** 5). The seals can thus be removed from the bearing so that it can be maintained, i.e. washed and regreased, after which the seals can be reinserted and secured.

Bearing storage
Before leaving the factory, SKF sealed spherical roller bearings are treated with a corrosion inhibitor. They can be stored in their unopened original packages for up to three years, provided the relative humidity in the store does not exceed 60 % (➔ **fig** 6).

Maintenance

SKF sealed spherical roller bearings having a bore diameter of 110 mm and above can be washed, inspected and regreased. The retaining rings should be removed with care. The head of the tool used should have well rounded edges (➔ **fig** 7). Once the retaining rings have been removed, the inner ring can be swivelled out and the seals removed via the rollers from the grooves in the outer ring side faces.

When the seals are to be replaced they should be inserted in the groove in the outer ring. While one hand is used to hold part of the seal in the groove, the remainder should be pressed into the groove in sections, using a thumb (➔ **fig** 8). The seal should then be fixed in position using the retaining ring. Compress the retaining ring to insert it into the groove, then re-expand it using a suitable tool otherwise the seals may be damaged.

Correct storage of bearings and seals


Fig 6

Removing a retaining ring

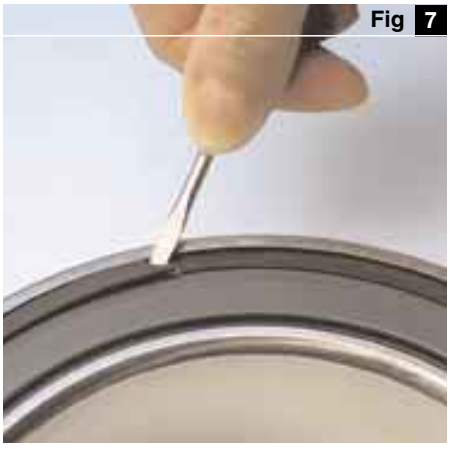


Fig 7

Inserting the retaining ring in the outer ring


Fig 8

Methods and tools to make things simpler

Mounting
Skill and cleanliness are essential when mounting bearings if they are to perform satisfactorily and attain their full potential. Above all, the correct method of mounting should be chosen and suitable tools used. This is particularly important where sealed spherical roller bearings are concerned since misalignments of the inner ring relative to the outer ring in excess of 0,5° may damage the seals.

Bearings with cylindrical bore
Sealed spherical roller bearings are normally mounted with an interference fit on the shaft and cannot simply be pressed into position. It is recommended that the bearings be mounted when hot (➔ **fig** 9). The temperature differential between bearing and seating depends on the degree of interference and the bearing size. Generally, bearings which are 60 to 80 °C (140 to 176 °F) hotter than the shaft can be mounted with ease. Please remember that the bearings should never be heated to more than 110 °C (230 °F).

The use of an SKF induction heater has been found very advantageous (➔ **fig** 10). An induction heater heats the bearing rapidly, and most models provide a temperature control that prevents overheating and consequent bearing damage. Non-metallic components such as the seals remain cold, as does the heater itself.

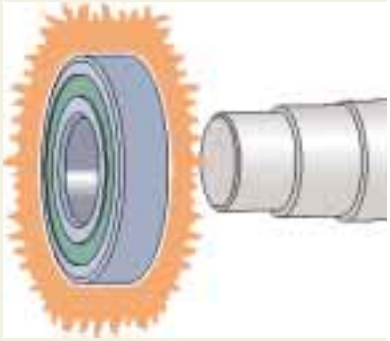
Bearings with tapered bore
To effectively mount sealed spherical roller bearings with tapered bore on tapered seatings it is only possible to use the drive-up distance as a measure, and the "New SKF Mounting Procedure" is recommended. This is based on measuring the axial displacement of the bearing on its tapered seating and allows an accurate determination of the initial starting position.

The SKF catalogue MP200 "The Tools for Trouble-Free Operation" contains guideline values for the starting position and axial displacement for all bearings with a bore diameter of 50 mm and above.

See also SKF catalogue MP200 "The Tools for Trouble-Free Operation".

Mounting a heated bearing

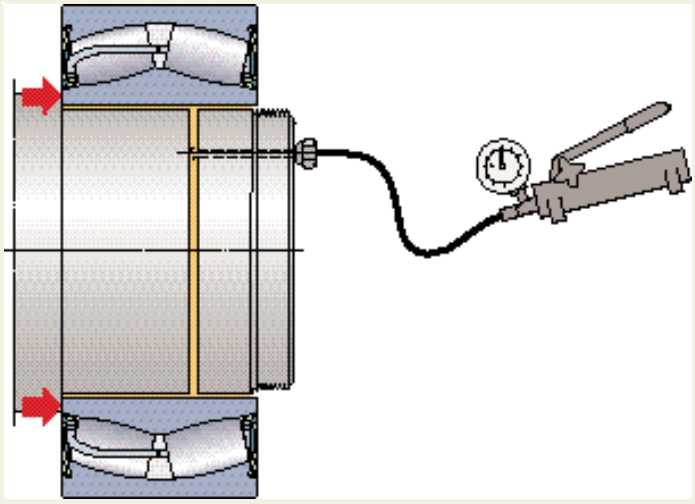
Fig 9



Bearing on an SKF induction heater

Fig 10

Fig 11



Dismounting a bearing from a cylindrical seating using the oil injection method

Dismounting

If bearings, or other associated components, are to be re-used after inspection, they must be dismounted as carefully as they were mounted. For this reason, it is wise when designing the bearing arrangement, to make provisions for easy dismounting.

Recesses in the housing shoulder, or the use of a support ring between the bearing and a shaft shoulder which the withdrawal tool can engage, are examples of such provisions. Small bearings can generally be removed using a mechanical puller. These withdrawal tools should grip over the rings from the inside or outside and engage the side faces to prevent damage.

Dismounting large bearings with an interference fit on the shaft is considerably easier if the SKF oil injection method is used (➔ **fig** 11). If this method is to be used, it is necessary to make provisions at the bearing arrangement design stage for the necessary ducts and distributor grooves (➔ “Design of bearing arrangements” on **page 12**).

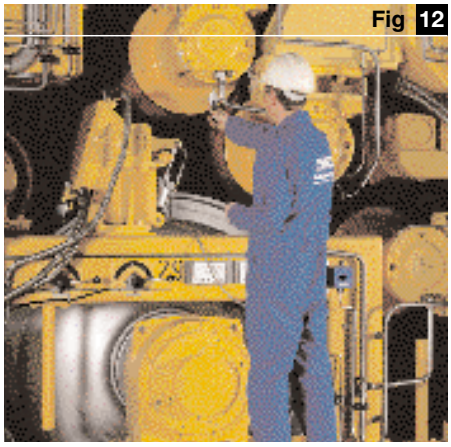
See also SKF publication 4100 “SKF Bearing Maintenance Handbook”.

Condition monitoring of bearings in operation

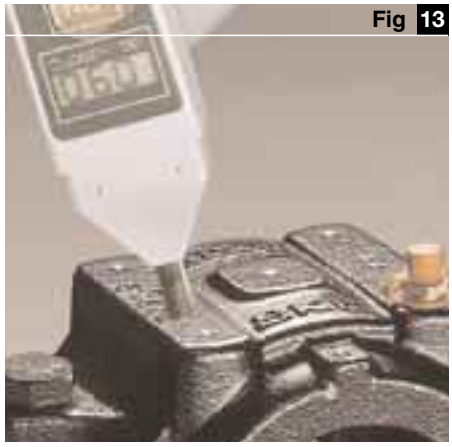
Properly dimensioned and mounted bearings are exceptionally reliable mechanical components as long as an adequate supply of suitable lubricant is available and other damaging events or adverse operating conditions are avoided.

In spite of this, it is recommended that bearing condition be monitored in certain applications either periodically or continuously. Condition monitoring enables incipient bearing damage to be detected and evaluated, so that bearing replacement can be scheduled for a time when the machine is not in operation, to avoid unplanned stoppages. With careful planning it is possible to exploit bearing service life completely. It is recommended that bearing arrangements be routinely checked for noise (➔ **fig** 12) and temperature (➔ **fig** 13) as well as visually, and that the lubrication is also checked regularly.

The most efficient way of monitoring bearing and/or machine condition is by vibration analysis (➔ **fig** 14).



Noise testing



Taking the temperature

Recording vibration measurements using an SKF Microlog data collection unit

Bearing data – general

Dimensions
The boundary dimensions of SKF sealed spherical roller bearings are in accordance with ISO 15-1981, except for the width of bearings of series BS2-22. These are basically bearings of series 222 E or 222 CC but are made slightly wider in order for the seals to be integrated.

Tolerances
SKF sealed spherical roller bearings are produced to Normal tolerances as specified in ISO 492:1994.

Internal clearance
SKF sealed spherical roller bearings are produced as standard with Normal radial internal clearance to ISO 5753:1991. To special order the bearings can be supplied with greater radial internal clearance to C3 or C4 specifications (➔ **Table** 3). The values in the table apply to bearings before mounting and under zero measuring load.

Misalignment
SKF sealed spherical roller bearings can accommodate angular misalignments of the shaft with respect to the housing of up to approximately 0,5°. This guideline value applies as long as loads are normal (C/P >10), and when the position of the misalignment is constant with respect to the outer ring. Provided the guideline value is not exceeded, there will be no detrimental effect on the efficiency of the seals.

Influence of operating temperature on the bearing materials
All SKF spherical roller bearings, including the sealed bearings, are subjected to a special heat treatment so that they can be used at temperatures up to +200 °C (392 °F) for up to 2 500 hours without any inadmissible dimensional changes occurring. For operating temperatures above +110 °C (230 °F), however, it is necessary to use bearings fitted with fluoro rubber seals, designation suffix 2CS2, and the special high temperature grease.

Speed ratings
The permissible speeds at which sealed spherical roller bearings can be operated depends on the type of seal and the type and quantity of the grease used, the magnitude of the load and the ambient temperature, and they are considerably lower than for the corresponding open (unsealed) bearings. The speed ratings for bearings with nitrile rubber seals, lubricated with normal temperature grease, are approximately 40 % of those for open bearings. Bearings fitted with fluoro rubber seals and lubricated with the special high temperature grease are only intended for low speed operation. The permissible speeds in this case are determined by the quantity of grease incorporated.

Radial internal clearance of spherical roller bearings with cylindrical bore

Table 3

Bore diameter d		Radial internal clearance Normal		C3		C4	
over	incl.	min	max	min	max	min	max
mm		μm					
40	**50**	35	55	55	75	75	100
50	**65**	40	65	65	90	90	120
65	**80**	50	80	80	110	110	145
80	**100**	60	100	100	135	135	180
100	**120**	75	120	120	160	160	210
120	**140**	95	145	145	190	190	240
140	**160**	110	170	170	220	220	280
160	**180**	120	180	180	240	240	310
180	**200**	130	200	200	260	260	340
200	**225**	140	220	220	290	290	380

Minimum load
To guarantee satisfactory performance, spherical roller bearings must always be subjected to a given minimum load, especially if they are used in applications with high accelerations or rapid changes in the direction of load. Under such conditions the inertia forces of the rollers and cage and the friction in the lubricant can have a detrimental influence on rolling conditions in the bearing and may cause damaging sliding movements to occur between the rollers and raceways.

The minimum load required for sealed spherical roller bearings in such cases can be estimated using

$$F_{rm} = 0{,}02\ C - Y_0 F_a$$

where
F_{rm} = minimum radial load, N
C = basic dynamic load rating, N
Y_0 = calculation factor
F_a = axial component of combined load, N

The values of C and Y_0 will be found in the product table.

When starting up at low temperatures when the lubricant may be highly viscous, even greater loads may be required. The weights of the components supported by the bearing, together with the external forces, often exceed the requisite minimum load. If this is not the case, the bearing must be subjected to an additional radial load.

Equivalent dynamic bearing load
For spherical roller bearings

$$P = F_r + Y_1 F_a \quad \text{when } F_a/F_r \leq e$$
$$P = 0{,}67\ F_r + Y_2 F_a \quad \text{when } F_a/F_r > e$$

The values of e, Y_1 and Y_2 will be found in the bearing table.

Equivalent static bearing load
For spherical roller bearings

$$P_0 = F_r + Y_0 F_a$$

The values of Y_0 will be found in the bearing table.

Sealed spherical roller bearing designations

The complete designation of a sealed spherical roller bearing consists of the series and size identification and suffixes which identify the design, the seals, the grease and any other features. The designation scheme is shown opposite and the meaning of the individual figures and letters explained in the order in which they appear.

Designation scheme for SKF sealed spherical roller bearings

Designation examples: BS2-2215 C-2CS
24030-2CS2W

BS2 - 22 15 C-2CS
240 30 - 2CS2 W

Prefix

–	Bearing with standard dimensions
BS2	Bearing with non-standard width; special bearing

Bearing series

22	Bearing of series 222 with increased width
230	Bearing of series 230
231	Bearing of series 231
232	Bearing of series 232
239	Bearing of series 239
240	Bearing of series 240
241	Bearing of series 241

Bore diameter

08 × 5	40 mm bore diameter
to	
44 × 5	220 mm bore diameter

Design

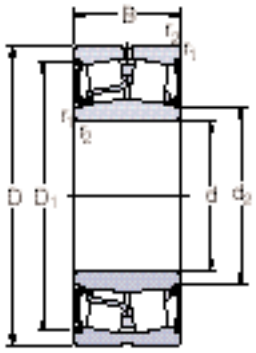
–	CC or E design – bearings with suffix 2CSW are CC design bearings while bearings denoted with suffix 2CS are E design bearings
C	CC design

Seals and grease

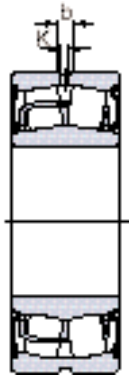
2CS	Sheet steel reinforced rubbing seal of nitrile rubber at both sides; normal temperature grease; grease fill corresponds to 40 % of free space in bearing
2CS2	Sheet steel reinforced rubbing seal of fluoro rubber at both sides; high temperature grease; grease fill corresponds to 70 to 100 % of free space in bearing

Other features

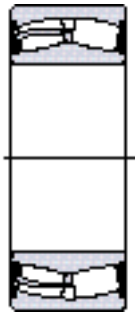
–	Normal radial internal clearance
C3	Radial internal clearance greater than Normal
C4	Radial internal clearance greater than C3
W	Without relubrication facility



Serie BS2-22-2CS(2)



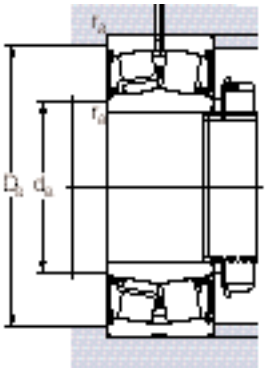
Serie BS2-22 C-2CS(2)



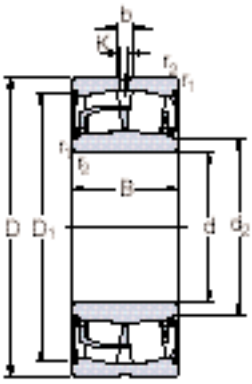
Design 2CS2W

The speed rating for bearings of the 2CS design is valid only when the bearing is relubricated (→ **Table 1, page 12**).

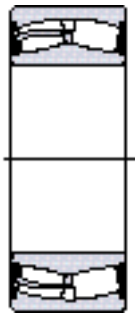
Principal dimensions			**Basic load ratings** dynamic	static	**Fatigue load limit**	**Speed rating**	**Mass**	**Designation**
d	D	B	C	C_0	P_u			
mm			N		N	r/min	kg	–
40	80	28	89 700	98 000	10 600	2 200	0,57	**BS2-2208-2CS**
	80	28	89 700	98 000	10 600	280	0,57	**BS2-2208-2CS2**
45	85	28	77 100	88 000	9 500	2 000	0,62	**BS2-2209 C-2CS**
	85	28	77 100	88 000	9 500	260	0,62	**BS2-2209 C-2CS2**
50	90	28	84 500	100 000	11 000	1 900	0,67	**BS2-2210 C-2CS**
	90	28	84 500	100 000	11 000	240	0,67	**BS2-2210 C-2CS2**
55	100	31	115 000	137 000	15 000	1 700	1,00	**BS2-2211-2CS**
	100	31	115 000	137 000	15 000	200	1,00	**BS2-2211-2CS2**
60	110	34	140 000	173 000	19 000	1 600	1,30	**BS2-2212-2CS**
	110	34	140 000	173 000	19 000	190	1,30	**BS2-2212-2CS2**
65	120	38	148 000	183 000	21 200	1 500	1,60	**BS2-2213 C-2CS**
	120	38	148 000	183 000	21 200	180	1,60	**BS2-2213 C-2CS2**
70	125	38	179 000	228 000	25 500	1 400	1,80	**BS2-2214-2CS**
	125	38	179 000	228 000	25 500	170	1,80	**BS2-2214-2CS2**
75	115	40	152 000	232 000	28 500	950	1,55	**24015-2CS**
	115	40	152 000	232 000	28 500	130	1,55	**24015-2CS2**
	130	38	184 000	240 000	26 500	1 300	1,90	**BS2-2215-2CS**
	130	38	184 000	240 000	26 500	170	1,90	**BS2-2215-2CS2**
80	140	40	207 000	270 000	29 000	1 200	2,40	**BS2-2216-2CS**
	140	40	207 000	270 000	29 000	160	2,40	**BS2-2216-2CS2**
85	150	44	244 000	325 000	34 500	1 100	3,00	**BS2-2217-2CS**
	150	44	244 000	325 000	34 500	140	3,00	**BS2-2217-2CS2**
90	150	72	322 000	510 000	56 000	90	4,80	**BS2-6359-2CS2**
	160	48	282 000	375 000	39 000	1 000	3,70	**BS2-2218-2CS**
	160	48	282 000	375 000	39 000	130	3,70	**BS2-2218-2CS2**
100	150	50	248 000	415 000	45 500	800	3,20	**24020-2CS**
	150	50	248 000	415 000	45 500	95	3,20	**24020-2CS2W**
	165	52	322 000	490 000	53 000	850	4,40	**23120-2CS**
	165	52	322 000	490 000	53 000	100	4,40	**23120-2CS2W**
	170	65	397 000	640 000	68 000	85	6,00	**BS2-6169-2CS2**
	180	55	368 000	490 000	49 000	900	5,50	**BS2-2220-2CS**
	180	55	368 000	490 000	49 000	110	5,50	**BS2-2220-2CS2**
	180	60,3	414 000	600 000	63 000	700	6,70	**23220-2CS**
	180	60,3	414 000	600 000	63 000	85	6,70	**23220-2CS2W**



Dimensions						Abutment and fillet dimensions				Calculation factors			
d	d_2 ≈	D_1 ≈	$r_{1,2}$ min	b	K	d_a min	d_a max	D_a max	r_a max	e	Y_1	Y_2	Y_0
mm						mm				–			
40	47	73	1,1	5,5	3	47	47	73	1	0,28	2,4	3,6	2,5
	47	73	1,1	5,5	3	47	47	73	1	0,28	2,4	3,6	2,5
45	53	77,1	1,1	5,5	3	52	53	78	1	0,26	2,6	3,9	2,5
	53	77,1	1,1	5,5	3	52	53	78	1	0,26	2,6	3,9	2,5
50	58,1	82,1	1,1	5,5	3	57	58	83	1	0,24	2,8	4,2	2,8
	58,1	82,1	1,1	5,5	3	57	58	83	1	0,24	2,8	4,2	2,8
55	64	91,9	1,5	5,5	3	64	64	92	1,5	0,24	2,8	4,2	2,8
	64	91,9	1,5	5,5	3	64	64	92	1,5	0,24	2,8	4,2	2,8
60	69,3	100	1,5	5,5	3	69	69,3	101	1,5	0,24	2,8	4,2	2,8
	69,3	100	1,5	5,5	3	69	69,3	101	1,5	0,24	2,8	4,2	2,8
65	74	111	1,5	5,5	3	74	74	111	1,5	0,24	2,8	4,2	2,8
	74	111	1,5	5,5	3	74	74	111	1,5	0,24	2,8	4,2	2,8
70	80,1	115	1,5	5,5	3	79	79	116	1,5	0,23	2,9	4,4	2,8
	80,1	115	1,5	5,5	3	79	79	116	1,5	0,23	2,9	4,4	2,8
75	81,8	105	1,1	5,5	3	81,8	81,8	108	1	0,28	2,4	3,6	2,5
	81,8	105	1,1	5,5	3	81,8	81,8	108	1	0,28	2,4	3,6	2,5
	84,5	119	1,5	5,5	3	84	84,5	121	1,5	0,22	3	4,6	2,8
	84,5	119	1,5	5,5	3	84	84,5	121	1,5	0,22	3	4,6	2,8
80	92,0	128	2	5,5	3	90	92	130	2	0,22	3	4,6	2,8
	92,0	128	2	5,5	3	90	92	130	2	0,22	3	4,6	2,8
85	98,2	138	2	5,5	3	95	98	140	2	0,22	3	4,6	2,8
	98,2	138	2	5,5	3	95	98	140	2	0,22	3	4,6	2,8
90	100	131	1,1	5,5	3	97	100	143	1	0,40	1,7	2,5	1,6
	103	148	2	5,5	3	100	103	150	2	0,24	2,8	4,2	2,8
	103	148	2	5,5	3	100	103	150	2	0,24	2,8	4,2	2,8
100	108	139	1,5	5,5	3	108	108	141	1,5	0,28	2,4	3,6	2,5
	108	139	1,5	–	–	108	108	141	1,5	0,28	2,4	3,6	2,5
	113	152	2	5,5	3	110	113	155	2	0,27	2,5	3,7	2,5
	113	152	2	–	–	110	113	155	2	0,27	2,5	3,7	2,5
	110	150	2	5,5	3	110	110	160	2	0,37	1,8	2,7	1,8
	114	160	2,1	8,3	4,5	112	114	168	2	0,24	2,8	4,2	2,8
	114	160	2,1	8,3	4,5	112	114	168	2	0,24	2,8	4,2	2,8
	114	160	2,1	8,3	4,5	112	114	168	2	0,30	2,3	3,4	2,2
	114	160	2,1	–	–	112	114	168	2	0,30	2,3	3,4	2,2



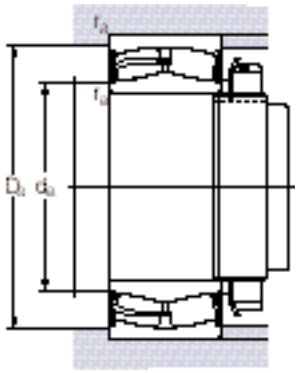
Design 2CS



Design 2CS2W

The speed rating for bearings of the 2CS design is valid only when the bearing is relubricated (→ **Table 1, page 12**).

Principal dimensions			**Basic load ratings** dynamic	static	**Fatigue load limit**	**Speed rating**	**Mass**	**Designation**
d	D	B	C	C_0	P_u			
mm			N		N	r/min	kg	–
110	170	45	267 000	440 000	46 500	900	3,75	**23022-2CS**
	170	45	267 000	440 000	46 500	110	3,75	**23022-2CS2W**
	180	56	374 000	585 000	61 000	800	5,55	**23122-2CS**
	180	56	374 000	585 000	61 000	95	5,55	**23122-2CS2W**
	180	69	460 000	750 000	78 000	630	6,85	**24122-2CS**
	180	69	460 000	750 000	78 000	80	6,85	**24122-2CS2W**
120	180	46	305 000	510 000	53 000	850	4,20	**23024-2CS**
	180	46	305 000	510 000	53 000	100	4,20	**23024-2CS2W**
	180	60	374 000	670 000	68 000	670	5,40	**24024-2CS**
	180	60	374 000	670 000	68 000	80	5,40	**24024-2CS2W**
	200	80	575 000	950 000	95 000	560	10,0	**24124-2CS**
	200	80	575 000	950 000	95 000	70	10,0	**24124-2CS2W**
130	200	52	374 000	610 000	61 000	800	6,10	**23026-2CS**
	200	52	374 000	610 000	61 000	95	6,10	**23026-2CS2W**
	200	69	477 000	830 000	81 500	600	7,95	**24026-2CS**
	200	69	477 000	830 000	81 500	75	7,95	**24026-2CS2W**
	210	80	598 000	1 000 000	100 000	530	11,0	**24126-2CS**
	210	80	598 000	1 000 000	100 000	67	11,0	**24126-2CS2W**
140	210	69	495 000	900 000	88 000	560	8,45	**24028-2CS**
	210	69	495 000	900 000	88 000	70	8,45	**24028-2CS2W**
	225	85	673 000	1 160 000	112 000	500	13,0	**24128-2CS**
	225	85	673 000	1 160 000	112 000	60	13,0	**24128-2CS2W**
150	225	75	564 000	1 040 000	100 000	530	10,5	**24030-2CS**
	225	75	564 000	1 040 000	100 000	67	10,5	**24030-2CS2W**
	250	100	897 000	1 530 000	146 000	450	19,5	**24130-2CS**
	250	100	897 000	1 530 000	146 000	56	19,5	**24130-2CS2W**
160	240	80	656 000	1 200 000	114 000	500	13,0	**24032-2CS**
	240	80	656 000	1 200 000	114 000	60	13,0	**24032-2CS2W**
	270	86	845 000	1 400 000	129 000	530	20,5	**23132-2CS**
	270	86	845 000	1 400 000	129 000	67	20,5	**23132-2CS2W**
170	280	109	1 070 000	1 860 000	170 000	400	26,5	**24134-2CS**
	280	109	1 070 000	1 860 000	170 000	50	26,5	**24134-2CS2W**
180	280	100	937 000	1 730 000	156 000	430	23,0	**24036-2CS**
	280	100	937 000	1 730 000	156 000	55	23,0	**24036-2CS2W**
190	320	128	1 400 000	2 500 000	212 000	340	42,0	**24138-2CS**
	320	128	1 400 000	2 500 000	212 000	50	42,0	**24138-2CS2W**
200	340	140	1 580 000	2 800 000	232 000	320	52,0	**24140-2CS**
	340	140	1 580 000	2 800 000	232 000	50	52,0	**24140-2CS2W**
	360	128	1 610 000	2 700 000	228 000	340	58,0	**23240-2CS**
	360	128	1 610 000	2 700 000	228 000	50	58,0	**23240-2CS2W**
220	300	60	546 000	1 080 000	93 000	600	13,0	**23944-2CS**



Dimensions						Abutment and fillet dimensions				Calculation factors			
d	d_2 ≈	D_1 ≈	$r_{1,2}$ min	b	K	d_a min	d_a max	D_a max	r_a max	e	Y_1	Y_2	Y_0
mm						mm				–			
110	122	157	2	8,3	4,5	120	122	160	2	0,22	3	4,6	2,8
	122	157	2	–	–	120	122	160	2	0,22	3	4,6	2,8
	123	166	2	8,3	4,5	120	123	170	2	0,27	2,5	3,7	2,5
	123	166	2	–	–	120	123	170	2	0,27	2,5	3,7	2,5
	121	163	2	5,5	3	120	121	170	2	0,35	1,9	2,9	1,8
	121	163	2	–	–	120	121	170	2	0,35	1,9	2,9	1,8
120	133	168	2	5,5	3	130	133	170	2	0,20	3,4	5	3,2
	133	168	2	–	–	130	133	170	2	0,20	3,4	5	3,2
	130	166	2	5,5	3	130	130	170	2	0,28	2,4	3,6	2,5
	130	166	2	–	–	130	130	170	2	0,28	2,4	3,6	2,5
	132	179	2	5,5	3	130	132	190	2	0,37	1,8	2,7	1,8
	132	179	2	–	–	130	132	190	2	0,37	1,8	2,7	1,8
130	145	186	2	8,3	4,5	140	145	190	2	0,21	3,2	4,8	3,2
	145	186	2	–	–	140	145	190	2	0,21	3,2	4,8	3,2
	141	183	2	5,5	3	140	141	190	2	0,30	2,3	3,4	2,2
	141	183	2	–	–	140	141	190	2	0,30	2,3	3,4	2,2
	142	190	2	5,5	3	140	142	200	2	0,33	2,0	3,0	2,0
	142	190	2	–	–	140	142	200	2	0,33	2,0	3,0	2,0
140	152	194	2	5,5	3	150	152	200	2	0,28	2,4	3,6	2,5
	152	194	2	–	–	150	152	200	2	0,28	2,4	3,6	2,5
	153	203	2,1	8,3	4,5	152	153	213	2	0,35	1,9	2,9	1,8
	153	203	2,1	–	–	152	153	213	2	0,35	1,9	2,9	1,8
150	162	206	2,1	5,5	3	162	162	213	2	0,28	2,4	3,6	2,5
	162	206	2,1	–	–	162	162	213	2	0,28	2,4	3,6	2,5
	163	221	2,1	8,3	4,5	162	163	238	2	0,37	1,8	2,7	1,8
	163	221	2,1	–	–	162	163	238	2	0,37	1,8	2,7	1,8
160	173	218	2,1	8,3	4,5	172	173	228	2	0,28	2,4	3,6	2,5
	173	218	2,1	–	–	172	173	228	2	0,28	2,4	3,6	2,5
	180	244	2,1	13,9	7,5	172	180	258	2	0,28	2,4	3,6	2,5
	180	244	2,1	–	–	172	180	258	2	0,28	2,4	3,6	2,5
170	185	249	2,1	8,3	4,5	182	185	268	2	0,37	1,8	2,7	1,8
	185	249	2,1	–	–	182	185	268	2	0,37	1,8	2,7	1,8
180	195	251	2,1	8,3	4,5	192	195	268	2	0,31	2,2	3,3	2,2
	195	251	2,1	–	–	192	195	268	2	0,31	2,2	3,3	2,2
190	210	284	3	11,1	6	204	210	306	2,5	0,4	1,7	2,5	1,6
	210	284	3	–	–	204	210	306	2,5	0,4	1,7	2,5	1,6
200	220	300	3	11,1	6	214	220	326	2,5	0,4	1,7	2,5	1,6
	220	300	3	–	–	214	220	326	2,5	0,4	1,7	2,5	1,6
	227	318	4	16,7	9	218	225	342	3	0,35	1,9	2,9	1,8
	227	318	4	–	–	218	225	342	3	0,35	1,9	2,9	1,8
220	239	284	2,1	8,3	4,5	232	239	288	2	0,15	4,5	6,7	4,5

Other related products for optimum performance

Spherical roller bearings
Self-aligning bearings are the SKF flagship. The spherical roller bearing was invented at SKF by Arvid Palmgren in 1919. Since then it has undergone three major development stages. The first of these culminated in the C design which had markedly improved performance. The second brought the CC design with lower friction and higher speed capability. The third and most recent produced the E design with optimised load carrying capacity.

The SKF range of spherical roller bearings covers all the 12 dimension series found on the market today and sizes range from 20 to 2 300 mm bore diameter. This is the most comprehensive range available from any source today. All sizes can be supplied with either a cylindrical or a tapered bore enabling various methods of shaft mounting to be used.

For specific demands several special bearings are available, e.g. bearings for vibrating machines or for cold Pilger mills.

See also SKF publication 4401 "SKF spherical roller bearings – profit from our leadership".

Lock nuts

SKF lock nuts, also referred to as shaft nuts, are available in several designs to axially locate bearings on shaft ends. The most popular are those of series KM, KML and HM. These nuts have four or eight equally spaced slots in the outside diameter and are locked in position with locking washers or locking clips engaging a groove in the shaft. The nut dimensions are in accordance with ISO 2982-2:1995 as are the dimensions of the series MB and MBL locking washers.

Other lock nuts produced by SKF include those of series KMT, KMK and KMF which do not require a special groove in the shaft.

See also SKF catalogue 3766/I "Bearing accessories".

Lubricating greases

Lubrication is an integral part of rolling bearing technology. For SKF, therefore, lubricating greases are bearing design components. For this reason, SKF has 13 lubricating greases for rolling bearings, each suitable for different application areas.

Tools and methods for mounting and dismounting

SKF sealed spherical roller bearings require a high degree of skill when mounting or dismounting them as well as the correct tools and methods.

The comprehensive SKF range of tools and equipment includes all that is required, e.g. various sizes of induction heater and several designs of hydraulic equipment.

See also SKF catalogue MP200 "The Tools for Trouble-Free Operation".

Induction heater, hydraulic pumps, hydraulic nut, mounting fluid and anti-fretting paste from SKF

SKF lubricating greases and grease gun

The SKF Group – a worldwide corporation

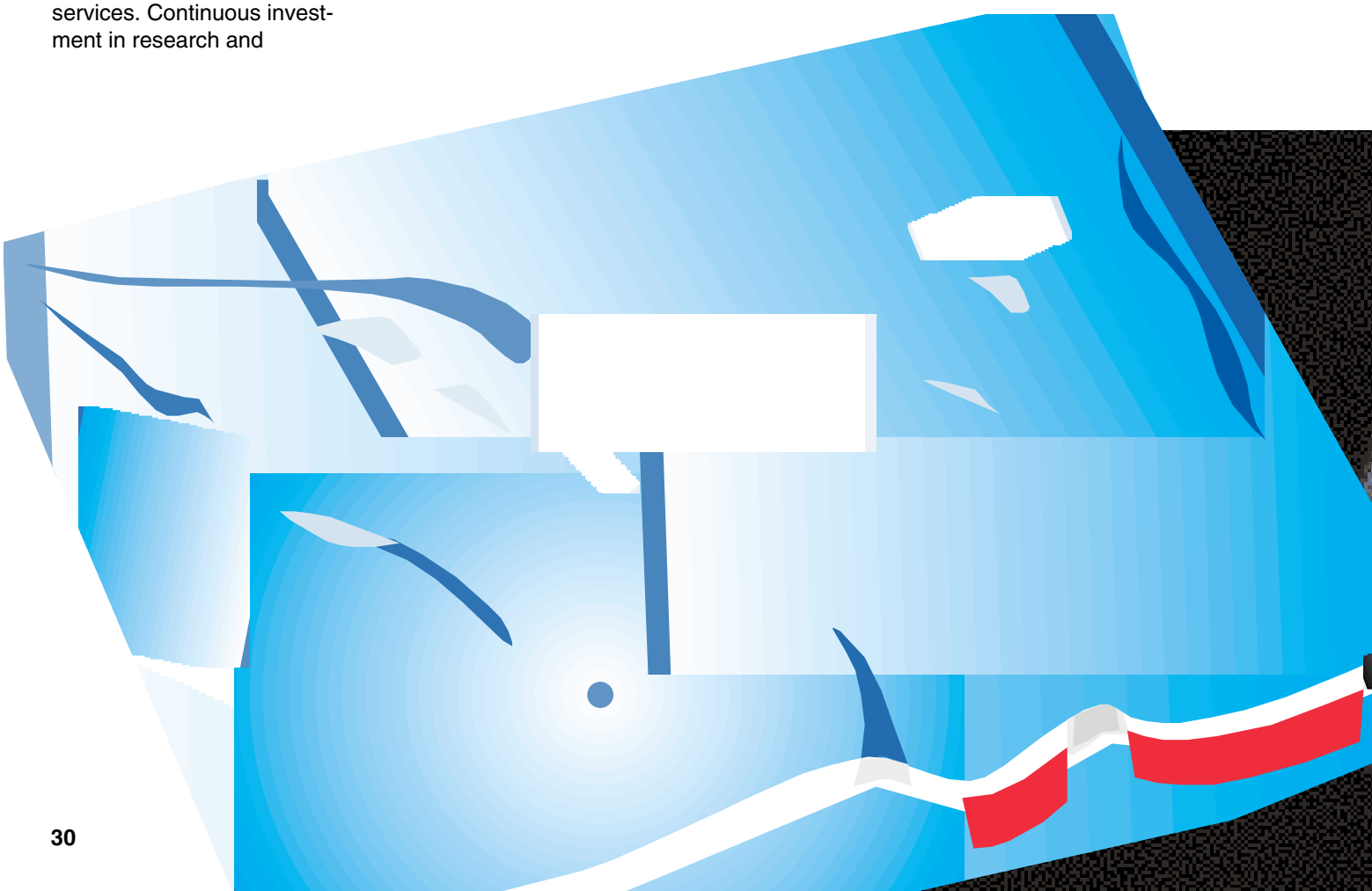
SKF is an international industrial Group operating in some 130 countries and is world leader in bearings.

The company was founded in 1907 following the invention of the self-aligning ball bearing by Sven Wingquist and, after only a few years, SKF began to expand all over the world.

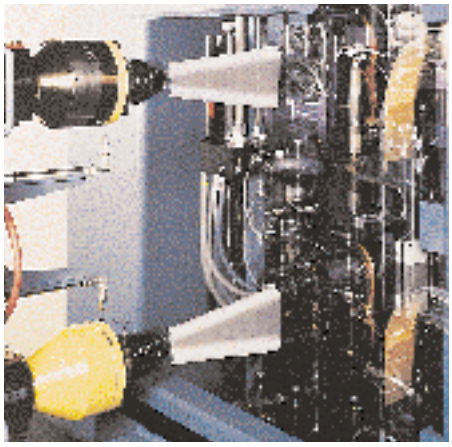
Today, SKF has some 43 000 employees and around 80 manufacturing facilities spread throughout the world. An international sales network includes a large number of sales companies and some 20 000 distributors and retailers. Worldwide availability of SKF products is supported by a comprehensive technical advisory service.

The key to success has been a consistent emphasis on maintaining the highest quality of its products and services. Continuous investment in research and development has also played a vital role, resulting in many examples of epoch-making innovations.

The business of the Group consists of bearings, seals, special steel and a comprehensive range of other high-tech industrial components. The experience gained in these various fields provides SKF with the essential knowledge and expertise required in order to provide the customers with the most advanced engineering products and efficient service.

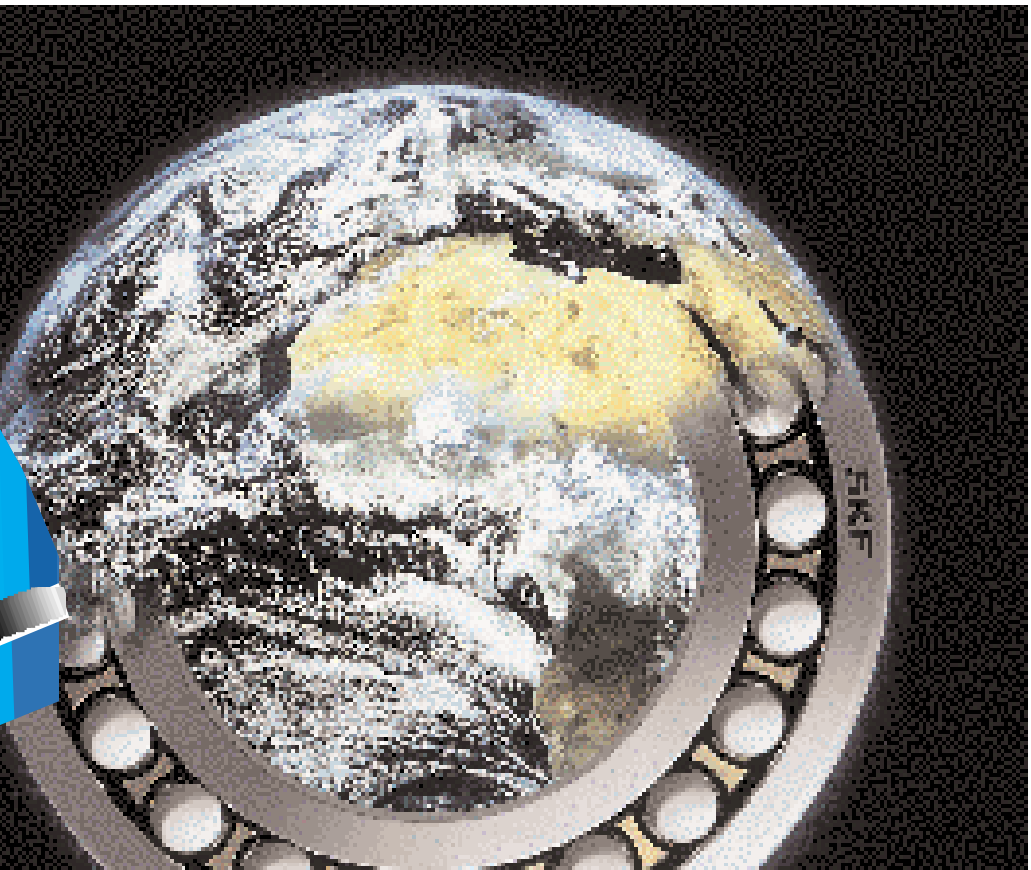


The SKF house colours are blue and red, but the thinking is green. The latest example is the factory in Malaysia, where the bearing component cleaning process conforms to the strictest ecological standards. Instead of trichloroethylene, a water-based cleaning fluid is used in a closed system. The cleaning fluid is recycled in the factory's own treatment plant.



The SKF Engineering & Research Centre is situated just outside Utrecht in The Netherlands. In an area of 17 000 square metres (185 000 sq.ft) some 150 scientists, engineers and support staff are engaged in the further improvement of bearing performance. They are developing technologies aimed at achieving better materials, better designs, better lubricants and better seals – together leading to an even better understanding of the operation of a bearing in its application. This is also where the SKF Life Theory was evolved, enabling the design of bearings which are even more compact and offer even longer operational life.

SKF has developed the Channel concept in factories all over the world. This drastically reduces the lead time from raw material to end product as well as work in progress and finished goods in stock. The concept enables faster and smoother information flow, eliminates bottlenecks and bypasses unnecessary steps in production. The Channel team members have the knowledge and commitment needed to share the responsibility for fulfilling objectives in areas such as quality, delivery time, production flow etc.



SKF manufactures ball bearings, roller bearings and plain bearings. The smallest are just a few millimetres (a fraction of an inch) in diameter, the largest several metres. In order to protect the bearings effectively against the ingress of contamination and the escape of lubricant, SKF also manufactures oil and bearing seals. SKF's subsidiaries CR and RFT S.p.A. are among the world's largest producers of seals.

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